5 Method of Operation

5.1 The program structure

To give you a better understanding of the method of operation of the microcomputer–controlled switchgear interlocking unit the most important functions of the program structure are explained below.

The program is subdivided into a startup program and a run program.

The startup program is executed once after the power supply from the power supply module has been connected or restored or after a reset by the watchdog circuit. The startup time is approx. four seconds.

In the startup program the microcomputer updates itself with the current breaker position checkback signals, compares these with the configuration data and performs data exchange with the central unit via the serial interface.

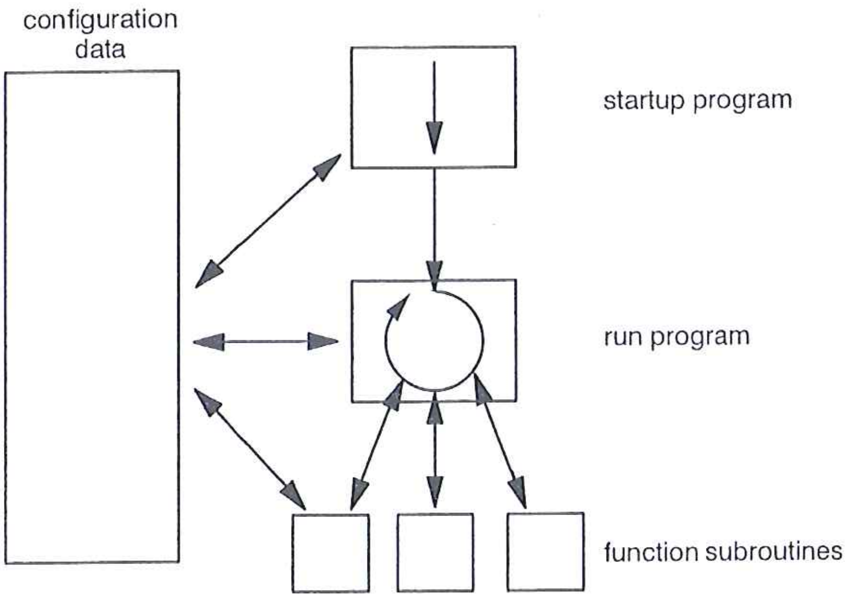


Fig. 5.1 Program structure

The run program is executed cyclically in a loop. Here, data are compared and checked, regular data exchange with the central unit is monitored and indications are set in the event of a fault. Various function subroutines are also called from this loop.

5.1.1 Reading in the circuit–breaker position checkback signals into the feeder unit

Each switchgear interlocking unit maintains a checkback image of all breaker position checkback signals of the feeder. This image is duplicated to increase safety. Each image is constantly updated by cyclic input of the checkback signal so that for feeder units with up to 14 switching devices values are written to one of the images (alternating) at intervals of 10 ms.

The assignment in the switching device between the slot in the isolation part and the position of the unit in the feeder image is performed by software marshalling and has to be configured.

5.1.2 Data exchange between the feeder unit and the central unit via the serial interface

Data exchange between the feeder and central unit is performed cyclically via a serial interface in asynchronous mode at 9600 baud. The transmission message is framed with d= 4 (cross parity). Because data exchange is cyclic, simple monitoring of the receiver and the transmitter of the remote station is possible.

The message has the following format (simplified):

feeder unit – central unit		horizontal parity by UART
startup message ID		
identifiers	feeder number	
information part		
longitudinal parity end of message ID		

central unit – feeder unit	horizontal parity by UART
startup message ID	
identifiers	
information part	
longitudinal parity end of message ID	

For switching devices that have to be interlocked against each other within a switchyard, a switchyard image of all breaker position checkback signals is kept in the central unit. This image is also duplicated for safety reasons. The cyclic data exchange between the central unit and each feeder unit means that these two switchyard images are updated alternately at up to 180 ms intervals for the maximum switchyard expansion (32 feeders).

The checkback signals are only frozen if a complete message is received without error.

Note: The message structure is not standardized so data exchange with other LSA components is not possible.

5.1.3 Scanning of command inputs

The command inputs are scanned cyclically at up to 30 ms intervals. A command input is valid if CLOSE or OPEN (exclusive) is applied via the control key and precisely one device selection is applied. If the switching operation is permissible after a double check of the interlock conditions, a valid command input is stored (command execution). During command output, only input of the counter command is scanned for, depending on the type of control. If the interlock conditions are fulfilled, the counter–control command interrupts the current command output if the switchgear operating mechanism permits it (see "Command execution").

5.1.4 Checking the interlock conditions

The microcomputer checks the interlock conditions before the switching operation. The switchgear position signal (bit pair) is examined for an intermediate position. If there is no intermediate position a check is made for a match with the selected final position of the switching device. If a CLOSE command is given for a device which is already closed, the fault indication F3 is set. If the switching command is permissible the interlock check is performed. The interlock check is fulfilled if all switching devices are in the required final positions. The positions of the keyswitches S2, S3 and S4 are also included in certain interlock checks.

5.1.5 Output of switching commands

The microcomputer controls a command output relay (motor circuit control relay) in three steps:

- enable for the switching device with the command input
- general enable of the switching operation by the microcomputer,
  setting the first latching relay
- single pole connection of the command output relay (CLOSE or OPEN) directly by the microcomputer,
  setting the second latching relay

A switching device can only be switched if a command input, i.e. confirmation of the device pushbutton or telecontrol commands are applied to the switchgear interlocking unit. As soon as the microcomputer has set both output relays during command input (two passes = setting two latching relays), command execution is active. Command output on the initiative of the microcomputer is not possible for this reason alone.

With command output, a time-out is started. The command is terminated when the selected position of the switching device has been signalled. If the switching device does not reach its final position, the command is only terminated after the programmed device operating time-out has elapsed and the appropriate fault indications have been set.

To prevent simultaneous output of switching commands in several feeders, the intermediate position of this switching device is communicated to the central unit after a sufficient delay before command output.

5.1.6 Performing test routines

The microcomputer–controlled switchgear interlocking system runs the following test routines automatically. These can display the error messages shown in brackets:

- cyclic triggering of a watchdog circuit
- program and data memory test
  (fault F1)
- time monitoring of the receiver and the data transmission line
  (fault F2)
- testing of the command output circuits before each command output and after every test call, including testing the coils of the output relay
  (error F5/ HR)
- monitoring of the circuit–breaker checkback signals (error F4)
- indication and display "circuit–breaker trip" (LSF), e.g. in the event of a protection trip

5.2 Method of operation of the units

General notes

Every switching bay that is equipped with a switchgear interlocking unit must be equipped with a PROTECTION CIRCUIT BREAKER FOR CONTROL AND CHECKBACK and a separate PROTECTION CIRCUIT BREAKER FOR MOTOR OPERATION.

The function of a switching operation via the microcomputer–controlled switchgear interlocking unit is described in the overview on page 5/11.

The microcomputer–controlled switchgear interlocking units are generally equipped for command execution of switching operations in normal modes.

As for the conventional switchgear interlocking units (8TH / 8TJ), the keyswitches S1 to S4 are required to enable higher level switching operations. The keys can only be withdrawn from the lock in the zero position. The electronic switchgear interlocking unit also contains a three–position switch S5 with the functions remote control / local control / feeder disconnected. This switch is also a keyswitch, but the key can be withdrawn in any of the three positions.

If the unit is operated by "remote control", the steady light switch RL must be off, i.e. the lamp of the switch itself, the lamps of the control keys CLOSE/OPEN, and all intermediate position lamps (LEDs) are off. In this way the power consumption of the unit can be reduced to a minimum. Before local operation on the unit a suitable sequence of operations must be observed. The three position switch is switched from the "remote control" position to the "local control" position. By operating the steady light switch the lamps RL, EIN, AUS and all LEDs are switched on. If one of these LEDs is off without a fault message F1 to F6 being displayed, it is necessary to press the acknowledgement key QUIT. The pushbutton QUIT also has the function "lamp test" for the LEDs on the ABB module. If one LED remains off it is defective and the module might have to be replaced. If one of the pushbuttons RL, EIN or AUS is off, the defective lamp in the pushbutton must be replaced.

5.2.1 Normal operation

During normal operation the power supply is on and the keyswitch S1 is not operated. In the standard version of the interlocking unit we recommend the control mode "REMOTE CONTROL ON / LOCAL CONTROL OFF"; which is set on the manual control module (FGB) (see also page 5/16). If the three position switch is in the REMOTE position and this standard jumper B–C is inserted, commands are only accepted from the local / remote control (see overview, page 5/11).

REMOTE CONTROL

Remote control is implemented as a two–pole control. Using two higher level optocouplers per feeder combination for the control direction CLOSE or OPEN and one optocoupler per switching device connected in the series, control is performed via a conductor saving connection of the control lines. This ensures that if an optocoupler is defective no switching command can be executed (Fig. 5.2).

LOCAL CONTROL

If switch S5 is in the LOCAL position switch conditions can only be performed by manual operation on the unit (see circuit diagram page 5/11). The REMOTE / LOCAL position can be signalled to the higher level control, e.g. as a "remote control on/off" indication via floating changeover contact of a latching relay. This switch position is also signalled to the microcomputer as the input signal "MCE LOCAL" via an optocoupler.

Example: Closing a switching device

For example, if you want to close a switching device via local control CLOSED, you must perform the two-handed operator action of pressing the higher level control key CLOSE (–S9) and the switching device key, here, for example, –S11. By means of an optocoupler the required switching direction is signalled to the microcomputer via the microcomputer input "MCE CLOSE". The contact of the switching device key is multiplied with the aid of the key auxiliary relay –K7 and the intention to close the switching device is signalled to the microcomputer via the optocoupler "MCE Q...".

The monostable relay "MCA ENABLE L+28 V" is the first safety level in the command output circuit in correct operation.

Only if precisely two command inputs (MCE CLOSE and MCE Q...) are recognized by the microcomputer does the interlock check begin. If more than two keys are pressed or if two identical keys are recognized (e.g. both control keys and / or two switching device keys) the microcomputer immediately detects the incorrect command input and outputs the error message F (see page 5/18).

If input is performed correctly, the microcomputer checks the checkback of this switching device. If the checkback signal does not match the switching direction (for this closing operation the checkback signal must be OPEN), the checkback signal OPEN in the feeder image is overwritten with the information INTERMEDIATE POSITION. This INTERMEDIATE POSITION is communicated to the central unit (coupler bay) and stored in the switchyard image so that switchyard interlocking is ensured before the microcomputer begins with the second interlock condition check for the unit to be switched. Illogical switching commands, e.g. close command for a closed device are detected and rejected by the microcomputer and the error message F3 is set.

If the command input is logical, the microcomputer performs the first internal or external interlock check with the first feeder or switchyard image. After this, all circuit–breaker position checkback signals in the second feeder and switchyard image are updated by the microcomputer and a second interlock check is performed with this new checkback image during command input. If both interlock checks are positive, the first latching relay MCA ENABLE L–48V is set by the microcomputer. Now a destination check is performed to see if this is the only command input assigned to that latching relay which is applied. If the destination check is positive, the microcomputer sets the second latching relay MCA CLOSE.

The monostable relay –K5 is excited; the motor circuit control relay –K1 CLOSE is connected and the command is executed via its contacts.

At the same time the optocoupler for controlling the intermediate position lamp on the interface and control module of the device to be switched is set by the microcomputer so that the intermediate position lamp blinks during the entire device operating time. With the command output, the motor circuit command relay –K1 is set, command execution becomes active, the motor drive of the switching device is switched via floating contacts of the relay –K1 and the device run time monitoring is started in the microcomputer.

A command input duration of at least 500 ms is required before the relay contacts –K1 are closed or until command execution has been established.

If the switching device has reached the selected switch position (here CLOSE), the circuit–breaker position indicator –H11 and the checkback relays –K9, –K13 are actuated via an auxiliary switch contact. The closing operation is acquired via the microcomputer input CHEKCBACK MCE CLOSE and the device operating time monitoring is reset by the microcomputer and the relays –K1, –K5 terminated. The new circuit–breaker position checkback signal is acquired in the feeder image and transmitted to the central unit via the serial interface where it is stored in the switchyard image. When the circuit–breaker position indicator –H11 switches over and the intermediate position lamp has a steady light the switching operation has been completed.

If operation is not performed correctly, the switching operation is cancelled after a timeout and the error message, F4 and / or F6, is set. The associated intermediate lamp continues to blink. In this way, a unique assignment of an error to a switching device is possible. If you press the acknowledgement key ACKNOW you can clear the error messages and the intermediate position lamp lights up again (lamp test).

Dynamic errors such as F6 in this example, remain reset. Static errors that still exist after acknowledgement, here, for example, the intermediate position of the switching device, are detected by the microcomputer immediately. This responds by setting the error message F4 again and having the intermediate position lamp of the switching device affected blink (see "Systematic fault analysis" page 9/1).

A switching operation in "REMOTE CONTROL" is performed analogously to the closing operation under local control; instead of the control pushbutton of the switching device and the switching direction pushbutton CLOSE / OPEN, telecontrol optocouplers are switched as stated on page 5/5.

5.2.2 Operation without interlocking (S1 operation)

CAUTION !

In operation without interlocking, i.e. bypassing the interlocking conditions with the total interlock cancellation switch S1 to execute emergency switching operations under the responsibility of the operating personnel, a distinction is made between two control modes:

- S1 – remote interlock cancellation
- S1 – interlock cancellation at the switchgear interlocking unit

Switching operations without interlocking via the switchgear interlocking unit might be required if a disabled switching operation has to be performed for operational reasons and the interlocking must be temporarily cancelled.

