EnCal 3000 Gas Chromatograph
Commissioning and Maintenance Manual

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1 Introduction

The first part of this manual describes the main steps of a commissioning for an Encal3000 gas chromatograph. This covers the gas connections and the setting of the pressure for the connected gases, the connection of power supply and communication cables, the start-up of the device, a check of the parameter settings, the preparation of a new basic calibration and a performance test of the device.

The second part is focused on the actions that should be done for maintenance. These are a check of the pressures for carrier gas, sample gas and calibration gas, a performance test and an optionally new basic calibration if the calibration gas bottle has to be changed. An advised time period for the maintenance is at least once a year.

The commissioning should be done only by service people that are qualified for it. To get this qualification Elster offers Encal3000 service and commissioning trainings. Maintenance can be done also by other people who at least received an introduction to the use of the RGC3000 Software.

2 Steps for Commissioning

This chapter contains a summary of the main steps for the installation of the device in the field. In addition to that it contains a checklist for the installed hardware, the set pressures for the used gases and the used parameter settings for the analysis of the sample gases and for the communication of the results.

2.1 Gas Connections and Set Values for the pressure of the connected gases

The following gases are needed for the operational work of the device:

- carrier gas: Helium with a quality of 5.0 or higher (and optionally as a second carrier gas Argon with a quality 5.0 or higher for special applications like Biogas)
  Supply pressure 5.5 barg Flow ± 4 ml/min per channel
- calibration gas: Composition preferably close to pipe line composition
  Quality 2.0 or higher (with a maximal uncertainty of 1% relative deviation for each component) Supply pressure 1 to 4 barg nominal;
  Pressure peak protection up to 4 barg; Flow ± 30 ml/min
- up to five different sample gases, in the most application one or two different sample gases has to be analysed

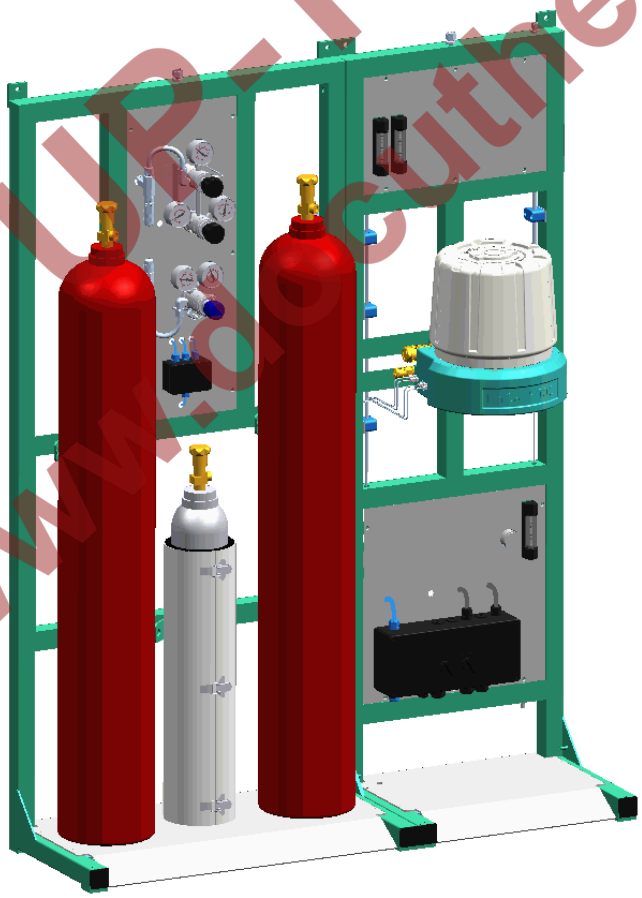
For each of these gases stainless steel tubes should be used for the piping, the connection to the device is done with 1/8” Swagelok connections. It is possible to use another size for the tubes but than adapters to 1/8” are needed. Before these tubes become connected to the device they should be flushed for about 30 seconds with the carrier gas to remove particles, rest air and rest moisture that is inside these tubes. For the sample gas tubes it is also possible to flush it with sample gas if the sample gas pressure has been reduced already to 1-4 barg. Advised is to close the gas supply from the pipeline and to use only the rest pressure in the tubes for the flushing with sample gas. This should be done to limit the amount of flameable gas that would come out of the tubes during this flushing.

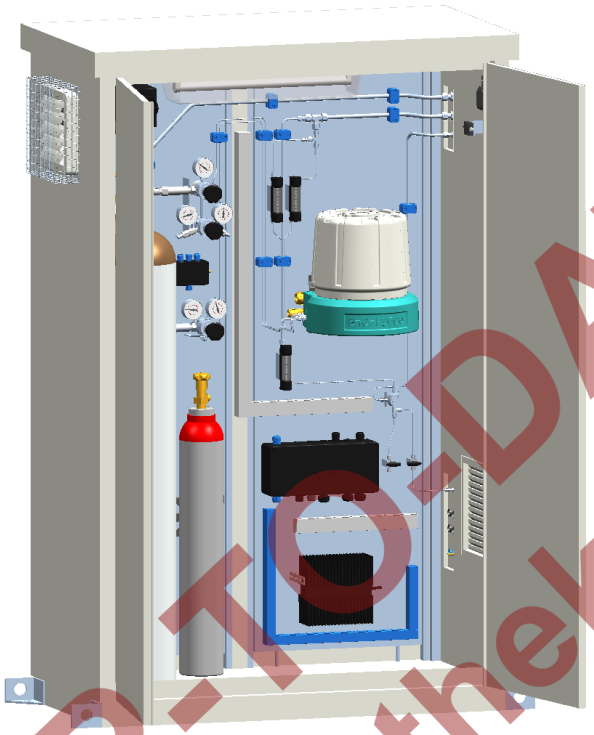
A carrier gas cylinder has typically volume of 50l at a pressure about 200 barg. For the regulation of the pressure that is needed for the carrier gas supply of the device a pressure reduction, that

reduces the pressure to a range of 5-6 barg, is needed. The optimal set pressure for the carrier gas supply of the device is 5.5 barg. Preferred is to use a dual stage regulator for the carrier gas.

The device cannot operate without carrier gas, because of that it is recommended to have always two carrier gases cylinders available with an easy switch system from one cylinder to the other. In this way it is possible to use the other cylinder if one is already empty and to continue with the sample gas analysation also if the new ordered cylinder has not arrived yet. The change to the second bottle should be done if the fill pressure of the first is below 20 barg. The carrier gas consumption of the Encal3000 is 8 ml/min. One 50l cylinder with an original fill pressure of 200 barg is useable for about two years if it becomes used for one Encal3000. Sometimes there are two or more devices in one station and one carrier gas installation becomes used for all this devices. In this case one 50l cylinder would be useable for a time that is equal to two years divided by the number of devices.

The following picture shows an example for a possible installation of carrier gas, calibration gas and the analyzer in one system. An installation like this can be easily used if the device becomes installed in a room or a hall. If the station is build outside without the use of a closed room this installation can also be used but in addition a roof is needed to protect the device from direct sunlight, from rain etc. Advised is to put this installation in a cabinet to be able to guarantee stable measurement conditions.





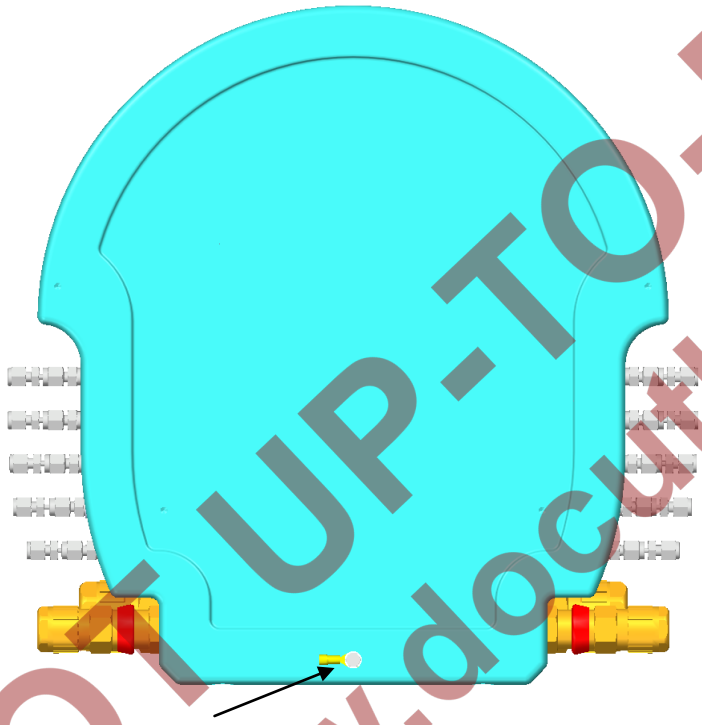
For the calibration gas it is possible to use a 10l cylinder because the consumption of the calibration gas is very low. Typically one 10l cylinder with an original fill pressure of 120 barg is useable for more than three years and after this time the certificate would be also not valid anymore. For the calibration gas it is possible to use a standard composition which delivers good results for a specified bandwidth of sample gases or a calibration gas with a composition that is close to the sample gas. The use of a calibration gas which is close to the sample gas is only advised if only one sample gas becomes analysed and if the variation of this sample gas is not strong. Also important is that the concentration of the components in the calibration gas are not too small, they should be at least ten times higher than the detection limit, otherwise the calculated response factors can be too unstable. For the standard calibration gas are defined two different compositions with their corresponding measurement ranges (see following table).

Type name	**11D**		**P1-11K**	
Component name	**Calibration Gas [mol%]**	**Measurement range [mol%]**	**Calibration Gas [mol%]**	**Measurement range [mol%]**
Nitrogen	4	**0 - 22**	8	**0 - 22**
Methane	88,9	**55 - 100**	79,25	**55 - 100**
Carbon Dioxide	1,5	**0 - 12**	3	**0 - 12**
Ethane	4	**0 - 14**	6,5	**0 - 14**
Propane	1	**0 - 5**	2	**0 - 5**
i-Butane	0,2	**0 - 1,5**	0,5	**0 - 3**
n-Butane	0,2	**0 - 1,5**	0,5	**0 - 3**
neo-Pentane	0,05	**0 - 0,1**	0,025	**0 - 0,1**
i-Pentane	0,05	**0 - 0,3**	0,1	**0 - 0,3**
n-Pentane	0,05	**0 - 0,3**	0,1	**0 - 0,3**
n-Hexane / C6+	0,05	**0 - 0,3**	0,025	**0 - 0,3**

The allowed pressure range for the calibration gas and the sample gases after the pressure reduction is 1-4 barg, advised is to use a set pressure of about 2 barg for these gases.

2.2 Power Supply and Communication

The next step is to prepare the connections for power supply, Modbus communication and TCP-communication. For the power supply a two wire connection (+ and -) is needed (see hardware manual chapter 5.1.6), the third position for the ground should not be used. For the grounding of the device use the prepared connection at the bottom of the housing instead.



