

SUE 3000

High Speed Transfer Device

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1 General

Voltage decreases or complete supply interruptions represent the most important and critical problems for the quality of energy supply today. It is especially true that voltage disturbances with electronic control systems and other sensitive installations can lead to complete loss of production and long stoppage time.

The SUE 3000 High Speed Transfer Device guarantees an optimum safeguarding of energy supply. The device ensures the continued supply to the consumer through automatic transferring to a stand-by feeder and protects the subsidiary process from expensive stoppage time. Furthermore, through the possibility of manually-initiated transfers – for targeted clearings, for example – the operation of the installation is considerably simplified.

As a long-established supplier of High Speed Transfer Devices, with more than 2100 systems and devices already supplied world-wide, ABB can rely on a unique know-how in this area of specialization.

The SUE 3000 High Speed Transfer Device can be implemented everywhere where a disturbance of the electrical supply would lead to a breakdown in production, which would lead as a result to costs.

Possible areas of utilization include, for example:

Auxiliary installations serving power stations, as for example

- Steam power stations
- Gas turbine power stations
- Combined cycle power stations
- Nuclear power stations

Environmental technology installations

- Flue gas purification
- Refuse incineration installations

Voltage supply to continuous industrial processes

- Chemical plants
- Industrial facilities with high degrees of automation
- Fiber manufacturing
- Petrochemical processes

In order to realize a permanent availability, the load is supplied from at least two synchronized feeders which are independent from one another and which are equipped with High Speed Transfer Devices.

When switching in the grid is influencing the typically independent synchronous supply voltages an additional supporting function (see chapter 5.5) may properly execute the transfer.

In doing so, the High Speed Transfer Device has the task of ensuring uninterrupted continuous operation of the connected devices in case of a power supply breakdown, taking into account different physical factors, through the most rapid possible transfer to a different feeder kept stand-by.

Corresponding to its multifaceted areas of application, the SUE 3000 is set up for different switchgear arrangements:

1.1 Switchgear configuration with two circuit-breakers (Variant 1)

This arrangement is often used in auxiliary installations serving thermal power stations. One of the two power supplies normally feeds the busbar. One of the two is switched on, the other is switched off. A coupled operation of both power supplies is not intended, and due to reasons of rating (short circuit withstand), it is often also not permissible.

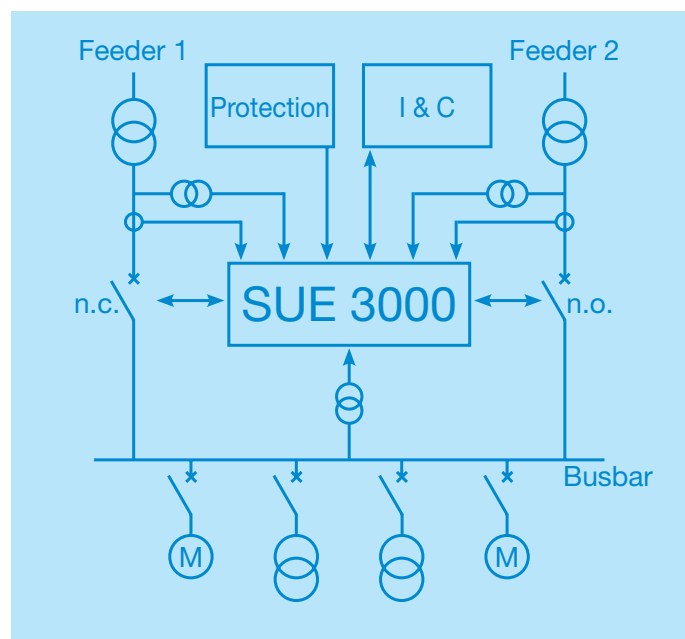


Figure 1-1 Busbar with two feeders – Variant 1

If an error leads to a disturbance of the feeder currently in operation, the transfer device switches the load over to the second feeder in the shortest possible time. Following successful transfer, the busbar is then supplied further by the second feeder. Once the main feeder is again in operation, a manually initiated transfer back can take place and the normal status can be restored once again. The High Speed Transfer Device SUE 3000 is designed completely symmetrical, so that a protection-initiated transfer can be executed from either of the feeders, in case for example two feeders with equal status are present.

1.2 Switchgear configuration with two incoming feeders and one busbar sectionalizer (Variant 2)

With this configuration, the load is divided between two busbar sections due to reasons of redundancy. The coupling circuit-breaker usually remains open. Both feeders are in operation. In case of a disturbance of one feeder a transfer from the circuit-breaker of the disturbed feeder to the coupling circuit-breaker follows: The previously feeding circuit breaker is opened and the bus coupler is closed.

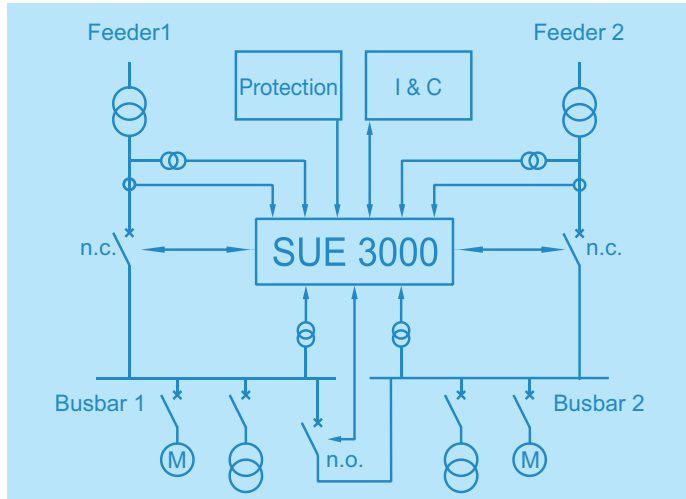


Figure 1-2 Switchgear configuration with two incoming feeders and one busbar sectionalizer – Variant 2 and 4

After that, both busbar sections are supplied by one feeder. Once the disturbed feeder is again available, a manually-initiated transfer back can be executed in order to restore normal status once again.

1.3 Switchgear configuration with three incoming feeders and selection function (Two out of three) (Variant 3)

This configuration is utilized, if more than two incomers feeding a busbar and a two out of three selection is required. Transfer will take place only between the two pre-selected feeders.

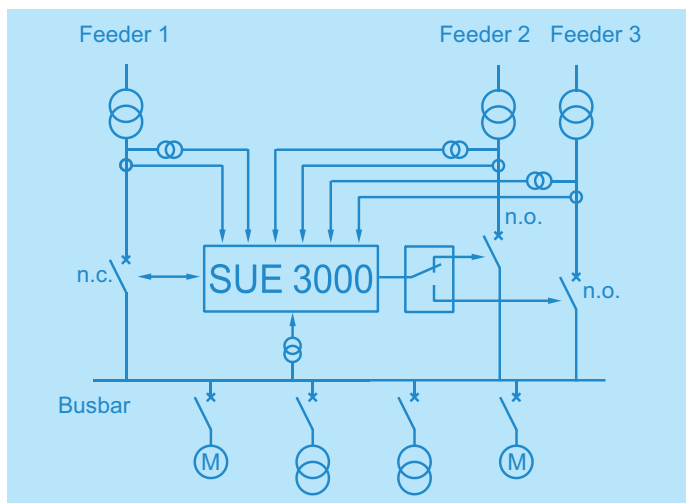


Figure 1-3 Busbar with three feeders and a two out of three pre-selection – Variant 3

All necessary input signals (e.g. control circuits, position indication, feeder voltages) are connected to the SUE 3000 transfer controller in a fixed way. So this solution reaches the same reliability as two or three-breaker solution. The pre-selection logic can be combined with additional logical conditions in order to provide semi-automated or fully-automated selection of the transfer direction.

