SIEMENS

Protection Systems

SIPROTEC 4 7VU683 V4.7
High Speed Busbar Transfer Device

Chapter for the Catalog SIP · Edition No. 7

Answers for infrastructure and cities.

7VU683

High Speed Busbar Transfer

You will find a detailed overview of the technical data under www.siemens.com/siprotec

Fig. 1 SIPROTEC 4 7VU683 multifunction high speed busbar transfer device

Description

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 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 supply 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.

Based on the existing world-wide used SIPROTEC 4 platform, the reliability, stability and efficiency of HSBT 7VU683 are guaranteed. Thanks to its powerful and flexible performance, multi functions are integrated into one system, e.g, power supply transfer, relay protection and supervision.

The compact solution HSBT 7VU683 is designed to fit for the primary diagrams of single busbar with 2-CB, sectionalized single busbar with 3-CB and single busbar with 3-CB. It has incorporated the traditional HSBT philosophy. Additionally, the unique Real Time Fast Transfer mode helps to improve the efficiency.

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.

Function overview

<u>High speed busbar transfer function</u>

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

<u>Protection functions for tie-CB</u>

- Overcurrent protection
- Ground overcurrent protection
- Overcurrent protection against switch-onto-fault
- Ground overcurrent protection against switch-onto-fault

<u>Monitoring functions</u>

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

<u>Communication interfaces</u>

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

High Speed Busbar Transfer - Application

Application

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

- 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.

HSBT function

In station service system of thermal power station and some industrial plants, a lot of asynchronous motor are connected. The restarting motors after some seconds power loss will cause heavy starting current and system voltage drop. On the other hand, the incorrect reconnecting to alternative power source will even damage the winding of rotor.

The version HSBT 7VU683 is designed for this case. It will evaluate the necessary switching conditions to ensure the fast but secure transfer. Some improvements like as REAL-TIME FAST transfer mode, additional line current criteria will significantly help to the efficiency and safety.

Protection functions for tie-CB

The integrated protections are intend to protect the tie-CB in sectionalized single busbar diagram against short-circuit or earth fault.

Some special concerning is done to the busbar switch-onto-fault. Protection functions will only be active for a settable time.

Programmable logic

The integrated logic characteristics (CFC) allow the user to implement their own functions and generate user-defined messages.

Measuring values

The measuring values like as U, I, f, dU, df, dφ, U_{diff}/f and CB closing time can be recorded and displayed.

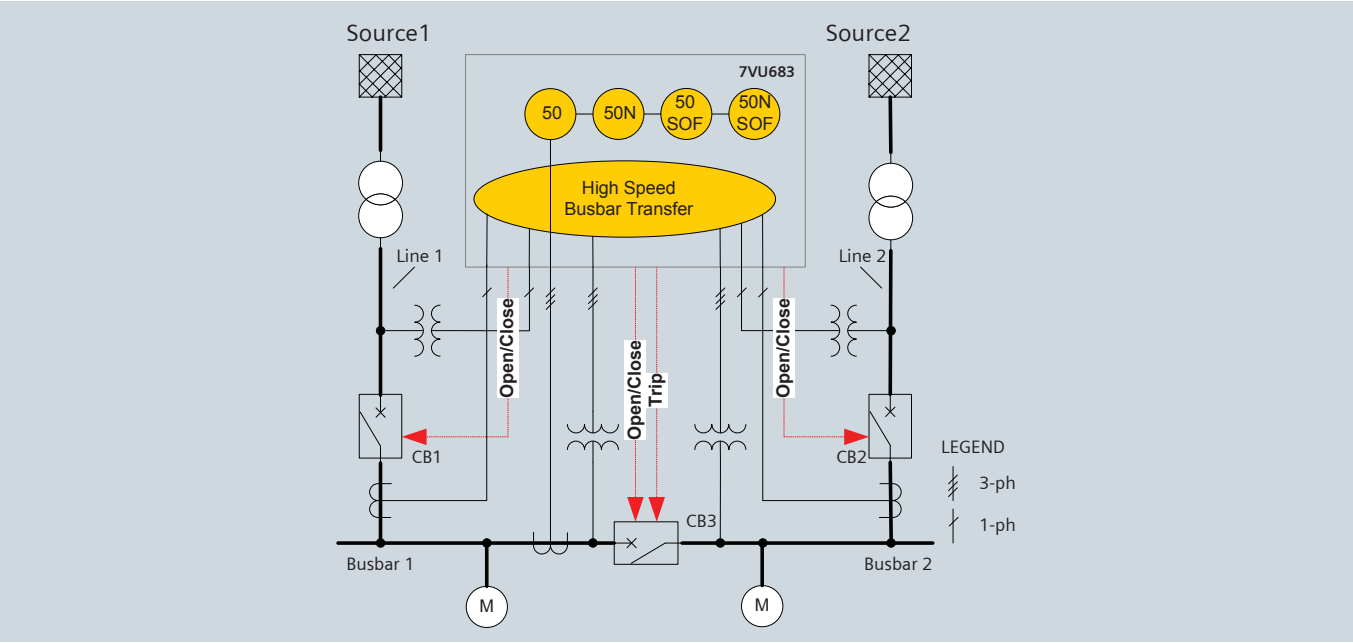

Fig. 2 Function diagram

Function	Abbreviation	ANSI Code	2 Line-CBs	2 Line-CBs +1 Tie-CB	3 Line-CBs
HSBT					
Line1->Line2			X	X	X
Line2->Line1			X	X	X
Line1->Line3					X
Line3->Line1					X
Line2->Line3					X
Line3->Line2					X
Busbar1->Busbar2				X	
Busbar2->Busbar1				X	
Busbar1->Line1				X	
Busbar2->Line2				X	
Protection					
Time overcurrent protection	I>+V<	50		X	
Earth time overcurrent protection	3I0>+3U0>	50N		X	
Time overcurrent protection for busbar energization	I>+V<	50.SOF		X	
Earth time overcurrent protection for busbar energization	3I0>+3U0>	50N.SOF		X	
Supervision					
Phase sequence		47	X	X	X
Voltage circuit		60FL	X	X	X

Table1 Functional scope of HSBT 7VU683

Construction

The SIPROTEC 4 units have a uniform design and a degree of functionality which represents a whole new quality. Local operation has been designed according to ergonomic criteria. Large, easy-to read displays were a major design aim. The device HSBT 7VU683 is equipped with a graphic display thus providing and depicting more information especially in industrial applications. The DIGSI 4 operating program considerably simplifies planning and engineering and reduces commissioning times.

1/1-rack size is the available housing width of the device HSBT 7VU683, referred to a 19" module frame system. The height is a uniform 245 mm. Only flush-mounting housing with screw type terminals is available. All cables can be connected with or without ring lugs.

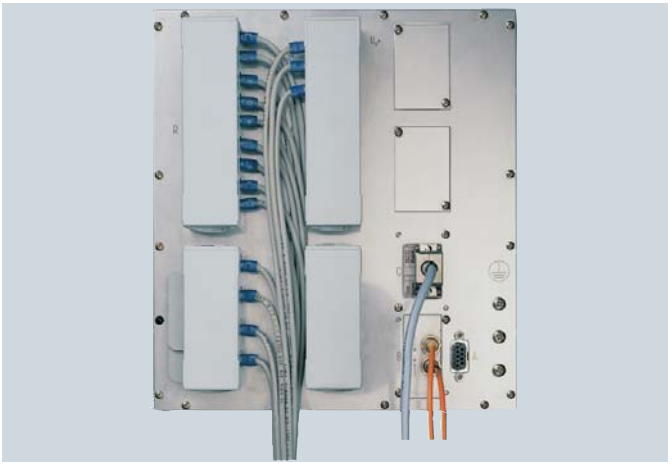

Fig.3 Rear view with wiring terminal safety cover and serial interface

HSBT functions

Starting conditions

The device HSBT 7VU683 is designed to support the following staring conditions,

– NORMAL condition
– FAULT condition
– Inadmissible Under-voltage condition
– Inadmissible Under-frequency condition
– Inadmissible df/dt
– Reverse power
– Inadvertent CB Open condition

The above conditions can be freely combined together, i.e, one of them can be individually switched "**OFF**".

