IQANdevelop

and IQANsimulate

USER MANUAL

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Contents

1 Introduction

IQANdevelop is a development tool for designing and developing application programs for IQAN's module-based control systems.

IQANdevelop is a Windows©-based program with which you can create applications for the simplest to the most complex mobile machine within forestry, excavation or material handling.

You develop your application in the PC to thereafter "download" the application to the IQAN system's master module. In IQANdevelop, you also find functions for measuring and fault-finding which facilitates work during service.

The manual is intended to function as a reference book when working. In the chapters, you find short explanations to all the menus and dialog boxes.

We show with examples how you create functions for the different channels as well as how you use IQANdevelop's measuring system.

We have written a *Getting started* chapter as a practical introduction to IQANdevelop and it is intended that you use the PC at the same time as you read the chapter.

It is important to point out that the examples are not complete with regard to safety and must not be used on a machine.

2 Installation

Installing IQANdevelop

Before you install IQANdevelop, please read the Safety regulations in chapter 3.

- Insert the CD into your computer's CD-ROM unit. The installation program starts automatically. If not, open the CD-ROM unit in the Explorer and double-click on Install.exe.
- Follow the instructions in the installation program. If there is something you do not understand, click on the *Next* > button or press *Enter* to continue the installation.
- The installation file also contains IQANsimulate. To install IQANsimulate, follow the instructions given by the installation program.

You can always download the latest upgrade of IQANdevelop from our home page, www.iqan.com.

3 Safety regulations

This chapter contains regulations to improve safety when you use IQANdevelop. It is important that you read this chapter before you start creating applications for machines.

This is what a warning symbol looks like!

Warning symbol

Note that all warning symbols in the manual also refer to safety precautions.

Emergency stop

Without exception, every machine must have an emergency stop that can break the power supply to the IQAN system or stop the diesel engine. It must be easily accessible from the operator's position. IQANdevelop should not be adjusted from locations where the user cannot reach the emergency stop, for example outside the driver's cabin.

Testing the application for machine

A risk assessment should be carried out with regard to function and unpredictable occurrences. We refer to the standard for the Machine directives.

It is very important to test the program for the machine to check that nothing unexpected occurs. IQANsimulate software is prepared for verification and fault-finding of the application.

If the application is to be tested in machine, people and other objects that can be injured or damaged must be out of range of the machine's working area.

Sending data to the IQAN system

When downloading data to the IQAN system, the machine's engine must be switched off. No part of the machine, for example a crane, may be in extended position. The machine must stand on a flat surface to prevent rolling. People or objects that can be damaged must be kept outside of the machine's working area. Note that when the application is being downloaded to the IQAN system, the system's output channels become inactive.

Downloading via modem

You need to be extra careful when sending data to the master via a modem. Before the downloading can begin, the driver must acknowledge the downloading request on the master display.

Protecting the application

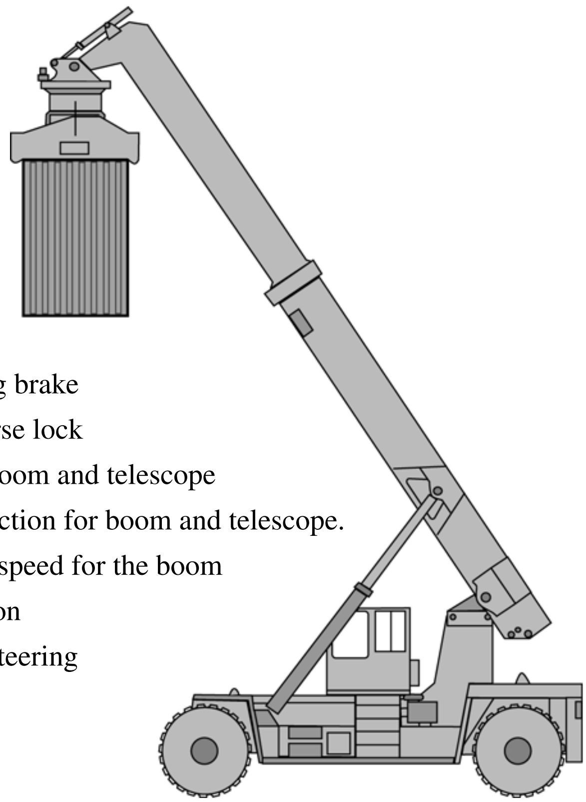
It is possible to protect the application in a machine with an application code. In this way, you cannot get the application from the machine if you don't have the code.

ALWAYS CONSIDER SAFETY WHEN DEVELOPING AND TESTING THE APPLICATION.

4 Getting started

This chapter is intended as a practical introduction to IQANdevelop which means that you should use the PC at the same time as you read the chapter. The intention of *Getting started* is to give you an overview of the contents and functionality in IQANdevelop.

We have chosen to construct an application for a Reach Stacker where we will create the following functions:



- Windshield wiper
- Automatic parking brake
- Forward and reverse lock
- Manoeuvring of boom and telescope
- End reduction function for boom and telescope.
- Limited lowering speed for the boom
- Overload protection
- Feedback wheel-steering

The application is not complete and cannot, therefore, be used on a machine!

It is possible to work with the chapter at the speed you find appropriate as well as using it as a reference when you have gathered more facts.

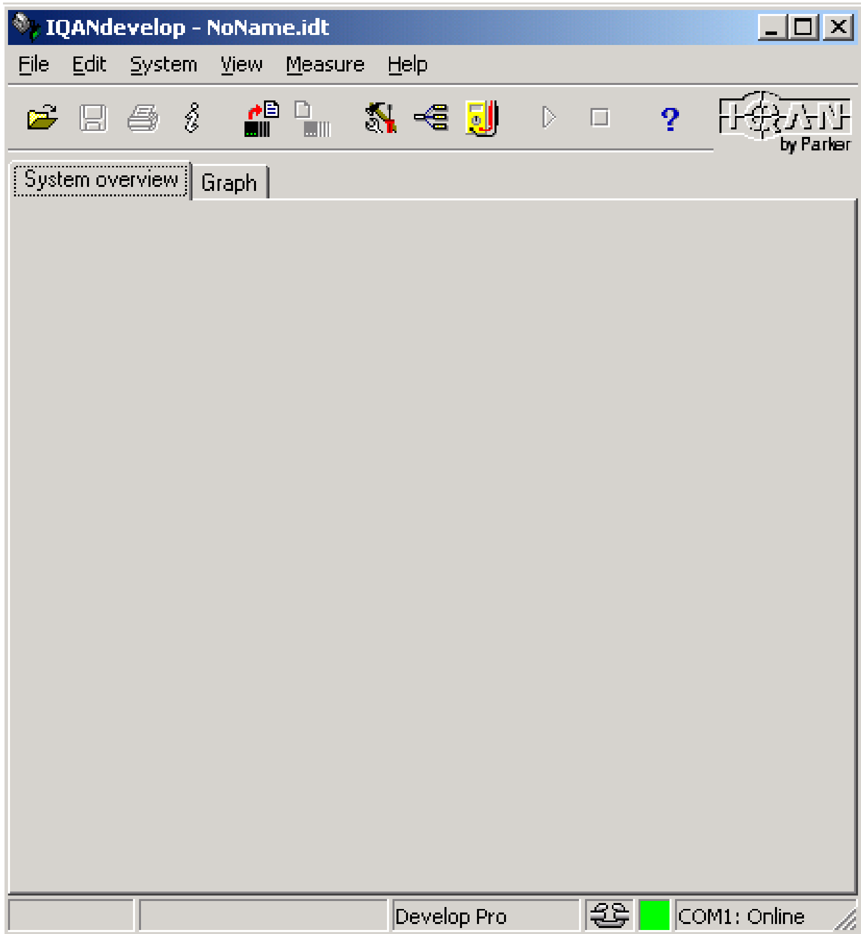
NOTE

The examples are not complete in point of safety. The application must not be used on a machine.

Starting IQANdevelop

To start the program, click on the IQANdevelop icon or the exe-file in the Explorer.

IQANdevelop's main window is displayed.



The main window in IQANdevelop.

In the main window, you find all the commands in the drop-down menus or as buttons in the tool bar.

At the bottom of the window, there is a status bar which shows, for example, your access level.

Building an application in IQANdevelop

To create our Reach Stacker application, we will need the following modules:

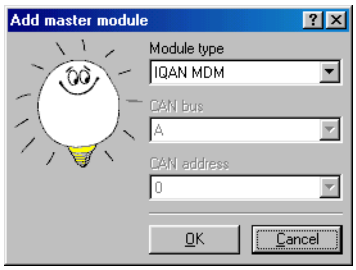
- 1 IQAN-MDM (master module)
- 1 IQAN-XP (expansion module)
- 1 IQAN-Lx (lever)

The first thing we have to do to is to build up the module system in IQANdevelop. Every module is represented by a block diagram where we get access to all channel types.

Add a master

An IQAN system must always contain a *master module*. Therefore, we start by adding this module.

- Select: *System* > *Add module*. The following dialog box is opened.



Dialog box Add master module.

- Click *OK* to add the module IQAN-MDM.

Add IQAN-XP

The next module we need is an IQAN-XP (eXpansion Power module) to get access to inputs and outputs.

- Select: *System* > *Add module.*
- Click in the drop-down list box *Module type* and select *IQAN-XP*. Check that the CAN address is 0 and click *OK*.

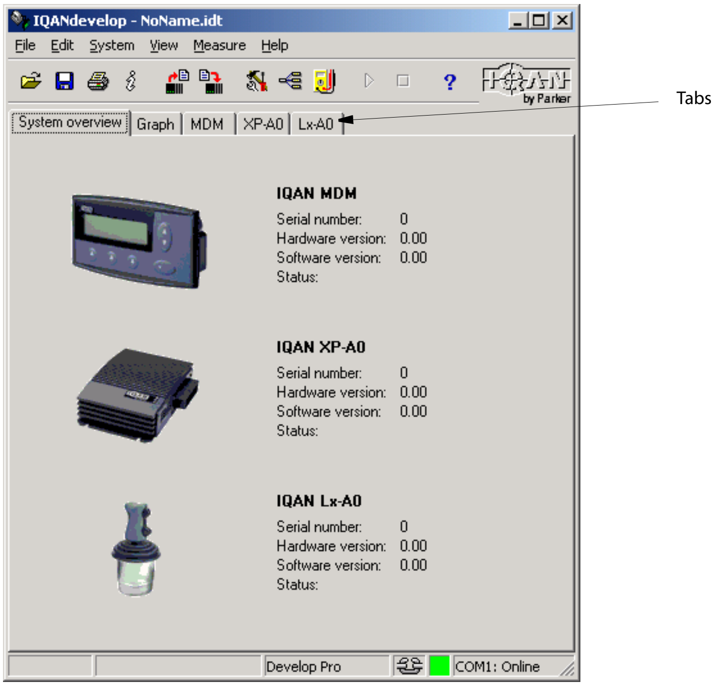
Add IQAN-Lx

- Add IQAN-Lx, CAN address 0.

We have now added the three modules that we will need to create our Reach Stacker application.

System overview

All added modules are represented in the system overview. To see the modules' block diagrams click on respective module.



Every module is represented in the system overview.

Alternating between block diagrams

IQANdevelop presents each block diagram in separate forms. You can easily alternate between the block diagrams by clicking on tabs of the forms.

The forms' tabs.

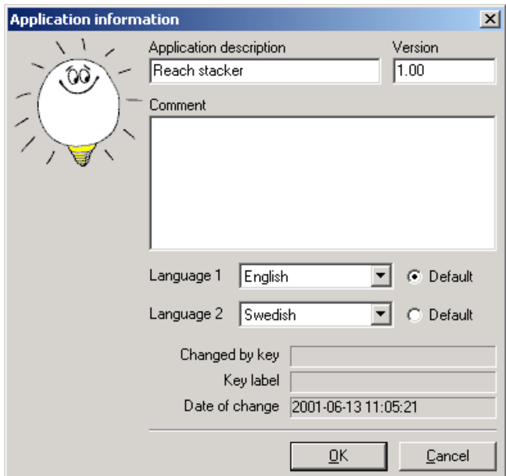
Naming and saving the application

In order to identify the application later you should name your application, and save it with a filename that is explanatory.

Application information

Application information includes description and version which helps you to identify your application.

- Select: *File* > *Info*. The following dialog box is opened.



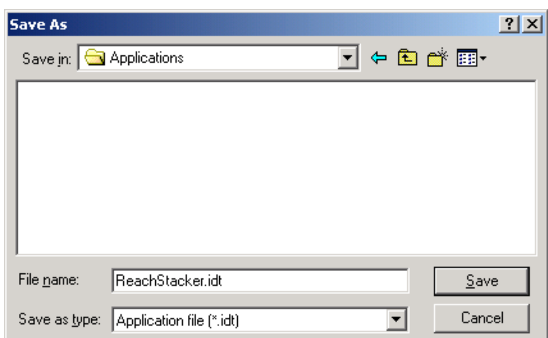
Application information dialog box.

- Enter *Application description* and *Version*. Click *OK*.

Save application

It is time to save your application.

- Select: *File* > *Save as*. The following dialog box is opened.



The dialog box to save a file.

- Select the folder where you want to put your application and enter a file name.
- Click *Save*.

Ensure that you save the application at regular intervals by using the *Save* button in the tool bar.

Digital inputs and outputs

A typical function where we need to use digital inputs and outputs is the control for a *windshield wiper*. It is perhaps not the first function you construct on a machine but it is a simple example to start with when introducing you to IQANdevelop.

We have chosen to construct the functions in this chapter using our working methodology with one exception, the safety aspect is omitted in order not to make the introduction too extensive. For more information on the working methodology, see section Recommendation of work method, on page 371.

What do we want to happen?

Pressing the button will give one stroke of the windshield wiper.

How will it work?

When the button is pressed, a pulse to the windshield wiper of at least 0.5 s is generated.

What do we need to know?

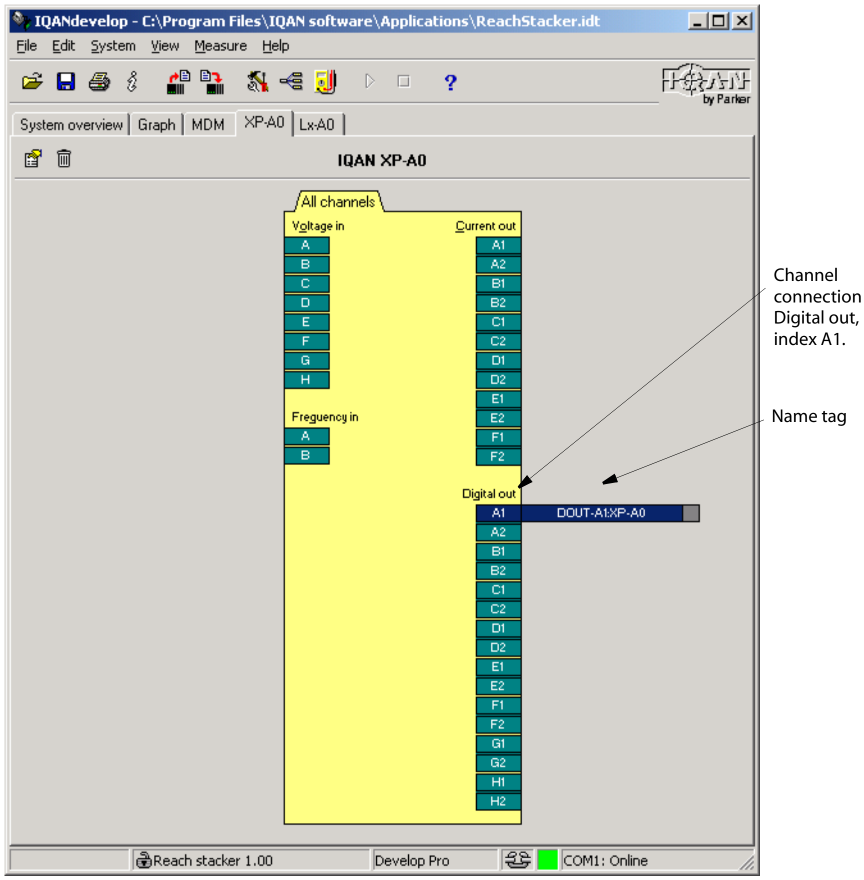
If the button is pressed in.