The required voltage for the device is 24V. The typical required current for start-up is about 3A for the nonheated version and about 7A for the heated version. It is recommended to use shielded cables for the power supply and for the communication. In addition to that it is recommended to use one entrance in form of the cable glands for the power supply and another for the communication cables. Before the device becomes switched on the above mentioned values for the power should be checked. If the power is to low the device cannot start up and a sound that is comparable to humming noise would come from the Interconnection board of the device.

For the TCP-IP communication a four wire cable with the connection of TX+, TX-, RX+ and RX- is needed. The TCP-IP connectors are located near the main board at position J7 of the interconnection board. For Ethernet and serial Modbus communication twisted pair cables should be used. The length of a cable for Ethernet communication is typically limited to 100 meter.
For the serial Modbus communication up to two connections with a four wire connection (one pair becomes used for A and B, the remaining two for the ground) are available. The connectors are also located close to the main board at position J6 of the interconnection board (see hardware manual, chapter 5.1.6).

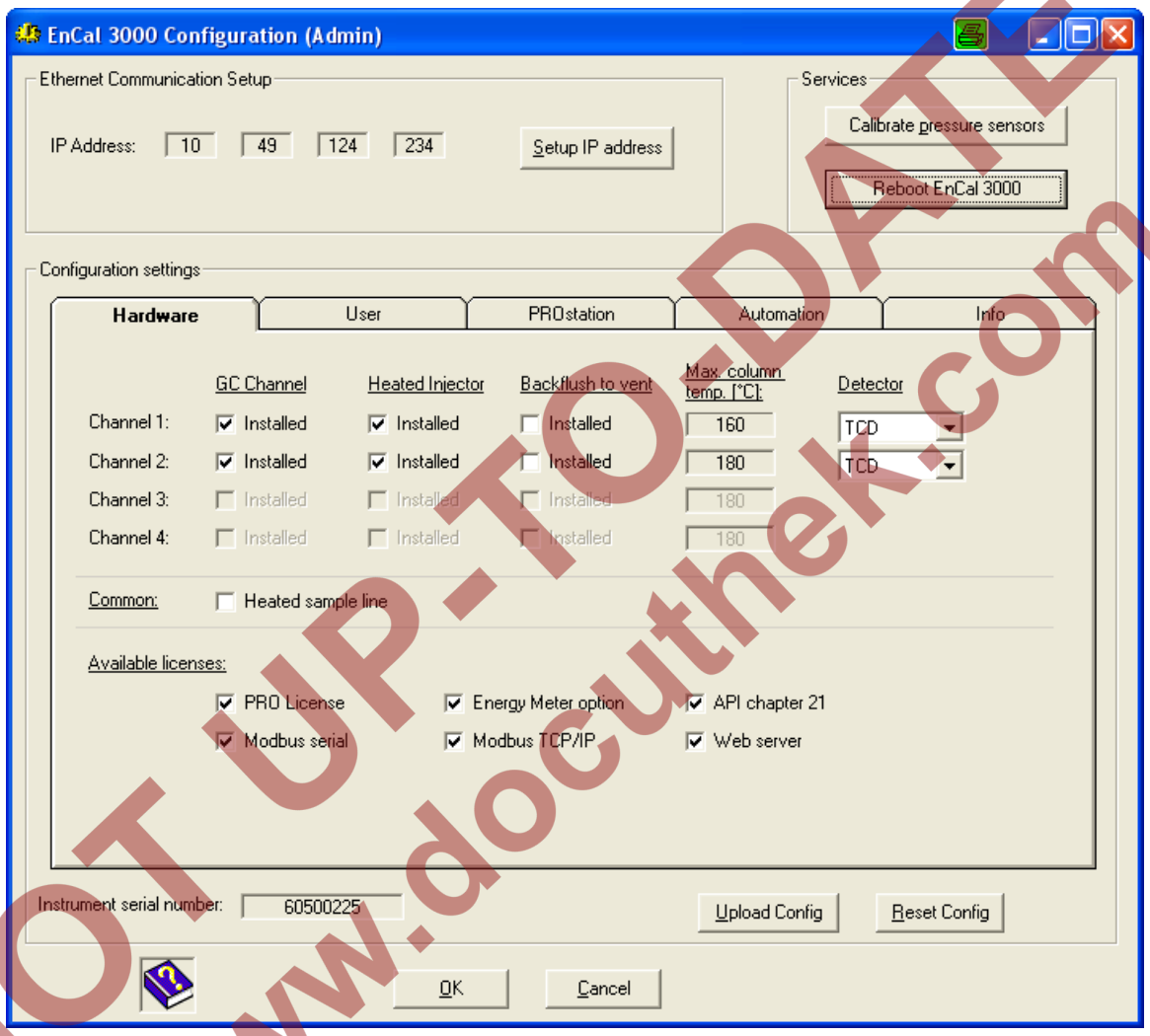
2.3 Device Start-Up

After the installation is finished the device can be switched on and prepared for the operational work. The first step is to install the RGC3000 software on the computer that becomes used for the communication to the device. The second step is to get communication to the device and to make a backup of the configuration and the parameter Settings of the device.

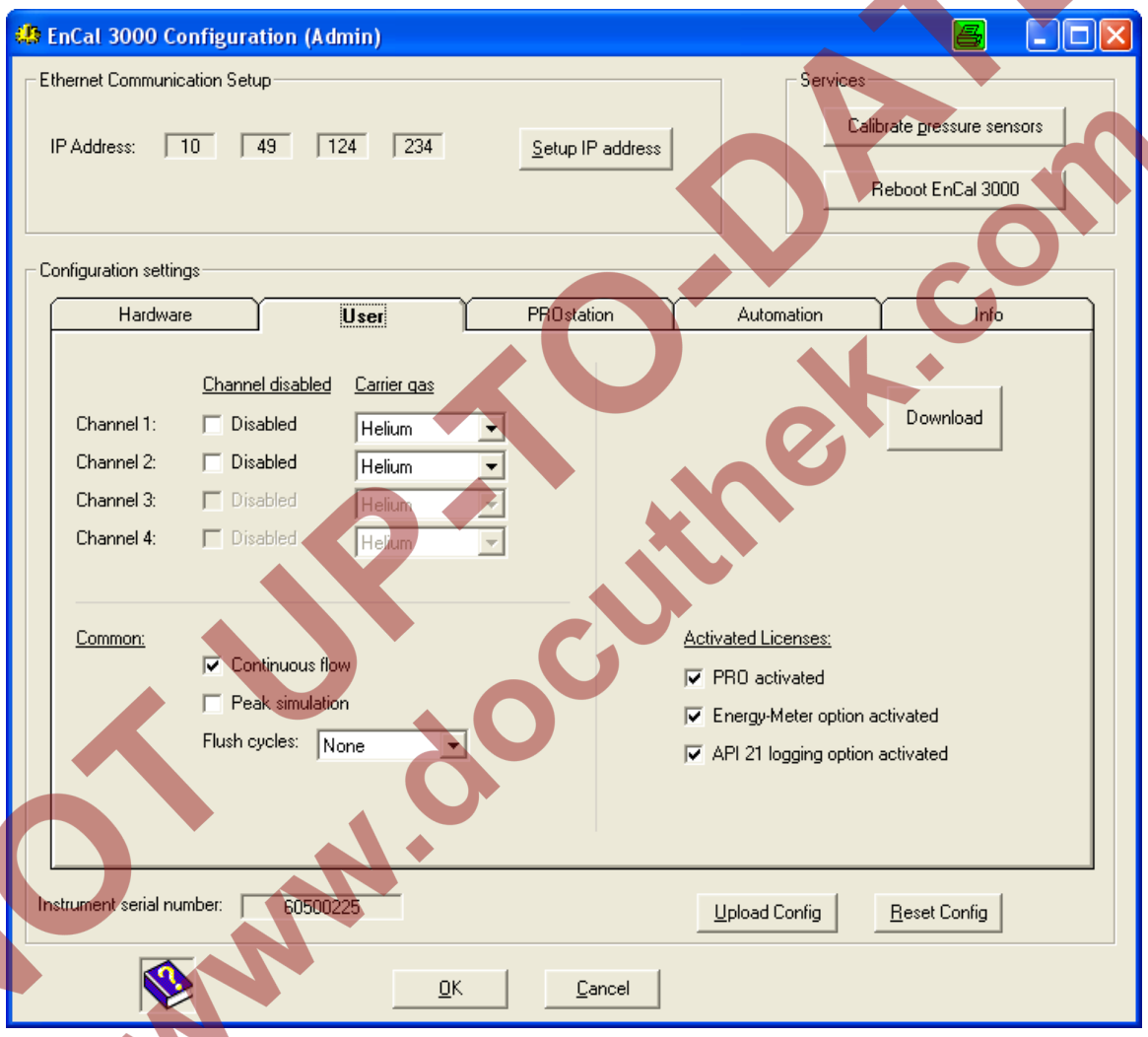
The RGC3000 software can only communicate by TCP-IP to the device. For this communication the I.P. address of the device and the computer must be in the same subnet. For that the Subnet Mask must be the same. For the I.P. address the first numbers must be the same if in the Subnet Mask the number 255 is used. The last numbers of the I.P.-address (other value than 255 for the subnet mask) of the computer, the chromatograph and all other partners in the subnet must be different. Otherwise this results into I.P. conflicts. After deliverance the device has a typical I.P. setting that was used during the production. It is either possible to use this setting or to set a new I.P. address and subnet mask. The original I.P. address is typically labelled at the device (for example 10.16.1.50) and the used Subnet Mask is 255.0.0.0. If you like to change the I.P. address to and the subnet mask, don't forget that this is only possible if the device in Boot P – mode (see software manual chapter 2.3).

The next step is to make an "Upload" of the configuration and to check if the settings in this configuration are ok. With the command "Upload" the configuration from the device are loaded into the program. With the command "Download" the setting becomes sent to the device.

