High Speed Transfer Device and System
SUE 3000
Agenda

- High-speed transfer device SUE 3000
  - Philosophy / Benefits
  - Construction
  - Functional modes
- High-speed transfer system
  - Idea
  - Concept / construction
  - A real system approach
Task of High Speed Transfer Devices

- Ensuring continuous power supply to essential electrical equipment by changing over from a main to a stand-by feeder as fast as possible
Interruption of processes results in

- Lost productivity
- Damaged production equipment
- Damaged products
- Delays in delivery
- Lost confidence of clients
- Injury to people
- Pollution of environment
Key issues

- Power quality
- Uninterrupted power supply
- Permanent availability of electricity
- Assurance of continuous processes
- Prevention of outages
- Protection of facilities
- Protection of employees
Application of High Speed Transfer Devices

- Supply systems of power stations
  - Steam-power stations
  - Combined cycle power stations
  - Nuclear power stations
- Environmental plants
  - Flue gas cleaning systems
  - Incineration plants
- Chemical plants
  - Fiber industry
  - Petrochemical plants
- Industrial plants with sensitive load
Important processes

- **Pumps**
  - Boiler feed-water pump
  - Condensate extraction pump
  - Cooling water pump
  - District heating circulation pump
  - Limestone slurry feed and absorbent circulation pump

- **Fans**
  - Primary and secondary air fan
  - ID and ID booster fan

- **Other**
  - Conveyor
  - Coal mill
  - Oxidation air compressor
  - Gas turbine starter
  - Fuel gas booster compressor
Prerequisites for the application

- Existence of at least two - usually independent - synchronous feeders
- Circuit-breakers with short operating times
- General suitability of plant for network change-over
- Load configuration with rotating devices
- Existence of appropriate initiation devices
Interfaces

- Circuit Breakers
  - Control
  - Indication
- Analogue Measurements
  - Voltage
  - Feeder current (optional)
- External protection
- Instrumentation & Control
Block diagram

Analog Output Board

Analog Input Module

0/4..20mA

0/4..20mA

Communication Board

RX

TX

CP Communication Processor

Main Board

DSP

Phase Comparision and Analog Measurement

μC

Control

Analogue Input Board

AI 1

AI 2

AI 3

AI 4

AI 5

AI 6

AI 7

AI 8

CAN

Eth.

Time Synch.

Binary I/O-Board(s)

Binary Inputs

Binary Outputs
Communication capability

- IEC 61850-8-1
- LON / LAG 1.4 according to IEC 60870-5-101/103 with interbay communication
- IEC 60870-5-103 interface according to VDEW recommendation
- MODBUS RTU interface
- SPA interface
- Ethernet interface
- PROFIBUS DP (with protocol conversion)
Construction of the device

- Analogue input board
- Main board
- Communication board
- Analogue output board
- 3 x I/O Board
- Power supply board

HMI
Mechanical options

- Installation in LV-Compartment of MV-Switchbay
- Installation in a steel sheet cubicle
SUE 3000 – High Speed Transfer Device
Available Configuration – Variant 1

2-Circuit-breaker configuration

- One busbar
- Transfer takes place between the two feeders
SUE 3000 – High Speed Transfer Device
Available Configuration - Variant 2

3-Circuit-breaker configuration

- 2 busbar sections, Busbar coupling breaker
- Transfer between each feeder and busbar coupling breaker
SUE 3000 – High Speed Transfer Device
Available Configuration - Variant 3

3-Circuit-breaker configuration with internal pre-selection

- One busbar
- 2 of 3 selection
SUE 3000 – High Speed Transfer Device
Available Configuration - Variant 4

3-Circuit-breaker configuration with internal pre-selection

- 2 busbar sections,
  Busbar coupling breaker

- Transfer between:
  - Each feeder and busbar coupling breaker and
  - Feeder 1 and feeder 2 when bus coupler breaker is closed
SUE 3000 – High Speed Transfer Device
Available Configuration - Variant 5

3-Circuit-breaker configuration with internal pre-selection

- One busbar
- Transfer between each feeder
The logical states are displayed online.
Fault recorder module and visualization
HSTD (High Speed Transfer Device)
Transfer modes

Phase
Busbar Voltage

FAST TRANSFER
RESIDUAL VOLTAGE TRANSFER
TRANSFER AT 1ST PHASE COINCIDENCE
TIME DEPENDING TRANSFER

Busbar Voltage (% U_N)

Phase (degree)

Start

100%

0

0

-360°

0

Time

Transfer modes
Transfer modes

Fast Transfer

- Phase
- Busbar Voltage
- Time

Transfer modes:
- Fast Transfer
- Residual Voltage Transfer
- Transfer at 1st Phase Coincidence
- Time Depending Transfer
Fast transfer
Transfer modes
Transfer at first coincidence