To create the above-mentioned function, we need to use a digital output to generate a pulse to the windshield wiper and a digital input to connect the button.

Creating the channels with their properties

Windshield wiper; digital out

- Click on the XP-0 tab to open the block diagram for the module.



Block diagram for XP-0.

- To create the digital output, right-click on the channel connection *Digital out, index A1* and select: *Add channel.* A name tag is created.

The channel has a pre-set name:

Channel type - Channel index: Module type - CAN address

NOTE

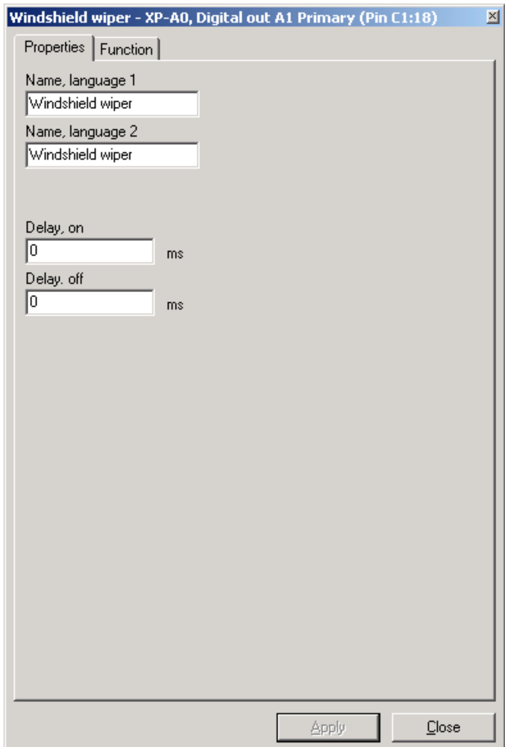
Every digital output has two channels. One primary and one secondary. We will use the upper one, the primary.

(To *Delete* a channel, right-click on the channel's connection and select *Delete channel*. A dialog box to confirm the deletion is opened. Click *Yes*.)

- Select the channel's name tag and select: *View > Show channel info.*
- The dialog box *Channel information* consists of two forms. Click on the *Properties* tab.
- Click in the *Name, language 1* box and enter the name of the channel: *Windshield wiper.*

The pulse that will activate the windshield wiper shall be 500 ms.

- Click in the *Delay, off* box and enter *500*.



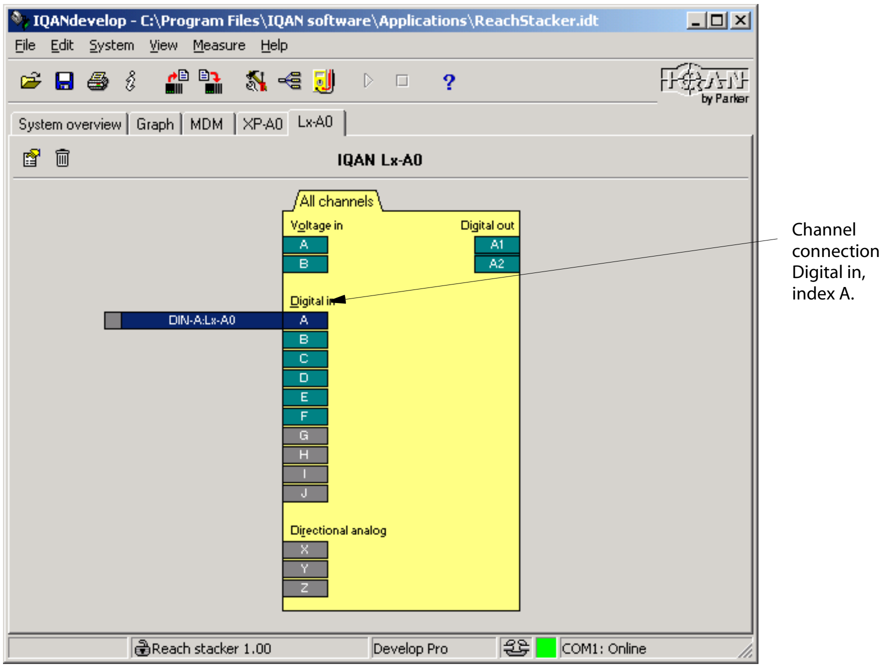
Properties for the digital output, Windshield wiper.

- Click on *Apply* to store.

Windshield wiper, button; digital in

- Click on the tab for the lever unit Lx-0.

The lever unit is equipped with a number of digital inputs. We will use one of them to connect the button for the windshield wiper.



The block diagram for LX-0.

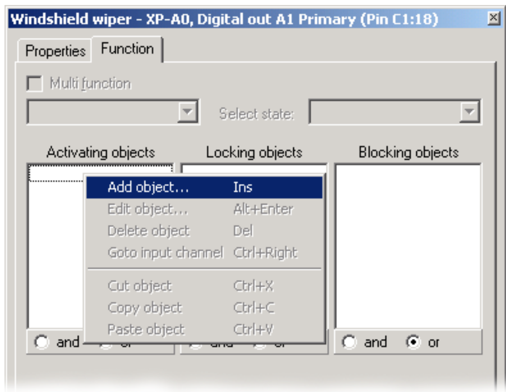
- To create the digital input, right-click on the channel connection *Digital in, index A* and select: *Add channel*. A name tag for the channel is created.
- Select: *View* > *Show channel info* to open the dialog box *Channel information*.
- Click in the *Name*, *language 1* box and enter the channel's name: *Windshield wiper, button*.
- Click on *Apply* to store.

Creating the function

We will now create the function. When the digital input *Windshield wiper, button* is activated, the *Windshield wiper* output will be activated. We will use the channel *Windshield wiper, button* as the input signal to an activating object for the output.

Windshield wiper

- Click on the *Function* tab in the dialog box *Channel information*.
- Right-click in *Activating objects* and select: *Add object*.



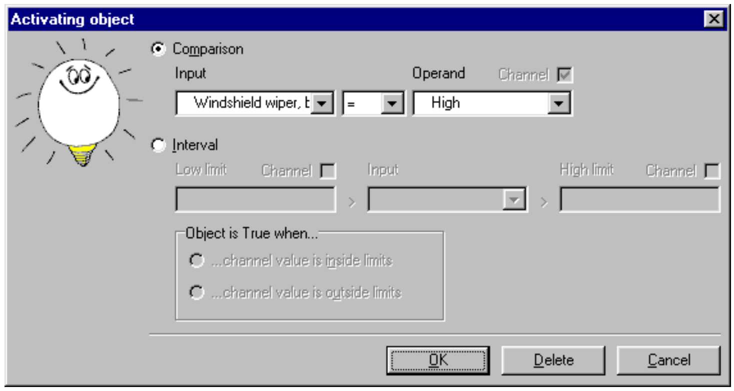
Function page for the digital output, Windshield wiper.

We will now enter an expression which will activate the digital output.

Windshield wiper, button = High

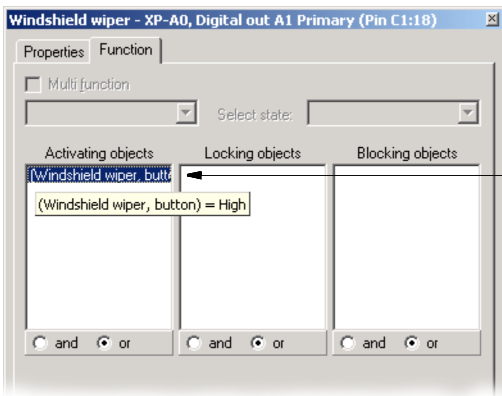
When the input signal *Windshield wiper, button* has the state *high* (1), the output *Windshield wiper* will be activated.

- As the above mentioned condition is a comparison, make sure that the *Comparison* option is selected.
- Click in the drop-down list box for *Input* and select the channel *Windshield wiper, button.* A condition is suggested. Check that it is correct and click *OK*.



The dialog box for Activating objects.

We have now created the activating object and the function for the windshield wiper.



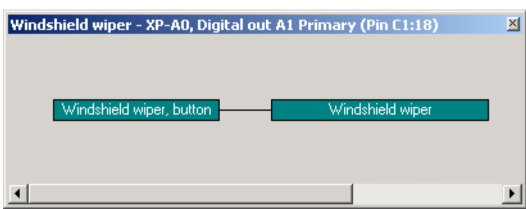
Windshield wiper, button is now an activating object.

An activating object for the function windshield wiper.

Navigating

By using IQANdevelop's *Navigator*, you can get an overview of the function.

- Select the output *Windshield wiper* in the block diagram for XP-0.
- Select: *View* > *Show Navigator*.



Windshield wiper, button is connected to the output Windshield wiper.

In the navigator, every channel is represented by a block. The channels affected by each other are linked with a line.

Frequency input

To show how to use a frequency input, we have chosen to make a function for an automatic parking brake where the vehicle's speed plays a central roll.

What do we want to happen?

Automatic activation of the parking brake when the machine stops and automatic release of the brake when you start driving.

How will it work?

When the speed is less than 1 km/h and the speed pedal is released, the parking brake is activated with a delay of 0.5 s.

As soon as the speed pedal is pressed, the parking brake is released.

For safety reasons, following will apply for the digital output for the brake:
High output signal -> Parking brake released.
Low output signal -> Parking brake on.

What do we need to know?

The vehicles´ speed.
If the speed pedal is pressed.

To solve the above problem, we need a digital output for the parking brake, a digital input for the speed pedal's safety switch as well as a frequency input for the vehicle speed.

Creating the channels and their properties

We begin by creating the digital channels and their properties.

Parking brake, released; digital out

- Open the block diagram for XP-0.
- Create the digital output by right-clicking on the channel connection *Digital out, index B1* and select: *Add channel*.
- Select: *View > Show channel info.*
- Enter the following name on the channel: *Parking brake, released*.
- The parking brake's output signal shall be activated after 0.5 s. Click in the box *Delay off* and enter *500* [ms].
- Click on *Apply* to store.

Switch, speed pedal; digital in

- Open the block diagram for Lx-0.
- Right-click on *Digital in, index B* and select: *Add channel.*
- Select: *View > Show channel info.*

- Enter the following name for the channel: *Switch, speed pedal*.
- Click on *Apply* to store.

Speed; frequency in

We will now create the frequency input and define the channel's properties.

- Right-click on *Frequency in, index A* in the block diagram for XP-0 and select: *Add channel.*
- Select: *View > Show channel info.*
- Click in the *Name, language 1* box and enter the channel name: *Speed.*
- Click in the upper *Unit* box and enter the unit *km/h*.

As the input is a frequency [Hz] signal we need to rescale the signal to the unit [km/h] to be able to use it in our calculations. Scaling occurs as follows:

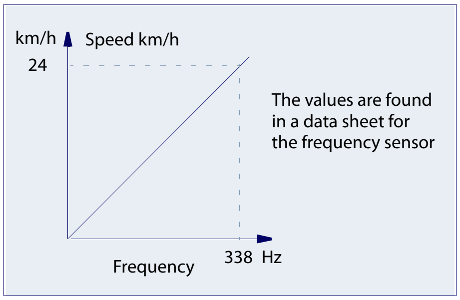


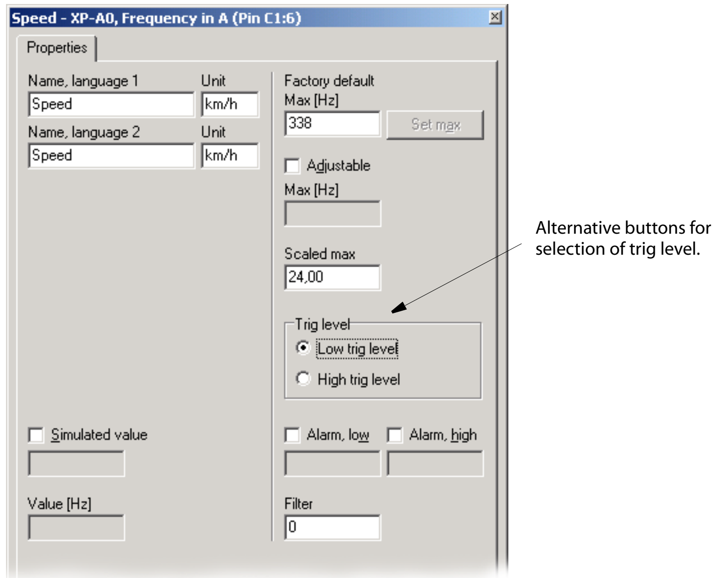
Diagram for scaling the input signal.

Further information about the scaling and sensor type, see properties frequency in.

- Click in the *Max [Hz]* box and enter *338*.
- Click in the *Scaled max* box and enter *24*.

In this instance, we use an inductive passive sensor to measure the speed. To indicate the signal from the sensor, we select *Low trig level.*

- Select the alternative *Low trig level*.
- Click on *Apply.*



Properties for the frequency input Speed.

Creating the function

We will now create the function for the digital output, which is as follows:

When the speed is greater than1 km/h, the parking brake will be released (off). The status for the output will be *High*.

When the speed is less than 1 km/h and the speed pedal is not pressed, the parking brake will apply. The output's status will be *Low*.

Parking brake, released

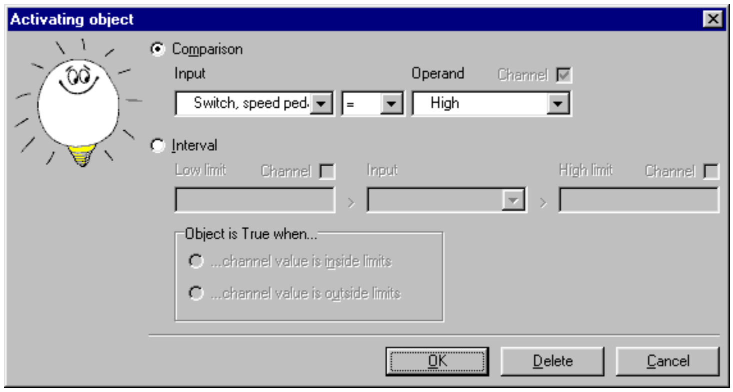
- Open the dialog box *Channel information* for the digital output, *Parking brake, released,* XP-0.
- Click on the *Function* tab.

We begin with the speed pedal's affect.

Switch, speed pedal = High => Parking brake, released

We will create an activating object to activate the output if the speed pedal is pressed.

- Right-click in *Activating objects* and select: *Add object*.
- Select the *Comparison* alternative.
- Select: *Switch, speed pedal* as *Input.*
- IQANdevelop suggests a condition, check that it is correct according to the above.



Dialog box for activating objects.

- Click *OK* to create the object.

We have now created the following function:

Speed pedal pressed down-> Parking brake released.
Speed pedal not pressed down-> Parking brake on.

We will now extend the function for the output with an object for the speed.

Speed > 1 km/h -> Parking brake released.
Speed < 1 km/h **and** Speed pedal not pressed down -> Parking brake on.

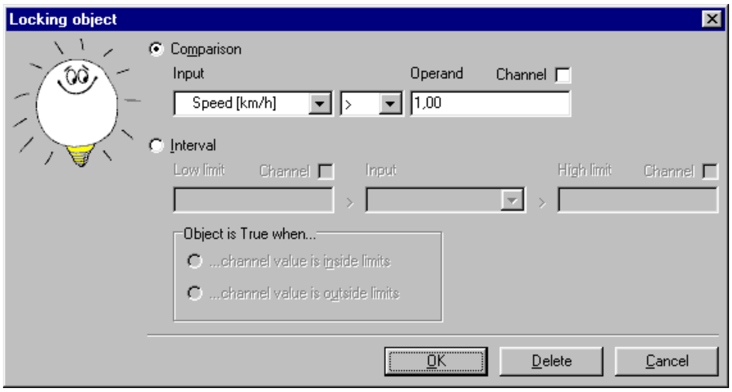
We will use a *Locking object*. A locking object has higher priority than an activating object, which means that as soon as the conditions for the locking object are true, the output's value is locked.

In practice: as long as the speed is > 1 km/h, the system disregards the signal from the switch in the speed pedal. However, if the speed is < 1 km/h, the conditions for the locking object do not apply any longer and instead the conditions for the speed pedal that we created as an activating object will apply.

