



# Modular Control System KS vario



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Kassel, April 3, 2006

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## General

The following description shows how to setup a simple KS vario system.

### The Example Application

We demonstrate an example project with the following specification:

- 8 Temperature loops with T/C Inputs (Type K)
- 4 Loops heating and cooling
- 4 Loops heating only
- Monitoring of heating current
- Connection to a PC via Ethernet

Necessary Hardware:

- 1 x KS VARIO BK ETH - Order number KSVC-101-00131
- 1 x KS VARIO T8/UTH - Order number KSVC-104-00441
- 1 x VARIO DO 4/24 - Order number KSVC-102-00231
- 1 x Current transformer - Order number 9404-407-50001



For system wiring diagrams, refer to the user manuals of the used modules.  
Download at <http://www.pma-online.de/en/products/ksvario-menue.html>

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## Configuration

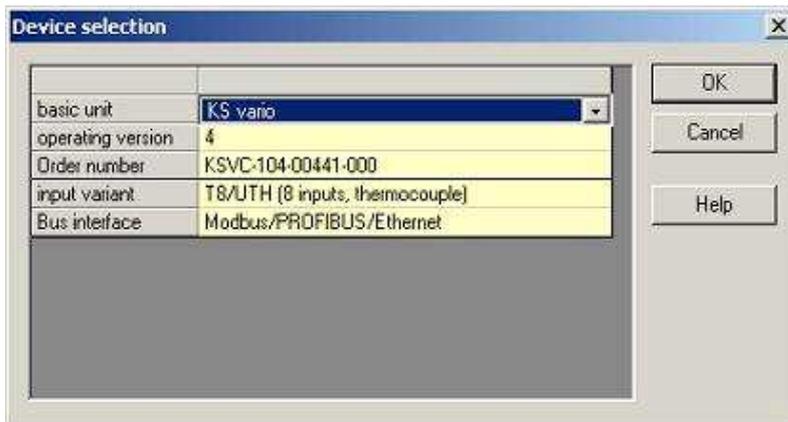
Start up the BlueControl configuration software.

The latest version is available at: <http://www.pma-online.de/en/products/download.html>

Once BlueControl is started, select 'Create a new project' and click 'OK'.



Select your device.



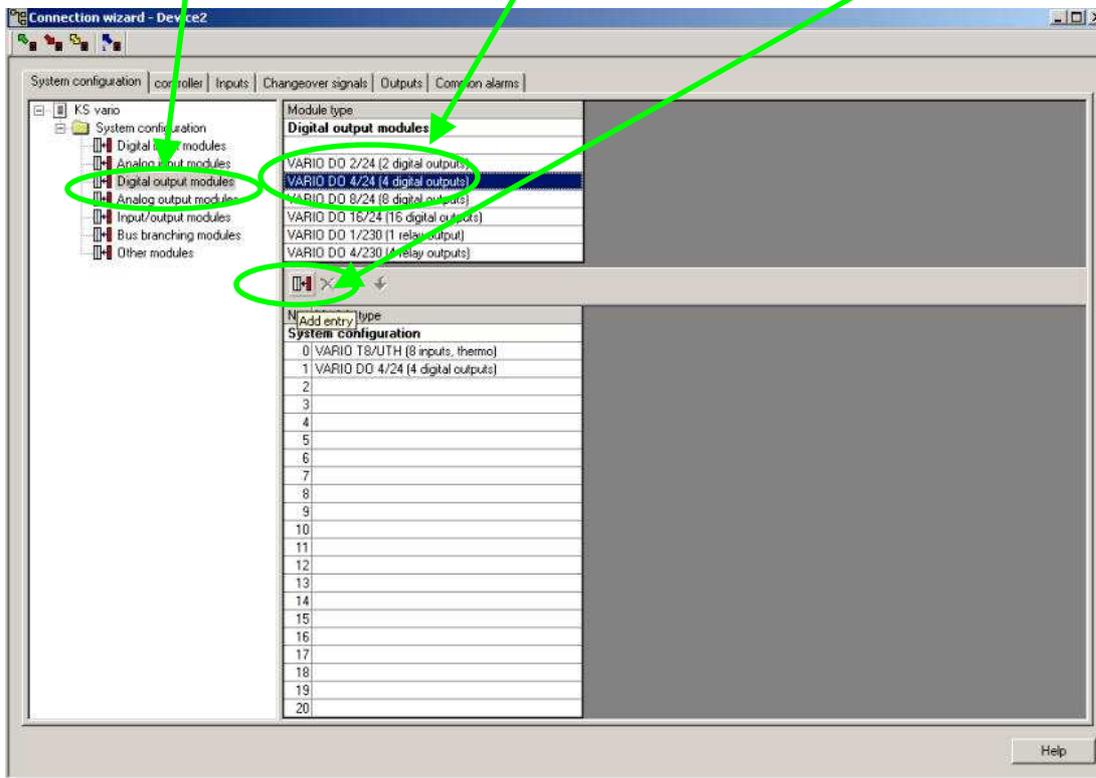
If desired, the Project Info window can be used to add notes about the project.



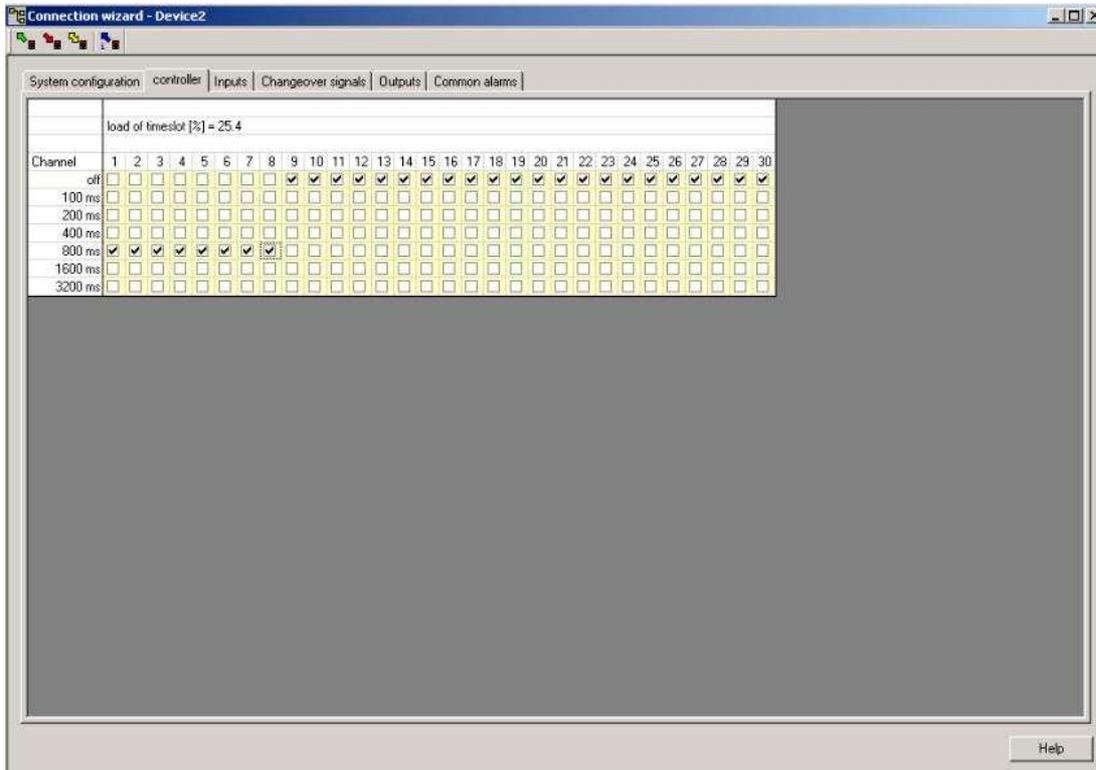
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**Open Connection wizard window**

Select System configuration tab.  
Choose module type and select the module you need. Then press the 'Add entry' icon.



Select controller tab.  
Activate as many controllers as you need. Faster scan times use more processor bandwidth, the bandwidth can not exceed 100%.