• NORMAL condition

Under the NORMAL condition, the power system is fault free and the starting command must be manually issued. This command can come from remote control center and/or local controller via wiring connection or communication over protocol, e.g,

– DCS of power station
– Turbine control system
– Local panel

The switching of remote and local starting authority is done by internal CFC logic and controlled by device switching key "Remote/Local". The starting command can only be remotely executed over communication when the switching key is at position "Remote", vice versa.

• FAULT condition

Under the FAULT condition, power system fault must be there on the in-feeder line and the starting command must be externally issued by other device, e.g, protection device. The faults are classified into two types: type A, e.g, for electric fault; type B, e.g, for non-electric fault.

• Abnormal condition

Under the abnormal condition, voltage disturbance must be there on the busbar due to any causes. The starting command can be internally issued by device HSBT 7VU683 according to the following abnormal conditions

– Inadmissible Under-voltage
– Inadmissible Under-frequency
– Inadmissible df/dt
– Reverse power
– Inadvertent CB Open

During the electric fault or motor starting, the starting will be blocked by integrated logic of fault detection and motor start recognition. To secure the starting reliability, line current is used as the additional criterion to the above conditions.

In case the operating CB is manually tripped, transfer must not be started. This can be recognized via indication 17864 "**>NonManu.Op.CB1**" and 17865 "**>NonManu.Op.CB2**" in configuration matrix. Or, the manual open signal can be directly routed via indication 17620 "**>Block HSBT**".

Switching sequences

The category HSBT 7VU683 is designed to serve for the following switching sequences according to CBs' operating behavior,

– PARALLEL switching sequence
– SIMULTANEOUS switching sequence
– SEQUENTIAL switching sequence

PARALLEL switching sequences can exclusively support the starting condition NORMAL while SIMULTANEOUS and SEQUENTIAL can support all starting conditions.

• PARALLEL switching sequence

If the two sources are allowed to work on busbar in parallel for a short time, the PARALLEL sequence can be used for power supply transfer.

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

– PARALLEL Auto sequence
– PARALLEL Half-Auto sequence

Under PARALLEL Auto sequence, the device will automatically issue an OPEN command after a settable time delay when the closure is successful. Under PARALLE Half-Auto sequence, the device will not issue the OPEN command until the Manual Open command arrived. The sync-check criterions for PARALLEL switching sequece are as below,

– df < 8851 *"PARAL. Delta f"*
– dU < 8852 *"PARAL. Delta U"*
– dφ < 8853 *"PARAL. Delta Phi"*

If the trunning source CB failed to open, the device will automatically de-couple the closed alternative source CB.

The time sequence under PARALLE can be understandable via the below figure (assumed switching of closing CB2 and opening CB1),

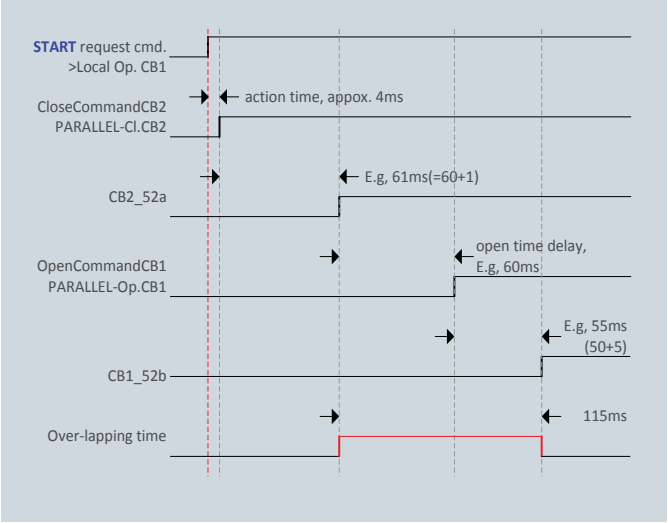

Fig. 4 Switching sequence illustration of PARALLEL

The advantage of PARALLEL sequence is to avoid any interruption of busbar power supply. PARALLEL Auto sequence should be always preferred to reduce the overlapping risk of two sources.

- SIMULTANEOUS switching sequence

If the two sources are not allowed to work on busbar in parallel, the SIMULTANEOUS sequence can be used for power supply transfer. Under SIMULTANEOUS sequence, HSBT 7VU683 will firstly issue a OPEN command to the runnning source CB after the device gets the starting command. Meanwhile, the device will issue a CLOSE command to the alternative source CB if criterions are met.

If the running source CB failed to open, the device will automatically de-couple the closed alternative source CB.

The time sequence under SIMULTANEOUS can be understandable via the below figure (assumed switching of closing CB2 and opening CB1),

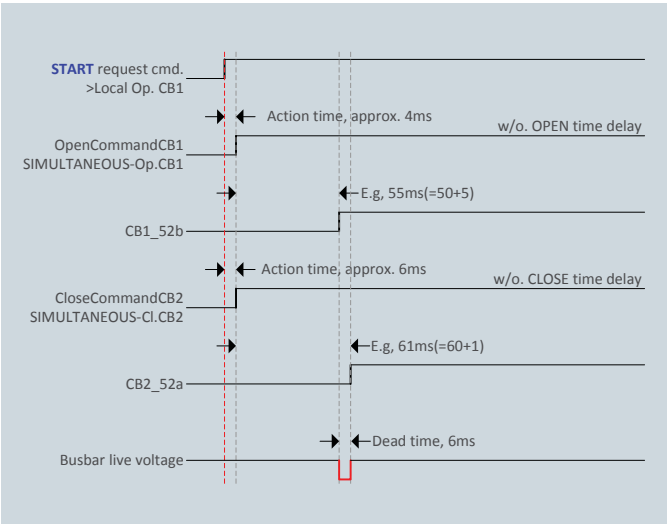

Fig. 5 Switching sequence illustration of SIMULTANEOUS

Due to CB operating time of the difference (CB normally opens faster than it closes), the power supply of busbar will be interrupted for a few milliseconds. The length of this dead interval depends on the difference of CB operating time. The busbar dead interval can be shortened via the settable CB open time delay. Or, the dead interval can be prolonged via the settable CB close time delay to avoid any over-lapping.

- SEQUENTIAL switching sequence

Under SEQUENTIAL sequence, HSBT 7VU683 will firstly issue a OPEN command to the running source CB after the device get the starting request command. SEQUENTIAL sequence can only issue CLOSE command after the running source CB is opened.

The time sequence under SEQUENTIAL can be understandable via the below figure (assumed switching of closing CB2 and opening CB1),

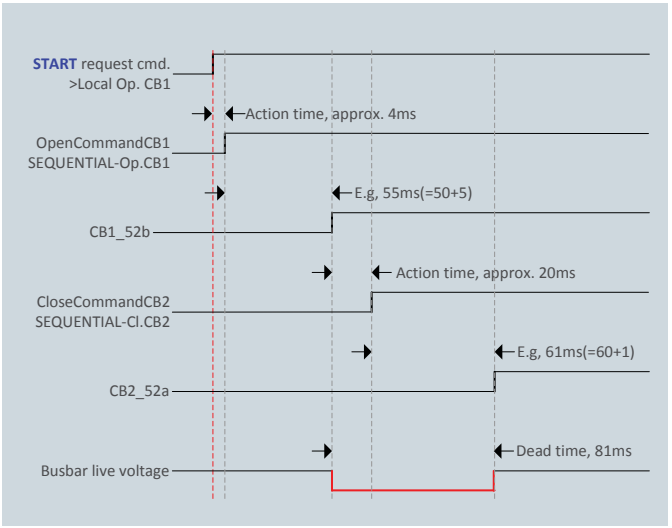

Fig. 6 Switching sequence illustration of SEQUENTIAL

Transfer modes

In the station service system of power station and industrial plants, lots of asynchronous motors are connected. In case of the main source interruption, the residual voltage of busbar will be induced by connected asynchronous motors. Fig.7 shows the well-known typical diagram of vector trajectory of residual voltage.