We create the following comparison:

Speed > 1.00 => Locks the output's value

- Add a *Locking object*.
- Select: *Speed [km/h]* as *Input*.
- Click in the drop-down list box for operation characters and select: > *(greater than)*.
- Click in the drop-down list box for *Operand* and enter *1.00*



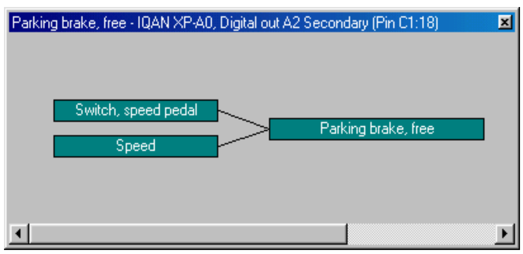
Dialog box for Locking objects.

- Click *OK* to create the object.
- Close the dialog box *Channel information*.

Navigating

We have now created the function for an automatic parking brake.

- Select the channel *Parking brake, released.*
- Select: *View* > *Show Navigator.*



The Navigator.

From the navigator, we see that the output *Parking brake, released* is affected by the inputs *Switch, speed pedal* and *Speed.*

Voltage input

In this chapter, we will look at how to use analog voltage inputs. We will, for example, connect analog sensors with a signal range of 0 - 5 Vdc.

To demonstrate how to use a voltage input, we have chosen to make a function for a forward/reverse lock to prevent change of direction when this is not permitted. We need to measure the oil pressure to the parking brake with a pressure sensor to get a voltage signal.

What do we want to happen?

Prevent switching between forward and reverse directions during operation and also when the parking brake is applied.

How will it work?

Forward and reverse locks when speed exceeds 1 km/h.

Forward and reverse must not be active at the same time.

Forward or reverse must not be active if the parking brake pressure is low (= parking brake applied).

What do we need to know?

The vehicle speed.
The status of the forward and reverse switch.
The parking brake pressure.

To solve the above problems, we need two digital outputs for the gearbox's forward and reverse, two digital inputs for the switch status, a frequency input for the speed and an analog voltage input for the parking brake's oil pressure.

Creating the channels and their properties

We begin by creating the digital channels.

Gearbox, forward; digital out

- Open the block diagram for XP-0.
- Right-click on the channel connection *Digital out, index C* and select: *Add channel.*
- Select: *View* > *Show channel info.*
- Enter the following name: *Gearbox, forward*.
- Click on *Apply* to store.

Gearbox, reverse; digital out

Create *Digital out, index D* in the same way with the name: *Gearbox, reverse*.

Switch, forward; digital in

- Open the block diagram Lx-0.
- Right-click on the channel connection *Digital in, index C* and select: *Add channel*.
- Select: *View > Show channel info.*
- Enter the following name: *Switch, forward*.
- Click on *Apply* to store.

Switch, reverse; digital in

Create *Digital in, index D* in the same way with the channel name: *Switch, reverse*.

Speed; frequency in

In this function, we use the frequency input *Speed* that we created in the previous section. The frequency input is thereby ready.

Pressure, parking brake; voltage in

We will now create an analog input in the block diagram XP-0.

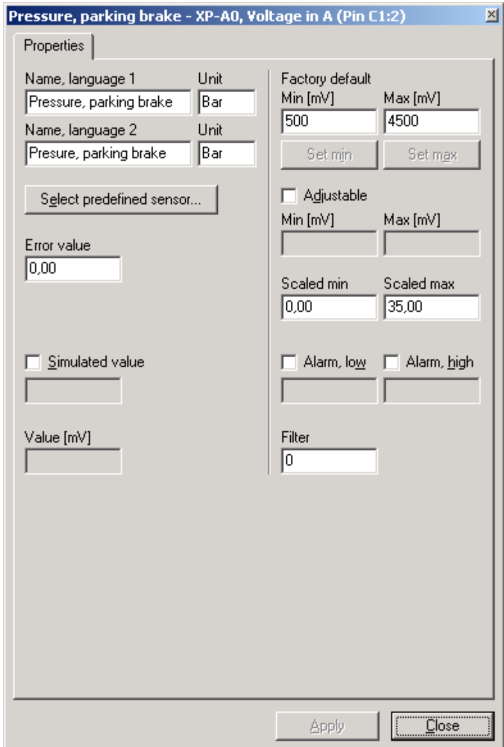
- Add the channel *Voltage in, index A* and open the *Properties* page.
- Click in the *Name, language 1* box and enter: *Pressure, parking brake*.
- Enter the unit *Bar* in the upper *Unit* box.

As per specification, the pressure sensor's signal varies within the voltage range 500 mV - 4500 mV.

- Click in the *Min [mV]* box and enter *500.*
- Click in the *Max [mV]* box and enter *4500.*

To be able to use the pressure sensor's signal, we need to rescale it to the unit *Bar*. In the data sheet for the sensor, we see that the above voltage range corresponds to 0 - 35 bar.

- Click in the *Scaled Min* box and enter *0.00*
- Click in the *Scaled Max* box and enter *35.00*



Properties for the voltage input Pressure, parking brake.

- Click *Apply* to store.

Creating the function

The functions for the channels *Gearbox, forward* and *Gearbox, reverse* will, in general, be similar. The only thing that will separate them is that the interlocking devices *forward* and *reverse* cannot apply at the same time.

Gearbox, forward

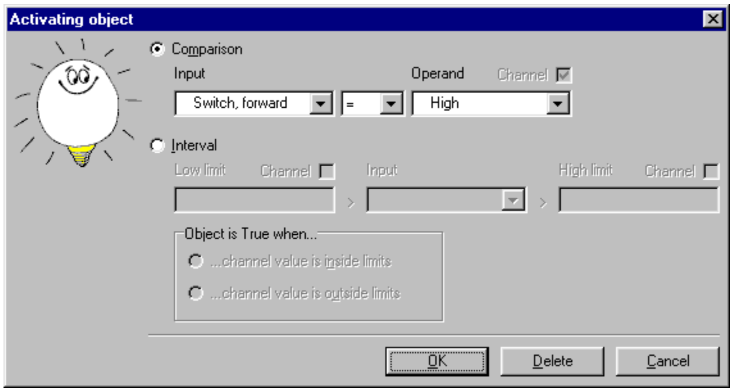
We begin by creating the main function, the switch function.

Switch, forward = high => Gearbox, forward will be activated

When the switch is in its forward position, *Gearbox, forward* shall be activated. To solve this, we need an activating object where the input signal comes from *Switch, forward*.

- Open the dialog box *Channel information*, the *Function* tab.
- Add an *activating object*.
- Select the *Comparison* alternative.

- Select: *Switch, forward* as *Input*. Check that the suggested condition is correct according to the above.



Activating object for Gearbox, forward.

- Click *OK* to create the object.

We will now extend the function with consideration to the affect of the parking brake.

(Switch, forward = high) AND (Pressure, parking brake > 30) => Activate Gearbox, forward

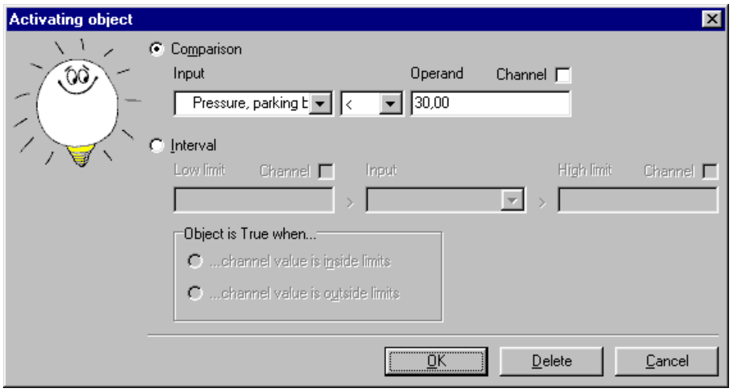
If the parking brake's pressure exceeds 30 bar, the parking brake is released and the output *Gearbox, forward* becomes active.

In practice, this means that as soon as the parking brake is applied, the pressure drops and the output *Gearbox, forward* becomes inactive to make sure that there is no direction remaining in the gearbox.

We will create an activating object.

- Add an *activating object*.
- Select the *Comparison* alternative and select: *Pressure, parking brake* as *Input*.
- Select < (less than) in the list box for operation characters.

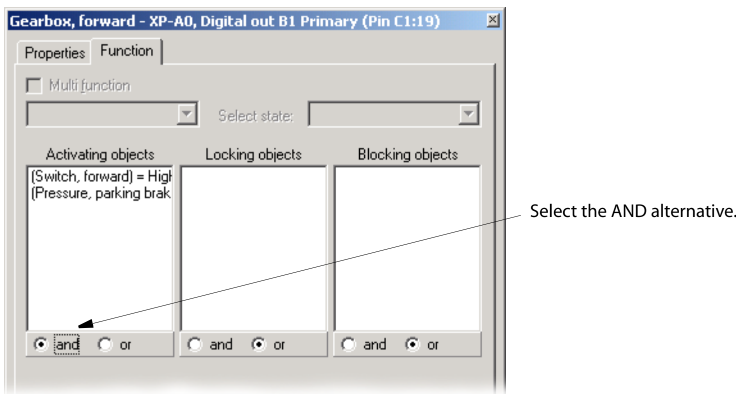
- Enter *30.00* as *Operand* and click *OK*.



Activating object for Gearbox, forward.

We now have two activating objects for the output. We need to state that the boolean operation *AND* will apply for the objects.

- Select the *AND* alternative for the activating objects.



Both activating objects have to be true to activate the output.

The last object for the function:

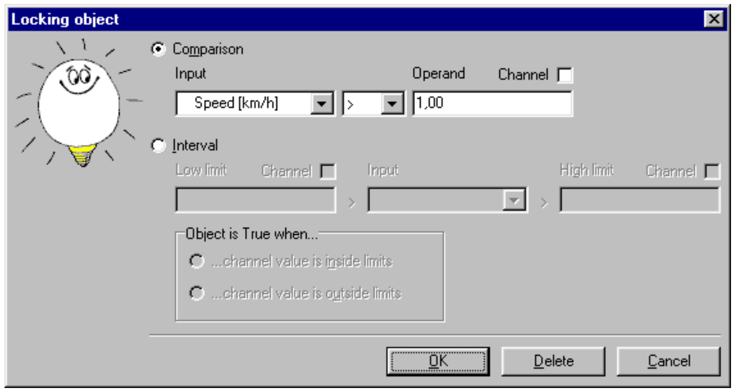
Speed > 1 km/h => Locks the output's state

The speed must be less than 1 km/h to permit switching between forward and reverse direction, that is the output *Gearbox, forward* is locked when the speed is greater than 1 km/h.

As in previous section we choose to use the frequency input, *Speed* as input signal to a locking object.

- Add a *locking object*.
- Select the *Comparison* alternative.

- Select *Speed* as *Input*.
- Select: > *(greater than)* as operation character.
- Enter *1.00* for *Operand*.



Locking object for Gearbox, forward.

- Click *OK* to create the object.

We have now created the function for *Gearbox, forward*.

Gearbox, reverse

Create the following for *Gearbox, reverse*.

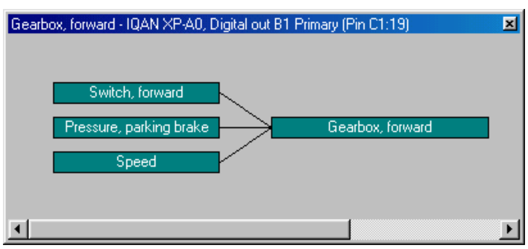
(Switch, reverse = high) AND (Pressure, parking brake < 30) => Activate the output

Speed > 1.00 km/h => Locks the output's state

After creating the function for *Gearbox, reverse* the whole function is done.

Navigating

- Select the channel *Gearbox, forward*.
- Select: *View > Show Navigator.*



The navigator shows the connection between the inputs and the output.

From the navigator, we see that the output *Gearbox, forward* is affected by the inputs *Switch, forward*; *Pressure*, *parking brake* and *Speed*. Select the channel *Gearbox, reverse* in the block diagram to see it's inputs.

Current outputs

In this section, we will look at how to use the analog current outputs. A current output is used, for example, to control proportional valves. To look at this, we have chosen to create a function to manoeuvre the boom and the telescope on the Reach Stacker machine.

What do we want to happen?

The boom and the telescope will be controlled, using a lever.

How will it work?

When the lever is in its centre position, both the boom and the telescope will be stationary.

When the lever is in its maximum position, the boom and the telescope will have maximum speed.

To get a more stabilized signal from the lever, there shall be a dead band of 10% around the central position of the lever.

What do we need to know?

The lever's position in X direction.
The lever's position in Y direction.

To solve the above problem, we need one analog current output for the boom and one for the telescope. We need one channel for the lever's position in X direction and one channel for the lever's position in Y direction.

The following directions are defined for the machine

Up	Positive direction (+)
Down	Negative direction (-)
Out	Positive direction (+)
In	Negative direction (-)
Right	Positive direction (+)
Left	Negative direction (-)

Creating the channels and their properties

We begin by creating the analog current outputs for the proportional valves.

Proportional valve, boom; current out

- Open the block diagram for XP-0.
- Right-click on the channel connection *Current out, index A1* and select *Add channel.*

As with the digital outputs, each channel connection has two outputs. We will use the upper one.

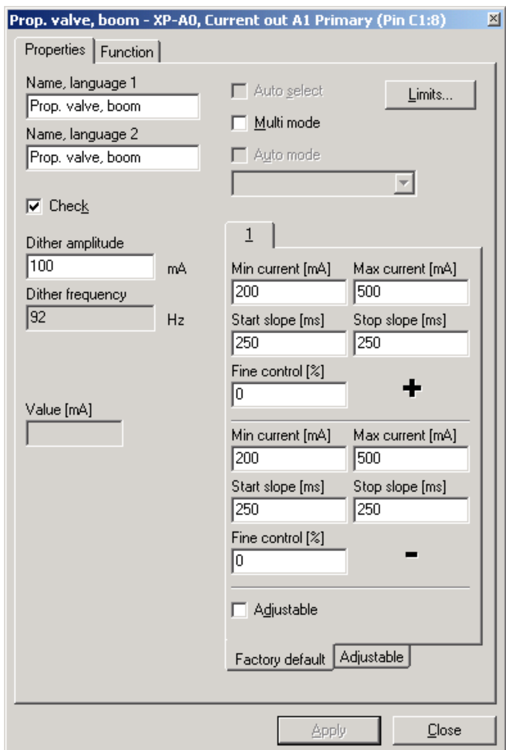
- Select: *View > Show channel info.*
- Click in the *Name, language 1* box and enter *Prop. valve, boom.*

We now need to enter the current range for the valve. We enter minimum and maximum current, which correspond to 0 - 100 % output.

From the data sheet for the valve, we find the current values.

- Positive direction (+).
  Click in the *Min Current [mA]* box and enter *200*.
  Click in the *Max Current [mA]* box and enter *500*.
  The above current values are pre-set in IQANdevelop.
- Negative direction (-)
  Enter the values for the negative direction. They must be the same as for the positive direction.

In other fields, there are pre-set values that we do not need to change for this function.



Properties for the current output, Prop. valve, boom.

- Click on *Apply* to store.

Proportional valve, telescope; current out

We continue with the analog output for the telescope's proportional valve.

- Right-click on the channel connection *Current, Out, index B* and select: *Add channel.*
- Select: *View > Show channel info.*
- Enter the channel name: *Prop. valve, telescope.*
- We enter the same current values for both the *positive* and *negative* direction.
  Minimum current [mA] = 200
  Maximum current [mA] = 500
- Click on *Apply* to store.

We will now create the channels for the lever's directions X and Y.

Lever, boom; directional analog

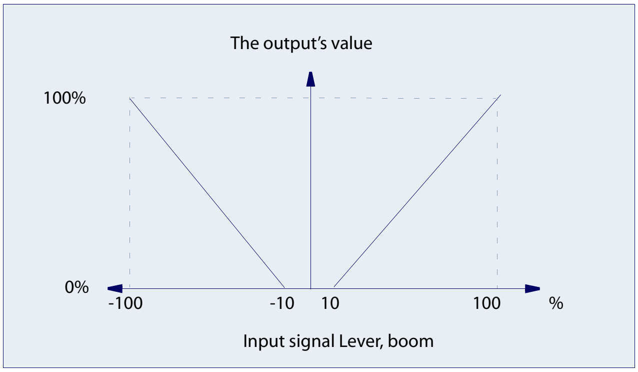
- Open the block diagram for Lx-0.
- Right-click on the channel connection *Directional analog, index X* (the lever's X direction) and select: *Add channel*.
- Select: *View > Show channel info.*
- Click in the *Name, language 1* box and enter: *Lever, boom*.
- Click on *Apply* to store.

