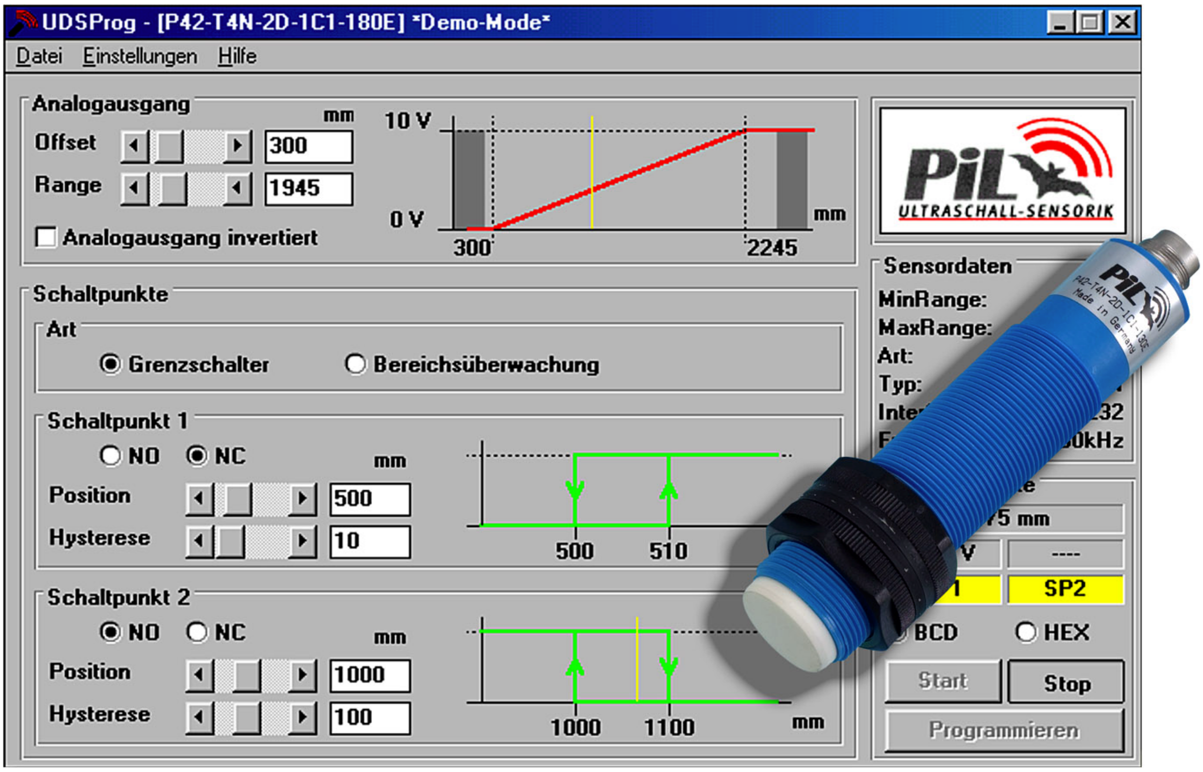
ULTRASONIC DISTANCE SENSORS



MANUAL
PROGRAMMING
THE P42-T4N-2D-… SENSOR SERIES

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KEB 10/99

INTRODUCTION

HOW TO USE THIS MANUAL

This manual should help the user to program sensors of series P42T

Basics are described in chapter **Programming of Sensors with RS232 Interface**
This chapter contains a general overview of

structure of memory in the P42 series,
hardware set-up,
structure of commands,
special registers
and a description of the very important software tools
UDSE.EXE and **SENDE.EXE**
Software **UDSDEMO.EXE**

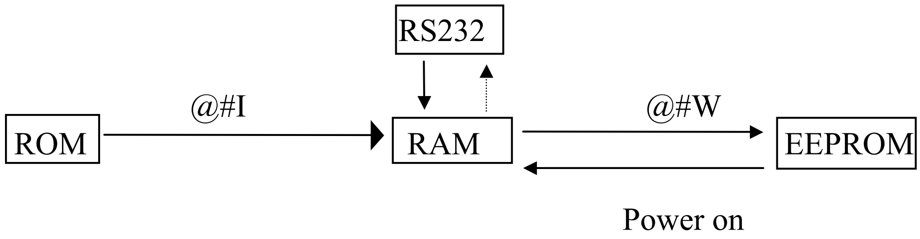
In the chapter **Programming of the Sensors** the specific characteristics of each sensor is listed. The programmer should start directly with the sensor he wants to program.

The rubric **Programming** lists all commands available.
Examples shows specific applications and their realisation.

PROGRAMMING OF SENSORS WITH RS232 INTERFACE

STRUCTURE OF MEMORY ORGANISATION

The memory organisation of the P42 series is shown in the following sketch:



The **RAM** could get information from different sources:

1. **EEPROM**
   By connecting the power supply to the sensor, the data from the EEPROM will be loaded into the RAM
2. **ROM**
   With a special command the factory setting is shifted from the ROM into the RAM.
3. **RS 232**
   Via the RS 232 interface the user has direct access to the RAM.

From the **RAM** information can be communicated to:

1. **EEPROM**
   The actual setting can be stored.
2. **RS 232**
   Via RS 232 the actual distance information or status information can be communicated to the PC.

HARDWARE SET-UP

The most effective way to change settings of the sensor is the programming with a PC via the RS 232 interface.
For this use

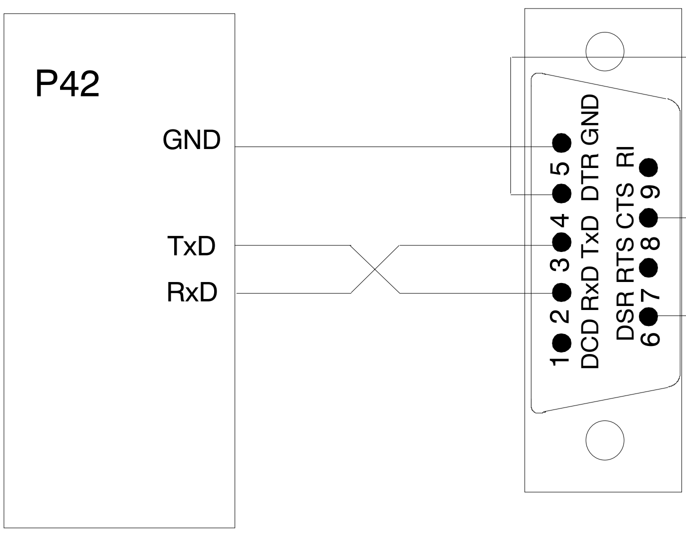
- **baud rate of PC has to be set to 9600 baud, no parity, 8 bit 2 stop bits. ***
- **the sensor should be run in the 'hold' mode** (connection of the HLD-input with GND)**, to avoid data collisions on the interface.**
- **the connection SENSOR - PC has to be done the following way:**

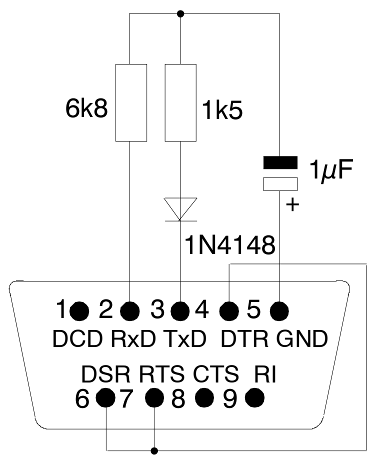
*Programs UDSE.EXE; SENDE.EXE or UDSDEMO.EXE are setting the interface COM1 or COM2 in the needed mode.

Sensor		**PC**		
P42-T4N-1C/D.	Function	Function		
PIN			SubMinD9	SubMinD25
5	TXD-----	RXD	2	3
6	RxD-----	TxD	3	2
3	GND----	GND	5	7

The connection of pins (DTR-DSR-CTS) of the PC connector is necessary for programs using the MS-DOS Int 14h (for example DOS, BASIC, GWBASIC,...).

With some PC's the level of the TxD signal is too small. This can be shifted with the sketched circuit.





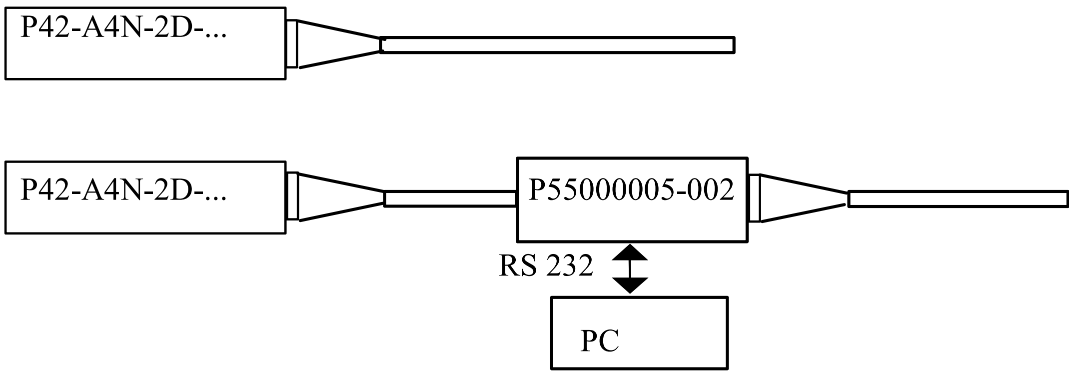
Pin connection from outside PC.

PROGRAMMING ADAPTER

A very useful tool for the programming of the compact P42-T4N-... series is the **PROGRAMMING ADAPTER**

Listing: **P55000005-002**

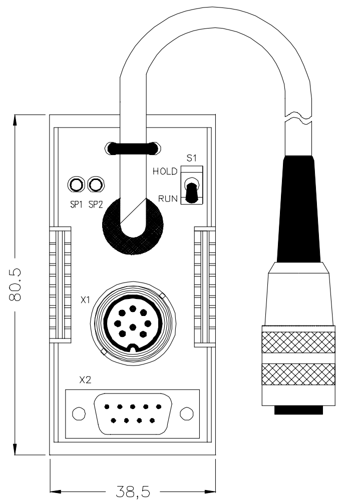
It can be mounted directly to an installed sensor. The sensor has to be disconnected and between the two connectors the programming module can be inserted.
This programming module has a SubMinD9 connector, identical with most laptop COM interfaces. With a standard RS232 cable the connection between programming module and PC can be done.
It also has two LEDs indicating the status of the switching outputs and switch to set the sensor in the hold mode.

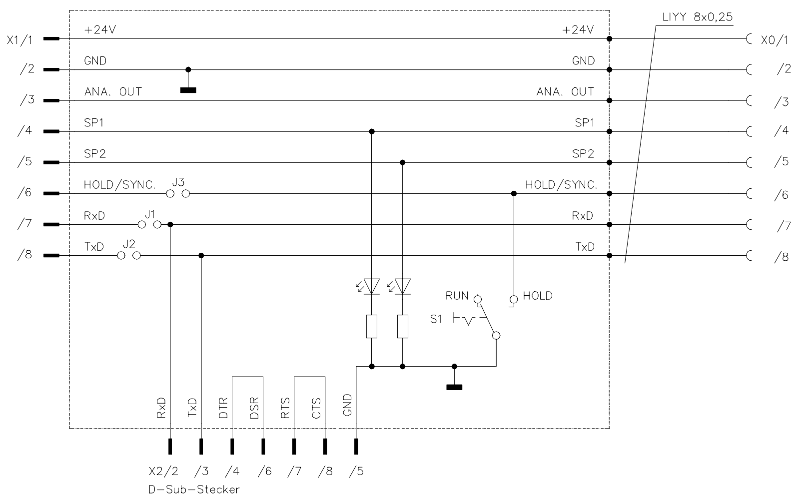


Advantages:

- Easy access with a laptop to the RS 232 lines.
- Programming can be done in close proximity to the sensor.
- TxD-, RxD- and HLD/Sync lines do not need to be installed.
- Status of set points can be surveyed.
- No limitation in cable length. (Length of RS 232 cable should be limited to 2 m)

The following drawings show the adapter and its electrical circuit.



