BOSCH

PowerBox PBX 90

Manual

Version 2.0 02/08/2024

Content

1 About PowerBox PBX 90

The Bosch PowerBox PBX 90 takes the whole Power Control Module concept much further than existing modules. It provides an effective and inspired alternative to conventional relays, circuit breakers, fuses and wires that can so often be a tangle of complexity and untidiness around a typical racing car's power junction box.

PowerBox PBX 90 is a compact and light weight module, measuring 214 x 159 x 57.5 mm (including connectors).

PowerBox PBX 90 has 36 outputs. All outputs are protected against reversed battery polarity. Current draw can be measured on all outputs from 500 mA .

Any of these channels can be controlled by various types and combinations of inputs. You'll find more information at Technical Specifications [▶ 45].

Instead of using a conventional control program, PowerBox PBX 90 benefits from a 667 MHz dual Core Processor and a multitasking operating system, allowing simultaneous executions of operations.

Please note that the maximum recommended current draw per channel is limited by the connector contacts (wiring loom side) - not by PowerBox PBX 90s driver stages. We have rated the individual channel's current draw in relation to the connector manufacturer's specifications.

PowerBox PBX 90 is programmed to shut overloaded channels down if the current draw or internal junction temperatures exceed pre-set levels.

A smart algorithm allows automatically turning-on of loads with a high inrush current.

The current draws and channel status can be logged internally and exported via one of the three available CAN busses.

⚠ WARNING

Please note that the PowerBox PBX 90 is not intended to be used to control safety-critical systems on a vehicle, such as ABS braking, power steering, etc..

Bosch Motorsport shall not be responsible for any incidental or consequential damages or injuries that may occur if the unit is used to control these, or similar, safety-critical systems.

2 Hardware

The Bosch PowerBox PBX 90 enclosure is partially CNC machined to the highest standards. The two parts of the casing are sealed by an O-ring, located in a recess in the main half. A lip in the lid presses on the O-ring and assures a protection against ingress of splash water. The connectors are individually sealed.

2.1 Housing

On the housing, you'll find the three connectors X1, X2 and X3 and the LEDs for **Failure**, **User**, **Power** and **Run**.

2.2 Status LEDs

Each LED on the PBX 90 has its own color code with different meanings.

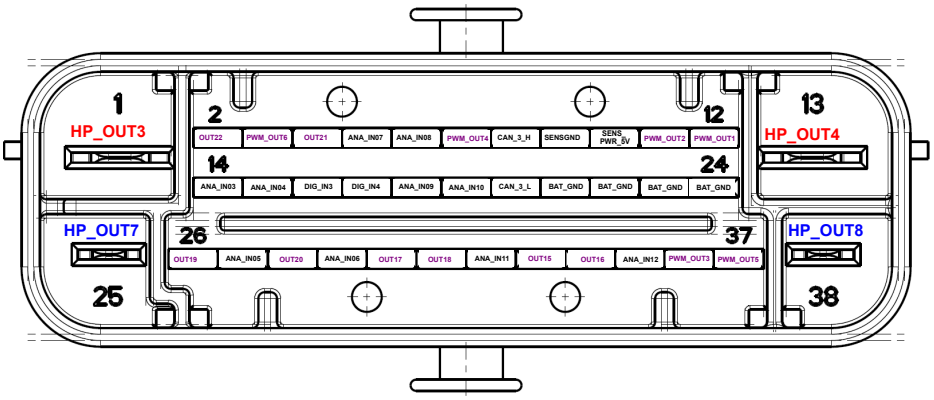
The following table explains the different meanings:

Failure		**Off** No error
		Red solid At least one entry in the error log
		Red blinking (2 Hz) At least one active error present
User		**Off/Blue** Controlled by functionblock „User_LED“
Power		**Off** Power supply missing
		Green solid Power supply valid
Run		**Green solid** No configuration active
		Green blinking (2 Hz) Configuration active
		Orange blinking (2 Hz) Configuration error
		Orange solid Emergency state

2.3 Connectors

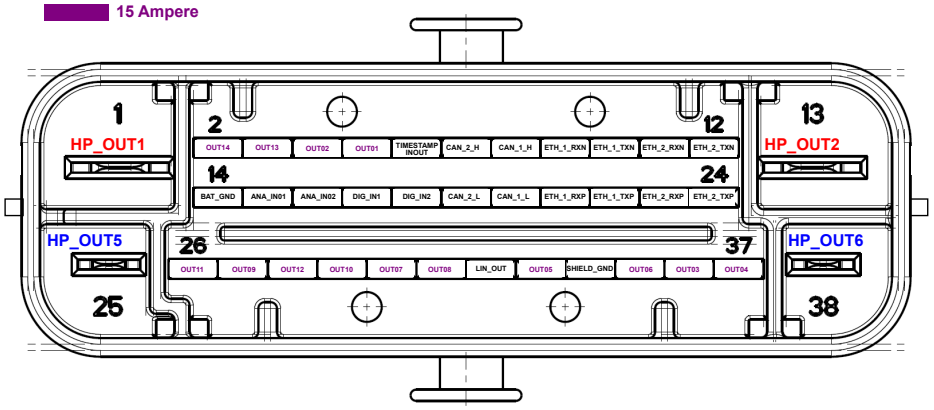
X1 PBX90

40 Ampere
25 Ampere
15 Ampere



X2 PBX90

40 Ampere
25 Ampere
15 Ampere



2.4 Pin Configuration

Connector X1: 38 way (ABS/ESR) Code 1			
Pin	**Signal**	**Cont. [A]**	**Peak [A]**
1	HP_OUT3	40	150
2	OUT22	15	100
3	PWM_OUT6	15	75
4	OUT21	15	100
5	ANA_IN07	0 to 5 V, Pull-up	
6	ANA_IN08	0 to 5 V, Pull-up	
7	PWM_OUT4	15	75
8	CAN_3_H	1 Mbaud max.	
9	SENSGND	GND for AIN[x]	
10	SENSPWR_5V	0.4	
11	PWM_OUT2	15	75
12	PWM_OUT1	15	75
13	HP_OUT4	40	150
14	ANA_IN03	0 to 5 V, Pull-up	
15	ANA_IN04	0 to 5 V, Pull-up	
16	DIG_IN3	0 to 12 V, Pull-up, Pull-down	
17	DIG_IN4	0 to 12 V, Pull-up, Pull-down	
18	ANA_IN09	0 to 5 V, Pull-up	
19	ANA_IN10	0 to 5 V, Pull-up	
20	CAN_3_L	1 Mbaud max.	
21	BAT_GND	15	100
22	BAT_GND	15	100
23	BAT_GND	15	100
24	BAT_GND	15	100
25	HP_OUT7	25	150
26	OUT19	15	100
27	ANA_IN05	0 to 5 V, Pull-up	
28	OUT20	15	100
29	ANA_IN06	0 to 5 V, Pull-up	
30	OUT17	15	100
31	OUT18	15	100
32	ANA_IN11	0 to 5 V, Pull-up	
33	OUT15	15	100
34	OUT16	15	100
35	ANA_IN12	0 to 5 V, Pull-up	
36	PWM_OUT3	15	75
37	PWM_OUT5	15	75
38	HP_OUT8	25	150

Connector X2: 38 way (ABS/ESR) Code 2			
Pin	**Used for**	**Cont. [A]**	**Peak [A]**
1	HP_OUT1	40	150
2	OUT14	15	100
3	OUT13	15	100
4	OUT02	15	100
5	OUT01	15	100
6	TIMESTAMP_INOUT	1 kHz open drain	
7	CAN_2_H	1 Mbaud max.	
8	CAN_1_H	1 Mbaud max.	
9	ETH_1_RXN	10/100 Mbps	
10	ETH_1_TXN	10/100 Mbps	
11	ETH_2_RXN	10/100 Mbps	
12	ETH_2_TXN	10/100 Mbps	
13	HP_OUT2	40	150
14	BAT_GND	15	100
15	ANA_IN01	0 to 5 V, Pull-up	
16	ANA_IN02	0 to 5 V, Pull-up	
17	DIG_IN1	0 to 12 V, Pull-up, Pull-down	
18	DIG_IN2	0 to 12 V, Pull-up, Pull-down	
19	CAN_2_L	1 Mbaud max.	
20	CAN_1_L	1 Mbaud max.	
21	ETH_1_RXP	10/100 Mbps	
22	ETH_1_TXP	10/100 Mbps	
23	ETH_2_RXP	10/100 Mbps	
24	ETH_2_TXP	10/100 Mbps	
25	HP_OUT5	25	150
26	OUT11	15	100
27	OUT09	15	100
28	OUT12	15	100
29	OUT10	15	100
30	OUT07	15	100
31	OUT08	15	100
32	LIN	Control of Bosch Motorsport LIN devices included. Support of other devices on request.	
33	OUT05	15	100
34	SHIELD_GND	shield	
35	OUT06	15	100
36	OUT03	15	100
37	OUT04	15	100
38	HP_OUT6	25	150

Connector X3: Amphenol Radsok Automotive Pinlock Connector 8 mm (35 mm^2, 50 mm^2)			
Pin	**Used for**	**Cont. [A]**	**Peak [A]**
1	BATT_POS	120	180

2.5 Warnings and shutdown Thresholds

Due to thermal or pin current overload, there are several warnings and shutdown thresholds. You can see an overview of these below.

Overcurrent	
Warning overcurrent X3	140 A for 0.2 s
Shutdown overcurrent X3	180 A for 2 s

Overtemperature	
Warning overtemperature CPU	95°C for 2 s
Shutdown overtemperature CPU	100°C for 2 s
Warning overtemperature Device	110°C for 2 s
Shutdown overtemperature Device	115°C for 2 s

2.6 Mounting

Hardware

Make sure that all connectors are plugged and locked before appyling supply voltage. PowerBox PBX 90 will instantly start operation when supply is available.

Boot time is about 1 sec.

New hardware is preconfigured, no outputs will turn on.

3 PBX Suite Installation

The setup file for the PBX Suite is provided at the Bosch Motorsport internet homepage at the product page of the PowerBox PBX 90.

For the PBX Suite v2.5.0.3 and 2.5.1 or higher, no personal license key is required.

For older versions, a required personal license key can be requested by mail to LicenseMotorsport.BEG@de.bosch.com

The installation requires administrator rights.

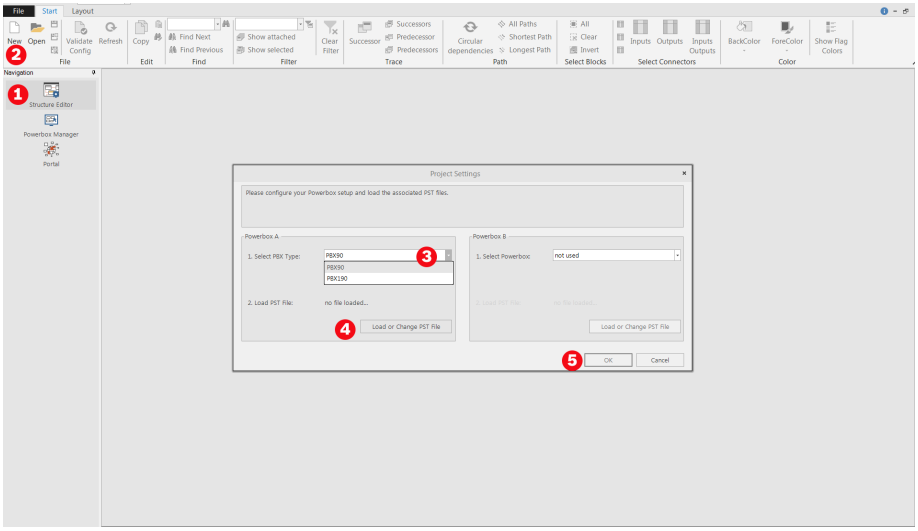
Start the installation by running **setup.exe** and follow the wizard steps.