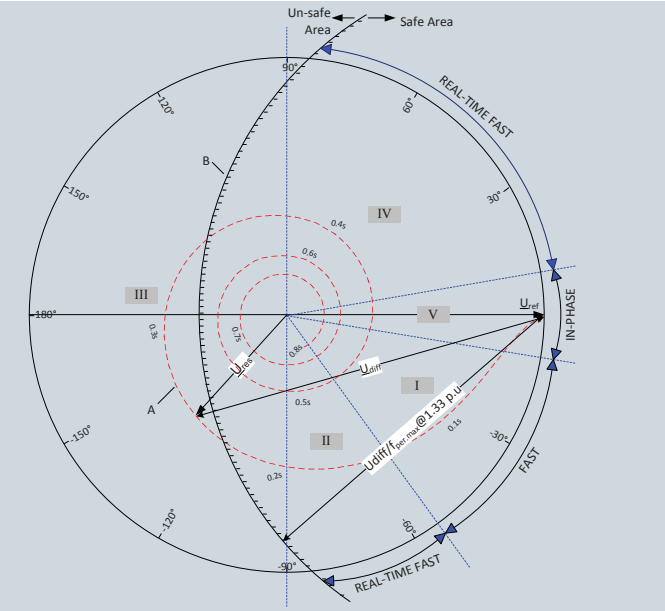

Fig. 7 Vector trajectory of residual voltage U_{res}

Some notes are there regarding curve A according to Fig.7 The amplitude and frequency of residual voltage will decrease regarding time, while the delta phase angle against referred voltage will increase. Fig.8 gives more messages to differential voltage U_{diff}.

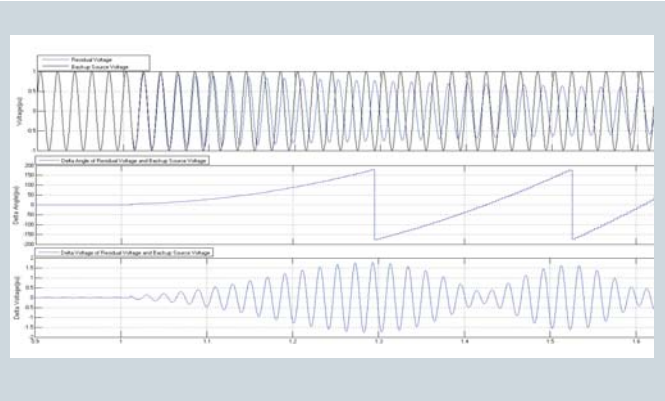

Fig. 8 Characteristic of vector U_{diff}

Fig.9 illustrates the differential voltage U_{diff} resulted from reference voltage Uref and motor busbar residual voltage U_{res}.

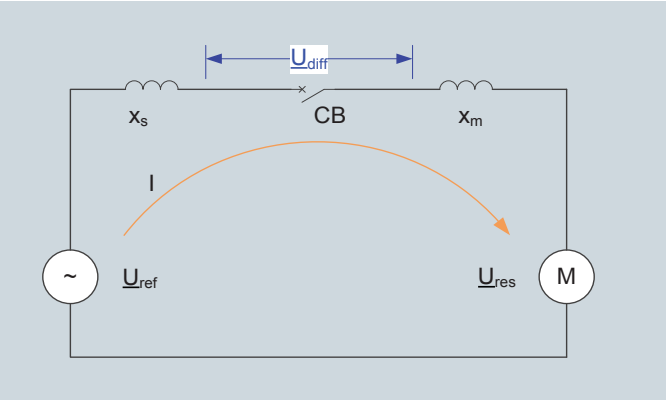

Fig. 9 Equivalent transient circuit during transfer

General conclusion can be made based on Fig.9 that transient impact must be there due to the differential voltage 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 to20 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 busbar 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, and
  – The max. phase angle between the motor residual volts per hertz vector and the system equivalent volts per hertz doesn't exceed 90 degrees, and
- 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 fig. 10

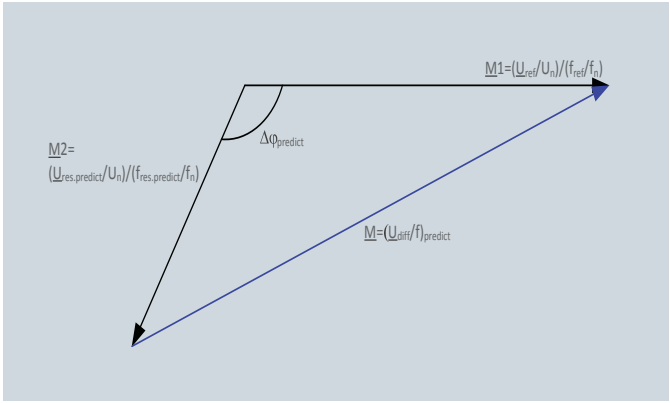

Fig.10 Fast transfer definition in ANSI C50.41-2012

Accordingly, the plane is divided into two parts by Curve B. The left is defined as un-safe transfer area because U_{diff}/f at alternative CB closing instant is bigger than the permitted maximum 1.33 p.u. Vice versa, the right is safe area.

Based on the above principles, the device HSBT 7VU683 is designed to have the following transfer modes (refer to Fig.7) to fit for the safe transfer,

– FAST transfer mode (area **I**)
– REAL-TIME FAST transfer mode (area **II** and **IV**)
– IN-PHASE transfer mode (area **V**)
– RES-VOLT transfer mode
– LONG-TIME transfer mode

Transfer mode combination of FAST and REAL-TIME FAST seamlessly meets the fast transfer definition in C50.41-2012. Meanwhile the transfer modes of IN-PHASE, RES-VOLT and LONG-TIME are served as the backup. All of above modes can be freely combined together, i.e, one of them can be individually switched *"ON"* or "*OFF*" remotely via communication or locally at device panel.

To be noted that the original dφ and dU between busbar voltage and alternative voltage due to wiring and installation can be automatically compensated by device during configuration.

• FAST transfer mode

The study and testing results show, in most cases the typical values of df, dφ and dU are smaller enough within the first tens of millisecond from the instant the CB opens. It's good to safe and fast transfer due to the slight shock to motors. FAST transfer mode is aimed to restrict the dφ at closing instant within a small value, e.g, 60°. If the real-time measured values of df, dφ and U_{res} meet the set criterions, the device will immediately issue the CLOSE command to the alternative source CB. The criterions are as below,

– df < 8858 *"FT Delta f"*
– dφ < 8859 *"FT Delta Phi"*
– U_{res} > 8860 *"FT U/V Blk"*

The typical operating time of 7VU683 in this case is approx.20ms under fn@50Hz.

• REAL-TIME FAST transfer mode

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

This mode is to extend the dφ at closing instant to 90°according to C50.41-2012. Meanwhile the U_{diff}/f at closing instant regarding C50.41-2012 must not exceed1.33p.u. The intelligent device 7VU683 then estimates the values of dφ and U_{diff}/f at the instant of CB closing based on real-time slipping rate and the settable "*CBx Closing Time*" by exclusive predictive algorithm. If all the quantity of predicted dφ 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 " *FT Delta f*"
– dU < 8862 "*RTFT U_{diff}/f*"
– dφ < 8863 "*FT Delta Phi*"
– U_{res} > 8864 *"RTFT U/V Blk"*

• IN-PHASE transfer mode

When the residual voltage comes close to the referred voltage, it comes to transfer mode IN-PHASE. It's good for safe transfer if the CB closes at the instant the value dφ is close to zero.

The intelligent device 7VU683 estimates the delta phase angle dφ at the instant of CB closing based on real-time slipping rate and the settable "*CBx Closing Time*". If all the quantity of predicted dφ, the real-time df and U_{res} meet the defined criterions, the device will immediately issue the CLOSE command to the alternative source CB. The criterions are as below,

– df < 8868 *"IN-PHA Delta f"*
– dφ < 8869 *"IN-PHA Delta Phi"*
– U_{res} > 8870 *"IN-PHA U/V Blk"*

• RES-VOLT transfer mode

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

When the residual voltage U_{res} under-shots the settable parameter 8871 "*RES-VOLT Threshold*", the RES-VOLT transfer mode will perform and the device will immediately issue the CLOSE command to the alternative source CB. The typical setting could be 30%U_n.

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

High Speed Busbar Transfer - HSBT functions

• LONG-TIME transfer mode

The last criterion to start the transfer is LONG-TIME mode if all above mentioned modes failed.

When the transfer time is more than the settable parameter 8872 "*LONG-TIME Threshold*", the LONG-TIME transfer mode will perform and the device will immediately issue the CLOSE command to the alternative source CB. The typical setting could be 3s.

Switching directions

HSBT supports bi-direction busbar transfer under NORMAL condition, i.e from main source 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-direction switching is always supported under any starting condition.

To be noted that the device has default agreement that source1 is exclusively defined as main while others as alternative. Then, if mono-direction against NORMAL condition is required, main source must be always connected to Ux_L1.