S1 – remote interlock cancellation

The switching of the microcomputer controlled switchgear interlocking unit has been structured in such a way that total interlock cancellations S1 – REMOTE can only be performed if the position of the three–position switch S5 is REMOTE. These switching operations are performed in a similar way to the remote control commands for normal operation but without checking the interlocking conditions via the microcomputer and the corresponding outputs. The intermediate position and the changed circuit–breaker position are stored in the feeder / switchyard image so that if S1 – remote interlock cancellation is applied to a feeder, the switchyard interlocking is ensured for the other feeders.

S1 – interlock cancellation at the switchgear interlocking unit

With total key interlock cancellation S1 – LOCAL switching operations without interlocking can also be performed with the three–position switch in the remote control position, i.e. operation of this keyswitch on the unit has priority. Because of the two-handed operation on the unit the function for S1 interlock cancellation is implemented as a switch, the key itself can only be withdrawn from the lock in the basic position (normal operation). By switching over contacts the control pushbutton CLOSE / OPEN (–S9/–S10) and the switching device pushbutton (–S11) are connected directly to the 48 V DC of the power supply. A switching operation can be initiated by pressing the control key CLOSE (–S9) or OPEN (–S10) and a switching device key (e.g. –S11). The keys switch the motor circuit control relay ON / OFF (–K1/–K2) directly. The keys must be pressed during the whole operating time of the switching device, i.e. no command execution is active. If command input is interrupted the switching device remains in its previous position. Once the selected final position has been reached the switching command is terminated by the checkback relay –K13/–K14 and the circuit–breaker position indicator with bar indicator –H11 moves. The keys can now be released. For this type of S1 operation, too, the keys are connected in such a way that incorrect operation of the keys does not execute any command or terminate any current switching operation.

Caution: When the keyswitch total interlock cancellation S1 – LOCAL is switched over, the steady light of the intermediate lamps is switched off; the switching operation executed is only visible by the changing position of the bar display.

As with S1 remote interlock cancellation, in fault-free operation of the microcomputer the intermediate position and the changed switch position are acquired via the microcomputer inputs CHECKBACK MCE CLOSE / OPEN and stored in the feeder / switchyard image in S1 interlock cancellation of the unit as well.

Caution: With switching operations without interlocking, differential positions between a high voltage unit and the stored checkback image can occur!
The switching operations are the exclusive responsibility of the operating personnel!

5.2.3 Feeder shut down

A function is assigned to the third position of the three–position switch that is required as part of the overall switchyard to maintain switchyard interlocking.

For the purposes of disconnecting or inspecting a bay or switchyard section the intentional shutting down of one or more feeder units might be required. To prevent other feeders and switchyard sections being blocked the switchyard interlocking must be maintained. For this reason, the following sequence must be observed when shutting down a feeder unit.

The switching devices of the feeder must be positioned in the required final position. By switching the three–position switch to the OFF position (feeder shutdown), the microcomputer of the feeder transfers the circuit–breaker position signal input of all devices in the feeder image to the central unit. No commands from the local / remote control or from operation on the unit are accepted. No S1 operation (operation without interlocking) is possible in this key position. The serial data transmission line between the feeder unit and the central unit must be disconnected. The switchgear interlocking unit can be shut down completely by switching off the power supply module.

The central unit checks the interlocking conditions with the breaker positions stored in the switchyard image of the shut down feeder.

If it is necessary to switch the high voltage switchgear of the feeder during inspection work, it is possible to select one of two control positions on the switchgear interlocking unit:

- partially interlocked operation for local control on the switchgear interlocking unit
- S1 operation without interlocking for local control on the switchgear interlocking unit

Partially interlocked operation for local control on the switchgear interlocking unit

The three position switch is switched from the OFF position to local control. When the power supply is restored, the microcomputer begins with a cold restart and acquires the breaker positions in the feeder image. After the test run the error message F2 is set because the serial data transmission line is not connected.

Now switching operations can be performed on this interlocking unit and interlock conditions are checked, i.e. only those switching devices are enabled that are only subject to the feeder interlocking (e.g. circuit–breakers, working earthing switches, load interrupters, etc.). Switching devices that depend on enabling from the central unit remain disabled (e.g. busbar, auxiliary busbar disconnector).

S1 operation without interlocking for local control on the switchgear interlocking unit

In the local control position all switching devices of the feeder can be operated by additional switchover of the total interlocking key S1. This can cause differences in the checkback image of the feeder and the image stored in the central unit that might make incorrect switching possible!
(CAUTION! Personal responsibility for the switching operation.)

5.2.4 Command execution

In normal operation the microcomputer–controlled switchgear interlocking unit always works with command execution. Command input must last for the minimum command time of approx. 500 ms at the switchgear interlocking unit before retention becomes active.

In order to influence a switching operation during the device operating time, one of the following parameters can be selected

- first counter–control command: reversal
- first counter–control command: STOP; second counter–control command: reversal
- forced command execution

One of these planning entries must be specified when selecting the order number for programming.

First counter–control command: reversal

During command execution the microcomputer monitors command input for the counter–control command. The switching operation is cancelled immediately if the counter–control command is detected and the reversal of the switching device is performed immediately. This control mode is possible for motor drives with a reversing drive.

First counter–control command: STOP; second counter–control command: reversal

If immediate execution of the counter–control command is not required, this can be taken account of in the programming such that the first counter–control command interrupts the switching operation (STOP) as the second counter–control command causes reversal of the switching device. With this control mode it is important to note that non-reversing motor drives can only perform this switching operation via the first switching position selected in the direction of the second counter–control command because of their mechanical characteristics (e.g. a switching device is to be closed, the first counter–control command causes a STOP, on the second counter–control command the switching device is reversed into the OPEN position via the CLOSED position without any interruption). Checking the interlock conditions ensures protection and therefore reliability of the switching operation.

Forced command execution

In parameterization of a forced command execution, a permissible switching command is executed and the switching operation is completed in the selected final position of the switching device. A counter–control command during the device operating time is not accepted. This control mode is intended for all types of motor drives and is the standard.

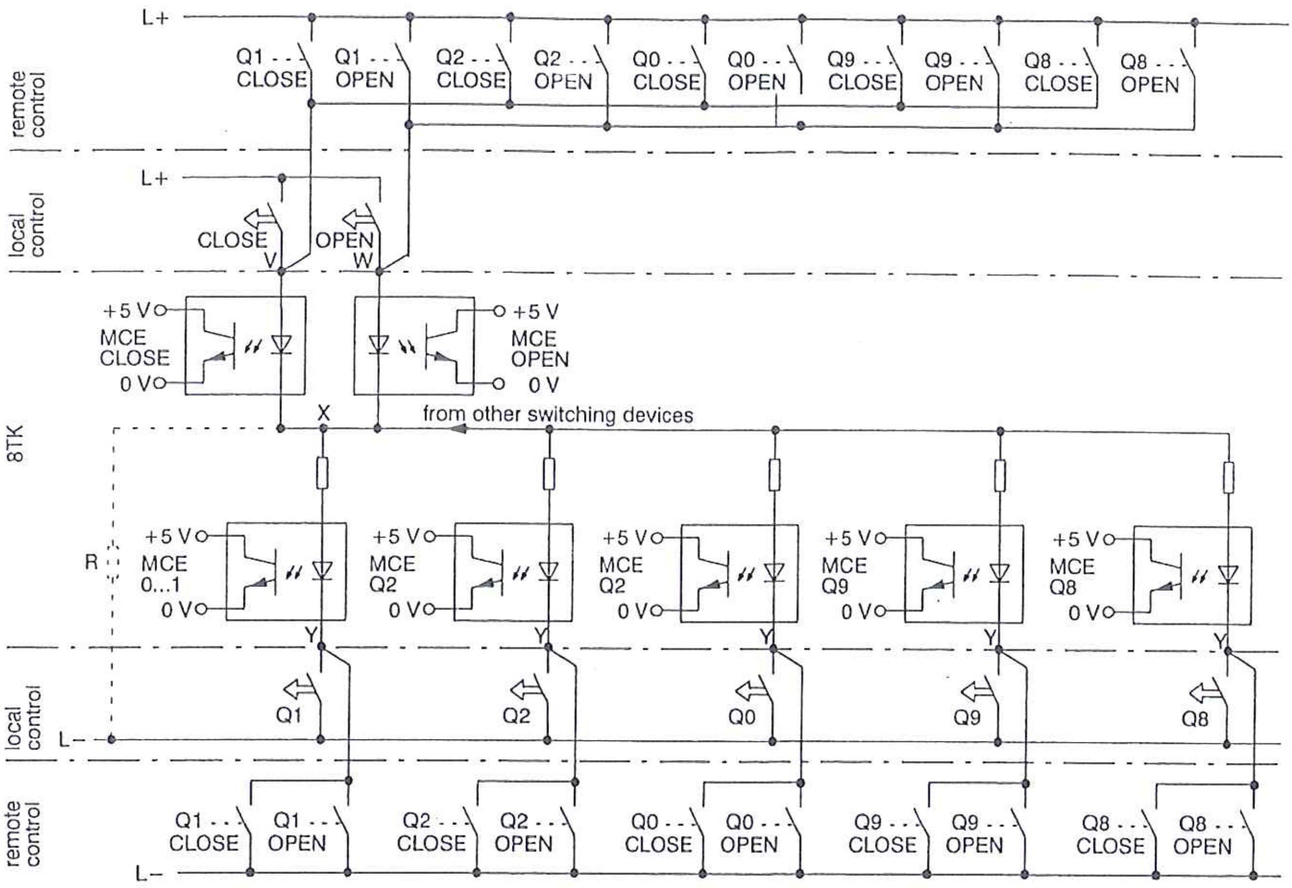
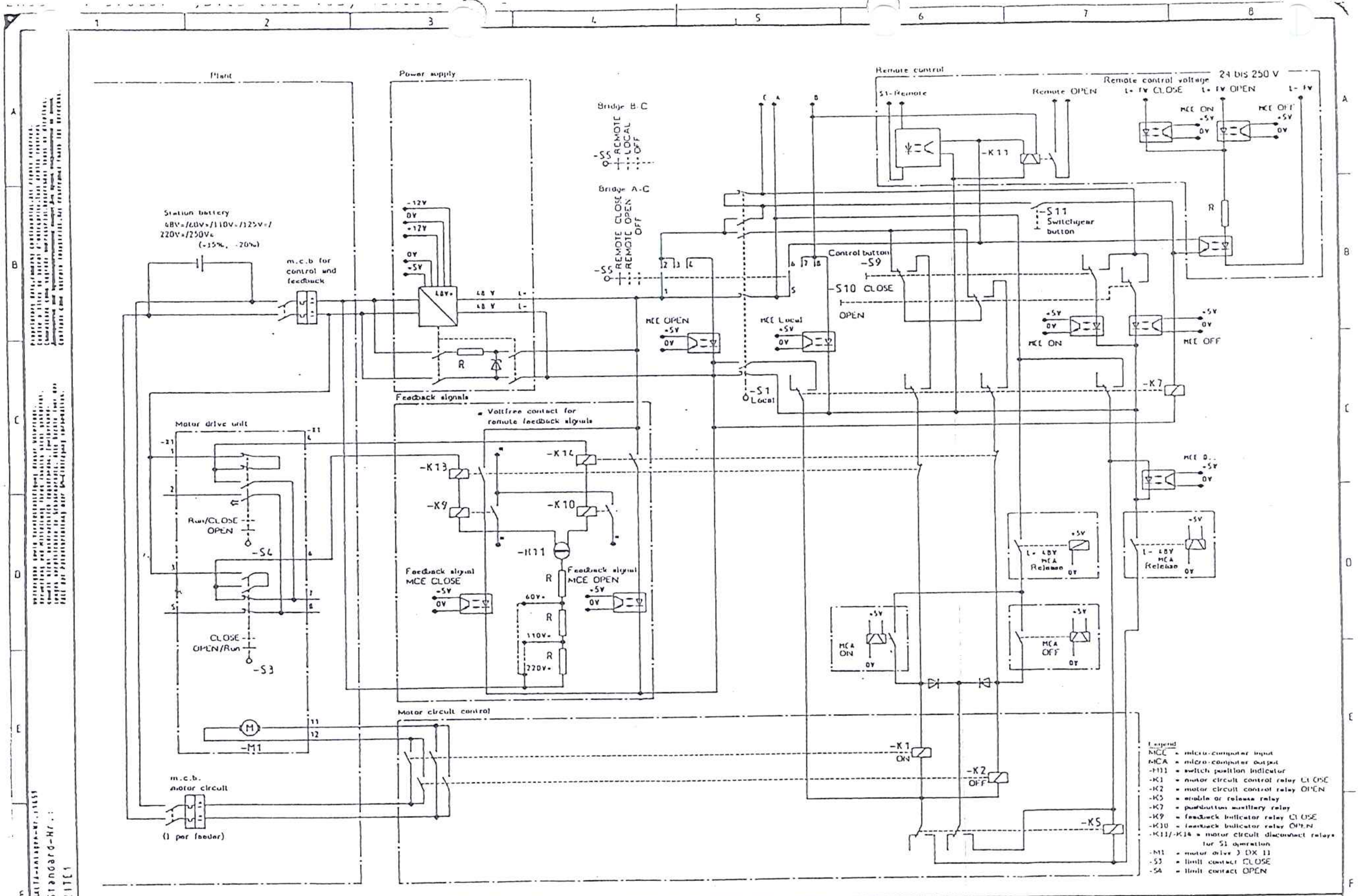


Fig. 5.2 Local / remote control, actuation

Caution!

The remote control voltage must only be connected to terminals V (L+ CLOSE), W (L+ OPEN) and Y (L– switching device selection). This also applies to voltage / current measurements for test purposes. The "node" X contains internal wiring and must not be disconnected and / or connected.



Datum	31.07.84	Fig 12	Simplified circuit diagram	Siemens AG	Micro-computer based interlock unit
Bearb.	ZIXT				
Gepr.					
Norm		Urspr./Ers. f./Ers. d.			Blatt / Bl.

