SIEMENS

SIMATIC S5

S5-155U
Programmable Controller
(CPU 946/947)

Manual

Order No. 6ES5998-0UM22
Release 07

Contents

Warnings Information Suggestions/Corrections	C79000-R8576-C647	
Product Summary CPU 946/947	C79000-T8576-C647-01	1
Installation Guide Programmable Controllers of the U Series	C79000-B8576-C452-04	2
S5-155U/S5-155H Central Controller Instructions	C79000-B8576-C380-05	3
CPU 946/947 Instructions	C79000-B8576-C532-06	4
355 Memory Module Instructions	C79000-B8576-C382-06	5
923 C Coordinator Instructions	C79000-B8576-C349-06	6
Multiprocessor Operation Instructions	C79000-B8576-C500-02	7
Multiprocessor Communication User's Guide	C79000-B8576-C468-05	8
CPU 946/947 Programming Guide	C79000-B8576-C637-03	9
Space for Pocket Guide CPU 946/947, CPU 946R/947R	C79000-B8576-C054-01	10
Appendix	C79000-A8576-C647-01	11
		12

The Pocket Guide CPU 946/947, CPU 946R/947R (C79000-B8576-C111-02) is included in the front pocket of this Manual.

Summary of Product Number and Corresponding Documentation for the S5-155U Programmable Controller

The following table shows the assignment of the product documentation to the individual products. The listed sections of the documentation relate to the manual S5-155U (CPU 946/947) with the order no. 6ES5 998-0UM22, release 07.

Product		Product Documentation
Order No.	Title	
6ES5 155-3UA11 **6ES5 155-3UA21**	**Central Controller S5-155U**	**Instructions:** **(Part 3):** Central Controller S5-155U/155H C79000-B8576-C380-05 **(Part 7):** Multiprocessor Operation in the Central Controllers S5-135U/155U C79000-B8576-C500-02 **User's Guide** **(Part 8):** Multiprocessor Communication S5-135U Programmable Controller, CPU 922 and 928 S5-155U Programmable Controller, CPU 946/947 C79000-B8576-C468-05 **Installation Guide** **(Part 2):** Programmable Controllers of the U Series C79000-B8576-C452-04
6ES5 946-3UA11 **6ES5 946-3UA12** **6ES5 946-3UA21** **6ES5 947-3UA11** **6ES5 947-3UA21**	**CPU 946/947**	**Instructions** **(Part 4):** CPU 946/947 C79000-B8576-C532-06 **Programming Guide** **(Part 9):** S5-155U Programmable Controller, CPU 946/947 and S5-155H Programmable Controller, CPU 946R/947R C79000-B8576-C637-03 **List of Operations** (in the front pocket) CPU 946/947, CPU 946R/947R C79000-B8576-C111-02
6ES5 355-3UA11	**355 Memory Module**	**Instructions** **(Part 5):** 355 Memory Module C79000-B8576-C382-06
6ES5 923-3UC11	**923 C Coordinator**	**Instructions** **(Part 6):** 923 C Coordinator C79000-B8576-C349-06

Preface

This manual provides an overview of the structure and functions of the programmable logical controller S5-155U. It explains how you configure, program, test and start your programmable controller.

This manual is intended as a guide for you to learn to use the PLC and to make optimum use of the features of the device.

This manual is intended for engineers, programmers and maintenance personnel who have a general knowledge of programmable controller concepts.

If you have any questions which have not been answered in this manual, please contact your local Siemens representative.

How To Use This Manual

The following information is intended to make it easier for you to use the S5-155U manual, (order no. 6ES5 998-0UM22).

Overview of Contents

- **Part 1 : Product Summary**

This part provides an overview of the structure of the S5-155U programmable controller with CPU 946R/947R. This overview provides you with the basic information to aid your understanding of the following chapters.

- **Part 2 : Programmable Controllers of the U Series - Installation Guide**

This part provides the information about how the programmable controllers of the U series must be structured. Different configurations, power supply, wiring, fans, temperature monitoring, safety measures and interference suppression are described.

- **Part 3 : 155U Central Controller - Instructions**

This part provides the instructions to the S5-155U central controller. Both the hardware as well as the installation procedure, start-up procedure and the maintenance of the central controller are described. After installation is complete, you will find the information in this section that you need to guarantee trouble free operation of the central controller.

- **Part 4 : CPU 946/947 - Instructions**

This part provides the instructions with a technical description and information about the installation procedure and use of the CPU 946/947; the standard central unit of the SIMATIC S5-155U programmable controller.

- **Part 5 : 355 Memory Module - Instructions**

This part provides the instructions on the memory module The instructions describe which modules you can use and what you must note about the installation and operation of the individual modules.

- **Part 6 : 923C Coordinator - Instructions**

Here you will find a description of how the modules function and what you must know about operating the coordinator.

- **Part 9 : STEP 5 Programming Instructions for the S5-155U**

The mode of operation and application of the CPU 946/947 are described in this section. Comprehensive information is available so that you can make optimum use of the S5-155U programmable controller.

- **Part 11 : Appendix**

The order numbers of all the components and spare parts mentioned in this manual are listed here.

Index

Each part of this manual has its own index.

Training

For information about training courses in connection with this device, please contact your local Siemens representative.

Warning

Risks involved in the use of so-called SIMATIC-compatible modules of non-Siemens manufacture

"The manufacturer of a product (SIMATIC in this case) is under the general obligation to give warning of possible risks attached to his product. This obligation has been extended in recent court rulings to include parts supplied by other vendors. Accordingly, the manufacturer is obliged to observe and recognize such hazards as may arise when a product is combined with products of other manufacture.

For this reason, we feel obliged to warn our customers who use SIMATIC products not to install so-called SIMATIC-compatible modules of other manufacture in the form of replacement or add-on modules in SIMATIC systems.

Our products undergo a strict quality assurance procedure. We have no knowledge as to whether outside manufacturers of so-called SIMATIC-compatible modules have any quality assurance at all or one that is nearly equivalent to ours. These so-called SIMATIC- compatible modules are not marketed in agreement with Siemens; we have never recommended the use of so-called SIMATIC-compatible modules of other manufacture. The advertising of these other manufacturers for so-called SIMATIC-compatible modules wrongly creates the impression that the subject advertised in periodicals, catalogues or at exhibitions had been agreed with us. Where so-called SIMATIC-compatible modules of non-Siemens manufacture are combined with our SIMATIC automation systems, we have a case of our product being used contrary to recommendations. Because of the variety of applications of our SIMATIC automation systems and the large number of these products marketed worldwide, we cannot give a concrete description specifically analyzing the hazards created by these so-called SIMATIC-compatible modules. It is beyond the manufacturer's capabilities to have all these so-called SIMATICcompatible modules checked for their effect on our SIMATIC products. If the use of so-called SIMATIC-compatible modules leads to defects in a SIMATIC automation system, no warranty for such systems will be given by Siemens.

In the event of product liability damages due to the use of so-called SIMATIC-compatible modules, Siemens are not liable since we took timely action in warning users of the potential hazards involved in so-called SIMATIC-compatible modules."

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.

A knowledge of the safety instructions and warnings contained in this manual and their appropriate application are prerequisites for safe installation and commissioning as well as safety in operation and maintenance of the product described. Only qualified personnel as defined in section 2 have the specialized knowledge that is necessary to correctly interpret the general guidelines relating to the safety instructions and warnings 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 technical description, 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 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 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 faults, 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, make sure that proper electrical isolation is provided between the mains supply and the 24 V supply. Only use power supply units to IEC 364-4-41 or HD 384.04.41 (VDE 0100 Part 410).
- 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 drive control, an active fault is generally dangerous because it can result in an unauthorized startup of the drive. On the other hand, a passive fault in a signalling function can result in a dangerous 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.

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, additional external measures must 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)

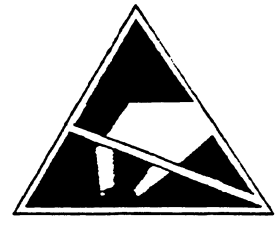
1 What is ESD?

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

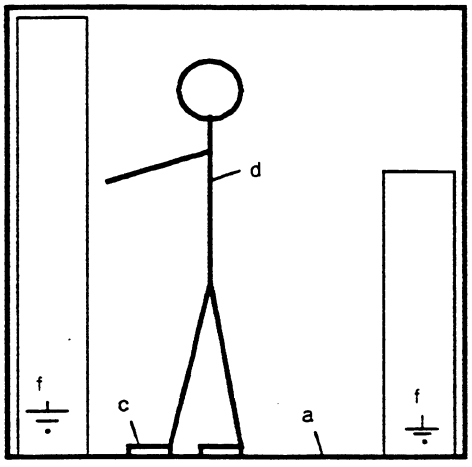
- Most plastic materials are highly susceptible to static charge and must therefore be kept as far away as possible from ESDs.
- Personnel who handle ESDs, the work table and the packing must all be carefully grounded.

4 Handling of ESD Modules

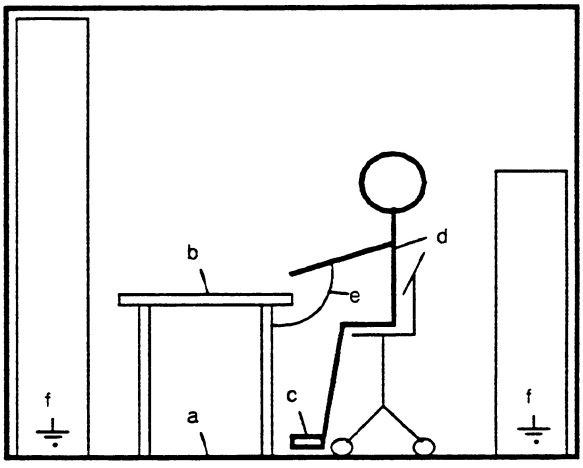
- One basic rule to be observed is that electronic modules should be touched by hand only if this is necessary for any work required to be done on them. Do not touch the component pins or the conductors.
- Touch components only if
  - the person is grounded at all times by means of a wrist strap

  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).

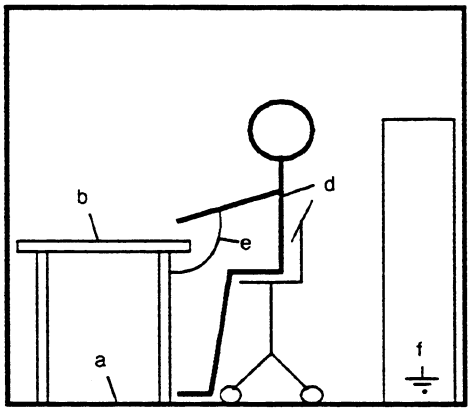
The diagram below shows the required protective measures against electrostatic discharge.



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.

SIEMENS

SIMATIC S5

CPU 946/947 Product Summary C79000-T8576-C647-01

CPU 946/947 Product Summary

The product summary provides an overview of the functions and characteristics of the CPU 946/947. It briefly describes general performance features and fields of application; the programming languages used are also mentioned.

Performance features

In the S5-155U programmable controller the CPU 946/947 can be used in single and in multiprocessor mode. It is designed for fast processing of all STEP 5 operations. With a maximum of 896 kbytes this CPU offers a large memory capacity.

The most outstanding features are:

- Max. 896 kbyte memory for data and user programs, as RAM and/or EPROM. 128 kbyte RAMs are already integrated in the CPU.
- - 2048 flags
  - 32768 S flags
  - 256 timers
  - 256 counters
- Processing from up to 4096 binary inputs/outputs each
  192 analog inputs/outputs each
  Via special interface modules up to 520 000 digital inputs/outputs each or
  32 000 analog inputs/outputs each

  is possible.

Programming language and program processing

Use the STEP 5 programming language /1/ to program the CPU 946/947. The types of representation for STEP 5 are the ladder diagram (LAD), control system flow chart (CSF) and statement list (STL). Furthermore GRAPH 5 is available which is used to program sequential controls (step sequences).

The CPU 946/947 allows user programs which are

- cyclic
- alarm-controlled
- time-controlled (max. 9 clock grids).

A hardware clock is also integrated.

The average processing time of 1K instructions is

- 1.4 ms for binary instructions
- 1.7 ms for command mix (60 % bits, 40 % words)

In the Programming Instructions in Part 9 of this manual you will find detailed information on programming the CPU 946/947. All operations and their running times are described in the Pocket Guide in Part 10 of this manual.

SIEMENS

SIMATIC S5

Programmable Controllers of the U Series

Installation Guide C79000-B8576-C452-04

Page

1 Introduction to Use of Installation Guidelines ... 3

2 Fundamentals of EMC ... 4

3 Selection and Design of Cabinets ... 6

3.1 Selection Criteria ... 6

3.2 Types of Cabinets ... 6

3.3 Specifications When Designing a Cabinet ... 8

3.4 Power Loss ... 10

3.4.1 Power Loss in Cabinet and Cabinet Cooling ... 10
3.4.2 Example of Calculating Cabinet Type ... 11

3.5 Example of a Cabinet Design ... 12

4 Design and Connection of Power Supplies ... 15

4.1 Internal Power Supply for Central Controllers and Expansion Units ... 15

4.2 Load Power Supply ... 16

4.3 Electrical Design with Process Peripherals ... 17

4.3.1 Power Supply for CCs, EUs and Process Peripherals from Grounded Battery or Grounded Power Supply Units ... 18
4.3.2 Power Supply for CCs, EUs and Process Peripherals from Centrally Grounded Battery or Centrally Grounded Power Supply Units ... 19
4.3.3 Power Supply for CCs, EUs and Process Peripherals from Non-Grounded Battery or Non-Grounded Power Supply Units ... 20

4.4 Load Power Supply from Two Power Supply Units ... 21

4.4.1 Non-floating Modules ... 21
4.4.2 Floating Modules ... 22

5 Wiring Layout ... 23

5.1 Wiring Layout Inside a Cabinet ... 23

5.2 Wiring Layout Outside Cabinets ... 24

5.3 Wiring Layout Outside Buildings ... 25

5.4 Equipotential Bonding ... 25

6	Cabinet Wiring and Design with Respect to EMC	26
6.1	Grounding of Inactive Metal Components	27
6.2	Shielding of Devices and Cables	28
6.3	Use of Special Noise Suppression Measures	30
6.4	Example of an EMC-compatible Cabinet Design	32
6.5	Checklist for EMC-compatible Cabinet Design	34
7	Framework and Wall Mounting of SIMATIC S5 Controllers	36
8	Lightning Protection Measures	38
9	Safety Measures	39
9.1	Protection against Indirect Contact	39

1 Introduction to Use of Installation Guidelines

This document is intended for planning, installation and commissioning engineers.

The installation guidelines are divided into the following sections:

- **Chapter 1** Introduction to Use of Installation Guidelines

- **Chapter 2** Fundamentals of EMC
  This section provides a summary of the rules you must observe to ensure electromagnetic compatibility.

- **Chapter 3** Selection and Design of Cabinets
  This section lists criteria which must be considered when selecting the cabinet. The conditions resulting from the power loss of the modules used and the ambient temperature are considered in particular. The power losses of SIMATIC modules are listed.

- **Chapter 4** Design and Connection of Power Supplies
  This section provides information you must observe for the electrical connection of the power supply to CCs, EUs and process peripherals.

- **Chapter 5** Wiring Layout
  This section describes how you can achieve a high interference-resistance of your programmable controller by using a correct wiring layout.

- **Chapter 6** Cabinet Wiring and Design with Respect to EMC
  This section describes the measures required to ensure EMC of your programmable controller. It shows how you can prevent fundamental errors when designing and wiring cabinets. A checklist is provided to check the EMC-compatible cabinet design.

- **Chapter 7** Framework and Wall Mounting
  This section describes what you must observe if you fit your SIMATIC controller in a framework or on a wall.

- **Chapter 8** Lightning Protection Measures
  This section provides information about the measures you should take to protect outdoor cables and lines for SIMATIC devices from lightning strikes.

- **Chapter 9** Safety Measures
  This section provides a summary of the measures you must always take when planning the use of programmable controllers in order to prevent danger during operation. The regulations CENELEC HD 384.4.41 (IEC 364-4-41) (VDE 0100) and EN 60 204 (IEC 204-1) (VDE 0113) must be applied in order to carry out these measures.

We recommend that users who are using a SIMATIC S5 controller for the first time follow the installation guidelines right from the beginning when planning the control system.
We strongly recommend that all users particularly observe the sections and paragraphs concerned with preventing danger (especially Chapter 9) and protection from sources of error (especially Chapter 6). Even if you are an experienced user, check your design using the checklist in Chapter 6.

2 Fundamentals of EMC

Definition of EMC

Electromagnetic compatability (EMC) means that an electrical device is able to function correctly in a defined electromagnetic environment without disturbing other devices in its vicinity.

It is frequently sufficient to observe a few elementary rules to achieve electromagnetic compatibility (EMC). It is essential for you to observe the following four rules when installing your programmable controller.

Rule 1: Make sure there is a perfectly functioning reference ground (central grounding point)

- Connect the central controller and expansion units to the central grounding point in a star-shaped configuration without loops.
- Protect the PLC from external influences by installing it in a cabinet or housing. Incorporate the cabinet or housing into the ground system.
- Shield electromagnetic fields resulting from inductors (transformers, motors, contactor coils) from the PLC using barriers (steel, highly permeable material).
- Use metal plug housings (not plastic) for screened data transmission lines.

Rule 2: Use a large-area ground.

- Connect all inactive metal components with a large-area contact and a low impedance.
- Establish a central connection between the inactive metal components and the central grounding point.
- The screw connections on inactive, painted metal components should be made using NOMEL contact washers [1].
- Do not forget to incorporate the screen bar into the ground system. This means that the screen bar itself must be connected to ground via a large-area contact.
- Aluminium components are unsuitable for grounding.

[1] Contact washer Siemens standard 70093 available from
- Siemens ANL A443 Werkzeug 8520 Erlangen
- Teckentrup GmbH und Co. KG, Postfach 120, D-5974 Herscheid 2,
- NOMEL S.A. Tour Franklin, Cedex 11, F-92081 Paris.
- or from your local Siemens representative

Rule 3: Plan the wiring layout and ensure that the plan is kept to

- Divide the cables into groups and route them separately.
  (power cables, power supply cables, signal lines, data lines)
- Always route power cables and signal cables in separate ducts or bundles.
- All the cables should only be fed into the cabinet from one side.
- Route the signal cables as close as possible to grounded components (e.g. cabinet members).
- We recommend the twisting of the forward and return lines of individually routed cables.

Rule 4: Ensure that your cables are well shielded

- Data transmission cables should be screened and connected at both ends.
- Analog cables should be screened and the screen connected at one or both ends.
- The cable screens must be connected at the cabinet inlet to the screen bar using a large-area contact and secured with clamps.
- Route the screen up to the module without interruptions.

3 Selection and Design of Cabinets

3.1 Selection Criteria

The following criteria must be observed when selecting and dimensioning a cabinet:

(i) Ambient conditions

(ii) Quantity and type of power supplies and subracks to be used

(iii) Total power loss of components present in the cabinet.

The ambient conditions present where the cabinet is located (temperature, humidity, dust, chemical influences) define the required degree of protection of the cabinet (IP XX) as shown in Fig. 1. Further information on degrees of protection can be found in IEC 529 and DIN 40050.

The required design of the cabinet is described in Section 3.3. Make sure that the maximum ambient temperature for the modules is not exceeded.
This involves both the ambient temperature outside the cabinet and the power loss in the cabinet.
It may be necessary to provide a fan or heat exchanger if the power loss is too high. A typical cabinet design is shown using an example at the end of the section.

3.2 Types of Cabinets

The following diagram shows a summary of the most common types of cabinet. It also shows the principle of heat dissipation used, the maximum achievable heat dissipation and the degree of protection.

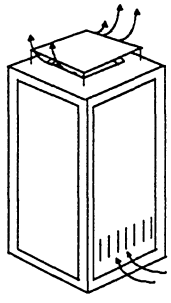
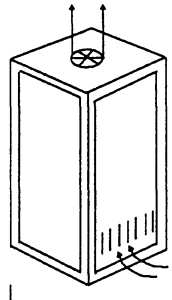
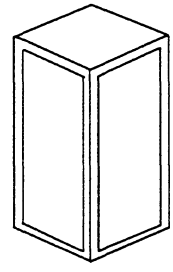
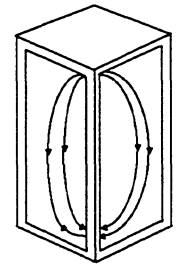
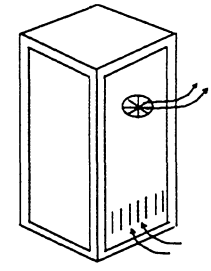
Open cabinets			Closed cabinets	
Through-ventilation by natural convection	Increased through-ventilation using external fan (with filter)	Natural convection	Forced circulation using fan assembly, improvement of natural convection	Forced circulation using heat exchanger[2], external ventilation inside and outside
				
Heat dissipation primarily by natural thermal convection, small portion via the cabinet wall.	Increased heat dissipation through increased air movement.	Heat dissipation only through the cabinet wall; only low power loss permissible. Heat accumulation usually occurs in the top of the cabinet.	Heat dissipation only through the cabinet wall. Forced ventilation of the internal air results in improved heat dissipation and prevention of heat accumulation.	Heat dissipation through exchange between heated internal air and cool outside air. The increased surface area of the heat exchanger and the forced circulation between the inside and outside air permit good heat dissipation.
Temperature difference between ambient temperature and cabinet temperature (measured at top in the cabinet): 20 °C[4]				
Power loss P[3] with cabinet dimensions of 2200 mm x 600 mm x 600 mm				
Installation as single unit:				
Up to approx. 700 W	Up to approx. 2700 W (approx. 1400 W with very fine filter)	Up to approx. 260 W	Up to approx. 360 W	Up to approx. 1700 W
Degree of protection IP 20[1]	Degree of protection IP 20[1]	Degree of protection IP 54[1]	Degree of protection IP 54[1]	Degree of protection IP 54[1]

Fig. 1 Types of cabinets

1) The location and the ambient conditions present there are decisive for selection of the type of cabinet protection (see IEC 529 and DIN 40050).
2) See Catalog NV21 for heat exchangers.
3) The values only apply if the guidelines for installation are adhered to (for further details refer to the following section).
4) If other temperature differences are present, refer to the temperature characteristics of the cabinet manufacturer.

3.3 Specifications When Designing a Cabinet

You must first define the components to be fitted in the cabinet. Then calculate the total power loss of the individual components. The following specifications must be observed:

- The expansion units can be accommodated together with the respective central controller in one cabinet, or also in several cabinets (centralized or distributed). See Section 2 for the installation dimensions of the subracks.
- As a result of the required spacing between devices and the maximum permissible installation height for control elements, a maximum of three U-type devices can be arranged one above the other (see Fig. 2).

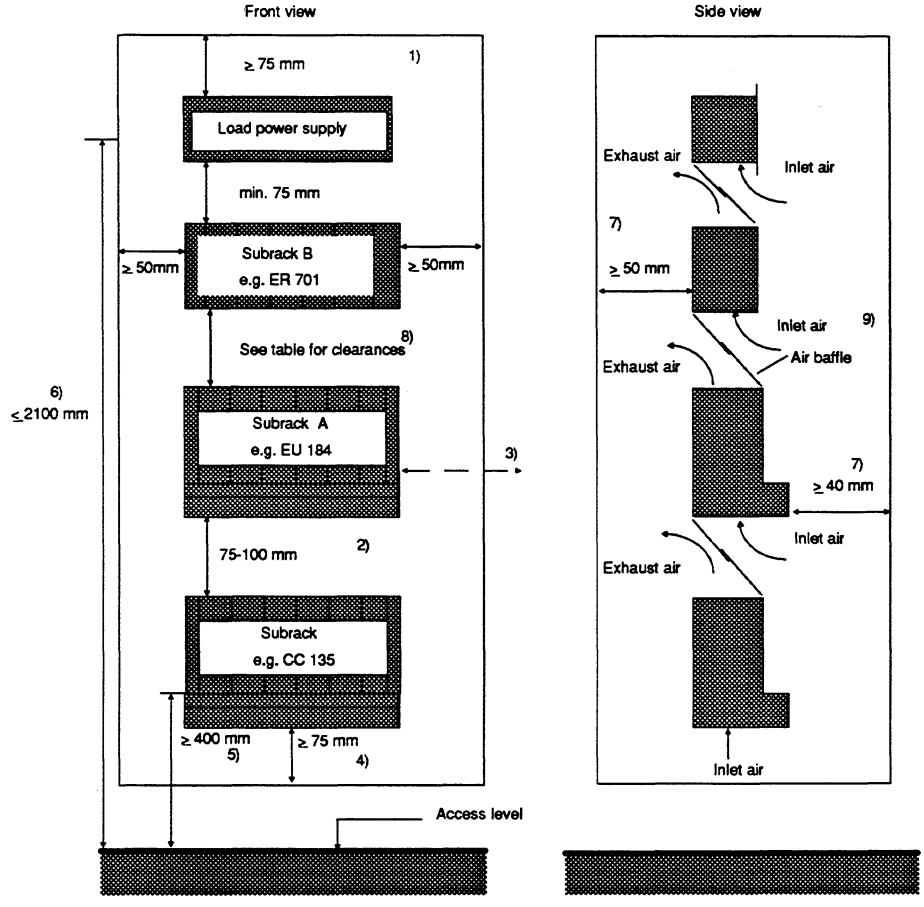


Fig. 2 Installation dimensions for SIMATIC controllers in cabinet

1) Min. 75 mm with closed cabinet roof. Smaller distances are possible with a perforated cabinet roof and an additional, separate ventilation roof.
2) Min. 75 mm space for inlet air and exhaust air, max. 100 mm because of cable length between the CC/EU interface modules.
3) Max. spacing of 400 mm possible (min. 50 mm) when connecting devices next to one another (with IM 312).
4) Min. 75 mm from obstructions (large equipment) in the inlet air area.
5) Min. installation height above access level 400 mm for control elements, 200 mm for connections.
6) Max. installation height for control elements: 2100 mm to VDE 0106, Part 100, 2000 mm to EN 60 204 (IEC 204-1) (VDE 0113).
7) Space for air circulation (400 mm deep cabinets are sufficient).
8) See Table 2-1 for the distances between subracks A and B.
9) The installation of air baffles is recommended to provide a better air supply.

Note:

The expansion unit with the largest power loss should be positioned as the top unit.

- If subracks are combined (CC and EU), the clearances listed in Table 1 must be observed.

Subrack A [1]	Subrack B [1]	Minimum clearance	Maximum clearance
S5-135U/155U or S5-115U or S5-100U	S5-135U	75 mm	Limited by the length of the connection cables to the interface modules
	S5-115U with fan	60 mm	
	S5-115U without fan	100 mm	
	S5-100U	75 mm	

Table 1 Required clearance between subracks

[1] See Fig. 2, Installation dimensions for SIMATIC controllers in cabinet

Note:

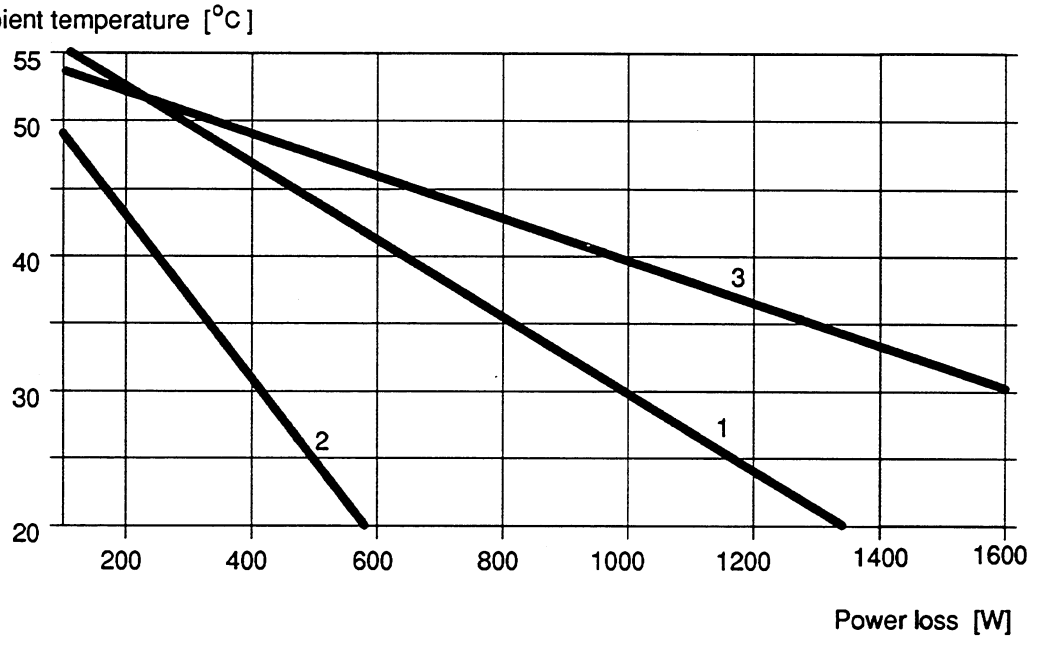
If subracks from the S5-135U/155U series are used together with subracks of the S5-115U in the same cabinet, ensure that the rear panels of the subracks have the same clearance to the rear panel of the cabinet. This results in improved air circulation.

3.4 Power Loss

3.4.1 Power Loss in Cabinet and Cabinet Cooling

The power loss that can be dissipated from a cabinet depends on the cabinet design, its ambient temperature and the arrangement of units in the cabinet.

Fig. 3 shows the permissible ambient temperature of a cabinet with dimensions of 600 mm x 600 mm x 2200 mm depending on the power loss. The values indicated only apply to the arrangement of units in the cabinet as shown in Fig. 2. You can obtain more information from Catalogs NV21 and ET1.



Curve 1 Cabinet (open) with through-ventilation by natural convection.
Curve 2 Closed cabinet with natural convection and internal forced circulation using fan.
Curve 3 Closed cabinet with heat exchanger. Heat exchanger size 11/6 (920 mm x 460 mm x 111 mm).

Fig. 3 Maximum cabinet environment temperature depending on the power loss

Note:

When fitting the subracks of the S5-135U/155U series, the maximum power loss which can be dissipated by the fans must not be exceeded.
The max. dissipated power loss per unit with an inlet temperature of 55 °C is 250 W. This value is increased by 20 W for each reduction in the inlet temperature by 1 °C.

Caution:

Modules with a hard disk drive can only be used up to an ambient temperature of 50 °C.

3.4.2 Example of Calculating Cabinet Type

The following example shows the maximum permissible ambient temperature for different types of cabinet with the same power loss.

Example:

The following configuration is present:

1 central controller	200 W
2 expansion units, each with 250 W power loss	500 W
1 load power supply, 24 V/40 A, 6EV1 362-5BK00 (full load)	200 W
Total power loss:	900 W

Fig. 3 shows the max. ambient temperatures for a total power loss of 900 W:

Cabinet design (see Fig. 1)	Max. ambient temperature
Closed, with natural convection and forced circulation	(use not possible)
Open with through-ventilation	Approx. 33 °C
Closed, with heat exchanger	Approx. 42 °C
Framework/wall	Max. 55 °C

The power losses of the modules can be found in the technical data in the catalogs or in the manuals.
If these values are not listed in the technical data, they can be calculated easily from the power consumption. To do this, multiply the value of the power consuption by the appropriate voltage.

