SIEMENS

SIMATIC S5

GRAPH 5/II Version 7.1

Manual

This manual has the order number:
6ES5998-1MA24

09/99
C79000-G8576-C180
Edition 02

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 warning triangle and are marked as follows according to the level of danger:

Danger

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

Warning

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

Caution

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

Note

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.

Trademarks

SIMATIC®, SIMATIC NET® and SIMATIC HMI® are registered trademarks of SIEMENS AG.

Third parties using for their own purposes any other names in this document which refer to trademarks might infringe upon the rights of the trademark owners.

Copyright © Siemens AG 1999 All rights reserved

The reproduction, transmission or use of this document or its contents is not permitted without express written authority. Offenders will be liable for damages. All rights, including rights created by patent grant or registration of a utility model or design, are reserved.

Siemens AG
Bereich Automatisierungs- und Antriebstechnik
Geschaeftsgebiet Industrie-Automatisierungssysteme
Postfach 4848, D-90327 Nuernberg

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.

© Siemens AG 1999
Subject to change without prior notice.

Important Information

Purpose of the Manual

This manual has the following aims:

- To explain the basic concepts of the GRAPH 5 software
- To introduce its most important functions

The software used to program sequencers in SIMATIC S5 programmable logic controllers was developed according to modern ergonomic principles. Handling the software is therefore easy to learn and to a large extent self-explanatory.

When procedures are explained, you will find the relevant menu commands are also described. However, instructions on how to fill out dialog boxes are not included since this is explained in online help.

Audience

This manual is intended for installation personnel, programmers, and service personnel who have little or no experience of working with the software package GRAPH 5/II version 7.1.

Scope of the Manual

This manual is valid for the GRAPH 5/II programming software, version 7.1.

Installation and Authorization of the Software

Installing the GRAPH 5 software and transferring the authorization to hard disk is described in the product information.

Structure of the Manual

This manual is divided into the following parts:

- Chapters 1 to 3 contain general information on terminology, basic handling of the standard GRAPH 5 software, and on preparing for a programming session. You should read the first three chapters before you start working with the software.
- Chapter 4 describes in detail how to create sequencers on the programming device and on the PLC.
- Chapter 5 describes the two methods of process synchronization, FB synchronization and automatic process synchronization.
- Chapter 6 contains a description of GRAPH 5 diagnostics that allows you to investigate and document timeouts in sequencers.
- Chapter 7 describes the use of the various data blocks belonging to a sequencer.

- Chapter 8 contains instructions for starting up and testing your sequential control system.
- The appendix contains S5 terminology, a list of S5 file types and the list of references.

If you have already created a small project and gained some experience, you can read each chapter separately as and when you require information on the topic it covers.

Online Help

In addition to the manual, detailed information is also available to you in the integrated online help system when you are working with the software. You can call up the help system by pressing the **F7** and **F8** keys.

Additional Assistance

If you have any questions about the software described in this manual and cannot find an answer here or in the online help, please contact the Siemens representative in your area. You will find a list of addresses in the catalogs.

You can contact our **SIMATIC Customer Support** by phone at the number +49 (911) 895-7000 or by fax at +49 (911) 895-7002. You can also send questions by email on the Internet.

Siemens also offers a number of training courses to introduce you to the SIMATIC S5 automation system. Please contact your regional training center or the central training center in Nuremberg, Germany for details:

D-90327 Nuremberg, Tel. (+49) (911) 895 3154.

Information Updates

The latest information about SIMATIC products is always available:

- on the Internet under `http://www.ad.siemens.de/simatic`
- at the fax polling no. 08765-93 02 77 95 00

Our SIMATIC Customer Support can also help you with up-to-date information and downloads that can be useful when working with SIMATIC products:

- on the Internet under `http://www.ad.siemens.de/simatic-cs`
- in the SIMATIC Customer Support mailbox at the number +49 (911) 895-7100

To contact the mailbox, use a modem with up to V.34 (28.8 Kbaud), with the following parameters: 8, N, 1, ANSI, or dial on ISDN (x.75, 64 Kbits).

Contents

Overviews

1

Chapter Overview

1.1 Guide to the Manual

Software User's Contract

Before installing the software, please read the "General Conditions for Software Products for Automation Engineering" and the Product Information carefully. The instructions for installing and setting up the programming device, handling diskettes and hard disk drives can be found in the programming device manuals. The procedure for installing the GRAPH 5/II software package is described in the Product Information.

Backup Copy

Make at least one backup copy of all original diskettes. Starting the main S5 menu is described in the STEP 5/ST manual. This manual describes the functions of GRAPH 5/II. For programming at the zoom-in level, you require knowledge of STEP 5. To run the program on the PLC, you must call the function blocks for the specific PLC (FB 70, FB 71 etc.) for the required version of the sequential control system, assign parameters and transfer the program to the PLC memory using the standard FBs.

If you require information on these topics, we recommend the following documentation:

- Manual for the STEP 5/ST V7.1 basic package
- Manuals for the programmable controllers, for example the S5-155U. These manuals also include programming guides.

1.2 Graphic User Interface

As in STEP 5, all the GRAPH 5/II functions are available via the main and submenus. Within these menus, you can use either the mouse or keyboard to select the tools and utilities you require during your session at the programming device.

Function Selection

Calling a function or an editor requires two steps:

- Selecting the function in the main or submenu
- Specifying the function by entering parameters and confirming with the return key

1.3 Selection Functions

Starting in the main menu, you select a function or an editor using the appropriate submenus. The current operating status or mode of the programming device or PC determines whether or not certain functions can be activated or not, for example when there is no connection to a PLC.

To activate the main menu of GRAPH 5, follow the steps outlined below:

Starting STEP 5/ST

If you installed STEP 5 as a Windows program, you can start STEP 5/ST with the Start menu **Simatic > STEP 5 > STEP 5**

The following PIF files are available for Windows 95/98:

Name	Call
STEP 5 full screen	S5.BAT call in full screen mode
STEP 5 window	S5.BAT call in window mode
STEP 5 MS-DOS mode	S5.BAT call in MS-DOS mode with own AUTOEXEC.bat, CONFIG.SYS.
S5 driver installation	S5DRV.BAT call
S5 keyboard editor	S5KEDIT.BAT call

When using larger files and COM and optional packages, it is advisable to start STEP 5/ST, V7.1 under MS-DOS. To start MS-DOS enter S5 and then press <Return>.

For further information, refer to the STEP 5/ST manual.

Starting GRAPH 5/II

You are in the main menu of STEP 5/ST.

In the Change menu, you can select the various optional packages. Click GRAPH 5/II. The main menu of GRAPH 5/II then appears.

Sequential Control and GRAPH 5

2

Chapter Overview

2.1 What is a Sequential Control System?

In control engineering, a distinction must be made between logic control systems and sequential control systems. Logic control systems describe the static relationships between the input and output signals of a controller. Control tasks in which the timing of inputs and outputs is important, are implemented by sequential control systems.

A mode of control, forcing step-by-step sequential operation, one step proceeding to the next programmed step dependent on step enabling conditions is known as a sequential control system.

There are two different types of sequential control system:

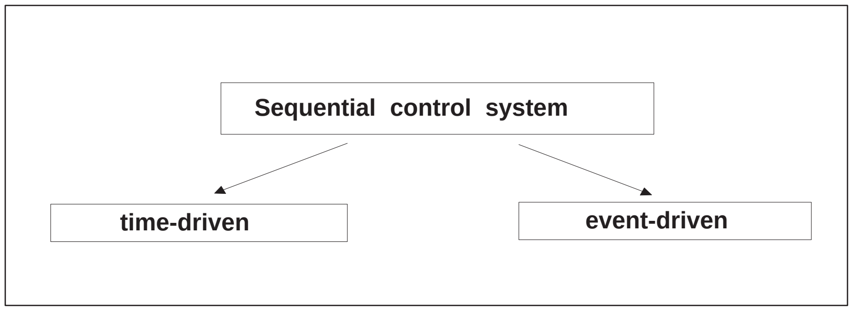


Figure 2-1 Types of Sequential Control

The step enabling conditions are only dependent on the time (e.g. waiting or monitoring times).

The step enabling conditions are dependent on signals from the process being controlled (e.g. on acknowledgements/feedback).

In practice, a combination of the two is usually found.

The main characteristics of sequential control systems are steps and step enabling conditions. The control task is divided into single steps whose execution is dependent on step enabling conditions.

Each step is assigned control operations and step enabling conditions.

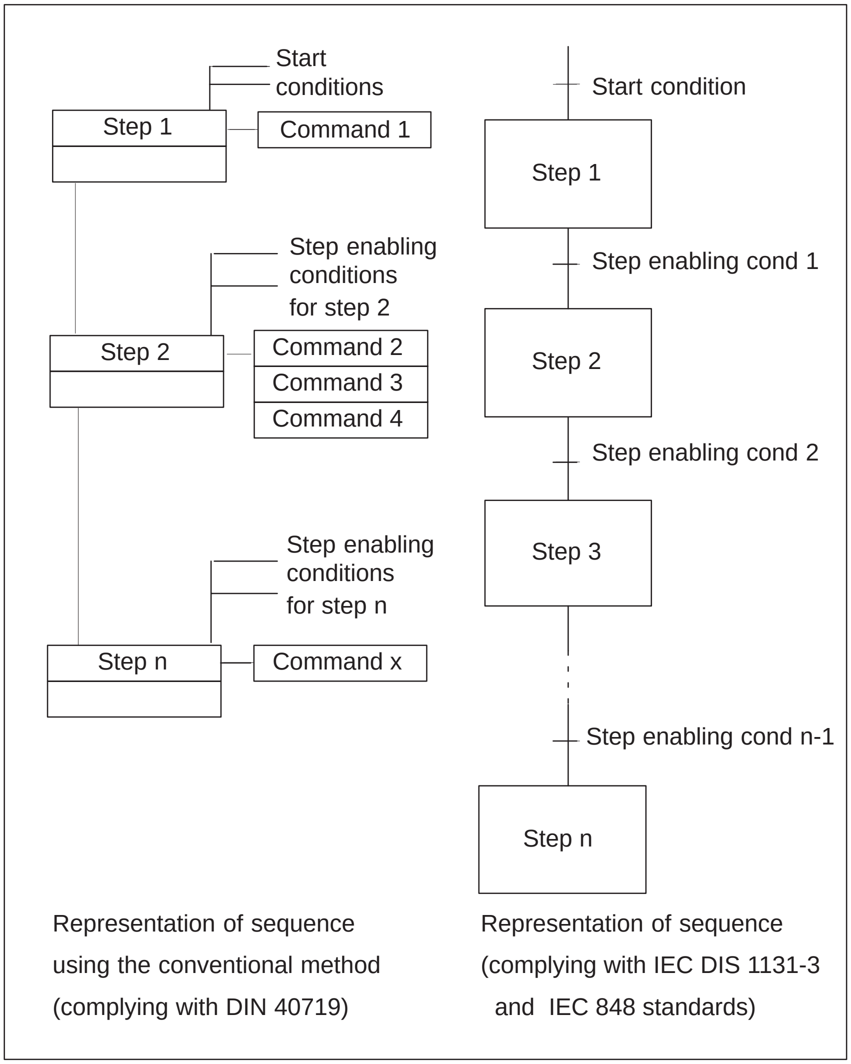


Figure 2-2 Control Commands and Step Enabling Conditions

Sequential Control System

The step enabling conditions allow the program to continue from one step to the next. The operations within a step consist of instructions for internal and external units (e.g. set flag, start timer, switch control elements).

Structure of a Sequential Control System

In general, a sequential control system consists of the following:

- Mode section
- Sequencer
- Command output

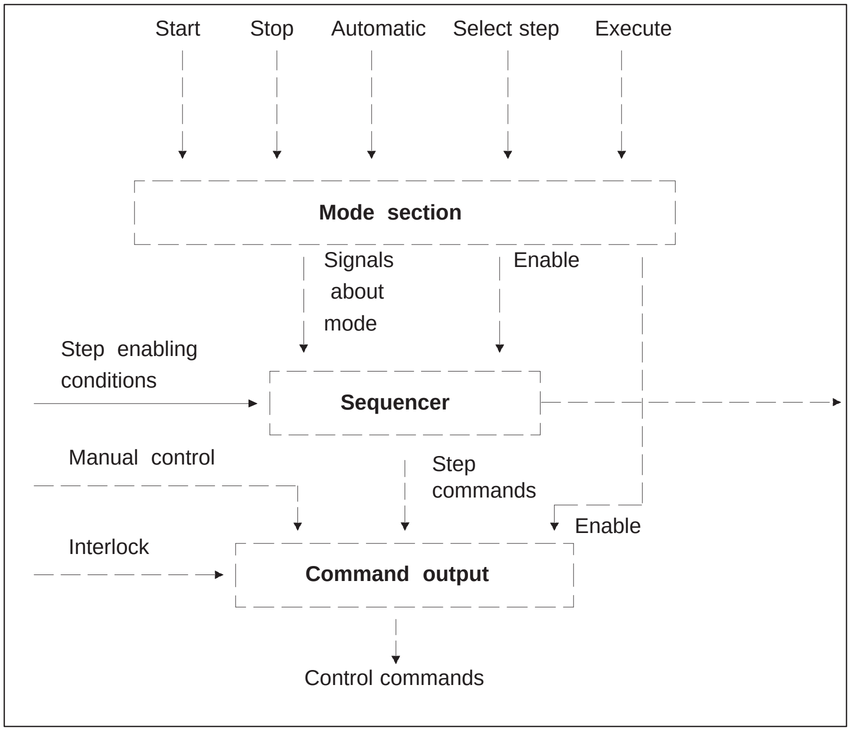


Figure 2-3 Structure of a Sequencer

The preset parameters for the operating mode are processed in the mode section. The result is passed on to the sequencer and to command output in the form of signals (e.g. enable).

The sequencer ensures that the control is executed step-by-step. Depending on the step enabling conditions, the program proceeds from one step to the next.

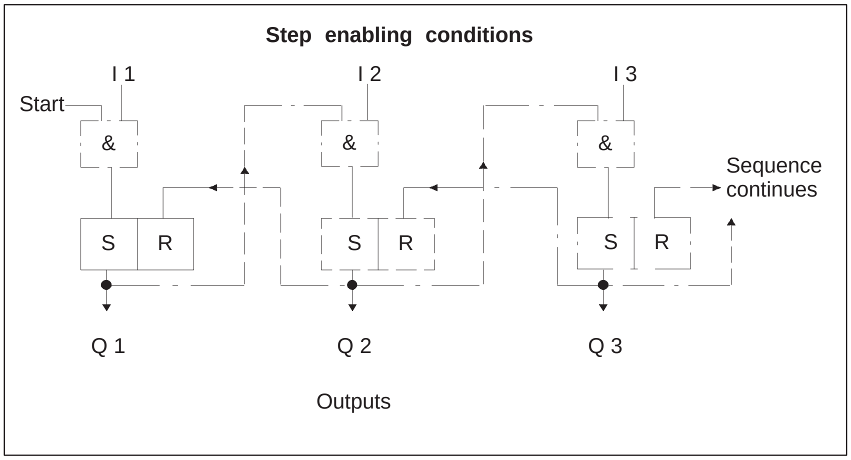


Figure 2-4 Basic Structure of a Sequencer (in conventional notation)

A step corresponds to a flip-flop. The output sends commands, initializes the next step and resets the previous step. The sequencer continues depending on the step enabling conditions. The output of the control command can be directly from the step itself; however, the commands are usually sent to the control elements via the command output.

In the command output the step operations of the sequencer are logically linked with the signals from the mode section and the interlocks.

The outputs are commands to the control elements.

Apart from the benefits when programming, GRAPH 5 also has the following advantages:

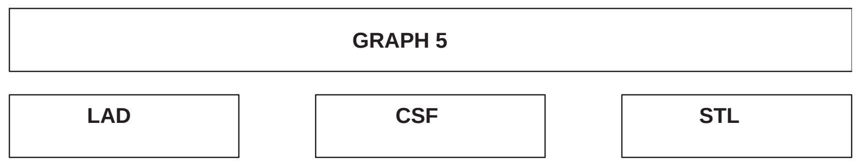
- GRAPH 5 provides clearly defined functions for project configuration on the programmer.
- GRAPH 5 is a powerful structuring tool for economic creation of programs.
- GRAPH 5 converts the configured sequence structure into a program automatically.
- GRAPH 5 allows fast diagnostics from the overview to the detailed level.
- GRAPH 5 provides convenient documentation.

With GRAPH 5, sequencers can be programmed clearly, reliably and quickly. Programming with GRAPH 5 is easy to learn and use.

2.2 What is GRAPH 5?

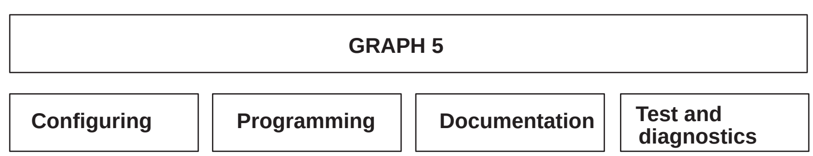
GRAPH 5 is a software package for graphic configuring and programming of sequential control systems and is an extension of STEP 5.

With GRAPH 5, a step-by-step program sequence (sequential controller) required to meet the technical demands of your plant can be configured as an overview. The zoom-in or detailed representation is then programmed in LAD, CSF or STL.



GRAPH 5

- is available as the optional package GRAPH 5/II for the basic package STEP 5/ST
- allows a sequencer to be structured by breaking it down into steps (actions) and transitions (step enabling conditions)
- supports configuring and design, programming, documentation, testing/diagnostics
- supports programming at the overview and zoom-in levels
- supports the various modes and functions of the process sequence and its diagnostics by means of standard blocks on the PLC.



A sequencer is programmed with GRAPH 5 in two levels of representation:

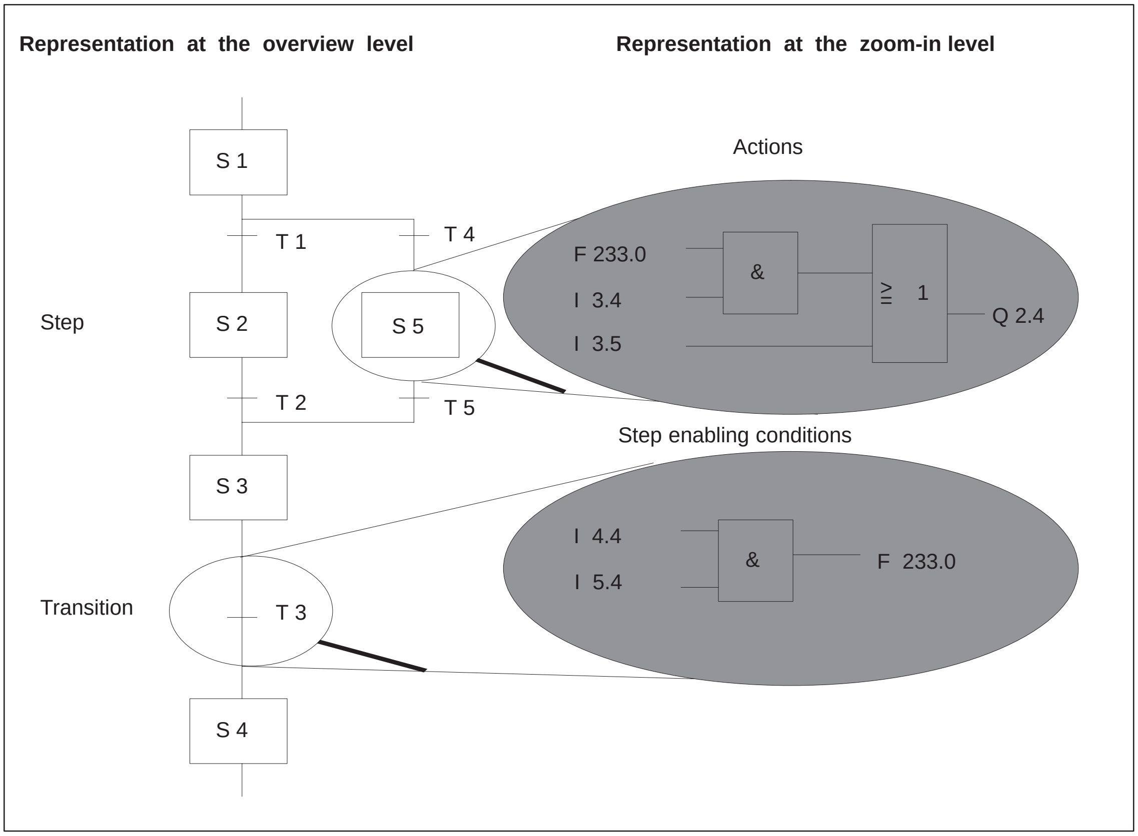


Figure 2-5 Levels of Representation

The Overview Level

The overall structure of the sequencer is created at the overview level. Steps and transitions, simultaneous and alternative branches and their junctions, as well as jumps, can be programmed. Waiting and monitoring times can be entered.

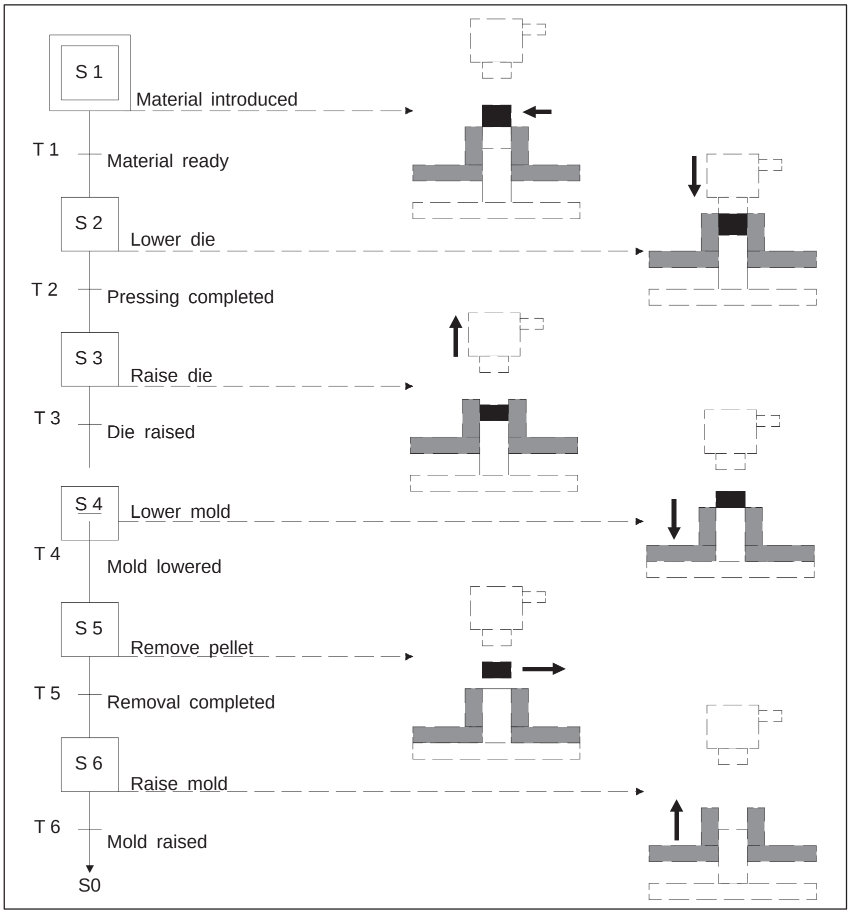


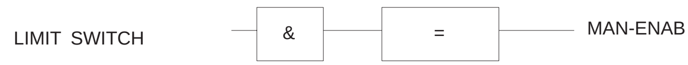
Figure 2-6 Representation at the Overview Level (example: powder press)

The Zoom-In Level

At the zoom-in level the contents of the steps and transitions are programmed using the zoom-in function:

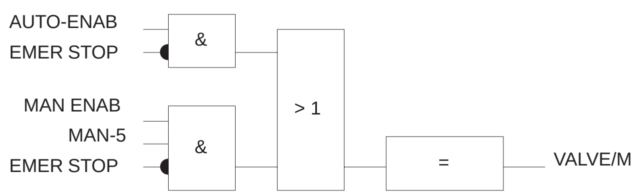
- the actions in the step
- the step enabling conditions in the transition

TRANSITION 2 PRESSING END?



LIMIT SWITCH	=	I	5.0	LOWER DIE POSITION
AUTO-ENAB	=	F	233.0	CURRENT STEP FLAG

STEP 5 REMOVAL OF PELLET



AUTO-ENAB	=	F	233.0	CURRENT STEP FLAG (AUTO)
EMER STOP	=	I	4.1	EMER OFF (DISABLE OUTPUTS)
MAN-ENAB	=	F	205.6	MAN FLAG
MAN-5	=	I	8.7	
VALVE/M	=	Q	6.0	REMOVAL

Figure 2-7 Representation at the Zoom-In Level (example: powder press, transition 2 and step 5)

After configuring the structure of the sequencer at the overview level and programming the steps and transitions at the zoom-in level, the sequential control program is completely established.

GRAPH 5/II therefore provides you with an interface with which you can create straightforward sequential control systems easily and quickly.

Apart from supporting configuring and programming, GRAPH 5 also supports documentation and testing/diagnostics.

Documentation

During configuring and programming, you can:

- enter comments for the steps and transitions at the overview level
- enter (step/transition) segment titles, statement and segment comments and display the assignment list of symbols used at the zoom-in level.

You can print the following:

- sequencer identification dialog
- overview level with all comments
- list of all transitions and transition comments
- list of all steps with step comments and corresponding waiting and monitoring times
- all the transitions at the zoom-in level with transition comments (segment titles), statement comments, assignment list of the symbols used
- all the steps at the zoom-in level with step comments (segment titles), statement comments, assignment list of the symbols used

Test and Diagnostics

The current status of the sequencer is displayed in a status display, i.e. active steps are clearly marked. The status of individual steps and transitions can also be followed at the zoom-in level, with the statuses of individual operands and logic operations displayed on the screen.

If a timeout occurs, the affected sequencer is indicated. The cause of the timeout can be traced from the overview level through to the zoom-in level. If you select the sequencer involved, you can display the affected step (steps). You can find out the exact cause of the timeout at the zoom-in level.

Graph 5 Diagnostics ("G5-DIAG" Package)

With the group diagnostics function you can monitor up to four PLCs simultaneously. Using the criteria analysis function, you can display unsatisfied assignments and their criteria. In the operating field, preset and current parameters of the FB are displayed in the CSF representation. Changes to the current parameters can also be made on the programming device.

2.3 How does GRAPH 5 Function?

A sequence control system is characterized by its steps, i.e. by the subdivision of a control task into individual sequence steps. It proceeds to the next step depending on the step enabling conditions.

With GRAPH 5, the structure of the sequencer is determined by the following:

- steps and
- transitions

Step

Description of the actions executed by the sequencer when a certain status exists. These actions are programmed at the zoom-in level; a flag (F 233.0) is used as a substitute for the enable signal for the modes AUTOMATIC, STEP SELECTION and EXECUTE. for the MANUAL mode, flag F 205.6 serves as the enable signal.

Transition

Description of the step enabling conditions with which a sequencer changes from one status to the next (i.e. proceeds from one step to the next). These step enabling conditions are programmed at the zoom-in level. The result of logic operation (RLO) is not the definitive step enabling condition, it can, in some cases, still be corrected by the GRAPH 5 program, e.g. waiting times not yet elapsed etc. Flag 233.0 is used to activate the next step(s).

For configuring and programming, the GRAPH 5/II optional package is necessary. The program for a sequential control system is created offline.

To run the program on a programmable logic controller (PLC), the standard function blocks for GRAPH 5 are necessary. These FBs are available for specific PLCs. The FBs are used to implement the modes of the sequencer. Per sequencer, at least one standard block is called and assigned parameters. Test and diagnostics are executed online with the PLC.

2.4 The Elements of GRAPH 5

You create GRAPH 5 programs at the following levels of representation:

- overview level
- zoom-in level

At the overview level, you specify the overall structure of your program.

At the zoom-in level, you can then program these sections in detail.

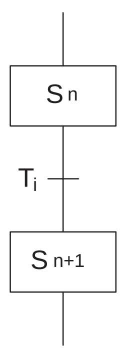
2.4.1 Elements at the Overview Level

The elements result from a series of steps and transitions. The following rule applies:

Every transition must follow a step and every step must follow a transition.

Linear Sequence

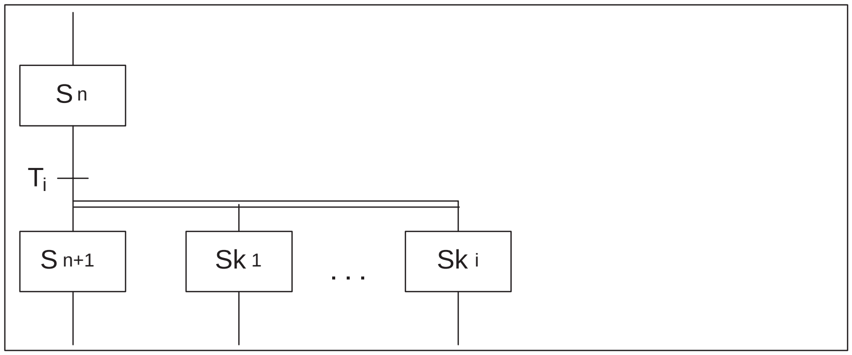
The sequence proceeds from S_n to S_{n+1}. When T_i switches, S_{n+1} is activated and S_n deactivated. If several steps follow on in a linear sequence, they are lined up one after the other.



Opening a Simultaneous Branch

Several steps are activated simultaneously by only one transition. The sequence proceeds from S_n to $S_{n+}1$ and Sk1 and ... Sk_i within a PLC cycle.

When T_i switches, S_{n+1} to Sk_i are activated and S_n is deactivated (corresponds to an AND sequence).



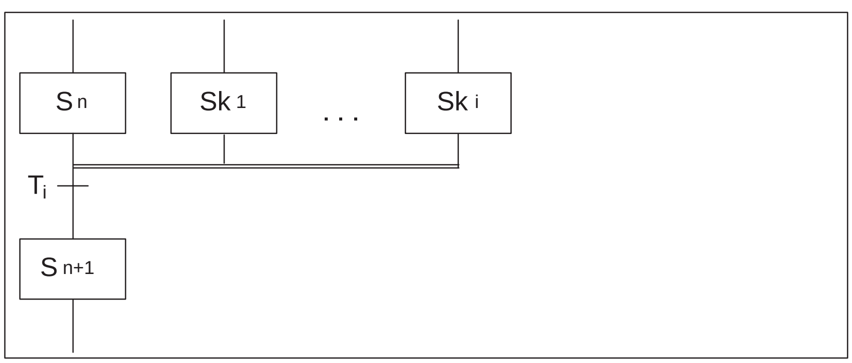
Closing a Simultaneous Branch

Simultaneous branches are joined again by means of the synchronization. The sequence proceeds from S_n and Sk1 and... Sk_i to S_{n+1} within a PLC cycle.

T_i becomes valid when all the preceding steps S_n to Sk_i are active. When T_i switches, these steps are deactivated, S_{n+1} is activated.

Note

Every simultaneous branch must run through as far as the junction.



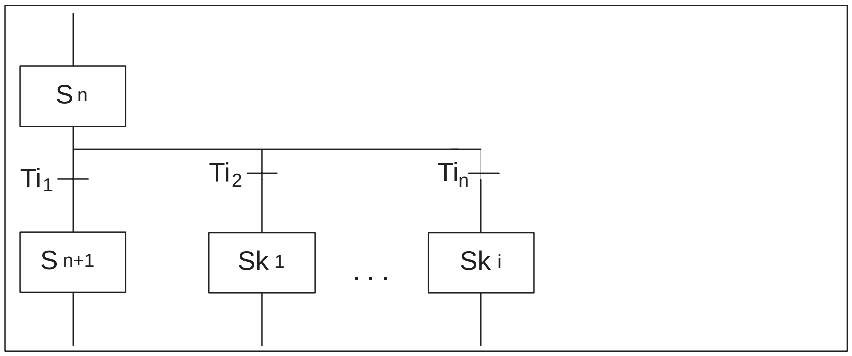
Alternative Branch

One of the branches will be run through. The sequencer proceeds from Sn to Sn+1 or (exclusive) Sk1 or... Ski within a PLC cycle.

As soon as Sn is active, all the transitions Ti1 to Tin are processed. The transition with a satisfied enabling condition will switch.

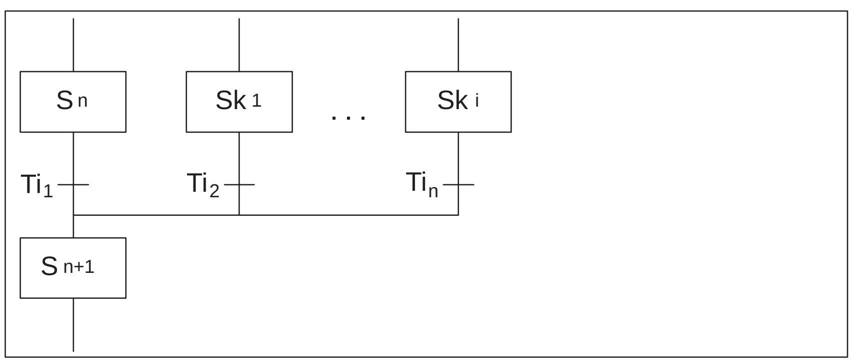
Note

If possible, the step enabling conditions of the transitions Ti_1 to Ti_n should be mutually exclusive. If the conditions for several transitions are satisfied simultaneously, the transition furthest left will be enabled (corresponds to OR sequence).



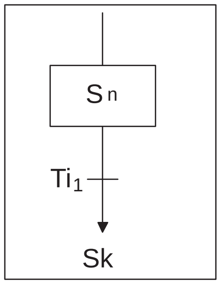
Alternative Junction (Graphic)

When alternative branches join again, the following step S_{n+1} will be activated when one of the previous transitions Ti_1 to Ti_n switches. The sequencer therefore proceeds from S_n or Sk_1 or... Sk_i to the next step within a PLC cycle.

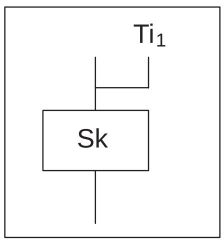


Jump
- End of Sequence
- Alternative Junction

The sequencer proceeds from S_n to Sk (as with the linear sequence, however, without a graphic connection). When Ti_1 switches, S_n is deactivated and Sk is activated.

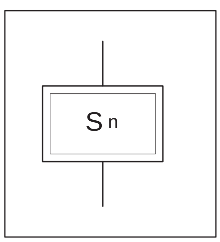


A graphic reference is automatically stored at the jump destination.



Initial Step

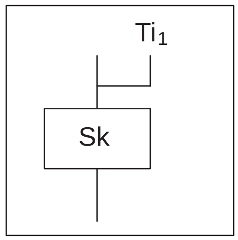
This is activated at the start of the sequencer without the conditions being checked and it becomes active after the jump to S 0 when the sequencer is running cyclically.



Selective Step

The action part of a step marked as selective is only processed when the step is active. Normally (without selective steps) all the steps of the sequencer are run through cyclically; if a step is not active, the actions are carried out with RLO=0. With a selective step, the action part is skipped if the step is not active.

You can use selective steps, for example, for process sequence counters.

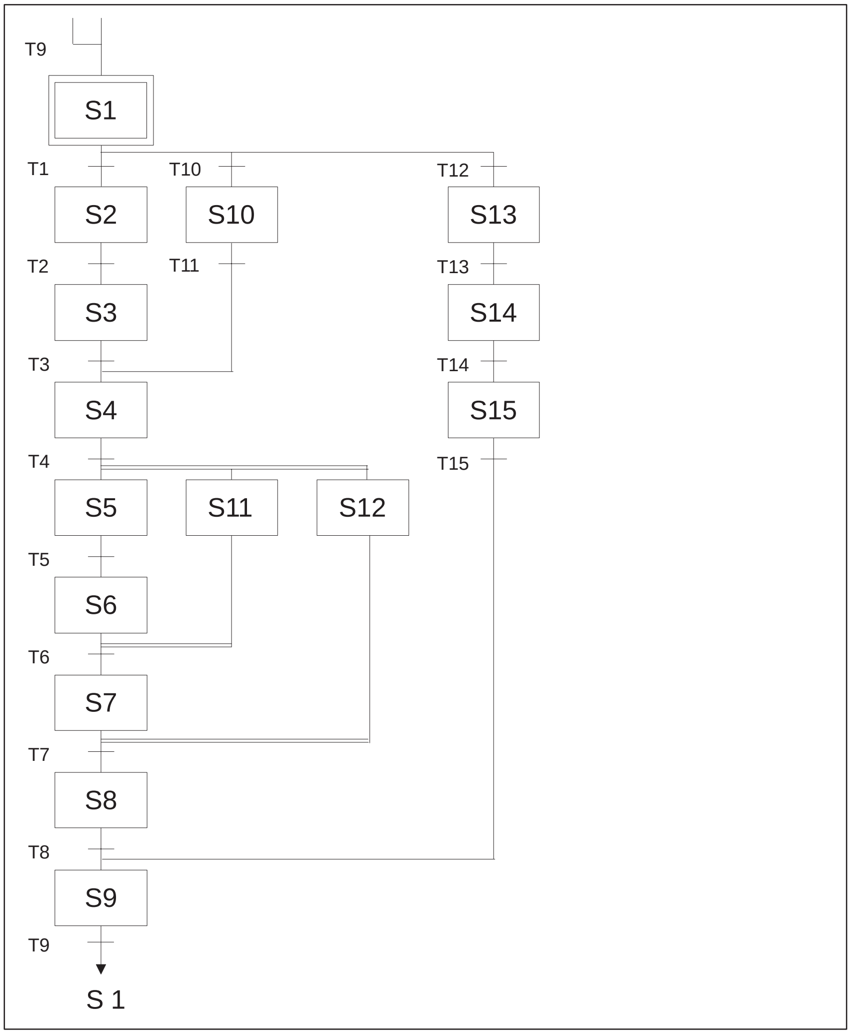


Note

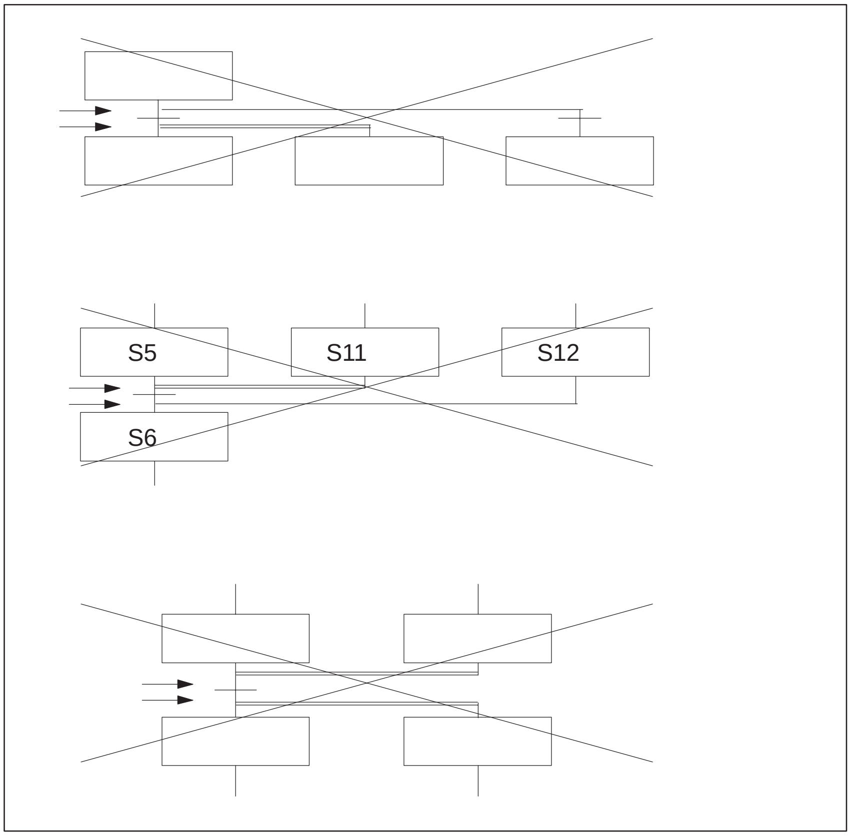
The assignments remain set. You may need to delete them.

You can program the structure of your sequencer with these elements.

By nesting parallel and alternative branches, complex structures can be created, as shown below:



The following constructions are not possible:



Note

Two branches following each other immediately must have a step between them.

Each simultaneous branch must be opened and closed graphically.

Alternative branches within simultaneous branches must be closed before the junction.

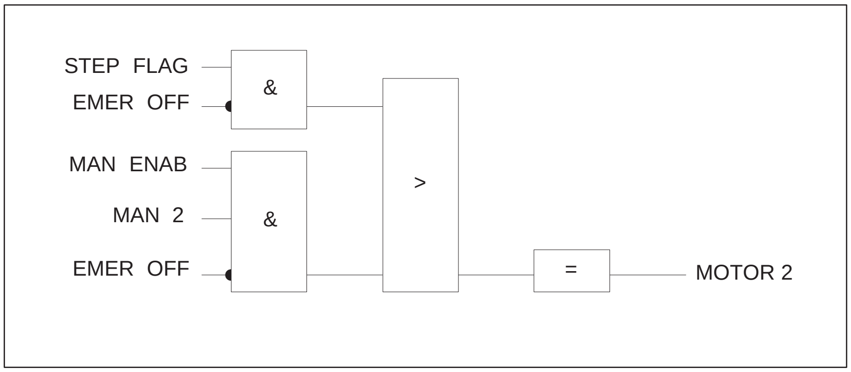
Jumps between different simultaneous branches are not permitted since they generally cause an incorrect response in the sequencer.

2.4.2 Programming at the Zoom-In Level

The steps and transitions are programmed at the zoom-in level, i.e. their content is specified in LAD, CSF or STL.

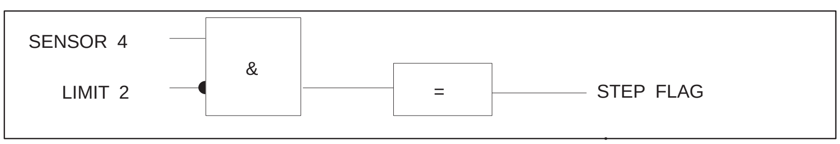
Programming the Steps

Steps are the active part of the sequencer. Commands, e.g. to actuators, load and transfer operations, starting timers and counters and FB calls are programmed in the steps. The step flag is assigned by GRAPH 5; the action part can be programmed as required for the task in hand. Interlocks are programmed at the same time (single control element).



Programming the Transitions

Transitions are the step enabling conditions for the steps. The conditions that must be satisfied (RLO=1) to allow the next step (or steps) to be activated must be programmed.



Note

Only the last result of logic operation (RLO) before the end of the transition (BE) decides whether or not the transition switches.

2.4.3 Waiting and Monitoring Times

A waiting and a monitoring time can be assigned to every step.

Waiting Time

This is the minimum time TW, for which a step remains enabled even if the following transition has already been satisfied. The next step will only become active after the waiting time has elapsed.

Maximum Monitoring Time

The program checks whether or not the step enabling conditions for the next step become active within a preset time (TM). The sequencer must switch to the next step before TM elapses, otherwise a timeout will be detected.

Minimum Monitoring Time

By assigning appropriate FB parameters, you can have the TW interpreted as a minimum monitoring time (parameter TUE-MIN). Here, the program checks whether the step enabling conditions for the next step are fulfilled before the time has elapsed. If this is the case, an error message is displayed.

You can specify different values for TM and TW in every step. You simply need to enter time values. The time function does not need to be scanned in the next transition, but is evaluated automatically by the standard function blocks for the modes.

2.4.4 Comments

You can specify a comment for every step and transition. The comments are displayed both at the overview and at the zoom-in level.

2.4.5 Multistep Zoom-In

Refer to Chapter 4.

2.5 Program Structure of a Sequencer with GRAPH 5

Figure 2-8 provides you with an overview of the interaction of the individual components of a sequencer.

The program structure shown in the diagram is largely generated and managed by the GRAPH 5 software program. The creation of the program (sequence block and data block) is supported by the programmer.

To run the program on the programmable logic controller, you must call and assign parameters (modes, sequence block number etc.) to the standard function block "main sequence".

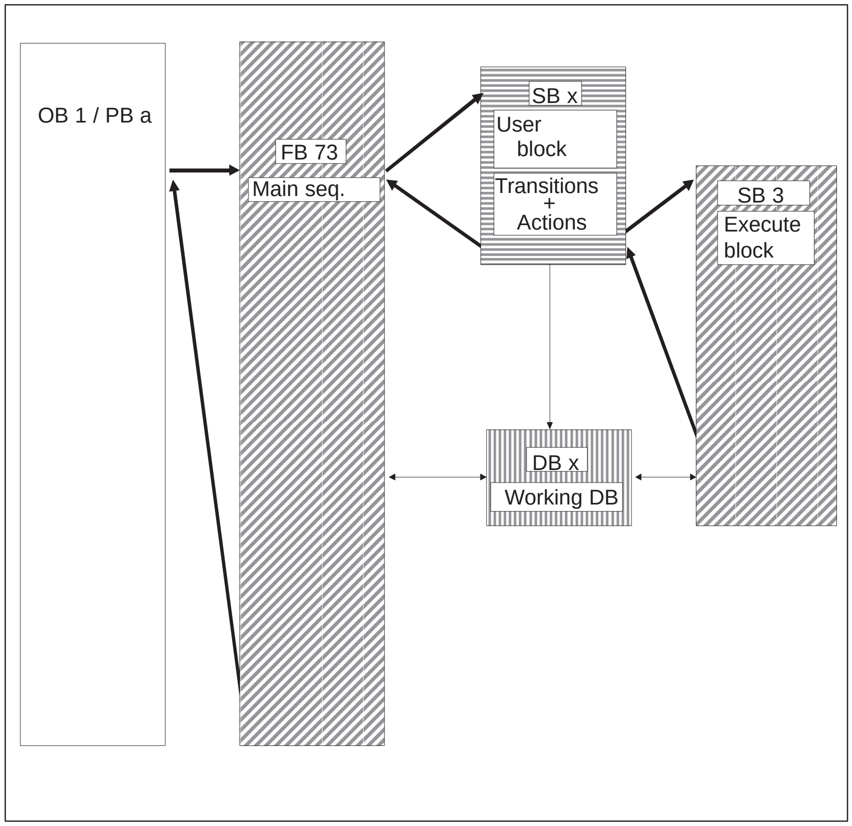
The structure of the sequencer and all the actions and step enabling conditions are located in the sequence block SBx. This is the heart of this sequential control system and you must create it yourself. At each transition, the "execute" SB is called to execute the modes. You must simply load the execute block in the PLC.

The DBx is the user data block for SBx. It is not programmed but is generated with the programming device function DB-GEM and you must load this in the PLC.

The FB and the corresponding SB are available as standard blocks (standard blocks are specific to the CPU).

You yourself must create a PB with the appropriate parameters for the FB and OB 1 which triggers the parameter assignment.

For more detailed information about diagnostics, refer to Chapter 6.

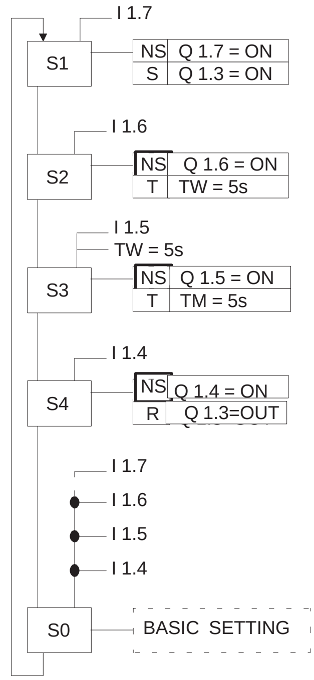


: Data traffic
: Block calls
: Generated by LAD / CSF / STL programming device software (Edit OB / PB)
: Standard block
: Generated by user with GRAPH 5 programming device software (Edit SB)
: Generated by GRAPH 5 programming device software (DB-GEN)
FB 73 : Control main sequence (fast version)
SB 3 : Execute block
SB x : User block (transitions and actions), x ≥ 10
DB x : Working DB (DB<G5:sequence>)

Figure 2-8 Program Structure of a Sequencer

2.6 Example With and Without Using GRAPH 5

Old representation (DIN standard 40719)



STL program for sequencer

```
Segment 1
   : A     I     1.7
   : A     F    16.0
   : S     F    16.1
   : R     F    16.0
   :***
Segment 2
   : A     F    16.1
   : =     Q     1.7
   : S     Q     1.3
   : A     I     1.6
   : A     F    16.1
   : R     F    16.1
   : S     F    16.2
   : ***
         .
         .
         .
         .
         .
Segment 5
   : A     F    16.4
   : =     Q     1.4
   : R     Q     1.3
   : AN    I     1.7
   : AN    I     1.6
   : AN    I     1.5
   : AN    I     1.4
   : R     F    16.1
   : R     F    16.2
   : R     F    16.3
   : R     F    16.4
   : S     F    16.0
   : BE
```

Figure 2-9 Programming without GRAPH 5

It was previously not possible to program sequencers graphically. According to the DIN standard, the design had to be translated into an STL program.

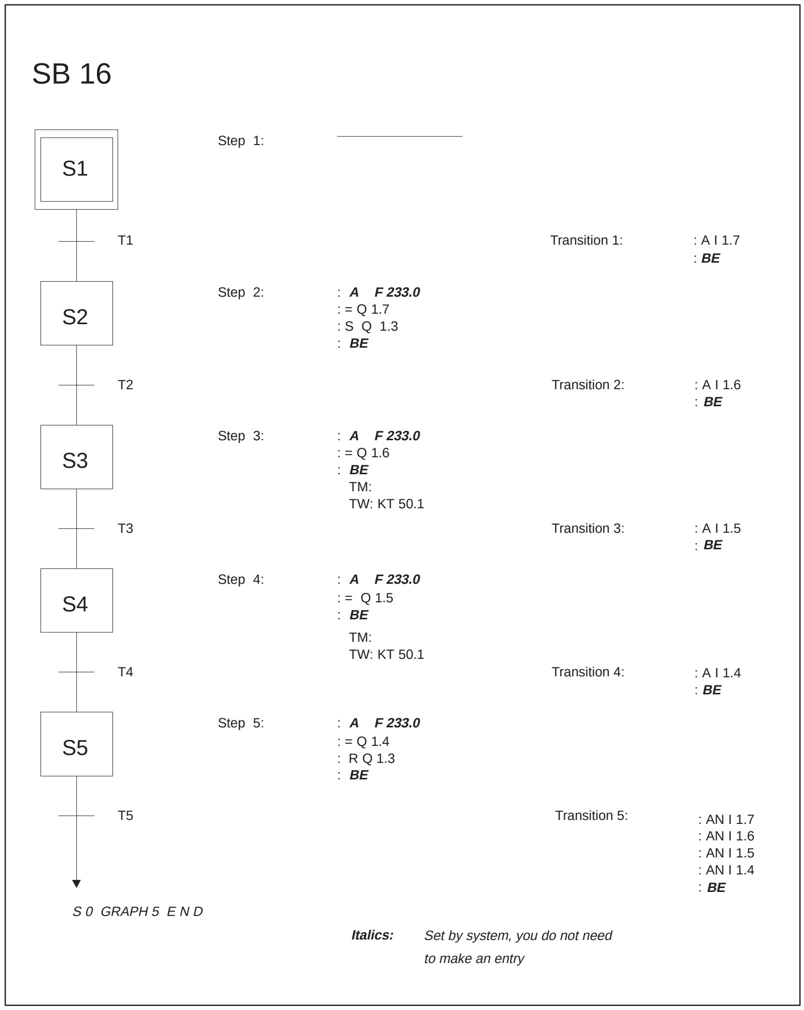


Figure 2-10 Programming with GRAPH 5

The sequencer is programmed graphically at the overview level. The zoom-in programming can be performed in LAD, CSF or STL. The entire sequencer is located in one SB. The structure is clearly established in the overview. You only need to program the actions and step enabling conditions, the program code for the sequencer (switching mechanism) is generated automatically by GRAPH 5.

Advantages of Programming with GRAPH 5

With GRAPH 5, you can program sequencers both easily and clearly. Compared with the conventional methods of programming sequencers, GRAPH 5 makes your job much simpler.

Without GRAPH 5	With GRAPH 5
A sequence block had to be programmed for every step.	One sequence block contains the whole sequencer.
Manual conversion of the sequencer into LAD, CSF, STL.	Programming in GRAPH 5. Conversion is automatic.
The sequencer structure had to be established by the program. SBs required special handling for branches, junctions and jumps. You had to make sure that the correct step was called.	The overview representation contains all the information about the structure. The sequence is fixed and is automatically converted to program code.
You had to start and scan monitoring and waiting times.	You can specify a waiting and/or monitoring time for each step. The times are started and evaluated automatically.
Greater time and effort required to make changes.	Less time and effort required to make changes with the support of an editor.
Process sequence difficult to recognize without graphic support.	Process sequence easy to recognize within the graphic structure.
	Representation complying with IEC standard 1131-3 (SFC = Sequential Flow Chart).

GRAPH 5 Product Overview

3

Chapter Overview

3.1 Product Overview: the Components of GRAPH 5/II

The GRAPH 5 system allows user-friendly handling of sequential control systems. The components of the system are as follows:

- GRAPH 5 for creating and modifying sequencers and
  GRAPH 5 diagnostics for diagnostics and manipulating of sequencers
- Function blocks, similar to an operating system for controlling sequencers

Programming Device Components

The essential functions are as follows:

- creating and modifying a sequencer
- generating the appropriate data areas
- creating the program framework (calling the sequencer or the standard blocks). Refer to Chapter 4.
- Diagnostics and documentation of timeouts in sequential control systems. Refer to Chapter 6.

PLC Components: the Function Blocks

There are different blocks available for the various programmable logic controllers. Not all functions are possible on all PLCs. The same block numbers, however, represent the same range of functions.

Table 3-1 Overview of the Function Blocks

FB 70/SB 0	Sequencer control (standard version)
FB 71	Subsequencer control (only with standard version)
FB 72/SB 2	Sequencer control (fast version)
FB 73/SB 3	Sequencer control (fast version, only linear)
FB 74	Mode expansion (only for FB 72/FB 73)
FB 75	Timer handling
FB 67,68,69	Diagnostics
SB 5	Synchronization

Creating Sequencers

4

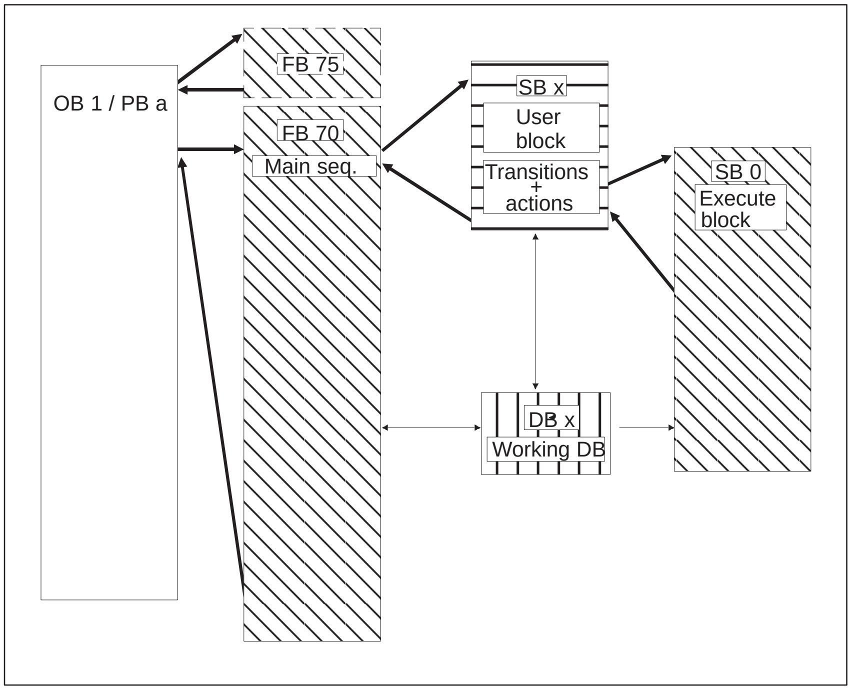
Chapter Overview

4.1 Introduction

This chapter contains a complete description of how to create sequencers both on the PG and the PLC. After working through this chapter, you will be able to create, call, run and test sequencers. The chapter is deliberately restricted to the basic functions. Process synchronization and diagnostics are not described. You can find detailed information about these functions in Chapters 5 and 6.

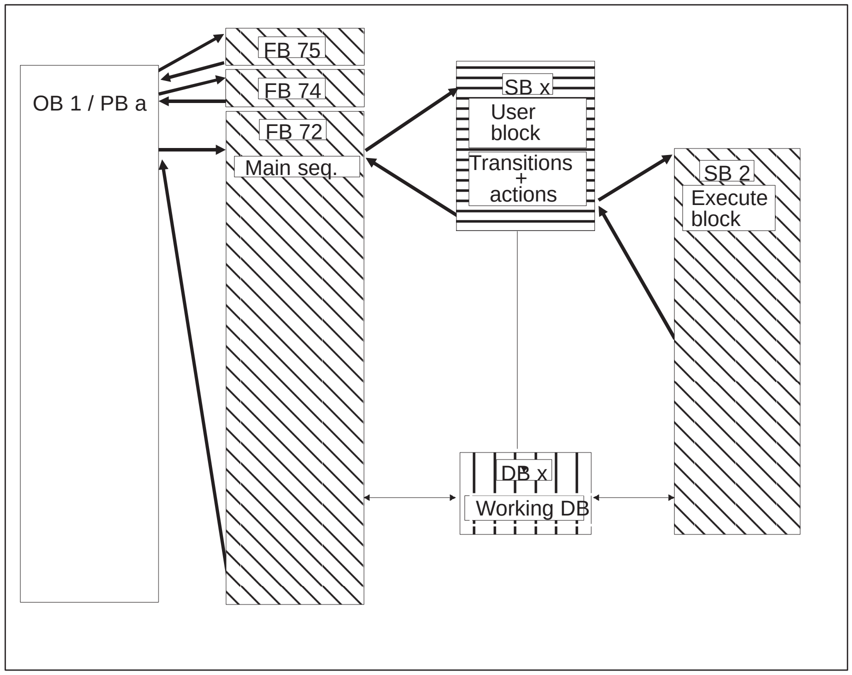
4.2 Call Diagrams

Call Sequence Using FB 70



: Data transfer
: Block calls
: Created by LAD /CSF / STL PG software (Edit OB / PB)
: Standard block
: Created by user using GRAPH 5 PG software (Edit SB)
: Created by GRAPH 5 PG software (DB-GEN)
FB 70 : Control of main sequencer (standard version)
FB 75 : Timer handling (optional)
SB 0 : Execute block (control of the mode)
SB x : User block, (transitions and actions), x ≥ 10
DB x : Working DB (DB<G5:sequence>)

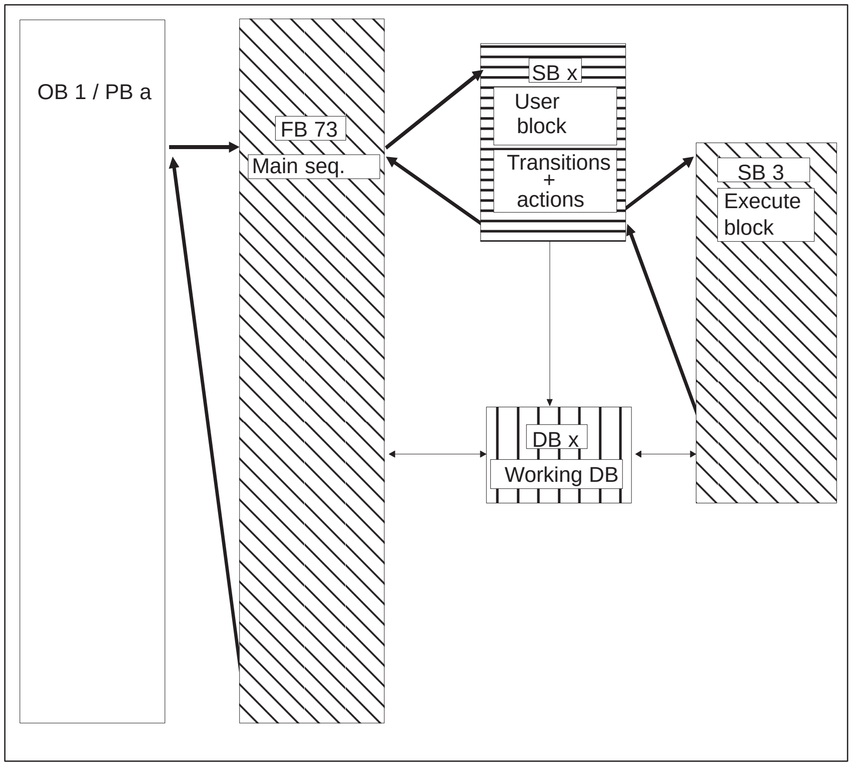
Call Sequence Using FB 72



: Data transfer
: Block calls
: Created by LAD /CSF / STL PG software (Edit OB / PB)
: Standard block
: Created by user using GRAPH 5 PG software (Edit SB)
: Created by GRAPH 5 PG software (DB-GEN)

FB 72 : Control main seq. (fast version)
FB 74 : Additional modes (only for FB 72/ FB 73)
FB 75 : Timer handling (optional)
SB 2 : Execute block
SB x : User block, (transitions and actions), x ≥ 10
DB x : Working DB (DB <sequence>)

Call Sequence Using FB 73



: Data transfer

: Block calls

: Created by LAD /CSF / STL PG software (Edit OB / PB)

: Standard block

: Created by user using GRAPH 5 PG software (Edit SB)

: Created by GRAPH 5 PG software (DB-GEN)

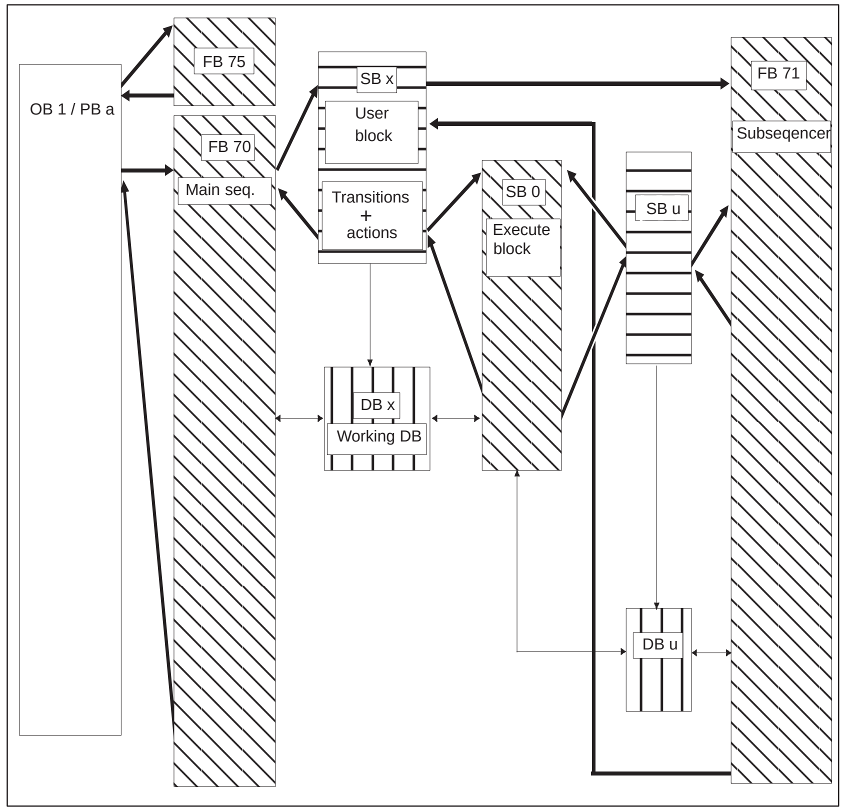
FB 73 : Control main seq. (fast version)

SB 3 : Execute block

SB x : User block, (transitions and actions), x ≥ 10

DB x : Working DB (DB<G5:sequence>)

Call Sequence Using FB 70/71



- ⟷ : Data transfer
- ⟶ : Block calls
- (blank box) : Created by LAD /CSF / STL PG software (Edit OB / PB)
- (diagonal hatching) : Standard block
- (horizontal lines) : Created by user using GRAPH 5 PG software (Edit SB)
- (vertical lines) : Created by GRAPH 5 PG software (DB-GEN)

FB 70	: Control of main sequencer (standard version)
FB 71	: Control of subsequencer (standard version)
FB 75	: Timer handling (optional)
SB 0	: Execute block
SB x, u	: User block, (transitions and actions), x ≥ 10
DB x, u	: Working DB (DB<G5:sequence>)

4.3 Creating Functional Sequencers

Main Sequencer

You specify the sequential structure and the commands of your program in a main sequencer by programming an SB with GRAPH 5. Information about the individual elements of a structure can be found in Section 2.4.