Just. | Aenderung | Datum | Name

Standard-Nr.: 21TE1

5.3 Method of operation of the switchgear interlocking modules

5.3.1 Interface and control module (ABB)

5.3.1.1 Version supplied until 9.93

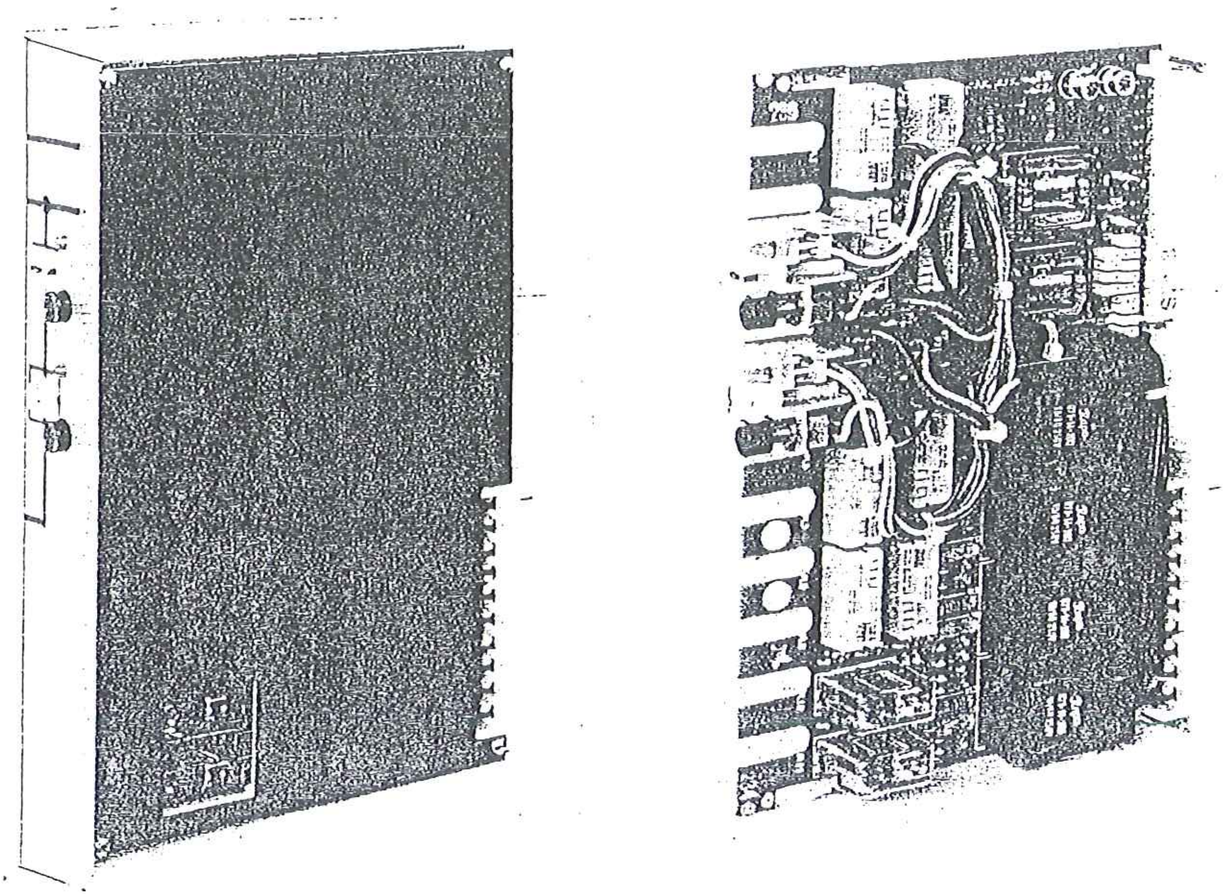


Fig. 5.3 Interface and control module, with and without shielding plate, front panel

The method of operation is explained using the block diagram (Fig. 5.4). The circuits for command input and output and for acquisition and display of the circuit–breaker position indications are identical on the module for both switching devices.

Command input

The type of command input depends on the position of the keyswitch REMOTE–LOCAL–OFF on the manual control module.

Two types of command input are possible:

- pressing the device key (16) locally
- via the telecontrol input (18)

In both cases the key auxiliary relay responds and provides a processing signal to the microcomputer on the microcomputer module (BSF).

The telecontrol input (18) is designed for an input voltage range of 24 V to 60 V with a common P connection and connected to a varistor for protection against overvoltages.

The other contacts of the pushbutton auxiliary relay are used for the double operating disable for S1 operation (emergency switch operation) in which the arcs of the output relay (12) are directly excited by a command input. Depending on the switching status of the keys CLOSE and OPEN on the enable module, one of the two contacts (15) switches either L+48 V (S1) CLOSE or L+48 V (S1) OPEN immediately onto the selected output relay. A further antiparallel contact (16) connects the common M pole of the output relay with M48 V.

Command output

Two types of command output are possible:

- S1 operation under the responsibility of the operating personnel (see 5.2.2)
- microcomputer-controlled command output

With microcomputer controlled command output, after a command input L+48 V has been detected and processed it is switched to input (9), input (10) is still highly resistive. After the test routines of the microcomputer have run, M48 V is switched to input (10) so that the command output auxiliary relay (13) picks up. The lower connection of the command output relay (12) is therefore switched to low resistance after M48 V and the command output relay also picks up. The command output circuit therefore becomes retentive. Command input must continue until this time. Because the command output auxiliary relay (13) picks up, direct scanning of the device key (or telecontrol command input) is possible (important for scanning and counter command). To terminate the command, the microcomputer switches (9) and (10) to high resistance.

Breaker position signal

The circuit for acquiring the breaker position signal consists of two identical circuits, switching device CLOSE / switching device OPEN (4) with common M connection. In the M connection a resistor (8) is used to adapt the voltage. This resistor is located in the cover of the heavy current connector.

A series of switched, low-power board relays (6) are used for potential conversion. A Zener diode is switched parallel with each relay that performs the task of a spark quenching diode in the forward direction and is used for voltage limitation on the relays in the breakdown direction. Moreover, it is ensured that if a relay coil is interrupted the other part of the circuit remains functional. Varistors are used for protection against destruction of the circuit by overvoltages.

An open-circuit contact of the relay (3) is used to acquire the breaker position signal by the microcomputer, another working contact (5) provides a common isolated potential at the heavy current connector. The closed circuit contacts (11) of the relay (6) terminate the S1 command when the breaker position signal arrives or do not permit a command in the direction of the current final position.

For local display, a bistable semaphore (7) is inserted in this series connection. Here to, a zener diode prevents loss of other information because of a defect in the display.

Intermediate position lamps (LEDs)

The intermediate position lamps (2) are two yellow diodes connected in series whose common center and two end points are connected to the 48-way connector. The intermediate position lamps are controlled by the input / output module (EAB).

The resistor (1) is used to adapt the total series resistance of the series circuit to all intermediate position lamps to the number of isolating and control modules.

The intermediate position lamp is lit when the steady light switch is operated (see enable module) at the final positions of the high voltage switchgear.
In the intermediate position (no / double checkback), for example, this LED blinks at a frequency of approx. 1 Hz during the whole device operating time.

Soldered jumpers (see also Section 12)

Ju. 1: End of the antiparallel M48 V loop for S1 operation

Ju. 2: End of the series circuit of the intermediate position lamps

5.3.1.2 Version as supplied from 10.93

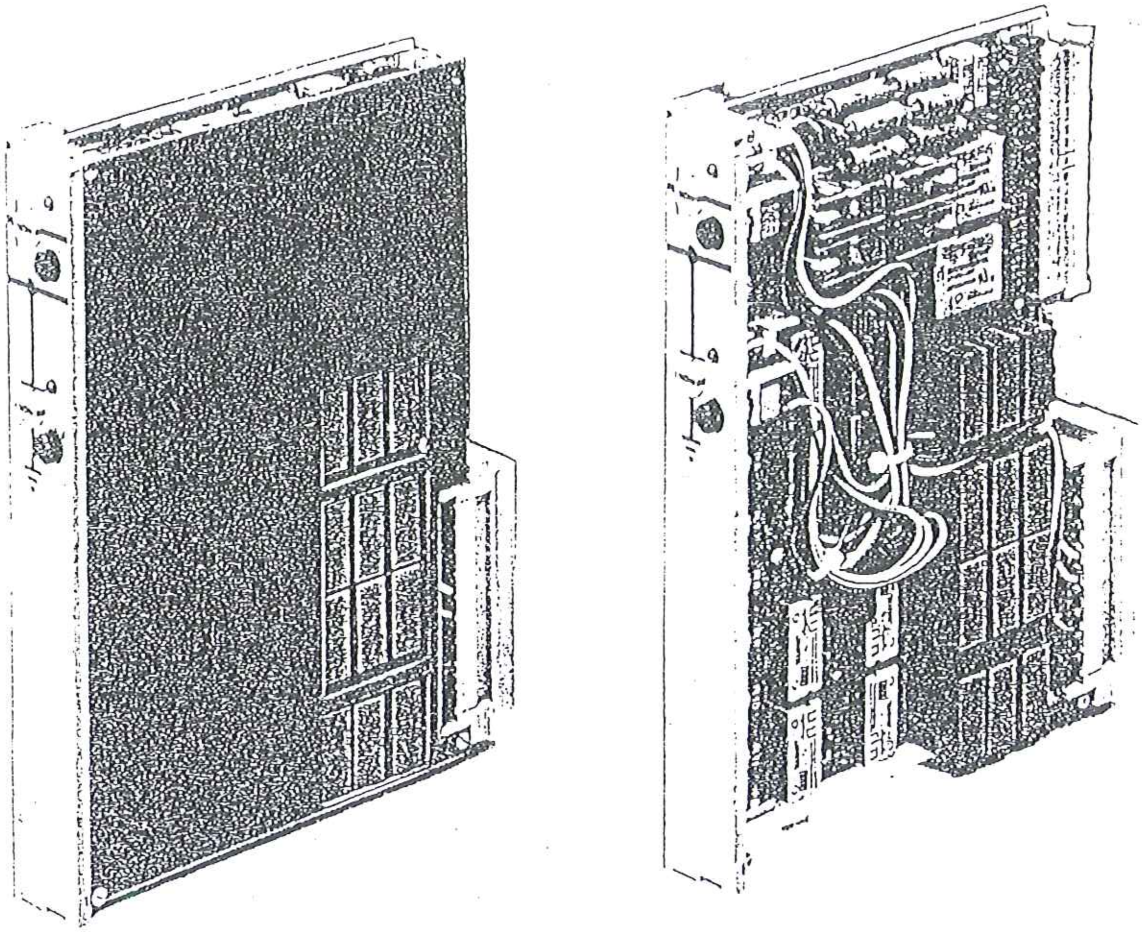


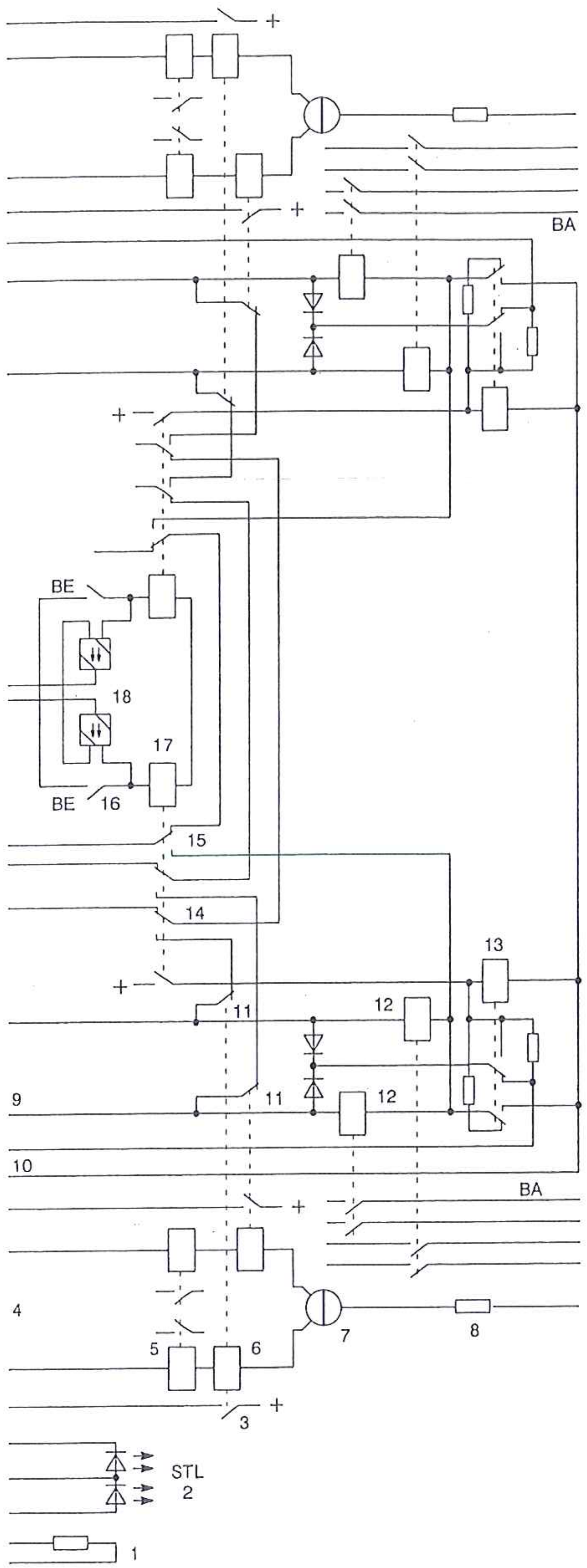
Fig. 5.4 Interface and control module with and without shielding plate

The method of operation is analogous to the functions described in Section 5.3.1.1.