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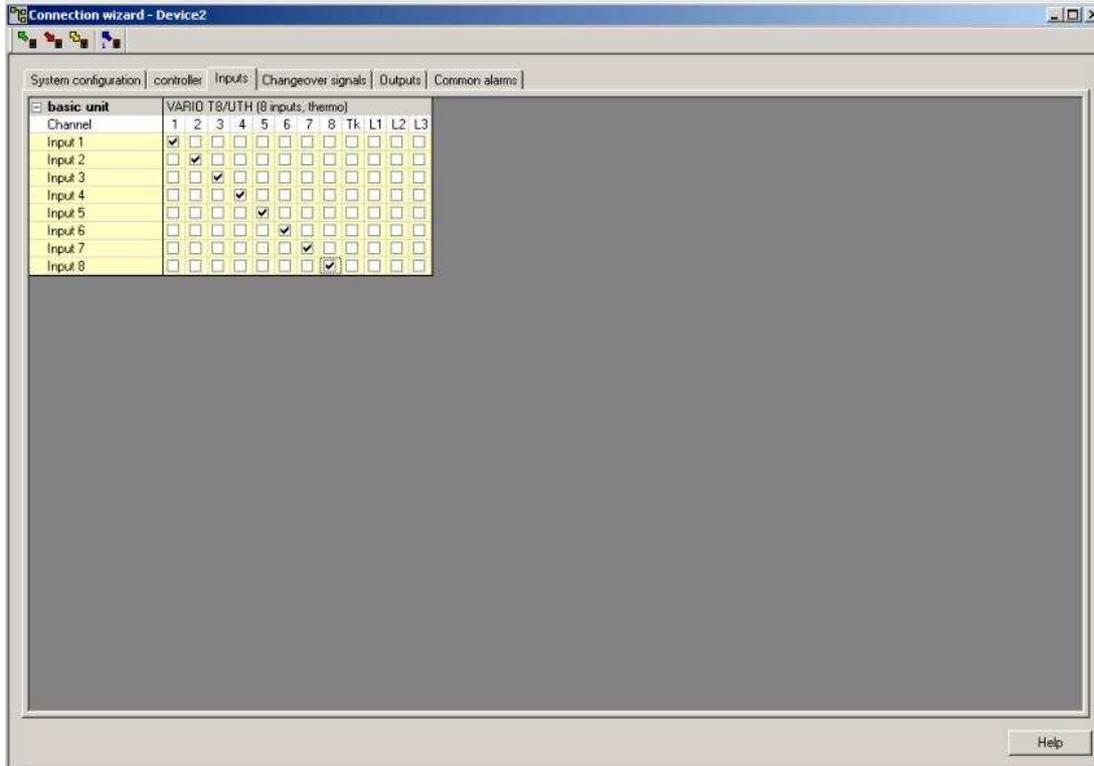
Select Inputs tab.

Assign the T/C inputs to the control loops.

Note:

Tk is to define external cold-junction compensation.

L1, L2, L3 can be used to connect external line-voltage measurement equipment.

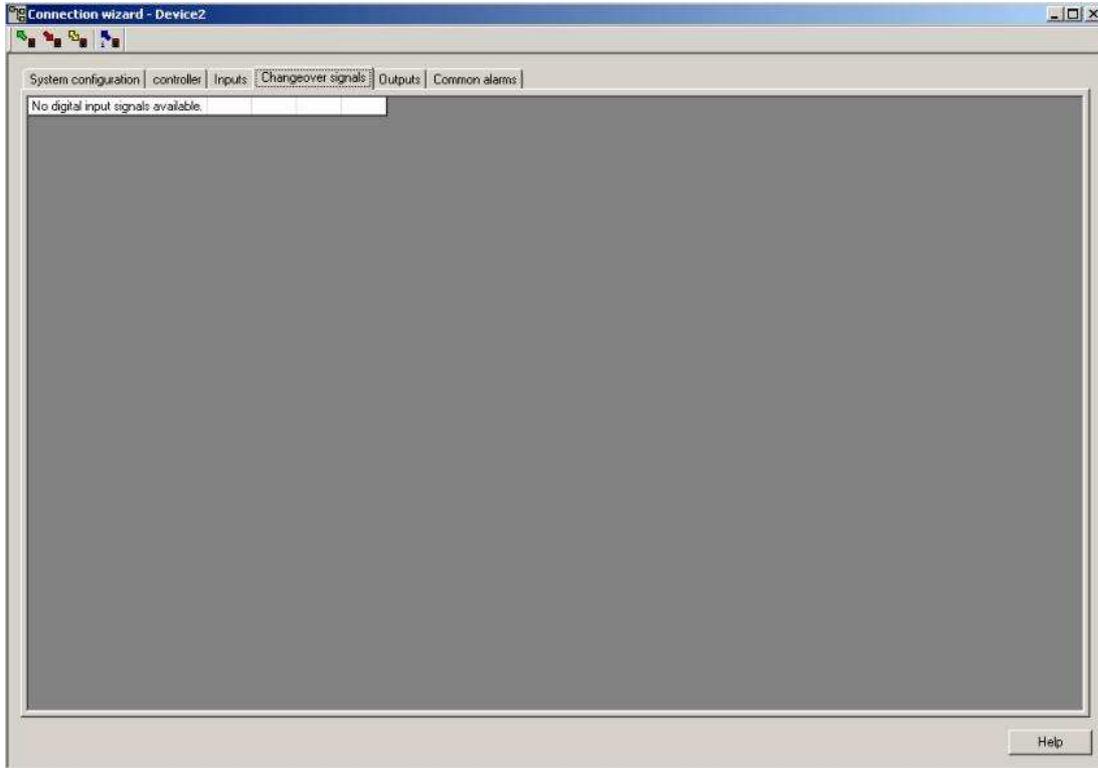


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Select Changeover signals tab.

The digital input tab is to connect inputs to internal control signals.

In this example, there are no digital inputs available for use.



## Quick Start Guide for KSVario

Select Outputs tab.

Assign output functions to hardware outputs.

Y1 = heating output digital

Y2 = cooling output digital

Lim1 = state of first limit signal

Lim2 = state of second limit signal

Lim3 = state of third limit signal

Loop = Loop alarm

} A 'limit signal' is the alarm function of the KSVario.

Yout1 = heating output (0-100%)

Yout2 = cooling output (0-100%)

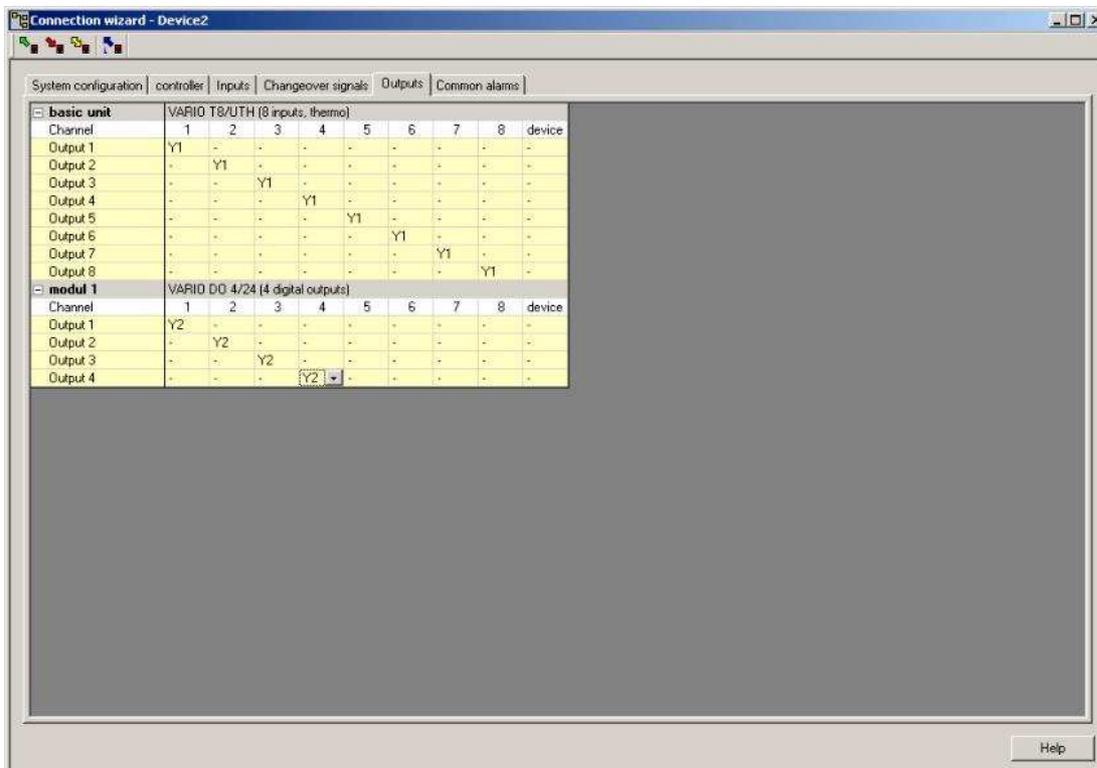
Ypid = controller output (-100-100%)

Xeff = effective input signal (measured temperature, process value)

Weff = actually used setpoint

Xw = process value deviation from Weff

Unused outputs can be used by a PLC as additional outputs, enable forcing in the device column. Furthermore you can output up to six signals defined in the Common alarm tab



The above screen shot shows the first 8 outputs, contained in the first module, as the heat outputs and the second modules outputs are the cooling outputs for the first 4 loops.

