SIEMENS

SIMATIC

Heating Controller HS 724

Description

6ES7 171-1XX00-8BA0
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Safety Guidelines

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a safety alert symbol and are marked as follows according to the level of danger:

Danger

indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

Warning

indicates an potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution

used with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Caution

used without safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

Notice

used without the safety alert symbol indicates a potential situation which, if not avoided, may result in an undesireable result or state.

Note

draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel

The device/system may only be set up and operated in conjunction with this manual.
Only **qualified personnel** should be allowed to install and work on this equipment. Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Correct Usage

Note the following:

Warning

This device and its components may only be used for the applications described in the catalog or the technical description, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.
This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

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Disclaimer of Liability

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

Technical data subject to change.

Siemens Aktiengesellschaft

Order No. 6ES7 171-1XX00-8BA0

Foreword

Purpose of this description

This description provides you with reference material on installation, commissioning and operation of the HS 724 heating controller and information concerning data communication between the S7-CPU and the HS 724.

The operation of the HS 724 on the PROFIBUS-DP field bus and the preparation of your user program using the STEP7 programming software are covered in separate manuals.

- Manual for PROFIBUS networks
- STEP 7 manual

The included program floppy disk contains a sample S7 program for the HS 724.

How to locate information

This description provides you with the following aids to make it easier to locate the information you are looking for quickly.

- At the beginning of this description, you will find a complete table of contents plus separate lists of figures and tables contained in this description.
- In the individual chapters, you will find information in the left-hand margin of each page which will give you an overview of the contents of that particular paragraph.
- At the end of this description, you will find a comprehensive index for fast access to the information you need.

Additional support

Your local Siemens representative will be glad to answer any questions you may have on the use of products mentioned in this description.

Concerning questions or comments on the manual itself, please fill out the questionnaire at the end of this description and return it to the address indicated. We are especially interested in your personal opinion of this description.

We offer courses to make getting started with the SIMATIC S7 programmable controller easier. For more information, contact your regional training center or call our central training center in Nuremberg (tel: 0911/895-3200).

Monitoring the heater elements

Warning

The user is responsible for monitoring the heater elements.

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Product Overview

1

This chapter provides you will an introduction to the components of the heating controller and the system.

1.1 Description of the HS 724 Heating Controller

The HS 724 heating controller is used to control radiant heater fields for industrial applications. A primary application area of the HS 724 is the control of heater fields in thermoforming machines and paint dryers in the automotive industry.

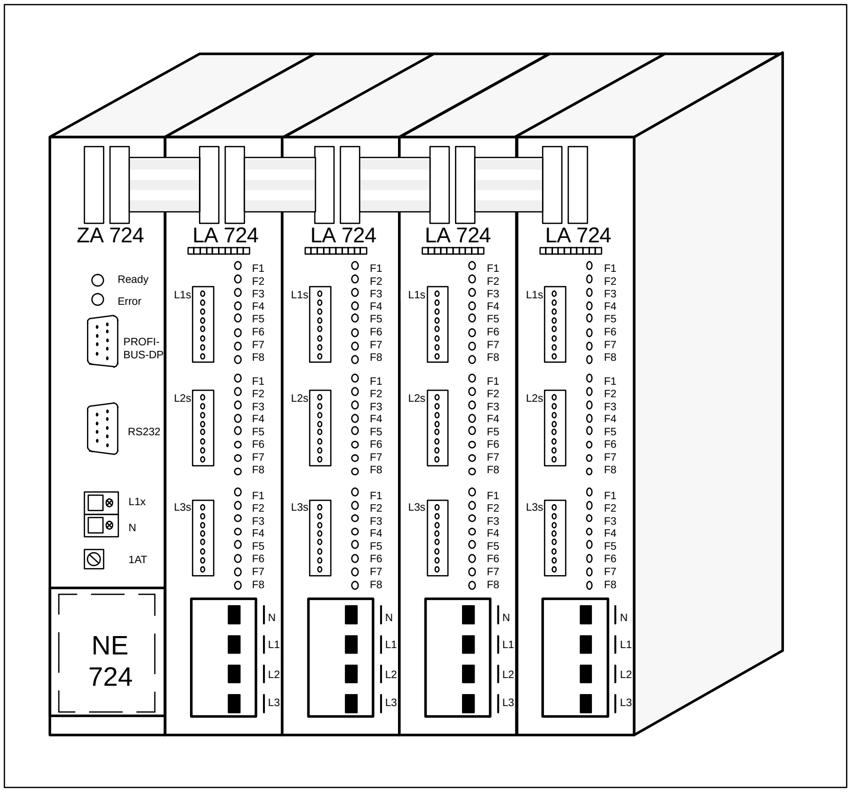

Figure 1-1 Design of the HS 724

The heart of this product is a central interface (ZA) which permits an expansion of up to 16 power outputs (LA). Using the SINEC L2-DP field bus, the central interfaces communicate as slaves with the master controller.

A parallel bus between central interface and power outputs is used to transfer the control information generated by the central interface and report back the status of the power outputs to the central interface. A system voltage acquisition module (NE) can be installed as an option to eliminate fluctuations in the voltage supply.

The ZA 724 and LA 724 components are each enclosed in a metal capsule and mounted on a carrying plate in the switching cabinet.

1.2 System Overview

A complete system is made up of the following components.

- Host controller as PROFIBUS-DP master. Examples: SIMATIC S5 with IM 308-C, or SIMATIC S7 (e.g., with CPU 315-2 DP or CPU 414-2 DP).
- Central interface ZA 724 as PROFIBUS-DP slave with integrated µP system for controlling the LA 724 power outputs
- NE 724 system voltage acquisition module (option)
- 1 to 16 LA 724 power outputs with 24 channels each
- Operator panel
- Radiant heater field

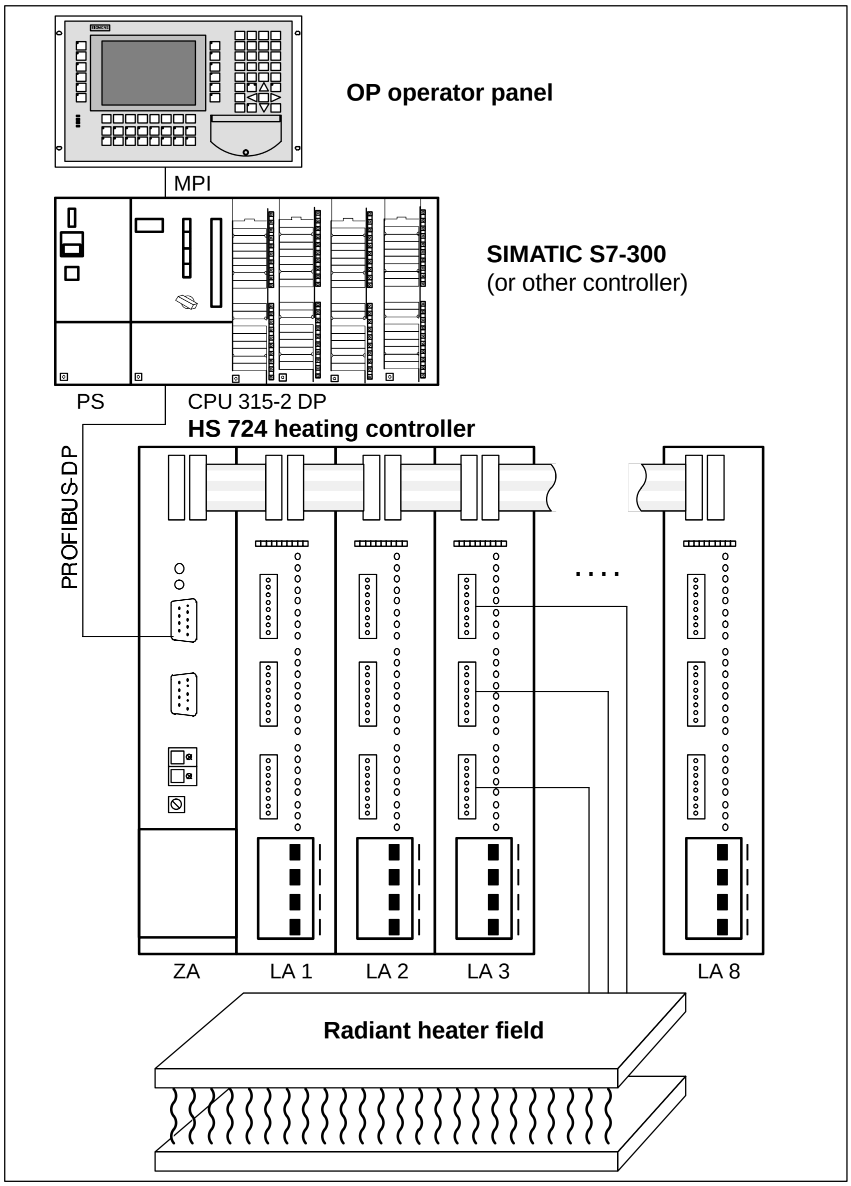

Figure 1-2 System components of the heating controller

Maximum configuration

Up to 7 HS 724 with 1 ZA 724 each and with up to 16 LA 724 each can be connected to one PROFIBUS-DP master.

Figure1-3 shows the maximum configuration.

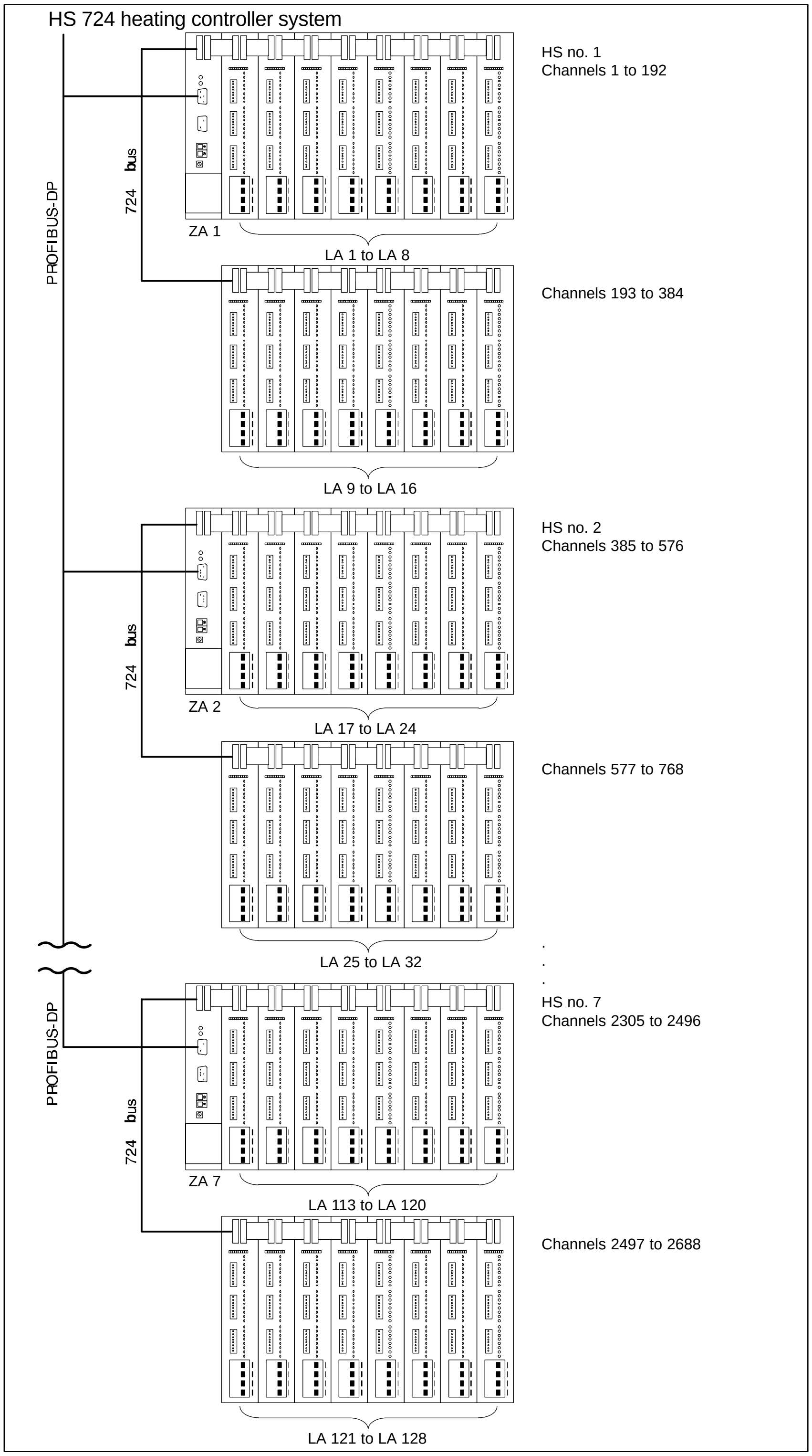

Figure 1-3 Maximum configuration

The HS 724 Heating Controller 2

This chapter provides you with information on the design of the following modules.

- Central interface
- Power output
- Network voltage acquisition

2.1 Central Interface ZA 724

Features of the product

The ZA 724 central interface offers the following features.

- Module installed in a metal capsule
- Connections for a maximum of 16 LA 724 power outputs per ZA 724 module via two parallel bus interfaces
- 80C165 µP system with configurable bus connection and integrated watchdog for controlling the power outputs
- Communication with host system via PROFIBUS-DP interface
- PROFIBUS-DP address range adjustable from 00 to 99 via rotary type switches
- Synchronization to phase L1
- Optional: Expansion with the NE 724 system voltage acquisition module
  - To maintain same power to the radiant heaters even when system voltage fluctuates
  - To monitor the back-up fuse
- Phase sequence identification to check correct connection of phases L1, L2 and L3
- Check for disconnected directly grounded conductor (for power networks with directly grounded conductors)
- Automatic recognition of the power frequency
- Bus transmission rates of up to 12 MBaud (6ES7 171-1AA01-0AA0)

2.1.1 Design of the Module

Components of the ZA 724

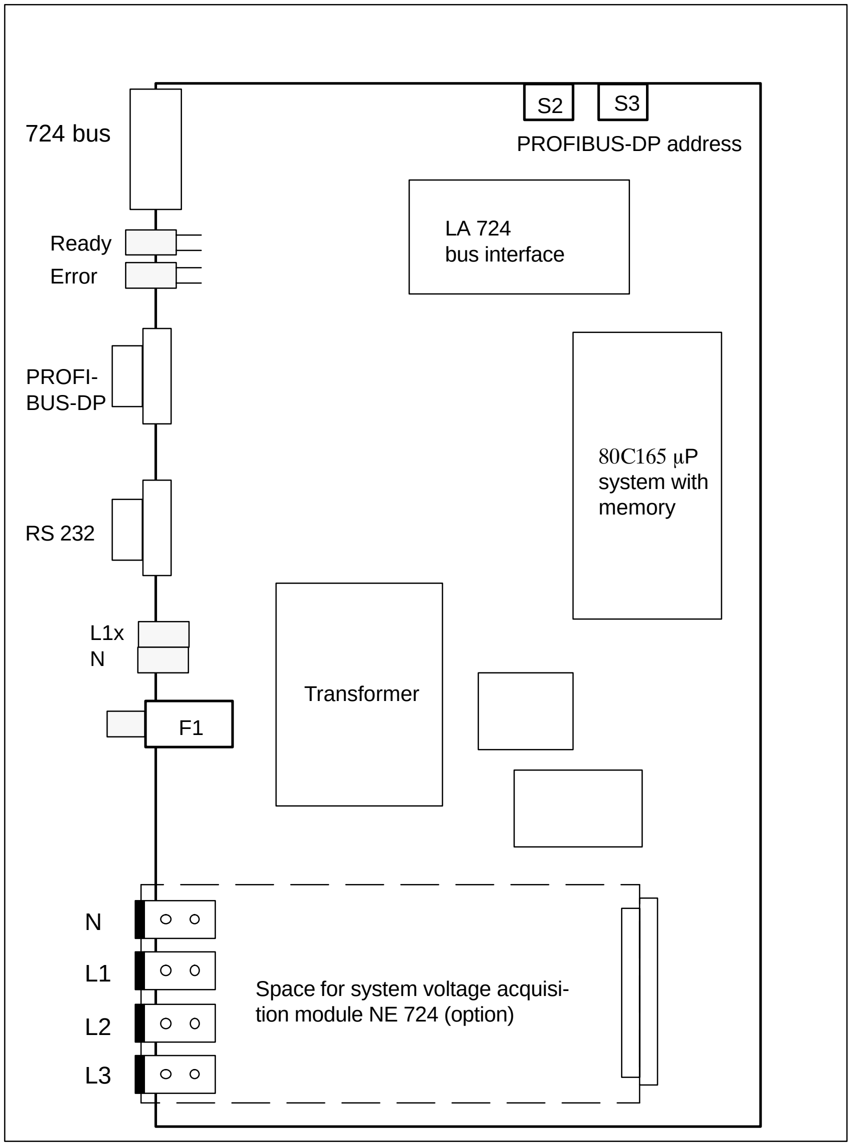

Figure 2-1 Design of the ZA 724 (view of the board)

Figure 2-1 shows the design of the central interface board. The ZA contains the following components.

- Indicator elements
- PROFIBUS-DP slave interface (potentially isolated via optocoupler)
- Rotary switch for setting the PROFIBUS-DP address
- 80C165 μP system with memory for controlling the power outputs
- FLASH EPROM (Firmware updates can be performed via the serial interface.)
- RS 232 serial interface (non-floating) is used to load the firmware.
- Parallel bus interface to the power outputs
- Decoding circuit for addressing the power outputs
- Plug connector to power connection and to bus
- Hardware for power synchronization of a phase
- Voltage supply for the HS 724 and the electronics
- Floating voltage supply for the PROFIBUS-DP slave interface

Voltage supply

The input alternating current of 230 V (min. of 187 V, max. of 264 V) is converted to an alternating current of 24 V with an integrated transformer. A controlled direct current of 5 V is then generated for the module logic.

When the voltage supply is turned on, an automatic reset signal is generated for the μP system. This resets both the power outputs and the processor to a defined operational state.

A floating voltage supply which is obtained from the controlled 5 V voltage is available for the PROFIBUS-DP.

Power network synchronization

To ensure synchronization of the power outputs with the power network, the 80C165 μP is synchronized to phase L1.

2.1.2 Plug Connectors

The ZA 724 is equipped with the five plug connectors shown in table 2-1 and an insert slot for the optional NE 724 system voltage acquisition module. See also figure 2-1.

Table 2-1 Plug connectors on the ZA 724

Label	Function
724 bus	Connection of the LA 724 to the parallel bus LA 1 to LA 8: Right connector LA 9 to LA 16: Left connector
PROFIBUS-DP	Connection of the host system via PROFIBUS-DP
RS 232	Sub D connector for connection to RS 232 interface
L1x	Terminal for connection of phase L1
N	Terminal for connection of the directly grounded conductor

2.1.3 Indicator Elements

Two LEDs on the ZA 724 provide information on the current operational status.

Green LED: Ready
Red LED: Error

Table 2-2 provides information on the LEDs for the various operational states of the ZA 724.

Table 2-2 LED status for the operational states of the ZA 724

Red LED	Green LED	Operational State
☼	○	No bus connection to the master
Flashing	○	ZA 724 is waiting for synchronization with the controller (e.g., coupling SW isn't working).
○	Flashing	Initialization of the ZA 724 (BAV control bits, see chap. 5.4)
○	☼	Normal operation of the ZA 724
☼	☼	ZA 724 is waiting for new firmware to be loaded (approx. 1 sec during booting)
Flashing	Flashing	Error in phase sequence or disconnection of the directly grounded conductor

2.1.4 Technical Specifications

Table 2-3 Technical data of ZA 724

Supply voltage permissible range	230 V AC 187 V to 264 V
Nominal frequency permissible range	50/60 Hz 47 Hz to 63 Hz
Harmonic content of the 3rd harmonic	10%
Non-cyclic overvoltage (in acc. w. EN 60204, part 1) • Limit value • Duration • Rise/fall time	 2 x U_{Nom} 1.5 msec (single pulse) 500 nsec to 500 µsec
Short voltage interruption (output status: lower limit of the nominal voltage = 187 V) • Interruption time • Recovery time • Events per hour	 Max. of 20 msec At least 1 sec Max. of 10
Power consumption	35 W (typical) 46 W (maximum)
Dimensions of ZA 724 (W x H x D) Weight (approx.)	50 mm x 480 mm x 210 mm 4,2 kg

2.2 Power Output LA 724

Features of the product

The LA 724 power output offers the following features.

- Module integrated in a metal capsule
- 24 power channels with 230 V each (8 outputs per phase)
  - 650 W switching capacity at 230 V AC per output with a simultaneity of 100% without external ventilation
  - 1000 W switching capacity at 230 V AC per output with a simultaneity of 100% with external ventilation
  - 1500 W switching capacity at 230 V AC per output with a simultaneity of 100% with external ventilation and reduction to 12 channels per module

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Note

Total current per phase of 32 A may not be exceeded.

- Status message for each channel via parallel bus
- Connection of the phases via conductor rails
- Connection of the radiant heaters via front plug connector
- No settings required on the module
- Two-stage temperature monitoring via heat conductor
- Diagnostics capability for recognition of internal or external errors
- One ZA 724 can be equipped with up to 16 LA 724 modules in two rows.

There are two models of the LA 724.

- Standard (6ES7 171-2AA01-0AA0)
  The channel fuses are located on the PCB and cannot be accessed from the front.
- Convenience model (6ES7 171-2AA02-0AA0)
  The channel fuses can be accessed from the front.

2.2.1 Design of the Module

Components of the LA 724

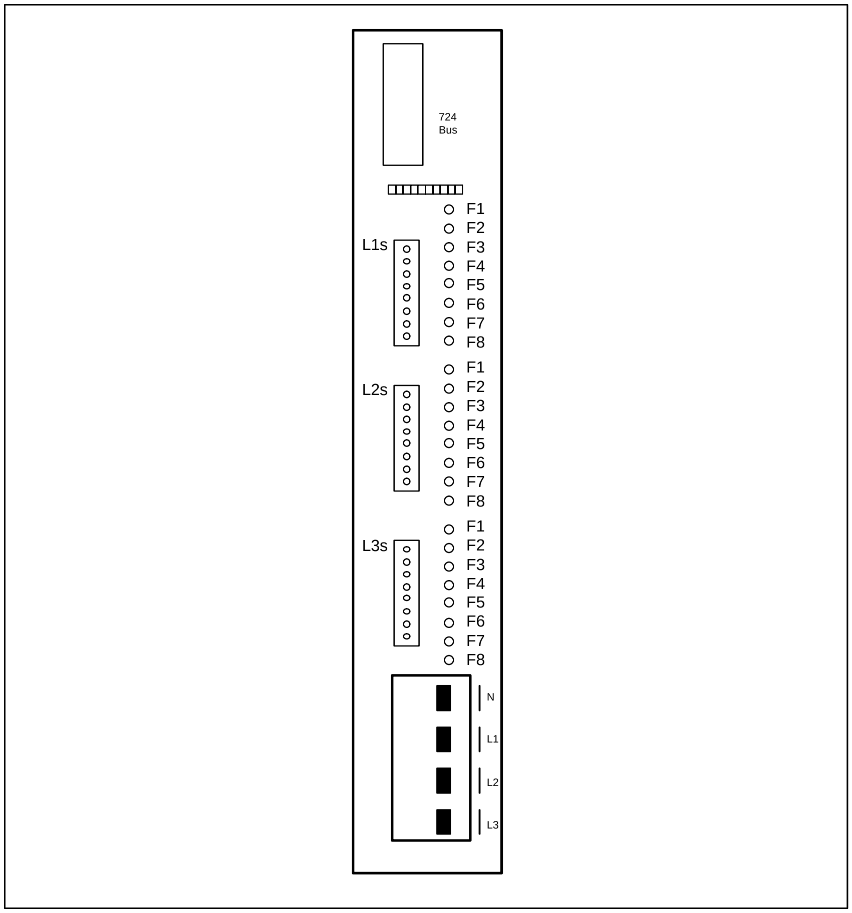


Figure 2-2 Front view of the LA 724 convenience model (6ES7 171-2AA02-0AA0)

The LA is equipped with the following components.