In addition:
1. telecontrol inputs extended
2. capture circuit for 200 ms pulse control, only in conjunction with SW version > 3.0

Concerning 1.
The telecontrol input is designed for an input voltage (24, 48, 60, 110, 125, 220, and 250 V) with a common P connection and is connected with a varistor for protection against overvoltage.

Concerning 2.
For acquisition of telecontrol pulses ≧ 200 ms < 500 ms, the module has been redesigned. The short–time pulses are acquired with software support (SW > 3.0) and the command output relay is set after all tests have been concluded.

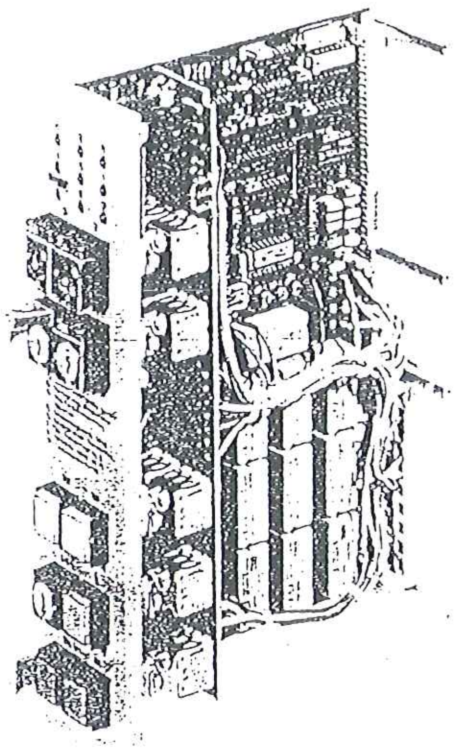


1 parallel resistor for adaptation of the intermediate position lamp
2 intermediate position lamps STL
3 breaker position signal for MC
4 breaker position signal from the switchyard
5 breaker position signal for telecontrol
6 alarm relay
7 bistable breaker position indicator
8 series resistor for alarm relay
9 MC command output for device Qn/Close
10 MC command enable
11 terminating contacts for S1 operation
12 command output relay
13 command output auxiliary relay
14 P contacts for S1 operation
15 M contact for S1 operation
16 command input key
17 key auxiliary relay
18 telecontrol command input

Fig. 5.5 Block diagram of the interface and control module (ABB)

5.3.2 Manual control module (FGB)

Version as supplied until 9.91



Version as supplied from 10.91

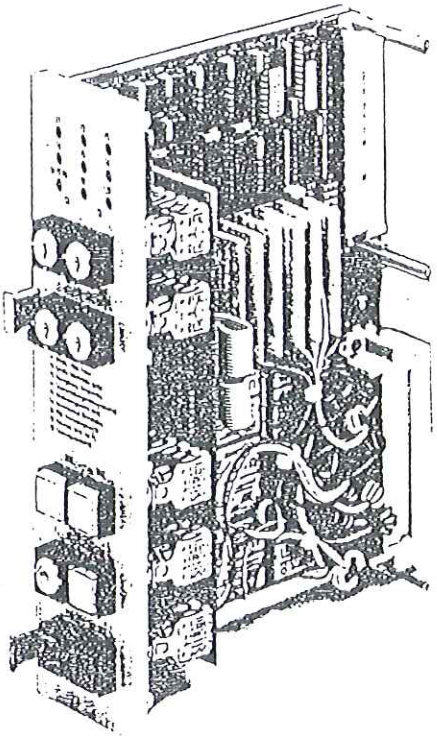


Fig. 5.6 Manual control module without shielding plate

The method of operation is explained using the block diagram (Fig. 5.7).

Bus coupling

The control signals RD (read) and WR (write) are fed through a 2–to–4 decoder (10) to the FGB. This prevents simultaneous occurrence of RD and WR on the module. The ALE signal (address latch enable) is decoupled via a simple TTL gate.

The data bus is fed to the FGB via a bidirectional TTL driver (3). The direction of the flow of information is determined by the reading signal RD, the general enable of the driver (3) is performed by the address decoder (5).

The information of the address bus is stored directly on FGB with signal ALE (4).

Address decoding

Address decoding (5) compares the stored address bits with a set bit combination. This bit pattern is permanently assigned via the edge connector in the backplane wiring (9) in the switchgear interlocking unit.

If the address bits and the general module enable are identical, an enable signal is generated on the module addressed. This signal enables the data bus driver and a 2–to–4 decoder.

Reading / writing the ports is performed with the control signal RD and WR.

Function of the operating elements

Designation		Function
S 1	(1)	CAUTION! Total interlock cancellation, control of the output relay directly by keys, i.e. without checking the interlock conditions possible; microcomputer without function. Switching operation under personal responsibility.
S 2...4	(8)	Information for software interlock cancellation of certain switching devices.
R–L–O S 5	(2)	Remote–Local–Off keyswitch; hardware and software switchover of the enable for command input.
TEST	(13)	Call to perform test routine
ACKNOW.	(13)	Call to reset all errors displayed
IND. ON/OFF	(14)	Steady light switch; hardware switch–on of all intermediate position lamps.
CLOSE, OPEN	(11)	Direction of operation selection for command output

Acquisition of the operating elements

The switching states of all mechanical operating elements in the front panel (1, 2, 8, 11, 13) with the exception of the steady light switch (IND. ON/OFF), are provided to the microcomputer via input ports 1 and 2 (6, 12). The 48 V switching voltage of the operating elements is converted to the 5 V level via optocouplers (15). A filter is connected to all optocouplers on the secondary side to suppress interference pulses and contact chattering times (up to approx. 10 ms).

Telecontrol inputs

The telecontrol inputs (24 V...60 V, as of supply date 10.91 24 V...250 V) are converted to the internal 48 V level using optocouplers (16). The telecontrol inputs for TEST and ACKNOW are connected parallel to the front operating elements on the 48 V side. Telecontrol CLOSE and telecontrol OPEN are led to port 1 as a second channel (for the local inputs). All telecontrol inputs are equipped with varistors for protection against overvoltage.

Direction display

The direction of a switching device for a command output controlled by the microcomputer is displayed by extinction of the appropriate lamp in the CLOSE or OPEN key (11). These 48 V lamps are controlled via port 3 (17) using a monostable miniature relay (18).

Fault and alarm display

Faults are displayed on the front panel by means of red LEDs (20). They are registered one after the other, if necessary, by port 4 (21) via a BDC–to–decimal decoder in a D–flip–flop (22) and are then steadily active. It is only possible to reset all faults together.

The three alarms (S1 remote, LRD, CBT) are displayed using yellow LEDs (19). The alarms S1 remote and CBT are controlled directly from port 3 (17), alarm LRD from port 4 (21).

The front displays (19, 20) have the following functions:

Designation	Function (see also 9.2.2: Fault displays and indications)
F 1	Fault 1: EPROM / RAM fault
F 2	Fault 2: function of the serial interface disrupted
F 3	Fault 3: interlocking command input fault
F 4	Fault 4: breaker position indication defective
F 5	Fault 5: command output circuit defective
F 6	Fault 6: device travel time exceeded
S1 REMOTE	total interlock cancellation S1–REMOTE activated
LRD	supplement to Fault 5: latching relay defective
CBT	alarm circuit–breaker trip (LED steady light: contact LSF 100 ms transient pulse)

Fault and alarm output

Faults 1 to 6 are provided isolated at a contact (24) from bistable 5 V PCB relays (23). The relays are controlled from port 4 (21) via a BCD–to–decimal decoder (23). The relays must be reset in pairs.

The alarms S1–REMOTE and CBT are also provided at the contacts of bistable 5 V PCB relays (25)(24), that are controlled from port 3 (17).

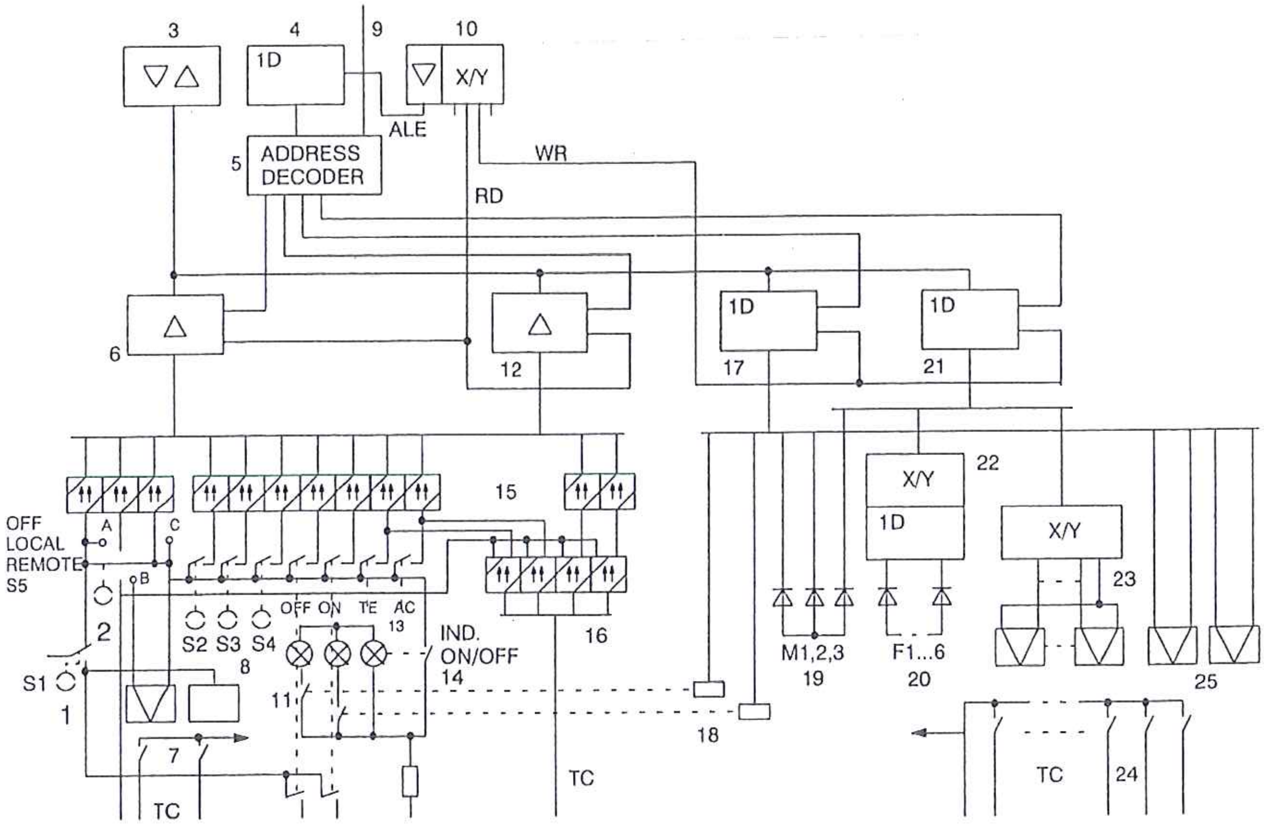
The positions of the keyswitches S1 (1) and R–L–O (2) are acquired using PCB relays on the 48 V side. The switching state of the R–L–O keyswitch is stored during voltage failure.

Test routine

If you press the TEST pushbutton either only the LEDs or the LEDs and the alarm contacts are set depending on the control mode (jumper B–C or A–C) by the test routine (see also Section 12, FGB).

The control mode is set by jumper B–C or A–C :

jumper B–C 8TK3002 – 1/3/5/7 **00	jumper A–C 8TK3002 – 2/4/6/8 **00	keyswitch position
remote control ON, local control OFF	remote control ON, local control ON	REMOTE ●
remote control OFF, local control ON		LOCAL ○
feeder disconnected: remote control OFF, local control OFF		OFF ■



1 S1 total interlock cancellation
2 REMOTE–LOCAL–OFF keyswitch S5
3 bidirectional bus driver
4 memory for address bus
5 address decoding
6 input port 1
7 telecontrol signals S1, R–L–O
8 keyswitch S2, S3, S4
9 module address
10 control bus decoupling
11 CLOSE/OPEN pushbutton with direction display
12 input port 2
13 TEST, ACKNOW pushbutton
14 steady light switch
15 optocoupler inputs
16 telecontrol inputs
17 output port 3
18 miniature relay for direction control
19 LEDs for S1–REMOTE, LRD, CBT
20 LEDs for faults 1...6
21 output port 4
22 control for fault LEDs
23 miniature relay for fault alarms
24 contacts of the telecontrol signals
25 telecontrol signals for S1–REMOTE and CBT

Fig. 5.7 Block diagram of the manual control module (FGB)

5.3.3 Input / output module (EAB)

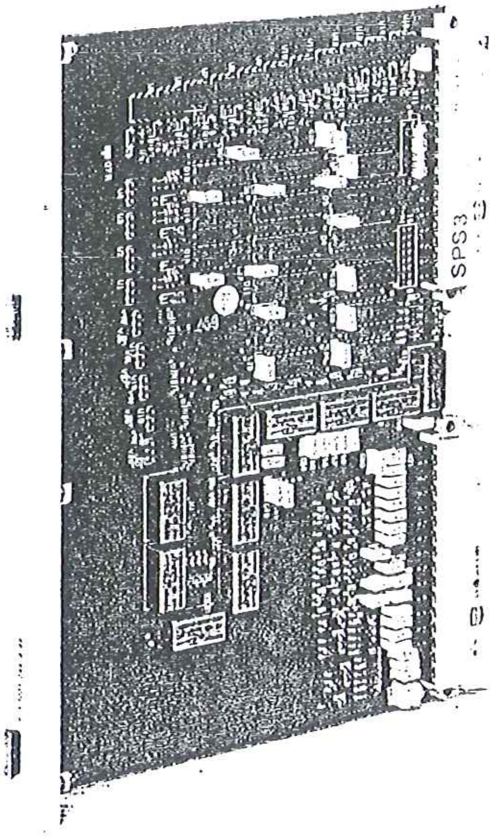


Fig. 5.8 Input / output module

The operating method is explained using the block diagram (Fig. 5.9).