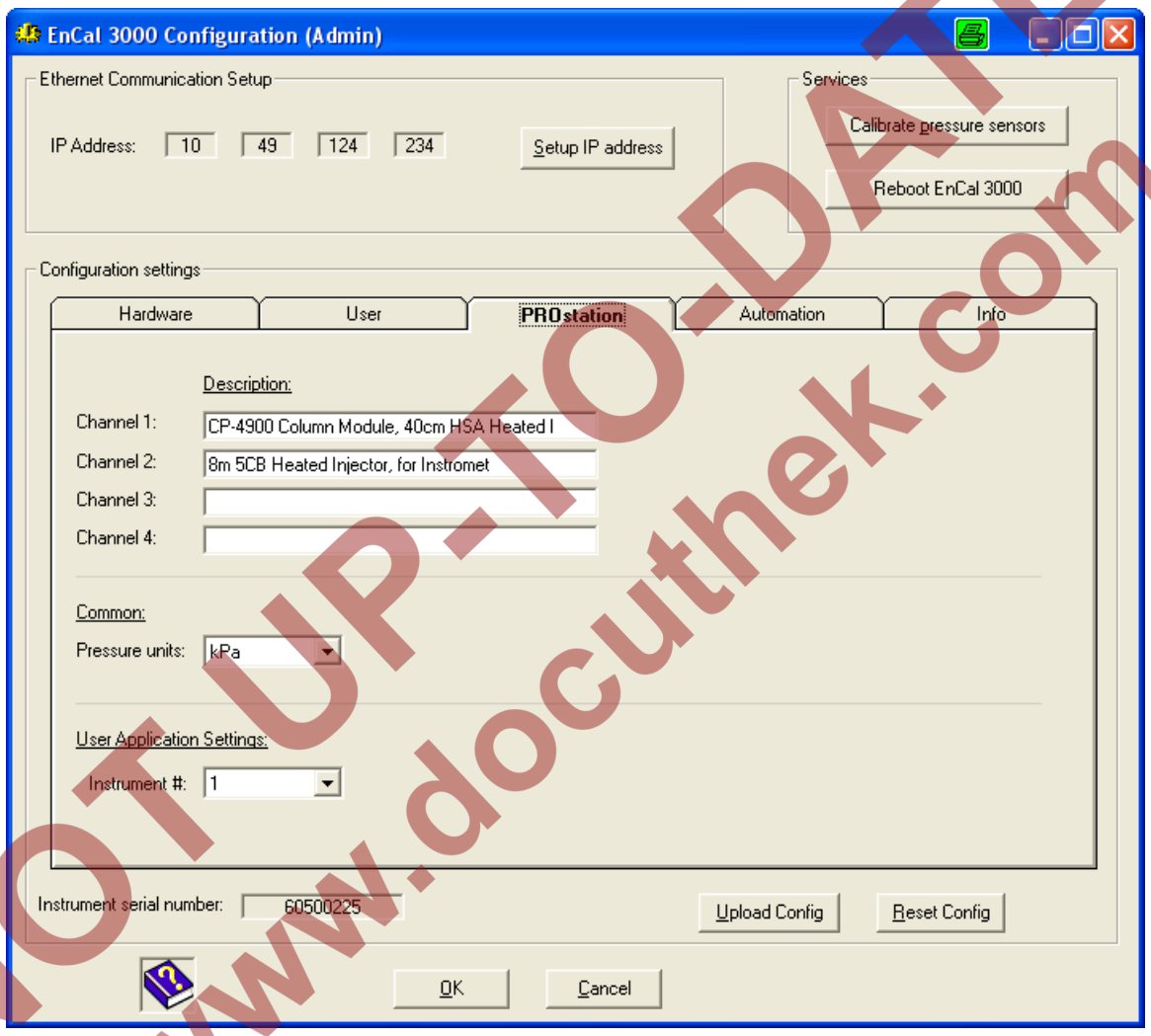
In the menu hardware for the standard device two channels with a heated injector and the available licences should be visible.



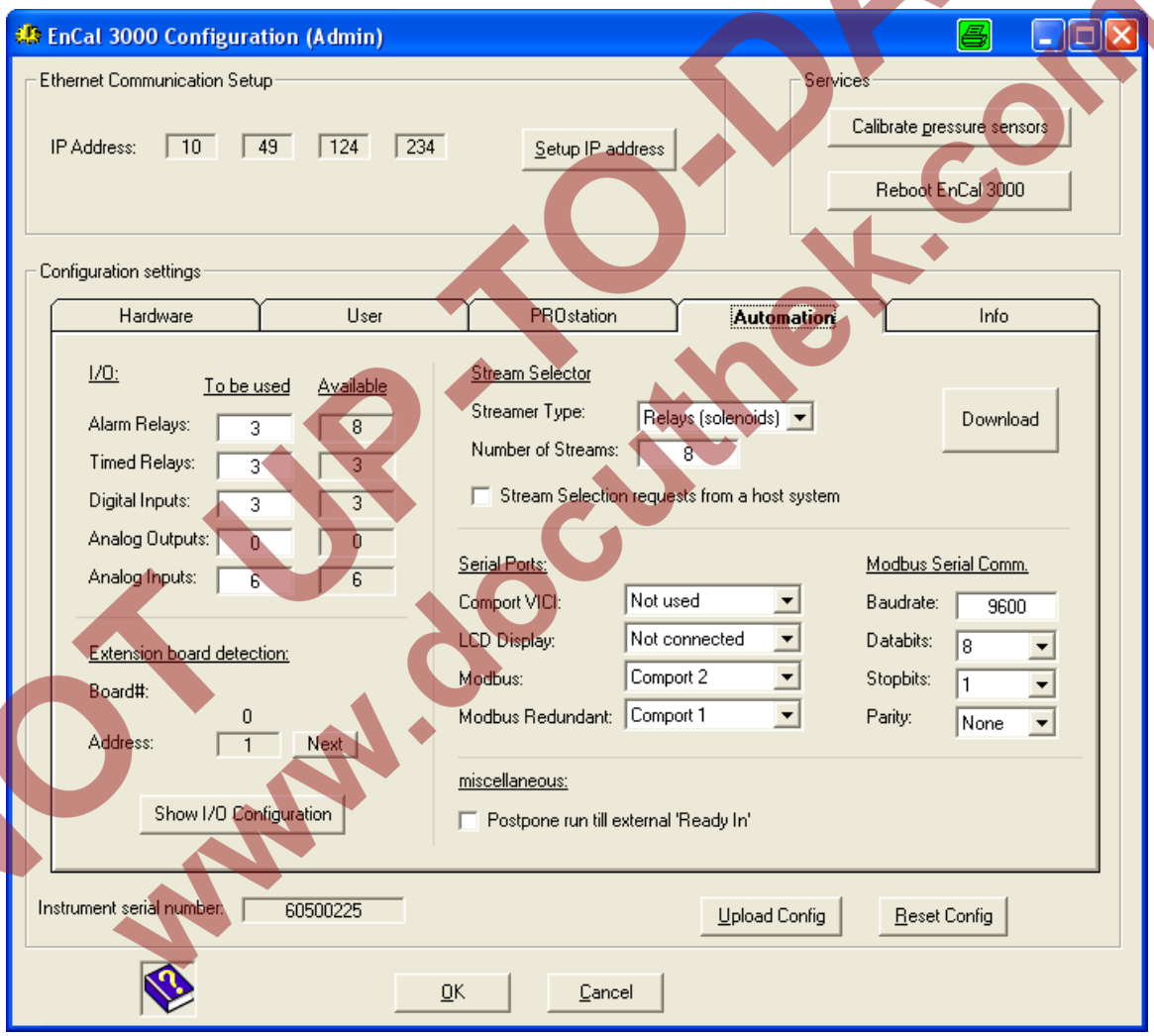
In the menu “User” the used carrier gases for both channels are visible. Here it is important that the right carrier gas type is selected for both channels. For a standard device the right setting is helium for both channels. In addition to that the check button for continues flow should be activated and all available licenses should be activated. For the number of flush cycles the setting is typically “None”.



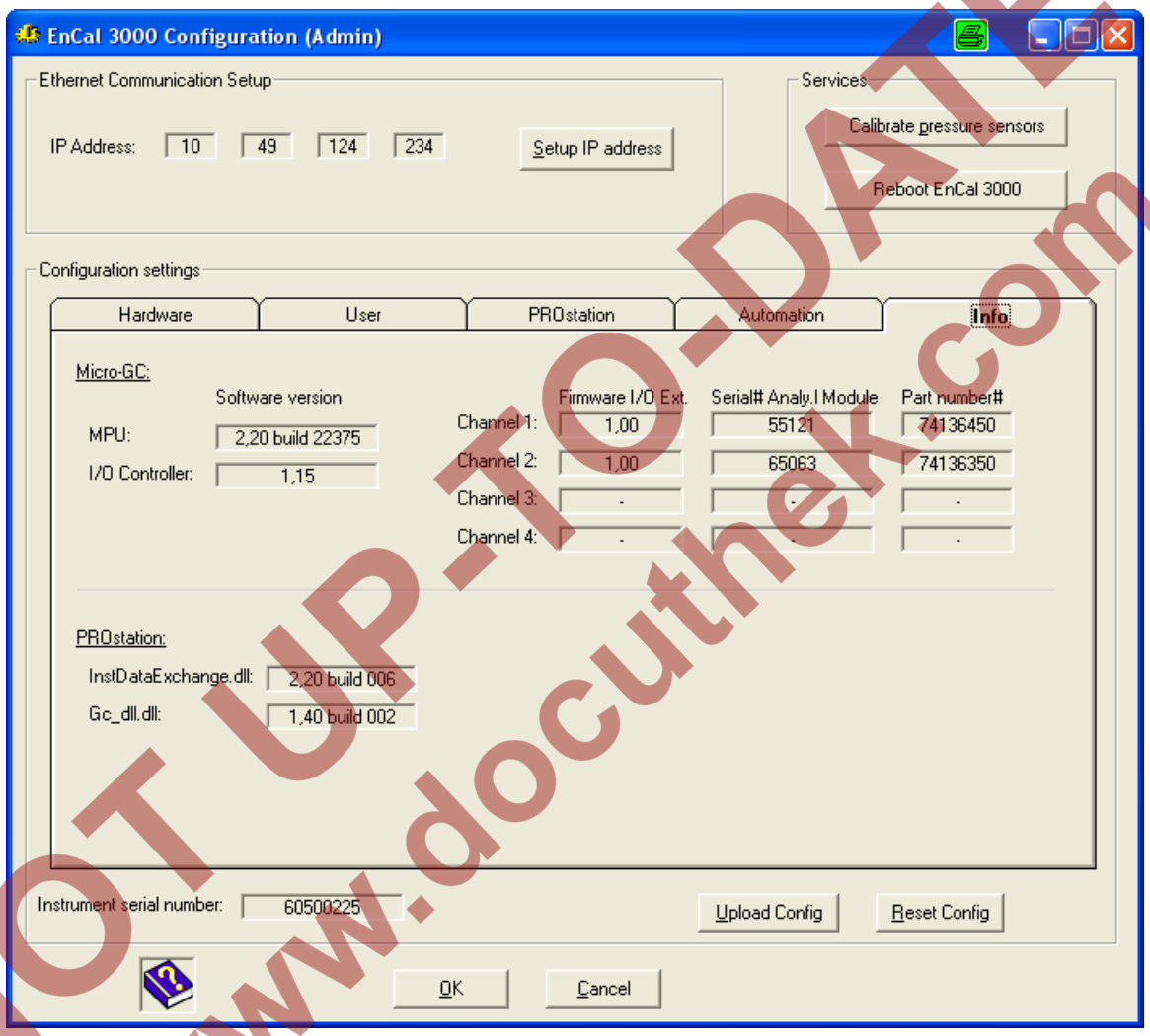
In the menu “PROstation” the type names of the used channel and the unit for the column pressure are visible. This information can be used for example for a check if the right channels are used for an approved operational Analysis. Also if spare parts are needed this information can be used to order the right spare channel type.



