SIEMENS

Programmable Controller SIMATIC S5-101R

Operating Instructions — Order No. GWA 4NEB 810 2038-02

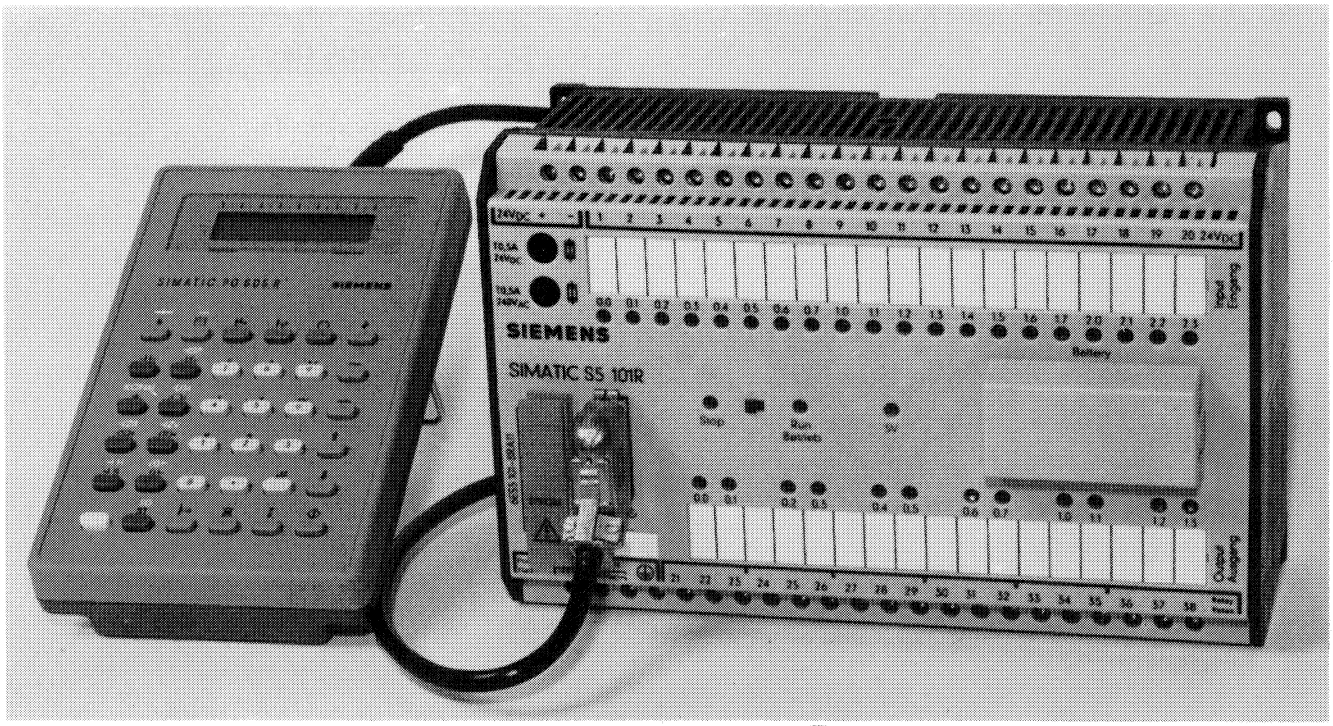


Fig. 1 S5-101R Programmable controller with 605R programmer

CONTENTS

1. Description

1.1 Application

The 101R is a programmable controller (PC) of the SIMATIC S5 system.
It was developed as a compact PC for automation tasks in the lower performance range as an economical replacement for as few as 10 relays or contactors. The PC can be used for applications involving logic control with timing and counting functions.
The PC is programmed with the hand-held 605R programmer or with the 655R CRT-based programmer in the ladder diagram (R-LAD) method of representation.

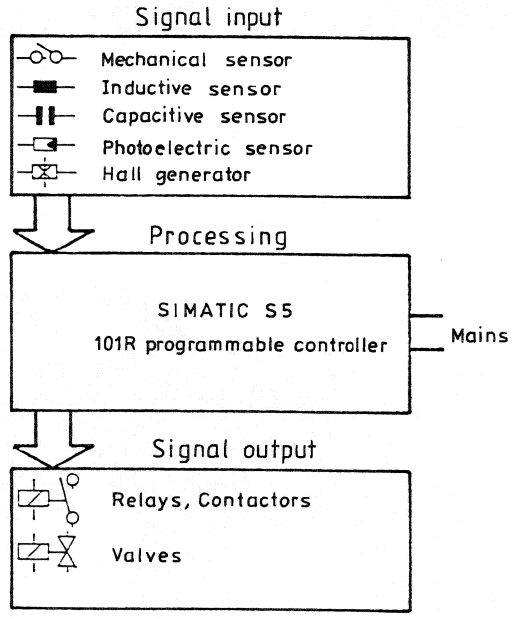


Fig. 2: Applications of the 101R programmable controller

1.2 Design

Compact PC for cabinet and wall mounting.

Screw-type terminals are used for all connections as in contactor systems (SIGUT SYSTEM)

Internal power supply for sensors; no external sensor supply therefore necessary

Signal status display of the inputs. Inputs 24 V DC floating

Receptacle for external memory submodule

Connector for 605R or 655R programmer (TTY interface)
The programmer connector can be plugged in or withdrawn with the power on.