Bus coupling

The control signals RD (read) and WR (write) are led to the EAB vi a 2–to–4 decoder (8). Simultaneous occurrence of RD and WR is therefore prevented on the module. The ALE signal (address latch enable) is decoupled via a simple TTL gate (8).

The data bus is led to the EAB via a bidirectional TTL driver (1). The direction of the information flow is determined by the read signal RD. The general enable of the driver (1) is performed by the address decoding (4).

The information of the address bus is stored directly on the EAB with the ALE signal (3).

Address decoding

Address decoding (4) compares four stored address bits with a set bit combination. This bit pattern is assigned permanently in the interlocking unit via the edge connector in the backplane wiring and depends on the slot (5).

If all four bits and the general module enable are equal an enable signal is generated on the module addressed. This signal enables the data bus driver and a 2–to–4 decoder.

Reading / writing to the ports is performed with the RD or WR control signal.

Optocoupler inputs

The EAB contains 15 optocoupler inputs (13) that must be read in by the microcomputer via ports 1 and 2 (11, 12). The switching state of the device keys on the ABBs is applied to the five optocouplers on the primary side. The other optocouplers are used to acquire breaker position checkback signals. A filter is connected to all optocouplers on the secondary side to suppress interference pulses and relay chatter times (up to 10 ms).

Optocoupler outputs

Port 3 (9) is used to control five intermediate position lamps (STL1–5). Low active optocoupler outputs (10) whose series connected collector-emitter lines are in parallel to the intermediate position lamps (LEDs) must be addressed. In order to maintain the function of the remaining LEDs if one series connected LED should fail, a zener diode must be connected parallel to each collector-emitter line.

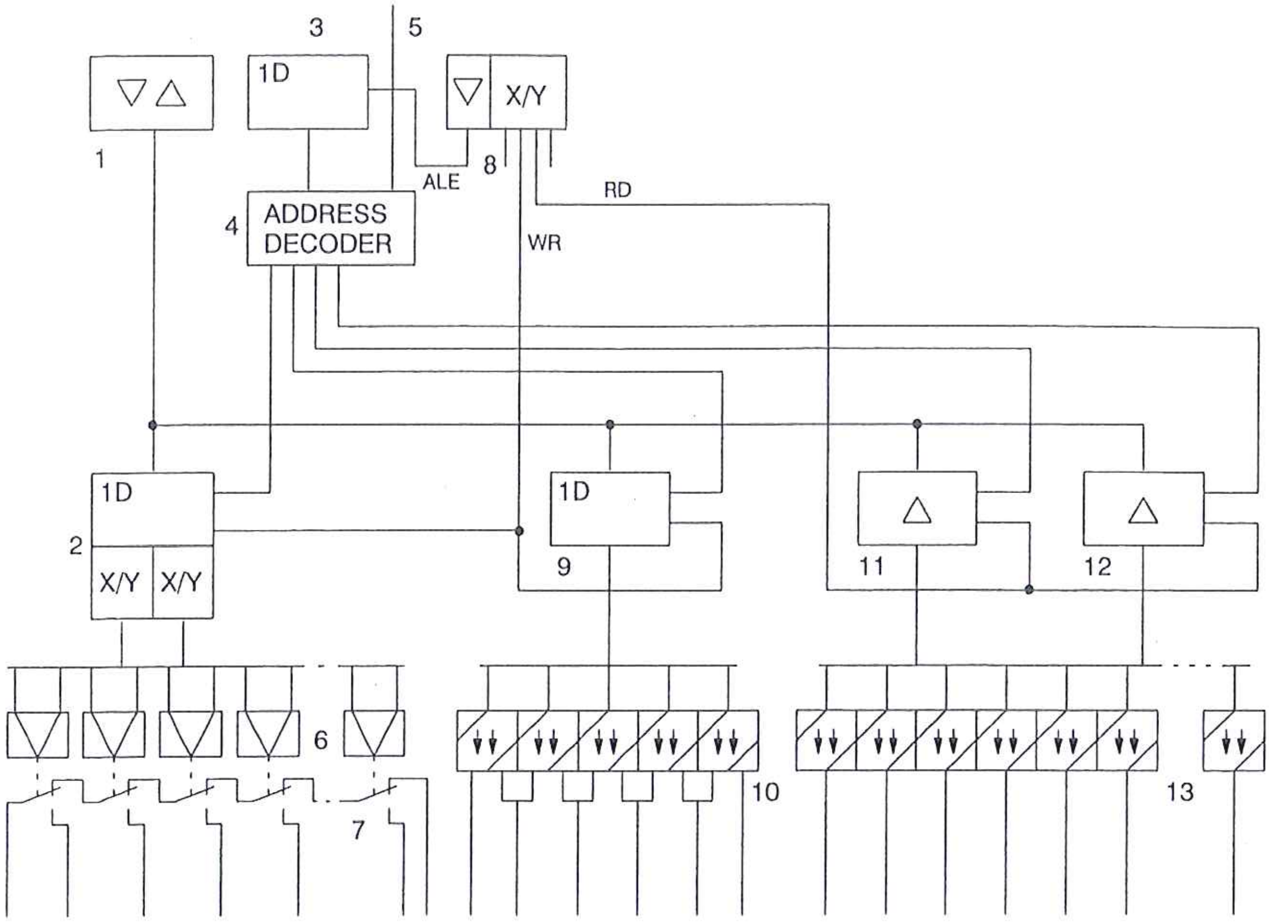
Latching relay outputs

Bistable miniature relays (6) are used to control the command output relays on the ABBs. Simultaneous control of several command output relays is prevented by series connected contacts (7) (1 out of n). The normal position of all latching relays can be scanned by the microcomputer.

The energizing sides of the relays are grouped together to form two function blocks each of which can be addressed separately via a BDC–to–decimal decoder (2). For example, all relays for control direction CLOSE can be set or reset via port 4, D0...3 and all relays of control direction OPEN via port 4, D4...7.

Soldered jumpers

The end of the contact series connection of the latching relays must be set with soldered jumper 1. This jumper is only inserted on the left–most EAB.



1	bidirectional data bus driver	7	contacts of the latching relays
2	output port 1	8	data bus decoupling
3	address memory	9	output port 2
4	address decoding	10	optocouplers for controlling the device lamps
5	external module address	11	input port 1
6	latching relay to control	12	input port 2
		13	optocoupler for acquiring checkback and command inputs (5 each)

Fig. 5.9 Block diagram input / output module (EAB)

5.3.4 Microcomputer module (BSF)

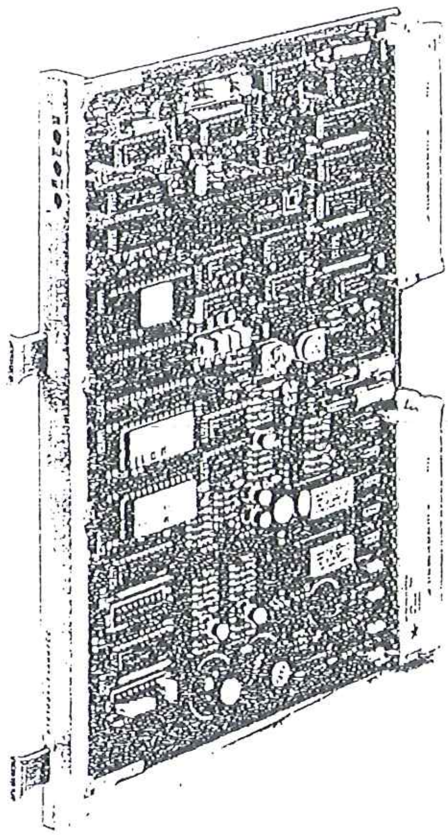


Fig. 5.10 Microcomputer module, without cover

The method of operation is explained using the block diagram (Fig. 5.11).

The microcomputer module is equipped with the 8031 microcomputer (8). It has access to a data memory (RAM) (13) with 1 K x 8 bit and four program memories that are designed either as 4 K, 8 K or 16 K x 8 bits EPROM (14). The memory capacity is set using jumpers on jumper base X2. A fixed address range is assigned to each memory.

The nominal access time of the memory (EPROM) is max. 250 ns.

Bus systems

Because the microcomputer used has an address / data bus with multiplex operation, it is necessary to buffer the lower eight address bits with the control signal ALE (address latch enable) (12). The lower six of these stored addresses are led to the upper connector decoupled via TTL power drivers (15).

The data bus of the microcomputer is also led to the upper connector via a bidirectional TTL power driver (9). The direction of the flow of information of the driver is determined by the read signal (RD) of the microcomputer and by the most significant address bit (A15). This address bit distinguishes between

- read / write from peripherals on the BSF
- read / write from module ports.

The control bus consists of four signals (ALE, RD, WR, PSEN) of which three (ALE, RD, WR) are led to the upper connector decoupled via TTL drivers (16). The ALE signal is delayed by approx. 80 ns beforehand in order to ensure reliable storage of the address on the modules. To ensure addressing in the central unit from the serial interface modules, the interrupt lines of the BSF are led out on the upper edge connector (18).

Jumper bases

All higher level functions are set with the jumpers of X1. X2 is only used for setting the EPROM capacity, X3 and X4 are scanned via the microcomputer bus over their entire width (8 bits).

Jumper base	Function
X1	transmit signal on V24 (RS232C) transmit signal on X11/d28 invert transmit signal invert receiver signal IO "LOW" watchdog deactivated
X2	setting the memory capacity (4 K/16 K x 8 bits)
X3	contains feeder numbers in binary code
X4	contains the information as to which configuration module or function subroutine is to be accessed

See pages 12/11 to 12/14 for further information about the jumper bases

Watchdog and voltage monitoring

The watchdog (11) is used for self monitoring of the microcomputer. A monoflop must be retriggered at intervals no larger than 30 ms through two series–connected D flip flops that must be set and reset in a defined sequence. If this is not the case, a second monoflop generates an approx. 80 µs long reset pulse for the microcomputer. This signal is also led to the upper edge connector via an open collector output (17).

To monitor the supply voltage there is a circuit (10) that resets the microcomputer if the operating voltage rises too high or drops too low (4.75 V...5.25 V). Moreover, if the voltage monitoring function responds, the transistor for controlling the L+48 V enable relay (2) is blocked.

Enable relay, optocoupler inputs

The L+48 V enable relay (2) is used for higher level enabling of the supply voltage (48 V) for all optocoupler inputs and command outputs. The relay is controlled via a transistor whose base current is controlled by the voltage monitoring function. This influence is necessary to prevent unwanted command output from the microcomputer in the undefined operating voltage range (4.75 V > V > 5.25 V) reliably. Moreover, the microcomputer has a control function for the L+48 V enable relay. The emitter potential of the transistor can be switched via PORT 1.

The M48 V enable relay (3) is a bistable relay which is switched directly by the microcomputer. The make contact of the relay enables M48 V in the event of a command output.

The normal position of all latching relays (M48 V enable and command output latching relay on the input / output modules) is scanned with the optocoupler of the latching relay monitoring (HRÜ) (5).

The task of the optocoupler of the make contact (4) of the M48 V enable relay is to acquire the current through the command output circuits during the test routines.

Both optocoupler inputs are scanned directly by the microcomputer.

Serial interface

The serial interface is used for data exchange with the central unit. It is a four–wire connection via which data are transmitted at a rate of 9600 baud with V24 (RS232C) levels. An 11 MHz quartz is used to achieve this standard baudrate.

In the transmit direction (7) the 5 V signal of the microcomputer is used to control a short–circuit proof amplifier stage with optocouplers. Depending on the microcomputer level, a transistor switches +12 V or –12 V through the output line. A suppressor diode protects the output transistors.

The receiver stage (6) consists of two antiparallel connected optocouplers so that both the positive and the negative receive level are used. A series connected flip flop compensates for slow switching edges. A varistor is used for protection against overvoltage.

LED displays; BSF feeder unit

The front panel contains three LEDs (1) to display fault, transmitting and receiving.

The uppermost red LED (STO) indicates a "fault" of the microcomputer that might be caused by the watchdog elapsing, the voltage monitoring function responding, or an external RESET (parallel connection of several open collector outputs).

The "receiving lamp" (ELL; middle, green LED) indicates that the receiver is functioning correctly. If the serial connection is interrupted or a continuous series of defective message blocks is received, the ELL is switched off.

The "transmitting lamp" (SLL, lower, green LED) indicates the cyclic scan of the transmitter register (microcomputer internal).

The two lamps (ELL, SLL) have no function in interlocking units that have been configured as stand-alone units (always off).

LED displays; BSF central unit

The front panel contains three LEDs (1) to display faults, data exchange with the SAB 1 and data exchange with the SAB 2.