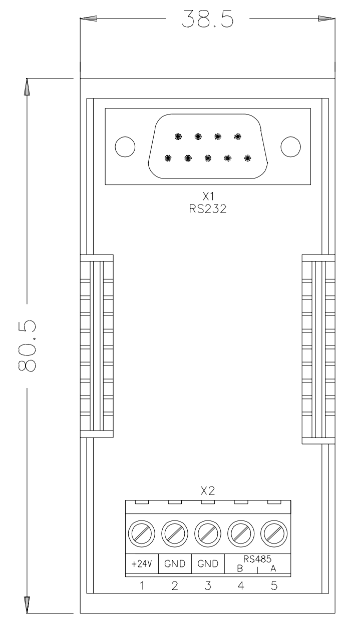


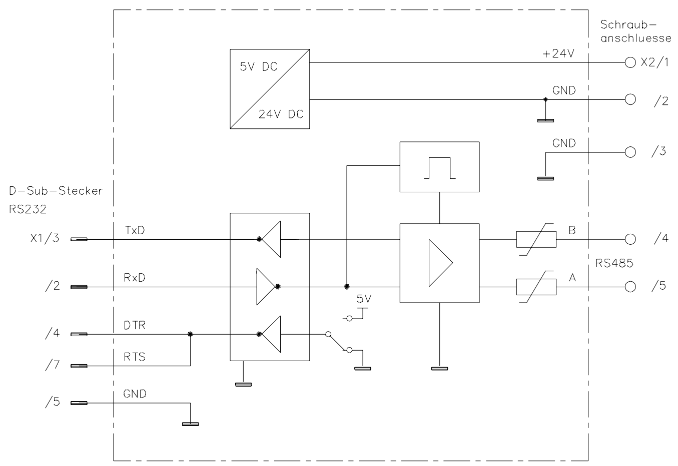
Electrical circuit programming module

RS 232 - RS 485 CONVERTER

Some sensors the P42-A4N-2D-1E/F.... series are equipped with a RS 485 interface.
Programming is exactly the same as with RS 232 interface.
A RS 232 - RS 485 converter is available.
This small device can be mounted on a DIN rail and enables the communication with all RS485 sensors.
Listing:

P55000003-002





STRUCTURE OF COMMANDS

The sensors can be adjusted to its special application with a set of commands, transmitted via the RS 232 (RS 485) interface.
Special commands exist for setting of following parameters:

Set points of switching outputs,
Hysteresis,
Characteristics of switching outputs (NO or NC),
Analogue output range,
Offset of analogue output,
Under range (Dead zone),
Over range counter,
Cycle time,
Transmission time of ultrasonic pulse,
Adjustment of sensor offset,
Fail pulse suppression,
Setting of MODE register

This list might vary, depending on sensor type.
The actual settings can be:

Stored into the EEPROM,
Display on the screen or
Copied into a file in the PC

Each command has the same structure: **@abp<CR>**
with:

@ - Start of command, always identical
a - Address of the sensor, in addition every sensor responds to the address **'#'**
b - Command
<CR> - End of command <CR> = ENTER = #13

After receiving the 'End of command' <CR> the sensor change it's operation.

COMMANDS

In this chapter a description of the most important commands is listed. A detailed list of commands for each sensor with a description of their functions can be found in the chapter describing the special sensor series.

WRITE FACTORY SETTING INTO RAM
@aI<CR>

The initial factory setting will be written from the ROM into the RAM. If the sensor was programmed incorrectly and doesn't operate the way it should; by using this command the sensor can be restored to ist original Factory Setting.

WRITE ACTUAL SETTING INTO EEPROM
@aW<CR>

The actual sensor settings can be written into the EEPROM, so, when the power supply of the sensor is switched off and on again the settings from the EEPROM will be loaded into the RAM.

READ OUT SENSOR SETTINGS
@aD<CR>

The command **@aD<CR>** will cause the sensor to send 8 (9) words of the actual setting via the RS 232 (RS 485) interface. This information contains:

MODE register,
Set points of switching outputs,
Hysteresis,
Analogue output range,
Offset of analogue output,
Under range (Dead zone),
Over range counter,
Cycle time,
Transmission time of ultrasonic pulse,
Adjustment of sensor offset,
Fail pulse suppression

The information is in HEX format. As one word contains 8 bit, some of the words are divided into 2 parts with 4 bits, containing different information.

The specific list for each sensor you will find in the chapter describing the special sensor series.

CHANGE SENSOR ADDRESS
@aAp<CR>

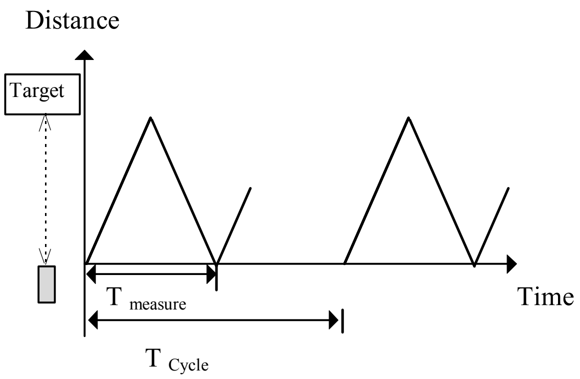
This command changes address from ‘a’ to ASCI value of p: ASC(p). For example @aA98<CR> renames sensor address from a to b (ASC(98)=b).
All sensors have in addition the address‘#’. This is important, if the sensor address is unknown.
Following addresses can be used:

ASCII table:

Dec.	**Chr.**	**Dec.**	**Chr.**	**Dec.**	**Chr.**	**Dec.**	**Chr.**	**Dec.**	**Chr.**
97	a	107	k	117	u	127	□	137	ë
98	b	108	l	118	v	128	Ç	138	è
99	c	109	m	119	w	129	ü	139	ï
100	d	110	n	120	x	130	é	140	î
101	e	111	o	121	y	131	â	141	ì
102	f	112	p	122	z	132	ä	142	Ä
103	g	113	q	123	{	133	à	143	Å
104	h	114	r	124	|	134	å	144	É
105	i	115	s	125	}	135	ç	.	
106	j	116	t	126	~	136	ê	.	

CYCLE TIME ADJUSTMENT
@aCp<CR> p = 64; 32; 16; 8; 4 msec

Measurement principle of the distance measurement is shown in the following drawing.



The sensor (grey) is transmitting an ultrasonic pulse along the dotted line to the target. At the target surface it will be deflected back to the sensor where it will be received.
In the diagram the position of the pulse versus time is shown.
Starting from the sensor face to the target, back to the sensor and once more reflected in the direction to the target. The end of this line indicates that the intensity of the ultrasonic pulse is so small that it cannot be detected anymore. Now the next measurement can be taken and a new ultrasonic pulse can be transmitted.

The time between transmissions of the pulses is called the cycle time T_{cycle}.
Cycle time determines the response time of the sensor. Obviously sensors used for long distance measurement also have long response times. With the programming of the cycle time the response time of the sensor can be adjusted to the application.
Cycle time must always be longer than the time needed to absorb the transmitted ultrasonic pulse!
The time of flight of the pulse (Sensor-Target-Sensor): $T_{measure}$ is proportional to the distance of the object. This time is measured and transformed in the corresponding distance.

In the following table a maximum distance for given cycle times is proposed:

Command	**Cycle time ms**	**Distance m**
@aC4<CR>	4	0.3
@aC8<CR>	8	0.7
@aC16<CR>	16	2.5
@aC32<CR>	32	4.5
@aC64<CR>	64	10.

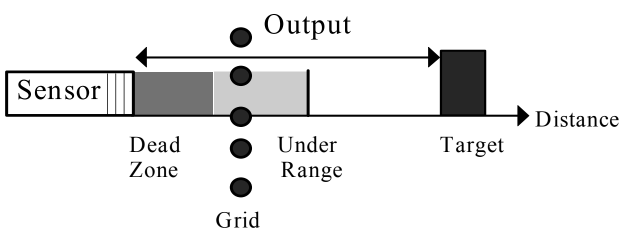
For more information see also: **MEASUREMENT WINDOW**

UNDER RANGE ADJUSTMENT

@aUp<CR> 0≤p≤255 cm

During transmission ultrasonic transducers cannot receive ultrasonic pulses. Each sensor has it's own characteristic zone in front of it, where objects cannot be detected. This zone is called '**DEAD ZONE**'.

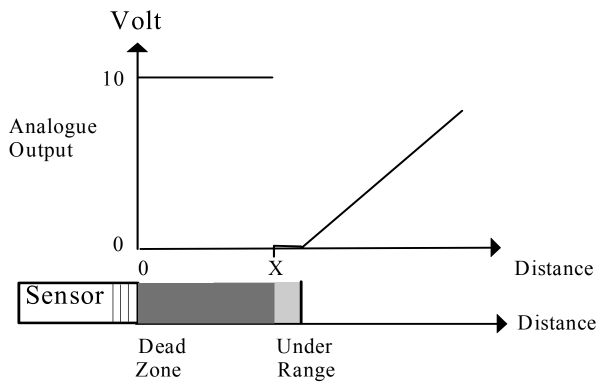
With this command this zone can be enlarged. Parameter p - length of the zone - starts at the sensor face. Echoes in this zone will be ignored.
Disturbing objects in front of the sensors can be ignored, choosing the right setting for the under range. See sketch.



A sensor can detect targets for example through a protecting grid without being disturbed by the reflection of this grid.

Example 1: SMALL OBJECT

Under range and offset of the analogue range of a sensor are identical.
Analogue output 0 to 10 V has positive slope. A small target is moved towards the sensor head.
In the diagram the output is shown decreasing to 0V at the start of the under range and remains at 0 until point X where it jumps to 10V.



