Interface Protocol

ZD/ZW

Version 6

Table of Contents

1. Sensor List

The interface protocol is valid for the following Sensors:

- ZD600PCT3
- ZW200PCT3
- ZW600PCT3

2. Serial Interface

The ZD/ZW range of Sensors can be addressed via the V24 protocol.
The Teach-In Input serves as an RxD line, and the Switching Output as a TxD line.

The interface has to be set to 9600 baud, N, 8, 1.

2.1. TxD Line

The Switching Output is implemented as a positive switching Output against +Ub (PNP-version). The A232 Adapter Box must be interconnected for direct connection to the PC. With direct Connection to a SPS-input, the Connection box is not necessary.

2.2. RxD Line

The Teach-In Input (pin 2) serves as an RxD line.

Recognition of a logical 1 at input pin 2: U_{Pin2} = +8 V to Ub
Recognition of a logical 0 at input pin 2: U_{Pin2} = 0 to +3 V

2.3. Transmission Formats

A pause of greater than 300 ms must be included between each of the transmitted characters.
All characters are transmitted in ASCII format.
All data values are transmitted in hexadecimal format as ASCII characters.

2.4. Command Overview

Command	Command Character
Teach-In	/T
Activate Normal Teach-In (default setting)	/N
Activate Minimum Teach-In	/I
Activate Time Delay	/A
Deactivate Time Delay	/a
Set Register Pointer	/P
Change Register Content	/D
Delete Bit from Register	/R
Set Bit in Register	/S
Increment Threshold	/+
Decrement Threshold	/-
Single-Stage Filter	/1
2-Stage Filter	/2
Read Out All Register Content	/W

2.5. Teach-In

2.5.1. Teaching the Sensor In /T

Signal to the Sensor:

	Date			Length
	ASCII	Dec	Hex	Bytes
Start character	/	47	2F	1
Command character	T	84	54	1

Sensor response:

Sensor response:	Date			Length
	ASCII	Dec	Hex	Bytes
Start character	/	47	2F	1
Command character	T	84	54	1
Teach-In status	1	49	31	1
Teach-In value 1		xx	xx	2
Separator	:	58	3A	1
Teach-In value 2		xx	xx	2
Terminator	.	46	2E	1
LF		10	0A	1
CR		13	0D	1

Example: Data to Sensor: /T ➔ Response from Sensor: /T1xx:xx.

2.5.2. Setting the Teach-In Mode

Activating Normal Teach-In /N

Signal to Sensor:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
N	84	54	Command character

Sensor response:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
N	78	4E	Command character
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

Example: Data to Sensor: /N ➔ Response from Sensor: /N.

Key: LF = line feed (control characters)
CR = carriage return (control characters)

Activate Minimum Teach-In Mode /I

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
I	73	49	Command character

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
I	73	49	Command character
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

Example: Data to Sensor: /I ➔ Response from Sensor: /I.

2.5.3. Adjust switching threshold one digit /+, /-

With this command, the Sensor's switching threshold (ONL(22h), OFFL(21h)) can be shifted up or down, one digit at a time.
Hysteresis (ONL-OFFL) remains unchanged.

Signal to Sensor for adjusting the switching threshold up:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
+	43	2B	Command

Response from Sensor:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
+	43	2B	Command echo
OFFLh	xh	xh	New content of OFFL (21h) OFFL = OFFLh *16+ OFFLl
OFFLl	xl	xl	
:	58	3A	Separator
ONLh	dh	dh	New content of ONL (22h) ONL = ONLh *16+ ONLl
ONLl	dl	dl	
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

Signal to Sensor for adjusting the switching threshold down:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
-	43	2B	Command

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
-	43	2B	Command echo
OFFLh	xh	xh	New content of OFFL (21h) OFFL = OFFLh *16+ OFFLl
OFFLl	xl	xl	
:	58	3A	Separator
ONLh	dh	dh	New content of ONL (22h) ONL = ONLh *16+ ONLl
ONLl	dl	dl	
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

2.6. Time Delay

2.6.1. Activating Time delay /A

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
A	65	41	Command character

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
A	65	41	Command character
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

Example: Data to Sensor: /A ➔ Response from Sensor: /A.