Subsequencer

If the number of steps and transitions in the main sequencer is not adequate for your purposes, you can separate your program using subsequencers.

A subsequencer can be understood as inserting steps in a single step. This can only be called once per main sequencer (refer also to Section 4.3.5 “Restrictions when Creating Subsequencers”).

MSZ

The multistep zoom-in (MSZ) is not assigned directly to any step in the sequencer. Here, you can program multistep actions and can assign a number of steps to each segment for which these actions are valid. Moreover, positive synchronization conditions and supplementary conditions can be assigned to this MSZ.

Step Types

To be able to match your program to your requirements, there are various step types available, as follows:

Permanent Step

The programmed actions are executed dependent on the RLO. All steps of the sequencer are run through cyclically, i.e. a step is also run through when it is not active. The operations to be executed in a permanent step are controlled by the RLO.

The RLO is set by the first command of a step programmed in GRAPH 5 “A F 233.0”. Commands independent of the RLO are always executed, RLO-dependent commands only when the RLO = 1.

Selective Step

The action part of a selective step is only processed when the step is active. If the step is not active, the action part is skipped.

Initial Step

This becomes active as the first step when a sequencer starts without the conditions being scanned. This is also the case following a jump to S0 during cyclic sequencer processing.

Timer Functions

There are, of course, various timer functions available:

Waiting Time (TW)

TW is the minimum time a step remains enabled even if the follow-on transition is already satisfied before this time elapses. The follow-on step becomes active at the earliest when the waiting time TW has elapsed.

Maximum Monitoring Time (TM)

The step enable conditions for the next step must be satisfied within the preset monitoring time (TM). If the follow-on step does not become active within TM, a timeout message is displayed. As an alternative, you can use TW as the parameter TUE-MIN.

Minimum Monitoring Time (TUE-MIN)

With the appropriate DB parameter assignment in DB<G5:sequence> (D 33.2 = 1), you can have TW interpreted as a minimum monitoring time TUE-MIN. In this case, the program checks whether the step enabling conditions are met before the time elapses. If this is the case, you receive an error message.

TW and TM can have different values in each step. Programming simply involves entering the timer values. The timer functions do not need to be scanned in the next transition, but are evaluated automatically by the standard function blocks for the modes.

Integrated Tools

You create and edit your program with **GRAPH 5**. You are, however, supported by tools when using your program (SB).

If you trigger the function **DB-GEN** the diagnostic DB, DB<G5:DIAG> and the working DB, DB<G5:sequence> are generated.

If problems occur when you run your program, you are supported by the **process synchronization** when you restart the SB in the online mode (refer to Section 5.3 where you will find the additional settings that must be made).

If you have problems starting up your sequential control system or timeouts occur when sequencers are running, the online diagnostic system **GRAPH 5 diagnostics** will support you in troubleshooting.

Using GRAPH 5 diagnostics, you can monitor up to four PLCs simultaneously.

Further Tools

The standard STEP 5 tools (such as cross reference list, documentation, rewiring ...) are also available under GRAPH 5. (Refer also to the STEP 5/ST manual.)

Adapting the Timers

The timers required by GRAPH 5 to run an SB are assigned using the ID dialog (refer to Section 4.5.4).

Note

If you run more than one SB simultaneously, you must make sure that the timers do not overlap.

GRAPH 5 programs can range from simple to extremely complex. When you work with GRAPH 5 for the first time, you should start with the fast version, since fewer parameters must be taken into account. The following sections explain the minimum configuration and ways in which this can be expanded.

The following sections explain the minimum configuration and ways in which this can be expanded.

Minimum Configuration

A minimum configuration would be a standard FB with the corresponding sequence block, i.e. FB 70/SB 0, FB 72/SB 2
or FB 73/SB 3, supplemented by a user SB generated with GRAPH 5 and the corresponding DB, DB<G5:sequence> generated with DBGEN.

You must also create a block containing the sequencer call.

Possible Expansions

The minimum configuration outlined above can be extended essentially using the following components:

FBs to extend performance
dependent on the standard FB:

FB 70	FB 71 subsequencer, refer to Section 4.3.5 and 4.7
FB 72, 73	FB 74 additional modes; refer to Section 4.9.1
FB 70, 72, 73	FB 75 timer handling; refer to Section 4.9.3

Diagnostic functions

FB 67, FB 68 and FB 69, and the required DBs:
DB<G5:DIAG>
DB<DIAG>
DB<G5:PARA>

Process synchronization

SB 5 and SB<Sync>

4.3.1 Entering a Sequencer (SBx)

You enter the sequencer using the dialogs described in Section 4.5.

You first select the sequential structure of the sequencer at the overview level. To do this, you describe the structure of the steps and corresponding transitions, particularly branches and junctions within the sequencer. The sequencer is completed with a jump to a previous step. If you want the processing of the sequencer to be continued with one or more INIT steps, you must jump to S0.

Following this, you can program the steps and transitions. To do this, you first select the step or transition and then change to the zoom-in level. In the steps, you program the output commands and the required interlocks. The call and supply of parameters for the subsequencers (FB 71, with the standard version) is made in the corresponding steps. In the transitions (between the steps) you enter the step enabling conditions for the sequencer. Any steps and transitions you have not yet programmed are displayed at the overview level with a question mark.

The number of the corresponding data file (DB<G5: sequence>) for the sequencer is displayed in the ID dialog. This dialog also displays the number of the first timer for the sequencer (timer base). The sequencer then automatically occupies two timers for each simultaneous branch of the sequencer, i.e. with a maximum of 8 branches, 16 consecutive timers are required in the PLC.

These timers must be available exclusively for the GRAPH 5 system for this SB and must not be used for other purposes.

When you select the FB, you must stipulate the standard FB to be used. After programming all the steps, transitions and the ID dialog, SB x is saved and the processing completed.

4.3.2 Generating the Required Data Blocks

Using the function DB-GEN on the PG, you must generate a special data block DB x for every SB x generated with GRAPH 5 (x is assigned automatically and is the same for the SB and DB). You must also generate a data block DB y common to all sequence blocks (y can be freely selected) for diagnostic purposes which is, however, only required for GRAPH 5 diagnostics (with FB 67-69). The data blocks must be regenerated not only after you create the sequencer (SB x) but also following certain modifications to the sequencer.

Calling DB-Gen

The conditions for calling DB-GEN can be found in the following table.

Where Change is Made	**Offline Change in *.S5D**		**Online/ PLC in STOP Change in PLC (Output SB)**		**Online / PLC in RUN Change in PLC (Output SB)**		**Online / PLC in RUN Change in PLC (Status SB)**	
Type of Change								
	allowed	DB-GEN required	allowed	DB-GEN required	allowed	DB-GEN required	allowed	DB-GEN required
Zoom-in	yes / no		yes / no		yes / no		yes / no	
TW / TM time value	yes / no		yes / no		yes / no		yes / --	
TW / TM timer base in ID screen form	yes / yes		yes / yes		yes / yes		-– / --	
Selective / permanent	yes / no		yes / no		yes / no		no / --	
Comment	yes / no		yes / no		yes / no		no / --	
Insert / clear steps	yes / yes		yes / yes		no / --		no / --	
Include /clear simultaneous branches	yes / yes		yes / yes		no / --		no / --	
INIT steps	yes / yes		yes / yes		no / --		no / --	
Generate / delete an MSZ	yes / yes		yes / yes		no / --		no / --	

The editor can automatically execute DB-Gen for GRAPH 5/II blocks. For older GRAPH 5 SBs only an already existing DB>G5:sequence> can be updated. For this the editor dialog box has the option

updating DBs:

No	DB-Gen is not automatically called but has to be called by the user.
DB<G5:sequence>	The working-DB DB<G5:sequence> is updated or newly created, if necessary. Restriction: For GRAPH 5 sequencers older than V6.0, DB-Gen always has to be carried out simultaneously for all sequencers. Therefore, the DB cannot be newly created for this. It can only be updated. The DB-Gen function has to be carried out once for each SB, because some data has to be read from the existing DB for updating.
DB<G5:sequence> and DB<G5:diag>	If this option is activated, the working DB DB<G5:sequence> and the diagnostic DB DB<G5:diag> are updated or newly created (same restriction).

You can also start DB-Gen from the menu via **Management > GRAPH 5 DB Gen ....** For older GRAPH 5 SBs DB-Gen must always be started for all SBs and with diagnostic DBs. For GRAPH 5/II SBs you can input a block list. The diagnostic DB is only required, if you are using the GRAPH 5 diagnostics with FB 69.

Creating Shortened DBs

Only use this option, if the memory in the PLC is too small. However, make sure, that the applicable restrictions are kept to, as the standard blocks do not check this.

4.3.3 FB Selection / SB Assignment

The standard FBs available differ from each other in terms of their range of functions, speed and size and the possible additional function blocks. For more detailed information refer to Section 4.9.

GRAPH 5 Diagnostics

With **GRAPH-5 diagnostics** (refer to Chapter 6) you also require the DB<G5:DIAG>, DB<DIAG> and DB<G5:PARA>.

Remember that FB 69 creates a further temporary DB in the PLC and the DB number (DB<G5:DIAG> +1) must be reserved for this.

Synchronization

Here, GRAPH 5 automatically generates a synchronization SB for each SB<G5:sequence>. You can stipulate the number of this SB in the ID dialog. The default is the number SB<G5:sequence>+100. You must also load SB 5 supplied as a standard block in the PLC (refer to Chapter 5).

Fast Version:

Sequencer with alternative branches

Function Block	Corresponding SB	Description
FB 73	SB 3	sequencer control
FB 74		mode expansion (only with FB 72 or FB 73), optional
FB 75		timer handling, optional
FB 67, 68, 69		diagnostics, optional
	SB 5	synchronization, optional

Sequencer with simultaneous and alternative branches

Function Block	Corresponding SB	Description
FB 72	SB 2	sequencer control
FB 74		mode expansion (only with FB 72 or FB 73), optional
FB 75		timer handling, optional
FB 67, 68, 69		diagnostics, optional
	SB 5	synchronization, optional

Standard Version:

Sequencer with simultaneous and alternative branches and subsequencer; all modes integrated

Function Block	Corresponding SB	Description
FB 70	SB 0	sequencer control
FB 71		subsequencer control, optional
FB 75		timer handling, optional
FB 67, 68, 69		diagnostics, optional
	SB 5	synchronization, optional

4.3.4 Programming the OB, Assigning Parameters for the FB

To allow an SB to be processed, the corresponding standard FB must be assigned and integrated in the (cyclic) program execution (OB 1).

The FB assignment should preferably be made in a PBxx with the same number as the SB to be integrated. To do this, the following code should be entered in OB 1:

: JU PBxx

For a detailed description of the data for assigning the selected standard FB, refer to Section 4.9.

To implement the cold restart function for the sequencer, you must reset the parameter N-ST in a start-up OB of the PLC (OB 20, 21 or 22, depending on the PLC used; refer to Section 4.9.2).

For N-ST, you must use a flag bit that is not used at any other point. The reason for this is that RLO = 0 for N-ST resets the sequencer. FB 70 reads and writes to N-ST.

4.3.5 Restrictions when Creating Subsequencers

FB 70 must be used. The subsequencer SB n can then be created using the GRAPH 5 program in the same way as a main sequencer. A subsequencer can be started in any step of a main sequencer. The subsequencer should be understood as the insertion of steps within a step of the main sequencer and is used to extend the available capacity. A subsequencer must be stored as a separate sequence block. It can only be called once per main sequencer and must not be nested any further. The subsequencer is controlled by FB 71 which is called unconditionally in the step of the main sequencer and assigned parameters. You can mark the main sequencer step with a subsequencer ID.

SB 0 (of the main sequencer) is also used as the standard sequence block and is therefore already available.

The subsequencer can only run in conjunction with a main sequencer (refer also to Section 4.7).

4.3.6 Operation with Several SBs

To control a process, you can use several sequencers simultaneously in the PLC. You must only call each sequencer once. Make sure that the timers do not overlap.

Each sequencer requires its own FB parameter assignment section.

The standard FBs/SBs are, however, only required once.

4.3.7 Further Restrictions / Limit Values

Sequence block SB x	Number of the block is selectable between 10 and 255.
Steps, transitions, MSZ	The maximum total number of steps and MSZs is 127, with a maximum of 26 MSZs. The maximum size of an SB is 4096 words.
MSZ	*The length displayed at the top right must not exceed 180 *The length displayed at the top right plus the number of 233.0 flags times the number of assignments plus 1 must be less than 256.
Step zoom-in	*Length for a permanent step max. 180 commands displayed on the screen at the top right. *Length of selective step max. 127 commands, displayed on the screen at the top right.
Transition zoom-in	The maximum length depends on the sequence structure; between 64 and 127 commands.
Simultaneous or parallel branches	A maximum of 8 simultaneous or parallel branches; in total max. 31 branches and/or junctions; max. 8 initial steps can be defined; step numbers from 1 to 127.
Flag area	Flags F 200.0 to 255.7 must not be used (except for expressly permitted and described flags, manual flag: 205.6, step flag: 233.0)

* Length according to screen display.

4.4 Loading and Starting the Sequencer

You must perform the following to process the sequencer in the PLC:

Load the corresponding FB, SB and DB in the PLC depending on the selected standard FB and the additional functions. The assignment is described in Section 4.3.2 or 4.3.3.

You must perform the following to start the sequencer:

Transfer the start-up and parameter assignment OB/PB to the PLC (refer to Section 4.3.4).

4.5 Creating Sequencers on the PG

4.5.1 Structure of the User Interface

In GRAPH 5, you work using the following user interfaces:

ID Screen Form

When you create a new SB, the ID screen form is displayed first. In this dialog, you enter the configuration parameters and the identification. (Refer to Section 4.5.4.)

When you press the enter key, you change to the overview level.

Overview Level

Here, the SBs are displayed in structured elements.
(Refer to Section 4.5.5.)

If you press SHIFT F5 Zoom-in, the detailed or zoom-in level is displayed.

Zoom-in Level

Here, you program the contents of transitions and steps.
(Refer to Section 4.5.6.)

Editing Mode / Output Mode

At the overview level and at the zoom-in level you must distinguish between the editing mode and the output mode. In the output mode, you can display already existing data. In the editing mode, you can modify existing data or enter new data.

The functions described in Section 4.5.2 are available in the dialogs of both these levels.

4.5.2 Functions and Keys Available in GRAPH 5

Display Modes

At the Overview Level

At this level, you can use the **SHIFT F4** key to switch over between the comment output options half/full screen. The sequencer is displayed in the left half of the screen and the comment in the right half.

The comment of the sequencer element marked by the cursor appears in the lower comment line.

In the “half screen” representation (4 parallel sequencers), a maximum of four sequencer columns is displayed. The right-hand half of the screen is used to list the comments of the first three columns (sequencers) on the left of the screen.

By moving the left-hand screen contents to the left or right, you can display the other sequencers and comments.

To display the comments of the 4th column, you must position the cursor in this column and then move it again towards the right.

Ready to start?	Setting: with comments A sequence block is displayed at the overview level.
Keystrokes	Press the **SHIFT F4** key. Each time you press this key, the display changes from “half” to “full screen” and vice-versa.

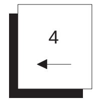
At the Zoom-In Level

In the output or editing mode of STL, you can switch over between the line and symbol comments by pressing the **SHIFT F4** key.

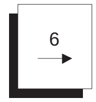
Ready to start?	Setting:	represent: with comments symbolic display	STL
	Display of a step or transition at the zoom-in level.		
Keystrokes	Press the **SHIFT F4** key. The display changes from symbol comments to line comments and vice-versa.		

Scrolling

Arrow key left



Arrow key right



At the Overview Level

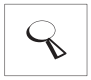
If there are more than three parallel sequencers and you are using the “half screen” mode, only three leftmost sequencers along with their step and transition comments can be displayed. In the left half of the screen, you can see the sequencer and in the right half the comment.

At the Zoom-In Level

Using the **arrow keys right/left**, you can move the display on the left-hand side of the screen horizontally. The comments are then updated.

Ready to start?	Setting: with comments A sequence block is displayed at the overview level. Half screen display.
Keystrokes	To move the left half of the screen to the right or left: Press the **arrow key right/left**

Zoom-In Function



Zoom-in function
Special function in GRAPH 5

END

At the zoom-in level of a step (in the output mode and with synchronization selected): you are in the selection menu for synchronization zoom-ins.
The contents of transitions and steps are programmed at the zoom-in level in STEP 5 (LAD, CSF, STL). You position the cursor on the required step or transition. With **SHIFT F5** (zoom-in key), you then display the first segment of the step or transition. When you switch over to the zoom-in level, the PG is in the output mode. You must then press **F6** (Edit) to change to the edit mode.

Ready to start? A sequence block is displayed at the overview level

To Change to the Zoom-In Level

Keystrokes Press **SHIFT F5** (Zoom In) or double-click a step or transition

To Change to the Overview Level

Keystrokes Enter the segment with **F7** and return to the overview level, or cancel segment editing with the **F8** key and return to the overview level.

Steps and transitions are programmed at the zoom-in level just as other blocks in STEP 5. At the zoom-in level, a step or a transition is like a separate block. It can have segments added and can contain comments etc.

A **?** no longer appears to the left of steps and transitions at the overview level once their segments are programmed.

At the zoom-in level you can use the **page down/up** keys to jump to the previous or next step/transition without returning to the overview level. When the prompt *Change step/transition?* appears, you can reply with yes or no.

Titles/Comments

At the overview level you can input comments for each step and each transition by pressing **SHIFT F6**. Each comment can be up to 32 characters long. This comment corresponds to the segment title in a STEP 5 block.

With the zoom-in function, not only comments for a step or transition can be entered, but also segment comments. In the statement list, you can also enter statement comments.

Ready to start?	Setting COMMENTS: YES

At the Overview Level

Title for step/transition (segment title)

Keystrokes	Position the cursor on the step or transition at the overview level. Press the **SHIFT F6** key. The cursor is now positioned in the comment input field. Type in the comment. To enter the comment Press the **return** key. To discard the comment Press the **ESC** key.

Comments for step/transition

Keystrokes	Position the cursor on the step or transition. Press the **COM** key twice Type in the comment and enter it with the **return** key Return to the overview level with **F8** or the **enter key**.

At the Zoom-In Level

Title for step/transition

If you press the **COM** key or **SHIFT F6** once at the zoom-in level, you jump to the comment dialog. Here, press **SHIFT F6**, you can enter a segment title.

The segment title of the first segment of a step or transition is the same as the title at the overview level.

Statement comments

In STEP 5 STL, you can enter statement comments with a maximum length of 32 characters.

Keystrokes	Select the segment of the step or transition. Select the editing mode with **CORR** or **F6**. Position the cursor on the statement and then position the cursor in the field for the statement comment using the **SHIFT arrow key right**. Input or modify the statement comment. Complete the statement comment with the **return** key. Complete editing with the **enter key**.

Titles and statement comments can also be entered in SC comment blocks.

Comments for steps and transitions

You can enter a segment comment for each step or transition. If a step or transition consists of several segments, then only one segment comment is possible per step or transition. It is advisable to enter the segment comment only in the first segment.

Ready to start?	The cursor is located within the segment. or at the overview level on a step or transition.
Keystrokes	Press the **COM** key twice. Type in the segment comment and complete the input with the **return** key.

To enter the comment and return to the segment or overview level:

Keystrokes	Press the **enter** key. To discard the comment and return to the segment. Press the **ESC** key.

Correction

CORR	Edit mode	5 CORR

In the output mode, the **CORR** key **F6 Edit** switches over to the editing mode.

At the Overview Level

When an SB is displayed for editing, the sequencer and the following function key menu appear:

F1	F2	F3	F4	F5	F6	F7	F8
Initial	Selective	Exchange	Copy	Zoom-In	Seg Com	Extras	Help
Step	Jump	Search	TM-TW	Open	Close	Enter	Cancel

You can now make changes at the overview level.

At the Zoom-In Level

At this level, **F6** switches over to the editing mode.

Depending on the selected method of representation, LAD, CSF or STL, a modified function key menu appears.

LAD

F1	F2	F3	F4	F5	F6	F7	F8
Math	Blocks	Shift		Compare	Seg Com	Extras	Help
┤├	┤/├	┤	-( )-	Bin Oper	Seg End	Enter	Cancel

CSF

F1	F2	F3	F4	F5	F6	F7	F8
Math	Blocks	Shift		Compare	Seg Com	Extras	Help
&	>=1	┤	—O	Bin Oper	Seg End	Enter	Cancel

STL

F1	F2	F3	F4	F5	F6	F7	F8
Fld End			SymbCom		Seg Com	Extras	Help
Fld Sta		Delete	Ins Fld		Seg End	Enter	Cancel

You can now make changes in the segment.

Deleting

Delete characters

You can use the **delete key** in the editing mode, both at the overview and at the zoom-in level.

At the Overview Level

Delete step/transition, branch or jump

Depending on the cursor position, you can delete a step/transition pair or a transition/step pair. If you position the cursor on the ends of branches, these are deleted. Jumps can be deleted in the same way.

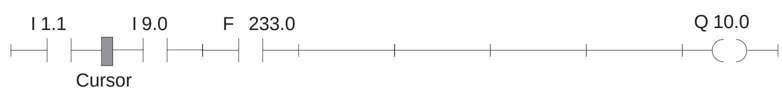
Keystrokes	Position the cursor on the step or transition. Press the **delete** key.

At the Zoom-In Level

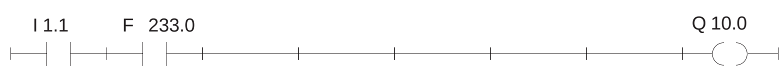
Delete operands

LAD/CSF

Delete at the cursor position, e.g. LAD:



Keystrokes	Press the **delete** key. Contact I 9.0 is deleted.



STL

Delete statements or part of a statement at the cursor position, for example you want to delete the statement A I 9.0.

Position the cursor on the ":", and press the **delete key**.

: A I 1.1	: A I 1.1
: A I 9.0 > Press the **delete key**:	→A F 233.0
: A F 233.0	: = Q 10.0
: = Q 10.0	: BE
: BE	

4.5.3 Getting Started

Starting STEP 5/ST

If you installed STEP 5 as a Windows program, you can start STEP 5/ST with the Start menu **Simatic > Step5V70 >STEP 5/ST**

The following PIF files are available for Windows 95/98:

Name	Call
STEP 5 full screen	S5.BAT call in full screen mode
STEP 5 window	S5.BAT call in window mode
STEP 5 MS-DOS mode	S5.BAT call in MS-DOS mode with own AUTOEXEC.bat, CONFIG.SYS.
S5 driver installation	S5DRV.BAT call
S5 keyboard editor	S5KEDIT.BAT call

When using larger files and COM and optional packages, it is advisable to start STEP 5/ST, V7.0 under MS-DOS. To start MS-DOS enter S5 followed by RETURN.

Starting GRAPH 5

You are in the main menu of STEP 5/ST.

In the Change menu, you can select the various optional packages. Click GRAPH 5/II. The main menu of GRAPH 5/II then appears. In the following diagram, the menu items that differ from STEP 5/ST are shown on a gray background.

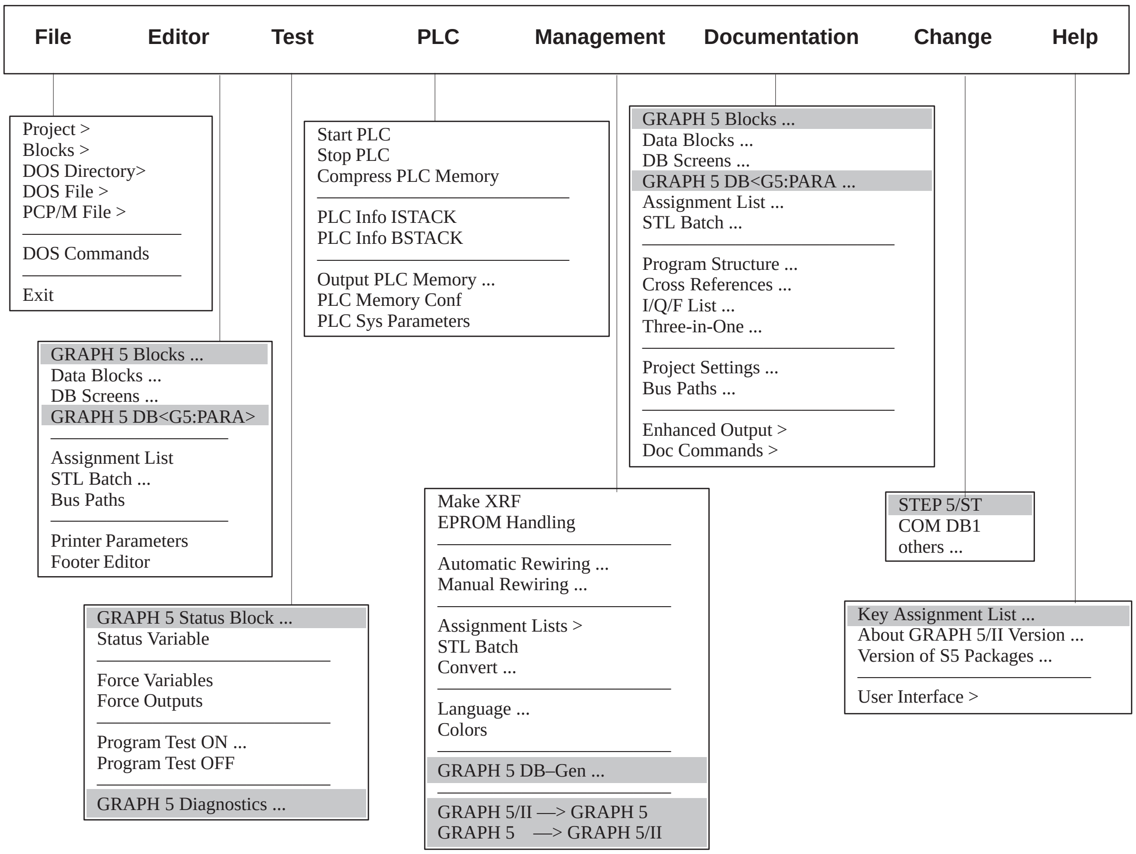
Preparations

Project settings

Note

The project settings from the basic package remain unchanged. If you have not yet selected your presets in the basic package this must be done now. Presets are selected in GRAPH 5 in the same way as in the basic package.

Main Menu of GRAPH 5



The following table indicates the additional functions and differences compared with the STEP 5 user interface.

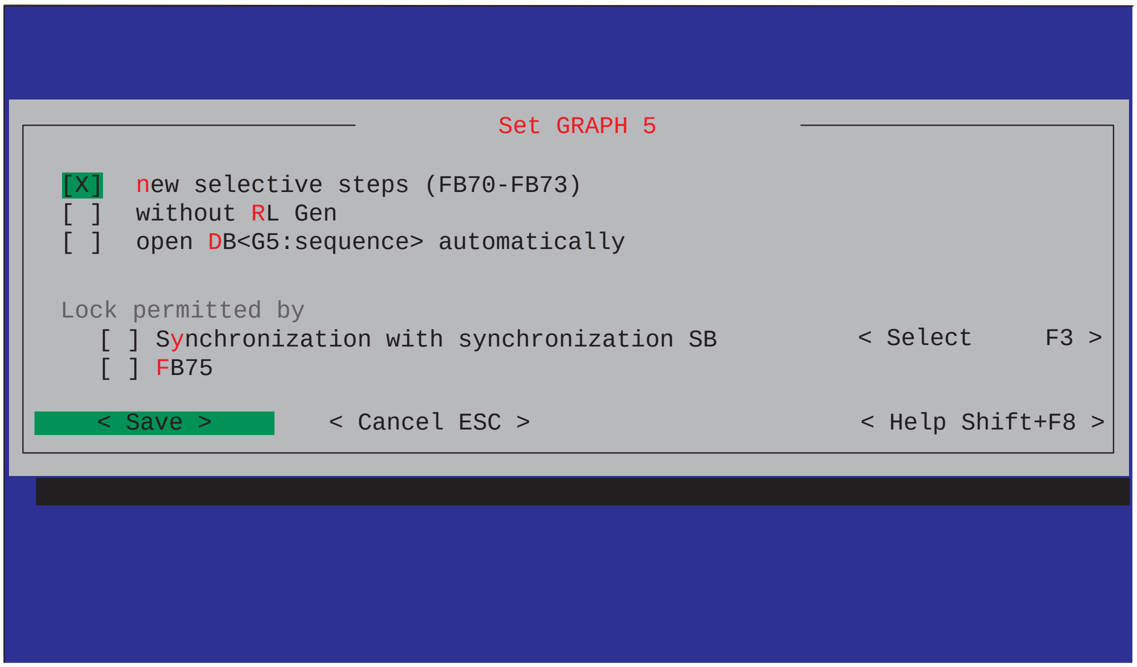
Menu	Effect
Editor/GRAPH 5 block	Output GRAPH 5 blocks
Editor/GRAPH 5 DB<G5:PARA> ...	Edit GRAPH 5 diagnostic parameters in the program file or in the PLC
Test/GRAPH 5 block status	Status display of GRAPH 5
Test/GRAPH 5 diagnostics ...	Output the SB list or the current messages of up to 4 PLCs
Management/GRAPH 5 DB-GEN ...	Create the diagnostic DB and working DB
Management/GRAPH 5/II → GRAPH 5	Convert GRAPH 5/II blocks to GRAPH 5 V3.0 in the program file
Management/GRAPH 5 → GRAPH 5/II	Convert GRAPH 5 blocks to GRAPH 5/II in the program file
Documentation/GRAPH 5 Blocks	Output GRAPH 5 blocks to printer or file
Documentation/GRAPH 5 DB<G5:PARA>	Output GRAPH 5 diagnostic parameters to printer or file

Change/STEP 5/ST	Change to STEP 5
Help/About GRAPH 5/II version	Information about the GRAPH 5 version

Set Global Options

Select the menu command **File** > **Project** > **Set GRAPH 5 ...**

The following screen form appears:



Options

New Selective Steps (FB70-FB73)

If this option is activated, the new steps are generated selectively. As usual they can be converted into permanent steps.

Without RL Gen

With this option the output of the GRAPH 5-SBs is locked using the RL file.

Open DB<G5:sequence> Automatically

The working DB (DB<G5:sequence>) of a GRAPH 5 sequencer will be opened when the command A DB or AX DX is executed in a program segment which calls the working DB. If a specific DB is to be called, then it has to be opened in steps at some time before the first call, and in every transition in which the DB is called.

The blocks can be processed further using an older GRAPH 5 version. For the GRAPH 5 block in V3.x format, the option can only be used either if the last step is a permanent one or if no DB/DX is opened in the steps.

Lock Permitted by

Synchronization with Synchronization SB

With this option you can generate shorter working DBs. Shorter DB<G5:sequence> generation has to be selected individually for each SB.

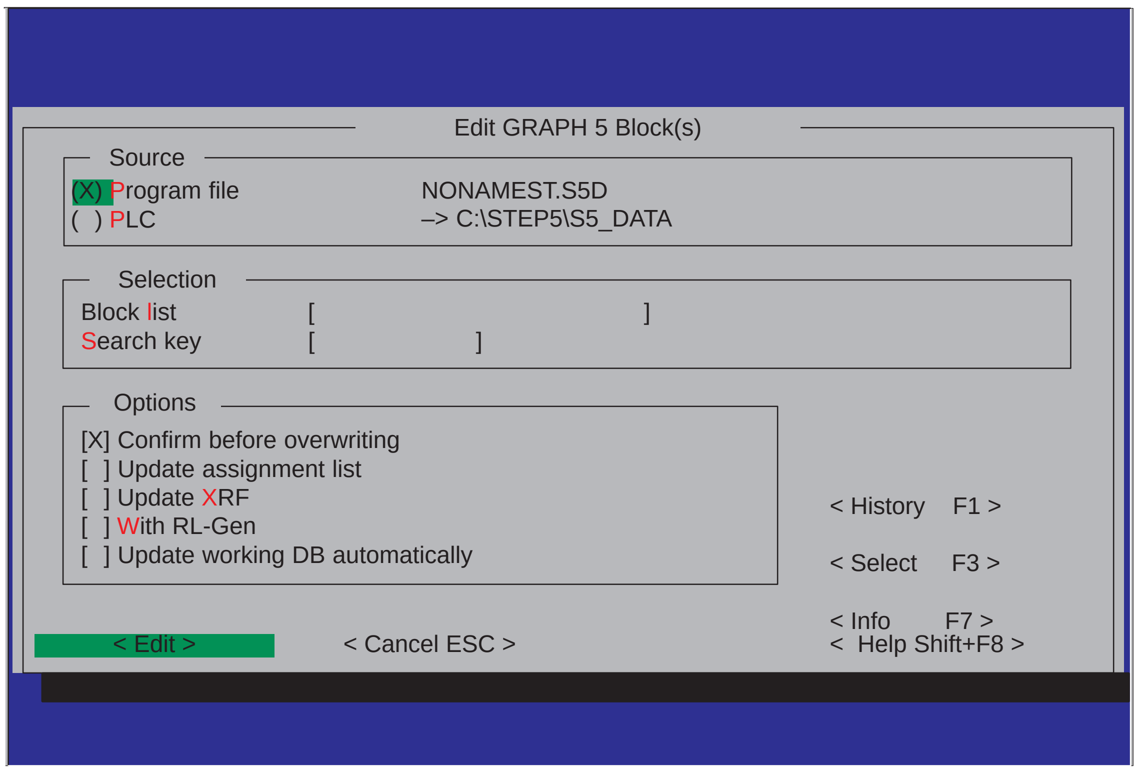
FB75

With this option you can generate shorter working DBs. Shorter DB<G5:sequence> generation has to be selected individually for each SB.

Creating Blocks

Select the menu command **Editor > Graph 5 Block...**

The following dialog appears:



Keystrokes

Type in the new sequence block number (SB x).

The sequence block number must be greater than or equal to 10.

Confirm with the **Edit** key.
This calls the GRAPH 5 editor in which you can edit an SB.

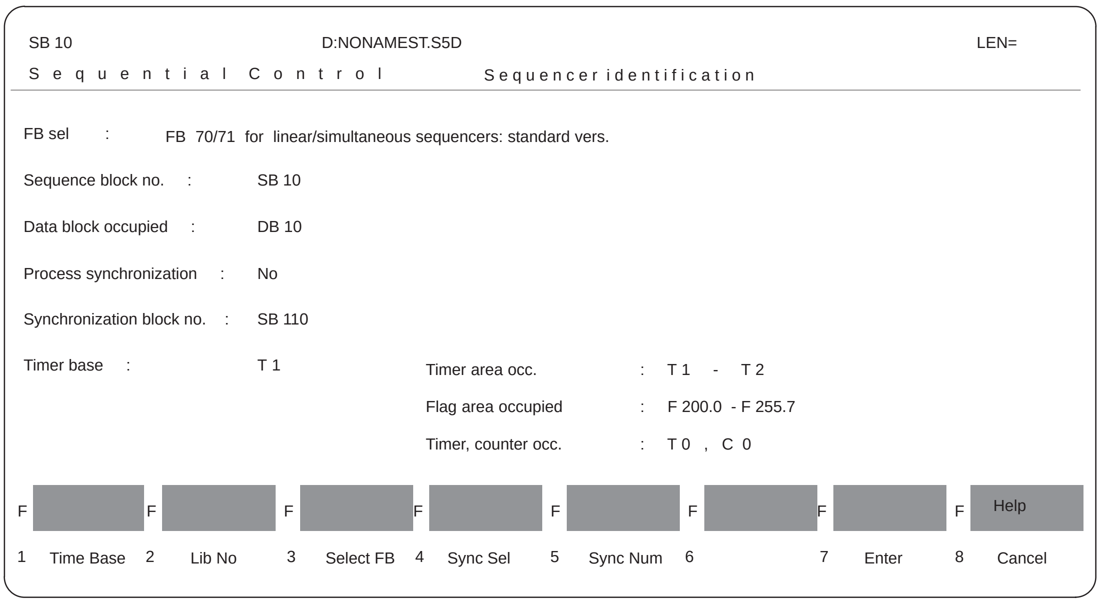
Options	Only for GRAPH 5
With RL Gen	The retranslation list is either updated or used for the fast retranslation when the block is read in. It is generated if it does not yet exist or when the comparison of the versions indicates a difference. It is used for the fast retranslation when it exists and when no difference is detected between the versions.
Updating DBs	
No	DB Gen is not called automatically, it has to be called by the user.
DB <G5:sequence>	If required, the working-DB DB<G5:sequence> is updated or newly created. Restriction: For old GRAPH 5 sequencers before V6.0 DB Gen must always be carried out simultaneously for all sequencers. This is why the DB cannot be regenerated. It can only be updated. For updating, some data has to be read from the existing DB, the DB Gen function has to be carried out once for each SB.
DB <G5:sequence> and DB<G5:diag>	If this option is activated, the working-DB DB<G5:sequence> and the diagnostic-DB DB<G5:diag> is updated or regenerated (same restriction).

4.5.4 Programming the ID Screen Form

If there is not yet an SB with the selected number, the ID screen form is first displayed. If an SB with this number does already exist, refer to Section 4.5.5.

The data block number corresponds to the sequence block number; this 1:1 assignment cannot be altered. You can use sequence blocks from SB 10 onwards. Flags, timers and counters used by GRAPH 5 are displayed in the ID screen form.

The flag area is not available within the sequencer, outside the sequencer it can be used as a scratchpad area.



F1: Edit time base

F2: Edit library number

F3: Select between FB 70/71 or FB 72 or FB 73 or FB 78 for controlling the sequencer

F4: Select/deselect process synchronization

F5: Edit the number of the synchronization SB

F7: Enter the dialog

FB 78 belongs to the GRAPH 5-EDDI package.

FB 78 and process synchronization cannot be selected simultaneously. For more details on FB 78 please refer to the GRAPH 5-EDDI manual.

Time Base

If you press **F1** (Time Base) you can enter the time base (T 1 through T 254). The time base specifies the start of the area used for waiting and monitoring times. Timer T 0 is used by GRAPH 5. Two timers are required per simultaneous branch (max. 2 x 8 = 16), i.e. if a simultaneous branch is programmed, T 1 to T 252 can be used as the start address of the time base. With 8 simultaneous branches, T 1 to T 238 are possible as the start address.

These timers are occupied even if no times are entered in the branch; they must not be used outside GRAPH 5. The timers permitted depend on the particular PLC. They must not overlap for different sequence blocks loaded in the PLC.

Lib No

If you press **F2** (Lib No) you can enter a 1 to 5 digit library number. The library number can only be input or modified in the sequencer identification dialog. When you output (display) an SB, the **F2** (Lib No) key displayed in the function key menu has no effect in GRAPH 5.

Select FB

If you press **F3** (Select FB), you select the standard FBs you want to use.

The following function blocks are available:

FB 70/71	for linear/alternative/simultaneous/subsequencer: standard version
FB 72	for linear/alternative and simultaneous sequencer: fast version
FB 73	for linear and alternative sequencer: fast version
FB 78	for GRAPH 5-EDDI; This function is described in the GRAPH 5-EDDI manual.

The selected FB and the corresponding “execute” SB (SB 0 for FB 70/71, SB 2 for FB 72, SB 3 for FB 73) must be available in the programmable controller. If FB 73 (for linear sequencers) is selected, then no simultaneous branch can be entered in the sequencer.

Sync Sel

Only for linear sequencers (including alternative branches).

For further information about process synchronization, refer to Chapter 5.

Sync Num

Here, you enter a sequence block number.

The number must be > 10.
The default is: sequencer number plus 100, maximum however 255.

Note

When you exit the ID screen form by pressing the ESC key when first creating a sequence block, you can continue to work with the selected block in LAD, CSF or STL.

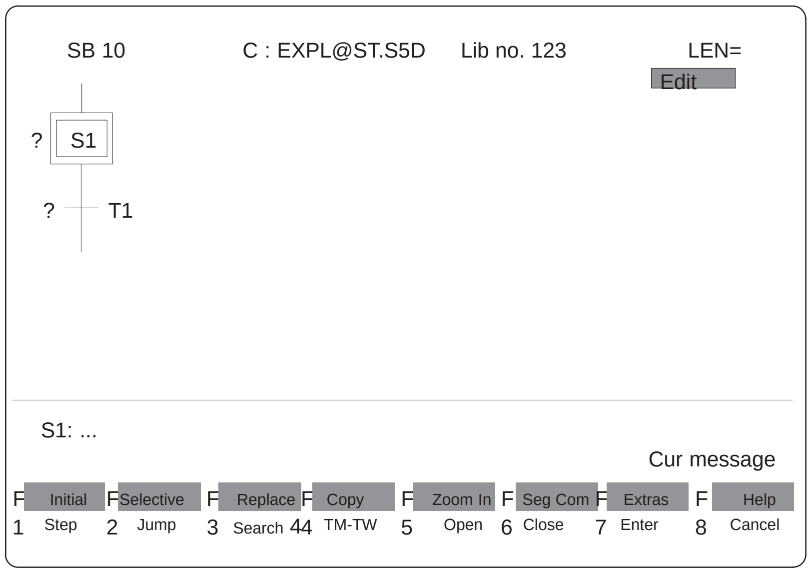
If you press the enter key, the overview level is displayed.

4.5.5 Programming at the Overview Level

Start of the Sequencer

After you have entered the data in the ID screen form (refer to Section 4.5.4) by pressing **F7** (Enter) or the **enter key**, the start of a sequencer is displayed on the screen. You are in the editing mode at the overview level.

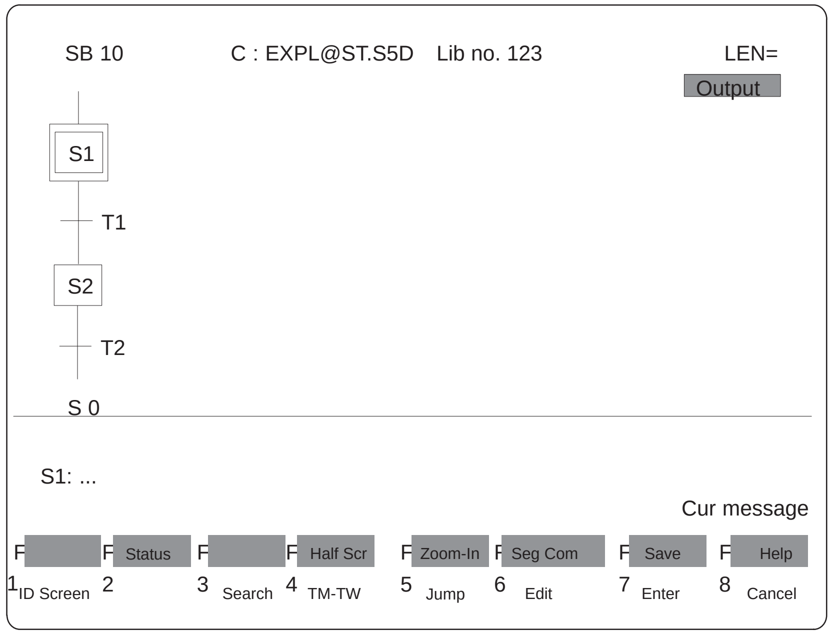
You can expand the sequencer using the cursor and function keys.



The question marks in the display mean that the step (transition) has not yet been programmed at the zoom-in level.

Changing the SB

If you call an existing FB in the block list (refer to Section 4.5.3), the following dialog appears:



You are in the output mode at the overview level. You can change to the editing mode by pressing **F6**.

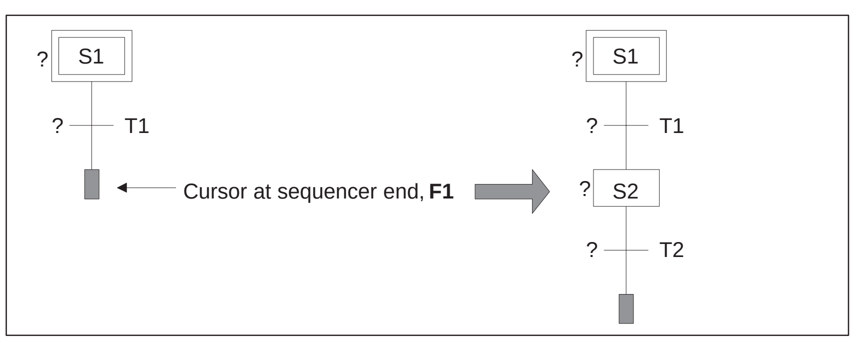
The **Shift F2** (status) function, which causes a change from the output into the status, is only active in online mode.

Step/Transition

Depending on the cursor position, you can expand the sequencer by one step/transition pair or transition/step pair (max. 127 steps or transitions). A transition always follows a step.
A step or jump to a step always follows a transition.

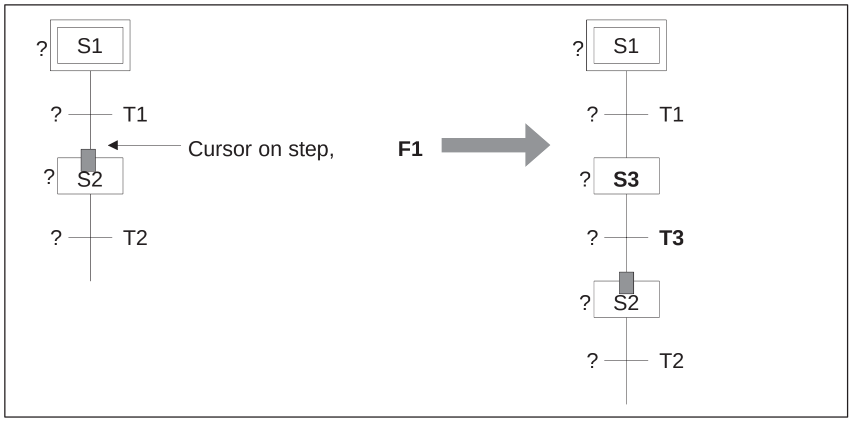
Adding a Step/Transition to the Sequencer or Branch End

Keystrokes Position the cursor at the end of the sequencer or branch
Press **F1** (Step).



Inserting a Step/Transition

Keystrokes Position cursor on step.
Press **F1** (Step).



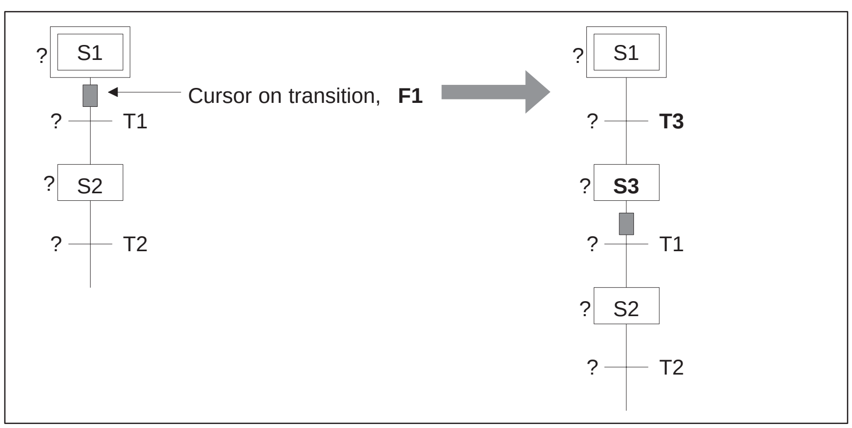
Buffer Limit

If you want to make use of the maximum number of steps/transitions (127) and then want to delete or reposition individual steps in the sequencer, the PG displays the following message: *memory or internal buffer full*.

Reason: the deleted steps are only taken into account when you store the modified sequencer. You must first store the sequencer (with F7) and then output it again before you can enter the remaining steps.

Inserting a Transition/Step

Keystrokes Position cursor on transition.
Press **F1** (Step).



Numbering

The steps and transitions are numbered by the GRAPH 5 software when they are stored. Numbering is consecutive from top to bottom. If there are several parallel branches, the branch on the extreme left is numbered from top to bottom, then the second from left branch from top to bottom and so on.

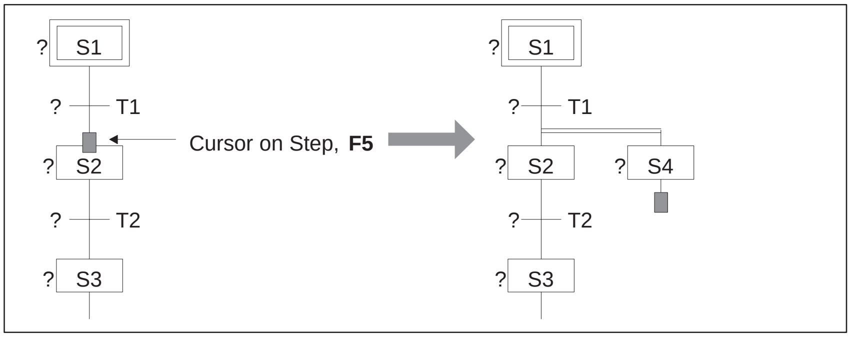
Simultaneous Branch

To open a simultaneous branch, the cursor must be positioned on a step.

Opening a Simultaneous Branch

Keystrokes	Position cursor on step. Press **F5** (Open).

A simultaneous branch can only be opened with the settings FB 70/71 and FB 72. With the setting FB 73 (linear sequencer) the following error message is displayed: `Action not permitted at this point`.



Number of Branches, Messages

You can program a maximum of 8 simultaneous or parallel branches with 31 branches and/or junctions. If this value is exceeded, the PG displays the following messages:

more than 8 simultaneous or parallel branches: `Structure limits exceeded` or

more than 31 branches and/or junctions: `Memory or internal buffer full`.

Closing a Simultaneous Branch

An open simultaneous branch always ends with a step and must therefore be connected to a transition. You can either specify the target transition directly using the cursor or indirectly by typing in the target transition number.

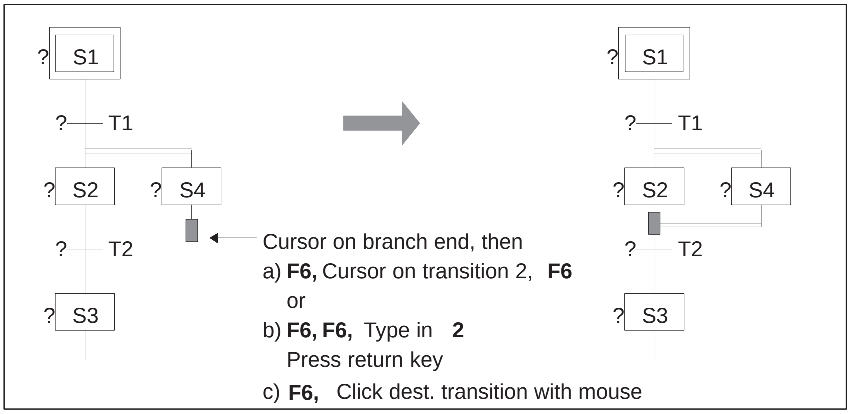
Keystrokes

Position cursor on the end of the branch.
Press **F6** (Close)

a) directly:
Position cursor on target transition.
Press **F6** (Close) again.

b) indirectly:
Press **F6** (Close) again.
Type in the number of the target transition.
Press the **return** key.

c) with the mouse:
Click on the target transition with the mouse.

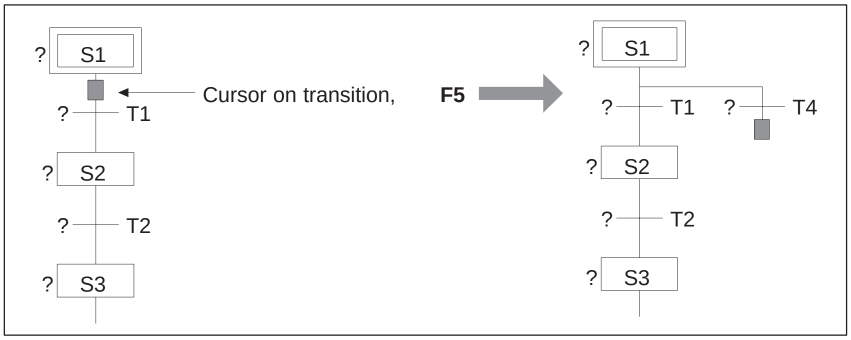


Alternative Branch

Before you open an alternative branch, you must position the cursor on a transition.

Opening an Alternative Branch

Keystrokes	Position cursor on transition. Press **F5** (Open).



Number of Branches, Messages

You can program a maximum of 8 simultaneous or parallel branches with 31 branches and/or junctions.
If this value is exceeded, the PG displays the following messages:

more than 8 simultaneous or parallel branches: `Structure limits exceeded` or

more than 31 branches and/or junctions: `Memory or internal buffer full`.

Closing an Alternative Branch

An open alternative branch always ends with a transition and must therefore be connected to a step. You can specify the target step either directly using the cursor or indirectly by typing in the target step number.

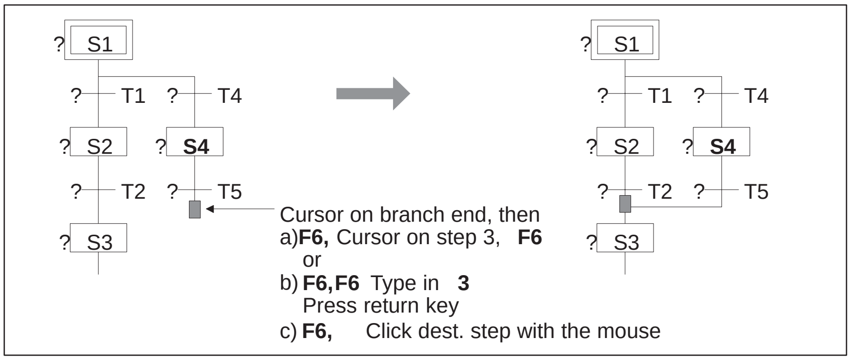
Keystrokes

Position cursor on the end of the branch.
Press **F6** (Close)

a) directly:
Position cursor on target step.
Press **F6** (Close) again.

b) indirectly:
Press **F6** (Close) again.
Type in the number of the target step.
Press the **return** key.

c) with the mouse:
Click on the target step with the mouse.



If you wish, you can also close an alternative branch using the jump function.

Number of Branches, Messages

You can program a maximum of 8 simultaneous or parallel branches with 31 branches and/or junctions.
If this value is exceeded, the PG displays the following messages:

more than 8 simultaneous or parallel branches: `Structure limits exceeded` or

more than 31 branches and/or junctions: `Memory or internal buffer full`.

You can also close an alternative branch with the jump function.

Jump Commands

A sequencer or open alternative branches can be closed by a jump. The jump can be made to any step in the sequencer. Jumps can also be made to S0 (sequencer end). You can specify the target step either directly using the cursor or indirectly by typing in the target step number.

Keystrokes

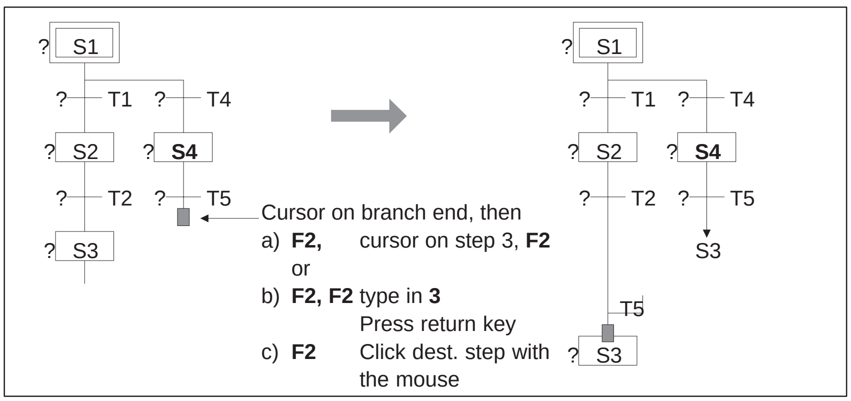
Position cursor on the end of the branch or sequencer. Press **F2** (Jump).

a) directly:
Position cursor on target step.
Press **F2** (Jump) again.

b) indirectly:

Press **F2** (Jump) again.
Type in the number of the target step.
Press the **return** key.

c) with the mouse:
Click on the target step with the mouse.



End of a Sequencer

The sequencer is completed by a jump to any step or to step 0 (S0). When the sequencer is run the INIT steps are processed again after the end of the sequencer with a jump to S0.

Exception: programming the subsequencer with the KEND parameter. The sequencer does not need to be completed with a jump to S0. Step 0 means that the programming of the sequencer is terminated at this point. The comment GRAPH 5 END is automatically displayed.

Timers

You can assign a monitoring and/or waiting time to every step except for initial steps.

Possible input: KT..., IW, QW, FW, PW, OW (DW not permitted!).

Waiting Time (TW)

The waiting time (TW) is the minimum time a step remains enabled even if the follow-on transition is already satisfied before this time elapses. The follow-on step becomes active at the earliest when the waiting time TW has elapsed.

Monitoring Time (TM/TM-MIN)

Maximum monitoring time

The step enable conditions for the next step must be satisfied within the preset monitoring time (TM). If the follow-on step does not become active within TM, a timeout message is displayed. As an alternative, you can you can use TM as follows:

Minimum monitoring time

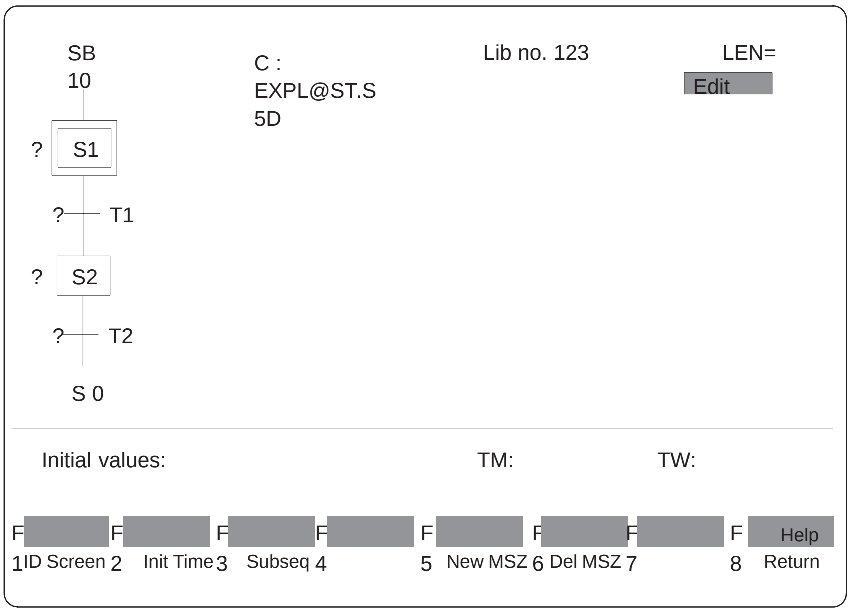
With the appropriate FB parameter assignment (refer to Section 4.9.3) you can arrange for the TM to be interpreted as a minimum monitoring time TM-MIN. In this case, a check is made as to whether the step enabling conditions for the next step are satisfied before the time elapses. If this is the case, you obtain an error message.

In every step, TW and TM can have different values. The programming simply involves entering the timer values (parameter assignment). The timer function does not need to be scanned in the next transition, but is automatically evaluated by the standard function blocks for the modes.

Init Time

You can enter the initial values for TM/TW.

Ready to start?	You are in the editing mode at the overview level.
Keystrokes	Position the cursor on the step to be assigned a timer. Using **SHIFT F7** (Extra) change to the second function key level. The following dialog then appears:



Here, using **F2** (Init Time), you can enter the initial values for TM/TW. If you enter values here, these are adopted as default values if you subsequently insert a step. Subsequent changes are only possible for specific steps.

Subsequencer

You can assign the ID ’U’ to a step. Using this ID, you can highlight a step which calls a subsequencer.

Ready to start?	You are in the editing mode at the overview level.
Keystrokes	Using **SHIFT F7** (Extra), change to the second function key level.
	The same screen form as shown on the previous page is then displayed.
	Click on **F3** (Subseq) and mark the step or steps to be assigned an ID.

Initial Step

The "initial" function is used to specify the initial steps. A maximum of 8 initial steps can be defined. These steps **must** be located in different simultaneous branches. You cannot assign monitoring times (TM) or waiting times (TW) to initial steps.

Changing over between a permanent and initial step

A step becomes an initial step and an initial step becomes a permanent step as follows:

Keystrokes	Position the cursor on the required step Press **SHIFT F1** (Initial). Pressing **SHIFT F1** (Initial) repeatedly defines a step alternately as an initial or permanent step.

An initial step is activated as follows:

when cold starting the sequencer without scanning conditions

after a jump to step S0 in a main sequencer

Permanent Step/ Selective Step

The programmed actions are executed depending on the RLO. All steps of the sequencer are run through cyclically both active and inactive steps.

Permanent Step

The operations to be performed in a permanent step are controlled by the step flag.

The step flag is entered by GRAPH 5 in each step as the first statement: “A F233.0”.

With active steps, GRAPH 5 sets the step flag to “1”, with inactive steps to “0”. RLO-independent commands are therefore performed in every cycle, RLO-dependent commands only when the RLO = 1.

Note

Transitions are always processed selectively. The step flag is set by the switching transition for the next step (= 1) and reset for the previous step (= 0). Transitions which do not enable a step do not change the step flag.

Selective Step

A selective step is only processed in the cycle in which the appropriate step flag is set. Otherwise the selective step is skipped. In the automatic mode, a maximum of one step per simultaneous branch can be active.

Only the active step zoom-in is processed.

If a selective step is not active all the statements at the zoom-in level are skipped and no longer executed.

Changing between a Permanent and Selective Step

Keystrokes

Position cursor on the appropriate step.
Press **SHIFT F2** (Selective).

Pressing **SHIFT F2** (Selective) repeatedly defines a step alternately as a selective or permanent step.

Search

The way in which the search function operates is explained in the STEP 5/ST manual.

You can use the search function in the following situations:

- at the overview level to search for steps or transitions
- to search for step zoom-ins or transition zoom-ins
- to search for operands
- to search for multistep zoom-ins (MSZ) or synchronization conditions.

Using the search function, you can position the cursor directly on the element you want to find.

Searching for a Step or Transition

Keystrokes	Press **F3** (Search). Enter Sn or TRn. (with an MSZ, the no. is a letter between A and Z). Press the **return** key.

During this, the function keys are inactive. The way in which these terms are searched for is always the same.

Searching for a Step or Transition Zoom-In

Keystrokes	Press **F3** (Search). Enter SLn-no. or TRLn-no. Press the **return** key

During this, the function keys are inactive.

Searching Synchronization Conditions

SS-no. searches for a synchronization condition of the step with the specified number

For further information about synchronization conditions, refer to Chapter 5.

Searching for an Operand

If you specify an operand as the search key, you cannot complete this with the **return** key but must press one of the function keys as follows:

F4 (Step 1)	searches from the first step and therefore within the whole block
F5 (Trans 1)	searches from the first transition and therefore within the transitions of a block
Return or **F3** (Continue)	searches from the current position

Searching for Addresses/Segment Numbers

You can only search for addresses or segment numbers in GRAPH 5 blocks at the zoom-in level.

Exchanging Contents of Steps or Transitions at the Zoom-in Level

With this function you can exchange the contents of two steps or two transitions at the zoom-in level. Comments (segment titles, segment and statement comments), monitoring and waiting times (TM/TW) and the step characteristics INITIAL/SELECTIVE (and assignments in the MSZ) are also exchanged.

First, position the cursor on one of the two steps or transitions. Then press **Shift F3** (Exchange) and the step or transition is marked (invisibly). After this, specify the second step (target step) or second transition (target transition)

You can specify the target step or transition either directly using the cursor or indirectly by typing in the target step or transition number. You cannot exchange a step with a transition or vice-versa.

Keystrokes	Press **F6** (Edit) or **Corr**. Position cursor on step or transition. Press **SHIFT F3** (Exchange). a) directly: Position cursor on target step or target transition. Press **SHIFT F3** (Exchange). b) indirectly: Press **SHIFT F3** (Exchange). Type in the number of the target step or target transition. Press the **return** key. c) with the mouse: Click the target step or target transition with the mouse.

Copying the Contents of a Step or Transition at the Zoom-in Level

With this function you can copy the contents of a step or transition at the zoom-in level.

Comments (segment titles, segment and statement comments), monitoring and waiting times (TM/TW) and the step characteristics INITIAL/SELECTIVE (and the assignments in the MSZ) are copied.

First position the cursor on the step or transition to be copied. Then press **Shift F4** (Copy), the step or transition is marked (invisibly). Then specify the target step or transition to which you want to copy the content.

You can specify the target step or transition directly using the cursor or indirectly by typing in the target step or transition number. You cannot copy from a step to a transition and vice-versa.

