30 ms High Speed Transfer System (HSTS) Product Description

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Reference documents

Title	Document Number	Revision	Date
Operating Manual High Speed Transfer System SUE 3000	1HDK400072	D	Feb. 2008
Operating Manual Switchbay Protection and Control Unit REF542*plus*	1MRS756367	C	Apr. 2008
Protection Manual REF542*plus*	1MRS755860	B	Sep. 2006
REF542*plus*, Release 2.6 (SP1), Drawing and Connection Diagram	1VCD400049		Sep. 2003
Operating Instructions BA 543/01 Vacuum Circuit-Breaker VM1-T	GCEA670543P0102		Mar. 2011
REF542*plus* Product Data Sheet	1MRS756368	A	Jan. 2007

List of abbreviations

Abbreviation	Meaning
HSTD	High Speed Transfer Device
HSTS	High Speed Transfer System
FDI	Fast Direction Indication
VS	Voltage Supervision
DSP	Digital Signal Processor

1 General

1.1 Description of the 30 ms high speed transfer system HSTS

In order to protect medium-voltage applications and systems against voltage failures, and to assure almost uninterrupted continued operation of the consumers connected to the process involved, the SUE 3000 high speed transfer device is used. In the event of a disturbance in the supply, it will transfer to a standby supply, taking various factors into due account.

The SUE 3000 is used predominantly in the auxiliary supply systems of power plants and in industrial facilities.

In conjunction with conventional circuit-breakers and protection devices total transfer times in the range of < 100 ms will be achieved (counting from the occurrence of the fault in the main feeder until the circuit-breaker of the standby feeder is closed). For smooth operation of motor-driven consumers, a transfer in this range will usually be sufficient and non-critical.

For extremely stringent requirements in the millisecond range, only thyristor-based, static systems are a viable option. These, however, will typically possess only a limited connected load capability, necessitate high capital investment, and cause substantial running operation costs, e.g. due to continual losses through cooling systems. For this reason, their use is mostly restricted to protecting important mainframe computer systems.

Market investigations and customer requirements more and more show that there is an increasing demand for transfer systems that provide transfer times between the two solutions mentioned above. For this purpose, the SUE 3000 has been extended with additional components and performance-enhancing features, to create the High Speed Transfer System (HSTS). This system with optimized medium voltage circuit breaker VM1-T and switchbay protection and control unit REF542*plus*, achieves transfer times of 30 ms. This result in a transfer time that permits sensitive industrial processes to continue in operation without any interruption.

1.2 Applications

The applications for high speed transfer systems HSTS include sensitive production processes in which even a brief voltage dip can cause serious damage to important production lines and may also result in a total loss of production. Expensive downtimes may ensue.

Processes of this sensitivity are characterized by computer-controlled manufacturing and a multiplicity of numerical controls. Typical examples here would include:
- Automotive production
- Semiconductor production
- Paper industry
- Chemical and petrochemical industry
- Logistics
- Glass production
- etc.

2 The 30 ms High Speed Transfer System (HSTS)

2.1 System preconditions

The high speed transfer system HSTS is able to transfer consumer groups to a standby supply within 30 ms. To enable such ultra-fast transfer times, the system's components have been specifically harmonized for optimum interaction:

- Voltage sensors
- Extremely fast detectors for detecting the location of the fault
- Short signal propagation time thanks to static outputs
- Optical communication link between REF542*plus* and the SUE 3000
- VM1-T circuit-brekaer with extremely short operating times

2.2 System structure

The HSTS is available for switchgear layouts with 2 feeders and one common busbar (2 circuit breaker configuration) or 2 feeders with 2 busbar sections and a coupling circuit-breaker (3 circuit-breaker configuration). For further information on these two variants please consult the Operating Manual of the SUE 3000 high speed transfer device. The function and structure of the two variants differ only in the number of circuit-breakers installed.

Each of the feeders is monitored by an REF542*plus*. These are connected in three phases to sensors for voltage supervision and transformers or sensors for current supervision.

A fault in a feeder is detected by extremely fast detectors (VS and FDI), integrated in the REF542*plus*. Via an optical link this will lead to the initiation of the SUE 3000 high speed transfer device.

The SUE 3000 is connected to the two feeders and to the busbar(s) via transformers. In contrast to the REF542*plus*, the current is measured in a single phase, and the voltage is measured using a concatenated voltage (e.g. L1-L2).