- 24 opto-triacs for addressing the power triacs
- 24 power triacs
- Hardware for temperature monitoring
- Diagnostic circuit for recognition of
  - An error on the module
  - A line disconnection outside the module
- 24 fuses for protection of the triacs
- 3 fuses in the phase feeders
- 3 eight-way front plug connectors for connection of the radiant heaters
- 4 conductor rails for connection of phases L1, L2, and L3, and the directly grounded conductor
- Bus plug connector

The module is equipped with a heat dissipater to absorb power loss. The triacs are secured directly to this heat dissipater.

Protection circuitry

Triacs and opto-triacs are protected against overvoltages of the electrical power network by a Transil diode. In addition, the triac is protected against short circuits and overload by a fuse.

Potential isolation

The control current circuits all operate with protective low voltage (SELV) and are reliably isolated electrically from the power and load current circuits in accordance with EN 50178.

Temperature monitoring

The heat dissipater is equipped with a heat conductor for monitoring the temperature of the heat dissipater.

When the temperature reaches 92˚ C (± 3˚ C), this temperature-dependent resistor issues a message to the S7-CPU via the ZA 724.

When a second threshold of 100˚ C (± 3˚ C) is reached, the power outputs of the module are switched off.

2.2.2 Plug-In Connections

The power output module is equipped with the following plug-in connections.

Table 2-4 Plug connectors on the LA 724

Label	Function
724 bus	Connection of the next LA 724 (right-hand socket) and the previous LA 724 or ZA 724 (left-hand socket) to the parallel bus
L1s	Connection of radiant heaters 1 to 8 to phase L1
L2s	Connection of radiant heaters 9 to 16 to phase L2
L3s	Connection of radiant heaters 17 to 24 to phase L3
N	Connection of the directly grounded conductor via a conductor rail
L1	Connection of phase L1 via a conductor rail
L2	Connection of phase L2 via a conductor rail
L3	Connection of phase L3 via a conductor rail

Note

The plug connectors for connection of the heater elements are **not** included with the LA 724.
Three plug connectors are required for each LA 724. They can be ordered individually.
Information on ordering: Phoenix plug connector, can be screwed
WKF ID no. 400 18 384

Connection diagram

Figure 2-3 shows the connection diagram of the LA 724.

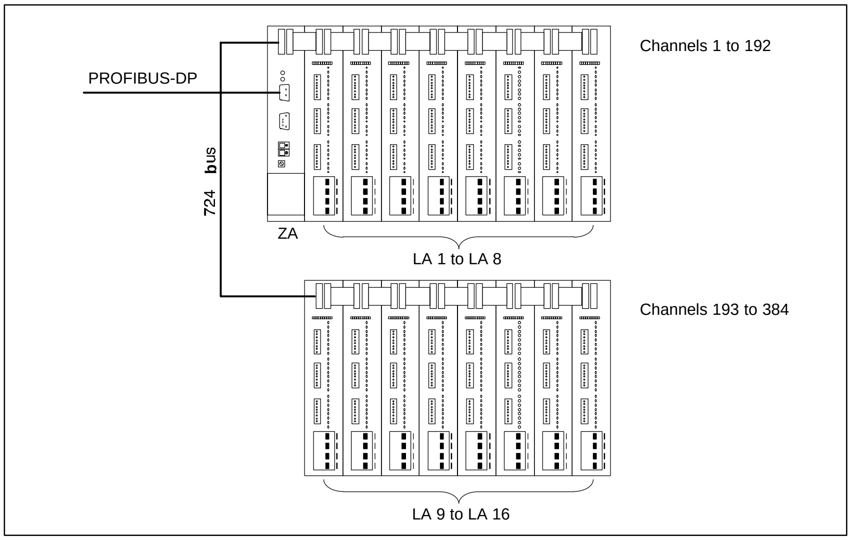


Figure 2-3 Connection diagram of the LA 724

2.2.3 Technical Specifications of the Power Outputs

Table 2-5 Technical specifications of the power outputs

Outputs per LA 724 power output	24
Potential isolation to the controller portion	Via opto-triac and optocoupler specified in acc. w. VDE 0884
Isolation voltage Opto-triac Optocoupler	 5 kV 5.3 kV
Potential isolation of the power outputs from each other	No
Load voltage (for star and delta circuit) Nominal value Permissible range Frequency	 230 V AC 187 V to 264 V 50/60 Hz (47 Hz to 63 Hz)
Total current per phase and module	Max. of 32 A
Current per conductor rail	Max. of 120 A
Output voltage	Full-wave or half-wave switched during zero crossing
Output current Nominal value Permissible range Residual current	 6.3 A 0.3 A to 6.3 A Max. of 7 mA
Power loss	85 W without fan at 650 W per channel 145 W with fan at 1000 W per channel
Switching capacity (simultaneity of 100%)	650 W per channel at 230 V without external ventilation 1000 W per channel at 230 V with external ventilation 1500 W per channel at 230 V with external ventilation and reduction to 12 channels per LA 724 (external ventilation with air current speed > 2.5 m/sec) Note: The total current per phase of 32 A may not be exceeded.
Total switching capacity per LA 724 Without external fan With external fan	 16 kW 24 kW
Type of load	Ohmic consumer with max. of 2-fold cold current
Overload	5-fold nominal current for 20 msec
Thermal protection	Yes, with heat conductor 92° C (± 3° C): Warning to host controller via PROFIBUS-DP 100° C (± 3° C): Power outputs switched off
Short circuit protection	One 5 A/250 V F fuse per output
Overvoltage protection	Via Transil diodes

Table 2-5 Technical specifications of the power outputs

Connection cable	R_{max} = 14 Ohm (ensures short circuit protection)
Cable length	50-m unshielded (signal lines of one phase in one cable) 100-m shielded (signal lines of one phase in one cable)
Dimensions of LA 724 (W x H x D) Weight (approx.)	50 mm x 480 mm x 210 mm 5,6 kg
Dimensions of the fan unit (W x H x D) Weight (approx.)	100 mm x 50 mm x 162 mm 1 fan unit is hung under 2 modules (2 x LA 724 or 1 x ZA 724 and 1 x LA 724 0,8 kg

2.3 System Voltage Acquisition Module NE 724 (6ES7 171-1XX00-6AA0)

The system voltage acquisition unit is a separate module and can be used as an option on the ZA 724 when power fluctuations are to be offset. The module is installed from the front in the insert slot of the ZA 724. The slot is located near the conductor rail. The opening is closed with the conductor rail covering when the NE 724 is not used. When the NE 724 is used, the covering serves as a protection against accidental touch.

Note

Central interfaces are not available with the system voltage acquisition installed. If voltage fluctuation offset is desired, the submodule and the module (i.e., NE 724 and ZA 724) must be ordered and then put together by the user. See section 3.9.

An NE 724 cannot be used if the radiant heater is connected to the LA 724 with a delta circuit.

Features of the product

The NE 724 system voltage acquisition offers the following features.

- Measurement of the voltage on phases L1, L2 and L3
- Connection of phases L1, L2 and L3 and the directly grounded conductor via cable with Teflon insulation
- Potential isolation via a transformer
- Bus interface to the ZA 724
- Evaluation of the system voltage and calculation of the offset factors using the 80C165 µP on the ZA 724

2.3.1 Design of the Module

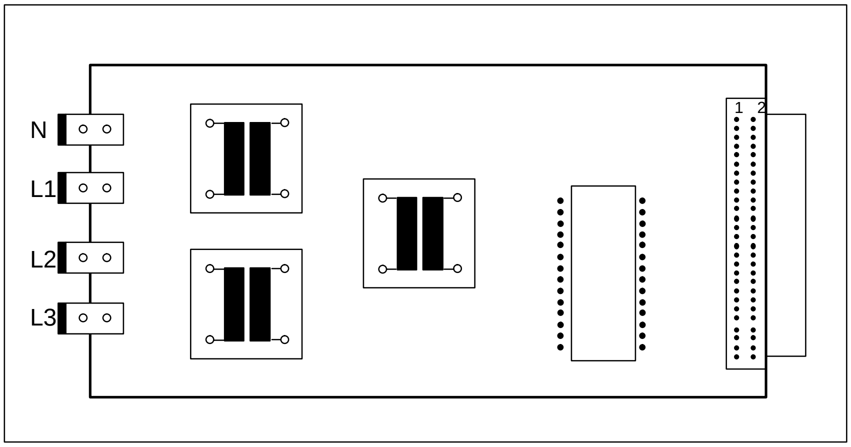


Figure 2-4 Design of the NE 724

Figure 2-4 shows the design of the system voltage acquisition board. The NE contains the following components.

- Three voltage adaptations and filter units on the 230 V side
- Three transformers for potential isolation and voltage adaptation
- Three precision rectifiers followed by filter
- One 4-channel, A/D converter
- One 5 V voltage supply for the converter
- One connection plug to the ZA 724

The dimensions of the module are: Approx. 180 mm x approx. 80 mm (L x W).

2.3.2 Plug-In Connections

The system voltage acquisition module is equipped with the following plug-in connections.

Table 2-6 Plug connectors on the NE 724

Label	Function
N	Connection of the directly grounded conductor
L1	Connection of phase L1
L2	Connection of phase L2
L3	Connection of phase L3
None	Plug-in connection to the ZA 724

2.4 Ambient Conditions for All HS 724 Components

Table 2-7 Climatic ambient conditions

Operating temperature • Permissible range • Relative humidity at 25˚ C • Temperature gradient	 0˚ to 55˚ C 95% ≤ 10 grd/h (briefly 1 grd/3 min)
Storage temperature • Permissible range • Relative humidity at 25˚ C • Temperature gradient	 –40˚ to 70˚ C 95% ≤ 20 grd/h
Air pressure during operation • Minimum • Maximum	 860 hPa (= 1500 m NN) (reduced cooling capacity when air pressure is low) 1080 hPa
Air pressure during storage • Minimum • Maximum	 660 hPa (= 3500 m NN) 1080 hPa
Fan	Own or external fan

Table 2-8 Physical ambient conditions

Vibration during operation (stationary use) • 10 Hz to 58 Hz • 58 Hz to 500 Hz	IEC 68, part 2-6 0.075 mm amplitude 9.8 m/s^2 (= 1 g constant acceleration)
Oscillations during transportation and storage (in shipping package) • 5 Hz to 9 Hz • 9 Hz to 500 Hz	IEC 68, part 2-6 3.5 mm amplitude 9.8 m/s^2 (= 1 g constant acceleration)
Tilting/falling ot the unpackaged device • Height of fall	IEC 68, part 2-31 100 mm

Table 2-9 Electromagnetic compatibility

HS 724 is installed in the switching cabinet.	
Interference suppression (interference emission)	Limit value class A in acc. w. EN 55011: 1991 group 1
Interference immunity against interference on lines (Burst) • Alternating current-supply lines • Signal lines which leave the device	In acc. w. EN 61000-4-4: 1995 2 kV with snap-on network 2 kV with snap-on connector
Interference immunity against interference on lines (HF electrification)	In acc. w. ENV 50141: 1993 10 V (0.15 MHz to 80 MHz)
Interference immunity against discharge of static electricity • Discharge on contact • Discharge in air	In acc. w. EN 61000-4-2: 1995 4 kV 8 kV
Interference immunity against high-frequency radiation	In acc. w. ENV 50140: 1993 or ENV 50204: 1995 10 V/m (80 MHz to 1000 MHz) 10 V/m, pulse modulated (900 $\pm$ 5 MHz)

Installation 3

This chapter shows you the necessary installation steps in preparation for commissioning.

3.1 General Requirements

The HS 724 heating controller is designed for stationary installation in a switching cabinet.

Note

The components of the HS 724 are designed with a protection rating of IP 00. The required protection against touch must be provided in the switching cabinet in which the HS 724 is installed.

Adhere to EMC guidelines during installation.

The HS 724 is not designed for connection to the public low voltage network. It must be powered by a separate, medium voltage transformer (industrial network).

Warning

Since voltages of > 60 V are present in the switching cabinet, suitable safety precautions against touching must be provided during commissioning and maintenance work.

Use of FI protection as the only protection against indirect touching is not permitted.

Requirements for the switching cabinet

To preclude injury to operating personnel, the following requirements must be fulfilled by the switching cabinet.

- Closed cabinet
- Grounded cabinet
- Interface connections and ribbon tables to the devices may not be touched by single-isolated lines carrying voltage in the switching cabinet.

Adjustment of channel fuses to type of radiant heater

The LA 724 channel fuses listed in table 3-1 should be used, based on the type of radiant heater you are going to operate on the HS 724. The power outputs are always equipped with 5 A F fuses.

If necessary, the fuses must be changed before you install the LA capsules in the switching cabinet. See chapter 4.5 for a description of how to change the fuses.

Super rapid-action 6.3 A fuses can be ordered as accessories.

Table 3-1 Channel fuse values based on the heater type

Type of Heater	Capacity	Recommended Fuse
Quartz heater	Max. of 1500 W	5 A, rapid-action/ 6.3 A, super rapid-action
Ceramic heater		
Flash heater	Max. of 750 W	5 A, rapid-action

3.2 Setting the Bus Address

Communication of the heating controller with the master (e.g., S7-CPU) is handled by the PROFIBUS-DP field bus and requires that the bus address (i.e., slave address) be set on the ZA. The ZA is equipped with two rotary-type switches which can be used to set the address from 00 to 99.

How to proceed

1. Rotary switch S2 Set ones position of the PROFIBUS-DP address
2. Rotary switch S3 Set tens position of the PROFIBUS-DP address

The rotary switches can be accessed from above through the ventilation slits of the ZA capsule.

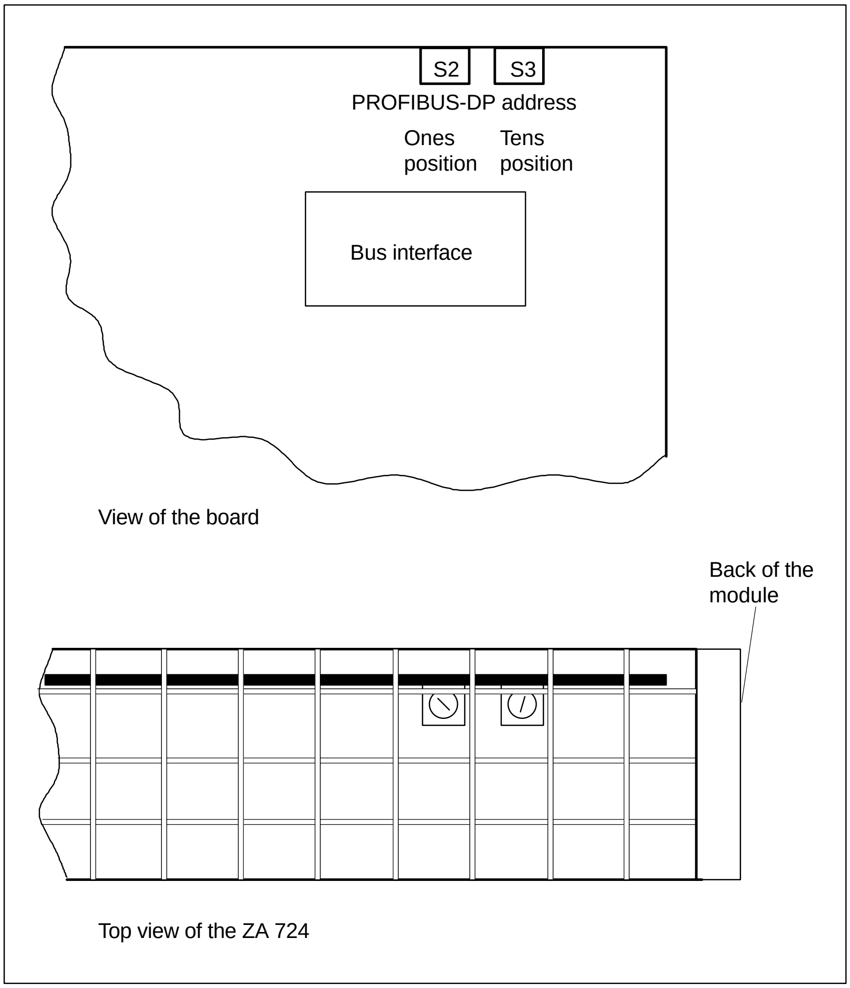


Figure 3-1 Setting the bus address

3.3 Mounting the Components on the Carrying Plate

The central interface and the power outputs of the HS 724 are installed in metal capsules. These capsules are mounted on a carrying plate in the switching cabinet.

How to proceed

1. Isolate the switching cabinet from the voltage supply.
2. Screw the capsules to the mounting clips on the carrying plate.

Spacing dimensions for installation

When the HS 724 is installed in a switching cabinet, the minimum distances to cabinet walls, cable ducts, etc. shown in figure 3-2 must be adhered to.

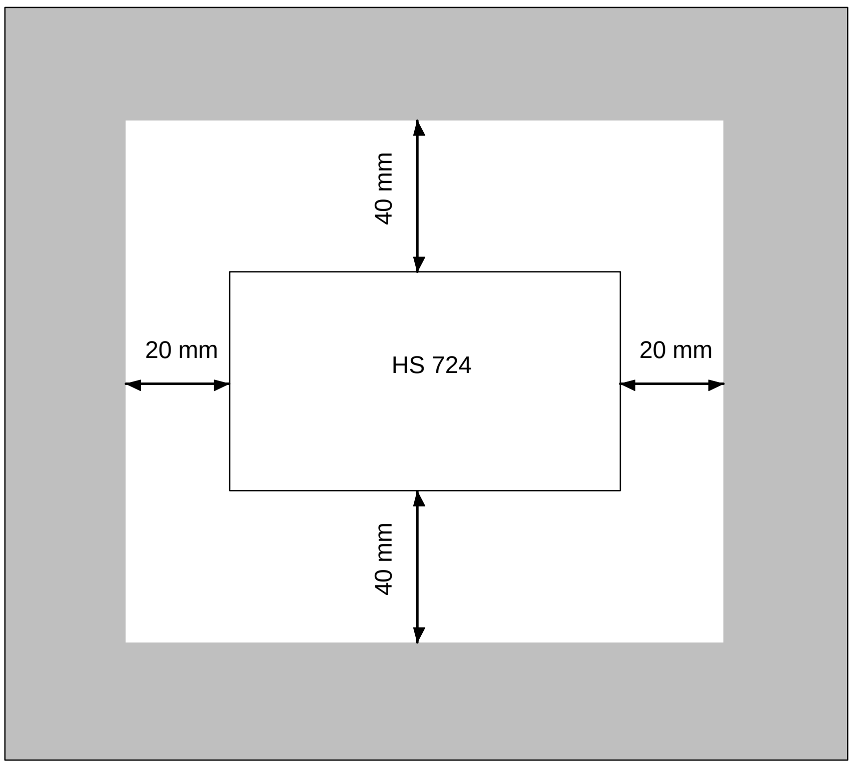


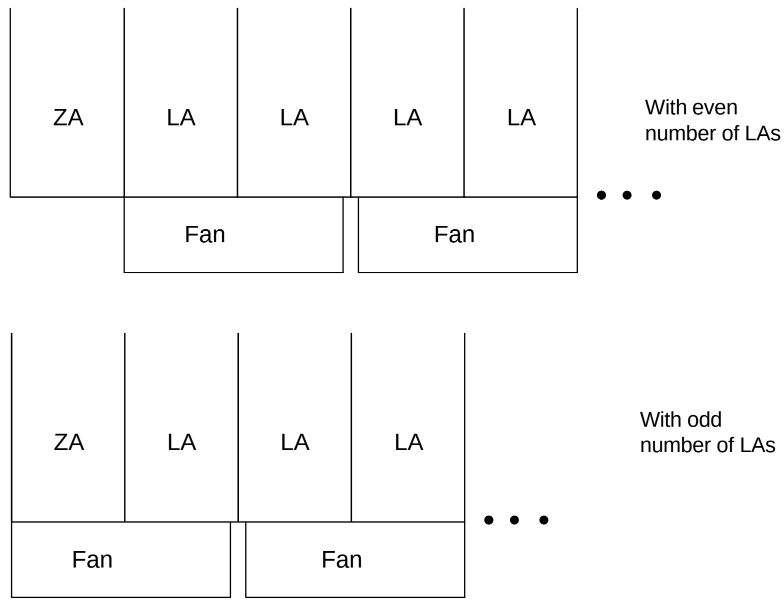
Figure 3-2 Spacing dimensions for installation of an HS 724

3.4 Installing the Optional Fan Unit

When the switching capacity per channel exceeds 650 W, the LA 724 must be equipped with the optional fan unit.

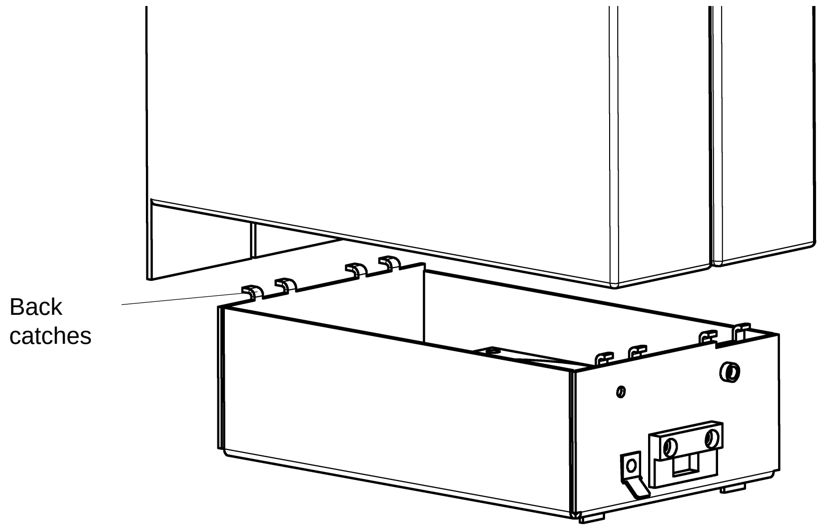
Mounting

The fan unit is hung under 2 LA 724 modules or under the ZA 724 and 1 LA 724.