Lever, telescope; directional analog

- Add the channel *Directional analog, index Y.*
- Click in the *Name, language 1* box and enter *Lever, telescope*.
- Click on *Apply* to store.

Creating the function

We will now create a function to make the boom move vertically.



The lever signal's affect on the output signal.

We will use *controlling objects* for this function. For further information on controlling objects, see section Controlling objects, on page 222.

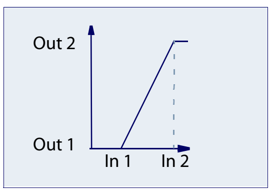
Proportional valve boom

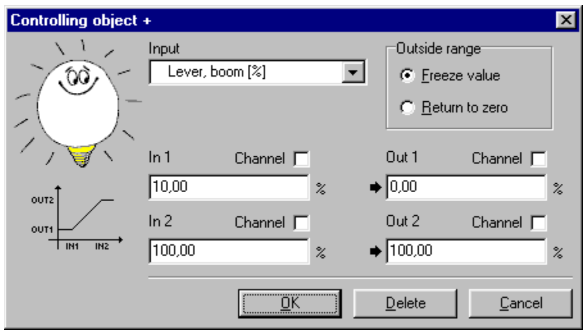
As the *Lever, boom* channel will control the current output for the manoeuvring of the boom, we use this channel as input signal to a controlling object for the current output.

- Open the dialog box *Channel information* for *Prop. valve, boom*. Click on the *Function* tab.

We begin by creating the function in positive direction.

- Right-click in *Controlling objects (+)* and select: *Add object.*
- Click in the drop-down list box for *Input* and select: *Lever, boom*.
- Enter *10* [%] in the *In 1* box and *0* [%] in the *Out 1* box.
- Enter *100* [%] in the *In 2* box and *100* [%] in the *Out 2* box.



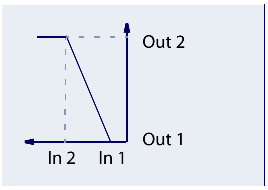


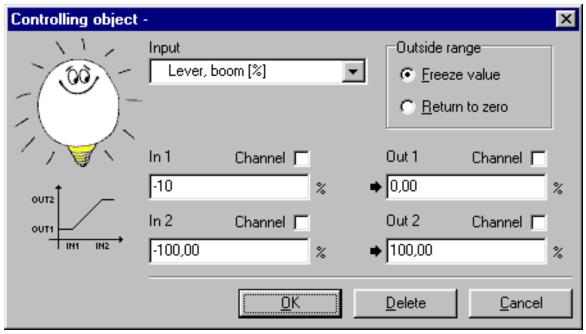
Controlling object(+) for the output Prop. valve, boom.

- Click *OK* to create the object.
- Right-click in *Controlling objects (-)* and select: *Add object*.

When we define values for negative direction, we enter the direction with (-).

- Select *Lever, boom* in the drop-down list box *Input*.
- Enter -*10* [%] in the *In 1* box and *0* [%] in the *Out 1* box.
- Enter -*100* [%] in the *In 2* box and *100* [%] in the *Out 2* box.





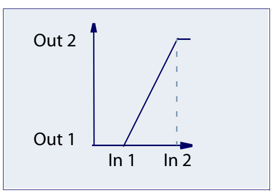
Controlling objects(-) for the output Prop. valve, boom.

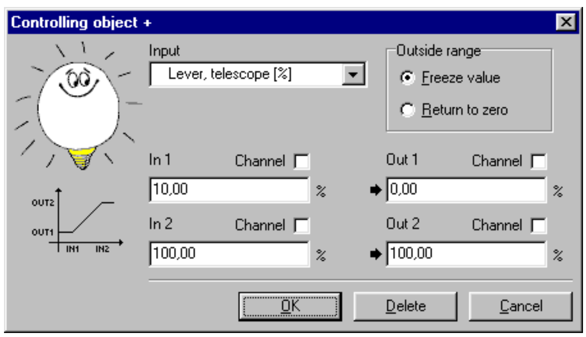
- Click *OK* to create the object.

We have now created the function for *Prop. valve, boom*. We will now perform the same procedure for *Prop. valve, telescope*.

Proportional valve telescope

- Open the dialog box *Channel information*, the *Function* tab for *Prop. valve, telescope*.
- Right-click in *Controlling objects (+)* and select: *Add object*.
- Select: *Lever, telescope* as *Input*.
- Enter *10* [%] for *In 1* and *0* [%] for *Out 1*.
- Enter *100 [%]* for *In 2* and *100* [%] for *Out 2*.



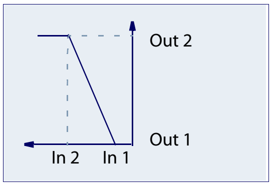


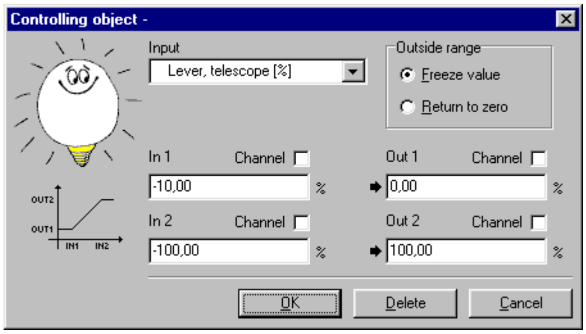
Controlling object for the output Prop. valve, telescope (+).

- Click *OK* to create the object.

Now create the function for the proportional valve's negative direction.

- *Input= Lever, telescope*
- *In 1 [%] = -10, Out 1 [%] = 0.*
- *In 2 [%] = -100, Out 2 [%] = 100.*





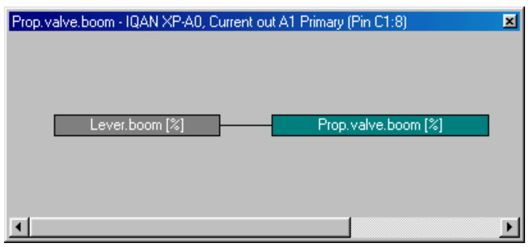
Controlling object for the output Prop. valve, telescope (-).

- Click *OK* to create the object.

We have now created functions to be able to control the boom and the telescope with a lever.

Navigating

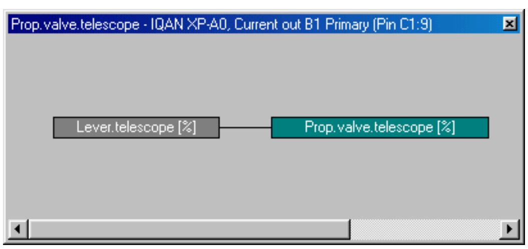
- Select the channel *Prop. valve, boom.*
- Select: *View* > *Show Navigator.*



The navigator shows that Lever, boom is connected to the output Prop. valve, boom.

In the navigator, we see that the output *Prop. valve, boom* is affected by the input *Lever, boom*.

- Click on the output *Prop. valve, telescope.*



The navigator shows that Lever, telescope is connected to the output Prop. valve, telescope.

In the navigator, we see that the output *Prop. valve, telescope* is affected by the input *Lever, telescope*.

Using more than one object for the current output

We will now describe another object type for the analog current outputs. We have already looked at controlling objects. In this section, we will introduce limiting objects.We have, therefore, chosen to extend the function for the boom and telescope with a function for end position attenuation.

What do we want to happen?

Boom and telescope will brake before mechanical stop.

How will it work?

When the boom is 5° from its end position, the speed will be limited.

2° from the mechanical end position, the speed must not exceed 20 % of the maximum speed.

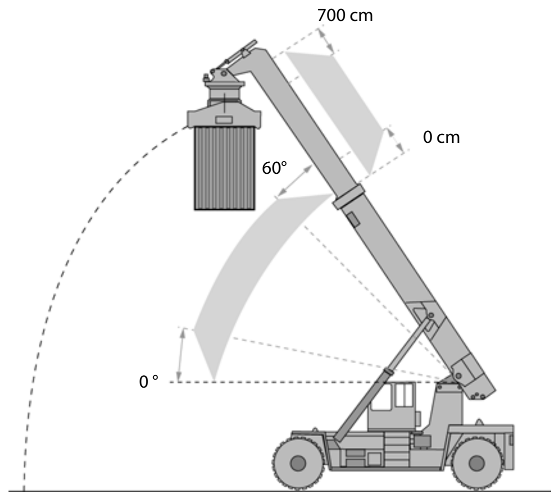
When the telescope is 40 cm from its end position, the speed will be limited.

20 cm from the mechanical end position, the speed must not exceed 20 % of the maximum speed.

Horizontal position for the boom = 0°, maximum angle for the boom = 60°. Minimum extended telescope = 0 cm, maximum extended telescope 700 cm.

What do we need to know?

The boom angle
The telescope’s position.



To solve the above problems, we continue to build upon the previous application. We do, however, need an additional two analog voltage inputs for the boom angle and the telescope’s position.

Creating the channels and their properties

As we have already gone through how to create properties for the voltage inputs, we will just give a few short instructions.

Angle, boom; voltage in

- Add the channel *Voltage in, index B* in the block diagram XP-0.
- Enter the following channel properties:
  Name: *Angle, boom*
  Unit: °, *(degrees)* (To write the ° symbol, press [Alt+248])
  Minimum Voltage [mV] = 500
  Maximum Voltage [mV] = 4500
  Scaled min [°] = 0
  Scaled max [°] = 60
- Click on *Apply* to store.

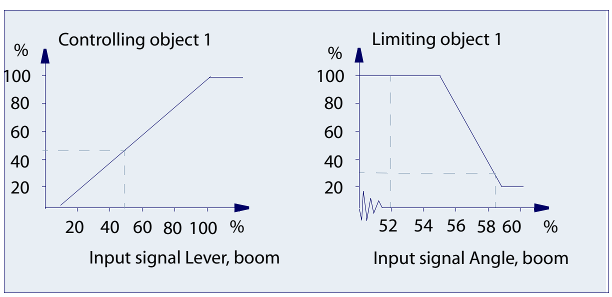
Position, telescope; voltage in

- Add the channel *Voltage in, index C.*
- Enter the following channel properties:
  Name: *Position, telescope*
  Unit: *cm*
  Minimum Voltage [mV] = 500
  Maximum Voltage [mV] = 4500
  Scaled minimum [cm] = 0
  Scaled maximum [cm] = 700
- Click on *Apply* to store.

Creating the function

Before we begin to create the functions, we will look at how IQANdevelop handles *controlling* and *limiting* objects.

We will demonstrate this with a mathematical example. The function is applicable for the output *Prop. valve, boom*.



Controlling and limiting objects.

The output’s value is determined by the following equation:

Output value = Minimum of [(Control 1 x Control 2 x Control 3..Control 8);
(Limiting 1, Limiting 2, Limiting 3..Limiting 8)]

From the diagram, we get:
Input signal *Lever, boom* = 50 % => *Controlling object* = 45 %.
Input signal *Angle, boom* = 58.5° => *Limiting object* = 30 %.
The objects’ output signals are compared and the least one gives the current output’s value.

45% > 30% => The output signal is limited to 30%.

From the diagram, we get:
The lever’s input value = 50% => *Controlling object* = 45 %.
The boom’s angle = 52° => *Limiting object* = 100 %.

45% < 100% => The output signal will be 45%, i.e. it is not limited by the limiting object.

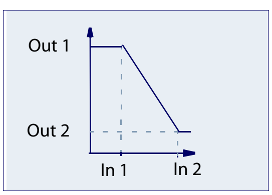
Thus: If there had been several controlling objects, they would have been multiplied to one product and then compared with the limiting objects.

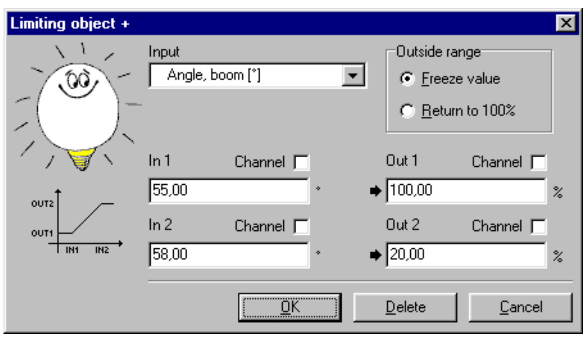
For further information, see section Limiting objects, on page 224.

We will now create a function to get end reduction on the boom.

Proportional valve, boom

- Open the dialog box *Channel information*, *Function* tab.
- Right-click in *Limiting objects (+)* and select: *Add object*.
- Select: *Angle, boom* in the drop-down list box *Input*.
- Enter *55 [°]* for *In 1* and *100 [%]* for *Out 1*.
- Enter *58 [°]* for *In 2* and *20 [%]* for *Out 2*.

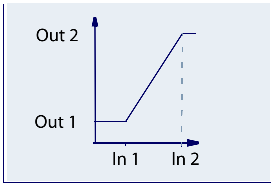


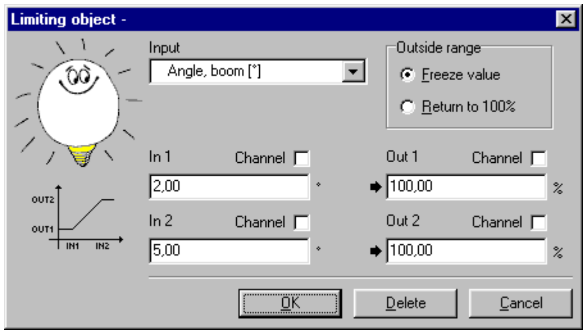


Limiting object for the output Prop. valve, boom (+).

- Click *OK* to create the object.

- Right-click in *Limiting objects (-)* and select: *Add object.*
- Select *Input*: *Angle, boom*
- Enter *2 [°]* for *In 1* and *20 [%]* for *Out 1*.
- Enter *5 [°]* for *In 2* and *100 [%]* for *Out 2*.





Limiting object for the output Prop. valve, boom (-).

- Click *OK* to create the object.

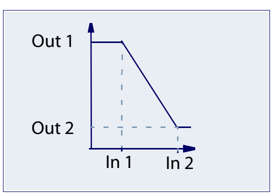
We have now created the end position attenuation for the boom and will now be able to create the function for the telescope.

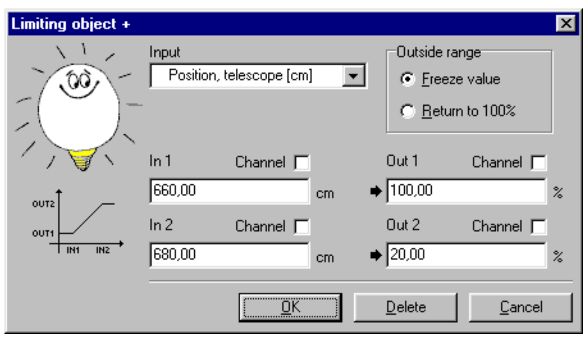
The function is applicable for the output *Prop. valve, telescope*.

We will now create the function for the telescope's movement in and out.

Proportional valve, telescope

- Open the dialog box *Channel information*, *Function* tab.
- Right-click in *Limiting objects (+)* and select: *Add object.*
- Select *Input*: *Position, telescope*.
- Enter *660 [cm]* for *In 1* and *100 [%]* for *Out 1*.
- Enter *680 [cm]* for *In 2* and *20 [%]* for *Out 2*.