Keystrokes

Press **F6** (Edit) or Corr.
Position cursor on step or transition.
Press **SHIFT F4** (Copy).

a) directly:
Position cursor on target step or target transition.
Press **SHIFT F4** (Copy).

b) indirectly:
Press **SHIFT F4** (Copy).
Type in the number of the target step or transition.
Press the **return** key.

c) with the mouse
Click the target step or target transition with the mouse.

Completing Editing

Condition You are in the editing mode at the overview level.

You have created a new block

To save the Block

Keystrokes Press the ENTER key.
GRAPH 5 changes to the output mode. Press the ENTER key again.
Editing is completed and the block is stored in the default program file.

To Cancel Editing without Storing the Block

Keystrokes Press the **ESC** key.
GRAPH 5 changes to the output mode. Press the **ESC** key again.
The PG displays the following message if you have changed the SB: `Discard modified block?`

Yes: (Cancel)Press the ENTER or **RETURN** key.
Return to the menu.

No: (Continue)Click on the no field.
The PG remains at the overview level.

You have changed the block:

To Save the Block

Keystrokes Press the **enter key** 2x
Editing is terminated and the PG displays the following:
`SB already in file, overwrite?`
If you select "yes", the block is stored in the default program file.

To Cancel Editing without Storing the Block

Keystrokes Press the **ESC** key.
The system returns to the old version of the block and changes to the output mode.

Note

After each structural change to an SB, the working data block DB-GEN must be regenerated. Structural changes are all changes at the overview level, i.e.:
- changes in the ID screen form
- inserting or deleting an MSZ
- inserting or deleting steps and transitions
- inserting or deleting simultaneous/alternative branches
- INIT steps

If the *Update DB* option: *DB<G5:sequence>* is selected and the DB<G5:SEQUENCE> already exists, it is regenerated if necessary.

4.5.6 Zoom-In Level

Programming Steps/Transitions

Procedure

At the zoom-in level of a step or transition, statements can be programmed in LAD, CSF and STL just as in STEP 5. This also applies to statement comments, segment titles and segment comments.

At the zoom-in level, you must switch over from the output mode to the editing mode by pressing **F6** (Edit).

If you press the ENTER key or **F7**, you return to the output mode.

Special considerations

The RLO valid at :BE may, if necessary, be updated by the GRAPH 5 software (see above) and then used to enable a further step. (Refer also to Section 4.3.8 “Further Restrictions”.)

Note

You can only enter one segment comment per step/transition (first segment in the zoom-in). The commands BEC or BEU must not be used in zoom-ins. When data blocks are opened, the working DB, DB<G5:sequence>must be called again before BE.

Flag 233.0 in Steps

All the step flags used in the program are represented by flag 233.0 when output on the PG.

The term “F 233.0” disguises real flags, e.g. F 234.1, F 234.2 etc. This internal assignment is made by GRAPH 5. The procedure is not visible to the user.

Flag 233.0 is used as a substitute for the enable signal of the displayed step. It can be scanned at any point and as often as required within the zoom-in of a step, however, it must not be changed (assignment, setting, resetting).

Flag 233.0 can be used as an interface between step and MSZ.

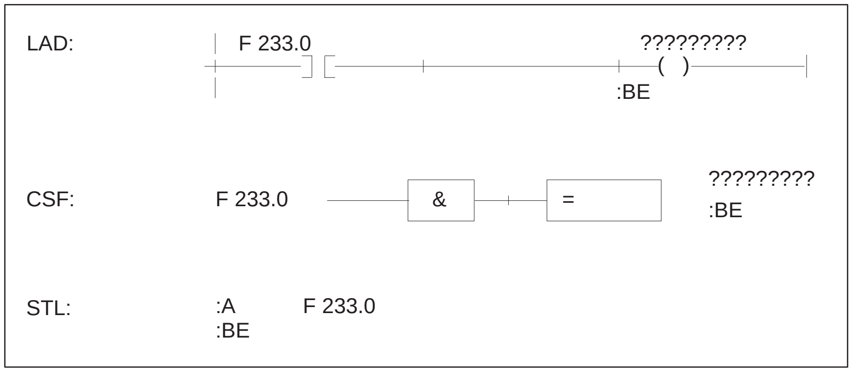
In an MSZ, however, the flag 233.0 is restricted as follows:

- it can only be scanned once using Boolean operations (A,O), otherwise no operations are permitted
- it cannot be used as a parameter for an FB (either as input/output/throughput parameter).

This enable signal has the value 1 when the corresponding step is active in automatic operation.

A flag bit is assigned uniquely to each step.

The following diagram illustrates the various representations of the flag F 233.0.



Since the programming/modification of the step flag has a considerable influence on the process control, changes should only be made when you are sure of the following:

- the consequences of the change and
- you can test the program before using it without any danger resulting from unexpected reactions/actions.

Flag 233.0 in Transitions

At the zoom-in level, the transition indicates the user section of the step enabling conditions. The result of logic operation (RLO) obtained is not the definitive step enabling condition, and may still be corrected by GRAPH 5 (waiting time not yet elapsed, UQIT, T+1 signal does not exist for conditional step control etc.).

STL at the Zoom-In Level

Only the user part of the step enabling condition is displayed.

LAD/CSF at the Zoom-In Level

LAD and CSF segments must be completed with an assignment (exception block call). For this reason, a non-existent assignment in the PLC must be simulated for the display on the screen.

Step Enabling Conditions

Using F 233.0 indicates that the resulting signal will be used to activate the next step(s). This flag bit is generated automatically by the GRAPH 5 software, no command is issued in the PLC. This means that there is also no status display for this assignment.

In CSF and LAD, no flags from the area F 200.0 to F 255.7 may be programmed.

Note

Flag 233.0 must not be programmed anywhere in transitions at the zoom-in level. If it is required for the graphics, it will be generated automatically.

Segment Functions

Programming segments in steps/transitions

At the zoom-in level of a step or transition, statements can be programmed in LAD, CSF and STL just as in STEP 5. This also applies to statement comments, segment titles and segment comments.

At the zoom-in level, you must switch over from the output mode to the editing mode by pressing **F6** (Edit).

If you press the **enter** key or **F7**, you return to the output mode.

Inserting, appending, deleting segments

You can insert, append or delete segments at the zoom-in level of a step or transition in LAD, CSF and STL just as in STEP 5. Select the segment in the output mode at the zoom-in level.

The retranslation list #SBRL is regenerated when the SB is next output.

Inserting a Segment in a Step or Transition

Ready to start? The PG is in the output mode at the zoom-in level.

Keystrokes Select the segment before which you want to insert the segment.
Press **F5** (Seg Fct).
Press **F5** (Insert).
There are now three ways of inserting a further segment:

1. Press **F1** (New)
   to create a new segment
   A segment is inserted, the PG is in the editing mode and the segment can be programmed as normal.
2. Press **F2** (Buffer)
   to read in a segment from the buffer
3. **F3** (Seg)
   Here, you can enter the number of the segment you want to place at this position.

Appending a Segment to a Step or Transition

Ready to start? The PG is in the OUTPUT mode at the zoom-in level.

Keystrokes Select the last segment.
Press **F5** (Seg Fct).
Press **F6** (Append).
There are now three ways of appending a further segment:

1. Press **F1** (New)
   to append a segment you will create.
   A segment is appended, the PG is in the editing mode and the segment can be entered as usual.
2. Press **F2** (Buffer)
   to read in a segment from the buffer.
3. **F3** (NW)
   Here, you can enter the number of the segment you want to append. Deleting a segment in a step or transition

Deleting a Segment in a Step or Transition

Ready to start? The PG is in the output mode.

Keystrokes Select the segment to be deleted.
F5 (Seg Fct), then
Press **Shift F4** (Delete).
The PG prompts: `Delete?`
Yes:
Press the ENTER key**.**
The segment is deleted.
No:
Press the **ESC** key.
The segment is not deleted.

Note

If you delete the last segment of an MSZ , you also delete the assignments.

For further information about editing blocks in LAD, CSF or STL refer to the STEP 5/ST manual.

Multistep Zoom-Ins (MSZ)

With the GRAPH 5 software prior to version V 6.0, it was difficult to program the multiple use of actions in steps and to create the required multiple interlocks.

The new version makes this easier with the multistep zoom-in (MSZ).

Using this, you can program the actions valid either for all steps or assigned to selected steps.

The MSZ is implemented using step zoom-ins assigned to some or all the steps at the overview level.

Instead of step numbers, letters are assigned to the MSZ. Possible MSZ names are as follows: SLA, SLB...SLZ. The MSZ names are assigned by GRAPH 5 in alphabetical order when the MSZ is generated.

An MSZ is always run through

- after all steps have been executed
- in alphabetical order.

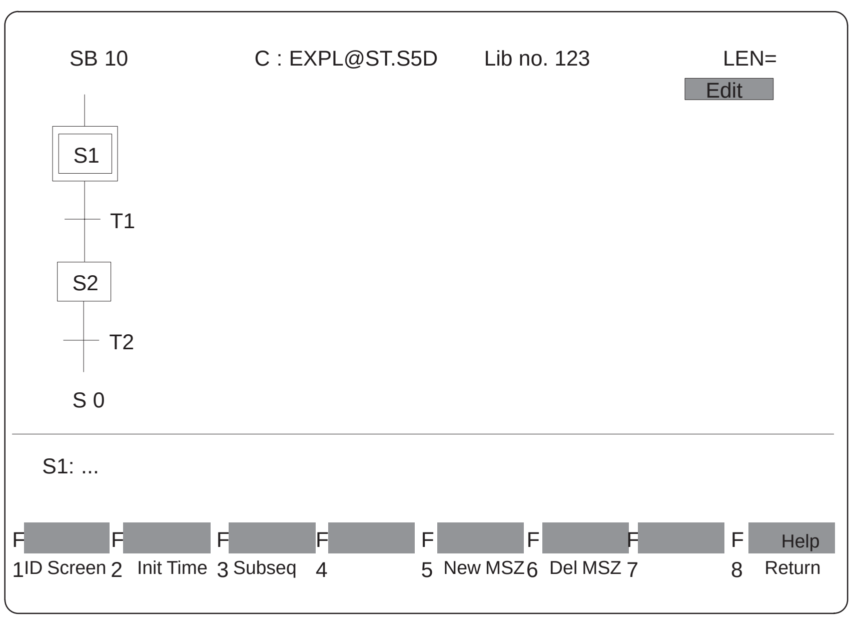
At least one step must be assigned to an MSZ; as the maximum you can assign all steps to an MSZ.

If flag 233.0 is programmed more than once in an MSZ, the status display no longer functions.

Creating/Deleting an MSZ

Ready to start? You are in the editing mode at the overview level.

Keystrokes Using **SHIFT F7** (Extra) change to the second function key level. The following dialog then appears:



Creating an MSZ	**Keystrokes**	Press **F5** (New MSZ) Create the new MSZ.
Deleting an MSZ	**Keystrokes**	Press **F6** (Del MSZ) A line appears in the dialog in which you can enter the number of the MSZ you want to delete.

You can also find an MSZ using the “search” function:

Ready to start?	Select the overview or step/transition zoom-in
Keystrokes	Select the editing mode. Press **F3** (Search). Type in the search key (e.g. SLA). Press the return **key.** The system displays the SLA zoom-in. Type in the assignment to the steps (S2, S5...) Below the segment and above the function key menu you will see a line in which the numbers of the steps assigned to this segment are listed. If you press **F4** (Assignmt) you move the cursor to this line and you can enter the assigned steps in the form Sx. Press the **enter key**. Select the editing mode. Program and enter the MSZ step A (B,C...).

Correcting an MSZ	**Ready to start?**	Select the overview or step/transition zoom-in
	Keystrokes	Press **F3** (Search). Type in the required step (e.g. SLA), press the return key. The system displays the zoom-in of SLA. Make the corrections or change the assignment with **F4**. Press the enter key to save the changes.

Note

The total number of steps and MSZs is restricted to 127, with a maximum of 26 MSZs.

Application Example

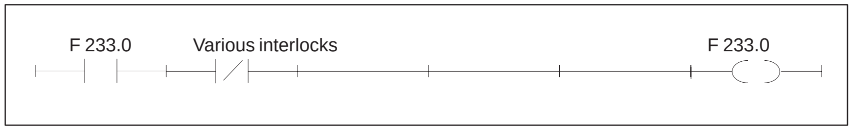
Multistep zoom-ins (MSZs) make the programming of the following tasks much easier:

Actions common to several steps (e.g. S2 and S5) and which require the same interlocks.

Procedure

– The zoom-ins of S2 and S5 can remain empty

– Programming of SLA with the action



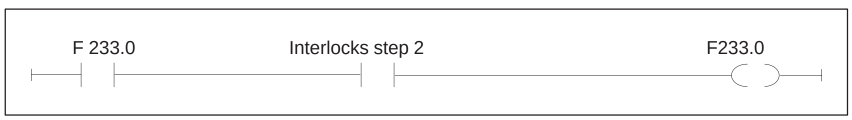
– Assignment of SLA to S2 and S5

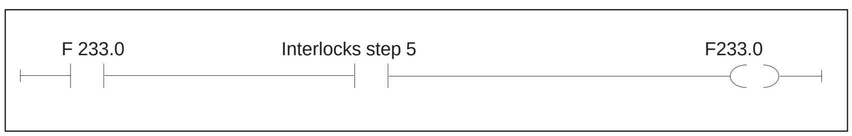
You only need to program the action at one place and do not require auxiliary constructions as previously; i.e. you do not need to access a global flag.

Actions common to several steps (e.g. S2 and S5) which in some cases require different interlocks

Procedure

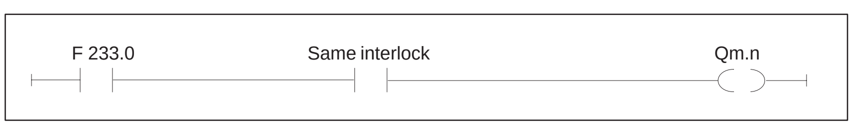
– Zoom-ins of S2 and S5 with different interlocks:





When one of these assigned steps S2 or S5 is active, the current step enable (F 233.0) for this sub-segment is set.

– SLA with the action and the same interlock: program MSZ as below and assign S2, S5.

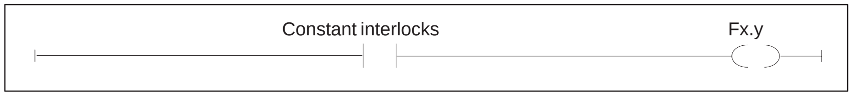


Program sections required constantly in several steps

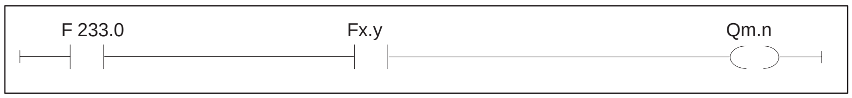
Centralized creation of commonly required interlocks/program sections

Procedure

– Programming of SLA for a constant interlock (A...;...; = F xy)



– Programming individual actions in assigned step zoom-ins with interlock using F xy



Assignment editor

The following functions described for the assignment editor can only be executed in the MSZ.

Editing steps

Keystrokes	Enter the steps and step numbers S<no>. (Illegal input includes S0 and step numbers higher than 127.) Confirm your input with the return key. (The system remains in the assignment editor.) Enter further steps. Confirm your entries with the enter key.

The whole assignment is accepted and you exit the assignment editor.

If you previously selected the assignment ALL STEPS, the flag F 233.0 is not entered in the segment.

Key functions for the assignment

F5 or SHIFT cursor left	Moves the existing assignment to the left in the assignment line
F6 or SHIFT cursor right	Moves the existing assignment to the right in the assignment line
F3 Delete	Deletes the step assignment to the left
F2 Del All	Deletes the whole assignment line
F1 All steps	Assigns all steps and exits the assignment editor. The segment is executed independently of the steps. The flag F 233.0 is deleted if it had previously existed
F4 Insert	Insert a further assignment between existing assignments

Empty Steps/ Empty Transitions

Steps/transitions which have not been programmed are marked in the structure display with a question mark (?).

Transition

The input to the zoom-in contains question marks (?????????).

Step

The output of the zoom-in contains question marks (?????????).

Effect

The running of the sequencer is not effected.

Empty Transition

The following step is enabled without any conditions, i.e. the step enabling condition is always satisfied.

Empty Step

Since no action takes place in this step, there is no output signal for a program cycle.

Special features of an empty step:
An output is to remain set in several steps, implemented by ORing auxiliary flags. If there is an empty step within this sequence of steps, this output is reset during the empty step, i.e. during a program cycle.

4.5.7 Creating the Data Blocks

Each sequencer requires a working DB with a number identical to that of the sequence block. For diagnostics of the sequencers in the PLC memory, a diagnostic DB (DB<G5:DIAG>) is also required that is accessed when you call the diagnostic function. The diagnostic DB is the same for all sequencers in the PLC.

Ready to start?

You have selected the GRAPH 5 package and the program file or the correct PLC in the project settings.

Procedure

Select the menu command
Management GRAPH 5 DB GEN.

In the dialog box that appears, select **source** in the input box the device on which you want to execute DB GEN

The input SB for all SBs or the selection of SBs for a delta generation is possible in the input box **select**.

The following options are active in the input box **options:**

Confirm before overwriting
Create diagnostic DB (DB<G5:Diag>)

Clicking the button “CREATE” closes the dialog box and DB Gen builds the SB list.

DBs already generated are displayed in the column *DB already existing* with *yes.*

Pressing ENTER finishes the generation.

The number of the diagnostic DB can be entered if the option “create diagnostic DB (DB<G5:Diag>)” is selected. If a working DB already exists, the number of the diagnostic DB is determined and entered in the input box.

By double-clicking on a SB in the DB Gen SB list, a selection box with the DB lengths possible is opened. The DB lengths possible depend on the global option ’Lock-out allowed by Synchronization with Synchronization SB’ and ’Lock-out allowed by FB75’. If a DB length shorter than the maximum possible is used, a warning is given with a note regarding the disabled functions before the generation of this DB. When updating the DBs, the length of the existing DBs is entered.

Warning

Creating shortened DBs

Only use this option, if the memory in the PLC is too small. However, make sure that the applicable restrictions are kept to, as the standard blocks do not check this.

If the diagnostic DB already exists, the message:
`DB already in file, overwrite? appears.`

A message appears for each DB which the user has to acknowledge if the option ”Confirm before overwriting” is active. The program then jumps to the next SB/DB pair.

After generation you have correctly assigned working DBs and diagnostic DB numbers. Version numbers are checked, too.

Creation of the DB is always valid for all selected SB/DB pairs which are in the program file or AG. As a test, the occupied timer area and the DB length are also given.

Note

The working DBs only need to be created once with DB-GEN. After this, the DBs are updated automatically if you select the option *Update DBs*.

4.5.8 Fast Retranslation of Sequence Blocks

To display long sequence blocks quickly, you can store retranslation information for the SB in a list, the retranslation list #SBRL.nnn. You activate this fast retranslation with the option “Activated with RL-GEN”. If this option is not activated, the retranslation list #SBRL.nnn is neither created nor read.

The retranslation list is either updated or used for the fast retranslation when the GRAPH 5 SB is read in. It is generated if it does not yet exist or when the comparison of the versions indicates a difference. It is used for the fast retranslation when it exists and when no difference is detected between the versions.

The retranslation list contains an internal version identifier that is also entered in the SB. The version identifier is used to ensure the consistency of the SB and its corresponding retranslation list #SBRL. Each time an SB is modified, the version number is incremented.

If the “With RL-GEN” option is activated, the retranslation list #SBRL.xxx is created and updated by the system automatically as soon as the SB is modified.

The SB with the new version identifier must be written back to the source device (FD or PLC).

Outputting an SB with Fast Retranslation

If the “With RL-GEN” option is activated, when an SBn is displayed using the PG function (OUTPUT, STATUS), the program checks whether or not a retranslation list #SBRL.nnn exists. If it does, the information stored in it will be used for a fast retranslation. Long blocks can be displayed much more quickly using this list.

If the version identifiers of the SB and #SBRL do not match (for example after modifying the SB), the retranslation takes place as normal. Following the retranslation, the retranslation information can be entered in the retranslation list #SBRL.

You should always make changes to the SB on hard disk and the SB should only then be transferred to the PLC.

Deleting the Retranslation List

You can delete a retranslation list #SBRL.nnn in the same way as a DOC file. (For more detailed information, refer to the STEP 5/ST manual.)

4.5.9 Cross Reference Lists with GRAPH 5

You select the cross reference lists just as for STEP 5 blocks. The information is divided according to steps and transitions. In the TIMERS section of the cross reference list, the times of the steps are shown as assignments in the previous transition. Some of the information refers to the operation part, this can be ignored. This includes the following:

data words of the working DB (refer to Chapter 7)

standard SB call (SB 0 to SB 9)

flag > 200.0 to flag 255.7

Multistep zoom-ins are displayed like normal steps. The number is made up from the maximum step number + the number of the MSZ. (Example: In an SB with 10 steps, MSZ B has the number 12.)

4.5.10 Rewiring GRAPH 5 Blocks

Rewiring is described in the STEP 5 manual.

Note

The following must not be rewired:
- flags from F 200.0 onwards and
- the working DBs and diagnostic DBs

4.5.11 Printing out a Sequence Block

Sequence blocks can be printed out as usual in STEP 5. In the dialog box, you can enter a search key instead of a range of segments.

4.6 Call Structure

Example of an FB72/73 Call

Starting a sequence SB 11, controlled by FB 72/SB 2 (FB 73/SB 3 analogous), in the automatic mode (see also Chapter 7):

```
          JU      FB 72
NAME : GPH:  SIM1
SBNR : KF    + 11
AUS  : F     0.0
A/H  : F     0.1
TIPP : F     0.2
T+1  : F     0.3
QIT  : F     0.4
STO  : Q     1.0   Timeout indicator
O      F     0.1
ON     F     0.1   (RLO=1)
=      F     0.1   (permanent signal 1 = automatic mode)
AN     F     0.1
=      F     0.0
=      F     0.2
=      F     0.3
=      F     0.4
```

4.7 Nesting Main and Subsequencers

Nesting is only possible with the use of FB 70. The subsequencer SBn can then be created like a main sequencer using the GRAPH 5 program. A subsequencer can be started in every step of a main sequencer. The subsequencer must be understood as inserting steps within a step of the main sequencer and is used to extend capacity. You must save a subsequencer as a sequence block. This can only be called once per main sequencer and must not be further nested. The subsequencer is controlled by FB 71 which is called and assigned parameters in the step of the main sequencer with an unconditional jump. You can mark the step with a subsequencer ID in the main sequencer.
The block SB 0 of the main sequencer is used as the processing block and therefore already exists.

The block SB 0 of the main sequencer is used as the processing block and therefore already exists.

The subsequencer can only be used in conjunction with a main sequencer (standard function block FB 70 and FB 71).

4.7.1 Further Conditions

The subsequencer must be called directly from a step in the main sequencer or from an MSZ. The steps with a subsequencer call must be

- either in the linear section or in an alternative branch
- permanent steps
- programmed with a waiting time

Each subsequencer must only be called once.

Each subsequencer must be stored in its own sequence block.

Subsequencers must not be nested further.

Note

You cannot call subsequencers in selective steps!

4.7.2 Programming

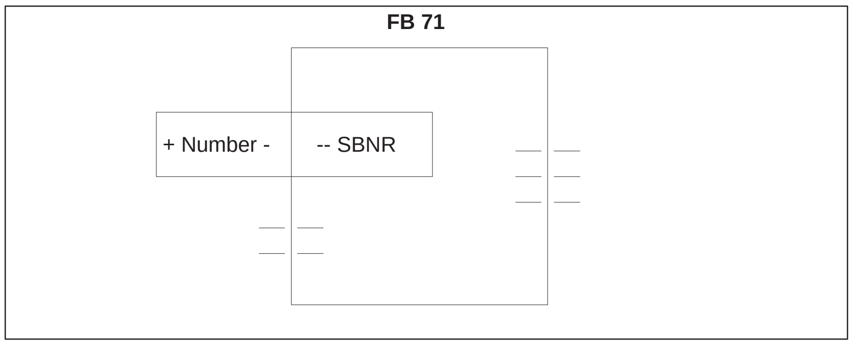
To use a subsequencer, the following preparations must be made:

- preparations in the main sequencer
- creation of the subsequencer
- generation of the corresponding DB

Preparations in the Main Sequencer

In the step of the main sequencer you must call function block FB 71 (:JU FB 71) and assign parameters to it for the subsequencer, as follows:

1. Enter the number of the subsequencer.



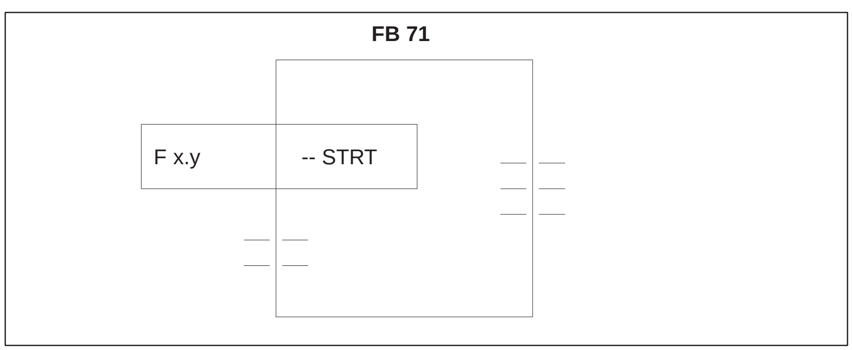
The number of the sequence blocks is transferred.

2. Enter the start signal of the main sequencer.

The subsequencer must be started extra (parameter=STRT), either with a separate signal or with the step flag F 233.0 which must be programmed in the step of the main sequencer.

The flag F 233.0 is the step flag from the main sequencer (TAKT enable signal from GRAPH 5).

The step containing the subsequencer call must be a permanent step and must be programmed with waiting time TW.

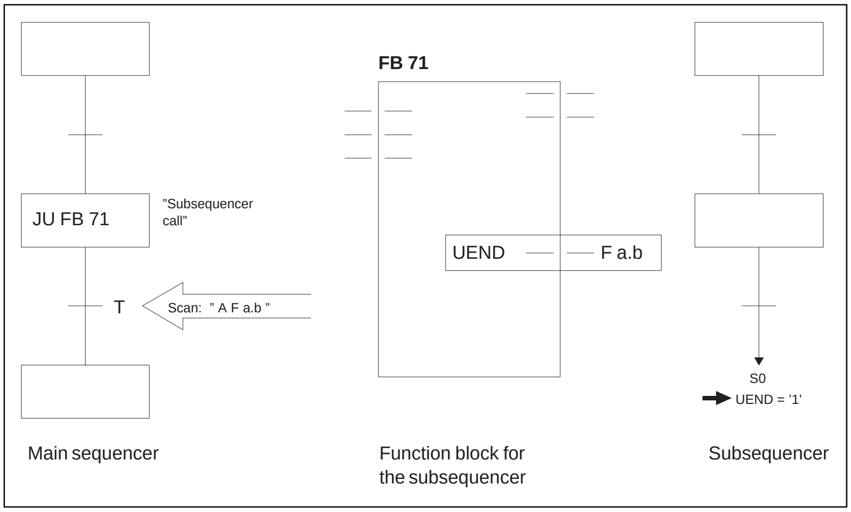


Fx.y= the flag which transfers the value of F 233.0 to the called sequence block.

The mode for the FB is adopted internally from the main sequencer; explicit parameter assignment is not necessary.

3. Reply signal from the subsequencer and continuing the main sequencer.

The end of the subsequencer is defined by a jump to step 0. In this status, the subsequencer supplies the signal UEND = 1. This signal must be scanned in the main sequencer in the transition following the step containing the subsequencer call.



4. Mark step x of the main sequencer with the subsequencer ID U.

Creating the Subsequencer

Create the subsequencer SBn with the system program GRAPH 5 (just as for a main sequencer)

Generating the Corresponding DB

Once you have completed programming, you must call DB-GEN on the PG to generate/update the data blocks. DB-GEN generates the DB for all sequence blocks (main sequencer and subsequencer).

4.7.3 Loading in the PLC

Once you have completed the work outlined in Section 4.7.2 you can load the PLC with the generated blocks and the required standard blocks (refer to Section 4.3.2 or 4.3.3).

4.8 Testing and Starting Up

Transferring the Program

The menu **File** > **Blocks** > **Transfer ...** is described in the STEP 5/ST manual.

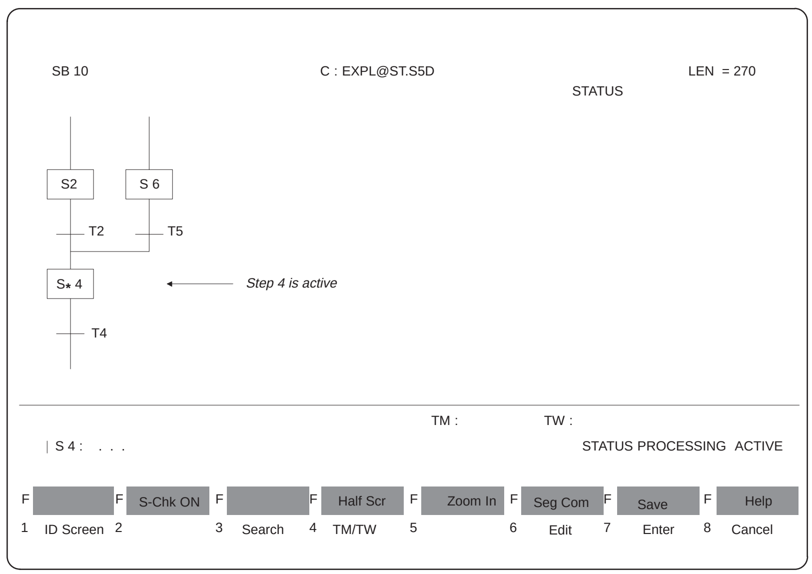
GRAPH 5 Status

The status display indicates the status of the currently active sequencer.

The active steps are marked with a ” ***** ” symbol at the overview level.

By positioning the cursor on a step or transition in the overview display, and then pressing SHIFT F5 (Zoom In), you can display the status of the contents of the step or transition. This allows you to check the status of individual inputs and outputs at the zoom-in level.

Status display of the sequencer at the overview level



You can toggle between the static overview display and the automatic monitoring of the active step with **F2**.

During the automatic monitoring for the active step, the active step (of the selected level) is automatically searched for after the cycle in which the step is activated. The level can be selected with the the arrow keys.

By pressing ESC the status is only paused. To exit the status you have to press ESC once again.

Example

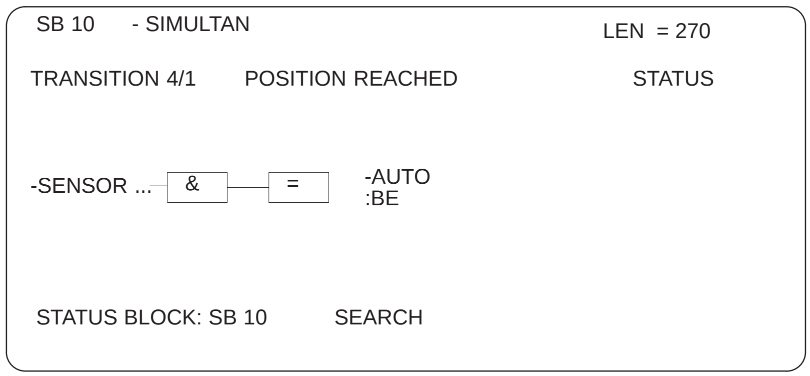
You want to display the status of SB 10.

Status Display of the Sequencer at the Zoom-In Level

The status of the content of a step or transition can be displayed and corresponds to the status display of a segment.

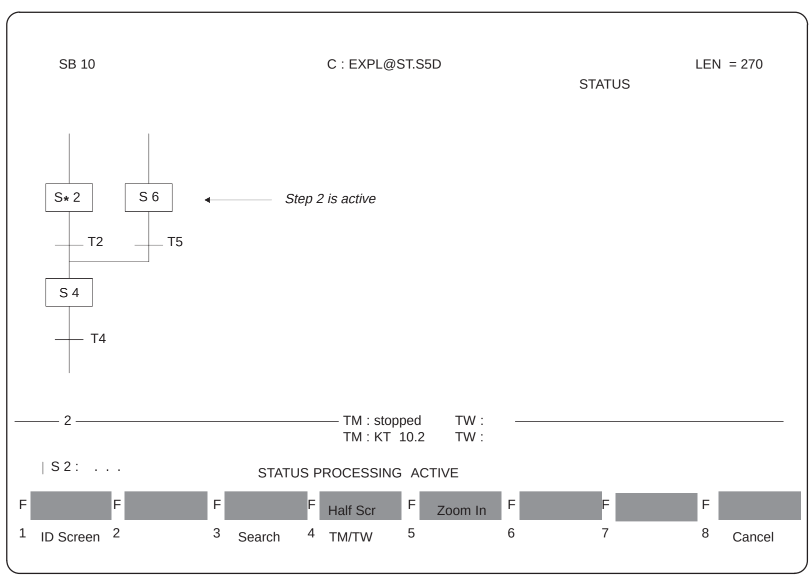
Ready to start?	Status display at the overview level.
Keystrokes	Position the cursor on a step or transition. Press **SHIFT F5** (Zoom In).

The segment of the selected step/transition is displayed in the STATUS mode.



Displaying Waiting and Monitoring Times

Ready to start?	Status display at the overview level.
Keystrokes	Position the cursor on a step with a monitoring time (TM) and/or waiting time (TW).



If the step is active, the current timer values are displayed. Once the monitoring time has elapsed, the message **stopped** is displayed.

4.9 The Standard Blocks

For the fast versions, the following blocks are available:

FB 72, SB 2 fast version for simple modes with alternative an simultaneous branches

FB 73, SB 3 fast version for simple modes with alternative branches, but **without** simultaneous branches

FB 74 functions additional to FB 72, FB 73

FB 75 saving and re-activating waiting and monitoring times

For the standard versions, the following blocks are available:

FB 70, SB 0 standard version with more modes

FB 71, SB 0 subsequencers for the standard version

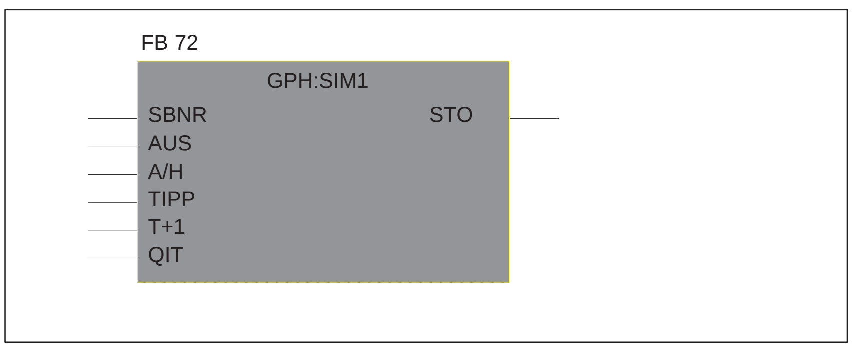
FB 75 saving and re-activating waiting and monitoring times

4.9.1 Fast Versions

With these FBs you can run linear and alternative sequencers

FB 72 /SB 2 for **Linear, Alternative and Simultaneous Sequencers**

Calling the Function Block



Displays and Operating Elements

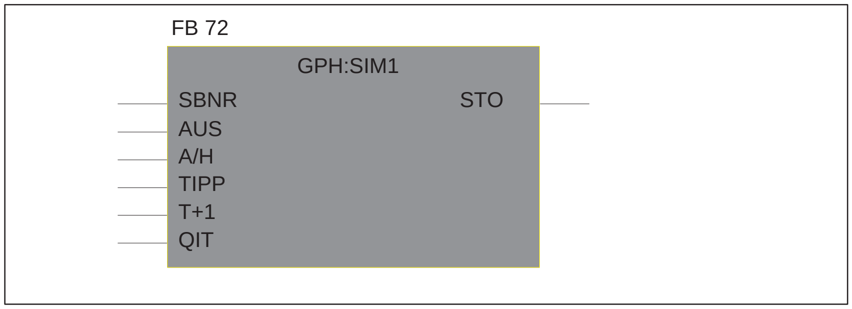
(SBNR)	Number of the user sequence block
(AUS, A/H)	Modes OFF/AUTO/MAN
(TIPP, T+1)	EXECUTE with condition with actions
(QIT)	Acknowledge a timeout
(STO)	Timeout

SB 2 for Processing the Sequencer

You require this block for processing GRAPH 5 functions in the PLC. You only need to transfer SB 2 to the PLC.

FB 73/SB 3 for Linear and Alternative sequencers

Calling the Function Block



Displays and Operating Elements

(SBNR)	Number of the user sequence block
(AUS, A/H)	Modes OFF/AUTO/MAN
(TIPP, T+1)	EXECUTE with condition with actions
(QIT)	Acknowledge a timeout
(STO)	Timeout

SB 3 for Processing the Sequencer

You require this block for processing GRAPH 5 functions in the PLC. You only need to transfer SB 3 to the PLC.

Parameters for FB 72 and FB 73

Name	Para type	Data type	Meaning	Remarks
SBNR	D	KF	Sequence block no.	Number of the sequence block to be processed **Note:** The sequence block must be created with GRAPH 5
AUS	I	BI	Sequencer OFF (RESET)	Evaluation as permanent signal AUS = 1→ AUS active **Effect:** – deselects the current mode – sequencer set to step 0 – STO deleted – output commands of all steps, except latching statements, are disabled **Note:** If AUS = 1 no other mode can be selected
A/H	I	BI	Mode AUTOMATIC/ MANUAL	Evaluation as permanent signal A/H = 1 AUTOMATIC active **Condition:** AUS = 0 **Effect:** – if the sequencer is in step 0, the INIT steps are set if A/H = 1 – the sequencer switches further owing to the satisfied transitions – step output commands are active
TIPP	I	BI	Mode EXECUTE single step with condition	Evaluation as permanent signal TIPP = 1 → TIPP operation active **Condition:** A/H = 0 and AUS=0 **Effect:** – sequencer with corresponding transition switches further at a signal change from 0 to 1 at parameter T+1 – step output commands active – wait times are effective – monitoring times are not effective – if the sequencer is in step 0, the INIT steps are set with T+1
T+1	I	BI	Switch further in EXECUTE/single step	Evaluation of signal change from 0 to 1. For effect, refer to TIPP

Name	Para Type	Data Type	Meaning	Remarks
QIT	I	BI	ACKNOWLEDGMENT of a timeout	Evaluation of signal change from 0 to 1. Effective when timeout STO is active due to elapsed monitoring time TM or TM-MIN **Effect in AUTOMATIC** Step enabling by 1. Transition satisfied 2. QIT = 1 (positive edge) → STO becomes = 0 **Effect in EXECUTE** Step enabling by 1. Transition satisfied 2. QIT = 1 (positive edge) → STO becomes = 0 3. T+1 = 1 (positive edge) **Effect in MANUAL** (A/H = 0, TIPP = 0) 1. QIT = 1 (positive edge) STO becomes = 0, regardless of the transitions
STO	Q	BI	TIMEOUT	Signal state = 1 when: sequencer has a timeout due to elapsed monitoring time TM./TM-MIN Note:switching further only possible with QIT

Recommendation

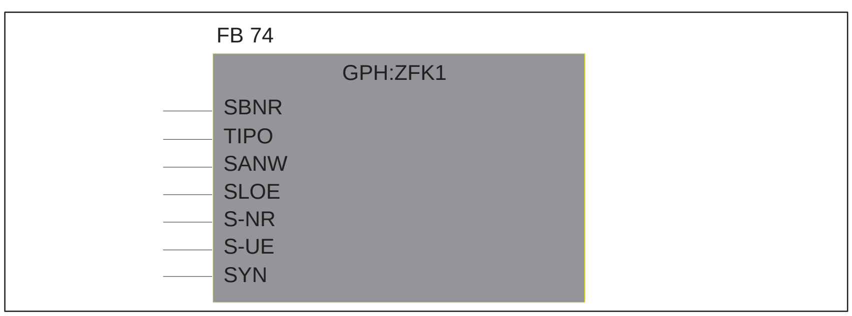
Unused input or output parameters can be supplied values from the flag area flag word 206 to 216.

Remember that the input parameters must be at RLO = 0 and the output parameters must be written constantly.

FB 74, Additional Functions for FB 72/73

FB 74 is only effective in conjunction with blocks FB 72 or FB 73; it must be called unconditionally with JU FB 74 before FB 72 or FB 73 is called and is used to implement additional modes.

Calling the Function Block



Displays and Operating Elements

(SBNR)	Number of the user sequence block
(TIPO)	EXECUTE without condition
(SANW, S-NR, S-UE)	Step selection in BCD code
(SLOE, S-NR, S-UE)	Delete step in BCD code
(SYN)	Synchronization

Parameters for FB 74

Name	Para Type	Data Type	Meaning	Remarks
SBNR	D	KF	Sequencer	Number of the sequence block to be processed, same value as for FB 72 / FB 73
TIPO	I	BI	Execute without condition (single step)	Evaluation as permanent signal **Condition:** In FB 72 / 73: EXECUTE, (TIPP = 1, A/H = 0, AUS = 0) with T+1 all levels are switched further without a condition without a special program in the transitions, (refer to program example no. 9) **Effect:** – sequencer switches without a valid transition – output commands active – waiting times are not effective – monitoring times are not effective
SANW	I	BI	Step selection	Evaluation as permanent signal **Condition:** only effective in MANUAL (TIPP = 0, TIPO = 0) **Effect:** In the sequencer, the step number selected in the parameter S-NR is set with a positive edge at S-UE. **Note:** Only one step can be set in linear sequencers Any number of steps can be set in simultaneous sequencers. The structure of the sequencer must be kept in mind otherwise incorrect reaction when switching over to AUTO/EXECUTE Last step set indicated in DW 20 of the DB x
SLOE	E	BI	Delete step	Evaluation as permanent signal **Condition:** only effective in MANUAL (TIPP = 0, SANW = 0)

				Effect: – In the sequencer, the step selected in S-NR is deleted with signal change at S-UE – Last deleted step indicated in DW 20 of the DB x **Caution:** After deleting the last step: DW 20 = 0 further edge; renewed attempts to delete lead to repeated indication of the last step deleted
S-NR	I/Q	W	Step number	Evaluation in BCD code, 3-digit (right justified) **Note:** You can use the 4th digit of the word for the parameter S-NR Permitted operands: IW, QW, FW, in DBx: DW 240 to DW 255
S-UE	I	BI	Signal for step selection/delete step	Evaluation with signal change from 0 to 1
SYN	I	BI	Synchronization (This parameter has nothing to do with synchronization described in Chapter 5)	Evaluation as permanent signal only effective in AUTO with FB 72/73 **Effect:** – waiting/monitoring times not effective – sequencer runs to next fulfilled transition **Note:** The synchronization requires considerable programming in the transitions refer to program example no. 11 Automatic program synchronization is possible as described in Chapter 5.

Description of the Modes of FB 72 and FB 73

The following modes are possible with FB 72 and FB 73:

Sequencer in OFF

Activation Parameter OFF = 1 (continuous signal)
other parameters can have any signal state.

Effect Deselects the current mode;
sequencer is set to step 0;
STO is deleted;
output commands of all steps, except latching statements, are disabled.

Note

Only the output commands programmed as an assignment (=Q x.y) are disabled. The latching output commands (S Q x.y) must be disabled by a delete program.

Note The OFF mode has the highest priority.

MANUAL Operation (Setting Up)

Activation A/H = 0, TIPP = 0, AUS = 0

Effect waiting times not effective;
monitoring times no longer effective;
existing STO retained;step number retained;
output commands are inactive due to F 233.0 and can be activated via F 205.6;
submode/setting up operation possible (see programming examples).

Note MANUAL operation (setting up) has the lowest priority

AUTOMATIC

Activation A/H = 0, TIPP = 0, AUS = 0

Effect Automatic enabling of the steps according to the programmed transition. If the sequencer is in step 0, the INIT steps are started. Current step output commands (actions) active due to F 233.0.The waiting times programmed in the sequencer structure are effective. The monitoring times in the sequencer structure are effective.
A timeout occurs when:
1. the monitoring time TM of a step has elapsed (group signal STO)
2. the transition is satisfied within the time TM-MIN (time value TW + D 33.2 = 1).

For implementing “automatic start with enter key” refer to Section 4.9.4, example number 1)

Note A/H = 1 and TIPP = 1
A/H has higher priority than TIPP

EXECUTE with Condition and Command Output

Activation	TIPP = 1, A/H = 0, AUS = 0 Positive edge at T+1
Effect	With a positive edge at T+1 and if TW has elapsed, the sequencer moves on one step further per simultaneous branch if the transition is satisfied. If the sequencer is in step 0, the INIT steps are started. Waiting times are effective. Monitoring times TM are not effective. Current step output commands (actions) are active due to F 233.0 being active. The sequencer runs as in the automatic mode, simultaneous branches are processed in parallel.
Note	EXECUTE is only active when MANUAL operation (A/H=0) is selected.

Note

Programming example for:
EXECUTE without condition (FB 74 refer to example 9)
EXECUTE without command output (refer to example 8)
EXECUTE with indication of step enabling (refer to example 10)

TIMEOUT STO = 1

Caused by TM elapsing or TM-MIN not being reached (only in AUTOMATIC).

Effect	Sequencer is stopped. Command output remains active and can be influenced via D 33.0 (for assignments of all steps = 0) or via D 33.1 (only assignments of the steps with a timeout = 0).

Continuation only with acknowledgement (QIT).

Activation	**I.) in AUTOMATIC:** a) Clear timeout (transition satisfied) b) Activate QIT
Effect	→ Sequencer moves on to all steps for which the cause of the timeout has been eliminated.
Activation	**II.) in EXECUTE:** a) Clear timeout (transition satisfied) b) Activate QITc) Activate T+1 c) Activate T+1
Effect	→ The sequencer moves on to all steps for which the cause of the timeout is eliminated.

Description of the Modes of FB 74

FB 74 is only effective in conjunction with FB 72/73 and implements additional functions. It can be called directly before FB 72/73 with the unconditional call JU FB 74.

EXECUTE WITHOUT CONDITION

Activation TIPO = 1 (continuous signal)
In FB 72/73 EXECUTE (TIPP = 1, A/H = 0)
→ All levels switch without a condition, with T+1 without the programmed transitions, the actions are active (refer to Section 4.9.4, example number 8/1).

STEP SELECTION (SANW) / DEACTIVATE STEP (SLOE)

Activation 1. SANW = 1, SLOE = 0:
step selection / activate step or
2. SANW = 0, SLOE = 1: deactivate step

In FB 72/73: MANUAL operation: A/H = 0, TIPP = 0; with S-NR, select the number of the step to be set/deleted in BCD code.
3. Activate with S-UE = step number (S-NR).

Effect General: actions = 0
The structure of the simultaneous sequencer cannot be checked by the system in the STEP SELECTION mode, i.e.:

– you can activate more than one step in a simultaneous sequence.
– if only one step is set in the whole sequencer and if this is deactivated by SLOE, the sequencer is set to step 0. After further SLOE attempts, the last deactivated step is indicated.

Note

Prior to SANW, the sequencer should be switched to OFF. This means that all steps are deleted and no selective deleting is required.

Step display

During the STEP SELECTION/DEACTIVATE STEP mode, the step numbers of levels 2 - 8 are deleted in DW 21-27 of DB x and no longer updated so that the steps influenced cannot be checked. The last step number to be processed is simply stored in DW 20 of DB x at SANW and SLOE. DW 20 is then responsible for all levels in this situation. DW 21 - 27 only contain the current status for levels 2 - 8 again after enabling the steps in AUTO or EXECUTE.

Note

The structure of the sequencer is not checked. Illogical setting or resetting of steps can lead to incorrect responses when switching to AUTO or EXECUTE. You must take full responsibility for correct activation of the steps.

SYNCHRO-NIZATION

Activation SYN = 1
in FB 72/73 AUTO (A/H = 1)

Effect TW/TM are reset with SYN.
In the automatic mode, the sequencer runs as far as the first non-satisfied transition. A certain amount of programming is necessary to achieve this.

Condition You cannot program synchronization generally in the system, since the same transitions may occur at several different locations.
For this reason, you must program the conditions for moving on to the current steps extra in the transitions as a parallel branch.

Note The sequencer is also in the AUTO mode (actions active), for this reason, the actions in the steps should be interlocked with the SYN signal. (Refer to Section 4.9.4, example number 10).

Note

The synchronization parameter has nothing to do with process synchronization as described in Chapter 5.

Possible Modes of FB 72, FB 73 and FB 74

Modes	Implemented with
Sequencer OFF (RESET)	FB 72/73
AUTOMATIC	FB 72/73
MANUAL	FB 72/73
EXECUTE with condition	FB 72/73
EXECUTE without condition	FB 72/73, FB 74
STEP SELECTION/DEACTIVATE STEP	FB 72/73, FB 74
SYNCHRONIZATION	FB 72/73, FB 74
TIMEOUT	FB 72/73
ACKNOWLEDGEMENT of the timeout	FB 72/73

Parameters 1) FB 72/73 FB 74						Mode	Effect	
AUS	**A/H**	**TIPP**	**TIPO**	**SANW**	**SYN**		**Actions**	**Remark**
1	X	X	X	X	X	Reset (sequencer OFF)	0	Sequencer stopped at step 0, other modes disabled
0	1	X	0	X	0	AUTOMATIC	1	Enable step if transition satisfied, TW, TM effective
0	0	1	0	0	0	EXECUTE with condition	1	Step enabled if transition satisfied with T+1, TW effective, TM not effective
0	0	0	0	0	0	Submode/ SETTING UP	0	Each movement must be linked into the step with the manual flag F 205.6
0	0	1	1	0	0	EXECUTE without condition	1	No special programming necessary in transition, TW, TM not effective.
0	0	0	0	1	0	Step selection	0	
0	1	0	0	0	1	Synchronization	1	Special programming in transition. TW, TM not effective.

1:signal state of the parameter “1”

0:signal state of the parameter “0”

X:parameter can have any signal state

1): refer to Section 4.9.1 for an explanation of the parameters

---

Note

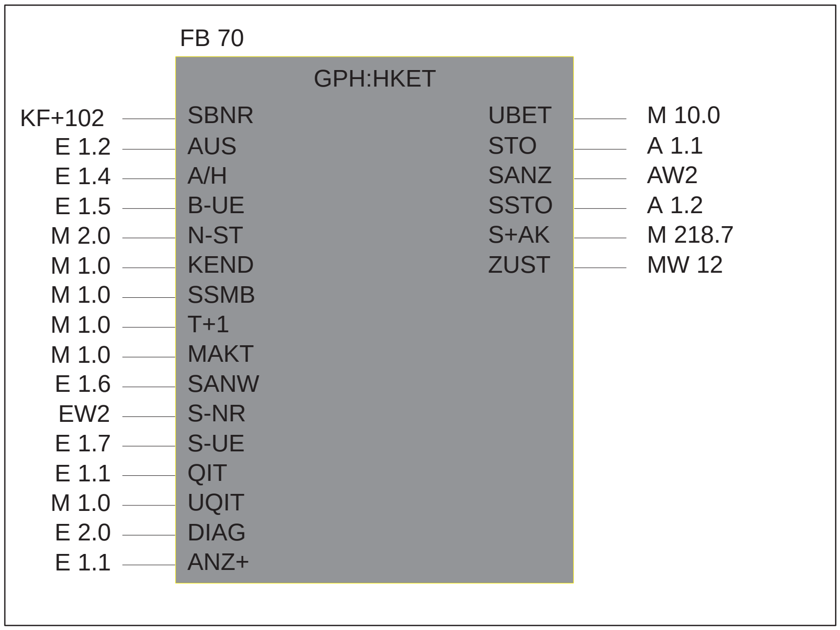
Other constellations cause mixed reactions.

4.9.2 Standard Version

FB 70/SB 0 for a Main Sequencer

Using this FB, you can process linear, alternative and simultaneous sequencers. If you also include FB 71, you can also process subsequencers.

Calling the Function Block



Displays and operating elements

Input parameters

(SBNR)	Number of the user sequence block (sequencer)
(AUS, A/H, B-UE)	Modes: OFF/AUTO/MANUAL
(N-ST)	RESET or warm restart during restart
(KEND)	Automatic sequencer end
(SSMB, T+1)	Step control with conditions
(MAKT)	Command output deselectable
(SANW, S-NR, S-UE)	Step selection with decade switch in BCD code
(QIT, UQIT)	Acknowledge a timeout
(DIAG)	Select extended diagnostics
(ANZ+)	Move on step display

Output parameters

(UBET)	Enable submode
(STO)	General timeout
(SANZ)	Display of step number in BCD code
(SSTO)	Timeout in displayed step
(S+AK)	More than one step active at same time
(ZUST)	Status / operator error

SB 0 for Sequencer Processing

You require this block for processing GRAPH 5 functions in the PLC. SB 0 is only transferred to the PLC.

Parameters of FB 70

Name	Para Type	Data Type	Meaning	Remarks
SBNR	D	KF	Sequencer	Number of the sequence block to be executed **Note:** The sequence block must be created with GRAPH 5.
AUS	I	BI	Sequencer OFF (reset)	Evaluation as permanent signal AUS = 1 → AUS active **Effect:** – Deselects the current mode – Sequencer set to step 0 – Output commands of all steps, except latching programmed steps, are disabled **Note**: If AUS = 1, no other mode can be selected
A/H	I	BI	Mode AUTOMATIC / MANUAL	Evaluation as permanent signal **Condition:** A/H = 1 → AUTOMATIC selected The AUTO mode is adopted with signal parameter B-UE → AUTO active Output commands active A/H = 0 → MANUAL active **Note:** The sequencer switches due to the satisfied transitions. Changing to manual immediately stops the automatic mode. Output commands are disabled.
B-UE	I	BI	Adopt the mode AUTO and SSMB	Evaluation of the signal change from 0 to 1 **Effect:** The signal state = 1 of A/H or SSMB is adopted.
N-ST	I/Q	BI	COLD RESTART ON PLC or COLD RESTART	Evaluation as permanent signal of manual cold restart on the PLC: **Condition:** N-ST = 0 **Effect:** – The entire sequencer is deactivated – The mode is deselected

Name	Para Type	Data Type	Meaning	Remarks
			for entire program or	– All output commands are disabled – The sequencer is set to step 0 **Condition:** N-ST = 1 **Effect:** – Step number before stop state is retained – Mode before stop state is retained
			WARM RESTART for sequencer	– Output commands of current steps remain set **Caution:** Only a flag bit <=F 199.7 or F 206.0 to F 218.7 is permitted as a parameter. This flag must not be used for other parameters because it is set permanently to 1 by FB 70. The operand N-ST only needs to be programmed when the warm restart function is required. In this case, the flag N-ST must be set in the startup OB of the PLC.
			COLD RESTART for rest of program	– The program outside the sequencer goes through a cold restart as in the PLC description.
KEND	I	BI	Sequencer end selection	Evaluation as permanent signal **Condition:** KEND = 1: **Effect:** – The sequencer is stopped in step 0 only in AUTOMATIC. – All other reactions as for OFF.
SSMB	I	BI	Step control with condition	Evaluation as permanent signal **Condition:** SSMB = 1 (A/H = 0, SANW = 0)-> SSMB selected SSMB is adopted with the signal parameter B-UE → SSMB active **Effect:** – Sequencer switches if the transition is satisfied and there is a signal change from 0 to 1 at parameter T+1 – The step command output is only active with MAKT = 1 – The programmed waiting times are effective – The programmed monitoring times are **not** effective.
T+1	I	BI	Move on in SSMB	Evaluation of the signal change from 0 to 1; only effective in the SSMB mode
MAKT	E	BI	Output of the step commands	Evaluation as permanent signal

Name	Para Type	Data Type	Meaning	Remarks
				Condition: Only effective in SSMB **Effect:** – MAKT = 1: output commands in step are set. The subsequencer (FB 71) is only active with MAKT = 1! – MAKT = 0: all non-latching programmed output commands in the steps are disabled.
SANW	I	BI	Step selection	Evaluation as permanent signal; **Condition:** Effective only with A/H = 0 **Effect:** With an edge at S-UE, the sequencer is set to the step number selected in the parameter S-NR.
S-NR	I	W	Step number for SANW	Evaluation in BCD code; 3-digit, see SANW **Note:** The first decade of the word for the parameter S-NR can be used for the program outside the sequencer. permitted operators: IW, QW, FW, DB x: DW 240-255
S-UE	I	BI	Trigger signal for step selection	Evaluation of the signal change from 0 to 1; see SANW trigger signal for S-NR effective when SANW = 1
QIT	I	BI	Acknowledgment of a timeout	Evaluation of the signal change from 0 to 1 effective when there is a timeout caused by elapsed monitoring time TUE /TUE-MIN Step enabling possible when the step enabling condition is satisfied later and there is an edge at QIT
UQIT	I	BI	Unconditional acknowledgment of a timeout	Evaluation of the signal change from 0 to 1 Effective when: There is a timeout STO caused by an elapsed monitoring time TUE/TUE-MIN Step enabling regardless of step enabling conditions
DIAG	I	BI	Diagnostic check	DIAG = 1: During the diagnostic check, the basic conditions for running the sequencer on the PLC are checked and errors indicated in the status ZUST in bits 12 - 15. If an error is detected, execution of the sequencer is disabled. DIAG = 0: To save cycle time, the functions above are disabled.
ANZ+	I	BI	Move on step display	Evaluation of the signal change from 0 to 1. If several steps are set at the same time (with simultaneous branches) these step numbers can be indicated one after the other in the step display SANZ.

Name	Para Type	Data Type	Meaning	Remarks
UBET	Q	BI	Submode (= setup mode)	Signal state = 1 when MANUAL (A/H = 0) and SSMB = 0 and SANW = 0 (no mode mode selected) **Response of the sequencer:** The step number is retained. The step output commands are disabled except for the programmed latching commands. The step output commands can be activated regardless of the sequencer functions using the manual flag F 205.6.
STO	Q	BI	Timeout, general	Signal state = 1 due to timeout in the sequencer caused by elapsed monitoring time TUE/TUE-MIN **Note:** Sequencer can only move on with QIT or UQIT.
SSTO	Q	BI	Step with timeout	Signal state = 1 due to timeout in the sequencer caused by elapsed monitoring time TUE/TUE-MIN and a step with timeout is indicated in SANZ (see ANZ+, SANZ). **Note:** The sequencer can be forced to move on with UQIT.
SANZ	Q	W	Step indicator	Output of the step number in BCD code, 3-digit **Note:** The 4th decade of the word for the parameter SANZ can be used for the program outside the sequencer program. (see ANZ+, SSTO) Permitted operands: IW, QW, FW, DBx: DW 240 - 255
S+AK	Q	BI		Signal state = 1 when more than one step is active at the same time (with simultaneous branches)

Name	Para Type	Data Type	Meaning	Remarks
ZUST	Q	W	Status word	
			signal state = 1 in: Bit 0: Sequencer in OFF mode Bit 1: Sequencer in AUTO mode Bit 2: Sequencer in MANUAL mode Bit 3: Reserved Bit 4: Sequencer in SANW mode Bit 5: Reserved Bit 6: Sequencer in SSMB Bit 7: SSMB and MAKT Bit 8: DIAG Bit 9: KEND selected and sequencer end reached in AUTO Bit 10: Step 0 is set Bit 11: Incompatible; PG/PLC software Bit 12: SB 0 does not exist (PLC) Bit 13: Working data block DB x not loaded on PLC Bit 14: The sequence block (SBNR) to be executed is not programmed in GRAPH 5 Bit 15: The sequence block to be executed (SBNR) is not loaded on the PLC	
				Caution: Permitted as operand for ZUST: only IW, QW, FW (< FW 200), DB x: DW 240 - 255 Note: If bits 11, 12, 13, 14 or 15 are set the sequencer is not executed. These checks are only made when DIAG = 1.

Recommendation

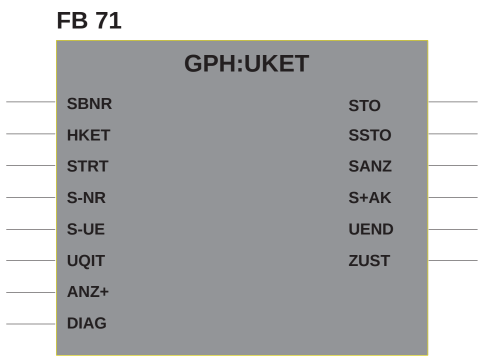
Unused input and output parameters can be supplied values from the flag area (flag words 206 to 216).

Remember that the input parameters must have RLO = 0 applied and the output parameters must be written to continuously.

FB 71/SB 0 for Subsequencers

This FB can be used in addition to FB 70.

Calling the Function Block



Displays and Operating Elements

Input parameters

(SBNR)	Number of the sequence block (sequencer)
(HKET)	Modes of the main sequencer
(STRT)	Start sequencer
(S-NR, S-UE)	Step selection with decade switches in BCD code
(UQIT)	Acknowledgment of a timeout
(ANZ+)	Move on step display
(DIAG)	Select extended diagnostics

Output parameters

(STO)	Timeout general
(SSTO)	Timeout in indicated step
(SANZ)	Indication of step number in BCD code
(S+AK)	Several steps active at the same time
(UEND)	Subsequencer end
(ZUST)	Status / operator error

SB 0 for Sequencer Processing

This block is required for processing GRAPH 5 functions on the PLC. SB 0 is only transferred to the PLC.

Parameters of FB 71

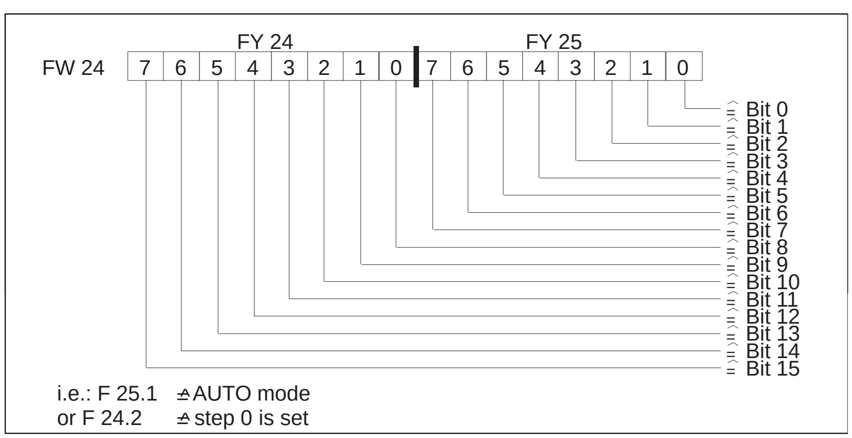
Name	Para Type	Data Type	Meaning	Remarks
SBNR	D	KF	Sequencer	Number of the sequence block to be executed **Note:** The sequence block must be created with GRAPH 5.
HKET	I	W	not used	The modes of the main sequencer are set internally Named with any flag word
STRT	I	BI	Start the subsequencer	Evaluation of the signal change from 0 to 1
S-NR	I	W	Step number for SANW	Evaluation in BCD code; 3-digit, see SANW **Note:** The first decade of the word for the parameter S-NR can be used for the program outside the sequencer. permitted operators: IW, QW, FW, DB x: DW 240-255
S-UE	I	BI	Trigger signal for step selection	Evaluation of the signal change from 0 to 1; see SANW trigger signal for S-NR effective when SANW = 1
UQIT	I	BI	Unconditional acknowledgment of a timeout	Evaluation of the signal change from 0 to 1 effective when: There is a timeout STO caused by an elapsed monitoring time TUE/TUE-MIN. Step enabling regardless of step enabling conditions
DIAG	I	BI	Diagnostic check	DIAG = 1: During the diagnostic check, the basic conditions for running the sequencer on the PLC are checked and errors indicated in the status ZUST in bits 11 - 15. If an error is detected, execution of the sequencer is disabled. DIAG = 0: To save cycle time, the functions above are disabled.
ANZ+	I	BI	Move on step display	Evaluation of the signal change from 0 to 1. If several steps are set at the same time (with simultaneous branches) these step numbers can be indicated one after the other in the step display SANZ.
STO	Q	BI	Timeout, general	Signal state = 1 due to timeout in the sequencer caused by elapsed monitoring time TUE/TUE-MIN. **Note:** Sequencer can only move on with QIT or UQIT.
SSTO	Q	BI	Step with timeout	Signal state = 1 due to timeout in the sequencer caused by elapsed monitoring time TUE/TUE-MIN and a step with timeout is indicated in SANZ (see ANZ+, SANZ). **Note:** The sequencer can be forced to move on with UQIT.

Name	Para Type	Data Type	Meaning	Remarks
SANZ	Q	W	Step indicator	Output of the step number in BCD code, 3-digit **Note:** The 4th decade of the word for the parameter SANZ can be used for the program outside the sequencer program. (see ANZ+, SSTO) Permitted operands: IW, QW, FW, DBx: DW 240 - 255
S+AK	Q	BI	Step indicator	Signal state = 1 when more than one step is active at the same time (with simultaneous branches)
UEND	Q	BI	Subsequencer end	UEND = 1: Sequencer not yet started or Sequencer executed to end UEND = 0: Sequencer started in AUTO or MANUAL mode **Note:** The parameter must be scanned for status = 1 in the transition of the main sequencer after the step with the subsequencer call (step enabling condition for the main sequencer).