The heating outputs are all 'contained' in the first module so that the heater current measurement feature may be used. The controller module can not measure heater current from the digital output module.

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## Quick Start Guide for KSvario

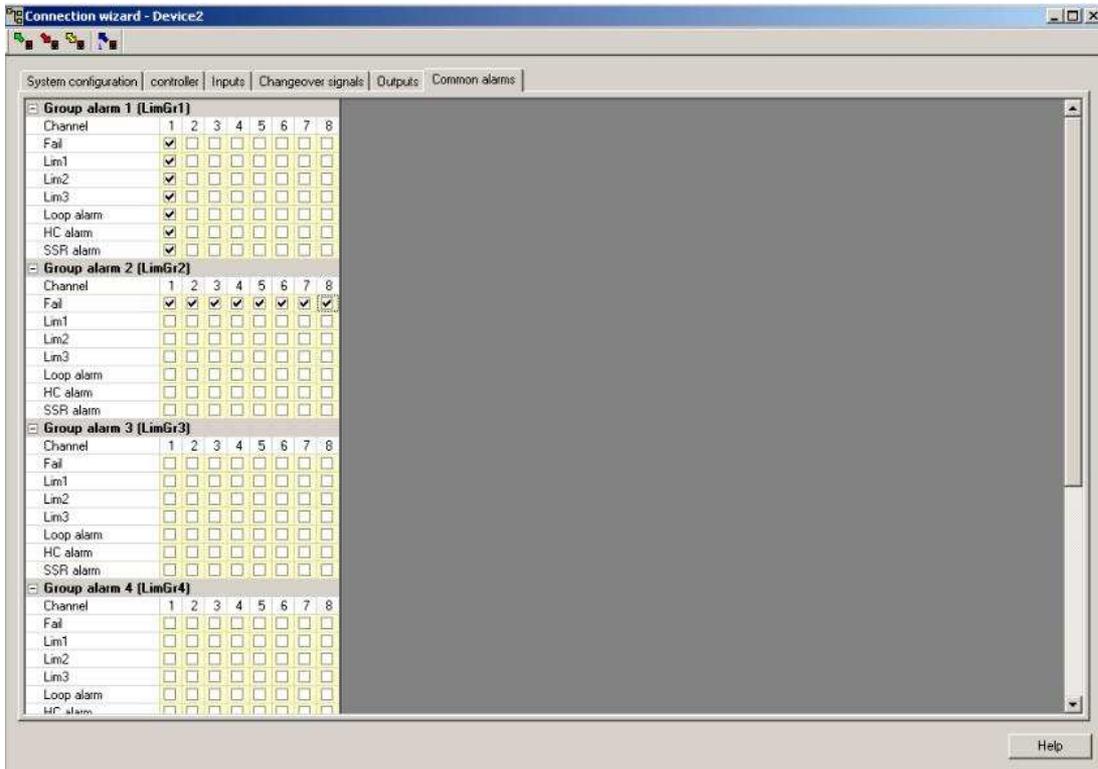
Select Common alarm tab.

In this section you can combine single alarm signals to groups (logical OR).

Examples (see screenshot):

LimGr1 = any alarm of channel 1

LimGr2 = Sensor break error from any loop

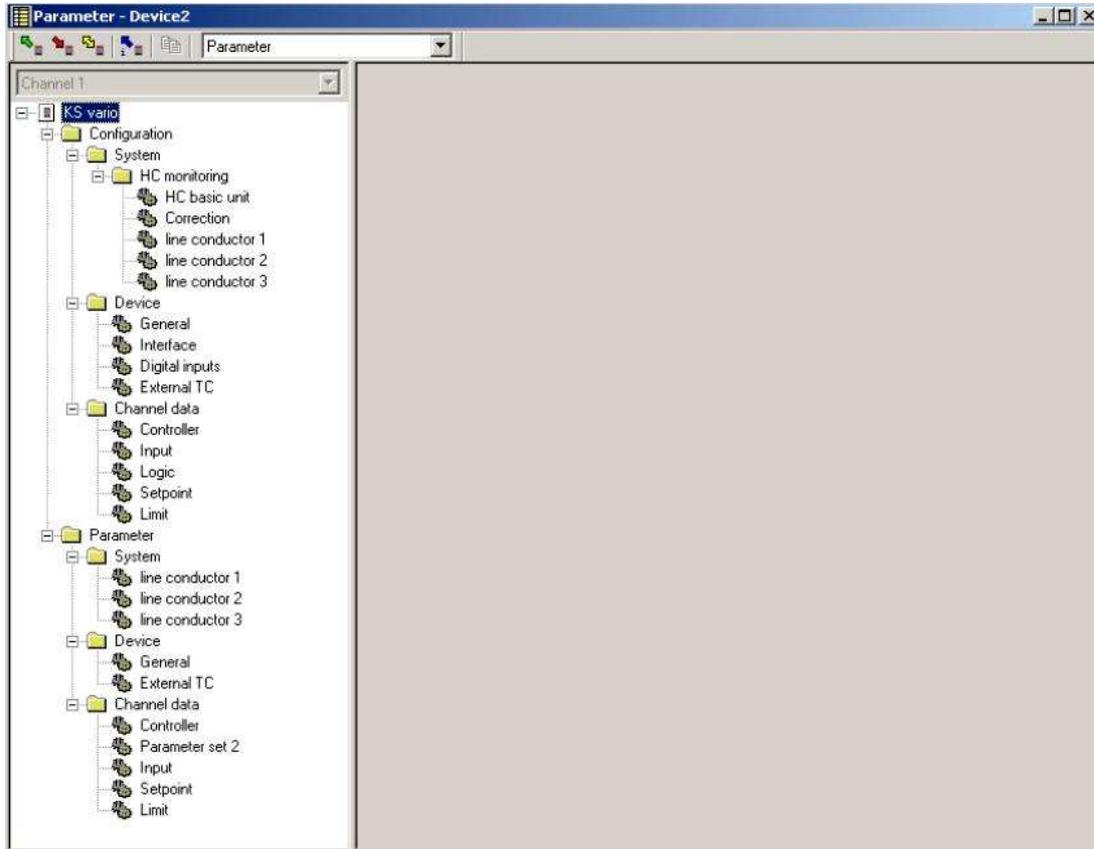


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### Open Parameter window

Select the View menu then click 'Parameter' to open the parameter window.

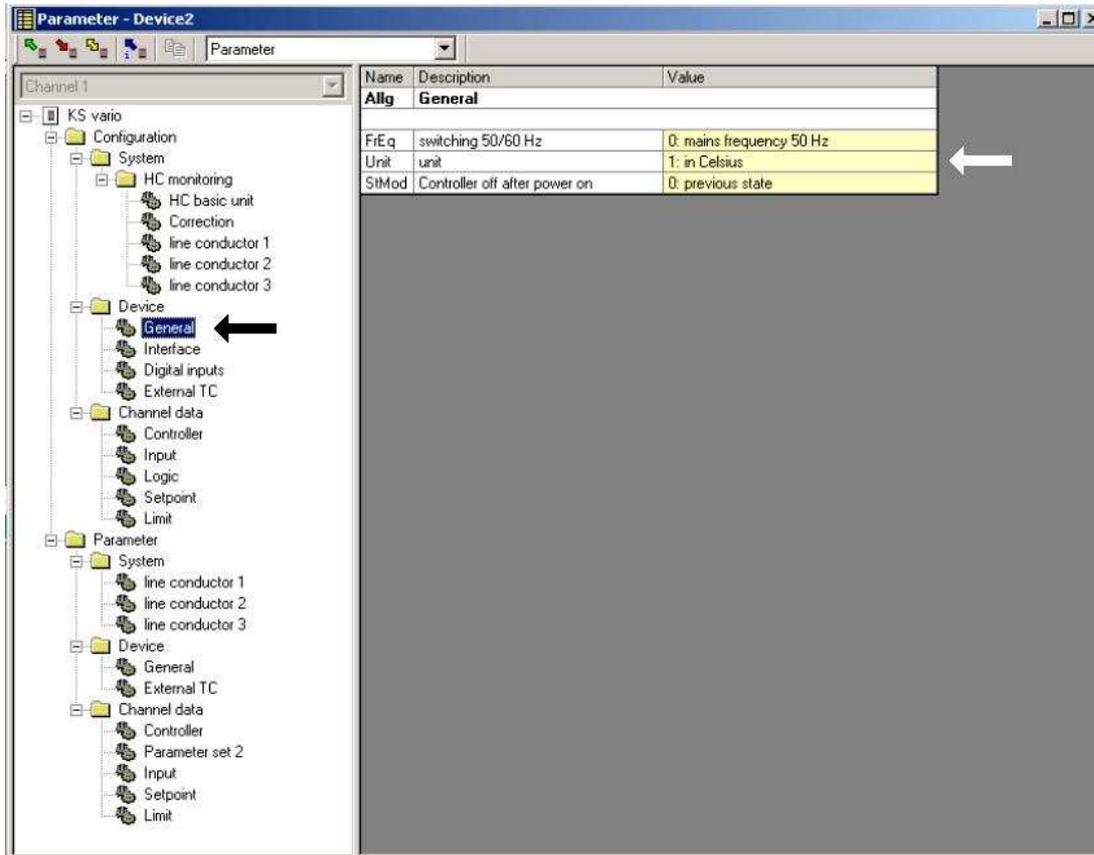
You can find an explorer tree with the Configuration and Parameter section of the KSvario. Each section is divided into specific function areas.



## Quick Start Guide for KSvario

First setup the global device configuration.

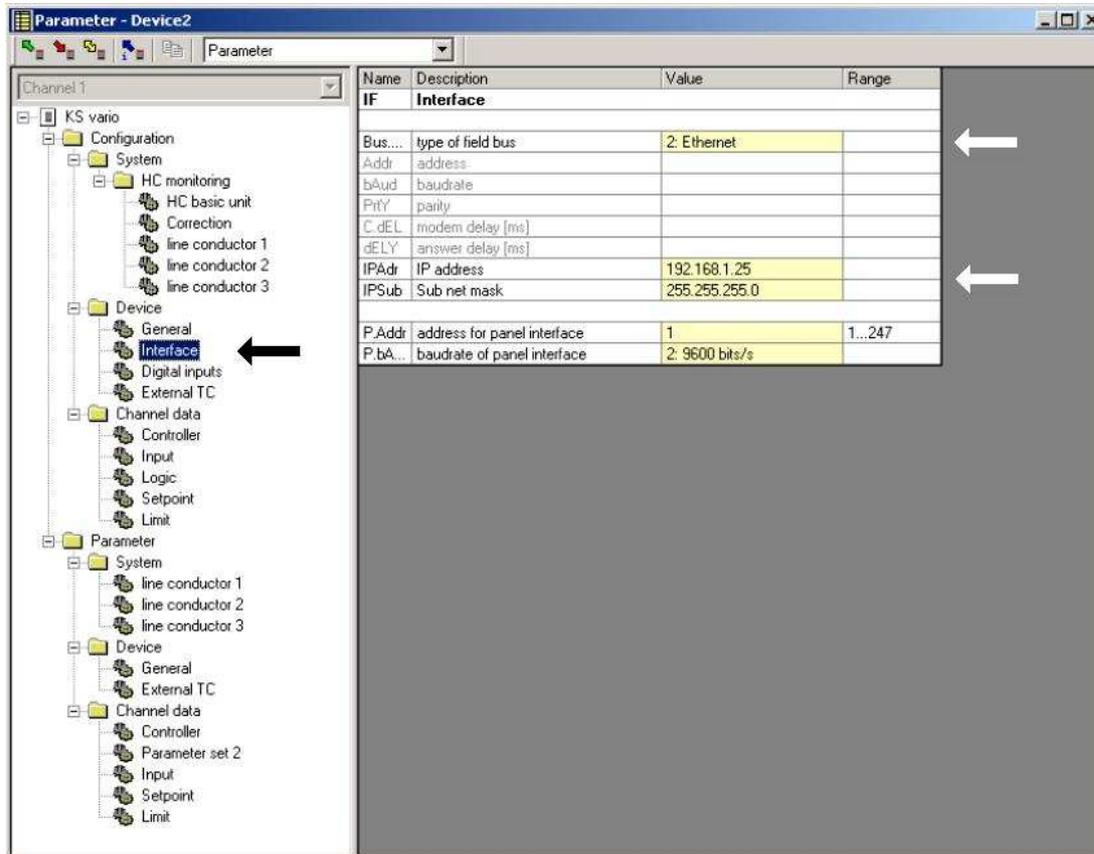
- Select your local mains frequency for the input filters.
- Select °C or °F
- Choose what the control loops should do after power fail.



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Set communication parameter for the bus coupler.

- Select the type of fieldbus
- Enter communication settings



The screenshot displays the 'Parameter - Device2' window. The left-hand tree view shows the configuration hierarchy for 'KS vario', with 'Interface' selected under the 'Device' folder. The right-hand pane shows a table of parameters for the selected 'Interface'.

Name	Description	Value	Range
<b>IF</b>	<b>Interface</b>		
Bus...	type of field bus	2: Ethernet	
Addr	address		
bAud	baudrate		
PrY	parity		
C.dEL	modem delay [ms]		
dELY	answer delay [ms]		
IPAdr	IP address	192.168.1.25	
IPSub	Sub net mask	255.255.255.0	
P.Addr	address for panel interface	1	1...247
P.bA...	baudrate of panel interface	2: 9600 bits/s	

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## Quick Start Guide for KSvario

Configure the heating / cooling loops.

Note: This and the following settings are available for each channel.

- Select the right controller type.
- You should attach loops with shared heat (i.e. on the same barrel) to a group for synchronized auto tuning. There may be a total of 4 self tuning groups.
- Select the auto tuning mode. We recommend step and impulse function
- The control range is important for the resolution of self tuning calculations. You should set this parameter close to your typical operating temperature.

Name	Description	Value	Range
<b>Cntr</b>	<b>Controller</b>		
Cycl...	cycle time for channel 1	4.800 ms	
C.Fnc	control behaviour	3.2 x PID (3-point and continuous)	
C.dF	effect of D action	0: on variable X	
C.Act	direction of operation	0: inverse, e.g. heating	
FAIL	behaviour at sensor break	1: switch to Y2	
SP.2C	cooling with SP 2	0: admitted	
CYCL	switching behaviour	0: standard	
LP.AL	loop alarm	0: no LOOP alarm	
AdtG	group selftuning	1: join group 1 selftuning	
Adt0	tuning of cycle time t1, t2	0: automatic tuning	
Tune	auto-tuning mode	0: step function at start up + impulse function at setpoint	
Strt	start of auto-tuning	0: only manual	
B.FAIL	reaction at bus error		
mGL	lower control range [phys]	0.000	-3000..499.0
mGH	upper control range [phys]	500.0	1.000..3200

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Set the setpoint range.

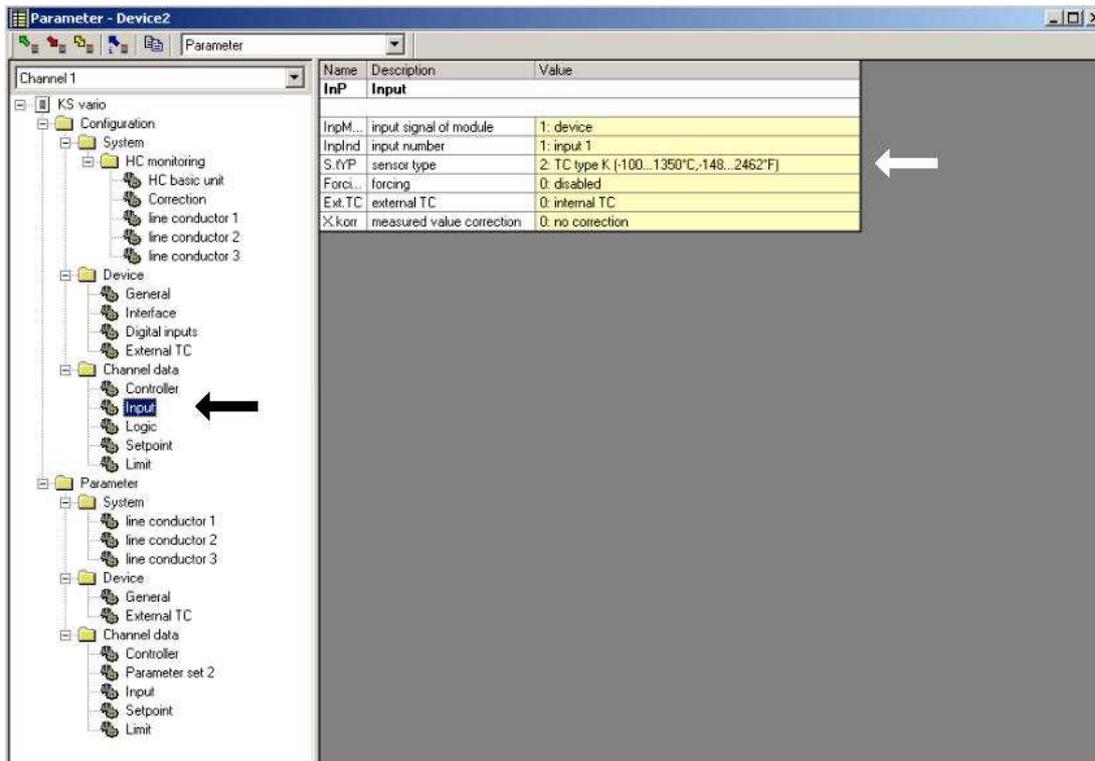
- Normally the same range as the control range
- Setpoint limitation (except for 2<sup>nd</sup> setpoint SP.2)
- Setpoint reserve for tuning by step function is 10% of SP.Hi - SP.Lo

The screenshot shows the 'Parameter - Device2' window. On the left is a tree view with 'Channel 1' selected. The 'Setpoint' parameter is highlighted in the tree. On the right is a table of parameters.

Name	Description	Value	on	Range
<b>Setp</b>	<b>Setpoint</b>			
SP.Lo	lower setpoint range [phys]	0.000		-3000...3200
SP.Hi	upper setpoint range [phys]	500.0		-3000...3200
SP.2	2nd setpoint [phys]	0.000		-3000...3200
rSP	setpoint ramp [/min]	off	<input type="checkbox"/>	0.010...3200
SP.bo	boost increasing [phys]	30.00		-3000...3200
t.bo	boost duration [min]	10.00		0.000...3200
SP.St	setpoint for start-up [phys]			
t.St	start-up time [min]			
Gef	Controlled heat-up	0: no leading		

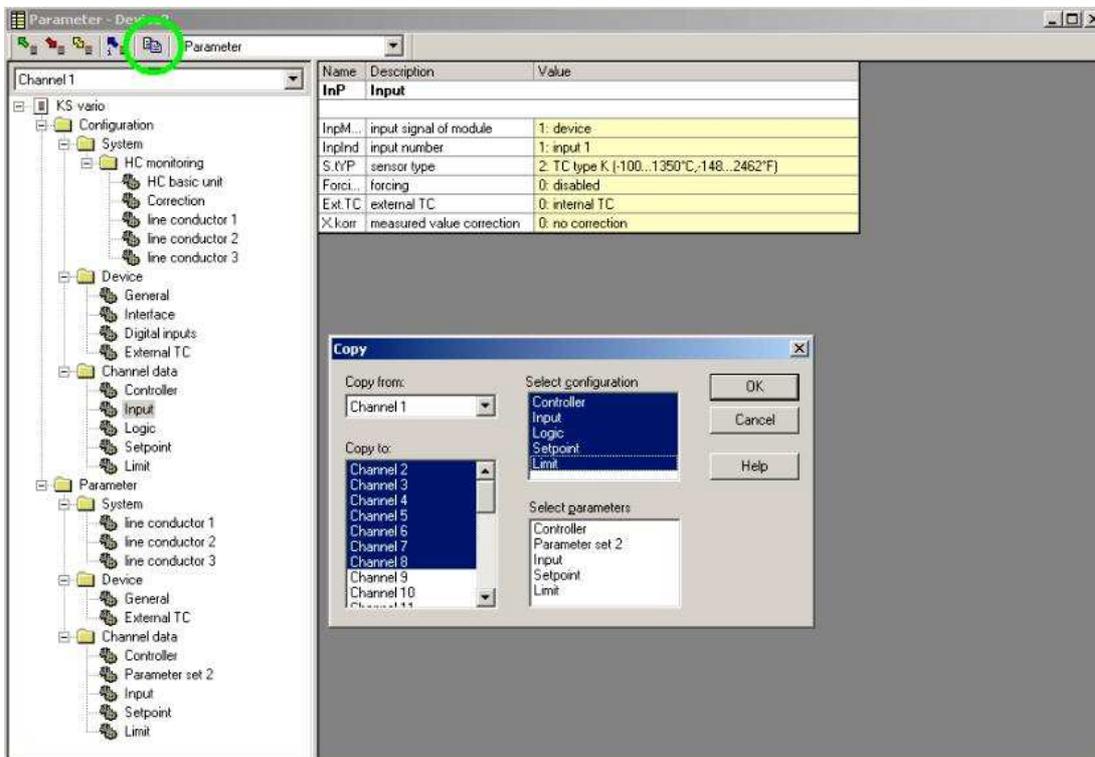
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Choose the TC type



At any point, you can copy settings from channel 1 to the other channels to speed up the configuration. Make sure that all the common settings are complete before copying; this will leave only the settings that need to be different for each loop left to be configured.

Press the copy icon and select the areas to be copied.



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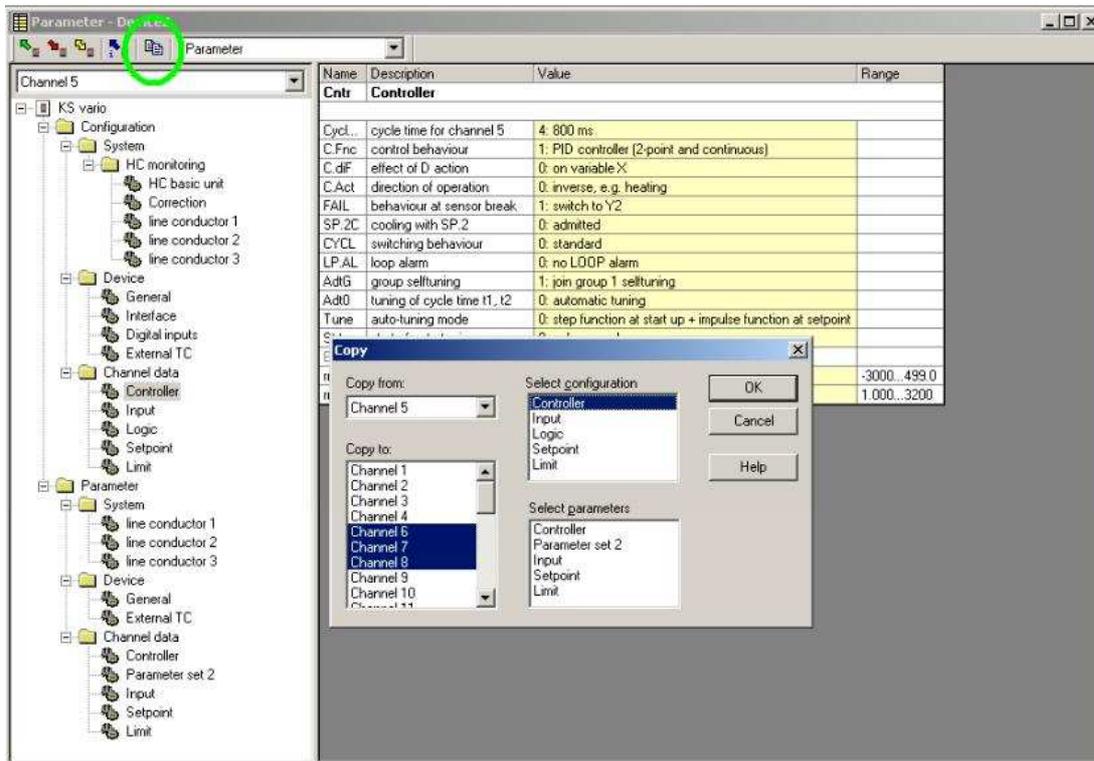
Change loop 5 - 8 to heat only mode.

- Select channel 5
- choose 2 point controller

Name	Description	Value	Range
<b>Cntr</b>	<b>Controller</b>		
Cycl...	cycle time for channel 5	4.800 ms	
C.Fnc	control behaviour	1: PID controller (2.point and continuous)	
C.dF	effect of D action	0: on variable X	
C.Act	direction of operation	0: inverse, e.g. heating	
FAIL	behaviour at sensor break	1: switch to Y2	
SP.2C	cooling with SP.2	0: admitted	
CYCL	switching behaviour	0: standard	
LP.AL	loop alarm	0: no LOOP alarm	
AdtG	group selftuning	1: join group 1 selftuning	
Adt0	tuning of cycle time t1, t2	0: automatic tuning	
Tune	auto-tuning mode	0: step function at start up + impulse function at setpoint	
Stt	start of auto-tuning	0: only manual	
B.FAIL	reaction at bus error		
mGL	lower control range [phys]	0.000	-3000. .499.0
mGH	upper control range [phys]	500.0	1.000. .3200

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Copy this setting to channel 6, 7 and 8

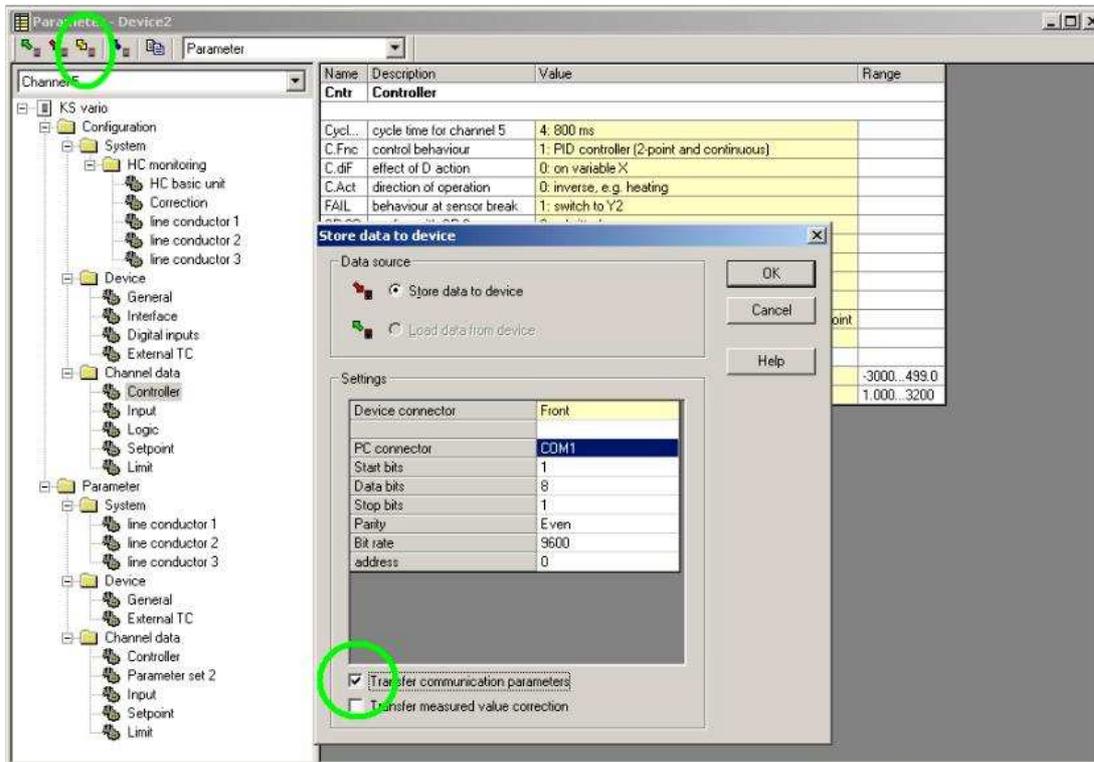


For detailed description of configurations and parameters refer to the functional description. Download at <http://www.pma-online.de/en/products/ksvario-menue.html>

## Operation

### Download to your device and start online mode

- Press the yellow double sided arrow icon; this is used to open a live connection with the KSVario.
- Check 'Transfer communication parameters', select your comm. port, leave everything else at default, and then click 'OK'.



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## Quick Start Guide for KSvario

### View the online window

We recommend setting the controllers to manual operation first.

- Check 'Manual operation'
- Set 'Actuating variable' to 0.0

Operation - Device2									
	device	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Channel 7	Channel 8
<b>Overview</b>									
process value		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Internal setpoint		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective setpoint		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
control deviation									
Actuating variable		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manual operation		<input checked="" type="checkbox"/>							
2nd setpoint		<input type="checkbox"/>							
controller off		<input type="checkbox"/>							
2nd actuator value		<input type="checkbox"/>							
Boost		<input type="checkbox"/>							
Gradient active		<input type="checkbox"/>							
Soft start function active		<input type="checkbox"/>							
All channels automatic									
All channels off									
Leaded setpoint	inactive								
<b>alarms</b>									
<b>self tuning</b>									
Individual self-tuning									
Start		<input type="checkbox"/>							
Process lined out		<input type="checkbox"/>							
Status		10: Control							
Active parameter set		1	1	1	1	1	1	1	1
pulse attempt		Active pro...	Active pro...	Active pro...	Active pro...				
Result heat		0: ---	0: ---	0: ---	0: ---	0: ---	0: ---	0: ---	0: ---
Tu [s]		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vmax		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Result cool		0: ---	0: ---	0: ---	0: ---				
Tu [s]		0.000	0.000	0.000	0.000				
Vmax		0.000	0.000	0.000	0.000				
<b>meas. value correcti...</b>									
Measured value		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
process value		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Common correction		<input type="checkbox"/>							
Corrected value 1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apply 1		<input type="checkbox"/>							
Corrected value 2		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Apply 2		<input type="checkbox"/>							
Delete		<input type="checkbox"/>							

PC... Simulation

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## Quick Start Guide for KSvario

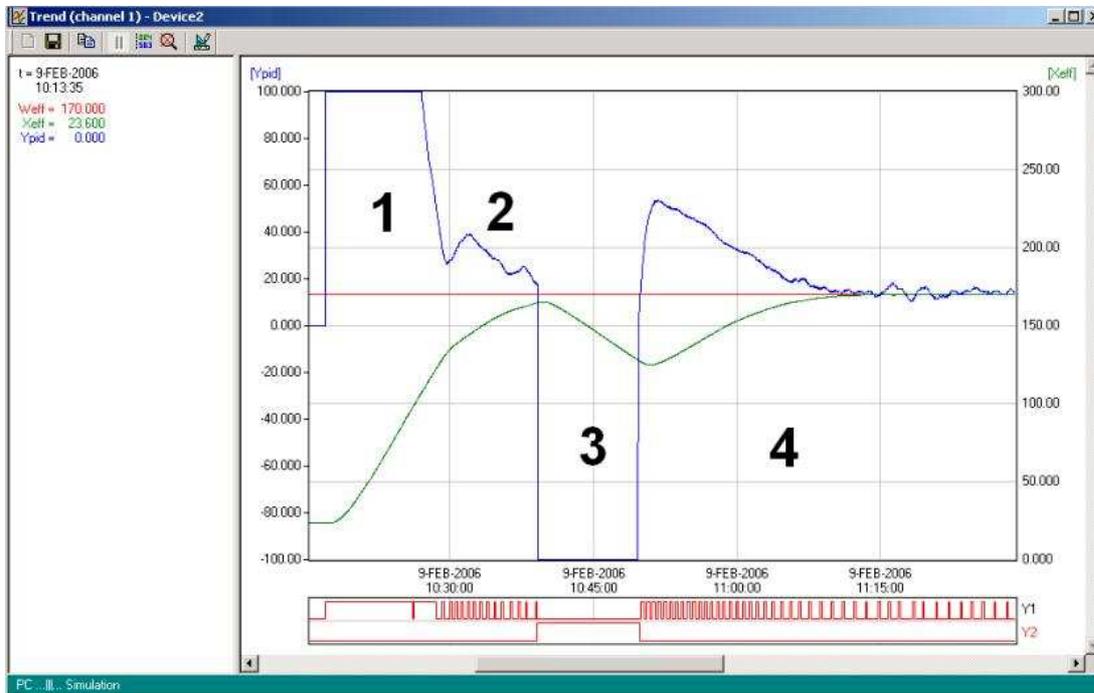
Heat up the machine and start the step auto tuning.

- Set setpoints to typical values.
- Best is to use the synchronized group-tuning, by selecting a group.
- Start with the checkbox of any loop.

Operation - Device2									
	device	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Channel 7	Channel 8
<b>Overview</b>									
process value		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Internal setpoint		210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0
Effective setpoint		210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0
control deviation									
Actuating variable		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manual operation		<input type="checkbox"/>							
2nd setpoint		<input type="checkbox"/>							
controller off		<input type="checkbox"/>							
2nd actuator value		<input type="checkbox"/>							
Boost		<input type="checkbox"/>							
Gradient active		<input type="checkbox"/>							
Soft start function active		<input type="checkbox"/>							
All channels automatic		<input type="checkbox"/>							
All channels off		<input type="checkbox"/>							
Leaded setpoint		inactive							
<b>alarms</b>									
<b>self tuning</b>									
Group self-tuning 1		<input checked="" type="checkbox"/>							
Start		<input checked="" type="checkbox"/>							
Process lined out		<input type="checkbox"/>							
Status		351: Step...							
Active parameter set		1	1	1	1	1	1	1	1
pulse attempt		Active pro...	Active pro...	Active pro...	Active pro...				
Result heat		0: ---	0: ---	0: ---	0: ---	0: ---	0: ---	0: ---	0: ---
Tu [s]		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vmax		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Result cool		0: ---	0: ---	0: ---	0: ---				
Tu [s]		0.000	0.000	0.000	0.000				
Vmax		0.000	0.000	0.000	0.000				
<b>meas. value correcti...</b>									
Measured value		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
process value		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Common correction		<input type="checkbox"/>							
Corrected value 1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apply 1		<input type="checkbox"/>							
Corrected value 2		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Apply 2		<input type="checkbox"/>							
Delete		<input type="checkbox"/>							

To view the process, open a trend window with the View menu and select 'Trend', then the loop desired. You will see the results similar to the curve below

1. Heating step of auto tuning
2. Close loop control to stabilize the process
3. Cooling step of auto tuning
4. Close loop control (normal operation to setpoint)



Following preconditions are of interest for the auto tuning in step-mode:

Preconditions:

- The distance between actual temperature and setpoint must be larger than 10% of the setpoint range (see settings above). It is best to start with a cold machine and use your production setpoints.
- Output range (output power) should not be limited.

