



SIEMENS

SIPROTEC

**Multifunction High Speed
Busbar Transfer Device
7VU683**

V4.70

User Manual

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**Note**

For safety purposes, please note instructions and warnings in the Preface.

Disclaimer of Liability

We have checked the contents of this manual against the hardware and software described. However, deviations from the description cannot be completely ruled out, so that no liability can be accepted for any errors or omissions contained in the information given.

The information given in this document is reviewed regularly and any necessary corrections will be included in subsequent editions.

We appreciate any suggested improvements.

We reserve the right to make technical improvements without notice.

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Preface

Purpose of this manual

This manual describes the functions, operation, installation, and commissioning of devices 7VU683-> In particular, one will find:

- Information regarding the configuration of the scope of the device and a description of the device functions and settings > Chapter 2;
- Instructions for Installation and Commissioning > Chapter 3;
- Technical Data > Chapter 4;
- As well as a compilation of the most significant data for advanced users > Appendix A.

General information with regard to design, configuration, and operation of SIPROTEC 4 devices are set out in the SIPROTEC 4 System Description /1/.

Target Audience

Protection engineers, commissioning engineers, personnel concerned with adjustment, checking, and service of selective protective equipment, automatic and control facilities, and personnel of electrical facilities and power plants.

Applicability of this Manual

This manual applies to: SIPROTEC 4 Power Supply Transfer Device 7VU683; firmware version V4.70.

Indication of Conformity

	This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EG) and concerning electrical equipment for use within specified voltage limits (Low-voltage Directive 2006/95 EG). This conformity is proved by tests conducted by Siemens AG in accordance with the Council Directive in agreement with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the standard EN 60255-5 for the low-voltage directive. This product is designed and manufactured for application in industrial environment. The product conforms with the international standards of IEC 60255 and the German specification VDE 0435.
---	--

Additional Standards IEEE 37.90

Additional Support

Should further information on the System SIPROTEC 4 be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the local Siemens representative.

Our Customer Support Center provides a 24-hour service.

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Safety Information

This manual does not constitute a complete index of all required safety measures for operation of the equipment (module, device), as special operational conditions may require additional measures. However, it comprises important information that should be noted for purposes of personal safety as well as avoiding material damage. Information that is highlighted by means of a warning triangle and according to the degree of danger, is illustrated as follows.



DANGER!

Danger indicates that death, severe personal injury or substantial material damage will result if proper precautions are not taken.



WARNING!

indicates that death, severe personal injury or substantial property damage may result if proper precautions are not taken.



Caution!

indicates that minor personal injury or property damage may result if proper precautions are not taken. This particularly applies to damage to or within the device itself and consequential damage thereof.



Note

indicates information on the device, handling of the device, or the respective part of the instruction manual which is important to be noted.

**WARNING!****Qualified Personnel**

Commissioning and operation of the equipment (module, device) as set out in this manual may only be carried out by qualified personnel. Qualified personnel in terms of the technical safety information as set out in this manual are persons who are authorized to commission, activate, to ground and to designate devices, systems and electrical circuits in accordance with the safety standards.

Use as prescribed

The operational equipment (device, module) may only be used for such applications as set out in the catalogue and the technical description, and only in combination with third-party equipment recommended or approved by Siemens.

The successful and safe operation of the device is dependent on proper handling, storage, installation, operation, and maintenance.

When operating an electrical equipment, certain parts of the device are inevitably subject to dangerous voltage. Severe personal injury or property damage may result if the device is not handled properly.

Before any connections are made, the device must be grounded to the ground terminal.

All circuit components connected to the voltage supply may be subject to dangerous voltage.

Dangerous voltage may be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

Operational equipment with exposed current transformer circuits may not be operated.

The limit values as specified in this manual or in the operating instructions may not be exceeded. This aspect must also be observed during testing and commissioning.

Typographic and Symbol Conventions

The following text formats are used when literal information from the device or to the device appear in the text flow:

Parameter Names

Designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are marked in bold letters in monospace type style. The same applies to the titles of menus.

1234A

Parameter addresses have the same character style as parameter names. Parameter addresses contain the suffix **A** in the overview tables if the parameter can only be set in DIGSI via the option **Display additional settings**.

Parameter Options

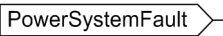
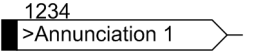
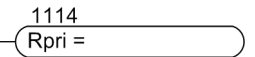
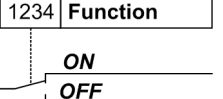
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are additionally written in italics. The same applies to the options of the menus.

Message

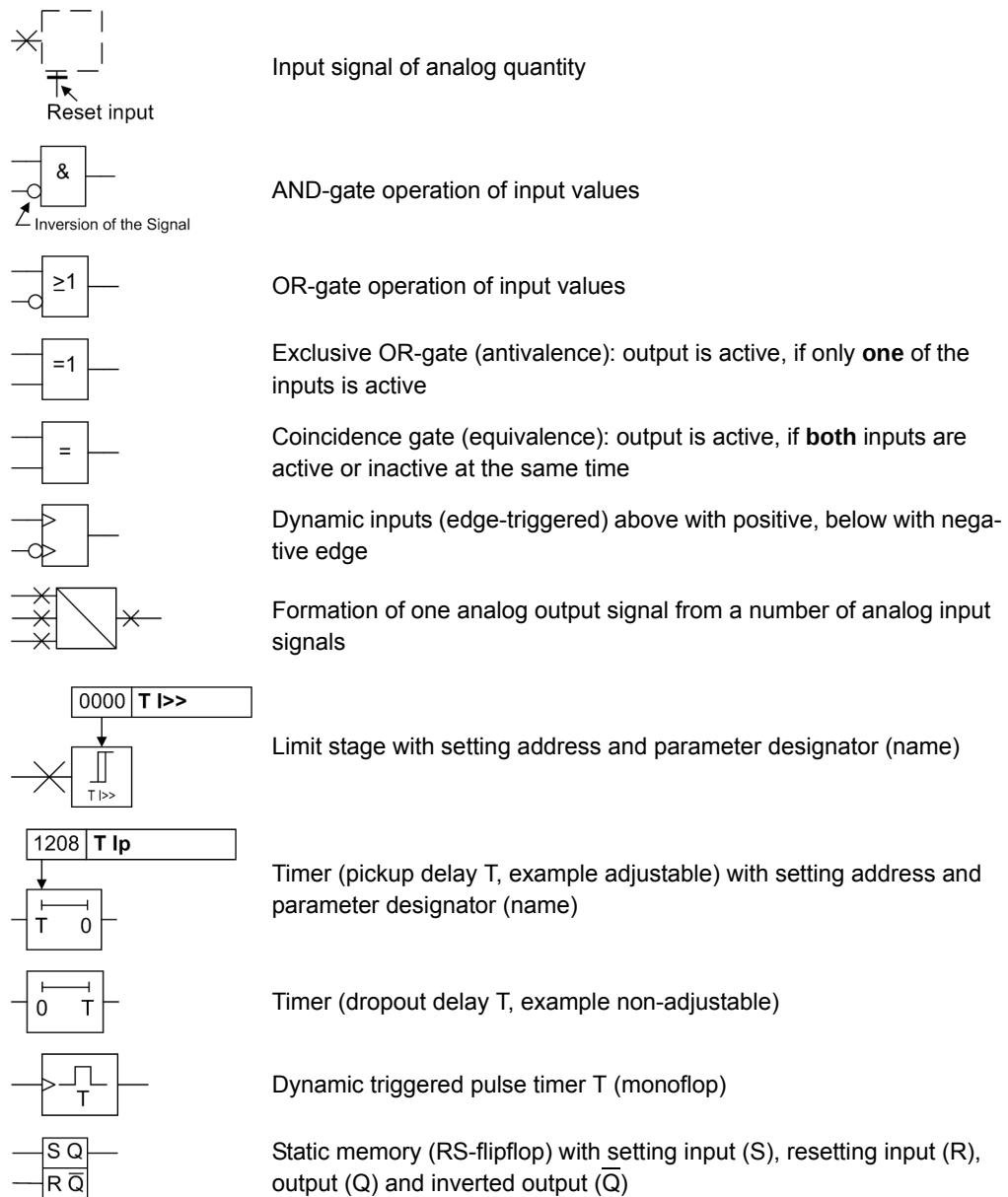
Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

Deviations may be permitted in drawings and tables when the type of designator can be obviously derived from the illustration.

The following symbols are used in drawings:

	Device-internal logical input signal
	Device-internal logical output signal
	Internal input signal of an analog quantity
	External binary input signal with number (Binary input, input indication)
	External binary output signal with number (device indication)
	External binary output signal with number (device indication) used as input signal
	Example of a parameter switch designated FUNCTION with address 1234 and the possible settings ON and OFF

Besides these, graphical symbols are used in accordance with IEC 60617-12 and IEC 60617-13 or similar. Some of the most frequently used are listed below:



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Introduction

1

This chapter introduces the power supply transfer devices 7VU683. It presents an overview of the scope of application, the properties, and functional scope of the 7VU683.

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1.1 Application Scope

Permanent availability of electricity is essential for reliable production of a great number of processes in power stations and industrial plants where lots of inductive motor are installed. To achieve this, a motor busbar is normally equipped with two or more independent in-coming power sources to provide the possibility to switch to standby source in case of main source interruption or failure.

The power source interruption with tens of millisecond has small impact to rotating loads. Thus, the high speed busbar transfer (HSBT) device helps to control and monitor the progress to ensure the fast but reliable switching-over. It can be initiated manually or automatically.

The high speed busbar transfer device 7VU683 in SIPROTEC 4 family is compact multifunction unit which has been developed for very fast power source transfer of motor busbar which is installed with big rotating loads. It accommodates the primary diagram of single busbar with 2-CB, sectionalized single busbar with 3-CB and single busbar with 3-CB. It incorporates all the necessary HSBT conditions and even some protection functions. It is specially suitable for the fast motor busbar transfer for:

- Coal-fired power station
- Gas-fired power station
- Combined cycle power station
- Integrated gasification combined cycle (IGCC) power station
- Nuclear power station
- Chemical plant
- Petrochemical plant
- Refinery plant
- Iron and steel plant
- Cement plant

The numerous other additional functions assist the user in ensuring the cost effective system management and reliable power supply. Local operation has been designed according to economic criteria. A large, easy-to-use graphic display is a major design aim.

The integrated protective functions are to protect the tie-CB in sectionalized single busbar diagram against short-circuit and earth fault. The integrated supervision functions are to monitor the voltage phase sequence and voltage secondary circuit, then gives out alarm in case of failure.

The integrated programmable logic (CFC) allows the users to implement their own functions. The flexible communication interfaces are open for modern communication architectures with control system.

1.2 Function Configuration

HSBT

- Starting conditions
 - NORMAL condition
 - FAULT condition
 - In-admissible under-voltage
 - In-admissible under-frequency
 - In-admissible df/dt
 - Reverse power
 - In-advertent CB open
- Switching sequences
 - PARALLEL Auto sequence
 - PARALLEL Half-Auto sequence
 - SIMULTANEOUS sequence
 - SEQUENTIAL sequence
- Transfer modes
 - FAST mode
 - REAL-TIME FAST mode
 - IN-PHASE mode
 - RES-VOLT mode
 - LONG-TIME mode
- Primary diagram of single busbar with 2-CB, sectionalized single busbar with 3-CB and single busbar with 3-CB are supported
- High speed contact with approx. 1ms for closing
- Permission of bi-direction switching settable
- Low voltage load-shedding settable
- CB decoupling when OPEN failed
- NORMAL start locally or remotely
- Manual CB closing to block HSBT
- ON/OFF set locally or remotely
- HSBT test mode supported

Protections for tie-CB

- Over-current protection
- Ground over-current protection
- Over-current protection against switch-onto-fault
- Ground over-current protection against switch-onto-fault

Monitoring

- Self-supervision of the device
- Oscillographic fault recording
- Phase sequence of busbar voltage
- Voltage circuit of busbar and line

Communication and interface

- PC front port for setting with DIGSI 4
- System interface
 - IEC 60870-5-103, redundant optional
 - IEC 61850, Ethernet
 - DNP 3.0
 - Profibus-DP
 - Modbus RTU
- Service interface for DIGSI 4 (modem)
- Time synchronization via IRIG B/DCF 77

1.3 Characteristics

General

- Fast transfer in accordance to ANSI C50.41-2012
- Fast transfer success increased - exclusive *REAL-TIME FAST* complied with *C50.41-2012* using predictive algorithm
- Engineering effort saving - typical connection diagram and default configuration suitable for most cases
- Cost saving - auto adapt line VT installation at transformer HV side, no matching VT required
- Cost saving - protection functions for tie-CB integrated
- Switching sequences optimized - FAULT starting condition classified into Type A and B, less bus dead time under non-electric fault transfer
- Setting "free" - default transfer settings suitable for most cases
- Kinds of abnormal starting condition to cover power loss and in-advertent CB open, stabilized against fault and motor starting
- Manual start remotely over protocol or locally by binary input, controlled by REMOTE/LOCAL key switch
- Function's on/off remotely over protocol or locally on device panel
- Support both mono-direction and bi-direction switching
- Performance enhanced - the high speed relay contact (approx. 1ms) designed for CB closing
- Specially designed HSBT online test mode and powerful SIGRA help the functional test and settings' verification
- Application extended to single busbar w. 3-CB besides single busbar w. 2-CB and sectionalized single busbar w. 3-CB

- Friendly HMI with large graphic LCD
- Smart LCD display of transfer data, e.g. dU , df , dj , U_{res} and U_{diff}/f
- Smart oscillographic record, e.g. differential voltage U_{diff} , residual voltage U_{res}
- Kinds of supervision function
- Kinds of international standard communication interface/protocol.



Function

2

This chapter describes the individual functions available on the SIPROTEC 4 device 7VU683. It shows the setting possibilities for each function in maximum configuration. Guidelines for establishing setting values, and formular are given where required.

Additionally, on the basis of the following information, it may be defined which functions are to be used.

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2.1 General

This chapter describes the analogue inputs' connection between HSBT and voltage, current circuit.

2.1.1 VT Installation

Line voltage and bus voltage are necessary for criterions. During the transfer, device makes decisions based on the measuring and computing results derived from voltages across the alternative source CB. Figure 2-1 shows the voltage connection example.

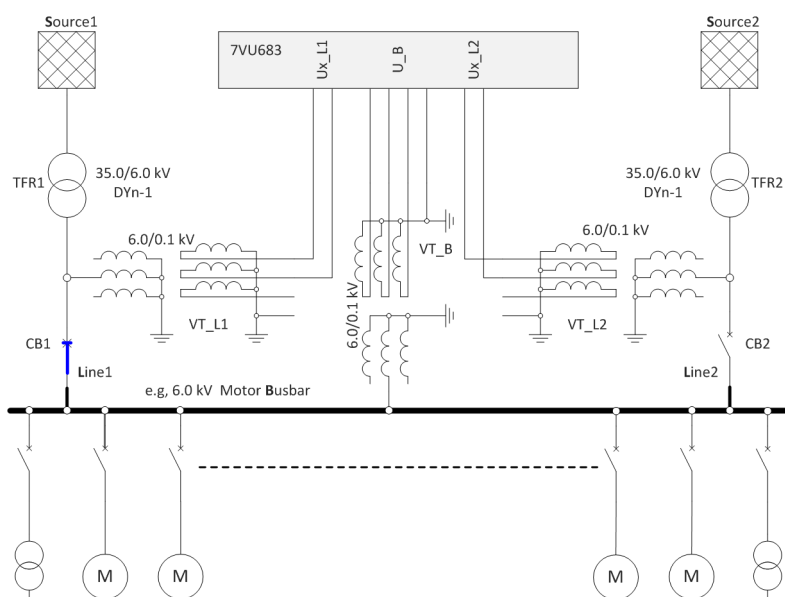


Figure 2-1 Voltage connection illustration

Only 1-ph voltage is required for line side. Either phase-earth voltage or phase-phase voltage can be used. And, this must be parameterized under Power System Data 1, e.g. 0213 **VT connection of Line 1 = Uab**.

3-ph voltage is required for bus side. It's essential for voltage phase sequence check, fault detection, etc.

In some case, line voltage can only be taken from high voltage side of in-feeding transformer. 7VU683 supports this application. It will auto-adapt the voltage amplitude and angle difference by two parameters, e.g. 0283 **Voltage balancing factor of Line 1** and 0284 **Voltage angle adjustment of Line 1**. No matching VT is required. Figure 2-2 shows the application.

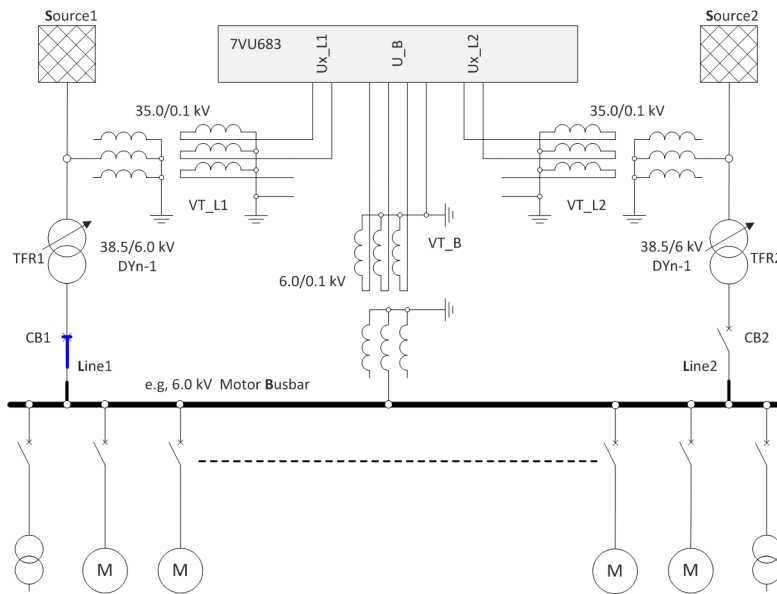


Figure 2-2 VT installation illustration at HV side of in-feeding transformer

Calculation example for Figure 2-2:

0283 **Balancing factor of line1:** $= (38.5/35 \cdot 0.1) / (6/6 \cdot 0.1) = 1.10$

Default setting: 1.00

0284 **Angle adjustment of line1:** $= 1 \cdot 30^\circ = 30^\circ$

Default setting: 0.0°

2.1.2 CT Installation

Line current is helpful for reliable self-start which can be used as the additional criteria, e.g, for under-voltage starting condition. Only 1-ph current is required for line side.

3-ph bus current is only required if protective functions for tie-CB under primary diagram of sectionalized single busbar with 3-CB are configured.

Figure 2-3 shows the current connection example.

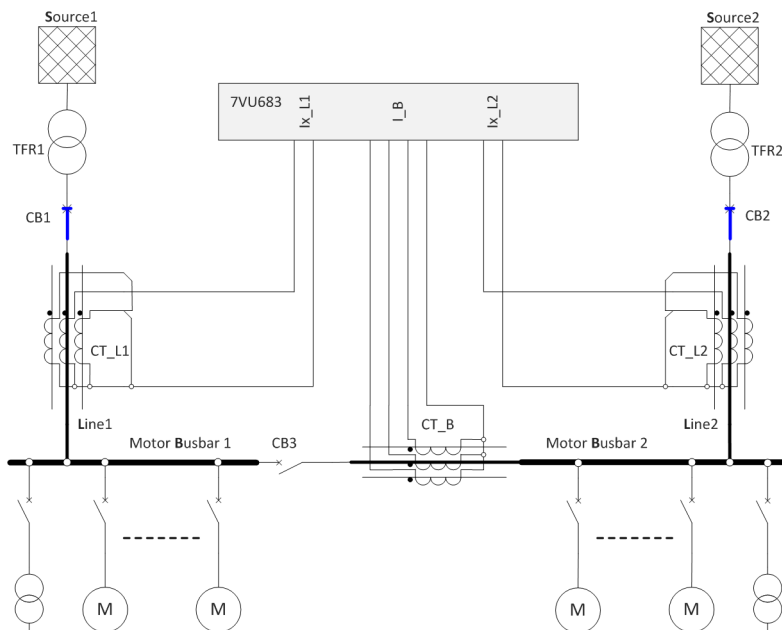


Figure 2-3 CT connection illustration

Line current is only essential for self-auto starting condition of reverse power. Then, the connection must be parameterized under **Power System Data 1**, e.g, 0280 CT connection of Line 1 = I_B .

2.1.3 Remote ON/OFF

The device 7VU683 supports to remotely switch on/off functions over protocol if parameter 0650 **Remote setting ON/OFF** is set to YES.

Below functions can be remotely switched on/off over protocol,

- HSBT function;
- Protection function;
- Kinds of switching direction;
- Kinds of transfer mode;

2.2 HSBT

2.2.1 General

After power loss of running source, the decaying residual voltage on bus is there which is produced by induction motors. To transfer the motor bus to alternative source, the asynchronous switching must occur. Special consideration must be taken into account to avoid any damages to motors.

Key points are to secure the safe but fast transfer for motor bus to minimize the impact to motor winding and processing loads. All relevance to fast transfer will be described in below chapters, e.g, starting conditions, switching sequences, transfer modes, etc.

2.2.1.1 Bus residual voltage

After power loss, residual voltage will be there on motor bus which is induced by rotating motors with remanence. Figure 2-4 shows the simulation results.

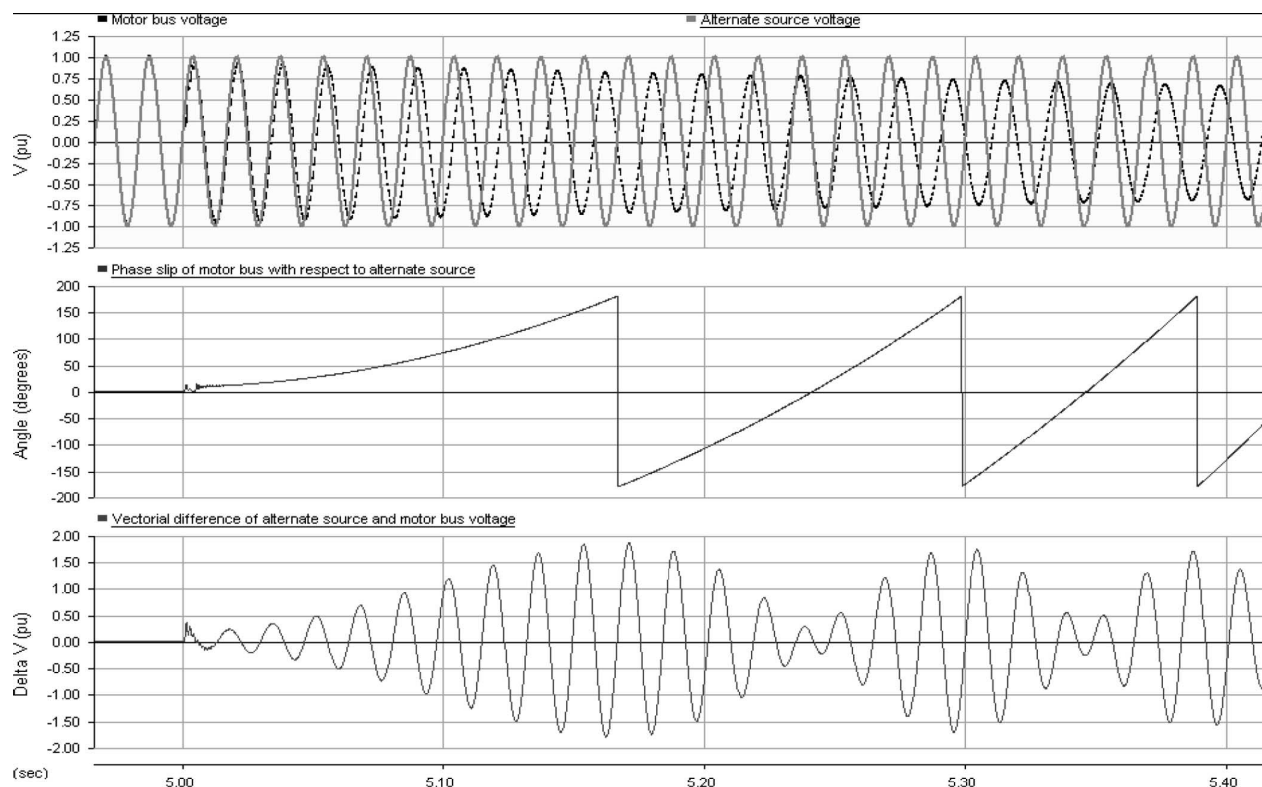


Figure 2-4 Residual voltage simulation on motor bus

Key conclusions regarding the simulation,

- The amplitude of residual voltage is decaying;
- The frequency of residual voltage is decaying;
- The phase angle difference between the residual voltage and alternative source is more and more big;
- The differential voltage across the alternative source CB is swinging, i.e, from -180° to 180° .

2.2.1.2 Philosophy

Some attentions must be paid to the co-ordination between HSBT and protective relays. Figure 2-5 shows the overview.

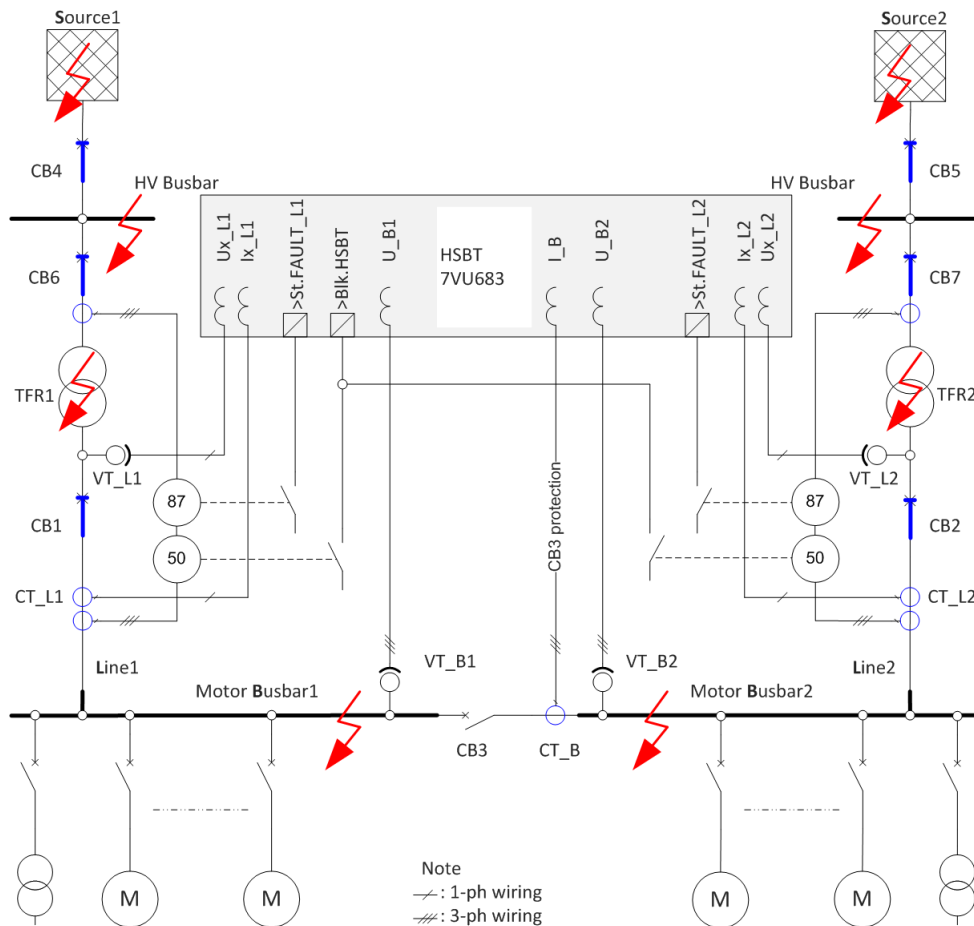


Figure 2-5 Co-ordination philosophy between HSBT and protective relays

Some basic rules can be drawn from Figure 2-5,

- Protective relay will detect and clear any system fault or HV bus fault, and result at CB4 (CB6) trip. This leads to power loss of motor bus. Normally there is not any indication routed to HSBT. HSBT can only be self-started by integrated ab-normal detection criterions, e.g, under-voltage, under-frequency, etc.
- Protective relay, e.g, differential protection (ANSI 87), will detect and clear any fault on in-feeding transformer, and result at CB1 trip. Meanwhile, HSBT should be externally started by protective relay.
- Protective relay, e.g, over-current protection (ANSI 50), will detect and clear any fault on motor bus, and result at CB1 trip. Meanwhile, HSBT should be externally blocked by protective relay.

HSBT should be externally started under planned operation, e.g, starting up of generator. This can be actualized via binary input, e.g, push the external button of OPEN CB1. It will also be externally started under fault, e.g, in-feeding transformer over-loading, this can be actualized via binary input, e.g, the indication from protective relays. HSBT should be internally self-started under power loss of motor bus, e.g, up-stream CB is tripped.

Switching sequence means the operating sequence of running source CB and alternative source CB. Three possible sequences are there. PARALLEL sequence is to send the CLOSE command to alternative source CB first, then send the OPEN command to running source CB. That is, the two sources will over-lap for short time

on motor bus. **SIMULTANEOUS** sequence is to send the OPEN and CLOSE command at the same time. Very short source dead time caused by the operating time difference of two CBs could be there. The last **SEQUENTIAL** sequence is to send the OPEN command to running source CB first, then the CLOSE command to alternative source CB. That is, a significant source dead time on motor bus will be there.

PARALLEL sequence is actually to make synchro-check to alternative source CB under steady condition. It's only available for planned operation if over-lapping is allowed. The OPEN command can be automatically sent out after the alternative source CB is switched on under switching sequence *PARALLEL Auto*. It can also be manually sent out after the alternative source CB is switched on under switching sequence *PARALLEL Half-Auto*.

Special attentions have to be paid for both *SIMUTANEOUS* and *SEQUENTIAL* sequence under dynamic condition. Then, various transfer modes are applied. Each mode acts as different criterions and has different action time. Both FAST and REAL-TIME FAST modes are designed according to the fast transfer definition in ANSI C50.41-2012. The other three slow modes serve as the backup transfer. Each mode has to be parameterized.

To avoid the possible over-loading of alternative source during the low voltage re-starting of bus motors after transfer, it's helpful to deploy the low voltage load-shedding function before transfer mode RES-VOLT.

The overall workflow in HSBT 7VU683 is shown in Figure 2-6.

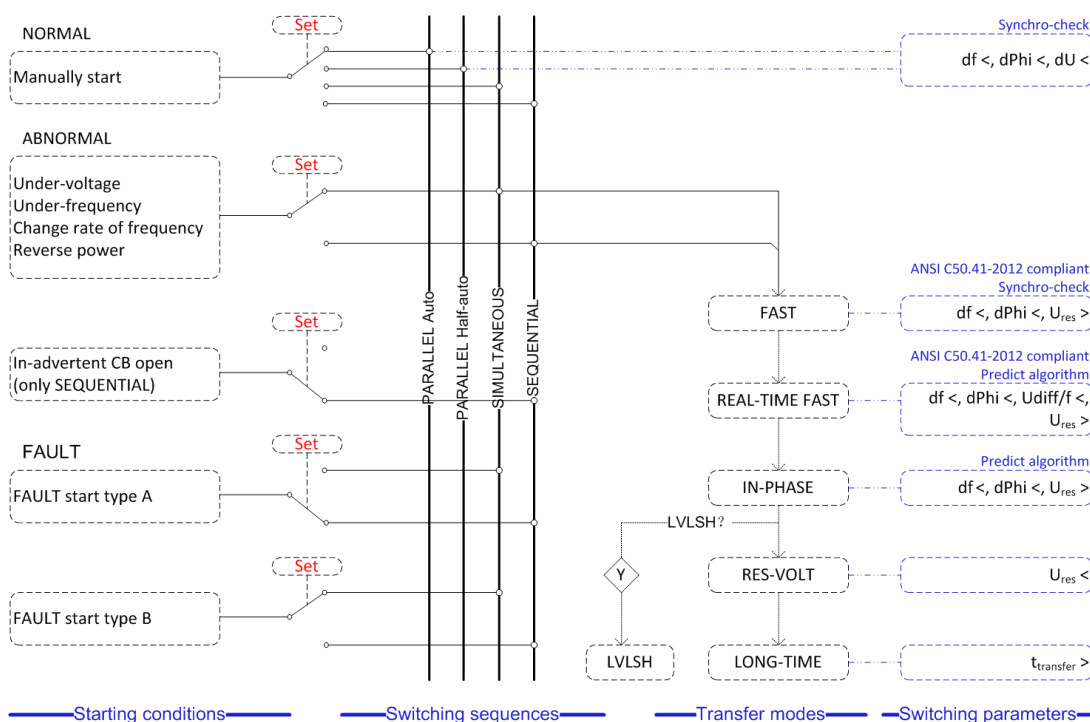


Figure 2-6 Overview of HSBT 7VU683 workflow

Some key messages can be addressed from Figure 2-6,

- Five abnormal starting logics are deployed to recognize the power loss of motor bus. The under-voltage, under-frequency, change rate of frequency and reverse power caused by power loss is to self-start HSBT. Even, the in-advertent CB open can be quickly and reliably recognized by 7VU683 and is used to self-start HSBT.

- FAULT starting condition is classified into type A and B, and can have different switching sequence. This could be practical in some cases, i.e, type A reflects electric fault while type B reflects non-electric faults.

2.2.1.3 Block and reset

To avoid the unwanted transfer, measures have to be taken to block HSBT under some operation conditions, e.g,

- CB manual open;
- MCB trip of bus voltage;
- Motor bus fault.

The blocking indications from operator, MCB auxiliary status and bus protective relay should be externally wired to the binary input 17620 **>Block HSBT**.

HSBT will automatically be in blocking status and reject any new transfer request after every transfer failure. It has to be manually reset.

In some cases, it is required to block the device even after the successful transfer and can only conduct the next transfer request after manual reset. This can be actualized by setting the parameter 8817 **Manual Reset HSBT** = YES.

The reset command can be recognized via BI indication 17863 ">Manually reset" or LED reset button on device panel.

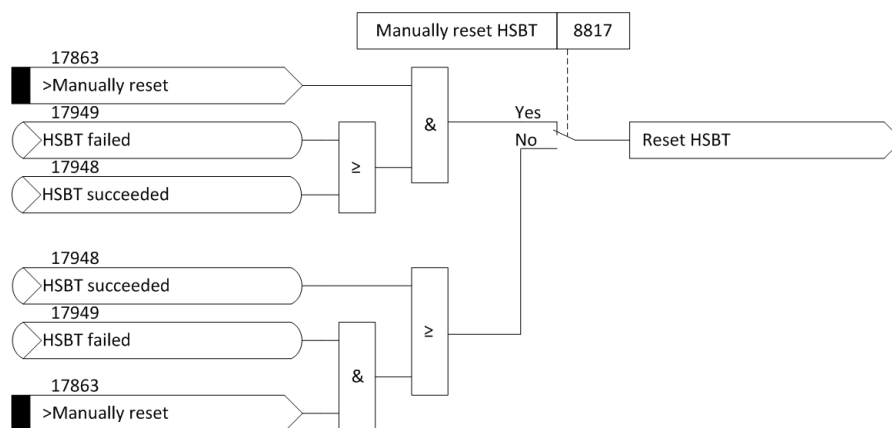


Figure 2-7 Reset logic

Default setting No means HSBT will automatically be valid for next transfer request after successful transfer.

2.2.1.4 Power system data

System data as below can be parameterized under Power System:

- Rated frequency: support 50Hz or 60Hz;
- VT connection of line: support either phase-earth voltage of U_a , U_b , U_c or phase-phase voltage of U_{ab} , U_{bc} , U_{ca} ;
- Voltage balancing factor of line: the voltage amplitude difference caused by primary diagram can be internally compensated by device. Thus, no matching VT is required. Default value 1.000 means no voltage amplitude difference is there;
- Voltage angle adjustment of line: the voltage phase angle difference caused by primary diagram can be internally compensated by device. Thus, no matching VT is required. Default value 0.0 means no voltage angle difference is there;
- Busbar live voltage threshold: the live status of motor bus voltage is monitored by this parameter;
- Busbar dead voltage threshold: the dead status of motor bus voltage is monitored by this parameter;
- Line live voltage threshold: the live status of line voltage is monitored by this parameter;
- Line dead voltage threshold: the dead status of line voltage is monitored by this parameter;
- Line dead current threshold: the live status of line current is monitored by this parameter.

Functionality as below can be activated or de-activated under Function:

- High speed busbar transfer: the factory setting is *ON*;
- Protection functions: the factory setting *ON* has to be changed to *OFF* during configuration if protections for tie-CB under primary diagram of sectionalized single busbar with 3-CB is not required.

Voltage transformer has to be parameterized as below under VT's:

- VT rated primary voltage of line: directly taken from line VT's plate;
- VT rated secondary voltage of line: directly taken from line VT's plate;
- VT rated primary voltage of busbar: directly taken from bus VT's plate;
- VT rated secondary voltage of busbar: directly taken from bus VT's plate.

Current transformer has to be parameterized as below under CT's:

- CT rated primary current of line: directly taken from line CT's plate;
- CT rated secondary current of line: directly taken from line CT's plate;
- CT rated primary current of busbar: directly taken from bus CT's plate;
- CT rated secondary current of busbar: directly taken from bus CT's plate;
- Earth CT rated primary current of busbar: directly taken from bus CT's plate. It's only required if measured value instead of computed value of earth current for ground fault protection is adopted;
- Earth CT rated secondary current of busbar: directly taken from bus CT's plate; It's only required if measured value instead of computed value of earth current for ground fault protection is adopted.

The minimum pulse width of OPEN and CLOSE command can be parameterized under CB:

- Minimum TRIP command duration: the factory value 0.2s should be enough for most cases;
- Minimum CLOSE command duration: the factory value 0.2s should be enough for most cases.

2.2.1.5 Settings

Address	Parameter	Range	Default Setting	Note
<i>Device Configuration</i>				
0103	Setting group change option	Disable Enable	Disable	
0158	High speed busbar transfer	Disable Enable	Enable	
0160	Protection functions	Disable Enable	Enable	Sectionalized single busbar
<i>Power System Data 1-> Power System</i>				
0211	Rated frequency	50 Hz 60 Hz	50 Hz	
0213	VT connection of Line1	Ua Ub Uc Uab Ubc Uca	Uab	
0214	VT connection of Line2	Ua Ub Uc Uab Ubc Uca	Uab	
0218	VT connection of Line3	Ua Ub Uc Uab Ubc Uca	Uab	Single busbar with 3-CB
0280	CT connection of Line1	IA IB IC not connected	IB	
0281	CT connection of Line2	IA IB IC not connected	IB	
0282	CT connection of Line3	IA IB IC not connected	IB	Single busbar with 3-CB
0283	Voltage balancing factor of Line1	0.500<= ... <=2.000	1.000	
0284	Voltage angle adjustment of Line1	0.0<= ... <=359.9	0.0°	
0285	Voltage balancing factor of Line2	0.500<= ... <=2.000	1.000	

Address	Parameter	Range	Default Setting	Note
0286	Voltage angle adjustment of Line2	0.0<= ... <=359.9	0.0°	
0287	Voltage balancing factor of Line3	0.500<= ... <=2.000	1.000	Single busbar with 3-CB
0288	Voltage angle adjustment of Line3	0.0<= ... <=359.9	0.0°	Single busbar with 3-CB
8900	Busbar live voltage threshold	0.550<= ... <=0.900	0.700 U/Un	
8901	Busbar dead voltage threshold	0.100<= ... <=0.450	0.300 U/Un	
8902	Line live voltage threshold	0.550<= ... <=0.900	0.700 U/Un	
8903	Line dead voltage threshold	0.100<= ... <=0.450	0.300 U/Un	
8904	Line dead current threshold	0.05<= ... <=0.50	0.10 I/In	
<i>Power System Data 1-> Function</i>				
0221	High speed busbar transfer	ON OFF	ON	
0226	Protection functions	ON OFF	ON	Sectionalized single busbar
<i>Power System Data 1-> VT's</i>				
0231	VT rated primary voltage Line1	0.15<= ... <=1200.0	6.3 KV	
0232	VT rated secondary voltage Line1	80<= ... <=125	100 V	
0233	VT rated primary voltage Line2	0.15<= ... <=1200.0	6.3 KV	
0234	VT rated secondary voltage Line2	80<= ... <=125	100 V	
0241	VT rated primary voltage Line3	0.15<= ... <=1200.0	6.3 KV	Single busbar with 3-CB
0242	VT rated secondary voltage Line3	80<= ... <=125	100 V	Single busbar with 3-CB
0235	VT rated primary voltage Busbar	0.15<= ... <=1200.0	6.3 KV	
0236	VT rated secondary voltage Busbar	80<= ... <=125	100 V	
<i>Power System Data 1->CT's</i>				
0251	CT rated primary current Line1	100<=...<=20000	3000 A	
0252	CT rated secondary current Line1	1 A 5 A	1 A	
0253	CT rated primary current Line2	100<=...<=20000	3000 A	
0254	CT rated secondary current Line2	1 A 5 A	1 A	
0259	CT rated primary current Line3	100<=...<=20000	3000A	Single busbar with 3-CB
0260	CT rated secondary current Line3	1 A 5 A	1 A	Single busbar with 3-CB
0255	CT rated primary current Busbar	100<=...<=20000	3000 A	Sectionalized single busbar
0256	CT rated secondary current Busbar	1 A 5 A	1 A	Sectionalized single busbar
0257A	Earth CT rated primary current Busbar	100<=...<=20000	3000 A	Sectionalized single busbar
0258A	Earth CT rated secondary current Busbar	1 A 5 A	1 A	Sectionalized single busbar

Address	Parameter	Range	Default Setting	Note
<i>Power System Data 1->CB</i>				
0261	Minimum TRIP command duration	0.01<=...<=10.00	0.20 sec	
0262	Minimum CLOSE command duration	0.01<=...<=10.00	0.20 sec	

2.2.1.6 Information List

No.	Information	Type	Fun. NO.	Inf. NO.
17621	> CB1 52a	SP		
17622	> CB1 52b	SP		
17623	> CB2 52a	SP		
17624	> CB2 52b	SP		
17625	> CB3 52a	SP		
17626	> CB3 52b	SP		
17864	> Non manually open CB1	SP		
17865	> Non manually open CB2	SP		
30401	> Non manually open CB3	SP		
17877	> Busbar MCB 52a	SP		
17868	> Busbar1 MCB 52a	SP		
17869	> Busbar2 MCB 52a	SP		
17817	Bus live voltage	OUT		
17736	Bus dead voltage	OUT		
17818	Bus1 live voltage	OUT		
17819	Bus2 live voltage	OUT		
17723	Bus1 dead voltage	OUT		
17726	Bus2 dead voltage	OUT		
17820	Line1 live voltage	OUT		
17821	Line2 live voltage	OUT		
30403	Line3 live voltage	OUT		
17724	Line1 dead voltage	OUT		
17725	Line1 dead current	OUT		
17727	Line2 dead voltage	OUT		
17728	Line2 dead current	OUT		
30404	Line3 dead voltage	OUT		
30405	Line3 dead current	OUT		
17760	Command: open CB1	OUT	200	1
17761	Command: open CB2	OUT	200	2
17762	Command: open CB3	OUT	200	3
17767	Command: close CB1	OUT	200	8
17768	Command: close CB2	OUT	200	9
17769	Command: close CB3	OUT	200	10
17774	Fail: open CB1	OUT		
17775	Fail: open CB2	OUT		

17776	Fail: open CB3	OUT		
17781	Fail: close CB1	OUT		
17782	Fail: close CB2	OUT		
17783	Fail: close CB3	OUT		
18005	Warn: CB1 status unavailable	OUT		
18006	Warn: CB2 status unavailable	OUT		
18007	Warn: CB3 status unavailable	OUT		
18021	Command: close CB1(Test)	OUT		
18022	Command: close CB2(Test)	OUT		
18023	Command: close CB3(Test)	OUT		
17960	HSBT ON/OFF	IntSP	200	63
17962	Protections ON/OFF	IntSP	200	65

2.2.2 Transfer modes

To secure the fast but safe transfer during asynchronous switching alternative source CB, HSBT need to continuously monitor and control the switching conditions at closing instant, e.g. delta frequency, delta phase angle, etc.

The fast transfer is the best way to help the process continuity after power loss. If fast transfer is not possible, slow transfer should be possible to serve as the backup transfer. Transfer modes will be described in this chapter.

2.2.2.1 General

General conclusion can be made based on Figure 2-4 that transient impact must be there due to the differential voltage across the alternative source CB during fast transfer. ANSI C50.41-2012 describes the transfer impact to motors as below,

- Induction motors are inherently capable of developing transient current and torque considerably in excess of rated current and torque when exposed to out-of phase bus transfer or momentary voltage interruptions and reclosing on the same bus. The magnitude of this transient current and torque may range from 2 to 20 times rated and is a function of the motor's electrical characteristics, operating conditions, switching time, rotating system inertia and torsional spring constants, number of motors on the bus, etc.
- Studies to determine the magnitude of the transient current and torque are recognized to be complex and require detailed knowledge of the motor, the driven equipment, and the power supply.

It's known from the above description that to calculate the transient impact for each case is not practical. Then, one simplified guideline was made in ANSI C50.41-2012 to motor bus fast transfer as below.

Based on limited studies and experience, a fast transfer or reclosing is defined as one which:

- Occurs within a time period of 10 cycles or less,
- The max. phase angle between the motor residual volts per hertz vector and the system equivalent volts per hertz doesn't exceed 90 degrees,
- The resultant volts per hertz between the motor residual volts per hertz phasor and the incoming source volts per hertz phasor at the instant of transfer or reclosing is completed doesn't exceed 1.33 per unit volts per hertz on the motor rated voltage and frequency basis. Refer to Figure 2-8.

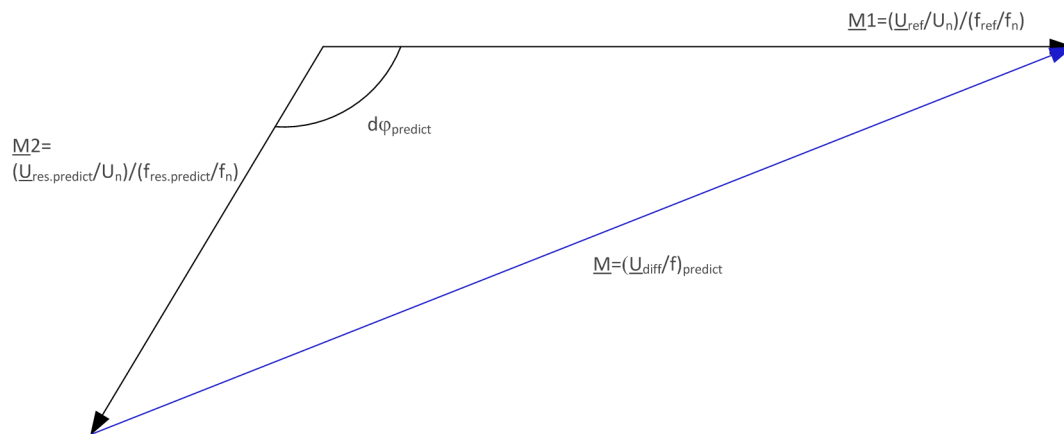


Figure 2-8 Illustration of fast transfer defined in ANSI C50.41-2012

$\underline{U}_{ref}$ is the reference voltage which is taken from alternative source. $\underline{U}_{res}$ is the residual voltage which is induced by asynchronous motors. Comply to ANSI definition, delta phase angle $d\phi_{predict}$ at alternative source CB closing instant must be $\leq 90^\circ$, while the amplitude of resultant $\underline{M}$ must be ≤ 1.33 .

The illustration in Figure 2-4 can be transformed into R-φ plane as below Figure 2-9.

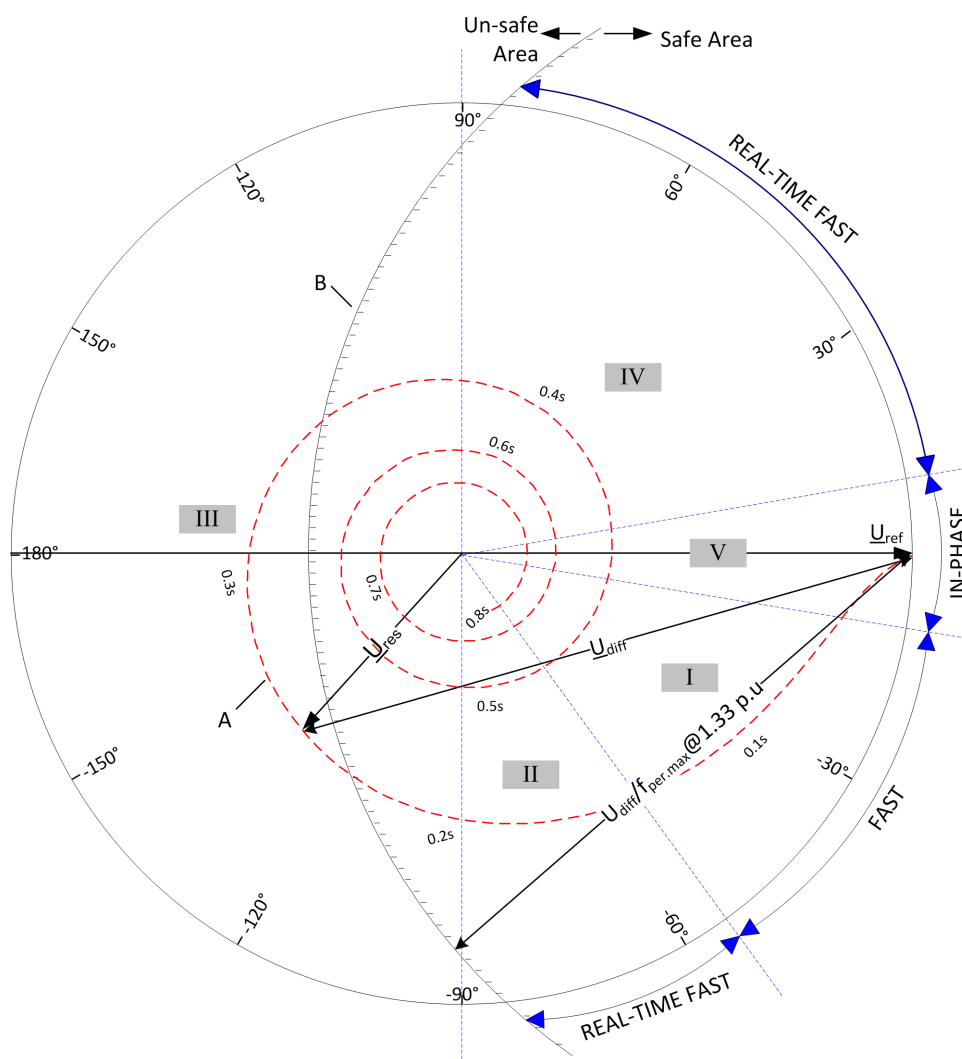


Figure 2-9 Illustration of residual and reference voltage in R- ϕ plane

Curve A is $\underline{U}_{res}$ trajectory. Curve B is the permitted maximum (1.33) of resultant volts per hertz ($\underline{U}_{diff}/f$). Derived from Figure 2-9, as time's going after power loss, the amplitude (R) of $\underline{U}_{res}$ is decaying, while delta phase angle (ϕ) between $\underline{U}_{ref}$ and $\underline{U}_{res}$ becomes bigger and bigger.

The plane is divided into five areas based on delta phase angle. Area I is defined in 7VU683 as FAST mode. Area II and IV is defined in 7VU683 as REAL-TIME FAST mode. Both FAST and REAL-TIME FAST modes are to meet the criterions set by C50.41-2012. Details are described in following chapters.

2.2.2.2 FAST mode

The study and testing results show, in most cases, the typical values of df , $d\phi$ and dU are smaller enough within the first tens of millisecond from the instant of running source CB opens. It's good to safe and fast transfer due to the slight shock to motors. FAST transfer mode is aimed to restrict $d\phi$ at the instant of transfer within a small value, e.g. 60° . It can obviously be seen, on Figure 2-9, that the resultant volts per hertz ($\underline{U}_{diff}/f$) at $d\phi=60^\circ$ is ≤ 1.00 .

The real-time values of df , $d\Phi$ and U_{res} are set as criterions:

- $df < 8858$ **FAST mode: delta frequency**
- $d\Phi < 8859$ **FAST mode: delta phase angle**
- $U_{res} > 8860$ **FAST mode: under-voltage block**

Where,

df = calculated real-time frequency difference of residual voltage U_{res} and reference voltage U_{ref}

$d\Phi$ = calculated real-time phase angle difference of residual voltage U_{res} and reference voltage U_{ref}

U_{res} = maximum phase-phase value of measured real-time residual voltage on motor bus

CB closing time has to be taken into account, i.e, closing time at 60ms for vacuum CB, average frequency difference at 1.5Hz during the early tens of second after power loss, equivalent delta phase angle will be,

$$60ms / (1,000 * 1/1.5Hz) * 360^\circ = 32.4^\circ$$

Thus, parameter 8859 **FAST mode: delta phase angle** should be set as below,

$$60^\circ - 32.4^\circ = 27.6^\circ$$

The shortest action time for FAST mode is approx. 1 cycle.



Note:

FAST mode is only valid within the first 120 ms after the running source CB is tripped. If the time is expired, FAST mode will be skipped and the transfer proceeds with other modes.

2.2.2.3 REAL-TIME FAST mode

If FAST mode failed to transfer, the device can automatically, if activated, turn to next transfer area REAL-TIME FAST.

This mode is to extend $d\Phi$ at alternative source CB closing instant to 90° according to C50.41-2012. Meanwhile, resultant volts per hertz U_{diff}/f at alternative source CB closing instant regarding C50.41-2012 must not exceed 1.33 p.u.