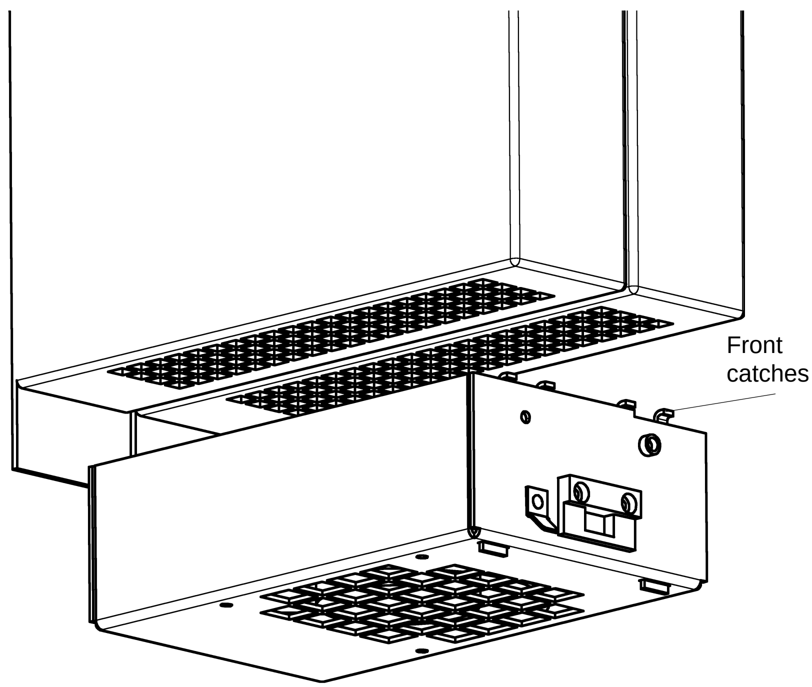


How to proceed

1. Remove clamping plate on the front of the fan unit (2 oval head screws)
2. Hang the catches of the fan unit in the back in the mesh plates of the modules.

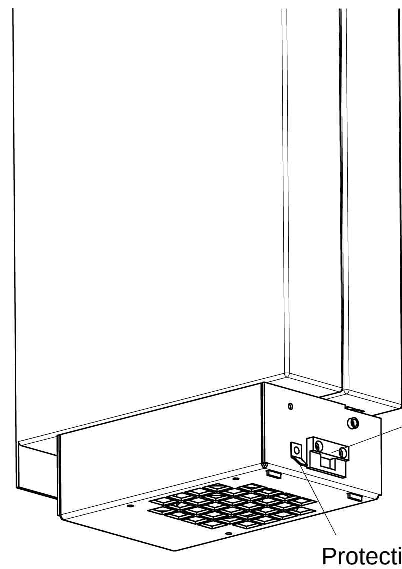


3. Hang the clamping plate in the front in the mesh plates of the modules, and secure with 2 oval head screws (M3 x 8).



4. Make protective conductor connection

   The protective conductor must have a cross section of 0.75 mm^2 and must be inserted on the Faston plug–in tab with a lockable Faston plug connector (6.3 x 0.8). It must be ensured that the connection cannot become disconnected.



5. Provide power supply for the fan.

   230 V AC are required to run the fan.

Warning

The power feeder line must be without current while the fan is being connected.

The power feeder line (0.75 mm^2) must be connected to the included plug connector, and this connector must be inserted on the duct terminal on the front of the fan unit. The plug must be secured with 2 screws (M3 x 8).

Note

The feeder lines to the fan must be protected so that line protection in accordance with EN 60204, part 1 or EN 50178 is ensured.

Caution

When the fan unit is running, do not reach though the bottom mesh plate and touch the rotating fan wheel.

3.5 Connecting the PROFIBUS-DP Field Bus

Communication of the central interface with the host controller (i.e., master) requires that both components be connected via the PROFIBUS-DP field bus.

How to proceed

1. Connect plug of the bus cable to the nine-way, sub D socket "PROFIBUS-DP".
2. Secure plug to the socket.

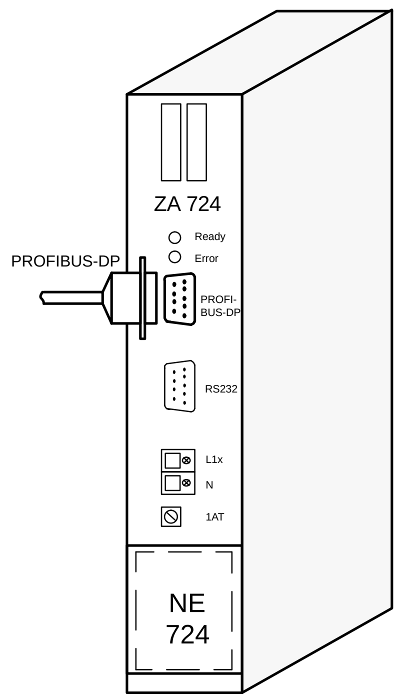


Figure 3-3 Connection of PROFIBUS-DP

3.6 Connecting the Parallel Bus

The power outputs are connected to the central interface with a parallel bus which is looped through with a ribbon cable.

How to proceed

1. Press ribbon cable plug connector of the central interface into the right-hand socket labeled “724 Bus” until it snaps in.
2. Press ribbon cable plug connector of the first power output into the left-hand socket labeled “724 Bus” until it snaps in.

Only when several power outputs are used with one central interface:

3. Press plug connector of a further ribbon cable into the right-hand socket (labeled “724 Bus”) of the power output connected last, until it snaps in.
4. Press ribbon cable plug connector into the left-hand socket (labeled “724 Bus”) of the next power output, until it snaps in.

To connect additional power outputs, repeat steps 3 and 4. See figure 3-4.

Arrangement or the LA in two rows:

5. Press ribbon cable plug connector of the ZA into the left-hand socket labeled “724 Bus” until it snaps in.
6. Press ribbon cable plug connector of the first LA of the second row into the left-hand socket labeled “724 Bus” until it snaps in.

To connect additional LAs, repeat steps 3 and 4. See figures 3-5 and 3-6.

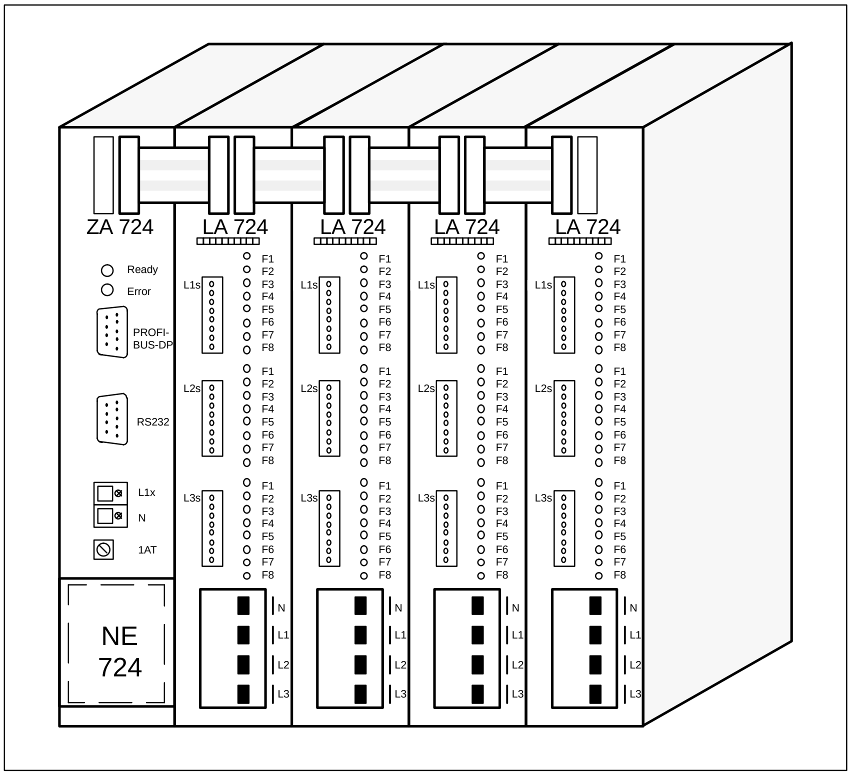


Figure 3-4 Connecting the parallel bus

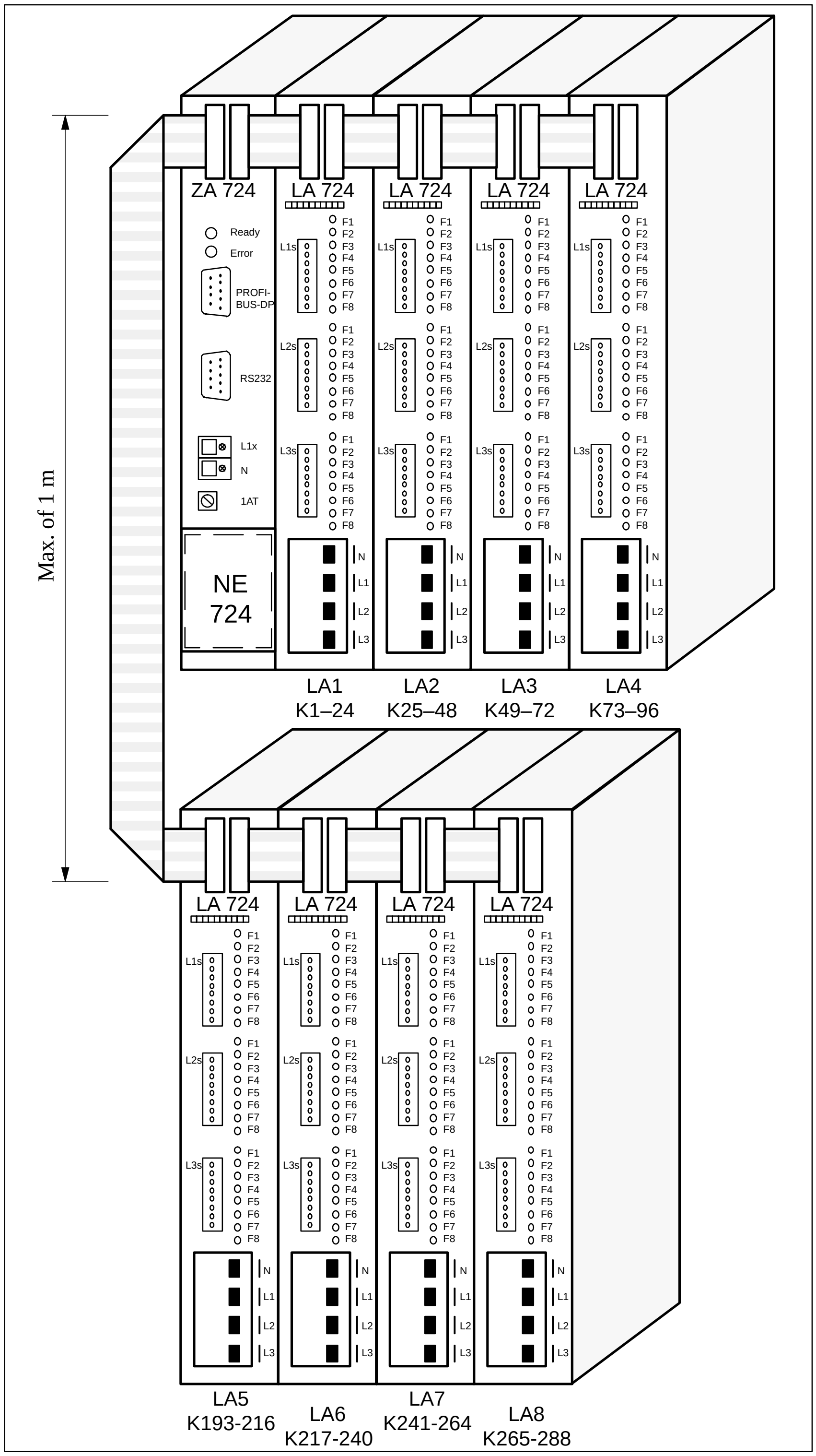


Figure 3-5 Connecting the parallel bus with two-row setup

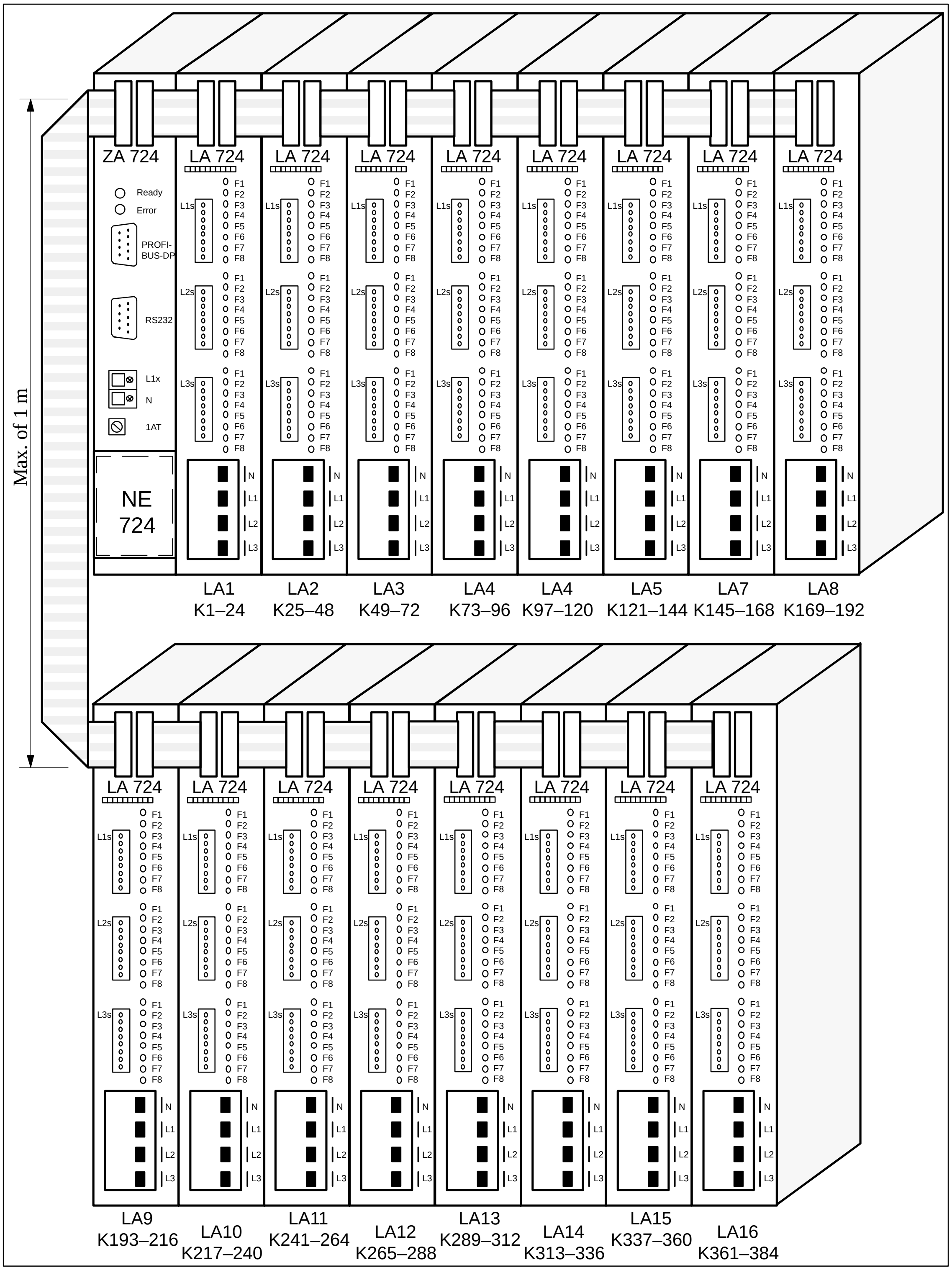


Figure 3-6 Connecting the parallel bus with two-row setup (maximum configuration)

3.7 Connecting the Radiant Heater

The radiant heaters are connected to the socket strips on the front of the power outputs with three, eight-way pin strips with screw-type terminals. The three-phase current is supplied via four conductor rails (three phases + a directly grounded conductor).

The HS 724 is not designed for connection to the public low voltage network. It must be powered by a separate, medium voltage transformer (industrial network).

Warning

- Only install or remove pin strips for the radiant heaters on/from the socket strips when the voltage is off. The power feed lines must be isolated from the voltage when connecting the three-phase current to the conductor rails.
- The user is responsible for monitoring the heater elements.

How to proceed

1. Strip insulation from the lines of the radiant heater, and clamp them in the screw-type terminals of the eight-way pin strip.

Note

The connection lines must meet the following requirements.

- Length: $\leq$ 50 m, unshielded
  $\leq$ 100 m, shielded
- Resistance: $\leq$ 14 Ohm

2. Insert pin strip of radiant heaters 1 to 8 in socket strip L1s.
3. Insert pin strip of radiant heaters 9 to 16 in socket strip L2s.
4. Insert pin strip of radiant heaters 17 to 24 in socket strip L3s.
5. Connect protective conductor to metal capsule (i.e., housing)
   The protective conductor must have at least the cross section of the phase feeding of L1, L2 or L3.
6. Connect directly grounded conductor to conductor rail “N”.
7. Connect phase L1 to conductor rail “L1”.
8. Connect phase L2 to conductor rail “L2”.
9. Connect phase L3 to conductor rail “L3”.

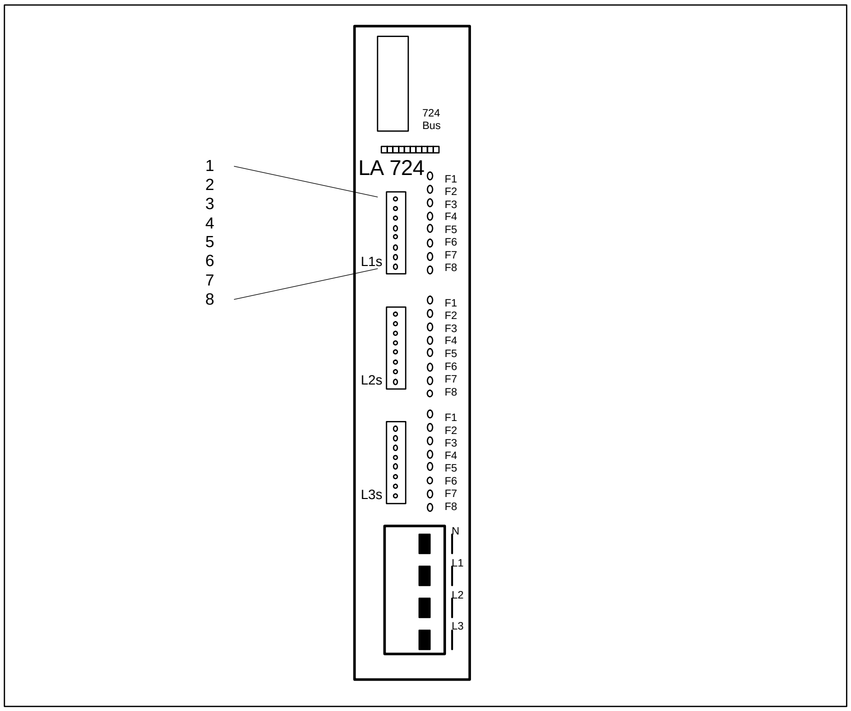


Figure 3-7 Front view of the LA 724 with the sockets for connection of the radiant heater

Table 3-2 Allocation of the radiant heaters to the pins of the pin strips

Pin Strip	Pin	Radiant Heater (Channel)
L1s	1 2 : 8	1 2 : 8
L2s	1 2 : 8	9 10 : 16
L3s	1 2 : 8	17 18 : 24

Danger

After the conductor rails have been connected, the covers of the conductor rails must be installed again as protection against accidental touch. The exterior cover must also be closed with the included “touch protection” pads. After the operational voltage has been turned on in the switching cabinet, the conductor rails carry a voltage of 230 V AC. Installation or service work may only be performed when the system has been isolated from the voltage.

Y connection

Figure 3-8 shows the Y-type connection of the radiant heaters to the LA 724.

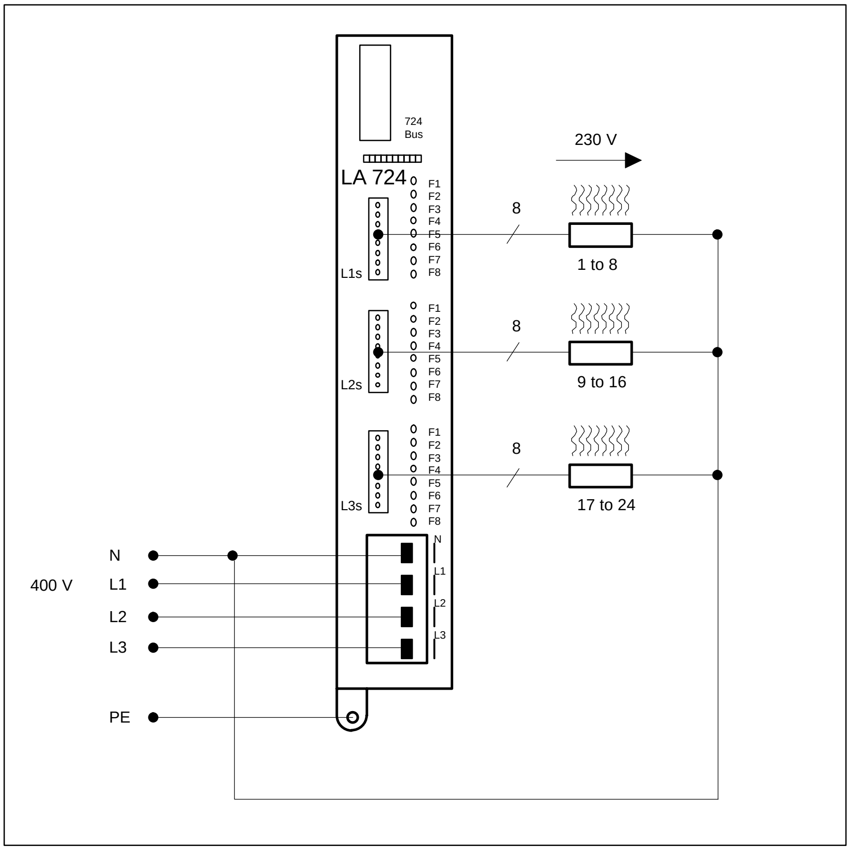


Figure 3-8 Y-type connection of the radiant heaters

Delta connection

Figure 3-9 shows the Delta-type connection of the radiant heaters to the LA 724.

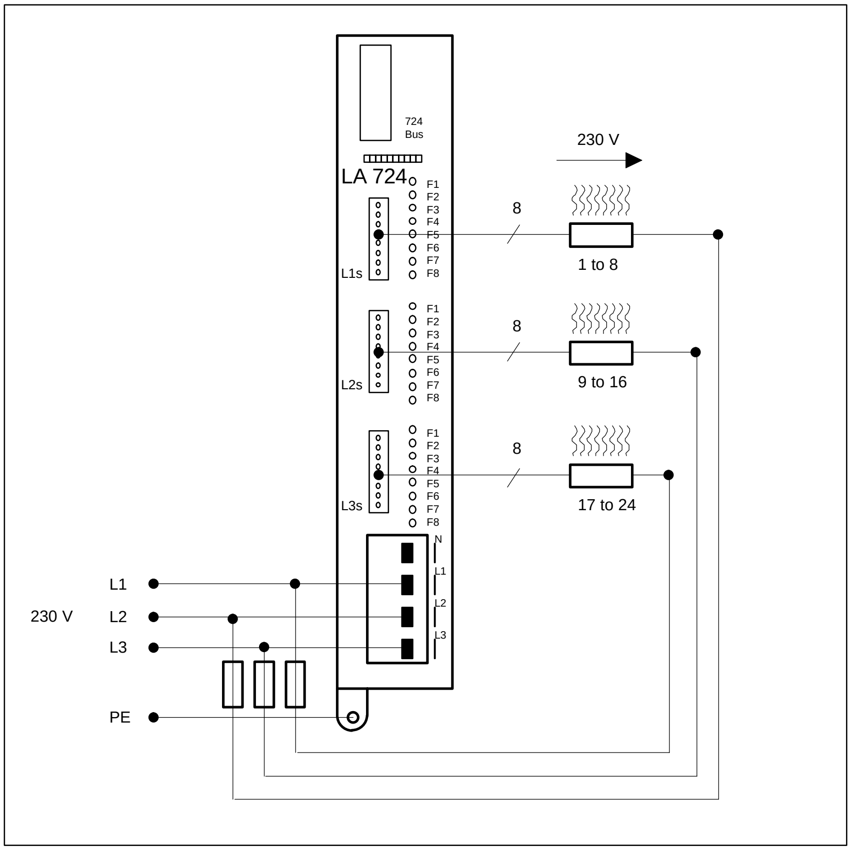


Figure 3-9 Delta-type connection of the radiant heaters

Note

The return lines of the radiant heaters must be protected so that they meet the line protection requirements of EN 60204, part 1 or EN 50178. These measures are the responsibility of the plant engineer.