4 The Structure Editor: Create a new configuration

A configuration is the unit you exchange between the programming tool PBX Suite and your PowerBox PBX 90 after all changes and modifications.

For creating a configuration we developed the PBX Suite. This software tool enables visual programming of the configuration of your PowerBox.

- Start the program **PBX Suite**.
- Click **Structure Editor** in the menu box on the left side (1).

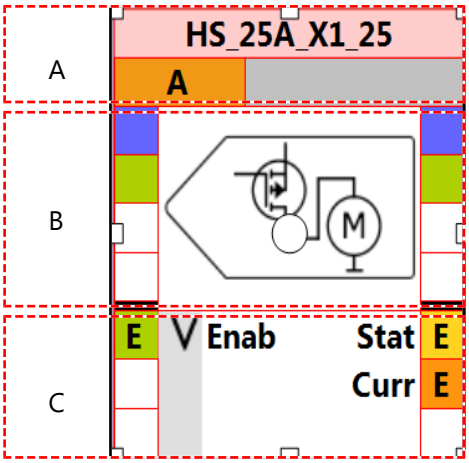


- Click **New** (2).
- Select your PBX type (3).
- Load the corresponding PST file (4).
- Confirm by clicking **OK** (5).

4.1 Function Blocks

The key technology of the PBX Suite is the function block. All functions of the PowerBox can be programmed and modified by using a string of function blocks.

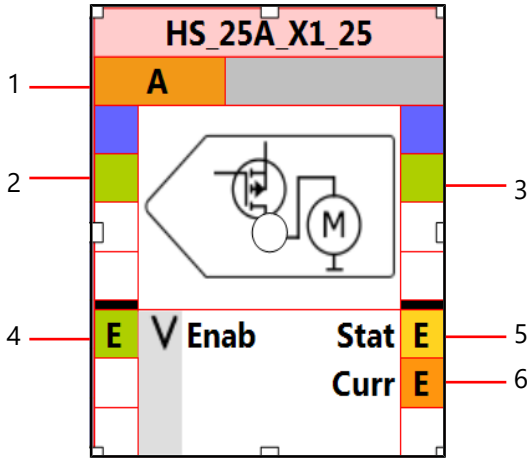
Every function block is divided into three parts:



- **A** is the top part that includes the unique name of the function block. It is user changeable.

- **B** is the middle part that shows static parameters of the function block.
- **C** is the bottom part that shows dynamic input and output signals of the function block.

In part B and part C, the colored rectangles symbolize the signal connections: inputs on the left side and outputs on the right side.



1. Client assignment
2. Optional global block enable input.
3. Optional global block enable output, daisy-chained with input.
4. Signal input. Data type Boolean. Enabled for online view and export to RaceCon.
5. Signal output. Data type Integer. Enabled for online view and export to RaceCon.
6. Signal output. Data type Float. Enabled for online view and export to RaceCon.

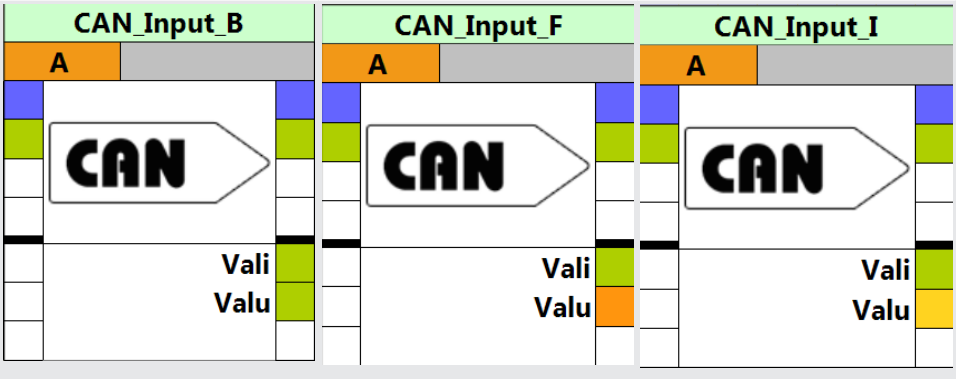
As you will have realized in the steps 4 to 6, the system offers signals of three different data types:

- **Boolean** (Background color always GREEN)
- **Integer** (Background color always YELLOW)
- **Float** (Background color always ORANGE)

If function blocks are available as different data type, you can identify the data type from the background color of the inputs and outputs and from the end of the function blocks name. The last letter will show the data type.

Example:

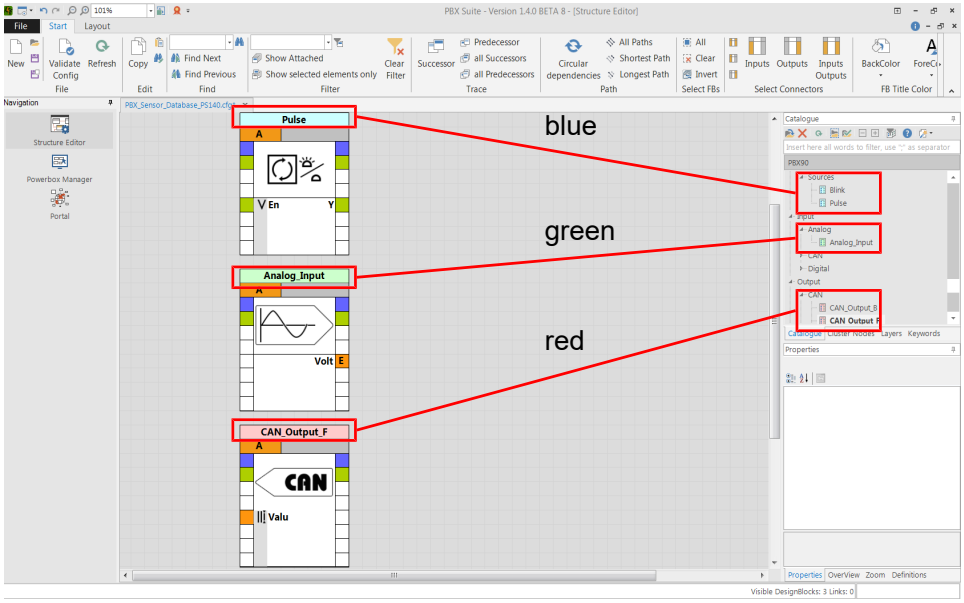
The function block CAN_Input is available as data type Boolean or data type Integer or data type Float. To separate one from the other, we put a letter at the end of the function blocks name:



Color Scheme

The color of the function blockhead and the color of the symbol in the catalog both show the type of the function block:

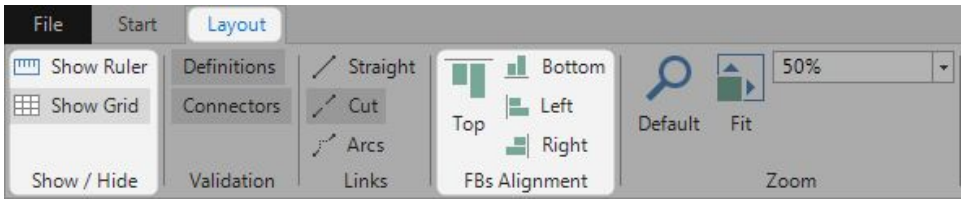
- **blue** for functions
- **green** for inputs
- **red** for outputs



4.2 Utilities for placing and arranging of Function Blocks

At the **Layout** tab

- Rulers and Grid can be enabled or disabled,
- several functions helping to align the function blocks are available.



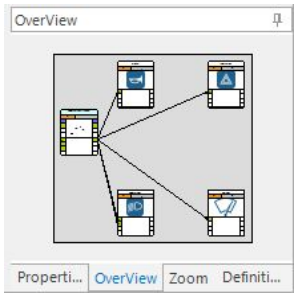
4.3 Navigating through the configuration

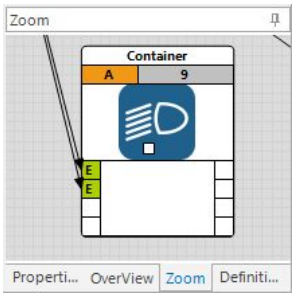
Use mouse wheel for zooming in or out.

Space bar toggles between current view and Zoom to Fit.

At the Quick Access Toolbar, several zoom options are provided.

Use **OverView** or **Zoom** tab for a second farer or closer view.

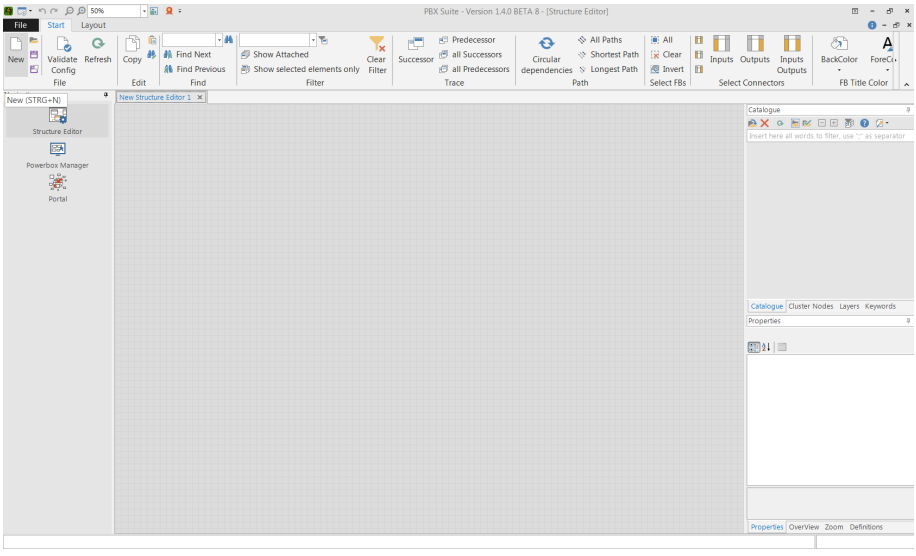




4.4 Example “Blower Control”

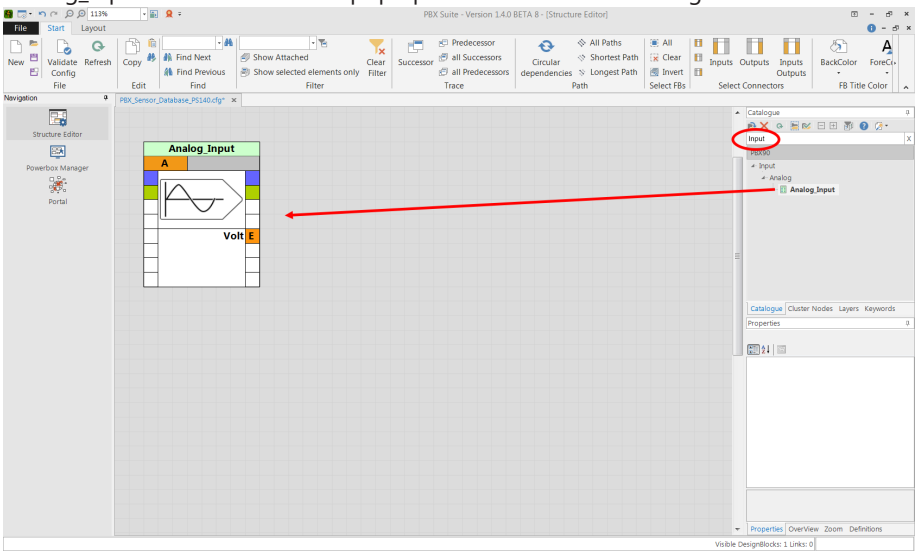
This chapter shows an example how to program the function **Blower Control** with the PBX Suite. The function shall start the cooling fan when the water temperature exceeds e.g. 90°C and stops it when the temperature falls below e.g. 80°C. You’ll reach it by setting Default to 90 and Hysteresis to 10 as shown in the following instructions.

