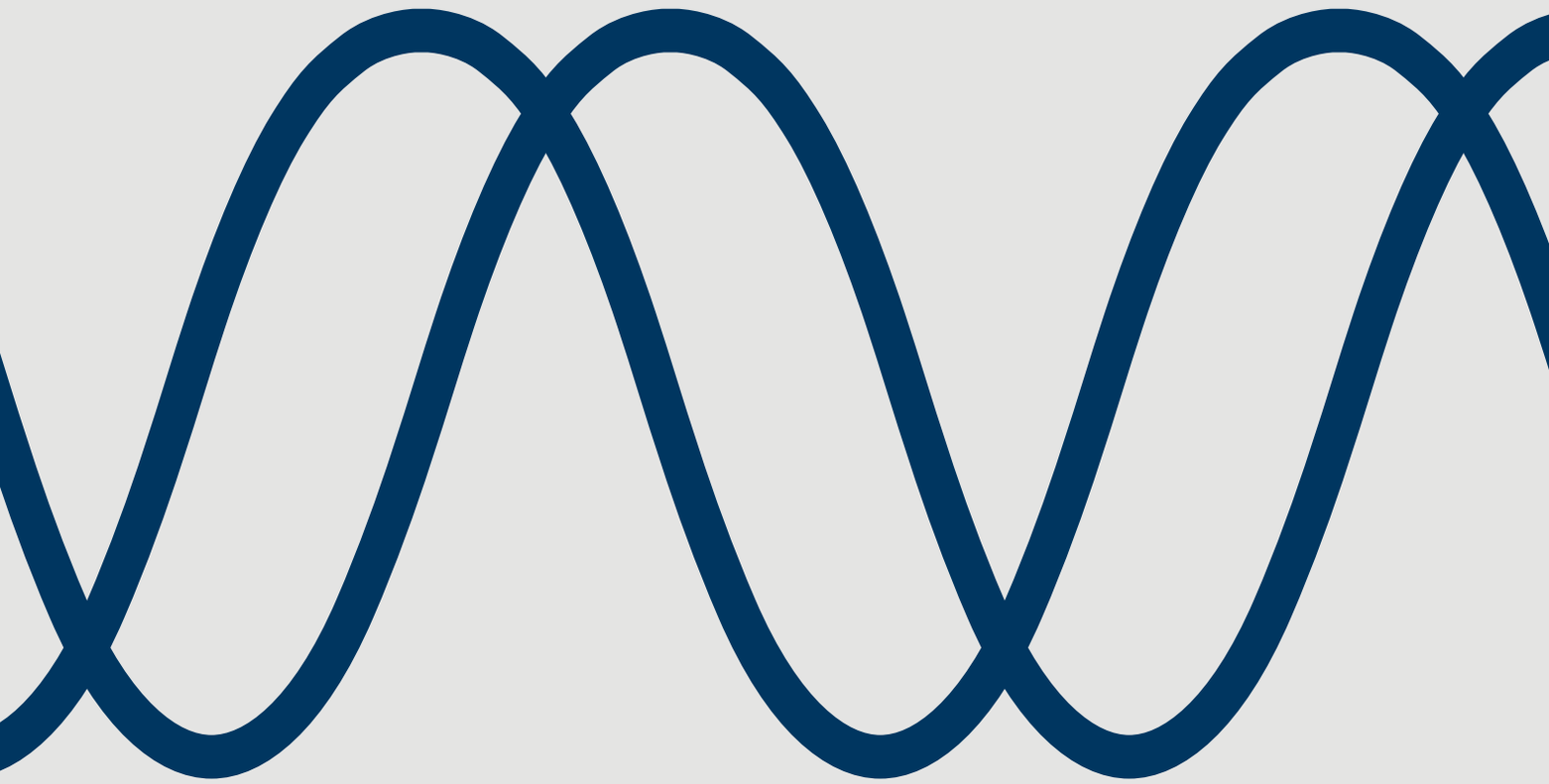
LEINE LINDE



PROFIBUS DPV0

FOR 900 SERIES ENCODERS

MANUAL / USERS GUIDE

PROFIBUS®

AMI
Automation and Metrology International, LLC
8808 Tyler Blvd, Mentor, OH 44060
1-888-354-2525 | sales@auto-met.com
Request a quote: auto-met.com

Leine & Linde AB
T +46-(0)152-265 00
F +46-(0)152-265 05
info@leinelinde.com
www.leinelinde.com

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LEINE LINDE

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Specifications and content in this document are subject to change without prior notice due to our continuous efforts to improve the functionality and performance of our products.

1 General information

Thank you for choosing this device produced by the Swedish encoder manufacturer Leine & Linde. In your hands you have a state of the art component that is ready to be used in the outmost demanding environment.

This manual describes the installation procedures and configuration options of our absolute encoders in the 900 series with DPV0 functionality. If you are in need of assistance during the commissioning or during operation, please make sure that you contact your local Leine & Linde representative.

1.1 Applicability of manual

This product manual is fully applicable to the encoder versions equipped with PROFIBUS DPV0 interface within the following encoder series:

PSE 901	**PHE 901**	**PSE 921**	**PHE 921**
PSE 903	**PHE 903**	**PSE 923**	**PHE 923**

Leine & Linde is a company that often customizes the product to fit individual requirements of our customers. Such customised products may therefore not be fully compliant with the descriptions in this product manual. Customised encoder devices are indicated by their type label, and marked 991 or 993 where the “9” digit in the second position indicates that the device has some customised parameters. Encoder series with the following name and type plate information may therefore have deviating functional performance.

PSE 991	**PHE 991**
PSE 993	**PHE 993**

If your product is of the above mentioned type, contact Leine & Linde to obtain the product’s complete functional description.

1.2 Absolute encoders

With an absolute encoder each angular position is assigned a coded position value. On singleturn encoders, i.e. an encoder producing absolute positions within one revolution, the absolute position information repeats itself with every revolution. So called multiturn encoders can also distinguish between revolutions. The number of unique revolutions is determined by the resolution of the multiturn scanning and repeats itself after the total resolution is reached.

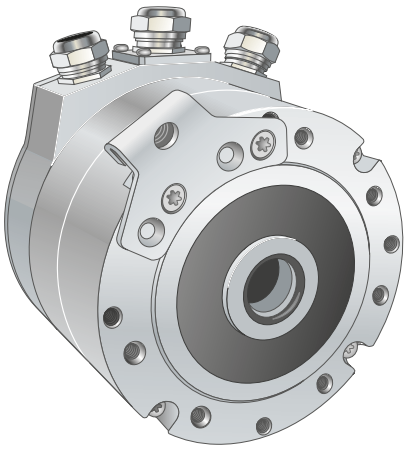


Figure 1 900 series PROFIBUS encoder

1.3 PROFIBUS technology

PROFIBUS is a powerful and versatile 2-wire non-proprietary open fieldbus standard defined by several international standards such as EN 50170, IEC 61158 together with different device profiles. There are 3 different PROFIBUS versions available today, DP, FMS and PA. Leine & Linde products support the DP version. In addition to manufacturer-specific functions, the Leine & Linde products described in this manual support class 2 according to the encoder profile 3.062. The encoder device profile describing encoder functionality and additional information about PROFIBUS can be ordered from PROFIBUS User Organization, PNO or directly from Leine & Linde AB.

PROFIBUS User Organization
Haid-und-Nue Straße 7
DE-76131 Karlsruhe, Germany

Tel: +49-(0)721-96 58 590
Fax: +49-(0)721-96 58 589
Web: www.profibus.com

1.4 About Leine & Linde AB

For more than 40 years, the Sweden-based company Leine & Linde has concentrated on one thing – development and manufacturing of advanced encoders that meet the most rigorous demands a user can place on them. That is why a wide assortment of incremental and absolute encoders with obvious concentration on robust products and quality down to the last detail can be offered. Leine & Linde's encoders provide the utmost in reliability year after year, in working conditions where vibration, dirt, cold, and other harsh environmental conditions are common.

Leine & Linde can meet very specific individual demands. The encoders are adapted exactly to the customers' needs with respect to resolution, electrical connections and interfaces, voltage, casings, etc, due to modular design within every product range. Leine & Linde concentrates on advanced development of intelligent encoders with integrated ASICs, new special features, and with adaptations to different fieldbus systems. . Leine & Linde concentrate on advanced development of intelligent encoders with integrated ASICs, new special features and with adaptations to different fieldbus systems. This enables us to meet the need for increasingly effective and dependable machines and automation to an even higher degree.

1.4.1 Technical and commercial support

Leine & Linde is represented by subsidiaries in many countries around the world. In addition to the address listed here, there are many services agencies and distributors located worldwide ready to reply to commercial enquiries or technical support. For more contact information, please visit our web site or contact Leine & Linde in Strängnäs, Sweden.

Leine & Linde AB

Box 8
SE-645 21 Strängnäs, Sweden

Tel: +46-(0)152-265 00
Fax: +46-(0)152-265 05
E-mail: info@leinelinde.com
Web: www.leinelinde.com

1.5 References

PROFIBUS Encoder profile V1.1, Order No. 3.062

1.5.1 Abbreviations

PROFIBUS	**Pr**ocess **Fi**eld **Bus**
PI	**P**ROFIBUS **I**nternational
PNO	**P**ROFIBUS **N**utzer**o**rganisation e.V. (PROFIBUS user organization)
GSD	German term "**G**eräte**s**tamm**d**aten". A GSD is the device database file, also called "device datasheet".
DP	**D**ecentral **P**eriphery
Input data	Data which the master receives from the encoder
Output data	Data which the encoder receives from the master.
PDU	**P**rotocol **D**ata **U**nit
DDLM	**D**irect **D**ata **L**ink **M**apper, the interface between PROFIBUS-DP functions and the encoder software
DDLM_Set_Prm	Interface during parameterization
DDLM_Data_Exchange	Interface during data exchange (normal operation)
DDLM_Slave_Diag	Interface during diagnostics data transfer
DDLM _Chk_Cfg	Interface during configuration

2 Absolute encoder installation

2.1 Settings inside the encoder

The encoder node address and bus termination must be configured during commissioning of the device. This is done by removing the back cover, i.e. screwing off the three screws at the rear of the encoder.

