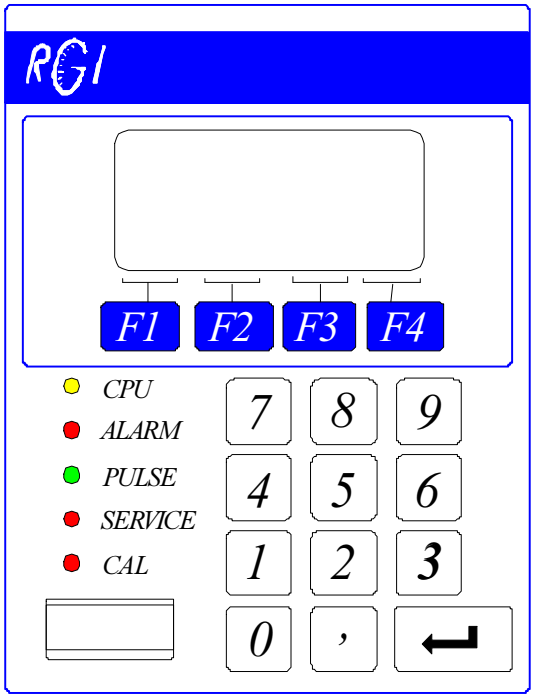
INDUSTRIEMESSGERÄTE GMBH

Manual

Pocon 21



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Content

1 Summary *POCON 21*

POCON 21 is a microcomputer specially outlayed for the potassium measurement at saturation volumina. By choice of the adequate detector (2π or 4π-geometry) the instrument can be optimized for your measurement task as well for liquids as for solids. The calibration will deliver the percentage of KCl or K_2O . The internal data table stores up to 20 reference values.

For the potassium measurement *POCON 21* offers two operating modes. One is for a continuous measurement, the other is a batch mode with start and stop signals.

All in- and outputs are insulated form the computer ground and protected against pole reversal. The potassium percentage is available as an analogue 0/4-20mA signal with 10 bit accuracy (precision better than 0.5%).The scaling can be defined freely.

Details to the factory setup of the *POCON 21* and to the electrical connections are given at the appendix.

2 Structure of the menu based software

The main menu contains following functions:

MEASUREMENT	F1
CALIBRATION	F2
PARAMETER	F3
SERVICE	F4

The softkeys F1 to F4 guilds you through the program. A function can be selected by pressing the corresponding softkey. Depending on the requirements of the menu or submenu the softkeys changes their function. Pressing a valid key will be confirmed by a short acoustical signal. Pressing an invalid key will be ignored (no signal):

MEASUREMENT is the most frequently used screen. It displays the actual measurement value and appears at startup automatically.

CALIBRATION contains all functions for the assignment of the measured values to the reference values (lab. values). The calibration function will be computed automatically using a linear regression approach.

PARAMETER contains all system parameters for the adjustment of the instrument to the actual measurement task.

SERVICE delivers an overview of the status of all interfaces. This function is only used for service purposes (for installation or for changing the factory setup).

A detailed overview of the menu handling is given at the appendix MENU. The most important program instructions are explained step by step with flow charts.

3 Password request

To avoid changes of parameters by unauthorized persons, you must enter a password to change parameters. The visualization of the parameters is not protected. The password request is indicated by ****.

Entering the password activates the service mode (diagram). The service mode is indicated by a status LED at the front side of the instrument. It allows the consecutive input of several parameters. The service mode can be finished by a softkey. After 20 minutes the service mode will terminated automatically if no key is pressed in this time.

DATA RECORDS	
EDIT	F1
REGRESSION	F2
CODE	ESC

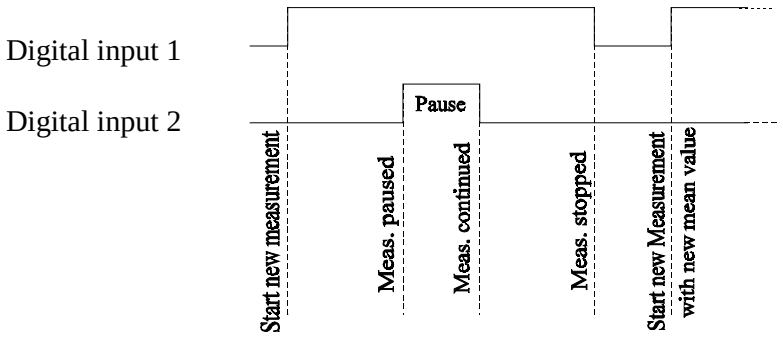
4 Measurement

For the measurement of the potassium content the radiation of the natural potassium isotope K40 is detected. Due to the long life time and the constant concentration of this isotope in natural potassium the K40 concentration is a measure for the total potassium content in a sample. The calibration eliminates environmental effects or effects of the sample composition.