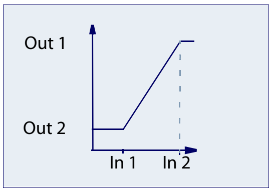


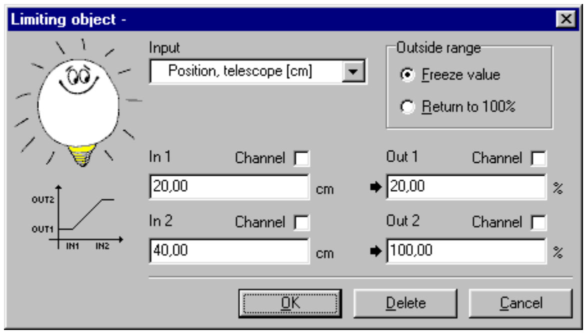


Limiting object for the output Prop. valve, telescope (+).

- Click *OK* to create the object.

- Right-click in *Limiting objects (-)* and select: *Add object.*
- Select *Input*: *Position, telescope.*
- Enter *20 [cm]* for *In 1* and *20 [%]* for *Out 1*.
- Enter *40 [cm]* for *In 2* and *100 [%]* for *Out 2*.





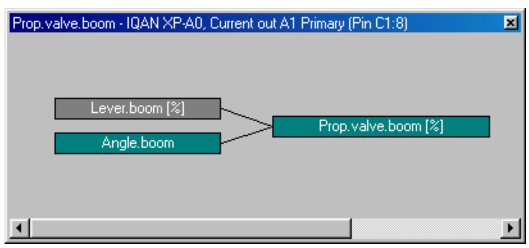
Controlling object for the output Prop. valve, telescope (-).

- Click *OK* to create the object.

We have now created a function for boom and telescope with end reduction.

Navigating

- Select the output *Prop. valve, boom*.
- Select: *View > Show Navigator.*



Two channels affect the output Prop. valve, boom.

Using the navigator, we can see that for the function the output *Prop. valve, boom* is also affected by the input *Angle, boom*. Click on the output *Prop. valve, telescope* to see it's inputs.

Mathematical analog channel

It is possible to set up mathematical functions to create advanced applications. For this, we need mathematical channels. There are analog mathematical channels which give an “analog” value and digital mathematical channels which give the state true or false.

In this section, we deal with *analog mathematical* channels. We are going to create a function to limit the lowering speed of the boom if the load is too far out (if the telescope is extended).

To look at the problem, we will divide the section up into two parts.

What do we want to happen?

Lowering of the boom will be stopped if the load is too far out.

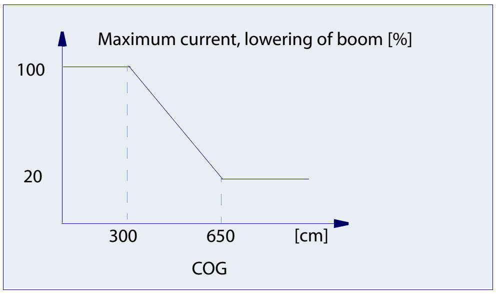
How will it work?

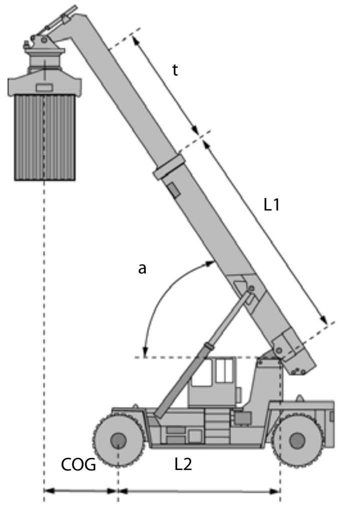
When COG (Centre Of Gravity) is greater than 300 cm, the maximum output current for the boom lowering will be limited.

When COG is 650 cm or more, the maximum current for the boom lowering will be 20%.

What do we need to know?

COG (Centre Of Gravity), the distance between the centre of the load and the front axle. Maximum permitted lowering speed as function of COG.





To solve the problem we need to calculate the distance *COG*. For that, we need a mathematical analog channel. To be able to create the application, we have to divide the problem into two parts. In the first part, we assume that we have *COG* as a result of a mathematical operation. In the second part, we will show how to use the mathematical channel’s function to calculate *COG*.

Creating the channel and its properties

We need to create the *COG* channel in order to use it when we create the function for the lowering of the boom.

- Open the block diagram MDM.
- Right-click on the channel connection *Math analog, index A* and select: *Add channel.*
- Select: *View > Show channel info.*
- Give the channel the name: *COG.*
- Enter *cm* in the upper *Unit* box.
- Click on *Apply* to store.

Creating the function

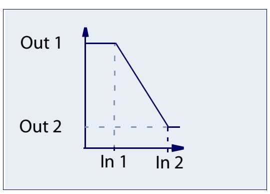
We will now create the function to limit the lowering speed on the boom. We need to create a limiting object for the output *Prop. valve, boom.*

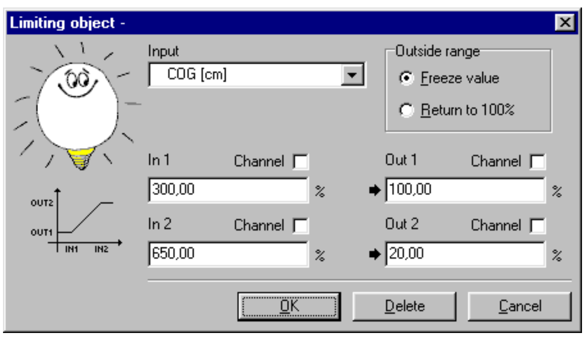
Proportional valve, boom

- Open the function page for the channel *Prop. valve, boom.*

As this function concerns the lowering speed, we will only create a limiting object for the boom's negative direction.

- Right-click in *Limiting objects (-)* and select: *Add object.*
- Select: *COG* in the drop-down list box *Input*.
- Enter *300 [cm]* for *In 1* and *100 [%]* for *Out 1*.
- Enter *650 [cm]* for *In 2* and *20 [%]* for *Out 2*.





Limiting object for the output Prop. valve, boom (-).

- Click *OK* to create the object.

We now have to create the function for *COG* to make the application work.

Calculations with a mathematical analog channel

We will now demonstrate how to create a mathematical function using a mathematical analog channel. The function gives an analog value.

What do we want to happen?

The distance between the centre of the load and the front axle will be calculated (= COG).

How will it work?

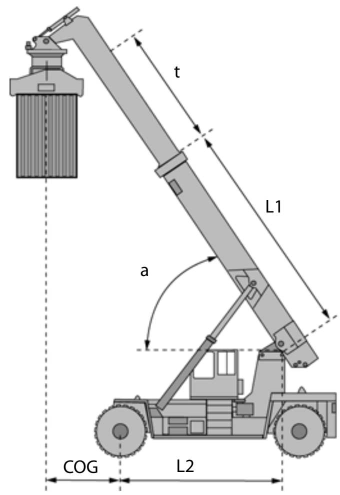
COG = cosα ∗ (L1+t)-L2
L1 = 860 cm
L2 = 580 cm

What do we need to know?

Angle, boom (= α)
Position, telescope (= t)
L1 and L2, see illustration

From the illustration, we get:

cosα = (COG+L2) / (L1+t)
=> cosα ∗ (L1+t) = COG+L2
=> COG = cosα * (L1+t)-L2



Previously in our application, we have created the analog voltage inputs *Angle, boom* and *Position, telescope*.

The distances *L1* and *L2* are set distances on the machine.

We need to create the function with a mathematical channel to calculate *COG*.

The properties for the mathematical analog channel, *COG,* have already been defined in the previous section.

Creating the function

- Open the block diagram MDM.
- Click on the channel *COG* and open the dialog box *Channel information*, the *Function* tab.

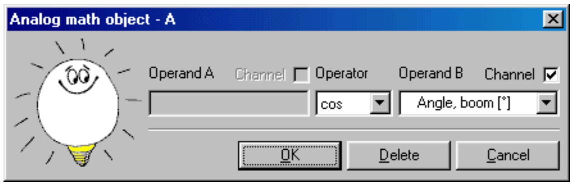
On the page, it is possible to build mathematical expressions using 16 positions A-P. The expressions are divided into subexpressions. For further information, see section Mathematical analog, on page 244.

COG = cos(Angle, boom) * (860 + Position, telescope) - 580

- Right-click on a row and select: *Add object.*

A dialog box is opened to enter a mathematical expression.

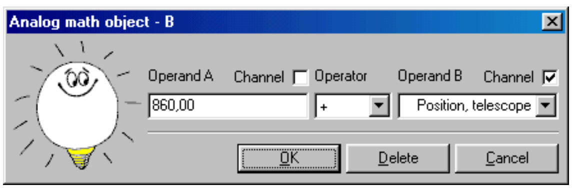
- Click in the drop-down list box *Operator* and select: *cos (cosine for the angle).*
- Check the *Channel* box and select *Angle, boom* in the drop-down list box *Operand B*.



The mathematical expression for position A. (= cos (Angle, boom)).

- Click *OK* to store.

- Right-click on a row and select: *Add object*.
- Select: + *(addition)* in the drop-down list box *Operator.*
- Enter *860* in the box *Operand A*.
- Select: *Position, telescope* for *Operand B*.



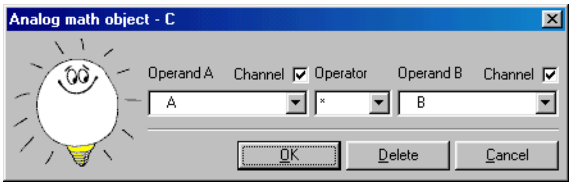
The mathematical expression for position B. (= 860 + Position, telescope).

- Click *OK* to store.
- Right-click on a row and select: *Add object.*

We will now multiply the expressions at *position A* and *position B*.

- Select: * *(multiplication)* in the drop-down list box *Operator.*
- Check the *Channel* box and select: *A* in the drop-down list box for *Operand A*.

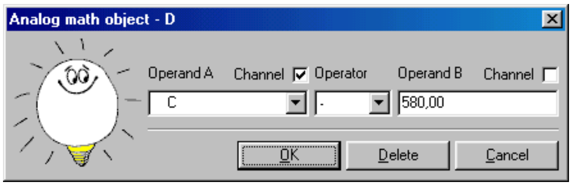
- Check the *Channel* box and select: *B* in the drop-down list box for *Operand B*.



The mathematical expression for position C (= A* B).

- Click *OK* to store.

- Right-click on a row and select: *Add object.*
- Select: - *(subtraction)* in the drop-down list box *Operator.*
- Select: *C* in the drop-down list box for *Operand A*.
- Enter *580* in the box *Operand B*.

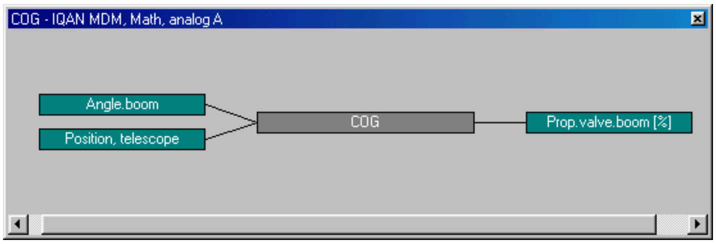


The mathematical expression for position D. (= C- 580, where C= A * B).

- Click *OK* to store.

We have now created the whole function to limit the lowering speed on the boom.

Navigating



The navigator shows the connection of the channels to and from COG.

The navigator shows that the output *Prop. valve, boom* is affected by the internal channel *COG*. We also see that the inputs *Angle, boom* and *Position, telescope* affect the internal channel *COG*. The internal channels are grey. The inputs and outputs are green.

Channels for conditional messages

The master unit, MDM, has a display for giving information to the machine's operator. In this section, we will show how to create text messages for the display. We have selected to extend the boom and telescope application with an overload warning. To detect overload, we will use a mathematical digital channel.

What do we want to happen?

There will be a warning before the overload occurs.

The movements *Boom down* and *Telescope out* will be blocked in the event of an overload.

How will it work?

A warning message on the display will occur when the load weight reaches 90 % of the maximum weight.

When the load weight exceeds the maximum weight, the movements for *Boom down* and *Telescope out* are blocked to prevent the machine from tipping.

A message will be shown on the display in the event of an overload.

What do we need to know?

The maximum permitted weight in relation to the position of the telescope and the boom.

The load weight.

To look at the problem, we will divide the section up into two parts. First, we will look at the blocking of the outputs at an overload indication and create the corresponding text messages for the display. In the second part, we will create the functions for the calculations of the different load situations.

For the warning messages, we need two *conditional message* channels.

We will use an analog sensor to measure the load weight. We connect this to an analog current input. To calculate *Maximum load* and *90% of the maximum load,* we use two mathematical analog channels and to indicate *Overload,* we use a mathematical digital channel.

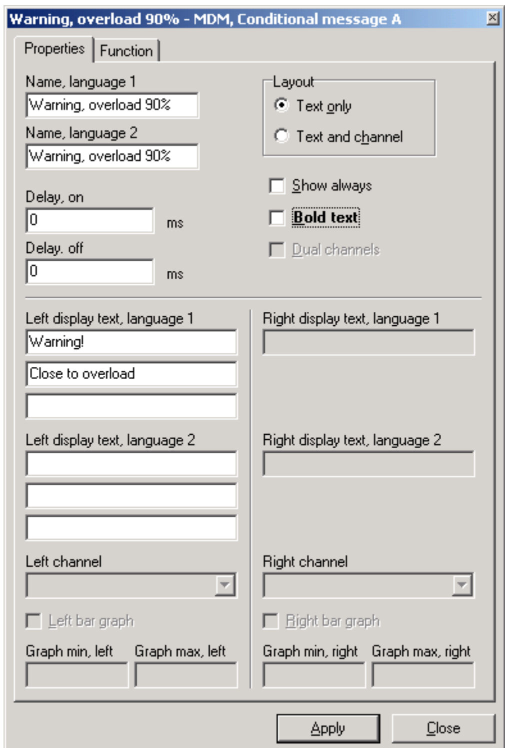
Creating the channels and their properties

The messages we want to be shown on the display are *Conditional messages*. For example, we want the operator to be warned with a message when *90% of the maximum weight* is exceeded and when *Overload* is indicated.

We will now create two channels for conditional messages.

Warning, overload 90%; conditional message

- Right-click on the channel connection, *Conditional message, index A* in the block diagram MDM and select: *Add channel.*
- Select: *View > Show channel info*.
- Enter the channel name: *Warning, overload 90%* in the box *Name, language 1*.
- Select the alternative *Text only,* which, makes it possible to show three text rows on the display.
- Remove the selection *Show always*.
- Click on the first row for *Left display text, language 1* and enter: *Warning!* Thereafter click on the second row and enter *Close to overload*.



Properties for the Conditional message, Warning overload 90%.

- Click on *Apply* to store.

Warning, overload; conditional message

- Create a channel for channel connection, *Conditional message, index B*.
- Give the channel the following properties:
  Name: *Warning, overload.*
  Select the alternative: *Text only.*
  Select the alternative: *Bold text.*
  Display text row 1: *OVERLOAD*.
- Click on *Apply* to store.

We have now created the channels for text messages, we will return to the function later.

We will now create the mathematical channels for calculation of the different load situations. We must, however, start by creating an analog input to be able to measure the load weight.

Load weight; voltage in

- Open the block diagram XP-0 and create the channel *Voltage in, index D*.
- Give the channel the following properties:
  Name: *Load weight*
  Unit: *ton*
  Min voltage [mV]: *500*
  Max voltage [mV]: *4500*
  Scaled min [ton]: *0*
  Scaled max [ton]: *45*
- Click on *Apply* to store.

Maximum weight; mathematical analog

- Open the block diagram MDM and create the channel *Math analog, index B*.
- Give the channel the following properties:
  Name: *Max weight*
  Unit: *ton*
- Click on *Apply* to store.

90% of maximum weight; mathematical analog

- Create the channel *Math analog, index C.*
- Give the channel the following properties:
  Name: *90% of max weight*
  Unit: *ton*

- Click on *Apply* to store.

Overload; mathematical digital

A mathematical digital channel gives a result from a calculation as high, low; true or false depending on whether the mathematical condition is fulfilled or not.

Load weight > Maximum weight => Overload indication

If the input signal *Load weight* is greater than the input signal *Maximum weight*, the condition is true and an overload is indicated. If the condition is not fulfilled, the result is false.

We will now create the properties for a *Mathematical, digital* channel. The procedure is the same as for the other channels but we will take it step by step as it is a new channel type.