1. Start the PBX Suite.
2. Click **Structure Editor** in the menu box on the left side.

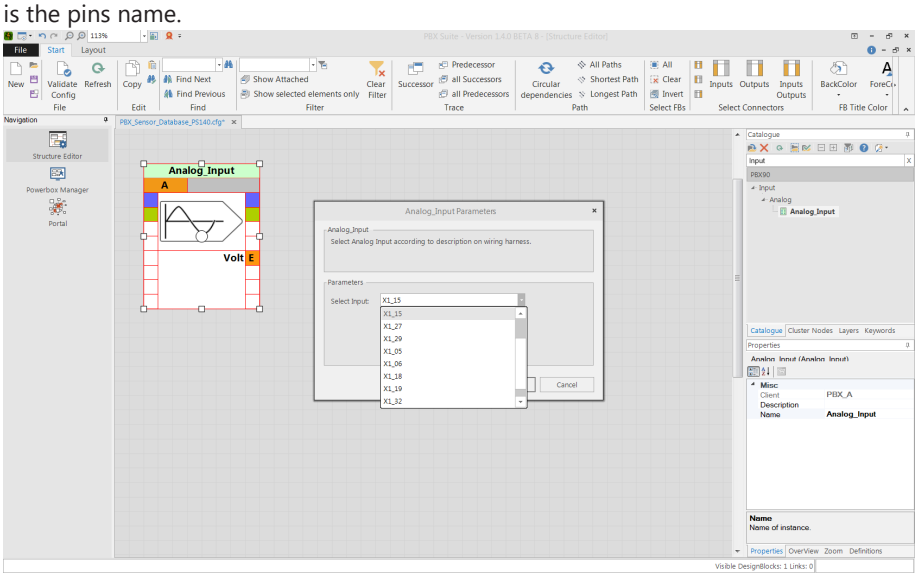


3. Click **New.**
4. Select your PBX Type.
5. Load the corresponding PST File.
6. Confirm by clicking **OK**.
7. Write **Input** in the text field of the Catalogue *[Insert here all words to filter, use “;” as separator]*.

8. Drag and Drop the function **Analog_Input** from the Catalogue onto the screen. The Analog_Input function block will pop up as shown in the following screenshot.

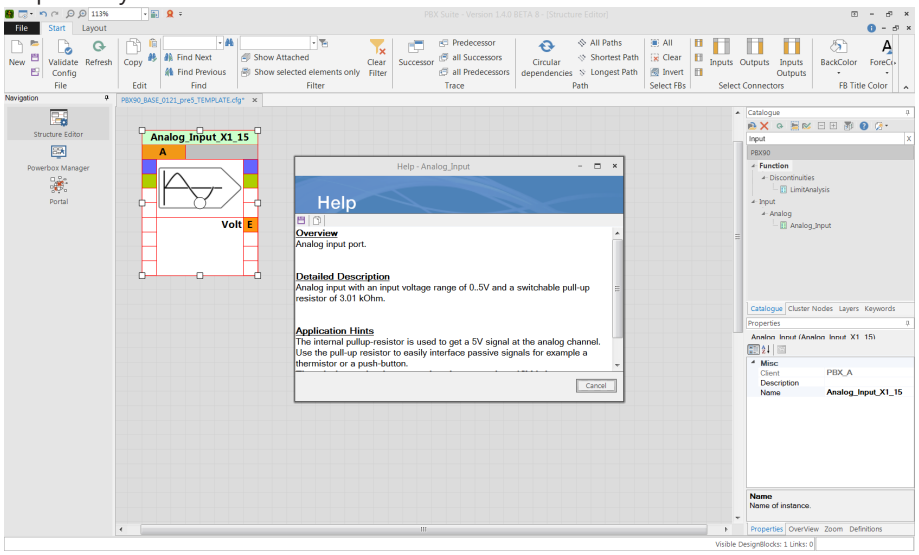


9. With double-click on the selected function block, you open the pin assignment wizard. Select Input X1_15 from the pull down menu. X1 is the connectors name and 15 is the pins name.

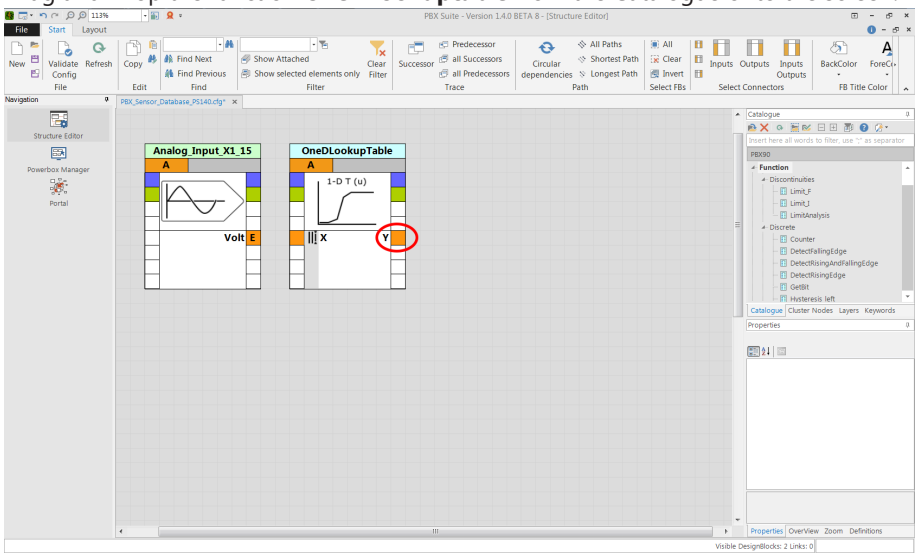


10. The assigned connector and pin are part of the function blocks name shown in the headline of the function block. Here it is X1_15, as you can see in the following screen shot.
    Notice: All function blocks can be renamed by changing the name in Properties / Name.

With click on F1 while function block selected, you open the context sensitive online help. Here you find further information.

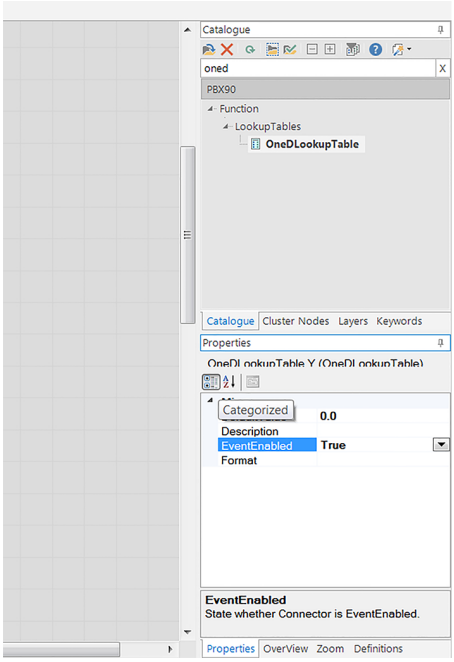


11. Write **Table** in the text field of the Catalogue.
12. Drag and Drop the function **OneDLookuptable** from the Catalogue onto the screen.

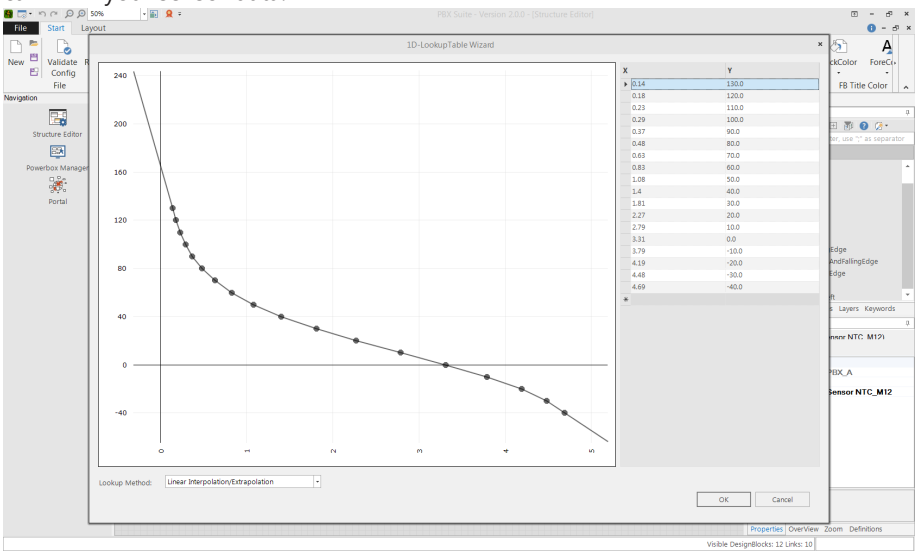


If you want to see the actual temperature in the Live Data later, please enable the OneDLookupTable by setting Y to enabled (red ring). Therefore you click on the or-

ange rectangle right of the Y. It gets red if activated. Choose Event Enabled -> True in the Properties block as shown in the following screenshot.

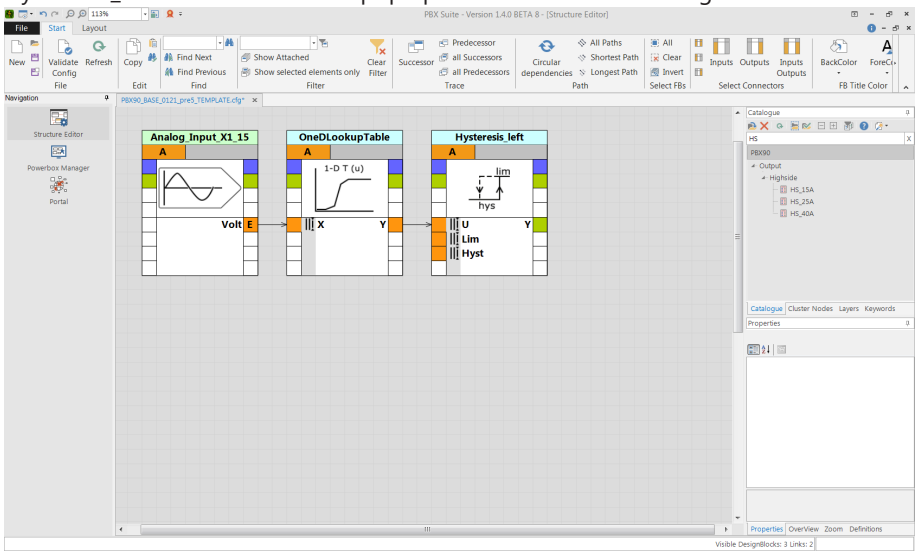


13. For more information about Live Data, please see View Live Data [▶ 29].
14. Double-click on the function OneDLookuptable opens a curve and a table where you can fill in your sensor data.