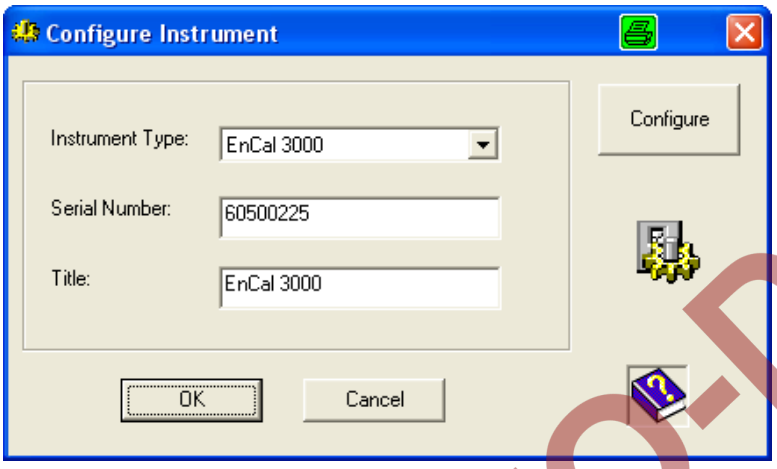
In the menu “Automation” are visible the number of available streams, Relays, In- and Outputs, the used comports for Modbus communication and the corresponding baud rate. Check here if these settings for the Modbus communication are correct, if not they have to be changed at this menu in the configuration and must be downloaded to the device. After a “Download” of changed settings in the configuration the device must be restarted. Also check if the number of available streams is “8”. If this number is lower it can happen for example that the calibration gas stream (position 6) is not available and than it is not possible to calibrate the device in the right way. If the number of available streams is “8” the number of available Alarm Relays and Time Relays is “3”. Check also if the right number of relays becomes used.



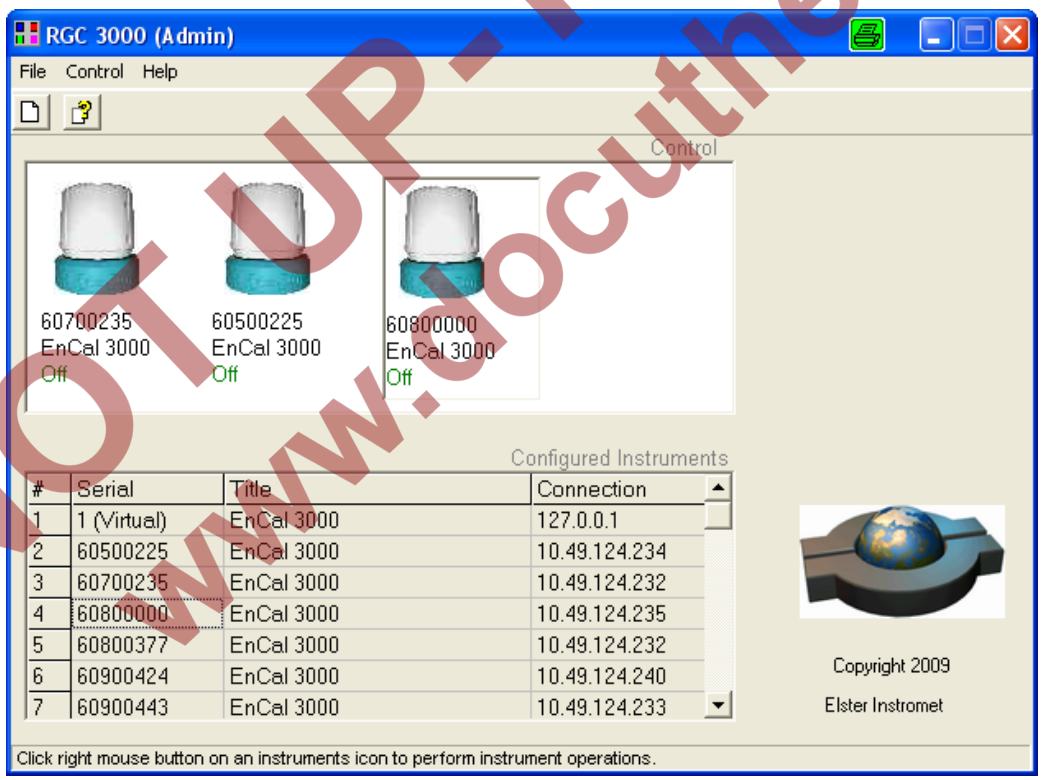
In the menu “Info” it is possible to check the versions of the used software for the MPU-firmware, I/O Controller and the PROstation Software on the used computer. An update of this software packages cannot be done from here. For that special update tools would be needed.



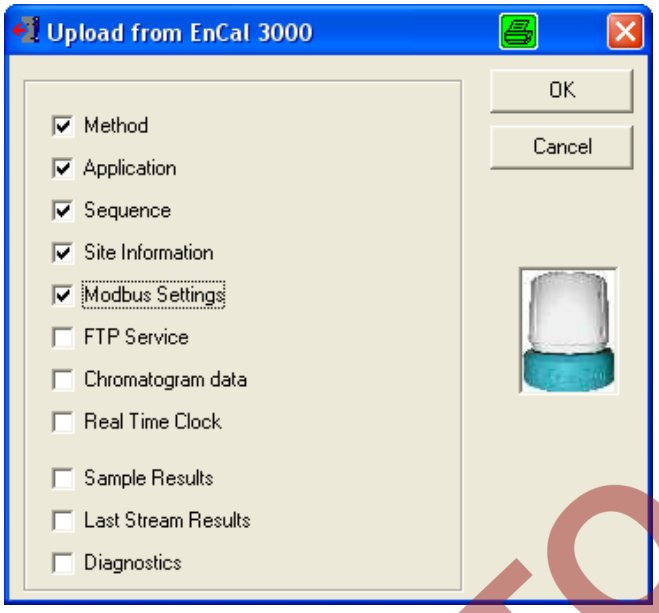
If every setting in the configuration is ok, it can be confirmed with a click on ok. After that another window appears, click on ok again.



After that the configuration part is finished and the device can be selected for a start of the control software with a double click on the picture for the device that you like to use.



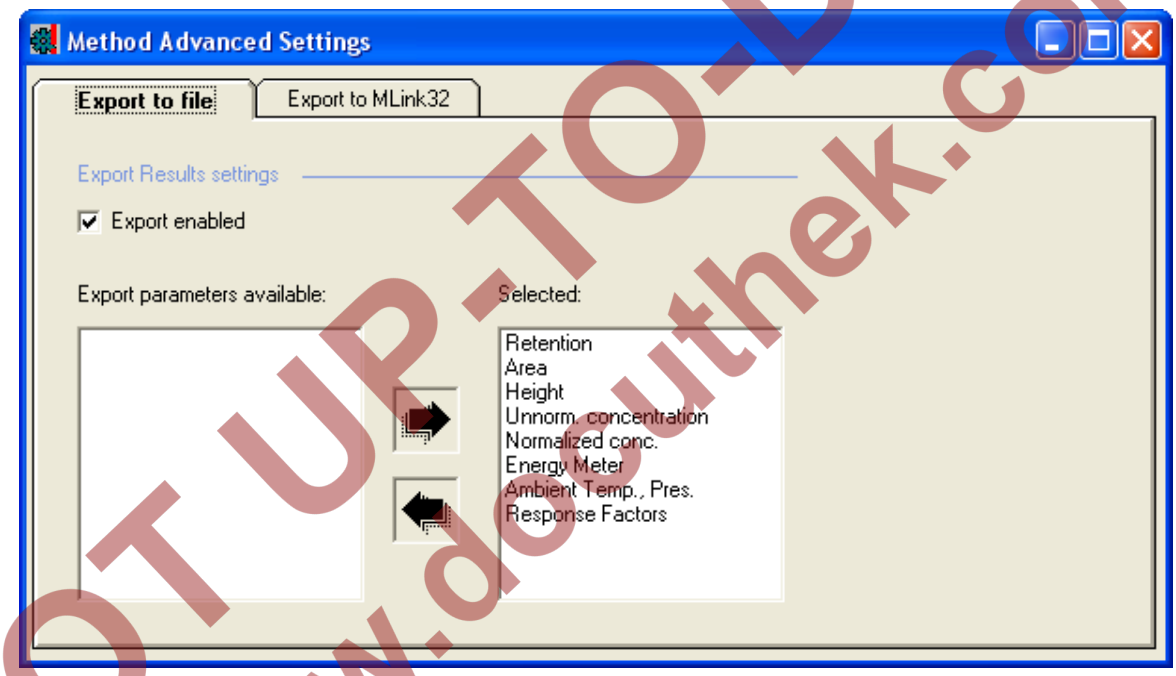
Directly after opening the control software an upload of the actual parameter settings and back up of these setting should be done. The upload can be done in the menu control/ upload. Select here the first five parameter settings.



Each of these parameter settings has to be saved separately. This can be done in the menu File.

2.4 Check of the parameter settings

Compare the actual settings in the menu method with the documented settings that are visible in the test report which becomes delivered together with the device. The right starting point for the method to use is this documented factory settings.
All parameters in the menus method/Instrument Setup, method/Integration Events, method/peak Identification, method/peak calibration and method/properties should be the same as in the documented factory settings. If this is the case the first measurements with sample gas can be started. If there is no sample gas available it is also possible to start with some analysis of the calibration gas. If you like to save some measurements for a commissioning protocol don't forget to activate the export to file in the menu method/ advanced.

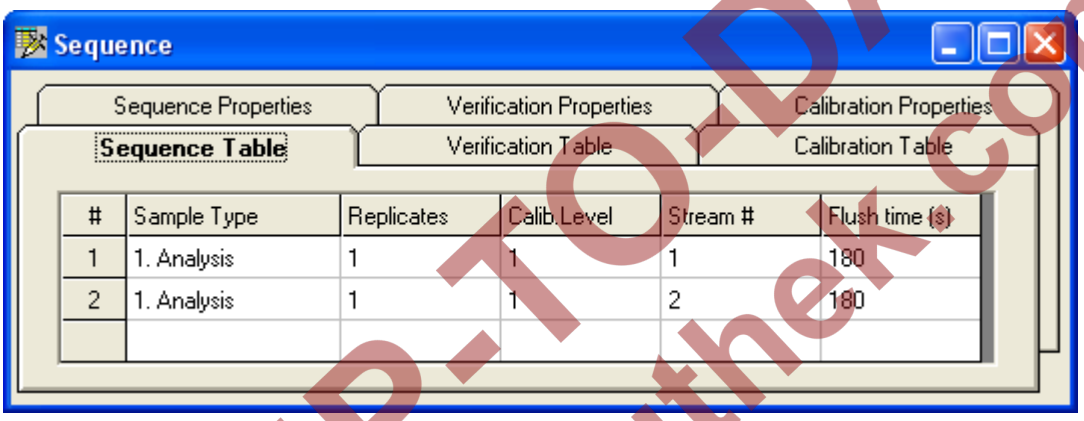


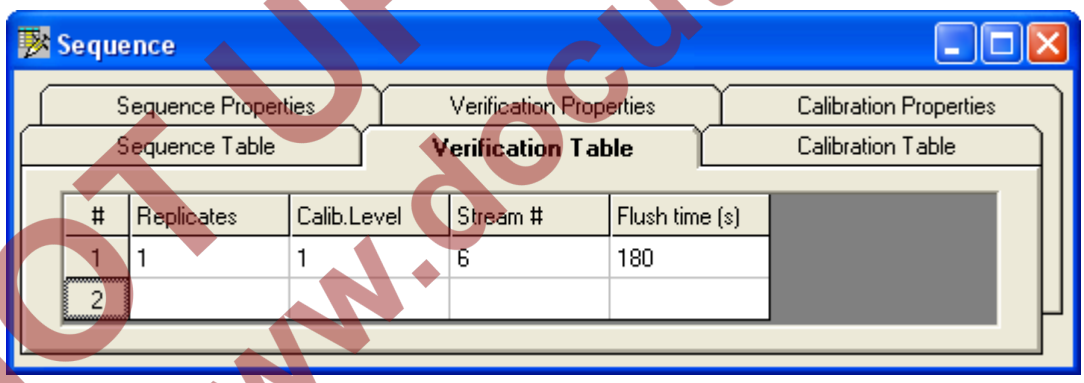
Typically directly after the start-up of the device the measurement results will be unstable, because the device is not thermally stabilized yet. An indicator if the measurement results of the device is stable or not is the unnormalized sum. Directly after start-up the unnormalized sum is typically too high (for example 120 or more). After about one hour (or at least 10 measurements) the results should become stable and than the unnormalized sum should be in a range between 95 and 105. If the unnormalized sum is still too high the set value for the carrier gas pressure is maybe too high or the instrument is still not stable yet. One other cause for a too high unnormalized sum can also be a higher atmospheric pressure or a lower ambient temperature than during the time when the instrument was calibrated for the last time. For a too low value of the unnormalized sum the reason can be a too low carrier gas pressure, a too low gas flow for the carrier gas or a partly blocked carrier gas flow. Another possible reason for a too low unnormalized sum is a much lower ambient pressure than during the last time that the device was calibrated or a much higher ambient temperature than during the time the device was calibrated last time. Also a too low pressure for sample gas or a blocked sample gas flow can be a cause for a too low unnormalized sum.

After about one hour the results are quite stable but the temperature inside the housing is not completely stable. Because of that we advice to let the device run for at least 8 hours or over night after start-up and to continue with the preparation of the new basic calibration afterwards. During this time also the rest amount of air and moisture which is often left in the gas tubes for the sample gas becomes completely removed by the sample gas flow.

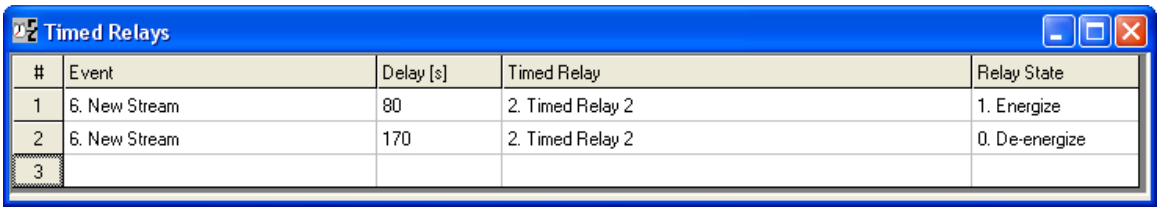
2.5 Preparation of a new Basic Calibration

The first step is to check the parameter settings in the menu Automation/Sequence. Check here especially if a flushing time of 180 seconds becomes used for every sample gas stream, for the verification and calibration gas.

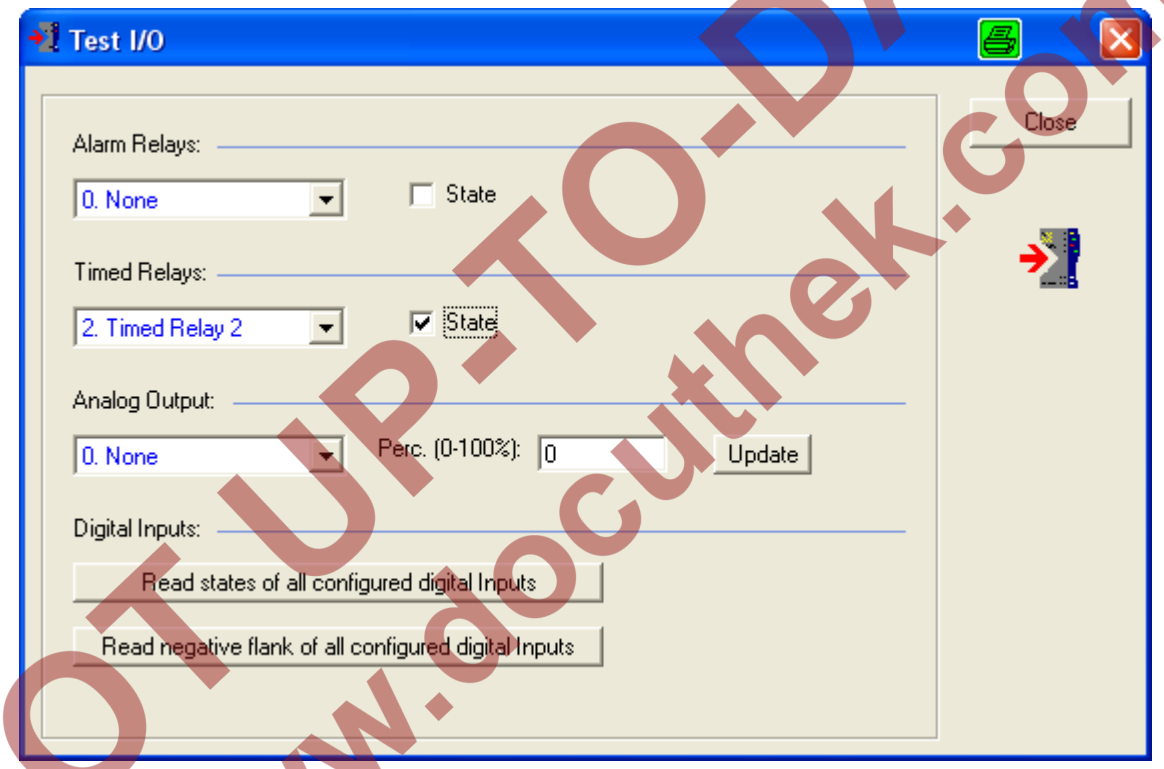




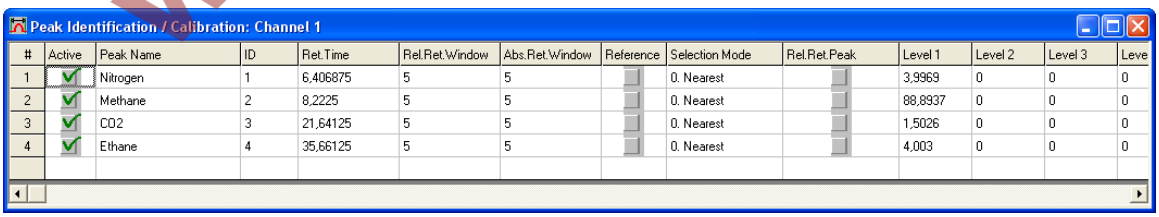
Also the settings in the menu Application/Time Relays for the activation of the internal bypass should be checked. The internal bypass should be activated only if the stream for the analysis becomes changed. It becomes activated a while after the new stream has been selected. The internal bypass should be deactivated again within the parameterized time for flushing (for example after 170 seconds after the change of the stream).



Before the new basic calibration becomes started some test measurements with the calibration gas should be done. Important is that the analysis results for the calibration gas is stable enough. Typically at the beginning the nitrogen and the propane concentrations are too high and are also unstable. The reason for this effect is that there is often some rest air in the tube for the calibration gas. Continue with the test measurements with the calibration gas until the results are stable. This is the case if the repeatability for the calculated results like the heating value is better than 0.01% relative standard deviation. If the tubes were not flushed well, this would take a few hours. It is possible to speed this up by a manual activation of the internal bypass. This manual activation can be done in the menu Control/ Time Relays. Select “2. Timed Relay 2” and activate it with the button state. This is not possible during a running measurement. Because of that the analysis has to be stopped before the internal bypass can be activated manually.



The next step after the test measurements with the calibration gas are finished is to enter the certified values for the calibration gas in the menu method/peak identification. Typically these values should be entered in the column called “level 1”.



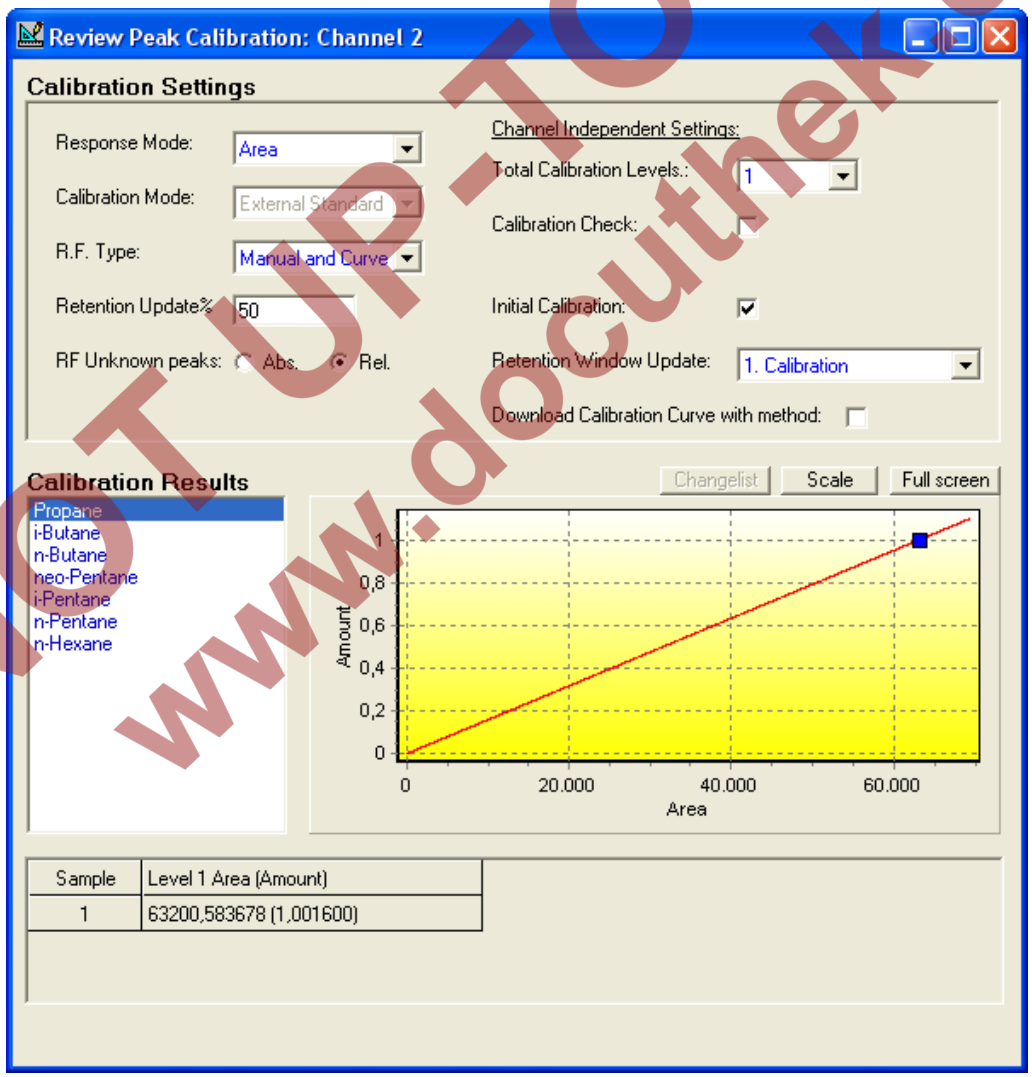
#	Active	Peak Name	ID	Ret.Time	Rel.Ret.Window	Abs.Ret.Window	Reference	Selection Mode	Rel.Ret.Peak	Level 1	Level 2	Level 3	Leve
1	✓	Nitrogen	1	6,406875	5	5		0. Nearest		3,9969	0	0	0
2	✓	Methane	2	8,2225	5	5		0. Nearest		88,8937	0	0	0
3	✓	CO2	3	21,64125	5	5		0. Nearest		1,5026	0	0	0
4	✓	Ethane	4	35,66125	5	5		0. Nearest		4,003	0	0	0

Peak Identification / Calibration: Channel 2

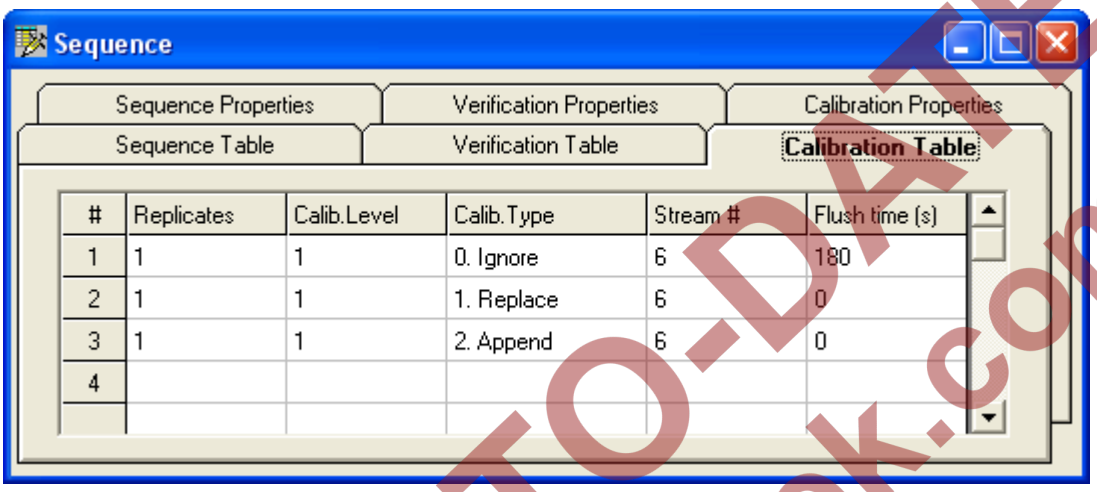
#	Active	Peak Name	ID	Ret.Time	Rel.Ret.Window	Abs.Ret.Window	Reference	Selection Mode	Rel.Ret.Peak	Level 1	Level 2	Level 3	Leve
1	✓	Propane	1	11,31063	5	5		0. Nearest		1,0016	0	0	0
2	✓	i-Butane	2	13,68812	5	5		0. Nearest		0,2008	0	0	0
3	✓	n-Butane	3	15,58625	5	5		0. Nearest		0,201	0	0	0
4	✓	neo-Pentane	4	16,54688	5	5		0. Nearest		0,05	0	0	0
5	✓	i-Pentane	5	22,13688	5	5		0. Nearest		0,0499	0	0	0
6	✓	n-Pentane	6	25,40375	5	5		0. Nearest		0,0501	0	0	0
7	✓	n-Hexane	7	48,15125	5	5		0. Nearest		0,0504	0	0	0

Only if the device has been multilevel calibrated during the production, another calibration level should be used. In this case in the field also just one calibration would be used but the certified should be entered at “level 8 Rw” instead of “level 1.

The next step is to check in the menu method/peak calibration if the option “initial calibration” is activated and that the total number of calibration levels is 1. Only if the device has been multilevel calibrated before it was delivered the number of calibration levels should be 2 or higher.

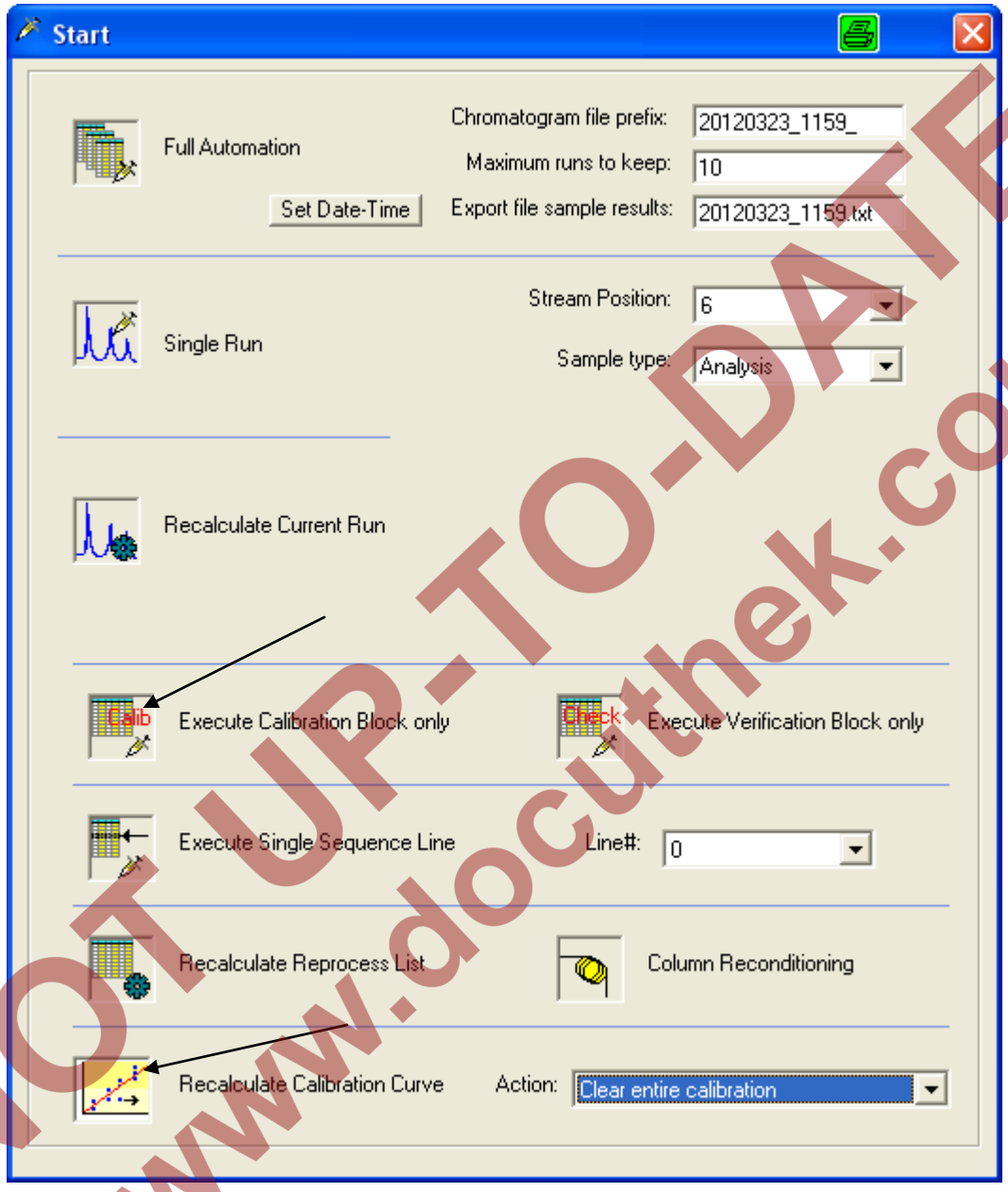


After the changes in the menu method are finished, don't forget to download the new method to the device. Before the calibration can be started also the settings in the menu automation/ sequence should be checked.

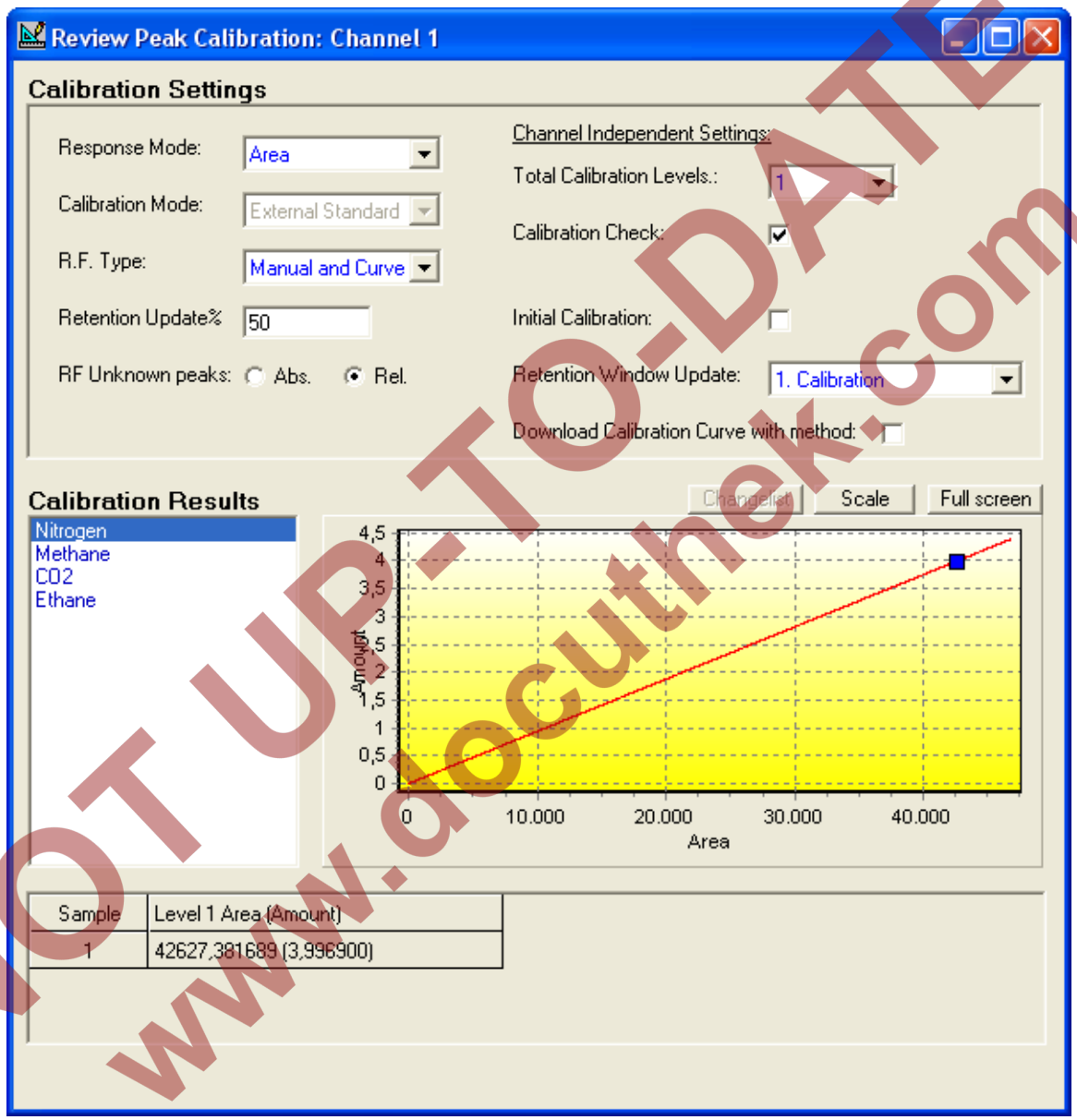


Typically for a calibration three measurements are done, the first one would be ignored and the other two would be used. The average of them would be used for the calculation of the response factors. Check also if the right calibration level becomes used. It must be the same as the used level in the menu method/ peak identification. If you have changed some settings in the menu automation/ sequence the new sequence must be downloaded to the device.

Before the new basic calibration can be started the old response factors has to be deleted. This can be done in the menu Control/ Start with a click on the button "Recalculate Calibration Curve" if the action "Clear entire calibration" has been selected. After that the basic calibration can be started with a click on the button "Execute Calibration Block only".



After the basic calibration is finished the option “initial calibration” in the menu method/ peak calibration should be deactivated and the option “calibration check” should be activated. This option becomes used for a check of the daily calibration.



The results of the daily calibration will be compared with the results from the basic calibration and from the last valid calibration. If the results are outside the defined limits, which can be parameterized in the menu method/ peak identification, the calibration results becomes discarded and the last valid calibration results would be used for the further analysis. Typically these limits are 5% for the main components and 10% for the higher hydrocarbons butanes to C6+. If also the higher hydrocarbons n-Heptane to n-Nonane are identified in addition to the other hydrocarbons the limit for these components for the calibration check is typically 25%.

Peak Identification / Calibration: Channel 1

#	Intercept coeff.	Linear coeff.	Quadratic coeff.	Cubic coeff.	Rw factor	Manual RF	Manual RF	InitialRF%	CurrentRF%
1	0	9,37636758733614E-05	0	0	1		1	5	5
2	0	1,10969594950185E-04	0	0	1		1	5	5
3	0	7,89816505745805E-05	0	0	1		1	5	5
4	0	7,32707458258219E-05	0	0	1		1	5	5

Peak Identification / Calibration: Channel 2

#	Intercept coeff.	Linear coeff.	Quadratic coeff.	Cubic coeff.	Rw factor	Manual RF	Manual RF	InitialRF%	CurrentRF%
1	0	1,9464940446575E-05	0	0	1		1	5	5
2	0	1,68789481589218E-05	0	0	1		1	5	5
3	0	1,62489223271616E-05	0	0	1		1	5	5
4	0	1,62767610689957E-05	0	0	1		1	10	10
5	0	1,47807830100304E-05	0	0	1		1	10	10
6	0	1,44744468845713E-05	0	0	1		1	10	10
7	0	1,26665254616644E-05	0	0	1		1	10	10

Download the method again after the changes in the menus method/ peak calibration and method/ peak identification are finished. After that a performance test can be started.

2.6 Performance Test

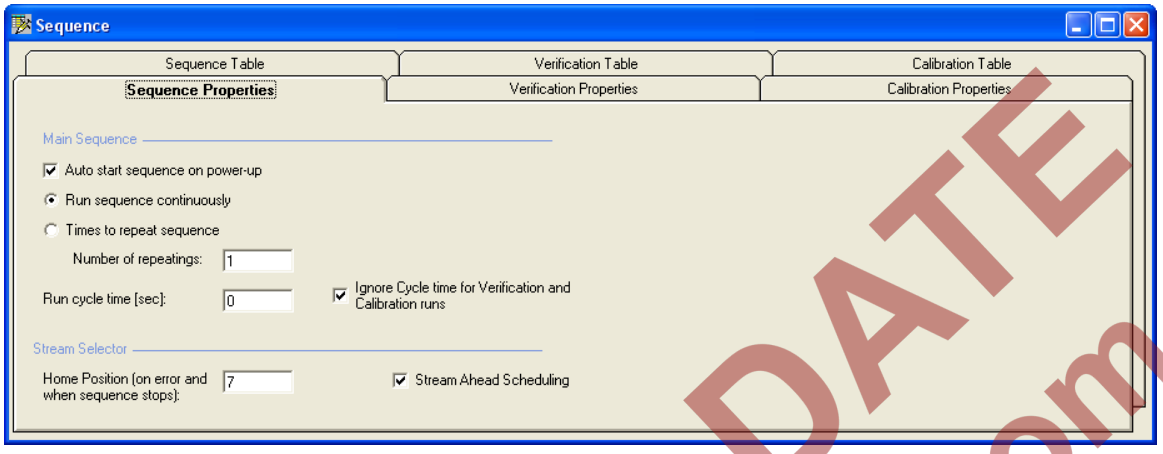
The number and the type of gases that can be used for a performance test can be fixed for example in the approval and the corresponding verification procedure. If this is not the case a performance test is optional. If you like to do one we advise to use two different gases for the performance test. One should be a gas with a low heating value. This gas should contain a higher amount of nitrogen and carbon dioxide and a lower concentration of the hydrocarbons than the calibration gas. The second gas should be a gas with a high calorific value. This gas should contain a higher amount of hydrocarbons and a lower concentration of nitrogen and carbon dioxide than the calibration gas. For each of these two test gases a set of measurements (at least 5) should be made. These test results can be reported and used for the commissioning protocol.

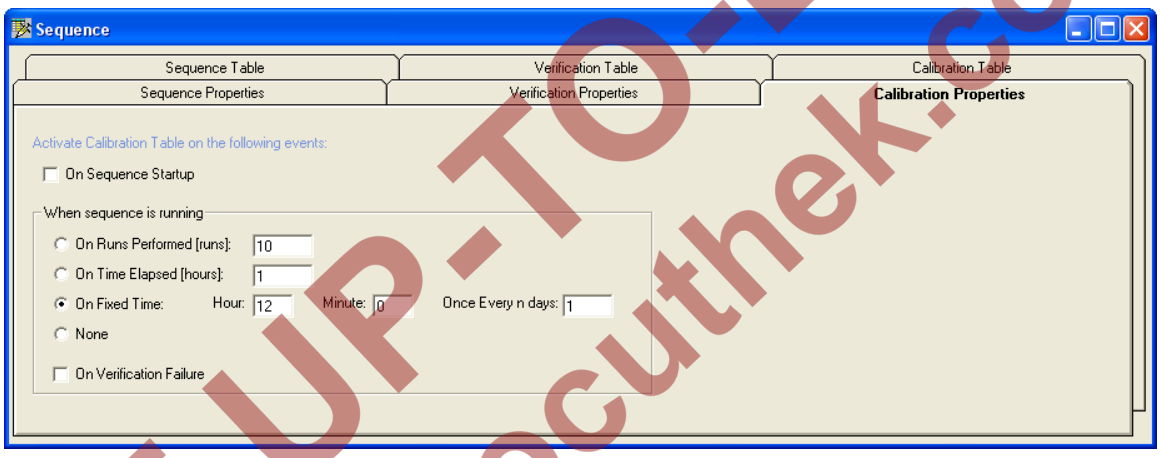
The results for the heating value and the other calculated results for these two test gases should be better than 0.1% relative deviation to the certified values of the used test gases. If the results are a little worse the reason is typically that the used test gases are near to the limits of the specified measurement ranges. In this case the results would be still acceptable. A possible test result could be like the following example. In this case two test gases with a low and a high heating value were used and the measurement results show that the performance of the device in inside our defined specification for the measurement uncertainty.

Component	Cal. gas	Test gas 1	Analysis	Test gas 2	Analysis
	ID 114	ID69 (L1-11K)	run 148	ID101 (H2-11K)	run 157
	[mol%]	Certificate [mol%]		Certificate [mol%]	
Nitrogen	3.9969	10.9900	11.006471	0.9599	0.961028
Methane	88.8937	86.0163	85.992868	84.9955	84.994751
CO2	1.5026	1.5430	1.542957	1.4507	1.451595
Ethane	4.0030	0.7499	0.752696	8.9945	8.997382
Propane	1.0016	0.3002	0.300117	2.9991	2.994548
i-Butane	0.2010	0.1006	0.101052	0.2019	0.201084
n-Butane	0.2008	0.1007	0.102243	0.1993	0.199594
neo-Pentane	0.0500	0.0497	0.049328	0.0509	0.049850
i-Pentane	0.0499	0.0499	0.051838	0.0486	0.049894
n-Pentane	0.0501	0.0499	0.050302	0.0497	0.050103
n-Hexane	0.0504	0.0498	0.050126	0.0499	0.050172
Heating value [kWh/m3]	11.1270	9.9076	9.90708	12.2209	12.22013
Error [%]			-0.005		-0.006
Allowed Error [%]			0.1		0.1

If the deviations are much bigger than 0.1% for the heating value, it is either possible that some settings in the method are wrong or that the new basic calibration was not good. If the deviations for the calculated results are to big the deviations for the components should also be checked. Find out which components have the biggest deviation. For these components the peak integration should be checked and the entered value for the certified concentration in the menu method/ peak identification should be checked also. If there was a value not correct, a new basic calibration would be needed after the wrong values has been corrected. If the integration of these components is not ok, the settings in the menu method/ peak integration should be adjusted. In the most cases if the integration of a peak is not good the used setting for the parameter “Set Threshold” is a little too high or the setting for the parameter “Set Peak Width” is to low. Try some different settings for these parameters to optimize the peak integration. After each change the method must be downloaded to the device and after a recalculation of the actual measurement results the effect for the peak integration is visible. If the optimization of the settings in the method/ peak integration has been finished a new basic calibration would be needed.

After the performance test has been successfully finished the last step for the commissioning would be to check the sequence for the operational sample gas analysis. In Sequence Properties the buttons “Auto start sequence on power-up” and “Run sequence continuously” should be activated. For the “Home Position” a stream number where no gas is connected should be used. Because maximal six streams (5 sample + calibration gas) are available this is typically “7”. In addition to that the button “Stream Ahead Scheduling” should be activated.
In Calibration Properties a fixed time for the calibration, that becomes typically done once every day, should be selected.





