SIEMENS

TELEPERM M

AS 235 H
Automation System

ES 100 K
Extension System

Manual

Bestell-Nr. C79000-G8076-C293-07

Contents		
Warning Information Suggestions/Corrections	C79000-R8076-C293-02	
AS 235 H Automation System	C79000-B8076-C293-05	**1**
ES 100 K Extension System	C79000-B8076-C124-04	**2**
Comparator Coupler Module 6DS1142-8AA	C79000-T8076-C345-02	**3**
Synchronization Module 6DS1143-8AA	C79000-T8076-C344-02	**4**
I/O Comparator and Switchover 6DS1144-8AA	C79000-T8076-C343-02	**5**
I/O Bus Interface Module 6DS3303-8AA	C79000-T8076-C403-02	**6**
Mini Floppy Disk Unit 6DS3900-8AC, -8AD	C79000-B8076-C137-05	**7**
Interface Module for Mini Floppy Disk Unit 6DS1326-8BB	C79000-B8076-C287-04	
Alphanumeric Keyboard 6DS3303-8AA	C79000-B8076-C036-04	**8**
Process Operation Keyboard 6DS3305-8BA	C79000-B8076-C410-01	
Process Communication Keyboard 6DS3305-8AA	C79000-B8076-C038-05	
		9
Spare Part Lists: AS 235 H Automation System System Cabinets ES 100 K Extension System	 C79000-E8076-C293-05 C79000-E8076-C006-10 C79000-E8076-C124-02	**10**

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We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

Technical data subject to change.

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Register Contents

"Important Notes, Information, Suggestions/Corrections"

CE Labeling	"Notes on the CE Symbol for TELEPERM M AS" C79000-Q8076-C001-03
Guidelines	"Instructions and Guidelines for Planning, Installation and Operation of TELEPERM M Systems" Reference to the Guidelines Manual (with brief summary) for the TELEPERM M range C79000-D8076-C411-01
Safety-Related Guidelines	"Safety-Related Guidelines for the User" Summary of the safety-related aspects during operation of TELEPERM M systems C79000-D8076-C402-04
ESD Guidelines	"Guidelines for Handling Electrostatically Sensitive Devices" Summary of the rules concerning the module handling C79000-D8076-C333-01
Suggestions/ Corrections	"Suggestions/Corrections for Document/Manual" A return sheet for suggestions of improvement is enclosed. C79000-D8075-C404-08

Notes on the CE Symbol for TELEPERM M AS

EC Directive EMC

The following applies to the TELEPERM M products described in this manual:

89/336/EEC

Products which carry the CE symbol fulfil the requirements for the EC Directive 89/336/EEC.

The EC declaration of conformity and the documentation relating to this are available to the authorities concerned, according to the above–mentioned EC Directive, Article 10 (2), from:

CE

Siemens AG
Automation & Drives Group
A&D SE S21 S
Siemensallee 84
D–76187 Karlsruhe

Products which do not have the CE symbol meet the requirements and standards given in the System Manuals under ”General Technical Data”.

Fields of Application

For the TELEPERM M System, the following field of application apply according to this CE symbol:

Field of Application	**Requirement for**	
	Emitted interference	**Noise immunity**
Industry	EN 50081–2:1993	EN 50082–2:1995

Observing the Setup Guidelines

The setup guidelines and notes on safety given in the System Manuals must be observed during startup and when operating the TELEPERM M System.

Working on Cabinets

To protect the modules from the static electricity, the user must discharge his body’s electrostatic charge before opening cabinets.
Observe the general ESD Guidelines.

Notes on the CE Symbol for TELEPERM M AS

Notes on Manual–Auto Stations

A filter must be inserted in the power supply lines (SIFI C, B84113–C–B30 or similar).

Updated Technical Data

In addition to the specifications in the ”General Technical Data” of the System Manuals, the specifications on noise immunity and electromagnetic compatibility given below apply to modules carrying the CE symbol.

The specifications are valid for systems which are assembled according to the above–mentioned setup guidelines.

Electromagnetic Compatibility (EMC)

Radio interference suppression to EN 55011	
Limit value class	A [1]
Interference by conduction on AC and DC supply lines to EN 61000–4–4 / IEC 1000–4–4 (Burst)	2 kV
Interference by conduction on signal lines to EN 61000–4–4 / IEC 1000–4–4 (Burst)	2 kV
Interference by conduction on process lines to EN 61000–4–4 / IEC 1000–4–4 (Burst)	2 kV
Noise immunity to discharges of static electricity to EN 61000–4–2 / IEC 1000–4–2 (ESD)	4 kV [2]
Noise immunity to electromagnetic HF field [1] amplitude modulated to ENV 50140 / IEC 1000–4–3	80 to 1000 MHz 10 V/m 80 % AM (1 kHz)
Noise immunity to electromagnetic HF field [1] pulse modulated to ENV 50204	900 MHz 10 V/m 50 % c.d.f.
Noise immunity to high frequency (sinusoidal) to ENV 50141	0.15 to 80 MHz 10 V 80 % AM

1) With closed doors for AS 235 and AS 235 H, open for AS 235 K and ES 100 K

2) With AS 235 K and ES 100 K: 6 kV

Instructions and Guidelines for Planning, Installation and Operation of TELEPERM M Systems

Installation/operation

A summary of the basic requirements, ambient conditions and instructions for installing and operating TELEPERM M systems is contained in a separate Manual for the entire TELEPERM M range.
Title of the manual
"TELEPERM M
"Instructions and Guidelines for Planning, Installation, and Operation"

Manual contents

The manual deals with the following topics:

- Safety-related guidelines
- ESD guidelines
- Room planning and furnishing
- Installation instructions
- Mains and environmental requirements
- Data carriers
- Operation licenses
- Configuration instructions
- Mounting instructions
- Thermal load of the cabinet
- CS 275 bus system
- Surge protection
- Standards, directives, regulations

Manual directives

The manual is intended to be used by planning and configuring engineers, installation personnel and users of TELEPERM M systems.
It has to be taken into account during planning and commissioning.

Order No.

C79000-G8076-C417

TELEPERM M/ME
Safety-Related Guidelines for the User

1 General

This manual provides the information required for the intended use of the particular product. The documentation is written for technically qualified personnel such as engineers, programmers or maintenance specialists who have been specially trained and who have the specialized knowledge required in the field of instrumentation and control., called automation in the following.

A knowledge of the safety instructions and warnings contained in this manual and their appropriate application are prerequisites for safe installation, commissioning and maintenance as well as safe and proper operation of the product described. Only qualified personnel as defined in section 2 have the specialized knowledge that is necessary to correctly interpret the general danger notices and warnings contained in this documentation and implement them in each particular case.

This manual is an inherent part of the scope of supply even if, for logistic reasons, it has to be ordered separately. For the sake of clarity, not all details of all versions of the product are described in the documentation, nor can it cover all conceivable cases regarding installation, operation and maintenance. Should you require further information or face special problems that have not been dealt with in sufficient detail in this documentation, please contact your local Siemens office.

We would also point out that the contents of this product documentation shall not become a part of or modify any prior or existing agreement, commitment or legal relationship. The Purchase Agreement contains the complete and exclusive obligations of Siemens. Any statements contained in this documentation do not create new warranties or restrict the existing warranty.

2 Qualified Personnel

Persons who are **not qualified** should not be allowed to handle the equipment/system. Non-compliance with the warnings contained in this manual or appearing on the equipment itself can result in severe personal injury or damage to property. Only **qualified personnel** should be allowed to work on this equipment/system.

Qualified persons as referred to in the safety guidelines in this manual as well as on the product itself are defined as follows:

- System planning and design engineers who are familiar with the safety concepts of automation equipment;
- Operating personnel who have been trained to work with automation equipment and are conversant with the contents of the manual in as far as it is connected with the actual operation of the plant;
- Commissioning and service personnel who are trained to repair such automation equipment and who are authorized to energize, deenergize, clear, ground and tag circuits, equipment and systems in accordance with established safety practices.

3 Danger Notices

The notices and guidelines that follow are intended to ensure personal safety, as well as protecting the product and connected equipment against damage.

The safety notices and warnings for protection against loss of life (the users or service personnel) or for protection against damage to property are highlighted in this manual by the terms and pictograms defined here. The terms used in this manual and marked on the equipment itself have the following significance:

Danger

indicates that death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

Warning

indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Caution

indicates that minor personal injury or property damage **can** result if proper precautions are not taken.

Note

is an important information about the product, its operation or a part of the manual to which special attention is drawn.

Important

If in this manual "Important" should appear in bold type, drawing attention to any particularly information, the definition corresponds to that of "Warning", "Caution" or "Note".

4 Proper Usage

- The equipment/system or the system components may only be used for the applications described in the catalog or the manual, and only in combination with the equipment, components and devices of other manufacturers as far as this is recommended or permitted by Siemens.
- The product described has been developed, manufactured, tested and the documentation compiled in keeping with the relevant safety standards. Consequently, if the described handling instructions and safety guidelines described for planning, installation, proper operation and maintenance are adhered to, the product, under normal conditions, will not be a source of danger to property or life.

Warning

- After opening the housing or the protective cover or after opening the system cabinet, certain parts of this equipment/system will be accessible, which could have a dangerously high voltage level.
- Only suitably qualified personnel should be allowed access to this equipment/system.
- These persons must be fully conversant with any potential sources of danger and maintenance measures as set out in the instructions contained in this manual.
- It is assumed that this product be transported, stored and installed as intended, and maintained and operated with care to ensure that the product functions correctly and safely.

5 Guidelines for the Planning and Installation of the Product

The product generally forms a part of larger systems or plants. These guidelines are intended to help integrate the product into its environment without it constituting a source of danger.
The following facts require particular attention:

Note

Even when a high degree of safety-related reliability has been designed into an item of automation equipment by means of multichannel configuration, it is still imperative that the instructions contained in this manual be exactly adhered to. Incorrect handling can render ineffective the preventive measures incorporated into the system to protect it against dangerous process states, and even create new sources of danger.

The following advice regarding installation and commissioning of the product should - in specific cases - also be noted.

Warning

- Follow strictly the safety and accident prevention rules that apply in each particular case.
- Units which are designed as built-in units may only be operated as such, and table-mounted or portable equipment only with its casing closed.
- In the case of equipment with a permanent power connection which is not provided with an isolating switch and/or fuses which disconnect all poles, a suitable isolating switch or fuses must be provided in the building wiring system (distribution board). Furthermore, the equipment must be connected to a protective ground (PE) conductor.
- For equipment or systems with a fixed connecting cable but no isolating switch which disconnects all poles, the power socket with the grounding pin must be installed close to the unit and must be easily accessible.
- Before switching on the equipment, make sure that the voltage range setting on the equipment corresponds to the local power system voltage.
- In the case of equipment operating on 24 V DC, use an extra-low voltage with a protective separation with the mains supply. The protective separation has to comply with the following requirements:
  - VDE 0100 Part 410 ≙ HD 384-4-41 ≙ IEC 364-4-41 (as function extra-low voltage with protective separation) or
  - VDE 0805 ≙ EN 60950 ≙ IEC 950 (as a safety extra-low voltage SELV) or
  - VDE 0106 Part 101.
- The I/O modules are designed for operation with safety extra-low voltage acc. to IEC 950 / EN 60950/VDE 0805. Therefore only components whose connection points are separated in a safe manner (by means of the protective measure "Protective separation") from voltages (e.g. mains) may be connected to the inputs/outputs of these modules.
- Fluctuations or deviations of the power supply voltage from the rated value should not exceed the tolerances specified in the technical specifications. Otherwise, functional failures or dangerous conditions can occur in the electronic modules/equipment.
- Suitable measures must be taken to make sure that programs that are interrupted by a voltage dip or power supply failure resume proper operation when the power supply is restored. Care must be taken to ensure that dangerous operating conditions do not occur even momentarily. If necessary, the equipment must be forced into the "emergency off" state.
- Emergency tripping devices in accordance with EN 60204/IEC 204 (VDE 0113) must be effective in all operating modes of the automation equipment. Resetting the emergency off device must not result in any uncontrolled or undefined restart of the equipment.

Caution

- Install the power supply and signal cables in such a manner as to prevent inductive and capacitive interference voltages from affecting the automation functions.
- Automation equipment and its operating elements must be installed in such a manner as to prevent unintentional operation.
- Automation equipment can assume an undefined state in the case of a wire break in the signal lines. To prevent this, suitable hardware and software measures must be taken when interfacing the inputs and outputs of the automation equipment.