2.6.2. Deactivating Time Delay /a

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
a	97	61	Command character

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
a	97	61	Command character
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

Example: Data to Sensor: /a ➔ Response from Sensor: /a.

2.7. Editing the Register Directly

2.7.1. Setting the Register Pointer/Pxx

A pointer can be set to the register in the Sensor with this command. Current register content is returned as an echo.
The register indexed with this command can then be edited using the following commands:

Re-describe register contents: /D
Delete bit from the register: /Rb (b = bit position 0 ... 7)
Set bit in the register: /Rb (b = bit position 0 ... 7)

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
P	87	57	Command
xh	x	x	Register address in hex R=xh*16+xl
xl	x	x	

Calculation of xx:

xx = R+16

Where R+16 > 255:

xx=R-240

Key: R = actual register address

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
P	87	57	Command echo
xh	xh	xh	Register address in hex R=xh*16+xl
xl	xl	xl	
:	58	3A	Separator
dh	dh	dh	Content of register in hex D=dh*16+dl
dl	dl	dl	
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

2.7.2. Changing Register Content /Dxx

The register addressed with /Pxx can be edited with this command.

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
D	68	44	Command
dd	x	x	New register content

Calculation of dd:

dd = D+48

Where D+48 > 255:

dd=R-208

Example 1:

If date 0 is to be written to the memory location addressed with /P, dd is calculated as follows:

dd = 0 +48 = 48

➔ Command sequence to Sensor: /D0 (because 0 is ASCI 48)

Example 2:

If date 250 is to be written to the memory location addressed with /P, dd is calculated as follows:

dd = 250 +48 = 298 ➔ greater than 255 ! thus dd = 250 -208 = 42

➔ Command sequence to Sensor: /D* (because * is ASCI 42)

Key: D = actual register contents

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
D	68	44	Command echo
xh	xh	xh	Register address in hex R=xh*16+xl
xl	xl	xl	
:	58	3A	Separator
dh	dh	dh	New register content D=dh*16+dl
dl	dl	dl	
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

2.7.3. Deleting a Bit from the Register /Rb

The register addressed with /Pxx can be deleted bit by bit with this command.

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
R	82	52	Command
b	x	x	Bit location to be deleted

allowed area from b : 0 (ASCII48) .. 7 (ASCII 55)

Example:

If bit 3 in the memory location previously addressed with /P is to be deleted, the following command sequence must be transmitted to the sensor:

➔ Command sequence to Sensor: /R3

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
R	82	52	Command echo
xh	xh	xh	Register address in hex
xl	xl	xl	R=xh*16+xl
:	58	3A	Separator
dh	dh	dh	New register content
dl	dl	dl	D=dh*16+dl
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

2.7.4. Setting a Bit in the Register /Sb

The register addressed with /Pxx can be set bit by bit with this command.

Signal to Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
S	83	53	Command
b	x	x	Bit location to be deleted

Permissible range for b: 0 (ASCII48) to 7 (ASCII 55)

Example:

If bit 7 in the memory location previously addressed with /P is to be set, the following command sequence must be transmitted to the sensor:

➔ Command sequence to Sensor: /S3

Response from Sensor:

Date			Remark
ASCII	**Decimal**	**Hex**	
/	47	2F	Start character
S	83	53	Command echo
xh	xh	xh	Register address in hex R=xh*16+xl
xl	xl	xl	
:	58	3A	Separator
dh	dh	dh	New register content D=dh*16+dl
dl	dl	dl	
.	46	2E	Stop character
	10	0A	LF
	13	0D	CR

2.7.5. Selecting All Register Content /W

The Sensor reads out all register content via the serial port. Usable data are within a range of 20h to 38h.

Signal to Sensor:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
W	87	57	Command

Response from Sensor:

Date			Remark
ASCII	Decimal	Hex	
/	47	2F	Start character
W	87	57	Command echo
8	56	38	Sensor version
6	52	34	
0	48	30	Sensor group
7	55	37	
0	48	30	Sensor type
1	49	31	
	10	0A	LF
	13	0D	CR
0	48	30	Register 00
0	48	30	
:	58	3A	Separator
x	x	x	Content of register 00
x	x	x	
	10	0A	LF
	13	0D	CR
0	48	30	Register 01
1	49	31	
:	58	3A	Separator
x	x	x	Content of register 01
x	x	x	
	10	0A	LF
	13	0D	CR
.....			

Example: Data to Sensor: /W

➔ Response from Sensor: /W840701<CR><LF>
00:xx<CR><LF>
01:xx<CR><LF>
..
aa:dd<CR><LF>
..
FE:xx. <CR><LF>
FF:xx. <CR><LF>

Key:
aa: actual register address
dd: date of the corresponding register

2.7.6. Resetting the Sensor to its Factory Default Settings

If a value of 0 is written to the VERSION register (2Fh), the Sensor executes a reset which returns it to its factory default settings. The following command sequence, according to the above described procedure, is required:

xx = R+16 ➔ xx=2Fh+16_d=63 ➔ ASCII 63 = “?”

➔ Sequence to be sent: /P?

The address pointer is now set to the VERSION register (2Fh).

Write a new value to the register subsequently.

➔ Sequence to be sent: /D0

The VERSION register (2Fh) has now been set to 0.

It then transmits the following sequence once:
5.2.0107
The Sensor is reset to its factory default settings.

2.8. Examples

2.8.1 Example 1: Read out the Sensor's current set analog signal value

The SIGNAL register (34h) contains the Sensor's current analog signal value.

Set the register pointer to 34h.

➔34h +16d=52d+16d=**68d** ➔ ASCII 68 = „D“

To Sensor /PD transmit

The Sensor responds with /PD:dd.

Date of SIGNAL register (34h) is dd (hexadecimal format)

The Sensor's current analog value is dd.

2.8.2. Example 2: Query the Sensor's contamination warning:

The VERSC bit (bit 3) in the FLAGS2 register (38h) contains the status of the contamination warning.

Set the register pointer to 38h.
➔38h +16d=56d+16d=**72d** ➔ ASCII 72 = „H“

To Sensor /PH transmit

The Sensor responds with /PH:dd.

Date of FLAGS2 register is dd (hexadecimal format)

Evaluation of bit 3 from date dd

1 ➔ Contamination warning is activated.
0 ➔ Contamination warning is deactivated.

3. Register Bit Structure

Register	Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-volatile memory	Default Setting[1]
--	00-1Fh	Temporarily occupied, may not be changed[2]									U
OFFH	20h	Temporarily occupied, may not be changed								X	FFh
ONL	21h	On threshold								X	U
OFFL	22h	Off threshold								X	U
CONFIG 0	23h	SHL	LED1	LED2	OUTA	OUT	FLEV	ADUI	NC	X	10011001b
MODE	24h	SOUT 2	ANZ	ETM	TM	TS	SOUT 1	SOUT 0	DEL	X	01000000b
CONFIG1	25h	MMIN	MDYN	SOV	ROV	MC	MFT	INV	EACK	X	00000000b
FILTER	26h	FIL7	FIL6	FIL5	FIL4	FIL3	FIL2	FIL1	FIL0	X	11000000b
ZYKLUS	27h	Temporarily occupied, may not be changed								X	10000010b
DELAYH	28h	Delay time, high register								X	00h
DELAYL	29h	Delay time, low register								X	64h
CTDELL	2Ah	Temporarily occupied, may not be changed								X	U
CTDELH	2Bh	Temporarily occupied, may not be changed								X	U
WND	2Ch	Temporarily occupied, may not be changed								X	U
RAUSCH	2Dh	Temporarily occupied, may not be changed								X	U
ONH	2Eh	Temporarily occupied, may not be changed								X	FFh
VERSION	2Fh	VN	Software version							X	86h
STYP	30h	Information on sensor type								--	07h
SGRUPPE	31h	Information on sensor group								--	01h
SIMPULS	32h	Temporarily occupied, may not be changed								--	U
BAUD	33h	Temporarily occupied, may not be changed								--	U
SIGNAL	34h	Momentary signal value								--	U
REFSIG	35h	Temporarily occupied, may not be changed								--	U
FLAGS0	36h	V24BC	V24P	V24S	V24E	TPF	TNF	T0EV	TAS	--	U
FLAGS1	37h	BLED	V24PT	V24DT	RESS	OR	RBLED	LOCK	TFAIL	--	U
FLAGS2	38h	DSTP	DSTRT	SEN1	SEN0	VERSC	RDYN	REC	V24TF	--	00xx xxxx
	39h-7Fh	Temporarily occupied, may not be changed								--	U

Table 1

[1] U = undefined

[2] These memory locations may not be written because they are being temporarily used and do not contain any usable data.

4. Detailed Register Description

4.1. ONL (address 21h)

The Sensor's output is activated when the signal level (SIGNAL register (34h)) is below a value of ONL.[3]

4.2. OFFL (address 22h)

The Sensor's output is deactivated when the signal level (SIGNAL register (34h)) exceeds a value of OFFL.[4]

4.3. CONFIG0 (address 23h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-volatile memory	Status after reset
SHL	LED1	LED2	OUTA	OUT	FLEV	ADUI	NC	X	10011001 b

Bit 7: **SHL:** May not be changed

Bit 6: **LED1**: Read only
1 = yellow LED is on
0 = yellow LED is off

Bit 5: **LED2**: Read only
1 = contamination LED is on
0 = contamination LED is off

Bit 4: **OUTA:** May not be changed

Bit 3: **OUT**: Read only
Where NC = 1:
1 = output is connected
0 = output isn't connected
Where NC = 0:
0 = Output is connected
1 = Output isn't connected

May not be changed

Bit 2: **FLEV:** May not be changed

[3] Bit NC = 1 (normally closed)

[4] Bit NC = 1 (normally closed)

Bit 1: **ADUI:** May not be changed

Bit 0: **NC**:

Read / write

Change-over / normally closed / normally open

1 = normally closed (output not activated when the light beam is interrupted)

0 = normally open (output activated when the light beam is interrupted)

4.4. MODE (address 24h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-volatile memory	Status after reset
SOUT2	ANZ	ETM	TM	TS	SOUT1	SOUT0	DEL	X	01000000b

Bit 7: **SOUT2**

Read / write

Read-out of Min-Max values.

Bit 6: **ANZ**:

Read / write

1 = on-delay mode

0 = off-delay mode

Activated time delay with bit DEL.

Ser time with DELAYH (28h) and DELAYL (29h)

Bit 5: **ETM:** May not be changed

Bit 4: **TM:** May not be changed

Bit 3: **TS:** May not be changed

Bit 2,1: **SOUT1, SOUT0:**

Read / write

SOUT2	SOUT1	SOUT0	Function
x	0	0	Normal switching signal output
0	0	1	Continuous read-out of the analog signal value via the serial port
1	0	1	Continuous read-out of the analog signal value via the serial port with additional read-out of Min-Max values
x	1	0	Changes to the switching output status are read out via the serial port.
0	1	1	Continuous read-out of the analog signal value via the serial port with additional transmission of switching and contamination status
1	1	1	Continuous read-out of the analog signal value via the serial port with additional transmission of switching and contamination status, as well as read-out of Min-Max values

Bit 0: **DEL**:

Read / write

Activating the time delay function

1 = Time delay function is activated.

0 = Time delay function is deactivated.

The mode (on-delay or off-delay) is specified with the ANZ bit.

Set time with DELAYH (28h) and DELAYL (29h).

4.5. CONFIG1 (address 25h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-volatile memory	Status after reset
MMIN	MDYN	SOV	ROV	MC	MFT	INV	EACK	X	00000000b

Bit 7: **MMIN**: definition of Teach-In mode

Read/Write

1 = Normal Teach-In

In the Normal Teach-In mode, the switching threshold is set to 100% signal reserve after the Teach-In procedure.

0 = Minimum Teach-In

In the Minimum Teach-In mode, the switching threshold is automatically set to the lowest possible signal reserve after the Teach-In procedure.

The Teach-In process is started by pressing a key (on the device or externally), or by means of a serial control command.

Bit 6: MDYN: May not be changed, must be set to 0

Bit 5: SOV: May not be changed, internal use

Bit 4: ROV: May not be changed, internal use

Bit 3: MC: May not be changed, internal use

Bit 2: MFT: May not be changed, must be set to 0

Bit 1: INV: May not be changed, must be set to 0

Bit 0: EACK: May not be changed, internal use

4.6. FILTER (address 26h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-volatile memory	Status after reset
FIL7	FIL6	FIL5	FIL4	FIL3	FIL2	FIL1	FIL0	X	11000000b

Bit 7-0: **FIL7:FIL0**

00000000 : impermissible
10000000 : no signal filtering, switching frequency: 2 kHz
11000000 : single signal filtering, switching frequency: 1 kHz (standard)
11100000 : double signal filtering, switching frequency: 0.66 kHz
11110000 : triple signal filtering, switching frequency: 0.5 kHz
11111000 : quadruple signal filtering, switching frequency: 0.4 kHz
11111100 : quintuple signal filtering, switching frequency: 0.33 kHz
11111110 : sextuple signal filtering, switching frequency: 0.28 kHz
11111111 : not allowed

4.7. DELAYH (address 28h), DELAYL (address 29h)

Time delay duration. DELAYH High-Byte DELAYL Low-Byte.

Calculation formula:

DELAYH = INT(T/25600)
DELAYL = INT((T/ T_{Cycle})- DELAYH*256)

T_{Cycle}	Sensor
100	LM89,TM11,LD86,LW86
200	TM55,UM55
50	ZD/ZW

Key: T = desired delay time in microseconds within a range of 0 to 5,000,000

4.8. VERSION (address 2Fh)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non Volatile Memory	Status after Reset
VN	Software version							X	10000110b

Bit 7: VN: compatibility bit, must be set to 1

Bit 7-0: Sensor version

4.9. SGRUPPE (address 31h)

Contains information about the Sensor group
Content: 01

4.10. SIGNAL (address 34h)

Contains the current value of the light's incident intensity (analog signal level). This value is compared with switching thresholds ONL(21h) and OFFL(21h), and switching of the Sensor output results if the thresholds are exceeded or fallen short of.

4.11. FLAGS0 (address 36h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-volatile memory	Status after reset
V24BC	V24P	V24S	V24E	TPF	TNF	T0EV	TAS	--	U

Bit 7: V24BC: May not be changed, internal use
Bit 6: V24P: May not be changed, internal use
Bit 5: V24S: May not be changed, internal use
Bit 4: V24E: May not be changed, internal use
Bit 3: TPF: May not be changed, internal use
Bit 2: TNF: May not be changed, internal use
Bit 1: T0EV: May not be changed, internal use
Bit 0: TAS: May not be changed, internal use

4.12. FLAGS1 (address 37h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-Volatile memory	Status after reset
BLED	V24PT	V24DT	RESS	OR	RBLED	LOCK	TFAIL	--	U

Bit 7: BLED: May not be changed, internal use
Bit 6: V24PT: May not be changed, internal use
Bit 5: V24DT: May not be changed, internal use
Bit 4: RESS: May not be changed, internal use
Bit 3: OR: May not be changed, internal use
Bit 2: RBLED: May not be changed, internal use
Bit 1: LOCK: May not be changed, internal use
Bit 0: TFAIL: May not be changed, internal use

4.13. FLAGS2 (address 38h)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Non-Volatile memory	Status after reset
DSTP	DSTRT	SEN1	SEN0	VERSC	RDYN	REC	V24TF	--	00xx xxxx

Bit 7: **DSTP** :
Read/Write
0 => 1 : Min-Max values are no longer updated.
1 => 0 : Min-Max values are updated every 10 ms.

Bit 6: **DSTRT** :
Read / write
0 => 1 : Min-Max values are reset, recording of Min-Max values begins.
1 => 0 : Min-Max values are updated every 10 ms.

Bit 5: SEN1: May not be changed, internal use

Bit 4: SEN0: May not be changed, internal use

Bit 3: **VERSC**: contamination warning
Read / write
1 = contamination warning has occurred

0 = contamination warning has not occurred

This bit is set if the Sensor's optics are contaminated and the switching function might be impaired.

Bit 2: RDYN: May not be changed, internal use

Bit 1: REC: May not be changed, internal use

Bit 0: V24TF: May not be changed, internal use