2.1.1 Node address

The node address of the encoder can be set via two decimal rotary switches located inside the back cover. The weighting, x10 or x1 are specified beside the switches. Permissible address range is between 0 and 99, but the lower addresses 0 to 2 are normally used by the master and not recommended to be used by the encoder. Each address used in a PROFIBUS network must be unique and may not be used by other devices.

The encoder address is only read and adopted when the encoder power supply is switched on. A restart of the encoder is therefore required in order to adopt changes done to the address settings.

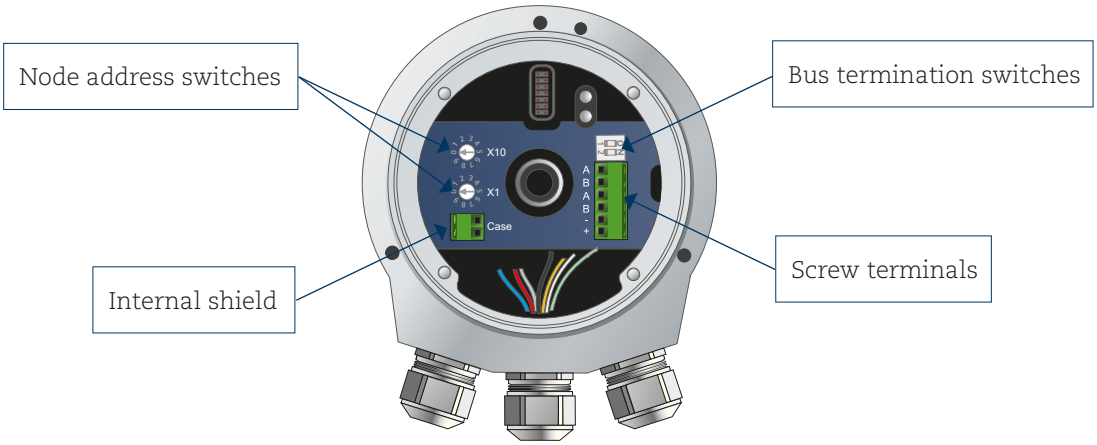


Figure 2 Settings inside the encoder

Example: If the node address shall be set to 85, the x10 switch shall be set to 8 and the x1 switch shall be set to 5.

2.1.2 Bus termination

In a PROFIBUS net, all devices are connected in a bus structure. Up to 32 devices (master and/or slaves) can be connected in one segment. When more devices are needed repeaters should be used to amplify the signals between segments. An active termination must be added in the beginning and end of each bus segment in order to ensure error-free operation. In case of the encoder being equipped with cable glands such terminators are integrated inside the back cover and can be activated via dip switches as shown in picture 2. If the device is un-powered the A and B lines are internally terminated by a 220Ω resistor.

Bit 1	Bit 2	Effect
ON	ON	There is a 220 ohm resistor between bus-A and bus-B line.
ON	OFF	Not a valid setting.
OFF	ON	Not a valid setting.
OFF	OFF	There is no resistor between bus-A and bus-B line.

Table 1 Terminating switch settings

When encoders with M12 connectors are used the termination should be done using a terminating resistor plug. The terminating resistor plug is available as an accessory from Leine&Linde.

Note: When M12 terminating resistor plugs are used, the internal terminating switch shall not be activated.

2.2 Connecting the encoder

2.2.1 Power supply

The power supply connection of M12 equipped encoders are constituted by a male A-coded 4 pin M12 connector.

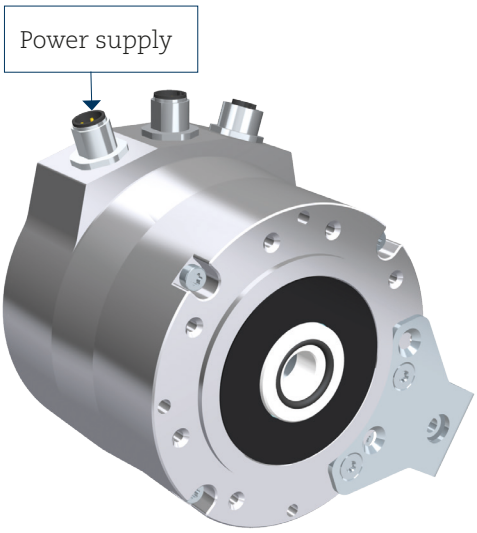


Figure 3 Orientation of M12 power supply connector

Power supply M12 version	
Function	Pin
+E Volt (9-36 Vdc)	1
Not connected	2
0 Volt	3
Not connected	4

Table 2 Pinning M12 power supply connector

Encoders equipped with cable glands are delivered with a dust protection foil from the factory. The protection foil needs to be removed prior to installation of the cables. The cable gland encoders should always be equipped with a shielded power supply cable with conductor area between 0,34 mm^2 to 1.5 mm^2. Permissible outer cable diameter is ø 6 mm to ø 8 mm for the power supply cable. Located inside the back cover are two screw terminals containing the required power supply terminals marked (+) and (-).

In the case where the encoder is the last node in the bus-structure and only the cable glands for Supply and Bus-in are in use, the Bus out cable gland should be replaced with a M16 filler plug to ensure proper sealing. The M16 filler plug is available as an accessory from Leine&Linde.

The (+) terminal shall be used to connect the +EV-line
The (-) terminal shall be used to connect the 0V-line.

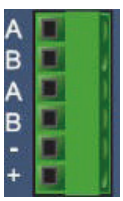


Figure 4 Terminal connection of power supply cables

Note: Tighten all screws in the terminal, even if no cable has been attached.

2.2.2 BUS lines

The PROFIBUS bus line connections of the M12 equipped devices are constituted by a male B-coded 5 pin M12 connector (bus in), and a female B-coded 5 pin M12 connector (bus out).

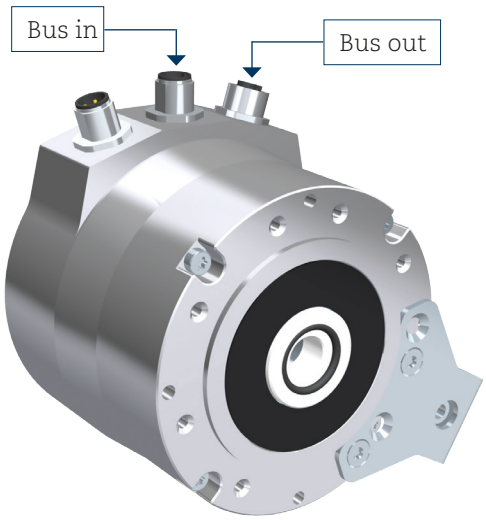


Figure 5 Orientation of M12 bus connectors

Bus in lines		Bus out lines	
Function	Pin	Function	Pin
Not connected	1	VP	1
A	2	A	2
Not connected	3	DGND	3
B	4	B	4
Chassi	5	Chassi	5

Table 3 Pinning M12 bus in/out lines

The cable gland encoders shall be equipped with twisted pair shielded cable in accordance with EN 50170 and PROFIBUS guidelines. The guidelines recommend a conductor area higher than 0,34 mm^2. Permissible outer cable diameter is ø 8 mm to ø 10 mm for the bus line cables. Located inside the back cover are four screw terminals containing the required bus line terminals marked (A) and (B). Cable glands not used should be replaced with a M16 filler plug to ensure proper sealing. The M16 filler plug is available as an accessory from Leine & Linde.

The (A) terminal shall be used to connect the A-line.
The (B) terminal shall be used to connect the B-line.

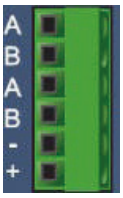


Figure 6 Terminal connection of bus line cables

Note: Tighten all screws in the terminal, even if no cable has been attached.

Note: The two A-terminals are internally connected to each other and the two B-terminals are also internally connected to each other so it does not matter to which terminal the bus lines are connected.

2.3 Shielding philosophy

To achieve the highest possible noise immunity and resistance against other EMI related disturbances the bus and power supply cables shall always be shielded. The screen should be connected to ground on both ends of the cable. In certain cases compensation current might flow over the screen. Therefore a potential compensation wire is recommended.

2.4 GSD files

Absolute encoders with PROFIBUS can be configured and parameterized corresponding to the requirements of the user. When the system is started, the PROFIBUS devices are set and configured in DDLM_Set_Prm mode, i.e. the encoder class set by means of the GSD file in the configuration tool and the operating parameters are transferred to the respective slave.

Available GSD files can be downloaded from www.leinelinde.com

GSD file	
Encoder functionality	GSD file
Integrated encoder, DPV0	ENC_0EC8.GSD

Table 4 Available GSD file for DPV0 encoders

When configuring the encoders various configurations can be selected as described in chapter 5. Selectable parameters and functionality of the device depends on the selected configuration. This data, saved in the PROFIBUS master is transferred once to the encoder when the system is powered on. If the encoder has been started with the GSD file for DPV0 functionality and a GSD file with a different ID-number shall be used, the encoder needs to be restarted before it can use the new GSD file. The 900 series encoder can only be configured as a class 2 PROFIBUS slave device.

After the configuration and parameter data have been received the encoder enters normal operation with cyclic data transfer i.e. “DDLM_Data_Exchange mode”.

Installation of GSD-files:

1) Select and save the GSD file for the respective device from our homepage www.leinelinde.com and then copy the *.gsd file into the respective directory of the PROFIBUS configuration tool.
2) Select the bitmap file of the respective device on the floppy disk and copy the *.bmp file into the respective directory of the PROFIBUS configuration tool.
3) Update the GSD files (SCAN).