Two measurement modes are available:

1. Continuous measurement: The measurement value is given by the running mean value of the average time. Always the value of the average time is a compromise between a good accuracy (averaging over a long time) and a good time resolution of the signal (averaging over a short time). So the average time must be determined individually concerning the measurement task.

2. Charge measurement: The measurement is controlled by Start/Stop/Break signals. The signals can be provided by digital inputs or manually by the keyboard. The measurement time and therefore the achievable precision were determined by the time interval between the start and stop signal.



Accuracy Considerations

The potassium measurement is based on the radioactive decay of the potassium isotope K40. Therefore the achievable precision underlies the statistical behaviour of the stochastic nuclear decay process. A measurement delivers only a statement over a mean value ("there is a mean value of decays per second available for the measurement"). The uncertainty or the error of this mean value is given by the standard deviation.
This error decreases with the square root of the measurement time. For example a four times increased measurement time gives only a two times improved precision.

The potassium content is calculated with the following formula using the mean count rate per second (**MZR**):

$$\text{Potassium} = Ka * \mathbf{MZR} + Kb$$

Ka and Kb are constants given by the calibration of the POCON 21 (see also next section).

The standard deviation σ, which can be regarded as the measurement error, can be calculated by

$$\sigma = Ka * \sqrt{\frac{MZR}{meas.time}}$$

In case of a batch measurement the measurement time is exactly the time between the *start* and *stop* signal. In the continuous mode the measurement time corresponds two times the averaging time.

At POCON 21 the display of the standard deviation can be switched on or off.

5 Calibration

The potassium content is calculated by a mathematical formula using the mean count rate of the potassium detector (ref. chapter 3). The parameters Ka and Kb fits the formula to the measurement setup. Ka adjusts the sensitivity of the detector and Kb compensates the mean natural radioactive count rate (background radiation)..
Both parameters cannot be predicted very accurately. They depend on the distance between detector and the sample, the shape and material of the container and other factors in a complex manner.

The calibration is the procedure to determine these coefficients Ka and Kb precisely. The calibration is based on data records gathered in some calibration runs. During a calibration run the computer reads the count rate of the potassium detector once per second, averages the count rates and stores the mean value in a data table. For this calibration run a reference value of the potassium content is required. The reference value must be representative for the material measured during the run. A precise calibration is only performable with precise reference values. The potassium reference value is to be entered in the corresponding data record in the data table.

For achieving a high accuracy over the complete measurement range the potassium values of the different calibration runs must cover the complete potassium range which should be measured. The coefficients Ka and Kb, which are used for calculating the potassium content from the count rate of the potassium detector, are determined from the calibration data records by a linear regression.

POCON 21 is able to store up to 20 data records. The user can mark an arbitrary combination of data records for the calibration. The calibration uses only the marked data records for the determination of the coefficients Ka and Kb.

Is only one data record marked in the data table automatically a single point calibration is performed giving only the coefficient Ka. Kb remains unchanged.

6 Parameter

In this menu the analogue and digital outputs can be scaled and the measurement and calibration parameters can be edited. After selecting the envisaged parameter a value can be entered by the numerical key pad. The value will be accepted by pressing the < 5> key.

AVERAGE TIME
(0 – 9999s)
TIME: 10s
9 8 CODE ESC

Average time
The average or integration time determines the precision of the measurement. A fast change of the measuring signal will be reproduced to 63% after one time constant (one integration time).

CALIBRATION
TIME
(0 – 9999s)
TIME : 10 s

Calibration time
Input for the duration of a calibration run.

COEFFICIENTS
KA . 0.009
KB : 1.019
9 8 +/- ESC

Coefficients
Display and editor of the calibration coefficients Ka and Kb.

THRESHOLDS
DIGITAL OUTPUTS

9 8 6 ESC

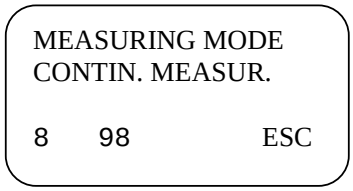
Thresholds for the digital outputs
Display of the thresholds. Lower and upper threshold can be edited. If the measurement value leaves the range defined by

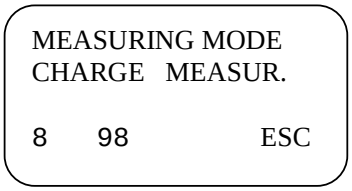
thresholds the corresponding relay will set.