The transfer permission under various starting conditions and switching directions can be referred to below three tables.

CB1 Status	CB2 Status	Switching-over		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	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.

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

CB1 Status	CB3 Status	CB2 Status	Switching-over		Voltage Comparison		Busbar Transfer Permitted?						
			From	To			NOR-MAL	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_B1	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

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

CB1 Status	CB2 Status	CB3 Status	Switching-over		Voltage Comparison		Busbar Transfer Permitted?						
			From	To			NOR-MAL	FAULT	Inadmissible Under-volt.	Inadmissible Under-Freq.	Inadmissible Neg. df/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.

Table 4 Transfer permission under default setting, single busbar w. 3-CB

HSBT on-line 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 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.

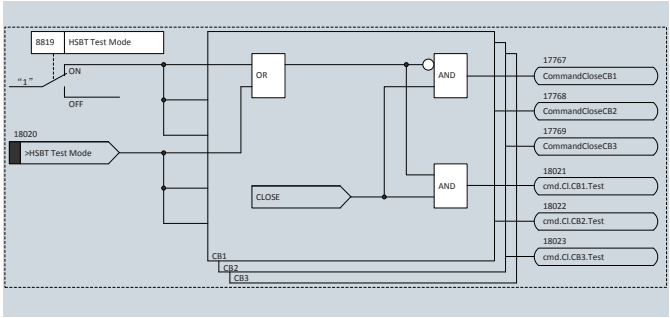

Fig.11 Logic diagram of on-line test mode

Reset of transfer

HSBT will be in "un-ready" status and has to be manually reset after every transfer failure.

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.

Default setting is "NO".

Sample of oscillographic FAST transfer

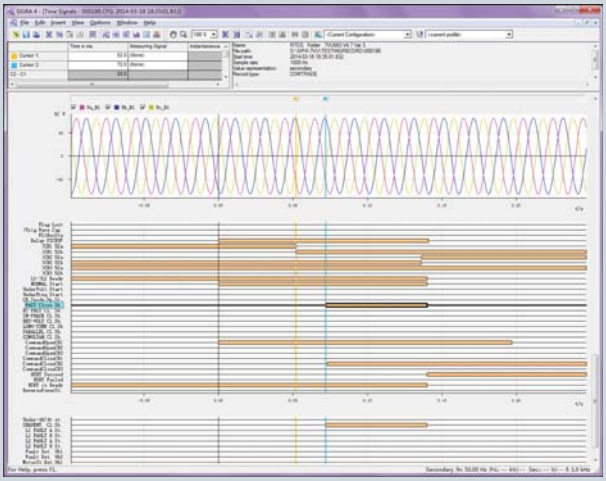

Fig.12 Oscillographic FAST transfer

30406	>NORMAL Open CB1	ON	18.03.2014 18:19:03.288
17644	NORMAL Start	ON	18.03.2014 18:19:03.292
00301	Power System fault	1 - ON	18.03.2014 18:19:03.293
17760	Command: Open CB1	ON	18.03.2014 18:19:03.293
17621	>CB1 52a	OFF	18.03.2014 18:19:03.345
17622	>CB1 52b	ON	18.03.2014 18:19:03.345
30406	>NORMAL Open CB1	OFF	18.03.2014 18:19:03.346
30452	SEQUENTIAL Sequence Cl. Standby Supply	ON	18.03.2014 18:19:03.368
17651	FAST Mode Close Standby Source	ON	18.03.2014 18:19:03.368
17768	Command: Close CB2	ON	18.03.2014 18:19:03.369
17623	>CB2 52a	ON	18.03.2014 18:19:03.432
17624	>CB2 52b	OFF	18.03.2014 18:19:03.432
17871	Line1 -> Line2 Succeeded	ON	18.03.2014 18:19:03.436
17948	HSBT Succeed	ON	18.03.2014 18:19:03.436
17643	Line1 -> Line2 is Ready	OFF	18.03.2014 18:19:03.436
18012	HSBT is Ready	OFF	18.03.2014 18:19:03.436
17644	NORMAL Start	OFF	18.03.2014 18:19:03.436
30452	SEQUENTIAL Sequence Cl. Standby Supply	OFF	18.03.2014 18:19:03.436
17651	FAST Mode Close Standby Source	OFF	18.03.2014 18:19:03.436
00301	Power System fault	1 - OFF	18.03.2014 18:19:03.437
17760	Command: Open CB1	OFF	18.03.2014 18:19:03.492
17768	Command: Close CB2	OFF	18.03.2014 18:19:03.567

Fig.13 Transfer log of FAST mode

Some notes to the two figures,

- Sectionalized single busbar with 3-CB
- CB1 and CB3 in closing status while CB2 in open status
- Manually open CB1, SEQUENTIAL switching sequence, L1->L2
- At instant -4ms, get transfer request ">NORMAL Op. CB1"
- At instant 0ms, HSBT picked up and issued "CommandOpenCB1" 1ms later
- At instant 53ms, CB1 is opened
- At instant 76ms, FAST transfer mode picked up and issued "CommandCloseCB2" 1ms later
- At instant 139ms, CB2 is closed
- HSBT succeeded. Busbar dead time is approx. 86ms.

Protection functions

Protection functions for tie-CB in primary connection of sectionalized single busbar w. 3-CB are integrated in high speed busbar transfer device 7VU683. This function can be set "**Enabled**" or "**Disabled**" during configuration.

Below protection functions are included,

– Phase over-current protection
– Ground over-current protection
– Phase over-current SOF protection
– Ground over-current SOF protection

To secure the reliability and sensitivity, the voltage element is additionally introduced to current criterion to release trip command.

For functions of phase over-current protection and phase over-current protection against switch-onto-fault, compound voltage elements are used. The criterion of compound voltage elements is illustrated in Fig.14,

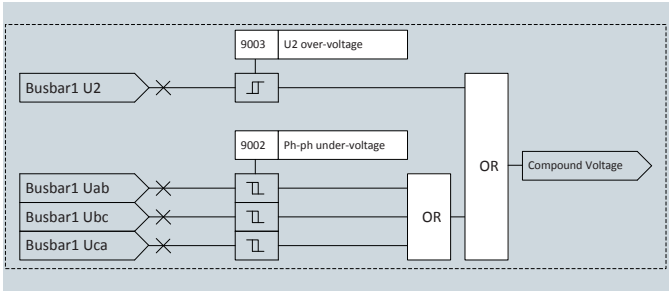

Fig.14 Logic of compound voltage element

For functions of ground over-current protection and ground over-current protection against switch-onto-fault, the element of zero sequence over-voltage is used. The quantity is derived from calculated 3U0 based on measured busbar1 voltage.

The validity of protections against switch-onto-fault can be set under parameter 9019A "*Active time for Switch-onto-fault*".

Each of above functions can be separately switched "*ON*" or "*OFF*" remotely via communication or locally at device panel.

Phase-overcurrent protection

The function is designed to detect short-circuit faults in MV system. The device will evaluate all current inputs at channel I_B and will pickup immediately if one of phase current over-shots the settable threshold.

The function has two stages, one time delay for each stage.

The voltage element can be activated or de-activated under parameter 9001 *"Compound Voltage Control"*.

Ground-overcurrent protection

This function is designed to detect ground fault in MV system. The device will evaluate zero sequence current and will pickup immediately if it over-shots the settable threshold.

The quantity of zero sequence current be derived from calculated 3I0 or measured earth current Ie. This can be set under parameter 9018 "*3I0/Ie Assignment*".

The function has two stages, one time delay for each stage.

The voltage element can be activated or de-activated under parameter 9011 "*3U0 Control*".

Phase-overcurrent protection against switch-onto-fault

To fast clear the short-circuit fault in case of switch-onto-fault, the function phase over-current protection can trip without time delay. But this special consideration should only be applied for short time. A special function "*phase over-current SOF protection*" is specially designed for this utilization.

The function has the same criterion and stages to phase over-current protection. It will only be activated for a settable active time after tie-CB is closed.

Ground-overcurrent protection against switch-onto-fault

To fast clear the ground fault in case of switch-onto-fault, the function ground over-current protection can trip without time delay. But this special consideration should only be applied for short time. A special function "*ground over-current SOF protection*" is specially designed for this utilization.

The function has the same criterion and stages to ground over-current protection. It will only be activated for a settable active time after tie-CB is closed.