2.5 LED indication

In order to determine the status of the encoder two LEDs are visible from the rear end of the encoder. The module LED indicates status of the module itself. The bus LED indicates the status of the bus. The table below defines the diagnostic messages using a red (BUS) and a bicolor, Red/Green, LED (MODULE).

Bus	Module	Meaning	Cause
Off	Off	No Power	
Red	Green	No connection to another device Criterion: no data exchange	- Bus disconnected - Master not available / switched off
Red 2)	Red 2)	No connection to another device No connection between EnDat encoder and PROFIBUS PCB	- No connection to EnDat Encoder at power up

Bus	Module	Meaning	Cause
Blinking Red 1)	Green	Parameterization or configuration fault	- Configuration received differs from the supported configuration. - Parameter error in the parameterization.
Green	Red	System failure	- Diagnosis exists, slave in data exchange mode - Position error
Green	Green	Data exchange Slave and operation ok	

Table 5 LED indication

1) The **blinking** frequency is 0.5 Hz. Minimal indication time is 3 sec.
2) Position error is when an alarm occurs in the encoder or if the EnDat encoder is disconnected from the PROFIBUS interface PCB.

3 Profile overview

Encoder Profile for DPV0, version 1.1, Order no 3.062.

The operating functions in this profile are divided into two device classes named Class 1 and Class 2. Class 1 encoders offer basic functions that all PROFIBUS-DP encoders must support. An encoder of class 1 can optionally support selected functions of class 2 but these functions must be implemented according to the profile. To support early PROFIBUS-DP implementations the size of the protocol data units (PDU) is limited to 16 bytes. Encoders of class 2 must support all functions of class 1 as well as the additional functionality of class 2. In addition to the two classes, parameters and diagnostic ranges are reserved for manufacturer-specific functions.

For further information regarding the encoder functionality refer to the device profile. The profile and PROFIBUS technical information can be ordered at PNO in Karlsruhe, Germany (www.profibus.com).

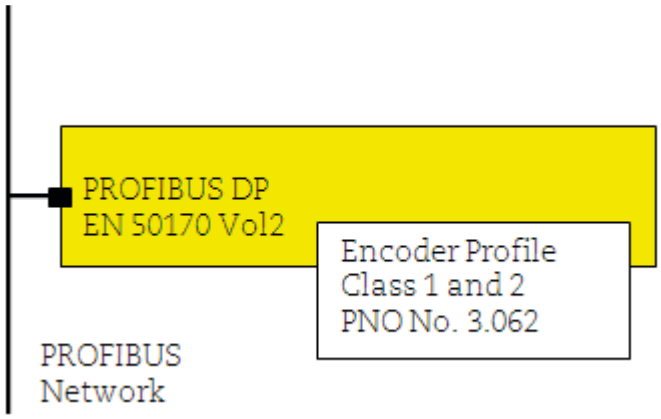


Figure 7 Overview encoder profile and related documents

3.1 DPV0 encoder class

The 900 series encoder can only be configured as a class 2 PROFIBUS slave device. Class 2 configuration is extended to optionally access velocity information from the encoder.

CLASS 2

In the Class 2 configuration output data values and input data words are transferred. Both the input data and output data consist of two data words (32 bits).

The following functions are available:
- Scaling function
- Preset value function
- Velocity read-out
- Extended diagnostic data

Configuration data:

Position	Class 2 – 32 bits: F1hex, 2 input data word, 2 output data words for preset value, data consistency
Position + Velocity	Class 2 – 32+16 bits: F1+D0hex, 3 input data word, 2 output velocity data words for preset value, data consistency

To enable full functionality it is recommended to choose the 32 bit + 16 bit velocity configuration.

4 Encoder functionality, DPV0

4.1 Basic functionality

The picture below gives an overview of the basic encoder and gateway functions and how the functionality is conducted within the device.

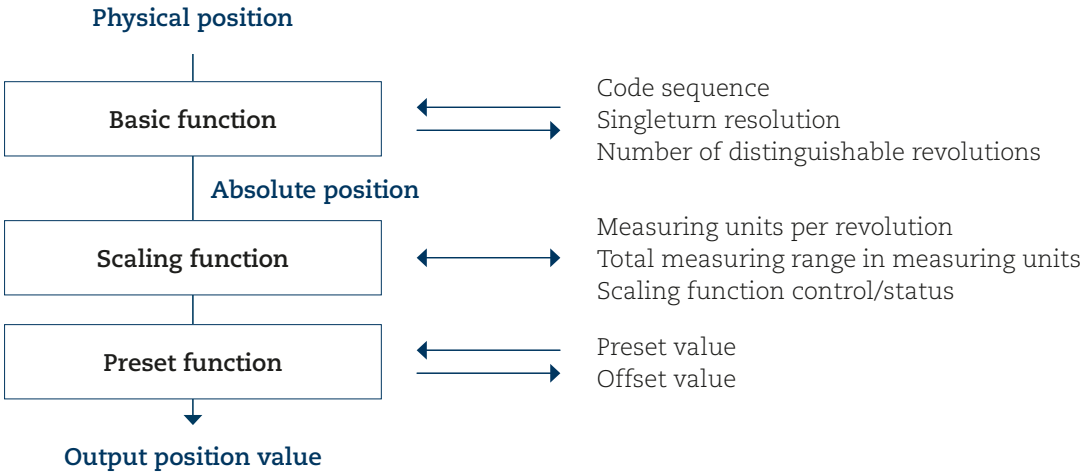


Figure 8 Basic functionality

4.2 PROFIBUS data transfer principle

The PROFIBUS-DP devices can be configured and parameters can be set according to the user's needs. In this context it is useful to know that with PROFIBUS there are different types of data transmission.

4.2.1 During configuration (DDLM_Chk_Cfg mode)

The configuration function allows the DP-Master to send the configuration data to the DP-device for checking. The main purpose is to define the number of bytes used for the Data_Exchange function.

4.2.2 During parameterization (DDLM_Set_Prm mode)

When the system is started, the PROFIBUS devices are parameterized (DDLM_Set_Prm mode), i.e. the encoder class set by means of the GSD file in the configuration tool and the set operating parameters (see chapter 4.4) are transferred to the respective slave.

4.2.3 Normal operation (DDLM_Data-Exchange mode)

In the normal mode (DDLM_Data-Exchange mode), data are exchanged between master and slaves. The preset function can be carried out only in this operating mode. The data exchange is described in chapter 4.5.

4.3 Configuration, DPV0

The configuration of a DPV0 device is conducted by choosing encoder class, i.e. setting the input/output data structure. The configuration options are 32-bit or 32-bit + 16-bit velocity input data, for explanation view chapter 3.1.

4.4 Parameterization, DPV0

The PROFIBUS-DPV0 device is parameterized by means of the operating parameters. The values selected in the configuration tool are saved in the DP master and are transferred to the PROFIBUS-DP slave each time the network is started.

The following table lists all available parameters:

Parameters	Data type	Parameter octet number
Code sequence	Bit	9
Scaling type	Bit	9
Scaling function control	Bit	9
Measuring units per revolution	Unsigned 32 bits	10 – 13
Total measuring range in measuring units	Unsigned 32 bits	14 – 17
Manufacturer specific functions	Bit	26 – 28
Velocity output unit	2 bit	39

Table 6 Operating parameters in DPV0

The parameters described in octet 9 are defined bit by bit as follows:

Octet	9
Bits	7 – 0
Data	$2^7 – 2^0$
	Operating parameters

Bits	Definition	= 0	= 1
0	Code sequence	Clockwise (CW) Increasing position values when rotated clockwise (seen from flange side)	Counter-clockwise (CCW) Increasing position values when rotated counter-clockwise (seen from flange side)
3	Scaling function control	Disable scaling	Enable scaling. Scaling parameters are taken into octets 10 to 17.
4	Scaling type	Binary (A) or Non-binary (B)	Free scaling (C)
5	Reserved for future use		

Table 7 Octet 9, Parameter definition

4.4.1 Code sequence

The code sequence defines whether the absolute position value should increase during clockwise or counter-clockwise rotation of the encoder shaft seen from flange side. The code sequence is by default set to increase the absolute position value when the shaft is turned clockwise (0).

Note: The position value will be affected when the code sequence is changed during operation. It might be necessary to perform a preset after the code sequence has been changed.

4.4.2 Class 2 functionality

The Class 2 functionality for 900 series PROFIBUS encoders is by default enabled. The class 2 functionality enables the scaling, preset and velocity readout function. Leine & Linde 900 series only support class 2.

4.4.3 Commissioning diagnostics

The commissioning diagnostics function enables the device to perform internal diagnostic tests of the encoder components responsible for position detection during a standstill of the encoder (i.e. light unit, photovoltaic cells etc.). In conjunction with the position alarms, it enables thorough checking of whether the position values provided by the absolute encoder are correct. The commissioning diagnostics function is started by the commissioning bit in the operating parameters. If an error is found within the absolute encoder, this is indicated in the diagnostic function by the commissioning diagnostics alarm bit (see chapter 4.6.2).

The commissioning diagnostics function is an option. To find out whether the encoder supports commissioning diagnostics, the commissioning diagnostics bit in the operating status, (octet 9 in the Diagnostics) can be read out and checked.

4.4.4 Scaling function control

The scaling function converts the encoder's physical absolute position value by means of software in order to change the resolution of the encoder.

The parameters "Measuring units per revolution" and "Total measuring range" are the scaling parameters set by the parameter function in octet 10 to 17. Scaling is active only if the control bit for the scaling function is set to 1 (Enabled). When the scaling function control bit is set to 0, the scaling function is disabled.

Note: After downloading new scaling parameters the Preset function must be used to set the encoder starting point to absolute position 0 or to any required starting position within the scaled operating range.

4.4.5 Scaling type

The encoder has different kinds of scaling possibilities depending on the users' need or use of the encoder.