SCALING
CURRENT OUTPUT

9 8 6 ESC

Scaling of the current output
Here the potassium contents are assigned to the minimal and Maximal output current.





Measuring mode

The adequate measuring mode depends on the measuring task. In the continuous mode the measurement values were determined by continuous averaging the secondly acquired count rates.

For charge measurements the batch mode can be used. Here the measurement is started or stopped by a keyboard entry or controlled by external signals which are connected to the digital inputs of the instrument. Also the measurement can be paused by an external signal .

7 Service

This menu point gives access to different values and parameters, which only are necessary for the installation or trouble shooting.

Raw data
The raw data screen allows the control of the signals, which should lay at the clamps of the POCON 21:

Counter input:	Shows the pulse rate per **counting interval**
Current output:	Value in mA.
Digital inputs:	**0**: voltage < 0.8V **1**: voltage >2.4V
Relay:	**0**: Relay open **1**: Relay closed
Digital outputs:	**0** means a voltage < 1.5V, **1** means 15V, without an external voltage supply U_{SS} or U_{SS} with a connected external voltage supply .

Standard data

The standard data screen shows the levels and signals internally used by the POCON 21.

Counter input:	Shows the pulse rate per **second**.
Current output:	Current value, normalized to 100% Example: Display 25% means at Setup 0-20mA : 5mA Setup 4-20mA : 8mA
Digital inputs:	**0**: input inactive, **1**: input active the output state depends on the selected logic (high or low active) !
Relay:	**0**: ouput inactive, **1**: output active the output state depends on the selected logic (high or low active) !
Digital outputs:	**0**: output inactive, **1**: output active the output state depends on the selected logic (high or low active) !

Configuration

Counter inputs:	Selection of the active counter input (No1 or No 2) Selection of the measurement intervals of the counter per second
Digital inputs:	Positive or negative logic
Digital outputs:	Positive or negative logic
Current output:	Selection of 0-20mA or 4-20mA

8 Status LEDs

CPU: This LED signalizes the correct operation of the instrument. In reset status (Watch-Dog-function) this LED is off and the alarm LED on.

Alarm: The alarm LED can be used for an error analysis.

1. CPU LED off alarm LED on	-Watch-Dog active
2. Alarm LED on pulse LED on	-overload at the digital output or -cable break at the current output
3. Alarm LED on pulse LED off	-no pulses at counter input

PULSE: indicates incoming count rates (seen by the computer)

SERVICE: For setting or changing parameters of the instrument a password must be entered (ref. Chapter 2.2). The LED signalizes that parameters can be changed without renewed password entry.

CAL: The LED signalizes a running calibration

9 Outputs

Digital relay outputs:

Relay output 1: if the measured value falls below the threshold defined at the parameter menu output 1 will be activated.

Relay output 2: exceeds the measurement value the threshold defined at the parameter menu the output 2 will be activated

Relay output 3: optional

Relay output 4: alarm relay (functionally coupled with the alarm-LED, ref. Chapter 8)

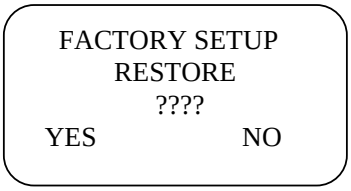
10 Reinitialisation of POCON 21

To restore the factory setup following steps have to be done:

! ATTENTION ! All stored values and parameters (data records, coefficients) will be deleted !

- switch off the instrument
- press the decimal point key and switch the instrument on

following screen appears:



Pressing *YES* (F1) the factory setup will be restored

Pressing *NO* (F4) nothing will be changed

A Appendix

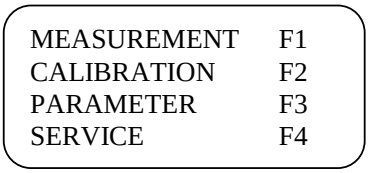
Menu handling

Technical Appendix

Explanation of the Menu Handling

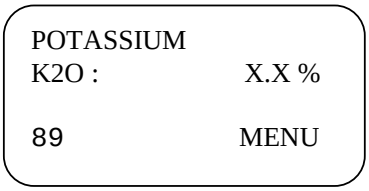
The following flow charts give an overview of the menu points.The necessary program steps are arranged below each other and plotted with the corresponding menu screens.