Following table shows distance X depending on the value of the under range adjustment:

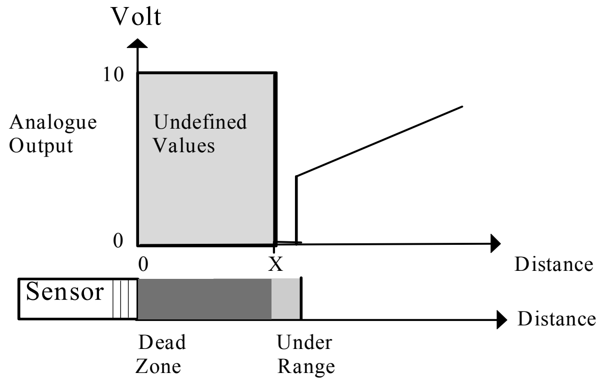
Command	**p**	**X cm**
@aU20<CR>	20	14
@aU30<CR>	30	22
@aU40<CR>	40	32
@aU50<CR>	50	42
@aU100<CR>	100	85
@aU200<CR>	200	178

Limitations:

- **Minimum under range is determined by the transducer ringing. p=0 has no effect.**
- **Echoes of a massive target in the dead zone will be suppressed, but 2nd or 3rd echoes can be received if their time of flight is longer than the programmed dead zone. Output will then display a distance corresponding 2 or 3 times of the real one.**

Example 2: LARGE OBJECT

Offset of the analogue range of a sensor = 0, analogue output 0 to 10 V has positive slope. A large target is moved from far to the sensor head.
In the drawing the output is shown.
It is decreasing until the start of the under range, where it drops to 0 V and remains at 0 V until point X it then jumps back up (It may than jump to undefined values caused by double echoes).



SET POINT ADJUSTMENT

SET POINT 1

@a1p<CR> 0≤p≤10000 mm

SET POINT 2

@a2p<CR> 0≤p≤10000 mm

Defines the status of the switching PNP outputs depending of the distance of the target and whether it is set to NO or NC characteristics.
See also Hysteresis, Switching Window

NO: Distances higher than selected set point, the output is high resistant.
Distances lower, equal selected set point, the output is low resistant, current flow up to 100 mA.

NC: Distances higher than selected set point, the output is low resistant, current flow up to 100 mA.
Distances lower, equal selected set point, the output is high resistant.

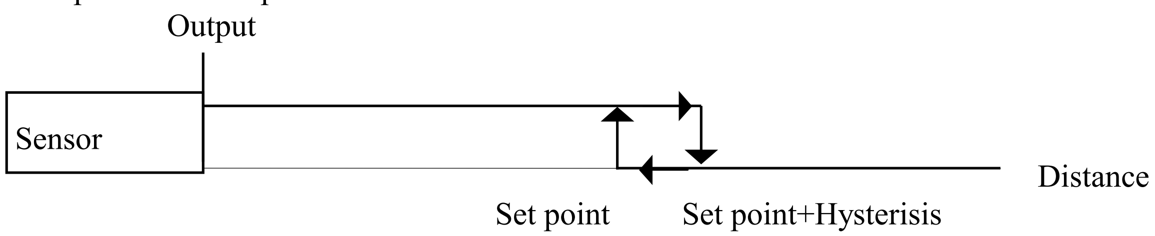
HYSTERESIS SET POINT 1

@aHp<CR> 0≤p≤255 mm

HYSTERSIS SET POINT 2

@aGp<CR> 0≤p≤255 mm

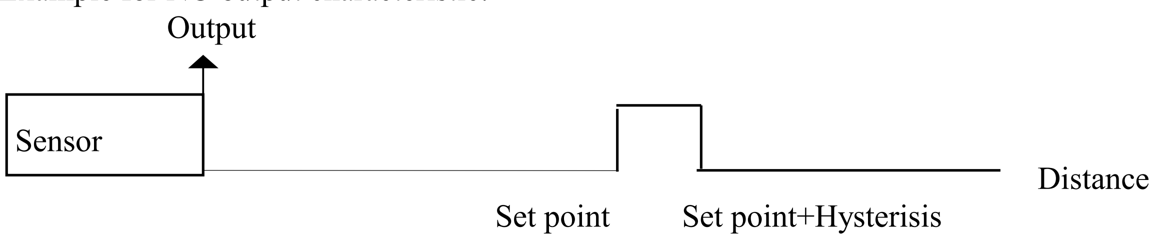
To avoid a flickering of the switching output if the measured distance corresponds exactly to the set point a hysteresis can be programmed. See also Switching Window.
Example for NO output characteristic:



If an object is approaching the sensor from large distance, output will change at distance = set point.
If the object now returns, the change of the output will be at the distance = set point+hysteresis.

SWITCHING WINDOW

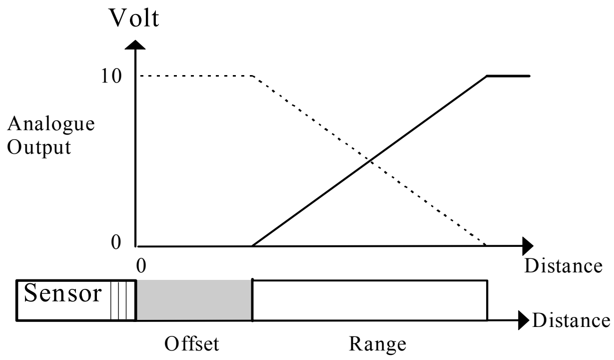
Some of the sensors can be driven in the mode **'Switching Window'**. This can be selected by setting the corresponding bit. In this mode the sensor is switching if the target is in the range between set point and set point+hysteresis.
Example for NO output characteristic:



ANALOGUE OUTPUT

The analogue output is set with two commands

OFFSET AND RANGE



OFFSET OF THE ANALOGUE OUTPUT

@aOp<CR> $0 \leq p \leq 10000$ mm

Offset of the analogue output is the distance from the sensor head to the beginning of the analogue output range. The parameter p defines the distance in cm or mm.

RANGE OF THE ANALOGUE OUTPUT

@aSp<CR> $0 \leq p \leq 10000$ mm

Analogue output range is the range where the analogue output is changing between 0 to 10 V or 4 to 20 mA. The parameter p defines the length of the range in cm or mm.

MODE REGISTER

@aMp<CR>

Sensor characteristics can be programmed by setting bits in the **MODE** register for adjustment of the following functions:

Enable/disable input via front panel
Enable/disable serial asynchronous data output
Positive/negative slope of analogue output
Output with/without mean value routine
NO/NC characteristics of switching outputs
Switching window characteristic of switching output
HEX/BCD digital output of the serial interface

Determination the value of the parameter ‘p’ for programming the Mode register.
This register is an 8 bit word. Each bit has a special function. It can be selected dependent of it’s value 0 or 1.

MSB LSB

Mode register | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

Here MSB stands for Most Significant Bit value: 128 and LSB for the Lowest Significant Bit value: 1.

Example:
The Mode register of the P42-T4N-2D-1X1-XXX allows following settings:

Mode register

Description	**bit**	**value**
Output if target betw. Sp and SP+Hyst.	1	* 128
Limit switch	0	
RS 232 data output disabled	1	* 64
RS 232 data output enabled	0	
Special function	1	* 32
Normal operation	0	
Negative slope of analogue output	1	* 16
Positive slope of analogue output	0	
Output without mean value	1	* 8
Output with mean value	0	
Switch 2 is NC	1	* 4
Switch 2 is NO	0	
Switch 1 is NC	1	* 2
Switch 1 is NO	0	
Digital output in BCD	1	* 1
Digital output in HEX	0	

Selecting the following settings the value of the Mode register parameter is the sum of all values:

MSB LSB

| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |

Mode register

Description	**bit**	**value**
Output if target betw. Sp and SP+Hyst	1*128=	128
RS 232 data output enabled	0* 64=	0
Normal operation	0* 32=	0
Negative slope of analogue output	1* 16=	16
Output with mean value	0* 8=	0
Switch 2 is NO	0* 4=	0
Switch 1 is NC	1* 2=	2
Digital output in BCD	1* 1=	1

$$p = \Sigma(\text{values(bits)}) = 147$$

The command for the setting is: @#M147<CR>

For each sensor series a special MODE register exists. You will find it in detail in the chapter: Programming of Sensors.

OFFSET ADJUSTMENT OF SENSOR

@aXp<CR> $1 \le p \le 255$ mm

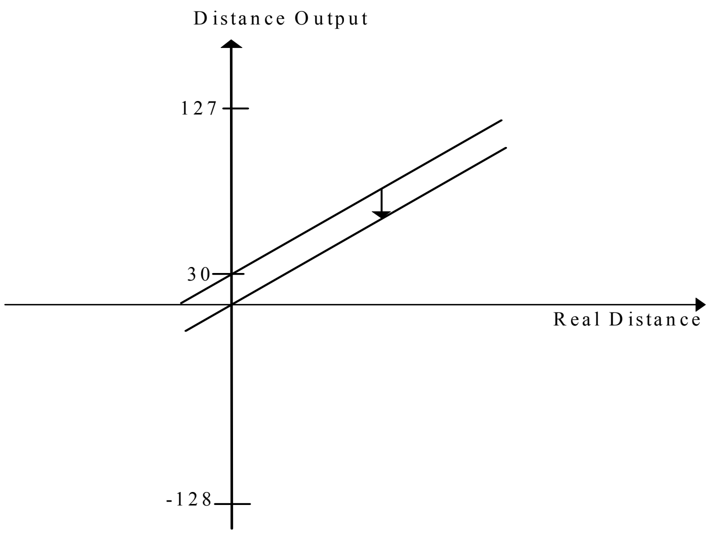
There can be a difference between distance output of the sensor and the real distance. The position of the distance 0 of the output and the location of the sensor face can differ. The position of the 0 can be adjusted with the sensor head offset adjustment.
0 < p < 128 is for positive offset shift, when the 0 of the distance output is in front of the sensor face. 126 < p < 256 is for negative offset shift, when the 0 of the distance output is behind the sensor face in the sensor.

Example for negative offset:

Offset -30 mm, the sensor output differs 30 mm. Output shows a value 30 mm too far.

Parameter p for negative values has to be calculated the following way:

$p = -30 + 256 = 226$



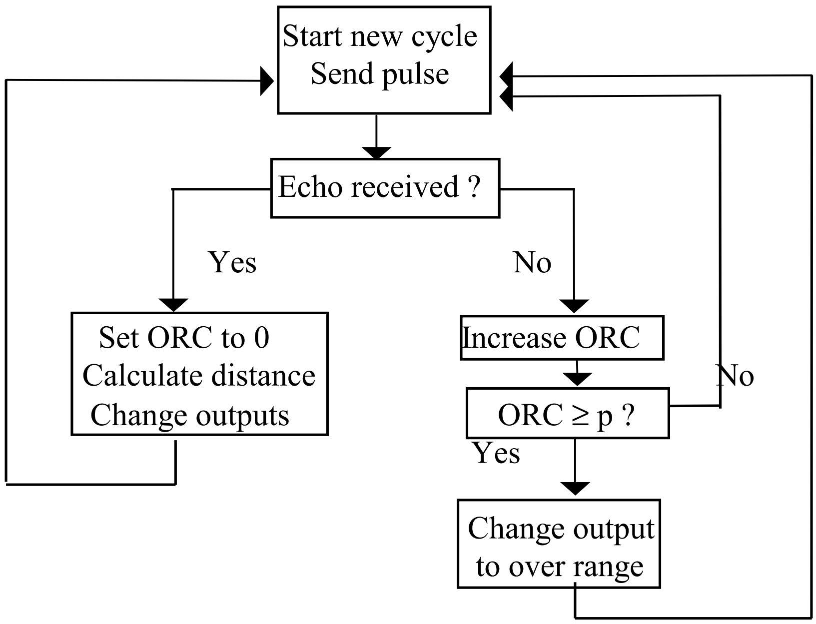
The offset can be adjusted with @aX226<CR>

OVER RANGE COUNTER

@aRp<CR> $1 \le p \le 255$

If the sensor has to measure the distance to a small target which is difficult to detect, it might happen that the sensor outputs will be very unstable. They will flicker between the actual distance and over range.

