Servo Controller
SE-24

- **Profibus Manual**

Complementary document to the Operating Instructions

This manual is a complementary document to the operating instructions and applies to:

Type	Order No.
SE-24 Profibus	50315435

Assembly and initial start-up may be carried out by qualified personnel only and according to these operating instructions.

Version of this documentation: SE-24-Profibus-Manual vers. 1.7 en. 01.06.2022

⚠ CAUTION	
	As this manual is a complementary document to the operating instructions it alone is not sufficient to carry out installation and commissioning of the device. Please pay attention to the notes in *1.1 Documentation*

Symbols:

DANGER	
	**Indicates imminent danger.** **Disregard of this information can result in death or serious personal injuries (invalidity).**

WARNING	
	Indicates a possible dangerous situation. Disregard of this information can result in death or serious personal injuries (invalidity).

CAUTION	
	Indicates a possibly dangerous situation. Disregard of this information can result in damage to property or light to medium personal injuries.

NOTE	
	Indicates general notes, useful operator tips and operating recommendations which don't affect safety and health of the personnel.

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Table of Contents

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1 General

1.1 Documentation

For the Servo Controllers of the SE-24 series are considerably documentations available. There are main documents and complementary documents.

The documents contain safety instructions that must be followed

Main document:

present	documentation / description
☐	▪ **SE-24 Operating Manual** Description of the technical data and the functions of the device as well as notes on the plug assignment, installation and operation of the SE-24 servo controller. It is meant for persons who want to get familiar with the SE-24 servo controller.

CAUTION	
	**The operating manual is the main document and must be read by all means before installation and start-up of all devices of the SE-24 series independent of the respective model.**

Complementary documents to the operating manual:

present	documentation / description
☐	▪ **SE-24 Software Manual** Description of the “afagTools” parameterization program.
☐	▪ **SE-24 IO Manual** Description of the I/O control of the SE-24 servo controller.
☒	▪ **SE-24 Profibus Manual** Description of the fieldbus control of the SE-24 servo controller under PROFIBUS-DP.
☐	▪ **SE-24 programming example Siemens S7 V5.5** Description to the programming example for Siemens S7 V5.5.
☐	▪ **SE-24 programming example Siemens TIA V12.0** Description to the programming example for Siemens TIA V12.0.
☐	▪ **SE-24 EtherCAT Manual** Description of the fieldbus control of the SE-24 servo controller under EtherCAT.
☐	▪ **SE-24 programming example Beckhoff TwinCAT 2** Description to the programming example for Beckhoff TwinCAT 2.
☐	▪ **SE-24 CANopen Manual** Description of the fieldbus control of the SE-24 servo controller under CANopen.

These documents are available for download on our homepage:

www.afag.com

2 Safety instructions

⚠ CAUTION	
	**The safety instructions in the operating manual must be followed.** **The operating manual is the main document and must be read by all means before installation and start-up of all devices of the SE-24 series independent of the respective model.**

3 PROFIBUS-DP

3.1 Overview of DP and its power stages

The communications protocol DP (DP = Decentral Periphery) is designed for fast data exchange at the field level. Here, central automation devices like PLCs, PCs or process control systems communicate over a fast serial connection with decentral field devices like I/O, drives, valves, measuring transducers or analyzers. The data exchange with the decentral devices mainly takes place cyclically. The communication functions required for this purpose are defined by the DP basic functions (power stage DP-V0).

DP was expanded in steps over and above these basic functions, with special functions, based on the special requirements of the different areas of application, so that DP is today available in three output stages, DP-V0, DP-V1 and DP-V2, with every stage having a special focus. The most important features of the three stages are:

- DP-V0 This stage provides the basic functionalities of DP. This includes the cyclic data exchange as well as the station-specific, module-specific and channel-specific diagnosis.
- DP-V1 This stage contains enhancements with an orientation to process automation, especially the acyclic data traffic for parameterization, operation, observation and alarm handling of intelligent field devices, in parallel to the cyclic useful data traffic. This allows the online access to bus subscribers using engineering tools. Furthermore, DP-V1 contains alarms. It includes among others, the status alarm, update alarm and a manufacturer-specific alarm.
- DP-V2 This stage contains additional enhancements and is primarily oriented to the requirements of the drive technology. By means of additional functionalities like isochronous slave operation and slave cross-traffic, among other things, DP-V2 can also be used as a drive bus for controlling fast movement sequences in drive axes.

  This power stage requires corresponding hardware. The controllers of the target applications of the SE-24 servo controller currently do not have this hardware. Support for DP-V2 is therefore not provided.

The power stages of DP are specified in detail in the IEC 61158 (4).

Every DP system consists of different device types, with a distinction being made between three types: DP-master class 1, DP-master class 2 and DP-slaves. Using DP mono- and multi-master systems can be realized. As a result, a high degree of flexibility in the system configuration is possible. A maximum of 126 devices (master or slaves) can be connected to a bus.

The extensive diagnosis functions of DP allow fast fault localization. The diagnosis messages are transmitted over the bus and compiled by the master.

The DP-master class 1 (DPM1) is a central controller, which cyclically exchanges information in a defined messaging cycle with the decentral stations (slaves). Typical DPM1 devices are e.g. programmable logic controllers (PLC) or PCs.

DP-master class 2 (DPM2) are engineering projection or operating devices. They are used for commissioning and for maintenance and diagnosis to configure the connected devices, to evaluate the measured values and parameters as well as to query the device status. A DPM2 must not be connected permanently to the bus system.

A slave is a peripheral device (I/O, drive, etc.), which reads process information and/or uses output information for intervening in the process. Slaves are passive devices with regard to the communication; they only respond to a direct query from a DPM1 or DPM2.

3.2 Basic functions DP-V0

The central controller (master) cyclically reads the input information from the slaves and writes the output information cyclically to the slaves. Here, the bus cycle time must be shorter than the program cycle time of the central automation system, which is about 10 ms in many applications. A high data throughput alone, however, is not enough for the successful use of a bus system. Rather, simple operation, good diagnosis options and a transmission technology that is safe from interference must be ensured. In the case of DP-V0, these properties were optimally combined.

For transmitting 521 bit input- and 512 bit output signals distributed between 32 subscribers DP only needs 1 ms for 12 MBits. With DP input- and output data is transmitted in one message cycle. The useful data transmission takes place, in the case of DP, with the SRD service (Send and Receive Data Service) of the ISO/OSI-layer 2.

The transmission of data with the DP-V0 service requires the definition of how much data is transferred and the meaning of the data from the side of master and slave. Therefore, the user must make this determination when planning the PROFIBUS connection. Only then should the parameterization of the field bus connection on both sides be done.

3.3 Documentation on PROFIBUS

PROFIBUS (**PRO**cess **FI**eld**BUS**) is a standard that has been compiled by the PROFIBUS Nutzerorganisation e.V. (organization of PROFIBUS users). The complete description of the fieldbus system can be found in the following standard:

IEC 61158 "Digital Data communication for measurement and control – Fieldbus for use in industrial control systems": This standard is divided into several parts and defines 10 "Fieldbus Protocol Types". PROFIBUS has been specified as type 3. There are two PROFIBUS models. Among them is PROFIBUS-DP for fast data exchange in production engineering and building automation (DP = Decentral Periphery). The embedding in the ISO/OSI layer model is also described in this standard.

Further information, contact addresses etc. can be found at **www.profibus.com**.

Further, more detailed documentation on the use of PROFIBUS-DP:

1. PROFIBUS-DP
   Grundlagen, Tips und Tricks für Anwender
   Manfred Popp
   Hüthig-Verlag, Heidelberg 1998

2. Dezentralisieren mit PROFIBUS-DP
   Aufbau, Projektierung und Einsatz des PROFIBUS-DP mit Simatic S7
   Josef Weigmann, Gerhard Kilian
   Siemens, Erlangen/München 1998

3. Der neue Schnelleinstieg für PROFIBUS DP
   Von DP-V0 bis DP-V2
   Manfred Popp
   PROFIBUS Nutzerorganisation e.V., Karlsruhe 2002

4. IEC 61158 - Feldbus für industrielle Leitsysteme

4 Wiring and pin assignment

4.1 Pin assignment

The PROFIBUS connection on the SE-24 servo controller is carried out as a 5 pole M12 plug or socket (b-coded) according to EN 50170.

4.1.1 Profibus IN [X2b]

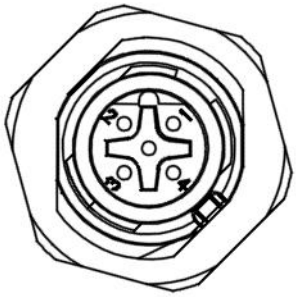


Figure 1: View of the X2b connection

X2b, Profibus IN		
Flush-type plug, 5 pole M12, b-coded Phoenix: 1419661 SACC-DSI-M12MSB-5CON-M16/0,5		
Pin	**Designation**	**Specification**
1	n.c.	
2	A line (R/TxD-N)	Data line -
3	n.c.	
4	B line (R/TxD-P)	Data line +
5	n.c.	

4.1.2 Profibus OUT [X3b]

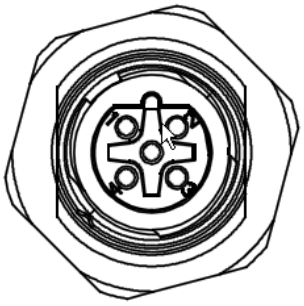


Figure 2: View of the X3b connection

X3b, Profibus OUT		
Flush-type socket, 5 pole M12, b-coded Phoenix: 1419674 SACC-DSI-M12FSB-5CON-M16/0,5		
Pin	**Designation**	**Specification**
1	+5V (VCC_ISO)	+5 V supply
2	A line (R/TxD-N)	Data line -
3	ISOGND	Data ground
4	B line (R/TxD-P)	Data line +
5	n.c.	

NOTE	
	PROFIBUS cabling Owing to the very high possible baud rates, we recommend the use of the standardized cables and connectors exclusively. These are, to an extent, equipped with additional diagnosis options and in case of a fault, simplify the fast analysis of the fieldbus hardware. When constructing the PROFIBUS network, follow the advice of the current literature or the following information and instructions without fail, to get a stable and fault-free system. In the case of cabling not having been done properly, faults can occur on the PROFIBUS during operation, which can result in the servo controller getting switched off with an error message, for reasons of safety.

4.2 Bus cable for PROFIBUS

The following cables of the company Phoenix Contact should be used for the Profibus connection:

Bus system cable, PROFIBUS, 2 pole, PUR halogen-free, violet RAL 4001, shielded, straight M12-SPEEDCON plug, b-coded, on straight M12-SPEEDCON socket, b-coded

Phoenix Contact Profibus cable

PROFIBUS cable:	Order No.	Length in m
	1518106	0,3
	1518119	0,5
	1518122	1
	1518135	2
	1518148	5
	1518151	10
	1518164	15

4.3 Termination and bus terminating resistors

Every bus segment of a PROFIBUS network must be fitted with bus terminating resistors, to minimize cable reflections, to ensure a nearly constant load behavior at the bus and to set a defined equilibrium rest potential on the cable. The termination is done at the beginning and at the end of a bus segment.

Due to the high protection class the PROFIBUS module of the SE-24 servo controller has no integrated terminating resistors.

Therefore, an M12 connector terminating resistor should be used.

The following bus terminating resistor of the company Phoenix Contact should be used for the Profibus termination:

Phoenix Contact Profibus terminating resistor

Profibus terminating resistor

Type	Article No.
SAC-5P-M12MS PB TR	1507803

NOTE	
	The erroneous or wrong bus termination is a frequent cause of troubles.

5 PROFIBUS connection

5.1 Introduction

A number of steps are necessary to create a functioning PROFIBUS-connection. Some of these settings should or must be executed before the activation of the PROFIBUS communication. This chapter provides an overview of the corresponding steps. The exact procedure is described in more detail in the following chapters.

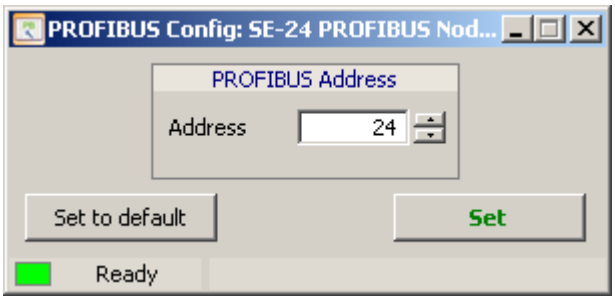
The data transfer with the DP-V0 service is carried out by means of so-called telegrams. The data on the slave side (in this case the SE-24) is assigned fix. Therefore, only the number of data to be transmitted and its assignment must be defined on the master side.

5.2 Setting the Profibus address

Proceed as follows to set the Profibus-Slave address:

1. Call up the “afagTools” parameterization program.
2. Select the “PROFIBUS Config” tool:

3. Set the Profibus-Slave address in the following window and confirm with “Set”:



4. **Important:** The address is only retrieved when the controller is restarted.

5.3 Baud rate

The SE-24 servo controller automatically detects the baud rate of the Profibus communication and supports speeds up to **max. 12Mbaud**.

5.4 Control

Two registers are required for operation of the SE-24: the status register which contains the ACTUAL values of the drive, and the control register where the TARGET values are entered.

The signals are described and specified on the following pages.

5.4.1 Status register (actual values)

5.4.1.1 Signal description of the output data of the SE-24 servo controller

Object		Description
ready	*BOOL*	This signal is set when the drive is ready-to-operate and can be energized. If there is a fault in the drive this signal and the “drive_enable_ok“ signal will be reset. The signal “ready” is only set after the error was acknowledged by resetting the “drive_enable/fault_res“ signal.
drive_enable_ok	*BOOL*	Power output stage and control are active.
ref_valid	*BOOL*	This signal is set when a valid reference position exists. The signal is not set during an ongoing reference movement. It is set for the first time or once again only after a successfully executed reference movement.
move_ok	*BOOL*	This bit is set depending on the traverse mode. In position mode the signal is set when the actual position is within the position window for a longer time than the set delay time. In current mode the bit is set when the actual current value is within the current value window for a longer time than the set delay time. **Important:** The signal is reset when the “start_move” signal is set. This however happens with a certain delay. Therefore it should be noted that the “move_ok” signal must first be queried for LOW and afterwards for HIGH after a run was started with the signal “start_move”.
error_no	*INT16*	Display of the error which has occurred.
position_value [µm] [°/1000]	*INT32*	Actual position
current_value [mA]	*INT32*	Actual motor current

5.4.1.2 Output telegram of the SE-24 servo controller (Big Endian)

TX PDO 1 (2 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								ready	drive_enable_ok	ref_valid	move_ok				

TX PDO 2 (2 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
error_nr (16bit)															

TX PDO 3 (4 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
position_value (µm, °/1000, 32bit)																															

TX PDO 4 (4 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
current_value (mA, 32bit)																															

5.4.2 Control register (target values)

5.4.2.1 Signal description of the input data of the SE-24 servo controller

Object		Description
drive_enable / fault_res	*BOOL*	This signal is assigned twice. Controller release = Hi-active / Error acknowledgement = Lo-active LOW => Motor is not energized, errors are acknowledged. Change 0=>1, if there is no error the motor will be energized during a change from LOW to HIGH and remains controlled until an error occurs or the signal is set to LOW. If this input is only set for the first time after a restart the offset angle of the commutation position will be defined (only for motors **without** Hall-effect probe). Change 1=>0, if there is an error the controller tries to acknowledge the pending errors. This is only possible after the cause for the error was rectified.
start/stop_ref	*BOOL*	A rising edge causes a reference run to be executed. A falling edge aborts the reference run. The sequence is as follows: Setting of the signal “drive_enable/fault_res”, wait until the signal “drive_enable_ok” is at HIGH. Then set the signal “start/stop_ref”, the reference run is executed. Wait until the signal “ref_ok” is at HIGH, the reference run is terminated. The controller is now ready for positioning.
start/stop_move	*BOOL*	A rising edge signals that a new movement order should be undertaken and started. In case of a falling edge the SE-24 is stopped quickly. This input has no influence during a reference run. Precondition is however that no error is pending, that controller release is active and a successful reference run was carried out, i.e. the outputs “ready”, “drive_enable_ok” and “ref_valid” must be set.
mode	*BOOL*	Operating mode: position / current mode LOW = position controller mode HIGH = current controller mode
pos_nr	*INT4*	Position set (binary) which should be approached. The position sets (1-15) are preconfigured with the tool window “Positioning sets” in the “Manual operation" tool of the “afag Tools” parameterization software. **Caution: When the movement is made using the position sets, the values of the „mode“, „move_relative“, „target_position“, „velocity“, „deceleration“, „acceleration“ and „target_current“ objects are ignored.**

Object		Description	
jog_pos		*BOOL*	When the input is set the drive accelerates with the acceleration set for the Jog mode to a pre-parameterized positive movement speed. In case of a falling edge at this input, the drive brakes to a standstill with the deceleration set for the quick-stop. This input has no effect during the reference-, position or current run.
jog_neg		*BOOL*	When the input is set the drive accelerates with the acceleration set for the Jog mode to a pre-parameterized negative movement speed. In case of a falling edge at this input, the drive brakes to a standstill with the deceleration set for the quick-stop. This input has no effect during the reference-, position or current run.
move_relativ		*BOOL*	Change from absolute to relative. LOW=absolute, HIGH=relative
target_position	**[µm]** **[°/1000]**	*INT32*	Target position The position target value is interpreted as an absolute or relative position depending on the signal “move_relative”.
velocity	**[mm/s]** **[°/s]**	*INT16*	Target movement speed
deceleration	**[mm/s²]** **[°/s²]**	*INT16*	Target deceleration
acceleration	**[mm/s²]** **[°/s²]**	*INT16*	Target acceleration
target_current	**[%]**	*INT16*	Target current The moment target value is determined by the higher level control system (in % of the positive current limiting). It defines the moment with which the drive should move.