Name	Para Type	Data Type	Meaning	Remarks
ZUST	Q	W	Status word	
			When signal state = 1 in: Bit 0: Sequencer in OFF mode Bit 1: Sequencer in AUTO mode Bit 2: Sequencer in MANUAL mode Bit 3: Reserved Bit 4: Sequencer in SANW mode Bit 5: Reserved Bit 6: Sequencer in SSMB Bit 7: SSMB and MAKT Bit 8: DIAG Bit 9: KEND selected and sequencer end reached in AUTO Bit 10: Step 0 is set Bit 11: Incompatible; PG/PLC software Bit 12: SB 0 does not exist (PLC) Bit 13: Working data block DB x not loaded on PLC Bit 14: The sequence block (SBNR) to be executed is not programmed in GRAPH 5 Bit 15: The sequence block to be executed (SBNR) is not loaded on the PLC	
				Caution: Permitted as operand for ZUST: only IW, QW, FW (< FW 200), DB x: DW 240 - 255 Note: If bits 11, 12, 13, 14 or 15 are set the sequencer is not executed. These checks are only made when DIAG = 1.

The modes required bit 0-7/T+1/acknowledge and S 0 active are activated internally by the subsequencer.

e.g.: ZUST = FW 24



Word parameters S-NR, SANZ, ZUST

only IW, QW, FW, DB x: DW 240 - 255 permitted

calling a data block with C DB .. before FB 70 does not allow other data words to be used, since the user data block is switched over by the standard FB

Parameters S-NR and SANZ

The parameters S-NR and SANZ must be at least 12-bit long words: for this reason the smallest parameter type is a word (16 bits). The four bits of the 4th decade of S-NR and SANZ can be used by other programs; refer to the following examples.

Parameter S-NR

Wiring:

Connection to a decade switch. The decade switch must supply its value in BCD code.

Parameter SANZ

Connection to 7-segment display; the value for this display is supplied in BCD code.

Example: S-NR = IW 10

Example: SANZ = QW 8

QB 8 IB 10		QB 9 IB 11		
10.7 . . . 10.4	10.3 . . . 10.0	11.7 . . . 11.4	11.3 . . . 11.0	
0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	
- - - -	8 4 2 1	8 4 2 1	8 4 2 1	Value within the decades
FREE	HUNDREDS	TENS	ONES	
4th decade	3rd decade	2nd decade	1st decade	Value in BCD

4th decade

The input of the 4th decade can be used freely for other programs.

Modes of FB 70/71

The following modes are possible with FB 70/71:

Mode OFF: Sequencer Stopped

Activation
Parameter AUS = 1, continuous signal required
other parameters: any signal state

Effect
All functions and modes are disabled.
A new mode can only be selected when OFF is deactivated.
After deactivating OFF, step 0 is set but not the INIT steps.

Note

Output commands programmed as latching (SQxy, SFna...) are not disabled when the sequencer is OFF.

Mode AUTO: Normal Operation

Activation

1. Parameter A/H = 1, continuous signal required (AUS = 0).
2. Activated with a positive edge at parameter B-UE (key function, corresponds to AUTO START)

Effect
Steps automatically enabled according to the programmed transition.
The step output commands (actions) of the current steps are activated.
The waiting times programmed in the sequencer structure are effective.
The monitoring times programmed in the sequencer structure are effective.
A timeout occurs when:

- the monitoring time TM of a step has elapsed (group signal STO)
- when the transition is satisfied within the time TM-MIN (time value TW + D 33.2 = 1).

Clearing the Timeout and Enabling Steps with QIT (Acknowledge)

Condition	An error has occurred in step n. The subsequencer transition must be active and satisfied to ensure that the sequencer continues to run normally.
Activation	Positive edge (key function) at parameter QIT.
Effect	All the steps fulfilling the condition above (several steps in simultaneous branches) switch on to the next step according to the sequencer structure. The STO message is reset.

Note

Response to timeouts as with FB 72/73.

UQIT (Unconditional Acknowledgment)

Condition	AUTO or SSMB active (in all other modes only the timeouts are cleared).
Activation	Positive edge (key function) at parameter UQIT.
Effect	The STO or SSTO message is cleared. If the condition above is met, the sequencer enables the next step according to the sequencer structure, ignoring the transition. With simultaneous branches, all active steps move on one step unconditionally.

Note on QIT / UQIT

QIT and UQIT are only effective when there is a timeout (STO). UQIT enables the next step unconditionally and without a timeout. The next step can only be enabled after the waiting time has elapsed. (Refer also to table: acknowledging a timeout, Section 4.7.2)

MANUAL Mode

The mode is switched from AUTO to MANUAL with the parameter A/H. To use the MANUAL mode you must set the parameter A/H = 0. In this mode you can then select the following:

Step control with condition	(SSMB)
Step selection	(SANW)
Submode	(UBET)

Activation	Parameter A/H = 0, AUS = 0
Effect	The output commands of the steps are disabled or remain disabled. Latching output commands, however, remain set if they were active prior to the MANUAL mode. The previous step number is retained.

MANUAL Mode: Step Control with Condition (SSMB)

Activation

1. A/H = 0 (MANUAL) AUS = 0
2. SSMB = 1 and SANW = 0, continuous signal required (mutual interlock)
3. Activated with a positive signal edge at parameter B-UE (key function).

Effect

Step enabled when:

1. The next transition is satisfied (no timeout) and (!)
2. A positive signal edge at parameter T+1 (key function)

The monitoring times programmed in the sequencer structure are not effective.
You can disable the step output commands with the parameter MAKT (apart from latching commands).

MAKT = 1, command output active
MAKT = 0, command output not active

Note

In SSMB, the sequencer is executed with the same structure as in the AUTO mode but is controlled by the T+1 key. Simultaneous branches are executed parallel to each other as in the AUTO mode.
T+1 has the effect of an additional transition condition.
An active timeout must be acknowledged.

MANUAL Mode: Step Selection (SANW), only with Main Sequencers

Selecting and setting a step

Condition

Sequencer in MANUAL A/H = 0, AUS = 0, SSMB = 0
Selected step number in S-NR < highest step number of the sequencer and not equal to zero.

Activation

1. A/H = 0 (MANUAL)
2. SANW = 1 and SSMB = 0 (mutual interlock)
3. Activated with positive signal edge at parameter S-UE (key function).

Effect

Step output commands remain disabled. The selected step number is set. Even with simultaneous sequencers, you can only set one step of the whole sequencer. If you select a step in a further simultaneous branch, the step in the previous simultaneous branch is cleared. Waiting and monitoring times are not activated.

MANUAL Mode: Submode (UBET)

Condition

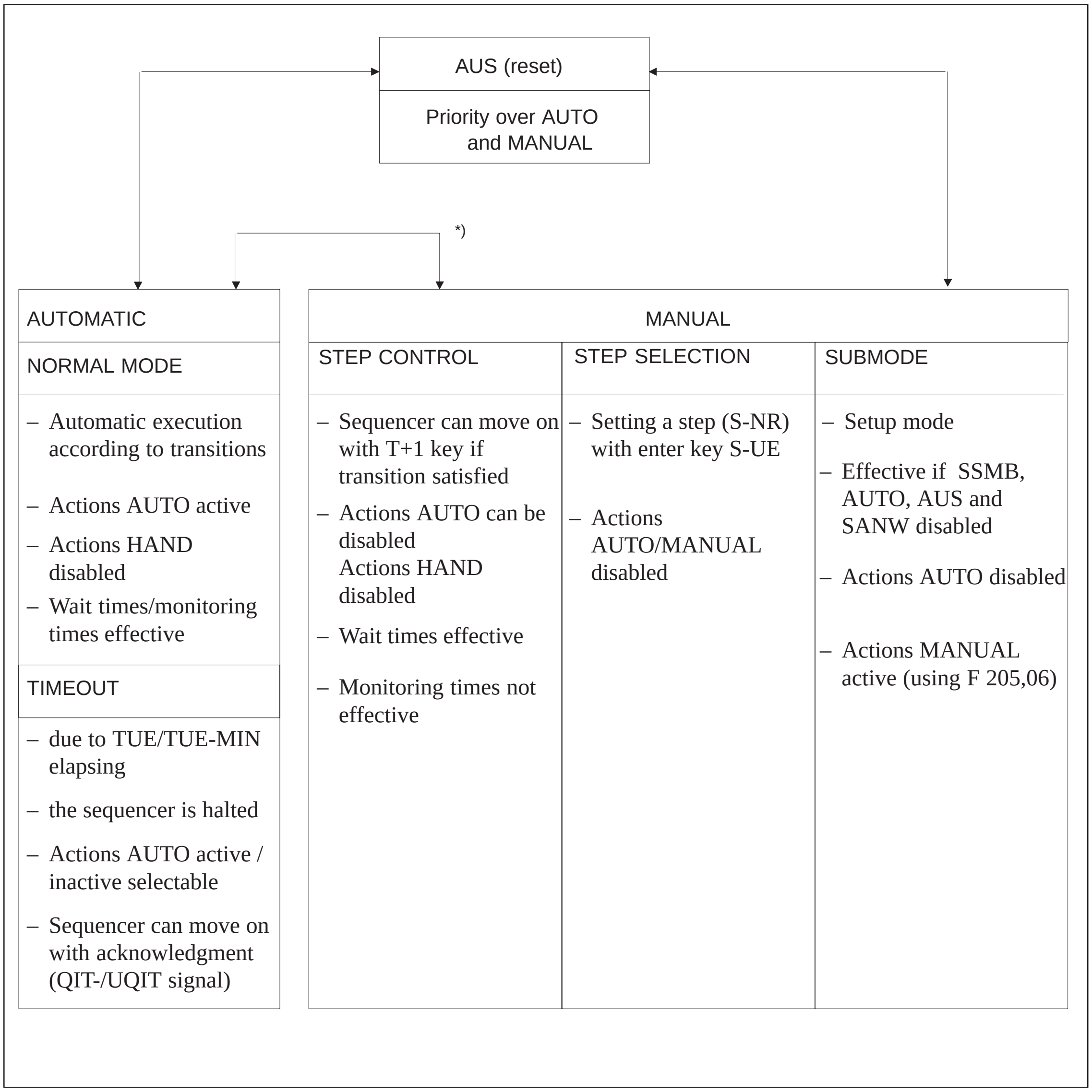
AUS = 0, SANW = 0, SSMB = 0, A/H = 0

Effect

Step output commands are disabled.
The previous step number is retained.
The step output commands can be controlled regardless of the transition and the step numbers using manual flag F 205.6 (single control/setting up).
Signal parameter UBET = 1.

Possible Modes for the Sequencer

The modes are determined by the signal states at the parameters of FB 70/FB 71.



*)When changing from AUTO to MANUAL and vice versa, the current step number and current timeout are retained.

Switching Over Modes

Mode before change		Mode after switching over: AUTO	SSMB	SANW	UBET
	AUTO		Sequence: 1. A/H=0 -> Akt=0 -> S=const. -> TWA= const. 2. SSMB=1 3. B-UE=1 -> Akt active when MAKT=1	Sequence: 1. A/H=0 -> Akt=0 -> S=const. -> TWA=0 2. SANW=1 3. set step with S-UE=1	Sequence: 1. A/H=0 -> Akt=0 -> S=const. -> TWA= const. 2. SSMB=0 3. SANW=0
	SSMB	Sequence: 1. A/H=1 -> S=const. -> TWA= const. 2. B-UE=1 -> Akt active		Sequence: 1. SSMB=0 -> S=const. -> TWA=0 2. SANW=1 3. set step with S-UE=1	Sequence: 1. SSMB=0 -> S=const. -> TWA= const. 2. SANW=0
	SANW	Sequence: 1. A/H=1 -> S=const. 2. B-UE=1 -> Akt active	Sequence: 1. SANW=0 -> S=const. 2. SSMB=1 3. B-UE=1 -> Akt active when MAKT=1		Sequence: 1. SANW=0 -> S=const. (2. SSMB=0)
	UBET	Sequence: 1. A/H=1 -> S=const. 2. B-UE=1 -> Akt active	Sequence: 2. SSMB=1 -> S=const. 3. B-UE=1 -> Akt active when MAKT=1	Sequence: 1. SANW=1 -> S=const. 2. set step with S-UE=1	

S=const.: step no. is retained

: Positive edge (key function)

TWA = const.: a wait time that has started is not reset

TWA = 0 : a wait time that has started is cleared

	Preset [1]						Response of the sequencer or resulting mode [1]						
	AUS	A/H	KEND	SSMB	MAKT	SANW	AUS	AUTO	HAND	UBET	SSMB	MAKT	SANW
	0	0	X	0	X	0			#	#			
	0	0	X	0	X	1			#				#
	0	0	X	1	X	1			#				
Operation: 1. SSMB+B-UE[2]	0	0	X	1 [4]	0	X			#		#		
2. SANW 1 o. 0[5]	0	0	X	1 [4]	1	X			#		#	#	
	0	1	X	X	X	X							
2) 3) 5)	0	1 [4]	X	X	X	X		#					
	1	X	X	X	X	X	#						
Operation : AUS changes from 1 to 0	1->0	1	X	X	X	X							
	1->0	0	X	0	x	0			#	#			

1: Signal state of the parameter “1”	Submode
0: Signal state of the parameter “0”	Step adopted with S-UE
x: Signal state of the parameter any value	SSMB cannot be adopted with B-UE
#: Response of the sequencer according to description of the modes	SSMB without command output
	SSMB with command output
1) For an explanation of the parameters, see FB 70	AUTO preselected
2) AUTO and SSMB only become active with an edge at B-UE	AUTO with priority over SSMB
3) Changes A/H from 1 to 0, if AUTO is disabled and MANUAL active	AUS has highest priority
4) Already adopted with B-UE	AUTO preselected
5) Change from AUTO <-> SSMB only effective when change at A/H and positive edge again at B-UE.	Submode

Explanation of further parameters of FB 70/FB 71

Acknowledgement of a timeout (main and subsequencers)

Status of the sequencer			QIT ⟶ Effect	
STO	SSTO	Transition	QIT	Switch to next step
0	0	1 0	X	yes no
1	X	0	X	no
1	X	1	1	yes

Status of the sequencer			UQIT ⟶ Effect	
STO	SSTO	Transition	UQIT	Switch to next step
0	0	1 0	X 1	yes yes
1	0	0	1	yes
1	1	X	0	no
1	0	1	1	yes
1	1	X	1	yes

The condition that must be met before there is an effect caused by QIT is that there must be a timeout.

QIT: effective when STO = 1 and transition = 1

UQIT: effective when STO = 1 and transition = x (either 1 or 0)

A timeout in the subsequencer is cleared with the parameter QIT of the main sequencer.

Monitoring, Diagnostics and Clearing Timeouts

The diagnostics of a sequencer is based on monitoring the current step number and on the indication of a timeout owing to an elapsed monitoring time.

With GRAPH 5, there are two ways of diagnosing and remedying errors:

1. Signal states in the parameters of FB 70 and FB 71:

SANZ:	Step display
S+AK:	More than one step active
ANZ+:	Move on step display SANZ
STO:	General timeout (also FB 72/73)
SSTO:	Displayed step has timeout
ZUST:	Active modes and possible programming errors, reading out the user DB

2. By using the PG with the status functions and/or GRAPH 5 diagnostics and/or another diagnostic unit.

Signal States of the Parameters

Monitoring With the SANZ parameter (step display) you can monitor the current step numbers.

If the sequencer moves on in simultaneous branches, the parameter S+AK indicates that several steps are active simultaneously. You can now move the step display on using the parameter ANZ+ and display all the current steps one after the other.

Diagnostics A timeout is indicated in the parameter STO. You can bring the step with a timeout into the SANZ display using ANZ+. The parameter SSTO (step with timeout) then has signal state = 1.

The signal states within a step and the next transition can be monitored using the STATUS display on the PG.

Using the Programmer

Status display (monitoring)

With the status display on the PG you can follow the current step numbers and signal states in the zoom-ins.

Keystrokes The programmer must be online with the PLC.
Call status SB n using the function keys.

Display of the current step number

- In the overview of the sequencer the current steps are marked by an inversely displayed “asterisk”.
- Below the overview, the number of the current steps are listed in a line.
- Steps with a timeout are marked with a broad, red bar.

For display of the diagnostic data from GRAPH 5 diagnostics, refer to Chapter 6.

Cold Restart Function

To implement the cold restart function for the sequencer, you must reset the parameter N-ST in a start-up OB of the PLC.

You can only use a flag bit for N-ST that is not used elsewhere (reason: RLO = 0 at N-ST causes the sequencer to be reset; FB 70 reads and writes to N-ST).

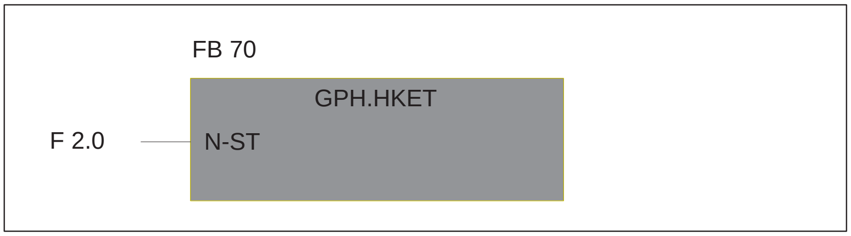
Example 4:
N-ST: F 1.0

Start-up OB:
OB 20 (S5-135 U, S5-150 U, S5-155 U)
OB 21 (S5-95 U, S5-100 U, S5-115 U, S5-135 U, S5-150 U, S5-155 U)
OB 22 (S5-95 U, S5-100 U, S5-115 U, S5-135 U, S5-150 U, S5-155 U)

Selection switch
A I 4.0 - selection switch = 0 → cold restart active
= F 2.0
BE

Only software
A F 1.0
R F 2.0 → cold restart active
BE

Parameter in FB 70



Effect of the cold restart function

F 2.0	Warm restart for sequencer	RESET for sequencer	
“ 1 ”	yes	no	N-ST not effective
“ 0 ”	no	yes	N-ST effective

Handling unused functions of function blocks FB 70/FB71

Remember the following rules:

– Supply the input parameters of the standard FBs with RLO = 0.

– Output parameters are overwritten and must not be used as input parameters.

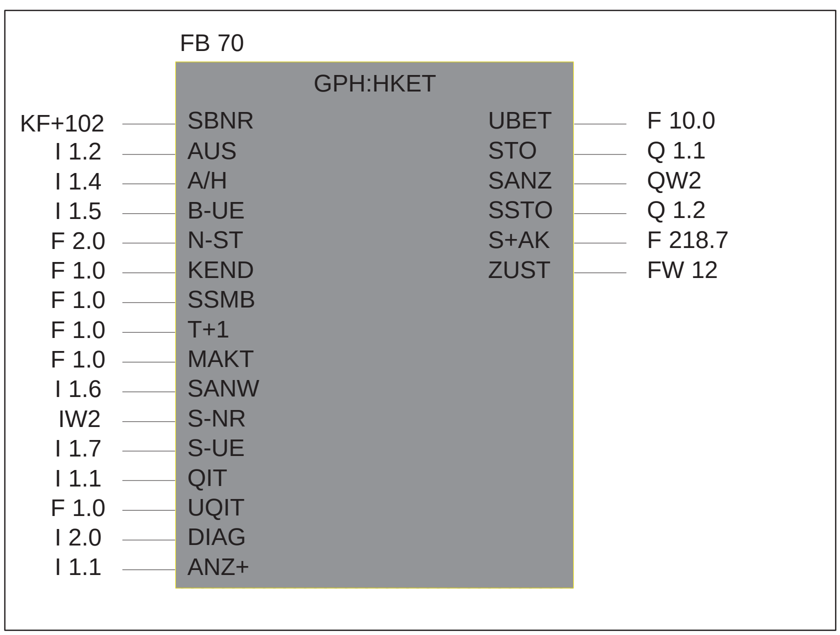
– If you have several sequencers in a PLC, you can use the same flag for all input parameters: exception: N-ST.
The same applies to output parameters.

Note

For the parameters N-ST, each sequencer must have its own flag. This flag must not be used with any other parameters in FB 70.
Permitted flag area:
F 0.0 - F 199.7
F 206.0 - F 218.7

Example 5

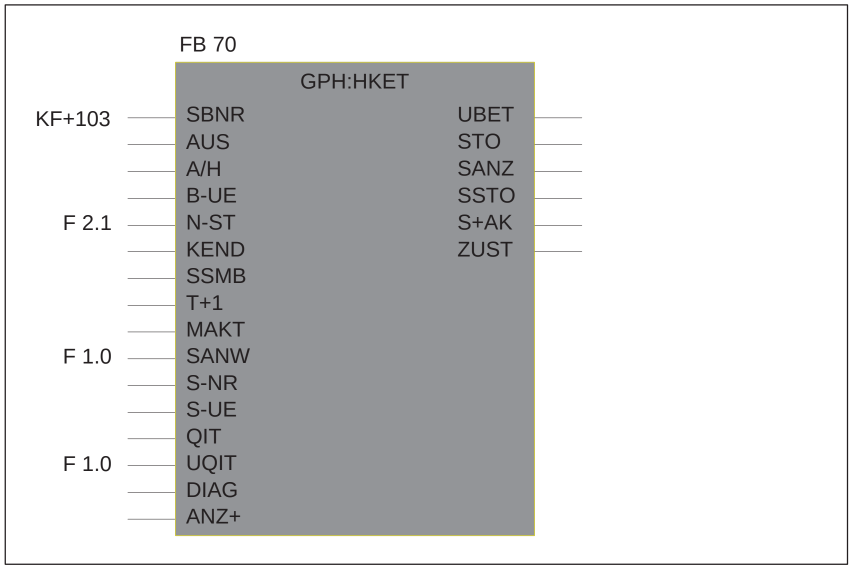
Sequencer 1:
Not used:
N-ST, KEND, SSMB, T+1, MAKT, UQIT, S+AK



F 2.0	Cold restart flag reserved for SB 102
F 1.0	Flag constantly 0
F 218.7	Output scratchpad flag

All other parameters are used.

Sequencer 2:
Not used:
N-ST, SANW, UQIT



F 2.1	Cold restart flag reserved for SB 103
F 1.0	Flag constantly 0

4.9.3 Additional Functions

FB 75 for Additional Functions

The function block FB 75 “GRH: REAK” is used to save and reactivate waiting and monitoring times, both programmed times and times still left to run.

The parameters of the previous blocks FB 70 to FB 74 have the same meaning and effect with FB 75.

When using FB 70, you must link the parameter “A/H” in FB 75 with the parameter B-UE of FB 70 so that the times only become active when the mode is activated.

Programmed times are only saved at the point in time when the sequencer moves on.

Times still to run are saved until both the parameters A/H and TIPP are supplied the value RLO = 0.

If A/H and TIPPare supplied the value RLO = 0, then you can change the time still to run to any value. To illustrate, an FB is described in Section 4.9.4.

Times are reactivated when a positive-going signal edge is detected at the input A/H or TIPP. This applies both to programmed times and to times still left to run. The parameters P/R, TW, TM determine how the re-activation is handled.

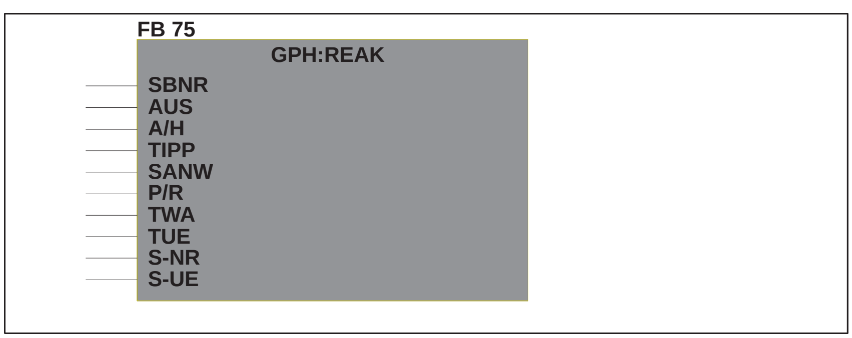
When reactivating TW/TM you have the following options:

- only reactivate TW (TM continues to run)
- only reactivate TM (TW continues to run) or
- reactivate TW and TM

Note

It is possible to overlap the re-activation of TW and TM.
Reactivating the TM timer causes the sequencer timeout to be cleared.
Exception: time still to run = 0 causes an immediate timeout

Calling the Function Block



(only unconditional call possible)

Displays and Operating Elements

(SBNR)	Number of the user sequence block
(AUS, A/H, TIPP)	Modes
(SANW, S-NR, S-UE)	Step selection with decade switch
(P/R)	Selection of configured times/times remaining
(TWA)	Waiting times
(TUE)	Monitoring times

Explanation of the Parameters

The parameters SBNR, AUS, A/H, TIPP, SANW, S-NR and S-UE of FB 75 must be connected with the corresponding parameters of the sequencer function blocks (FB 70-FB 74). Keep in mind the special connection possibilities.

Name	Para Type	Data Type	Meaning	Remarks
SBNR	D	KF	Sequencer	Number of the sequence block to be executed **Note:** The sequence block must be created with GRAPH 5.
AUS	I	BI	OFF mode	Evaluation as permanent signal Effect when AUS = 1: Saving and reactivating the timer is no longer possible!
A/H	I	BI	Mode AUTOMATIC / MANUAL	Evaluation as permanent signal Effect when A/H = 0 → 1: Timers for TWA and/or TUE are started again; Effect when A/H = 1 → 0: Times remaining for TWA and TUE are saved.
TIPP	I	BI	EXECUTE mode	Evaluation as permanent signal Effect when TIPP = 0→ 1: Timers for TWA and/or TUE are started again; Effect when TIPP = 1 → 0: Times remaining for TWA and TUE are saved.
SANW	Q	BI	mode SANW (step selection)	Evaluation as permanent signal **Condition:** A/H = 0 and TIPP = 0 With FB 71: connect input to RLO 0!
P/R	I	BI	Configured timer values / times remaining	Evaluation as permanent signal **Effect:** when P/R = 1: configured timer values can be reactivated. when P/R = 0: remaining times can be reactivated.

Name	Para Type	Data Type	Meaning	Remarks
TWA	I	BI	Wait times	Evaluation as permanent signal **Condition:** TWA = 1 **Effect:** Waiting times can be reactivated
TUE	I	BI	Monitoring times	Evaluation as permanent signal **Condition:** TUE = 1: **Effect:** Monitoring times can be activated.
S-NR	I	W	Step number	Evaluation in BCD code, 3-digit Permitted operand is FW (IW, QW, DW, DB x) With FB 71: connect to scratchpad flag word!
S-UE	I	BI	Trigger signal for step selection and clearing steps	Evaluation of the signal change von 0 → 1 With FB 71: connect S-UE to RLO = 0!

Description of the Modes of FB 75

OFF Mode

When the “OFF” mode is set, the block does not save and reactivate timers.

The timer buffer is deleted.

AUTOMATIC Mode (AUS = 0, TIPP = 0)

With a positive signal edge at parameter A/H, the current time values are reactivated.

With a negative signal edge at A/H, the current time values are saved.

A/H = 0 → A/H = 1: Reactivation of timers with current time values

The parameters **P/R, TW, TM** determine how the timers are reactivated.

The modes A/H and TIPP have the same priority and are interlocked in terms of deleting/resetting and reactivating the timers.

Execute Mode (AUS = 0, A/H = 0)

The reaction is as for AUTOMATIC, however, activated via the TIPP input.

SANW Mode

The parameters SANW and S-UE of FB 75 must be connected to the same signals as with FB 70/74.

When the step number is activated, the programmed time values are entered and the times left to run are deleted.

Note

This function may only be activated when the user sequence block is programmed exclusively with 1-word binary commands.

Combination: FB 75 / FB 74 / FB 73 or FB 72

Deselect the current mode

Apply 1 signal to SANW

Specify S-NR (not 0)

Activate S-UE in FB 74
Search for timer values active

Apply 0 signal to SANW

Re-activation of the timers by
A/H = 0 $\rightarrow$ A/H = 1
or
TIPP = 0 $\rightarrow$ TIPP = 1

Timers running

Note

With a combination of FB 75 and FB 70 the parameters B-UE must be linked with the parameter A/H or TIPP.

Response to a Timeout

You can influence the response of the command output using data bits D 33.0 and 33.1.

Standard assignment

```
DW 33 KM = 0000 0000 0000 0000

only step flags with timeout off
              all step flags off
```

Simultaneous/Linear Sequencer

The step flags (assigned outputs) are switched if there is a timeout, i.e. command output is active.

If you require a different response, you have two possibilities:

All the step flags can be disabled in the event of a timeout. In the DB for the sequencer, data bit D 33.0 must be written with RLO = 1, i.e. the command output is inactive.

Only step flags with a timeout are disabled. In the DB of the sequencer, data bit D 33.1 must be written with RLO = 1. With simultaneous sequencers, all branches without a timeout continue as far as the next junction, i.e. command output is active.

You must only apply RLO = 1 to one of the two data bits (D 33.0 or 33.1).

Possible Block Combinations

Combination of the previous blocks with FB 75

Linear sequencers:
FB 75/FB 73 or
FB 75/FB 74/FB 73

Simultaneous sequencers:
FB 75/FB 72 or
FB 75/FB 74/FB 72
FB 75/FB 70
FB 75/FB 70/user SB/FB 71
FB 75/FB 70/user SB/FB 75/FB 71

Note

Input parameters of FB 75 which are not used must be assigned RLO = 0 or a scratchpad flag.

Skipping Steps

Skipping steps is a function of FB 70, FB 71, FB 72 and FB 73. The function is active when bit D 33.4 is active in the working DB (DB<sequence>).

The transitions are worked through from 1 to n in succession. Each valid transition switches. (The check to determine whether a transition has already switched at the corresponding simultaneous level in the current cycle is omitted.)

A transition is valid when:

1. Its condition is satisfied and
2. all previous steps are active and
3. the waiting time of the previous step(s) has elapsed. This also means that a step which had a waiting time programmed for it cannot be skipped.

Transitions following a simultaneous or alternative junction are processed before the transitions in the "right-hand" simultaneous or alternative branches. This produces the following response:

The algorithm stops

– at simultaneous or alternative junctions

– at the end of the sequencer

– at the first invalid transition.

The actions of the steps that are active after this algorithm are executed for at least one cycle.

After an alternative junction, the transitions "to the left" before the level in which the last switching transitions are located are no longer processed. This means that the sequencer is some times run through differently from when it is executed without skipping steps. This can be avoided by programming a waiting time in the step after the alternative junction.

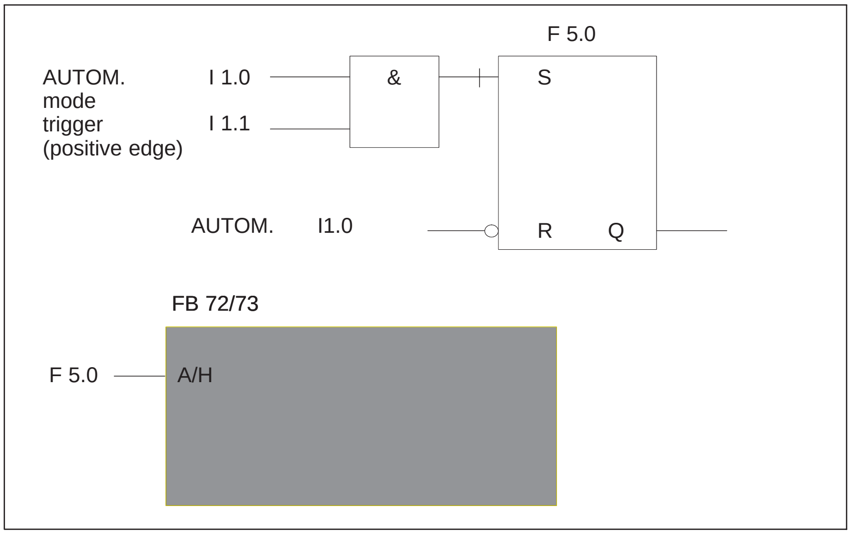
Note

Skipped steps do not become active. The actions that were programmed in a skipped step are therefore not executed. By programming a (possibly extremely short) waiting time it is possible to ensure that a step is not skipped.

4.9.4 Programming Examples for Implementing Modes

No.1 Activate signal for AUTO

CSF

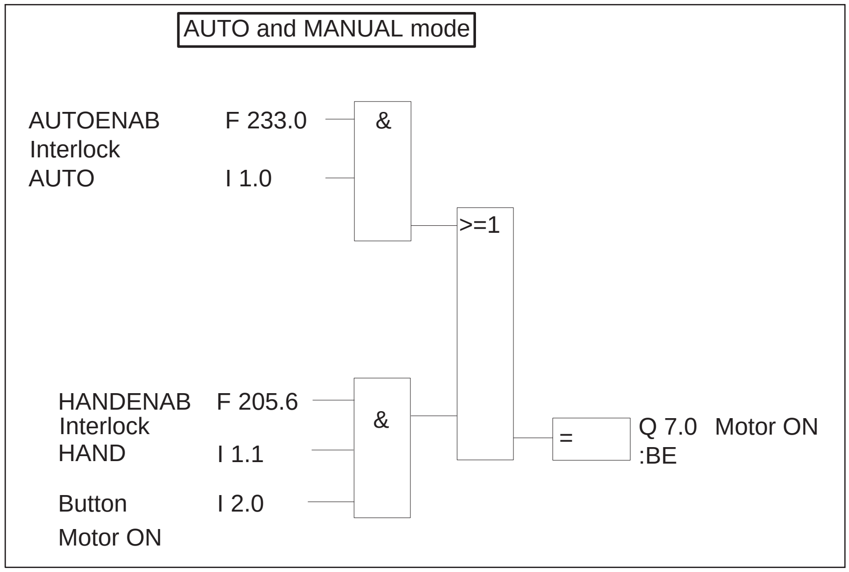


STL

:A	I	1.0
:A	I	1.1
:S	F	5.0
:AN	I	1.0
:R	F	5.0
:BE		

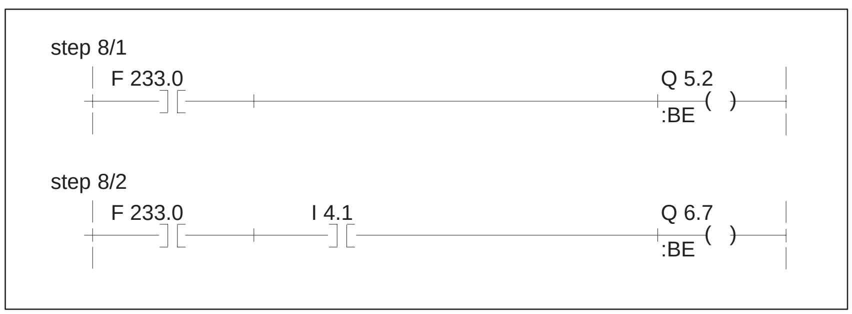
In FB 70, this function is implemented with the parameter B-UE.

No. 2 Separating AUTO/MANUAL in the step zoom-in

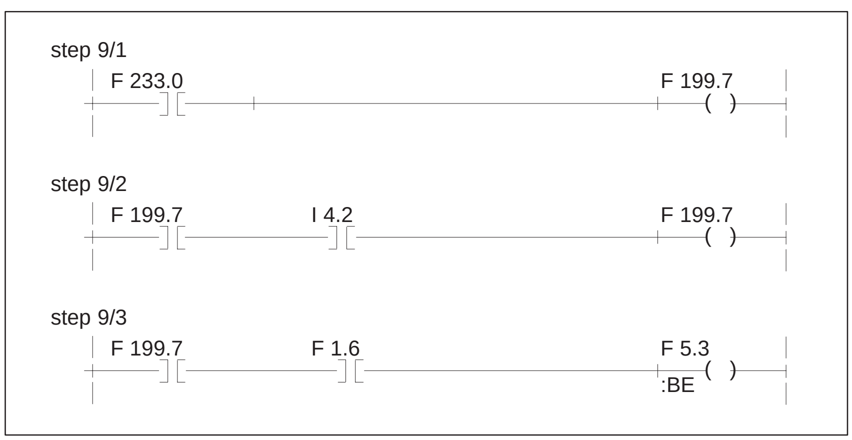


No. 3 Several segments within a step

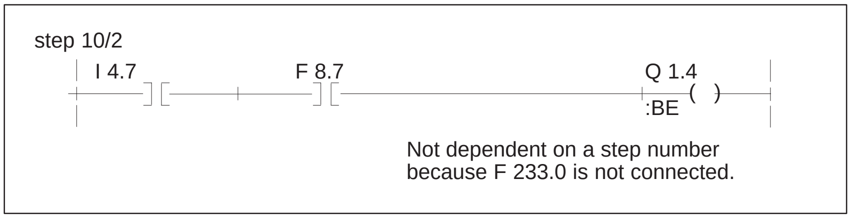
Various program lines:



Continuous program lines:



No.4 Functions independent of a step number (e.g. setting up)



No.5 Deleting (RESET) the sequencers in MANUAL COLD RESTART on the PLC:

During a cold restart on PLC, the sequencer goes through a warm restart in terms of the step number and the mode since the flag areas are saved in the user DB.

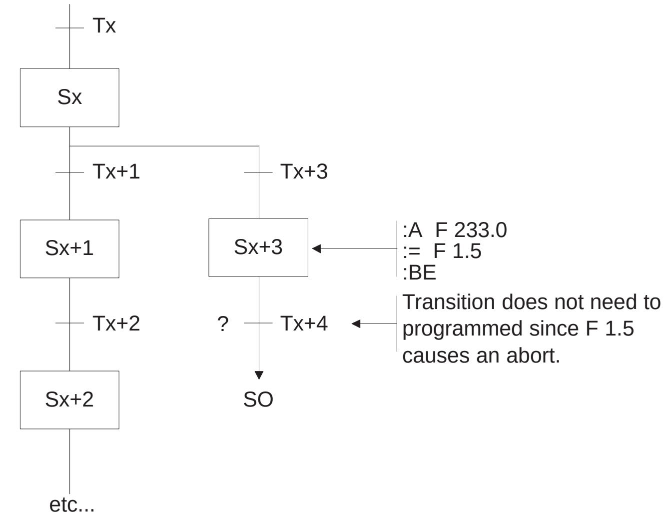
To bring the sequencer to step 0, you must set the sequencers to OFF in the cold restart OB.

Restart OB:

OB 20 (S5-135 U, S5-150 U, S5-155 U
OB 21 (S5-95 U, S5-100 U, S5-115 U, S5-135 U, S5-150 U, S5-155 U
OB 22 (S5-95 U, S5-100 U, S5-115 U, S5-135 U, S5-150 U, S5-155 U

```
OB 20/21                    PB x
      :AN F 11.0             :O  I 1.1        RESET BUTTON
      :S    F 11.0           :O  F 11.0
      :BE                    :=  F 11.2
                             :***

                            FB 72/73
                            +------------------+
                            | SBNR             |
              F 11.2 -------| AUS              |
                            |   :              |
                            |   :              |
                            +------------------+
                            :A   F 11.0
                            :R   F 11.0        only for 1 cycle
                            :
                            Remaining program
```

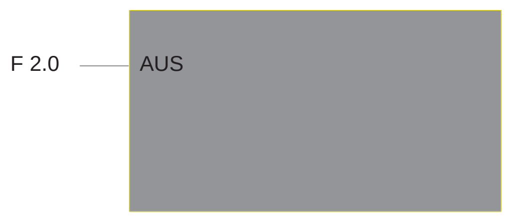
No.6 Sequencer end (for a cycle)



PB x

```
:O  I 5.0        RESET BUTTON
:O  F 1.5
:=  F 2.0
:***
```

FB 72/73

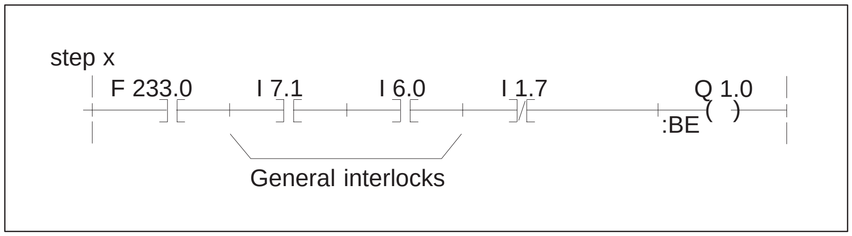


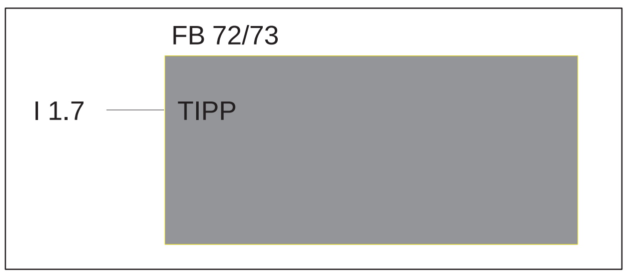
If the sequencer is to remain in step S0 for several cycles, flag F 2.0 must be programmed so that it is latching (S F 2.0).

No.7 EXECUTE with condition without actions

– FB 72/73 switches the actions through

– Without actions the following interlocks are required in the step:
I 1.7 = “1” actions = 0
I 1.7 = “0” actions = 1
I 1.7: Parameters “TIPP” in FB 72/73





No.8/1 EXECUTE without condition with actions

1. possibility: all levels are switched further simultaneously.

   a) Set FB 72/73 to TIPP = 1 (A/H = 0, AUS = 0).
   b) Set FB 74 to TIPP = 1, TW/TM are deleted.
   with T+1 at FB 72/73, all the steps at all levels are switched further without special programming in the transition.

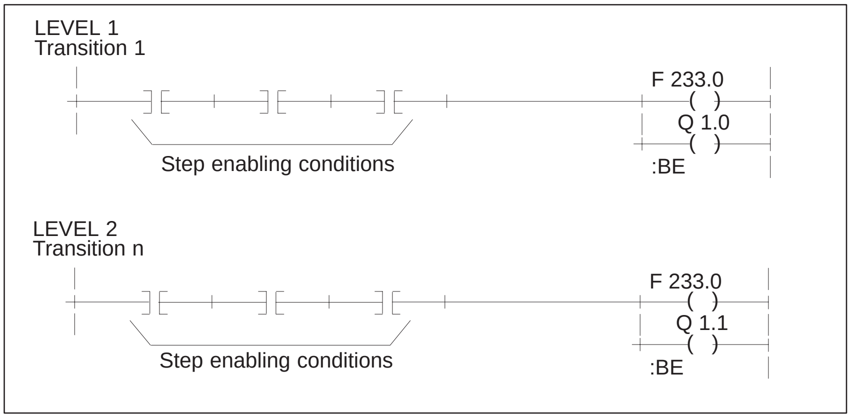
No.8/2 EXECUTE without condition without actions

Program interlocks in the steps as shown in example No. 7.

No.9 EXECUTE with condition with indication of the satisfied transition

The indication is integrated in key T+1 (e.g. illuminated push-button). This indicates that pressing the T+1 key enables the next step.

The indication is programmed in the transition with a separate indication for each level. (For all transitions in one level, you can activate the same output, since the transition are processed selectively.)



Exception

Here, the opening of an alternative branch (several transitions are processed) must be considered as a further level.

On completion of a simultaneous branch, you must reset the relevant indicator output, since there is no reset command in the sequencer for this level.

To simplify matters, a program is written before the sequencer to clear all indicator outputs.

PB x with 2 simultaneous branches

```
:A   F x.y
:R   Q 1.0
:R   Q 1.1
:***
```

FB 72/73

or with 8 simultaneous branches:

```
:L   KB 0
:T   QB 1
:***
```

FB 72/73

Figure 4-1 Example

No.10 SYNCHRONIZATION with FB 74

Note

For automatic synchronization refer to Chapter 5.

Activation

FB 74 SYN = “1” TW and TM are deleted.
FB 72/73 AUTO (A/H = “1”)

You must program special conditions for synchronization in the transitions.

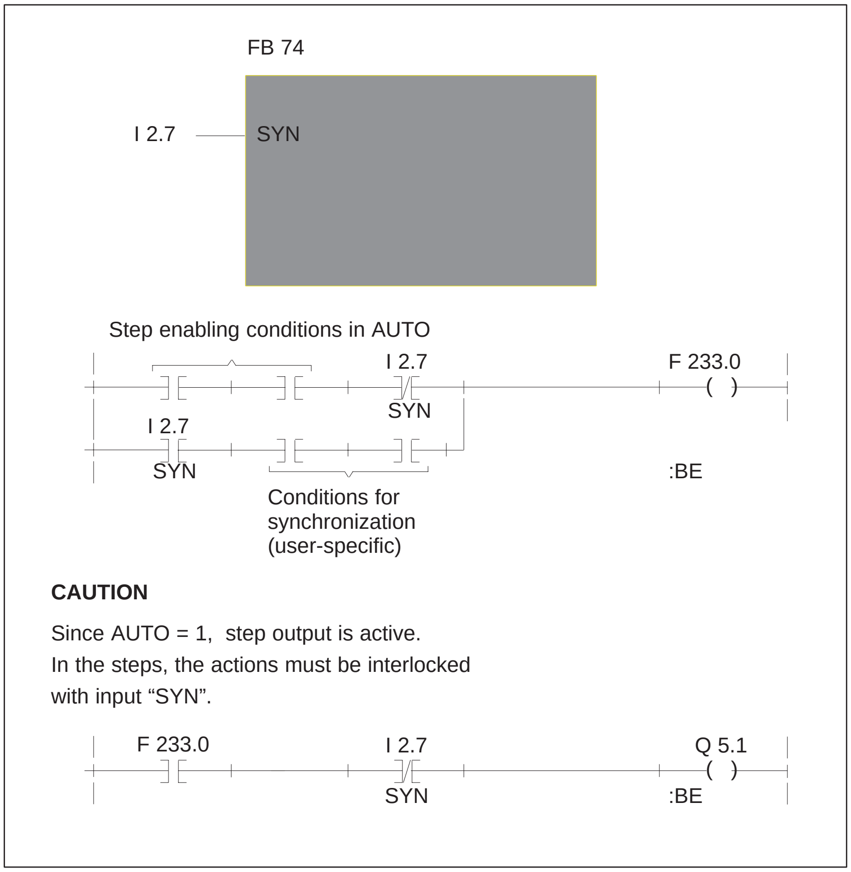


Figure 4-2 Example

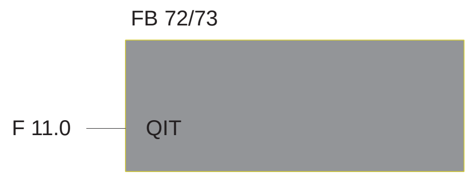
Effect

At the first transition that is not satisfied (RLO = 0) the sequencer stops.

No.11 Automatic acknowledgement of a timeout in AUTO

If the sequencer is to continue automatically once the cause of a timeout is cleared, the QIT signal must be generated automatically. One possibility would be a pulse generator connected to the QIT parameter.

```
PB x
   :AN  F 11.0
   :=   F 11.0             Cycle clock pulse
   :***
```



No.12 Starting a timer with FB 75 using the QIT signal and AUTO selection

By means of a special interconnection of the parameters, you can arrange for waiting times and monitoring times to be restarted after acknowledging a timeout or after AUTO selection.

Example of an FB 72 call

```
L       KB      0
T       FW      180 Scratchpad flag word
A       F       5.0
R       F       5.0 Flag with RLO = 0
AN      F       5.1
S       F       5.1 Flag with RLO = 1

A       F       4.5
AN      F       6.0
=       F       6.1 Pulse from QIT signal
A       F       4.5
=       F       6.0

A       F       10.0 A/H input of FB 72
AN      F       6.1 Pulse from QIT signal
=       F       10.7 A/H input of FB 75

JU      FB      75

NAME:   : GPH:  REAK
SBNR    : KF    +11
AUS     : F     9.0
A/H     : F     10.7
TIPP    : F     5.0
SANW    : F     5.0
P/R     : F     5.0
TWA     : F     5.1
TUE     : F     5.1
S-NR    : FW    180
S-UE    : F     5.0
JU      FB 72

NAME    : GPH:  SIM1
SBNR    : KF     +11
AUS     : F     9.0
A/H     : F     10.0
TIPP    : F     5.0
T+1     : F     5.0
QIT     : F     4.5
STO     : F     12.0
```

Example of a call for FB 70

Condition:

1. Pulse QUIT signal as for FB 70
2. Input 1. A/H of FB 75

```
A       F       4.5     QUIT FB 70
AN      F       6.0
=       F       6.1     Pulse from QIT signal
A       F       4.5
=       F       6.0
```

Here A/H and B-UE of FB 70 must be connected

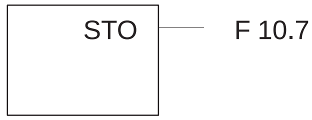
```
A       F       10.0    A/H FB 70
A       E       1.1     B-UE FB 70
S       F       10.1
AN      F       10.0    A/H FB 70
R       F       10.1

A       F       10.1
AN      F       6.1
=       F       10.7

JU      FB      75

NAME:   : GPH:  REAK
SBNR    : KF    +11
AUS     : F     9.0
A/H     : F     10.7
TIPP    : F     5.0
SANW    : F     5.0
P/R     : F     5.0
TWA     : F     5.1
TUE     : F     5.1
S-NR    : FW    180
S-UE    : F     5.0

JU      FB 70

NAME    : GPH:  HKET
SBNR    : KF     +11
AUS     : F     9.0
A/H     : F     10.0
B-UE    : E     1.0
N-ST    : F     70.0
  :     :       :
  :     :       :
QIT     : F     4.5
  :     :       :
```

Note

With further applications, the connection should be established as explained in this description. FB 75 must be called unconditionally before FB 70 to FB 74.

No.13 Edge evaluation using the example of the STO output

FB 70 or FB 72 or FB 73



Positive edge: evaluated as entering timeout state

PB x

```
:
: A     F     10.7
: AN    F     12.7   Auxiliary flag
: =     F     12.0   Pulse STO entering state
: A     F     10.7   (1 PLC cycle)
: =     F     12.7
:
```

Negative edge: evaluated as leaving timeout state

PB x

```
:
: AN    F     10.7
: A     F     12.7   Auxiliary flag
: =     F     12.0   Pulse STO leaving state
: A     F     10.7   (1 PLC cycle)
: =     F     12.7
:
```

No.14/1 Example call FB 73 + FB 74 + FB 75

Search for timer values in SANW and start with AUTO/TIPP selection

```
         : JU     FB  75
NAME:    : GPH:   REAK
SBNR     :        KF +10      identical to SBNR of FB 74 and FB 73
AUS      : F      10.0        identical to AUS of FB 73
A/H      : F      10.1        identical to A/H of FB 73
TIPP     : F      10.2        identical to TIPP of FB 73
SANW     : F      10.4        identical to SANW of FB 74
P/R      : F      7.5
TWA      : F      7.6
TUE      : F      7.7
S-NR     : FW     12          identical to S-NR of FB 74
S-UE     : F      11.7        identical to S-UE of FB 74
         :
         :
         : JU     FB 74
NAME     : GPH:   ZFK1
SBNR     :        KF +10      identical to SBNR of FB 75 and FB 73
TIPO     : F      10.3
SANW     : F      10.4        identical to SANW of FB 75
SLOE     : F      10.5
S-NR     : F      12          identical to S-NR of FB 75
S-UE     : F      11.7        identical to S-UE of FB 75
SYN      : F      10.6
         :
         :
         : JU     FB 73
NAME     : GPH:   LIN1
SBNR     :        KF +10      identical to SBNR of FB 75 and FB 74
AUS      : F      10.0        identical to AUS of FB 75
A/H      : F      10.1        identical to A/H of FB 75
TIPP     : F      10.2        identical to TIPP of FB 75
T+1      : F      11.0
QIT      : F      11.4
STO      : F      10.7
         :
```

No.14/2 Example call FB 70 + FB 75

Search for timer values in SANW and start with AUTO/TIPP selection

```
        : A     F     10.1        Connection of FB 70: A/H with B-UE
        : A     F     11.2
        : S     F     108.0       Enter at FB 75: A/H
        : AN    F     10.1
        : R     F     108.0
        :
        : A     F     10.2        Connection of FB 70: SSMB with B-UE
        : A     F     11.2
        : S     F     108.1       Enter at FB 75: TIPP
        : AN    F     10.2
        : R     F     108.1
        :
        :
        : JU    FB 75
NAME    :GPH:   REAK
SBNR    :       KF +12      identical to SBNR of FB 70
AUS     : F     10.0        identical to AUS of FB 70
A/H     : F     108.0       Note: see logical connection above
TIPP    : F     108.1       Note: see logical connection above
SANW    : F     10.4        identical to SANW of FB 70
P/R     : F     7.5
TWA     : F     7.6
TUE     : F     7.7
S-NR    : FW    12          identical to S-NR of FB 70
S-UE    : F     11.3        identical to S-UE of FB 70
        :
        :
        : JU    FB 70
NAME    : GPH:  HKET
SBNR    :       KF +12      identical to SBNR of FB 75
AUS     . F     10.0        identical to AUS of FB 75
A/H     : F     10.1        Note: see logical connection above
B-UE    : F     11.2
N-ST    : F     70.0
KEND    : F     11.1
SSMB    : F     10.2        Note: see logical connection above
T+1     : F     11.0
MAKT    : F     10.7
SANW    : F     10.4        identical to SANW of FB 75
S-NR    : FW    12          identical to S-NR of FB 75
S-UE    : F     11.3        identical to S-UE of FB 75
QIT     : F     11.4
UQIT    : F     11.5
DIAG    : F     70.1
UBET    : F     70.2
STO     : F     70.3
SANZ    : FW    8
ANZ+    : F     11.6
SSTO    : F     70.4
S+AK    : F     70.5
ZUST    : FW    106
        :
```

No. 14/3 Changing the time still to run in DB<G5:sequence>

With the following FB you can change the times left to run, with which the sequencer in FB 75 is reactivated with, to any value. FB 11 has to be called before FB 75 and has to be called once per step. FB 11 functions only if A/H and TIPP at FB 75 are supplied with RLO = 0.

```
FB 11
Name :G5TIME
Decl  :SBNR       I/Q/D/B/T/C: I  BI/BY/W/D: W
Decl  :S-NR       I/Q/D/B/T/C: I  BI/BY/W/D: W
Decl  :TWA        I/Q/D/B/T/C: I  BI/BY/W/D: W
Decl  :TUE        I/Q/D/B/T/C: I  BI/BY/W/D: W

       :L   =SBNR                current GRAPH 5 sequencer
       :T   –SB number
       :L   KF +1                Step 1 and 0 are
       :L   =S-NR                not allowed
       :<=F
       :JC =END
       :DO   –SB number
       :C   DB   0               C DB <G5:sequence>
       :
       :L   KF +20               active steps are in
       :T   –level+19            DW 20 to DW 27
VGL    :                         REPEAT
       :DO   –level+19           FW 226 = 19 + active level
       :L   DW   0               active step in active level
       :L   =S-NR                is compared with S-NR
       :!=F
       :JC =GEF                  S-NR is in level n active
       :L   –level+19            set next level
       :L   KF +1
       :+F
       :T   –level+19
       :L   KF +28               all levels already searched?
       :!=F
       :JC =ENDE                 Editing not possible
       :JU =VGL                  UNTIL S-NR not found
GEF    :L   –level+19            Level = FW226 - 19
       :L   KF +157              DW-No. for time still to run TWA is:
       :+F                       176 + level
       :T   –DW No. TUE/TWA
       :L   =TWA
       :DO   –DW-Nr. TUE/TWA     DW-No. edit time still to run TWA
       :T   DW   0               Enter TWA in DW 176 + level
       :L   –DW-No. TUE/TWA      Enter DW No. TUE is
       :L   KF +8                DW No. time still to run TWA + 8
       :+F
       :T   –DW-No. TUE/TWA
       :L   =TUE
       :DO   –DW-No. TUE/TWA     Edit DW-No. time still to run TUE
       :T   DW   0               Enter TUE in DW 184+level
END    :BE

FW 224   = SB Number
FW 226   = Level+19
FW 228   = DW-No. TUE/TWA
```

4.10 Example of Configuring and Starting Up

Task

You want to automate a powder press for producing pellets.

Parts of the Press

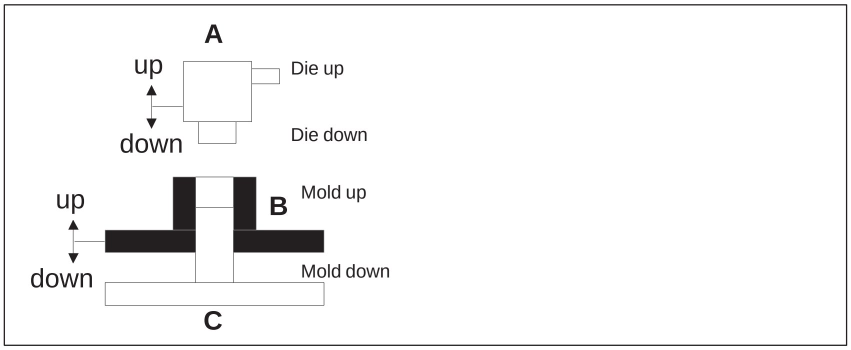
moveable, upper die A

moveable mold B

fixed, lower die C

unit to introduce material

unit to remove the pellet



Working Cycle

The operation runs as follows:

When mold B and upper die A are in their upper positions, the material can be introduced.

Once the material has been introduced, die A is lowered, compresses the powder in the mold and then returns to its upper position.

Mold B is lowered until it reaches its lower position, the compressed pellet can now be removed.

The mold then returns to its starting position and a new cycle can begin.

4.10.1 Configuration

Concept Phase

The operation is studied to determine which steps the sequencer can be divided into and what will determine the end of one and the beginning of the next step (when is the transition? → step enabling condition, transition).

Step/action:	Insert material
Transition/condition:	Material ready?
Step/action:	Lower die A
Transition/condition:	Pressing complete?
Step/action:	Raise die A
Transition/condition:	Die A up?
Step/action:	Lower mold B
Transition/condition:	Mold B down?
Step/action:	Remove part
Transition/condition:	Removal complete?
Step/action:	Raise mold B
Transition/condition:	Mold B up?

The sequence of the steps and transitions can be represented graphically:

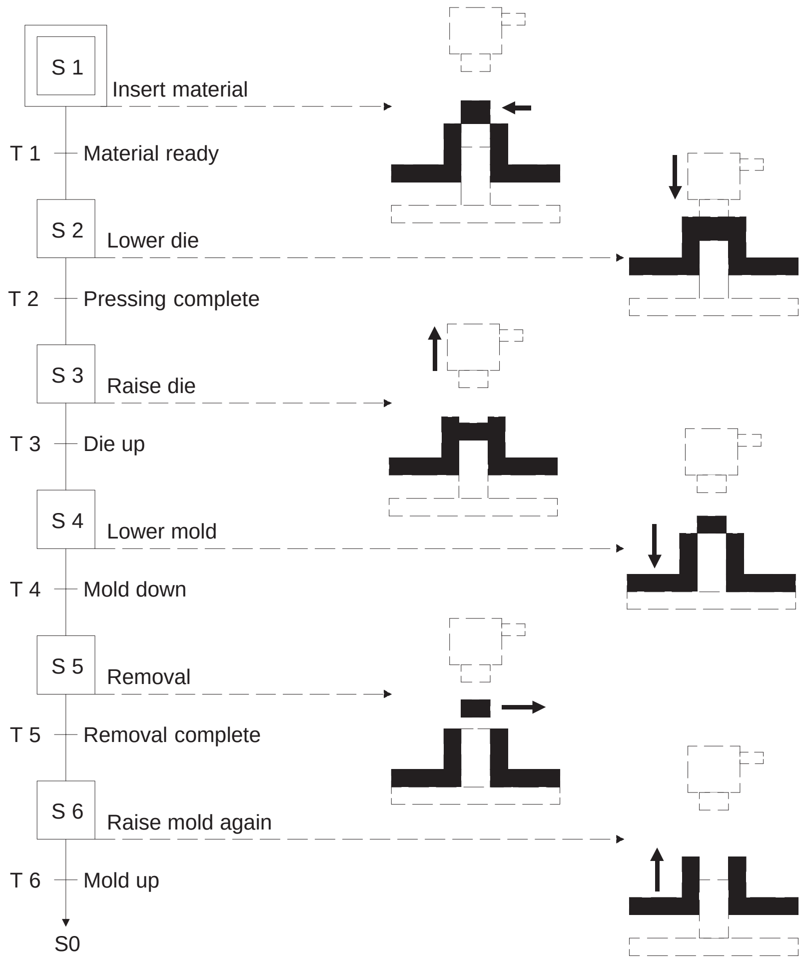


Figure 4-3 Sequence of Steps and Step enabling Conditions for the “Powder Press” Example

Configuring on the Programming Device

Based on the created concept, you can now input the graphical solution to the task as a step-transition structure in GRAPH 5 on the programming device.

Call GRAPH 5 input:
call the input function with **Editor > GRAPH5 Block (F1)** and fill in the job box.

Fill in the sequencer identification screen form, for example as follows:

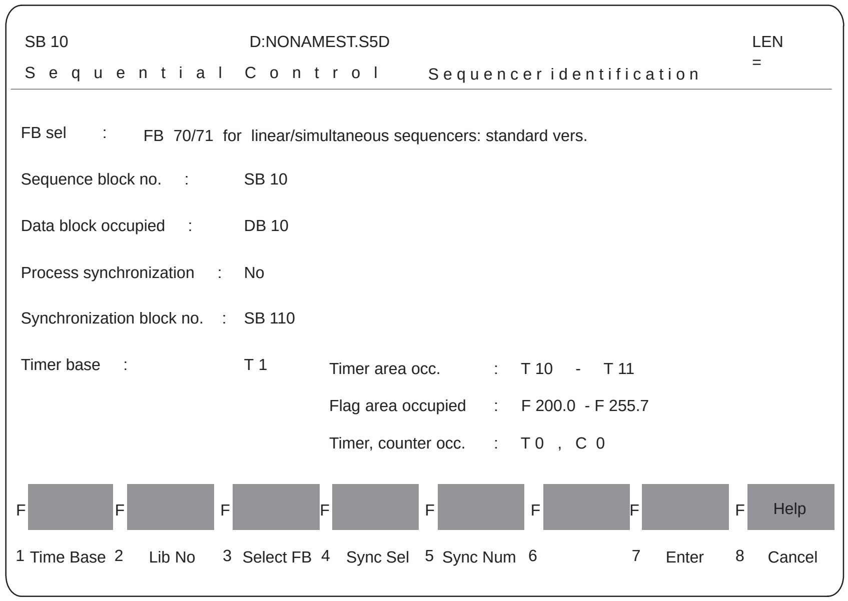


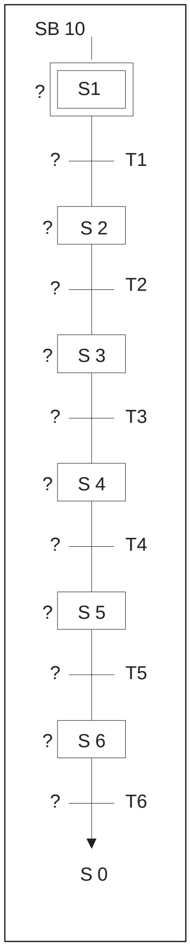
Figure 4-4 ID Screen Form for the Powder Press

SEQUENCE BLOCK NO:	SB 10	Specified SB
DATA BLOCK NO:	DB 10	Number of the working DB for the sequencer. The numbers of the SB and DB match.
FLAF AREA OCCUPIED:	F 200.0 - F 255.7	This area is fixed within GRAPH 5 and must not be used elsewhere within the SB. Outside it can only be used as a scratchpad area.
TIMER BASE:	T10	Specifies the time base for the waiting and monitoring times.

Enter the ID screen form by pressing **F7<Enter>**.