Two-side powering

The HS 724 must be powered on two sides if one-side powering exceeds the maximum phase current. Figure 3-10 shows an example of two-side powering.

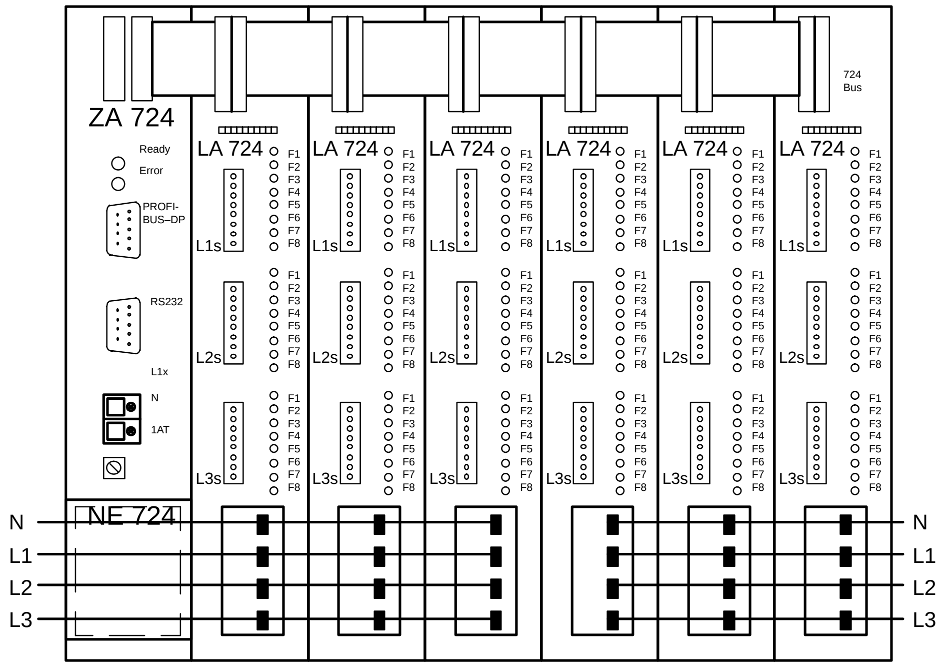


Figure 3-10 Example of two-side powering of an HS 724

Note

When configuring, make sure that the maximum current of 120 A per current conductor is not exceeded.

3.8 Connecting the Supply Voltage

The module is supplied with operating voltage via a powerpack which is integrated on the central interface.

How to proceed

1. Strip insulation from the power connection line.
2. Connect phase L1 to the screw-type terminal labeled “L1x”.
   The HS 724 is not designed for connection to the public low voltage network. It must be powered by a separate, medium voltage transformer (industrial network).

Note

L1x must have the same phase as the L1 conductor rail.

---

3. Connect the directly grounded conductor to the screw-type terminal labeled “N”.

Note

With the Delta-type circuit of the radiant heater, phase L2 must be connected to screw-type terminal “N” instead of using the neutral conductor.

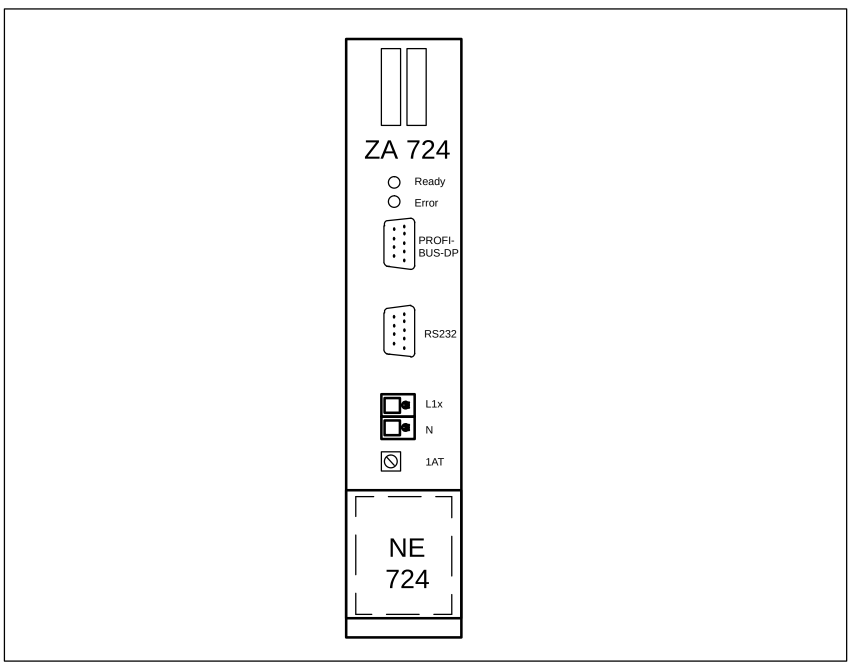


Figure 3-11 Location of the power connection terminals on the ZA 724

3.9 Connecting the NE 724

The NE 724 module is inserted from the front in the installation slot of the ZA 724, and pressed into the plug connector. The cables on the module are connected with the 3 phases and the directly grounded conductor of the next LA 724.

Note

The NE 724 cannot be used with the Delta-type circuit of the radiant heater.

How to proceed

1. Remove the conductor rail covers of the ZA 724 and LA 724.
2. Insert the NE 724 module with the plug connector in front into the installation slot of the ZA 724.

   Make sure that the PCB is in the grooves of the guide pins. See figure 3-12.
3. Snap in plug connector.
4. Connect the cables of the NE 724 module to the conductor rail connectors of the next LA 724. See figure 3-12.

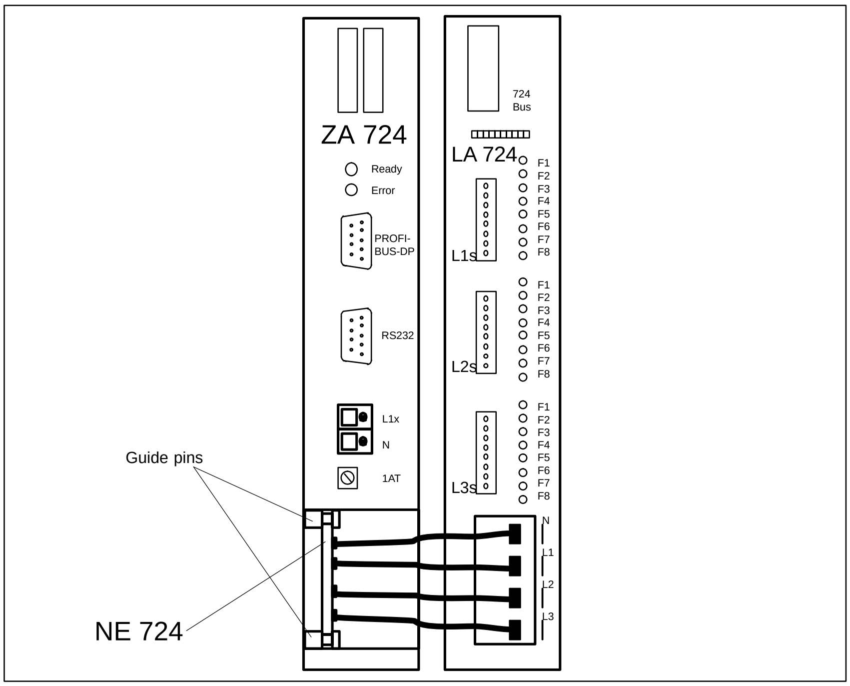


Figure 3-12 Location and connection of the NE 724

5. Replace conductor rail covers of the ZA 724 and LA 724.

Note

The conductor rail covers will not snap into the front plate unless conductor rail and NE 724 are correctly connected.

Operation 4

This chapter provides you with information on the commissioning, initialization and normal operation of the HS 724 heating controller.

You will learn how the power outputs are monitored and how the system reacts when an error occurs. Helpful tips are provided on how to correct errors on the power outputs.

4.1 Commissioning

4.1.1 Hardware Prerequisites

Controller

Required, for example:

- SIMATIC S5 with IM 308-C or
- SIMATIC S7 CPU 3xx or CPU 4xx with integrated PROFIBUS-DP interface.

Heating controller

Required for heating controller:

- One central interface (ZA 724)
- Power output(s) (LA 724)

4.1.2 Software Prerequisites

Contents of program floppy disk

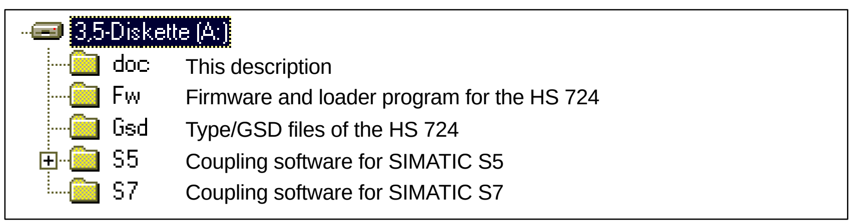


Figure 4-1 Contents of the program floppy disk

Directory \doc

HS724.exe file Descriptions of coupling software and sample program

Directory \Fw

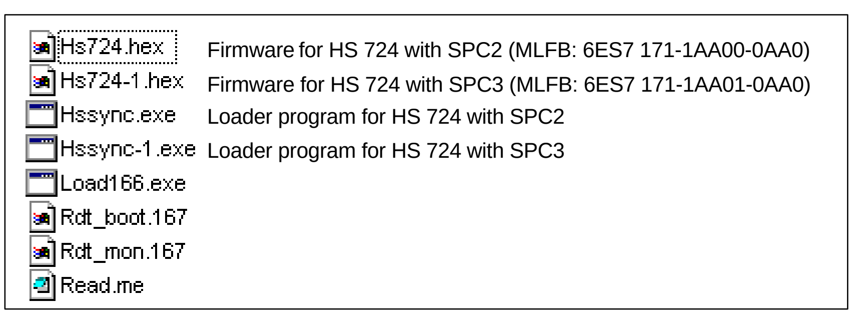


Figure 4-2 Directory \Fw

Directory \Gsd\S5	HS724__x.200	Type file of HS 724 with 1.5 Mbaud
Directory \Gsd\S7\1.5Mbit	HS724__x.200	Type file of HS 724 with 1.5 Mbaud
Directory \Gsd\S7\12Mbit	SIEM002B.gsd	Type file of HS 724 with 12 Mbaud

Directory \S5\115U

Hs7240zf.seq	Symbology
Hs7240z0.seq	Symbology
S5hs55st.s5d	STEP 5 program for CPU 945
S5hs50st.s5d	STEP 5 program for CPU 942 to CPU 944
Hs7240z2.ini	Symbology
Hs7240z1.ini	Symbology
Hs7240z0.ini	Symbology
S5hs55.et2	Configuration for IM 308-C and CPU 945
S5hs50_2.et2	Configuration for IM 308-C and CPU 944
Hs724__x.200	Type file of HS 724

Figure 4-3 Directory \S5\115U

Directory \S5\135U

Hs724__x.200	Type file of HS 724
Hs7240z0.ini	Symbology
Hs7240z0.seq	Symbology
Hs7240z1.ini	Symbology
Hs7240z2.ini	Symbology
Hs7240zf.seq	Symbology
S5hs23.et2	Configuration for IM 308-C and CPU 928B
S5hs23st.s5d	STEP 5 program for CPU 928B

Figure 4-4 Directory \S5\135U

Directory \S7

Hs724a05.arj	STEP 7 program for SIMATIC S7-400
Hs724b05.arj	STEP 7 program for SIMATIC S7-300
Siem002b.gsd	GSD file for configuration of HS 724 in the hardware configuration

Figure 4-5 Directory \S7

4.1.3 Linking the HS 724 to the Hardware Configuration

Type/GSD files for the SIMATIC S7 configuration software are included for the configuration of the ZA 724.
The type/GSD file (device master data file) contains all the characteristics of a DP slave. STEP 7 requires a type/GSD file for each DP slave so that the DP slave (HS 724) can be selected in the module catalog.

ZA 724: 6ES7 171-1AA0**0**-0AA0	HS724__x.200
ZA 724: 6ES7 171-1AA0**1**-0AA0	SIEM002B.GSD

Importing GSD file

Only for the ZA 724 with the order number 6ES7 171–1AA0**1**–0AA0

How to integrate the GSD file in the module catalog

1st step First, create a new project or open an already existing one.

2nd step Open the hardware configuration of your project and select:
Extras → Neue GSD installieren ...

3rd step Select the file SIEM002B.GSD.

Linking in the type file

Only for the ZA 724 with the order number 6ES7 171–1AA0**0**–0AA0

Copy the type file HS724__x.200 to the directory STEP7 → S7data → GSD.

Note

In STEP 7, you may only install **one** of the two type/GSD files.

4.1.4 Loading the Firmware for the HS 724

Delivery status of ZA 724 central interface

On delivery, the ZA 724 central interface has already been loaded with the current firmware release.

In case of problems or an update, the firmware can be loaded with the included program HSSYNC.EXE or. HSSYNC-1.EXE.

What firmware do I need for my ZA 724?

For the ZA 724 with MLFB 6ES7171-1AA00-0AA0: Use loader program HSSYNC.EXE.
For the ZA 724 with MLFB 6ES7171-1AA01-0AA0: Use loader program HSSYNC-1.EXE.

How do I load the firmware of the HS 724?

Notice

The standard model of the ZA 724 comes with the current firmware version and is ready for operation.
The following steps are only required when the ZA 724 with another firmware version must be updated.

You will need a zero modem cable to load the firmware. If you do not have such a cable, you can also use a cable with the following allocation.

RxD 2————3 TxD
TxD 3————2 RxD
Gnd 5————5 Gnd

Note

With 25-way plug connector: Use pin 7 instead of pin 5 for Gnd.

To load the firmware, proceed as shown below.

1. Turn off ZA 724.
2. Connect serial interface RS 232 of the ZA 724 with interface cable to COM1 or COM2 on the PC.
3. Call HSSYNC (for ZA 724 up to 1.5 MBaud, 6ES7 171–1AA00–0AA0) or HSSYNC–1 (for ZA 724 up to 12 MBaud, 6ES7 171–1AA01–0AA0), and enter the interface used on the PC (COM1 or COM2).
4. Turn on ZA 724.

The rest of the procedure is performed automatically. You can watch the progress of the program on your PC.
The new firmware is activated by turning the ZA 724 off and on again.

Note

The load voltage must be turned off while the firmware is being loaded.

4.1.5 Procedure for (Standard) Commissioning

Steps

1. Check release states of the ZA 724 central interface and the LA 724 power output (see sections 2.1 and 2.2).
2. Set PROFIBUS address to the central interface with rotary switches S2 and S3 (see section 3.2).
3. Mount components in the switching cabinet (see sections 3.3 and 3.4).
4. Connect parallel bus (see section 3.6).
5. Connect radiant heater (see section 3.7).
6. Install network voltage acquisition NE 724 (optional), and connect (see section 3.9).
7. Connect voltage supply (see section 3.8).
8. Connect PROFIBUS–DP (see section 3.5).
9. Load coupling software to the S7, and configure appropriately. See sample program on the delivery floppy disk. The STEP 7 sample program for the HS 724 contains a detailed description.
10. For additional information on data communication, see sections 5 and 6.

4.2 Initialization

Introduction

When the S7-CPU starts up (e.g., after the power has been turned on), startup software automatically performs a system initialization.

Initialization of the central interface(s) must then be started by the user. The interprocess communication data blocks must be assigned with appropriate data, and jobs must be triggered via the interprocess communication software.

Hardware configuration

For information on the hardware configuration for the HS-724, see the readme file on the included floppy disk.

Behavior during startup

- After “power on”, the red LED on the ZA 724 stays on until the bus link to the master has been established.
- Afterwards, the ZA 724 performs a check (approx. 1 second) to determine whether new firmware is to be loaded. See “loading new firmware” below. The red and the green LEDs are both on.
- If the ZA 724 does not receive an acknowledgment signal to load firmware by the time the wait period expires, it continues the startup process. See “stages of initialization” on the next page.

Stages of initialization

Table 4-1 shows the stages of initialization.

Table 4-1 Stages of initialization

Stage	Description	Red LED	Green LED
1	The PROFIBUS-DP field bus is initialized.		
2	The configuration buffer is transferred.		
3	The PROFIBUS-DP makes the data buffer (input and output buffer) available. Data communication between master (i.e., S7-CPU) and slave(s) (i.e., ZA 724) is now possible. (Synchronization with the controller)	Flashing	○
4	Preselection of operating mode: Initialization The BAV control bits in interprocess communication data block DB_KOP must be set to the value “1” by the user. See chapter 5.4. Note: Before you can send the following jobs to the ZA, the ZA must have switched to initialization (i.e., the response bits BAR have the value “1”). See chapter 5.4.		
5	The S7-CPU must send job 01 to the ZA. The ZA then reports the LA 724s present to the S7-CPU, together with information on whether an NE 724 is installed, and the firmware version.		
6	The S7-CPU must send job 02 to the ZA. The following values are preset to “zero”. • Setpoints • Production values • Standby values The system voltage offset values are assigned with “100” (≙ factor 1). The field allocations are reset. The check of all power outputs is switched off. The ZAs are parameterized.	○	Flashing
7	The S7-CPU must send job 03 with field allocations to the ZA.		

Table 4-1 Stages of initialization

Stage	Description	Red LED	Green LED
8	The S7-CPU must send job 09 to the ZA to conclude the initialization. The following procedures are then performed. • The power frequency is determined automatically. • A check is performed to determine whether the phase connection of the three-phase AC network is correct. • For a three-phase AC network with directly grounded conductor, a check is performed to determine whether the directly grounded conductor is disconnected.	○	Flashing
9	Initialization is concluded by selecting the “normal operation” mode. Set control bits BAV to the value “2”. See chapter 5.4. After correct initialization, the ZA 724 sets the response bit BER to signal that it is ready for operation. See chapter 5.4.	○	☼

Initialization is now concluded. All channels of the LA 724 power outputs output “zero”, and no further checks of the power outputs are performed.

Note

During initialization, jobs 01, 02 and 03 may only be sent once while job 09 can be sent more than once if necessary.

Reinitialization can only be performed by switching from normal operation to initialization operating mode.

Configuration buffer

The configuration buffer contains the specifications for the output and the input buffer of the slaves (i.e., ZA 724).

It consists of 2 bytes and has the following contents.

Byte 0	$5F_H$	→ 16-word input buffer Consistency check via byte/word
Byte 1	$6F_H$	→ 16-word output buffer Consistency check via byte/word

Identification number

The HS 724 has been assigned the identification number 002B HEX by the PROFIBUS User Organization.

4.3 Normal Operation

Introduction

After initialization has been performed successfully, the HS 724 heating controller must be switched to “normal operation” with the appropriate control bits (i.e., BAV bits). The ZA 724 central interfaces cyclically monitor the data for changes and the power outputs. The radiant heaters are addressed with the current manipulated variables.

Operating cycle

The following procedures are performed cyclically during normal operation.

- Toggle watchdog
- Check temperature of the power outputs
- Scan output buffer for changes
- Provide input and diagnostic data, if new data available

The S7-CPU stores data for the HS 724 in the output buffer, while the HS 724 stores the input data for the S7-CPU in the input buffer.

Diagnostic data are supplied by the firmware.

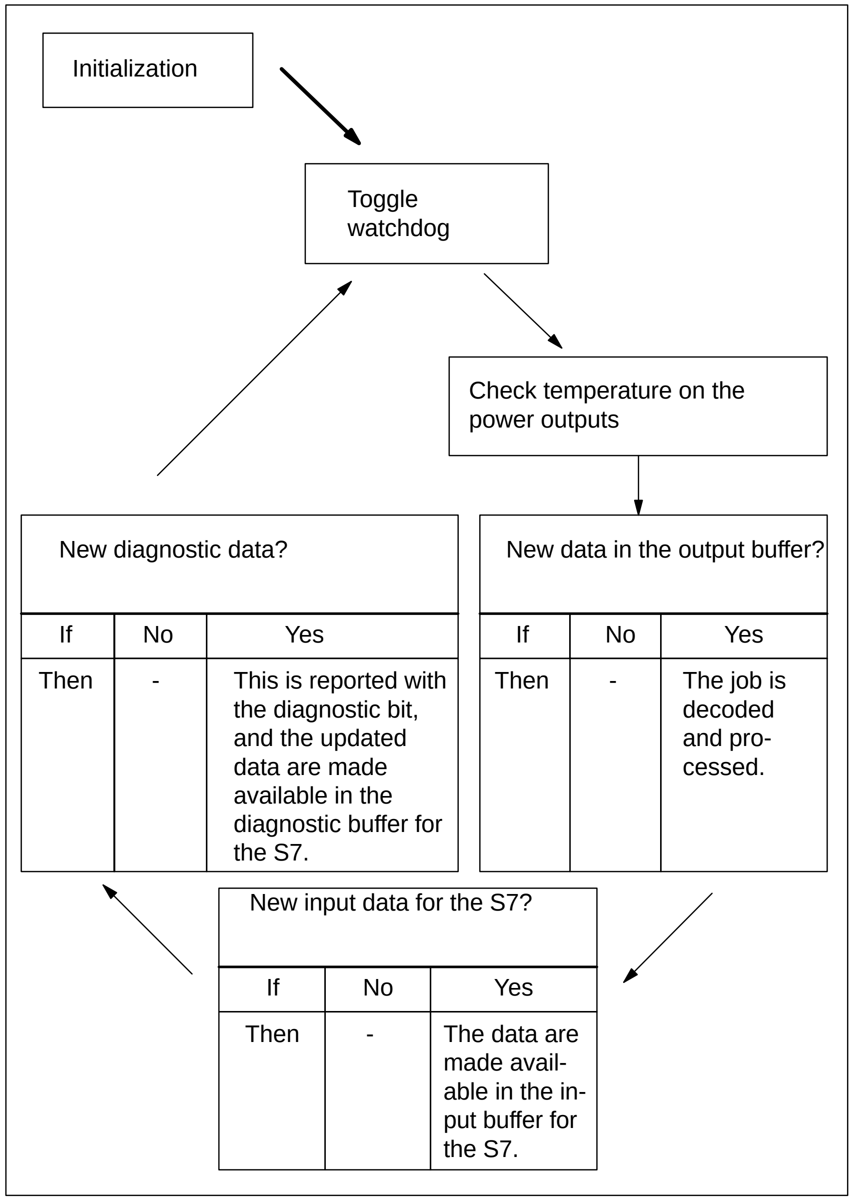


Figure 4-6 Normal operation cycle

4.3.1 Calculating Manipulated Variables

After valid radiant heater setpoints and production values have been transferred, the heating controller calculates the manipulated variables for the individual channels of the LA 724 power outputs. System voltage offset values can also be included.