Backup battery compartment

Output signal status display

Relay outputs

Power terminals

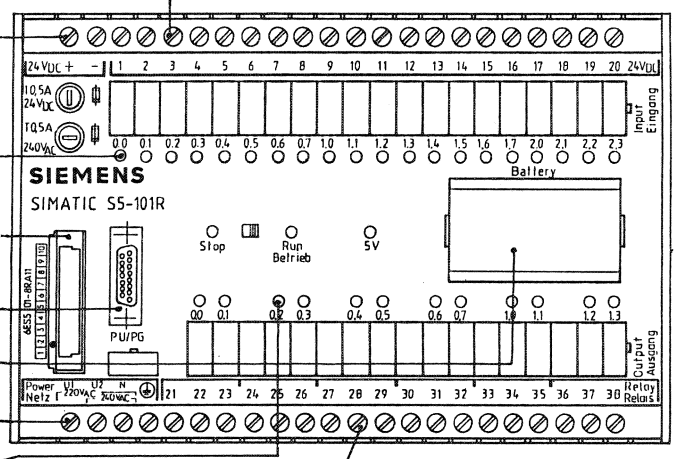


Fig. 3: Frontplate of the 101R programmable controller

1.3 Principle of operation

CENTRAL PROCESSING UNIT (CPU)

The CPU consists of a single-chip microprocessor and performs the following functions:

- Program processing
- Scanning of inputs and output (coils)
- Processing of timers and counters
- Controlling of outputs
- Programming of the memory submodule (EEPROM only)
- Servicing the serial port when a programmer is connected

INTERNAL MEMORY

The user program is stored in the internal memory. The microprocessor always processes the program from this memory.
The user program is retained for at least 3 years if a backup battery is used.

EXTERNAL MEMORY SUBMODULE

The user program is dumped in the memory submodule for long-term storage.
Both an EPROM and an EEPROM submodule are available:

- The EEPROM submodule, is programmed direct on the PC with the aid of the programmer.

- The EPROM submodule can only be programmed direct on the 655R programmer and on the 105R PC using a programming adapter

Note: The power supply must be switched off before a memory submodule is plugged in or withdrawn.

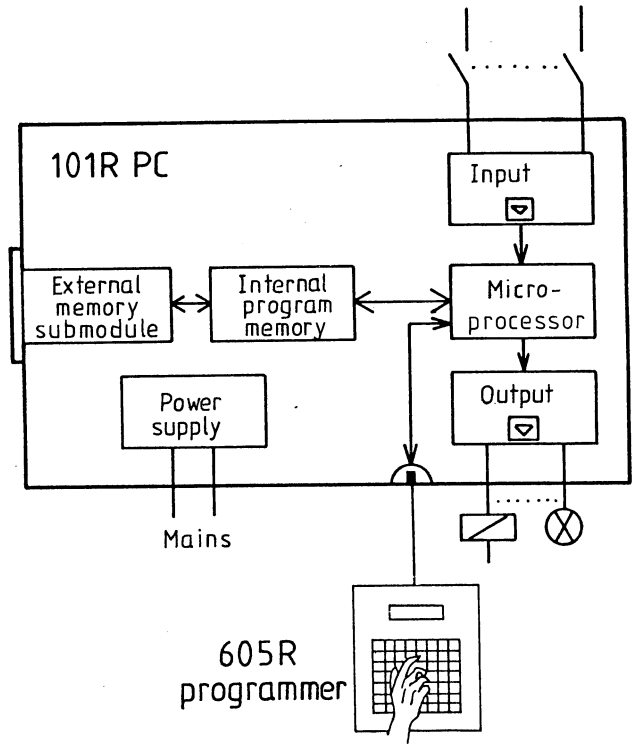


Fig. 4: Block diagram of the 101R

PROGRAM PROCESSING

The program is stored in the PC memory in the form of program elements, which are scanned in sequence. When the last element has been scanned, the first is then scanned again. This is called cyclic program scanning.

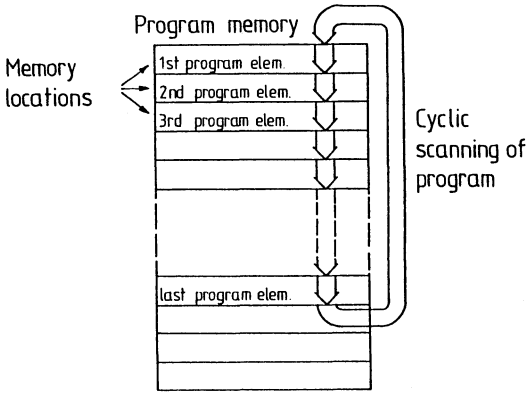


Fig. 5: Program scan

All inputs are interrogated before a program scan and stored in the process input image, part of the internal memory (1.). During program scanning, only this process input image is accessed (2.).
While the program is running, the output statuses are first assigned to the process output image. After the final program element has been scanned, this process output image is transferred to the outputs (3.).
The PC has a scan time check for self-monitoring. Before a jump is made back to (1), the scan time monitor is informed that the program is being correctly processed.
If a fault occurs, the monitor disables all outputs after max. 300 ms and the PC enters the "STOP" state.