- FAST TRANSFER
- Phase
- Busbar Voltage
- RESIDUAL VOLTAGE TRANSFER
- TIME DEPENDING TRANSFER
- TRANSFER AT 1st PHASE COINCIDENCE

Phase (degree)

Busbar Voltage (% U_N)

Start

0 -360° 100%
Transfer modes
Transfer at first coincidence (1)
Transfer modes
Transfer at first coincidence (2)
Transfer modes
Transfer at first coincidence (3)
Transfer modes
Transfer at first coincidence (4)
Transfer modes
Transfer at first coincidence (5)
Transfer modes
Residual Voltage Transfer
Transfer modes
Residual Voltage Transfer

\[ U_{BB} \]
\[ U_{Diff} \]
\[ I_{Feeder 1} \]
\[ I_{Feeder 2} \]
Transfer modes
Time depending Transfer

- **FAST TRANSFER**
- **RESIDUAL VOLTAGE TRANSFER**
- **TRANSFER AT 1\textsuperscript{st} PHASE COINCIDENCE**

- Phase
- Busbar Voltage
- Time

- Start
- 0
- -360°
- 100%
Fast transfer
Transfer modes - from fast to …
super-fast!

Diagram showing a graph with the x-axis labeled as 'Time' and the y-axis labeled as 'Phase (degree)' and 'Busbar Voltage (% U_N)'. The graph illustrates the process of fast transfer, residual voltage transfer, and transfer at 1st phase coincidence. Key points include:

- **Start**
- **T_D**
- **T_CB**
- **Phase**
- **Busbar Voltage**
- **Residual Voltage Transfer**
- **Time Depending Transfer**

The graph also highlights the relationship between phase and busbar voltage over time.
30ms High Speed Transfer System

- For sensible plants with **highest** demands like
  - Semiconductor industry
  - Plants with high degree of automation, etc.

- Unique performance
  - VM 1-T Circuit breaker
    - 16 ms Making-time
    - 9 ms Breaking time

- References
  - Otto Versand (mail-order business)
  - Philips Semiconductors
  - Wiegand Glas factory
  - Petrochemicals (RU)
30ms Transfer

$U_{BB}$

$I_{Feeder 1}$

$I_{Feeder 2}$
30ms HSTS – optimized architecture

30ms-Transfer animation
FDI/VS-Object
VS-Object

- VS: Voltage Supervision
  - Extremely fast (undelayed)
    Under- and Overvoltage detection
  - Blocking by substantial overcurrent
FDI-Object

- **FDI**: Fast Direction Indication
  - Determination of reverse power case
  - Blocking by substantial overcurrent
Requirements for HSTS (30ms transfer time)

- Integration of Fast fault detection
  - VS (Voltage supervision)
  - FDI (Fast direction indication)
- Optimized Controller
  - Improvements on REF542plus architecture
- Accelerated Circuit breakers
  - VM1-T (ca. 16ms operating time)
- Optimized signal flow
  - Optical links
  - IRQ-architecture
## Transfer duration

<table>
<thead>
<tr>
<th>Transfer mode</th>
<th>Average transfer duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Transfer</td>
<td>30 – 100 ms</td>
</tr>
<tr>
<td>Transfer at 1st phase coincidence</td>
<td>250 – 500 ms</td>
</tr>
<tr>
<td>Residual voltage dependent transfer</td>
<td>400 – 1200 ms</td>
</tr>
<tr>
<td>Time delayed transfer</td>
<td>&gt; 1500 ms</td>
</tr>
</tbody>
</table>
VM1-T (Transfer Switch)

Used for High Speed Transfer Systems to ensure uninterrupted power supply

- Ratings available (fixed & withdrawable):
  - 12/17,5kV, ...2500A, ...25kA
  - 24kV, ...1250A, ...25kA

- Faster opening / closing times:

<table>
<thead>
<tr>
<th></th>
<th>VM1-T</th>
<th>VM1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closing time</td>
<td>approx. 16ms</td>
<td>approx. 45…60ms</td>
</tr>
<tr>
<td>Opening time</td>
<td>approx. 10ms</td>
<td>approx. 35…50ms</td>
</tr>
<tr>
<td>Arcing duration (50Hz)</td>
<td>&lt;=15ms</td>
<td>&lt;=15ms</td>
</tr>
<tr>
<td>Total opening time</td>
<td>&lt;=25ms</td>
<td>&lt;=60ms</td>
</tr>
</tbody>
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- Hardware differences (compared to VM1):
  - Electronic board with booster board
  - More capacitors
  - Less windings of the actuator coils
VM1-T
Truck version

- Frame and contact system for the following switchgear types available:
  - UniGear ZS1
  - UniSafe
  - PowerBloc
  - ZS 8.4
Major benefits

- Improvement of plant availability
- Protection of production facilities
- Prevention of costly outages
- Improvement of product quality
- Protection of employees and environment