Examples:

- CPU 928B: power consumption 4 A/5 V ⟶ power loss = 20 W
- CP 143: power consumption 4 A/5 V, 0.5 A/15 V, 0.04 A/24 V ⟶ power loss approx. 21 V
- IM 304 power consumption 1.5 A/5 V ⟶ power consumption = 7.5 W

3.5 Example of a Cabinet Design

Figs. 4 and 5 show a design using the example of a metric 8MF cabinet (2200 mm x 600 mm x 600 mm). This design has a number of advantages:

- Universal application
- Independent of the cabinet width (550 to 1200 mm possible)
- The units can be installed asymmetrically; you thus gain more space on one side for routing signal cables.
- All devices can be installed and removed from the front, even after initial installation. The M6 screws must be premounted on the 19-inch cabinet member at the correct mounting height. You can then hook in the subrack and tighten the screws (one-man installation)
- The separate cable routing for analog, digital and power supply lines in cable ducts increases the resistance to mutual interferences between the signals.

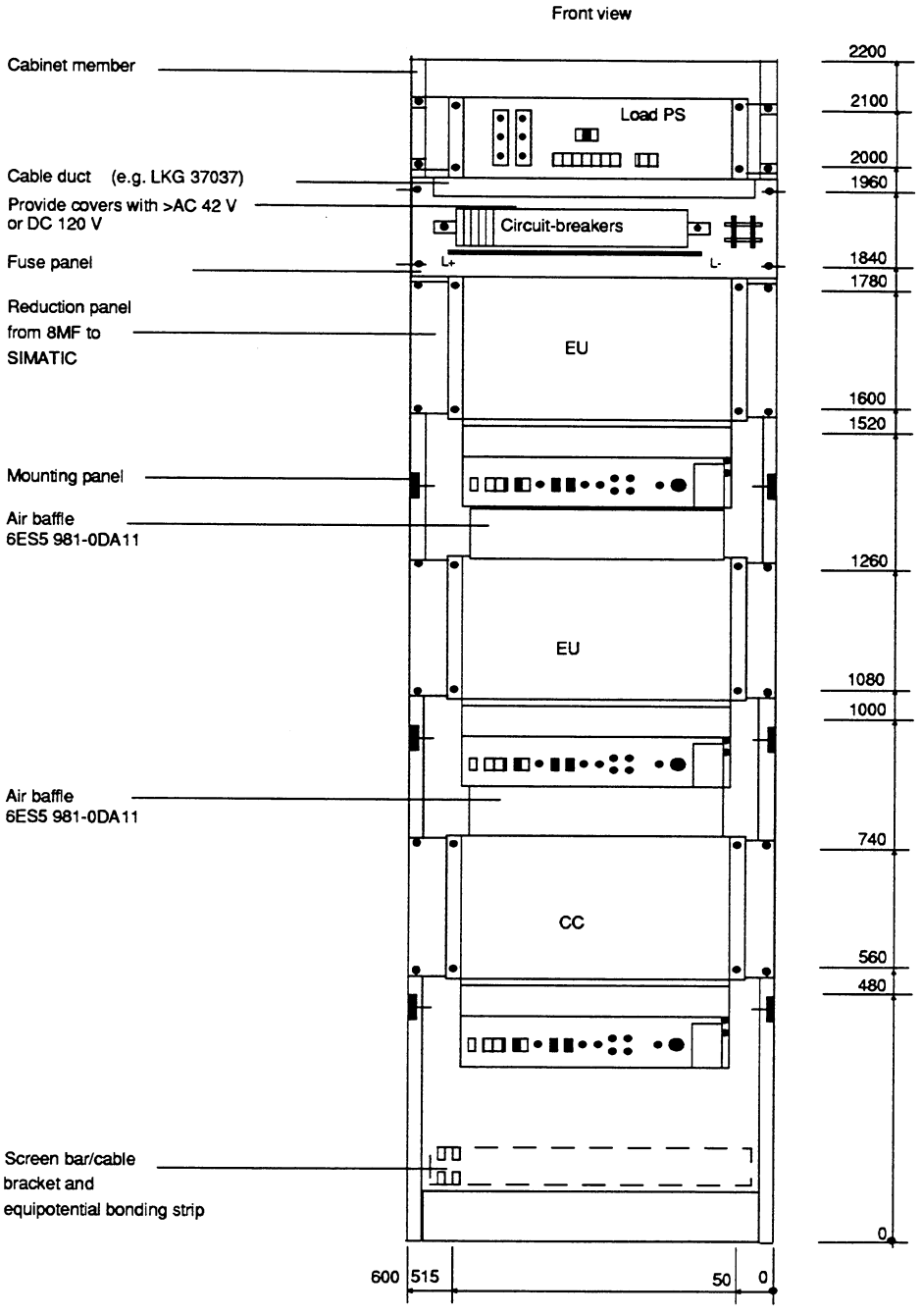


Fig. 4 Front view of 8MF cabinet

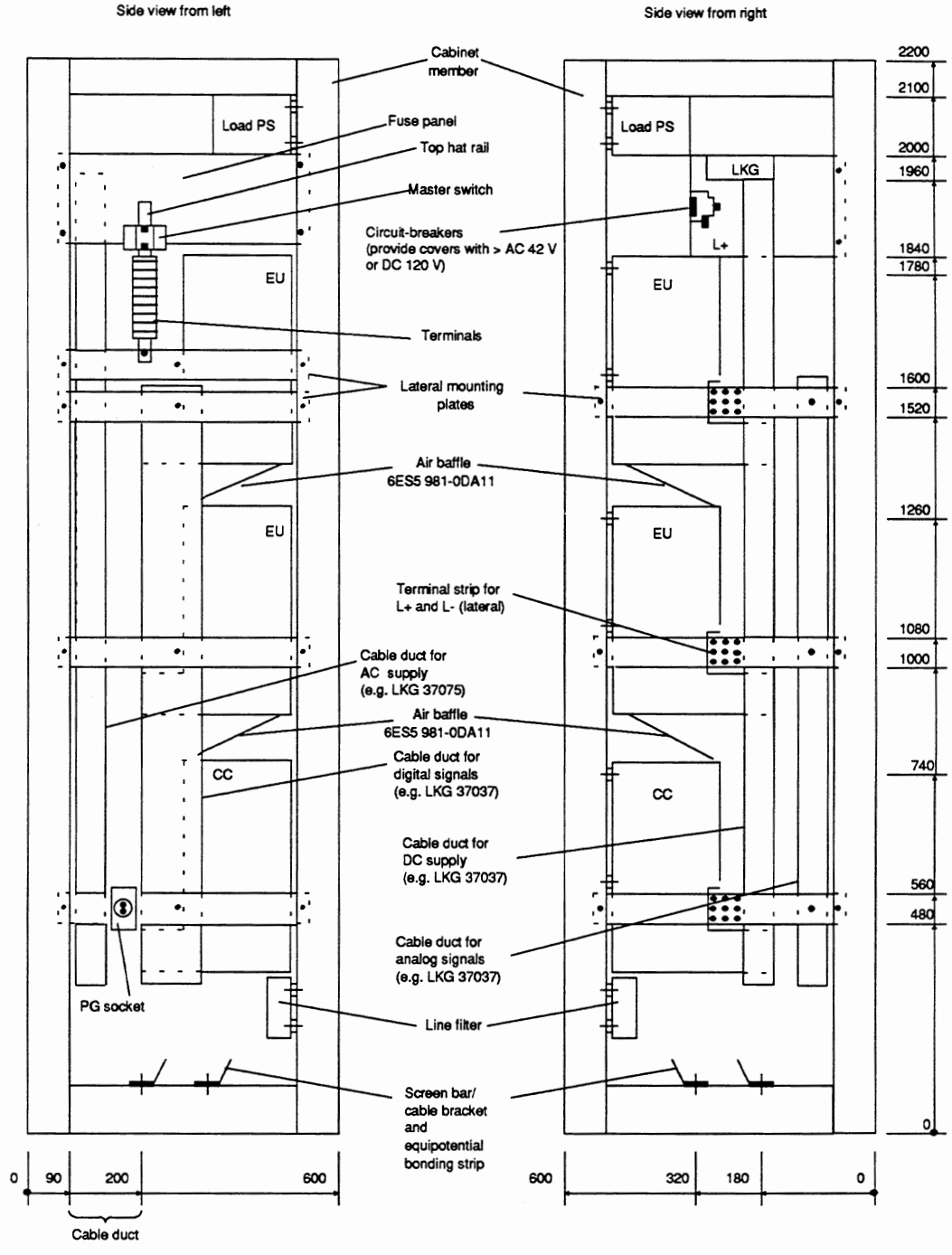


Fig. 5 Side views of 8MF cabinet

4 Design and Connection of Power Supplies

The following section provides information you must observe for the electrical connection of the power supply.

Different power supplies are required for SIMATIC S5 systems:

- Internal power supply for central controllers and expansion units

  The internal power supply of the SIMATIC modules is obtained from power supply units in the form of plug-ins. These power supply units are fixed components of the CC and the EU. You can find their technical data in the Instructions of the respective units and in the catalogs.

- Load power supply for the I/O modules as well as sensors and actuators.

4.1 Internal Power Supply for Central Controllers and Expansion Units

The power supplies fitted in the CCs and EUs deliver the internal DC voltages of 5 V, 15 V and 24 V from the input voltage of 120/230 V AC or 24 V DC.

When equipping the CCs and EUs, ensure that the rated current of the respective power supply is not exceeded. You can find the current consumption of the individual modules with the 5 V supply e.g. in the catalogs and the Instructions of the respective module (Technical Data).

Floating and non-floating power supplies are available for the input voltage of 24 V DC.

The permissible input voltage for power supplies with a rated input voltage of 24 V DC is:

- Static DC 20 to 30 V.

The permissible input voltage is as follows for power supplies with a rated input voltage of 230/120 V AC:

- With rated voltage 230 V: 187 to 253 V AC
- With rated voltage 120 V: 93 to 127 V AC.

4.2 Load Power Supply

The series 6EV 13.. power supply units from Siemens (output currents 20 and 40 A) can be used to supply the I/O modules as well as the CC and EU power supplies with the input voltage of 24 V DC. Detailed information can be found in Catalog ET1.

The following must be observed when dimensioning load power supplies for digital output modules (S5-135U/155U series):

- To protect the cables and lines from overcurrents and to protect the modules from short-circuits, additional fuses are present on the modules in addition to the electronic short-circuit protection (in the power supply). The fuses also serve as protection if the power supply connections are reversed.

- The electronic short-circuit protection for digital outputs only responds when 2-3 times the rated current is exceeded. You should therefore make sure that the load power supply can supply the current required to trigger the short-circuit protection of an output.

- Note when selecting the load power supply, and taking into consideration all connected output loads, that two to three times the rated output current can flow briefly at the output in the event of a short-circuit before the pulsed electronic short-circuit protection takes effect. This excess current is generally present with non-regulated load power supply units.

- In the case of regulated load power supply units, especially with small output currents up to 20 A, the rated output current of the load power supply must be dimensioned such that several times the rated current can flow in the event of a short-circuit.

Caution:

Safe electrical isolation according to CENELEC HD 384.4.41 (IEC 364-4-41) Part 4 (VDE 0100) or VDE 0160 must be guaranteed with all power supply units used for SIMATIC S5 devices and modules. All electrically-isolated Siemens power supplies of the 6EV13... series satisfy this condition.

4.3 Electrical Design with Process Peripherals

The following section shows various designs of power supplies for CCs, EUs and process peripherals.

The following are possible:

- Grounded power supply
- Centrally grounded power supply
- Non-grounded power supply.

You must observe the following fundamental points when designing the electrical configuration of the process peripherals:

- A master switch (to VDE 0113)[1] or a disconnection facility (to VDE 0100)[2] must be provided for the CC, EU and load power supply.
- For DC 24 V load circuits you require a load power supply with guaranteed electrical isolation. Non-regulated load power supplies must be provided with a capacitor (dimensioning: 250 µF per 1 A load current). This means you must connect a capacitor in parallel to the output terminals.
- Electrical isolation by means of a transformer (to VDE 0113[1] Section 6.1.1 and VDE 0100[2]) is recommended for load circuits for supplying external control devices with electromagnetic operating coils (e.g. more than 5).
- The circuits for the sensors and actuators can be used in groups.
- To protect against parasitic voltages, the subracks must be connected together with a large-area contact and low impedance.

1) VDE 0113 is equivalent to EN 60 204, IEC 204-1
2) VDE 0100 is equivalent to CENELEC HD 384.4.31 (IEC 364-4-41).

4.3.1 Power Supply for CCs, EUs and Process Peripherals from Grounded Battery or Grounded Power Supply Units

The ground of the internal supply voltages is connected to the subrack housing. Grounded operation provides the best noise immunity.

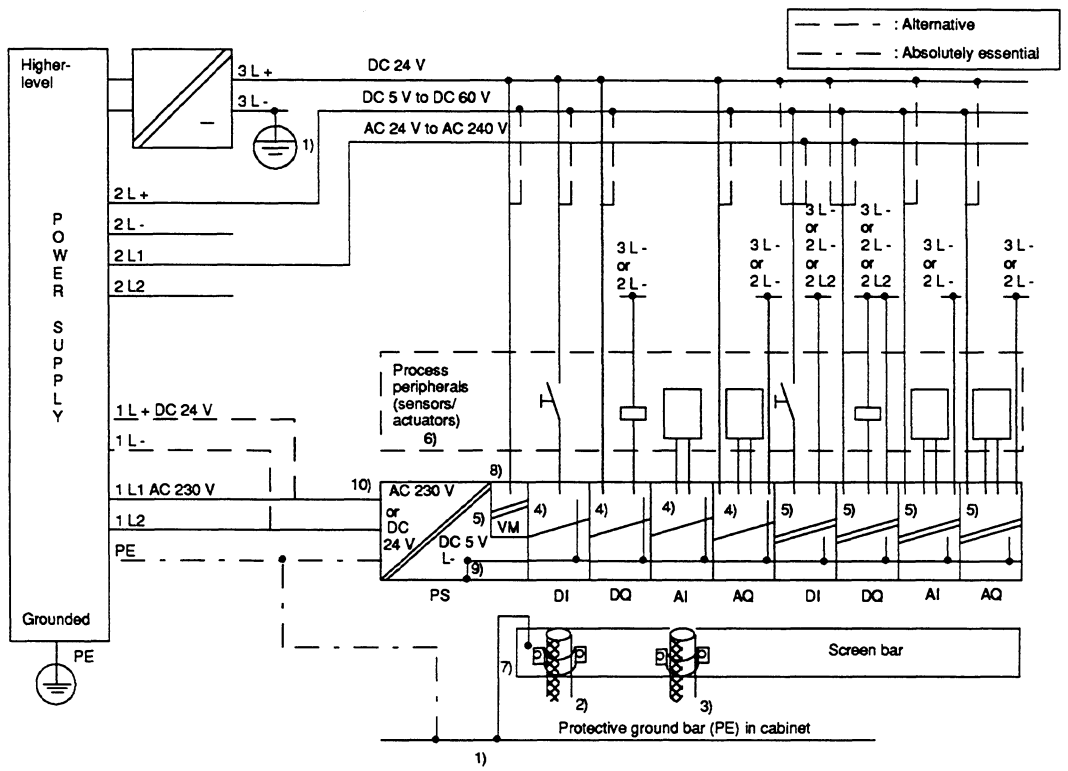


Fig. 6 Possible connections for sensors/actuators of the process peripherals to grounded power supply units

1) Housing potential (cabinet potential) = protective ground conductor.
2) Use cable screen, if available, for digital modules. Provide screening with longer cables; connect at one end to cabinet inlet or connect at both ends.
3) Connect cable screen at one end to cabinet inlet with analog modules or also at both ends; lead on up to module.
4) Non-floating module.
5) Floating module.
6) Protective ground conductor required to housings of sensors and actuators.
7) Connection cable with as large a cross-section as possible (black) > 16 mm^2; if the screen is used as the protective ground conductor (green/yellow), connect at both ends.
8) Only with S5-135U/155U series: monitoring of load voltage L+ (24 V DC).
9) Non-removable connection between the internal ground of the supply voltages and the housing.

Particularly important:

10) Electrical isolation is not available with the power supply unit 24 V/10 A (order no. 6ES5 955-3NA12); operation is only possible without problems on grounded power supply unit.

4.3.2 Power Supply for CCs, EUs and Process Peripherals from Centrally Grounded Battery or Centrally Grounded Power Supply Units

If SIMATIC S5 programmable controllers are to be installed where a central grounding is available, then proceed as shown in Fig. 7. This is, however, not as immune to noise as the grounded system in Fig. 6.

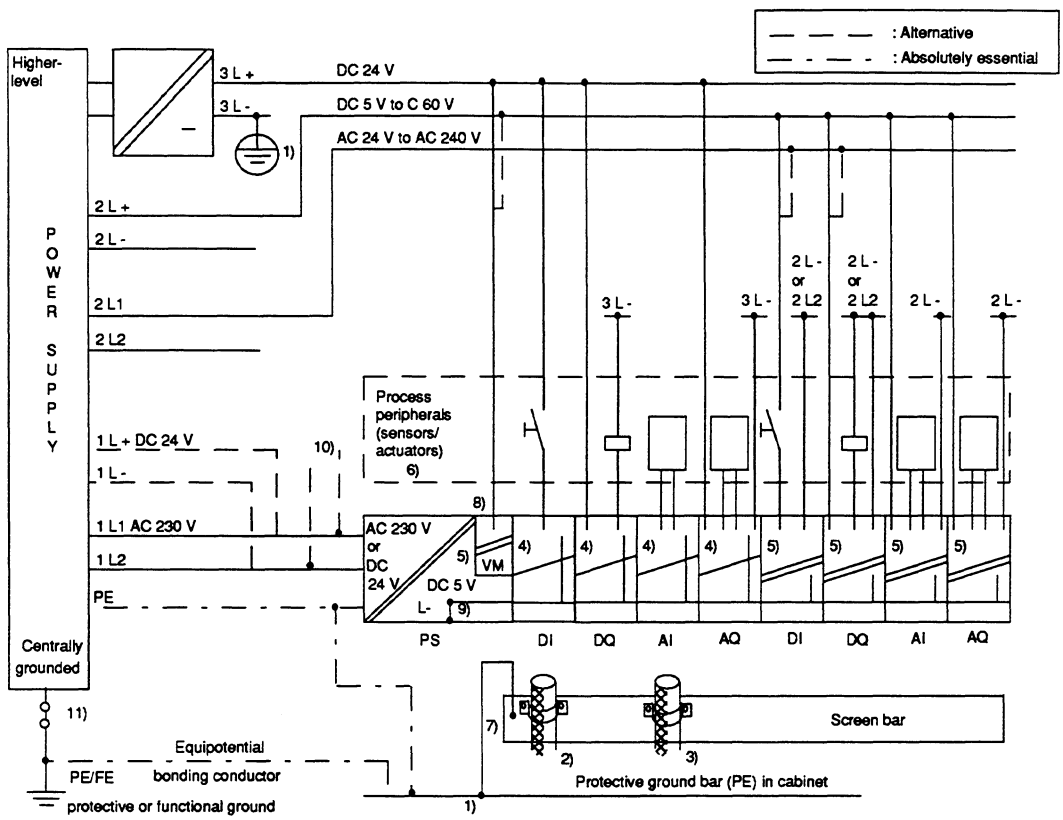


Fig. 7 Possible connections for sensors/actuators of the process peripherals to centrally grounded power supply units

1) Housing potential (cabinet potential) = protective ground conductor.
2) Use cable screen, if available, for digital modules. Provide screening with longer cables; connect at one end to cabinet inlet or connect at both ends.
3) Connect cable screen at one end to cabinet inlet with analog modules or also at both ends; lead on up to module.
4) Non-floating module.
5) Floating module.
6) Protective ground conductor required to housings of sensors and actuators; can be omitted for safely generated functional extra-low voltages.
7) Connection cable with as large a cross-section as possible (black) > 16 mm^2.
8) Only with S5-135U/155U series: monitoring of load voltage L+ (24 V DC).
9) Non-removable connection between the internal ground of the supply voltages and the housing.

Particularly important:

10) Electrical isolation is not available with the power supply unit 24 V/10 A (order no. 6ES5 955-3NA12); operation on a centrally grounded power supply unit is therefore not directly possible. Voltage supply required via 3L+/-.

11) Removable connection for test purposes.

4.3.3 Power Supply for CCs, EUs and Process Peripherals from Non-Grounded Battery or Non-Grounded Power Supply Units

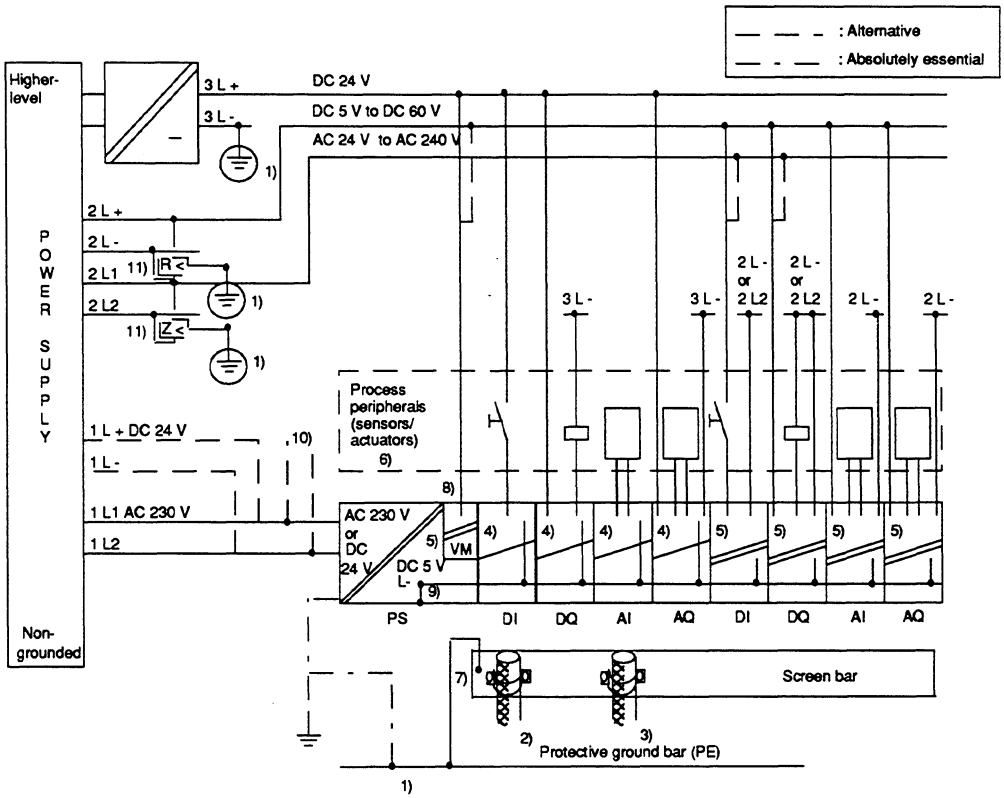


Fig. 8 Possible connections for sensors/actuators of the process peripherals to non-grounded power supply units

1) Housing potential (cabinet potential) = protective ground conductor.
2) Use cable screen, if available, for digital modules. Provide screening with longer cables; connect at one end to cabinet inlet or connect at both ends.
3) Connect cable screen at one end to cabinet inlet with analog modules or also at both ends; lead on up to module.
4) Non-floating module.
5) Floating module.
6) Protective ground conductor required to housings of sensors and actuators; can be omitted for safely generated functional extra-low voltages.
7) Connection cable with as large a cross-section as possible (black); if the screen is used as the protective ground conductor (green/yellow), connect at both ends.
8) Only with S5-135U/155U series: monitoring of load voltage L+ (24 V DC).
9) Non-removable connection between the internal ground of the supply voltages and the housing.

Particularly important:

10) Electrical isolation is not available with the power supply unit 24 V/10 A (order no. 6ES5 955-3NA12); operation on a centrally grounded power supply unit is therefore not directly possible. Voltage supply required via 3L+/-.

11) Insulation monitoring equipment is required if dangerous conditions could result through double faults and/or with voltages > 42 V AC or 120 V DC. Only one insulation monitor is required per supply unit (to VDE 0113 Section 6.2.2).

4.4 Load Power Supply from Two Power Supply Units

The design of the load power supply using two power supply units enables you to specifically disconnect parts of the process peripherals. The inputs and outputs of different modules can be assigned as a group to one power supply unit.

The supply to inputs and outputs of different modules from two power supply units is indicated below using two examples.

4.4.1 Non-floating Modules

In the case of non-floating input/output modules it must be ensured that the negative poles (L-) of the power supply units are connected to the reference potential (SIMATIC device/cabinet housing). This is necessary since the inputs are referred to ground.

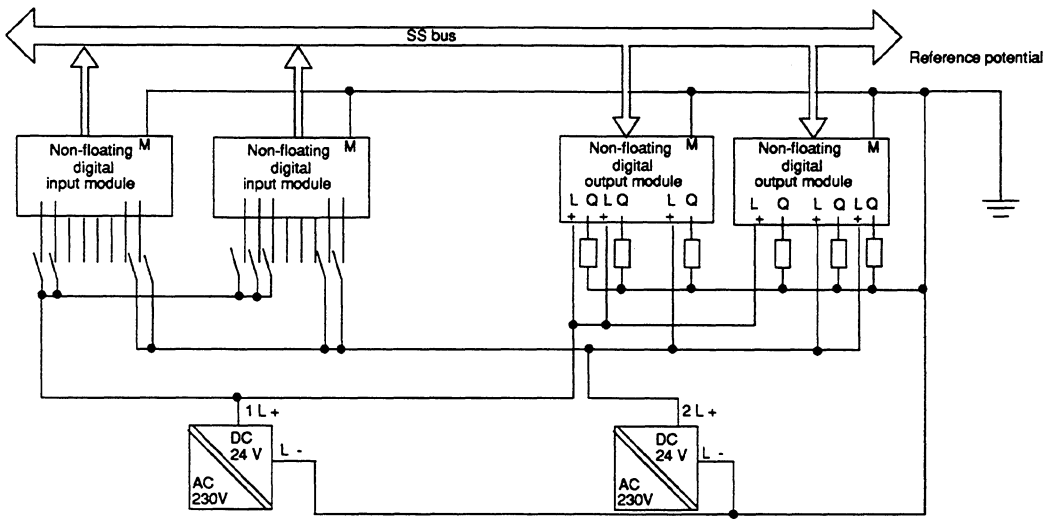


Fig. 9 Example of supply of non-floating peripheral modules from two power supply units

4.4.2 Floating Modules

In the case of floating modules, the inputs or outputs can be supplied from two power supply units by dividing into isolated groups.

Note that electrical isolation between the groups is lost as a result of the connection of inputs or outputs of two floating groups to one power supply unit.

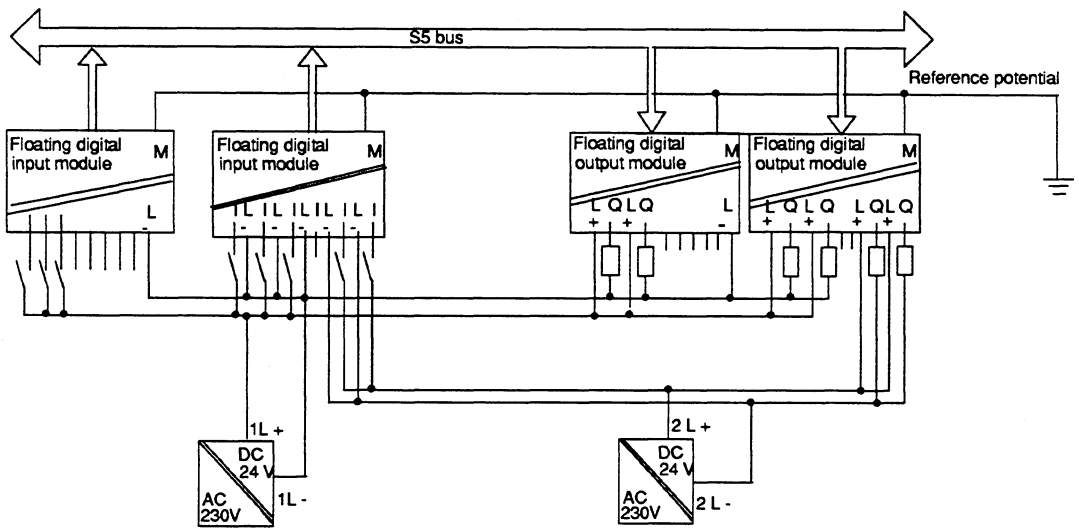


Fig. 10 Supply of floating peripheral modules from two power supply units

When using CCs and EUs with a mains connection, we recommend a Siemens power supply unit from the 6EV13.. series with electrical isolation as the power supply for the process peripherals (load voltage).

5 Wiring Layout

You can achieve a high noise immunity for your programmable controller by using a correct wiring layout. The measures required are described in the following sections.

5.1 Wiring Layout Inside a Cabinet

To ensure a correct layout of wiring inside cabinets, the wiring must be divided into the following groups:

Group A: screened data lines (for PG, OP, SINEC L1, CP 525 etc.)
screened analog lines
screened signal lines for DC and AC voltages ≤ 400 V
non-screened lines for DC and AC voltages ≤ 60 V

Group B: non-screened lines for DC and AC voltages > 60 V and ≤ 400 V

Group C: non-screened lines for DC and AC voltages > 400 V and ≤ 1 kV

Route all wiring groups separately in the cabinet. Separately means that the wiring is routed in

- separate cable ducts
- separate wiring bundles with approx. 10 cm clearance.

When laying screened lines (e.g. analog lines) make a large-area contact of the screen to a cable clamping rail at the inlet to the cabinet and connect the screen further to the final point without an interruption (see Section 6.4).

5.2 Wiring Layout Outside Cabinets

- Route the cables outside cabinets and within buildings on metal cable trays. Make a conductive connection between the ends of two adjacent cable trays and connect these to ground at distances of 20 to 30 m.

  The following may be routed on the same cable trays (cable routes, gutters, channels):

  - cables from group A and
  - cables from group B with approx. 10 cm clearance.

  Route cables in group C on separate cable trays (cable routes, conduit).

- Always screen analog lines.

- Non-screened cables (e.g. signal lines, power supply lines) must be routed with as large a clearance from sources of interference (contactor, transformer, motor, electric welding unit) as possible.

- Signal lines and associated equipotential bonding lines should be routed with the smallest possible distance from one another and on the shortest path.

- Lines between the programmable controller and sensors/load should be installed whenever possible without breaks. If a break in the line is unavoidable, screen the terminal block e.g. with a metal box making large-area contact to a screen bar.

- Route associated single lines (e.g. forward and return lines, power supply cables) as close as possible to one another. If possible these lines should be twisted.

Note:

Signal lines and power cables up to 1 kV must be routed separately but can be routed in parallel. A minimum clearance of 10 cm must be observed. The clearance should be increased proportionally with higher voltages, and the safety regulations must be observed (e.g. IEC 664/664A).

5.3 Wiring Layout Outside Buildings

- If you route cables outside buildings, a double-screened cable must always be used for analog and data signal transmissions.
  The following must be observed when routing double-screened cables:
  - connect the outer screen to ground at both ends
  - only connect the inner screen at one end to the receiver side.