Binary (A)

If the numbers of revolution is set to an 2^X number of turns (where x = 2,4,8... and so on) the encoder will operate in an endless cyclic mode (0-max-0-max....).

Non-binary (B)

If the numbers of revolution is set to a value not equal to 2^X numbers (where x = 2,4,8…) of turns, then the encoder will work in a non-binary scaling, which means that the encoder's total measuring range will be within a limited range. The position value will be set to the encoder's highest scaled position value, until a preset is made, or until the position value has reached the maximum value of its non-scaled full working range. Then it starts over from 0 again.

Free scaling (C)

The encoder resolution can be set to any desired working range within the encoder's maximum resolution.

For more information about the operating modes depending on the scaling types, please refer to chapter 4.4.7.

4.4.6 Measuring units per revolution

The total measuring range is calculated by multiplying the singleturn resolution with the number of distinguishable revolutions.

Format of the scaling parameters:

Octet	10	11	12	13
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} –2^{0}$
	Measuring units per revolution			

Table 8 Singleturn scaling parameter format

Octet	10	11	12	13
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} –2^{0}$
	Measuring units per revolution			

Table 9 Multiturn scaling parameter format

The data format for both scaling parameters is 32 bits without sign, with a value range from 2^0 to 2^{31}. The permissible value range is limited by the resolution of the encoder. For a 31 bit encoder with a singleturn resolution of 19 bits the permissible value range for "Measuring units per revolution" is between 2^0 and 2^{19} (524288) and for the "Total measuring range" the permissible value range is between 2^0 and 2^{31} (2147483648). The scaling parameters are securely stored in the PROFIBUS-DP master and are reloaded into the encoder at each power-up. Both parameters are output data in 32-bit format.

Example of scaling and entry:
If the user wants to scale the encoder to a single turn resolution of 4000 unique positions per revolution and a total number of turn count equal to 3200 revolutions, the configuration shall be as:

Measuring units per revolution = 4000_{10} steps
Total measuring range in measuring units
= 4000 steps x 3200 revolutions
= $12\ 800\ 000_{10}$

Entry in the master configuration software:
Measuring units per revolution = 4000
Total measuring range (steps) = 12800000

4.4.7 Total measuring range

The total measuring range is defined by the parameter "Total measuring range in measuring units".

The parameter "Scaling type" (see chapter 4.4.5) affects which operating mode is going to be used.

If scaling type "binary (A)" has been chosen, an automated check is done whether a binary scaling can be used or not. If a binary scaling can be used, the device selects operating mode (A) Binary scaling. If not, operating mode (B) Non-binary scaling is selected.

If the scaling type has been set to Free scaling (C),the encoder uses the operating mode (C) Free scaling.

(A) Binary, cyclic scaling
Cyclic operation is used when operating with 2^X number of turns (2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048 and 4096 number of turns). If the desired measuring range is equal to the specified singleturn resolution * 2^X (where

x<=16) the encoder operates in endless cyclic operation (0–max–0–max…). For example: If the position value increases above the maximum value by rotating the encoder shaft, the encoder continues from 0.

Example of a cyclic scaling:
Measuring units per revolution = 1000
Total measuring range = 32 000 (2^5 = number of revolutions 32)

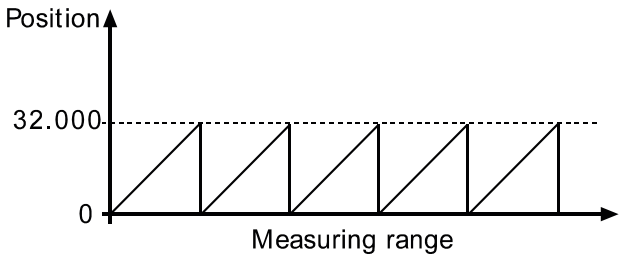


Figure 9 Cyclic scaling

(B) Non-binary, non-cyclic scaling
If the measuring range is used to limit the encoder value range to a value not equal to the specified singleturn resolution * 2^X, the output position value is limited within the operating range. If the position value increases or decreases outside the measuring range by rotating the encoder shaft beyond the maximum value or below 0, the device outputs the total measuring range value.

Example of non-cyclic scaling:
Measuring units per revolution = 100
Total measuring range = 5 000 (number of revolutions 50)

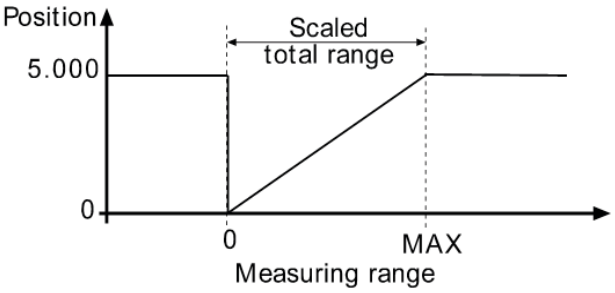


Figure 10 Non-cyclic scaling

(C) Free scaling
Free scaling means that the resolution of the encoder can be set to any desired number within the limitation of the encoder's maximum total resolution. The encoder will then work in endless cyclic operation, which means that the encoder counts from 0 to maximum set value and then starts over from 0 again (0–max–0–max–0…).

Example of scaling:
Measuring units per revolution = 1000 steps
Total Measuring range in measuring units = 3000 (Measuring units per revolution x 3 revolutions)

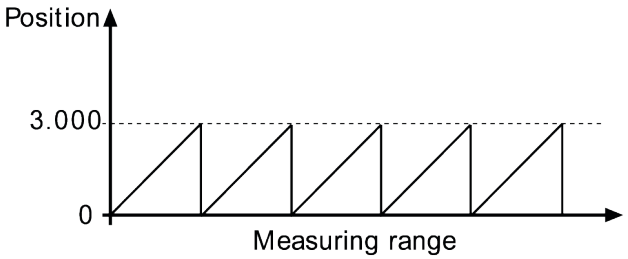


Figure 11 Free scaling

4.4.8 Velocity control

The velocity data can be accessed if class 2, 32 bit + 16 bit velocity configuration is used. In this case the input data consists of 32-position data plus 16-bit signed velocity data. The input velocity value is negative in CCW direction if code sequence is set to CW. If the measured velocity is higher then what is possible to present with the selected velocity unit, the value is set to 0x7FFF(32768) or 0x8000 (-32768) depending on direction of shaft rotation.

Note: If the velocity control function is used and scaling is set to the device, the velocity calculation is based on the scaled position value. Consequently the accuracy of the velocity value is dependent of the scaling set to the device.

4.4.9 Velocity calculation

The velocity calculations are made with a maximum of 19 bits resolution. If the resolution is higher than 2^{19}, the value used for velocity calculations is automatically reduced to 2^{19}. For a multiturn encoder with 2^{12} multiturn resolution, the maximum singleturn value will be 2^{19} and the velocity will be calculated on the same resolution as presented in the diagnostic structure. For a singleturn encoder the resolution can be up to 31 bits, but the velocity calculations will be made on maximum 19 bits. This means that in the diagnostic structure, the value 2^{31} can be presented, but the resolution used for velocity calculations is not presented if the singleturn resolution is higher than 2^{19}.

The parameter for velocity unit, octet 39, can be seen below:

Octet	**39**
Bits	7 – 0
Data	$2^7 – 2^0$
	Velocity control

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Velocity unit**
			0	0					Steps/s
			0	1					Steps/100ms
			1	0					Steps/10ms
			1	1					RPM(revolutions/min)

Table 10 Octet 39 Velocity Control

In case of the step/s unit, an average is made over 200 ms, and the value is multiplied by 5.

4.5 Data transfer in normal operation (DDLM_Data_Exchange)

The DDLM_Data_Exchange mode is the normal status of the device when operated. In this mode the position value is transmitted from the device in a cyclic manner. Output data can also be sent to the device i.e. preset commands.

4.5.1 Data exchange mode

The actual position value is transferred to the master as 32-bit values (double word). The position value is right-aligned in the data field.

DDLM_Data_Exchange mode

Standard configuration:

Octet	**1**	**2**	**3**	**4**
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$
	Data_Exchange – 32 bits			

Table 11 Data exchange 32-bits

Configuration data:
Device class 2: F1hex 2 input data words, 2 output data words for preset value, data consistency.

4.5.2 Preset function

The preset function enables adaptation of the position value from the encoder to a known mechanical reference point of the system. The preset function sets the actual position of the encoder to zero or to the selected preset value. The preset value is written to the encoder as output data in the Data_Exchange function. If scaling is used, the preset function shall be used after the scaling function, to ensure that the preset value is entered in the current measuring unit.

The most significant bit (MSB) of the preset value controls the preset function as follows:

Normal operating mode: MSB = 0 (bit 31)
The encoder will not change the preset value.

Activated mode: MSB = 1 (bit 31)
With MSB = 1, the encoder accepts the transferred value (bits 0 – 30) as a preset value in binary code. The encoder reads the current position value and calculates an offset value from the preset value and the read position value. The position value is shifted by the calculated offset value. If the input position value equals the preset value, the preset mode is terminated and the MSB can be set to 0 by the master. The offset value can be read with the diagnostic function and is securely stored in case of a power interruption and is reloaded at each start-up.

Note: The preset function should only be activated at encoder standstill.