1.4 Switchgear configuration with two incoming feeders and one busbar sectionalizer (Variant 4)

Variant 4 is a further development of Variant 2. In this configuration, the load can also be split between two busbar sections for reasons of redundancy. If the sectionalizer circuit-breaker is open, infeed is via the two incoming feeder panels. On disturbance to one incoming feeder, switchover from the circuit-breaker in the faulty feeder panel to the sectionalizer breaker takes place: The previously closed circuit-breaker in the faulty incoming feeder is opened, and the busbar sectionalizer closed.

Then, both busbar sections are supplied by one incoming feeder. When the faulty feeder is once again available, manual switchback can be initiated to restore the normal operating condition.

If only one incoming feeder is to supply the complete busbar, the busbar sectionalizer must be closed. Variant 4 (see figure 1-2) performs a transfer switching operation between the two incoming feeders when a fault occurs in the feeder with closed breaker. The busbar is then supplied by the other incoming feeder. When the faulty feeder is once again available, switchback can be initiated to restore the desired normal operation.

1.5 Switchgear configuration with three incoming feeders and a selection function (Variant 5)

Variant 5 is a further development of Variant 3.

This configuration is used when three incoming feeders are available. Transfer switching can be performed in this configuration between any two incoming feeders.

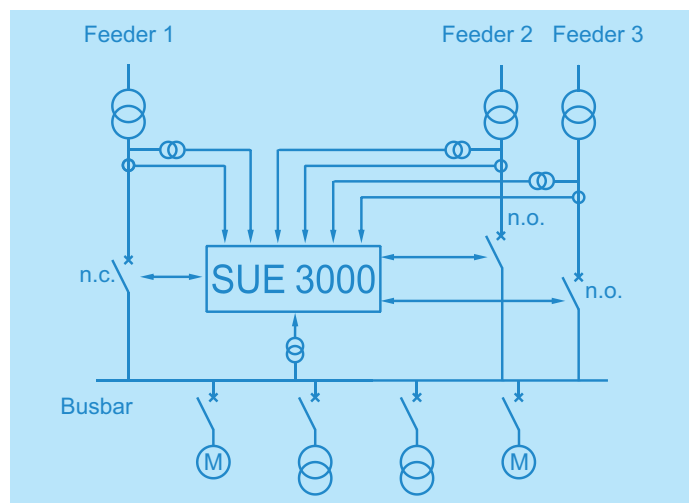


Figure 1-4 Switchgear configuration with three incoming feeders and a selection function – Variant 5

All the necessary input signals (e.g. control circuits, position signals and feeder voltages) are hard wired to the high speed transfer device. This configuration thus achieves optimum availability.

The selection logic can additionally be linked with further logical conditions, for example to facilitate semi-automatic or fully automatic selection of incoming feeders.

1.6 Prerequisites for the optimum utilization of the SUE 3000

In order to ensure optimal utilization of the SUE 3000, the following prerequisites should be fulfilled:

- Existence of at least two synchronous feeders, which are independent of one another during normal operation
- Circuit-breaker with short operating time
- Switchgear assembly/load suitable for network transfers
- Fast protective relays for initiation of the High Speed Transfer Device
- Rotating loads stabilize the bus bar voltage in case of a fault

In case of disturbance leading to the breakdown of the distribution voltage, an interruption is avoided through the automatic intervention of the High Speed Transfer Device.

Transfers can continue to be manually triggered, depending on operation.

The enhancement of the installation availability leads to considerable cost savings and to a short-term amortization of the investment:

Even just one single successful transfer, which ensures the continued operation of an installation, prevents stoppage time and saves on expensive re initialization processes, can mean a complete amortization of the investment costs for the High Speed Transfer Device.

2 Integration

The SUE 3000 High Speed Transfer Device can be connected without difficulty to switchgear which are being newly installed as well as to ones which already exist. All of the usual voltage levels are supported.

2.1 Interfaces

Interfaces exist mainly with the following components (Figure 1-1 to Figure 1-4)

Switchgear (circuit-breakers, voltage transformers, measuring transducers (optional protective current transformers), overcurrent relays, etc.)

Protection (protection for unit, transformer, differential, cable, overcurrent, undercurrent, etc.)

Control room or system (remote control, signaling)

Auxiliary voltage supply (DC feeder)

2.2 Initiation of the SUE 3000

Something which continues to be significant for the optimum fulfillment of all requirements of the High Speed Transfer Device is the rapid, direct and non- delayed initiation.

This is usually ensured by the connection to the appropriate rapid protective relays. The protective triggering which switches the feeder switch off (and thus interrupts the supply to the busbar) is used in parallel fashion as initiation signal for the transfer.

Control inputs and signals for complete remote control and remote signaling continue to be available.

3 Design

The SUE 3000 is based on a real-time microprocessor system. The measurement and analog signal processing functions are executed by a Digital Signal Processor (DSP), while a Micro Controller (MC) is executing the logical processing and communication with binary input and output device. The Communication Processor (CP) is needed for connection to a station automation system. A block diagram of the SUE 3000 is shown in Figure 3-1.

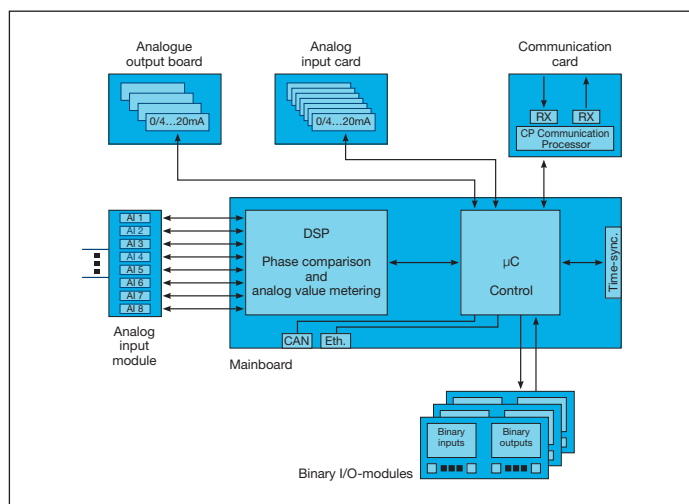


Figure 3-1 SUE 3000 block diagram (Central unit)

The feeder voltages, the voltage(s) of the busbar(s) as well as the currents of the feeders are connected as measurands. Transformers which perform an internal adjustment to the required extra-low voltages are integrated in the controller accordingly.

The individual components are conceived for connection to medium- and high-voltage switchgear and fulfill all the relevant requirements in this area of utilization.



Figure 3-2 SUE 3000 (Central Unit and HMI)

SUE 3000, as shown in Figure 3-2, consists of two parts, a Central Unit and a separate Human Machine Interface (HMI). The Central Unit contains the power supply, processor and analog and binary Input and Output (I/O) modules, as well as optional modules for supplementary functions.