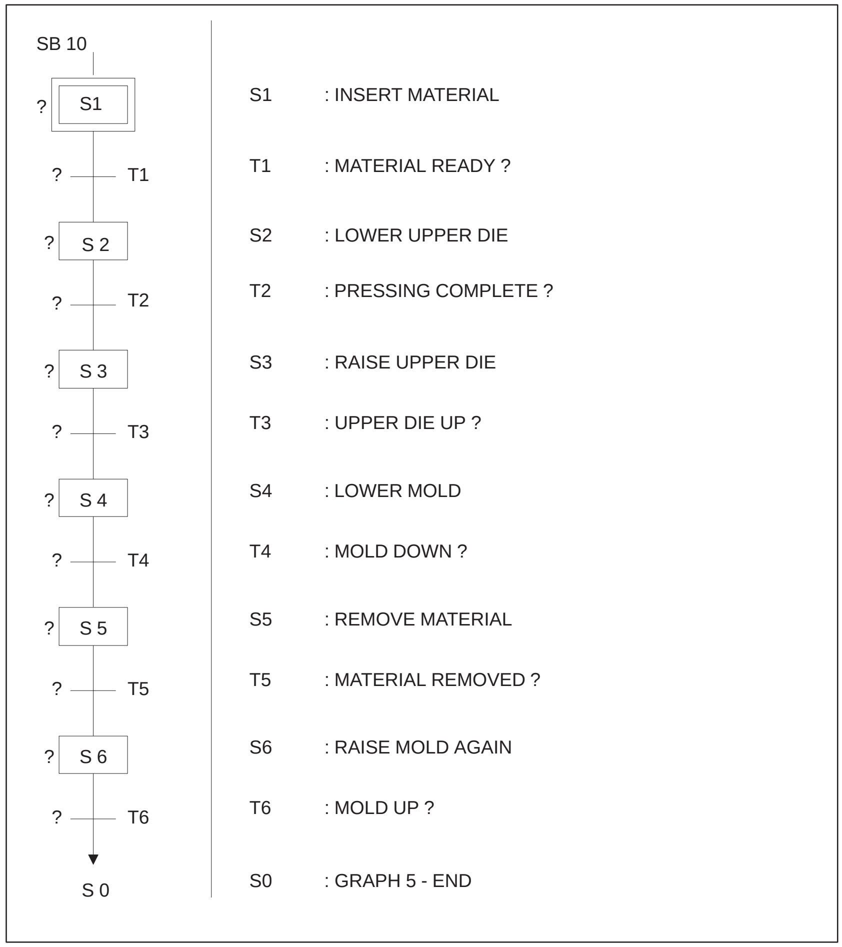
Inputting the Sequencer

You input the sequencer structure with **F1** and **F2** as shown below (see Section 4.5.5).



Inputting Comments

After you have completed the overview, you can add comments to the steps and transitions. To do so, press the **Shift + F6** key combination. Comments can be entered in both upper and lower case characters (see Section 4.5.2).



Enter the sequencer by pressing **F7<Enter>**.

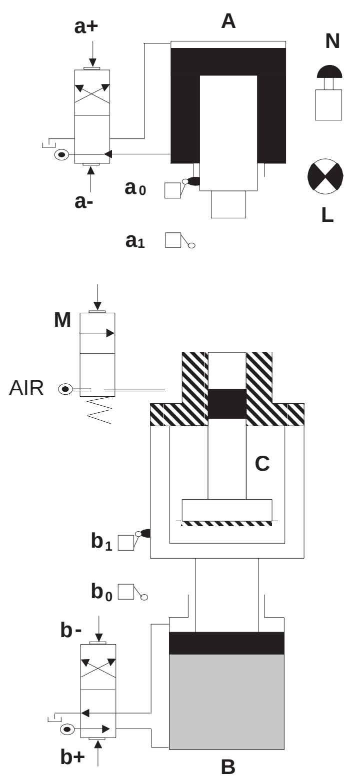
4.10.2 Programming

Preparing for Programming

To implement the sequential control, appropriate sensors, actuators etc. must be selected and the necessary commands and feedback messages determined.

In addition to this, other (symbolic) assignments can be made for manual interventions, releases etc.

The assignment list is stored in a symbols file, for example:



Control Actuators:

Q 3.0	-HYDRO/a+	: Lower die
Q 4.0	-HYDRO/a-	: Raise die
Q 5.0	-HYDRO/b-	: Lower mold
Q 7.0	-HYDRO/b+	: Raise mold
Q 6.0	-VALVE/M	: Removal
Q 2.0	-INDLAMP	: “ready” lamp

Actuator Position:

I 5.0	-LIMSWIa1	: Lower die position
I 6.0	-LIMSWIa0	: Upper die position
I 7.0	-LIMSWIb0	: Lower mold position
I 9.0	-LIMSWIb1	: Upper mold position
I 4.0	-ENABLE	: For cycle start
I 4.1	-EMSTP/N	: Interlock EMSTP

Input the assignment list via the menu **Editor > Assignment list** (F7). The STEP 5/ST manual describes how to create an assignment list.

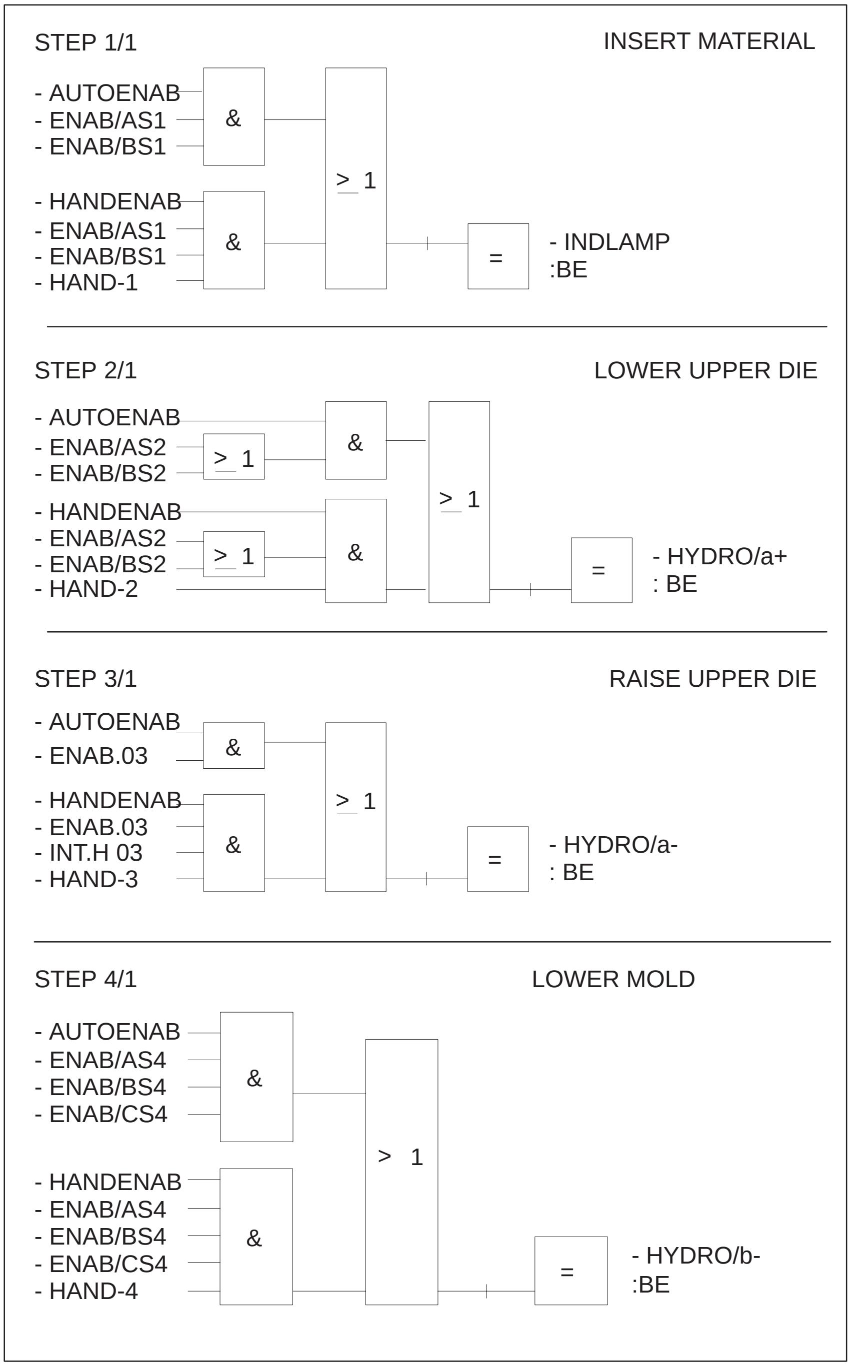
C:PRESSEZ0.SEQ

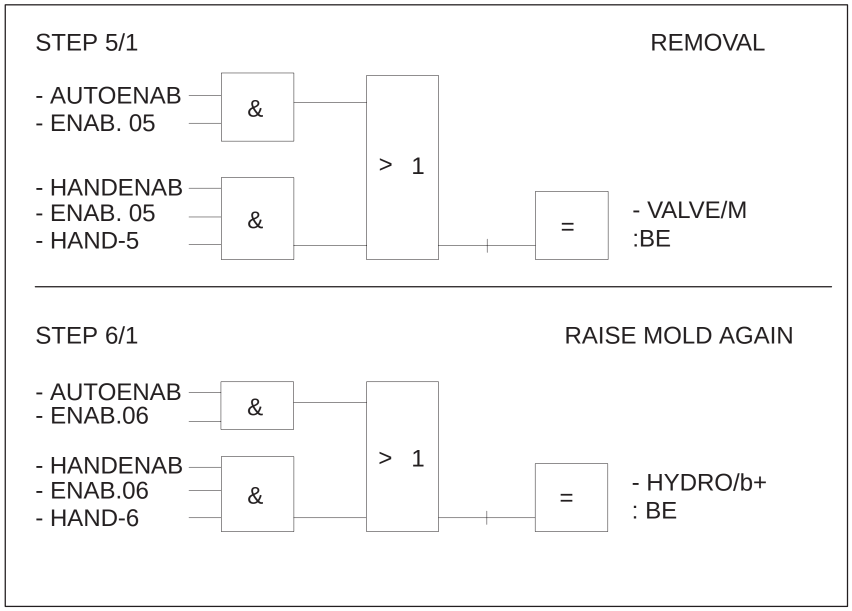
OPERAND	SYMBOL	COMMENT
I 4.0	ENABLE	For cycle start
I 4.1	EMSTP/N	Interlock EMSTP
I 4.2	SB 10/QIT	SB 10: acknowledge timeout
I 4.3	ENAB/AS1	First enable signal for step 01
I 4.4	ENAB/BS1	Second enable signal for step 01
I 4.7	HAND-1	Console “A”, switch insert material
I 5.0	LIMSWIa1	Lower die position
I 5.3	ENAB/AS2	First enable signal for step 02
I 5.4	ENAB/BS2	Second enable signal for step 02
I 5.7	HAND-2	Console “A”, lower die switch
I 6.0	LIMSWIa0	Upper die position
I 6.3	ENAB.03	Enable for step 03
I 6.6	INT.H 03	Interlock for manual switch HAND-3
I 6.7	HAND-3	Console “A”, raise die switch
I 7.0	LIMSWIb0	Lower mold position
I 7.3	ENAB/AS4	First enable signal for step 04
I 7.4	ENAB/BS4	Second enable signal for step 04
I 7.5	ENAB/CS4	Third enable signal for step 04
I 7.7	HAND-4	Console “B”
I 8.3	ENAB.05	Raise mold switch
I 8.7	HAND-5	Enable for step 05
I 9.0	LIMSWIb1	Console “B”, removal switch
I 9.3	ENAB.06	Upper mold position
I 9.7	HAND-6	Enable for step 06
Q 1.5	STO/SB 10	Console “C”, raise mold switch
Q 2.0	INDLAMP	Timeout display SB 10
Q 3.0	HYDRO/a+	“ready” lamp
Q 4.0	HYDRO/a	Lower die
Q 5.0	HYDRO/b	Raise die
Q 6.0	VALVE/M	Lower mold
Q 7.0	HYDRO/b+	Removal
F 1.0	RLO=0	Raise mold
F 205.6	HANDENAB	Flag constantly “0”
F 233.0	AUTOENAB	Manual mode - Enable in SB<G5:sequence>
T 10	TW: L 1	Automatic mode - Enable in SB<G5:sequence>
T 11	TM: L 1	No. waiting time level 1
PB10	START/10	No. monitoring time level 1
SB3	TIPP SB3	Powder press start call
SB10	PRESS	EXECUTE BLOCK for GRAPH 5 sequencer
FB73	GPH:LIN1	POWDER PRESS program FB for GRAPH-5 sequencer, linear
DB10	WORKDB/03	POWDER PRESS WORKING DB
DB255	DIAGNOS	Communication DB for diagnostics

Programming on the PG

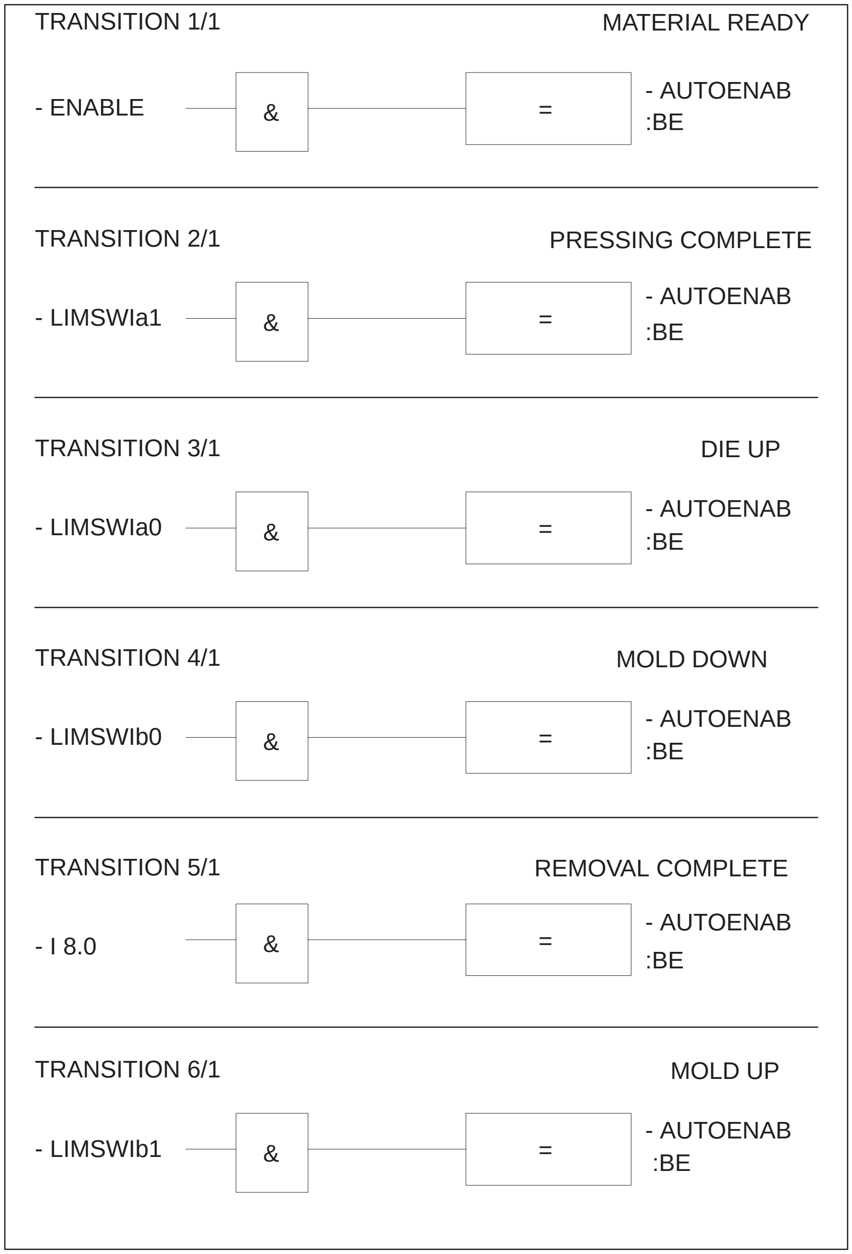
Steps and transitions are programmed at the zoom-in level as follows:

Program all steps




STEP 5/1
REMOVAL
- AUTOENAB
- ENAB. 05
&
- HANDENAB
- ENAB. 05
- HAND-5
&
> 1
=
- VALVE/M
:BE
STEP 6/1
RAISE MOLD AGAIN
- AUTOENAB
- ENAB.06
&
- HANDENAB
- ENAB.06
- HAND-6
&
> 1
=
- HYDRO/b+
: BE

Program all transitions



The current step flag F 233.0 has been assigned the symbolic name -AUTOENAB in this example.

Entering the Waiting and Monitoring Times

You assign waiting and monitoring times with F4 (TM/TW). You can also specify the time using symbols.

Step 2 (LOWER UPPER DIE) has a monitoring time. If the lower position a1 (pressing complete) is not reached after 5 seconds, a timeout is signalled.

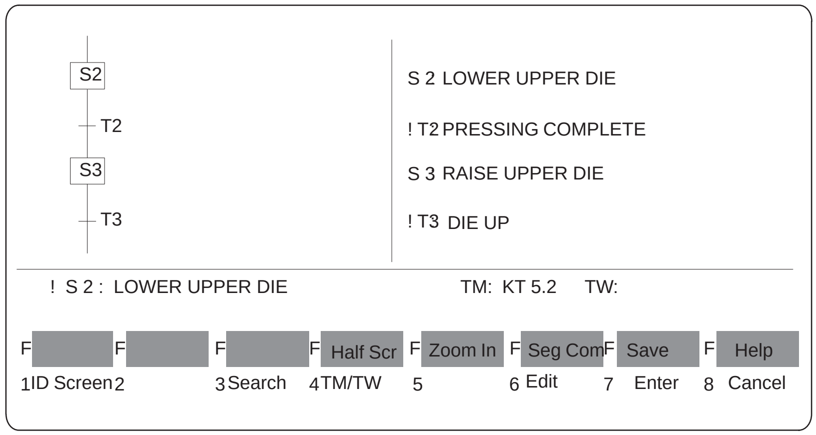


Figure 4-5 Example of Step 2 with a Monitoring Time of 5s

Step 5 (removal) has a waiting time of 3 seconds.

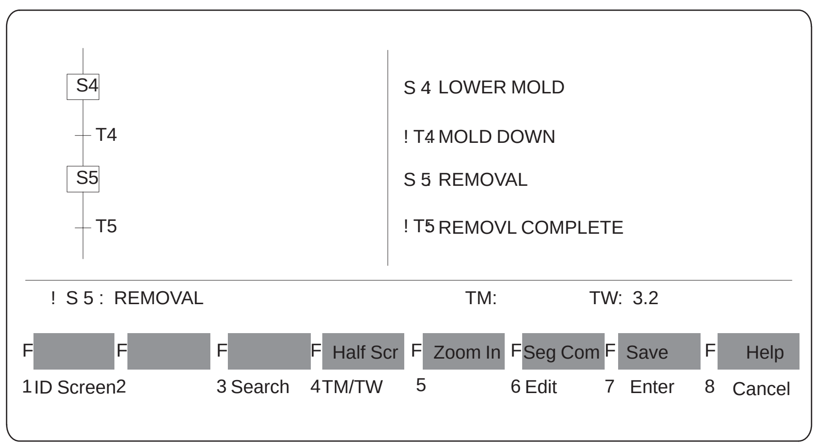


Figure 4-6 Example of Step 5 with a Waiting Time of 5s

4.10.3 Starting Up and Testing

Transferring the Program

The menu **File > Blocks > Transfer** is described in the STEP 5/ST manual.

Transferring the blocks required for running the sequencer in the PLC:

For a sequencer, the standard function blocks SB 3 and FB 70 are required. These blocks must be loaded in the PLC.

SB 3	is called at each transition. It executes the modes that have been transferred to FB 73 as parameters.
FB 73	calls GRAPH 5. It manages the modes and monitors the sequencer.

Generating the Diagnostic DB and the Working DB

To diagnose sequencers loaded in the PLC, a diagnostic DB is required and is accessed when the DIAGNOSTIC function is called.

Each sequencer also requires a working DB (with a number identical to the SB number). These data blocks are generated with the menu **Management > GRAPH 5 DB-Gen**; the diagnostic DB is the same for all sequencers in the PLC. If these data blocks are not generated directly in the PLC (DB-GEN Source PLC) they must be transferred to the PLC. With the option **Update** *DBs: DB<G5:sequence> and DB<G5:diag* an existing working DB and the diagnostic DB are automatically updated.

Calling FB 73 in the Program

In OB 1, a program block (PB) is called that in turns calls FB 73 (with JU FB73).

The number of the PB must be the same as the number of the sequence block.

OB

```
Segment1
  : JU -START/10
  : BE
```

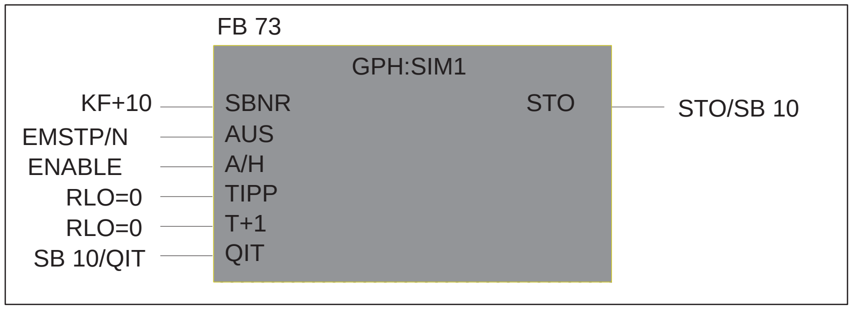
for example CSF:

PB 10

Segment 1 Flag constantly 0

```
  : STL
  : A   RLO=0
  : R   RLO=0
  : xxx
```

Segment 2   Sequencer powder press



Testing the Program

With the status function, you can test the status of the sequencer at the overview and zoom-in levels.

4.10.4 Printing Out the Program

If you print out the final program, you obtain the following:

Sequencer identification screen form

Overview level with all comments

Lit of all transition with transition comments

List of all steps with step comments and waiting and monitoring times TM/TW

All transitions at the zoom-in level with comments and assignment lists of the symbols used

All steps at the zoom-in level with comments and assignment list of the symbols used

4.10.5 Programming Step /MSZ

Permanent Processing

The default for processing the steps of a sequencer is permanent.

The whole program of all steps in a sequence block is processed in each cycle regardless of the current step number.

The following are processed:

non-active steps, if the RLO=0 for F 233.0

the active steps when the RLO=1 for F 233.0

Consequence

If the same output is required in several steps, you cannot program this with the assignment command (=Q x.y) in every step.

Reason

The following not yet active step clears the output command again. As an alternative, you can program an MSZ in this situation.

Possibilities and restrictions with permanent processing

Steps are processed in the AUTOMATIC and MANUAL modes.

Operations not dependent on the RLO (load commands such as LKH, LKF ... and block calls such as JU PB, JU FB ... etc.) are processed constantly, i.e. in each cycle.

As an alternative the selective processing of a step is possible.

Selective Processing

Selective steps are only processed when the corresponding step flag is set. This means that inactive selective steps are skipped and active selective steps are processed when RLO = 1.

Consequence

Assignments remain set when the sequencer switches further and must therefore be reset with a separate delete program.

Possibilities and restrictions with selective processing

Operations are only executed when the step is active. Here, operations not dependent on the RLO can be used e.g. machine pulse counters or absolute block calls.

In the manual (setting up) mode, the selective step is always skipped (the step is not active).

Multistep Zoom-In (MSZ)

The MSZ is a higher ranking step zoom-in. Logical operations in an MSZ can be assigned to a selection or to all steps.

Consequence

Output which have to be activated several times or identical logical operations in the steps can be programmed using the MSZ and assigned to individual steps.

In a special situation, the step zoom-ins remain empty and the actions with the logic operations are written exclusively in the MSZ.

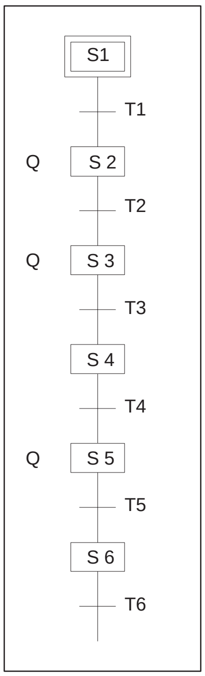
Possibilities and restrictions using the MSZ

During processing, the MSZ behaves like a permanent step.

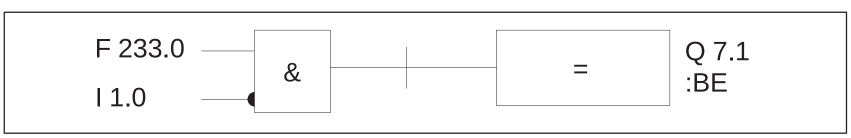
The MSZ is processed following the programmed steps. The processing order is as follows: S 1, S2,...Sxxx, SA, SB...SJ (MSZ).

Example 1

Multistep zoom-in
Q 7.1 active in steps 2, 3 and 5 with the same interlock



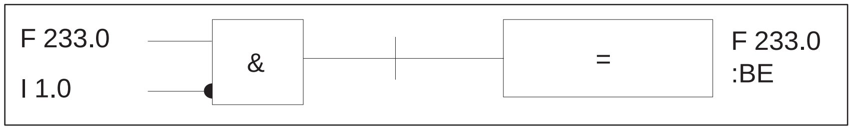
Step A/1, assigned: S 2, S 3 and S 5
Step zoom-ins S 2, S 3 and S 5 remain empty



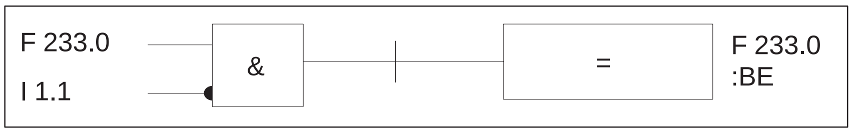
Example 2

Multistep zoom-in
Q 7.1 active in steps 2, 3 and 5 with different interlocks

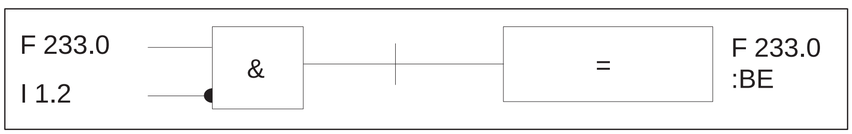
Step 2/1, assigned: S A



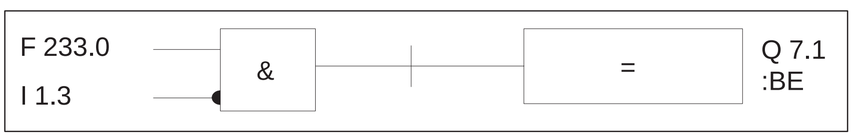
Step 3/1, assigned: S A



Step 5/1, assigned: S A



Step A/1, assigned: S 2, S 3 and S 5



S 2, S 3, S 5 mixed with S A.

Process Synchronization 5

Chapter Overview

5.1 Introduction

The synchronization function synchronizes a sequencer (on the PLC) and the process it is controlling if the current step and process status no longer match. This inconsistency can result from manual intervention, errors, faults or other influences.

For GRAPH 5/II V7.1 there are two methods of synchronization:

- Synchronization with the automatically generated synchronization SB.
- Synchronization with the standard FB (FB 70 to 73) that controls the sequencer.

The DB <G5:sequence> may not be generated in shortened form (DB Gen function) if synchronization with the automatically generated synchronization SB is used.

With automatic process synchronization, the step of a linear sequencer can be activated which corresponds to the process status. If there is an inconsistency, the step from which operation can be resumed is determined. This is achieved using an automatic status analysis of the process based on the input and output states. The following takes place in the program:

- for step/transition pairs, synchronization conditions are generated automatically (if necessary, these can be added to manually)
- the process status is detected and
- synchronized to the step.

FB synchronization can be used for any GRAPH 5 SBs. Based on the transition conditions, a possible sequencer status is calculated cyclically (in each PLC cycle). If the sequencer status matches the status of the process, the result is adopted.

Both synchronization methods can only be used in the manual mode. After successfully running through a synchronization procedure (generated synchronization SB or synchronization with a standard FB), the sequencer can be switched back to the automatic mode after the cause of the problem has been eliminated.

	Generated Synchronization SB	**FB Synchronization**
Simultaneous branches	not possible	possible
Steps	Synchronization with satisfied action	ignored
Transitions	Synchronization with non-satisfied transition condition	Synchronization with satisfied transition condition
Automatic	partly	yes
Additional measures by user	In the synchronization SB	In the transitions

5.2 Automatic Process Synchronization

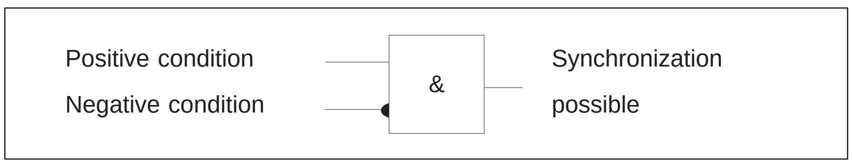
Synchronization Conditions

It is necessary to stipulate the conditions which uniquely identify the step for continued operation. These conditions are generated automatically when you select “yes” for process synchronization in the sequencer identification screen form.

It is possible that the system cannot synchronize using a step with a timeout, e.g. steps which describe basic settings and in which no actions are executed. The absence of the action on the other hand means that there are no synchronization conditions and that there is not enough information for status recognition. In this case, supplementary synchronization conditions can be edited manually.

Principle

A positive and a negative synchronization condition is formed for each step. An active step and an unsatisfied transition result make synchronization possible.



5.3 Overview of Process Synchronization

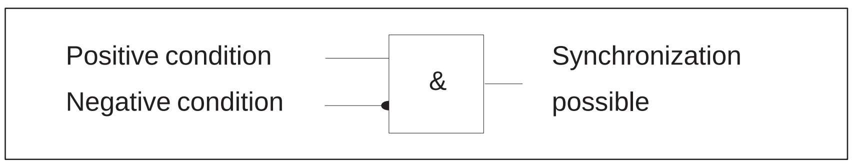
The synchronization conditions represent the basis for status recognition.

- Process synchronization is only possible for sequencers without simultaneous branches.
- Only assigned outputs are activated automatically from within the steps.
- Only logically connected inputs are activated from within the transitions.
- The step before an alternative branch is automatically synchronized with the left transition.

Logic operations which do not match these rules can, if necessary, be included in the supplements.

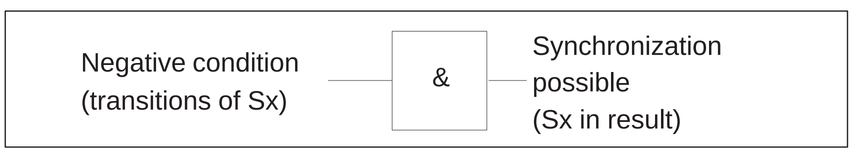
Principle of Dynamic Synchronization

Application: when making a movement, the process will be synchronized with the corresponding step if the transition is not satisfied.



Principle of Static Synchronization

Application: process synchronization only after the transition is satisfied (ignoring the actions).



Status Recognition

The aim of status recognition is to identify program steps of a sequencer. The control program specifies which actions of the process can be activated by the steps of the sequencer. Process synchronization can only use signals for status recognition which are exchanged between the process and the control program. This means that only the signal values of inputs and outputs can be used. Flags, timers and counters are internal signals which are not transferred to the process but are only used to calculate the output signal values in the control program. To allow signal values to be used for automatic status recognition, they must meet the following conditions:

- Signal value dependent on the current process status.
  At least two process statuses must exist in which the signal has a different value.
- Fixed relationship between the signal value and process status.
  There may be several process statuses in which the signal has the same value, however, within a status, the signal can only have a specific defined value.
- Assignment of signal value and process status possible.
  If this assignment exists, conclusions about the process status can be derived from the signal value.

Input, Output Signals

Process synchronization uses the values of input and output signals as information for status recognition. To be able to determine the assignment of the steps to the sequencer automatically, synchronization conditions are necessary. These are generated automatically if “yes” is selected for process synchronization in the sequencer identification screen form. The synchronization conditions can, if necessary, be supplemented manually.

Synchronization conditions are implemented by assigning a positive and a negative synchronization condition to each step in the sequencer. Using these conditions, it is possible to determine whether a step can be active or not.

If synchronization is selected in the ID screen form, the positive and negative synchronization conditions are generated automatically according to a fixed algorithm, regardless of whether the programmed input and output signals meet the conditions above.

Selection Algorithm

The selection algorithm functions as follows:

- determining the group of possible steps (a)
- reduction of this number (b)
- display of single/multiple candidates (Section 5.3.2).

Determining the Number of Steps

A step is marked as a possible synchronization step candidate when one of its outputs is set.

Here, only genuine assignments (=Qn.m) are taken into account, and no other output manipulations such as S Q n.m.

Reducing the Number of Steps

A step is excluded from being an active step for synchronization when either

- none of its outputs is set or -

- all inputs of the following transition are set.

To allow automatic generation of the synchronization conditions, all the input signals within a transition must form the automatically generated end condition for the action programmed in the previous step. Here, only logically linked (A I, O I) input signals are accepted.

Subsequencers/ Further Main Sequencers

Subsequencers are treated as further main sequencers in process synchronization. They have their own SB-sync, which must have a different SB number from that of the main sequencer.

5.3.1 Synchronization Conditions

The total number of all synchronization conditions of a sequence block are put together as a separate block, SB-sync. The synchronization conditions are structured for each specific step as follows:

- Positive synchronization condition, generated automatically.
- Negative synchronization condition, generated automatically.
- Supplementary, positive synchronization condition, can be supplemented manually (Section 5.5).
- Supplementary, negative synchronization condition, can be supplemented manually (Section 5.5).

The type of representation of the synchronization conditions at the zoom-in level is the same as for the steps.

SB-sync must be called by the user (e.g. in OB 1 or in a user PB) (JU SB-sync). After initiating synchronization, the block is then run and determines the group of possible synchronization steps. SB 5 then determines whether a single step is involved and, if it is, activates the selected step.

Flag 233.1 represents the result of the automatically generated synchronization conditions.

Single Candidate

In the simplest case, if certain rules are adhered to when planning the sequencer (Section 5.5.2), the automatically generated synchronization conditions are unique.
Unique means that a synchronization run, whatever the program/ process status, always results in one synchronization step. (The group of synchronization steps is exactly one step.)
Note: with the automatically generated synchronization conditions, it is not possible to synchronize with an empty step, since it has no outputs set.

Multiple Candidates

Multiple candidates means that following the synchronization run, the group of possible synchronization steps includes more than one step.

Multiple candidates occur with

- steps which describe basic settings and in which no actions are executed (refer to the example of process synchronization, step 1 and 5).
- multistep zoom-ins (MSZ).

Avoiding Multiple Candidates

Multiple candidates during status recognition can be avoided by adding additional information. You can program this additional information in the supplementary positive and negative synchronization conditions.

With multistep zoom-ins (MSZ) the supplements must be made in the corresponding steps, since the positive synchronization conditions of the MSZ apply to all assigned steps.

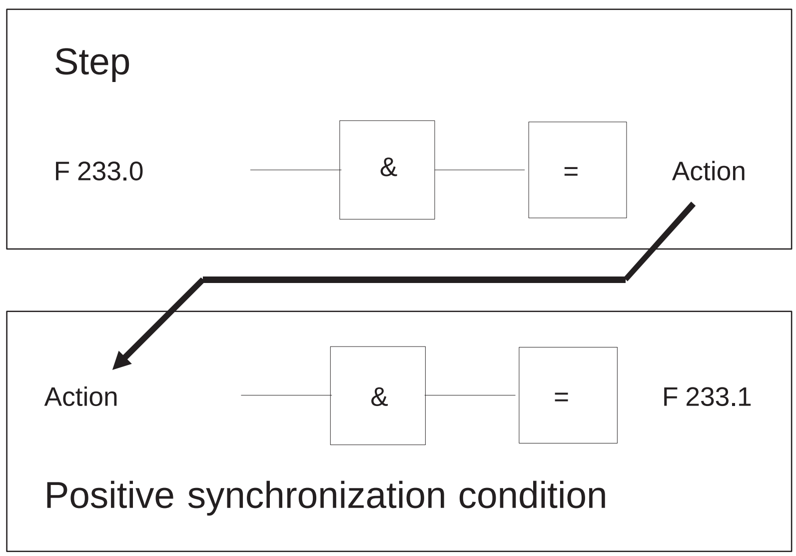
Positive Synchronization Conditions

This condition makes sure that the flag 233.1 used internally for synchronization is set to 1 when the action is active in the step (value TRUE). If no supplementary positive synchronization condition was programmed (Section 5.5.4), the step is included in the group of possible synchronization steps.

A positive condition could appear as follows:

O action

= F233.1



(The OR before the action is necessary in case several actions are triggered from within a step. This step is then a candidate for being the active step when one of the actions is executed.) Instead of ”O action” any Boolean operation involving input and output signals is also possible.

Note

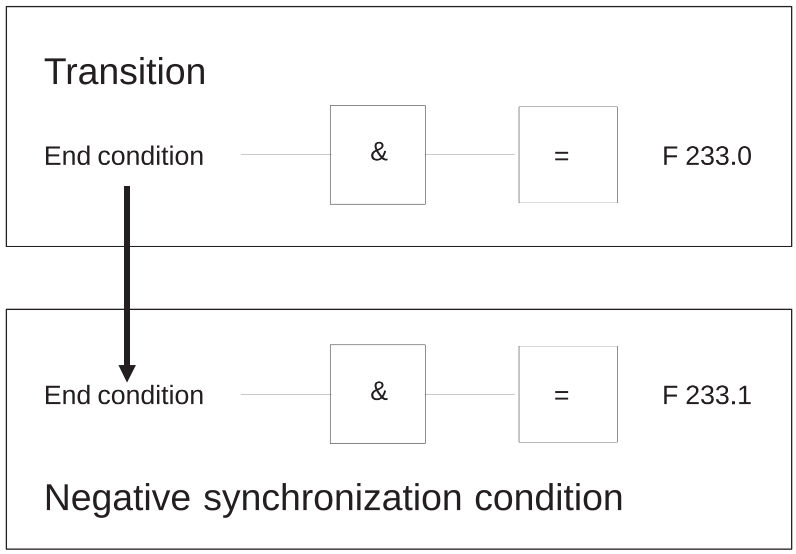
In the methods of representation LAD and CSF, an AND logic operation is displayed with only one action.

Negative Synchronization Condition

This condition ensures that the step is removed from the group of possible synchronization steps when the end condition is fulfilled (all inputs of the next transition have the value 1). A negative condition could be as follows:

A end condition

= F 233.1



5.3.2 Multistep Zoom

The multistep zoom-in (MSZ) is not directly assigned to any step in the sequencer. Here, you can program multistep actions and assign a number of steps to each segment for which these actions are valid. In addition to this, this MSZ can also be assigned positive synchronization conditions and supplements.

These synchronization conditions are particularly important for multistep actions. If, for example, an action is executed in steps Si and Sj, the status recognition can only detect that Si or Sj is active.

Programming

When programming in the MSZ, the following segment must be entered:

O F233.0

= action

The positive synchronization condition for this action appears as follows:

O action

= F233.1

For correct status recognition, multistep actions must only appear in the synchronization conditions of the MSZ. Otherwise, correct creation of the synchronization conditions is not possible. The synchronization conditions of the MSZ are assigned to the steps of the MSZ and take their step assignment from it.

Each MSZ can be assigned a positive synchronization condition.

5.4 Description of the Structure

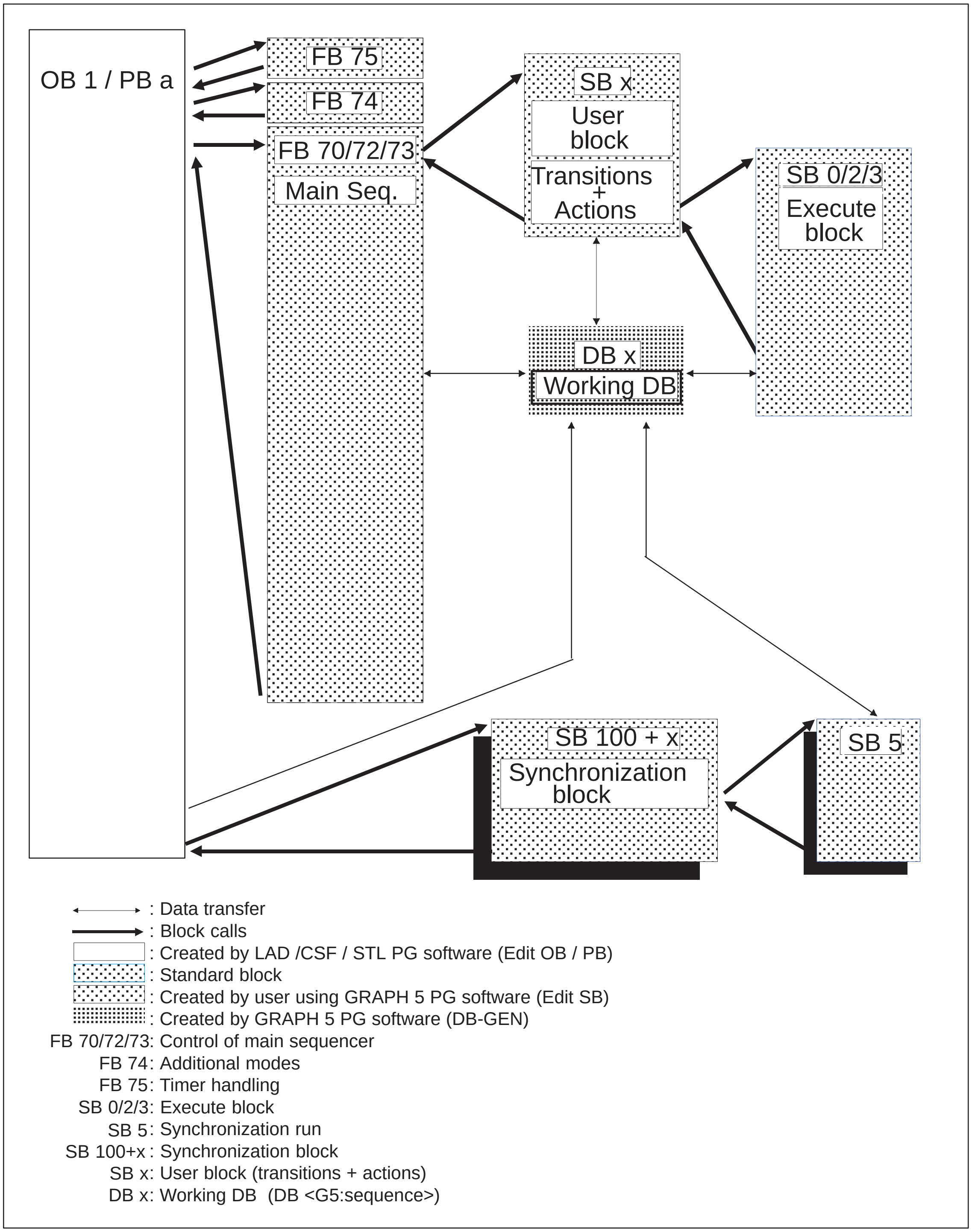


Figure 5-1 Call Strategy

5.4.1 Overview of the Standard Components

As can be seen from the call strategy, the following new blocks are required for synchronization:

- the synchronization block SB-sync generated along with the user SB (one SB-sync per user SB)
- SB 5 supplied as a standard block (once per CPU).

Saving Synchronization Conditions

The synchronization conditions are saved separately from the sequencer in their sequence block (SB-sync), and a separate SB-sync must exist for each sequencer to be synchronized. This SB-sync is generated automatically if process synchronization “yes” was selected in the ID screen form.

Processing SB-Sync

In the normal automatic mode, the processing of SB-sync is aborted immediately, which means that the synchronization conditions only extend the cycle time by a minimum amount.

Process synchronization is only necessary when inconsistencies between the process status and the control program occur, for example, as a result of a timeout and manual elimination of the problem. At this point, you must trigger process synchronization explicitly.

SB-sync can be called by the user OB/PB, following which the standard block SB 5 is called by the SB-sync.

Selection Procedure

At the beginning of process synchronization, the group of steps which may become the active step includes all the steps of the sequencer. After triggering process synchronization, all the synchronization conditions are checked one after the other (segments of SB-sync processed). If, during the evaluation, the positive synchronization conditions provide the value TRUE, the step belongs in the group of possible synchronization steps.

If the evaluation of the negative synchronization conditions provides the value TRUE, the corresponding step is removed from the group.

Synchronization Conditions of an MSZ

Positive synchronization conditions of an MSZ are effective for all assigned steps in the same way as described above.

5.5 Creating Supplementary Conditions on the PG

Defaults

You must select process synchronization in the ID screen form. A further sequence block (SB-sync) is then automatically generated from the positive and negative synchronization conditions, including the supplements. As the default, the sequencer block number plus 100 is used. An SB number > 154 means that the number 255 is set as the SB-sync number. With ***<>F5** (SB-sync)* any block number > 10 can be set.

For subsequencers, a synchronization block with its own SB number must also be specified.

5.5.1 Selecting Synchronization Conditions for Editing

The positive and negative synchronization conditions and supplements can be selected at the overview and zoom-in level of a step. Regardless of the currently displayed level, you can obtain the synchronization level using the function ***<>F3** (Search)* and specifying the characters ***<>SS*** and the step number or using the zoom-in key.

Level	Keystrokes		
Overview level, output or input mode	F3 (Search)	Characters SSn	Return or enter
Zoom-in level output mode	F3 (Search)	Characters SSn	Return or enter
	n = step number		

Function Keys at the Synchronization Level

F1	(Pos Sync)	Change to automatically generated, positive synchronization condition.
F2	(Pos Add)	Change to additional information for the positive synchronization condition.
F3	(Neg Sync)	Change to automatically generated negative synchronization condition.
F4	(Neg Add)	Change to additional information for the negative synchronization condition.
F8	(Return)	Return to the zoom-in level.

5.5.2 Programming Rules for Automatic Generation

When process synchronization is selected, the positive and negative synchronization conditions are generated during each translation, this does not, however, include the additional information which remains unchanged.

- The positive and negative synchronization condition for each step is created automatically.
- If a step contains one or more assignments (= Qn.m), these (and only these) are ORed into the positive synchronization condition of this step.
- All inputs of the next transition (and only this transition) which were programmed directly in the transition are ANDed into the negative synchronization condition regardless of the context.
- The result of these conditions is entered into the working DB of the sequencer. Therefore it may not be generated in shortened form.

End Conditions in the Transitions

The end conditions of the actions are required for the negative synchronization conditions. There are two reasons why an action is not executed, firstly the action was completed correctly and secondly the action was aborted owing to an error. The step in which the action is controlled can, however, only be excluded as a candidate for the active step when the action was correctly completed.

For this reason, the end conditions are also relevant for status recognition. End conditions are input signals and cannot automatically be distinguished from other input signals, e.g. enable signals. For this reason, for automatic generation of synchronization conditions, all the input signals within a transition are the end condition for the action programmed in the previous step. Only logically combined input signals are accepted.

Multistep Zoom-In (MSZ)

The positive synchronization condition of the MSZ; (multistep zoom-in MSZ) is valid for the steps assigned to the MSZ. If the positive synchronization condition of the MSZ is satisfied when the evaluation takes place, all the steps assigned to the MSZ remain in the group of possible candidates.

For an MSZ, only the positive synchronization condition can be initialized, since there is no follow-on transition which can supply the end condition for the negative synchronization condition.

Multiple candidates can be avoided by additional negative synchronization conditions in the steps.

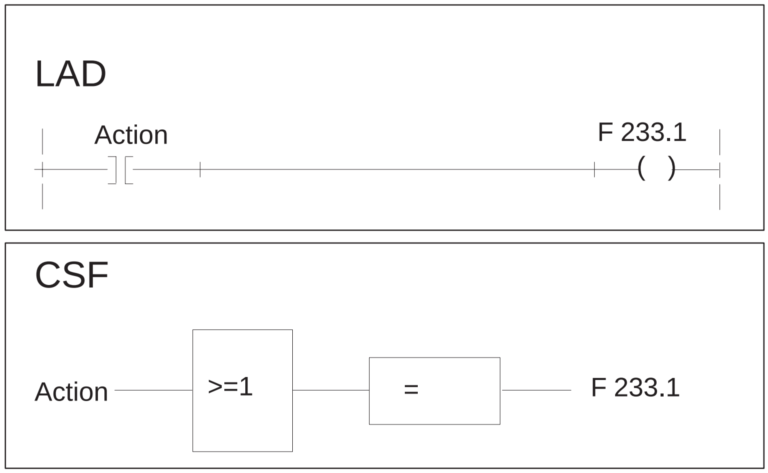
Flag 233.1

Flag F 233.1 represents the result of the automatically generated synchronization condition (note: both for positive and negative conditions). Eliminating flag F 233.1 means that the automatically generated synchronization condition of the corresponding step is not taken into account in process synchronization, but only the additional information is evaluated as the synchronization condition. The deciding factor for the evaluation result of the positive and negative synchronization conditions is the RLO at the end of each additional condition.

5.5.3 Display of Automatically Generated Synchronization Conditions

If a step Si has an action and the next transition Ti has an input (end condition), the automatically generated synchronization conditions are as follows:

Positive Synchronization Condition



STL

: O Action
: = F 233.1

Step with More than One Output

Si contains several outputs (= Q 1.0, = Q 1.1, = Q 1.2), the positive synchronization condition then appears as follows:

O Q 1.0

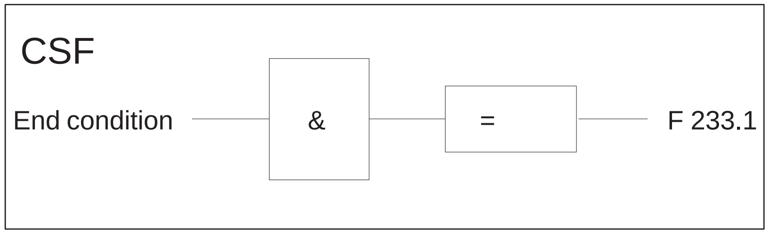
O Q 1.1

O Q 1.2

= F 233.1

For a step with several outputs, the outputs are ORed in the positive synchronization condition.

Negative Synchronization Condition



STL

```
: A end condition
: = F 233.1
```

Transition with More than One Input

Si has several outputs (= Q 1.0, = Q 1.1, = Q 1.2) and the next transition has several inputs (1.0, I 1.1), the negative synchronization condition then appears as follows:

A I 1.0

A I 1.1

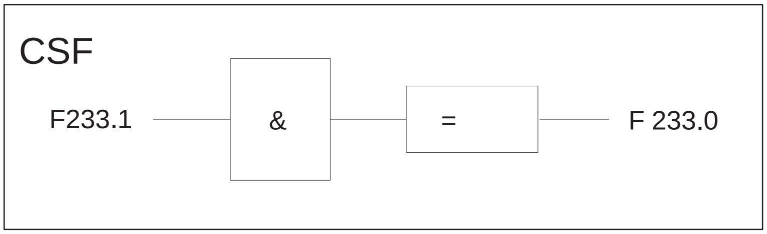
= F 233.1

With more than one input in the next transition, the inputs are ANDed.

Displaying the Additional Information

If additional information already exists, this is displayed, otherwise the following is displayed:

Additional, Positive Synchronization Condition



STL

```
: A F 233. 1
: = F 233.0
```

Additional, Negative Synchronization Condition

The preassignment for the negative synchronization condition is the same as for the positive synchronization condition.

5.5.4 Supplementing Automatically Generated Synchronization Conditions

For process synchronization, you have an editor available in which you can display and add information to automatically generated synchronization conditions. You can edit the additional information in LAD, CSF or STL. You can call up the synchronization conditions at the zoom-in level of a step (Section 5.5.2) using the function keys ***<>F1** (Pos sync) ... **<>F4** (Neg add).*

Editing Options

You can manipulate the automatically generated synchronization conditions in the following way

- **The automatically generated synchronization condition is adequate.**

  Do not make any additional entry in the screen form for additional information.

- **You want to extend the automatically generated synchronization condition.**

  Enter the required information in the screen form for additional positive synchronization conditions and OR this with flag 233.1. In the additional negative synchronization condition, AND flag 233.1.

- **You want to remove inputs/outputs from the automatically generated synchronization condition.**

  Since the automatically generated synchronization condition cannot be modified, you cannot remove inputs/outputs there. It is, however, possible to remove the interim flag F 233.1 in the screen form for additional information (refer to Section 5.5.2, flag 233.1). Since the flag F 233.1 represents the result of the automatically generated synchronization condition, removing this flag means that the automatically generated synchronization condition of the corresponding step is not taken into account and only the additional information you have entered as a synchronization condition is evaluated.

  All entries in the LAD, CSF, STL editor are permitted but not all are useful, for example using timers and counters within the synchronization conditions, since these are internal signals which do not provide any information whatsoever for status recognition. Flags are also only useful in the form of interim flags, since flags are only valid internally.

Additional Synchronization Conditions

If the sequencer contains basic settings and other steps without assigned actions, no positive synchronization conditions can be generated for these steps and they are difficult to identify in the status recognition, leading to multiple candidates. With empty steps, the positive synchronization conditions provide the value 0 (false). Quite often, however, there are combinations of signal values which can be uniquely assigned to these steps, but which are irrelevant for running the sequencer.

Typical examples of basic settings are manual introduction of material and manual removal of material. In both steps, no action is executed, but the sequencer waits until the material is ready or has been removed. The scan material ready/material removed is made in the next transition.

Only a negative synchronization condition can be generated for these steps.

Example

excerpt from the example in Section 5.9.

Negative synchronization condition, material input

A material
= F 233.1

Negative synchronization condition, material removed

AN material
F 233.1

The condition “material ready” also applies to all the steps in which the product is processed apart from material removal.

The steps material input and material removal can nevertheless be assigned unique positive synchronization conditions.

Material Input, Additional Positive Synchronization Condition

No action of the sequencer is executed:
AN action 1
AN action 2
AN action 3
Limit switch is reached:
A end condition
material not yet ready:
AN material

Material Removal, Additional Positive Synchronization Condition

No action of the sequencer is executed:
AN action 1
AN action 2
AN action 3
Limit switch is reached:
A end condition
material still ready:
A material

The synchronization conditions specified in this example cannot be generated automatically. On the other hand, however, the information is known to the person writing the sequencer program.

5.6 Integrating Process Synchronization

To integrate synchronization, additional software is required in the in the PLC (SB 5), SB-sync must be generated and transferred to the PLC (ID screen form with process synchronization: “yes”), and S-sync must be started in OB 1 or PBn.

SB 5 uses DW 230 – DW 239 from the DB<G5:sequencer> for calculating the synchronization result. Therefore, make sure that the DB<G5:sequencer> has not been shortened. DW 230 – DW 238 can be initialized with 0.

Integration in the Cyclic Program

- The requirements described in Section 5.5 are met (SB-sync in the ID screen form).
- Synchronization block called in OB or PB: JU SBn.
- Loading the software in the PLC.

If the synchronization conditions are unique, after triggering and evaluation, the group of synchronization steps only contains the required step. This step is set manually and you then switch over to the automatic mode. With a signal change at B-UE, automatic operation is restarted from this step onwards.

5.7 Loading in the PLC

Transferring the user program to the PLC:

- all SBs, FBs, PBs, required with or without synchronization for running the sequencer and
- SB sync
- SB 5
- modified block (OB or PB) with SB-sync call.

Testing and Starting Up

Here, each sequencer (AUTOMATIC) must be synchronized at least once with every possible manual operation to be able to recognize any additions required in the positive or negative conditions and to implement them.

5.8 Activating Process Synchronization

1. Activate synchronization.
2. Check synchronization for single candidate.
3. If single candidate, trigger activation of the step.
4. Check whether synchronization was successful.
5. Switch over to automatic after activating the step.
6. Activate the automatic mode with a signal change at B-UE.

5.8.1 Functions

The synchronization conditions are stored segment by segment in a separate sequence block (SB-sync). The segments are edited so that flag F 233.0 is replaced by the genuine step flag. At the time of the synchronization, this SB-sync is called and processed by the user OB/PB. After processing a segment, SB 5 is called which makes the comparison with the steps still candidates for becoming the synchronization step.

5.8.2 Support by the Standard SB 5

This block is only loaded in the PLC and cannot be output on the PG.
The standard SB 5 evaluates the control word DW 33 of DB<G5:SEQUENCE> and adopts the required synchronization conditions until the sequencer starts automatically. The required information is made available by SB-sync.

5.8.3 DB<G5:sequence>

The possible steps for synchronization are stored in DB<G5:SEQUENCE> as a bit pattern in DW 231 to DW 238 (KM format), and if there is only one candidate, the selected step is stored in DW 230 (KF format).

Data word 33 has the following significance for process synchronization:

1. Starting Synchronization

D 33.8

You must set and also reset this bit.

The bit is set: in SB 5 the signal change at D 33.8 is evaluated; when a pulse is recognized, synchronization is triggered.

Note

The internal synchronization is only active when no AUTO/TIPP/AUS is selected in the corresponding sequencer. If you want to activate synchronization constantly in manual operation, you must change the signal state of D 33.8 cyclically.

---

2. Display: Single Yes/ No

yes:	D 33.11 = 1
no:	D 33.11 = 0

This bit is set and reset by the SB.

Bit set: the synchronization produced a single candidate.

Bit not set: the synchronization was unable to produce a single candidate, i.e. more than one step qualified for the synchronization step, therefore no synchronization is possible. Triggering D 33.8 completed.

3. Activating Synchronization (with Single Step)

D 33.9

You must set and reset this bit.
The bit is set: the condition is that neither AUTOMATIC nor EXECUTE mode are activated.
Signal change evaluation in SB 5.
The step determined is activated (only if single candidate), and the sequencer can once again be switched to the automatic mode.

4. Display: Step Activation Successful

D 33.10

This bit is set and reset by the SB.
Bit set: a single step could be activated and the synchronization completed successfully. Triggering D 33.9 completed.

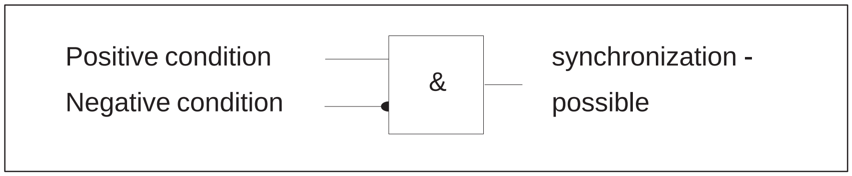
Stipulating the Synchronization Procedure

D 33.12

You must set and reset this bit. Depending on the application, you can select between two synchronization procedures, whereby the principle shown in the diagrams is applied to each step.

D 33.12 = 0 default: full range of functions of the generated conditions.

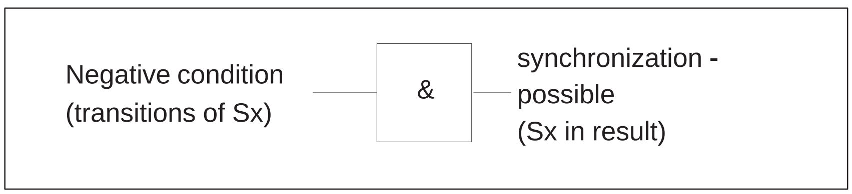
Principle:



Application: during a traversing movement synchronization should be performed with the corresponding step if the transition is not satisfied.

D 33.12 = 1 default: full range of functions of the generated conditions.

Principle:



Application: synchronization after a satisfied transition (regardless of the actions).

5.8.4 Example of Handling the Data Interface

1. Start synchronization

   D 33.8 from 0 to 1, evaluation of the positive-going edge

   D 33.9 = 0
   D 33.10 = 0
   D 33.11 = 0
   D 33.12 = 0

2. The search is only active in one PLC cycle, followed by display single yes/ no

   D 33.11 = 1, single : yes

   Activation of the synchronization step found

   (internally only active if single: yes)

   D 33.8 = 1
   D 33.9 = from 0 to 1, evaluation of positive-going edge
   D 33.10 = 0
   D 33.11 = 1
   D 33.12 = 0

3. Indication of the activation of the synchronization step successful

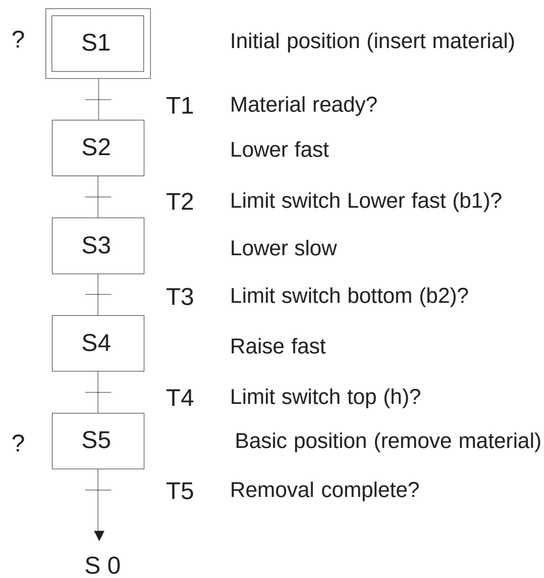
   D 33.10 = 1 step activated in the sequencer.

   Following this the synchronization can be started again at point 1. Start: D 33.8 and D 33.9 = 0.

5.9 Process Synchronization Based on an Example

The concept of process synchronization is explained based on an example. This example is not intended for transfer to a particular process but is simply intended to illustrate process synchronization.

The functions of an automatic drill can be described by a linear sequencer.



5.9.1 Description of the Operating Sequence

In the initial position, you fix a work piece in the clamp. The drill is then lowered quickly until it almost meets the work piece (limit switch b1).

Following this, it is lowered slowly and drills as far as the bottom limit switch (b2).

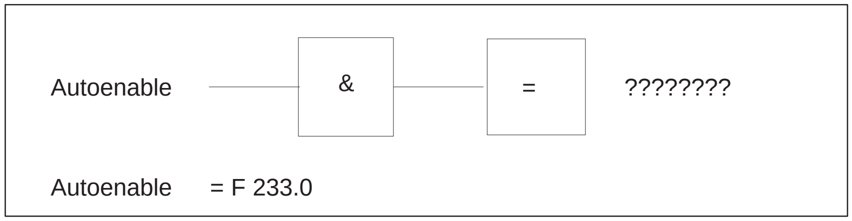
The drill then returns quickly to the upper limit switch (h). Once this initial position has been reached again, the work piece can be removed.

5.9.2 Programming Steps and Transitions

You program the steps and transitions as usual at the zoom-in level. You can choose the method of representation you prefer, in the example we are using CSF.

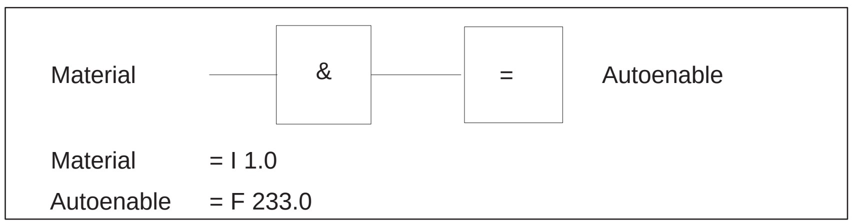
Step 1: Initial Position (Insert Material)

Step 1 is an empty step for introducing material (no actions programmed, RLO = 0).

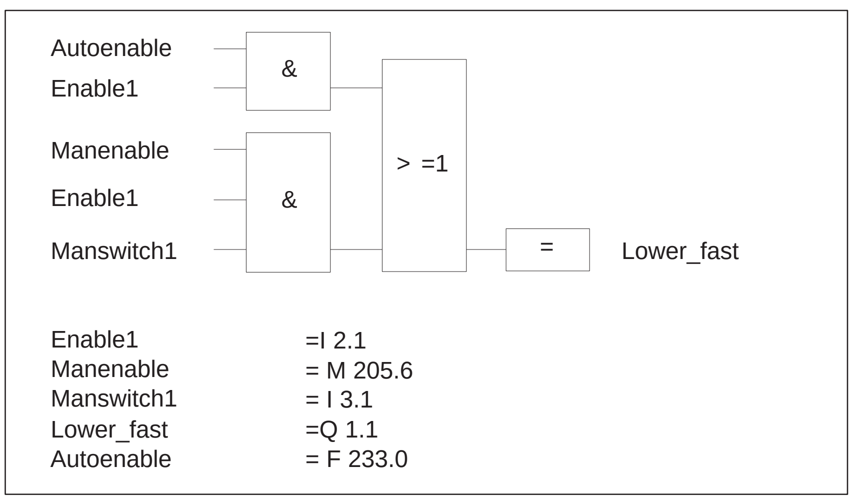


Transition 1: Material Ready?

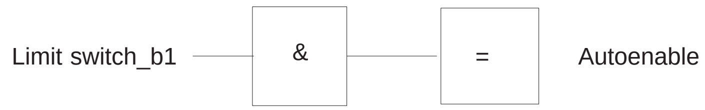
If the material is clamped, the step enabling condition is satisfied.



Step 2: Lower Fast

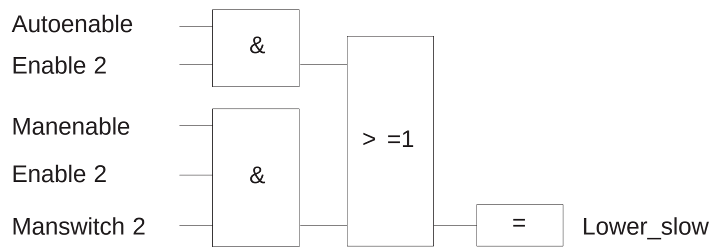


Transition 2: Limit Switch Lower Fast?



