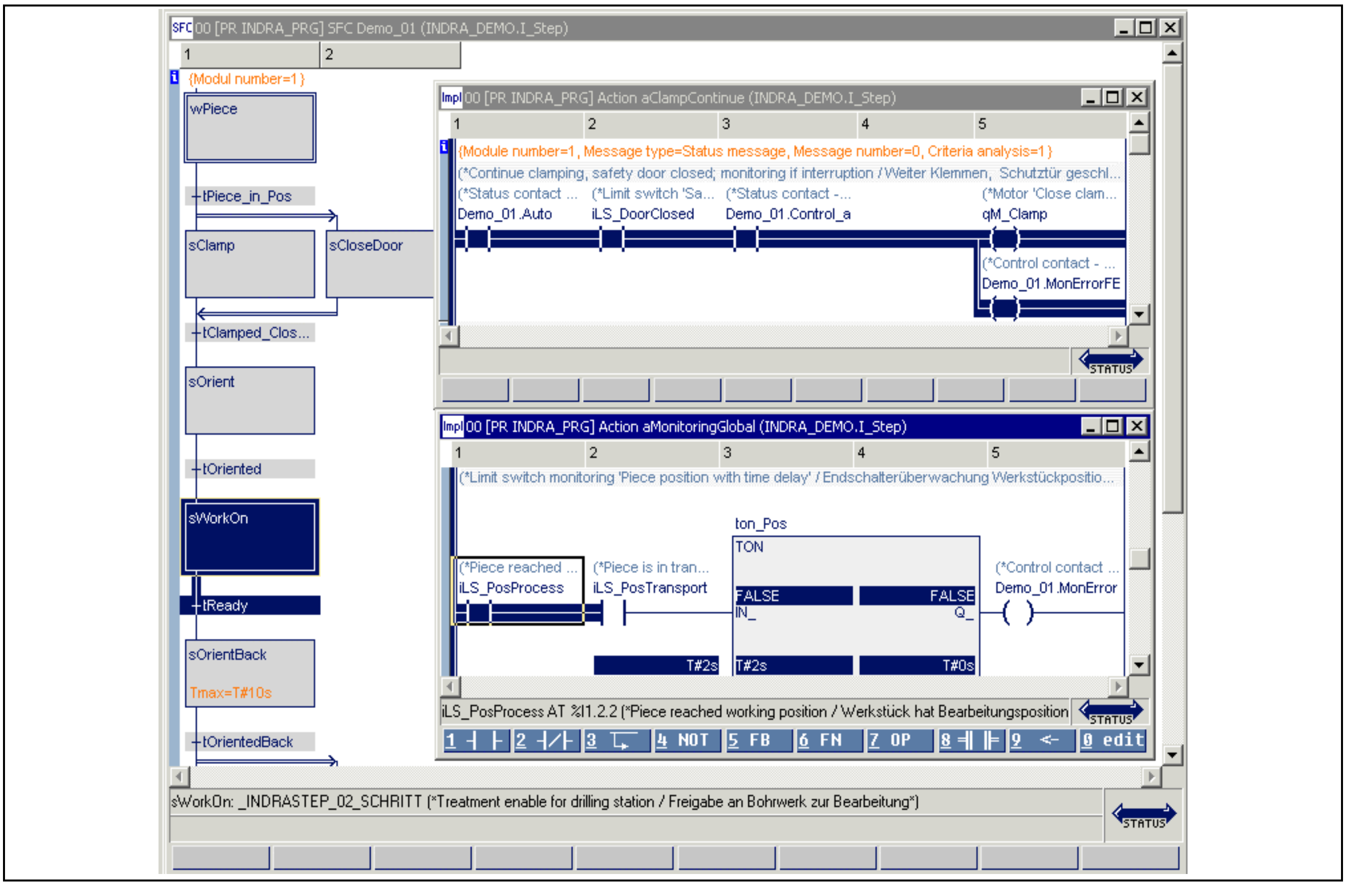
Rexroth


00 [PR INDRA_PRG] SFC Demo_01 (INDRA_DEMO.I_Step)
{Modul number=1}
wPiece
tPiece_in_Pos
sClamp
sCloseDoor
tClamped_Clos...
sOrient
tOriented
sWorkOn
tReady
sOrientBack
Tmax=T#10s
tOrientedBack
00 [PR INDRA_PRG] Action aClampContinue (INDRA_DEMO.I_Step)
{Module number=1, Message type=Status message, Message number=0, Criteria analysis=1}
(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschl...
(*Status contact ...
(*Limit switch 'Sa...
(*Status contact -...
(*Motor 'Close clam...
Demo_01.Auto
iLS_DoorClosed
Demo_01.Control_a
qM_Clamp
(*Control contact - ...
Demo_01.MonErrorFE
STATUS
00 [PR INDRA_PRG] Action aMonitoringGlobal (INDRA_DEMO.I_Step)
(*Limit switch monitoring 'Piece position with time delay' / Endschalterüberwachung Werkstückpositio...
ton_Pos
TON
(*Piece reached ...
iLS_PosProcess
(*Piece is in tran...
iLS_PosTransport
FALSE
IN_
FALSE
Q_
(*Control contact ...
Demo_01.MonError
T#2s
T#2s
T#0s
iLS_PosProcess AT %I1.2.2 (*Piece reached working position / Werkstück hat Bearbeitungsposition
STATUS
1 ┤├ 2 ┤/├ 3 4 NOT 5 FB 6 FN 7 OP 8 9 ← 0 edit
sWorkOn: _INDRASTEP_02_SCHRITT (*Treatment enable for drilling station / Freigabe an Bohrwerk zur Bearbeitung*)
STATUS

Programming with IndraStep SFCs with Mode Control and Diagnosis

Application Manual

SYSTEM200

DOK-CONTRL-SPS*ISTEP02-AW02-EN-P

Rexroth Indramat

Title Programming with IndraStep
SFCs with Mode Control and Diagnosis

Type of Documentation Application Manual

Document Typecode DOK-CONTRL-SPS*ISTEP02-AW02-EN-P

Internal File Reference Document Number, 120-0400-B374-02/EN

Purpose of Documentation This documentation servers to adjust to the possibilities of the mode control with IndraStep on the basis of a continuous example. Diagnosis and criteria analysis are shown for the different mode controls.

Record of Revisions

Description	Release Date	Notes
120-0400-B374-02/EN	01/03	First English issue

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Contents

1 General Information

1.1 Documentation Contents

These programming instructions contain a description of the operating mode support provided by “IndraStep” within the WinPCL programming system for the programmable logic controllers (PLC) of Messrs. Bosch Rexroth, illustrated by a general example.

This documentation should be filed between the ***Description of the User Interface for High-Volume-Production Machines /2/*** and the PLC programming instructions ***Programming with WinPCL 04VRS /1/.***

This documentation contains the following chapters:

- Creating a root program (chapter 4.1)

  This chapter provides the IndraStep beginner with information on how to create a resource with a program in a variant. The program contains an IndraStep sequential function chart. Please note that this root program is initially independent of the example.

  The root program is filed in the IndraStep_Demo_00.APV archive in
  ... \Basic Data\TEMPLATES.

- Description of an example and extension of the root program by this example in the automatic mode (chapters ,4.2, 4.3).

- Options of error control (chapter 4.4).

  The options of error control are presented on the basis of the IndraStep example.

- Diagnosis options - criteria analysis (chapter 4.5).

  This chapter shows that the WinPCL features permit minimum diagnosis in the startup phase which should, however, be extended by the WinHMI diagnosis features for practical use.

  The example is used to describe the various error types and the associated diagnosis messages.

- For the IndraStep sequences, the automatic mode is extended by the AutoStep mode (chapter 4.6). This does not result in any changes to the sequential function chart used in the example.

- The functions possible in the manual mode are explained. The automatic sequential function chart of the example is extended by the manual mode (chapter 4.7).

- The possibilities of activating the outputs in the manual mode are discussed:

  - Activating the outputs by forcing

  - Activating the outputs by operating screens

    Creation of operating screens is explained in detail. The connection between the operating screen and the diagnosis is shown by means of the example.

  - Activating the outputs by compact operator panels

  - Activating the outputs while overriding the locking mechanism (ManualForce)

- The diagnosis options are shown by means of ProVi messages (chapter 4.8).

- Instructions on how to update IndraStep files (chapter 4.9).

The following chapters complete the documentation by

- an overview of system variables of steps, transitions, actions, and sequences (chapter 5),
- an overview of ProVi messages (excerpt from /1/ and /2/) (chapter 6),
- FAQs, which are constantly updated in chapter 7.

1.2 Additional Documentations

Number	Title	Contents	Documentation code
/1/	Programming with WinPCL 04VRS	- Description of the Menu Structure - Editor Description - Description of the Standard and Firmware Types / Functions / Function Blocks	DOK-CONTRL-WINPCL*4VRS-AW..-EN-P
/2/	MTC200/ISP200/MTA200 WinHMI User Interface	Description of the User Interface for High-Volume-Production Machines	DOK-CONTRL-WIN*HMI*V22-AW..-EN-P
/3/	PC Compound	- Description of the actions required for establishing a PC network - Requirements for remote programming	DOK-CONTRL-PC**NET*V21-AW..-EN-P
/4/	ScreenManager for Miniature Control Panels Application Description	- Compact operator terminals	DOK_SUPPL*-SCM*BEDIEN*AW..-EN-P

Fig. 1-1: Additional documentations

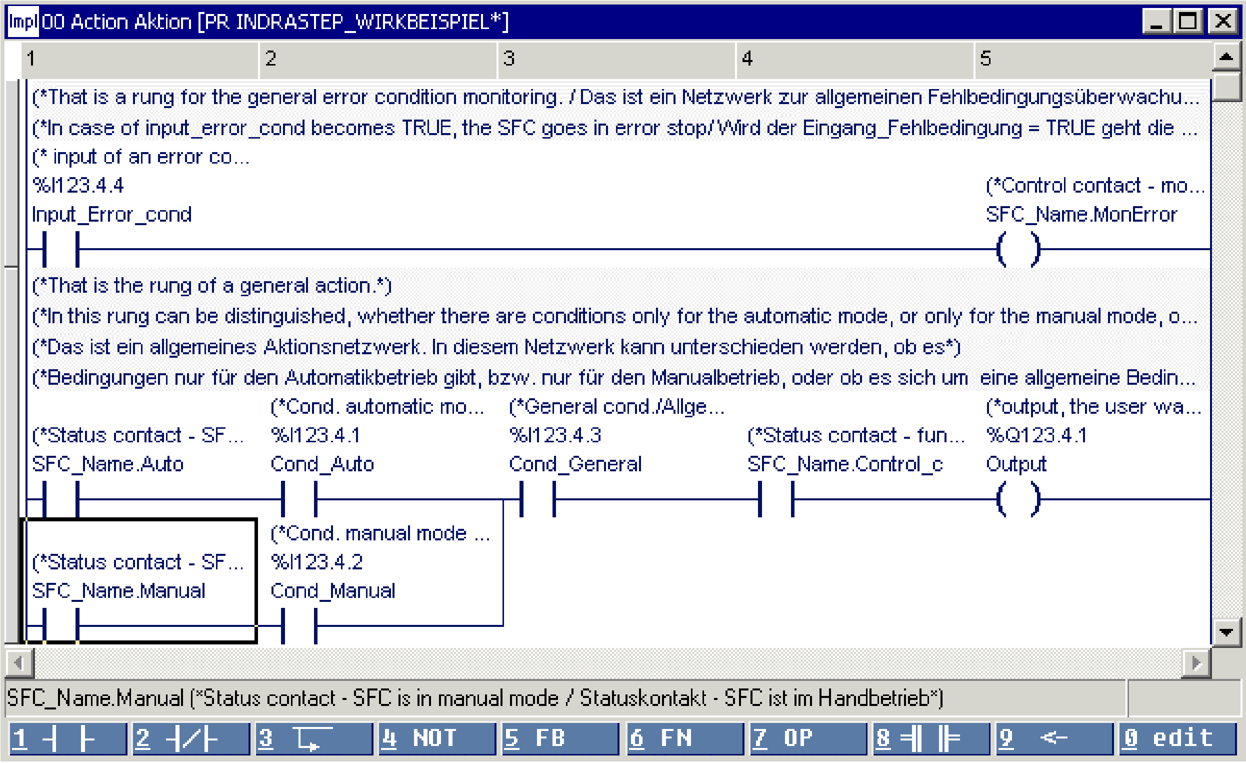
1.3 Differences Between Standard SFC and IndraStep

The sequential function charts defined in EN 61131-3 do not provide any support on mode control and diagnosis. As a result, this support must be completely programmed by the programmer.

This can be avoided by using IndraStep. Contrary to standard SFCs, IndraStep provides full mode and diagnosis support. This support is automatically added to each element to be controlled. This automatic support also increases the operational reliability, since no element will ever be forgotten. Each sequential function chart is provided with its own closed mode and diagnosis evaluation with first-error analysis.

In the action shown in Fig. 1-2, the user utilizes the features provided by IndraStep in order to configure the following rungs:

- monitoring rung for an error condition,
- activation of an output in the automatic mode and in the manual mode.



Impl 00 Action Aktion [PR INDRASTEP_WIRKBEISPIEL*]

(*That is a rung for the general error condition monitoring. / Das ist ein Netzwerk zur allgemeinen Fehlbedingungsüberwachu...
(*In case of input_error_cond becomes TRUE, the SFC goes in error stop/ Wird der Eingang_Fehlbedingung = TRUE geht die ...
(* input of an error co...

%I123.4.4
Input_Error_cond

(*Control contact - mo...
SFC_Name.MonError

(*That is the rung of a general action.*)
(*In this rung can be distinguished, whether there are conditions only for the automatic mode, or only for the manual mode, o...
(*Das ist ein allgemeines Aktionsnetzwerk. In diesem Netzwerk kann unterschieden werden, ob es*)
(*Bedingungen nur für den Automatikbetrieb gibt, bzw. nur für den Manualbetrieb, oder ob es sich um eine allgemeine Bedin...

(*Status contact - SF...
SFC_Name.Auto

(*Cond. automatic mo...
%I123.4.1
Cond_Auto

(*General cond./Allge...
%I123.4.3
Cond_General

(*Status contact - fun...
SFC_Name.Control_c

(*output, the user wa...
%Q123.4.1
Output

(*Status contact - SF...
SFC_Name.Manual

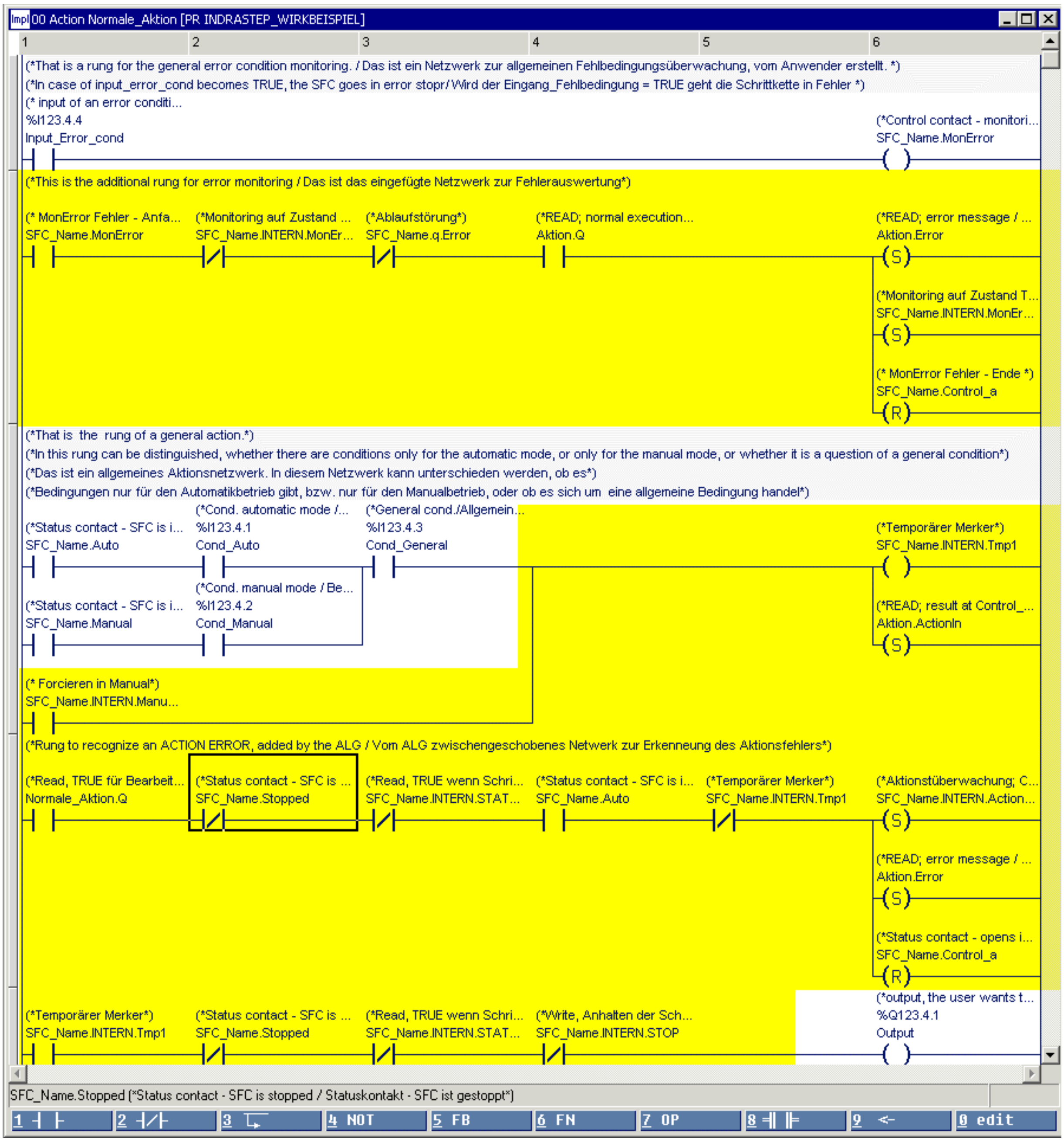
(*Cond. manual mode ...
%I123.4.2
Cond_Manual

SFC_Name.Manual (*Status contact - SFC is in manual mode / Statuskontakt - SFC ist im Handbetrieb*)

Aktion_IndraStep.bmp

Fig. 1-2: Rungs with IndraStep features

The contacts resulting in the desired functionality are highlighted in yellow in the following equivalent circuit diagram (Fig. 1-3). This part is not applicable in the input and startup phases.



00 Action Normale_Aktion [PR INDRASTEP_WIRKBEISPIEL]

(*That is a rung for the general error condition monitoring. / Das ist ein Netzwerk zur allgemeinen Fehlbedingungsüberwachung, vom Anwender erstellt. *)
(*In case of input_error_cond becomes TRUE, the SFC goes in error stopr/ Wird der Eingang_Fehlbedingung = TRUE geht die Schrittkette in Fehler *)

(*This is the additional rung for error monitoring / Das ist das eingefügte Netzwerk zur Fehlerauswertung*)

(*That is the rung of a general action.*)
(*In this rung can be distinguished, whether there are conditions only for the automatic mode, or only for the manual mode, or whether it is a question of a general condition*)
(*Das ist ein allgemeines Aktionsnetzwerk. In diesem Netzwerk kann unterschieden werden, ob es*)
(*Bedingungen nur für den Automatikbetrieb gibt, bzw. nur für den Manualbetrieb, oder ob es sich um eine allgemeine Bedingung handel*)

(*Rung to recognize an ACTION ERROR, added by the ALG / Vom ALG zwischengeschobenes Netzwerk zur Erkenneung des Aktionsfehlers*)

SFC_Name.Stopped (*Status contact - SFC is stopped / Statuskontakt - SFC ist gestoppt*)

1
2
3
4
5
6
(* input of an error conditi...
%I123.4.4
Input_Error_cond
(*Control contact - monitori...
SFC_Name.MonError
(* MonError Fehler - Anfa...
SFC_Name.MonError
(*Monitoring auf Zustand ...
SFC_Name.INTERN.MonEr...
(*Ablaufstörung*)
SFC_Name.q.Error
(*READ; normal execution...
Aktion.Q
(*READ; error message / ...
Aktion.Error
S
(*Monitoring auf Zustand T...
SFC_Name.INTERN.MonEr...
S
(* MonError Fehler - Ende *)
SFC_Name.Control_a
R
(*Status contact - SFC is i...
SFC_Name.Auto
(*Cond. automatic mode /...
%I123.4.1
Cond_Auto
(*General cond./Allgemein...
%I123.4.3
Cond_General
(*Temporärer Merker*)
SFC_Name.INTERN.Tmp1
(*Status contact - SFC is i...
SFC_Name.Manual
(*Cond. manual mode / Be...
%I123.4.2
Cond_Manual
(*READ; result at Control_...
Aktion.ActionIn
S
(* Forcieren in Manual*)
SFC_Name.INTERN.Manu...
(*Read, TRUE für Bearbeit...
Normale_Aktion.Q
(*Status contact - SFC is ...
SFC_Name.Stopped
(*Read, TRUE wenn Schri...
SFC_Name.INTERN.STAT...
(*Status contact - SFC is i...
SFC_Name.Auto
(*Temporärer Merker*)
SFC_Name.INTERN.Tmp1
(*Aktionstüberwachung; C...
SFC_Name.INTERN.Action...
S
(*READ; error message / ...
Aktion.Error
S
(*Status contact - opens i...
SFC_Name.Control_a
R
(*Temporärer Merker*)
SFC_Name.INTERN.Tmp1
(*Status contact - SFC is ...
SFC_Name.Stopped
(*Read, TRUE wenn Schri...
SFC_Name.INTERN.STAT...
(*Write, Anhalten der Sch...
SFC_Name.INTERN.STOP
(*output, the user wants t...
%Q123.4.1
Output
1
2
3
4 NOT
5 FB
6 FN
7 OP
8
9 <-
0 edit

Aktion_normal.bmp

Fig. 1-3: Completed rungs according to the desired function (additional contacts are highlighted in yellow)

2 Important Directions for Use

2.1 Appropriate Use

Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

Note: Bosch Rexroth AG, as manufacturer, is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the product takes the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

Areas of Use and Application

IndraStep serves to support the mode control within the programming system WinPCL for programmable logic controls of Rexroth.

Note: Operation is only permitted in the specified configurations and combinations of hardware components using the software and firmware as specified in this documentation.

2.2 Inappropriate Use

Using IndraStep outside of the above-referenced areas of application or under operating conditions other than described in the document and the technical data specified is defined as “inappropriate use".

IndraStep may not be used if it is subject to operating conditions that do not meet the above specified ambient conditions. Furthermore, IndraStep must not be used for applications that the manufacturer has not specifically released for that intended purpose. Please note the specifications outlined in the general Safety Instructions!

2.3 Delivery Stipulations for Computer Programs

The copyrights, present and future commercial proprietary rights of all kinds, as well as all the rights of exploitation to delivered computer programs -- in equipment or separate from it -- belong exclusively to the Supplier.

A computer program may only be used in one single piece of equipment. Exceptions are commissioning software, which are marked with the designation -COPY at the end. These can be copied freely within the context of regular product usage by the customer.

Every act exceeding the minimum use outlined in the proprietary rights requires the consent of the Supplier. If a computer program delivered by the Supplier is not protected by proprietary rights, then the minimum use stated in the proprietary rights laws is declared as agreed upon.

If the Orderer transfers a computer program then he must completely surrender the program carrier and all copies in their entirety to the Acquiring Party, or these must be erased. A limitation of use corresponding to these stipulations (1 through 6) must be agreed upon with the Acquiring Party.

The Supplier will eliminate any fault in the computer program either by a circumvention of the fault, which is agreeable to the Orderer, or by delivering a new program.

All documents and information needed to reconstruct a fault must accompany the notification of a fault in the computer program.

Otherwise, the general delivery stipulations outlined by Bosch Rexroth apply.

3 Safety Instructions for Electric Drives and Controls

3.1 Introduction

Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.

Do not attempt to install or start up this equipment without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation of the equipment prior to working with the equipment at any time. If you do not have the user documentation for your equipment, contact your local Bosch Rexroth representative to send this documentation immediately to the person or persons responsible for the safe operation of this equipment.

If the equipment is resold, rented or transferred or passed on to others, then these safety instructions must be delivered with the equipment.

⚠ WARNING

Improper use of this equipment, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

3.2 Explanations

The safety instructions describe the following degrees of hazard seriousness in compliance with ANSI Z535. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions.

Warning symbol with signal word	Degree of hazard seriousness according to ANSI
⚠ DANGER	Death or severe bodily harm will occur.
⚠ WARNING	Death or severe bodily harm may occur.
⚠ CAUTION	Bodily harm or material damage may occur.

Fig. 3-1: Hazard classification (according to ANSI Z535)

3.3 Hazards by Improper Use

⚠
DANGER

High voltage and high discharge current! Danger to life or severe bodily harm by electric shock!

⚠
DANGER

Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!

⚠
WARNING

High electrical voltage due to wrong connections! Danger to life or bodily harm by electric shock!

⚠
WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

⚠
CAUTION

Surface of machine housing could be extremely hot! Danger of injury! Danger of burns!

⚠
CAUTION

Risk of injury due to improper handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock or incorrect handling of pressurized systems!

⚠
CAUTION

Risk of injury due to incorrect handling of batteries!

3.4 General Information

- The Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this equipment.
- Only persons who are trained and qualified for the use and operation of the equipment may work on this equipment or within its proximity.
  - The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
  - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and equipment on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The equipment is designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Use only safety features and applications that are clearly and explicitly approved in the Project Planning Manual.
  For example, the following areas of use are not permitted: construction cranes, elevators used for people or freight, devices and vehicles to transport people, medical applications, refinery plants, transport of hazardous goods, nuclear applications, applications sensitive to high frequency, mining, food processing, control of protection equipment (also in a machine).
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
  The machine and installation manufacturer must
  - make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
  - make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

- Operation is only permitted if the national EMC regulations for the application are met.
  The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".
  The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.

3.5 Protection Against Contact with Electrical Parts

Note: This section refers to equipment and drive components with voltages above 50 Volts.

Touching live parts with voltages of 50 Volts and more with bare hands or conductive tools or touching ungrounded housings can be dangerous and cause electric shock. In order to operate electrical equipment, certain parts must unavoidably have dangerous voltages applied to them.

DANGER

High electrical voltage! Danger to life, severe bodily harm by electric shock!

⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain or repair this equipment.

⇒ Follow general construction and safety regulations when working on high voltage installations.

⇒ Before switching on power the ground wire must be permanently connected to all electrical units according to the connection diagram.

⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the ground wire is not permanently connected to the points of the components provided for this purpose.

⇒ Before working with electrical parts with voltage higher than 50 V, the equipment must be disconnected from the mains voltage or power supply. Make sure the equipment cannot be switched on again unintended.

⇒ The following should be observed with electrical drive and filter components:

⇒ Wait five (5) minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.

⇒ Never touch the electrical connection points of a component while power is turned on.

⇒ Install the covers and guards provided with the equipment properly before switching the equipment on. Prevent contact with live parts at any time.

⇒ A residual-current-operated protective device (RCD) must not be used on electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.

⇒ Electrical components with exposed live parts and uncovered high voltage terminals must be installed in a protective housing, for example, in a control cabinet.

To be observed with electrical drive and filter components:

⚠ DANGER

High electrical voltage on the housing! High leakage current! Danger to life, danger of injury by electric shock!

⇒ Connect the electrical equipment, the housings of all electrical units and motors permanently with the safety conductor at the ground points before power is switched on. Look at the connection diagram. This is even necessary for brief tests.

⇒ Connect the safety conductor of the electrical equipment always permanently and firmly to the supply mains. Leakage current exceeds 3.5 mA in normal operation.

⇒ Use a copper conductor with at least 10 mm² cross section over its entire course for this safety conductor connection!

⇒ Prior to startups, even for brief tests, always connect the protective conductor or connect with ground wire. Otherwise, high voltages can occur on the housing that lead to electric shock.

3.6 Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 0 and 50 Volts on Rexroth products are protective low voltages designed in accordance with international standards on electrical safety.

⚠ WARNING

High electrical voltage due to wrong connections! Danger to life, bodily harm by electric shock!

⇒ Only connect equipment, electrical components and cables of the protective low voltage type (PELV = Protective Extra Low Voltage) to all terminals and clamps with voltages of 0 to 50 Volts.

⇒ Only electrical circuits may be connected which are safely isolated against high voltage circuits. Safe isolation is achieved, for example, with an isolating transformer, an opto-electronic coupler or when battery-operated.

3.7 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of the connected motors. Some common examples are:

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily injury and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

⚠ DANGER

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

⇒ Ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. Unintended machine motion is possible if monitoring devices are disabled, bypassed or not activated.

⇒ Pay attention to unintended machine motion or other malfunction in any mode of operation.

⇒ Keep free and clear of the machine’s range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine’s range of motion:

- use safety fences
- use safety guards
- use protective coverings
- install light curtains or light barriers

⇒ Fences and coverings must be strong enough to resist maximum possible momentum, especially if there is a possibility of loose parts flying off.

⇒ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don’t operate the machine if the emergency stop is not working.

⇒ Isolate the drive power connection by means of an emergency stop circuit or use a starting lockout to prevent unintentional start.

⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone. Safe standstill can be achieved by switching off the power supply contactor or by safe mechanical locking of moving parts.

⇒ Secure vertical axes against falling or dropping after switching off the motor power by, for example:

- mechanically securing the vertical axes
- adding an external braking/ arrester/ clamping mechanism
- ensuring sufficient equilibration of the vertical axes

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!

⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:

- maintenance and repair work
- cleaning of equipment
- long periods of discontinued equipment use

⇒ Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such equipment cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

3.8 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated near current-carrying conductors and permanent magnets in motors represent a serious health hazard to persons with heart pacemakers, metal implants and hearing aids.

⚠ WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

⇒ Persons with heart pacemakers, hearing aids and metal implants are not permitted to enter the following areas:

- Areas in which electrical equipment and parts are mounted, being operated or started up.
- Areas in which parts of motors with permanent magnets are being stored, operated, repaired or mounted.

⇒ If it is necessary for a person with a heart pacemaker to enter such an area, then a doctor must be consulted prior to doing so. Heart pacemakers that are already implanted or will be implanted in the future, have a considerable variation in their electrical noise immunity. Therefore there are no rules with general validity.

⇒ Persons with hearing aids, metal implants or metal pieces must consult a doctor before they enter the areas described above. Otherwise, health hazards will occur.

3.9 Protection Against Contact with Hot Parts

⚠ CAUTION

Housing surfaces could be extremely hot! Danger of injury! Danger of burns!

⇒ Do not touch housing surfaces near sources of heat! Danger of burns!

⇒ After switching the equipment off, wait at least ten (10) minutes to allow it to cool down before touching it.

⇒ Do not touch hot parts of the equipment, such as housings with integrated heat sinks and resistors. Danger of burns!

3.10 Protection During Handling and Mounting

Under certain conditions, incorrect handling and mounting of parts and components may cause injuries.

⚠ CAUTION

Risk of injury by incorrect handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock!

⇒ Observe general installation and safety instructions with regard to handling and mounting.

⇒ Use appropriate mounting and transport equipment.

⇒ Take precautions to avoid pinching and crushing.

⇒ Use only appropriate tools. If specified by the product documentation, special tools must be used.

⇒ Use lifting devices and tools correctly and safely.

⇒ For safe protection wear appropriate protective clothing, e.g. safety glasses, safety shoes and safety gloves.

⇒ Never stand under suspended loads.

⇒ Clean up liquids from the floor immediately to prevent slipping.

3.11 Battery Safety

Batteries contain reactive chemicals in a solid housing. Inappropriate handling may result in injuries or material damage.

CAUTION

Risk of injury by incorrect handling!

⇒ Do not attempt to reactivate discharged batteries by heating or other methods (danger of explosion and cauterization).

⇒ Never charge non-chargeable batteries (danger of leakage and explosion).

⇒ Never throw batteries into a fire.

⇒ Do not dismantle batteries.

⇒ Do not damage electrical components installed in the equipment.

Note: Be aware of environmental protection and disposal! The batteries contained in the product should be considered as hazardous material for land, air and sea transport in the sense of the legal requirements (danger of explosion). Dispose batteries separately from other waste. Observe the legal requirements in the country of installation.

3.12 Protection Against Pressurized Systems

Certain motors and drive controllers, corresponding to the information in the respective Project Planning Manual, must be provided with pressurized media, such as compressed air, hydraulic oil, cooling fluid and cooling lubricant supplied by external systems. Incorrect handling of the supply and connections of pressurized systems can lead to injuries or accidents. In these cases, improper handling of external supply systems, supply lines or connections can cause injuries or material damage.

CAUTION

Danger of injury by incorrect handling of pressurized systems !

⇒ Do not attempt to disassemble, to open or to cut a pressurized system (danger of explosion).

⇒ Observe the operation instructions of the respective manufacturer.

⇒ Before disassembling pressurized systems, release pressure and drain off the fluid or gas.

⇒ Use suitable protective clothing (for example safety glasses, safety shoes and safety gloves)

⇒ Remove any fluid that has leaked out onto the floor immediately.

Note: Environmental protection and disposal! The media used in the operation of the pressurized system equipment may not be environmentally compatible. Media that are damaging the environment must be disposed separately from normal waste. Observe the legal requirements in the country of installation.

Notes

4 Creating an IndraStep Example Project

The benefits of IndraStep are illustrated below by means of an example project:

- The first step is the development of a root program which can be reused irrespective of the particular application.
- Then an example project is presented illustrating essential features of the IndraStep mode control.
- The automatic sequential function chart of the example is integrated in the root program.
- The actions are extended by the necessary manual mode.

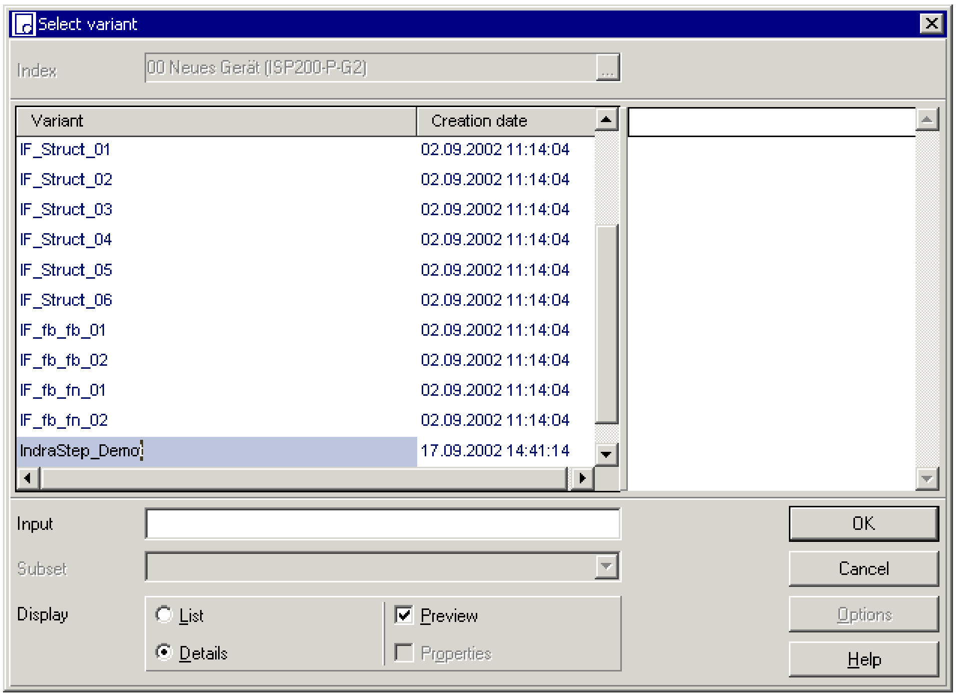
4.1 Preparing the Root Program in WinPCL

To prepare the root program, proceed as follows:

- Create the folder of the variant.
- Load the IndraStep structures.
- Create the IndraStep program and its resource.

Creating a New Variant

Using the *File/ Variant selection for control*** menu item, click the right mouse button in the left-hand field of the variant selection screen to create a new variant, rename it by **"IndraStep_Demo"** and select it as the current variant.



Index: 00 Neues Gerät (ISP200-P-G2)

Variant	Creation date
IF_Struct_01	02.09.2002 11:14:04
IF_Struct_02	02.09.2002 11:14:04
IF_Struct_03	02.09.2002 11:14:04
IF_Struct_04	02.09.2002 11:14:04
IF_Struct_05	02.09.2002 11:14:04
IF_Struct_06	02.09.2002 11:14:04
IF_fb_fb_01	02.09.2002 11:14:04
IF_fb_fb_02	02.09.2002 11:14:04
IF_fb_fn_01	02.09.2002 11:14:04
IF_fb_fn_02	02.09.2002 11:14:04
IndraStep_Demo	17.09.2002 14:41:14

Input

Subset

Display: ○ List ● Details ☑ Preview □ Properties

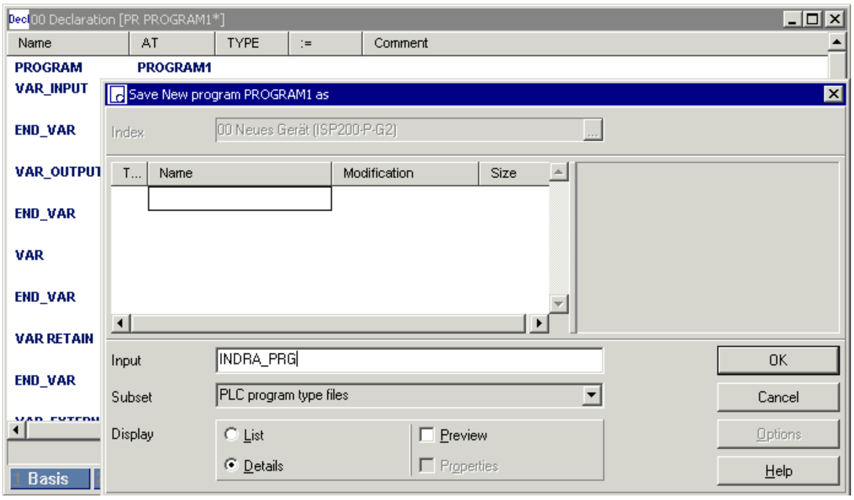
Anlage_neue_Variante.bmp

Fig. 4-1: Creating the variant

The IndraStep functionality can only be used if the IndraStep structures are present within the variant.

Creating the Program

In the next step, create the program using the *“File / New / Programs”* menu item.



00 Declaration [PR PROGRAM1*]

Name	AT	TYPE	:=	Comment
PROGRAM	PROGRAM1			
VAR_INPUT				
END_VAR				
VAR_OUTPUT				
END_VAR				
VAR				
END_VAR				
VAR RETAIN				
END_VAR				

Save New program PROGRAM1 as

Index: 00 Neues Gerät (ISP200-P-G2)

Input: INDRA_PRG

Subset: PLC program type files

Display: ○ List ● Details □ Preview □ Properties

Anlage_neues_PR.bmp

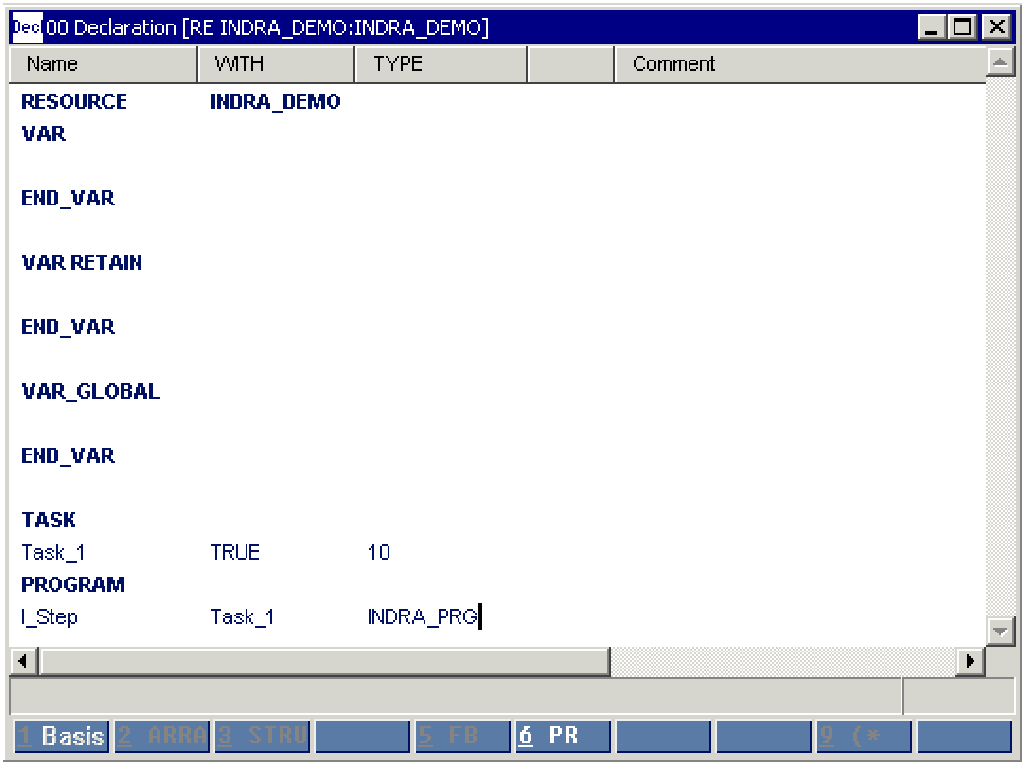
Fig. 4-2: Creating a new program

Initially, the blank program is adequate for the following steps.

Creating the Resource and Entering the Program

Then create the resource using the *“File / New / Resource”* menu item.

A task which controls the program is defined.



00 Declaration [RE INDRA_DEMO:INDRA_DEMO]

Name	WITH	TYPE		Comment
RESOURCE	INDRA_DEMO			
VAR				
END_VAR				
VAR RETAIN				
END_VAR				
VAR_GLOBAL				
END_VAR				
TASK				
Task_1	TRUE	10		
PROGRAM				
I_Step	Task_1	INDRA_PRG		

Anlage_neue_RE.bmp

Fig. 4-3: Creating a new resource

After the **“RE_INDRA_DEMO”** resource has been saved, all windows are closed.

The resource, the program and the IndraStep structures of the template are now available. Load the resource via *File / Open.* Press <Ctrl>+<Enter> or double-click the mouse on the program instance name (I_Step) to open the program (see Fig. 4-3).

The programming system opens the ladder diagram editor (implementation) of the program.

Entering of the variables, however, requires the declaration editor of the program. The declaration editor can be called via *View / Declaration* or <ALT>+<F2>.

Declaring the Variables for Mode Control

The names of the variables mentioned below have been selected such that they match the IndraStep structures.

In a real program, the mode control is controlled by a higher-order program part. In our programming example, the control of IndraStep is directly connected to the inputs and outputs of peripheral equipment.

For that reason, these variables must be entered in the declaration in the VAR…END_VAR area of the program.

Name	**AT**	**TYPE**	**:=**	**Comment**
(*Mode control==*)				
i_Start	%I1.0.0	BOOL		(*Start SFC*)
i_Stop	%I1.0.1	BOOL		(*Stop SFC*)
i_AutoStep	%I1.0.2	BOOL		(*Single step mode (automatic)*)
i_Manual	%I1.0.3	BOOL		(*Manual mode*)
i_ManualForce	%I1.0.4	BOOL		(*Manual mode; force outputs controlled by Control_a*)
i_SetStep	%I1.0.5	BOOL		(*Steps with <step name>.SYNC = TRUE to activate when changing from manual to automatic mode*)
i_Reset	%I1.0.6	BOOL		(*Reset SFC; activate INITIAL_STEP of SFC*)
i_ClearError	%I1.0.7	BOOL		(*Delete error status*)
q_Run	%Q1.0.0	BOOL		(*SFC executes active steps or in manual mode at least one step is activated')
q_Active	%Q1.0.1	BOOL		(*SFC is active - not in the INITIAL_STEP*)
q_Manual	%Q1.0.2	BOOL		(*Manual mode is active*)
q_Ready	%Q1.0.3	BOOL		(*Ready*)
q_Error	%Q1.0.4	BOOL		(*Error in SFC*)
q_ErrorStp	%Q1.0.5	BOOL		(*Unable to takeover the steps set with <step name>.SYNC in automatic mode*)
q_Stopped	%Q1.0.6	BOOL		(*SFC stopped*)
q_WaitOnTransition	%Q1.0.7	BOOL		(*At least one transition following the active step/s is clear*)

Fig. 4-4: “Mode control” area in the declaration of a program

Note: This variable block is required for each SFC with mode control (IndraStep). For that reason, it must be entered and checked only once, then copied and adjusted with regard to the absolute addresses.

You can now continue to create the sequential function chart. The declaration window can either be minimized or closed.

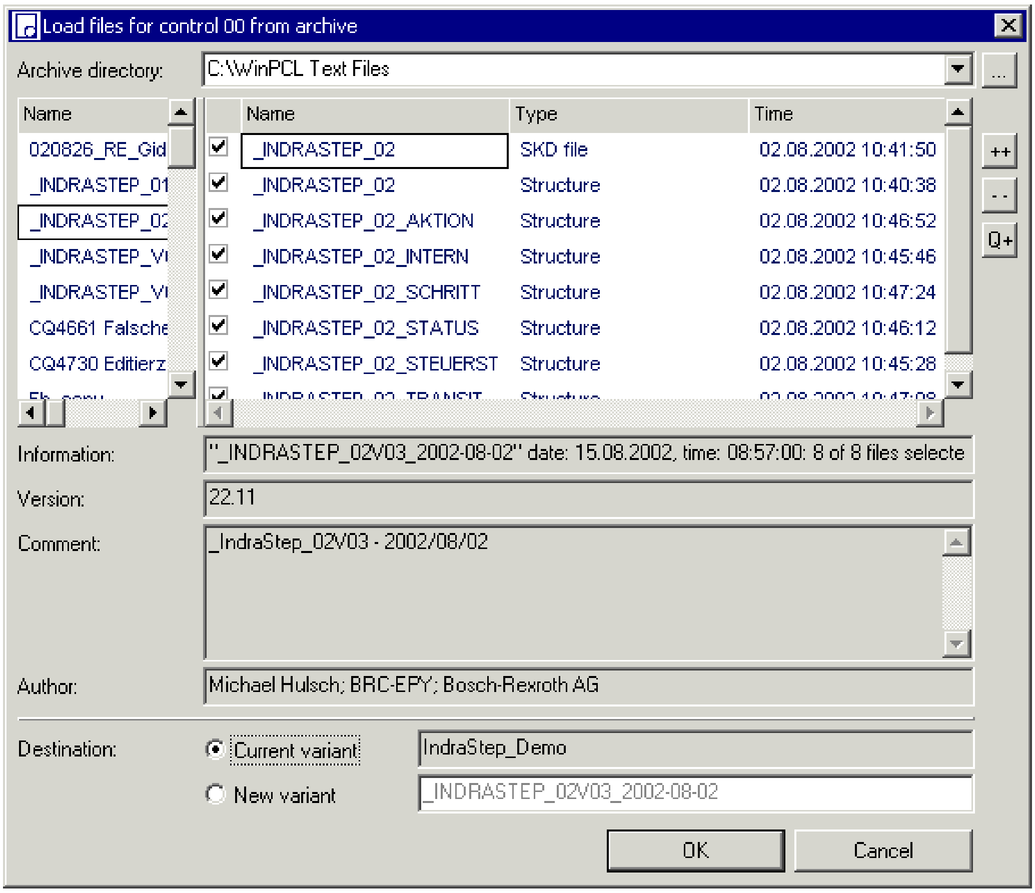
Mode control of the sequence (of the sequential function chart) requires that the folder (the variant) contains the IndraStep files.

Loading the IndraStep Files

The ***empty*** SFC selection window in Fig. 4-6 indicates that there are no IndraStep structures. If not yet available, the IndraStep structures can be loaded via *File / Archive / Load archive.* The files are contained as **archives** for WinHMI or WinPCL in the following folders:

- *Mtgui\BasicData\TEMPLATES*
- *WinPCL\BasicData\TEMPLATES*

When loading the IndraStep_02 archive, make sure to select “Current variant” as the destination. Seven structure files and one SKD file are loaded.



Load files for control 00 from archive

Archive directory: C:\WinPCL Text Files

Name
020826_RE_Gid
_INDRASTEP_01
_INDRASTEP_02
_INDRASTEP_VI
_INDRASTEP_VI
CQ4661 Falsche
CQ4730 Editierz

	Name	Type	Time
☑	_INDRASTEP_02	SKD file	02.08.2002 10:41:50
☑	_INDRASTEP_02	Structure	02.08.2002 10:40:38
☑	_INDRASTEP_02_AKTION	Structure	02.08.2002 10:46:52
☑	_INDRASTEP_02_INTERN	Structure	02.08.2002 10:45:46
☑	_INDRASTEP_02_SCHRITT	Structure	02.08.2002 10:47:24
☑	_INDRASTEP_02_STATUS	Structure	02.08.2002 10:46:12
☑	_INDRASTEP_02_STEUERST	Structure	02.08.2002 10:45:28

Information: "_INDRASTEP_02V03_2002-08-02" date: 15.08.2002, time: 08:57:00: 8 of 8 files selecte

Version: 22.11

Comment: _IndraStep_02V03 - 2002/08/02

Author: Michael Hulsch; BRC-EPY; Bosch-Rexroth AG

Destination: ● Current variant IndraStep_Demo

○ New variant _INDRASTEP_02V03_2002-08-02

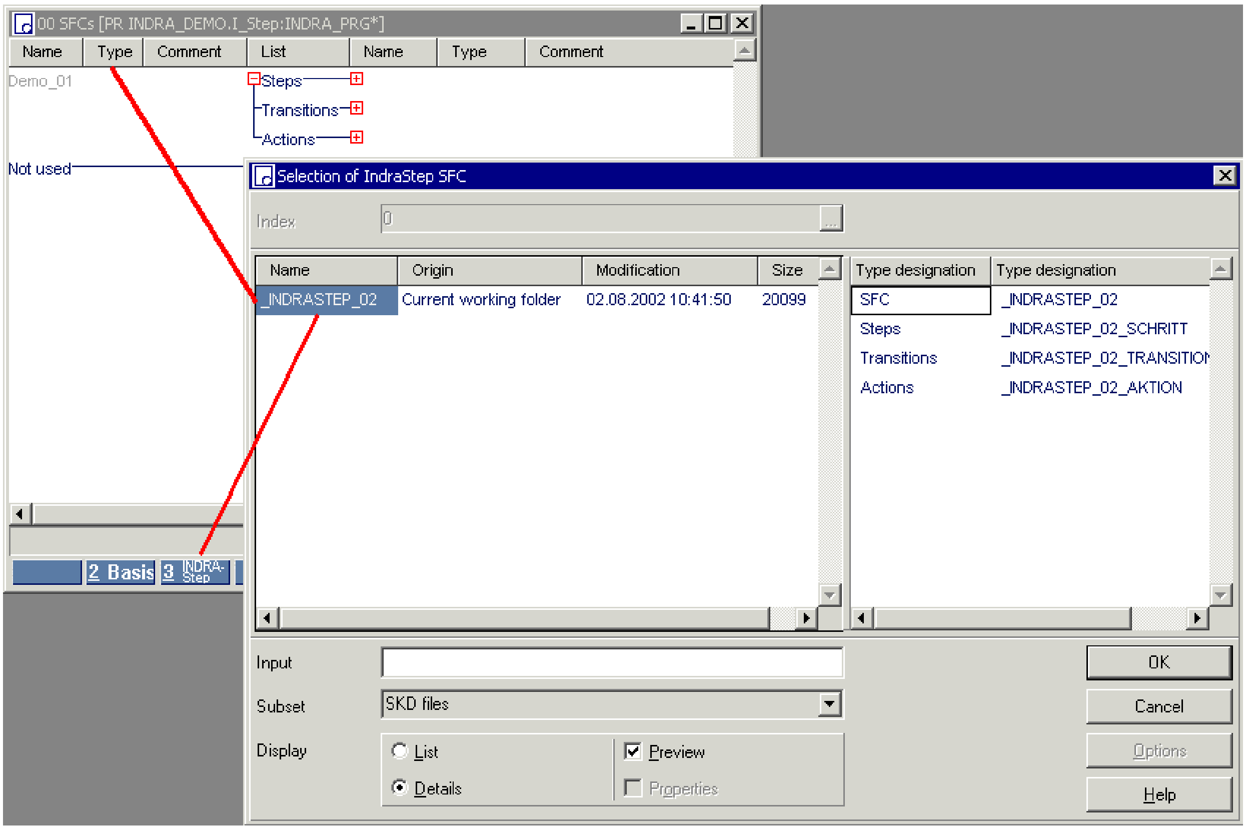
IndraStep_Strukturen.bmp

Fig. 4-5: Loading the “IndraStep structures” archive to the “IndraStep_Demo” variant.

Creating a Sequential Function Chart

An IndraStep SFC is created on the program or FB level via *View/SFCs* (<ALT>+<F3>).

Enter the name of the name of the SFC in the first column of this SFC editor. Move to the “TYPE” column using the <space bar> and select IndraStep using the footer command “3-IndraStep” or <ALT>+<3>).



00 SFCs [PR INDRA_DEMO.I_Step:INDRA_PRG*]

Name	Type	Comment	List	Name	Type	Comment
Demo_01			Steps Transitions Actions			
Not used						

Selection of IndraStep SFC

Index: 0

Name	Origin	Modification	Size
_INDRASTEP_02	Current working folder	02.08.2002 10:41:50	20099

Type designation	Type designation
SFC	_INDRASTEP_02
Steps	_INDRASTEP_02_SCHRITT
Transitions	_INDRASTEP_02_TRANSITION
Actions	_INDRASTEP_02_AKTION

Input:

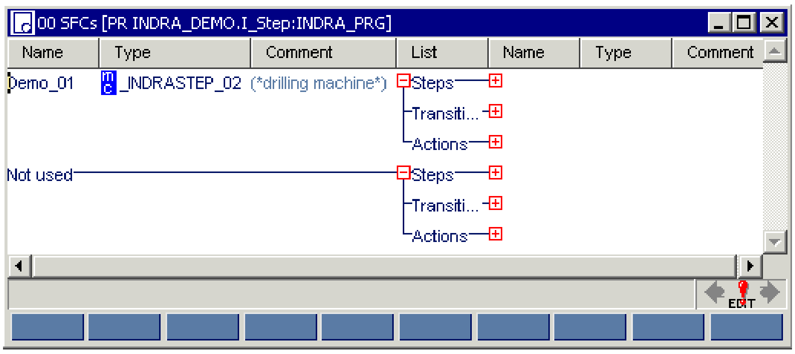
Subset: SKD files

Display: ○ List ● Details ☑ Preview □ Properties

Auswahl_Ablauftyp.bmp

Fig. 4-6: Selecting an SFC type, here IndraStep

The line for the SFC is completed by entering a comment.



00 SFCs [PR INDRA_DEMO.I_Step:INDRA_PRG]

Name	Type	Comment	List	Name	Type	Comment
Demo_01	_INDRASTEP_02	(*drilling machine*)	Steps Transiti... Actions			
Not used			Steps Transiti... Actions			

Auswahl_Ablauftyp_komplett.bmp

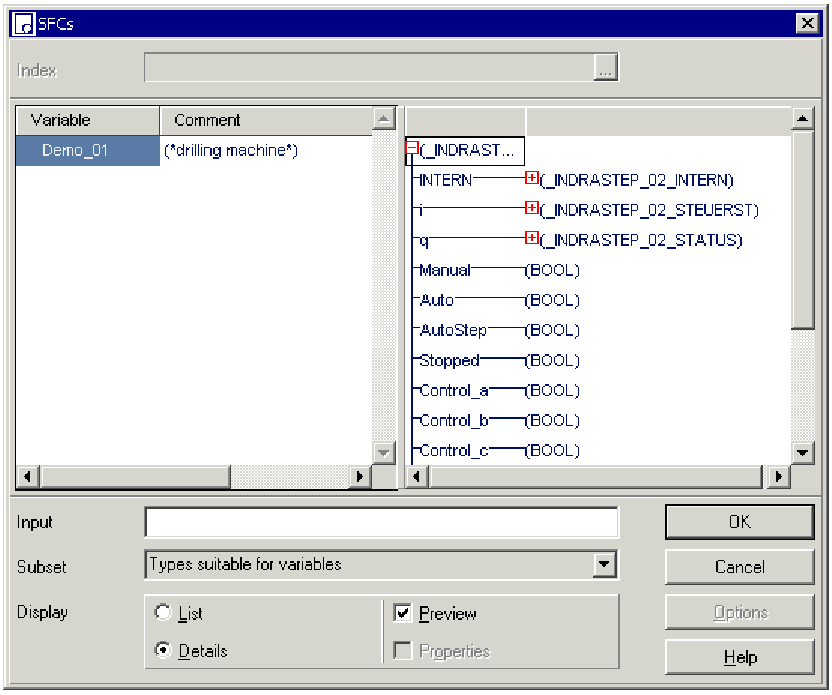
Fig. 4-7: Defining the SFC type

The mc symbol indicates that the SFC is an IndraStep SFC with mode control. Press <Ctrl>+<Enter> or double-click on the name of the SFC (Demo_01) to open the SFC editor for entering the steps and transitions.