The intelligent device 7VU683 estimates the values of $d\Phi$ and U_{diff}/f at the instant of transfer based on real-time slipping rate and the settable CBx closing time by exclusive predictive algorithm. If all the quantities of predicted $d\Phi$ and U_{diff}/f , the real-time df and U_{res} meet the pre-set criterions, the device will immediately issue the CLOSE command to the alternative source CB. The criterions are as below,

- $df < 8861$ **REAL-TIME FAST mode: delta frequency**
- $U_{diff}/f < 8862$ **REAL-TIME FAST mode: U_{diff}/f**
- $d\Phi < 8863$ **REAL-TIME FAST mode: delta phase angle**
- $U_{res} > 8864$ **REAL-TIME FAST mode: under-voltage block**

Where,

df = calculated real-time frequency difference of residual voltage U_{res} and reference U_{ref}

U_{diff}/f = predicted resultant volts per hertz between the motor residual volts per hertz phasor and the reference volts per hertz phasor at the instant of transfer

$d\Phi$ = predicted phase angle between the motor residual volts per hertz vector and the reference equivalent volts per hertz vector at the instant of transfer

U_{res} = measured real-time residual voltage on motor bus

The factory values for parameter 8862 and 8863 are directly taken from C50.41-2012.

The shortest action time for REAL-TIME FAST mode is approx. 3 cycles.

2.2.2.4 IN-PHASE mode

If fast transfer of both FAST and REAL-TIME FAST mode failed, the device can automatically, if activated, turn to slow transfer area IN-PHASE.

When the residual voltage is going to be in-phase with the reference voltage, it's good for safe transfer.

The criterions are as below, The intelligent device 7VU683 estimates the value $d\Phi$ at the instant of transfer based on real-time slipping rate and the settable CBx closing time by exclusive predictive algorithm. If all the quantity of predicted $d\Phi$, the real-time df and $\underline{U}_{res}$ meet the pre-set criterions, the device will immediately issue the CLOSE command to the alternative source CB. The criterions are as below,

- $df < 8868$ **IN-PHASE mode: delta frequency**
- $d\Phi < 8869$ **IN-PHASE mode: delta phase angle**
- $\underline{U}_{res} > 8870$ **IN-PHASE mode: under-voltage block**

2.2.2.5 RES-VOLT mode

If all above modes failed, the transfer can still go on with mode RES-VOLT.

When the residual voltage $\underline{U}_{res}$ under-shots the settable parameter 8871 **RES-VOLT threshold**, the RES-VOLT mode will perform and the device will immediately issue the CLOSE command to the alternative source CB.

The typical setting could be $30\% \cdot U_n$.

To avoid the alternative source over-loading in case of motors' low voltage restarting, it is helpful to implement low voltage load-shedding(LVLSH) function before RES-VOLT mode. LVLSH is setting-free which pickup value is taken from 8870 **IN-PHASE mode: under-voltage block**, with one stage, no time delay. This function can be activated or de-activated manually on site.

2.2.2.6 LONG-TIME mode

The last mode is LONG-TIME which serves as the final backup transfer.

When the transfer time is more than the settable parameter 8872 **LONG-TIME threshold**, the LONG-TIME mode will perform and the device will immediately issue the CLOSE command to the alternative source CB.

The typical setting could be 3 s.

2.2.3 Switching sequences

Switching sequence has big impact to transfer. It will be described in this chapter.

2.2.3.1 General

Switching sequence means the operating sequence of running source CB and alternative source CB. Three possible sequences are there.

- **PARALLEL** sequence is to send the CLOSE command to alternative source CB first, then send the OPEN command to running source CB. That is, the two sources will over-lap for short time on motor bus.
- **SIMULTANEOUS** sequence is to send the OPEN and CLOSE command at the same time. Very short source dead time caused by the operating time difference of two CBs could be there.

- The last SEQUENTIAL sequence is to send the OPEN command to running source CB first, then the CLOSE command to alternative source CB. That is, a significant source dead time on motor bus will be there.

PARALLEL sequence is actually to make synchro-check to alternative source CB under steady condition. It's only available for planned operation if over-lapping is allowed. The OPEN command can be automatically sent out after the alternative source CB is switched on under switching sequence *PARALLEL Auto*. It can also be manually sent out after the alternative source CB is switched on under switching sequence *PARALLEL Half-Auto*.

Special attentions have to be paid for both *SIMULTANEOUS* and *SEQUENTIAL* sequence under dynamic condition. Then, various transfer modes are applied. Each mode acts as different criterions and has different action time. Both FAST and REAL-TIME FAST modes are designed according to the fast transfer definition in ANSI C50.41-2012. The other three slow modes serve as the backup transfer. Each mode has to be parameterized.

2.2.3.2 PARALLEL sequence

If the two sources are allowed to be momentary parallel on motor bus, the PARALLEL sequence can be used for power source transfer.

Under PARALLEL sequence, HSBT 7VU683 will firstly issue out a CLOSE command to the alternative source CB after the device get the starting command. When the closure is successful, the device will issue out an OPEN command to trip the running source CB. The OPEN command can be automatically generated by device or derived from manual operation which are dependent on settings,

- *PARALLEL Auto* sequence
- *PARALLEL Half-Auto* sequence

Under *PARALLEL Auto* sequence, the device will automatically issue out an OPEN command after a settable time delay when the closure is successful. Under *PARALLEL Half-Auto* sequence, the device will not issue out the OPEN command until the manual open command arrived.

The synchro-check criterions for *PARALLEL Auto* switching sequence are as below,

- $df < 8851$ **PARALLEL sequence: delta frequency**
- $dU < 8852$ **PARALLEL sequence: delta U**
- $d\Phi < 8853$ **PARALLEL sequence: delta phase angle**
- $t_{closing} > 8854$ **PARALLEL Auto: CB open time delay**

Where,

df = calculated real-time frequency difference of residual voltage $\underline{U}_{res}$ and reference voltage $\underline{U}_{ref}$

$d\Phi$ = calculated real-time phase angle difference of residual voltage $\underline{U}_{res}$ and reference voltage $\underline{U}_{ref}$

dU = calculated real-time amplitude difference of residual voltage $\underline{U}_{res}$ and reference voltage $\underline{U}_{ref}$

$t_{closing}$ = the duration of alternative source CB is closed. It makes no sense to *PARALLEL Half-auto* sequence

If the running source CB failed to trip within 1 s, the device will automatically decouple the closed alternative source CB.

The time sequence under PARALLEL can be understandable via below Figure 2-10 (assumed switching on CB2 and switching off CB1).

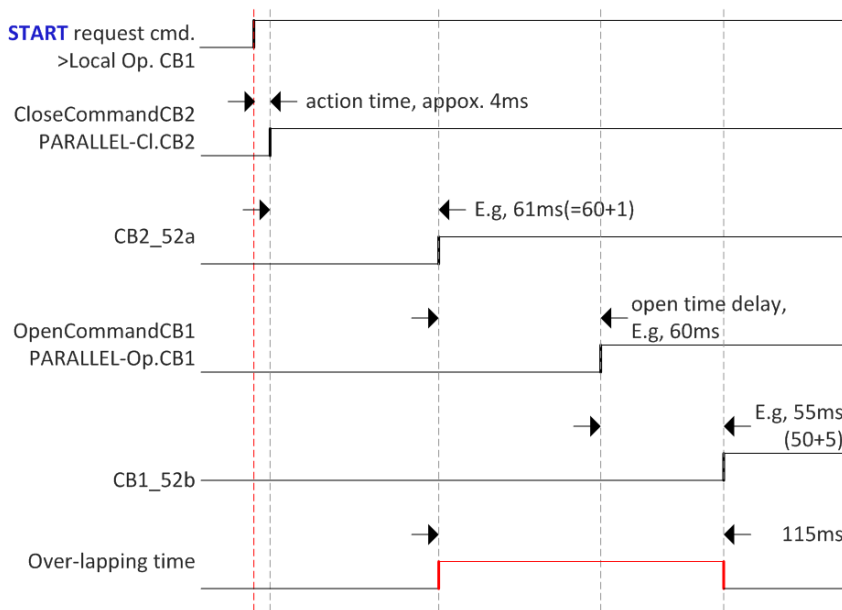


Figure 2-10 Switching sequence illustration of PARALLEL

Some assumptions to above figure,

- CB1 breaking time at 50ms and 7VU683 BO making time at 5 ms(fast speed relay, e.g, BO9)
- CB2 making time at 60ms and 7VU683 BO making time at 1 ms(high speed relay, e.g, BO11)
- PARALLEL Auto switching sequence

The advantage of PARALLEL sequence is to avoid any power source interruption on motor bus. PARALLEL Auto sequence should be always preferred and parameter 8854 could be small enough(e.g, 20 ms) to reduce the overlapping risk of two sources.

Switching logic can be referred to below Figure 2-11.

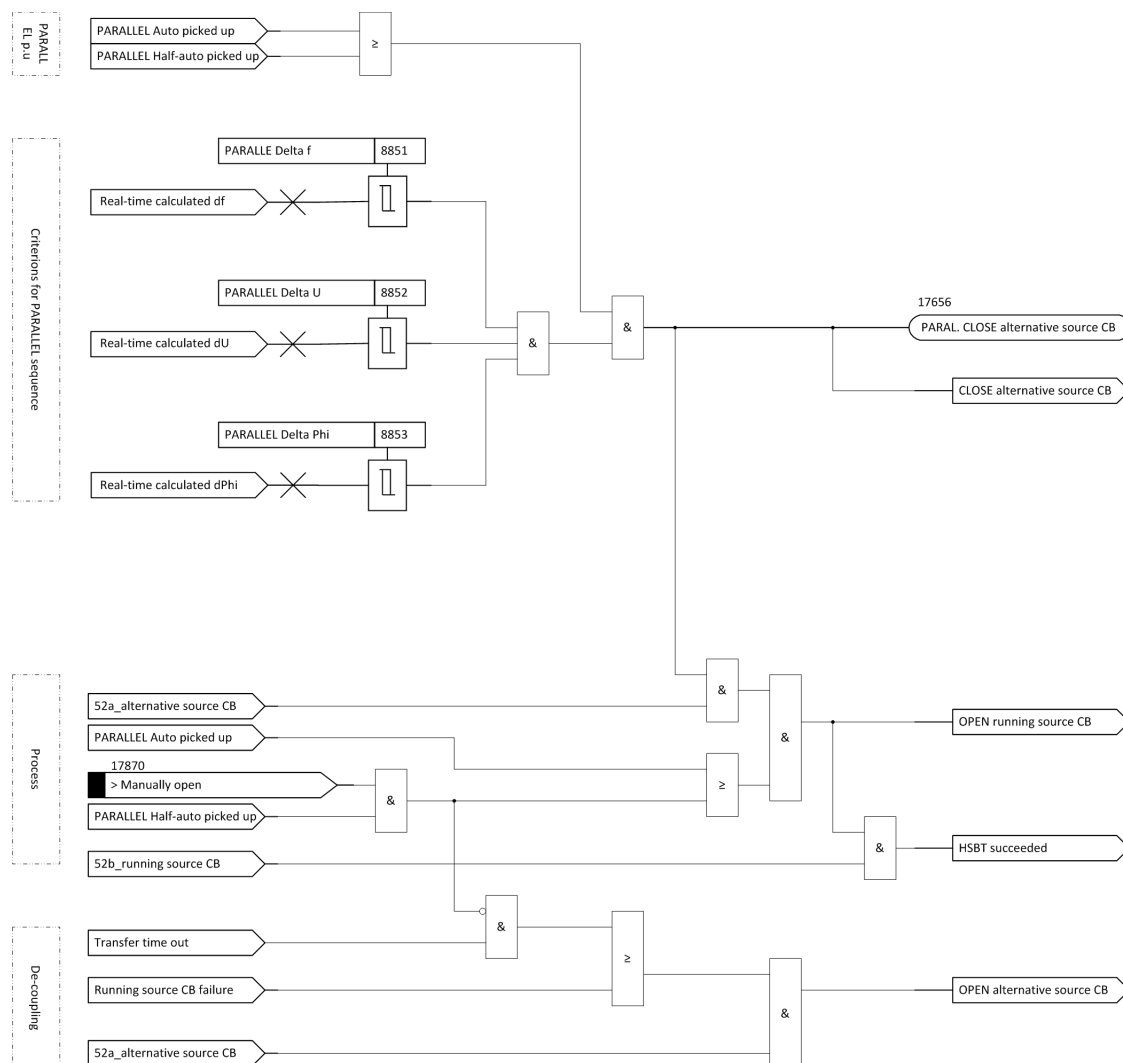


Figure 2-11 Switching logic illustration of PARALLEL sequence

2.2.3.3 SIMULTANEOUS sequence

If the two sources are not allowed to work on motor bus in parallel, the SIMULTANEOUS sequence can be used for power supply transfer.

Under SIMULTANEOUS sequence, HSBT 7VU683 will firstly issue out an OPEN command to the running source CB after the device gets the transfer request command. Meanwhile, the device will issue out a CLOSE command to the alternative source CB if criterions are met.

If the running source CB failed to trip within 1 s, the device will automatically decouple the closed alternative source CB.

The time sequence under *SIMULTANEOUS* can be understandable via via below Figure 2-12 (assumed switching on CB2 and switching off CB1).

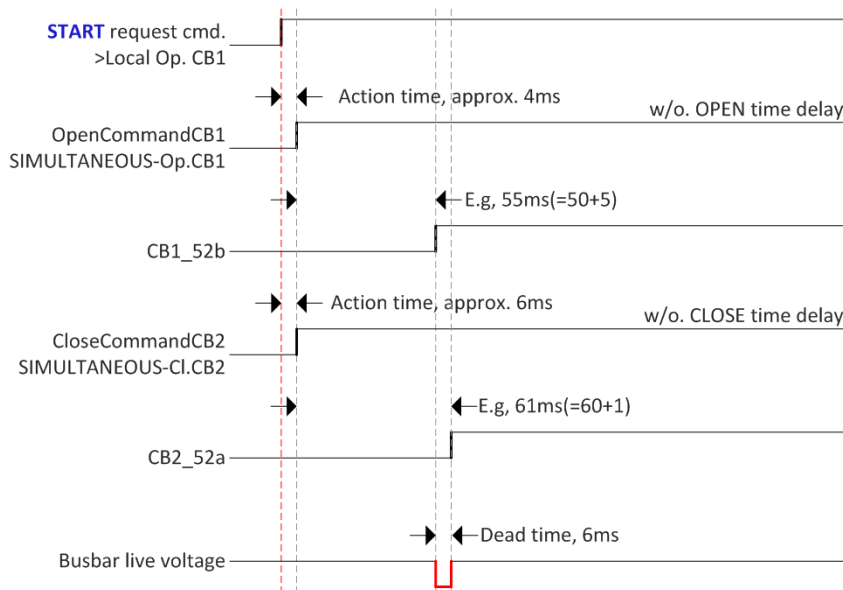


Figure 2-12 Switching sequence illustration of SIMULTANEOUS

Some assumptions to above figure,

- CB1 breaking time at 50 ms and 7VU683 BO making time at 5 ms(fast speed relay, e.g, BO9)
- CB2 making time at 60 ms and 7VU683 BO making time at 1 ms(high speed relay, e.g, BO11)
- Both OPEN time delay and CLOSE time delay set to 0ms
- Closed by FAST transfer mode
- Criteria are met at instant of transfer request

Due to CB operating time difference (CB breaking time is normally less than making time), the power supply of motor bus will be interrupted for a few milliseconds. The length of this dead duration depends on the difference of CB operating time. The motor bus dead duration can be shortened via the settable parameter 8873 **SIMULTANEOUS sequence: CB open time delay**. Or, the dead duration can be prolonged via the settable parameter 8857 **SIMULTANEOUS sequence: CB close time delay** to avoid any over-lapping.

The advantage of *SIMULTANEOUS* sequence is to have very short dead duration and to have negligible switching impacts to motors during transfer.

Switching logic can be referred to below Figure 2-13.

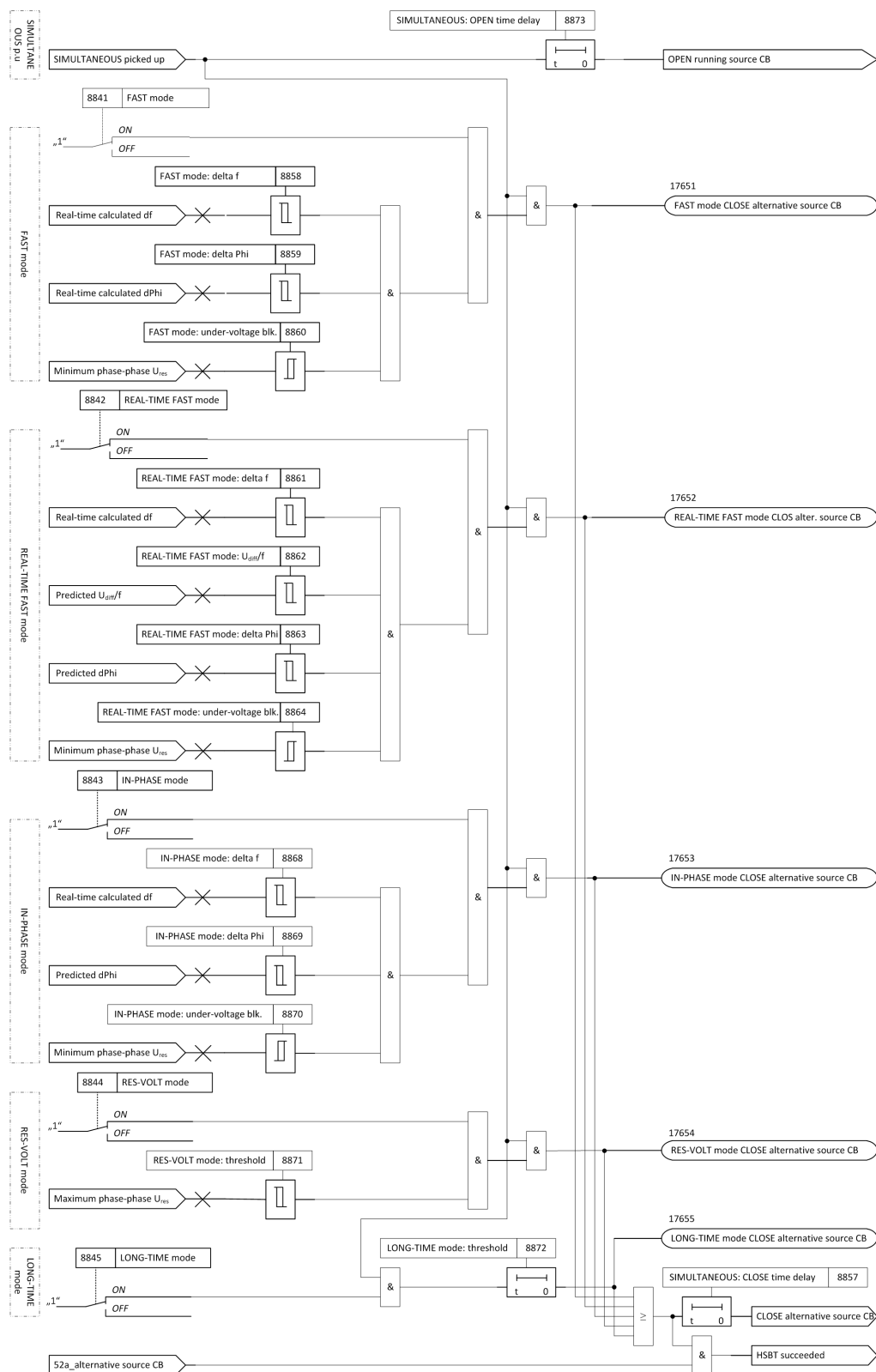


Figure 2-13 Switching logic illustration of SIMULTANEOUS sequence

2.2.3.4 SEQUENTIAL sequence

In case of some operation conditions, e.g. electric fault at in-feeding transformer, switch-onto-fault after transfer has to be avoided. Generally it's exclusively allowed to switch on the alternative source CB after the running source CB is tripped. Hence, SEQUENTIAL switching sequence is deployed.

Under SEQUENTIAL sequence, HSBT 7VU683 will firstly issue out an OPEN command to the running source CB after the device get the transfer request command. After the running source CB is opened, the device begins to evaluate the switching logic. CLOSE command will be issued out if criterions are met.

The time sequence under SEQUENTIAL can be understandable via below Figure 2-14 (assumed switching on CB2 and switching off CB1).

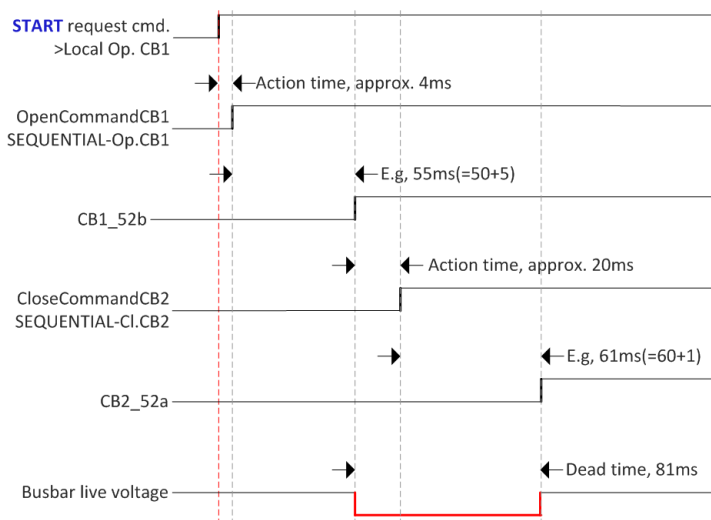


Figure 2-14 Switching sequence illustration of SEQUENTIAL

Some assumptions to above figure,

- CB1 breaking time at 50 ms and 7VU683 BO making time at 5ms(fast speed relay, e.g. BO9)
- CB2 making time at 60 ms and 7VU683 BO making time at 1ms(high speed relay, e.g. BO11)
- Closed by FAST transfer mode
- Criterions are met after CB1 is opened

Obviously, power source dead duration on motor bus must be there. The length of this dead duration depends on transfer action time and the alternative source CB making time.

The advantage of SIMUTANEOUS sequence is to completely avoid the switch-onto-fault.

Switching logic can be referred to below Figure 2-15.

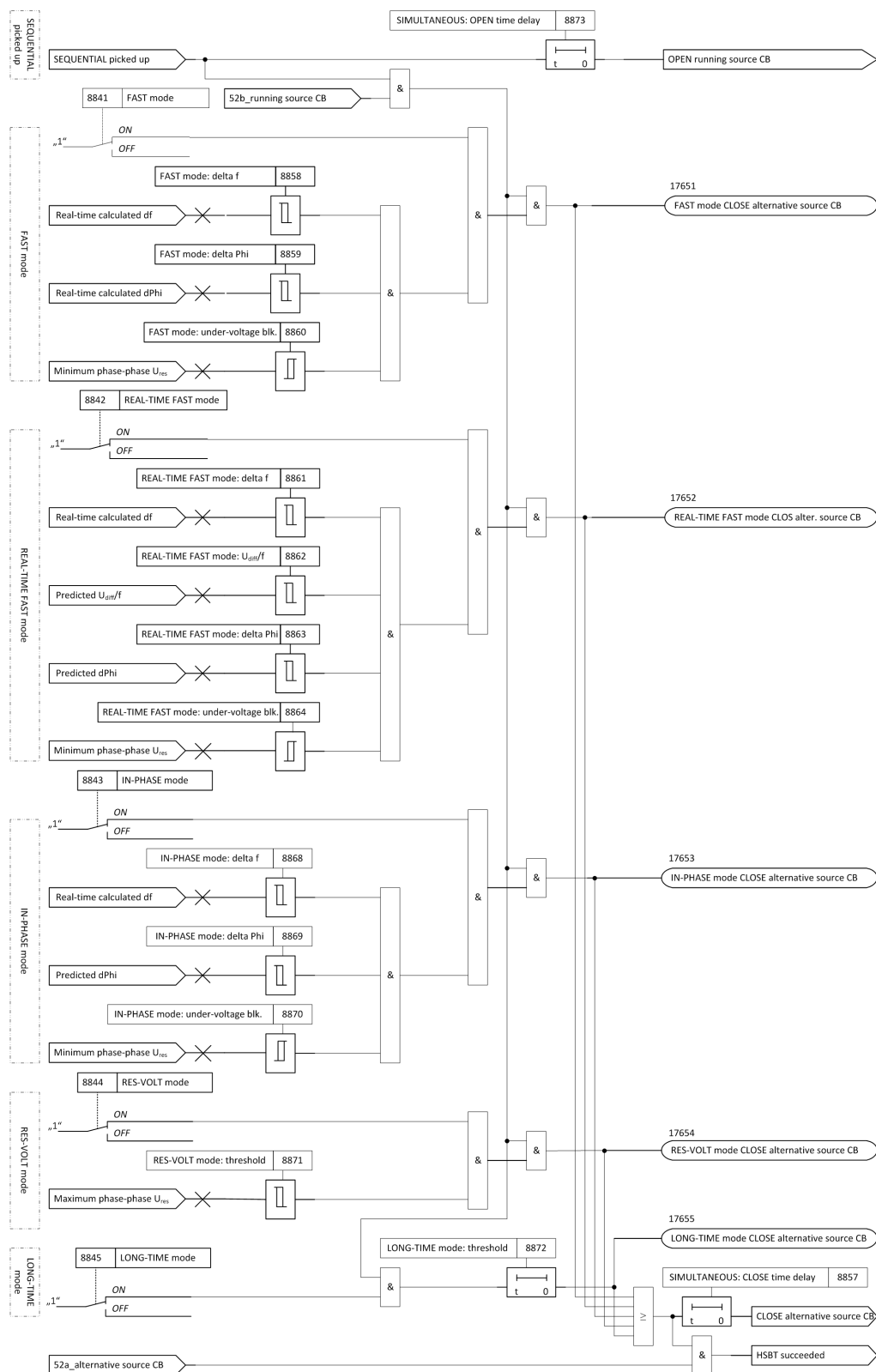


Figure 2-15 Switching logic illustration of SEQUENTIAL sequence

2.2.4 Single busbar with 2-CB

This chapter is to describe the application of primary diagram *single busbar w. 2-CB*.

2.2.4.1 General

The primary diagram of single bus with 2-CB is typically seen in thermal power plant. The station service system is supplied by the auxiliary transformer of generator-transformer block during the normal operation. On the other hand, it's supplied by standby transformer during the planned starting-up, shutting down, etc.

Comprehensive transfer concepts include switching direction, readiness, starting condition, low voltage load-shedding and local/remote start, etc.

Figure 2-16 illustrates the general switching command.

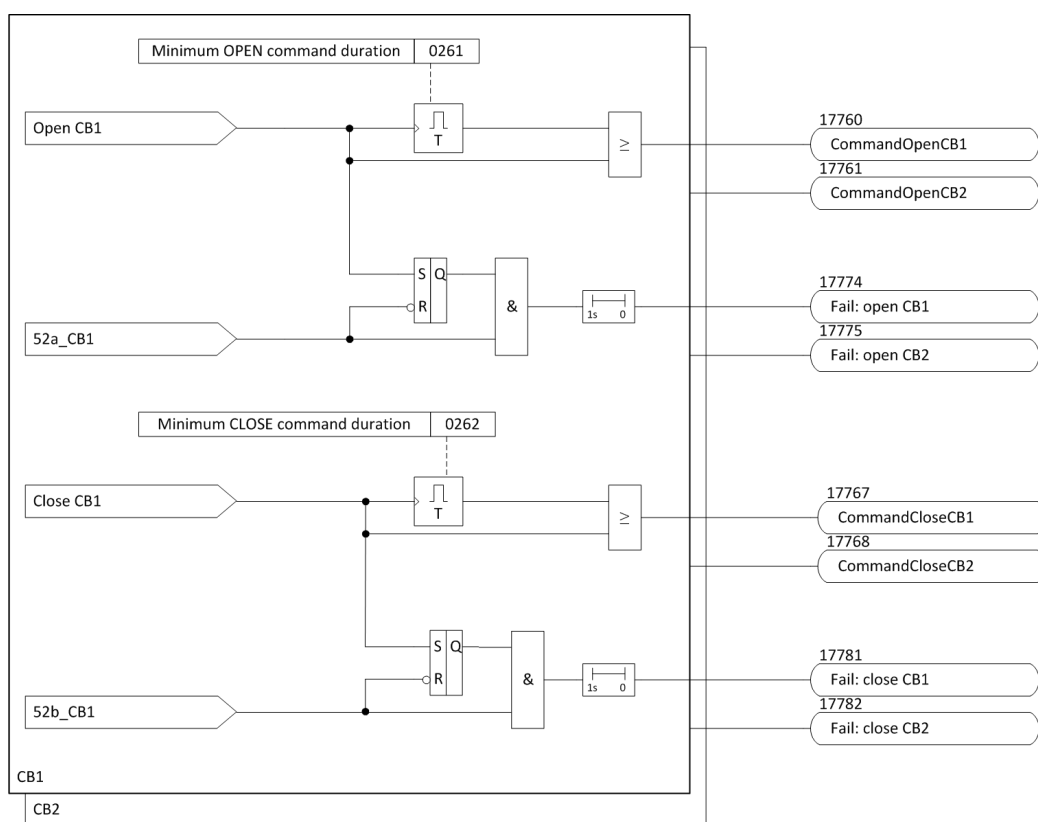


Figure 2-16 General switching command for primary diagram of single bus with 2-CB

Parameter 0261 **Minimum OPEN command duration** is to expand the OPEN command pulse to ensure the reliable CB trip. Factory setting should be enough for most cases.

Parameter 0262 **Minimum CLOSE command duration** is to expand the CLOSE command pulse to ensure the reliable CB closure. Factory setting should be enough for most cases.



Note:

- The device does not support control function. It's impossible to switch CB via device front panel.
- CB status position is recommended to be routed to device by double point indication. It can also be routed to device by single point indication. In this case, the link for device display needs to be updated. That is, e.g for CB1, if only 52a_CB1 is connected to BI7, both indication 17621 >**CB1 52a** and 17622 >**CB1 52b** are routed to BI7 with respective configuration "H" and "L".

Below Figure 2-17 illustrates the general transfer information.

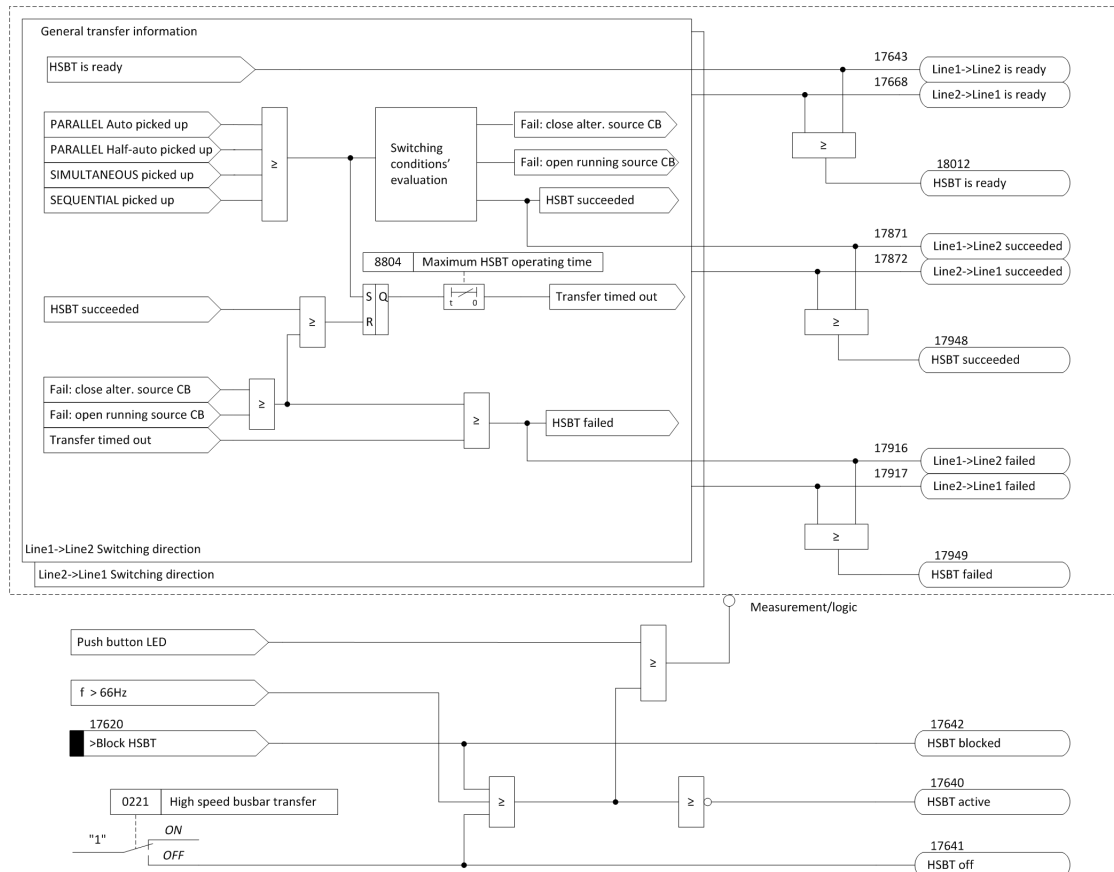


Figure 2-17 General transfer information for primary diagram of single bus with 2-CB

Parameter 8804 **Maximum HSBT operating time** is to monitor the whole transfer duration. If the time is expired since transfer pick up, it is seen as transfer time out and indicated by HSBT failed. Factory setting should be enough for most cases.

2.2.4.2 Switching direction

Two switching directions are possible under primary diagram of single bus with 2-CB. To switch off CB1 and to switch on CB2 is defined as switching direction **Line1->Line2**. To switch off CB2 and to switch on CB1 is defined as switching direction **Line1->Line2**.

See the Figure 2-18 as below.

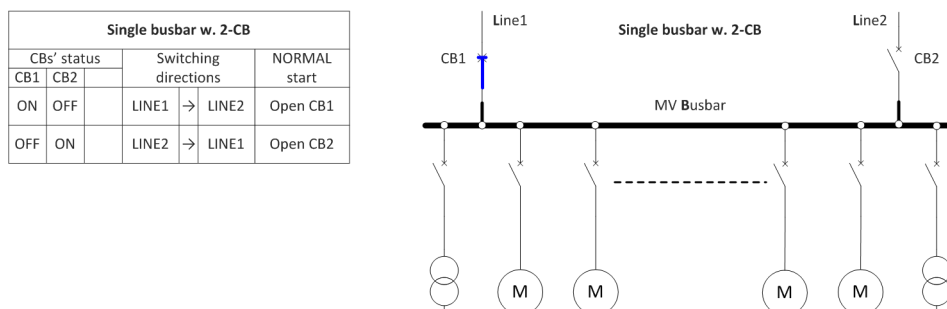


Figure 2-18 Possible switching direction for primary diagram of single busbar with 2-CB

Under normal operation only one CB is in closing status and only one switching direction is possible. HSBT 7VU683 will automatically determine the switching direction based on the actual CBs' status and the source of transfer request command.

Each switching direction can be individually parameterized *ON* or *OFF* remotely via communication or locally at device panel.

HSBT supports bi-directional bus transfer under **NORMAL** condition, i.e, from main source to alternative source, vice versa.

In some cases, the switching is limited to mono-direction, i.e, from main source to alternative, under starting conditions of FAULT and Abnormal. The requirement can be implemented by setting the parameter 8831 **Mono-direction against NORMAL condition** = YES. The default setting NO means bidirectional switching is always supported under each starting condition.

To be noted that the device has default agreement that the source of voltage input Ux_L1 is exclusively defined as main while other as alternative. Then, if mono-direction against NORMAL condition is required, main source must be always connected to device channel Ux_L1.

The transfer permission under various starting conditions and switching directions can be referred to below Table 2-1.

Table 2-1 Transfer permission under default setting, single busbar w. 2-CB

CB1 Status	CB2 Status	Switching direction		Voltage Comparison		Busbar Transfer Permitted?						
		From	To			NORMAL	FAULT	Inadmissible Under-volt.	Inadmissible Under-Freq.	Inadmissible Neg.dfdt	Reverse Power	Inadvertent CB Open
ON	OFF	L1	L2	U_B	U_L2	YES	YES	YES	YES	YES	YES	YES
OFF	ON	L2	L1	U_B	U_L1	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾

¹⁾ If parameter 8831 **Mono-direction against Normal**=NO, this cell says Yes. Otherwise, this cell says No.

2.2.4.3 Readiness

To secure the reliable transfer, the device 7VU683 will continuously monitor the normal operation conditions. If all criterions are met, the device goes into readiness prepared for transfer.

Only under ready status, transfer request command can be executed. Otherwise, HSBT is in un-ready state and no transfer is possible.

In some regions, e.g, P. R. China, any manual CB open/close command(remote/local) is interpreted and indicated as message **NonManu.Op.CBx** by device Operation-box. If CB is manually tripped, the message indicates "0". This can be directly routed, e.g for CB1, to 17864 >**NonManu.Op.CB1** to block the transfer.

If no Operation-box is there, please leave the indication **>NonManu.Op.CBx** not configured.

Factory values for parameter 8818 **Time delay to readiness** and 8819 **Time delay to un-readiness** should be applied for most cases.

Please refer to below readiness logics for each switching direction.

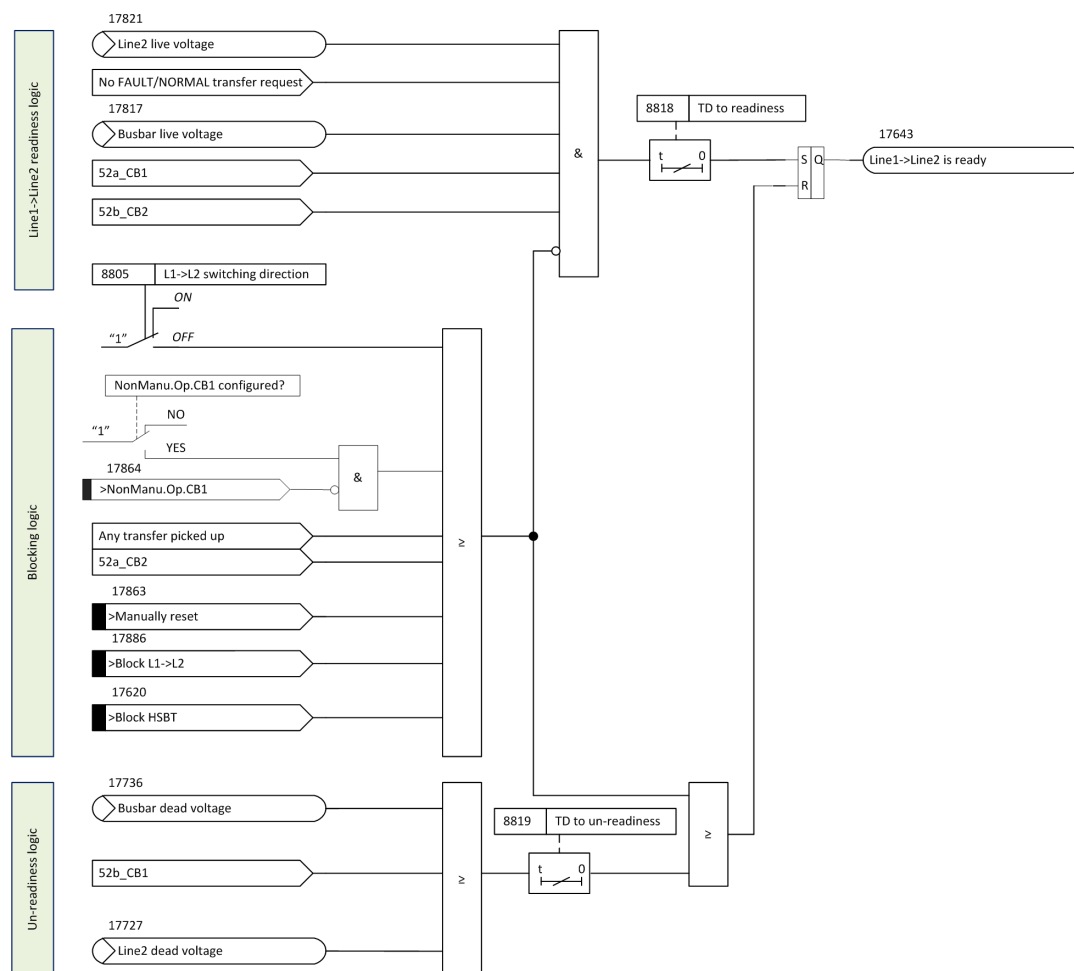


Figure 2-19 Readiness logic for switching direction Line1->Line2, single bus with 2-CB

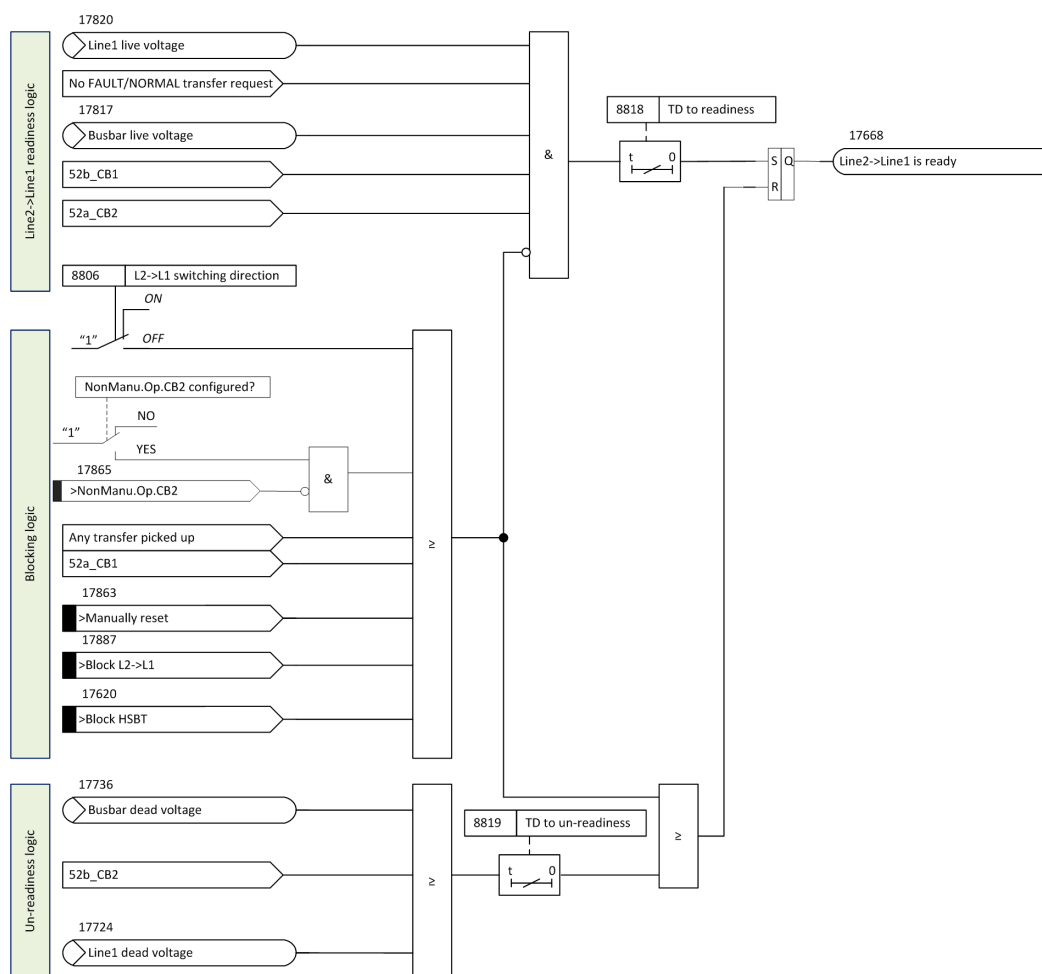


Figure 2-20 Readiness logic for switching direction Line2->Line1, single bus with 2-CB

2.2.4.4 Starting conditions

Resulted from Figure 2-6, 7VU683 supports various starting conditions.

NORMAL starting condition

In case of planned switching-over, HSBT is manually started. It's defined in 7VU683 as **NORMAL** starting condition.

The transfer request command from operator can be sent out by below two channels,

- Communication: remotely over protocol
- Binary input: locally over binary input via wiring

The transfer request command can be derived from DCS, turbine control system or local panel.

All switching sequences, i.e. *PARALLEL Auto*, *PARALLEL Half-auto*, *SIMULTANEOUS* and *SEQUENTIAL*, are possible.

The transfer request command from operator is directly routed to device indication input, e.g. **>NORMAL Op. CB1** for switching direction **Line1->Line2**.

Starting logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-21.

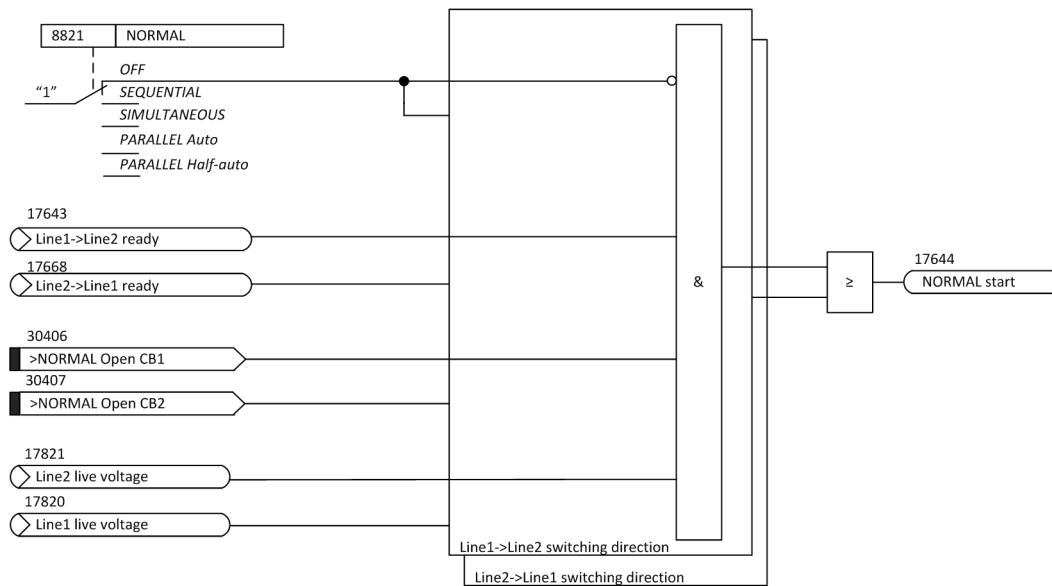


Figure 2-21 NORMAL start logic for primary diagram of single bus with 2-CB

ABNORMAL starting condition

Up-stream CB trip resulted from system fault or in-feeder CB in-advertent open will lead to power source loss on motor bus. It will raise the need of self-start of HSBT. It's defined as ABNORMAL starting condition. Below starting logics are included in 7VU683,

- In-admissible under-voltage
- In-admissible under-frequency
- In-admissible df/dt
- Reverse power
- In-advertent CB open

The above self-start logics can be freely combined together, i.e., one of them can be individually switched ON/OFF.

For reliable self-starting transfer, special attention must be paid, i.e., self-start logic must be blocked during electric fault, motor starting up, bus voltage MCB trip, manual trip of running source CB, etc.

Kinds of electric fault can be recognized by integrated Fault Detection function, see elow Figure 2-22.

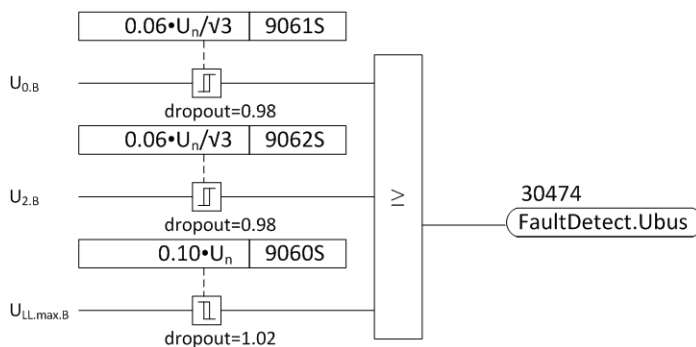


Figure 2-22 Fault detection logic for primary diagram of single bus with 2-CB

Motor starting up can be recognized by Motor Start Recognition function, see below Figure 2-23.

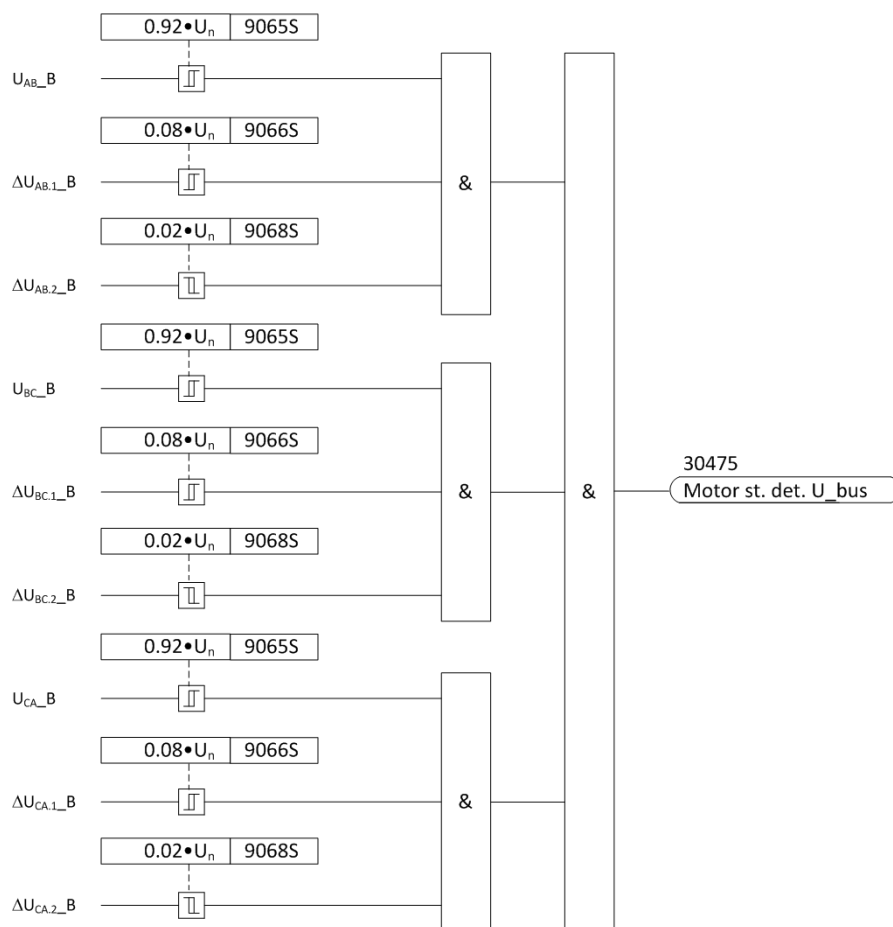


Figure 2-23 Motor starting-up recognition logic for primary diagram of single bus with 2-CB

Additionally the line current can be used to block the self-start logic, i.e, self-start logic can only be released under line dead current.

Under-voltage self-start logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-24.

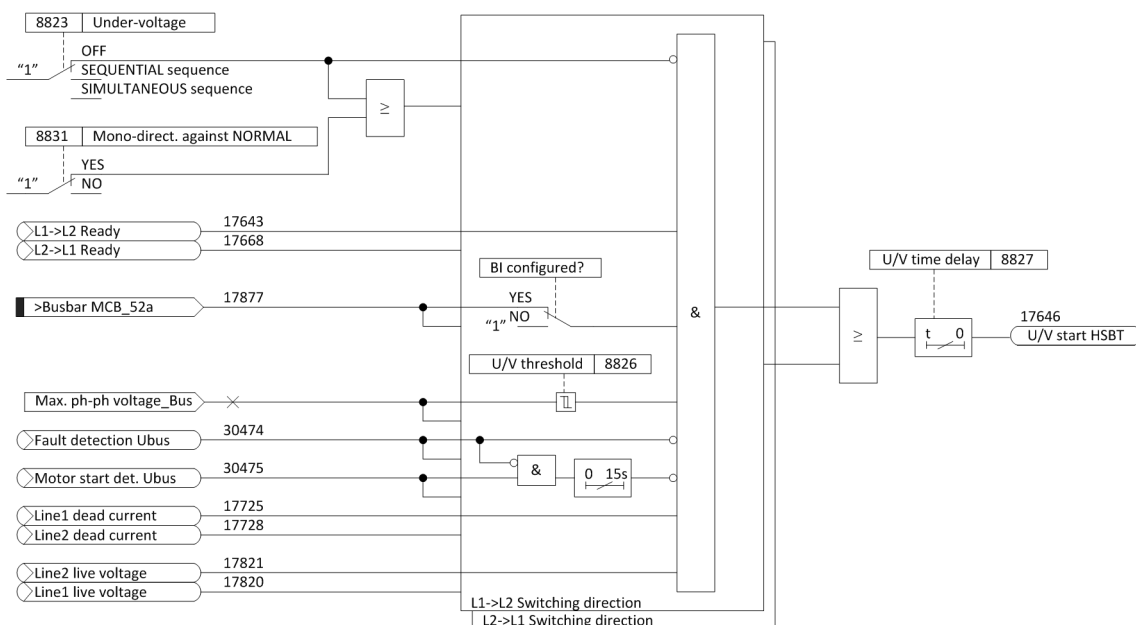


Figure 2-24 Under-voltage self-start logic for primary diagram of single bus with 2-CB

Under-frequency self-start logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-25.

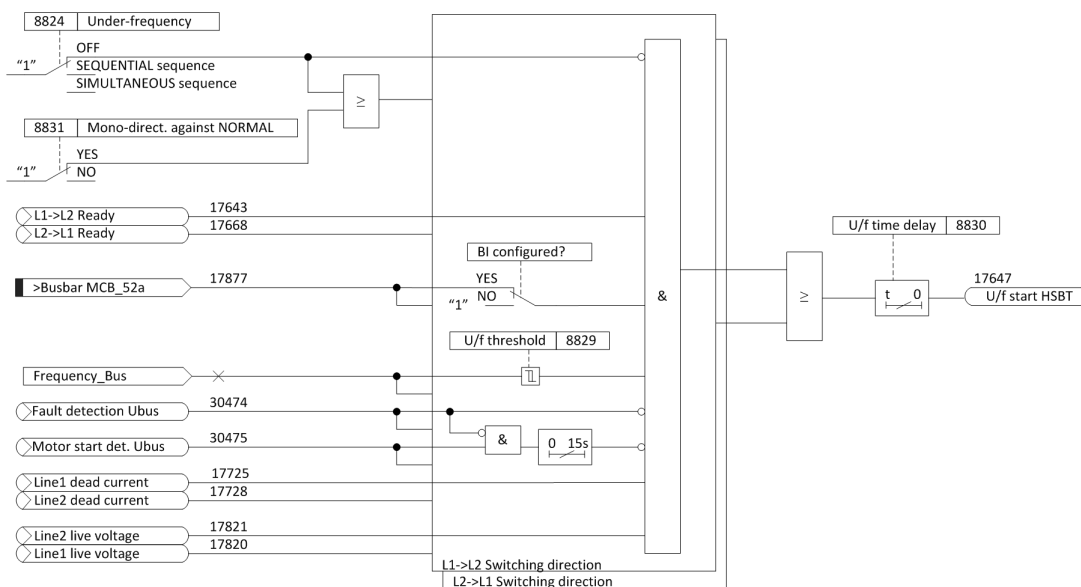


Figure 2-25 Under-frequency self-start logic for primary diagram of single bus with 2-CB

Reverse power self-start logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-26.