Controlling a process with these outputs might result in a catastrophe.
These abrupt changes can be suppressed with the **over range counter**.
It’s operation is shown in the flow chart:



At the begining of the measurement cycle, sensor is transmitting an ultrasonic pulse.

If an echo is received, the over range counter ORC will be set to 0, and the new measured distance calculated, if necessary the outputs changed and then the next ultrasonic pulse transmitted.

If no echo is received, the over range counter ORC will be increased.

If ORC below the parameter p no changes in the output will be made, the sensor will transmit a pulse during the next measurement cycle.

If ORC is equal or higher than p, outputs will be changed to over range and the sensor will transmit a pulse during the next measurement cycle.

Example:
A sensor with the following setting:
@aC64<CR>
@aR200<CR>
If suddenly the target disappears, the sensor needs 200*64 ms = 12.8 s until it's outputs change to over range.

FAIL PULSE SUPPRESSION

Sensor electronics are well protected against electromagnetic disturbances of the environment. In addition the microprocessor is used in a very effective way to filter the right signal out of noisy environment.
In this chapter the interested reader will be informed about the mechanism how fail pulse suppression by software is realised.
Factory settings are optimised to fulfil most of the measurement tasks. But sometimes in very special applications these information can be helpful to understand the behaviour of the sensor and to adapt it the best way.

With the **Mean Value Bit** in the **Mode Register** the software filtering and fail echo suppression is activated.

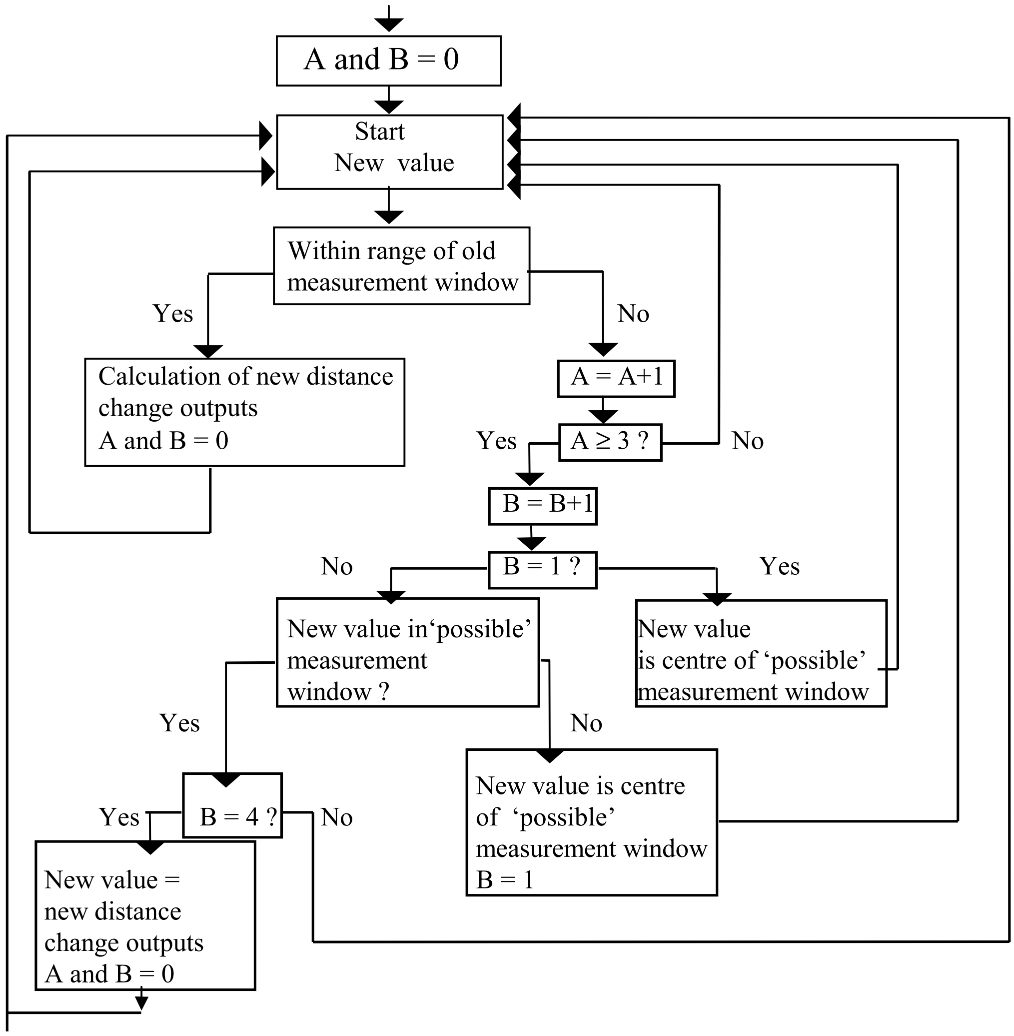
Around the actual measured distance a window is created with the size of normally ± 32 mm. This window is called **Measurement Window.** (For adjustment of this measurement window see the special point Measurement Window.)

If the next measurement / new value is within this measurement window it will be used to calculate the new distance which will then be displayed. Around this actual distance a new measurement window is placed.
Two counters one ‘A’ for the lock-out of the actual distance and the other ‘B’ for the lock-in are set to 0.

If the next measurement / new value is outside this measurement window this measurement will be ignored and the distance output will be unchanged.

> The counter counting the number of measurements outside which are not in the measurement window is increased from 0 to 1.
>
> If the **Lock Out Counter** A is below 3 (programmable) the program jumps back to the start and a new measurement is made.
>
> If it is higher or equal 3 the **Lock In Counter** B is increased.
>
> > If B = 1, the measured value is assumed to be the new distance and a new measurement window is created. The program jumps back to the start and a new measurement is made.
> >
> > If B > 1 and the new measurement is outside the new measurement window, B is set to 1 and the program jumps back to the start and a new measurement is made.
> >
> > If B = 4 (programmable) the new measurement now is realised as the new distance. Output is now changed and the lock out and lock in counters are set to 0. The program jumps back to the start and a new measurement is made.

The following diagram shows the different steps of the program.



LOCK OUT / LOCK IN COUNTER ADJUSTMENT

@aTp<CR> $1 \leq p \leq 255$

@aTp<CR> @aEp<CR> $1 \leq p \leq 255$*

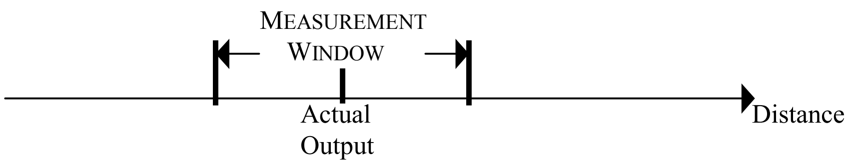
The values for counters A and B as described above can be set with the command T. Parameter p corresponds to a 8 bit, where the above 4 bits are used for the Lock In Counter B and the lower 4 bits are for the Lock Out counter A.

@aT67<CR> sets the Lock In Counter B to 4 and Lock Out Counter A to 3; HEX 43 corresponds to DEC 67. See BCD-HEX conversion list.

* In series P42-M0A-2D-1G1-xxxx the Lock-out and Lock-in counter are programmed separately with the commands:
@aTp<CR> @aEp<CR>

MEASUREMENT WINDOW

Operating the sensor with the mean value routine - the bit 'OUTPUT WITH MEAN VALUE' is set in the mode register- a window is created around the actual measured distance.
Measured distance values which are in this window will be taken into account for the calculation of the new distance. This new distance is then the new centre of the measurement window. The window is moving with the target movement.
The maximum speed of the window movement limits the speed of a target which should be detected. If the target moves faster, distance measurements will be ignored by the fail pulse suppression algorithm.
The maximum speed depends on the cycle time and on the size of the used measuring window.
With the command of cycle time adjustment it is also possible to adjust the measurement window.



Normal size of this measurement window is ± 32 mm.

Cycle Time and Measurement Window Adjustment @aCp<CR>

The command adjusting the cycle time can also be used for the Measurement Window adjustment. Following table is showing for different values of P the CYCLE TIME, the size of the MEASUREMENT VALUE and the MAXIMUM SPEED of the MEASUREMENT WINDOW.

COMMAND	**CYCLE TIME ms**	**WINDOW ± mm**	**MAX . SPEED OF WINDOW cm/s**
@aC0<CR>	4	32	400
@aC1<CR>	4	2	24
@aC2<CR>	4	4	50
@aC3<CR>	4	8	100
@aC4<CR>	4	16	200
@aC5<CR>	4	32	400
@aC6<CR>	4	64	800
@aC7<CR>	4	128	1600
@aC8<CR>	8	32	200
@aC9<CR>	8	2	12
@aC10<CR>	8	4	25
@aC11<CR>	8	8	50
@aC12<CR>	8	16	100
@aC13<CR>	8	32	200
@aC14<CR>	8	64	400
@aC15<CR>	8	128	800

COMMAND	CYCLE TIME ms	WINDOW ± mm	MAX . SPEED OF WINDOW cm/s
@aC16<CR>	16	32	100
@aC17<CR>	16	2	6
@aC18<CR>	16	4	12
@aC19<CR>	16	8	25
@aC20<CR>	16	16	50
@aC21<CR>	16	32	100
@aC22<CR>	16	64	200
@aC23<CR>	16	128	400
@aC32<CR>	32	32	50
@aC33<CR>	32	2	3
@aC34<CR>	32	4	6
@aC35<CR>	32	8	12
@aC36<CR>	32	16	25
@aC37<CR>	32	32	50
@aC38<CR>	32	64	100
@aC39<CR>	32	128	200
@aC64<CR>	64	32	25
@aC65<CR>	64	2	2
@aC66<CR>	64	4	3
@aC67<CR>	64	8	6
@aC68<CR>	64	16	12
@aC69<CR>	64	32	25
@aC70<CR>	64	64	50
@aC71<CR>	64	128	100

BCD - HEX CONVERSION LIST

	0	1	2	3	4	5	6	7	8	9
0	0	1	2	3	4	5	6	7	8	9
10	A	B	C	D	E	F	10	11	12	13
20	14	15	16	17	18	19	1A	1B	1C	1D
30	1E	1F	20	21	22	23	24	25	26	27
40	28	29	2A	2B	2C	2D	2E	2F	30	31
50	32	33	34	35	36	37	38	39	3A	3B
60	3C	3D	3E	3F	40	41	42	43	44	45
70	46	47	48	49	4A	4B	4C	4D	4E	4F
80	50	51	52	53	54	55	56	57	58	59
90	5A	5B	5C	5D	5E	5F	60	61	62	63
100	64	65	66	67	68	69	6A	6B	6C	6D
110	6E	6´F	70	71	72	73	74	75	76	77
120	78	79	7A	7B	7C	7D	7E	7F	80	81
130	82	83	84	85	86	87	88	89	8A	8B
140	8C	8D	8E	8F	90	91	92	93	94	95
150	96	97	98	99	9A	9B	9C	9D	9E	9F
160	100	101	102	103	104	105	106	107	108	109

For example: 88 BCD corresponds to 58 HEX

Software

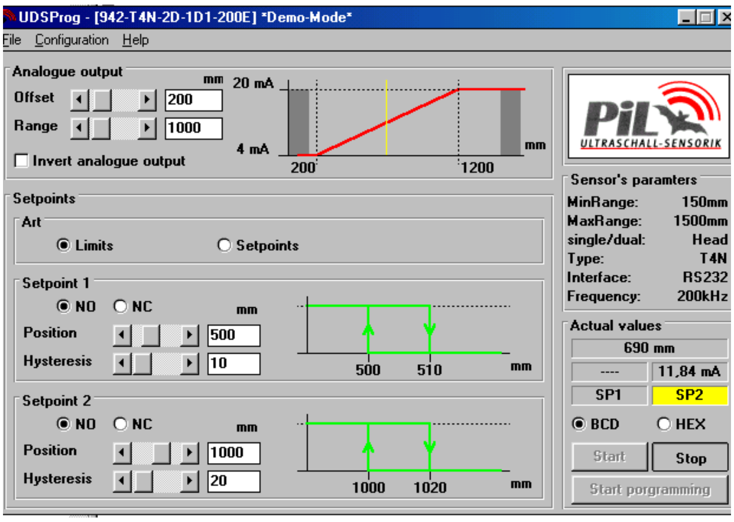
Communication with the PC can be done either:-
with the programs, we are distributing with our software tools or with your own GW-BASIC program shown in the next chapter.