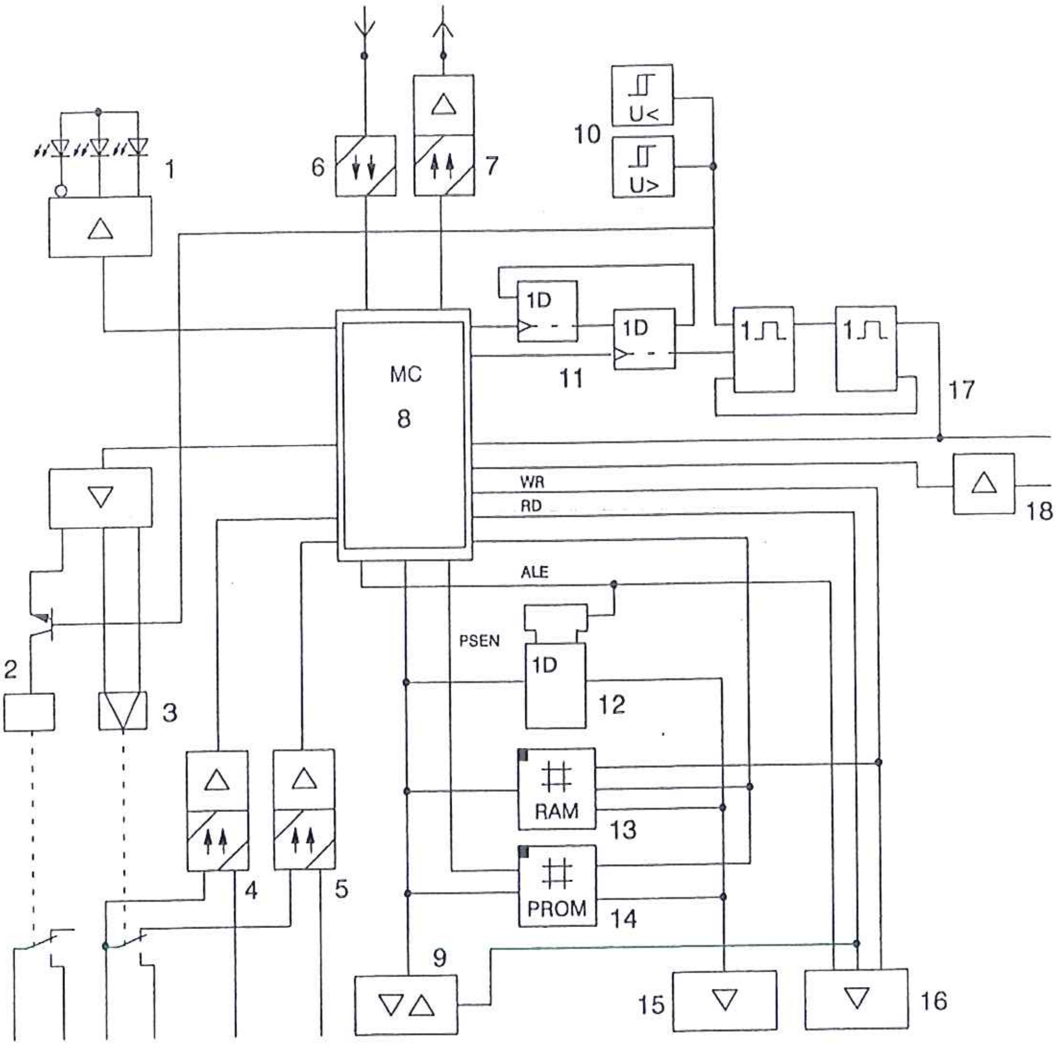
The uppermost red LED (STO) indicates a "fault" of the microcomputer that might be caused by the watchdog elapsing, the voltage monitoring function responding, or an external RESET (parallel connection of several open collector outputs).

"Data lamp 1" (DDL1; center, green LED) indicates error-free data exchange with SAB 1 (slot + AC135, Fig. 3.6); if communication is interrupted or a continuous sequence of defective telegram blocks is received, DDL1 is switched off.

"Data lamp 2" (DDL2; lower, green LED) indicates error-free data exchange with SAB 2 (slot + AC141, Fig. 3.6); if communication is interrupted or a continuous sequence of defective telegram blocks is received, DDL2 is switched off. If there is no SAB 2, this LED is always off.

Coupling of two central units

In order to achieve a greater expansion of the installation, it is possible to connect a second central unit if required. In this case, the two central units are connected via a serial V24 (RS232C) interface of the BSF (see Fig. 5.11). A special cable is required for the connection. Switchyards with up to 64 bays can be interlocked if two central units are connected.



1	LEDs	10	voltage monitoring
2	enable for L+48 V	11	watchdog
3	enable for M48 V	12	buffer
4	optocoupler for relay test	13	static RAM
5	optocoupler for latching relay monitoring	14	EPROM
6	V24 (RS232C) receiver interface	15	TTL line driver
7	V24 (RS232C) transmitter interface	16	TTL line driver for ALE, RD, WR signals
8	8031 microcomputer	17	open collector output
9	TTL line driver, bidirectional	18	interrupt input

Fig. 5.11 Block diagram of microcomputer module (BSF)

5.3.5 SAB transmitter / receiver controlling module

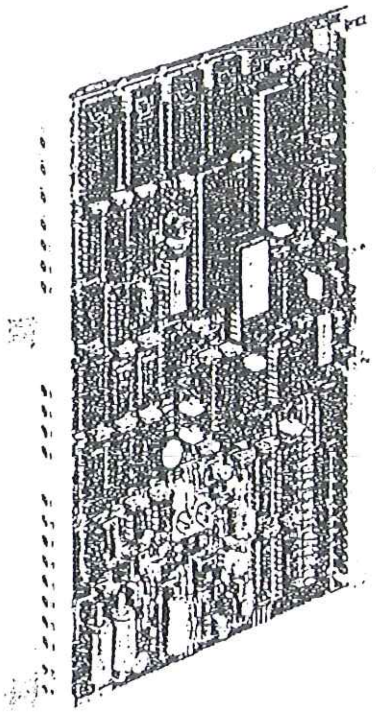


Fig. 5.12 Transmitter / receiver controlling module, without shielding plate

The method of operation is described with the aid of the block diagram (Fig. 5.13).

Connection to the external data bus

Connection of the SAB to the interlocking unit internal data bus is implemented with a FIFO component (5) with a depth of 128 Bytes. The FIFO functions bidirectionally. It has two interrupt outputs (2,4) that trigger an interrupt in the SAB microcomputer (10) or the BSF in certain data configurations. The interrupt line of the FIFO that goes to the data bus of the interlocking unit is connected with an open collector stage (2) because one or two SAB modules are plugged in depending on the degree of expansion of the switchyard. The position of the transmitter / receiver controlling module is defined by the position of the jumper in X13 / X14 in accordance with the the slot +AC135/+AC141 (see Fig. 3.6) (jumper SAB1 = +AC135, SAB2 = + AC141). The FIFO and the data bus terminals on the edge connector are decoupled using bidirectional drivers (3).

Address decoding and interrupt

The BSF in the central unit of the interlocking unit can distinguish which FIFO has triggered an interrupt. To do this, the module address is stored on the module via the address bus with the ALE signal (control bus) and compared with the set module address (6). If the set and the stored address are identical the chip select for the FIFO is formed and the read and write line (control bus) enabled. The BSF can only read the internal check register of the FIFO and ascertain whether and which interrupt has been triggered.

An interrupt (4) is also used to inform the microcomputer of the SAB (10) (type 8031) whether the data intended for it are ready to be fetched in the FIFO or whether the FIFO can take in new data. The data are read in or out of the microcomputer via the 8 bit wide data bus.

Correct functioning of the FIFO is indicated by the LED (9) on the front panel.

Memory (EPROM, RAM, NVRAM)

The size of the program memory (11) is set in the range from 8 K Bytes to 32 K Bytes using a jumper for EPROM types 2764, 27128 and 27256.

The external, volatile data memory (13) is composed of two static RAM components of type 2114 (1 K x 4).

For non-volatile storage of data (12) the module contains two components with 256 bits x 4 of type X 2212.

For type X 2212, the storage pulse for accepting information is generated in the non-volatile part of the 5 V voltage monitoring function (8) that outputs a storage pulse if the voltage limits are violated. As soon as the voltage is within its permissible limits again (4.80 V to 5.25 V), a cancellation pulse is output by the voltage monitoring function that relocates the data from the non-volatile part into the volatile part of the NVRAM.

Serial interface

The inputs of the four USARTs (16) of type 8251A are connected to the outputs of the multiplexer components (18) of type 74HCT253. The USARTs receive the filtered serial signals of the VES modules and convert them into parallel information for the microcomputer. The send and receive cycle of the USARTs is generated by the microcomputer. The USARTs function asynchronously.

The address of the multiplexer components is formed by the microcomputer. There is an LED (14) (ELL1 to ELL16) for each serial input which shows whether a serial signal is being applied to the input channel.

The eight serial transmitter outputs (17) are subdivided into two times four channels. Four transmitter channels can be controlled by the USARTs separately, i.e. four different messages can be sent. The other four transmitter channels are controlled by the serial output of the microcomputer.

The LEDs SLL (9) on the front panel show that the serial transmitter is operating.

Watchdog and voltage monitoring

To monitor the microcomputer, there is a "watchdog" (7) on the module that must be triggered at 30 ms intervals. The watchdog consists of a divider that requires two input pulses to generate an output pulse and two monoflops. The two input signals must be generated by the microcomputer one after the other. If this is not the case, a reset for the microcomputer is generated. The reset is active for up to 83 µs, after which the microcomputer is enabled. If the watchdog is not triggered again, a reset is retriggered. In the event of microcomputer failure, a cyclic reset is therefore generated.

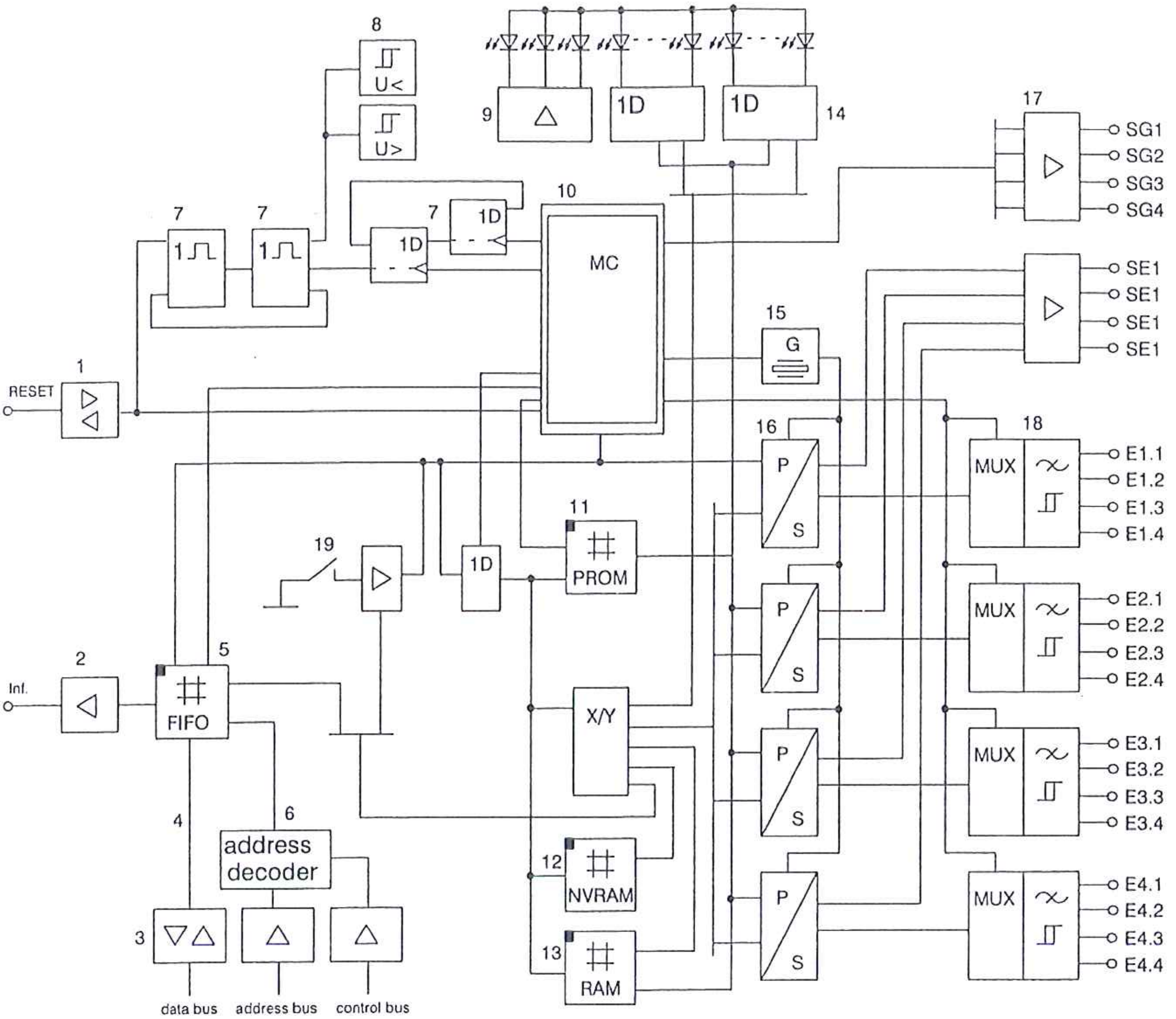
The reset signal is combined with the voltage monitoring function. The voltage monitoring function checks the supply voltage for adherence to the permissible supply voltage tolerances (4.80 V to 5.25 V as the guaranteed working range) for TTL components. If the supply voltage is outside these limits, a reset signal is generated.

The reset signal (1) is led as an open collector signal.

Clock frequency generation

A quartz generator (15) generates the system clock necessary for operation. The microcomputer obtains its working frequency from it. The quartz frequency divided by four is supplied to the USARTs.

CAUTION:
From development version CC, software version SFS SAB V2.0 or higher is required for this module. Older software versions (SFS SAB V1.*) are no longer compatible.