First, however, call only the SFC itself (i.e. without any content) in the implementation of the program. To achieve this, either minimize or close the SFC list editor (Fig. 4-7). Now, the still empty ladder diagram editor or IL editor is required.

Calling the SFC in the Ladder Diagram

In an empty ladder diagram rung, use the 4–SFC footer command or the <ALT>+<4> keys to call the selection window which displays the SFCs available.



Variable	Comment
Demo_01	(*drilling machine*)

```
(_INDRAST...
INTERN——(_INDRASTEP_02_INTERN)
i———————(_INDRASTEP_02_STEUERST)
q———————(_INDRASTEP_02_STATUS)
Manual——(BOOL)
Auto————(BOOL)
AutoStep(BOOL)
Stopped—(BOOL)
Control_a(BOOL)
Control_b(BOOL)
Control_c(BOOL)
```

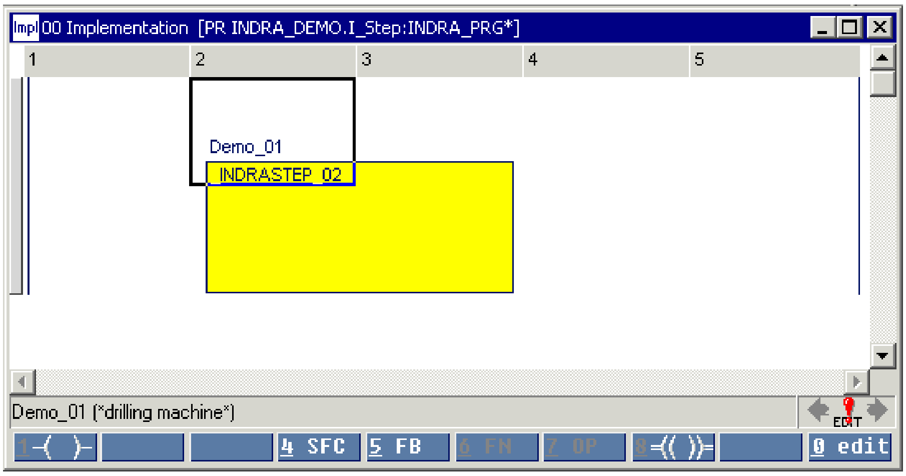
Subset: Types suitable for variables

Display: ○ List ● Details ☑ Preview □ Properties

Auswahlfenster_Ablaeufe.bmp

Fig. 4-8: Selecting the desired “Demo_01” SFC

The right-hand field of the “SFCs” window shows a preview of all variables which are assigned to the “**Demo_01”** SFC.


Impl 00 Implementation [PR INDRA_DEMO.I_Step:INDRA_PRG*]
1
2
3
4
5
Demo_01
INDRASTEP_02
Demo_01 (*drilling machine*)
EDIT
1 -( )-
4 SFC
5 FB
6 FN
7 OP
8 =(( ))=
0 edit

Ablauf_im_KOP.bmp

Fig. 4-9: SFC selected from the ladder diagram

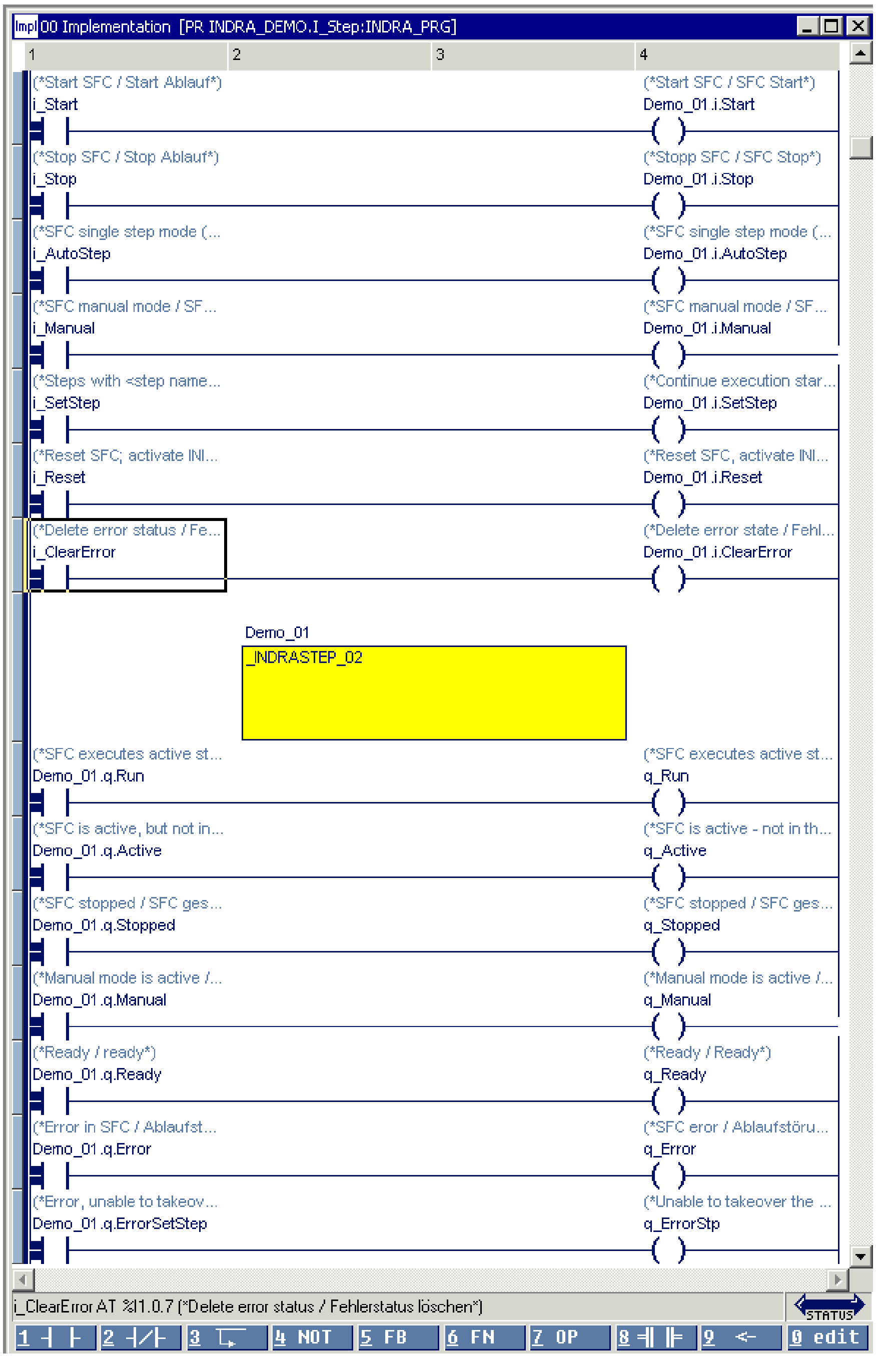
The variables of the **“Demo_01”** SFC (see Fig. 4-8) provided by IndraStep are now activated by the already declared variables for mode control (Fig. 4-4).

Here, the declared input variables are applied to the elements of the “<SFC name>.i.xxx” input structure and the output variables to the elements of the “<SFC name>.q.xxx” output structure of the SFC.

The SFC itself is positioned between these two assignment blocks.

Note: Up to that point, the program does not yet contain any user-specific information – with the exception of the <SFC name>. For that reason, the program should be saved to the archive at this point. The <SFC name> can be adjusted without any loss in the SFC list (Fig. 4-7).

Using the implementation editor, add the required rungs to the ladder diagram:



00 Implementation [PR INDRA_DEMO.I_Step:INDRA_PRG]

1	2	3	4
(*Start SFC / Start Ablauf*) i_Start			(*Start SFC / SFC Start*) Demo_01.i.Start
(*Stop SFC / Stop Ablauf*) i_Stop			(*Stopp SFC / SFC Stop*) Demo_01.i.Stop
(*SFC single step mode (... i_AutoStep			(*SFC single step mode (... Demo_01.i.AutoStep
(*SFC manual mode / SF... i_Manual			(*SFC manual mode / SF... Demo_01.i.Manual
(*Steps with <step name... i_SetStep			(*Continue execution star... Demo_01.i.SetStep
(*Reset SFC; activate INI... i_Reset			(*Reset SFC, activate INI... Demo_01.i.Reset
(*Delete error status / Fe... i_ClearError			(*Delete error state / Fehl... Demo_01.i.ClearError
	Demo_01 _INDRASTEP_02		
(*SFC executes active st... Demo_01.q.Run			(*SFC executes active st... q_Run
(*SFC is active, but not in... Demo_01.q.Active			(*SFC is active - not in th... q_Active
(*SFC stopped / SFC ges... Demo_01.q.Stopped			(*SFC stopped / SFC ges... q_Stopped
(*Manual mode is active /... Demo_01.q.Manual			(*Manual mode is active /... q_Manual
(*Ready / ready*) Demo_01.q.Ready			(*Ready / Ready*) q_Ready
(*Error in SFC / Ablaufst... Demo_01.q.Error			(*SFC eror / Ablaufstöru... q_Error
(*Error, unable to takeov... Demo_01.q.ErrorSetStep			(*Unable to takeover the ... q_ErrorStp

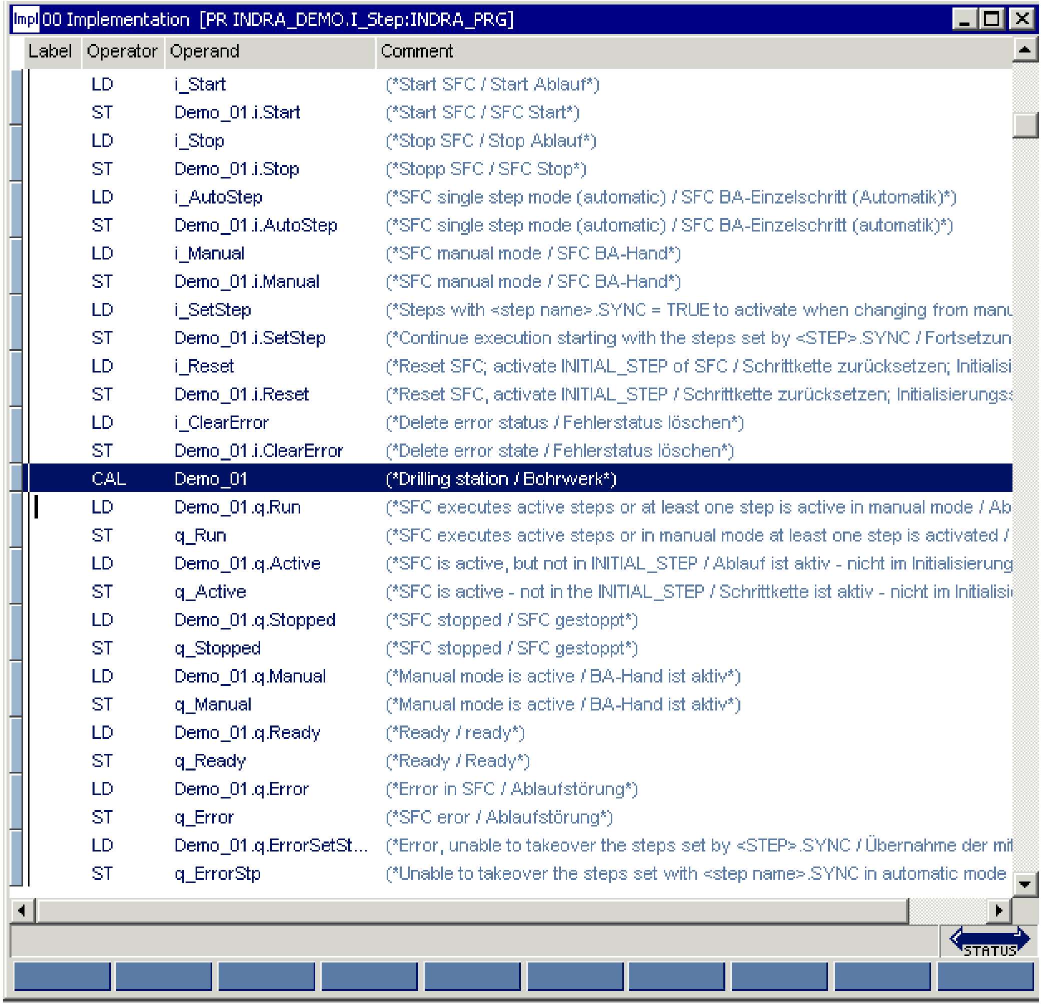
i_ClearError AT %I1.0.7 (*Delete error status / Fehlerstatus löschen*)

BA-Ansteuerung_im_Kontaktplan.bmp

Fig. 4-10: Mode control in the ladder diagram

Calling the SFC in the Instruction List

As an alternative, the instruction list is shown with equal contents in the implementation editor. The call of the SFC (CAL Demo_01) is selected as a block.



Label	Operator	Operand	Comment
	LD	i_Start	(*Start SFC / Start Ablauf*)
	ST	Demo_01.i.Start	(*Start SFC / SFC Start*)
	LD	i_Stop	(*Stop SFC / Stop Ablauf*)
	ST	Demo_01.i.Stop	(*Stopp SFC / SFC Stop*)
	LD	i_AutoStep	(*SFC single step mode (automatic) / SFC BA-Einzelschritt (Automatik)*)
	ST	Demo_01.i.AutoStep	(*SFC single step mode (automatic) / SFC BA-Einzelschritt (automatik)*)
	LD	i_Manual	(*SFC manual mode / SFC BA-Hand*)
	ST	Demo_01.i.Manual	(*SFC manual mode / SFC BA-Hand*)
	LD	i_SetStep	(*Steps with <step name>.SYNC = TRUE to activate when changing from manu
	ST	Demo_01.i.SetStep	(*Continue execution starting with the steps set by <STEP>.SYNC / Fortsetzun
	LD	i_Reset	(*Reset SFC; activate INITIAL_STEP of SFC / Schrittkette zurücksetzen; Initialisi
	ST	Demo_01.i.Reset	(*Reset SFC, activate INITIAL_STEP / Schrittkette zurücksetzen; Initialisierungs
	LD	i_ClearError	(*Delete error status / Fehlerstatus löschen*)
	ST	Demo_01.i.ClearError	(*Delete error state / Fehlerstatus löschen*)
	CAL	Demo_01	(*Drilling station / Bohrwerk*)
	LD	Demo_01.q.Run	(*SFC executes active steps or at least one step is active in manual mode / Ab
	ST	q_Run	(*SFC executes active steps or in manual mode at least one step is activated /
	LD	Demo_01.q.Active	(*SFC is active, but not in INITIAL_STEP / Ablauf ist aktiv - nicht im Initialisierung
	ST	q_Active	(*SFC is active - not in the INITIAL_STEP / Schrittkette ist aktiv - nicht im Initialisi
	LD	Demo_01.q.Stopped	(*SFC stopped / SFC gestoppt*)
	ST	q_Stopped	(*SFC stopped / SFC gestoppt*)
	LD	Demo_01.q.Manual	(*Manual mode is active / BA-Hand ist aktiv*)
	ST	q_Manual	(*Manual mode is active / BA-Hand ist aktiv*)
	LD	Demo_01.q.Ready	(*Ready / ready*)
	ST	q_Ready	(*Ready / Ready*)
	LD	Demo_01.q.Error	(*Error in SFC / Ablaufstörung*)
	ST	q_Error	(*SFC eror / Ablaufstörung*)
	LD	Demo_01.q.ErrorSetSt...	(*Error, unable to takeover the steps set by <STEP>.SYNC / Übernahme der mi
	ST	q_ErrorStp	(*Unable to takeover the steps set with <step name>.SYNC in automatic mode

BA-Ansteuerung_in_AWL.bmp

Fig. 4-11: Mode control in the IL

Section	Component	Task
Implementation of LD rungs at the top		Assigning the variables to the SFC control signals
Demo_01 SFC	Transitions	Calculating the steps to be activated
	INTERN.aIN_USER	System action
	User actions	Execution of actions (order as specified in the SFC list)
	INTERN.aOUT_USER	System action
Implementation of LD rungs at the bottom		Assigning the SFC status signals to the variables

Fig. 4-12: Order of execution in Fig. 4-10 and Fig. 4-11

4.2 Example Project: Drilling Station

The example below is to be programmed. It has been simplified to a large degree.

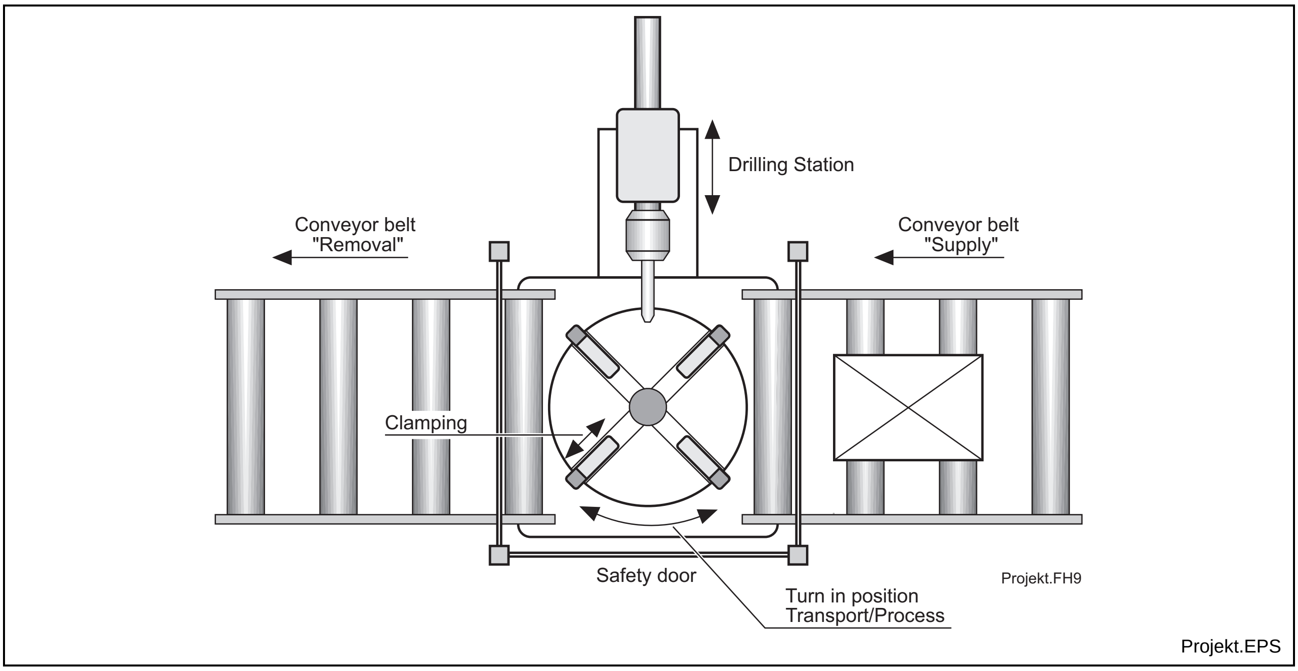


Fig. 4-13: Example of the IndraStep mode control

The example to be programmed is a drilling station with supply and removal of material.

Sequence of Steps

- The material is supplied by a conveyor belt from the right with open safety door only.
- Once the workpiece has reached the transport position below the drilling station, the conveyor belt is stopped; after the safety door has been closed, the workpiece is clamped.
- The clamped workpiece is turned to its machining position.
- Then it is machined.
- After having been machined, the workpiece is turned back to the transport position.
- Now, the workpiece can be unclamped and the safety door opened.
- With open safety door, the workpiece is transported to the left. The machining cycle is completed when the workpiece has been removed.

The new machining cycle starts when the next workpiece is supplied.

Details of the workpiece machining cycle are not covered by the example. Only a possible tool breakage causing the work to be stopped will be considered.

Assigning Inputs and Outputs

The following variables are declared in the declaration part of the programs for controlling the safety door, the clamping mechanism and the supply and removal of material.

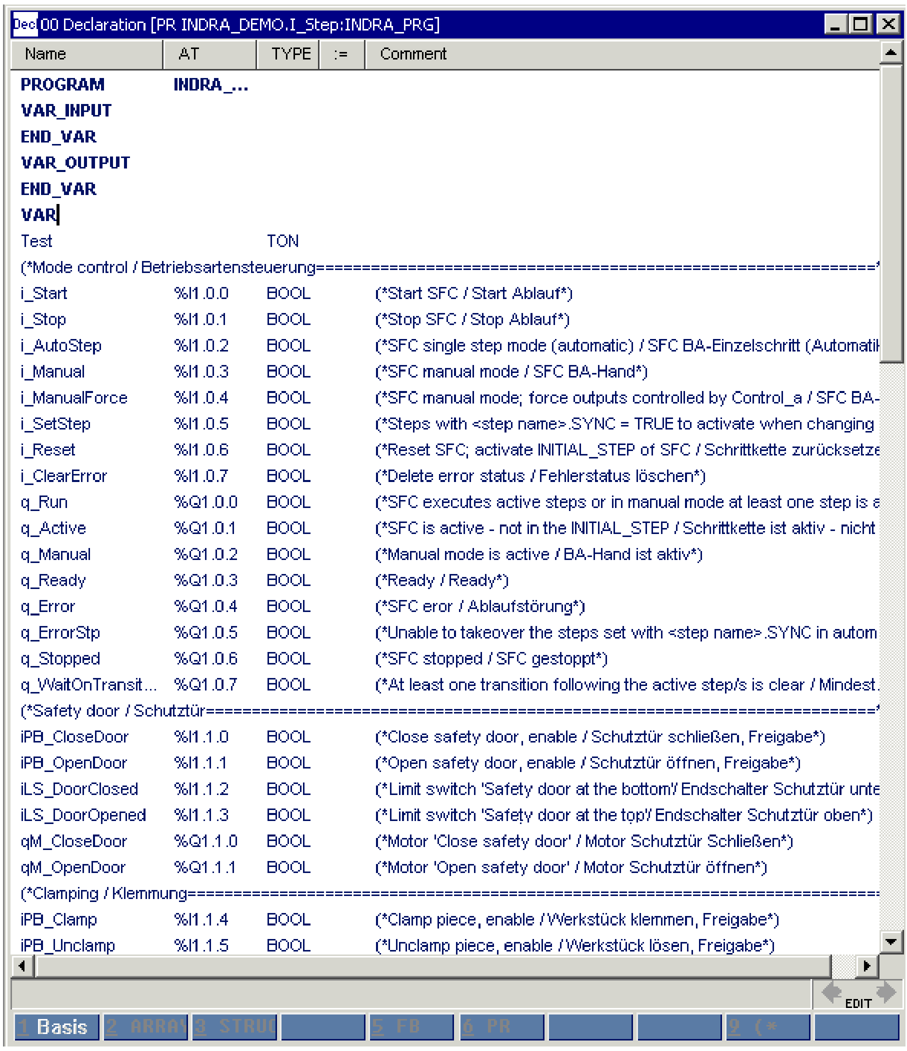
Name	AT	TYPE	:=	Comment
(*Safety door==*)				
iPB_CloseDoor	%I1.1.0	BOOL		(*Close safety door; jog*)
iPB_OpenDoor	%I1.1.1	BOOL		(*Open safety door; jog*)
iLS_DoorClosed	%I1.1.2	BOOL		(*Limit switch 'Safety door at the bottom'*)
iLS_DoorOpened	%I1.1.3	BOOL		(*Limit switch 'Safety door at the top*)
qM_CloseDoor	%Q1.1.0	BOOL		(*Motor 'Close safety door'*)
qM_OpenDoor	%Q1.1.1	BOOL		(*Motor 'Open safety door'*)
(*Clamping==*)				
iPB_Clamp	%I1.1.4	BOOL		(*Clamp piece, jog*)
iPB_Unclamp	%I1.1.5	BOOL		(*Unclamp piece, jog*)
iLS_Clamped	%I1.1.6	BOOL		(*Limit switch 'Clamping closed'*)
iLS_Unclamped	%I1.1.7	BOOL		(*Limit switch 'Clamping opened*)
qM_Clamp	%Q1.1.4	BOOL		(*Motor 'Close clamping*)
qM_Unclamp	%Q1.1.5	BOOL		(*Motor 'Open clamping*)
(*Treatment==*)				
iPB_ToPosProcess	%I1.2.0	BOOL		(*Turn in working position, jog*)
iPB_ToPosTransport	%I1.2.1	BOOL		(*Turn in transport position, jog*)
iLS_PosProcess	%I1.2.2	BOOL		(*Piece reached working position*)
iLS_PosTransport	%I1.2.3	BOOL		(*Piece is in transport direction*)
iLS_BrokenDie	%I1.3.0	BOOL		(*Piece breakage*)
iLS_NoCooling	%I1.3.1	BOOL		(*Breakdown of the cooling system*)
qM_ToPosProcess	%Q1.2.0	BOOL		(*Motor 'Turn piece in working position'*)
qM_ToPosTransport	%Q1.2.1	BOOL		(*Motor 'Turn piece in transport position'*)
ton_Pos		TON		(*Delay 'Limit switch monitoring'*)
(*Conveyor belts==*)				
iPB_FeedRemove	%I1.2.4	BOOL		(*Conveyor belt 'Removal', jog*)
iPB_FeedLoad	%I1.2.5	BOOL		(*Conveyor belt 'Supply, jog*)
iLS_PieceRemoved	%I1.2.6	BOOL		(*Piece left conveyor belt*)
iLS_WorkFinished	%I1.2.7	BOOL		(*Treatment completed*)
qM_FeedLoad	%Q1.2.4	BOOL		(*Motor 'Conveyor belt, supply', jog*)
qM_FeedRemove	%Q1.2.5	BOOL		(*Motor 'Conveyor belt, removal', jog*)

Fig. 4-14: Input and output assignment of the example

4.3 Incorporating the Example in the “Root Program”

Extending the Declaration by the Variables of the Example

Enter the variables of the example (Fig. 4-14) in the declaration part of the program in the VAR...END_VAR area.



```
PROGRAM          INDRA_...
VAR_INPUT
END_VAR
VAR_OUTPUT
END_VAR
VAR
Test                        TON
(*Mode control / Betriebsartensteuerung=================================================================*
i_Start          %I1.0.0    BOOL       (*Start SFC / Start Ablauf*)
i_Stop           %I1.0.1    BOOL       (*Stop SFC / Stop Ablauf*)
i_AutoStep       %I1.0.2    BOOL       (*SFC single step mode (automatic) / SFC BA-Einzelschritt (Automatik
i_Manual         %I1.0.3    BOOL       (*SFC manual mode / SFC BA-Hand*)
i_ManualForce    %I1.0.4    BOOL       (*SFC manual mode; force outputs controlled by Control_a / SFC BA-
i_SetStep        %I1.0.5    BOOL       (*Steps with <step name>.SYNC = TRUE to activate when changing
i_Reset          %I1.0.6    BOOL       (*Reset SFC; activate INITIAL_STEP of SFC / Schrittkette zurücksetze
i_ClearError     %I1.0.7    BOOL       (*Delete error status / Fehlerstatus löschen*)
q_Run            %Q1.0.0    BOOL       (*SFC executes active steps or in manual mode at least one step is a
q_Active         %Q1.0.1    BOOL       (*SFC is active - not in the INITIAL_STEP / Schrittkette ist aktiv - nicht
q_Manual         %Q1.0.2    BOOL       (*Manual mode is active / BA-Hand ist aktiv*)
q_Ready          %Q1.0.3    BOOL       (*Ready / Ready*)
q_Error          %Q1.0.4    BOOL       (*SFC eror / Ablaufstörung*)
q_ErrorStp       %Q1.0.5    BOOL       (*Unable to takeover the steps set with <step name>.SYNC in autom
q_Stopped        %Q1.0.6    BOOL       (*SFC stopped / SFC gestoppt*)
q_WaitOnTransit... %Q1.0.7  BOOL       (*At least one transition following the active step/s is clear / Mindest.
(*Safety door / Schutztür===============================================================================*
iPB_CloseDoor    %I1.1.0    BOOL       (*Close safety door, enable / Schutztür schließen, Freigabe*)
iPB_OpenDoor     %I1.1.1    BOOL       (*Open safety door, enable / Schutztür öffnen, Freigabe*)
iLS_DoorClosed   %I1.1.2    BOOL       (*Limit switch 'Safety door at the bottom'/ Endschalter Schutztür unte
iLS_DoorOpened   %I1.1.3    BOOL       (*Limit switch 'Safety door at the top'/ Endschalter Schutztür oben*)
qM_CloseDoor     %Q1.1.0    BOOL       (*Motor 'Close safety door' / Motor Schutztür Schließen*)
qM_OpenDoor      %Q1.1.1    BOOL       (*Motor 'Open safety door' / Motor Schutztür öffnen*)
(*Clamping / Klemmung====================================================================================
iPB_Clamp        %I1.1.4    BOOL       (*Clamp piece, enable / Werkstück klemmen, Freigabe*)
iPB_Unclamp      %I1.1.5    BOOL       (*Unclamp piece, enable / Werkstück lösen, Freigabe*)
```

Ergaenzte_Deklaration.bmp

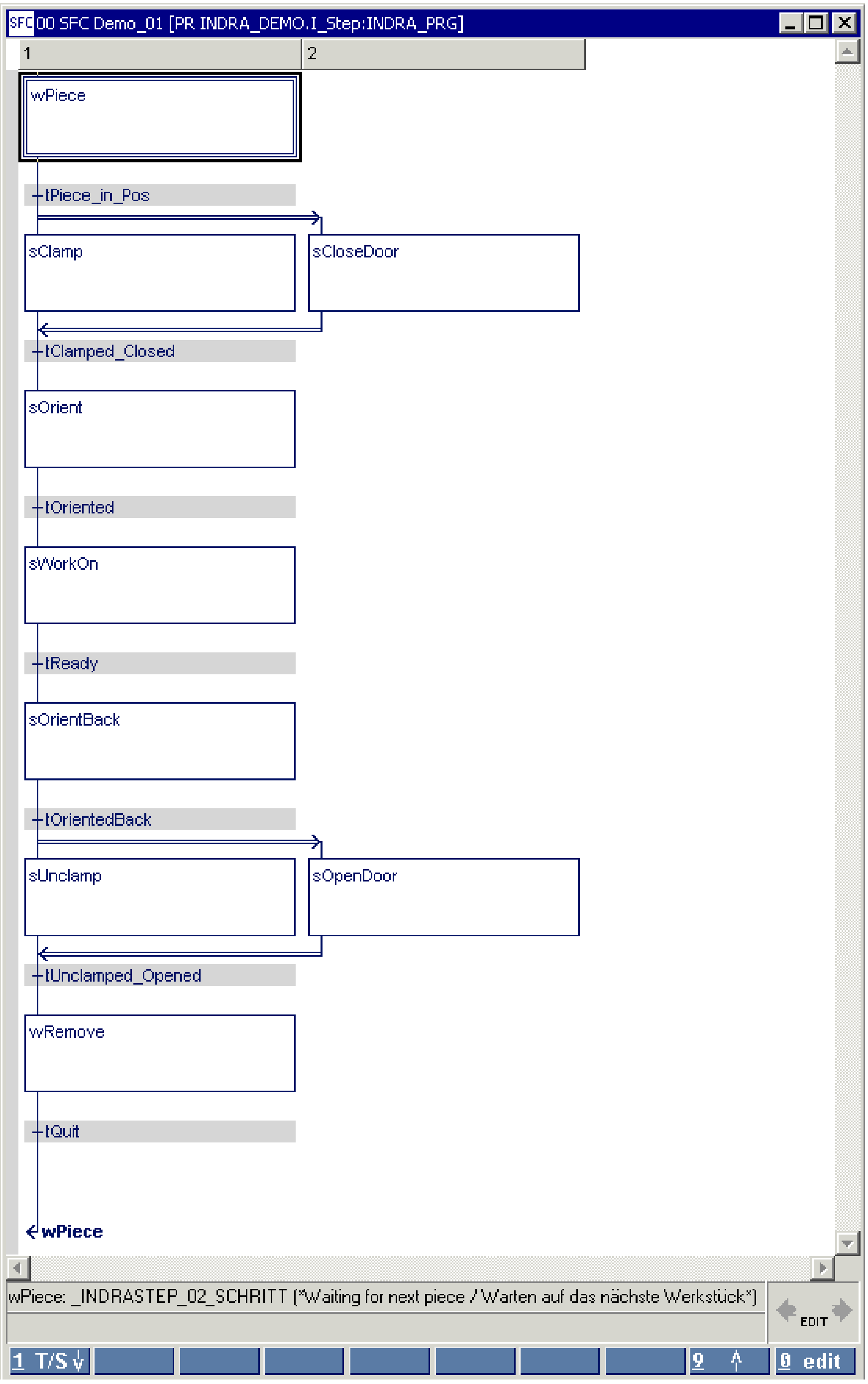
Fig. 4-15: Extending the declaration part by the variables of the example

Completing the SFC (Automatic Mode) According to the Example

The still empty SFC can be reached

- via the ladder diagram,
  implementation <Shift>+<F2> of the program,
  double-click or <Ctrl>+<Enter> on the yellow box of the call (Fig. 4-10);
- via the instruction list,
  implementation <Shift>+<F2> of the program,
  double-click or <Ctrl>+<Enter> on the **“Demo_01”** operand of the call (Fig. 4-11);
- via *View / SFCs* <Alt>+<F3>,
  double-click or <Ctrl>+<Enter> on the **“Demo_01”** name of the SFC (Fig. 4-7).

Enter the SFC as a sequence of steps and transitions, according to the verbal description of the example. Initially, the steps and transitions are blank.



wPiece: _INDRASTEP_02_SCHRITT (*Waiting for next piece / Warten auf das nächste Werkstück*)

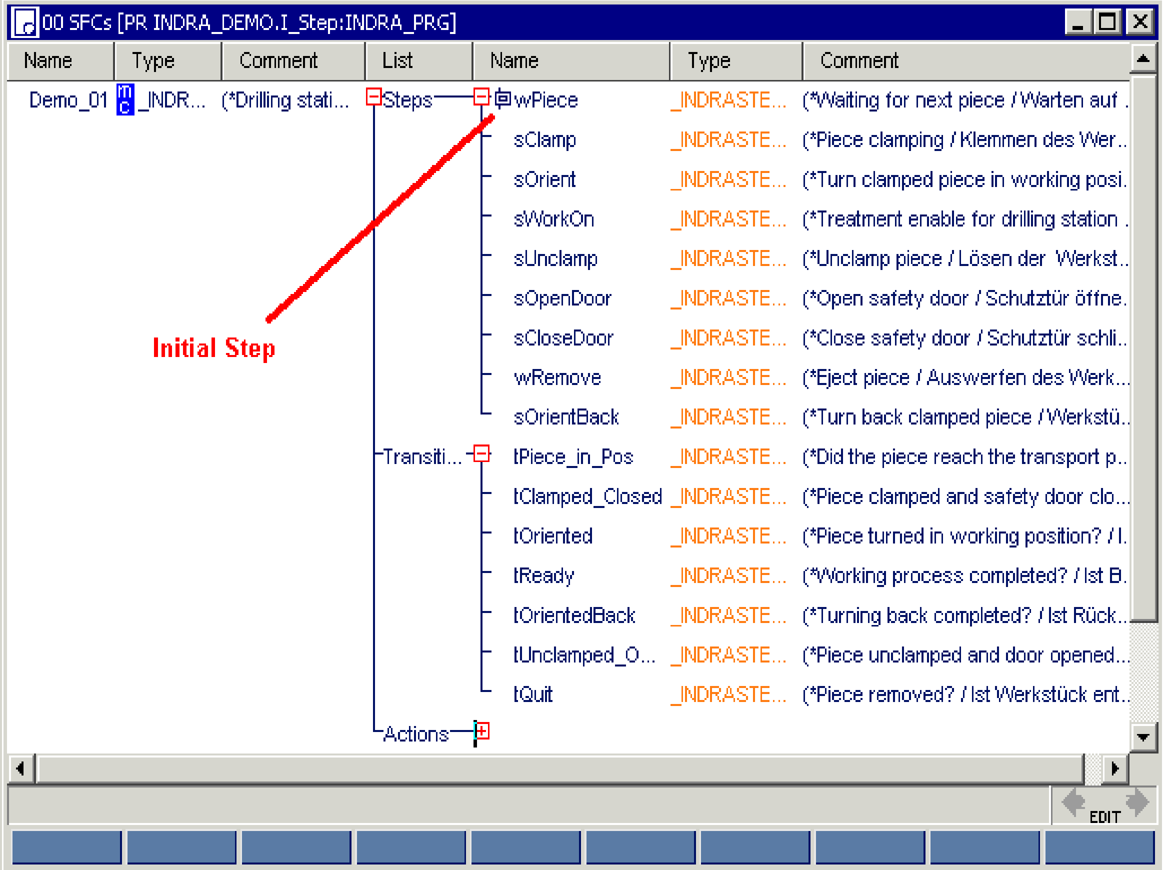
Ablauf_Bsp.bmp

wAAA:	Waiting step (evaluation in the author’s opinion)
sBBB:	General step
tCCC:	General transition

Fig. 4-16: SFC of the example

The **“sCloseDoor”** and **“sClamp”** or **“sUnclamp”** and **“sOpenDoor”** steps can be arranged in a sequence. Their arrangement in parallel steps that has been selected here is intended to show that IndraStep can also be used in parallel sequential function charts.

The steps and transitions entered are also displayed in the SFC list.



00 SFCs [PR INDRA_DEMO.I_Step:INDRA_PRG]

Name	Type	Comment	List	Name	Type	Comment
Demo_01	_INDR...	(*Drilling stati...	Steps	wPiece	_INDRASTE...	(*Waiting for next piece / Warten auf .
				sClamp	_INDRASTE...	(*Piece clamping / Klemmen des Wer..
				sOrient	_INDRASTE...	(*Turn clamped piece in working posi.
				sWorkOn	_INDRASTE...	(*Treatment enable for drilling station .
				sUnclamp	_INDRASTE...	(*Unclamp piece / Lösen der Werkst..
				sOpenDoor	_INDRASTE...	(*Open safety door / Schutztür öffne.
				sCloseDoor	_INDRASTE...	(*Close safety door / Schutztür schli..
				wRemove	_INDRASTE...	(*Eject piece / Auswerfen des Werk...
				sOrientBack	_INDRASTE...	(*Turn back clamped piece / Werkstü..
			Transiti...	tPiece_in_Pos	_INDRASTE...	(*Did the piece reach the transport p..
				tClamped_Closed	_INDRASTE...	(*Piece clamped and safety door clo...
				tOriented	_INDRASTE...	(*Piece turned in working position? / I.
				tReady	_INDRASTE...	(*Working process completed? / Ist B.
				tOrientedBack	_INDRASTE...	(*Turning back completed? / Ist Rück..
				tUnclamped_O...	_INDRASTE...	(*Piece unclamped and door opened...
				tQuit	_INDRASTE...	(*Piece removed? / Ist Werkstück ent..
			Actions			

Initial Step

Schritte_Trans_in_AblaufListe.bmp

Fig. 4-17: Steps and transitions in the SFC list

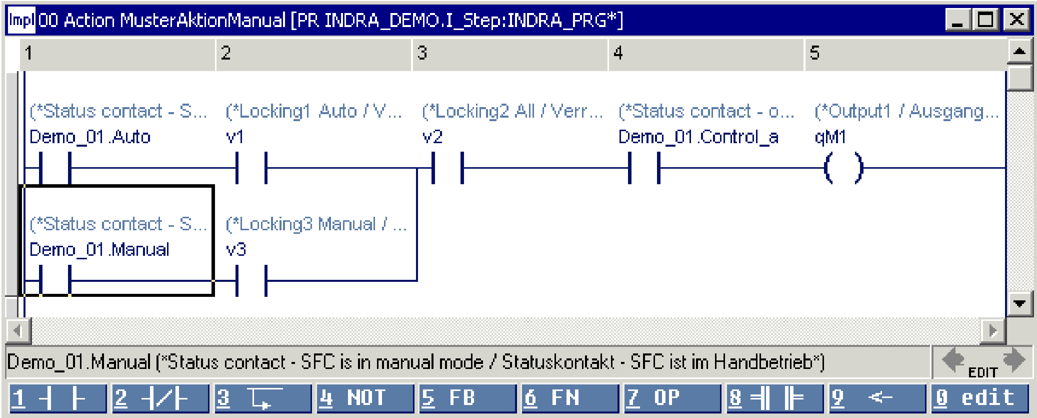
“Self-explaining” names and a comment describing the task should be assigned to the steps and transitions. The names and/or comments can be changed in the SFC list without any loss of information.

Principles of Entering Actions and Switch-On Conditions (Automatic Mode)

The method of entering the complete SFC first (overview) and then completing the steps and transitions one after the other has the advantage that the user can focus on details now.

General Structure of an Action in the Manual and Automatic Modes

The mode support provides the following possibility of easily realizing the manual and automatic modes:



Muster_Aktion_Manual.bmp

Fig. 4-18: Sample action with manual and automatic modes

The meaning of the elements in Fig. 4-18 is as follows:

Element	Meaning	
<SFC name>.Auto here: demo_01.Auto	Status contact which is closed as long as the SFC is in the automatic mode	
v1 Activation Auto	Contacts which assume the task of activating output qM1 in the **automatic mode** 0…n contacts	
v2 Activation in general	Contacts which assume the task of activating output qM1 in the **all modes** 0…m contacts	
<SFC name>.Control_* here: demo_01.Control_*	<SFC name>.Control_a	Status contact - opens on action end, stop, error, and in case of the AutoStep mode with AutoStepEnable
	<SFC name>.Control_b	Status contact - opens at the end of the action (in analogy with <action name>.Q)
	<SFC name>.Control_c	Status contact - function same as for Control_a, with additional diagnosis if the logic result before the contact is FALSE (starting with the second working cycle)
<SFC name>.Manual here: demo_01.Manual	Status contact which is closed as long as the SFC is in the manual mode	
v3 Activation Manual	Contacts which assume the task of activating output qM1 in the **manual mode** 0…p contacts	

Fig. 4-19: Elements of the sample action

Note: If the user needs a third branch for the "AutoStep" mode, then this branch must be generated ***after*** the **"<SFC name>.Auto"** contact. This is caused by the criteria analysis which can, up to now, only differentiate between automatic mode and manual mode.

Processing and Postprocessing of Actions

Chronological Coordination of Action Processing

Processing of actions has been fixedly bound to the graphical structure of the SFC. For that reason, the actions must be processed as specified by the steps. To achieve this, the following processing strategy is implemented by the structure interpreter:

- The steps of the SFC are processed line by line from left to right and from top to bottom.
- The action blocks are processed in the order resulting from the order of steps, i.e. from left to right and from top to bottom (cf. action list). This list can be resorted manually.
- If actions are entered repeatedly in one step (in parallel steps which are activated at the same time), they are still processed only once per cycle.

Chronological Coordination of Action Postprocessing

Postprocessing of all actions is achieved alternately with <action name>.Q and <action name>.A.

Since actions must be postprocessed only once, this is done independently of the graphical structure of the SFC. Actions are postprocessed in the order represented in the action list.

Examples are illustrated in the sections below.

Definition of the 'Step is active' Time

If the condition of the 'tOn' transition is fulfilled, the step is rated as being active in the same PLC cycle when the action is calculated.

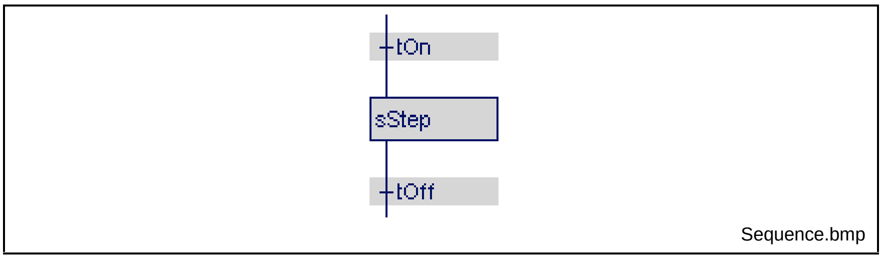


Fig. 4-20: The step becomes active

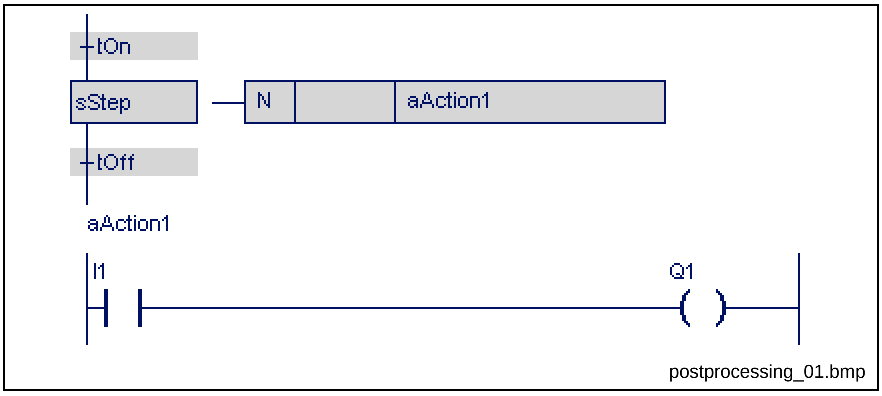
Definition of the 'Step is inactive' Time

If the condition of the 'tOff' transition is fulfilled, the step is rated as being inactive in the same PLC cycle when the action is calculated.

When the step is becoming inactive, the Boolean variables and the negated variables are still calculated in the same PLC cycle, as specified above.

Results from Postprocessing of Actions – Example

Postprocessing of actions results in the question how the behavior of the outputs can be controlled when a step is exited.



I1: Input for enabling the output Q1

Fig. 4-21: Step ‘sStep’ with action ‘aAction1’ and an LD rung within

Processing of the action ‘aAction1’ is specified uniquely:

- Once the transition condition ‘tOn’ is fulfilled with active predecessor step, the step ‘sStep’ is activated (sStep.X: FALSE → TRUE).
- The action ‘aAction1’ is processed according to its action qualifier **“N”** (aAction1.Q and aAction1.A: FALSE → TRUE).
- The output Q1 follows the switch I1; we assume that the switch I1 is just TRUE and, thus, the output Q1 is also TRUE, if the transition condition for ‘tOff’ is fulfilled.
- Once ‘tOff’ is fulfilled, the step ‘sStep’ is inactive (sStep.X → FALSE) and the action ‘aAction1’ is not processed any longer (aAction.Q → FALSE). However, the action is postprocessed one more time (aAction.A is still TRUE).
- On postprocessing, all activities are completed.

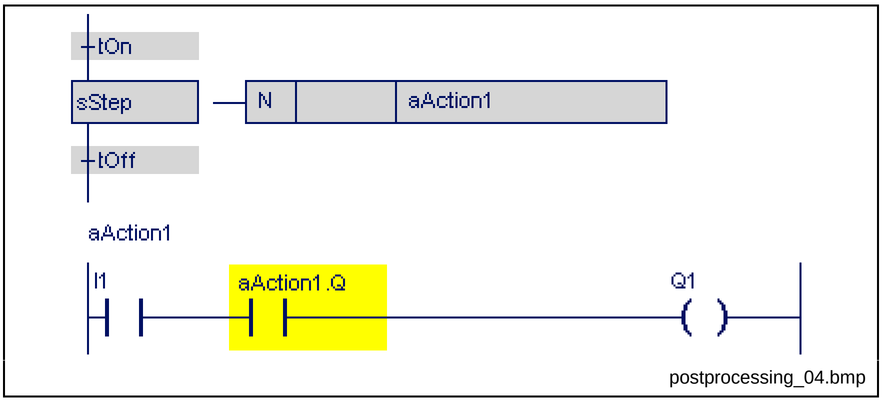
From the user’s view, there are two interesting situations with regard to output Q1:

- Q1 is to activate a **motor.** The transition ‘tOFF’ corresponds to the acknowledgement ‘object has reached destination’. The user expects that the motor is turned off when the step and the action are becoming inactive.
- Q1 is to activate a **clamping device.** The transition ‘tOFF’ corresponds to the acknowledgement ‘object is clamped’. The user expects that the clamping device is still activated when the step and the action are becoming inactive.

The different expected behaviors can be achieved only by a manipulation on the part of the user:

Motor case:

The output Q1 is to be deactivated when the step is exited.



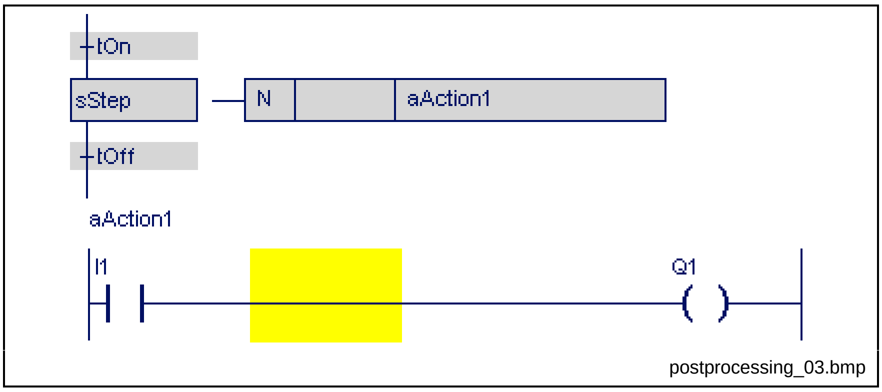
Input I1: TRUE

Fig. 4-22: Modification for the motor case (forced turnoff)

When the step ‘sStep’ is exited, sStep.X and aAction1.Q are becoming FALSE. Postprocessing of the action results in that the output ‘Q1’ becomes FALSE independently of the input ‘I1’.

Clamping device case:

The value of the output ‘Q1’ is to be preserved when the step is exited.



Input I1: TRUE

Fig. 4-23: Circuit for the **clamping device** case

When the step ‘sStep’ is exited, the action is not processed any longer; postprocessing does not cause any modification of the value of output ‘Q1’ either; the clamping device remains activated.

Hence, the position highlighted in yellow is suited to cause a behavior defined by the user, when components are turned off or in relation to the operating mode.

This task is assumed by the contacts <SFC name>.Control_a, <SFC name>.Control_b or <SFC name>.Control_c according to Fig. 4-18 / Fig. 4-19.

Entering Actions and Transitions

The automatic mode is entered
→ irrespective of the manual mode and
→ without error monitoring.

For that reason,

- the <step name>,
- the actions of the step, and
- the ladder diagrams required for implementing the actions are entered thereafter.

If transitions are concerned,

- the <transition name> and
- the switch-on condition are entered as a ladder diagram.

wPiece: _INDRASTEP_02_SCHRITT – (Initial Step)

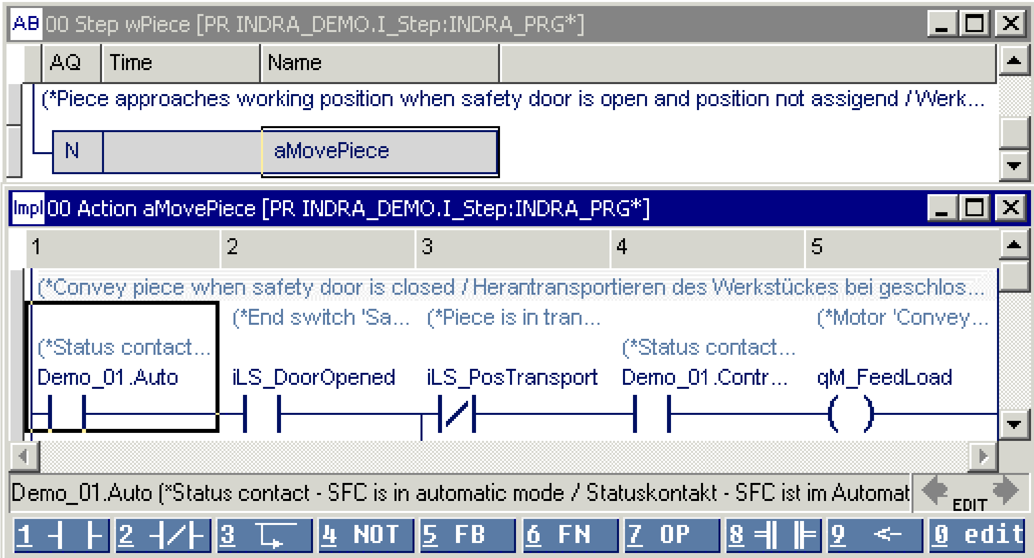
Name	Comment	Remark
wPiece	(*Waiting for next piece*)	The workpiece is conveyed if the safety door is open and the transport position is unused.

Fig. 4-24: **"wPiece"** step (initial step)

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises both windows:



00 Step wPiece [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
(*Piece approaches working position when safety door is open and position not assigend / Werk...		
N		aMovePiece

00 Action aMovePiece [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Convey piece when safety door is closed / Herantransportieren des Werkstückes bei geschlos...

1	2	3	4	5
(*Status contact...	(*End switch 'Sa...	(*Piece is in tran...	(*Status contact...	(*Motor 'Convey...
Demo_01.Auto	iLS_DoorOpened	iLS_PosTransport	Demo_01.Contr...	qM_FeedLoad

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automat

Aktion_zu_wPiece0.bmp

Fig. 4-25: Details on step **"wPiece"**

The contact sequence is to be provided with a comment:

The first contact **"Demo_01.Auto"** (<SFC name>.Auto) permits enabling for the automatic mode only. The user can be sure that this branch will be active in this mode only, without his further doing anything.

The following contacts **"iLS_DoorOpened"** (safety door is open) and **"iLS_PosTransport"** (no more workpieces in the supply unit) are normal switch-on conditions.

The contact **"Demo_01.Control_a"** assumes the task of deactivating the output in case of a regular action end, stop and error.

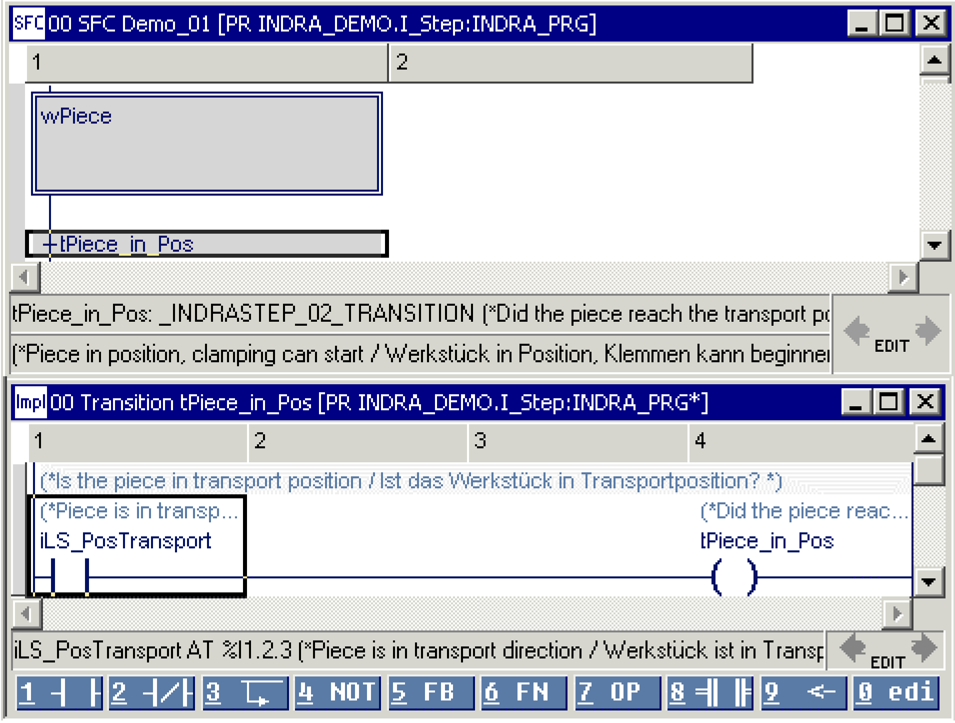
The coil **"qM_FeedLoad"** activates the motor of the supply conveyor belt.

tPiece_in_Pos: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tPiece_in_Pos	Did the piece reach the transport position?	Workpiece in position; clamping can start.

Fig. 4-26: **"tPiece_in_Pos"** transition

The step **"wPiece"** is exited when the transition **"tPiece_in_Pos"** is fulfilled.