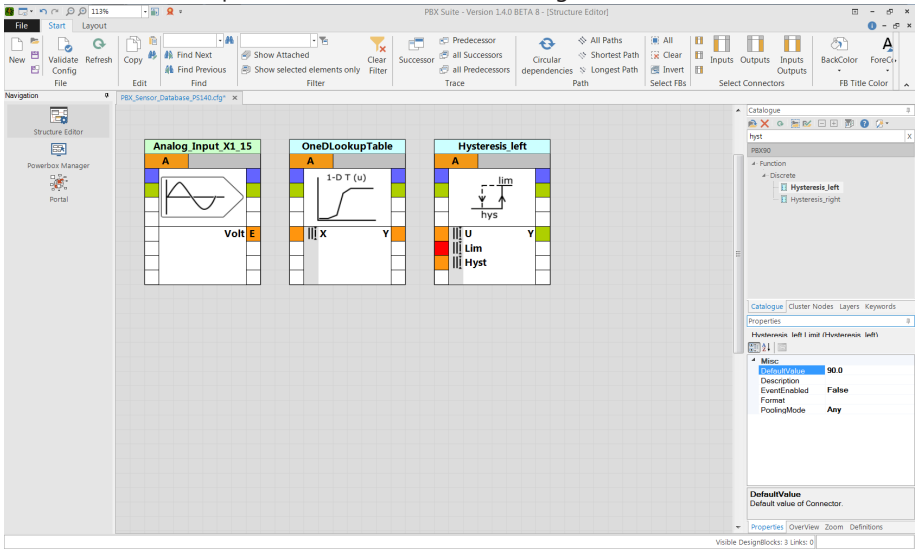


15. Write **hyst** in the text field of the Catalogue.

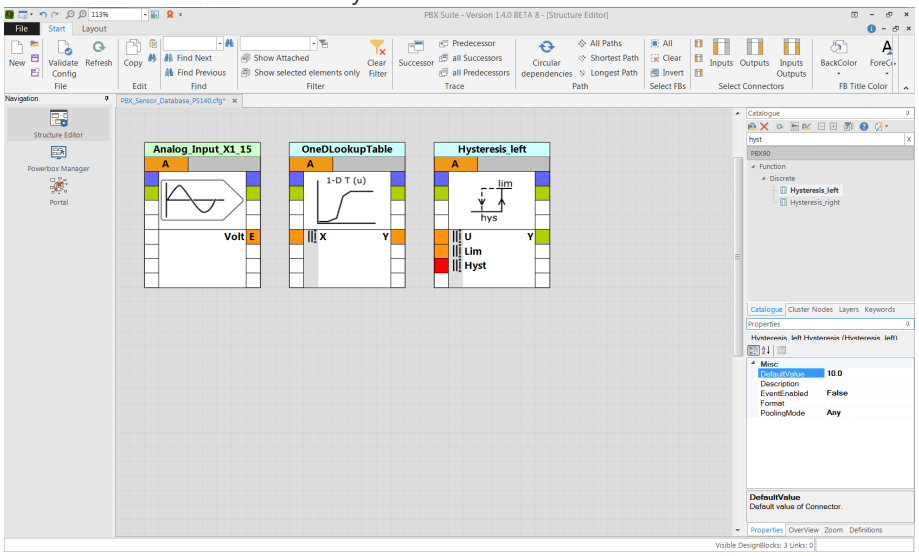
16. Drag and Drop the function **Hysteresis_left** from the Catalogue onto the screen. The Hysteresis_left function block will pop up as shown in the following screenshot.



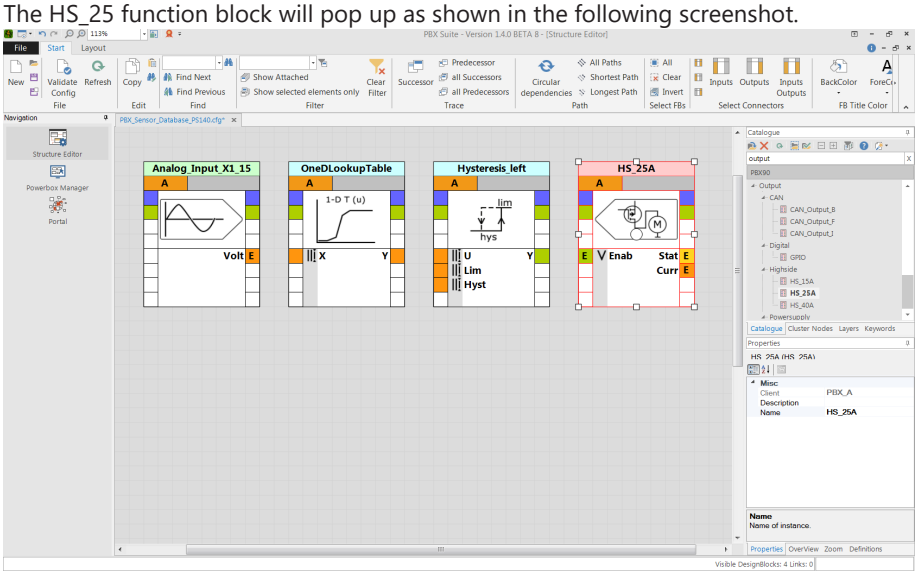
17. For setting the default values click the orange square left to Lim in the Hysteresis_left function block. It changes color to red when activated. Sign in the value 90.0 as DefaultValue under Properties as shown in the following screenshot.



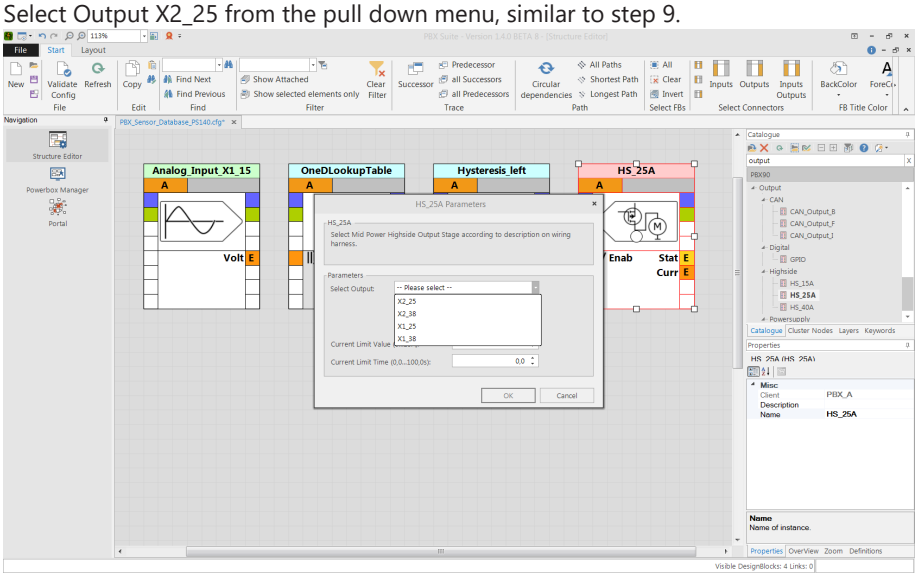
18. Set 10.0 as DefaultValue under Hyst in the same function block.



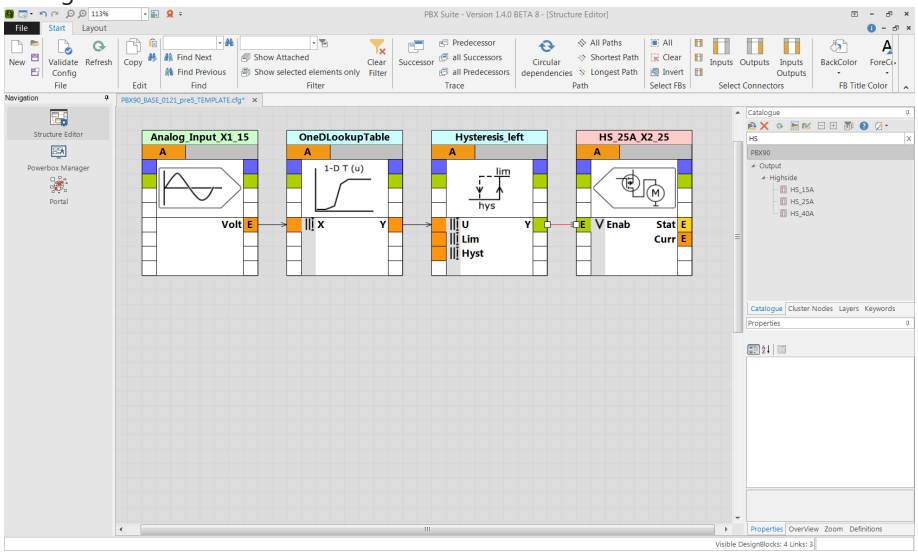
19. Write **output** in the text field of the Catalogue.
20. Drag and Drop the function **Highside HS_25A** from the Catalogue onto the screen. The HS_25 function block will pop up as shown in the following screenshot.



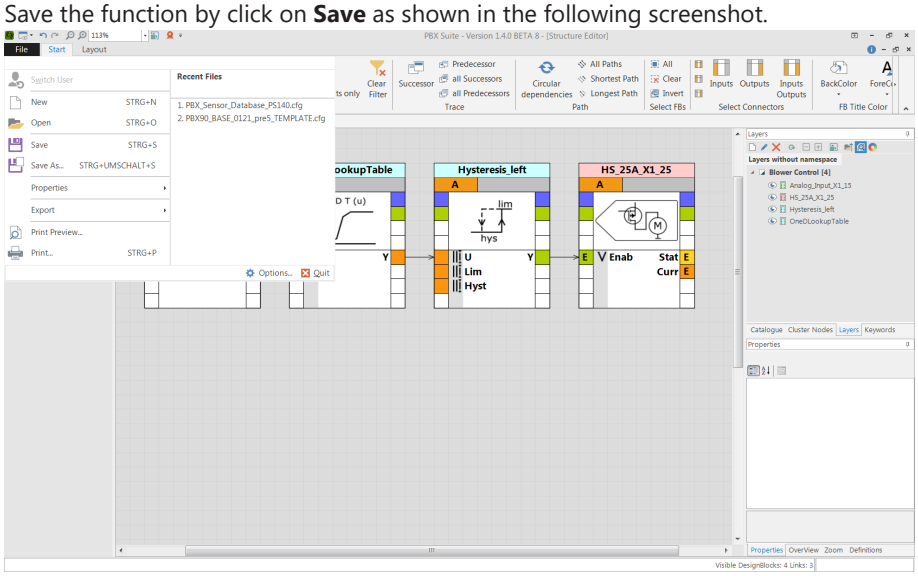
21. With double-click on the selected function block you open the pin assignment wizard. Select Output X2_25 from the pull down menu, similar to step 9.



22. Connect the square angles of the function blocks by pulling lines as shown in the following screenshot.



23. Save the function by click on **Save** as shown in the following screenshot.



Congratulations! You have programmed your first function!