Communication

With respect to communication, particular emphasis has been placed on high levels of flexibility, data integrity and utilization of standards common in energy automation. The design of the communication modules permits interchangeability on the one hand, and on the other hand provides openness for future standards (for example, Industrial Ethernet).

Local PC interface

The PC interface from the front of the unit permits quick access to all parameters and fault event data. The use of the DIGSI 4 operating program during commissioning is particularly advantageous.

Rear mounted interface

At the rear of the unit there is one fixed interface and two communication modules which incorporate optional equipment complements and permit retrofitting. They assure the ability to comply with the requirements of different communication interfaces (electrical or optical) and protocols (IEC 60870, PROFIBUS, DIGSI). The interfaces make provision for the following applications:

Service interface (fixed)

In the RS485 version, several protection units can be centrally operated with DIGSI 4. By using a modem, remote control is possible. This provides advantages in fault clearance, in particular in unmanned substations.

System interface

This is used to communicate with a control or protection and control system and supports, depending on the module connected, a variety of communication protocols and interface designs. Furthermore, the units can exchange data through this interface via Ethernet and IEC 61850 protocol and can also be operated by DIGSI.

IEC 61850 protocol

As of mid-2004, the Ethernet-based IEC 61850 protocol is the worldwide standard for protection and control systems used by power supply corporations. Siemens is the first manufacturer to support this standard. By means of this protocol, information can also be exchanged directly between bay units so as to set up simple masterless systems for bay and system interlocking. Access to the units via the Ethernet bus will also be possible with DIGSI.

IEC 60870-5-103

IEC 60870-5-103 is an internationally standardized protocol for communication in the protected area. IEC 60870-5-103 is supported by a number of manufacturers and is used worldwide.

PROFIBUS DP

PROFIBUS is an internationally standardized communication system (EN 50170). PROFIBUS is supported internationally by several hundred manufacturers and has to date been used in more than 1,000,000 applications all over the world. With the PROFIBUS-DP, the device can be directly connected to a SIMATIC S5/S7. The transferred data are fault data, measured values and information from or to the logic (CFC).

Modus RTU

MODBUS is also a widely utilized communication standard and is used in numerous automation solutions.

DNP 3.0

DNP 3.0 (Distributed Network Protocol version 3) is a messaging-based communication protocol. The SIPROTEC 4 units are fully Level 1 and Level 2 compliant with DNP 3.0. DNP 3.0 is supported by a number of protection device manufacturers.

Safe bus architecture

• RS485 bus

With this data transmission via copper conductors, electromagnetic interference influences are largely eliminated by the use of twisted-pair conductor. Upon failure of a unit, the remaining system continues to operate without any faults.

• Fiber-optic double ring circuit

The fiber-optic double ring circuit is immune to electromagnetic interference. Upon failure of a section between two units, the communication system continues to operate without disturbance.

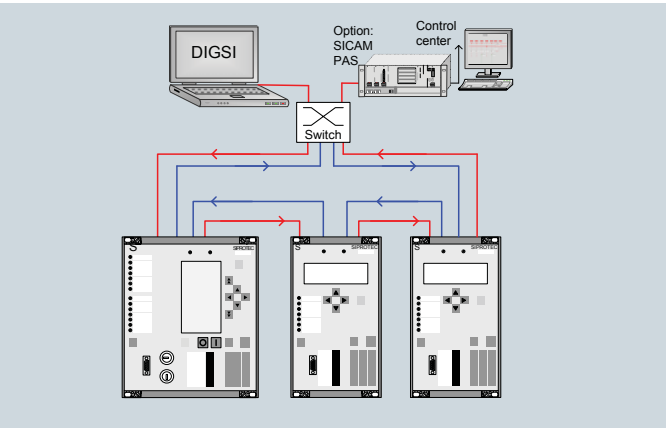

Fig. 15 IEC 60870-5-103: Radial electrical or fiber-optic connection

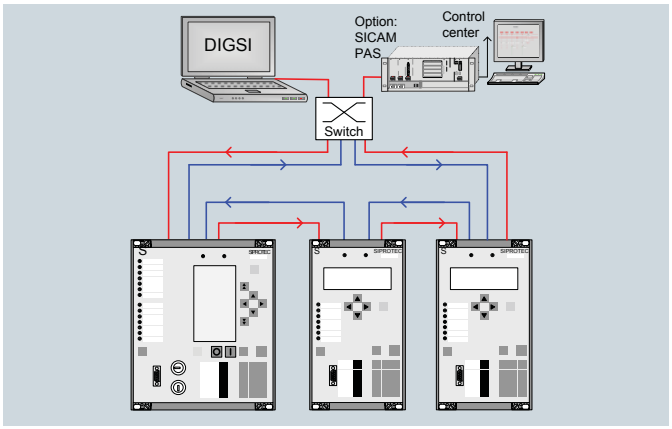

Fig.16 Bus structure for station bus with Ethernet and IEC 61850, fiber-optic ring

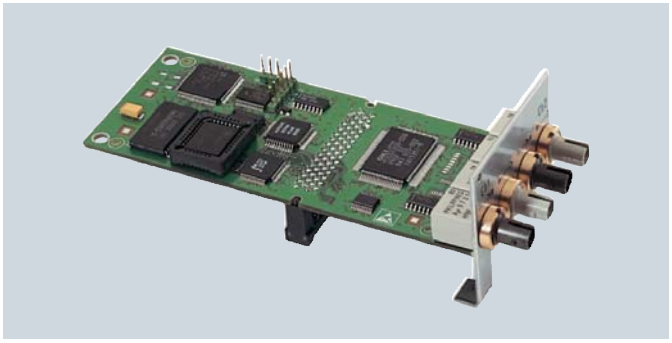

Fig.17 PROFIBUS: Optical double ring cirucuit

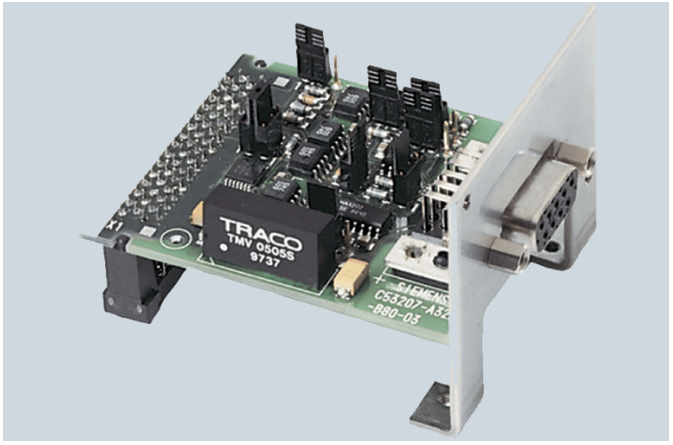

Fig.18 RS232/RS485 electrical communication module

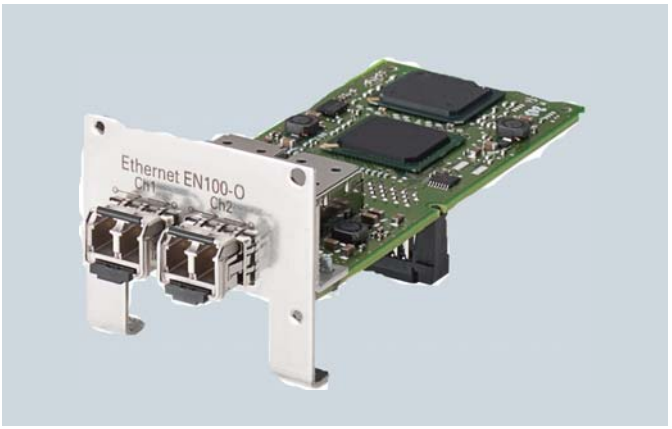

Fig.19 Optical Ethernet communication module for IEC 61850 with integrated Ethernet-switch

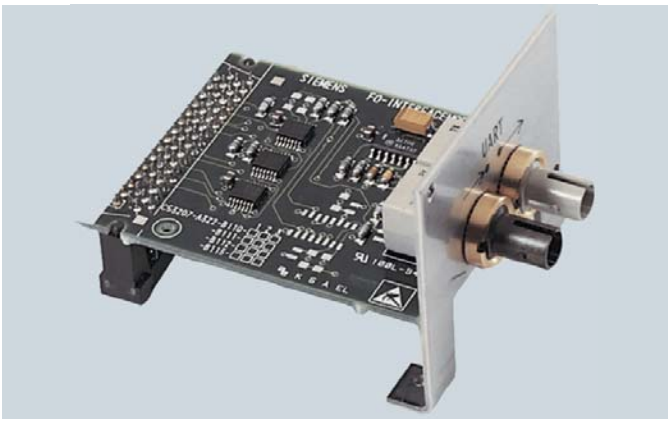

Fig.20 Fiber-optic communication module

System solution

SIPROTEC 4 is tailor-made for use in SIMATIC-based automation systems.