In order to execute a transfer, the SUE 3000 monitors and controls all the VM1-T circuit-breakers in the system.

2.2.1 Busbar with two feeders (2 circuit-breaker configuration)

The configuration consists of two independent synchronous feeders, each able to supply the entire load of the busbar. One supply is the main feeder, while the other is the reserve supply for the busbar. Both feeders are connected to the busbar via circuit-breakers. The circuit-breaker of the main supply is closed, while the other one of the standby supply is opened.

In case of a fault, the high speed transfer system transfers between the faulty and the reserve feeder. Once the fault in the disturbed feeder has been cleared, a transfer back to the recovered main feeder is possible.

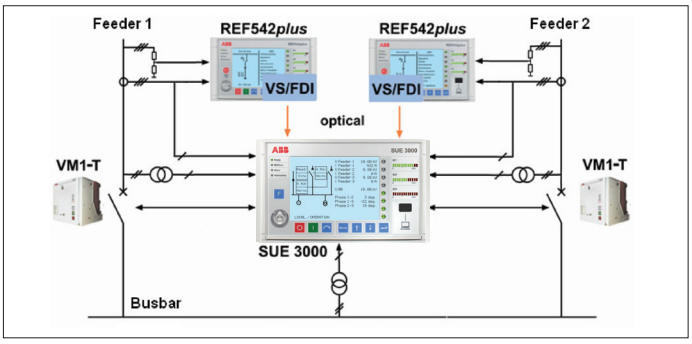

Figure 1: Structure of the HSTS for a busbar with two feeders

In the system, the REF542*plus* monitors the actual main feeder. It evaluates the phase voltages and currents by means of the detectors VS and FDI, and in the event of a fault will initiate the SUE 3000 high speed transfer device. This, taking due account of various factors, transfers to the other supply in the fastest possible transfer mode. (See the Operating Manual for the SUE 3000).

2.2.2 Busbar with two feeders and a busbar coupling (3 circuit-breaker configuration)

The configuration consists of two independent synchronous feeders, each able to supply the entire load of the busbar.

The system consists of two busbar sections, connected to each other via a coupling breaker. In normal operation, the circuit-breakers of the two feeders are closed, and the coupling circuit-breaker is opened.

In case of a fault, the system transfers between the faulty feeder and the coupling where-upon the intact feeder supplies both busbar sections. Once the fault in the disturbed feeder has been cleared, a transfer back to the recovered main feeder is possible.

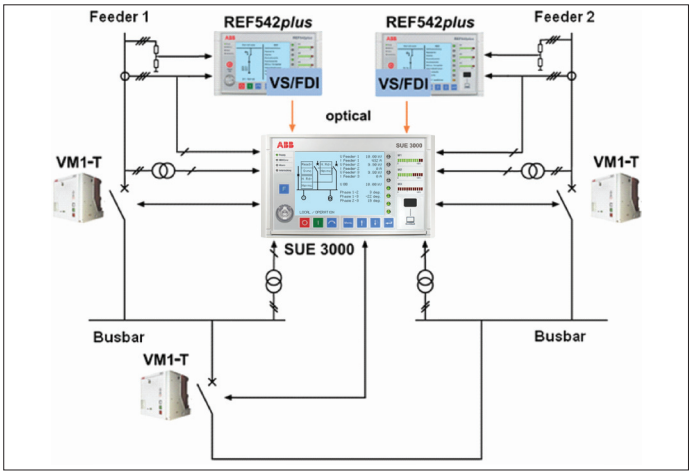

Figure 2: Structure of the HSTS for a busbar with two feeders and a coupling breaker

2.3 System components

System component	2-breaker configuration	3-breaker configuration	Equipped with
REF542*plus*	2	2	Sensor board, Full-Mainboard, FDI/VS detectors
SUE 3000	1	1	Full-Mainboard, static I/O boards
VM1-T	2	3	Optimized magentic operating mechanism
Current transformer / current sensors	1 set of transformers / sensors per REF542*plus* 1 transformer / sensor per supply for SUE 3000	1 set of transformers / sensors per REF542*plus* 1 transformer / sensor per supply for SUE 3000	
Voltage sensors / voltage transformer	1 set of sensors per REF542*plus* 2 transformers per supply and 2 transformers for the busbar for SUE 3000	1 set of sensors per REF542*plus* 2 transformers per supply and 2 transformers for the busbar section for SUE 3000	

2.3.1 REF542*plus* switchbay protection and control unit

Besides the general control and protection functions, the REF542*plus* are equipped with special, innovative detectors for detecting the location of the fault. The high speed transfer device will be initiated in ≤10 ms.