Further steps

After creating the configuration, you got the following options:

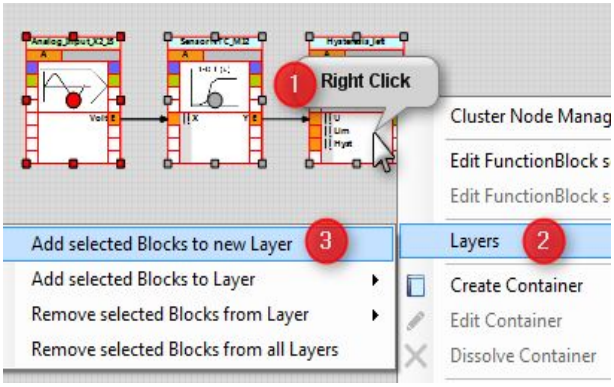
- transfer and activate the configuration to the PowerBox PBX 90 with PowerBox Manager,
- follow the signal values with PowerBox Manager,
- use the automatically generated *.prg file for RaceCon to measure, record and analyze, see also Integration to RaceCon [▶ 32].

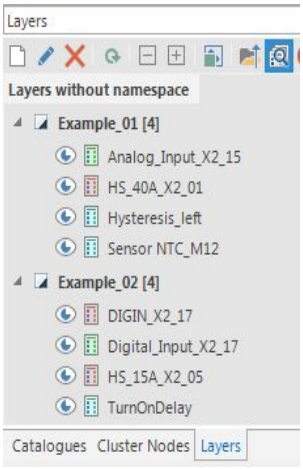
Please visit our website bosch-motorsport.com for more information on how to work with the PBX suite.

4.5 Structuring of complex configurations

4.5.1 Layer

Use **Layer** mechanism for logically grouping of Function Blocks.



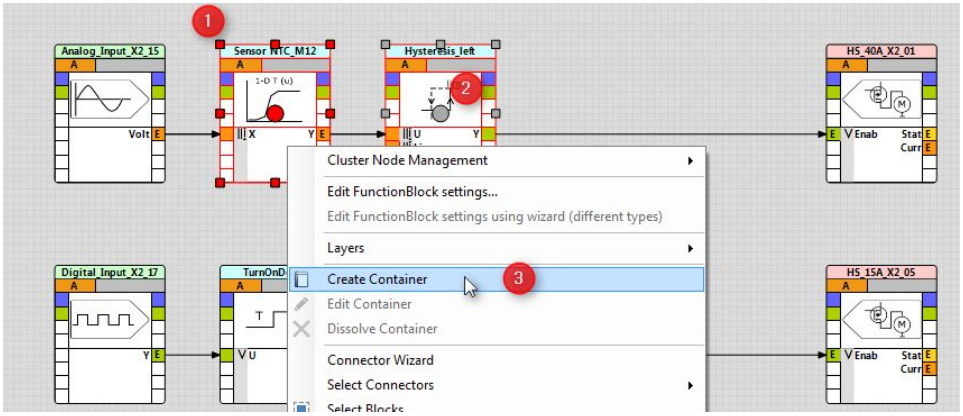


Function Blocks can belong to several Layers.

Layers are supported by the View Online Data of the Powerbox Manager allowing an easy filtering for the data of interest.

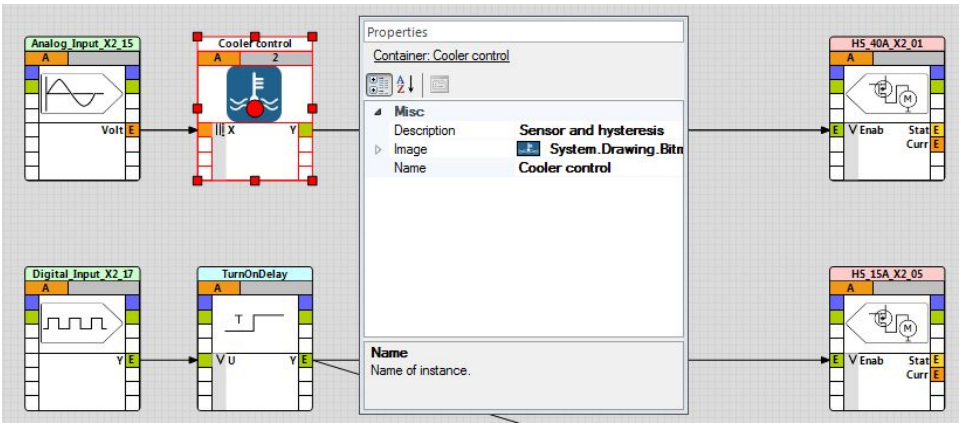
4.5.2 Container

1. Select two or more function blocks.
2. Right click on a selected function block to open the context menu
3. Select Create Container



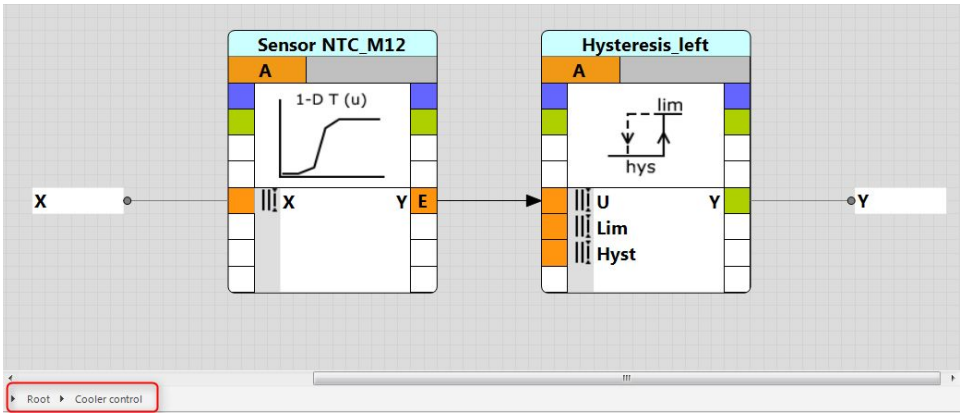
A Container block appears which is connected to the environment.

In the properties tab a description, an image or an alternative name can be setup.



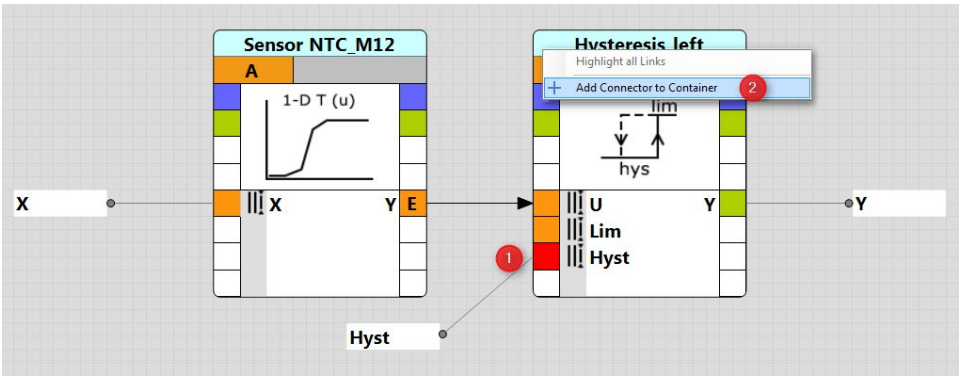
Double clicking the Container switches inside the container, showing the included functionblocks and the outside connections.

Navigation to the outside is done in the lower left corner.



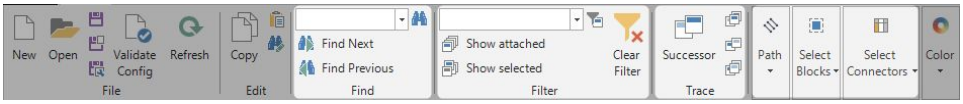
A further outside connection can be generated by

1. Right clicking on an in- or output port,
2. Select Add Connector to Container.



4.6 Utilities for navigating through complex configurations

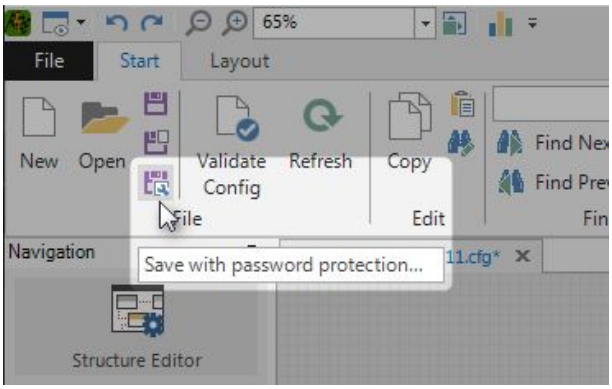
At the **Ribbon** bar, several functions assist for finding, filtering, tracing, and selecting of Function Blocks in complex configurations.



4.7 Password protecting a configuration

Protecting a configuration with a password can be done by clicking the Button ‘Save with password protection’.

Enter the password and confirm it.



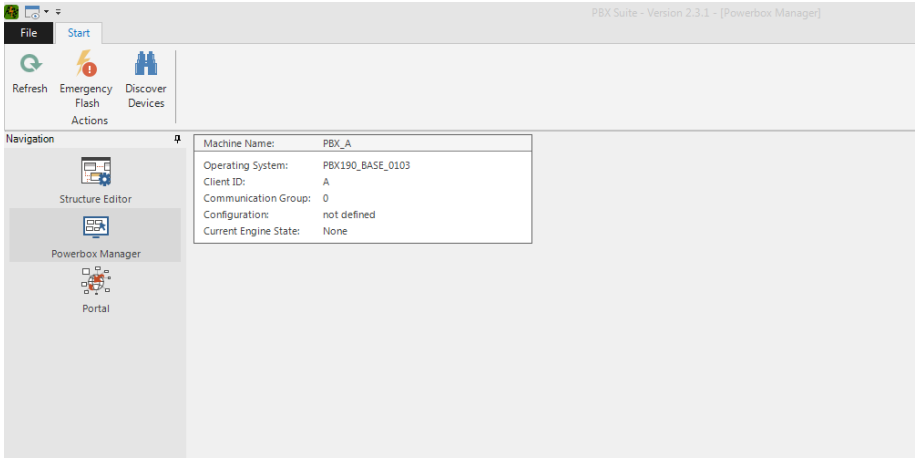
From now on the correct password has to be entered to open this configuration.

5 First Upload of a configuration

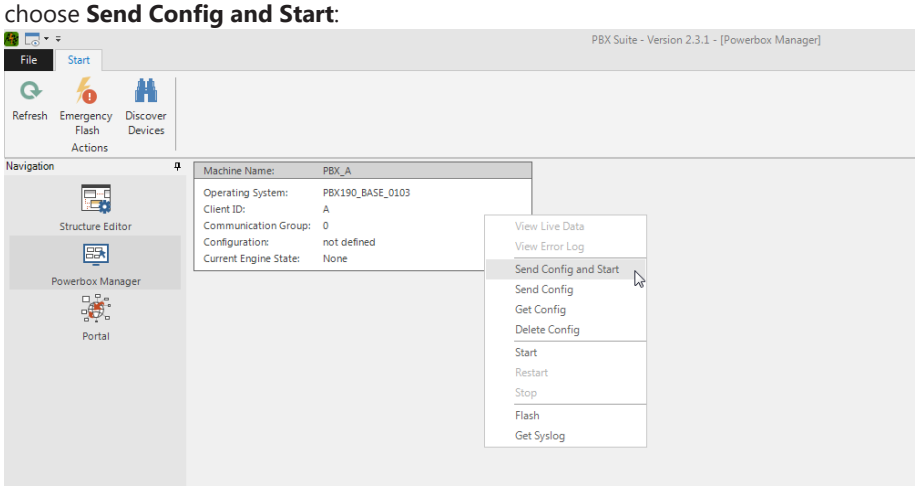
This chapter will show how to upload the new designed configuration file to the Power-Box.