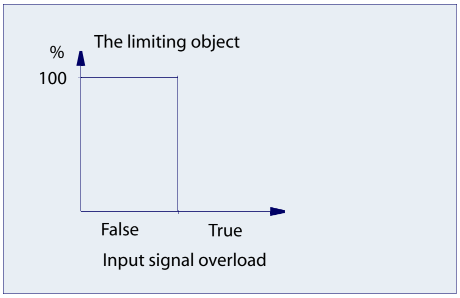
- Right-click on the channel connection *Math, digital, index A* and select: *Add channel.*
- Select: *View > Show channel info.*
- Click in the *Name, language 1* box and enter *Overload*.
- Click on *Apply* to store.

When we have created all channels, we can use them in functions for the current outputs.

Creating the function

The conditions for blocking during overload are only applicable to the movements *Boom down* and *Telescope out*. We will use limiting objects to block the outputs. To attain a blocking result, we define 0 % output when overload is indicated. This means that minimal current will be output and the boom and the telescope will not move.

The overload condition is either true or false. (Either it is overload or not). The limiting object's value is as below:

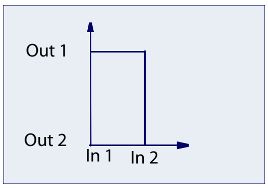


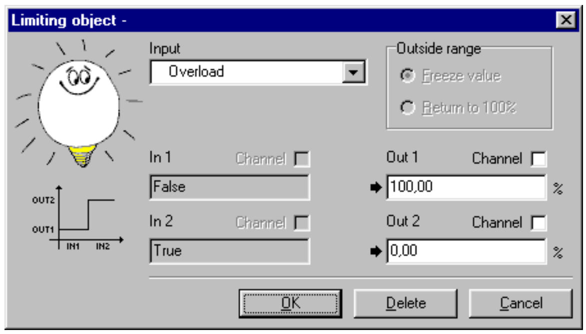
The input signal Overload.

For the boom, there will be a limiting object in the negative direction and for the telescope, there will be a limiting object in the positive direction.

Proportional valve boom

- Open the dialog box *Channel information*, *Function* tab for the channel *Prop. valve, boom.*
- Right-click in *Limiting objects (-)* and select: *Add object*.
- Select *Overload* in the drop-down list box *Input*.
- For *In 1 = false*, enter *100 [%]* for *Out 1*
- For *In 2 = true*, enter *0 [%]* for *Out 2*





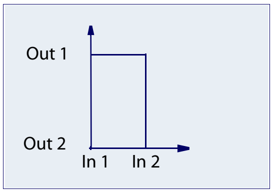
Limiting object for the output Prop. valve, boom (-).

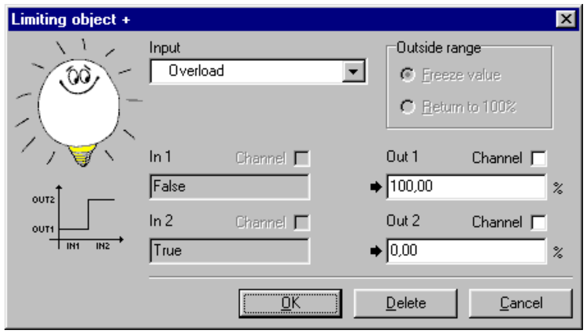
- Click *OK* to create the object.

We now carry out the same procedure to create the telescope's function.

Proportional valve telescope

- Open the function page for the channel *Prop. valve, telescope*.
- Add a *Limiting object (+)*.
- Select *Input*: *Overload.*
- For *In 1 = false*, enter *100 [%]* for *Out 1*.
- For *In 2 = true*, enter *0 [%]* for *Out 2*.





Limiting object for the Prop. valve, telescope (+).

- Click *OK* to create the object.

We will now create the functions for the channels *Conditional message*.

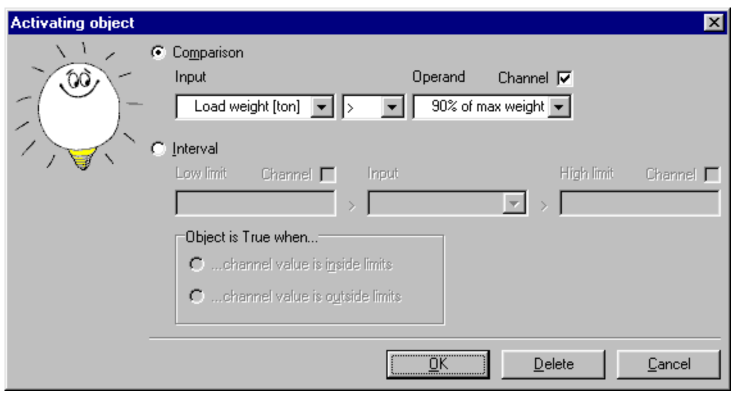
Warning, overload 90%

- Open the function page for the channel *Warning overload 90%.*

The function for a conditional message is as for a digital output with its *activating*, *blocking* and *locking objects*.

We will now define when the text for *Warning overload 90%*, will be activated. We create it as an activating object.

- Add an *Activating object*.
- Select *Load weight* as *Input*.
- Select: > *(greater than)* as operator character.
- Check the *Channel* box and select the channel *90% of max weight* as *Operand*.



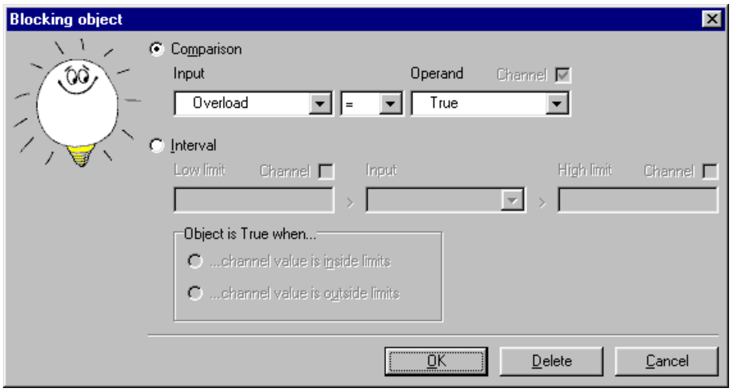
Activating objects for Conditional message, Warning overload 90%.

- Click *OK* to create the object.

When an overload indication occurs, the above condition *Load weight > 90% of max weight* also applies.

Therefore, we need to create a blocking object to remove the text "Warning! Close to Overload", at overload indication.

- Add a *Blocking object*.
- Select the channel *Overload* as *Input*.
- Select *True* as *Operand*.



Blocking object for Conditional message, Warning, overload 90%.

- Click *OK* to create the object.

For the channel *Warning, overload* we only need to create one activating function to "light" the message on the display.

Warning, overload

- Open the function page for the channel *Warning overload.*
- Add an *Activating object.*
- Select the channel *Overload* as *Input*.
- Select: *True* for *Operand*.
- Click on *Apply* to store.

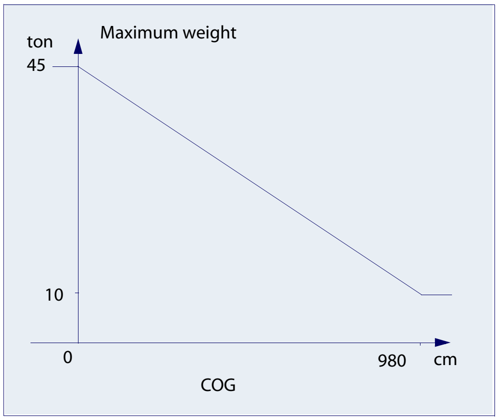
Now the functions for the *Conditional message* channels are created.

Calculations with mathematical channels

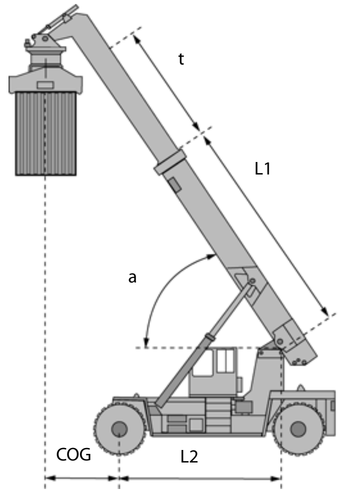
What do we want to happen?

The maximum weight will be calculated as a function of COG.

How will it work?



Maximum weight as a function of the telescope's position.



From the diagram, we get:

$$\mathit{Maximum\ permitted\ weight} = \frac{(\mathit{Maxload}) - (\mathit{Maxload} - \mathit{Minload})}{\mathit{COGmax} - \mathit{COGmin}} x\mathit{COG}$$

From the diagram, we get:

$$\mathrm{MaxWeight} = 45 - \left(\frac{45 - 10}{980 - 0}\right) X\mathit{COG}$$

The maximum load weight for the machine is 45 tons.
The machine can, independent of COG, lift loads of less than 10 tons.

What do we need to know?

COG

As we have already calculated COG, we can use this when we calculate the maximum weight.

Creating the function

Max weight

- Open the function page for the channel *Max weight.*
- Right-click on a row and select: *Add object*.
- Select: */ (division)* as *Operator.*
- Enter *35* as *Operand A*.
  (The expression 45 - 10 = 35)
- Enter *980* as *Operand B*.
  (The expression 980 - 0).
- Click *OK* to store.

- Right-click on a row and select: *Add object.*
- Select: * (multiplication) as *Operator.*
- Select: *A* as *Operand A*.
- Select: *COG* as *Operand B*.
- Click *OK* to store.

- Right-click on a row. Select: *Add object.*
- Enter the expression *45-B*.
- Click *OK* to store.

90% of maximum weight

- Open the function page for the channel *90% of max weight.*
- Select: *Add object* and enter the expression *0.90 * Max weight.*
- Click *OK* to store.

Carrying out calculations with a mathematical digital channel

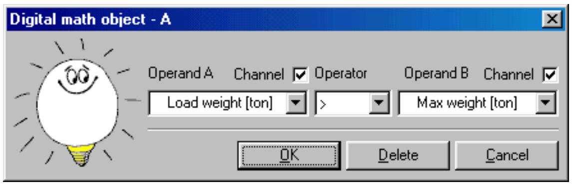
To indicate overload, we compare the current load weight with the maximum load weight.

Load weight > Maximum weight => Overload indication

Overload

- Open the function page for the channel *Overload.*
- Right-click on a row and select: *Add object.*
- Select: *> (greater than)* as *Operator.*
- Select: *Load weight* as *Operand A*.

- Select: *Max weight* as *Operand B*.



The mathematical expression for position A.

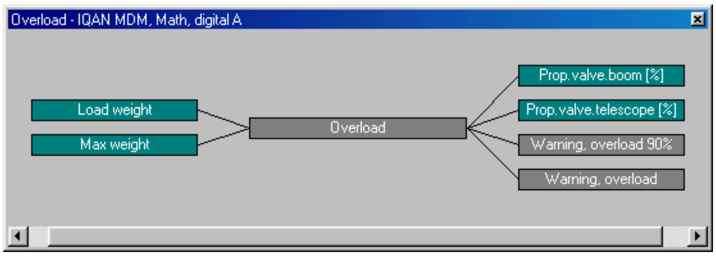
- Click *OK* to store.

We have now created the overload function for the boom and the telescope with accompanying warning messages on the display.

Navigating

In the navigator, there is not sufficient space for the complete function for overload indication. We will look at the function in stages.

- Click on the channel *Overload.*
- Select: *View > Show Navigator.*



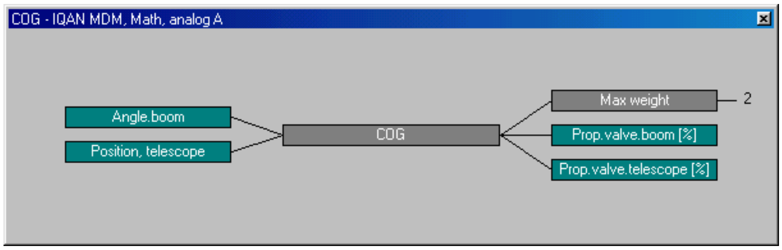
The navigator shows the connection between the internal channel Overload and respective output channels.

In the navigator, we see that the outputs *Prop. valve, boom* and *Prop. valve, telescope* and the conditional message channels *Warning, overload 90%* and *Warning, overload* are affected by the mathematical channel *Overload.*

The mathematical digital channel *Overload* is affected by the input *Load weight* and the mathematical analog channel *Max weight*.

We will proceed to look at the channel *Max weight.*

- Click on the channel *Max weight* in the navigator. Thereafter click on the channel *COG*.



The navigator shows the input signals to COG and also to the channels COG is connected.

In the mathematical analog channel *Max weight*, we use the value from the mathematical analog channel *COG*. We have created the channel *COG* in a previous section.

PID regulator

We have now reached the last section in this chapter. We will show you how to use a PID regulator.

We have chosen to construct a feed-back wheel steering function for the Reach Stacker machine. At high speed it shall not be possible to turn the machine too sharply. We want to construct a speed-dependant control, where the wheel angle is limited as the speed increases.

What do we want to happen?

It will be possible to manoeuvre the vehicle using a lever.

The wheel-steering will be speed dependant when you use the lever.

How will it work?

When the orbitrol is used, the lever manoeuvring will not work (i.e. when you are using the steering wheel to manoeuvre the vehicle, the lever will not work).

The wheel angle is limited with regard to the machine's speed.

What do we need to know?

Is the orbitrol being used?
The lever actuation.
The machine's speed.
The wheel angle.

To solve the above problems, we need an analog current output for the wheel-steering, a PID regulator to regulate the wheel-steering, an input for the lever, two analog voltage inputs to measure the orbitrol pressure and the wheel angle.

We will use the previously-used frequency input to measure the speed.

We will use an internal analog channel for the set value to the PID regulator as we need two controlling objects, one for the speed and one for the lever actuation, but we will deal with this later. To activate the regulation when the steering wheel is not used, we will use an internal digital channel.

Creating the channels and their properties

We begin by creating the current output for the wheel-steering.

Wheel-steering; current out

- Open the block diagram XP-0 and add the channel *Current Out, index C*.
- Enter the channel name: *Wheel-steering.*

For wheel-steering, we define:

Right turn (clockwise)	positive direction
Left turn (counter-clockwise)	negative direction

- We use the following current range for both the positive and the negative direction.
  Minimum current [mA]: *200*
  Maximum current [mA]: *500*
  As they are pre-set in IQANdevelop, we do not need to change anything.
- Click on *Apply* to store.

If you use the steering wheel to manoeuvre the machine, the wheel-steering occurs hydromechanically. The *orbitrol* distributes the oil in the servo-unit depending on how you turn the wheel.

When you use the lever to manoeuvre the machine, the oil is distributed via electromagnetic valves. By measuring the orbitrol pressure, we know if the steering wheel is used or not.

Orbitrol pressure; voltage in

We create an analog current input where we connect a sensor.

- Create the channel, *Voltage in, index E* in the block diagram XP-0.
- Give the channel the following properties:
  Name: *Orbitrol pressure*
  Unit: *Bar*
  From the data sheet, we find that:
  Minimum [mV]: *500*
  Maximum [mV]: *4500*
  Scaled minimum [bar]: *0*
  Scaled maximum [bar]: *500*
- Click on *Apply* to store.

Angle sensor, wheel; voltage in

The wheel-steering will be speed dependant, which means that the wheel angle is determined by the lever stroke and the vehicle's speed. We need to measure the wheel angle to regulate the steering.

- Create the channel, *Voltage in, index F* in the block diagram XP-0.
- Give the channel the following properties:
  Name: *Angle sensor, wheel.*
  Unit: *%*
  Minimum voltage [mV]: *500*
  Maximum voltage [mV]: *4500*
  Scaled minimum [%]: *-100*
  Scaled maximum [%]: *100*
- Click on *Apply* to store.

The angle sensor is installed so that 0 % corresponds to the wheel being directed straight forward. -100 % corresponds to a complete wheel turn to the left and 100 % corresponds to a complete wheel turn to the right.

Lever, wheel-steering; directional in

We will now create the channel for the lever.

We are going to use the lever's z direction (z rocker) to manoeuvre the machine.

- Open the block diagram Lx-0 and create the channel *Directional analog, index Z.*
- Open the dialog box *Channel information* and enter *Lever, wheel-steering* in the *Name, language 1* box.