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## Quick Start Guide for KSvario

After auto tuning you should upload the actual data from the device.  
Press the green arrow icon, then click 'OK'.  
When the upload is complete, you will find the new control parameter Pb, ti and td.

The screenshot shows the 'Parameter - Device2' window. The left pane displays a tree view of the device configuration. The right pane shows a table of parameters. A green circle highlights the 'Parameter' button in the top toolbar. A black arrow points to the 'Controller' folder in the tree view. A white arrow points to the 'ti' parameter row in the table.

Name	Description	Value	on	Range
<b>Cntr Controller</b>				
Pb1	proportional band 1 [phys]	100.0		0.100..3200
Pb2	proportional band 2 [phys]	100.0		0.100..3200
ti1	integral action 1 [s]	180.0	<input checked="" type="checkbox"/>	1.000..3200
ti2	integral action 2 [s]	180.0	<input checked="" type="checkbox"/>	1.000..3200
td1	derivative action 1 [s]	180.0	<input checked="" type="checkbox"/>	1.000..3200
td2	derivative action 2 [s]	180.0	<input checked="" type="checkbox"/>	1.000..3200
t1	min. cycle time 1 [s]	10.00		0.400..3200
t2	min. cycle time 2 [s]	10.00		0.400..3200
tP	min. pulse length [s]			
t.on	puls. water cooling [s]			
t.oFF	min. pulse pause [s]			
F.H2O	characteristic watercooling			
E.H2O	min. temperature [phys]			
SH	neutral zone [phys]	2.000		0.000..3200
HY.S.L	hysteresis low [phys]			
HY.S.H	hysteresis high [phys]			
ti	motor travel time [s]			
d.SP	additional contact D / Y [phys]			
Y2	correcting variable 2	0.000		-100.0..100.0
Y.Lo	lower output range [%]	-100.0		-105.0..99.00
Y.Hi	upper output range [%]	100.0		-99.00..105.0
Y.0	working point [%]	0.000		-100.0..100.0
OvLH	Overlap output heat	0.000		-100.0..100.0
OvLC	Overlap output cool	0.000		-100.0..100.0
Ym.H	max. mean value [%]			
L.Ym	max. deviation mean [phys]			
Y.St	start-up actuating value			
F.Yop	factor for pulse height	1.000		-10.00..10.00
T.Pir	Monitoring time process at rest [min]	10		1..1000
O.Hk	pulse attempt	0: Active process		

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### Heating current monitoring

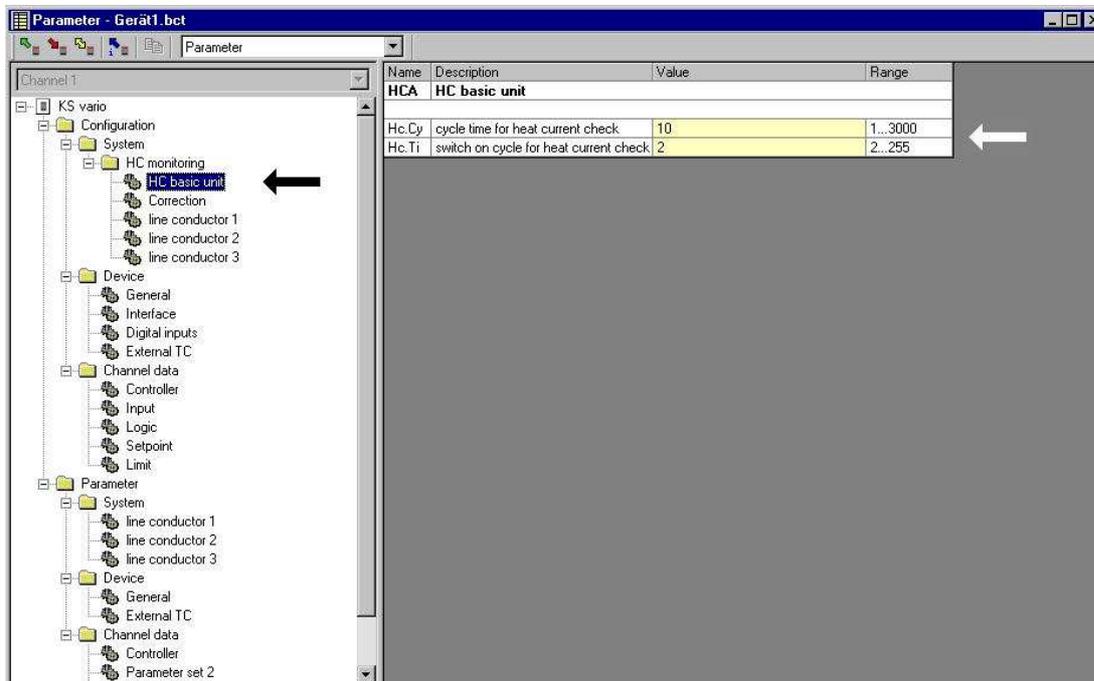
Output monitoring is available with:

KS Vario UTH 4	KSVC-104-X0431
KS Vario UTH 6	KSVC-104-X0441
KS Vario RTD 4	KSVC-104-X0331
KS Vario RTD 6	KSVC-104-X0341
Vario UTH 4-DO8	KSVC-103-00431
Vario UTH 8-DO8	KSVC-103-00441
Vario RTD 6-DO8	KSVC-103-00341

To use the monitoring function a current transformer has to be connected to the device.  
One transformer is used for all 8 outputs of the device

Settings per device:

- cycle time defines how often the measurement cycle runs (default = 10sec)
- switch time defines how long the output is active for measuring (default = 2 x 100ms)

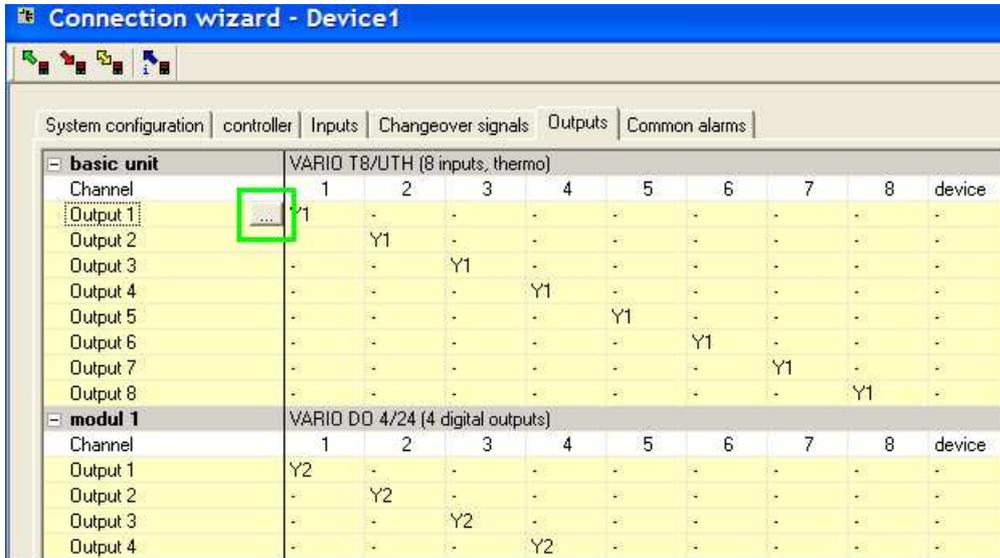


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## Quick Start Guide for KSvario