1. Connect your computer and the PowerBox via Ethernet.
2. Activate your PowerBox.
3. Start your PBX Suite and activate the PowerBox Manager by clicking on the button as shown in the following screenshot:

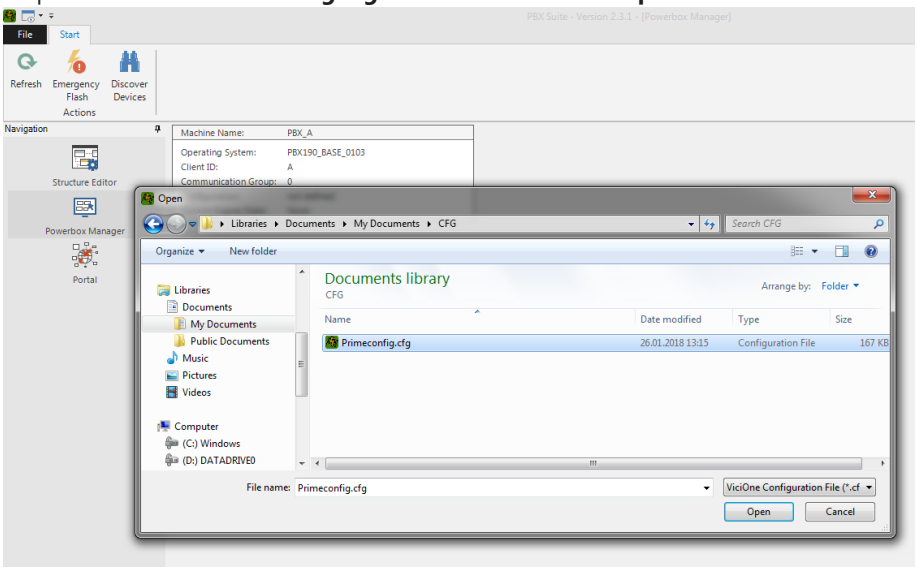
4. After a short while the screen will show your device:



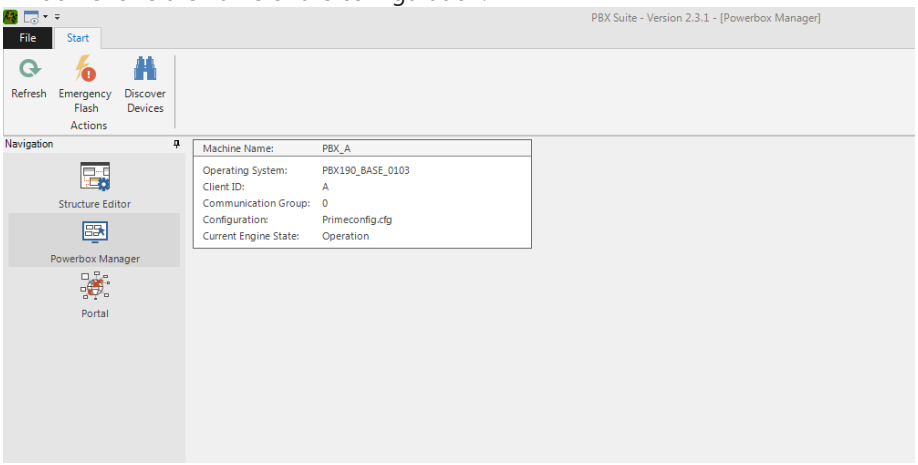
5. Now you can transfer the config file. Therefore right-click on the device window and choose **Send Config and Start**:



6. Choose the configuration file which you want to put on your PowerBox. In this example it is named **Primeconfig.cfg**. Confirm with click on **Open**.



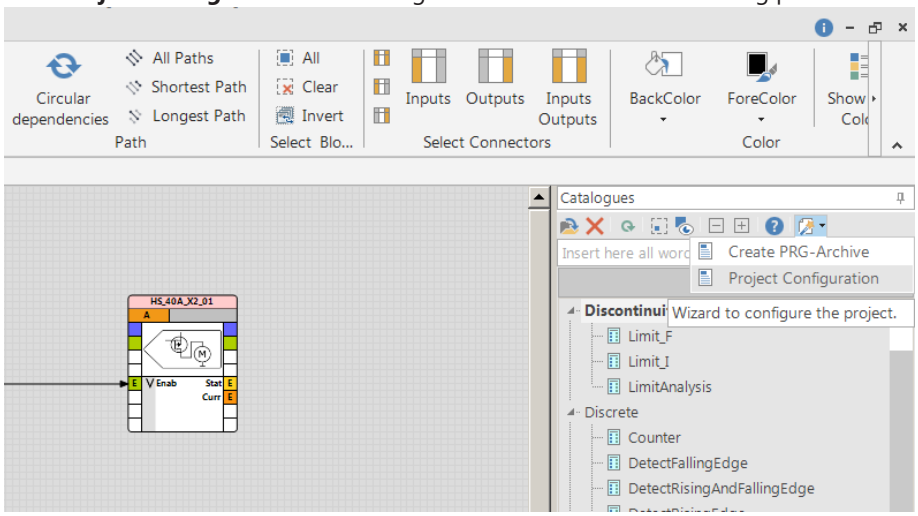
7. The config file was put on the PowerBox, and after an automatically restart the device window shows the name of the configuration:



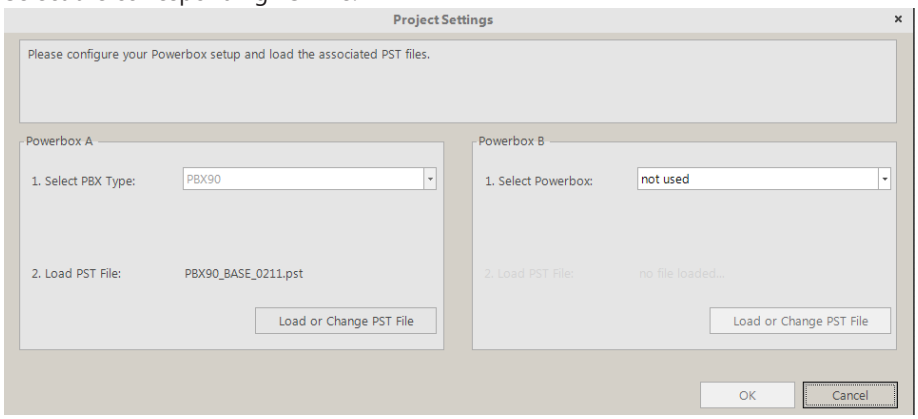
6 Update of an existing configuration

This chapter will show how to update a configuration.

1. Click **Project Configuration** on Catalogue tab as shown in the following picture.



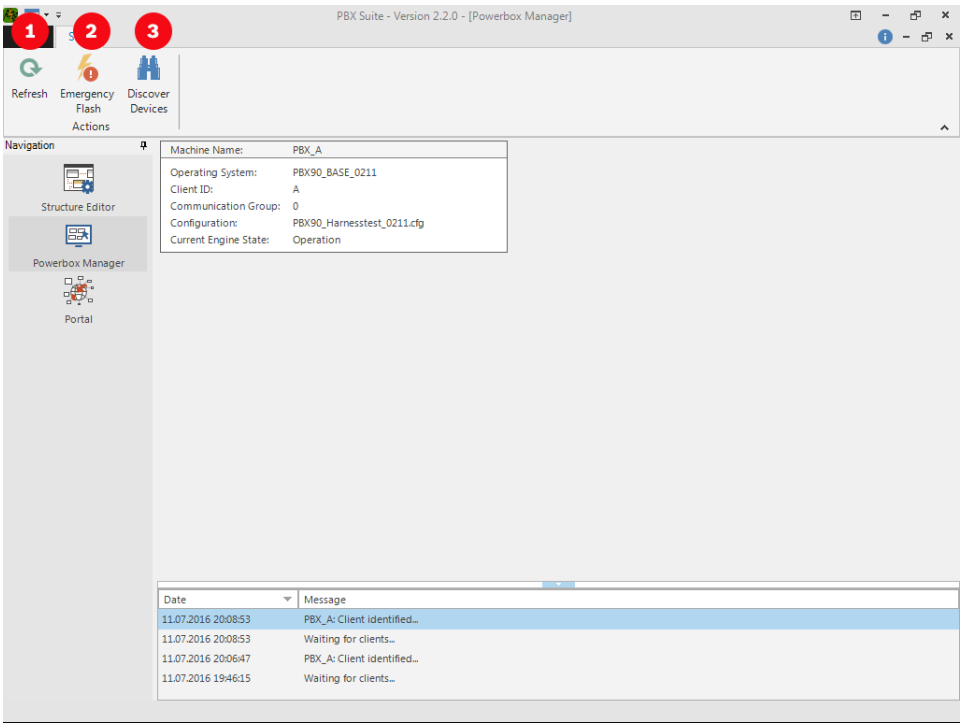
2. Select the corresponding PST file.



3. Confirm by clicking **OK**.

7 The Powerbox Manager

The Ribbon Bar

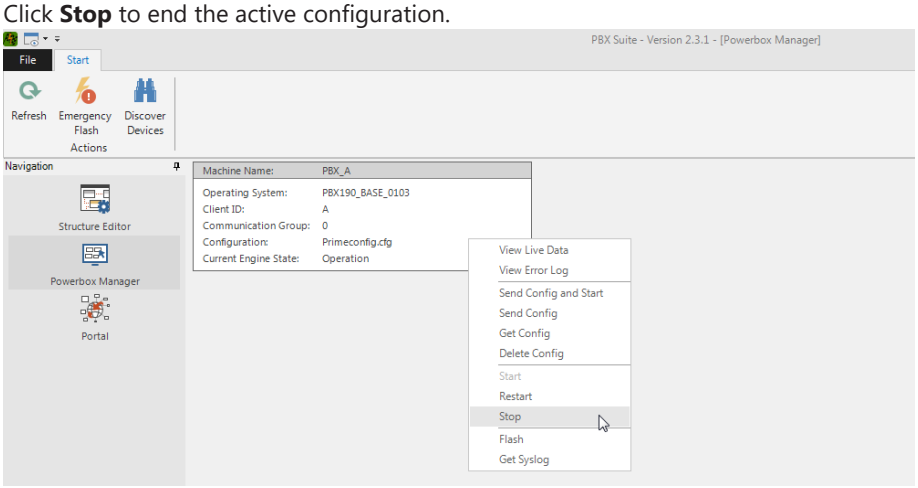


1. Refresh: Updates the current view
2. Emergency Flash: Allows to Flash a device which has entered the emergency state
3. Discover Devices: Used to assign in a double-PBX system the 2nd PBX device a different allocation

7.1 Switch between configurations

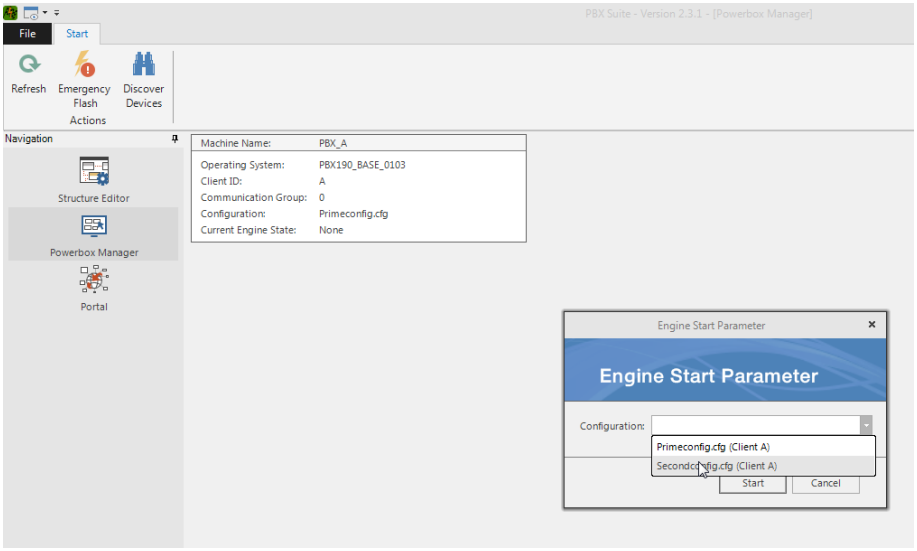
This chapter will show how to switch between different configurations on your PowerBox.