Preset value format (2 words, 32 bits):

Octet	1		2	3	4
Bits	31	30-24	23 – 16	15 – 8	7 – 0
Data	0 / 1	2^{30}-2^{24}	2^{23} – 2^{16}	2^{15} – 2^{8}	2^{7} – 2^{0}
	Preset control bit	Preset value - max. 31 bits			

Table 12 Preset value, 32-bit format

4.6 Diagnostics

The diagnostic information contains diagnostic data which are defined in the PROFIBUS-DP specification (octets 1 to 6) but also encoder-specific diagnostic data:

DDLM_Slave_Diag

Diagnostic function	Data type	Diagnostic. octet number
Station status 1	Bits	1
Station status 2	Bits	2
Station status 3	Bits	3
Diagnostic master address	Bits	4
PNO identification number	Bits	5-6
Extended diagnostic header	Octet string	7
Alarms	Octet string	8
Operating Status	Octet string	9
Encoder type	Octet string	10
Singleturn resolution (encoder) Measuring unit (linear encoder)	32 without sign	11-14
Number of distinguisable revolutions (Lower bytes)	16 without sign	15-16 (see also octet 58-59)
Additional alarms	Octet string	17
Supported alarms	Octet string	18-19
Warnings	Octet string	20-21
Supported warnings	Octet string	22-23
Profile version	Octet string	24-25
Software version	Octet string	26-27
Operating time	32 without sign	28-31
Offset value	32 with sign	32-35
Manufacturer offset value	32 with sign	36-39
Measuring units per revolution	32 without sign	40-43

Diagnostic function	Data type	Diagnostic. octet number
Total measuring range in measuring units	32 without sign	44-47
Serial number	ASCII string	48-57
Number of distinguishable revolutions (Higher bytes)	16 without sign	58-59 (See also octet 15-16)

Table 13 Diagnostics message, DPV0

Note: For PROFIBUS-DP encoders of class 2, the length of the encoder specific diagnostic data including the extended diagnostic header is 59 bytes.

The DDLM_Slave_Diag memory range up to octet 99 is reserved for future diagnostic data of class 2.

4.6.1 Extended diagnostic header

The extended diagnostic header byte specifies the maximum size of diagnostics directory, including this header byte (below). The format of the transmission length is hexadecimal.

DDLM_Slave_Diag

Octet	7		
Alarms	7	6	5 – 0
Data	0	0	xxh
	Set to 00		Length incl. header
	Extended diagnostics		

Table 14 Diagnostic header

4.6.2 Alarms

Alarm is generated by the device when failure occurs which effects the position value. Octet 8 in the diagnostic function (DDLM_Slave_Diag) indicates the status of the alarms. Additional alarms for device class 2 are added in the diagnostic octet 17.

If an alarm is given, the Ext_Diag bit and the Stat_Diag bit in the diagnostic function are set to high and remain high until the alarm is cleared and the encoder can provide a correct position value. Alarms are cleared when the functionality is within the specification and the position value is correct.

Note: Not every encoder supports every alarm. For encoders of class 2 the diagnostic information "supported alarms" (see chapter 4.6.8) makes it possible to find out which individual alarm bits are supported.

DDLM_Slave_Diag

Octet	8
Bits	7 – 0
	Alarms

Bits	Definition	= 0	= 1
0	Position error	No	Yes

Bits	Definition	= 0	= 1
1	Voltage supply error	No	Yes
2	Current is too high	No	Yes
3	Commissioning diagnostics	OK	Error
4	Memory error	No	Yes
5	Currently not assigned		
6			
7			

Table 15 Alarms

4.6.3 Operating status

Octet 9 in the diagnostic function provides information about encoder-specific parameters. A class 2 encoder sets the functionality bit for class 2 commands in order to show the DP master that all class 2 commands are supported. The DP master must activate the class 2 functionality bit in the parameter message (DDLM_Set_Prm) to enable the use of class 2 functions.

The status bit of the scaling function is set when the scaling function is activated and the resolution of the encoder is calculated by means of the scaling parameters.

DDLM_Slave_Diag

Octet	9
Bits	7 – 0
	Operating status

Bits	Definition	= 0	= 1
0	Code sequence	Clockwise (CW) Increasing position values when rotated clockwise (seen from flange side)	Counter-clockwise (CCW) Increasing position values when rotated counter-clockwise (seen from flange side)
1	Class 2 functionality= 1 (Enabled)		
2	Commissioning diagnostics	No, not supported	Yes
3	Scaling function status	Scaling disabled	Scaling enabled
4	Scaling type	Binary (A) or Non-binary (B)	Free scaling (C)
5-7	Currently not assigned		

Table 16 Operating status

4.6.4 Encoder type

The type of encoder can be read in octet 10 of the diagnostic function. The type of encoder is defined in hex code in the range from 0 to FF.

DDLM_Slave_Diag

Octet	**10**
Bits	0 - FF
	Encoder type

Bits	**Definition**
00	Absolute singleturn encoder
01	Absolute multiturn encoder
02	Absolute singleturn encoder with electronic revolution counter
03	Incremental rotary encoder
04	Incremental rotary encoder with battery buffer
05	Incremental linear encoder
06	Incremental linear encoder with battery buffer
07	Absolute linear encoder
08	Absolute linear encoder with periodic coding
09	Currently not assigned
•	
•	
FF	

Table 17 Diagnostics, encoder type

4.6.5 Singleturn resolution or measuring step

The singleturn resolution in the diagnostic function has different meanings depending on the type of encoder.

For rotary or angle encoders, the diagnostic octets 11 to 14 indicate the physical resolution in number of measuring steps per revolution which is transferred for the absolute singleturn position value. The maximum singleturn resolution is 2^{31}.

For linear encoders the measuring steps is presented with respect to the resolution of the linear encoder, i.e. each increment of the measuring step is equal to the actual resolution for the linear encoder in use. Typical values for the linear resolution are 1µm - 40 µm.

DDLM_Slave_Diag

Octet	**11**	**12**	**13**	**14**
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$
	Singleturn resolution			

Table 18 Diagnostics, singleturn resolution

4.6.6 Number of distinguishable revolutions

The number of distinguishable revolutions that the encoder can transfer is defined by octets 15, 16, 58 and 59 of the diagnostic function. In accordance with the formula below, the measuring range for an encoder results from the number of distinguishable revolutions multiplied by the singleturn resolution.

Measuring range = number of distinguishable revolutions x singleturn resolution.

DDLM_Slave_Diag

Octet	**58**	**59**	**15**	**16**
Bits	31 – 24	23 – 16	15 – 8	7 – 0
	High octets		Low octets	
	Number of distinguishable revolutions			

Table 19 Diagnostics, number of distinguishable revolutions

4.6.7 Additional alarms

The diagnostic octet 17 indicates additional alarms for device class 2. The additional alarms are serious internal errors that has occured inside the encoder. If these errors occur, please contact Leine & Linde.

DDLM_Slave_Diag

Octet	**17**
Bits	7 – 0
	Additional alarms

Bits	**Definition**	**= 0**	**= 1**
0	–	–	–
1	–	–	–
2	–	–	–
3	Internal frequency error	No	A serious internal frequency error has occurred, contact Leine & Linde
4	Internal checksum error (CRC)	No	A serious internal checksum error has occurred, contact Leine & Linde
5	EnDat multiturn error	No	A serious internal multiturn error has occurred, contact Leine & Linde
6	Endat singleturn error	No	A serious internal singleturn error has occurred, contact Leine & Linde
7	Internal module checksum error (CRC)	No	A serious checksum error has occurred, contact Leine & Linde

Table 20 Diagnostics, additional alarms

4.6.8 Supported alarms

The diagnostic octets 18 and 19 contain information on the supported alarms.

DDLM_Slave_Diag

Octet	**18**	**19**
Bits	15 – 8	7 – 0
	Supported alarms	

Bits	**Definition**	**= 0**	**= 1**
0	Position error	Not supported	Supported
1	Voltage supply error	Not supported	Supported
2	Current is too high	Not supported	Supported
3	Commissioning diagnostics	Not supported	Supported
4	Memory error	Not supported	Supported
5-10	Saved for future use		
11	Internal frequency error	Not supported	Supported
12	Internal checksum error (CRC)	Not supported	Supported
13	EnDat multiturn error	Not supported	Supported
14	EnDat singleturn error	Not supported	Supported
15	Internal module checksum error (CRC)	Not supported	Supported

Table 21 Diagnostics, supported alarms

4.6.9 Warnings

Warnings indicate that tolerances for certain internal parameters of the device have been exceeded. Contrary to alarms, no faulty position values are expected in case of warnings.

Octets 20 and 21 of the diagnostic function indicate the status of the warnings. If a warning is set, the Ext_Diag bit in the diagnostic function is logically set to 1 until the warning is cleared. All warnings are deleted when the diagnostic message of the device has been read. However, if the tolerances are still exceeded, the warning is activated again. The warning "Maximum operating time exceeded" (bit 4) is not activated before the system is switched on again.

Note: Not every encoder supports every warning. Please refer to the diagnostic information under "Supported Warnings", see chapter 4.6.10, for information on the support of specific warnings.

DDLM_Slave_Diag

Octet	**20**	**21**
Bits	15 – 8	7 – 0
	WARNINGS	

Bits	**Definition**	**= 0**	**= 1**
0	Frequency exceeded	No	Yes
1	Temperature exceeded	No	Yes
2	Light control reserve	Not reached	Reached
3	CPU monitoring status (Watchdog)	OK	Reset
4	Maximum operating time exceeded	No	Yes
5	Battery error	OK	Too low
6	Reference point	Reached	Not reached
7	Currently not assigned		
•			
15			

Table 22 Diagnostics, warnings

4.6.10 Supported warnings

The diagnostic octets 22 and 23 contain information on supported warnings.

DDLM_Slave_Diag

Octet	**22**	**23**
Bits	15 – 8	7 – 0
	Supported Warnings	

Bits	**Definition**	**= 0**	**= 1**
0	Frequency warning	Not supported	Supported
1	Temperature warning	Not supported	Supported
2	Light control reserve warning	Not supported	Supported
3	CPU monitoring status (Watchdog) warning	Not supported	Supported
4	Maximum operating time exceeded warning	Not supported	Supported
5	Battery charging warning	Not supported	Supported
6	Reference point warning	Not supported	Supported
7	Currently not assigned		
•			
15			

Table 23 Diagnostics, supported warnings

4.6.11 Profile version

Octets 24 and 25 of the diagnostic function provide the PROFIBUS-DP encoder profile version that is implemented in the device. The octet's revision number and index are combined.