SFC 00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

1 2

wPiece

tPiece_in_Pos

tPiece_in_Pos: _INDRASTEP_02_TRANSITION (*Did the piece reach the transport pc

(*Piece in position, clamping can start / Werkstück in Position, Klemmen kann beginnei

Impl 00 Transition tPiece_in_Pos [PR INDRA_DEMO.I_Step:INDRA_PRG*]

1 2 3 4

(*Is the piece in transport position / Ist das Werkstück in Transportposition? *)

(*Piece is in transp...

iLS_PosTransport

(*Did the piece reac...

tPiece_in_Pos

iLS_PosTransport AT %I1.2.3 (*Piece is in transport direction / Werkstück ist in Transp

tPiece_in_Pos.bmp

Fig. 4-27: Details on the transition **"tPiece_in_Pos"**

The step **"wPiece"** is exited when the workpiece has reached the transport position. The action **"aMovePiece"** is postprocessed; the conveyor belt is turned off.

sCloseDoor: _INDRASTEP_02_SCHRITT

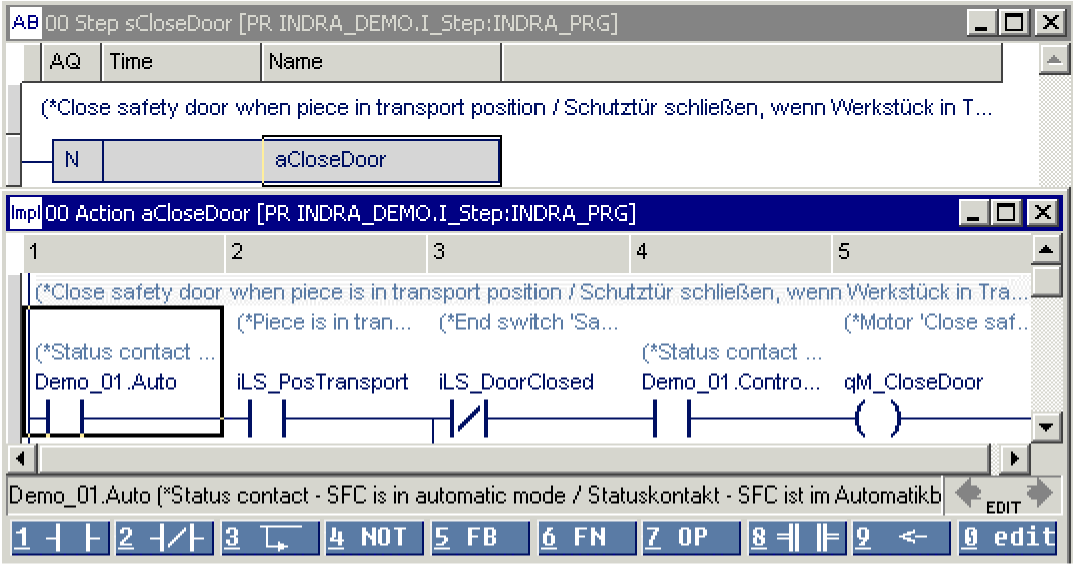
Name	Comment	Remark
sCloseDoor	(*Close safety door*)	Close the safety door when the workpiece has reached the transport position

Fig. 4-28: **"sCloseDoor"** step

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises both windows:



00 Step sCloseDoor [PR INDRA_DEMO.I_Step:INDRA_PRG]

AQ	Time	Name
N		aCloseDoor

(*Close safety door when piece in transport position / Schutztür schließen, wenn Werkstück in T...

00 Action aCloseDoor [PR INDRA_DEMO.I_Step:INDRA_PRG]

(*Close safety door when piece is in transport position / Schutztür schließen, wenn Werkstück in Tra...

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*Piece is in tran... iLS_PosTransport	(*End switch 'Sa... iLS_DoorClosed	(*Status contact ... Demo_01.Contro...	(*Motor 'Close saf... qM_CloseDoor

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikb

Details_sCloseDoor.bmp

Fig. 4-29: Details on step **"sCloseDoor"**

The contact sequence is to be provided with a comment:

The first contact **"Demo_01.Auto"** (<SFC name>.Auto) permits enabling for the automatic mode only.

The contact **"iLS_PosTransport"** permits closing of the door when a workpiece waits for being processed inside the safety door.

The contact **"iLS_DoorClosed"** locks the door in the closed state (preventing it from being lowered further).

The contact **"Demo_01.Control_a"** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

The coil **"qM_CloseDoor"** activates the motor for closing the safety door.

sClamp: _INDRASTEP_02_SCHRITT

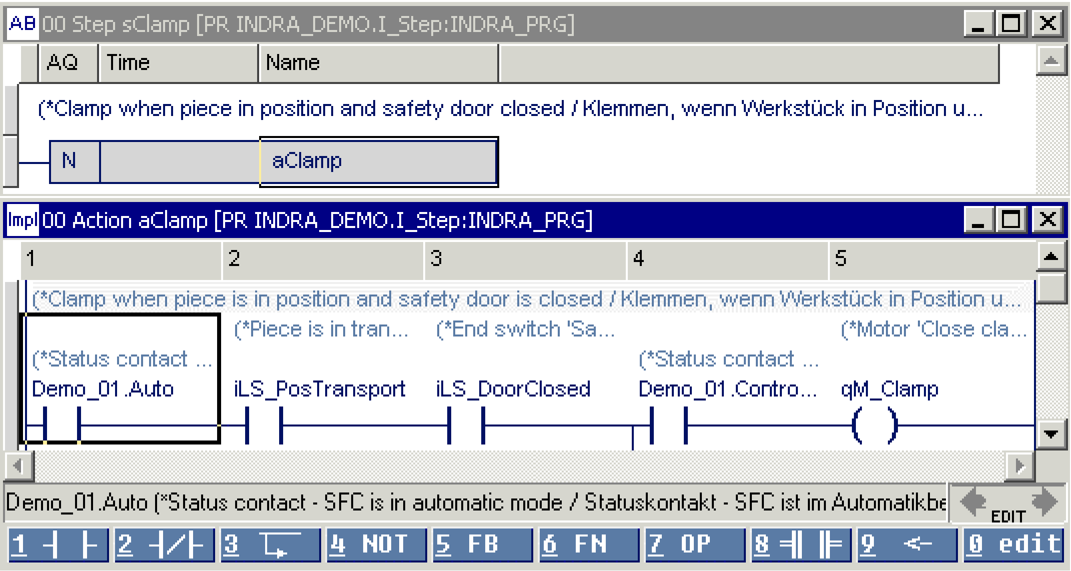
Name	Comment	Remark
sClamp	(*Piece clamping*)	Clamp as soon as the workpiece is in its position and the safety door is closed.

Fig. 4-30: **“sClamp”** step

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises both windows:



AB 00 Step sClamp [PR INDRA_DEMO.I_Step:INDRA_PRG]

AQ	Time	Name

(*Clamp when piece in position and safety door closed / Klemmen, wenn Werkstück in Position u...

N		aClamp

Impl 00 Action aClamp [PR INDRA_DEMO.I_Step:INDRA_PRG]

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*Piece is in tran... iLS_PosTransport	(*End switch 'Sa... iLS_DoorClosed	(*Status contact ... Demo_01.Contro...	(*Motor 'Close cla... qM_Clamp

(*Clamp when piece is in position and safety door is closed / Klemmen, wenn Werkstück in Position u...

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbe

Details_sClamp.bmp

Fig. 4-31: Details on step **“sClamp”**

The contact sequence is to be provided with a comment:

The first contact **“Demo_01.Auto”** (<SFC name>.Auto) permits enabling for the automatic mode only.

The contact **“iLS_PosTransport”** permits clamping when a workpiece waits for being machined inside the safety door.

The contact **“iLS_DoorClosed”** confirms that the door is closed.

The contact **“Demo_01.Control_a”** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

The coil **“qM_Clamp”** controls the motor for clamping the workpiece.

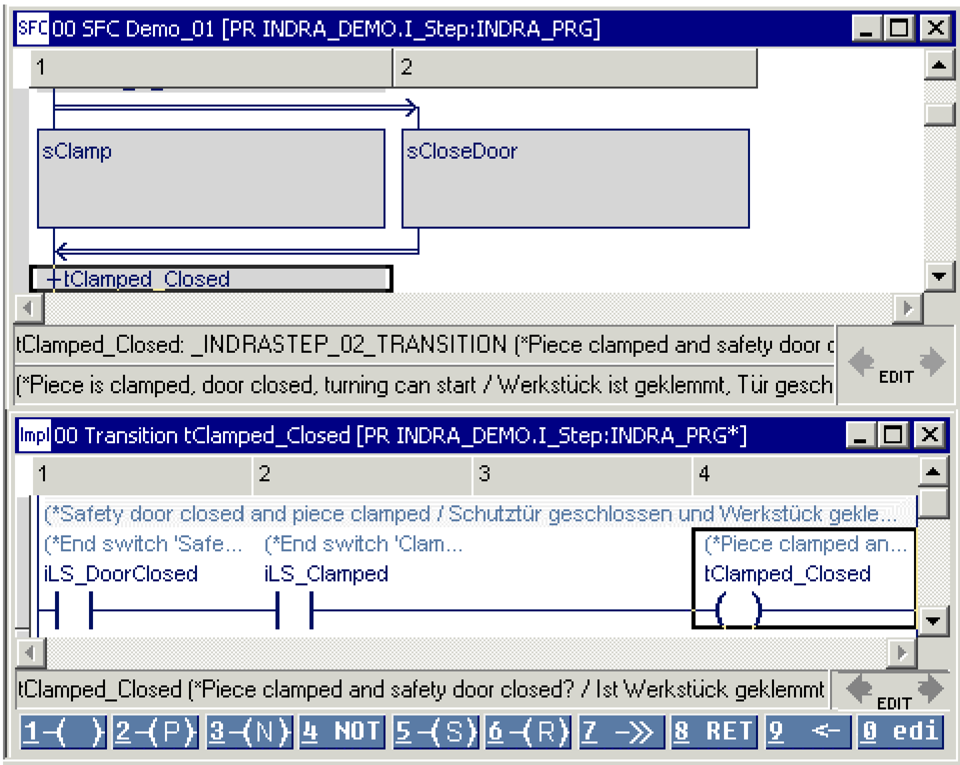
When the step **“sClamp”** is exited, the action **“aClamp”** is postprocessed and the motor **“qM_Clamp”** turned off. Since this is not desired, clamping must again be activated in the next step. This is done without any interruption.

tClamped_Closed: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tClamped_Closed	Piece clamped and door closed?	The workpiece is clamped; the door is closed; turning of the workpiece can start

Fig. 4-32: **“tClamped_Closed”** transition

The steps **“sClosedDoor”** and **“sClamped”** are exited once the transition **“tClamped_Closed”** is fulfilled. Now, the safety door is closed and the workpiece is clamped.



00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

tClamped_Closed: _INDRASTEP_02_TRANSITION (*Piece clamped and safety door c

(*Piece is clamped, door closed, turning can start / Werkstück ist geklemmt, Tür gesch

00 Transition tClamped_Closed [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Safety door closed and piece clamped / Schutztür geschlossen und Werkstück gekle...

(*End switch 'Safe... (*End switch 'Clam... (*Piece clamped an...

iLS_DoorClosed iLS_Clamped tClamped_Closed

tClamped_Closed (*Piece clamped and safety door closed? / Ist Werkstück geklemmt

Details_tClamped_Close.bmp

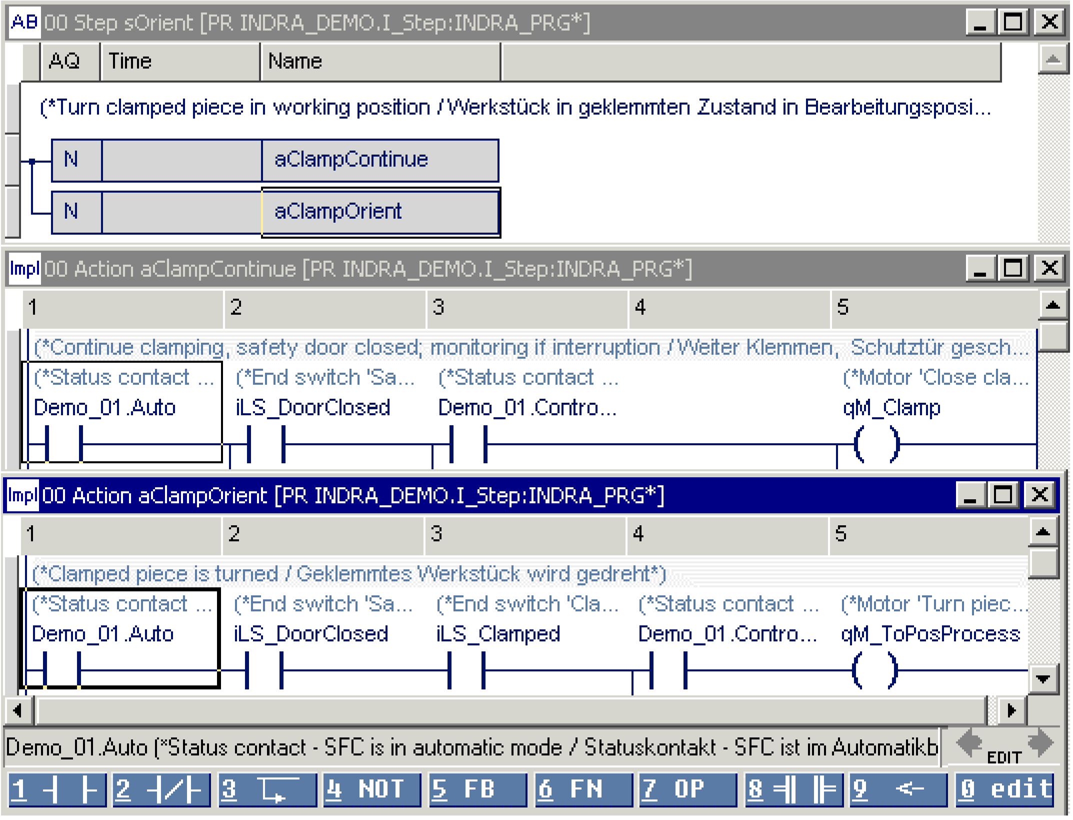
Fig. 4-33: Details on transition **“tClamped_Closed”**

sOrient: _INDRASTEP_02_SCHRITT

Name	Comment	Remark
sOrient	(*Turn clamped piece in working position*)	Turn the clamped workpiece to the machining position.

Fig. 4-34: **“sOrient”** step

The step **“sOrient”** requires that the workpiece must remain clamped. This also applies to its successors **“sWorkOn”** and **“sOrientBack”. For** that reason, activation of clamping is separated into the action **“aClampContinue”.**



00 Step sOrient [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
N		aClampContinue
N		aClampOrient

(*Turn clamped piece in working position / Werkstück in geklemmten Zustand in Bearbeitungsposi...

00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG*]

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*End switch 'Sa... iLS_DoorClosed	(*Status contact ... Demo_01.Contro...		(*Motor 'Close cla... qM_Clamp

(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür gesch...

00 Action aClampOrient [PR INDRA_DEMO.I_Step:INDRA_PRG*]

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*End switch 'Sa... iLS_DoorClosed	(*End switch 'Cla... iLS_Clamped	(*Status contact ... Demo_01.Contro...	(*Motor 'Turn piec... qM_ToPosProcess

(*Clamped piece is turned / Geklemmtes Werkstück wird gedreht*)

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikb

Details_sOrient.bmp

Fig. 4-35: Details on step **“sOrient”**

The step **“sOrient”** contains the actions **“aClampContinue”** and **“aClampOrient”.**

Action **“aClampContinue”:**

The first contact **“Demo_01.Auto”** (<SFC name>.Auto) permits enabling for the automatic mode only.

The following contact **“iLS_DoorClosed”** (safety door closed) is a normal switch-on condition.

The contact **“Demo_01.Control_a”** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

The coil **“qM_Clamp”** activates clamping of the workpiece. It assumes this task without any interruption from the preceding step **“sClamp”.**

Action **“aClampOrient”:**

The first contact **“Demo_01.Auto”** (<SFC name>.Auto) permits enabling for the automatic mode only. The user can be sure that this branch will be active in this mode only, without his further doing anything.

The following contact **“iLS_DoorClosed”** (safety door closed) is a normal switch-on condition.

“iLS_Clamped” confirms that the workpiece is clamped.

The contact **“Demo_01.Control_a”** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

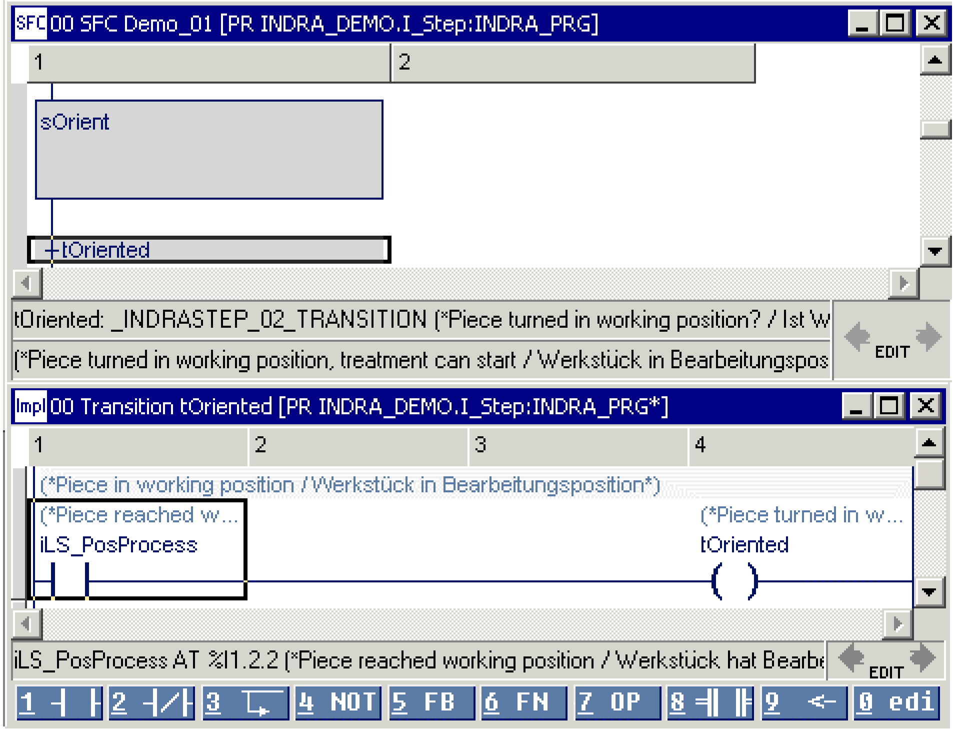
The coil **“qM_ToPosProcess”** activates the turning movement to the machining position.

tOriented: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tOriented	Piece turned in working position?	The workpiece has been turned to the machining position; machining can start.

Fig. 4-36: **“tOriented”** transition

The step **“sOrient”** is exited once the transition **“tOriented”** is fulfilled.



SFC 00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

tOriented: _INDRASTEP_02_TRANSITION (*Piece turned in working position? / Ist W

(*Piece turned in working position, treatment can start / Werkstück in Bearbeitungspos

Impl 00 Transition tOriented [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Piece in working position / Werkstück in Bearbeitungsposition*)

iLS_PosProcess AT %I1.2.2 (*Piece reached working position / Werkstück hat Bearbe

Detail_tOriented.bmp

Fig. 4-37: Details on transition **“tOriented”**

If the step **“sOrient”** were exited, the action **“aClampOrient”** would be postprocessed and the motor **“qM_Clamp”** would be turned off. Since this is not desired, clamping must again be activated in the next step. This is done without any interruption.

sWorkOn: _INDRASTEP_02_SCHRITT

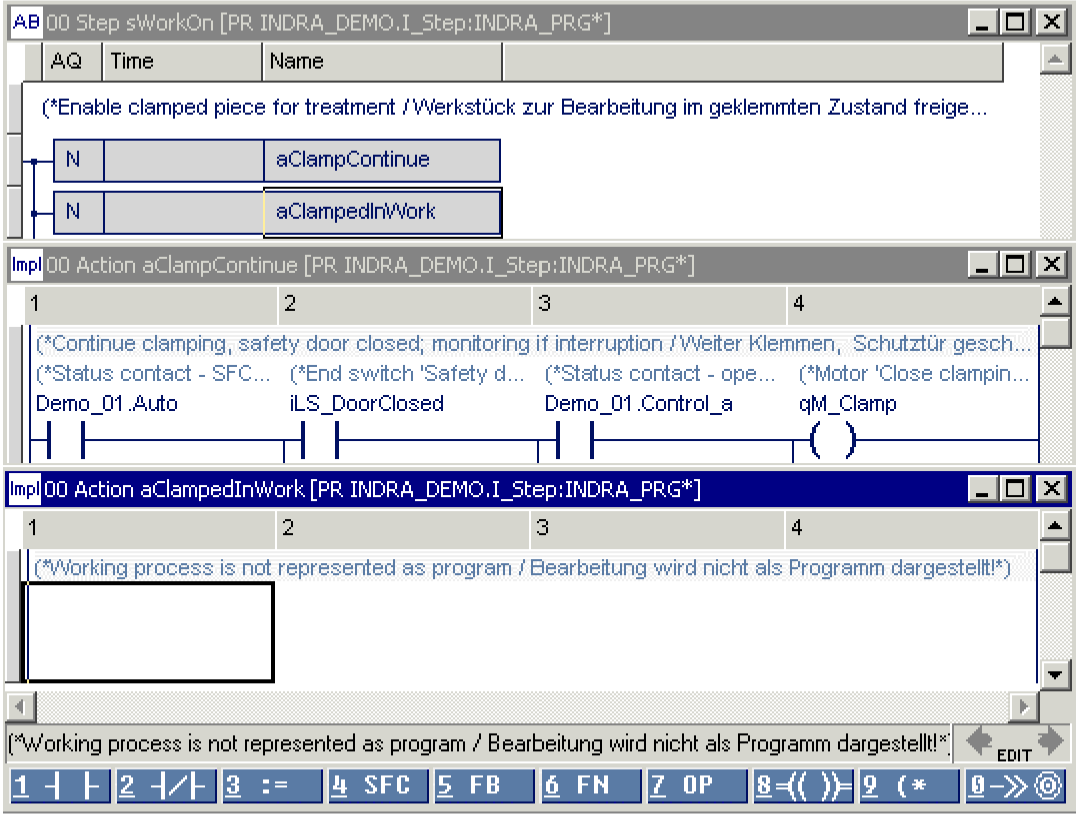
Name	Comment	Remark
sWorkOn	(*Treatment enable for drilling station')	The clamped workpiece is enabled for machining.

Fig. 4-38: **"sWorkOn"** step

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises the windows:



00 Step sWorkOn [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
N		aClampContinue
N		aClampedInWork

(*Enable clamped piece for treatment / Werkstück zur Bearbeitung im geklemmten Zustand freige...

00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür gesch...

1	2	3	4
(*Status contact - SFC...	(*End switch 'Safety d...	(*Status contact - ope...	(*Motor 'Close clampin...
Demo_01.Auto	iLS_DoorClosed	Demo_01.Control_a	qM_Clamp

00 Action aClampedInWork [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Working process is not represented as program / Bearbeitung wird nicht als Programm dargestellt!*)

(*Working process is not represented as program / Bearbeitung wird nicht als Programm dargestellt!*

Details_sWorkOn.bmp

Fig. 4-39: Details on step **"sWorkOn"**

The action **"aClampContinue"** continues to activate the clamping process without any interruption.

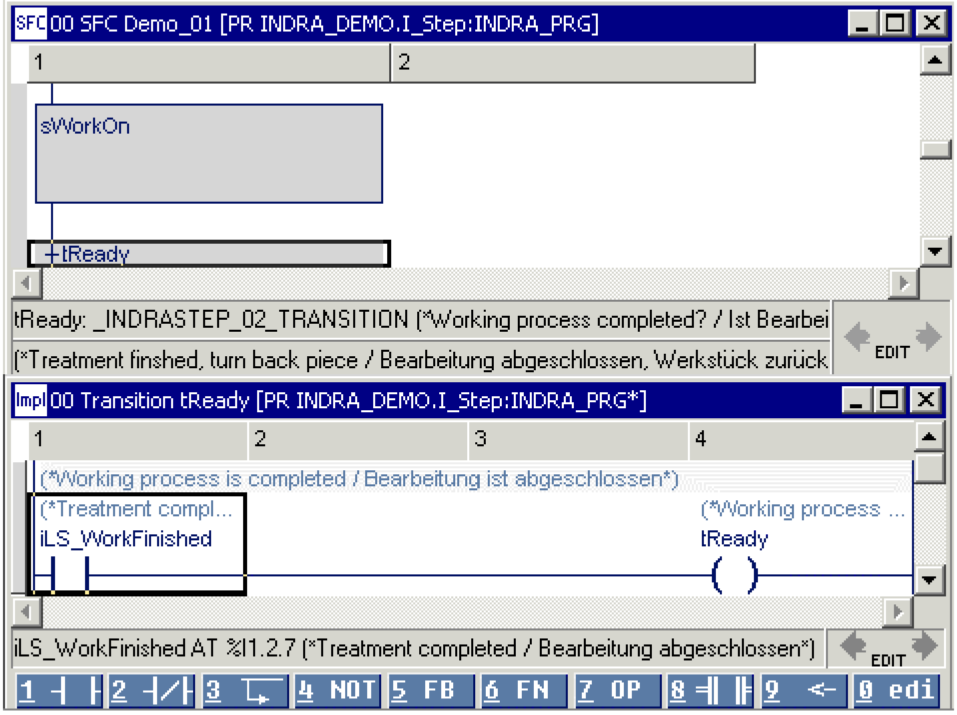
Note: Since they are of no interest here, details on machining will not be described in this program example.

tReady: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tReady	Working process completed?	Machining is completed; unclamp the workpiece; open the door.

Fig. 4-40: **“tReady”** transition

The step **“sWorkOn”** is exited once the transition **“tReady”** is fulfilled.



00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

tReady: _INDRASTEP_02_TRANSITION (*Working process completed? / Ist Bearbei

(*Treatment finshed, turn back piece / Bearbeitung abgeschlossen, Werkstück zurück

00 Transition tReady [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Working process is completed / Bearbeitung ist abgeschlossen*)

(*Treatment compl...

iLS_WorkFinished

(*Working process ...

tReady

iLS_WorkFinished AT %I1.2.7 (*Treatment completed / Bearbeitung abgeschlossen*)

Details_tReady.bmp

Fig. 4-41: Details of transition **“tReady”**

If the step **“sWorkOn”** were exited, the action **“aClampContinue”** would be postprocessed and the motor **“qM_Clamp”** would be turned off. Since this is not desired, clamping must again be activated in the next step. This is done without any interruption.

sOrientBack: _INDRASTEP_02_SCHRITT

Name	Comment	Remark
sOrientBack	(*Turn clamped piece in working position*)	Turn the clamped workpiece to the machining position.

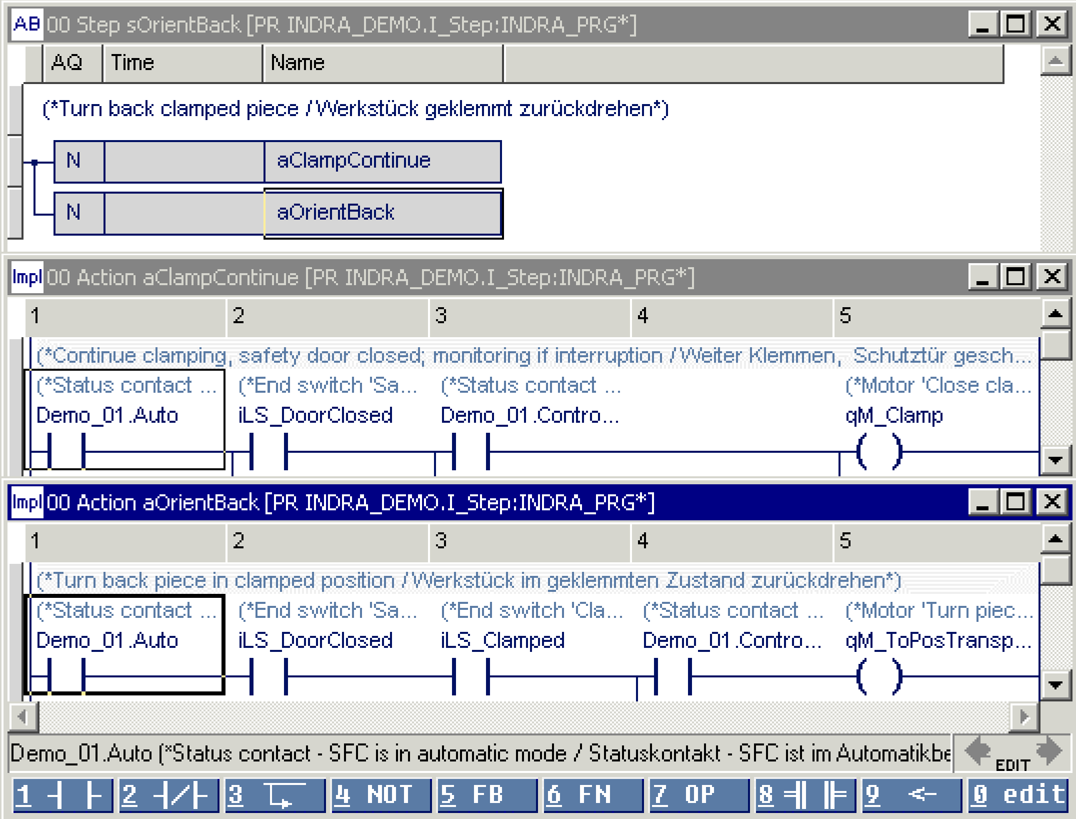
Fig. 4-42: **“sOrientBack”** step

The step **“sOrientBack”** requires that the workpiece must remain clamped. This also applies to its predecessors **“sWorkOn”** and **“sOrient”.** For that reason, activation of clamping is separated into the action **“aClampContinue”.**

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises the windows:



AB 00 Step sOrientBack [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
N		aClampContinue
N		aOrientBack

(*Turn back clamped piece / Werkstück geklemmt zurückdrehen*)

Impl 00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG*]

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*End switch 'Sa... iLS_DoorClosed	(*Status contact ... Demo_01.Contro...		(*Motor 'Close cla... qM_Clamp

(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür gesch...

Impl 00 Action aOrientBack [PR INDRA_DEMO.I_Step:INDRA_PRG*]

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*End switch 'Sa... iLS_DoorClosed	(*End switch 'Cla... iLS_Clamped	(*Status contact ... Demo_01.Contro...	(*Motor 'Turn piec... qM_ToPosTransp...

(*Turn back piece in clamped position / Werkstück im geklemmten Zustand zurückdrehen*)

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbe

Details_sOrientBack.bmp

Fig. 4-43: Details on step **"sOrientBack"**

The step **"sOrientBack"** contains the actions **"aClampContinue"** and **"aClampBack".**

Action **"aClampContinue":**

The first contact **"Demo_01.Auto"** (<SFC name>.Auto) permits enabling for the automatic mode only.

The following contact **"iLS_DoorClosed"** (safety door closed) is a normal switch-on condition.

The contact **"Demo_01.Control_a"** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

The coil **"qM_Clamp"** activates clamping of the workpiece. It assumes this task without any interruption from the preceding step **"sClamp".**

Action **"aOrientBack":**

The first contact **"Demo_01.Auto"** (<SFC name>.Auto) permits enabling for the automatic mode only.

The following contact **"iLS_DoorClosed"** (safety door closed) is a normal switch-on condition.

"iLS_Clamped" confirms that the workpiece is closed.

The contact **"Demo_01.Control_a"** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

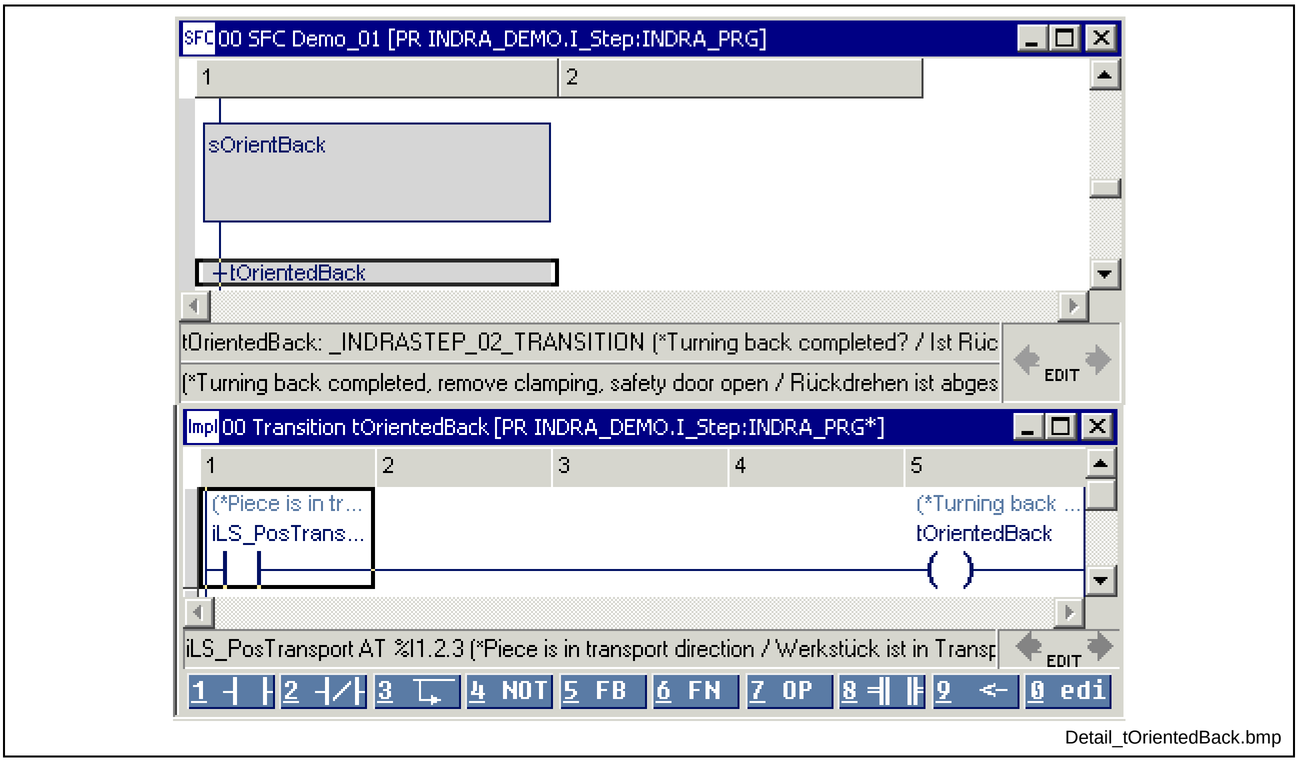
The coil **"qM_ToPosTransport"** activates the turning movement to the transport position.

tOrientedBack: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tOrientedBack	Turning back completed?	Turning back of the workpiece is completed; unclamp the workpiece; open the safety door.

Fig. 4-44: **“tOrientedBack”** transition

The step **“sOrientBack”** is exited once the transition **“tOrientedBack”** is fulfilled.



tOrientedBack: _INDRASTEP_02_TRANSITION (*Turning back completed? / Ist Rüc

(*Turning back completed, remove clamping, safety door open / Rückdrehen ist abges

iLS_PosTransport AT %I1.2.3 (*Piece is in transport direction / Werkstück ist in Transp

Detail_tOrientedBack.bmp

Fig. 4-45: Details on transition **“tOrientedBack”**

When the step **“sOrientBack”** is exited, the action **“aClampContinue”** is postprocessed and the motor **“qM_Clamp”** turned off.

sUnClamp: _INDRASTEP_02_SCHRITT

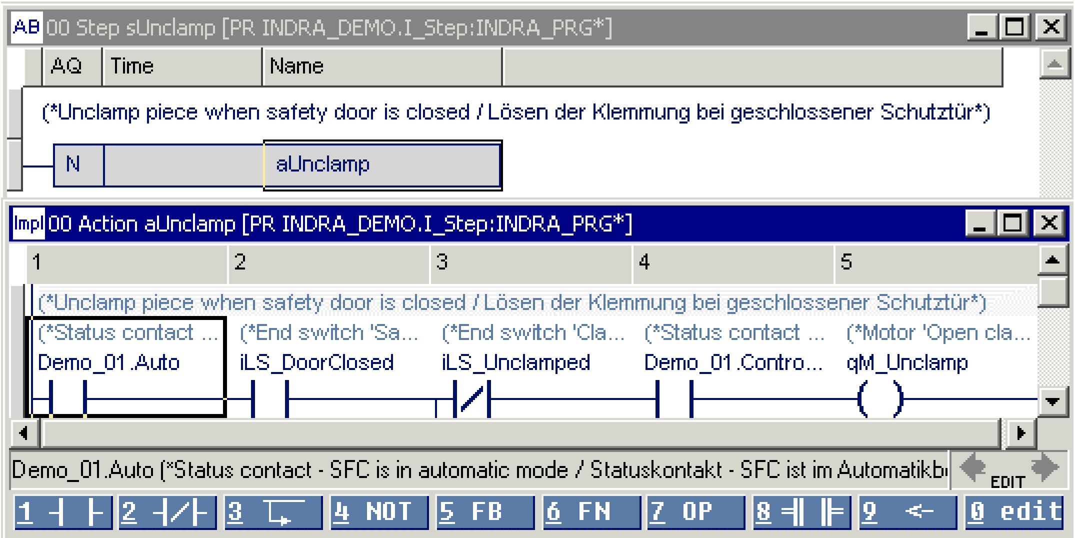
Name	Comment	Remark
sUnClamp	(*Unclamp piece*)	Unclamp the workpiece with closed safety door

Fig. 4-46: **“sUnClamp”** step

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises both windows:



00 Step sUnclamp [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
N		aUnclamp

(*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Schutztür*)

00 Action aUnclamp [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Schutztür*)

1	2	3	4	5
(*Status contact ...	(*End switch 'Sa...	(*End switch 'Cla...	(*Status contact ...	(*Motor 'Open cla...
Demo_01.Auto	iLS_DoorClosed	iLS_Unclamped	Demo_01.Contro...	qM_Unclamp

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikb

Details_sUnClamp.bmp

Fig. 4-47: Details of step **“sUnClamp”**

The contact sequence is to be provided with a comment:

The first contact **“Demo_01.Auto”** (<SFC name>.Auto) permits enabling for the automatic mode only.

The contact **“iLS_DoorClosed”** confirms that the door is closed.

The contact **“iLS_UnClamped”** limits unclamping of the workpiece.

The contact **“Demo_01.Control_a”** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

The coil **“qM_Unclamp”** activates the motor for clamping the workpiece.

sOpenDoor: _INDRASTEP_02_SCHRITT

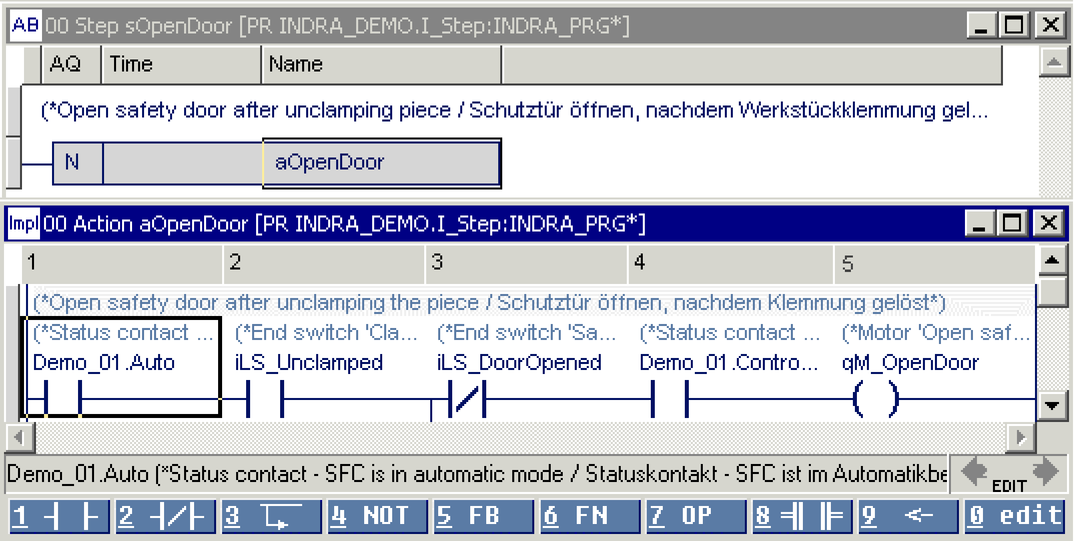
Name	Comment	Remark
sOpenDoor	(*Open safety door*)	Open the safety door after having unclamped the workpiece.

Fig. 4-48: **"sOpenDoor"** step

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises both windows:



00 Step sOpenDoor [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
N		aOpenDoor

(*Open safety door after unclamping piece / Schutztür öffnen, nachdem Werkstückklemmung gel...

00 Action aOpenDoor [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Open safety door after unclamping the piece / Schutztür öffnen, nachdem Klemmung gelöst*)

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*End switch 'Cla... iLS_Unclamped	(*End switch 'Sa... iLS_DoorOpened	(*Status contact ... Demo_01.Contro...	(*Motor 'Open saf... qM_OpenDoor

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbe

Details_sOpenDoor.bmp

Fig. 4-49: Details on step **"sOpenDoor"**

The contact sequence is to be provided with a comment:

The first contact **"Demo_01.Auto"** (<SFC name>.Auto) permits enabling for the automatic mode only.

The contact **"iLS_UnClamped"** indicates that the workpiece is unclamped.

The contact **"iLS_DoorOpened"** locks the door in the open state (preventing it from being opened further).

The contact **"Demo_01.Control_a"** assumes the task of deactivating the output if the step becomes inactive on a regular action end, in case of a stop, an error or a positive starting edge in the AutoStep mode.

The coil **"qM_OpenDoor"** activates the motor for opening the safety door.

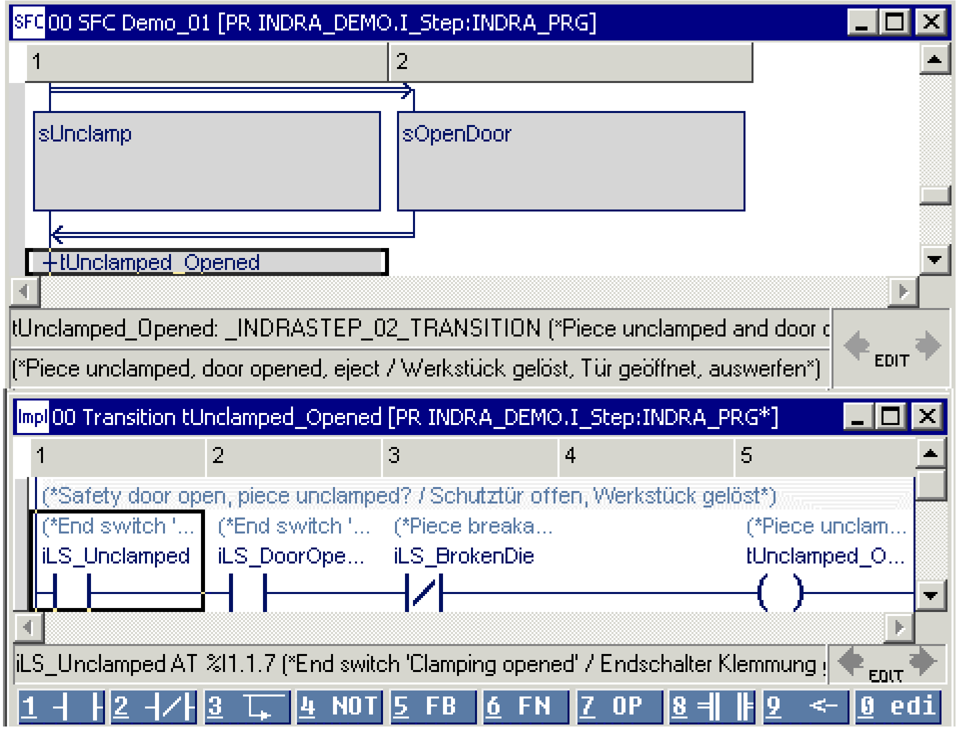
tUnClamped_Opened: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tUnClamped_Opened	Piece unclamped and door opened?	The workpiece is unclamped; the door is open; eject the workpiece.

Fig. 4-50: **“tUnClamped_Opened”** transition

The steps **“sUnClamped”** and **“sDoorOpened”** are exited once the transition **“tUnClamped_Opened”** is fulfilled. Now, the safety is door open and the workpiece is unclamped. It can be ejected.

However, removal of the workpiece is prevented in the event of a tool breakage.



00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

tUnclamped_Opened: _INDRASTEP_02_TRANSITION (*Piece unclamped and door c

(*Piece unclamped, door opened, eject / Werkstück gelöst, Tür geöffnet, auswerfen*)

00 Transition tUnclamped_Opened [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Safety door open, piece unclamped? / Schutztür offen, Werkstück gelöst*)

iLS_Unclamped AT %I1.1.7 (*End switch 'Clamping opened' / Endschalter Klemmung

Detail_tUnClamp.bmp

Fig. 4-51: Detail on transition **“tUnClampedOpened”**

wRemove: _INDRASTEP_02_SCHRITT

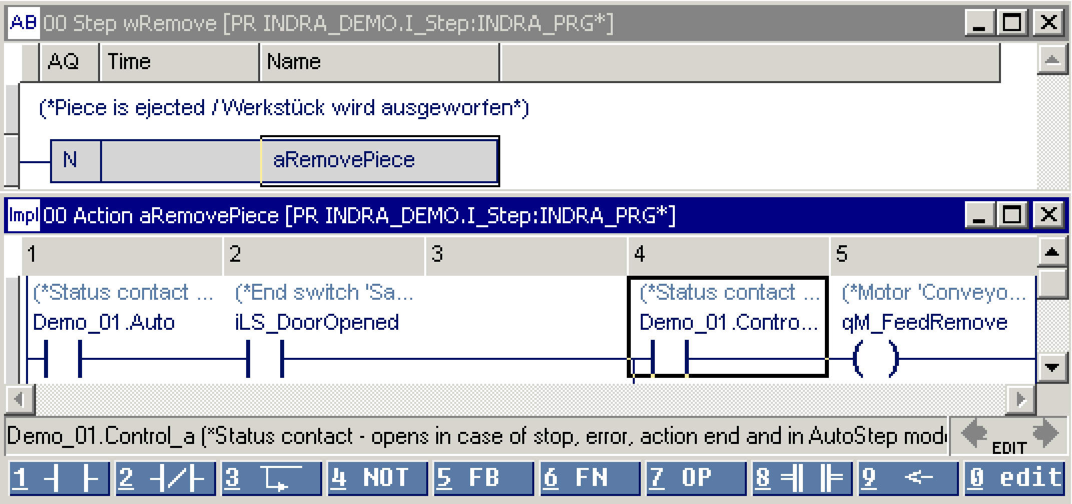
Name	Comment	Remark
wRemove	(*Eject piece*)	The workpiece is ejected; if necessary, use Demo_01.Control_c for diagnosis purposes to detect whether the safety door is open.

Fig. 4-52: **"wRemove"** step

Open the step by double-clicking on it or by pressing <Ctrl>+<Enter>. Now a comment and the action block can be entered.

Press <Ctrl>+<Enter> or double-click on the name of the action to move to the ladder diagram.

The following figure comprises both windows:



00 Step wRemove [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
N		aRemovePiece

(*Piece is ejected / Werkstück wird ausgeworfen*)

00 Action aRemovePiece [PR INDRA_DEMO.I_Step:INDRA_PRG*]

1	2	3	4	5
(*Status contact ... Demo_01.Auto	(*End switch 'Sa... iLS_DoorOpened		(*Status contact ... Demo_01.Contro...	(*Motor 'Conveyo... qM_FeedRemove

Demo_01.Control_a (*Status contact - opens in case of stop, error, action end and in AutoStep mod

Details_wRemove.bmp

Fig. 4-53: Details on step **"wRemove"**

The contact sequence is to be provided with a comment:

The first contact **"Demo_01.Auto"** (<SFC name>.Auto) permits enabling for the automatic mode only.

The following contact **"iLS_DoorOpened"** (safety door open) is a normal switch-on condition.

The contact **"Demo_01.Control_c"** assumes the task of deactivating the output on a regular action end, in case of a stop and an error with additional diagnosis, if the logic result before the contact is FALSE.

The coil **"qM_FeedRemove"** activates the motor of the removal conveyor belt.

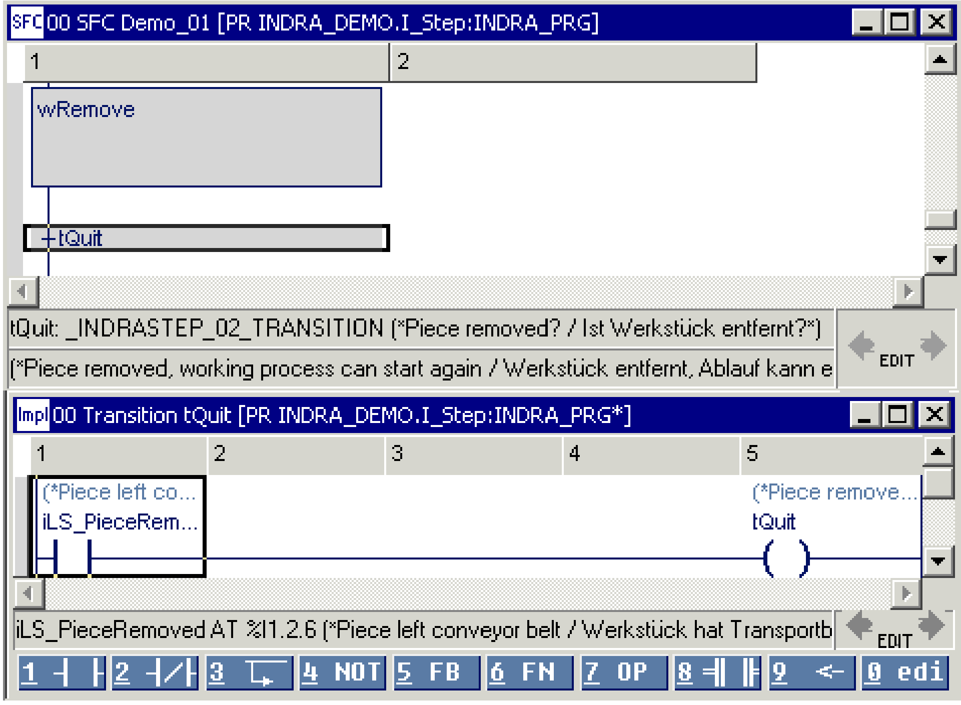
Note: The safety door must be opened, because otherwise **"Demo_01.Control_c"** would react with stopping the SFC and setting the error signal **"Demo_01.q.Error".**

tQuit: _INDRASTEP_02_TRANSITION

Name	Comment	How to continue
tQuit	Piece removed?	The workpiece has been removed; the SFC can be restarted.

Fig. 4-54: **“tQuit”** transition

The step **“wRemove”** is exited once the transition **“tQuit”** is fulfilled.



SFC 00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

tQuit: _INDRASTEP_02_TRANSITION (*Piece removed? / Ist Werkstück entfernt?*)

(*Piece removed, working process can start again / Werkstück entfernt, Ablauf kann e

Impl 00 Transition tQuit [PR INDRA_DEMO.I_Step:INDRA_PRG*]

iLS_PieceRemoved AT %I1.2.6 (*Piece left conveyor belt / Werkstück hat Transportb

Detail_tQuit.bmp

Fig. 4-55: Detail on transition **“tQuit”**

The step **“wRemove”** is exited when the workpiece has left the conveyor belt. The action **“aRemovePiece”** is postprocessed; the conveyor belt is turned off.

SetStep in the Automatic Mode

In the automatic mode, a jump to a different step assignment of the SFC can be prepared and, if necessary, executed.

This jump is prepared by setting the SYNC variables of the desired steps and the SetStep flag of the SFC. If a non-implementable step combination prevents the jump from being executed, the SFC stops (<SFC name>.q.Stop) with an error message (<SFC name>.q.ErrorStp).

In the example, this situation is present in the step **“sWorkOn”.** In this case, it is only possible to stop machining, unclamp the workpiece and open the safety door after a tool breakage.

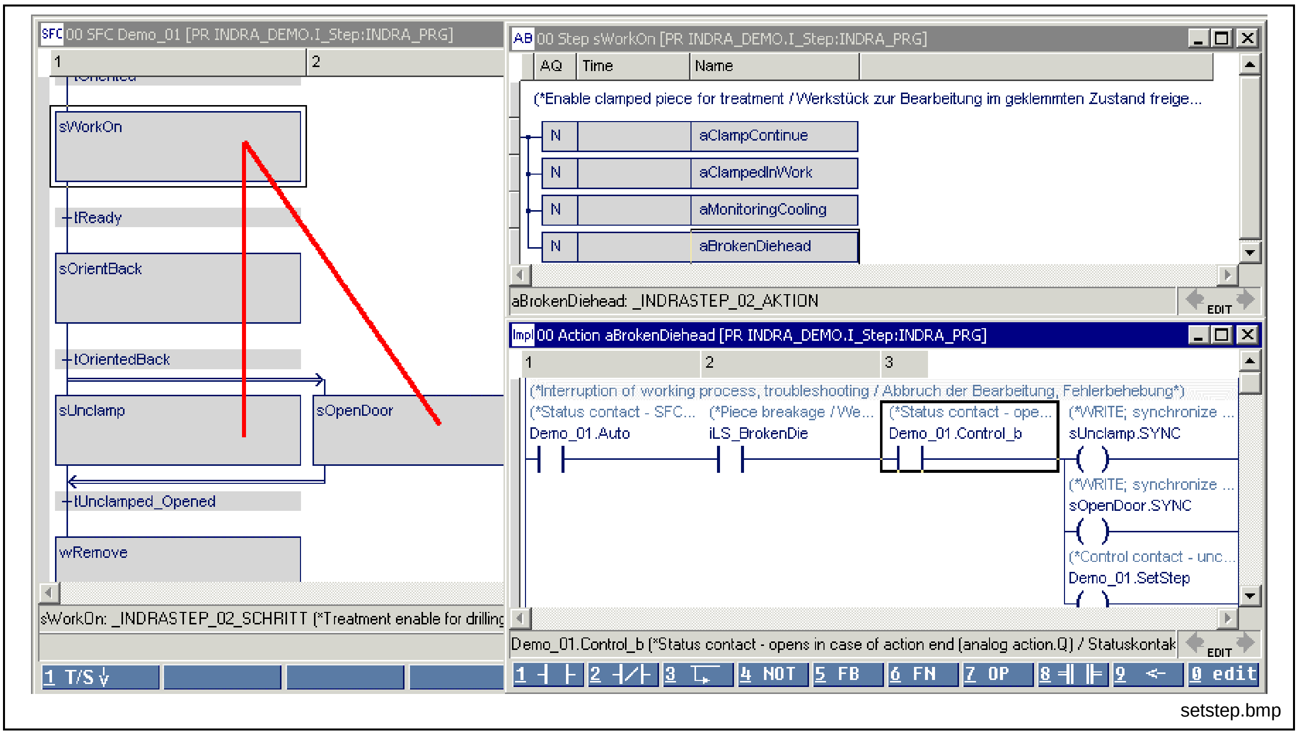

00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]
1
2
sWorkOn
tReady
sOrientBack
tOrientedBack
sUnclamp
sOpenDoor
tUnclamped_Opened
wRemove
sWorkOn: _INDRASTEP_02_SCHRITT (*Treatment enable for drilling
1 T/S
00 Step sWorkOn [PR INDRA_DEMO.I_Step:INDRA_PRG]
AQ
Time
Name
(*Enable clamped piece for treatment / Werkstück zur Bearbeitung im geklemmten Zustand freige...
N
aClampContinue
N
aClampedInWork
N
aMonitoringCooling
N
aBrokenDiehead
aBrokenDiehead: _INDRASTEP_02_AKTION
EDIT
00 Action aBrokenDiehead [PR INDRA_DEMO.I_Step:INDRA_PRG]
1
2
3
(*Interruption of working process, troubleshooting / Abbruch der Bearbeitung, Fehlerbehebung*)
(*Status contact - SFC...
(*Piece breakage / We...
(*Status contact - ope...
(*WRITE; synchronize ...
Demo_01.Auto
iLS_BrokenDie
Demo_01.Control_b
sUnclamp.SYNC
(*WRITE; synchronize ...
sOpenDoor.SYNC
(*Control contact - unc...
Demo_01.SetStep
Demo_01.Control_b (*Status contact - opens in case of action end (analog action.Q) / Statuskontak
EDIT
1
2
3
4 NOT
5 FB
6 FN
7 OP
8
9
0 edit
setstep.bmp

Fig. 4-56: Jump of **“sWorkOn”** in case of a tool breakage

The action **“aBrokenDieHead”** is also processed in the step **“sWorkOn”.** If there is a tool breakage **“iLSBrokenDie=TRUE”** in the automatic mode, the variables **“sUnClamp.SYNC”** and **“sOpenDoor.SYNC”** are set; at the same time, the jump to the step assignments **“sUnClamp”** and **“sOpenDoor”** is initiated via **“Demo_01.SetStep”.**

Since this is a valid following assignment, the jump is executed and the step **“sOrientBack”** is skipped without processing. Continued transport of the workpiece is prevented by the condition in **“tUnClamped_Opened”.** This problem must, at any rate, be solved manually.