1. Right mouse click on the device window will open the menu as shown in the following screenshot.
2. Click **Stop** to end the active configuration.

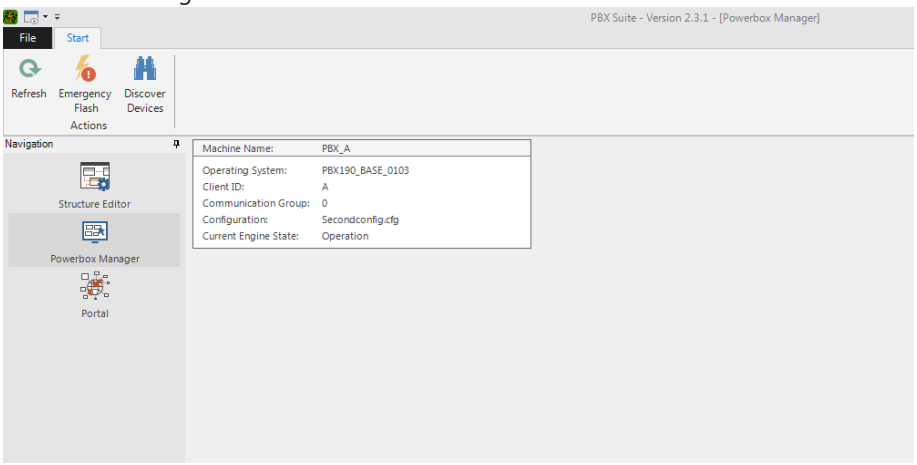


3. Click **Start** to choose the new configuration.

4. Choose the new configuration from the pull-down menu, here “Secondconfig.cfg”. Confirm with click on **Start**.

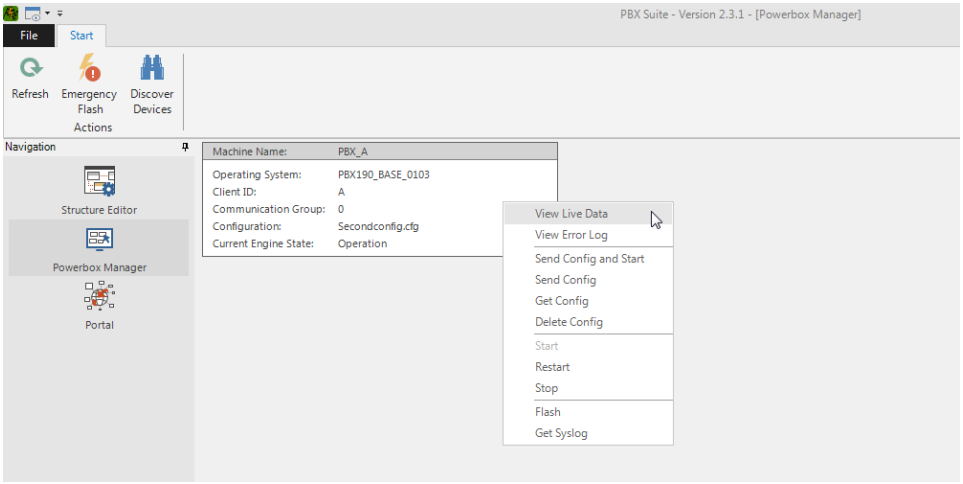


5. The device will restart, and after a short time the device window shows the name of the second configuration.

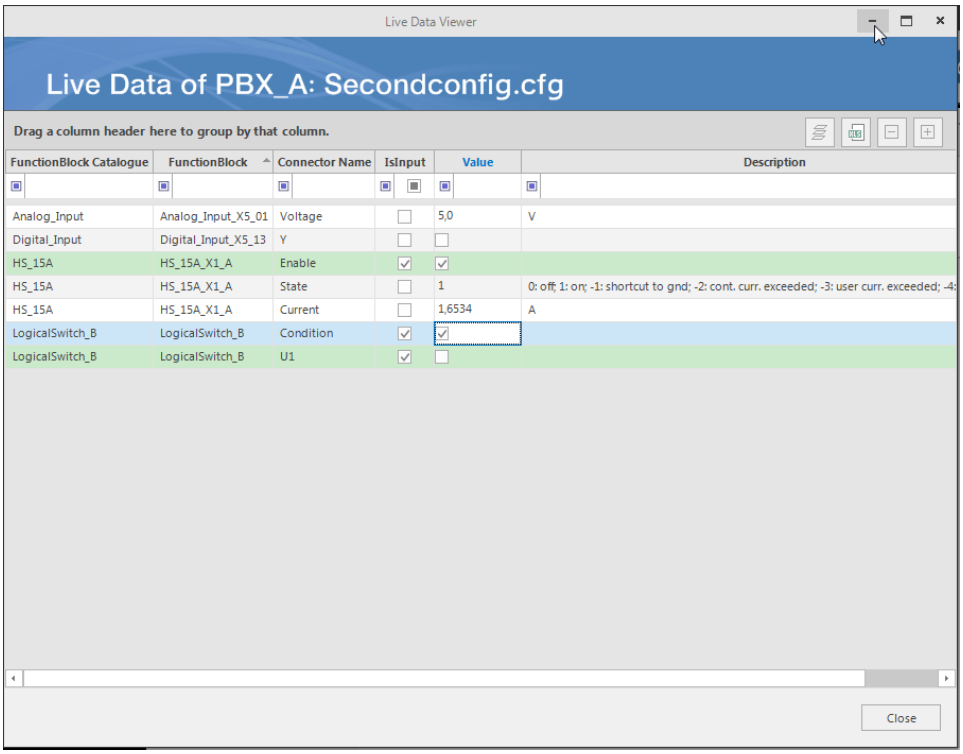


7.2 View Live Data

This chapter will show how you can view live data with your PowerBox Suite. Right click on your device opens a window where you choose View Live Data.



Now you can see the entire Event enabled data on your screen.



Every in- or output port of the Function Blocks checked for EventEnabled is represented as a row.

For output ports, the current value is shown, some with additional Description information.

For input ports, it is possible to affect the operative value. The result is controlled by the selected PoolingMode.

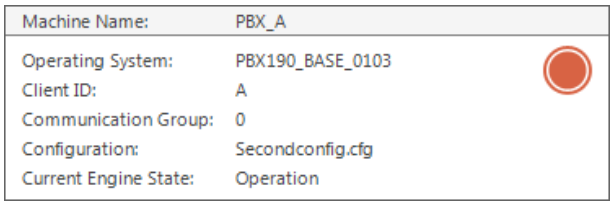
Various support for filtering the amount of data is provided, including the support for Layers.

7.3 Error log

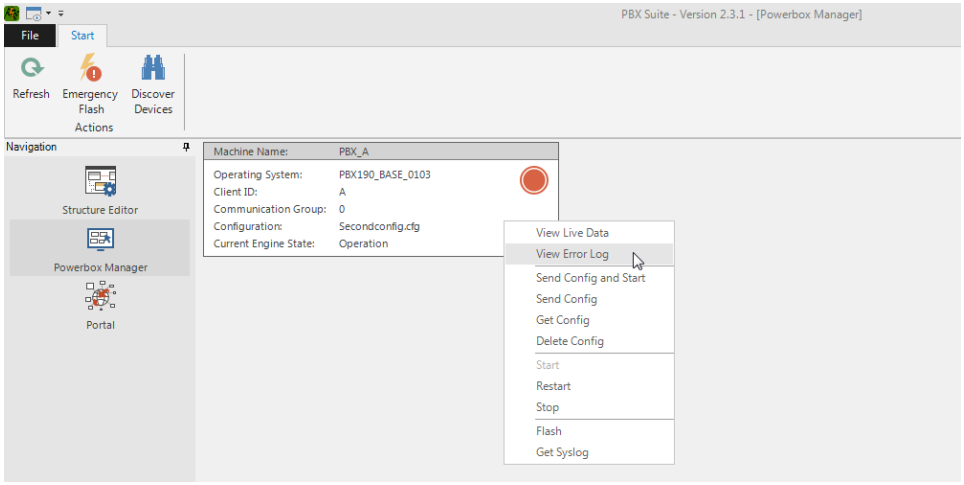
A red dot in the upper right corner of the box indicates if the error log contains at least one entry.

If blinking, at least one active error entry is present.

Else only passive error(s) are present.

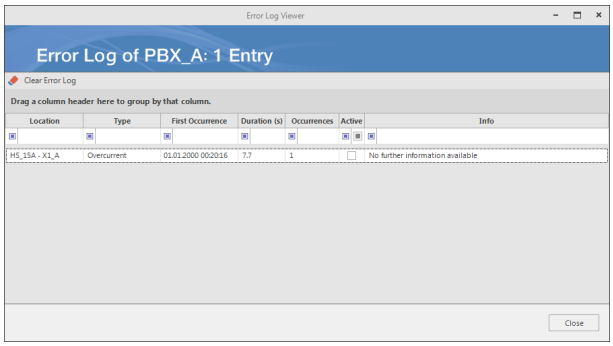


In the context menu select **View Error Log** to view the error log entries.



Besides the location and type further information are available.

To clear the error log, click **Clear Error Log** in the upper left corner of the error log window.



The Error Log can also be accessed with RaceCon.

RaceCon also provides access to the following measurements variables:

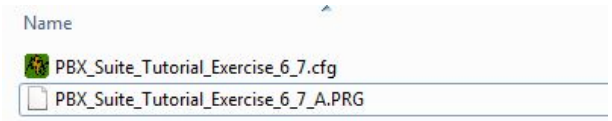
- General Error Log Status (device measurement label “error_state”)
  - No error present in memory
  - At least one inactive error present in memory, no active errors
  - At least one active error present in memory
- Error type (device label “error_type_rotate”)
  e.g., “below_threshold” for a violation of the minimum voltage range defined in the configuration, “shortcut_Batt” for a shortcut to battery voltage etc.

