Functions integrated in the drive using conveyor-related applications as example

SINAMICS G120 and SINAMICS G120D

Application • May 2012

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Functions integrated in the drive using conveyor-related applications as example

Valid for FW V4.5

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1 Overview

Frequently, fast and reproducible responses of frequency converters to binary signals are required in applications.

A typical example of such an application is the changeover from rapid traverse/crawl and fast stop (quick stop) via sensors for conveyor-related applications.

Generally, applications such as these are realized by entering the sensor signals into the PLC via digital input modules – and the PLC then appropriately controls the frequency converter. However, the disadvantage of this solution is a fluctuating response time that is frequently too long. This is caused by the PLC cycle time and the bus circulating time.

All SINAMICS G120 – with the exception of the SINAMICS G120C – have ***freely parameterizable function blocks (FFB)*** as standard. These can be used in the frequency converter to implement pre-processing interlocking logic that can result in fast and reproducible responses.

By using the digital inputs and outputs of the SINAMICS G120 or the SINAMICS G120D as distributed I/O of the PLC, frequently, no additional I/O modules are required to connect sensors and actuators.

Fig. 1-1 SINAMICS G120 and SINAMICS G120D

2 Task description

The PLC should control the drive motor of a conveyor belt via the fieldbus (Profibus or Profinet) and supply the frequency setpoint (rapid traverse velocity).

Just in front of the stop sensor, when another sensor is actuated, the drive motor should be decelerated from rapid traverse to crawl and then shut down at the stop sensor itself.

For each direction, there is a sensor for the crawl motion and a sensor for the fast stop. The direction of motion defines which sensor pair is active. The other pair is deactivated.

A bypass signal from the PLC should be provided to move the goods being transported or to restart the conveyor belt when the stop sensor has been actuated.

In addition, the digital inputs of the G120 / G120D should be read-in as distributed I/O in the PLC and the digital outputs of the G120 / G120D used as distributed I/O of the PLC to control actuators (e.g. valves).

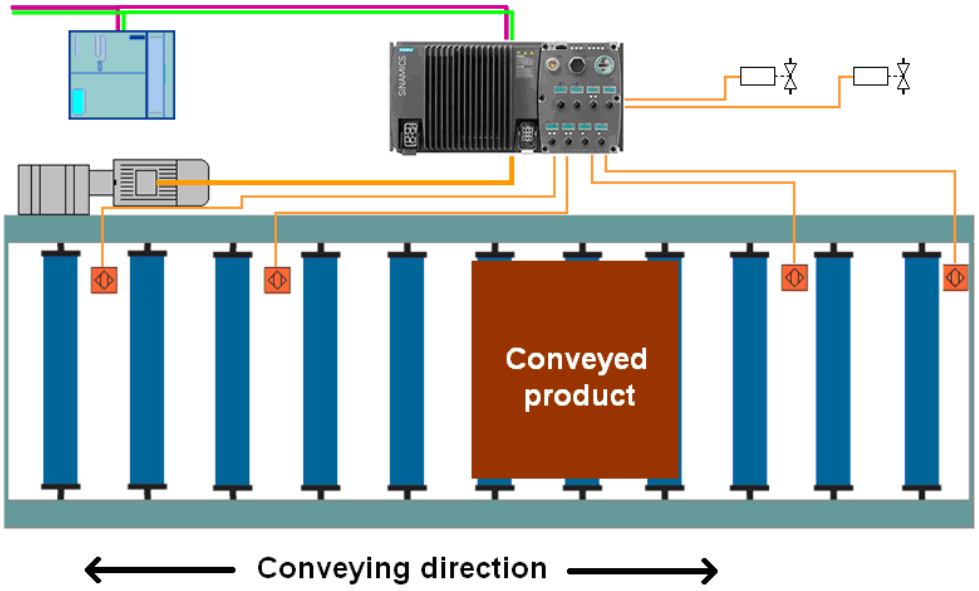

Fig. 2-1 Control of a conveyor

The implementation of the functionality will be subsequently described based on the SINAMICS G120 CU240D-2 PN. In principle, the procedure is the same for all other SINAMICS G120.

3 Implementation

The implementation is sub-divided between the S7 program and the SINAMICS G120 parameterization (parameter assignment).

3.1 SINAMICS Control Units

This Application is valid for the following SINAMICS G120 / G120 D Control Units (CU):

Table 3-1 Control Units

CU240B-2 DP	CU240D-2 DP
	CU240D-2 PN
CU240E-2 DP	CU240D-2 DP-F
CU240E-2 PN	CU240D-2 PN-F
CU240E-2 DP-F	CU240D-2 PN-F PP
CU240E-2 PN-F	

3.2 S7 program

In the S7 program, the SINAMICS G120 frequency converter is controlled and supplied with the frequency setpoint via the fieldbus (Profibus or Profinet).

An example of the S7 program is provided in this Application.

FC100

The FC 100 organizes the communication between the S7 and the drive. Status words from the drive are read-in and control words are sent to the drive.

FC 10

The information for the drive are interconnected at the FC100 in the FC10. Here, for example, the required enable signals for the drive are set via the control words. The bypass signal, control word 1 bit 12, is controlled in network 1.

Fieldbus telegram structure

Table 3-2 Fieldbus telegram structure

Word	S7 ➔ SINAMICS G120D	SINAMICS G120D ➔ S7
1	STW1	ZSW1
2	Frequency setpoint	Frequency actual value
3	Torque setpoint	Status of the DIs
4	STW2	ZSW2
5	---	Last fault number
6	---	Last alarm number

In addition to the usual signals of the STW1, the following signals should be supplied:

- STW1, bit 12 (signal 1 = sensors jumpered)
- STW2, bit 6 (signal 1 = control of the G120 DO 0)
- STW2, bit 7 (signal 1 = control of the G120 DO 1)

3.3 SINAMICS

In SINAMICS G120 / G120D, the appropriate logic operations are executed using a script file. Using a script file, similar to a macro, the logic operations to be implemented in the drive can be configured in a very user-friendly fashion. The script file is called once for this purpose.

For a better understanding, the control signals from the PLC and the essential interconnections in the SINAMICS are subsequently shown, marked in red in the function diagram.

3.3.1 Rapid traverse / crawl changeover function

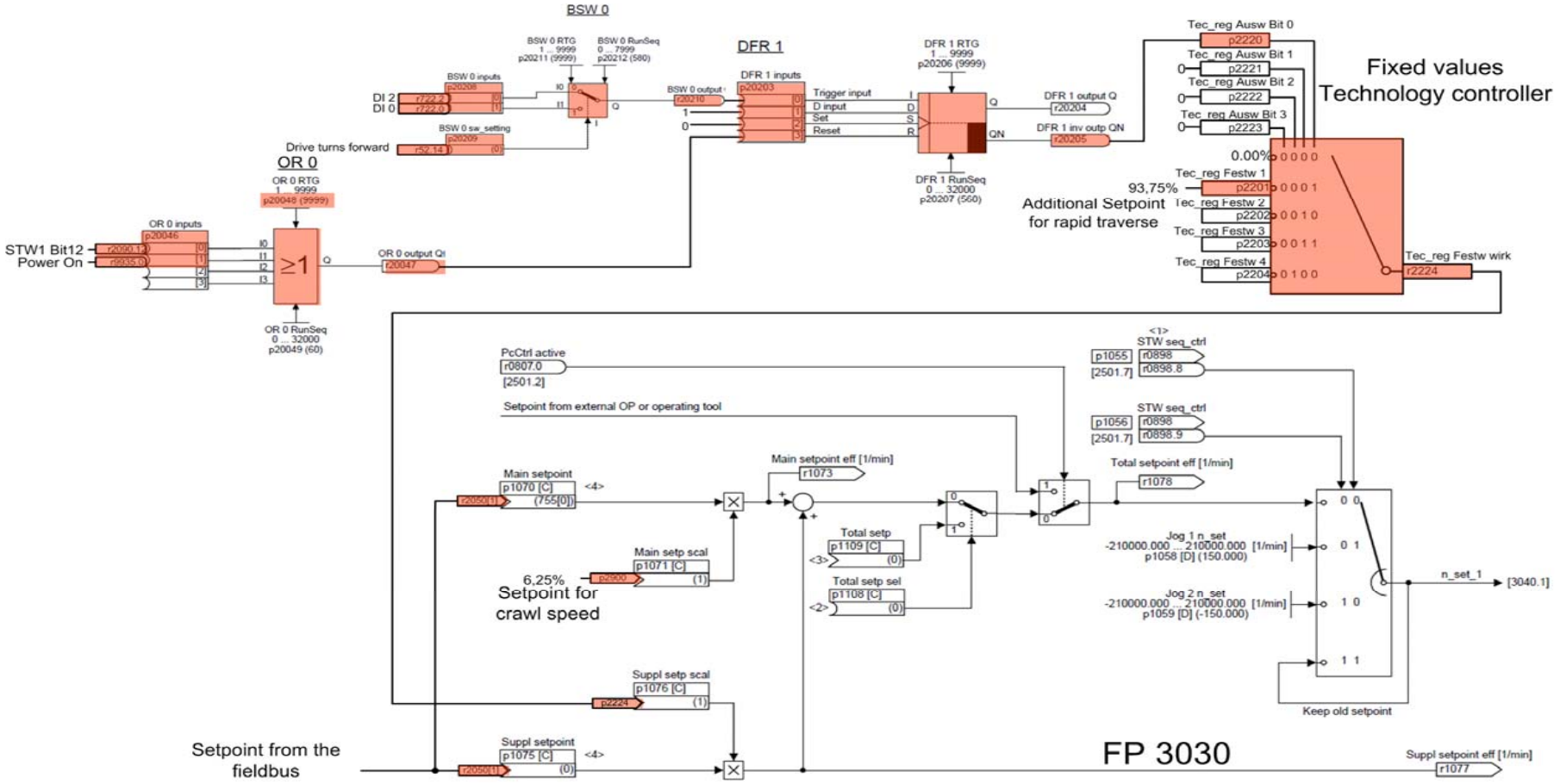

Figure 3-1 Rapid traverse / crawl changeover function

3.3.2 Fast stop function

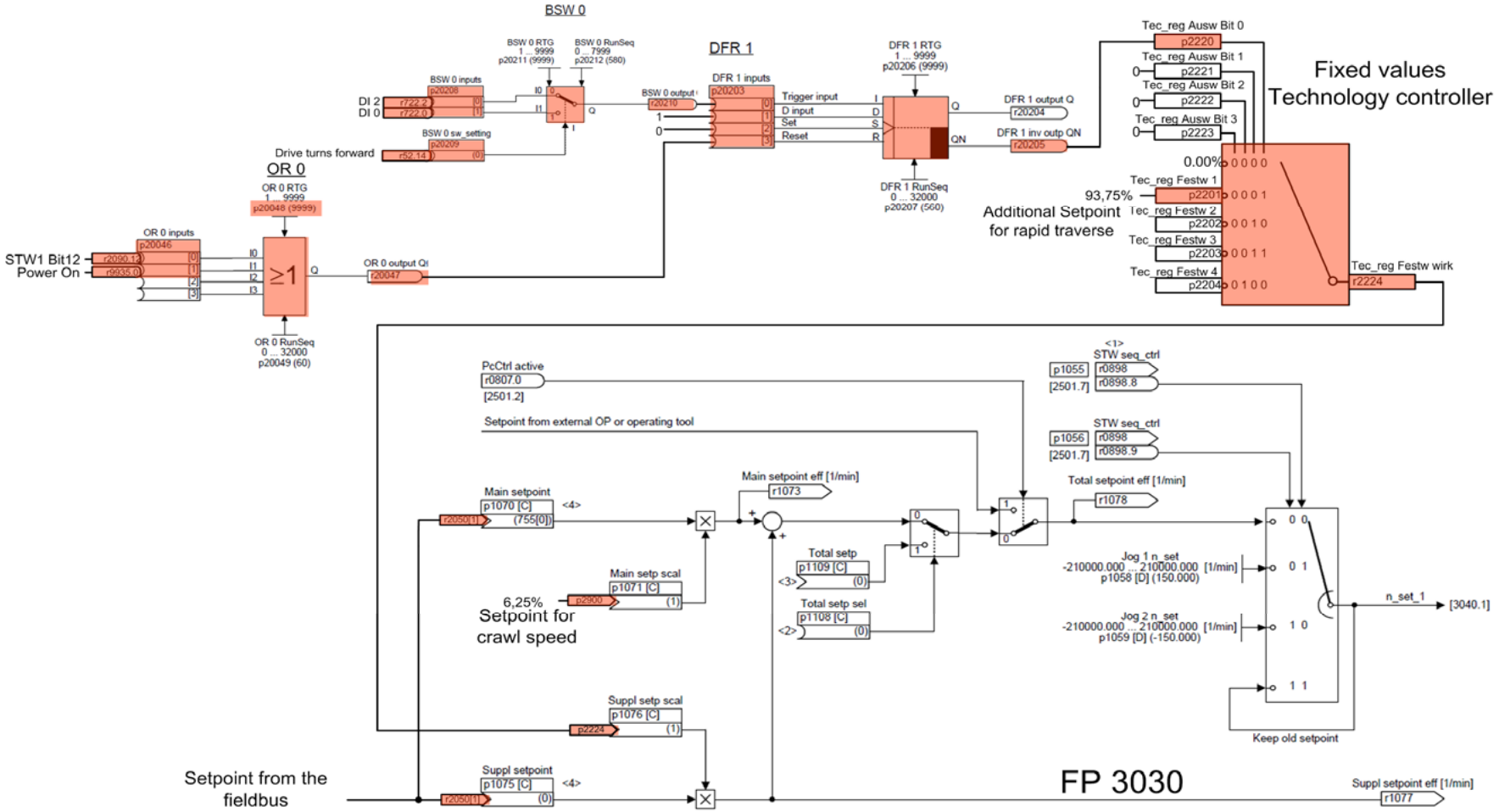

Figure 3-2 Fast stop function

3.3.3 Digital output control function

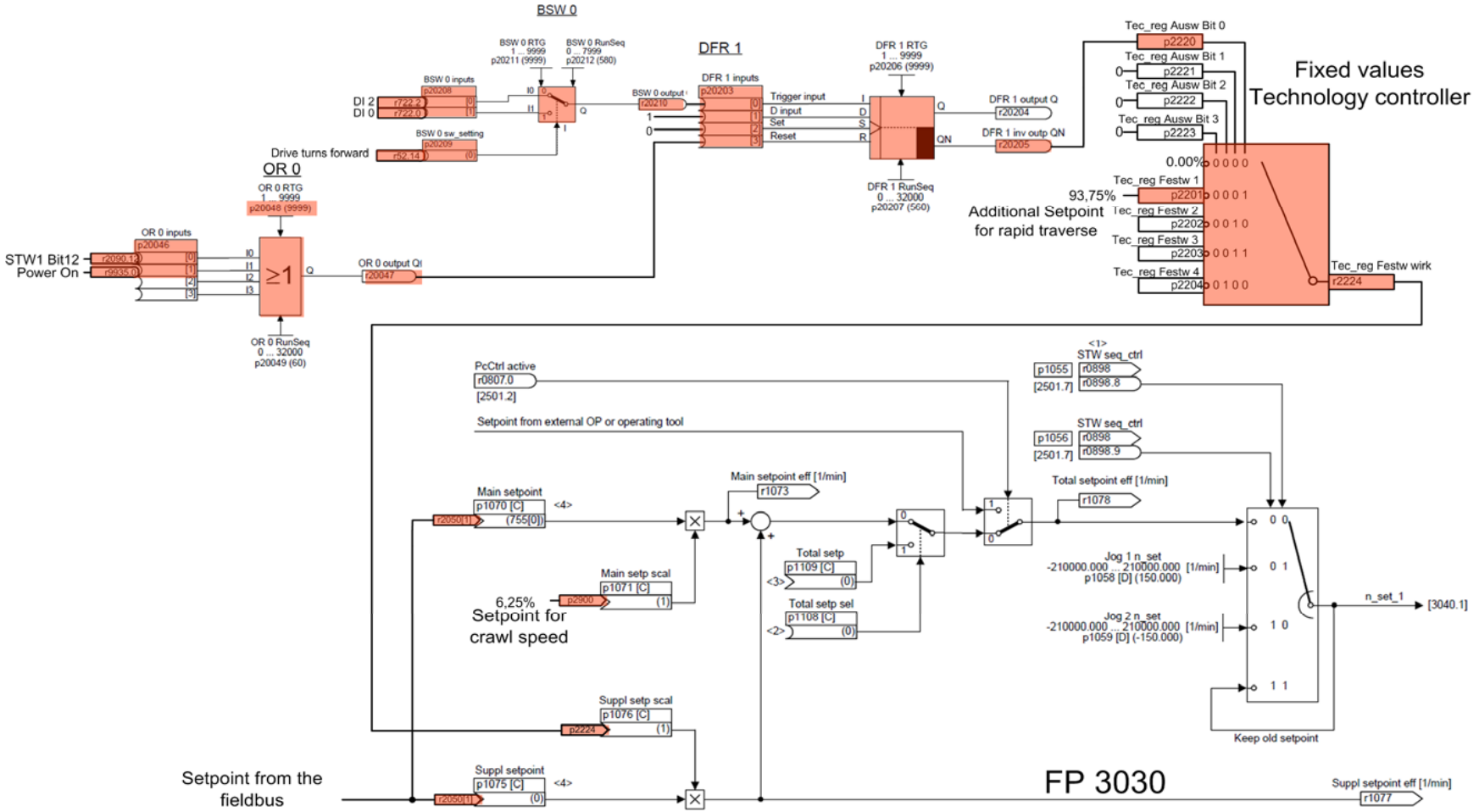

Figure 3-3 Digital output control function

4 Version

4.1 HW configuration

The SINAMICS G120 /G120D should be inserted in the hardware configuration of the S7 control with either Profibus or Profinet.

4.1.1 Profibus

With Profibus, for communication between the PLC and the SINAMICS, under***DP slave properties*** for ***Default: None*** should be selected. Create a slot for ***Actual value*** with a length of ***6 words*** and a slot for ***Setpoint*** with a length of ***4 words***.

Please ensure that the starting address of the actual value and the setpoint slot are the same.

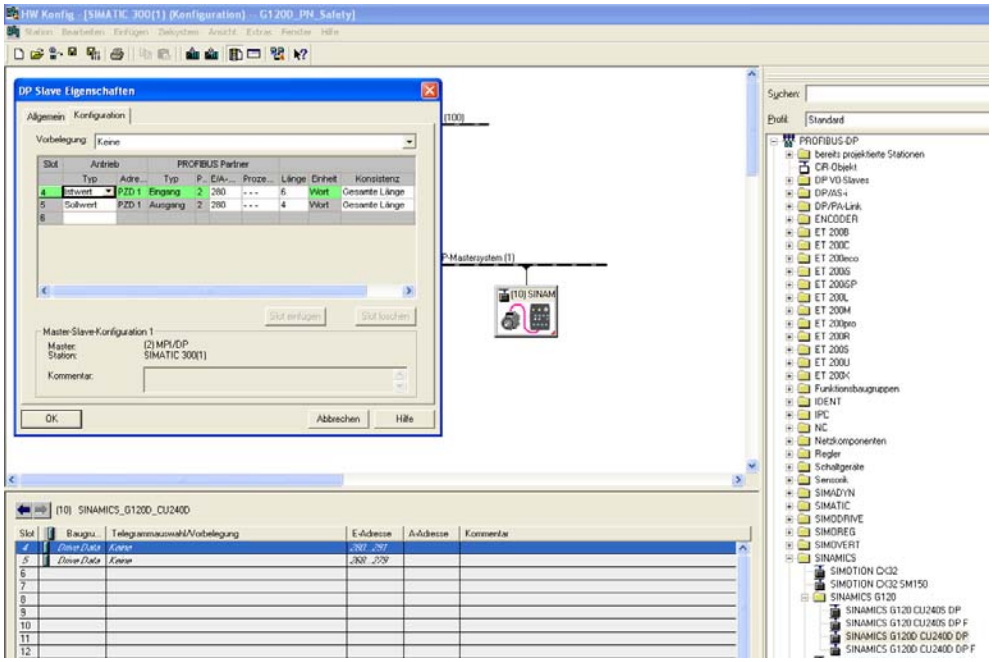

Fig. 4-1 HW configuration for Profibus

4.1.2 PROFINET

For Profinet, the ***Free message frame*** telegram type should be selected for communications between the PLC and the SINAMICS device. Under ***Inputs*** create a range with a length of ***6 words*** and under ***Outputs***, a range of ***4 words***.

In this case, it must be ensured that the starting addresses of the input and the output ranges are the same.

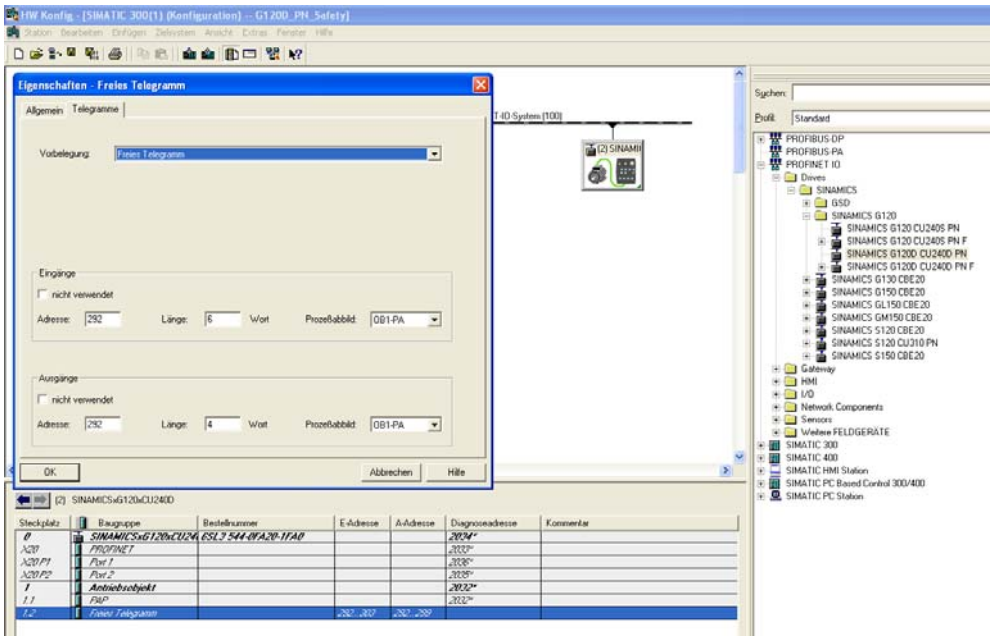

Fig. 4-2 HW configuration for Profinet

4.2 S7 program

4.2.1 Rapid traverse / crawl changeover and quick stop function

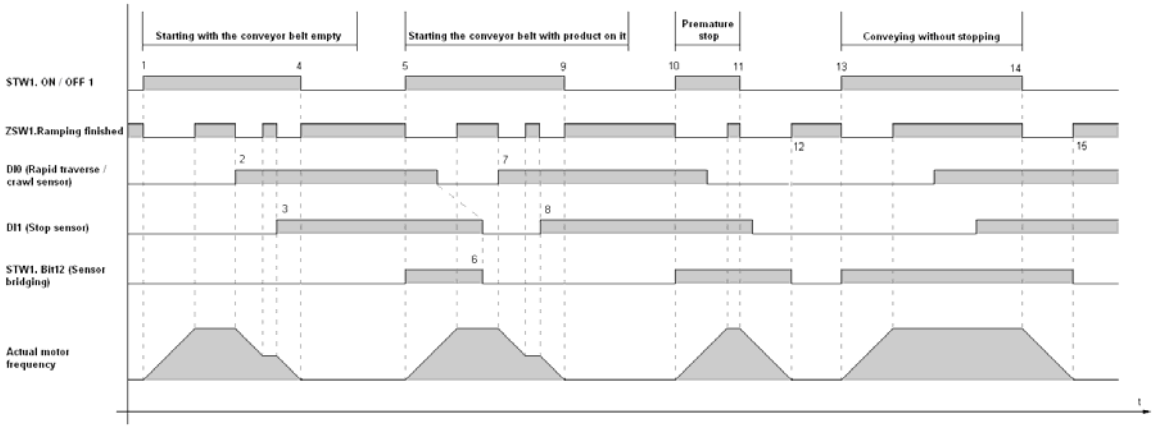

Fig. 4-3 State diagram of the rapid traverse/crawl changeover and quick stop function

For the control, a distinction is made between four scenarios:

- Starting with the conveyor belt empty
  - (1) The motor is started via STW1.ON/OFF1. The two sensors are not actuated when starting – this means that control bit STW1.bit12 does not have to be activated.
  - (2) When the rapid traverse/crawl sensor (DI0 forwards or DI2 backwards) is actuated, the drive makes the changeover to the crawl velocity.
  - (3) The motor is stopped by the drive when the stop sensor (DI1 forwards or DI3 backwards) is actuated.
  - (4) If the stop sensor is actuated and the down ramp has been completed (ZSW1.Ramping finished), then control bit STW1.ON/OFF1 should be reset.

- Starting the conveyor belt with product on it
  - (5) The motor is started via STW1.ON/OFF1. The two sensors (DI0 and DI1) are actuated when starting. This means that control bit STW1.Bit12 should be activated.
  - (6) Control bit STW1.Bit12 should be activated with the falling edge of the two inputs DI0 and DI1 (or DI2 and DI3).
  - (7) When the rapid traverse/crawl sensor (DI0 forwards or DI2 backwards) is actuated, the drive makes the changeover to the crawl velocity.
  - (8) The motor is stopped by the drive when the stop sensor (DI1 forwards or DI3 backwards) is actuated.
  - (9) If the stop sensor is actuated and the down ramp has been completed (ZSW1.Ramping finished), then control bit STW1.ON/OFF1 should be reset.

- Premature stop
  - (10) The motor is started via STW1.ON/OFF1. The control bit STW1.Bit12 should be activated as the two sensors are actuated when starting.
  - (11) The motor is stopped when STW1.ON/OFF1 is reset.
  - (12) Control bit STW1.Bit12 should be reset once the down ramp has been completed (ZSW1.Ramping finished).

- Conveying without stopping
  - (13) The motor is started via STW1.ON/OFF1. The control bit STW1.Bit12 should be activated as the two sensors are actuated when starting.
  - Control bit STW1.Bit12 should be permanently set to 1 in order that the system does not respond to the two sensors.
  - (14) The motor is stopped when STW1.ON/OFF1 is reset.
  - (15) Control bit STW1.Bit12 should be reset once the down ramp has been completed (ZSW1.Ramping finished).

The following signals must be appropriately controlled (energized) in the S7 program:

- STW1.ON/OFF1 (signal 0 = stop motor, signal 1 = start motor)
- STW1.Bit 12 (signal 1 = sensors jumpered)

4.2.2 Function, controlling the digital outputs at the G120 / G120D

The number of digital outputs depends on the Control Unit being used. The CU 240B-2 only has only one digital output (DO 0). Two free signals in the STW2 are used to control the outputs of the SINAMICS device.

- STW2, bit 6 (signal 1 = control of the G120 DO 0)
- STW2, bit 7 (signal 1 = control of the G120 DO 1)

These two signals must be appropriately interconnected in the S7 program.

Please note that the digital outputs must be connected as specified in the manual.

4.3 SINAMICS parameterization

The SINAMICS G120 should first be commissioned using the quick commissioning function.

For the presetting (default) of the I/O configuration, "No selection" should be selected, as the script interconnects the signals required.

4.4 Running the SINAMICS script file

The following script files are provided in this FAQ:

- Rapid_Traverse_Crawl_Qstop_DO

A description is provided below on how you can run the corresponding script file:

- Insert a script file folder into your STARTER project

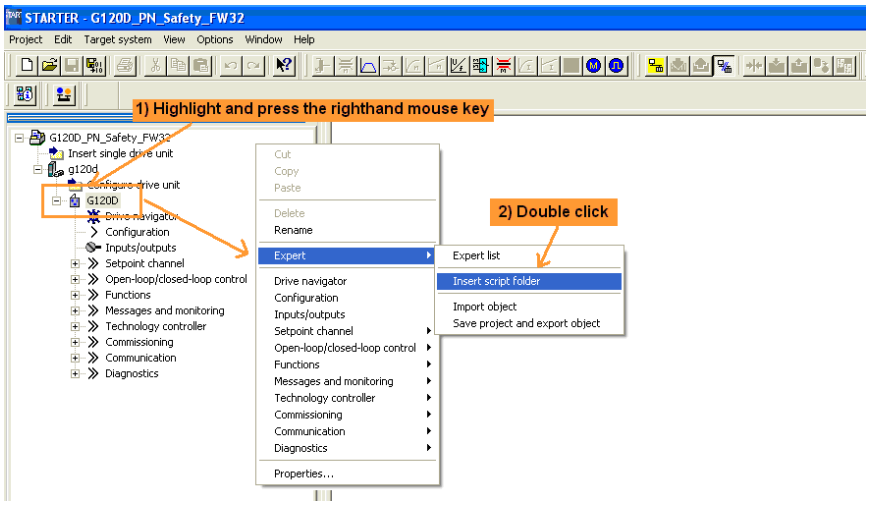

Fig. 4-4 Inserting the script folder

- Import the script file into STARTER

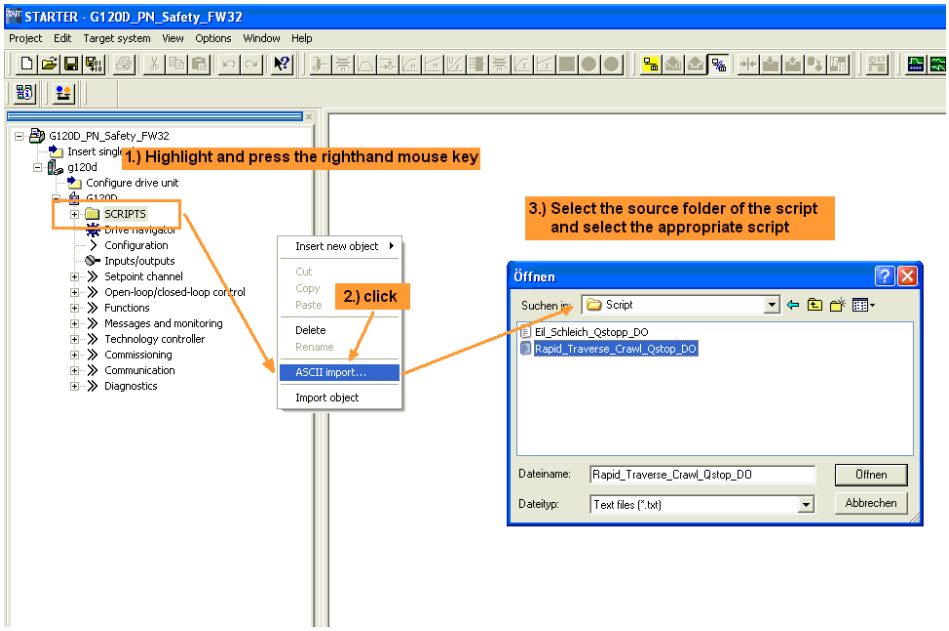

Fig. 4-5 Importing the script file

- The script can be run both online and offline.
- The device type can only be read out if the online connection has been established – or an upload was already performed from the device. Otherwise, the device type can be manually selected.

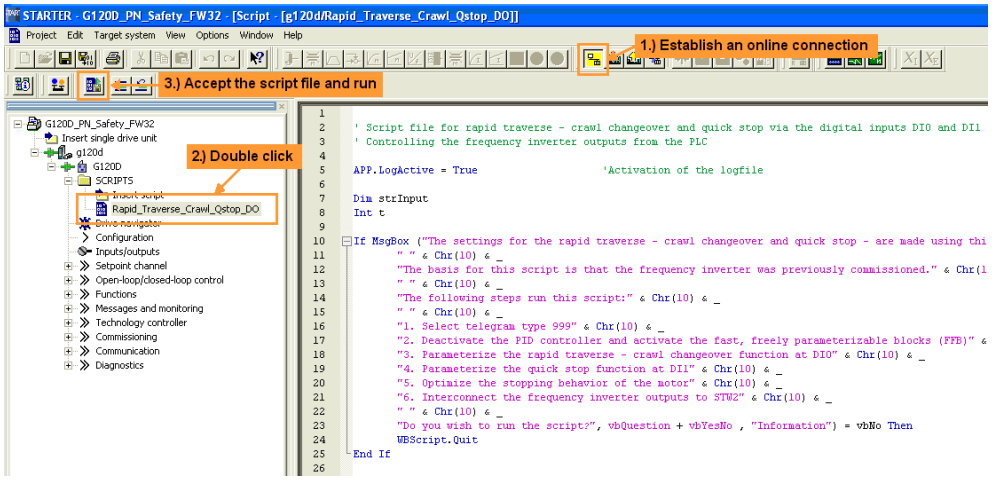

Fig. 4-6 Establish an online connection to the drive and run the script file

- While the script file is being run, you will be requested to enter the settings for this function via the dialog boxes.
- To start, you will be shown an overview of the script file functions:

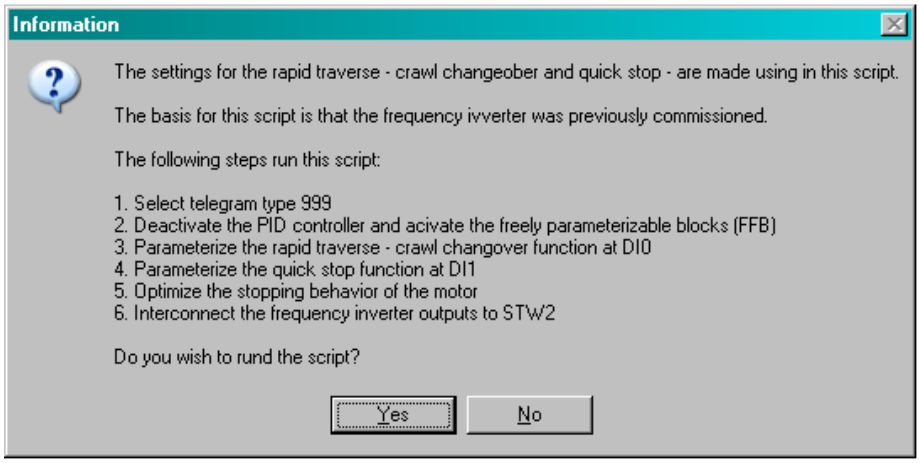

Fig. 4-7 Overview of the script file functions

- If the device type cannot be read-out, then you must manually enter it. To do this, enter the number of the device being used.

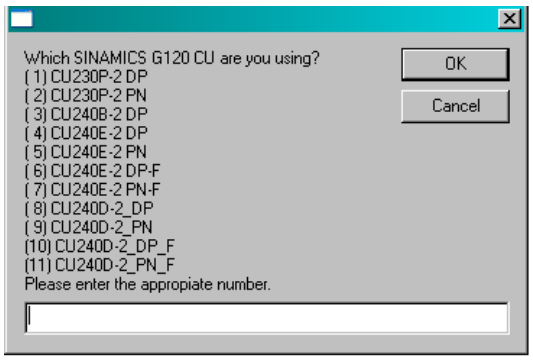

Fig. 4-8 Selecting the device being used

- Enter the crawl speed as a % of the maximum speed:

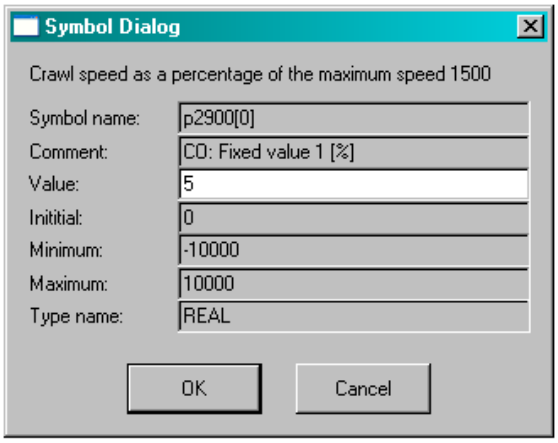

Fig. 4-9 Entering the crawl speed as a %

- Enter the standard ramp-up time in s:

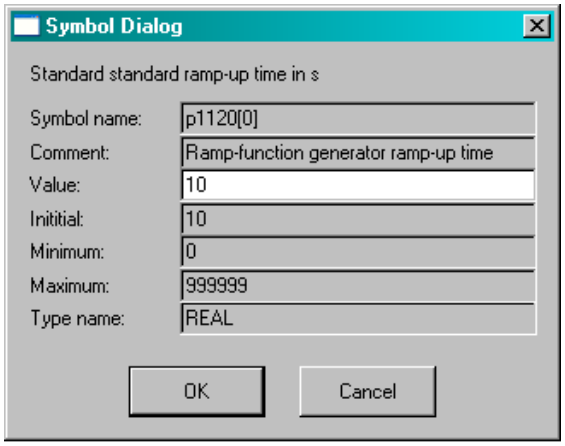

Fig. 4-10 Entering the standard ramp-up time in s

- Enter the standard ramp-down time in s:

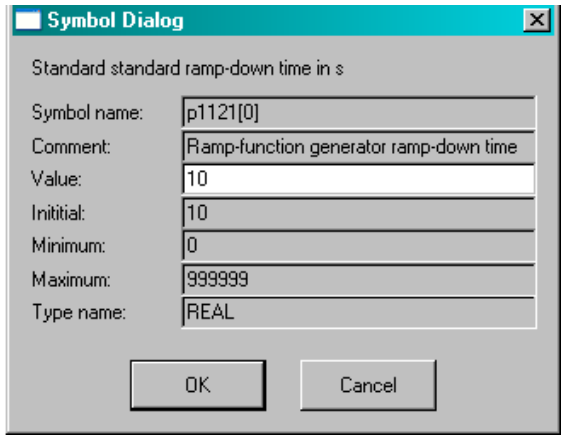

Fig. 4-11 Entering the standard ramp-down time in s

- Enter the ramp-down time (decelerating time) in s when activating the quick stop:

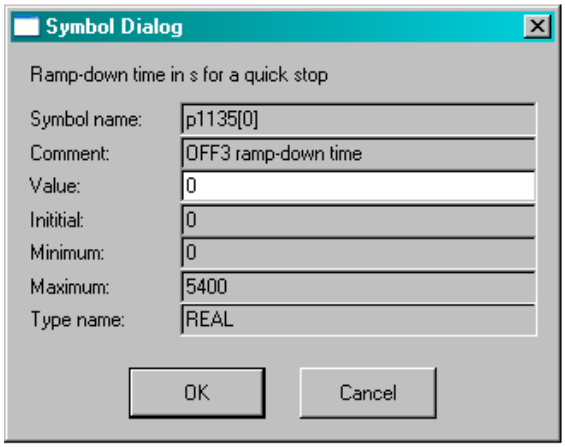

Fig. 4-12 Entering the ramp-down time in s when activating the quick stop

Using the following settings, you can optimize how the motor stops (stopping behavior).

- Using the ***Threshold for zero speed detection (p1226)*** , you define the speed where, after the ***Zero speed detection monitoring time (p1227)*** has expired (see the next dialog box) the pulse inhibit is initiated and the motor coasts down.

  Caution, if the selected value is too low, then the motor can start to oscillate.

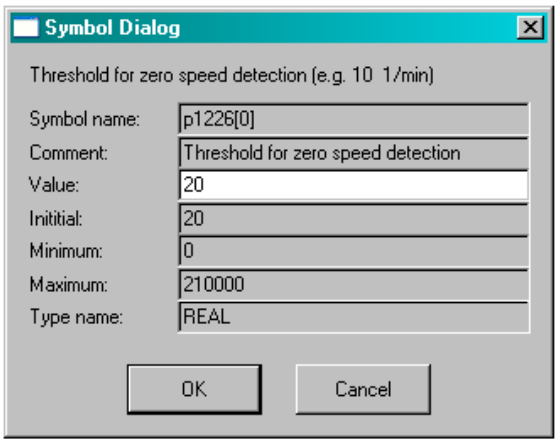

Fig. 4-13 Entering the threshold for zero speed detection

- The ***Zero speed detection monitoring time*** is started after reaching the ***Speed threshold***. After the time has expired, the pulse inhibit is initiated and, as a consequence, the motor coasts down.

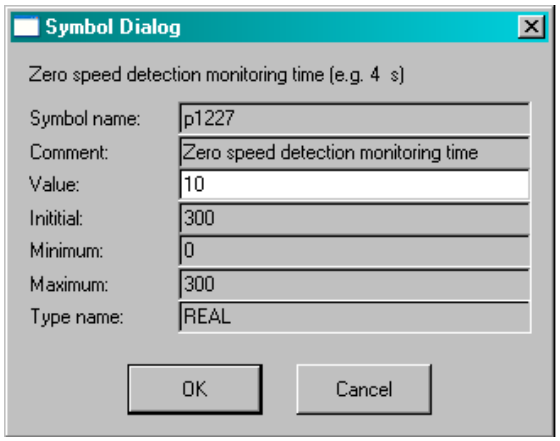

Fig. 4-14 Entering the zero speed detection monitoring time in s

Interconnecting the outputs to STW2

The script identifies the device type of the SINAMICS CU, if a CU 240B-2 is identified, then only DO 0 is interconnected. If the CU type cannot be uniquely identified, then the system completely skips interconnecting the outputs.

- The completion of the script file run is displayed in the lower area of the STARTER parameterizing software under the ***Scripting*** tab with ***Script run completed***

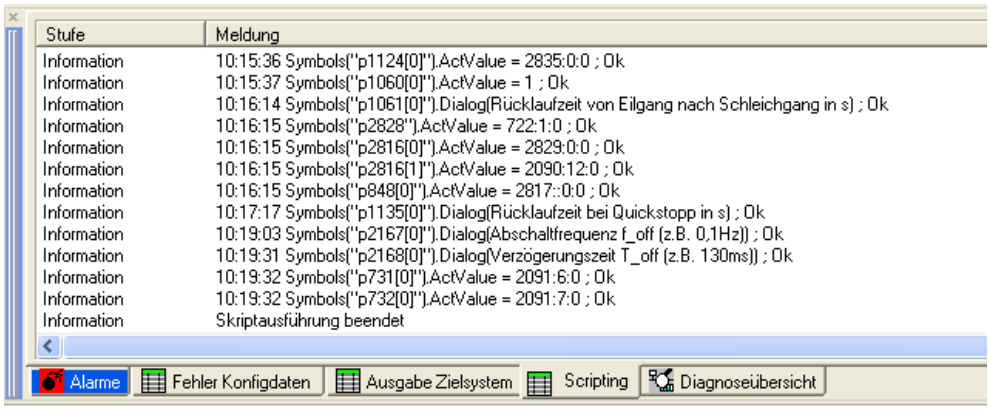

Fig. 4-15 Script run completed

Acknowledge any error messages that are present

5 Internet links - data

This list is in no way complete and only reflects a selection of suitable literature.

Table 5-1

	Subject area	Title
\1\	Documentation	SINAMICS G120
\2\	Documentation	SINAMICS G120D
\3\	Application	STARTER: Creating Application macros

6 Contact

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7 History

Table 7-1 History

Version	Date	Change
V1.0	January 2012	first Edition