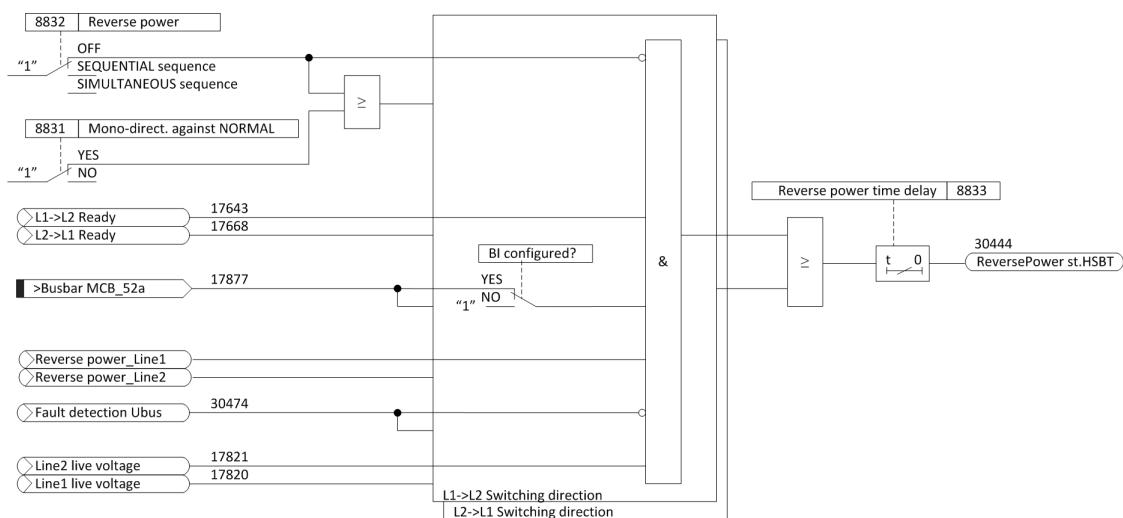


Figure 2-26 Reverse power self-start logic for primary diagram of single bus with 2-CB

Change rate of frequency self-start logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-27.

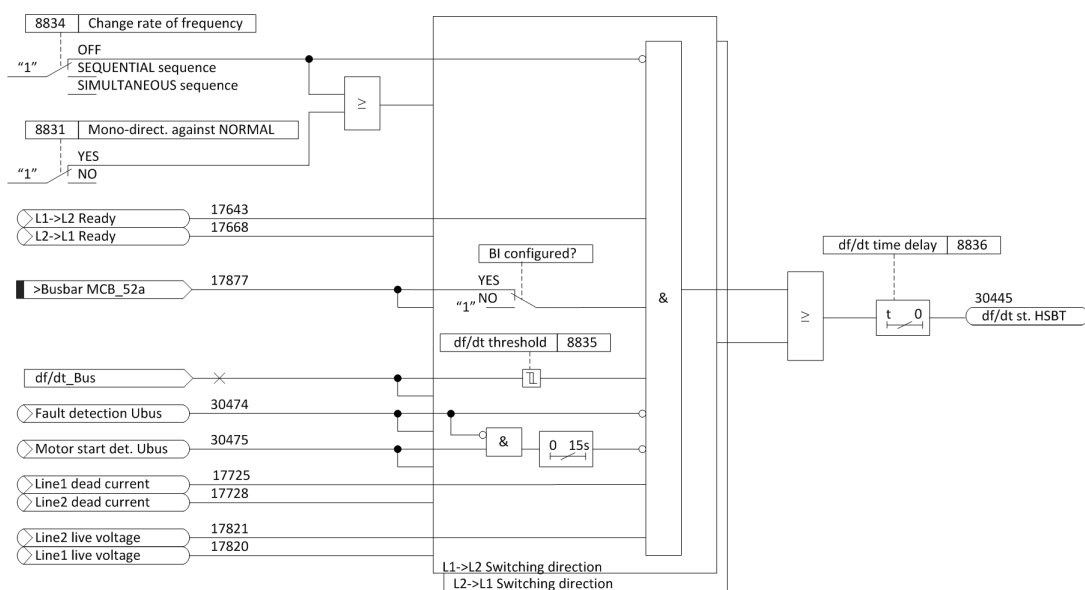


Figure 2-27 Change rate of frequency self-start logic for primary diagram of single bus with 2-CB

In-advertent CB open self-start logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-28.

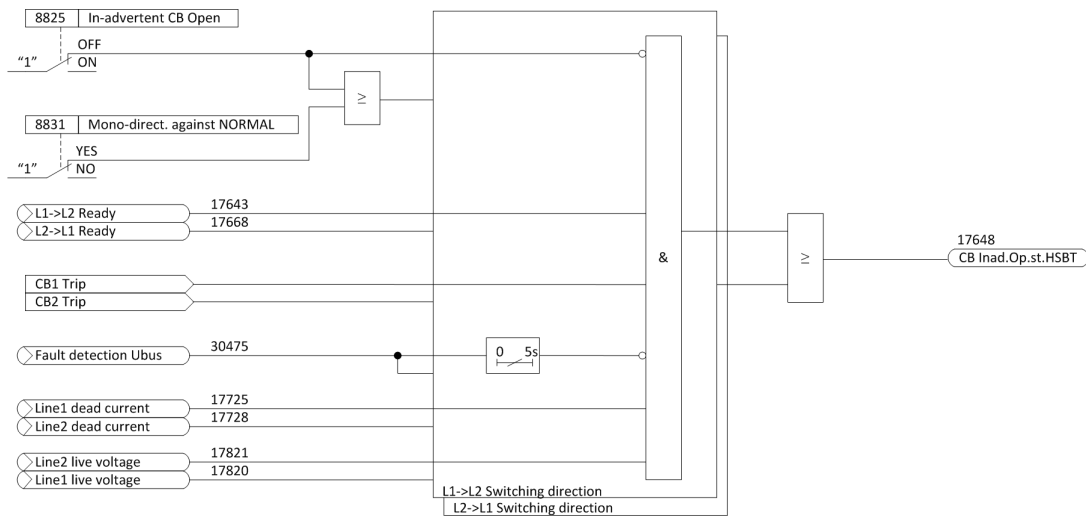


Figure 2-28 In-advertent CB open self-start logic for primary diagram of single bus with 2-CB

FAULT starting condition

Under the FAULT starting condition, power system fault must be there on the in-feeding source and the starting command must be externally issued by other device, e.g, protective relays.

Faults on the in-feeding source will be detected and cleared by protective relays, e.g, transformer differential relay. Meanwhile, HSBT should be externally started. The faults can be classified into two types regarding the electric symmetry. Then, optimization of switching sequence can be deployed. E.g,

- Type A: e.g, electric fault, i.e, GEN, TFR trips, to deploy SEQUENTIAL sequence;
- Type B: e.g, non-electric fault, i.e, boiler, turbine trips, to deploy SIMULTANEOUS sequence.

Starting logic for switching direction **Line1->Line2** and **Line2->Line1** can be referred to below Figure 2-29 and Figure 2-30.

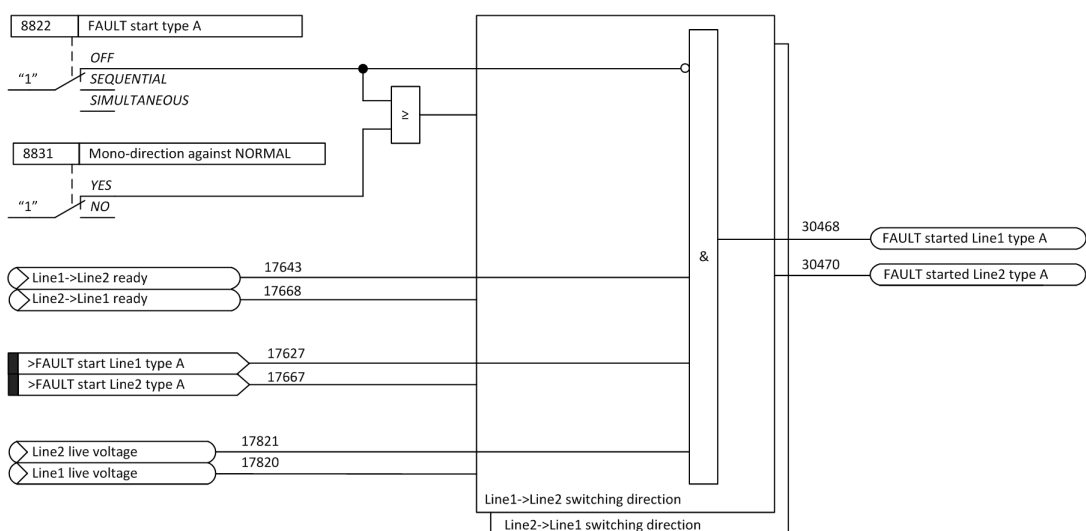


Figure 2-29 FAULT start logic for primary diagram of single bus with 2-CB, type A

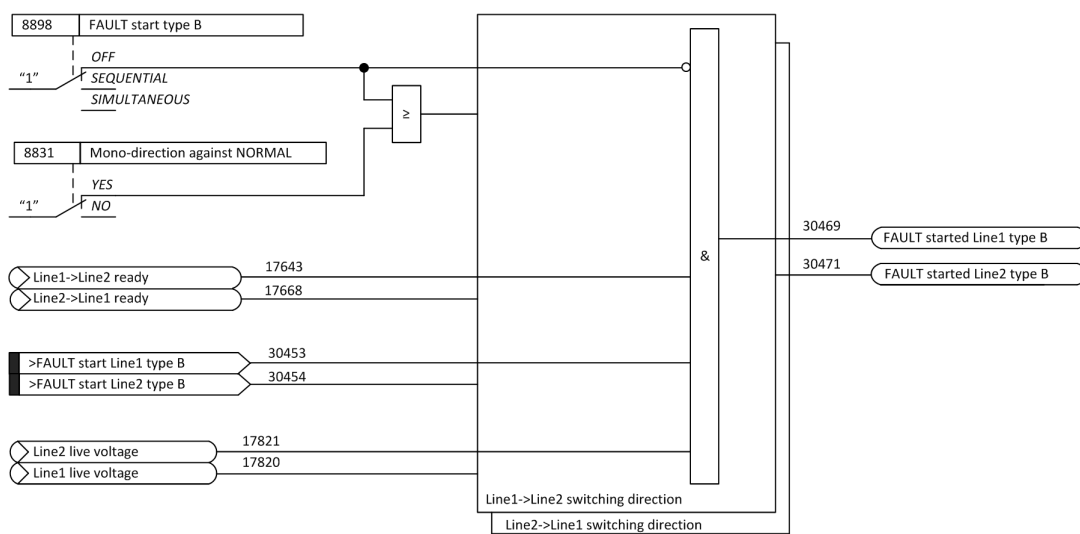


Figure 2-30 FAULT start logic for primary diagram of single bus with 2-CB, type B

2.2.4.5 Local/remote start

The authority of manual start is controlled by key switch LOCAL/REMOTE on device panel. The pre-CFC is already implemented in device to connect either binary input or protocol transfer request command.

To be noted that, protocol transfer requesting command can only be treated when LOCAL/ REMOTE switching key on device front panel is in REMOTE position. Otherwise, BI transfer requesting command will be treated.

Factory CFC in device for local/remote start logic can be referred to below Figure 2-31.

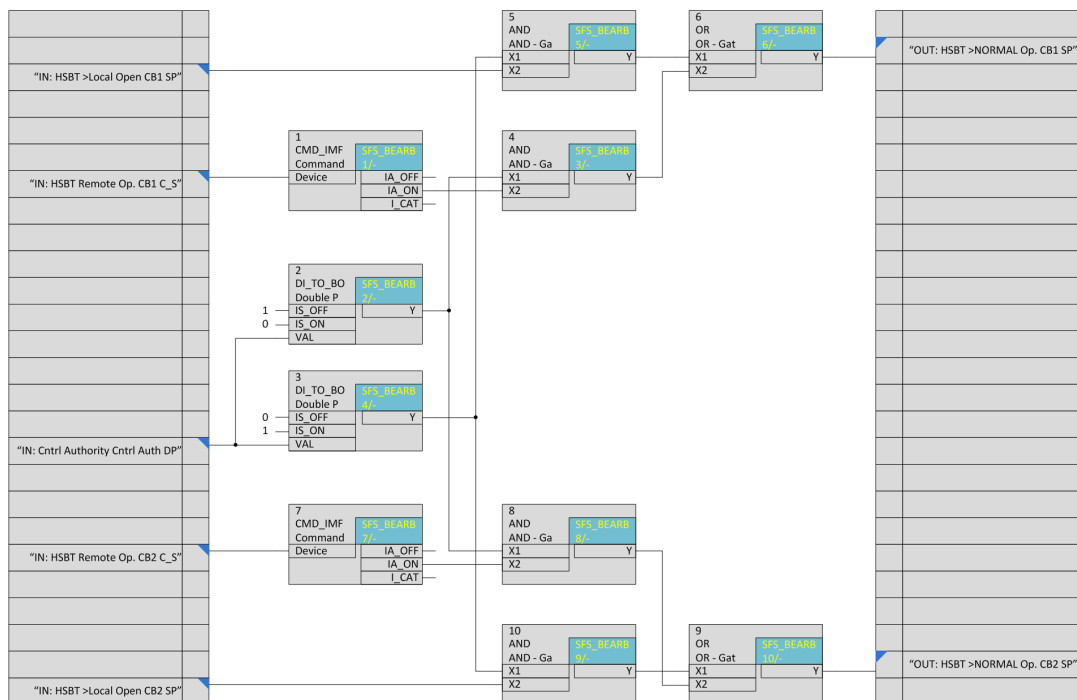


Figure 2-31 Local-remote start logic for primary diagram of single bus with 2-CB



Note:

This CFC logic block can only be programmed with the priority of Interlocking (SFS_BEARB / INTERLOCK).

2.2.4.6 Low voltage load-shedding

To avoid the alternative source over-loading in case of motors' restarting under low voltage transfer, it is helpful to implement low voltage load-shedding (LVLSH) function before RES-VOLT transfer. LVLSH is setting free which pickup value is taken from 8870 **IN-PHASE mode: under-voltage block**, with one stage, no time delay. This function can be activated or de-activated manually on site.

The loads to be shed are the customer's decision.

Low voltage load-shedding logic can be referred to below Figure 2-32.

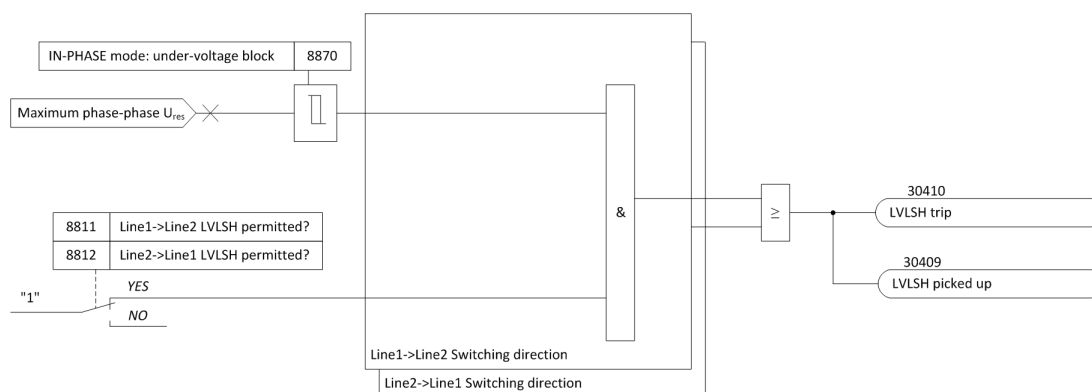


Figure 2-32 LVLSH for primary diagram of single bus with 2-CB

2.2.4.7 Settings

Address	Parameter	Range	Default Setting	Note
<i>HSBT->General</i>				
8801	CB1 closing time	20<=...<=150	70 ms	
8802	CB2 closing time	20<=...<=150	70 ms	
8804	Maximum permitted HSBT operating Time	10<=...<=60	20 sec	
8805	Switching direction Line1->Line2	ON OFF	OFF	
8806	Switching direction Line2->Line1	ON OFF	OFF	
8811	Line1->Line2 LVLSH permitted	YES NO	NO	
8812	Line2->Line1 LVLSH permitted	YES NO	NO	
8817	Manually reset	YES NO	NO	
8818	Time delay to readiness	5<=...<=60	10 sec	
8819	Time delay to un-readiness	10<=...<=60	10 sec	
8820	HSBT test mode	ON OFF	OFF	
<i>HSBT->Start Condition</i>				
8821	NORMAL	OFF PARALLEL Auto PARAL. Half-Auto SIMULTANEOUS SEQUENTIAL	PARALLEL Auto	
8822	FAULT start type A	OFF SIMULTANEOUS SEQUENTIAL	SEQUENTIAL	
8898	FAULT start type B	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8823	Under-voltage	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8826	Under-voltage threshold	0.700<=...<=0.950	0.850 U/Un	
8827	Under-voltage time Delay	0<= ...<=1000	10 ms	
8824	Under-frequency	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8829	Under-frequency threshold	45.00<=...<=49.50	47.50 Hz	f _n = 50 Hz
8829	Under-frequency threshold	55.00<=...<=59.50	57.00 Hz	f _n = 60 Hz
8830	Under-frequency time Delay	0<=...<=1000	10 ms	
8832	Reverse power	OFF SIMULTANEOUS SEQUENTIAL	OFF	
8833	Reverse power time delay	0<=...<=1000	10 ms	

Address	Parameter	Range	Default Setting	Note
8834	Change rate of frequency	OFF SIMULTANEOUS SEQUENTIAL	OFF	
8835	Change rate of frequency threshold	-10.0<=...<=-0.5	-0.5 Hz/s	
8836	Change rate of frequency time delay	0<=...<=1000	10 ms	
8825	Inadvertent CB Open	OFF ON	ON	
8831	Mono-direction against NORMAL	YES NO	NO	
<i>HSBT->Transfer Mode</i>				
8841	FAST	OFF ON	ON	
8842	REAL-TIME FAST	OFF ON	ON	
8843	IN-PHASE	OFF ON	ON	
8844	RES-VOLT	OFF ON	ON	
8845	LONG-TIME	OFF ON	ON	
<i>HSBT-->Transfer Set</i>				
8851	PARALLEL sequence: delta frequency	0.02<=...<=2.00	0.10 Hz	
8852	PARALLEL sequence: delta U	1.0<=...<=40.0	2.0 V	
8853	PARALLEL sequence: delta phase angle	2.0<=...<=80.0	10.0 °	
8854	PARALLEL Auto: CB open time delay	0.00<=...<=2.00	0.10 sec	
8857	SIMULTANEOUS sequence: CB close time delay	0<=...<=40	0 ms	
8873	SIMULTANEOUS sequence: CB open time delay	0<=...<=40	0 ms	
8858	FAST mode: delta frequency	0.50<=...<=2.50	1.00 Hz	
8859	FAST mode: delta phase angle	10.0<=...<=50.0	20.0 °	
8860	FAST mode: under-voltage block	0.500<=...<=0.900	0.700 U/Un	
8861	REAL-TIME FAST mode: delta frequency	1.00<=...<=15.00	3.00 Hz	
8862	REAL-TIME FAST mode: U_{diff}/f	1.00<=...<=1.33	1.33 p.u.	
8863	REAL-TIME FAST mode: delta phase angle	70.0<=...<=90.0	90.0 °	
8864	REAL-TIME FAST mode: under-voltage block	0.500<=...<=0.900	0.700 U/Un	
8868	IN-PHASE mode: delta frequency	1.00<=...<=15.00	5.00 Hz	
8869	IN-PHASE mode: delta phase angle	0.5<=...<=20.0	5.0 °	
8870	IN-PHASE mode: under-voltage block	0.200<=...<=0.800	0.400 U/Un	
8871	RES-VOLT mode: threshold	0.200<=...<=0.600	0.300 U/Un	
8872	LONG-TIME mode: threshold	0.50<=...<=10.00	3.00 sec	

2.2.4.8 Information List

No.	Information	Type	Fun. NO.	Inf. NO.
17620	>BLOCK HSBT	SP		
17863	>Manually reset	SP		
17627	>FAULT start Line1 type A	SP		
17667	>FAULT start Line2 type A	SP		
30453	>FAULT start Line1 type B	SP		
30454	>FAULT start Line2 type B	SP		
30406	>NORMAL open CB1	SP		
30407	>NORMAL open CB2	SP		
17870	>Manual open command in PARALL.Half-Auto	SP		
18020	>HSBT test mode	SP		
17640	HSBT is active	OUT		
17641	HSBT is switched off	OUT		
17642	HSBT is blocked	OUT		
30474	Fault detected Ubus	OUT		
30475	Motor start detected Ubus	OUT		
17644	NORMAL start	OUT		
17646	Under-voltage start	OUT		
17647	Under-frequency start	OUT		
30444	Reverse Power start	OUT		
30445	Change rate of frequency start	OUT		
17648	Inadvertent CB open start	OUT		
17651	FAST mode close standby source	OUT		
17652	REAL-TIME FAST mode close standby source	OUT		
17653	IN-PHASE mode close standby source	OUT		
17654	RES-VOLT mode close standby source	OUT		
17655	LONG-TIME mode close standby source	OUT		
17656	PARALLEL sequence close standby source	OUT		
17657	SIMULTANEOUS sequence close standby source	OUT		
30452	SEQUENTIAL sequence close standby source	OUT		
30456	df at CB closing command triggered	VI		
30457	dU at CB closing command triggered	VI		
30458	dφ at CB closing command triggered	VI		
30459	Residual voltage at CB closing command triggered	VI		
30460	V/Hz p.u. at CB closing command triggered	VI		
30461	df at CB closing instant	VI		
30462	dU at CB closing instant	VI		
30463	dφ at CB closing instant	VI		
30464	Residual voltage at CB closing instant	VI		
30465	V/Hz p.u. at CB closing instant	VI		
18017	CB1 Closing Time =	VI		
18018	CB2 Closing Time =	VI		
18019	CB3 Closing Time =	VI		
17886	>BLOCK Line1 -> Line2	SP		
17950	Line1 -> Line2 is blocked	OUT		

No.	Information	Type	Fun. NO.	Inf. NO.
17643	Line1 -> Line2 is ready	OUT		
17871	Line1 -> Line2 succeeded	OUT	200	15
17922	Line1 -> Line2 timed out	OUT		
17916	Line1 -> Line2 failed	OUT	200	21
17887	>Block Line2 -> Line1	SP		
17951	Line2 -> Line1 is blocked	OUT		
17668	Line2 -> Line1 is ready	OUT		
17872	Line2 -> Line1 succeeded	OUT	200	16
17923	Line2 -> Line1 timed out	OUT		
17917	Line2 -> Line1 failed	OUT	200	22
18012	HSBT is ready	OUT	200	93
17948	HSBT succeeded	OUT	200	91
17949	HSBT failed	OUT	200	92
30409	Low voltage load-shedding pick up	OUT	150	1
30410	Low voltage load-shedding trip	OUT	150	2
17963	Line1 -> Line2 ON/OFF	IntSP	200	66
17964	Line2 -> Line1 ON/OFF	IntSP	200	67
17969	FAST transfer mode ON/OFF	IntSP		
17970	REAL-TIME FAST transfer mode ON/OFF	IntSP		
17971	IN-PHASE transfer mode ON/OFF	IntSP		
17972	RES-VOLT transfer mode ON/OFF	IntSP		
17973	LONG-TIME transfer mode ON/OFF	IntSP		
	Remote open CB1	C_S		
	> Local open CB1	SP		
	Remote open CB2	C_S		
	> Local open CB2	SP		
30468	FAULT started Line1 type A	OUT		
30469	FAULT started Line1 type B	OUT		
30470	FAULT started Line2 type A	OUT		
30471	FAULT started Line2 type B	OUT		

2.2.5 Sectionalized single busbar with 3-CB

This chapter is to describe the application of primary diagram sectionalized **single busbar w. 3-CB**.

2.2.5.1 General

The primary diagram of sectionalized single bus with 3-CB is typically seen in industrial plant. The tie-CB(section CB) is open, and the two motor buses are powered by two sources respectively during the normal operation. On the other hand, both buses are supplied by one source during maintenance, source fault, etc.

Comprehensive transfer concepts include switching direction, readiness, starting condition, low voltage load-shedding and local/remote start, etc.

Figure 2-33 illustrates the general switching command.

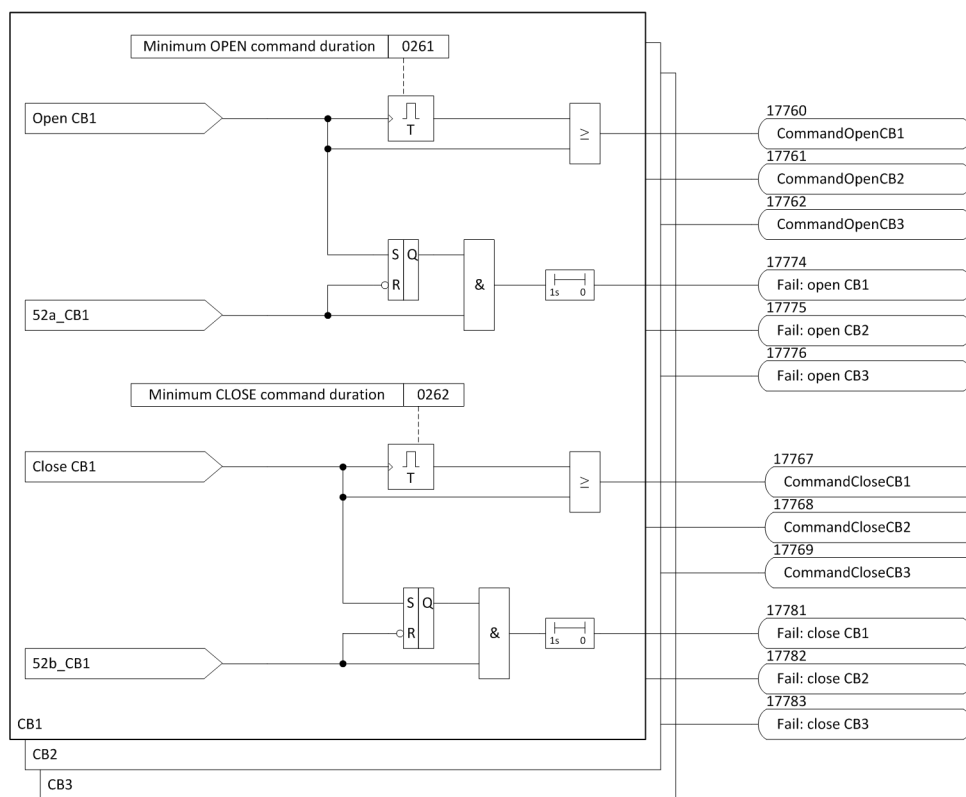


Figure 2-33 General switching command for primary diagram of sectionalized single bus with 3-CB

Parameter of 0261 **Minimum OPEN command duration** is to expand the OPEN command pulse to ensure the reliable CB trip. Factory setting should be enough for most cases.

Parameter of 0262 **Minimum CLOSE command duration** is to expand the CLOSE command pulse to ensure the reliable CB closure. Factory setting should be enough for most cases.



Note:

- The device does not support control function. It's impossible to switch CB via device front panel.
- CB status position is recommended to be routed to device by double point indication. It can also be routed to device by single point indication. In this case, the link for device display needs to be updated. That is, e.g for CB1, if only 52a_CB1 is connected to BI7, both indication 17621 >**CB1 52a** and 17622 >**CB1 52b** are routed to BI7 with respective configuration "H" and "L".

Below Figure 2-34 illustrates the general transfer information.

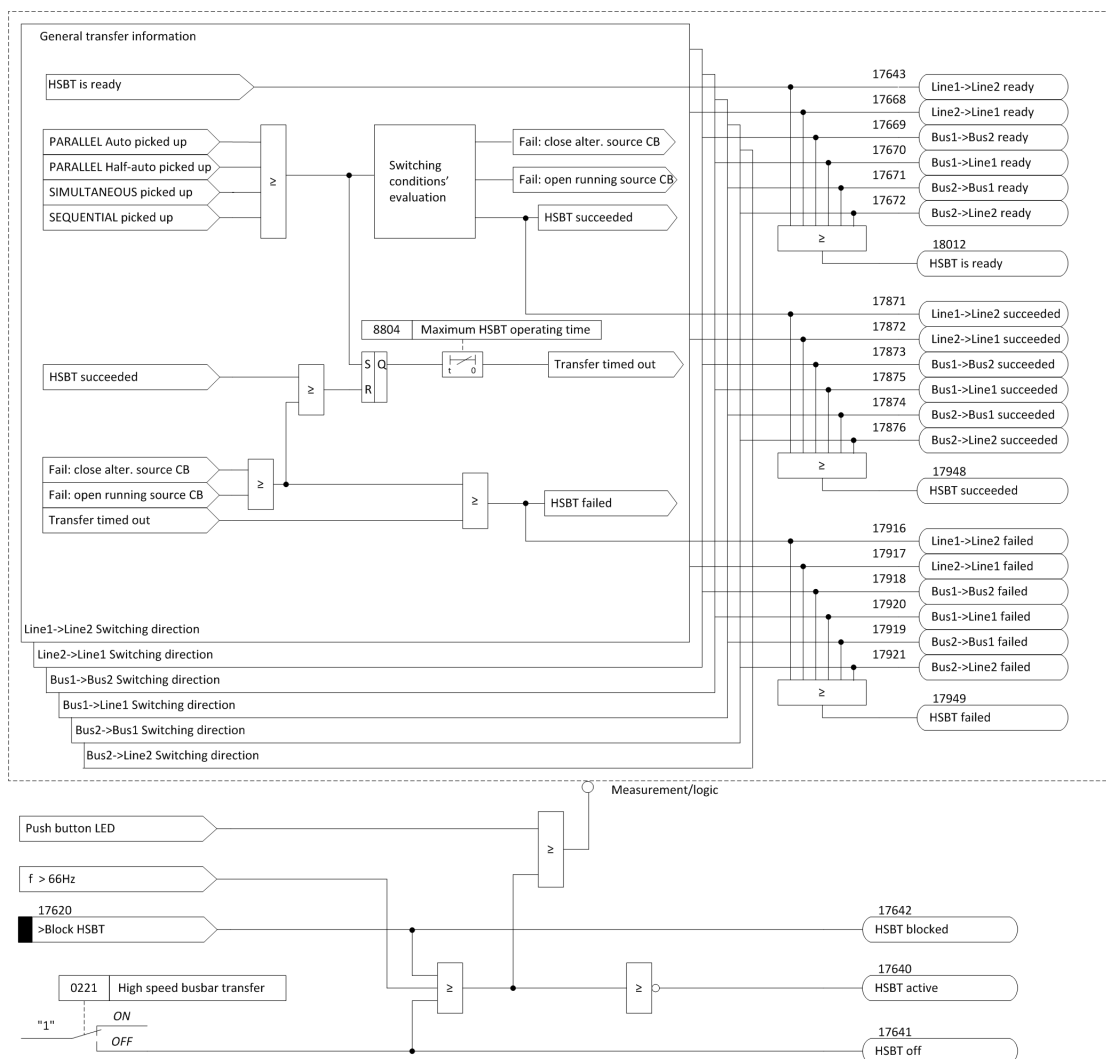


Figure 2-34 General transfer information for primary diagram of sectionalized single bus with 3-CB

Parameter 8804 **Maximum HSBT operating time** is to monitor the whole transfer duration. If the time is expired since transfer pick up, it is seen as transfer time out and indicated by HSBT failed. Factory setting should be enough for most cases.

2.2.5.2 Switching direction

Six switching directions are possible under primary diagram of sectionalized single bus with 3-CB.

To switch off CB1 and to switch on CB2 is defined as switching direction **Line1->Line2**. To switch off CB2 and to switch on CB1 is defined as switching direction **Line2->Line1**. To switch off CB1 and to switch on CB3 is defined as switching direction **Bus1->Bus2**. To switch off CB2 and to switch on CB3 is defined as switching direction **Bus2->Bus1**. To switch off CB3 and to switch on CB1 is defined as switching direction **Bus1->Line1**. To switch off CB3 and to switch on CB2 is defined as switching direction **Bus2->Line2**.

See the Figure 2-35 as below.

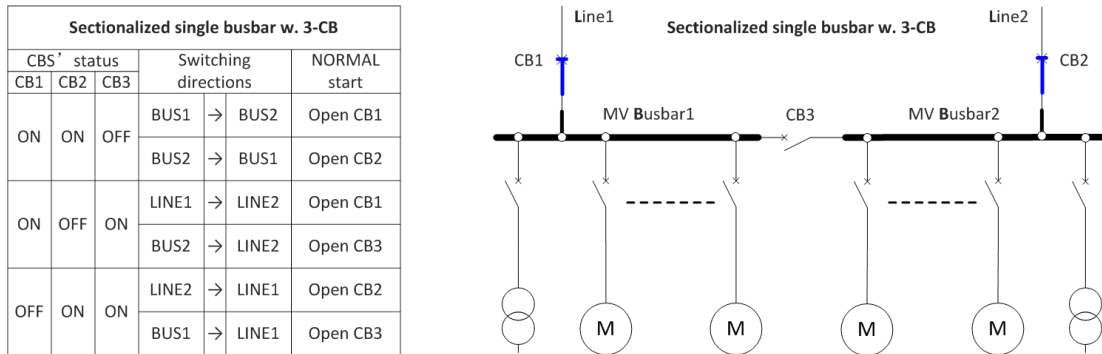


Figure 2-35 Possible switching direction for primary diagram of sectionalized single busbar w. 3-CB

Under normal operation two CBs are in closing status and two switching direction are possible. HSBT 7VU683 will automatically determine the switching direction based on the actual CBs' status and the source of transfer request command.

Each switching direction can be individually parameterized *ON* or *OFF* remotely via communication or locally at device panel.

HSBT supports bi-directional bus transfer under *NORMAL* condition, i.e, from main source to alternative source, vice versa.

In some cases, the switching is limited to mono-direction, i.e, from main source to alternative, under starting conditions of *FAULT* and *Abnormal*. The requirement can be implemented by set the parameter 8831 **Mono-direction against NORMAL condition** = *YES*. The default setting *NO* means bi-directional switching is always supported under each starting condition.

To be noted that the device has default agreement that the source of voltage input Ux_L1 is exclusively defined as main while other as alternative. Then, if mono-direction against *NORMAL* condition is required, main source must be always connected to device channel Ux_L1.

The transfer permission under various starting conditions and switching directions can be referred to below Table 2-2.

Table 2-2 Transfer permission under default setting, sectionalized single busbar w. 3-CB

CB1 Status	CB2 Status	CB2 Status	Switching direction		Voltage Comparison		Busbar Transfer Permitted?						
			From	To			NORMAL	FAULT	Inadmissible Under-volt.	Inadmissible Under-Freq.	Inadmissible Neg.df/dt	Reverse Power	Inadvertent CB Open
ON	OFF	ON	L1	L2	U_B2	U_L2	YES	YES	YES	YES	YES	YES	YES
			B2	L2	U_B2	U_L2	YES	--2)	--2)	--2)	--2)	--2)	--2)
ON	ON	OFF	B1	B2	U_B1	U_B2	YES	YES	YES	YES	YES	YES	YES
			B2	B1	U_B2	U_B2	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾
OFF	ON	ON	L2	L1	U_B1	U_L1	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾
			B1	L1	U_B1	U_L1	YES	--2)	--2)	--2)	--2)	--2)	--2)

¹⁾ If parameter 8831 "**Mono-direction against Normal**"="NO", this cell says Yes. Otherwise, this cell says No.

²⁾ Not applicable for this cell.

2.2.5.3 Readiness

To secure the reliable transfer, the device 7VU683 will continuously monitor the normal operation conditions. If all criterions are met, the device goes into readiness prepared for transfer.

Only under ready status, transfer request command can be executed. Otherwise, HSBT is in un-ready state and no transfer is possible.

In some region, e.g. P. R. China, any manual CB open/close command(remote/local) is interpreted and indicated as message **NonManu.Op.CBx** by device Operation-box. If CB is manually tripped, the message indicates "0". This can be directly routed, e.g. for CB1, to 17864 >**NonManu.Op.CB1** to block the transfer.

If no Operation-box is there, please leave the indication >**NonManu.Op.CBx** not configured.

Factory values for parameter 8818 **Time delay to readiness** and 8819 **Time delay to un-readiness** should be applied for most cases.

Please refer to below readiness logics for each switching direction.

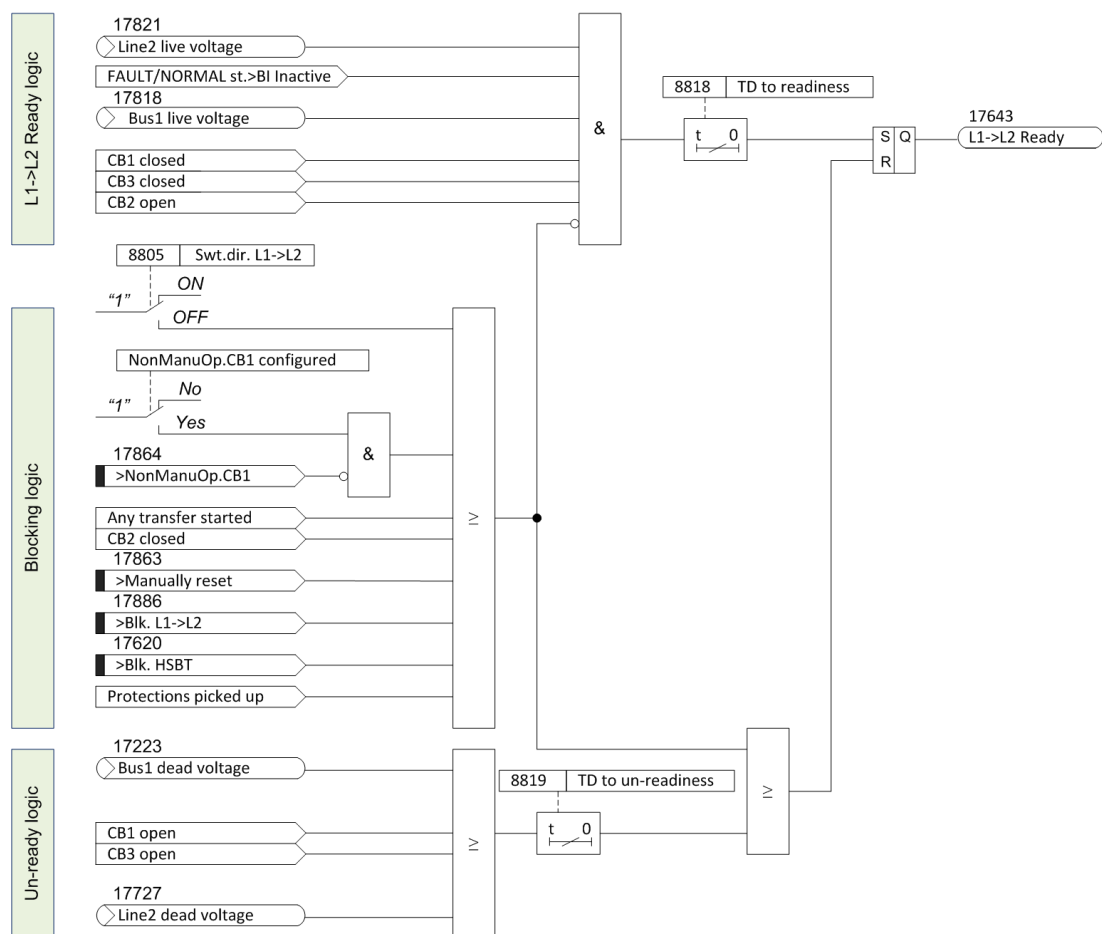


Figure 2-36 Readiness logic for switching direction Line1->Line2, sectionalized single bus with 3-CB

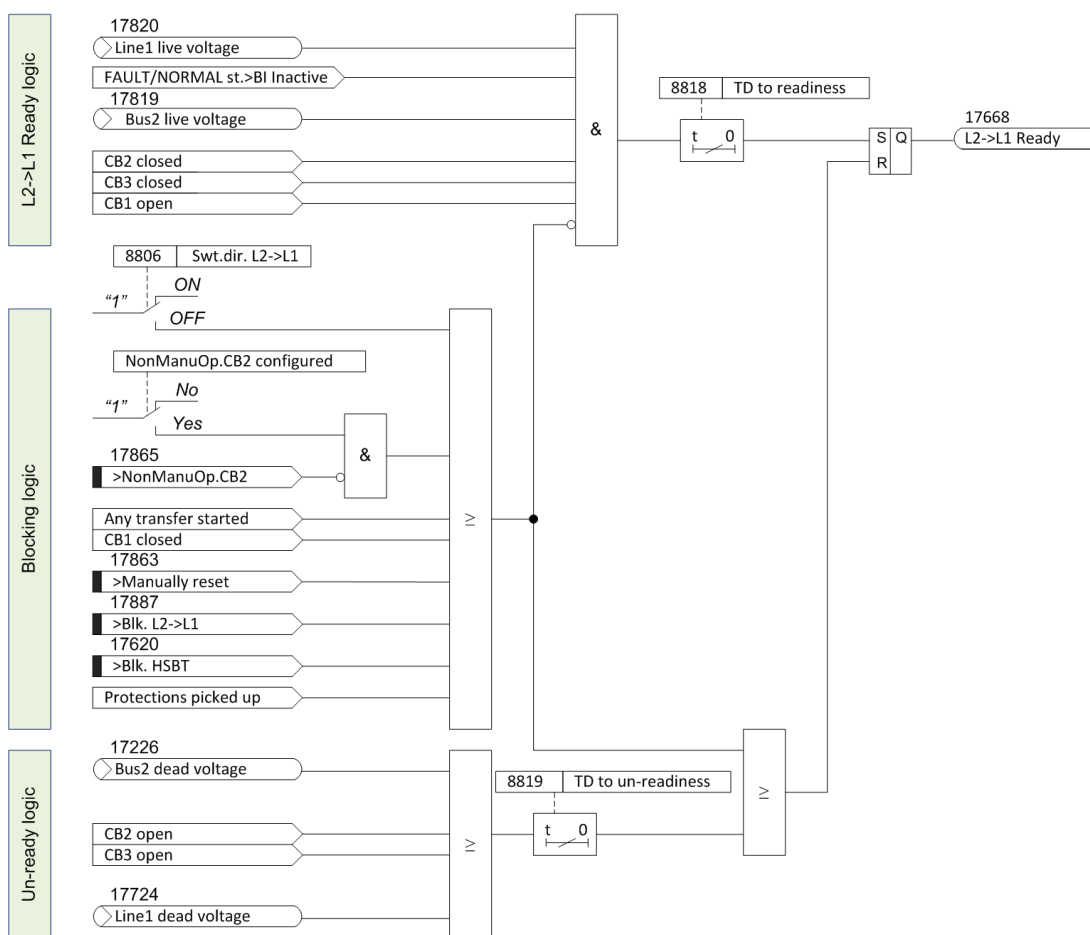


Figure 2-37 Readiness logic for switching direction Line2->Line1, sectionalized single bus with 3-CB

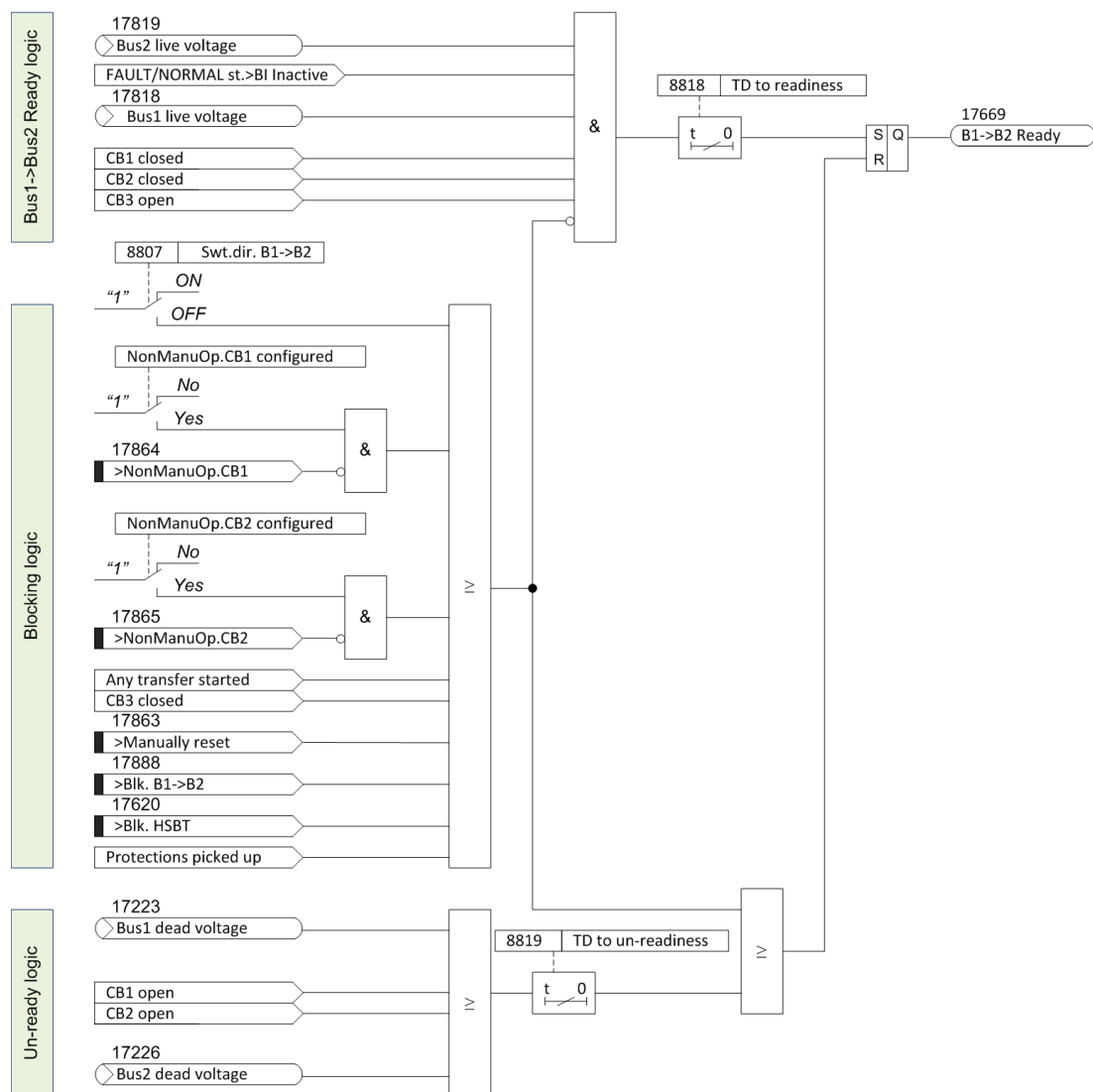


Figure 2-38 Readiness logic for switching direction Bus1->Bus2, sectionalized single bus with 3-CB

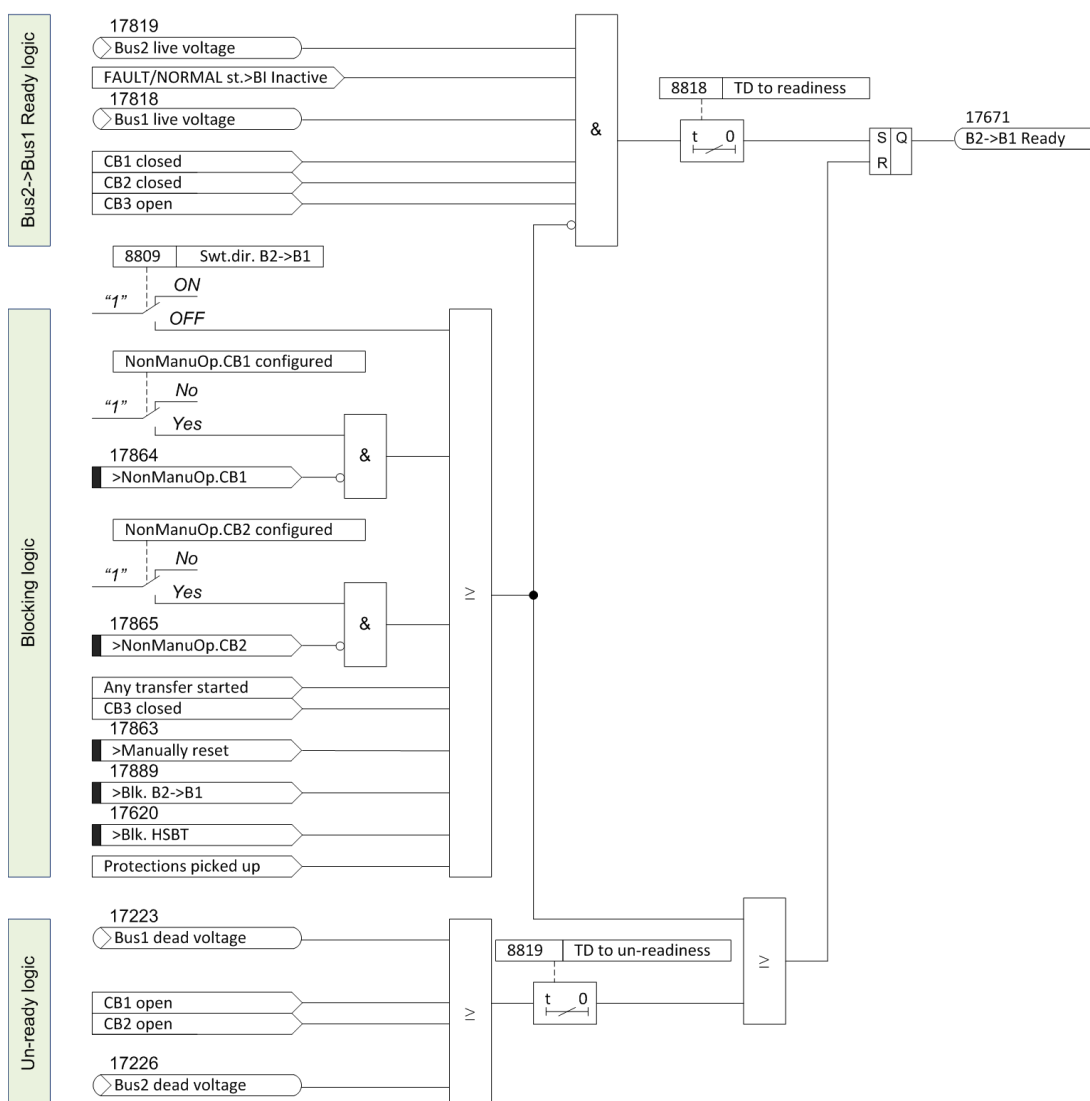


Figure 2-39 Readiness logic for switching direction Bus2->Bus1, sectionalized single bus with 3-CB

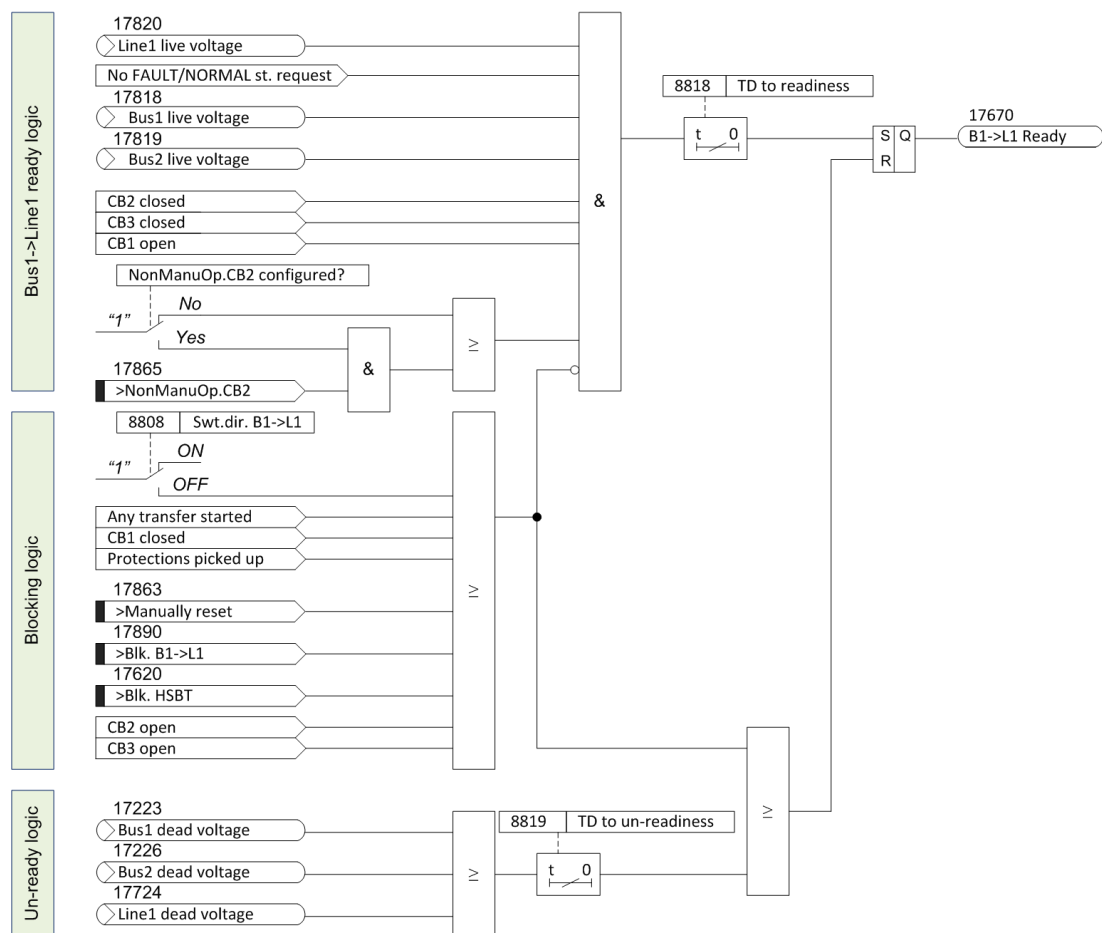


Figure 2-40 Readiness logic for switching direction Bus1->Line1, sectionalized single bus with 3-CB

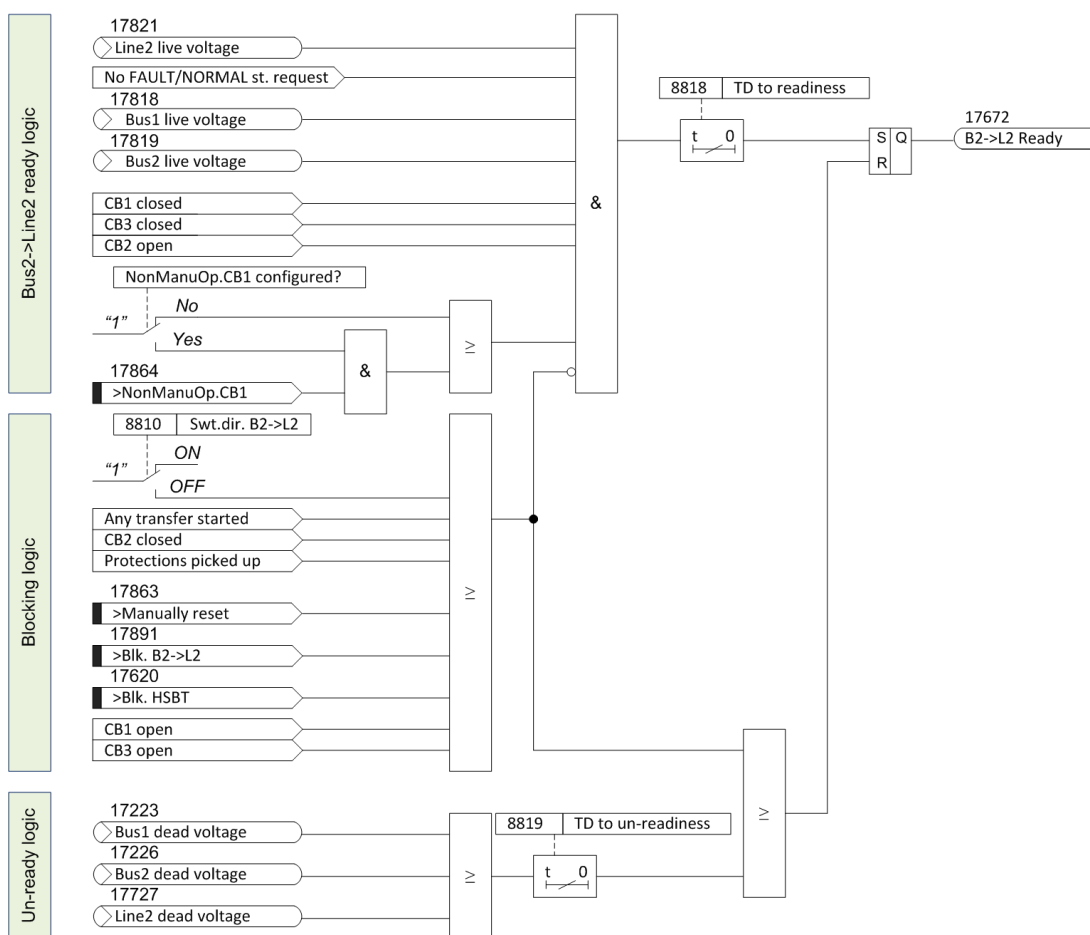


Figure 2-41 Readiness logic for switching direction Bus2->Line2, sectionalized single bus with 3-CB

2.2.5.4 Starting conditions

Resulted from Figure 2-6, 7VU683 supports to various starting conditions.