- Ensure that the equipotential bonding is sufficient. Connect an equipotential bonding conductor if necessary.

- The lightning protection and grounding regulations must be observed.

5.4 Equipotential Bonding

Different potentials can occur between different parts of your plant (e.g. different power supplies). These differences can be reduced by laying equipotential bonding lines to ensure the correct functioning of electronic components.

Keep the following points in mind when laying an equipotential bonding line:

- The effectiveness of equipotential bonding is directly related to the impedance of the line (less impedance - greater effectiveness). This means that the connection required for equipotential bonding must have not only a low ohmic resistance but also as small an inductance as possible (achieved by keeping line lengths short).

- If screened signal lines with the screens grounded at both ends are required between parts of the plant, the impedance of the additional equipotential bonding line must not exceed a maximum of 10% of the screen impedance.

- The cross-sectional area of the equipotential bonding line must be selected for the max. equalizing currents.

- The equipotential bonding line must be laid so that loops (e.g. between equipotential bonding line and signal lines) cover as small an area as possible.

- The equipotential bonding line must make large-area contact with ground or chassis (see Section 6.4)

6 Cabinet Wiring and Design with Respect to EMC

EMC: electromagnetic compatibility (EMC) is understood to be the ability of an electric device to function without faults in a defined electromagnetic environment without influencing other devices in the environment.

Measures to guarantee EMC must already be made when designing and wiring the individual components in cabinets. The interfering environment must not be ignored if fault-free functioning of the programmable controller and wiring is to be obtained.

The measures required to guarantee EMC, as well as an example of a cabinet design as concerns EMC, are described in the following sections. The check list at the end of this section serves as an aid for checking the EMC-compatible design of your cabinet.

The following section as well as Section 5.1, Wiring Layout Inside a Cabinet, must be observed when designing your cabinet to guarantee EMC. These sections handle the subjects:

- Grounding of all inactive metal components
- Wiring layout in the cabinet
- Shielding of devices and cables
- Use of special interference-suppression measures.

6.1 Grounding of Inactive Metal Components

An important factor which contributes towards interference-free operation is consistent grounding. Grounding is understood to be the electrical connection of all inactive metal components (VDE 0160). Large-area grounding must always be used.

Large-area grounding means:

- Ground all conducting parts.
  These include subracks, cabinet members, cabinet panels, cabinet doors, screen bars, filter housings.

Measures to be observed when grounding:

- Make all ground connections with a low impedance.
- Connect all metal parts with a large-area contact.
- Use ground straps for the connection. Metallic wire mesh made of tin-plated copper strands is suitable as the ground strap. It should be kept as short as possible. The surface area of the ground straps is decisive, and not the cross-section, because of the high-frequency noise pulses discharged.
- Make the screw connections using NOMEL contact washers[1)].

NOMEL contact washers
Assemble contact washers such that the teeth bite into the part to be screwed and thus generate a metallic contact.

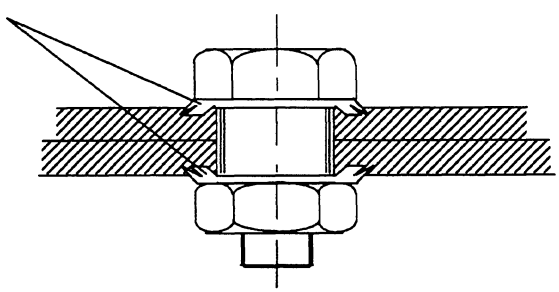


Fig. 11 NOMEL contact washers

1) Contact washer Siemens standard 70093 available from
- Siemens ANL A443 Werkzeug 8520 Erlangen
- Teckentrup GmbH und Co. KG, Postfach 120, D-5974 Herscheid 2,
- NOMEL S.A. Tour Franklin, Cedex 11, F-92081 Paris.
- or from your local Siemens representative

6.2 Shielding of Devices and Cables

Shielding is a way of attenuating (dampening) magnetic, electric or electromagnetic interferences. Shielding can be divided into:

Device shielding

Cabinets and housings must be incorporated into the measures for shielding the programmable controllers. The following must be observed:

- Cabinet enclosures such as side panels, rear walls, roof and floor panels must be connected sufficiently often with a low impedance in the case of an overlapping arrangement (connection interval e.g. 50 mm).
- Doors must additionally be connected to the cabinet ground. Use at least 2 ground straps.
- If sources of strong interference are present in the cabinet (transformers, cables to motors etc.), these must be isolated from sensitive electronics areas by metal partitions (steel, highly permeable material, e.g. mu-metal). The panels must be screwed several times to the cabinet ground with a low impedance.

The central grounding point must be connected to the protective ground conductor (grounding bar) with a low impedance and a Cu conductor ≥ 16 mm^2 as short as possible.

Cable screening

Screened cables must be connected at both ends to the grounding bar with a large-area contact and if possible directly at the cabinet inlet. Good attenuation of all conducted frequencies can only be achieved by connecting at both ends.

The following must be observed when handling the screen:

- Use metal cable clamps to secure the braided screens with a large-area contact.
- Avoid the use of cables with foil screens since the foil can be easily damaged by tension or pressure when fitting, thus leading to a poorer screening effect.

Note:

An equalizing current may flow via the screen connected at both ends in the case of variations in the ground potential. Use an additional equipotential bonding conductor in this case (see Section 5.4 Equipotential Bonding).

In certain cases the screen can also be connected at only one end. Only the lower frequencies are then attenuated. Connection of the screen at one end may be more favorable if:

- An equipotential bonding conductor cannot be laid
- Analog signals (several mV or µA) are transmitted.

Interferences on cable screens are discharged to ground via the grounding bar and the equipotential bonding conductor. A low-impedance path to ground for the interfering currents must be provided so that these discharged currents do not produce a source of interference themselves:

- Tightly connect the screws of cable plugs, modules and equipotential bonding conductors.
- Protect the contact surfaces of equipotential bonding conductors and ground lines from corrosion.

6.3 Use of Special Noise Suppression Measures

Connection of inductors

Provide suppression (e.g. using RC elements, varistors or free-wheeling diodes) for inductors installed in the same cabinet (e.g. contactor and relay coils) not activated by SIMATIC S5 modules.

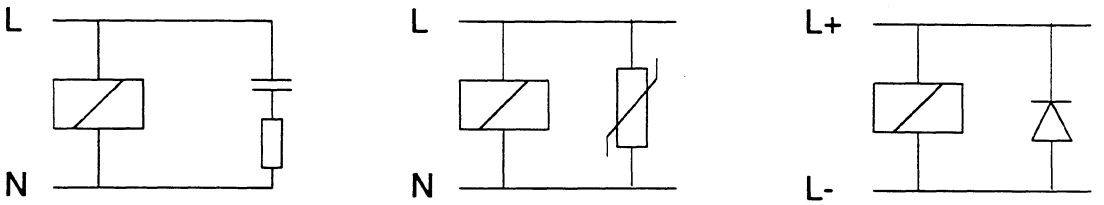


Fig. 12 Wiring inductors (example)

If further contacts are connected in series to SIMATIC outputs, the SIMATIC internal fusing is not effective. In such cases the inductor must be fused directly.

Protection against electrostatic discharge

Use metal housings or cabinets that are closed in at all sides to protect devices and modules against electrostatic discharge. Connect these housings or cabinets to the grounding point where you set them up so as to form a good contact.

Caution:

If you must work on the system with the cabinet open, follow the guidelines to protect electrostatically sensitive devices and modules (ESD).

The interference resistance is always reduced when the cabinet is open.

Mains power connection for programmers

Provide a grounded socket in each cabinet to supply power for a programmer. The sockets should be connected to the distribution board to which the protective ground conductor of the cabinet is also connected.

Cabinet illumination

Do not use fluorescent lamps for the cabinet illumination since these generate interferences. If you must use fluorescent lamps, take the precautions shown in Fig. 13 LINESTRA® lamps are more suitable.

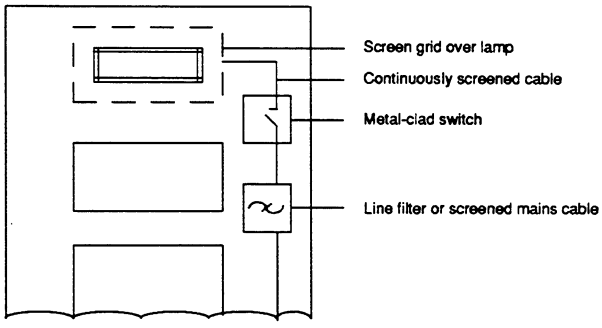


Fig. 13 Measures to suppress noise from fluorescent lamps in a cabinet

6.4 Example of an EMC-compatible Cabinet Design

The example of a cabinet design shown in Fig. 14 - taking into consideration EMC - shows the grounding of all inactive metal components and the connection of screened cables. This example only applies to grounded operation. Observe the points listed in Fig. 14 during installation.

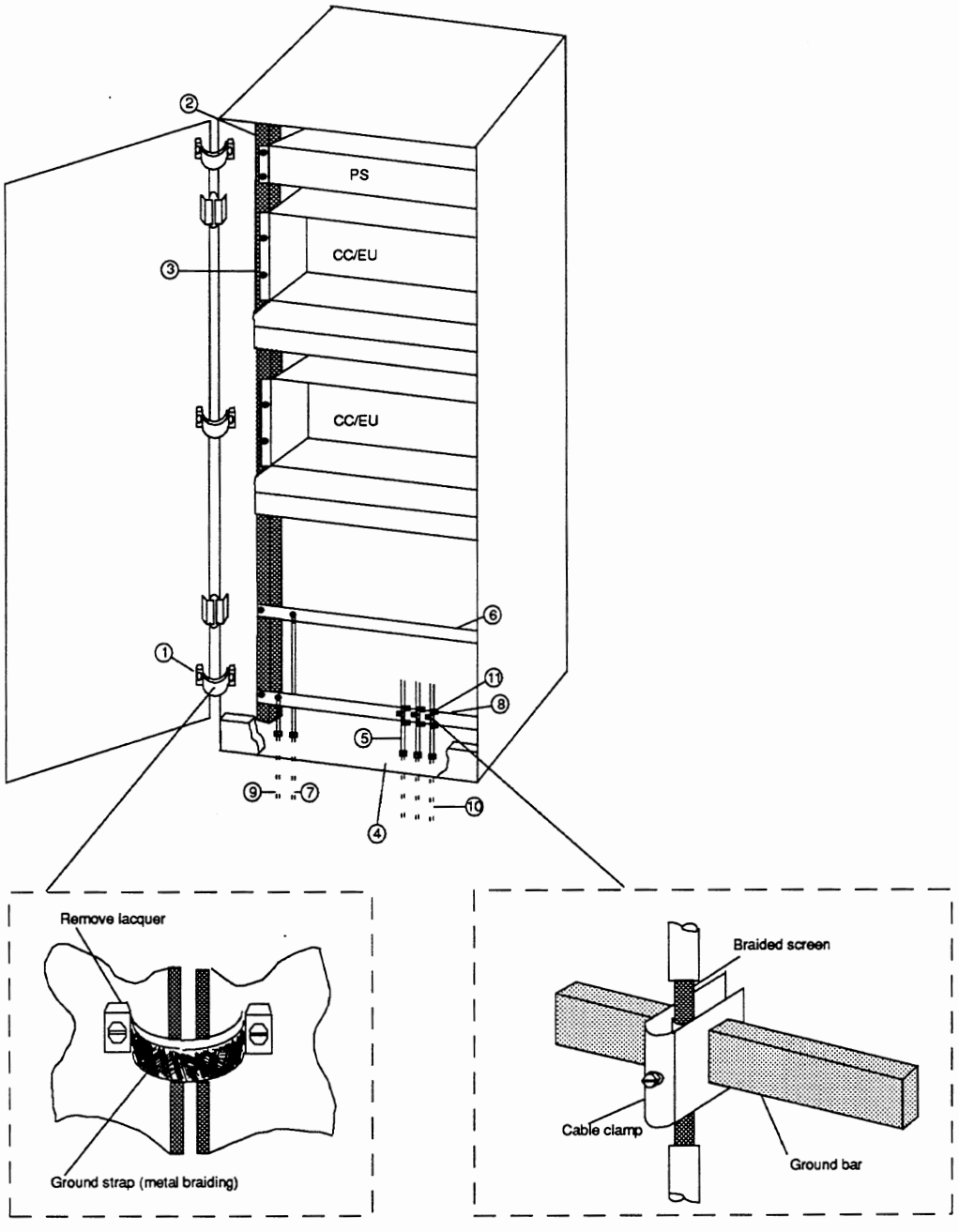


Fig. 14 Example of an EMC-compatible cabinet design

Re 1. **Ground straps**
All inactive metal components (e.g. cabinet doors and supporting panels) must be connected using ground straps if large-area metal-metal connections are not present. Metallic wire mesh made of tin-plated copper strands is suitable as the ground strap. It should be kept as short as possible, with a ratio between the length and width of less than 3 to 1.

Re 2. **Cabinet members**
The cabinet members must be connected to the cabinet housing with a large-area contact (metal-metal connection).

Re 3. **Mounting bracket**
A large-area metal-metal connection must be made between the cabinet member and mounting bracket.

Re 4. **Base panel**
A large-area metal-metal connection to the cabinet housing must be guaranteed.

Re 5. **Cable screwed glands**
Unused cable screwed glands must be closed using blanking plates in the case of closed cabinets with heat exchangers.

Re 6. **Equipotential bonding bar**
The bar must be connected to the cabinet members with a large-area contact (metal-metal connection).

Re 7. **Equipotential bonding conductor**
The conductors must be connected to the equipotential bonding bar.

Re 8. **Ground bar**
This serves as the central grounding point of the cabinet and must be connected to the cabinet members with a large-area contact (metal-metal connection). The ground bars must be connected to the external central grounding point to guarantee discharging of interfering and fault currents. It can additionally be used to connect screened cables.

Re 9. **Cable from central grounding point**
The cable must be connected to the grounding bar with a large-area contact.

Re 10. **Signal cables**
The screen of screened signal cables must be connected to the grounding bar with a large-area contact using cable clamps or to an additional screen bar connected with a large-area contact, and then routed further to the end point (e.g. I/O module) without interruption.

Re 11. **Cable clamp**
The cable clamp must enclose the braided screen over a large area.

6.5 Checklist for EMC-compatible Cabinet Design

EMC measures	Remarks
Connection of inactive components (Section 6.1)	
Are all inactive metal components connected together with a large-area contact and low impedance, and grounded?	
Is there a sufficient connection to the central grounding point?	
Screw connections made using NOMEL contact washers?	
Particularly check the connections to: • Subracks • Cabinet members • Cabinet bar • Filter housing	
Equipotential bonding (Section 5)	
With a spacially separated design, check the routing of the equipotential bonding conductor	
Device screening (Section 6.2)	
All cabinet components provided with contacts at sufficient intervals?	
Doors connected to the cabinet body using ground straps?	
Are only metallic device plugs used?	
Cable screening (Section 6.2)	
Are all analog cables screened? Are screens connected at both ends?	
Are cable screens connected to ground bar or screen bar at cabinet inlet?	
Are cable screens connected via cable clamps with a large-area contact, completely enclosed and with a low impedance?	
Inductors (Section 6.3)	
Are isolating panels used in event of magnetic influences from inductors?	
Are all coils of contactors connected to RC elements?	

Table 2 Checklist for EMC-compatible cabinet design

EMC measures	Remarks
Cable routing (Section 5)	
Cabling divided into groups?	
Power supply cables (230 V) and signal cables routed in separate ducts or bundles?	
Complete cabling introduced into cabinet at one position?	
Signal cables routed close to grounded surface?	
Forward and return lines of individually routed conductors twisted if possible?	

Table 2 Checklist for EMC-compatible cabinet design (continued)

7 Framework and Wall Mounting of SIMATIC S5 Controllers

If you operate your SIMATIC controllers in a environment which is free from interferences to the greatest possible extent, you can fit the central controllers and expansion units on a framework or directly on a wall.

The following must be observed:

- A reference surface made of sheet-steel should be provided to improve the deviation of interfering currents conducted via the inlet cables. This reference surface must be at least 480 mm x 250 mm large and connected to the central grounding point. If you use screening or cable clamping rails, space must be provided for these on the reference surface. In the case of framework mounting, the metal frame serves as the reference surface.

- Fit the screen bar or cable clamping bar to this reference surface or to the framework. Ensure that the connection between the rails and the reference surface or framework is made with a large-area contact and low impedance (metal-metal connection).

- Connect all inactive metal components together with a large-area contact and low impedance. Inactive metal components are: subrack, power supply, reference surface, screen bar, protective ground bar.

- Also observe the points for the wiring layout (see Section 5).

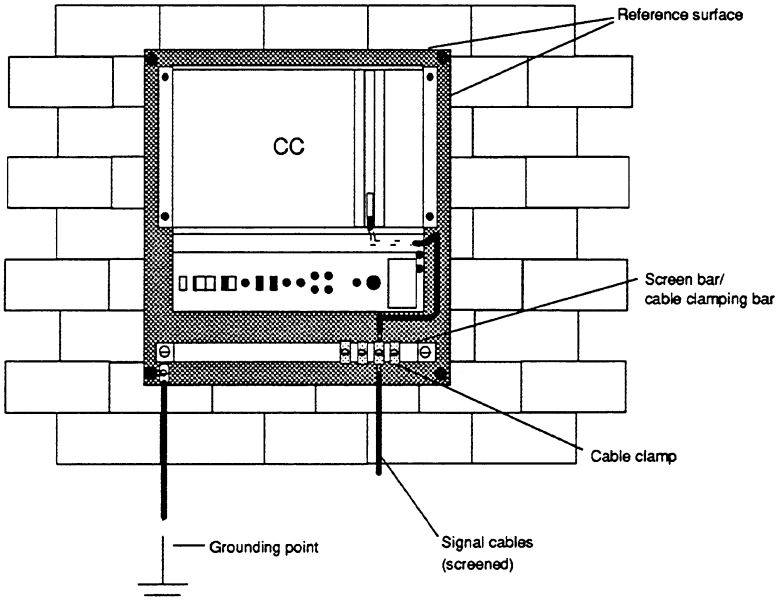


Fig. 15 Wall mounting

Note:

If you mount subracks from the S5-135U/155U series on a wall, provide a minimum clearance from the rear panel of ≥ 30 mm. This is necessary to guarantee heat exhange on the heat sink of the power supply.

Note:

When using radio telephones the field strength must not exceed 3 V/m at the programmable controller.

Owing to unknown values such as output power and frequency range, radio telephones should only be used when a certain safety clearance from PLCs not installed in cabinets is maintained.

8 Lightning Protection Measures

If cables and lines for SIMATIC S5 devices are laid outdoors, the lightning protection regulations must be adhered to.

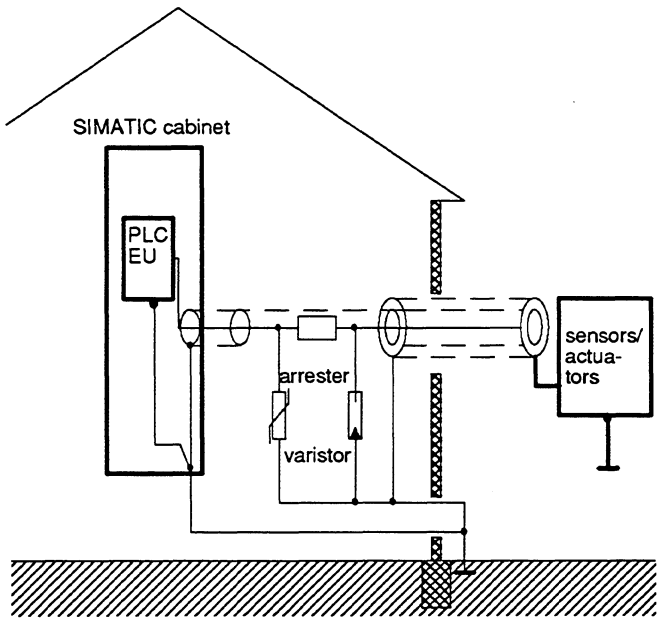


Fig. 16 Arrangement of lightning protection elements

Protect signal lines from overvoltages as follows:

- varistors

  or

- inert gas-filled lightning arresters

Install these protective elements

- as close as possible to the point of entry into the building
- before cables enter the cabinet

Note:

Lightning protection must be adapted to each situation individually. Please contact your local Siemens representative if you require advice.

9 Safety Measures

When configuring systems that have programmable controllers - as is the case with contactor equipment - follow the relevant regulations: CENELEC HD 384.4.41 (IEC 364-4-41) "Electrical installations of buildings" and also EN 60204 (European standard, corresponds to IEC 204-1), "Electrical equipment of industrial machines" (VDE 0113).

Pay special attention to the following points:

- Prevent conditions that could endanger or injure people or which could damage machines and material.
- When power is restored after a power failure or after EMERGENCY STOP units are released, machines must not be able to restart automatically.
- When a programmable controller malfunctions, commands from EMERGENCY STOP units and from safety limit switches must remain effective under all conditions. These safety measures must have a direct effect on the actuators in the power circuit independent of the programmable controller.
- When EMERGENCY STOP units are activated, safety must be guaranteed for people and systems as follows:

Note:

As operator of the system, you are responsible for the measures described in the section "Safety Measures" to avoid dangerous situations.

9.1 Protection against Indirect Contact

Parts which can be touched must not carry dangerous currents even in the event of a fault. They must be incorporated into the protective measures against dangerous currents.

This requirement is satisfied if all metal parts which can be touched and which could be dangerous in the event of a fault are safely connected electrically to the protective ground conductor (PE). The max. permissible resistance between the protective ground conductor and the part to be protected is 0.5 Ω.

SIEMENS

SIMATIC S5

155U Central Controller for the S5-155U and S5-155H

Instructions

C79000-B8576-C380-05

Preface

This manual contains the hardware description and installation and maintenance procedures for the central controller 155U (6ES5 155-3UA11 and 6ES5 155-3UA21). This manual also provides everything you need to know about operation, maintenance and technical specifications.

This manual is intended for engineers, programmers, and maintenance personnel.

If you have any questions about the S5-155U central controller not answered in this manual, please contact your local Siemens representative.

How to Use This Book

This section discusses information that may be helpful as you use this book.

The main information you will find in:

- Section 1.2.1, Possible Configurations
- Chapter 2, Installation / Dimensions of the S5-155U Central Controller
- Section 4.5.3, Checklist for Starting Up

The individual chapters offer you the following:

- **Chapter 1: Technical Description**
  This chapter discusses the application of the S5-155U programmable controller and describes its central controller. It includes details on possible configurations and possible links with expansion units.

- **Chapter 2: Installation of the S5-155U Central Controller**
  This chapter describes the installation procedure for the central controller, including its integrated power supply and 15-V supplementary module.

- **Chapter 3: Wiring Connections on the Power Supply Unit of the S5-155U Central Controller**
  This chapter describes all connections and explains how to set the installed fan and battery monitoring. It also includes recommendations on wiring for fan and temperature monitoring on the programmable controller.

- **Chapter 4: Operation of the S5-155U Central Controller**
  This chapter discusses the commissioning and the operation requirements. It explains the LEDs and operating elements on the power supply unit, jumper locations, and the functions of the alarm relays in the power supply unit.

- **Chapter 5: Maintenance of the S5-155U Central Controller**
  This chapter explains how to change the modules and the back-up battery. It also provides information on the connector pin assignments of the bus PCB including the interrupt signals.

- **Chapter 6: Technical Data of the S5-155U Central Controller**
  This chapter lists the technical data for the central controller, including its integrated power supply unit and 15-V supplementary module. It informs you about device safety, climatic and mechanical ambient conditions and interference immunity.

- **Index**
  The index contains an alphabetical list of key words and subjects covered in this book and their corresponding page numbers.

- **Remarks Form**
  The remarks form is provided for your comments and recommendations.

Training
Contact your local Siemens representative for information on training courses to aid you in becoming familiar with this product.

Reference Material

The following books that support the S5-155U system are recommended:

- *Catalog ST 54.1: S5-135U, S5-155U and S5-155H Programmable Controllers (Order No. E86010-K4654-A111-A6-7600)**

Programmer manuals:

- *S5-135U (CPU 928B) (Order No. 6ES5 998-2UL22)**
- *S5-135U (CPU 928) (Order No. 6ES5 998-1UL23)**
- *S5-135U (S and R Processor) (Order No. 6ES5 998-0UL22)**
- *U Periphery (Order No. 6ES5 998-0PC22)**
- *PG 685 Programmer (Order No. 6ES5 885-0SC21)**
- *PG 710 Programmer (Order No. 6ES5 814-0MC21)**
- *PG 730 Programmer (Order No. 6ES5 834 0FC21)**
- *PG 750 Programmer (Order No. 6ES5 886-0FC21 for Processor 386)* (Order No. 6ES5 886-0FC22 for Processor 486)**
- *PG 770 Programmer (Order No. 6ES5 887-0FC21)**
- *STEP 5 Programming Package for Personal Computers (Order No. 6ES5 896-0SC21)**
- *You will find an introduction to programming with STEP 5, as well as an explanation of how to work with the S5-155U programmable controller and its I/O modules in the following book:*

  Automating with the SIMATIC S5-155U
  by Hans Berger
  Siemens AG, ISBN 3-8009-1562-6

* Order this book from your local Siemens representative.

Contents

Preface ..... **0 - 1**

How to Use This Book ..... **0 - 3**

1 Technical Description of the S5-155U Central Controller ..... **1 - 1**

1.1 Application ..... 1 - 1

1.2 Design ..... 1 - 3

1.2.1 Possible Configurations of the S5-155U Central Controller ..... 1 - 5
1.2.2 Possible Configurations of the S5-155H Programmable Controller ..... 1 - 6
1.2.3 Addressing the I/O Modules ..... 1 - 7

1.3 Device Configuration of the S5-155U Programmable Controller ..... 1 - 8

1.4 Interfacing Between Central Controllers and Expansion Units ..... 1 - 8

1.4.1 Central Interfacing ..... 1 - 9
1.4.2 Distributed Interfacing ..... 1 - 10
1.4.3 Examples of Interfacing Possibilities ..... 1 - 12

1.5 Mode of Operation ..... 1 - 13

1.5.1 Single/Multiprocessor Operation ..... 1 - 13
1.5.2 Unit Interfacing ..... 1 - 14

2 Installation of the S5-155U Central Controller ..... **2 - 1**

2.1 Installing the Central Controller ..... 2 - 1

2.2 Installing the Power Supply Unit ..... 2 - 3

2.2.1 Installing the 15-V Supplementary Module ..... 2 - 3

2.3 Installation of the Modules ..... 2 - 4

2.3.1 Connections to the CPUs, CPs and Interface Modules ..... 2 - 4
2.3.2 Connections to the I/O Modules ..... 2 - 4

3 Wiring Connections on the Power Supply Unit of the S5-155U Central Controller ..... **3 - 1**

3.1 Connections of the Power Supply Units ..... 3 - 1

3.2 Recommended Wiring for Fans and Temperature Monitoring ..... 3 - 2

3.2.1 Setting the Fan Monitoring ..... 3 - 3
3.2.2 Setting the Back-Up Battery Monitoring ..... 3 - 4

4	**Operation of the S5-155U Central Controller**	**4 - 1**
4.1	General Notes on the Power Supply Unit	4 - 1
4.2	Operating and Display Elements of the Power Supply Unit	4 - 3
4.3	Functions and Locations of Jumpers on the Power Supply Unit 6ES5 955-3xxyy	4 - 4
4.4	Power Supply Behaviour in the Event of Faults	4 - 6
4.5	Start-Up and Functional Test (only for S5-155U Programmable Controller)	4 - 7
4.5.1	Start-Up with Single Processor Operation	4 - 8
4.5.2	Start-Up with Multiprocessor Operation (only for S5-155U Programmable Controller)	4 - 9
4.5.3	Checklist for Starting Up	4 - 10
5	**Maintenance of the S5-155U Central Controller/Pin Assignment**	**5 - 1**
5.1	Removing and Inserting S5 Modules	5 - 1
5.2	Removing and Inserting Power Supply Units	5 - 2
5.3	Replacing the Back-Up Battery and the Fans	5 - 3
5.4	Pin Assignments of the Power Supply Unit	5 - 5
5.5	Pin Assignment of the Bus PCB	5 - 6
5.6	Pin Designation of the Interrupt Signals on the Bus PCB (only for S5-155U Programmable Controller)	5 - 11
6	**Technical Data of the S5-155U Central Controller**	**6 - 1**
6.1	Power Supply Unit 6ES5 955-3LF12	6 - 3
6.2	Power Supply Unit 6ES5 955-3NF11	6 - 5
	Index	**I - 1**

Figures

1 S5-155U central controller ... 1-3
2 Device configuration of the S5-155U programmable controller ... 1-8
3 Example of central design with S5-155U central controllers and EG-183U / S5-184U expansion units ... 1-9
4 Example of a distributed configuration up to max. 600 m with S5-155U central controller and EG-183U7184U/187U expansion units, ER 701-1/701-3 subracks ... 1-10
5 Device dimensions of the S5-155U central controller ... 2-1
6 Different ways of fixing mounting brackets ... 2-2
7 Mounting location of the 15-V supplementary module ... 2-3
8 Connections of the power supply unit ... 3-1
9 Recommended connections for fan/temperature monitoring when using S5-155U CC and EG-183U EUs ... 3-2
10 Operating and display elements of the power supply units ... 4-3
11 Power supply unit 6ES5 955-3LF12 ... 4-5
12 Starting up ... 4-7
13 Battery compartment ... 5-3
14 Plug X1, view from rear of device ... 5-5
15 Plug X2, view from rear of device ... 5-5

Tables

1 Assignment of power supply unit and S5-155U ... 1-1
2 Possible configurations for the S5-155U central controller ... 1-5
3 Possible configurations for the S5-155H central controller ... 1-6
4 Examples of interfacing possibilities ... 1-12
5 Standard slots in ES 902 = 15.24 ... 2-4
6 6ES5 955-3LF12 power supply unit jumper assignment ... 4-4
7 Fault message and reaction of the power supply unit ... 4-6
8 Pin assignment of the bus PCB ... 5-6 to 5-10
9 Pin designation of the interrupt signals ... 5-11
10 Technical data ... 6-1 to 6-6

NOTE

These instructions do not cover all details or variations in equipment or provide for every circumstance that can arise with installation, operation, or maintenance. If you want further information or if particular problems arise that are not covered sufficiently for your purposes, contact your local Siemens sales office.

The contents of this manual shall not become part of or modify any prior or existing agreement, commitment, or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

This description applies for the S5-155U programmable controller with the following power supply units:

Order number of the central controller with power supply unit [1]	Order number of integrated power supply unit	Technical data
6ES5 155-3UA11	6ES5 955-3LF12	230 V/5 V/40 A IN: 230 V/120 V~ OUT: 5 V-/40 A 24 V-/2,8 A 15 V-/... [1]
6ES5 155-3UA21	6ES5 955-3NF11	24 V/5 V/40 A IN: 24 V- OUT: 5 V-/40 A 24 V-/2,8 A 15 V-/... [1]

IN = INPUT (primary)
OUT = OUTPUT (secondary)

1) A 15-V module can be inserted into all power supply units. This is necessary if you use a CP 535 or CP 143 communications processor. The total current of the 24 V DC and 14 V DC supplies must not exceed the maximum current of 0.8 A or 2.8 A.