We define the following directions:

Upper z rocker	positive direction (the vehicle turns clockwise)
Lower z rocker	negative direction (the vehicle turns counter-clockwise)

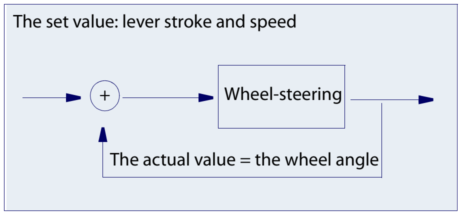
The lever's direction starts from the z rocker's central position. We define the total movement range for the rocker as -100% - 100% so that the rocker's central position is 0%.

- Click on *Apply* to store.

Speed; frequency in

For the speed signal, we will use the frequency input that we created in a previous section.

We will use the built-in PID regulator to create a feedback control system for the wheel-steering. We want the PID regulator to regulate the wheel angle in relation to the vehicle's speed and lever stroke.



Regulation of wheel angle.

The set value for the regulation depends on the vehicle's speed and the lever's value.

The actual value for the regulation is the signal from the angle sensor on the wheel axle.

PID, wheel-steering; PID

We will now create the channel for the PID regulator.

- Open the block diagram for MDM.
- Create the channel connection *PID, index A*.
- Open the dialog box *Channel information* and enter *PID, wheel-steering* in the *Name, language 1* box.
- Click on *Apply* to store.

Using internal analog channels

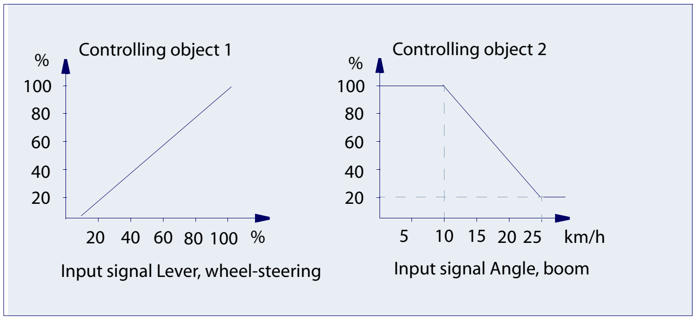
Command value, wheel-steering

As set value for the regulator, we will use the vehicle's speed and the lever actuation. For this, we will use an internal digital channel that we will use as input signal to the PID channel.

- Open the block diagram for MDM and add the channel *Internal analog, index A*.
- Open the dialog box *Channel information* and enter *Command, wheel-steering* in the *Name, language 1* box.
- Click on *Apply* to store.

Creating the regulator's function

As the regulator's set value, we will use the lever's value and the vehicle's speed. Depending on the lever's stroke and the vehicle's speed, the wheel angle is determined. We create these as controlling objects for the internal analog channel.



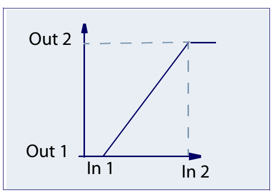
The value from the internal analog channel has the unit [%].

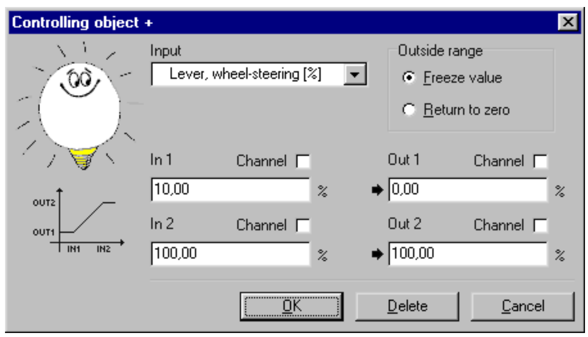
Command, wheel-steering

- Open the function page for the channel *Command, wheel-steering.*

We begin by creating a controlling object with the lever's input value.

- Add a *Controlling object (+).*
- Select: *Lever, wheel-steering* as *Input.*
- Enter *10* [%] for *In 1* and *0* [%] for *Out 1*.
- Enter *100* [%] for *In 2* and *100* [%] for *Out 2*.

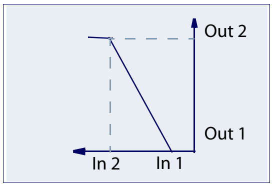


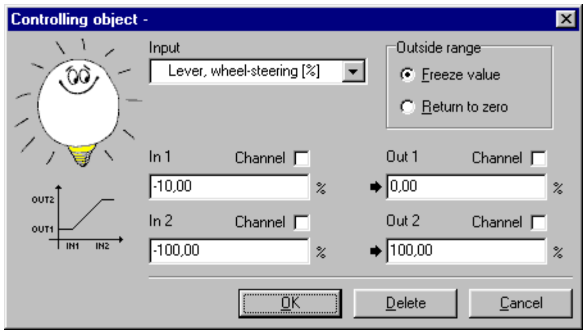


Controlling object for the Internal analog channel (+)Command, wheel-steering.

- Click *OK* to create the object.

- Right-click in *Controlling objects (-)* and select: *Add object.*
- Select: *Lever, wheel-steering* as *Input.*
- Enter -*10* [%] for *In 1* and *0* [%] for *Out 1*.
- Enter -*100* [%] for *In 2* and *100* [%] for *Out 2*.



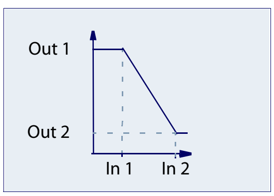


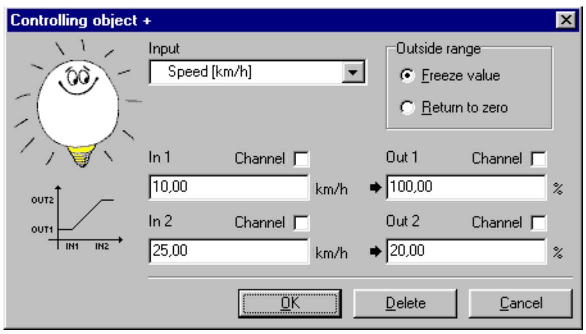
Controlling object for the Internal analog channel (-) Command, wheel-steering.

- Click *OK* to create the object.

We now need to create a controlling object with the speed signal as input.

- Add a *Controlling object (+).*
- Select: *Speed* as *Input.*
- Enter *10 [km/h]* for *In 1* and *100 [%]* for *Out 1*.
- Enter *25 [km/h]* for *In 2* and *20 [%]* for *Out 2*.





Controlling object (+) for the Internal analog channel Command, wheel-steering.

- Click *OK* to create the object.
- Add a controlling object in negative direction (-) with the same input and output values as above.

PID wheel-steering

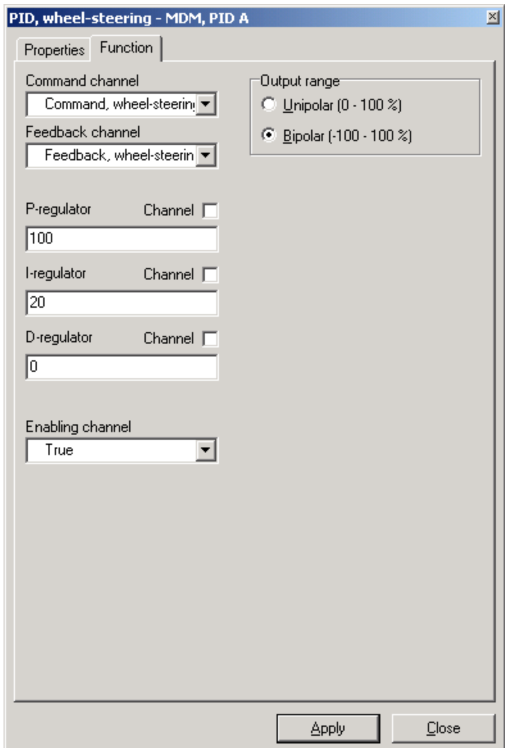
We will now state which channels that will function as *Command* and *Feedback* value for the regulator.

- Open the function page for *PID wheel-steering*.
- Select the alternative *Bipolar (-100 - 100%)*. In this way, we can have a regulation in both positive and negative direction.
- Click in the *Command channel's* drop-down list box and select: *Command, wheel-steering.*

- Click in the *Feedback channel's* drop-down list box and select: *Feedback, wheel-steering*.

There are rules on how to dimension the PID parameters. We refer to the Function chapter for more information. Enter the following values for the PID parameters:

- P regulation = *100*
- I regulation = *20*
- D regulation = *0*



Function page for PID wheel-steering.

We have now created the function for the PID regulation. The next step is to define when the regulation will be activated, i.e. start. In this instance, we want the regulation to begin when the orbitrol pressure is less than 40 bar, then we know that the steering wheel is not used to manoeuvre the machine.

Orbitrol pressure; internal digital

To activate the PID regulator, we use an internal digital channel as we want a time delay from when the orbitrol pressure drops below 40 bar until when the lever can be used (the regulation starts).

- Add the channel *Internal digital, index A* in the block diagram MDM.

- Open the dialog box *Channel information* and enter *Orbitrol inactive* in the *Name, language 1* box.

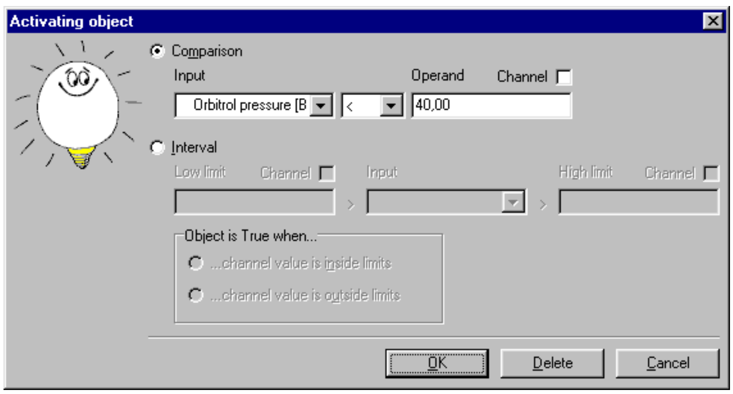
To make the transition between using the steering wheel and using the lever more stable, we want an operation delay of 1000 ms before the lever will work.

- Enter *1000* [ms] in the *Delay, on* box.

Orbitrol inactive

As we want the regulation to start when the orbitrol pressure is less than 40 bar, we create an activating object for the internal digital channel *Orbitrol, inactive*.

- Open the function page for the channel *Orbitrol inactive*.
- Add an *Activating object.*
- Select: *Orbitrol pressure* as *Input*.
- Select: < *(less than)* as operator character.
- Enter *40* as *Operand.*



Activating object for the Internal digital channel Orbitrol inactive.

- Click *OK* to create the object.

PID, wheel-steering

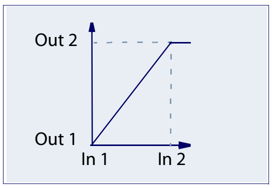
Define the activating channel for the PID regulator.

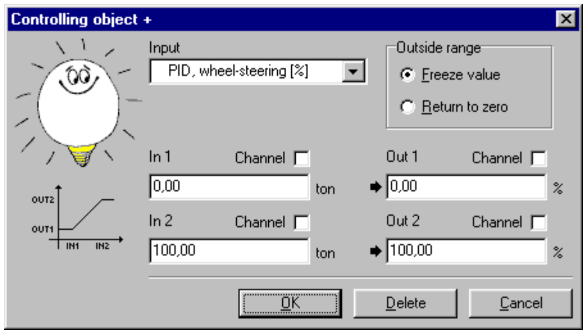
- Open the function page for the channel *PID, wheel-steering*.
- Select the channel *Orbitrol, inactive* in the drop-down list box *Enabling channel*.

We have now created the complete function for the PID regulator, with *Command* value, *Feedback* value and activation of the regulation. All that remains to do for everything to work is to connect the PID-regulator as a controlling object to the current output *Wheel-steering*.

Wheel-steering

- Open the function page for the channel *Wheel-steering.*
- Add a *Controlling object (+).*
- Select *PID wheel-steering* as *Input.*
- Enter *0* [%] for *In 1* and *0* [%] for *Out 1*.
- Enter *100* [%] for *In 2* and *100 [%]* for *Out 2*.

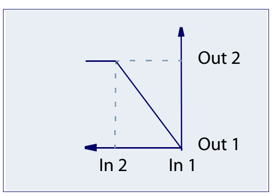


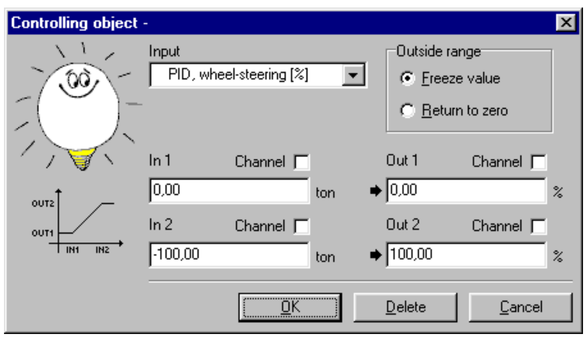


Controlling object (+) for the analog current output.

- Click *OK* to create the object.

- Right-click in *Controlling objects (-)* and select: *Add object*.
- Select channel *PID, wheel-steering* as *Input*.
- Enter *0 [%]* for *In 1* and *0 [%]* for *Out 1*.
- Enter -*100* [%] for *In 2* and *100 [%]* for *Out 2*.



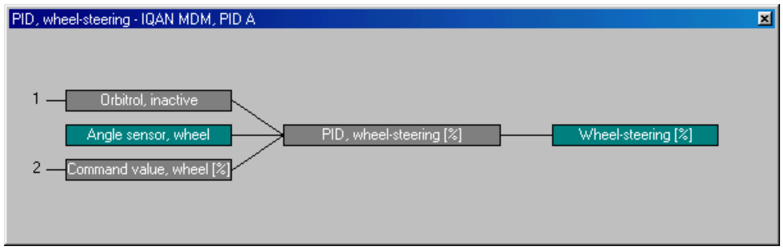


Controlling object (-) for the analog current output.

- Click *OK* to create the object.

We have now created a feedback system for the wheel-steering.

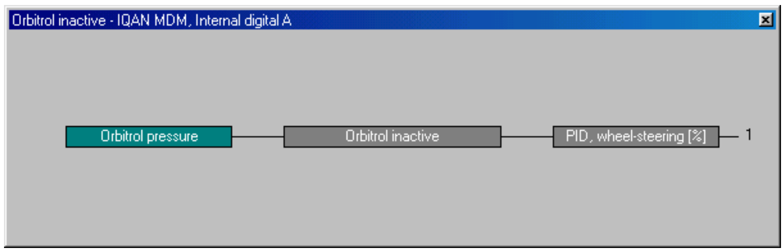
Navigating



The navigator shows the connection to the PID regulator and the connection to the output Wheel-steering.

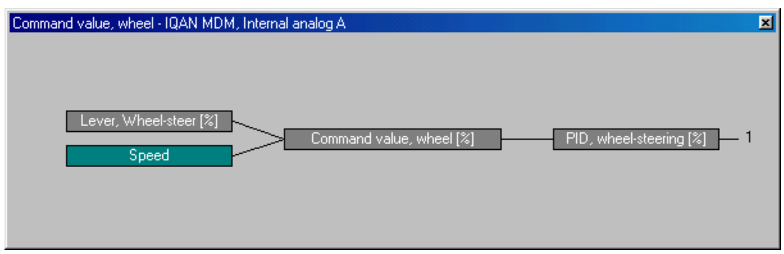
To the output *Wheel-steering*, we have connected the regulator *PID, Wheel-steering*. There are three channels which affect the PID regulator, *Orbitrol inactive*, *Command wheel-steering* and *Angle sensor, wheel*.

To see which channel is connected to *Orbitrol, inactive*, click on the block for the channel.



The connection between Orbitrol pressure and Orbitrol inactive and the connection to PID wheel-steering.

To see which inputs affect the set value, click on the channel *Command, wheel-steering* in the block diagram.



Lever, wheel-steering and Speed affect the PID regulator's set value.

The internal analog channel *Command, wheel-steering* is affected by two inputs; *Lever, wheel-steering* and *Speed*.

Summary

Hopefully, you now have learned something about what you can do in IQANdevelop and with IQAN control systems.