NORMAL starting condition

In case of planned switching-over, HSBT is manually started. It's defined in 7VU683 as NORMAL starting condition.

The transfer request command from operator can be sent out by below two channels,

- Communication: remotely over protocol
- Binary input: locally over binary input via wiring

The transfer request command can be derived from DCS, turbine control system or local panel.

All switching sequences, i.e, *PARALLEL Auto*, *PARALLEL Half-auto*, *SIMULTANEOUS* and *SEQUENTIAL*, are possible.

The transfer request command from operator is directly routed to device indication input, e.g, **>NORMAL Op. CB1** for switching direction **Line1->Line2**.

Starting logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2**, **Bus2->Bus1**, **Bus1->Line1** and **Bus2->Line2** can be referred to the Figure 2-42 as below.

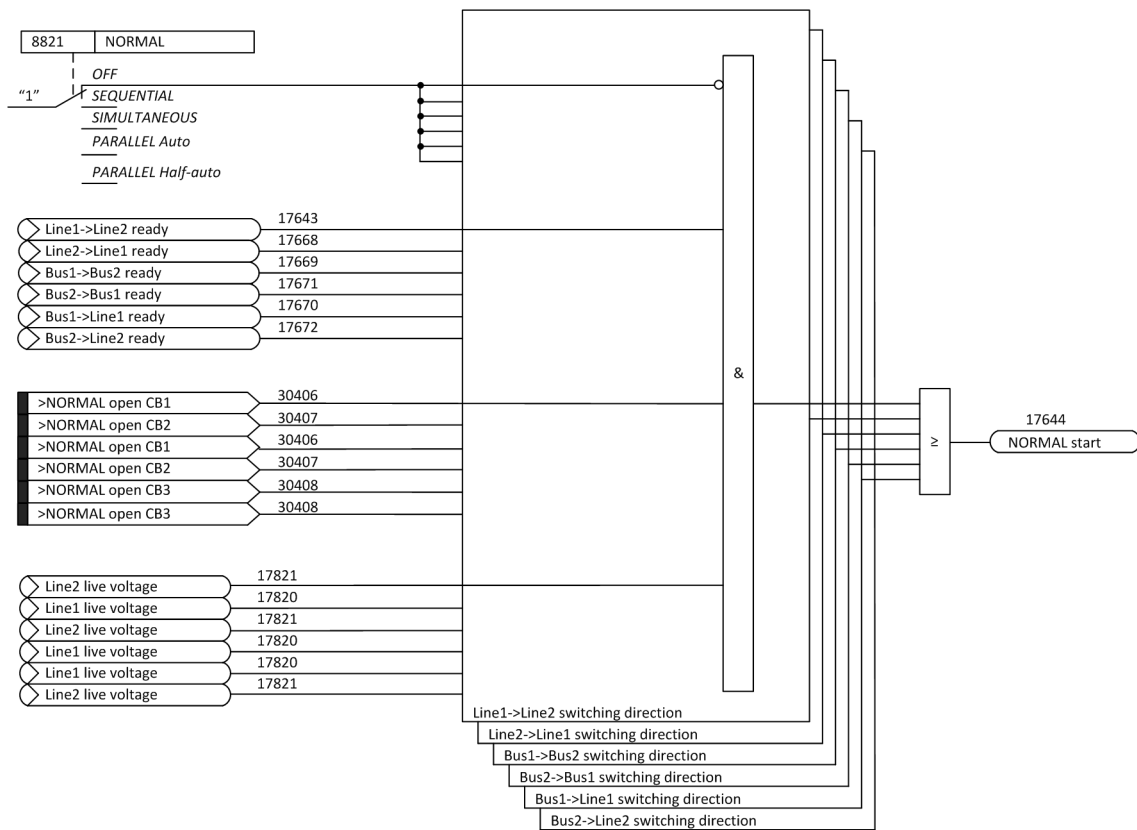


Figure 2-42 NORMAL start logic for primary diagram of sectionalized single bus with 3-CB

ABNORMAL starting condition

Up-stream CB trip resulted at system fault or in-feeder CB in-advertent open will lead to power source loss on motor bus. It will raise the need of self-start of HSBT. It's defined as ABNORMAL starting condition. Below starting logics are included in 7VU683.

- In-admissible under-voltage
- In-admissible under-frequency
- In-admissible df/dt
- Reverse power
- In-advertent CB open

The above self-start logics can be freely combined together, i.e., one of them can be individually switched ON/OFF.

For reliable self-starting transfer, special attention must be paid, i.e., self-start logic must be blocked during electric fault, motor starting up, bus voltage MCB trip, manual trip of running source CB, etc.

Kinds of electric fault can be recognized by integrated Fault Detection function, see the Figure 2-43 as below.

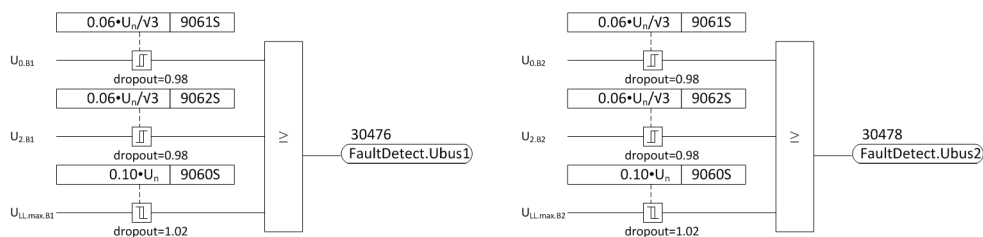


Figure 2-43 Fault detection logic for primary diagram of sectionalized single bus with 3-CB

Motor starting up can be recognized by Motor Start Recognition function, see the Figure 2-44 as below.

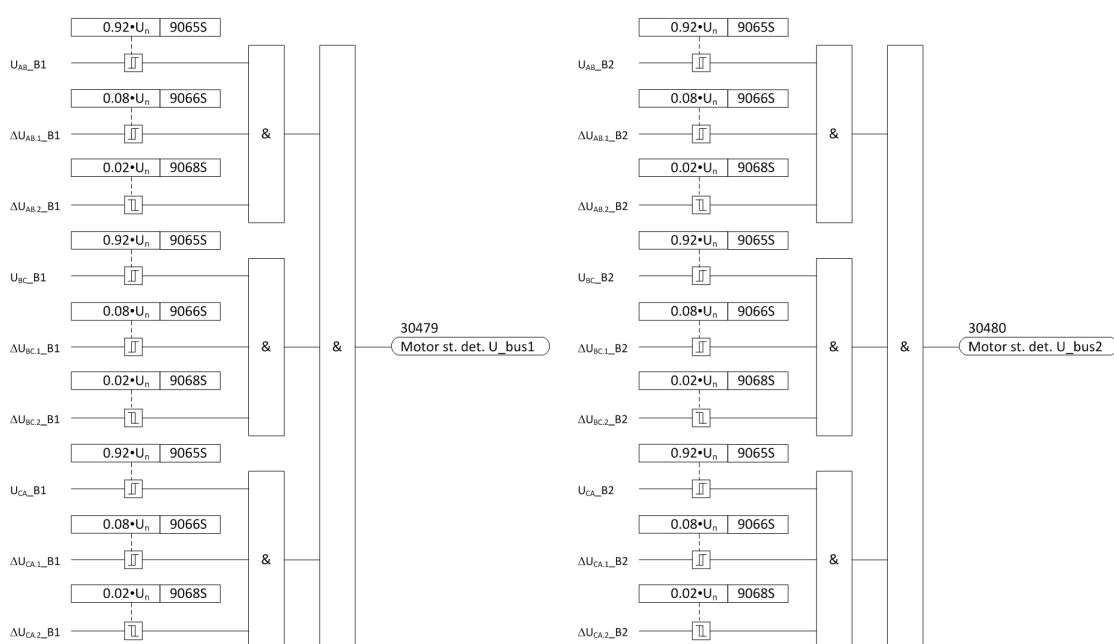


Figure 2-44 Motor starting-up recognition logic for primary diagram of sectionalized single bus with 3-CB

Additionally the line current can be used to block the self-start logic, i.e, self-start logic can only be released under line dead current.

Under-voltage self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2** and **Bus2->Bus1** can be referred to below Figure 2-45.

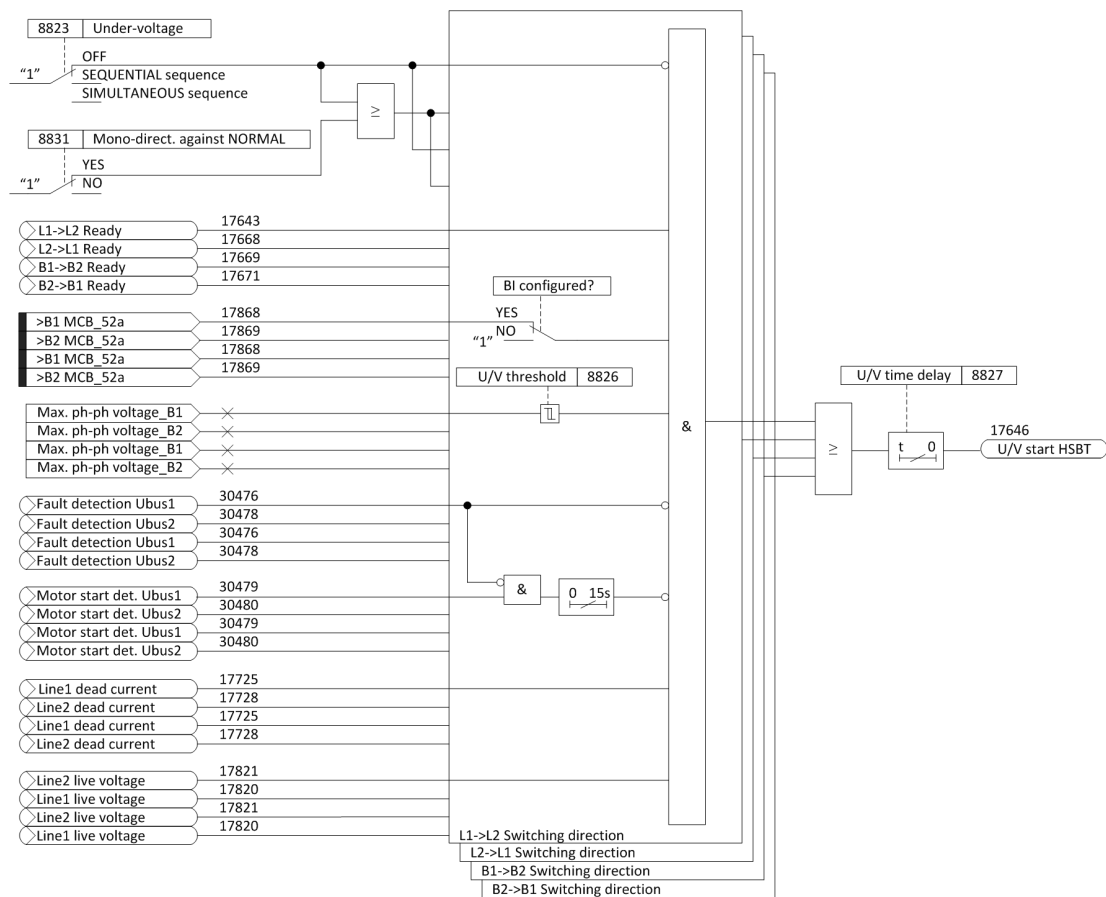


Figure 2-45 Under-voltage self-start logic for primary diagram of sectionalized single bus with 3-CB

Under-frequency self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2** and **Bus2->Bus1** can be referred to below Figure 2-46.

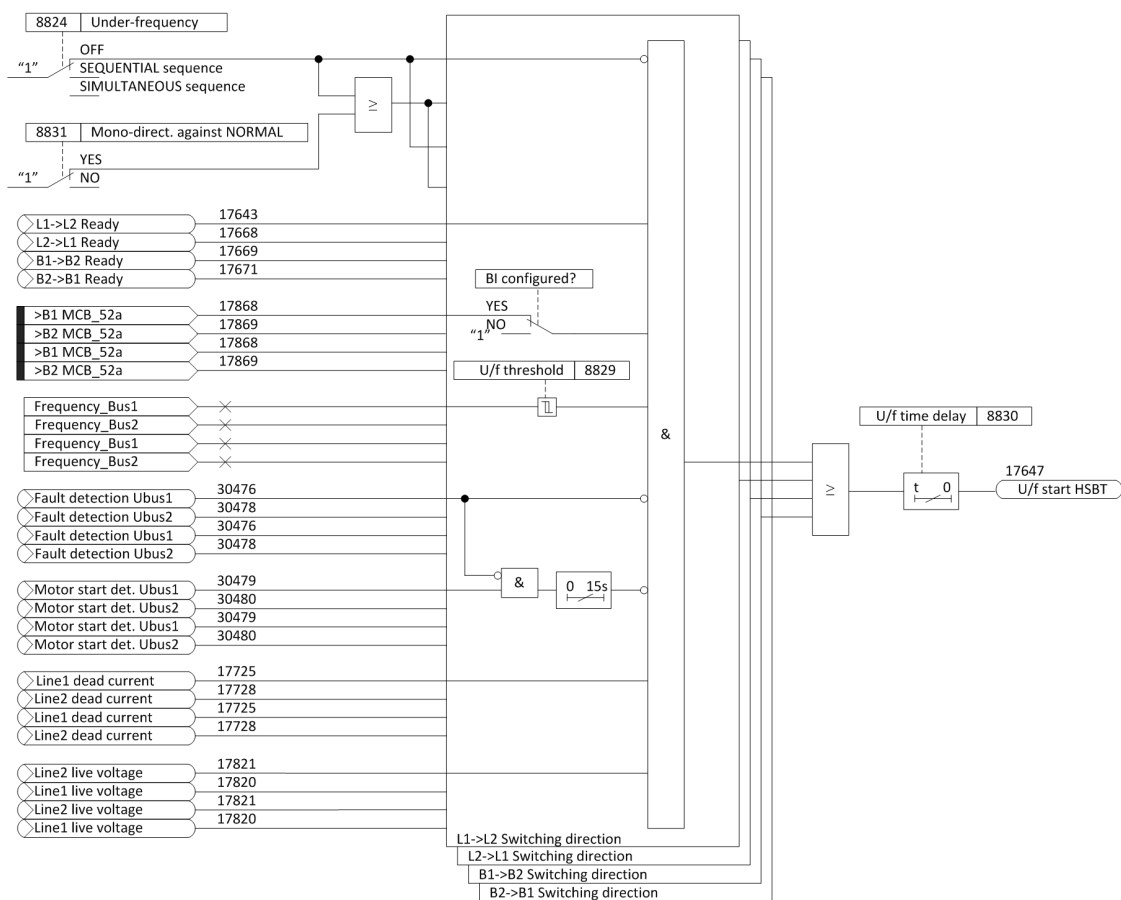


Figure 2-46 Under-frequency self-start logic for primary diagram of sectionalized single bus with 3-CB

Reverse power self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2** and **Bus2->Bus1** can be referred to below Figure 2-47.

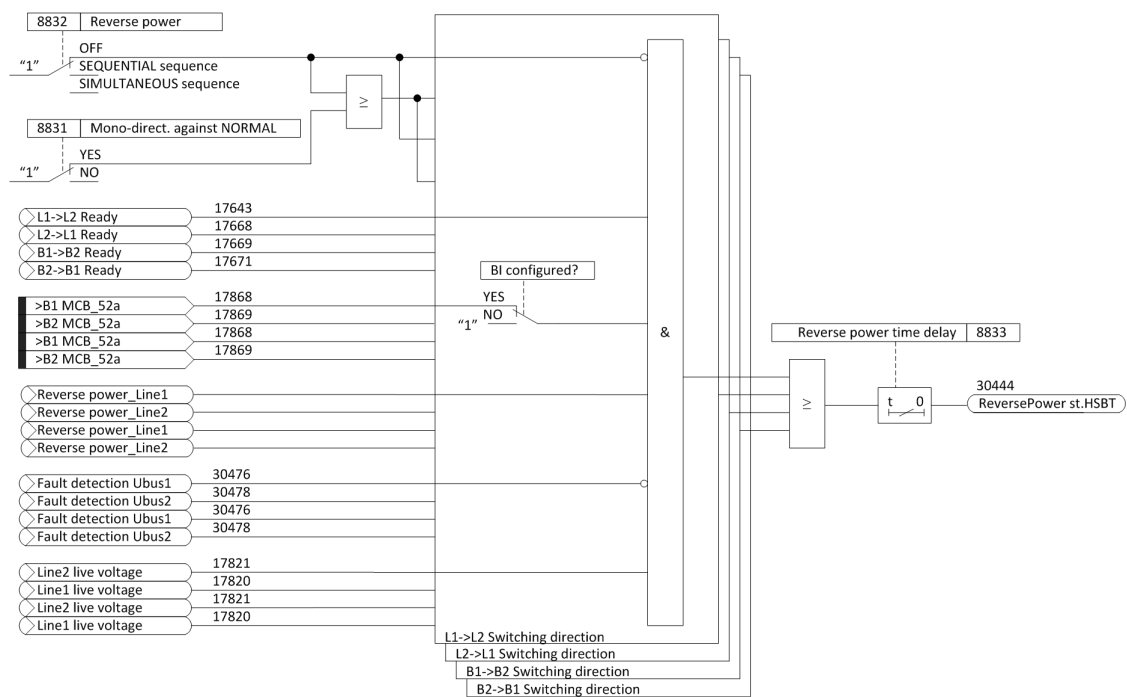


Figure 2-47 Reverse power self-start logic for primary diagram of sectionalized single bus with 3-CB

Change rate of frequency self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2** and **Bus2->Bus1** can be referred to below Figure 2-48.

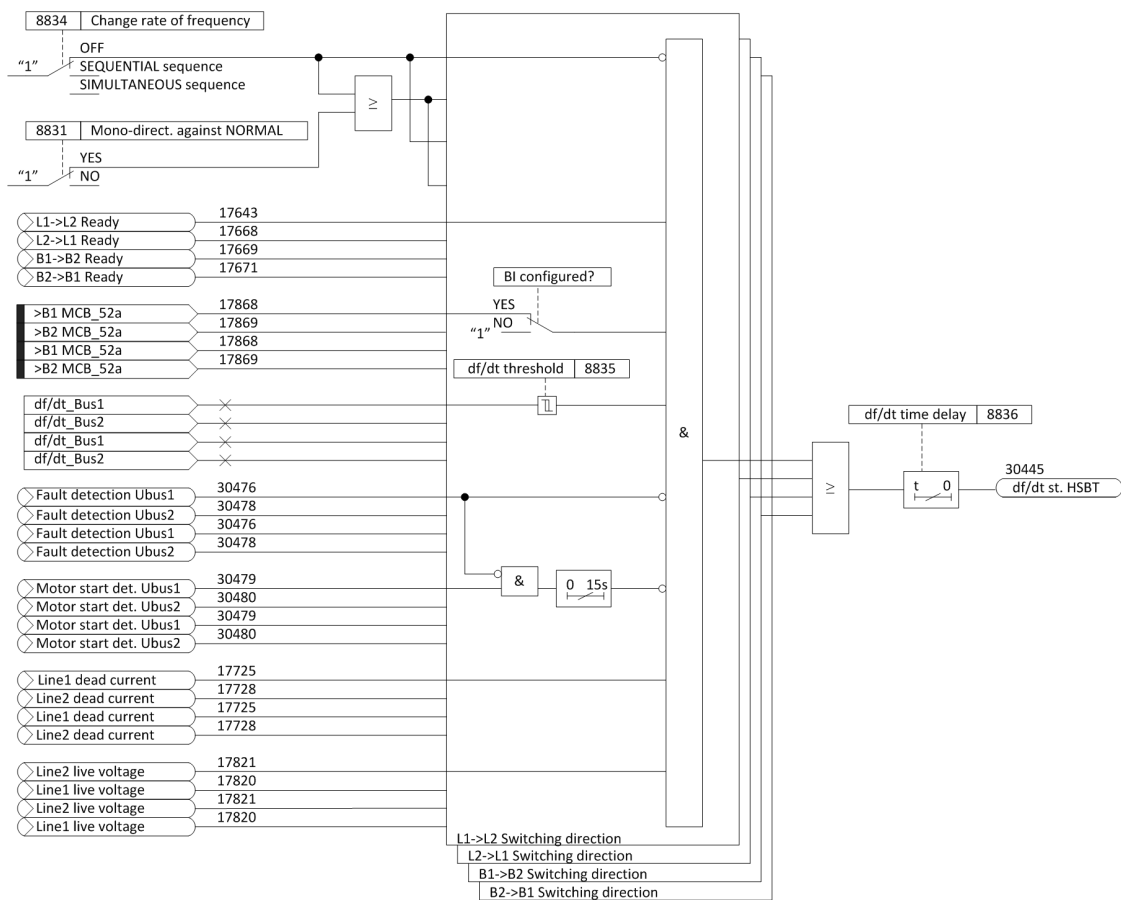


Figure 2-48 Change rate of frequency self-start logic for primary diagram of sectionalized single bus with 3-CB

In-advertent CB open self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2** and **Bus2->Bus1** can be referred to below Figure 2-49.

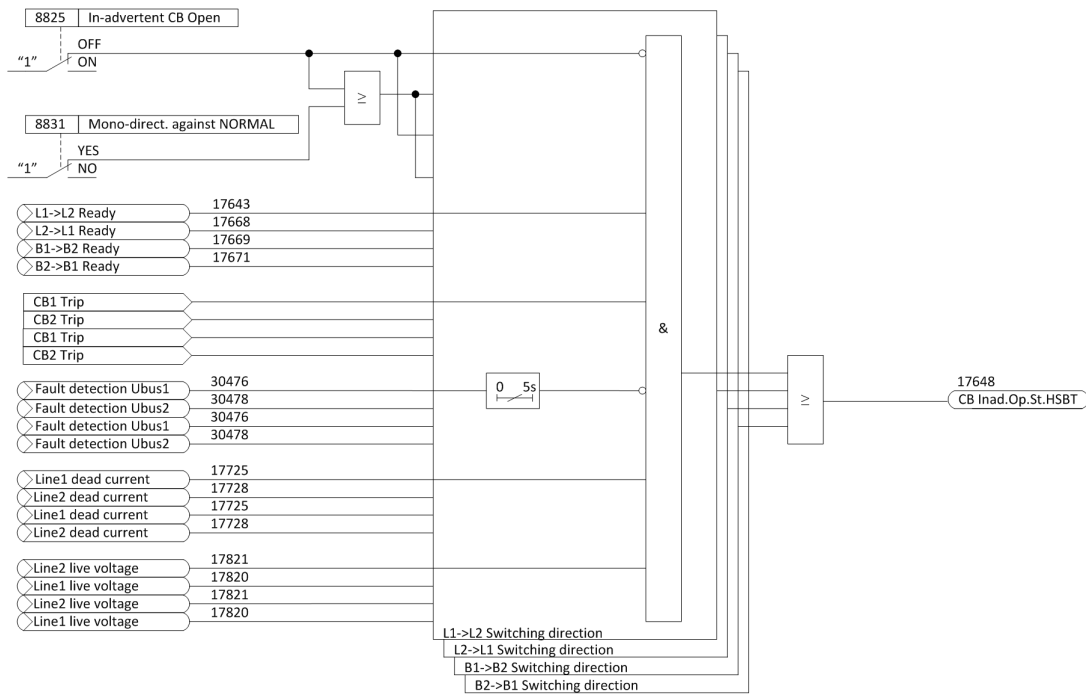


Figure 2-49 In-advertent CB open self-start logic for primary diagram of sectionalized single bus with 3-CB **FAULT** starting condition

Under the **FAULT** starting condition, power system fault must be there on the in-feeding source and the starting command must be externally issued by other device, e.g, protective relays.

Faults on the in-feeding source will be detected and cleared by protective relays, e.g, transformer differential relay. Meanwhile, HSBT should be externally started. The faults can be classified into two types regarding the electric symmetry. Then, optimization of switching sequence can be deployed. E.g,

- Type A: e.g, electric fault, i.e, GEN, TFR trips, to deploy **SEQUENTIAL** sequence;
- Type B: e.g, non-electric fault, i.e, boiler, turbine trips, to deploy **SIMULTANEOUS** sequence.

Starting logic for switching direction **Line1->Line2**, **Line2->Line1**, **Bus1->Bus2** and **Bus2->Bus1** can be referred to below Figure 2-50 and Figure 2-51.

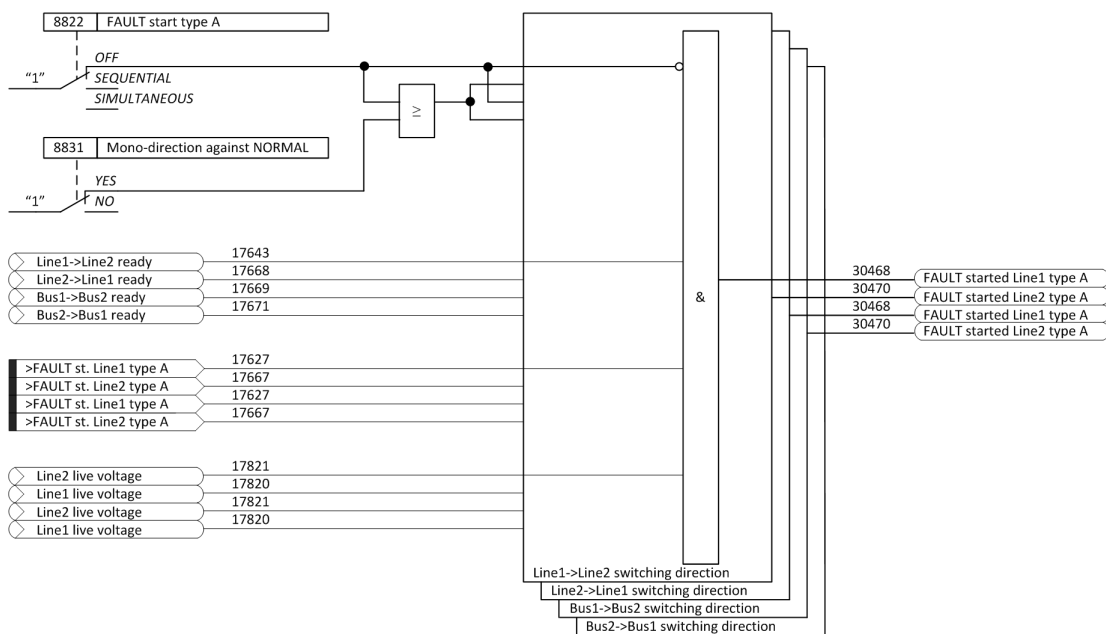


Figure 2-50 FAULT start logic for primary diagram of sectionalized single bus with 3-CB, type A

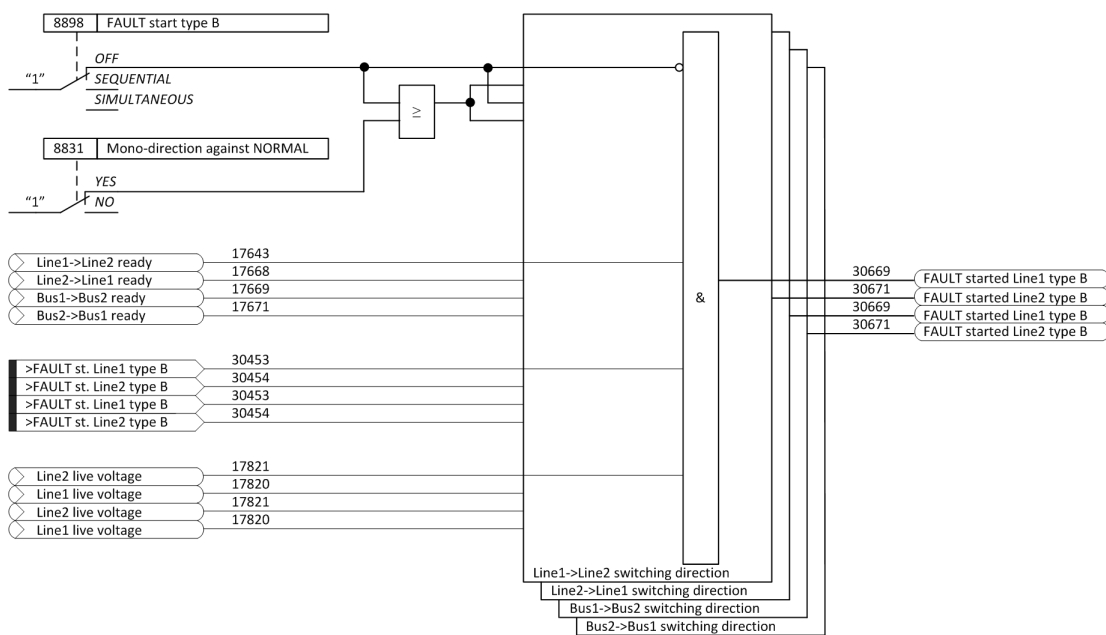


Figure 2-51 FAULT start logic for primary diagram of sectionalized single bus with 3-CB, type B

2.2.5.5 Local/remote start

The authority of manual start is controlled by key switch LOCAL/REMOTE on device panel. The pre-CFC is already implemented in device to connect either binary input or protocol transfer request command.

To be noted that, protocol transfer requesting command can only be treated when LOCAL/ REMOTE switching key on device front panel is in REMOTE position. Otherwise, BI transfer requesting command will be treated.

Factory CFC in device for local/remote start logic can be referred to the Figure 2-52 as below.

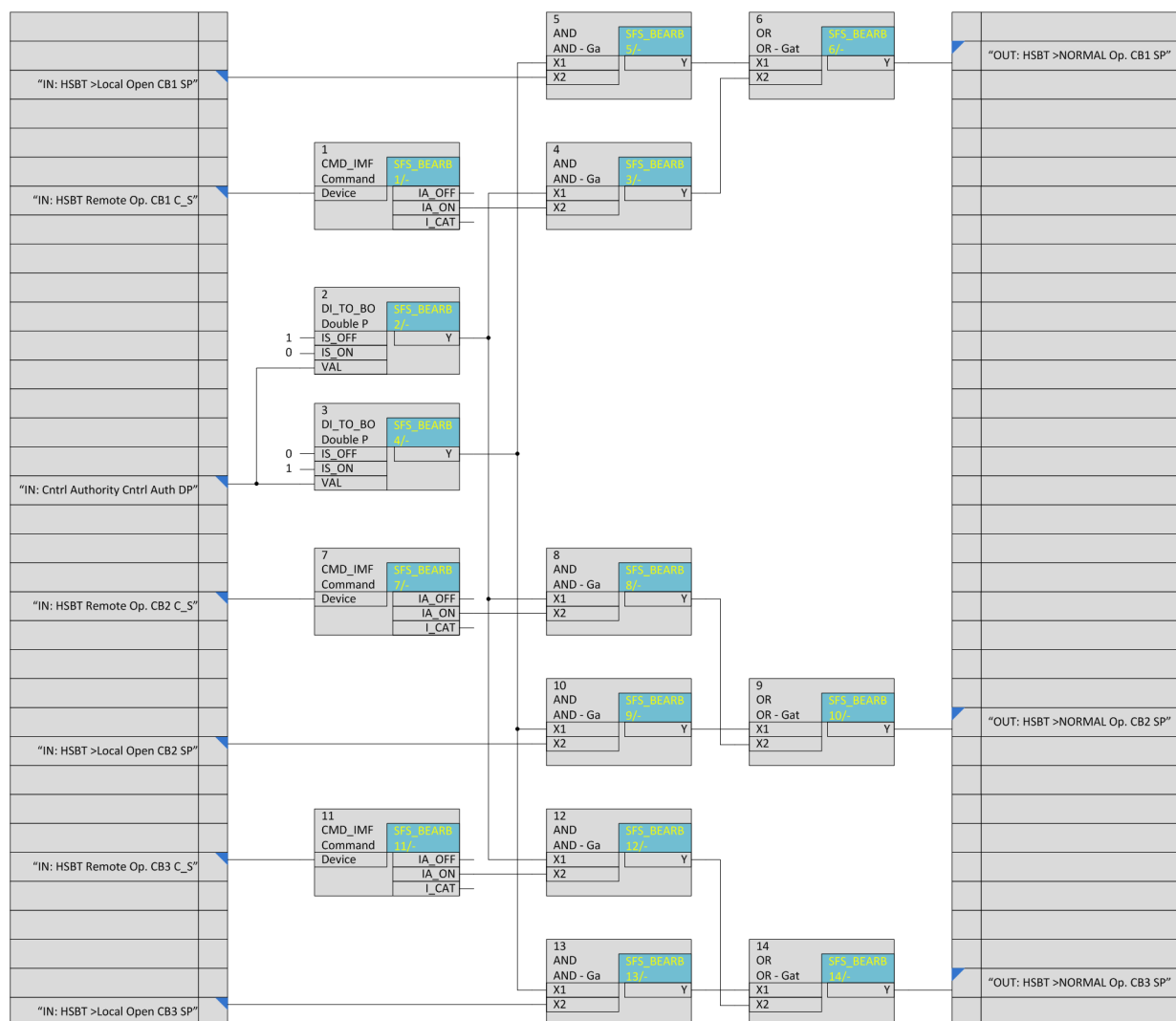


Figure 2-52 Local-remote start logic for primary diagram of sectionalized single bus with 3-CB



Note:

This CFC logic block can only be programmed with the priority of Interlocking (SFS_BEARB / INTERLOCK).

2.2.5.6 Low voltage load-shedding

To avoid the alternative source over-loading in case of motors' restarting under low voltage transfer, it is helpful to implement low voltage load-shedding (LVLSH) function before RES-VOLT transfer. LVLSH is setting free which pickup value is taken from 8870 **IN-PHASE mode**: under-voltage block, with one stage, no time delay. This function can be activated or de-activated manually on site.

The loads to be shed are the customer's decision.

Low voltage load-shedding logic can be referred to below Figure 2-53.

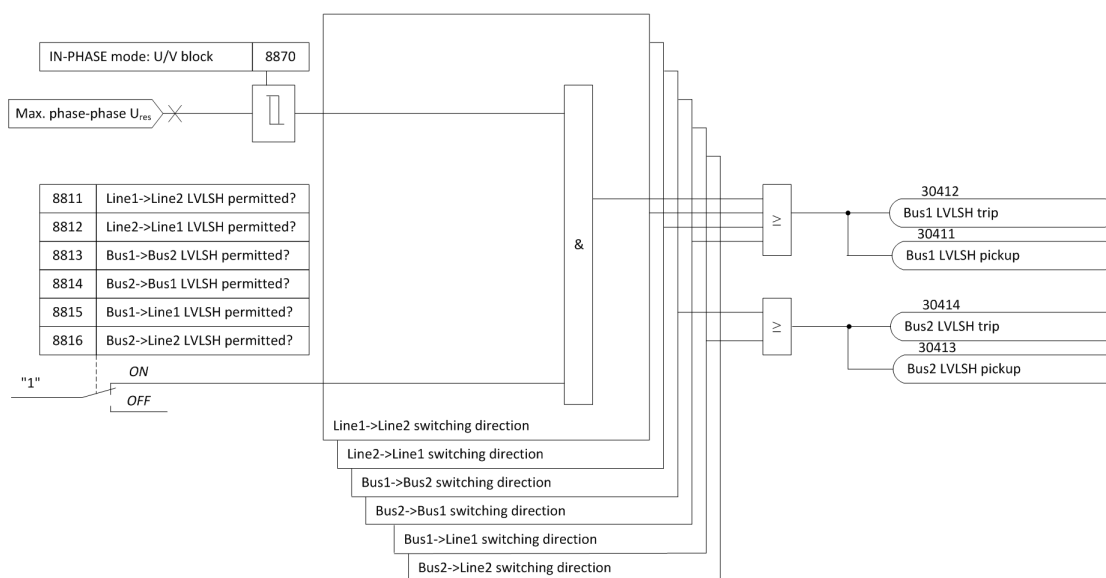


Figure 2-53 LVLSH for primary diagram of sectionalized single bus with 3-CB

2.2.5.7 Settings

Address	Parameter	Range	Default Setting	Note
<i>HSBT->General</i>				
8801	CB1 Closing Time	20<=...<=150	70 ms	
8802	CB2 Closing Time	20<=...<=150	70 ms	
8803	CB3 Closing Time	20<=...<=150	70 ms	
8804	Maximum permitted HSBT operating time	10<=...<=60	20 sec	
8805	Switching direction Line1->Line2	ON OFF	OFF	
8806	Switching direction Line2->Line1	ON OFF	OFF	
8807	Switching direction Busbar1->Busbar2	ON OFF	OFF	
8808	Switching direction Busbar1->Line1	ON OFF	OFF	
8809	Switching direction Busbar2->Busbar1	ON OFF	OFF	
8810	Switching direction Busbar2->Line2	ON OFF	OFF	
8811	Line1->Line2 LVLSH permitted	YES NO	NO	
8812	Line2->Line1 LVLSH permitted	YES NO	NO	
8813	Busbar1->Busbar2 LVLSH permitted	YES NO	NO	
8814	Busbar2->Busbar1 LVLSH permitted	YES NO	NO	
8815	Busbar1->Line2 LVLSH permitted	YES NO	NO	
8816	Busbar2->Line2 LVLSH permitted	YES NO	NO	
8817	Manually reset	YES NO	NO	
8818	Time delay to readiness	5<=...<=60	10 sec	
8819	Time delay to un-readiness	10<=...<=60	10 sec	
8820	HSBT test mode	ON OFF	OFF	
<i>HSBT->Start Condition</i>				
8821	NORMAL	OFF PARALLEL Auto PARAL. Half-Auto SIMULTANEOUS SEQUENTIAL	PARALLEL Auto	
8822	FAULT start type A	OFF SIMULTANEOUS SEQUENTIAL	SEQUENTIAL	
8898	FAULT start type B	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	

Address	Parameter	Range	Default Setting	Note
8823	Under-voltage	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8826	Under-voltage threshold	0.700<=...<=0.950	0.850 U/Un	
8827	Under-voltage time delay	0<= ...<=1000	10 ms	
8824	Under-frequency	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8829	Under-frequency threshold	45.00<=...<=49.50	47.50 Hz	f _n = 50 Hz
8829	Under-frequency threshold	55.00<=...<=59.50	57.00 Hz	f _n = 60 Hz
8830	Under-frequency time delay	0<= ...<=1000	10 ms	
8832	Reverse power	OFF SIMULTANEOUS SEQUENTIAL	OFF	
8833	Reverse power time delay	0<=...<=1000	10 ms	
8834	Change rate of frequency	OFF SIMULTANEOUS SEQUENTIAL	OFF	
8835	Change rate of frequency threshold	-10.0<=...<=-0.5	-0.5 Hz/s	
8836	Change rate of frequency time delay	0<= ...<=1000	10 ms	
8825	Inadvertent CB open	OFF ON	ON	
8831	Mono-direction against NORMAL	YES NO	NO	
<i>HSBT->Transfer Mode</i>				
8841	FAST	OFF ON	ON	
8842	REAL-TIME FAST	OFF ON	ON	
8843	IN-PHASE	OFF ON	ON	
8844	RES-VOLT	OFF ON	ON	
8845	LONG-TIME	OFF ON	ON	
<i>HSBT-->Transfer Set</i>				
8851	PARALLEL sequence: delta frequency	0.02<=...<=2.00	0.10 Hz	
8852	PARALLEL sequence: delta U	1.0<=...<=40.0	2.0 V	
8853	PARALLEL sequence: delta phase angle	2.0<=...<=80.0	10.0 °	
8854	PARALLEL Auto: CB open time delay	0.00<=...<=2.00	0.10 sec	
8857	SIMULTANEOUS sequence: CB close time delay	0<=...<=40	0 ms	
8873	SIMULTANEOUS sequence: CB open time delay	0<=...<=40	0 ms	
8858	FAST mode: delta frequency	0.50<=...<=2.50	1.00 Hz	
8859	FAST mode: delta phase angle	10.0<=...<=50.0	20.0 °	

Address	Parameter	Range	Default Setting	Note
8860	FAST mode: under-voltage block	0.500<=...<=0.900	0.700 U/Un	
8861	REAL-TIME FAST mode: delta frequency	1.00<=...<=15.00	3.00 Hz	
8862	REAL-TIME FAST mode: U_{diff}/f	1.00<=...<=1.33	1.33 p.u.	
8863	REAL-TIME FAST mode: delta phase angle	70.0<=...<=90.0	90.0 °	
8864	REAL-TIME FAST mode: under-voltage block	0.500<=...<=0.900	0.700 U/Un	
8868	IN-PHASE mode: delta frequency	1.00<=...<=15.00	5.00 Hz	
8869	IN-PHASE mode: delta phase angle	0.5<=...<=20.0	5.0 °	
8870	IN-PHASE mode: under-voltage block	0.200<=...<=0.800	0.400 U/Un	
8871	RES-VOLT mode: threshold	0.200<=...<=0.600	0.300 U/Un	
8872	LONG-TIME mode: threshold	0.50<=...<=10.00	3.00 sec	

2.2.5.8 Information List

No.	Information	Type	Fun. NO.	Inf. NO.
17620	>BLOCK HSBT	SP		
17863	>Manually reset	SP		
17627	>FAULT start Line1 type A	SP		
17667	>FAULT start Line2 type A	SP		
30453	>FAULT start Line1 type B	SP		
30454	>FAULT start Line2 type B	SP		
30406	>NORMAL open CB1	SP		
30407	>NORMAL open CB2	SP		
30408	>NORMAL open CB3	SP		
17870	>Manual open command in PARALLEL Half-auto	SP		
18020	>HSBT test mode	SP		
17640	HSBT is active	OUT		
17641	HSBT is switched OFF	OUT		
17642	HSBT is blocked	OUT		
30476	Fault detected Ubus1	OUT		
30478	Fault detected Ubus2	OUT		
30479	Motor start detected Ubus1	OUT		
30480	Motor start detected Ubus2	OUT		
17644	NORMAL start	OUT		
17646	Under-voltage start	OUT		
17647	Under-frequency start	OUT		
30444	Reverse power start	OUT		
30445	Change rate of frequency start	OUT		
17648	Inadvertent CB open start	OUT		
17651	FAST mode close standby source	OUT		
17652	REAL-TIME FAST mode close standby source	OUT		
17653	IN-PHASE mode close standby source	OUT		
17654	RES-VOLT mode close standby source	OUT		
17655	LONG-TIME mode close standby source	OUT		

No.	Information	Type	Fun. NO.	Inf. NO.
17656	PARALLEL sequence close standby source	OUT		
17657	SIMULTANEOUS sequence close standby source	OUT		
30452	SEQUENTIAL sequence close standby supply	OUT		
30456	df at CB closing command triggered	VI		
30457	dU at CB closing command triggered	VI		
30458	dφ at CB closing command triggered	VI		
30459	Residual voltage at CB closing command triggered	VI		
30460	V/Hz p.u. at CB closing command triggered	VI		
30461	df at CB closing instant	VI		
30462	dU at CB closing instant	VI		
30463	dφ at CB closing instant	VI		
30464	Residual voltage at CB closing instant	VI		
30465	V/Hz p.u. at CB closing instant	VI		
18017	CB1 closing time =	VI		
18018	CB2 closing time =	VI		
18019	CB3 closing time =	VI		
17886	>Block Line1 -> Line2	SP		
17950	Line1 -> Line2 is blocked	OUT		
17643	Line1 -> Line2 is ready	OUT		
17871	Line1 -> Line2 succeeded	OUT	200	15
17922	Line1 -> Line2 timed out	OUT		
17916	Line1 -> Line2 failed	OUT	200	21
17887	>Block Line2 -> Line1	SP		
17951	Line2 -> Line1 is blocked	OUT		
17668	Line2 -> Line1 is ready	OUT		
17872	Line2 -> Line1 succeeded	OUT	200	16
17923	Line2 -> Line1 timed out	OUT		
17917	Line2 -> Line1 failed	OUT	200	22
17888	>Block Busbar1 -> Busbar2	SP		
17952	Busbar1 -> Busbar2 is blocked	OUT		
17669	Busbar1 -> Busbar2 is ready	OUT		
17873	Busbar1 -> Busbar2 succeeded	OUT	200	17
17924	Busbar1 -> Busbar2 timed out	OUT		
17918	Busbar1 -> Busbar2 failed	OUT	200	23
17889	>Block Busbar2 -> Busbar1	SP		
17953	Busbar2 -> Busbar1 is blocked	OUT		
17671	Busbar2 -> Busbar1 is ready	OUT		
17874	Busbar2 -> Busbar1 succeeded	OUT	200	18
17925	Busbar2 -> Busbar1 timed out	OUT		
17919	Busbar2 -> Busbar1 failed	OUT	200	24
17890	>Block Busbar1 -> Line1	SP		
17954	Busbar1 -> Line1 is blocked	OUT		
17670	Busbar1 -> Line1 is ready	OUT		
17875	Busbar1 -> Line1 succeeded	OUT	200	19
17926	Busbar1 -> Line1 timed out	OUT		
17920	Busbar1 -> Line1 failed	OUT	200	25

No.	Information	Type	Fun. NO.	Inf. NO.
17891	>Block Busbar2 -> Line2	SP		
17955	Busbar2 -> Line2 is blocked	OUT		
17672	Busbar2 -> Line2 is ready	OUT		
17876	Busbar2 -> Line2 succeeded	OUT	200	20
17927	Busbar2 -> Line2 timed out	OUT		
17921	Busbar2 -> Line2 failed	OUT	200	26
18012	HSBT is ready	OUT	200	93
17948	HSBT succeeded	OUT	200	91
17949	HSBT failed	OUT	200	92
30411	Bus 1 low voltage load-shedding pick up	OUT	150	3
30412	Bus 1 low voltage load-shedding trip	OUT	150	4
30413	Bus 2 low voltage load-shedding pick up	OUT	150	5
30414	Bus 2 low voltage load-shedding trip	OUT	150	6
17963	Line1 -> Line2 ON/OFF	IntSP	200	66
17964	Line2 -> Line1 ON/OFF	IntSP	200	67
17965	Busbar1 -> Busbar2 ON/OFF	IntSP	200	68
17966	Busbar1 -> Line1 ON/OFF	IntSP	200	69
17967	Busbar2 -> Busbar1 ON/OFF	IntSP	200	70
17968	Busbar2 -> Line2 ON/OFF	IntSP	200	71
17969	FAST transfer mode ON/OFF	IntSP		
17970	REAL-TIME FAST transfer mode ON/OFF	IntSP		
17971	IN-PHASE transfer mode ON/OFF	IntSP		
17972	RES-VOLT transfer mode ON/OFF	IntSP		
17973	LONG-TIME transfer mode ON/OFF	IntSP		
	Remote open CB1	C_S		
	> Local open CB1	SP		
	Remote open CB2	C_S		
	> Local open CB2	SP		
	Remote open CB3	C_S		
	> Local open CB3	SP		
30468	FAULT started Line1 type A	OUT		
30469	FAULT started Line1 type B	OUT		
30470	FAULT started Line2 type A	OUT		
30471	FAULT started Line2 type B	OUT		

2.2.6 Single busbar with 3-CB

This chapter is to describe the application of primary diagram *single busbar w. 3-CB*.

2.2.6.1 General

The primary diagram of single bus with 3-CB is rarely seen in power plant. The motor bus is powered by one of three sources during the normal operation. On the other hand, the motor bus is transferred to other source during maintenance, source fault, etc.

Comprehensive transfer concepts include switching direction, readiness, starting condition, low voltage load-shedding and local/remote start, etc.

Figure 2-54 illustrates the general switching command.

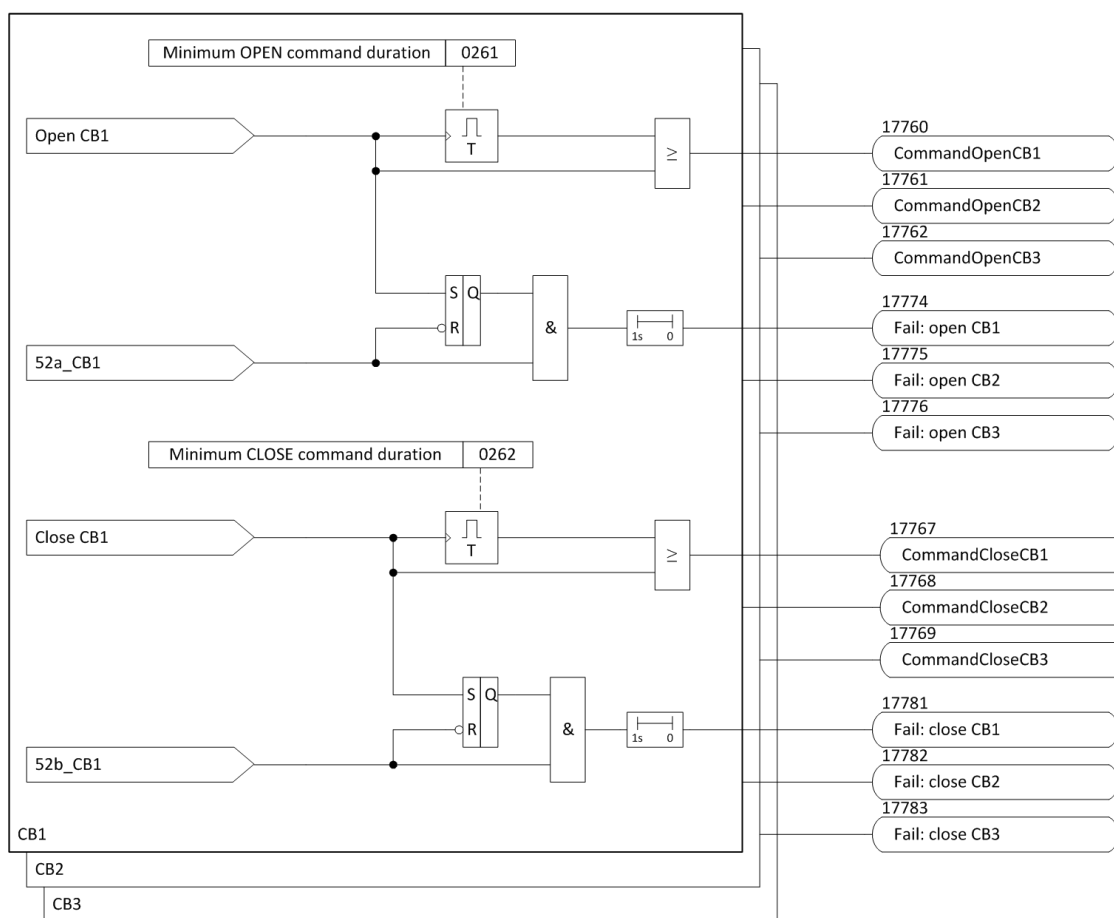


Figure 2-54 General switching command for primary diagram of single bus with 3-CB

Parameter of 0261 **Minimum OPEN command duration** is to expand the OPEN command pulse to ensure the reliable CB trip. Factory setting should be enough for most cases.