6 Active and Passive Faults in Automation Equipment

- Depending on the particular task for which the electronic automation equipment is used, both **active** as well as **passive** faults can result in a **dangerous** situation. For example, in actuator control (e.g. press control), an active fault is generally dangerous because it can result in an unauthorized startup of the actuator. On the other hand, a passive fault in a signalling function (alarm signalling system) can result in a dangerous, command-blocking operating state not being reported to the operator.
- This differentiation of the possible faults and their classification into dangerous and non-dangerous faults, depending on the particular task, is important for all safety considerations in respect of the product supplied and the its interaction with the process to be controlled.

Warning

In all cases where a fault in an automation equipment can result in severe personal injury or substantial damage to property, ie. where a dangerous fault can occur, safety-related and fail-safe systems (in general prototype-tested by the German Technical Inspectorate (TÜV)) must be used or additional external measures be taken or equipment provided to ensure or force safe operating conditions even in the event of a fault (e.g. by means of independent limit monitors, mechanical interlocks etc.).

7 Procedures for Maintenance and Repair

If measurement or testing work is to be carried out on an active unit, the rules and regulations contained in the "VBG 4.0 Accident prevention regulations" of the German employers liability assurance association (Berufsgenossenschaften) must be observed. Particular attention is drawn to paragraph 8 "Permissible exceptions when working on live parts". Use only suitable electrical tools.

Warning

- Repairs to an item of automation equipment may only be carried out by **Siemens service personnel** or **an authorized Siemens repair center.** For replacement purposes, use only parts or components that are contained in the spare parts list or listed in the "Spare parts" section of this manual. Unauthorized opening of equipment and improper repairs can result in loss of life or severe personal injury as well as substantial property damage
- Before opening the equipment, always remove the power plug or open the disconnecting switch.
- Only use the fuse types specified in the technical specifications or the maintenance instructions of this manual.
- Do not throw batteries into an open fire and do not carry out any soldering work on batteries (danger of explosion). Maximum ambient temperature 100°C. Lithium batteries or batteries containing mercury should not be opened or recharged. Make sure that the same type is used when replacing batteries.
- Batteries and accumulators must be disposed of as classified waste.
- The following points require attention when using monitors:
  Improper handling, especially the readjustment of the high voltage or fitting of another tube type can result in excessive X-ray radiation from the unit. The license to operate such a modified unit automatically lapses and the unit must not be operated at all.

Guidelines for Handling Electrostatically Sensitive Devices (ESD)

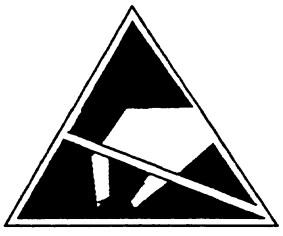
1 What is ESD?

VSLI chips (MOS technology) are used in practically all SIMATIC S5 and TELEPERM M modules. These VLSI components are, by their nature, very sensitive to overvoltages and thus to electrostatic discharge:

They are therefore defined as
"Electrostatically Sensitive Devices"

"ESD" is the abbreviation used internationally.

The following warning label on the cabinets, subracks and packing indicates that electrostatically sensitive components have been used and that the modules concerned are susceptible to touch:



ESDs can be destroyed by voltage and energy levels which are far below the level perceptible to human beings. Such voltages already occur when a component or a module is touched by a person who has not been electrostatically discharged. Components which have been subjected to such overvoltages cannot, in most cases, be immediately detected as faulty; the fault occurs only after a long period in operation.

An electrostatic discharge
- of 3500 V can be felt
- of 4500 V can be heard
- must take place at a minimum of 5000 V to be seen.

But just a fraction of this voltage can already damage or destroy an electronic component.

The typical data of a component can suffer due to damage, overstressing or weakening caused by electrostatic discharge; this can result in temporary fault behavior, e.g. in the case of
- temperature variations,
- mechanical shocks,
- vibrations,
- change of load.

Only the consequent use of protective equipment and careful observance of the precautions for handling such components can effectively prevent functional disturbances and failures of ESD modules.

2 When is a Static Charge Formed?

One can never be sure whether the human body or the material and tools which one is using are not electrostatically charged.

Small charges of 100 V are very common; these can, however, very quickly rise up to 35 000 V.

Examples of static charge:

– Walking on a carpet	up to 35 000 V
– Walking on a PVC flooring	up to 12 000 V
– Sitting on a cushioned chair	up to 18 000 V
– Plastic desoldering unit	up to 8 000 V
– Plastic coffee cup	up to 5 000 V
– Plastic bags	up to 5 000 V
– Books, etc. with a plastic binding	up to 8 000 V

3 Important Protective Measures against Static Charge

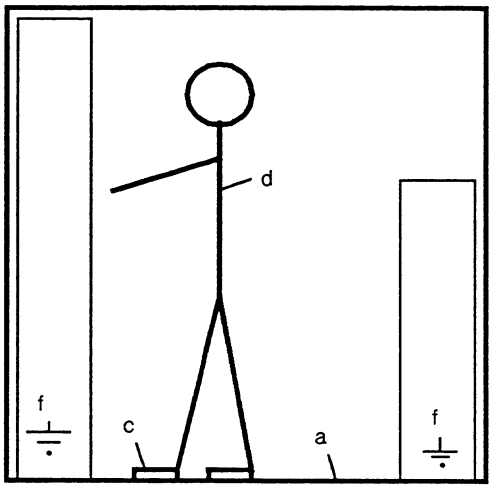
- Most plastic materials are highly susceptible to static charge and must therefore be kept as far away as possible from ESDs.
- Personnel who handle ESDs, the work table and the packing must all be carefully grounded.

4 Handling of ESD Modules

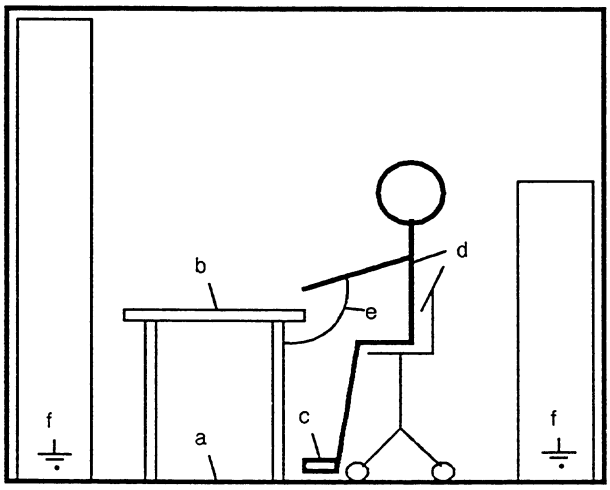
- One basic rule to be observed is that electronic modules should be touched by hand only if this is necessary for any work required to be done on them. Do not touch the component pins or the conductors.
- Touch components only if
  - the person is grounded at all times by means of a wrist strap

  or
  - the person is wearing special anti-static shoes or shoes with a grounding strip.
- Before touching an electronic module, the person concerned must ensure that (s)he is not carrying any static charge. The simplest way is to touch a conductive, grounded item of equipment (e.g. a blank metallic cabinet part, water pipe, etc.) before touching the module.
- Modules should not be brought into contact with insulating materials or materials which take up a static charge, e.g. plastic foil, insulating table tops, synthetic clothing, etc.
- Modules should only be placed on conductive surfaces (table with anti-static table top, conductive foam material, anti-static plastic bag, anti-static transport container).
- Modules should not be placed in the vicinity of monitors, TV sets (minimum distance from screen > 10 cm).

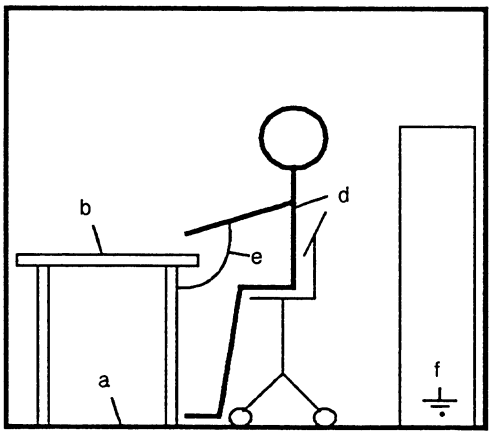
The diagram below shows the required protective measures against electrostatic discharge.



Standing position



Standing/sitting position



Sitting position

a Conductive flooring
b Anti-static table
c Anti-static shoes
d Anti-static coat
e Grounding wrist strap
f Grounding connection of the cabinets

5 Measurements and Modification to ESD Modules

- Measurements on modules may only be carried out under the following conditions:
  - The measuring equipment is grounded (e.g. via the PE conductor of the power supply system) or
  - when electrically isolated measuring equipment is used, the probe must be discharged (e.g. by touching the metallic casing of the equipment) before beginning measurements.
- Only grounded soldering irons may be used.

6 Shipping of ESD Modules

Anti-static packing material must always be used for modules and components, e.g. metalized plastic boxes, metal boxes, etc. for storing and dispatch of modules and components.

If the container itself is not conductive, the modules must be wrapped in a conductive material such as conductive foam, anti-static plastic bag, aluminium foil or paper. Normal plastic bags or foils should not be used under any circumstances.

For modules with built-in batteries ensure that the conductive packing does not touch or short-circuit the battery connections; if necessary cover the connections with insulating tape or material.

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Suggestions Corrections
Propositions Corrections
Propuestas Correcciones

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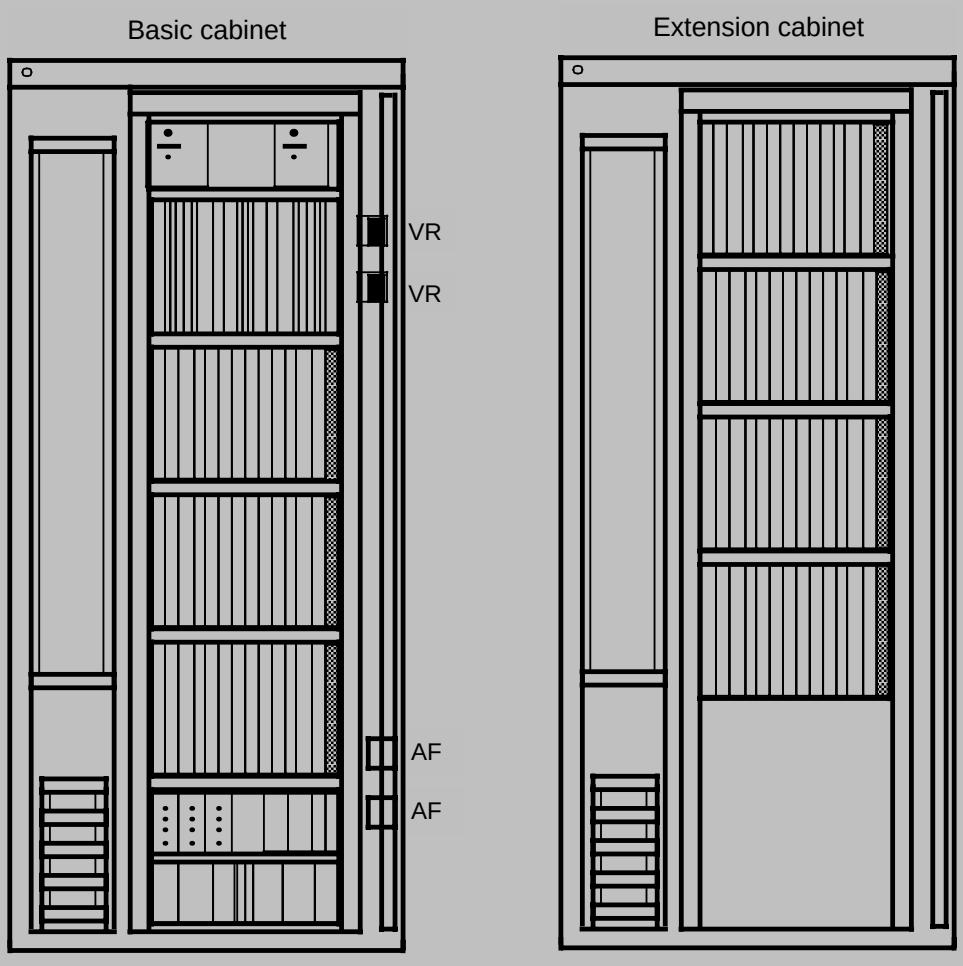
TELEPERM M