Via the PROFIBUS-DP, indications (pickup and tripping) and all relevant operational measured values are transmitted from the protection unit.

Via modem and service interface, the protection engineer has access to the protection devices at all times. This permits remote maintenance and diagnosis (cyclic testing).

Parallel to this, local communication is possible, for example, during a major inspection.

For IEC 61850, an interoperable system solution is offered with SICAM PAS. Via the 100 Mbit/s Ethernet bus, the unit are linked with PAS electrically or optically to the station PC. The interface is standardized, thus also enabling direct connection of units of other manufacturers to the Ethernet bus. With IEC 61850, however, the units can also be used in other manufacturers' systems.

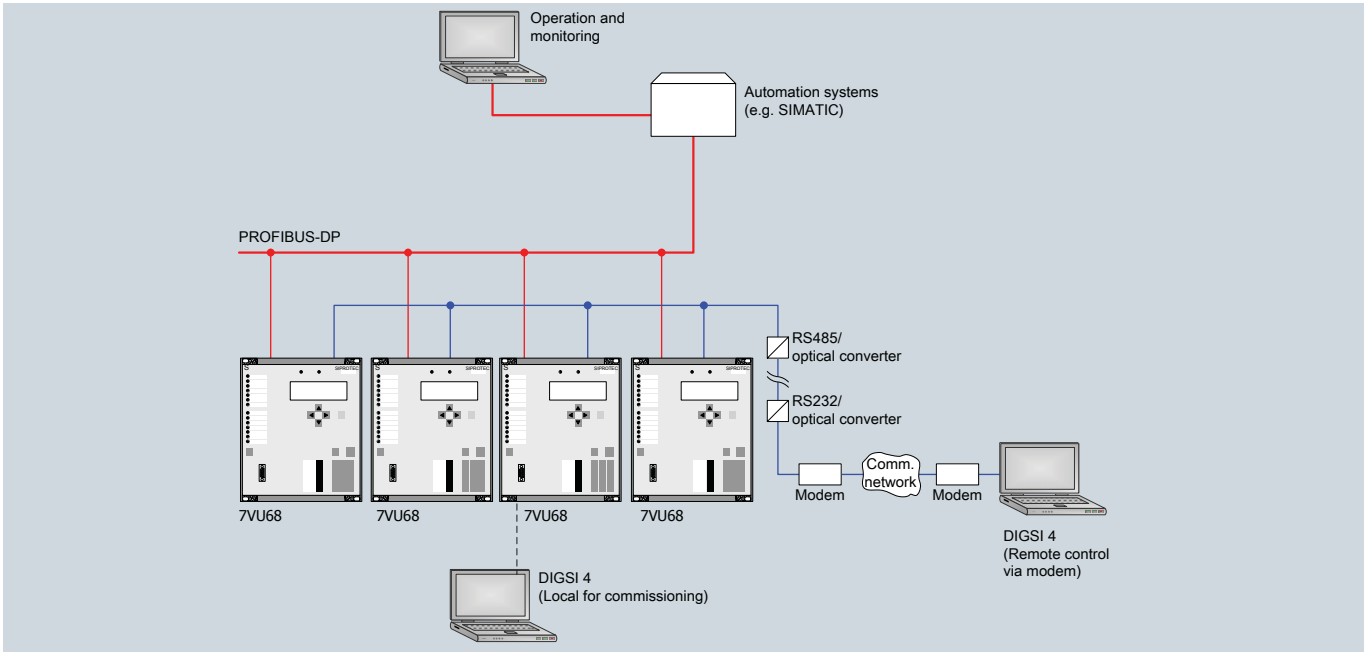

Fig.21 System solution: communication

High Speed Busbar Transfer - Typical applications

Typical applications

Primary connection of single busbar w. 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 starting request command.

Each switching-over can be individually switched *"ON"* or *"OFF"* remotely via communication or locally at device panel.

Single busbar w. 2-CB						
CBS' status			Switching directions			NORMAL start
CB1	CB2					
ON	OFF		LINE1	→	LINE2	Open CB1
OFF	ON		LINE2	→	LINE1	Open CB2

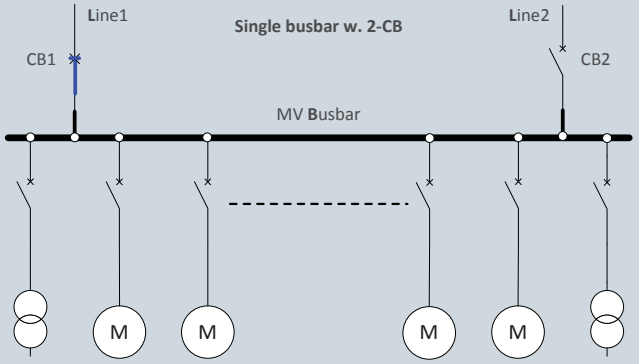

Fig.22 Switching direction and primary diagram

Primary connection of sectionalized single busbar w. 3-CB

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

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

Sectionalized single busbar w. 3-CB						
CBS' status			Switching directions			NORMAL start
CB1	CB2	CB3				
ON	ON	OFF	BUS1	→	BUS2	Open CB1
			BUS2	→	BUS1	Open CB2
ON	OFF	ON	LINE1	→	LINE2	Open CB1
			BUS2	→	LINE2	Open CB3
OFF	ON	ON	LINE2	→	LINE1	Open CB2
			BUS1	→	LINE1	Open CB3

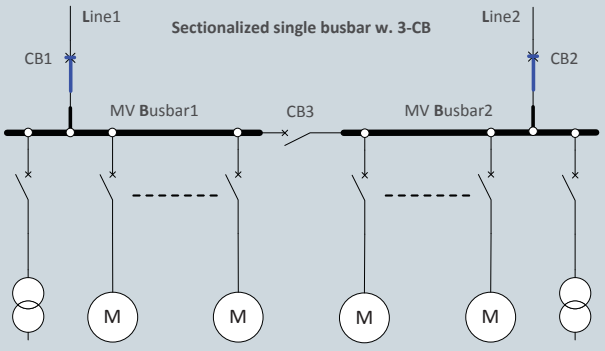

Fig.23 Switching direction and primary diagram

Primary connection of single busbar w. 3-CB

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

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

Single busbar w. 3-CB						
CBS' status			Switching directions			NORMAL start
CB1	CB2	CB3				
ON	OFF	OFF	LINE1	→	LINE2	Open CB1
			LINE1	→	LINE3	Open CB1
OFF	ON	OFF	LINE2	→	LINE3	Open CB2
			LINE2	→	LINE1	Open CB2
OFF	OFF	ON	LINE3	→	LINE1	Open CB3
			LINE3	→	LINE2	Open CB3