Software Tools

UDSProg.EXE

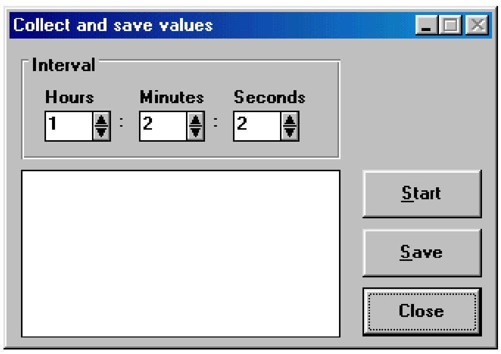
This program is the most easiest way to set up the sensor under a windows surface.
All settings can be done in a self explaining way.

Analogue output: the offset and the range can be selected in mm steps – either by scrolling the bars or directly by entering the wanted values. The sense of the slope can be inverted only by a mouse click. The result is shown directly graphically.
Set point outputs can be selected either as limit switches using the mode **Limits** or – using **Setpoints** as a range control where the range is defined by the set point and the set point + hysteresis.
Characteristics **NO** or **NC** of each switching output can be adjusted. Also **Position** and **Hysteresis** are adjustable in mm accuracy in the same way as the Offset and Range.



Clicking on File a menue with following possibilities is shown:

Save values	choosing this, a new window opens. Here the time between the measurement can be selected. From seconds over minutes to hours. These values can be stored and directly evaluated in Excel.



Write sensorparameters — writes the parameters of the actual dipplayed setting in a file on the disk. With the next command in this menue

Load sensorparameters — these values are loaded from the disk transferred into the sensor.

With the Configuration a special menue occurs offering following possibilities:

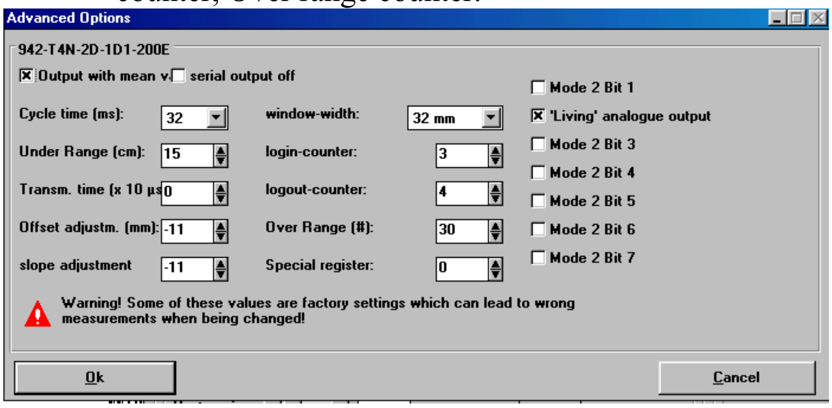
Read configuration from sensor: the actual configuration of the sensor will be shown.

Write configuration to sensor: the changed parameters shown on the screen will be transferred into the sensor. The same result is achieved by clicking onto the bottom Start programming on the main screen.

Initialize sensor: Sensor will be set to factory settings.

Configure sensor and interface: Sensor, comport … can be selected.

Advanced options: Cycle time, Under range, Transmitting time, Offset and Slope adjustment, Window width, Lock-in and Lock out counter, Over range counter.



Additional window in test-mode — In the start modus a separate window can be opened, where distance and status of switching output is displayed.

UDSDEMO.EXE

UDSDEMO (COMPORT)

This program diplays the actual measured distance on the screen. Pressing the <SPACE> bar changes the size of the characters.

Two programmes for supporting the programming of the sensors are available:
UDS*.EXE and SEND*.EXE.

* = E : english version
* = F : french version
* = D : german version

UDSE.EXE

UDSE (COMPORT)

With this programme the sensor parameter can be set on-line. There is a direct access to the RAM of the sensor, so settings will change immediately. The adjustment can be done in an experimental way step by step.

Using the parameter COM2 or 2; COM 2 of the PC will be used. If the parameter is missing, COM 1 will be used. All other adjustments of the interface - baud rate, parity etc. - will be done by this programme.

On the first screen the programmable sensor can be selected by typing the corresponding number.
Then the programming screen appears.

The screen is divided in three windows:

- **input** window,
- **output** window and
- a window with a **list of commands**.

(See picture)

Setting sensor into the 'HOLD' modus (connecting 'HLD' to GND) and pressing the space bar, a 4th window opens, displaying the **actual sensor settings** the sensor had at the moment the space bar was pressed. Whenever an update of these data is required, the space bar has to be pressed.

In the **input window** the commands sent to the sensor are displayed. If an error occurs during input please enter <CR> and repeat the correct command.

In the **output window**, the actual distance to the target is shown.

Example of the screen for programming the P42-M3A-2D-1G1-XXXX series:

********** PIL Sensoren GmbH ULTRASONIC DISTANCE SENSORS **************
********** P42-M3A-2D-1G1-XXXX **************

Command INPUT

@#S220
@#U100

*Distance OUT *

825
825
825
825
825
825
825
825
825
825
825
825
825
825
825
825

DESCRIPTION OF COMMANDS:

Comm	Function
@#UY	Dead zone 0<Y<255 in cm
@#OY	Analogue Offset 0<Y<10000 in mm
@#SY	Analogue Range 0<=Y<<10000 in mm
@#1Y	Set point 1 0<Y<10000 in mm
@#2Y	Set point 2 0<Y<10000 in mm
@#RY	Over range counter 0<Y<255
@#CY	Cycle. Time Y=64 64ms; 32 32ms; 16 16ms; 4 4ms
@#W	Setting to EEPROM
@#I	Load factory setting (220S) into RAM
@#D	Display RAM Settings
@#M	Mode Register (8 bit word)

BIT	Val	Function (1)	Function (0)
7	128	No Function	
6	64	Ser.data out RS232 disabled	-enabled
5	32	No Function	
4	16	Negative Slope anal. out.	-positive
3	8	Output without mean value	-with mean value
2	4	Use for FM heads	-AM heads
1	2	Switches set points in cm	-in mm
0	1	Front panel disabled	-enabled

If the '>' button is pressed, the actual sensor setting will be written in a file named **STATUS.TXT** in the currently used directory. Sensor settings listed in this file can be transferred with the programme sende.exe into the sensor.

SENDE.EXE
SENDE (FILENAME)(COMPORT)

The easiest way of storing sensor settings is to write the commands in an ASCII file. This will be the best solution for applications, where many sensors have to be programmed with the same settings.

The programme SENDE.EXE will adjust the interface - baud rate, parity etc. -, the transfer of all commands to into the sensor.
Parameter 1 (FILENAME) has to be the name of the ASCII file containing the commands.
Parameter 2 (Comport) can be used optionally for COM2.

In this file **commands** have to be always in the begin of the line and start with '@'. One line for each command. Lines not beginning with '@' are treated as **comments**. Comments also can be added behind the command, separated by a 'TAB' or 'SPACE' sign.

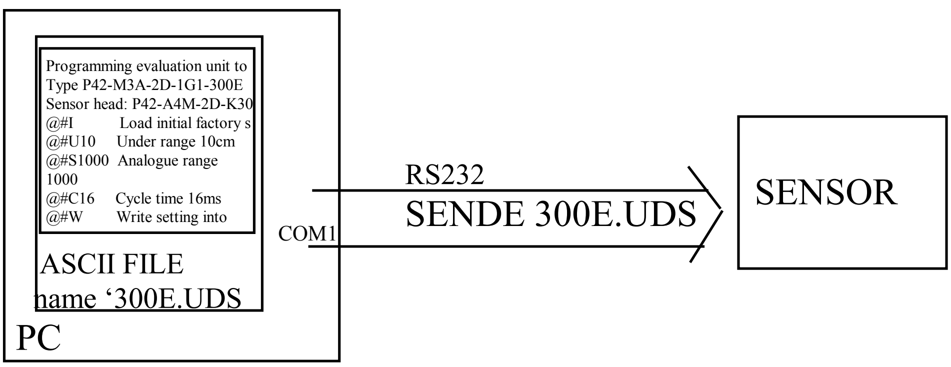
Example:
ASCII file for adjustment P42- evaluation box to the P42-M0A-2D-1G1-300E

File name: '**300E.UDS** '

```
Programming evaluation unit to
Type P42-M3A-2D-1G1-300E
Sensor head: P42-A4M-2D-K300E
@#I         Load initial factory setting
@#U10       Under range 10cm
@#S1000     Analogue range 1000mm
@#C16       Cycle time 16ms
@#W         Write setting into EEPROM
```

This file will be transmitted to the sensor:

SENDE 300E.UDS	via COM1 or
SENDE 300E.UDS COM2	and
SENDE 300E.UDS 2	via COM2.