AS 235 H Automation System

Instructions **C79000-B8076-C293-05**



Contents

		Page
Preface		0-5
Abbreviations		0-6
1	**Application**	1-1
2	**Design**	2-1
2.1	Cabinet	2-2
2.2	Power Supply Unit	2-4
2.3	Basic Unit	2-4
2.4	Extension Unit	2-6
2.5	Cabinet Power Supply Unit	2-8
2.6	Cabinet Configuration (Heat Dissipation)	2-9
2.6.1	Power Loss	2-9
2.6.2	AS 235 H Basic Cabinet	2-9
2.6.3	AS 235 H Extension Cabinet	2-10
2.6.4	AS 235 H Cabinet with Forced Ventilation	2-11
2.6.5	AS 235 H Cabinet without Heat Exchanger (WT)	2-11
2.6.6	AS 235 H Cabinet with Heat Exchanger	2-11
2.6.7	Fan Module (Option)	2-12
3	**Method of Operation**	3-1
3.1	System Configuration	3-1
3.2	Faultless Operation	3-2
3.2.1	Central Unit Functions	3-4
3.2.2	I/O System Functions	3-11
3.2.3	Cabinet Power Supply Unit	3-16
3.2.4	Power Supply	3-19
3.3	Failure	3-21
3.3.1	Fault Delimitation	3-22
3.3.2	System Behaviour	3-23
3.3.3	Cold Restart, Warm Restart	3-31
4	**Installation**	4-1
4.1	General	4-1
4.2	Connecting the Supply Voltage	4-2
4.3	Grounding	4-3
4.3.1	Central Grounding Point	4-4
4.3.2	Grounding the M Potential	4-7
4.4	Connecting the Process Signal Cables	4-9
4.5	Using the Bus Components	4-14
4.5.1	Local Bus	4-14
4.5.2	Remote Bus	4-15
4.5.3	Computer Connection via N-V.24	4-16
4.6	Connecting the I/O Devices	4-18
4.6.1	Process Monitors	4-18
4.6.2	Keyboards and Printers	4-21
4.6.3	Floppy Disk Unit (MDE) 6DS3900-8AD	4-26
4.7	Jumper Settings	4-29
4.7.1	Central Processing Unit	4-29
4.7.2	I/O Comparator and Switchover Module (EAVU)	4-41
4.7.3	Wire Jumpers at the EAVU X2 Backplane Connector	4-42
4.7.4	SF61 Group Interrupt Module	4-43
4.7.5	Slot Addresses in the I/O Area	4-44
4.7.6	Slot Addresses and Jumper Settings for ES 100 K	4-46
4.7.7	Blinking Clock-Pulse Generator	4-50
4.7.8	SES Cabinet Power Supply Unit	4-52
4.7.9	Setting up the Event Recorder and Logging Printer	4-53
4.7.9.1	PT88/89 Printer	4-53
4.7.9.2	PT90 Printer	4-57
4.7.9.3	SICOMP DR 210-N/DR 211-N Printer	4-60
4.7.9.4	Printer DR 215-N/DR 235-N and DR 236-N	4--67
4.7.9.5	Printer Converter	4-70
4.8	Basic Unit and I/O Bus Cabling	4-74

4.8.1 Central Unit Power Supply Connections 4-74
4.8.2 Ribbon Cables between Basic Unit and Extension Unit 4-75

5 Commissioning 5-1

6 Maintenance 6-1
6.1 Qualified Personnel 6-1
6.2 Fault Elimination 6-2
6.3 Backup Battery 6-3
6.4 Circuit Diagrams 6-5

7 Technical Data 7-1

Annex Index . . . . . A - 1

Preface

The seven chapters of these Instructions provide the information required for safe and smooth operation of the **AS 235 H** automation system.

Chapter 1 shows possible **applications** and the features of the system.

Chapter 2 provides an overview of the **design** and possible system extensions.

Chapter 3 explains the **method of operation** and the system and its components.

Chapter 4 informs you about **installation** work and installation requirements to be met.

Chapter 5 specifies **commissioning**.

Chapter 6 deals with **maintenance**.

Chapter 7 summarizes the **technical data**.

First of all, read the **Safety-related Guidelines for the User**. You find these Instructions in this Manual in the Section before Register 1.

You also find the **Guidelines for Handling Electrostatically Sensitive Devices** in that Section. Reading these instructions carefully helps you to prevent personal injury and damages to the equipment before and during operation.

Abbreviations

I II	Identification numbers (Roman numerals) of the redundant subsystems (redundancies) within a multi-redundant system.
AA	Analog output module
ABE	Interrupt generating binary signal input module
AE	Analog input module
AF	Remote bus connector board
AS	Automation system
ASG	Interrupt generating signal transmitters
AZR	Flag register of the CPU 235 H
B	Backup (CPU status = synchronization and updating)
BA	Binary output module
B&B	Operator control and monitoring
BE	Binary input module
BGT	Subrack
BKA	Operator input channel interface module
BKU	Operator input channel switchover (video relay and adapter cable with AS 235 H)
BL	Blinking clock-pulse generator module
CS 275	LAN for linking TELEPERM M systems
CPU 235 H	Central processing unit 235 H
DG	Diagnostic unit
DGA	Diagnostic unit interface module
DMA	Direct memory access
DS	Data save (protective signal for memory modules)
E/A	Input and output (I/O)
EABA	I/O bus interface module
EE	Extension unit
EANK	One-out-of-n code; TELEPERM M procedure for detecting I/O addresses with no or multiple assignments
ES	Extension cabinet
EAVU	I/O comparator and switchover module
EPDL	Erasable programmable logic device
EPROM	Ultraviolet erasable programmable read-only memory
F	Failure (CPU mode)
F	Fail-safe (by redundancy)
FDC	Floppy-disk controller
FIFO	First in first out (queuing or handling hierarchy)
GE	Basic unit
GS	Basic cabinet
H	Fault-tolerant (by redundancy)
HF	H and F in compatible combination
LAN	Local area network; mid-range communications bus
L+	Positive supply voltage, 24 V rated value
LBG	Fan module
LED	Light emitting diode
LOES	Clearing the user memory by entering the keyboard command "LOES;"
LTM	I&C alarm

M	Earth, negative pole
M	Master (CPU mode)
MDA	Mini floppy disk interface module
MDE	Mini floppy disk unit
MDR	Event recorder
MDT	Mean downtime (mean time between the occurrence of a failure and operation restart)
ML	Alarm logic module
MTBF	Mean time between failures (mean time between two failure occurrences, i.e. faultless interval)
MtU	Technical document to be supplied with the system
MZ	Off-load earth, reference potential for analog inputs
N-AS	Local bus interface module for AS, new development, replaces N8-H
N8	TELEPERM M local bus interface, 8 bits on CS275 bus system
N8-H	N8 in a fault-tolerant 1-out-of-2 master/reserve configuration of a redundant automation system
NAU	Power failure
NV	Local bus distributor
OS	Operator control and monitoring system
P	Passive (asynchronous CPU status; no N8-H access etc.)
PBE	Testable binary input module
PBT	Process communication keyboard (TELEPERM M AS accessory)
PDR	Logging printer
PE	Protective earth, cabinet potential
PESP	Peripheral memory area
PUM	Buffer module
PRA	Testable relay output module
PROM	Programmable read-only memory
PM	L+ for alarm purposes
PS	L+ for logic "1" of 24-V inputs
PÜ	L+ for monitoring purposes
PU	Process interrupt
PU5	Standard: unassigned process interrupt No. 5 (PU5) which is exclusively used for redundancy-related purposes
QVZ	Time-out during memory or peripheral access
R	Standby (CPU mode)
RAM	Random access memory
RDY	Ready
ROM	Read-only memory
RSOF	Software reset
SAE	Cabinet connection element
SB	Synchronization module
SED31	Cabinet power supply diode
SEP	Standard slot in a subrack, 15.24 mm wide
SES	Cabinet power supply unit
SF	Signal interface module
SF61	Signal interface module in slot address 61 (mnemonic name for a group interrupt module in this slot; 48-bit binary input module)

SP	Memory module
STA	Starting block processing (keyboard input = STA)
STO	Halting block processing (keyboard input = STO)
SV	Power supply module
SVE	Power supply unit
SVME	Power supply unit for extension unit
SW	Software
TM	TELEPERM M
UI	Inductive bus converter unit for CS275
VD 11	Logic diode module for messages
VKB	Comparator coupler module
VR	Video relay
ZE	Central processing unit
ZEP	Central grounding point
ZRS	Central reset
ZT	Central unit (with AS 235 H containing two redundant CPUs)

1 Application

The new AS 235 H automation system is an enhancement of the 235 product family which satisfies particularly high requirements in the field of process control.

The AS 235 standard system is supplemented by a fault-tolerant and highly available variant.

H for "high availability"

The H in AS 235 H signals a higher availability than exists in a normal standard system.

This system has a redundant structure which enables the user to continue process manipulation and control tasks even after a tolerable fault has occurred.

The present system is a "1-out-of-2 system" whose availability is significantly increased by a redundant CPU configuration. Dedicated fault delimitation yields a high degree of non-interaction, this means that a solitary fault cannot be propagated from one subsystem to another. User-specific configuration enables a multiple redundant structure of the I/O system to be established which utilizes the given redundancy and permits easier execution of process tasks.

Warning:

The AS 235 H automation system (H system) is **not** a fail-safe system, despite its higher availability, its fault-tolerance and its non-interacting structure. It may **not** be used in plants where AS faults (e.g. the (unlikely) total failure of both CPUs) could cause hazardous conditions for persons, machinery or environment.
Such safety-relevant automation tasks require the use of either a fail-safe automation system (such as an F or HF system that has been prototype-tested by the German Technical Inspectorate) or an AS 235 H system equipped with suitable interlocking circuits and protective systems which safely prevent the occurrence of hazardous conditions.

Notes

 C79000-B8076-C293-05

2 Design

The AS 235 H standard configuration consists of the basic cabinet with one 1-tier and up to five 2-tier subracks. These subracks contain the power supply unit for the basic unit, both central processing units, up to three extension units, and the cabinet power supply unit.

One extension cabinet with up to four 2-tier subracks may be connected in addition. The subracks contain extension units.

Two operation units, each with color monitor, keyboards (process communication keyboard and**/**or configuring keyboard) and two printers (logging printer**/**event recorder), may be connected to the system.

The ES 100 K extension system provides further extension possibilities.
(Please refer to Chapter 4.7.6 for corresponding configuration suggestions.)

2.1 Cabinet

The AS 235 H automation system is installed in an AS 235 standard cabinet. Like the standard version, this cabinet is available with or without forced ventilation.

- Basic cabinet (GS)

The basic cabinet has the following structure (from top to bottom):

Power supply unit (SVE)

- one 24-V buffer module (internal 2-channel structure)
- two 5-V power supply modules (supply one CPU each)

Basic unit (fully equipped)

- one comparator coupler module (for both CPUs)
- two synchronization modules
- two diagnostic unit interface modules (option) [1)]
- two memory modules
- two central processor units (CPU 235 H)
- four I/O bus interface modules (2 as an option)
- four operator input channel interface modules (2 as an option)
- two mini floppy disk interface modules [2)]
- two N-AS or N8-H local bus interface modules (option) [3)]

Up to three extension units, each with

- one I/O comparator and switchover module
- up to 13 I/O modules [4)]

Cabinet power supply

- 24 circuit breakers
- three alarm logic modules (ML) (the third module is only required if an ES is connected)
- two VD11 diode modules (option)
- two SED31 power diode modules
- two UI bus converter units (option)
- one blinking clock-pulse generator
- two socket outlet tiers (connectors for up to four keyboards and two MDEs)

- Extension cabinet (ES)

Up to four extension units (EE), each with

- one I/O comparator and switchover module
- up to 13 I/O modules

Caution:

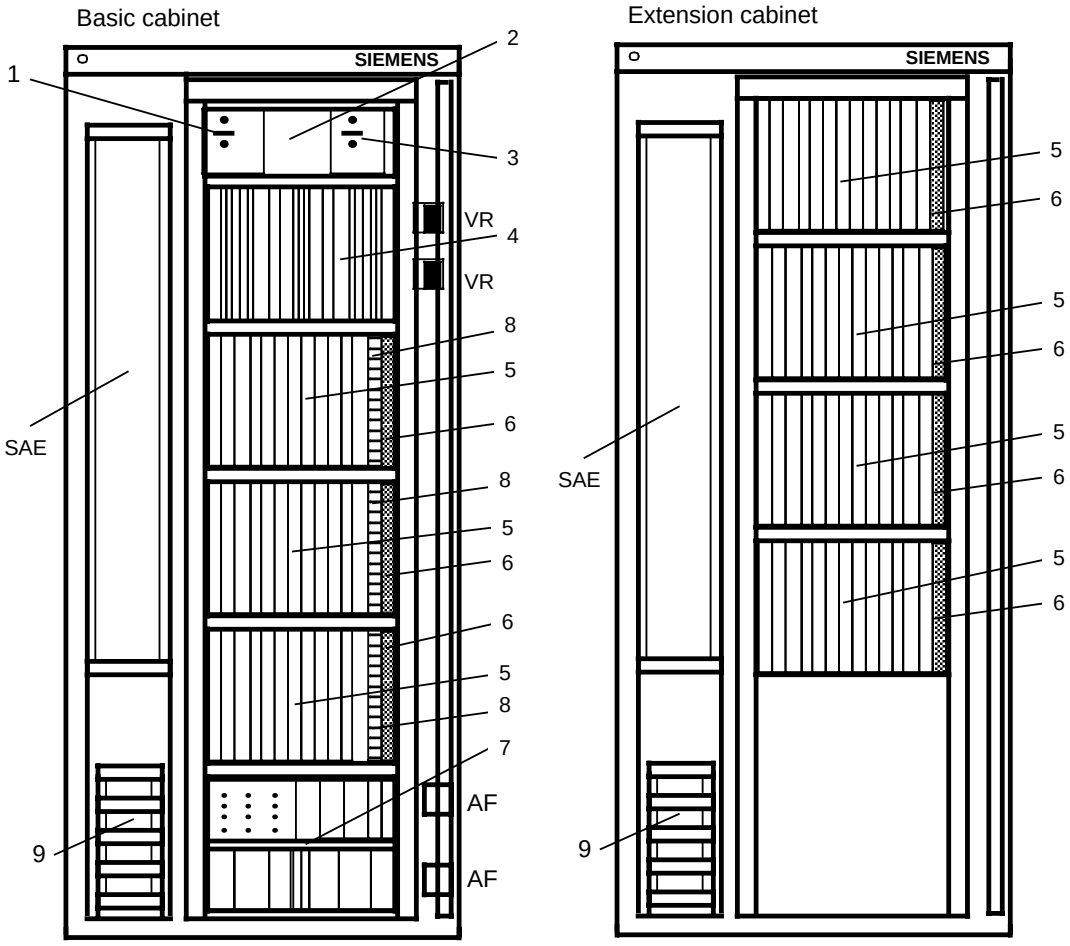
CPU 235 H (6DS1 141-8AA) may **not** be replaced by CPU 235 (6DS1140-8AA).

1) Only one module may be used in normal redundancy mode.
Caution: If there is no diagnostic interface module the module C74951-L445-B20 must be inserted.

2) Redundant installation of the mini floppy disk interface unit is necessary although only one drive is used.

3) Redundant installation is required if the CS275 bus system is used for communication.

4) One I/O module per extension unit in the basic cabinet may be replaced by a group interrupt module 6DS1 601-8BA (or 6DS1615-8AA).
Group interrupt modules in an AS 235 H system can be installed in up to triple-redundant mode in the EE slots 13, immediately next to the EAVU.



AF Remote bus connector board
SAE Cabinet connection elements
VR Video relay
1 Power supply unit I (5V)
2 Buffer module (24 V)
3 Power supply II (5V)
4 Basic unit (CPU I+II)
5 Extension unit (EE)
6 I/O comparator and switchover module (EAVU)
7 Cabinet power supply unit with:
Circuit breakers, socket outlets, alarm logic modules, logic diode modules, cabinet power supply diodes, inductive bus converter unit (option), blinking clock-pulse generator module
8 Group interrupt module (option) or I/O module
9 Process cable clamping bars

Fig 2.1 Cabinet layout

2.2 Power Supply Unit (SVE)

The power supply unit is installed in the topmost tier of the basic cabinet and provides the basic unit with both supply voltages.

Internally, the 24-V buffer module has a two-channel structure and buffers the DC 24-V voltage twice (for SV I and SV II).

The power supply modules at either side of the buffer module supply both CPUs independently with 5 V.

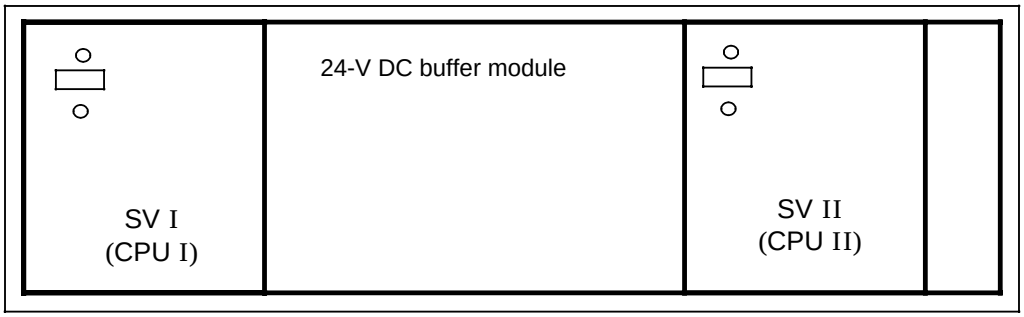
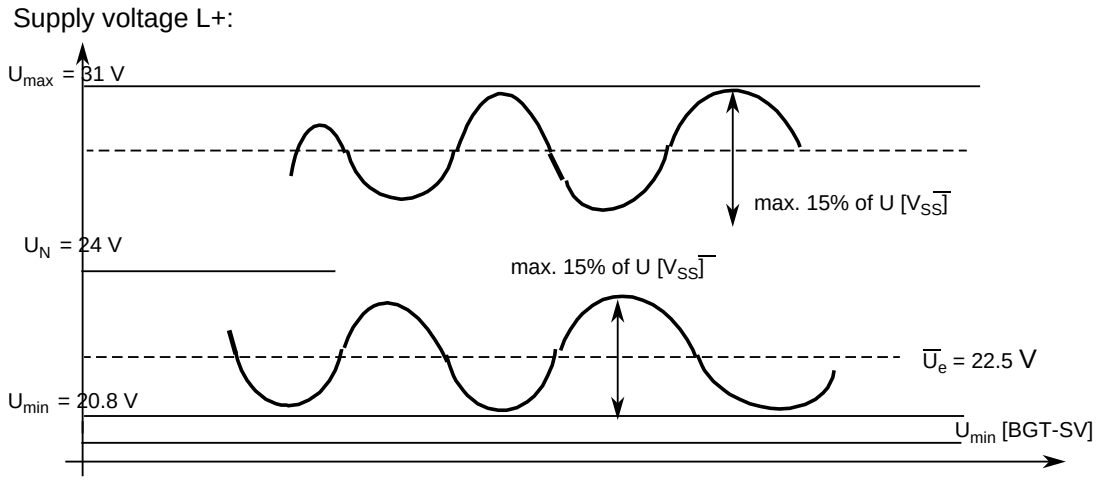
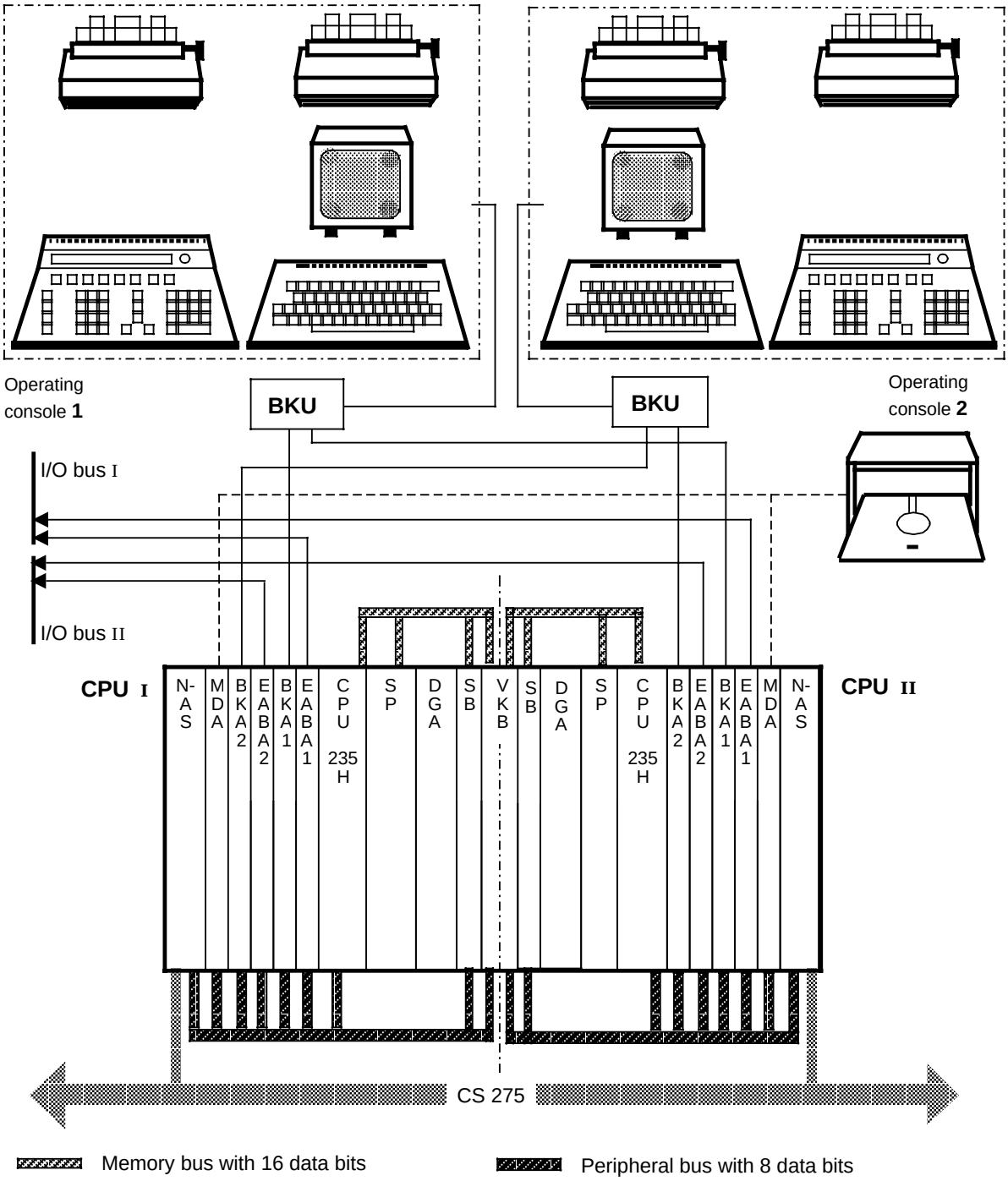


Fig. 2.2 AS 235 H power supply unit



2.3 Basic Unit (GE)

The basic unit consists of two central units (CPU I and CPU II) which are arranged in a mirrored structure in the subrack. The comparator coupler module (VKB), which is redundant in itself, forms the mirror axis of this system.
Seen from the front, the left-hand part is defined as CPU I, the right-hand part as CPU II.
Different to the AS 235 system, the backplane of the basic unit is completely structured as a supply and bus board. Yet, a detrimental connection of the two central units is not possible.
The supply voltages are fed to the central units via 2 x 1 cables (DC 24 V) and 2 x 3 cables (5 V).
The connection between operator input channel interface (BKA) and process communication keyboard*/*configuring keyboard*/*printer consists of standard cables *and* a special adapter cable.
A video relay is used for connecting a monitor to the two redundant BKA modules.
Ribbon cables which are plugged into the back of the basic unit interconnect the I/O bus interface modules and the I/O comparator and switchover modules (EAVU) in the extension units. The ribbon cables are plugged into the EAVU front panels.



KB Comparator coupler module
SB Synchronization module
DGA Diagnostic unit interface module [1])
SP Memory module
CPU Central processor unit module
BKU Operator input channel switchover unit, consisting of video relay and adapter cable
EABA 1 I/O bus interface module 1
BKA 1 Operator input channel interface 1
EABA 2 I/O bus interface module 2
BKA 2 Operator input channel interface 2
MDA Mini floppy disk interface module
N-AS Local bus interface module (N8-H permissible as well)

Fig. 2.3 System configuration

2.4 Extension Unit (EE)

An extension unit consists of a double-height subrack. Up to three extension units can be installed in a basic cabinet; an extension cabinet can accommodate up to four extension units.

Each extension unit features 14 slots. The I/O comparator and switchover module (EAVU) must always be installed in slot 14.

Any mix of I/O modules may be installed in the remaining 13 slots. A group interrupt module [1)] is to be installed in slot 13.

