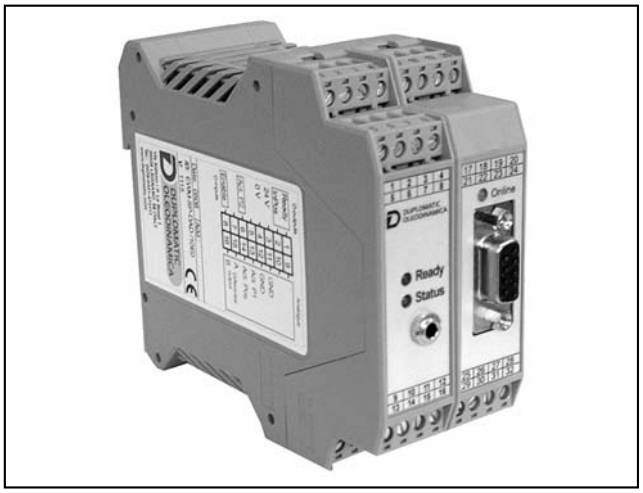


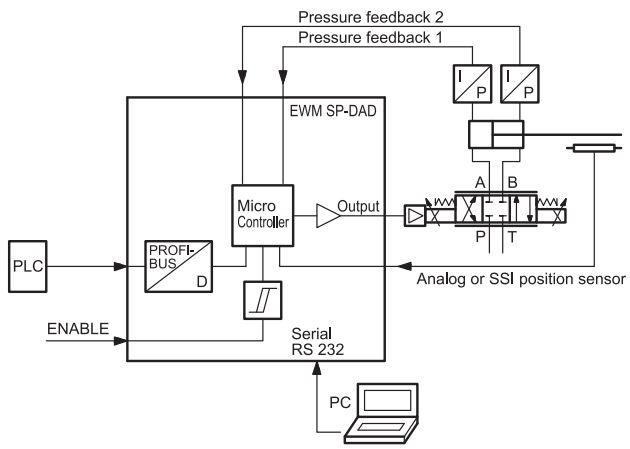
EWM-SP-DAD

CARD FOR AXIS CONTROL (STROKE AND PRESSURE) WITH PROFIBUS COMMUNICATION INTERFACE

SERIES 10

RAIL MOUNTING TYPE: DIN EN 50022

OPERATING PRINCIPLE



— This card has been developed to drive the positioning of the hydraulics actuators where an high accuracy is needed, using a digital sensor with SSI interface to measure the positions, or an analog sensor with an accuracy of up to 0,01%

— Additionally an integrated control for pressure limitation, for one or two sensors (differential pressure), is implemented.

— The card works as an axis controller and communicates with the PLC via the integrated Profibus interface and vice versa.

— The card works in three ways: stroke depending deceleration, NC mode and force control mode.

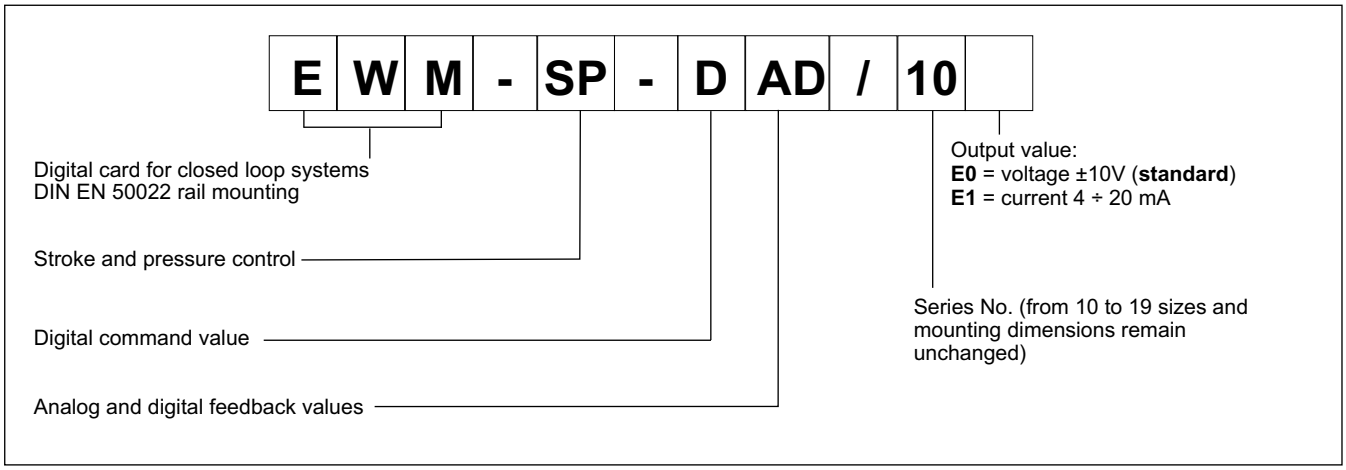
— Tipically used for general positioning control with integrated closed loop pressure control.

— The card use the RS232C interface, and is settable via PC, using the software kit (EWMPC).

TECHNICAL CHARACTERISTICS

Power supply	V DC	12 ÷ 30 ripple included - external fuse 1,0 A
Current consumption	mA	400 + sensor power consumption
Command value		via Profibus DP - ID number 1810h
Position feedback value	SSI V mA	digital sensor with any interface SSI 0 ÷ 10 (R_I = 33 kΩ) 4 ÷ 20 (R_I = 250 Ω)
Pressure feedback value	V mA	0 ÷ 10 (R_I = 33 kΩ) 4 ÷ 20 (R_I = 250 Ω)
Output value: - E0 version - E1 version	V mA	±10 (max load 5 mA) 4 ÷ 20 (max load 390 Ω)
Position accuracy	%	± 2 bits of sensor resolution
Interface		RS 232 C
Electromagnetic compatibility (EMC): according to 2004/108/CE standards		Emissions EN 61000-6-3 Immunity EN 61000-6-2
Housing material		thermoplastic polyammide PA6.6 combustibility class V0 (UL94)
Housing dimensions	mm	120 (d) x 99(h) x 46(w)
Connector		4x4 poles screw terminals - PE direct via DIN rail
Operating temperature range	°C	-20 / +60
Protection degree		IP 20

1 - IDENTIFICATION CODE



The EWM-SP-DAD is card for positioning and force control loop, which can be combined or single position or force.

The card is designed both for digital or analogue position feedback; the communication with the PLC is via Profibus DP.

the card can be used as point to point controller (stroke depended deceleration) as well as in NC mode.

With only few parameters the controller can be optimized and the movement profile is preset via Profibus (position and velocity).

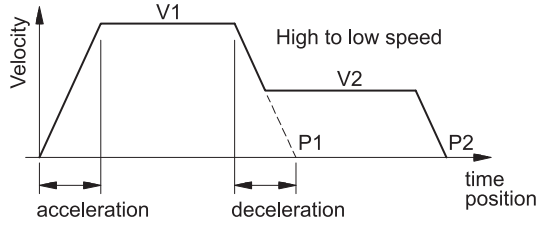
Here below an example of profile with a switch speed:

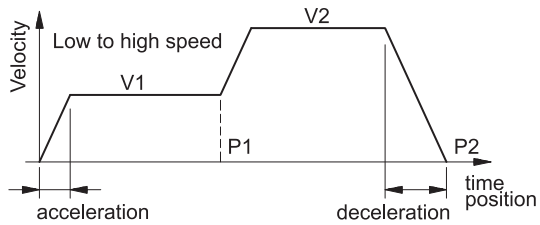
- the target position is command value 2 (P2) combined with velocity 2 (V2).
- the switch over position is command value 1 (P1), combined with velocity 1 (V1).

The switchpoint from high to low velocity is calculated depending on the speed V2 and the braking.

The switchpoint from low to high speed is made in the P1 position with the ramp acceleration, as shown below.

If the command position P2 is between the current position and the position value of P1, the positioning in P2 can only be driven with V1 velocity.





Pressure limitation control function:
For p/Q control a dynamic zero-overlapped control valve is necessary.

The pressure loop is managed according to the value of pressure measured in both chambers of the cylinder. The control value for the force loop is maintained via profibus (see par. 9.1.2). If the pressure (or force) exceeds the controller reduces the output signal to the valve (only in a negative scale) until it reaches the preset pressure value.

The switch from 'positioning mode' to 'pressure limitation' is handled automatically.

The sampe time of the card is 1 millisecond.

2 - FUNCTIONAL SPECIFICATIONS

2.1 - Power supply

This card is designed for 12 to 30 VDC (typical 24 V) of a power supply. This power supply must correspond to the actual EMC standards.

All inductivities at the same power supply (relays, valves) must be provided with an over voltage protection (varistors, free-wheel diodes).

It is recommended to use a regulated power supply (linear or switching mode) for the card supply and for the sensors.

2.2 - Electrical protections

All inputs and outputs are protected with suppressor diodes and RC-filters against transient overshoots.

2.3 - Digital Input (ENABLE)

The digital input must have a voltage from 12 to 24 V; Low level: <4V, high level >12V with current <0,1A. See the block diagram at paragraph 8 for the electric connections.

2.4 - Reference signal

The reference signal is run through the card-bus and addressed to the individual modules via Profibus, ID number 1810h (see par. 10).

2.5 - Position feedback values

The card works both with digital (SSI) or analog sensors.

SSI: parameters are settable via software (see SSI parameters in the table on next page).

ANA: The analogue signal must be voltage 0 ÷ 10V with RI = 33 kΩ or current 4 ÷ 20 mA (250Ω), with RI = 250 kΩ
The analogue resolution is of 0,01% of the sensor stroke.

⚠ Using analog sensors, the SSI parameters in the software assume default preset values that the user must not change.

2.6 - Pressure feedback values

The analogue signal must be voltage 0 ÷ 10V with RI = 33 kΩ or current 4 ÷ 20 mA (250Ω), with RI = 250 kΩ.

When a sensor failure occurs, (READY signal) the hardware-enable-signal has to be deactivated.

2.7 - Output values

E0 version: output voltage 0 ±10 V (standard).
E1 version: output current 4 ÷ 20 mA. (max load 390 Ω)

2.8 - Digital Output

Two digital output are available, INPOS and READY, that are displayed via LEDs on the front panel.

Low level <4V; High level >10V (I_{max} 50 mA with load of 200Ω)

3 - LED FUNCTIONS

There are three leds on the card: one on the profibus interface, that indicates the online status of Profibus connection, and two on the other module:

GREEN: Shows if the card is ready.

ON - The card is supplied
OFF - No power supply or ENABLE is inactive.
FLASHING - Failure detected (internal or 4 ÷ 20 mA) only if SENS = ON

YELLOW: Is the signal of the control error monitoring.

ON - No control error
OFF - Error detected, depending of a parameter error.

4 - ADJUSTMENTS

On the EWM cards the adjustment setting is possible only via software. Connecting the card to the PC, the software automatically recognises the card model and shows a table with all the available commands, with their parameters, the default setting, the measuring unit and an explanation of the commands and its uses.

The parameters changes depending on the card mode.

5 - SOFTWARE KIT EWMPC/10 (code 3898401001)

The software kit comprising a USB cable (2 mt lenght) to connect the card to a PC or notebook and the software.

During the identification all information are read out of the module and the table input will be automatically generated.

Some functions like baud rate setting, remote control mode, saving of process data for later evaluation are used to speed up the installation procedure.

The software is compliant with Microsoft XP® operating systems.

EXAMPLE OF PARAMETERS TABLE

Commands	Parameter	Defaults	Units	Description
inpx	X= SSI|ANA	SSI	-	Selection of the sensor input channel. The standard is a digital sensor with SSI specification at the corresponding connections (clamps 25 to 28 and 31, 32). Alternatively an analogue input which is indicated in the command as parameters “ANA” can be used. The command AIN is used for input scaling of the analogue input.
vmode x	x= on|off	off	-	Activation of the NC-generator. In **OFF** state the stroke depended deceleration is active; the velocity preset limits the output signal. In **ON** state a profile generator generates the positioning demand value and the axis drives to the target position with the defined velocity. The stroke time is defined by the parameter **VMAX**.
pdpadr x	X= 1… 126	5		Profibus address
sens x	x= on|off	on	-	Activation of the sensor and internal failure monitoring.
stroke x	X= 2… 3000	500	mm	Length of the sensor. The length of the stroke sensor is needed for the scaling of the analogue input and for the calculation of the braking stroke.
ssioffset x	X= -30000… 30000	0	0,01 mm	Zero point adjustment of the sensor.
ssires x	X= 10… 1000	1000	inkr/mm	Resolution of the digital sensor. This sensor resolution is always used for the input data via Profibus and is needed for the internal calculations. (see **NOTE**)
ssibits x	X= 8… 31	24	-	Data protocol length in bits
ssicode x	X= GRAY|BIN	GRAY	-	Transmitting code of the sensor.
ssipol x	X= +|-	+	-	Sensor polarity. In order to reverse the working direction of the sensor, the polarity can be changed via this command. In any case also the SSIOFFSET has to be adjusted. Ex: Sensor length = 200 mm opposite working direction. SSIPOL is set on “-“ and SSIOFFSET on 20000.
ain:i a b c x	i= XL|XP1|XP2 a= -10000… 10000 b= -10000… 10000 c= -10000… 10000 x= V|C	 : 10000 : 10000 : 0 : V	 - - 0,01% -	Analogue input scaling. **XL** for position, **XP1** or **XP2** for pressure. (**NOTE**) Input signal: **V** = voltage and **C** = current. With the parameters **a**, **b** and **c** the input can be scaled (output = a / b * (input - c)). Because of the programming of the **x**-value (x = **C**) the corresponding input will be switched over to current automatically.

vramp x	x= 1… 2000	200	ms	Ramp time for the external velocity. Operating shocks can be reduced when changing the external velocity.
vmax x	X= 1… 20000	50	mm/s	Parameter is active in vmode = ON only. **vmax** defines the maximum speed. Via the external command speed an actual speed between 0,5… 100 % can be selected.
a:i x	i= A|B x= 1… 2000	:A 200 :B 200	ms ms	Acceleration time depending on direction. **A** indicates analogue output 15 and **B** indicates analogue output 16. Normally **A** = flow P-A, B-T and **B** = flow P-B, A-T.
d:i x	i= A|B|S X= 50… 10000	:A 2500 :B 2500 :S 1000	0,01% 0,01%	Deceleration stroke depending on direction. This parameter is set in 0,01% units of the maximum length of the sensor. The braking distance is set dependent from the direction. The controller gain will be calculated by means of the braking distance. The shorter the braking distance the higher the gain (see command CTRL). In case of instabilities a longer braking distance should be set. The parameter **D** indicates the ratio between the maximum sensor length and and a indicated stopping point;will become active after the removal of the 'START' signal only .
ctrl x	x= lin|sqrt1|sqrt2	sqrt1	-	Selection of the control function: (see **NOTE**) **lin** = standard linear P-control, **sqrt1** = progressive time optimized deceleration curve, **sqrt2** = sqrt1 with a higher gain in position
inpos x	i= S|D X= 0… 5000	32	0,01%	Range for the InPos signal (status output) **S** is used for the static INPOS window. **D** is used for the dynamic (following error) monitoring in NC mode.
hand:i x	i= A|B x= -10000… 10000	:A 3300 :B -3300	0,01% 0,01%	Velocity command in manual mode, in both A and B directions
ap:i x	i= UP|DOWN x= 0… 60000	:A 100 :B 100	ms ms	Ramp time for pressure UP and DOWN.
poffset x	x= -2000… 2000	0	0,01%	Pressure offset.
c:i x	i= P|I|D|T1|IC :P x= 0… 10000 :I x= 0… 2050 :D x= 0… 120 :T1 x= 0… 100 :IC x= 0… 10000	 :P 50 :I 400 :D 0 :T1 1 :IC 5000	 0,01 ms ms ms 0,01%	PID-compensator used for pressure control. P-Gain, 50 = nominal gain of 0,5. I-Gain, in ms, can be deactivated by values > 2010. D-Gain, in ms. T1 in ms; damping of the D-Gain. IC-Factor; activation point of the integrator.
perror x	x= 0..2000	100	0,01%	The command 'ERROR' defines the window within which the error message is displayed on the led. But the controller is always active.
pol x	x= +|-	+	-	Output polarity. All **A** and **B** adjustments depend on the output polarity. The right polarity should be defined first. Output polarity. All **A** and **B** adjustments depend on the output polarity. The right polarity should be defined first.
save	-	-	-	Storing the programmed parameter in E²PROM.
loadback	-	-	-	Reloading the parameter from E²PROM in working RAM
default	-	-	-	Preset values will be set.

wl **xl** **v** **xw** **wp** **xp** **xp1** **xp2,** **xwp** **up** **u**	Command signal Actual signal Speed limitation Position error (wl-xl) Pressure command XP1-XP2 (differential) Sensor pressure 1 Sensor pressure 2 Pressure error Output of the pressure control function Controller output	-	-	Data monitoring process. The data can be read and show the real-time command and actual values
st	-	-	-	Monitoring the status words. You can use this command from the tool 'terminal' of the software to read the values of the status word in binary format.

NOTE about the SSIRES command: the standard of measurement for this parameter is defined as increment/mm (inkr/mm). The maximum settable value is 1000 and corresponds to 1 µm (0,001 mm), that is the highest resolution available.

Example: A sensor with resolution 5 µm (0.005 mm) has a resolution 5 times lower than the maximum set.
The SSIRES value is calculated as follows: *1000* (full scale ink) */ n* (sensor resolution in µm) = *1000 / 5 = 200*

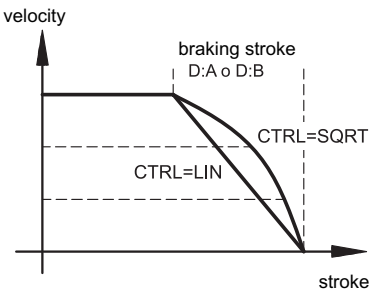
NOTE about the AIN command: This command is for analogue sensor only. With this command each input can be scaled individually. For the scaling function the following linear equation is taken: output signal = *a / b * (input signal - c)*.

At first the offset (c) will be subtracted (in 0,01% units) from the input signal, then the signal will be multiplied with factor **a** / **b**. **a** and **b** should always be positive. With these both factors every floating-point value can be simulated (for example: 1.345 = 1345 / 1000).

With the x parameter value the internal measuring resistance for the current measuring (4… 20 mA) will be activated (V for voltages input and C for current input). ATTENTION: This resistor is never activated at the k input.

	AIN:X	**a**	**b**	**c**	**x**
i with voltage:	AIN:i	1000	1000	0	V
i with current:	AIN:i	1250	1000	2000	C

NOTE about the CTRL command:: This command controls the braking characteristic of the hydraulic axis. With positive overlapped proportional valves one of both SQRT braking characteristics should be used because of the linearization of the non-linear flow curve typical of these valves If zero overlapped proportional valves (control valves) are used, you can choose between LIN and SQRT1 according to the application. The progressive gain characteristic of SQRT1 has the better positioning accuracy.



According to the application there is maybe a longer braking distance, so that the total stroke time will be longer.

LIN: Linear braking characteristics (control gain corresponds to: 10000 / d:i).

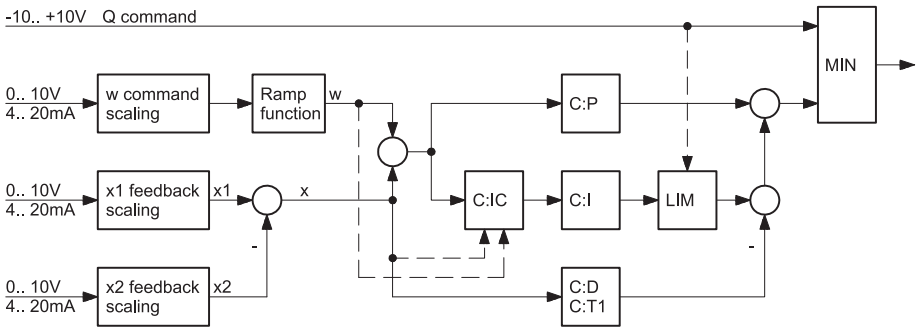
SQRT*: Root function for the calculation for the braking curve.
SQRT1: with small control error. control gain corresponds to 30000 / d:i ;
SQRT2: control gain corresponds to 50000 / d:i

NOTE about the C command (pressure limitation function): The control function will be parameterized via this command. The P, I and D gain are similar to a standard PID controller. The T1 factor is a filter for the D-gain in order to suppress high-frequency noise.

To reduce pressure overshoots, an activation point for the integrator can be programmed via the IC-value. The integrator is activated if the actual pressure is higher than the programmed threshold:

$$I\,on = x > \frac{w \cdot c : ic}{100\%}$$

At *c:ic = 0* the integrator is always active. By high IC-values and a small P-gain the velocity of the drive is limited. The IC-value activates the integrator in % of the current command value.



Pressure limitation function

C:P	P-gain
C:I	I-gain
C:D	D-gain
C:T1	filter for D-gain
C:IC	integrator activation

6 - INSTALLATION

The card is designed for rail mounting type DIN EN 50022.

The wiring connections are on the terminal strip located on the bottom of the electronic control unit. It is recommended to use cable sections of 0.75 mm^2, up to 20 m length and of 1.00 mm^2 up to 40m length, for power supply and solenoid connections. For other connections it is recommended to use cables with a screened sheath connected to earth only on the card side.

NOTE 1

To observe EMC requirements it is important that the control unit electrical connection is in strict compliance with the wiring diagram.

As a general rule, the valve and the electronic unit connection wires must be kept as far as possible from interference sources (e.g. power wires, electric motors, inverters and electrical switches).

In environments that are critical from the electromagnetic interference point of view, a complete protection of the connection wires can be requested.

6.1 - Profibus functions

The module supports all baud rates from 9,6 kbit/s up to 12000 kbit/s with auto detection of the baud rate. The functionality is defined in IEC 61158. The Profibus address can be programmed by a terminal program, EWMPC/10 or online via the Profibus. A diagnostic LED indicates the online status.

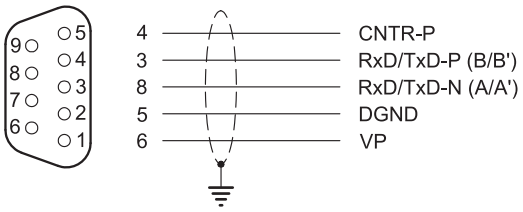
Upon request Duplomatic supplies the .GSD file for the configuration of the Profibus communication between PLC and EWM.

The communication parameter are 16 bytes (8 words) for IN and OUTPUT variables.

6.2 - Profibus port

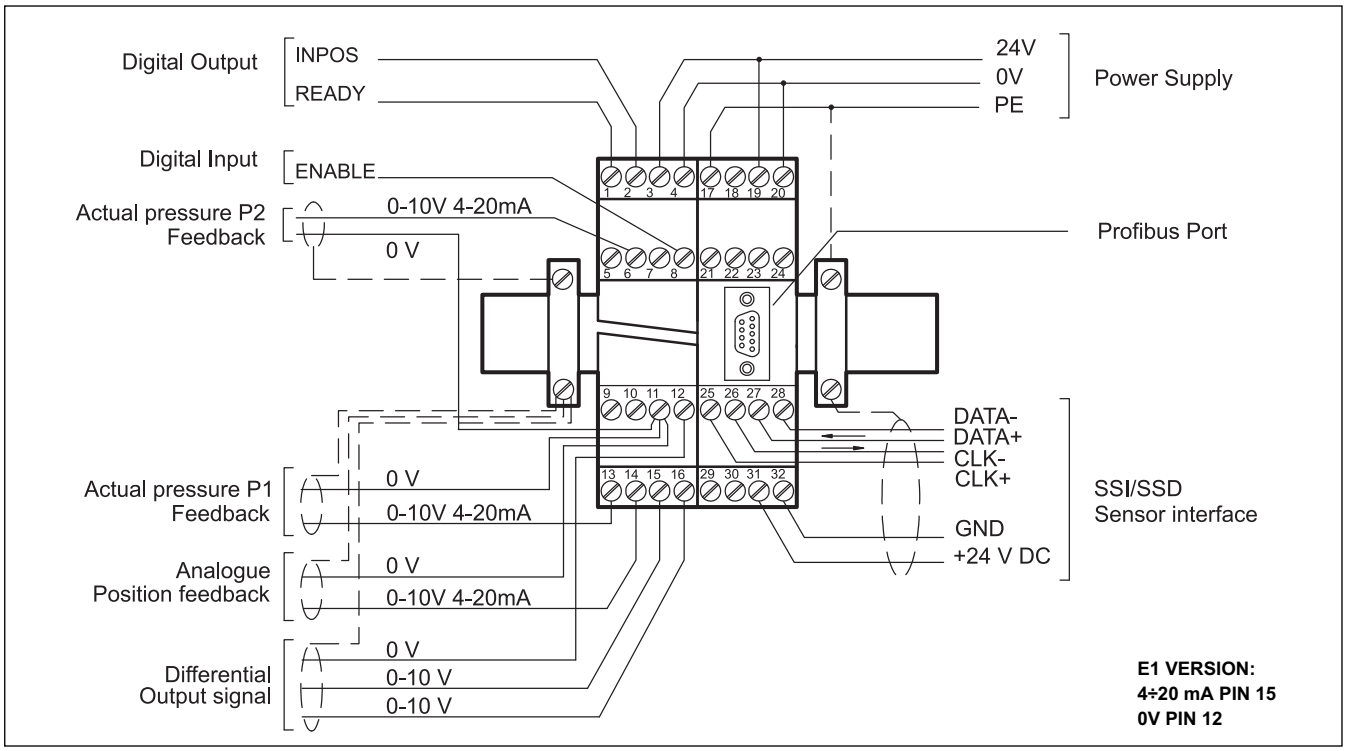
A typical screened Profibus plug (D-Sub 9pol with switchable termination) is mandatory. The address is preset and can be modified just via Profibus (default = 3). Wire not included.

PROFIBUS PORT WIRING AND LINKING CONFIGURATION



pin	Signal name	Function
1-2-7-9	not used	-
3	RxD/TxD-P (B-Line)	Receive/Send P data
4	CNTR-P/RTS	Request to Send
5	DGND	Data ground
6	VP	+5 V DC for external bus termination
8	RxD/TxD-N (A-Line)	Receive/Send N data

7 - WIRING DIAGRAM



ANALOGUE INPUT AND OUTPUT

PIN 6 — Analogue pressure feedback value (XP2), range 0 ÷ 100% corresponds to 0 ÷ 10V or 4 ÷ 20 mA

PIN 13 — Analogue pressure feedback value (XP1), range 0 ÷ 100% corresponds to 0 ÷ 10V or 4 ÷ 20 mA

PIN 14 — Analogue position feedback value (XL), range 0 ÷ 100% corresponds to 0 ÷ 10V or 4 ÷ 20 mA

PIN 15/16 — Differential output (U) ±100% corresponds to ± 10V differential voltage, optionally (E1 version) current output ±100% corresponds to 4 ÷ 20 mA (PIN 15 to PIN 12)

DIGITAL INPUT AND OUTPUT

PIN 8 — ENABLE input:
This digital input signal initializes the application. The analogue output is active and the READY signal indicates that all components are working correctly. Target position is set to actual position and the drive is closed loop controlled.

SSI SENSOR INTERFACE

PIN 25 — CLK+ output

PIN 26 — CLK- output

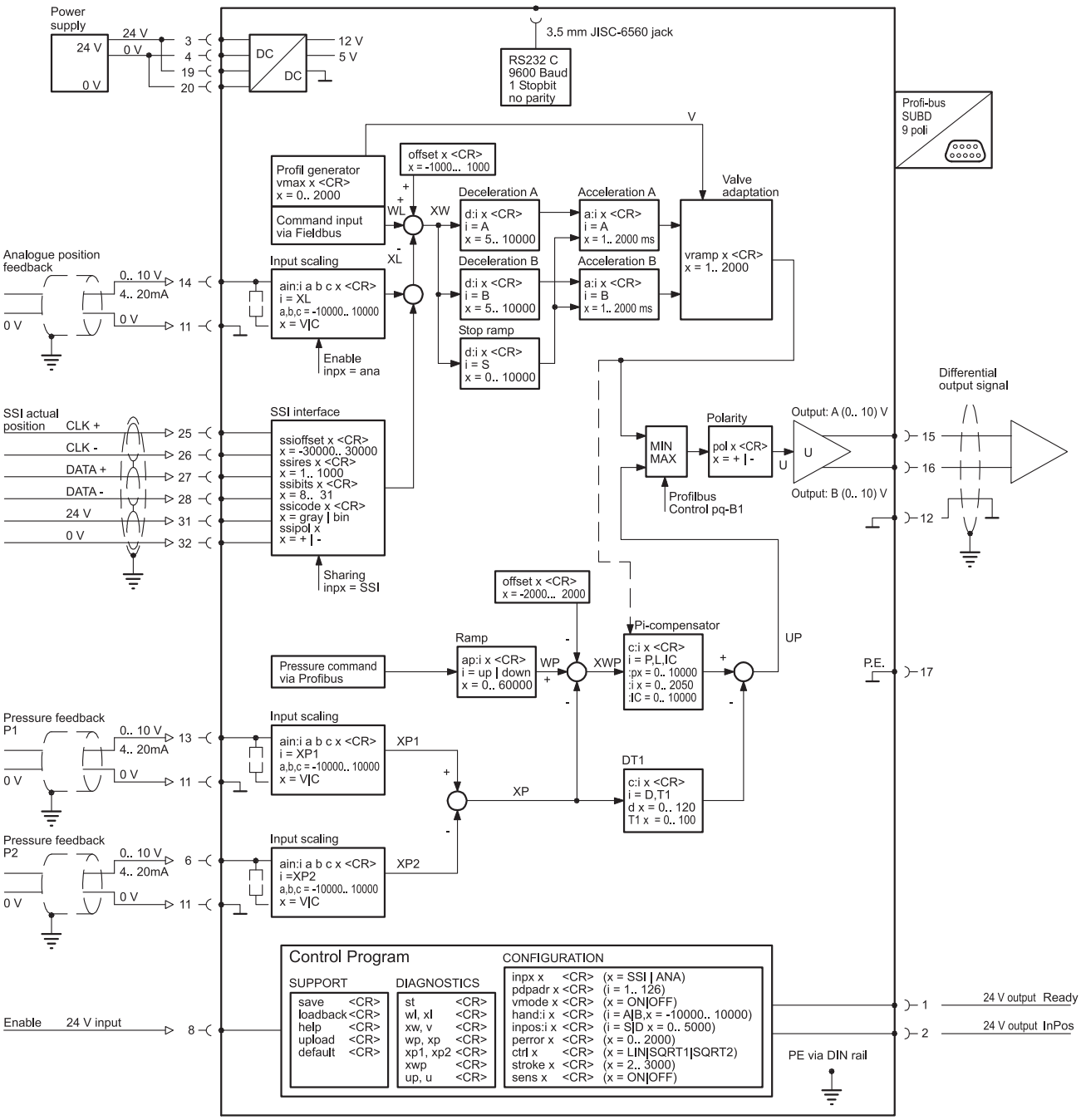
PIN 27 — DATA+ input

PIN 28 — DATA- input

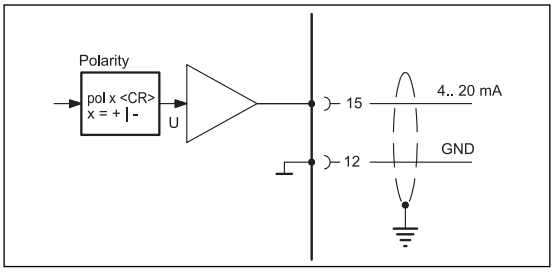
PIN 31 — 24V Power supply of the SSI sensor

PIN 32 — 0V Power supply of the SSI sensor

8 - CARD BLOCK DIAGRAM



OUTPUT SIGNAL - E1 VERSION



9 - PROFIBUS COMMUNICATION

The PROFIBUS interface always works at the highest resolution possible, which corresponds to the full resolution of the sensors used.

The module receives from the PLC via profibus 8 bytes of data, which contain information relating to the control words, the two command position, the two command velocity, and the pressure value.

The card send informations about the status word, the pressure and position values detected by the sensors, and the differential pressure, for a total of 16 bytes of data.

Using ST command in EWMPC, those data can be read out and they appearing in this way:

(high byte / low byte)
control word : 0000 0000 / 0000 0000

Enable: ENABLE (card enabled; Profibus & Hardware enabled)

9.1 - Data sent to the axes:

The Profibus interface is set as follows:
(Hi = High byte; Lo = low byte)

Byte	Function	Comment
0	control word Hi	
1	control word Lo	not used
2	command position 1 Hi	
3	command position 1	
4	command position 1	
5	command position 1 Lo	
6	velocity 1 Hi	
7	velocity 1 Lo	
8	command position 2 Hi	active, if a second velocity is programmed (Bytes 13 and 14)
9	command position 2	
10	command position 2	
11	command position 2 Lo	
12	velocity 2 Hi	set to zero for deactivate.
13	velocity 2 Lo	
14	demand pressure Hi	
15	demand pressure Lo	

9.1.1 - Control words

The control words contain the following informations:

ENABLE: Must be activated in addition to the hardware signal.

START: The new command position is taken over by a signal change from low to high (from 0 to 1). By deactivation of this bit, the system stops via a programmed deceleration ramp.

HAND+: HAND-: manual mode .

PQ: activation of the pressure limitation mode

PI changing of the direction of the pressure limitation.
0 = pressure limitation at extending
1= pressure limitation at retracting
In both directions positive pressure demand values are used. The polarity is changed by this BIT.

The definition of the control word are:

Byte 0 - control word Hi		
bit	**Function**	
0		
1		
2	PI inverse	1 = active
3	PQ active	1 = active
4	Hand+	1 = active
5	Hand-	1 = active
6	Start	1 = active
7	Enable (with hardware enable)	1 = ready

9.1.2 - Position setpoint description

Command position: according to the sensor resolution.

Byte 2, 3, 4 and 5 - command position 1		
bit	**Function** defined by the sensor resolution	
from 0 to 7	Command position Lo byte	Byte 5
from 8 to 15	Command position	Byte 4
from 16 to 23	Command position	Byte 3
from 24 to 31	Command position Hi byte	Byte 2

Byte 8 to 11 - command position 2		
bit	**Function** defined by the sensor resolution	
from 0 to 7	Command position Lo byte	Byte 11
from 8 to 15	Command position	Byte 10
from 16 to 23	Command position	Byte 9
from 24 to 31	Command position Hi byte	Byte 8

Example of calculation of position control for SSI sensor resolution = 5 µm and 100% stroke = 300 mm.

Position setpoint = 150 mm (= 50% stroke)

STROKE • SSIRES = 100% stroke (dec)

300 • 200 = 60.000 (dec) → EA60 (hex)
50% di 60.000 = 30.000 (dec) → 7530 (hex)

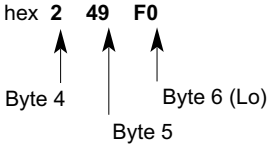
Example of calculation of position control for ANA sensor with 100% stroke = 300 mm. With analog sensors SSIRES value is preset and unchangeable.

Position setpoint = 150 mm (= 50% stroke)

STROKE • SSIRES = 100% stroke (dec)

300 • 1000 = 300.000 (dec) → 493E0 (hex)
50% di 300.000 = 150.000 (dec) → 249F0 (hex)

Example: command position to send, for decimal value 150000:



9.1.3 - Speed setpoint description

Command velocity: 0x3fff corresponds to 100 %.

Byte 6 and 7 - command velocity 1		
bit	**Function max value 0x3FFF**	
from 0 to 7	velocity Lo byte	Byte 7
from 8 to 15	velocity Hi byte	Byte 6

Byte 12 and 13 - command velocity 2		
bit	**Function**	
from 0 to 7	velocity Lo byte	Byte13
from 8 to 15	velocity Hi byte	Byte 12

9.1.4 - Demanded pressure description

0x3fff corresponds to 100 %.

Byte 14 and 15 - demanded pressure		
bit	**Funzion max value 0x3FFF**	
from 0 to 7	demanded pressure Lo	Byte 15
from 8 to 15	demanded pressure Hi	Byte 14

9.2 - Data sent to the profibus

Data sent to the profibus interface are: two status words, the commands sent (position, velocity and pressure) and the current actual values, totally of 16 bytes of data.