1	reset input / output	10	microcomputer
2	driver for FIFO interrupt	11	program memory
3	bidirectional bus driver	12	non-volatile data memory
4	control line for FIFO	13	volatile data memory
5	BSF/SAB communication component	14	LED driver, memory (ELL1−16)
6	address coding	15	quartz generator
7	watchdog	16	USART
8	voltage monitoring	17	driver for transmit direction
9	LED driver (STO, SLL, DLL)	18	multiplexer
		19	jumper base X4

Fig. 5.13 Block diagram for transmitter / receiver controlling module (SAB)

5.3.6 Four–channel serial interface module (VES)

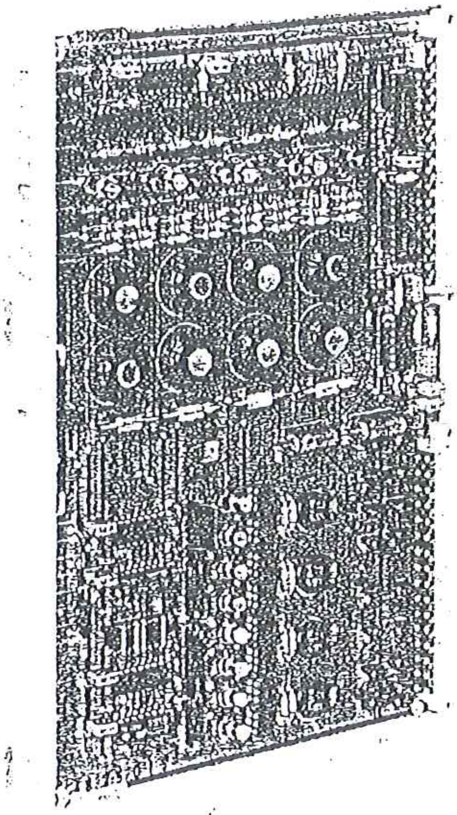


Fig. 5.14 Four–channel serial interface module

The method of operation is described with the aid of the block diagram (Fig. 5.15).

Receiver

The four receiver inputs Ee1 to Ee4 (7) are passive circuits that contain a varistor at the input as a protection against overvoltage. The receive circuit (6) processes both the positive and the negative level of the input signal and converts them to the internal 5–V–TTL level. By relocating a jumper (5) in the 5 V range, it is possible to define whether the receiver circuit is only to process positive or both positive and negative voltage levels.

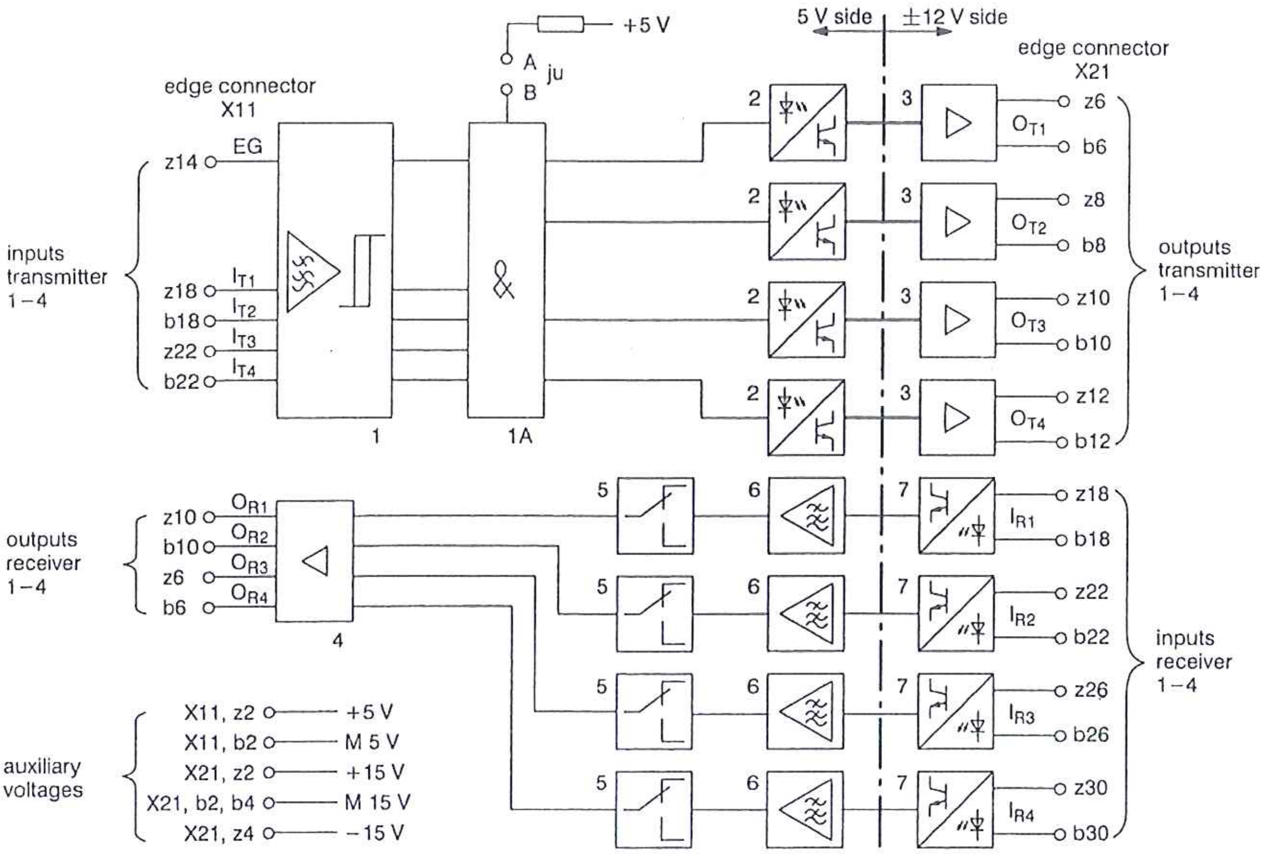
Using sockets on the front panel, the function of the receiver circuits can be checked. The load connected must not be more than 15 CB–TTL loads

Transmitter

The four transmitters work with an operating voltage of ± 8 V to ± 17 V. The outputs are short–circuit proof and protected against overvoltage by suppressor diodes (transient absorbing zener diodes).

Inputs ES1 to ES4 must be connected for transmitter single operation; parallel operation of all transmitters is possible if jumper AB is inserted and input EG (1A) is used. The 5 V input signals are led to Schmitt triggers (1) via filters and converted to the transmit level of $V_{nom} = \pm 12$ V and amplified (3).

Using sockets on the front panel, it is possible to check that the transmitter circuits are functioning. The load connected must not be more than 15 LS–TTL loads.



1	input filters and Schmitt triggers	4	output amplifiers in the receiver circuit
1A	AND gate	5	switchover for receive level
2	optocouplers in the transmit circuit	6	input filters in the receiver circuit
3	output amplifiers	7	optocouplers in the receiver circuit

Fig. 5.15 Block diagram of the four–channel serial interface module (VES)

5.3.7 30 W power supply module (SV30)

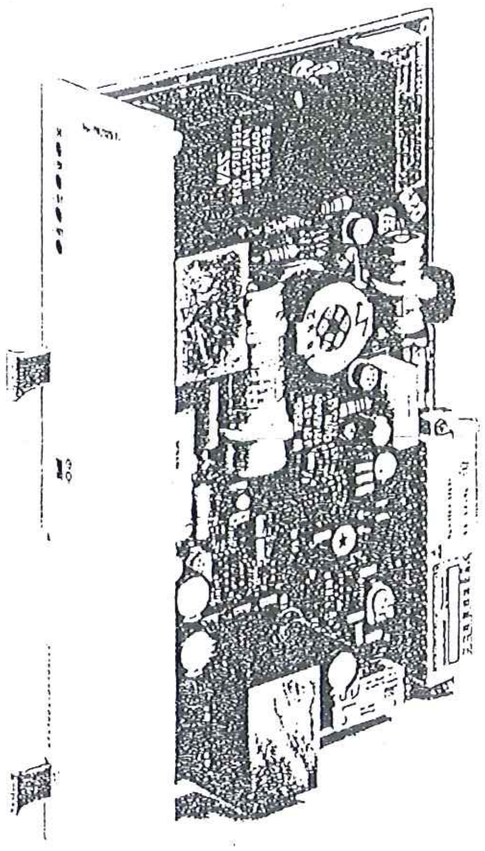


Fig. 5.16 30 W power supply module

The method of operation is explained with the aid of the block diagram (Fig. 5.17).

A DC voltage from a battery or from a rectifier unit is used as the input voltage, the maximum residual ripple being 6%.

The input circuit contains a fuse (1) that is blown in the event of internal faults and which is accessible when the module is removed.

After the input protected against transient overvoltages by a varistor (2) the input voltage is led to the switching transistor (4) via a filter with a diode (3) for protection against incorrect connection. It is then fed to the transformer (5) as a pulse–width–modulated quantity. The transformer functions as a single–pulse isolating transformer in this type of circuit.

The various rectified and smoothed output voltages are then provided isolated from one another. The 5 V output bears the main load. Here, the actual value for the control (14) is acquired and passed to the controller (11) via an optocoupler (13). The output of the controller supplies the pulse–width–modulated signal via a controlling transformer (9). This signal is used to control the switching transistor (4). At the maximum permissible input voltage and minimum load at the outputs, the control pulses have their minimum width. Similarly, they have their greatest width when the input voltage is at its lowest and the outputs have the greatest load.

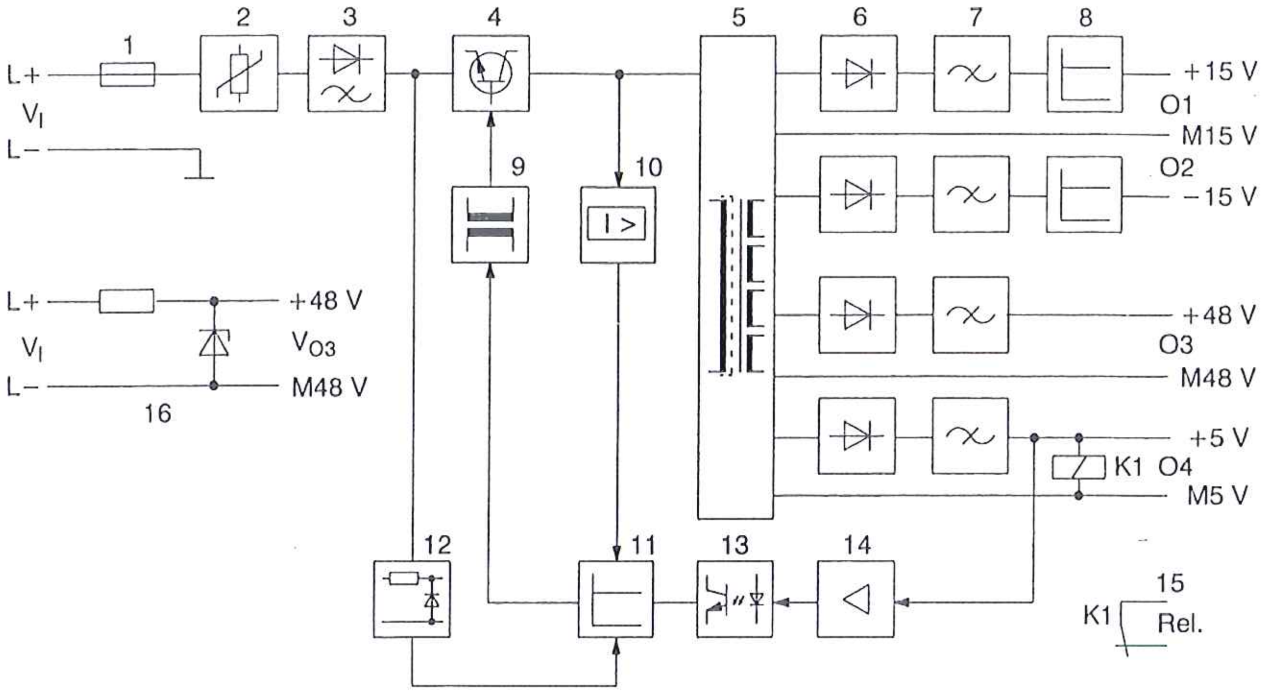
The outputs +15 V and −15 V contain an additional voltage controller that maintains the precontrolled output voltage at a constant magnitude.

If the power supply module and the input voltage should fail, this is signalled via an isolated relay contact (15).

The output voltage of the power supply can be switched off with the slide switch on the front panel (without galvanic isolation of the input from the network). The four green LEDs indicate the switched on state.

No longer used from development version EE: Voltage divider for S1 operation (16)

For emergency operation if the power supply is defective, the module can be removed from the rack, turned through 180° (back–to–front operation) and inserted into the rack again. The voltage divider limits the input voltage V_I to the output voltage V_{O3} (intermediate voltage +48 V).



1 fuse
2 input varistor
3 reverse voltage protection diode, input filter
4 switching transistor
5 transformer
6 rectifier
7 output filter
8 voltage controller
9 controlling transformer
10 overload protection
11 controller
12 internal auxiliary voltage supply
13 optocoupler
14 actual value acquisition
15 power supply / voltage failure relay
16 voltage divider for S1 operation (not used as of development version EE)

Fig. 5.17 30 W power supply module (SV30)

5.3.8 75 W power supply module (SV75)

The method of operation is explained with the aid of the block diagram (Fig. 5.18).

A DC voltage from a battery or from a rectifier unit is used as the input voltage, the maximum residual ripple being 6 %.

The input circuit contains a fuse (1) that is blown in the event of internal faults and which is accessible when the module is removed.

After the input protected against transient overvoltages by a varistor (2) the input voltage is led to the switching transistor (4) via a filter with a diode (3) for protection against incorrect connection. It is then fed to the transformer (5) as a pulse–width–modulated quantity. The transformer functions as a single–pulse isolating transformer in this type of circuit.

The storage function is taken over into the output filters (6) from the reactors. The various rectified and smoothed output voltages are then available isolated from one another. The 5 V output bears the main load. Here the actual value for the control is acquired (16) and passed to the controller (13) via an optocoupler (15). The output of the controller supplies the pulse–width–modulated signal via a driver stage (19). The signal is used to control the switching transistor (4). At the maximum permissible input voltage and minimum load at the outputs, the control pulses have their minimum width. Similarly, they have their greatest width when the input voltage is at its lowest and the outputs have the greatest load.