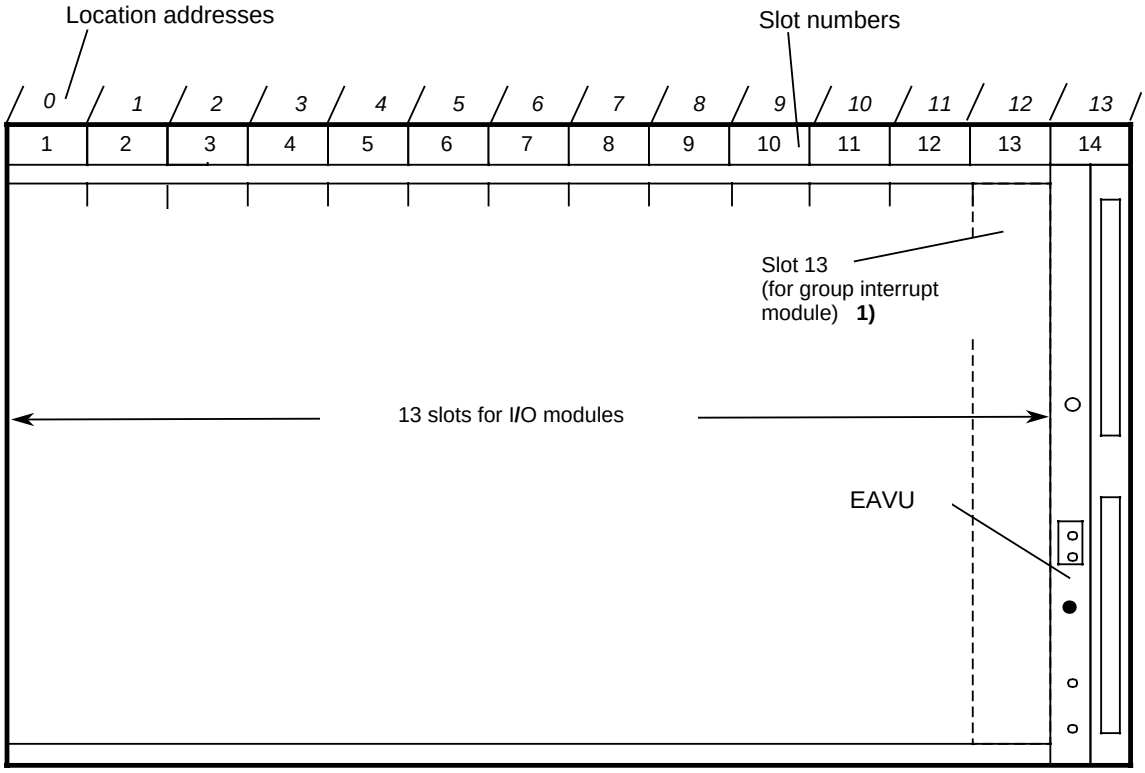


Fig. 2.4 Front of extension unit (EE)

1) Up to three group interrupt modules may be installed in the basic cabinet (one per extension unit).

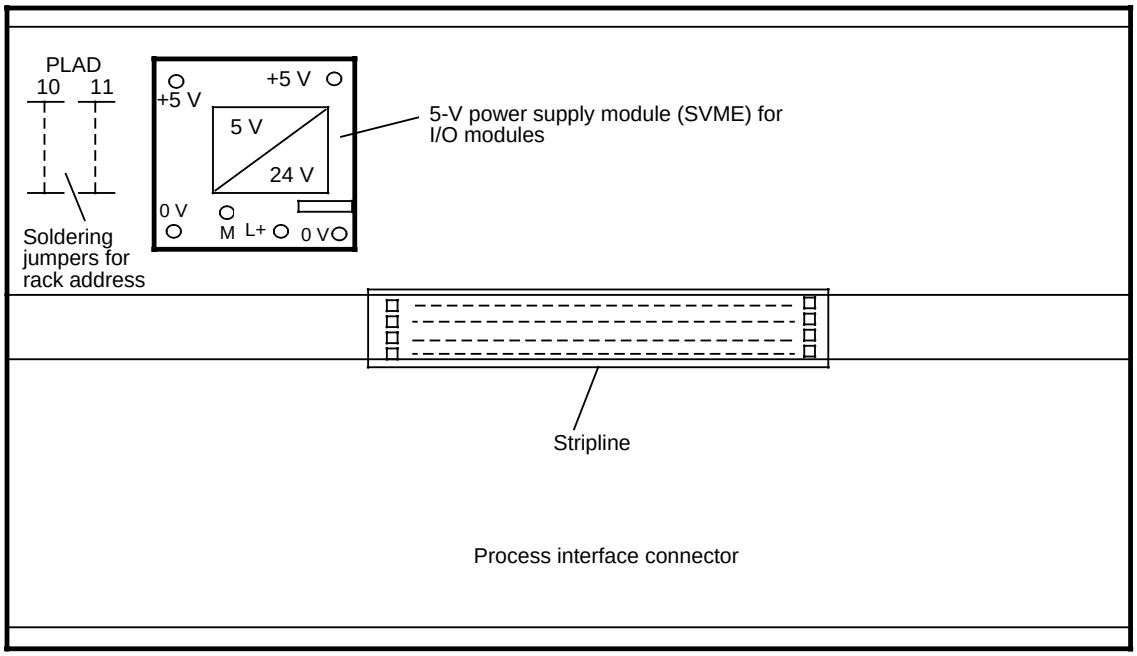
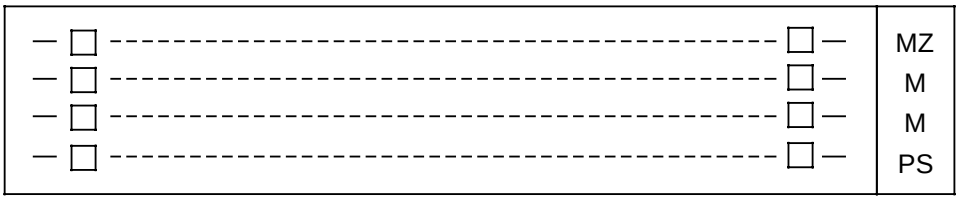


Fig. 2.5 Extension unit (rear)

Stripline:



The stripline may only be used for connecting the process interfaces of the I/O modules in the subrack (e.g. for I/O module input connections).
The stripline may not be used for feeding transducers, contacts etc.

The PS signal (24 V) is supplied by the EAVU. It is fused (1.6 A) on the EAVU module and routed via the X2 backplane connector to the stripline.

Caution:

Signal lines **may not** be routed from pins f32 and d32 (the process interface at the bottom connector of the I/O modules). The fuse ratings of the L+ potentials there are too high.

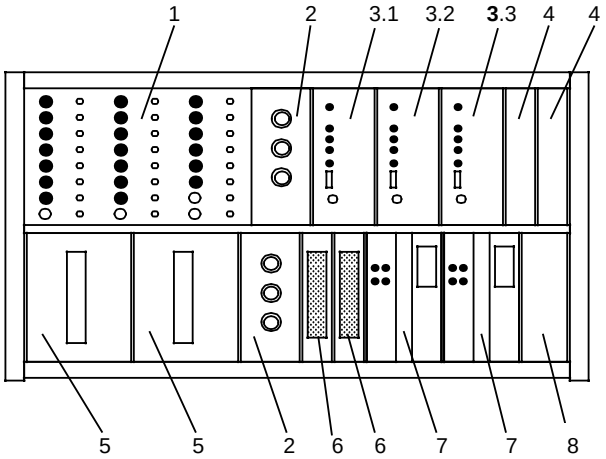
2.5 Cabinet Power Supply Unit (SES)

The cabinet power supply unit is a 2-tier subrack that is installed in the lower part of the main rack (location W) inside the basic cabinet.

The front section of the cabinet power supply unit contains the circuit breakers for the individual system components, the socket outlets for keyboard and mini floppy disk unit connections and the connectors for the cabinet power supply diodes, the cabinet monitoring modules and the remote bus.

The rear part of the cabinet power supply unit accommodates the terminal blocks for distributing the M potential and the individually fused 24-V voltages, and isolating terminals for connecting zener diode blocks (surge diverters) for the 24-V voltages.

A fully equipped cabinet power supply unit has the following structure:



1 Circuit breakers (F) for:

F1	CPU I	F9	EE 1	F17	PÜ 1
F2	CPU II	F10	EE 2	F18	PÜ 2
F3	Process communication keyboard 1	F11	EE 3	F19	Fan 1 for GS
F4	Process communication keyboard 2	F12	EE 4	F20	Fan 2 for ES
F5	Mini floppy disk unit 1	F13	EE 5	F21	Fan 1 for ES
F6	Mini floppy disk unit 2	F14	EE 6	F22	Fan 2 for ES
F7	UI	F15	EE7	F23	Heat exchanger for GS
F8	Reserve	F16	Reserve	F24	Heat exchanger for ES

2 Socket outlets for keyboard and mini floppy disk unit
3.1 ML alarm logic module for CPU I
3.2 ML alarm logic module for CPU II
3.3 ML alarm logic module for ES
4 VD11 diode module (option)
5 SED 31 cabinet power supply diode
6 Local bus connector (connection distribution unit)
7 UI bus converter unit (option)
8 BL flashing pulse generator module

Fig. 2.6 AS 235 H cabinet power supply unit

2.6 Cabinet Configuration (Power Dissipation)

2.6.1 Power Loss

The power loss must be controlled when the AS cabinets (including the I/O modules) are configured. The AS 235 H automation system may be used without a fan module if the permissible cabinet power loss values are not exceeded.

The following power loss limits P_{Smax} must be taken into account when the cabinets are configured: (=cabinet entry temperature)

=25 °C	P_{Smax} = 450 W	30 °C	P_{Smax} = 420 W
35 °C	P_{Smax} = 380 W	40 °C	P_{Smax} = 350 W

As long as P_{Smax} is not exceeded, the components installed in the basic and extension cabinet may be used without a fan. If the power loss of the cabinet exceeds P_{Smax} due to the use of I/O modules, the air flow rate must be increased. In this case, fan modules or heat exchangers have to be configured (option).

2.6.2 AS 235 H Basic Cabinet

1. If the power loss P_{Smax} is not exceeded in the cabinet and a value of 150 W is not exceeded in any of the extension units of the cabinet either, the cabinet can be used without forced ventilation up to the cabinet entry temperatures specified above.
2. An extension unit without forced ventilation may only be loaded up to a value of 150 W. A forced ventilation must be provided in the cabinet if this value is exceeded.
3. If the cabinet is equipped with a lot of I/O modules with a higher power loss value, the modules should not be installed next to each other but be distributed in the subracks so as to prevent hot spots.

Configuration rules for the AS 235 H basic cabinet

The following values must be used for calculating the thermal load of the cabinet:
Configuration value of base AS configuration:
P_{Gmax} 150 W + N×7 W; N=number of EAVUs
Typical average power loss of an I/O module: $P_{I/O\ module}$=5.4 W
Typical maximum power loss of an I/O module: $P_{I/O\ module}$=7 W

Maximum power loss of an I/O module: see PLT 111 Catalog, Edition 1993.

Basic cabinet

Formula: $P_{I/O\ max} = P_{Smax}$ Power loss I/O $_{max}$ cabinet

Typical permissible number of I/O modules in the cabinet: (at 40°C)

$$A_{I/O\ typ} = \frac{200\ W}{5.4\ W/module} = 37\ modules_{typ}$$

Permissible number $_{typ.,min}$ I/O modules in the cabinet: (at 40°C)

$$A_{I/O\ min} = \frac{200\ W}{7\ W/module} = 28.6\ modules_{typ.,min}$$

The base value P_{Smax} must be adapted according to the table (see above, under item 2.6.1).

This rough calculation can be used to determine whether or not the typical/maximum power loss resulting from I/O modules has been exceeded. (Rule of thumb: 2 completely filled I/O subracks with 13 I/O modules each).

From 28 I/O modules onwards, checking against the power specifications in the PLT 111 Catalog (Edition 1993, Catalog Section 5, "I/O Modules") is recommended. The process signals should be included if necessary (maximum number: 39).

Different distribution (e.g. in an additional extension cabinet) or a fan module is required if the I/O modules exceed the power loss P_{Smax}.

2.6.3 AS 235 H Extension Cabinet

1. With a typical module configuration, the power loss limit of the cabinet is not exceeded if the AS 235 H extension cabinet is used without a fan. (Up to 52 I/O modules, without EAVU modules).
   Only in the case of an atypical configuration (many identical I/O modules, modules >8 W) a more detailed checking is recommended.
   If the power loss P_{Smax} is not exceeded **and** a value of 150 W is not exceeded in any of the extension units in the cabinet either, the cabinet may be operated up to the specified cabinet entry temperature without forced ventilation (see Chap. 2.6.5) .
2. An extension unit without forced ventilation may only be loaded up to a value of 150 W. A forced ventilation must be provided in the cabinet if this value is exceeded.
3. If the cabinet is equipped with a lot of I/O modules with a higher power loss value, the modules should not be installed next to each other but be distributed in the subracks so as to prevent hot spots.