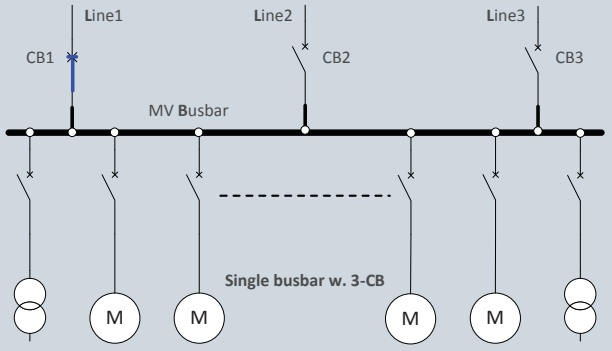

Fig.24 Switching direction and primary diagram

7VU683

High Speed Busbar Transfer – Selection and ordering data

Description	Order No.	Short code
Multifunctional High Speed Busbar Transfer 7VU683 V4.7	**7VU683 □ - □ E □□□ - 1 □ A 0 - □□□**	
Case, binary inputs and outputs		
Case 1/1 19", 17 BI, 18 BO (incl.5 High Speed), 1 life-status contact		
Current transformer: In		
IN=1A[1]	1	
IN=5A[1]	5	
Auxiliary Voltage		
DC 24 to 48 V, binary input threshold DC 19 V[3]	2	
DC 60 to 125 V[2], binary input threshold DC 19 V[3]	4	
DC 110 to 250 V[2], 115/230 V AC, binary input threshold DC 88 V[3]	5	
DC 220 to 250 V[2], 115/230 V AC, binary input threshold DC 176 V[3]	6	
Construction		
Flush-mounting case, screw-type terminals (direct connecting/ ring-type cable lugs)	E	
Region-specific default settings/ language Settings		
Region World,English[4], 50/60Hz	B	
Region China,Chinese[4], 50/60Hz	W	
Port B: (System port on rear of device)		
No system port	0	L 0 □
IEC 60870-5-103 Protocol, electric RS232	1	
IEC 60870-5-103 Protocol, electric RS485	2	
IEC 60870-5-103 Protocol, 820 nm fibre, ST-connector	3	
Profibus DP Slave, RS485	9	A
Profibus DP Slave, 820 nm fibre, double ring, ST-connector	9	B
Modbus, RS485	9	D
Modbus, 820 nm fibre, ST-connector	9	E
DNP 3.0, RS485	9	G
DNP 3.0, 820 nm fibre, ST-connector	9	H
IEC 60870-5-103 Protocol, redundant RS485	9	P
IEC 61850, 100 Mbit Ethernet, electric, double, RJ45-connector	9	R
IEC 61850, 100 Mbit Ethernet, with integrated switch optical, double, LC-connector	9	S
Only Port C		
DIGSI 4/Modem, electric RS232;	1	
DIGSI 4/Modem/ RTD-box, electric RS485;	2	
Measuring/ fault recording		
Basic measured values	1	
Functions		
HSBT function (single busbar w. 2-CB), ANSI C50.41-2012 Supervision functions	B	
HSBT function (sectionalized single busbar w. 3-CB), ANSI C50.41-2012 Protection functions (Phase/earth O/C prot., Phase/earth O/C prot. against switch-onto-fault) Supervision functions	C	
HSBT function (single busbar w. 3-CB), ANSI C50.41-2012 Supervision functions	D	

1) Rated current 1/5 A can be selected by means of jumpers

2) Transition between the three auxiliary voltage can be selected by mean of jumpers

3) The threshold of each binary input can be set via jumpers

4) Device language can be selected via DIGSI.

Description	Order No.
DIGSI 4 Software for configuration and operation of Siemens protection units running underMSWindows 2000/XP Professional Edition device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper) Basis Full version with license for 10 computers, on CD-ROM (authorization by serial number)	7XS5400-0AA00
Professional Professional DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)	7XS5402-0AA00
Professional + IEC 61850 Complete version DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation) + IEC 61850 system configurator	7XS5403-0AA00
IEC 61850 Systemconfigurator Software for configuration of stations with IEC 61850 communication under DIGSI, running underMSWindows 2000 or XP Professional Edition Optional package for DIGSI 4 Basis or Professional License for 10 PCs. Authorization by serial number. On CD-ROM	7XS5460-0AA00
SIGRA 4 (generally contained in DIGSI Professional, but can be ordered additionally) Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running underMSWindows 95/98/ME/NT/2000/XP Professional. Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM	7XS5410-0AA00
Connecting cable able between PC/notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	7XV5100-4

High Speed Busbar Transfer - Accessories

Description		Order No.		Size of package	Supplier	Fig.
Mounting rail		C73165-A63-D200-1		1	Siemens	29
Short-circuit link	For current terminals	C73334-A1-C34-1		1	Siemens	30
	For other terminals	C73334-A1-C34-1		1	Siemens	31
Safety cover for terminals	Large	C73334-A1-C31-1		1	Siemens	
	Small	C73334-A1-C32-1		1	Siemens	

1) Your local Siemens representative can inform you on local suppliers.