Table 1 Assignment of power supply unit and S5-155U

1 Technical Description of the S5-155U Central Controller

1.1 Application

The SIMATIC S5-155U programmable controller is a versatile multiprocessor unit for automation tasks in the top performance range.

The standardized instrument technology, the modular design of the units and the expansion facilities mean that the S5-155U programmable controller can be easily adapted to the respective automation tasks. It can be configured according to your requirements. The system provides you with various expansion facilities (e.g. S5-185U expansion unit), communications facilities (e.g. SINEC H1) and a range of operation, monitoring and programming devices of varying performance.

With the S5-155U programmable controller you can solve the following automation tasks simply and economically:

- Open-loop control
- Closed-loop control and computing
- Communication
- Operation and monitoring.

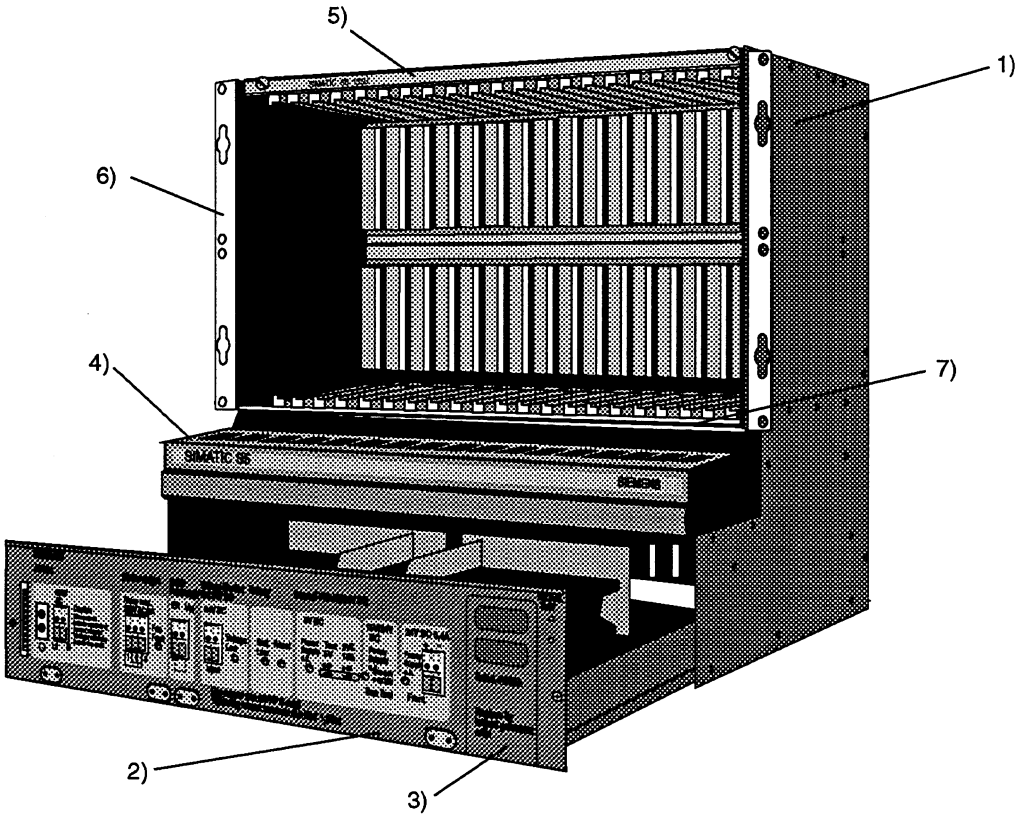
The controller is thus suitable for:

- Machine controls
- Process automation and
- Process monitoring.

The programming language is STEP 5 with the following methods of representation:

- Contol system flow chart - CSF
- Ladder diagram - LAD
- Statement list - STL
- Higher-level sequence diagram - GRAPH 5
- Additionally the CPU 946/947 can be programmed in the programming language C.

1.2 Design



1 Housing with 21 module slots
2 Power supply unit with fans
3 Plug-in for back-up battery
4 Cable duct
5 Locking rail
6 Mounting bracket
7 Rail for individual locking

Fig. 1 S5-155U central controller

Housing

The housing consists of screwed sheet-steel sections with ventilation openings at the top and bottom, as well as aluminium parts. The sheet-steel sections are chromium-plated, the aluminium locking rails are tin-plated. The housing contains the bus PCB which serves to connect the modules electrically. All slots have guide rails to ensure correct connection of the modules. At the top of the housing there is a locking bar to lock all modules at once. Modules with individual locking mechanisms can be secured using the bottom rail. A cable duct for incoming and outgoing signal cables is located at the front of the housing.

Power supply unit

The power supply unit with its fans is accommodated in a tier at the bottom in the housing. The input voltage is either 24 V DC or 230/120 V AC depending on the type of power pack used. An internal selector is present for adaptation with 230/120 V AC.

The central controller is available with two types of power supply

- primary 120/230 V AC
  secondary +5 V/40 A, +24 V/2.8 A

- primary 24 V DC
  secondary +5 V/40 A, +24 V/2.8 A

A 15-V submodule must be installed in the power supply unit when using the SINEC H1 modules CP 535 or CP 143.

The CPU 946/947 consists of several components:

- CPU 946 double-width
- CPU 947 single-width
- either one or two 355 memory modules with RAM or EPROM memory submodules

1.2.1 Possible Configurations of the S5-155U Central Controller

The following table shows the possible configurations for the 155U CC.

Module \ Slots	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
COOR C 6ES5 923-3UC..																					
CPU 946 1) 6ES5 946-3UA..																					
CPU 947 6ES5 947-3UA..																					
355 memory module 6ES5 355-3UA..																					
CPU 920 (M-processor) 6ES5 920-3UA..																					
CPU 922 (R-processor) 6ES5 922-3UA..																					
CPU 928 ,928B 1) 6ES5 928-3UA../-3UB11																					
300-3 interface module 6ES5 300-3...																					
301-3 interface module 6ES5 301-3....																					
304-3 interface module 6ES5 304-3....																					
300-5 interface module 6ES5 300-5....																					
301-5 interface module 6ES5 301-5....																					
302-3 interface module 6ES5 302-3....																					
307-3 interface module 1) 6ES5 307-....																		5)	5)	4)	4)
308-3 interface module 6ES5 308-3....																					
IP 240, 241, 242 243, 244																		2)	2)		
IP 245, 257, 260, 261																					
IP 246, 247, CP 513, 524, 525, 526, 527, 551, 552																		2)	2)		
IP 242A, 2 etc., 252 CP530, 143, 580 1)																		2)	2)		
I/O modules DI/DQ/AI/AQ																					
HW alarm evaluation of DI 432 and IPs																					
PG-MUX slots with 6) COOR 923C 3)		1		1			2		2			3	4	5	6	7	8				

1 CPU 946, CPU 928 and CPU 928B, AS 307, CP 535 and IM 307 take up two slots each
2 Jumpers 1 to 16 on the bus board which are accessible after removing the rear cover plate must be soldered in place. As delivered: slots 139/147 not suitable for these modules
3 Slots 91 to 131 are especially well suited for IPs and CPs since they have MUX capacity.
4 Here, no interrupt link to EU or ER is possible.
5 These slots are suitable for interrupt relaying according to 2.
6 The numbers in the table indicate the sub-addresses for PG communication via the PG multiplexer.

Table 2 Possible configurations for the S5-155U central controller

CPU 946/947 can only be operated as a unit; CPU 946 and CPU 947 cannot function individually.

Caution

Do not plug modules into slots for which they were not intended as this can destroy these or other modules.

1.2.2 Possible Configurations for the S5-155H Programmable Controller

If you equip two 155 U central controllers each with one CPU 946R/947R and connect them together via the parallel connection IR 304/IM 324 R the resulting device is a central controller S5-155H. One 155U CC is then master and the other standby.

Multiprocessor operation is **not** possible with the S5-155H. The CPU 946R/947R can only be used once, whereby the slots 11, 19 and 27 are to be employed. The coordinator 923C may not be used.

The following table shows the possible configurations for the S5-155H:

Modules \ Slots	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
CPU 946R 1) 6ES5 946-3UR..																					
CPU 947R 1) 6ES5 947-3UR..																					
355 memory module 6ES5 355-3UA..																					
Parallel connection IM 304/IM 324R 2)																					
301-3 interface module 6ES5 301-3....																					
304-3 interface module 6ES5 304-3....																					
300-5 interface module 6ES5 300-5....																					
301-5 interface module 6ES5 301-5....																					
308-3 interface module 6ES5 308-3....																					
I/O modules DI/DQ/AI/AQ																					
CP 524,525,526,527,551, CP580																		3)	3)		
CP 530 and CP 143																					

1 CPU 946R takes up two slots
2 IM 304 in central controller B, IM 324R in central controller A (see Instructions for S5-155H)
3 If CPs are to be plugged in, jumpers 1 to 16 on the bus board which are accessible after removing the rear cover plate must be soldered in place.
As delivered: slots 139/147 not suitable for CP.

Table 3 Possible configurations for S5-155H central controller

1.2.3 Addressing the I/O Modules

I/O modules can be addressed in the P and/or O (extended) I/O areas.

- I/O modules to be addressed in the O area must be plugged into the expansion unit. Depending on which combination of interface modules you require to communicate, you must set the address area either on the expansion unit interface module 300, 301, 307 or on the central controller interface module 314, 318.

It is also possible to multiply the O area:

- By setting "O area pages" on the IM 308 interface module a multiplexer function can be implemented which multiplies the O area by 256. The "O page number" must first be entered in O byte 255 before the operations L/T OB or L/T OW can be used to access the I/Os. The "O page numbers" are set on the EPROM of the IM 308.
  When using this procedure, the O area described above is not available.

Caution

To prevent double addressing:
If using an input module in the extended address area (O area) in an expansion unit (EU), make sure that there is no input module under the same I/O address in the central controller. The same applies for output modules.

1.3 Device Configuration of the S5-155U Programmable Controller

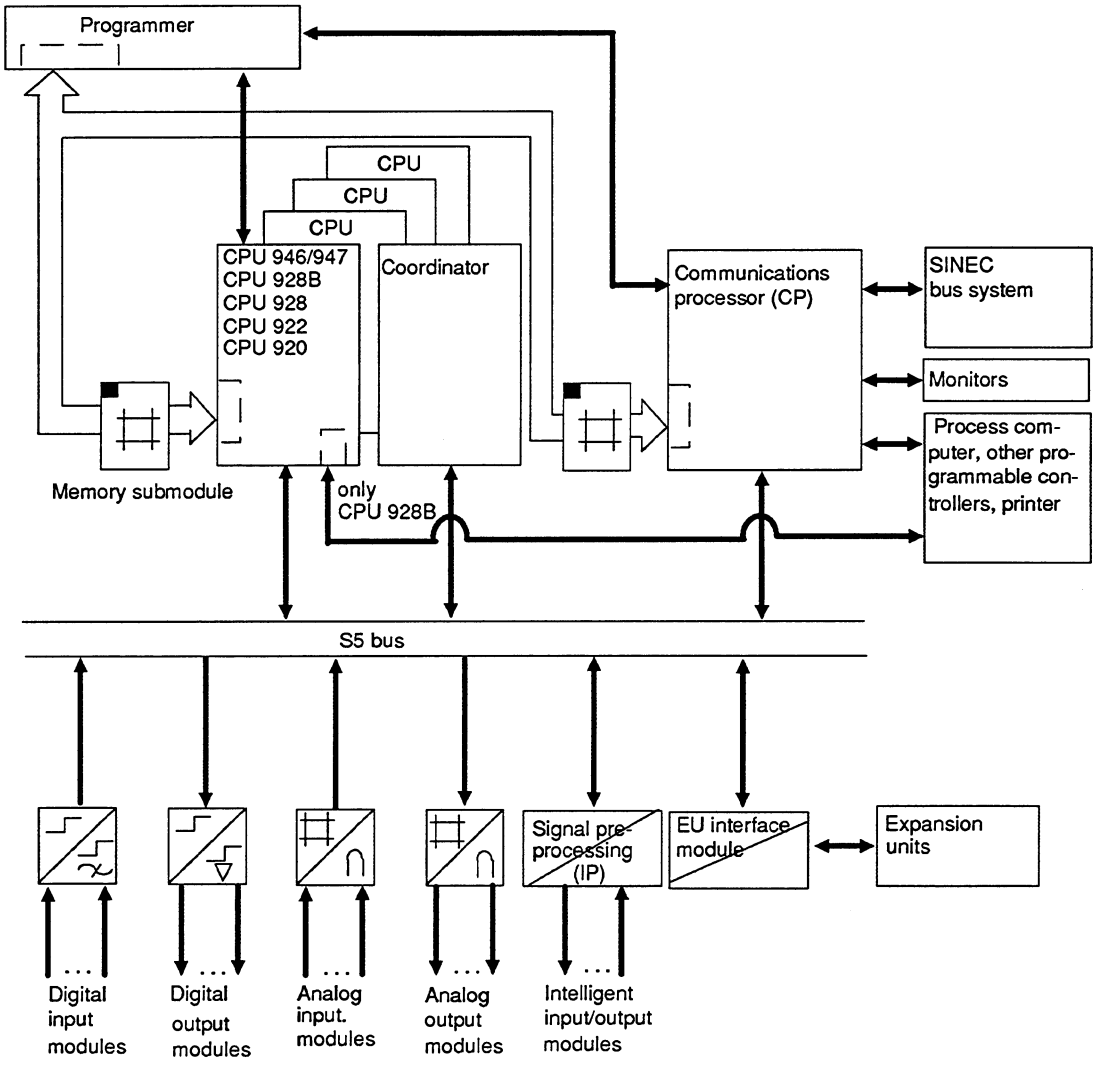


Fig. 2 Device configuration of the S5-155U programmable controller

1.4 Interfacing Between Central Controllers and Expansion Units

Expansion units can be connected if the number of slots in the central controller is insufficient. In this case refer to the Instructions of the expansion units (Manual U-Periphery).

When addressing the P or O I/O area note the following:
To avoid double addressing of the modules, do not use the same addresses in the I/O area (P area) of the central controller as in the extended I/O area (O area) of the expansion units. You can fully use the P and O I/O area if all I/O modules are in the expansion units. With the S5-155H programmable controller systems refer to the S5-155H Instructions.

1.4.1 Central Interfacing

Central interfacing means that the expansion units are accomodated together with the central controller in the same cabinet or in an adjacent cabinet. The total cable length from the central controller to the furthest expansion unit must not exceed 2 m.

The example (Fig. 3) shows how the S5-155U CC and the EG-183U/184U expansion unit are connected with the appropriate interface modules.

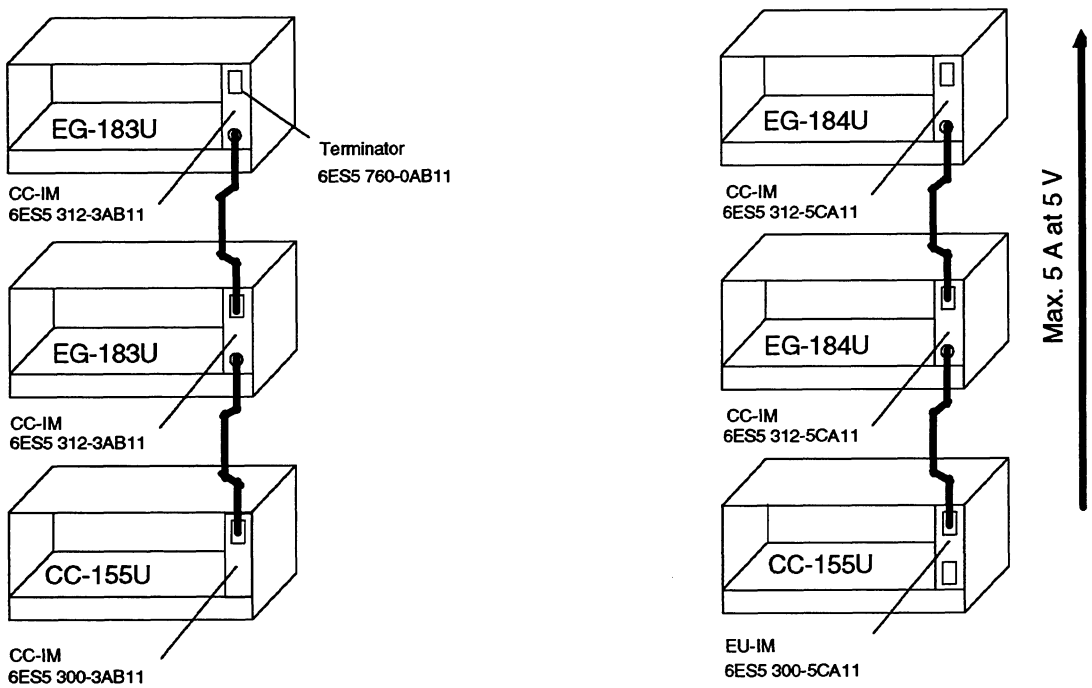


Fig. 3 Example of central design with S5-155U central controllers and EG-183U / S5-184U expansion units.

Please note:

- A terminator must be used on the last CC-IM 312-3....
- If you use expansion units without a power supply, the maximum load on the interface cable is 5 A (at 5 V).

For further designs with other interface modules, see Catalogs ST 54.1/ST 52.3 and the manual "U-Periphery" 6ES5 998-0PC22.

1.4.2 Distributed Interfacing

Distributed interfacing means that the expansion units are accomodated in a cabinet located further away from the central controller. The total cable length from the CC to the most remote EU must not exceed defined values. These distances depend on the interface module used (see Section 1.4.3, table: Examples of further interfacing possibilities). A distributed configuration up to 600 m is shown in the example (Fig. 4).

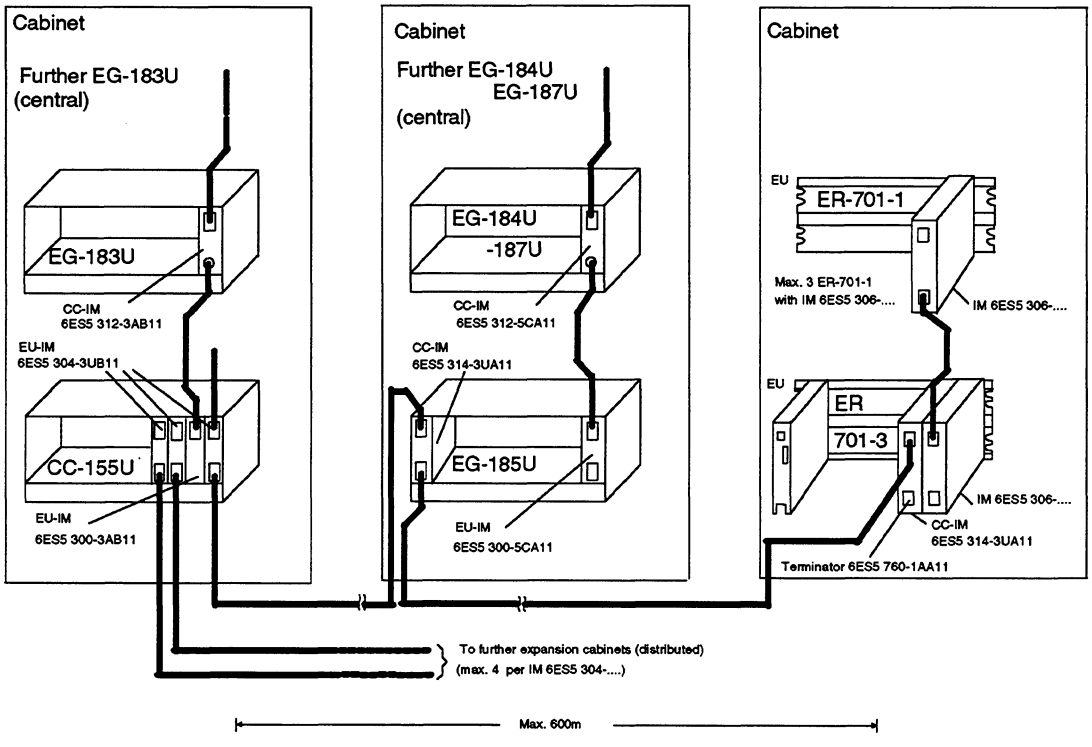


Fig. 4 Example of a distributed configuration up to max. 600 m with S5-155U central controller and EG-183U/ 184U /187U expansion units, ER 701-1 / 701-3 subracks

Please note:

- A distributed connection of up to 2 lines with 4 subracks (EG-183U, EG-185U, EG-186U expansion units, ER 701-2 and ER 701-3 subracks) can be made to a CC using an EU-IM 304 via the CC-IM 314.
- The total length (cable connector 721) from the CC up to the last EU can be up to 600 m per line.
- Further subracks can be connected centrally to the EG-185U expansion units and ER 701-3 subracks connected with a distributed configuration.
- Terminators must be inserted in the last CC-IM 314 of each line and in the last central connection of the CC-IM 312-3.

For further designs with other interface modules, see Catalogs ST 54.1/ST 52.3 and the manual "U-Periphery" 6ES5 998-0PC22.

Caution:

Only original cable connectors must be used to connect the interface modules to one another.
The screen of these cables is connected at both ends (do not isolate!).
The screen connection to the CC/EU subrack must be guaranteed via the springs on the metal front panel of the interface module or - in the case of plastic front panels - via the springs in the guide rails of the subrack.
Ensure that these important contact springs are not bent or dirty and are not interrupted at any point.

1.4.3 Examples of Interfacing Possibilities

The following table shows which interface modules and cable connectors can be used to connect the various expansion units to the central controller.

For S5-155H systems note the S5-155H Instructions

Type of design	Interface module in central controller	Expansion unit	Interface module in expansion unit	Cable connector
Central	6ES5 300-3AB11 6ES5 301-3AB13	EG 183U	6ES5 312-3AB11 6ES5 312-3AB31	Fixed on module 312 "
	6ES5 300-5CA11 6ES5 301-5CA12	EG 184U EG 187U	6ES5 312-5CA11 6ES5 312-5CA21	" "
	6ES5 300-5LB11	ER 701-1	6ES5 306-7LA11	6ES5 705-0xxxx
Distributed up to 200 m	6ES5 301-3AB13	ER 701-2	6ES5 310-3AB11	6ES5 721-0xxxx
	6ES5 301-5CA12 6ES5 301-3AB13	EG 183U		
Distributed up to 600 m	6ES5 304-3UB11	ER 701-2 ER 701-3 EG 183U EG 185U EG 186U	6ES5 314-3UA11	6ES5 721-0xxxx
Distributed up to 3000 m	6ES5 308-3UA12	ER 701-2 ER 701-3 EG 183U EG 185U EG 186U	6ES5 318-3UA11	Screened, twisted 2-wire cable
		ET 100U (Catalog ST 52.1)	6ES5 318-8MA12	
		ICM 560	-	
Distributed up to 1500 m	6ES5 307-3UA11	ER701-2 ER701-3 EG183U EG185U EG186U	6ES5 317-3UA11	6ES5 722-2xxxx (fiber-optic cable)

Table 4 Examples of interfacing possibilities

Note:

An equipotential bonding conductor ≥ 10 mm^2 must be provided for a distributed connection of central controllers and expansion units via the interface module 301/310 (up to 200) or 304/314 (up to 600) if a potential difference of more than 7 V can occur (see IEC 364-4-41, VDE 0100).The interface modules 301/310 and 304/314 are non-floating.

Connection via fibre-optic interface module IM 307/317:
The fibre-optic interface module IM 307/317 provides an isolated connection that can also transfer interrupts from an expansion unit (EG 186U or ER 701-3) to a central controller (on the slots 139 and 147, provided that the jumpers 1 to 16 on the rear bus PCB are closed).

1.5 Mode of Operation

The S5-155U programmable controller belongs to the SIMATIC S5 range. The controller can be used as a single processor as well as for multiprocessing with up to four CPUs. In multiprocessing operation a 923C coordinator is required. The exception is the CPU 946R/947R for S5-155H, which cannot be used for multiprocessing.

1.5.1 Single/Multiprocessor Operation (only for S5-155U Programmable Controller)

The user program is executed cyclically. Access to the input and output modules is possible at all times via the S5 bus. If the 923C coordinator is present, you can configure the S5-155U programmable controller with more than one CPU.
The S5-155U programmable controller is a multiprocessing device with processors for specific tasks which can be combined in a variety of ways:

- CPU 946/947 — Fast processing of all STEP 5 operations. With a maximum of 896 kbytes this CPU offers maximum memory configuration.
- CPU 928B — Designed for multiple tasks; provides very fast binary signal processing (open-loop control tasks) as well as very fast word processing (computing and closed-loop control). Has a second interface for point-to-point link with external devices (PC, PLC, PG, printer...).
- CPU 928 — Designed for multiple tasks; provides fast binary signal processing (open-loop control tasks) as well as fast word processing (computing and closed-loop control).
- CPU 922 (R processor) — Mainly for fast word processing (computing and closed-loop control). Binary signal processing is also possible.
- CPU 920 (M Processor) — For processing of measured values, arithmetic and statistics. Programming is carried out in BASIC, C or Assembler.

The automation task can be clearly organized by using several CPUs. Each CPU executes its program independent of the others. This increases the overall processing speed. Each processor can be started independent of the others. Up to four processors can be operated in the programmable controller, and the user program can be divided amongst several CPUs for specific tasks. All data to be exchanged between CPUs is transferred via the S5 bus.

In multiprocessor operation, you must specify address lists in data block DB 1 of each CPU to allow the input/output modules to be assigned to the individual CPUs. DB 1 must not be programmed as a standard DB. In single processor operation, DB 1 can be used to increase the processing speed.
The coordinator assigns each processor access to the S5 bus cyclically. Information is exchanged between the processors via the coordinator, which has a memory for this purpose.The coordinator 923C has an interprocessor communication flag area, a memory for multiprocessor communication and a central programmer connection. Via this, up to 8 modules (CPU, CP, IP) can be accessed without reconnecting the cable to the PG or SINEC-CP.

1.5.2 Unit Interfacing

The S5-155U central controller can be connected to:

- **Programmers**

  The programmers can be directly connected to the processors or the 923C coordinator for programming or system start-up.
  PG multiplexer function: with an electronic switch on the 923C coordinator you can access up to 8 modules in the central controller from the PG.

- **Standard and peripheral devices and computers**

  The communications processors (CP) can handle data traffic independently with

  - standard peripheral devices such as printers, keyboards, monitors,
  - computers or
  - other programmable controllers.

  The data required for texts and displays can be programmed for each communications processor in a RAM or EPROM submodule.

  The CPU 928B can handle data traffic independently via its second interface with

  - standard peripheral devices such as printers, keyboards,
  - computers or
  - other programmable controllers.

- **SINEC buses**

  The communications processors (CP) can handle data traffic independently with

  - PGs, computers or
  - other programmable controllers.

You can also use CPs for operation and monitoring, to display and/or modify process data. CPs are also available to display diagnostic messages and there are also CPs with mass memories.

2 Installation of the S5-155U Central Controller

2.1 Installing the Central Controller

The S5-155U central controller is designed for installation in cabinets, on frameworks and on walls (see Section 3.3 in Part 2; Specifications when Installing a Cabinet and Section 2.7; Framework and Wall Mounting of SIMATIC S5 Controllers).

The S5-155U central controller need only be accessible from the front for carrying out connections and maintenance.

The following Figs. show you the dimensions relevant to installation of the central controller.

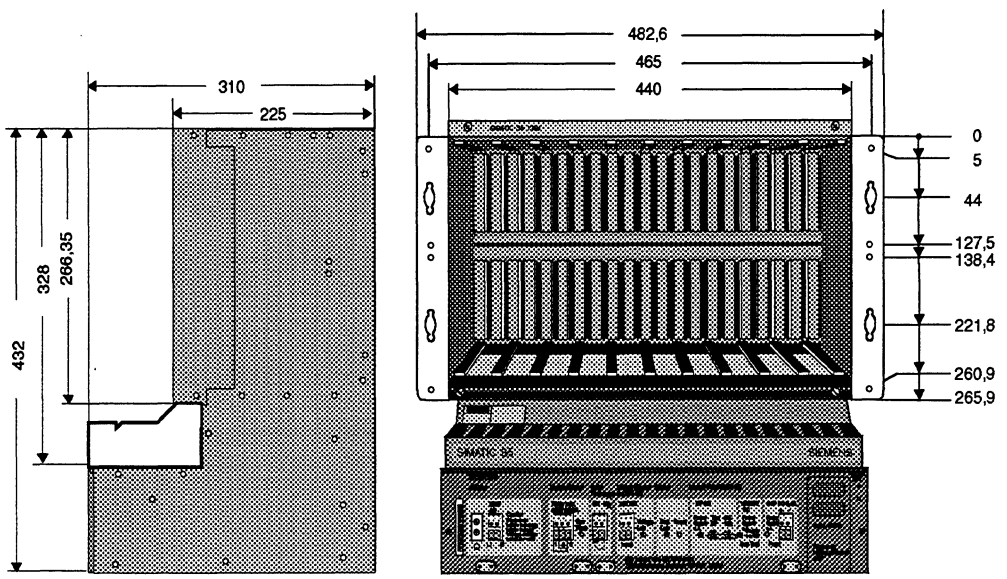


Fig. 5 Device dimensions of the S5-155U central controller (in mm)

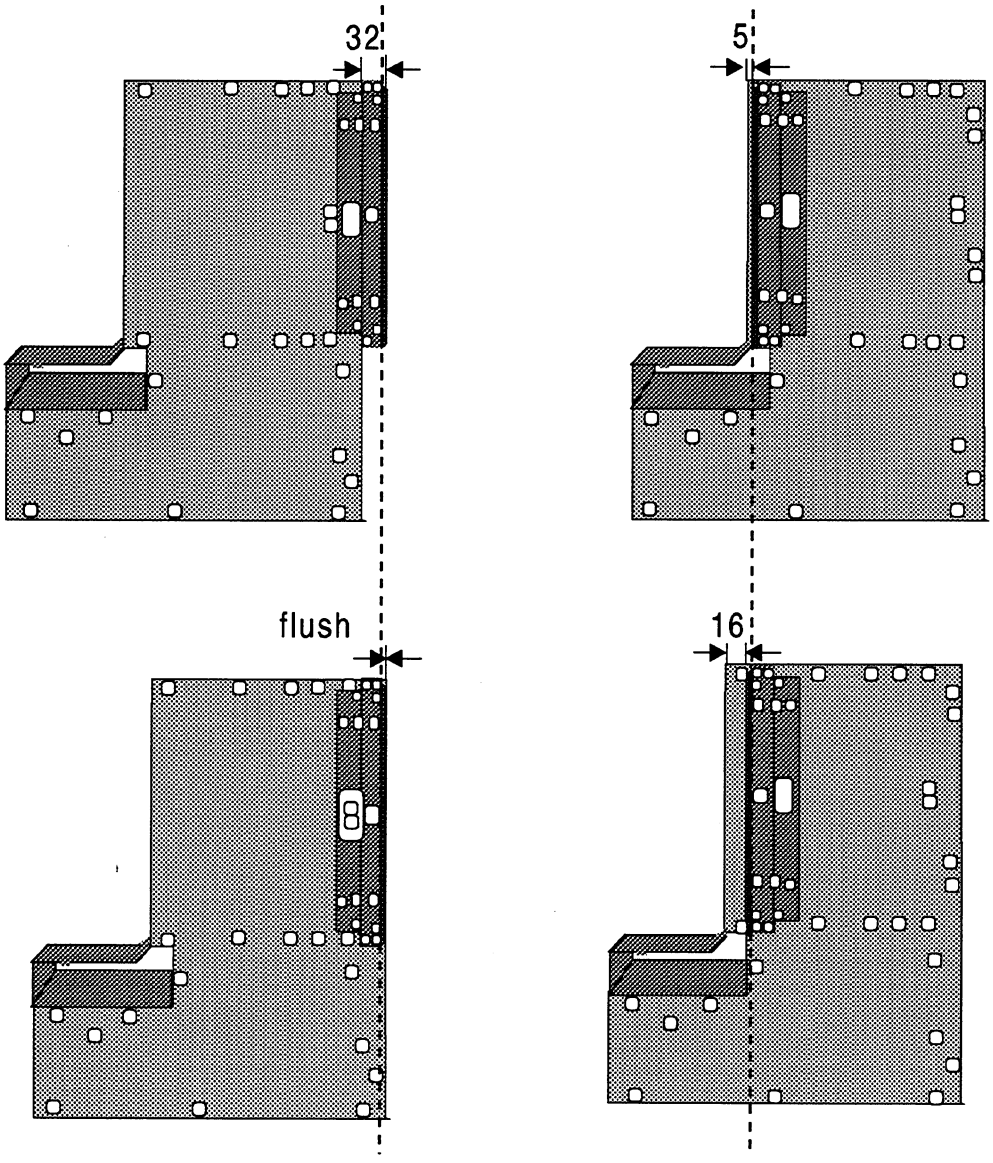


Fig. 6 Different ways of fixing mounting brackets

Note :

The same installation dimensions apply to the EG-183U/184U/185U and 186U expansion units as to the central controller.