Configuration rules for the AS 235 H extension cabinet

In maximum configuration, each of the four extension racks in the extension cabinet may be equipped with one EAVU module (power loss 7 W).

A value of 28 W can therefore be assumed as a configuration value of the base configuration P_G of the four extension units.

The maximum number of I/O modules is 4×13=52 (without EAVUs).

The following formula shows that a typical configuration does not cause the power loss of the extension cabinet to be exceeded:

Formula: $P_{I/O\ max} = P_{Smax} - 28\ W$ Power loss I/O $_{max}$ cabinet

Typical average power loss of an I/O module: $P_{I/O\ module} = 5.4\ W$

Typical maximum power loss of an I/O module: $P_{I/O\ module} = 7\ W$

Typical permissible number of I/O modules in the cabinet: (at 40°C)

$$A_{I/O\ typ.} = \frac{322\ W}{5.4\ W/module} = 59\ modules_{typ.}$$

Permissible number of $_{typ.,min}$ I/O modules in the cabinet: (at 40°C)

$$A_{I/O\ min} = \frac{322\ W}{7W/module} = 46\ modules_{typ.,min}$$

A fan module must be provided or the distribution of the I/O modules in several extension units changed if the power loss of the I/O modules in an extension rack exceeds 150 W.

One or two fan modules must be added according to the above-mentioned configuration rules if the total power loss exceeds P_{Smax}.

The P_{Smax} base value must be adapted in accordance with the table (see 2.6.1 above).

This rough calculation can be used to determine whether or not the typical */* maximum power loss resulting from I/O modules has been exceeded.

From three filled extension units onwards or in the case of an atypical configuration, checking against the power specifications in the PLT 111 Catalog (Edition 1993, Catalog Section 5, ”I/O modules”) is recommended. The process signals should be included if necessary.

A fan module is required if the I/O modules exceed the power loss P_{Smax}.

2.6.4 AS 235 H Cabinet with Forced Ventilation

Depending on the thermal load (power loss) of the I/O modules, up to two fan modules (6DS9 943-8AA) may be required in the TELEPERM M cabinet, basic and/or extension cabinet.

2.6.5 AS 235 H Cabinet without Heat Exchanger (WT)

If the power loss (Ps)

>350 W at a cabinet entry temperature of 40°C

>380 W at a cabinet entry temperature of 35°C

>420 W at a cabinet entry temperature of 30°C

>450 W at a cabinet entry temperature of 25°C

or if a subrack is equipped with modules whose total power loss >150 W, a fan module is required in the basic cabinet at installation location 13 or in the extension cabinet at installation location 9.

If both criteria apply, each cabinet must be equipped with two fan modules.
In the basic cabinet, the second fan module must be fitted in installation location 29 and in the extension cabinet in installation location 25.
The following power loss limits apply in this case:

Ambient temperature	40°C
Power loss of the cabinet	700 W

Cabling and fusing have been laid out for the connection of a maximum of two fans per cabinet.

2.6.6 AS 235 H Cabinet with Heat Exchanger

1. If the total cabinet power loss P_S does not exceed a value between 350 W and 450 W (depending on the ambient temperature) and if the power loss in each individual extension unit (EE) is less than 150 W, the cabinet (with heat exchanger) may be used **without** an additional fan module.
2. Up to a total power loss P_S of 700 W at an ambient temperature of 40°C **and** provided that the power loss in each individual extension unit (EE) is less than 150 W, the cabinet (with heat exchanger) may be used **with one** fan module.
   The fan module must be installed in the basic cabinet between the base unit and the 1st EE at installation location 13 and in the extension cabinet between the 4th EE and 5th EE at installation location 9.
3. If the power loss in one of the three or four extension racks exceeds the limt of 150 W **or** the total power loss P_S>700 W, a second fan module must be installed in the base cabinet between the 2nd EE and 3rd EE (installation location 29) or in the extension cabinet between the 6th EE and the 7th EE (installation location 25) .

   In this case P_{Smax}=1000 W can be reached at an ambient temperature of 40°C .

2.6.7 Fan Module (Option)

The fan module 6DS9 943-8AA is used to provide forced-air cooling. A fan module features 3 fan motors each of which is monitored for speed; an electronic short-circuit fuse is integrated.

The fan monitors of the fan modules and the heat exchanger are connected in series and applied to the basic unit as alarm signal LK.

The following cable sets are available (option) :

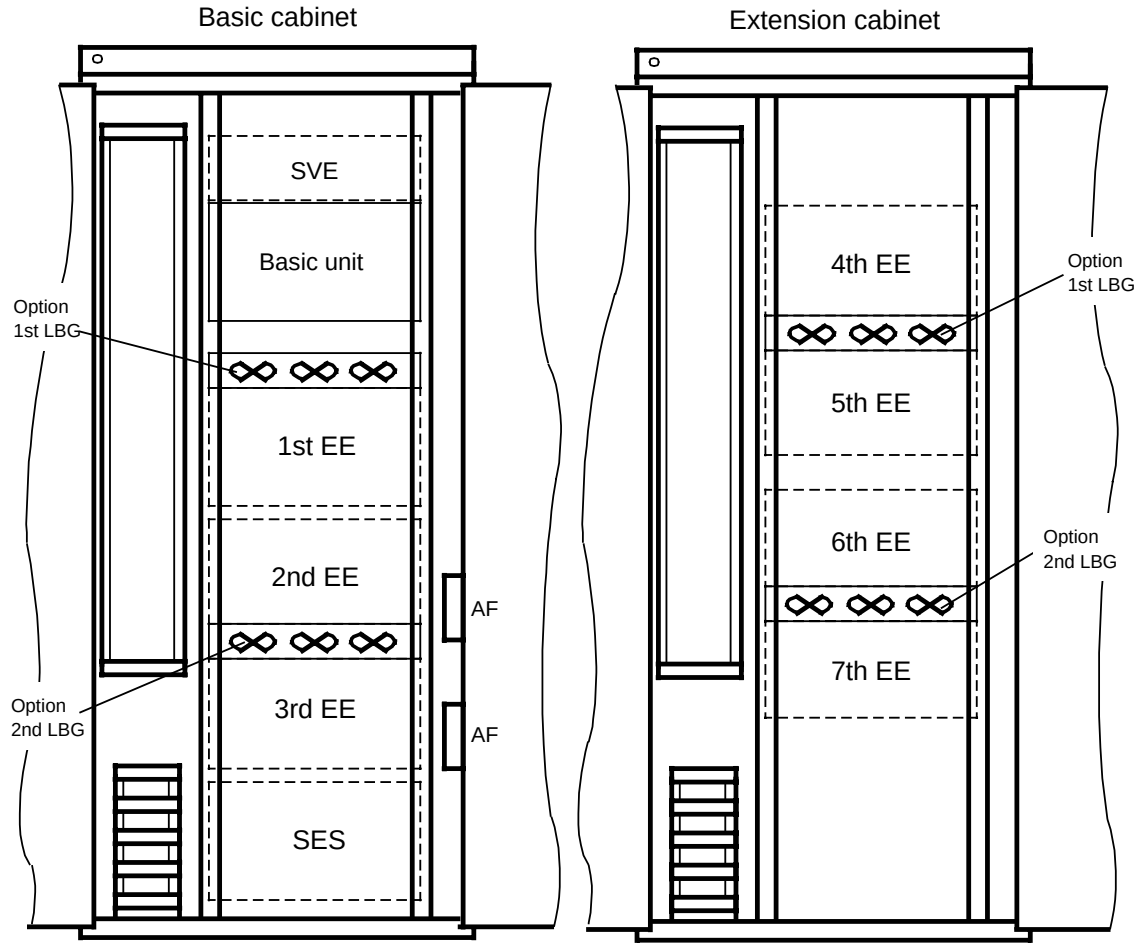
C79195-A3831-H220	to connect one fan module (supply and alarm output) in the basic cabinet (L=2.2 m)
C79195-A3831-H450	as for -H220, but for the extension cabinet (L=4.5 m)
C79195-A3828-H230	to connect one heat exchanger (alarm output) in the basic cabinet) (L=2.3 m)
C79195-A3828-H390	as for -H220, but for the extension cabinet (L=3.9 m).

One cable set is required per fan module. It includes the connection of the power supply and the alarm signal; as far as the heat exchanger is concerned, wiring of the series connection of the alarm signal is included.

The operating voltage is supplied via a cable at the rear of the module. The alarm signals from the monitoring circuit also run via the 6-pin connector of this cable.

The fan module is used to provide forced ventilation of module subracks in AS 235 H system cabinets. The fan module unit is designed for operation with DC 24 V.
The module has the same dimensions as an ES 902 subrack and like the latter can be installed in main frames.

The fan motors issue a square wave signal wih a frequency that is proportional to the speed. The square wave pulses are fed to the monitoring circuit which monitors the lower frequency (speed) limits of the individual motors. (See Fig. 2.7 for the installation locations of fan modules).



LBG Fan module

Fig. 2.7 Cabinet layout, location of fan modules (options)

A red LED lights up and a floating changeover contact is actuated if the speed of a motor falls below the minimum rate.

- The LED is used for fault location
- The changeover contact can be used for issuing a fault signal via an external signal line or for triggering external signals or switching activities.

Error messages are suppressed during start-up after the supply voltage has been switched on.
The changeover contact function can be selected by setting the plug-in jumper X16:

- active non-fault alarm=passive fault alarm
  The relay drops in the case of a malfunction (when LED is ON).

Upon delivery, the X16 plug-in jumper is set for active fault alarm.
The fan module connecting cables C79195-A3828-H220 (length 2.20 m) are used for power supply and signal line connection in the basic cabinet (fan module 1 or 2), or 79195-A3828-H450 (length 4.50 m) for fan modules in the extension cabinet.

Warning

Ensure that the fan module is not used without the finger guard!

The fan module is maintenance-free.

Based on the fan service life (approx 40,000 h) specified by the manufacturer, it is recommended to replace the fan or the fan module every 4 years.

Settings to be made after the module has been replaced: jumper setting for alarm signal (see Fig. 2.8).

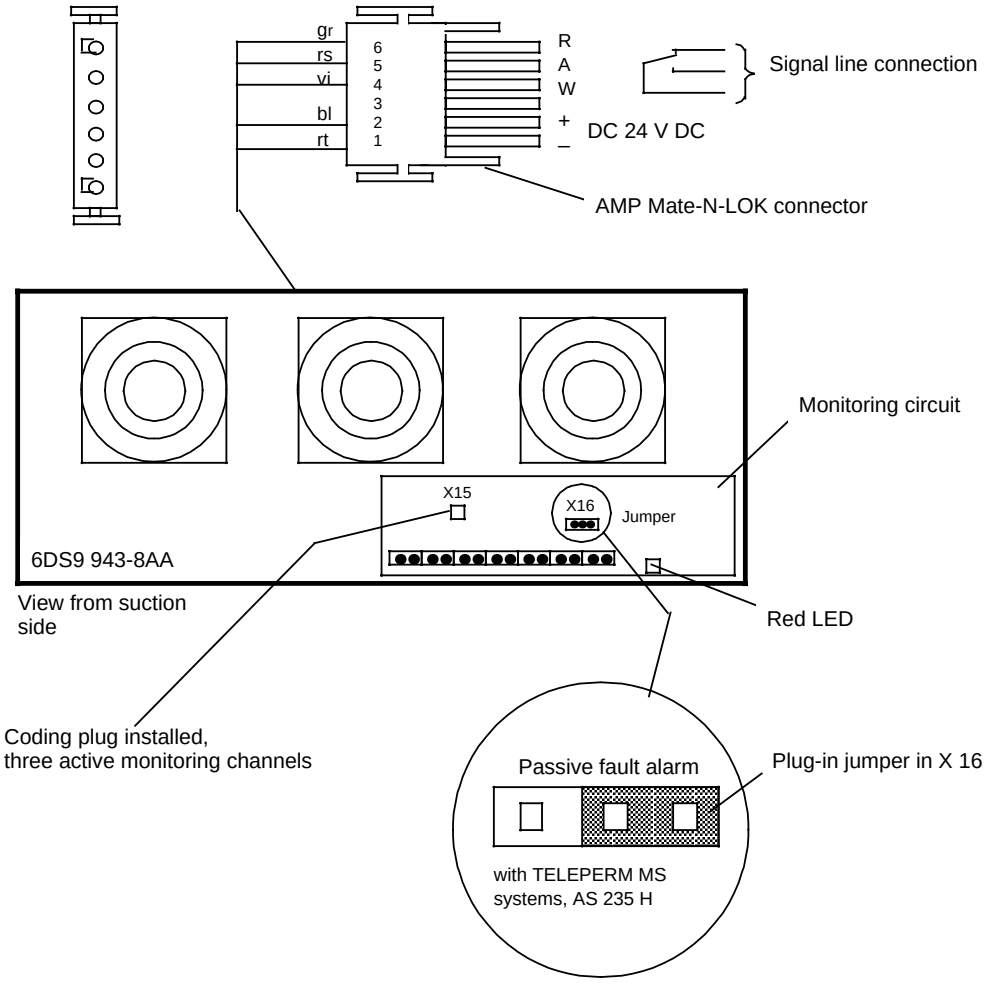


Fig. 2.8 Fan module

Automatic circuit breakers (F) are provided in the SES for the connection of fan modules:

Fan 1 fused via F19 (KL 43) in the basic cabinet and via F21 (KL 49) in the extension cabinet.