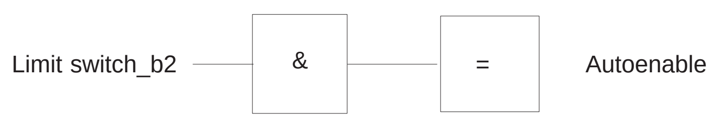
Limit switch_b1 = I 1.1
Autoenable = F 233.0

Step 3: Lower Slow



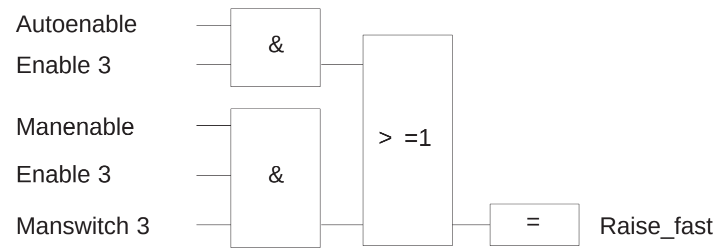
Enable 2	=I 2.2
Manenable	= M 205.6
Manswitch 2	= I 3.2
Lower_slow	=Q 1.2
Autoenable	= F 233.0

Transition 3: Bottom Limit Switch?



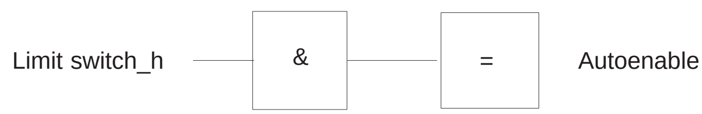
Limit switch_b2 = I 1.2
Autoenable = F 233.0

Step 4: Raise Fast



Enable 3	=I 2.3
Manenable	= M 205.6
Manswitch 3	= I 3.3
Raise_fast	=Q 1.3
Autoenable	= F 233.0

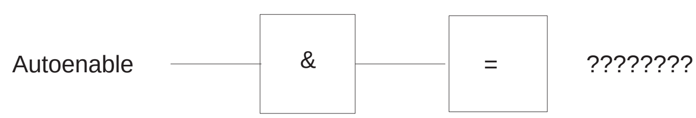
Transition 4: Limit Switch Top?



Limit switch_h	= I 1.3
Autoenable	= F 233.0

Step 5: Basic Position (Remove Material)

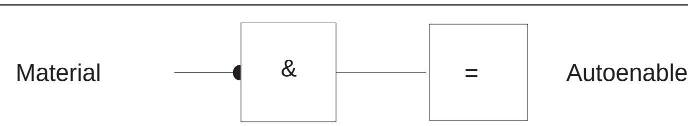
Step 5 is an empty step for removing the material (no actions programmed, RLO = 0).



Autoenable	= F 233.0

Transition 5: Material Removed?

If the material has been removed, the step enabling condition is satisfied.



Material	= I 1.0
Autoenable	= F 233.0

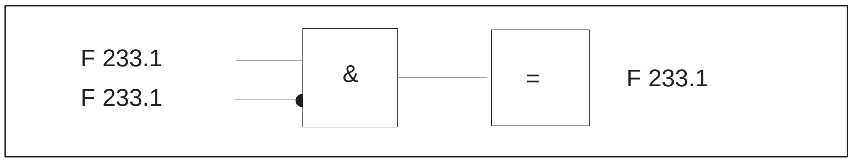
5.9.3 Synchronization Conditions

For this example, CSF was selected as the method of representation. You can also select LAD or STL.

With automatic generation, the following positive and negative synchronization conditions can be created for steps 1 to 5:

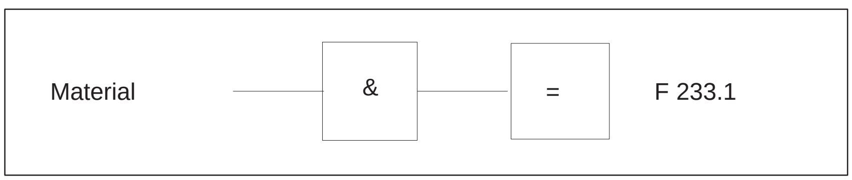
Step 1:

Step 1 is an initial position, in which no action is programmed (RLO = 0). The step is eliminated from the results and therefore no positive synchronization condition can be generated for S1.

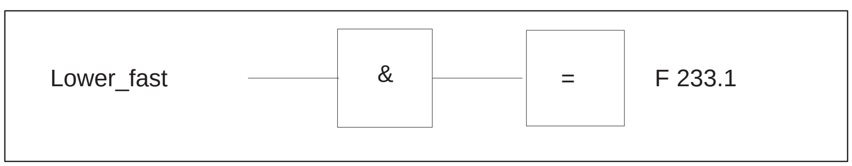


Negative Synchronization Condition

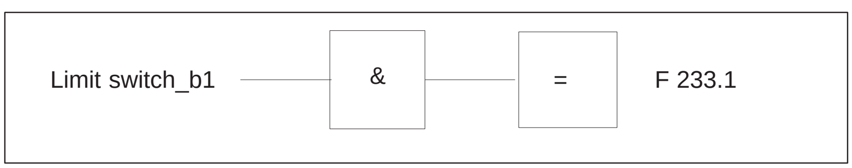
A negative synchronization condition is possible due to the input in T1.



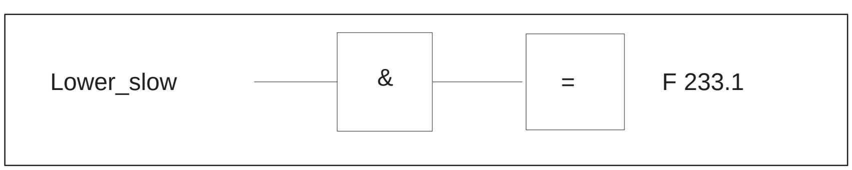
Step 2: Positive Synchronization Condition



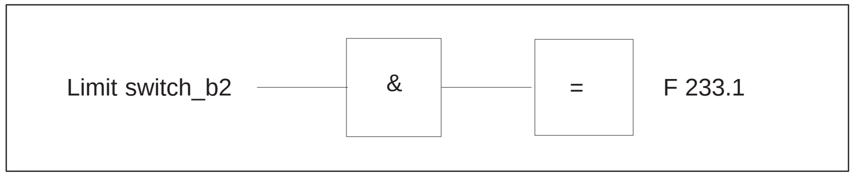
Negative Synchronization Condition



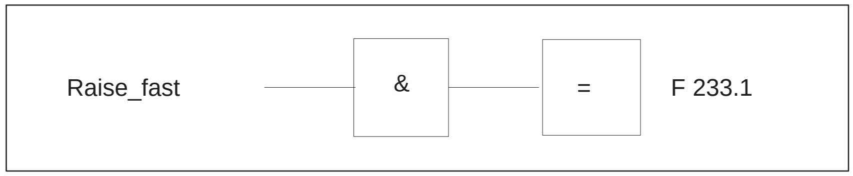
Step 3: Positive Synchronization Condition



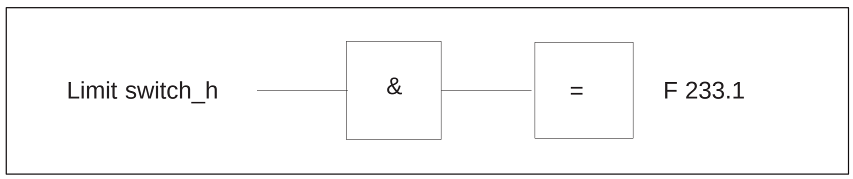
Negative Synchronization Condition



Step 4: Positive Synchronization Condition



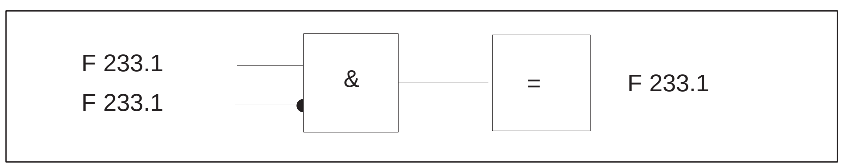
Negative Synchronization Condition



Step 5:

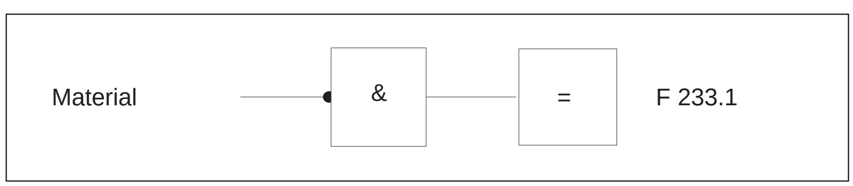
Step 5 is an initial position, with no action programmed in its zoom-in. No positive synchronization condition can therefore be generated for S5.

Positive Synchronization Condition



Negative Synchronization Condition

A negative synchronization condition is possible due to the input in T5.



5.9.4 Evaluation of Automatically Generated Synchronization Conditions

At the beginning of status recognition, all steps 1 to 5 are included in the group of possible synchronization steps.

Case 1, Step 2: Lower Fast

The drill is in the “S2 lower_fast” phase.

At the time of the status recognition, the drill is moving down fast and is located between the two limit switches h and b1.

The positive synchronization condition of step 2 is satisfied. This means that all steps except S2 are removed from the group of possible synchronization steps. When limit switch_b1 is reached, S2 is also removed from this group. If limit switch_b1 is not reached, S2 remains in the group.

Case 2, Step 3: Lower Slow

The drill is in the “S3 lower_slow” phase.

At the time of the status recognition, the drill is moving down slowly and is located between the two limit switches b1 and b2.

This case is analogous to case 1. Only the positive synchronization condition of step 3 is satisfied. Synchronization is then only possible at all using step 3.

Case 3, Step 4: Raise Fast

The drill is in the “S4 raise_fast” phase.

At the time of the status recognition, the drill is moving up fast and is located between the two limit switches b2 and h.

This case is analogous to case 1. Only the positive synchronization condition of step 4 is satisfied.

Case 4, Step 1: Insert Material

The drill is in the initial position “S1 insert material” .

At the time of the status recognition, the drill is not moving and is located at the upper limit switch h, while the operator clamps a work piece in position, i.e. I 1.0 = 0 is still set.

This fact leads to multiple candidates during status recognition.

Since only the negative synchronization conditions of steps 4 and 5 are satisfied, only these are removed from the group of possible synchronization steps.

After evaluation of all the synchronization conditions, steps 1, 2 and 3 remain in the group of possible synchronization steps and synchronization is not possible.

Case 5, Step 5: Remove Material

The drill is in the initial position "S5 remove material".

At the time of the status recognition, the drill is not moving and is located at the upper limit switch h, while the operator removes the work piece in position, i.e. I 1.0 = 0 is still set.

This also leads to multiple candidates in status recognition.

Since only the negative synchronization conditions of steps 4 and 1 are satisfied, only these are removed from the group of possible synchronization steps.

After evaluation of all the synchronization conditions, steps 2, 3 and 5 are still in the group of possible synchronization steps and synchronization is not possible.

5.9.5 Restricting Multiple Candidates Using Additional Information

This example illustrates that process synchronization with automatically generated synchronization conditions functions for all steps which have an output (= an action) assigned. All the other steps (in the example the initial positions S1 and S5) cannot be identified on the basis of the automatically generated synchronization conditions.

Owing to the absence of an output, no positive synchronization conditions could be generated automatically for the initial positions S1 and S5. When writing the sequencer, on the other hand, you can edit these conditions and add additional information.

Procedure

1. Steps and transitions are programmed (Section 5.9.2).
2. The synchronization conditions are generated automatically when the sequencer is translated (Section 5.9.3).
3. Add information to the positive and negative synchronization conditions at the zoom-in level.

Positive Synchronization Condition

The synchronization conditions have the following significance: when none of the actions

- lower_fast,
- lower_slow and
- raise_fast is being executed
- the material is not yet in position and
- the drill is located at the upper limit,

then step 1 ”initial position insert material” is active.

Negative Synchronization Condition

This step is not active when the material has been inserted (automatically generated synchronization condition), one of the actions

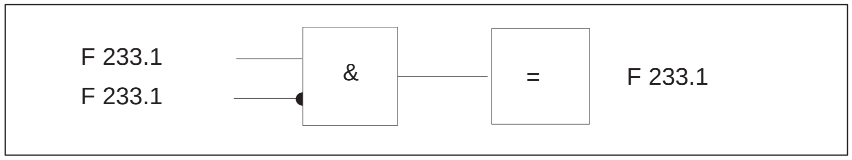
- lower_fast,
- lower_slow or
- raise_fast is being executed or
- the drill is not located at upper limit switch h.

Step 1

The synchronization conditions of the initial position S1 could appear as follows:

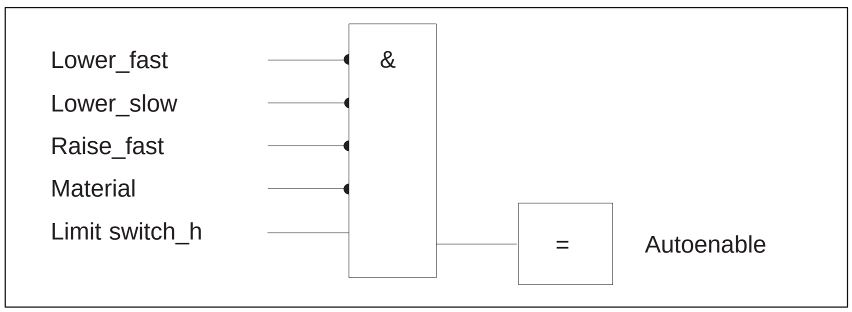
Positive Synchronization Condition

The positive synchronization condition is empty.



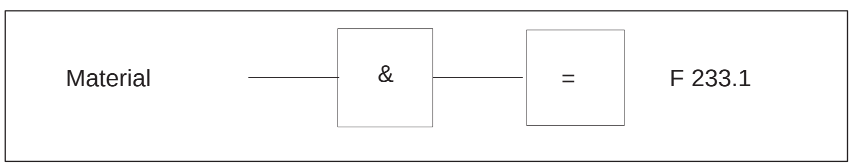
Additional Information for Positive Synchronization Condition

The automatically generated synchronization condition is empty, for this reason interim flag F 233.1 is ignored.



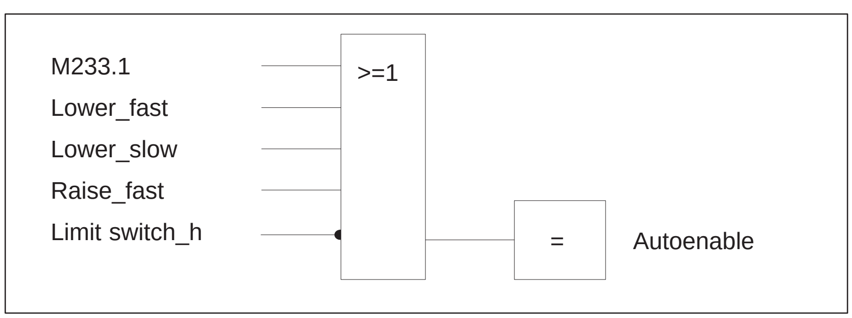
Negative Synchronization Condition

Automatically generated synchronization condition.



Additional Information for Negative Synchronization Condition

The interim flag F 233.1 is used here since an automatically generated, negative synchronization condition exists which is supplemented by additional information.

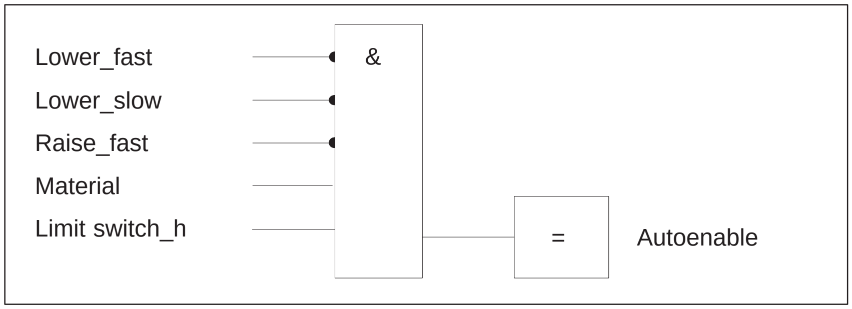


Step 5

Analogous to step 1, the following segments result:

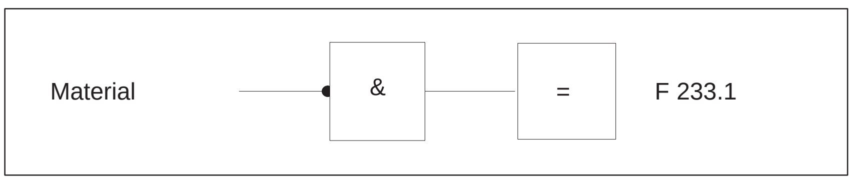
Additional Information for Positive Synchronization Condition

The automatically generated synchronization condition is empty, for this reason interim flag F 233.1 is ignored.

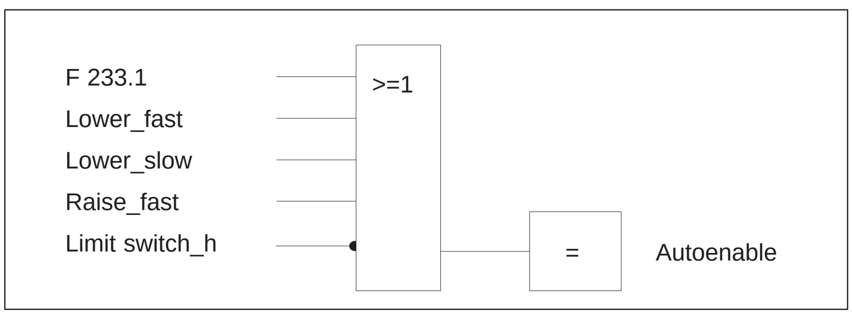


Negative Synchronization Condition

Automatically generated synchronization condition.



Additional Information for Negative Synchronization Condition



Evaluation of the Additional Synchronization Conditions

Since the synchronization conditions in Section 5.7.5 were only extended by the conditions for steps 1 and 5, cases 1, 2 and 3 no longer need to be taken into account since the status recognition in Section 5.7.4 already produced a correct result.

Re: Case 4,
Step 1:
Insert Material

The current status “initial position insert material”, i.e. at the time of process synchronization, the drill is not moving and is located at upper limit switch h, while the operator clamps a work piece.

The positive synchronization condition of step 1 is satisfied and identifies S1 as the synchronization step. The negative synchronization condition of S5 is also satisfied and would eliminate S5 from the group of possible synchronization steps if it was still contained. All other synchronization conditions are unsatisfied and do not affect the group of possible synchronization steps, the step searched for could nevertheless be uniquely identified.

Re: Case 5,
Step 5:
Remove Material

Current status “initial position remove material”, i.e. at the time of process synchronization, the drill is not moving and is located at the upper limit switch h, while the operator removes the work piece.

This case is analogous to case 4. The negative synchronization condition of S1 is satisfied and removes S1 from the group of possible synchronization steps. In addition to this, the positive synchronization condition of S5 is satisfied and removes all steps except S5 from the group of possible synchronization steps and therefore identifies S5 as the synchronization step.

5.10 FB Synchronization

FB synchronization can only be started in the manual mode (with FB 70: submode). To start FB synchronization, you must set bit D33.5 to ‘1’ in DB<Sequence>. With bit D33.6, you can make sure that only one candidate is available.

Note

If the manual mode was set for FB 70 of GRAPH 5/II “Version 7.0” and the manual mode is not the only possible mode (SANW = 1 and SSMB = 1), the sequencer is executed in the submode. This can mean that synchronization is started when it is not required.

	D33.5 = 0	**D33.5 = 1**
D33.6 = 0	No FB synchronization	FB synchronization multiple candidates permitted
D33.6 = 1	No FB synchronization	FB synchronization single candidate forced

Synchronization Algorithm for Multiple Candidates (D33.5 =1 and D33.6 = 0)

The FB (FB 70 to 73) evaluates all transitions by simulating the RLO of the transition.

FB synchronization processes all transitions from 1 to n successively (where n is the number of the last transition).

Each transition is first tested to determine whether its condition is fulfilled (waiting and monitoring times are ignored).

If the transition condition is not satisfied, no action is executed for this transition.

If the transition condition is satisfied, the following actions are executed:

- For all simultaneous levels (at least one and a maximum of eight simultaneous levels; linear sequences have one simultaneous level) that come together with this transition, the previous search result is deleted.
- If several simultaneous levels come together, the higher levels are disabled. For the level in which the transition is located, actions can enter a new result for subsequent transitions. For the other simultaneous levels brought together by the transition, no new result can be entered.
- All the steps that are activated by this transition are entered for the corresponding simultaneous levels as the result. (Exception: in the levels that were disabled due to the second action of satisfied previous transitions, nothing is entered).
- If the transition activates step 0, step 0 is entered as the result for all simultaneous levels and the search is terminated; in other words when executing the following transitions, the search result is no longer changed.

In addition to this, only the last result for each simultaneous level is saved. This means that with several transitions that produce a result for a simultaneous level, the result of the last of these transitions is used.

Synchronization Algorithm for Single Candidate (D33.5 = 1 and D33.6 = 1)

The FB (FB 70 to 73) evaluates all the transitions by simulating the RLO of the transition.

The FB synchronization processes all transitions from 1 to n successively (where n is the number of the last transition).

Each transition is tested to determine whether its condition is satisfied; waiting and monitoring times are ignored.

If the transition condition is not satisfied, the search continues with the next transition.

If the transition condition is satisfied, the following actions are executed:

- If a search result has already been found for one of the simultaneous levels brought together by this transition, the search result is discarded and the search terminated.
- If more than one simultaneous level is brought together, the result of the levels further to the right is step S0.
- All steps that are activated by this transition are entered for the corresponding simultaneous levels as the result.
- If the transition activates step 0 and no search result has been found for the first simultaneous level, step 0 is entered as the result for all simultaneous levels and the search is terminated.
- If the transition activates step 0 and a search result has already been found for the first simultaneous level, the search result is discarded and the search terminated.

System Characteristics of FB Synchronization

The algorithms mentioned above result in the following system characteristics:

- Graphic conventions are ignored.
- Each simultaneous level is considered on its own. A simultaneous level may cover several graphically independent sections of the sequencer.
- The transitions before opening the simultaneous branches belong to all simultaneous branches that are opened by them.
- The transitions after the junction of the simultaneous branches belong to all simultaneous branches that are closed by them.

Priority List for the Result of FB Synchronization

A result with lower priority is overwritten by a result with higher priority.

Priority	Single Candidate	Multiple Candidates
1 (low)	If there is more than one or no satisfied transition in a simultaneous level, no result is entered. For this level, the step that was previously entered remains active. Otherwise, the step following the satisfied transition is entered as the result for this level. **Note:** At each level, the opening and closing transitions must also be counted.	The step following the satisfied transition with the highest number is entered for each simultaneous level. If no transition is satisfied, the step that was previously entered remains active in this level. **Note:** The opening and closing transitions must also be counted.
2	If in level 1: 1. Exactly one transition is satisfied and 2. This transition belongs to a jump to step S0, step S0 is entered as the result for all levels.	A satisfied transition at level 1 with a jump to S0 means that step S0 is entered as the result for all levels.
3	If in a level: 1. A transition is satisfied and 2. A satisfied transition brings together this simultaneous level with a level further right, step S0 is entered as the result for this level.	If a satisfied transition in a level brings this level together with a level further to the right, step S0 is entered as the result for this level. The result cannot be overwritten.
4		If overwriting the result is prevented due to priority 3: A satisfied transition that opens several levels and is not located in a disabled level enables the levels that it opens so that the result can be overwritten.

The following table describes the possible result of FB synchronization dependent on single candidate or multiple candidates.

First Linear Sequencer (possibly with alternative branches)	**Single Candidate (D 33.6 = 1)**	**Multiple Candidates (D 33.6=0)**
No transition was found	No result is entered (the last sequencer status is retained)	As for single candidate
Exactly one transition Tx is satisfied	The step following Tx is entered as the result	As for single candidate
Exactly one is satisfied and this belongs to a jump to S0	The result is S0 (and the initial step is activated)	As for single candidate
Several transitions are satisfied	No result is entered (the last sequencer status is retained)	The step following the satisfied transition with the highest number is entered as the result.

Second Simultaneous Sequencer	**Single Candidate (D 33.6 = 1)**	**Multiple Candidates (D 33.6=0)**
No transition was found	No result is entered (the last sequencer status is retained)	As for single candidate
Exactly one transition Tx_i is satisfied in simultaneous level i (if Tx_i is located before a simultaneous branch is opened or after it is closed, Tx_i belongs to all simultaneous branches that are opened or closed here.)	The step(s) following Tx_i is/are entered as the result for level i. **Exception:** If Tx_i is located in level j, (j<i) and it closes level i, S0 is the result for level i.	As for single candidate
Exactly one transition in level 1 is satisfied and it belongs to a jump to S0	The result for all levels is S0 (and the initial steps are activated)	As for single candidate
More than one transition is satisfied in level 1 and the last transition belongs to a jump to S0	No result is entered (the last sequencer status is retained)	The result for all levels is S0 (and the initial steps are activated)
More than one transition in level i is satisfied	No result is entered for level i (the last active step in level i remains active)	For level i, the step following the satisfied transition with the highest number is entered as the result.

Warning

Since this procedure ignores the graphic structure, sequencer statuses can be found that would be impossible in normal operation. This can mean stoppages or additionally active steps when the changeover is made to the automatic mode.

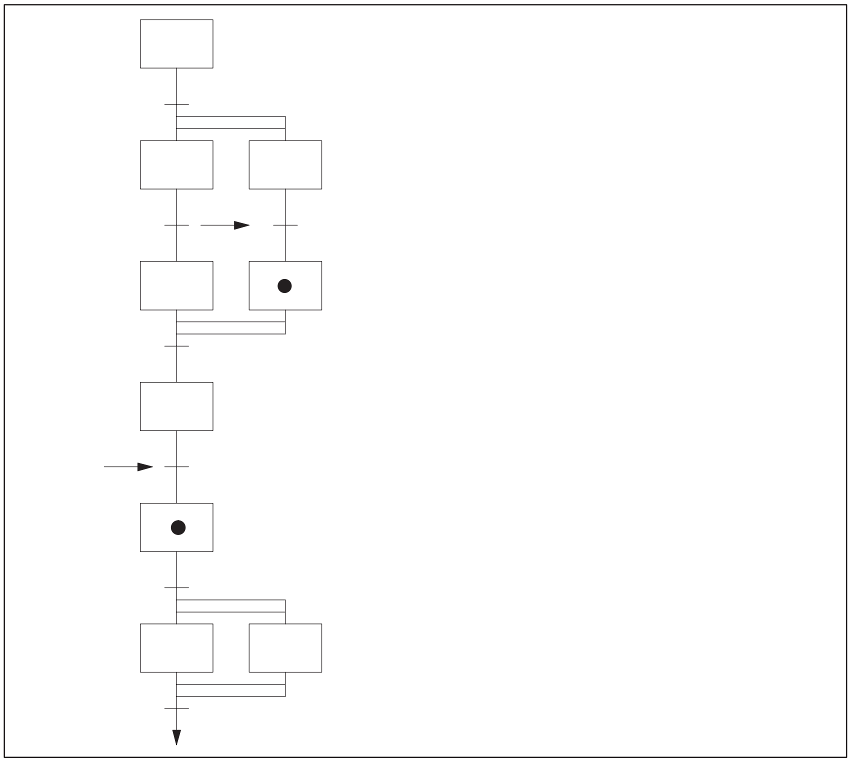
Possible Conflicts

The following conflicts are possible in sequencers with simultaneous branches:

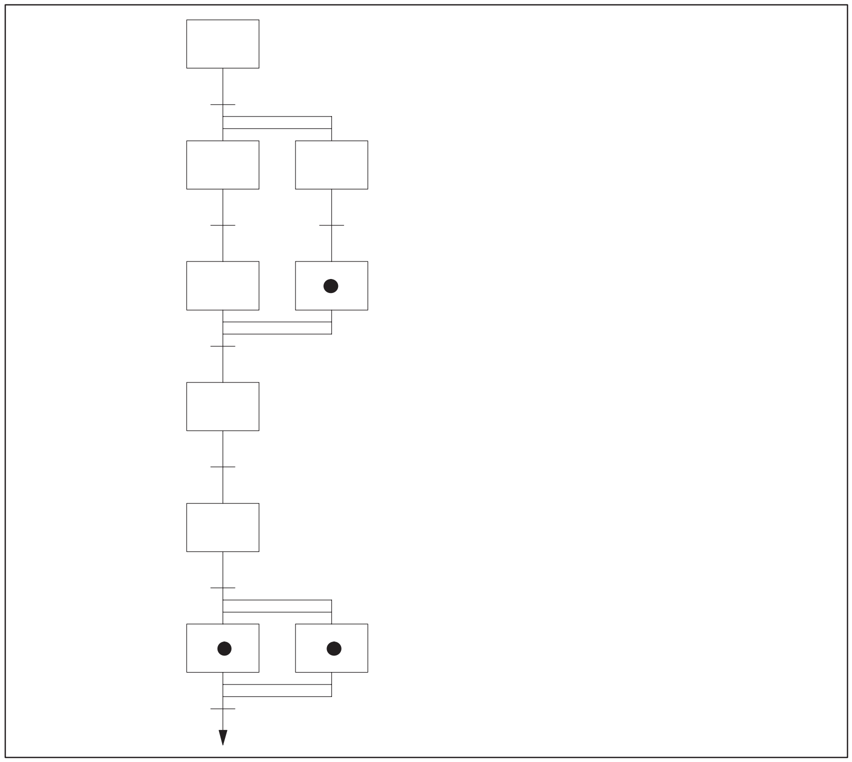
- Additional steps

When the end of the sequencer is reached, all additional steps are switched inactive. This means that this conflict does not necessarily mean a problem in certain situations.

In the following examples, satisfied transitions are indicated by an arrow and the steps of the synchronization result with a dot.



If this sequencer changes to the automatic or execute mode, two steps are active in the second simultaneous level.



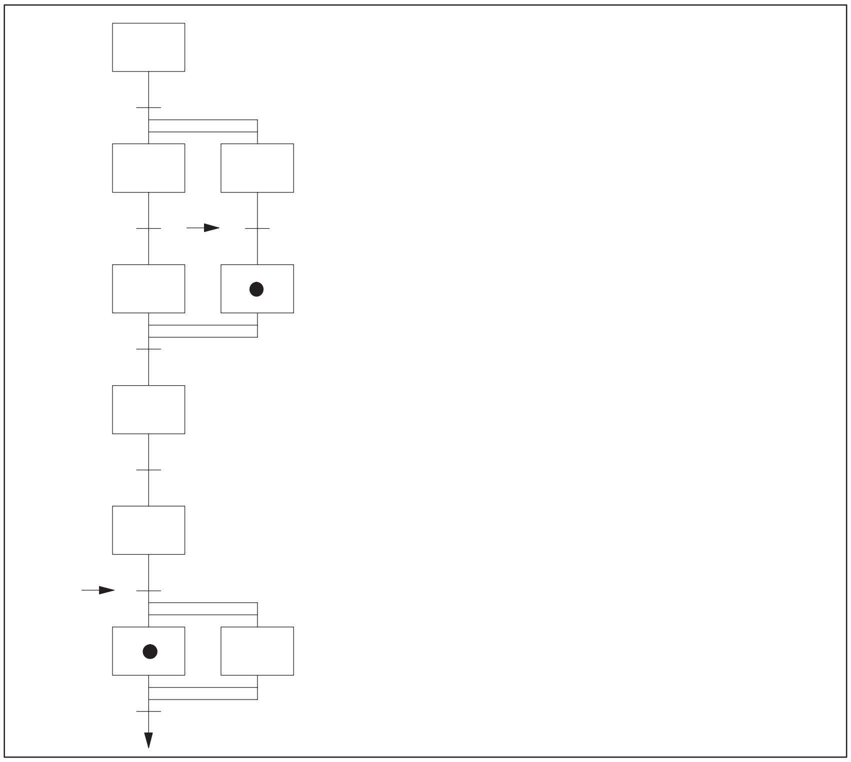
If a jump to S0 is reached, all steps are deactivated and the initial steps activated. It is possible that the additional step is reached again. Following this the sequencer continues normally. In many situations, this conflict does not therefore cause problems.

- Steps in (graphically) different parts of the sequencer

The sequencer can no longer run in the automatic mode. You should make sure during configuration that this conflict cannot occur.

If a single candidate is required (D 33.6 = 1), this conflict is often impossible.

You can program the transitions so that only one transition can be valid per simultaneous level. The transition before the simultaneous branches are opened belongs to all simultaneous branches that are opened there.



This sequencer can no longer be switched further even with ‘UQUIT’ (with FB70/71) since there is no transition for which all the previous steps are active.

These conflicts are not possible in linear/alternative sequencers. In simultaneous sequencers, they can often be avoided by extending the transition.

Procedure for FB Synchronization

To use FB synchronization, the following procedure is suggested:

- Synchronization is started in the manual mode (in FB 70: submode).
  (Set D 33.5 to 1)
- The sequencer is operated in the manual mode until the synchronization provides a permitted result.
- Synchronization is then deactivated. (Set D 33.5 to 0.)
- The synchronization result is then checked once again.
- The sequencer can then be switched to the automatic mode.

GRAPH 5 Diagnostics

6

Chapter Overview

6.1 Introduction

GRAPH 5 diagnostics allows the diagnostics and documentation of timeouts in sequential control systems. GRAPH 5 diagnostics is divided into two software parts: the software for the programming device for editing and operating and the standard FBs and DBs for running diagnostic functions on the PLC.

The new feature of the diagnostic functions is the analysis of the part of a sequencer with a timeout (step/transition) on the PLC and the output of messages on the PG or printer.

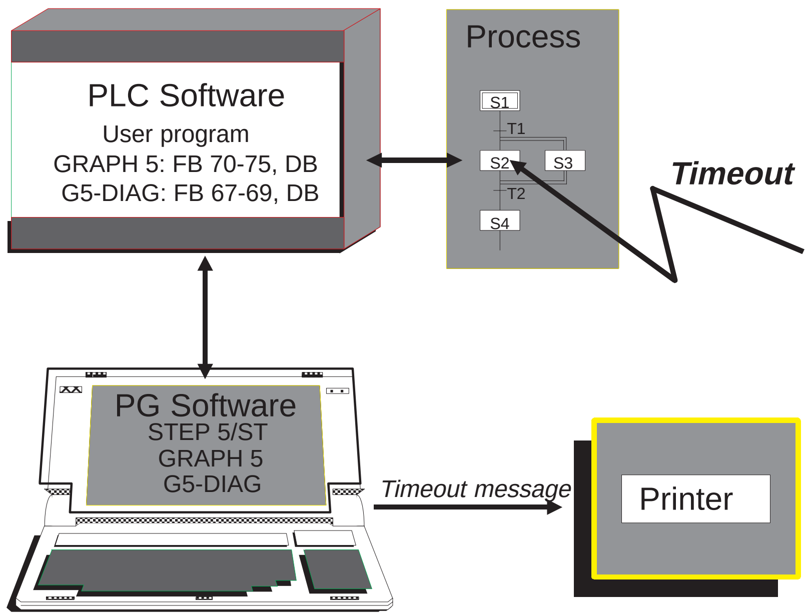


Figure 6-1 Interaction between Hardware and Software

6.1.1 Difference between GRAPH 5 Diagnostics, Stage 5 and 6

The software package GRAPH 5 diagnostics (G5-DIAG) replaces and extends the old GRAPH 5 diagnostic function.

The Most Important Differences:	
Stage 5	**> Stage 6**
Diagnostics only with sequencers FB 70/71.	Diagnostics with all sequencers FB 70 to FB 74.
Sequencer with timeout called using function key F6 (Diagnostics).	Sequencers with timeout selectable via the user interface and dialogs.
No automatic printout of messages.	Automatic printout of messages and criteria with date and time.
New Features	
Per PG and active user program, four CPUs can be monitored.	
The analysis of the section of a sequencer with a timeout is new. The error criteria can be output with symbol names and comments.	
A new software operating field on the PG allows you to set the sequencer modes and acknowledge errors.	
The diagnostics is monitored and organized by a function block (FB 69).	

6.1.2 Overview of Diagnostics

The diagnostic functions on the PLC permanently monitor all the sequencers and the diagnostic information is buffered. The PG can then access this information.

Functions

For operation and monitoring of sequencers in up to 4 PLCs there are several functions available:

- SB list provides a sequencer overview and detailed information about a block.
  The SB list function outputs the status of the sequencers on the selected PLC. An SB indicated in the overview can be further investigated if there is a timeout (criteria analysis).
  Output on screen or printer.
- Messages
  The messages function outputs detailed timeout messages of all SBs being monitored on the screen or printer. An SB indicated in the overview can be further investigated if there is a timeout (criteria analysis).
- Software input field
  You can assign parameters for the program/call interface of the FBs (FB 70 to FB 74) using a software input field.

  There are two types of input fields:

  – simple input field
  – FB input field

Blocks

These diagnostic functions are supported by standard blocks on the PLC:

- Function blocks:

FB 69	Diagnostics (standard FB)
FB 67	Read data (standard FB)
FB 68	Write data (standard FB)

- Data blocks:

DB <G5:DIAG>	Diagnostic DB (generated automatically with DB-GEN)
DB <DIAG>	Data buffer DB (temporarily set up by FB 69 on the PLC)
DB <G5:PARA>	Parameter data DB (to be created by the user)

Software

GRAPH 5 diagnostics is based on the interaction between two software parts:

- PLC: standard blocks on the PLC: FB 67 to FB 69
- PG: GRAPH 5 diagnostics on the PG: G5-DIAG

Diagnostic Data

The diagnostic data are saved in a data buffer on the PLC (max. 4000 words long) to allow them to be called by the PG.

Criteria Analysis

The most important innovation in the diagnostic functions is the analysis of a part of a sequencer with a timeout (step/transition) on the PLC. An analysis is made to find out why an action was not executed.

Non-satisfied assignments and the corresponding conditions (criteria) are saved. This is known as criteria analysis.

The data of the individual sequencers are prepared for criteria analysis and buffered in the data buffer DB.

GRAPH 5 diagnostics distinguishes between initial value messages and the current timeout status.

The initial value reflects the situation as it is after a block is run through in the cycle in which the timeout occurred the first time.

The current timeout status (current or refresh value) reflects the situation in terms of changes that have taken place since the first occurrence.

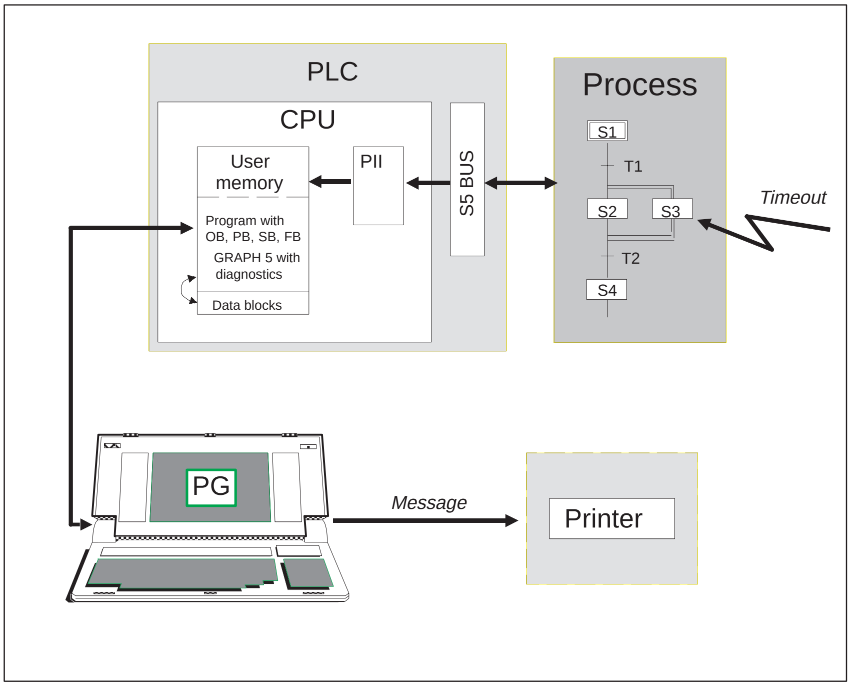
Using the criteria analysis function, you can display error criteria directly on the PG with symbol names and comments.

Note

Changes occurring between the type of error and the SB end (when running through parameter steps) cannot be detected by GRAPH 5 diagnostics. This may mean that the analysis results are misleading.

6.1.3 Single Diagnostics

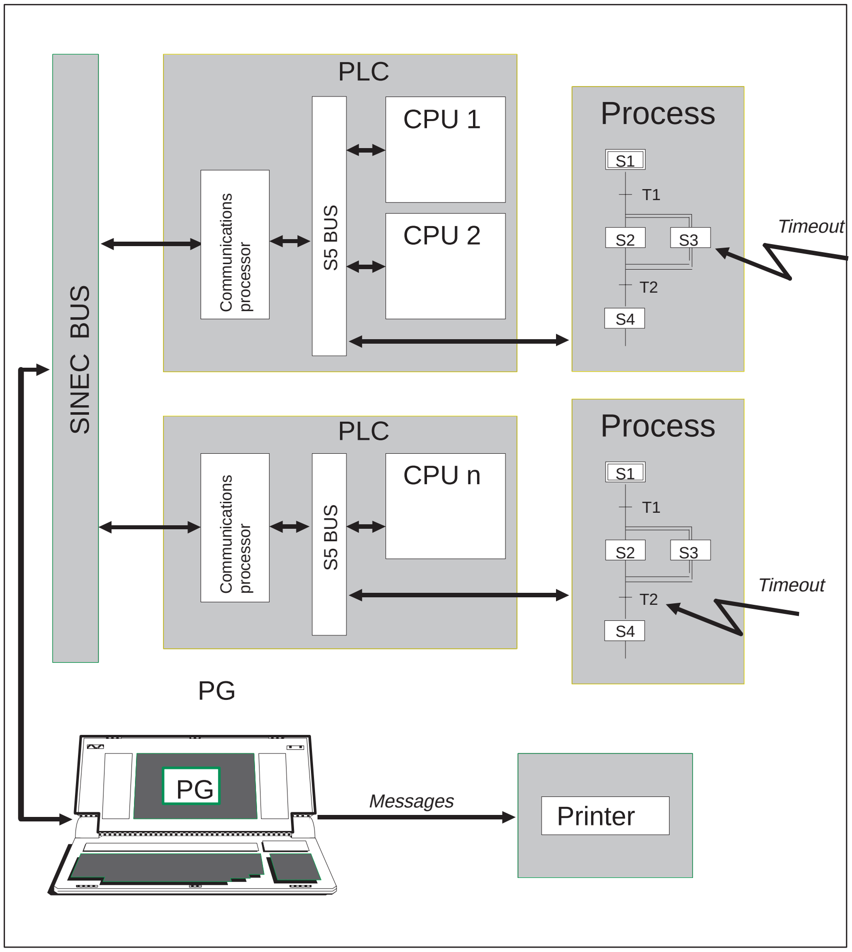
Single diagnostics means that the sequencer of a PLC is monitored, timeouts diagnosed and indicated.



6.1.4 Group Diagnostics

The difference between single and group diagnostics is that in group diagnostics, up to four PLCs can be monitored simultaneously and in single diagnostics only one PLC.

In group diagnostics, the PG is connected with the PLC via a bus.



6.1.5 Hardware and Software Configuration

GRAPH 5 diagnostics is based on the sequencer information in the working data block and sequencer block.

The following expansions are required for this:

MS-DOS >= 5.0
PG 7xx
STEP 5 Basic package V7.x

Expansions:

Function GRAPH 5/II Diagnostics of GRAPH5/II V7.x

with mode selection
group and single diagnostics
and criterion analysis

CPU
SINEC H1
SINEC L2
AS 511

PLC (with GRAPH 5 software SBx, DBx, standard FB and SB)

Expansions:

Standard blocks	FB 67-69
Diagnostic DB	DB<G5:DIAG> (created with DB-GEN)
Data buffer DB	DB<DIAG> (created temporarily by FB 69)
Parameter data DB	DB<G5:PARA> (edited by user)

The following are permitted:

S5-100	CPU 103
S5-115U	CPU 941 - 944
	CPU 944 A: release PLC software ≥ Z03
	CPU 945
S5-135U	CPU 922/CPU 928
S5-150U	CPU 924 - 927
S5-155U	CPU 922/CPU 928
	CPU 946-3UA23 or higher/CPU 947

To reduce the cycle time and memory requirements, the CPU 944/928/946/947 or S5-150U are recommended.

Software Configuration

The following diagram represents standard diagnostics with the required software in the PLC.

GRAPH 5: sequential control	
e.g. FB 72/SB 2/	SB<G5:SEQUENCE>
	DB<G5:SEQUENCE>
GRAPH 5 diagnostics	
Standard blocks	FB 67-FB 69
	DB<G5:DIAG>
	DB<DIAG> (temporary)
	DB<G5:PARA>

For sequential control, you require the standard blocks.

From the following combinations of standard blocks, select the optimum combination for yourself (listing according to priority: minimum cycle time and memory requirements):

1.	FB 73 and SB 3	Linear sequencers
2.	FB 72 and SB 2	Linear sequencers and simultaneous sequencers
3.	FB 70 (71) and SB 0	Linear sequencers, simultaneous sequencers and subsequencers

You can extend the functions of these basic combinations using additional blocks such as FB 74/75 (see also Chapter 4).

GRAPH 5 diagnostics in the PLC (FB 67 to 69) prepares the data and communicates with the PG software G5-DIAG.

6.2 Understanding the Diagnostic Program

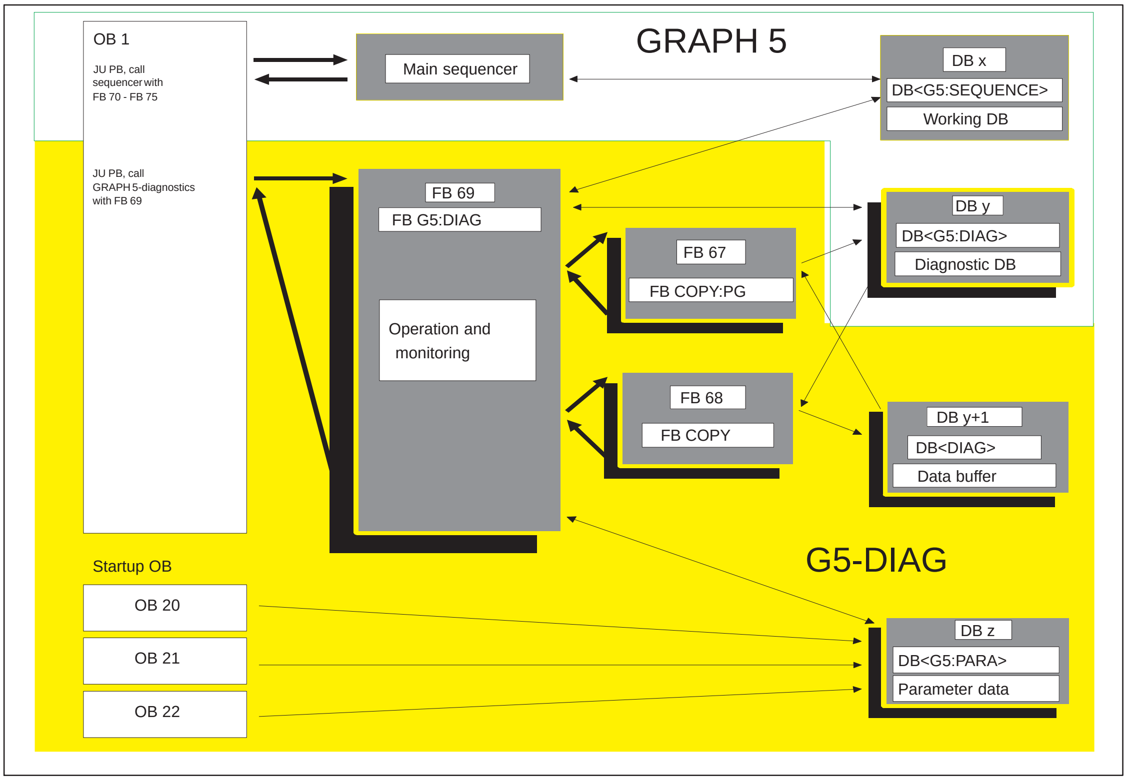


Figure 6-2 Program Execution in the PLC

6.2.1 Blocks on the PLC

In addition to the GRAPH 5 blocks (SB, FB 70 to FB 75, the user DB, SB-execute) the following are also required.

FB 69 Diagnostics

FB 69 consists of executable program and an operation and monitoring section.

This block must be transferred along with the selected DB <G5:PARA> and integrated in cyclic program execution.

FB 67 Read Data

FB 67 is called by FB 69 and is responsible for the correct entry of a message from the DB<DIAG> to DB<G5:DIAG>.

This block only needs to be transferred to the PLC.

FB 68 Write Data

FB 68 is called by FB 69 and is responsible for the correct entry of a message from DB<G5:DIAG> to DB<DIAG>.

This block only needs to be transferred to the PLC.

Diagnostic DB

This block is the GRAPH 5 diagnostic data block for analysis of criteria. It is generated with the PG function DB-GEN.

Data Buffer DB

This DB is used as a data buffer (FIFO principle), until a PG reads the information. It is generated by FB 69 with the DB number of the diagnostic DB + 1. The length of the DB depends on the number of entries in the parameter data DB.

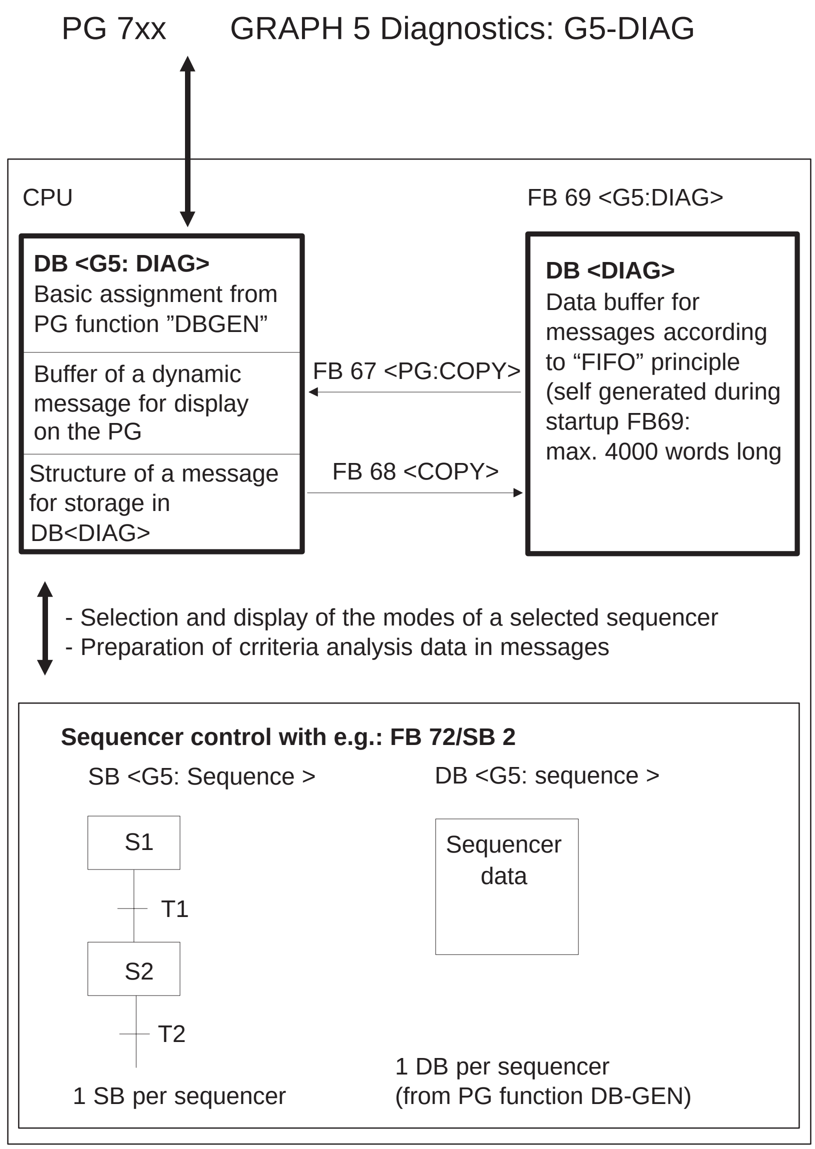
Note

This DB number must be kept free.

Parameter Data DB

This DB contains 20 DWs with parameter data. You must edit this DB. The default assignments can be found in Section 6.3 and in Section 7.3.

6.2.2 Structures on the PLC



The data for criteria analysis are edited in messages with a field length of 30 DW (fixed).

6.2.3 Mode of Operation on the PLC

GRAPH 5 diagnostics is an integral part of a GRAPH 5 sequencer on a PLC (CPU). The interface between a sequencer and GRAPH 5 diagnostics is represented by the user DB and the diagnostic DB.

The organization and monitoring of GRAPH 5 diagnostics on the PLC is handled by FB 69.

The standard software on the PLC (FB 67 to FB 69) uses existing sequencer data and stores the individual criteria (statuses) of the steps, MSZs and transitions in a data buffer DB (DB<DIAG>).

The secondary functions “read data” (FB 67) and “write data” (FB 68) are monitored and assigned parameters by FB 69.

FB 69 is divided into two major sections, the startup section and the operating and monitoring section (diagnostic section).

The diagnostic section only becomes active, however, when the startup section is completed without an error.

The parameter data for startup and the cyclic section (e.g. startup OB, max. number of timeouts, max. number of entries in the diagnostic DB etc.) are stored in a parameter data DB (DB <G5:PARA>).

Note

The GRAPH 5 sequencer also functions without the standard software for GRAPH 5 diagnostics (FB 67 to FB 69, data buffer DB and parameter data DB), since the interface is implemented by DBs (see above).

6.3 Preparing the Diagnostic Program

To allow the diagnostic program to run as an integral part of the GRAPH 5 program, you must make the following preparations.

- Defaults for diagnostics
- Edit parameter data
- Integrate the diagnostic program in the user program

6.3.1 Defaults

With the DB-GEN, the diagnostic DB can be assigned the maximum number 254, since the number of the data buffer DB (DB<DIAG>) = the number of the diagnostic DB plus 1
(DB<G5: DIAG>).

The DB number must therefore be kept free.

6.3.2 Editing the Parameter Data DB

Select the menu command **Editor > GRAPH 5 DB<G5:PARA>** to edit the diagnostic parameters in the program file or in the PLC. A dialog box is displayed in which you select a DB. After closing the dialog box with the **<Edit>** button, the screen form editor for DB<G5:PARA> is started. The DB<PARA> can then be edited in the same way as a DB screen form.

The block length is 20 DWs. For defaults, see also Section 7.3.

6.3.3 Integration in the User Program

To allow the diagnostic program to run on the PLC, three actions are necessary.

1. Calling FB 69 in OB 1 or PB.

FB 69 has only one form of operand for the parameter data DB (PARA). FB 69 is called after the sequencer FB.

Example:

```
                : JU FB (70 to 73)
```

then

```
                : JU FB 69
Name            : G5:DIAG
PARA            :     DB 111     (parameter data DB)
                : BE
```

2. For the startup section, call the parameter data DB and transfer the startup OB number to DW 8.

To ensure that the startup section is constantly in the test routine, integrate the following program section in OB 1 or the PB before calling FB 69.

```
C DB<G5:PARA>
L KF + 1
T DW 8
```

The reason for this is that the startup section is constantly in the test routine which means that changes in the sequencers or data of the corresponding data blocks are immediately entered in GRAPH 5 diagnostics.

Integration in the startup OB 20 to 22 (depending on the specific PLC).

```
C DB<G5:PARA>  data block for parameter assignment on the PG
L KF<OB-Nr.>
T DW 8
```

3. For the cyclic program section, call FB 69 in OB 1, PB or FB and assign the number of the parameter DB.

Integration in the cyclic program execution (following the sequencers):

- Assignment of DB<G5:PARA> on the PG
- Call in OB 1 or PB x or FB x

```
JU FB 69
NAME: G5:DIAG
PARA: DB<G5:PARA>
```

Note

S5-135U CPU 922/928 If a startup error (DB<G5:DIAG> D162.3) is caused by there being too little free RAM and if the error remains despite compressing, DW 17 in DB<G5:PARA> must have the value KH 0000 written to it once. If a startup error still occurs after compressing (DB<G5:DIAG> D 162.3), the RAM area is not large enough.

6.4 Transferring and Testing the Diagnostic Program

The diagnostic program is transferred to the PLC and tested in much the same way as the GRAPH 5 program, since it is a component of GRAPH 5.

Loading on the PLC

Transferring blocks to the PLC

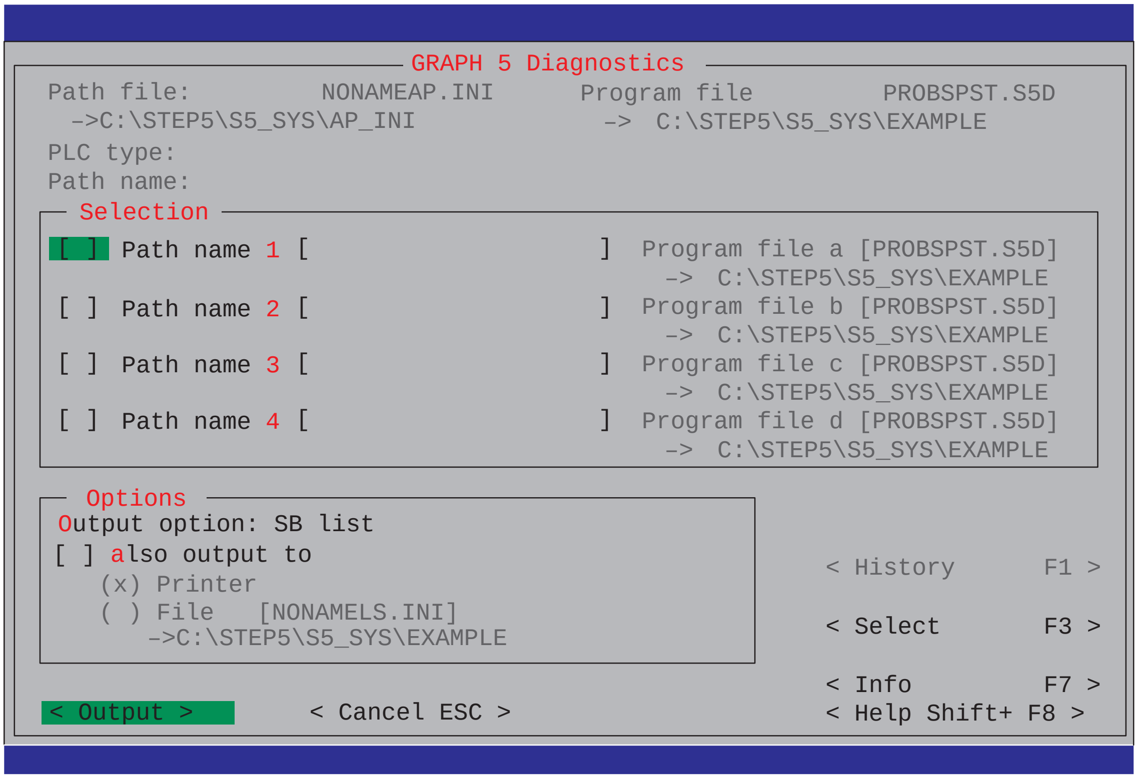
FB 67 to FB 69, DB<G5:PARA>, DB<G5:DIAG>,
OB 1, PB x,FB x, OB 20-22 (for the specific PLC) to the PLC.

Test and Startup

Start up your sequencer(s) on the PLC and check that it or they function correctly.

6.5 Working with Diagnostics on the PG

To activate diagnostics and the display of messages for sequencers on the PG or output on a printer, select the menu command **Test > GRAPH 5 Diagnostics...**. The following dialog appears:



Each path name is assigned a program file. For individual diagnostics or if no program file has been selected, the program file of the project is used.

Input Field	Explanation

`[ ] Path name 1 []`
`[ ] Path name 2 []`
`[ ] Path name 3 []`
	No path name selected: single diagnostics for the PLC selected as the online connection in the project settings (displayed in the information field "PLC Type")

`[ ] Path name 4 [ ]`	A path name is selected: single diagnostics for the selected PLC Up to four path names selected: group diagnostics for up to four PLCs simultaneously. The path names must all be located in the path file (entered in the bus paths editor). The path file is used that is selected in the project settings.

`Output option:`
`SB list`
 	
`Curr. messages`
	Select by double-clicking, **F3** or clicking **Select F3**
	The "Sequencer overview" displays the status of the sequencers on the selected PLC.
	The "Sequencer diagnostics" displays the messages of the sequencers with timeouts.

`[ ]  Also output to printer/file`	Messages with output to printer or file. The data for the print function are taken from the project settings.
`(x)  Printer`	If the option is activated, the messages and the corresponding criteria are output on the screen and to the printer. If the option is not activated, the messages are only displayed on the screen.
`( )  File`	If the option is activated, the messages and the corresponding criteria are output on the screen and to a file. If the option is not activated, the messages are only displayed on the screen.

6.5.1 Basic Functions for Diagnostics on the PG

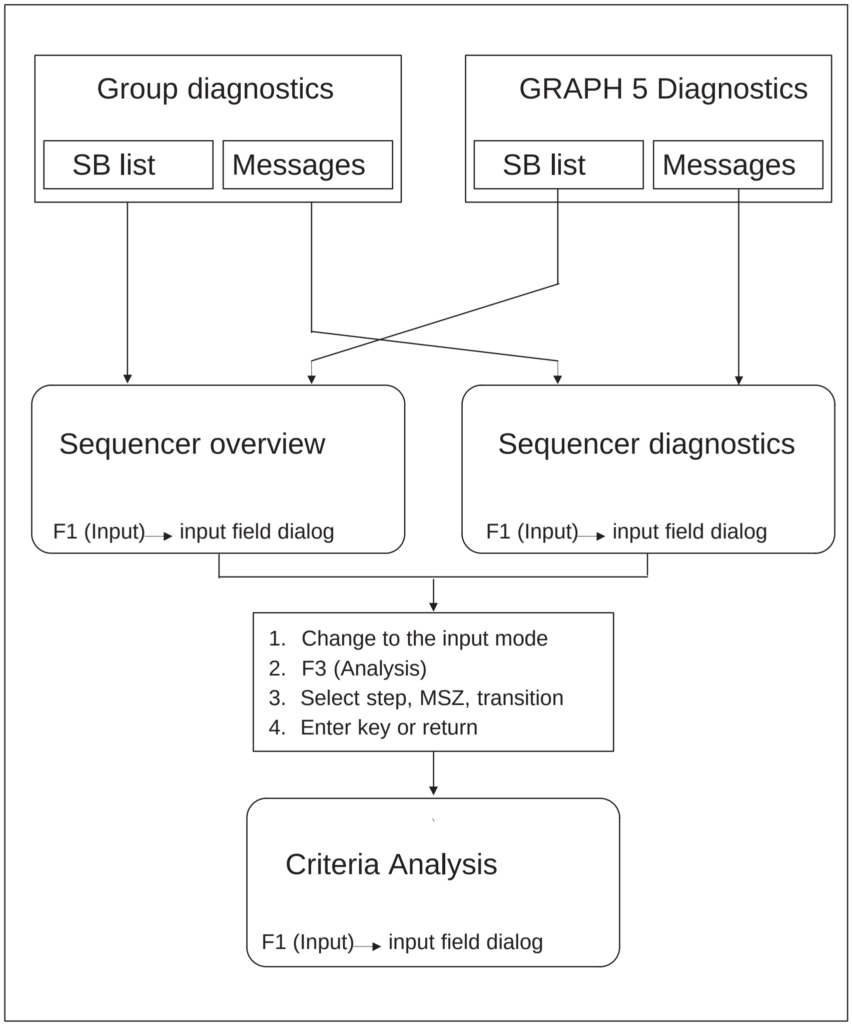
The main functions of GRAPH 5 diagnostics include the recording of sequencers with a timeout, recording the date and time, the analysis of the timeouts and their causes (criteria). Various dialogs can be selected for display on the screen or for printing out.

- SB list (sequencer overview),
- messages (sequencer diagnostics),
- and selection of criteria analysis for both together.
- and output to printer for both

Input Dialog

From the three dialogs, sequencer overview, sequencer diagnostics and criteria analysis, you can call the input dialog using ***F1*** *(Input)*.