Example:

Profile version:	1.40	
Octet no.	24	25
Binary code.	00000001	01000000
Hex:	1	40

DDLM_Slave_Diag

Octet	**24**	**25**
Bits	15 – 8	7 – 0
Data	2^7 – 2^0	2^7– 2^0
	Revision number	Index
	Profile version	

Table 24 Diagnostics, profile version

4.6.12 Software version

Octets 26 and 27 of the DDLM_Slave_Diag function provide the software version of the device.
The octet's revision number and index are combined.

Example:

Software version:	1.40	
Octet no.:	26	27
Binary code:	00000001	01000000
Hex:	1	40

DDLM_Slave_Diag

Octet	**26**	**27**
Bits	15 – 8	7 – 0
Data	$2^7 – 2^0$	$2^7 – 2^0$
	Revision number	Index
	Software version	

Table 25 Diagnostics, software version

4.6.13 Operating time

The operating time monitor stores the operating time for the device in operating hours. The operating time is saved every six minutes in the non-volatile memory in the device. This happens as long as the device is under power. The operating time is displayed as a 32-bit value without sign in 0.1 h by the DDLM_Slave_Diag function.

If the operating time function is not supported by the device, it is set to the maximum value (FFFF FFFF hex).

DDLM_Slave_Diag

Octet	**28**	**29**	**30**	**31**
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^8$	$2^7 – 2^0$
	Operating time			

Table 26 Diagnostics, operating time

4.6.14 Offset value

The offset value is calculated by the preset function and shifts the position value by the calculated value. The offset value is stored in the device and can be provided by the diagnostic octets 32 to 35. The data type for the offset value is a 32-bit binary value with sign, whereby the offset value range is equal to the measuring range of the device.

The preset function is used after the scaling function. This means that the offset value is indicated according to the scaled resolution of the device.

DDLM_Slave_Diag

Octet	32	33	34	35
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$
	Offset value			

Table 27 Diagnostics, offset value

4.6.15 Offset value of the encoder manufacturer

The manufacturer offset value indicates the encoder offset set by the manufacturer. This value gives information on the shift of the position zero point in number of positions from the physical zero point of the encoder. The data type for the offset value is a 32-bit binary value with sign. The value range corresponds to the measuring range of the encoder. The offset value of the manufacturer of the encoder is indicated in the number of units according to the basic resolution of the encoder. The value is stored in write-protected memory, which can be changed only by the encoder manufacturer. This value has practically no importance for the user.

DDLM_Slave_Diag

Octet	36	37	38	39
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$
	Offset value of the encoder manufacturer			

Table 28 Diagnostics, offset value of the encoder manufacturer

4.6.16 Scaling parameters settings

The scaling parameters are set in the DDLM_Set_Prm function. The parameters are stored in the octets 40 to 47 of the diagnostic data. The “Measuring units per revolution” and “Total measuring range in measuring units” parameters define the selected resolution of the encoders. The status bit of the scaling function in the operating status (octet 9 of the diagnostic data) indicates whether the scaling function is enabled.

Values preset by the manufacturer of the encoder:
Measuring units per revolution = singleturn resolution.
Total measuring range in measuring units = singleturn resolution x number of distinguishable revolutions.

The data type for both values is unsigned 32 bits.

DDLM_Slave_Diag

Octet	40	41	42	43
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$
	Measuring units per revolution			

DDLM_Slave_Diag

Octet	44	45	46	47
Bits	31 – 24	23 – 16	15 – 8	7 – 0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$
	Total measuring range in measuring units			

Table 29 Diagnostics, scaling parameters setting

4.6.17 Encoder serial number

Octets 48 to 57 of the diagnostic function provide the serial number of the encoder as a 10-character ASCII string.

DDLM_Slave_Diag

Octet	48 – 57
Bits	79 – 0
Data	ASCII
	Serial number

Example of a serial number

Octet	48	49	50	51	52	53	54	55	56	57
ASCII string	30	30	30	35	39	46	38	44	45	35
Serial (hex.)	0	0	0	5	9	F	8	D	E	5
Serial (dec.)	9434 2629									

Table 30 Diagnostics, encoder serial number

5 Configuration example

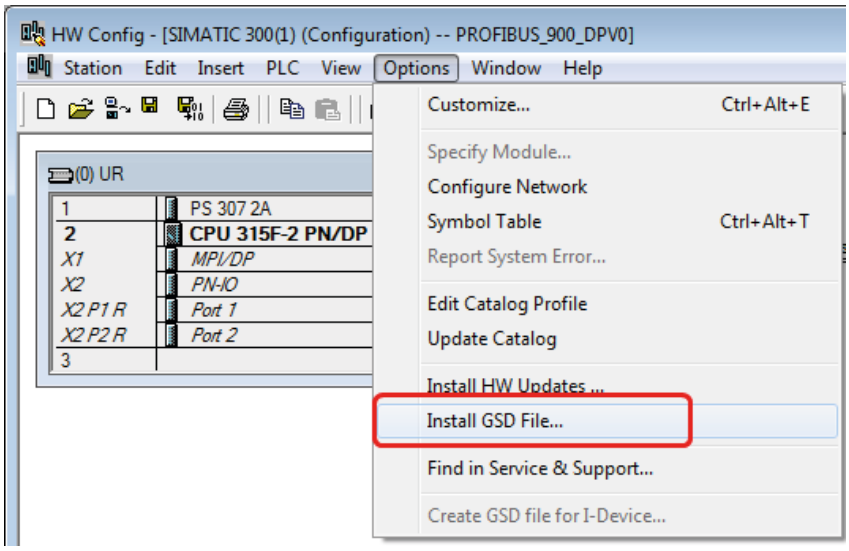
This chapter will illustrate how to set up and configure a 900 series encoder with DPV0 Class 2 functionality. In the example below, a Siemens Step 7 PLC and SIMATIC MANAGER were used.

5.1 Device description file installation (GSD file)

In order to start using an encoder gateway with PROFIBUS interface, a device description file needs to be downloaded and imported to the configuration software. The device description file is called a “Generic Station Description” file and contains the necessary implementation parameters needed for a PROFIBUS device.

The latest available GSD file can be downloaded from www.leinelinde.com.

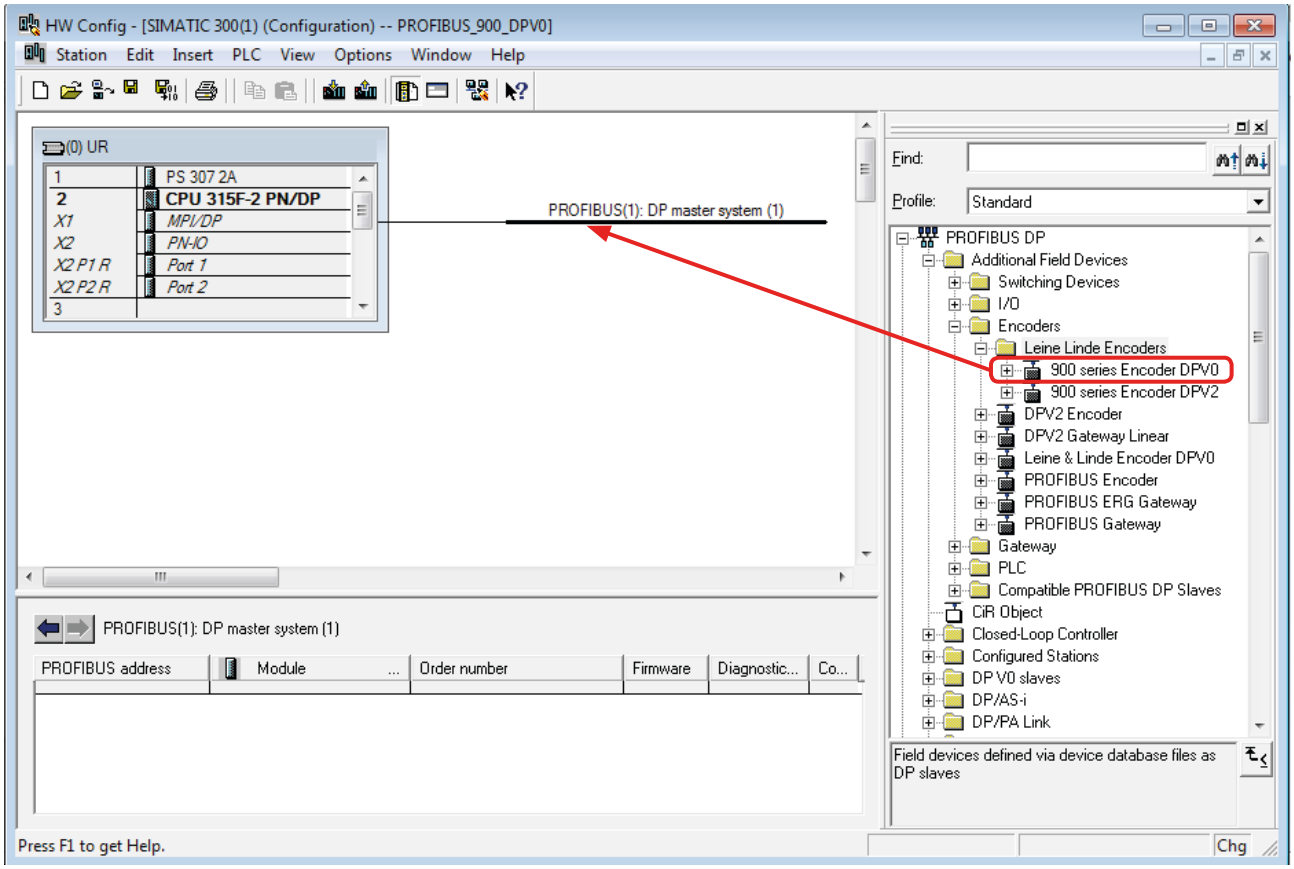
Installation of GSD-files in SIMATIC MANAGER:



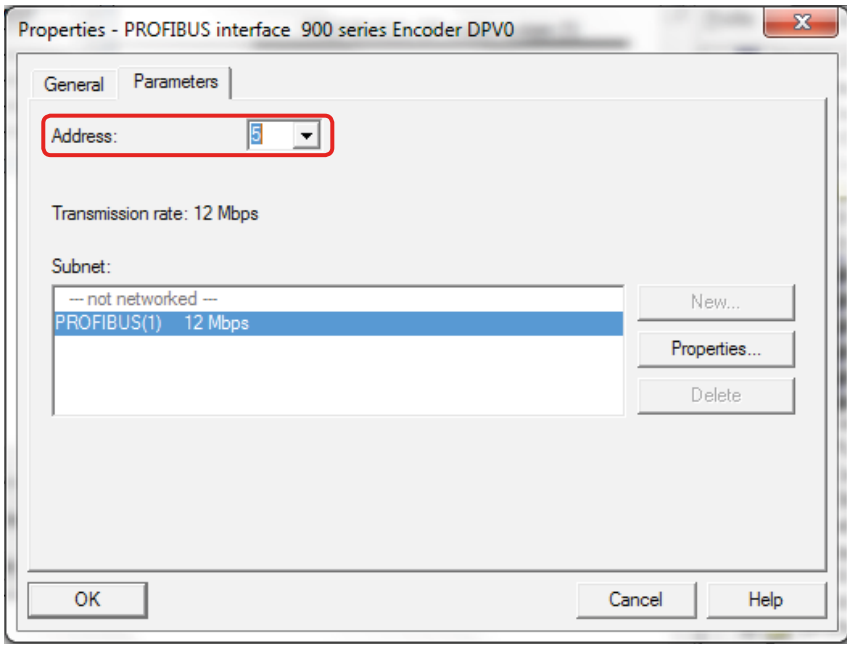
1) Select Options -> Install GSD File and click the “Browse” button to navigate to the location of the GSD file. If a bitmap picture representing the encoder is requested, make sure that the bitmap file is located in the same folder as the GSD file. A bitmap file is included in the zip-file downloadable from www.leinelinde.com.
2) Select the GSD file and click the “Install” button to start installing the selected GSD file.

5.2 Setting the encoder configuration

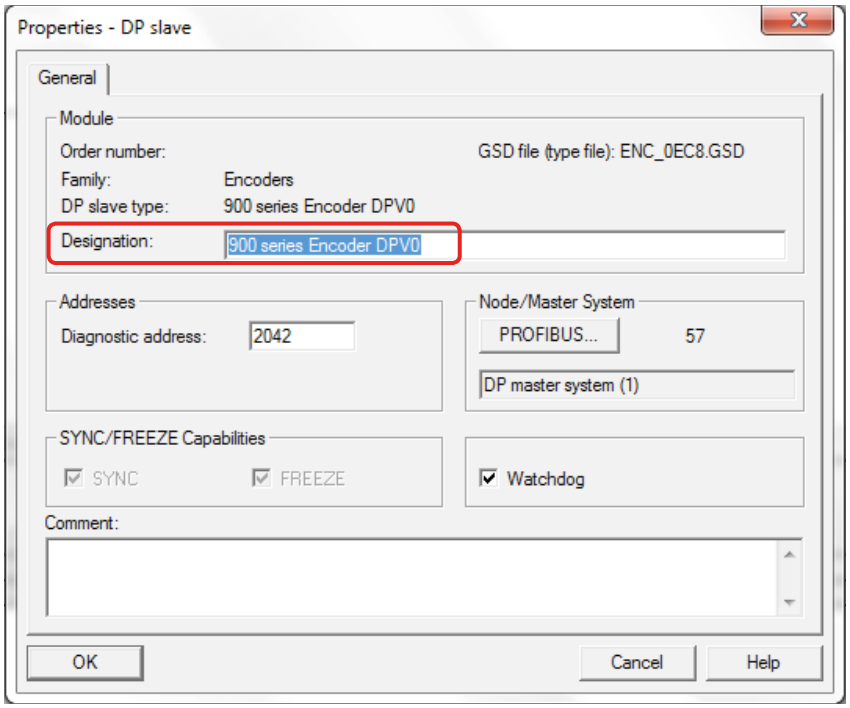
Once the GSD file has been installed the PROFIBUS encoder can be found in the SIMATIC MANAGER -> HWConfig under PROFIBUS DP -> Additional Field Devices -> Encoders -> Leine & Linde Encoders. Select the appropriate encoder to be configured and drag and drop the device onto the PROFIBUS DP system as shown in the picture below. In the example below, the Leine & Linde 900 series DPV0 was chosen. If more than one device is to be configured then the following steps need to be performed once again for each connected device.



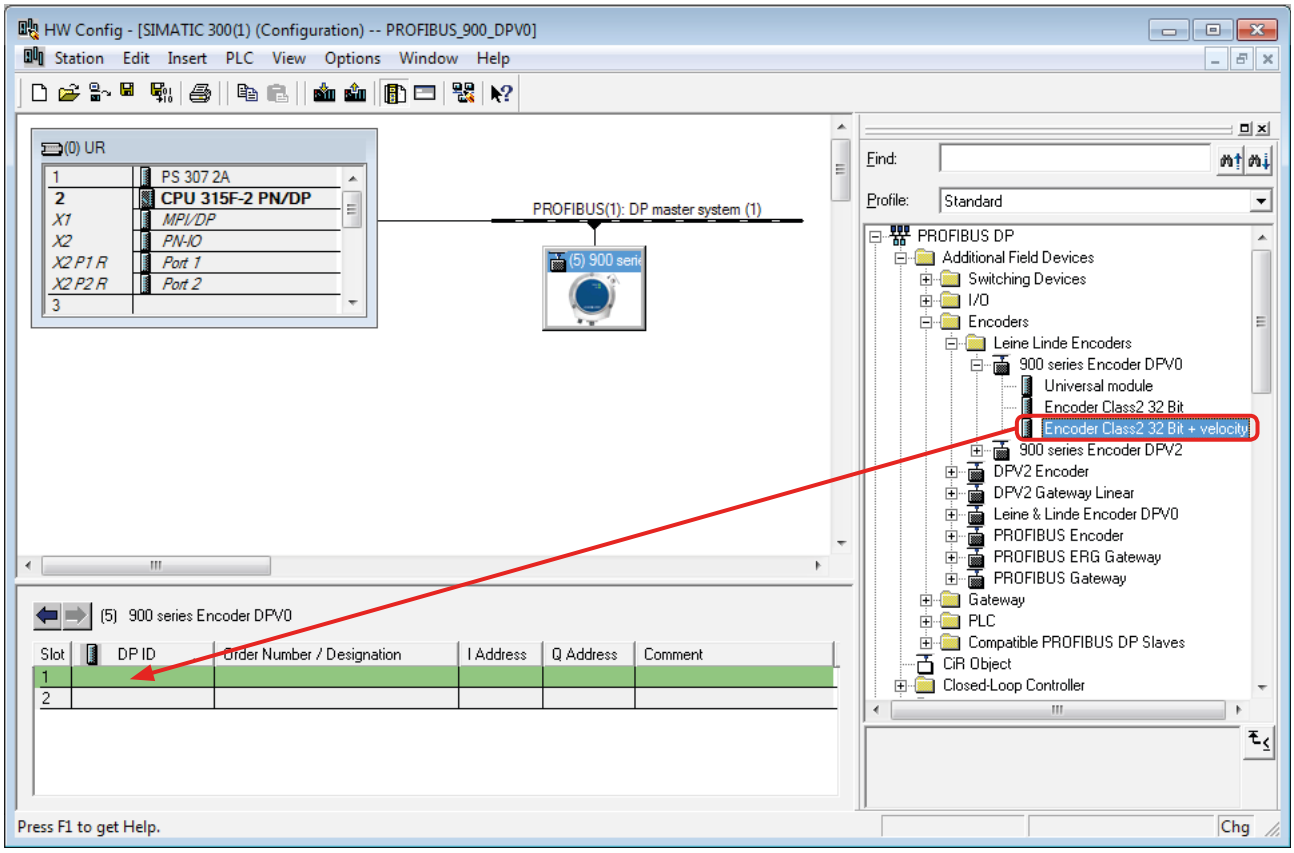
When dropping the encoder on the bus a PROFIBUS node address must be assigned. This address must be the same as assigned on the hardware address switches on the back of the encoder.



Open the properties window for the encoder by double clicking on the encoder icon on the bus.
If appropriate, enter a name for the device.



