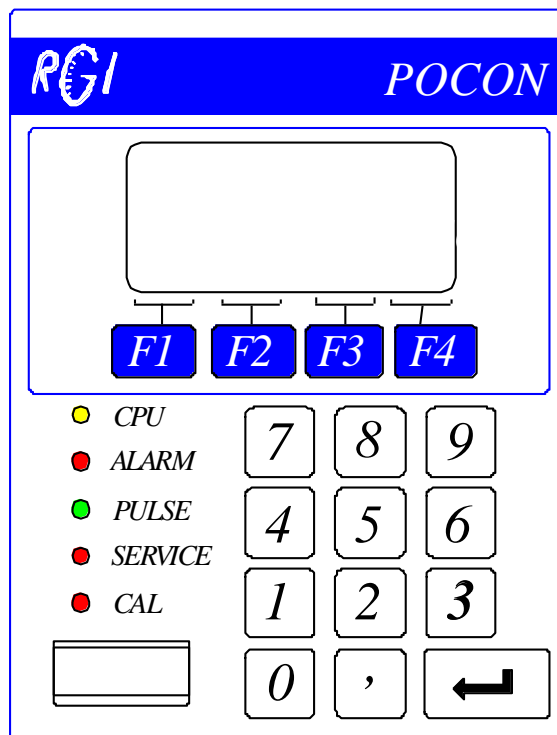




INDUSTRIEMESSGERÄTE GMBH

# POCON 21

Evaluation Unit for  
RGI Potassium Measurement System



## User Manual

User Manual Version: 1.00  
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## 1. Introduction

The Potassium Measurement Unit **POCON 21** is a microcomputer, especially outlaid for the potassium measurement. By choice of the adequate detector ( $2\pi$  or  $4\pi$ -geometry) the instrument can be optimized for your measurement task as well for liquids as for solids.

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

The calibration will deliver the percentage of  $KCl$ ,  $K_2O$  or  $K$ . The internal data table stores up to 20 reference values.

All in- and outputs are insulated from the computer ground and protected against pole reversal.

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

## 2. System Installation

In this chapter the necessary steps and instructions for the setup of the **POCON** are given.

When describing the key press combinations for navigating the display screens we assume that you always start from the main menu. The main menu can be entered from every submenu by pressing several times the *F4* key.

In order to modify internal parameters of the **POCON** or to record a Calibration Sample a password is required (*Service F4*). The factory setting of the password is 0000.

Measurement	<i>F1</i>
Calibration	<i>F2</i>
Parameters	<i>F3</i>
Service	<i>F4</i>

F1	F2	F3	F4
----	----	----	----

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

**MEASUREMENT** is the main status screen that is active during measurement.

**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.

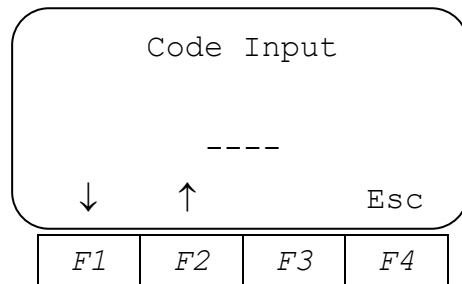
**PARAMETER** contains all system parameters for the adjustment of the instrument to the actual measurement task.

**SERVICE** delivers an overview of the status of all interfaces. This function is used for service purposes (for installation or changing the factory setup). You also have the possibility to change some system and hardware configurations.

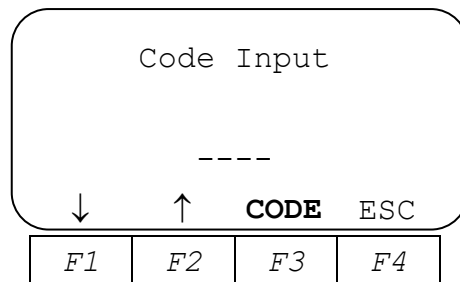
A detailed overview of the menu handling is given in the appendix “Menu Structure”. The most important program instructions are explained step by step with flow charts.

## 2.1 Password Request

When opening one of the menus “Calibration”, “Parameters” or “Service” the first task is to enter the defined password in order to avoid changes by unauthorized persons. The parameter view is not protected. The password request is indicated by “----”. On delivery the password is set to “0000”.



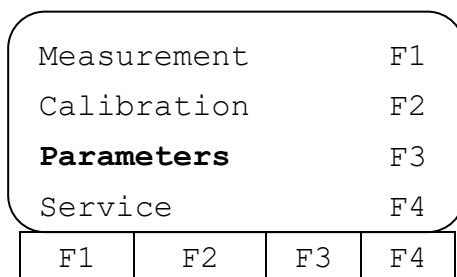
Entering the password activates the *Service* mode. This is indicated by the status LED “Service” on the display plate. It allows the consecutive input of the necessary parameters. The service mode can be finished pressing **ESC** (*F4*) or by pressing **↑** (*F2*). After 20 minutes the service mode will terminate automatically if no key was pressed during that time.



The service mode will be switched off by pressing the function key **CODE** (*F3*).

After entering the password you can determine the measurement and calibration parameters starting with softkey **↓** (*F1*).

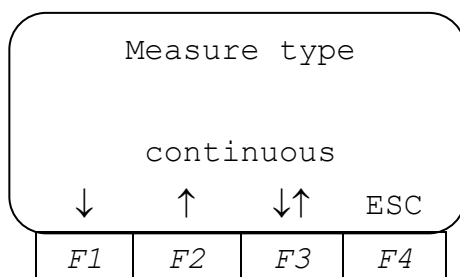
## 2.2 Parameter setup in menu “Parameters” (F2)



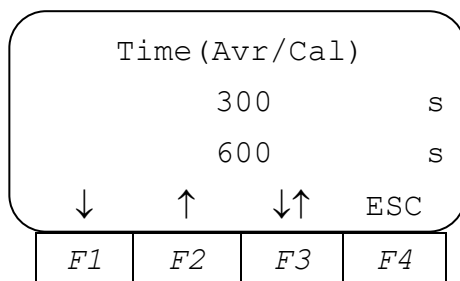
To change parameter values two steps are necessary: selection of the parameter with softkey ↓ (F1). The values will be entered after pressing ↑↓ (F3) with the numeric keypad and confirmed with “enter” (↵). BRK (F4) only appears in the entry mode.

When you have to enter more than one value (typical case: min. and max. values) you use ↑↓ (F3). In some cases the input has to be done after selecting the symbol →.

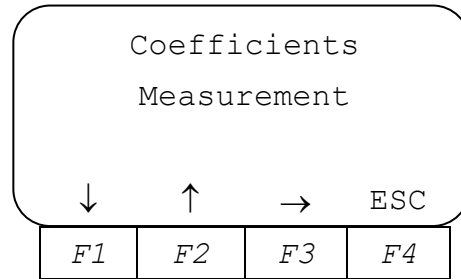
With ↓ (F1) and ↑ (F2) you can switch to the different parameters. ESC leads you back one or more steps.



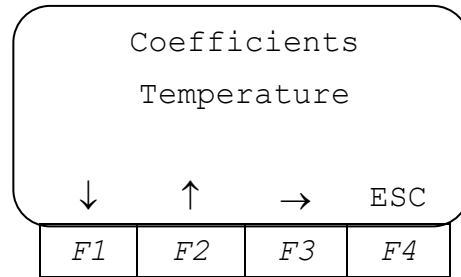
**Measure type:** Two measurement types are available: “continuous” and “batch”. The adequate measuring mode depends on the measuring task. Selection is done via button ↑↓ (F3). For detailed information see chapter 4.



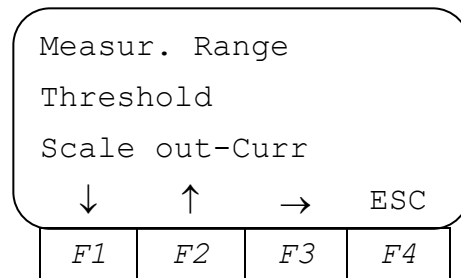
**Time (Avr/Cal):** The **average time** in seconds determines the precision of the measurement. If the potassium content changes abruptly, the shown measurement value has reached 63 % of the changed value when reaching the end of an average time.



**Coefficients measurement:** Display and editing of the calibration coefficients  $\alpha$  und  $\beta$ .



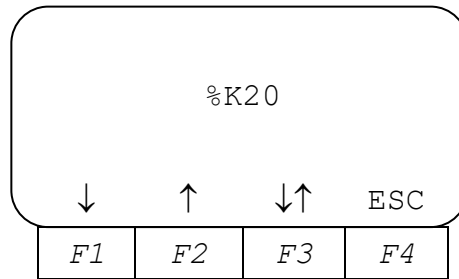
**Coefficients Temperature:** Display and editing of the coefficients for calculation of the connected detector temperature in °C.



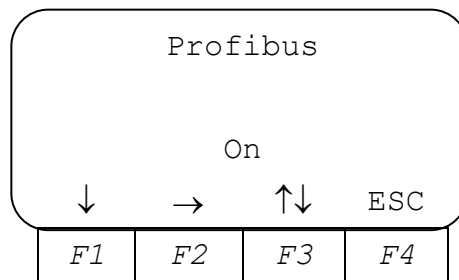
**Measur. Range Threshold Scale Out-Curr:**

- a) **Measur. Range:** Input of the threshold scales and scaling of the power output range.
- b) **Pulses:** Pulse rates ranging in the stated limits are valid. Pulse rates out of the stated limits will be considered as detector mistake and in such cases the alarm relay #4 will be switched on.
- c) **Scale Out-Curr:** Definition of the current output according to the potassium content. **Max.** corresponds to current 20 mA
- d) **Threshold:** As soon as the measurement value lies outside the specified limits relay #1 will be activated.
- e) **Threshold Temperature:** As soon as the measured temperature of the detector exceeds the specified limit relay #2 will be activated.





**%K20, %KCl, %K or g/l:** Selection of the measurement unit with softkey ↓↑ (*F3*) .



**Profibus** (optional): With this parameter you can switch **on** or **off** the cyclical data output via the profibus interface after pushing the softkey ↑↓ (*F3*).

When it is turned on, you can set up the **slave address** of the connected bus device in the next screen by pushing → (*F2*).

The last setting “**Swap more bytes**” in the next screen → (*F2*) is a rarely necessary debug option that can be used by an RGI technician. It is supposed to keep turned on.

### 2.3 Parameter setup in menu “Service” (F4)

Measurement	F1
Calibration	F2
Parameters	F3
<b>Service</b>	F4

<i>F1</i>	<i>F2</i>	<i>F3</i>	<i>F4</i>
-----------	-----------	-----------	-----------

After selecting the “Service” menu a submenu is opened:

Data	F1
<b>Configuration</b>	F2
Sys Info	F3
Main Menu	F4

<i>F1</i>	<i>F2</i>	<i>F3</i>	<i>F4</i>
-----------	-----------	-----------	-----------

In the “**Configuration**” submenu you have to set further parameters:

Submenu	Parameter Settings
<b>Current Output:</b>	Adjustment of 0-20 mA or 4-20 mA
<b>Logic Output: D1 D2 D3 D4</b>	Positive oder negative logic (0 or 1)
<b>Logic Input: D1 D2 D3 D4</b>	Positive oder negative logic (0 or 1)
<b>Pulses Counter #:</b>	Setup of the active counter no. (No.1 oder No.2)
<b>Input TemperatuCurrent:</b>	Current input of the detectors` temperature sensor – Selection: no. 1, no. 2 or “Off” (–)
<b>Sort Batch-RUN:</b>	Batch measurement will be started via keyboard, digital input or can be switched off here. If the conveyor belt stops the measurement unit will have an external stop signal. Selection: keyboard, digital input or Off
<b>Batch-RUN:</b>	Selection: keyboard or digital input
<b>Test Mode:</b>	Setup of pulses and current

### 3. Menu “Calibration”

The potassium content is calculated by a mathematical formula using the mean count rate per second of the potassium detector. The parameters  $\alpha$  and  $\beta$  fit the formula to the measurement setup.  $\alpha$  adjusts the sensitivity of the detector and  $\beta$  compensates the mean natural radioactive count rate (background radiation). Both parameters cannot be predicted very accurately. They depend e. g. on the distance between detector and material, the shape and material of the container and other factors in a complex manner.

The calibration is the procedure to determine these coefficients  $\alpha$  and  $\beta$  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. After this calibration run a reference value of a potassium content is required. The reference value must be representative for the material. A precise calibration is only performable having 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  $\alpha$  and  $\beta$ , which are used for calculating the potassium content from the count rate of the potassium detector, are determined from the calibration data records by linear regression.

**POCON** 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  $\alpha$  and  $\beta$ . For a regression calculation at least two samples must be marked.

### 3.1 Calibration

Measurement				F1
<b>Calibration</b>				F2
Parameters				F3
Service				F4
	F1	F2	F3	F4

#### 3.1.1 Samples

The calibration screen is started from the main menu (F2). The next screen (after password entry) offers the following submenu:

<b>Samples</b>				F1
-----				F2
Regression				F3
Main Menu				F4
	F1	F2	F3	F4

After selecting Samples (F1) you see the following screen:

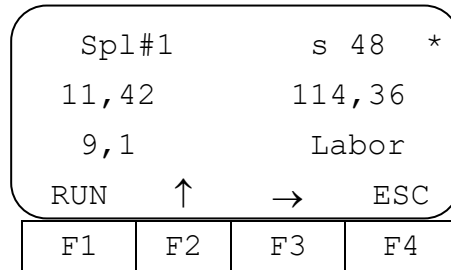
Spl#1	s 48	*	
11,42	114,36		
0,0	Labor		
↓	MRK	CAL	ESC
F1	F2	F3	F4

**Line 1:** Sample A with sample no. (Spl#), duration of sample collection (48 seconds) and marking sign "\*" for regression.

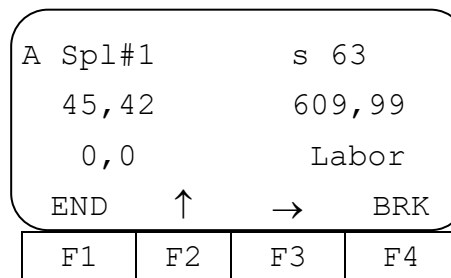
**Line 2:** Measured value of the sample (11,42 %), average pulse rate (114,36 Imp/s)

**Line 3:** The laboratory value of sample #1 has to be entered

F1 leads you to the next value set. With MRK (F2) you mark the sample for regression. F2 only shows a function (within the service mode) when a sample has the assigned lab value. This happens, when the duration of the test run takes more than 5 valid seconds. On pressing the CAL (F3) softkey you reach the screen for sample Calibration.

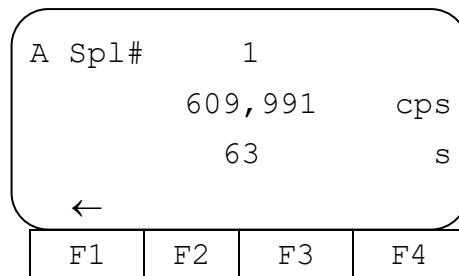


Calibration starts with RUN (F1). After starting this softkey it will get the function (END). F2 (↑) This leads you back to the screen where you can enter the lab values and mark the samples, if you want them for regression.



The running sample calibration will end with softkey END (F1), BRK (F4) stops the calibration.

After pressing the END-Button (F1) you have the possibility to recover the sample data by pressing F3, if they are registered before. On the following screen you can specify the pulse rate of the sample:



If several calibration runs shall take place you have to repeat the sample selection ↓ (F1), the sample calibration CAL (F3) and starting this calibration RUN (F1) depending on the number of calibrations. Pressing ESC (F4) leads you to sample #1, pressing (F4) again brings you back to the main menu.

### 3.1.2 Regression

Samples				F1
-----				F2
<b>Regression</b>				F3
Main Menu				F4
F1	F2	F3	F4	

**Please note:**

For regression the system considers only samples that are marked and having a lab value greater than 0,0 %.

After having pressed the softkey *F3* the following screen reports the number of valid marked samples. The number has to be at least 2 to allow a regression.

Regression			
Selected			
2			
		RUN	ESC
F1	F2	F3	F4

If the number of valid samples is below 2, only ESC (*F4*) is active. Softkey *F3* starts the regression and shows the results in the following screen - the coefficients  $\alpha$  and  $\beta$ .

Coefficients			
$\alpha$	0,024		
$\beta$	-2,35		
YES	NO		
F1	F2	F3	F4

You have the possibility to accept YES (*F1*) or to reject NO (*F4*) the calculated values. In that case the system keeps the old values.

After the selection you come back to the calibration submenu level.

## 4. Menu "Measurement"

Two measurement modes are available:

- 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). Continuous measurement can be stopped/continued via the digital input #2. Measurement starts by switching-on the device and ends with switching off.
- Batch measurement: The measurement is controlled by Start/Stop signals that are activated via digital entry #1 or by the console. The measurement time and therefore the achievable precision is determined by the time interval between the start and stop signal.

### 4.1 Accuracy Considerations

The potassium measurement is based on the radioactive decay of the potassium isotope per time unit. Therefore the achievable precision underlies the statistical behaviour of the random nuclear decay process. A measurement delivers only a statement over a mean value. The uncertainty or the error of this mean value is given by the standard deviation that will be achieved by continuous measuring.

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 standard error is calculated as follows:

$$\text{Measurement} - \text{Mistake} = \frac{\sigma}{\sqrt{\text{Measurement} - \text{Time}}}$$

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 mistake will not be calculated by the device.

## 4.2 Measurement

Measurement	F1
Calibration	F2
Parameters	F3
Service	F4

F1	F2	F3	F4
----	----	----	----

The measurement screen will be called on the main menu with the softkey *F1*. Depending on the selected measurement you see the following measurement screens:

### 4.2.1 Continuous Measurement

Measurement	On
	235 s
A	8,5 %K20
	SRT CODE Menu

F1	F2	F3	F4
----	----	----	----

The function CODE (*F3*) for deactivating the service mode is only to be seen in the service mode. „Measurement On” in the first line means that the measurement is running. It also can have the status „Pause“.

You will see the standard deviation only in the continuous measurement mode.

### 4.2.2 Batch Measurement

Measurement	On
$\sigma$	48s
A	7,91 %K20
END	SRT CODE MENU

Measurement	Off
$\sigma$	0,03 158s
A	7,91 %K20
RUN	SRT CODE MENU

F1	F2	F3	F4
----	----	----	----

In the Batch Measurement mode the measured time (158 s), the current measuring value and the measurement error  $\sigma$  is shown. Softkey *F1* has the function RUN (measurement is "Off") or END (measurement is "On").

After pressing the Menu button (*F4*) you get back to the main menu.



## 5. Menu "Service"

In this main menu you have access to different values and parameters which only are necessary for installation or trouble shooting.

Measurement	F1
Calibration	F2
Parameters	F3
<b>Service</b>	F4

F1	F2	F3	F4
----	----	----	----

The softkey *F4* opens the service sub menu.

Data	F1
Configuration	F2
SysInfo	F3
Main Menu	F4

F1	F2	F3	F4
----	----	----	----

### 5.1 Data

In the sub menu „**Data**“ you can lookup the raw data (pulses [cps], digital output, digital input, current output [mA] , current input [mA] and [°C] and relay status.

<b>Pulses:</b>	Shows the pulse rates per counting intervall (1 second)
<b>Digital Output: D1 D2 D3 D4</b>	0 = Output condition not present on this output channel 1 = Output condition present on this output channel
<b>Digital Input: D1 D2 D3 D4</b>	0 = Voltage < 0.8V 1 = Voltage >2.4V
<b>Current Output:</b>	Value in mA
<b>Current Input:</b>	Value in mA and temperature in °C of the detector(s) (optional)
<b>Test RS232</b>	Hexadecimal

## 5.2 Configuration

In this submenu the device hardware will be configured by selecting from different value lists. The following settings can be done:

<b>Current Output:</b>	Adjustment of 0-20 mA or 4-20 mA
<b>Logic Output: D1 D2 D3 D4</b>	Positive oder negative logic (0 or 1)
<b>Logic Input: D1 D2 D3 D4</b>	Positive oder negative logic (0 or 1)
<b>Pulses Counter #:</b>	Setup of the active counter no. (No.1 oder No.2)
<b>Input Temperature:</b>	Current input of the detectors` temperature sensor – Selection: no. 1, no. 2 or "Off" (--)
<b>Sort Batch-RUN:</b>	Batch measurement will be started via keyboard, digital input or can be switched off here. If the conveyor belt stops the measurement unit will have an external stop signal. Selection: keyboard, digital input or Off
<b>Batch-RUN:</b>	Selection: keyboard or digital input
<b>Test Mode:</b>	Setup pulses and current

## 5.3 SysInfo

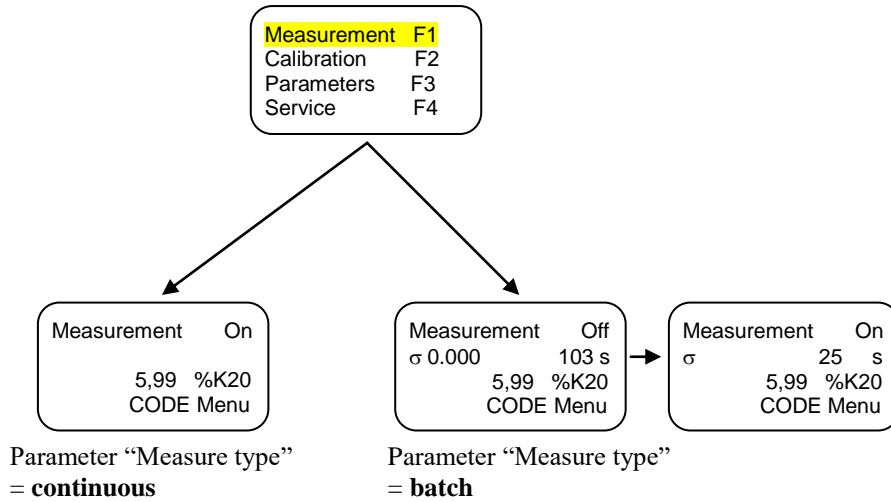
In the sub menu **SysInfo** you can enter the device-IDs (0 – 31) for connected devices, check the firmware version, enter the actual date / time and change the password.

<b>Device ID (0-31):</b>	Allocation of ID numbers for connected devices
<b>Version Pocon-PB: T</b>	Version-no. and date
<b>Date:</b>	Setup of current date and time
<b>New Code:</b>	Setup of a new password

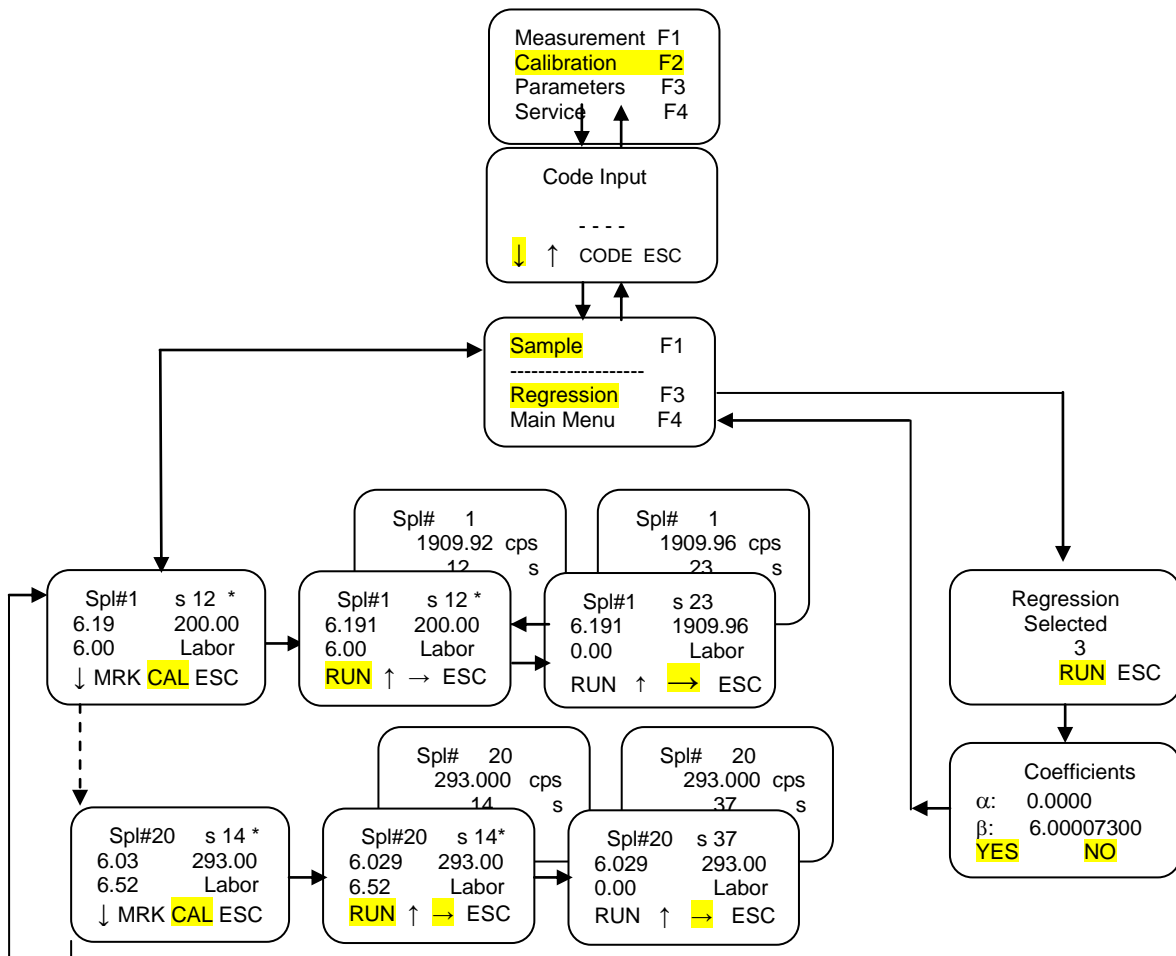
## 6. POCON Menu Structure

The necessary program steps are visualized consecutively with their corresponding menu screens.

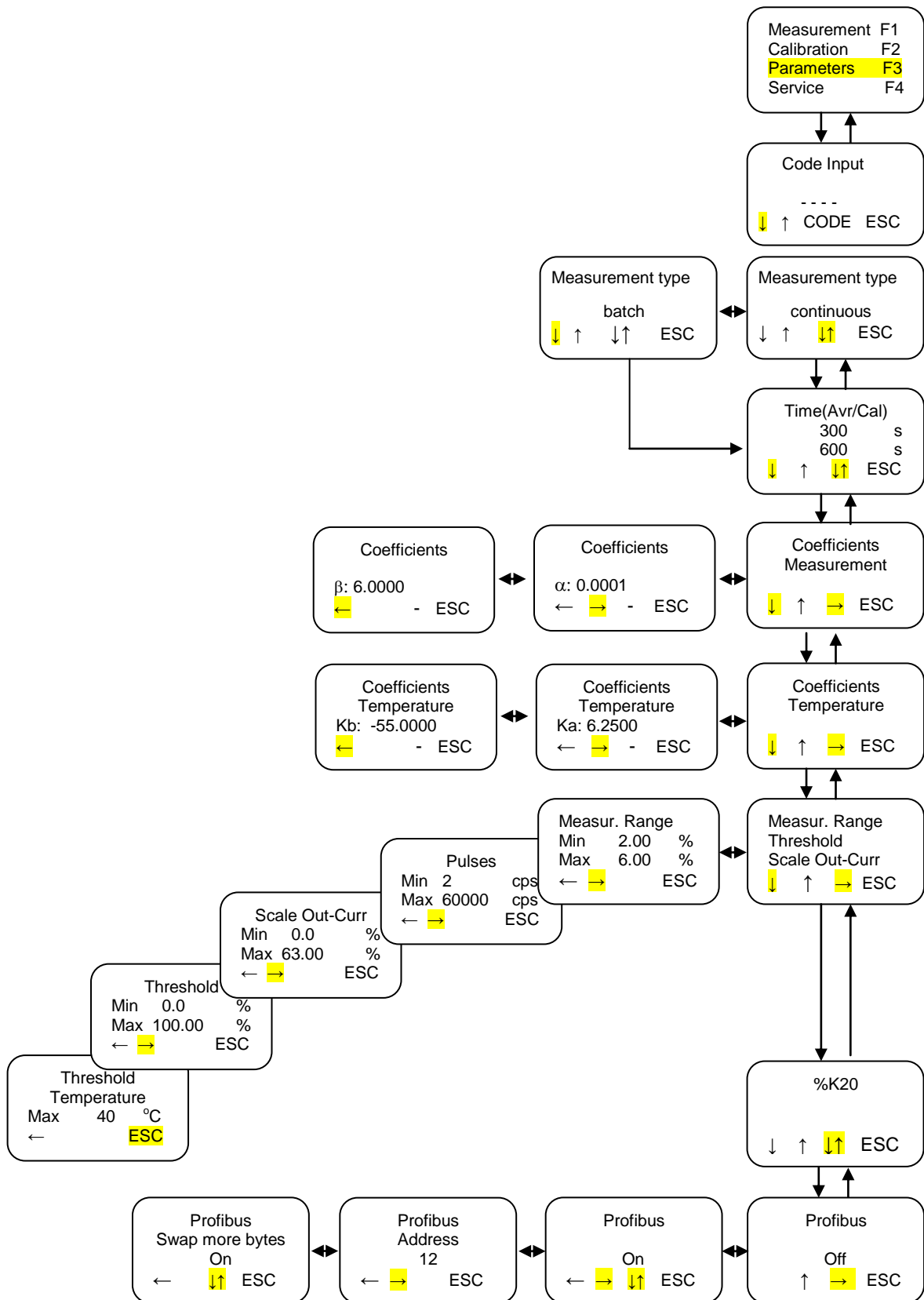
### 6.1 Menu “Measurement”



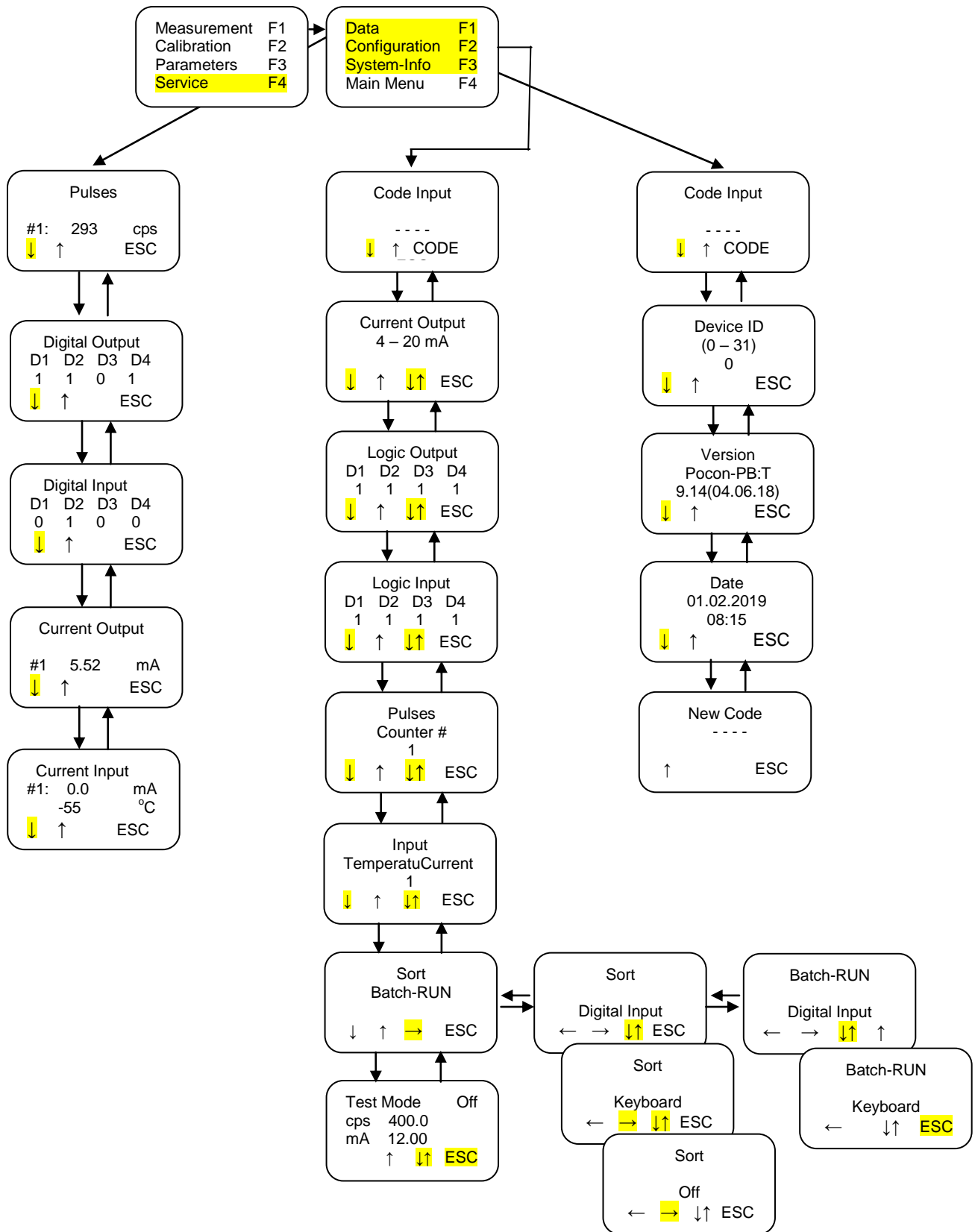
## 6.2 Menu “Calibration”



## 6.2 Menu “Parameters”



### 6.4 Menu “Service”



## 7. Technical Data

### 7.1 Reinitialization of POCAN 21

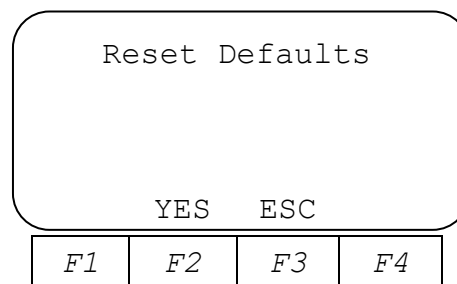
**ATTENTION**

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

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

1. Switch off the device.
2. Press the decimal point key and switch on the device simultaneously.

The following screen appears:



- Pressing *YES* (*F1*) the factory setup will be restored.
- Pressing *ESC* (*F3*) nothing will be changed and the previously stored data will be kept.

## 7.2 Technical Specifications

Properties	Optional	<ul style="list-style-type: none"> <li>• Illuminated 4-Line-LCDisplay (4x16 Characters)</li> <li>• Keyboard with tactile and acoustical feedback</li> <li>• Alarm signal</li> <li>• Battery buffered by a lithium cell</li> <li>• Integrated Watch-Dog function</li> <li>• Serial interface</li> </ul>
Power supply	Standard Optional	<ul style="list-style-type: none"> <li>• 230V~</li> <li>• 115V~, 24V~, 24V=</li> </ul>
Counter inputs		<ul style="list-style-type: none"> <li>• 2 galvanically insulated 16 bit counter</li> <li>• dead time # 1,5µs</li> <li>• max. pulse rise time # 250ns</li> <li>• Maximal count rate <math>8 \cdot 2^{16}</math> pulses/s (at 8 readouts/s)</li> <li>• 1, 2, 4 or 8 readouts per second</li> </ul>
Digital inputs		<ul style="list-style-type: none"> <li>• Galvanically insulated inputs (switching threshold <math>\geq 3V</math>)</li> <li>• Maximal input voltage 24V</li> <li>• Selectable logic for each input</li> </ul>
Digital outputs	Optional  Optional	<ul style="list-style-type: none"> <li>• 4 potential free relay contacts (changers) max. 110V DC, 125V AC</li> <li>• max. 1A; max. 30W</li> <li>• 4 electronic relay outputs (galvan. insulated)</li> <li>• Max. output voltage 30V</li> <li>• Overload protection</li> <li>• Selectable logic for each output</li> </ul>
Current output	Optional  Optional	<ul style="list-style-type: none"> <li>• 1 analogue output (galvan. insulated)</li> <li>• 0..20mA or 4..20mA adjustable</li> <li>• Accuracy <math>\leq 0,5\%</math></li> <li>• Free scalable</li> <li>• Detection of cable break in both operating modes</li> <li>• 2. analogue output</li> </ul>
Operation temperature		<ul style="list-style-type: none"> <li>• 0°-55°C (environment temperature)</li> </ul>
Dimensions		<ul style="list-style-type: none"> <li>• 101,4mm (20TE) x 132,5 (3HE) x 160mm (WxHxD)</li> </ul>
Weight		<ul style="list-style-type: none"> <li>• 318 g</li> </ul>
Housing		<ul style="list-style-type: none"> <li>• IP 65 classification</li> </ul>