Note: Before the new step assignment is set, it is checked for being suitable for an SFC.

In case of an error, the jump is not executed and, with the SFC stopped, **“<SFC name>.q.ErrorStp=TRUE”** is set.

Problem Solution

- Eliminate the error cause.
  - Enter the correct step assignment (possible in the online-edit mode).
- Acknowledge the error.
  - Acknowledge **“Demo_01.i.ClearError”.** The error message **“Demo_01.q.ErrorStp=FALSE”** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **“Demo_01.i.Start”. “Demo_01.q.Stopped= FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** are becoming TRUE.

The SFC jumps to the desired step assignment.

Instructions on Starting the Program Example

To be able to start the program example, load the resource file once more.. Depending on their availability, establish the connections to the input and output elements in the IO editor. A DEA box, which can be activated by means of the IO modules of any bus, was used as input/output device.

At this point, we recommend to put the programmed level into operation. This permits an immediate test of the following steps.

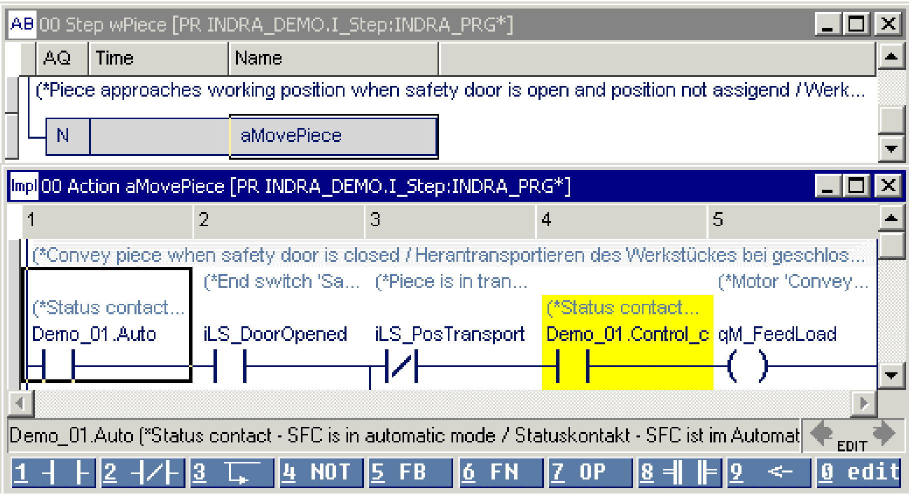
4.4 Possibilities of Error Monitoring

Action Errors

Diagnoses from action errors represent the easiest possibility of detecting an incorrect behavior..

It is initiated by the contact “<SFC name>.Control_c”, if the logic result before the contact is FALSE longer than one machining cycle with the step and the action being active.

The contact “<SFC name>.Control_c” is used instead of the contact “<SFC name>.Control_a”. Please replace by the action **“aMovePiece”!**



00 Step wPiece [PR INDRA_DEMO.I_Step:INDRA_PRG*]

AQ	Time	Name
(*Piece approaches working position when safety door is open and position not assigend / Werk...		
N		aMovePiece

00 Action aMovePiece [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Convey piece when safety door is closed / Herantransportieren des Werkstückes bei geschlos...

1	2	3	4	5
	(*End switch 'Sa...	(*Piece is in tran...		(*Motor 'Convey...
(*Status contact...			(*Status contact...	
Demo_01.Auto	iLS_DoorOpened	iLS_PosTransport	Demo_01.Control_c	qM_FeedLoad

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automat

Aktion_zu_wPiece1.bmp

Fig. 4-57: Action error initiated by “<SFC name>.Control_c” (yellow)

The SFC is started after the resource has been downloaded.

The safety door (**“iLS_DoorOpened”**) is not opened, thus preventing the conveyor belt motor from being activated.

“Demo_01.Control_c” initiates an error:
“Demo_01.q.Error= TRUE”; “Demo_01.q.Stopped= TRUE”.

Refer to the status display of the SFC – display of the active step, the active actions and/or their contents – for more information.

Problem Solution

- Eliminate the error cause
  - Open the safety door (manual mode) until **“iLS_DoorOpened=True”.**
- Acknowledge the error.
  - Acknowledge **“Demo_01.i.ClearError”.** The error message **“Demo_01.q.Error=FALSE”** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **“Demo_01.i.Start”. “Demo_01.q.Stopped= FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** are becoming TRUE.

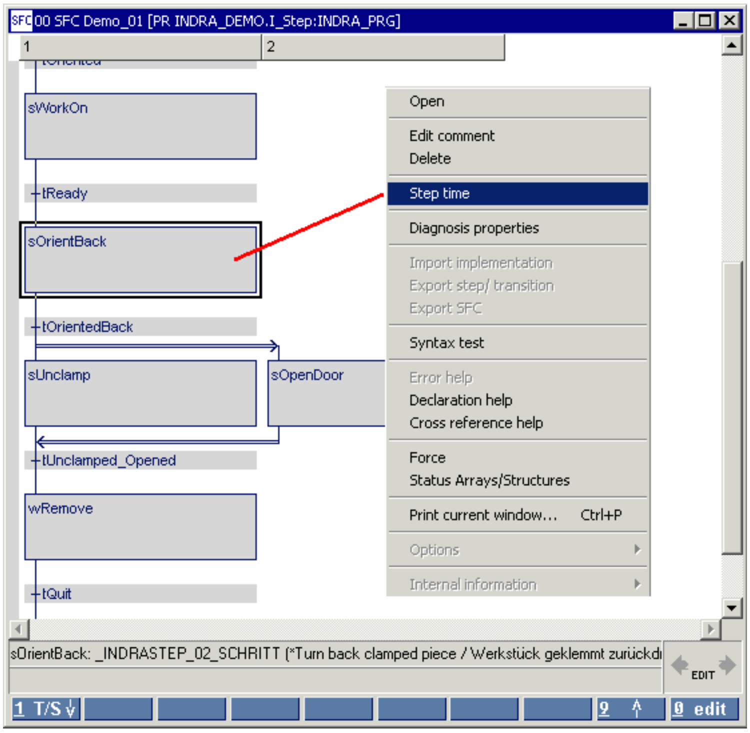
Note: An action error is not evaluated for the first processing cycle of the action.

Purpose: If the following transition is directly fulfilled after a step, an action diagnosis (error message) is not executed even if the action is not fulfilled.

Time Errors

IndraStep permits to monitor steps with regard to their maximum and minimum processing time as well as to monitor signals over time.

Enter the times in the SFC as follows: Position the cursor on the desired step, click the right mouse button or press the <Shift>+<F10> keys, Step time.



sOrientBack: _INDRASTEP_02_SCHRITT (*Turn back clamped piece / Werkstück geklemmt zurückd

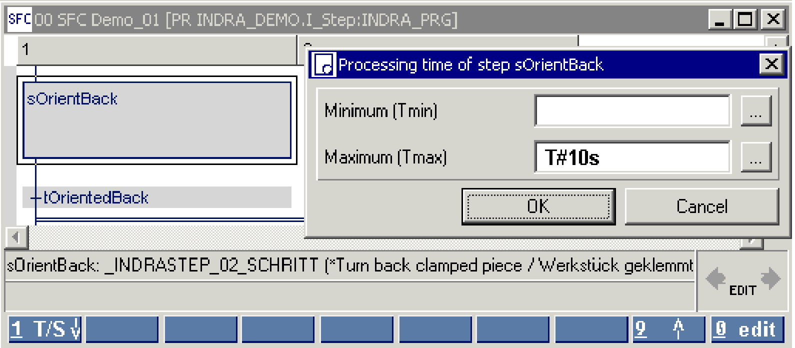
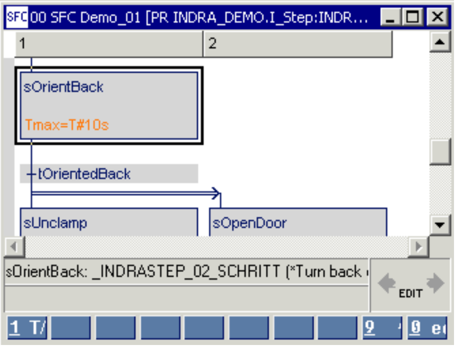
PopUp_Verweilzeit_Schritt.bmp

Fig. 4-58: Pop-up menu, step time

Maximum Processing Time (Example)

The step **“sOrientBack”** has proven to be susceptible to faults, owing to the chips produced during machining. For that reason, the time required for turning the workpiece from the working position back to the transport position is to be monitored.

This time can be specified as absolute time or as a variable of type TIME.

Entering the dwell time	Viewing the dwell time
	

00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG]

Processing time of step sOrientBack

Minimum (Tmin)

Maximum (Tmax) T#10s

sOrientBack: _INDRASTEP_02_SCHRITT (*Turn back clamped piece / Werkstück geklemmt

00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDR...

sOrientBack: _INDRASTEP_02_SCHRITT (*Turn back

Fig. 4-59: Specifying the maximum step time in the step **“sOrientBack”**

If the maximum set time is exceeded, the SFC stops:

“Demo_01.q.Error = TRUE”; “Demo_01.q.Stopped = TRUE”.

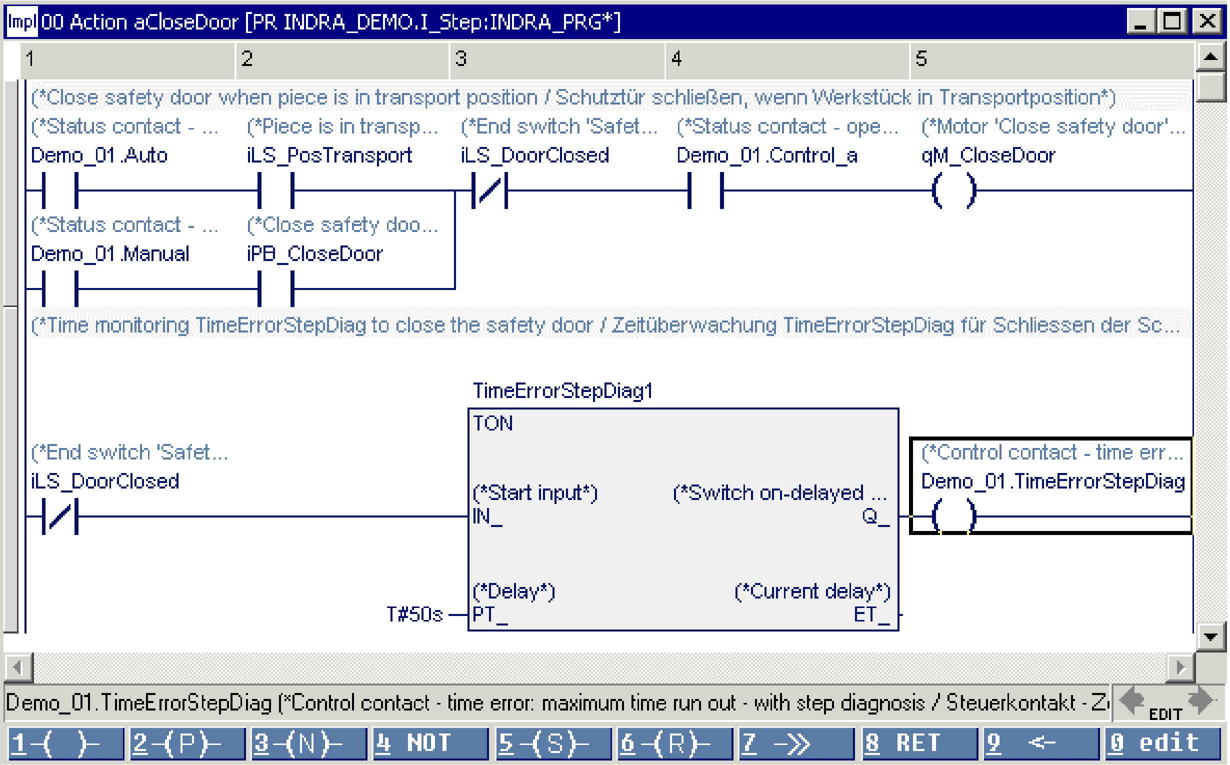
Problem Solution

- Eliminate the error cause.
  - The switch-on condition of **“tOrientBack”** must be fulfilled.
- Acknowledge the error.
  - Acknowledge **“Demo_01.i.ClearError”.** The error message **“Demo_01.q.Error=FALSE”** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **“Demo_01.i.Start”. “Demo_01.q.Stopped= FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** are becoming TRUE.

Time Errors with TimeErrorStepDiagnosis

In contrast to the maximum step time, this feature can be used to check a monitoring condition. The desired signal is applied to the input of a time stage. If the time is exceeded, the variable (<SFC name>.TimeErrorStepDiag) is set.

The step **"sCloseDoor"** is used in the example. If the safety door **"iLS_DoorClosed"** fails to be closed within 5 sec, the SFC must be stopped and an error message emitted.



00 Action aCloseDoor [PR INDRA_DEMO.I_Step:INDRA_PRG*]

Demo_01.TimeErrorStepDiag (*Control contact - time error: maximum time run out - with step diagnosis / Steuerkontakt - Z

TimeErrorStepDiag_DoorClosed.bmp

Fig. 4-60: Monitoring the down movement of the safety door

This monitoring measure is appropriate if the step remains active for a longer time than the activity to be monitored may be running. Here, the step remains active for a longer time because of the parallelity with **"sClamp"** and the subsequent clamping cycle.

The time stage is not applicable in case of immediate reactions.

If the maximum set time is exceeded, the SFC enters the stop state:

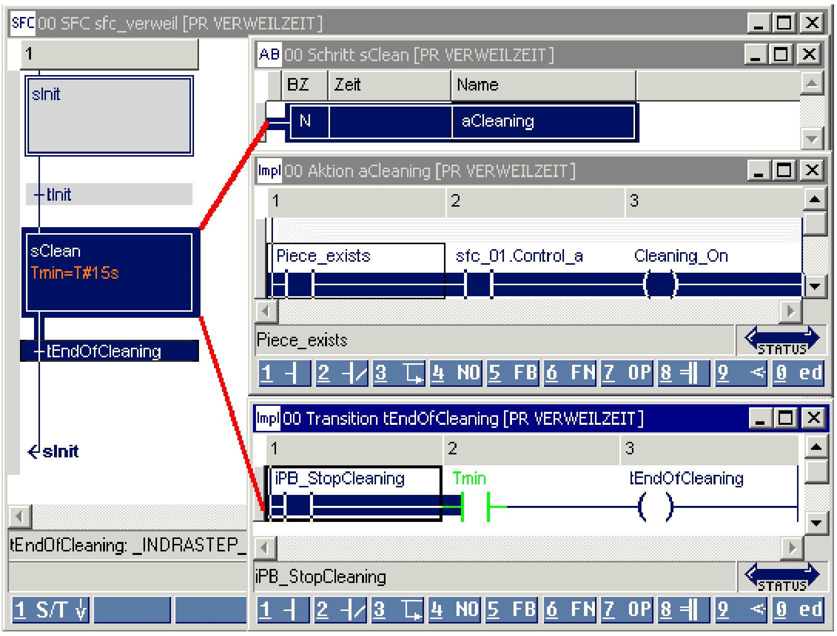
"Demo_01.q.Error = TRUE"; "Demo_01.q.Stopped = TRUE".

Problem Solution

- Eliminate the error cause
  - Close the safety door until **"iLS_DoorClosed=TRUE".**
- Acknowledge the error.
  - Acknowledge **"Demo_01.i.ClearError".** The error message **"Demo_01.q.Error=FALSE"** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **"Demo_01.i.Start". "Demo_01.q.Stopped= FALSE", "Demo_01.q.Run"** and **"Demo_01.q.Active"** are becoming TRUE.

Minimum Processing Time

The minimum processing time has weaker effects on processing of the SFC. Here, the set minimum processing time of a step is ensured even if the transition condition is fulfilled beforehand. Example: Workpiece cleaning should take 15 seconds. An error cannot occur.


00 SFC sfc_verweil [PR VERWEILZEIT]
sInit
tInit
sClean
Tmin=T#15s
tEndOfCleaning
sInit
tEndOfCleaning: _INDRASTEP_
1 S/T
00 Schritt sClean [PR VERWEILZEIT]
BZ
Zeit
Name
N
aCleaning
00 Aktion aCleaning [PR VERWEILZEIT]
Piece_exists
sfc_01.Control_a
Cleaning_On
Piece_exists
STATUS
00 Transition tEndOfCleaning [PR VERWEILZEIT]
iPB_StopCleaning
Tmin
tEndOfCleaning
iPB_StopCleaning
STATUS
1 ⊣ 2 ⊣/ 3 4 NO 5 FB 6 FN 7 OP 8 9 < 0 ed

kriterien_2.bmp

Fig. 4-61: Equivalent circuit diagram “Minimum processing time”, Tmin in green color

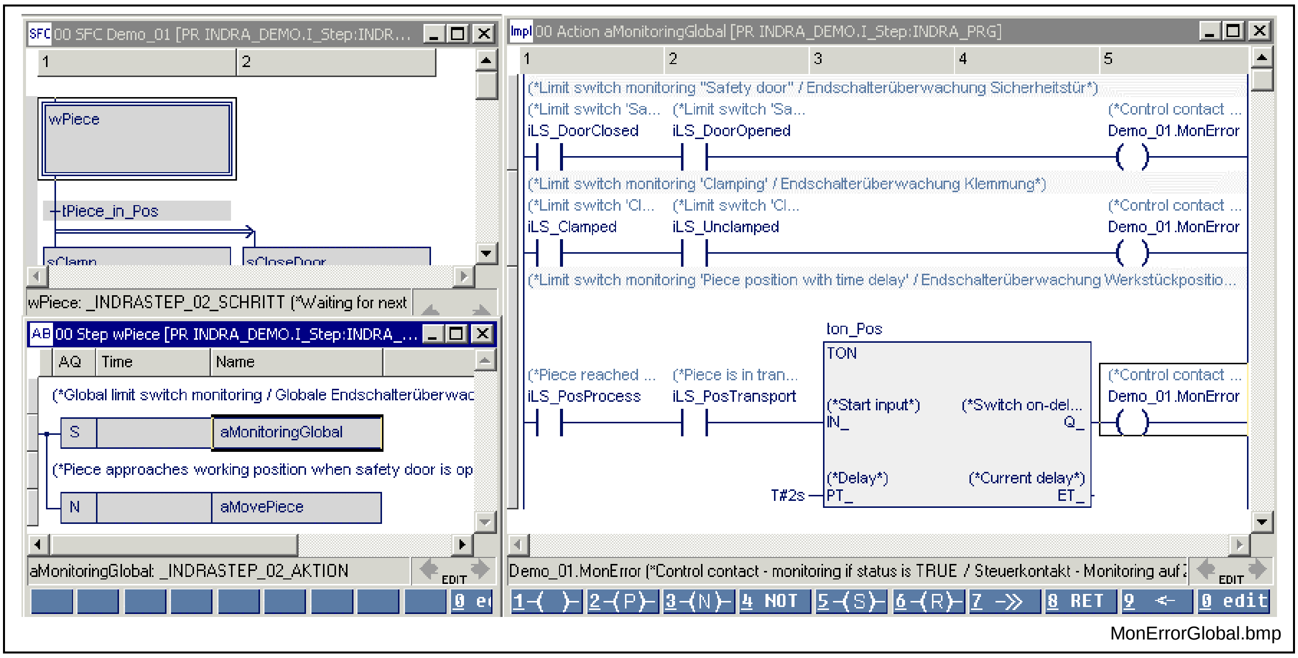
Error Monitoring

The monitoring function permits to check monitoring conditions globally for all steps or locally in the active steps immediately or delayed. If such an error occurs, the SFC stops and indicates an error (<SFC name>.q.Stop) with error message (<SFC name>.q.Error).

Error Monitoring (Global)

If the global limit switch monitoring function is used, the state or mode of the SFC is irrelevant.

To achieve this, a stored action incorporating the limit switches to be monitored must be entered in the initial step.


00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDR...
wPiece
tPiece_in_Pos
sClamp
sCloseDoor
wPiece: _INDRASTEP_02_SCHRITT (*Waiting for next
00 Step wPiece [PR INDRA_DEMO.I_Step:INDRA_...
AQ Time Name
(*Global limit switch monitoring / Globale Endschalterüberwac
S aMonitoringGlobal
(*Piece approaches working position when safety door is op
N aMovePiece
aMonitoringGlobal: _INDRASTEP_02_AKTION
00 Action aMonitoringGlobal [PR INDRA_DEMO.I_Step:INDRA_PRG]
(*Limit switch monitoring "Safety door" / Endschalterüberwachung Sicherheitstür*)
iLS_DoorClosed
iLS_DoorOpened
Demo_01.MonError
(*Limit switch monitoring 'Clamping' / Endschalterüberwachung Klemmung*)
iLS_Clamped
iLS_Unclamped
Demo_01.MonError
(*Limit switch monitoring 'Piece position with time delay' / Endschalterüberwachung Werkstückpositio...
ton_Pos
TON
iLS_PosProcess
iLS_PosTransport
(*Start input*) IN_
(*Switch on-del... Q_
(*Delay*) PT_
(*Current delay*) ET_
T#2s
Demo_01.MonError
Demo_01.MonError (*Control contact - monitoring if status is TRUE / Steuerkontakt - Monitoring auf
1 -( )- 2 -(P)- 3 -(N)- 4 NOT 5 -(S)- 6 -(R)- 7 -» 8 RET 9 <- 0 edit

MonErrorGlobal.bmp

Fig. 4-62: Global limit switch monitoring

The following items are monitored in Fig. 4-62:

- Safety door: **“iLS_DoorClosed”** versus **“iLS_DoorOpened”**
- Clamping state: **“iLS_Clamped”** versus **“iLS_Unclamped”**
- Workpiece positions: **“iLS_PosProcess”** and **“iLS_PosTransport”**

An overlap of no more than 2 sec is tolerated for the workpiece positions.

Note: Although all rungs feed the variable <SFC name>.MonError, the rung can be localized in case of an error.

If an error message is emitted, the SFC stops:

“Demo_01.q.Error=TRUE”; “Demo_01.q.Stopped=TRUE”.

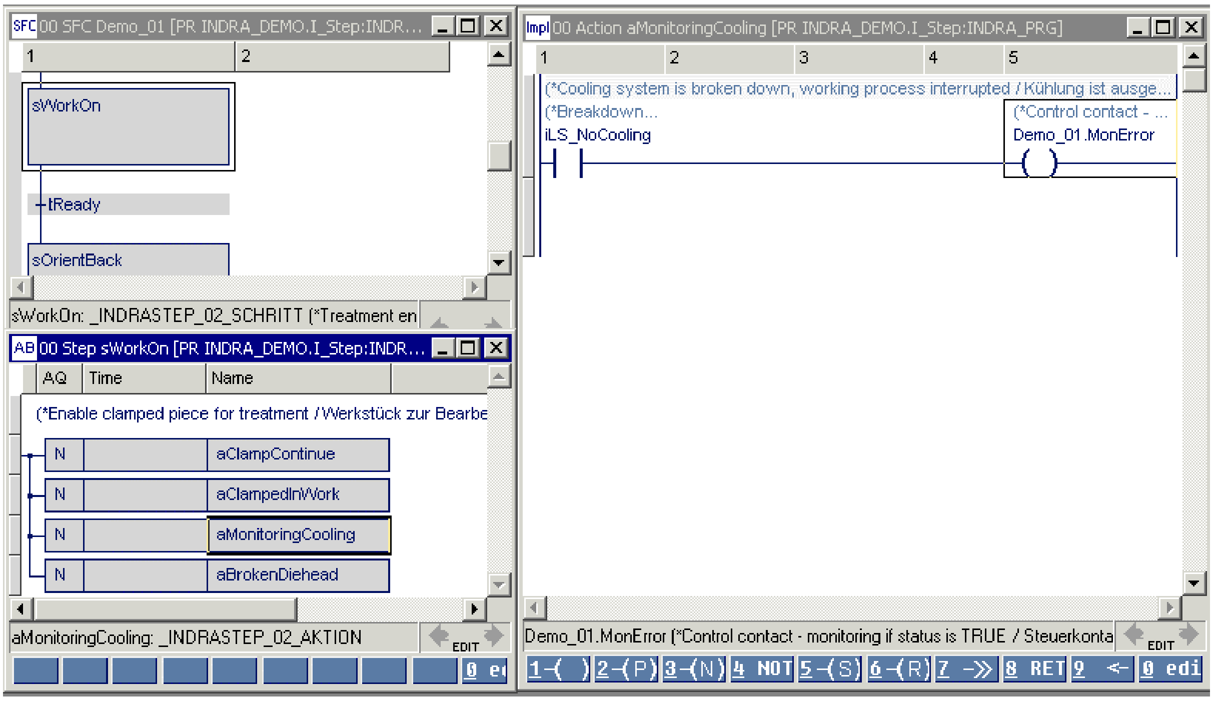
Problem Solution

- Eliminate the error cause
- Acknowledge the error.
  - Acknowledge **“Demo_01.i.ClearError”.** The error message **“Demo_01.q.Error=FALSE”** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **“Demo_01.i.Start”. “Demo_01.q.Stopped= FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** are becoming TRUE.

Error Monitoring (Local)

If an error can occur within the SFC in a specific step only, the monitoring function can be executed in this step by means of a non-stored action.

The error is exactly localized for the particular rung. The same action can be called in several steps. In case of an error, the step causing the error is also determined.



00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDR...

sWorkOn

tReady

sOrientBack

sWorkOn: _INDRASTEP_02_SCHRITT (*Treatment en

00 Step sWorkOn [PR INDRA_DEMO.I_Step:INDR...

AQ	Time	Name
(*Enable clamped piece for treatment / Werkstück zur Bearbe		
N		aClampContinue
N		aClampedInWork
N		aMonitoringCooling
N		aBrokenDiehead

aMonitoringCooling: _INDRASTEP_02_AKTION

00 Action aMonitoringCooling [PR INDRA_DEMO.I_Step:INDRA_PRG]

(*Cooling system is broken down, working process interrupted / Kühlung ist ausge...

(*Breakdown...

iLS_NoCooling

(*Control contact - ...

Demo_01.MonError

Demo_01.MonError (*Control contact - monitoring if status is TRUE / Steuerkonta

MonErrorLokal.bmp

Fig. 4-63: Local error monitoring

If the cooling unit fails, the SFC is stopped and an error message is displayed.

If an error message is emitted, the SFC enters the stop state:

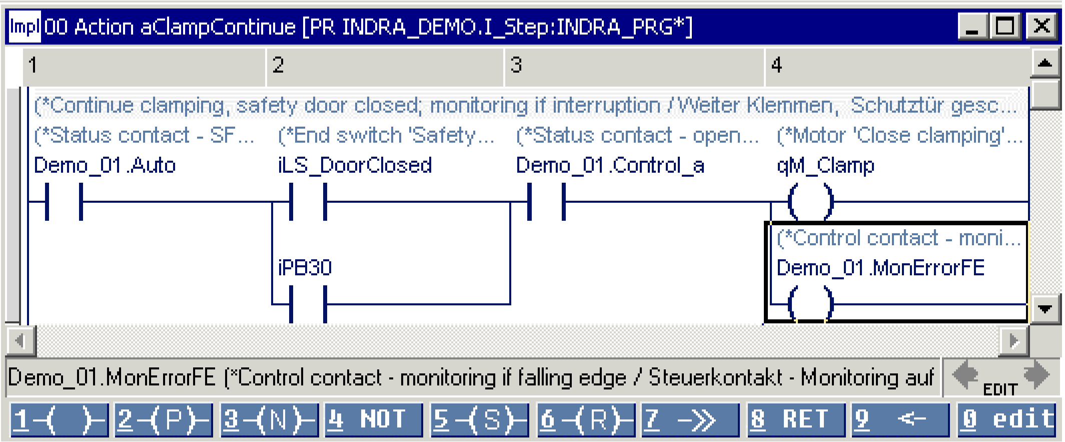
“Demo_01.q.Error= TRUE”; “Demo_01.q.Stopped= TRUE”.

Problem Solution

- Eliminate the error cause.
- Acknowledge the error.
  - Acknowledge **“Demo_01.i.ClearError”.** The error message **“Demo_01.q.Error=FALSE”** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **“Demo_01.i.Start”. “Demo_01.q.Stopped= FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** are becoming TRUE.

Dynamic Error Monitoring (MonErrorFE)

IndraStep permits to monitor output signals for being interrupted briefly.



Impl 00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG*]

(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür gesc...

1	2	3	4
(*Status contact - SF...	(*End switch 'Safety...	(*Status contact - open...	(*Motor 'Close clamping'...
Demo_01.Auto	iLS_DoorClosed	Demo_01.Control_a	qM_Clamp
	iPB30		(*Control contact - moni... Demo_01.MonErrorFE

Demo_01.MonErrorFE (*Control contact - monitoring if falling edge / Steuerkontakt - Monitoring auf

MonErrorFE.bmp

Fig. 4-64: Dynamic monitoring of an output signals

The action **“aClampContinue”** organizes the permanent activation of the clamping state over several steps. If the activation of **“qM_Clamp”** is interrupted briefly, then this is registered by the parallel contact <SFC name>.MonErrorFE, with emission of an error message.

Note: Each action can be monitored only **once.** The step, in which the interruption occurred, is determined.

If an error message is emitted, the SFC enters the stop state:

“Demo_01.q.Error= TRUE”; “Demo_01.q.Stopped= TRUE”.

Problem Solution

- Eliminate the error cause.
- Acknowledge the error.
  - Acknowledge **“Demo_01.i.ClearError”.** The error message **“Demo_01.q.Error=FALSE”** disappears, but the SFC is still stopped.
- Enable continued processing of the SFC.
  - Press **“Demo_01.i.Start”. “Demo_01.q.Stopped= FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** are becoming TRUE.

4.5 Diagnosis Options

Diagnosis Options in WinPCL

The present diagnosis function in WinPCL permits

- to display the status information of the SFC,
- to eliminate the errors occurred,
- to acknowledge the error message, and
- to restart the SFC.

Action error example:

The SFC is started after the resource has been downloaded.

The safety door (**“iLS_DoorOpened”**) is not opened, thus preventing the conveyor belt motor from being activated.

“Demo_01.Control_c” initiates an error:

- **“Demo_01.q.Error=TRUE”**
- **“Demo_01.q.Stopped=TRUE”**

Refer to the status display of the SFC (display of the active step) and the active actions and/or their contents for more information.

Problem Solution

- Eliminate the error cause.
  - Open the safety door until **“iLS_DoorOpened=TRUE”.**
- Acknowledge the error.
  - Confirm **“Demo_01.i.ClearError”.** Thereafter, the error message **“Demo_01.q.Error=FALSE”** disappears, but the SFC is still in the stop state.
- Enable continued processing of the SFC.
  - Confirm **“Demo_01.i.Start”. “Demo_01.q.Stopped=FALSE”, “Demo_01.q.Run”** and **“Demo_01.q.Active”** become TRUE, unless the SFC is in the initial step.

Advanced Diagnosis in WinHMI

In WinHMI /2/, there are eight different display areas:

- System error messages: Error messages causing a stop of the complete control. Operation can only be continued after the control has been reset.
- Start requirements: Switch-on conditions of the entire machine.
- Warnings: Instructions on a control; user guide for bottlenecks in the near future.
- Setup diagnosis: Diagnosis for operating screens (OP4-Manual).
- CNC failures and/or mechanism faults of a module.
- **Processing faults**

  IndraStep SFC faults of a module
- General faults: PLC faults of a module
- Messages: PLC operating and CNC status messages of a module

The sections below describe the advanced diagnosis functions for processing faults.

Preparing the Use of the Diagnosis Functions in WinHMI

Remark:

Working with WinHMI requires a BTV, because it permits easy handling via the function keys (<F2>…<F9>), operation keys (<OP2>…<OP9>) and machine function keys (<L1>…<L8> as well as <R1>…<R8>).

The WinHMI and WinPCL screens can be toggled with <ALT>+<TAB> /2/. However, we recommend to operate the BTV with “remote control”. In this case, the WinHMI screens can be viewed on the BTV screen, while the WinPCL screens can be displayed on the remote PC (notebook or the like) without toggling being necessary.

Make the following preparations:

Loading the Archive “HMI_SPS.APV”

All data types and function blocks required for implementing the process connection between WinHMI and the PLC are comprised in the PLC archive “HMI_SPS.APV” .

The archive must be loaded once to the WinPCL programming system using *“File / Archive / Load archive…”*.

The archive resides in the

Drive:\Programme\Indramat\Mtgui\Basicdata\templates

folder.

Defining the Module Configuration

The “Module” structuring instrument is available for extending the existing control structure. The module definition is called module configuration and exists once per PC.

In contrast to the control structure described above, the module configuration is primarily made under aspects of machine construction and operation.

Note: WinHMI requires the configuration of at least one module. Optionally, further modules can be configured.

Modules permit to comprise and group processes, SFCs and diagnoses in relation to the application.

Creating the file ModulDef.ini

After a new WinHMI user interface has been set up, a template file “ModulDef.ini” is generated.

The file must be adjusted before WinHMI is called because, otherwise, it is not possible to assign devices, modules, processes, etc. to the display areas.

The template file ModulDef.ini contains several commented entries. The machine manufacturer has to define the final assignment and adjust the file to the software structure. “,” must be removed accordingly.

The file ModulDef.ini exists once per PC, e.g. in the BTV20. At present, the file must be edited directly with an editor, e.g. NotePad.

The following figure shows the file ModulDef.ini for our example:

Moduldef.ini	Remark
;Default Module definition MUI/GUI version 20V01	
[ModulGeneral]	General definition for the modules
[ModulGeneral\ModulDescription]	Designation of the module level in the various languages

DE = Einheit
EN = Unit
	German name
	English name

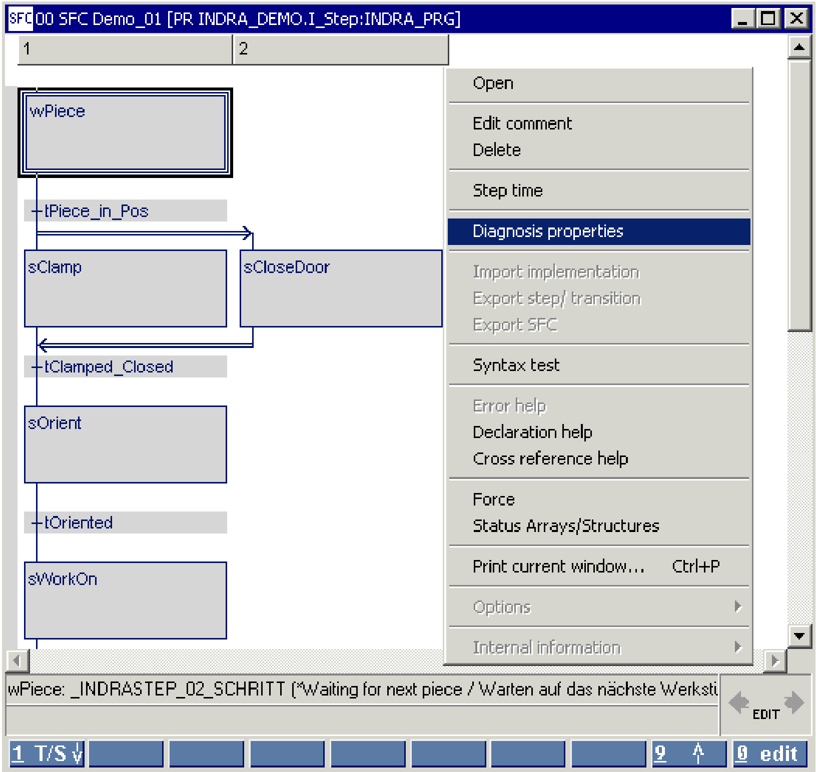
[DeviceAddr0]	Device (control) assignment with device address, e.g. device 0
[DeviceAddr0\Modul1] ModulName = Modul 1 Drilling Station	Assignment of module 1 of device 0 Name of module 1
;[DeviceAddr0\Modul1\Process] ;Entry1 =	Assignment of the processes (no.) to module 1 of device 0 number of the process assigned: Still empty

Fig. 4-65: ModulDef.ini for our example

Assigning the module definition in the SFC editor

To be able to use the advanced diagnosis options, you must assign a module number to the SFC.

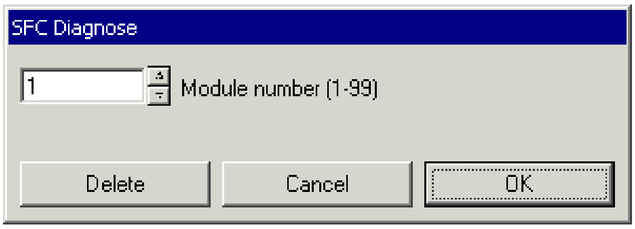
The assignment can be made with the pop-up menu of the editor, which is opened by clicking the right mouse button or pressing the <Shift>+<F10> keys.



wPiece: _INDRASTEP_02_SCHRITT (*Waiting for next piece / Warten auf das nächste Werksti

PopUp_Diagnose_Schritt.bmp

Fig. 4-66: Enabling the diagnosis



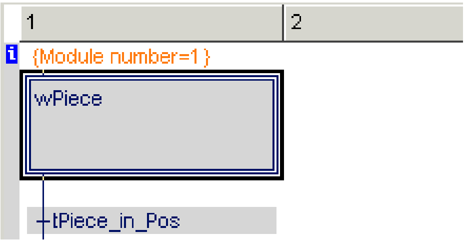
SFC Diagnose

Module number (1-99): 1

Eintrag_Modulnummer.bmp

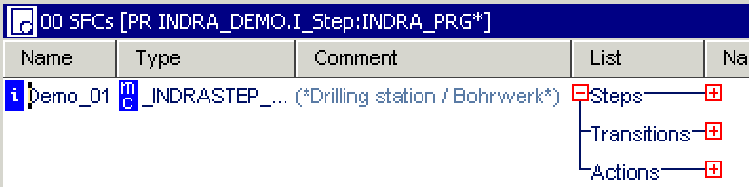
Fig. 4-67: Entering the module number

After the assignment has been completed, the SFC concerned is marked with i.



Modulzuordnung_erfolgt_SFC.bmp

Fig. 4-68: “Entry of module number executed” marked in the SFC



00 SFCs [PR INDRA_DEMO.I_Step:INDRA_PRG*]

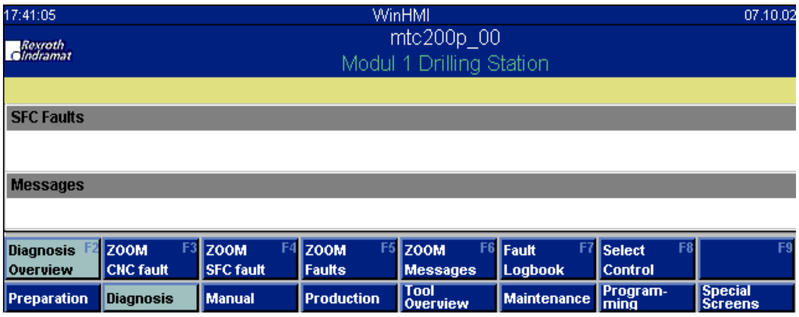
Name	Type	Comment	List	Na
i Demo_01	_INDRASTEP_...	(*Drilling station / Bohrwerk*)	Steps Transitions Actions	

Modulzuordnung_erfolgt_SFCL.bmp

Fig. 4-69: “Entry of module number executed” marked in the SFC list

Starting WinHMI on the BTV and WinPCL in the Remote Mode

After WinHMI has been started and Diagnosis / Diagnosis Overview has been activated, the monitor of the BTV shows the following screen, provided no failure has occurred:



Diagnose_Ablaufstörung_01.bmp

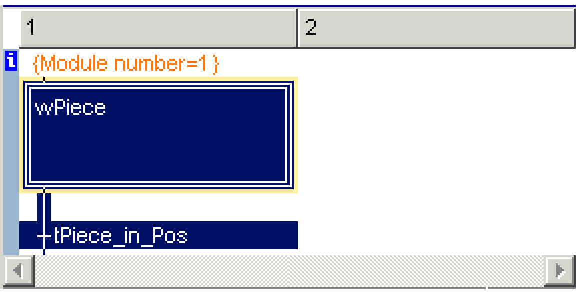
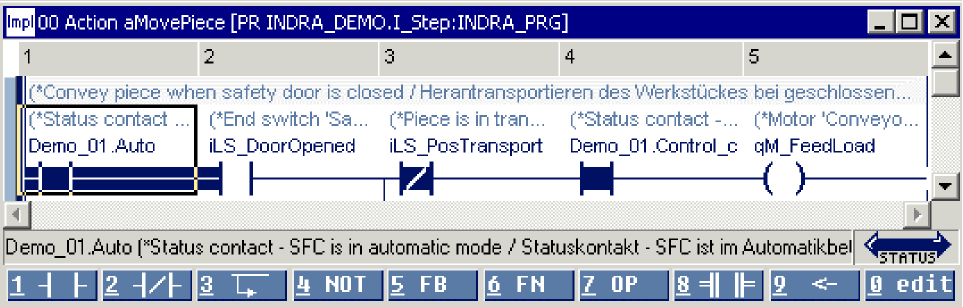
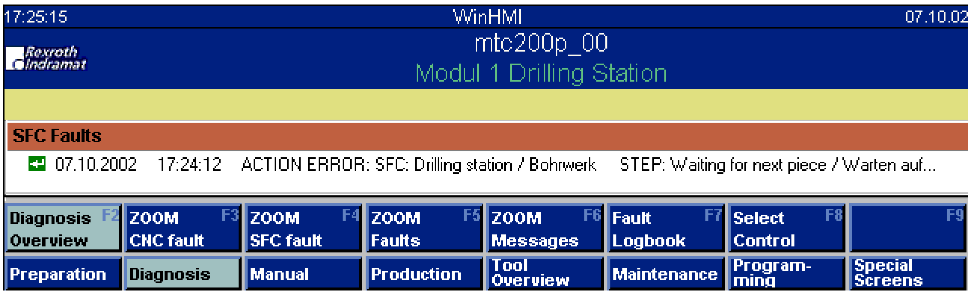
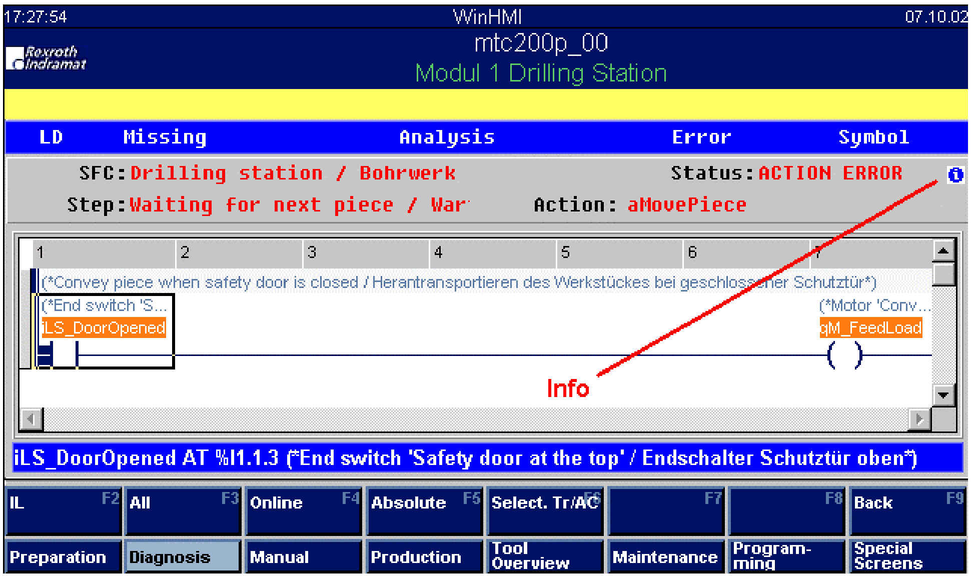
Fig. 4-70: Diagnosis in WinHMI, faultless operation

Note: If the “No diagnosis” message is displayed instead of the “SFC Faults” message, the module number is not assigned to the SFC.

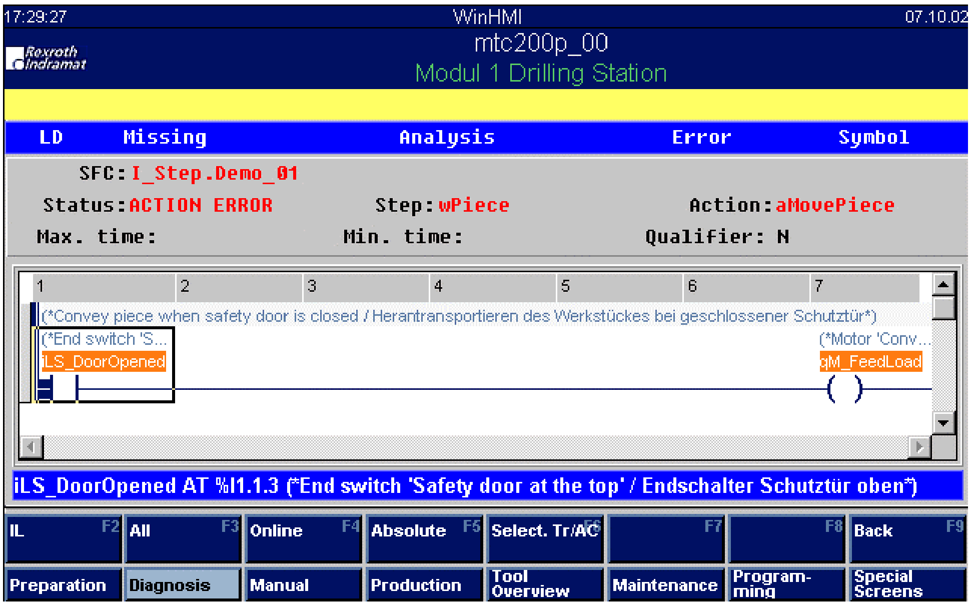
This screen changes if an error occurs.

Action Errors

Diagnoses caused by action errors have been described in the section on diagnosis options in WinPCL. They are initiated by the contact "<SFC name>.Control_c", if the logic result before the contact is FALSE with the step and the action being active.

Component	Representation
WinPCL, step "wPiece", "Waiting for next piece"	
Action "aMovePiece" in the step "wPiece"	 Impl 00 Action aMovePiece [PR INDRA_DEMO.I_Step:INDRA_PRG] 1 2 3 4 5 STATUS 1 ┤ ├ 2 ┤/├ 3 4 NOT 5 FB 6 FN 7 OP 8 9 <- 0 edit (*Convey piece when safety door is closed / Herantransportieren des Werkstückes bei geschlossen... (*Status contact ... (*End switch 'Sa... (*Piece is in tran... (*Status contact -... (*Motor 'Conveyo... Demo_01.Auto iLS_DoorOpened iLS_PosTransport Demo_01.Control_c qM_FeedLoad Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbet
Error description	The safety door is not open, the contact "iLS_DoorOpened" is not closed. For that reason, the motor "qM_FeedLoad" is not activated. There is no workpiece. "iLS_PosTransport" (neg.) is closed. The contact "Demo_01.Control_c" signalizes an SFC fault.
WinHMI, SFC fault	 17:25:15 WinHMI 07.10.02 Rexroth Indramat mtc200p_00 Modul 1 Drilling Station SFC Faults Diagnosis Overview F2 ZOOM CNC fault F3 ZOOM SFC fault F4 ZOOM Faults F5 ZOOM Messages F6 Fault Logbook F7 Select Control F8 F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Programming Special Screens 07.10.2002 17:24:12 ACTION ERROR: SFC: Drilling station / Bohrwerk STEP: Waiting for next piece / Warten auf...
	Selection of the fault displayed; <Enter>
WinHMI, criteria analysis The rung is reduced to the contact which prevents the activation.	 17:27:54 WinHMI 07.10.02 Rexroth Indramat mtc200p_00 Modul 1 Drilling Station LD Missing Analysis Error Symbol 1 2 3 4 5 6 7 Info IL F2 All F3 Online F4 Absolute F5 Select. Tr/AC F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Programming Special Screens SFC: Drilling station / Bohrwerk Status: ACTION ERROR Step: Waiting for next piece / War Action: aMovePiece (*Convey piece when safety door is closed / Herantransportieren des Werkstückes bei geschlossener Schutztür*) (*End switch 'S... (*Motor 'Conv... iLS_DoorOpened qM_FeedLoad iLS_DoorOpened AT %I1.1.3 (*End switch 'Safety door at the top' / Endschalter Schutztür oben*)

After the Info key on the BTV has been pressed.



17:29:27 WinHMI 07.10.02

mtc200p_00

Modul 1 Drilling Station

LD Missing Analysis Error Symbol

SFC: I_Step.Demo_01

Status: ACTION ERROR Step: wPiece Action: aMovePiece

Max. time: Min. time: Qualifier: N

(*Convey piece when safety door is closed / Herantransportieren des Werkstückes bei geschlossener Schutztür*)

iLS_DoorOpened AT %I1.1.3 (*End switch 'Safety door at the top' / Endschalter Schutztür oben*)

Fig. 4-71: Advanced diagnosis up to the criteria analysis

The criteria analysis can provide further information.
The default setting is represented in **bold** letters below:

- <F2>: Toggling of IL and **ladder diagram**
- <F3>: All contacts of the automatic branch in the rung are displayed; the manual branch is suppressed. / **Only the missing contacts** are displayed.
- <F4>: All non-closed contacts are displayed in the online mode / **Error:** The rung is frozen when the error occurs and is preserved for evaluation.
- <F5>: Absolute address / **symbolic name.**
- <F6>: Selection of transitions / **actions** pertaining to the step. Additional information can be obtained from the remaining actions of the step or the following transitions. In the selection list, the action/transition causing the error is displayed with a red background, the currently selected one with a blue background. The display shows contacts which are not fulfilled.

Note: The ℹ symbol in the criteria analysis window indicates additional information. This information can be called by pressing the “Info” key of the BTV.

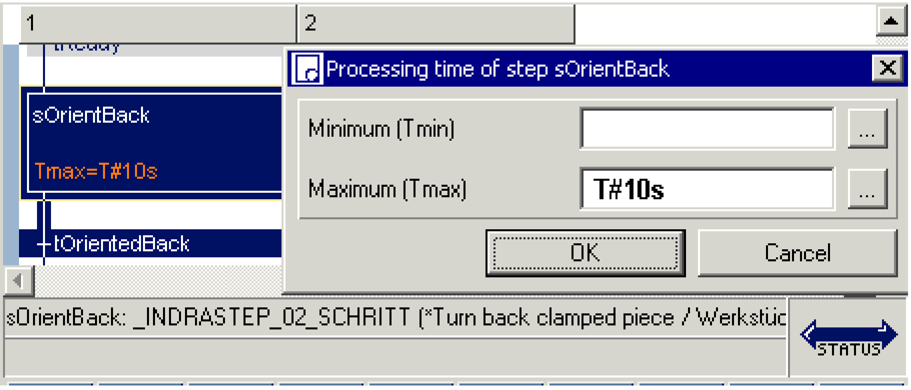
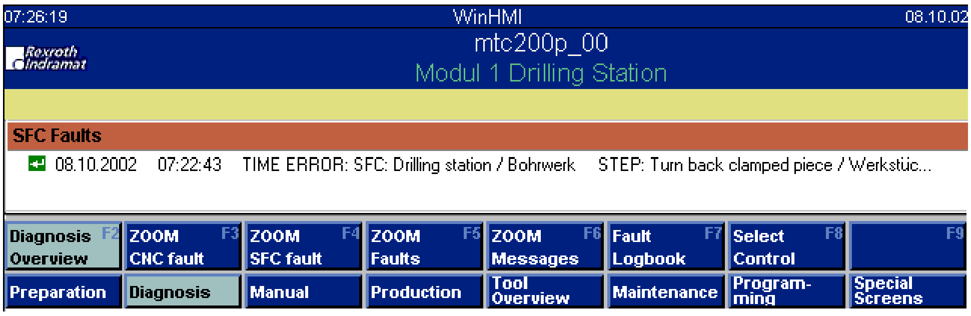
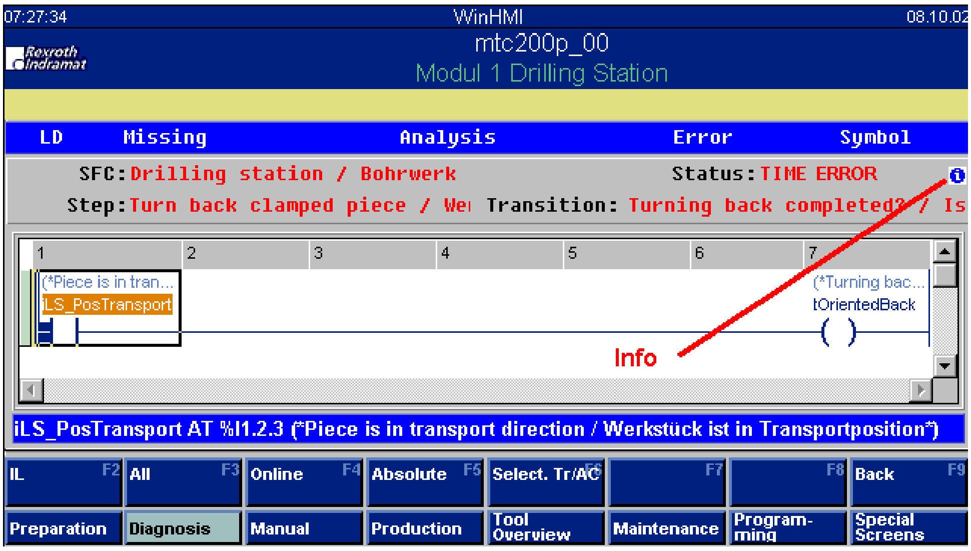
	Without Info key	**With Info key**
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	ACTION ERROR	ACTION ERROR
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Action:	Name of the action	Name of the action
Qualifier		Action qualifier of the actions selected

Fig. 4-72: Additional information after the Info key of the BTV has been pressed

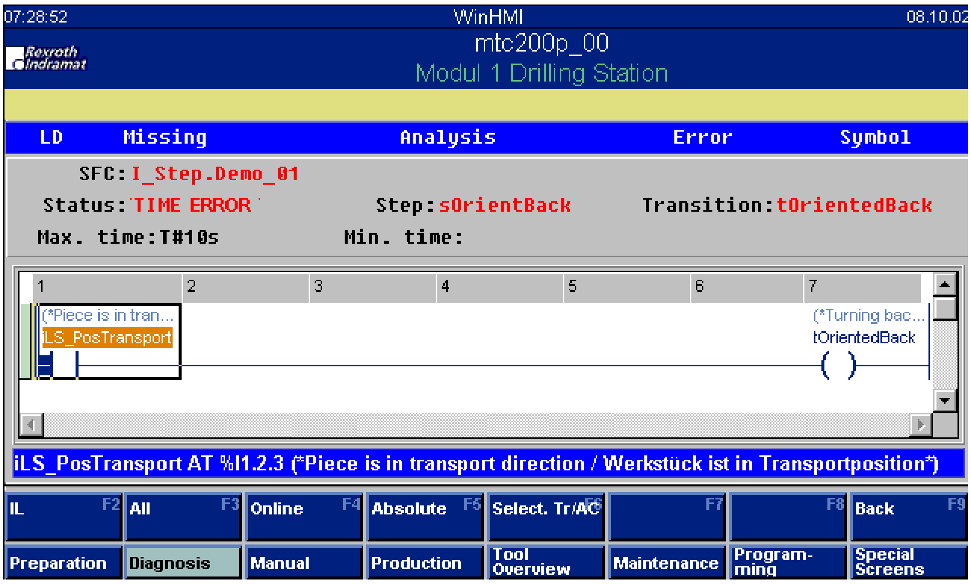
Maximum Processing Time

If the set maximum time is exceeded, the SFC enters the stop state (<SFC name>.q.Stop) with the error being displayed (<SFC name>.q.Error).