2.2 Installing the Power Supply Unit

Insert or remove the power supply unit only when the device is switched off.
Push the power supply unit to the back. Push it firmly against the limit stop until the panel is flush with the device frame. The spring action of the contacts must be overcome. Then tighten both screws in the frame at the right and left of the front panel. The protective jumper at the left must be securely connected to the front panel terminal and the rack of the central controller.

2.2.1 Installing the 15-V Supplementary Module

The supplementary module [1)] must only be inserted when no voltage is applied.
Remove the power supply unit as described in Sections 2.2 and 5.2, and insert the 15-V supplementary module in the space shown in Fig. 7.

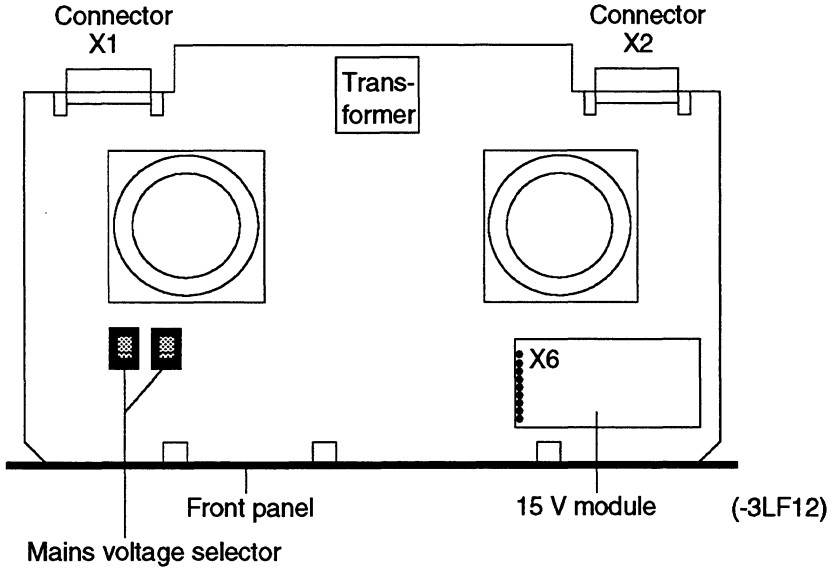


Fig. 7 Mounting location of the 15-V supplementary module

1)See "Ordering Information" for Order No. in the Appendix

2.3 Installation of the Modules

The dimensions of the S5-155U programmable controller modules correspond to the double-height Europa format (w x h x d: 20.32 mm x 233.4 mm x 160 mm).

There are modules with different widths:

Slots occupied	Standard slots [1]	Front panel width	Module
1	1 1/3	20.32 mm	e.g. CPU 947, memory module 355
2	2 2/3	40.64 mm	e.g. CPU 946, CPU 928B
4	5 1/3	81.28 mm	e.g. CP 580

1) Standard slot in ES 902 = 15.24

Table 5 Examples of widths of modules

Observe the following when installing the modules:

- Insert each module into the subrack as far as possible
- Lock the modules with individual locking mechanisms
- Screw the top locking rail for modules onto the central controller.

To improve the ventilation and the degree of protection, you can cover vacant slots using dummy front panels. See "Ordering Information" in the Appendix.

2.3.1 Connections to the CPUs, CPs and Interface Modules

Connect the cables from CPUs, communications processors and expansion unit interface modules using front plugs. There are two kinds of metal front plugs:

1. Metal front plugs with a sliding locking mechanism are locked by pushing the slinding bracket down.
2. Metal front plugs with a thumb wheel screw are screwed to the device.

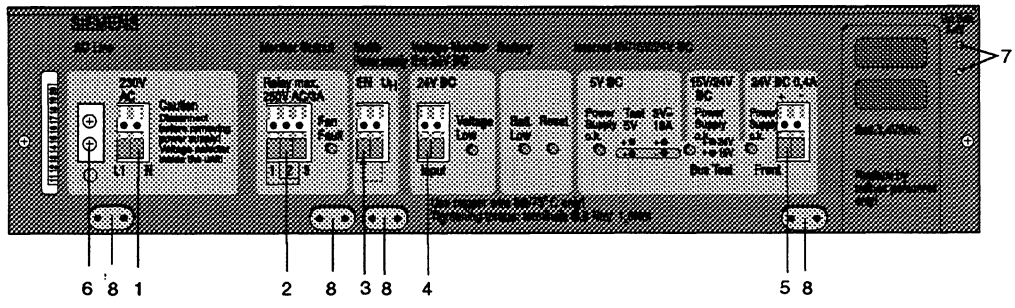
Take care to assign the plugs to the correct modules as damage could otherwise result.

2.3.2 Connections to the I/O Modules

Information on how to connect the cables to the I/O modules can be found in the U-Periphery Manual (Order No. 6ES5 998-0PC...) and in the ST catalogs.

3 Wiring Connections on the Power Supply Unit of the S5-155U Central Controller

3.1 Connections of the Power Supply Units



1 AC line :
230 V/120 V selectable input voltage (a 24 V DC line is also possible depending on the type of power supply unit).
2 Monitor output :
external signalling on LED and relay contact if one or both fans stops; this results in the output voltages being switched off (function selectable using jumper F-R of the power supply unit; in this case only relay signal and LED display).
In addition, failure of the back-up battery can be signalled on the power supply unit with the jumper RR-LL closed.
- See Section 4.3. for the functions and locations of the jumpers on the power supply units.
- See Section 3.2. for recommended wiring.
3 Enable power supply :
the power supply unit is switched off if no voltage is present at the EN input. Not more than 7 EN inputs (front terminal) can be set with an U_H output.
- See Section 3.2. for recommended wiring.
4 Voltage monitor :
24 V load voltage monitor input, must be connected or switched inactive by means of jumper BA-EX in the power supply unit. This does not apply to the power supply unit 6ES5 955-3NA12.
5 24 V DC, 0.4 A output:
this output can be used to supply the enable inputs of the U periphery.
6 Protective ground conductor connection:
7 Connection socket for external back-up voltage of 3.4 to 3.6 V.
8 Cable detensioners for connection cables with metal contact surface for cable screens.

Fig. 8 Connections of the power supply unit

Caution :

The appropriate safety regulations must be adhered to, especially IEC 364-4-41.
The terminals at the front are suitable for cables with a cross-section up to 4 mm^2.
The 230/120 V AC power connection must have a core cross-section of at least 0.75 mm^2.
Ensure that the tension on the cables is relieved sufficiently.

3.2 Recommended Wiring for Fans and Temperature Monitoring

If several devices with fan subassemblies are to be monitored together, connect the terminals EN and U_H of the power supply unit according to the following diagram. **All devices are switched off if the fan fails in one device.** The jumper settings required on the power supply units for this purpose are described in the following sections.

If you have installed the device in a cabinet with heat exchanger, the maximum internal temperature could be exceeded even with the fans working.
It is advisable to install a temperature monitoring device or thermostat in the top of the cabinet (in the exhaust air flow) (see Catalog NV 21). If a fault develops, the signal from the fan or temperature monitoring should be transferred immediately to the CPU to activate a programmed response. The actual shut-down should be triggered by a (customer-installed) time-delay relay after a maximum of 60 seconds, by interrupting the U_H-EN loop.

Up to 7 EN inputs can be controlled using on U_H output.

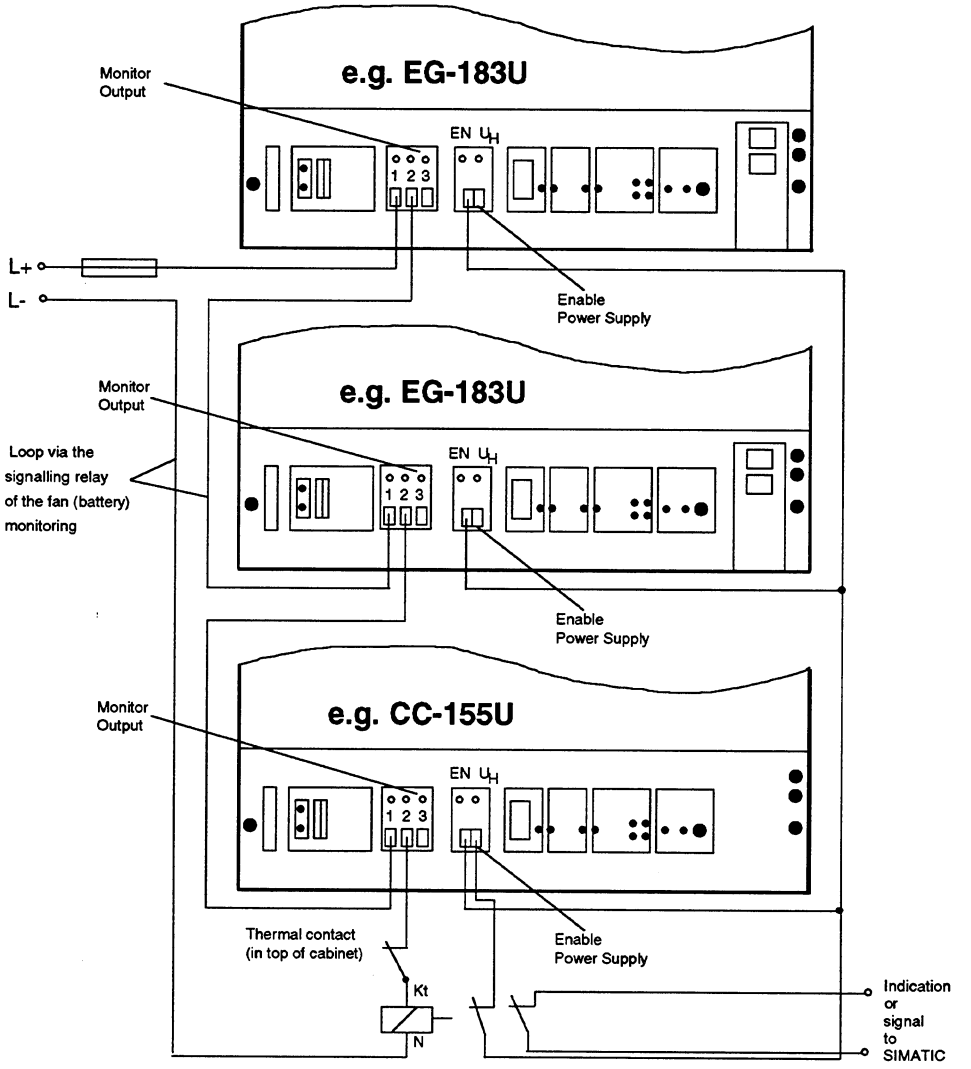


Fig. 9 Recommended connections for fan/temperature monitoring when using S5-155U CC and EG-183U EUs

Caution

Modules with a Winchester disk drive can only be used at an ambient temperature of up to 50 °C [122 °F]. The permissible switching point of the thermal contact in the top of the cabinet must be adapted. If necessary, use an adjustable thermostat (see Catalog NV 21).

3.2.1 Setting the Fan Monitoring

You can use the jumper F-R on the power supply units to select whether the internal supply voltages U_A (5 V) are to be switched off or not in the event of a fan failure:

- Jumper F-R closed: U_A switched off (signal via contact)
- Jumper F-R open: U_A not switched off (signal via contact).

The signalling relay ("Monitor Output") is activated if one or both fans stops. The LED "Fan Fault" lights up at the same time.

- Relay contact 2-1 closed: fan running

- Relay contact 2-3 closed: fan failure

Relay contact 2-3 closed is also the normal position, i.e. position when the power is off (intrinsic safety). The position of the jumpers on the power supply unit is shown in Section 4.3.

Caution

Jumper F-R must be opened if switching-off cannot take place immediately. In this case you must ensure that the power supply is switched off at the latest after 60 s. This can be achieved e.g. using a time-delay relay. This prevents modules being damaged by overheating.

3.2.2 Setting the Back-Up Battery Monitoring

Using jumper RR-LL on the power supply unit you can select whether the signalling relay ("Monitor Output") is to be switched not only upon a fan failure but also upon a battery failure:

- Jumper RR-LL open (factory setting): relay only signals fan failure.
- Jumper RR-LL closed: relay signals fan and battery failures.

The signalling relay ("Monitor Output") is switched in the event of a battery failure or standstill of one or both fans. The LED "Batt Low" lights up at the same time.

- Relay contact 2-1 closed: battery OK or (optionally) fan running.

- Relay contact 2-3 closed: battery faulty or (optionally) fan failure.

The position of the jumper on the power supply unit is shown in Section 4.3.

Note

The signalling relay is activated if a fan or the battery fails. The signalling relay must be wired by the user to adapt it to both faults.
If the signalling relay is triggered in the event of a battery failure, and as a result the PLC is switched off, the program in the user memory is lost. This can be avoided by having an external back-up voltage applied to the sockets on the front panel of the power supply unit while the PLC is being switched off (see Fig. 8).

4 Operation of the S5-155U Central Controller

Before you start up the programmable controller, read the notes in the following section. These notes explain the requirements for operating a PLC and contain useful information about starting up and operating the S5-155U system.

The S5-155U programmable controller of the type 6ES5 155-3UA1x is set at the factory for operation with 230 V AC. If you want to operate the PLC with 120 V AC remove the power supply unit and change the slider switch settings to 120 V (see Fig. 7). Before refitting the unit please stick the label "120 V" over the printed label "230 V". When you refit the power supply unit make sure that the short protective ground cable is reconnected to the power supply unit and housing.

The S5-155U programmable controller of the type 6ES5 155-3UA2x is designed for an operating voltage of 24 V DC.

4.1 General Notes on the Power Supply Unit

- No voltages > 50 V must occur between the power supply outputs and the protective ground conductor of the power supply unit.

- The protective ground conductor must always be connected as well as the jumper between the CC rack and the front panel of the power supply unit.

- If there is an overvoltage at the internal DC supply voltages U_{o1} = +5 V and U_{o3} = +15 V, the power supply unit is switched off without loss of data. A voltage ≤ 0.5 V (see Chapter 6, Technical Data, for overvoltage switch-off) is present at U_{o1} and U_{o3} in the switched-off condition.
  The power supply unit can be started up again by switching the external power supply off and then on again to reset the memory flip-flop, provided that the overvoltage was not caused by an internal fault.

- The power supply unit will only function correctly if the +5 V side has a load of at least 1 A (2 A with power supply unit -3LF12).

- An air filter [1)] can be installed in the base of the power supply unit housing.

- Make sure the voltage level (3.4 V) and polarity are correct when using an external back-up voltage.

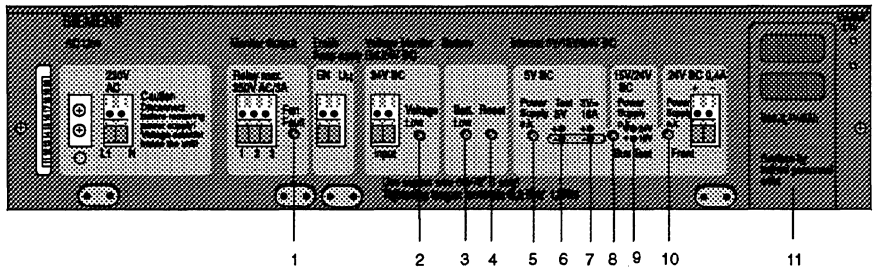
- **The back-up battery is supplied loose and must be fitted before you start up. Without the battery, the PLC will not start when the power is switched on. The battery must first be inserted. Then press the RESET button. Then perform an overall reset.**

- The wire jumper for "enable power supply" from U_H and EN enables the power supply. By suitable wiring of the monitoring outputs with the EN inputs, you can block the PLC in the event of a fault (see Section 3.2).

1) See Catalog ST 54.1 and Appendix for order nos.

- Undervoltage or the absence of voltage at the input terminals "voltage monitor" for 24 V DC activates the signal BASP in the CC and connected expansion units so that all digital outputs are disabled (the function can be disabled with jumper BA-EX). In this situation the CPUs do not recognize that the BASP signal is active. If you want the CPUs to recognize this, a digital output must be set constantly to 1 and be connected to an input that is scanned at least once per cycle.

4.2 Operating and Display Elements of the Power Supply Unit



1 LED "Fan Fault"
The red LED lights up if a fan fault has occurred. The power supply unit then switches off (jumper F-R closed) with a delay of approx. 6 to 10 s. The jumper F-R must be opened if the programmable controller cannot be switched off immediately for technical reasons. The programmable controller must always be switched off within 60s (overheating of module).

2 LED "Voltage Low"
The red LED lights up if an undervoltage is present at the load voltage monitor input
(omitted with power supply unit -3NA12).

3 LED "Batt. Low"
The yellow LED lights up if the battery voltage has dropped below 2.7 V; the data buffered in the RAM are lost following "power off/on".

4 Key "Reset"
If the programmable controller is in the power-off state, the battery must be replaced following mains-on and with the LED "Batt. Low" lit. Press this key after replacing the battery, the LED "Batt. Low" then goes out.

5 LED "Power Supply O.K."
The green LED lights up when the output voltage of 5 V is present.

6 Test sockets "Test 5 V"
For checking the output voltage V_{o1} (standard setting: 5.1 V DC ± 0.5 %)

7 Test sockets "3 V $\triangleq$ 18 A or 40 A
For checking the output current I_{o1} (3 V $\triangleq$ max. output current of respective power supply unit).

8 LED "Power Supply O.K." (Bus)
The green LED lights up when the output voltage of 15 V (if the 15 V supplementary module is used) **and** the output voltage of 24 V are present.

9 Test sockets "15 V/24 V DC" (Bus)
a) For checking the output voltage V_{o2} (24 V DC +25 %/-17 %)
b) For checking the output voltage V_{o3} (15 V DC ±5 % provided the 15 V supplementary module is plugged in)

10 LED "Power Supply O.K." (terminal)
The green LED lights up when the output voltage for the enable supply is present at the terminal "24 V DC".

11 Battery plug-in

Fig. 10 Operating and display elements of the power supply units

4.3 Functions and Locations of Jumpers on the Power Supply Unit 6ES5 955-3xxyy

Function	Jumpers
Battery monitoring ($\overline{BAU}$) ON Battery monitoring (BAU) OFF	NN-MM closed * NN-MM open
Power supply unit switched off after fan fault Power supply unit not switched off after fan fault (only signal LED and relay)	**F-R closed *** F-R open
Operation with load voltage monitoring Operation without load voltage monitoring	**BA-EX open *** BA-EX closed
Activation of signal relay in the event of a fault (relay contact 2-3 closed)	
• **by fan fault**	Independent of other jumpers
• **by battery fault signal** [1]	RR-LL closed
• **without battery fault signal**	**RR-LL open ***
• **by low voltage signal** [2] (BASPA = low)	BB-AA closed
• **without low voltage signal**	**BB-AA open ***

1) Battery undervoltage (V_{BATT} < 2.7 V), leads to a battery fault signal (can be switched off using jumper MM-NN). In addition to display "Batt. Low" and output of the signal $\overline{BAU}$, the signal relay can be activated via the jumper RR-LL if the following power supply units are used:

   Power supply units:

   6ES5 955-3NF11 from version 7 onwards
   6ES5 955-3LF12 from version 5 onwards

   Jumper RR-LL does not function in other power supply units.

2) If there is an undervoltage at the monitor input (V_M < 20 V, -25 % can be switched off via jumper BA-EX) or at the 5V output (V_o < 4.75 V), the "BASPA = low" signal is output. Thus the indirect and digital outputs are inhibited.

Table 6 6ES5 955-3LF12 power supply unit jumper assignment

*) Factory setting

There is a 6 A fast-acting input fuse at position F107 and a 4 A fast-acting output fuse at position F255. For the 6ES5 955-3NF11 power supply unit, the input fuse is at position F110 and the output fuse is at position F117. The position and the number are printed on the PCB.

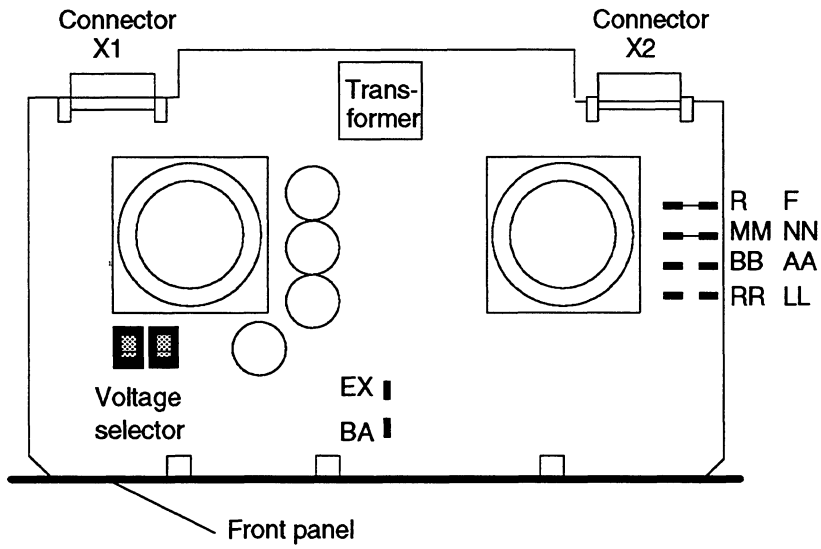


Fig. 11 Power supply unit 6ES5 955-3LF12

4.4 Power Supply Behaviour in the Event of Faults

If the power supply is switched off, relay contact 2-3 is closed and relay contact 1-2 open.
In normal operation, relay contact 1-2 is closed and relay contact 2-3 open.
In addition to fan faults, other faults (see jumper description) can set the sigal relay to the normal position (relay contact 2-3 closed) by means of appropriate jumper settings.

The following table shows the response of the power supply in the event of faults (condition: jumper MM-NN closed, jumper BA-EX open).

Fault and jumper settings / Reaction					Message		Output voltage Vo (5V) switched off
					LED "Fan fault"	Closed relay contact	
Enable (jumper EN-UH) present	No fan fault		No battery fault and no undervoltage message		Dark	1-2	No
			Battery fault	RR-LL closed		2-3	
				RR-LL open		1-2	
			Undervoltage message	BB-AA closed		2-3	
				BB-AA open		1-2	
	Fan fault	F-R open			Lights up		Yes
		F-R closed					
No enable (jumper EN-UH)	No fan fault		No battery fault		Dark		
			Battery fault	RR-LL closed			
				RR-LL open			
			Undervoltage message	BB-AA closed			
				BB-AA open			

Table 7 Fault message and reaction of the power supply unit

4.5 Start-Up and Functional Test (only for S5-155U Programmable Controller)

Requirement: 1 S5-155U with one processor (CPU)

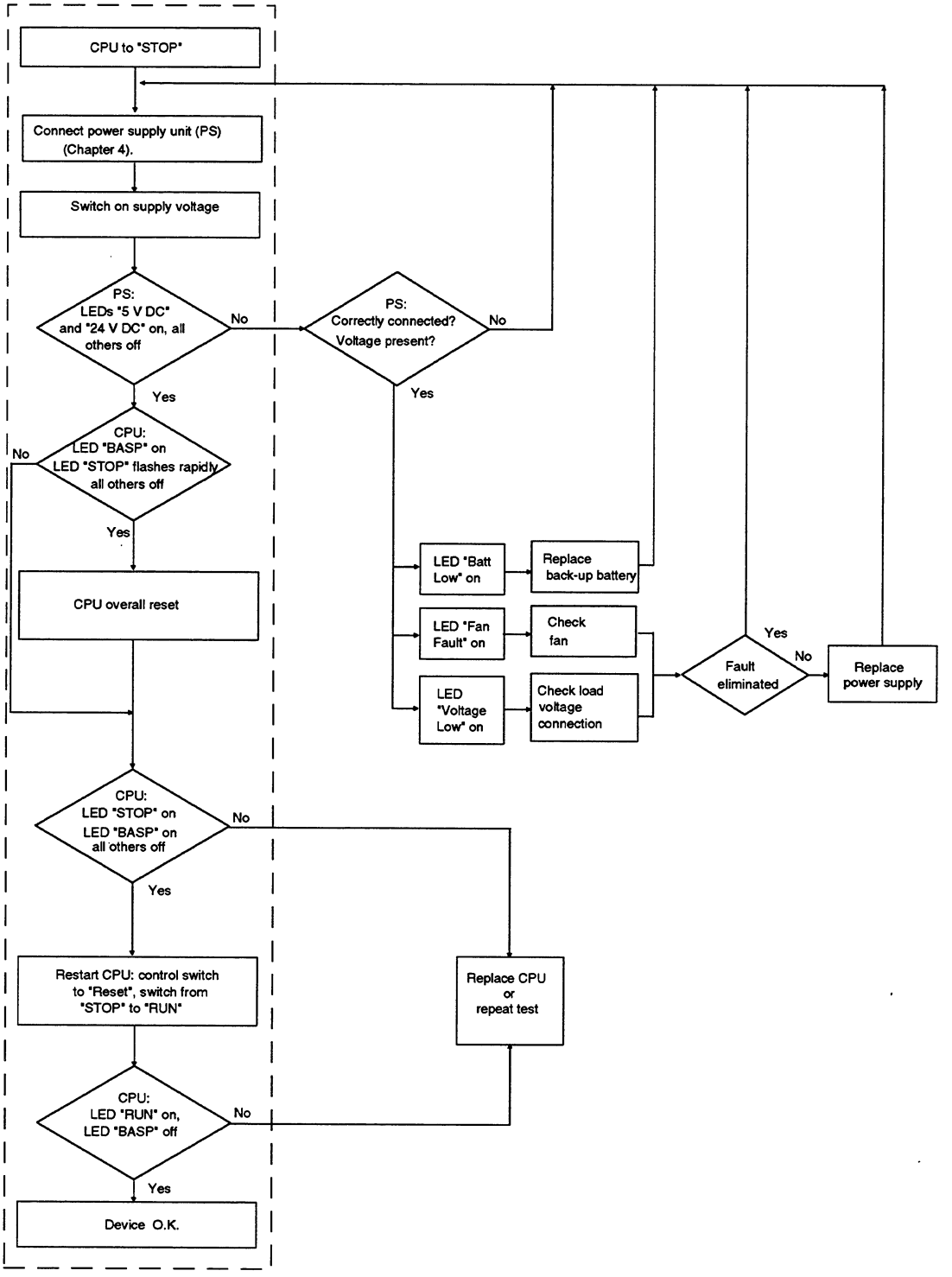
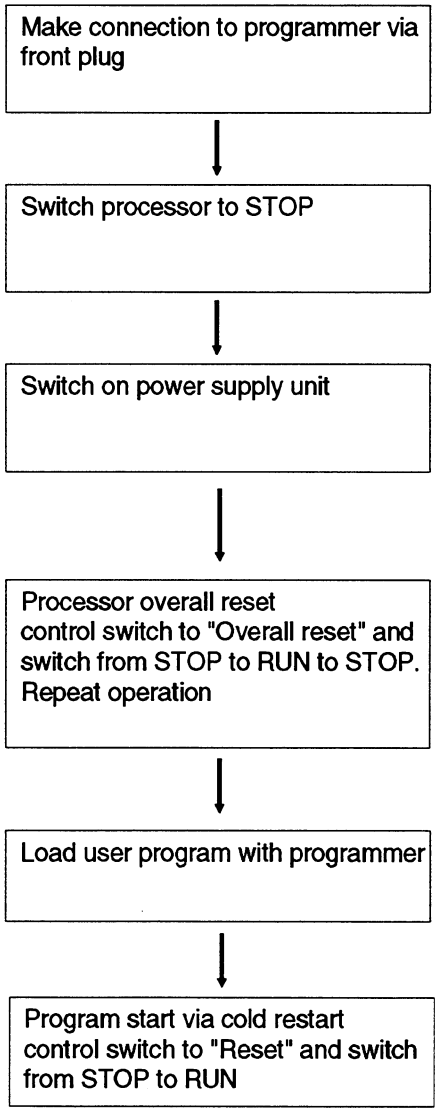
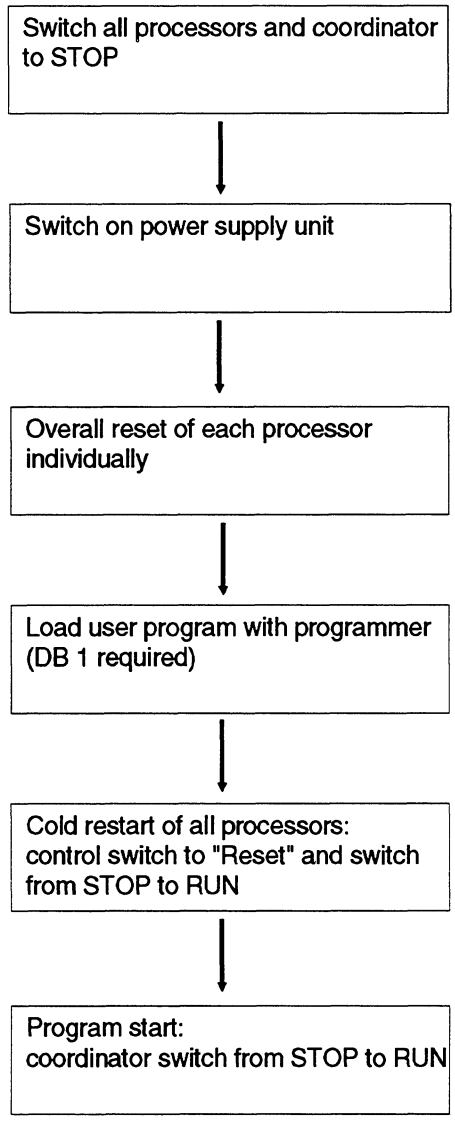


Fig. 12 Starting up

4.5.1 Start-Up with Single Processor Operation



4.5.2 Start-Up with Multiprocessor Operation (only for S5-155U Programmable Controller)



4.5.3 Checklist for Starting Up

Start up the PLC in the order described here. This brings you to the first trial run with the CPU.