5.4.2.2 Input telegram of the SE-24 servo controller (Big Endian)

RX PDO 1 (2 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
jog_pos	jog_neg	move_relative						drive_enable / fault_res	start/stop_ref	start/stop_move	mode	pos_nr_bit0	pos_nr_bit1	pos_nr_bit2	pos_nr_bit3

RX PDO 2 (4 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
target_position (µm, °/1000, 32bit)																															

RX PDO 3 (2 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
velocity (mm/s, °/s 16bit)															

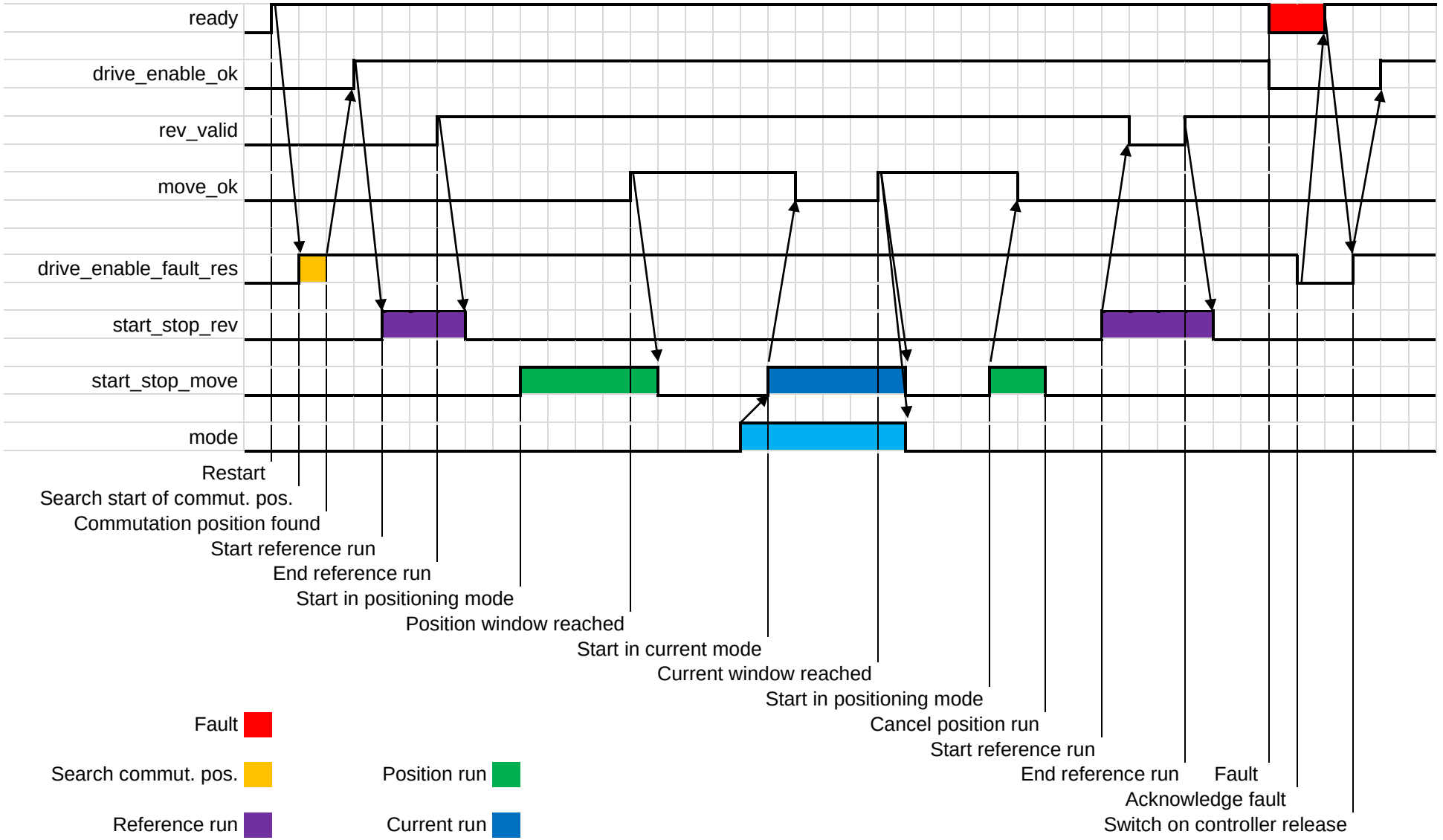
RX PDO 4 (4 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
deceleration (mm/s^2, °/s^2, 16bit)																acceleration (mm/s^2, °/s^2, 16bit)															

RX PDO 5 (2 bytes)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
target_current (%, 16bit)															

6 Signal diagram



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