### 7.3 Status-LEDs

- CPU:** This LED signalizes the correct operation of the device. In reset status (Watch-Dog-function) this LED is off and the alarm LED on.
- Alarm:** The alarm LED can be used for a first error analysis.
1. CPU LED off / alarm LED on: Watch-Dog active
  2. Alarm LED on / pulse LED on: Digital output overload or cable break at the current output
  3. Alarm LED on / pulse LED off: Input counter receives no pulses
- PULSE:** Indicates incoming count rates (registrated by the computer)
- SERVICE:** For setting parameters or other entries at the device a password must be entered. (see chapter 3.). The LED signalizes that changes in the program could be done **without** renewed passord entry.
- CAL:** This LED signalizes a running calibration.

### 7.4 Digital Inputs and Outputs

#### Digital Inputs:

- Input 1: Start/Stop signal for the measurement.
- Input 2: Pause signal for the measurement.
- Input 3: Defines together with input 4 the measured type of potassium
- Input 4: Defines together with input 3 the measured type of potassium

#### Digital Outputs:

- Output 1: If the measured value falls below the threshold defined at the parameter menu, output 1 will be activated.
- Output 2: If the measured vaue falls below or exceeds the threshold for temperature, input 2 will be activated.
- Output 3: Optional
- Output 4: Alarm-relay (functionally linked with the alarm-LED; see chapter 8)

### 7.5 Internal electrical connections

Clamp	Connect to	Function	Signal	Remarks	Type	Logic
1		<i>RXI</i>		<i>COM 1 receive</i>	<i>RS 232</i>	
2		<i>TXI</i>		<i>COM 1 transmit</i>		
3		<i>GND</i>		<i>COM reference mass</i>		
4		<i>Threshold 1</i>	<i>Contact</i>	<i>Normally open</i>	<i>Relay 1</i>	<i>Positive</i>
5			<i>Contact</i>	<i>Normally closed</i>	<i>Relay 1</i>	
6			<i>Contact</i>	<i>Changer</i>	<i>Relay 1</i>	
7		Start/Stop	Digital	Digital input 1 +	Static	Start = 1
8			Digital	Digital input 1 -		Stop = 0
9		Pause	Digital	Digital input 2 +	Static	Pause = 1
10			Digital	Digital input 2 -		
11		<i>K2O [%]</i>	<i>analogue</i>	<i>Analogue output 1 , 0/4-20mA</i>	<i>Analogue</i>	
12		GND	analogue	Reference Ground	Analogue	
13	PE					Mass
14	PE					Mass
15	L1	~230V		Phase		
16	N			Zero		
17			<i>Contact</i>	<i>Normally open</i>	<i>Relay 3</i>	<i>Positive</i>
18			<i>Contact</i>	<i>Normally closed</i>	<i>Relay 3</i>	
19			<i>Contact</i>	<i>Changer</i>	<i>Relay 3</i>	
20		<i>Threshold 2</i>	<i>Contact</i>	<i>Normally open</i>	<i>Relay 2</i>	<i>Positive</i>
21			<i>Contact</i>	<i>Normally closed</i>	<i>Relay 2</i>	
22			<i>Contact</i>	<i>Changer</i>	<i>Relay 2</i>	
23		<i>K2O [%]</i>	<i>analogue</i>	<i>Analogue output 2 , 0/4-20mA</i>	<i>Analogue</i>	
24			<i>analogue</i>		<i>Analogue</i>	
25	Detector 1	Impulse +	Pulse	Counter 1 +		
26		Impulse -	Pulse	Counter 1 -		
27		Impulse +	Pulse	Counter 2 +		
28		Impulse -	Pulse	Counter 2 -		
29	+24V	+24V		Power supply		

Klemme	verbunden mit	Funktion	Signal	Bemerkungen	Art	Logik
30	GND	0 V	Mass	Mass Detector		
31	+24V	Power supply		Power supply POCON 21		
32	GND	Power supply		Mass POCON 21		
33		<i>RX2</i>		<i>COM 2 receive</i>	<i>RS 232</i>	
34		<i>TX2</i>		<i>COM 2 transmit</i>		
35		<i>GND</i>				
36		Ref. Probe 2	digital	Digital input 4 +		
37			digital	Digital input 4 -		
38		Ref. Probe 1	digital	Digital input 3 +		
39			digital	Digital input 3 -		
40		<i>Eingang</i>	<i>analog</i>	<i>Analogue input 2+, 0/4-20mA</i>		
41			<i>analog</i>	<i>Analogue input 2-, 0/4-20mA</i>		
42		<i>Eingang</i>	<i>analog</i>	<i>Analogue input 1+, 0/4-20mA</i>		
43			<i>analog</i>	<i>Analogue input 1-, 0/4-20mA</i>		
44		<i>Impulse +</i>	<i>Pulse</i>	Counter 3 +		
45		<i>Impulse -</i>	<i>Pulse</i>	Counter 3 -		
46		<i>Alarm</i>	<i>Kontakt</i>	<i>Normally open</i>	<i>Relay 4</i>	<i>Negative</i>
47			<i>Kontakt</i>	<i>Normally closed</i>	<i>Relay 4</i>	
48			<i>Kontakt</i>	<i>Changer</i>	<i>Relay 4</i>	

(clamps in italic font: optionally available)