MOVITRAC® 31..
Frequency Inverter

Fieldbus Unit Profile
Manual

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SEW EURODRIVE

Important Notes

- **Read this User Manual carefully before you start installation and commissioning work on MOVITRAC® frequency inverters with fieldbus options.**
  This User Manual assumes that the user is familiar with and has at his disposal all relevant documentation on the MOVITRAC® system, particularly the Installation and Operating Instructions.

- **Safety notes:**
  Always follow the safety notes contained in this User Manual.
  Safety notes are marked as follows:

	Electrical hazard, e.g. during live working
	Mechanical hazard, e.g. when working on hoists
STOP	**Important instructions** for the safe and fault-free operation of the system, e.g. presetting before commissioning. Failure to follow these instructions may result in injury to people and damage to property.

- **General safety notes for bus systems:**

  The fieldbus option gives you a communications system which allows you to match the MOVITRAC® 31.. drive system to the specifics of your application to a very high degree. As with all bus systems there is, however, the risk of parameters being changed, which will not show outside (i.e. the inverter) but affect the behaviour of the inverter. This may result in unexpected (not uncontrolled, though) system behaviour.

- **In these instructions, cross-references are marked with a** →, e.g.,
  (→ MC_SHELL) means: Please refer to the MC_SHELL User Manual for detailed information or information on how to carry out this instruction.
  (→ section x.x) means: Further information can be found in section x.x of this User Manual.

- Each unit is manufactured and tested to current SEW-EURODRIVE technical standards and specifications.
  The manufacturer reserves the right to make changes to the technical data and designs as well as the user interface herein described, which are in the interest of technical progress.
  A requirement for fault-free operation and fulfilment of any rights to claim under guarantee is that these instructions and notes are followed.
  These instructions contain important information for servicing, they should therefore be kept in the vicinity of the unit.

Preface

This *Fieldbus Unit Profile Manual* describes the operation of the MOVITRAC® 31.. frequency inverter when connected to a higher-level automation system via a fieldbus option pcb. In addition to descriptions of all the fieldbus parameters, the various control concepts and potential applications are dealt with in the form of brief examples of programs. The application examples are described both in graphic form as well as in Simatic-S5 syntax. These application examples can be used with almost all fieldbus option pcbs that fit the MOVITRAC® 31.. inverter.

In addition to this Fieldbus Unit Profile User Manual, the following more detailed documentation on fieldbus is also necessary in order to enable the MOVITRAC® 31.. to be connected simply and efficiently to the fieldbus system (e.g. PROFIBUS-DP, PROFIBUS-FMS, INTERBUS-S, etc.):

- User Manual for PROFIBUS (FFP 31..) option, part number 0922 6818
- User Manual for INTERBUS-S (FFI 31..) option, part number 0922 6915
- User Manual Communications Interfaces and Parameter List MOVITRAC® 31.., part number 0923 0580

The FFP 31.. PROFIBUS Option PCB User Manual describes the installation and commissioning of the FFP 31.. PROFIBUS option pcb and gives further examples of applications specifically for setting the inverter parameters via PROFIBUS-DP and PROFIBUS-FMS.

The FFI 31.. INTERBUS Option PCB User Manual describes the installation and commissioning of the FFI 31.. INTERBUS-S option pcb and gives further examples of applications specifically for setting the inverter parameters via INTERBUS-S.

The MOVITRAC® 31.. Parameter List contains a list of all the inverter's parameters that can be read or written via the various communication interfaces such as the RS-232, RS-483 and via the fieldbus interface.

Contents

1 Introduction

Fieldbus systems are increasing in significance in mechanical and industrial engineering. Not only can they bring about considerable savings in installation and maintenance costs, but they also offer an ideal way of creating a digital network of intelligent sensors and actuators with higher-level automation systems such as programmable logic controllers (PLCs), industrial PCs (IPCs), etc.

Because of the large number of bus systems available on the market, designers and constructors of industrial plants are these days often required to have a knowledge of more than one system. Consequently, a universally applicable fieldbus interface which can support different fieldbus systems, is an absolute necessity for field equipment at sensor/actuator level.

The commissioning and diagnostic facilities of the fieldbus systems are another major point. These days, diagnosis is generally made via the master module or via specific bus monitors (which can often only be operated by specialists), so intelligent field equipment should also provide extremely simple fieldbus diagnostic facilities.

The SEW MOVITRAC®31.. inverters meet these requirements and can be linked to systems such as the open, standardized serial bus systems PROFIBUS-DP, PROFIBUS-FMS and INTERBUS-S by using fieldbus option pcbs. The MOVITRAC® 31.. also enables connections to other fieldbus systems to be made thanks to the powerful, universal structure of its fieldbus interface.

A major feature of the MOVITRAC® 31.. inverter is the field-bus-independent, uniform behaviour of the unit (unit profile) when controlled via a fieldbus. Because it operates independently of the fieldbus, it enables plant constructors and PLC programmers to use different fieldbus systems with the same applications program, i.e. the actual application concept and program can be implemented very easily with different fieldbus systems.

2 Overview of Functions

Thanks to its high-performance, universal fieldbus interface, the MOVITRAC® 31.. inverter enables connections to be made with higher-level automation systems via a wide range of fieldbuses, such as INTERBUS-S, PROFIBUS-DP, PROFIBUS-FMS, etc. The underlying behaviour of the inverter, known as the unit profile, is independent of the fieldbus and is thus uniform.

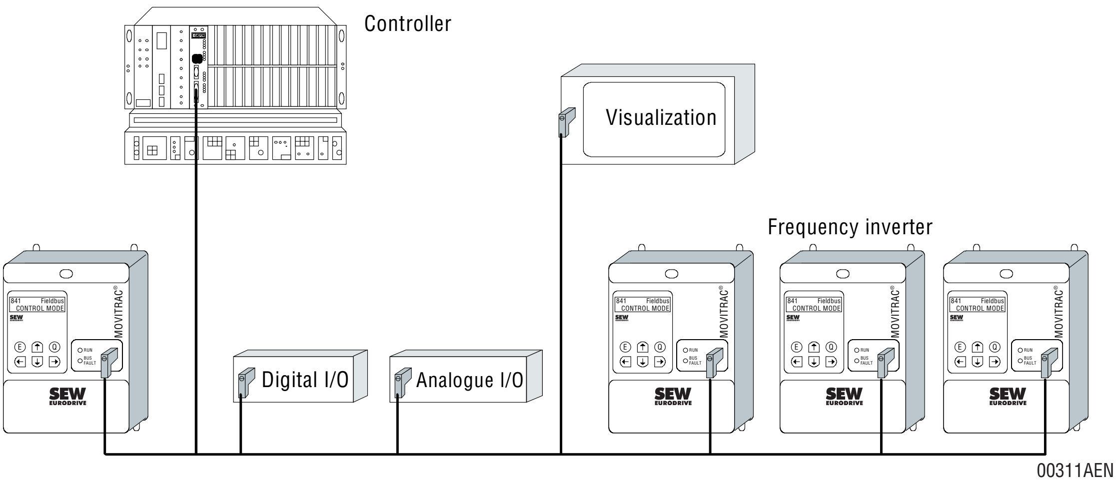


Fig. 1: Typical bus configuration in a field environment

MOVITRAC® 31.. offers digifunctions via the fieldbus interface. The inverter is controlled by the high-speed cyclic process data. This process data channel provides the facility to specify setpoints such as setpoint speeds, ramp generator times for acceleration and deceleration etc., as well as various drive functions such as enable, controller inhibit, stop, rapid stop, etc. to be triggered. This channel can also be used to read back actual values from the inverter, such as actual speed, current, unit status, error number or reference messages.

Whereas process data are generally exchanged in cycles, the drive parameters can also be read and written acyclically via functions such as READ and WRITE. This exchange of parameter data enables applications where all major drive parameters are stored in the higher-level automation unit to be implemented, thus avoiding manual adjustment of parameters on the inverter itself, which can often be very time-consuming.

The fieldbus option pcbs are designed so that all settings specific to the fieldbus, such as the fieldbus address, can be made on the option pcb by means of a hardware switch. These manual settings enable the inverter to be integrated into the fieldbus and switched on in a very short space of time. Parameters can be set fully automatically by the higher-level fieldbus master (parameter download). This forward-looking version offers the benefits of a shorter commissioning period for the plant as well as simpler documentation of the application program, as all major drive parameter data are now recorded directly in the control program.

The use of a fieldbus system in drive technology requires additional monitoring functions, such as fieldbus timeout or special emergency stop concepts. The monitoring functions of the MOVITRAC® 31.. can be matched to the specific application for which it is to be used. This feature enables you, for instance, to specify which error response the inverter should trigger if an error should occur in the bus. A rapid stop will be practical for many applications, but it is also possible to freeze the last setpoints, so that the drive can continue with the last valid setpoints (e.g. conveyor belt). As the functionality of the control terminals is also ensured when the inverter is operated in the fieldbus mode, fieldbus-independent emergency stop concepts can still be implemented via the inverter's terminals.

The MOVITRAC 31®.. inverter offers numerous diagnostic facilities for commissioning and servicing. For instance, both the setpoints transmitted from the higher-level control unit as well as the actual values can be checked with the fieldbus monitor in the hand-held keypad. It also provides a lot of additional information on the status of the fieldbus option pcb. The PC software MC_SHELL offers even more convenient diagnostic facilities in that it provides a detailed display of the fieldbus and unit status information as well as the facility to set all the drive parameters (including the fieldbus parameters).

3 Inverter Control with Process Data

By *Process Data (PD)* we mean all time-critical (real time) data in a process which have to be processed or transferred at high speed. These data are characterized by the fact that they are highly dynamic and always up to date. Examples of process data are setpoints and actual values of the inverter, or peripheral conditions of limit switches. They are exchanged in cycles between the automation unit and the inverter.

Control of the MOVITRAC® 31.. inverter by means of process data takes place on the fieldbus system.

The process data interfaces for *Process Input (PI)* and *Process Output (PO)* should be treated separately. Process input data (PI) are data that are transmitted from the inverter to the higher-level automation unit (e.g. status information, actual values, etc.). Process output data (PO) are data that are output to the inverter by the automation unit (e.g. setpoints, control commands, etc.).

3.1 Commissioning the Inverter

Parameters can be assigned to the MOVITRAC® 31.. inverter via the fieldbus system immediately after the fieldbus option pcb has been installed; no further settings are necessary. Amongst other things, this enables all parameters directly to be downloaded from the higher-level automation unit via the fieldbus system after switching on the inverter.

To control the inverter via the fieldbus system, however, the latter must first be switched to the relevant control mode. This can be done with the parameter *P841 Control Mode*. After the inverter is set to the factory settings, this parameter is set to *STANDARD* (control and setpoint processing via input terminals). The inverter is parameterized to accept the setpoints from the fieldbus with the setting *P841 Control Mode = FIELDBUS*. The MOVITRAC® 31.. will now react to the process output data transmitted by the higher-level automation unit.

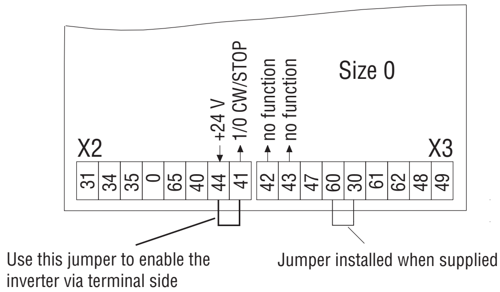
Activation of the fieldbus control mode is signalled to the higher-level control by means of the *Fieldbus Mode Active* bit in the status word.

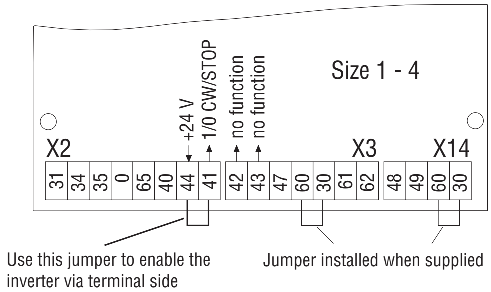
For safety reasons, the inverter must also be enabled on the terminal side in order for it to be controlled via the fieldbus system. The terminals should therefore be wired or programmed so that the inverter is enabled via the input terminals. The simplest method of enabling the inverter via the terminals is to provide input terminal 41 (*CW/STOP* function) with a +24 V signal and to program input terminals 42 and 43 to *NO FUNCTION*. Fig. 1 demonstrates how the MOVITRAC®31.. inverter is commissioned with a fieldbus connection.

Attention!
Carry out commissioning with mains voltage switched off and with the external 24 V-supply only. This prevents the drive from starting to move automatically during reprogramming. Switch on mains voltage only after completed setting of parameters.

1. ENABLE the inverter on the terminal side

Apply a +24 V signal on input terminal 41 (Function CW/STOP) (e.g. set jumper as shown below).





2. For setting inverter parameter only switch on 24 V supply (no mains voltage!)

3. Control mode = fieldbus

Set control and setpoint processing of the drive inverter to FIELDBUS in parameter P841.

841	FIELDBUS
	CONTROL MODE

4. Input terminal 42 = NO FUNCTION:

Program functionality of input terminal 42 to NO FUNCTION in parameter P600.

600	NO FUNCT.
	TERMINAL 42

5. Input terminal 43 = NO FUNCTION:

Program functionality of input terminal 43 to NO FUNCTION in parameter P601.

601	NO FUNCT.
	TERMINAL 43

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Fig. 2: Activating the FIELDBUS control mode

3.2 Process Data Configuration

The MOVITRAC® 31.. inverter can be controlled via the fieldbus system with one, two or three process data words. The number of process input data (PI) and process output data (PO) is identical.

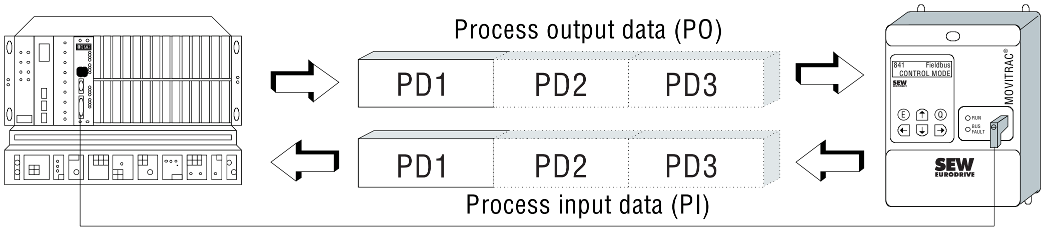

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Fig. 3: Process data channel for the SEW MOVITRAC® 31.. inverter

The process data configuration settings are made via the fieldbus option pcb, either through the hardware (e.g. FFI 31A) or via the fieldbus master at the start of the bus system (e.g. PROFIBUS-DP). The inverter automatically receives the right setting from the fieldbus option pcb.

You can check the current process data configuration in the menu item *P070 PD Configuration* by means of the fieldbus monitor on the hand-held keypad or by means of MC_SHELL (Fig. 4).

```
070          3PD+PARAM
     PD CONFIGURATION
```

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Fig. 4: Process data configuration

Depending on the type of fieldbus option pcb used, PD configurations according to the following table can be used.

PD configuration	
1 Process data word + parameter channel	1PD+PARAM
1 Process data word	1PD
2 Process data words + parameter channel	2PD+PARAM
2 Process data words	2PD
3 Process data words + parameter channel	3PD+PARAM
3 Process data words	3PD

The parameter channel is only of significance for fieldbus systems without layer 7 functionality, e.g. PROFIBUS-DP. Only the number of process data (i.e. 1PD..., 2PD... or 3PD...) is of interest when controlling the inverter by means of process data.

Programmable logic controllers are used as fieldbus masters, the process data are generally sent directly to the I/O or peripheral area. The I/O or peripheral area in the PLC must therefore make sufficient memory space available for the inverter process data (Fig. 5). Addresses are usually allocated between the inverter process data and the PLC address area on the fieldbus master module.

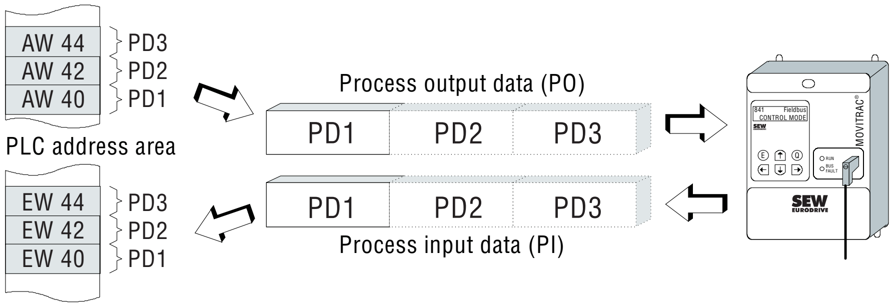

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Fig. 5: Process data mapping in the PLC

3.3 Process Data Description

The process data description defines the content of the process data to be transmitted. All three process data words can be assigned individually by the user. In general, the process input data and the process output data are handled separately. This enables you to specify which process output data (setpoints) are to be transmitted to the inverter from the control unit, and which process input data (actual values) are to be transferred from the MOVITRAC® 31.. inverter in the opposite direction to the higher-level control unit for your particular application. The following six fieldbus parameters are available for defining the individual process data:

P560 PO1 Setpoint Description
P561 PI1 Actual Value Description
P562 PO2 Setpoint Description
P563 PI2 Actual Value Description
P564 PO3 Setpoint Description
P565 PI3 Actual Value Description

When one of the above-mentioned parameters is changed, acceptance of the process output data for setpoint processing via the fieldbus is automatically blocked. The process output data received will not be processed according to the new actual value and setpoint descriptions until the fieldbus parameter

P570 Enable Fieldbus Setpoints = YES

is re-activated (see also Section 3.3.4.).

3.3.1 Setpoint Description for the PO Data

The *PO1 - PO3 Setpoint Description* parameters define the content of the process output data words, which are sent via the fieldbus system from the higher-level automation unit (Fig. 6). Each process output data word is defined by its own parameter, so altogether three fieldbus parameters offering the same options are available to describe the process output data.

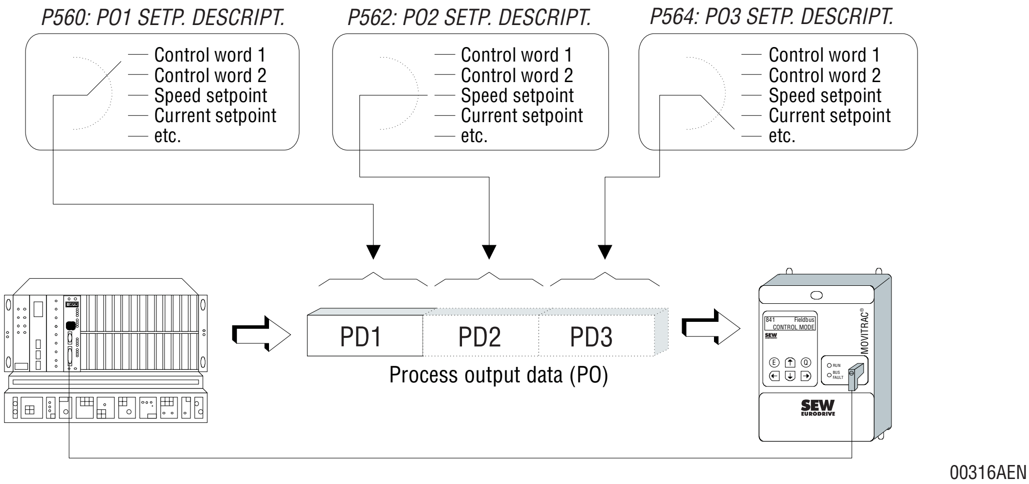

Fig. 6: Setpoint description of the process output data (PO)

Process output data words PO1, PO2 and PO3 are used to transmit the setpoints listed in the following table through the process output data channel. 32-bit values, such as e.g. position values, are transmitted in two process data words. You may decide yourself in which process data word you wish to transmit the more significant part (high) and the less significant part (low) respectively.

NO FUNCTION
SPEED
SPEED [%]
POSITION LO *)
POSITION HI *)
MAX. SPEED
MAX. CURRENT
SLIP
RAMP
CONTROL WORD 1
CONTROL WORD 2

*) Setting not possible for MOVITRAC® 31..., size 0

No Function (NO FUNCTION)

If the *NO FUNCTION* setting is active, the inverter will not use this process output data word for setpoint processing. The content of the process output data word programmed to *NO FUNCTION* will be ignored even though the higher-level control might specify a real setpoint via the fieldbus system.

Speed Setpoint (SPEED)

The *SPEED* setting causes the MOVITRAC® 31.. inverter to interpret the setpoint transmitted in this process data word as speed setpoint. Scaling of the speed setpoint see Section 3.3.5.

If the speed setpoint is assigned to the process output data word, the analogue setpoint will automatically be deactivated. Execution of internal setpoint functions such as e.g. the selection of internal fixed setpoints or the motorized potentiometer function are, however, given priority, i.e. the speed setpoint specified via the fieldbus will not be effective in this case!

Consequently, the speed setpoint processing of the MOVITRAC® 31.. inverter is subject to the priorities shown in the table.

Processing priority in the inverter	Setpoint source
Highest priority:	Internal fixed setpoints
	Motorized potentiometer
	Fieldbus setpoint
Lowest priority:	Analog setpoint (unipolar)

If the speed setpoint is not specified via the bus system, the analogue input will become the setpoint source, even though the control mode is set to “Fieldbus”. This option permits applications to be implemented where the control signals (enable, controller inhibit etc.) are specified via the fieldbus, while the setpoint is specified by an automation unit, which does not have a fieldbus interface.

Relative Speed Setpoint (speed [%])

With the parameter speed [%] set the inverter MOVITRAC® 31.. interprets the setpoint transmitted in this process data word as percental speed setpoint. The scaling of the speed setpoint is described in section 3.3.5.

With the assignment of the relative speed setpoint to a process output data word the analog setpoint is deactivated automatically. The execution of internal setpoint functions such as the selection of internal fixed setpoints or motor potentiometer is higher-level, this means that in these cases the speed setpoint set via fieldbus is not effective!

With the setpoint descriptions SPEED and SPEED [%] a speed setpoint is specified generally. Consequently programming both setpoint variants at the same time is technically not efficient and is treated as double assignment of the process-output data channel, which means that only the first speed setpoint programmed is processed by the inverter.

The relative speed setpoint always refers to the current applicable maximum limit of the speed or frequency f_{max} , this means a percental setpoint of 100% is generally equivalent to the current applicable value of f_{max}, whereas a set value of 0% is generally equivalent to 0 Hz. Due to the fact that f_{max} is the active maximum limit, setpoints higher than 100% cannot become effective. In the case of a setpoint entry higher than 100% the frequency f_{max} is set.

Position-Setpoint (POSITION LO/HI) (not for MOVITRAC®31.., size 0)

Position setpoints may only be used in conjunction with the internal *IPOS* positioning control. Unless the inverter is fitted with the *IPOS* option and its pertinent functions, this setting will be rejected.

Position setpoints must be spread over two process data words, as the position is generally entered as a signed 32-bit value (integer32). You must therefore specify the more significant position setpoint (*POSITION HI*) and the less significant position setpoint (*POSITION LO*) (Fig. 7). Otherwise the inverter will not respond to the position entry. Scaling of the position setpoint see Section 3.3.5.

CAUTION!
When handling the position setpoints in the application program of the higher-level automation unit, make sure that both process output data words containing the position data are dealt with consistently, i.e. that the position setpoint high is always transmitted together with the position setpoint low! Otherwise the inverter might approach undefined positions, as e.g. an old position setpoint low and a new position setpoint high might be active together!