The chapters of the publications describing the steps in detail are shown in brackets.

To avoid the start up being too complex at this stage, you should simply begin with one CPU and without any expansion units.

1) Install the PLC so that air can circulate freely. If you are using several devices (PLC and EU) in one cabinet, make sure the required clearances are maintained and if necessary install air baffles (Installation Guidelines, Section 3.3).

2) Fit the back-up battery (Section 5.3).

3) Install the CPU and set the mode selector to STOP.

4) Connect the power supply to the monitoring input and when using the 230/120 V AC supply the 24 V load voltage.

5) Switch on the power and, if present, the 24 V supply: green LED "Power supply o.k." in the "5 V DC" and "15/24 V DC" fields and the yellow LED "Batt. Low" light up.

6) Press the RESET button on the power supply unit. The yellow LED "Batt. Low" goes out (Section 4.2).

7) OVERALL RESET of the CPU :
Hold the CPU button in the "overall reset" position and switch the mode selector from STOP to RUN: the "STOP" LED flashes quickly.
Repeat this step: the LED "STOP" is lit constantly.
Hold the button in the "RESET" position and switch the selector from STOP to RUN: the green LED "RUN" lights up, the small yellow LED "BASP" goes out (Section 4.5).

The CPU is now running through an empty cycle. After switching off the power supply, you can now plug the other modules into the rack and connect the expansion units. Remember to plug in modules only in the permitted slots (Section 1.2.1), the addressing possibilities with the P and O areas and the settings on the interface modules (U Periphery manual) and the installation guidelines (Part 2).

When starting up with more than one CPU remember that the address list must be programmed on DB 1 of all CPUs. Refer to the "Multiprocessor Operation Instructions" for detailed information about multiprocessing.

5 Maintenance of the S5-155U Central Controller / Pin Assignments

If measurements or tests are required on active devices, the accident prevention regulations (VBG 4.0) must be observed and suitable tools used

Warning:

Repairs on automation equipment must only be carried out by the **Siemens servicing department** or by **qualified personnel** (see above).

Always remove the mains plug or open the isolating switch before opening the device.

Only use replacement fuses of the same type.

5.1 Removing and Inserting S5 Modules

Warning:

I/O modules with an active enable circuit may only be removed during operation if the enable voltage is switched off. This is achieved when the front plug is removed.
All inputs of this module are written into the process image of the inputs as "zero" if the enable voltage is missing, if the front plug is disconnected or if the module is removed. With a direct access to the process I/Os, the inputs are also written into ACCU 1 as "zero".

With all the other modules you must first switch off the device before removing or inserting a module. Removing or inserting these modules while voltage is applied can damage the module and lead to undefined system statuses.

You must ensure in the organization block in which the acknowledgement delay is checked that a hazardous condition in the process or on the machine cannot occur if a fault occurs or when a module is replaced.

Caution

Dangerous voltages may be present at the front sockets of I/O modules 435, 436, 455 and 456 if the front plugs are removed and inserted during operation. When under voltage, modules must only be replaced by electricians or trained personnel.

If it is not necessary to remove and insert modules during operation, the wiring of the enable circuit (F_+/F_-) can be omitted on the I/O modules. The jumper for switching over the enable mode must then be removed.
After removing the jumper for the enable mode, the module can be addressed via the S5 I/O bus irrespective of how the enable circuit F_+/F_- is connected. Connection of the enable voltage is no longer necessary. You must never remove or insert I/O modules connected to voltage if the enable circuit is not activated since this can damage the module and lead to undefined system statuses.

5.2 Removing and Inserting Power Supply Units

Power supply units must only be removed when no voltage is applied.
The connection between the back-up battery and the backplane bus is retained when the power supply unit is removed, thus ensuring that the user program is still backed-up.

5.3 Replacing the Back-Up Battery and the Fans

The back-up battery can be changed without losing any data in the memory if the power supply unit is switched on or if an external voltage (3.4 V) is applied to the sockets "Ext. Batt.". The back-up battery should be replaced every three years regardless of the memory configuration or the extent to which it had been used.

Proceed as follows to replace the battery:

- Pull down the cover.
- Pull the battery module to the front and remove it.
- Replace the battery.
- Make sure the polarity is correct.
- Once the new battery is fitted and the power is on, press the RESET button on the power supply module (see Fig. 11).

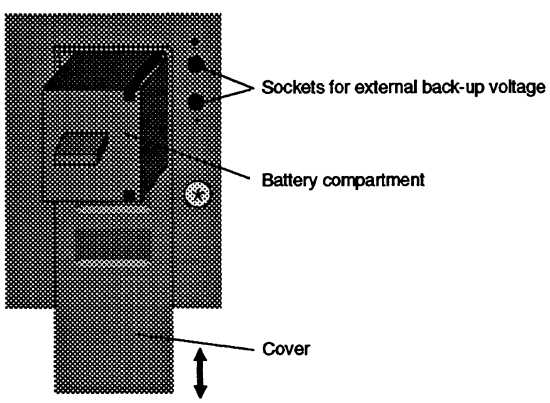


Fig. 13 Battery compartment

Caution:

Ensure correct polarity when fitting a battery or applying an external back-up voltage.

Caution: LITHIUM THIONYL CHLORIDE BATTERY!

Do not dispose of batteries in fire and do not solder on cell body - danger of explosion (max. temperature 100 °C [212 °F]) and do not attempt to recharge them. Do not open batteries. Only replace by batteries of the same type. Order replacement batteries only from Siemens using the order numbers listed in the Catalog ST 54.1 or in the Appendix in Part 9. You can then be sure that you are using a short-circuit proof battery.
Old batteries with some charge remaining should be discharged with a 10 Ω resistor or torch bulb until no further no-load voltage can be measured.
Completely discharged batteries no longer contain thionyl chloride and are therefore non-toxic and can be disposed of with normal garbage.
Charged lithium thionyl chloride batteries must otherwise be treated as toxic waste.

Replacing fans

The service life of the fans (see Section 6.1 "Technical Data") depends on the operating time, ambient temperature and ambient conditions. Resulting damage, e.g. on modules, can be avoided in the event of a fan failure during operation if the fan monitoring is switched on (jumper F-R closed); the power supply unit is then switched off.
In particular circumstances, it may be advisable to replace the fans at corresponding maintenance intervals as a preventive measure.

To replace the fans, proceed as follows:

- Switch off the voltage to the power supply.
- Disassemble the power supply.
- Loosen the fixing screws of the fans.
- Disconnect the plug contacts for the fan power supply.

Insert the fans in the reverse order.

The order nos. of the back-up battery and the various fans can be found in the Appendix.

5.4 Pin Assignments of the Power Supply Unit

- The connections of the power supply lines between the power supply unit and the bus PCB are on an 8-pin plug (subminiature plug, 8-pin, fitted with 8 power contacts, series D to MIL-C24308).

For 6ES5 955-3LF12 / 6ES5 955-3NF11 :

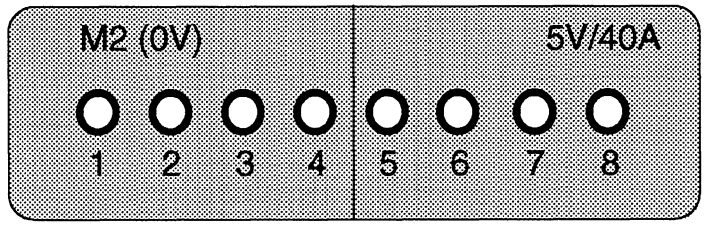


Fig.14 Plug X1, view from rear of device

- The signal connections on the power supply unit are on a 37-pin plug (subminiature plug connector, 37-pin, series D to MIL - C24308).

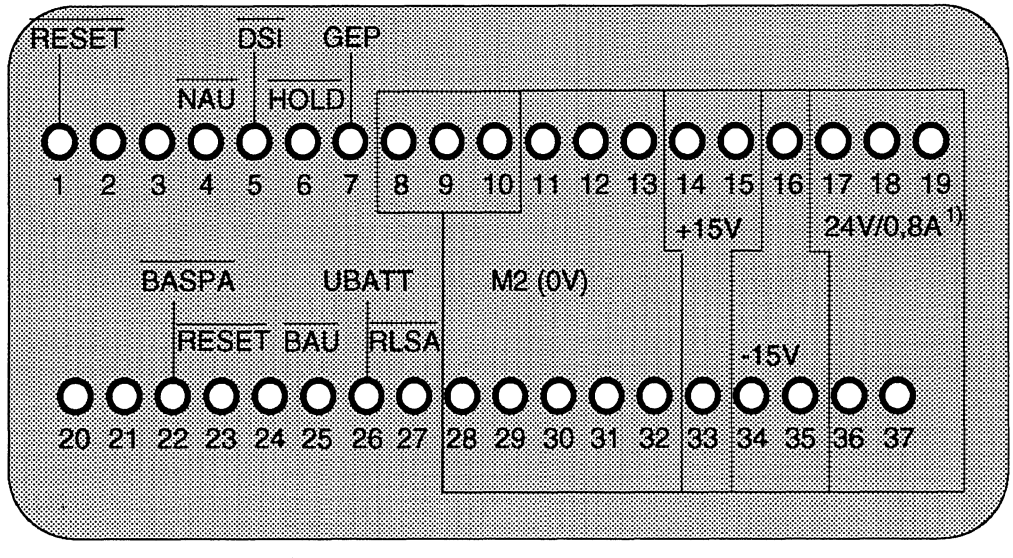


Fig. 15 Plug X2, view from rear of device

1) 2.8 A with power supply unit 6ES5 955-3LF12

5.5 Pin Assignment of the Bus PCB

Backplane Connector	Slot 3					Slot 11/51				
	Pin Row					Pin Row				
1	Pin No.	d	b	z		Pin No.	f	d	b	z
	2		M	+ 5V		2	xLAB0	M	M	+ 5V
	4	UBAT	PESP	+ 5V		4	xLAB1	UBAT	PESP	+ 5V
	6	GAB12	GAB0	CPKL		6	xLAB2	GAB12	GAB0	CPKL
	8	GAB13	GAB1	/GMEMR		8	xLAB3	GAB13	GAB1	/GMEMR
	10	GAB14	GAB2	/GMEMW		10	xLAB4	GAB14	GAB2	/GMEMW
	12	GAB15	GAB3	/GRDY		12	xLAB5	GAB15	GAB3	/GRDY
	14	BUSEN1	GAB4	GDB0		14	xLAB6	/IRA	GAB4	GDB0
	16	BUSEN2	GAB5	GDB1		16	xLAB7	M	GAB5	GDB1
	18	BUSEN3	GAB6	GDB2		18	xLAB8	/xINTMC	GAB6	GDB2
	20	BUSEN4	GAB7	GDB3		20	xLAB9	/xINTAS	GAB7	GDB3
	22		GAB8	GDB4		22	xLAB10	/IR E	GAB8	GDB4
	24		GAB9	GDB5		24	xLAB11	/IR F	GAB9	GDB5
	26		GAB10	GDB6		26	xLAB12	/IR G	GAB10	GDB6
	28	DSI	GAB11	GDB7		28	xLAB13	DSI	GAB11	GDB7
	30		BASP			30	xLAB14	BUSENx	BASP	
	32	/BASPA	M	/HALT		32	xLAB15	/BASPA	M	/HALT
Backplane Connector	2		M	+ 5V		2	xLDB0	xLAB16	M	+ 5V
	4		GDB8	GDB12		4	xLDB1	xLAB17	GDB8	GDB12
	6	/RXD8	GDB9	GDB13		6	xLDB2	M	GDB9	GDB13
	8	TXD8	GDB10	GDB14		8	xLDB3	xLAB18	GDB10	GDB14
2	10	/RXD7	GDB11	GDB15		10	xLDB4	xLAB19	GDB11	GDB15
	12	TXD7	/RXD6			12	xLDB5	/xLMEMR	/xTAU	M
	14	/RXD5	TXD6	/NAU		14	xLDB6	/xLMEMW	PGBUSX	/NAU
	16	TXD5	/RXD4	/BAU		16	xLDB7	/xLRDY	PGBUSY	/BAU
	18	/RXD3	TXD4	+ 5V		18	xLDB8	xNS	M	+ 5V
	20	TXD3	/STEU			20	xLDB9	/xHOLDA	/STEU	/xHOLD
	22	/RXD1	/STOPPA			22	xLDB10	TXDx	/STOPPA	/PEU
	24	TXD1	/RXD2	GEP		24	xLDB11	xHOLDO	M	GEP
	26	/TEST	TXD2			26	xLDB12	/TEST	/RXDx	/xPARE
	28		/PERO	5V		28	xLDB13		/PERO	5V
	30	M24V	M24V	M24V		30	xLDB14	M24V	M24V	M24V
	32	15V	M	24V		32	xLDB15	15V	M	24V

x = 1 (slot 11)
x = 2 (slot 51)

Table 8 Pin assignment of the bus PCB (1 of 5)

Slot 19/59							Slot 27/67					
Backplane Connector 1	Pin Row						Pin Row					
	Pin No.	f	d	b	z		Pin No.	f	d	b	z	
	2	xLAB0	M	M	+ 5V		2	xLAB0	M	M	+ 5V	
	4	xLAB1	UBAT	PESP	+ 5V		4	xLAB1	UBAT	PESP	+ 5V	
	6	xLAB2	GAB12	GAB0	CPKL		6	xLAB2	GAB12	GAB0	CPKL	
	8	xLAB3	GAB13	GAB1	/GMEMR		8	xLAB3	GAB13	GAB1	/GMEMR	
	10	xLAB4	GAB14	GAB2	/GMEMW		10	xLAB4	GAB14	GAB2	/GMEMW	
	12	xLAB5	GAB15	GAB3	/GRDY		12	xLAB5	GAB15	GAB3	/GRDY	
	14	xLAB6	/IRA/B	GAB4	GDB0		14	xLAB6	/IRA/B	GAB4	GDB0	
	16	xLAB7	M	GAB5	GDB1		16	xLAB7	M	GAB5	GDB1	
	18	xLAB8		GAB6	GDB2		18	xLAB8	/xINTMC	GAB6	GDB2	
	20	xLAB9		GAB7	GDB3		20	xLAB9	/xINTAS	GAB7	GDB3	
	22	xLAB10	/IR E	GAB8	GDB4		22	xLAB10	/IR E	GAB8	GDB4	
	24	xLAB11	/IR F	GAB9	GDB5		24	xLAB11	/IR F	GAB9	GDB5	
	26	xLAB12	/IR G	GAB10	GDB6		26	xLAB12	/IR G	GAB10	GDB6	
	28	xLAB13	DSI	GAB11	GDB7		28	xLAB13	DSI	GAB11	GDB7	
	30	xLAB14		BASP			30	xLAB14	BUSENx	BASP		
	32	xLAB15	/BASPA	M	/HALT		32	xLAB15	/BASPA	M	/HALT	
Backplane Connector 2	2	xLDB0	xLAB16	M	+ 5V		2	xLDB0	xLAB16	M	+ 5V	
	4	xLDB1	xLAB17	GDB8	GDB12		4	xLDB1	xLAB17	GDB8	GDB12	
	6	xLDB2	M	GDB9	GDB13		6	xLDB2	M	GDB9	GDB13	
	8	xLDB3	xLAB18	GDB10	GDB14		8	xLDB3	xLAB18	GDB10	GDB14	
	10	xLDB4	xLAB19	GDB11	GDB15		10	xLDB4	xLAB19	GDB11	GDB15	
	12	xLDB5	/xLMEMR	/xTAU	M		12	xLDB5	/xLMEMR	/xTAU	M	
	14	xLDB6	/xLMEMW	PGBUSX	/NAU		14	xLDB6	/xLMEMW	PGBUSX	/NAU	
	16	xLDB7	/xLRDY	PGBUSY	/BAU		16	xLDB7	/xLRDY	PGBUSY	/BAU	
	18	xLDB8	xNS	M	5V		18	xLDB8	xNS	M	5V	
	20	xLDB9	/xHOLDA	/STEU	/xHOLD		20	xLDB9	/xHOLDA	/STEU	/xHOLD	
	22	xLDB10		/STOPPA	/PEU		22	xLDB10	TXDx	/STOPPA	/PEU	
	24	xLLB11	xHOLDO	M	GEP		24	xLDB11	xHOLDO	M	GEP	
	26	xLDB12	/TEST		/xPARE		26	xLDB12	/TEST	/RXDx	/xPARE	
	28	xLDB13		/PERO	5V		28	xLDB13		/PERO	5V	
	30	xLDB14	M24V	M24V	M24V		30	xLDB14	M24V	M24V	M24V	
	32	xLDB15	15V	M	24V		32	xLDB15	15V	15V	24V	

x = 1 (slot 19)
x = 2 (slot 59)

x = 1 (slot 27)
x = 2 (slot 67)

Table 8 Pin assignment of the bus PCB (2 of 5)

Slot 35/43/75/83						Slot 91/99			
Backplane Connector 1	Pin Row					Pin Row			
	Pin No.	f	d	b	z	Pin No.	d	b	z
	2	xLAB0	M	M	+ 5V	2	M	M	+ 5V
	4	xLAB1	UBAT	PESP	+ 5V	4	UBAT	PESP	+ 5V
	6	xLAB2	GAB12	GAB0	CPKL	6	GAB12	GAB0	CPKL
	8	xLAB3	GAB13	GAB1	/GMEMR	8	GAB13	GAB1	/GMEMR
	10	xLAB4	GAB14	GAB2	/GMEMW	10	GAB14	GAB2	/GMEMW
	12	xLAB5	GAB15	GAB3	/GRDY	12	GAB15	GAB3	/GRDY
	14	xLAB6	/IR A	GAB4	GDB0	14	/IRC/D	GAB4	GDB0
	16	xLAB7	/IR B	GAB5	GDB1	16	M	GAB5	GDB1
	18	xLAB8	/IR C	GAB6	GDB2	18		GAB6	GDB2
	20	xLAB9	/IR D	GAB7	GDB3	20		GAB7	GDB3
	22	xLAB10	/IR E	GAB8	GDB4	22	/IR E	GAB8	GDB4
	24	xLAB11	/IR F	GAB9	GDB5	24	/IR F	GAB9	GDB5
	26	xLAB12	/IR G	GAB10	GDB6	26	/IR G	GAB10	GDB6
	28	xLAB13	DSI	GAB11	GDB7	28	DSI	GAB11	GDB7
	30	xLAB14	xSTCK	BASP		30	BUSENx	BASP	
	32	xLAB15	/BASPA	M	/HALT	32	/BASPA	M	/HALT
Backplane Connector 2	2	xLDB0	xLAB16	M	+ 5V	2		M	+ 5V
	4	xLDB1	xLAB17	GDB8	GDB12	4		GDB8	GDB12
	6	xLDB2	M	GDB9	GDB13	6	M	GDB9	GDB13
	8	xLDB3	xLAB18	GDB10	GDB14	8		GDB10	GDB14
	10	xLDB4	xLAB19	GDB11	GDB15	10		GDB11	GDB15
	12	xLDB5	/xLMEMR		M	12			M
	14	xLDB6	/xLMEMW	PGBUSX	/NAU	14		PGBUSX	/NAU
	16	xLDB7	/xLRDY	PGBUSY	/BAU	16		PGBUSY	/BAU
	18	xLDB8		M	5V	18		M	5V
	20	xLDB9		/STEU		20		/STEU	
	22	xLDB10		/STOPPA		22	TXDx	/STOPPA	/PEU
	24	xLLB11		M	GEP	24		M	GEP
	26	xLDB12	/TEST		/xPARE	26	/TEST	/RXDx	
	28	xLDB13		/PERO	5V	28		/PERO	5V
	30	xLDB14	M24V	M24V	M24V	30	M24V	M24V	M24V
	32	xLDB15	15V	M	24V	32	15V	M	24V

x = 1 (slots 35 and 43)
x = 2 (slots 75 and 83)

x = 1 (slot 91)
x = 2 (slot 99)

Table 8 Pin assignment of the bus PCB (3 of 5)

Slot 107/115/123/131					Slot 139/147			
Backplane Connector	Pin Row				Pin Row			
1	Pin No.	d	b	z	Pin No.	d	b	z
	2	M	M	+ 5V	2		M	5V
	4	UBAT	PESP	+ 5V	4	(UBAT)	PESP	5V
	6	GAB12	GAB0	CPKL	6	GAB12	GAB0	CPKL
	8	GAB13	GAB1	/GMEMR	8	GAB13	GAB1	/GMEMR
	10	GAB14	GAB2	/GMEMW	10	GAB14	GAB2	/GMEMW
	12	GAB15	GAB3	/GRDY	12	GAB15	GAB3	/GRDY
	14	/IRA	GAB4	GDB0	14	(/IRA)	GAB4	GDB0
	16	/IRB	GAB5	GDB1	16	(/IRB)	GAB5	GDB1
	18	/IR C	GAB6	GDB2	18	(/IRC)	GAB6	GDB2
	20	/IR D	GAB7	GDB3	20	(/IRD)	GAB7	GDB3
	22	/IR E	GAB8	GDB4	22	(/IRE)	GAB8	GDB4
	24	/IR F	GAB9	GDB5	24	(/IRF)	GAB9	GDB5
	26	/IR G	GAB10	GDB6	26	(/IRG)	GAB10	GDB6
	28	DSI	GAB11	GDB7	28	(DSI)	GAB11	GDB7
	30		BASP		30	M	BASP	
	32	/BASPA	M	/HALT	32	/BASPA	M	
Backplane Connector	2		M	+ 5V	2		M	+ 5V
	4		GDB8	GDB12	4		GDB8	GDB12
	6	M	GDB9	GDB13	6		GDB9	GDB13
	8		GDB10	GDB14	8		GDB10	GDB14
2	10		GDB11	GDB15	10		GDB11	GDB15
	12			M	12			
	14		PGBUSX	/NAU	14			(/NAU)
	16		PGBUSY	/BAU	16			(/BAU)
	18		M	5V	18		/PEU	/CPKLA
	20				20			
	22	TXDx	/STOPPA		22		(/STOPPA)	M
	24		M	GEP	24		M	(GEP)
	26		/RXDx		26			M
	28		/PERO	5V	28		M	M
	30	M24V	M24V	M24V	30	(M24V)	(M24V)	(M24V)
	32	15V	M	24V	32	(15V)	M	(24V)

x = 5 (slot 107)
x = 6 (slot 115)
x = 7 (slot 123)
x = 8 (slot 131)

( ) only if jumpers 1 - 16 are closed (not as deliverd)

Table 8 Pin assignment of the bus PCB (4 of 5)

Slot 155/163				
Backplane Connector	Pin Row			
	Pin No.	d	b	z
1	2		M	5V
	4	5V	PESP	5V
	6	GAB12	GAB0	CPKL
	8	GAB13	GAB1	/GMEMR
	10	GAB14	GAB2	/GMEMW
	12	GAB15	GAB3	/GRDY
	14	5V	GAB4	GDB0
	16	5V	GAB5	GDB1
	18		GAB6	GDB2
	20		GAB7	GDB3
	22	M	GAB8	GDB4
	24	M	GAB9	GDB5
	26	M	GAB10	GDB6
	28		GAB11	GDB7
	30	M	BASP	
	32	/BASPA	M	
Backplane Connector	2		M	5V
	4		GDB8	GDB12
	6		GDB9	GDB13
	8		GDB10	GDB14
2	10		GDB11	GDB15
	12		5V	5V
	14		5V	5V
	16		5V	5V)
	18		/PEU	/CPKLA
	20			
	22			M
	24		M	
	26			M
	28		M	M
	30			
	32		M	

Table 8 Pin assignment of the bus PCB (5 of 5)

5.6 Pin Designation of the Interrupt Signals on the Bus PCB (only for S5-155U Programmable Controller)

	Interrupt sink*				Interrupt source*			
Module	CPU 1	CPU 2	CPU 3	CPU 4	I/Os / CP			
Slot no.	11	51	91	99			35, 43, 75, 83, 107, 115, 123, 131	139,147 **
Signal								
$\overline{IRA}$	1d 14				1d 14		1d 14	1d 14
$\overline{IRB}$		1d 14				1d 14	1d 16	1d 16
$\overline{IRC}$			1d 14				1d 18	1d 18
$\overline{IRD}$				1d 14			1d 20	1d 20
$\overline{IRE}$	1d 22	1d 22	1d 22	1d 22	1d 22	1d 22	1d 22	1d 22
$\overline{IRF}$	1d 24	1d 24	1d 24	1d 24	1d 24	1d 24	1d 24	1d 24
$\overline{IRG}$	1d 26	1d 26	1d 26	1d 26	1d 26	1d 26	1d 26	1d 26

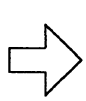
Table 9 Pin designation of the interrupt signals (on connector X1)

* Designations according to ISO 2382/XVI - 1978 (DIN 44301)
Interrupt sink = module that receives the interrupt
Interrupt source = module that generates the interrupt

** These slots can only be used for PE modules with interrupt outputs, when the jumpers 7-13 are inserted in the bus PCB. (The jumpers are n o t inserted when delivered.)

Please set the necessary jumpers on the modules if you use the interrupt signals. The settings are described in the Instructions for CPU and I/O modules, whereas for the CPUs, only the CPU 946/947 has jumpers.

Also refer to the CPU 946/947 Programming Guide for notes on programming (Section "Interrupt Driven Program Processing").



Note

Interrupt processing is not possible in the S5-155H programmable controller (Interrupt processing only via EB 0).

6 Technical Data of the S5-155U Central Controller

This power supply is UL and CSA listed.

Device safety	
Device complies with	VDE 0160. Protection against overvoltage complying with VDE 0160 A1 (April 89), Section 6.3.4 (overvoltage proof) achievable with additional measures.
Protection class	I (safe electrical isolation of the primary and secondary circuit of the power supply unit)
Degree of protection	IP 20 to IEC 529/DIN 40050 with covering of empty slots by dummy front panels
Climatic ambient conditions (tested according to IEC 68-2/-1/-2/-3)	
Temperature: Operation - Device freely installed, supply air temperature at lower air inlet of the power supply	0 to 55 °C [32 to 131 °F]
- Device installed in cabinet	(When installing in a cabinet, take into account that the dissipated heat loss depends on the cabinet design, its ambient temperature and the device arrangement))
Transport and storage temperature	-40 to +70 °C [-40 to +158 °F]
Temperature change - operation - transport and storage	 max. 10 K/h max. 20 K/h (3 h adaption time when delivered below 0 °C [+32 °F] because of possible condensation)
Relative humidity - operation - transport and storage	 max. 95 % at 25 °C [77 °F], no condensation max. 95 % at 25 °C [77 °F], no condensation
Operating altitude - operation - transport and storage	 - 1000 m to + 1500 m [1)] - 1000 m to + 3500 m
Toxic substances SO_2 H_2S	 max. 0.5 ppm (relative humidity below 60 %) max. 0.1 ppm (relative humidity below 60 %)

1) Note, if the programmable controller is used above 1500 m:
It is advisable to contact your Siemens representative regarding the required cooling conditions.

Table 10 Technical data (1 of 6)

Mechanical ambient conditions (tested according to IEC 68-2-6)	
Vibrations during operation	10 to 58 Hz (constant amplitude 0.15 mm) 58 to 500 Hz (constant acceleration 2 g)
Noise immunity (EMC)	
Radio interference suppression	to DIN VDE 0871 (CISPR, Publication No. 11 and CENELEC, HD 344)
Limit class	A
Conducted interferences on: AC voltage supply lines (230 V AC)	2 kV to IEC 801-4 (burst) 1 kV to IEC 801-5 line against line (µs pulses) 2 kV to IEC 801-5 line against ground (µs pulses)
DC voltage supply lines (24 V-supply)	1 kV to IEC 801-4 (burst)
Signal lines (24 V DC)	1 kV to IEC 801-4 (burst)
Signal lines (230 V AC)	2 kV to IEC 801-4 (burst)
Noise immunity to discharges of static electricity	A noise immunity of 8 kV must be guaranteed by an appropriate design
Noise immunity with respect to RF radiation	RF radiation according to VG 95373 LFO2G limit class 3 (up to 200 MHz), corresponding to 3 V/m
Back-up battery	
Type	Lithium-thionyl-chloride
Capacity	5 Ah at I_{max} = 35 mA
No-load voltage	3.6 V
Operating voltage	3.4 V
Storage life	approx. 10 years
Service life during operation	max. 3 years
Mechanical design	
Mechanical requirements	Installation in fixed devices not free from vibrations; installation on ships and vehicles with observance of special installation specifications, but not on the motor
Weight	approx. 14 kg
Dimensions (w x h x d)	482.6 x 432 x 310 mm

Table 10 Technical data (2 of 6)

6.1 Power Supply Unit 6ES5 955-3LF12

This power supply unit is UL and CSA listed.

Input	
Rated input voltage U_{EN}	230/120 V AC + 10 %/- 18.7 % [1]
Undervoltage signal U_E	< 187 V AC (or 93 V AC)
Input frequency f_E	48 to 63 Hz
Input current I_{EN} with rated load and U_{EN} = 240 V (or 120 V)	2.4 A (4.8 A)
Inrush current peak I_{Emax}	200 A (100 A)
Efficiency with rated load, with fan	typically ≥ 70 %
Stored energy time during power failure	> 5 ms
Power factor cos φ	0.73
Input fuse (internal)	6 A fast-blow; 250 V; 6.3 x 32 mm ; location F107 (printed on power supply board)
Electrical isolation	yes
Output 1	
Rated output voltage U_{AN1}	5.1 V DC ± 0.5 %
Setting range of output voltage	(0.95 to 1.05) x U_{AN1}
Rated output current I_{AN1}	40 A DC
Ripple	≤ 1 % of U_{A1}
Dynamic voltage tolerance with load surge from 50 to 100 % I_N	≤ 5 % of U_{A1}
Settling time	≤ 5 ms
Overvoltage shut-down U_{A1}	6 V ± 5 %
Undervoltage signal U_{A1}	4.75 V + 5 %
Current limiting with overload	(1.05 to 1.15) x I_{AN1}
Output 2	
Rated output voltage U_{AN2}	24 V DC + 25 %/- 17 %
Rated output current I_{AN2}	2.8 A DC [2]
Total current load of the 24 V and 15 V output	≤ 2.8 A
Ripple	≤ 5 % of U_{A2}
Fuse for overcurrent protection	4 A fast-blow ; 250 V ; 6.3 mm x 32 mm ; location F255 (printed on power supply board)

1) Voltage selector

2) Total output currents (I_{A2} + I_{A3} + I_{A4}) ≤ 2.8 A DC

Table 10 Technical data (3 of 6)

Output 3 with supplementary module	
Rated output voltage U_{AN3} Rated output current I_{AN3} Ripple Overvoltage shut-down Undervoltage signal (LED on front panel) Overcurrent protection I_{A3} by current limiting	15 V DC ± 5 % 2 A DC[1)] ≤ 5 % of U_{AN3} U_{A3} ≥ 18.5 V U_{A3} ≤ 14 V ± 3 % 2 to 3 A
Output 4	
Rated output voltage U_{AN4} Rated output current I_{AN4} with output 2 and 3 omitted Current limiting (reaction threshold) Undervoltage signal (LED on front panel) Capacitive load	24 V DC + 6 V/- 5 V 0.4 A [1)] ≥ 0.44 A 16 V ± 20 % max. 100 nF
Fans	
Fan type Input voltage Delivery rate per fan Service life of fan Fan monitoring	2 axial fans 240/120 V AC, selectable 160 m^3/h (no load) typically 30 000 to 40 000 h at 55 °C [131 °F] typically 40 000 to 50 000 h at 30 °C [86 °F] Flow monitoring with thermistors as sensors; stoppage at 1 or both fans is recognized and signalled externally by LEDs and relay contacts and the output voltages are switched off. (Jumper F-R on power supply closed.) If jumper F-R is open, only the relay contact responds in the event of a fault and the power supply must be switched off externally.
Additional monitoring	
24 V load voltage (external voltage monitor)	≥ 14 to 20 V
Electrical isolation primary/secondary	yes

1) Total of output currents (I_{AN2} + I_{AN3} + I_{AN4}) ≤ 2.8 DC

Table 10 Technical data (4 of 6)

6.2 Power Supply Unit 6ES5 955-3NF11

This power supply unit is UL and CSA listed.

Input	
Rated input voltage U_{EN}	24 V DC + 25 %/-17 %
Undervoltage signal U_E	< 20 V DC
Input frequency f_E	-
Input current I_{EN} with rated load and U_{EN} = 24 V DC	17.5 A
Inrush current peak I_{Emax}	300 A
Efficiency with rated load, with fan	typically 65 %
Stored energy time during power failure	> 5 ms
Input fuse (internal)	30 A/medium time-lag; 250 V; 6.3x32 mm; location F110 (printed on power supply board)
Electrical isolation	yes
Output 1	
Rated output voltage U_{AN1}	5.1 V DC ≤ 0.5 %
Setting range of output voltage	(0.95 to 1.05) x U_{AN1}
Rated output current I_{AN1}	40 A DC
Ripple	≤ 1 % of U_{A1}
Dynamic voltage tolerance with load surge from 50 to 100 % I_N	≤ 5 % of U_{A1}
Settling time	≤ 5 ms
Overvoltage shut-down U_{A1}	6 V ± 5 %
Undervoltage signal U_{A1}	4.75 V ± 5 %
Current limiting with overload	(1.05 to 1.15) x I_{AN1}
Output 2	
Rated output voltage U_{AN2}	24 V DC + 25 %/- 17 %
Rated output current I_{AN2} [1)]	2.8 A DC
Total current load of the 24 V and 15 V output	≤ 28 A
Ripple	≤ 5 % of U_{A2}
Fuse for overcurrent protection	4 A fast-blow; 250 V ; 6.3 x 32 mm location F177 (printed on power supply board)
Output 3 with supplementary module	
Rated output voltage U_{AN3}	15 V DC ± 5 %
Rated output current I_{AN3} [1)]	2 A DC
Ripple	≤ 5 % of U_{AN3}
Overvoltage shut-down	U_{A3} ≥ 18.5 V
Undervoltage signal (LED on front panel)	U_{A3} ≤ 14 V ± 3 %
Overcurrent protection I_{A3} by current limiting	2 to 3 A

1) Total of output currents (I_{AN2} + I_{AN3} + I_{AN4}) ≤ 2.8 A DC

Table 10 Technical data (5 of 6)

Output 4 : 24 V-Front	
Rated output voltage U_{AN4} Rated output current I_{AN4} 1) Current limiting (reaction threshold) Undervoltage signal (LED on front panel) Capacitive load	24 V DC (+ 6 V/- 5 V) 0.4 A ≥ 0.44 A 16 V ± 20 % max. 100 nF
Fans	
Fan type Input voltage Delivery rate per fan Service life of fan Fan monitoring	2 axial fans 24 V DC 160 m^3/h (no load) typically 30 000 to 40 000 h at 55 °C [131 °F] typically 40 000 to 50 000 h at 30 °C [86 °F] Flow monitoring with thermistors as sensors; stoppage of 1 or both fans is recognized and signalled externally by LEDs and relay contacts and the output voltages are switched off (jumper F-R on power supply closed). If jumper F-R is open, only the relay contact responds in the event of a fault and the power supply must be switched off externally.
Additional monitoring	
24 V load voltage (external voltage monitor)	≥ 14 to 20 V
Electrical isolation primary/secondary	yes

1) Total of output currents ($I_{A2} + I_{A3} + I_{A4}$) ≤ 2.8 A DC

Table 10 Technical data (6 of 6)

Index

A

Ambient conditions 6-1

B

Back-up battery 5-3, 6-2
Battery failure 3-4
Battery voltage 4-3
Bus PCB 1-4

C

Cable duct 1-4
Coordinator ..... 1-13 - 1-14
CSA 6-1, 6-3, 6-5

D

Degree of protection 6-1
Device safety 6-1

E

EN input 3-1
Enable circuit 5-1
Enable Power Supply 3-1
Enable voltage 5-1
Equipotential bonding conductor 1-13

F

Fans 6-4, 6-6
Fibre-optic interface module 1-13
Front plug 2-4
Fuse 4-5

H

Heat exchanger 3-2

I

I/O address 1-7
I/O area 1-7
Individual locking mechanism 1-4
Input fuse 4-5
Installation specifications 6-2
Interface cable 1-9
Interrupt signals 5-11

L

Locking bar 1-4

M

Maintenance intervals 5-4
Mechanical design 6-2
Monitor Output 3-1, 3-4
Multiplexer function 1-5, 1-14
Multiprocessor operation 1-13, 4-9

N

Noise immunity 6-2

O

O (extended) I/O area 1-7
O page number 1-7
Output fuse 4-5

P

Power supply unit 1-4, 6-3, 6-5
Protection class 6-1

R

Reset 4-3

S

Screen connection 1-11
Signalling relay 3-4
Single processor operation 1-13, 4-8
Supplementary module 2-3

T

Temperature monitoring device 3-2
Terminator 1-9
Thermostat 3-2

U

UL 6-1, 6-3, 6-5

V

Voltage Monitor 3-1, 4-2

W

Winchester disk drive 3-3

SIEMENS

SIMATIC S5

CPU 946/947

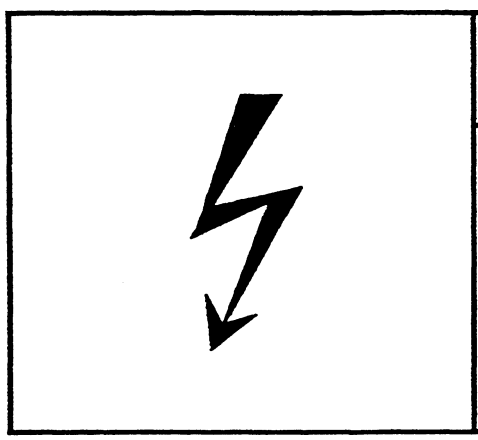
6ES5 946-3UA21/22/23

6ES5 947-3UA21/22/23

Instructions	C79000-B8576-C532-06

Siemens has developed this document for its licensees and customers. The information contained herein is the property of Siemens and may not be copied, used, or disclosed to others without prior written approval from Siemens. Users are cautioned that the material contained herein is subject to change by Siemens at any time and without prior notice.

Siemens shall not be responsible for any damages, including consequential damages, caused by reliance on material presented, including but not limited to typographical, electronic, arithmetic, or listing errors.



⚠ WARNING

Hazardous voltage.

Can cause death, severe personal injury, or substantial property damage.

Restrict use to qualified personnel.
See safety instructions.

Only qualified personnel should install or maintain this equipment after becoming thoroughly familiar with all warnings, safety notices, and maintenance procedures contained in this manual. The successful and safe operation of this equipment is dependent upon proper handling, installation, operation, and maintenance.

The following are definitions of the terms "qualified person," "danger," "warning," and "caution," as applicable for this document.

Qualified Person
One who is familiar with the installation, construction, and operation of this equipment and the hazards involved. In addition, the person should have the following qualifications:

- Be trained and authorized to use and tag circuits and equipment in accordance with established safety practices
- Be trained in the proper care and use of protective equipment in accordance with established safety practices
- Be trained in rendering first aid

DANGER
Indicates that loss of life, severe personal injury, or substantial property damage will result if proper precautions are not taken.

WARNING
Indicates that loss of life, 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.

First Printing, September 1989
Printed in the Federal Republic of Germany

Preface

CPU 946/947 is the standard central processing unit for the SIMATIC S5-155U programmable controller.

This book describes the hardware and installation procedure for CPU 946/947 and lists its technical specifications.

This book is intended for engineers, programmers, and maintenance personnel who have a general knowledge of programmable controller concepts.

If you have any questions about CPU 946/947 not answered in this book, please contact your local Siemens representative.

How to Use This Book

This section discusses information that may be helpful as you use this book.

Contents of This Book

- **Chapter 1 - Technical Description**

  This chapter describes the application and design of CPU 946/947 and includes its memory assignment and contains a list of technical data.

- **Chapter 2 - Installation and Operator Information**

  This chapter explains how to install and remove CPU 946/947. It also explains the control switches and LEDs on the front panel of CPU 946/947.

- **Chapter 3 - Operation**

  This chapter explains the restart procedure of CPU 946/947 and defines its restart types. It also discusses the programmer interface and the operation of peripheral modules.

- **Chapter 4 - Maintenance**

  This chapter explains the central register for error addresses of CPU 946/947. It also shows the layout of the CPU jumpers and describes the interface assignment for its backplane connectors and front connectors.

- **Index**

  The index contains an alphabetical list of key terms and subjects covered in this book and their corresponding page numbers.

- **Remarks Form**

  The remarks form is provided for your comments and recommendations.

- **Training**

  Contact your local Siemens representative for information on training courses to aid you in becoming familiar with this product.

- **Reference Materials**

It is recommended that you have the following books that support the S5-155U system:

- *Catalog ST 54.1: S5-135U, S5-155U and S5-155H Programmable Controllers (Order No. E86010-K4654-A111-A6-7600)*[1]

- Programmer Manuals*:

- *PG 685 Programmer Manual (Order No. 6ES5 885-0SC21)**

- *PG 710 Programmer Manual (Order No. 6ES5 814-0MC21)**

- *PG 730 Programmer Manual (Order No. 6ES5 834-0FC21)**

- *PG 750 Programmer Manual (Order No. 6ES5 886-0FC21)**

- *PG 750-486 Programmer Manual (Order No. 6ES5 886-0FC22)**

- *PG 770 Programmer manual (Order No. 6ES5 887-0FC21)**

- *STEP 5 for Personal Computers User Guide (Order No. 6ES5 896-0SC21)**

- *S5-135U (CPU 928B) Manual (Order No. 6ES5 998-2UL22)**

- *S5-135U (CPU 928) Manual (Order No. 6ES5 998-1UL23)**

- *S5-135U (CPU 921/922) Manual (Order No. 6ES5 998-0UL22)**

- *U Periphery Manual (Order No. 6ES5 998-0PC22)**

You will find an introduction to programming with STEP 5, as well as an explanation of how to work with the S5-155U programmable controller and its I/O modules in the following book...

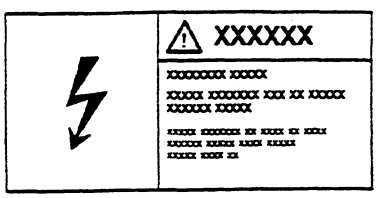
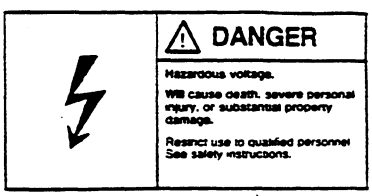
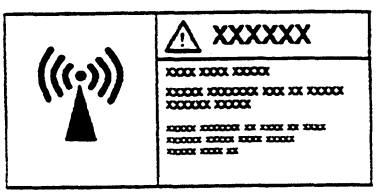
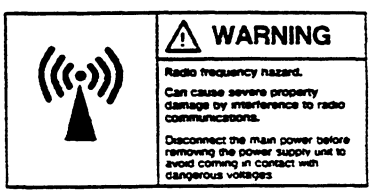
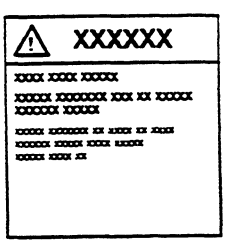
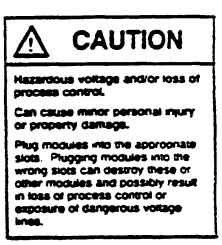
Automating with the SIMATIC S5-155U
by Hans Berger
Siemens AG, ISBN 3-8009-1562-6

---

* Order the appropriate book from your local Siemens representative.

Conventions

The following conventions are used in this book and are listed for your reference:

Convention	Definition	Example
	A box that indicates a type of hazard, describes its implications, and tells you how to avoid the hazard is safety notation. Some safety notation includes a graphic symbol representing an electrical or radio frequency hazard. All safety notation has one of the following levels of caution:	
	• A danger indicates that loss of life, severe personal injury, or substantial property damage will result if proper precautions are not taken.	
	• A warning indicates that loss of life, severe personal injury, or substantial property damage can result if proper precautions are not taken.	
	• A caution indicates that minor personal injury or property damage can result if proper precautions are not taken.	

Contents

Preface 0-1

How to Use This Book 0-3

Chapter 1 - Technical Description

1.1 Application 1-1
1.2 Design 1-1
1.3 System Structure 1-2
1.4 Memory Assignment 1-5
1.5 Technical Specifications 1-6
1.6 Functional Capabilities 1-8

Chapter 2 - Installation and Operator Information

2.1 Plugging In and Removing Modules 2-1
2.2 Control Switches and LEDs 2-2
2.2.1 "RUN/STOP" Switch 2-4
2.2.2 "RESET" Switch 2-4
2.2.3 Operating Status LEDs 2-5
2.2.4 Error and Signal LEDs 2-7
2.3 Restart Procedure for the CPU 946/947 2-9
2.4 Operation of Peripheral Modules 2-10

Chapter 3 - Operation

3.1 Restart Types 3-1
3.1.1 Cold Restart 3-1
3.1.2 Manual Warm Restart 3-1
3.1.3 Automatic Warm Restart 3-2
3.1.4 Automatic Cold Restart 3-2
3.1.5 Test Mode 3-2
3.2 Programmer Interface 3-2

Chapter 4 - Maintenance

4.1 Central Register for Error Addresses 4-1
4.2 Jumper Layout 4-2
4.3 Interface Assignment of the Backplane Connectors 4-8
4.4 Interface Assignment of the Front Connector 4-9

Index Index-1

Figures

1-1 Block Diagram of CPU 946/947 with Optional 355 Memory Module 1-2
2-1 Front Panel of CPU 946/947 2-3
4-1 Jumper Layout on CPU 946 (6ES5 946-3UA21) 4-2
4-2 Jumper Layout on CPU 947 (6ES5 947-3UA21) 4-3
4-3 Jumper Layout on CPU 946 (6ES5 946-3UA22) 4-4
4-4 Jumper Layout on CPU 947 (6ES5 947-3UA22) 4-5
4-5 Jumper Layout on CPU 946 (6ES5 946-3UA23) 4-6
4-6 Jumper Layout on CPU 947 (6ES5 947-3UA23) 4-7

Tables

1-1 CPU 946/947 Memory Assignment 1-5
2-1 CPU 946/947 "RESET" Switch Settings 2-3
4-1 Interface Assignment of the Backplane Connector 1 4-8
4-2 Interface Assignment of the Backplane Connector 2 4-8
4-3 Interface Assignment of the Front Connector 4-9

NOTE

These instructions do not cover all details or variations in equipment or provide for every circumstance that can arise with installation, operation, or maintenance. If you want further information or if particular problems arise that are not covered sufficiently for your purposes, contact your local Siemens sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment, or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

Chapter 1
Technical Description

CPU 946/947 is the standard central processing unit for the S5-155U programmable controller. This chapter explains its application and design and shows how it fits into the S5-155U system structure. This chapter also includes the memory assignment of CPU 946/947 and a list of technical data.

1.1 Application

CPU 946/947 is used in the central controller of the S5-155U programmable controller. You can use the 355 memory module to extend the CPU's memory up to 896 Kbytes. This memory capacity enables it to process extensive programs.

CPU 946/947 executes all STEP 5 operations at very high speed and is equipped with floating-point arithmetic. It has an integrated 64 Kword[1] RAM with parity monitoring and a real-time clock.

The following program processing levels are available individually or in combination:

- Cyclic
- Time driven (9 different time bases)
- Interrupt driven (8 interrupts at block boundaries or 4 hardware interrupts)
  The interrupt priorities can be selected. CPU 946/947 can process a user program for communication with communications processors (CPs) in the smooth "STOP" mode.

Using multiprocessing, you can also operate CPU 946/947 with an additional CPU 946/947 or with a CPU of the S5-135U.
CPU 946/947 uses the STEP 5 programming language.

For details on programming see the Programming Guide for the CPU 946/947, CPU 946R/947R in this manual.

1.2 Design

CPU 946/947 consists of two plug-in central processing units, 6ES5 946-3UA21/22/23 (CPU 946) and 6ES5 947-3UA21/22/23 (CPU 947).

---

[1] Kword stands for kiloword (one word equals 16 bits). One kiloword equals 1024 words (2^{10} words).

The electronics of CPU 946 are on two printed circuit boards. Two 64-pin male connectors on the mother board link the CPU to the S5 bus and S5 local bus for CPU 946/947 communication to the backplane housing. The front panel is $2^2/_3$ standard plug-in stations wide. Switches, buttons, and LEDs for operating the programmable controller and displaying modes of operation and faults are on the front panel.

The electronics of CPU 947 are on one printed circuit board. Two 64-pin male connectors link the CPU to the S5 local bus for CPU 946/947 communication. It has a 15-pin front connector that enables you to connect the CPU 946/947 to a programmer, operator panel or SINEC interface module.

1.3 System Structure

This section shows how CPU 946/947 is connected to the S5 bus and explains the structure of the CPU.

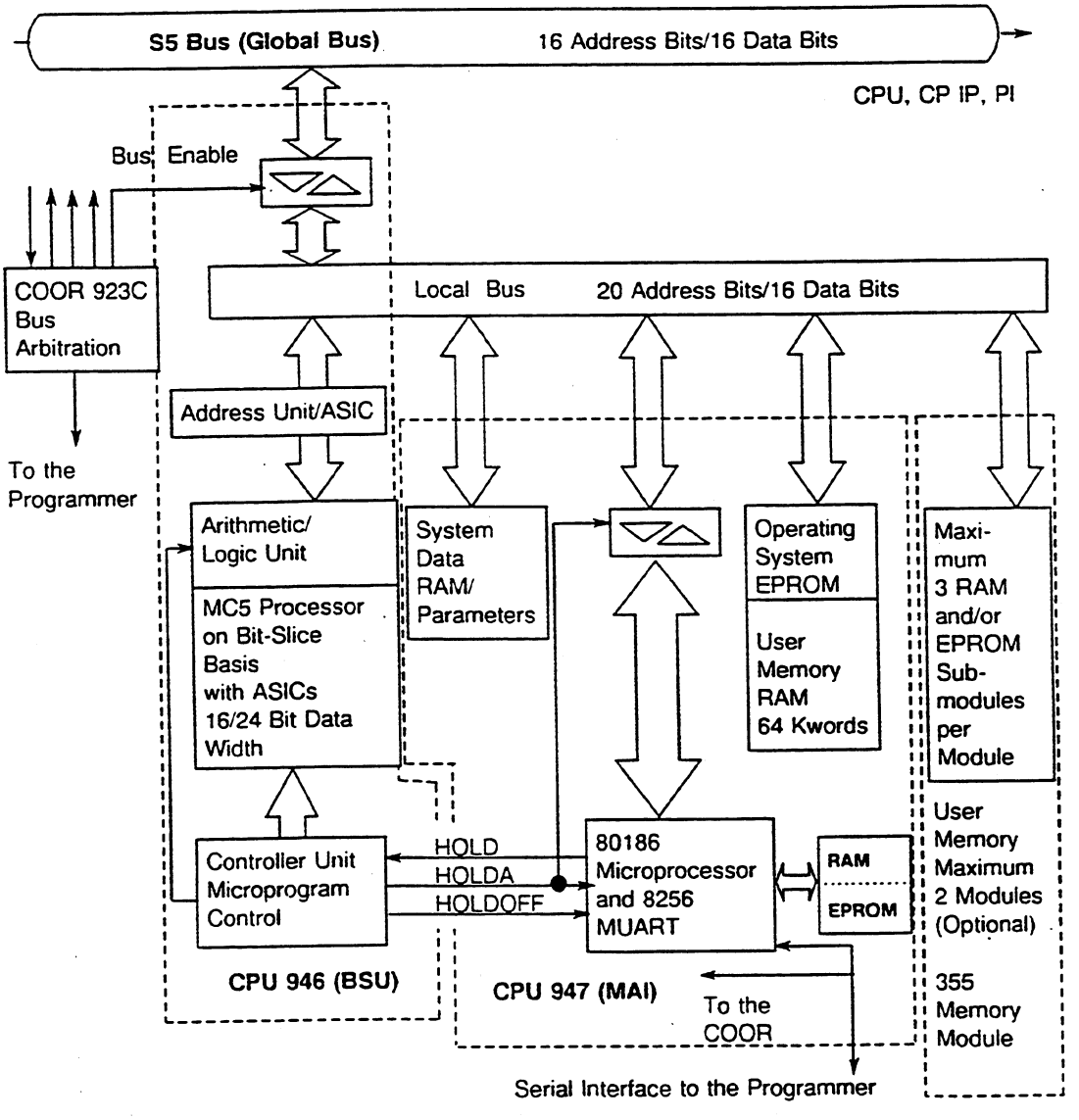


Figure 1-1 Block Diagram of CPU 946/947 with optional 355 Memory Module

The block diagram of CPU 946/947 (Fig. 1-1) shows the following two bus systems:

• **S5 bus (global bus)**	- address bus (ADB)	16 bits wide
	- data bus (DB)	16 bits wide
• **S5 local bus**	- local address bus (LAB)	20 bits wide
	- local data bus (LDB)	16 bits wide

The bus drivers between the S5 local bus and the S5 bus are in CPU 946. CPU 947 uses these drivers to access the S5 bus if the local bus enables have been acknowledged.

CPU 946/947 can always access the S5 bus in the single processor mode. With multiprocessing, a CPU can access the bus only through a time-slice procedure. Coordinator 923C uses time-division multiplexing to allocate bus access for each CPU.

The hardware structure of CPU 946/947 is divided into the following two large function areas:

- Bit Slice Unit **(BSU)** - in CPU 946
  and
- Memory and Interface **(MAI)** - in CPU 947

CPU 946 is divided into the following three main areas:

- control unit
- arithmetic/logic unit
- address unit

CPU 947 is divided into the following two areas:

- memory unit
- communication unit

Control Unit

This unit controls the arithmetic/logic unit, the address unit, and the data flow on the buses. It reads the MC5 operations and executes them in combination with the other units. It reads all interrupts and prioritizes them.

The control unit also updates the clock and timers.

Arithmetic/Logic Unit

A special logic unit implemented as an applications-specific integrated circuit (ASIC) carries out bit operations.
An arithmetic unit (registered arithmetic/logic unit, or RALU) implemented with bit-slice components (16/24 bits) processes arithmetic and other word operations.

Address Unit

An address unit implemented as an ASIC provides addresses (20 bits). It provides optimal support for the addressing format of the STEP 5 programming language.

Memory Unit

The memory unit has a one Mword[1] memory space divided into 16 pages of 64 Kwords each. This division is not significant for the user program assignment. The pages are assigned as follows:

- Page 0 contains the 64 Kword user RAM for code and data. It is permanently integrated in CPU 947.
- Pages 1 to 6 contain RAM memory and pages 8 to D EPROM memory for user programs and user data on the optional plug-in 355 memory module with submodules.
- Page E (system page) contains a 32 Kword EPROM for the operating system. The EPROM is physically in CPU 947. The E page also contains a 31.5 Kword RAM for system data (SD RAM).
- Page F (peripherals page) contains the memory area for the peripheral units. These include inputs/outputs (I/Os), intelligent inputs/outputs (IPs), and communications processors (CPs). These units are physically on the S5 bus.

Communication Unit

An 80186 microprocessor with its accompanying memories (RAM and EPROM) is the essential component of the communication unit. The communication unit uses the serial interface in the 8256 multifunction universal asynchronous receiver transmitter (MUART) along with its internal timers and input/output ports. The 80186 microprocessor uses its own special bus-lock logic to access the S5 bus.

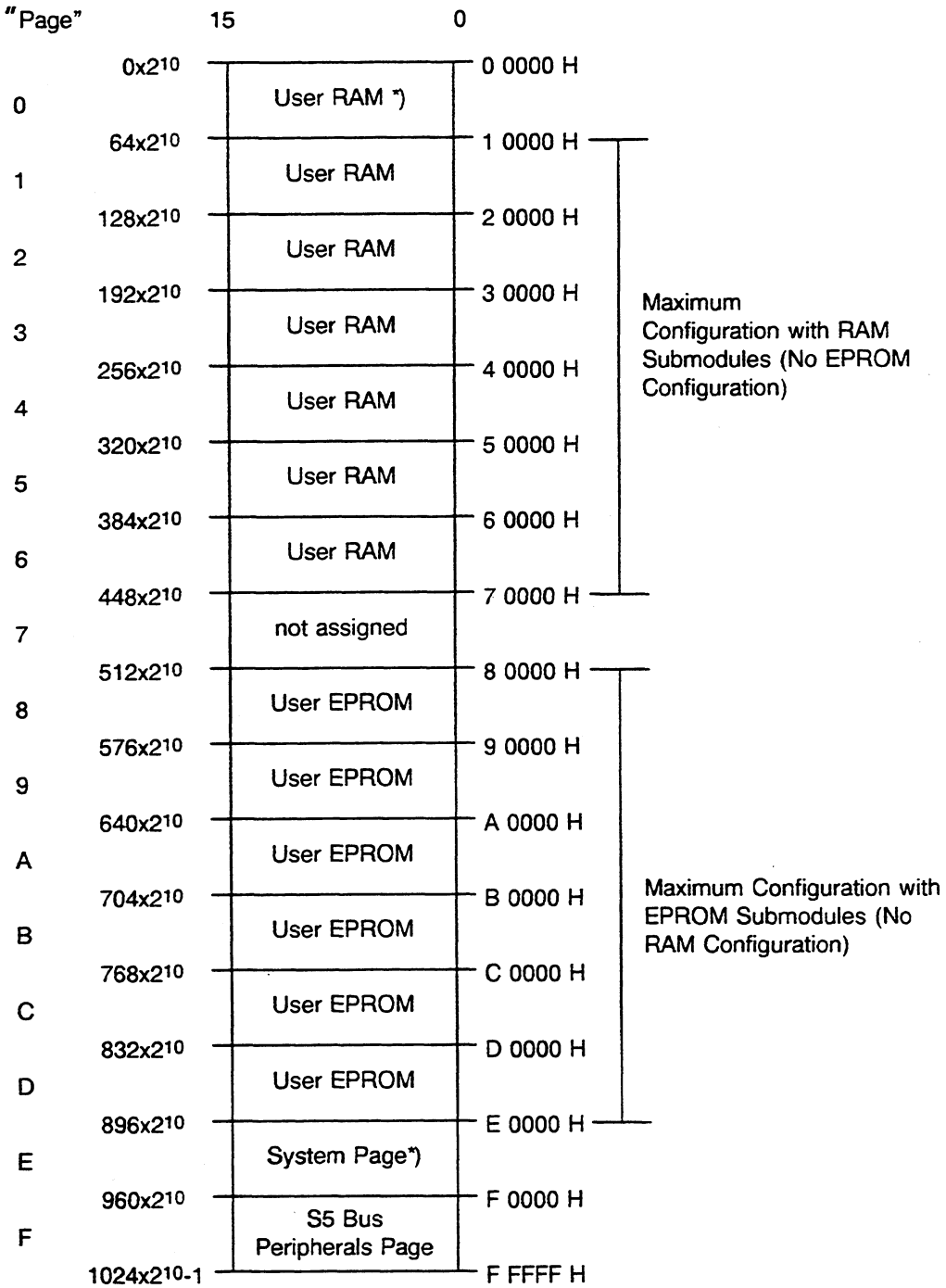
The communication unit can access the entire memory of CPU 946/947. You can use the interface to the programmer either directly via the front connector of CPU 947 or via the programmer multiplexer (PG-MUX).

---

[1] See Table 1-1

1.4 Memory Assignment

The following table shows the memory assignment for CPU 946/947. Pages 1 to 6 and 8 to D represent the user memory space in the optional 355 memory module with memory submodules.



*) *Memory in CPU 947*

Table 1-1 CPU 946/947 Memory Assignment

1.5 Technical Specifications

Degree of protection	IP[1] 00		
Permissible ambient temperature			
- operation	0° C to +55° C		
- storage and transport	− 40° C to +70° C		
Relative humidity	max. 95% at 25° C, noncondensing		
Operating altitude	Up to 3500 m (11,483.5 ft.)[2] above sea level		
Supply voltage	5 V DC, ± 5%		
Current consumption			
- CPU 946	approx. 6 A		
- CPU 947	approx. 2 A		
Back-up current CPU 946/947	approx. 10 µA		
	P Area	**O (Q) Area**	**Total**
Digital inputs			
- with process image	max. 1024	-	max. 1024
- without process image	max. 1024	max. 2048	max. 3072
Analog inputs	max. 64	max. 128	max. 192
Digital outputs			
- with process image	max. 1024	-	max. 1024
- without process image	max. 1024	max. 2048	max. 3072
Analog outputs	max. 64	max. 128	max. 192
Flags	2048		
S Flags	32768		
Timers	256		
Counters	256		
Size of the user memory	64 Kwords (16 bits wide)		
Memory extension with the 6ES5 355-3UA.. and submodules	max. 384 Kwords (16 bits wide)		
Maximum memory configuration	448 Kwords (16 bits wide) (complete with RAM, or 768 Kbyte EPROM plus 128 Kbyte RAM)		
Program blocks (PB)	256		
Sequence blocks (SB)	256		
Function blocks (FB)	256		
Data blocks (DB)	256 (254 for user programs)		
Extended function blocks (FX)	256		
Extended data blocks (DX)	256 (255 for user programs)		

[1] IP stands for an environmental rating. The first number (0 to 6) after IP is the dry particle rating and the second number (0 to 8) is the moisture rating.

[2] Where dimensions are indicated in meters and feet, the conversion factor used is 3.281 (1 m = 3.281 ft.) with feet rounded off to the nearest tenth of a foot.

Machine code	MC5, code of the STEP 5 programming language
Transmission speed of the programmer serial interface	9600 bits/sec.
Scan monitoring time	Can be set using software. Default setting is 200 msec.
Acknowledge monitoring time	150 µsec.
Dimensions (w x h x d)	
- CPU 946	40.64 mm x 233.4 mm x 160 mm (1.58 in. x 9.10 in. x 6.24 in.)[1]
- CPU 947	20.32mm x 233.4mm x 160mm (0.79in. x 9.10in. x 6.24in.)
Weight	
- CPU 946	approx. 900 g (1.98 lbs.)[2]
- CPU 947	approx. 500 g (1.10 lbs.)