6.5.2 Overview of the Main Functions on the PG



Group Diagnostics

If you want to monitor the sequencers in several PLCs, you must first inform the PLC of the connections (path, path name).

6.5.3 Sequencer Overview

The “sequencer overview” dialog displays the existing sequence blocks on the monitored PLC. The dialog has two modes:

- Display mode (polling mode) with cyclic polling. This displays detailed information about the marked sequence block. To change from polling to the input mode, you can use ***F1** or the ESC key.* A step with a timeout is indicated by a white asterisk on a red background.
- Input mode for selecting various displays and changing to the input dialog. This allows you to select one of the displayed SBs and to analyze it using the function keys. In this mode there is no updating of the message.

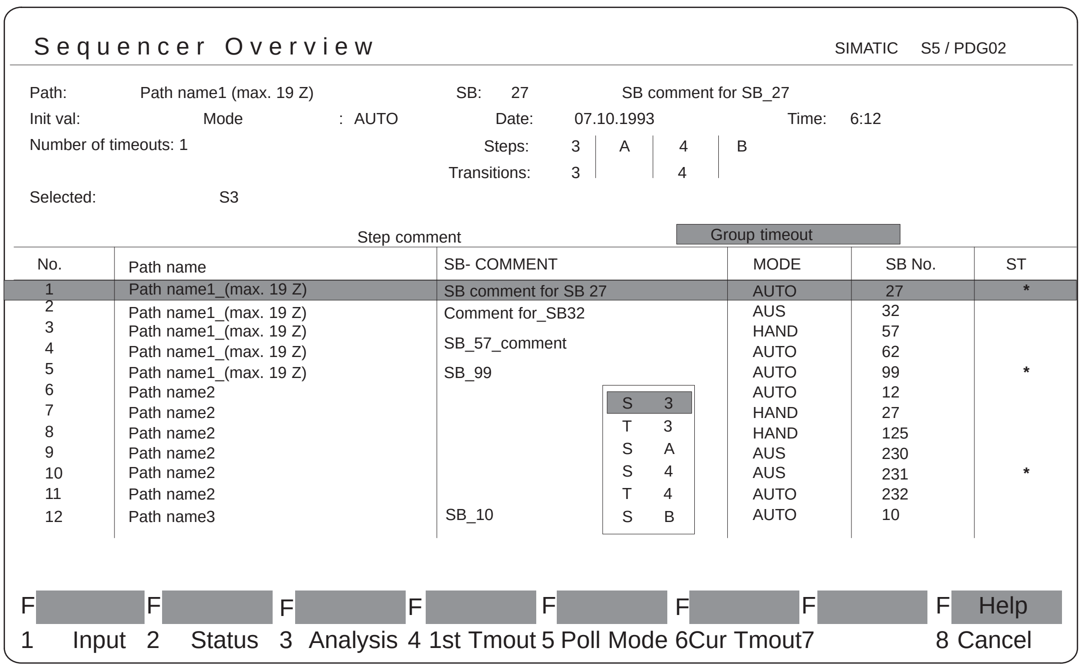


Figure 6-3 Sequencer Overview Dialog in Input Mode

Information about the Dialog

The following information is displayed for each of these sequence blocks:

- a consecutive number,
- the path name of the PLC,
- the comment from the assignment list,
- the SB number,
- the mode and
- an ID indicating whether the SB has a timeout or not.

The selected SB is marked by an inverse bar. If there is a message in the message buffer for this SB, this is displayed at the top edge of the screen. Any function keys you press relate to the selected SB. The timeouts are detected and updated in the polling mode by reading out the DB<G5:DIAG> cyclically.

The Function Keys

F1 *Input*	Branch to the input dialog
Shift F1 *FB Input*	Branch to the FB input dialog
F2 *Status*	Program status. If timeout criteria exists, the selection dialog (sequencer at the overview level, steps, transitions, MSZ) is displayed. Otherwise the status is started at the overview level.
F3 *Analysis*	Display “Criteria analysis” dialog. If timeout criteria exist, the selection dialog (steps, transitions, MSZ) is displayed. Without timeout criteria, no analysis is possible.
F4 *1st Tmout*	Display the initial value of a timeout
F5 *Cur Tmout*	Detect and display the current timeout. This brings about an automatic change to the polling mode to read out the current timeout and you then return to the operating mode. If timeout criteria are available they can now be analyzed.
F7 *Poll Mode*	Change to the polling mode
F8 *Cancel*	Return

The function key ***F4*** *(1st Tmout)* is only active when the current SB has a timeout and the “REFRESH” message is displayed.

The function key ***F6*** *(Cur Tmout)* is only active when the current SB has a timeout.

List Box in the Dialog

If you press either ***F3*** *(Analysis)* or ***F2*** *(Status)* when a timeout has occurred, a list box appears in the dialog. The list box for status also has the“sequencer” element for the overview level of the SB.

Group Timeout Message

This indicates that at least one SB on one of the monitored PLCs has a timeout. This means that an SB is marked as having a timeout in the diagnostic DB or a timeout message must have arrived at the PG.

If an SB has a timeout but there is not yet a message in the message buffer, then “no message in message buffer” is displayed at the top of the screen.

Direct Connection

With a direct connection via AS 511, DIRECT CONNECTION is entered as the path name.

Initial Value, Refresh Value

GRAPH 5 diagnostics distinguishes between an initial value message and the current timeout status.

The initial value message reflects (and stores) the situation as it was after the block was run through in the cycle in which the timeout first occurred. Only the initial value is buffered.

The current timeout status (current value or refresh value) reflects the situation when changes have occurred after the first timeout. The current value is not buffered, but is overwritten when the dialogs are updated.

Criteria Analysis Function

With the criteria analysis function, you can display error criteria directly on the PG with symbol names and comments.

6.5.4 Sequencer Diagnostics

Current messages about sequencers with a timeout are displayed in the “Sequencer Diagnostics” dialog.

The dialog has two modes:

- Display mode (polling mode) with cyclic polling. The only function key available is ***F1*** *(Inp Mode)* to change to the input mode.
- The input mode for selecting various displays and changing to the input dialog.

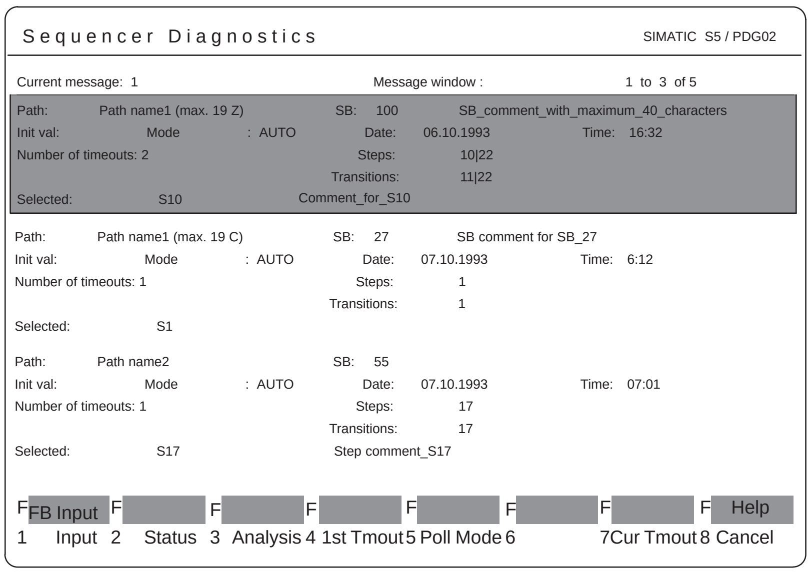


Figure 6-4 Sequencer Diagnostics Dialog in the Input Mode

Polling Mode

The polling mode is distinguished by the following:

- There is no timeout:
  an asterisk moving on an empty screen indicates that diagnostics is in process.
- There is a timeout:
  display of the timeout message with the function key menu.

Input Mode

There is no cyclic polling in the input mode.

In this dialog up to three timeouts per screen page are displayed. The currently selected timeout is displayed inversely. All inputs relate to this message and to the SB it describes.

You can return to the polling mode with the key ***F7*** *(Poll Mode)*.

If you change to the input mode without a selected timeout, only keys ***F7*** and ***F8*** are active.

The Function Keys

F1	*Input*	Branch to the input dialog
Shift F1	*FB Input*	Branch to the FB input dialog
F2	*Status*	Program status
F3	*Analysis*	Output criteria analysis
F4	*1st Tmout*	Display the initial value of a timeout
F5	*Cur Tmout*	Determine and display the current timeout
F7	*Poll Mode*	Change to the polling mode
F8	*Cancel*	Return

Messages

Messages are recognized by the cyclic reading out of the diagnostic DB. A message consists of all the messages belonging to an SB.

If an error occurs, FB 67 automatically generates a message which is entered in the diagnostic DB (= initial value).

Using the function key ***F5*** *(Cur Tmout)* a request bit for a refresh message is set in the diagnostic DB. This bit indicates to FB 67 that the current information about the timeout is required. FB 67 then enters the current data in the diagnostic DB again.

This means that the initial value (status when the timeout occurred and was detected) and refresh value (status when the refresh was requested) are available to you. You can check whether changes have taken place between these two points in time. Refresh values are not buffered.

Time Information

The times indicated in the message are the PG times when the timeout was recognized and entered in the message buffer on the PG.

Number of Messages

The PG can only manage a certain number of messages (depending on the number of entries between 10 and 30 messages). If this number is exceeded, you are prompted to decide whether the oldest message should be overwritten or the newest message not entered in the message buffer. This selection remains valid whenever the message buffer overflows until you exit the GRAPH 5 diagnostics package.

The number of messages on the PLC is also limited. If there is an overflow, messages are lost.

Steps/Transitions

The information “steps” and “transitions” indicate the steps or transitions for which FB 67 has supplied messages.

Selected

Under “selected: sequence block”, the comment from the comment block is displayed.

6.5.5 Criteria Analysis

Information about criteria analysis exists if the diagnostic program has found outputs which are not set or input scans which have not been fulfilled in the steps/transitions with timeouts.

Criteria Analysis for a Step

In the **criteria analysis** dialog, the assignments in a step which have not been fulfilled and their criteria are displayed. Absolute operands, symbols and additional comments are displayed for each operand.

If several steps and transitions have timeouts, you must select the required step or transition in the selection window prior to criteria analysis.

Note

Remember that the status of the SB after it has been run through is retained as the basis for automatic timeout analysis.

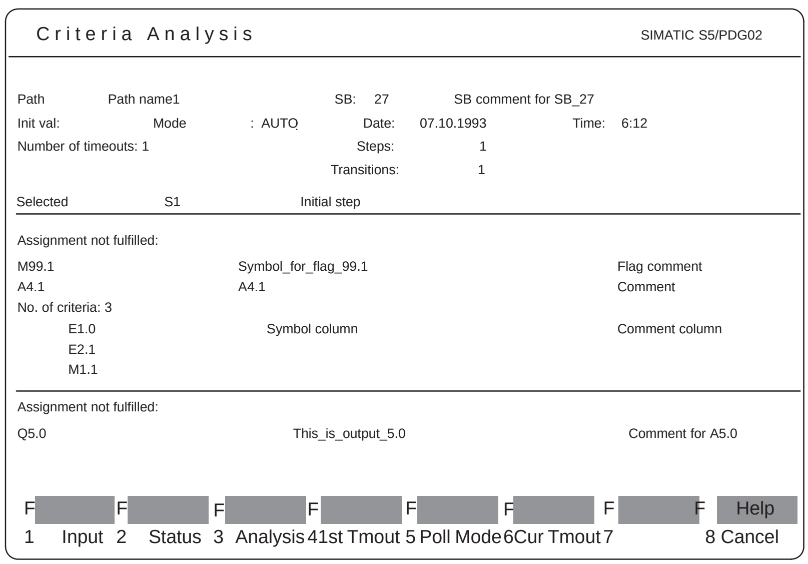


Figure 6-5 Criteria Analysis for a Step

Criteria Analysis for an MSZ

With an MSZ, the number of the MSZ and if it exists the MSZ comment are displayed below the default window (timeout information).

All the other information is the same as with the analysis of a step.

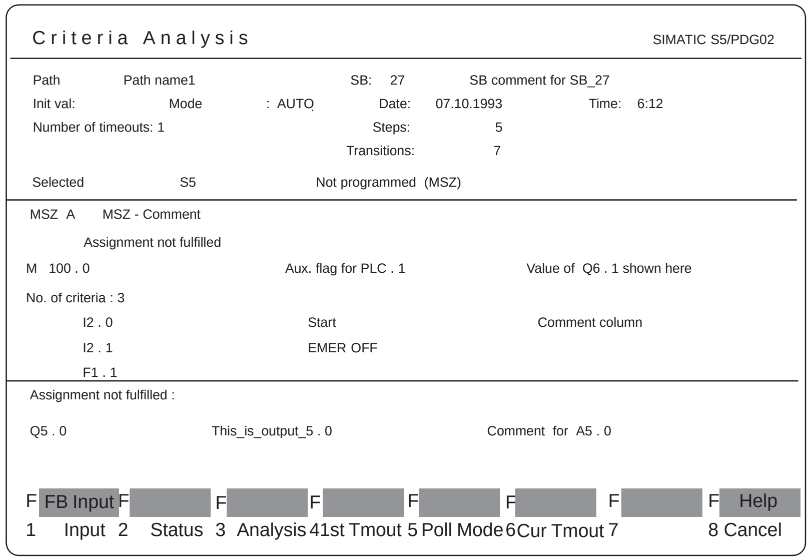


Figure 6-6 Criteria Analysis for an MSZ

Function Keys in the Criteria Analysis Dialog

F1	*Input*	Branch to the input dialog
Shift F1	*FB Input*	Branch to the FB input dialog
F2	*Status*	Program status
F3	*Analysis*	Display criteria analysis
F4	*1st Tmout*	Criteria analysis of the initial value
F6	*Cur Tmout*	Criteria analysis of the current value
F8	*Cancel*	Return to the previous dialog

Criteria Analysis for a Transition

In the criteria analysis for a transition, in contrast to steps or MSZs, only the unfulfilled criteria are displayed which determine the output RLO of the transition zoom-in. Any unfulfilled assignments in the transition are not evaluated or displayed. Normally, this involves the step flag.

Absolute operands, symbols and additional comments are displayed for each operand.

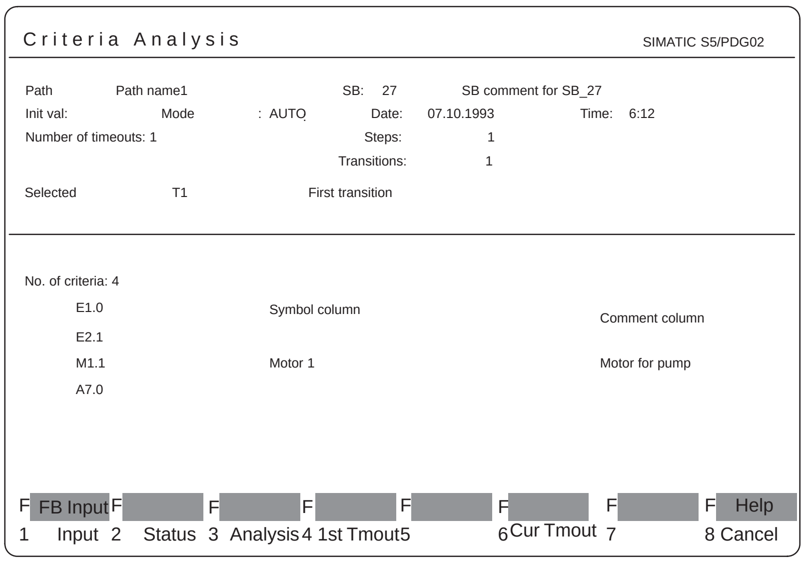


Figure 6-7 Criteria Analysis for a Transition

6.5.6 Input Dialog

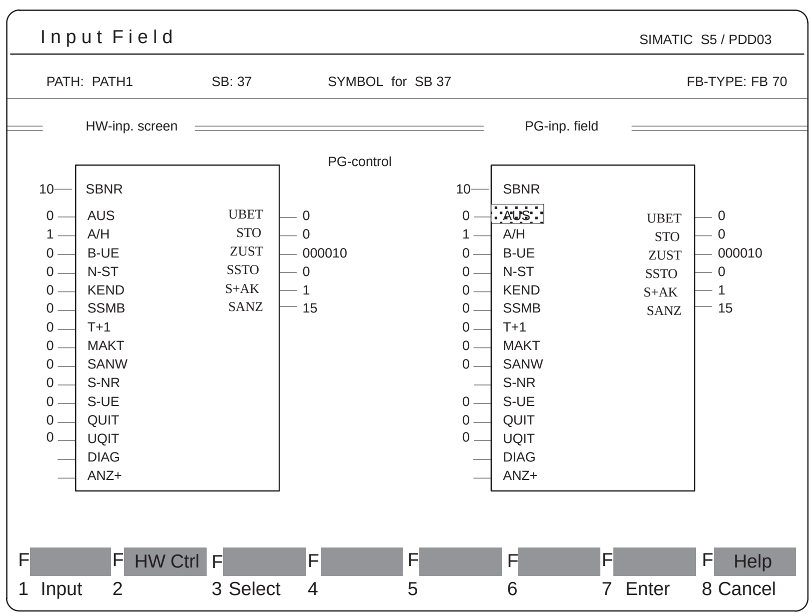
FB Input Dialog

The input dialog is divided into a display section (HW input screen) and an operating section (PG input field). In the display section, signal states of the hardware I/Os are indicated and in the operating section, you can change the set parameters in the editing mode. Both parts represent the FB used in CSF representation in the polling mode. In the polling mode, the status for each parameter is displayed. The bit inputs of the operating section can be changed using the select function in the editing mode.

Dialog with FB 70

The following parameters cannot be changed in this dialog:

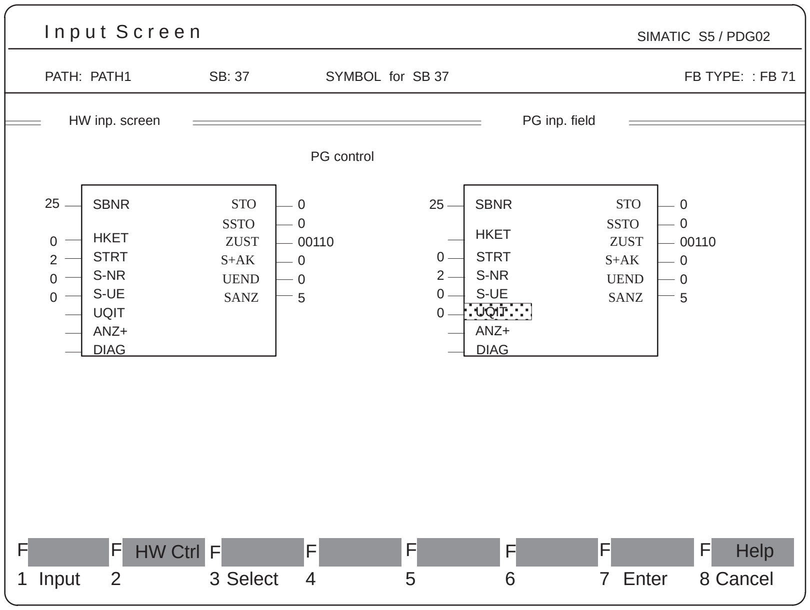
N-ST
DIAG
SBNR



Dialog with FB 71

The following parameters cannot be changed in this dialog:

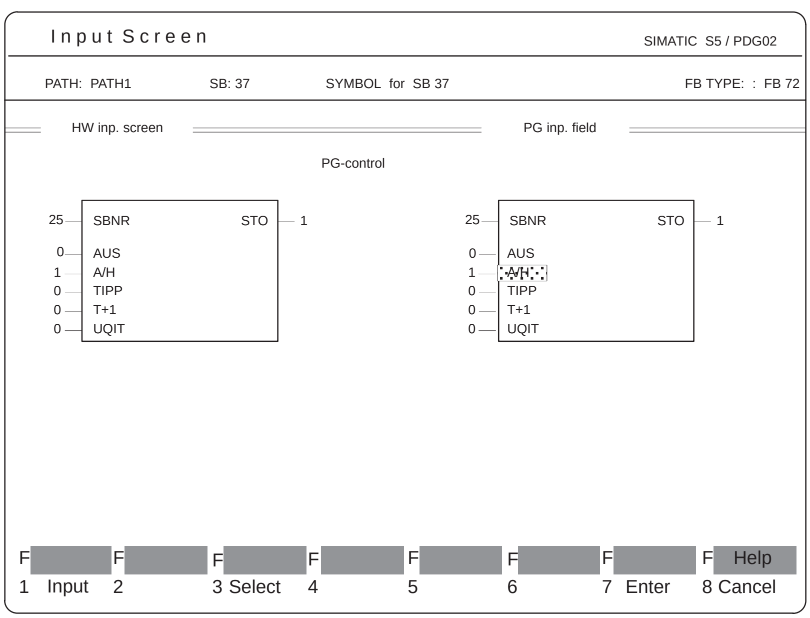
SBNR
HKET
STRT
DIAG



Dialog with FB 72/FB 73

The following parameters cannot be changed in this dialog:

SBNR

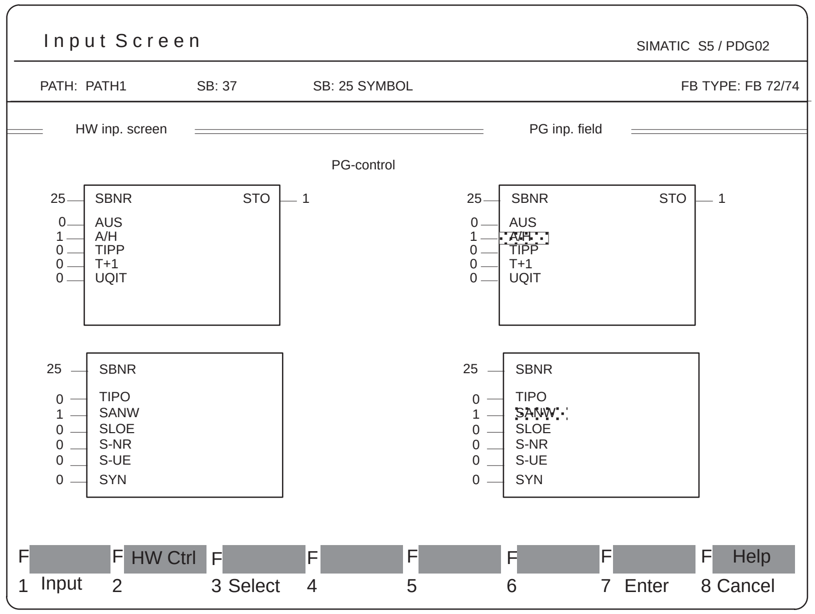


Dialog with FB 74

FB 74 can be used with:

- FB 72 or
- FB 73.

FB 74 cannot be executed alone.



Note

To change between a simple input field and FB input field:
F1 FB Input <–> Input

Simple Input Field

The simple input field allows you to make the most important selections for GRAPH 5/II sequencers:

- Change mode (manual, auto and off)
- Activate and deactivate actions (only with FB 70)
- Execute with condition (only with FB 72/73 with FB 74)
- Execute (T+1)
- Acknowledge timeouts
- Acknowledge unconditionally (only with FB70)
- Start synchronization
- Accept synchronization result

The only selections that are possible are those supported by the corresponding standard-FB (FB70/71/72/73). Synchronization can only be controlled when the synchronization SB has been generated and is run through cyclically.

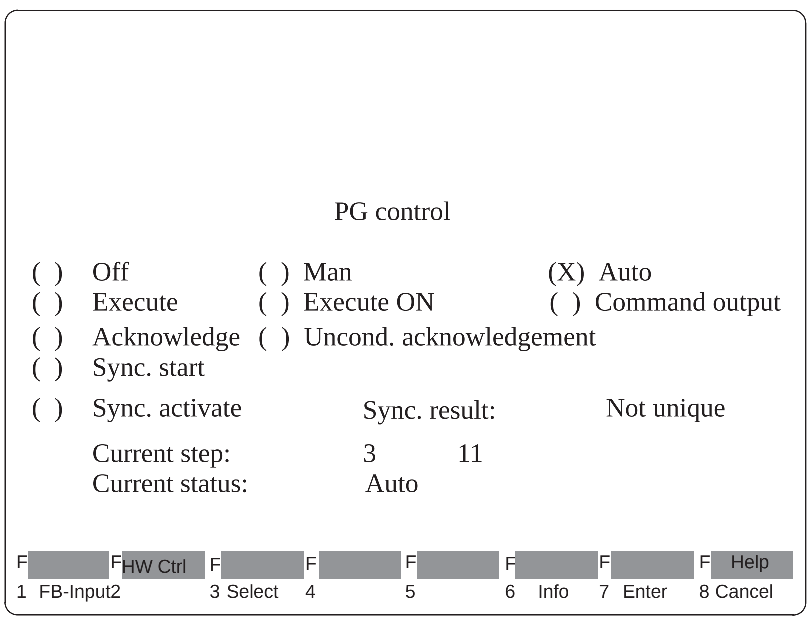
The synchronization result can only be accepted when it produces a single candidate and the last command was “Sync. start”. In this case the step number of the step to which the sequencer is synchronized is entered in the “Sync. result: Step” field. If the result is more than one step or if no result is found, the message “Not unique” is entered here.

The simple input dialog can be selected in diagnostics or in the FB input screen form with **F1** (Input). With **F1** (FB Input) you can change from the simple input dialog to the FB input dialog. The FB input dialog has not changed compared with GRAPH 5/II “Version 6.0”. It can now be selected in the input mode of diagnostics with Shift **F1** (FB-Input). Both input dialogs can be exited with **F8** (Cancel).

Note

For PG control, data words DW34 and DW35 in DB <Sequence> are supplied with values from the input dialog. To allow this, FB69 (FB diagnostics) of GRAPH 5/II must run on the PLC.

Dialog for an SB Controlled with FB70



Dialog for an SB Controlled with FB72 or FB73

PG control

( )	Off	( ) Man		(X) Auto
( )	Execute	( ) Execute		
( )	Acknowledge	ON		
( )	Sync. start			
( )	Sync. activate		Sync. result:	Not unique
	Current step:		3 11	
	Current status:		Auto	

F1	F2	F3	F4	F5	F6	F7	F8
FB-Input	HW Ctrl	Select			Info	Enter	Help Cancel

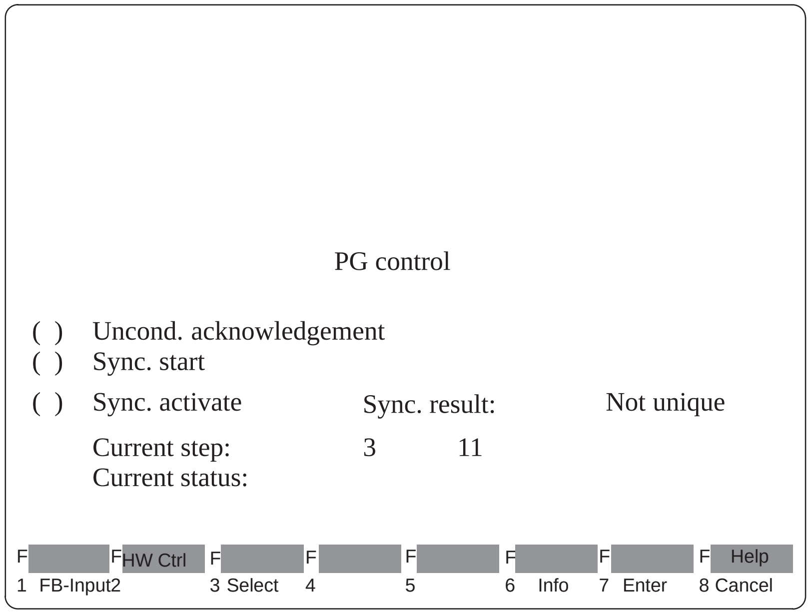
Dialog for an SB Controlled with FB72 or FB73 and FB74

PG control

( )	Off	( ) Man		(X) Auto
( )	Execute	( ) Execute		( ) Execute w/o cond.
( )	Acknowledge	ON		
( )	Sync. start			
( )	Sync. activate		Sync. result:	Not unique
	Current step:		3 11	
	Current status:		Auto	

F1	F2	F3	F4	F5	F6	F7	F8
FB-Input	HW Ctrl	Select			Info	Enter	Help Cancel

Dialog for an SB Controlled with FB71



Selections

The following selections are possible:

- You can change the mode with “Off”, “Man” and “Auto”. With the “Man” mode, you set either “Execute” or “Submode”. You can select this with “Execute ON”. When using FB71, the mode of the main sequencer is adopted.
- In the “Man” and “Execute ON” mode, the command output can be activated or deactivated with “Command Output” when using FB70.
- In the “Man” mode and “Execute ON” mode, the querying of the switching condition in the transitions can be activated or deactivated with “Execute w/o cond.” when using FB72/73 and FB74.
- A timeout can be acknowledged with “Acknowledge” or with FB70/71 with “Uncond. acknowledgement”.
- If synchronization is selected when editing the GRAPH 5/II-SB, this can be started with “Sync. start” and adopted with “Sync. activate”.

The current steps and mode of the sequencer are displayed in the status display. The status output and selections are started with F7 (Enter).

The required operation can be selected with the cursor or mouse. A field becomes active when it is selected and then

- You press **F3** (Select) or
- By activating the input field again with the mouse.

A field is active when X is entered in the brackets before the field.

Before the input is accepted by the PLC, the GRAPH 5/II sequencer must be set to PG input. The bit in DB<Sequence> can be switched between PG and HW input with **Shift F2** (PG Ctrl or HW Ctrl) if the bit is not hard wired. If PG control is set, the command can be sent to the PLC with **F7** (Enter).

Terms: PG Control, HW Control

If the data word in the user DB (DB<G5:SEQUENCE>)is set to “PG control allowed” (data word 33 bit 3=1), the set or modified parameters are entered and written to the diagnostic DB (DB<G5:DIAG>), when you press the enter key. This is displayed in the polling mode by the term “PG control”.

If the data word in the user DB is set to “external control” (I/Os) (data word 33 bit 3=0), the term “HW control” appears in the polling mode and you can set the parameters (mode, acknowledgement etc.) via the hardware I/Os.

Note

DW 33, Bit 3 = 0
If bit 3 is wired in the hardware, it is not completely protected from manipulation in the software.

Function Keys

F1	*FB–Input*	Change to FB input field
F3	*Select*	Change the parameter value
F7	*Enter*	Enter the selected functions
F8	*Cancel*	Return to the previous dialog

A change in the mode must be confirmed again after you make the selection.

Changing Parameters

If a parameter value has been changed, this is highlighted in color on the screen.

With parameters which react to a positive-going edge, the character “_-_” indicates that first the value 0 and then the value 1 is written to the diagnostic DB.

Note

You yourself must be responsible for the interaction of the selected parameters (some settings are only dependent on the mode).

6.6 Example of GRAPH 5 Diagnostics

The following example relates to the example “powder press” in Section 4.8.

The parts of the press, the cycle, the planning and programming of SB 10 are described in Section 4.8.

6.6.1 Blocks on the PLC

The following standard blocks must exist on the PLC:

SBs and FBs

SB 3	standard sequence block
FB 73	standard function block for main sequence
FB 69	diagnostic FB, FB<G5:DIAG>
FB 68	diagnostic FB, FB<COPY>
FB 67	diagnostic FB, FB<>

Parameter DBs

Assign parameters for DB<G5:PARA> with the DB editor (refer to the S5 basic package) and transfer it to the PLC.

Here, DB 249 is used as the DB<G5:PARA>. For information on DB<G5:PARA> refer to Sections 6.7 and 7.3.

Diagnostic DB and Working DB

Generate the diagnostic DB and the working DB with the function DB-GEN on the PG and then transfer them to the PLC:

DB 254	diagnostic DB = DB<G5:DIAG>
DB 10	working DB = DB<G5:SEQUENCE>

6.6.2 Programming Startup OBs

For this example, the startup OBs are programmed as follows and then transferred to the PLC:

OB 20

```
OB 20
:C   DB 249    Data block for parameter assignment
:L   KF +20    OB number
:T   DW 8
```

OB 21

```
OB 21
:C   DB 249    Data block for parameter assignment
:L   KF +21    OB number
:T   DW 8
```

OB 22

```
OB 22
:C   DB 249    Data block for parameter assignment
:L   KF +22    OB number
:T   DW 8
```

6.6.3 Block Calls

In OB 1, a program block PB 10 is called which then calls FB 73. The number of the PB should be the same as the number of the SB to make the program clearer.

After calling all the sequencers with the standard blocks FB 70 to FB 75, program block PB 9 is called in OB 1. This contains the cyclic part of all the GRAPH 5 diagnostics.

6.6.4 Blocks for the Cyclic Part

In this example, OB 1, PB 9 and PB 10 are programmed as follows and transferred to the PLC.

OB 1

```
OB 1
:A   F 1.0
:R   F 1.0      flag permanently 0
:JU  PB 10      call sequencer with FB 70-75
:JU  PB 9       call GRAPH 5 Diagnostics
```

PB 9

```
PB 9
:C   DB 10      open DB 10 (working DB)
:L   DR 33      DR 33 control word special functions
:T   FY 255
:A   I 11.7     HW inp. screen
:=   F 255.3    (control mode selection with D 33.3)
:L   FY 255
:T   DR 33
:JU  FB 69      call FB 69 GRAPH 5 Diagnostics
Name :G5:DIAG
PARA :DB 249    parameter data block
     :BE
```

(See also Chapter 7, ”Structure of the Data Blocks”).

PB 10

```
PB 10
Segment 1
:A    F 1.0
:R    F1.0          flag RLO permanently 0
      :***
Segment 2
      :JU FB 73     call FB 70
Name  :GPH:HKET
SBNR  :KF+10
AUS   :I 4.1        AUS switch on HW inp. screen
A/H   :I 4.0        A/H switch on HW inp. screen
TIPP  :F 1.0        TIPP switch on HW inp. screen
T+1   :F 1.0        T+1 button on HW inp. screen
QIT   :I 4.2        QIT button on HW inp. screen
STO   :A 1.5        STO display on HW inp. screen
      :BE
```

(see also Chapter 4 Detailed Description of the FB)

FB 73 must be transferred the number of the SB to be called (SB 10). The standard parameters of the function block FB 73 must also be supplied.

In, for example, the step sequence overview of GRAPH 5 diagnostics, you can now observe the SBs on the monitored PLC and locate the cause of a timeout using criteria analysis or program status.

6.7 Detailed Description of the FB

6.7.1 FB 69: Startup, Operation and Monitoring

FB 69 processes the diagnostics. When it is called, only the parameter data DB is transferred as a parameter (formal operand: PARA). FB 69 consists of a startup and a cyclic section.

FB 69 Startup Section

The parameter data DB (DB<G5:PARA>) contains the parameters necessary for GRAPH 5 diagnostics.

You assign values for DW 1 to DW 8. After the content of DW 8, FB 69 recognizes a startup ID, activates its startup section, triggers test routines and distinguishes the following:

- startup for DB<G5.DIAG>
- startup for DB<DIAG>

This is based on the assignment of the DB<G5:PARA>. (refer to Section 7.3)

Once the startup has been triggered (DB<G5:PARA>:DW 8), the following is checked:

- whether a GRAPH 5 SB exists on the PLC and
- whether the GRAPH 5 editor <F128>ô<F255> V6.0 has been used (compatibility check).

If these conditions are fulfilled, the startup section for DB<G5:DIAG> and DB<DIAG> is activated separately.

Startup for DB<G5:DIAG>

Transfer from DB<G5:PARA> to DB<G5:DIAG>

DW 1 DW 63

: ⇒ :

DW 7 DW 79

The parameters are accepted:

- during the first startup and
- when the PLC address is changed by DB<G5:DIAG> by transferring it from the PG.

The field length in DW 7 is fixed internally to KF + 30. If the data words DW 5 and DW 6 are not assigned, the pointer KF + 1 is entered.

- Generation of DB<DIAG> with the parameters from DB<G5:PARA>
- Entry of the start pointer in DB<DIAG> DW 0 to DW 11

The DB is generated when:

- DB<DIAG> has been deleted
- an incorrect DB<DIAG> exists on the PLC
- (calculated DB length does not match existing DB length)
- DB length min. 1 field, max. 135 fields
- not enough free RAM memory on the PLC.

In DB<G5:DIAG>, DW 162 is used to indicate the startup section. If there is an error, FB 69 remains in the startup section and monitors/checks the requests already executed.

DB<G5:DIAG>	D 162.0	startup section DB<DIAG> active
	D 162.1	startup section DB<G5:DIAG> active
	D 162.2	startup complete without errors
	D 162.3	startup error
	D 162.15	incompatible

Once the startup section has been completed successfully, the whole sequencer image is entered in DB<G5:DIAG> and all the timeout and acknowledgement messages are suppressed. Instead of these, a DB-GEN message is sent and the operating and monitoring section is enabled.

Note

When starting up the system software, in OB 1, the ID +1 can be written in DB< G5:PARA> DW 8. This means that the startup section is also active cyclically. Changes made for example with the PG function DB-GEN are taken into account immediately.

On conclusion of the planning phase, you should delete this program section to reduce the cycle time in OB 1 and only write DB<G5:PARA> DW 8 in the startup OB. The startup ID is cleared when the startup section is completed successfully.

FB 69 Operation Section

You can select a sequencer via DB<G5:DIAG> DW 20.

You can control the modes using DW 21 to DW 23 (assuming that DB<G5:SEQUENCE>:DW 33.3=1).

Messages from the sequencer are stored in DW 25 to DW 27. Enabling in DB<G5:SEQUENCE>:DW 33.3=1 does not cause the active mode to change.

GRAPH 5 diagnostics is not involved in the access procedure and therefore has the lowest priority. This procedure allows you to evaluate DB<DIAG> using other diagnostic units or other diagnostic concepts.

If you do use other diagnostic units, you must implement the function selection according to the following schematic:

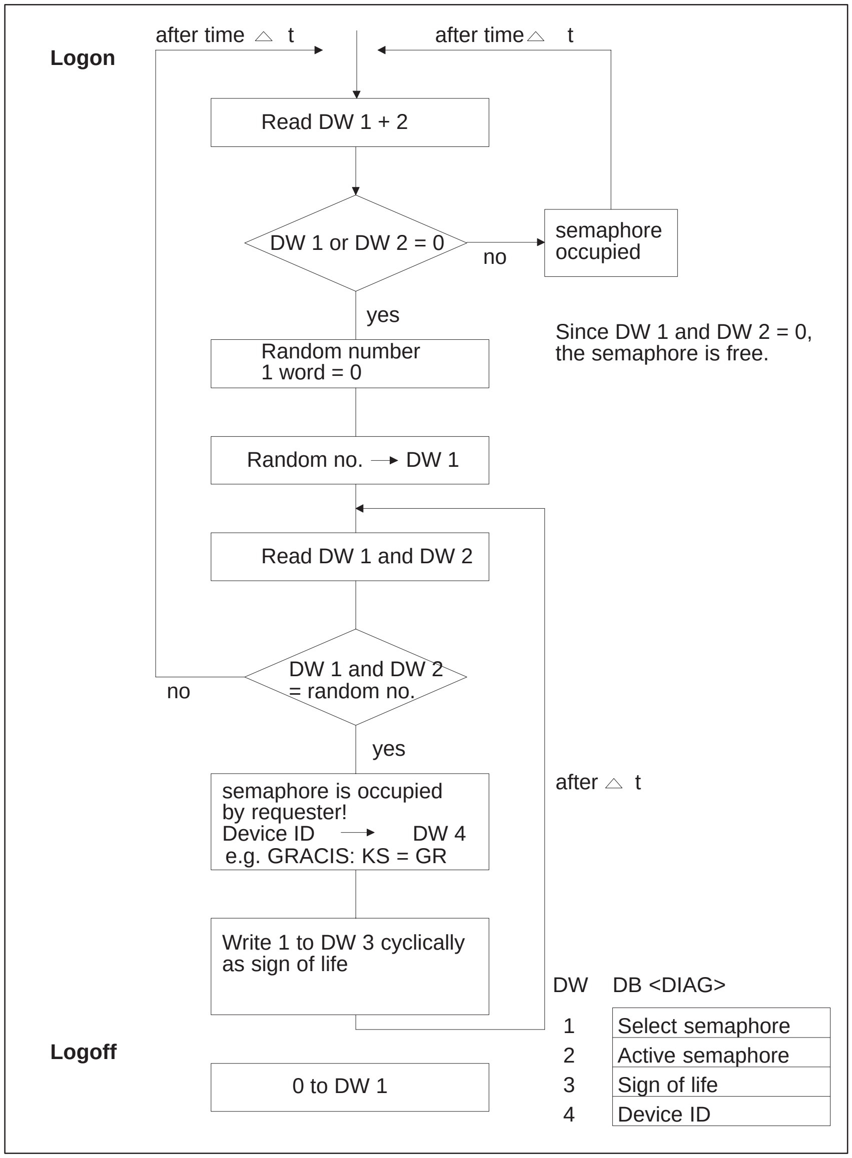
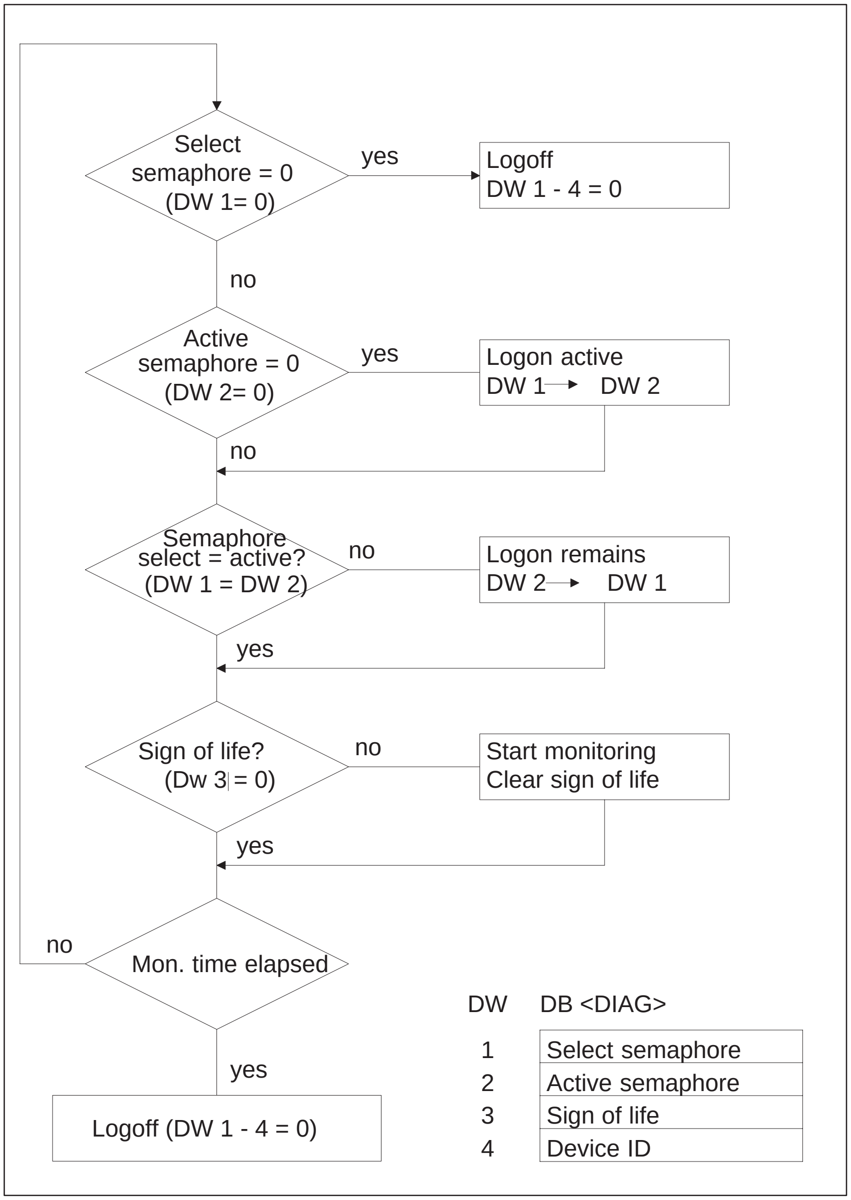


Figure 6-8 Program on the Diagnostic Unit

Principle of Semaphore Evaluation

The evaluation of the semaphore is integrated in FB 69 on the PLC.



The Monitoring Section

Here, FB 69 monitors all the sequencers entered in DB<G5:DIAG>, initially for two states and then sends appropriate messages:

1. Sequence x with timeout edge = timeout message
2. Sequence x no timeout edge = acknowledgement messages

In addition to this, there are refresh messages for certain sequencers (on request) and the DBGEN message from the startup section.

The messages are structured according to the following priorities:

1st	priority	DBGEN	:	No status evaluation Only one message with the header data from DB<G5:DIAG> DW 80 to DW 87 and all other messages suppressed for one PLC cycle. Status is not read.
2nd	priority	STOE	:	Status evaluation with all necessary data for acquiring the 1st timeout of every sequencer up to a maximum STOE number within the 1st PLC cycle. A separate timeout message is output for each simultaneous branch. The status is read.
3rd	priority	REFRESH	:	Message structure as with STOE, however, only for the selected sequencer via DB<G5:DIAG> DW 20. If there is no longer a timeout, a QUIT message is sent for the selected sequence.
4th	priority	QUIT	:	Message structure as for DB-GEN, however, with additional information about the SB number and status word of the sequencer. The status is not read.

Diagnostics is always from the start of a zoom-in (pointer list). FB calls and their parameters are excluded, as well as all commands which cannot be diagnosed.

The only commands which can be diagnosed are the following binary logic operations.

CPU 928B or CPU 946/947						
A	AN	O	ON	=	S	R
I	Q	F	S	T	C	

The individual statuses of the signal scan are formed and written into a message with the ID “statuses read”.

ID and Further Message Structure

The sequence of messages are structured on the PLC when necessary by FB<G5:DIAG> based on the type of field. The IDs and further message structure are illustrated in the following schematic.

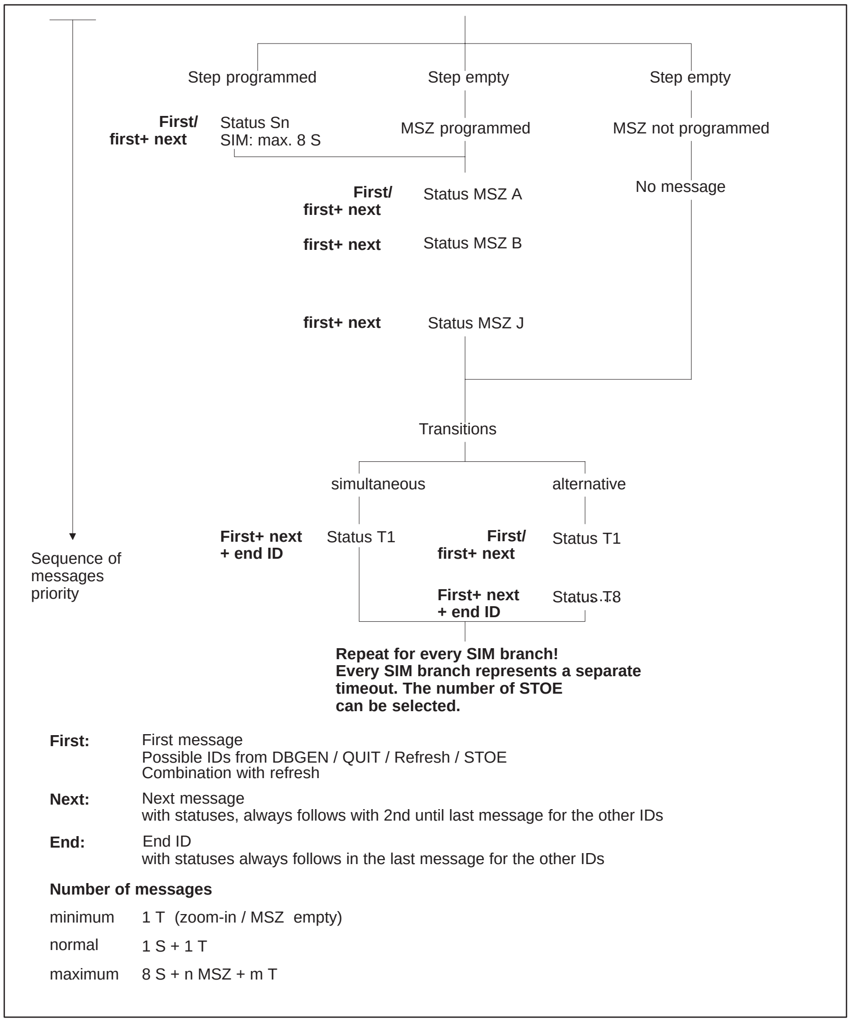


Figure 6-9 ID and Further Message Structure

6.7.2 FB 68: Write Data

This standard FB is called by FB 69 and is responsible for the correct entry of a message from DB<G5:DIAG> in DB<DIAG>. FB 68 monitors and sets the write pointer to the next message field and, if necessary, enters the OVERFLOW in DB<DIAG> DW 10.

Note

This block only needs to be loaded. You can only call it when you wish to include your own entries in DB<DIAG>. Note the following points.

Transfer Parameters

Before calling FB 68, the flag word must be supplied as input parameters.

FW 230	KF	DB-NR.	Source (structure of a message after occupying DB<G5:DIAG>DW 80 to 109)
FW 232	KF	DW-NR.	Source message start DB<G5:DIAG> $\rightarrow$ F+80)
FW 234	KF	DB-NR.	Destination $\rightarrow$ DB<DIAG>

After processing FB 68, its output parameters must be supplied if necessary in flag byte 246.

F 246.0 = 1	Message transfer complete without error

Internal scratchpad flags used: FY 230 to FY 246!

The scratchpad flags can be overwritten outside the FB 68 boundaries.

Note

- Whenever FB 68 is run through, a message is entered in DB<DIAG>.
- Limits DB<DIAG> (1st priority) write pointer = read pointer, and the last message is overwritten and OVERFLOW indicated in DW 10.

6.7.3 FB 67: Read Data

This standard FB is called by FB 69 and is responsible for the correct reading of a message from DB<DIAG> into DB<G5:DIAG>. FB 67 communicates with the “GRAPH 5 diagnostics” PG software via the control word DW 160 in DB<G5:DIAG>. FB 67 manages the reading of data as a passive partner of the PG software, i.e. the PG requests information, FB 67 reads and transfers the information to the PG. If the semaphore is entered in DB<DIAG>, FB 67 automatically sets itself to the second priority after all other diagnostic units and no longer destroys the data when it reads them. The information in DB<DIAG> must therefore be deleted by additional diagnostic units, otherwise DB<DIAG> will be written full.

You must only call this block when you are using your own diagnostics, to read information from DB<DIAG>. The following point must be remembered.

Note

This block only needs to be loaded. You can only call it when you want to read out your own entries from DB<DIAG> to the working DB. Please remember the following points:

Transfer Parameters

Before calling FB 67, the flag words must be supplied as input parameters

FW 230	KF	DB-NR.	Destination: structure of a message after occupying DB<G5:DIAG>DW 120 to 159
FW 232	KF	DW-NR.	Start of destination DB<G5:DIAG> $\rightarrow$ KF+120
FW 234	KF	DB-NR.	Source $\rightarrow$ DB<DIAG>

Internally occupied scratchpad flags: FY 230 to 247.

Each time data is read, the diagnostic unit must set D 160.0=1 in DB<destination>. FB 67 deletes this bit after entering a message and updates the status in DL 160.

After processing FB 67, its pointers are updated in DB<source> and its status bits in DB<destination>.

DB<dest>	D 160.8	One message read
<F128>	D 160.9	OVERFLOW (DB<source> DW 10)
	D 160.10	Last message read

Note

- Basic assignment DB<G5:DIAG> DW 120 to DW 160
  DB<DIAG>DW 5 to DW 11
- Semaphore of a different diagnostic unit active:
  status bit DB<dest> D 162.9=1

---

7 Structure of the Data Blocks

Chapter Overview

7.1 Assignment of the Working DB: DB<G5:Sequence>

This section describes the data words of the working data block of a sequencer. The data words are written to both statically and dynamically.

The DB<G5:Sequencer> can not be generated in shortened form.
1. without user data
2. as in 1. and without automatically generated synchronization SB
3. as in 2. and without FB 75 data

In the static part, the GRAPH 5 editor writes the data words with values for the specific sequencer during generation. These values are retained while the program is running and must not be modified.

The dynamic part of the working DB is overwritten by the standard function blocks such as FB 70, FB 71, FB 72 etc. cyclically and is therefore constantly changing.

Internal data must not be modified.

An overview of the static and dynamic assignment of the data words can be found at the end of this chapter where the working DB is illustrated once again.

The sequence block number is entered in DL 0.

The input parameter SBNR in FB 70 and FB 71 or FB 72 or FB 73 etc. must match DL 0 to be able to process the sequence block.

The length of the sequencer, i.e. the number of steps in the sequence block, is entered in DR 0 (without the steps SA, SB...).

Using the function DB-GEN on the PG, not only the working DB for the sequencer but also a diagnostic DB is generated. The block number of this diagnostic DB is entered in DR 1.

0	Sequence block no. (KF)	Number of steps (KF); (without SA, SB..Sn)
1	KH00	No. of the DB<G5:DIAG>(KF)

If a timeout occurs in a sequencer, the numbers of the steps with a timeout are entered in DW 2 to 5 (indicated by the timeout bar in the status of the sequencer overview).

A maximum of one step can have a timeout in a simultaneous branch.

2	S-no. timeout level 1(KF)	S-no. timeout level 2(KF)
3	S-no. timeout level 3(KF)	S-no. timeout level 4(KF)
4	S-no. timeout level 5(KF)	S-no. timeout level 6(KF)
5	S-no. timeout level 7(KF)	S-no. timeout level 8(KF)

When generating the data blocks, all the GRAPH 5 blocks are determined from the PLC or the program file.

In DL 7, the next GRAPH 5 block number if entered if it exists.

DW 8 and DW 9 contain IDs of the software releases used.

DW 8 contains an ID of the GRAPH 5 editor.

DW 9 is supplied by the standard FB with an ID of its release.

6	Reserved standard FB: expansions	
7	Next DB<G5:Sequence> KF	KH 00
8	PG software version (KY)	
9	PLC software version (KY)	

When the sequencer switches to the next step (step enabling condition fulfilled and waiting time elapsed) the new step numbers are entered in DW 10 to 17). These values are, however, only valid for this single cycle. Otherwise the values are identical to those of DW 20 to 27.

10	Next step at level 1 at the time of the switchover for one cycle (KF)
...	...
17	Next step at level 8 at the time of the switchover for one cycle (KF)

DL 18 contains the number of steps in code. A bit is set for each 16 steps.

Example: DL 18 0000 0111
The sequencer consists of 33<= steps<=48

The number of program simultaneous levels is indicated in DR 18. For each level created, a bit is displayed.

Example: DR 18 0000 1111
A sequencer with 4 simultaneous levels

The current step numbers in which the sequencer is currently located are entered in DW 20 to 70. One data word is reserved for each level (simultaneous branch). In a linear sequence (including alternative branches) only DW 20 is written to.

18	Coded number of steps 1 bit/16 steps	Number of simultaneous levels 1 bit/level
19	Internal data!	
20	Current step number level 1 (KF)	
...	...	
27	Current step number level 8 (KF)	
28	Reserved	

DW 29

The input parameters of the standard FBs (FB 70 to 75) are entered in DW 29 as follows:

D29

.0	AUS
.1	AUTO (A/H = 1)
.2	HAND (A/H = 0)
.3	SLOE
.4	SANW
.5	TIPO
.6	TIPP (SSMB)
.7	MAKT
.8	T+1
.9	KEND
.10	B-UE
.11	S-UE
.12	QUIT
.13	UQIT
.14	ANZ+
.15	

29	Image of the input parameters FB 70-74 (KM)

DW 30

The active modes and incompatibility with the standard FB are indicated in DW 30:

D30

.0	AUS
.1	AUTO
.2	HAND
.3	SLOE
.4	SANW
.5	TIPO
.6	TIPP (SSMB)
.7	SSMB +MAKT
.8	DIAG
.9	KEND
.10	SO
.11	standard FB incompatible with PG software
.12	
.13	S+AK: more than one step active
.14	SSTO: step with timeout indicated in SANZ
.15	STO

30	Active modes (KM)

DW 31

Pulses for operating a sequencer are saved in DW 31. These pulses (positive-going edge) are available for evaluating a PLC cycle.

D31

.0	T+1
.1	KEND/FB 74: SYN
.2	B-UE
.3	S-UE
.4	QUIT
.5	UQIT
.6	ANZ+
.7	step 0 is set

31	Pulses for modes

DW 32

DW 32 contains IDs entered by the standard FBs. This makes it easy to see which blocks processed the sequencer.

Example:	DW 32 = 0004	FB 73
	DW 32 = 0303	FB 72 + FB 74
	DW 32 = 5303	FB 72 + FB 74 + FB 75
	DW 32 = 5001	FB 70 + FB 75

32	FB identifier FB 74/75 (KH) FB 74 = 3 FB 75 = 50	FB identifier FB 70-73 (KH) FB 70 = 1; FB 71 = 2 FB 72 = 3; FB 73 = 4

DW 33

Using DW 33, special functions for processing the sequencer can be activated.

D33 If bit = 1 the following applies:

.0	If there is a timeout all step flags AUS
.1	If there is a timeout step flag AUS of steps with timeout
.2	Activate TM-MIN
.3	Select modes of the standard FBs via DW 34-35
.4	Step transition is switched on
.5	FB synchronization is switched on in manual operation
.6	For FB synchronization uniqueness is required.
.8	Start of the synchronization
.9	Activate the synchronization
.10	Indication: activate synchronization
.11	Indication: synchronization clear
.12	Select search function with synchronization

33	Selection and indication of mode special functions(KM)

DW 34

The selection of the modes is via DW 34 and DW 35 when D 33.3=1.

All the parameters of the standard FBs which can be addressed by DW 34 and DW 35 are deactivated.

D34	If bit = 1 the following applies:
.0	AUS
.1	AUTO (A/H = 1)
.2	HAND (A/H = 0)
.3	SLOE
.4	SANW
.5	TIPO
.6	TIPP (SSMB)
.7	MAKT
.8	T + 1
.9	KEND
.10	B-UE
.11	S-UE
.12	QUIT
.13	UQIT
.14	ANZ +
.15	step S0 active

A step number must be entered in DW 35 if SANW is to be activated via DW 34.

34	Selection of modes for operation and monitoring (KM)
35	Step number for SANW via DW 34 (KF)
36	Reserved for standard FB: expansions
...	
41	

All timer numbers for monitoring and waiting times are stored in the following data words.

A timer for the waiting time and a timer for the monitoring time are required per simultaneous level.

Timer base, i.e. the number of the first required timer, is stipulated in the ID screen form of the GRAPH 5 editor.

Example: A sequencer with 3 simultaneous levels;
T 20 was selected as the timer base.

DW 42	+ 20	T 20	waiting time	TW level1
DW 43	+ 22	T 22	waiting time	TW level2
DW 44	+ 24	T 24	waiting time	TW level3
DW 45-49	0			
DW 50	+ 21	T 21	monitoring time	TM level1
DW 51	+ 23	T 23	monitoring time	TM level2
DW 52	+ 25	T 25	monitoring time	TM level3
DW 53-57	0			

42 ... 49	KH 00 ... KH 00	Timer number for TW level 1 ... Timer number for TW level 8
50 ... 57	KH 00 ... KH 00	Timer number for TM level 1 ... Timer number for TM level 8

The flag addresses of the initial steps are entered in DW 58 to 66. A maximum of one initial step can be programmed per simultaneous level.

Example: A sequencer with initial step S1
DW 58 = 01EA 234.1

Important

At least one initial step per sequence.

58	Flag address for initial step level 1: Format: KY = X,Y where X = bit address and Y = byte address
... 65	... Flag address for initial step level 8

Each step of a sequencer has a separate step flag (symbolized on the PG by F 233.0).

The step flags are saved in the data area DW 66 to 73. If the sequencer is at step 10, then F 233.2=1.

FW 234 is written to DW 66 and D 66.2 therefore corresponds to step 10.

66	Step flag S 7 - S 0	Step flag S 15 - S 8
67	Step flag S 23 - S 16	Step flag S 31 - S 24
68	Step flag S 39 - S 32	Step flag S 47 - S 40
69	Step flag S 55 - S 48	Step flag S 63 - S 56
70	Step flag S 71 - S 64	Step flag S 79 - S 72
71	Step flag S 87 - S 80	Step flag S 95 - S 88
72	Step flag S 103 - S 96	Step flag S 111 - S 104
73	Step flag S 119 - S 112	Step flag S 127 - S 120

The following data words must not be modified:

74 ... 77	Internal data!

If a timeout occurs in the sequencer, the level of the sequencer with the timeout is entered in DL 78. If a linear sequence, this means that bit D 78.8 is always updated if there is a timeout.

78	STOE level 8-1 (KM)	Internal data

The following data words must not be modified:

79 ... 108	Internal data

DW 109 contains the step number for diagnostics. With FB 70, DW 109 is identical to the output parameter SANZ with the exception that in DW 109 the value is binary and not in BCD code. With FB 72/73, DW 109 only refers to level 1.

109	Indication: FB 70 SANZ / FB 72-73 S-no. level 1 for O&M

The following data words must not be modified:

130 ... 160	Reserved for standard FB: expansions

The following data words DW 161 to 192 are only used by FB 75 for storing timers.

The configured times of the current steps are saved in DW 161 to 176.

161 ... 168	Configured time value TW for level 1 (KT) ... Configured time value TW for level 8 (KT)
169 ... 176	Configured time value TM for level 1 (KT) ... Configured time value TM for level 8 (KT)

The remaining times of the current steps are saved in DW 177 to 192.

177 ... 184	Remaining time TW for level 1 (KT) ... Remaining time TW for level 8 (KT)
185 ... 192	Remaining time TM for level 1 (KT) ... Remaining time TM for level 8 (KT)

The following data words must not be modified:

193 ... 228	Internal data

DW 229 to 239 are used for automatic synchronization with the aid of SB 5.

229	Number of syn steps found (KF)
230	One step for synchronization: step number found (KF)

231 ... 238	Possible synchronization steps: S 0-S 15 (KM) ... Possible synchronization steps: S 112-S 127 (KM)

239	SB no. of generated synchronization block (KF)

240 ... 255	Free for user

Assignment of DB<G5:Sequence>

DW			static	dynamic
0	Sequence block no. (KF)	Number of steps (KF): (without SA, SB..Sn)	x	
1	KH00	No. of the DB<G5:DIAD>(KF)	x	x
2	S-no. timeout level 1(KF)	S-no. timeout level 2(KF)		x
3	S-no. timeout level 3(KF)	S-no. timeout level 4(KF)		x
4	S-no. timeout level 5(KF)	S-no. timeout level 6(KF)		x
5	S-no. timeout level 7(KF)	S-no. timeout level 8(KF)		x
6	Reserved standard FB: expansions			
7	Next DB<G5:Sequence> KF	KH 00	x	
8	PG software version (KY)		x	
9	PLC software version (KY)			x
10	Next step at level 1 at the time of the switchover for one cycle (KF)			x
...	...			...
17	Next step at level 8 at the time of the switchover for one cycle (KF)			x
18	Coded number of steps 1 bit/16 steps	Number of simultaneous levels 1 bit/level	x	
19	Internal data!			x
20	Current step number level 1 (KF)			x
...	...			...
27	Current step number level 8 (KF)			x
28	Reserved			x
29	Image of the input parameters FB 70-74 (KM)			x
30	Active modes (KM)			x
31	Pulses for modes			x
32	FB identifier FB 74/75 (KH) FB 74 = 3 FB 75 = 50	FB identifier FB 70-73 (KH) FB 70 = 1; FB 71 = 2 FB 72 = 3; FB 73 = 4		x
36 ... 41	Reserved for standard FB: expansions			x
42 ... 49	KH 00 ... KH 00	Timer number for TW level 1 ... Timer number for TW level 8	x ... x	
50 ... 57	KH 00 ... KH 00	Timer number for TM level 1 ... Timer number for TM level 8	x ... x	
58 ... 65	Flag address for initial step level 1: Format: KY = X,Y where X = bit address and Y = byte address ... Flag address for initial step level 8		x ... x	
66	Step flag S 7 - S 0	Step flag S 15 - S 8		x
67	Step flag S 23 - S 16	Step flag S 31 - S 24		x

DW			static	dynamic
68	Step flag S 39 - S 32	Step flag S 47 - S 40		x
69	Step flag S 55 - S 48	Step flag S 63 - S 56		x
70	Step flag S 71 - S 64	Step flag S 79 - S 72		x
71	Step flag S 87 - S 80	Step flag S 95 - S 88		x
72	Step flag S 103 - S 96	Step flag S 111 - S 104		x
73	Step flag S 119 - S 112	Step flag S 127 - S 120		x
74 ... 77	Internal data!			x
78	STOE level 8-1 (KM)	Internal data		
79 ... 108	Internal data			x
109	Indication: FB 70 SANZ / FB 72-73 S-no. level 1 for operation and monitoring			x
110...129	Internal data			x
130...160	Reserved for standard FB: expansions			x
161 ... 168	Programmed time value TW for level 1 (KT) ... Programmed time value TW for level 8 (KT)			x ... x
169 ... 176	Programmed time value TM for level 1 (KT) ... Programmed time value TM for level 8 (KT)			x ... x
177 ... 184	Remaining time TW for level 1 (KT) ... Remaining time TW for level 8 (KT)			x ... x
185 ... 192	Remaining time TM for level 1 (KT) ... Remaining time TM for level 8 (KT)			x ... x
193...229	Internal data			x
230	One step for synchronization: step number found (KF)			x
231 ... 238	Possible synchronization steps: S0-S15 (KM) ... Possible synchronization steps: S112-S127 (KM)			x ... x
239	SB no. of generated synchronization block (KF)		x	
240...255	Free for user		x	

7.2 Assignment of the GRAPH 5 Diagnostic DB: DB<G5:DIAG>

The DB is divided into a static and dynamic section.