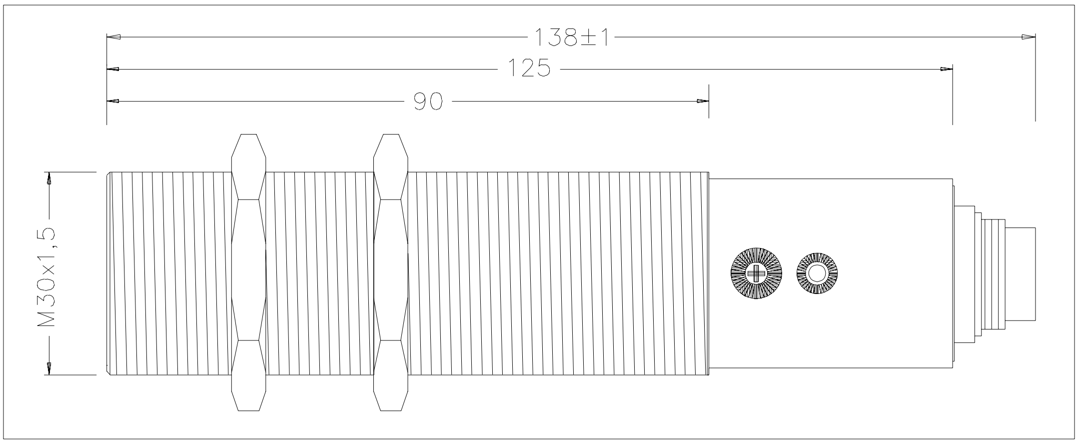
Two example of GW programs are shown:
Example 1
This program shows the measured distances on the screen.

```
100 REM * DEMO1.BAS    GW-BASIC Program *
110 REM * ! Sensor is operating in continuous mode ! *
120 REM * Distances are recorded in a string *
130 ON ERROR GOTO 200
140 OPEN ″COM1:9600,N,8,2″ AS #1
150 WHILE INKEY$=‘’’
160 IF NOT EOF(1) THEN LINE INPUT #1,C$:PRINT C$
170 WEND
180 CLOSE #1
190 END
200 IF ERR=57 THEN PRINT ″Device Error″: RESUME 150
210 IF ERR=69 THEN PRINT ″Buffer Overflow″:RESUME 150
220 STOP
```

Example 2
With this program the actual sensor setting is displayed on the screen. This program is written for the P42-A4N-2D-1.1-.... series.

```
 10 REM STATUS.BAS
 20 ON ERROR GOTO 350
 30 DEF FNDEC(H$)=(ASC(LEFT$(H$,1))-48+(ASC(LEFT$ (H$,1)) >58)*7)*16+ASC(RI
GHT$(H$;1))-48+(ASC(RIGH T$(H$,1))>58)*7
 40 CLS
 50 PRINT,″************************************************************ ″
 60 PRINT, ″***********      This program displays sensor settings   ***************″
 70 PRINT, ″***********          of  a P42-A4N-2D-1.1-xxxx           ***************″
 80 PRINT, ″************************************************************″
 90 REM OPEN ″COM1:9600,N,8,2″ AS #1
100 OPEN ″COM1:9600,N,8,2″ AS #1
110 PRINT #1,″@#D″
120 T=TIMER+.3
130 IF TIMER < T GOTO 130
140 LINE INPUT #1,D$
150 PRINT
160 PRINT″ Status of sensor: ″;D$
170 PRINT
180 PRINT″ Function″,,″Command″,,″Parameter″
190 PRINT″--------″,,″------″,″--------″
200 PRINT″Calibration slope    ″,″@#Y″,:PRINT USING″####″FNDEC(MID$(D$,2,2))
210 PRINT″Calibration offset   ″,″@#X″,:PRINT USING″####″FNDEC(MID$(D$,4,2))
220 PRINT″Mode register        ″,″@#M″,:PRINT USING″####″FNDEC(MID$(D$,7,2))
230 PRINT″Cycle time           ″,″@#C″,:PRINT USING″####″FIX(FNDEC(MID$(D$,9,2))/8)*8
240 PRINT″Under range          ″,″@#U″,:PRINT USING″####″FNDEC(MID$(D$,12,2))
250 PRINT″Addressode           ″,″@#A″,:PRINT USING″####″FNDEC(MID$(D$,14,2));:PRIN
T″ => ″;CHR$(FNDEC(MID$(D$,14,2)))
260 PRINT″Fail echo suppression″,″@#T″,:PRINT USING″####″FNDEC(MID$(D$,17,2))
270 PRINT″Over range counter ″,″@#R″,:PRINT USING″####″FNDEC(MID$(D$,19,2))
280 PRINT″Analogue offset      ″,″@#O″,:PRINT USING″####″FNDEC(MID$(D$,22,2))
290 PRINT″Analogue range       ″,″@#S″,:PRINT USING″####″FNDEC(MID$(D$,24,2))
300 PRINT″Hysteresis 1         ″,″@#H″,:PRINT USING″####″FNDEC(MID$(D$,27,2))
310 PRINT″Hysteresis 2         ″,″@#G″,:PRINT USING″####″FNDEC(MID$(D$,29,2))
320 PRINT″Set point 1          ″,″@#1″,:PRINT USING″####″FNDEC(MID$(D$,32,2))*256+
FNDEC(MID $(D$,34,2))
330 PRINT″Set point 2          ″,″@#2″,:PRINT USING″####″FNDEC(MID$(D$,37,2))*256+
FNDEC(MID $(D$,39,2))
340 END
350 IF ERR=57 THEN RESUME 150
360 IF ERR=24 THEN PRINT ″No sensor connected″
370 PRINT ″Error″;ERR;″ in Line ″;ERL
380 STOP
```

P42-T4N-2D-1C1-200E/ 130E
P42-T4N-2D-1D1-200E/ 130E
P42-T4N-2D-1E1-200E/ 130E
P42-T4N-2D-1F1-200E/ 130E



P42-T4N-2D-1C1-200E/ 130E
P42-T4N-2D-1D1-200E/ 130E
P42-A4N-2D-1E1-200E/ 130E
P42-A4N-2D-1F1-200E/ 130E

* PROGRAMMABLE
* ANALOGUE AND SWITCHING OUTPUTS
* REPEATABILITY ± 1 MM

Listings:

All sensors are equipped with 2 programmable PNP switching outputs.
Listing includes 8 pin connector : 66195126-001

Sensors with RS 232 interface:
Sensors with 0 to 10 V analogue output

	Analogue output	Sensing range in mm
P42-T4N-2D-1C1-130E	0 to 10 V	300 to 3000
P42-T4N-2D-1C1-220S	0 to 10 V	150 to 1500
P42-T4N-2D-1D1-130E	4 to 20 mA	300 to 3000
P42-T4N-2D-1D1-220S	4 to 20 mA	150 to 1500

Sensors with RS 485 interface:

	Analogue output	Sensing range in mm
P42-T4N-2D-1E1-130E	0 to 10 V	300 to 3000
P42-T4N-2D-1E1-220S	0 to 10 V	150 to 1500
P42-T4N-2D-1F1-130E	4 to 20 mA	300 to 3000
P42-T4N-2D-1F1-220S	4 to 20 mA	150 to 1500

P66195126-001	Standard connector
P55195126-001	Connector with 2m cable
P55000005-002	Programming adapter
P55195101-101	Program. software incl. cable with 1 sub min D9 connector
P55195101-102	Program. software incl. cable with 2 sub min D9 connector
P55000003-002	RS232-RS485 interface
P66195116-001	Compact beam deflector
P43192871-001	Beam deflector
43192871-002	Focusing beam deflector
P43178389-030	Mounting clamp 30 mm
STV.2413.574.00262	Mains filter

Technical Data

Specifications at 25° typically

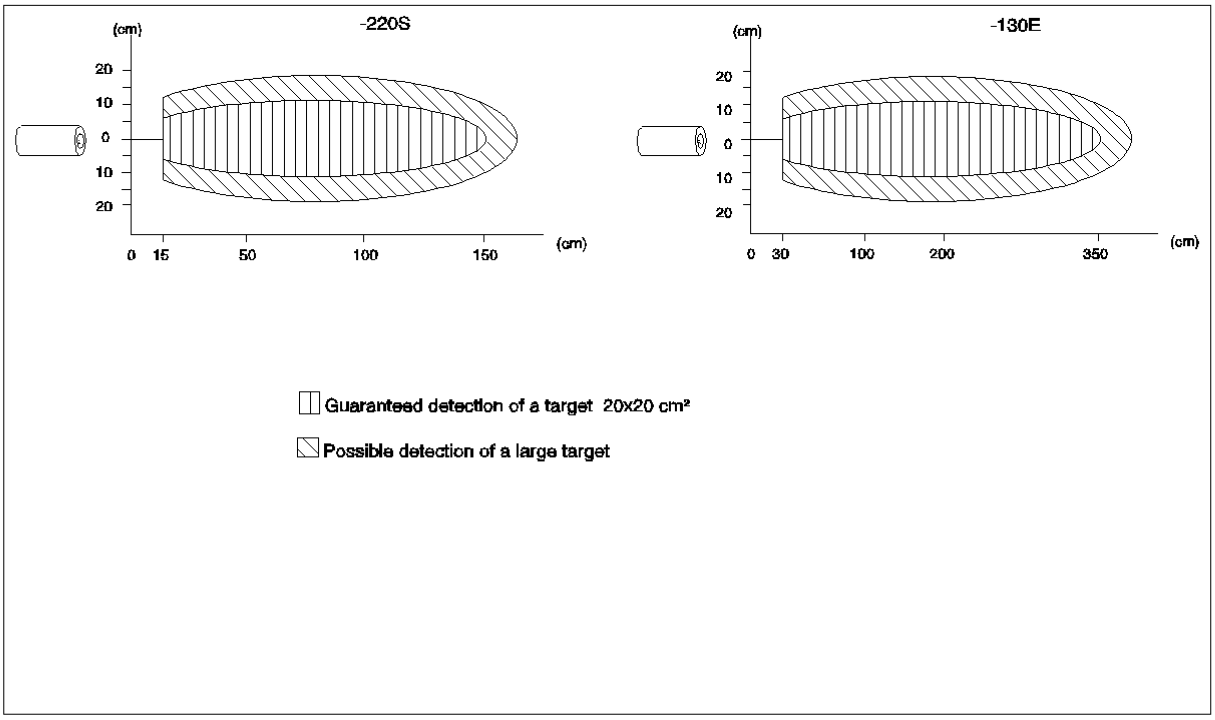
	-130E	-200E	
Max. Range mm	3500	1500	
Min. Range mm	300	150	
Beam angle(°)	8	8	
Carrier frequency (kHZ)	130	200	
Temperature compensation (°C)	Yes	Yes	
Interface	RS232 /RS485	RS232/RS485	RS232
Analogue output (V) or (mA)		0–10 or 4-20	
Repeatability (mm)		± 2 ±0.4%	
Response time (ms)		100	
Linearity (%)		± 0.5 / 3mm	
Output adjustment		Prog.	
Switching outputs		2 NO/ NC ; PNP	
Hysteresis (% of set point)		Prog.	
Switching frequency (Hz)		Prog. 5-30	
Output circuit		Open collector 100 mA	
Set point adjustment		Prog.	
Information output		Serial HEX/BCD	
Alignment LED		Yes	
Adjustable sensitivity		Potentiometer	
Control inputs		Hold/Synchronisation	
Temperature range (°C)		-15-+70	
Storage temperature range (°C)		-25-+85	
Supply voltage (V)		19-30	
Current consumption without load (mA)		<=25	
Circuit protection			
Reverse polarity on supply lines		Yes	
Voltage spikes on supply and output lines		Yes	
Short circuited switching output		Yes	
Sealing IP		65	
Housing		Stainless steel	

Hold/synchronisation input

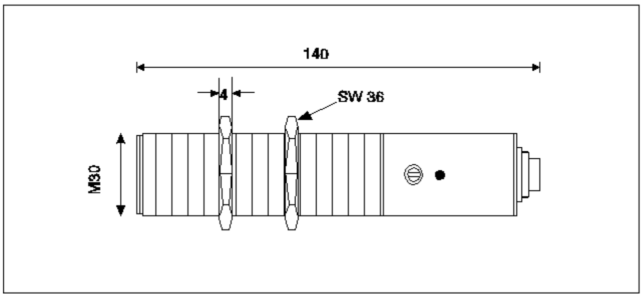
If a measurement is only to take place in a certain instant, the sensor transmit and receive can be suppressed by a LOW (0V) at the hold HLD input. The last calculated distance is stored and output. During programming the HLD input should also be connected with the HLD line. If the sensor is enabled once more (HLD open or HIGH), a new output occurs after completion of a measurement cycle.