This time can be specified as absolute time or as a variable of type TIME.

Component	Representation
WinPCL, step “sOrientBack”, “Turn back clamped piece” Dwell time of the step	 Processing time of step sOrientBack Minimum (Tmin) Maximum (Tmax) T#10s sOrientBack Tmax=T#10s tOrientedBack sOrientBack: _INDRASTEP_02_SCHRITT (*Turn back clamped piece / Werkstüc
Error description	The step sOrientBack has proven to be susceptible to faults, owing to the chips produced during machining. For that reason, the time required for turning the workpiece from the machining position back to the transport position is to be monitored.
WinHMI, time error	 07:26:19 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC Faults 08.10.2002 07:22:43 TIME ERROR: SFC: Drilling station / Bohrwerk STEP: Turn back clamped piece / Werkstüc... Rexroth Indramat Diagnosis Overview F2 ZOOM CNC fault F3 ZOOM SFC fault F4 ZOOM Faults F5 ZOOM Messages F6 Fault Logbook F7 Select Control F8 F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens
	Selection of the fault displayed; <Enter>
WinHMI, criteria analysis The rung is reduced to the contact which has interrupted the activation.	 07:27:34 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station LD Missing Analysis Error Symbol SFC:Drilling station / Bohrwerk Status:TIME ERROR Step:Turn back clamped piece / Wei Transition: Turning back completed? / Is (*Piece is in tran... iLS_PosTransport (*Turning bac... tOrientedBack iLS_PosTransport AT %I1.2.3 (*Piece is in transport direction / Werkstück ist in Transportposition*) Rexroth Indramat 1 2 3 4 5 6 7 Info IL F2 All F3 Online F4 Absolute F5 Select. Tr/AC F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens

After the Info key on the BTV has been pressed.



07:28:52 WinHMI 08.10.02

mtc200p_00

Modul 1 Drilling Station

LD Missing Analysis Error Symbol

SFC:I_Step.Demo_01

Status:TIME ERROR Step:sOrientBack Transition:tOrientedBack

Max. time:T#10s Min. time:

iLS_PosTransport AT %I1.2.3 (*Piece is in transport direction / Werkstück ist in Transportposition*)

Fig. 4-73: Advanced diagnosis up to the criteria analysis

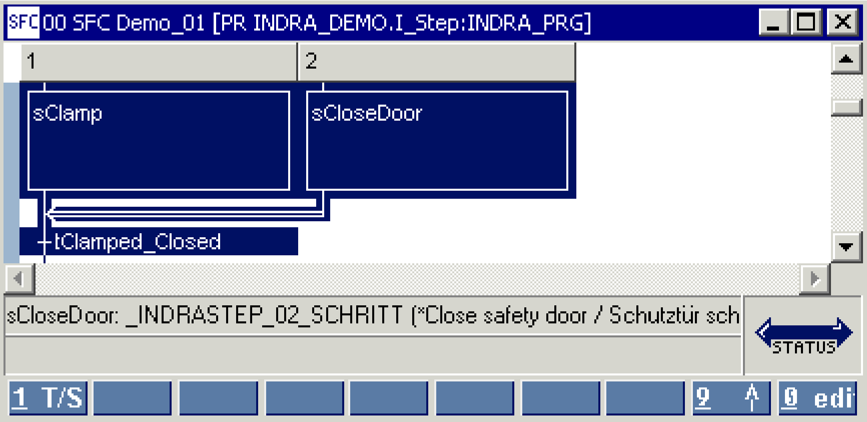
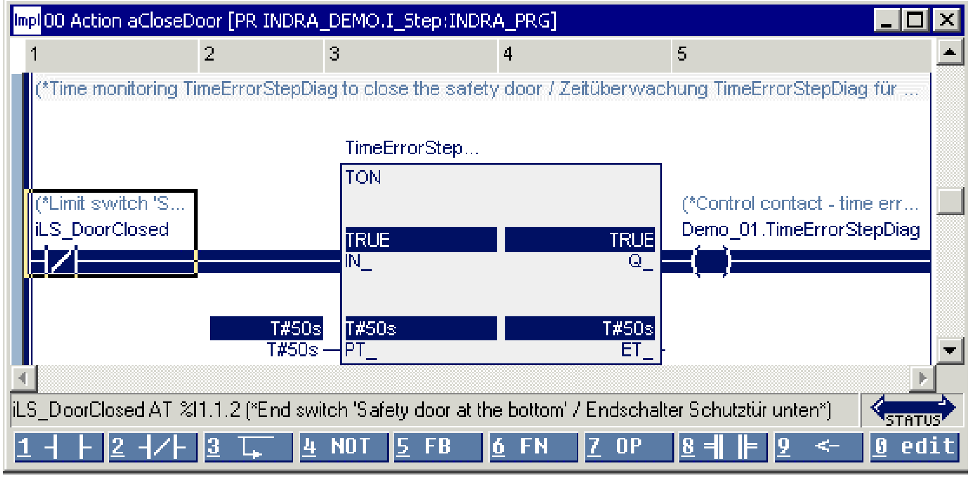
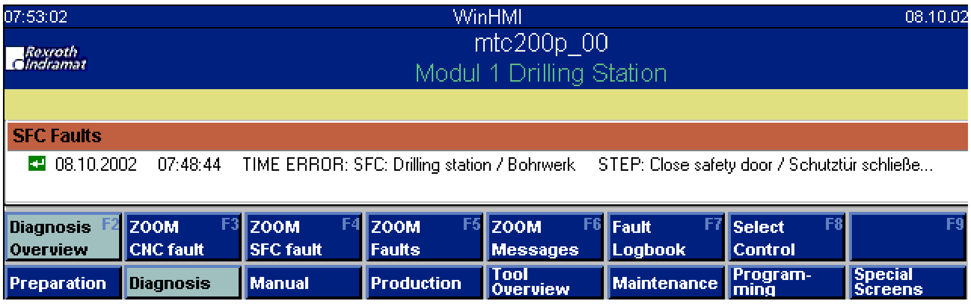
	Without Info key	With Info key
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	TIME ERROR	TIME ERROR
Step:	Comment on the step	<Step name>
Transition	Comment on the transition	<Transition name>
		Minimum step time
		Maximum step time
Action:	Name of the action	Name of the action

Fig. 4-74: Additional information after the Info key of the BTV has been pressed

Time Error – Resulting from TimeErrorStepDiag

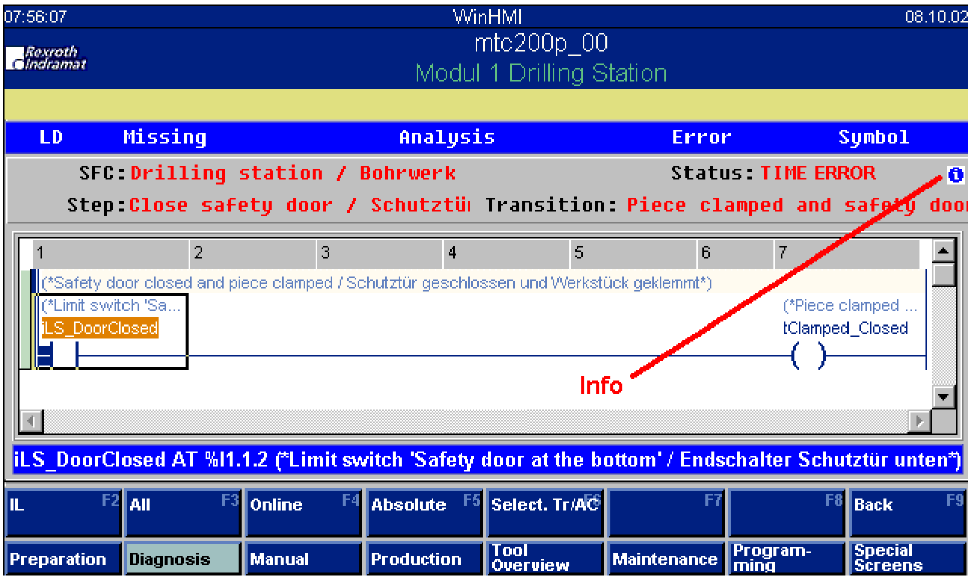
In contrast to the maximum step time, this feature can be used to check a monitoring condition. The desired signal is applied to the input of a time stage. If the time is exceeded, the variable (<SFC name>.TimeErrorStepDiag) is set.

The step **"sCloseDoor"** is used in the example.

Component	Representation
WinPCL, step "sCloseDoor", "Close safety door"	 00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG] sCloseDoor: _INDRASTEP_02_SCHRITT (*Close safety door / Schutztür sch 1 2 sClamp sCloseDoor tClamped_Closed STATUS 1 T/S 9 0 edi
Action "aCloseDoor" in the step "sCloseDoor"	 00 Action aCloseDoor [PR INDRA_DEMO.I_Step:INDRA_PRG] (*Time monitoring TimeErrorStepDiag to close the safety door / Zeitüberwachung TimeErrorStepDiag für ... iLS_DoorClosed AT %I1.1.2 (*End switch 'Safety door at the bottom' / Endschalter Schutztür unten*) 1 2 3 4 5 TimeErrorStep... TON (*Limit switch 'S... iLS_DoorClosed TRUE IN_ TRUE Q_ (*Control contact - time err... Demo_01.TimeErrorStepDiag T#50s T#50s T#50s PT_ T#50s ET_ STATUS 1 2 3 4 NOT 5 FB 6 FN 7 OP 8 9 0 edit
Error description	If the safety door "iLS_DoorClosed" fails to be closed within 5 sec, the SFC must be stopped and an error message emitted. The contact "Demo_01.TimeErrorStepDiag" signalizes a time error.
WinHMI, time error	 07:53:02 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC Faults 08.10.2002 07:48:44 TIME ERROR: SFC: Drilling station / Bohrwerk STEP: Close safety door / Schutztür schließe... Rexroth Indramat Diagnosis Overview F2 ZOOM CNC fault F3 ZOOM SFC fault F4 ZOOM Faults F5 ZOOM Messages F6 Fault Logbook F7 Select Control F8 F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens
	Selection of the fault displayed; <Enter>

WinHMI, criteria analysis

The switch-on condition is reduced to the contacts having prevented switch-on.



07:56:07 WinHMI 08.10.02

mtc200p_00

Modul 1 Drilling Station

SFC: Drilling station / Bohrwerk Status: TIME ERROR

Step: Close safety door / Schutztü Transition: Piece clamped and safety doo

(*Safety door closed and piece clamped / Schutztür geschlossen und Werkstück geklemmt*)

(*Limit switch 'Sa...

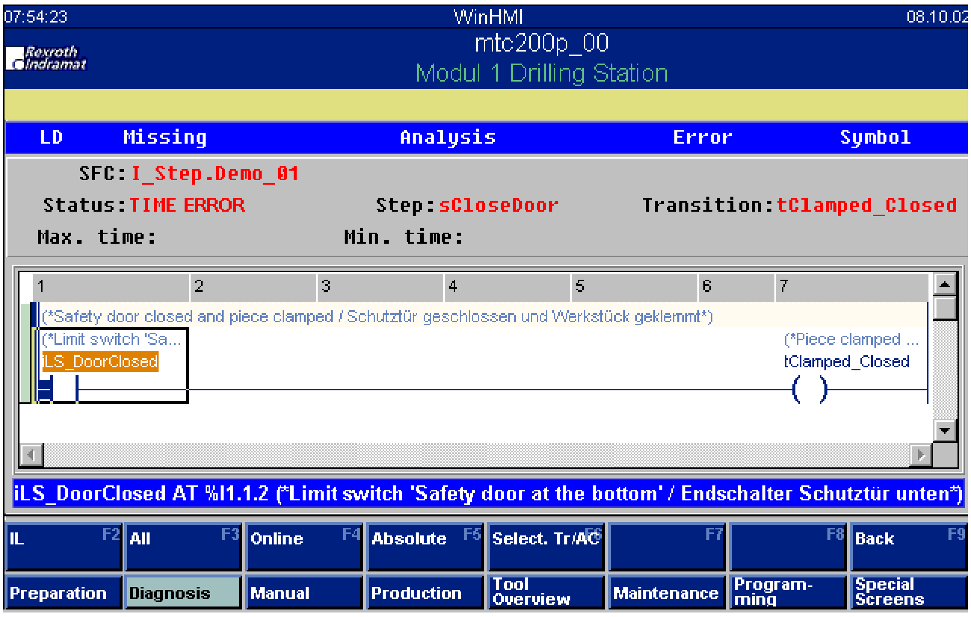
iLS_DoorClosed

(*Piece clamped ...

tClamped_Closed

iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten*)

After the Info key on the BTV has been pressed.



07:54:23 WinHMI 08.10.02

mtc200p_00

Modul 1 Drilling Station

SFC: I_Step.Demo_01

Status: TIME ERROR Step: sCloseDoor Transition: tClamped_Closed

Max. time: Min. time:

(*Safety door closed and piece clamped / Schutztür geschlossen und Werkstück geklemmt*)

(*Limit switch 'Sa...

iLS_DoorClosed

(*Piece clamped ...

tClamped_Closed

iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten*)

Fig. 4-75: Advanced diagnosis up to the criteria analysis

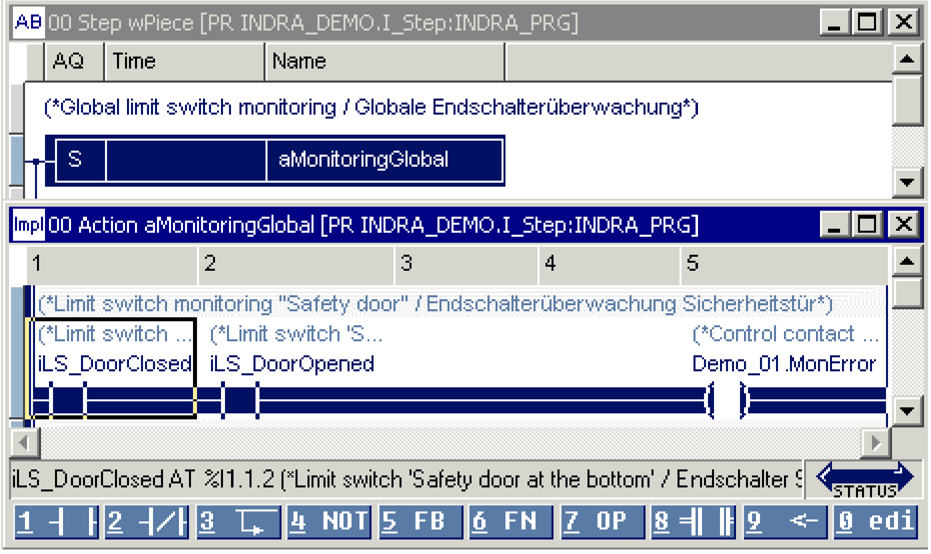
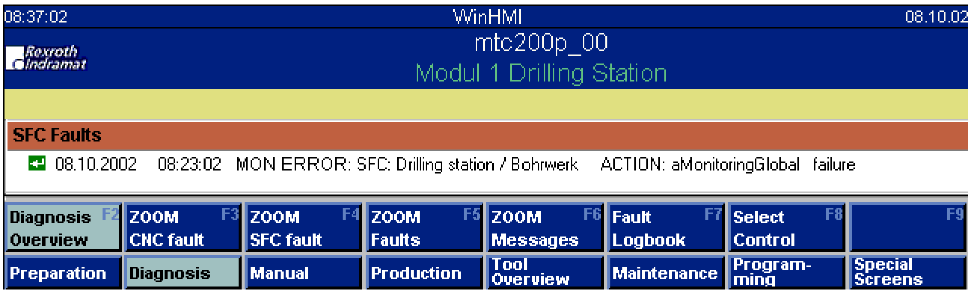
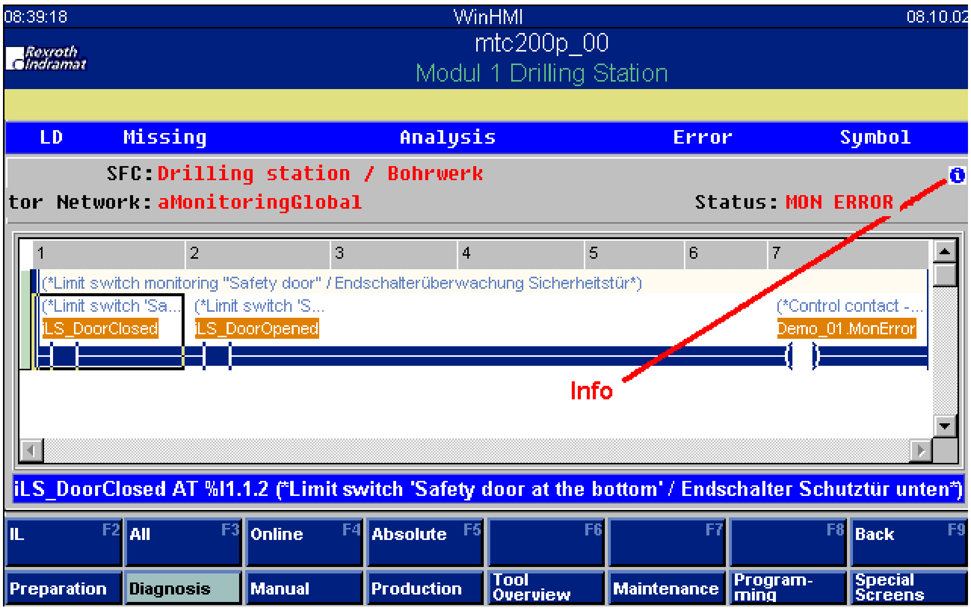
	Without Info key	**With Info key**
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	TIME ERROR	TIME ERROR
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Transition:	Comment on the transition	<Transition name>

Fig. 4-76: Additional information after the Info key of the BTV has been pressed

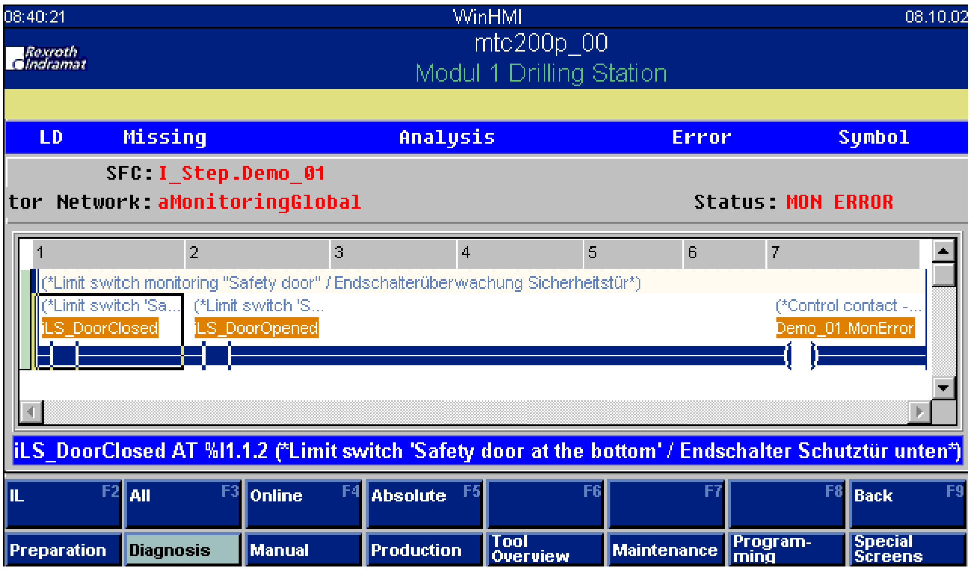
Undelayed Error Monitoring (Global)

If the global limit switch monitoring function is used, the state or mode of the SFC is irrelevant.

To achieve this, a stored action incorporating the limit switches to be monitored must be entered in the initial step.

Component	Representation
WinPCL, The initial step “wPiece” includes the stored action “aMonitoringGlobal”, which incorporates all limit switch monitoring functions.	 00 Step wPiece [PR INDRA_DEMO.I_Step:INDRA_PRG] AQ · Time · Name (*Global limit switch monitoring / Globale Endschalterüberwachung*) S · aMonitoringGlobal 00 Action aMonitoringGlobal [PR INDRA_DEMO.I_Step:INDRA_PRG] (*Limit switch monitoring "Safety door" / Endschalterüberwachung Sicherheitstür*) (*Limit switch ... · (*Limit switch 'S... · (*Control contact ... iLS_DoorClosed · iLS_DoorOpened · Demo_01.MonError iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter S AB 1 2 3 4 5 Impl STATUS 1 ┤ ├ 2 ┤/├ 3 4 NOT 5 FB 6 FN 7 OP 8 9 <- 0 edi
Error description	Monitoring for limit switch breakage, “iLS_DoorClosed”/”iLS_DoorOpened”
WinHMI, monitoring	 08:37:02 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC Faults 08.10.2002 08:23:02 MON ERROR: SFC: Drilling station / Bohrwerk ACTION: aMonitoringGlobal failure Rexroth Indramat Diagnosis Overview F2 ZOOM CNC fault F3 ZOOM SFC fault F4 ZOOM Faults F5 ZOOM Messages F6 Fault Logbook F7 Select Control F8 F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens
	Selection of the fault displayed; <Enter>
WinHMI, criteria analysis The rung is reduced to the contacts which have interrupted the activation.	 08:39:18 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station LD Missing Analysis Error Symbol SFC: Drilling station / Bohrwerk tor Network: aMonitoringGlobal Status: MON ERROR (*Limit switch monitoring "Safety door" / Endschalterüberwachung Sicherheitstür*) (*Limit switch 'Sa... · (*Limit switch 'S... · (*Control contact -... iLS_DoorClosed · iLS_DoorOpened · Demo_01.MonError iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten*) Rexroth Indramat 1 2 3 4 5 6 7 Info IL F2 All F3 Online F4 Absolute F5 F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens

After the Info key on the BTV has been pressed.



SFC: I_Step.Demo_01

tor Network: aMonitoringGlobal

Status: MON ERROR

iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten*)

Fig. 4-77: Advanced diagnosis up to the criteria analysis

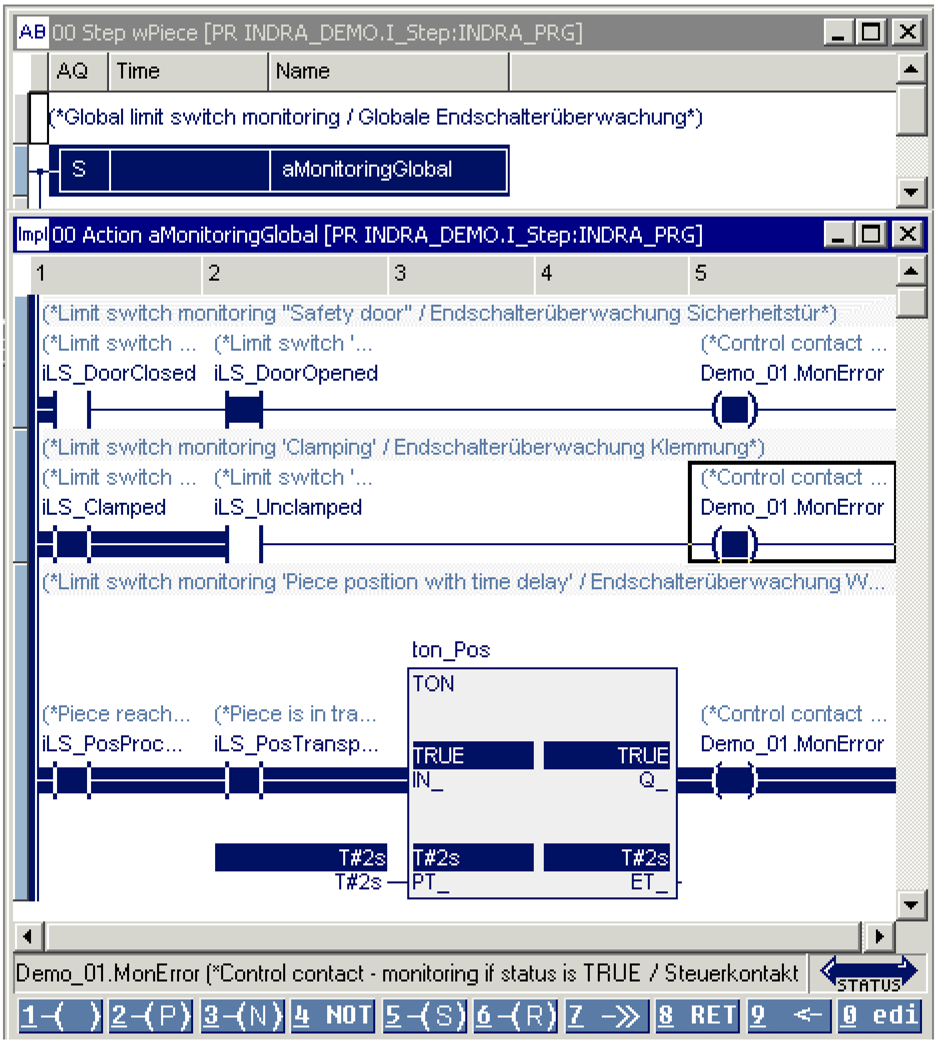
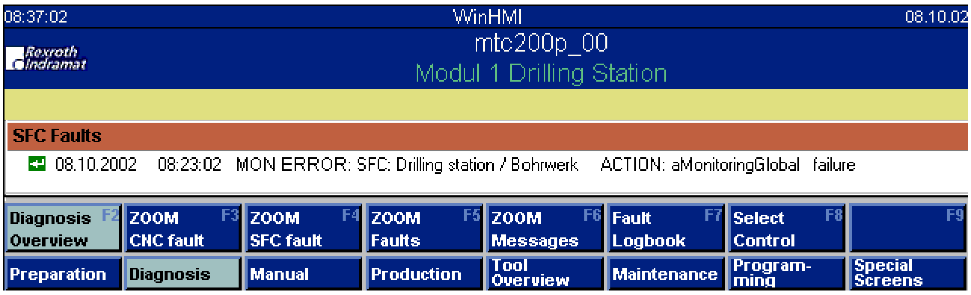
	Without Info key	With Info key
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	MON ERROR	MON ERROR
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Monitor NW:	Name of the action	Name of the action

Fig. 4-78: Additional information after the Info key of the BTV has been pressed

Delayed Error Monitoring (Global)

If the global limit switch monitoring function is used, the state or mode of the SFC is irrelevant.

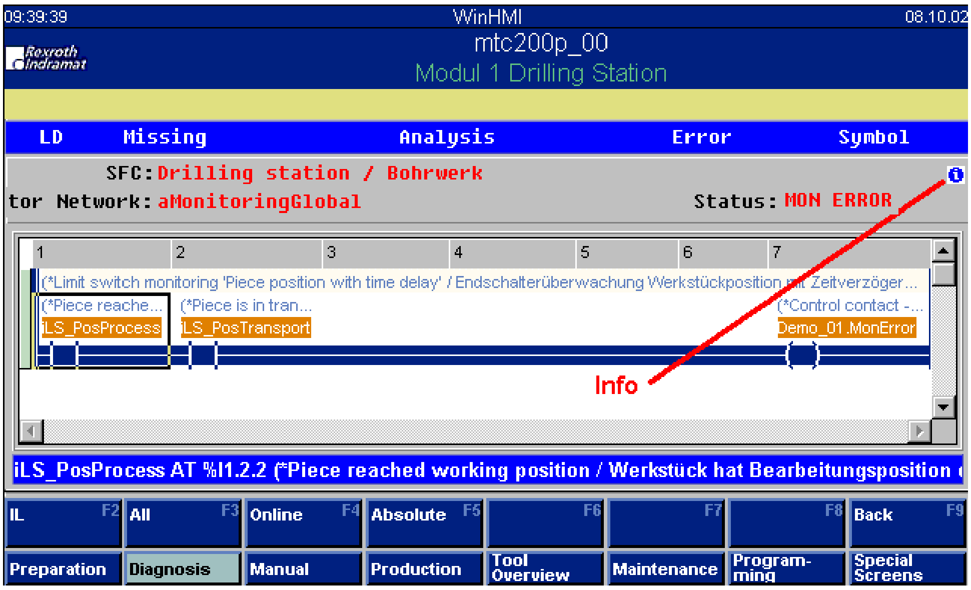
To achieve this, a **stored** action incorporating the limit switches to be monitored must be entered in the **initial step**.

Component	Representation
WinPCL, The initial step "wPiece" includes the stored action "aMonitoringGlobal", which incorporates all limit switch monitoring functions.	 AB 00 Step wPiece [PR INDRA_DEMO.I_Step:INDRA_PRG] AQ Time Name S aMonitoringGlobal Impl 00 Action aMonitoringGlobal [PR INDRA_DEMO.I_Step:INDRA_PRG] 1 2 3 4 5 (*Limit switch ... (*Limit switch '... (*Control contact ... iLS_DoorClosed iLS_DoorOpened Demo_01.MonError (*Limit switch ... (*Limit switch '... (*Control contact ... iLS_Clamped iLS_Unclamped Demo_01.MonError ton_Pos TON (*Piece reach... (*Piece is in tra... (*Control contact ... iLS_PosProc... iLS_PosTransp... Demo_01.MonError TRUE IN_ TRUE Q_ T#2s T#2s T#2s PT_ T#2s ET_ STATUS 1-( ) 2-(P) 3-(N) 4 NOT 5-(S) 6-(R) 7 ->> 8 RET 9 <- 0 edi (*Global limit switch monitoring / Globale Endschalterüberwachung*) (*Limit switch monitoring "Safety door" / Endschalterüberwachung Sicherheitstür*) (*Limit switch monitoring 'Clamping' / Endschalterüberwachung Klemmung*) (*Limit switch monitoring 'Piece position with time delay' / Endschalterüberwachung W... Demo_01.MonError (*Control contact - monitoring if status is TRUE / Steuerkontakt
Error description	Monitoring for limit switch breakage, "iLS_PosProcess"/"iLS_PosTransport" with delay time (limit switch ranges are intersecting)
WinHMI, monitoring	 08:37:02 WinHMI 08.10.02 Rexroth Indramat mtc200p_00 Modul 1 Drilling Station SFC Faults Diagnosis Overview F2 ZOOM CNC fault F3 ZOOM SFC fault F4 ZOOM Faults F5 ZOOM Messages F6 Fault Logbook F7 Select Control F8 F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens 08.10.2002 08:23:02 MON ERROR: SFC: Drilling station / Bohrwerk ACTION: aMonitoringGlobal failure
	Selection of the fault displayed; <Enter>

WinHMI, criteria analysis

The rung is reduced to the contacts which have interrupted the activation.

Caution!
The time stage is removed from the display in the criteria analysis.



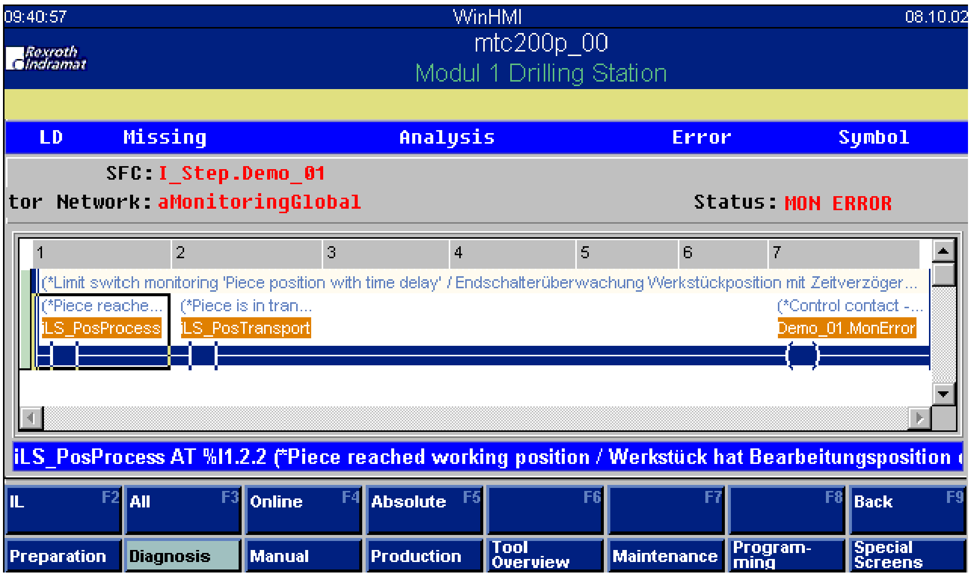
09:39:39 WinHMI 08.10.02
mtc200p_00
Modul 1 Drilling Station

SFC: Drilling station / Bohrwerk
tor Network: aMonitoringGlobal Status: MON ERROR

(*Limit switch monitoring 'Piece position with time delay' / Endschalterüberwachung Werkstückposition mit Zeitverzöger...
(*Piece reache... (*Piece is in tran... (*Control contact -...
iLS_PosProcess iLS_PosTransport Demo_01.MonError

iLS_PosProcess AT %I1.2.2 (*Piece reached working position / Werkstück hat Bearbeitungsposition

After the Info key on the BTV has been pressed.



09:40:57 WinHMI 08.10.02
mtc200p_00
Modul 1 Drilling Station

SFC: I_Step.Demo_01
tor Network: aMonitoringGlobal Status: MON ERROR

(*Limit switch monitoring 'Piece position with time delay' / Endschalterüberwachung Werkstückposition mit Zeitverzöger...
(*Piece reache... (*Piece is in tran... (*Control contact -...
iLS_PosProcess iLS_PosTransport Demo_01.MonError

iLS_PosProcess AT %I1.2.2 (*Piece reached working position / Werkstück hat Bearbeitungsposition

Fig. 4-79: Advanced diagnosis up to the criteria analysis

	Without Info key	**With Info key**
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	MON ERROR	MON ERROR
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Monitor NW:	Name of the action	Name of the action

Fig. 4-80: Additional information after the Info key of the BTV has been pressed

Note: FBs with the respectively topmost Boolean input and output can be removed from the display in connection with

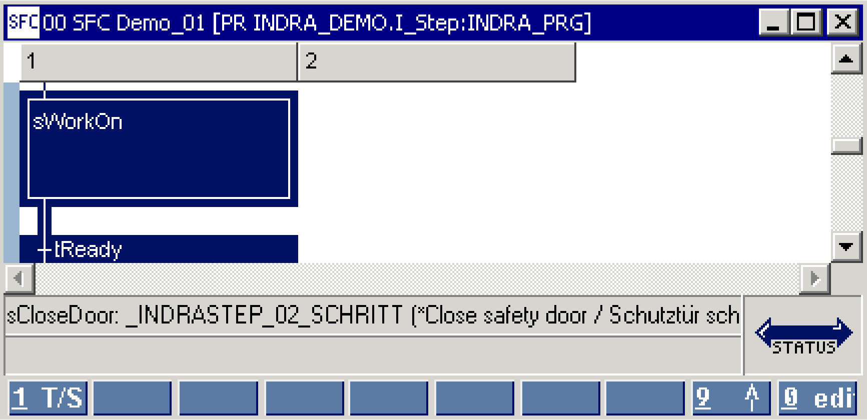
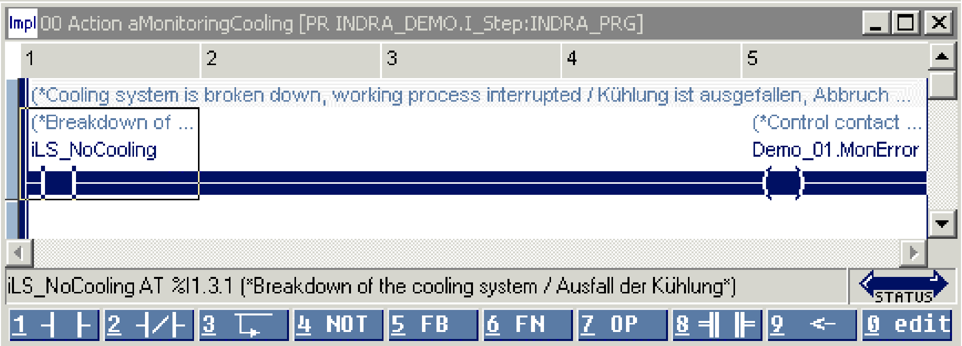
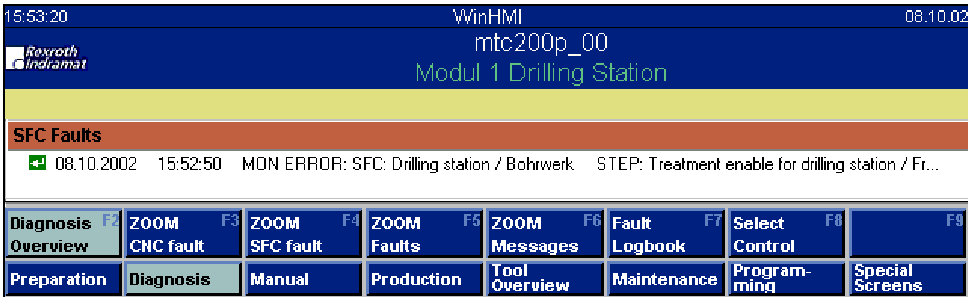
- <SFC name>.MonError
- <SFC name>.MonErrorFE

Error Monitoring (Local)

If an error can occur within the SFC in a specific step only, the monitoring function can be executed in this step by means of a non-stored action.

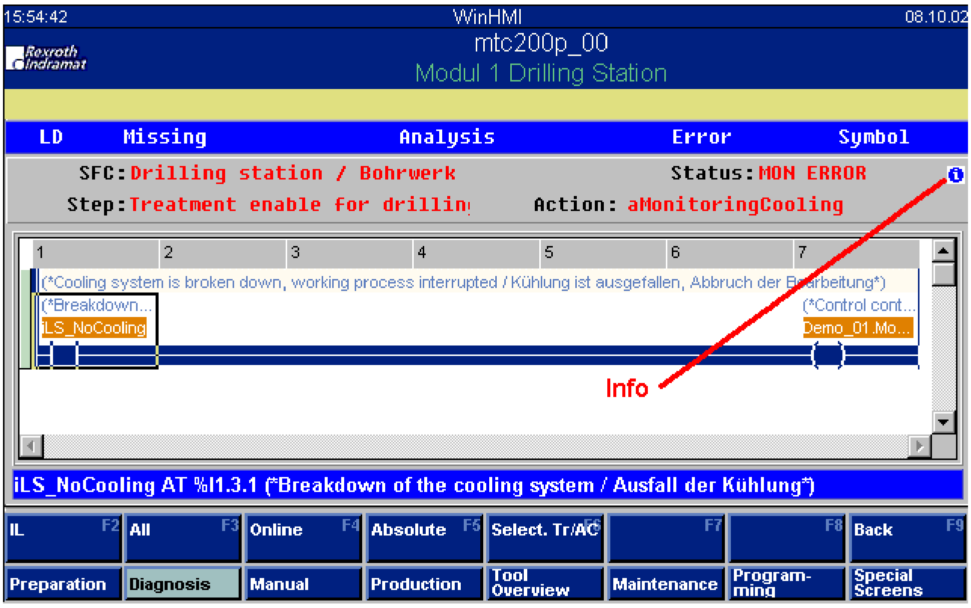
The error is exactly localized for the particular rung. The same action can be called in several steps. In case of an error, the step causing the error is also determined.

It is possible to program a time delay (also see the section on delayed error monitoring (global)).

Component	Representation
WinPCL, step “sWorkOn”, “Treatment enable for drilling station”	 SFC 00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG] 1 2 sWorkOn tReady sCloseDoor: _INDRASTEP_02_SCHRITT (*Close safety door / Schutztür sch STATUS 1 T/S 9 0 edi
Action “aMonitoringCooling” in the step “sWorkOn”	 Impl 00 Action aMonitoringCooling [PR INDRA_DEMO.I_Step:INDRA_PRG] 1 2 3 4 5 (*Cooling system is broken down, working process interrupted / Kühlung ist ausgefallen, Abbruch ... (*Breakdown of ... (*Control contact ... iLS_NoCooling Demo_01.MonError iLS_NoCooling AT %I1.3.1 (*Breakdown of the cooling system / Ausfall der Kühlung*) STATUS 1 ┤ ├ 2 ┤/├ 3 4 NOT 5 FB 6 FN 7 OP 8 ╡ ╞ 9 <- 0 edit
Error description	If the cooling unit fails, the SFC is stopped and an error message is displayed.
WinHMI, monitoring	 15:53:20 WinHMI 08.10.02 Rexroth Indramat mtc200p_00 Modul 1 Drilling Station SFC Faults 08.10.2002 15:52:50 MON ERROR: SFC: Drilling station / Bohrwerk STEP: Treatment enable for drilling station / Fr... Diagnosis Overview F2 · ZOOM CNC fault F3 · ZOOM SFC fault F4 · ZOOM Faults F5 · ZOOM Messages F6 · Fault Logbook F7 · Select Control F8 · F9 Preparation · Diagnosis · Manual · Production · Tool Overview · Maintenance · Program-ming · Special Screens
	Selection of the fault displayed; <Enter>

WinHMI, criteria analysis

The rung is reduced to the contact which has interrupted the activation.



SFC: Drilling station / Bohrwerk Status: MON ERROR

Step: Treatment enable for drillin Action: aMonitoringCooling

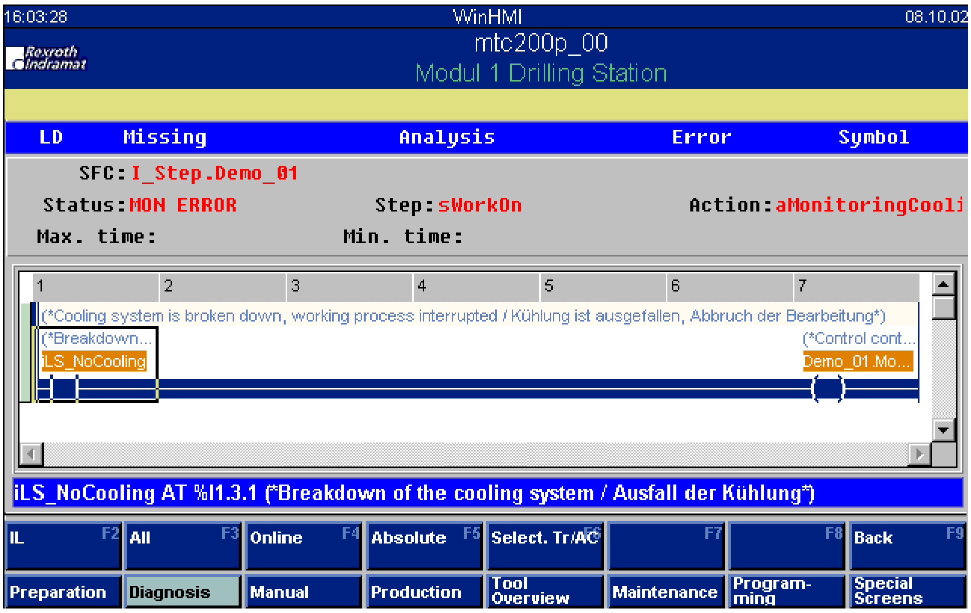
(*Cooling system is broken down, working process interrupted / Kühlung ist ausgefallen, Abbruch der Bearbeitung*)

(*Breakdown... (*Control cont...

iLS_NoCooling Demo_01.Mo...

iLS_NoCooling AT %I1.3.1 (*Breakdown of the cooling system / Ausfall der Kühlung*)

After the Info key on the BTV has been pressed.



SFC: I_Step.Demo_01

Status: MON ERROR Step: sWorkOn Action: aMonitoringCooli

Max. time: Min. time:

(*Cooling system is broken down, working process interrupted / Kühlung ist ausgefallen, Abbruch der Bearbeitung*)

(*Breakdown... (*Control cont...

iLS_NoCooling Demo_01.Mo...

iLS_NoCooling AT %I1.3.1 (*Breakdown of the cooling system / Ausfall der Kühlung*)

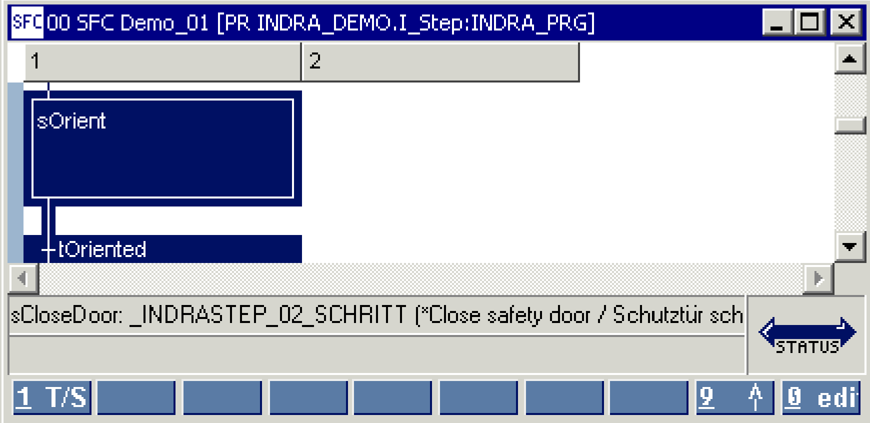
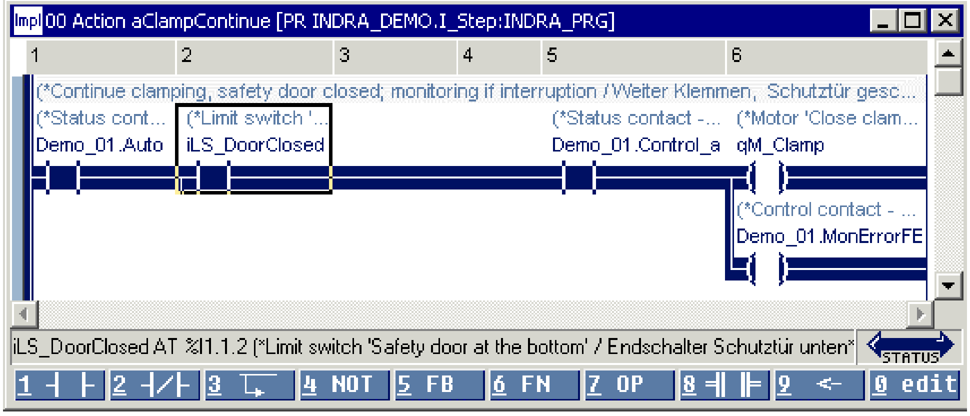
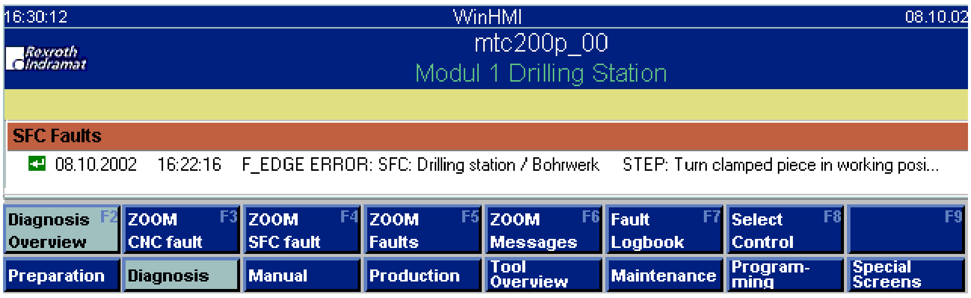
Fig. 4-81: Advanced diagnosis up to the criteria analysis

	Without Info key	**With Info key**
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	MON ERROR	MON ERROR
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Monitor NW:	Name of the action	Name of the action

Fig. 4-82: Additional information after the Info key of the BTV has been pressed

Dynamic Error Monitoring (MonErrorFE)

IndraStep permits to monitor output signals for being interrupted briefly.

Component	Representation
WinPCL, step "sOrient", "Turn clamped piece in working position"	 SFC 00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PRG] sOrient tOriented sCloseDoor: _INDRASTEP_02_SCHRITT (*Close safety door / Schutztür sch
Action "aClampContinue" in the step "sOrient" The action is used in other steps; objective: Detecting the step where the problem occurred.	 Impl 00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG] (*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür gesc... (*Status cont... Demo_01.Auto (*Limit switch '... iLS_DoorClosed (*Status contact -... Demo_01.Control_a (*Motor 'Close clam... qM_Clamp (*Control contact - ... Demo_01.MonErrorFE iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten* 1 2 3 4 5 6 STATUS 1 ┤├ 2 ┤/├ 3 4 NOT 5 FB 6 FN 7 OP 8 9 <- 0 edit
Error description	The safety door briefly opened "iLS_DoorClosed"; then the signal was stable again. Nevertheless, an error is generated and qM_Clamp is prevented from closing again.
WinHMI, falling edge error	 16:30:12 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC Faults 08.10.2002 16:22:16 F_EDGE ERROR: SFC: Drilling station / Bohrwerk STEP: Turn clamped piece in working posi... Rexroth Indramat Diagnosis Overview F2 ZOOM CNC fault F3 ZOOM SFC fault F4 ZOOM Faults F5 ZOOM Messages F6 Fault Logbook F7 Select Control F8 F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Program-ming Special Screens
	Selection of the fault displayed; <Enter>

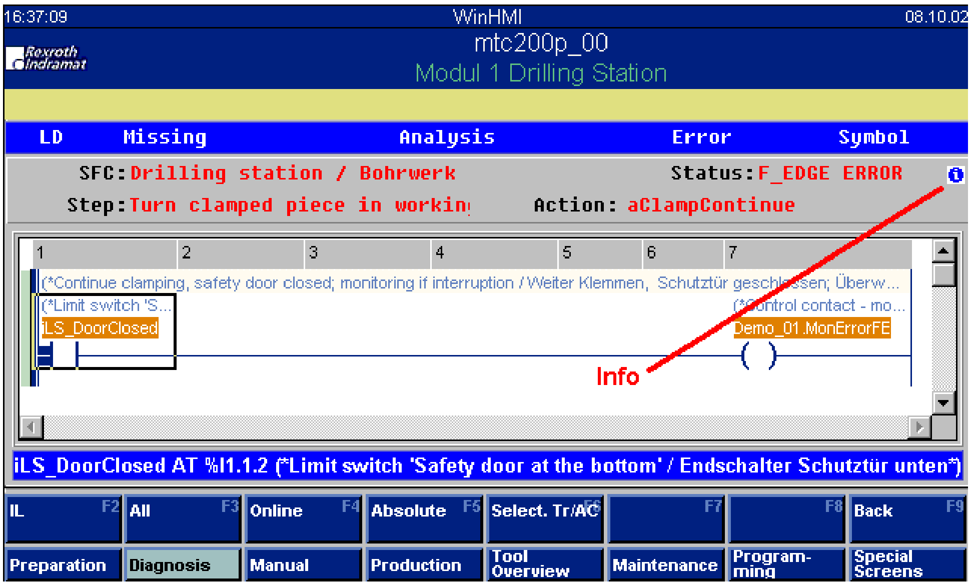
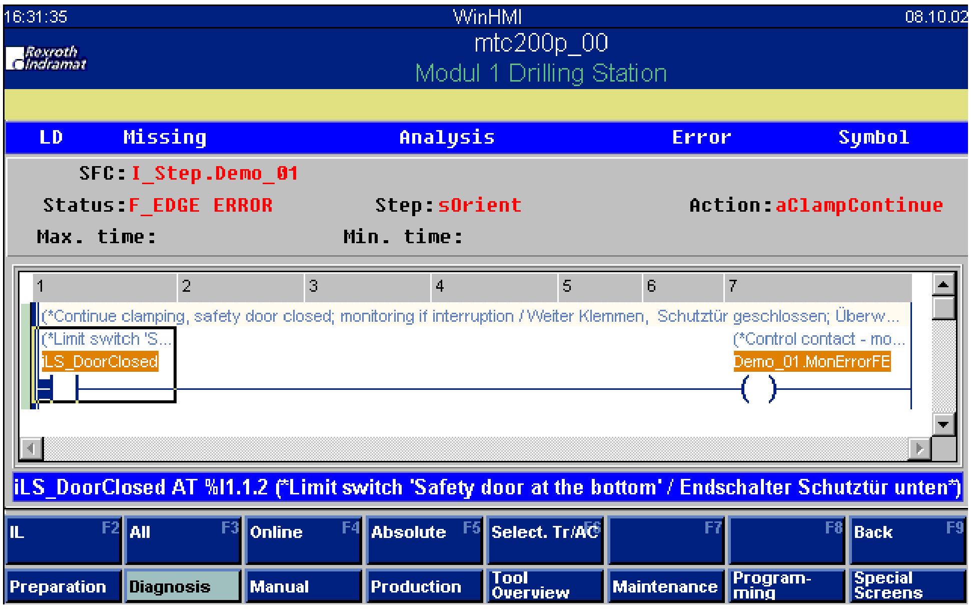
WinHMI, criteria analysis The rung is reduced to the contact which has interrupted the activation.	 16:37:09 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC: Drilling station / Bohrwerk Status: F_EDGE ERROR Step: Turn clamped piece in workin Action: aClampContinue (*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschlossen; Überw... (*Limit switch 'S... (*Control contact - mo... LS_DoorClosed Demo_01.MonErrorFE Info iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten*) Rexroth Indramat LD Missing Analysis Error Symbol 1 2 3 4 5 6 7 IL F2 All F3 Online F4 Absolute F5 Select. Tr/AC F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Programming Special Screens
After the Info key on the BTV has been pressed.	 16:31:35 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC: I_Step.Demo_01 Status: F_EDGE ERROR Step: sOrient Action: aClampContinue Max. time: Min. time: (*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschlossen; Überw... (*Limit switch 'S... (*Control contact - mo... LS_DoorClosed Demo_01.MonErrorFE iLS_DoorClosed AT %I1.1.2 (*Limit switch 'Safety door at the bottom' / Endschalter Schutztür unten*) Rexroth Indramat LD Missing Analysis Error Symbol 1 2 3 4 5 6 7 IL F2 All F3 Online F4 Absolute F5 Select. Tr/AC F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Programming Special Screens

Fig. 4-83: Advanced diagnosis up to the criteria analysis

	Without Info key	**With Info key**
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	FALLING EDGE ERROR	FALLING EDGE ERROR
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Monitor NW:	Name of the action	Name of the action

Fig. 4-84: Additional information after the Info key of the BTV has been pressed

4.6 AutoStep Mode

General Function

The **automatic single-step mode** is a special type of the **automatic mode** and is different in that switch-on from step to step must be enabled manually, in addition to the transition condition that must be fulfilled.

On actuation of **"i.AutoStep",** the automatic mode changes to the AutoStep mode.

If a *"transition condition"* following an active step is *"fulfilled"* and the transition variable *<transition name>.JOG = True,* **"q.WatiOnTrans"** is set without the old active step being left.

The following step is reached only, if **"i.Start"** is also actuated.

In this manner. the SFC can be run through step by step.

Note: The transition condition must, of course, still be fulfilled, if **"i.Start"** is to become effective.

Using <transition name>.JOG = FALSE

The initial value of the system variable "<transition name>.JOG" of all transitions is TRUE.

Hence, all transitions must be confirmed manually for switch-on.

The AutoStep mode can be accelerated if the JOG flags of those transitions which are to be run through without being confirmed manually are set to FALSE in the first action of their preceding step. In this case, the message **"q.WaitOnTrans"** and activation of the start signal are not applicable.

4.7 Manual Mode

Activation and Deactivation of the Manual Mode from the Automatic Mode

The automatic mode can be changed to the manual mode at any time by activating the signal "<SFC name>.i.Manual".

- The current step assignment is saved. The steps are deactivated.
- Actions with non-stored call are deactivated.
- Actions with stored call are still processed (limit switch monitoring in **"aMonitoringGlobal"**).

If the signal "<SFC name>.i.Manual" is deactivated again, the old step assignment is restored.

Changing the Step Assignment before Returning to the Automatic Mode

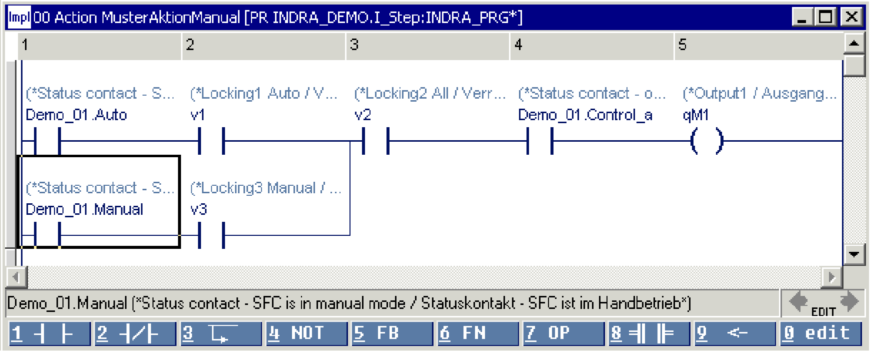
The step assignment can be changed if, in the manual mode, the desired steps are set (forced) with their variable <step name>.SYNC = TRUE and the variable <SFC name>.i.SetStep = TRUE is set. If the "<SFC name>.i.Manual" is now deactivated and the step assignment was valid, the automatic mode is continued at the desired assignment.