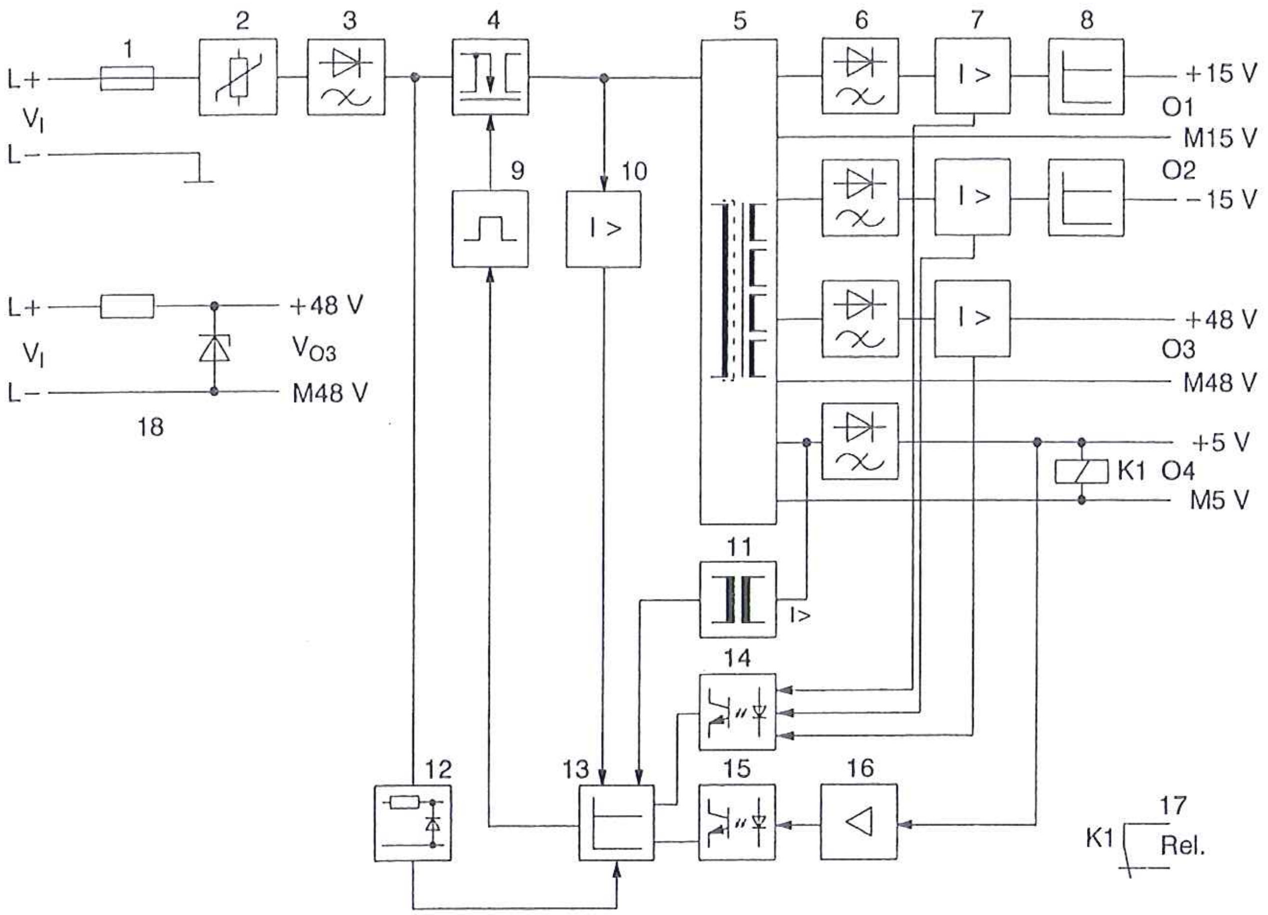
Overload protection circuits (7,14, 11) monitor the current of the outputs and control the controlling circuit when defined limit values are reached with increasing overload up to short circuit, i.e. all output voltage values tend towards zero. The output voltages achieve their nominal values again when the load drops below the critical limit.

The light load outputs contain an additional transductor control (8) to stabilize the precontrolled output voltages.

If the power supply module or the input voltage should fail, this is signalled via an isolated relay contact (17).

No longer used from development version EE: Voltage divider for S1 operation

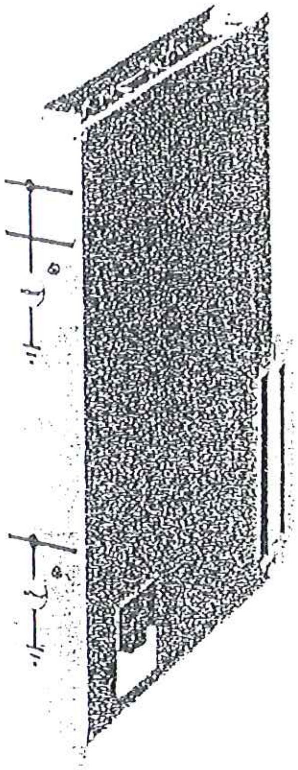
For emergency operation if the power supply is defective, the module can be removed from the rack, turned through 180° (back–to–front operation) and inserted into the rack again. The voltage divider limits the input voltage V_I to the output voltage V_{O3} (intermediate voltage +48 V).



1 fuse
2 input varistor
3 reverse voltage protection diode, input filter
4 switching transistor
5 transformer
6 rectifier, output filter
7 overload protection for ± 15 V and 48 V output
8 transductor stage
9 driver stage
10 overload protection on the primary side
11 overload protection for power supply output
12 internal auxiliary voltage supply
13 controller
14 optocoupler for overload protection
15 optocoupler for actual value acquisition
16 actual value acquisition
17 power supply / voltage failure relay
18 voltage divider for S1 operation (not used as of development version EE)

Fig. 5.18 Block diagram of the 75 W power supply module (SV75)

5.3.9 Contact multiplier module (KVB)



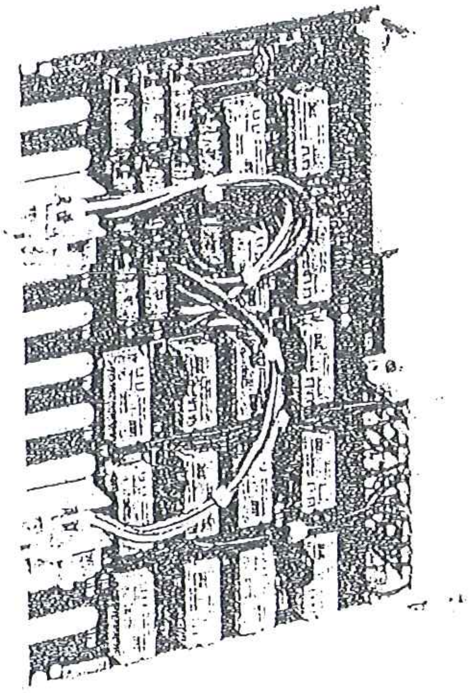


Fig. 5.19 Contact multiplier module, with and without cover, front panel

The method of operation is explained with the aid of the block diagram (Fig. 5.20).

The module performs the following functions:

- acquisition and indication of breaker position indications (like the ABB)
- contact multiplication for three devices
- simulation of the command – input / output functions of the ABB
- 8TK ⇔ 8TJ/8TH adaptation

As far as the EAB and BSF modules go, this module is compatible with the ABB. It is addressed by the computer in the same way as an ABB (software compatibility)

Breaker position indication

The circuit consists of two identical paths with a common ground connection. Each path has two inputs: Breaker closed – breaker open (4). If V_{RM} is applied to one input, the associated relay (5) operates and the semaphore is triggered (6). Both inputs are connected to ground via a common series resistor (7). The inputs are both protected against reverse current by diodes. Relays and semaphores are protected against overvoltage by Zener diodes. Each input path also has a varistor for protection against overvoltage. The Zener diodes at the relays are also used as freewheeling diodes.

The contacts (5) switched by the relays trigger the optocouplers on the EAB (compatible with ABB).

In the model for a 24 V battery voltage, the semaphores and relays are connected in parallel (8), in all other models they are in series. The function performed is the same in both cases.

Contact multiplication

Contact multiplication provides the states of each of three devices (close – open) at two isolated outputs. There are two inputs (10) for each device that are led to ground via a common series resistance (11). Each input switches two relays (12). Relay inputs are protected by diodes and varistors.

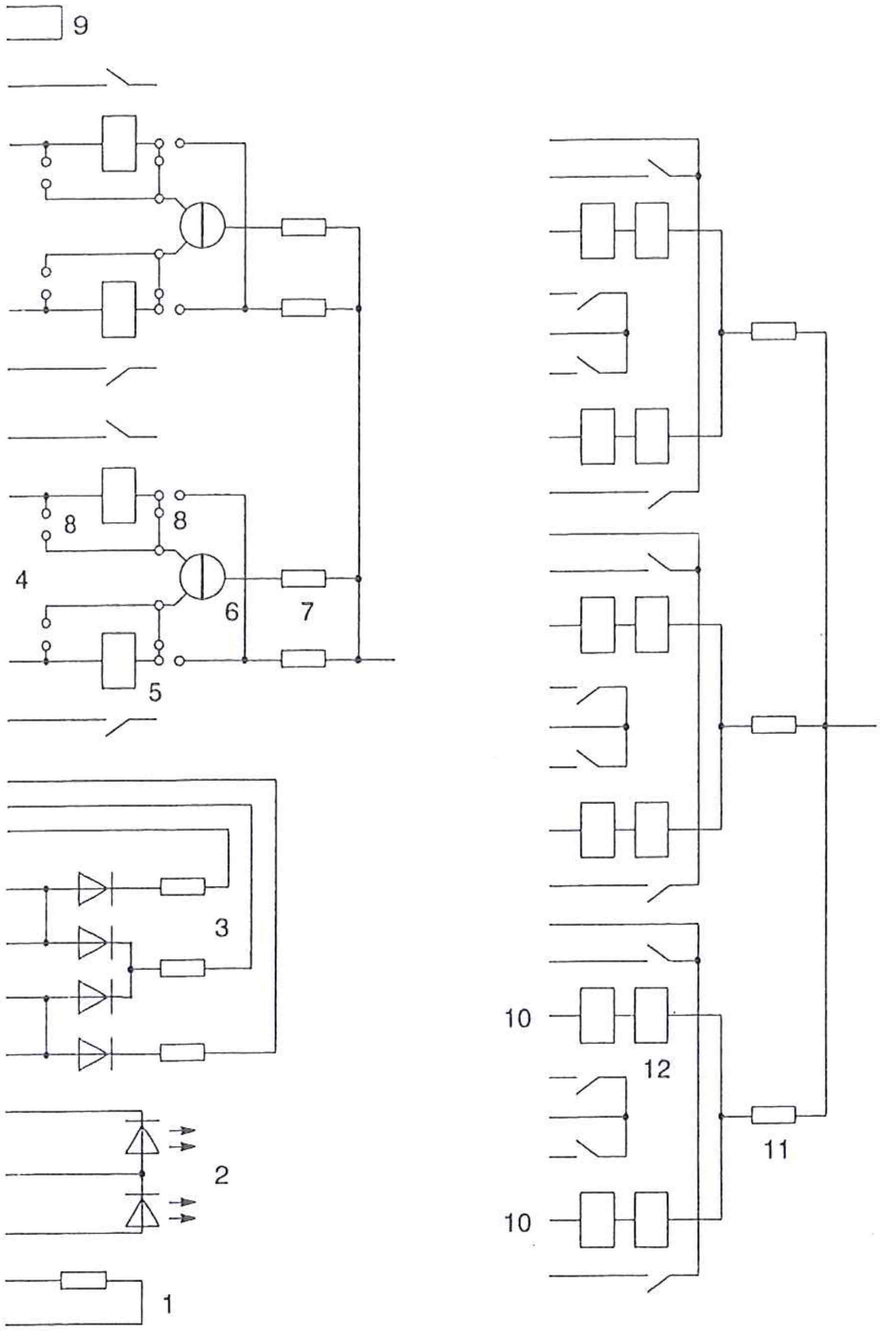
Simulation of command input / output

The computer on the BSF treats the module like an ABB. In normal operation, the absence of the command input / output signal circuit does not show up as a fault. In the initialization routine (after each restart) and on a TEST call, the computer checks the command input / output circuits on each ABB and KVB connected. To do this, a current is fed through each relay coil, and optocouplers detect whether the coils have continuity. The simulation circuit (3) on the KVB simulates the internal resistances of the relay coils (which are not in the circuit). In this way, the initialization and TEST routine are run without reporting a fault. The circuit is protected by diodes, which also ensure that the input currents are conducted to the appropriate outputs.

Moreover, groups of three inputs are connected to groups of three outputs by jumpers (9). These are necessary to allow ABBs and KVBs to be arranged in any order in the module rack because contacts on the pushbutton auxiliary relays are connected to all ABBs in series to avoid double operation in S1 operation. The jumpers simulate the closed contacts of the pushbutton auxiliary relays.

Intermediate position lamps

The intermediate position lamps are the same as those of the ABB (1) (2).



1 parallel resistance for adaptation of the fault lamp
2 intermediate position lamps
3 simulation of the input / output circuits
4 intermediate position indication from the switchyard
5 alarm relay / intermediate position indication for MC
6 bistable interface indicator
7 series resistance for alarm relay
8 series / parallel switchover
9 jumpers for S1 operation
10 switchyard signal for contact multiplication
11 series resistance for multiplying relays
12 contact multiplying relays

Fig. 5.20 Block diagram for contact multiplyer module (KVB)