Synchronisation
To avoid mutual interference from several sensors, these are very simply synchronised by interconnecting the hold inputs.

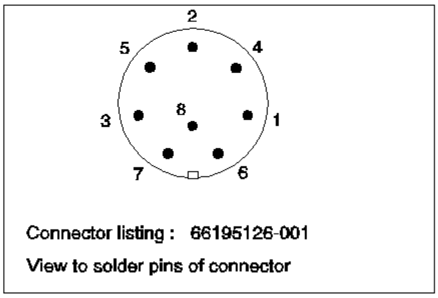
Detection cone



Dimensions mm



Connector Pins

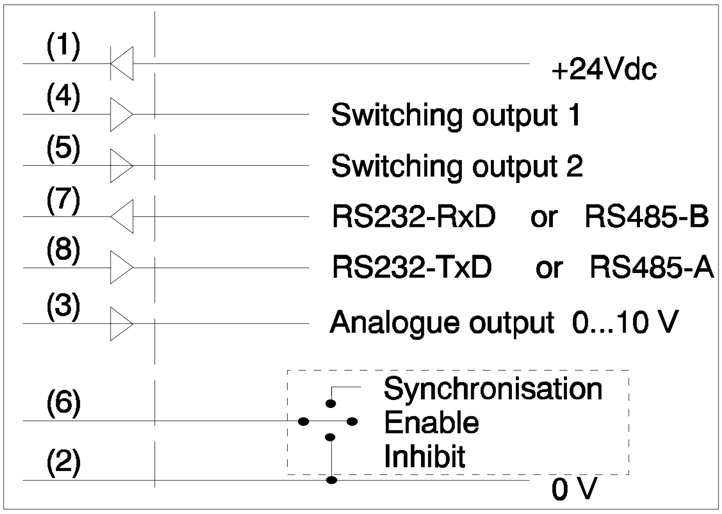


Wiring

Pin Function

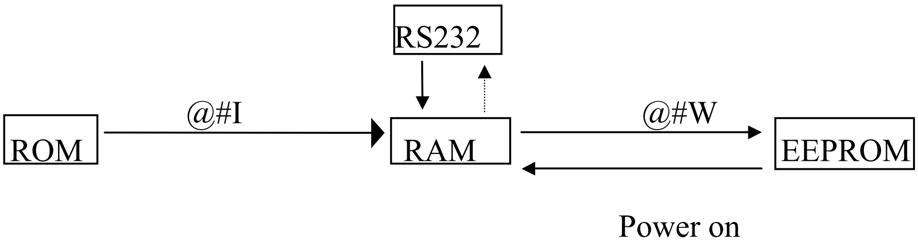
1	24 V= Supply
2	0 V GND
3	Analogue Output; 0 to 10 V
4	Switching output 1 (PNP)
5	Switching output 2 (PNP)
6	Transmit inhibit;/ Synchronisation HLD
7	RS232 RxD or RS485-B
8	RS232 TxD or RS485-A

Wiring Diagram



PROGRAMMING THE P42-T4N-2D-1C/D/E/F1-XXXX SENSOR SERIES

Structure of Memory Organisation



Programming instruction

During programming connect HLD (6) with GND (2).
Set baudrate fix to 9600,N,8,2 (no parity bit, 8 data bits and 2 stop bits).

Structure of commands

Each command has the same structure: @aBp<CR>

@	Beginning of command, always identical
a	Address of sensor; with '#' all sensors will be addressed
B	Command
p	Parameter
<CR>	End of command CR=ENTER=#13

A file containing only ASCII signs can be copied with the DOS command ‘COPY file.ext COM1’ via the interface into the evaluation electronics. As the sensor needs time for interpretation, the file may contend only one command. Time needed between different commands is around 1 ms. A more simple way to program the sensor is the use of the programs **UDSE.EXE** or **SENDE.EXE** available as accessories.

List of Commands:

Load factory setting into RAM **@#I<CR>**
The initial setting will be written from the EEPROM into the ROM. Factory settings added to the following commands are marked with a *.

Write actual setting into the EEPROM **@#W<CR>**
The actual setting will be written into the EEPROM. The content of the EEPROM will be loaded into the RAM after connecting power to the sensor.

Change sensor address from A to ASC(Y) @aAp<CR> p see list page 9 @aA97*
ASC(97) = a

Adjustment of the analogue output range @aSp<CR> 0≤p≤1000 mm @aS200*
Output range is the range were the analogue output is changing between 0 to 10V. An analogue output range of 200 means that within 200 cm the analogue output value changes from 0 to 10V or 4 to 20 mA.

Offset of the analogue output **@aOp<CR>** 0≤p≤1000 mm @aO0*
Offset of the analogue sensor is the distance from the sensor head to the beginning of the analogue output range. With an offset of 50 the analogue range begins 50 cm in front of the sensor. With normal slope of the output it starts with the lowest analogue value (0 V or 4 mA) and with inverted slope with the highest analogue value (10 V or 20 mA).

Switching output adjustments

Set point 1	**@a1p<CR>**	0≤p≤10000 mm	@a500*
Set point 2	**@a2p<CR>**	0≤p≤10000 mm	@a1000*

Hysteresis adjustments of the switching outputs

Hysteresis set point 1	**@aHp<CR>**	0≤p≤255 mm	@aH10
Hysteresis set point 2	**@aGp<CR>**	0≤p≤255 mm	@aG10

Under range adjustment **@aUp<CR>** 0≤p≤255 @aU15*
Parameter p defines the dead zone of the sensor. Echoes from targets in this zone will be ignored.

Cycle time adjustment **@aCp<CR>** @aC32*
With the cycle time also the max. detection range is determined. Following values could be selected:
Command/ Cycle time/ max. range: @aC64<CR> 64ms 10m; @aC32<CR> 32ms 5m; @aC16<CR> 16ms 2.5m; @aC8<CR> 8ms 1m; @aC4<CR> 4ms 0.3m.
With the 3 LSBits size of the widow for the mean value calculation is adjusted. (Size= $\pm 2^x$).

Offset adjustment **@aXp<CR>** 0≤p≤255 @aX238*
depends on sensor
There could be a difference between distance output and the real distance. 0<p<128 the offset is positive the 0 of the sensor is in front of the sensor face. 127<p<256 the offset is negative, the 0 of the sensor is behind the sensor face in the sensor. Negative offsets are adjusted the following way: Offset=-30 the sensor output is 30 mm too far -30+256=226 => @aX226<CR>

Over range counter **@aRp<CR>** 0<p<256 @aR30*
Parameter p is the number of cycles where no echoes are received before the output of the sensor indicates the over range.

Fail echo suppression counter **@aTp<CR>** 0≤p≤255 @aT52*
Upper 4 bits of parameter is the setting for the Lock-In Counter and lower 4 bits is the setting for the Lock Out Counter. Factory setting p=34, 34 HEX corresponds to 52 BCD.

Read out sensor setting **@aD<CR>**
The status will be returned via RS232 from the sensor. Information of consist of 8 HEX words:

	$****	$0125	$0F61	$341E	$00C8	$0A14	$01F4	$03E8
Corresponding commands:	Y X	M C	U A	T R	O S	Hyst1,2	1	2

(See detailed listing next page)

Read out of one Distance Measurement **a<CR>**
If sensor is HOLD-mode (HLD connected with GND) this command allows to take only one read out of a distance measurement. If during this measurement fail echo supression is done, the measurement is repeated until a valid value is on the output. Instead using the sensor address a, # can also be used.

Mode Register **@aMp<CR>** 0≤p≤255 @aM1*
Value of parameter p is between 0 and 255. It is determined by combination of following bits.

Name.	Bit	Value	Function (1)	Function (0)
SET	7	128	Range detection switching outputs	Normal switching function
SAO	6	64	Serial output disabled	Serial output enabled
HFT*	5	32	Special triggering of Echo	Normal triggering
INV	4	16	Negative slope analogue outputs	Positive slope
MWO	3	8	Output without mean value	With mean value
NC2	2	4	Switch 2 is NC	Switch 2 is NO
NC1	1	2	Switch 1 is NC	Switch 1 is NO
BCD	0	1	Digital output in BCD	Digital output in HEX

* HFT bit is recommended to be set to 0

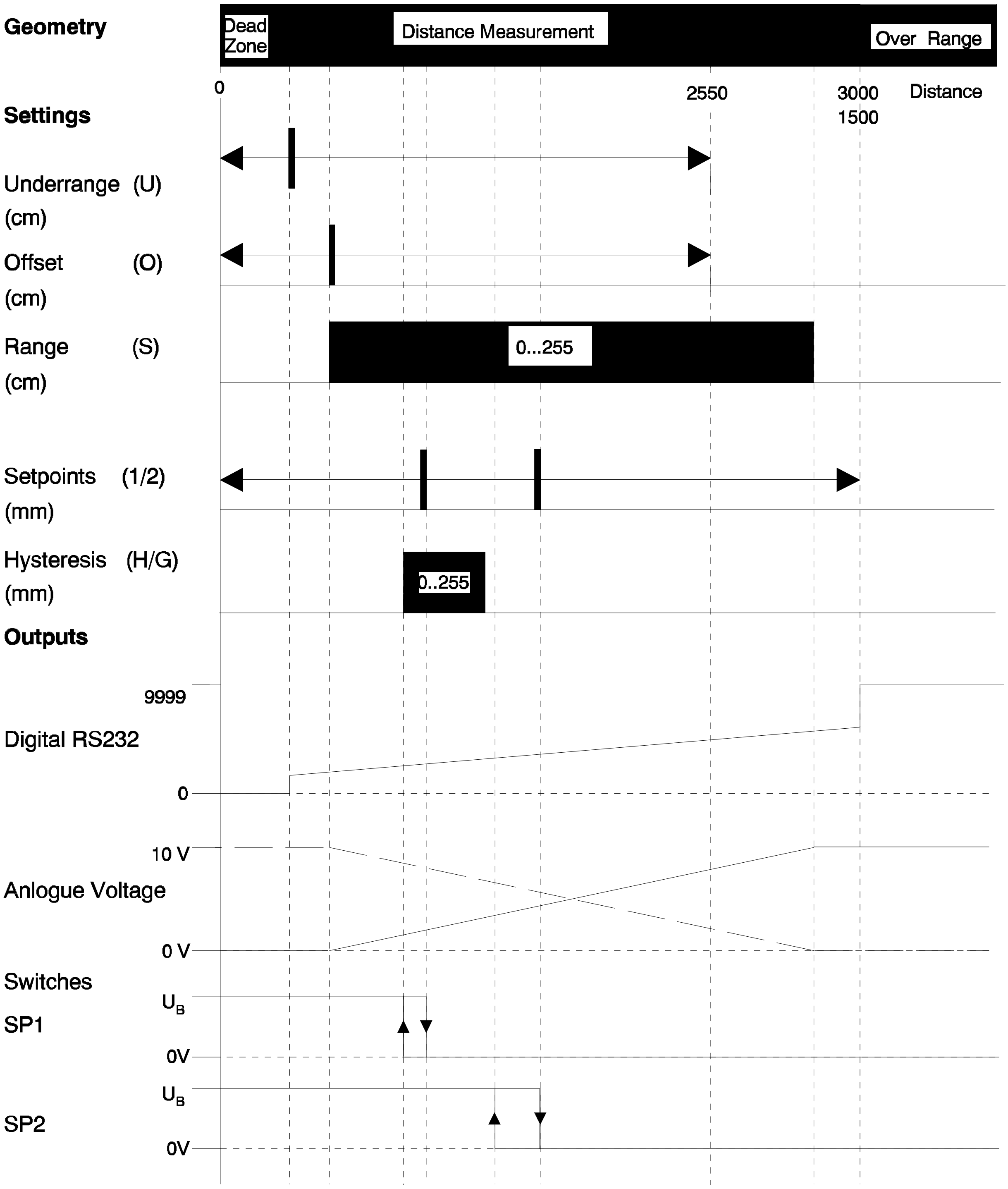
Example:
1 0 0 1 0 1 0 1

1*1	=	1	Output in BCD
0*2	=	0	Switch 1 is NO
1*4	=	4	Switch 2 is NC
0*8	=	0	Output with mean value
1*16	=	16	Negative slope of analogue output
0*32	=	0	Normal triggering
0*64	=	0	Enable serial asynchronous data output
1*128	=	128	Range detection of switching outputs
Total:		149	