After that start the measurement sequence with the button “Full Automation” in the menu Control/ Start.

2.7 Check Lists

	Description	OK?
Serial Number		☐
Tag Number		☐
IP address		☐
Certification Number	KEMA 05ATEX2191X / IECEx KEM 10.0094X	☐

Checked: Yes ☐ No ☐	**Result**: Accepted ☐ Comments ☐
Notes	*Problems Report(s) when comments:*

2.7.1 Visual Inspection Analyzer Equipment

Visual inspection of the equipment:

Action	OK?
Check for contamination and oxidation (rust) of equipment	☐
Check for unusual damages.	☐

Checked: Yes ☐ No ☐	**Result**: Accepted ☐ Comments ☐
Notes	*Problems Report(s) when comments:*

2.7.2 Check filters and probes

Action	Result	OK?
Check probes and filters for contamination. Replace if filters are contaminated.		☐

Checked: Yes ☐ No ☐	**Result**: Accepted ☐ Comments ☐
Notes	*Problems Report(s) when comments:*

2.7.3 Set up ENCAL 3000

Description	Content and Set point	Checked	OK
Pressure of Carrier gas bottle 1	> 20 Barg		☐
Pressure of Carrier gas bottle 2	> 20 Barg (if present)		☐
Set Pressure of Carrier gas	5.5 Barg		☐
Pressure of Calibration Gas bottle	> 20 Barg		☐
Set Pressure of Calibration Gas	2 Barg		☐
Set Pressure of Sample System	2 Barg		☐
Column Temperature Channel 1	Between 50°C and 80°C		☐
Column Temperature Channel 2	Between 50°C and 80°C		☐
Injector Temperature Channel 1	Between 55°C and 85°C		☐
Injector Temperature Channel 2	Between 55°C and 85°C		☐
Column Pressure Channel 1	Between 100 and 200 kPa		☐
Column Pressure Channel 2	Between 200 and 300 kPa		☐
Firmware version	2.20 build 19606 or 2.20 build 22375		☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐ Comments ☐
Notes		*Problems Report(s) when comments:*	

2.7.4 Check Method Table Encal 3000 According ISO 6976, GPA or GOST

Description	Preset	Checked	OK
Units	KWh /MJ BTU/ KCal		☐
Calibration Gas Components	According to Calibration Gas Certificate.		☐
Heating Value Calculation according to.	ISO 6976, GPA, ASTM or Gost		☐
Reference and combustion temperature.	(15/15), (0/0), (15/0), (25/0), (20/20), (25/20) for ISO 6976. 0/0 or 20/20 for Gost. 60°F and 14.696 PSI for GPA and ASTM		☐

Remarks: Underlined is as default.

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐ Comments ☐
Notes		*Problems Report(s) when comments:*	

2.7.5 Calibration Encal 3000

Action	Checked	OK?
Enter the calibration gas data into the method table.		☐
From the RGC 3000 software start a calibration run manually.		☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐ Comments ☐
Notes		*Problems Report(s) when comments:*	

2.7.6 Accuracy Check Encal 3000

Action	Result	OK?
When the Gas Chromatograph is well calibrated, let the Gas Chromatograph run and verify a single analysis with the test gas certificate	If difference between measurement and certificate is less than 0.1% on the heating value, it is OK.	☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐ Comments ☐
Notes		*Problems Report(s) when comments:*	

2.7.7 Parameter set backup

Action	Checked	OK?
Method table saved.		☐
Application table saved.		☐
Sequence table saved.		☐
Modbus table saved.		☐

Checked:	Yes ☐	No ☐	**Result**:	Accepted ☐ Comments ☐
Notes			*Problems Report(s) when comments:*	

3 Maintenance

To the maintenance of the device belong a visual check for the pressure of the used carrier gases, the calibration gas and the sample gases. In addition to that it is advised to make a manual calibration to be able to check if the daily calibration becomes accepted. Optionally is an additional performance test after the new calibration.

3.1 Pressure Check and Visual Check of the Equipment

Description	Content and Set point
Pressure of Carrier gas bottle 1	> 20 Barg
Pressure of Carrier gas bottle 2	> 20 Barg (if present)
Pressure of Carrier gas	5.5 Barg
Pressure of Calibration Gas bottle	> 20 Barg
Pressure of Calibration Gas	2 Barg
Pressure of Sample System	2 Barg

If the pressure of the carrier gas or the calibration gas is below these limits it is time to order a new cylinder for the gas that is getting empty.

In addition to the pressure of the carrier gas and calibration gas cylinders also a visual check for of the equipment should be done. This covers a check for contamination and oxidation, a check for unusual damages and a check of the probes and filter. If a probe or a filter is contaminated it should be replaced.

3.2 New Calibration and Performance Test

If the calibration gas cylinder is nearly empty (< 5 barg), it should be exchanged. In this case the certified values of the new calibration gas cylinder have to be entered in the menu method/ peak identification and a new basic calibration should be done. Otherwise just a normal manually calibration is enough. If this manual calibration becomes not accepted a new basic calibration should be done.
For the optional performance test it is possible to use one of the two gases that were used during the performance test for the commissioning. If the results for the heating value are still within the specification of < 0.1 %, no additional actions are needed. If the deviations are much bigger than 0.1% for the heating value it is recommended to make a new basic calibration.

3.3 Checklists first maintenance

Pressure Check and Performance Test:

Description	Min. Content and Set point	Actual content	OK
Pressure of Carrier gas bottle 1	> 20 Barg		☐
Pressure of Carrier gas bottle 2	> 20 Barg (if present)		☐
Pressure of Carrier gas	5.5 Barg		☐
Pressure of Calibration Gas bottle	> 20 Barg		☐
Pressure of new Calibration Gas bottle if the old one has been re-placed	> 20 Barg		☐
Pressure of Calibration Gas	2 Barg		☐
Pressure of Sample System	2 Barg		☐
New Calibration successful?			**Yes** ☐ **No** ☐
Performance Test successful?			**Yes** ☐ **No** ☐
New basic calibration performed if the bottle has been exchanged or if a normal manual calibration was not successful or if the performance test has been failed?			☐

Visual inspection of the equipment:

Action	OK?
Check for contamination and oxidation (rust) of equipment	☐
Check for unusual damages.	☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

Action	Result	OK?
Check probes and filters for contamination. Replace if filters are contaminated.		☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

3.4 Checklists second maintenance

Pressure Check and Performance Test:

Description	Min. Content and Set point	Actual content	OK
Pressure of Carrier gas bottle 1	> 20 Barg		☐
Pressure of Carrier gas bottle 2	> 20 Barg (if present)		☐
Pressure of Carrier gas	5.5 Barg		☐
Pressure of Calibration Gas bottle	> 20 Barg		☐
Pressure of new Calibration Gas bottle if the old one has been re-placed	> 20 Barg		☐
Pressure of Calibration Gas	2 Barg		☐
Pressure of Sample System	2 Barg		☐
New Calibration successful?			**Yes** ☐ **No** ☐
Performance Test successful?			**Yes** ☐ **No** ☐
New basic calibration performed if the bottle has been exchanged or if a normal manual calibration was not successful or if the performance test has been failed?			☐

Visual inspection of the equipment:

Action	OK?
Check for contamination and oxidation (rust) of equipment	☐
Check for unusual damages.	☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

Action	Result	OK?
Check probes and filters for contamination. Replace if filters are contaminated.		☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

3.5 Checklists third maintenance

Pressure Check and Performance Test:

Description	Min. Content and Set point	Actual content	OK
Pressure of Carrier gas bottle 1	> 20 Barg		☐
Pressure of Carrier gas bottle 2	> 20 Barg (if present)		☐
Pressure of Carrier gas	5.5 Barg		☐
Pressure of Calibration Gas bottle	> 20 Barg		☐
Pressure of new Calibration Gas bottle if the old one has been re-placed	> 20 Barg		☐
Pressure of Calibration Gas	2 Barg		☐
Pressure of Sample System	2 Barg		☐
New Calibration successful?			**Yes** ☐ **No** ☐
Performance Test successful?			**Yes** ☐ **No** ☐
New basic calibration performed if the bottle has been exchanged or if a normal manual calibration was not successful or if the performance test has been failed?			☐

Visual inspection of the equipment:

Action	OK?
Check for contamination and oxidation (rust) of equipment	☐
Check for unusual damages.	☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

Action	Result	OK?
Check probes and filters for contamination. Replace if filters are contaminated.		☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

3.6 Checklists fourth maintenance

Pressure Check and Performance Test:

Description	Min. Content and Set point	Actual content	OK
Pressure of Carrier gas bottle 1	> 20 Barg		☐
Pressure of Carrier gas bottle 2	> 20 Barg (if present)		☐
Pressure of Carrier gas	5.5 Barg		☐
Pressure of Calibration Gas bottle	> 20 Barg		☐
Pressure of new Calibration Gas bottle if the old one has been re-placed	> 20 Barg		☐
Pressure of Calibration Gas	2 Barg		☐
Pressure of Sample System	2 Barg		☐
New Calibration successful?			**Yes** ☐ **No** ☐
Performance Test successful?			**Yes** ☐ **No** ☐
New basic calibration performed if the bottle has been exchanged or if a normal manual calibration was not successful or if the performance test has been failed?			☐

Visual inspection of the equipment:

Action	OK?
Check for contamination and oxidation (rust) of equipment	☐
Check for unusual damages.	☐

Checked:	Yes ☐	No ☐	**Result**:	Accepted ☐ Comments ☐
Notes			*Problems Report(s) when comments:*	

Action	Result	OK?
Check probes and filters for contamination. Replace if filters are contaminated.		☐

Checked:	Yes ☐	No ☐	**Result**:	Accepted ☐ Comments ☐
Notes			*Problems Report(s) when comments:*	

3.7 Checklists fifth maintenance

Pressure Check and Performance Test:

Description	Min. Content and Set point	Actual content	OK
Pressure of Carrier gas bottle 1	> 20 Barg		☐
Pressure of Carrier gas bottle 2	> 20 Barg (if present)		☐
Pressure of Carrier gas	5.5 Barg		☐
Pressure of Calibration Gas bottle	> 20 Barg		☐
Pressure of new Calibration Gas bottle if the old one has been re-placed	> 20 Barg		☐
Pressure of Calibration Gas	2 Barg		☐
Pressure of Sample System	2 Barg		☐
New Calibration successful?			**Yes** ☐ **No** ☐
Performance Test successful?			**Yes** ☐ **No** ☐
New basic calibration performed if the bottle has been exchanged or if a normal manual calibration was not successful or if the performance test has been failed?			☐

Visual inspection of the equipment:

Action	OK?
Check for contamination and oxidation (rust) of equipment	☐
Check for unusual damages.	☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		

Action	Result	OK?
Check probes and filters for contamination. Replace if filters are contaminated.		☐

Checked:	Yes ☐ No ☐	**Result**:	Accepted ☐	Comments ☐
Notes		*Problems Report(s) when comments:*		