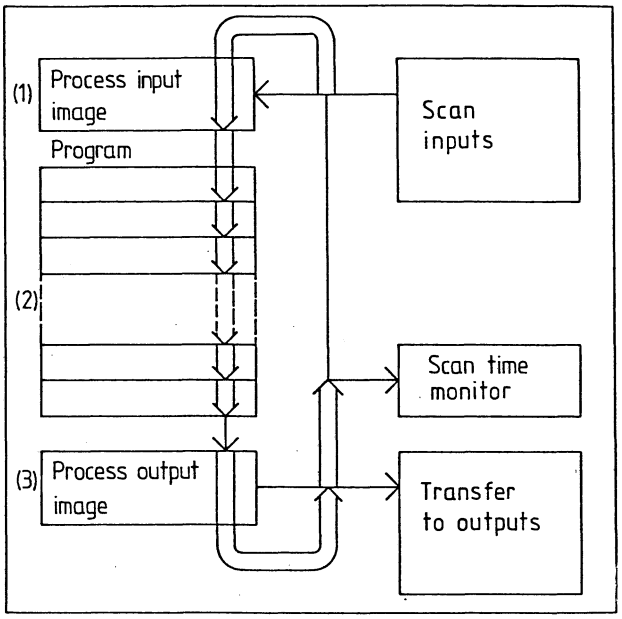


Fig. 6: Principle of operation of the 101R PC

2. Installation

2.1 Mechanical construction

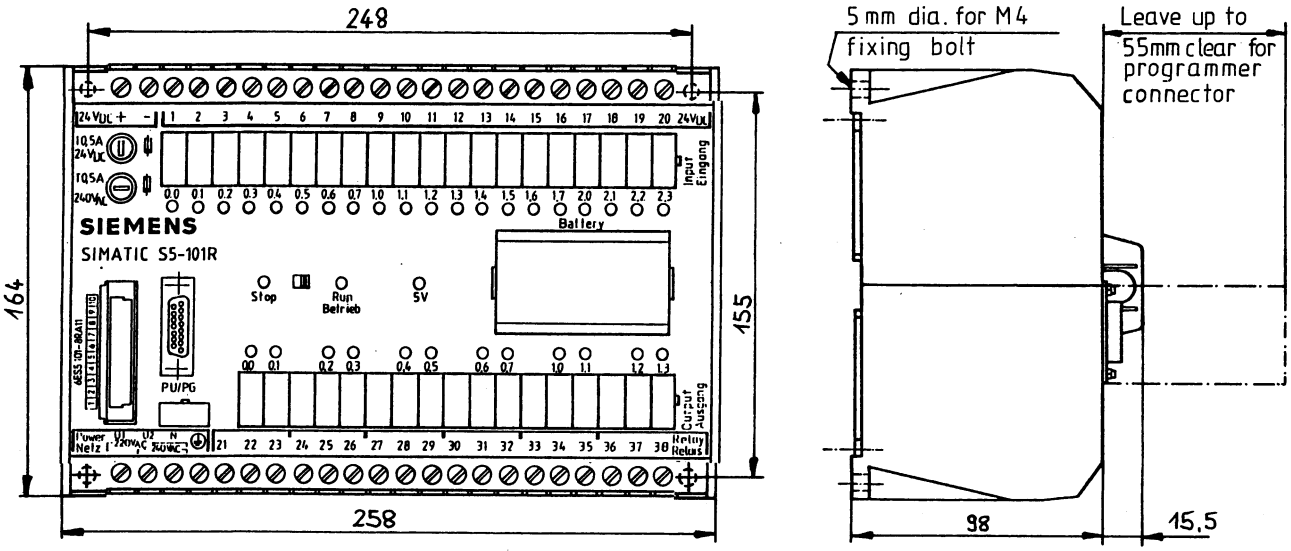


Fig. 7: Dimension diagram of the 101R PC

Mounting arrangements

The 101R is attached to a vertical mounting surface by means of four M4 bolts.

In order to avoid the accumulation of heat, make sure
- that the maximum angle of inclination is not exceeded
- that the minimum clearance between units mounted one above the other is observed (no clearance is necessary if the units are mounted side by side).

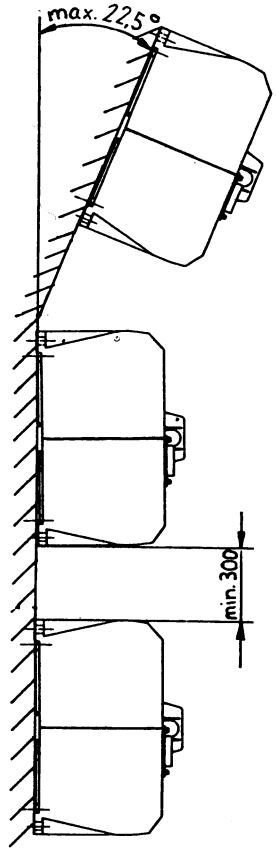


Fig. 8: Wall mounting arrangements

2.2 Electrical design

Screw-type terminals are used on the 101R for all electrical connections. Each terminal can take two conductors with the following cross-sectional areas:

Solid conductors	1 ... 2.5 mm^2	(AWG 26 ... 13)
Stranded conductors (with core and sleeves)	0.75 ... 1.5 mm^2	(AWG 18 ... 15)

The screws should be tightened with a torque of between 80 and 120 Ncm. 10 mm of insulation should be removed from the end of the leads.

2.2.1 Installation guidelines

The PC and field devices (sensors and actuators) should be connected up as shown below:

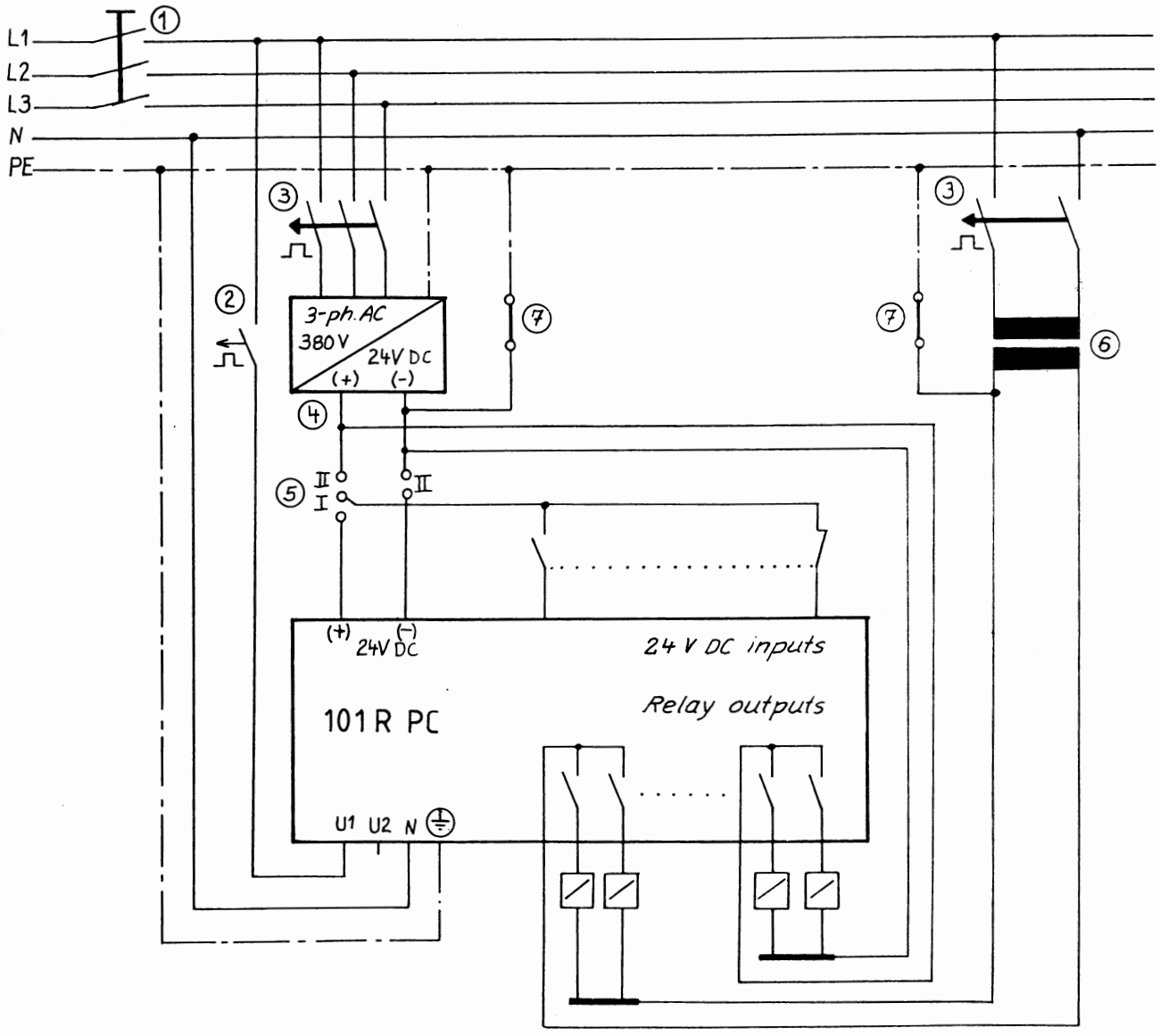


Fig. 9: Installation schematic for the 101R PC

When connecting up the PC, the following points should be noted:

- A common main switch (1) or isolating facility must be provided for the PC, sensors and actuators.

- The PC power connection must be fused (max. fuse rating 6 A) (2). An additional power switch is recommended in order not to have to open the main switch when replacing the memory submodule.

- A smaller conductor cross-sectional area can be used without fuses (3) for the power connection of the control circuits if the connecting line is less than 3 m long and is proof against earth faults and short-circuits.

- The power leads and I/Ø cabling must be run separately.

- A power supply unit (4) must be provided for the 24 V control circuits. 24 V lines must not be combined in a common cable with lines carrying higher voltages.
  The sensors (5) can be powered by the 24 V DC/300 mA power supply unit in the PC (connection I) or by an external 24 V DC power supply unit (connection II).

- In control circuits with more than 5 actuating coils, galvanic isolation by means of a control transformer (6) is recommended.

- Auxiliary circuits should be earthed either at one end (actuators and sensors must be arranged accordingly) or non-earthed auxiliary circuits with an insulation monitor must be provided. Earthed operation by means of a strap (7) between the protective earth conductor and the power supply unit or transformer is to be preferred.

- When connecting up the signal leads or bundling such leads, make sure that the ventilating slots are not covered. This applies in particular to the ventilating slots above the screw terminals.

- Cables must not be run in the immediate vicinity of the frontplate.

- The programmable controller has a high immunity to noise so that contactors can normally be operated in its immediate vicinity without having to take any additional measures to reduce noise.

- Note that the relay contacts of the outputs are fitted with varistors. (Max. leakage current 1 mA at 275 V_{rms}).