Parameter of 0262 **Minimum CLOSE command duration** is to expand the CLOSE command pulse to ensure the reliable CB closure. Factory setting should be enough for most cases.



Note:

- The device does not support control function. It's impossible to switch CB via device front panel.
- CB status position is recommended to be routed to device by double point indication. It can also be routed to device by single point indication. In this case, the link for device display needs to be updated. That is, e.g for CB1, if only 52a_CB1 is connected to BI7, both indication 17621 >**CB1 52a** and 17622 >**CB1 52b** are routed to BI7 with respective configuration "H" and "L".

Below Figure 2-55 illustrates the general transfer information.

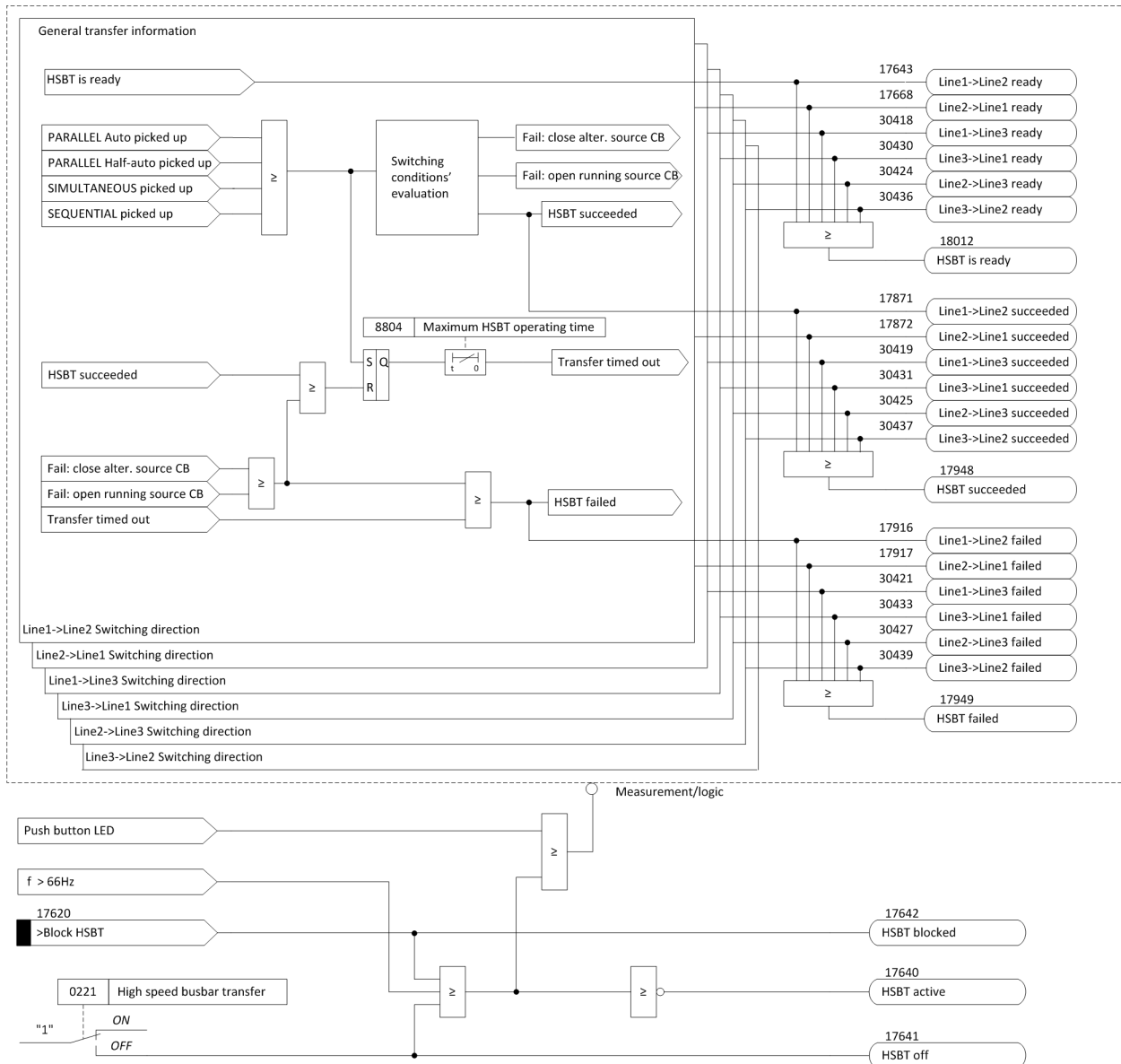


Figure 2-55 General transfer information for primary diagram of single bus with 3-CB

Parameter of 8804 **Maximum HSBT operating time** is to monitor the whole transfer duration. If the time is expired since transfer pick up, it is seen as transfer time out and indicated by HSBT failed. Factory setting should be enough for most cases.

2.2.6.2 Switching direction

Six switching directions are possible under primary diagram of single bus with 3-CB.

To switch off CB1 and to switch on CB2 is defined as switching direction **Line1->Line2**. To switch off CB2 and to switch on CB1 is defined as switching direction **Line1->Line2**. To switch off CB1 and to switch on CB3 is defined as switching direction **Line1->Line3**. To switch off CB3 and to switch on CB1 is defined as switching direction **Line3->Line1**. To switch off CB2 and to switch on CB3 is defined as switching direction **Line2->Line3**. To switch off CB3 and to switch on CB2 is defined as switching direction **Line3->Line2**.

See the Figure 2-56 as below.

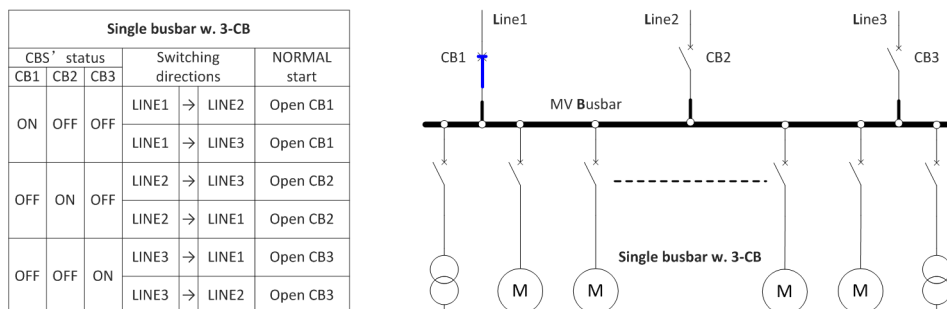


Figure 2-56 Possible switching direction for primary diagram of single busbar with 3-CB

Under normal operation two CBs are in open status and two switching directions are possible. HSBT 7VU683 will automatically determine the switching direction based on the actual CBs' status, the source of transfer request command and the defined transfer priority. Refer to below Table 2-3 for pre-defined transfer priority.

Table 2-3 Prior switching direction for primary diagram of single bus with 3-CB

CB1 Status	CB2 Status	CB3 Status	Prior switching direction per device <i>READINESS</i>				
ON	OFF	OFF	L1>L2 is ready	0	1	0	1
			L1>L3 is ready	0	0	1	1
			Switching direction	None	L1>L2	L1>L3	L1>L2
OFF	ON	OFF	L2>L3 is ready	0	1	0	1
			L2>L1 is ready	0	0	1	1
			Switching direction	None	L2>L3	L2>L1	L2>L3
OFF	OFF	ON	L3>L1 is ready	0	1	0	1
			L3>L2 is ready	0	0	1	1
			Switching direction	None	L3>L1	L3>L2	L3>L1

Each switching direction can be individually parameterized *ON* or *OFF* remotely via communication or locally at device panel.

HSBT supports bi-directional bus transfer under *NORMAL* condition, i.e, from main source to alternative source, vice versa.

In some cases, the switching is limited to mono-direction, i.e, from main source to alternative, under starting conditions of *FAULT* and *Abnormal*. The requirement can be implemented by set the parameter 8831 **Mono-direction against *NORMAL* condition** = *YES*. The default setting *NO* means bi-directional switching is always supported under each starting condition.

To be noted that the device has default agreement that the source of voltage input Ux_L1 is exclusively defined as main while other as alternative. Then, if mono-direction against *NORMAL* condition is required, main source must be always connected to device channel Ux_L1.

The transfer permission under various starting conditions and switching directions can be referred to below Table2-4.

Table 2-4 Transfer permission under default setting, single bus with 3-CB

CB1 Status	CB2 Status	CB3 Status	Switching direction		Voltage Comparison		Busbar Transfer Permitted?						
			From	To			NORMAL	FAULT	Inadmissible Under-volt.	Inadmissible Under-Freq.	Inadmissible Neg.d _f /dt	Reverse Power	Inadvertent CB Open
ON	OFF	OFF	L1	L2	U _B	U _{L2}	YES	YES	YES	YES	YES	YES	YES
			L1	L3	U _B	U _{L3}	YES	YES	YES	YES	YES	YES	YES
OFF	ON	OFF	L2	L3	U _B	U _{L3}	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾
			L2	L1	U _B	U _{L1}	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾
OFF	OFF	ON	L3	L1	U _B	U _{L1}	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾
			L3	L2	U _B	U _{L2}	YES	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾	YES ¹⁾

¹⁾ If parameter 8831 "Mono-direction against Normal"="NO", this cell says Yes. Otherwise, this cell says No.

2.2.6.3 Readiness

To secure the reliable transfer, the device 7VU683 will continuously monitor the normal operation conditions. If all criterions are met, the device goes into readiness prepared for transfer.

Only under ready status, transfer request command can be executed. Otherwise, HSBT is in un-ready state and no transfer is possible.

In some region, e.g. P. R. China, any manual CB open/close command(remote/local) is interpreted and indicated as message **NonManu.Op.CBx** by device Operation-box. If CB is manually tripped, the message indicates "0". This can be directly routed, e.g for CB1, to 17864 >**NonManu.Op.CB1** to block the transfer.

If no Operation-box is there, please leave the indication >**NonManu.Op.CBx** not configured.

Factory values for parameter 8818 **Time delay to readiness** and 8819 **Time delay to un-readiness** should be applied for most cases.

Please refer to below readiness logics for each switching direction.

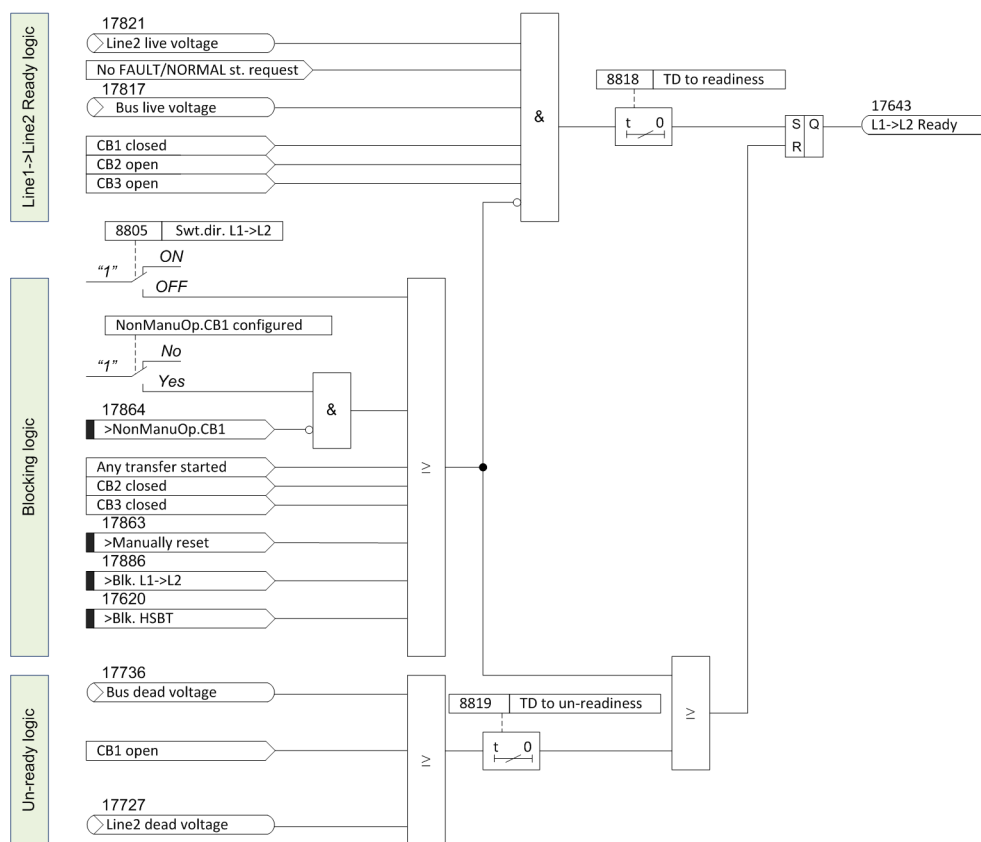


Figure 2-57 Readiness logic for switching direction Line1->Line2, single bus with 3-CB

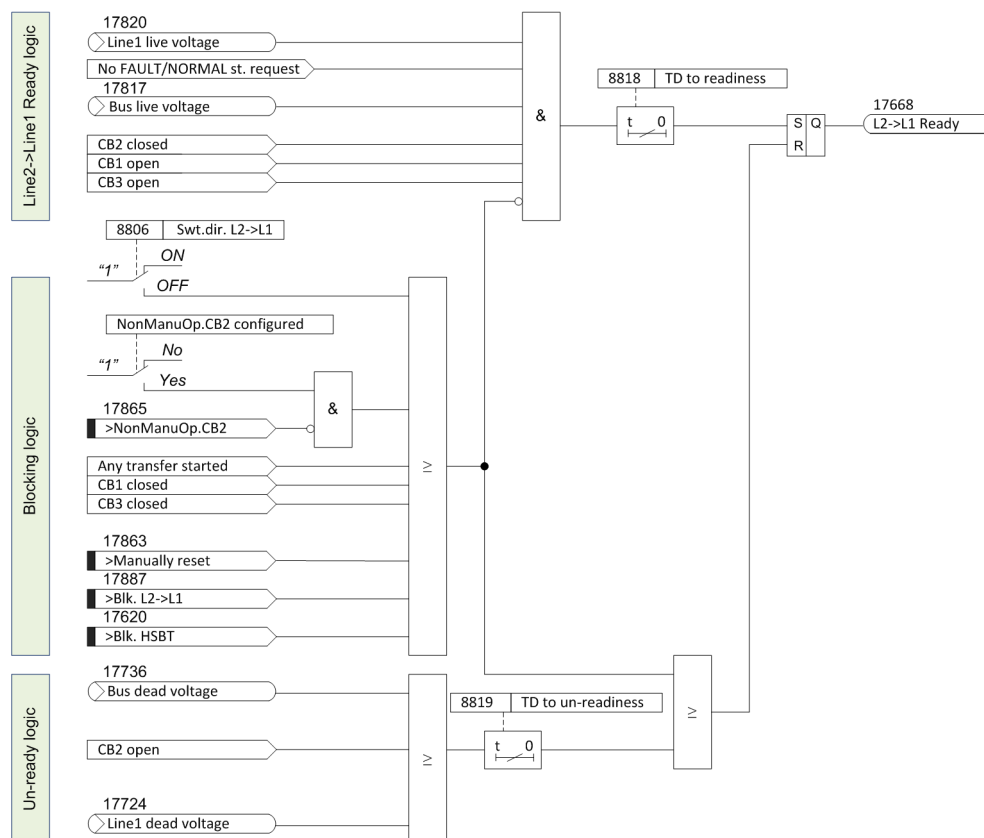


Figure 2-58 Readiness logic for switching direction Line2->Line1, single bus with 3-CB

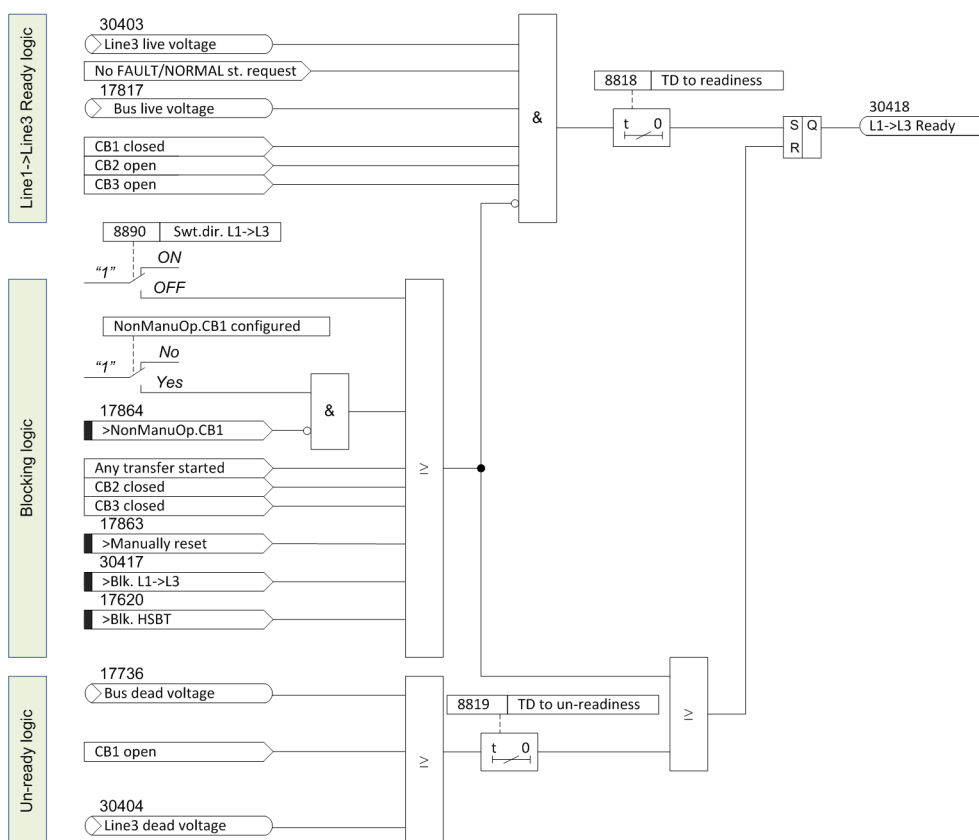


Figure 2-59 Readiness logic for switching direction Line1->Line3, single bus with 3-CB

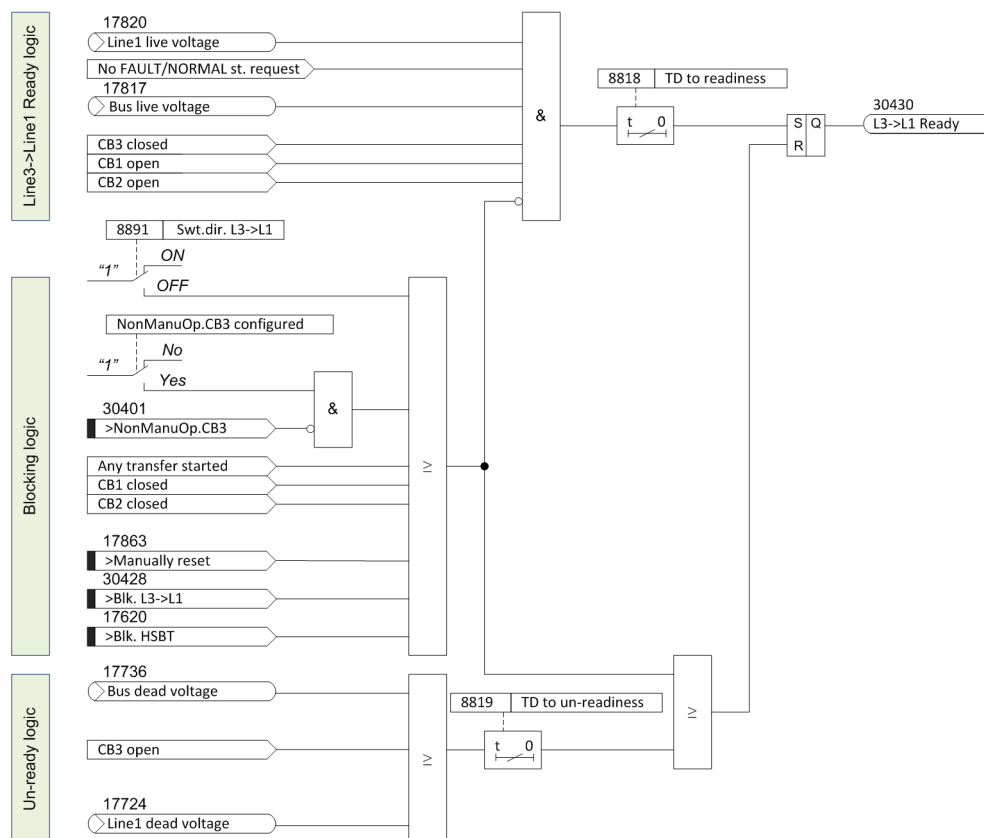


Figure 2-60 Readiness logic for switching direction Line3->Line1, single bus with 3-CB

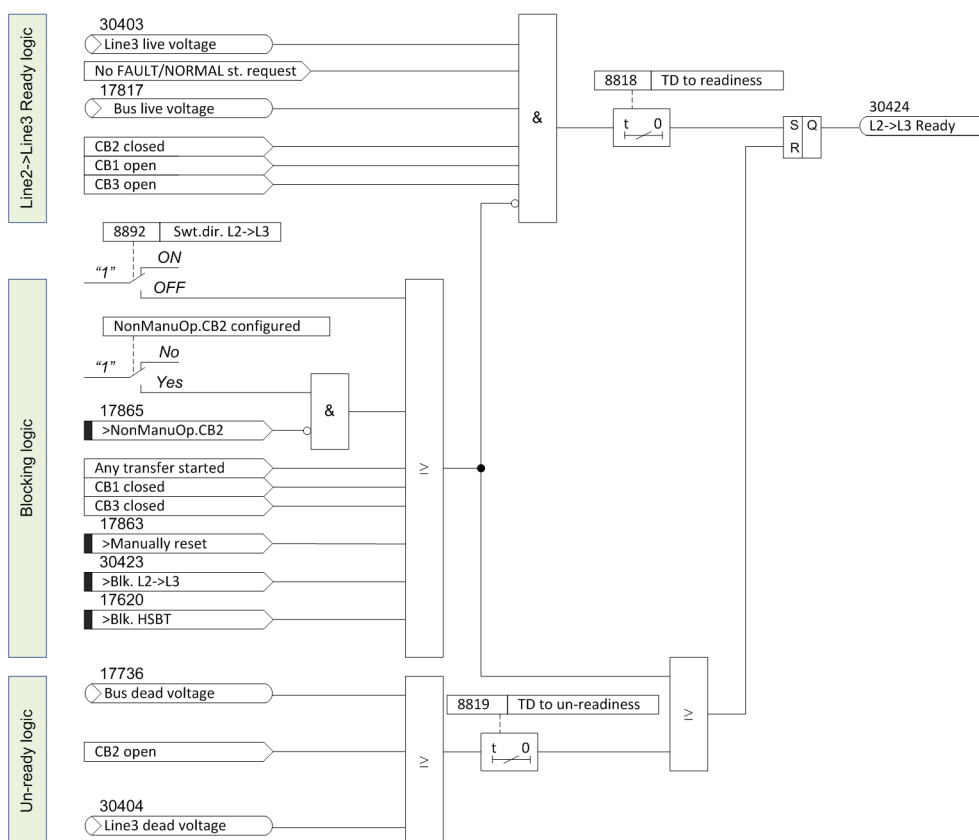


Figure 2-61 Readiness logic for switching direction Line2->Line3, single bus with 3-CB

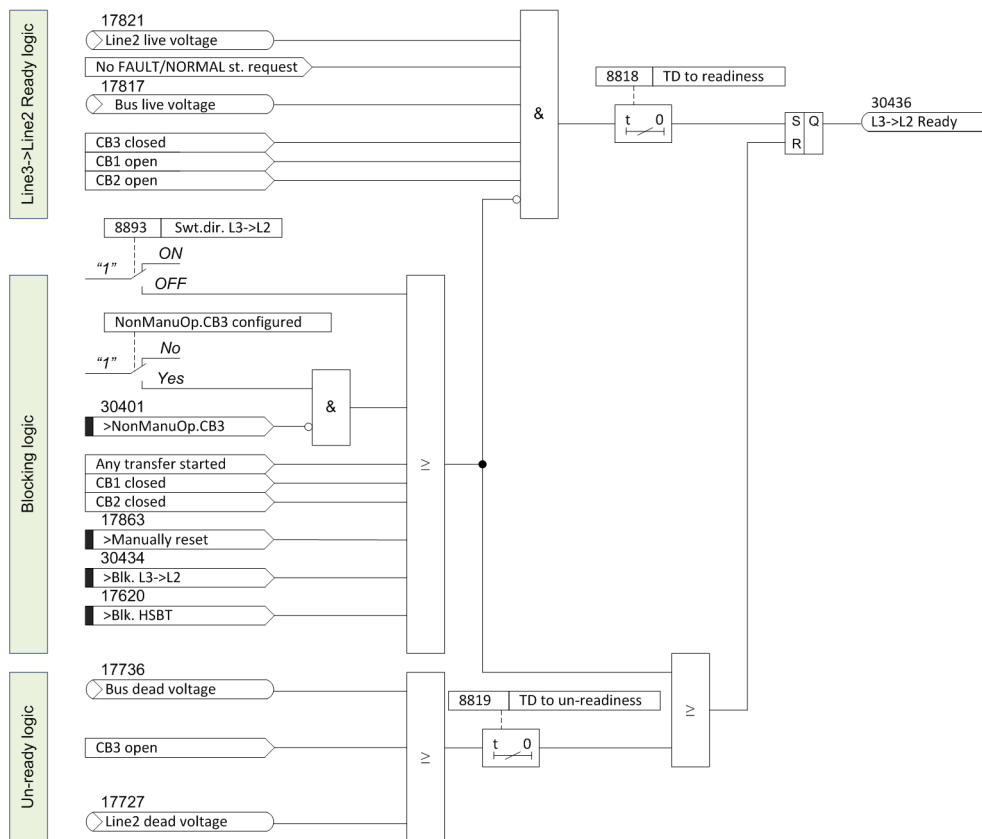


Figure 2-62 Readiness logic for switching direction Line3->Line2, single bus with 3-CB

2.2.6.4 Starting conditions

Resulted from Figure 2-6, 7VU683 supports to various starting conditions.

NORMAL starting condition

In case of planned switching-over, HSBT is manually started. It's defined in 7VU683 as NORMAL starting condition.

The transfer request command from operator can be sent out by below two channels,

- Communication: remotely over protocol
- Binary input: locally over binary input via wiring

The transfer request command can be derived from DCS, turbine control system or local panel.

All switching sequences, i.e, *PARALLEL Auto*, *PARALLEL Half-auto*, *SIMULTANEOUS* and *SEQUENTIAL*, are possible.

The transfer request command from operator is directly routed to device indication input, e.g, **>NORMAL Op. CB1** for switching direction **Line1->Line2**.

Starting logic for switching direction **Line1->Line2**, **Line2->Line1**, **Line1->Line3**, **Line3->Line1**, **Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-63.

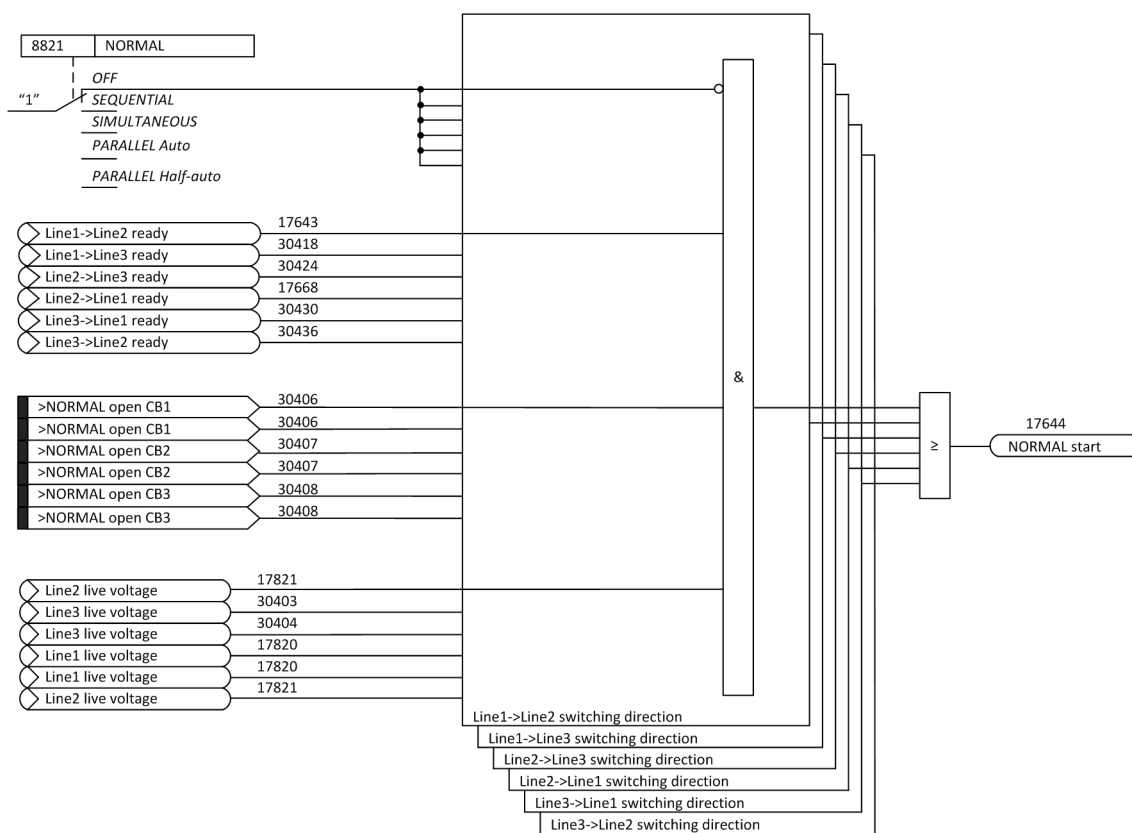


Figure 2-63 NORMAL start logic for primary diagram of single bus with 3-CB

ABNORMAL starting condition

Up-stream CB trip resulted at system fault or in-feeder CB in-advertent open will lead to power source loss on motor bus. It will raise the need of self-start of HSBT. It's defined as ABNORMAL starting condition. Below starting logics are included in 7VU683,

- In-admissible under-voltage
- In-admissible under-frequency
- In-admissible df/dt
- Reverse power
- In-advertent CB open

The above self-start logics can be freely combined together, i.e, one of them can be individually switched ON/OFF.

For reliable self-starting transfer, special attention must be paid, i.e, self-start logic must be blocked during electric fault, motor starting up, bus voltage MCB trip, manual trip of running source CB, etc.

Kinds of electric fault can be recognized by integrated Fault Detection function, see the Figure 2-64 as below.

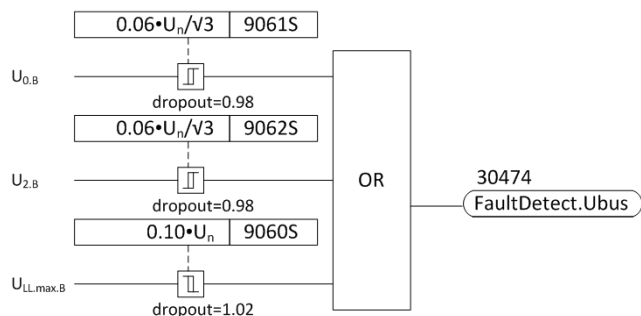


Figure 2-64 Fault detection logic for primary diagram of single bus with 3-CB

Motor starting up can be recognized by Motor Start Recognition function, see the Figure 2-65 as below.

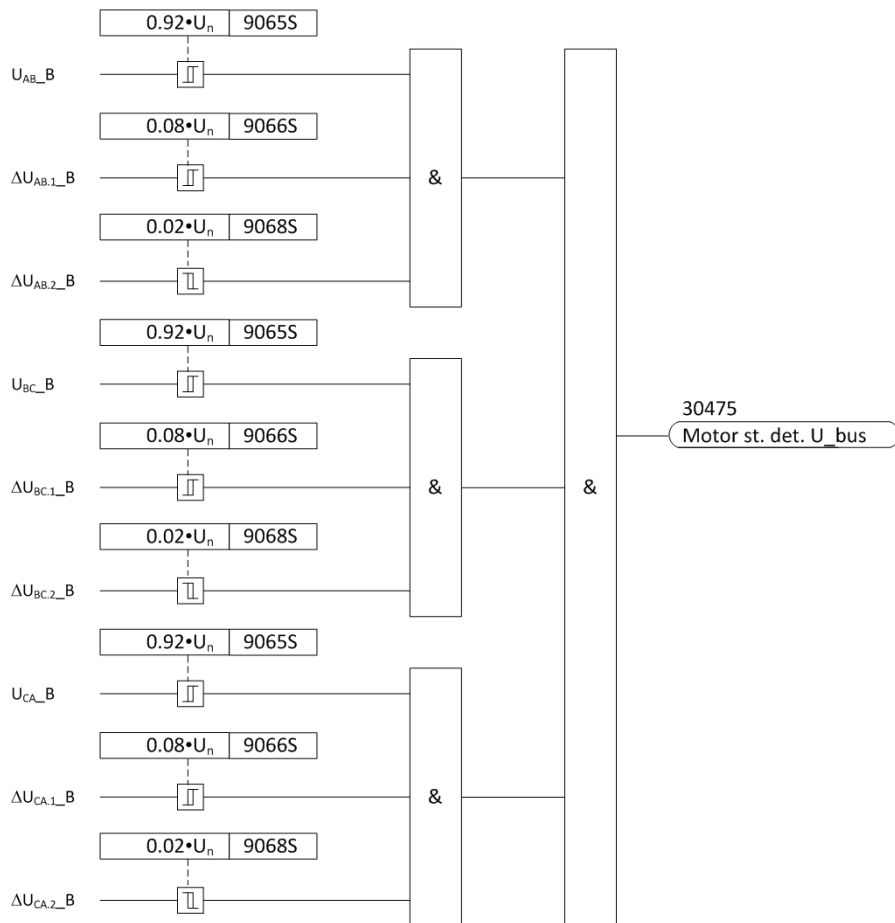


Figure 2-65 Motor starting-up recognition logic for primary diagram of single bus with 3-CB

Additionally the line current can be used to block the self-start logic, i.e, self-start logic can only be released under line dead current.

Under-voltage self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Line1->Line3**, **Line3->Line1**, **Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-66.

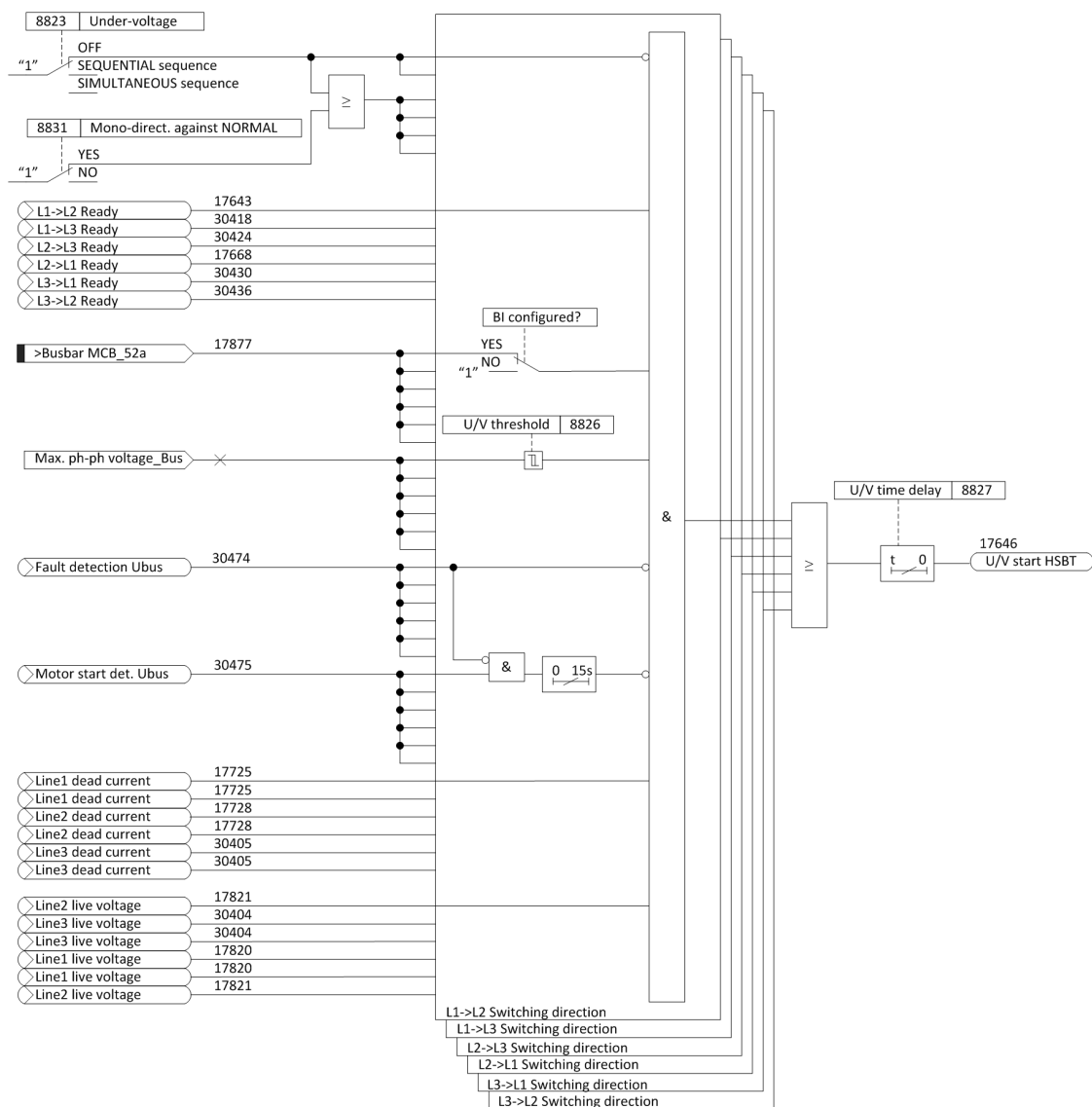


Figure 2-66 Under-voltage self-start logic for primary diagram of single bus with 3-CB

Under-frequency self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Line1->Line3**, **Line3->Line1**, **Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-67.

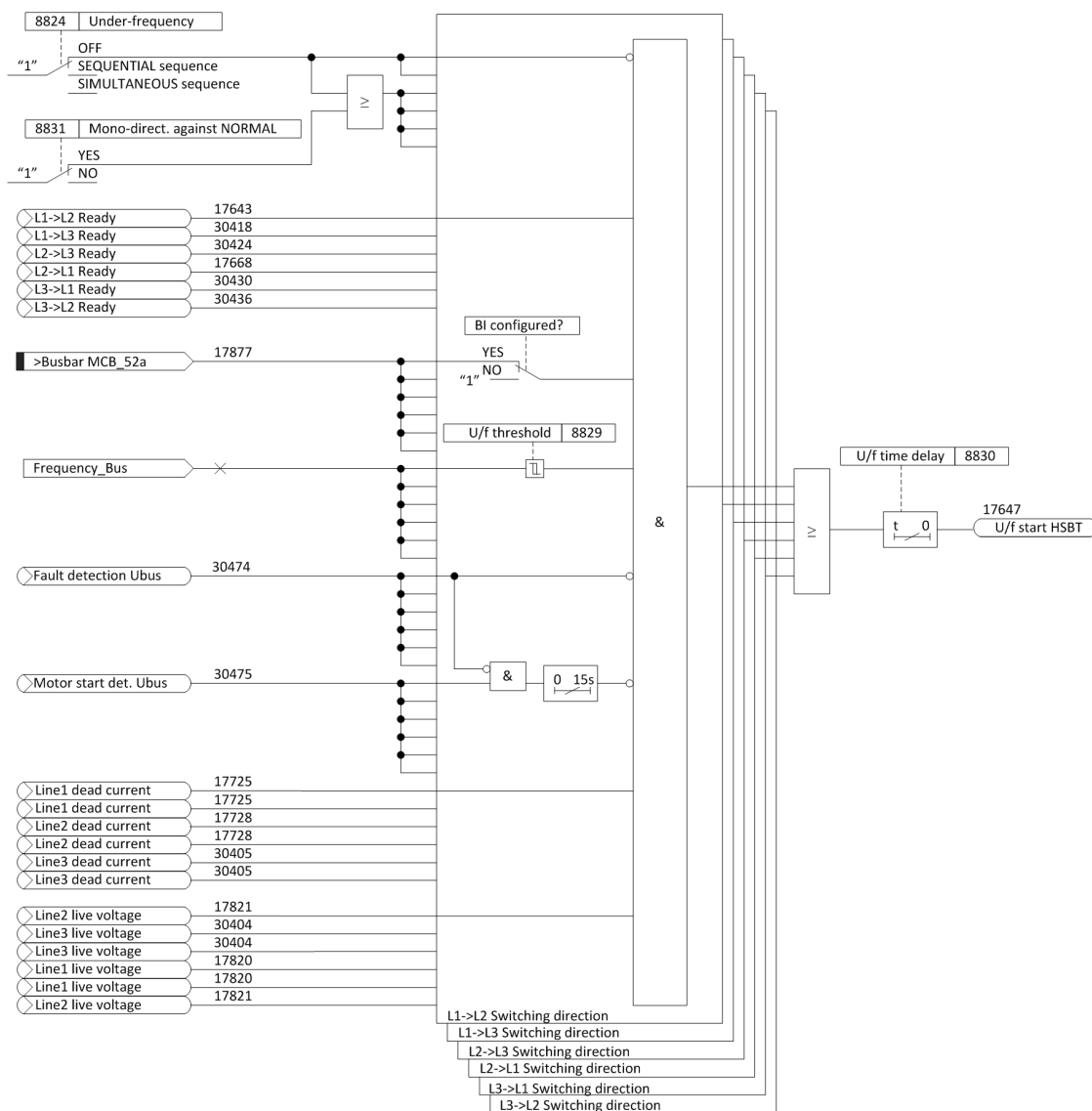


Figure 2-67 Under-frequency self-start logic for primary diagram of single bus with 3-CB

Reverse power self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Line1->Line3**, **Line3->Line1**, **Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-68.

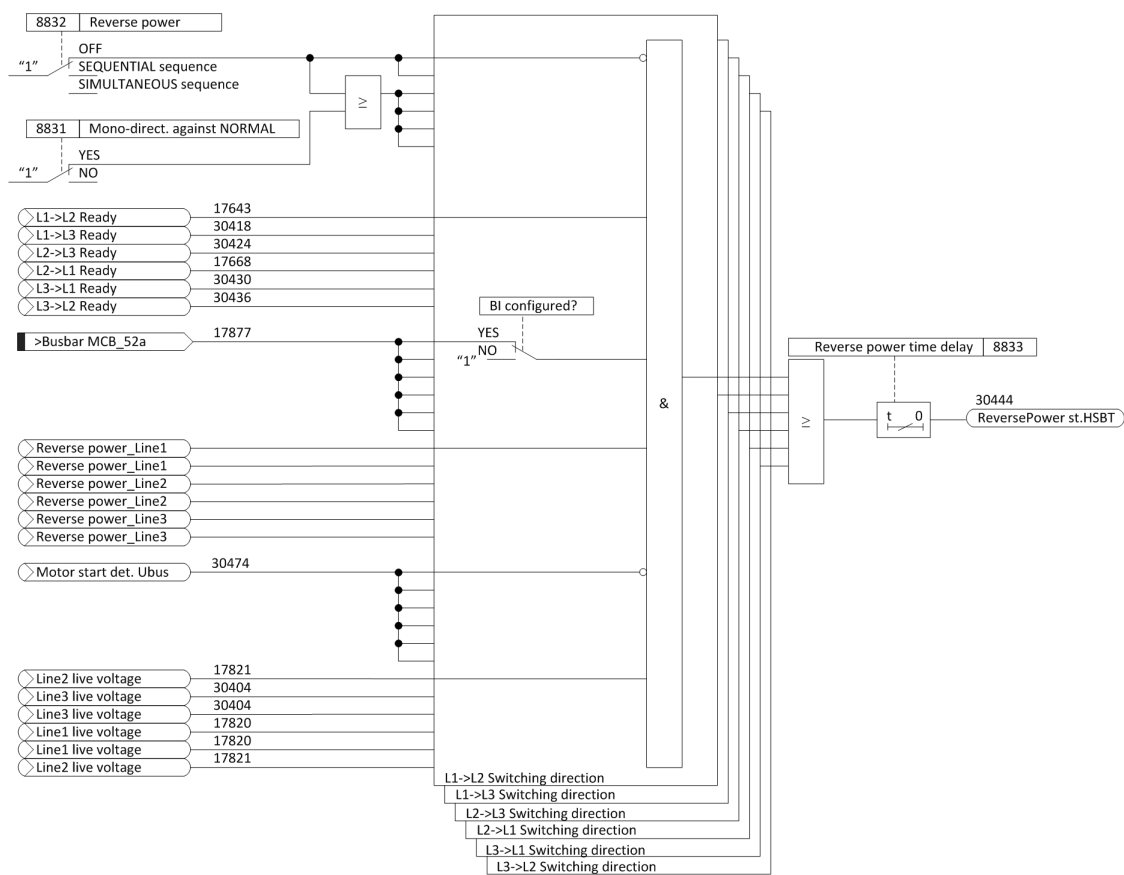


Figure 2-68 Reverse power self-start logic for primary diagram of single bus with 3-CB

Change rate of frequency self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Line1->Line3**, **Line3->Line1**, **Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-69.

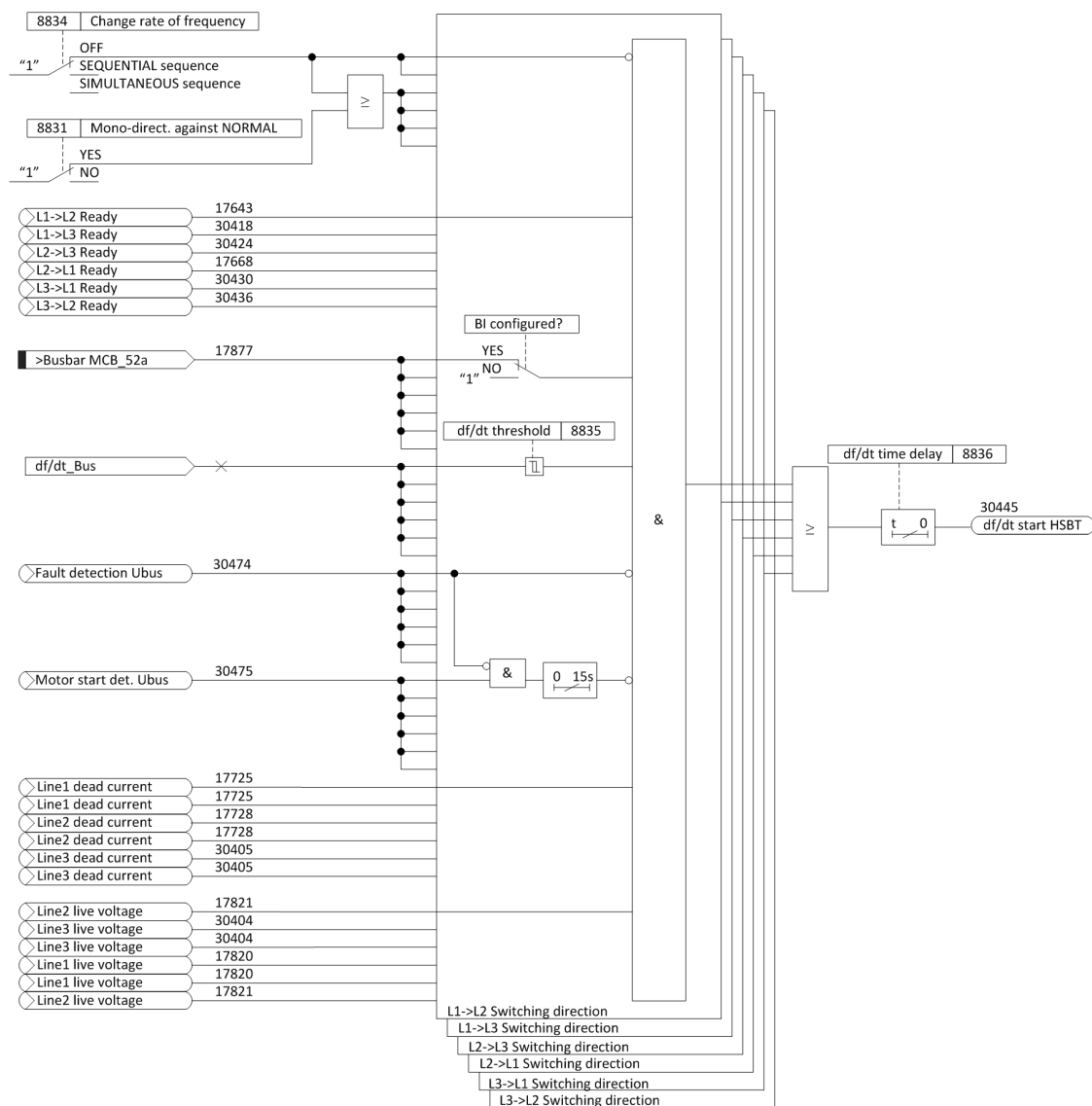


Figure 2-69 Change rate of frequency self-start logic for primary diagram of single bus with 3-CB

In-advertent CB open self-start logic for switching direction **Line1->Line2**, **Line2->Line1**, **Line1->Line3**, **Line3->Line1**, **Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-70.

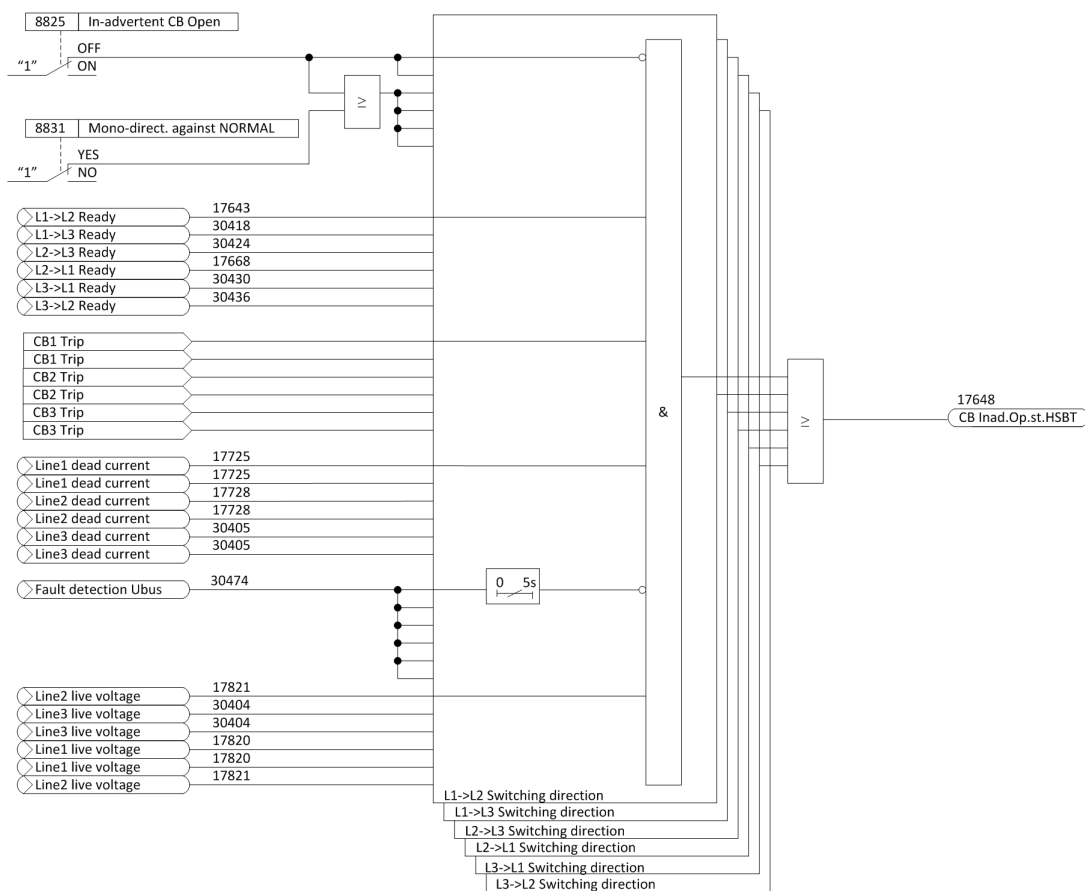


Figure 2-70 In-advertent CB open self-start logic for primary diagram of single bus with 3-CB

FAULT starting condition

Under the FAULT starting condition, power system fault must be there on the in-feeding source and the starting command must be externally issued by other device, e.g, protective relays.

Faults on the in-feeding source will be detected and cleared by protective relays, e.g, transformer differential relay. Meanwhile, HSBT should be externally started. The faults can be classified into two types regarding the electric symmetry. Then, optimization of switching sequence can be deployed. E.g,

- Type A: e.g, electric fault, i.e, GEN, TFR trips, to deploy SEQUENTIAL sequence;
- Type B: e.g, non-electric fault, i.e, boiler, turbine trips, to deploy SIMULTANEOUS sequence.

Starting logic for switching direction **Line1->Line2, Line2->Line1, Line1->Line3, Line3->Line1, Line2->Line3** and **Line3->Line2** can be referred to below Figure 2-71 and Figure2-72.