Supplementing the Manual Mode to the Example SFC

The actions which have been activated in the automatic mode before must be extended by the manual mode for the output elements to be controlled in the manual mode.

General Structure of an Action in the Manual and Automatic Modes

The mode support provides the following possibility of easily implementing the manual and automatic modes:



Impl 00 Action MusterAktionManual [PR INDRA_DEMO.I_Step:INDRA_PRG*]

Demo_01.Manual (*Status contact - SFC is in manual mode / Statuskontakt - SFC ist im Handbetrieb*)

Muster_Aktion_Manual.bmp

Fig. 4-85: Sample action with manual and automatic modes

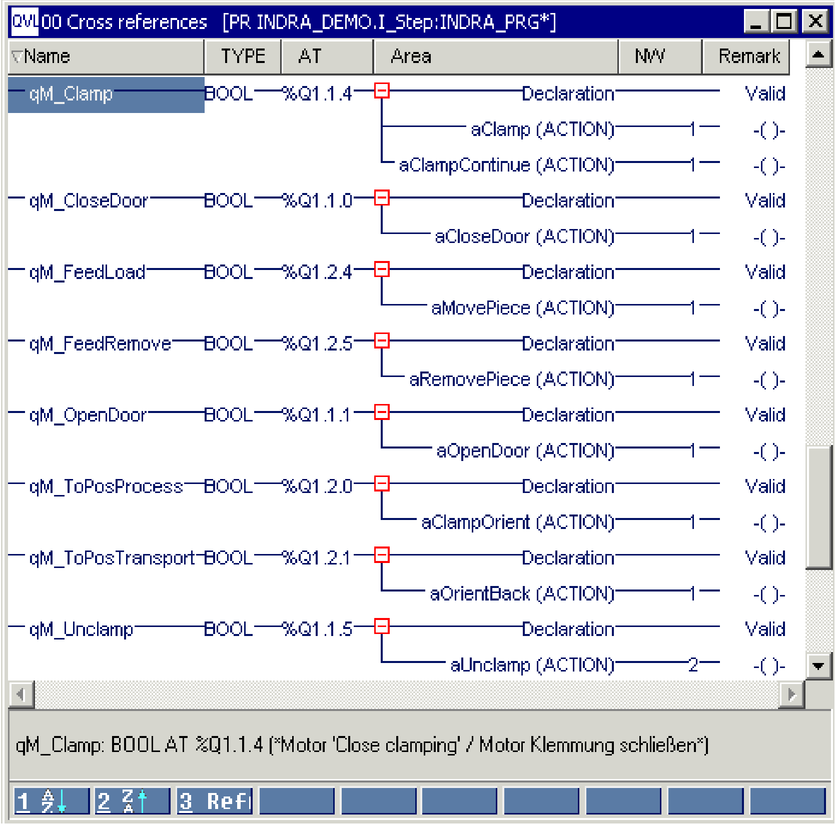
The meaning of the elements in Fig. 4-85 is as follows:

Element	Meaning	
<SFC name>.Auto here: demo_01.Auto	Status contact which is closed as long as the SFC is in the automatic mode	
v1 Activation Auto	Contacts which assume the task of activating output qM1 in the **automatic mode** 0…n contacts	
v2 Activation in general	Contacts which assume the task of activating output qM1 in **all modes** 0…m contacts	
<SFC name>.Control_* here: demo_01.Control_*	<SFC name>.Control_a	Status contact - opens on action end, stop, error, and in case of the AutoStep mode with AutoStepEnable
	<SFC name>.Control_b	Status contact - opens at the end of the action (analogously <action name>.Q)
	<SFC name>.Control_c	Status contact - function same as for Control_a, with additional diagnosis if the logic result before the contact is FALSE
<SFC name>.Manual here: demo_01.Manual	Status contact which is closed as long as the SFC is in the manual mode	
v3 Activation Manual	Contacts which assume the task of activating output qM1 in the **manual mode** 0…p contacts	

Fig. 4-86: Elements of the sample action

Note: If the user needs a third branch for the "AutoStep" mode, then this branch must be generated ***after*** the **"<SFC name>.Auto"** contact. This is caused by the criteria analysis which can, up to now, only differentiate between automatic mode and manual mode.

These elements can be determined by means of the cross-reference list:



Name	TYPE	AT	Area	N/W	Remark
qM_Clamp	BOOL	%Q1.1.4	Declaration		Valid
			aClamp (ACTION)	1	-( )-
			aClampContinue (ACTION)	1	-( )-
qM_CloseDoor	BOOL	%Q1.1.0	Declaration		Valid
			aCloseDoor (ACTION)	1	-( )-
qM_FeedLoad	BOOL	%Q1.2.4	Declaration		Valid
			aMovePiece (ACTION)	1	-( )-
qM_FeedRemove	BOOL	%Q1.2.5	Declaration		Valid
			aRemovePiece (ACTION)	1	-( )-
qM_OpenDoor	BOOL	%Q1.1.1	Declaration		Valid
			aOpenDoor (ACTION)	1	-( )-
qM_ToPosProcess	BOOL	%Q1.2.0	Declaration		Valid
			aClampOrient (ACTION)	1	-( )-
qM_ToPosTransport	BOOL	%Q1.2.1	Declaration		Valid
			aOrientBack (ACTION)	1	-( )-
qM_Unclamp	BOOL	%Q1.1.5	Declaration		Valid
			aUnclamp (ACTION)	2	-( )-

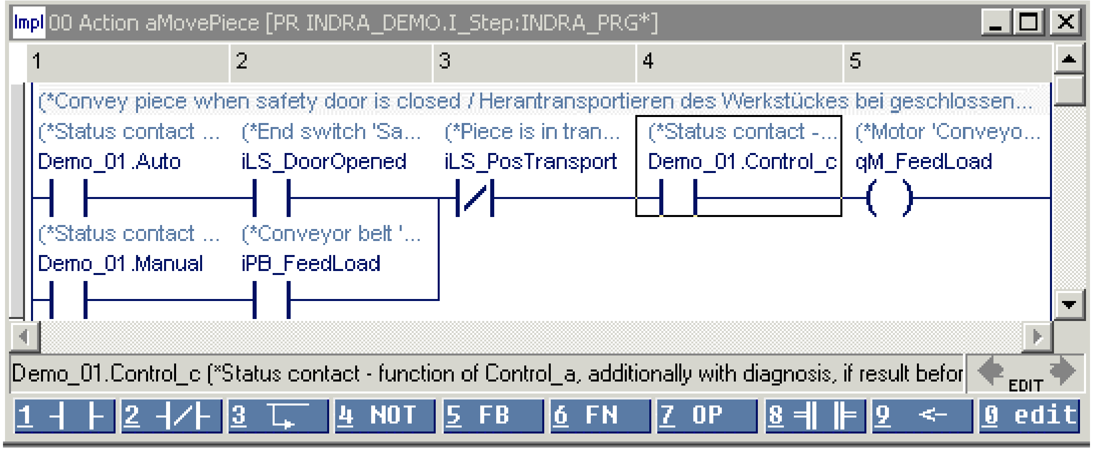
qM_Clamp: BOOL AT %Q1.1.4 (*Motor 'Close clamping' / Motor Klemmung schließen*)

qvl_ausgaenge.bmp

Fig. 4-87: Cross-reference list for determining the assignment of outputs

The actions are now extended by the necessary contacts:

aMovePiece - qM_FeedLoad



(*Convey piece when safety door is closed / Herantransportieren des Werkstückes bei geschlossen...

(*Status contact ... Demo_01.Auto — (*End switch 'Sa... iLS_DoorOpened — (*Piece is in tran... iLS_PosTransport — (*Status contact -... Demo_01.Control_c — (*Motor 'Conveyo... qM_FeedLoad

(*Status contact ... Demo_01.Manual — (*Conveyor belt '... iPB_FeedLoad

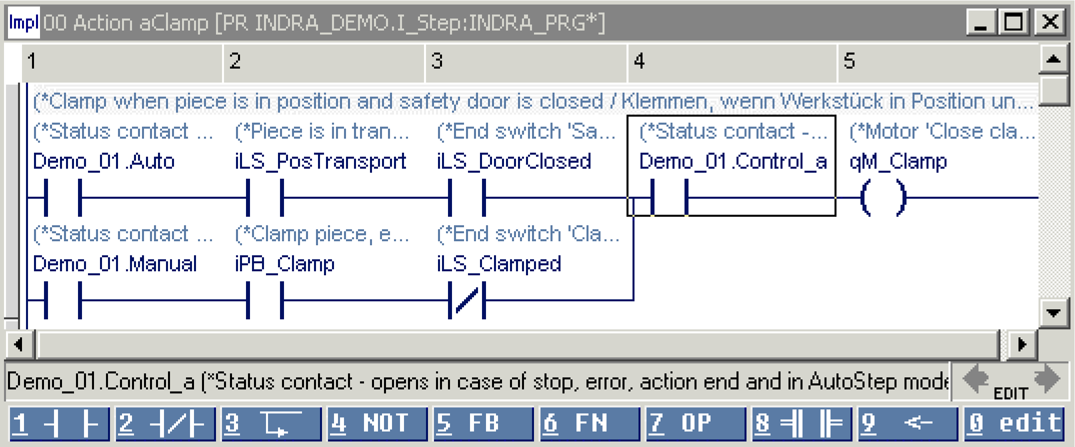
Demo_01.Control_c (*Status contact - function of Control_a, additionally with diagnosis, if result befor

aMovePiece-qM_FeedLoad.bmp

Fig. 4-88: Extension of **“aMovePiece” - “qM_FeedLoad”**

“iPB_FeedLoad” - enabling the supply conveyor belt

aClamp - qM_Clamp



Demo_01.Control_a (*Status contact - opens in case of stop, error, action end and in AutoStep mode

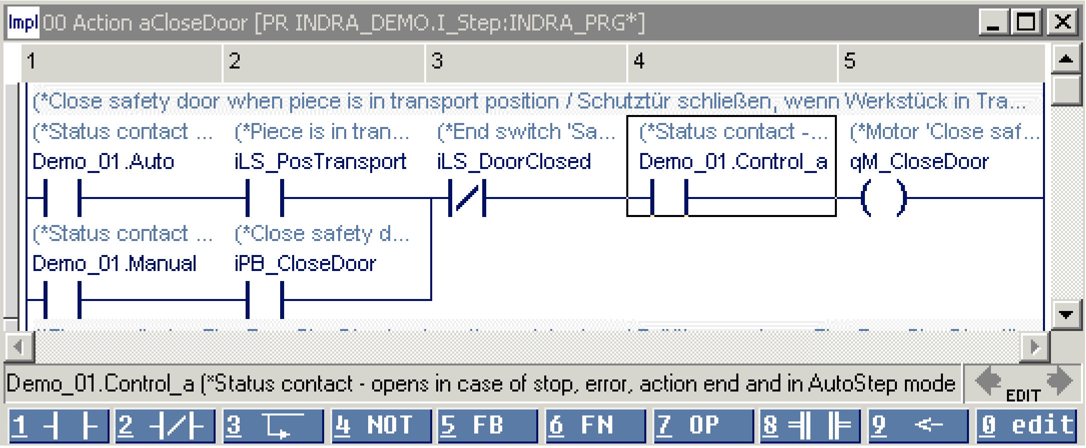
aClamp_qM_Clamp.bmp

Fig. 4-89: Extension of **"aClamp" - "qM_Clamp"**

"iPB_Clamp" - enable signal for **"qM_Clamp"**

"iLS_Clamped" - limit switch if the workpiece is clamped.

aCloseDoor - qM_CloseDoor



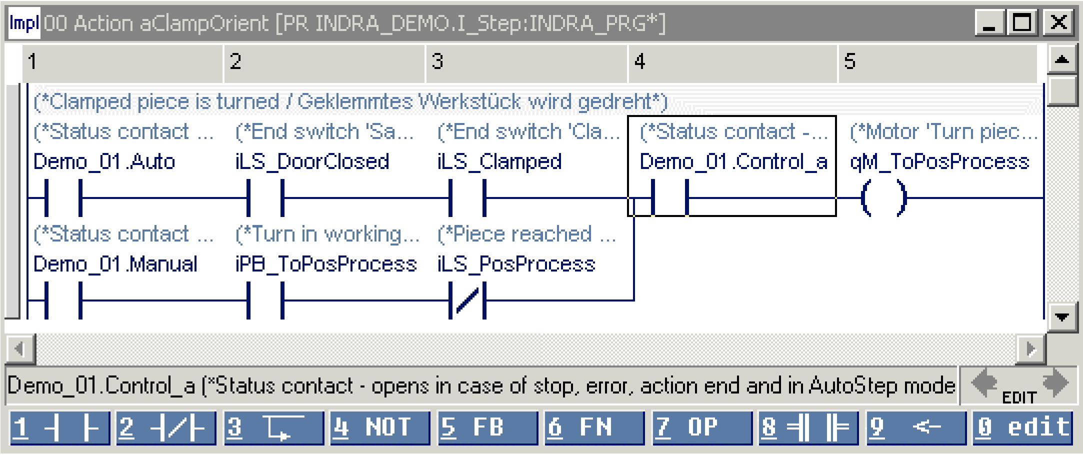
Demo_01.Control_a (*Status contact - opens in case of stop, error, action end and in AutoStep mode

aCloseDoor_qM_CloseDoor.bmp

Fig. 4-90: Extension of **"aCloseDoor" - "qM_CloseDoor"**

"iPB_CloseDoor" - enable signal for **"qM_CloseDoor"**

aClampOrient - qM_ToPosProcess



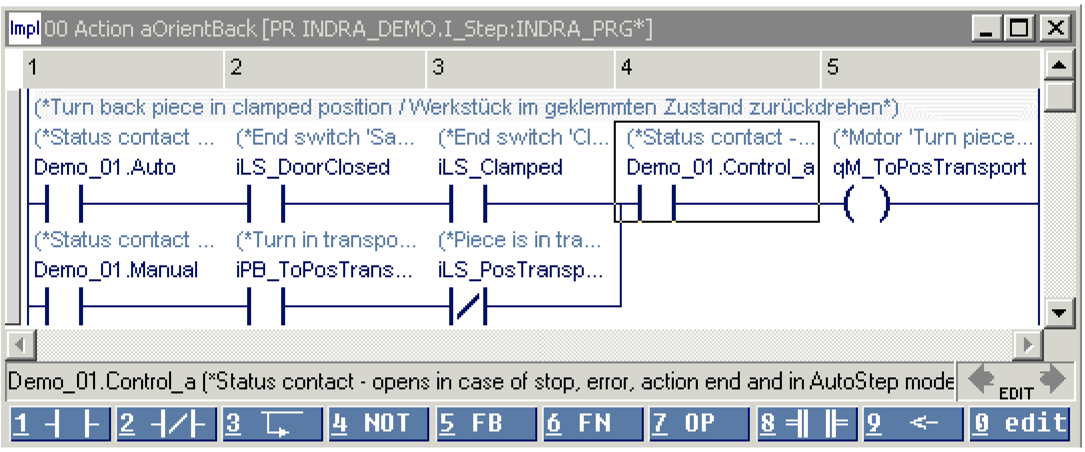
aClampOrient_qM_ToPosProcess.bmp

Fig. 4-91: Extension of **“aClampOrient” - “qM_ToPosProcess”**

“iPB_ToPosProcess” - enable signal for **“qM_ToPosProcess”**

“iLS_PosProcess” - limitation of the movement (machining position)

aOrientBack - qM_ToPosTransport



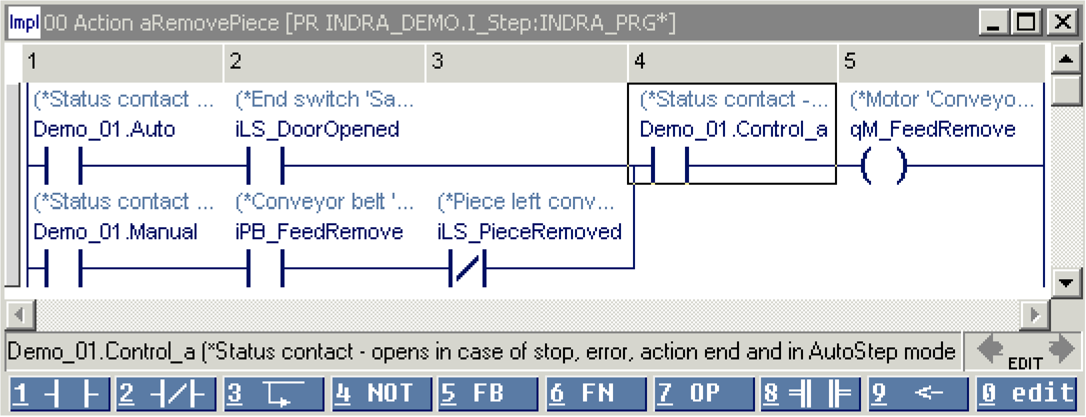
aOrientBack_qM_ToPosTransport.bmp

Fig. 4-92: Extension to **“aOrientBack” - “qM_ToPosTransport”**

“iPB_ToPosTransport” - enable signal for **“qM_ToPosTransport”**

“iLS_PosTransport” - limitation of the movement (transport position)

aRemovePiece - qM_FeedRemove



Demo_01.Control_a (*Status contact - opens in case of stop, error, action end and in AutoStep mode

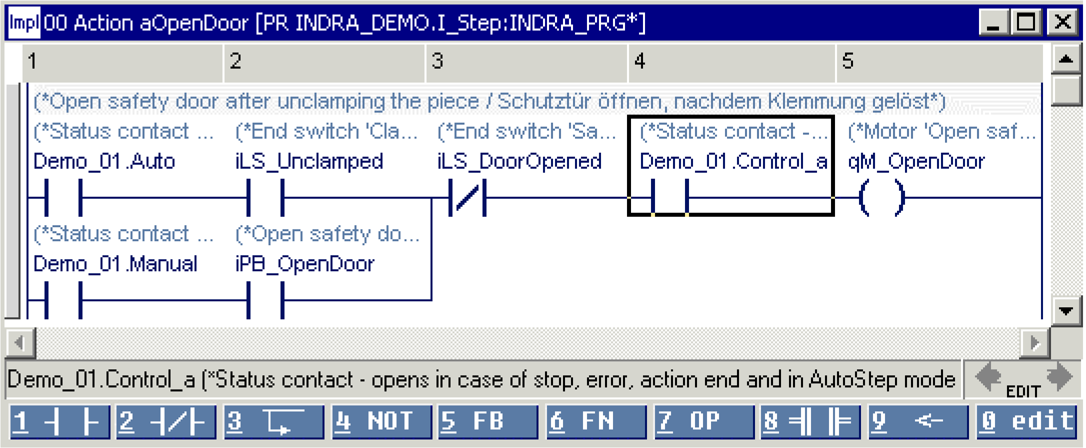
aRemovePiece_qM_FeedRemove.bmp

Fig. 4-93: Extension to **“aRemovePiece” - “qM_FeedRemove”**

“iPB_FeedRemove” - enabling the removal conveyor belt

“iLS_PieceRemoved” - workpiece not yet removed

aOpenDoor - qM_OpenDoor



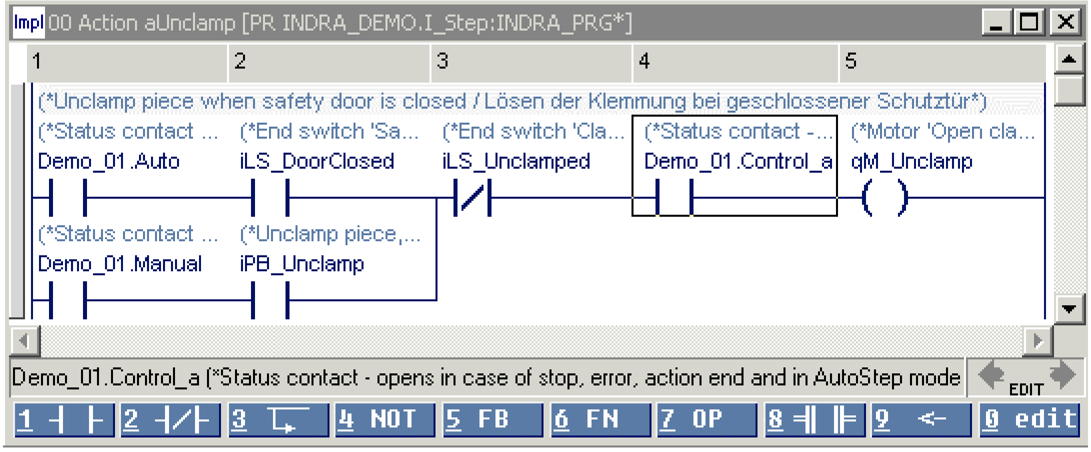
Demo_01.Control_a (*Status contact - opens in case of stop, error, action end and in AutoStep mode

aOpenDoor_qM_OpenDoor.bmp

Fig. 4-94: Extension to **“aOpenDoor” - “qM_OpenDoor”**

“iPB_OpenDoor” - enable signal for **“qM_OpenDoor”**

aUnclamp - qM_Unclamp



Demo_01.Control_a (*Status contact - opens in case of stop, error, action end and in AutoStep mode

aUnclamp_qM_UnClamp.bmp

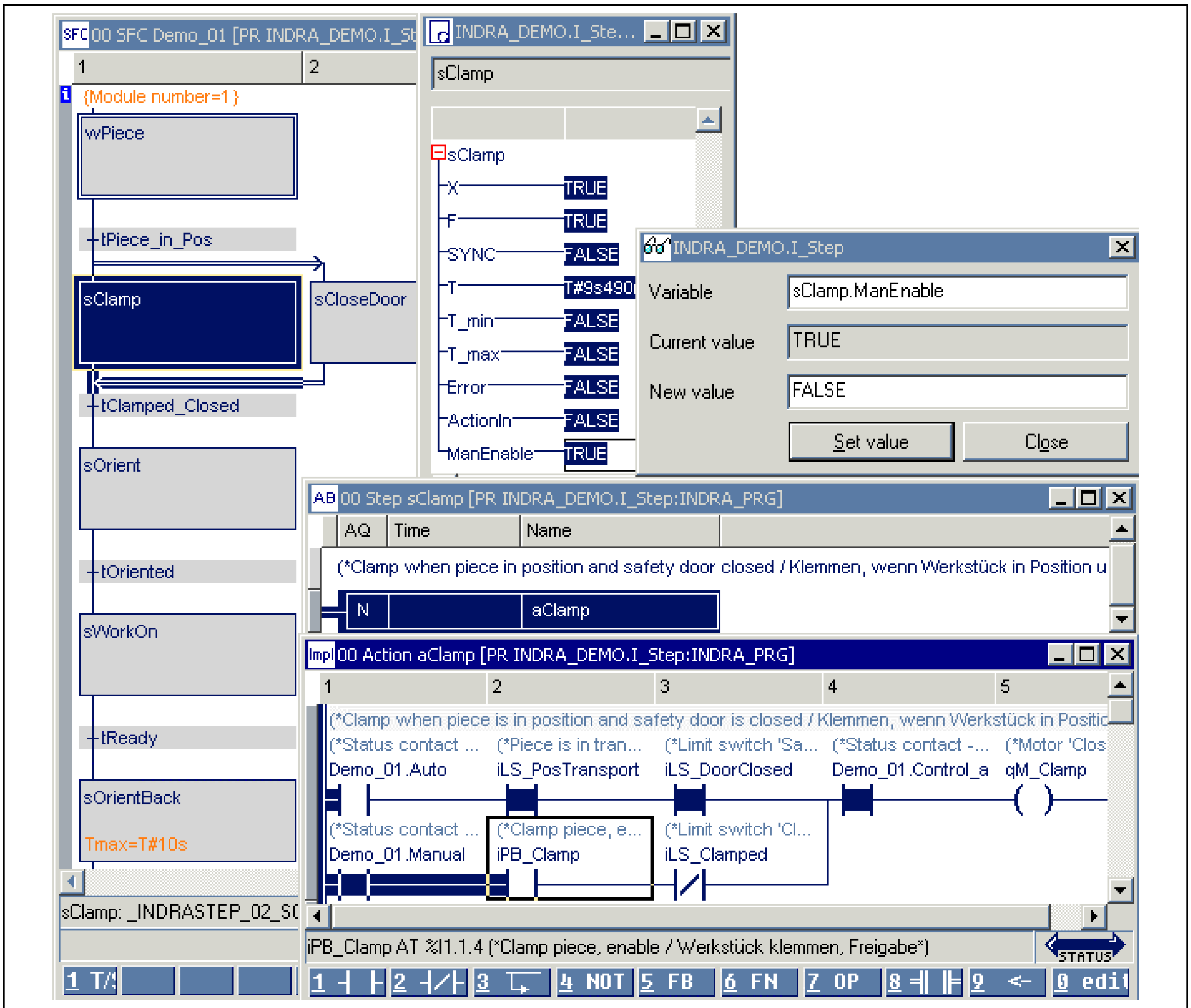
Fig. 4-95: **"aUnclamp" - "qM_Unclamp"**

"iPB_Unclamp" - enable signal for **"qM_Unclamp"**

Activating Outputs by Forcing Steps and/or Actions in the Manual Mode

Variables, steps and actions are always activated by the user in the manual mode.

Processing, however, is still pending as long as the step has neither been forced (setting of the <step name>.F) nor been activated otherwise for the manual mode. Setting the <step name>.ManEnable initiates setting of the <step name>.F.



sClamp

- X TRUE
- F TRUE
- SYNC FALSE
- T T#9s490
- T_min FALSE
- T_max FALSE
- Error FALSE
- ActionIn FALSE
- ManEnable TRUE

INDRA_DEMO.I_Step

Variable: sClamp.ManEnable

Current value: TRUE

New value: FALSE

Set value | Close

(*Clamp when piece in position and safety door closed / Klemmen, wenn Werkstück in Position u

(*Clamp when piece is in position and safety door is closed / Klemmen, wenn Werkstück in Positic

(*Status contact ... Demo_01.Auto — (*Piece is in tran... iLS_PosTransport — (*Limit switch 'Sa... iLS_DoorClosed — (*Status contact -... Demo_01.Control_a — (*Motor 'Clos qM_Clamp

(*Status contact ... Demo_01.Manual — (*Clamp piece, e... iPB_Clamp — (*Limit switch 'Cl... iLS_Clamped

iPB_Clamp AT %I1.1.4 (*Clamp piece, enable / Werkstück klemmen, Freigabe*)

Manual_Clamp_00.bmp

Fig. 4-96: Forcing the step **“sClamp”** via **“sClamp.ManEnable”**

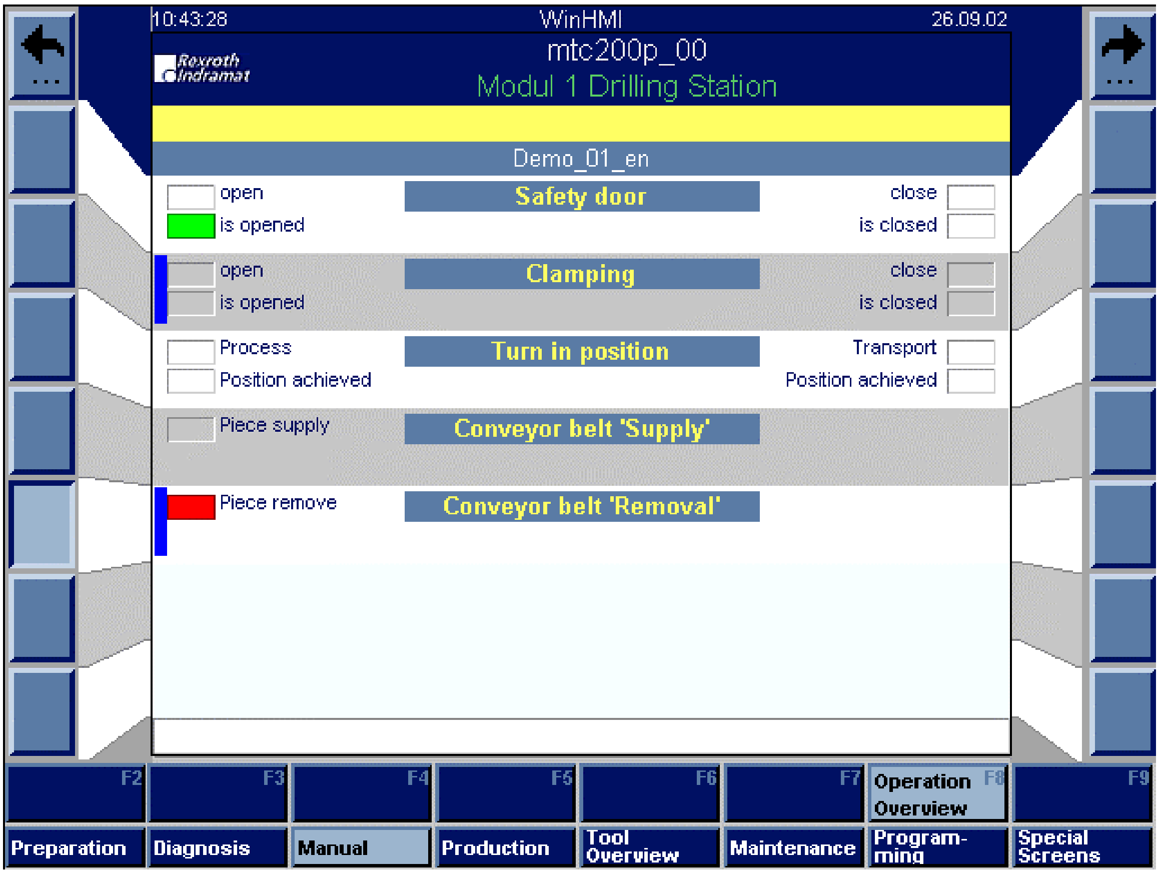
Now, activation of the motor **“qM_Clamp”** only depends on enabling **“iPB_Clamp”.**

Note: **“sClamp.ManEnable”** can be enabled by:

- forcing the variables (do not forget deactivation after having used them!),
- activation by pressing an M-key using an operator terminal,
- activation via a compact operator terminal.

Activating Outputs via Operating Screens in the Manual Mode

WinHMI permits to design operating screens which can be used in connection with machine function keys to control the output signals.



Bedienbild_00.bmp

L2:	Safety door	Open safety door (transparent), motor not activated; Is open (green); limit switch in end position.
L3:	Clamping	Motion instruction (blue) for clamping open (transparent), motor not activated; is open (transparent); limit switch open.
L6:	Conveyor belt Removal	Motion instruction (blue) given for transport; Material transport (red) pressed via M-key L6.

Fig. 4-97: Operating screen for controlling the example in the manual mode

Preparing the Use of the Operating Screens in WinHMI

Loading the Archive "HMI_SPS.APV"

All data types and function blocks required for implementing the process connection between WinHMI and the PLC are comprised in the PLC archive "HMI_SPS.APV" .

The archive must be loaded once to the WinPCL programming system using *"File / Archive / Load archive…"*. The archive resides in the

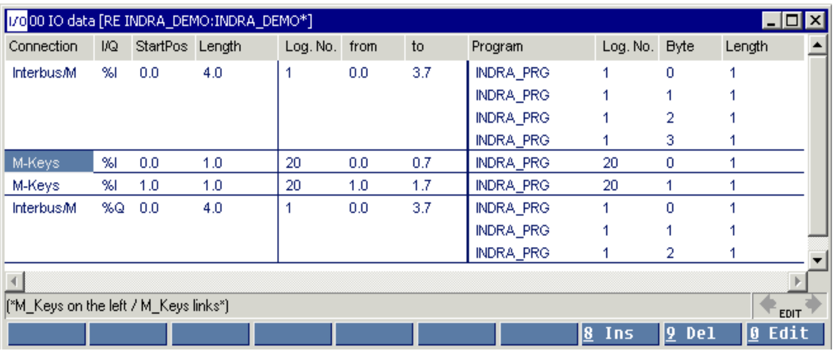
Drive:\Programme\Indramat\Mtgui\Basicdata\templates

folder.

Note: This step is, of course, not applicable, if it has already been implemented in connection with the diagnosis functions (preparing the use of the diagnosis functions in WinHMI)!

Supplementing the Declaration by the Necessary Variables / Instances for Activation of the Operating Screens

The connections to the machine function keys (M-keys) must be entered in the IO table of the resource.



I/O 00 IO data [RE INDRA_DEMO:INDRA_DEMO*]

Connection	I/Q	StartPos	Length	Log. No.	from	to	Program	Log. No.	Byte	Length
Interbus/M	%I	0.0	4.0	1	0.0	3.7	INDRA_PRG	1	0	1
							INDRA_PRG	1	1	1
							INDRA_PRG	1	2	1
							INDRA_PRG	1	3	1
M-Keys	%I	0.0	1.0	20	0.0	0.7	INDRA_PRG	20	0	1
M-Keys	%I	1.0	1.0	20	1.0	1.7	INDRA_PRG	20	1	1
Interbus/M	%Q	0.0	4.0	1	0.0	3.7	INDRA_PRG	1	0	1
							INDRA_PRG	1	1	1
							INDRA_PRG	1	2	1

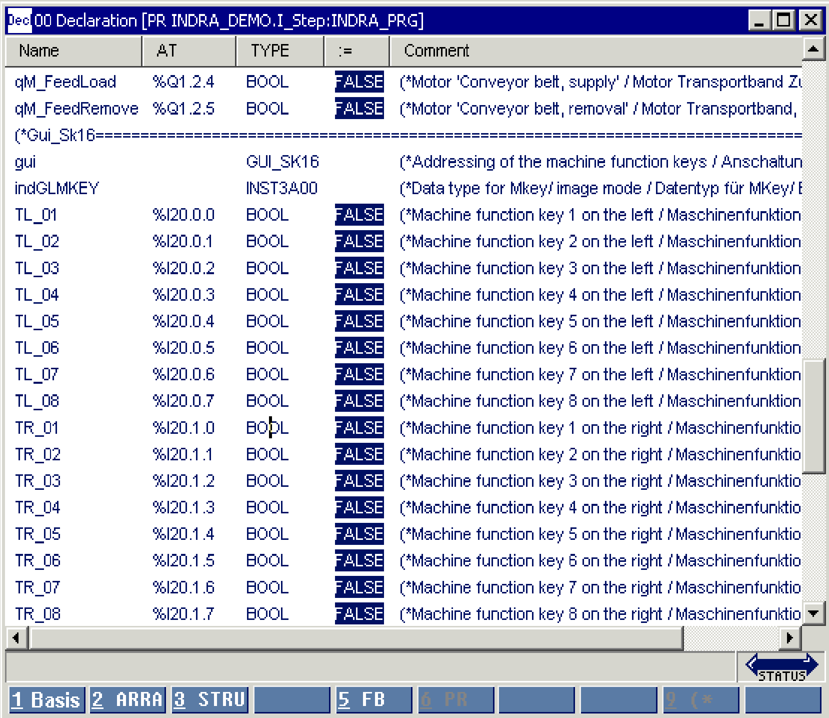
(*M_Keys on the left / M_Keys links*)

IO_Tafel_00.bmp

Interbus-M: Inputs and outputs of the DEA box via Interbus modules
M-keys: Connection of the machine function keys to the left and right

Fig. 4-98: IO table of the resource of the example

The declaration part is the next to be extended.



Dec 00 Declaration [PR INDRA_DEMO.I_Step:INDRA_PRG]

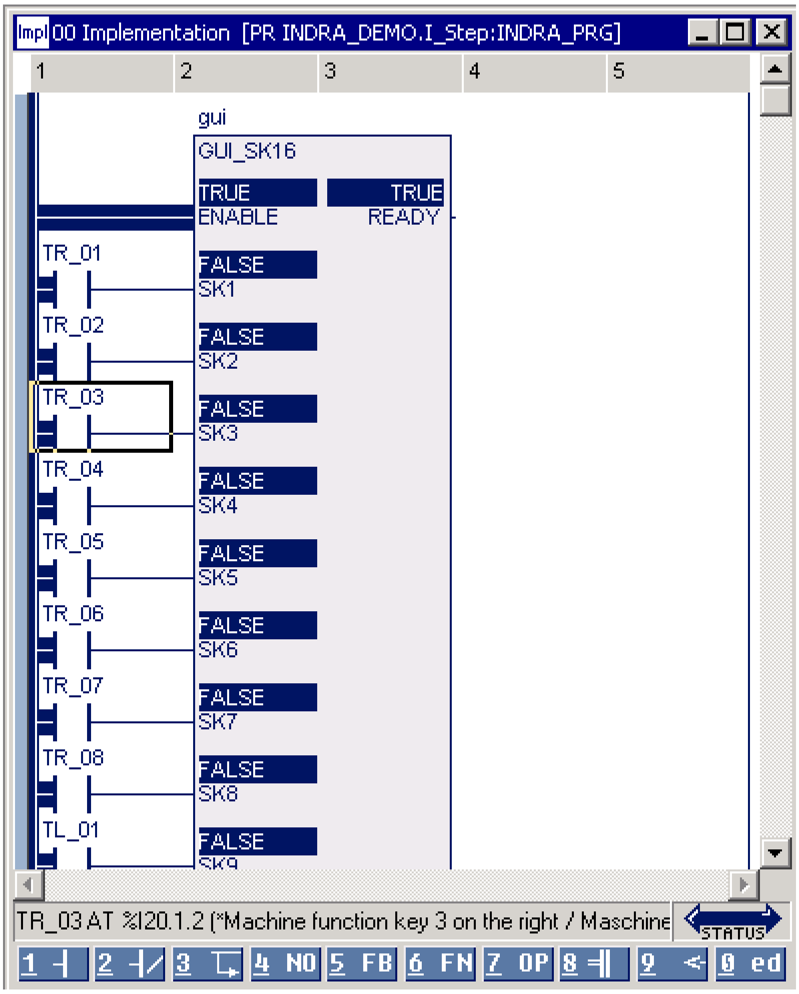
Name	AT	TYPE	:=	Comment
qM_FeedLoad	%Q1.2.4	BOOL	FALSE	(*Motor 'Conveyor belt, supply' / Motor Transportband Zu
qM_FeedRemove	%Q1.2.5	BOOL	FALSE	(*Motor 'Conveyor belt, removal' / Motor Transportband,
(*Gui_Sk16==				
gui		GUI_SK16		(*Addressing of the machine function keys / Anschaltun
indGLMKEY		INST3A00		(*Data type for Mkey/ image mode / Datentyp für MKey/ E
TL_01	%I20.0.0	BOOL	FALSE	(*Machine function key 1 on the left / Maschinenfunktion
TL_02	%I20.0.1	BOOL	FALSE	(*Machine function key 2 on the left / Maschinenfunktion
TL_03	%I20.0.2	BOOL	FALSE	(*Machine function key 3 on the left / Maschinenfunktion
TL_04	%I20.0.3	BOOL	FALSE	(*Machine function key 4 on the left / Maschinenfunktion
TL_05	%I20.0.4	BOOL	FALSE	(*Machine function key 5 on the left / Maschinenfunktion
TL_06	%I20.0.5	BOOL	FALSE	(*Machine function key 6 on the left / Maschinenfunktion
TL_07	%I20.0.6	BOOL	FALSE	(*Machine function key 7 on the left / Maschinenfunktion
TL_08	%I20.0.7	BOOL	FALSE	(*Machine function key 8 on the left / Maschinenfunktion
TR_01	%I20.1.0	BOOL	FALSE	(*Machine function key 1 on the right / Maschinenfunktio
TR_02	%I20.1.1	BOOL	FALSE	(*Machine function key 2 on the right / Maschinenfunktio
TR_03	%I20.1.2	BOOL	FALSE	(*Machine function key 3 on the right / Maschinenfunktio
TR_04	%I20.1.3	BOOL	FALSE	(*Machine function key 4 on the right / Maschinenfunktio
TR_05	%I20.1.4	BOOL	FALSE	(*Machine function key 5 on the right / Maschinenfunktio
TR_06	%I20.1.5	BOOL	FALSE	(*Machine function key 6 on the right / Maschinenfunktio
TR_07	%I20.1.6	BOOL	FALSE	(*Machine function key 7 on the right / Maschinenfunktio
TR_08	%I20.1.7	BOOL	FALSE	(*Machine function key 8 on the right / Maschinenfunktio

Bedienbild_Dekl_00.bmp

gui: GUI_SK16, FB instance for connecting the M-keys to the PLC
indGLMKEY: INST3A00, memory cells for the operation modes of the screen
TL_01. TL_08: Machine function keys, to the left of the operating screen
TR_01.TR_08: Machine function keys, to the right of the operating screen

Fig. 4-99: Extension of the declaration part of the example program

The next step is to assign the M-keys in the implementation of the example program.



TR_03 AT %I20.1.2 (*Machine function key 3 on the right / Maschine

Bedienbild_Impl_00.bmp

Fig. 4-100: Connection of the M-keys to the module for operating screens (1st rung in the program)

Note: The extensions in the IO table and in the declaration part as well as the entry of the GUI_SK16 instance and the connection of the M-keys are independent of the example and can be applied to the root program.

Creating the Operating Screen

The complete creation of the operating screen goes beyond the scope of this description. For that reason, only the “Clamping”, M-key “L3” “open” and “is opened” areas as well as the motion instruction will be treated here. Please refer to /2/ for a detailed description of screen creation.

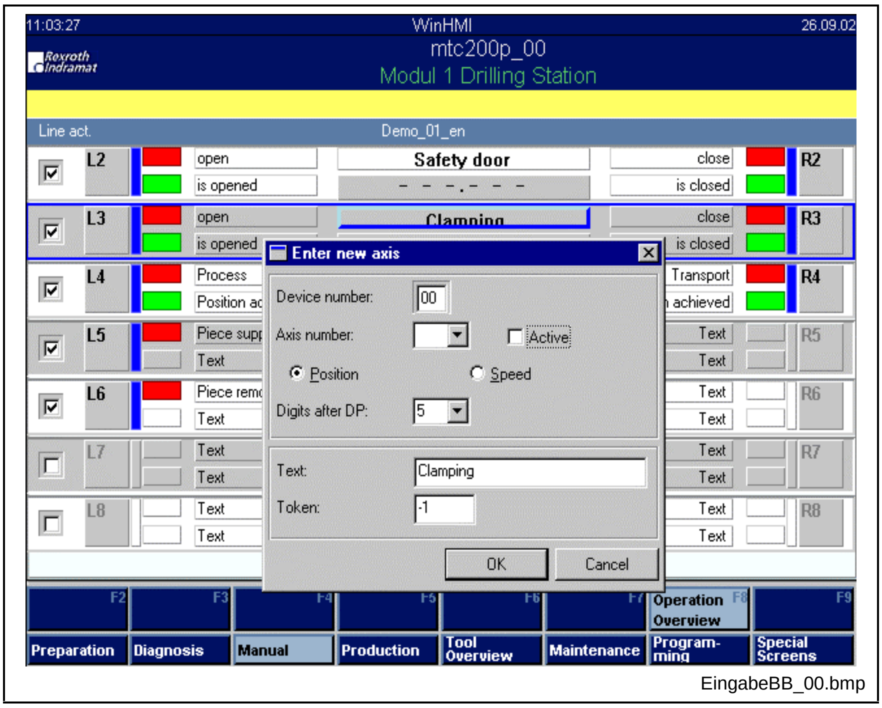
The entered operating screen is always bound to a control number. It can be executed in one language by defined texts or in several languages via token number and text files.

The texts are residing in “HMI_Manual_en.text”,

Drive:\Programme\Indramat\MTGUI\Project_000\CustomData\TEXT\EN

or the appropriate language folder.

“Clamping” Text



Enter new axis

Device number: 00

Axis number:

□ Active

● Position ○ Speed

Digits after DP: 5

Text: Clamping

Token: -1

EingabeBB_00.bmp

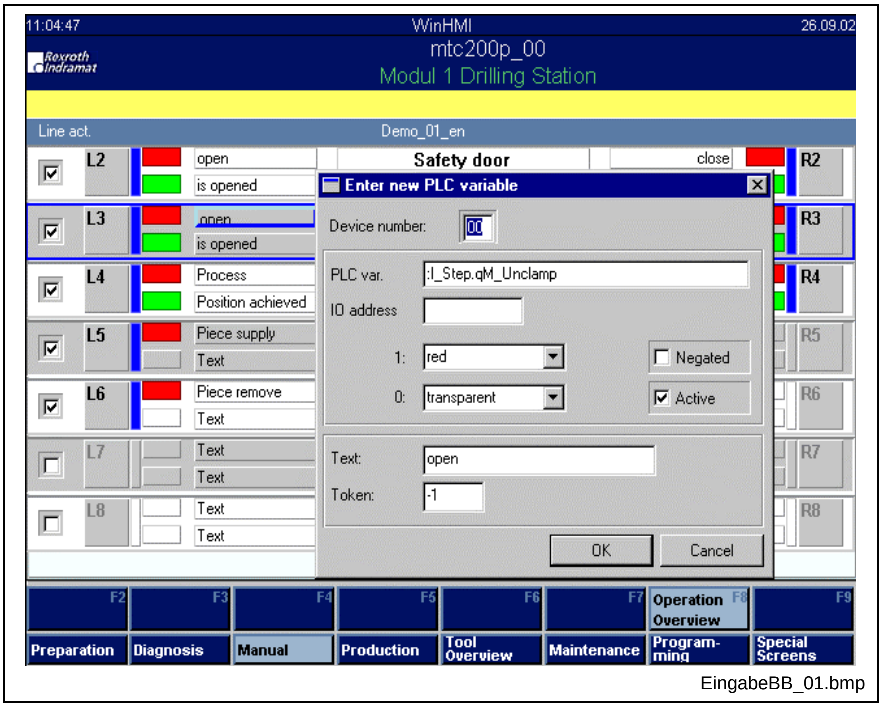
Fig. 4-101: “Clamping” entry

Enter the number of the control “00”.

Axis specifications are not applicable.

“Clamping” is entered as a defined text.

“Open” Text



Enter new PLC variable

Device number: 00

PLC var.: :I_Step.qM_Unclamp

IO address:

1: red □ Negated

0: transparent ☑ Active

Text: open

Token: -1

EingabeBB_01.bmp

Fig. 4-102: “Open” entry

Enter the number of the control “00”.

The name of the PLC variable **“:I_Step.qM_Unclamp”** consists of:

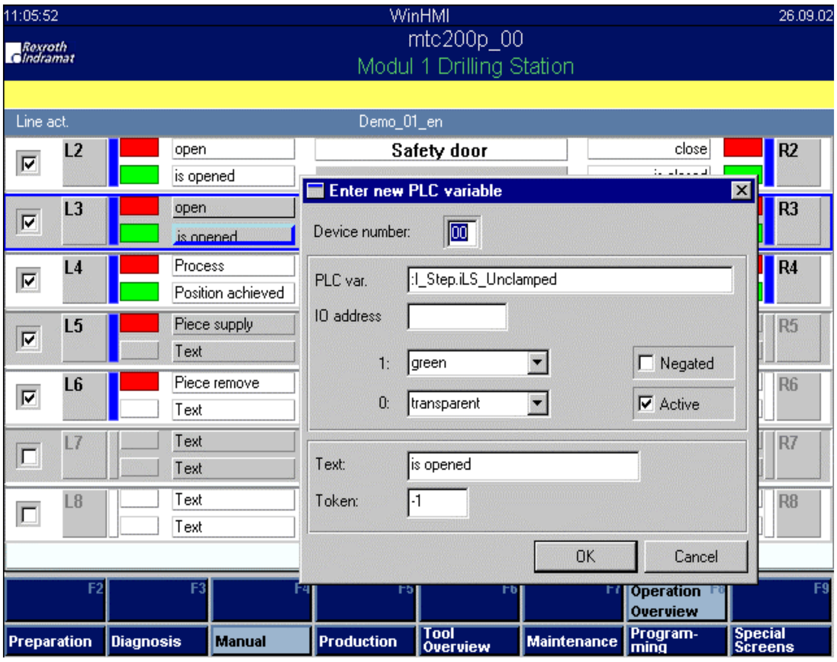
• ":"	Delimiter
• I_Step	Instance name of the program
• qM_Unclamp	Drive for unclamping the workpiece

The IO address of the variable is not necessary; access is achieved via the name.

If the variable is active, the field to the left is red, else it is transparent.

“Open” is entered as a defined text.

“Is opened” Text



Enter new PLC variable

Device number: 00

PLC var.: :I_Step.iLS_Unclamped

IO address:

1: green

0: transparent

☐ Negated

☑ Active

Text: is opened

Token: -1

EingabeBB_02.bmp

Fig. 4-103: “Is opened” entry

Enter the number of the control “00”.

The name of the PLC variable **“:I_Step.iLS_Unclamp”** consists of:

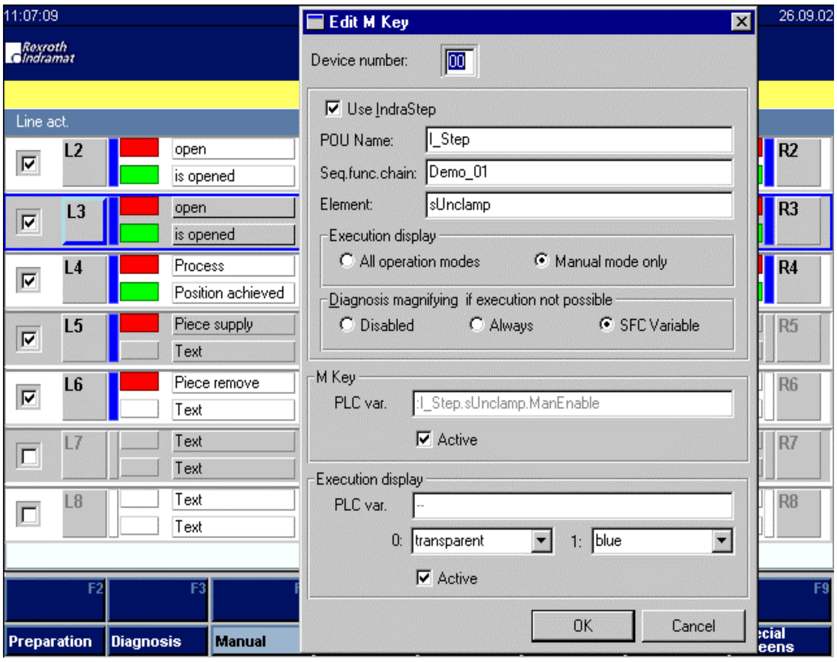
- ":" Delimiter
- I_Step Instance name of the program
- iLS_Unclamped Limit switch indicating that the workpiece is unclamped.

The IO address of the variable is not necessary; access is achieved via the name.

If the variable is active, the field to the left is green, else it is transparent.

“Is opened” is entered as a defined text.

Editing M-key L3



Edit M Key

Device number: 00

☑ Use IndraStep

POU Name: I_Step

Seq.func.chain: Demo_01

Element: sUnclamp

Execution display: ○ All operation modes ● Manual mode only

Diagnosis magnifying if execution not possible: ○ Disabled ○ Always ● SFC Variable

M Key

PLC var. :I_Step.sUnclamp.ManEnable

☑ Active

Execution display

PLC var. --

0: transparent 1: blue

☑ Active

OK Cancel

EingabeBB_02.bmp

Fig. 4-104: Editing M-key L3

Enter the number of the control “00”.

Check the “Use IndraStep” checkbox.

The name of the PLC variable of the M-key **“:I_Step.sUnclamp.ManEnable”** consists of:

- ":" Delimiter (automatically entered here)
- I_Step Instance name of the program (POU name)
- Demo_01 Name of the sequential function chart
- sUnclamp Name of the step to be used for controlling the clamping state in the manual mode.

Executability is displayed in the manual mode only; the diagnosis lens (in case of non-executability) is activated for SFC variables.

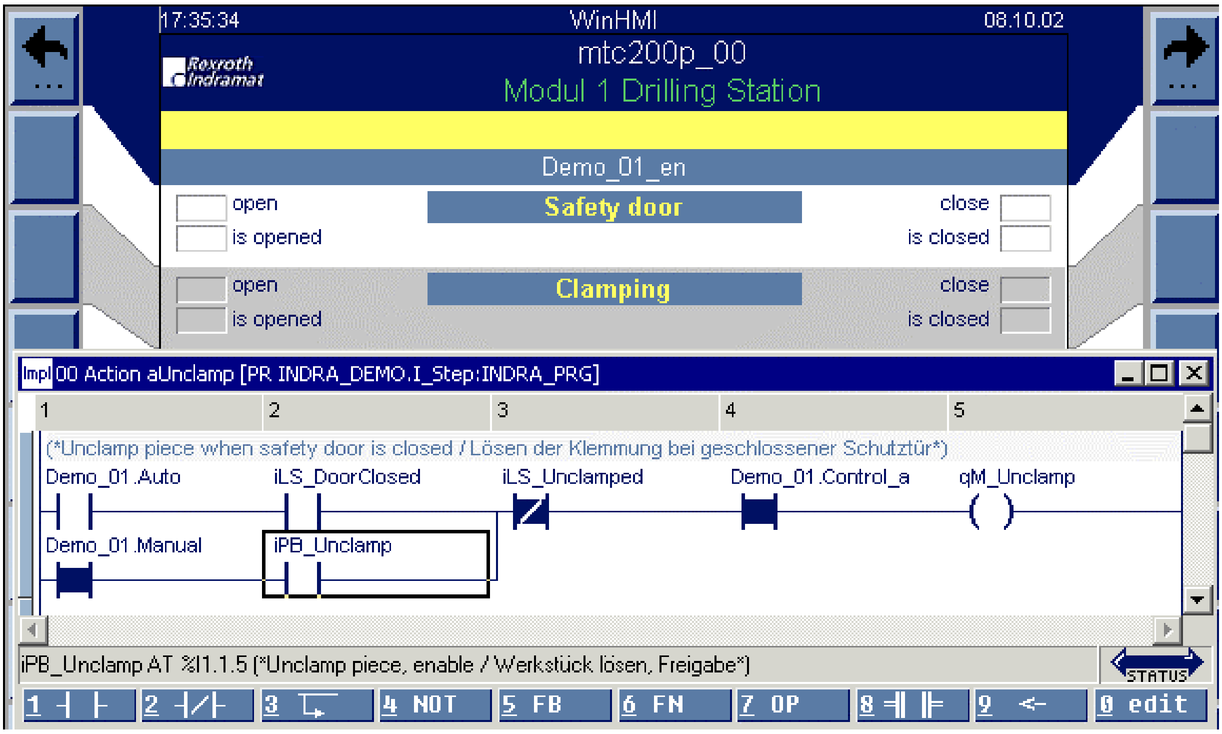
If execution is possible, the field to the right of M-key L3 is blue, else it is transparent.

The other fields of the operating screen must be completed appropriately.

Using the Operating Screen

In the sequence, operation steps typical for the manual mode are initiated and represented in WinPCL, step **“sUnclamp”,** action **“aUnclamp”,** and on the operating screen in the vicinity of M-key L3.