[1] Where dimensions are indicated in millimeters and inches, the conversion factor used is 0.039 (1 mm = 0.039 in.) with inches rounded off to the nearest hundredth of an inch.

[2] Where weights are indicated in kilograms and pounds, the conversion factor used is 2.2 (1 kg = 2.2 lbs.) with pounds rounded off to the nearest hundredth of a pound.

1.6 Functional Capabilities

CPU 946/947 processes, with a few exceptions, the complete range of STEP 5 operations. The operations are listed and described in the *S5-155U List of Operations* and in the *S5-155U: STEP 5 Programming Guide*.

The programming guide also describes the functions of the operating system, the user interface to the operating system, and the modes of operation.

Interrupt driven processing has the following two modes:

- 150S controller mode - Input byte 0 (IB0) is scanned at block boundaries. When a signal changes, program processing branches to the assigned OB.

- 155U controller mode - Program processing branches to the assigned OB at operation boundaries (at the end of each STEP 5 operation statement) when an interrupt occurs at one of the four interrupt inputs of CPU 946/947.

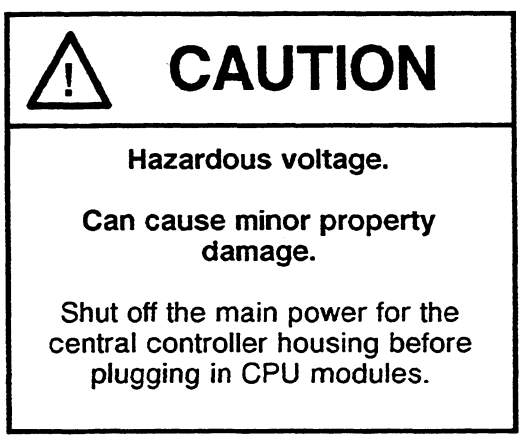
See section 5.5 of the *S5-155U Instructions* and the *S5-155U Central Controller Housing Hardware and Installation Guide* for information on interrupts and interrupt I/O modules (e.g., the 432 digital input module).

Chapter 2
Installation and Operator Information

This chapter tells you how to install and remove CPU 946/947. It also explains the control switches and LEDs on the front panel of CPU 946/947.

2.1 Plugging In and Removing Modules

Like all modules of the S5-155U programmable controller, CPU 946/947 is easily plugged into or removed from the central controller housing.



To plug CPU 946/947 into the central controller housing, use the following procedure:

- Select the correct slot according to the printed strip on the locking bar at the top of the housing.
- Insert the module so that it is aligned with the tracks at the bottom and top of the slot, being careful not to skew it. Push it all the way back until it engages with the connector and the release lever snaps into place.
- Tighten the plastic screw at the bottom of the module with a screwdriver.
- Secure the locking bar at the top of the module.

⚠ WARNING

Loss of process control.

Can cause death, severe personal injury, or substantial property damage.

Shut off the main power for the central controller housing before removing CPU modules.

To remove CPU 946/947 from the central controller housing, use the following procedure:

- Loosen the locking bar at the top of the central controller housing.
- Loosen the locking screw at the bottom of the module.
- Push the release lever and pull the module towards you.

Do not dismantle the CPU 946 double-width module.

2.2 Control Switches and LEDs

CPU 946/947 has control switches and LEDs on its front panel for operator control and information, these are explained in the following sections.

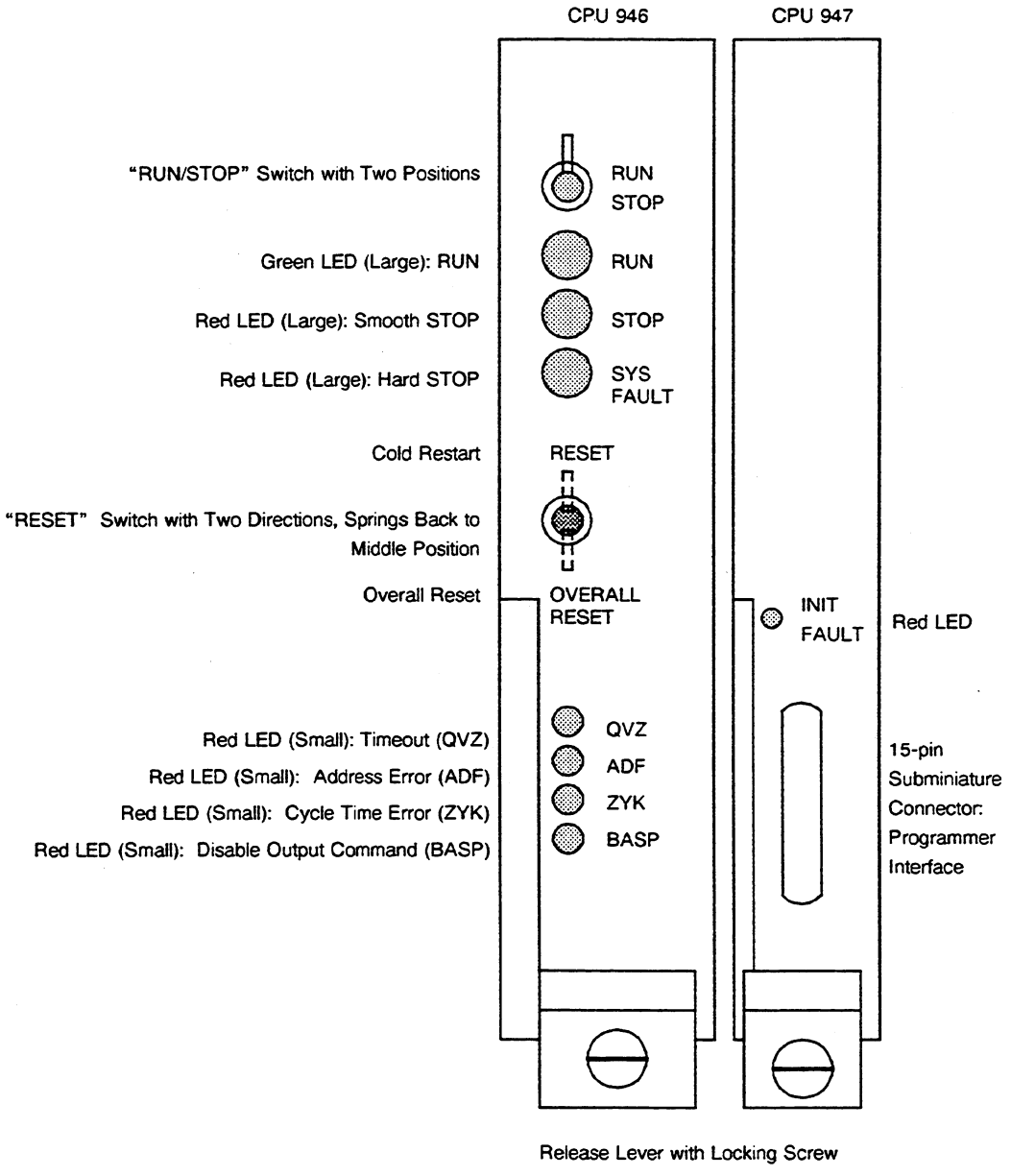


Figure 2-1 Front Panel of CPU 946/947

Switch Settings	Switch Position	Result of Switching from "STOP" to "RUN"
RESET	Top	Cold restart
0	Middle	Warm restart
OVERALL RESET	Bottom	Overall reset

Table 2-1 CPU 946/947 "RESET" Switch Settings

For more information on the modes of operation see the *S5-155U: STEP 5 Programming Guide* for CPU 946/947, CPU 946R/947R in this manual.

2.2.1 "RUN/STOP" Switch

This subsection describes the function of the "RUN/STOP" switch on the front panel of CPU 946/947.

"RUN" Position

When the "RUN/STOP" switch is in the "RUN" position, CPU 946/947 is in cyclic operation if the green "RUN" LED is lit at the same time. During cyclic operation, CPU 946/947 goes through the following continuous cycle: it reads in the process image of the inputs, processes the user program according to the call sequence in organization block 1 (OB1), transfers the process image to the outputs, updates the communication flags (as programmed in DB 1) and triggers scan time monitoring.

Timer update and time and process interrupts briefly interrupt cyclic processing. Acknowledged faults and online programmer functions can also interrupt this processing. The following errors in the system, in the programmable controller unit, and in the program can interrupt cyclic processing:

- power failure (NAU)
- timeout (QVZ)
- substitution error (SUF)

You can program reactions to these errors in organization blocks.

With the "RUN/STOP" switch in the "RUN" position at power up, an automatic warm restart takes place if the programmable controller was in cyclic operation before the power was shut off and if no error entries other than "NAU" are stored.

"STOP" Position

After you switch CPU 946/947 from "RUN" to "STOP," it goes into the smooth "STOP" mode. The CPU outputs the "BASP" signal, disabling the digital output modules. At this time, you can use the programmer to execute the FORCE function. The processor then suppresses the "BASP" signal and enables the digital outputs.

2.2.2 "RESET" Switch

This subsection describes the function of the "RESET" switch on the front panel of CPU 946/947 in relation to its two possible positions "OVERALL RESET" and "RESET" (see also Table 2-1).

Overall Reset Function

An overall reset erases and initializes all RAMs. Afterward, the "STOP" LED stays lit. Perform an overall reset as follows:

- Hold the "RESET" switch in the "OVERALL RESET" position.
- Move the "RUN/STOP" switch from "STOP" to "RUN" and then to "STOP" again.
- Release the "RESET" switch.

Result: The "STOP" LED flashes quickly, requesting an overall reset.

Note: At this point, you can interrupt an overall reset by moving the "RUN/STOP" switch from "STOP" to "RUN" and then to "STOP" again **without** touching the "RESET" switch. This stops an overall reset. CPU 946/947 remains in the "STOP" mode. The"STOP" LED stays lit.

- Again hold the "RESET" switch in the "OVERALL RESET" position.
- Move the "RUN/STOP" switch from "STOP" to "RUN" and then to "STOP" again.
- Release the "RESET" switch.

Result: An overall reset is executed. CPU 946/947 remains in the "STOP" mode and the "STOP" LED stays lit. Afterward, you can execute only a cold restart.

Restart Function

Use the "RESET" switch on CPU 946/947 to perform a cold or warm restart as follows (see chapter 3.1 for more information):

2.2.3 Operating Status LEDs

This subsection explains the function of the operating status LEDs on the front panel of CPU 946/947. The table below provides an overview of their respective conditions and meanings.

LED	Condition	Meaning
RUN (green)	Lit	Cyclic program processing
STOP (red) (smooth "STOP" mode)	Lit	Power on, in "STOP" mode, no errors
	Flashes quickly	Overall reset requested
	Flashes slowly	Cold restart required
SYS FAULT (red) (hard "STOP" mode)	Lit	System error

"RUN" LED

When the green "RUN" LED stays lit, it indicates cyclic program processing.

"STOP" LED (smooth "STOP" mode)

The red "STOP" LED can display the following three "STOP" statuses, lit continuously, flashing slowly or flashing quickly. In the smooth STOP mode the CPU 946/947 can cyclically process a user program to communicate with the CPs.

- "STOP" LED stays lit

- This occurs after the power is turned on if the "RUN/STOP" switch is at "STOP" and no errors occurred during initialization. System restart is possible. The following actions or errors can trigger the smooth "STOP" mode in

Single processor operation:

- Moving the "RUN/STOP" switch from "RUN" to "STOP"
- Executing the "PC STOP" programmer function
- Executing an overall reset
- Programmable controller errors that are not assigned to an individual CPU (BAU, NAU, PEU[1])
- After completing the programmer function End Program Test at another CPU.

The following actions can trigger the smooth "STOP" mode in

Multiprocessor operation:

- Moving the "RUN/STOP" switch on Coordinator 923C from "RUN" to "STOP"
- A different CPU or Coordinator 923C causes the smooth "STOP." (The "STOP" LED on a CPU not responsible for the smooth "STOP" stays lit.)
- Executing the "PC STOP" programmer function with a different CPU

- "STOP" LED flashes quickly (approximately twice per second)

This occurs after you or the system program requests an overall reset (see subsection 2.2.2). System restart is possible only if you perform an overall reset or if you eliminate any hardware errors and then perform an overall reset.

- "STOP" LED flashes slowly (approximately once per second)

This occurs under the following conditions to indicate that a cold restart is required:

- An error occurs during cyclic program processing of the CPU. The CPU is in the "STOP" mode because no appropriate error reaction was programmed. Switch the "RUN/STOP" switch to "STOP", the LED is then lit, as long as the error does not occur again.
- An operator error (e.g. an illegal restart mode or DB1/DX0 error).
- A STOP operation (STP and STS)[2] is being processed in the user program.
- In addition to the slowly flashing "STOP" LED, the following LEDs light up when certain programming and programmable controller errors occur:
  "QVZ" LED - timeout
  "ADF" LED - addressing error
  "ZYK" LED - cycle time exceeded
- The "End Program Test" programmer function is running at the CPU. ("Program Test" is a debugging tool. See the *S5-155U: STEP 5 Programming Guide* for more information.)

---

[1] BAU, NAU, and PEU stand for "battery failure," "power failure," and "I/O not operable," respectively.

[2] See the *S5-155U List of Operations* for an explanation of the STP and STS operations.

"SYS FAULT" LED (hard "STOP" mode)

The "SYS FAULT" LED lights up if a system error prevents the system program from operating properly. CPU 946/947 goes into the hard "STOP" mode. This ensures that operation does not continue with a defective system program.

The following conditions can trigger the hard "STOP" mode:

- timeout (QVZ) or parity error (PARE) in the system RAM or EPROM
- interrupt stack (ISTACK) overflow (STUEU)
- STEP 5 operation "stop for time interrupt processing" (STW)

NOTE

Only by switching the main power off and then on can you cancel the hard "STOP" mode (CPU 946/947 stopped).

2.2.4 Error and Signal LEDs

"QVZ" LED

The "QVZ" LED lights up under any of the following conditions:

- if the program attempts to address a peripheral module in single processor operation after a cold restart of CPU 946/947 in the area of the process image (IB 0 through IB 127, QB 0 through QB 127) which was entered in track 9, and the module no longer responds.

- if the program attempts to address a peripheral module in single or multiprocessor operation. The module does not respond, even though it is entered in DB1 (address list) and the module was detected as being plugged in during a cold restart.

- if a peripheral module does not respond or no longer responds when the program attempts to access it directly (e.g., using the L PB, L PW, T PB, T PW, L OB, L OW, T OB, or T OW operation[1]).

The following situations could cause the "QVZ" LED to light up:

- A module has failed.
- A module is removed while the programmable controller is operating, or in "STOP" mode or the power was shut off and no cold restart performed after power was turned on.

You can program an interface reaction to QVZ in organization blocks. (See the *S5-155U: STEP 5 Programming Guide* in this manual for more information.)

---

[1] See the *S5-155U List of Operations* for more information.

"ADF" LED

During cold restart of CPU 946/947, the operating system sets up a ninth track in the control RAM of CPU 947. All available I/O modules are marked in the ninth track in the process image area. During multiprocessing or programming of the address list in DB1, the operating system sets up a ninth track with the help of DB1. A check is made to see if the corresponding addresses are acknowledged. If in the user program an address in the process image is addressed under which no module has been configured, CPU 946/947 interrupts cyclic program processing (default). You can program a reaction to ADF in OBs (see the *S5-155U: STEP 5 Programming Guide*).

"ZYK" LED

The "ZYK" LED lights up if the maximum cycle time is exceeded. The cycle time is the total of the scan times of all user program parts (cyclic plus time controlled, plus process interrupt controlled). The "ZYK" error signal interrupts cyclic program processing. You can program a reaction to ZYK in OBs (see the *S5-155U: STEP 5 Programming Guide*).

"BASP" LED

The "BASP" LED lights up if command output is disabled. Digital outputs are switched directly to an "OFF" status. The "BASP" signal does not reset the memory registers in digital input/output modules. The "BASP" signal is output when the power supply unit is switched on and off, when the voltage is low, or when the CPU is in the "STOP" mode.

"INIT FAULT" LED

During system restart, the orange "INIT FAULT" LED on CPU 947 stays lit and then goes out after the restart procedure is completed. If an error prevents completion of the restart procedure, this LED flashes.

2.3 Restart Procedure for the CPU 946/947

You can start up the CPU 946/947 (together with the memory extension using the 355 memory module with memory submodules) without a programmer.

Ensure that the modules are plugged into the correct slots on the central controller 155U.

The back-up battery in the central controller 155U must be positioned in its slide-in module and fully functional before the CPU can go into operation.

Proceed as follows:

1) Switch the "RUN/STOP" switch on the CPU 946 to "STOP".

2) Switch on the power supply
   - green LED "5 V DC power supply ok" on the power supply illuminates
   - green LED "15 V/24 V DC power supply ok" on the power supply illuminates
   - red LED "STOP" on the CPU 946 illuminates
   - small red LED "BASP" on the CPU 946 illuminates.

3) Hold the switch in the position "OVERALL RESET" and simultaneously switch the "RUN/STOP" switch to "RUN":
   - red LED "STOP" on the CPU 946 flashes quickly.

4) Repeat procedure 3):
   - red LED "STOP" on the CPU 946 lights continuously.

The overall reset is then complete.

If, in addition, the red LED "SYS FAULT" on the CPU 946 should illuminate, an error has occurred during the overall reset. In that case repeat the overall reset according to 3) and 4), or switch off the power supply and begin again with 1) before employing other measures (reading out ISTACK with the programmer, exchanging the CPU etc.).

5) Switch the "RUN/STOP" switch to "STOP".

6) Hold the switch in the position "RESET" and switch the "RUN/STOP" switch to "RUN":
   - the red LED "STOP" goes out and the orange LED "INIT FAULT" illuminates

   and after a short interval:
   - the orange LED "INIT FAULT" goes out
   - the green LED "RUN" illuminates
   - the small red LED "BASP" goes out.

The CPU is now in cyclic mode, but without a user program.

While the CPU runs up, various tests are carried out. If errors occur during restart, this is indicated by the orange LED "INIT FAULT" flashing.

For maintenance and service purposes or in case of a fault, an initial report as to whether the CPU or the system program are still functioning at all can be obtained using the described restart procedure or user program. If the 355 memory module and RAM module are also plugged during a test of this kind, their functions are included in the test.

2.4 Operation of Peripheral Modules

The hardware of the CPU 946/947 works solely with addresses that are 20 bits wide. Consequently when you work with absolute addressing, this hardware is not compatible with the S5-150U programmable controller (see *STEP 5 Programming Guide*) for CPU 946/947, CPU 946R/947R in this manual.

The S5 bus (global bus) has addresses that are 16 bits wide, as does the S5-155U. The operation of digital and analog input/output modules in the P area and O (Q) area, the operation of communications processors (CPs) with page frame addressing and the use of intelligent input/output modules (IPs) all function in the same way as for the S5-150U and S5-135U.

Chapter 3
Operation

This chapter defines the types of restart for CPU 946/947 and explains the restart procedure and describes the programmer interfaces.

3.1 Restart Types

When CPU 946/947 starts up, its operating system determines and sets up the data necessary for cyclic operation. Afterwards, cyclic program processing begins (see the Programming Guide). The system program differentiates between the 3 types of restart described below:

3.1.1 Cold Restart

Flag, timer, and counter data and the I/O process images are cleared. User program processing starts over again.

The programmable controller must be in the "STOP" mode. With multiprocessing, the "RUN/STOP" switch on Coordinator 923C must be in the "STOP" position. Reset CPU 946/947 and put it into cyclic program processing using the following procedure:

- Hold the CPU 946/947 "RESET" switch in the "RESET" position.
- Move the "RUN/STOP" switch from "STOP" to "RUN."
- With multiprocessing, move the "RUN/STOP" switch on all CPUs in the S5-155U from "STOP" to "RUN." Then move the "RUN/STOP" switch on Coordinator 923C from "STOP" to "RUN."

3.1.2 Manual Warm Restart

Flag, timer, and counter data and the I/O process images are maintained. User program processing resumes from the point at which it was interrupted.

For a warm restart to function, the programmable controller must have been in cyclic operation before it went into the "STOP" mode. With multiprocessing, the "RUN/STOP" switch on Coordinator 923C must be in the "STOP" position. Put the CPU into cyclic program processing using the following procedure:

- Leave the CPU 946/947 "RESET" switch in the middle position.
- Move the "RUN/STOP" switch from "STOP" to "RUN."
- With multiprocessing, move the "RUN/STOP" switch on Coordinator 923C from "STOP" to "RUN."

3.1.3 Automatic Warm Restart

Flag, timer, and counter data and the I/O process images are maintained. User program processing resumes from the point at which it was interrupted.

An automatic warm restart is carried out after switching on the power supply under the following conditions:

- the PLC was in cyclic operation before the power was switched off or cut off,
- the "RUN/STOP" switch on the CPU 946/947 is still in the position "RUN" (in multiprocessing, also on the other CPUs and the 923 coordinator),
- user memory submodules were not removed or replaced; new ones were not inserted, and
- the back-up battery is functioning properly (i.e. the data in the RAM has been retained).

3.1.4 Automatic Cold Restart

You can select this restart mode instead of an automatic warm restart by programming DX 0 accordingly.

3.1.5 Test Mode

You will find information on the Test mode in the Programming Guide.

3.2 Programmer Interface

You can use the programmer interface on CPU 947 either via the front connector or Coordinator 923C.

Note:

1) It is not possible to operate the programmer interface via the front connector of CPU 947 and Coordinator 923C simultaneously. Just switching the programmer online, even without a command, operates the interface. Electrically, there is only one programmer interface. You can operate this single interface via two separate connections.

2) If you wish to operate a Coordinator 923C in the 155U controller mode (selectable in extended data block DX0), the S5-155U is automatically in multiprocessor operation. You must load DB1 with the address list: the CPU does not enter the "RUN" mode without DB1.

3) Do not plug in a coordinator if the CPU is in the 150U controller mode (default setting or selectable in extended data block DX0). Otherwise the CPU enters the "STOP" mode. You cannot use the PG-MUX of the coordinator in the 150U controller mode.

You can establish a connection to a programmer in any operating mode of the CPU.

Chapter 4
Maintenance

This chapter explains the central register for error addresses of CPU 946/947. It also shows the layout of the jumpers on the CPU and describes the interface assignment for its backplane connectors and front connector.

4.1 Central Register for Error Addresses

CPU 947 or the 355 memory module can trigger a parity interrupt. When this happens, the first incorrect address is stored in the error register in CPU 947.

If a timeout signal (QVZ) is detected when CPU 947 tries to access the local bus, the first QVZ address is stored in this register instead of the parity error address.

Read addresses E8004H and E8000H to determine the 20-bit wide error addresses on the local bus (e.g., using the programmer PC INFO function "OUTP ADDR"). Make sure you output the error addresses under E8004H first and then under E8000H.

Reading out the register resets any parity interrupts in the queue from CPU 947 or from the memory module. New error addresses cannot be stored until this resetting takes place. The readout does not erase the contents of the register. It is maintained until a new error address is stored.

Format of an Error Address Register:

E8004H: High part of the error address

Data bit 0 = Address bit 16 / Data bit 1 = Address bit 17
Data bit 2 = Address bit 18 / Data bit 3 = Address bit 19

The remaining data bits are insignificant.

E8000H: Low part of the error address

Data bits 0 to 15 correspond to error address bit numbers 0 to 15.

4.2 Jumper Layout

The following figures show the jumper layout on CPU 946/947.

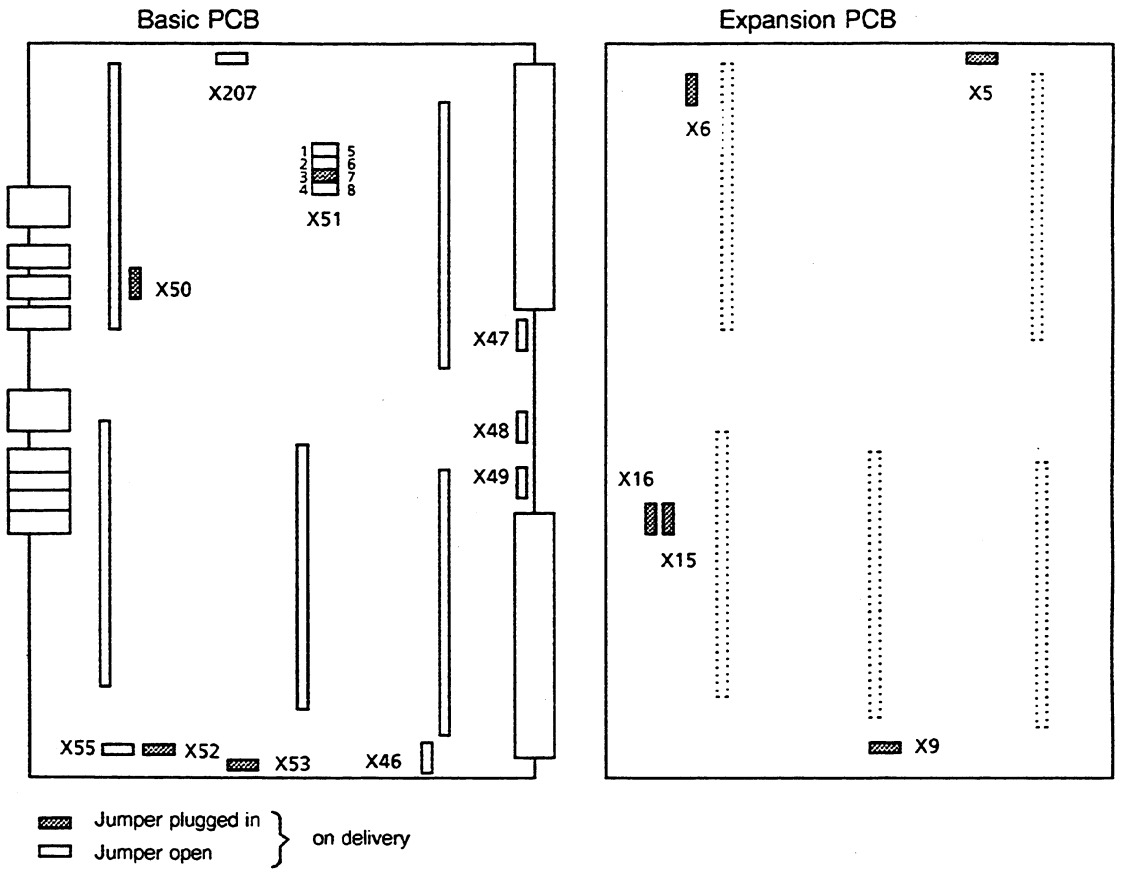


Figure 4-1 Jumper Layout on CPU 946 (6ES5 946-3UA21)

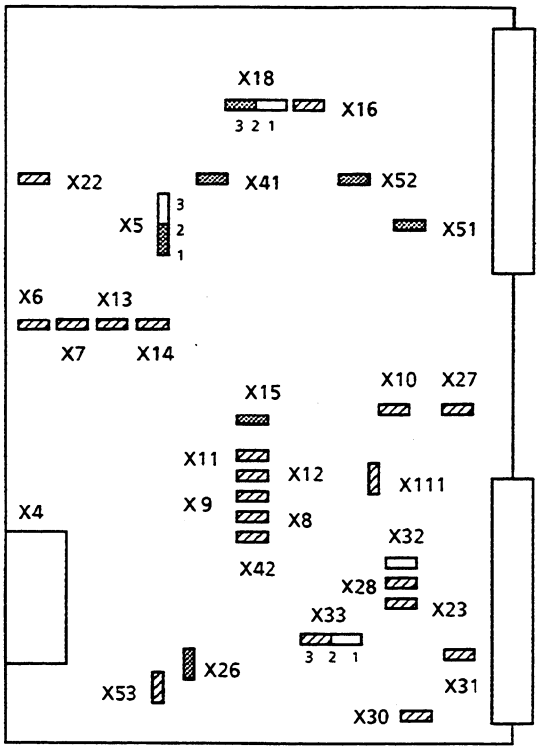


Figure 4-2 Jumper Layout on CPU 947 (6ES5 947-3UA21)

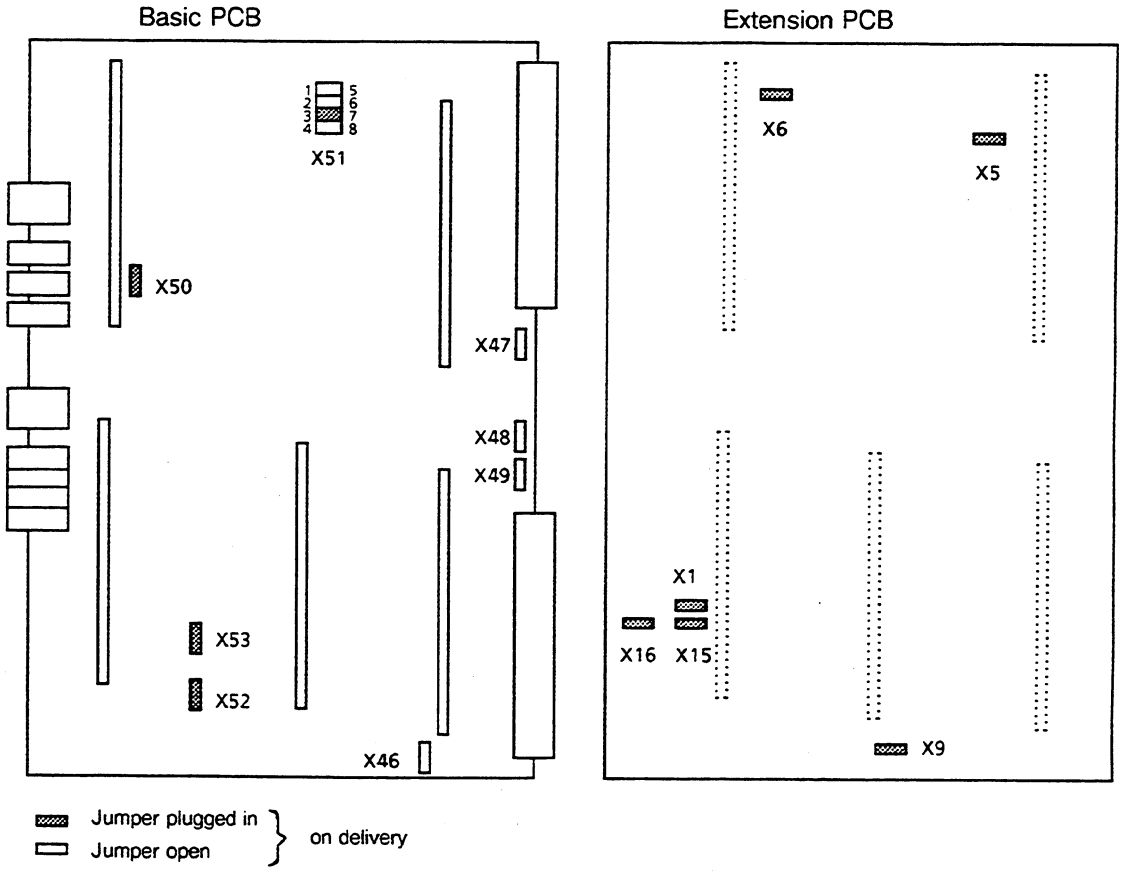


Figure 4-3 Jumper Layout on CPU 946 (6ES5 946-3UA22)