- Error location (device label “error_location_rotate”)
  e.g., “ANA01” for an error concerning the first ANA channel
- Error active state (device label “error_active_rotate”)
  All failure modes are continuously diagnosed; any error detected will be written to the error memory. Once an error is detected, it is qualified as “active”.
  - 1 (TRUE) Error was detected in most recent diagnose run (active)
  - 0 (FALSE) Error is inactive: error was not detected in most recent diagnostic run, however the error has not been cleared from the memory by the user and remains in the non-volatile memory

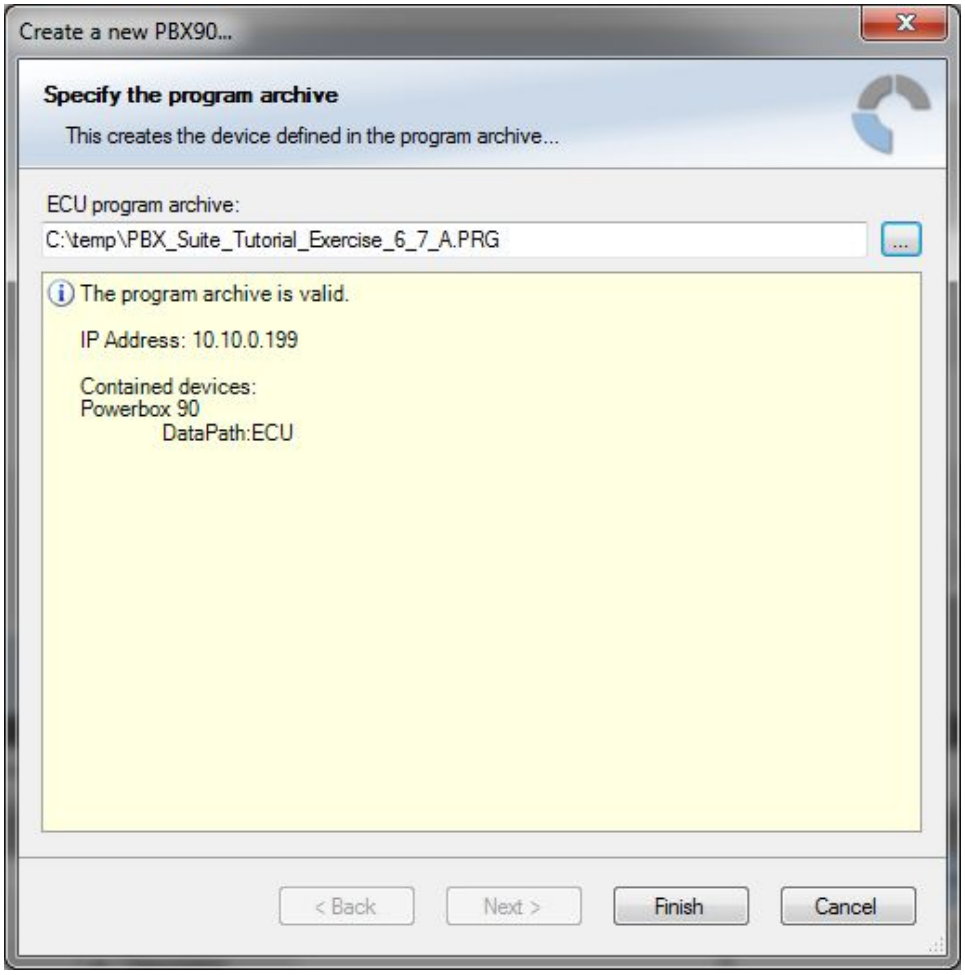
The aforementioned labels (error_active_rotate, error_location_rotate, error_type_rotate) cycle through the errors currently present in the memory and represent the respective property of each error periodically.

8 Integration to RaceCon

At the same location the Configuration is saved, an additional export file for RaceCon is written. It is suffixed by an ‚_A' or ‚_B' and the extension is ‚PRG':

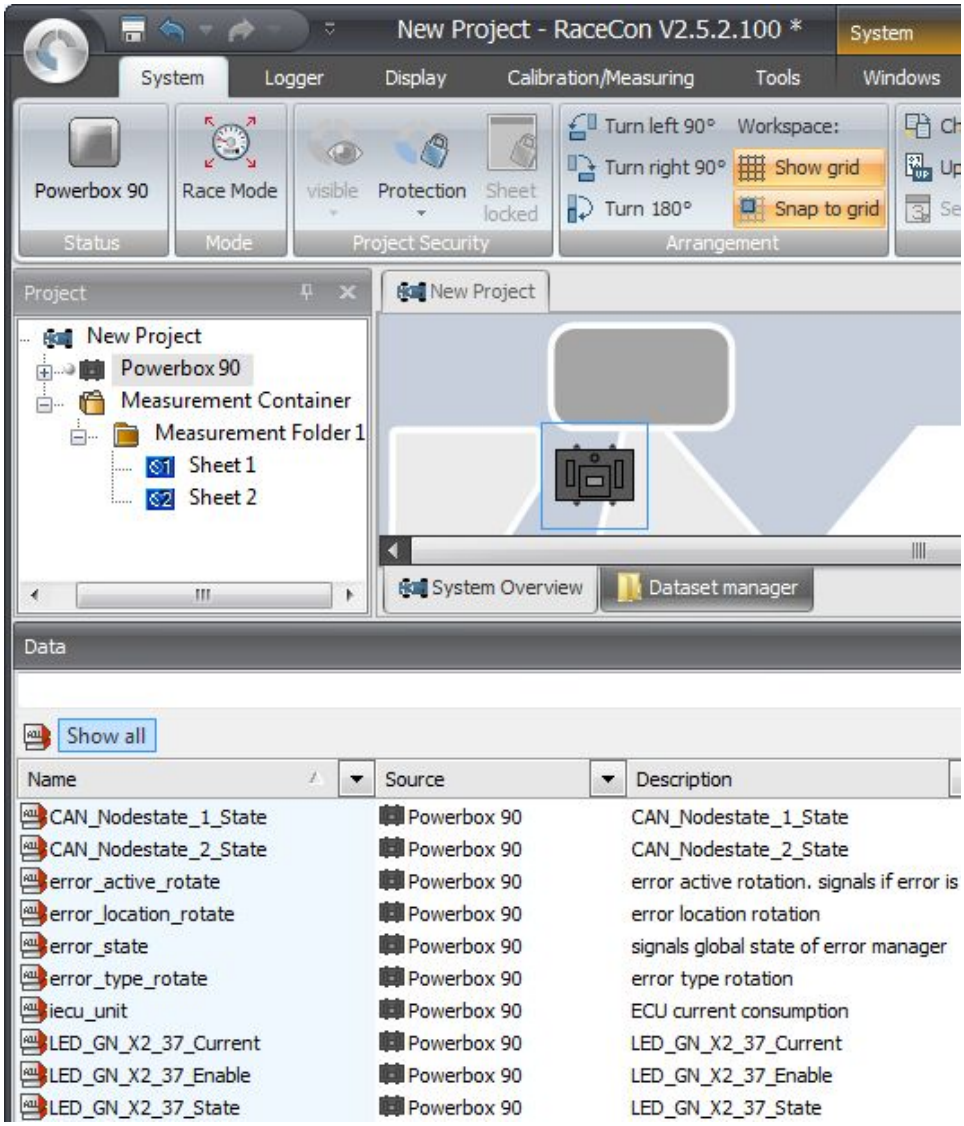


Drag & Drop a PowerBox PBX 90 in RaceCon into the project and select this ‚PRG' file if asked for the program archive:



All the In- and Output Ports of the configuration with EventEnabled set to True are now available and can be used for

1. Logger
2. Display
3. Measuring


New Project - RaceCon V2.5.2.100 *
System
System
Logger
Display
Calibration/Measuring
Tools
Windows
Powerbox 90
Race Mode
visible
Protection
Sheet locked
Turn left 90°
Turn right 90°
Turn 180°
Workspace:
Show grid
Snap to grid
Status
Mode
Project Security
Arrangement
Project
New Project
Powerbox 90
Measurement Container
Measurement Folder 1
Sheet 1
Sheet 2
New Project
System Overview
Dataset manager
Data
Show all
Name
Source
Description
CAN_Nodestate_1_State
Powerbox 90
CAN_Nodestate_1_State
CAN_Nodestate_2_State
Powerbox 90
CAN_Nodestate_2_State
error_active_rotate
Powerbox 90
error active rotation. signals if error is
error_location_rotate
Powerbox 90
error location rotation
error_state
Powerbox 90
signals global state of error manager
error_type_rotate
Powerbox 90
error type rotation
iecu_unit
Powerbox 90
ECU current consumption
LED_GN_X2_37_Current
Powerbox 90
LED_GN_X2_37_Current
LED_GN_X2_37_Enable
Powerbox 90
LED_GN_X2_37_Enable
LED_GN_X2_37_State
Powerbox 90
LED_GN_X2_37_State

9 FAQ

You'll find an FAQ list on the PowerBox product site of bosch-motorsport.com.

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SVHC Substance	CAS Number
Lead monoxide (lead oxide)	1317-36-8
Lead	7439-92-1

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ANTLR-2.7.7

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The primary ANTLR guy:

Terence Parr

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parrt@antlr.org

10.3.2 antlr311runtime.jar License

ANTLR-3.1.1

ANTLR 3 License

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10.3.8 xml_io_tools License

xml_io_tools

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10.3.9 Avalonia

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11 Disposal

Hardware, accessories and packaging should be sorted for recycling in an environment-friendly manner.

Do not dispose of this electronic device in your household waste.

12 Technical Specifications

Mechanical Data

Size	214 x 159 x 57.5 mm
Weight	830 g
Protection Classification	Protected against ingress of particles > 1 mm, splash water proof
Temp. range (at internal sensors)	-20 to 85°C
Max. vibration	Vibration profile 1 (see Downloads)

Electrical Data

Supply voltage range	5 to 20 V
Current consumption	<1 A
Maximum recommended output current	120 A continuously >180 A peak current (2 s)

Inputs

Number of digital inputs	4
Number of analogue inputs	12 x 0 to 5 V; 16 bit resolution
Number of CAN input channels	500

Outputs

All driver stages are thermally and reverse polarity protected.

Very high power channels

Number of individual outputs	4
Maximum continuously current draw per output	40 A
Maximum peak current each output	150 A inrush

High power channels

Number of individual outputs	4
Maximum continuously current draw per output	25 A
Maximum peak current each output	150 A inrush

Low power channels

Number of individual outputs	22
Maximum continuously current draw per output	15 A
Maximum peak current each output	100 A inrush

PWM channels

Number of individual outputs	6
Maximum continuously current draw per output	15 A

Maximum peak current each output	75 A inrush
Maximum applied frequency	20 kHz

Sensor supplies

Number of 5 V reference sensor supplies	1; 400 mA at 5 V

Communication

PC Interface	Ethernet
CAN bus	3
CAN protocol	2.0B
CAN baud rate (each CAN bus)	125/250/500/1000 Kbps
CAN identifiers	11 bit or 29 bit identifiers Motorola or Intel format Bit wise operator
LIN bus	1; Control of Bosch Motorsport LIN devices included. Support of other devices on request.
Ethernet	2 at 100 Mbit/s

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