2.2.2 Terminal assignments

Full complement with 6ES5 101-8RA11
Half complement with 6ES5 101-8RB11

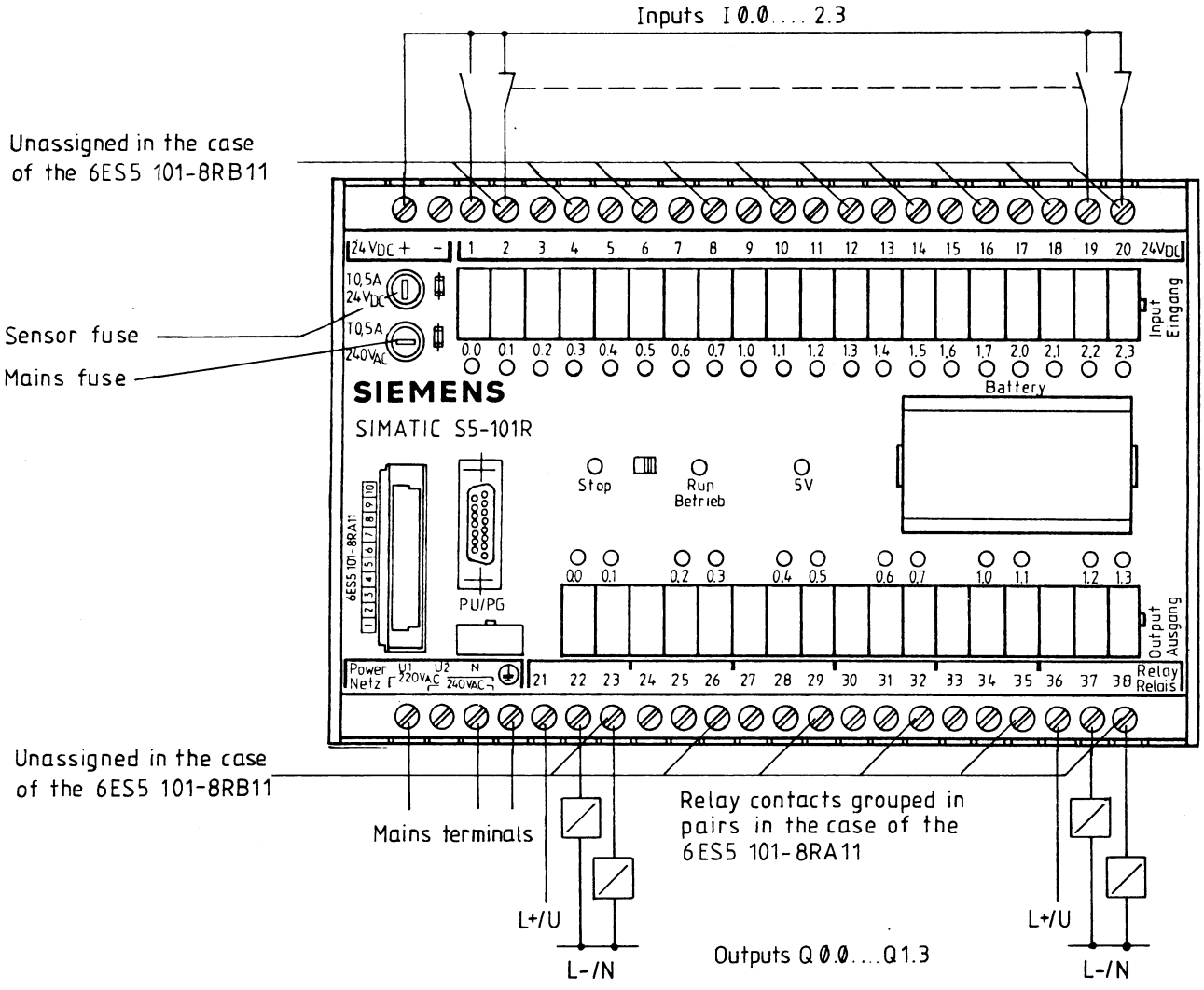


Fig. 10: Terminal assignments of the 101R programmable controller

Line connection:
220 V or 240 V AC

U1: Phase (220 V DC)
U2: Phase (240 V AC)
N : Neutral
⏚: Protective earth conductor

The plastics casing of the PC has a metallized inner surface so that the protective earth conductor must be connected at all costs.

Sensor power supply:
(24 V DC (max. 300 mA)

The -24 DC terminal is connected internally with the inputs:
If an external 24 V power supply unit is used, its -24 V DC terminal must be connected to the -24 V DC terminal of the PC. The +24 V DC terminal of the PC remains free in this case.

3. Start-up and Operation

3.1 Controls and displays

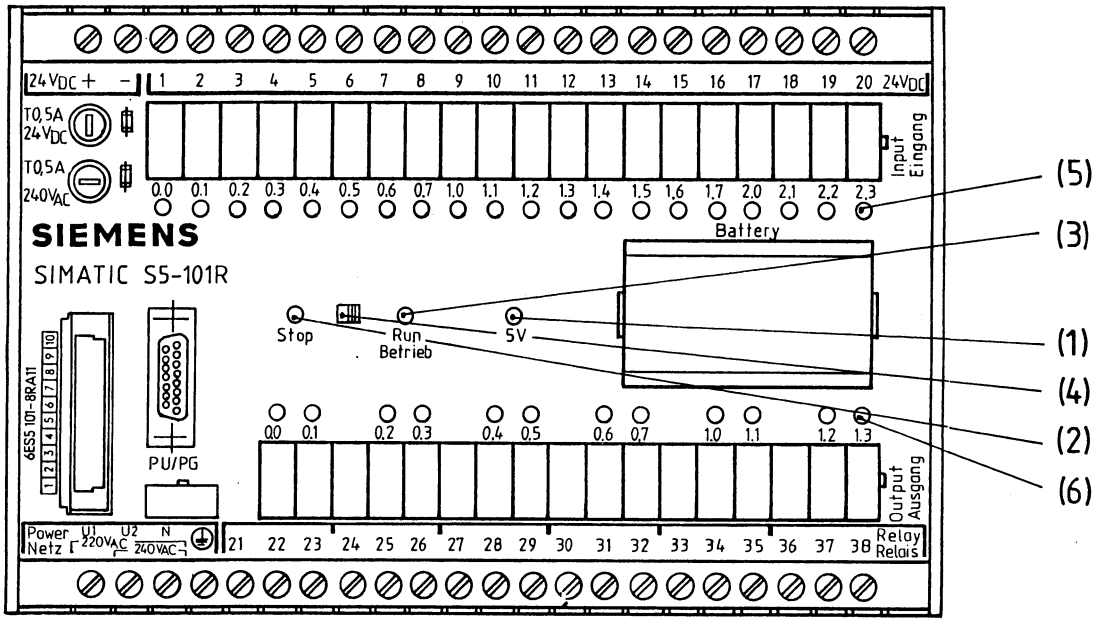


Fig. 11: Controls and displays of the 101R PC

The green "5V" LED (1) indicates that the internal power supply for the PC is available.

The red "Stop" LED (2) and the green "Run" LED (3) indicate the two operating states of the PC.

The "Stop" and "Run" operating states are selected with the mode selector (4).

The green LEDs marked Ø.Ø ... 2.3 (5) light up when the 24 V signal is applied to input terminals 1 ... 20 and thus indicate the signal state of the inputs direct.

The green LEDs marked Ø.Ø ... 1.3 (6) are connected in parallel with the excitation coils of the output relays and indicate the signal status of output relays and indicate the signal status of outputs (coils) 0.0 ... 1.3.

3.2 The "Run" and "Stop" modes

The 101R PC has two operating modes - "Stop" and "Run".

In the "Stop" mode - red LED (2) illuminated - the user program is not processed. All outputs or coils are disabled in this mode. The PC automatically enters the "Stop" state when faults or errors occur that prevent proper processing of the program.

The "Stop" state of the PC can be left again by moving the mode selector (4) to the "Run" position. The red LED (2) darkens and the green LED (3) lights up. This can take up to 1 s, depending on the length of the program . During this time, the user program is translated into microprocessor code. When the green LED (3) lights up, the program is being processed.

When the mode selector (4) is in the "Run" position, the operating state of the PC can be modified additionally by the "PC STOP" and "PC START" functions of the programmer.

3.3 Power-up

The 101R PC can be taken into service without a programmer being necessary. For start-up, the following conditions must be fulfilled:

- The PC must have a valid program in the internal program memory (RAM) or in the memory submodule plugged into it
- The mode selector must be in the "RUN" position.

An automatic cold restart after power-up requires:

- that the PC has a valid program (see above)
- that the mode selector is in the "RUN" position
- that the "AUTO RESTART" bit is set to "1" in the user program.

The PC remains in the STOP state after power-up if at least one of the following conditions has been fulfilled.

- Switch in STOP position
- The PC was in the STOP state before power-down
- The PC can find no valid program in the internal RAM or in the plugged-in module
- Program errors
- AUTO RESTART bit has been set to "0"
- Before power-down an entry was made in the program in the internal program memory and a module was plugged in.
- There is no back-up battery and the "FLAGS RETENTIVE" bit is set to "1" in the program.

The cause of the STOP state is displayed in plaintext using the PC DIAGNOSTIC function on the 605R programmer or the PC INFO function on the 655R programmer.

3.4 Using the memory submodule

The 101R PC has three possible types of memory:

- the internal program memory (RAM) without submodule
- additional EPROM submodule
- additional EEPROM submodule

The memory submodules are designed for long-term program storage or as copying submodules if one memory submodule is to be used for several PCs.

	Internal RAM	EPROM submodule	EEPROM submodule
Program generation with programmer	yes[1)]		
Storing the program	without additional measures in the PC	only direct on the 655R programmer and on the 105R PC using an adapter	with the STORE PROGRAM programmer function
Storage time	at least 3 years if battery is inserted (option)	no limit	no limit
Program erase	Erase program (general reset)	with UV lamp	not necessary; it is overwritten when the program is stored
Retentive flags	With at least 3 years back-up if a lithium battery has been inserted.		

Fig. 11: Using the individual memory types

1) Only possible if no memory submodule has been inserted

A program can be changed without using a programmer. The memory submodule is replaced in the following order:

- Switch off power
- Replace memory submodule
- Switch on power.

After power-up, the contents of the memory submodule are transferred to the internal program memory.
If, before the program was changed, an entry was made in the current program in the internal RAM using the programmer with the functions

- INPUT/DISPLAY

- ERASE PB

- FLAGS RETENTIVE

- AUTO RESTART,

the PC expects the next step to be the storing of the modified program on a memory submodule.

The contents of the next submodule plugged in are consequently not transferred to the internal program memory on power-up.

The contents of the memory submodule can only be read into the internal program memory when either the STORE PROGRAM function or the ERASE PROGRAM function have been successfully completed.

3.5 Start-up

On PC start-up the following sequence of operator procedures must be observed.

Condition	Operator procedure	Remarks
101R PC dead, i.e. the main switch (see Fig. 9) is open.	- Check power terminals (PE conductor must be connected) - Check whether all screw terminals are properly tightened - Make sure that there are no connections between 24 V lines and lines carrying higher voltages. - Withdraw the memory submodule	Visual check of the system.
Disconnect fuses for sensors and actuators. Switch off power circuits of the actuators. Close the main switch (see Fig. 9)	- Switch PC to "Stop" without memory submodule and connect the 605R or 655R programmer. - Reset the PC with the "ERASE PROGRAM" programmer function) and then set the PC to "Run".	When the main switch is closed, the green "5V" and red "Stop" LEDs light up. The red "Stop" LED darkens and the green "Run" LED lights up
Insert the fuses for the sensors. The fuses for the actuators and power circuits remain disconnected.	- Actuate all sensors one after the other.	If the sensors are properly connected, the corresponding LEDs at inputs I0.0 ... I2.3 will light up.
Insert the fuses for the actuators. The power circuits for the actuators remain disconnected (Fig. 9).	- Each output of the I/Os can now be driven with the STATUS/SET programmer function.	The LEDs of the set outputs must light up and the switch positions of the relevant actuators must change.
The power circuits for the actuators remain disconnected.	- Put the PC to "Stop" - Enter the program with the aid of the programmer (INPUT/DISPLAY function) or plug in memory submodule. - Test the program with the PWR FLOW/FORCE programmer function - Store program on memory submodule if necessary	The red LED on the CPU lights up. Program documentation should be produced for the information of third parties.
When the program has been fully tested, switch on the power circuits for the actuators.	- Put the PC to "Run"	The PC must now process the program properly.

4. Maintenance and Repairs

4.1 Error/fault diagnostics

If errors occur when developing and testing the program, detailed error information is provided by the programmer. This is described in more detail in the User Instructions of the respective programmer.
The programmer has the following diagnostic functions for testing the program and for troubleshooting:

- PWR FLOW/FORCE
  (see Programming Instructions, Section 3.Ø)

- STATUS/SET
  (see Programming Instructions, Section 3.2)

- PC DIAGNOSTIC

In the event of a fault on the 101R, the following troubleshooting procedure is recommended:

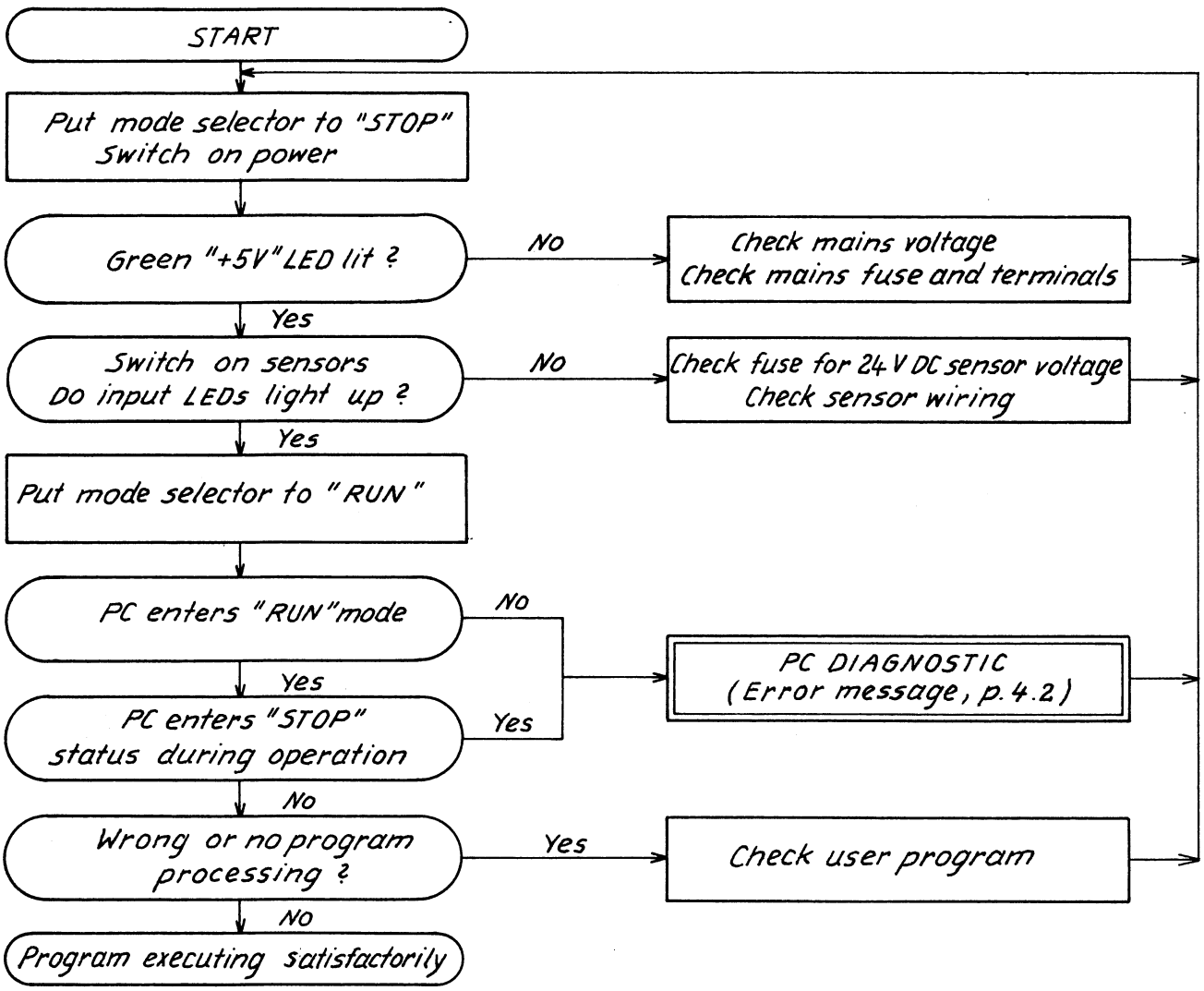


Fig. 12: Troubleshooting procedure

If the PC does not enter the "RUN" state when the power is switched on or the mode selector is actuated or should it leave the "RUN" state during normal processing, the cause of the fault can be investigated with the "PC DIAGNOSTIC" programmer function. If the function cannot be called and F0* appears in the display of the programmer, the PC must be switched off and switched on again and this function must be called again.

Error display	Cause	Remedy
STOP PC	Mode selector is in the "Stop" position or it was in this position before power-down	Move mode selector to "Run".
STOP PG	PC STOP programmer function executed	Execute "PC Run" programmer function or put mode selector on PC to RUN
STOP POWER DOWN	Line voltage failure; AUTO RESTART bit is set to "0" in the program	Operate mode selector
CODE ERROR PB 16	PC can find no valid program	Erase PC program or plug memory module in with valid program
CODE ERROR PBx	Program error in PBx or: if no error is to be found, internal program memory overflow	Correct or re-enter PBx Optimize program, use fewer PBs and nodes
RAM < > MODULE	Program in RAM has been modified and memory submodule plugged in	Store program in memory submodule or erase PC program
FLAGS RETENTIVE?	FLAGS RETENTIVE bit set to "1" and no back-up battery is plugged in	Plug-in battery or set FLAGS RETENTIVE bit to "0"

4.2 Changing the backup battery

The backup battery can be changed with the PC in the "Run" state. (If the battery is changed with the power off, the system voltage should be briefly connected again after changing the battery to allow the PC to recognize the new status. The power can then be switched on for continuous operation).

The battery is changed in the following order:

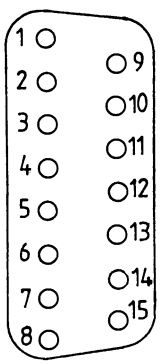
- Remove the cover of the battery compartment
- Take out the old battery
- Insert the new battery (noting polarity)
- Replace the battery compartment cover

Only the lithium battery in the list of spare parts may be used.
The battery has a backup time of at least 3 years.

4.3 Interface assignments

	c	b	a
1	AD12	M	V_{CC}
2	AD0	AD1	AD2
3	AD3	AD4	AD5
4	AD6	AD7	AD8
5	AD9	AD10	AD11
6			$\overline{RD}$
7	$\overline{PGM4/WR}$		
8			
9			
10	DØ	D1	D2
11	D3	D4	D5
12	D6	D7	
13	$\overline{CS1}$	$\overline{CS1}$	
14	$\overline{CS2}$		
15	Vpp1	$\overline{BUSY}$	K4
16	Vpp2	$\overline{RD}$	K5

Fig. 13: Assignment of interface signals to the memory submodule



1 Shielding/earth
2 Rec-
3 V_{PU}+5.2V
4 -
5 Zero volt reference potential
6 Driver+
7 Driver-
8 Shielding/earth
9 Rec+
10 -
11 T/20mA-(current source/receiver)
12 Zero V reference potential internal
13 R/20mA- (current source/receiver)
14 V_{PU}+5.2V
15 Zero V reference potential, internal

Fig. 14: Assignment of interface signals to the programmer

5. Technical specification

5.1 General data

Input voltage:
a) 220V AC (+10%, -15%) 48...53 Hz
b) 240V AC (+10%, -15%)

Current consumption:
a) 230mA at 220V AC
b) 210mA at 240V AC
Fuse: 250mA or 500mA slow

Temperature range:
Low temperature limit $0^{o}C$ } to
High temperature limit $55^{o}C$ } DIN 40040
Casing inlet air temperature $\leq 55^{o}C$
Storage temperature $-40...+70^{o}C$

Humidity rating:
F to DIN 40040
95 % relative atmospheric humidity at $25^{o}C$

Degree of protection:
IP20 to DIN 40050

Internal power supply for sensors:
24V DC/max. 300 mA (20 ... 30V DC)
Fuse: 500 mA slow (Dimensions 6.3mm x 32 mm)

Vibration test:
to DIN 400446, Sheet 8

Frequency range Hz	Constant amplitude of deflection	acceleration
10 to 58	0.075 mm	-
over 58 up to 500	-	1g

Impact test:
15g/11ms, trapezoidal to DIN 40046, Part 7

Creepage distances and clearances in air to VDE 0160

Dimensions: 258 mm x 167 mm x 114 mm (wxhxd)

Approx. weight: 2.7 kg

5.2 CPU/memory submodule

Processing time for one binary operation: approx. 5 µs

Operation set:

Binary operations
Setting/resetting operations
Timer and counter operations

Addressing in the case of the 6ES5 101-8RA11:

16 program blocks
24 program elements per PB
20 inputs (I0.0...I2.3)
12 outputs (coils) (Q0.0...Q1.3)
32 flags or internal relays (F0.0...F15.7)
16 retentive (F0.0...F1.8)
(with backup battery only)
8 counters C0...C7 (range 1...32767), max. counting frequency 50 Hz
8 timers T0...T7 (range 10 ms...999 min)

Addressing in the case of the 6ES5 101-8RB11:
10 inputs (I0.0...I2.2)
6 outputs (Q0.0...Q1.2)
All other values as for the 6ES5 101-8RA11

Internal program memory:
RAM for 384 program elements: supported for at least three years if a backup battery is used

Memory submodules (plug-in):
a) EPROM submodule
Storage of program with 655R programmer or on 105R PC with a programming adapter
Program erasure: UV lamp

b) EEPROM submodule
Storage and erasure of program direct on the PC with the programmer

5.3 I/Os

The inputs are galvanically isolated from the internal power supply by means of optocouplers. The signal statuses of the inputs are indicated by green LEDs; the LEDs are driven by the 24V signal voltage of the inputs.
The PC has relay outputs. The relay contacts are fitted with varistors having a maximum leakage current of 1 mA. The signal statuses of the outputs are indicated by green LEDs connected in parallel with the excitation coils of the relays.

Number of inputs	Rated input voltage	Rated input voltage for "0" signal	"1" signal	Nominal input current for "1" signal	Delay ON	Delay OFF	Maximum length of separately installed lines	Insulation for nominal voltage	Insulation tested at
20 or 10, floating	24V DC 2)	-35V...+4,5V or input open	+13V...+35V	8.5mA 1)	1.5 - 5ms		100m	36V DC	500V AC

Number of outputs		Contact switching capacity	Service life in operations	Maximum switching frequency	Simultaneity factor	Insulation for nominal voltage	Insulation tested at
12 or 6 relays 3)	each pair of relays to common output	250V 1.5A resitive 250V 0.4A inductive 30V DC 2.5A resitive 30V DC 0.5A inductive	to AC11 $1.5 \cdot 10^6$ to DC11 $2 \cdot 10^5$	10Hz resistive 2Hz inductive	100%	250V AC	2KV AC

T009

1) Applies also to two-wire proximity switches (voltage: 22V...30V DC)
2) If an external power supply unit is used, a smoothing capacitor must be fitted
3) Card relays of type E V23027-B002-A402 (SIEMENS); leakage current of parallel varistor 1 mA.

SIEMENS contactors

The following contactors can be driven with the output relays:

AC contactors		DC contactors		Auxiliary contactors	
3TJ50 3TB40/3TB41 3TB42/3TB43 3TB44	220V AC/240V AC 24V DC	3TC44	220V AC/240V AC 24V DC	3TH80 3TH82	220V AC/240V AC 24V DC
		3TC48 3TC52	220V AC/240V AC	3TH83 3TJ1	
3TB46 3TB47 3TB48 3TB50 3TB52	220V AC/240V AC				

Please refer to Catalog NS2 for the technical specifications of these contactors.

6. Spare parts

SPARE PART	Order No.
101R programmable controller with 20 inputs and 12 outputs	6ES5 101-8RA11
101R programmable controller with 10 inputs and 6 outputs.	6ES5 101-8RB11
Lithium battery (for RAM backup)	6ES5 980-0AE11
G-type fuse-link 6.3 mm x 32 mm 250 mA slow (10 pcs.) 500 mA slow (10 pcs.)	 4 NEF 990 0636 01 4 NEF 990 0636 02
375 memory submodule EPROM EEPROM (5V type)	 6ES5 375-0LA11 6ES5 375-0LC11
UV erasing facility	6ES5 985-0AA11
605R programmer with German labelling English labelling	 6ES5 605-0RA11 6ES5 605-0RB11
Carrying case	6ES5 986-0LA11
101R PC manual German English French	 6ES5 998-0RC11 6ES5 998-0RC21 6ES5 998-0RC31

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