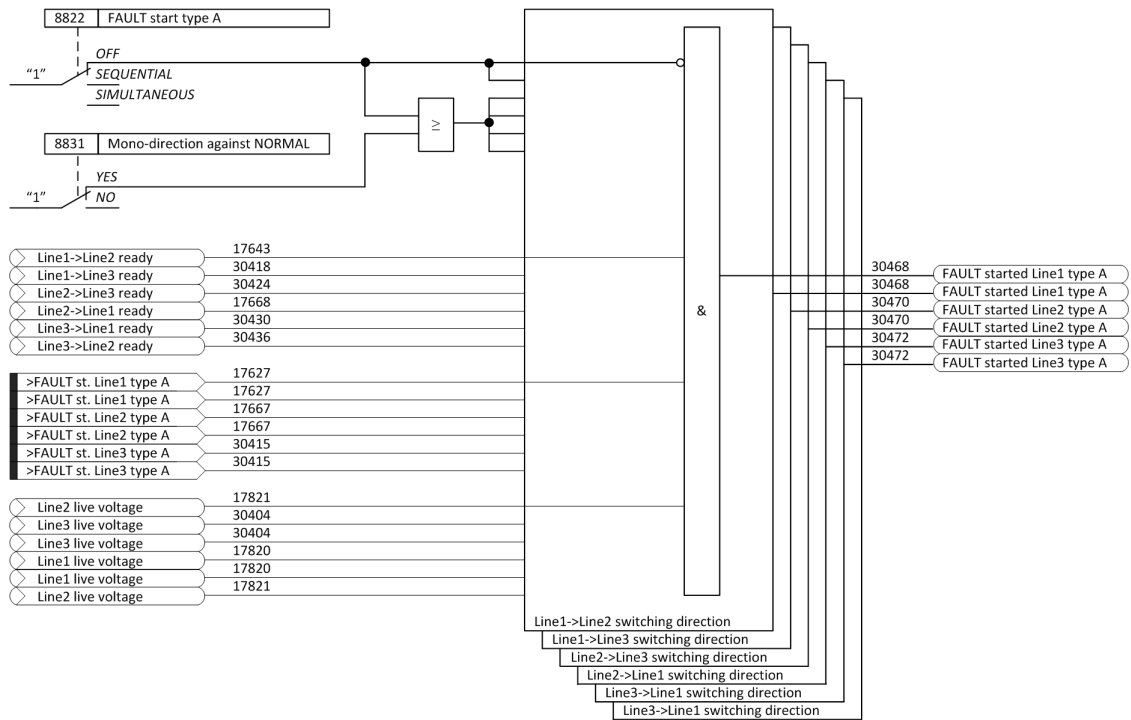


Figure 2-71 FAULT start logic for primary diagram of single bus with 3-CB, type A

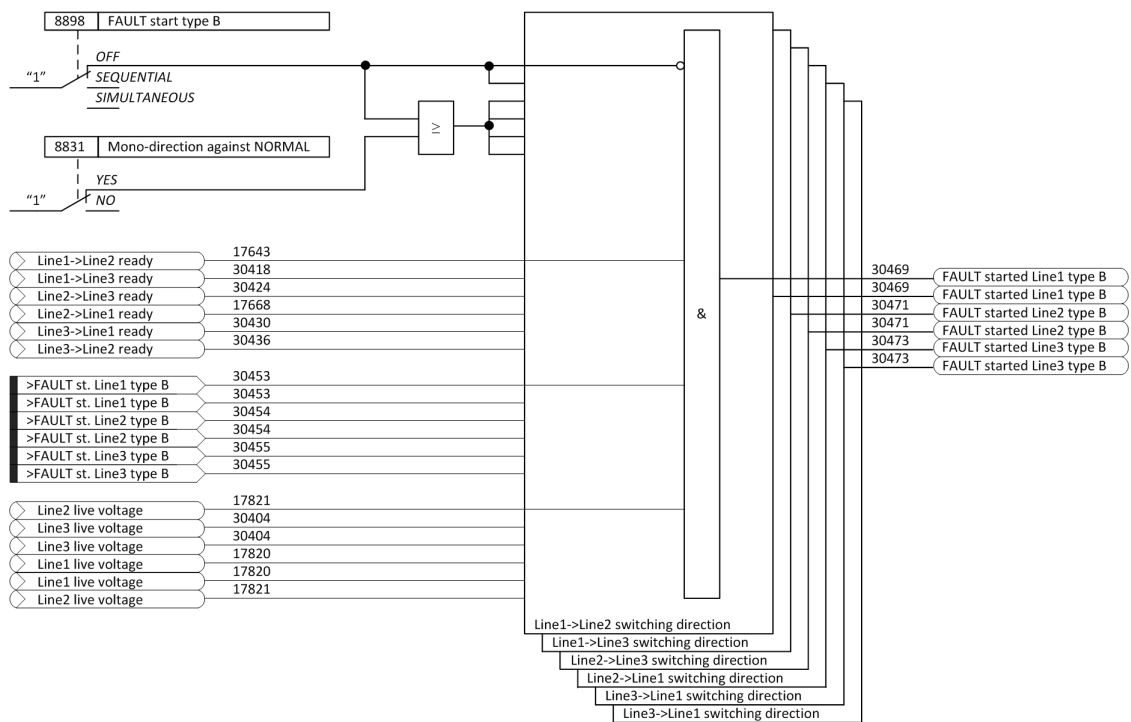


Figure 2-72 FAULT start logic for primary diagram of single bus with 3-CB, type B

2.2.6.5 Local/remote start

The authority of manual start is controlled by key switch LOCAL/REMOTE on device panel. The pre-CFC is already implemented in device to connect either binary input or protocol transfer request command.

To be noted that, protocol transfer requesting command can only be treated when LOCAL/ REMOTE switching key on device front panel is in REMOTE position. Otherwise, BI transfer requesting command will be treated.

Factory CFC in device for local/remote start logic can be referred to below Figure 2-73.

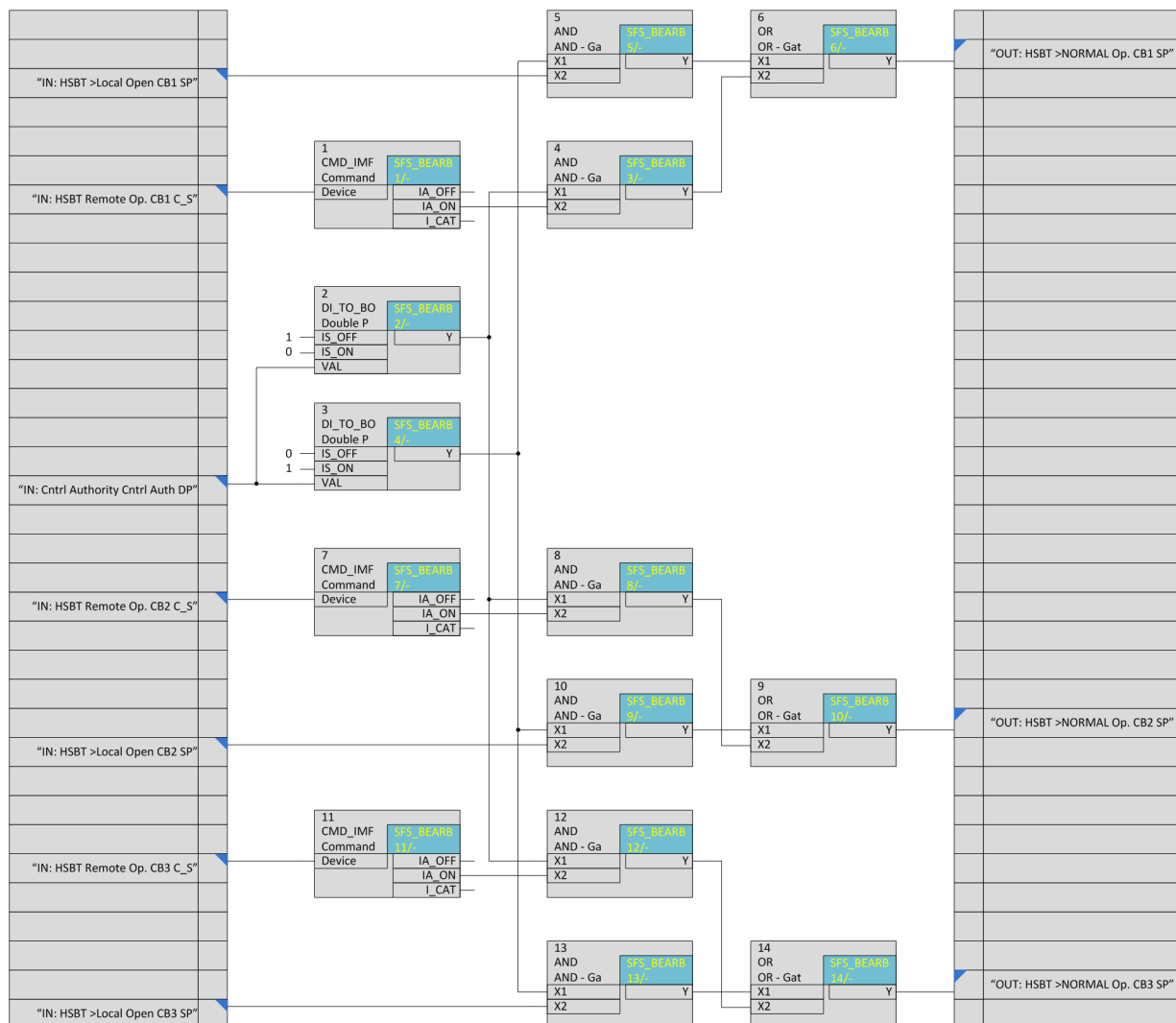


Figure 2-73 Local-remote start logic for primary diagram of single bus with 3-CB



Note:

This CFC logic block can only be programmed with the priority of Interlocking (SFS_BEARB / INTERLOCK).

2.2.6.6 Low voltage load-shedding

To avoid the alternative source over-loading in case of motors' restarting under low voltage transfer, it is helpful to implement low voltage load-shedding (LVLSH) function before RES-VOLT transfer. LVLSH is setting free which pickup value is taken from 8870 **IN-PHASE mode: under-voltage block**, with one stage, no time delay. This function can be activated or de-activated manually on site.

The loads to be shed are the customer's decision.

Low voltage load-shedding logic can be referred to below Figure 2-74.

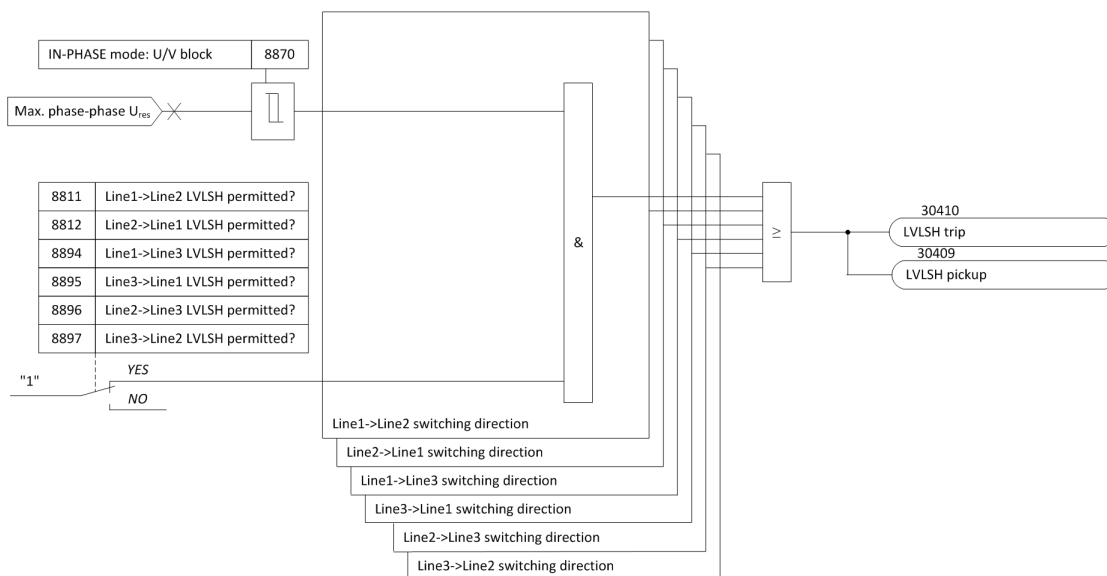


Figure 2-74 LVLSH for primary diagram of single bus with 3-CB

2.2.6.7 Settings

Address	Parameter	Range	Default Setting	Note
<i>HSBT->General</i>				
8801	CB1 closing time	20<=...<=150	70 ms	
8802	CB2 closing time	20<=...<=150	70 ms	
8803	CB3 closing time	20<=...<=150	70 ms	
8804	Maximum permitted HSBT operating Time	10<=...<=60	20 sec	
8805	Switching direction Line1->Line2	ON OFF	OFF	
8806	Switching direction Line2->Line1	ON OFF	OFF	
8890	Switching direction Line1->Line3	ON OFF	OFF	
8891	Switching direction Line3->Line1	ON OFF	OFF	
8892	Switching direction Line2->Line3	ON OFF	OFF	
8893	Switching direction Line3 ->Line2	ON OFF	OFF	
8811	Line1->Line2 LVLSH permitted	YES NO	NO	
8812	Line2->Line1 LVLSH permitted	YES NO	NO	
8894	Line1->Line3 LVLSH permitted	YES NO	NO	
8895	Line3->Line1 LVLSH permitted	YES NO	NO	
8896	Line2->Line3 LVLSH permitted	YES NO	NO	
8897	Line3 ->Line2 LVLSH permitted	YES NO	NO	
8817	Manually reset	YES NO	NO	
8818	Time delay to readiness	5<=...<=60	10 sec	
8819	Time delay to un-readiness	10<=...<=60	10 sec	
8820	HSBT test mode	ON OFF	OFF	
<i>HSBT->Start Condition</i>				
8821	NORMAL	OFF PARALLEL Auto PARAL. Half-Auto SIMULTANEOUS SEQUENTIAL	PARALLEL Auto	
8822	FAULT start type A	OFF SIMULTANEOUS SEQUENTIAL	SEQUENTIAL	
8898	FAULT start type B	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	

Address	Parameter	Range	Default Setting	Note
8823	Under-voltage	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8826	Under-voltage threshold	0.700<=...<=0.950	0.850 U/Un	
8827	Under-voltage time delay	0<= ...<=1000	10 ms	
8824	Under-frequency	OFF SIMULTANEOUS SEQUENTIAL	SIMULTANEOUS	
8829	Under-frequency threshold	45.00<=...<=49.50	47.50 Hz	f _n = 50 Hz
8829	Under-frequency threshold	55.00<=...<=59.50	57.00 Hz	f _n = 60 Hz
8830	Under-frequency time delay	0<= ...<=1000	10 ms	
8832	Reverse power	OFF SIMULTANEOUS SEQUENTIAL	OFF	
8833	Reverse power time delay	0<= ...<=1000	10 ms	
8834	Change rate of frequency	OFF SIMULTANEOUS SEQUENTIAL	OFF	
8835	Change rate of frequency threshold	-10.0<=...<=-0.5	-0.5 Hz/s	
8836	Change rate of frequency time delay	0<= ...<=1000	10 ms	
8825	Inadvertent CB open	OFF ON	ON	
8831	Mono-direction against NORMAL	YES NO	NO	
<i>HSBT->Transfer Mode</i>				
8841	FAST	OFF ON	ON	
8842	REAL-TIME FAST	OFF ON	ON	
8843	IN-PHASE	OFF ON	ON	
8844	RES-VOLT	OFF ON	ON	
8845	LONG-TIME	OFF ON	ON	
<i>HSBT-->Transfer Set</i>				
8851	PARALLEL sequence: delta frequency	0.02<=...<=2.00	0.10 Hz	
8852	PARALLEL sequence: delta U	1.0<=...<=40.0	2.0 V	
8853	PARALLEL sequence: delta phase angle	2.0<=...<=80.0	10.0 °	
8854	PARALLEL Auto: CB open time delay	0.00<=...<=2.00	0.10 sec	
8857	SIMULTANEOUS sequence: CB close time delay	0<=...<=40	0 ms	
8873	SIMULTANEOUS sequence: CB open time delay	0<= ...<=40	0 ms	
8858	FAST mode: delta frequency	0.50<=...2.50	1.00 Hz	
8859	FAST mode: delta phase angle	10.0<=...<=50.0	20.0 °	

Address	Parameter	Range	Default Setting	Note
8860	FAST mode: under-voltage block	$0.500 \leq \dots \leq 0.900$	0.700 U/Un	
8861	REAL-TIME FAST mode: delta frequency	$1.00 \leq \dots \leq 15.00$	3.00 Hz	
8862	REAL-TIME FAST mode: U_{diff}/f	$1.00 \leq \dots \leq 1.33$	1.33 p.u.	
8863	REAL-TIME FAST mode: delta phase angle	$70.0 \leq \dots \leq 90.0$	90.0 °	
8864	REAL-TIME FAST mode: under-voltage block	$0.500 \leq \dots \leq 0.900$	0.700 U/Un	
8868	IN-PHASE mode: delta frequency	$1.00 \leq \dots \leq 15.00$	5.00 Hz	
8869	IN-PHASE mode: phase angle	$0.5 \leq \dots \leq 20.0$	5.0 °	
8870	IN-PHASE mode: under-voltage block	$0.200 \leq \dots \leq 0.800$	0.400 U/Un	
8871	RES-VOLT mode: threshold	$0.200 \leq \dots \leq 0.600$	0.300 U/Un	
8872	LONG-TIME mode: threshold	$0.50 \leq \dots \leq 10.00$	3.00 sec	

2.2.6.8 Information List

No.	Information	Type	Fun. NO.	Inf. NO.
17620	>Block HSBT	SP		
17863	>Manually reset	SP		
17627	>FAULT start Line1 type A	SP		
17667	>FAULT start Line2 type A	SP		
30415	>FAULT start Line3 type A	SP		
30453	>FAULT start Line1 type B	SP		
30454	>FAULT start Line2 type B	SP		
30455	>FAULT start Line3 type B	SP		
30406	>NORMAL open CB1	SP		
30407	>NORMAL open CB2	SP		
30408	>NORMAL open CB3	SP		
17870	>Manual open command in PARALLEL Half-Auto	SP		
18020	>HSBT test mode	SP		
17640	HSBT is active	OUT		
17641	HSBT is switched off	OUT		
17642	HSBT is blocked	OUT		
30474	Fault detected Ubus	OUT		
30475	Motor start detected Ubus	OUT		
17644	NORMAL start	OUT		
17646	Under-voltage start	OUT		
17647	Under-frequency start	OUT		
30444	Reverse power start	OUT		
30445	Change rate of frequency start	OUT		
17648	In-advertent CB open start	OUT		
17651	FAST mode close standby source	OUT		
17652	REAL-TIME FAST mode close standby source	OUT		
17653	IN-PHASE mode close standby source	OUT		
17654	RES-VOLT mode close standby source	OUT		
17655	LONG-TIME mode close standby source	OUT		

No.	Information	Type	Fun. NO.	Inf. NO.
17656	PARALLEL sequence close standby source	OUT		
17657	SIMULTANEOUS sequence close standby source	OUT		
30452	SEQUENTIAL sequence close standby supply	OUT		
30456	df at CB closing command triggered	VI		
30457	dU at CB closing command triggered	VI		
30458	dφ at CB closing command triggered	VI		
30459	Residual voltage at CB closing command triggered	VI		
30460	V/Hz p.u. at CB closing command triggered	VI		
30461	df at CB closing instant	VI		
30462	dU at CB closing instant	VI		
30463	dφ at CB closing instant	VI		
30464	Residual voltage at CB closing instant	VI		
30465	V/Hz p.u. at CB closing instant	VI		
18017	CB1 closing time =	VI		
18018	CB2 closing time =	VI		
18019	CB3 closing time =	VI		
17886	>Block Line1 -> Line2	SP		
17950	Line1 -> Line2 is blocked	OUT		
17643	Line1 -> Line2 is ready	OUT		
17871	Line1 -> Line2 succeeded	OUT	200	15
17922	Line1 -> Line2 timed out	OUT		
17916	Line1 -> Line2 failed	OUT	200	21
17887	>Block Line2 -> Line1	SP		
17951	Line2 -> Line1 is blocked	OUT		
17668	Line2 -> Line1 is ready	OUT		
17872	Line2 -> Line1 succeeded	OUT	200	16
17923	Line2 -> Line1 timed out	OUT		
17917	Line2 -> Line1 failed	OUT	200	22
30416	>Block Line1 -> Line3	SP		
30417	Line1 -> Line3 is blocked	OUT		
30418	Line1 -> Line3 is ready	OUT		
30419	Line1 -> Line3 succeeded	OUT	150	7
30420	Line1 -> Line3 timed out	OUT		
30421	Line1 -> Line3 failed	OUT	150	8
30422	>Block Line2 -> Line3	SP		
30423	Line2 -> Line3 is blocked	OUT		
30424	Line2 -> Line3 is ready	OUT		
30425	Line2 -> Line3 succeeded	OUT	150	9
32426	Line2 -> Line3 timed out	OUT		
30427	Line2 -> Line3 failed	OUT	150	10
30428	>Block Line3 -> Line1	SP		
30429	Line3 -> Line1 is blocked	OUT		
30430	Line3 -> Line1 is ready	OUT		
30431	Line3 -> Line1 succeeded	OUT	150	11
30432	Line3 -> Line1 timed out	OUT		
30433	Line3 -> Line1 failed	OUT	150	12

No.	Information	Type	Fun. NO.	Inf. NO.
30434	>Block Line3 -> Line2	SP		
30435	Line3 -> Line2 is blocked	OUT		
30436	Line3 -> Line2 is ready	OUT		
30437	Line3 -> Line2 succeeded	OUT	150	13
30438	Line3 -> Line2 timed out	OUT		
30439	Line3 -> Line2 failed	OUT	150	14
18012	HSBT is ready	OUT	200	93
17948	HSBT succeeded	OUT	200	91
17949	HSBT failed	OUT	200	92
30409	Low voltage load-shedding pick up	OUT	150	1
30410	Low voltage load-shedding trip	OUT	150	2
17963	Line1 -> Line2 ON/OFF	IntSP	200	66
17964	Line2 -> Line1 ON/OFF	IntSP	200	67
30440	Line1 -> Line3 ON/OFF	IntSP	200	95
30441	Line2 -> Line3 ON/OFF	IntSP	200	96
30442	Line3 -> Line1 ON/OFF	IntSP	200	97
30443	Line3 -> Line2 ON/OFF	IntSP	200	98
17969	FAST transfer mode ON/OFF	IntSP		
17970	REAL-TIME FAST transfer mode ON/OFF	IntSP		
17971	IN-PHASE transfer mode ON/OFF	IntSP		
17972	RES-VOLT transfer mode ON/OFF	IntSP		
17973	LONG-TIME transfer mode ON/OFF	IntSP		
	Remote open CB1	C_S		
	> Local open CB1	SP		
	Remote open CB2	C_S		
	> Local open CB2	SP		
	Remote open CB3	C_S		
	> Local open CB3	SP		
30468	FAULT started Line1 type A	OUT		
30469	FAULT started Line1 type B	OUT		
30470	FAULT started Line2 type A	OUT		
30471	FAULT started Line2 type B	OUT		
30472	FAULT started Line3 type A	OUT		
30473	FAULT started Line3 type B	OUT		

2.2.7 Test Mode

To facilitate the functional testing and site commissioning, the on-line test mode is specially designed for this purpose. This function can be activated on site by parameter setting 8820 **HSBT Test Mode** = YES or by indication 18020 >**HSBT Test Mode** via binary input.

If the function HSBT goes into test mode, the transfer process is the same except that the CLOSE command will be blocked. Instead, CLOSE command with test mark will be issued out for indicating.

HSBT Test Mode could be helpful before the device is put into service. Under on-line test mode, transfer process can be monitored. Under the assistance of integrated fault recorder and event log, the operating progress and settings can be assessed. Optimization to parameter settings can be done based on the assessment.

The on-line test logic can be found in below Figure 2-75.

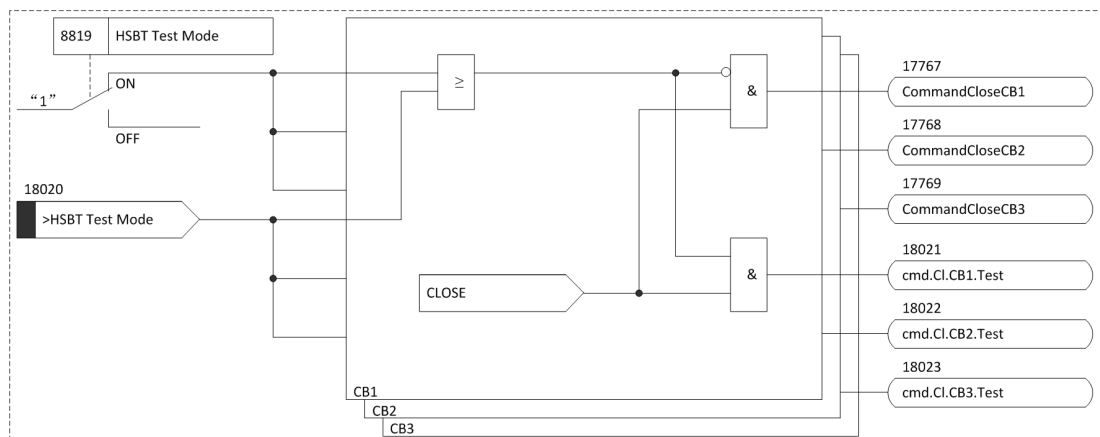


Figure 2-75 Illustration of on-line test

2.2.8 CB Closing Time

CB closing time is defined as the time length from the instant of CLOSE command triggered to the instant of CB closing. This is very important for reliable fast transfer.

It comprises below items:

- Operation time of 7VU683 output relay, i.e, approx. 1ms for high speed relay, 5 ms for fast speed relay and 8ms for normal speed relay. High speed relay is always proposed for CLOSE command;
- Operation time of inter-relay in closing circuit, if have;
- CB making time.

CB closing time will be recorded in each successful transfer log. The average value, i.e, derived from five transfer logs, can be set for each CB.

2.3 Protections for tie-CB

Protection functions can be set *ON/OFF* under the parameter 0226 **Protection Functions**.

For device 7VU683, the protection functions are exclusively designed for primary diagram of sectionalized single bus with 3-CB.

With $f_n = 50$ Hz, the operation range of frequency is 20-66 Hz. With $f_n = 60$ Hz, the operation range of frequency is 25-66 Hz. Protection functions will be invalid if frequency is out of this operation range.



Note:

The current related settings and default values are based on $I_n = 1$ A. If the rated secondary current is 5 A, the values should be multiplied by 5.

2.3.1 Phase Over-current Protection

This chapter describes the over-current protection for tie-CB.

2.3.1.1 Description

The device incorporates with definite time phase over-current protection with two stages.

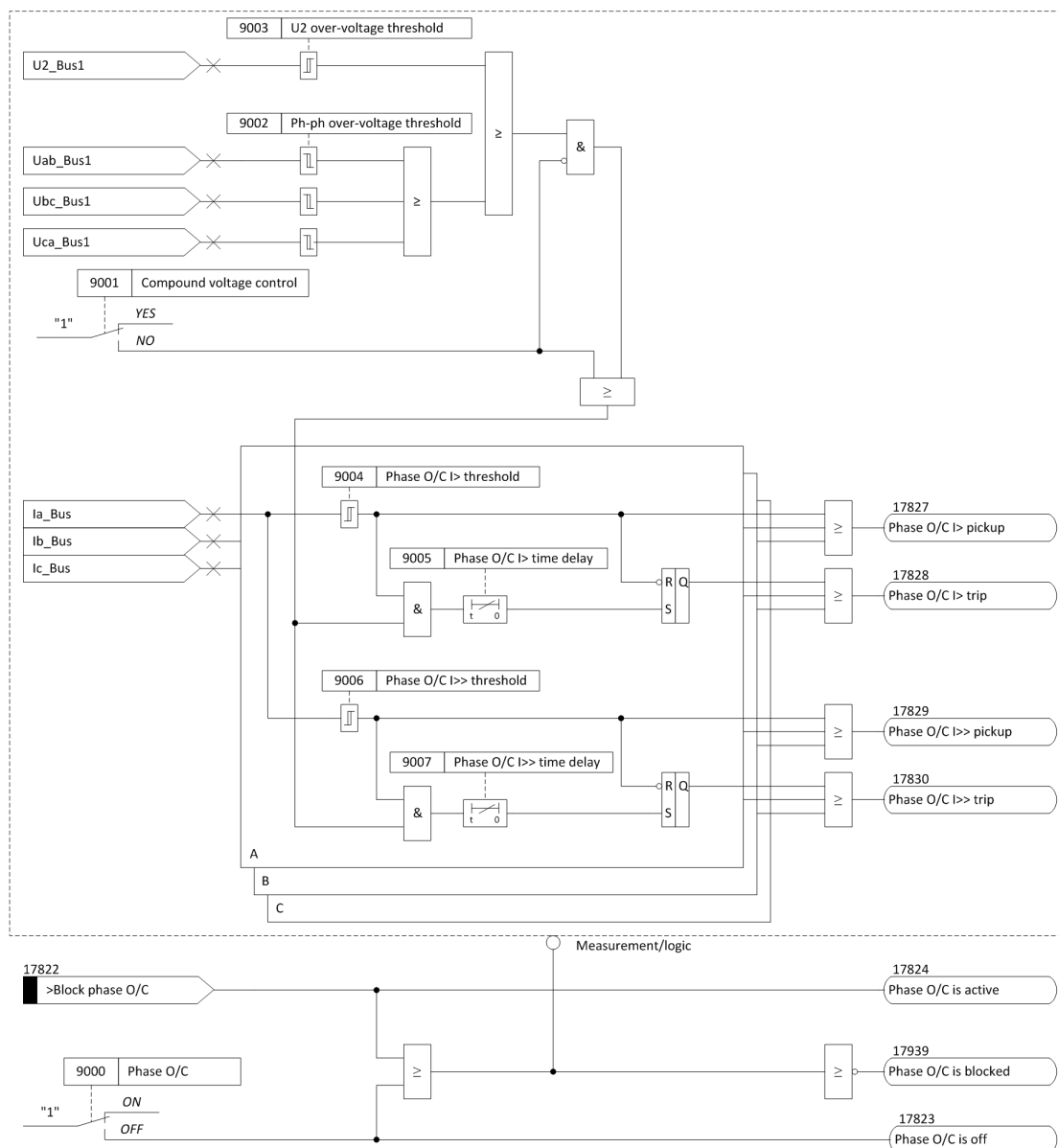


Figure 2-76 Logic diagram of phase over-current protection

Logic notes,

- The release element of voltage can be *ON/OFF* by parameter 9001 **Compound Voltage Control**;
- VT broken wire will not block the phase over-current protection;
- The tripping command will only be reset if the phase current criterion drops out.

2.3.1.2 Settings

Address	Parameter	Setting Options	Default Setting	Comments
<i>Protection Functions->General</i>				
9000	Phase over-current protection	ON OFF	OFF	
<i>Protection Functions -> Voltage Control</i>				
9002	Ph-ph under-voltage threshold	1.0<=...<=125.0, 0	70.0 V	
9003	U2 over-voltage threshold	1.0<=...<=125.0, ∞	8.0 V	
<i>Protection Functions -> Phase O/C</i>				
9001	Compound voltage control	YES NO	YES	
9004	Phase over-current I>threshold	0.10<=...<=35.00	3.00 A	
9005	Phase over-current I> time delay	0.00<=...<=60.00, ∞	0.50 s	
9006	Phase over-current I>>threshold	0.10<=...<=35.00	5.00 A	
9007	Phase over-current I>> time delay	0.00<=...<=60.00, ∞	0.10 s	

2.3.1.3 Information List

No.	Information	Type	Function No.	Inf.NO.
17822	>Block phase O/C	SP		
17939	Phase O/C is active	OUT		
17823	Phase O/C is off	OUT		
17824	Phase O/C is blocked	OUT		
17827	I> pick up	OUT		
17828	I> trip	OUT	200	44
17829	I>> pick up	OUT		
17830	I>> trip	OUT	200	46
17981	Ph.O/C On/Off	IntSP	200	85

2.3.2 Ground Over-current Protection

This chapter describes the ground over-current protection for tie-CB.

2.3.2.1 Description

The device incorporates with definite time ground over-current protection with two stages.

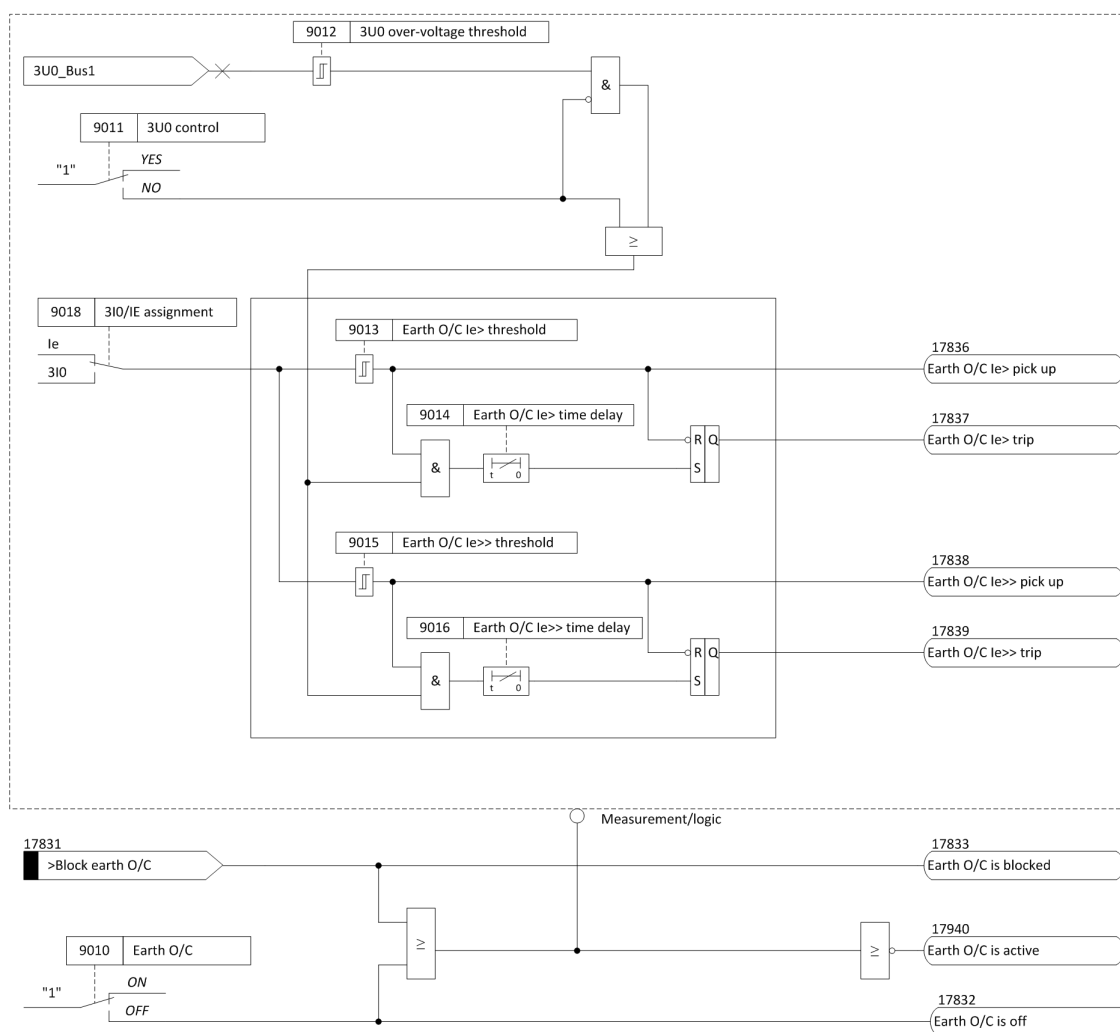


Figure 2-77 Logic diagram of ground over-current protection

Logic notes,

- The release element of voltage can be *ON/OFF* by parameter 9011 **3U0 Control**;
- VT broken wire will not block the ground over-current protection;
- The tripping command will only be reset if the ground current criterion drops out.

2.3.2.2 Settings

Address	Parameter	Setting Options	Default Setting	Comments
<i>Protection Functions-> General</i>				
9010	Earth over-current protection	ON OFF	OFF	
9018	3I0/IE assignment	IE 3I0	3I0	
<i>Protection Functions -> Voltage Control</i>				
9012	3U0 over-voltage threshold	1<=...<=200	30 V	
<i>Protection Functions -> Earth O/C</i>				
9011	3U0 Control	Yes No	Yes	
9013	Earth over-current $I_e >$ threshold	0.10<=...<=35.00	3.00 A	
9014	Earth over-current $I_e >$ time delay	0.00<=...<=60.00, ∞	0.50 s	
9015	Earth over-current $I_e \gg$ threshold	0.10<=...<=35.00	5.00 A	
9016	Earth over-current $I_e \gg$ time delay	0.00<=...<=60.00, ∞	0.10 s	

2.3.2.3 Information List

No.	Information	Type	Function No.	Inf.No.
17831	>Block earth O/C	SP		
17940	Earth O/C is active	OUT		
17832	Earth O/C is off	OUT		
17833	Earth O/C is blocked	OUT		
17836	$I_e >$ pick up	OUT		
17837	$I_e >$ trip	OUT	200	48
17838	$I_e \gg$ pick up	OUT		
17839	$I_e \gg$ trip	OUT	200	50
17982	Earth O/C On/Off	IntSP	200	86

2.3.3 Phase O/C Protection against Switch-Onto-Fault

This chapter describes the over-current protection for tie-CB against switch-onto-fault.

2.3.3.1 Description

The device incorporates with definite time phase over-current protection with two stages against switch-onto-fault.

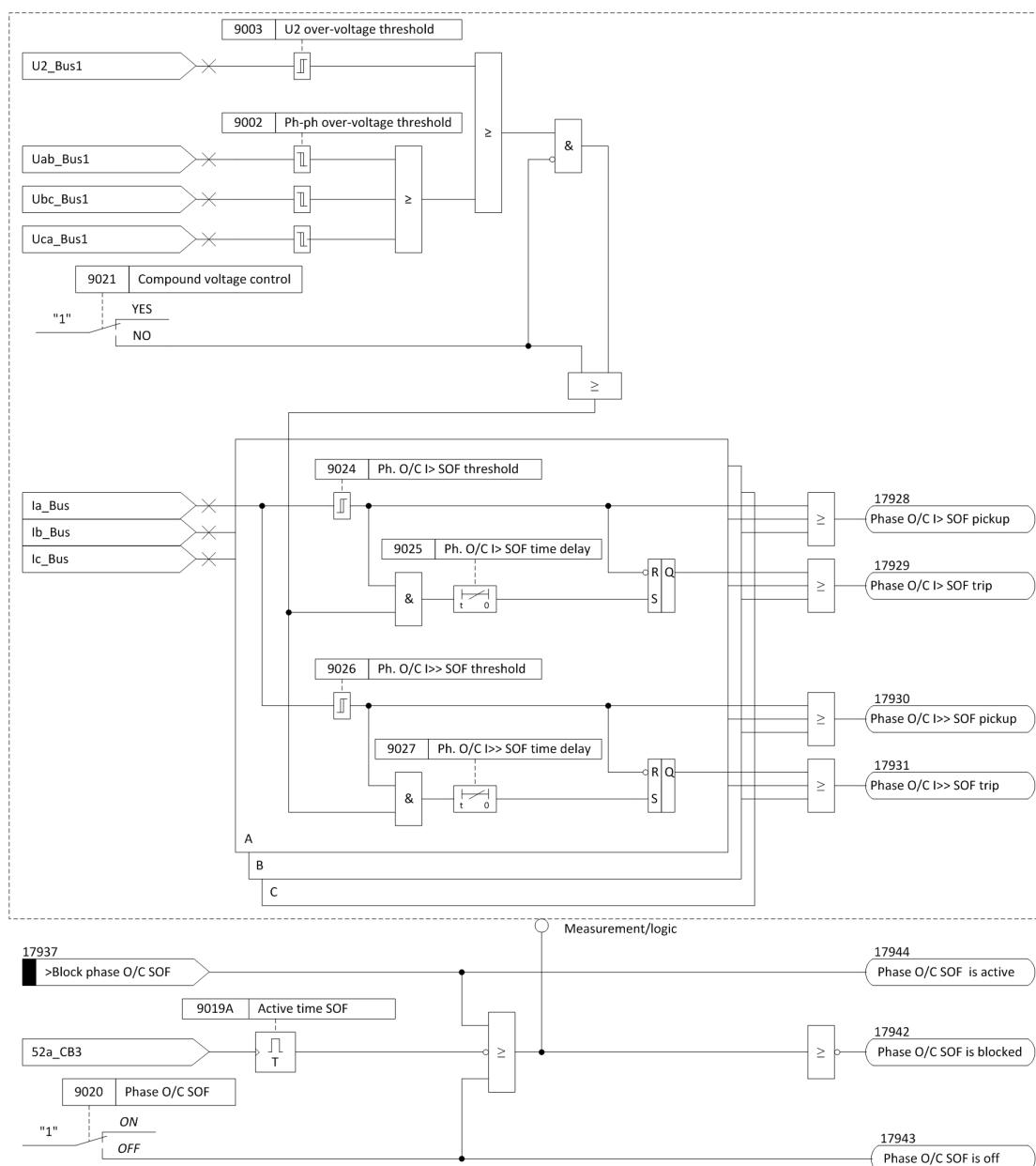


Figure 2-78 Logic diagram of phase over-current protection against switch-onto-fault

Logic notes,

- The release element of voltage can be *ON/OFF* by parameter 9021 **Compound Voltage Control**;
- VT broken wire will not block the phase over-current protection against switch-onto-fault;
- The tripping command will only be reset if the phasecurrent criterion drops out.

2.3.3.2 Settings

Address	Settings	Setting Options	Default Setting	Comments
<i>Protection Functions -> General</i>				
9020	Phase O/C switch-onto-fault protection	ON OFF	OFF	
9019A	Active time for switch-onto-fault protection	0.01<=...<=600.00	5.00 s	
<i>Protection Functions -> Voltage Control</i>				
9002	Ph-ph under-voltage threshold	1.0<=...<=125.0, 0	70.0 V	
9003	U2 over-voltage threshold	1.0<=...<=125.0, ∞	8.0 V	
<i>Protection Functions -> Ph. O/C SOF</i>				
9021	Compound voltage control	Yes No	No	
9024	Phase O/C I> switch-onto-fault threshold	0.10<=...<=35.00	2.00 A	
9025	Phase O/C I>switch-onto-fault time delay	0.00<=...<=60.00, ∞	0.50 s	
9026	Phase O/C I>>switch-onto-fault threshold	0.10<=...<=35.00	4.00 A	
9027	Phase O/C I>>switch-onto-fault time delay	0.00<=...<=60.00, ∞	0.10 s	

2.3.3.3 Information List

No.	Information	Type	Funcion No.	Inf. No.
17937	>Block phase O/C SOF	SP		
17942	Phase O/C SOF is active	OUT		
17943	Phase O/C SOF is off	OUT		
17944	Phase O/C SOF is blocked	OUT		
17928	I>SOF pick up	OUT		
17929	I>SOF trip	OUT	200	54
17930	I>>SOF pick up	OUT		
17937	I>>SOF trip	SP	200	56
17983	Phase O/C SOF ON/OFF	IntSP	200	87

2.3.4 Ground O/C Protection against Switch-Onto-Fault

This chapter describes the ground over-current protection for tie-CB against switch-onto-fault.

2.3.4.1 Description

The device incorporates with definite time ground over-current protection with two stages against switch-onto-fault.

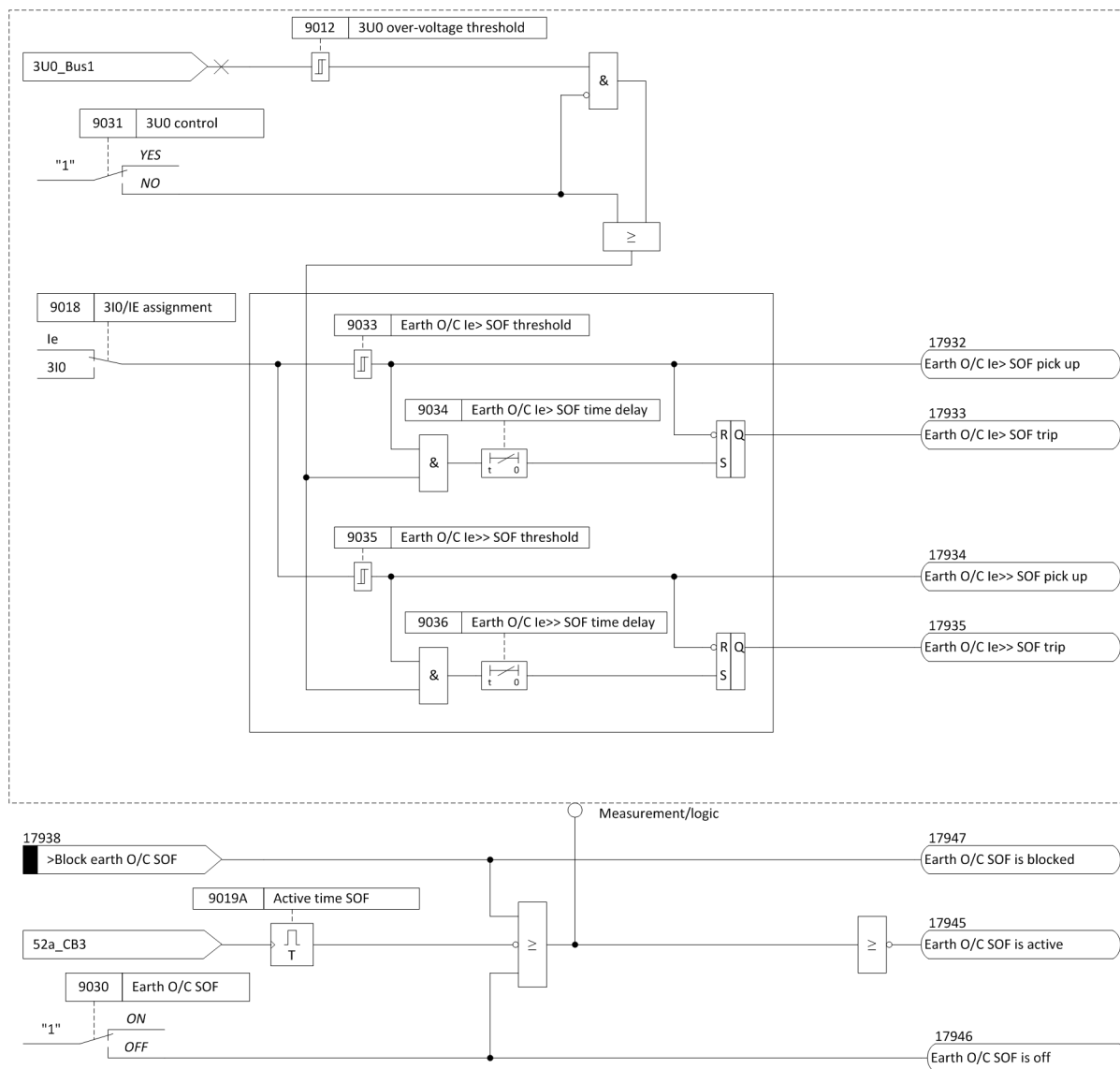


Figure 2-79 Logic diagram of ground over-current protection against switch-onto-fault

Logic notes,

- The release element of zero-sequence voltage can be *ON/OFF* by parameter 9031 **3U0 Control**;
- VT broken wire will not block the ground over-current protection against switch-onto-fault;
- The tripping command will only be reset if the ground current criterion drops out;
- The active time after the tie-CB is closed is controlled by parameter 9019A **Active time SOF**.

2.3.4.2 Settings

Address	Settings	Setting Options	Default Setting	Comments
<i>Protection Functions -> General</i>				
9030	Earth O/C switch-onto-fault protection	ON OFF	OFF	
9018	3I0/IE assignment	IE 3I0	3I0	
9019A	Active time for switch-onto-fault protection	0.01<=...<=600.00	5.00 s	
<i>Protection Functions -> Voltage Control</i>				
9012	3U0 over-voltage threshold	1<=...<=200	30 V	
<i>Protection Functions -> Earth O/C SOF</i>				
9031	3U0 Control	Yes No	Yes	
9033	Earth O/C I _e >switch-onto-fault threshold	0.10<=...<=35.00	2.00 A	
9034	Earth O/C I _e >switch-onto-fault time-delay	0.00<=...<=60.00, ∞	0.50 s	
9035	Earth O/C I _e >> switch-onto-fault threshold	0.10<=...<=35.00	4.00 A	
9036	Earth O/C I _e >>switch-onto-fault tim-delay	0.00<=...<=60.00, ∞	0.10 s	

2.3.4.3 Information List

No.	Information	Type	Funcion No.	Inf. No.
17938	>Block Earth O/C SOF	SP		
17945	Earth O/C SOF is active	OUT		
17946	Earth O/C SOF is off	OUT		
17947	Earth O/C SOF is blocked	OUT		
17932	I _e >SOF pick up	OUT		
17933	I _e >SOF trip	OUT	200	58
17934	I _e >>SOF pick up	OUT		
17935	I _e >>SOF trip	OUT	200	60
17984	Earth O/C SOF ON/OFF	IntSP	200	88

2.4 Monitoring Function

With $f_n = 50$ Hz, the operation range of frequency is 45-66 Hz. With $f_n = 60$ Hz, the operation range of frequency is 55-66 Hz. Monitoring functions will be invalid if frequency is out of this operation range.

2.4.1 VT Broken Wire Supervision

This chapter describes the monitoring function for VT wiring.

2.4.1.1 Description

VT broken wire supervision includes bus VT broken wire supervision and line VT broken wire supervision.

Bus VT wiring is supervised in case of primary diagram of single bus with 2-CB and single bus with 3-CB. Both bus 1 and bus 2 VT wiring are supervised in case of primary diagram of sectionalized single bus with 3-CB. Refer to Figure 2-80 for monitoring logic.

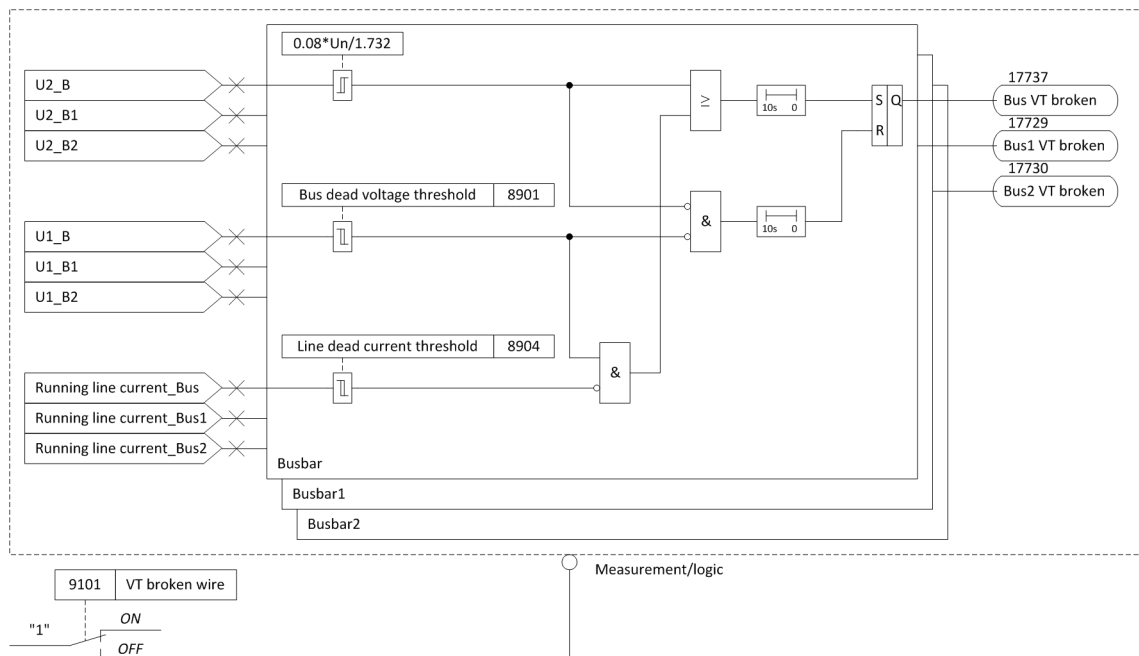


Figure 2-80 Bus VT broken wire monitoring logic

Running line current of bus is internally auto-decided by the device. E.g, if both Bus 1 and Bus 2 are powered by Line1, then the current of I_{x_L1} will be evaluated.

Also, every line VT wiring is supervised. Refer to Figure 2-81 for monitoring logic.

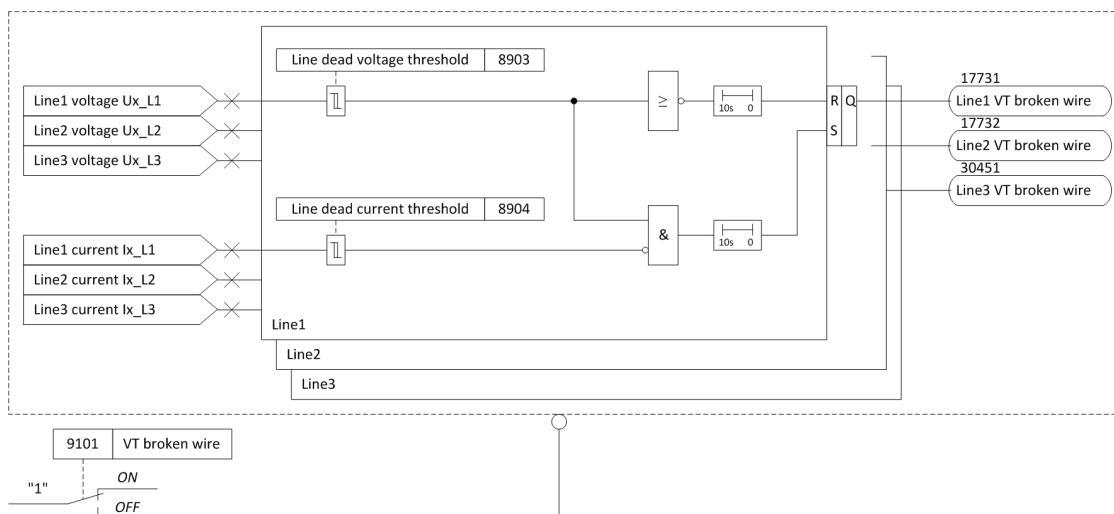


Figure 2-81 Line VT broken wire monitoring logic

2.4.1.2 Settings

Address	Settings	Setting Options	Default Setting	Comments
<i>Supervision</i>				
9101	VT Broken Wire	ON OFF	ON	

2.4.1.3 Information List

No.	Information	Type	Function No.	Inf. No.
17737	Bus VT broken	OUT		
17729	Bus1 VT broken	OUT		
17730	Bus2 VT broken	OUT		
17731	Line1 VT broken	OUT		
17732	Line2 VT broken	OUT		
30451	Line3 VT broken	OUT		

2.4.2 Bus Voltage Sequence Supervision

This chapter describes the monitoring function for bus voltage phase sequence.