These algorithms are used for very fast, undelayed under- and overvoltage detection and for monitoring the power direction.

The REF542*plus* continuously monitors the analog values of the supply network. When voltage and current sensors are used, they show the following advantages compared to conventional transformers:
- High accuracy
- Large linear range
- Compact dimensions
- Simple integration in a switchgear panel

Initiation of the SUE 3000 via an optical communication link: The transmission of the initiation signals between the REF542*plus* and the SUE 3000 is realized by means of optical signals in the high speed transfer system.

The REF542*plus* must be equipped with a Full Mainboard (Mainboard 6 Full Version, see REF542*plus* product data sheet).

The REF542*plus* is equipped with the following hardware:
- Full Mainboard (optical interfaces)
- Power supply
- 1-3 binary input/output modules
- Analog input board with voltage sensors and current sensors or current transformers
- Communication board (optional)

2.3.2 SUE 3000 high speed transfer device

The SUE 3000 is the heart of the high speed transfer system. The task of the SUE 3000 is to provide nearly uninterrupted transfer from a faulty supply to a redundant independent reserve supply. For this purpose, the SUE 3000 continually compares the network conditions of the feeder currently active with those of the reserve feeder.

If the networks are synchronous at the moment when a transfer is initiated, a fast transfer can be performed. In the case of non-synchronous networks, transfer will be performed, depending on the setting involved, in the first phase coincidence (in-phase transfer), after the busbar voltage has reached a permissible value (residual-voltage transfer) or after a parameterizable time has elapsed (time-controlled transfer).

Initiation of the SUE 3000 via an optical communication link: The transmission of the initiation signals between the REF542*plus* and the SUE 3000 is realized by means of optical signals in the high speed transfer system. The SUE 3000 must be equipped with a Full Mainboard (Mainboard 6 Full Version, see SUE 3000 operation manual).

The SUE 3000 is equipped with the following hardware:
- Full mainboard (with optical interfaces)
- Power supply
- 3 binary input/output modules (static I/O boards)
- Analog input board
- Communication board (optional)

2.3.3 VM1-T vacuum circuit-breaker

The VM1-T is a special version of the field-proven VM1 vacuum circuit-breaker for use in medium-voltage substations. In contrast to circuit-breakers with a spring operating mecha-nism, the VM1-T is equipped with a magnetic operating mechanism, enabling extremely fast operating times.

This will be achieved due to the following characteristics:
- Magnetic operating mechanism
- Optimization of the magnetic flux
- Intelligent control of the coil current
- Storage of the energy required for a switching cycle in integrated energy storage mechanisms (only a small amount of auxiliary energy needed for switching)
- Extremely fast operating times

The VM1-T can be used in all standard air-insulated substations from ABB and from many other manufacturers as well.

Further characteristics can be found in the VM1-T vacuum circuit-breaker operating manual BA 543/01.

2.4 How the high speed transfer system functions

In the high speed transfer system both of the two independent supplies are monitored by a REF542plus. In order to assure even faster reaction times, the REF542plus not only have available the usual protective functions but also two detectors developed specifically for the high speed transfer system to detect the location of the fault concerned:
- FDI (Fast Direction Indiction) and
- VS (Voltage Supervision)

The FDI module continuously checks the power direction of a supply, while the VS module continuously checks for over- or undervoltage. Both modules are described in the REF542*plus* protection manual).

FDI and VS evaluate phase voltages and currents continuously. If a fault is detected in one of the two supplies, the relevant REF542*plus* will initiate the SUE 3000. In order to obtain additional performance, the REF542*plus* are connected to the SUE 3000 by fiber-optic cables.

2.5 Operation time of the high speed transfer system

The system's performance has been verified by comprehensive testing under realistic conditions. The illustrations below provide examples of the reaction time achieved by the high-speed transfer system:

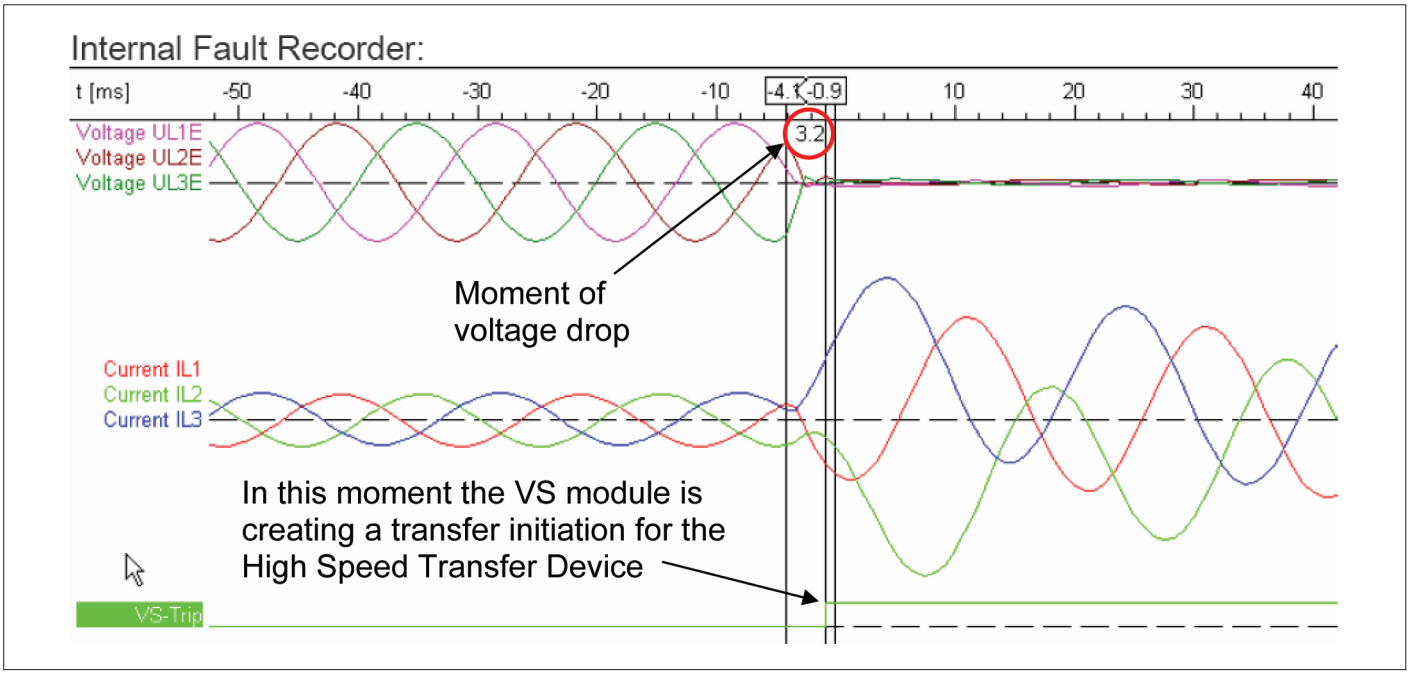

Figure 3: Reaction time of the VS protection function.
The time elapsing from detecting the voltage dip to issuing the trip command is in this case 3.2 ms.

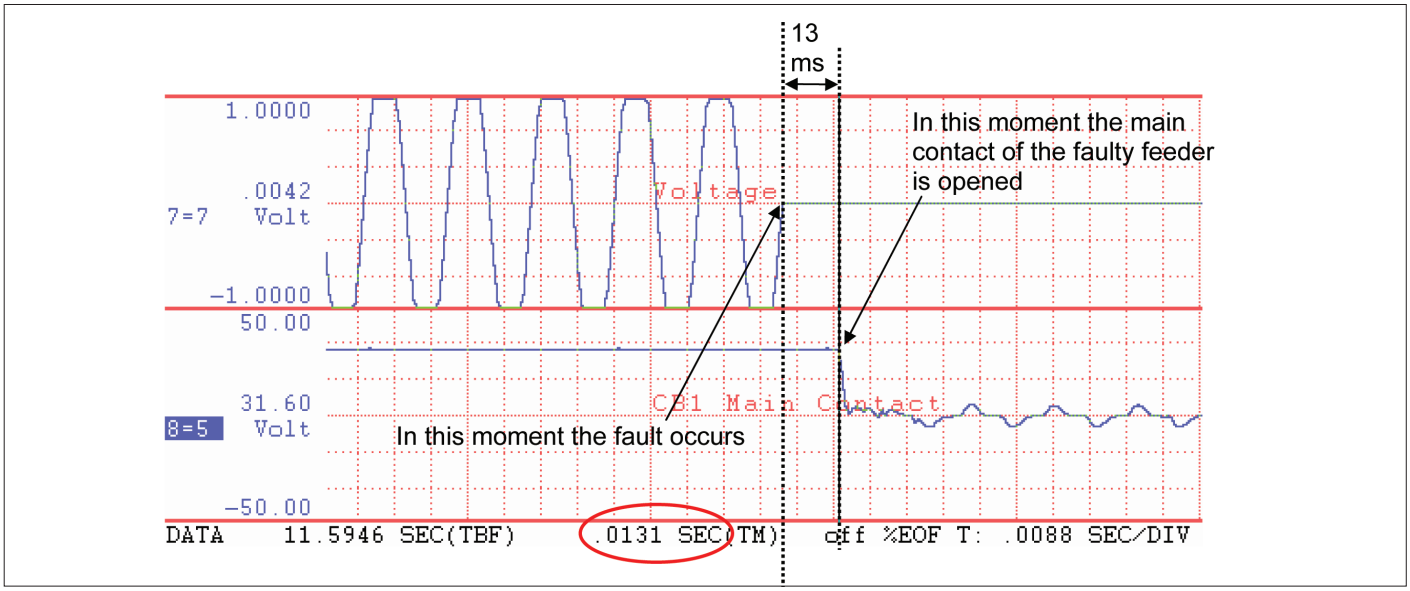

Figure 4: Reaction time of the system from occurance of the fault to opening of the main contact of the circuit-breaker of the fault supply (13 ms)

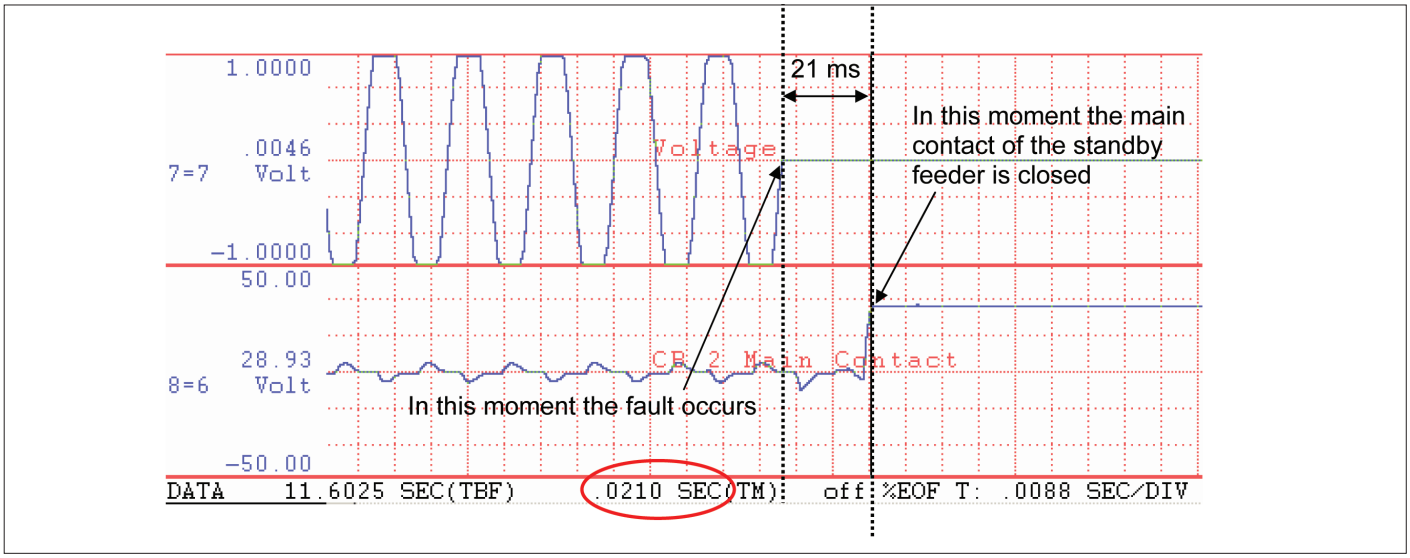

Figure 5: Reaction time of the system from fault to closing the main contact of the circuit-breaker of the reserve supply (21ms)