Fan 2 fused via F20 (KL 46) in the basic cabinet and via F22 (KL 52) in the extension cabinet.

The alarm signals of the fan(s) and*/*or the heat exchanger are connected in series via the marshalling rack (RV) in the SES and fed from there to the AS system.

The heat exchanger (230 V AC) is fused externally.

3 Method of Operation

3.1 System Configuration

Method of operation and configuration of the AS 235 H automation system are defined by the requirements of increased availability. This availability is mainly achieved by CPU redundancy where the same data is processed by two CPUs which operate independently at synchronous clock pulses.

Both CPUs are equivalent and have the same priority level, although the I/O comparator and switchover module (EAVU) routes only the signals from one CPU to the I/O modules. Also the communication via the CS 275 bus system does only take place via the N-AS or N8-H module of **one** CPU. This CPU is known as "master CPU".

CPU I assumes master function and thus process control if both CPUs are started simultaneously. CPU II becomes passive and, after updating, automatically assumes the function of the backup CPU which is able to take over mastership at any time. This enables the system to continue process operation without interruption after a tolerable fault has occurred.

Either CPU can assume one of the following states:

Master	(M)	Only master mode enables a CPU to actively control the process.
Standby	(R)	A CPU in backup mode executes the same instruction sequence as the master CPU.
Passiv	(P)	The CPU is separated; the two CPUs operate in asynchronous mode.
Backup	(B)	The CPU accepts the memory contents of the master CPU.
Fehler	(F)	The system software has located a fault in the CPU.

3.2 Faultless Operation

Both CPUs run synchronously during normal faultless operation.

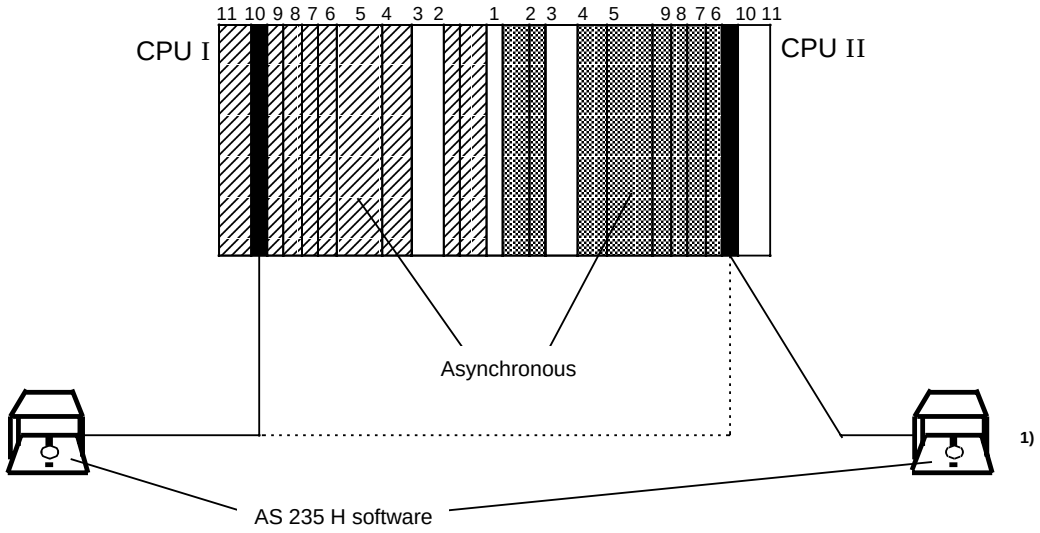
At first, both CPUs start up asynchronously. During commissioning, the same system software is loaded into the memories of the central processing units. This is performed either in succession (with one floppy disk drive) or in parallel (with two floppy disk drives). Subsequently, the system can be synchronized.

The memory contents of both memories are identical in synchronous operation. This means that identical data is read and written. The central processors provide control signals and addresses synchronously. The comparator coupler module (VKB) compares all incoming and outgoing data and signals of the central processing units.

One I/O comparator and switchover module (EAVU) per extension unit performs this comparison on the I/O level.

Each operator terminal possesses two operator input channel interface modules, one in CPU I and one in CPU II.

Although there are two local bus interface modules (N-AS or N8-H), if communication is performed via the CS275 bus system, only the N-AS**/**N8-H of the master CPU is active. (A single N-AS**/**N8-H module is not expedient since the connection to the CS 275 bus system would be interrupted if mastership were changed.)



1	Comparator coupler module (VKB)	(6DS1 142-8AA)
2	Synchronization module (SB)	(6DS1 143-8AA)
3	Diagnostic unit interface module (DGA)	
4	Memory module (SP)	(6DS1 837-8DA**/**-8EA**/**-8FA and 6DS1 844-8..)
5	Central processing unit (CPU)	(6DS1 141-8AA)
6	I/O bus interface module 1 (EABA1)	(6DS1 312-8BB)
7	Operator input channel interface module 1 (BKA1)	(6DS1 330-8CA)
8	I/O bus interface module 2 (EABA 2)	
9	Operator input channel interface module 2 (BKA2)	
10	Mini floppy disk interface module (MDA)	(6DS1 326-8BB)
11	N-AS or N8-H local bus interface module	(6DS1 223-8CA or 6DS1 220-8AA)

Fig. 3.1 Start-up and loading

1) Although only one mini floppy disk unit is sufficient for loading the system software and the user program, two mini floppy disk interface units are required. For booting, the mini floppy disk unit is connected to CPU I and CPU II in succession. Both interfaces must, however be installed.

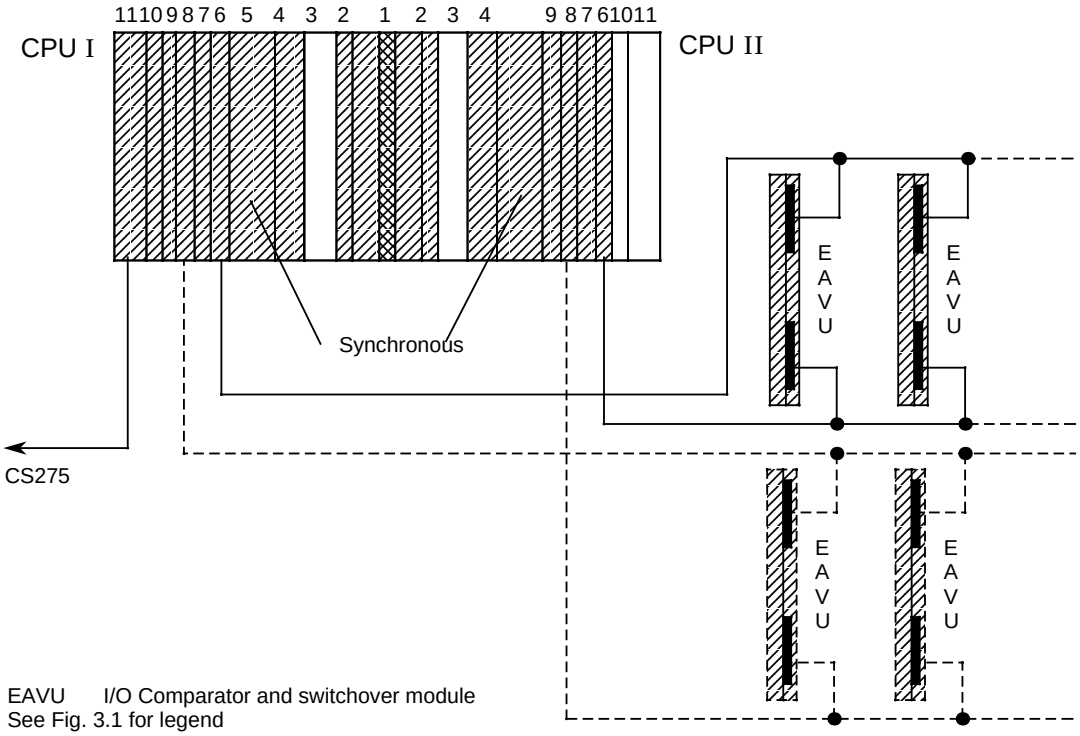


Fig. 3.2 I/O connection via EAVU, synchronous operation, CPU I is master

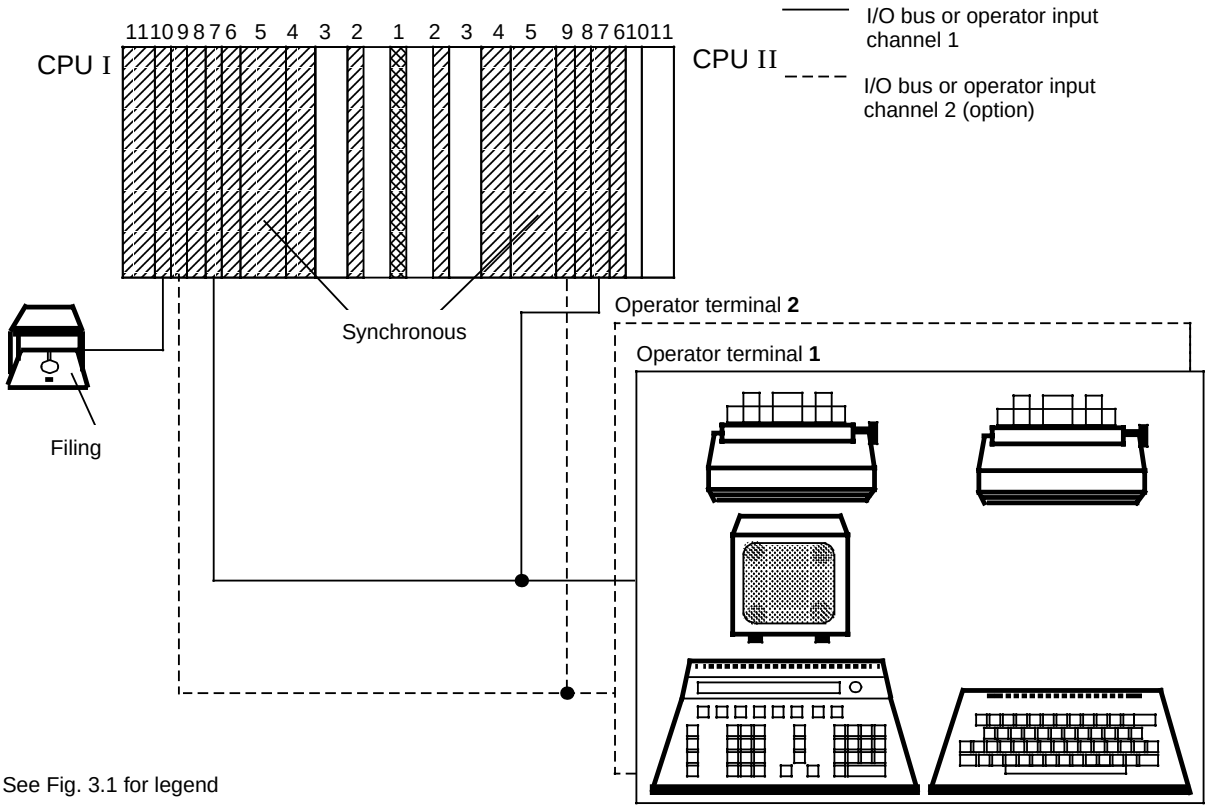


Fig. 3.3 Connection to operator input level, synchronous operation, CPU I or CPU II is master

3.2.1 Central Unit Functions

The fault-tolerant functions of the central unit with its two identical central processing units can only be performed if the specified configuration has been established.