Definitions

The values defined in table 4-2 are used for the manipulated variable calculation.

Table 4-2 Values for manipulated variable calculation

Value	Description	Value Range	Resolution
Radiant heater setpoint	Specification for each individual radiant heater (as percentage of maximum capacity)	0 to 100	1
Production value	Factor by which the radiant heater setpoint is multiplied during production operation One factor applies to an entire field.	0 to 255	1
Standby value	Factor by which the radiant heater setpoint is multiplied during standby operation One factor applies to an entire field.	0 to 255	1
System voltage offset value	Factor by which the radiant heater setpoint is always multiplied Allocation is phase-oriented.	64 to 255	1
Manipulated variable	Calculated output value with which the radiant heater is addressed (as percentage of maximum capacity)	0 to 100	1

Manipulated variable calculation

The manipulated variable is calculated as follows.

Manipulated variable$_{channelx}$ = radiant heater setpoint$_{channelx}$ x production value$_{fieldy}$ x system voltage offset value$_{Ln}$

Radiant heater x is addressed with the calculated manipulated variable. Only those channels are processed for which a radiant heater setpoint was specified.

Note

During standby operation, the standby value is used for the calculation instead of the production value.

Figure 4-7 shows a diagram of the principle of manipulated variable calculation.

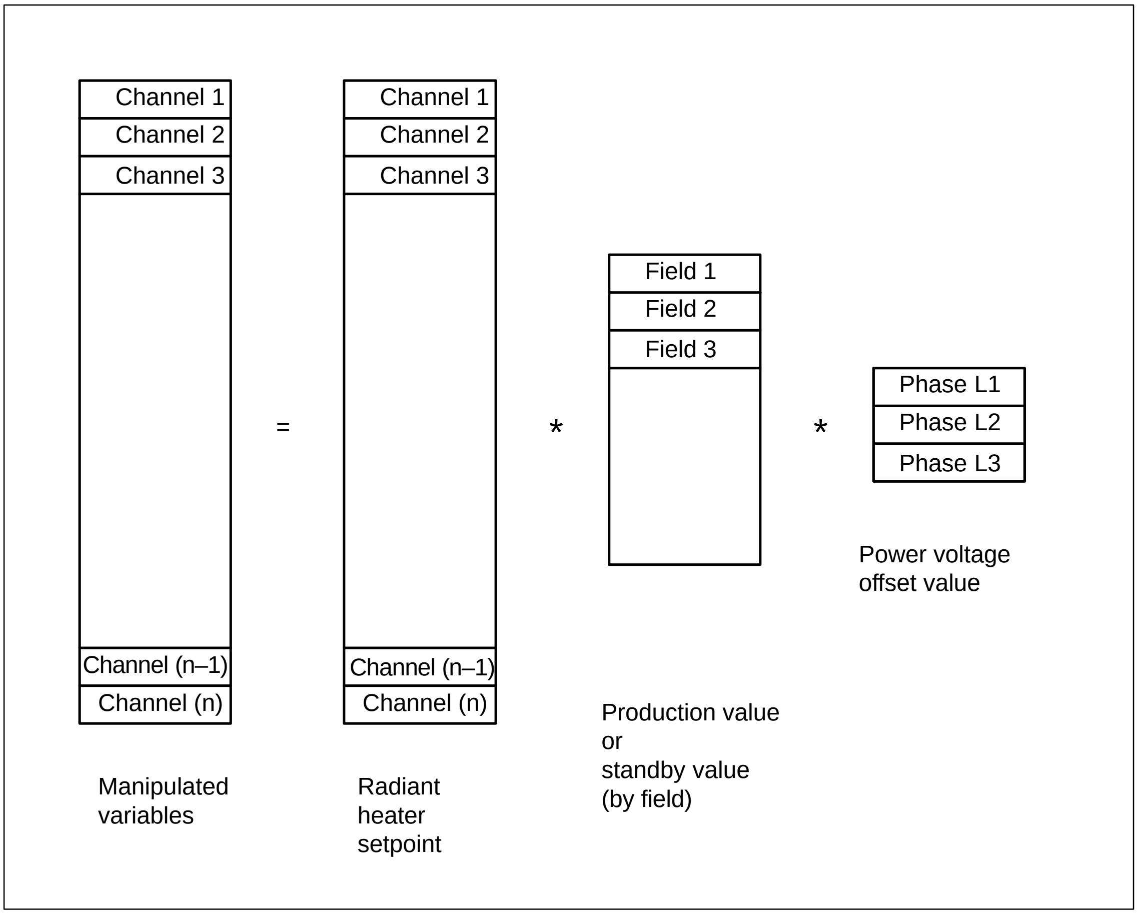


Figure 4-7 Principle of manipulated variable calculation

The capacity of the radiant heaters can set with a resolution of 1%.

The cycle time is shown below.

- 1 sec for half-wave operation
- 2 sec for full-wave operation

Synchronization with phase L1 is performed on the central interface.

Updating the manipulated variables

The manipulated variables are recalculated when new data arrive from the S7 (i.e., radiant heater setpoints, production or system voltage offset values).

- A radiant heater setpoint has changed. → The corresponding channel manipulated variable is recalculated.
- A production value has changed. → All channel manipulated variables of the affected field are recalculated.
- A system voltage offset value has changed. → The manipulated variables for all channels of the affected phase are recalculated.

4.3.2 Addressing the Power Outputs

Addressing the power outputs with the manipulated variables is synchronized by phase L1.

The L1 signal has the following functions.

- Trigger addressing of all power outputs of phase L1 directly
- Start a timer which starts the processing for the subsequent half-waves

New data

When new data arrive from the S7 during normal operation (i.e., radiant heater setpoints, production or system voltage offset values), output processing is not terminated. The new values are processed in stages (see “manipulated variable calculation” in chapter 4.3.1) and used for addressing the power outputs.

All power outputs are using the new manipulated variables no later than 2 seconds after the new data were received.

Power loss of the module

Depending on the switching capacity per output and the number of channels per module, the LA 724 has the power losses specified in table 4-3. The ambient temperature is 55˚ C.

Table 4-3 Power loss of the LA 724 at 55˚ C

Power Loss of the Module (in W)	Power Loss of the Module (in W)	
	With 24 Channels	With 12 Channels
100	16.3	7.6
200	21.8	10.7
300	34.0	16.5
400	47.5	22.9
500	61.6	29.6
600	77.0	36.7
700	93.0	44.1
800	110.5	52.0
900	128.5	60.3
1000	-	68.9
1100	-	77.9
1200	-	87.3
1300	-	97.1
1400	-	107.3
1500	-	117.9
1600	-	128.9

Figure 4-8 shows a graph of power loss.

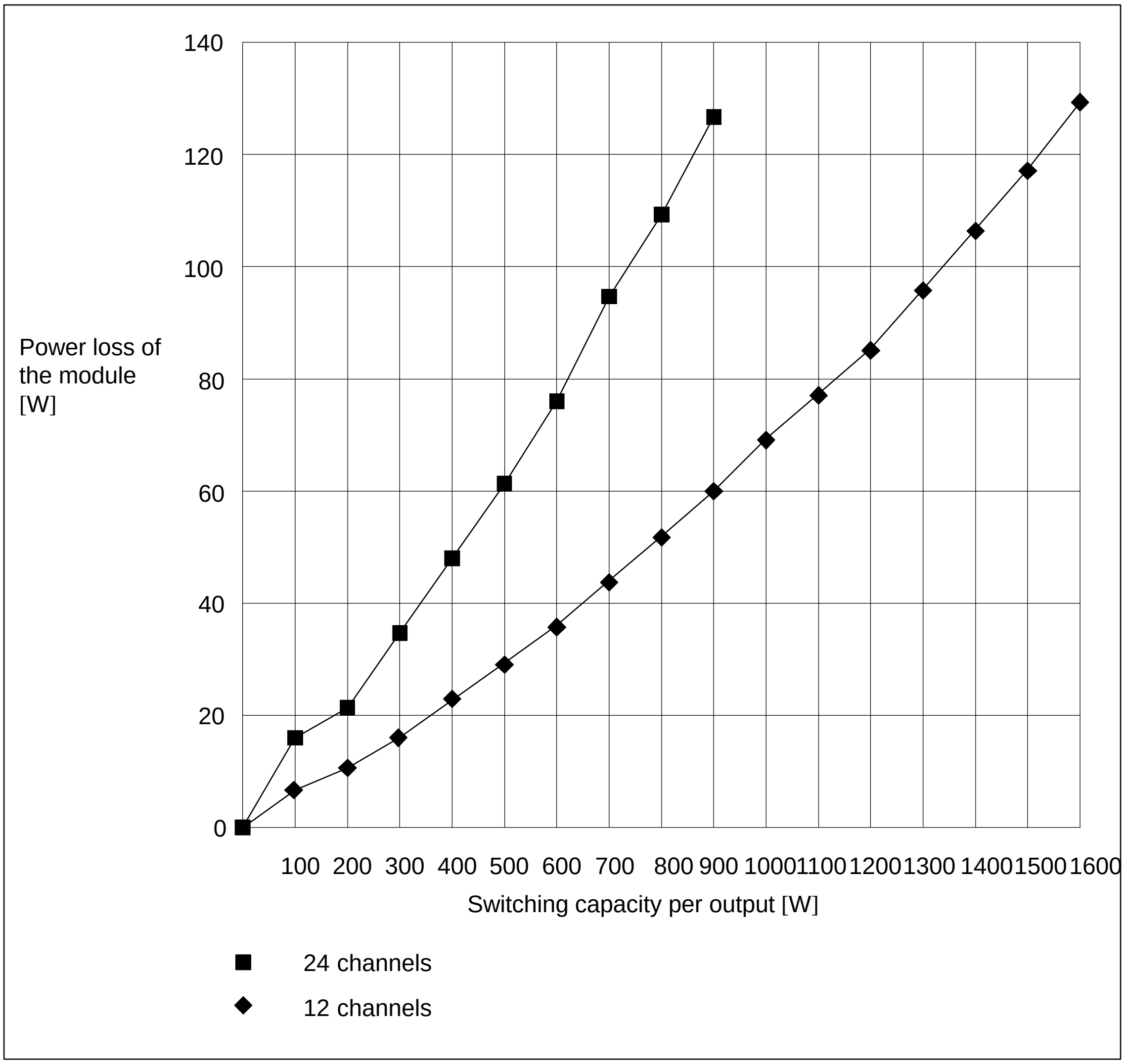


Figure 4-8 Power loss of the LA 724 at 55˚ C

4.3.3 Processing the Telegrams

The ZA 724 central interfaces act as slaves on PROFIBUS-DP.

The central interfaces receive parameter assignments and commands from the master (i.e., S7-CPU). At the same time, they provide the master with input data, and error and diagnostic information.

Data are exchanged in the form of telegrams on PROFIBUS-DP. New telegrams are recognized by polling the output and input buffers.

4.3.4 System Voltage Offset

To eliminate fluctuations in the system voltage, the HS 724 can be equipped with an NE 724 system voltage acquisition unit as an option.

The ZA then scans the system voltages cyclically, and integrates them using the integration time transferred during initialization.

Determination of the offset value

The ZA calculates a phase-related system voltage offset value from the system voltages determined and the standardization value (i.e., system voltage setpoint) transferred during initialization.

$$\text{Offset value} = \left(\frac{\text{Standardization value}}{\text{System voltage}}\right)^2 \times 100$$

If the system voltage corresponds to the system voltage setpoint specified (i.e., standardization value), the offset value is 100%. In other words, the setpoints are multiplied by the factor 1.

The offset value is fetched by the S7-CPU with FC_KOP. The controller then transfers the current system voltage offset values for the calculation of the manipulated variables to all ZA 724 central interfaces.

Note

System voltage offset values can also be transferred to the central interfaces when no NE 724 is installed.

Sample calculation

The following examples show the calculation of the offset value and the resulting change in the radiant heater setpoint for a power voltage greater or less than the standardized value.
The standard value is to be 230 V.

1. Power voltage = 210 V (< standardized value)

   $$\text{Offset value} = \left(\frac{230}{210}\right)^2 \times 100 = 120\ \%$$

   The parameterized radiant heater setpoint is multiplied by this offset value.
   Radiant heater setpoint before offset: 80 %
   Radiant heater setpoint after offset: 96 %

2. Power voltage = 240 V (> standardized value)

   $$\text{Offset value} = \left(\frac{230}{240}\right)^2 \text{ x } 100 = 92\ \%$$

   The parameterized radiant heater setpoint is multiplied by this offset value.
   Radiant heater setpoint before offset: 80 %
   Radiant heater setpoint after offset: 73 %

Standardization values

The standardization values are phase-related, and are permanently assigned to the channels.

The following applies to each LA 724 power output.

Channels 1 to 8	Phase L1
Channels 9 to 16	Phase L2
Channels 17 to 24	Phase L3

Reaction to errors

If the NE 724 determines a system voltage of less than 80% of the standardization value specified, an error in the system voltage acquisition is assumed. The offset value is set to “1”, and a message is output to the S7-CPU.

4.4 Monitoring

Description

The heating controller monitors the following.

- The outputs of the power outputs
- The temperature of the power output modules

When an error occurs, a diagnostic message is prepared for the S7-CPU.

Power outputs of a field which is not enabled for checks (see chapter 5.3.8) are not monitored.

To prevent HS 724 malfunctions, we recommend monitoring S7-CPU – ZA 724 communication.

Note

The temperature on the radiant heaters is not monitored by the HS 724.

4.4.1 Outputs of the Power Outputs

Introduction

During normal operation, the software monitors the power outputs in all fields enabled for the performance of checks.

Checking cycle and error message

Duration of a checking cycle for one ZA 724 with 384 channels (16 LA 724s):

- Approx. 15.3 sec at a power frequency of 50 Hz
- Approx. 12.8 sec at a power frequency of 60 Hz

As soon as an error is detected, the affected channel is tested a second time. If the error occurs again, the message is entered in the diagnostic buffer and the response message bit DIAG is set.

To prevent incorrect diagnoses for error types “module error” and ”triac short circuit,” the number of additional test measurements can be parameterized.

The first time an error occurs, an error-related identifier is entered in a buffer (1 byte per channel, total size: 384 bytes). If the same error occurs again during the next checking cycle after approx. 15 sec, the error entry is incremented by 1. When the sum of “initial value + parameterized number of test measurements” is reached, the type of error is entered in the diagnostic buffer to the S7-CPU. If the error disappears before the maximum number of measurements has been performed, the error buffer for the tested channel is deleted again.

With 3 additional measurements, approx. 1 minute passes between the occurrence of an error and its reporting.

Types of errors

Monitoring distinguishes between three types of errors.

- **Module errors**
  - The power switch cannot be turned on (i.e., triac has high resistance).
  - The module fuse has blown.

The diagnostic function of the HS 724 cannot specify these errors in more detail.

If a short circuit occurs on the output, the fuse blows when the output is addressed (≙ the module fuse blows).

- **External errors**

The heating current circuit has been interrupted by one of the following conditions.

  - External fuse has blown.
  - Cable break
  - Radiant heater breakdown

- **Triac has short circuited.**

  The power switch cannot be turned off.

If an external error or Triac short-circuit is involved, the error test is immediately started again for the affected channel (based on the parameterized number of test measurements for triac short-circuit). If the second test confirms the error, the diagnostic function of the module is called and the error is determined in detail.

4.4.2 Temperature on the Power Outputs

Description

The temperature of the heat dissipater is continuously monitored on the LA 724 power outputs.

An excess temperature equal to or greater than approximately 92° C is reported to the host controller.

A heating cycle in progress can always be concluded and must **not be aborted.**

Warning

Using the host S7-CPU, you must ensure that the next heating cycle cannot be started until the temperature has returned to its permissible range.

If the temperature of the heat dissipater continues to increase, the power outputs of the module are switched off when the temperature reaches approx. 100° C. See also chapter 2.2.1.

See chapter 4.5 for information on how to prevent excess temperatures.

4.4.3 Communication

Introduction

When communication between the S7-CPU and the ZA 724 is running correctly, the handshake bits (WD) alternate their states. See also chapter 6.1. When the watchdog bits stop alternating their status, communication between the partners has failed. Malfunctions can be caused by the HS 724.

Monitoring the WD bits

To prevent communication failures, we recommend that the user scan the status of **one** WD bit (either WD of the S7 or WD of the ZA) regularly in his/her controller program. See chapter 6.1.

Emergency switch-off

When the watchdog bit no longer alternates, the three-phase current network must be switched off via power contactors so that malfunctions can be effectively prevented.

4.5 Error Treatment and Correction

Introduction

Two categories of errors can occur on the HS 724 heating controller.

- Errors during startup (initialization)
- Error during normal operation

Errors on the power outputs which occur during normal operation can be prevented or corrected by specific measures.

Errors during startup

If it is detected that the neutral conductor is broken during ZA 724 startup (initialization), heating operation is not possible.
The error must be corrected.
After correction, job 09 must be sent to the ZA 724 again and the test routines are performed again for break in the neutral conductor.

When a rotary current network with neutral conductor is parameterized and the neutral conductor is not broken, a check is made to determine whether the phases of the rotary current network are correctly connected. If the phase sequence is reversed, the appropriate message is entered in the diagnostic buffer but heating operation is still continued. No information on the phase sequence is provided for networks without neutral conductors or when the neutral conductor is broken.

Errors during normal operation

When errors occur during normal operation, the heating controller reacts as shown in table 4-4.

Table 4-4 Errors during normal operation

Error	Reaction
Watchdog error (System is completely overloaded with regard to time, or a HW/SW error has occurred.)	Automatic hardware reset and new start (initialization) The user must transfer his/her jobs to the ZA again.
Bus error (Time out caused by a defective bus cable or an S7-CPU failure, for example)	Automatic reset of the outputs and new start (initialization) The user must transfer his/her jobs to the ZA again.
Module error	Message to the S7-CPU
Traic short circuit	Message to the S7-CPU
External errors	Message to the S7-CPU
Excessive temperature: 1st stage (92° C)	Message to the S7-CPU
Excessive temperature: 2nd stage (100° C)	Power outputs are switched off.
Value error The manipulated variable has exceeded the 100% value.	Message to the S7-CPU Processing is continued with the manipulated variable 100%.

Excessive temperature

Excessive temperatures can occur on an LA 724 power output when a switching capacity of 24 x 650 W with 100% simultaneity is exceeded without additional cooling.

Higher switching capacities can be achieved under the following conditions.

- 1000 W The LA 724 module is equipped with an external fan (air current speed ≥ 2.5 m/sec). See chapter 3.4.
  1500 W Only every second channel of the power output is used to address the radiant heaters, and the LA 724 is equipped with an external fan (air current speed ≥ 2.5 m/sec). See chapter 3.4.

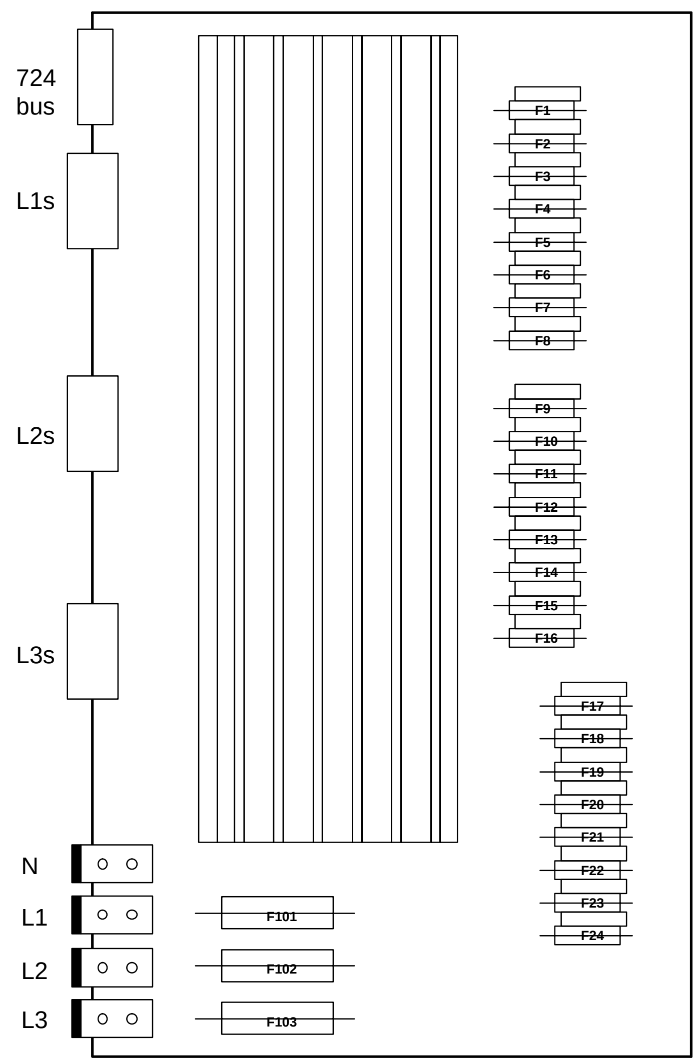
Blown fuse

Each channel of the LA 724 power output is equipped with a 5 A F fuse which will blow when a short circuit occurs on the output, for example.

These channel fuses are located on the power output.

- directly behind the heat dissipater (6ES7 171-2AA01-0AA0, see figure 4-9)
- directly on the front (6ES7 171-2AA02-0AA0, see figure 4-10)

Each of the three phase feeders is protected with a 32 A aM fuse.



F1 to F24: 5 A F (standard)

F101 to F103: 32 A aM

Figure 4-9 Location of the fuses on the LA 724 power output (6ES7 171-2AA01-0AA0)

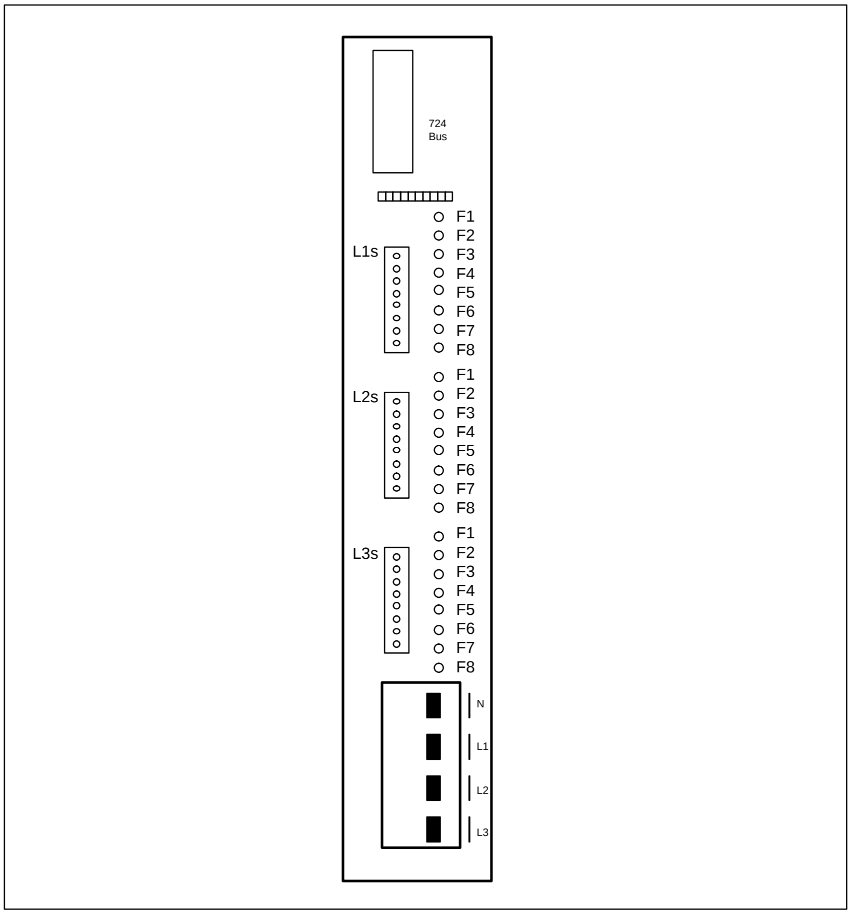


Figure 4-10 Location of the channel fuses on the LA 724 power output (6ES7 171-2AA02-0AA0)

The phase fuses on both LA 724s (6ES7 171-2AA01-0AA0 and -2AA02-0AA0) have the same location. See figure 4-9.

Replacing defective fuses

The LA 724 is equipped with a safety fuse for each channel to protect the power triac, and a fuse for each phase to limit the phase current (i.e., a total of 27 fuses).

To change a fuse, proceed as shown below.

Channel fuses on module 6ES7 171-2AA02-0AA0

Warning

The load circuit must be free of voltage before fuses can be changed.

1. Remove cap of fuse holder.
2. Replace defective fuse with fuse of same type.
3. Secure cap again.

Channel fuses on module 6ES7 171-2AA01-0AA0
Phase fuses on both module types

1. Disconnect ribbon cable of the parallel bus.
2. Disconnect the three plug-in connectors to the radiant heaters.
3. Disconnect the conductor rail connection.
4. Unscrew the two mounting screws with which the module is secured to the carrying plate.
5. Remove the module towards the front.
6. Unscrew the four screws on the right-hand side portion of the metal capsule. Unscrew one screw each on the top and bottom surfaces. Then remove the housing cover with front plate. See figure 4-11.
7. Replace defective fuse(s) with same type. See figure 4-9 for the location of the fuses on the module.
8. Proceed in reverse order to reassemble and reinstall the module.

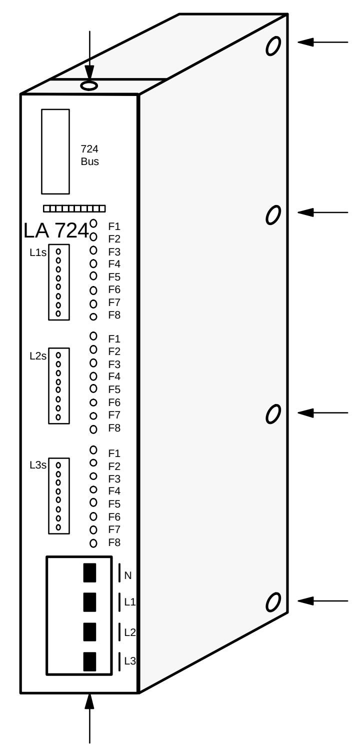


Figure 4-11 Opening the LA 724 for replacement of fuses

Reaction to supply voltage failures

A supply voltage failure which lasts longer than 20 msec triggers a restart of the HS 724 heating controller via reset.

The outputs of the LA 724 power outputs are reset after return of power.

Data Transmission with Use of Functions 5

This chapter describes the organization of data communication between S7-CPU (user program) and ZA 724 when functions are used.

The structure of the software and the layout of the data blocks are discussed.

All data are exchanged via jobs. The job headers and net data are shown for the individual jobs.

The system is controlled by control bits in the interprocess communication data block. Reactions are indicated by the response bits. Error messages keep the user informed of all malfunctions in the system.

The information in this chapter assumes that you have a knowledge of STEP7 programming.

5.1 Structure of the Software

The software for the HS 724 performs various tasks. It can be divided into four functional areas.

Startup software

During the transition from STOP to RUN, the startup software checks both the global and the ZA-related parameters in the DB_ZU allocation data block. It enables processing of the ZA, and synchronizes the enabled ZA with the controller. This requires that the FC_START function be called once in OB100.

The following checks are performed.

- The length of data blocks DB_IN and DB_OUT

  The data blocks may not be longer than 256 bytes. A configuration error of this type can cause the S7 CPU to switch to STOP. Using STEP7, the diagnostic entries of the S7 CPU can be used to localize the cause.

- The unambiguous allocation of the interprocess communication DBs to the ZAs (i.e., no assignment of identical DB numbers to different ZAs) Exception: No. DB_KOP = 0 means that the related ZA is not configured and subsequent checks are skipped. The ZA is not enabled for processing.

- The length of the DB_KOP

  The interprocess communication data blocks must be at least 204 bytes in length.

- The location of the DBW no. for the individual ZAs in DB_IN or DB_OUT

  The input and output areas of the ZA may not overlap. The DBW no. must be located in the valid area (i.e., DBW no. + 32 bytes ≤ length of DB_IN/DB_OUT).

If the data are reliable, the central interface is enabled for processing (write back in startup information).

If the data of a central interface are not reliable, the processing enable is disabled for all central interfaces. The appropriate error number is entered in the DB_ZU in the data area of the affected ZA, and the corresponding startup error message bit is set.

The startup software then checks the “ZA number with NE” entry. If this ZA does not have a processing enable, an error entry is made even when the ZA has not been configured. The entry “ZA number with NE = 0” entry suppresses processing of the system voltage offset.

The startup software sets the watchdog counter to 0 in the interprocess communication data blocks of the enabled ZA. This synchronizes controller and central interfaces before data communication begins.

Interprocess communication software

The interprocess communication software provides the interface between ZA 724 and user (S7-CPU).

All communication is handled by the DB_KOP data block. The system organization is stored in the DB_ZU data allocation data block. The DB_AP defines the data area for user applications.
The actual data transmission is executed by interprocess communication function FC_KOP. The FC_KOP must be called in OB1 once per S7 cycle and ZA.

The interprocess communication software transfers signals and data via bus software to PROFIBUS-DP, and then on to the individual ZA 724 central interfaces. Response messages and diagnostics are read by the ZA 724s and entered in the DB_KOP.

When an error occurs, the interprocess communication software is disabled for the entire HS 724.

Bus software

The bus software sends/receives data to/from the ZA 724 central interfaces via PROFIBUS-DP.

This software consists of the functions FC_IN and FC_OUT, and the data blocks DB_IN and DB_OUT.

There is one function for each direction of transmission.

- FC_IN distributes the input data from DB_IN to the interprocess communication DB
- FC_OUT copies the output data from the interprocess communication DB to DB_OUT.

These functions supply the current data both from PROFIBUS-DP and for PROFIBUS-DP. Data blocks DB_IN and DB_OUT are supplied cyclically with current data for all ZA 724s.

The FC_IN function must be called once in OB1 at the beginning of every S7 cycle. The FC_OUT function must be called once at the end of every S7 cycle. Errors during data transmission to the bus are recognized by these functions.

Control software

The control software is an independent application for the interprocess communication software.

In combination with the system voltage acquisition module, the control software keeps system voltage fluctuations from affecting the radiant heater capacity. This is achieved, for example, by specifying a system voltage offset value greater than 1 for a lower system voltage, and thus higher manipulated variables for the affected channels (radiant heater).

The FC_REG function accesses the input data in the DB_KOP of the ZA module with NE module. The function takes the required information from the allocation DB. If necessary, the function enters the system voltage offset values and the NSE control bit directly in the control area of all interprocess communication data blocks.

If necessary, the FC_REG function for processing the system voltage offset values can be included in the S7 cycle. The FC_REG must be called in OB1 once per S7 cycle.

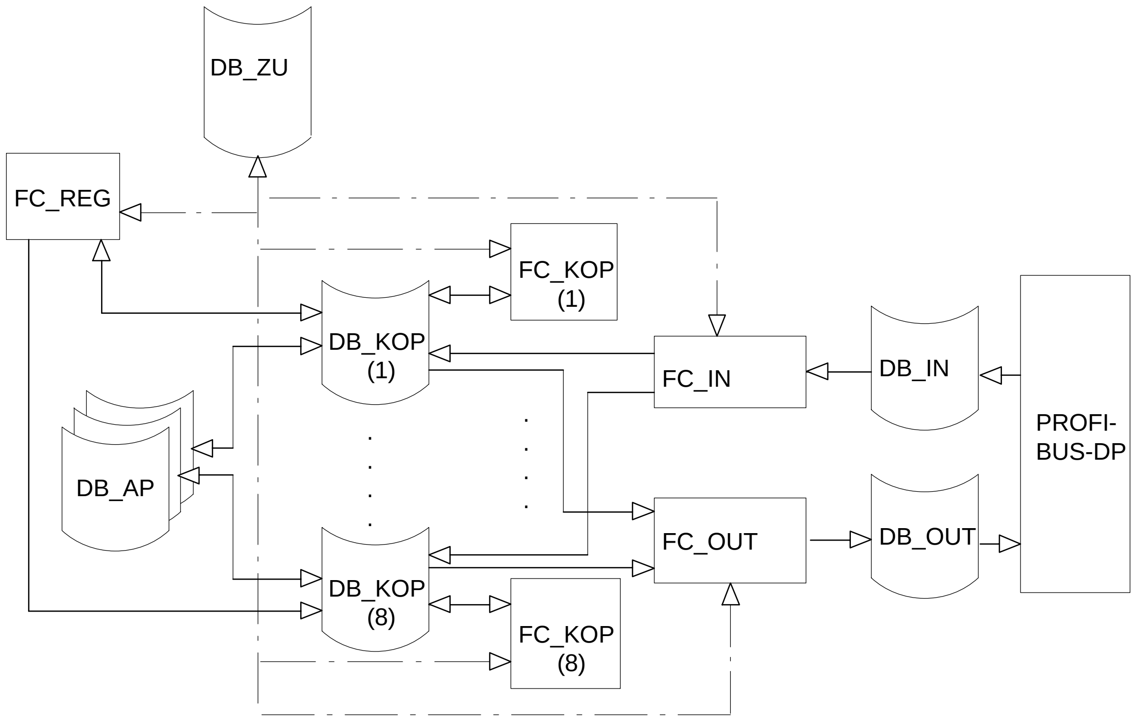


Figure 5-1 Structure of the S7 software

The functions must be called in OB1 (i.e., cyclic processing) in the sequence listed below.

1.	FC_IN	Read in data from the central interfaces
2.	FC_REG	Process the system voltage offset values
3.	FC_KOP	Process the data interface between ZA 724 and user for all central interfaces
4.	FC_OUT	Read out data for the central interfaces

5.2 Layout of the Data Blocks

The data blocks represent the actual user interface in the software.

The following data blocks must be set up by the user for operation of the HS 724.

- DZ_ZU Allocation data block
- DB_KOP Interprocess communication data block (once per ZA)
- DB_AP Data block for user applications
- DB_IN Data block for current data from all ZAs
- DB_OUT Data block with current data for all ZAs

5.2.1 DB_ZU (Allocation Data Block)

The organization of the system is described in the DB_ZU allocation data block. This data block must be fully parameterized and available before startup of the controller since it is evaluated there by the controller program and checked for consistency.

The data block contains the following information.

- Global information
- Specific information for each ZA 724
- Startup information

Layout

Figure 5-2 shows the layout of the DB_ZU allocation data block for CPUs **with** integrated PROFIBUS-DP interface (e.g., CPU 315-2 DP or CPU 413-2 DP).

DBW 0	DB_OUT no.	Global information
DBW 2	Length of DB_OUT in bytes	
DBW 4	DB_OUT no.	
DBW 6	Length of DB_OUT in bytes	
DBW 8	In reserve	
DBW 10	In reserve	
DBW 12	In reserve	
DBW 14	In reserve	
DBW 16	Number of OB cycles for watchdog	
DBW 18	No. of ZAs with NE 724	
DBW 20	DB_KOP no.	Data area for first ZA 724
DBW 22	DBW no. in DB_IN	
DBW 24	DBW no. in DB_OUT	
DBW 26	I/O address of the HS 724 on PROFIBUS-DP	
DBW 28	In reserve	
DBW 30	Job status FC_KOP	
DBW 32	Error number FC_KOP (FC_START)	
DBW 34	Extra error information FC_KOP (FC_START)	
DBW 36	In reserve	
DBW 38	In reserve	
DBW 40	DB_KOP no.	Data area for second ZA 724
DBW 42	DBW no. in DB_IN	
DBW 44	DBW no. in DB_OUT	
DBW 46	I/O address of the HS 724 on PROFIBUS-DP	
DBW 48	In reserve	
DBW 50	Job status FC_KOP	
DBW 52	Error number FC_KOP (FC_START)	
DBW 54	Extra error information FC_KOP (FC_START)	
DBW 56	In reserve	
DBW 58	In reserve	
	• • •	

⋮	⋮	
DBW 140	DB_KOP no.	Data area for seventh ZA 724
DBW 142	DBW no. in DB_IN	
DBW 144	DBW no. in DB_OUT	
DBW 146	I/O address of the HS 724 on PROFIBUS-DP	
DBW 148	In reserve	
DBW 150	Job status FC_KOP	
DBW 152	Error number FC_KOP (FC_START)	
DBW 154	Extra error information FC_KOP (FC_START)	
DBW 156	In reserve	
DBW 158	In reserve	
DBW 160	Processing enable slaves/error message slaves	Startup information
DBW 162	In reserve	
DBW 164	In reserve	
DBW 166	In reserve	
DBW 168	In reserve	
DBW 170	In reserve	
DBW 172	In reserve	
DBW 174	In reserve	
DBW 176	In reserve	
DBW 178	In reserve	

Figure 5-2 Layout of the DB_ZU allocation data block for CPUs with integrated PROFIBUS-DP interface

Global information

Global information is only stored once in the system and applies to all ZAs.

- Transmission blocks

  During startup, the controller program checks the transmission blocks DB_IN and DB_OUT by accessing the data word with the highest number. The controller switches to STOP if the data block is missing or does not have the specified length.

- Number of OB cycles for the watchdog

  This entry specifies the number of OB cycles which may be performed before the watchdog is triggered.

- Number of the ZA with NE 724

  An NE module may only be installed in one ZA 724 for the entire system. The control software evaluates the 'NSE' response message in the response signals of this ZA.

  Specification of 'number of the ZA with NE 724' = 0 means that no NE module is installed in a ZA.

Specific information for each ZA 724

Specific information must be stored for each of the seven possible ZA 724s. This information is checked for data consistency by the controller program during startup.

After the check has been performed successfully, this ZA is enabled for processing. This enable is recorded in the startup information.

- Number of the DB_KOP interprocess communication data block assigned to the ZA

  One DB_KOP interprocess communication data block must be set up for each ZA.

  During startup, the program checks the parameterized data area. Communication with this ZA can be suppressed during startup by specifying DB_KOP = 0. Subsequent data consistency checks of the specific information will also not be performed.

- Offset to the input area in the DB_IN transmission data block

  The 32-byte DP input area of the ZA starts at the offset address set.

  Specification of the offset address plus 32 bytes may not exceed the total length of DB_IN specified in the global information. In addition, the input areas of the various ZAs may not overlap.

- Offset to the output area in the DB_OUT transmission data block

  The 32-byte DP output area of the ZA starts at the offset address set.

  Specification of the offset address plus 32 bytes may not exceed the total length of DB_OUT specified in the global information. In addition, the output areas of the various ZAs may not overlap.

- I/O address of HS 724 on PROFIBUS-DP

  The entry must match the I/O address for the ZA (DP slave) specified in STEP 7 during hardware configuration.

- Job status of FC_KOP. See "application area in the DB_KOP" in chapter 5.2.2.
- Error number of FC_KOP. See "application area in the DB_KOP" in chapter 5.2.2.
- Extra error information of FC_KOP. See "application area in the DB_KOP" in chapter 5.2.2.

  If an error occurs during startup, the FC_START function also enters an error number or a piece of extra error information.

Startup information

- Enable for processing

  If the global and specific data are consistent, the ZA is enabled for processing.

X	EN 7	EN 6	EN 5	EN 4	EN 3	EN 2	EN 1	Enable (EN) for ZA no.
180.7	180.6	180.5	180.4	180.3	180.2	180.1	180.0	Bitnumber S7 convention

- Error messages

  If the data of one of the ZAs are inconsistent, the processing enable for all ZAs is disabled. In addition, the appropriate error number is entered in the DB_ZU, and the corresponding startup error message bit is set.

X	EM 7	EM 6	EM 5	EM 4	EM 3	EM 2	EM 1	Error message (EM) for ZA no.
181.7	181.6	181.5	181.4	181.3	181.2	181.1	181.0	Bit number S7 converntion

5.2.2 DB_KOP (Interprocess Communication Data Block)

The DB_KOP interprocess communication data block contains the following information for the corresponding ZA 724.

- The input and output areas with handshake, control and response bits
- The pointer to the user applications (DB_AP). Up to eight user applications are permitted.
- The working area for the FC_KOP

Layout

Figure 5-3 shows the layout of the DB_KOP interprocess communication data block

DBW 0	Handshake bits/I/O flag, job	32-byte transmission area[1] (read out from ZA 724)
DBW 2	Extra information/number of bytes	
DBW 4	Current frame number/number of frames	
DBW 6	Net data (maximum of 20 bytes)	
DBW 8		
DBW 10		
DBW 12		
DBW 14		
DBW 16		
DBW 18		
DBW 20		
DBW 22		
DBW 24		
DBW 26	Response bits	
DBW 28		
DBW 30	Reserved/handshake bits	
DBW 32	Handshake bits/I/O flag, job	32-byte-transmission area[2] (read in to ZA 724)
DBW 34	Extra information/number of bytes	
DBW 36	Current frame number/number of frames	
DBW 38	Net data (maximum of 20 bytes)	
DBW 40		
DBW 42		
DBW 44		
DBW 46		
DBW 48		
DBW 50		
DBW 52		
DBW 54		
DBW 56		
DBW 58	Control bits	
DBW 60		
DBW 62	Reserved/handshake bits	

1 The transmmission area is an image of the transmission interface in DB_IN.
2 The transmission area is an image of the transmission interface in DB_OUT.

Address	Content	Area
DBW 64	Application 1	Application area (14 bytes per application)
DBW 78	Application 2	
DBW 92	Application 3	
DBW 106	Application 4	
DBW 120	Application 5	
DBW 134	Application 6	
DBW 148	Application 7	
DBW 162	Application 8	
DBW 176 ⋮	Watchdog counter ⋮	Working area[3] FC_KOP

[3] Do not use

Figure 5-3 Layout of the DB_KOP interprocess communication data block

See chapter 5.4 for a detailed description of the control and response bits.

Note

Do not change handshake bits, extra information and net data in DB_KOP when using the functions.

Application area

The user communicates with the ZAs via jobs. Up to eight job interfaces (i.e., applications) are available in the DB_KOP.

The job header is entered in the interface.

The controller is the master (i.e., jobs are only sent from the controller to the central interfaces).

Transmission areas

The user can monitor the current status of the read/write jobs in the transmission areas. See chapters 5.3 and 5.4 for detailed information.

5.2.3 DB_AP (Application Data Block)

The DB_AP application data block defines the data area for the user applications.

The DB_AP contains the net data of a job which has been entered in the application area of the DB_KOP. See chapter 5.2.2.

The job data of an application in the DB_KOP contain the following information.

- The definition of the job (i.e., job identifier)
- The direction of transmission of the data
- The pointer to the data
- The length of the data
- Extra information
- The job status

Although data transmission is organized by the FC_KOP, the interprocess communication software does not check the job data.

Layout

Figure 5-4 shows the layout of the DB_AP application data block.

Due to the size of the output buffer, the data for an application are stored by frames in the DB_AP.

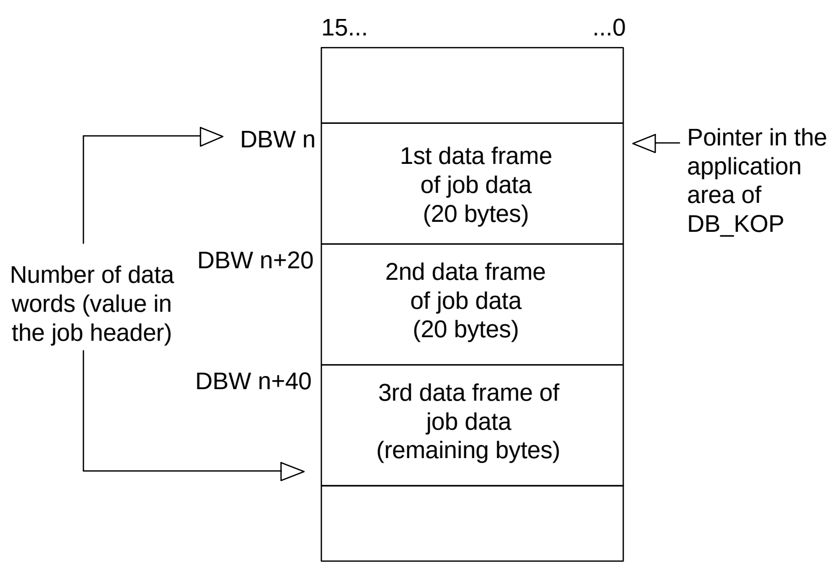


Figure 5-4 Layout of the DB_AP application data block

5.2.4 DB_IN (Read Transmission Data Block)

The DB_IN data block is used to transfer data from the ZA 724 central interfaces. Each ZA has 32 bytes of input data.

The integrated PROFIBUS-DP interface of the CPU coordinates bus access and data transmission via the PROFIBUS-DP field bus. FC_IN function calls must be included in the user program for the communication. The FC_IN function receives a pointer to the data in the DB_IN and the number of data bytes to be transferred.

Layout

Figure 5-5 shows a configuration for the DB_IN transmission data block.

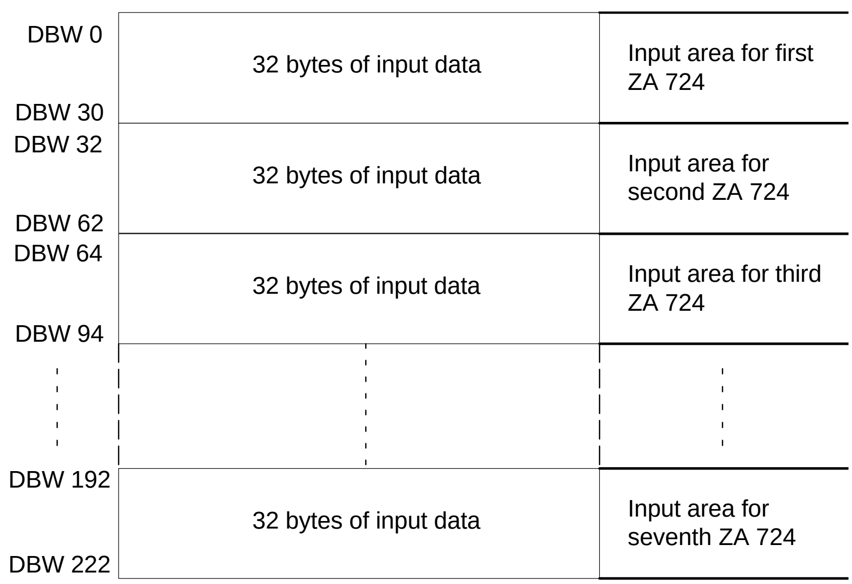


Figure 5-5 Layout of the DB_IN transmission data block

Note

Actual assignment of the input areas to the central interfaces must be parameterized in the DB_ZU allocation data block.

5.2.5 DB_OUT (Write Transmission Data Block)

The DB_OUT data block is used to transfer data to the ZA 724 central interfaces. Each ZA has 32 bytes of output data.

The integrated PROFIBUS-DP interface of the CPU coordinates bus access and data transmission via the PROFIBUS-DP field bus. FC_OUT function calls must be included in the user program for the communication. The FC_OUT function receives a pointer to the data in the DB_OUT and the number of data bytes to be transferred.

Layout

Figure 5-6 shows a configuration for the DB_OUT transmission data block.

DBW 0 DBW 30	32 bytes of output data	Output area for first ZA 724
DBW 32 DBW 62	32 bytes of output data	Output area for second ZA 724
DBW 64 DBW 94	32 bytes of output data	Output area for third ZA 724
⋮	⋮	⋮
DBW 192 DBW 222	32 bytes of output data	Output area for seventh ZA 724

Figure 5-6 Layout of the DB_OUT transmission data block

Note

Actual assignment of the output areas to the central interfaces must be parameterized in the DB_ZU allocation data block.

5.3 Jobs

Larger amounts of data are transferred only when required and not cyclically. This prevents high system loads and ensures data consistency. So-called “jobs” are used to transfer the data.

A job consists of a header and the net data. The header is stored in the application area of the DB_KOP interprocess communication data block. This application area can contain up to seven applications (i.e., job interfaces). The net data are entered in any of the DB_AP application data blocks.

Note

Remember the following when inputting and outputting data.

- The data to be transferred for one job must be located in one data block.
- The job must be called cyclically for a cyclic data update.
- A running job may not be terminated.

Job structure

A job is transferred as a telegram. Each telegram contains 32 bytes. See figure 5-7. The handshake bits are repeated in the last byte of the telegram for data consistency.

If a job contains more than 20 bytes of net data, it is divided into frames.

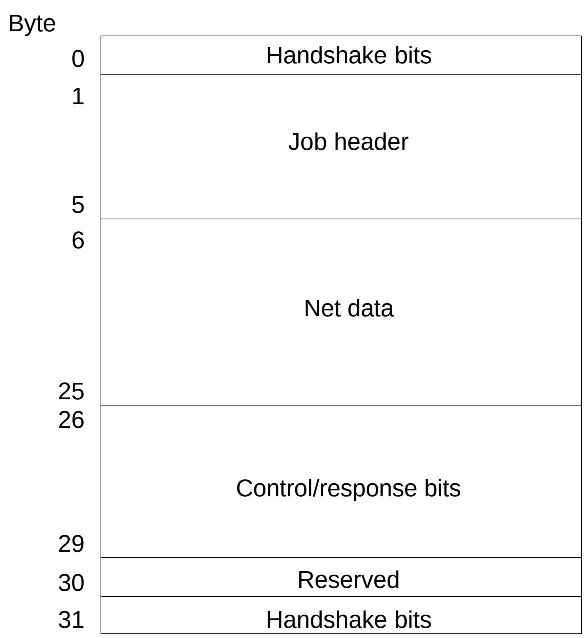


Figure 5-7 Structure of a job

5.3.1 Job Header

The job header contains information characteristic to a job.

Layout

Figure 5-8 shows the layout of the job header (i.e., excerpt from the DB_KOP interprocess communication data block).

DBW n	I/O flag; job/extra information
DBW n+2	In reserve
DBW n+4	DB_AP no.
DBW n+6	DBW no. in DB_AP
DBW n+8	Number of DWs for transmission
DBW n+10	Job status/in reserve
DBW n+12	Error no./extra error information

Figure 5-8 Layout of the job header

The shaded areas must be specified by the application (i.e., the user). The unshaded areas contain responses messages from the ZA 724 and FB_KOP to the application.

Contents

The individual data words contain the following information.

I/O flag	Read in/read out	
	DBX n.7=1	Transfer the data from the S7-CPU to the ZA 724 (read in)
	DBXn.7=0	Transfer the data from the ZA 724 to the S7-CPU (read out)
Job	Defines the job (i.e., specifies the type of job)	
Extra information	Additional parameter when a job must be specified in more detail	
DB_AP no./ DBW no. in DB_AP	Pointer to the net data of the job As soon as an entry other than 0 is made as the DB_AP no., a job is processed automatically. These two data words are cleared by the FC_KOP after the job has been completed.	
Number of DWs	Read in:	Number of data words to be transferred (i.e., net data) in DB_AP starting at the address specified
	Read out:	Number of the data words to be stored in DB_AP

Job status

Response message of the FC_KOP to the application concerning the current status of the job

0: No job active
1: Job running
2: Job finished without errors
3: Job finished with errors

Error no.

Error no. of the job which could not be executed correctly The error number is reported by either the ZA or the FC_KOP.

Only one error number is returned for each job since processing of the job is terminated after the first error is recognized.

Extra error information

Extra information can be reported for each error number.

Job status and error message are also entered in the DB_ZU and DB_KOP where they remain until a new job is triggered.

Table 5-1 contains a summary of the contents of the data headers for all jobs.

Table 5-1 List of the job headers for all jobs

Job	Meaning	I/O Flag	Extra Info	Number of DW	Operating Mode*
01	Module information	0	-	9	Initialization
02	Initialization	1	-	3	Initialization
03	Field allocation	1	-	x	Initialization/ Operation
04	Radiant heater setpoints	1	-	x	Operation
05	Production values	1	-	x	Operation
06	Standby values	1	-	x	Operation
07	Check command on/off	1	-	x	Operation
08	Diagnostics/general errors/temperature monitoring	0	0	2	Operation
08	Diagnostics/module error	0	1	24	Operation
08	Diagnostics/triac short circuit	0	2	24	Operation
08	Diagnostics/external error	0	3	24	Operation
08	Diagnostics/manipulated variable exceeded	0	4	24	Operation
09	Frequency measurement, check for phase sequence and directly grounded conductor	1	-	2	Initialization

x Depends on the number of ZA 724s

* The operating mode is set via the BAV control bits. See chapter 5.4.

5.3.2 Module Information (Job 01)

The following information is determined by the HS 724 during initialization.

- Which slots contain an LA 724
- Whether an NE 724 system voltage acquisition unit is installed
- The firmware version

The result is reported back in job 01.

If a bus connector or the bus cable is defective, only the modules up to the slot of the module with the defective bus connector/bus cable are recognized.

Net data

The module information is distributed as follows in nine data words. See example in figure 5-9.

DBW n — **LA 724 power output**

Bit = 0:	LA 724 installed
Bit = 1:	LA 724 not installed

One ZA 724 can handle up to 16 LA 724 modules.

DBW n+2 — **NE 724 system voltage acquisition unit**

DBW n+2 = 0:	NE 724 not installed
DBW n+2 = 1:	NE 724 installed

DBW n+4 to DBW n+16 — The firmware version is reported as an ASCII string with a fixed length of 14 bytes. The string is represented as follows: V0.04 06.14.96

DBW n	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
DBW n+2																1
DBW n+4 • • • DBW n+16	Firmware version															

Figure 5-9 Module information

5.3.3 Initialization (Job 02)

This job initializes and parameterizes the ZA.

- All radiant heater setpoints, production values and standby values are preset to “zero”.
- The system voltage offset values are preset to “100”.
- The field allocations are reset (i.e., cancelled).
- The power outputs are not checked.
- The counters for the test measurements for error types “module error” and “triac short-circuit” are preset to “0”.

Net data

The initialization data are distributed as follows over three data words. See example in figure 5-10.

DBW n

DBX (n+1).0(V) 0: Full-wave operation

1: Half-wave operation

DBX (n+1).1(V) 0: Power network without directly grounded conductor

1: Power network with directly grounded conductor

DBW n+2

Integration time: Multiple of 300 msec (default value: 10)

The NE 724 integrates the acquired system voltages over the specified time.

Standardization value: Setpoint voltage (default value: 240 V)

The values in DBW n+2 are only required when the NE 724 is installed in a ZA.

DBW n+4

Watchdog time: Multiple of 100 msec (default value: 20)

The watchdog time for the ZA 724 can be parameterized from 2 sec to 20 sec (value range: 20 to 200).

Number of test measurements: Value range: 0 to 3 (Default value: 0)

DBX (n+4).0 and .1 Number of additional evaluations of the “module error”

DBX (n+4).2 and .3 Number of additional evaluations of the “triac short-circuit”

DBX (n+4).4 to .7 Must be set to “0”

DBW n		N V
DBW n+2	Standardization value	Integration time
DBW n+4	Number of test measurements	Watchdog time

Figure 5-10 Initialization

Note

If the S7-CPU transfers illegal initialization data (e.g., for the watchdog time or bits 4 to 7 in DBB (n+4) are not 0), these data are automatically replaced by the firmware with the appropriate default values without a response message.

5.3.4 Field Allocation (Job 03)

The channels can be allocated to the fields by the S7-CPU as desired. Keep the following in mind when configuring.

- A maximum of 20 fields can be specified.
- Allocation of the channels to the fields can be selected via “field type”.

  0: All channels from the first channel to the last are allocated to the field number.

  1: Every second channel from the first channel to the last is allocated to the field number.

  2: The individual channels listed are allocated to the field number.
- Various allocations are permitted for a field number.
- The field allocation is completely specified after initialization. A new job 03 triggered during normal operation causes the channels specified in the job to be deleted from the existing field allocation and the new field allocation contained in the job to be entered.

Note

The HS 724 cannot be operated if not all the channels used are allocated to fields. See also chapter 4.3.1.

Net data

The example in figure 5-11 illustrates the definition of the field allocations. Allocation with three possible types of fields is used.

DBW n	Field no./field type (=0)
DBW n+2	Channel no., start
DBW n+4	Channel no., end
DBW n+6	Field no./field type (=2)
DBW n+8	Number of channels
DBW n+10	Channel no.
DBW n+12	Channel no.
	⋮
DBW n+x	Channel no.
DBW n+x+2	Field no./field type (=1)
DBW n+x+4	Channel no., start
DBW n+x+6	Channel no., end

Figure 5-11 Field allocation

5.3.5 Radiant Heater Setpoints (Job 04)

An individual radiant heater setpoint is transferred for each channel. These setpoints can be changed during normal operation.

After initialization, the heater setpoints for all channels are preset to “zero”.

Net data

Each heater setpoint can assume values from **0 to 100**. One unit corresponds to 1% (i.e., 100 = 100%).

The heater setpoints are defined as shown in figure 5-12.

DBW n	Channel no. 1	
DBW n+2	Reserved	Heater setpoint, channel no. 1
DBW n+4	Channel no. 2	
DBW n+6	Reserved	Heater setpoint, channel no. 2
DBW n+8	Channel no. 3	
DBW n+10	Reserved	Heater setpoint, channel no. 3
	. . . .	
	Channel no. x	
DBW n+y	Reserved	Heater setpoint, channel no. x

Figure 5-12 Radiant heater setpoints

5.3.6 Production Values (Job 05)

The production values are transferred for each field. The values can be changed during normal operation.

After initialization, the production values for all field are preset to “zero”.

Net data

The production values can be values from **0 to 255**. One unit corresponds to the factor 0.01 (i.e., 100 = 1.00).

The production values are defined as shown in figure 5-13.

DBW n	Field no. 1	Production value, field no. 1
DBW n+2	Field no. 2	Production value, field no. 2
DBW n+4	Field no. 3	Production value, field no. 3
	. . . .	
DBW n+2(z-1)	Field no. z	Production value, field no. z

Figure 5-13 Production values

5.3.7 Standby Values (Job 06)

The standby values are transferred for each field. The values can be changed during normal operation.

After initialization, the standby values for all fields are preset to “zero”.

Net data

The standby values can be values from **0 to 255**. One unit corresponds to the factor 0.01 (i.e., 100 = 1.00).

The standby values are defined as shown in figure 5-14.

DBW n	Field no. 1	Standby value, field no. 1
DBW n+2	Field no. 2	Standby value, field no. 2
DBW n+4	Field no. 3	Standby value, field no. 3
	. . . .	
DBW n+2(z-1)	Field no. z	Standby value, field no. z

Figure 5-14 Standby values

5.3.8 Check On/Off (Job 07)

The S7-CPU can use this job during normal operation to specifically include (i.e., “on”) or exclude (i.e., “off”) certain fields while checking the power outputs. As soon as the mode “normal operation” has been selected, the check routines are performed in the enabled fields. The channels of the fields which are excluded from the check are not checked.

After initialization, the standard setting is “do not check any fields” (channels).

Net data

The check command is specified as shown below.

- **0:** Do not check field.
- **1:** Check field.

Figure 5-15 shows examples of the transfer format of the check command.

DBW n	Field no. 1		1
DBW n+2	Field no. 2		1
DBW n+4	Field no. 3		0
		. . . .	
DBW n+2(z-1)	Field no. z		1

Figure 5-15 Check command

5.3.9 Read Out Diagnostics (Job 08)

Malfunctions of the HS 724 are reported as a group error with the DIAG response bit.

The appropriate area of the diagnostic buffer of the firmware must be read out using a job 08 with extra information.

Extra information = 0

Job 08 with “extra information = 0” transfers two data words in the DB_AP specified in the job. See figure 5-16.

DBW n					DS						NE -L3	NE -L2	NE -L1	NL	DF	
DBW n+2	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP

Figure 5-16 General errors/temperature monitoring

General errors:

- DBX (n+1).1 (DF) 0: No error
  1: Phase sequence has wrong direction.
- DBX (n+1).2 (NL) 0: No error
  1: Directly grounded conductor interrupted
- DBX (n+1).3 (NE-L1) 0: No error
  1: System voltage acquisition for phase L1 is defective.
- DBX (n+1).4 (NE-L2) 0: No error
  1: System voltage acquisition for phase L2 is defective.
- DBX (n+1).5 (NE-L3) 0: No error
  1: System voltage acquisition for phase L3 is defective.
- DBX n.0 to n.3 (DS) 0: No more reading out of diagnostics required
  DBX n.0= 1: Read out diagnostics for module errors
  DBX n.1= 1: Read out diagnostics for triac short circuit
  DBX n.2= 1: Read out diagnostics for external errors
  DBX n.3= 1: Read out diagnostics for “manipulated variable not permitted” type of error

Temperature monitoring: (For a maximum of 16 modules)

DBX (n+3).0 corresponds to the 1st module.

DBX (n+2).7 corresponds to the 16th module.

- TP bit = 0: Excessive temperature
- TP bit = 1: Normal temperature

Extra information = 1

Job 08 with “extra information = 1” transfers 24 data words in the DB_AP specified in the job.

The individual bits contain the information on module errors for all channels.

DBX (n+47).0 corresponds to channel 1.

DBX (n+47).1 corresponds to channel 2.

:

:

DBX (n+0).6 corresponds to channel 383.

DBX (n+0).7 corresponds to channel 384.

- Bit = 0: Channel has a module error.
- Bit = 1: Channel does not have a module error.

Extra information = 2

Job 08 with “extra information = 2” transfers 24 data words in the DB_AP specified in the job.

The individual bits contain the information on a triac short circuit for all channels.

DBX (n+47).0 corresponds to channel 1.

DBX (n+47).1 corresponds to channel 2.

:

:

DBX (n+0).6 corresponds to channel 383.

DBX (n+0).7 corresponds to channel 384.

- Bit = 0: Channel has a triac short circuit.
- Bit = 1: Channel does not have a triac short circuit.

Extra information = 3

Job 08 with “extra information = 3” transfers 24 data words in the DB_AP specified in the job.

The individual bits contain the information on external errors for all channels.

DBX (n+47).0 corresponds to channel 1.

DBX (n+47).1 corresponds to channel 2.

:

:

DBX (n+0).6 corresponds to channel 383.

DBX (n+0).7 corresponds to channel 384.

- Bit = 0: Channel has an external error.
- Bit = 1: Channel does not have an external error.

Extra information = 4

Job 08 with “extra information = 4” transfers 24 data words in the DB_AP specified in the job.

The individual bits contain the information for all channels as to whether the manipulated variable has exceeded the 100% value.

DBX (n+47).0 corresponds to channel 1.

DBX (n+47).1 corresponds to channel 2.

:

:

DBX (n+0).6 corresponds to channel 383.

DBX (n+0).7 corresponds to channel 384.

- Bit = 0: Channel has exceeded the 100% value.
- Bit = 1: Channel has not exceeded the 100% value.

5.3.10 Frequency Measurement, Check of Phase Sequence and Directly Grounded Conductor (Job 09)

If the conductor rails are not yet carrying voltage while the HS 724 is being initialized, the routines for frequency measurement, phase sequence monitoring and interruption of the directly grounded conductor will not be concluded successfully. These specific check routines are performed again with job 09 after voltage has been switched through to the conductor rails. A completely new initialization is not performed since the system has already been initialized.

Note

Checks of the phase sequence and the directly grounded conductor can only be executed correctly if the following has been provided for in the field allocation (i.e., job 03).
At least

- **one channel of phase L1** (channels 1 to 8) and
- **two channels of phase L3** (channels 17 to 24)

must be configured on the first LA 724.

If an error in the phase sequence or break in the directly grounded conductor is detected, the corresponding diagnostic bit is set. If the neutral conductor breaks, the power outputs cannot be addressed. Both LEDs (red and green) on the ZA start to flash. If there is an error in the phase field (phases are reversed), the HS 724 begins heating operation. The green LED on the ZA goes on.

Net data

The results of the checks are distributed as shown below over two data words. See also example in figure 5-17.

DBW n

Phase sequence
0: No error in the phase sequence
1: Error in the phase sequence
2: Channel for the phase sequence check not found

Power frequency
50: Power frequency = 50 Hz
60: Power frequency = 60 Hz

DBW n+2

Directly grounded conductor
0: Directly grounded conductor not interrupted
1: Directly grounded conductor interrupted: Test channel is not isolated (→ triac short circuit)
2: Directly grounded conductor interrupted: Test channel does not conduct (→ interruption of the directly grounded conductor or radiant heater break)
3: Channel for directly grounded conductor check not found

DBW n	Power frequency	Phase sequence
DBW n+2	Directly grounded conductor	

Figure 5-17 Frequency measurement, check of phase sequence and directly grounded conductor

5.4 Control and Response Bits

The DB_KOP interprocess communication data block contains the control and response bits in two data words each.

Each time FC_KOP is called, all control bits are transferred from DB_KOP to the ZA 724 and the response bits are read from the ZA 724 and entered in DB_KOP. This provides a cyclic update of the control and response bits.

Control bits

In the DB_KOP, the control bits are located in the data words shown in figure 5-18.

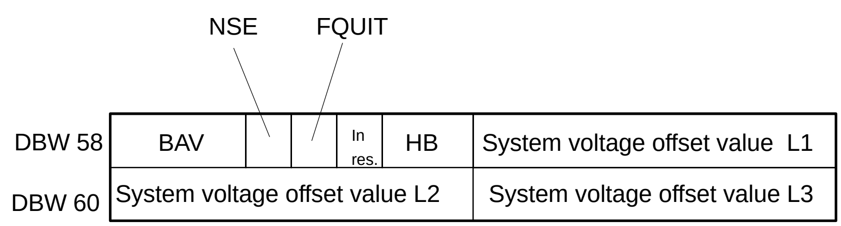


Figure 5-18 Control bits

Table 5-2 Meaning of the control bits

Bits	Meaning
BAV (DBX 58.5 to 58.7)	Preselection of operating mode 1: Initialization 2: Normal operation
NSE (DBX 58.4)	System voltage acquisition 0: No new offset values 1: New offset values
FQUIT (DBX 58.3)	Error acknowledgment 0 -> 1
HB (DBX 58.0 and 58.1)	Heating operation 0: Heating off 1: Production operation on 2: Standby operation on

System voltage offset values can be values from **64 to 255.** One unit corresponds to the factor 0.01 (i.e., 200 = 2.00).

The BAV and HB bits must be set **by the user** to meet his/her requirements. You can acknowledge the error message of the ZA by setting the FQUIT bit (i.e., edge acknowledgment bit).

The ZA with the NE 724 reports the presence of new system voltage offset values with the NSE response bit. The **FC_REG function** enters the system voltage offset values in the control interface and sets the NSE control bit. The new data are then accepted by all ZAs.

Response bits

In the DB_KOP, the response bits are located in the data words shown in figure 5-19.

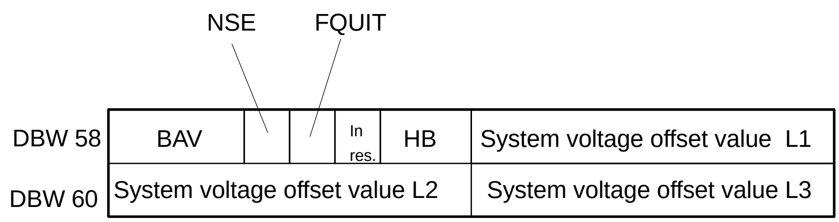


Figure 5-19 Response bits

Table 5-3 Meaning of the response bits

Bits	Meaning
BAR (DBX 26.5 to 26.7)	Response message of operating mode 1: Initialization 2: Normal operation
NSE (DBX 26.4)	System voltage offset values 0: No new offset values 1: New offset values
DIAG (DBX 26.3)	Diagnostics 0: No errors 1: Error on the modules
BER (DBX 26.2)	Ready for heating 0: Not ready 1: Ready
HB (DBX 26.0 and 26.1)	Heating operation 0: Heating off 1: Production operation on 2: Standby operation on

5.5 Error Messages

All malfunctions detected in the system are reported to the user via the communication interface (i.e., data blocks).

There are three types of error messages.

- Errors from the S7-CPU
- Errors in data communication
- Diagnostics

Errors from the S7-CPU and in data communication

Errors from the S7-CPU are detected by the FC_KOP function and reported. Some examples are listed below.

- Malfunction of communication to the ZA 724
- Bus errors
- DB does not exist.

Errors in data communication are detected by the firmware of the ZA 724 while the jobs are being processed (e.g., “channel does not exist” parameterization error).

Errors from the S7-CPU and in data communication are entered by the FC_KOP in the response message area of the job header in the DB_KOP. The shaded portion of figure 5-20 shows this response message area.

DBW n	I/O flag, job/extra information
DBW n+2	In reserve
DBW n+4	DB_AP no.
DBW n+6	DBW no. in DB_AP
DBW n+8	Number of DWs for transmission
DBW n+10	Job status/in reserve 3: Job finished with errors
DBW n+12	Error no./extra error information

Figure 5-20 Response message area of the job header

The error messages are organized by their error numbers.

- 1 to 100 Errors in data communication
- 101 to 200 Errors of the S7-CPU
- 201 to 255 Errors during startup

A piece of extra error information can be reported for every error number. Example: The message “value not permitted” occurs while the radiant heater setpoints are being read in. The channel number is then reported as extra error information.

The error number is retained in DB_ZU or DB_KOP until a new job is triggered. Only one error number is returned for each job since processing of the job is terminated after the first error is detected.

Table 5-4 contains a list of possible error messages.