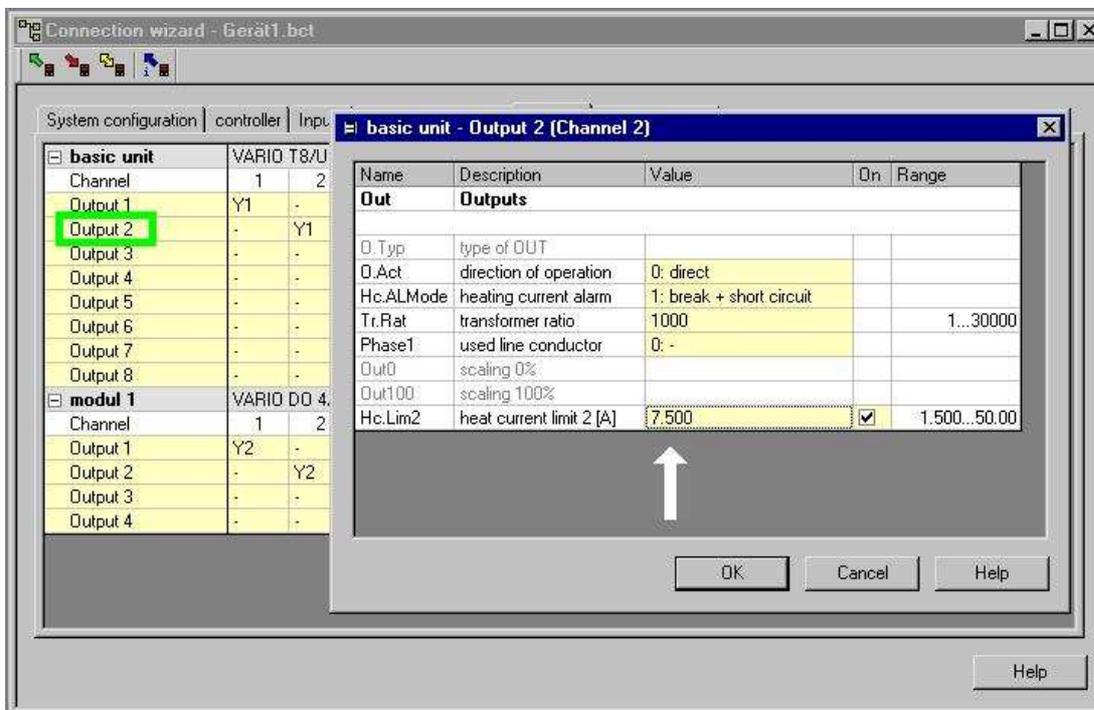
Settings per output:

On the 'Connection wizard' window (View menu, click Connection wizard), select the 'Outputs' tab. Click on Output 1 and a grey button will appear:



Click this button to bring up the individual settings for this output.

- Transformer ratio defines the ratio between measured current and transformer output
  - max 50mA input
  - default = 1000/1
- Alarm mode can be overload or break (default = break)
- Limit value (default = off)



Click 'OK' once done and select the next output.

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### Limit system

You can define three limit checks per loop.

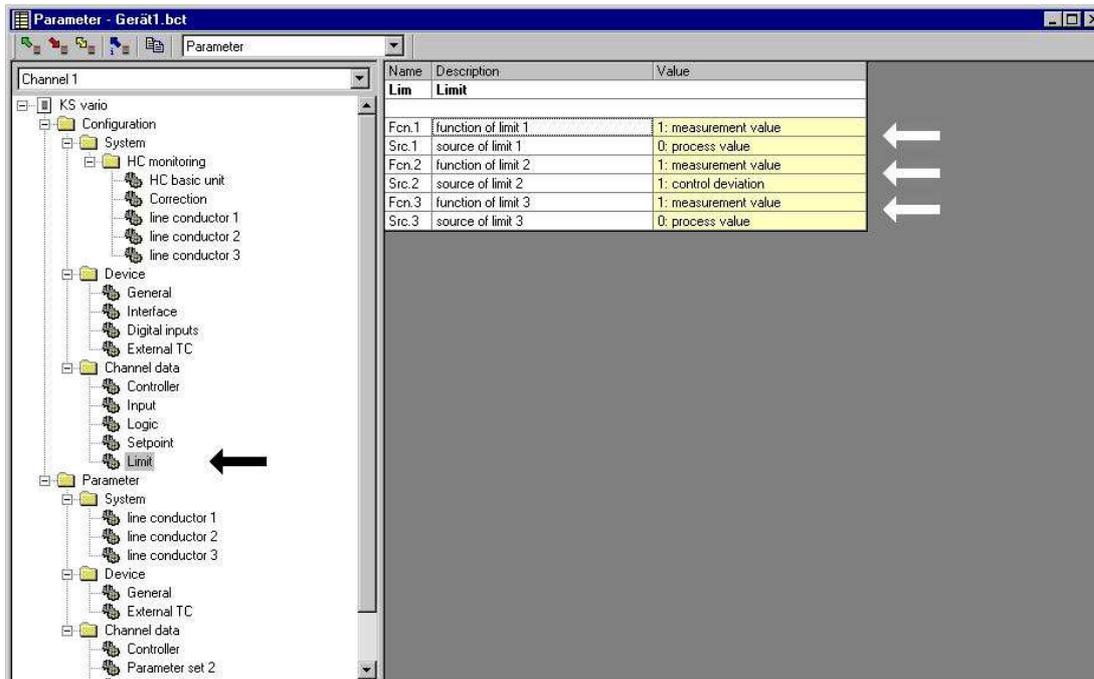
Limits can be set on measurements, output values and setpoints.

Furthermore you can define two alarm functions:

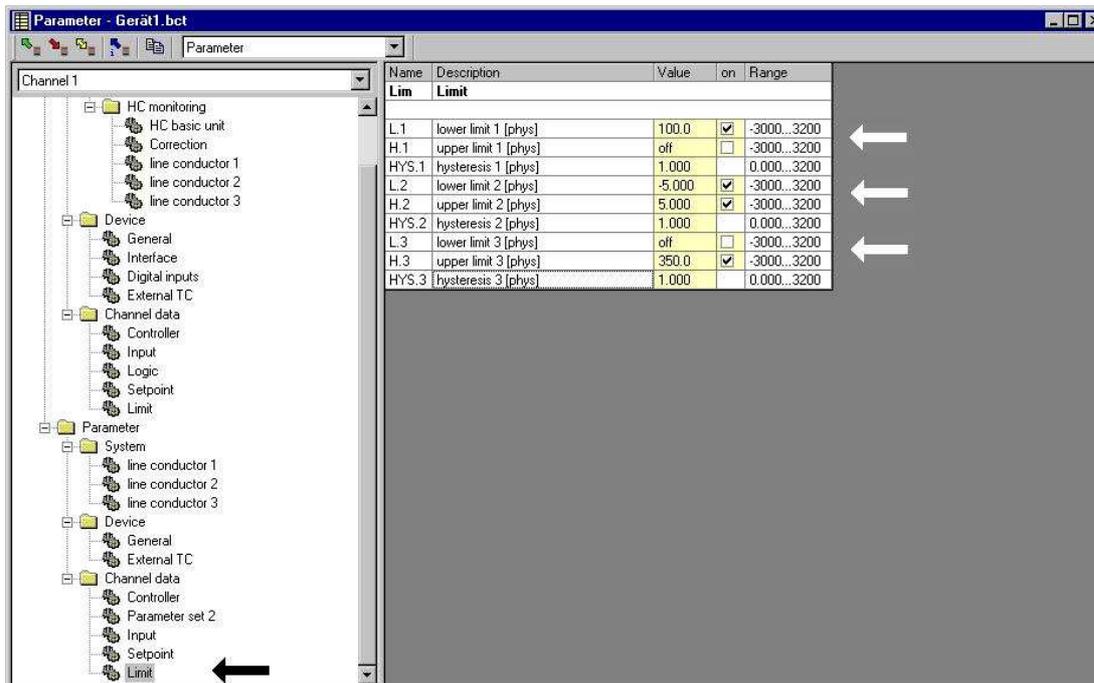
- alarms will come and go automatically (value)
- alarms have to be acknowledged (value with latch)

In our example we set the following:

- Limit 1 checks for temperatures below 100°.
- Limit 2 checks deviations greater than 5° from setpoint.
- Limit 3 checks for temperatures above 350°.



After the configuration you can set the limits in the parameter section.



L.1 is the value for the low limit (alarm).

H.1 is not used since we are only checking for low temperature on limit one.

L.2 and H.2 are both used since we want to check for deviation below and above the setpoint.

L.3 is not used since we are only checking for high temperature on limit three.

H.3 is the value for the high limit (alarm).

## Quick Start Guide for KSvario

Limit alarms and heating current values can be viewed in the online mode.

Operation - Gerät1.bct									
device	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Channel 7	Channel 8	
+ Overview									
- alarms									
Limit 1									
Limit 2									
Limit 3									
Loop alarm									
heat current limit									
SSR limit value									
Heating current value	7.80	7.71	8.00	6.90	7.86	7.80	7.71	7.86	
trigger heat current limit									
Group alarm 1 (LimGr1)									
Group alarm 2 (LimGr2)									
Group alarm 3 (LimGr3)									
Group alarm 4 (LimGr4)									
Group alarm 5 (LimGr5)									
Group alarm 6 (LimGr6)									
Reset									
+ self tuning									
+ meas. value correcti...									
PC ... Simulation									

*Subject to change without notice*