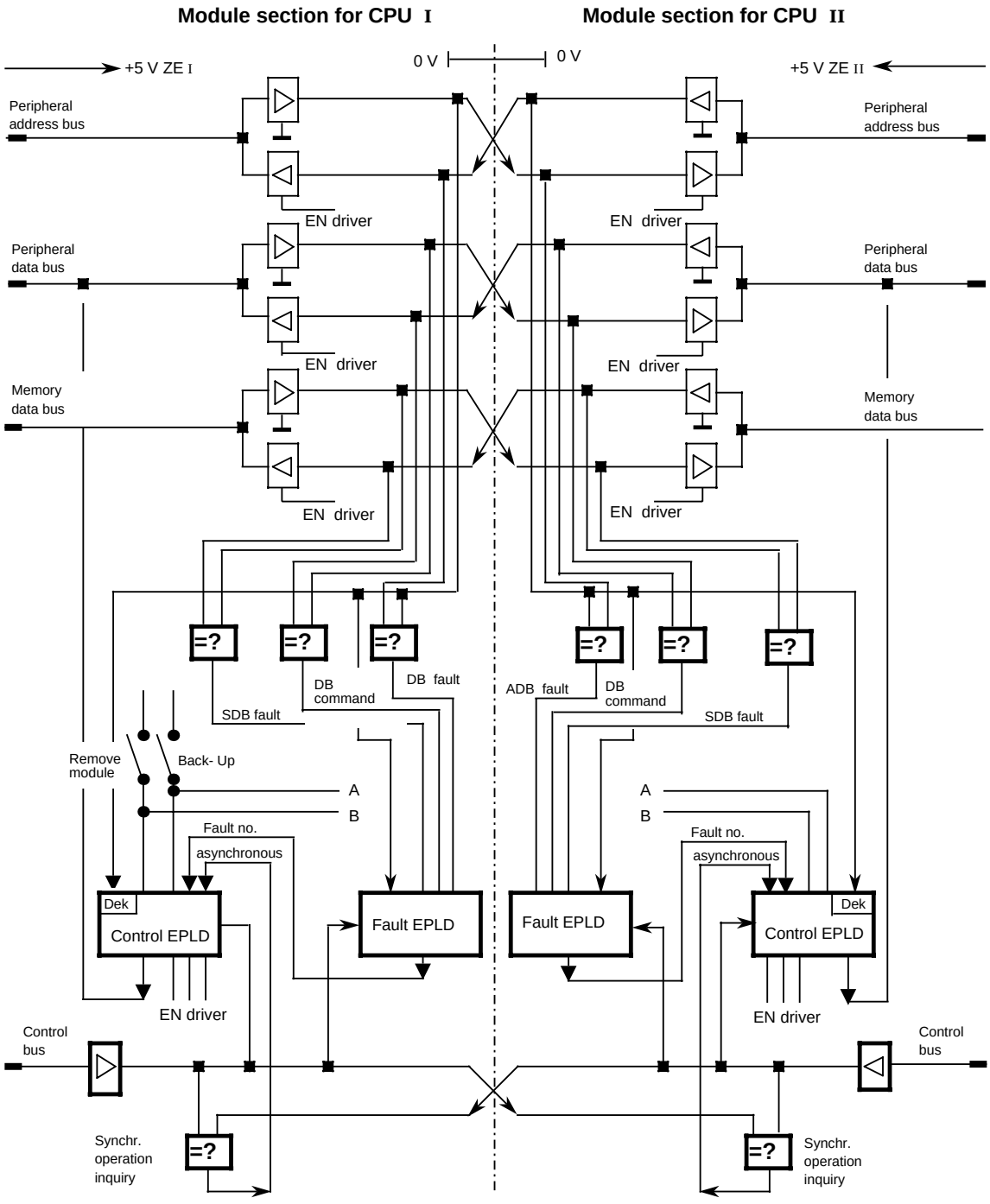
- Comparator coupler module (VKB)

The comparator coupler module (Fig. 3.4)

- compares the bus signals of both CPUs
- interconnects the parallel buses of both CPUs
- branches a single-channel input information to both CPUs
- transfers all read data items during backup operation from the memories/registers of the master CPU to the memories**/**registers of the second CPU.

Caution

The VBK may not be removed during operation unless the switch on the front is in AUS (OFF) position.
The switch itself may only be actuated during asynchronous operation.



EN = enable
=? = comparator
EPLD = Erasable programmable logic device

Fig. 3.4 Block diagram of the comparator coupler module (VKB)

- Synchronization module (SB)

The synchronization module (Fig. 3.5) provides the basis for synchronous operation of the two CPUs. It

- generates the processor and system clock pulses,
- synchronizes the CPU base clock pulse,
- synchronizes read and write data,
- synchronizes interrupt signals,
- supplies status messages to the CPU,
- controls synchronization.

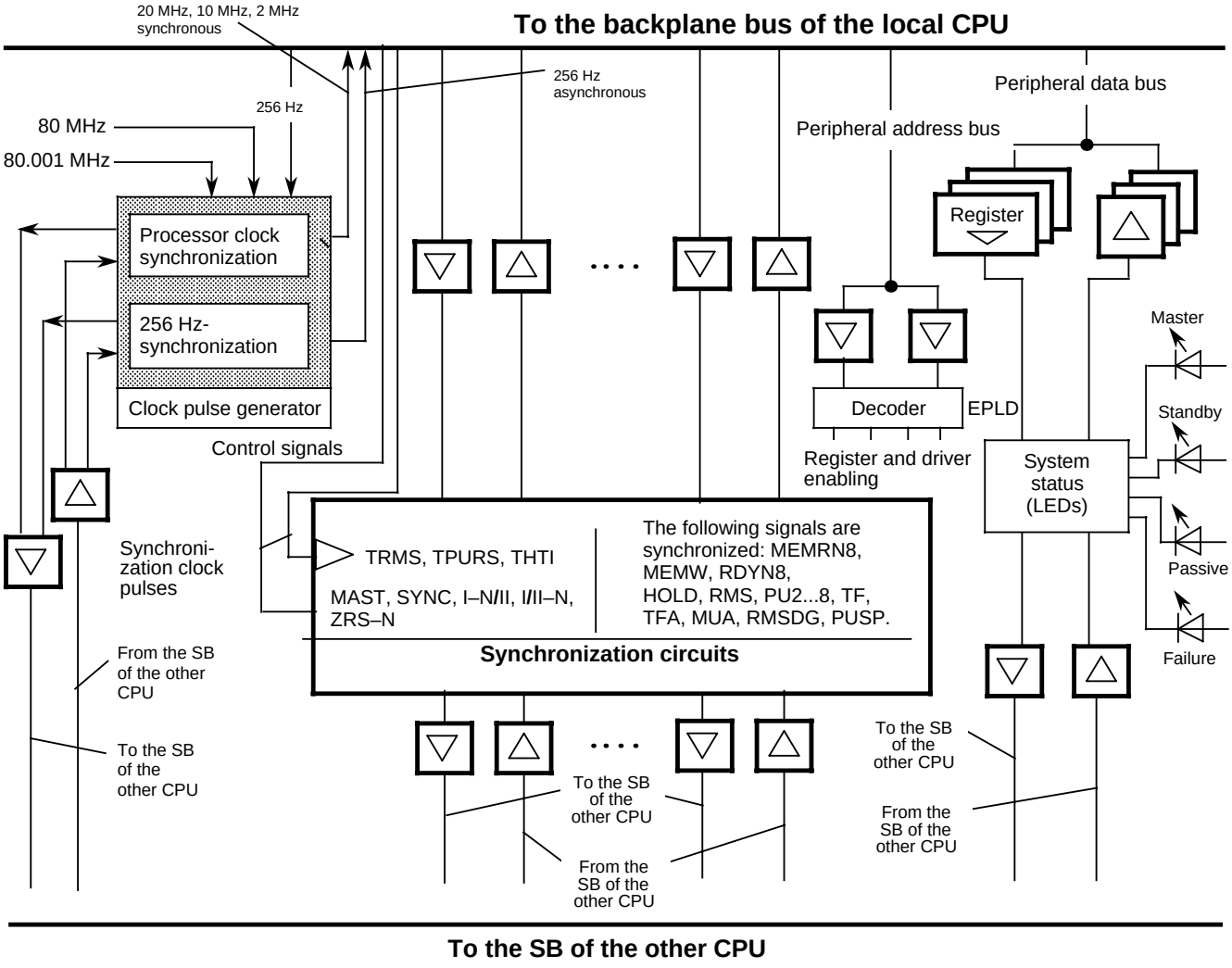


Fig. 3.5 Block diagram of the synchronization module (SB)

Memory Module

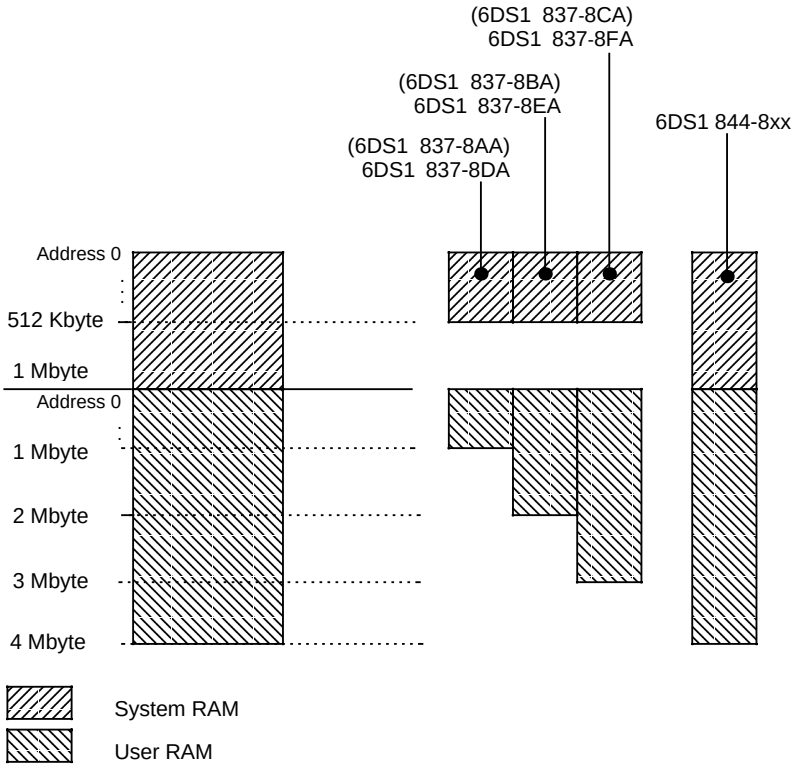
– 512 Kbyte system memory with memory module 6DS1 837-8xA *or*
  1 Mbyte system memory with memory module 6DS1 844-8xx
– 1, 2 or 3 Mbyte user RAM with memory module 6DS1 837-8xA *or*
  4 Mbyte user RAM with memory module 6DS1 844-8xx
  (4000 Kbyte are available for the user from a total of 4 Mbyte)
– Back-up battery
– Battery failure logic circuit
– Parity monitoring (byte per byte)
– Error and control register
– Error display and state display with LED on the front plate
– BOOT logic.

If a parity error is detected when a word is read, then this error is signalled with a PAF signal (parity error) and processed from the system programs.

	6DS1 837-8xA	6DS1 844-8xx
Cycle time Access time	500 ns 300 ns	500 ns 300 ns

Table 3.1 Memory module cycle time

Memory design



- Central processing unit (CPU 235 H)

The central processing unit

- contains a 16/32-bit processor,
- is responsible for system start-up and microprogram start-up,
- processes the automation functions according to the program in the user memory.

Caution

Some of the backplane connector pin assignments of CPU 235 H (6DS1 141-8AA) and CPU 235 (6DS1 140-8AA) are different due to the following modifications that are required for synchronous CPU operation:

- External supply of the 20-MHz and 10-MHz processor clock pulses via the two SB modules (the G1 and G2 quartz oscillators have not been installed on the CPU 235 H).
- The 1/256-Hz time clock pulse is routed via the SB module for synchronization.
- The TPURS signal is issued to the SB module.

Due to the different connector pin assignments, the CPU module could be destroyed if a CPU 235 H were installed in a standard AS 235 system and vice versa.

- I/O bus interface module (EABA)

The I/O bus interface module

- transfers data and signals from the CPU to the EAVUs,
- receives data and signals from the EAVUs and transfers them to the CPU.