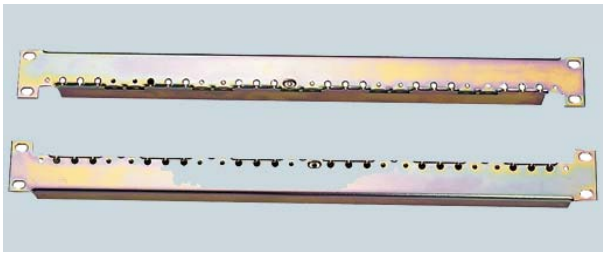

Fig.25 Mounting rail for 19" rack

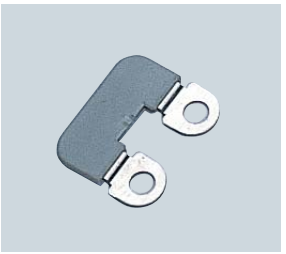

Fig.26 Short-circuit link for current terminals

Fig.27 Short-circuit link for voltage terminals/indications terminals

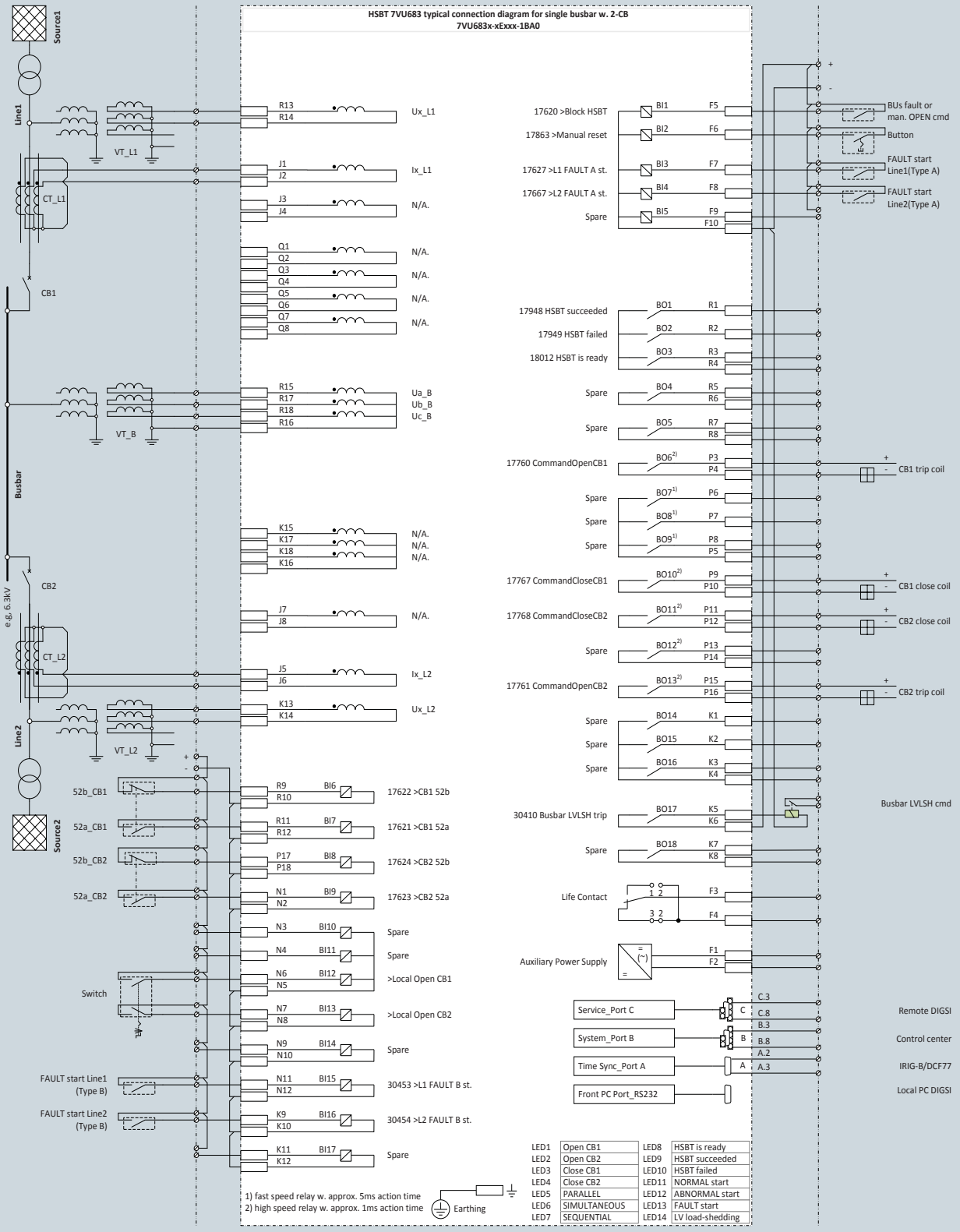

Fig.28 7VU683*-*E***-1BA0 typical connection and default configuration

High Speed Busbar Transfer - Connection diagram

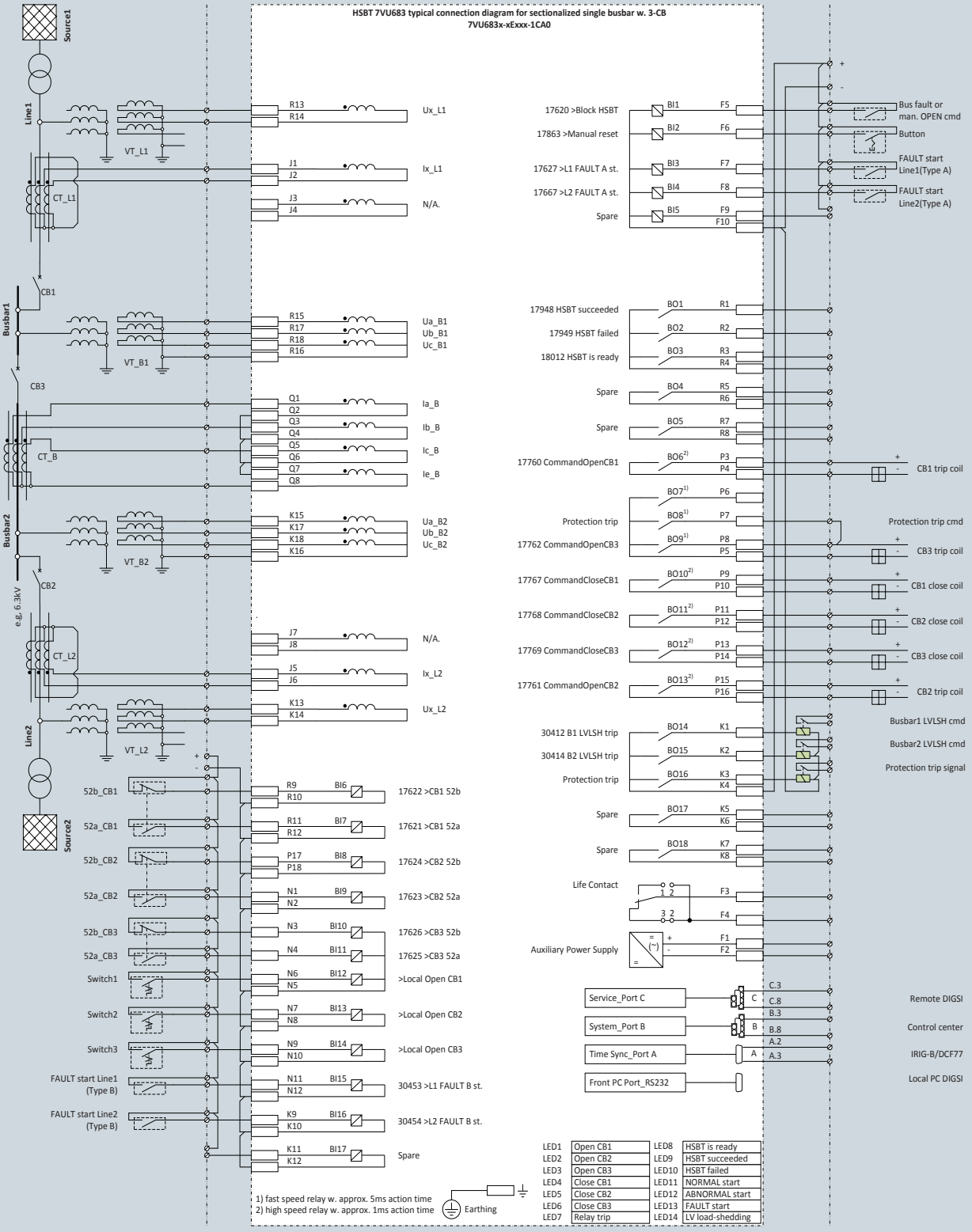

Fig.29 7VU683*-*E***-1BC0 typical connection and default configuration

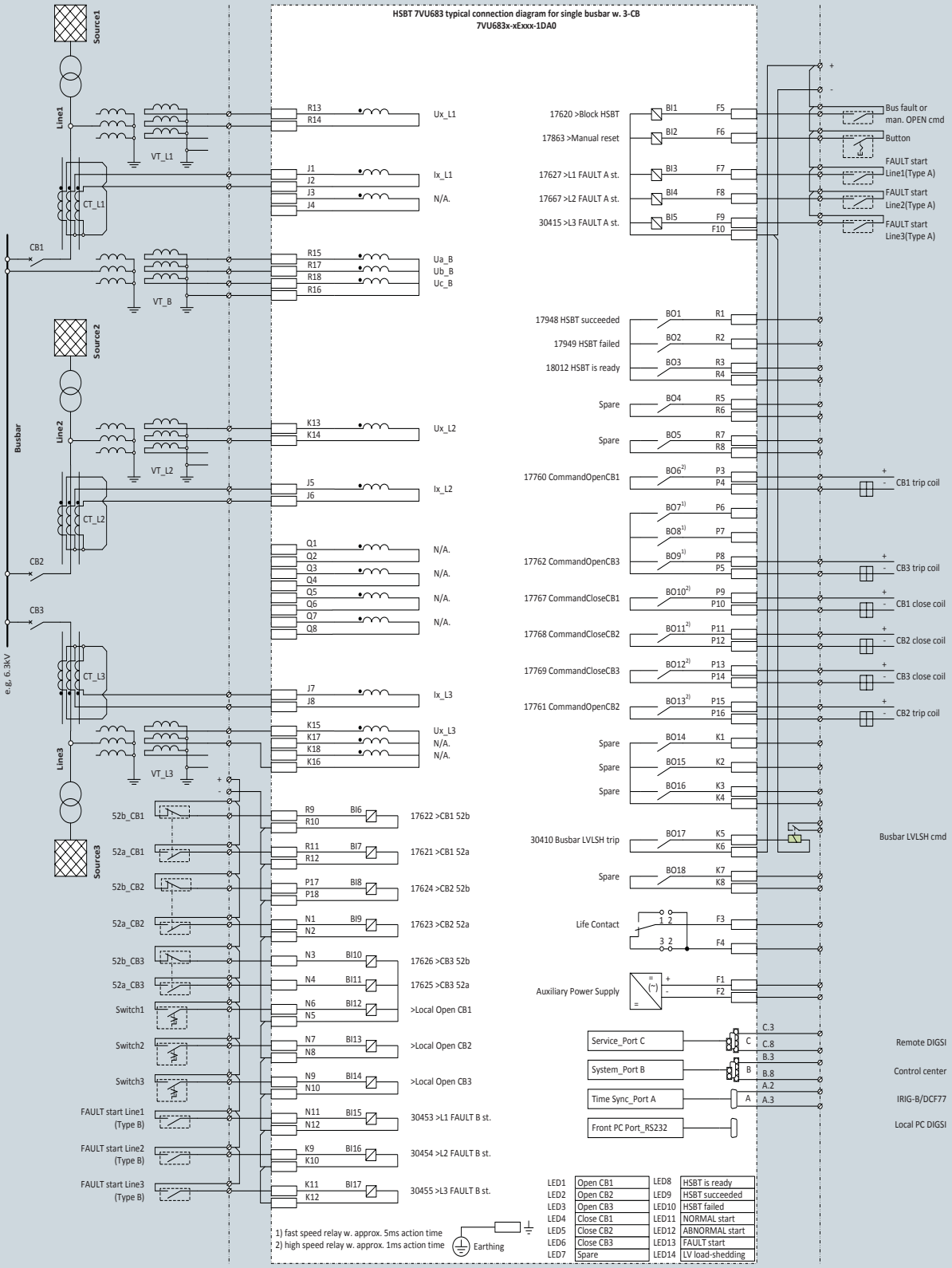

Fig.30 7VU683*-*E***-1DA0 typical connection and default configuration

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