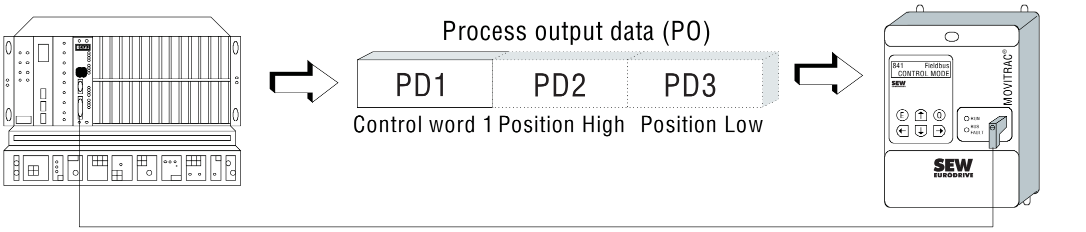

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Fig. 7: Assigning a position setpoint to the process output data

Speed Limit (MAX. SPEED)

The *Setpoint Description POx = MAX. SPEED* setting causes the MOVITRAC® 31.. inverter to interpret the transmitted setpoint as speed limit. The speed limit is therefore specified in the unit [1/min] and interpreted as absolute value for both directions of rotation. The supported range of values for the fieldbus speed limit corresponds to the range of values for the *P202 F-MAX 1* parameter. If the speed is below this range of values the minimum will become effective, if it exceeds the set range, the maximum of the set limit value will become effective. Scaling of the speed limit see Section 3.3.5.

Entering the speed limit via the fieldbus will automatically deactivate parameters
P202 F-MAX 1, *P212 F-MAX 2* and *P222 F-MAX 3* !

The speed limit value specified via the process output data is generally active.

Current Limit (MAX. CURRENT)

The *Setpoint Description POx = MAX. CURRENT* setting causes the MOVITRAC® 31.. inverter to interpret the transmitted process output data as current limit. The current limit is specified in per cent of the inverter rated current in the unit [% In] and is interpreted as absolute value for both directions of rotation. The supported range of values for the fieldbus current limit corresponds to the range of values for parameter *P320 I-MAX 1.* If the current is below this range of values, the minimum will become effective, if it exceeds the set range, the maximum of the set limit value will become effective. Scaling of the current limit see Section 3.3.5.

Entering the current limit via the fieldbus will automatically deactivate parameters *P320 I-MAX 1* and *P340 I-MAX 2*.

Slip Compensation (SLIP) (not for MOVITRAC®31.., size 0)

The *SLIP* setting causes the MOVITRAC® 31.. inverter to interpret the transmitted process output data word as slip compensation value. Scaling of the slip compensation value in the unit [1/min] see Section 3.3.5.

Entering the slip compensation via the fieldbus will automatically deactivate parameters *P323 SLIP 1 and P343 SLIP 2*.

Entering the slip compensation via the process data channel only makes sense for applications which operated under speed control as a change in the slip compensation will also have an indirect effect on the torque.

The range of values for this slip compensation value is identical with the range of values for parameter *P323 SLIP 1* and corresponds to a frequency range of 0-10 Hz. When specified via the process data channel, the slip compensation will be in the unit [1/min], you will therefore have to take account of the pole pair number of the connected motor. To calculate the range of values for the slip speed use the following formula:

$$n_S = \frac{f_S \cdot 60}{p}$$

n_S = slip speed specified
f_S = slip frequency
p = pole pair number of the motor

The value ranges for motors with different pole pair numbers determined from the above formula.

Motor pole pair number	Value range
1	0 - 600 1/min
2	0 - 300 1/min
3	0 - 200 1/min
4	0 - 150 1/min

If the slip specified in the process data is outside this range of values, the minimum or maximum will become effective if the specified slip is lower or higher than the given value range.

Process Ramp (RAMP)

The *RAMP* setting causes the MOVITRAC® 31.. inverter to interpret the transmitted setpoint as acceleration or deceleration ramp. Depending on the drive function specified in the control word, the unit will interpret the process ramp as acceleration ramp when an enable signal is given and as deceleration ramp when a stop is to be executed. The specified figure is the time in milliseconds and relates to a frequency change of 50 Hz. The rapid stop function is not affected by this process ramp.

When the process ramp is transmitted through the fieldbus system, ramp generators T11, T12, T21 and T22 will become inactive.

Scaling of the *Process Ramp* in the unit [ms] see Section 3.3.5.

Control Word 1 / Control Word 2

Assigning control word 1 or control word 2 to the process output data allows you to activate nearly all drive functions via the fieldbus system. For a description of control words 1 and 2 see Section 3.4.

Factory Setting for the *PO1-PO3 Setpoint Description*

When the factory setting has been activated, the following process output data are defined for the MOVITRAC® 31.. inverter:

PO 1 Setpoint Description:	*PO 2 Setpoint Description:*	*PO 3 Setpoint Description:*
CONTROL WORD 1	SPEED	NO FUNCTION

3.3.2 PO Data Processing in the Inverter

Separate setting of the process output data description allows a multitude of combinations to be set though not all of them make sense from a technical point of view. Table 5 gives a selection of combinations, which are technically expedient. A column is reserved in the table for each process output data word, the assignment of the column to the process output data PO1 - PO3 however is arbitrary so that the columns are designated as PO X - PO Z.

PO X	PO Y	PO Z	Functionality
CONTROL WORD 1	SPEED	–	Control and speed setpoint via fieldbus
CONTROL WORD 1	–	–	Control via fieldbus, setpoint via analog input or Control and motor pot./int. fixed setpoints via fieldbus
CONTROL WORD 1	SPEED	RAMP	Control/speed setpoint/ramp via fieldbus
CONTROL WORD 1	SPEED	MAX. SPEED	Control/speed setpoint/max. speed via fieldbus
CONTROL WORD 1	SPEED	MAX. CURRENT	Control/speed setpoint/max. current via fieldbus
CONTROL WORD 1	SPEED	SLIP*)	Control/speed setpoint/slip via fieldbus
CONTROL WORD 1	POSITION HI	POSITION LO*)	Control and position entry via fieldbus **(only in conjunction with IPOS)**
CONTROL WORD 2	SPEED	–	Control incl. virtual terminals and speed setpoint via fieldbus
CONTROL WORD 2	–	–	Control via fieldbus, function select via virtual terminals (e.g. IPOS table positions IPOS)
CONTROL WORD 2	POSITION HI	POSITION LO*)	Inverter control and position entry via fieldbus and, if applicable, processing of the virtual terminals in the IPOS program **(only in conjunction with IPOS)**

*) Setting not possible for MOVITRAC®31..., size 0

In addition to the process output data from the fieldbus system the digital input terminals and, in special cases, the analogue setpoint from the MOVITRAC®31.. inverter are used, too.
Special cases in respect of the process output data processing in the inverter are:

- No speed setpoint entry from the fieldbus system
- No control word entry from the fieldbus system
- Duplicate usage of the process output data channel
- Simultaneous transmission of control word 1 and control word 2
- 32-bit process output data

No Speed Setpoint Entry from the Fieldbus System

If no speed setpoint is transmitted via the process output data, the analogue setpoint or the internal setpoint functions, i.e. motorized potentiometer or fixed setpoints (n11...) (if activated via the control word), will be active.

No Control Word Entry from the Fieldbus System

If no control word is transmitted to the inverter via the process output data, control of the MOVITRAC® 31.. inverter is exclusively via the digital input terminals.

Duplicate Usage of the Process Output Data Channel

If several process output data words contain the same setpoint description, only the process output data word which is read first will be valid. The processing sequence in the inverter is PO1 - PO2 - PO3, i.e. if PO2 and PO3 contain the same setpoint description, only PO2 will be effective. The content of PO3 will be ignored.

Example: Duplicate usage of PO2 and PO3

Process output data words PO2 and PO3 both contain the SPEED setpoint.

P560 PO1 Setpoint Description = CONTROL WORD 1
P562 PO2 Setpoint Description = SPEED
P564 PO3 Setpoint Description = SPEED

The speed setpoint is transmitted twice within the process output data channel (duplicate usage of process output data words). As the inverter processes the process output data words in the order PO1 - PO2 - PO3 and recognizes duplicate usage of the process output data channel, the speed setpoint transmitted in PO3 will never become effective.

Simultaneous Transmission of Control Word 1 and Control Word 2

If control words 1 and 2 are transmitted simultaneously, the inverter is controlled in the same way via the basic control block of control word 1 and the basic control block of control word 2. In this case you must make sure that both basic control blocks are coded the same. The inverter will only be enabled, if both the digital input terminals and control words 1 and 2 give the enable command. The virtual terminals of control word 2 are evaluated directly only if they do not correspond to a control word 1 function.

32-Bit Process Output Data

Process data which are longer than 16 bits and therefore occupy more than one process data word will only be processed by the inverter if they are completely mapped to the process data channel. The position setpoint, for example, will only become effective if completely mapped to the process output data channel. Consequently both POSITION HI and POSITION LO must be specified in the process output data channel.

3.3.3 Actual Value Description of the PI Data

The *PI1 - PI3 Actual Value Description* parameters define the content of the process input data words which are transferred from the inverter to the higher level automation unit through the fieldbus system (Fig. 8). Each process data word is defined by its own parameter, so altogether three parameters are required to describe the process input data.

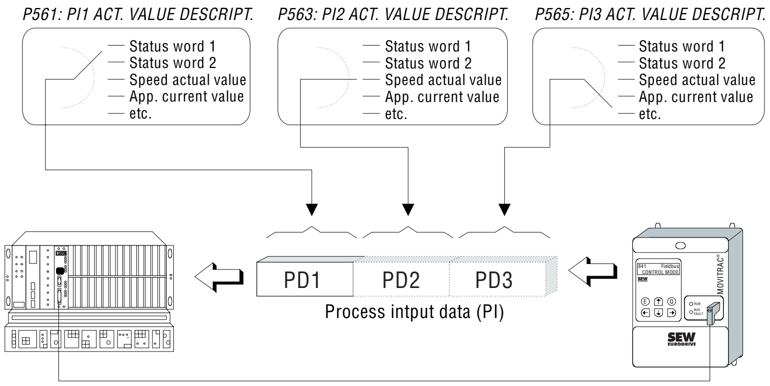


Fig. 8: Actual value description of the process input data (PI)

Process input data words PI1 to PI3 serve to transfer the parameters listed in the table below via the process data channel. 32-bit values, such as e.g. the actual position, are transmitted in two process data words. You may decide yourself in which process data word you wish to transmit the more significant part (high) and the less significant part (low) respectively.

NO FUNCTION
SPEED
APPARENT CURRENT
SPEED [%]
POSITION LO*)
POSITION HI*)
STATUS WORD 1
STATUS WORD 2

*) Setting not possible for MOVITRAC®31..., size 0

No Function

If you assign *NO FUNCTION* to a process input data word, the inverter will not update this process input data word. In this case, the MOVITRAC® 31.. will always return a value of 0000hex to the higher level control system.

Speed Actual Value (SPEED)

The *Actual Value Description PIx = SPEED* setting causes the inverter to return the current speed actual value to the higher-level automation unit in the unit [1/min]. Scaling of the speed actual value see Section 3.3.5.
The speed actual value can only be returned accurately if the inverter can determine the actual motor speed by means of a speed feedback facility. In a slip compensated application the difference to the real motor speed depends solely on the accuracy of the slip compensation set by the user.

Apparent Current Actual Value (APPARENT CURRENT)

The *Actual Value Description PIx = APPARENT CURRENT* setting causes the inverter to return the apparent current actual value to the higher-level automation system in the unit [% In] (in per cent of the inverter rated current). Scaling see Section 3.3.5.

Relative Actual Value of Speed (SPEED [%])

With the parameter set to actual value description PEx = SPEED [%] the inverter feeds the current relative actual value of speed with the unit [% f_{max}] back to the higher-level automation system. The scaling of the speed setpoint is described in section 3.3.5.

The relative actual value of speed can only be returned excactly if the inverter can determine the actual motor speed via speed feedback and is operated speed controlled. In the case of slip compensated applications the deviation from the actual motor speed is determined only by the accuracy of the slip compensation set by the user.

Actual Position (POSITION LO/HI)

Position actual values must be spread over two process data words, as the position is generally transmitted as integer32. This means you have to specify both the *Position Actual Value High* and the *Position Actual Value Low* (Fig. 7). Scaling of the actual position → Section 3.3.5.

Position actual values can only be used in conjunction with the internal *IPOS* positioning control. If the inverter is not fitted with the *IPOS* option and its pertinent functions, this setting will be rejected.

Status Word 1 / Status Word 2

Assigning status word 1 or status word 2 to the process input data allows you to access status data, fault and reference signals. For a description of status words 1 and 2 → Section 3.5.

Factory Setting of the *PI1-PI3 Actual Value Description*

When the factory setting has been activated, the following process output data are defined for the MOVITRAC® 31.. inverter:

PI 1 Actual Value Description:	*PI 2 Actual Value Description:*	*PI 3 Actual Value Description:*
STATUS WORD 1	SPEED	NO FUNCTION

3.3.4 Enable Fieldbus Setpoints

Re-parameterizing the process output data, e.g. changing the PO2 setpoint description from speed setpoint to current setpoint is usually done by means of parameter adjustment. Immediately after changing the PO2 setpoint description from speed setpoint to current setpoint the speed setpoint (e.g. 3000 1/min) transmitted by the higher-level control could be wrongly identified as current setpoint (e.g. 3000 %).

To avoid this, a defined interrupt between the process output data and the inverter setpoint processing is necessary. This interrupt facility is given by parameter

P570 Enable Fieldbus Setpoints = YES/NO

This parameter tells the inverter whether or not the process output data sent by the higher-level master are valid for the control and setpoint processing. This parameter can only be set to YES or NO. Fig. 9 shows the parameter functionality.

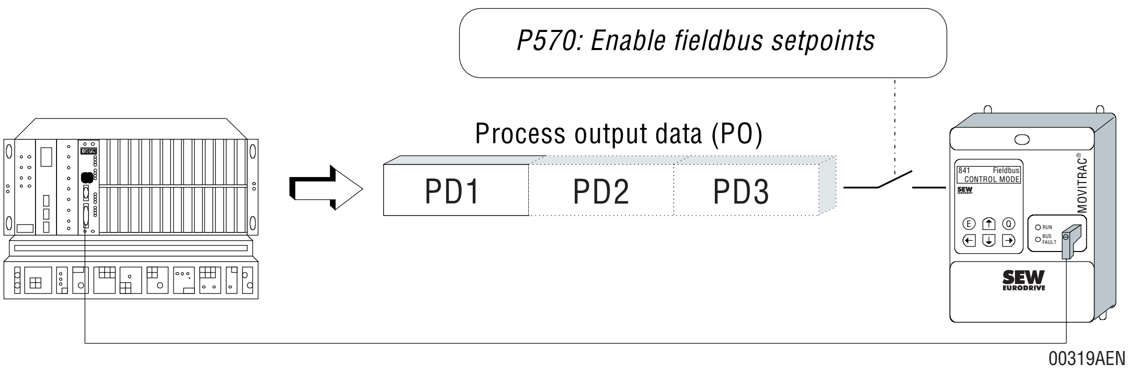


Fig. 9: Function of the Enable Fieldbus Setpoints parameter

When the *PO1-PO3 Setpoint Description* parameters are changed the process output data are automatically disabled through the *Enable Fieldbus Setpoints = NO* setting. Only when the *Enable Fieldbus Setpoints = YES* setting is initiated (e.g. by the higher-level control) will the process output data channel be enabled again for processing.

NO	Process output data disabled. The inverter will continue to use the last valid (frozen) process output data for this setpoint processing until the fieldbus setpoints are activated again.
YES	Process output data enabled. The inverter uses the process output data from the fieldbus;

Enable Factory Setting of the Fieldbus Setpoints Parameter

When the factory setting has been activated, the fieldbus parameter *570 Enable Fieldbus Setpoints* is defined as follows:

YES	Process output data enabled;

3.3.5 Scaling of the Process Data

Process data are always transmitted as hexadecimal data to facilitate their handling and processing by the system. Parameters with the same unit of measurement are given the same scaling to allow the setpoints and the actual values to be compared directly in the application program of the higher-level automation unit. There are four different process data types:
- Speed [1/min]
- Relative Speed [%]
- Current [% rated current]
- Ramp [ms]
- Position [degrees].
The different control word and status word variants are coded as bit fields and will be discussed in a separate section.

Scaling of the Speed

The *Speed Setpoint* and *Speed Actual Value* process data are specified in the unit [1/min] and mapped as signed values to a process data word (16-bit integer). The following table shows the scaling for *Speed* process data.

Data type:	Integer 16
Resolution:	1digit = 0.2 1/min
Range:	-6553.6 ....0.....+6553.4 1/min 8000_{hex} .....0.....$7FFF_{hex}$
Applies to:	actual value of speed speed setpoint speed limit slip compensation

If the motor is connected correctly, positive speed values correspond to CLOCKWISE direction of rotation or, in the case of hoisting applications, to CLOCKWISE = UP. Correspondingly negative speed values correspond to a COUNTERCLOCKWISE (DOWN) direction of rotation and are represented as two’s complement.

Example: Scaling of the speed in the process data channel

This example shows the coding you must apply to transfer the speed setpoint through the process data channel so that the drive will operate at 400 1/min in CLOCKWISE direction of rotation or at 750 1/min in COUNTER CLOCKWISE direction of rotation.

Direction of rotation	Speed	Scaling	Transferred process data
CW	400 1/min	$\frac{400}{0.2} = 2000_{dec} = 07D0_{hex}$	2000_{dec} or $07D0_{hex}$ resp.
CCW	750 1/min	$(-1) \cdot \frac{750}{0.2} = -3750_{dec} = F15A_{hex}$	-3750_{dec} or $F15A_{hex}$ resp.

Scaling of the Relative Speed

The process data relative speed setpoint [%] and relative actual value of speed [%] are specified in [% f_{max}] as percentage of the valid maximum frequency of the inverter and are represented signed in a process data word (16-bit-integer). The following table displays the scaling for the process data of the type "relative speed".

Data type:	Integer16
Resolution:	1digit = 0.0061 % (4000_{hex} = 100 %)
Reference:	Maximum frequency of the inverter (f_{max})
Range:	-3276.8 % ....0..... +3276.7 % 8000_{hex} .....0.....$7FFF_{hex}$
Valid for:	Relative speed setpoint [%] Relative actual value of speed [%]

Providing the motor is wired correctly, positive speed values indicate CLOCKWISE (CW) direction of rotation and in cases of hoist applications CLOCKWISE direction of rotation = UP. Negative speed values consequently indicate COUNTERCLOCKWISE (DOWN) direction of rotation and are represented as a two's complement.

Example: Scaling of the relative speed in the process data channel

This example shows, which code the relative speed setpoint [%] must be transferred over the process data channel with, in order to be able to operate the drive clockwise with 25% of the maximum frequency respectively counter clockwise with 75% of the maximum frequency.

Direction of rotation	Rel. Speed	Scaling	Transferred process data
CW	25 % f_{max}	$25 \cdot \frac{16384}{100} = 4096_{dec} = 1000_{hex}$	4096_{dec} or 1000_{hex} resp.
CCW	75 % f_{max}	$(-75) \cdot \frac{16384}{100} = -12288_{dec} = D000_{hex}$	-12288_{dec} or $D000_{hex}$ resp.

With the maximum frequency set to f_{max} = 50 Hz the drive in this example will rotate clockwise with 12.5 Hz respectively counterclockwise with 37.5 Hz.

Scaling of the Current

The *Current Setpoint*, *Apparent Current Actual Value* and *Active Current Actual Value* process data are given in per cent of the inverter rated current [% I_N] and mapped as signed values to the process data word (16-bit-integer).

Data type:	Integer16
Resolution:	1digit = 0.1 % I_N
Reference:	Inverter rated current
Range:	-3276.8 % ....0..... +3276.7 % 8000_{hex} .....0.....$7FFF_{hex}$
Valid for:	Apparent current actual value Active current actual value Current setpoint Current limit

Example: Scaling of the current in the process data channel

This example show the coding the higher-level control uses to exchange *Current* process data with the inverter.

Current	Conversion of the scaling	Transferred process data
45 % I_N	$\frac{45}{0.1} = 450_{dec} = 01C2_{hex}$	450_{dec} or $01C2_{hex}$ resp.
115.5 % I_N	$\frac{115.5}{0.1} = 1155_{dec} = 0483_{hex}$	1155_{dec} or 0483_{hex} resp.
-67 % I_N	$\frac{-67}{0.1} = 670_{dec} = FD62_{hex}$	-670_{dec} or $FD62_{hex}$ resp.

Scaling of the Ramp

The process ramp for acceleration and deceleration is specified in milliseconds relative to a frequency rate of change of 50 Hz and mapped unsigned to a process data word (16-bit unsigned). The table below shows the scaling for the process ramp.

Data type:	**Unsigned16**
Resolution:	1digit = 1ms
Reference value:	delta f = 50 Hz
Range:	0ms ... 65535ms 0000_{hex} .... $FFFF_{hex}$
Applies to:	Process ramp up/down

Example: Scaling of the process ramp

The inverter is enabled with an acceleration ramp of 300 ms and disabled again through the stop function using a deceleration ramp of 1.4 s.

Ramp time	Conversion of the scaling	Transferred process data
300 ms	300 ms ⇒ $300_{dec} = 012C_{hex}$	300_{dec} or $012C_{hex}$ resp.
1.4 s	1.4 s = 1400 ms ⇒ $1400_{dec} = 0578_{hex}$	1400_{dec} or 0578_{hex} resp.

Scaling of the Position

Position values generally are 32-bit values and therefore must be transmitted in two process data words. It is up to the user to decide in which process data word he wishes to transmit the more significant part of the position (high word) and the less significant part of the position (low). The position is therefore transmitted as signed 32-bit integer. The following table shows the scaling for *Position* process data.

Data type:	Integer32
Resolution:	1 motor revolution = 4096 increments, i.e. 1digit = $\frac{360°}{4096}$
Range [°]:	-188,743,680° ....0..... +188,743,679°
[Motor revolutions]:	-524 288 ....0.... +524287
[Increments]:	8000 (High) 0000 (Low) $_{hex}$ ......0...... 7FFF (High) FFFF (Low) $_{hex}$
Applies to:	Position actual value Position setpoint

If the motor is connected correctly position values are incremented for CLOCKWISE direction of rotation and decremented for COUNTERCLOCKWISE direction of rotation! After power-up the inverter is in position 0.

IMPORTANT

When handling the position setpoints in the application program of the higher-level automation unit make sure that both process output data words containing the position data, are dealt with consistently, i.e. that the position setpoint high is always transmitted together with a position setpoint low! Otherwise the inverter might approach undefined positions, as, e.g. an old position setpoint low and a new position setpoint high might be active together!

Example: Entry of a position setpoint via the process data channel

This example shows how position setpoints must be set specified by the higher-level control using the process data channel. In our example positions 1 and 2 shown in Fig. 10 shall be specified via the fieldbus system. For this example to work the motor must be in position 0 after power-up.

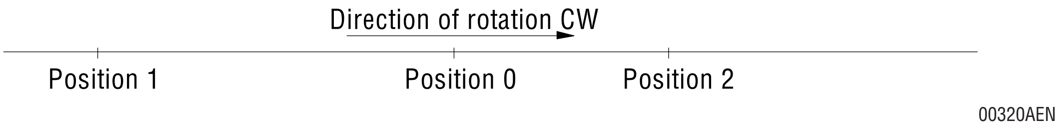


Fig. 10: Positioning example with starting position (0) and two target positions (1 and 2)

Position 1 is 35 motor revolutions CCW away from starting position 0, position 2 is 19 motor revolutions CW. The two positions then have the following process data codings:

Position	Conversion of the scaling	Transferred process data
Position 1: 35 revs CCW	$-35 \cdot 4096 = -143360_{dec}$ = *FFFD D* 000_{hex}	FFFD (Position HI) D000 (Position LO) $_{hex}$
Position 2: 19 revs CW	$19 \cdot 4096 = 77824_{dec}$ = 0001 3000_{hex}	0001 (Position HI) 3000 (Position LO) $_{hex}$

3.4 Definition of the Control Word

The control word is 16 bits long. Each bit has an inverter function assigned to it. The low byte comprises 8 function bits with a permanent definition each, which are always valid. The assignment of the more significant control bits varies for the different control words.

Functions, which the inverter does not generally support, cannot be activated via the control word either. In this case the individual control word bits are to be considered as reserved bits and set at logical 0 by the user!

3.4.1 Basic Control Block

The less significant part of the control word comprises 8 function bits, to which the most important drive functions are permanently assigned. Fig. 11 shows the basic control block assignment.

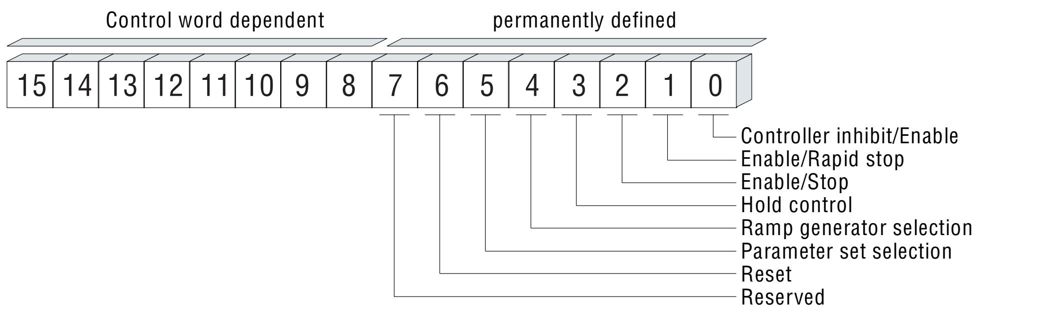


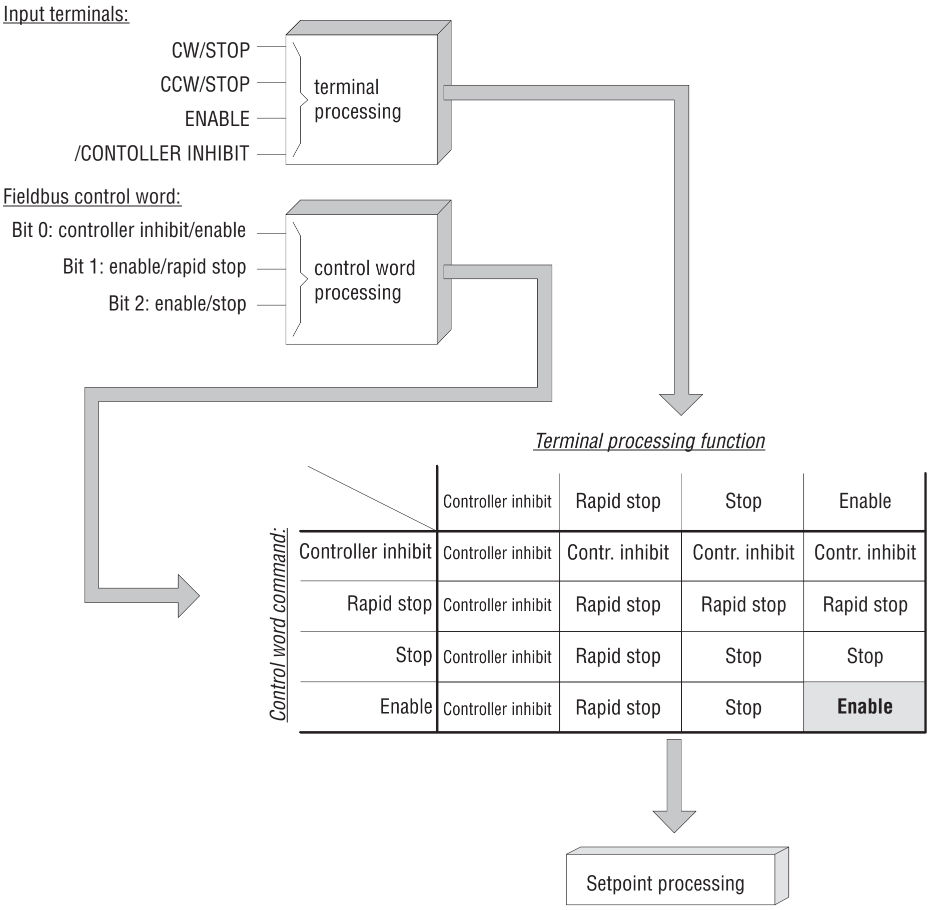
Fig. 11: Basic control block for all control words

Functionality of the single control bits:

Bit:	Functionality	Assignment
0	Controller inhibit	0 = Enable 1 = Inhibit controller, activate brake
1	Enable/Rapid stop	0 = Rapid stop 1 = Enable
2	Enable/stop	0 = Stop with generator ramp or process ramp 1 = Enable
3	Hold control*)	0 = Hold control not active 1 = Hold control active
4	Ramp generator selection	0 = Ramp generator 1 1 = Ramp generator 2
5	Parameter set selection*)	0 = Parameter set 1 1 = Parameter set 2
6	Reset	0 = Not active 1 = Reset fault
7	Reserved	Reserved bits are to be set to zero!

*) Not possible to assign bits to zero for MOVITRAC® 31..., size 0

The input terminals remain generally active, also in the FIELDBUS control mode. Safety-relevant functions such as *Controller Inhibit* and *Enable* are processed with equal priority both by the terminal strip and the fieldbus, i.e. for fieldbus control of the inverter, the inverter must first be enabled on the terminal side (Fig. 12). All other functions, which can be activated both via the terminals and via the control word are processed as OR functions.



	Controller inhibit	Rapid stop	Stop	Enable
Controller inhibit	Controller inhibit	Contr. inhibit	Contr. inhibit	Contr. inhibit
Rapid stop	Controller inhibit	Rapid stop	Rapid stop	Rapid stop
Stop	Controller inhibit	Rapid stop	Stop	Stop
Enable	Controller inhibit	Rapid stop	Stop	**Enable**

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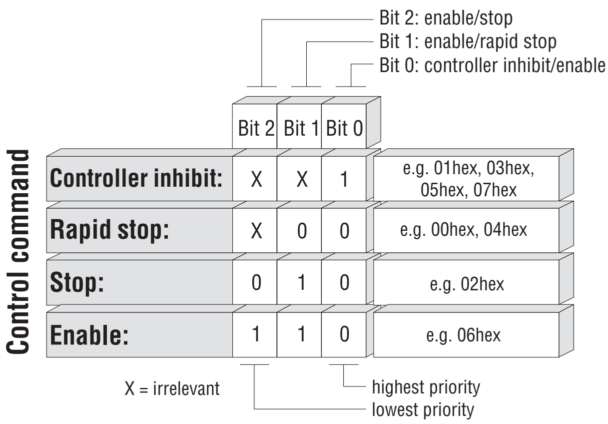
Fig. 12: Connecting the safety-relevant control signals from the input terminals and the fieldbus

For safety reasons the definition of the basic control block is such that the inverter adopts a safe state (*No Enable*) when a control word containing 0000hex is given, as all common fieldbus master systems definitely reset the outputs to 0000hex in the case of a fault or malfunction. In this case the inverter will carry out a rapid stop and then activate the mechanical brake.

Controlling the Inverter with a 0-2 Bit

When the inverter has been enabled via the terminals, it can be controlled with bit 0 - bit 2 of the basic control block. These three bits are used to activate four different control commands for inverter control through the fieldbus system (Fig. 13).



Control command	Bit 2	Bit 1	Bit 0	
Controller inhibit:	X	X	1	e.g. 01hex, 03hex, 05hex, 07hex
Rapid stop:	X	0	0	e.g. 00hex, 04hex
Stop:	0	1	0	e.g. 02hex
Enable:	1	1	0	e.g. 06hex

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Fig. 13: Coding of the control commands of the MOVITRAC® 31.. inverter

While the inverter is generally enabled with the *Enable* command, there is a choice of three control commands to stop the drive, i.e.

- *Controller Inhibit*
- *Rapid Stop*
- *Stop.*

In addition, the inverter can at any time be stopped via the input terminals, independent of the control command which is being sent. This control option enables you to integrate the inverters into a fieldbus-independent emergency stop concept.

The Enable Control Command

The *Enable* control command enables the inverter via the fieldbus system. If the process ramp is transmitted together with the *Enable* command via the fieldbus system, this control command will use the specified ramp value as acceleration ramp. If not, the inverter will use the typical ramp generators *Ramp up* for this control command, depending on the selected parameter and ramp generator sets (Fig. 14).

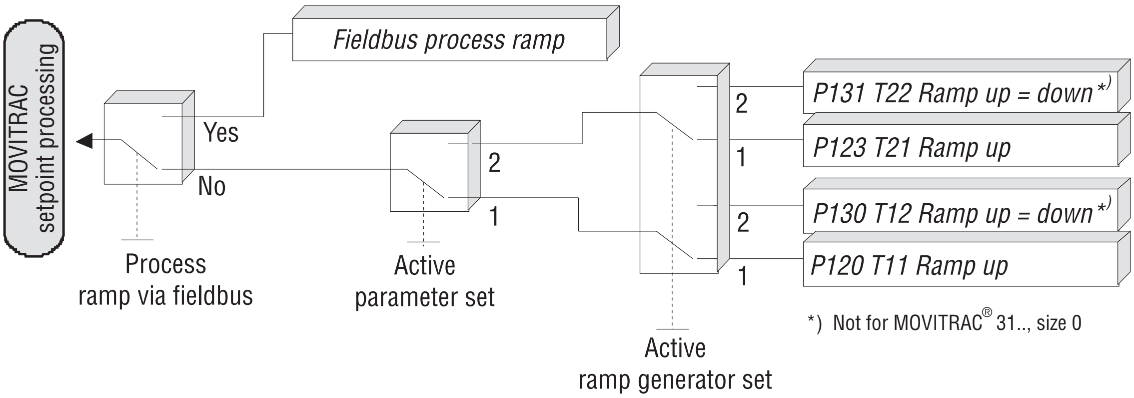

Fig. 14: Overview of the acceleration ramp options for the Enable control command

For the *Enable* control command to become active all three bits must be switched to *Enable* (110_{bin}). Fig. 14 shows the possible coding of the *Enable* control command with 06hex.

The Controller Inhibit Control Command

The *Controller Inhibit* control command allows you to disable the power output stages of the inverter and thus make them become high-resistance. At the same time the inverter will activate the mechanical motor brake causing the drive to stop immediately by way of mechanical braking. Motors which are not fitted with a mechanical brake will coast to rest when this control command is used.

Fig. 13 shows that it suffices to set *bit 0: Controller Inhibit/Enable* in the control word to initiate the *Controller Inhibit* control command, as all other bits are irrelevant. Consequently, this control bit has the highest priority in the control word.

The Rapid Stop Control Command

The *Rapid Stop* control command causes the inverter to ramp down the currently active rapid stop ramp. The set rapid stop ramps

P140 *T13 Stop Ramp* (if parameter set 1 is active)
P141 *T23 Stop Ramp* (if parameter set 2 is active)

will be active. The process ramp which might be specified via the fieldbus, has no effect on the rapid stop! Reset *Bit 1: Enable/Rapid Stop* to activate this control command (see Fig. 13).

The Stop Control Command

The *Stop* control command causes the inverter to ramp to rest. If the process ramp is transmitted via the fieldbus system, this control command will use the specified ramp value as value for the deceleration ramp. If not, the inverter will use the typical ramp generators *Ramp Down* for this control command, depending on the selected parameter and ramp generator sets (Fig. 15).

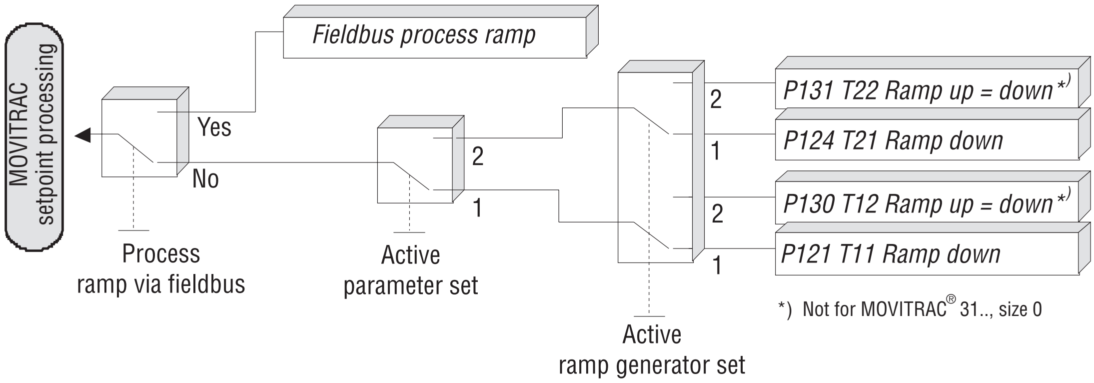

Fig. 15: Overview of the deceleration ramp options for the Stop control command

Use *Bit 2: Enable/Stop* to initiate the *Stop* control command. Of all three control commands available for stopping the drive, the *Stop* control command has the lowest priority.

Activating the Hold Control (not for MOVITRAC® 31.., size 0)

Set bit 3 = 1 of the control word to activate the *Hold Control* function when the inverter is in speed control mode. This function causes the inverter to carry out a stop using the active ramp and then hold the position under hold control. When the inverter is in V/f control mode, this bit is reserved, as the function cannot be activated. Therefore, when the V/f control mode, set this bit to 0.

Selecting the Effective Parameters Set (not for MOVITRAC® 31.., size 0)

Use bit 4 of the control word to select the effective ramp generators. The following table shows the ramp generators, which can be selected with this control bit.

Par. set	Ramp gen. set	Valid ramp generator
1	1	P120 T11 Ramp up P121 T11 Ramp down P140 T13 Ramp stop
	2	P130 T12 Ramp up = down P140 T13 Ramp stop
2	1	P123 T21 Ramp up P124 T21 Ramp down P141 T23 Ramp stop
	2	P131 T22 Ramp up = down P141 T23 Ramp stop

*) Parameter set 2 not available for MOVITRAC® 31.., size 0

This bit is OR'd with the input terminal function *Ramp Generator Selection*, i.e. a logic "1" on the input terminal OR in the control word bit will activate ramp generator set 2!

Selecting the Effective Parameter Set (not for MOVITRAC® 31.., size 0)

Use bit 5 of the control word to select the effective parameter set. Before, enable the parameter set selection in parameter in *P350 Enable Parameter Selection = YES.* It is not possible to change parameters sets while the drive is running. Selection of a different parameter set is only possible when the drive is in the *No Enable* or *Controller Inhibit* condition.

This bit is OR'd with the input terminal function *Parameter Set Selection*, i.e. a logic "1" on the input terminal OR in the control word bit will activate parameter set 2!

Resetting the Inverter after a Fault

Bit 6 of the control word resets the inverter via the process data channel in the case of a fault. Every set can only be initiated with a 0/1 transition in the control word. All other reset options continue to be active.

3.4.2 Control Word 1

In addition to the most important drive functions contained in the basic control block, control word 1, in its more significant byte, contains function bits for internal setpoint functions, which can be generated in the MOVITRAC® 31.. inverter. For example, control word 1 allows the internal fixed setpoints or the motorized potentiometer function to be activated.

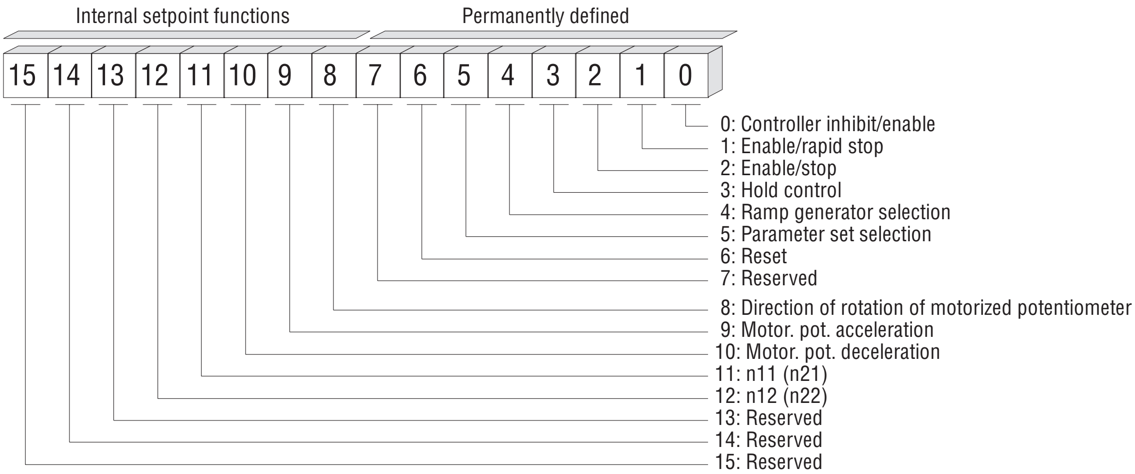

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Fig. 16: Definition of control word 1

When using the internal setpoint functions, control word 1 enables you to control the inverter with only one process output data word in the I/O or peripheral section of the higher-level automation unit.

Bit:	Function	Assignment
8	Direction of rotation for motor pot. or internal setpoints	0 = Direction of rotation CW 1 = Direction of rotation CCW
9 10	Motor pot. acceleration Motor pot. deceleration	10 9 0 0 = No change 1 0 = Deceleration 0 1 = Acceleration 1 1 = No change
11 12	Selection of internal fixed setpoints n11 to n13 or n21 to n23 resp.	12 11 0 0 = Speed setpoint via process output data word 2 0 1 = Internal setpoint n11 (n21) 1 0 = Internal setpoint n12 (n22) 1 1 = Internal setpoint n13 (n23)
13-15	Reserved	Reserved bits are generally to be set to zero!

When these internal setpoint functions are activated, entry of a speed setpoint via a different process output data word will no longer be effective.

Motorized Potentiometer Function via Fieldbus

Fieldbus control of the motorized potentiometer setpoint function works the same as control via the standard input terminals. Set parameter *P150 Motorized Potentiometer = YES* to activate the motorized potentiometer function. In this case a speed setpoint which might be specified via another process data word will no longer be considered.

To change the setpoint, use the two control word bits *Motorized Potentiometer Up* (bit 9) and *Motorized Potentiometer Down* (bit 10). Operating bit 9 *Motorized Potentiometer Up* will increase the setpoint, bit 10 *Motorized Potentiometer Down* will decrease the setpoint.

The direction of rotation is specified by bit 8 *Direction of Rotation* in the control word. *Direction of Rotation = 0* specifies clockwise direction of rotation, *Direction of Rotation = 1* counterclockwise direction of rotation.

The process ramp which may be specified via another process output data word has no effect on the motorized potentiometer function. Only the motorized potentiometer ramp generators

P151 T4 Ramp Up
P152 T4 Ramp Down

are used.

Internal fixed setpoints

Selection of the internal fixed setpoints via the fieldbus interface is the same as via the standard input terminals. To select the internal fixed setpoints use bit 11 and bit 12 of the control word respectively. The following table shows how the internal fixed setpoints are selected depending on the chosen parameter set.

Par. set	Bit 12	Bit 11	Active setpoint	Internally stored fixed setpoint parameter
1	0	0	Speed setpoint via fieldbus	–
	0	1	Internal fixed setpoint n11	P160 N1
	1	0	Internal fixed setpoint n12	P161 N1
	1	1	Internal fixed setpoint n13	P162 N1
2*)	0	0	Speed setpoint via fieldbus	–
	0	1	Internal fixed setpoint n21	P170 N21
	1	0	Internal fixed setpoint n22	P171 N22
	1	1	Internal fixed setpoint n23	P173 N23

*) Parameter set 2 not available for MOVITRAC® 31.., size 0

When an internal fixed setpoint is selected, the direction of rotation is determined by control word bit 8 *Direction of Rotation*. The process ramp which might be specified via the fieldbus has no effect when the internal setpoints are used.

3.4.3 Control Word 2

In addition to the function bits for the most important drive functions in the basic control block, control word 2, in its more significant section, contains the virtual input terminals. These terminals are freely programmable input terminals, which are not physically available however since the requisite hardware (option pcb) is not fitted. These input terminals are then mapped to the virtual input terminals of the fieldbus. Each virtual terminal is then assigned to an optional and physically not available input terminal and can be programmed to any function. This MOVITRAC® 31.. feature allows you to individually implement your fieldbus drive application making full use of all unit functions via the fieldbus interface.

Figure 17 shows the assignment of the control word 2 for the standard MOVITRAC® 31.. unit. As the terminals 48 and 49 are standard in the basic version of the inverter, here only the optional input terminals 50-54 are available as virtual terminals.

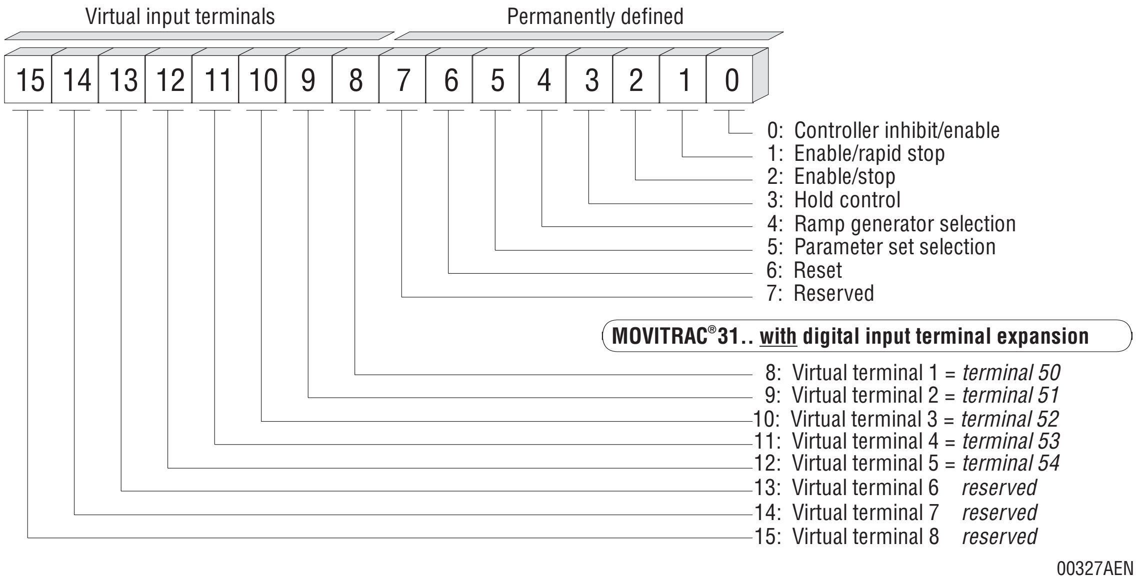

Fig. 17: Control word 2 for the MOVITRAC® 31B basic unit with digital input terminal expansion

You can program any function to the virtual input terminals. Table 16 shows the virtual input terminal assignment for the standard MOVITRAC® 31.. unit (with a digital input terminal expansion) and their functionality.

Virtual input terminal	Assigned to terminal	Functionality
1	50	Terminal function programmable to *P605 TERMINAL 50*
2	51	Terminal function programmable to *P606 TERMINAL 51*
3	52	Terminal function programmable to *P607 TERMINAL 52*
4	53	Terminal function programmable to *P608 TERMINAL 53*
5	54	Terminal function programmable to *P609 TERMINAL 54*
6-8	–	None

Fig. 18 shows control word 2 for the MOVITRAC® 31.. inverter without digital input terminal expansion, e.g. when the *FEN Speed Measurement* option is fitted. As no optional physical input terminals are available, these can be mapped completely to the virtual terminals of the fieldbus.

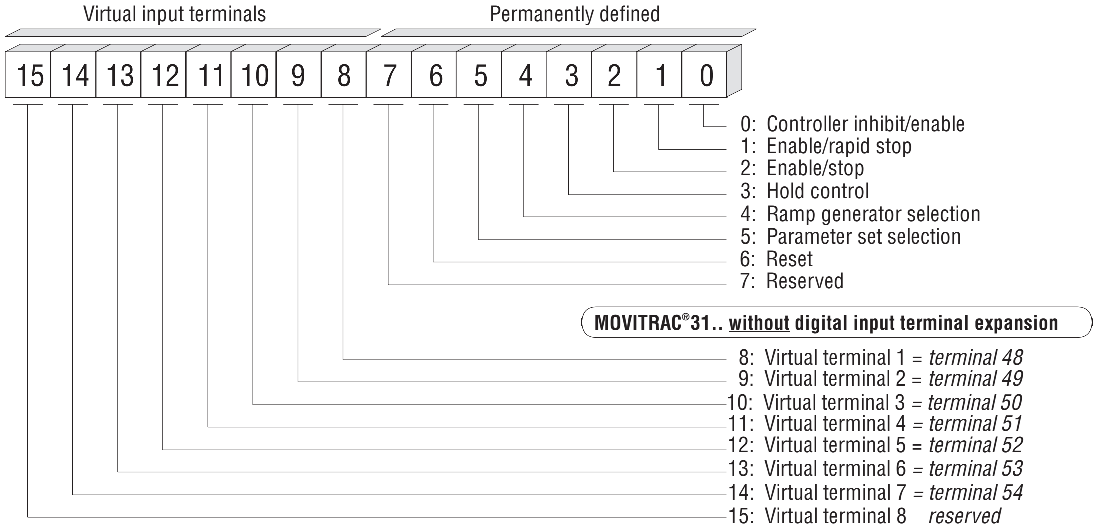

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Fig. 18: Control word 2 for MOVITRAC® 31.. without digital input terminal expansion

You can program any function to the virtual input terminals. The following table shows the virtual input terminal assignment for the MOVITRAC® 31.. inverter without digital input terminal expansion and their functionality.

Virtual input terminal	Assigned to terminal	Functionality
1	48	Terminal function programmable to *P603 TERMINAL 48*
2	49	Terminal function programmable to *P604 TERMINAL 49*
3	50	Terminal function programmable to *P605 TERMINAL 50*
4	51	Terminal function programmable to *P606 TERMINAL 51*
5	52	Terminal function programmable to *P607 TERMINAL 52*
6	53	Terminal function programmable to *P608 TERMINAL 53*
7	54	Terminal function programmable to *P609 TERMINAL 54*
8	–	None

3.5 Definition of the Status Word

The status word is 16 bits long. The less significant byte, the basic status block, comprises 8 status bits with a permanent definition, which reflect the most important drive conditions. The assignment of the more significant status bits varies for the different status words.

3.5.1 Basic Status Block

The basic status block of the status word contains status information which is required for nearly all drive applications. These unit conditions are coded as bit information, i.e. each bit has a piece of status information assigned to it (Fig. 19). The following table shows the assignment of the status word.

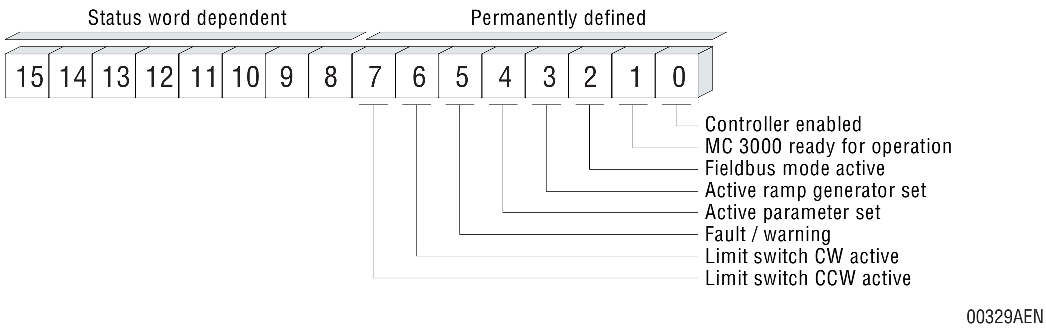


Fig. 19: Basic status block for all control words

Bit:	Status	Assignment
0	Controller enabled	0 = Controller is inhibited 1 = Controller is enabled
1	Ready for operation	0 = Drive not ready for operation (e.g. no mains supply) 1 = Drive ready for operation
2	Fieldbus mode active	0 = Fieldbus mode not active 1 = Fieldbus mode active, control/setpoint via fieldbus
3	Active ramp generator set	0 = Ramp generator 1 1 = Ramp generator 2
4	Active parameter set*)	0 = Parameter set 1 1 = Parameter set 2
5	Fault/warning	0 = No fault/warning 1 = Fault/warning present
6	Limit switch CW active*)	0 = Not activated 1 = Limit switch CW activated
7	Limit switch CCW active*)	0 = Not activated 1 = Limit switch CCW activated

*) Not available for MOVITRAC® 31.., size 0

The *Enable Controller* Status Bit

Bit 0 of the status word is determined from the combination of the input terminals and the control command contained in the control word. Fig. 20 shows the reaction of the *Controller Enable* status bit as a function of the *Enable* control command and the actual speed respectively.

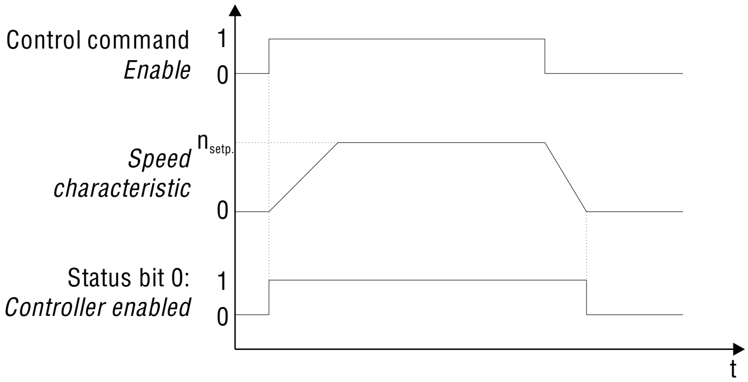


Fig. 20: Behaviour of status bit 0:Controller Enabled

The *Ready for Operation* Signal

When status bit 1 in the status word signals *Ready for Operation = 1*, then the inverter is ready to respond to control commands from an external control system. The inverter is not ready to respond, if

- the MOVITRAC® 31.. signals a fault
- the factory setting is ongoing (set-up)
- no mains voltage is present.

The *Fieldbus Mode Active* Signal

Status bit 2 signals whether the inverter is in the FIELDBUS control mode (*P841 Control Mode = FIELDBUS)* and responds to control commands/setpoints from the process data channel of the fieldbus interface.
Adjustment of the inverter parameters via the fieldbus interface is possible at any time independent of the set control mode.

Current Parameter Set/Ramp Generator (not for MOVITRAC® 31.., size 0)

Bits 3 and 4 of the status word indicate the currently selected parameter set and ramp generator.

Fault/Warning

In bit 5 of the status word the inverter signals a fault that may have occurred or issues a warning. When a fault is signalled, the inverter is no longer ready for operation, whereas a warning may occur temporarily without affecting the operational performance of the inverter. For exact filtering of a fault we therefore recommend to evaluate status bit 1: *Ready for Operation* in addition to this fault bit (prerequisite: mains voltage ON). For the coding of a fault or warning see the following table.

Bit 1: *Ready for Operation*	Bit 5: *Fault/Warning*	
0	0	Inverter not ready for operation
0	1	Fault
1	0	Inverter is ready for operation
1	1	Warning

If status word 1 is active (factory setting), bit 5 = 1 will at the same time signal the fault code in the more significant byte of status word 1. The fault bit remains set until the fault is cleared with a reset or the warning is cancelled. The more significant byte in status word 1 will then change to unit status indication again.

Limit Switch Processing (not for MOVITRAC® 31.., size 0)

Bits 6 and 7 signal the current status of the limit switches connected to the input terminal of the inverter. The limit switch processing is active if two inverter input terminals are programmed to *Limit Switch CW* and *Limit Switch CCW*. As soon as one of the limit switches is actuated, an internal switch-off is effected independent of the specified control word, and the corresponding status bits in the status word of the inverter are set accordingly. This will inform the higher-level master about the current status of the limit switches and enable it to instruct the inverter to travel in the opposite direction. While the terminal signals of the limit switches are active when "0", the condition of the limit switches in the status word of the inverter is indicated by a high ("1") level.

3.5.2 Status Word 1

In addition to the most important status data in the basic status block, status word 1, in the more significant status byte, alternately contains either *Unit Status* data or *Fault Code* data. Depending on the fault bit, the unit status is indicated if the fault bit = 0 whereas the fault code is displayed if a fault has occurred (fault bit = 1) (Fig. 21). When the fault is cleared, the fault bit is reset and the current unit status shown again.

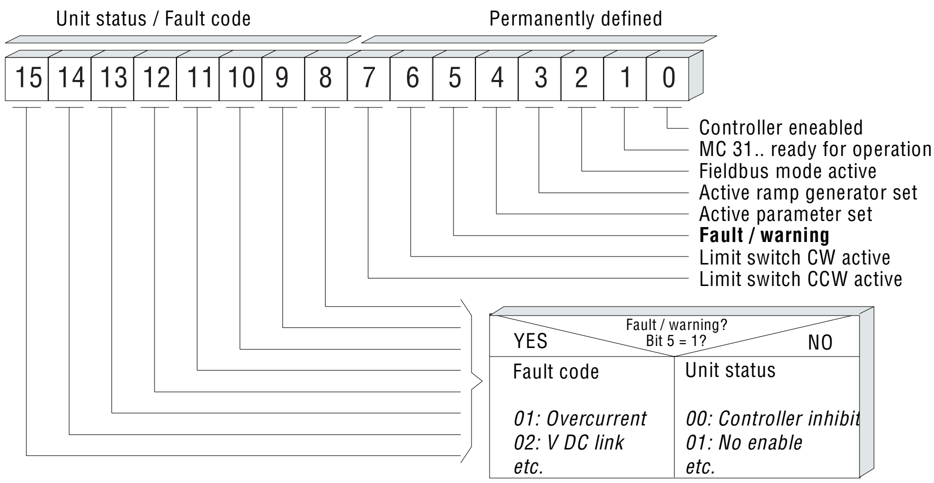


Fig. 21: Assignment of status word 1

The following table contains a list of MOVITRAC®31... unit conditions. Fault coding see MOVITRAC® 31.. *Parameter List* under *Index 12: Fault t-4.*

Code (decimal)	Unit status
0	Controller inhibit
1	No enable
2	Start magnetization
3	Stop magnetization
4	Rapid stop
5	Heating current
6	DC-braking
7	DC Holding current
8	Determining SxR
9	Preparing DC-braking
10	Enable
11	Reversing the direction of rotation
12	Normal stop
13	Rapid stop
14	Hold control
15	Braking time
16	Reference travel
17	Positioning
18	Synchronous operation
19	Coasting

3.5.3 Status Word 2

In addition to the most important status data in the basic status block, status word 2, in the more significant status byte, contains the virtual output terminals both of the standard unit and of the I/O option pcbs. This provides the user with all the unit information necessary to implement the most diverse applications. By programming the terminal functions of the output terminals you can process all the usual signals via the fieldbus system. Fig. 22 shows the assignment of the more significant status block.

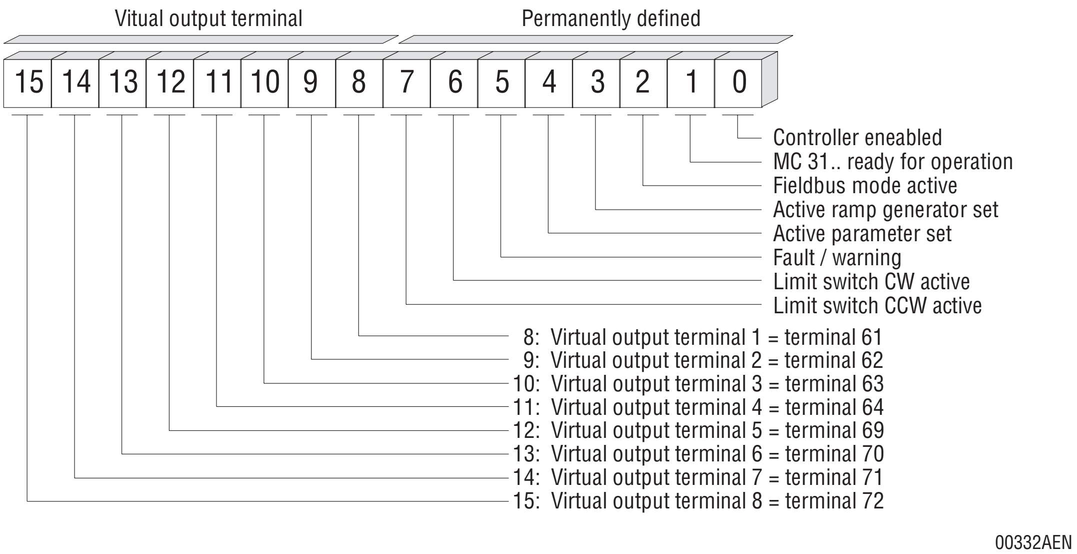


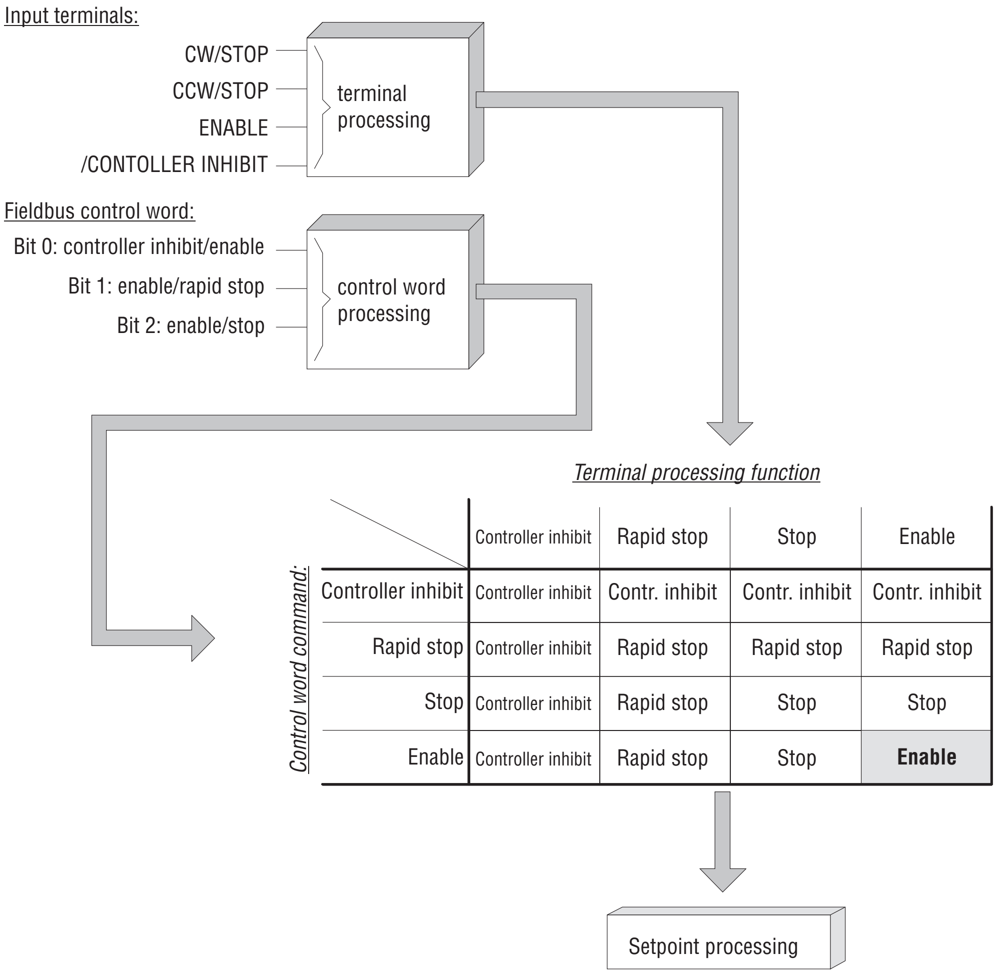
Fig. 22: Assignment of status word 2

With the exception of terminal 61 the virtual output terminals can be programmed to any function. The following table shows the assignment of the virtual output terminals to the standard and optional output terminals and their functionality.

Virtual output terminal	Assigned to terminal	Functionality	Functionality after factory setting
1	61	Brake	/BRAKE
2	62	Terminal function programmable to P611 TERMINAL 62	/FAULT
3	63	Terminal function programmable to P612 TERMINAL 62	IxT warning
4	64	Terminal function programmable to P613 TERMINAL 64	I_{REF} 1
5	69	Terminal function programmable to P614 TERMINAL 69	READY
6	70	Terminal function programmable to P615 TERMINAL 70	ROTATING FIELD OFF
7	71	Terminal function programmable to P616 TERMINAL 71	PARAMETER SET 1/2
8	72	Terminal function programmable to P617 TERMINAL 72	MOTOR WARNING 1

3.6 Active Input Terminal Functions

The input terminal functionality remains almost the same in the fieldbus mode. Safety-relevant functions used to enable the inverter are connected with the fieldbus control word commands as shown in Fig. 23. All other terminal functions are OR'd with the corresponding control word bits.



00322AEN

Fig. 23: Connecting the safety-relevant control signals from the input terminals and the fieldbus

The signal levels applied to activate the functions via the virtual terminals of control word 2 are the same as those for the standard terminal strip. Consequently, a function, which is activated by applying a signal level of "+24 V" on the input terminals, requires a logic "1" to be applied on the virtual terminal. Functions which are active when low (e.g. /delay monitoring) must be activated by applying a signal level of "0V" on the input terminals and a applying a logic "0" on the virtual terminals.
The following table lists the terminal functions which can be activated via the virtual terminals and their connection to the real terminals.

Function	Connecting of terminal and control word bit
CCW/Stop	OR + AND relation with basic control block (→ Fig. 23)
Enable/Stop	OR + AND relation with basic control block (→ Fig. 23)
Parameter set selection*)	OR
Fixed setpoint n11 (n21)	OR
Fixed setpoint n12 (n22)	OR
Reset	OR
Motor potentiometer Up	OR
Motor potentiometer Down	OR
/Deceleration monitoring	OR
Ramp generator selection	OR
/Controller inhibit	OR + AND relation with basic control block (→ Fig. 23)
/External fault	OR
CW/Stop	OR + AND relation with basic control block (→ Fig. 23)
No Function	OR
/Hold control*)	OR
/Limit switch CW*)	OR
/Limit switch CCW*)	OR
Reference cam*)	OR
Reference travel*)	OR
Fixed setpoint selection	OR
Setpoint active	OR
Characteristic selection	OR

*) Not available for MOVITRAC® 31.., size 0

Functions which cannot be used, can also not be selected (e.g. synchronous operation, master-slave).

3.7 Active Output Terminal Functions

The following table shows all possible terminal functions for the virtual terminals. Generally, only those output terminal functions can be used which are functionally available. As, for instance, simultaneous operation of the fieldbus and the synchronous operation is not possible (due to terminal assignment), the synchronous operation terminal functions cannot be used via the fieldbus.

MOVITRAC ready	Rotating field On
Rotating field Off	Brake On
Manual operation On	Active Parameter set*)
/Ixt warning	1. Frequency reference
2. Frequency reference*)	Actual value = setpoint*)
1. Current reference*)	2. Current reference
I_{max}*)	/Deceleration fault
/Fault	/External fault
/Current*)	/$V_{DC\text{-}link}$ >>
/Ixt>>	/Temperature >>
Frequency window skip*)	Brake Off
Speed zero*)	Motor warning 1
Motor warning 2*)	In Position*)
IPOS-output 1...8	

*) Not available for MOVITRAC® 31.., size 0

3.8 Integrated Input/Output-Module Functionality

The input and output terminals of the inverter can be used for digital input/output of sensor/actor signals via the fieldbus system. This way the inverter MOVITRAC® 31.. additionally takes on the functionality of an input/output-module on the fieldbus.

Consequently the higher-level control can read in the sensor signals on the inputs of the inverter and can control an actor via an output terminal of the inverter.

3.8.1 Scale of functions

In the basic design the inverter MOVITRAC® 31.. is equipped with 6 digital input terminals and 2 digital output terminals. For the I/O-module functionality all free programmable terminals can be used. Consequently the higher-level control is provided with maximum

5 digital input terminals and
1 digital output terminal.

3.8.2 Principle method of functioning

The I/O-module functionality is only available in the operating modes U/f-control or speed control (P770 operating mode = U/f-control or speed control), as the output terminal assignment IPOS-OUTPUT 1...8 is used. Thereby the first eight input terminals are assigned to the output terminal assignments IPOS-OUTPUT 1...8 according to the following table:

Input terminal	Assignemt via output terminal assignment	Available basic unit / with FEN/FPI
41	IPOS-output 1	physical
42	IPOS-output 2	physical
43	IPOS-output 3	physical
47	IPOS-output 4	physical
48	IPOS-output 5	physical/virtual in control word 2
49	IPOS-output 6	physical/virtual in control word 2
50	IPOS-output 7	virtual in control word 2
51	IPOS-output 8	virtual in control word 2

When activating the internal positioning control IPOS (P770 operating mode = positioning control) the I/O-module functionality must be simulated with the IPOS program.

The reflection of the physical input and output terminals onto the fieldbus takes place via the virtual input terminals of the control word 2 and the virtual output terminals of the status word 2.

In order to make the inverter ignore the input terminals used for the I/O-module functionality for drive control these terminals must be programmed to NO FUNCTION. The connection to the fieldbus is made by programming the output terminals to the function IPOS-OUTPUT 1...8.

Reading in Physical Inputs

In order to be able to read in the physical input terminal 42, for example, via fieldbus this terminal is programmed onto a virtual output terminal (e.g. P617 terminal 72 = IPOS-OUTPUT 2). This way the logic level of the input terminal 42 is available to the higher-level control via the virtual output terminal 72 of the status word 2. In order to avoid the drive functionality being affected by the level of the input terminal 42 the assigned terminal function is programmed to NO FUNCTION.

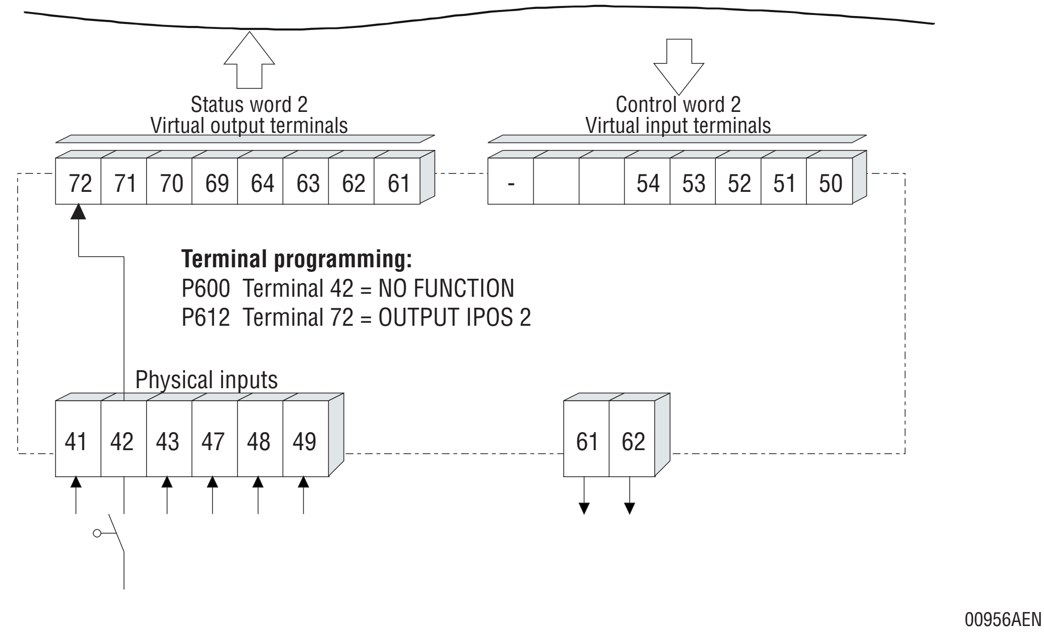


Fig. 24: Principle programming for reading in input terminals via fieldbus

Controlling physical outputs

The physical output terminal 62 is controlled via a virtual input terminal in the control word 2 of the inverter (e.g. P611 terminal 62 = IPOS-OUTPUT 7). Consequently the physical output terminal 62 can be controlled by the higher-level automation unit via the virtual input terminal 50 in control word 2. In order to avoid the drive functionality being affected by the virtual input terminal 50, the assigned terminal function is programmed to NO FUNCTION.

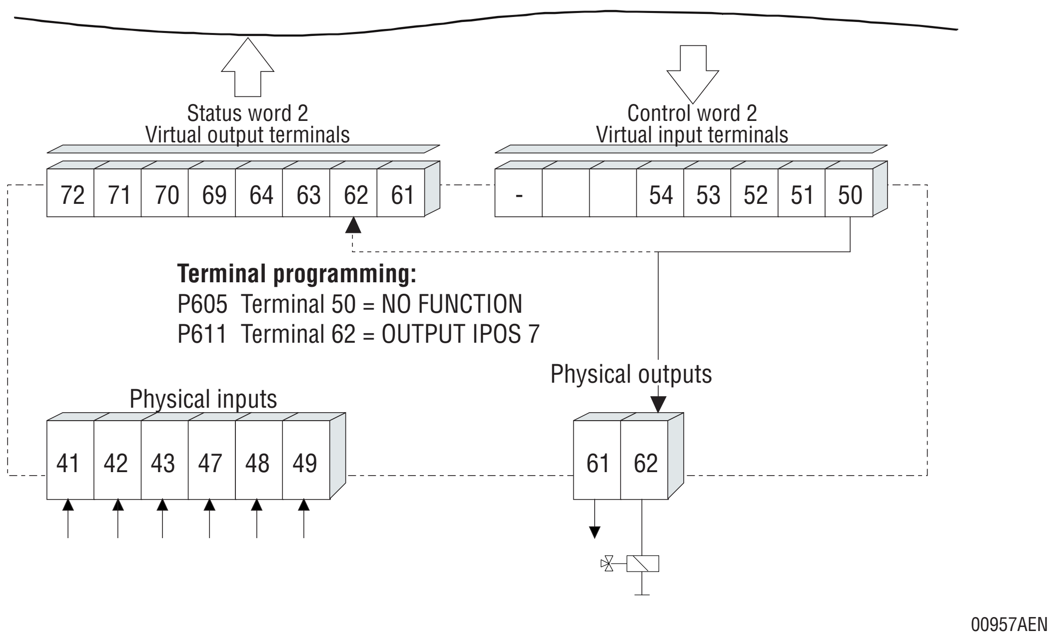


Fig. 25: Principle programming for controlling output terminals via fieldbus

4 Monitoring Functions

To ensure safe operation of the MOVITRAC® 31.. inverter when in the fieldbus mode, additional fieldbus monitoring functions were implemented which e.g. trigger a certain drive function in the case of a bus error. The required drive response can be set by the user. The two fieldbus parameters

P571 Fieldbus Timeout
P572 Timeout Response

allow the user to program an application-dependent drive response in the case of a bus error.

4.1 Fieldbus Timeout

The *Fieldbus Timeout* parameter determines the time after which the inverter is to respond to a bus error. If the system no longer receives cyclic process data, it recognizes a bus error, caused e.g. by a bus cable break. The drive must then automatically go into a safe state. The fieldbus timeout parameter is useful for all bus systems, the *Timeout* setting may, however, vary considerably for the different fieldbus systems. The following table defines the range of values for the *Fieldbus Timeout* setting.

Parameter name:	Fieldbus Timeout
Unit:	Seconds [s]
Range:	0.01 s to 650.00 s in increments of 10 ms
Special case:	650.00 = Fieldbus timeout switched off
Factory setting:	0.5 s

After a factory setting has been carried out, the *Fieldbus Timeout* parameter is set at 0.5 seconds!

IMPORTANT!

In the case of the PROFIBUS-DP parameter *571 Fieldbus Timeout* is set only through the response timeout, which is configured in the DP master for the complete DP system. Manual setting of this parameter at the keypad or with the MC_SHELL user interface remains without effect, the setting would be overwritten again at the next start-up of the PROFIBUS-DP.

4.2 Timeout Response

The fieldbus parameter *P572 Timeout Response* determines the response of the inverter in the case of a fieldbus timeout, i.e. the action the inverter is to trigger. The following table gives an overview of possible inverter responses to a fieldbus timeout.

Fault response	
RAPID STOP	Rapid stop with warning
EMERGENCY STOP	Emergency stop with warning
IMMEDIATE SWITCH-OFF	Immediate switch-off with warning
STOP/FAULT	Rapid stop with fault
EMERGENCY STOP/FAULT	Emergency stop with fault
IMMEDIATE SWITCH-OFF/FAULT	Immediate switch-off with fault
STANDARD MODE	Switch to standard mode
NO RESPONSE	No response

In respect of inverter responses to a fieldbus timeout a distinction is made between warnings and faults. In both cases the red V1 LED and the fault message *Fieldbus Timeout* signal an interruption of the fieldbus communications link. While, in the case of a warning, this fault indication is automatically cancelled when the bus system starts up again, in the case of a fault the inverter must be completely RESET with one of the available reset options (via the keypad, terminal or fieldbus).

After a factory setting has been carried out, this parameter has the value

P572 Timeout response	Rapid stop with warning

4.2.1 Rapid Stop with Warning

When the time set for the fieldbus time-out parameter has elapsed, the inverter will ramp down the rapid stop ramp *(P140 T13 Stop Ramp, P141 T23 Stop Ramp)* and issue a warning (fault 87), which is however automatically cleared when the fieldbus system starts up again. A manual reset of the inverter (Reset) is not required. If the DC braking mode (P730, P733) is activated, the drive is brought to a standstill with DC braking instead of a rapid stop.

4.2.2 Emergency Stop with Warning

As the MOVITRAC® 31.. inverter does not support emergency stop ramps, the fault response *Rapid Stop with Warning* (→ Section 4.2.1) will become effective.

4.2.3 Immediate Switch-off with Warning

When the time set for the fieldbus time out parameter has elapsed, the inverter will carry out an immediate switch-off, i.e. the output stage will be disabled and the mechanical motor brake activated immediately. Motors which are not fitted with a mechanical brake will coast to rest if this fault response is initiated. The inverter will issue a warning (fault 87). A manual reset of the inverter (Reset) is not required.

IMPORTANT

This fault response will stop the drive solely by means of the mechanical brake (no ramp down) which may subject the mechanical system components to considerable stresses. Make sure that your mechanical construction is sufficiently dimensioned to take up the loads that might occur in connection with this fault response.

4.2.4 Rapid Stop with Fault

When the time set for the fieldbus time-out parameter has elapsed, the inverter will ramp down the rapid stop ramp *(P140 T13 Stop Ramp, P141 T23 Stop Ramp)* and issue a warning (fault 28). This fault can only be cleared by resetting the inverter via the keypad, terminal or fieldbus. If the DC braking mode (P730, P733) is activated, the drive is brought to a standstill with DC braking instead of a rapid stop.

4.2.5 Emergency Stop with Fault

As the MOVITRAC® 31.. inverter does not support emergency stop ramps, the fault response *Rapid Stop with Fault* will become effective (→ Section 4.2.4).

4.2.6 Immediate Switch-off with Fault

When the time set for the fieldbus timeout parameter has elapsed, the inverter will carry out an immediate switch-off, i.e. the output stage will be disabled and the mechanical motor brake activated immediately. Motors which are not fitted with a mechanical brake will coast to rest if this fault response is initiated. To clear this fault (fault 34) you must reset the inverter at the keypad, via the terminals or the fieldbus.

IMPORTANT

This fault response will stop the drive solely by means of the mechanical brake (no ramp down) which may subject the mechanical system to considerable stresses. Make sure that your mechanical construction is sufficiently dimensioned to take up the loads that might occur in connection with this fault response!

4.2.7 Switching to Standard Mode

When the time set for the fieldbus timeout parameter has elapsed, the inverter will ramp down the rapid stop ramp (*P140 T13 Stop Ramp, P141 T23 Stop Ramp*) and issue a warning. This fault response enables the user to operate the inverter via the terminal strip in the case of a fieldbus system failure. When the time set for the fieldbus timeout parameter has elapsed, the inverter will ramp down the rapid stop ramp (*P140 T13 Stop Ramp, P141 T23 Stop Ramp*) and at the same time issue a warning (fault 87). The inverter has then already left the fieldbus mode. After a signal transition on the input terminal programmed to the *Controller Inhibit* the inverter can then be controlled using the digital input terminals and the analogue setpoint. To do this, proceed as follows:

1.) Fieldbus mode with input terminal *Controller Inhibit = +24 V* (controller enabled on terminal side), i.e. the inverter is controlled solely via the fieldbus.

2.) After a fieldbus timeout the terminals and the analogue input must be controlled in such a way that after a signal transition on the *Controller Inhibit* terminal the drive will travel in the desired direction.

3.) To exit this emergency operation mode you must disconnect the inverter completely from the supply (mains supply and 24 V supply) and then reconnect it. To avoid generating a fieldbus timeout error again, observe the following connection sequence:

    1) Connect the 24 V external supply.
    2) Start the fieldbus.
    3) Connect the mains supply.

4.2.8 No Response

The inverter continues to operate using the process output data last received until the bus system will send new process output data again. No fault signal is issued.

4.3 Fault *Fieldbus Timeout*

If no valid user data have been received within the time set for the fieldbus timeout parameter (*P571 Fieldbus Timeout*), the set fault response (*P571 Timeout Response*) and a fault or warning are issued. Depending on the set fault response the MOVITRAC® 31.. inverter will give out three different fault messages on the keypad display or in the MC_SHELL user interface. These fault messages only differ in the fault number that precedes them. In all three cases the fault messages signal that no valid user data have been received. The following table shows the fault codes signalled for the individual fault responses.

Fault code	Programmed fault response	Remedy
87	Rapid stop with warning	Automatic restart upon receipt of valid user data from fieldbus
87	Emergency stop with warning	
87	Immediate switch-off with warning	
28	Rapid stop with fault	Reset
28	Emergency stop with fault	
34	Immediate switch-off with fault	
87	Rapid stop with warning and switchover to standard mode	Unit off/on (mains supply + 24V)
None	No response	Not required

Fault 87 (Warning)
Fault 87 is a warning, i.e. the fault indication is automatically cleared when the fieldbus starts again. There is no reset required. The inverter will immediately respond again to the process data sent via the fieldbus.

Exception: the *Standard Mode* fault response (→ Section 4.2.7).

Fault 28 (Fault)
Fault 28 is a fault, it requires a system *Reset* to clear it.
This fault code is issued in connection with fault responses *Rapid Stop with Fault* and *Emergency Stop with Fault*. Remember to first re-activate the fieldbus system before you reset the inverter, as otherwise a fieldbus timeout will immediately be generated again.

Fault 34 (Fault)
Fault 34 is a fault, it requires a system *Reset* to clear it.
This fault code is issued in connection with the fault response *Immediate Switch-off with Fault*. Remember to first re-activate the fieldbus system before you reset the inverter, as otherwise a fieldbus timeout will immediately be generated again.

5 Setting Inverter Parameters

The drive parameters are read/written via the fieldbus system, using the READ and WRITE services of the application layer (layer 7). If layer 7 is absent, a suitable application layer needs to be emulated, i.e. mechanisms to assign frequency inverter parameters must be created. A parameter channel is defined in these circumstances. For further information on this subject refer to the User Manuals of the relevant option pcbs.

5.1 Parameter Setting Procedure

Parameter setting of the MOVITRAC®31.. frequency inverter is generally carried out according to a master-slave pattern, i.e. the inverter only supplies the information requested if asked to do so by the higher-level automation equipment. Thus MOVITRAC® 31.. invariably has slave functionality only (→ Fig. 26).

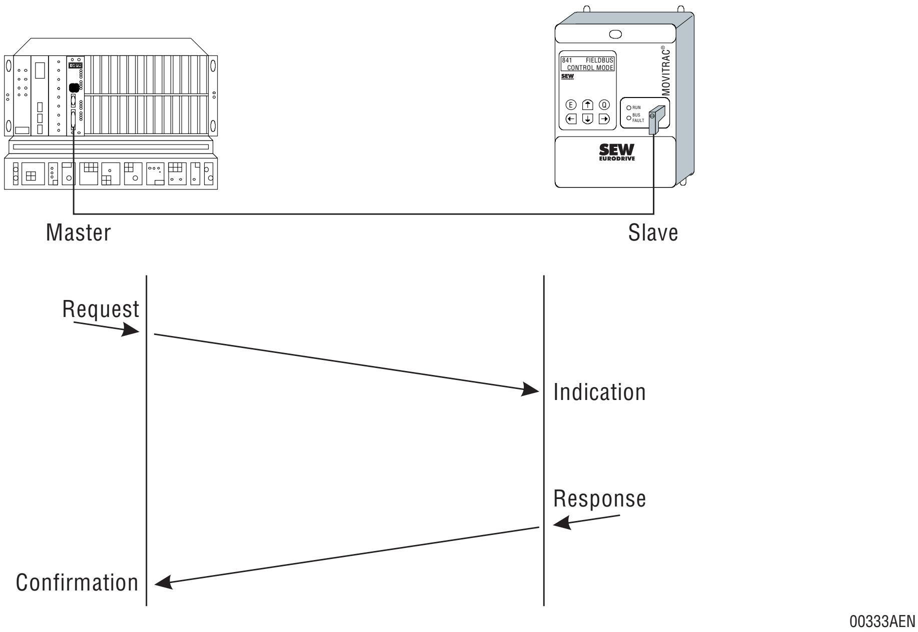


Fig. 26: Parameterizing the inverter to the master-slave-pattern

Functions such as READ or WRITE are normally provided from the master module or the higher-level automation equipment so that adjustment of inverter parameters can be carried out via the corresponding fieldbus system. Please see the User Manual for the fieldbus option pcb you are using for further information regarding inverter parameter adjustment.

5.1.1 Index Addressing

All MOVITRAC® 31.. frequency inverter parameters are listed in a separate document called the *MOVITRAC®* 31.. Parameter List. Each parameter is assigned a specific number (index) under which the parameter can be read or written. The index given in the *MOVITRAC®* 31.. Parameter List is the index for the serial interface. The value 1000_{dec} must be added to this index for access via the fieldbus interface.

5.1.2 Data Length/Coding

The parameter data length for MOVITRAC® 31.. frequency inverters amounts to a constant 4 bytes for all parameters. You can find detailed information about data length and coding as well as information on minimums and maximums in the *MOVITRAC®* 31.. Parameter List.

5.2 Reading a Parameter (READ)

Reading a parameter via the fieldbus interface is carried out using a *Read Request* from the automation equipment to the MOVITRAC® 31.. frequency inverter. When it receives this read request, the inverter is instructed to read the drive parameter of the index transferred (*Read Indication*). The service is then carried out in the inverter, and if the run is fault-free, the data are returned to the higher-level automation equipment in response (*Read Response*). The Read service is ended on receipt of confirmation of the service (*Read Confirmation*) by the automation equipment.

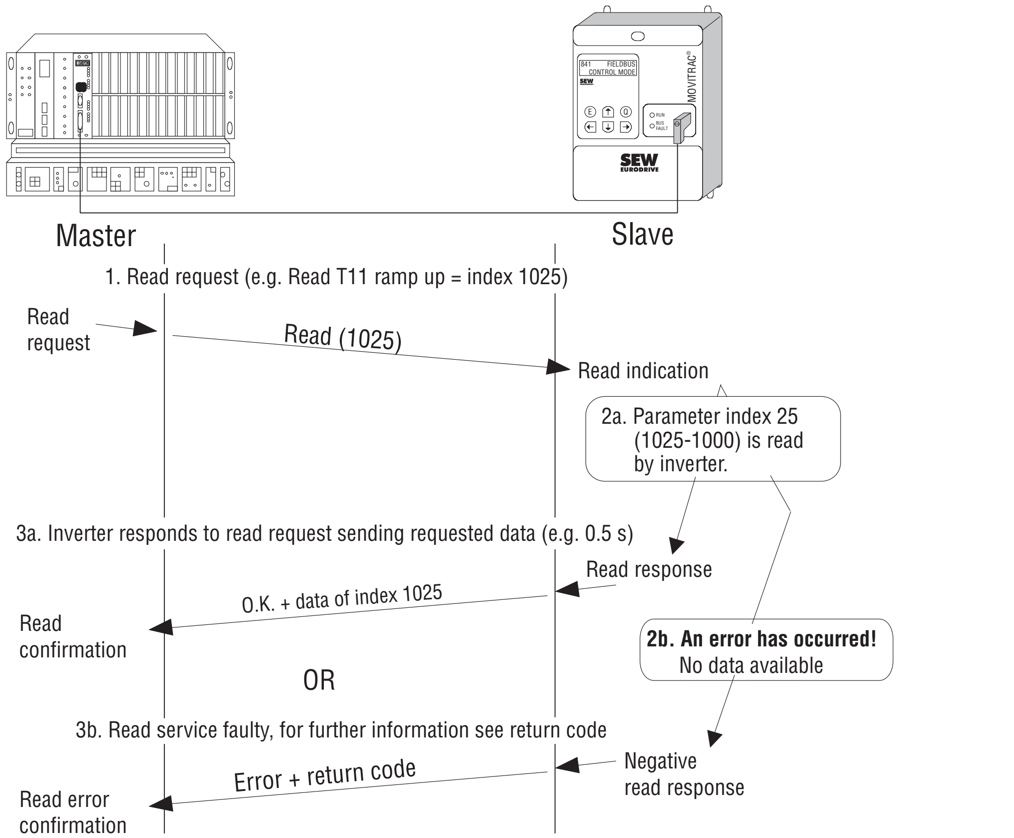


Fig. 27: Reading a parameter

If it is impossible to carry out the Read service in the inverter, this is reported back to the automation equipment by a negative answer *(Negative Read Response)*. The automation equipment thus receives a negative confirmation *(Read Error Confirmation)* with a detailed breakdown of the error.

5.3 Writing a Parameter (WRITE)

Writing a parameter is carried out via the fieldbus interface in a similar way to reading a parameter. A *Write Request* from the automation equipment informs the MOVITRAC® 31.. frequency inverter of the parameter index to be written, together with the new parameter data. When it receives the write request, the inverter is instructed to re-define the transferred drive parameter (*Write Indication*). The service is then carried out in the inverter, and if the run is fault-free, the positive response is returned to the higher-level automation equipment (*Write Response*). The Write service is ended on receipt of confirmation of the service (*Write Confirmation*) by the automation equipment.

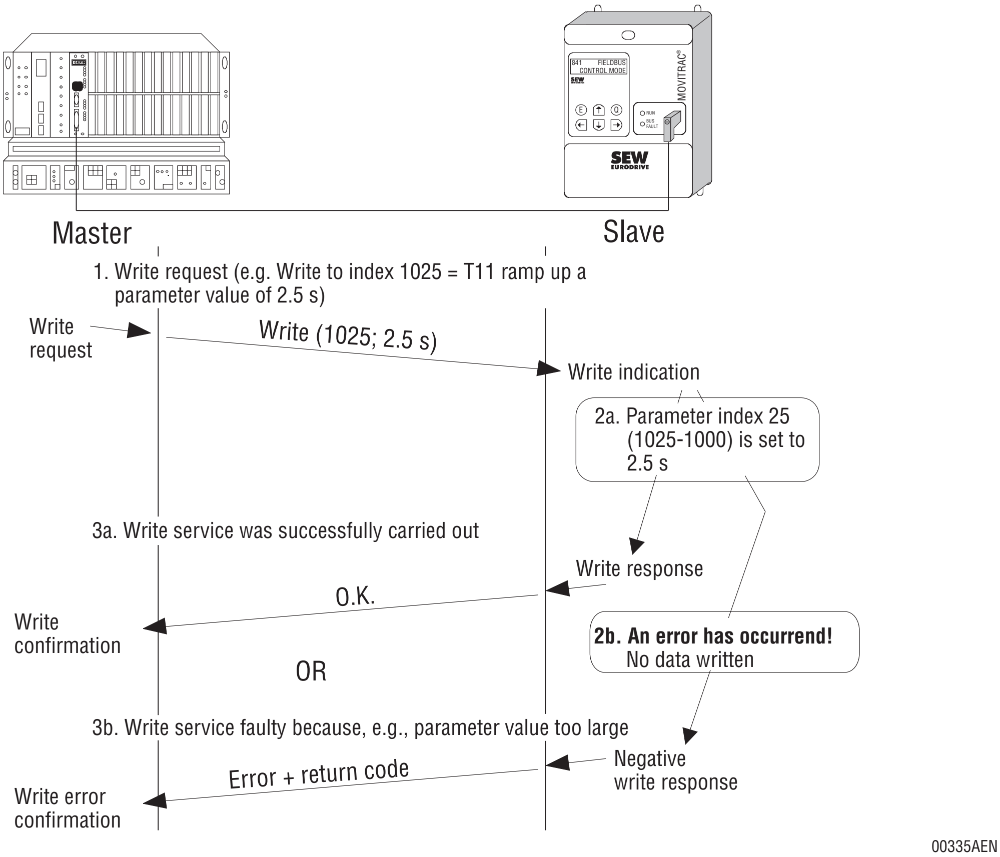


Fig. 28: Writing a parameter

If it is impossible to carry out the write service in the inverter, e.g. if false parameter data have been passed over, this is reported back to the automation equipment by a negative answer (*Negative Write Response*). The automation equipment thus receives a negative confirmation (*Write Error Confirmation*) with a detailed breakdown of the error.

5.4 Instructions to the User when Adjusting Parameters

When adjusting the parameters of the MOVITRAC® 31.. frequency inverter via the fieldbus system, all drive parameters can generally be accessed. However, since some of the drive parameters relate directly to communication via the fieldbus system, users should take note of the following instructions when adjusting parameters.

5.4.1 Factory Setting

All parameters are reset to the default value when activating the factory setting. For fieldbus operation, this means that the fieldbus control mode is exited, and that all fieldbus parameters are reset to the default values. New parameter values can then be assigned to the inverter, which can now be switched back to *P841 Control Mode = Fieldbus.*

Inverter parameters can be adjusted manually with the hand-held keypad, or with MC_SHELL, or via the fieldbus system in the form of a parameter download. The following procedure must be followed when the factory setting is activated via the fieldbus and parameters then adjusted:

1) Parameter to be written, *P830 Factory Setting = Yes* (fieldbus index 1203).
2) Parameter *P830 Factory Setting,* to be repeatedly read, until factory setting has been completely activated and *P830 Factory Setting = No* is returned.
3) All drive parameters that differ from the factory setting to be written
   (either by means of single write services, or as a download parameter block)

Inverter parameters can be adjusted manually with the hand-held keypad, or with MC_SHELL, or via the fieldbus system using the write service specific to that fieldbus.

IMPORTANT

The inverter must be enabled on the terminal side in order for it to be controlled via the fieldbus system. This means that the drive will be enabled subject to certain preconditions being met after the factory setting has been activated. Before the factory setting is activated, therefore, care must be taken that the digital input terminal signals following activation of the factory setting do not enable the inverter.

STOP

5.4.2 Saving to EEPROM

During parameter adjustment, it should be borne in mind that all parameters written via the fieldbus system are normally stored in the inverter. The MOVITRAC® 31.. inverter uses an EEPROM as resident storage, and the life of this is limited by the number of save operations. Therefore, if frequent parameter changes are made, the save function should be deactivated using the parameter

P801 Save = Off

Once this has been deactivated, parameters written subsequently will not be stored in resident memory, i.e. they will only be effective until the equipment is switched off or reset.

The following procedure must be followed in fieldbus mode if the inverter has parameter set cyclically with the fieldbus system write service:

1) Activate factory setting.
2) Set inverter parameters in such a way that the basic function of the application is guaranteed.
   All parameters are stored memory-resident, and become effective after switching the inverter off and then on again, or after a reset.
3) Deactivate the save to EEPROM function with P801 Save = Off.
   Any parameters subsequently modified will not be stored in resident memory.
4) Adjust parameters cyclically.

If the inverter is now switched off and on again or reset using the Reset function, the settings given in point 2) will become effective again. However, the *P801 Save* parameter remains switched off so that your application can immediately be controlled again at point 4).

5.4.3 Parameter Lock

The parameter lock prevents adjustable parameters from being changed in any way by activation of *P800 Parameter Lock = Yes.* Activating the parameter lock is useful when the inverter parameters have been completely adjusted and no further changes are necessary. Amongst other things, this parameter enables you to stop any change to the drive parameters being made on the hand-held keypad, for example.

IMPORTANT

STOP

The parameter lock prevents parameters being written altogether. Thus the write access via the fieldbus system is also disabled while the parameter lock is active.

5.4.4 Download Parameter Block

A number of fieldbus option pcbs offer the possibility of downloading up to 39 drive parameters simultaneously from the higher-level automation equipment to the inverter with one single write service. This downloading is carried out by a specific communications object, the *Download Parameter Block.*

When using the download parameter block, please bear the following in mind:

1) No factory setting should be carried out within the download parameter block.
2) Once the parameter has been set to *P801 Save = OFF,* none of the parameters written subsequently will be stored memory-resident.
3) Once the *P800 Parameter Lock = YES* parameter has been activated, all parameters written subsequently will be declined.

5.5 Parameter Adjustment Return Codes

If parameters are wrongly adjusted, various return codes are sent back from the inverter to the parameter setting master, providing detailed information about the cause of the error. These return codes are structured according to DIN 19245 Part 2. A distinction is made between the following elements:

Error Class
Error Code
Additional Code

5.5.1 Error Class

The type of error is classified in more detail using the Error Class element. The error classes listed in the following table are differentiated according to DIN 19245 Part 2.

Class (hex)	Designation	Meaning
1	vfd state	Status error of the virtual field unit
2	application reference	Error in the application program
3	definition	Definition error
4	resource	Resource error
5	service	Service error
6	access	Access error
7	ov	Error in the object list
8	other	Other error (→ Additional Code)

With the exception of *Error Class 8 = Other Error*, the error class is generated by the fieldbus pcb communications software if communication is faulty. All return codes supplied by the inverter system come under *Error Class 8 = Other Error.* A more detailed breakdown of the error is obtained from the Additional Code element.

5.5.2 Error Code

The Error Code element provides a more detailed analysis of the cause of the error within the error class. The error code is described in DIN 19245 Part 2 (Section 3.16.1.4.4). The error code is generated by the fieldbus pcb communications software if communication is faulty. In the case of *Error Class 8 = Other Error,* only *Error Code = 0* (Other Error Code) is defined, with a detailed breakdown provided in *Additional Code.*

5.5.3 Additional Code

The Additional Code contains the SEW-specific return codes for faulty inverter parameter adjustment. They are returned to the master under *Error Class 8 = Other Error*.

Add. code high (hex)	Add. code low (hex)	Meaning
00	10	Illegal parameter index
00	11	Function/parameter not implemented
00	12	Access is read only
00	13	Parameter lock active (P800)
00	14	Factory setting active (P830)
00	15	Parameter value too large
00	16	Parameter value too small
00	17	Necessary option pcb for this function/parameter not installed
00	18	Error in system software
00	19	Parameter access via this serial interface not permitted
00	1A	Speed control active (P770)
00	1B	Unauthorized access
00	1C	Output stage not disabled
00	1D	Invalid parameter value (e.g. invalid intermediate value)
00	1E	Factory setting started
00	22	4Q-operation 1 (P890) required, e.g. for hoist function 1 (P710)
00	23	4Q-operation 2 (P891) required, e.g. for hoist function 2 (P712)
00	24	DC braking 1 active (P730), modification not possible
00	25	DC braking 2 active (P733), modification not possible
00	26	Hoist function set 1 active (P710), modification not possible
00	27	Hoist function set 1 active (P730), modification not possible
00	28	Parameter not memory-resident; lost in case of power down
00	29	Parameter access via this serial interface not permitted
00	2A	Speed control not active (P770)
00	2B	Controller inhibit required
00	2C	Motor size-up 1 (P328) and rapid start 1 (P720) cannot be activated at the same time
00	2D	Motor size-up 2 (P348) and rapid start 2 (P723) cannot be activated at the same time
00	2E	Necessary option pcb for this function/parameter not installed
00	2F	4Q-operation 1 (P890) and DC braking 1 (P730) cannot be activated at the same time
00	30	4Q-operation 2 (P891) and DC braking 2 (P733) cannot be activated at the same time
00	31	Controller inhibit active, modification not possible
00	32	Synchronous operation not active (P760)
00	33	Synchronous operation: MOVITRAC is slave (P761)
00	34	Invalid parameter frame type

5.5.4 Special Return Codes (Special Cases)

Faults in parameter adjustment which cannot be identified from layer 7 of the fieldbus system or from the inverter system software are treated as special cases. This involves the following possible faults, depending on the fieldbus option pcb in use:

- Incorrect coding of a service via a parameter channel
- Incorrect indication of service length via a parameter channel
- Drive parameter accessing error

Further information can be found in the user manual for the relevant fieldbus option pcbs in the section entitled “Parameter Adjustment Return Codes”.

6 Diagnosis Using the Fieldbus Monitor Parameters

The MOVITRAC® 31.. frequency inverter provides a large amount of diagnostic information for fieldbus operation. In addition to the fieldbus parameters, diagnostic tools also include menu range P070 - P079, which contains the fieldbus monitor parameters. These parameters allow simple diagnosis of the fieldbus application from the inverter.

This section will primarily explain the fieldbus monitor parameters. The fieldbus parameters will only be given again for the sake of completion, since they are to be regarded in direct connection with the fieldbus monitor. Further information regarding parameters P560 - P572 can be found in the previous sections.

The following table illustrates the adjustable fieldbus parameters (P560 - P572) as well as the fieldbus monitor parameters (P070 - P079).

P070	Process data configuration
P071	Fieldbus type
P072	Fieldbus baud rate
P073	Fieldbus address
P074	PO1 setpoint (hex)
P075	PI1 I actual value (hex)
P076	PO2 setpoint (hex)
P077	PI2 actual value (hex)
P078	PO3 setpoint (hex)
P079	PI3 actual value (hex)
P560	Setpoint description PO1
P561	Actual value description PI1
P562	Setpoint description PO2
P563	Actual value description PI2
P564	Setpoint description PO3
P565	Actual value description PI3
P570	Enable fieldbus setpoints
P571	Fieldbus timeout
P572	Timeout response

6.1 Diagnosis of Process Output Data

Faulty operation of the inverter can normally be traced back to a faulty application program. This means that false control information or setpoints are occasionally sent to the inverter from the higher-level control. As a result, it is often helpful to know what control information and setpoints the inverter is receiving. User-friendly fieldbus master interface connections, e.g. rows of LEDs on the front cover, offer simple facilities for diagnosis of individual fieldbus process data.

In order to provide the user with even simpler access to these control values and setpoints, the MOVITRAC® 31.. frequency inverter offers a direct insight into process data received via the fieldbus system, using the fieldbus monitor parameters

P074 PO1 setpoint (hex)
P076 PO2 setpoint (hex)
P078 PO3 setpoint (hex)

(Fig. 29). Process output data received from the inverter are passed via the serial interface to the hand-held keypad or to the *MC_SHELL* PC program. Despite the loss of data because of the varying transmission speeds, this method of diagnosis has been shown in practice to be of assistance.

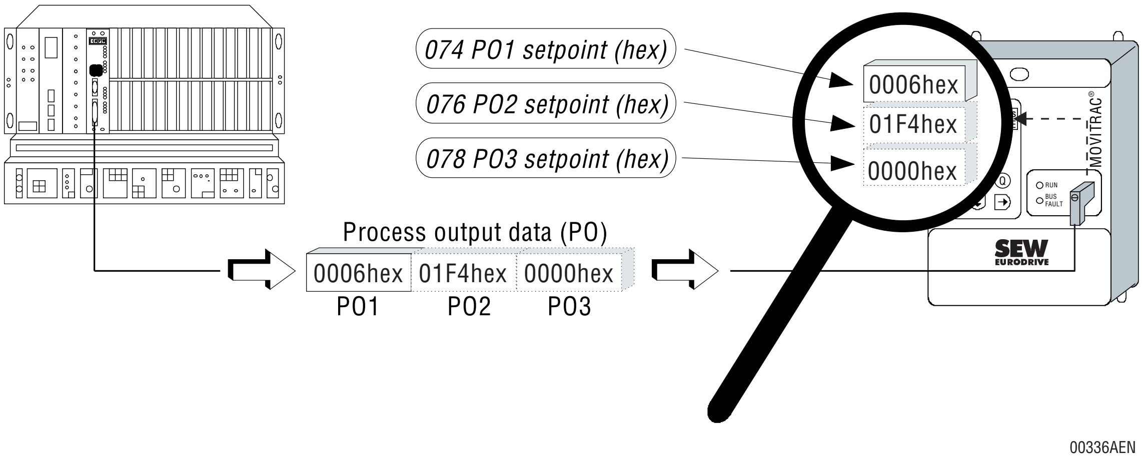


Fig. 29: Process output data diagnosis with MOVITRAC® 31..

These fieldbus monitor parameters allow all process output data to be checked in hexadecimal form using the inverter's hand-held keypad. In addition, the *MC_SHELL* PC program offers an interpretation of the process output data conforming to the unit profile, such as a display of speed setpoints in units of [1/min].

6.2 Diagnosis of Process Input Data

As is the case with diagnosis of process output data, the fieldbus monitor parameters

P075 PI1 actual value (hex)
P077 PI2 actual value (hex)
P079 PI3 actual value (hex)

can be used to access the status information or the actual values sent from the inverter to the higher-level control (Fig. 30).

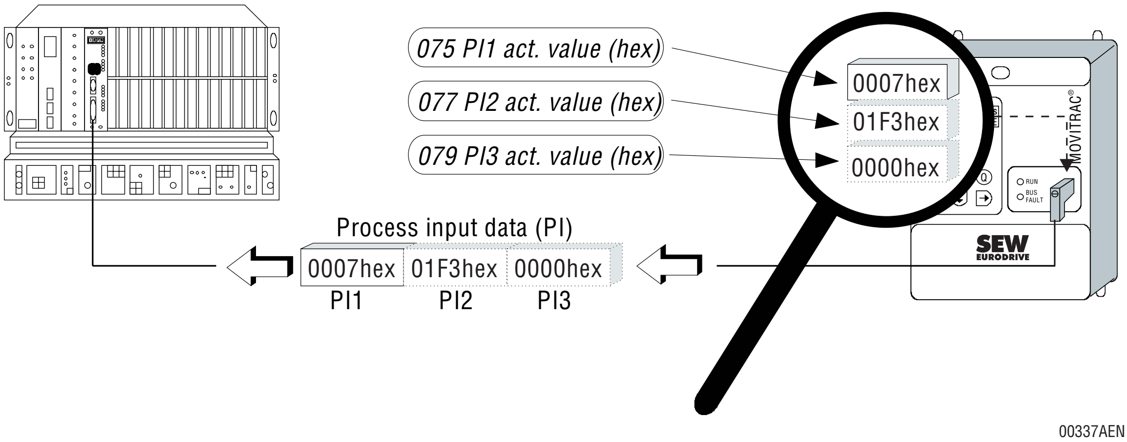
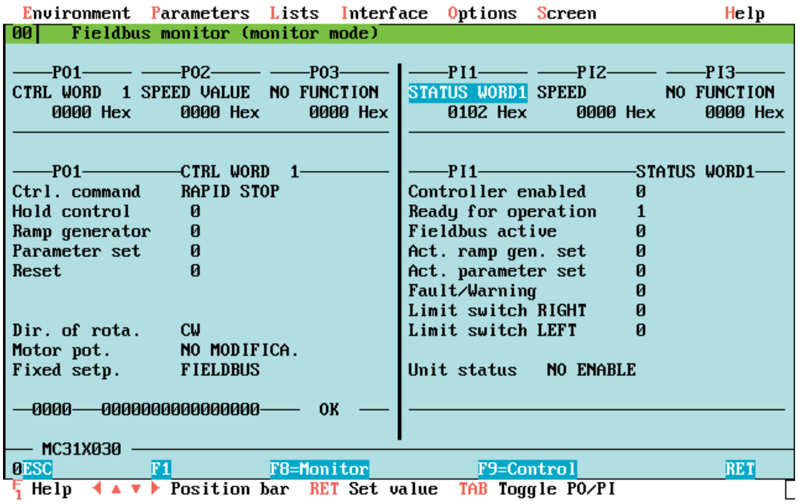


Fig. 30: Process input data diagnosis with MOVITRAC® 31..

6.3 MC_SHELL Fieldbus Monitor

The fieldbus monitor function can be used with the PC user interface MC_SHELL, version 2.40 or higher (Fig. 31). This function provides a user-friendly method of commissioning and diagnosis for the use of the inverter in conjunction with the fieldbus. The two operating modes *Monitor* and *Control* provide a choice between a purely diagnostic mode in which the process data channels can only be viewed, and a control mode in which modifications can also be carried out via the PC.



00338AEN

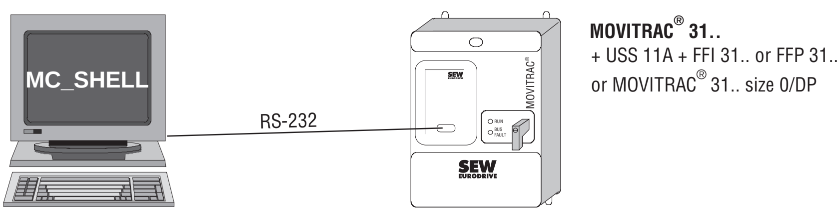
Fig. 31: MC_SHELL fieldbus monitor for diagnosis and control in the fieldbus mode

6.3.1 Diagnosis Using the Fieldbus Monitor

In *Monitor* mode, the MC_SHELL fieldbus monitor allows the setpoints and actual values exchanged between the higher-level control unit and the MOVITRAC® 31.. inverter to be continuously and clearly viewed and analyzed.
You will see all the information from the three process data channels, such as the description of the process input data PI1-PI3 (actual values) and process output data PO1-PO3 (setpoints), and their actual values as transmitted over the bus system.

6.3.2 Control Using the Fieldbus Monitor

In *Control* mode, the fieldbus monitor can be used for manual control of the inverter via the PC. In this case, the inverter displays the same drive characteristics as it does when it is controlled via the fieldbus interface. Amongst other things, this operating method can provide easy training in the concept of control of the MOVITRAC® 31.. frequency inverter via a fieldbus.
Since MC_SHELL communicates with the inverter via the serial interface, familiarity with the functionality of the inverter fieldbus can also be acquired without the fieldbus master, by entering all setpoints manually via the fieldbus monitor (*Control* mode). Fig. 32 shows which components you can use for training in the concept of inverter control using a fieldbus.



00339AEN

Fig. 32: Control via the MC_SHELL fieldbus monitor as a configuration aid

6.4 Verification of Parameter Adjustment

All MOVITRAC® 31.. frequency inverter parameters can be read or written via both the serial interface and the fieldbus interface. Thus either the hand-held keypad or the MC_SHELL PC program can be used for checking the adjustment of parameters via the fieldbus system.

It is consequently possible to use the serial interface to read and check parameters written using the fieldbus, for example. The *MOVITRAC® 31..* Parameter List provides co-ordination between the hand-held keypad menu number and the parameter index.

In principle, no verification is necessary, since the inverter responds with an appropriate error message if parameters have been wrongly adjusted (see also Section 5.5).

6.5 Information about the Fieldbus Option PCB

Further information about the fieldbus option pcb is provided by fieldbus monitor parameters P070 - P073.

6.5.1 Process Data Configuration

The fieldbus monitor parameter *P070 Process Data Configuration* shows how many process data words are used for inverter control, and whether the parameter channel is used. This parameter is either set with a hardware switch on the fieldbus option pcb, or via the fieldbus master during bus system start-up (e.g. with PROFIBUS-DP).

6.5.2 Fieldbus Option PCB Type

The fieldbus monitor parameter *P071 Fieldbus Type* shows which fieldbus system will be supported by the fieldbus option pcb used. Because the fieldbus interface on the MOVITRAC® 31.. frequency inverter is universal, this parameter is for information only.

6.5.3 Fieldbus Baud Rate

The *P072 Fieldbus Baud Rate* parameter shows the fieldbus baud rate in [kbaud]. Depending on the fieldbus system used, adjustment can either be made with a hardware switch on the fieldbus option pcb or via automatic baud rate detection. If the baud rate cannot be detected, the value 0.00 is displayed.

6.5.4 Fieldbus Address

The *P073 Fieldbus Address* parameter shows the actual fieldbus station address of the inverter. Adjustment of this address is carried out using a hardware switch on the fieldbus option pcb (see the User Manual for the option pcb).

This parameter will be set at 0 for fieldbus systems which do not need station addressing.

7 Application Examples

This section gives two examples of applications that demonstrate how to operate the MOVITRAC® 31.. inverter with a fieldbus connection and control it via the fieldbus option pcb.

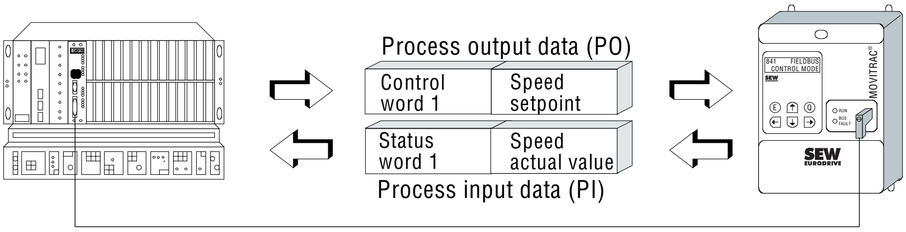
7.1 Control Using Two Process Data Words

This example uses the process data description parameters

P560	*PO1 Setpoint Description:*	*Control Word 1*
P561	*PI1 Actual Value Description:*	*Status Word 1*
P562	*PO2 Setpoint Description*	*Speed Setpoint*
P563	*PI2 Actual Value Description*	*Speed Actual Value*
P564	*PO3 Setpoint Description*	*No Function*
P565	*PI3 Actual Value Description*	*No Function*

valid after a factory setting has been carried out.

This configuration allows you to implement a broad range of applications without having to change the process data assignment. Fig. 33 shows the process data transmitted between the control unit and the inverter.



00340AEN

Fig. 33: Application example for inverter control using two process data words

7.1.1 Objective

The inverter is to be controlled by means of two process data words. The process output data *Control Word 1* and *Speed Setpoint* are to be specified by the higher-level control unit. Conversely, the inverter is to return the process input data *Status Word 1* and *Speed Actual Value* to the higher-level control unit.

The application program is to control the following inverter functions:

1) The digital input E1.1 is to trigger the control commands *Enable* and *Stop*.
   E1.1 = 1: Enable
   E1.1 = 0: Stop

2) The digital input E1.2 is to trigger the control commands *Enable* and *Rapid Stop*.
   E1.2 = 1: Enable
   E1.2 = 0: Rapid stop

3) The digital input E1.3 is to specify the speed setpoint.
   E1.3 = 1: 750 1/min CCW
   E1.3 = 0: 1000 1/min CW

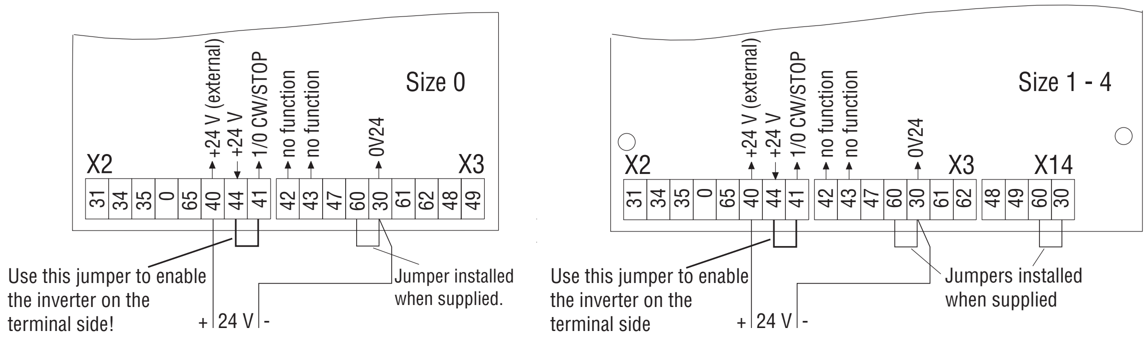
Only parameter set 1 and ramp generator set 1 are used. The drive shall accelerate using an acceleration ramp generator of 1.5 s, decelerate using a deceleration ramp generator of 2 s and carry out a rapid stop within 200 ms.

The inverter is also to recognize a bus error that lasts longer than 100 ms and to use the rapid stop to bring the drive to a standstill.

7.1.2 Commissioning

We recommend using the following method to implement this application example:

1. Wire the inverter in accordance with the Installation and operating Instructions. To operate with the fieldbus, connect the inverter to an external 24 V supply (terminals 30 and 40). Insert a jumper between terminals 41 and 44 in order to enable the inverter on the terminal side (Fig. 34).



00341AEN

Fig. 34: Wiring of the inverter for fieldbus application example 1

2. Set all the parameters specific to the fieldbus using the DIP switches on the fieldbus option pcb. For this example, configure the process data length to “2PD”. For the option FFI 31.. (INTERBUS-S), for example, this can be done via the DIP switches on the option pcb. In the case of PROFIBUS-DP (option FFP 31..), the process data length is configured in the master module. Please see the user manuals on the relevant fieldbus option pcb for further information.
3. Switch on the external 24 V supply. As the inverter has not yet had parameters set for fieldbus operation, do not yet switch on the mains voltage for safety reasons.
4. Activate the factory setting.

00342AEN

Fig. 35: Activating the factory setting from the keypad

5. Set the inverter Control Mode parameter at Fieldbus.

00343AEN

Fig. 36: Switching to fieldbus control mode via the keypad

6. Program the input terminals 42 and 43 to NO FUNCTION to enable the inverter on the terminal side via the jumper (installed before).

```
600          NO FUNCTION
             TERMINAL 42
```

```
601          NO FUNCTION
             TERMINAL 43
```

00344AEN

Fig. 37: Programming terminals 42 and 43 from the keypad

7. Program the fieldbus parameter *Fieldbus Timeout* to *100 ms* and the parameter *Timeout Response* to *Rapid Stop* as set out in the Objective.

```
571                0.10 s
         FIELDBUS TIME OUT
```

```
572            RAPID STOP
        TIME OUT RESPONSE
```

00345AEN

Fig. 38: Programming the fieldbus timeout and timeout response from the keypad

8. Now enter all parameters specific to the drive, such as motor parameters, frequency characteristics, etc. (→ MOVITRAC®31.. Installation and Operating Instructions).
9. Enter the ramp generators for the acceleration, deceleration and rapid stop ramps. As the first parameter set and the first ramp generator set of it are to be used, the ramp generators *T11 Ramp Up*, *T11 Ramp Down* and *T13 Stop Ramp* must be changed.

```
120    T11        1.50 s
                 RAMP UP
```

```
121    T11        2.00 s
               RAMP DOWN
```

```
140    T13        0.20 s
               STOP RAMP
```

00346AEN

Fig. 39: Programming the ramp generators used in the application program

All the parameters for this application example have now been assigned.

7.1.3 S5 Application Program

As a prerequisite to the application program described below, the process input and output data on a Simatic S5 must be at the peripheral addresses PW132 and PW134.

Read access:	`L PW 132`	`Read status word 1`
	`L PW 134`	`Read speed actual value`
Write access:	`T PW 132`	`Write control word 1`
	`T PW 134`	`Write speed setpoint`

To control the inverter only the two control word bits *Enable/Stop* and *Enable/Rapid Stop* must be changed. Fig. 40 shows how the control word is mapped in the Simatic S5.

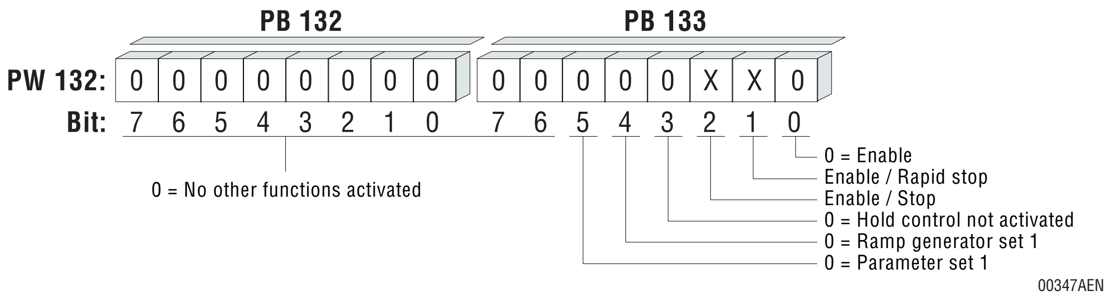


Fig. 40: Control word mapping in the Simatic S5

Fig. 41 shows the S5 program for this application example. In the upper section the setpoint is specified depending on input E1.3. Actual control of the inverter via the control word starts from the CONT jump flag. The control commands *Enable*, *Stop* and *Rapid Stop* are triggered depending on the digital inputs I 1.1 and I 1.2. These commands are coded as constant hex (KH) figures and transferred into the control word (PW132).

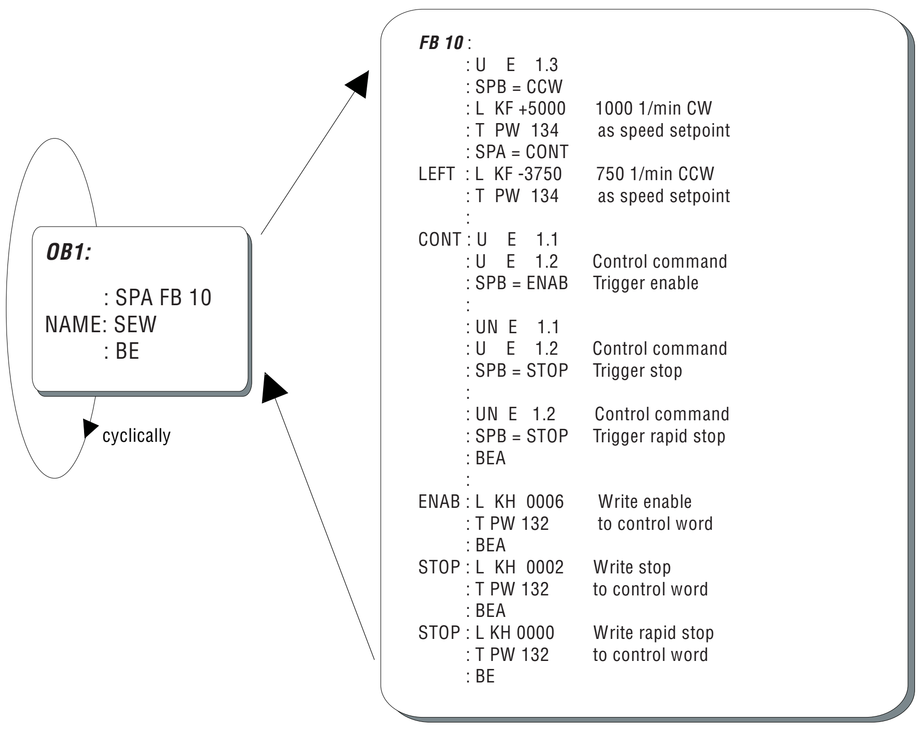


Fig. 41: Example of an S5 program for control of the MOVITRAC® 31.. inverter via the process data

7.1.4 Start-up Parameter Setting via Fieldbus

The manual configuration procedure described in section 7.1.2 can also be carried out automatically by the higher-level fieldbus master, i.e. all the drive parameters can be set automatically via the fieldbus when the control system starts up. In order to automatically set start-up parameters, please consult the *MOVITRAC® 31.. Parameter List* to establish the fieldbus index and the coding for the relevant setting from the menu numbers given in section 7.1.2.
The following table shows the indices and codings for start-up parameter setting taken from the Parameter List.

Menu no.	Parameter name	Setting	Fieldbus index (decimal)	Coding (4 byte hex)
830	FACTORY SETTING	YES	1203	00 00 01 00
841	CONTROL MODE	FIELDBUS	1205	00 00 03 00
600	TERMINAL 42	NO FUNCTION	1150	00 00 11 00
601	TERMINAL 43	NO FUNCTION	1151	00 00 11 00
571	FIELDBBUS TIMEOUT	0.10	1608	00 00 00 10
572	TIMEOUT RESPONSE	RAPID STOP	1609	00 00 00 00
...	drive-specific parameters	...	...	...
...		...	...	...
120	T11 RAMP UP	1.50	1025	00 00 01 50
121	T11 RAMP DOWN	2.00	1026	00 00 02 00
140	T13 RAMP STOP	0.20	1028	00 00 00 20

The parameters listed in the table can now be transferred to the inverter in the required order, e.g. via individual write services or via the download parameter block if supported by the option pcb. However, please note that all other parameters can only be written once the factory settings have been completely activated.

7.2 Control Using Three Process Data Words

This example describes how to control the inverter using three process data words. The process data description parameters are set as follows:

P560 PO1 Setpoint Description: Control Word 1
P561 PI1 Actual Value Description: Status Word 1
P562 PO2 Setpoint Description: Speed Setpoint
P563 PI2 Actual Value Description: Speed Actual Value
P564 PO3 Setpoint Description: Ramp
P565 PI3 Actual Value Description: Apparent Current Actual Value

Controlling the inverter using three process data words allows you to implement very powerful applications as communication between the fieldbus master and the inverter takes place via three process input and three process output data words.

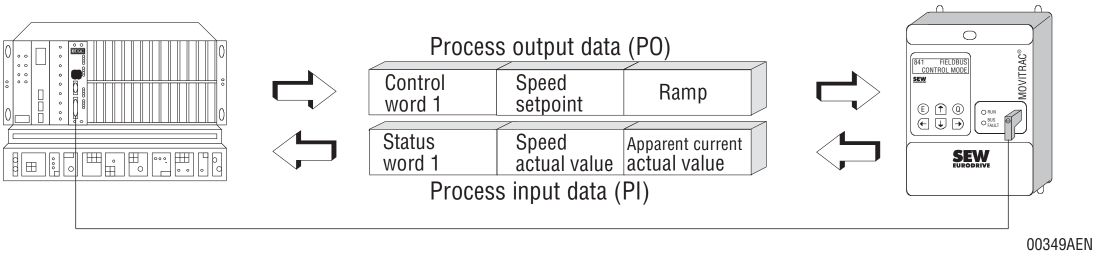


Fig. 42: Application example for control of the inverter using three process data words

7.2.1 Objective

The inverter is to be controlled by means of three process data words. The process output data *Control Word 1, Speed Setpoint* and *Ramp* are to be specified by the higher-level control unit. Conversely, the inverter is to return the process input data *Status Word 1, Speed Actual Value* and *Apparent Current Actual Value* to the higher-level control unit.

The application program is to control the following inverter functions:

1) The digital input E1.1 is to trigger the control commands *Enable* and *Stop*.
   E1.1 = 1: Enable
   E1.1 = 0: Stop

2) The digital input E1.2 is to trigger the control commands *Enable* and *Rapid Stop*.
   E1.2 = 1: Enable
   E1.2 = 0: Rapid stop

3) The digital input E1.3 is to specify the speed setpoint.
   E1.3 = 1: 750 1/min CCW
   E1.3 = 0: 1000 1/min CW

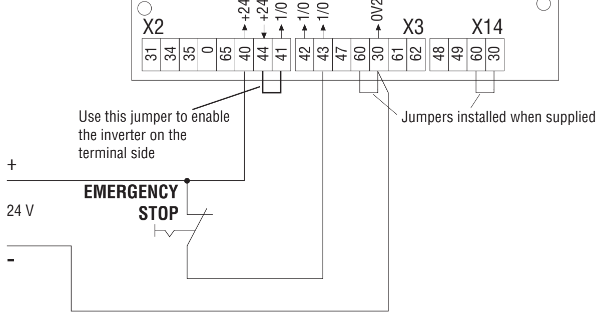
4) In the application, the acceleration and deceleration ramp generators are continually recalculated by another function module and temporarily stored in the flag words
   MW 100: current acceleration ramp generator
   MW 102: current deceleration ramp generator.

Only parameter set 1 and ramp generator set 1 are used. The drive is to be accelerated or decelerated with the ramp that is specified via the fieldbus and that can be continually varied. The rapid stop shall take place within 200 ms.The inverter is also to recognize a bus error that lasts longer than 100 ms and to use the rapid stop to bring the drive to a standstill. In an emergency stop situation, the inverter is to carry out a rapid stop independently of the fieldbus, directly via the input terminals.

7.2.2 Commissioning

We recommend using the following method to implement this application example:

1. Wire the inverter in accordance with the installation and operating instructions. To operate with the fieldbus, connect the inverter to an external 24 V supply (terminals 30 and 40). Insert a jumper between terminals 41 and 44 in order to enable the inverter on the terminal side (Fig. 43). Connect the emergency stop switch with input terminal 43 (Enable) on the inverter, in order to enable the emergency stop function to operate independently of the fieldbus.



00350AEN

Fig. 43: Wiring of the inverter with emergency stop function

2. Set all the parameters specific to the fieldbus using the DIP switches on the fieldbus option pcb. For this example, configure the process data length to "3PD". For the option FFI 31.. (INTERBUS-S), for example, this can be done via the DIP switches on the option pcb. In the case of PROFIBUS-DP (option FFP 31..), the process data length is configured in the master module. Please see the user manuals on the relevant fieldbus option pcb for further information.
3. Switch on the external 24 V supply. As the inverter has not yet had parameters for fieldbus operation, do not yet switch on the mains voltage for safety reasons.
4. Activate the factory setting.

```
830                 YES
    FACTORY SETTING
```

00342ADE

Fig. 44: Activating the factory setting from the keypad

5. Set the inverter Control Mode parameter at Fieldbus.

```
841            FIELDBUS
           CONTROL MODE
```

00343AEN

Fig. 45: Switching to fieldbus control mode via the keypad

6. As the description of process data PO1, PI1, PO2 and PI2 corresponds to the factory setting, you only have to change the process data description parameters for the third process data word to the setting specified.

```
564                RAMP
    PO3 SETP. DESCRIPT.
```

```
565    APPARENT CURRENT
 PI3 ACT. VALUE DESCRIPT.
```

00351AEN

Fig. 46: Setpoint and actual value description of the third process data word via the keypad

7. As you have changed the setpoint description for the process input data, the inverter has automatically locked with *Enable Fieldbus Setpoints = NO*. Enable the fieldbus setpoints with *P570 Enable Fieldbus Setpoints = YES*.

```
570                 YES
      ENABLE SETPOINTS
```

00352AEN

Fig. 47: Enabling the fieldbus setpoints from the keypad

8. Program the fieldbus parameter *Fieldbus Timeout* to *100 ms* and the parameter *Timeout Response* to *Rapid Stop* as set out in the Objective.

571 0.10 s
FIELDBUS TIME OUT

572 RAPID STOP
TIME OUT RESPONSE

00345ADE

Fig. 48: Programming the fieldbus timeout and timeout response from the keypad

9. Now enter all parameters specific to the drive, such as motor parameters, frequency characteristics, etc. (see MOVITRAC® 31.. Installation and Operating Instructions).
10. Enter the rapid stop ramp. As the first parameter set and the first ramp generator set of it are to be used, you must change the parameter *T13 Stop Ramp*.

140 T13 0.20 s
STOP RAMP

00353AEN

Fig. 49: Programming the ramp generators used by the application program

All the parameters for this application example have now been assigned.

The fieldbus-independent emergency stop function is implemented by connecting the enable terminal directly with the emergency stop. In normal mode, the emergency stop switch is closed, so that terminal 43 has a +24 V signal level and the inverter is enabled (together with the jumper at terminals 41-44). The drive is now controlled by the fieldbus by means of the control word.

In an emergency stop situation the emergency stop button is activated, terminal 43 receives a 0V signal level and thus activates the rapid stop. The drive will now come to a standstill within 200 ms (configured rapid stop ramp), although the fieldbus is transmitting a different control command via the control word.

IMPORTANT

In this application example, the assignment of the terminals has not been changed from that of the factory setting. The inverter is enabled on the terminal side by means of the jumper and the +24 V signal at terminal 43 (Enable). The effect of this is that the drive is accelerated immediately after the factory setting has been activated and when the mains voltage is switched on, as the parameter *P841 Control Mode = Standard* is activated after a factory setting has been carried out. So make sure that the drive is designed in such a way that only the 24 V supply is switched on after the factory setting has been activated. Do not switch on the mains voltage until the fieldbus control mode (*P841 Control Mode = Fieldbus)* has been activated, as the inverter is then controlled by the control word.

7.2.3 S5 Application Program

As a prerequisite to the application program described below, the process input and output data on a Simatic S5 must be at the peripheral addresses PW132, PW134 and PW136. This program corresponds to a great extent to the S5 program from the previous application example.

Read access:
```
L PW 132   Read status word 1
L PW 134   Read speed actual value
L PW 136   Read apparent current actual value
```

Write access:
```
T PW 132   Write control word 1
T PW 134   Read speed setpoint
T PW 136   Write ramp
```

Fig. 50 shows the S5 program in this example. The current acceleration ramp is temporarily stored in the flag word MW100 and the current deceleration ramp in MW102. If the *Enable* command is triggered (jump flag ENAB), the current acceleration ramp generator is first transferred from MW100 to PW136 (ramp) and the *Enable* command is then transferred to the control word with the coding 0006hex. Similarly, when the *Stop* command is given, the deceleration ramp generator is first transferred from MW102 to PW136 (ramp) and the *Stop* command is then transferred to the control word with the coding 0002_{hex}.

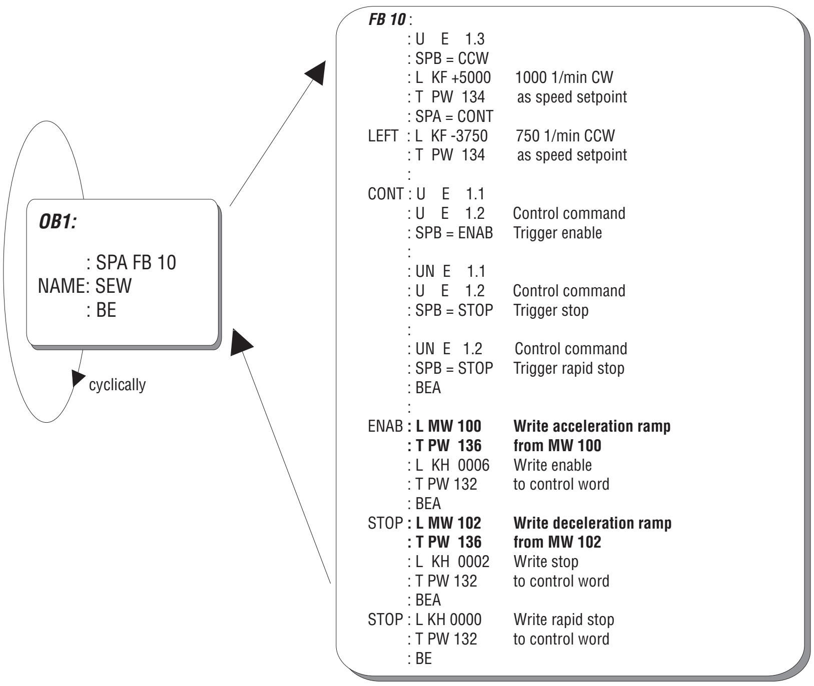


Fig. 50: Example of an S5 program for control of the MOVITRAC® 31.. inverter via the process data

The process input data *Status Word 1, Speed Actual Value* and *Apparent Current Actual Value* can be processed with the load command (e.g. L PW 132).

7.2.4 Start-up Parameter Setting via a Fieldbus

The manual configuration procedure described in section 7.2.2. can also be carried out automatically by the higher-level fieldbus master, i.e. all the drive parameters can be set automatically via the fieldbus when the control system starts up. In order to automatically set start-up parameters, please consult the *MOVITRAC® 31.. Parameter List* to establish the fieldbus index and the coding for the relevant setting from the menu numbers given in section 7.2.2.

The following table shows the indices and codings for start-up parameter setting taken from the Parameter List.

Menu no.	Parameter name	Setting	Fieldbus index (decimal)	Coding (4 byte hex)
830	FACTORY SETTING	YES	1203	00 00 01 00
841	CONTROL MODE	FIELDBUS	1205	00 00 03 00
564	PO3 SETP. DESCRIPT.	RAMP	1603	00 00 08 00
565	PI3 ACT. VALUE DESCRIPT.	APPARENT CURRENT	1606	00 00 02 00
570	ENABLE SETPOINTS	YES	1607	00 00 01 00
571	FIELDBBUS TIMEOUT	0.10	1608	00 00 00 10
572	TIMEOUT RESPONSE	RAPID STOP	1609	00 00 00 00
...	drive-specific parameters	...	...	...
...		...	...	...
140	T13 RAMP STOP	0.20	1028	00 00 00 20

The parameters listed in the table can now be transferred to the inverter in the required order, e.g. via individual write services or via the download parameter block if supported by the option pcb. However, please note that all other parameters can only be written once the factory settings have been completely activated.

7.3 Relative speed / I/O-module functionality

The following application example shows how the inverter is controlled via the relative speed setting. Additionally the I/O-module is used, so the higher-level automation unit reads 5 sensor signals via the input terminals of the inverter and controls a relay via output terminal 62.

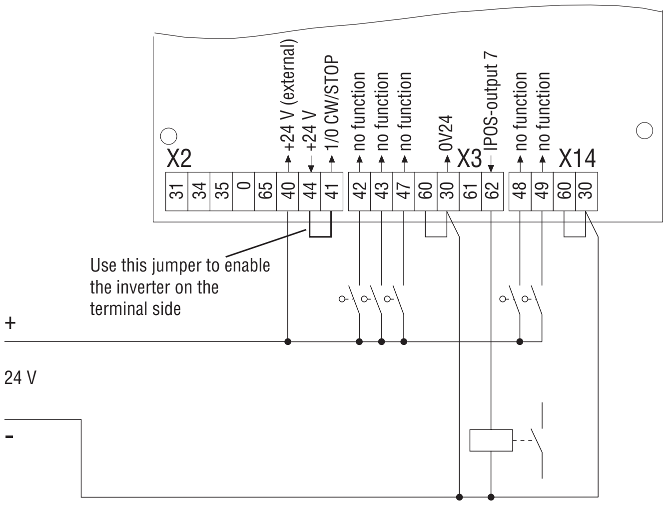
Therefore the inverter is controlled via two process data words. The process output data *control word 2* and *speed [%]-setpoint* is specified by the higher-level control, in the opposite direction the inverter returns the process input data *status word 2* and *speed [%]-actual value* to the higher-level control. The control program is supposed to control the following inverter functions:

1) The digital input E1.1 is to trigger the control commands Enable and Stop.
   E1.1 = 1: Enable
   E1.1 = 0: Stop
2) The digital input E1.2 is to specify the speed [%]-setpoint.
   E1.2 = 1: CW operation with 75 % of *P220 F-MAX 1*
   E1.2 = 0: CCW operation with 25 % of *P220 F-MAX 1*

The sensor signals at the input terminals X3:42, X3:43, X3:47, X14:48 and X14:49 of the inverter are supposed to control the relay at the output terminal X3:62 of the inverter in the control via an AND function. Only the first set of parameters and the first set of ramps are used. The drive shall accelerate and brake using the ramps specified in the factory setting. Further the inverter is supposed to recognize a bus fault, which is present longer than 100 ms, and bring the drive to a standstill using the rapid stop (= factory setting).

7.3.1 Commissioning

Carry out the wiring of the inverter according to the operating instructions. For fieldbus operation please connect the inverter to an external 24 V supply (terminals X3:30 and X2:40). Insert a jumper between terminals X2:41 and X2:44, in order to enable the inverter from the terminal side (Fig. 51). Connect the sensors and actors according to Fig. 51. When connecting the actor watch the maximum output current of this output terminal (see operating instructions MOVITRAC® 31C).



01140AEN

Fig. 51: Wiring of the inverter for application example with I/O-module functionality

1. Set all the parameters specific to the fieldbus using the DIP switches on the fieldbus option pcb. For this example, configure the process data length to “2PD”. For the option FFI 31.. (INTERBUS-S), for example, this can be done via the DIP switches on the option pcb. In the case of PROFIBUS-DP (option FFP 31..), the process data length is configured in the master module. Please refer to the User Manuals on the relevant fieldbus option pcb for further information.
2. Switch on the external 24 V supply.
   As the inverter has not yet had parameters set for fieldbus operation, do not yet switch on the mains voltage for safety reasons.
3. Activate the factory setting.

```
830                 YES
     FACTORY SETTING
```

00342AEN

Fig. 52: Activating the factory setting via the keypad

4. Set the inverter control mode parameter at Fieldbus.

841 FIELDBUS
CONTROL MODE

00343AEN

Fig. 53: Switching to control mode fieldbus using keypad

5. The process data-description parameters PO1, PI1, PO2 and PI2 are changed according to the application specification.

560 STATUS WORD 2
setpoint description PO1

561 STATUS WORD 2
actual value description PI1

562 SPEED [%]
setpoint description PO2

563 SPEED [%]
actual value description PI2

01141AEN

Fig. 54: Programming of the process data description parameters via keypad

6. As the setpoint description for the process input data has been changed, the inverter has locked automatically with *enable fieldbus setpoints = NO*. Re-enable the fieldbus setpoints with *P570 enable fieldbus setpoints = YES.*

570 YES
ENABLE SETPOINTS

00352AEN

Fig. 55: Enabling fieldbus setpoints via keypad

7. Program the input terminals 42 ... 50 to NO FUNCTION, so that the inverter is enabled on the terminal side via the previously inserted jumper and ignores the sensor/actor signals of the input terminals during drive control.

600 NO FUNCTION
TERMINAL 42

601 NO FUNCTION
TERMINAL 43

602 NO FUNCTION
TERMINAL 47

603 NO FUNCTION
TERMINAL 48

604 NO FUNCTION
TERMINAL 49

605 NO FUNCTION
TERMINAL 50

01142AEN

Fig. 56: Programming of the terminals 42 ... 50 via keypad

8. Program the output terminals to the corresponding IPOS-outputs, which are assigned to the input terminals 42 ... 50 (→ section 3.8.2)

611	IPOS-OUTPUT 7 TERMINAL 62	= input terminal 50	614	IPOS-OUTPUT 4 TERMINAL 69	= input terminal 47
612	IPOS-OUTPUT 6 TERMINAL 63	= input terminal 49	615	IPOS-OUTPUT 3 TERMINAL 70	= input terminal 43
613	IPOS-OUTPUT 5 TERMINAL 64	= input terminal 48	616	IPOS-OUTPUT 2 TERMINAL 71	= input terminal 42

01143AEN

Fig. 57: Programming of the terminals 62 ... 71 via keypad

9. Set the fieldbus parameter *fieldbus timeout* to *100 ms* as specified in the objective.

571	0.10 s
	FIELDBUS TIME OUT

01144AEN

Fig. 58: Programming of fieldbus timeout via keypad

10. Now enter all parameters specific to the drive such as motor parameter, frequency characteristics, etc. (→ MOVITRAC® 31.. Installation and Operating Instructions).

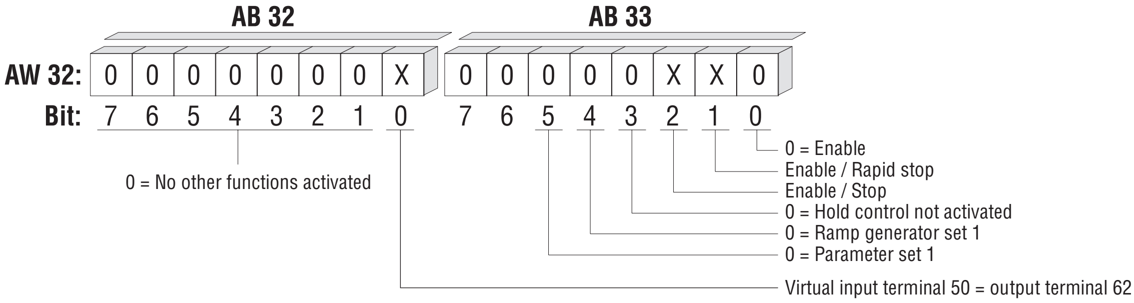
All the parameters for this application example have now been assigned.

7.3.2 S5 Application Program

As a prerequisite to the application program listed below, the process input and output data on a Simatic S5 must be at the peripheral addresses EW/AW32 and EW/AW34. Watch the consistent treatment of the EW/AW34, as the relative speed must be treated as 16 bit value. For this reason only use the loading and transfer commands (e.g. L EW34 or T AW 34) for access to EW/AW32. Access to the control/status word 2 organized in bits is possible via the common logic instructions. The I/O addresses contain the following information:

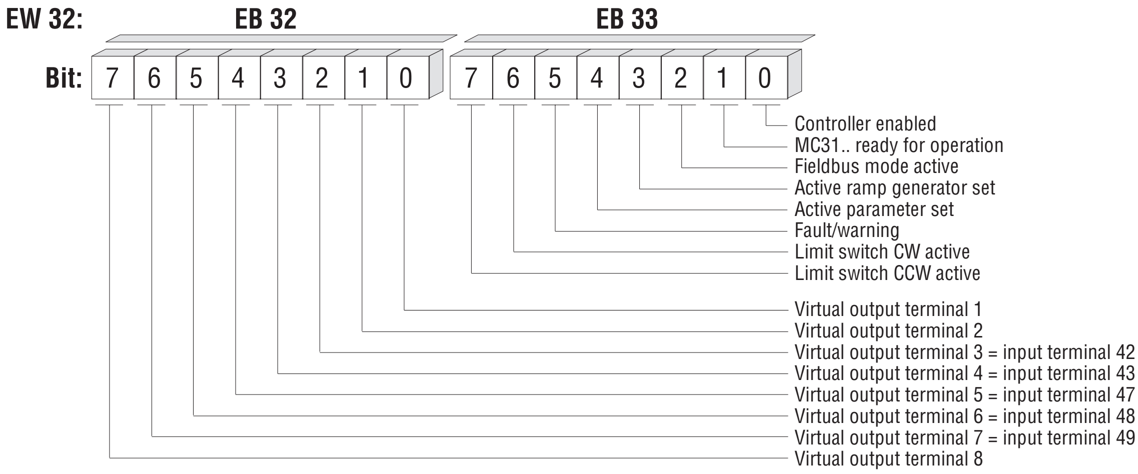
EW 32	status word 2
EW 34	speed [%] actual value
AW 32	control word 2
AW 34	speed [%] setpoint

For controlling the inverter only the two control word bits *enable/stop* and *enable/rapid stop* are used. For controlling the relay on the output terminal 62 of the inverter the output *A32.0* is used. Fig. 59 and Fig. 60 show how the control word 2 and the status word 2 are projected in the Simatic S5.



01145AEN

Fig. 59: Mapping of Control Word 2 in the Simatic S5

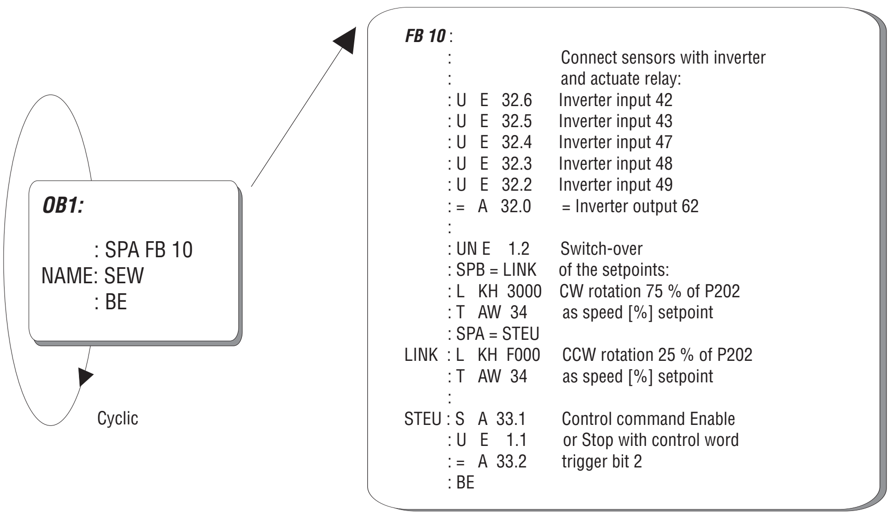


01146AEN

Fig. 60: Mapping of Control Word 2 in the Simatic S5

Fig. 61 shows the S5-program of this application example. First the inputs E 32.2 ... E32.6 for the control of the relay via output A 34.0 are connected via AND-relation in the function component FB10. Then the inverter receives the setpoint specification dependent on input E1.2.

Actual control of the inverter starts from the STEU jump flag via the digital input E1.1, which triggers the control commands *Enable* and *Stop*.



01147AEN

Fig. 61: S5 program example for controlling inverter MOVITRAC® 31.. via relative speed specification and implementation of the I/O-module functionality of the inverter

Fig. 62 again shows the logic mapping of the input and output terminals of the inverter onto the status and control word 2. Within the PLC the I/O-information on the common relation commands can be programmed.

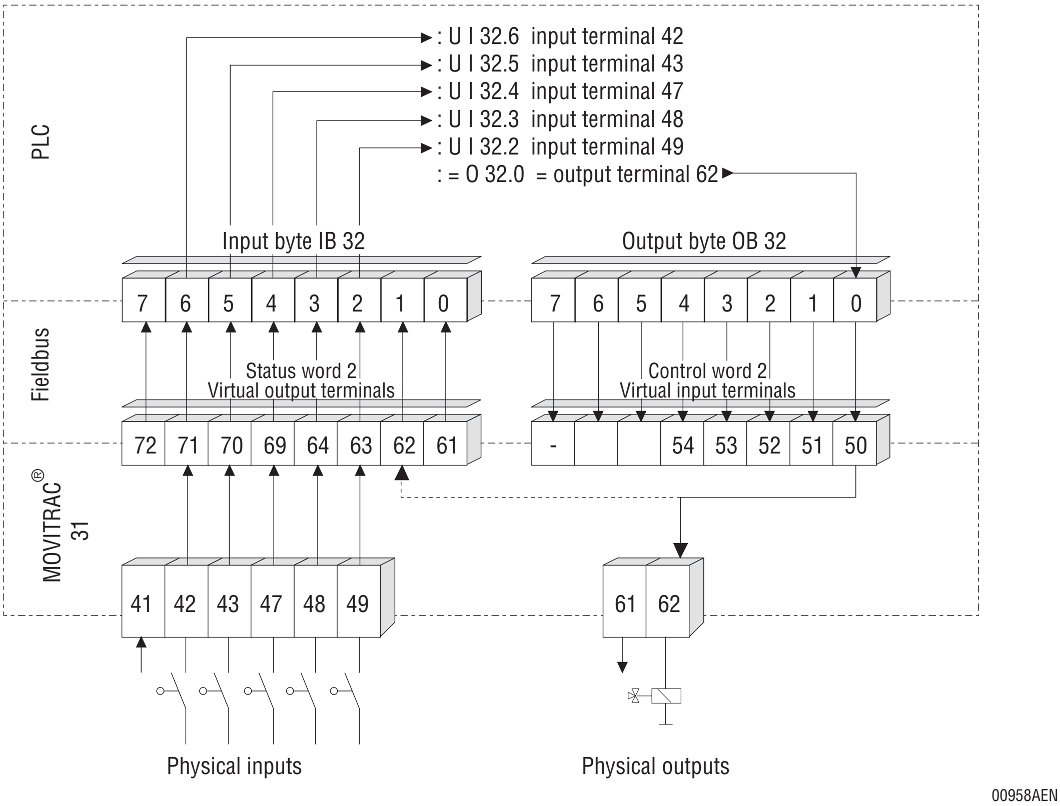


Fig. 62: Mapping of the I/O-information on the fieldbus and in the PLC

7.4 Positioning with IPOS via Fieldbus

The position specification via fieldbus requires that the inverter is equipped with the option FPI 31 and consequently the internal positioning control IPOS is activated!

This application example explains, how to transfer the position setpoints from the higher-level automation device via fieldbus to the MOVITRAC® 31.. and further how to be able to use the functions of the internal positioning control IPOS via fieldbus.

For a detailed description of the internal positioning control IPOS please refer to the documentation *MOVITRAC® 31.. FPI 31 Positioning Control IPOS*. This description is not part of this example.

7.4.1 Objective

The inverter MOVITRAC® 31.. is to receive different position setpoints via the fieldbus system and execute the positioning process independently. The complete control is to be carried out by the fieldbus master. Further the current actual value of the position as well as the status of the inverter must be returned to the higher-level master.

The inverter is to be controlled exclusively by the control word 2. Only the limit switches CW/CCW are connected to the unit. A corresponding IPOS-automatic program is to be programmed for the processing of the setpoint position.

In the case of a bus fault the drive must execute a rapid stop after 100 ms.

7.4.2 Implementation Possibilities with IPOS

Generally different possibilities of carrying out a positioning operation via fieldbus arise. The following variants, for example, can be implemented with IPOS:

– The fieldbus position setpoint is used as IPOS-manual operation-setpoint.
– The fieldbus position setpoint is used for the command GOPA in the IPOS automatic program.
– The fieldbus position setpoint is mapped to IPOS-variable and can be used universally.
– Virtual terminals of the control word 2 are used as pointers to the positioning table.

7.4.3 Process Data Description for Positioning Mode

As, in this example, the inverter is to receive control commands as well as the position setpoints, the process data length must be set to 3PD (Fig. 63). The largest application variety is achieved with the following process output data description, which can also be implemented in this example:

P560 Setpoint description PO1 control word 2
P562 Setpoint description PO2 position high
P564 Setpoint description PO3 position low

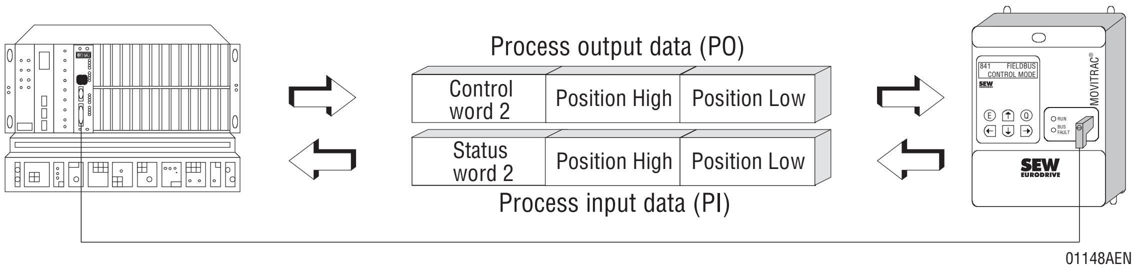


Fig. 63: Application example for position specification via fieldbus

While for the transfer of the position setpoints *position high* as well as *position low* must be programmed, the actual value description can be set at will.

For this application example the process input data is described as follows:

P561 Actual value description PI1 status word 2
P563 Actual value description PI2 position high
P565 Actual value description PI3 position low

With this setting you have the possibility to constantly evaluate the current actual position as well as further status information of the drive via the process data channel.

With the virtual terminals of the control word 2 and the status word 2 a direct connection between the higher-level automation device (fieldbus master) and the IPOS automatic program decentrally executed in the inverter. Therefore the virtual input and output terminals can be directly processed and controlled in the IPOS program. In this case the digital input and output terminals of the options FEA 31 or FIO 31 respectively, which are physically not available with the fieldbus option inserted, are projected onto the fieldbus system as virtual terminals within the control word 2 and the status word 2 (Fig. 64).

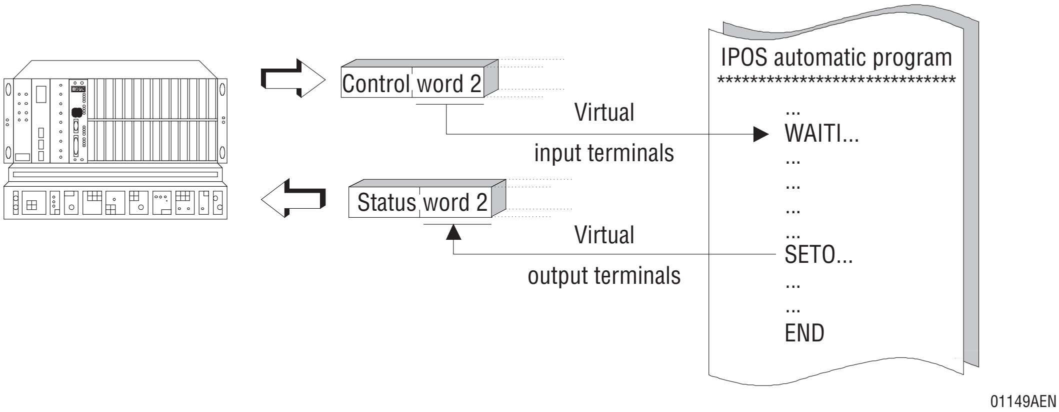


Fig. 64: Fieldbus applications with IPOS automatic program and control word 2/status word 2

7.4.4 Commissioning

Wire the inverter in accordance with the installation and operating instructions. For operation with the fieldbus, connect the inverter to an external 24 V supply (terminals X3:30 and X2:40). Insert a jumper between terminals X2:41 and X2:44, in order to enable the inverter on the terminal side (Fig. 65). Connect the two hardware limit switches for CW/CCW.

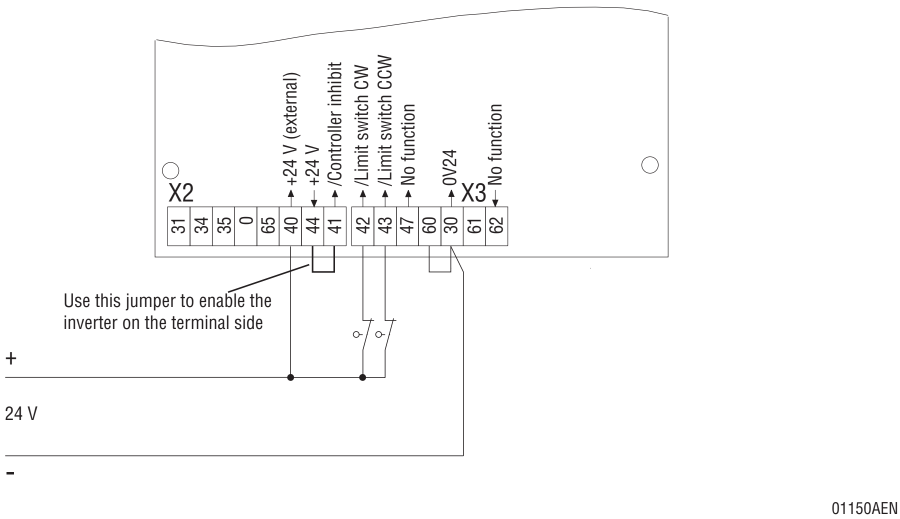


Fig. 65: Wiring of the inverter for application example with I/O-module functionality

1. Set all the parameters specific to the fieldbus using the DIP switches on the fieldbus option pcb. For this example, configure the process data length to “2PD”. For the option FFI 31.. (INTERBUS-S), for example, this can be done via the DIP switches on the option pcb. In the case of PROFIBUS-DP (option FFP 31..), the process data length is configured in the master module. Please refer to the User Manuals on the relevant fieldbus option pcb for further information.
2. Switch on the external 24 V supply. As the inverter has not yet had parameters set for fieldbus operation, do not yet switch on the mains voltage for safety reasons.

3. Activate the factory setting.

830	YES
	FACTORY SETTING

00342AEN

Fig. 66: Activating the factory setting via the keypad

4. Set the inverter control mode parameter at Fieldbus

841	FIELDBUS
	CONTROL MODE

00343AEN

Fig. 67: Switching to control mode fieldbus using keypad

5. The process data-description parameters PO1, PI1, PO2 and PI2 are changed according to the application specification.

560	STATUS WORD 2
	setpoint description PO1

563	POSITION HIGH
	actual value description PI2

561	STATUS WORD 2
	setpoint description PI1

564	POSITION LOW
	setpoint description PO3

562	POSITION HIGH
	setpoint description PO2

565	POSITION LOW
	setpoint description PI3

01151AEN

Fig. 68: Programming of the process data-description parameters via keypad

6. As the setpoint description for the process input data has been changed, the inverter has locked automatically with *enable fieldbus setpoints = NO*. Re-enable the fieldbus setpoints with *P570 enable fieldbus setpoints = YES*.

570	YES
	ENABLE SETPOINTS

00352AEN

Fig. 69: Enabling fieldbus setpoints via keypad

7. Program the fieldbus parameter *Fieldbus Timeout* to *100 ms* and the parameter *Timeout Response* to *Rapid Stop* as set out in the objective.

571	0.10 s
	FIELDBUS TIME OUT

572	RAPID STOP
	TIME OUT RESPONSE

00345AEN

Fig. 70: Programming the fieldbus timeout and timeout response via keypad

8. Program the input terminals X3:42, X3:43 and X3:47.

```
600     /LIMIT SWITCH CW
             TERMINAL 42
```

```
601    /LIMIT SWITCH CCW
             TERMINAL 43
```

```
602          NO FUNCTION
             TERMINAL 47
```

01153AEN

Fig. 71: Programming of the terminals X3:42, X3:43 and X3:47

9. Set the rapid stop ramp, as the drive is decelerated along the rapid stop ramp in case of a bus fault.

```
140    T13        0.20 s
               STOP RAMP
```

00353AEN

Fig. 72: Programming of the ramp generator used by this application program

10. Set the inverter control mode parameter at Fieldbus.

```
841             FIELDBUS
            CONTROL MODE
```

00343AEN

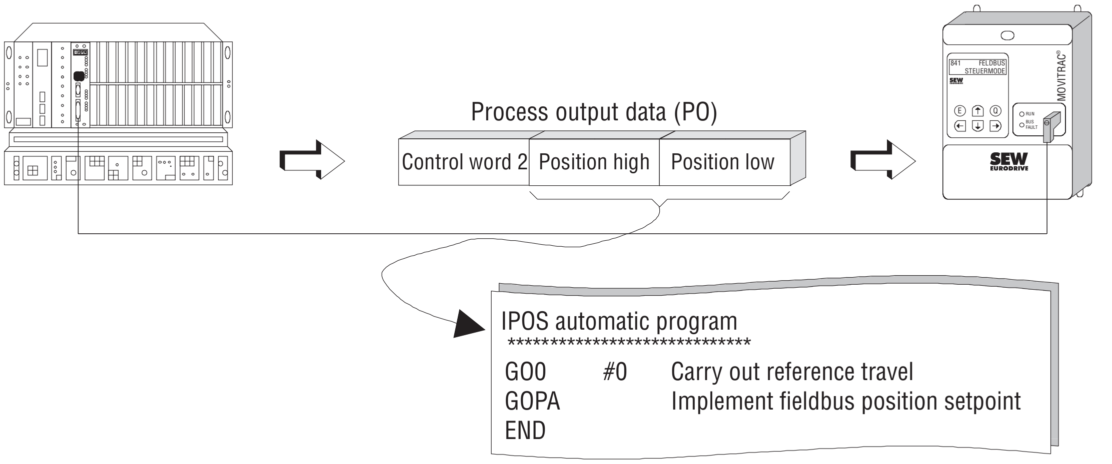
Fig. 73: Switching to control mode fieldbus using keypad

11. Set the machine parameters for IPOS according to your application.

12. The position setpoint specified via fieldbus, in this application example, is to be used in the automatic program of the inverter with the command *GOPA*. Therefore set the *IPOS-bus mode = 2*.

13. Set the reference travel to type 3 (= limit switch CW).

14. Now write the IPOS automatic program and use the command *GOPA*, in order to be able to implement the position setpoint of the fieldbus. Fig. 74 shows the minimum program for the use of the position setpoint of the fieldbus interface.



01154AEN

Fig. 74: Implementation of the position setpoint in the IPOS automatic program

15. Activate the IPOS automatic program in the inverter by initiating the control command *Enable* via the fieldbus and start the IPOS program with MC_SHELL.

All the parameters for this application example have now been assigned.

Important!

In this application example, the inverter is enabled on the terminal side by the means of the jumper between terminals X2:41 and X2:44. The effect of this is that the drive would accelerate immediately after the factory setting is activated and when the mains voltage is switched on, as the parameter *P841 Control Mode = Standard* is activated after a factory setting is carried out. So make sure that the drive is designed in such a way that only the 24 V supply is switched on after the factory setting has been activated. Do not switch on the mains voltage until the fieldbus control mode *(P841 Control Mode = Fieldbus)* has been activated, as the inverter is then controlled by the control word.

7.4.5 S5 Application Program

If, for example, the process input and output data is mapped to the peripheral addresses PW132, PW134 and PW136 within a Simatic S5, the control and specification of the position setpoints can be implemented with the corresponding load and transfer commands.

```
Read access:   L PW  132  read status word 2
               L PW  134  read actual value position high
               L PW  136  read actual value position low
Write access:  L PW  132  write status word 2
               L PW  134  write actual value position high
               L PW  136  write actual value position low
```

Important!

It is very important to make sure that the position values are treated consistently, i.e. that it is guaranteed that position high as well as position low provide the correct 32-bit position value within one program / bus cycle.

Index

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