Basic Manual Mode Setting



(*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Schutztür*)

iPB_Unclamp AT %I1.1.5 (*Unclamp piece, enable / Werkstück lösen, Freigabe*)

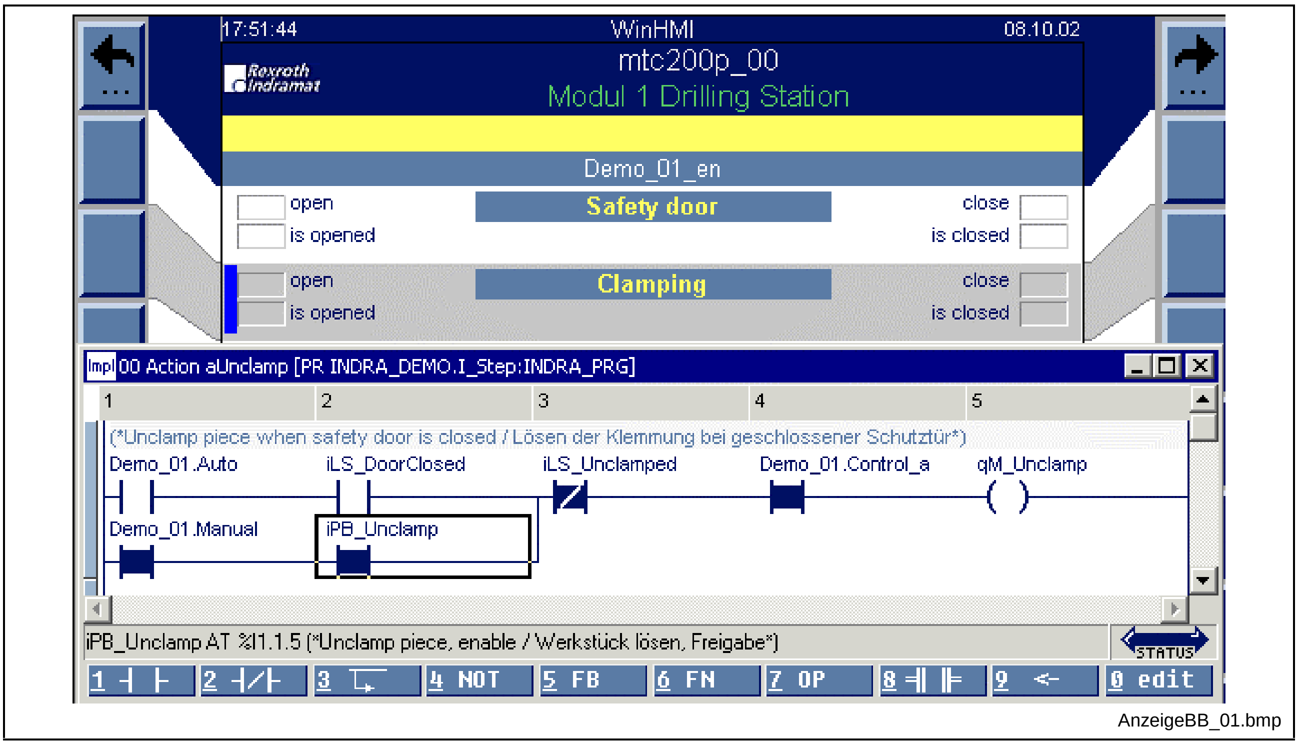
AnzeigeBB_00.bmp

Fig. 4-105: Display of the operating screen in its basic setting

The basic setting is characterized by

- WinPCL, an inactive step, left-hand bus-bar gray;
- WinPCL, **“Demo_01.Manual”** active, manual mode active;
- WinPCL, **“iPB_Unclamp”** inactive;
- WinHMI, motion instruction transparent;
- WinHMI, drive for unclamping the workpiece is inactive, transparent;
- WinHMI, clamping-is-opened limit switch, inactive, transparent.

Enabling "iPB_Unclamp" On enabling **"iPB_Unclamp",** the motion instruction is activated.



AnzeigeBB_01.bmp

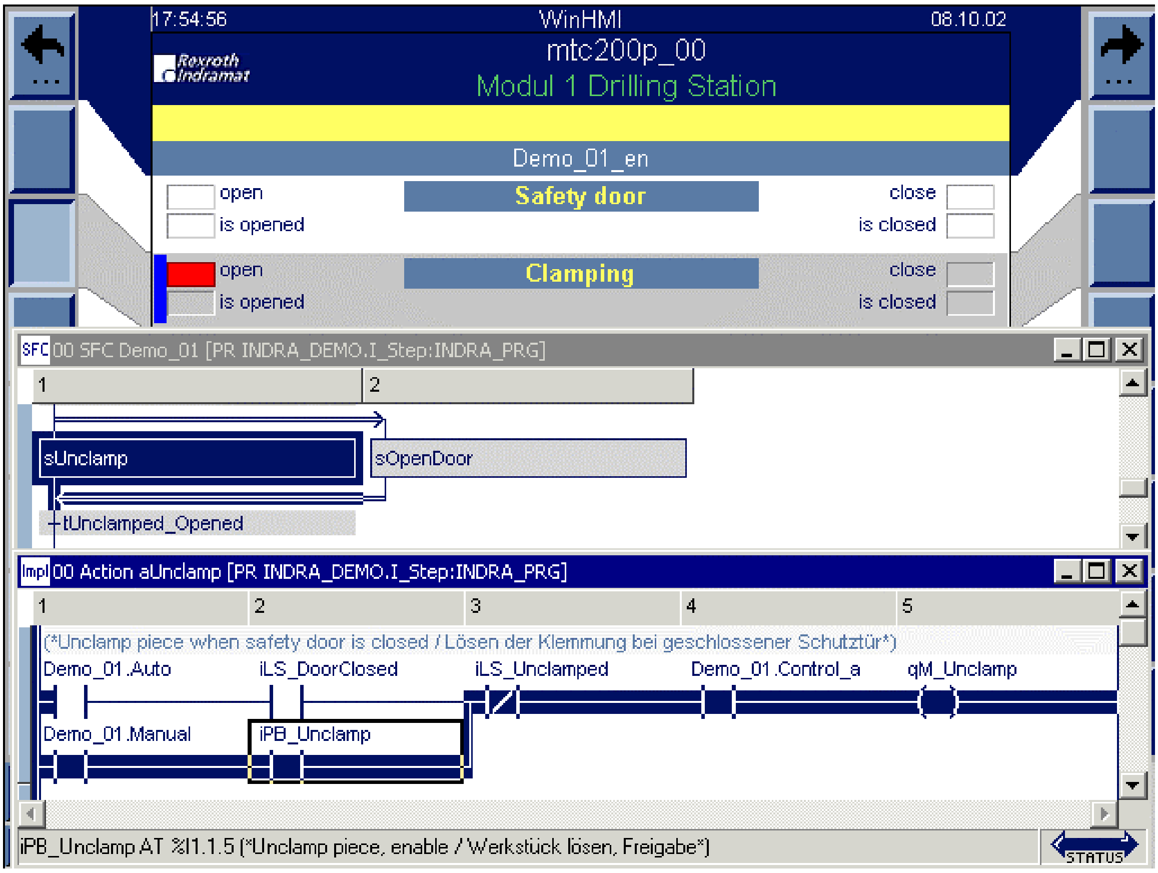
Fig. 4-106: Display of the operating screen with motion instruction

This setting is characterized by

- WinPCL, an inactive step, left-hand bus-bar gray;
- WinPCL, **"Demo_01.Manual"** active, manual mode active;
- WinPCL, **"iPB_Unclamp"** active;
- WinHMI, motion instruction blue;
- WinHMI, drive for unclamping the workpiece is inactive, transparent;
- WinHMI, clamping-is-opened limit switch, inactive, transparent.

Command for Unclamping the Workpiece via M-key L3

With active motion instruction, the step **"sUnclamp"** and, thus, the drive for unclamping the workpiece is activated, when the M-key L3 is actuated.



iPB_Unclamp AT %I1.1.5 (*Unclamp piece, enable / Werkstück lösen, Freigabe*)

AnzeigeBB_02.bmp

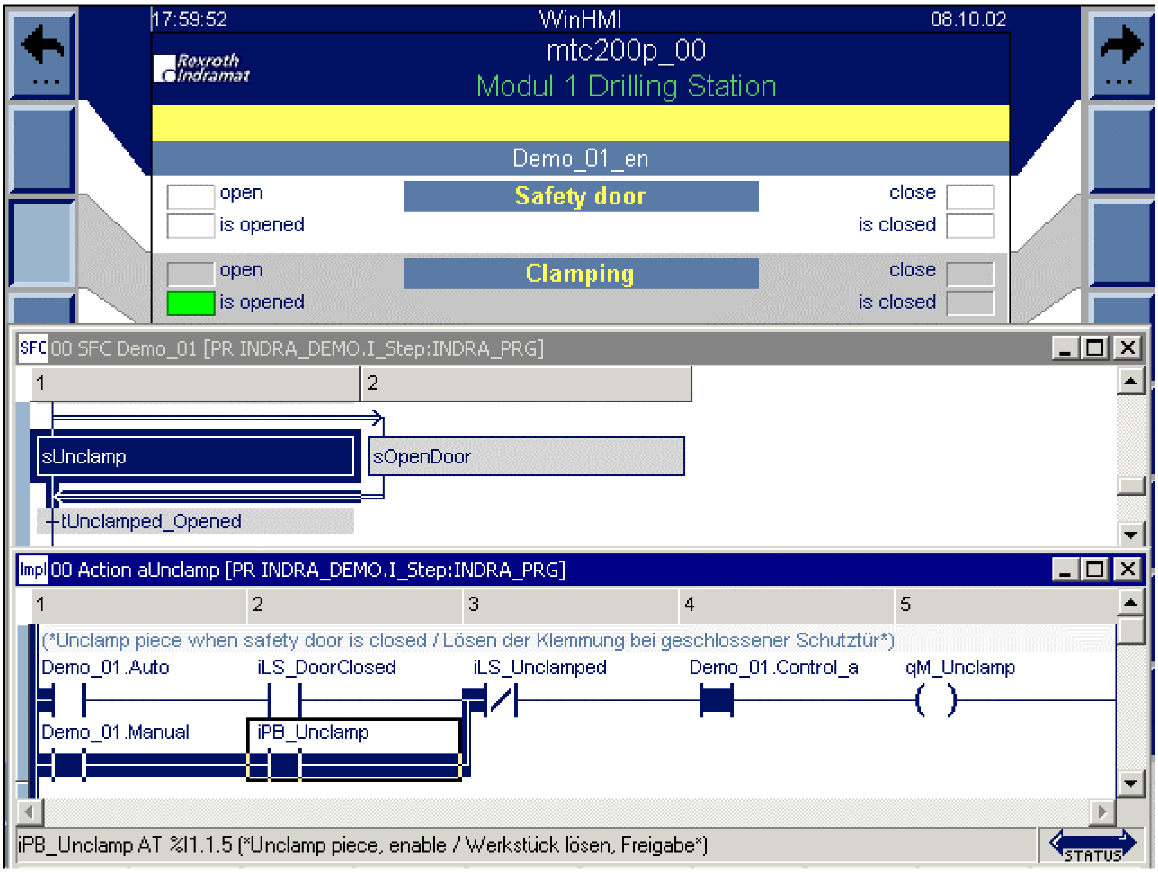
Fig. 4-107: Display of the operating screen with active drive

This setting is characterized by

- WinPCL, an inactive step, left-hand bus-bar blue;
- WinPCL, **"Demo_01.Manual"** active, manual mode active;
- WinPCL, **"iPB_Unclamp"** active;
- WinHMI, motion instruction blue;
- WinHMI, drive for unclamping the workpiece is active, red;
- WinHMI, clamping-is-opened limit switch, inactive, transparent.

Workpiece is Unclamped; iLS_Unclamped Responds

Once the workpiece is unclamped, the limit switch **“iLS_Unclamped”** responds and interrupts activation of the drive.



iPB_Unclamp AT %I1.1.5 (*Unclamp piece, enable / Werkstück lösen, Freigabe*)

AnzeigeBB_03.bmp

Fig. 4-108: Display of the operating screen with responding limit switch

This setting is characterized by

- WinPCL, an inactive step, left-hand bus-bar blue;
- WinPCL, **“Demo_01.Manual”** active, manual mode active;
- WinPCL, **“iPB_Unclamp”** active;
- WinPCL, **“iLS_Unclamped”** negated interrupts the power flow;
- WinHMI, motion instruction inactive, transparent;
- WinHMI, drive for unclamping the workpiece is inactive, transparent;
- WinHMI, clamping-is-opened limit switch, active, green.

Opening is achieved until the limit switch responds and is interrupted by the locking mechanism.

Activation of the M-key *without* Motion Enable

If the M-key is activated ***without*** motion enable signal, the diagnosis lens (criteria analysis) is activated after the M-key has been released.

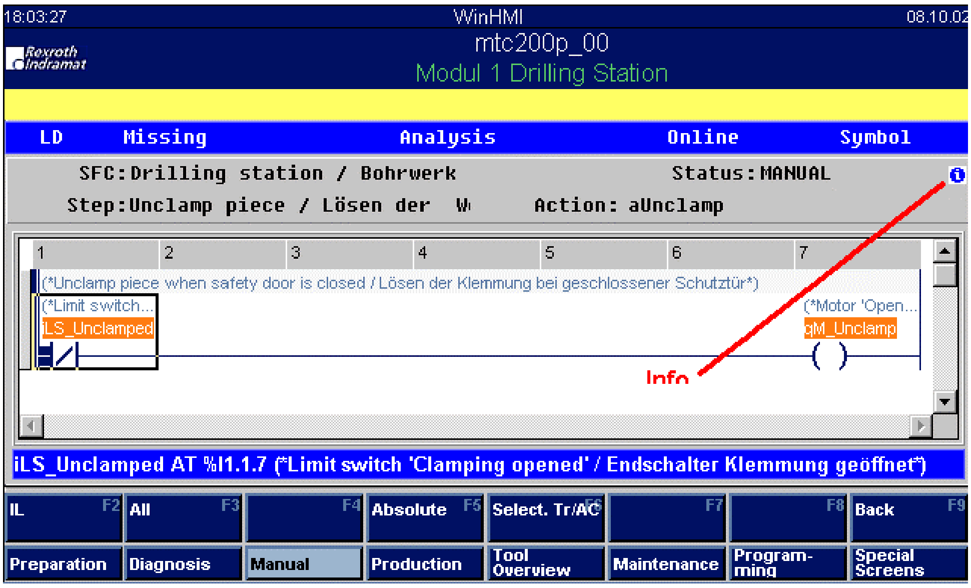
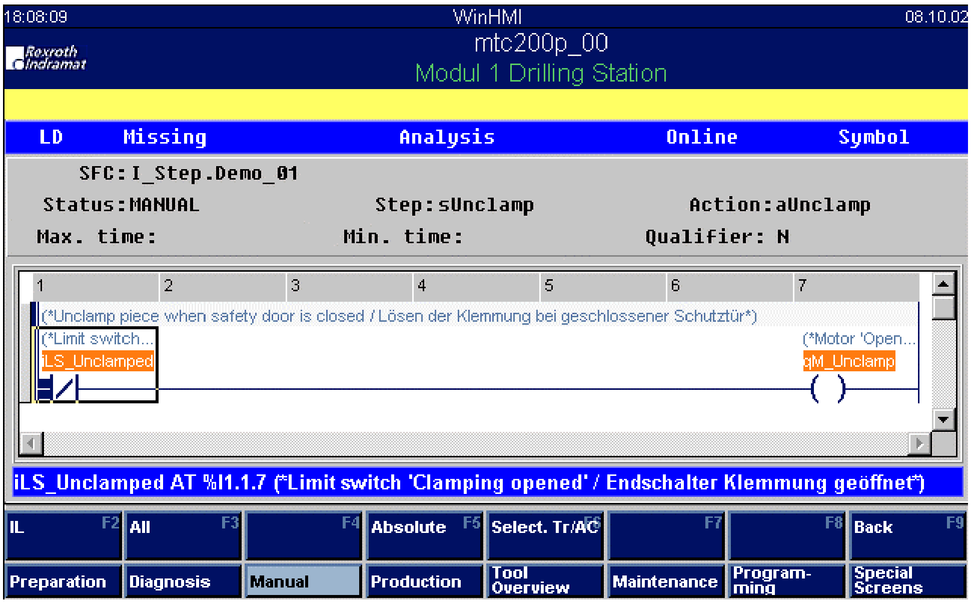
Component	Representation
BTV with WinHMI lens without additional information	 18:03:27 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC:Drilling station / Bohrwerk Status:MANUAL Step:Unclamp piece / Lösen der W Action: aUnclamp (*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Schutztür*) (*Limit switch... LS_Unclamped (*Motor 'Open... qM_Unclamp iLS_Unclamped AT %I1.1.7 (*Limit switch 'Clamping opened' / Endschalter Klemmung geöffnet*) LD Missing Analysis Online Symbol 1 2 3 4 5 6 7 Info IL F2 All F3 F4 Absolute F5 Select. Tr/AC F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Programming Special Screens
BTV with WinHMI lens without additional information	 18:08:09 WinHMI 08.10.02 mtc200p_00 Modul 1 Drilling Station SFC:I_Step.Demo_01 Status:MANUAL Step:sUnclamp Action:aUnclamp Max. time: Min. time: Qualifier: N (*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Schutztür*) (*Limit switch... LS_Unclamped (*Motor 'Open... qM_Unclamp iLS_Unclamped AT %I1.1.7 (*Limit switch 'Clamping opened' / Endschalter Klemmung geöffnet*) LD Missing Analysis Online Symbol 1 2 3 4 5 6 7 IL F2 All F3 F4 Absolute F5 Select. Tr/AC F6 F7 F8 Back F9 Preparation Diagnosis Manual Production Tool Overview Maintenance Programming Special Screens

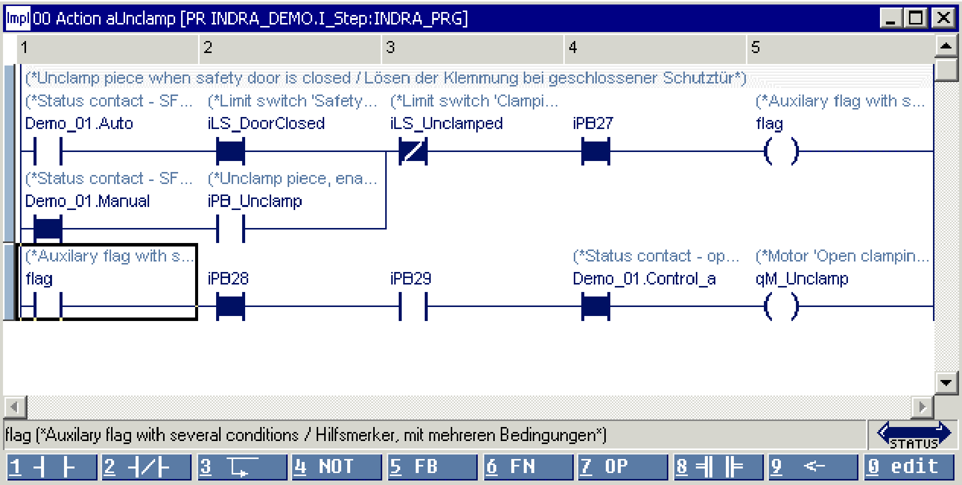
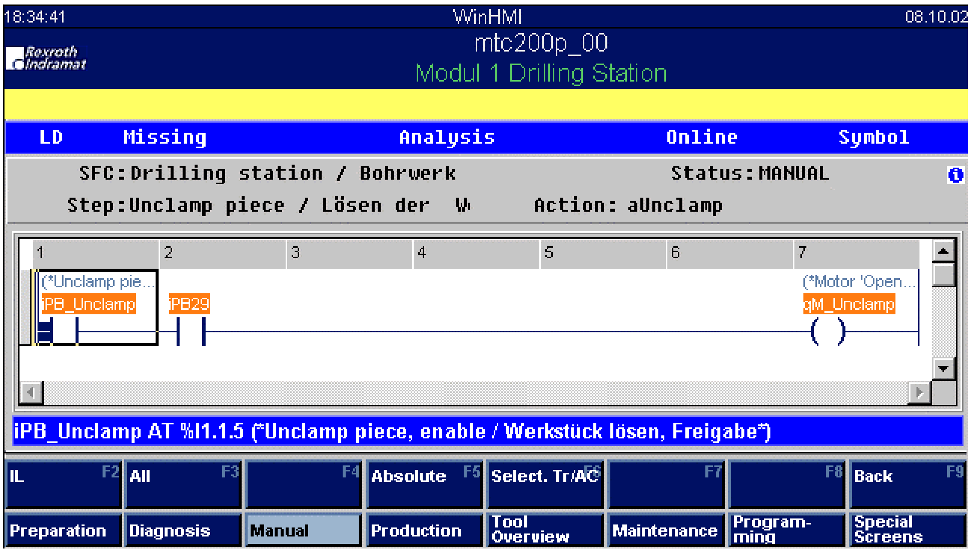
Fig. 4-109: Diagnosis lens without and with additional information (Info key on BTV)

	Without Info key	With Info key
SFC:	Comment on the SFC (instance name.<SFC name>)	Instance name.<SFC name>
Status:	MANUAL	MANUAL
Step:	Comment on the step	<Step name>
		Minimum step time
		Maximum step time
Action:	Name of the action	Name of the action
Qualifier:		Action qualifier

Fig. 4-110: Additional information by pressing the Info key

Using Auxiliary Flags in Case of Several Contacts

If the number of conditions before **“<SFC name>.Control_*”** exceeds the number that can be represented, the rung can be separated by means of auxiliary flags, as shown below:

Component	**Representation**
Separation of rungs by means of the auxiliary **“flag”** in WinPCL	
BTV with WinHMI comprises separated rungs on the screen.	

Impl 00 Action aUnclamp [PR INDRA_DEMO.I_Step:INDRA_PRG]
1
2
3
4
5
(*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Schutztür*)
(*Status contact - SF...
Demo_01.Auto
(*Limit switch 'Safety...
iLS_DoorClosed
(*Limit switch 'Clampi...
iLS_Unclamped
iPB27
(*Auxilary flag with s...
flag
(*Status contact - SF...
Demo_01.Manual
(*Unclamp piece, ena...
iPB_Unclamp
(*Auxilary flag with s...
flag
iPB28
iPB29
(*Status contact - op...
Demo_01.Control_a
(*Motor 'Open clampin...
qM_Unclamp
flag (*Auxilary flag with several conditions / Hilfsmerker, mit mehreren Bedingungen*)
STATUS
1 ┤ ├
2 ┤/├
3
4 NOT
5 FB
6 FN
7 OP
8
9 <-
0 edit

Fig. 4-111: Auxiliary flags for separating wide rungs

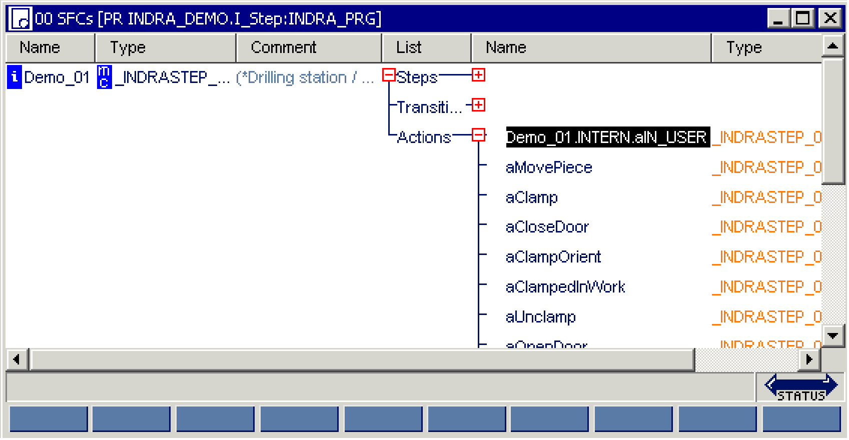
Note: The name of the auxiliary flag can be selected as desired.

The auxiliary flag can be used as often as desired, in one rung or in several rungs or even in various actions.

Activating Outputs via Compact Operator Terminals in the Manual Mode

(This section can be skipped if it is not intended to connect a compact operator terminal.)
Since compact operator terminals are not provided with operating screens, activation must be achieved by means of a PLC program block

The program block must be entered in the action **"INTERN.aIN_USER".**



00 SFCs [PR INDRA_DEMO.I_Step:INDRA_PRG]

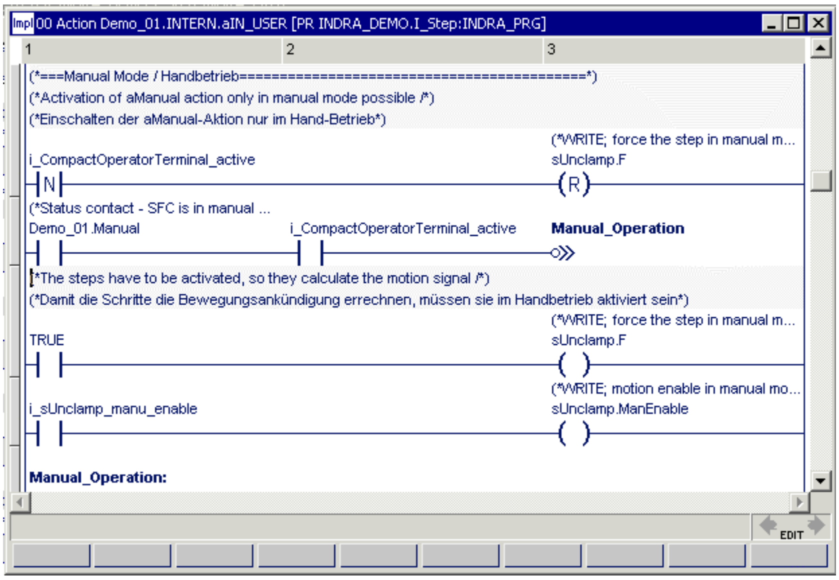
```
Name      Type            Comment                 List       Name                     Type
Demo_01   _INDRASTEP_...  (*Drilling station / ...  Steps
                                                  Transiti...
                                                  Actions    Demo_01.INTERN.aIN_USER  _INDRASTEP_0
                                                             aMovePiece               _INDRASTEP_0
                                                             aClamp                   _INDRASTEP_0
                                                             aCloseDoor               _INDRASTEP_0
                                                             aClampOrient             _INDRASTEP_0
                                                             aClampedInWork           _INDRASTEP_0
                                                             aUnclamp                 _INDRASTEP_0
                                                             aOpenDoor                _INDRASTEP_0
```

aInUser.bmp

Fig. 4-112: Access to **"INTERN.aIN_USER"** via View / SFCs

Branch down to the action by double-clicking the mouse or pressing <Ctrl>+<Enter>.

If a compact operator terminal is connected, this program block forces the particular step concerned (in the manual mode). If a compact operator terminal is not active, the force flags of the particular step concerned are reset.



00 Action Demo_01.INTERN.aIN_USER [PR INDRA_DEMO.I_Step:INDRA_PRG]

```
1                                   2                                   3
(*===Manual Mode / Handbetrieb==========================================*)
(*Activation of aManual action only in manual mode possible /*)
(*Einschalten der aManual-Aktion nur im Hand-Betrieb*)
                                                                        (*WRITE; force the step in manual m...
i_CompactOperatorTerminal_active                                        sUnclamp.F
-|N|--------------------------------------------------------------------(R)-
(*Status contact - SFC is in manual ...
Demo_01.Manual                      i_CompactOperatorTerminal_active    Manual_Operation
-| |--------------------------------| |---------------------------------o>>
(*The steps have to be activated, so they calculate the motion signal /*)
(*Damit die Schritte die Bewegungsankündigung errechnen, müssen sie im Handbetrieb aktiviert sein*)
                                                                        (*WRITE; force the step in manual m...
TRUE                                                                    sUnclamp.F
-| |--------------------------------------------------------------------( )-
                                                                        (*WRITE; motion enable in manual mo...
i_sUnclamp_manu_enable                                                  sUnclamp.ManEnable
-| |--------------------------------------------------------------------( )-

Manual_Operation:
```

Kleinbedienfeld_freigabe.bmp

"I_CompactOperatorTerminal_active":
A compact operator terminal is connected.
"I_sUnclamp_manu_enable":
Unclamping command (in analogy with the M-key on the operating screen)

Fig. 4-113: Preparing the "manual mode with compact operator terminal" in the action **"INTERN.aIN_USER"**

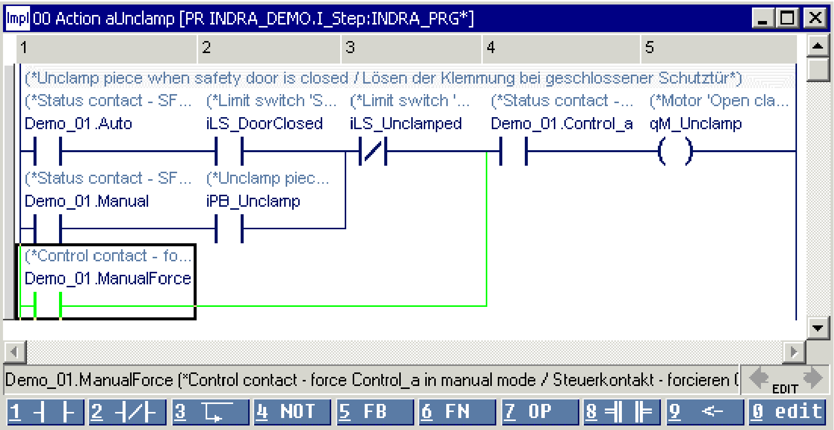
If a compact operator terminal is connected, forcing of the step **“sUnclamp.F”** preliminarily calculates the motion instruction. However, the contact **“Control_a”** is enabled only via **“ManEnable” (“sUnclamp.ManEnable”)** (also see Fig. 4-95).

Activating Outputs by ManualForce in the Manual Mode

If it is intended to force one of the outputs directly in the manual mode (without evaluation of the locking mechanism), the signal **“i.ManualForce”** can be used.

Note: The risk arising in connection with using this signal is reduced by

- separate programming in the action <SFC name>.INTERN.aIN_USER,
- locking with the key switch.

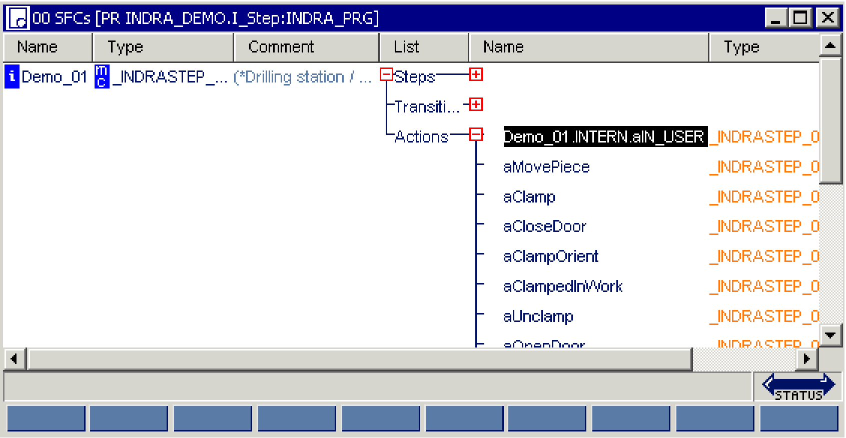


Demo_01.ManualForce (*Control contact - force Control_a in manual mode / Steuerkontakt - forcieren (

ManualForce_00.bmp

Fig. 4-114: **Equivalent circuit diagram;** the branch containing Demo_01-ManualForce (green) has been additionally highlighted

Signal transfer from the input switch **“I_ManualForce”** via the locking mechanism with the contact **“Key Switch”** to the control signal **“Demo_01.i.ManualForce”** is programmed in the action **“Demo_01.INTERN.aIN_USER”.**

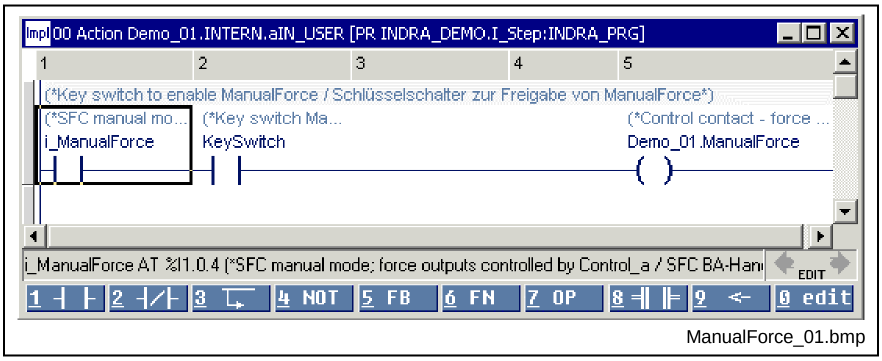


Name	Type	Comment	List	Name	Type
Demo_01	_INDRASTEP_...	(*Drilling station / ...	Steps		
			Transiti...		
			Actions	Demo_01.INTERN.aIN_USER	_INDRASTEP_0
				aMovePiece	_INDRASTEP_0
				aClamp	_INDRASTEP_0
				aCloseDoor	_INDRASTEP_0
				aClampOrient	_INDRASTEP_0
				aClampedInWork	_INDRASTEP_0
				aUnclamp	_INDRASTEP_0
				aOpenDoor	_INDRASTEP_0

aInUser.bmp

Fig. 4-115: Access to **“INTERN.aIN_USER”** via View / SFCs

Branch down to the action by double-clicking the mouse or pressing <Ctrl>+<Enter>.



00 Action Demo_01.INTERN.aIN_USER [PR INDRA_DEMO.I_Step:INDRA_PRG]

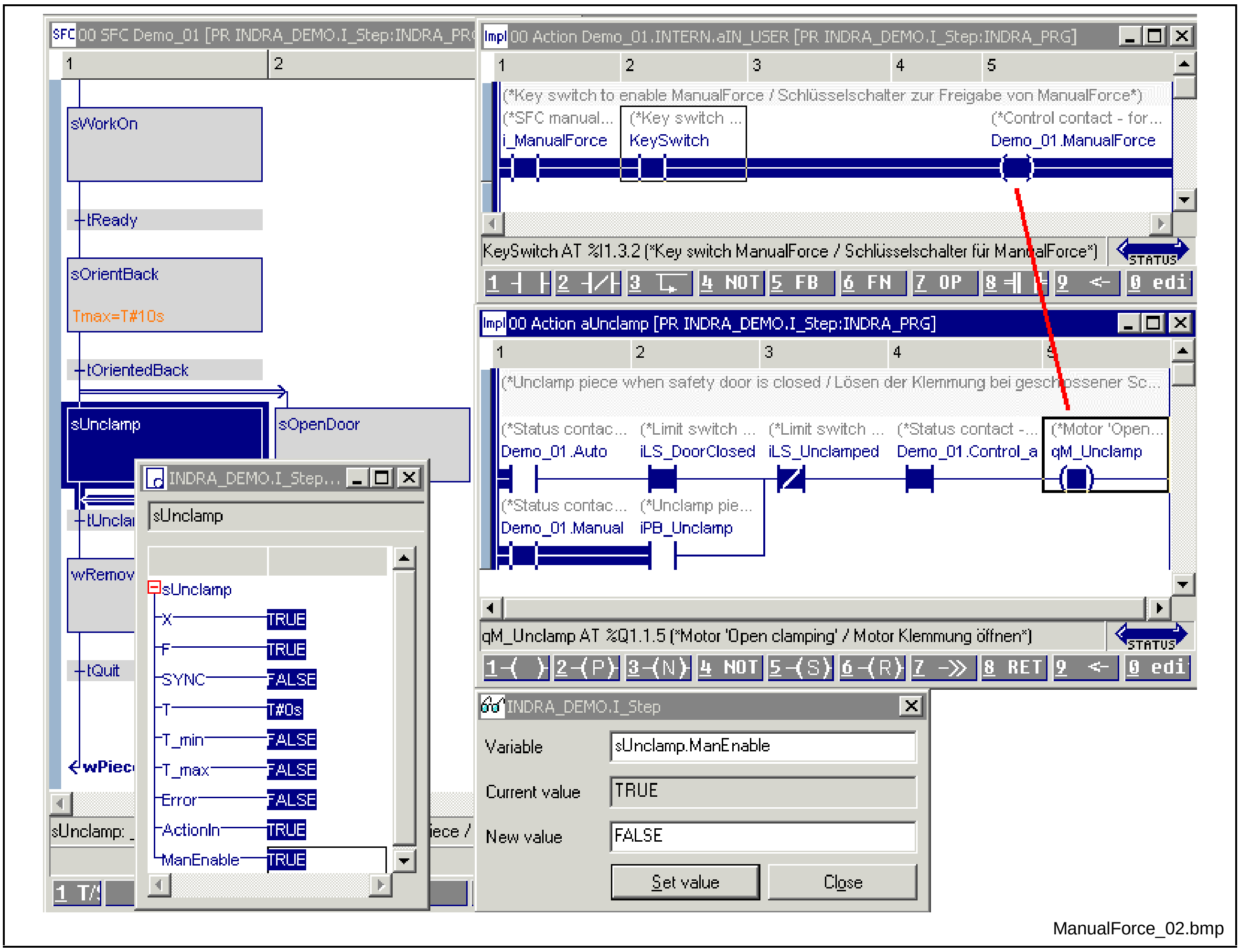
(*Key switch to enable ManualForce / Schlüsselschalter zur Freigabe von ManualForce*)

(*SFC manual mo...	(*Key switch Ma...	(*Control contact - force ...
i_ManualForce	KeySwitch	Demo_01.ManualForce

i_ManualForce AT %I1.0.4 (*SFC manual mode; force outputs controlled by Control_a / SFC BA-Han

Fig. 4-116: Locking **“ManualForce”** in the action **“INTERN.aIN_USER”**

This activates the following window:



00 SFC Demo_01 [PR INDRA_DEMO.I_Step:INDRA_PR

00 Action Demo_01.INTERN.aIN_USER [PR INDRA_DEMO.I_Step:INDRA_PRG]

(*Key switch to enable ManualForce / Schlüsselschalter zur Freigabe von ManualForce*)

(*SFC manual...	(*Key switch ...	(*Control contact - for...
i_ManualForce	KeySwitch	Demo_01.ManualForce

KeySwitch AT %I1.3.2 (*Key switch ManualForce / Schlüsselschalter für ManualForce*)

00 Action aUnclamp [PR INDRA_DEMO.I_Step:INDRA_PRG]

(*Unclamp piece when safety door is closed / Lösen der Klemmung bei geschlossener Sc...

(*Status contac...	(*Limit switch ...	(*Limit switch ...	(*Status contact -...	(*Motor 'Open...
Demo_01.Auto	iLS_DoorClosed	iLS_Unclamped	Demo_01.Control_a	qM_Unclamp
(*Status contac...	(*Unclamp pie...			
Demo_01.Manual	iPB_Unclamp			

qM_Unclamp AT %Q1.1.5 (*Motor 'Open clamping' / Motor Klemmung öffnen*)

INDRA_DEMO.I_Step...

sUnclamp

sUnclamp	
X	TRUE
F	TRUE
SYNC	FALSE
T	T#0s
T_min	FALSE
T_max	FALSE
Error	FALSE
ActionIn	TRUE
ManEnable	TRUE

INDRA_DEMO.I_Step

Variable: sUnclamp.ManEnable

Current value: TRUE

New value: FALSE

Fig. 4-117: **“ManualForce”** - forcing an output

Note: In this manner, the switch **“I_ManualForce”** activates

- all “relays” of the action with forced action,
- all “relays” of the step with forced step,

which are preceded by a variable **“Control_a”.**

“<Step name>.ManEnable” or **“<action name>.ManEnable”** must be activated for the desired step or desired action respectively.

SetStep on Changing from the Manual Mode to the Automatic Mode

If , on changing from the manual mode to the automatic mode, it is intended to use a step selection differing from that used before the manual mode has been activated, the following steps must be taken:

- Setting the SYNC variables of the appropriate steps **"<step name>.SYNC"**
- Setting the variable **"<SFC name>.i.SetStep"**
- Deactivating the manual mode **"<SFC name>.i.Manual = FALSE"**

On deactivation of the manual mode, it is checked whether the desired step assignment can be implemented.

If yes, the steps selected are activated.

If the step selected cannot be activated, the variable **"<SFC name>.q.ErrorSetStep"** is set.

4.8 ProVi Messages Used for Diagnosis

With the PLC program taken as a basis, ProVi messages are an additional instrument for displaying information on the WinHMI interface. The message can be emitted independently of whether IndraStep SFCs have been used or not.

Types of ProVi Messages

There are the following categories of messages which can be defined by the user:

- Faults
- Messages
- Warnings
- Start requirements
- Setup diagnosis messages

The type of message determines the type of display on the WinHMI interface (see /2/ WinHMI documentation).

Entering the Messages in the PLC Program

Organization of entering and processing the ProVi messages is uniform throughout the PLC program. A message can always be assigned to an LD or IL rung with Boolean output. If the Boolean output is activated, the message is displayed; if the output is not activated any more, the message disappears.

Note: If the rung is not processed any longer, for instance because it is skipped, the messages get “stuck”!

Messages are entered via the pop-up menu (<Shift>+<F10> keys or right mouse button), menu item “ProVi message”.

This opens a window of the Message Integrator (MI), see Fig. 4-118.

The following items can be selected:

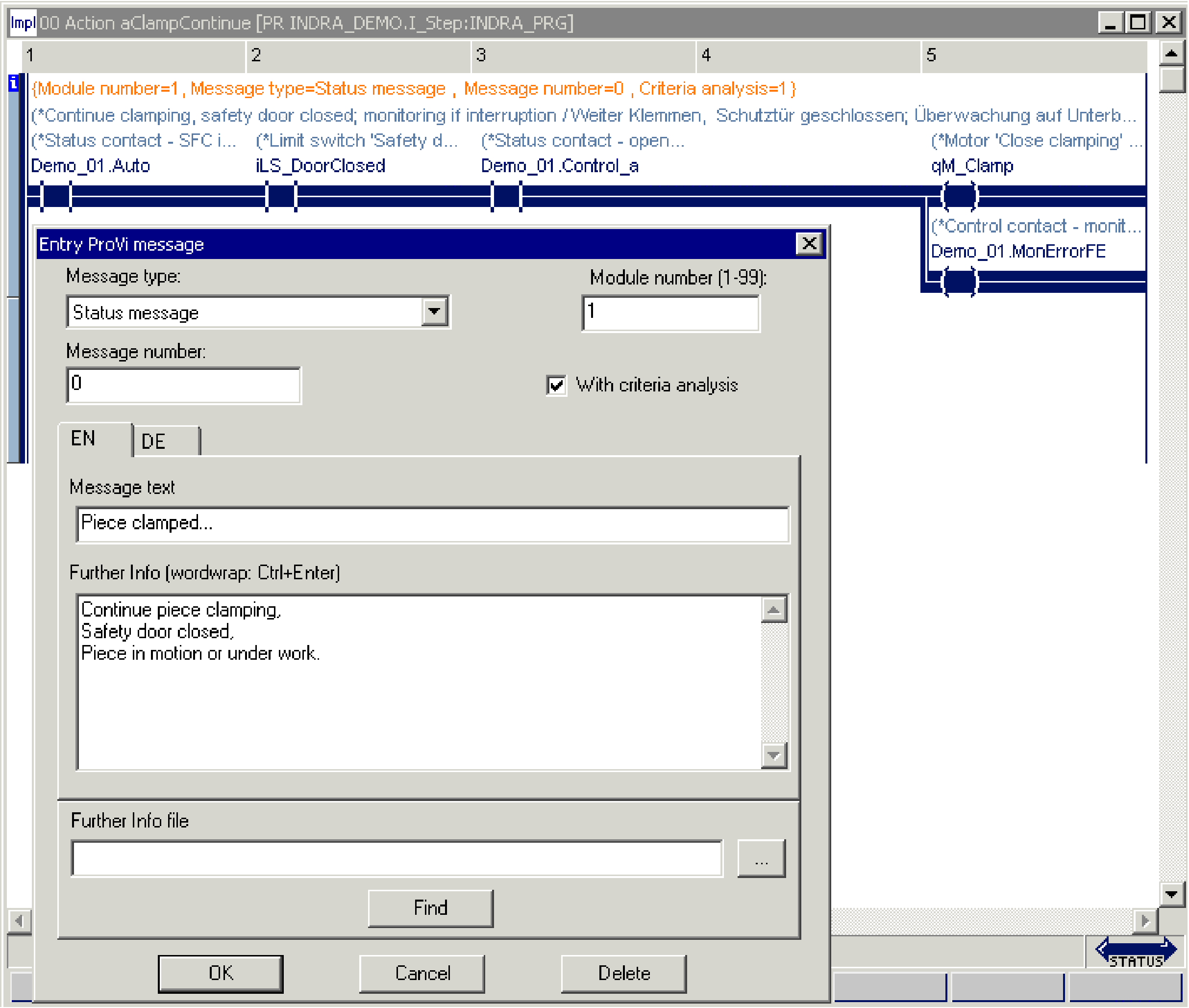
- module number,
- message type,
- message number (if the message is already existing, else it is assigned automatically),
- with or without criteria analysis;

and, in addition, multilingually:

- the desired message text,
- an additional message text (optional), and
- an advanced HTML file.

The multilingual text can be translated either immediately or as a complete file in the Message Integrator.

The i symbol to the upper left of the rung indicates that a ProVi message exists in WinPCL.



Impl 00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG]

{Module number=1 , Message type=Status message , Message number=0 , Criteria analysis=1 }

(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschlossen; Überwachung auf Unterb...

1	2	3	4	5
(*Status contact - SFC i...	(*Limit switch 'Safety d...	(*Status contact - open...		(*Motor 'Close clamping' ...
Demo_01.Auto	iLS_DoorClosed	Demo_01.Control_a		qM_Clamp
				(*Control contact - monit...
				Demo_01.MonErrorFE

Entry ProVi message

Message type: Status message

Module number (1-99): 1

Message number: 0

☑ With criteria analysis

EN | DE

Message text: Piece clamped...

Further Info (wordwrap: Ctrl+Enter):

Continue piece clamping,
Safety door closed,
Piece in motion or under work.

Further Info file:

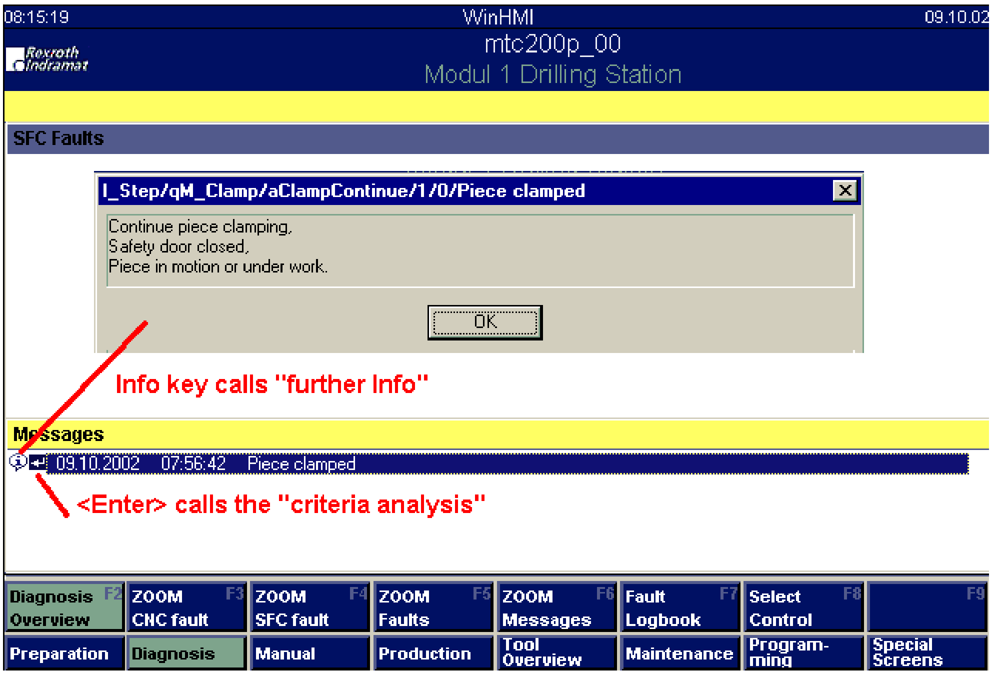
Eingabe_ProVi_00.bmp

Fig. 4-118: Entering a ProVi message

The ProVi message can be entered in the online edit mode. The HMI diagnosis window shown below displays the message, which can be seen in Fig. 4-119.

The two pictograms at the beginning of the line have the following meanings:

- ⓘ- HMI info; indicates that an additional comment can be displayed by pressing the Info key on the BTV.
  The header of the “Further info” box contains the information A/B/[C/]D/E - message text.
  - A: name of the POU instance (PLC program)
  - B: variable name
  - C: detail name (for “action” and “transition” detail types only)
  - D: rung number
  - E: message number
- 🟩- HMI-Enter; indicates that the criteria analysis (diagnosis lens) has been selected in Fig. 4-118.



08:15:19 WinHMI 09.10.02

mtc200p_00

Modul 1 Drilling Station

SFC Faults

I_Step/qM_Clamp/aClampContinue/1/0/Piece clamped

Continue piece clamping,
Safety door closed,
Piece in motion or under work.

Messages

09.10.2002 07:56:42 Piece clamped

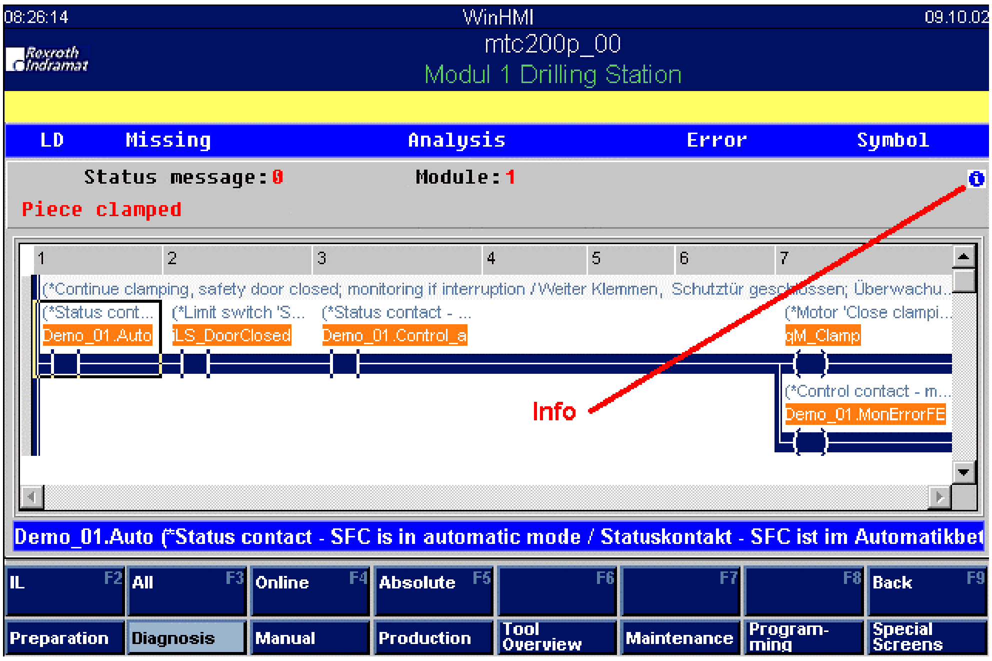
Info key calls "further Info"

<Enter> calls the "criteria analysis"

InfoZuProvi_01.bmp

Fig. 4-119: HMI diagnosis window with display of the ProVi message

Pressing the <Enter> key activates the criteria analysis:



08:26:14 WinHMI 09.10.02

mtc200p_00

Modul 1 Drilling Station

LD	Missing	Analysis	Error	Symbol

Status message:0 Module:1

Piece clamped

(*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschlossen; Überwachu...

(*Status cont... (*Limit switch 'S... (*Status contact - ... (*Motor 'Close clampi...

Demo_01.Auto LS_DoorClosed Demo_01.Control_a qM_Clamp

(*Control contact - m...

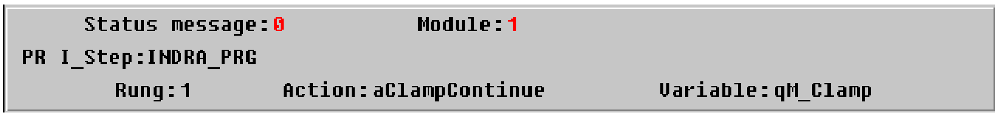
Demo_01.MonErrorFE

Info

Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbet

InfoZuProvi_02.bmp

Fig. 4-120: Diagnosis lens (criteria analysis)



```
      Status message:0          Module:1
PR I_Step:INDRA_PRG
       Rung:1        Action:aClampContinue        Variable:qM_Clamp
```

InfoZuProvi_03.bmp

Fig. 4-121: Header of the diagnosis lens (criteria analysis) after pressing of the Info key

The display shows the entire rung having caused activation of the variables.

Depending on whether the Info key has been pressed or not, the header of the screen displays the following information:

	Without Info key	With Info key
Status message:	Number in the Message Integrator	Number in the Message Integrator
Modules:	Number in the Message Integrator / in the SFC_diagnosis	Number in the Message Integrator / in the SFC_diagnosis
Comment:	ProVi message	
		Instance name and type of program
		Rung number in the action
		Variable having initiated the message

Fig. 4-122: Additional information after pressing of the Info key

Removing Function Blocks from the Displays of ProVi Rungs

The following example shows that function blocks which have one Boolean input and one Boolean output each as topmost connections will be removed from the criteria analysis if the condition is fulfilled:

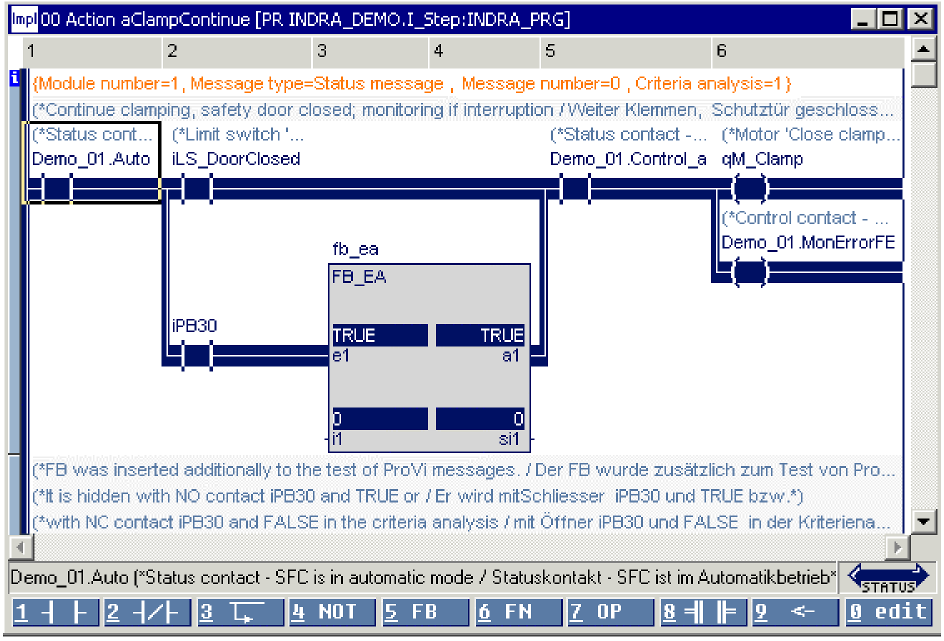
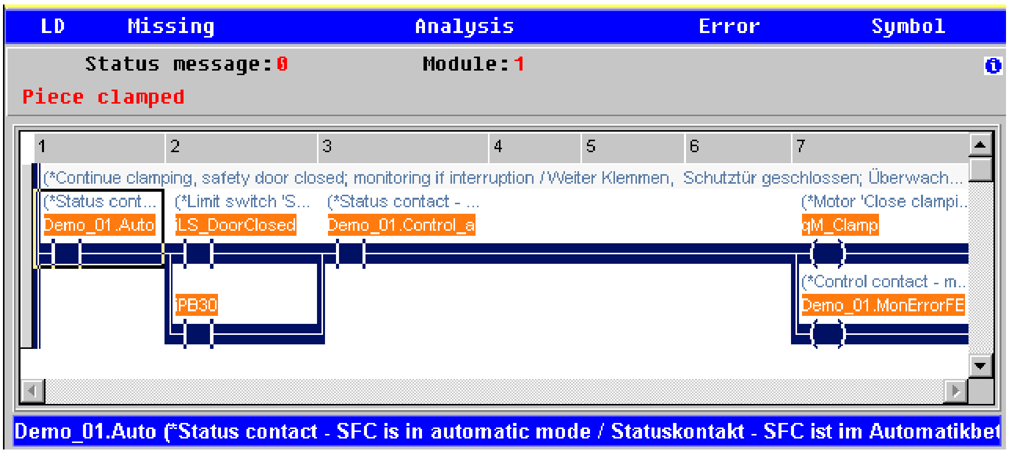
Comment	Example
The branch with iPB30 and fb_ea has been added for test purposes.	 Impl 00 Action aClampContinue [PR INDRA_DEMO.I_Step:INDRA_PRG] {Module number=1 , Message type=Status message , Message number=0 , Criteria analysis=1 } (*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschloss... (*Status cont... Demo_01.Auto (*Limit switch '... iLS_DoorClosed (*Status contact -... Demo_01.Control_a (*Motor 'Close clamp... qM_Clamp (*Control contact - ... Demo_01.MonErrorFE iPB30 fb_ea FB_EA TRUE e1 TRUE a1 0 i1 0 si1 (*FB was inserted additionally to the test of ProVi messages. / Der FB wurde zusätzlich zum Test von Pro... (*It is hidden with NO contact iPB30 and TRUE or / Er wird mitSchliesser iPB30 und TRUE bzw.*) (*with NC contact iPB30 and FALSE in the criteria analysis / mit Öffner iPB30 und FALSE in der Kriteriena... Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbetrieb* 1 ┤ ├ 2 ┤/├ 3 4 NOT 5 FB 6 FN 7 OP 8 9 <- 0 edit
FB removed.	 LD Missing Analysis Error Symbol Status message:0 Module:1 Piece clamped (*Continue clamping, safety door closed; monitoring if interruption / Weiter Klemmen, Schutztür geschlossen; Überwach... (*Status cont... Demo_01.Auto (*Limit switch 'S... iLS_DoorClosed (*Status contact - ... Demo_01.Control_a (*Motor 'Close clampi... qM_Clamp iPB30 (*Control contact - m... Demo_01.MonErrorFE Demo_01.Auto (*Status contact - SFC is in automatic mode / Statuskontakt - SFC ist im Automatikbet

Fig. 4-123: Removing function blocks

4.9 Updating IndraStep Files

IndraStep files (SKD file and structures) should only be changed after consultation with the customer service.

The user should, in particular, inform himself about further developments, so as to come to more beneficial solutions by using these new possibilities.

The following steps should be taken:

1. Archive the complete project (without secondary files).
2. Read the archive back to a new folder (variant).
3. Open the resource.
4. Export the files from WinPCL starting with the resource (main file).
5. Load the text file (ANSI) to a simple text editor (e.g. NotePad).
6. Replace the character strings for all types of use, e.g. "_INDRASTEP_01" by "_INDRASTEP_02", and save them.
7. Import the changed ANSI file. A great number of editor windows is opened, with the resource being the topmost one.
8. Save the imported files. The following files are of no relevance, i.e. actually they do not have to be saved:
   - _INDRASTEP_02,
   - _INDRASTEP_02_SCHRITT, _INDRASTEP_02_TRANSITION, _INDRASTEP_02_AKTION,
   - _INDRASTEP_02_INTERN, _INDRASTEP_02_STEUERST, _INDRASTEP_02_STATUS
9. Load the new IndraStep files from the archive.

   The files are contained as **archives** for WinHMI or WinPCL in the following folders:

   - *Mtgui\BasicData\TEMPLATES*
   - *WinPCL\BasicData\TEMPLATES*

   The new files bear the same names as those recorded under item 8, overwriting them.
10. Complete compilation starting with the resource (main file).

5 System Variables of Steps, Transitions, Actions and Sequences (Overview)

5.1 Modes for Sequential Function Charts

According to the standard EN 61131-3, 2nd edition, the properties of steps, transitions and actions should be capable of being read back and modified by assigning system variables (flags) in programs and function blocks.

These requirements are met by the programming system WinPCL which, going beyond the variables contained in the standard, also supports additional variables by assigning data types.

In this manner, the following modes are implemented by **IndraStep:**

- Automatic mode
- Manual mode
- AutoStep mode

Note: Here, several sequential function charts are supported in each program or function block.

Using the footer command “3 - IndraStep”, an SKD file (**S**chritt**K**etten-**D**iagnose = SFC diagnosis) containing a set of data types and the necessary scripts is assigned to each sequential function chart.

SFC element	Data type
SFC (sequential function chart)	_INDRASTEP_02
STEP	_INDRASTEP_02_SCHRITT
TRANSITION	_INDRASTEP_02_TRANSITION
ACTION	_INDRASTEP_02_AKTION

Fig. 5-1: Data types for the “IndraStep” mode control

System Actions

Calling the SKD file also provides two actions with system support:

Name	Use
<SFC name>.INTERN.aIN_USER	Whenever the SFC is executed, the action is executed ***before*** the SFC.
<SFC name>.INTERN.aOUT_USER	Whenever the SFC is executed, the action is executed ***after*** the SFC.

Fig. 5-2: System actions for the “IndraStep” mode control

Any activities which are executed independently of the active steps and the current mode can be programmed in these actions . However, actions are included in the SFC and they are part of the yellow box in the implementation.

The actions can be reached via

- the *View / SFCs* menu item,
- the actual SFC,
- actions.

5.2 System Variables of Steps

Depending on the type that is assigned, the user has access to the following variables (<SFC name>.<variable name>):

EN 61131-3	Basis	IndraStep	Type	Remark
X	X	X	BOOL	Step flag; TRUE if the step is active; read only
	F	F	BOOL	Forcing of the step in the manual mode; r/w
	SYNC	SYNC	BOOL	If TRUE: the step to be set as active step is selected, r/w
T	T	T	TIME	Step-active time, time elapsed since the step has been set; read only
		T_min	BOOL	If TRUE: the minimum step time is active; read only
		T_max	BOOL	If TRUE: the maximum step time is active; read only
		Error	BOOL	If TRUE: step failure; read only
		ActionIn	BOOL	Internal; motion instruction; read only
		ManEnable	BOOL	Motion enabled in the manual mode; acts on Control_a/Control_c; write

Fig. 5-3: Overview of step system variables

Using the pop-up menu (<Shift>+<F10> or right mouse button), two time values, i.e. a minimum and a maximum step time, can be entered for each step. The times can be entered as constants (T#…) or variables of type “TIME”.

If TIME variables are used for the minimum / maximum step time, their value is saved when the step is becoming active.

Note: Only if a time value has been entered will the appropriate code be generated. Entering T#0s causes unnecessary effort!

The **minimum step time** forces the system to remain in the step, even if the following transition has already been fulfilled. The error and T-min flags of the step as well as the MinTime flag of the following transition are set in the time interval between *“Condition fulfilled”* and *“minimum step time not yet elapsed completely”*.

After this time has elapsed, the system moves to the following step, with the transition condition still fulfilled. The error and T_min flags of the step as well as the MinTime flag of the transition are reset.

The **maximum step time** permits to check whether the transition condition has been fulfilled rapidly enough, so that the step could be exited.

If this time is exceeded, the T_max and error flags are set. The entire SFC is stopped with set SFC error flag. If the condition is fulfilled thereafter, it is not possible to move to the following step. The error must be eliminated and the SFC restarted.

Note: If the minimum step time exceeds the maximum step time, the maximum step time and, thus, its error mechanism will become ineffective.

The **ManEnable** flag will be described in the section on forcing of actions in the manual mode.

5.3 System Variables of Transitions

Depending on the type that is assigned, the user has access to the following variables (<transition name>.<variable name>):

EN 61131-3	Basis	IndraStep	Type	Remark
	JOG	JOG	BOOL	Stop point in the jog mode; TRUE if the transition, with the condition fulfilled, is to switch on after confirmation only (initial value); write
		X	BOOL	Logic result of the transition rung; write
		MinTime	BOOL	TRUE - minimum step time is running; read only

Fig. 5-4: Overview of transition system variables

The MinTime flag indicates that the transition condition was fulfilled before the minimum step time had elapsed. It will be reset after the transition has been passed.

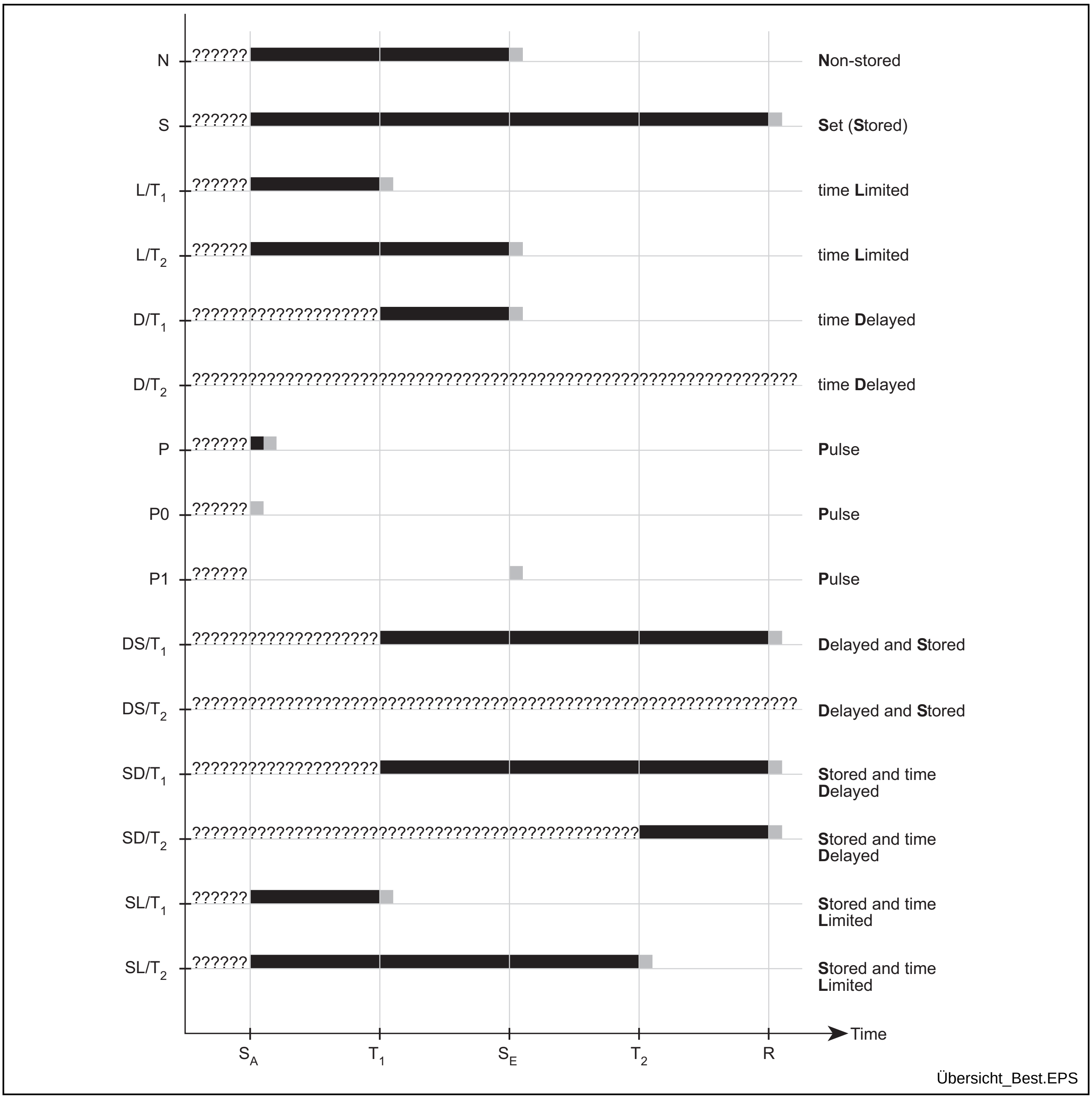
5.4 System Variables of Actions

Depending on the type that is assigned, the user has access to the following variables (<action name>.<variable name>):

EN 61131-3	Basis	IndraStep	Type	Remark
Q	Q	Q	BOOL	Action flag; regular action processing according to the action qualifier; read only
A	A	A	BOOL	Postprocessing flag Regular action processing + postprocessing; read only
	F	F	BOOL	If TRUE: forcing of the action in the manual mode; write
	JOG	JOG	BOOL	TRUE - in the JOG mode, if the following transition is fulfilled; read only
		Error	BOOL	If TRUE: error message; read only
		ActionIn	BOOL	TRUE, if the action conditions are fulfilled; read only
		ManEnable	BOOL	TRUE - permits action processing in the manual mode; write
		MonErrorFE	BOOL	Used internally; flag for indication of a falling edge (criteria analysis)

Fig. 5-5: Overview of action system variables

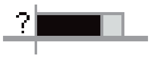
5.5 Overview of Action Qualifiers



S_A: The step becomes active
T_1: The action time is between S_A and S_E
S_E: The step becomes inactive
T_2: The action time is outside of S_E
R: The action block is reset

Fig. 5-6: Time diagram for the action qualifiers

The bar is to be interpreted as follows:



?: No statement on processing

Black: The action is being processed.

Gray: The action is being postprocessed (once).

5.6 System Variables of Sequences

The sections below describe the data type “_INDRASTEP_02” .

- **INTERN** Mode management; for internal use only
- **i** Input signals for mode control of the sequence
- **q** Status signals for mode control of the sequence
- **Flags** which can be used to activate the mode-depending outputs.

_INDRASTEP_02	**STRUCT**	
INTERN	_INDRASTEP_02_INTERN	Internal control interface of the IndraStep sequential function chart
i	_INDRASTEP_02_STEUERST	Control Signals “i”
q	_INDRASTEP_02_STATUS	Status Signals “q”
Manual	BOOL	Contact which indicates the manual mode (read only)
Auto	BOOL	Contact which indicates the automatic mode (read only)
AutoStep	BOOL	Contact which indicates the AutoStep mode (read only)
Stopped	BOOL	Contact which indicates that the sequential function chart has stopped (read only)
Control_a	BOOL	Status contact - opens on a stop, error, and in case of the AutoStep mode with AutoStepEnable
Control_b	BOOL	Status contact - opens at the end of the action (in analogy with action.Q)
Control_c	BOOL	Status contact - function same as for Control_a, with additional diagnosis if the logic result before the contact is FALSE
Transition_OK	BOOL	Contact which is closed under the marginal condition *“AutoStep mode”, “Action processing = TRUE”,* and *“Following transition condition fulfilled”.*
WaitOnTransition	BOOL	Contact which indicates that one transition is fulfilled in the AutoStep mode. "Start" switches on to the next step (see AutoStep Mode on page 4-61)
MonError	BOOL	This flag can be used for monitoring purposes in a rung. If the flag is set to TRUE, the sequential function chart enters the failure mode. In this case, the IndraStep ***criteria analysis*** analyzes only this rung.
MonErrorFE	BOOL	Has the same effects as MonError, with the exception that, here, only the falling edge is evaluated. Can be used to diagnose falling conditions (interruptions).
TimeErrorStepDiag	BOOL	This contact can be used to monitor error conditions. If it responds, the possible error causes (inactive outputs with their control rungs) or, if these are not available, the non-fulfilled transition rung is searched from all actions of the active step.
SetStep	BOOL	Permits, in the automatic mode, further processing of the sequential function chart starting with that step assignment which has been selected by <step name>. **Sync** (see SetStep in the Automatic Mode on page 4-34)
ManualForce	BOOL	Permits to set variables in the manual mode, without taking the locking conditions into consideration. Beforehand, the signal must be applied in <SFC name>.**INTERN.aIN_USER** (see Activating Outputs by ManualForce in the Manual Mode on page 4-82)
END_STRUCT		

Fig. 5-7: Structure “_INDRASTEP_02” (flag highlighted in gray)

Notes on the Control_a, Control_b and Control_c Flags

- **Control_a**

Status contact - opens on action end, stop, error, and in case of the AutoStep mode with **AutoStepEnable**

Control_a is TRUE, if:	**Control_a is FALSE, if:**
SFC.AutoStepEnable = TRUE in the AutoStep mode	<SFC name>.Enable = FALSE in the AutoStep mode
Regular processing of actions	Postprocessing of actions
No error (e.g. MonError)	Error
Not stopped	Stopped

Fig. 5-8: **Control_a** conditions

- **Control_b**

Status contact - opens at the end of the action (in analogy with <action name>.Q)

- **Control_c**

Status contact - function same as for **Control_a,** with additional diagnosis if the logic result before the contact is FALSE

Note: An action error is not evaluated for the first processing cycle of the action.

Purpose: If the following transition is directly fulfilled after a step, an action diagnosis is not executed even if the action is not fulfilled.

Control Signals "i"

Input signals which can be used to change the operating modes and to manipulate the sequence.

_INDRASTEP_02_STEUERST	**STRUCT**	
Start	BOOL	Start signal for the sequential function chart after a stop
Stop	BOOL	The sequential function chart is stopped.
Revers	BOOL	Recommended for users: Using the <step name>.**SYNC** variables and **SetStep,** the user is able to program reverse processes.
AutoStep	BOOL	Selection of the AutoStep mode
Manual	BOOL	Selection of the manual mode
ManualForce	BOOL	Permits to activate an output controlled via **Control_a** in the manual mode, without taking the enable conditions into consideration. To achieve this, the **ManualForce** signal must be locked in the action **INTERN.aIN_USER,** by means of a key switch contact.
SetStep	BOOL	Unconditional jump to steps specified by <step name>.SYNC. Here, parallel steps must be taken into consideration.
Reset	BOOL	The sequential function chart is reset to the initial step und to the initial state.
ClearError	BOOL	An existing error is cleared.
END_STRUCT		

Fig. 5-9: Control signals for mode control

Status Signals "q"

Output signals indicating the current mode as well as its additional properties, such as error messages and the like.

_INDRASTEP_02_STATUS	**STRUCT**	
Error	BOOL	An error is existing; the sequential function chart is stopped.
ErrorSetStep	BOOL	Error in setting the steps which have been preselected by the <step name>.SYNC variables and whose processing has been initiated by setting **i.SetStep.** Note: Take note of parallel steps!
Stopped	BOOL	The sequential function chart is in the stop mode.
Manual	BOOL	The sequential function chart is in the manual mode.
AutoStepActive	BOOL	At least one step/transition is in the AutoStep mode.
WaitOnTransition	BOOL	At least one transition following an active step is fulfilled.
Revers	BOOL	Recommended for users: The sequential function chart is in the reverse mode.
Ready	BOOL	Recommended for users: The sequential function chart is ready for the start enable signal.
Active	BOOL	The SFC is active **and** has exited the initial step.
Run	BOOL	The SFC processes active steps, or at least one step is active in the manual mode.
END_STRUCT		

Fig. 5-10: Status signals of the mode control

6 ProVi Messages (Overview)

This section contains information on how to handle diagnosis messages in WinPCL:

- ProVi Messages (Diagnosis in LD / IL Rungs)
- Sequential Function Chart Diagnosis
- Module Assignment (Multiple Use of POUs)
- Diagnosis Display of I/O Addresses in PRs and FBs

A difference is made between diagnosis messages which are related to instruction-list or ladder-diagram rungs and diagnosis messages which are bound to sequential function charts.

Since a diagnosis message is always filed in the program code, it is necessary to assign modules, if several instances exist of one function block with diagnosis generation.

6.1 ProVi Messages (Diagnosis in LD / IL Rungs)

General Information

ProVi messages are messages which are emitted by the PLC and can be displayed on the WinHMI interface or on the compact operator terminals by means of the Screen Manager /3/.

ProVi messages comprise five different messages types:

- Errors
- Messages
- Warnings
- Start requirements
- Setup diagnosis messages

The type of message determines the type of display on the WinHMI interface (see /2/ WinHMI documentation).

The “warning, start requirement and setup diagnosis” message types are existing only once per control.

The “error and message” message types are existing only once per module. If several modules are provided in one control, the message types may also exist several times (for modules see /2/ WinHMI documentation).

The text to be displayed for a ProVi message must be entered in the ***Message Integrator.*** There the message can also be translated for the multilingual diagnosis function (also see /2/ WinHMI documentation).

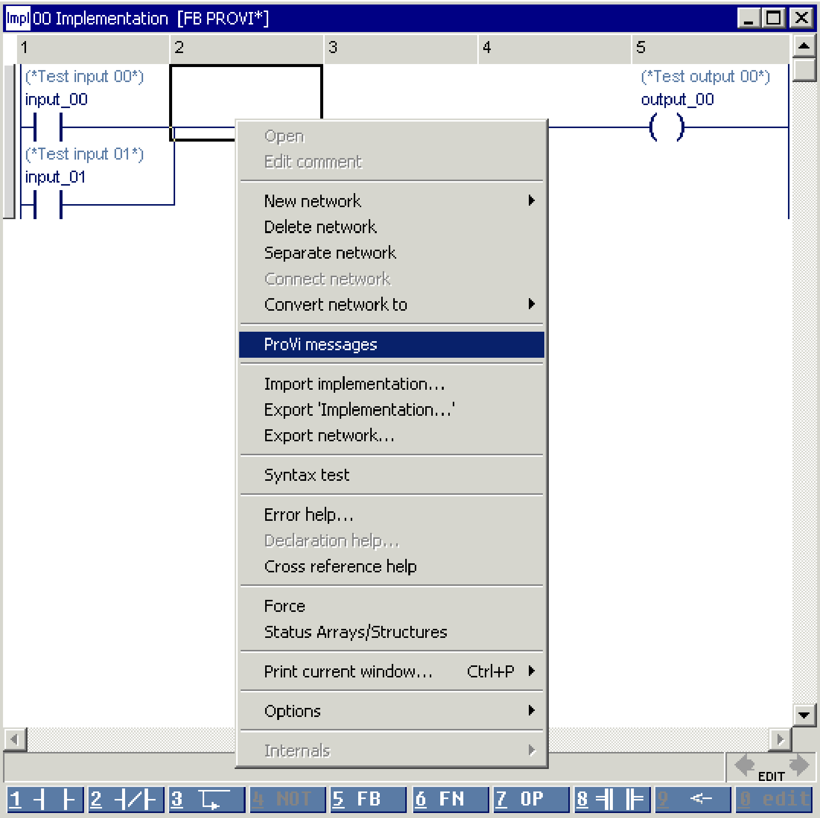
Programming a ProVi Message

ProVi messages can be emitted in each program and in each instance of a function block.

In these programs and function blocks, a ProVi message can be assigned to each rung having a Boolean result.

Proceed as follows:

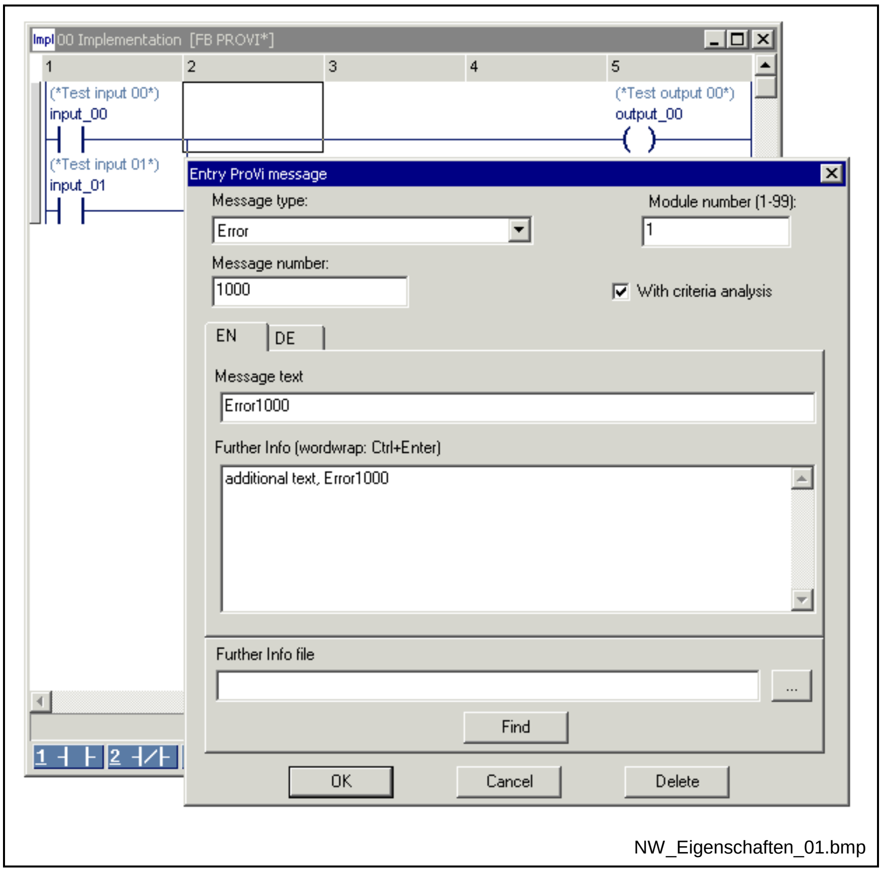
- Program the rung to initiate the ProVi message.
- Click the right mouse button (or press <Shift>+<F10>) to select the ProVi messages item.



NW_Eigenschaften_00.bmp

Fig. 6-1: Assigning the network (rung) properties

- This opens a dialog where the message type (error, message, warning, etc.), the message number and the module number can be entered.


Message type: Error

Module number (1-99): 1

Message number: 1000

☑ With criteria analysis

Message text: Error1000

Further Info (wordwrap: Ctrl+Enter): additional text, Error1000

Further Info file:

NW_Eigenschaften_01.bmp

Fig. 6-2: Dialog for selecting the message type

ProVi Message, Input Dialog

This dialog (“Entry ProVi message”) can be used to enter the text to be displayed for a ProVi message in several languages. The data entered here will then be displayed in the Message Integrator and, in WinHMI, for the diagnosis message.

The dialog can also be used to select texts already existing in the Message Integrator and to assign these texts to a message in a rung.

Selecting an unused message number automatically

If the dialog is opened for a rung which does not contain any ProVi message, an unused message number is automatically suggested after a message type and a module number have been selected. This number corresponds to the highest existing message number + 1.

This message number can then be used to enter the message text, the further info text and the further info file in this dialog.

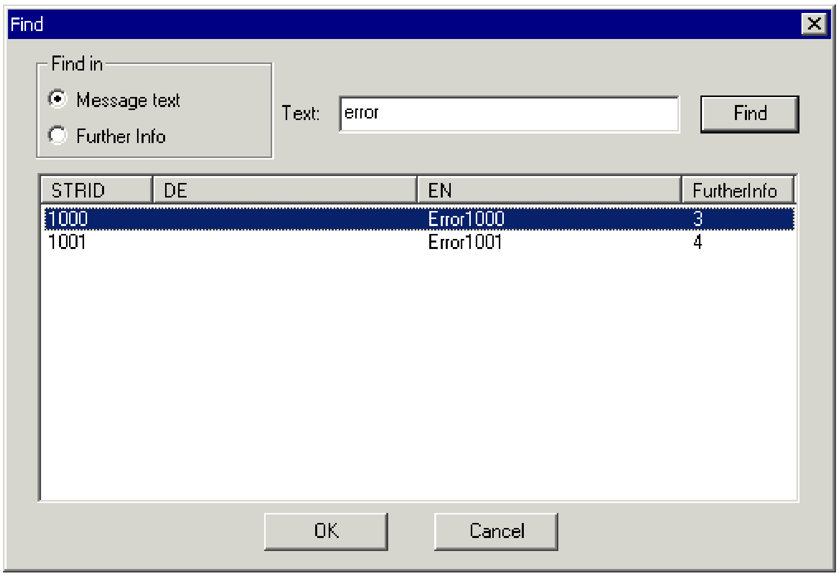
Selecting an unused message number manually

If the automatically selected message number fails to be the desired one, the message number can also be entered manually. If the ***Message Integrator*** contains data for this message number, this data is displayed in the dialog where it can also be edited.

Finding a message number

It is also possible to find an already existing message text and to apply its message number.

The find dialog can be called up by clicking the “Find” button.



● Message text
○ Further Info

Text: error

STRID	DE	EN	FurtherInfo
1000		Error1000	3
1001		Error1001	4

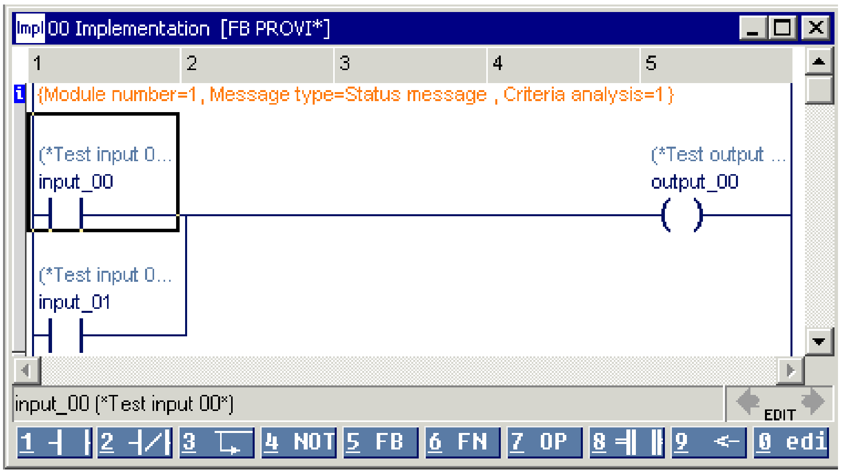
NW_Eigenschaften_03.bmp

Fig. 6-3: Find window entered from the “Entry ProVi message” window

Message numbers can be found in the message texts or in the further info texts. The search is always made in all existing languages.

Once the dialog is exited with OK, the message number selected is applied to the ProVi message input dialog.

- Any ProVi message assigned to the rung is indicated by the “i” to the left of the status bar of the rung.



{Module number=1, Message type=Status message, Criteria analysis=1}

input_00 (*Test input 00*)

NW_Eigenschaften_02.bmp

Fig. 6-4: The “blue I” indicating a ProVi message

Output of ProVi Messages

If the Boolean result of a ProVi rung is TRUE, the message is emitted. The message remains active until the result of this rung becomes FALSE again.

Here, the status of the variable at the time of processing the rung is of relevance, and not the status of the variable at the end of the cycle. Hence, the same variable can be used in various ProVi rungs.

Note: If a rung is not processed any more, e.g. if it is skipped, or if the action is not active any longer, a change of the ProVi message is no longer possible. In other words: If the condition for output of a message is not fulfilled any more and the rung of this message is not processed any longer, the message still remains active.

ProVi Criteria Analysis

The default setting of ProVi messages is without criteria analysis. However, the ***criteria analysis*** can be activated for each single message.

In order to achieve a reasonable diagnosis, certain programming guidelines must be observed.

- The code in the sequential function chart may contain Boolean variables only.
- Operations with XOR are not permitted.
- Function or function block calls are not permitted.
- Temporary flags, i.e. an assignment within a rung, are not permitted.

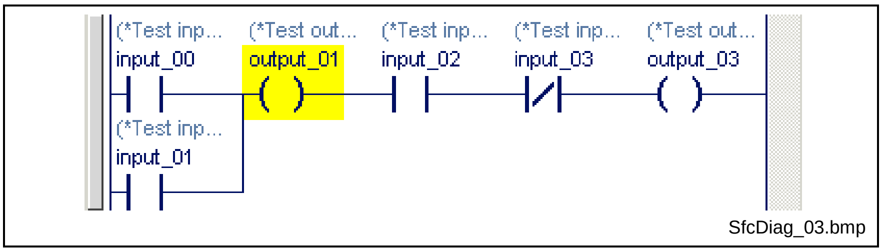


Fig. 6-5: Impermissible use of the temporary flag “output_01” (yellow)

Permissible exceptions are the following:

- *Temporary flags* which are only used within their own action.
- *Variables whose rungs are not displayed in the diagnosis:*
  If the IndraStep variables ***TimeErrorStepDiag*** and ***SetStep*** are used in rungs, these rungs are removed from the diagnosis.
- *Hiding function blocks from the diagnosis:*
  Function blocks in rungs to be subjected to diagnosis are removed from the diagnosis if the first (topmost) input and the first (topmost) output of the function block are of the BOOL type.

  Time stages (TON) are typical for this application.

  The code at the first input and output is displayed (see example of the “output_03” variable).

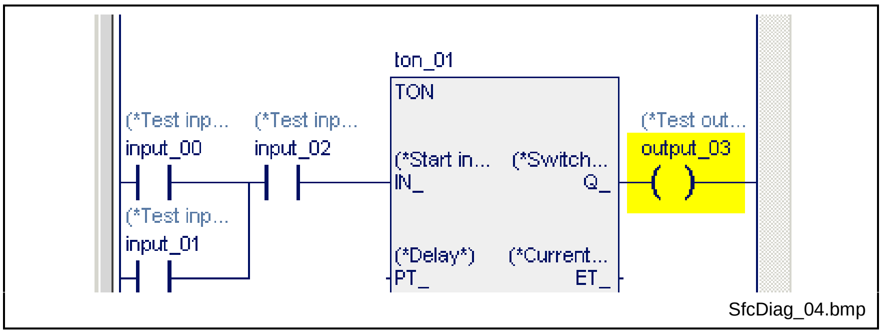


Fig. 6-6: Hiding function blocks in the diagnosis by defined variables (yellow)

The diagnosis display is as follows:

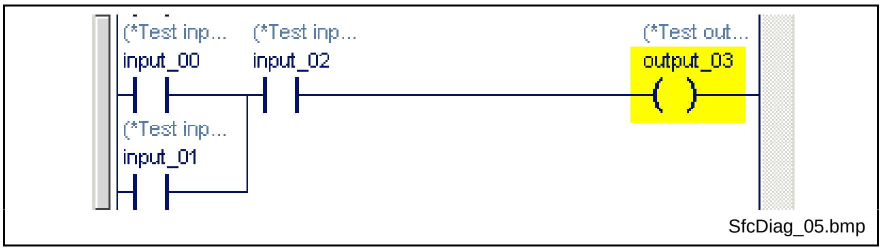


Fig. 6-7: Hidden FB

In the ProVi criteria analysis, the I/O addresses of the variables are displayed (see Section 6.3, Diagnosis Display of I/O Addresses in PRs and FBs).

6.2 Sequential Function Chart Diagnosis

General Information

Each sequential function chart with operating modes is able to generate diagnosis messages on the WinHMI interface.

The ***criteria analysis*** can be called for this sequential function chart. The criteria analysis will then display one or several contacts having triggered the error of the sequential function chart.

The ***criteria analysis*** is activated automatically for each sequential function chart with diagnosis that has failed, without an additional code having to be programmed. The following section, Programming Instructions on page 6-3, contains a couple of restrictions which are required to obtain a reasonable criteria analysis.

By assigning a sequential function chart to a module, the place of display on the WinHMI interface is determined.

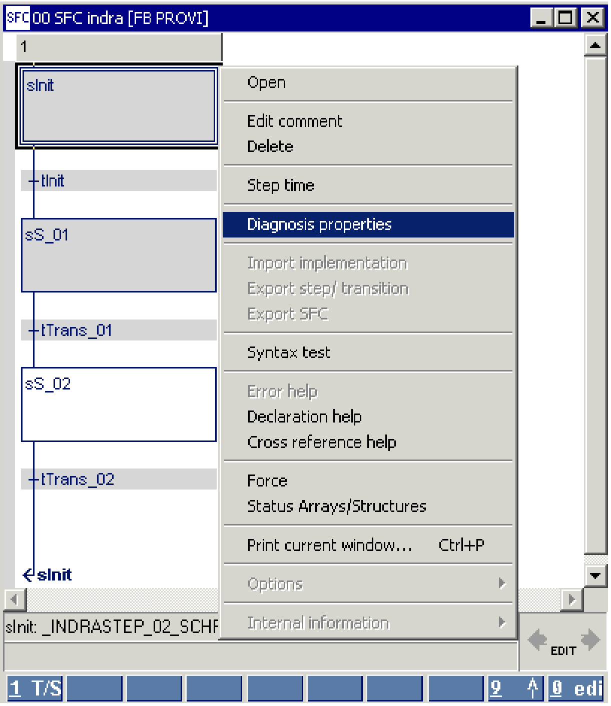
The diagnosis comments of the sequential function chart (sequence, action, transition, steps, variables, IL / LD) can be translated in the ***Message Integrator*** to provide a multilingual display of the diagnosis.

Programming a Sequential Function Chart Diagnosis

The assignment of a module to the sequential function chart results automatically in the diagnosis for this sequential function chart.

Proceed As Follows:

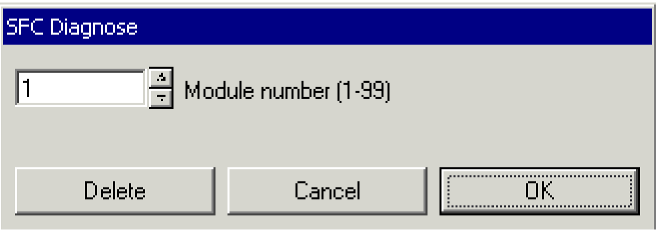
- Program the sequential function chart which is to trigger the diagnosis message.
- Click the right mouse button or press <Shift>+<F10> to select the Diagnosis properties item.



SfcDiag_00.bmp

Fig. 6-8: Assigning the diagnosis properties

- This opens a dialog box for entering the module number.



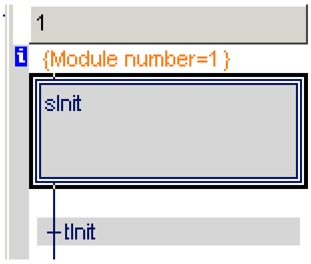
SFC Diagnose

1 Module number (1-99)

SfcDiag_01.bmp

Fig. 6-9: Dialog box for entering the module number

- The i to the left of the status bar of the sequence indicates that diagnosis information has been assigned to this sequential function chart.



SfcDiag_02.bmp

Fig. 6-10: The “blue I” indicating a sequential function chart with diagnosis

Output of Sequential Function Chart Diagnosis Messages

If a sequential function chart enters the failure mode, a message is emitted.

This message contains the SFC name, the step that has failed and the error type of the sequential function chart. This message remains active until the error of the sequential function chart has been cleared.

For this failed sequential function chart, the criteria analysis can also be called on the WinHMI interface (see WinHMI documentation /2/).

Programming Instructions

These instructions are applicable to programming the sequential function chart, i.e. only those actions and transitions are concerned which are contained in a sequential function chart with diagnosis.

The implementation as well as the actions and transitions which are not used in the sequential function chart diagnosis are not displayed in the ***criteria analysis.*** As a consequence, these rules are not applicable to the code contained therein either.

- It is not permitted to use Boolean transitions or Boolean actions.
- The code in the sequential function chart may contain Boolean variables only.
- Operations with XOR are not permitted.
- Function or function block calls are not permitted.
- Temporary flags, i.e. assignments within a rung, are not permitted (see the example below).

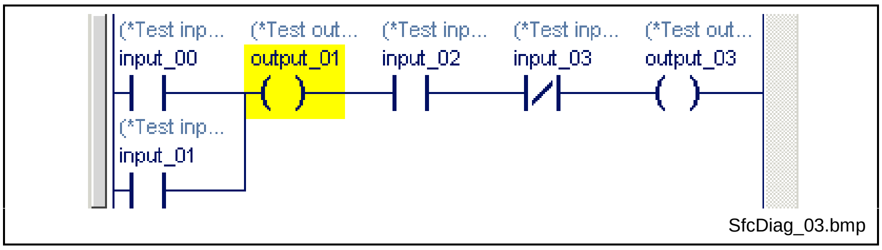


Fig. 6-11: Impermissible use of the temporary flag “output_01” (yellow)

Permissible exceptions are the following:

- *Temporary flags* which are only used within their own action.
- *Variables whose rungs are not displayed in the diagnosis:*
If the IndraStep variables ***TimeErrorStepDiag*** and ***SetStep*** are used in rungs, these rungs are removed from the diagnosis.
- *Hiding function blocks from the diagnosis:*
Functions blocks in rungs to be subjected to diagnosis are removed from the diagnosis if the first (topmost) input and the first (topmost) output of the function block are of the BOOL type.

  Time stages (TON) are typical for this application.

  The code at the first input and output is displayed (see example of the “output_03” variable).

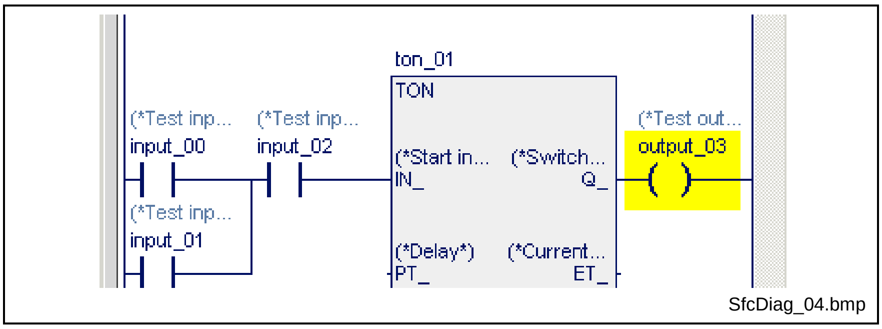


Fig. 6-12: Hiding function blocks in the diagnosis by defined variables (yellow)

The diagnosis display is as follows:

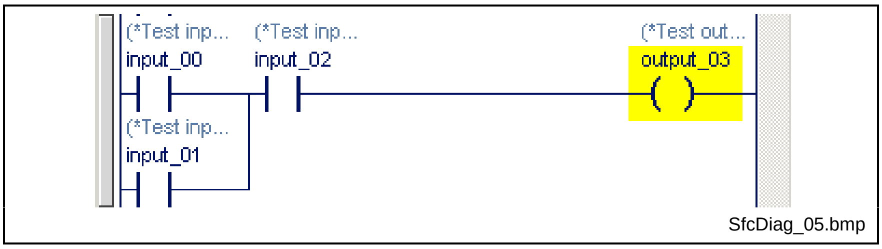


Fig. 6-13: Hidden FB

6.3 Diagnosis Display of I/O Addresses in PRs and FBs

In the ***criteria analysis,*** the I/O address and the related comment are displayed for those variables which are connected to absolutely addressed inputs and outputs.

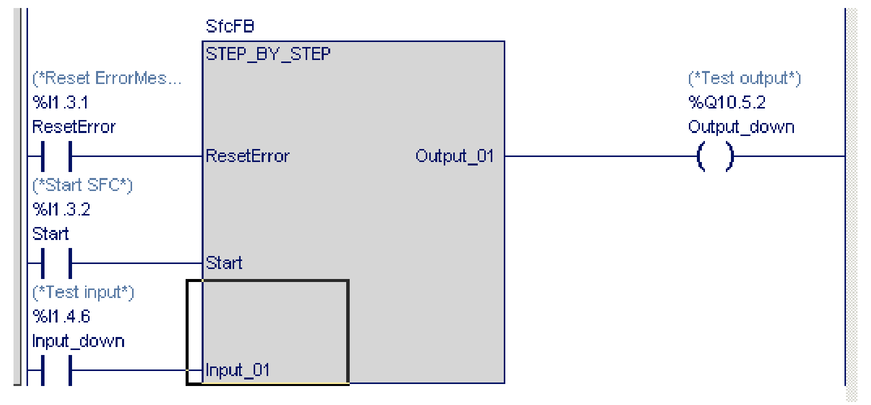
This also functions under the following conditions, if the real I/O variable is not defined in the POU of the sequential function chart, but is only transferred to it:

1. The I/O variable is defined globally and is used as VAR_EXTERNAL variable in the POU.
2. The variable displayed is an input or output of the POU. An I/O variable is directly connected to this input or output. The variable may neither be negated nor be linked to other variables.

Note: A call of the POU must always be processed since, otherwise, the status of the internal variables is not the same as the status of the input or output.

Example:

The variable input_01 is used in the sequential function chart of the POU SfcFB. For this variable, the criteria analysis displays the address %I1.4.6 and the comment “test_input”.



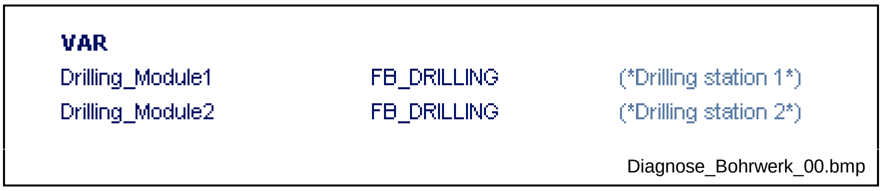
SfcDiag_06.bmp

Fig. 6-14: Diagnosis display of absolute addresses in FBs

6.4 Module Assignment (Multiple Use of POUs)

If a function block or a program with diagnosis is provided with several instances, it is necessary to define the instance where the diagnosis should be displayed.

Example:
There is a function block (FB_DRILLING) which entirely controls a drill and also contains the diagnosis messages of the drill. One control is to control two modules each of which contains one drill. Instances of the same function block are used for the two drills.



```
VAR
Drilling_Module1          FB_DRILLING          (*Drilling station 1*)
Drilling_Module2          FB_DRILLING          (*Drilling station 2*)
```

Diagnose_Bohrwerk_00.bmp

Fig. 6-15: Declaration of two instances of FB_DRILLING

ProVi messages (errors and messages) and a sequential function chart (drilling station) are programmed in this function block.

During programming, module numbers had to be specified for these diagnosis messages (sequential function chart diagnosis). In our example, module number 1 has been programmed. The diagnosis for one of the drills, however, is to be displayed in module 1 and that of the other drill in module 2.

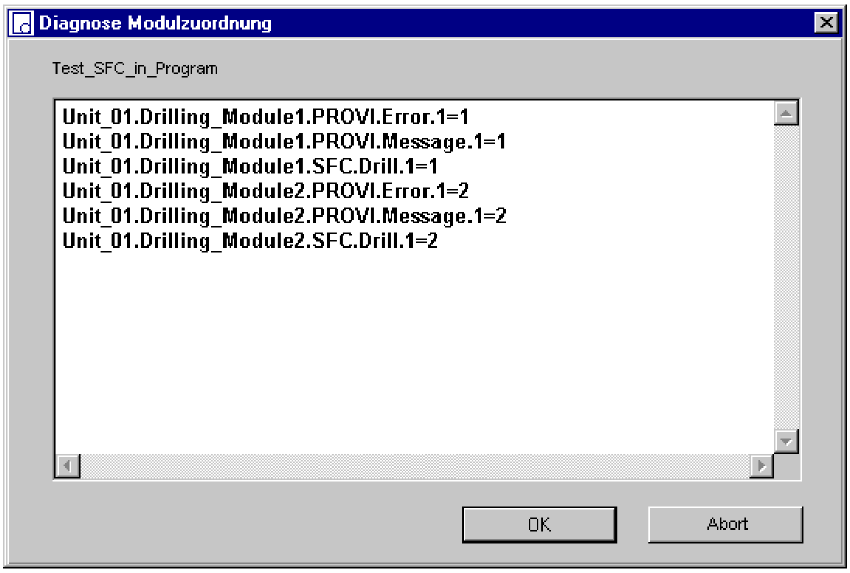
In the resource, each use of a diagnosis message can be provided with its own module number.

The dialog for the module assignment can only be called for the resource of the PLC program. It can be reached via the menu item *Tools / Diagnosis module assignment.*

This dialog contains an ASCII editor where the module assignments can be entered, with the appropriate syntax being observed.

Example:
The program where the two drills (see above) are declared is declared as unit_01 in the resource.

In this dialog, module number 1 is assigned to all diagnosis messages from Drilling_Module1 and module number 2 to all diagnosis messages from Drilling_Module2.



```
Unit_01.Drilling_Module1.PROVI.Error.1=1
Unit_01.Drilling_Module1.PROVI.Message.1=1
Unit_01.Drilling_Module1.SFC.Drill.1=1
Unit_01.Drilling_Module2.PROVI.Error.1=2
Unit_01.Drilling_Module2.PROVI.Message.1=2
Unit_01.Drilling_Module2.SFC.Drill.1=2
```

Diagnose_Bohrwerk_01.bmp

Fig. 6-16: Diagnosis module assignment

If no entry is made in this dialog, the original module number is assigned, i.e. the entry for Drilling_Module1 in the figure above is actually not necessary because the original module number is already 1.

Syntax:

- The various specifications are always separated by a dot.
- Defined keywords are **SFC, PROVI, ERROR, MESSAGE.**
- The complete instance must be entered for the POU. The various instances of the POUs are separated by a dot. Example: Unit_01.Drilling_Module1
- Sequential function charts are specified by **SFC.***SfcName.ModuleNo.*
  - *SfcName* = name of the sequential function chart in the POU
  - *ModuleNo.* = originally programmed module number (sequential function chart diagnosis)
- ProVi messages are specified by **PORVI.***MessageType.ModuleNo.*
  - *MessageType* = **ERROR** or **MESSAGE**
  - *ModuleNo.* = originally programmed module number (diagnosis in LD/IL rungs)

  Since there is no module number for the other ProVi message types, they cannot be assigned here.

The assignment to the module number can be made at any point in the path. That is why it is not necessary to enter the entire character string:

Character string	**Meaning**
Unit_01.Drilling_Module2.PROVI.Error.1=3	Only this message type is displayed in module 3.
Unit_01.Drilling_Module2.PROVI.Error=3	All ProVi errors in this instance are displayed in module 3.
Unit_01.Drilling_Module2.PROVI=3	All ProVi messages in this instance are displayed in module 3.
Unit_01.Drilling_Module2.SFC.Drill=4	Only this sequential function chart is displayed in module 4.
Unit_01.Drilling_Module2.SFC=4	All sequential function charts of this instance are displayed in module 4.
Unit_01.Drilling_Module2=5	All diagnosis messages of this instance of the POU are displayed in module 5. This also applies to all instances of the POUs which are declared int his POU.
Unit_01=5	All diagnosis messages occurring in this program are displayed in module 5. This also applies to all instances of the POUs which are declared in this POU (in our example: Drilling_Module1 and Drilling_Module2).

Fig. 6-17: Examples for the assignment of module numbers

It is always the last module assignment in an instance path that transfers its value. If, for instance, the following assignments are made:

Unit_01.Drilling_Module2.SFC.Drill=4

Unit_01.Drilling_Module2=3

Unit_01=2

the diagnosis messages from the example are displayed in the following modules:

- Instance Unit_01.Drilling_Module1
  - ProVi error 1 in module 2
  - ProVi message 1 in module 1
  - Sequential function chart drill 1 in module 2
- Instance Unit_01.Drilling_Module2
  - ProVi message 1 in module 3
  - ProVi message 1 in module 3
- Sequential function chart drill 1 in module 4

7 Instructions

7.1 Criteria Analysis

ProVi messages and IndraStep sequential function charts can be ***supplemented*** by automatically generated diagnosis messages, which can be displayed directly on the HMI interface without requiring any additional configuration. In the case of ProVi networks, this is the network property with activated “criteria analysis”; in the case of IndraStep sequential function charts, it is the assignment to a module in the sequence overview. The criteria analysis is not necessarily activated in the case of IndraStep sequential function charts and ProVi messages. If it is used, however, certain rules must be followed. Should these rules not be observed, the syntax check or the compiler will not cause any errors, but the diagnosis may be incorrect or incomplete.

Which Elements can be Processed by the Criteria Analysis?

As a matter of principle, only operations of Boolean variables can be analyzed. These may be declared globally and locally. They may be part of multi-element variables (ARRAYs and structures as well as mixtures of these). Here, it is not permitted

- to determine an intermediate result within the rung,
- to use the XOR operation,
- to analyze operations, functions and function blocks.

If non-Boolean variables are existing in the rung, e.g. a comparison of two numerals, they are always considered to be faulty or, when the motion signal is calculated by IndraStep, to be fulfilled.

ProVi An exception here are function blocks whose topmost input is a Boolean input and whose topmost output is a Boolean output.

Such a function block is completely suppressed by the criteria analysis, i.e. the criteria analysis considers the topmost input to be connected to the topmost output. As a consequence, e.g. timers for delaying the message in case of limit-switch pair monitoring can be used. To generate a reasonable error display, the function block used must transfer a positive network result (logic result VKE = TRUE) from its topmost input to its topmost output in the event of an error.

To save the error state, a ***latch*** can be programmed. If a latch is provided in the rung, the complete OR branch is suppressed by the criteria analysis, even if it comprises still other contacts, thus not appearing on the display.

IndraStep Here as well, an exception are function blocks whose topmost input is a Boolean input and whose topmost output is a Boolean output.

In the case of IndraStep, the output of the FB must, in addition, be assigned to specific IndraStep elements (MonError, MonErrorFe).

Such a function block is completely suppressed by the criteria analysis, i.e. the criteria analysis considers the topmost input to be connected to the topmost output. As a consequence, e.g. timers for delaying the message in case of limit-switch pair monitoring can be used. To generate a reasonable error display, the function block used must transfer a positive network result (logic result VKE = TRUE) from its topmost input to its topmost output in the event of an error.

In the case of IndraStep, a difference can be made between manual and automatic network branches (<SFC name>.Manual or <SFC name>.Auto), depending on the operating mode. If the automatic mode is activated, the branch in which the <SFC name>.Manual has been programmed is ignored, thus not appearing in the analysis.

Complete networks, which activate a <SFC name>.SetStep or <SFC name>.TimeErrorStepDiag relay, are excluded from the diagnosis.

These networks can also contain FBs and functions, etc.

How Many Rungs are Covered by the Criteria Analysis?

ProVi As far as ProVi is concerned, the criteria analysis covers only the particular rung to which the ProVi property has been assigned. In other words, all contacts involved in the error must be within the rung.

IndraStep As far as IndraStep is concerned, errors are covered by the criteria analysis within an action. For that reason, a dummy calculation can even be made within the failed action with IndraStep. If diagnosis is necessary, only an action or transition will be displayed as the error cause. If several actions are programmed in a step, the first action processed (order from the SFC list) will be signalled as the faulty action. If several rungs are contained in a failed action, the rungs are analyzed for non-compliance and, thus, displayed in the order of processing, in the event of an action or time error.

If several rungs in one action are connected via dummies, the particular dummy is replaced by the rung above it.

Using FBs, FNs and OPs

With the exception of the simple FBs for delaying failures which are not displayed in the criteria analysis, it should be avoided to use FBs, FNs or OPs in rungs which can be subjected to the criteria analysis. If, however, it is necessary to use such functionalities nonetheless, they should not be used within the IndraStep sequential function chart or ProVi rungs with criteria analysis. If, for instance, an excess temperature is to be displayed, the temperature comparison must be programmed outside of the sequential function chart, before calling the sequence (the yellow box) or in the action **“aInUser”** or before the ProVi rung. The result of such a function is to be mapped on a Boolean flag which is used in the stead of the function in the rung to be analyzed. This has the advantage, that the operator of the machine receives a clear message (in our case a flag contact **“excess temperature (*excess temperature oil hydraulics assembly XYZ*)**) which can usually be understood more easily than a comparison with values requiring interpretation.

Supplement of Future IndraStep Versions with FBs/FNs/OPs

To be able to use FBs/FNs/OPs directly within an action, a flag **“NoDiag”** must be added as relay to the operation result. If this flag name is used, the rung where it is used as relay will be excluded from diagnosis.

A second normal flag (e.g. **“excess temperature: BOOL; (*excess temperature at assembly XYZ*)”**) which has been switched in parallel can be used for diagnosis in the following rung.

Displayed Status Values of a Criteria Analysis

On the one hand, the criteria analysis displays the stored state of the variables used as it was when the error occurred and, on the other hand, the current status value corresponding to the usual online display of the editor.

The stored status value corresponds to the stored states of the involved variables immediately after the rung has been processed. As is the case with the normal status display, the current online variable values correspond to the variable values at the end of the PLC cycle.

7.2 Motion Signal with IndraStep

The motion signal is calculated by the HMI operating screen themselves, without the logic in the PLC being processed.

Steps and actions of the IndraStep sequential function chart are not processed in the manual mode. The logic of the step and its actions is only processed when the M-key is pressed.

To establish the motion signal without active processing, use is made of the functionality of the criteria analysis. The actions existing in a step, including their rungs, are checked for a positive rung result by the criteria analysis. As soon as at least one rung has a positive result (TRUE), the motion signal is signaled.

The calculation is functioning if only Boolean elements capable of analysis are used in the rungs.

In cases of doubt, i.e. if FBs, FNs or OPs are used, a positive result is assumed, i.e. a motion signal is displayed. In other words, it is possible that a motion and, thus, a diagnosis, is ***not*** initiated when the M-key is pressed.

8 Glossary

Criteria analysis

Tool for detecting error causes in the event of ***monitor errors*** or ***time errors.***

Device

In WinHMI, a control or a unit is also called device.

Diagnosis lens

If execution is not possible, the ***diagnosis lens*** permits to determine the conditions which are not fulfilled, using the ***criteria analysis.*** The function of calling the diagnosis lens can be deactivated, can always be active or can be bound to the manual mode via an SFC variable.

Head-end control

Main operator panel of the system

IndraStep

Sequence (sequential function chart) in a PLC function block or a PLC program on the basis of the IndraStep data types.

Local control

Device in front of the operator.

Mode = operating mode

Automatic mode = Auto

Automatic single-step mode = AutoStep mode

Manual mode = Manual

Module

WinHMI provides the option of designing the structure of the user interface according to mechanical-engineering or operating units by means of so-called modules. A module represents such a mechanical-engineering or operating unit.

Monitor errors

The ***criteria analysis*** of WinHMI cause exactly those rungs to be displayed in which the error variables **MonError** and **MonErrorFE** are controlled.

Motion instruction

Summary of all conditions to the left of **Control_a;**

Its calculation requires that the step / the action is active (automatic mode) or forced (manual mode).

MTGUI

Graphical user interface for calling and managing or configuring the programming system for NC (WinMTC) and PLC (WinPCL) as well as the WinHMI user interface. It is also based on Windows.

PC compound

Name for the PC network at a machine (e.g. transfer machine).

Process

Name same as in the NC area, i.e. designation of a sequential function chart programmed in the NC control.

ProVi

System for the generation (in the PLC) or display (in WinHMI) of various types of messages and/or failures.

Time errors

Time errors are errors for which the ***criteria analysis*** initially searches the output that has caused the error in all actions of the currently active step(s). For this output or these outputs, the rungs are signalled for diagnosis.

If the criteria analysis fails to find such an output, the rung of the non-fulfilled transition is signalled for diagnosis.

9 List of Figures

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