The HMI Control Unit is a stand-alone unit with its own power supply. It can be installed on the Low Voltage (LV) compartment door or in a dedicated compartment close to the Central Unit. The HMI is normally used to set the parameters of the device and to operate it locally. The HMI is connected to the Central Unit by a shielded, isolated twisted pair according to the RS 485 interface.

Figure 3-3 shows an installation of a SUE 3000 in a steel sheet cubicle.

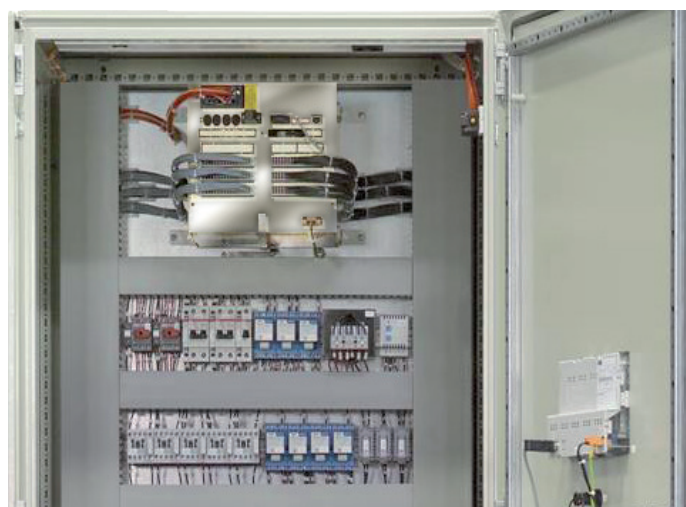


Figure 3-3 High Speed Transfer Device SUE 3000, mounted in a steel sheet cubicle

The HMI Control Unit features a back-illuminated Liquid Crystal Display (LCD), four status LEDs, seven push buttons, eight (virtual 32) signal LEDs, 3 LED bars for indication of analogue values and an electronic key interface.

The language of the display can be selected via the related configuration software tool, which is also used to define the functional scheme of the High Speed Transfer Device.

The left half of the LCD display is reserved for the Single Line diagram. The right half is used to display either measured or calculated analogue values or the appropriate menu or sub-menu as determined by the user. Two different electronic keys with different access rights are available.

Two fixed and one freely programmable LED bars are provided on the front of the HMI Control Unit. Each LED bar consists of ten green and two red LEDs. The third bar is user configurable to display any required analogue value. The red LEDs are used to indicate values above the rated value.

The functions of the SUE 3000 can be tailored to the system requirements via a user-specific configuration. The user-specific configuration is loaded during commissioning. For that purpose the configuration computer, normally a personal computer running Microsoft Windows XP® or Windows 7, is connected to the optical interface on the front side of the HMI Control Unit.

The interface of the SUE 3000 to the primary process is as follows:

Analog inputs to measure current and voltage signals from instrument transformers or non conventional sensors

Binary inputs with optical couplers for the galvanic separation of the external signals to be processed

Binary outputs with conventional mechanical relays or static outputs for the control of switching devices

Optional six channel analog inputs
0 ... 20 mA or 4 ... 20 mA

Optional four channel analog outputs
0 ... 20 mA or 4 ... 20 mA

Optional connection to ABB or third party station automation system

4 Functions

SUE 3000 High speed transfer device integrates all the required functions in a single unit. This multifunctional unit also features a permanent self-monitoring function. All functions are designed as freely configurable software modules. Therefore, a wide range of operation requirements can be met without any problems. The versatility of the software makes it possible to use the SUE 3000 in nearly every switchboard independent on the specific application required.

4.1 Mode of operation

A significant task of the SUE 3000 is to ensure that when there is an initiation, a minimum short transfer time is achieved, the transient effects of which represent no danger to the connected users during the transfer.

For this purpose, the SUE 3000 is equipped with a fast processing logic as well as a high-precision analogue signal processing.

The device compares, on a permanent basis, the voltage of the busbar with the voltage of the stand-by feeder. The following synchronicity criteria are generated from out of the monitoring of the voltage amplitudes as well as the difference of the frequency and of the phase angle:

$\varphi < \varphi_{\text{Max}}$ **Phase angle**

The phase angle is determined between the voltage of the busbar and that of the stand-by feeder. The limit values for building the synchronicity criteria can be adjusted individually for leading and lagging busbars. A typical setting value is $\pm 20^\circ$.

$\Delta f < \Delta f_{\text{Max}}$ **Frequency difference**

The system determines the frequency difference between busbar voltage and the voltage of the stand-by feeder. In view of the transfer process, the frequency difference provided permits indications of the running down behavior of the connected consumers (e.g. of medium-voltage motors) as well as their dynamic loads. The usual factory setting is 1 Hz.

$U_{\text{Stand-by}} > U_{\text{Min1}}$ **Stand-by feeder voltage**

The monitoring of the voltage level of the stand-by feeder is an important criterion relevant the transfer: The SUE 3000 is only then ready for transfer when an intact stand-by feeder is available.

U_{Min1} is set at the factory to 80 % U_{Nominal}

$U_{\text{Busbar}} > U_{\text{Min2}}$ **Busbar voltage**

The value of the busbar voltage plays an important role in the selection of the transfer mode: In case the busbar lies below a preset value (U_{Min2} - usually set to 70 % U_{Nominal}), no fast transfer is carried out.

4.2 Permanent determination of the network conditions

An exceptionally important characteristic of the SUE 3000 High Speed Transfer Device is that the synchronicity criteria named are continuously available, e.g. that they are computed on-line by the SUE 3000.

For that reason, in case of an initiation, the transfer mode which comes under consideration is already determined and can be immediately initiated. This means that the probability of a fast transfer is considerably enhanced. Systems which wait for the instant of initiation to initiate the determination of the network status have no opportunity, when one considers the physical givens, to perform a fast transfer with minimum interruption time.

This fact clearly distinguishes the High Speed Transfer Device SUE 3000 from competing concepts.

The High Speed Transfer Device is ready for operation only when both circuit breakers to be actuated are definitely to be found in different switching statuses (plausibility monitoring) and also in operating position.

5 Transfer modes

Decisive for the kind of transfer carried out are the network relationships in the instant of initiation of the High Speed Transfer Device. Here the corresponding optimum transfer mode is selected, taking the physical interrelationships into consideration.

Four different transfer modes are available in detail:

Fast transfer:

- Simultaneous control of both involved circuit-breakers (fastest mode)
- Sequential control of both involved circuit-breakers (make before break)

Transfer at the 1st phase coincidence

Residual voltage transfer

Time-operated transfer

Both fast transfer modes are the optimum transfer modes for ensuring in case of fault that only a minimum interruption of the voltage supply occurs. Should it be that the network status does not permit one of these modes, less rapid transfer modes are selected.

Figure 5-1 shows the typical decay characteristics (voltage and frequency) of a disconnected busbar and the possible closing moments.