Static Structure of DB<G5:DIAG>

This block is generated following static assignment with a length of 261 (DW 0 to DW 255) using the function DB-GEN and is used when dynamically assigned as the GRAPH 5 diagnostic data block for criteria analysis.

The existing GRAPH 5 sequence blocks are entered according to a defined pattern with binary IDs in DW 2 to DW 17 and the editor version in DW 18. All other DWs have the default value KH = 0000.

DW	Left Byte								Right Byte							
0	Reserve (KH 0000)															
1																
SB no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB no.	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
3	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4	SB no. 47 - 32															
5	SB no. 63 - 48															
6	SB no. 79 - 64															
7	SB no. 95 - 80															
8	SB no. 111 - 96															
9	SB no. 127 - 112															
10	SB no. 143 - 128															
11	SB no. 159 - 144															
12	SB no. 175 - 160															
13	SB no. 191 - 176															
14	SB no. 207 - 192															
15	SB no. 223 - 208															
16	SB no. 239 - 224															
17	SB no. 255 - 240															
18	Version of GRAPH 5 editor KY = xxx, yyy xxx = Root number for software test; number only changed if incompatibility detected yyy = Subnumber for updates															
19 : 255	Buffer area for PLC (PG function: DB-GEN KH 0000)															

Dynamic Structure of DB<G5:DIAG>

(With the standard FBs 67 to FB 69). This block is generated as "static DB<G5:DIAG>" with the function DB-GEN.

During cyclic processing with the standard FBs 67 to 69 and the GRAPH 5 diagnostic package, the static DWs have the significance listed below. The image on the system always corresponds only to the specially used subset.

If DB-GEN is run, all the dynamic data are deleted and FB 69 first updates the complete sequencer image by suppressing all messages apart from one DB-GEN message.

DW 2 to DW 17 are marked by the DB-GEN function according to a particular pattern based on the existing GRAPH sequence blocks.

The fixed assignment of the individual bits to the SB numbers can be found in the following table:

DW	Left Byte								Right Byte							
0	Reserved															
1	Reserved															
SB no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB no.	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
3	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4	SB no. 47- 32															
5	SB no. 63- 48															
6	SB no. 79- 64															
7	SB no. 95- 80															
8	SB no. 111- 96															
9	SB no. 127- 112															
10	SB no. 143- 128															
11	SB no. 159- 144															
12	SB no. 175- 160															
13	SB no. 191- 176															
14	SB no. 207- 192															
15	SB no. 223- 208															
16	SB no. 239- 224															
17	SB no. 255- 240															
18	Version of GRAPH 5 editor 1. version supplied KY = 4,0 KY = xxx, yyy xxx = Root number for software test; Number only changed if incompatibility detected yyy = Subnumber for updates															
19	Buffer area for PLC (PG function: DB-GEN KH 0000) Version of PLC software: FB<G5:DIAG> first version supplied KY = 4,0															

DW 21 to DW 24 are only active for operation and monitoring (DB<G5:Sequence> D 33.3=1).

If this is the case, the data are transferred to DB<G5:Sequence> and are activated for the sequencer according to the following principle:

DW 20	Selection of the sequencer (10 $\leq$ x $\geq$ 255)
DW 21	—> DB<G5:Sequence> DW 34
DW 23	—> DB<G5:Sequence> DW 35

Here, there is no evaluation of the sign-of-life in DB<DIAG>.

Selection of the sub-sequence (FB 71) only via the main sequence (FB 70).

DW 20	SB no. for mode selection/display/acknowledgement
DW 21	Mode selection/acknowledgement
	0 → AUS
	1 → AUTO
	2 → HAND
	3 → SLOE
	4 → SANW
	5 → TIPO
	6 → TIPP (SSMB)
	7 → MAKT
	8 → T+1
	9 → KEND
	10 → B-UE
	11 → S-UE
	12 → QUIT
	13 → UQUIT
	14 → ANZ+1
	15 → REFRESH
DW 22	Reserve mode selection
DW 23	SANW: set step no. (right justified: binary code)
DW 24	Reserve

Access by user: write/read

DW 25 to DW 27 are updated constantly for the selected sequence (number in DW 20).

DW 25	RM modes	
	Bit	Meaning
	0	AUS
	1	AUTO
	2	HAND
	3	SLOE
	4	SANW
	5	TIPO
	6	TIPP (SSMB)
	7	MAKT
	8	DIAG
	9	KEND
	10	S0 ACTIVE
	11	INCOMPATIBLE
	12	
	13	S+AK
	14	SSTO
	15	STO
DW 26	Reserve RM modes	
DW 27	SANZ: step display (right justified: binary code)	
DW 28	Reserve	
DW 29	"	

The current sequencers with a timeout are entered in DW 30 to 45 according to the pattern in DW 1 to DW 16.

The following applies:

- RLO = 0 SB XXX o.k.
- RLO = 1 SB XXX with timeout

A signal change counts as an initial value group timeout for each sequencer.

	Meaning of the diagnostics: timeout new
DW 30	SB no. 15 - 0
DW 31	SB no. 31 - 16
	:
DW 45	SB no. 255 - 240

Access by user: Only read access!

The old sequencers with timeouts are entered according to the same pattern.

DW 46	SB no. 15 - 0
DW 47	SB no. 31 - 16
:	
DW 61	SB no. 255 - 240
DW 62	Reserved

Parameters for Diagnostics

The programmer configuring the system stores parameters in a parameter DB (DB<G5:PARA> DW 1 to 17). These parameters are read by FB<G5:DIAG> when the startup section is activated and entered in DW 63 to 79 and evaluated.

Cyclic modification of DW 63 to 66 and DW 70 is only permitted during the installation phase and must be entered in DB<G5:PARA> before the system is completed, since these data are only re-written during an FB 69 startup with a changed PLC address for DB<G5:DIAG>.

DW 63 to 79 are adopted by FB<G5:DIAG> from DB< PARA> DW 1 to 17.

DW 63	KF Max. number of timeouts per cycle
DW 64	KF Max. number of criteria per step/transition
DW 65	KY Node number / CPU number
DW 66	KF Number of cycles for sign of life
DW 67	KF Max. number of entries in DB<DIAG>
DW 68	KF First field in DB<DIAG>
DW 69	KF Field length for DB<DIAG>
DW 70	KF PLC start up: OB no. (1 cycle)
DW 71 : DW 73	Reserved
DW 74 : DW 79	Internal data for FB<G5:DIAG> from startup

DW 80 to 109 are occupied by the diagnostic field (DW 20 reserved exclusively).

These DWs are only updated with the following messages:

- DB-GEN message
- STO message
- REFRESH message
- QUIT message

These DWs are only used as a group buffer for the message to be edited. With the transfer to DB<DIAG>, the entry is released for the next message.

The last message edited is always in this data area DW 80 to 109.

Structure of the Message Field: DW 80 to DW 109 (Reserved up to DW 119)

Header data DW 80 to DW 86

DW 80	Field length	KF = length in words including header data for 1st version supplied: fixed KF +30 **Important:** The length depends on the maximum field length in the DB<DIAG> (1 field length)
DW 81	Reserved	
DW 82	Type of field	Bit 0: timeout message Bit 1: acknowledgment message Bit 2: next field message Bit 3: refresh message Bit 4: DBGEN message Bit 5: end identifier
DW 83	Field identifier	KS G5 GRAPH 5
DW 84	Hardware-ID:	KH 0000
DW 85	Version field	KY XXX,YYY 1st version supplied: KY=4.0 XXX = Root number for SW test. The number only changes if incompatibility is detected, e.g. different DB assignment/functions... YYY= Subnumber for updates Fixed:0 This number changes when the software is updated
DW 86	Address	KY KKK,CCC KKK=node address CCC=address CPU no.

Access by user: Only read access: last message field for entry in DB<DIAG>!

The useful data are updated by FB<G5:DIAG> according to the type of field.

DW 87	Diagnostic DB(= DB-GEN)
DW 88	KY = SB no., step no.
DW 89	KY= MSZ identifier, level (specifies SIM-level 1-8) 0= Step 1-8= Alternative T 10= MSZ

DW 90	Status word	
	Bit 0	AUS
	Bit 1	AUTO
	Bit 2	HAND
	Bit 3	SLOE
	Bit 4	SANW
	Bit 5	TIPO
	Bit 6	TIPP (SSMB)
	Bit 7	MAKT
	Bit 8	DIAG
	Bit 9	KEND
	Bit 10	S0 AKTIV
	Bit 11	INKOMPATIBEL
	Bit 12	
	Bit 13	S+AK
	Bit 14	SSTO
	Bit 15	STO
DW 91	Mode reserve	
DW 91	Offset address for start of status query in SB	
DW 93	ID STATUSES KY = XXX,YYY	XXX = FF Statuses read 00 -/- not read YYY = Number of statuses in MSZ

The statuses (max. 256) are stored according to the generation guidelines for the programmed criteria. The criteria are stored in ascending order with their statuses in DW 94 to DW 108.

K no.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
DW 94	15	14	13	12	11	10	8	8	7	6	5	4	3	2	1	0
: : DW 109																
DW 110 : : : : DW 119	Reserved for possible expansions															

DW 120 to 159 are used as a buffer for the messages read by the G5-DIAG package.

DW 160 is responsible for the communication.

The last message read is always located here.

DW 120 · · · DW 149	Entry of the GRAPH 5 message fields DB<DIAG> (for PG diagnostics) Assignment as DW 80 - 109
DW 150 · · · DW 159	Reserved for expansions in the message field Assignment as DW 110 - 119
DW 160	Control word for communication PLC ⟷ PG DR 160 control bit of PG software to PLC DL 160 control bit of PLC software to PG Bits: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bit 10: Last message Bit 9: Overflow DB<DIAG> Bit 8: Ready message from PLC: The next GRAPH 5 message from DBDIAG triggered with bit 0 is entered Bit 0: Trigger from PG: Read next GRAPH 5 message from DIAG!
DW 161	NR.DB<DIAG> (= DB<G5: DIAG> + 1)

If the G5-DIAG package does not exist on the PG/PC or is not used, DW 110 to 160 can be used for your own diagnostics with the same assignment.

DW 162 to 255 are used by the standard blocks FB 67 to 68 as their own working area.

DW 162	Status PLC software FB 67 – 69: Access read only! Bits: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bit 0: Startup DB<DIAG> active Bit 1: Startup DB<G5:DIAG> active Bit 2: Startup completed Bit 3: Startup error Bit 4: Select mode not active Bit 9: Other diagnostic device available Bit 15: Incompatible The other data bits are used for internal indicators and must not be overwritten.
DW 163 · · · DW 255	DW xxx used for internal data: FB<G5:DIAG>/FB<COPY>/ FB<COPY:PG>!

Access by user: Read access only!

7.3 Assignment of the GRAPH 5 Diagnostic Parameters: DB<G5:PARA>

Assignment of DB<G5:PARA> Length > 25 words DB<G5:DIAG>

DW		Area (permitted)	Example of an assignment	
DW 0	free		0	
DW 1	Max. number of timeouts/cycle	KF 1...50	1	DW 63
DW 2	Max. criteria per step/transition	KF 1....255	64	DW 64
DW 3	Node number/CPU number	KY xxx,xxx	0	DW 65
DW 4	Number of cycles for selection monitoring DB<DIAG>, DW 1-3	KF 1...32767	2000	DW 66
DW 5	Max. number of entries in DB-DIAG	KF 1...135	30	DW 67
DW 6	First field in DB-DIAG	KF 1...134	1	DW 68
DW 7	Field length for DB-DIAG	KF 30 fix	30	DW 69
DW 8	PLC startup ID: OB number	KF 1...255	0	DW 70
DW 9	not used at present	KH 0	0	DW 71
DW 10	not used at present	KH 0	0	DW 72
DW 11	not used at present	KH 0	0	DW 73
DW 12	not used at present	KH 0	0	DW 74
DW 13	not used at present	KH 0	0	DW 75
DW 14	Internal data	KH 0	0	DW 76
DW 15	Internal data	KH 0	0	DW 77
DW 16	Internal data	KH 0	0	DW 78
DW 17	Internal data	KH 0	0	DW 79
DW 18+ DW 19	Internal data	KH 0	0	

FB 69 → data entered in startup section

DW 9 to DW 19 must be preassigned “0”.

7.4 Assignment of the Diagnostic DB: DB<DIAG>

DB<G5:DIAG> is generated with the PG function DB-GEN. The diagnostic block DB<DIAG> is generated by FB<G5:DIAG> with the number DB<G5:DIAG>+1 and assigned the initial values in field 0.

The length of DB<DIAG> depends on the number of entries in DB<G5:PARA>.

This data block is used as a data buffer (FIFO principle) until a diagnostic unit reads the information.

Note

The assignment of the diagnostic DB is only of interest in the following situations:
- during installation or for additional evaluation or
- if you want to use your own diagnostic unit.

Data Word No.	Assignment	Field No.	Meaning	Example of Preassignment by FB 69
DW 0	Free		Free	KH 0
DW 1	Selection of semaphore (random number from diagnostic system)			KH 0
DW 2	Semaphore		Semaphore	KH 0
DW 3	Sign-of-life			KH 0
DW 4	Device ID			KH 0
DW 5	DW no. start of last field used		Max. 30 entries	KF 900
DW 6	DW no. start of last field used		First entry	KF 30
DW 7	Field length: fixed KF 30		Message length (DW) fixed	KF 30
DW 8	Write pointer (DW no. start of next field.)		Supplier of diagnostic data	KF 30
DW 9	Read pointer (DW no. start of next field)	0	Receiver of diagnostic data	KF 30
DW 10	OVERFLOW (=KHFFFF, otherwise KH0000)		Buffer is full = FFFF	KH 0
DW 11	PG diagnostics: read pointer		29th entry	KF 900
: : DW 29	Reserved			KH 0 : KH 0
DW 30 : : DW 59	Field 1	1	Diagnostic data for first timeout	Any
DW 60 : : DW 89	Field 2	2	Diagnostic data for second timeout	Any
DW 90			Last field	KH 0

Notes on DB<DIAG>

If the write pointer catches up with the read pointer (DW 8 = DW 9), then OVERFLOW is indicated in DW 10. Following this, only the last message field is overwritten by the new message field, the write pointer does not move.

Principle: Write Pointer = Read Pointer (1st Priority)

With the first priority (no diagnostic unit entered in the semaphore → B<G5:DIAG> D 162.9=0), the OVERFLOW is deleted by FB 67 after reading the next program field.

If a diagnostic unit is entered in the semaphore → (DB<G5:DIAG> D 162.9 = 1), the unit itself must delete the OVERFLOW when it reads the next message.

If the read pointer catches up with the write pointer, the read pointer remains on the last message field and reads this out via FB 67 repeatedly when requested (ID: last message) until the write pointer moves on.

Principle: Read Pointer = Write Pointer - 1st Field (2nd Priority)

In this case, a diagnostic unit can only evaluate a message again when the content (write pointer) has changed.

Notes on Installation and Testing

8

Chapter Overview

8.1 Fast Versions

List of Some Basic Errors

Description of Error	Possible Causes
PLC changed to STOP	Wrong blocks loaded (see section)
	SB was called directly in a block. (The SB call must not be programmed, since the current SB is called by a standard FB.)
	SB 2 or SB 3 not on PLC
	User DB not in PLC RAM
	Wrong FB number entered in the ID screen form
INIT steps not set	SB not on PLC
	User DB, diagnostic DB not in PLC RAM
	SB not programmed in GRAPH 5
	User DB not regenerated after correction or not transferred to PLC
	Step 0 not set after booting: remedy: apply pulse to parameter AUS and restart with AUTO
Display: check working DB	Software PG - software PLC does not match
Modes cannot be implemented	SB not on PLC
	SB not programmed in GRAPH 5
	User DB not in PLC RAM
	Wrong standard blocks loaded
	Input and output side of FB 72, FB 73, FB 74 not correctly programmed
Mode AUTO and output command = 0	Check the interlock conditions in the AUTO routine
	Mode interlock between FB 74 and FB 72 or FB 73 ignored
Error in modes of FB 74	FB 74 not called directly before FB 72 or FB 73
Sporadic errors	When using interrupt processing (OB 2..., OB 13..., OB 20, OB 21, OB 22, OB 23...) the flag area FW 200 to 254 used by GRAPH 5 is not saved and reloaded

Examples

The following tables contain examples for estimating the execution times. The values shown are the maximum values of measured times in milliseconds.

Total Cycle Times when Using FB 72 or FB 73 Separately

The times shown in the examples include the following block calls:

OB 1 → PB x → FB 72 SB x → SB 2 (simultaneous)

OB 1 → PB x → FB 73 SB x → SB 3 (linear)

When measuring the program execution times, the worst case was selected in which all step enabling conditions are fulfilled and the sequencers switch simultaneously in every cycle and to all branches. Each step of a sequencer consisted of three binary assignments and each transition of three binary scans.

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	5.9 ms	6.9 ms	8 ms	9.1 ms
2 simultaneous branches	11 ms	12.5 ms	13.5 ms	15.5 ms
4 simultaneous branches	19 ms	20.5 ms	22 ms	23 ms
8 simultaneous branches	38 ms	41 ms	42 ms	44 ms

Table 8-1 Table of Program Execution Times for the S5-95

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	13 ms	17 ms	20 ms	22 ms
2 simultaneous branches	27 ms	29 ms	31 ms	33 ms
4 simultaneous branches	43 ms	47 ms	55 ms	55 ms
8 simultaneous branches	65 ms	108 ms	109 ms	109 ms

Table 8-2 Table of Program Execution Times for the S5-100U (CPU 103)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	7 ms	7 ms	8 ms	8 ms
2 simultaneous branches	12 ms	12 ms	12 ms	14 ms
4 simultaneous branches	19 ms	19 ms	22 ms	23 ms
8 simultaneous branches	29 ms	37 ms	38 ms	39 ms

Table 8-3 Table of Program Execution Times for the S5-115U (CPU 941B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	6 ms	7 ms	7 ms	7 ms
2 simultaneous branches	11 ms	12 ms	13 ms	12 ms
4 simultaneous branches	17 ms	19 ms	22 ms	21 ms
8 simultaneous branches	30 ms	32 ms	34 ms	37 ms

Table 8-4 Table of Program Execution Times for the S5-115U (CPU 942B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	4.0 ms	4.35 ms	4.5 ms	4.7 ms
2 simultaneous branches	10.4 ms	10.6 ms	10.8 ms	11.0 ms
4 simultaneous branches	18.2 ms	18.6 ms	18.8 ms	18.8 ms
8 simultaneous branches	33.6 ms	34.1 ms	34.6 ms	35.1 ms

Table 8-5 Table of Program Execution Times for the S5-115U (CPU 943B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.0 ms	1.2 ms	1.3 ms	1.4 ms
2 simultaneous branches	1.3 ms	1.5 ms	1.65 ms	1.8 ms
4 simultaneous branches	2.0 ms	2.15 ms	2.25 ms	2.4 ms
8 simultaneous branches	3.2 ms	3.5 ms	3.7 ms	3.9 ms

Table 8-6 Table of Program Execution Times for the S5-115U (CPU 944B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.43 ms	0.46 ms	0.48 ms	0.52 ms
2 simultaneous branches	0.48 ms	0.52 ms	0.55 ms	0.58 ms
4 simultaneous branches	0.51 ms	0.61 ms	0.64 ms	0.68 ms
8 simultaneous branches	0.58 ms	0.73 ms	0.76 ms	0.80 ms

Table 8-7 Table of Program Execution Times for the S5-115U (CPU 945)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	10.4 ms	14.6 ms	18.6 ms	22.7 ms
2 simultaneous branches	18.0 ms	22.3 ms	26.4 ms	30.4 ms
4 simultaneous branches	29.0 ms	33.1 ms	37.2 ms	41.0 ms
8 simultaneous branches	51.1 ms	57.6 ms	61.6 ms	65.6 ms

Table 8-8 Table of Program Execution Times for the S5-135U (CPU 922)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.7 ms	0.8 ms	0.95 ms	1.15 ms
2 simultaneous branches	1.1 ms	1.25 ms	1.4 ms	1.55 ms
4 simultaneous branches	1.6 ms	1.85 ms	2.0 ms	2.2 ms
8 simultaneous branches	2.85 ms	3.05 ms	3.2 ms	3.45 ms

Table 8-9 Table of Program Execution Times for the S5-135U (CPU 928B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	2.0 ms	2.5 ms	3.0 ms	3.55 ms
2 simultaneous branches	2.95 ms	3.5 ms	4.0 ms	4.6 ms
4 simultaneous branches	4.3 ms	4.9 ms	5.4 ms	5.9 ms
8 simultaneous branches	7.0 ms	7.9 ms	8.4 ms	9.0 ms

Table 8-10 Table of Program Execution Times for the S5-150S

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.2 ms	1.6 ms	1.95 ms	2.3 ms
2 simultaneous branches	1.85 ms	2.25 ms	2.6 ms	3.0 ms
4 simultaneous branches	2.8 ms	3.15 ms	3.55 ms	3.95 ms
8 simultaneous branches	4.75 ms	5.5 ms	5.85 ms	6.1 ms

Table 8-11 Table of Program Execution Times for the S5-155U (CPU 946/947)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.5 ms	0.56 ms	0.63 ms	0.7 ms
2 simultaneous branches	0.67 ms	0.74 ms	0.8 ms	0.88 ms
4 simultaneous branches	0.94 ms	1.0 ms	1.06 ms	1.14 ms
8 simultaneous branches	1.44 ms	1.56 ms	1.64 ms	1.70 ms

Table 8-12 Table of Program Execution Times for the S5-155U (CPU 948)

Total Cycle Times with a Combination of FB 72 or FB 73 with FB 74

The times specified in the examples include the following block calls:

OB 1 → PB x → FB 74/FB 72 → SB x → SB 2 (simultaneous)

OB 1 → PB x → FB 74/FB 73 → SB x → SB 3 (linear)

When measuring the program execution times, the worst case was selected in which all step enabling conditions are fulfilled and the sequencers switch simultaneously in every cycle and to all branches. Each step of a sequencer consisted of three binary assignments and each transition of three binary scans.

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	8.5 ms	9.1 ms	10.5 ms	12.0 ms
2 simultaneous branches	14 ms	15 ms	16.1 ms	17.5 ms
4 simultaneous branches	22.5 ms	23.5 ms	24 ms	25.5 ms
8 simultaneous branches	41 ms	43 ms	44 ms	46 ms

Table 8-13 Table of Program Execution Times for the S5-95

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	19 ms	22 ms	26 ms	28 ms
2 simultaneous branches	29 ms	31 ms	39 ms	41 ms
4 simultaneous branches	47 ms	53 ms	60 ms	63 ms
8 simultaneous branches	71 ms	111 ms	115 ms	118 ms

Table 8-14 Table of Program Execution Times for the S5-100U (CPU 103)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	10 ms	10 ms	11 ms	11 ms
2 simultaneous branches	15 ms	15 ms	15 ms	17 ms
4 simultaneous branches	22 ms	22 ms	25 ms	25 ms
8 simultaneous branches	36 ms	39 ms	40 ms	42 ms

Table 8-15 Table of Program Execution Times for the S5-115U (CPU 941B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	9 ms	9 ms	10 ms	10 ms
2 simultaneous branches	13 ms	13 ms	15 ms	15 ms
4 simultaneous branches	19 ms	20 ms	24 ms	25 ms
8 simultaneous branches	33 ms	35 ms	37 ms	39 ms

Table 8-16 Table of Program Execution Times for the S5-115U (CPU 942B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	5.5 ms	5.7 ms	5.9 ms	6.0 ms
2 simultaneous branches	11.8 ms	11.9 ms	12.1 ms	12.3 ms
4 simultaneous branches	19.6 ms	19.8 ms	20.1 ms	20.2 ms
8 simultaneous branches	35.1 ms	36.1 ms	36.2 ms	36.4 ms

Table 8-17 Table of Program Execution Times for the S5-115U (CPU 943B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.15 ms	1.3 ms	1.4 ms	1.6 ms
2 simultaneous branches	1.45 ms	1.65 ms	1.8 ms	2.0 ms
4 simultaneous branches	2.1 ms	2.2 ms	2.4 ms	2.6 ms
8 simultaneous branches	3.3 ms	3.55 ms	3.8 ms	4.0 ms

Table 8-18 Table of Program Execution Times for the S5-115U (CPU 944B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.47 ms	0.50 ms	0.53 ms	0.56 ms
2 simultaneous branches	0.51 ms	0.53 ms	0.56 ms	0.60 ms
4 simultaneous branches	0.59 ms	0.63 ms	0.65 ms	0.71 ms
8 simultaneous branches	0.74 ms	0.79 ms	0.82 ms	0.85 ms

Table 8-19 Table of Program Execution Times for the S5-115U (CPU 945)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	13.9 ms	18.1 ms	22.1 ms	26.1 ms
2 simultaneous branches	21.6 ms	26 ms	29.8 ms	34.0 ms
4 simultaneous branches	32.6 ms	36.8 ms	40.6 ms	44.8 ms
8 simultaneous branches	54.6 ms	61.1 ms	65.1 ms	69.1 ms

Table 8-20 Table of Program Execution Times for the S5-135U (CPU 922)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.85 ms	1.0 ms	1.15 ms	1.3 ms
2 simultaneous branches	1.3 ms	1.45 ms	1.6 ms	1.75 ms
4 simultaneous branches	1.85 ms	2.0 ms	2.15 ms	2.4 ms
8 simultaneous branches	3.2 ms	3.4 ms	3.5 ms	3.65 ms

Table 8-21 Table of Program Execution Times for the S5-135U (CPU 928B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	2.4 ms	2.95 ms	3.5 ms	4.05 ms
2 simultaneous branches	3.4 ms	4.0 ms	4.5 ms	5.1 ms
4 simultaneous branches	4.8 ms	5.4 ms	5.9 ms	6.5 ms
8 simultaneous branches	7.5 ms	8.4 ms	9.0 ms	9.5 ms

Table 8-22 Table of Program Execution Times for the S5-150S

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.5 ms	1.9 ms	2.25 ms	2.6 ms
2 simultaneous branches	2.2 ms	2.55 ms	3.0 ms	3.3 ms
4 simultaneous branches	3.1 ms	3.45 ms	3.85 ms	4.25 ms
8 simultaneous branches	5.1 ms	5.85 ms	6.15 ms	6.55 ms

Table 8-23 Table of Program Execution Times for the S5-155U (CPU 946/947)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.57 ms	0.64 ms	0.7 ms	0.765 ms
2 simultaneous branches	0.74 ms	0.81 ms	0.88 ms	0.95 ms
4 simultaneous branches	1.0 ms	1.08 ms	1.14 ms	1.22 ms
8 simultaneous branches	1.52 ms	1.64 ms	1.70 ms	1.78 ms

Table 8-24 Table of Program Execution Times for the S5-155U (CPU 948)

8.2 Standard Version

List of Some Basic Errors

The following table lists some of the possible errors which can lead to incorrect processing of the sequencer.

Description of Error	Possible Causes
PLC changed to STOP	Wrong blocks loaded
	SB was called directly in a block. (The SB call must not be programmed, since the current SB is called by a standard FB).
	SB 0 not on PLC
	User DB not generated
	Wrong DB number entered in ID screen form
INIT steps are not set	SB not on PLC
	Diagnostic DB not in PLC RAM
	SB is not programmed in GRAPH 5 → check the status bits in the ZUST word
	User DB not regenerated after correction or not transferred to PLC
Display: check working DB	Software PG - software PLC does not match
Modes cannot be implemented	SB not on PLC
	User DB, diagnostic DB not in PLC RAM
	SB is not programmed in GRAPH 5 → check the status bits in the ZUST word
	Wrong standard block loaded
	Input side and output side of FB 70/71 not correctly programmed
	Flag for N-ST used elsewhere or I used instead of F
Mode AUTO and output comment = 0	Check the interlock conditions in the AUTO routine
Several sequencers on PLC, however, only one running	Parameter N-ST in FB 70 assigned the same signal for all sequencers
Sporadic error	When using interrupt processing (OB 2..., OB 13..., OB 20, OB 21, OB 22, OB 23...), the flag area FW 200 to 254 used by GRAPH 5 is not saved and reloaded

Description of Error	Possible Causes
The sequencer is in step x according to the overview display, the zoom-in, however, cannot be activated	Step (x-1) is programmed as a selective step containing double-word commands
When sub-sequences are called, the sub-sequence signals the end of the sequence without it having started	– No waiting time assigned for step with sub-sequence call – Start input for FB 71 not assigned correctly

Examples

The following tables contain examples for estimating the execution times. The values shown are the maximum values of measured times in milliseconds.

Total Cycle Times

The times shown in the examples include the following block calls:

OB 1 → PB x → FB 70 → SB x → SB 0

When measuring the program execution times, the worst case was selected in which all step enabling conditions are fulfilled and the sequencers switch simultaneously in every cycle and to all branches. Each step of a sequencer consisted of three binary assignments and each transition of three binary scans.

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	23 ms	29 ms	31 ms	31 ms
2 simultaneous branches	33 ms	38 ms	42 ms	46 ms
4 simultaneous branches	54 ms	58 ms	65 ms	67 ms
8 simultaneous branches	77 ms	119 ms	121 ms	123 ms

Table 8-25 Table of Program Execution Times for the S5-100U (CPU 103)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	13 ms	13 ms	13 ms	13 ms
2 simultaneous branches	17 ms	18 ms	18 ms	21 ms
4 simultaneous branches	29 ms	39 ms	39 ms	43 ms
8 simultaneous branches	41 ms	49 ms	62 ms	51 ms

Table 8-26 Table of Program Execution Times for the S5-115U (CPU 941B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	11 ms	11 ms	12 ms	13 ms
2 simultaneous branches	15 ms	17 ms	17 ms	19 ms
4 simultaneous branches	25 ms	28 ms	28 ms	28 ms
8 simultaneous branches	39 ms	43 ms	44 ms	44 ms

Table 8-27 Table of Program Execution Times for the S5-115U (CPU 942B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	10.1 ms	10.2 ms	10.3 ms	10.4 ms
2 simultaneous branches	14.4 ms	14.9 ms	14.9 ms	15 ms
4 simultaneous branches	22.6 ms	22.8 ms	22.8 ms	23.0 ms
8 simultaneous branches	38 ms	38.8 ms	39.0 ms	39.2 ms

Table 8-28 Table of Program Execution Times for the S5-115U (CPU 943B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.2 ms	1.4 ms	1.6 ms	1.65 ms
2 simultaneous branches	1.45 ms	1.65 ms	1.8 ms	2.15 ms
4 simultaneous branches	3.56 ms	3.85 ms	4.14 ms	4.34 ms
8 simultaneous branches	3.8 ms	4.0 ms	4.2 ms	4.3 ms

Table 8-29 Table of Program Execution Times for the S5-115U (CPU 944B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.49 ms	0.51 ms	0.54 ms	0.57 ms
2 simultaneous branches	0.51 ms	0.53 ms	0.58 ms	0.61 ms
4 simultaneous branches	0.58 ms	0.61 ms	0.64 ms	0.67 ms
8 simultaneous branches	0.72 ms	0.77 ms	0.82 ms	0.85 ms

Table 8-30 Table of Program Execution Times for the S5-115U (CPU 945)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	16.0 ms	20.4 ms	24.2 ms	28 ms
2 simultaneous branches	22.0 ms	26.6 ms	30.2 ms	34 ms
4 simultaneous branches	33.8 ms	38.1 ms	41.8 ms	45.6 ms
8 simultaneous branches	57.1 ms	63.6 ms	67.6 ms	71.1 ms

Table 8-31 Table of Program Execution Times for the S5-135U (CPU 922)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.0 ms	1.2 ms	1.5 ms	1.65 ms
2 simultaneous branches	1.5 ms	1.6 ms	1.85 ms	2 ms
4 simultaneous branches	1.9 ms	2.25 ms	2.45 ms	2.55 ms
8 simultaneous branches	3.35 ms	3.7 ms	4.0 ms	4.25 ms

Table 8-32 Table of Program Execution Times for the S5-135U (CPU 928B)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	2.5 ms	3.3 ms	3.8 ms	4.3 ms
2 simultaneous branches	3.5 ms	4.1 ms	4.5 ms	5.1 ms
4 simultaneous branches	4.9 ms	5.5 ms	6.1 ms	6.6 ms
8 simultaneous branches	8.0 ms	8.7 ms	9.2 ms	9.7 ms

Table 8-33 Table of Program Execution Times for the S5-150S

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	1.65 ms	2.05 ms	2.4 ms	2.8 ms
2 simultaneous branches	2.15 ms	2.6 ms	2.9 ms	3.3 ms
4 simultaneous branches	3.2 ms	3.55 ms	3.9 ms	4.25 ms
8 simultaneous branches	5.3 ms	5.95 ms	6.3 ms	6.7 ms

Table 8-34 Table of Program Execution Times for the S5-155U (CPU 946/947)

	Total number of steps per sequencer			
Sequencer structure	25	50	75	100
Linear sequencer	0.59 ms	0.66 ms	0.73 ms	0.79 ms
2 simultaneous branches	0.73 ms	0.80 ms	0.88 ms	0.94 ms
4 simultaneous branches	1.01 ms	1.08 ms	1.14 ms	1.22 ms
8 simultaneous branches	1.53 ms	1.61 ms	1.69 ms	1.78 ms

Table 8-35 Table of Program Execution Times for the S5-155U (CPU 948)

8.3 Comparison of the Fast Version with the Standard Version

Differences between FB 72, FB 73 (fast version) and FB 70 (standard version)

Parameter/ Function	FB 72/73	FB 70
A/H = 1	AUTO active without any activation, interlocked with TIPP	Must be activated with B-UE
A/H = 0	HAND as for FB 70, however, pending timeout STO is not deleted	STO is deleted
TIPP	EXECUTE active without any activation interlocked with AUTO	SSMB, must be activated with B-UE STO deleted in EXECUTE
T+1	as for FB 70	
TWA waiting time	effective in AUTO and TIPP as for FB 70	effective in AUTO and SSMB
TUE monitoring time	effective in AUTO and TIPP	only in AUTO
STO	in AUTO and TIPP	only in AUTO
QIT	in AUTO: as for FB 70 Switch over AUTO to MAN (A/H = 0) STO remains 1, if QIT = 1 all timeouts can be deleted in TIPP: STO can be deleted with transition = 1 and QIT, with T+1 switch to next step	timeout STO is deleted without QIT STO is deleted in TIPP (SSMB)
DIAG	not possible, diagnostic DB does not need to be loaded on the PLC	diagnostics with programming devices
DIMOS 85	as for FB 70	
SANW	FB 74 necessary, all steps of the sequencer can be set/reset; structure of the sequencer must be kept to, otherwise error when switching to AUTO/TIPP	SANW only <u>one</u> step can be set
SLOE , FB 74	FB 74	not possible
Step indication	step number read out from DW 20 to 27 see Section 4.5.6. ,	SANZ ANZ+
ID: submode	logical connection of the parameters A/H and TIPP see programming examples no. 2, 3, 4, 5	UBET
Timeout	step number of the steps with timeout read out from DW 25 see Section 4.5.4.	SSTO
Simultaneous branches active	from DW 20 to 27 see program example no. 14	S+AK
Status word	scan internal flag see program example no. 15	ZUST
Synchronization	FB 74 parameter SYN	not possible
Subsequence	not possible	implemented by FB 71

8.4 Blocks and PLC

The following table shows which standard blocks can be used on which CPU.

	FB 70/71 SB 0	FB 75	FB 72 SB 2	FB 73 SB 3	SB 5	FB 67-69
S5-95U	-	-	+	+	+	-
S5-100U						
CPU 100	-	-	-	-	-	-
CPU 102	-	-	-	-	-	-
CPU 103	+	+	+	+	+	+
S5-115U						
CPU 941	+	+	+	+	+	+
CPU 942	+	+	+	+	+	+
CPU 943	+	+	+	+	+	+
CPU 944	+	+	+	+	+	+
CPU 945	+	+	+	+	+	+
S5-135U						
CPU 922	+	+	+	+	+	+
CPU 928	+	+	+	+	+	+
CPU 928B	+	+	+	+	+	+
S5-150U						
CPU 926/927	+	+	+	+	+	+
S5-155U						
CPU 946/947	+	+	+	+	+	+
CPU 948	+	+	+	+	+	+

8.5 Compatibility with Earlier Releases

Points to note about SBs and FBs

The standard blocks and the SBs/DBs generated by the PG software are tailored to each other's needs. This means that only certain combinations are permitted. The following three procedures are possible:

- Continuing to use previous sequencers.

  It is possible to continue using sequencers created with the PG software GRAPH 5/Stage V and supported by standard blocks. However, all the sequencers on the CPU must use the same GRAPH 5 version. Status queries or modifications are possible with GRAPH 5/II V7.1 for all GRAPH 5 blocks version 3.0 or higher. Newly created blocks can be converted from the format GRAPH 5/II to the format GRAPH 5 V3.0 if no new language elements are used (MSZ, synchronization). Older GRAPH 5 versions are not supported.

- Porting old GRAPH 5 SBs to GRAPH 5/II

  The PG package GRAPH 5/II V7.1 recognizes both old and new GRAPH 5 blocks. An old block can be converted to the GRAPH 5/II format with **F6** (Edit), **Shift F7** (Extras) , **Shift F1** (–>G5/II). With the function GRAPH 5 –> GRAPH 5/II in the Management menu, you can convert all the GRAPH 5 blocks of a program file at once. Following the conversion, DB-Gen must be run.

  Since GRAPH 5/II blocks are longer than the old GRAPH 5 blocks, porting may, in some cases, not be possible (SB block length > 3000 words). A GRAPH 5/II sequencer is 15+2*number of steps+2* number of transitions longer than the corresponding sequencer in the GRAPH 5 version 3 format. Here, the block must be shortened by deleting steps/transitions.

- Porting GRAPH 5/II sequencers to GRAPH 5 version 3.0

  With the function GRAPH 5/II –> GRAPH 5 in the Management menu, you can convert all GRAPH 5/II SBs to the format of GRAPH 5 Version 3.0. Problems only occur if you use the new language elements MSZ or synchronization. An SB with an MSZ cannot be converted. Synchronization must be deselected prior to conversion.

Note

The changeover must be made for the whole CPU.

The retranslation lists (#SBRL.nnn, see Section 4.5.8) must be deleted for all converted blocks and recreated.

- Creating new blocks in the Stage VI environment.

  Here, you must simply remember that only GRAPH 5 SBs with the same version can run at the same time on a CPU.

GRAPH 5/II V7.1 also supports SBs in the format of GRAPH 5 V3.0 (Stage V). With older GRAPH 5 SBs, problems can occur.

Within a CPU, all SBs must be generated with the same version. This can be guaranteed by conversion.

Innovations in GRAPH 5/II Compared with GRAPH 5 V3.0

New diagnostic package
Automatic process synchronization
Response to timeouts
Multistep zoom-in
Sequencer modes controllable in working DB
Description of the data blocks
Timers can be retriggered; time plot selected by user
Sequencer can switch further in the same PLC cycle
User interface adapted to STEP 5 V 7.0 basic package
Monitoring window TUE/TUE-MIN
Combination of the two previous GRAPH 5 descriptions (6ES5998-1SA01) and standard function blocks (C79000-G8563-C587)
Separate manual/automatic in the zoom-ins for:
1. Operating the process
2. Displaying criteria analysis
Printing: Steps and transitions are printed out directly one after the other
Time initial values can be entered

Innovations of GRAPH 5/II V7.0 Compared with GRAPH 5/II V6.0

Simple input screen form
FB synchronization
Skipping steps
GRAPH 5/II <–> GRAPH 5 V3.0 converter
DB-Gen in the format of GRAPH 5 V3.0

Innovations of GRAPH 5/II V7.0 Compared with GRAPH 5/II V6.6

Option of updating DB-Gen in the Editor
Option “with RL-Gen” instead of the function RL-Gen
No automatic conversion when opening an SB
All diagnostic functions now in one dialog box
DB-Gen possible without a diagnostic DB

Innovations of GRAPH 5/II V7.1 Compared with GRAPH 5/II V7.0

Interface adjusted to basic package STEP 5/ST V 7.1
GRAPH 5 global settings.
Edit diagnostic parameters via dialog box
Expansion of the option *Updating DBs*
DB-Gen can be called for individual blocks and all SBs

Appendix A

Chapter Overview

A.1 S5 Terminology

The following list contains the most common SIMATIC S5 abbreviations. It does not include the function key names since these are explained in the HELP texts available in the user interface.

ABS	Absolute addressing, for example I 1.0
AS 511	Interface module 511, interface to the PLC
B	Block
BE	Block end
C	Counter
COM	Comment key
CORR	Correction key
CPU	Central Processing Unit
D	Data (1 bit)
DB	Data Block
DBDO.nnn	Documentation block for a DB data block
DC	Comment block for a DB data block
DCX	Comment block for DX data block
DIR	Directory of the hard disk, diskette, PLC, EPROM and files
DOCFILE	Documentation file, for example for plant comments
DSP ABS	Presets screen form, display operands in absolute format
DSP SYM	Presets screen form, display operands in symbolic format
DW	Data word (16 bits)
DXDO.nnn	Documentation block for DX data block
DX	Extended data block
EPROM	Erasable Programmable Read Only Memory
EEPROM	Electrically Erasable Programmable Read Only Memory
CSF	Control system flow chart, graphic representation of the automation task with symbols complying with DIN 40 700 / DIN 40 719
F, FY	Flag bit, flat byte
FB	Function block
FBDO.nnn	Documentation block for FB function block
FC	Comment block for FB function block
FCX	Comment block for FX function block
FD	Present program file on floppy disk (also stands for hard disk)
FV	Block preheader for an FB
FVX	Block preheader for an FX
FW, FD	Flag word and flag double word
FXDO.nnn	Documentation block for FX function block
FX	Extended function block

GRAPH 5	Software for configuring and programming sequential control systems in a clear graphic representation
ID Screen Form	Sequencer identification screen form
LAD	Ladder diagram, graphic representation of the automation task with symbols of a circuit diagram complying with DIN 19239
LEN	Length of a block
LIB	Library number
OB	Organization block
OBDO.nnn	Documentation block for an organization block
OC	Comment block for an organization block
OY, OW	Byte, word from the ’extended I/O’ area
PB	Program block
PBDO.nnn	Documentation block for a program block
PC	Personal Computer
PG	Programming device
PC	Comment block for a program block
PIQ	Process image of the inputs
PII	Process image of the inputs
PLC	Programmable Logic Controller
PW	Peripheral word
PY	Peripheral byte
RAM	Random Access Memory
REW	Rewire, rename inputs and outputs in the user program (XRF, COMP, REW package)
RLO	Result of logic operation (bit code)
S	S flag, extended flag area
SAC	STEP address counter
SB	Sequence Block
SBDO.nnn	Documentation block for a sequence block
SC	Comment block for step block
SEQ	Assignment list
SINEC H1	Bus system, network for industrial applications
STA	Status (bit condition codes)
STEP 5	Programming language for programming SIMATIC S5 programmable controllers
STL	Statement list, STEP 5 method of representation as a sequence of mnemonics representing PLC commands (corresponding to DIN 19239)
SYM	Symbolic addressing (for example -INPUT)
SYSID	Block for system identification

T	Timer
TM	Monitoring time
TW	Waiting time
XRF	Cross-reference list (XRF, COMP, REW package)

A.2 S5 Data Types

S5 Files

The basic package creates S5 files. There are several types of S5 file containing a variety of different data:

- Blocks in PROGRAM FILES of the type ST.S5D
- Assignment lists in SYMBOLS FILES of the type Z0.INI and Z1.INI
- Footers in FOOTER FILES of the type F1.INI and F2.INI
- Printer parameters in PRINTER FILES of the type DR.INI etc.

The following list shows the files in which STEP 5 or GRAPH 5 stores settings and data. Most of the files are saved in the STEP 5 working directory. The question marks in the file names stand for characters that can be selected by the user.

Paths	Settings
G5 MEMORY.DAT G5 HISTOR.DAT S5 MEMORY.DAT	Save the last values entered in job or list boxes.
S5@@@@CF.INI	(STEP 5 Configuration File) this records the path and name of the ??????PX.INI file last uses. This is saved in the STEP 5 home directory.
??????PX.INI	Data as specified in the “Settings” dialog.
G5???OPT.INI	Data set in the screen form “Set GRAPH 5”.
STL batch	
??????A0.SEQ	STL source file
??????A1.SEQ	STL temp file
??????AE.SEQ	STL log file
??????AF.SEQ	STL error list
??????AT.SEQ	Save the STL batch function key settings
Expanded documentation file	
??????DO.S5D	Saving all expanded documentation blocks of the type %. Each *DO.S5D file is assigned a *ST.S5D file with the same name in the same catolog.
Programs	
??????ST.S5D	STEP 5 program file.
Assignment list	
??????Z0.SEQ	Assignment list.
??????ZF.SEQ	Assignment error list: list of the errors when translating the ??????Z0.SEQ into the ??????Z0.INI file.
??????Z0.INI	Symbol file, translated assignment list.
??????Z#.INI	Assignment list index files (# = 1 or 2).
??????ZT.SEQ	Function key assignment.
Printer output	
??????DR.INI	Printer parameters
??????F1.INI	Footer file (80 characters)
??????F2.INI	Footer file (132 characters)
??????LS.INI	Redirect printer output to a file
Specific files	
??????XR.INI	Cross-reference list
??????SU.INI	Doc commands (submit) for documentation
??????SF.INI	Submit error list
??????TX.INI	Key macros
Bus selection	
??????AP.INI	Path file containing all the edited bus paths

A.3 Comparison Functions in STEP 5/ST

In STEP 5/ST, the comparison function for GRAPH 5 blocks as been expanded.

A distinction is made between three types of GRAPH 5 blocks:

1. GRAPH 5 up to Version 3.0
2. GRAPH 5/II
3. GRAPH 5/II synchronization blocks

Blocks of a different type cannot be compared. The type of block is displayed before the comparison result. The comparison starts at address 0 in every zoom-in.

In every transition, there are two program sections that are compiled by the GRAPH 5 compiler. These paths are known as organization part 1 / 2.

The following table describes the GRAPH 5-specific error messages when comparing two sequencers. Apart from the causes of differences described here, it is possible that commands have been overwritten by systems other than GRAPH 5. In this case you should not use the SB any longer since it has effectively been destroyed.

Error	Sequencer 1	Sequencer 2	Possible Difference(s) or Cause(s)
Linear or Linear	yes no	no yes	The ID for linear sequencer is different. One sequencer has one and the other has more than one simultaneous level.
Steps	xxx	yyy	The number of steps does not match.
Transitions	xxx	yyy	The number of transitions does not match.
IDs different			RLGEN was executed for one sequencer or one sequencer was edited.
Timer base	xxx	yyy	Different timers for waiting and monitoring time. (In some transitions, this leads to differences in the organization part 2). The timer base is entered in the ID screen form of the sequencer.
Initial step different			Different initial steps
Sx or Sx	SELECTIVE PERMANENT	PERMANENT SELECTIVE	Step Sx is selective in one sequencer and permanent in the other.
Sx	Assignments different		S x is an MSZ and the assignment of the steps is different.
FB sel	xx	yy	A different FB type was selected in the ID screen form.

Error Message	Sequencer 1	Sequencer 2	Possible Difference(s) or Cause(s)
Tx	Organization part 1 different		The previous or next steps have a different number or the previous or next steps belong to different simultaneous levels or the length of the transition (with both organization parts) is different.
Tx	Organization part 2 different		The previous or next steps have a different number or the transition belongs to a jump or for at least one subsequent step a different waiting or monitoring time was programmed.
Special commands different			The total length of all steps is different.
Additional information different			The additional information at the end of a GRAPH 5/II block is modified by almost all changes in the SB. If only the additional information is different, then the ID “U” for subsequencer is different.

A GRAPH 5/II synchronization block has an organization part. This only depends on the number of steps in the corresponding sequencer. In the STEP 5 comparison tool, the following abbreviations are used:

- pos. cond. for the number of positive synchronization conditions.
- neg. cond. for the number of negative synchronization conditions.
- PSx for the zoom-in of the automatically generated positive synchronization condition.
- PEx for the zoom-in of the additional positive synchronization condition.
- NSx for the zoom-in of the automatically generated negative synchronization condition.
- NEx for the zoom-in of the additional positive synchronization condition.

A.4 References

Introduction to PLCs

Grötsch, Eberhard

SPS. Speicherprogrammierbare Steuerungen vom Relaisersatz bis zum CIM-Verbund.
Einführung und Übersicht.
Oldenbourg-Verlag, München, Wien 1989.

Specialist Literature from Siemens

Berger, Hans

Automatisieren mit SIMATIC S5-155 U
Order no. A19100-L531-F176
ISBN 3-8009-1522-7

Berger, Hans

Automatisieren mit SIMATIC S5-135 U
Order no. A19100-L531-F187
ISBN 3-8009-1522-7

Berger, Hans

Automatisieren mit SIMATIC S5-115 U
Order no. A19100-L531-F189

Manuals from Siemens

STEP 5/ST V7.1

Order no. 6ES5 998-0MA24

GRAPH 5

Standard Function Blocks
S5-115U, -135U, -150U, -155U Programmable Logic Controllers
Order no. C79000-G8563-C587

GRAPH 5-EDDI

Standard Function Blocks
S5-115U, -135U, -150U, -155U Programmable Logic Controllers
Order no. C79000-G8574-C697

Further programming examples and instructions can be found in the manuals of the programmable controllers and the optional packages.

Glossary

Active step

A step in the sequencer is active, when its actions are being executed.

Actual value

The actual value or refresh value provides the current state of timeouts of a step or transition with regard to changes which have taken place since the first occurrence.

By comparing the initial value and the refresh value, you can check whether changes occurred between these points in time. The refresh value is not stored but overwritten when the screen form is updated.

Criteria analysis

Criteria analysis is a GRAPH 5 diagnostic function for the analysis of part of a sequencer with a timeout (step/transition, MSZ) on the PLC. The function investigates why an action was not executed.
Criteria analysis information is available when the diagnostic program has found outputs that are not set or input scans that were unfulfilled in the steps/transitions with a timeout.

If several steps and transitions have a timeout, you must select the step or transition of interest in a window before starting criteria analysis.

Data buffer DB
DB <DIAG>

This DB is used as a data buffer (FIFO principle) until a PG reads the information. It is generated temporarily by FB 69 with the DB number diagnostic DB + 1. The length of the DB depends on the number of entries in the parameter data DB.

Diagnostic DB
DB <G5:DIAG>

This block is the GRAPH-5 diagnostic data block for criteria analysis. It is generated with the PG function DB-GEN and is valid for all SBs in the program file.

Direct connection

With a direct connection via the AS 511 the path name DIRECT CONNECTION is entered.

FB 67
Read data

FB 67 is called by FB 69 and is responsible for the correct reading of a message from DB<DIAG> to DB<G5:DIAG>.

This block must simply be transferred to the PLC.

FB 68
Write data

FB 68 is called by FB 69 and is responsible for the correct entry of a message from DB<G5:DIAG> to DB<DIAG>.

This block must simply be transferred to the PLC.

FB 69
Diagnostics

FB 69 organizes and controls diagnostics in conjunction with FB 67 and FB 68.

FB 69 consists of executable program and an operation and monitoring section.

This block must be transferred with the assigned DB<G5:PARA> and integrated in the cyclic program.

Flag 233.1

The flag F 233.1 represents the result of the automatically generated synchronization condition. The evaluation result of positive and negative synchronization conditions depends on the RLO at the end of the supplementary condition.

Group diagnostics

The difference between single and group diagnostics is that in group diagnostics up to 4 PLCs can be monitored at the same time and in single diagnostics only one PLC.

In group diagnostics the PG is connected to the PLC via a bus.

Initial step

This becomes active as the 1st step when a sequencer is started without any conditions being scanned or after a jump to S 0 during cyclic operation.

Initial value

GRAPH 5 Diagnostics distinguishes between initial value and actual value (refresh value). The initial value message indicates and stores the situation as it was after block execution in the cycle in which the timeout first occurred. Only the initial value is buffered. The current state of the timeout (actual value) indicates the situation with regard to changes that have taken place since the first occurrence.

With the initial value (state at the time a timeout occurred and was detected) and refresh value (state at the time of the refresh request), you can check the changes that have taken place between these two points in time. Refresh values are not buffered.

Input mode

The“Sequencer overview” dialog is a PG function for GRAPH 5 Diagnostics. This screen form has two modes, the input mode and the polling mode. In this dialog, up to 3 timeouts per screen page are displayed. The currently selected timeout is displayed inversely. All input relates to this message and the SB it describes. In the input mode there is no cyclic scanning (polling).

Input screen

There are two types of input fields available as PG functions for GRAPH 5 diagnostics. The simple input field allows the most important functions of the sequencer to be executed. Only commands supported by the FB being used can be executed. The sequencer status (active steps, steps with timeout, current mode) is also displayed.

The FB input field is divided into a display section (HW input screen) and an operating section (PG input field). Both sections are the simulation of the FB being used, shown in the CSF method of representation in the polling mode. The status of every parameter is displayed in the polling mode.

In the display section, the signal states of the hardware I/Os is displayed.

In the software input field, parameters can be assigned to the program/call interface of FB (FB 70 ... FB 74. The input screen is called with ***F1** (Input)* in the ”Sequencer overview”, “Sequencer diagnostics” or ”Criteria analysis” dialog.

Login group diagnostics

If you want to monitor sequencers in more than one PLC, you must first inform the PG of the connections (path, path name) to the PLC. You edit this connection in the diagnostic dialog.

Message

Menu in GRAPH 5 Diagnostics for selecting the“Sequencer diagnostics” dialog. Here, all the current messages about steps with timeouts are displayed. The messages are detected by cyclic reading of the diagnostic DB. A message consists of all individual messages belonging to an SB.

The messages function outputs the timeout messages of all monitored SBs in detail on the screen or printer. An SB listed in the overview can be further investigated if there is a timeout (criteria analysis).

Message group timeout

This indicates that at least one SB on a monitored PLC has a timeout. This means that a timeout message must have arrived at the PG.

When an SB has a timeout, but there is no message entered in the message buffer, ”no message in message buffer” is displayed at the top of the screen instead of the message information.

Monitoring time (TM/TM-MIN)

The monitoring time (TM or TUE as a block parameter) is the time within which the step enabling conditions for next step must become active and the sequencer must switch on to the next step before the time has elapsed. If this is not the case, a timeout message is output. The monitoring time is evaluated automatically by the standard function blocks for the modes.

Maximum monitoring time

Here, a check is made to determine whether the step enabling conditions for the next step became active within the set monitoring time TM. Before TM elapses, the sequencer must have moved on to the next step, otherwise a timeout message is output. As an alternative, you can use TM as a minimum monitoring time.

Implementing a **minimum monitoring time**. With FB parameter assignment you arrange for TW to be interpreted as a minimum monitoring time TM-MIN. In this case, a check is made to establish whether the step enabling conditions for the next step are fulfilled before the time elapses. If this is the case, an error message is displayed.

TW and TM can have different values in every step. They are programmed simply by entering the time values. The time function does not need to be scanned in the next transition but is evaluated automatically by the standard function blocks for modes.

Multiple candidates

Multiple candidates means that the group of possible synchronization steps following a synchronization run consists of more than one step. This occurs in the following situations:

- steps describing basic settings in which no actions are executed
- multistep zoom-ins (MSZ)

Multistep zoom-in (MSZ)

A multistep zoom-in is a step containing actions assigned to all or to selected steps.
Instead of step numbers, the MSZ has letters. The names of the MSZs (SLA, SLB ...) are assigned in alphabetical order when they are generated.
MSZs are run through in alphabetical order once all the steps have been processed.

For an MSZ, only the positive synchronization condition can be initialized, since there is no follow-on transition to provide the end condition for the negative synchronization condition.

Multiple candidates for the synchronization step can be avoided by using supplementary negative synchronization conditions in the steps.

Network

Connection of several computers (PC, PG, PLC) via interface modules, a physical line and appropriate software to allow data exchange between the computers.

Overview level

The structure of the sequencer is established at the overview level (steps, transitions, simultaneous, alternative branches).

Parameter data DB DB <G5:PARA>

This DB contains 20 DWs with parameter data. You must edit this DB. The defaults can be found in Section 6.3 ”Preparing the Diagnostic Program” and Section 7.3 ”Assignment of the GRAPH 5 Diagnostic Parameters”.

Permanent step

The programmed actions are executed depending on the RLO. All the steps of the sequencer are run through cyclically even if the step is not active. The operations to be executed in a permanent step are controlled by the RLO. The RLO is set by the first command of a step stored under GRAPH 5: ”A F 233.0”. Commands independent of the RLO are always executed, RLO-dependent commands only when the RLO=1.

Note

Flag 233.0 is set by the previous transition. If the transition is not fulfilled, then flag 233.0 = 0 and if the transition is fulfilled, flag 233.0 =1.

Polling mode

The“Sequencer overview” dialog is a PG function for GRAPH 5 Diagnostics. This dialog has 2 modes: the polling mode and the input mode. The status of every parameter is displayed in the polling mode:

a)

there is no timeout:

a moving asterisk on the screen indicates that diagnostics is active

b)

there is a timeout:

the timeout message and function key menu are displayed

Presets (project settings)

Dialog with the parameters for the current STEP 5 package. With the function DB-GEN the maximum number that can be assigned for the diagnostic DB id 254, since the number of the data buffer DB (DB<DIAG)> = number of the diagnostic DB plus 1 (DB<G5: DIAG>).

This DB number must therefore be kept free.

Principle of process synchronization

A positive and a negative synchronization condition is formed for every step. An active step and an unfulfilled transition mean that synchronization is possible.

Process synchronization

If the process control program and the process status are no longer consistent due to a timeout or an intervention, they must be resynchronized with each other.

There are two methods of synchronization:

- Synchronization with a standard FB (FB 70 to 73) that controls the sequencer.
- Synchronization with the automatically generated synchronization SB.

Using automatic process synchronization the step corresponding to the process status can switched active (Chapter 5 Process synchronization).

Refresh value

See actual value.

SB<EXECUTE>

SB 0 (with FB 70/71), SB 2 (with FB 72), SB 3 (with FB 73)

SB list

SB list is a menu in GRAPH 5 Diagnostics for selecting the“Sequencer overview” dialog.

The“Sequencer overview” displays the status of the sequencers on the selected PLC. An SB listed in the overview can be further investigated if there is a timeout (criteria analysis).

SB sync

SB sync must always be called by the user (e.g. in OB 1 or the user PB) (JU SB sync). Once synchronization has been started, this block is executed and determines the number of possible synchronization steps. SB 5 detects whether there are multiple candidates or a single candidate and if there is only one possible step, this is set to active.

Segment

Division of a SIMATIC STEP 5 block.

Selective step

The action part of a selective step is only processed when the step is active. If the step is not active, the action part is skipped.

Sequence block

A sequence block (SB) is a STEP 5 block. There are two types of sequence blocks:

1. Sequence blocks in the LAD; CSF; STL package. These are like program blocks and contain user program or parts of it in the form of STEP 5 commands (basic operations) and possible comments.
2. Sequence blocks in the GRAPH 5 package. These are a special type of sequence block for sequential control. They contain the configured sequencer in the form of sequential steps, step enabling conditions (transitions) and branches. The steps and transitions in these blocks contain the user program in the form of STEP 5 commands and possible comments.

Sequencer

A controller which runs through a sequence of steps, one step switching to the next step according to programmed conditions.

Sequencer diagnostics

Current messages from sequencers with a timeout are displayed in the“Sequencer diagnostics” dialog.

The dialog has two modes:

1. Polling mode with cyclic scanning. The only function key available is ***F1*** *(Inp Mode)* to change to the input mode.
2. Input mode to select various displays and to change to the operating dialog.

Single candidate

Single candidate means that a synchronization run with any program status and process status will always produce one synchronization step only. (The group of possible synchronization steps consists of exactly one step.)

Note. an empty step cannot be the synchronization step with automatically generated synchronization conditions since no outputs are set in it.

Single diagnostics

Single diagnostics means that the sequencer of a PLC is monitored, timeouts are diagnosed and signalled.

Status recognition

The synchronization function with the automatically generated synchronization SB can only use signals exchanged between the process and control program for status recognition. This means that only the signal values of the inputs and outputs can be used. Flags, timers and counters are internal signals which are not transferred to the process. To be able to use signals for the automatic status recognition, the following conditions must be met:

The value of the signal must allow conclusions to be made about the process status.

FB synchronization uses the RLOs of the transitions for status recognition.

The aim of status recognition is to identify the program steps of a sequencer.

Step

A step is part of the sequencer and describes the actions executed by the controller in a certain status. The actions of a step are programmed at the zoom-in level in STEP 5.

Subsequencer

Subsequencers are treated as further main sequencers in process synchronization. They have their own SB-sync, whose SB number must not match that of the main sequencer.

Switching transition

A transition switches further when it is valid and the step enabling conditions are fulfilled. Switching means that the transition terminates previous step(s) and activates the next step(s).

Symbols file

Assignment list stored in a file.

Synchronization conditions

Synchronization conditions are implemented by assigning a positive and a negative synchronization condition in every step of the sequencer. These conditions determine whether a step can be active or not.

The automatically generated end condition for the action programmed in the previous step is formed from all the input signals within a transition and is for automatic generation of the synchronization conditions. The logically combined input signals are used (A I, O I).

The synchronization conditions are structured as follows:

1. Positive synchronization condition, generated automatically
2. Negative synchronization condition, generated automatically
3. Supplementary, positive synchronization condition, can be generated manually (Section 5.3).
4. Supplementary, negative synchronization condition, can be generated manually (Section 5.3).

All the synchronization conditions of a sequence block are put together to form a separate block, SB-sync. The method of representation of the synchronization conditions at the zoom-in level is the same as in the steps.

Transition

A transition is part of the sequencer and contains the step enabling conditions with which the sequencer changes from one status to the next. The step enabling conditions are programmed at the zoom-in level in STEP 5.
A transition is valid when its previous step(s) is (are) active. A transition switches when it is valid and the step enabling conditions are fulfilled. Switching means that the transition terminates the previous step(s) and activates the next step(s).
Transitions are always processed selectively.

Valid transition

A transition is valid when the previous step(s) is (are) active.

Working DB DB<G5:sequence>

Working DB for the sequence block with the same number. This is generated when DB-GEN is executed, i.e. the number is generated automatically. The option “Update DB” ensures that the working DB remains up to date.

Zoom-in level

The content of the steps and transitions are programmed at the zoom-in level using STEP 5 and the zoom-in function. Their status is also displayed at this level.

Index

F

G

I

J

L

M

N

O

P

R

S

Siemens AG
A&D AS E 81

Oestliche Rheinbrueckenstr. 50
D-76181 Karlsruhe
Federal Republic of Germany

From:
Your Name: _
Your Title: _
Company Name: _
Street: _
City, Zip Code _
Country: _
Phone: _

Please check any industry that applies to you:

- ❐ Automotive
- ❐ Chemical
- ❐ Electrical Machinery
- ❐ Food
- ❐ Instrument and Control
- ❐ Nonelectrical Machinery
- ❐ Petrochemical
- ❐ Pharmaceutical
- ❐ Plastic
- ❐ Pulp and Paper
- ❐ Textiles
- ❐ Transportation
- ❐ Other _ _ _ _ _ _ _ _ _ _ _

Remarks Form

Your comments and recommendations will help us to improve the quality and usefulness of our publications. Please take the first available opportunity to fill out this questionnaire and return it to Siemens.

Please give each of the following questions your own personal mark within the range from 1 (very good) to 5 (poor).

1. Do the contents meet your requirements? ☐
2. Is the information you need easy to find? ☐
3. Is the text easy to understand? ☐
4. Does the level of technical detail meet your requirements? ☐
5. Please rate the quality of the graphics/tables: ☐

Additional comments: