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OPERATING MANUAL

PDP

Combination Pressure Transmitter

*** VERSION 1.2 ***
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Technical Description

PDP's combined pressure sensors allow simultaneous differential and static absolute or gauge pressure measurement. This qualifies them especially for flow measurement in connexion with Laminar Flow Elements or for other effective differential pressure methods. During calibration of the PDP sensors a regression polynomial is calculated. This is used to compensate the remaining linearity deviations with TetraTec Instruments' controller S320 enhancing accuracy to ±0,1 % F.S. The PDP sensor in clip-on housing is directly compatible with the LFE series 50MK, 50MJ, 50MW, 50MH and 50MY. The flange variant of the PDP sensor is conveniently used with the LFE series 50MC and 50MR as well as with all other flow elements.

Calibration

The PDP sensor is calibrated ex factory. Calibration protocols as well as the linearisation functions to be embedded into the programs of the controller S320 are part of the scope of delivery.

Safety Instructions

- Mounting and demounting by competent personnel only!
- Before starting work, make sure that the measurement point is not under pressure.
- Make sure that no dangerous gases (poisonous, suffocative or inflammable) can discharge from the measurement point.
- Make sure that pressure range and supply voltage of the pressure sensor are appropriate for your application.

Ordering Information

Part No. Structure: PDP-*MS-MD-SE-HO-OO*

MS	**Measuring Range Static Pressure**	
000	- .. -	Without static pressure
001	0 .. 70 mbar	Gauge pressure
003	0 .. 350 mbar	Gauge pressure
010	0 .. 1000 mbar	Gauge or absolute pressure
020	0 .. 2000 mbar	Gauge or absolute pressure
040	0 .. 4000 mbar	Gauge or absolute pressure
070	0 .. 7000 mbar	Gauge or absolute pressure

MD	**Measuring Range Differential Pressure**	
01	0 .. 1 mbar	Differential pressure
02	0 .. 2 mbar	Differential pressure
10	0 .. 10 mbar	Differential pressure
20	0 .. 20 mbar	Differential pressure

SE	**Sensor Equipment**
R	Differential and gauge sensor
A	Differential and absolute sensor
D	Differential sensor **only**

HO	**Housing Option**
A	Clip-on housing (cf. picture)
F	Flange housing (for panel mounting)

OO	**Output Option**	**Signal**
U	Voltage:	0 .. 1,6 V, 4-wire, R_L > 100 kΩ
N	Current:	4 .. 20 mA, 4-wire, R_L < 500 Ω
S	Data:	Serial interface (RS485)

Only the output options U and S allow also bi-directional differential pressure measurement (±1 / ±2 / ±10 / ±20 mbar).
Special adjustment and calibration for all options on request.

Accessories	**Part No.**
PDP-SVK Pneumatic-quick-connection coupling DN5 x 1/4"NPT**m**	PDP-21KA-AN13-MPNS-01
PDP-SVN Pneumatic-quick-connector DN5 x G1/4"**m**	PDP-21SF-AW13-MXN

Cable for PDP Sensor (2,5 m long*)	**Part No.**
Current output: V50 coupling and V50 connector	PDP-K-L025-PVC-V50KU-V50ST
Voltage output: V70 coupling and V70 connector	PDP-K-L025-PVC-V70KU-V70ST
Voltage output: V70 coupling and 2x4-pin MC4 connector for slot card	PDP-K-L025-PVC-V70KU-MC4

*Replace L025 by L050 / L100 to get a 5 / 10 m long cable.

Additional accessories and services on request.

Specifications

Differential Pressure Sensor		**Comment**
Measuring principle	Capacitive	
Housing material	Ceramics	
Measuring ranges	1 / 2 / 10 / 20 mbar	Others on request [1]
Linearity deviation	Typ. ±0,5 % F.S.	Uncompensated [2]
Overrange limits	6 bar	Static & one-sided at high-p. side
	5 x upper range limit	One-sided at low-pressure side
Response behaviour	≈ 5 ms for T90	Accord. to pneum. connection
Repeatability	Typ. ±0,05 % F.S.	
Hysteresis	Typ. ±0,05 % F.S.	
Offset drift	Typ. < 100 ppm/K	
Gain drift	Typ. < 100 ppm/K	
Position dependency	±0,15 % F.S.	

[1] The standard version sensor is calibrated uni-directionally.
[2] After compensation with controller S320 typically ±0,05 % F.S.

Absolute/Gauge Pressure Sensor		**Comment**
Measuring principle	Piezoresistive	
Housing material	Nylon	
Measuring ranges absolute	1 / 2 / 4 / 7 bar	
relative	0,07 / 0,35 / 1 / 2 / 4 / 7 bar	
Linearity deviation	Typ. ± 0,1 % F.S.	Uncompensated [3]
Overrange limits	2 x upper range limit, max. 6 bar	
Repeatability	Typ. ±0,05 % F.S.	
Offset drift	Typ. ±0,1 % F.S.	Range 0 .. +70 ℃
Gain drift	Typ. ±0,2 % F.S.	Range 0 .. +70 ℃

[3] After compensation with controller S320 ±0,05 % F.S.

Enclosure and Connections		**Comment**
Process connections clip-on hous.	1/4" NPT**f**	Brass, nickel-plated
flange hous.	G 1/4"**f**	Brass, nickel-plated
Dimensions clip-on housing	66 x 116 x 56 mm	H x W x D
flange housing	66 x 140 x 56 mm	H x W x D
Weight	≈ 550 g	
Housing material	Aluminium	
Ingress protection	IP 54	

Operating Conditions		**Comment**
Storage temperature	-20 .. +60 ℃	
Operating temperature	0 .. +50 ℃	
Media	Most gases and air	Clean, dry, non-condensing, non-corrosive and non-inflammable

Voltage Output		**Comment**
Supply	24 VDC ± 20 %	
Output signals	≈ ±2 V [1]	Referred to REF
Reference	≈ 5 V	Referred to 0 V / GND
Load	> 100 kΩ	
Current consumption	≈ 20 mA	Plus output currents

[1] The standard version measuring range is calibrated / mapped to 0 .. 1,6 V.

Current Output		**Comment**
Supply	24 VDC ± 20 %	
Output signals	4 .. 20 mA	Referred to 0 V / GND
Load	< 500 Ω	
Current consumption	≈ 30 mA	Plus output currents

Data output (RS485)		**Comment**
Supply	24 VDC ± 20 %	
Output signals		Cf. RS485 specification
Current consumption	≈ 50 mA	Plus output currents

CE conformity		**Comment**
Interference emission	EN 50081-1	
Interference immunity	EN 61000-6-2	

Electrical Connection

With an adequate connection cable the PDP sensor can be connected to any convenient data acquisition unit. Usually you will connect the PDP sensor with the provided connection cable (see ordering information) directly to TetraTec Instruments‘ controller S320 - to this the PDP sensor attuned to. In this case it is connected to a type 100 slot card. Port0 of the slot card supplies the PDP sensor and receives the differential pressure signal, Port1 receives the absolute or gauge pressure signal. At single section devices with only one PDP sensor, the slot card designated to the PDP sensor is usually installed in Slot0.

Please check in any case by means of the controller documentation or its configuration file whether the controller S320 is configured correctly.

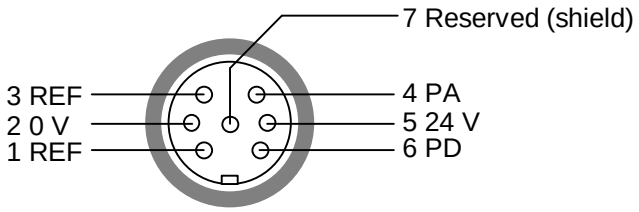
Note: The PDP sensors’ enclosure is connected to supply ground (0 V / GND) by a varistor (33 V). The enclosure has to be connected to protection earth potential PE, if this has not yet been done via the pipeline.

Voltage Output PDP Sensor (-2 .. +2 V)

- The PDP sensor is supplied with 24 V.
- The current consumption is approx. 20 mA plus the currents for both outputs.
- The output signal has the range -2 .. +2 V and must be measured in reference to the virtual ground (REF).
- The measuring range of the standard version pressure sensors (uni-directional) is mapped to the range 0 .. +1,6 V. Values outside of this range indicate an exceeding of measuring range.
- The PDP sensor has a type V70 (Lumberg) mounting connector.

REF has a static potential of approx. 5 V referred to 0 V / GND and must not be connected to 0 V or 24 V – also not shortly!

Connection Diagram of Voltage Output PDP Sensor (V70 Mounting Connector) - Top View



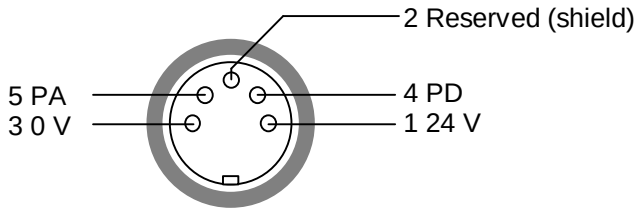
Connection Voltage Output PDP Sensor / Controller S320

Assignment	Colours (recommended)	Pins PDP (V70 mount. conn.)	Pins S320 (e.g. type 100 / Slot0)
24 V	Red	5	Port0: SUP
0 V	Blue	2	Port0: GND
PD	Yellow	6	Port0: +IN
REF	Green	1	Port0: -IN
PA	Pink	4	Port1: +IN
REF	Grey	3	Port1: -IN
Shield	-	-	Port0: GND

Current Output PDP Sensor (4 .. 20mA)

- The PDP sensor is supplied with 24 V.
- The current consumption is approx. 30 mA plus the currents for both outputs.
- The output signal has the range 4 .. 20 mA referred to 0 V / GND
- The measuring range of the standard version pressure sensors (uni-directional) is mapped to the range 4 .. 20 mA. Values outside of this range indicate an exceeding of measuring range.
- The PDP sensor has a type V50 (Lumberg) mounting connector.

Connection Diagram of Current Output PDP Sensor (V50 Mounting Connector) – Top View



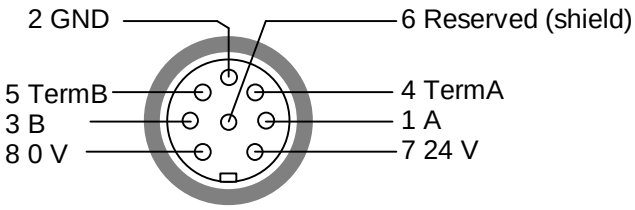
Connection Current Output PDP Sensor / Controller S320

Assignment	Colours (recommended)	Pins PDP (V50 mount. conn.)	Pins S320 (e.g. type 100 / Slot0)
24 V	Red	1	Port0: SUP
0 V	Blue	3	Port0: GND
PD	Yellow	4	Port0: +IN
0 V	Green	3	Port0: -IN
PA	Pink	5	Port1: +IN
0 V	Grey	3	Port1: -IN
Shield	-	-	Port0: GND

Data Output PDP Sensor (RS485)

- The PDP sensor is supplied with 24 V. The supply is electrical isolated from the RS485 interface (differential voltage: max. 50 V).
- The current consumption is approx. 50 mA.
- Via RS485 interface the PDP sensor provides digitized (decimal) measuring values of the range -1 .. +1.
- The measuring range of the standard version pressure sensors (uni-directional) is mapped to the range 0 .. 0,8. Values outside of this range indicate an exceeding of measuring range.
- Up to 32 sensors can be linked together. End devices have to be terminated by connection of the pins TermA and A as well as TermB and B (bridges). Termination resistors are provided in the sensor (390 / 120 / 390 Ω).
- The PDP sensor has type V80 (Lumberg) mounting connector.

Connection diagram of PDP sensor with Data Output (V80 Mounting connector) – Top View



Serial Data Transmission and Control of the PDP Sensor

The PDP sensor with serial interface provides the current measuring values digitized as decimal numbers of the range -1 to +1. These values result from the conversion of the measured voltages with an internal 24-bit analogue/digital converter, using the sigma-delta-principle, and subsequent normalisation.
The calibration data is saved in the sensor as polynomial values of the order PDN (differential pressure) or PSN (static pressure). After retrieval they can be used to linearise the measuring values (PDA / PSA) externally and to convert them to the physical SI basic unit (Pascal). Furthermore with the factors PDX and PDY or PSX and PSY they can be scaled additionally.
The calculation uses the following formalism. Doing the evaluation by the controller S320, you can use the functions of the POL.SPI library for it.

Differential pressure:

$$PD\,[Pascal] = \frac{\sum_{N=0}^{N-1} PDN * (PDA * PDX)^{N}}{PDY}$$

Static pressure:

$$PS\,[Pascal] = \frac{\sum_{N=0}^{N-1} PSN * (PSA * PSX)^{N}}{PSY}$$

The PDP sensor is driven by ASCII strings. Data and other information are returned the same way.
Because up to 32 PDP sensors can be linked together within a RS485 bus, every sensor has to be driven separately. As precondition for the simultaneous operation of multiple PDP sensors you have to assign to every sensor its own unique address of the range 00 to 99. If you use only one device, you can keep the default address (50).
Because of this all commands and outputs start with the address information (e.g. A*50*). It is followed by the proper control command. If a command is not understood or if the values are not valid the response is an error message (A*50*ERR). If there was a successful configuration command a confirmation is returned (A*50*OK).

The distance of two measurements you can set with the command A*50*Cycle. The response time depends on the given baud rate and the number of transmitted characters. The PDP sensor additionally needs an internal processing time of max. 10 ms for data conditioning.

The data format is fixed to "8N1" (8 data bits, no parity, 1 stop bit).

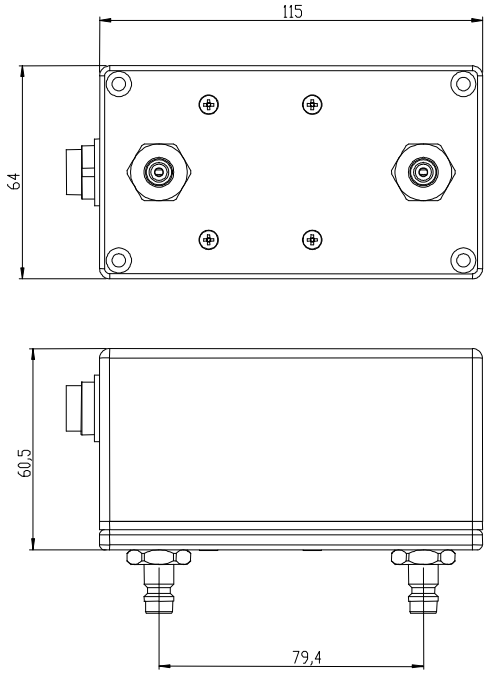
Commands for the PDP Sensor via Serial Interface

The following table lists the commands for the PDP sensor as well as its answer to them. Variable parts are written in italics and specified as an example; the rest of the command text is invariable. Please consider the case of the commands because they are not accepted otherwise.
All commands have to be supplied with a check sum ($*c*) and with a not listed terminator – quite the same is valid for the output. The check sum is used to validate a correct data transmission. It is calculated as sum of the ASCII values of all characters of the proper command text. Then, on this sum a modulo-16-operation is applied and the result is appended as hexadecimal value in the form „$*c*“. c may contain one of the following values: 0..9, A, B, C, D, E or F.

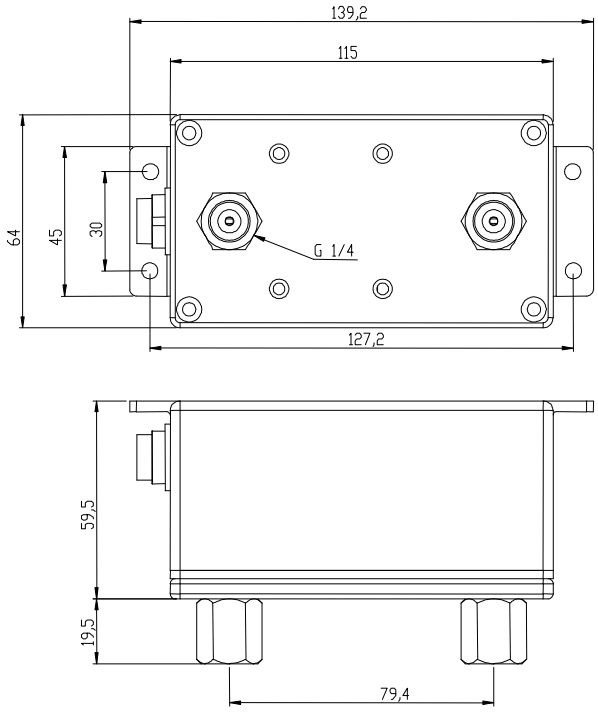
Command	**Answer**	**Meaning**
A*50*Term$*c*	A*50*Term=*LF*$*c*	Active terminator
A*50*Cycle$*c*	A*50*Cycle=*100*$*c*	Active integration interval in ms
A*50*PDA$*c*	A*50*PDA=*+0.1234567*$*c*	PD: current diff. pressure value, normalized
A*50*PDN$*c*	A*50*PDN=*4*$*c*	PD: order of regression polynomial (0..9)
A*50*PD*n*$*c*	A*50*PD*n*=*+1.2345678E+00*$*c*	PD: value of the nth coefficient (0..9)
A*50*PDX$*c*	A*50*PDX=*+1.2345678E+00*$*c*	PD: value of X scaling factor
A*50*PDY$*c*	A*50*PDY=*+1.2345678E+00*$*c*	PD: value of Y scaling factor
A*50*PSA$*c*	A*50*PSA=*+0.1234567*$*c*	PS: current static pressure value, normalized
A*50*PSN$*c*	A*50*PSN=*4*$*c*	PS: order of regression polynomial (0..9)
A*50*PS*n*$*c*	A*50*PS*n*=*+1.2345678E+00*$*c*	PS: value of the nth coefficient (0..9)
A*50*PSX$*c*	A*50*PSX=*+1.2345678E+00*$*c*	PS: value of X scaling factor
A*50*PSY$*c*	A*50*PSY=*+1.2345678E+00*$*c*	PS: value of Y scaling factor
A*50*SN$*c*	A*50*SN=*S807649B*$*c*	Serial number of PDP sensor
A*50*Range$*c*	A*50*Range=*PDP02020A-S*$*c*	Sensor type
A*50*Date$*c*	A*50*Date=*30.04.1998*$*c*	Date of calibration
A*50*Term=*CRLF*$*c*	A*50*OK$*c*	Terminator: CRLF or **LF**
A*50*Cycle=*100*$*c*	A*50*OK$*c*	Integration interval in ms: 20, 50 or **100**
A*50*Addr=*70*$*c*	A*70*OK$*c*	Sensor address: 00 to 99 (**50**)
A*50*Baud=*4800*$*c*	A*50*OK$*c*	Baud rate: 1200, 2400, 4800, **9600** o. 19200

Dimensions/Designs

Housing for direct LFE mounting



Flange housing



Mounting Instructions

Mounting Place

- Avoid mounting near interference sources (motors, pumps, valves, transmitters etc.) and heat sources - excessive vibrations or pressure peaks can corrupt the measuring signal or damage the sensor.

Mounting the PDP Sensor

- Clean all mounting holes. Pay attention that no contaminations result or remain from this in the flow range.
- Clip-on housing: If necessary, firstly mount the two NPT couplings at the flow element. At this pay attention that the screw-in depth of both couplings is identical. Then you can clip-on the PDP sensor easily. The pneumatic connection at the low-pressure side of the sensor has some play in order to compensate tolerances.
- Flange housing: Fasten the device by the four fixing holes.
  When mounting the customer-side pressure connections counter the G1/4"f connections of the sensor with an appropriate WS17 wrench in order to prevent them from turning relative to the housing. Pay attention that you don’t strip the threads on screwing.
- Mount the pressure sensor with the flow mark at the flow element pointing from high-pressure side to low-pressure side of the PDP sensor.
- Establish electrical connection.