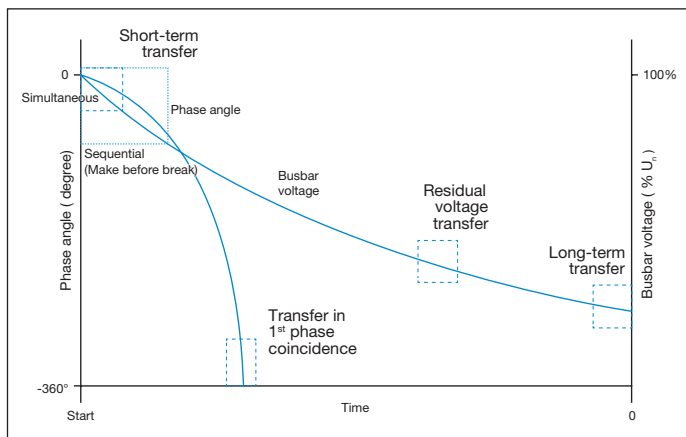


Figure 5-1 Transfer mode overview

The transfer modes are explained in brief below:

5.1 Fast transfer

The execution of fast transfers is the most preferred and most important functional principle of the SUE 3000.

A fast transfer takes place when the both the main and the stand-by feeder are within specified limit values at the moment of initiation, e.g. that slip and phase angle are limited between the networks and the stand-by voltage lies above a minimum value.

Here the open and close commands to the circuit-breaker from the High Speed Transfer Device are issued either simultaneous or sequential.

The current-free transfer time occurring in the first case for the users is exclusively dependent upon the difference between the operating time for closing and opening the circuit breakers concerned. These usually fall within the range of a few milliseconds with modern circuit-breakers, therefore one can assume an uninterrupted further operation of the installation.

Figure 5-2 shows an exemplary oscillogram of a fast simultaneous transfer with a current free transfer time (dead time) of approximately 20 ms.

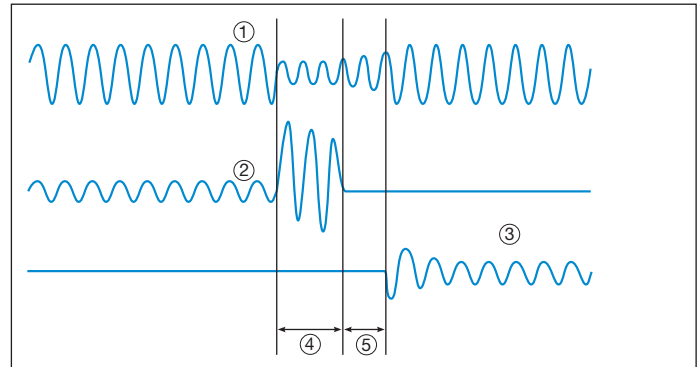


Figure 5-2 Oscillogram of a fast simultaneous transfer
 1. Voltage of the busbar
 2. Main feeder current
 3. Stand-by feeder current
 4. Total CB open time (Fault entry until CB open)
 5. Dead time without current flow (simultaneous)

In the sequential transfer mode the High Speed Transfer Device waits for the OPEN position indication of the infeeding circuit-breaker before issuing the close command to the circuit breaker of the standby feeder. SUE 3000 is constantly supervising the network environment to ensure the possibility of a fast transfer under the given conditions.

The dead time without current flow in the sequential transfer mode is strikingly longer. This results from the addition of both circuit breaker operating times plus an internal calculation time. The internal calculation is of utmost importance to ensure that the required network conditions are valid before issuing the close command.

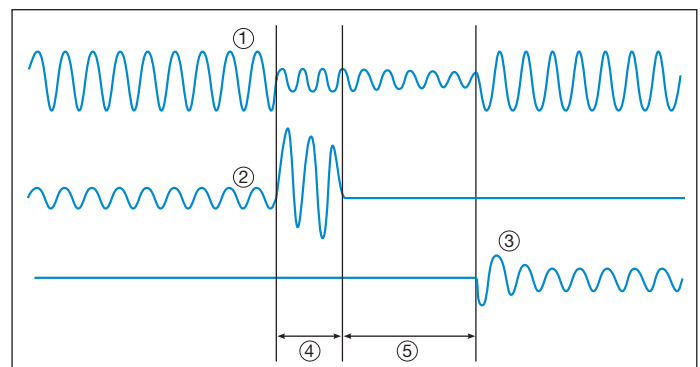


Figure 5-3 Oscillogram of a sequential fast transfer
 1. Voltage of the busbar
 2. Main feeder current
 3. Stand-by feeder current
 4. Total CB open time (Fault entry until CB open)
 5. Dead time without current flow (sequential)

5.2 Transfer at the 1st phase coincidence

The transfer at the 1st phase coincidence is executed when there are no synchronized conditions present at the moment of initiation, so that no fast transfer can be carried out, due to physical reasons.

First, the previous feeder will be opened without delay. Afterwards, the connected users are without power supply and run down in accordance with their specific characteristic curves.

For the connection of the stand-by feeder, a variety of points in time are possible at which an adherence to physical limit values is ensured.

For the transfer at the 1st phase coincidence, the open command is issued immediately and the connection of the stand-by network takes place in the first minimum of the difference of stand-by and busbar voltage ($U_{\text{Stand-by}} - U_{\text{Busbar}}$).

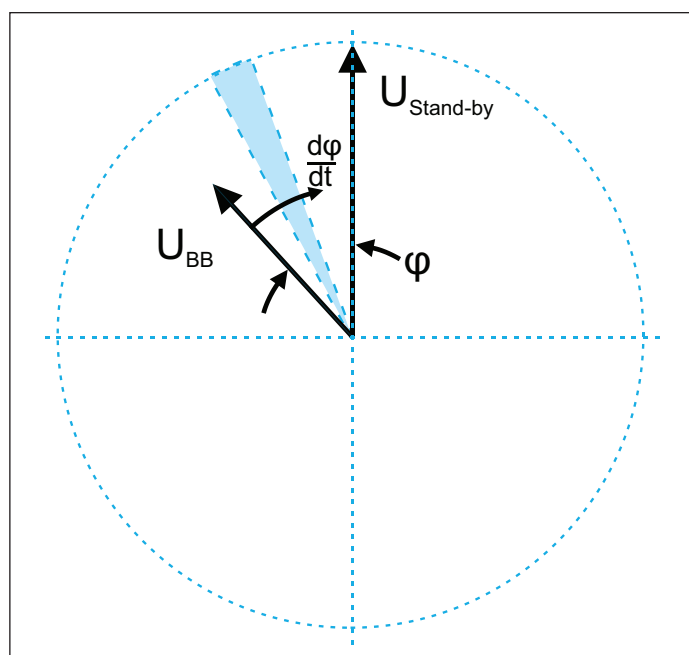



Figure 5-3 Vector diagram of a transfer at the 1st phase coincidence

-  Connection window (dependent upon breaker closing time and $d\phi/dt$)
- $U_{\text{Stand-by}}$ Stand-by feeder voltage
- U_{Busbar} Busbar voltage
- ϕ Angel between $U_{\text{Stand-by}}$ and U_{Busbar}
- $d\phi/dt$ Angle speed between $U_{\text{Stand-by}}$ and U_{Busbar} (resulting from Δf)

The High Speed Transfer Device determines the course of the difference voltage and the point in time of the 1st phase coincidence through anticipatory computation. In order to compensate for the installation-specific processing time (system response time, circuit breaker operating time), the close command is issued accordingly before the actual first minimum of the difference voltage occurs within a previously-defined connection window.

The conditions prevailing with a transfer at the 1st phase coincidence are presented in the vector diagram (Figure 5-3). The busbar voltage vector in the first minimum of the difference voltage has moved around against the fixed stand-by voltage and the angle has become zero.