2.4.2.1 Description

Phase sequence supervision for bus voltage is included.

The base phase sequence in device is A,B,C. That is, the measured voltage phase sequence is different from the base sequence, the monitoring function will issue out the alarm message in 5 s.

The under-voltage blocking for phase sequence monitoring is $80\%U_n$.

2.4.2.2 Settings

Address	Settings	Setting Options	Default Setting	Comments
<i>Supervision</i>				
9102	Phase Sequence Busbar Voltage	ON OFF	ON	

2.4.2.3 Information List

No.	Information	Type	Function No.	Inf. No.
17993	Failure: phase sequence Bus voltage	OUT		
17994	Failure: phase sequence Bus1 voltage	OUT		
17995	Failure: phase sequence Bus2 voltage	OUT		



Mounting And Commissioning

3

This chapter is intended for experienced commissioning staff. They should be familiar with the commissioning of protection and control equipment, with operation of the power system network and with the safety rules and regulations. Certain adaptations of the hardware to the power system specifications may be necessary.

3.1	Mounting and Connections	124
3.2	Checking Connections	141
3.3	Commissioning	148
3.4	Final Preparation of the Device	158

3.1 Mounting And Connections



WARNING!

Warning of improper transport, storage, installation, and application of the device.

Non-observance can result in death, personal injury or substantial property damage.

Trouble free and safe use of this device depends on proper transport, storage, installation, and application of the device according to the warnings in this instruction manual.

Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, ANSI, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

3.1.1 Configuration Information

Prerequisites

For mounting and connection the following requirements and conditions must be met: The rated device data has been tested as recommended in the SIPROTEC 4 System Description /1/ and their compliance with these data is verified with the Power System Data.

Connection Variants

Overview diagrams are shown in Appendix A.2. Connection examples for current and voltage transformer circuits are given in Appendix A.3. It must be checked that the setting configuration of the Power System Data 1, Section 2.5, corresponds with the connections.

Currents/Voltages

Connection diagrams are shown in the chapter 2 Function.

Binary Inputs and Outputs

Allocation possibilities of binary inputs and outputs, i.e. the individual matching to the system are described in the SIPROTEC 4 System Description /1/. The presettings of the device are listed in Appendix A, Section A.3. Check also whether the labelling corresponds to the allocated message functions.

Changing Setting Groups

If binary inputs are used to switch setting groups, please observe the following:

- Two binary inputs must be dedicated to the purpose of changing setting groups when four groups are to be switched. One binary input must be set for ">**Set Group Bit0**", the other input for ">**Set Group Bit1**".
- If either of these input functions is not assigned, then it is considered as not controlled. For the control of 2 setting groups one binary input is sufficient, namely ">**Set Group Bit0**", since the non-assigned binary input ">**Set Group Bit1**" is then regarded as not connected.
- The control signals must be permanently active so that the selected setting group is and remains active.

Where,

no = not energized or not connected, yes = energized If binary inputs are used to change setting groups, please observe the following:

Table 3-1 Changing setting groups using binary inputs

Binary Input		>Active Group
>Set Group Bit 0	>Set Group Bit 1	
No	No	Goup A
Yes	No	Goup B
No	Yes	Goup C
Yes	Yes	Goup D

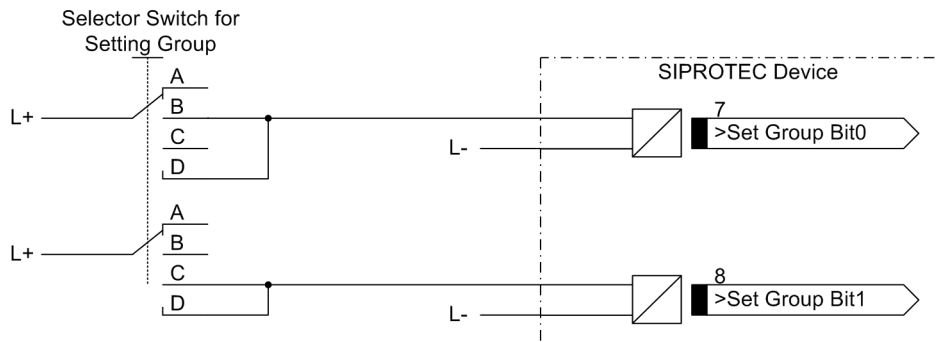


Figure 3-1 Changing setting groups using binary inputs

3.1.2 Hardware Modifications

3.1.2.1 General

Subsequent adaptation of hardware to the power system conditions may be necessary for example with regard to the control voltage for binary inputs or termination of bus-capable interfaces. The hints given in this section should be observed in all cases whenever hardware modifications are made.

Power Supply Voltage

There are different power supply voltage ranges for the auxiliary voltage (refer to the Ordering Information in the Appendix). The power supplies with the ratings 60/110/125 VDC and 110/125/220/250 VDC / 115/230 VAC are interconvertible. Jumper settings determine the rating. Jumper setting allocation to the rated voltage ranges, and their location on the PCB are described in this Section under the margin title "Processor Board C-CPU-2". When the device is delivered, these jumpers are set according to the name-plate sticker. Generally, they need not be altered.

Life Contact

The life contact of the device is a changeover contact, from which either the opener or closer can be connected to the device terminals F3 and F4 via a jumper (X40). Assignments of the jumpers to the contact type and the spatial layout of the jumpers are described in Section at margin heading "Processor Board C-CPU-2".

Nominal Currents

The input transformers of the devices are set to a rated current of 1 A or 5 A by burden switching. Jumpers are set according to the name-plate sticker. Location layout of these jumpers and their current rating allocation are described in this Section under "C-I/O-11 Input/Output Board ", All the relevant jumpers of one side must be set

uniformly for a rated current, i.e. one jumper each (X61, X63, X64) for each of the input transformers and additionally the common jumper X60.

If nominal current ratings are to be changed exceptionally, then the new change must be notified to the device at addresses **0252 CT Rated Secondary Current Line1**; **0254 CT Rated Secondary Current Line2**; **0260 CT Rated Secondary Current Line3**; **0256 CT Rated Secondary Current Busbar**; **0258A Earth CT Rated Secondary Current Busbar** in the Power System Data.

Note



The jumper settings must correspond to the secondary device currents configured . Otherwise the device is blocked and outputs an alarm.

The rated secondary current Line1, Line2 and Line3 must set same, because there is a common jumper X60.

Pickup Voltage for Binary Inputs

When the device is delivered the binary inputs are set to operate with a voltage that corresponds to the rated voltage of the power supply. If the rated values differ from the power system control voltage, it may be necessary to change the switching threshold of the binary inputs.

To change the switching threshold of a binary input, one jumper must be changed for each input. The allocation of the plug-in jumpers to the binary inputs and their actual positioning are described in this Section.

Contact Mode for Binary Outputs

Input/output modules can have relays that are equipped with changeover contacts. For this it is necessary to rearrange a jumper. For which relay on which board this applies is described in this Section under "Input/Output Board C-I/O -1" , "Input/Output Board C-I/O -10" and "Input/Output Board C-I/O -11".

Replacing Interface

The serial interfaces can only be exchanged in the versions for panel flush mounting and cubicle mounting. Which interfaces can be exchanged, and how this is done, is described in this Section under the margin title "Replacing Interface Modules".

Terminating Resistors for RS485 and Profibus DP (Electrical)

For reliable data transmission the RS485 bus or the electrical Profibus DP must be terminated with resistors at the respective last device on the bus. For this purpose termination resistors are provided on the PCB of the C-CPU-2 processor board and on the RS485 or PROFIBUS interface module which can be connected via jumpers. Only one of the three options may be used. The physical location of the jumpers on the PCB is described in this Section under the margin title "Processor Board C-CPU-2", and under the margin title "Bus-Capable Serial Interfaces" for the interface modules. Both jumpers must always be plugged in the same way.

The terminating resistors are disabled on unit delivery.

Spare Parts

Spare parts may be the backup battery that maintains the data in the battery-buffered RAM when the voltage supply fails, and the miniature fuse of the internal power supply. Their physical location is shown in Figure 3-3. The ratings of the fuse are printed on the board next to the fuse itself. When replacing the fuse, please observe the guidelines given in the SIPROTEC 4 System Manual /1/ in the chapter "Maintenance" and "Corrective Action / Repairs".

3.1.2.2 Disassembly

Disassembly of the Device



Note

It is assumed for the following steps that the device is not in operation.



Caution !

Caution when changing jumper settings that affect nominal values of the device

As a consequence, the ordering number (MLFB) and the ratings that are stated on the nameplate do no longer match the actual device properties.

If such changes are necessary, the changes should be clearly and fully noted on the device. Self adhesive stickers are available that can be used as replacement nameplates.

To perform work on the printed circuit boards, such as checking or moving switching elements or exchanging modules, proceed as follows:

- Prepare area of work: Preparing a surface appropriate to electrostatic sensitive devices (ESD). In addition to this, the following tools are required:
 - screwdriver with a 5 to 6 mm wide tip
 - a Philips screwdriver size 1
 - 5 mm socket or nut driver
- Unfasten the screw-posts of the D-subminiature connectors on the back panel at location "A" and "C". This activity does not apply if the device is for surface mounting.
- If the device has additional communication interfaces at locations "A", "C" and/or "B" "D" on the rear, the screws located diagonally to the interfaces must be removed. This activity does not apply if the device is for surface mounting.
- Remove the caps on the front cover and loosen the screws that become accessible.
- Remove the front panel and tilt it to the side.

Work on the Plug Connectors



Caution!

Mind electrostatic discharges

Non-observance can result in minor personal injury or material damage.

When handling with plug connectors, electrostatic discharges may emerge by previously touching an earthed metal surface must be avoided.

Do not plug or withdraw interface connections under power!

The following must be observed:

- Disconnect the ribbon cable between the front cover and the C-CPU-2 board (in Figures Figure 3-2) at the front cover side. To disconnect the cable, push up the top latch of the plug connector and push down the bottom latch of the plug connector. Carefully set aside the front cover.
- Disconnect the ribbon cables between the C-CPU-2 board (1) and the I/O boards (2) to (4), depending on the variant ordered).
- Remove the boards and set them on the grounded mat to protect them from ESD damage. In the case of the device variant for panel surface mounting, please be aware of the fact a certain amount of force is required in order to remove the C-CPU-2 module due to the existing plug connectors.
- Check the jumpers in accordance with Figures 3-2 to 3-9 and the following information, and as the case may be change or remove them.

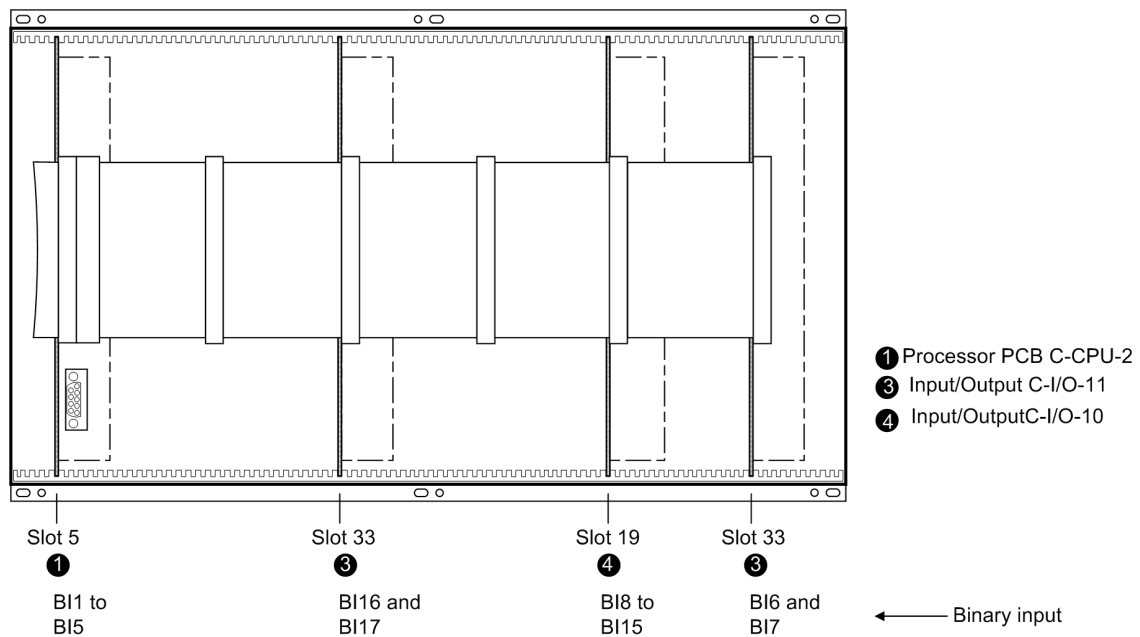


Figure 3-2 Front view of a 7VU683 (housing size 1/1) after removal of the front cover (simplified and scaled down)

3.1.2.3 Switching Elements on the Printed Circuit Boards

Processor Module C-CPU-2

The PCB layout of the processor board C-CPU-2 is illustrated in the following Figure. The set nominal voltage of the integrated power supply is checked according to Table 3-1, the quiescent state of the life contact according to Table 3-2, the selected operating voltages of binary inputs BI1 to BI5 according to Table 3-3 and the integrated interface RS232 / RS485 according to Tables 3-4 to 3-2. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following Figure.

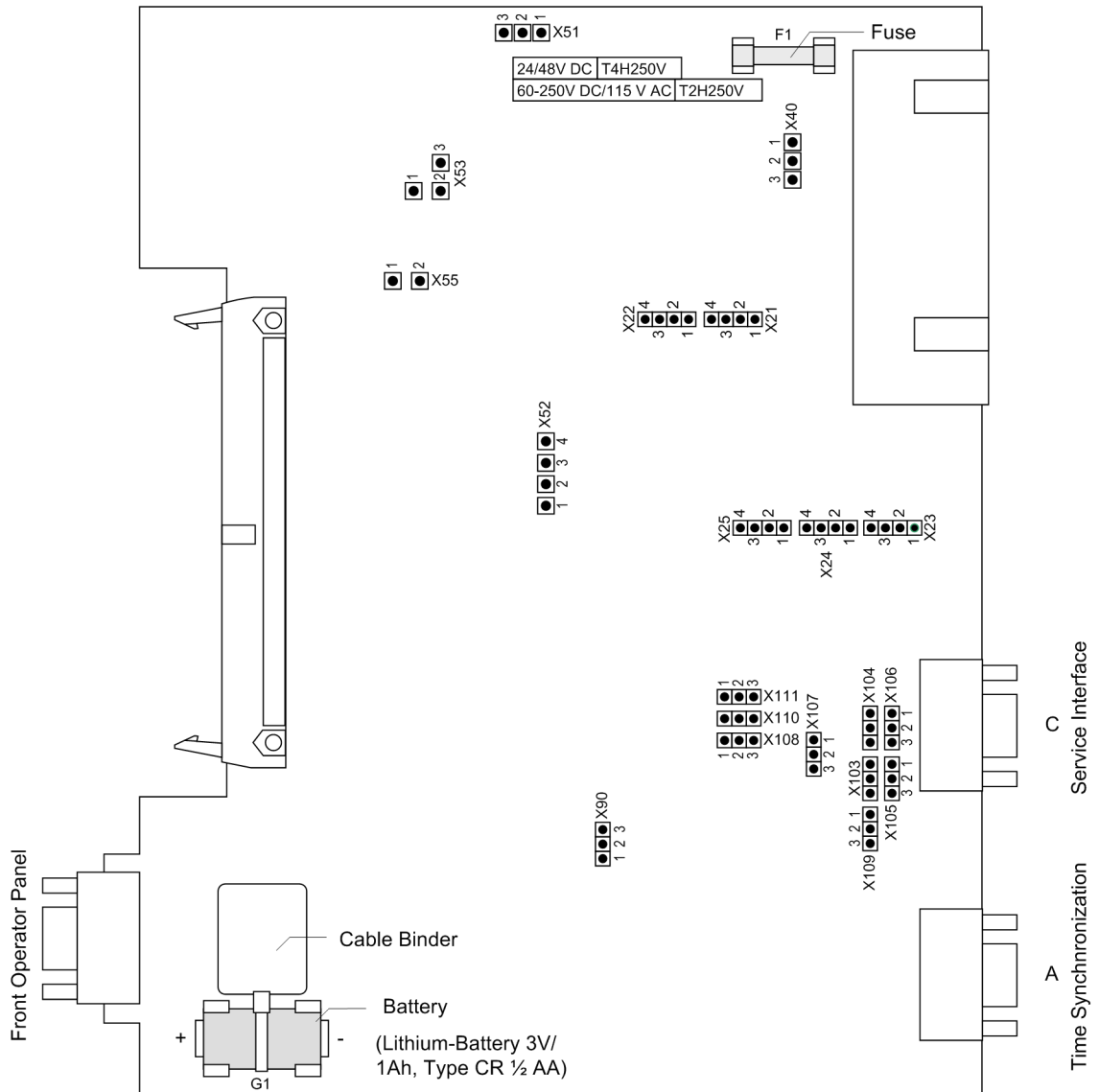


Figure 3-3 Processor Board C-CPU with Jumper Settings Required for the Board Configuration, of the Battery and Miniature Fuse

Table 3-2 Jumper setting of the rated voltage of the integrated **Power Supply** on the C-CPU-2 processor module

Jumper	Nominal Voltage		
	24 to 48 VDC	60 to 125 VDC	110 to 250 VDC, 115 to 230 VAC
X51	not used	1-2	2-3
X52	not used	1-2 and 3-4	2-3
X53	not used	1-2	2-3
X55	not used	not used	1-2
	cannot be changed	interchangeable	
Fuse	T4H250V	T2H250V	

Table 3-3 Jumper position of the quiescent state of the Life contact on the C-CPU-2 processor module

Jumper	Nominal Voltage		
	Open in the quiescent state (NO contact)	Closed in the quiescent state (NC contact)	Presetting
X40	1-2	2-3	2-3

Table 3-4 Jumper setting of the control voltages of binary inputs BI1 to BI5 on the C-CPU-2 processor module

Binary inputs	Jumper	19 V Threshold ¹⁾	88 V Threshold ²⁾	176 V Threshold ³⁾
BI1	X21	1-2	2-3	3-4
BI2	X22	1-2	2-3	3-4
BI3	X23	1-2	2-3	3-4
BI4	X24	1-2	2-3	3-4
BI5	X25	1-2	2-3	3-4

¹⁾ Factory settings for devices with rated power supply voltages of 24 VDC to 125 VDC

²⁾ Factory settings for devices with power supply voltages of 110 VDC to 250 VDC and 115/230 VAC

³⁾ Use only with pickup voltages 220 VDC or 250 VDC

The R485 interface can be converted into an RS232 interface by modifying the jumpers. Jumpers X105 to X110 must be set to the same position.

Table 3-5 Jumper Settings of the Integrated RS232/RS485 Interface on the C-CPU-2 Board

Jumper	/CTS from interface RS232	/CTS triggered by /RTS
X103 to X104	1-2	1-2
X105 to X110	1-2	2-3

The jumpers are preset at the factory according to the configuration ordered.

With interface RS232 jumper X111 is needed to activate CTS which enables the communication with the modem.

Table 3-6 Jumper setting for CTS (flow control) on the C-CPU-2 processor module

Jumper	/CTS from interface RS232	/CTS triggered by /RTS
X111	1-2	2-3 ¹⁾

¹⁾ Default setting of releases 7VU68.../BB

Jumper setting 2-3: The connection to the modem is usually established with a star coupler or fibre-optic converter. Therefore the modem control signals according to RS232 standard DIN 66020 are not available. Modem signals are not required since the connection to the SIPROTEC 4 devices is always operated in the half-duplex mode. Please use the connection cable with order number 7XV5100-4.

Jumper setting 1-2: This setting makes the modem signals available, i. e. for a direct RS232-connection between the SIPROTEC 4 device and the modem this setting can be selected optionally. We recommend use of a standard RS232 modem connection cable (converter 9-pole on 25-pole).

Note



For a direct connection to DIGSI with interface RS232 jumper X111 must be plugged in position 2-3.

If there are no external terminating resistors in the system, the last devices on a RS485 bus must be configured via jumpers X103 and X104.

Table 3-7 Jumper settings of the Terminating Resistors of interface RS485 on the C-CPU-2 processor

Jumper	Terminating Resistor Connected	Terminating Resistor Disconnected	Presetting
X103	2-3	1-2	1-2
X104	2-3	1-2	1-2

Note



Both jumpers must always be plugged in the same way!

Jumper X90 has currently no function. The factory setting is 1-2.

The terminating resistors can also be connected externally (e.g. to the connection module). In this case, the terminating resistors located on the RS485 or PROFIBUS interface module or directly on the PCB of the processor board C-CPU-2 must be de-energized.

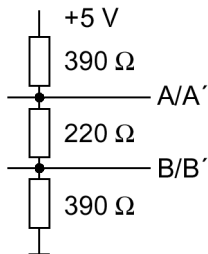


Figure 3-4 Termination of the RS485 interface (external)

Input/Output Board C-I/O-10 (Only 7VU683)

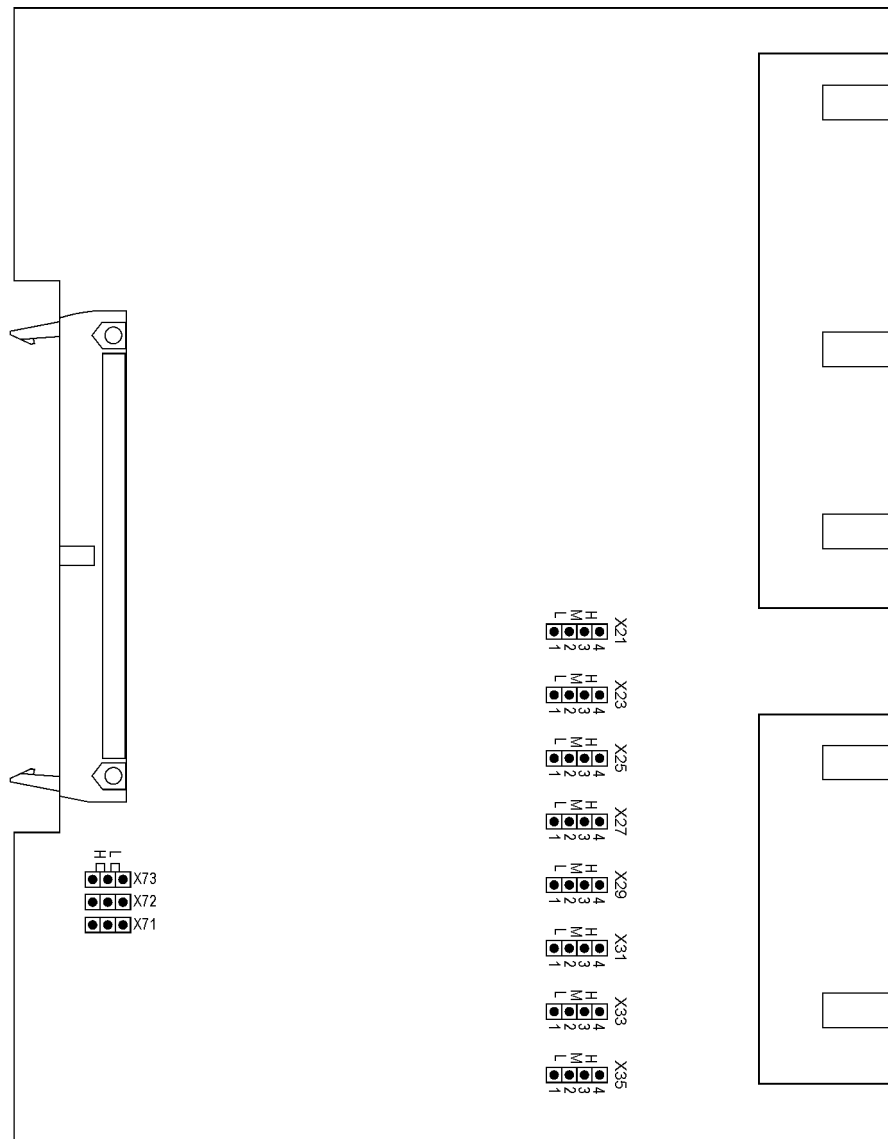


Figure 3-5 Input/output board C-I/O-10 with representation of jumper settings required for checking configuration settings

Table 3-8 Jumper setting of pickup voltages of binary inputs BI8 to BI15 on Input/Output module module C- I/O-10 in the 7VU683

Binary inputs	Jumper	19 VDC Threshold ¹⁾	88 VDC Threshold ²⁾	176 VDC Threshold ³⁾
BI8	X21	L	M	H
BI9	X23	L	M	H
BI10	X25	L	M	H
BI11	X27	L	M	H
BI12	X29	L	M	H
BI13	X31	L	M	H
BI14	X33	L	M	H
BI15	X35	L	M	H

¹⁾ Factory settings for devices with rated power supply voltages of 24 VDC to 125 VDC

²⁾ Factory settings for devices with power supply voltages of 110 VDC to 250 VDC and 115/230 VAC

³⁾ Use only with control voltages 220 VDC to 250 VDC

Jumpers X71, X72 and X73 on the input/output board C-I/O-10 are used to set the bus address and must not be changed. The following Table lists the jumper presettings.

Table 3-9 Jumper settings of PCB Address of the input/output board C-I/O-10

Jumper	Presetting
X71	2-3(L)
X72	2-3(L)
X73	1-2(H)

Input/Output Board C-I/O-11

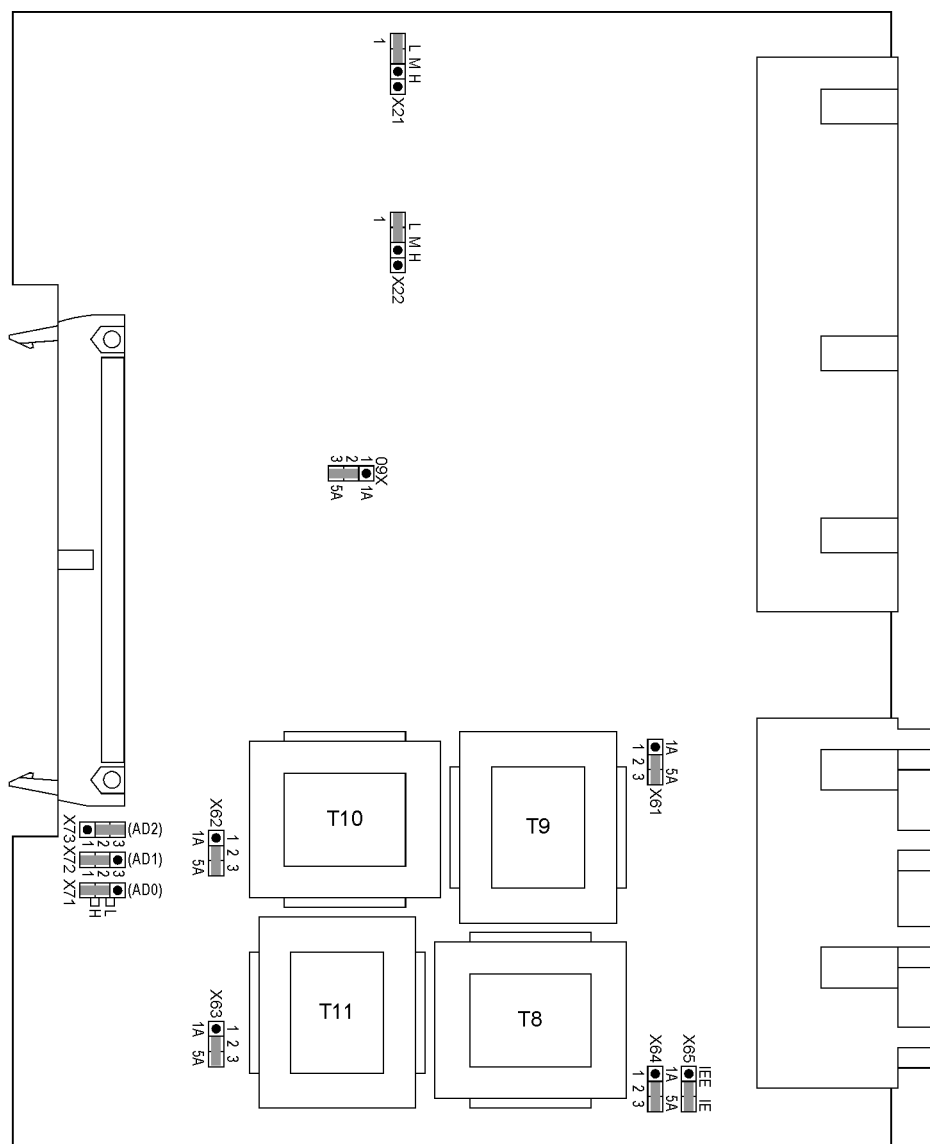


Figure 3-6 C-I/O-11 input/output board with representation of jumper settings required for checking configuration settings

The set nominal currents of the current input transformers are to be checked on the input/output board C-I/O-11. All jumpers must be set for one nominal current, i.e. respectively one jumper (X61 to X63) for each input transformer and additionally the common jumper X60.

Jumper X64 is set to the required rated current for IE current input: "1 A" or "5 A", jumper X65 set "IE"

There are 3 measuring inputs for the single phase measuring location Ix_Line 1, Ix_Line2 and Ix_Line3. The jumpers X61, X63, X64 and common jumper X60 belonging to this measuring location must be plugged all to the rated secondary current of the connected current transformers: "1 A" or "5 A".

Table 3-10 Jumper setting of pickup voltages of binary inputs BI6, BI7 and BI16, BI17 on Input/Output module C- I/O-11

Binary Input	Jumper	19 VDC Threshold ¹⁾	88 VDC Threshold ²⁾	176 VDC Threshold ³⁾
BI6	X21	L	M	H
BI7	X22	L	M	H
BI16	X21	L	M	H
BI17	X22	L	M	H

¹⁾ Factory settings for devices with rated power supply voltages of 24 VDC to 125 VDC

²⁾ Factory settings for devices with power supply voltages of 110 VDC to 250 VDC and 115/230 VAC

³⁾ Use only with control voltages 220 VDC to 250 VDC

The jumpers X71, X72 through X73 serve for setting the bus address. Their position may not be changed. The following table shows the preset jumper positions.

Installation Place

Table 3-11 Jumper settings of module addresses of the input/output module C-I/O-11 (Left Slot 33 No.4)

Jumper	Factory Setting
X71	1-2(H)
X72	2-3(L)
X73	1-2(H)

Table 3-12 Jumper settings of module addresses of the input/output module C-I/O-11 (right Slot 33 No.3)

Jumper	Factory Setting
X71	1-2(H)
X72	1-2(H)
X73	2-3(L)

3.1.2.4 Interface Module

Replacing Interface Modules

The interface modules are located on the C-CPU-2 board. The following figure shows the PCB with location of the modules.

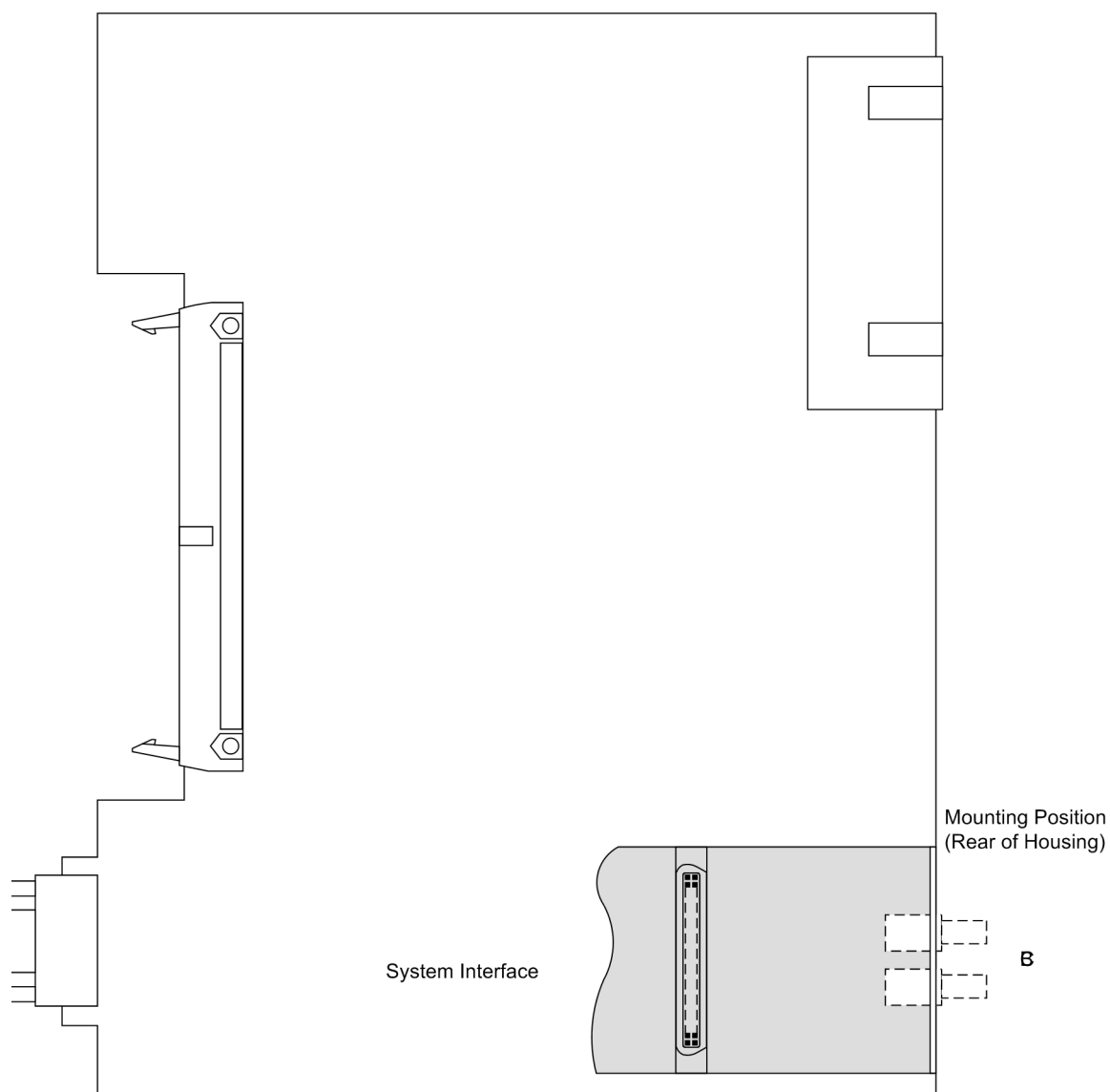


Figure 3-7 C-CPU-2 board with interface modules

Please note the following:

- The interface modules can only be replaced in devices for panel flush mounting and cubicle mounting.
- Only interface modules can be used with which the device can be ordered from the factory also in accordance with the order number .

Table 3-13 Replacing interface modules

Interface	Mounting Location/Interface	Replacement Module
System Interface	B	Only interface modules that can be ordered in our facilities via the order key

EN100 Ethernet Module (IEC 61850)

The Ethernet interface module has no jumpers. No hardware modifications are required to use it.

Interface Termination

For bus-capable interfaces a termination is necessary at the bus for each last device, i.e. terminating resistors must be connected. With the 7VU683 device, this concerns the variants with RS485 or PROFIBUS interfaces.

The terminating resistors are located on the RS485 or Profibus interface module, which is on the C-CPU-2 board ((1) in Figures 3-2), or directly on the PCB of the C-CPU-2 board (see margin title "C-CPU-2 Processor Board", Table 3-3).

The module for the RS485 interface is shown in Figure 3-9, the module for the Profibus interface in Figure 3-10.

On delivery the jumpers are set so that the terminating resistor are disconnected. Both jumpers of a module must always be plugged in the same way.

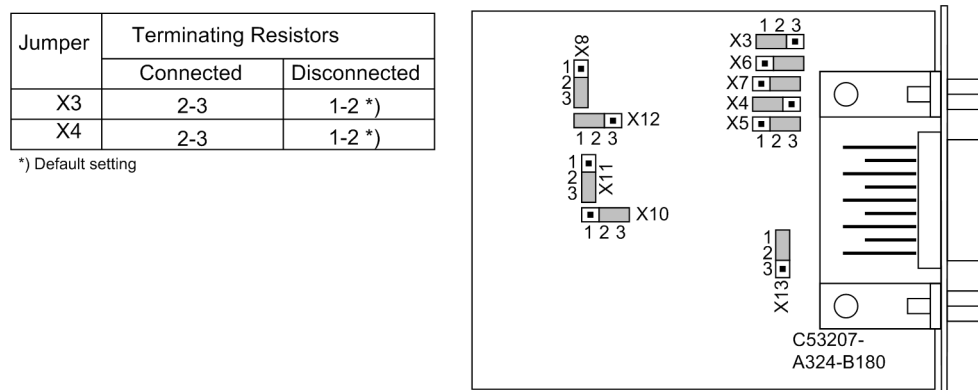


Figure 3-8 Position of Terminating Resistors and the Plug-in Jumpers for Configuration of the RS485 Interface

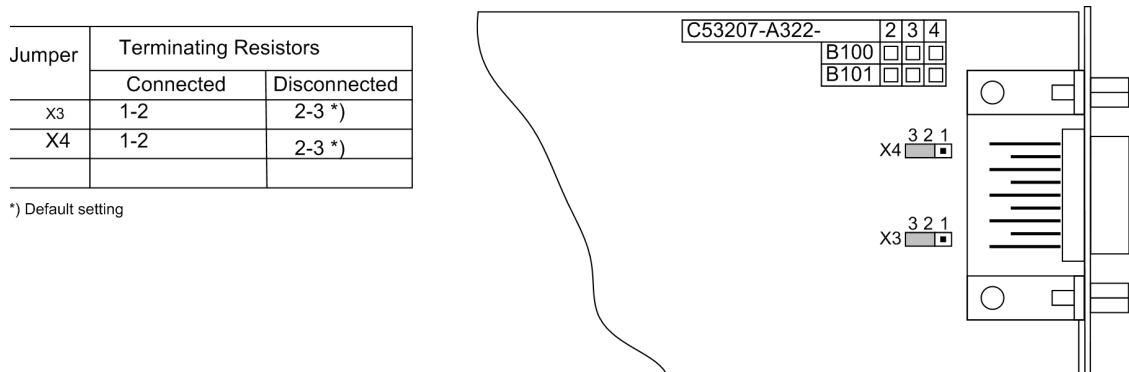


Figure 3-9 Position of the Plug-in Jumpers for the Configuration of the Terminating Resistors at the Profibus (FMS and DP), Modbus and DNP Interfaces

The terminating resistors can also be connected externally (e.g. to the terminal block), see Figure 3-5. In this case, the matching resistors located on the RS485 or PROFIBUS interface module or directly on the PCB of the C-CPU-2 board of must be disabled.

It is possible to convert the R485 interface to a RS232 interface by changing the jumper positions and vice-versa.

The jumper positions for the alternatives RS232 or RS485 (as in Figure 3-10) are derived from the following Table.

Table 3-14 Configuration for RS232 or RS485 on the interface module

Jumper	X5	X6	X7	X8	X10	X11	X12	X13
RS232	1-2	1-2	1-2	1-2	1-2	2-3	1-2	1-2
RS485	2-3	2-3	2-3	2-3	2-3	2-3	1-2	1-2

The jumpers X5 to X10 must be plugged in the same way.

The jumpers are preset at the factory according to the configuration ordered.

3.1.2.5 Reassembly

The device is assembled in the following steps:

- Insert the boards carefully in the housing. The mounting locations are shown in Figures 3-2.
- Plug in the plug connectors of the ribbon cable onto the input/output modules I/O and then onto the processor module C-CPU-2. Be careful not to bend any connector pins! Do not apply force!
- Connect the plug connectors of the ribbon cable between the C-CPU-2 board and the front panel to the front panel plug connector.
- Press the plug connector interlocks together.
- Replace the front panel and screw it tightly to the housing.
- Replace the covers again.
- Screw the interfaces on the rear panel of the device tight again.

This activity does not apply if the device is for surface mounting.

3.1.3 Mounting

3.1.3.1 Panel Flush Mounting

For the 1/1 housing size (Figure 3-10) there are six covers and six holes.

- Remove the 4 covers at the corners of the front cover, for size 1/1 the two covers located centrally at the top and bottom also have to be removed. The 6 elongated holes in the mounting bracket are revealed and can be accessed.
- Insert the device into the panel cut-out and fasten it with four or six screws. For dimensions refer to Appendix A.4.
- Mount the six covers.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm².
- Connections use the screw terminals on the rear side of the device in accordance the wiring diagram. For screw connections with forked lugs or direct connection, before inserting wires the screws must be tightened so that the screw heads are flush with the outer edge of the connection block. A ring lug must be centred in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC 4 System Description has pertinent information regarding wire size, lugs, bending radii, etc.

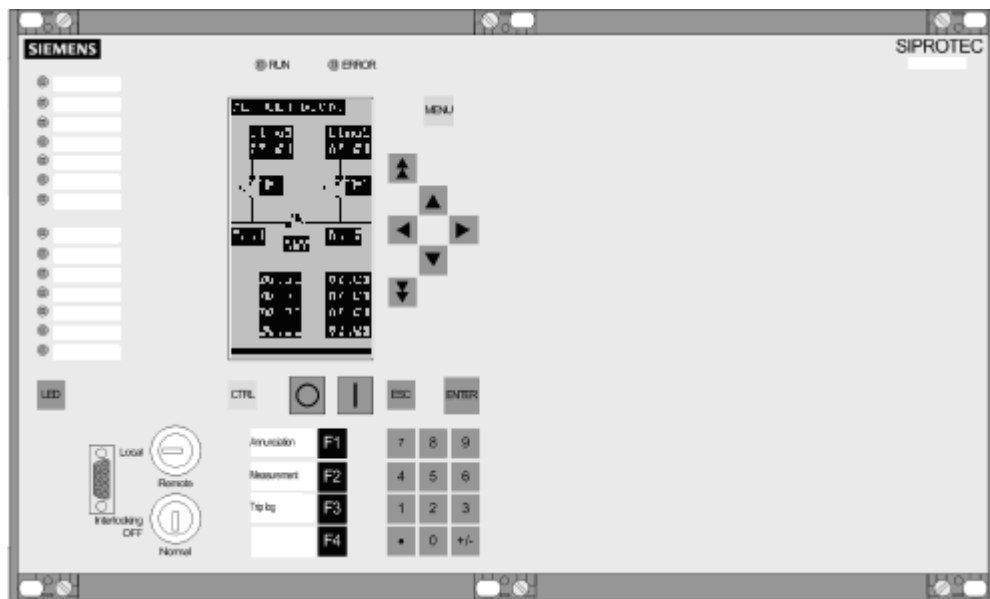


Figure 3-10 Example of panel flush mounting of a device (housing size 1/1)

3.1.3.2 Rack and Cubicle Mounting

For the 1/1 housing size (Figure 3-11) there are six covers and six holes.

To install the device in a frame or cubicle, two mounting brackets are required.

- Loosely screw the two mounting brackets in the rack or cubicle with six screws.
- Remove the 4 covers at the corners of the front cover, for size 1/1 the two covers located centrally at the top and bottom also have to be removed. Thus the 4 respectively 6 slots in the mounting flange are revealed and can be accessed.
- Fasten the device to the mounting brackets with four or six screws.
- Mount the six covers.
- Tighten fast the eight screws of the angle brackets in the rack or cubicle.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm².
- Connections use the screw terminals on the rear side of the device in accordance the wiring diagram. For screw connections with forked lugs or direct connection, before inserting wires the screws must be tightened so that the screw heads are flush with the outer edge of the connection block. A ring lug must be centred in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC 4 System Description /1/ has pertinent information regarding wire size, lugs, bending radii, etc.

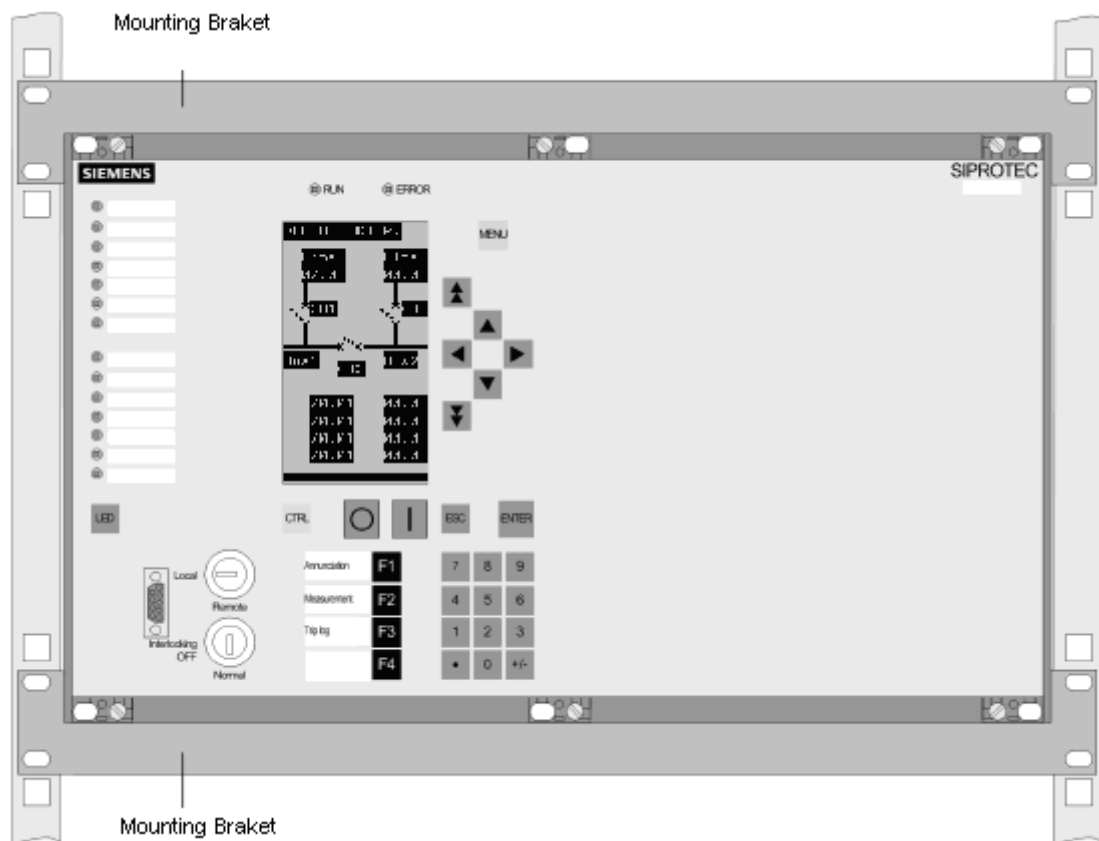


Figure 3-11 Example of rack or cubicle mounting of a device (housing size 1/1)

3.2 Checking Connection

3.2.1 Checking Data Connections of Serial Interfaces

Pin-Assignment

The tables of the following margin headings list the pin assignments for the different serial interfaces, the time synchronization interface and the Ethernet interface of the device. The position of the connections can be seen in the following figures.

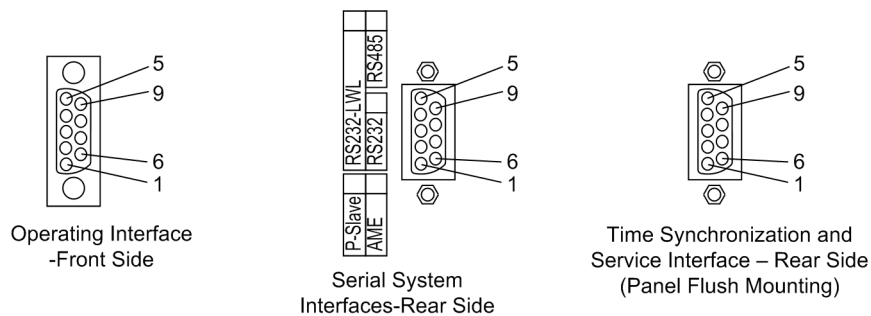


Figure 3-12 9-pin D-subminiature female connectors

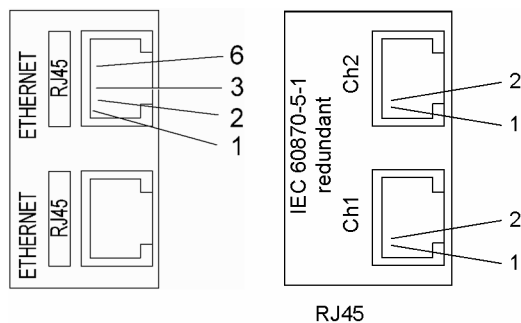


Figure 3-13 Ethernet connector and IEC 60870-5-1 redundant interface

3.2.2 System Interface

For versions equipped with a serial interface to a control center, the user must check the data connection. The visual check of the assignment of the transmission and reception channels is of particular importance. With RS232 and fibre optic interfaces, each connection is dedicated to one transmission direction. Therefore the output of one device must be connected to the input of the other device and vice versa.

With data cables, the connections are designated according to DIN 66020 and ISO 2110:

- TxD = Data Output
- RxD = Data Input
- $\overline{\text{RTS}}$ = Request to Send
- $\overline{\text{CTS}}$ = Clear to Send
- GND = Signal / Chassis Ground

The cable shield is to be grounded at both ends. For extremely EMC-loaded environments the GND may be integrated into a separate individually shielded wire pair to improve the immunity to interference.

Table 3-15 The assignments of the D-subminiature and RJ45 connector for the various interfaces

Pin No.	RS232	RS 485	Profibus DP Slave, RS 485	Modbus/DNP, RS485	Ethernet EN100	Redundant T103
1	Shield (with shield ends electrically connected)				Tx+	B/B' (RxD/TxD-P)
2	RxD	–	–	–	Tx-	A/A' (RxD/TxD-N)
3	TxD	A/A' (RxD/TxD-N)	B/B' (RxD/TxD-P)	A	Rx+	
4	–	–	CNTRA-(TTL)	RTS (TTL level)	–	
5	EARTH	C/C' (EARTH)	C/C' (EARTH)	EARTH1	–	
6	–	–	+5 V (max. load < 100 mA)	VCC1	Rx-	
7	RTS	– ¹⁾	–	–	–	
8	CTS	B/B' (RxD/TxD-P)	A/A' (RxD/TxD-N)	B	–	
9	–	–	–	–	Disabled	

¹⁾ Pin 7 also carries the RTS signal with RS232 level when operated as RS485 Interface. Pin 7 may therefore not be connected!

3.2.3 Termination

The RS485 interface is capable of half-duplex service with the signals A/A' and B/B' with a common relative potential C/C' (GND). Verify that only the last device on the bus has the terminating resistors connected, and that the other devices on the bus do not. The jumpers for the terminating resistors are located on the interface module RS485 (see Figure 3-9) or on the PROFIBUS module RS485 (see Figure 3-10). The terminating resistors can also be connected externally. In this case, the terminating resistors located on the module must be disabled.

If the bus is extended, make sure again that only the last device on the bus has the terminating resistors switched-in, and that all other devices on the bus do not.

3.2.4 Time Synchronization Interface

Either 5 VDC, 12 VDC or 24 VDC time synchronization signals can be processed if the connections are made as indicated in the table below.

Table 3-16 D-subminiature connector assignment of the time synchronization interface

Pin No.	Designation	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Return Line
4	M_TSYNC ¹⁾	Return Line ¹⁾
5	Shield	Shield Potential
6	–	–
7	P12_TSIG	Input 12 V
8	P_TSYNC ¹⁾	Input 24 V ¹⁾
9	SHIELD	Shield Potential

¹⁾ Assigned, but not used.

3.2.5 Optical Fibres



WARNING!

Do not look directly into the fibre-optic elements!

The transmission via fibre optics is particularly insensitive to electromagnetic interference and thus ensures galvanic isolation of the connection. Transmit and receive connections are shown with the symbols for transmit and for receive.

The character idle state for the optical fibre interface is "Light off". If the character idle state is to be changed, use the operating program DIGSI, as described in the SIPROTEC 4 System Description.

3.2.6 Checking Device Connection

General

By checking the device connections the correct installation of the protection device e.g. in the cubicle must be tested and ensured. This includes wiring check and functionality as per drawings, visual assessment of the protection system, and a simplified functional check of the protection device.

Auxiliary Voltage Supply

Before the device is connected for the first time to voltage, it should be have been at least 2 hours in its operating room, in order to attain temperature equilibrium and to avoid dampness and condensation.



Note

If a redundant supply is used, there must be a permanent, i.e. uninterruptible connection between the minus polarity connectors of system 1 and system 2 of the DC voltage supply (no switching device, no fuse), because otherwise there is a risk of voltage doubling in case of a double earth fault.

Switch on the auxiliary voltage circuit breaker (supply protection), check voltage polarity and amplitude at the device terminals or at the connection modules.

Visual Check

Check the cubicle and the devices for damage, condition of the connections etc., and device earthing.

Secondary Check

This test does not undertake to check the individual protection functions for the accuracy of their pick-up values and characteristic curves. Unlike analog electronic or electromechanical protective devices, no protection function test is required within the framework of the device test, since this is ensured by the factory tests. Protection functions are only used to check the device connections.

A plausibility check of the analog-digital converter with the operational measured values is sufficient since the subsequent processing of the measured values is numerical and thus internal failures of protection functions can be ruled out.