Measurement

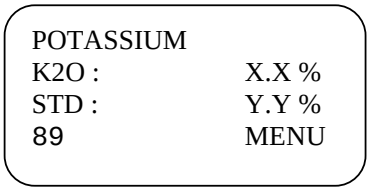


The measurement screen is called by the key <F1>. Depending on the selected measuring mode one of the both displays appears:

1. Continuous Measurement:

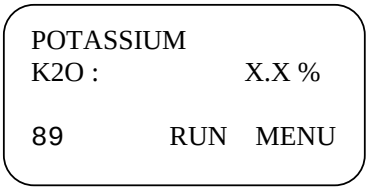


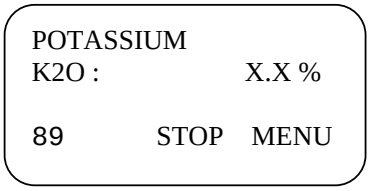
or



The display of the standard deviation can be toggled on or off by pressing < F1> (key marked by the arrow symbols).

2. Batch measurement:

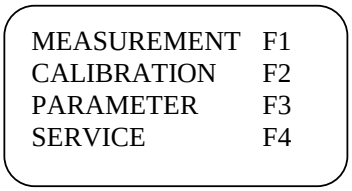




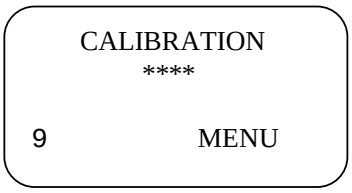
Pressing *RUN* / *STOP* (F3) the measurement will be started or stopped.
Pressing *MENU* (f4) switches back to the main menu.

Calibration/Edit

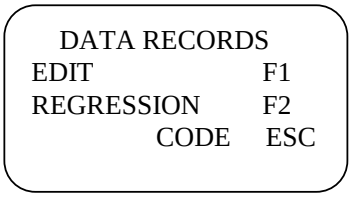
Step 1: select calibration menu with <F2>.



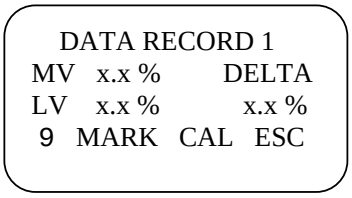
Step 2: enter password (this screen will be skipped if service LED is on)



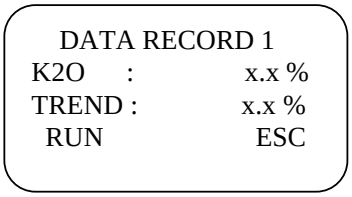
Step 3: open menu EDIT by Pressing <F1>.



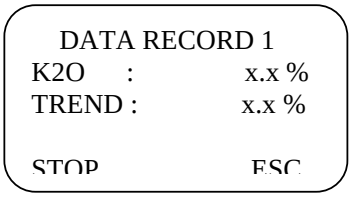
Step 4: select data record with 9 (F1) Then press *CAL* .



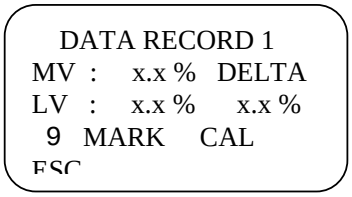
Step 5: start calibration run with *RUN* (F1).



Step 6: The calibration run stops automatically after the parametrized calibration time. It can be stopped with *STOP* (F1) or cancelled with *ESC* (F4)

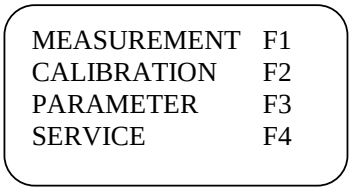


For performing several calibration runs repeat for each step 4 to 6 and enter the corresponding reference values. Pressing one times *ESC* (F4) displays data record 1, pressing ESC again switches back to the main menu

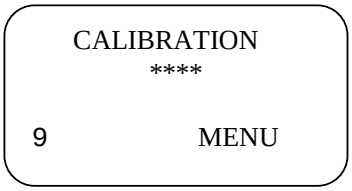


Calibration/Regression

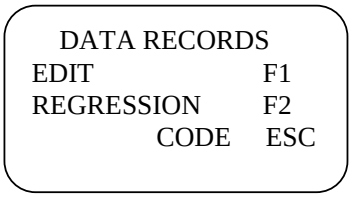
Step 1: select the calibration menu with F2



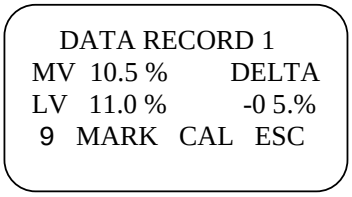
Step 2: enter password (this screen will be skipped if service LED is on)



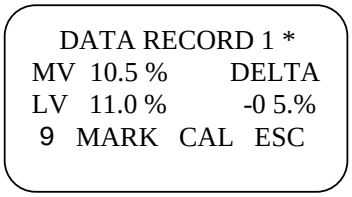
Step 3: press F1 to mark data records for regression.



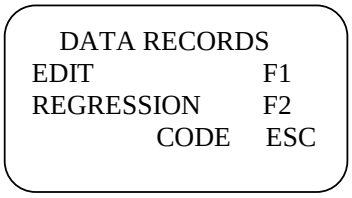
Step 4: select a data record with 9 (F1) and mark it with *MARK* (F2).



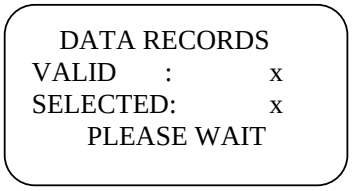
A star behind the data record number indicates that the data record is marked. Without any marked data record no regression is possible. If only one data record is marked a single point calibration is performed.



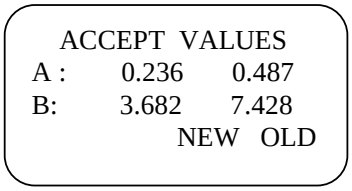
Step 5: go back to menu data record with *ESC*



Step 6: start the regression with F2

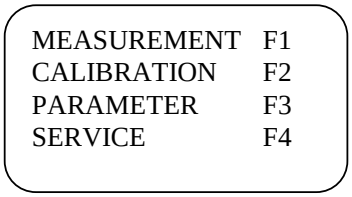


Step 7: With *NEW* (F2) the new values for the coefficients a and b were accepted, with *ALT* <F4> the system will keep the old values and discard the new ones

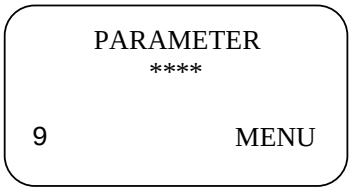


Parameter

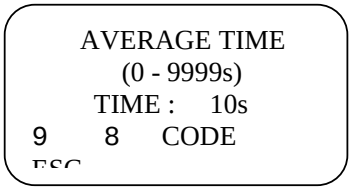
Step 1: select the parameter menu with F3



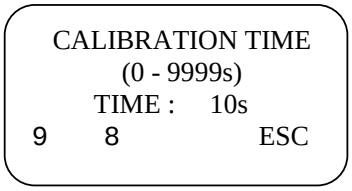
Step 2: enter password (this screen will be skipped if *service-LED* is on). 9 (F1) 8 (F2) switches to the selected menu pages, *ESC* (F4) switches one level back. Values can be entered by the numerical keypad and confirmed by 5 .



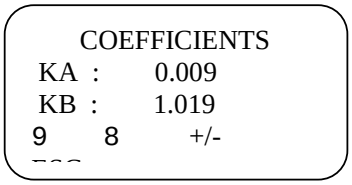
Enter time constant for averaging

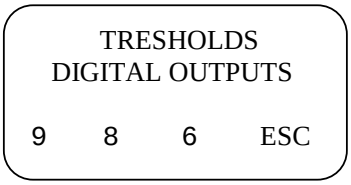


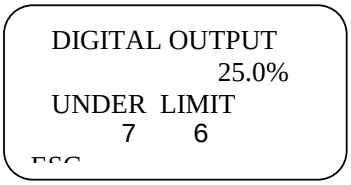
Enter duration of a calibration run

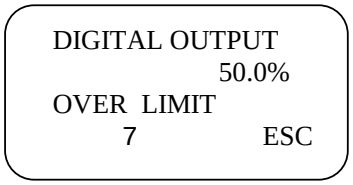


Switch between the coefficients with *RETURN*
Select the sign with *F3*



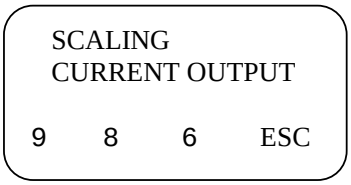


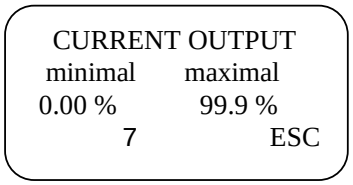




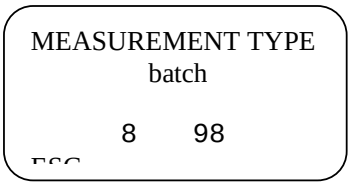
7 (F2) and 6 (F3) toggles between the upper and lower threshold of the digital output.

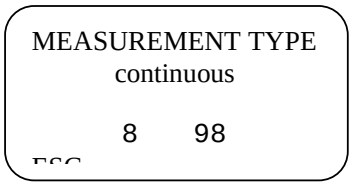
Define the potassium content for current minimum (0% current) and the maximum current (100% current)





Measurement type selection.
<F3> toggles between continuous and batch measurement

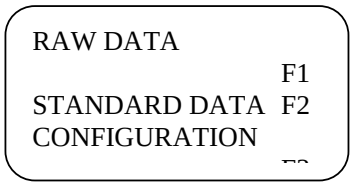




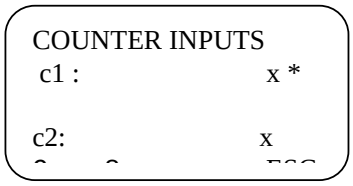
Service/Raw data

Step 1: select the service menu with F4

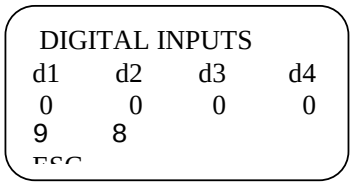
Step 2: select the raw data menu with F1



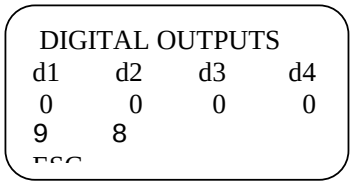
Display of counts in the in the measurement interval and indication of the active counter input (marked by a *)



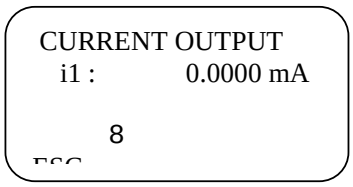
Status of the digital inputs independent of the chosen logic: 0 × no voltage at input
1 × voltage at input



Status of the digital outputs independent of the chosen logic: 0 × 0V at output
1 × voltage at output



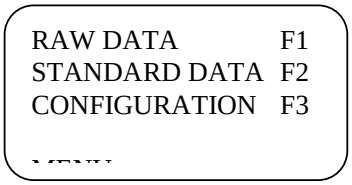
Display of the actual current at the output, usable as test of the interface. It depends on the configuration (0/4 – 20mA) and the measured value



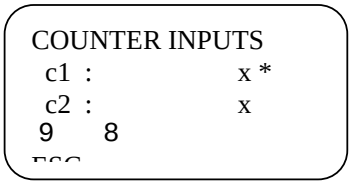
Service/Standard data

Step 1: select service menu with F4

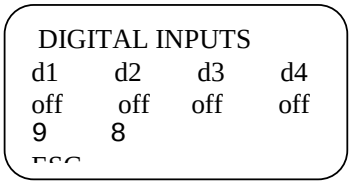
Step 2: select standard data by F2



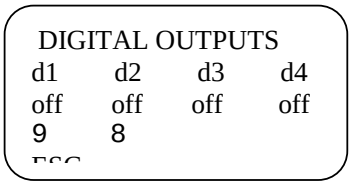
.
On the display are shown:
Marked counter input, measured pulses normalized at counts per second (independent on the measurement cycle, i.e. independent on the number of measurements per second)



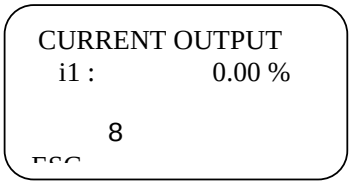
In this screen the status of the digital inputs is shown. Active inputs were indicated by “on”



In this screen the status of the digital outputs is shown. Active outputs were indicated by “on”



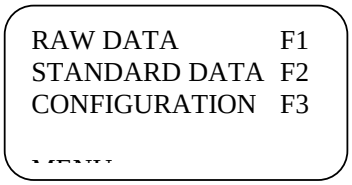
Display of the actual current output in percent.



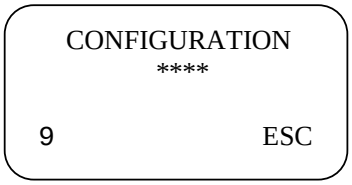
Service/Configuration

Step 1: Select the service menu with *F4*

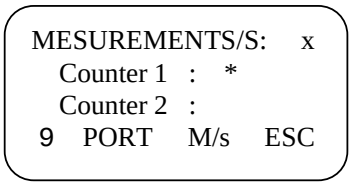
Step 2: Select the menu configuration with *F3*

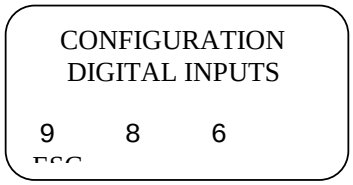


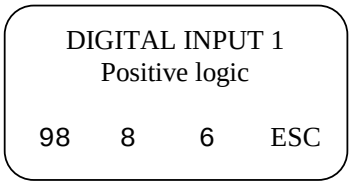
Step 3: Enter the password (this screen appears only if the service LED is off)



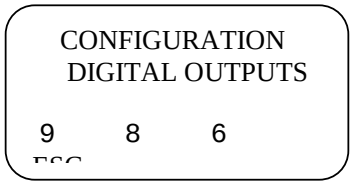
Step 4: Select the counter input with *F2* and select the number of measurements per second with *F3*. Go forward to the digital inputs with *F1.*

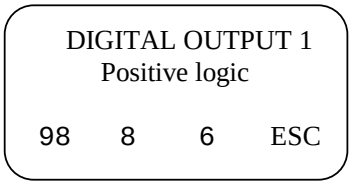






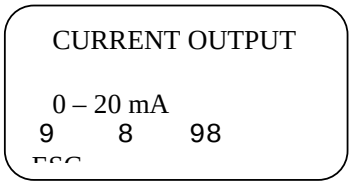
Step 5: Select the different digital inputs with 6 (F3) and select the logic (positive or negative) with 98 (F1). Press F4(ESC) or F2 until you comes back to the previous menu page.



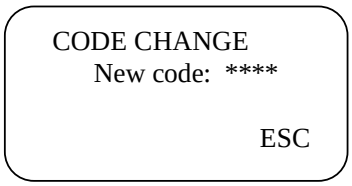


Step 6: You reach the different digital outputs pressing 6 (F3). Toggle between positive and negative logic by 98 (F1). F4(ESC) or F2 until you comes back to the previous menu page.

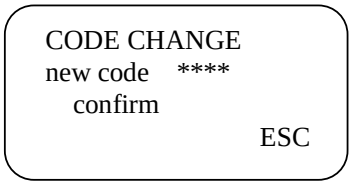
Step 7: Press *F1* and set the current output to 0–20mA or to 4–20mA with 98 (F3)



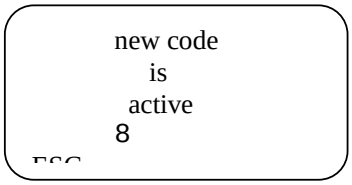
Step 8: For changing the password press F1



Step 9: Enter new password



Step 10: Confirm the new password by entering it again. It will be stored automatically.



Technical Appendix

Electrical connections: RGI - POCON 21

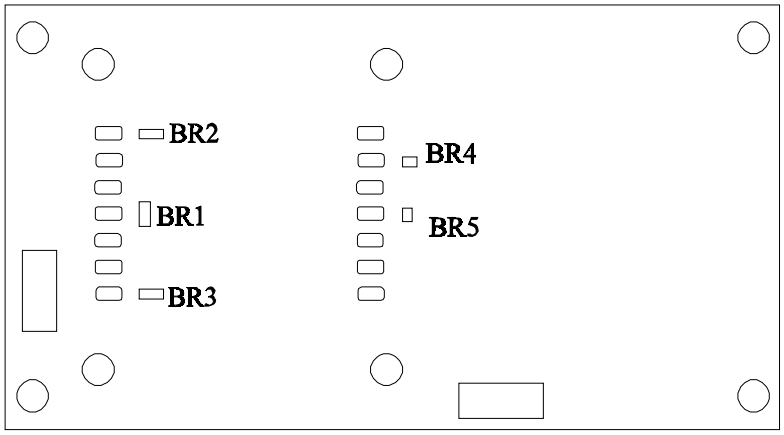
Clamp	Connect to	function	signal	Remark	Type	logic
1		*RX1*		*COM1 receive*	*RS232*	
2		*TX1*		*COM1 transmit*		
3		GND		COM reference mass	mass	
4	Threshold 1	Value below	contact	Normally open	Relay 1	positive
5			contact	Normally closed	Relay 1	
6			contact	changer	Relay 1	
7	Start/Stop	Input	digital	Digital input 1 +	static	Start = 1
8			digital	Digital input 1 -		Stop = 0
9	Pause	Input	digital	Digital input 2 +	static	Pause = 1
10			digital	Digital input 2 -		
11	K2O [%]	output	analogue	Analogue output 1, 4 – 20 mA	analogue	
12			analogue	Reference ground	analogue	
13	PE					Mass
14	PE					Mass
15	L1	~230V		Phase		
16	N			Zero		
17			*contact*	*Normally closed*	*Relay 3*	*positive*
18			*contact*	*Normally open*	*Relay 3*	
19			*contact*	*Changer*	*Relay 3*	
20	Threshold 2	Value above	contact	Normally closed	Relay 2	positive
21			contact	Normally open	Relay 2	
22			contact	Changer	Relay 2	
23			*analogue*	*Analogue output 2, 4-20mA*	*analogue*	
24			*analogue*	*Reference ground*	*analogue*	
25	Detector	Pulses +	pulse	Counter 1+		
26		Pulses -	pulse	Counter 1-		
27		Pulses +	pulse	Counter 2+		
28		Pulses -	pulse	Counter 2-		
29	+24V	+24V supply		Power supply		
30	GND	0 V	ground			

31	~24V	Power supply				
32	~24V	Power supply				
33		*RX2*		*COM2 receive*	*RS232*	
34		*TX2*		*COM2 transmit*		
35		*GND*				
36			*digital*	*Digital input 4+*		
37				*Digital input 4-*		
38			*ground*	*Digital input 3+*		
39				*Digital input 3-*		
40		*input*	*analogue*	*Analogue input2+, 4-20mA*		
41			*analogue*	*Analogue input2-, 4-20mA*		
42		*input*	*analogue*	*Analogue input 1+, 4-20mA*		
43			*analogue*	*Analogue input 1-, 4-20mA*		
44		*Pulses+*	*pulse*	*Counter 3+*		
45		*Pulses-*	*Pulse*	*Counter 3-*		
46		alarm	Contact	Normally closed	Relay 4	negative
47			contact	Normally open	Relay 4	
48			contact	changer	Relay 4	

(*cursive clamps 1-2, 17-19,23-24,33-45 optionally available*)

Selection of the Operating Voltage

The POCON 21 is able to work with different operating voltages. The adjustment to the actual operating voltage is done by jumpers on the board containing the power supply. In *Picture 1* this board is shown with the position of the jumpers, seen from below (soldering side).
Table 1 shows the jumpers for possible settings.



Picture 1 Soldering side

Table 1

Operating voltage	BR1	BR2	BR3	BR4	BR5
230V	Closed	Open	Open	-	-
115V	Open	Closed	Closed	-	-
24V=/24V-	-	-	-	Open	-
Ground at PE	-	-	-	-	Closed

Technical Data:

Power supply:	`	Standard: - 230V~
	`	Optional: - 115V~, 24V~, 24V=
Counter inputs:	`	2 galvanically insulated 16 bit counter
	`	dead time # 1,5µs
	`	max. pulse rise time # 250ns
	`	Maximal count rate $8*2^{16}$ pulses/s (at 8 readouts/s)
	`	1, 2, 4 or 8 readouts per second
Digital inputs:	`	4 galvanically insulated inputs (switching threshold $ 3V)
	`	maximal input voltage 24V
	`	selectable logic for each input
Digital outputs:	`	Standard: - 4 potential free relays contacts (changers) max. 110V DC, 125V AC max. 1A; max. 30W
	`	Optional: - 4 electronic Relays outputs galvanically insulated maximal output voltage 30V overload protection selectable logic for each output
Current output:	`	Standard: - 1 Analogue output (galvan. insulated) 0..20mA or 4..20mA adjustable Accuracy # 0,5% Free scalable Detection of cable break
	`	Optional: - 2. Current output
General:	`	illuminated 4-Line-LCDisplay (4x16 Characters)
	`	keyboard key click and acoustical feedback
	`	alarm signal
	`	battery buffered by a lithium cell
	`	integrated Watch-Dog function
	`	optional: - serial interface
Operation temperature:	`	0°-55°C (environment temperature)
Dimensions:	`	101,4mm (20TE) x 132,5 (3HE) x 160mm (WxHxD)
Weight:	`	318g
Housing:	`	IP 54 classification