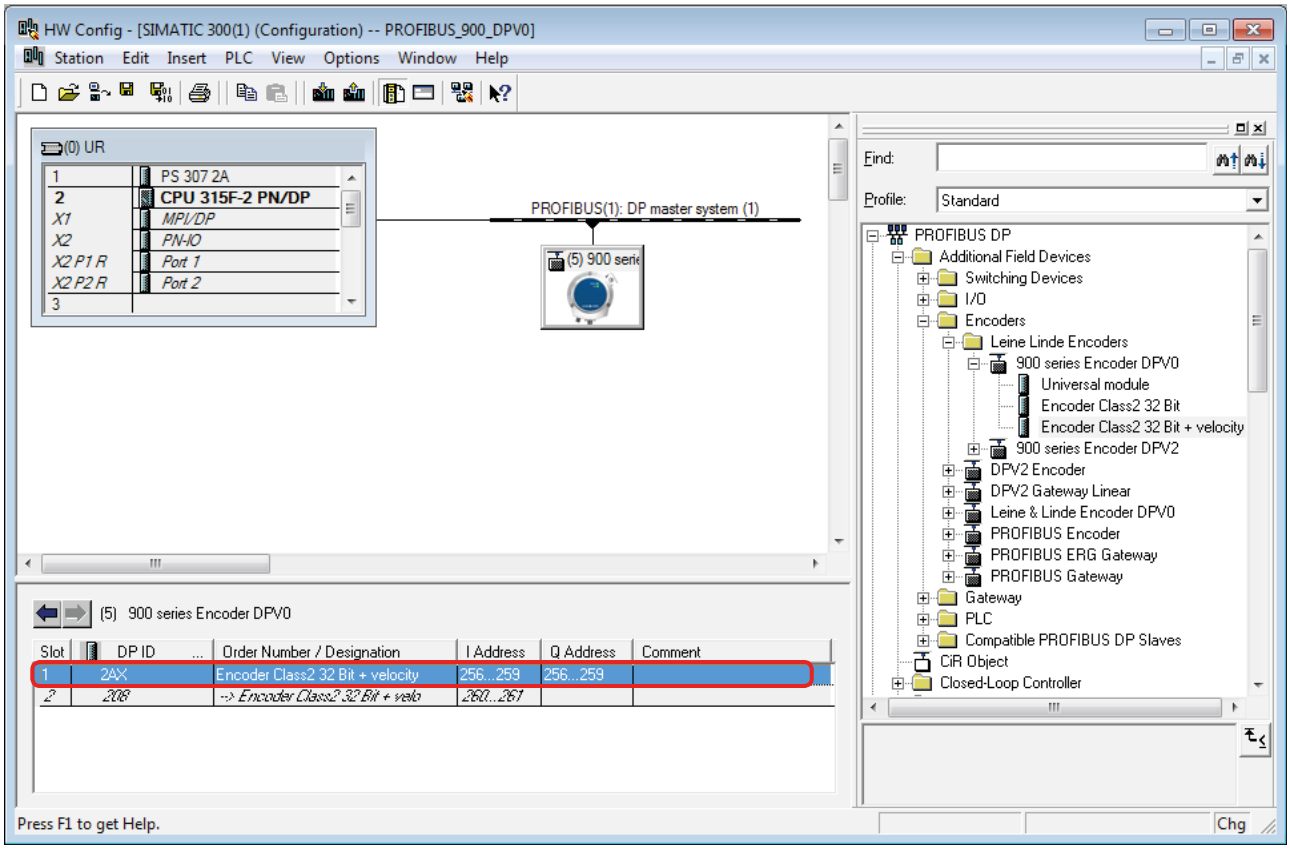
The next step is to choose the data length and the type of data that is to be sent to and from the controller. This is done by choosing configuration. Leine & Linde 900 series supports Class 2, 32 bits position value or 32 bits position value +16 bits velocity information.



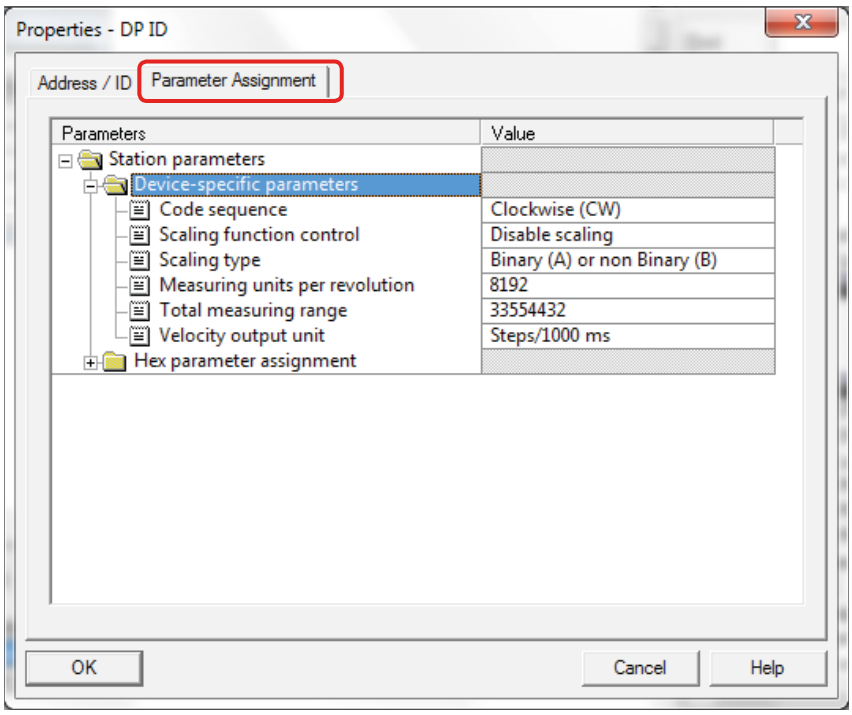
Please note that the steps described above need to be performed for each connected device.

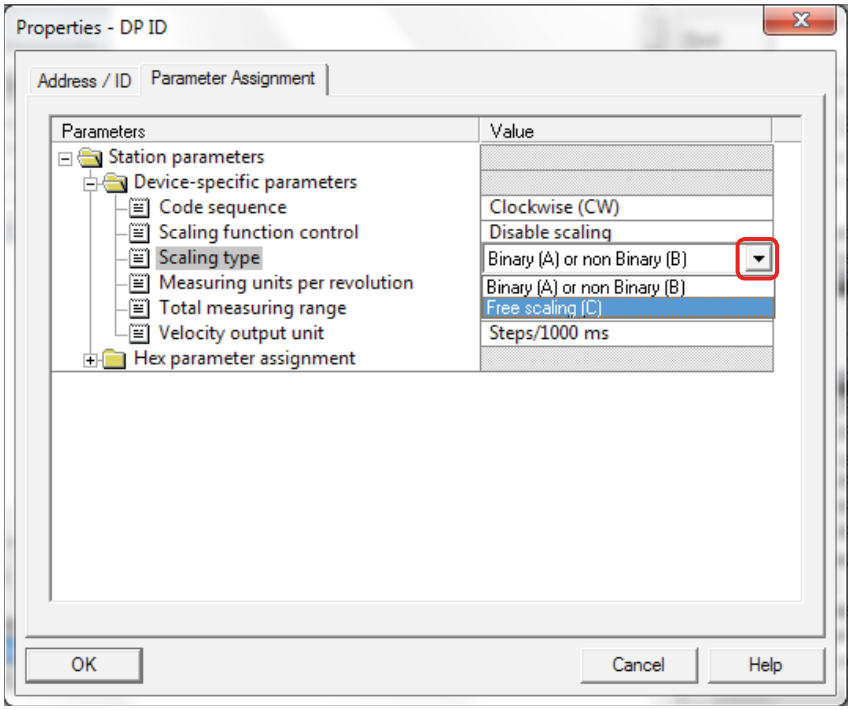
5.3 Setting the encoder parameters

To set the parameter data, choose the device and then double click on the line according to below.

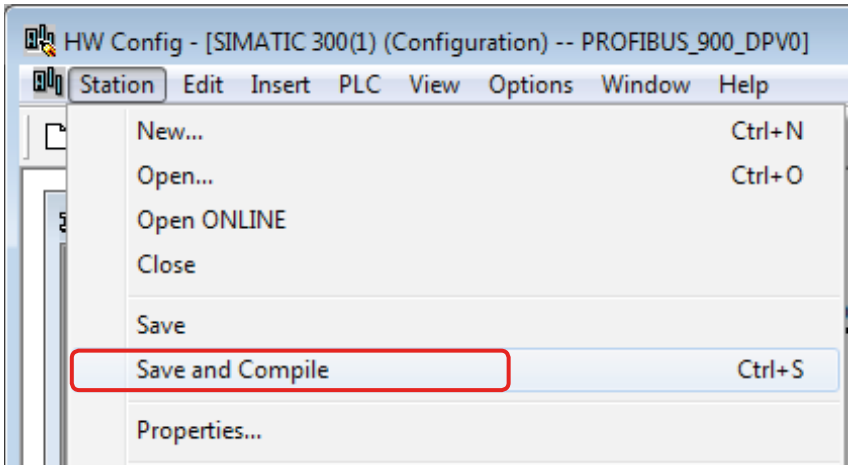


In the Properties windows that opens, open the Parameter Assignment tab. To set the parameter data, change the value of the different parameters by clicking on the “Value” field for the respective parameter.

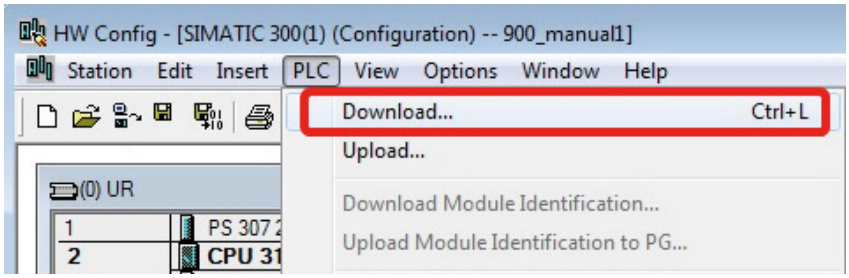




Once the configuration and parameterization of the device has been completed, the settings need to be saved and compiled. This is done by clicking on the “Save and Compile” option under the “Station” tab.



The settings then need to be downloaded to the controller.
This is done by clicking on the “Download” option under the “PLC” tab.



If all settings and configuration have been done correctly the encoder shall be ready for use and the Bus and Module LEDs on the encoder shall be green.

Note: Please refer to the respective manufacturer for information on the configuration of other PROFIBUS-DP master interface modules.

6 Revision history

Revision	Date	Changes
Rev. 0	2015-02-26	First release
Rev. 1	2016-02-17	Correction supported encoder classes

Table 31 Revision history



The best encoders are those you never have to think about. Those that simply do their job – year after year. Leine & Linde develops and manufactures customised encoder solutions for demanding environments, advanced measuring systems for accurate feedback of speed and position.

LEINE LINDE

+46-(0)152-26500 www.leinelinde.com

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AMI
Automation and Metrology International, LLC
1-888-354-2525
auto-met.com