Where secondary tests are to be performed, a three-phase test equipment providing test currents and voltages is recommended (e.g. Omicron CMC 56 for manual and automatic testing). The phase angle between currents and voltages should be continuously controllable.

The accuracy which can be achieved during testing depends on the accuracy of the testing equipment. The accuracy values specified in the Technical data can only be reproduced under the reference conditions set down in IEC 60 255 resp. VDE 0435/part 303 and with the use of precision measuring instruments.

Tests can be performed using the currently set values or the default values.

If unsymmetrical currents and voltages occur during the tests it is likely that the asymmetry monitoring will frequently pickup. This is of no concern because the condition of steady-state measured values is monitored which, under normal operating conditions, are symmetrical; under short circuit conditions these monitorings are not effective.



Note

If during dynamic testing, measured values are connected from or reduced to zero, a sufficiently high value should be present at least one other measuring circuit (in general a voltage), to permit frequency adaptation.

Measured values in earth paths of voltage or current (IEE, UE) can not adapt the scanning frequency. To check them a sufficiently high value measured value should be present in one of the phases.

Wiring

It is particularly important to check the correct wiring and allocation of all device interfaces. The margin heading titled "Test function for checking the binary inputs and outputs" provides additional information to this end.

For analog inputs a plausibility check can be controlled as described above under the margin title "Secondary Testing".

Function Check

The only functional test required for protective relays is a plausibility check of the operational measured values by means of some secondary test equipment; this is to ensure that no damage has occurred during transit (see also side title "Secondary Testing").

LEDs

After tests where the displays appear on the LEDs, these should be reset in order that they present information only on the currently executed test. This should be done at least once each using the reset button on the front panel and via the binary input for remote reset (if allocated). Observe that an independent reset occurs also on the arrival of a new fault and that setting of new indications can be optionally made dependent on the pickup or a trip command (parameter 0201 **FltDisp.LED/LCD**).

Test Switch

Check the functions of all test switches that are installed for the purposes of secondary testing and isolation of the device. Of particular importance are "test switches " in current transformer circuits. Be sure these switches short-circuit the current transformers when they are in the test mode.

3.2.7 Checking System Incorporation

General Information



WARNING!

Warning of dangerous voltages

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Therefore, only qualified people who are familiar with and adhere to the safety procedures and precautionary measures shall perform the inspection steps.

With this check of the protection, the correct incorporation of the device into the power system is tested and ensured.

Checking of protection parametrization (allocations and settings) in accordance with the power system requirements, is an important test step here.

The interface-wide incorporation check in the power system results on the one hand in testing of cubicle wiring and drawing record in accordance with functionality, and on the other hand the correctness of cabling between transducer or transformer and protection device.

Auxiliary Voltage Supply

Check the voltage magnitude and polarity at the input terminals.



Note

If a redundant supply is used, there must be a permanent, i.e. uninterruptible connection between the minus polarity connectors of system 1 and system 2 of the DC voltage supply (no switching device, no fuse), because otherwise there is a risk of voltage doubling in case of a double earth fault.



Caution!

Be careful when operating the device on a battery charger without a battery

Non-observance of the following measure can lead to unusually high voltages and consequently, the destruction of the device.

Do not operate the device on a battery charger without a connected battery. (Limit values can be found in the technical data).

Visual Check

During the visual check the following must be considered:

- Check of the cubicle and the devices for damage;
- Check of earthing of the cabinet and the device;
- Check the external cabling for condition and completeness.

Acquisition of Technical Power System Data

For checking protection parameterization (allocation and settings) in accordance with power system requirements, recording of technical data of the individual components is necessary in the primary system. This includes the voltage and current transformers.

Where deviations from the planning data are found, the settings of the protection must be modified accordingly.

Analog Inputs

The check of the current and voltage transformer circuits includes:

- Acquisition of technical data
- Visual check of transformers, e.g. for damage, assembly position, connections
- Check of transformer earthing, especially earthing of the broken delta winding in only one phase
- Check cabling in accordance with circuit diagram
- Check of the short circuiters of the plug connectors for current circuits

Further tests are under certain circumstances necessary in accordance with contract:

- Insulation measurement of cable
- Measurement of transformation ratio and polarity
- Burden measurement
- Checking the functions of test switches, if used for secondary testing.
- Measuring transducers/ Measuring transducer connection

Binary Inputs and Outputs

For more information see also Section 3.3.

- Setting of binary inputs:
 - Check and match jumper allocation for pickup thresholds (see Section 3.1)
 - Check the pickup threshold - if possible - with a variable DC voltage source

- Check the tripping circuits from the command relays and the tripping lines down to the various components (circuit breakers, excitation circuit, emergency tripping, switchover devices etc.)
- Check the signal processing from the signal relays and the signal lines down to the station control and protection system; to do so, energize the signal contacts of the protective device and check the texts in the station control and protection system
- Check the control circuits from the output relays and the control lines down to the circuit breakers and disconnectors etc.
- Check the binary input signals from the signal lines down to the protective device by activating the external contacts.

Voltage Trans-former Miniature Circuit Breaker (VT mcb)

Since it is very important for the undervoltage protection, that this functions are blocked automatically if the circuit breaker for the voltage transformers has tripped, the blocking should be checked along with the voltage circuits. Switch off voltage transformer protection switches.

One should check in the operational annunciations that the VT mcb trip was detected. A requirement for this is that the auxiliary contact of the VT mcb is connected and correspondingly allocated.

Close the VT mcb again: The above annunciations appear under the "going" operational annunciations, i.e. with the comment "OFF" (e.g. ">L1 MCB Closed" " "OFF").

If one of the indications does not appear, check the connection and allocation of these signals.

If the "ON" and "OFF" messages are exchanged, then the breaker auxiliary contact type should be checked and corrected if necessary.

3.3 Commissioning



WARNING!

Warning of dangerous voltages when operating an electrical device.

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Only qualified people shall work on and around this device. They must be thoroughly familiar with all warnings and safety notices in this instruction manual as well as with the applicable safety steps, safety regulations, and precautionary measures.

The device is to be grounded to the substation ground before any other connections are made.

Hazardous voltages can exist in the power supply and at the connections to current transformers, voltage transformers, and test circuits.

Hazardous voltages can be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

After removing voltage from the power supply, wait a minimum of 10 s before re-energizing the power supply. This wait allows the initial conditions to be firmly established before the device is re-energized.

The limit values given in Technical Data must not be exceeded, neither during testing nor during commissioning.

When testing the device with secondary test equipment, make sure that no other measurement quantities are connected and that the TRIP command lines and possibly the CLOSE command lines to the circuit breakers are interrupted, unless otherwise specified.



DANGER!

Hazardous voltages during interruptions in secondary circuits of current transformers.

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Short-circuit the current transformer secondary circuits before current connections to the device are opened.

For the commissioning switching operations have to be carried out. A prerequisite for the prescribed tests is that these switching operations can be executed without danger. They are accordingly not meant for operational checks.



WARNING!

Warning of dangers evolving from improper primary tests

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Primary test may only be carried out by qualified personnel, who are familiar with the commissioning of protection systems, the operation of the plant and the safety rules and regulations (switching, earthing, etc.).

3.3.1 Test Mode/Transmission Block

If the device is connected to a central or main computer system via the SCADA interface, then the information that is transmitted can be influenced. This is only possible with some of the protocols available.

If **Test mode** is set **ON**, then a message sent by a SIPROTEC 4 device to the main system has an additional test bit. This bit allows the message to be recognized as resulting from testing and not an actual fault or power system event. Furthermore it can be determined by activating the **Transmission block** that no indications at all are transmitted via the system interface during test mode.

The SIPROTEC 4 System Description /1/ describes how to activate and deactivate test mode and blocked data transmission. Note that when DIGSI is being used, the program must be in the **Online** operating mode for the test features to be used.

3.3.2 Test System Interface

Prefacing Remarks

If the device features a system interface and uses it to communicate with the control centre, the DIGSI device operation can be used to test if messages are transmitted correctly. This test option should however definitely "not" be used while the device is in service on a live system.



DNAGER!

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the testing mode during "real" operation performing transmission and reception of messages via the system interface.



Note

After termination of the hardware test, the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

The interface test is carried out using DIGSI in the Online operating mode:

- Open the Online directory by double-clicking; the operating functions for the device appear.
- Click on Test; the function selection appears in the right half of the screen.
- Double-click on Testing Messages for System Interface shown in the list view. The dialog box Generate Annunciations opens (refer to the following figure).

Structure of the Test Dialogue Box

In the column **Indication** the display texts of all indications are displayed which were allocated to the system interface in the matrix. In the column **Status SCHEDULED** the user has to define the value for the messages to be tested. Depending on the indication type, several input fields are offered (e.g. "ON"/ "OFF"). By double-clicking onto one of the fields the required value can be selected from the list.

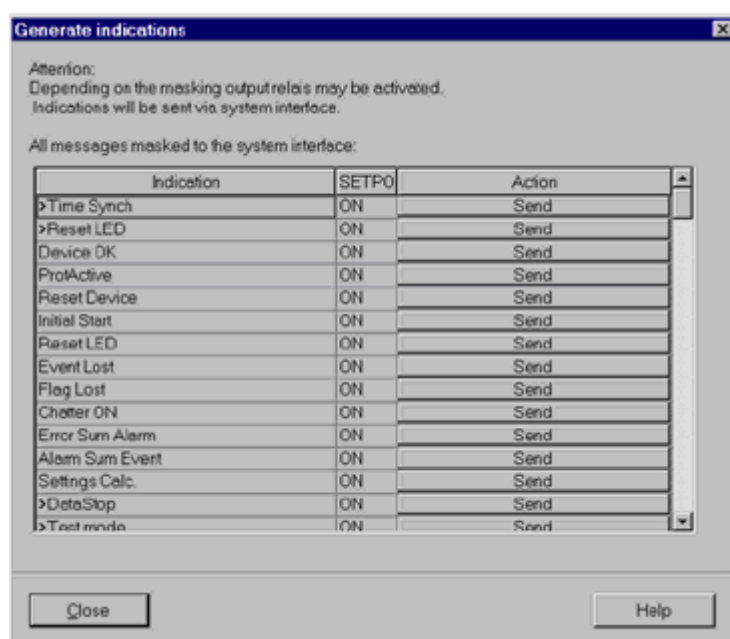


Figure 3-14 System interface test with dialog box: Generate indications - example

Changing the Operating State

On clicking one of the buttons in the column **Action** you will be prompted for the password No. 6 (for hardware test menus). After correct entry of the password, individual annunciations can be initiated. To do so, click on the button **Send** in the corresponding line. The corresponding annunciation is issued and can be read out either from the event log of the SIPROTEC 4 device or from the substation control center.

As long as the window is open, further tests can be performed.

Test in Message Direction

For all information that is transmitted to the central station test in Status Scheduled the desired options in the list which appears:

- Make sure that each checking process is carried out carefully without causing any danger (see above and refer to DANGER!).
- Click on Send in the function to be tested and check whether the transmitted information reaches the central station and shows the desired reaction. Data which are normally linked via binary inputs (first character ">") are likewise indicated to the central station with this procedure. The function of the binary inputs itself is tested separately.

Exiting the Test Mode

To end the System Interface Test, click on **Close**. The device is briefly out of service while the start-up routine is executed. The dialogue box closes.

3.3.3 Checking the Binary Inputs and Outputs

Prefacing Remarks

The binary inputs, outputs, and LEDs of a SIPROTEC 4 device can be individually and precisely controlled in DIGSI. This feature is used to verify control wiring from the device to plant equipment (operational checks) during commissioning. This test option should however definitely "not" be used while the device is in service on a live system.



DANGER!

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the testing mode during "real" operation performing transmission and reception of messages via the system interface.



Note

After termination of the hardware test, the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

The hardware test can be carried out using DIGSI in the Online operating mode:

- Open the Online directory by double-clicking; the operating functions for the device appear.
- Click on Test; the function selection appears in the right half of the screen.
- Double-click in the list view on Hardware Test. The dialog box of the same name opens (see the figure 3-15 as below).

Structure of the Test Dialogue Box

The dialog box is divided into three groups: **BI** for binary inputs, **REL** for output relays, and **LED** for light-emitting diodes. On the left of each group is an accordingly labelled button. By double-clicking these buttons you can show or hide the individual information of the selected group.

In the column **Status** the current status of the particular hardware component is displayed. It is displayed symbolically. The actual states of the binary inputs and outputs are displayed by the symbol of opened and closed switch contacts, those of the LEDs by a symbol of a lit or extinguished LED.

The opposite state of each element is displayed in the column **Scheduled**. The display is made in plain text.

The right-most column indicates the commands or messages that are configured (masked) to the hardware components.

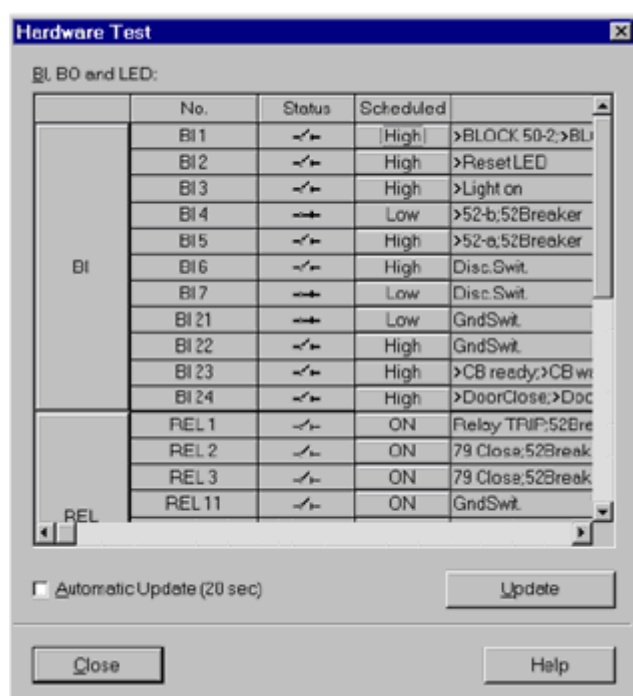


Figure 3-15 Testing of the binary inputs and outputs - example

Changing the Operating State

To change the condition of a hardware component, click on the associated switching field in the **Scheduled** column.

Password No. 6 (if activated during configuration) will be requested before the first hardware modification is allowed. After entry of the correct password a condition change will be executed. Further condition changes remain possible while the dialog box is open.

Test of the Binary Outputs

Each individual output relay can be energized allowing a check of the wiring between the output relay of the 7VU683 and the system, without having to generate the message that is assigned to the relay. As soon as the first change of state for any of the output relays is initiated, all output relays are separated from the internal device functions, and can only be operated by the hardware test function. This means, that e.g. a TRIP command coming from a control command from the operator panel to an output relay cannot be executed.

Proceed as follows in order to check the output relay:

Ensure that the switching of the output relay can be executed without danger (see above under DANGER!).

- Each output relay must be tested via the corresponding **Scheduled**-cell in the dialog box.
- The test sequence must be terminated (refer to margin heading "Exiting the Procedure"), to avoid the initiation of inadvertent switching operations by further tests.

Test of the Binary Inputs

To test the wiring between the plant and the binary inputs of the 7VU683 the condition in the system which initiates the binary input must be generated and the response of the device checked.

To do this, the dialog box **Hardware Test** must again be opened to view the physical state of the binary inputs. The password is not yet required.

Proceed as follows in order to check the binary inputs:

- Activate in the system each of the functions which cause the binary inputs.
- The response of the device must be checked in the **Status** column of the dialog box. To do this, the dialog box must be updated. The options may be found below under the margin heading "Updating the Display".
- Terminate the test sequence (see below under the margin heading "Exiting the Procedure").

If however the effect of a binary input must be checked without carrying out any switching in the plant, it is possible to trigger individual binary inputs with the hardware test function. As soon as the first state change of any binary input is triggered and the password no. 6 has been entered, all binary inputs are separated from the plant and can only be activated via the hardware test function.

Test of the LEDs

The LEDs may be tested in a similar manner to the other input/output components. As soon as you have initiated the first state change for any LED, all LEDs are disconnected from the functionality of the device and can only be operated by the hardware test function. This means e.g. that no LED is illuminated anymore by a device function or by pressing the LED reset button.

Updating the Display

During the opening of the dialog box **Hardware Test** the operating states of the hardware components which are current at this time are read in and displayed.

An update occurs:

- for each hardware component, if a command to change the condition is successfully performed,
- for all hardware components if the **Update** button is clicked,
- for all hardware components with cyclical updating (cycle time is 20 s) if the **Automatic Update (20 s)** field is marked.

Exiting the Test Mode

To end the hardware test, click on **Close**. The dialog box closes. The device becomes unavailable for a brief start-up period immediately after this. Then all hardware components are returned to the operating conditions determined by the plant settings.

3.3.4 Testing User-defined Functions

CFC Logic

The device has a vast capability for allowing functions to be defined by the user, especially with the CFC logic. Any special function or logic added to the device must be checked.

Naturally, general test procedures cannot be given. Rather, the configuration of these user defined functions and the necessary associated conditions must be known and verified. Of particular importance are possible interlocking conditions of the switchgear (circuit breakers, isolators, etc.).

3.3.5 Commissioning Test

General Information



WARNING!

Warning of hazardous voltages when operating electrical devices

Nonobservance of the following measure will result in fatality, severe personal injury or substantial material damage.

Only qualified people shall work on and around this device. They must be thoroughly familiar with all warnings and safety notices in this instruction manual as well as with the applicable safety steps, safety regulations, and precautionary measures.

For the commissioning switching operations have to be carried out. A prerequisite for the prescribed tests is that these switching operations can be executed without danger. They are accordingly not meant for operational checks.



WARNING!

Warning of dangers evolving from improper primary tests

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Primary test may only be carried out by qualified personnel, who are familiar with the commissioning of protection systems, the operation of the plant and the safety rules and regulations (switching, earthing, etc.).

Safety Instructions

All relevant safety rules and regulations (e.g. VDE 105, VBG4 or comparable national regulations) must be complied with.

Before undertaking any work, observe the following "5 safety rules":

- Enable
- Secure against reswitching on
- Establish absence of voltage
- Earth and short circuit
- Cover or fence in live parts in the vicinity

In addition the following must be observed:

- Before making any connections, the device must be earthed at the protective conductor terminal.
- Hazardous voltages can exist in all switchgear components connected to the power supply and to measurement and test circuits.
- Hazardous voltages can be present in the device even after the power supply voltage has been removed (capacitors can still be charged).
- After removing voltage from the power supply, wait a minimum of 10 s before reenergizing the power supply. This allows defined initial conditions when the device is re-energized.

- The limit values specified in the Technical Specifications (section 4.1) must not be exceeded, also not during testing and during commissioning.



DANGER!

Hazardous voltages during interruptions in secondary circuits of current transformers.

Nonobservance of the following measure will result in fatality, severe personal injury or substantial material damage.

Short-circuit the current transformer secondary circuits before current connections to the device are opened.

If test switches are installed that automatically short-circuit the current transformer secondary circuits it is sufficient to place them into the "Test" position provided the short-circuit functions has been previously tested.

All secondary test equipment should be removed and the measurement voltages connected. The operational preparations must be completed.

Preparation

Please perform the following preparatory commissioning steps:

- Install an EMERGENCY OFF button for direct trip of the excitation
- Check the parameter setting, if need temporarily setting in commissioning, change to temporarily setting.
- Check the binary input and measurement input.
- The mode of power support transfer is same with test scheme, according to the requirement of site.

Test

Please perform the following preparatory commissioning steps:

- Manual/remote Open CB. Check device Binary output, LEDs is same with the setting.
- Check function, site/remote start power support transfer function, check device doing is same with the setting.
- According the setting, cut off power of busbar (fault start mode, undervoltage mode...etc), check device doing is same with the setting.

3.3.6 Checking the Voltage Circuits

General

The voltage circuits of the machine are checked to ensure the correct cabling, polarity, phase sequence, transformer ratio etc. of the voltage transformers - not to check individual protection functions of the device.

Test Instruction

The checks of all voltage transformer circuits (protection, measuring, metering etc.) are carried out with about 30 % of the rated transformer voltage.

The measuring circuit supervision of the rotor earth fault protection (see below) can be checked when testing the voltage circuits, or after the synchronization.

Amplitudes

Read out voltages in all three phases in the operational measured values and compare with the actual voltages. The voltage of the positive sequence system U1 must be approximately the same as the indicated phase voltages. If there are significant deviations, the voltage transformer connections are incorrect.

Phase Rotation

The phase rotation must conform with the configured phase sequence; otherwise an indication "Fail Ph. Seq.V.B1" or "Fail Ph. Seq.V.B2" will be output. The allocation of measured values to phases must be checked and corrected, if necessary. If significant deviations are found, check, and if necessary correct, the voltage transformer circuits and repeat the test. It is also possible to use for this check the operational measured value of positive-sequence component U1 of the voltages: With $U1 \neq U_L - E$ a wiring error is indicated.

3.3.7 Checking the Current Circuits

General

The checks of the current circuits are performed with the generator to ensure correct CT circuit connections with regard to cabling, polarity, phase sequence, CT ratio etc., not in order to verify individual protection functions in the device.

Test Instruction

Then the checks of the current transformer circuits are carried out with max. 20 % of the rated transformer current. Tests with generator currents of more than 20 % are not normally required for digital protection.

Amplitude Values

The currents can be read out from the device front panel or from the PC via the operator interface under operational measured values and compared with the actual measured values. If significant deviations are found, the CT connections are not correct.

3.3.8 Creating a Test Fault Record

General

At the end of commissioning, an investigation of switching operations of the circuit breaker(s) or primary switching device(s), under load conditions, should be done to assure the stability of the protection during the dynamic processes. A maximum of information on protection behaviour is supplied by fault recordings.

Requirement

Along with the capability of storing fault recordings via pickup of the protection function, the 7VU683 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. For the latter, event ">Trig.Wave.Cap." must be allocated to a binary input. Triggering of the recording then occurs, for example, via the binary input when the protection object is energised.

Such externally started test fault recordings (that is, without a protection pickup) are handled by the device as normal fault recordings, i.e. for each measurement record a fault log is opened with its own number, for unequivocal allocation. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

Start Waveform Recording

To trigger test measurement recording with DIGSI, click on **Test** in the left part of the window. Double click the entry **Test Wave Form** in the list of the window.

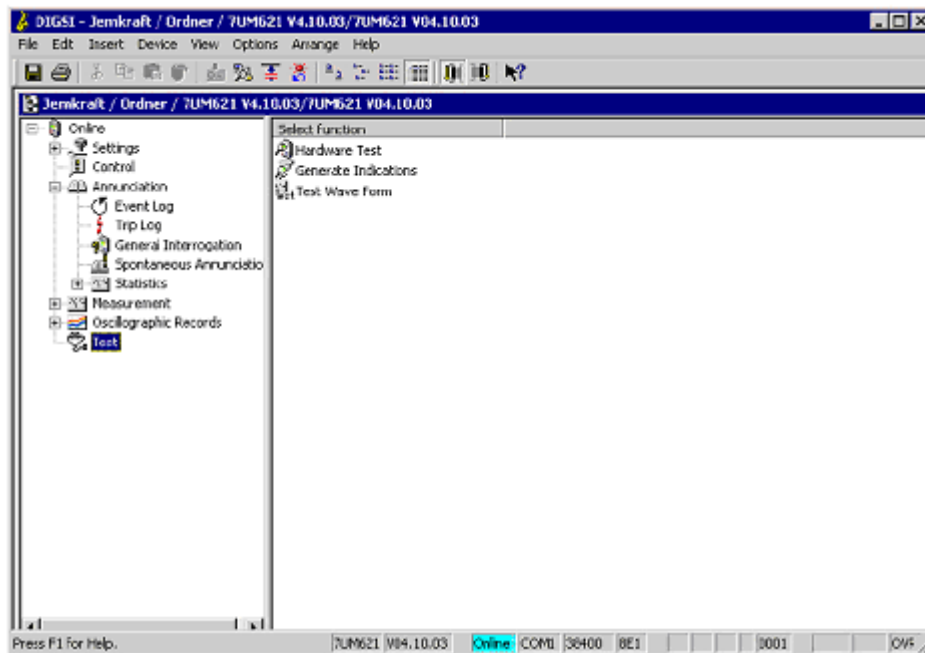


Figure 3-16 Figure 3-40 Triggering Oscillographic Recording with DIGSI - Example

A test measurement record is immediately started. During recording, an indication is given in the left part of the status bar. Bar segments additionally indicate the progress of the procedure.

For display and evaluation of the recording you require one of the programs SIGRA or ComtradeViewer.

3.4 Final Preparation of the Device

Firmly tighten all screws. Tighten all terminal screws, including those that are not used.

Caution!



Inadmissible tightening torques

Non-observance of the following measure can result in minor personal injury or property damage.

The tightening torques must not be exceeded as the threads and terminal chambers may otherwise be damaged!

In case service settings were changed, check if they are correct. Check if power system data, control and auxiliary functions to be found with the configuration parameters are set correctly (Section 2). All desired elements and functions must be set *ON*. Keep a copy of all of the in-service settings on a PC.

Check the internal clock of the device. If necessary, set the clock or synchronize the clock if the element is not automatically synchronized. For assistance, refer to the SIPROTEC 4 System Description /1/.

The indication buffers are deleted under **MAIN MENU** → **Annunciation** → **Set/Reset**, so that in the future they only contain information on actual events and states (see also /1/). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC 4 System Description /1/).

The counters of the operational measured values (e.g. operation counter, if available) are reset under **Main Menu** → **Measurement** **Reset**.

Press the ESC key, several times if necessary, to return to the default display. The default display appears in the display (e.g. display of operation measured values).

Clear the LEDs on the front panel by pressing the LED key, so that they only show real events and states. In this context, also output relays probably memorized are reset. Pressing the LED key also serves as a test for the LEDs on the front panel because they should all light when the button is pushed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green "RUN" LED must be on. The red "ERROR" LED must not be lit.

Close the protective switches. If test switches are available, then these must be in the operating position.

The device is now ready for operation.



Technical Data

4

This chapter provides the technical data of SIPROTEC 4 devices 7VU683 and their individual functions, including the limiting values that must not be exceeded under any circumstances. The electrical and functional data for the device with all options, as well as the mechanical data with dimensional drawings, are provided in the following.

4.1	General	160
4.2	Rated electrical parameter	160
4.3	Technical Data	160

4.1 General

Current Input

Recommended permanent operating temperature	-5 ~ 55°C
Limiting temporary (transient) operating temperature	-20 ~ 70°C
Limit temperatures during transport	-25 ~ 70°C

4.2 Rated electrical parameters

Auxiliary voltage:	24-48 VDC, 60-250 VDC, 115/230 VAC
Tolerance	+20%, -20%
Rated voltage	80 ~ 125 VAC (U_n)
Rated current	1/5 A (I_n)
Rated frequency	50/60 Hz
Overload capability:	
Current overload capability	4* I_n continuous
	30* I_n for 10 s
	100* I_n for 1 s
Voltage path overload capacity	230 V continuous
Power consumption:	
Current	Approx. 0.3 VA ($I_n=5$ A)
	Approx. 0.05 VA ($I_n=1$ A)
Voltage	Approx. 0.10 VA/Phase
Power Consumption:	Quiescent, Approx. 8 W
	Energized, Approx. 15 W

4.3 Functional Data

4.3.1 HSBT

Resolution of external Binary Inputs	Approx. 1 ms
Action time of high speed output relay	Approx. 1 ms
Fastest action time of FAST mode	50 Hz: Approx. 20 ms
	60 Hz: Approx. 16.7 ms
Angle tolerance	<0.2°
Frequency tolerance	<0.02 Hz
Voltage tolerance	<0.2 V
Current tolerance	<0.01* I_n

4.3.2 Protection

Operation frequency	50 Hz, Frequency Range: 20 Hz~66 Hz 60 Hz, Frequency Range: 25 Hz~66 Hz
Pickup Time	< 50ms
Time tolerance	Approx. 1% t_{set} 10 ms
Voltage tolerance	Approx. 1% U_{set} or 0.5 V
Current tolerance	Approx. 1% I_{set} or 0.01 In

4.3.3 Electrical Tests

Immunity test

Standards:		IEC 60255-6 and -22 EN 60082-6-2
High frequency test IEC 60255-22-1, class III		2.5 kV (peak); 1 MHz; $\tau = 15 \mu s$; 400 surges per s; test duration 2s; $R_i = 200 \Omega$
Electrostatic discharge IEC 60255-22-2 class IV IEC 61000-4-2, IV		8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; $R_i = 330 \Omega$
Irradiation with RF field, frequency sweep, IEC 60255-22-3, IEC 61000-4-3 class III		10 V/m and 20 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz 10 V/m; 800 MHz to 960 MHz; 80 % AM; 1 kHz 20 V/m; 1,4 GHz to 2,0 GHz; 80 % AM; 1 kHz
Fast transients interference, bursts IEC 60255-22-4 and IEC 61000-4-4, class IV		4 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; $R_i = 50 \Omega$; test duration 1 mln
High-energy surge voltages (SURGE), IEC 61000-4-5, installation class III		Impulse: 1.2/50 μs
	Auxiliary supply	Common (longitudinal) mode: 2 kV; 12 Ω ; 9 μF Differential (transversal) mode: 1 kV; 2 Ω ; 18 μF
	Analog inputs, binary inputs, binary outputs	Common (longitude) mode: 2 kV; 42 Ω ; 0.5 μF Differential (transversal) mode: 1 kV; 42 Ω ; 0.5 μF
Line-conducted HF, amplitudemodulated IEC 61000-4-6, class III		10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Fast transient surge withstand capability, ANSI/IEEE C37.90.1		4 kV; 5/50 ns; 5 kHz; burst 15 ms; repetition rate 300 ms; both polarities; duration 1 min.; $R_i=80$

EMC tests for interference emission

Standards:	EN 61000-6-3
Conducted interference, only auxiliary supply IEC-CISPR 22	150 kHz to 30 MHz Limit class B
Radio interference field strength IEC-CISPR 22	30 MHz to 1000 MHz Limit class B

Insulation tests

Standards:	IEC60255-5-2000
Voltage test (100 % test) All circuits except for auxiliary supply, binary inputs and communication interfaces	2.5 kV (rms), 50 Hz
Auxiliary voltage and binary inputs (100 % test)	3.5 kV–
RS485/RS232 rear side communication interfaces and time synchronization interface (100 % test)	500 V (rms), 50 Hz
Impulse voltage test (type test) All circuits except for communication interfaces and time synchronization interface, class III	IEC60255-5-2000 5 kV (peak); 1.2/50 µs; 0.5 J 3 positive and 3 negative impulses at intervals of 5 s



Appendix

A

This appendix is primarily a reference for the experienced user. This section provides ordering information for the models of this device. Connection diagrams for indicating the terminal connections of the models of this device are included. Following the general diagrams are diagrams that show the proper connections of the devices to primary equipment in many typical power system configurations. Tables with all settings and all information available in this device equipped with all options are provided. Default settings are also given.

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A.1 Ordering Information

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Housing, Number of Binary Inputs and Outputs	Pos. 6
High Speed Bus transfer device, Housing 1/1 19", 17 BI, 18 BO(include 5 High Speed contact), 1 Live Status Contact	3

Nominal current	Pos. 7
1 A	1
5 A	5

Auxiliary Voltage	Pos. 8
24 to 48 VDC, binary input threshold 19 V	2
60 to 125 VDC, binary input threshold 19 V	4
110 to 250 VDC, 115 to 230 VAC, binary input threshold 88 VDC	5
220 to 250 VDC, 115 to 230 VAC, binary input threshold 176 VDC	6

Housing	Pos. 9
Flush mounting case, screw-type terminals (direct connection / ring and spade lugs)	E

Region-specific Default / Language Settings and Function Versions	Pos. 10
Region World, 50/60 Hz, IEC/ANSI, Language English	B
China, Chinese, changeable, 50/60 Hz	W

System Interfaces or Analog Output (Port B)	Pos. 11
No system interface	0
IEC 60870-5-103 Protocol, electrical RS 232	1
IEC 60870-5-103 Protocol, RS485	2
IEC 60870-5-103 Protocol, Fiber 820 nm, ST Connector	3
For further interface options see the following Additional Information L	9

MLFB extension	Supple-mentary
PROFIBUS DP Slave, RS485	+ L 0 A
Profibus DP Slave, 820 nm, Optical Double Ring, ST Connector	+ L 0 B
Modbus, RS485	+ L 0 D
Modbus, 820 nm, Optical, ST Connector	+ L 0 E
DNP 3.0, electric RS485	+ L 0 G
DNP 3.0, Fiber 820 nm, ST-Connector	+ L 0 H
IEC 60870-5-103, Redundant RJ45	+ L 0 P
IEC 61850, 100Mbit Ethernet, electric, double, RJ45 connector	+ L 0 R
IEC 61850, 100Mbit Ethernet, with integrated switch optical, double, LC-connector	+ L 0 S

Port C,Port D	Pos. 12
Port C: DIGSI 4/Modem, RS232	1
Port C: DIGSI 4/Modem/RTD-Box, RS485	2

Measurement	Pos. 13
Basic measurements	1

Functions	Pos. 14
HSBT, single busbar with 2-CB, ANSI C50.41-2012 compliant/Supervision	B
HSBT, sectionalized busbar with 3-CB, ANSI C50.41-2012 compliant/Protections/Supervision	C
HSBT, single busbar with 3-CB, ANSI C50.41-2012 compliant/Supervision	D

A.2 Terminal Assignments

A.2.1 7VU683 terminal assignments

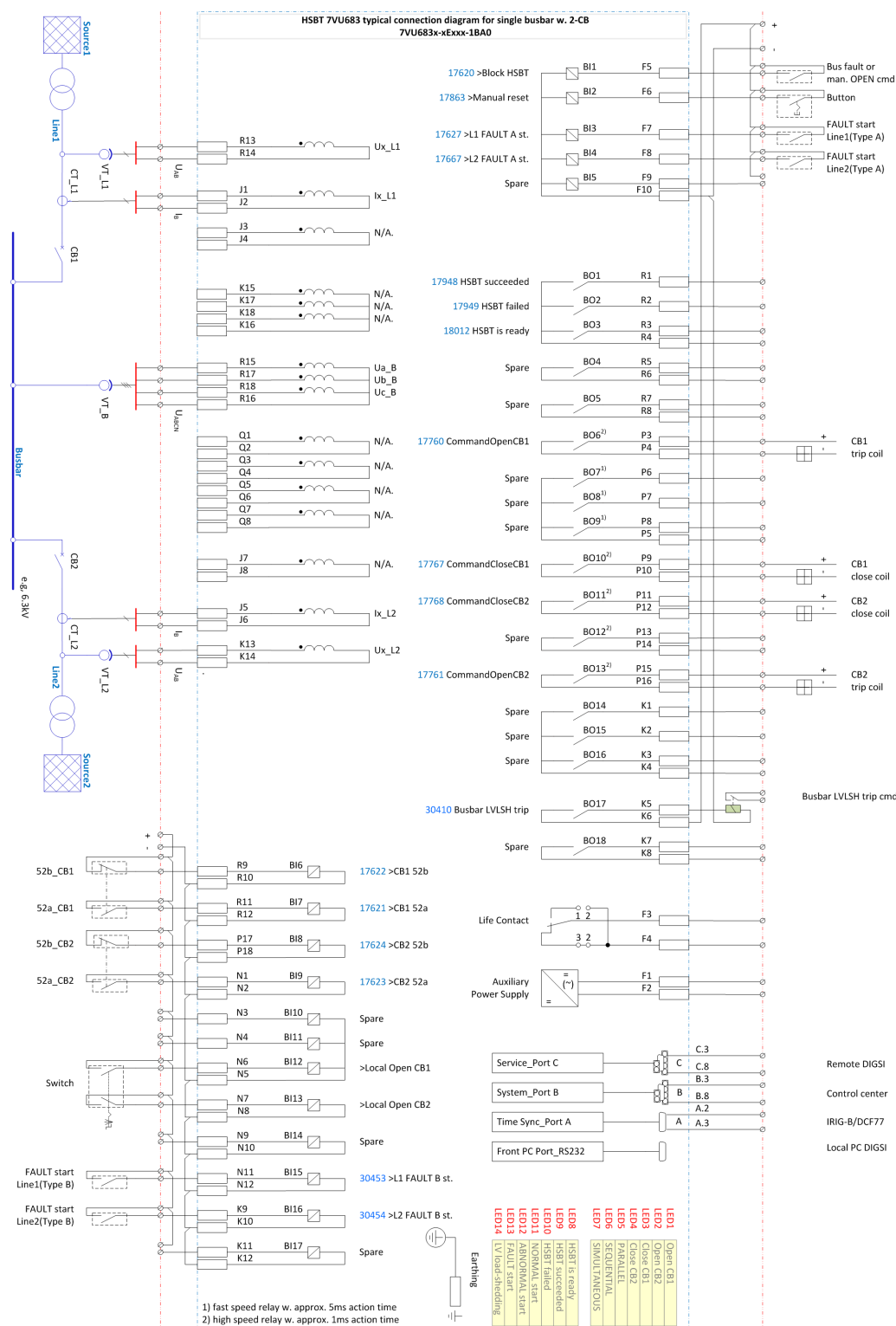


Figure A-1 Typical Primary Diagram and default configuration - Single Busbar with 2-CB

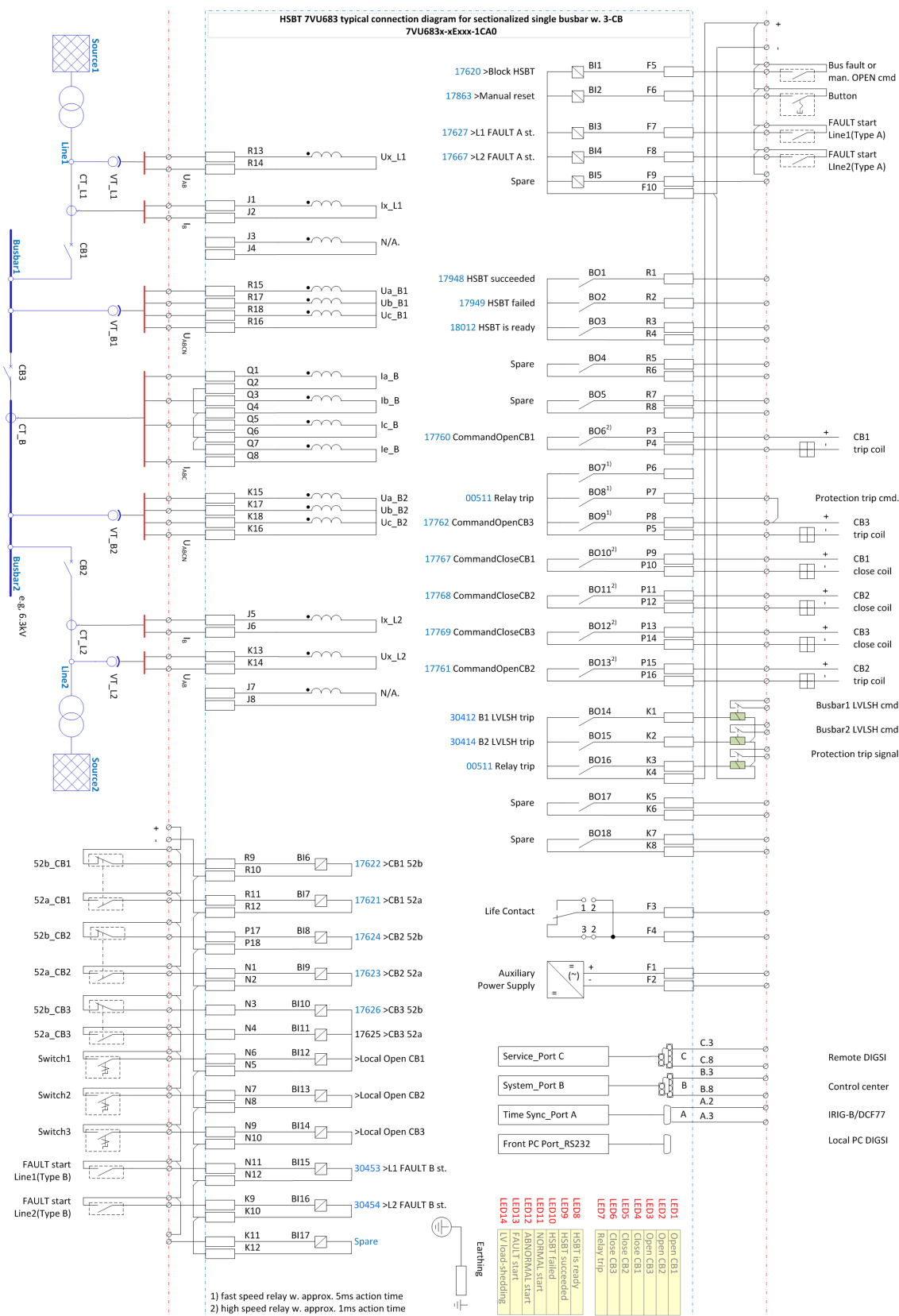
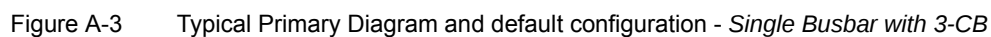


Figure A-2 Typical Primary Diagram and default configuration - Sectionalized Single Busbar with 3-CB



A.3 Default Settings

When the device leaves the factory, a large number of LED indicators, binary inputs and outputs as well as function keys are already preset. They are summarized in the following table.

A.3.1 LEDs

LED default configuration for Single Busbar with 2-CB

LEDs	Function No.	Allocated Function
LED1	17760	Command: Open CB1
LED2	17761	Command: Open CB2
LED3	17767	Command: Close CB1
LED4	17768	Command: Close CB2
LED5	17656	PARALLEL Sequence Close Standby Source
LED6	17657	SIMULTANEOUS Sequence Cl. Standby Source
LED7	30452	SEQUENTIAL Sequence Close Standby Source
LED8	18012	HSBT is ready
LED9	17948	HSBT succeeded
LED10	17949	HSBT failed
LED11	17644	NORMAL start
LED12	17646	Under-voltage start
	17647	Under-frequency start
	30444	Reverse power start
	30445	Change Rate of Frequency Start
	17648	Inadvertent CB Open Start
LED13	30468	FAULT Started Line1 Type A
	30469	FAULT Started Line1 Type B
	30470	FAULT Started Line2 Type A
	30471	FAULT Started Line2 Type B
LED14	30410	Low Voltage Load-Shedding Trip

LED Default configuration for Sectionalized Single Busbar with 3-CB

LEDs	Function No.	Allocated Function
LED1	17760	Command: Open CB1
LED2	17761	Command: Open CB2
LED3	17762	Command: Open CB3
LED4	17767	Command: Close CB1
LED5	17768	Command: Close CB2
LED6	17769	Command: Close CB3
LED7	00511	Relay GENERAL TRIP command
LED8	18012	HSBT is ready
LED9	17948	HSBT succeeded
LED10	17949	HSBT failed
LED11	17644	NORMAL start

LEDs	Function No.	Allocated Function
LED12	17646	Under-voltage start
	17647	Under-frequency start
	30444	Reverse power start
	30445	Change Rate of Frequency Start
	17648	Inadvertent CB Open Start
LED13	30468	FAULT Started Line1 Type A
	30469	FAULT Started Line1 Type B
	30470	FAULT Started Line2 Type A
	30471	FAULT Started Line2 Type B
LED14	30411	Bus1 Low Voltage Load-Shedding Trip
	30412	Bus2 Low Voltage Load-Shedding Trip

LED Default configuration for Single Busbar with 3-CB

LEDs	Function No.	Allocated Function
LED1	17760	Command: Open CB1
LED2	17761	Command: Open CB2
LED3	17762	Command: Open CB3
LED4	17767	Command: Close CB1
LED5	17768	Command: Close CB2
LED6	17769	Command: Close CB3
LED7	Not functions configured	Not functions configured
LED8	18012	HSBT is ready
LED9	17948	HSBT succeeded
LED10	17949	HSBT failed
LED11	17644	NORMAL start
LED12	17646	Under-voltage start
	17647	Under-frequency start
	30444	Reverse power start
	30445	Change Rate of Frequency Start
	17648	Inadvertent CB Open Start
LED13	30468	FAULT Started Line1 Type A
	30469	FAULT Started Line1 Type B
	30470	FAULT Started Line2 Type A
	30471	FAULT Started Line2 Type B
	30472	FAULT Started Line3 Type A
	30473	FAULT Started Line3 Type B
LED14	30410	Low Voltage Load-Shedding Trip

A.3.2 Binary Input Default Configuration

Default Binary Input for *Single Busbar with 2-CB*

LEDs	Function No.	Allocated Function
BI1	17620	>Block HSBT
BI2	17863	>Manually Reset
BI3	17627	>FAULT Start Line1 Type A
BI4	17667	>FAULT Start Line2 Type A
BI5	No functions configured	No functions configured
BI6	17622	>52b CB1
		CB1 Open/Close
BI7	17621	>52a CB1
		CB1 Open/Close
BI8	17624	>52b CB2
		CB2 Open/Close
BI9	17623	>52a CB2
		CB2 Open/Close
BI10	No functions configured	No functions configured
BI11	No functions configured	No functions configured
BI12		>Local Open CB1
BI13		>Local Open CB2
BI14	No functions configured	No functions configured
BI15	30453	>FAULT Start Line1 Type B
BI16	30454	>FAULT Start Line2 Type B
BI17	No functions configured	No functions configured

Default Binary Input for *Sectionalized Single Busbar with 3-CB*

LEDs	Function No.	Allocated Function
BI1	17620	>Block HSBT
BI2	17863	>Manually Reset
BI3	17627	>FAULT Start Line1 Type A
BI4	17667	>FAULT Start Line2 Type A
BI5	No functions configured	No functions configured
BI6	17622	>52b CB1
		CB1 Open/Close
BI7	17621	>52a CB1
		CB1 Open/Close
BI8	17624	>52b CB2
		CB2 Open/Close
BI9	17623	>52a CB2
		CB2 Open/Close
BI10	17626	>52b CB3
		CB3 Open/Close
BI11	17625	>52a CB3
		CB3 Open/Close
BI12		>Local Open CB1

LEDs	Function No.	Allocated Function
BI13		>Local Open CB2
BI14		>Local Open CB3
BI15	30453	>FAULT Start Line1 Type B
BI16	30454	>FAULT Start Line2 Type B
BI17	No functions configured	No functions configured

Default Binary Input for *Single Busbar with 3-CB*

LEDs	Function No.	Allocated Function
BI1	17620	>Block HSBT
BI2	17863	>Manually Reset
BI3	17627	>FAULT Start Line1 Type A
BI4	17667	>FAULT Start Line2 Type A
BI5	30415	>FAULT Start Line3 Type A
BI6	17622	>52b CB1
		CB1 Open/Close
BI7	17621	>52a CB1
		CB1 Open/Close
BI8	17624	>52b CB2
		CB2 Open/Close
BI9	17623	>52a CB2
		CB2 Open/Close
BI10	17626	>52b CB3
		CB3 Open/Close
BI11	17625	>52a CB3
		CB3 Open/Close
BI12		>Local Open CB1
BI13		>Local Open CB2
BI14		>Local Open CB3
BI15	30453	>FAULT Start Line1 Type B
BI16	30454	>FAULT Start Line2 Type B
BI17	30455	>FAULT Start Line3 Type B

A.3.3 Binary Output Default Configuration

Default Binary Output for *Single Busbar with 2-CB*

LEDs	Function No.	Allocated Function
BO1	17948	HSBT Succeeded
BO2	17949	HSBT Failed
BO3	18012	HSBT is Ready
BO4	No functions configured	No functions configured
BO5	No functions configured	No functions configured
BO6	17760	Command: Open CB1
BO7	No functions configured	No functions configured
BO8	No functions configured	No functions configured
BO9	No functions configured	No functions configured
BO10	17767	Command: Close CB1
BO11	17768	Command: Close CB2
BO12	No functions configured	No functions configured
BO13	17761	Command: Open CB2
BO14	No functions configured	No functions configured
BO15	No functions configured	No functions configured
BO16	No functions configured	No functions configured
BO17	30410	Low Voltage Load-Shedding Trip
BO18	No functions configured	No functions configured

Default Binary Output for *Sectionalized Single Busbar with 3-CB*

LEDs	Function No.	Allocated Function
BO1	17948	HSBT Succeeded
BO2	17949	HSBT Failed
BO3	18012	HSBT is Ready
BO4	No functions configured	No functions configured
BO5	No functions configured	No functions configured
BO6	17760	Command: Open CB1
BO7	No functions configured	No functions configured
BO8	17828	Phase Over-current I> Trip
	17830	Phase Over-current I>> Trip
	17837	Earth Over-current I> Trip
	17839	Earth Over-current I>> Trip
	17929	Phase O/C I> Switch-Onto-Fault Trip
	17931	Phase O/C I>> Switch-Onto-Fault Trip
	17933	Earth O/C I> Switch-Onto-Fault Trip
	17935	Earth O/C I>> Switch-Onto-Fault Trip
BO9	17762	Command: Open CB3
BO10	17767	Command: Close CB1
BO11	17768	Command: Close CB2
BO12	17769	Command: Close CB3
BO13	17761	Command: Open CB2
BO14	30412	Bus1 Low Voltage Load-Shedding Trip

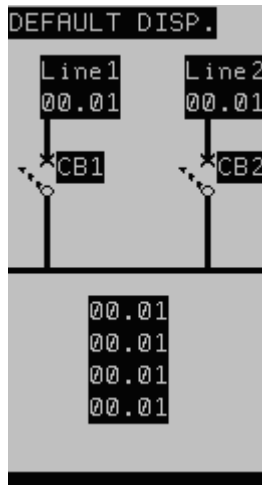
LEDs	Function No.	Allocated Function
BO15	30414	Bus2 Low Voltage Load-Shedding Trip
BO16	17828	Phase Over-current I> Trip
	17830	Phase Over-current I>> Trip
	17837	Earth Over-current I> Trip
	17839	Earth Over-current I>> Trip
	17929	Phase O/C I> Switch-Onto-Fault Trip
	17931	Phase O/C I>> Switch-Onto-Fault Trip
	17933	Earth O/C I> Switch-Onto-Fault Trip
	17935	Earth O/C I>> Switch-Onto-Fault Trip
BO17	No functions configured	No functions configured
BO18	No functions configured	No functions configured

Default Binary Output for *Single Busbar with 3-CB*

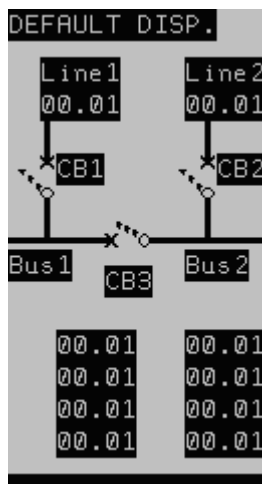
LEDs	Function No.	Allocated Function
BO1	17948	HSBT Succeeded
BO2	17949	HSBT Failed
BO3	18012	HSBT is Ready
BO4	No functions configured	No functions configured
BO5	No functions configured	No functions configured
BO6	17760	Command: Open CB1
BO7	No functions configured	No functions configured
BO8	No functions configured	No functions configured
BO9	17762	Command: Open CB3
BO10	17767	Command: Close CB1
BO11	17768	Command: Close CB2
BO12	17769	Command: Close CB3
BO13	17761	Command: Open CB2
BO14	No functions configured	No functions configured
BO15	No functions configured	No functions configured
BO16	No functions configured	No functions configured
BO17	30410	Low Voltage Load-Shedding Trip
BO18	No functions configured	No functions configured

A.3.4 Default Display

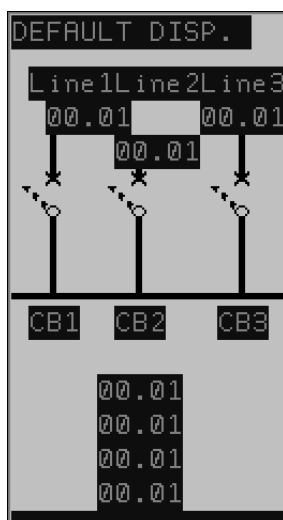
Default display for primary diagram of single bus with 2-CB is as below:



Default display for primary diagram of sectionalized single bus with 3-CB is as below:

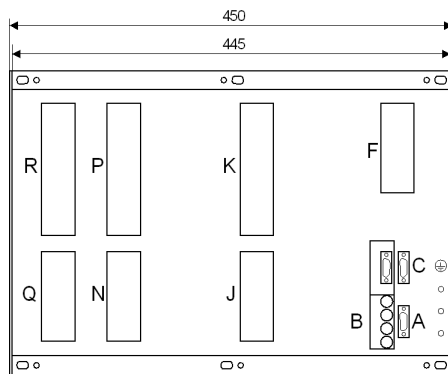


Default display for primary diagram of single bus with 3-CB is as below:

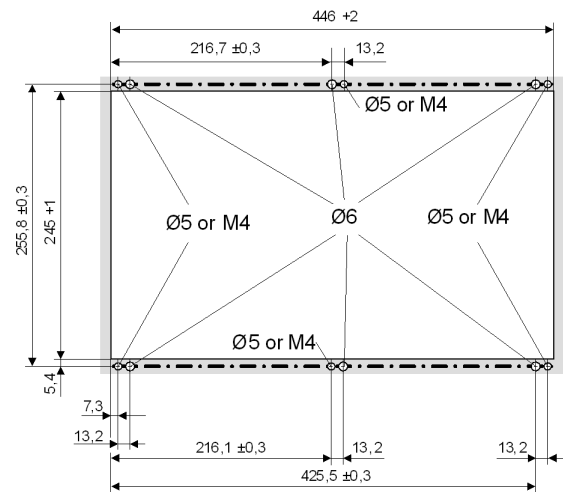




Side View (with Screwed Terminal)



Rear View



Panel Cut-Out
(Regarded from the Front Side)

Figure A-4 7VU683 dimensions for panel flush mounting or cubicle mounting (housing size 1/1)



Literature

- /1/ SIPROTEC 4 System System Description; E50417-H1176-C151-B1
- /2/ SIPROTEC DIGSI, Start UP; E50417-G1176-C152 -A3
- /3/ DIGSI CFC, Manual; E50417-H1176-C098 -A9
- /4/ SIPROTEC SIGRA 4, Manual; E50417-H1176-C070

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