The difference voltage resulting at the moment of transfer is thereby exclusively determined by the residual voltage value of the busbar. The synchronized connection makes possible a transfer time which is exceptionally protective of the process while still being at the same time of minimum duration.

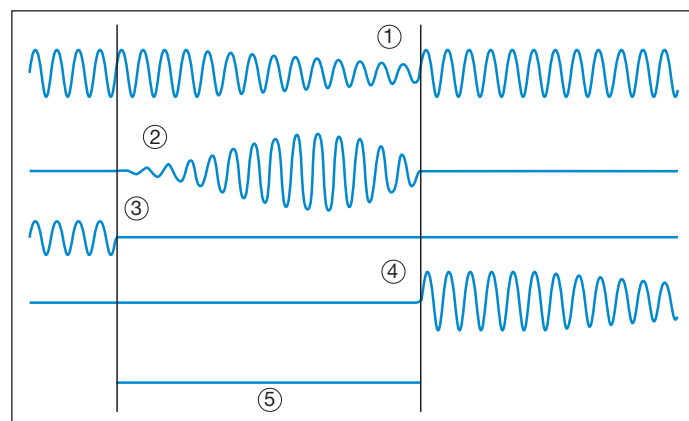


Figure 5-4 Oscillogram of a transfer at the 1st phase coincidence

1. Voltage of the busbar
2. Difference voltage between stand-by and busbar voltage
3. Main feeder current
4. Stand-by feeder current
5. Transfer duration

For a transfer at the 1st phase coincidence, project-specific details (such as, for example, circuit-breaker operating time, user characteristics, permissible frequency difference, connection window) must be clarified on a case-by-case basis. For this reason, the application of this functionality requires very careful engineering and a competent commissioning procedure.

5.3 Residual voltage transfer

The residual voltage transfer is utilized when a connection in the 1st phase coincidence is not possible. The conditions at the instant of initiation and the opening of the previously feeding circuit breaker are the same as with the transfer at the 1st phase coincidence. It is solely the connection of the stand-by feeder which distinguishes itself clearly from the transfer at the 1st phase coincidence.

The connection of the stand-by feeder takes place when the voltage of the busbar has subsided to a preset, permissible value.

The connection takes place without assessment of the angle or of the difference frequency, thus in unsynchronized fashion. Because the voltage of the busbars has however reached a sufficiently low residual voltage value, the transient effects of the connection are manageable (momentary jolt, current needed for users to run up again, voltage reduction).

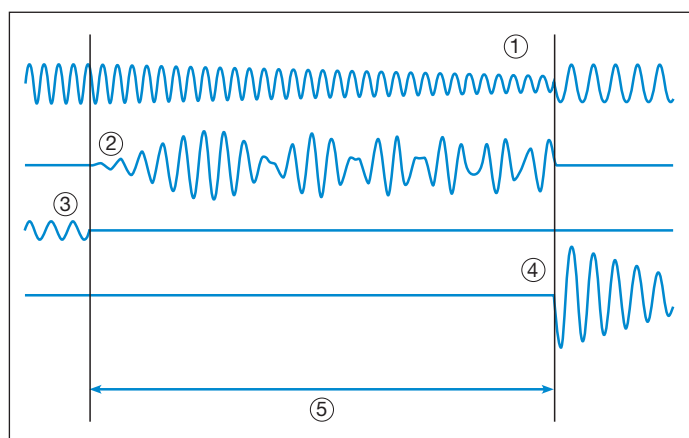


Figure 5-5 Oscillogram of a residual voltage transfer in phase opposition

1. Voltage of the busbar
2. Difference voltage between stand-by and busbar voltage
3. Main feeder current
4. Stand-by feeder current
5. Transfer duration

5.4 Time-operated transfer

A time-operated transfer takes place when no other switching event could be determined before a preset time ran out during a transfer (one which did not take place on a fast basis).

This case is not expected to occur when the High Speed Transfer Device finds itself within normal operating parameters, and it normally can occur only when there is near-simultaneous arrival of several disturbances.

For this reason, the time-operated transfer can be considered simply as a safety stage.

5.5 Supporting special functions

5.5.1 Decoupling

Fast transfers are performed in typically synchronous networks as a general rule. Their principal of simultaneous commands results in short transfer times with nearly uninterrupted power supply of the transferred process. In case of a mechanical failure of the opening circuit breaker a short term coupling of the (synchronous) feeders occur. This is detected by the SUE 3000 and autonomously reversed to avoid an unauthorized coupling of the networks.

5.5.2 Circuit-breaker tripped transfer

This configurable function of SUE 3000 allows the monitoring of the circuit breaker position. In the case of an incoming feeder opening without a reason (e.g. Opening via mechanical interface of circuit breaker, opening via HMI) the SUE 3000 will perform a transfer if configured and READY conditions are valid.

5.5.3 Transfer mode for nonindependent networks for variant 1)

Changing network conditions create faults more often which will affect both feeders. This could result into an unready standby feeder which won't allow a transfer. The new transfer mode for nonindependent networks uses a programmed time frame in which the standby feeder has to indicate READY condition to perform the transfer if still possible.

5.6 Summary

A very important characteristic of the SUE 3000 High Speed Transfer Device is that the selection of the transfer mode carried out takes place dynamically in connection with the respective current network relationships.

If one starts from the premise of networks which are usually synchronized, then fast transfers will be carried out as a general rule.

If the networks are not synchronized at the point of time of the initiation, then no fast transfer takes place. The current-free interlude time that then arise are different, depending on the installation involved, whereby the load to be switched over determines the run-down behavior of the busbar voltage and with it the transfer duration.

The various transfer types can be selectively activated or deactivated, in a way dependent on the orientation. Thus it is ensured that, in accordance with the special requirements, the optimum transfer concept can be released for the overall installation.

6 Configuration

The SUE 3000 has at its disposal comprehensive project planning and parameterization options for ensuring an optimum accommodation of assembly- specific situational details.

Each application can easily be configured by software function modules, which make arbitrary definition of the following features possible:

LED's (meaning and colors) for local indication

Single Line diagram to show the status of switching devices cooperated

Control schemes

Automation sequences

All functions of the transfer device can be specified in collaboration with ABB. The result of the configuration is saved and delivered together with the High Speed Transfer Device to the users.

Additional locking, releases or blocking may be required with other components, due to the many individual structuring possibilities of switchgear and the operational criteria.

These can also be flexibly and comfortably included in the planning by using the "Functional block Programming Language" (FUPLA) which offers engineers, even those who are not software experts, the opportunity of easily updating the operation of the High Speed Transfer Device.

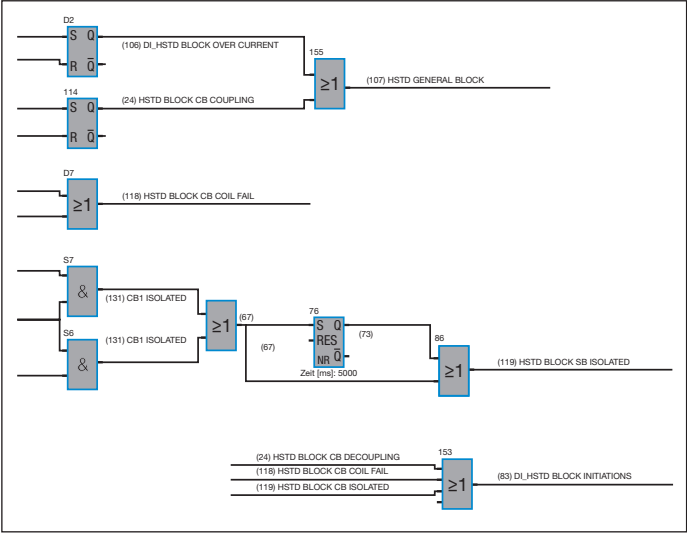


Figure 6-1 Exemplary logic diagram for an installation-specific configuration of the SUE 3000

With SUE 3000 the user has the benefit of a transfer device that is fully integrated in a true programmable controller. This flexibility is very advantageous for defining control functions for automation sequences, which can, for example, include blocking the release of specific functions, as well as required sequences for load shedding etc.

The SUE 3000 High Speed Transfer Device provides a wide range of logical functions so that each required control schemes can be configured. The range of logical functions includes:

AND logic gate

NAND logic gate

OR logic gate

NOR logic gate

XOR logic gate

Bistable and monostable flip flop

Counters

Timers

Pulse generators

Memories

6.1 Parameters

The parameters can be changed via the HMI Control Unit without using a personal computer. Additional functions can be executed with a personal computer running the configuration software and connected to the optical interface on the front of the HMI unit. These additional functions are:

Parameterization of the functional scheme

Read-out of the current measurement values

Read-out of the status of the binary inputs and outputs

Read-out of the fault recorder

Read-out of event lists

Viewing of the FUPLA logic I/O states (online monitoring)

The typical setting options are listed below and explained in brief:

Transfer types and directions

The individual transfer modes can be individually activated and/or deactivated, depending on transfer direction.

Circuit-breaker command delays

For optimization (reduction) of transfer interludes with simultaneous fast transfers caused by different circuit-breaker operating time, the commands can be delayed on an individual basis.

Time settings for various functions

The time relationships within the logical control unit can be influenced by means of installation-specific project planning:

- Time-operated transfer
- Decoupling time
- Delay time for undervoltage initiation etc.

Limit values of analog signal processing

Determination of the synchronicity criteria (angle, frequency differences, voltage inquiries)

General interventions in the functional processes of the SUE 3000

All known installation-specific details are taken into account within the framework of the installation project planning and a customer-specific parameter setting is undertaken.

The configuration is stored in nonvolatile RAM (NVRAM). It could be modified by the customer without difficulty by means of the configuration tool contained in the scope of supply.

6.2 Changeable functional parameters

Description	Setting range (Default setting)
Frequency difference	0.5 – 2.5 Hz (1 Hz)
for release of fast transfers	
Angle between the networks	$\pm 50^\circ$ ($\pm 20^\circ$)
for release of fast transfers	
Voltage value of the busbar	$0.6 - 0.8 \times U_{\text{Nominal}}$ ($0.7 \times U_{\text{Nominal}}$)
for release of fast transfers	
Stand-by feeder voltage	$0.7 - 0.9 \times U_{\text{Nominal}}$ ($0.8 \times U_{\text{Nominal}}$)
up to which the High Speed Transfer Device is "ready"	
Max. frequency gradient	5 – 40 Hz/s
up to which the "Transfer at the 1 st phase coincidence" will be initiated	
Residual voltage value of the busbar	$0.2 - 0.55 \times U_{\text{Nominal}}$ ($0.4 \times U_{\text{Nominal}}$)
at which the residual voltage- dependent connection takes place	
Undervoltage value of the previous feeder	$0.1 - 1.2 \times U_{\text{Nominal}}$ ($0.7 \times U_{\text{Nominal}}$)
at which an undervoltage initiation will be initiated	
Delay time for undervoltage initiations	40 – 30,000 ms (0.1 s)
Time until time-operated close command	0.1 – 60 s (2 s)
Delay time for circuit-breaker commands	0 – 60 ms (0 ms)
for compensation of different circuit-breaker operating time	

6.3 Fault recording

The High Speed Transfer Device SUE 3000 is equipped with a fault recorder module, which records and encodes analog and binary data. The number of recorded data channels depends on the initial configuration. Up to eight signals of the analog channels and 32 binary signals can be recorded. The analog input signals are recorded with a sampling rate of 1.2 kHz for a period of at least 1000 ms to a maximum of 5000 ms. The recording time is a combination of pre- and post trigger time. The records are saved using a typical ring buffer process, i.e. the oldest record is always overwritten with a new one (FIFO characteristics). The number of saved fault records depends on the record time. For example, a maximum of 5 fault records can be saved with a recording time of 1000 ms. Fault records can be exported and converted by the configuration software. The transfer of records can be done also via the interbay bus.

With this useful feature recorded transfers could be analyzed and e.g. project specific parameters could be verified.

7 Operation

A wide range of functions can be controlled and operated using the simple, user-friendly interface on the HMI Control Unit. This user-friendly interface is shown in the following Figure 7-1.

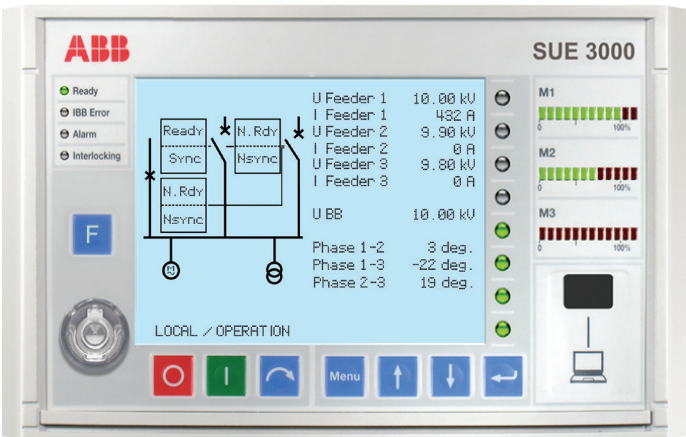


Figure 7-1 HMI as Control Unit

The HMI consists of the following features:

7.1 LCD (Liquid crystal display)

The back-illuminated LC display of the HMI provides a graphical display of the switching devices in the switchbay controlled by the SUE 3000. The intensity and the duration of the illumination can be set as required. The Single Line diagram shows the current status of all the switching devices. The right half of the LC display is for plain text, such as measurement values, main menu and submenus descriptions, protection signals and event recording.

On the LC display, the following can be shown:

- Up to eight switching device icons
- Various icons for motors, transformers, sensors, transducers
- A maximum of 40 individual lines

7.2 Status indication

Four system LEDs, describe in the following chapters, indicate the status of the SUE 3000.

7.2.1 Operational status

On the HMI front panel, the operational status is called “Ready” and is displayed by a green LED. The unit is not operational when this LED is off, and this occurs for example during the downloading of the configuration or if a fault condition is detected in the Central Unit.

7.2.2 Communication status

If the SUE 3000 is to be connected to a station automation system, the appropriate communications board is required. In this case a green LED is used to indicate the correct operational status of this optional board. The LED color changes to red if a communication failure has occurred.

7.2.3 Alarm indication

Several arbitrary alarm conditions can be defined and configured by the user. If one of these conditions is fulfilled, the red LED will be on.

7.2.4 Interlocking status

- Not used -

7.3 LED indication

7.3.1 Freely programmable LEDs

Eight freely programmable, three color LED's are provided for local indication. The number of LED display options can be quadrupled through the menu structure. As a result, a total of 32 indication options are available for status indication regarding control, monitoring and supervision functions.

Status dependent LED texts are provided.

7.3.2 Bar displays

Three LED bars are provided for showing the measurement values. Two of them are used to display the current measurements of the feeding sources (if required). The third bar is freely configurable. Each bar consists of ten green and two red LEDs. The nominal values of each LED bar, which corresponds to the ten green LEDs are defined by the configuration software. If the measurement values exceed the rated values, the red LEDs will get illuminated indicating an overload situation.

7.4 Control push buttons

The control push buttons are used for operation of the High Speed Transfer Device during local control. A total of seven push buttons are available, three for commanding the primary equipment (if required) and four for browsing the display and operating the SUE 3000.

7.5 Function key

The function key button allows e.g. to start an inside the FUPLA implemented function or a control command.

7.6 Electronic key

Two different electronic keys are provided. One key can only be used for the parameterization of the High Speed Transfer Device. The other one is for control modes selection: local, remote or local/remote. By using these two keys a certain separation between parameterization and control operation can be achieved. The sensor for recognizing which electronic key has been used is located on the front panel of the HMI Control.

The following displays and operating functions are provided on the front of the device:

- Switching the SUE 3000 On/Off
- Manual initiation

Single-line display of the circuit board configuration

- Position monitoring of the circuit-breakers
- Voltages of the feeders and of the busbars
- Operating currents of the feeders
- Status of the High Speed Transfer Device
- Phase angle between the feeders

Alarm LEDs with clear-text lettering and acknowledgment function

Off/Local/remote-selection with key switches

Operation/set-selection with key switches

Furthermore, the High Speed Transfer Device can be operated completely by remote control. Manual triggering are executed from the control room and disturbance-specific, automatic initiations are triggered independently by the protection mechanisms. Status and disturbance messages can be signaled to the control room and/or to a process control system.

8 Testing, quality control

The thoroughly consistent application of the ABB Quality and Environmental Management System in conformity with EN ISO 9001 and EN ISO 14001 guarantees a high quality standard during the course of the entire engineering and manufacturing procedure, all the way up to the delivery of the devices.

In addition to the execution of the one-time type tests, every system is submitted to an isolation testing and a functional examination at the factory prior to delivery. Project-specific solutions can be tested using switchgear simulation models.

9 Operational safety

During the development of the SUE 3000 High Speed Transfer Device, special emphasis was placed on the realization of a maximum operational safety.

A large number of internal monitoring functions, but also of diagnostics transcending individual devices, such as permanent coil monitoring as well as running time monitoring of the circuit-breakers, ensured the highest degree of safety.

The planning, production and application know-how gathered at ABB over the course of decades for High Speed Transfer Devices has been thoroughly incorporated into the design of the SUE 3000. The device represents the current state of the technology of automatic transfer schemes with conventional circuit-breakers.

10 Technical data

10.1 Response time

Response time is the time between protective initiation of the High Speed Transfer Device SUE 3000 and the command being issued to the circuit breakers involved.

Response time with solid state (Static I/O board)	< 2 ms
--	--------

10.2 Current and voltage transformer

10.2.1 Rated current

Rated current I_N	1 A or 5 A
Rated voltage U_N	100 V ... 125 V
Rated frequency f_N	50 Hz / 60 Hz

10.2.2 Thermal load capacity

Current path	250 I_N (peak value) 100 I_N (dyn.) für 1 s 4 I_N continuous
Voltage path	2 $U_N/\sqrt{3}$ continuous

10.2.3 Consumption

Current path	0.1 VA with I_N
Voltage path	0.25 VA with U_N

10.3 Binary inputs and outputs

In order to achieve the operations of the primary equipment and establish conventional (parallel) communication, the SUE 3000 is equipped with binary I/O boards.

The inputs of the binary signals are isolated by an opto-coupler. Each input has a minimum fixed filter time of 1 ms.

However, in order to achieve the required fast operating time for high speed transfer applications, static outputs have to be installed.

A maximum of 3 binary I/O board can be installed.

10.3.1 Binary I/O board with static relays

Number of inputs	14 per board
Input voltage	48 ... 265 V DC / 110 ... 265 V DC (Threshold 35 V DC or 75 V DC)

Number of power outputs	2 per board
-------------------------	-------------

Operating voltage	48 ... 265 V DC
-------------------	-----------------

Making current	70 A ($t \leq 10$ ms)
----------------	------------------------

Load current	12 A ($t \leq 30$ s)
--------------	-----------------------

Number of other power outputs	4 per board
----------------------------------	-------------

Operating voltage	48 ... 265 V DC
-------------------	-----------------

Making current	16 A ($t \leq 10$ ms)
----------------	------------------------

Load current	10 A ($t \leq 30$ s)
--------------	-----------------------

Number of signal outputs	2 per board
--------------------------	-------------

Operating voltage	48 ... 265 V DC
-------------------	-----------------

Making current	1 A ($t \leq 10$ ms)
----------------	-----------------------

Load current	0.3 A ($t \leq 30$ s)
--------------	------------------------

Number of watchdog outputs (WD)	1 per board
------------------------------------	-------------

Operating voltage	48 ... 265 V DC
-------------------	-----------------

Max. current	0.3 A
--------------	-------

Total inputs	14 per board
--------------	--------------

Total outputs	9 per board (8 freely configurable)
---------------	--

Number of power outputs with coil supervision	2 (Coil OK if $R_{Coil} < 10$ k Ω)
--	---

10.4 Communication interfaces

10.4.1 HMI control unit

Optical/electrical standard interface RS 232 to the Notebook PC (at the front)

Electrical isolated standard interface RS 485 to the Central Unit (at the rear)

10.4.2 Central unit

Electrical isolated standard interface RS 485 to the HMI

Electrical standard service interface RS 232 for updating the firmware

Input for time synchronization (optional, the supported protocol is IRIG, format B000, B002, B003).

Glass fiber	Wavelength:	820 nm
	Max. distance:	1500 m
	Connector type:	ST

10.5 Analog input board (optional)

0 ... 20 mA or 4 ... 20 mA (six channels)

10.6 Analog output board (optional)

0 ... 20 mA or 4 ... 20 mA (four channels)

10.7 Communication to a station automation system (optional)

IEC 61850-8-1 *
electrical interface with two RJ45 connectors or optical interface with two pair LC connectors for glass fiber (multi-mode)

SPA
optical plastic fiber interface with snap-in type connector; or glass fiber (multi mode) with F-SMA or ST connectors

IEC 60870-5-103
with extension according to VDN guidelines for control, glass fiber (multi-mode) optical interface with ST connectors

ModBUS RTU
electrical interface with two galvanically insulated RS-485 ports or optical interface with four standard ST connectors for glass

ModBUS TCP

Electrical RJ-45 connector or optical LC connector for glass fiber (multi mode) on Ethernet board

Ethernet interface

Standard RJ45 connector on the core module

Profibus DP

electrical RS 485 interface (with adapter)

* IEC 61850 communication hardware and firmware is similar to the REF542*plus* platform version

10.8 Power supply

10.8.1 Central unit

Rated voltage	48 ... 220 V DC (-15%, +10%)
---------------	------------------------------

Power consumption	≤ 40 W
-------------------	--------

Inrush current	10 A peak value (for 200 ms)
----------------	------------------------------

Admissible ripple	< 10 %
-------------------	--------

10.8.2 HMI control unit

Rated voltage	48 ... 220 V DC (-15%, +10%)
---------------	------------------------------

Power consumption	≤ 6 W
-------------------	-------

Admissible ripple	< 10%
-------------------	-------

10.9 Environmental conditions

Ambient operation temperature	-10 .. +55°C
-------------------------------	--------------

Ambient transport and storage temperature	-25 .. +70°C
---	--------------

Ambient humidity	Upt o 95% without condensation
------------------	--------------------------------

Altitude < 1000 m above sea level

10.10 Protection degree

10.10.1 Central unit

Case	IP20
------	------

10.10.2 HMI control unit

Front	IP44
-------	------

Rear	IP20
------	------

11 Housing

11.1 Abmessungen

The SUE 3000 housing for the Central Unit is made from sheet aluminum. Its exterior is both to protect the housing against corrosion and to gain the shielding against EMC disturbances. In the housing could be integrated up to three I/O boards, an optional communication board and an analogue board.

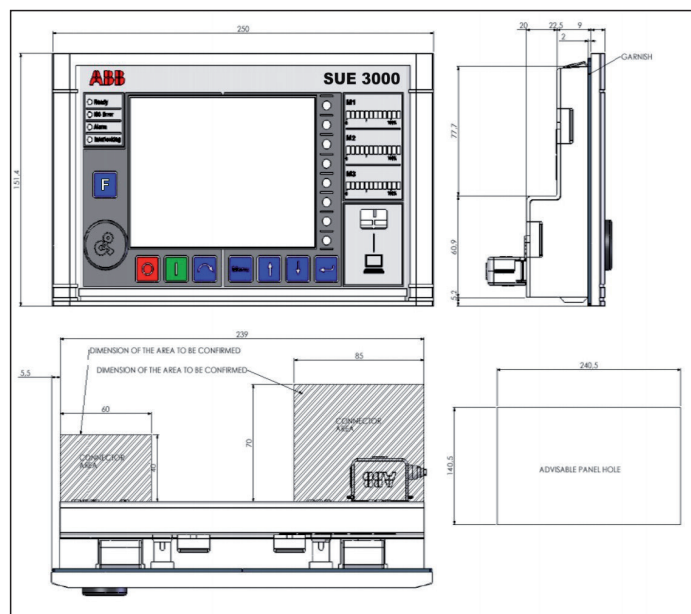


Figure 11-1 Dimension of the HMI control unit

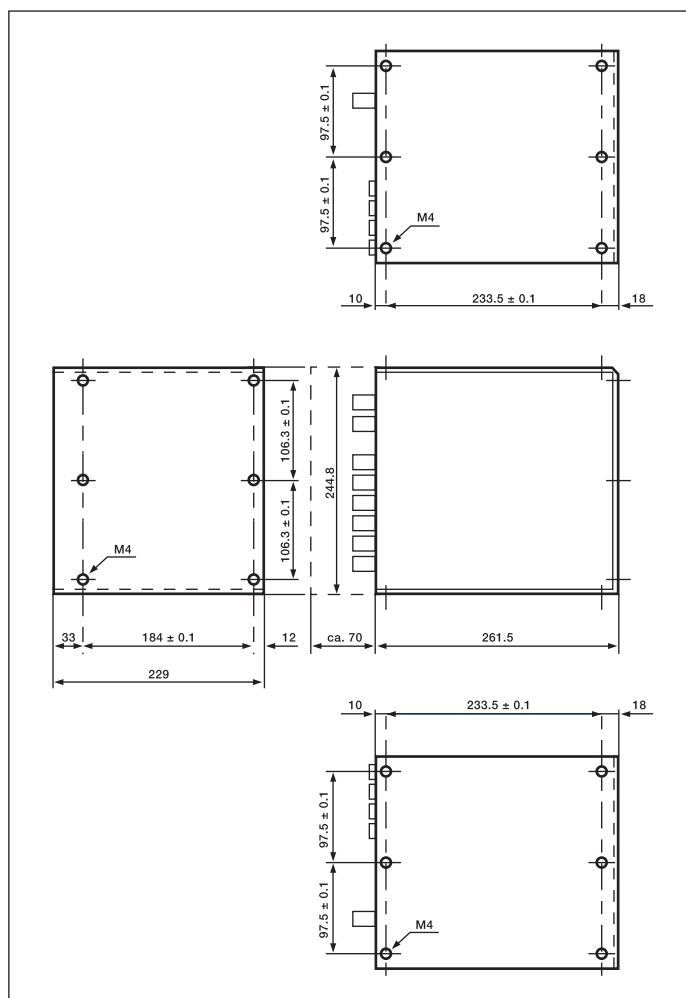


Figure 11-2 Dimension drawing of the central unit

11.2 Available design

The SUE 3000 High Speed Transfer Device can be supplied in a choice of 2 different mechanical models.

Single control unit for loose installation in a low-voltage compartment of a switchbay

Installed ready for connection in a steel-sheet cabinet fully enclosed in steel sheet cubicles including all required devices such as MCBs, terminals, relays, etc.

12 Type test

12.1 Functional test

All relevant tests are performed according to IEC 60255 standard series and the test specification for the testing of the transfer functions.

12.2 EMC

The SUE 3000 High Speed Transfer Device fulfils all important national and international EMC regulations. All relevant tests are according to the following standard series:

Interference suppression according to EN 55022 respectively IEC CISPR 11, Group 1

Immunity to electrostatic discharge according to IEC 61000-4-2, level 3

Immunity to radiated electromagnetic energy according to IEC 61000-4-3, level 3

Electrical fast transient or burst according to IEC 61000-4-4, level 3

Surge immunity tests according to IEC 61000-4-5, level 3

Immunity to conducted disturbances induced by radio frequency fields according to IEC 61000-4-6, level 3

Power frequency magnetic field immunity according to IEC 61000-4-8, level 5

Pulse magnetic field immunity according to IEC 61000-4-9, level 5

Damped oscillatory magnetic field immunity according to IEC 61000-4-10, level 5

Oscillatory waves immunity according to IEC 61000-4-12, level 3

Oscillatory waves immunity in the range from 0 to 150 kHz according to IEC 61000-4-16, level 3

Ripple on DC input power port immunity according to IEC 61000-4-17, level 3

Voltage dips, short interruptions and voltage variations on DC input power ports per IEC 61000-4-29, 50 ms

12.3 Isolation

Voltage test according to IEC 60255-5 with 2 kV RMS, 50 Hz during 1 min

Impulse voltage withstand test according to IEC 60255-5 with 5 kV 1.2/50 µs.

12.4 Mechanical properties

Vibration test according to IEC 60255-21-1

Earthquake test according to IEEE 693

12.5 Environmental conditions

Cold test according to IEC 60068-2-1

Dry heat test according to IEC 60068-2-2

Damp Heat and Cycling test according to IEC 60068-2-30

12.6 RoHS compliance

Complies with RoHS directive 2002/95/EC

12.7 IEC 61850-8-1 communication

KEMA IEC 61850 Certificate Level A¹ - based on REF542*plus* Feeder Terminal with IEC 61850 interface (1MRS756326)

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