Command for mode register: @aM149<CR>

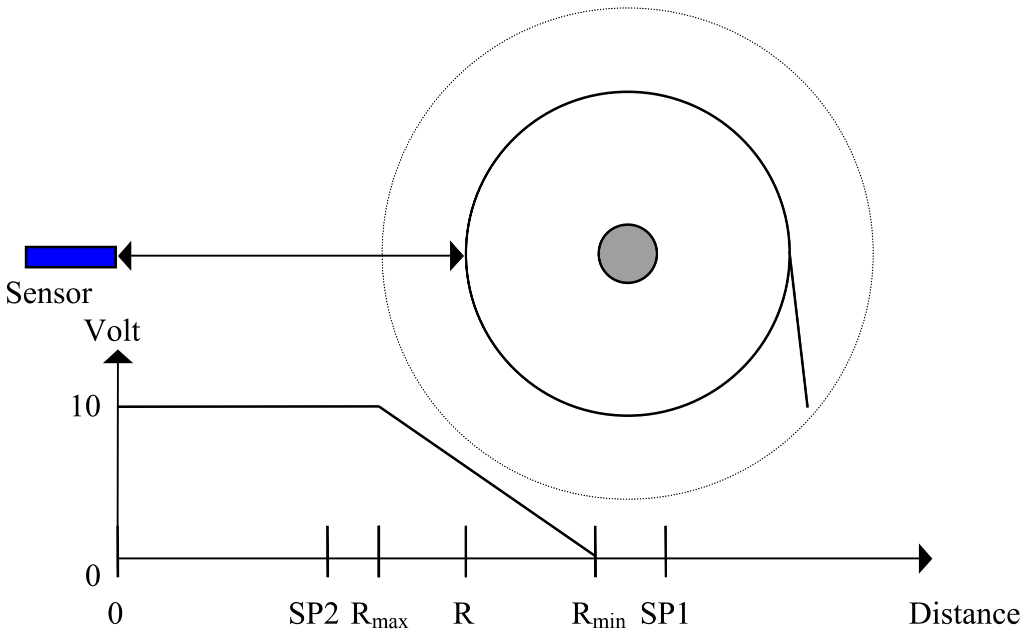
Read out actual sensor settings

Output	Factory Setting		Description
	HEX	BCD	
$1A1B			Word 1
1A1B	**	**	Factory setting
$2A2B			Word 2
2A	01	01	Mode register
2B	25	37	Cycle time
$3A3B			Word 3
3A	0F	15	Under range setting (cm)
3B	61	97	Address of sensor "a"
$4A4C			Word 4
4A	34	52	Factory setting
4C	1E	30	Over range counter
$5A5B			Word 5
5A	0	0	Offset of analogue range
5B	C8	200	Analogue output range (cm)
$6A6B			Word 6
6A	0A	10	Hysteresis set point 1 (mm)
6B	14	20	Hysteresis set point 2 (mm)
$7AAA			Word 7
7AAA	1F4	500	Set point 1 (cm)
$8AAA			Word 8
8AAA	3E8	1000	Set point 2 (cm)


Geometry
Dead Zone
Distance Measurement
Over Range
0
2550
3000
1500
Distance
Settings
Underrange (U)
(cm)
Offset (O)
(cm)
Range (S)
(cm)
0...255
Setpoints (1/2)
(mm)
Hysteresis (H/G)
(mm)
0..255
Outputs
9999
Digital RS232
0
10 V
Anlogue Voltage
0 V
Switches
SP1
U_B
0V
SP2
U_B
0V

Examples

Winding / unwinding control
P42-T4N-2D-1C1-220S
Diameter measurement of thin material.
Maximum coil diameter: 1.4 m.
Core diameter of coil :   0.2 m
Check if coil is in place.
Switch off if coil diameter is bigger than 10% of max. coil diameter.
Distance sensor - centre of coil: 1.1 m
0 V at minimum coil diameter
10 V at maximum coil diameter



Setting:
Mode register:
0 0 0 1 0 0 0 1

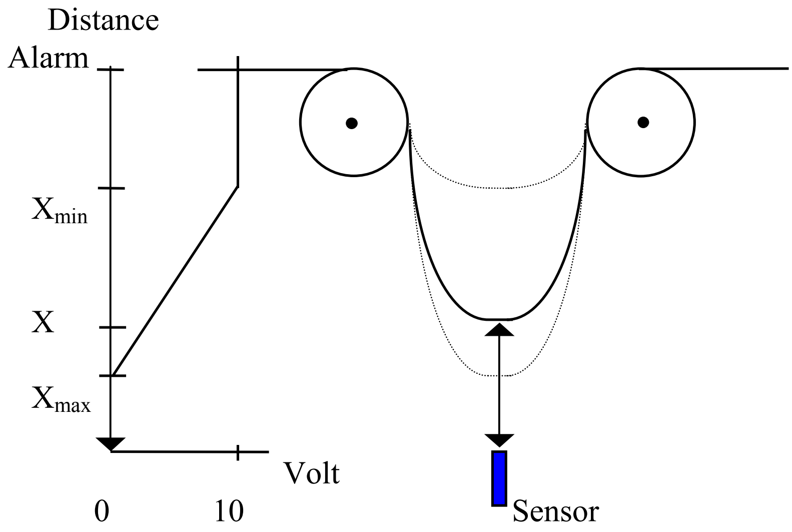
1*1=	1	Output in BCD
0*2=	0	Switch 1 is NO
0*4=	0	Switch 2 is NO
0*8=	0	With mean value routine
1*16=	16	Negative slope of analogue outputs
0*32=	0	Normal triggering
0*64=	0	Serial output enabled
0*128=	0	Normal switching function
Total:	17	

@aM17<CR>
@a11200<CR>   Check if coil is in place
@a2330<CR>   Coil diameter bigger than 10% of max. diameter
@aO400<CR>   Offset of analogue range
@aS600<CR>Range of analogue output

Slope control

P42-T4N-2D-1C1-220S

Stock of material before it enters pressing process.
Maximum slope 1800
Minimum slope 300
Alarm if no slope; material might be stretched.
Alarm if slope larger than maximum.
Distance sensor - Slope = 2.2 m.



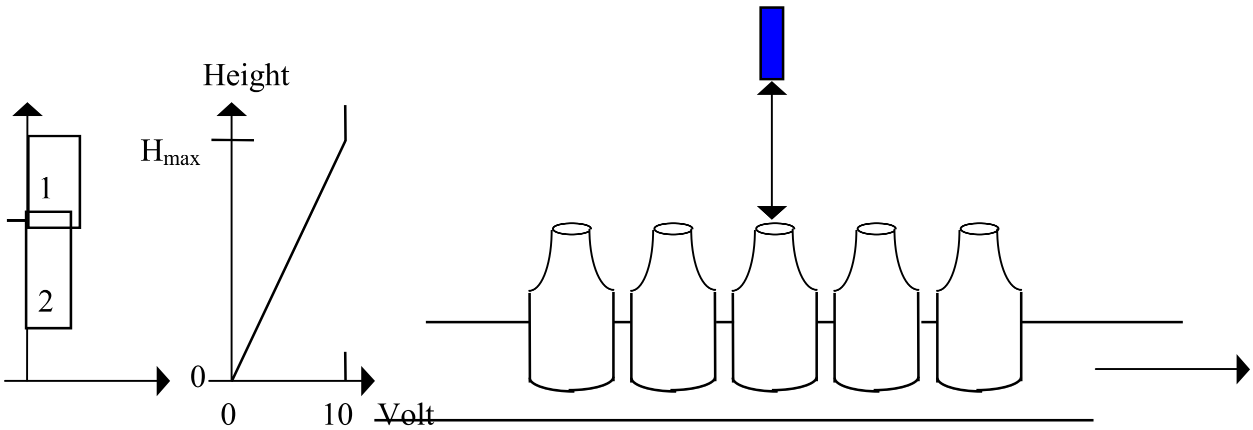
Setting:
Mode register:
0 0 0 0 0 0 1 1

1*1=	1	Output in BCD
1*2=	2	Switch 1 is NC
0*4=	0	Switch 2 is NO
0*8=	0	With mean value routine
0*16=	0	Positive slope of analogue outputs
0*32=	0	Normal triggering
0*64=	0	Serial Output enabled
0*128=	0	Normal switching function
Total:	3	

@#M1<CR>
@#12200<CR> Alarm „material might be stretched“ SP1.
@#H0<CR> Hysteresis set point 1 = 0 mm.
@#2400<CR> Alarm slope too large.
@#G10<CR> Hysteresis set point 2 = 10 mm.
@#O400<CR> Offset of analogue range.
@#S1500<CR> Analogue range.
@#R255<CR> Over range counter to maximum to suppress fail signals if slope is swinging and not all echoes are detected.

Rapidly changing targets
P42-T4N-2D-1C1-220S

Check of correct bottles by sorting of height.
Correct bottle height: 250 mm
Maximum height: 300 mm
Distance sensor conveyor: 450 mm
Following switching output information desired:
Bottle too high: height 255 to 350 mm
Bottle too small: height 5 to 245 mm
Correct bottle: height 245 to 255 mm



Setting:
Mode register:
1 1 0 1 1 0 0 1

1*1	=	1	Output in BCD
0*2	=	0	Switch 1 is NO
0*4	=	0	Switch 2 is NO
1*8	=	8	Output with mean value
1*16	=	16	Negative slope of analogue output
0*32	=	0	Normal triggering
1*64	=	64	Disable serial asynchronous data output
1*128	=	128	Range detection of switching outputs
Total:		217	

@aM217<CR>	
@aC4<CR>	Cycle time 4 ms
@aO150<CR>	Offset of analogue range
@aS300<CR>	Analogue range
@a1100<CR>	Set point 1 at 100 mm
@aH105<CR>	Hysteresis set point 1 = 95 mm. Switching output 1 switches if top of the bottle is in range 1.
@a2195<CR>	Set point 2 at 195 mm.
@aG250<CR>	Hysteresis set point 2 = 250 mm. Switching output 2 switches if top of the bottle is in range 2.

	Switching output 1	Switching output 2
Bottle too high:	ON	OFF
Bottle too small:	OFF	ON
Bottle correct height:	ON	ON

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