Table 5-4 List of error messages

Error Number	Description	In Job No.
001	Length of job data in the job header is incorrect.	2, 3, 4, 5, 6, 7, 8
002	Field could not be set up.	3
003	Setpoint incorrect	4
004	Channel management list could not be set up.	3
005	Phase management list could not be set up.	3
006	Channel could not be entered in the channel management list.	3
007	Channel cannot be entered in the phase management list.	3
008	Field number unknown	5, 6, 7
009	Channel number unknown	4
011	Field could not be changed (i.e., memory error).	3
012	Channel could not be changed.	3
101	Watchdog expired -> SYNC (S7)	
102	SYNC (ZA) detected	
103	Error in the specification of the net data to be transferred	
104	Wrong frame number	
105	Wrong number of last frame	
106	Wrong user data length in frame number x	
200	DB_IN no. = 0	
201	Length of DB_IN violates area (> 256)	
202	DBB in DB_IN does not exist.	
203	DB_OUT no. = 0	
204	Length of DB_OUT violates area (> 256)	
205	DBB in DB_OUT does not exist.	
206	Number of DB_KOP not unique. The number has already been assigned to ZA x.	
207	DB_KOP too short (< 172)	
208	DBW no. for DB_IN too large	
209	DBW no. for DB_IN inconsistent	
210	DBW no. for DB_OUT too large	

Table 5-4 List of error messages

Error Number	Description	In Job No.
211	DBW no. for DB_OUT inconsistent	
212	Number of the ZA with NE 724 is invalid (i.e., ZA not configured).	
213	DB_IN no. same as DB_OUT no.	
214	DB_IN no. same as DB_ZU no.	
215	DB_OUT no. same as DB_ZU no.	
216	DB_KOP no. same as DB_IN no.	
217	DB_KOP no. same as DB_OUT no.	
218	DB_KOP no. same as DB_ZU no.	
255	Job was not processed.	1 to 9

Diagnostics

Diagnostic messages can occur anytime during normal operation. In contrast to errors in data communication, these messages are not bound to a certain action. Because of this fact, they are reported with the DIAG response bit in DB_KOP which is updated cyclically by FC_KOP. See chapter 5.4.

The firmware of the ZA 724 supplies the complete diagnostics buffer. The individual messages are entered there, organized by type of error.

Figure 5-21 shows the layout of the diagnostic buffer.

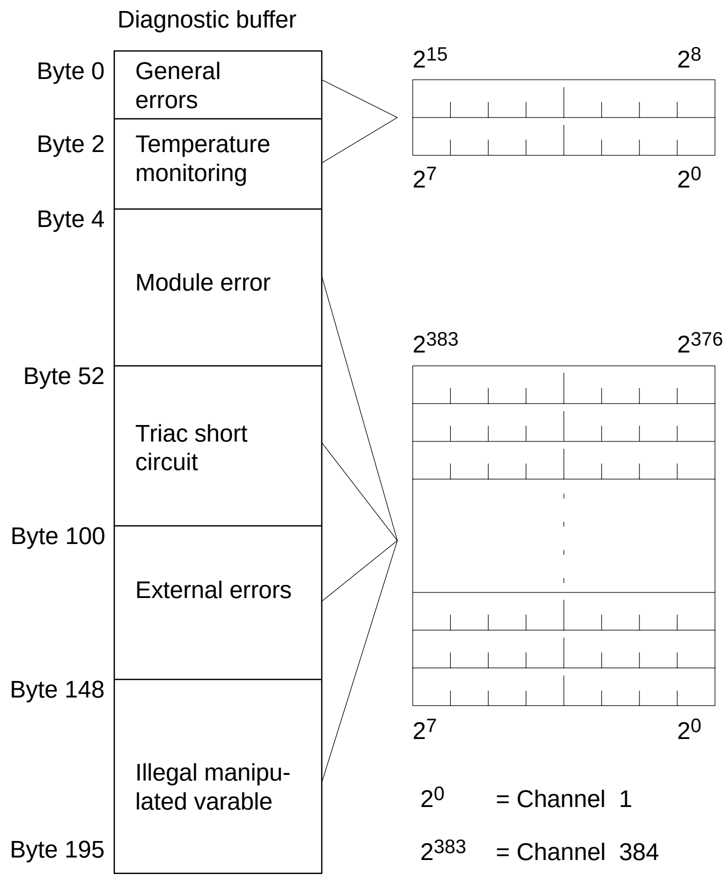


Figure 5-21 Layout of the diagnostic buffer

The diagnostic messages are read out of the diagnostic buffer via a diagnostic job containing appropriate extra information. See chapter 5.3.9. After the job has been executed, the messages are available in the DB_AP specified.

The firmware only provides the diagnostic messages. The user must then take action depending on the type of error (e.g., switch off the affected heater field).

6 Data Transmission Without Functions

This chapter describes data communication between S7-CPU and ZA 724 when no functions are used.

As when functions are used, the data are also stored in data blocks.

- DB_ZU System organization
- DB_KOP User applications
- DB_AP Data for user applications

The user must enter a job for the ZA 724 in the application area of DB_KOP. The S7-CPU recognizes the job and sets up your telegram(s) for the ZA 724. The ZA 724 processes the data in accordance with the job and provides response messages.

Handshake bits control the telegram communication between these two communication partners.

Telegrams to the ZA contain 4 control bytes for the system. Telegrams from the ZA contain 4 response message bytes. The appropriate error message is issued when an error occurs.

6.1 Telegram Handshake

Data are exchanged between S7-CPU and ZA 724 using 32-byte telegrams. Telegram exchange is always triggered by the S7-CPU since the S7-CPU is the master on the PROFIBUS-DP field bus. The handshake bits handle the coordination of the jobs and the synchronization during data communication.

Handshake bits

The handshake bits are located in byte 0 of the telegram and are repeated in byte 31 to ensure data consistency. Assignment of the handshake bits is the same for both the S7-CPU and the ZA 724.

7	6	5	4	3	2	1	0	Bit no.
0	0	FLT	RDY	ACT	STR	SYN	WD	Byte 0

WD

Watch**D**og

The S7-CPU continually attempts to keep the two bits (i.e., WD(S7) and WD(ZA)) in the same state. When the ZA 724 supplies a “0” in WD(ZA), the S7-CPU also sets its WD(S7) to “0”. When the ZA 724 supplies a “1” in WD(ZA), the S7-CPU also sets its WD(S7) to “1”.

In contrast, the ZA 724 continually attempts to keep the two bits (i.e., WD(S7) and WD(ZA)) in opposite states. When the S7-CPU supplies a “0” in WD(S7), the ZA 724 sets its WD(ZA) to “1”, and vice versa.

The watchdog is triggered when the communication partner does not supply the state of the WD bit expected, within the specified “number of OB cycles for watchdog” (DBW 16 in DB_ZU). See chapter 5.2.1.
The control program provides a counter for each ZA central interface. This counter is incremented until the ZA 724 has set its WD(ZA) to a state opposite to WD(S7). The counter is then reset to 0, and the watchdog is started again.
If the counter reaches the specified “number of OB cycles for watchdog”, this causes a watchdog error. S7-CPU and ZA 724 must be synchronized again.

SYN

SYNc_Request

When a new start is performed by the ZA 724 or the S7-CPU (e.g., after power on, STOP -> RUN of the CPU, watchdog error, bus connector reconnected, and so on), it requests synchronization via SYNc_Request (SYN bit = 1). The communication partner recognizes the transition from 0 -> 1 and also sets its SYN bit to “1”. Synchronization can now begin.

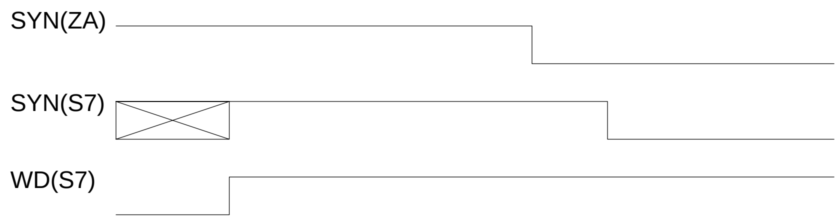
- The S7-CPU and ZA 724 set their bits 2 to 7 to “0” (i.e., external synchronization).
- Each communication partner synchronizes itself internally.
- After conclusion of the internal synchronization, the S7-CPU and the ZA 724 set their SYN bit to “0”.

Synchronization is now complete, and data communication can begin.

Note

The watchdog must be in operation during synchronization.

Example:
After experiencing a failure, the S7-CPU starts up again. The ZA 724 has already set its SYN bit to “1” since its watchdog had expired due to the S7-CPU failure. The states of the bits are shown in the diagram below.



STR

STRobe
Data communication is controlled with the STR bit.
When the S7-CPU wants to send a telegram, it enters the data in its sending mailbox and inverts its STR bit.
Based on the inverted state of the STR bit, the ZA 724 recognizes that data are waiting to be received. It accepts the data, enters its own telegram information if necessary, and inverts its STR bit.

Note

The S7-CPU may not enter new data in its sending mailbox as long as the STR bits have differing states.

ACT

ACTive
The ACT bit indicates whether data communication between S7-CPU and ZA 724 is taking place.
It is set (i.e., ACT = 1) under the following conditions.

- The S7-CPU sends the first frame of a telegram.
- The ZA 724 has received the first frame of a telegram.

It is reset (i.e., ACT = 0) under the following conditions.

- The last frame of a telegram has been sent.
- The last frame of a telegram has been received.
- An error has occurred.
- Synchronization has been requested (i.e., SYN = 1).

RDY

Rea**DY**
The RDY bit is set (i.e., RDY = 1) under the following conditions.

- Sending of the last frame of a telegram
- Correct receipt of the last frame of a telegram

The RDY bit is reset (i.e., RDY = 0) under the following conditions.

- Start of a transmission
- An error
- Request for synchronization (i.e., SYN = 1)

FLT

Fau**LT**
The FLT bit is set (i.e., FLT = 1) when an error occurs during data communication. See chapter 5.5.
It is reset (i.e., FLT = 0) under the one of the following conditions.

- Start of a transmission
- Request for synchronization (i.e., SYN = 1)

Figure 6-1 shows a diagram of the interplay of the 6 handshake bits.

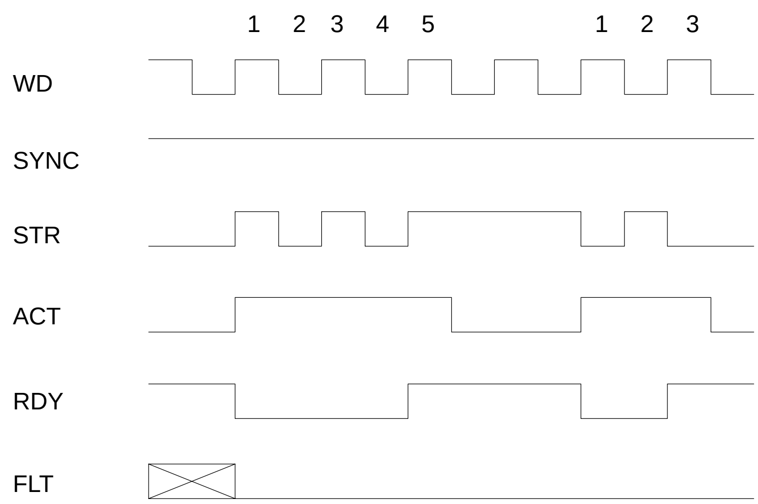


Figure 6-1 Status diagram of the handshake bits

6.2 Control and Response Bits

The bits for control of the ZA 724 (HS 724) and the bits with the response messages for the S7-CPU are located in bytes 26 to 29 of a telegram.
The following occurs each time the control program is called.

- All control bits are transferred to the ZA 724.
- All response message bits are read.

If no job is waiting to be executed, the STR handshake bit is not inverted when the control and response bits are transferred.

Control bits

BAV	NSE	FQUIT	X	HB	Control byte 1
System voltage offset value L1					Control byte 2
System voltage offset value L2					Control byte 3
System voltage offset value L3					Control byte 4

See chapter 5.4 for the meaning of the control bits.

Response bits

BAR	NSE	DIAG	BER	HB	Response message byte 1
System voltage offset value L1					Response message byte 2
System voltage offset value L2					Response message byte 3
System voltage offset value L3					Response message byte 4

See chapter 5.4 for the meaning of the response bits.

6.3 Reading In Data (S7 → ZA)

A job to read in data from the S7 to the ZA is indicated in the job header by setting the I/O flag to 1.

Information on the job

The following information must be entered by the user in the job header (i.e., application area of DB_KOP, see chapters 5.2.2 and 5.3.1).

- I/O flag = 1; job
- Extra information if necessary
- DB_AP no.
- DBW no. in DB_AP
- Number of DWs to be transferred

Execution of the job

The S7 does not perform further checks on the information contained in the job header. The net data are read from the area of the DB_AP (see chapter 5.2.3) specified in the job header, and transferred to the ZA 724 where the data are processed as specified by the job.

Telegram layout

DB_AP no. $\neq$ 0 tells the S7 that a job has been entered in the application area. I/O flag = 1 tells the S7 that a job to read in data is involved.
The S7-CPU then sets up its telegram to the ZA 724. See figure 6-2.

Byte	Contents
0	Handshake bits
1	I/O flag = 1; job
2	Extra information
3	Number of bytes of net data in the telegram
4	Current frame number
5	Number of frames
6	Maximum of 20 bytes of net data
...	
25	
26	Control byte 1
27	Control byte 2
28	Control byte 3
29	Control byte 4
30	Reserved
31	Handshake bits

Tele- gram header (bytes 0–5)

Figure 6-2 Frame of a telegram for reading from S7 to ZA

The I/O flag, job and extra information are copied directly from the application area of DB_KOP. The S7 uses the "number of DWs for transmission" entered by the user in the job header to calculate the following information.

- Number of bytes of net data in the telegram
- Current frame number
- Number of frames

Up to 20 bytes of net data can be transferred in one telegram.

Transmission

The S7 sets its ACT handshake bit for transmission of the first frame. The ZA acknowledges receipt of a telegram by inverting its STR bit. The S7 only evaluates the handshake and response message bits. Except for FLT(ZA) = 1, the other data in the telegram of the ZA are disregarded by the S7. See chapter 6.5.

After acknowledgment has been received, the S7 transfers the next frame of the telegram to the ZA. When the last frame is transferred, the S7 sets its RDY handshake bit.

The ZA sets up the complete telegram data between the first and the last frame. Since the telegram header is supplied with every frame of a telegram, the ZA has an additional method of monitoring the telegram. This also makes it easy for the user to follow the data transfer.

6.4 Reading Out Data (ZA → S7)

A job to read data from the ZA to the S7 is indicated in the job header by resetting the I/O flag to 0.

Information on the job

The following information must be entered by the user in the job header (i.e., application area of DB_KOP, see chapters 5.2.2 and 5.3.1).

- I/O flag = 0; job
- Extra information if necessary
- DB_AP no.
- DBW no. in DB_AP
- Number of DWs to be transferred

Execution of the job

The S7 does not perform further checks on the information contained in the job header. The net data are stored the area of the DB_AP (see chapter 5.2.3) specified in the job header. The data must be evaluated by the user after all frames of a telegram have been transferred.

Transmission

The transmission procedure for reading out data is illustrated by an example. Twenty-five data words (i.e., 50 bytes) are to be transferred to DB_AP.

During transmission, the handshake bits assume the states shown in figure 6-3.

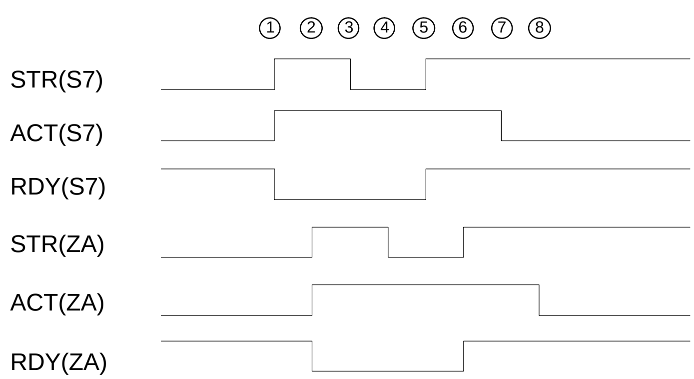


Figure 6-3 States of the handshake bits while data are being read out

The activities of the communication partners (i.e., S7 and ZA) will now be explained using the points in time ① to ⑧.

Point in time ①:
DB_AP no. $\neq$ 0 tells the S7 that a job has been entered in the application area. I/O flag = 0 tells the S7 that a job to read out data is involved.
Since “number of DWs for transmission” = 25, 3 telegram frames must be transferred from the ZA to the S7.
The S7-CPU then sets up its request telegram to the ZA 724. See figure 6-4.

Byte	Contents
0	Handshake bits
1	I/O flag = 0; job
2	Extra information
3	Number of bytes of net data in the telegram = 4
4	Current frame number = 1
5	Number of frames = 3
6	Net data requested = 50 (bytes)
7	
8	Current frame number = 1
9	Number of frames = 3
10	Not used
...	...
25	Not used
26	Control byte 1
27	Control byte 2
28	Control byte 3
29	Control byte 4
30	Reserved
31	Handshake bits

Figure 6-4 1st frame of the telegram for reading out from S7 to ZA

The I/O flag, job and extra information are copied directly from the application area of DB_KOP. The “number of bytes of net data in the telegram” is fixed at 4. The “current frame number” is 1, and the “number of frames” is 3.

The net data contain the explicit number of data bytes requested to be transferred from the ZA to the S7. The S7 performs no further checks on this number.

When the 1st frame is transferred, the S7 sets handshake bits

- ACT(S7) = 1 and
- RDY(S7) = 0 since there are still 2 frames to be transferred.

The S7 then inverts its STR bit.

Point in time ②:
Since STR(S7) $\neq$ STR(ZA), it is now the ZA 724's turn to take action. The I/O flag = 0 tells the ZA that a job to read out data is involved.
ACT(S7) = 1 and "current frame number" = 1 signal the ZA the 1st frame from the S7. "Net data requested" = 50 means that 3 frames have been requested by the S7. Accordingly, the ZA sends back the data in frames.

The ZA sets up its first data delivery telegram to the S7. See figure 6-5.

Byte	Contents	
0	Handshake bits	
1	I/O flag = 0; job	
2	Extra information	
3	Number of bytes of net data in the telegram = 20	Telegram header
4	Current frame number = 1	
5	Number of frames = 3	
6	20 bytes of net data	
7		
...		
25		
26	Response message byte 1	
27	Response message byte 2	
28	Response message byte 3	
29	Response message byte 4	
30	Reserved	
31	Handshake bits	

Figure 6-5 1st frame of the telegram for reading out from ZA to S7

The ZA copies the telegram header, enters the first 20 bytes of net data, sets ACT(ZA) = 1, and acknowledges receipt of the 1st frame by inverting its STR bit.

Point in time ③:

STR(S7) = STR(ZA) tells the S7 that the ZA has supplied the data.
Using the "number of bytes of net data in the telegram", the S7 can determine when the ZA has supplied all the data. The last frame from the ZA must also contain RDY bit = 1.
The S7 stores the data from the first to the last frame in DB_AP. Since the telegram header is included in every frame of a telegram, the S7 has an additional method of monitoring the telegram. It also makes it easy for the user to follow the data transmission. The S7 sets the "current frame number" to 2, and requests the next frame by inverting the STR bit. See figure 6-6.

Byte	Contents
0	Handshake bits
1	I/O flag = 0; job
2	Extra information
3	Number of bytes of net data in the telegram = 4
4	Current frame number = 2
5	Number of frames = 3
6	Net data requested = 50 bytes
7	
8	Current frame number = 2
9	Number of frames = 3
10	Not used
...	...
25	Not used
26	Control byte 1
27	Control byte 2
28	Control byte 3
29	Control byte 4
30	Reserved
31	Handshake bits

Figure 6-6 2nd frame of the telegram for reading out from S7 to ZA

Point in time ④:
The ZA sets up its 2nd data delivery telegram. See figure 6-7.

Byte	Contents
0	Handshake bits
1	I/O flag = 0; job
2	Extra information
3	Number of bytes of net data in the telegram = 20
4	Current frame number = 2
5	Number of frames = 3
6	20 byte of net data
7	
...	
25	
26	Response message byte 1
27	Response message byte 2
28	Response message byte 3
29	Response message byte 4
30	Reserved
31	Handshake bits

Figure 6-7 2nd frame of the telegram for reading out from S7 to ZA

The ZA copies the telegram header, enters the next 20 bytes of net data, and inverts its STR bit.

Point in time ⑤:
STR(S7) = STR(ZA) tells the S7 that the ZA has delivered the data.
After the data have been entered in DB_AP, the S7 sets the “current frame number” to 3. Since this is the last frame, RDY(S7) is also set to 1. The S7 requests this last frame by inverting the STR bit. See figure 6-8.

Byte	Contents
0	Handshake bits
1	I/O flag = 0; job
2	Extra information
3	Number of bytes of net data in the telegram = 4
4	Current frame number = 3
5	Number of frames = 3
6	Net data requested = 50 bytes
7	
8	Current frame number = 3
9	Number of frames = 3
10	Not used
...	...
25	Not used
26	Control byte 1
27	Control byte 2
28	Control byte 3
29	Control byte 4
30	Reserved
31	Handshake bits

Figure 6-8 3rd frame of the telegram for reading out from S7 to ZA

Point in time ⑥:
The ZA sets up its 3rd data delivery telegram. See figure 6-9.

Byte	Inhalt
0	Handshake bits
1	I/O flag = 0; job
2	Extra information
3	Number of bytes of net data in the telegram = 4
4	Current frame number = 3
5	Number of frames = 3
6	10 bytes of net data
7	
...	
25	Not used
26	Response message byte 1
27	Response message byte 2
28	Response message byte 3
29	Response message byte 4
30	Reserved
31	Handshake bits

Figure 6-9 3rd frame of the telegram for reading out from ZA to S7

The ZA copies the telegram header and enters the last 10 bytes of net data. Since this is the last frame (i.e., RDY(S7) = 1), the ZA also sets its RDY bit to 1, and inverts its STR bit.
The ZA can perform an additional check here. If RDY(S7) = 1, the “current frame number” must equal the calculated number of frames to be transferred.

Point in time ⑦:
STR(S7) = STR(ZA) tells the S7 that the ZA has sent the last frame. The S7 resets its ACT bit to 0. The job is concluded for the S7.

Point in time ⑧:
The ZA also resets its ACT bit to 0.

6.5 Errors in Data Communication

Errors in data communication are detected by the firmware of the ZA 724 while the jobs are being processed (e.g., the parameterization error “channel does not exist”).

Telegram layout

When an error occurs, the ZA sets its FLT handshake bit to 1 while the job is running, and passes on the error message in the telegram to the S7. See figure 6-10.

Byte	Inhalt
0	Handshakebits
1	I/O flag; job
2	Extra information
3	Number of bytes of net data in the telegram = 2
4	Current frame number = x
5	Number of frames = x
6	Error number
7	Extra error information
8	Not used
...	...
25	Not used
26	Response message byte 1
27	Response message byte 2
28	Response message byte 3
29	Response message byte 4
30	Reserved
31	Handshake bits

Figure 6-10 Telegram with errors in data communication from ZA to S7

Reaction of the S7

The S7 enters the error information in the corresponding application area of the DB_KOP (see chapter 5.2.2), and the data area of the affected ZA in the DB_ZU (see chapter 5.2.1).

The job is “finished with errors”.

Index

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