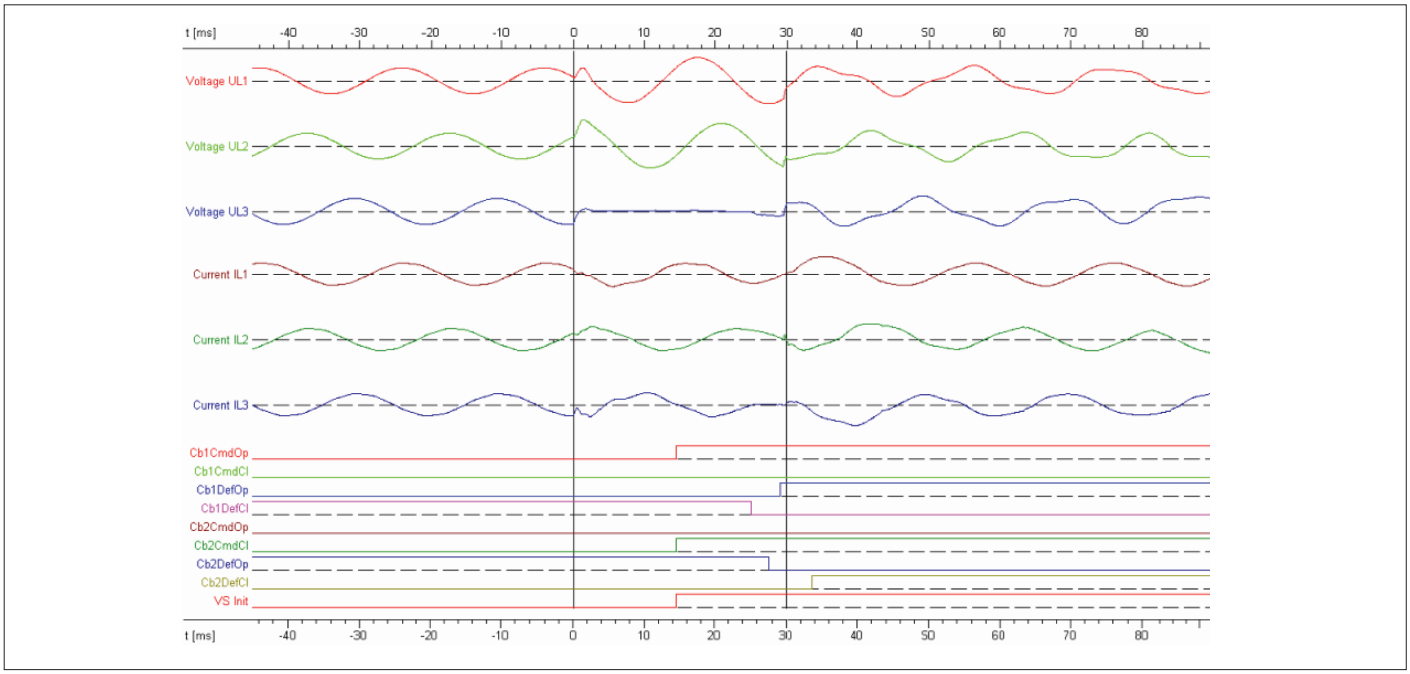

Figure 6: Total transfer time of the HSTS (30 ms) exemplified on a single-phase voltage fault

3. Technical data (*)

Opening time VM1-T circuit-breaker	10 ms
Closing time VM1-T circuit-breaker	16 ms
Total transfer time (in case of a fast transfer)	30 ms

The times are referenced to the circuit-breaker VM1-T 1212-25

Auxiliary voltage supply	110 / 220 V DC
Rated frequency	50 / 60 Hz
Rated voltage	12 kV
Rated current	1,250 / 2,000 A
Short-circuit breaking current	25 kA

(*) Other technical data on request

Contact

ABB AG
Calor Emag Medium Voltage Products
Oberhausener Strasse 33
40472 Ratingen, Germany
Phone: +49(0)21 02/12-0
Fax: +49(0)21 02/12-17 77
Email: powertech@de.abb.com

ABB AG
Calor Emag Medium Voltage Products
Petzower Strasse 8
14542 Werder (havel) OT Glindow, Germany
Phone: +49(0)21 02/12-0
Fax: +49(0)21 02/12-17 77
Email: powertech@de.abb.com

www.abb.com/mediumvoltage

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