(Hi = High byte; Lo = low byte)

Byte	Function	Comment
0	status word Hi	
1	status word Lo	not used
2	actual position Hi	
3	actual position	
4	actual position	
5	actual position Lo	
6	internal command position Hi	
7	internal command position	
8	internal command position	
9	internal command position Hi	
10	Pressure difference *xp* Hi	
11	Pressure difference *xp* Lo	
12	Pressure feedback *xp1* Hi	
13	Pressure feedback *xp1* Lo	
14	Pressure feedback *xp2* Hi	
15	Pressure feedback *xp2* Lo	

9.2.1 - Status word descriptions

READY: System is ready for positioning.

INPOS: In position signal.

PERROR: Pressure failure is higher than the programmed PERORR value.

SENSOR ERROR: if the sensor control is activated and if there exists a sensor failure, the READY signal will be deactivated.

COMMAND POSITION: Can be interpreted variously according to the mode.
Normal = preset command position
NC-mode = calculated command position of the generator,

ACTUAL POSITION: corresponding to the sensor solution.

CONTROL DEVIATION (X-W): according to the sensor resolution.
In the NC-mode shows the profile error (difference in the value of the nominal value generator to the actual value).

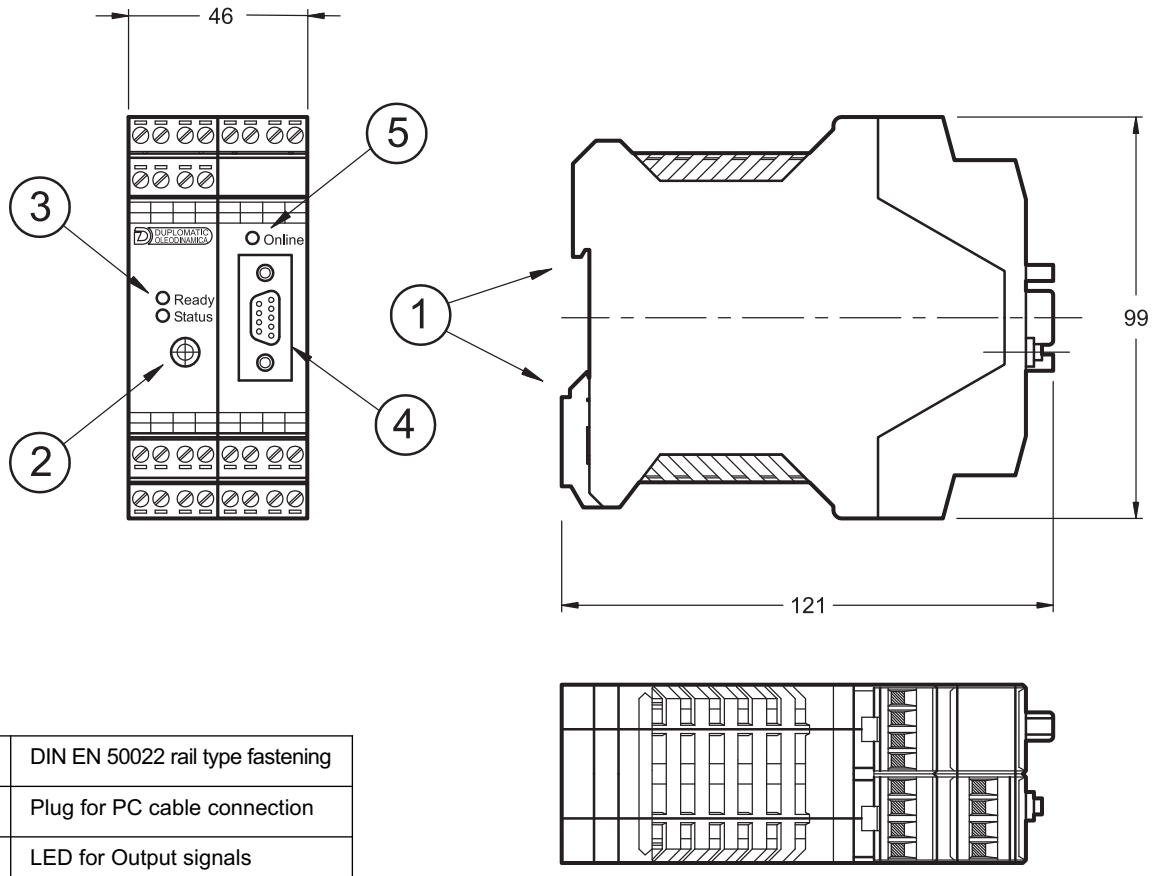
the status word is encoded as follow:

Byte 0 - status word Hi		
bit	**Function**	
0		
1		
2		
3	PERROR	1 = value in error window
4		
5		
6	INPOS	1 = value in pos-window
7	READY	1 = ready to operate

Byte 2, 3, 4 and 5 - Actual position		
byte	**Function** defined by the sensor resolution	
from 0 to 7	Actual positionn Lo-Byte	Byte 5
from 8 to 15	Actual position	Byte 4
from 16 to 23	Actual position	Byte 3
from 24 to 31	Actual position Hi-Byte	Byte 2

Byte 6 to 9 - internal command position		
byte	**Function** defined by the sensor resolution	
from 0 to 7	Command position Lo-Byte	Byte 9
from 8 to 15	Command position	Byte 8
from 16 to 23	Command position	Byte 7
from 24 to 31	Command position Hi-Byte	Byte 6

10 - OVERALL AND MOUNTING DIMENSIONS



1	DIN EN 50022 rail type fastening
2	Plug for PC cable connection
3	LED for Output signals
4	Profibus Interface port
5	Profibus LED

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