As we have only briefly described the program in this chapter, we hope that you will continue using the manual as a reference when you construct your applications.

Verify the application

A very important part that we have not dealt with in this chapter is safety in the application.

Always construct your application considering safety in every function. Always check your application with a simulation tool to verify your functions.

Trouble-shooting

With IQANdevelop's measuring functions, you can easily trouble-shoot your application, for further information, see section Measuring and fault finding, on page 309.

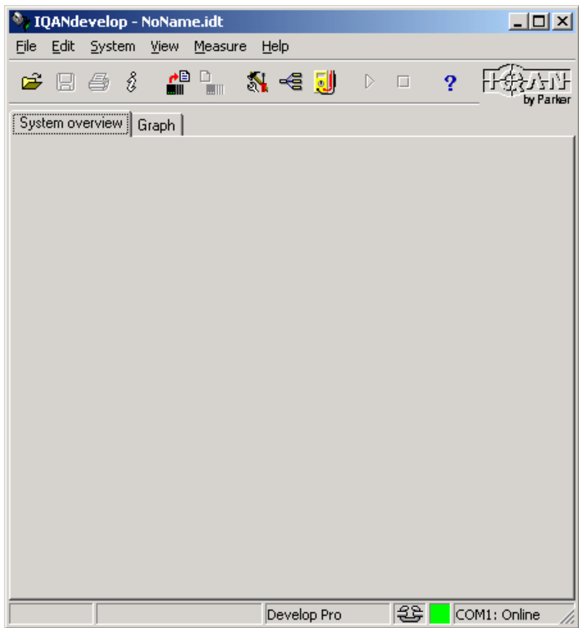
5 Menu overview

This chapter deals with the following:

- the menu bar
- the tool bar
- the status bar

This section of the manual is intended as a reference to get information quickly on different commands and the tool bar's' function buttons.

In the menu bar, you find drop-down menus with different commands. There is everything from the usual commands *Open, Save, Cut* and *Paste* to those which are more program-specific such as *Add, Remove module.*



The main window in IQANdevelop.

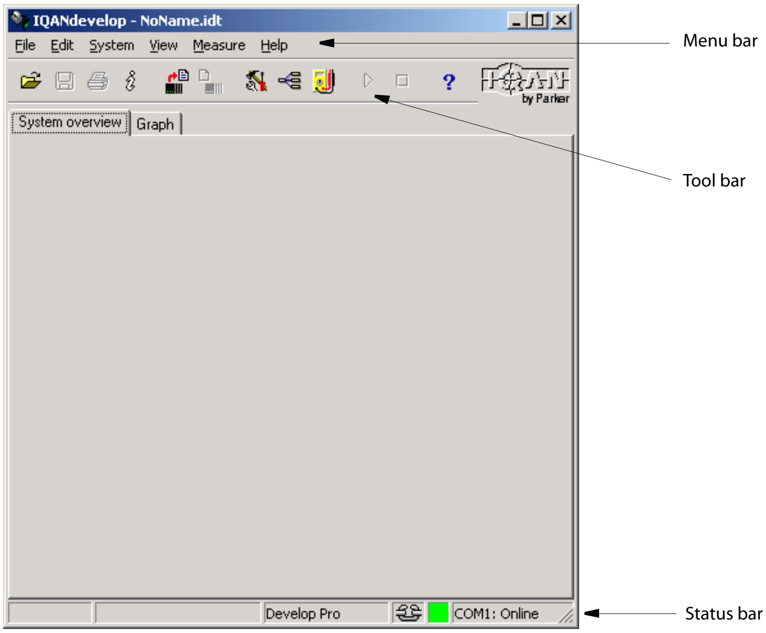
Some commands are needed more often than others. Therefore, we have created a tool bar with a number of function buttons. On every button, there is a figure to symbolize the button's function.

The status bar contains information which facilitates things for you during the programming. For example, there is a description of which application is loaded, the current user level as well as the status of the connection to the IQAN system.

The main window

You create your application from the main window. In the main window, there is a menu bar, a tool bar and a status bar.

The commands are found in drop-down menus and the commands you need most often are found on the buttons in the tool bar.



Main window in IQANdevelop.

Depending on where in IQANdevelop you are, certain menus, commands and function buttons are not available. These buttons and menus are shown in grey, see screen illustration above.

Drop-down menus

In the menu bar, the following menu headings are found: *File, Edit, System, View, Measure and Help*. The drop-down menus are opened by clicking on respective menu heading. You can also reach the menus by pressing Alt+respective underlined letter key. E.g. Alt+F for the File menu, Alt+M for the Measure menu.

File

Under the *File* menu, there are the usual file functions, such as *New*, *Open*, *Save* and *Print*. There are also specific functions for IQANdevelop, such as settings for communication, languages preferences for the display's text messages as well as the manager for application codes.

New	Ctrl+N	Creates a new application.
Open...	Ctrl+O	Opens an existing application.
Save	Ctrl+S	Saves application.
Save as...		Saves the application with desired filename.
Info...		Shows general information on the application.
Application code...		Protects the application with a code to keep unauthorized from making changes.
Print...	Ctrl+P	Prints channels, measured graphs and block diagrams.
Properties...		Here, you enter properties for communication, dialog and language for the application in IQANdevelop.
Predefined...		Here, you enter the data for the sensors you want to use as predefined.
Application code manager...		Lets you add and delete application codes to your application code file.
Create safe code...		Lets you create a safe application code that cannot be read by anyone so you can safely send it via email.
Exit		Exits the program. A dialog window is displayed if you have not saved the application or the latest changes.

Edit

Under the *Edit* menu, there are the usual editing functions.

Undo	Ctrl+Z	Undo the latest command.
Cut	Ctrl+X	Cut channels.
Copy	Ctrl+C	Copy channels.
Paste	Ctrl+V	Paste channels.
Delete	Del	Delete channels.
Move channel to		Moves a channel to another module.
Copy properties		*Factory defaults to adjustables.* *Adjustables to factory defaults*. There are two alternatives when copying properties, either are the *factory default* properties copied to the *adjustable* or vice versa. Note that all channels with adjustable properties will be affected.

System

In the system menu, there are functions for adding and removing modules from the application as well as functions to send or get an application from the master module.

Add module	Shift+Ins	Adds a module to the application. The program checks that the maximum number of modules is not exceeded.
Remove module	Shift+Del	Deletes a module from the application. To delete a module, all defined channels on that module *must* first be deleted. A warning message is displayed.
Module properties...	Shift+ Enter	To change a module´s properties. You need to open the module´s block diagram before you can select the command in the system menu.
Check application...	F9	Checks if the application contains any errors or warnings.
Send application...	F2	Sends the application to the IQAN master.
Get application	F3	Gets the application from the IQAN master.

Get error/event log...	Ctrl+F3	Gets the error/event log together with the application from the IQAN master.
Update vmAC...		Updates the operating system in an IQAN module.
Chat...		You can send text messages from IQAN-develop to communicate with an IQAN user.
Display control...		You can control and view the IQAN-MDM display via this dialog box.
Restart master		Restarts the IQAN master module without breaking the power.
Clear error/event log		Clearing the error and event log in the master.
Set clock		Set date and time in the IQAN master. The clock on the PC is used as a reference. If you want to enter another time, you must do this from the IQAN display.
Connect via modem...		By connecting a modem to an IQAN master, it is possible to do remote communication. You can send or get an application, chat and measure channels.
Disconnect		Disconnects the modem connection that was used for remote communication.

View

Under this menu, there are functions to show the properties for a channel, the navigator and the multimeter.

Show channel info	Ctrl+1	Shows properties and functions for a channel. Click a channel and select *Show channel info*, or double-click on the channel's name.
Show navigator	Ctrl+2	The navigator is a tool to get an overview of the connection between input and output channels. Click a channel and select *Show navigator.*
Show multimeter	Ctrl+3	With the function *Show multimeter*, you get a view of all channels you measure on. You can measure on several channels located on different modules at the same time.

Next window Previous window	F11 F12	If you have several windows/dialog boxes open at the same time, you can alter between them by selecting next window or previous window.

Measure

In the measure menu, you find functions to measure the different channels in the modules. There are two types of measures; the multi-meter or you can have the measure presented in the form of a graph. (To activate the graph window, click on the *Graph* tab in the upper left corner of the main window). For further information, see section Measuring and fault finding, on page 309.

Start measure/ Stop measure	F4	Start/stop the measuring procedure.
Start automatically		When you activate a channel for measurement in the block diagram, i.e. click on its measure flag, the measure starts automatically without you having to select *Start measure*.
Reset selected		The block diagrams are reset so no measure flags are activated for measure.
Clear log	Ctrl+L	If you have used the graph during measuring, you must clear the measure log before you can select to measure on other channels.
Zoom out	Ctrl+M	Restores window after you have zoomed in. (i.e. zoom out to normal measure window).
Graph properties...		You can setup your measure window with regard to colors and if you want a grid to be shown or not.
Channel properties...		You can change scaling of the Y axis for one channel and change the color of its curve.
Comment...		You can create comments for your measurements.
Create/Remove print tags		Tags to identify the curves during print-out.
Open settings...		Opens measurement settings.
Save settings...		Saves measurement settings.

Help

Under the *Help* menu, there are functions to get help in different ways.

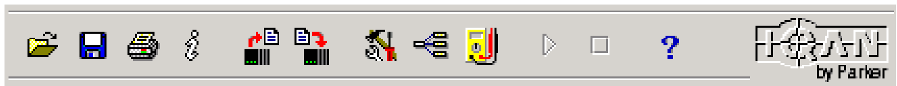
Contents	F1	View the user manual. Requires Adobe Acrobat Reader.
About...		Information box about IQANdevelop.

The tool bars

Certain functions need to be more accessible as you need to use them more often. These functions are found as buttons in the tool bar. If you position the mouse over a button, a short explanation about the button is shown.

By clicking on the desired button, its function is activated.

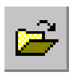
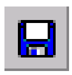
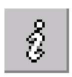
The main window tool bar



Function buttons in the tool bar.

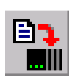
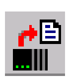
File functions

The buttons for the file functions contain the usual *Open*, *Save* and *Print* functions but there is also an information button to obtain information about the application.

	Open an existing application.
	Save application.
	Print
	Show general information about the application.

System functions

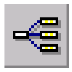
The system functions handles sending and getting applications.

	Send all data to IQAN master.
	Get all data from IQAN master.

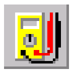
Show functions

With the buttons below, you get information on the current channel, you can activate the multimeter to measure the different channels as well as obtain an overview of the application with the navigator.

Show channel information. Show properties and functions for the channel. Mark the name for the channel and click on the button *Show channel info*.



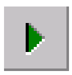
Show navigator. The navigator gives an overview of included channels for one function.



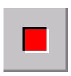
Show multimeter. Gives an overview of all the channels you are measuring on.
After having activated desired channels for measurement click on *Show multimeter* to show a window with all channels at the same time. In this way, you can measure on several channels located on different modules at the same time.

Measure functions

With the buttons, you can start or stop a measure.



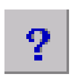
Start measure. The button is enabled when the measure can start.



Stop measure. The button is enabled when measurement is in progress.

Help functions

If you need help, you can use the button below.

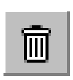


Help for IQANdevelop.

The module tool bar

Each module has two buttons at the top left corner of the module page; *Module properties* and *Remove module*.

Shows the properties dialog box for a module.



Removes current module from the application. You have to delete all channels from the module before it can be deleted.

The status bar

The status bar

The status bar consists of six smaller fields where the following information is shown.

1	In the first field from the left, there is a short description of the button or the field that the mouse is pointing to.
2	The name you have given the application is shown in the second field. The padlock indicates whether the application is protected by an application code or not. If the padlock is unlocked, there is no code entered.
3	The third field gives the access level of the user.
4	The fourth field indicates if the IQANsimulate program is running and if there is a connection between IQANsimulate and IQANdevelop. If the chain is broken there is no communication. Click here to synchronize with IQANsimulate, i.e. force IQANsimulate to use the same file as you have opened in IQANdevelop.
5, 6	The fifth and sixth fields give status for the connection to the master. During connection, the square lamp in the fifth field is green. The sixth field shows messages regarding the communication with IQAN.

NOTE

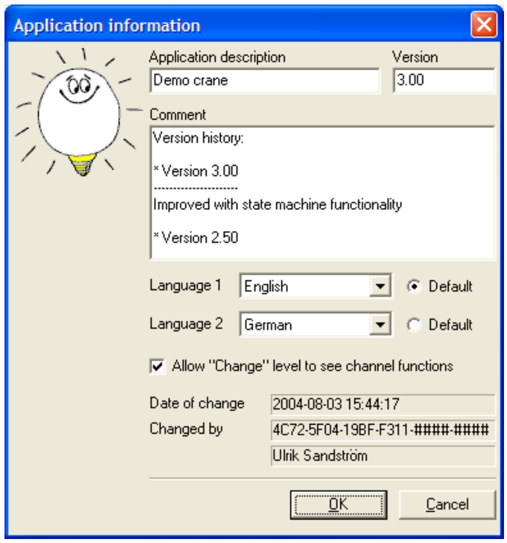
If the connection between the IQAN system and your PC is broken, click on the green status lamp to try to reconnect. If this does not work, the supply voltage to the IQAN master module may be too low or there may be a cabling failure. Check the connection between the PC and the IQAN system and that the correct COM-port is being used. Check that no other program is using the same COM-port.

6 Application

An IQANdevelop file is called an application. The application contains all information needed by the master module to control the machine. An application consists of application information, modules, channels and objects.

Application information

Select: *File > Info* to open the dialog box for application information.



Application information.

Application description	Description of the application, normally the machine type or name. Max 19 characters.
Version	Version of the application. Helps you to do version control of your applications.
Comment	Comment on the application, for example, how it functions, etc. Max 255 characters.
Language 1 and 2, Default	Select which languages this application uses. The default language is the one used the first time you send an application to a master module.
Allow "Change" level to see channel functions	Check this to allow users at the "Change" level to see the function tab in the channel information dialog box.

Date of change	The date when the latest change of the application was carried out. Cannot be changed.
Changed by	Licence/id and name of the last person who made changes in the application. Cannot be changed.

Click *OK* to store the information. *Cancel* closes the dialog box without storing above changes.

Language preferences

When developing an application in IQANdevelop, it is possible to give texts, channel names and units in two languages.

The menu system in an IQAN master module can also be shown in two languages. The languages are the same as the ones selected in the application.

Languages supported by IQAN

English	Italian
German	Swedish
French	Finnish
Spanish	Norwegian
Portuguese	Danish

File types

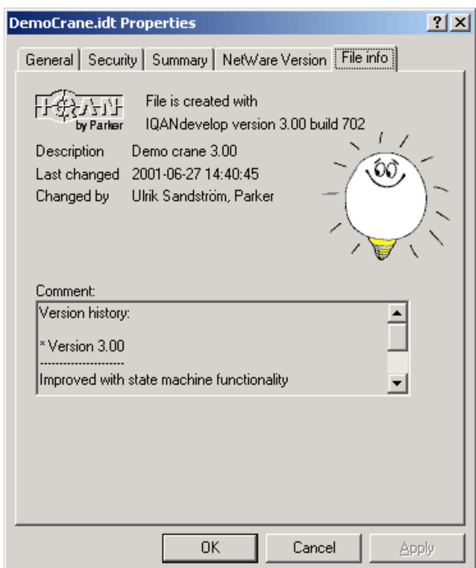
File types with the following suffixes are used in IQANdevelop:

.idt	Contains a complete application.
.idl	Contains an .idt-file and a graph log with information such as header, comment and start time.
.idm	Contains a group of channels selected for measure. Graph and channel properties are also stored such as colors and scales.
.ide	Contains an .idt-file and an error/event log.
.ido	Contains an IQAN operating system, vmAC (= virtual machine for Application Control).
.reg	Windows registry file. When you export a phone book or a predefined sensor from IQANdevelop, it is saved in a .reg-file. To import a .reg-file, double-click on it in the file manager. It will be imported to Windows registry.

Properties for an IQAN file

You can get information on an IQAN file directly in Windows Explorer.

- Open the Explorer and select the file.
- Right-click on the file and select *Properties*.
- Select the tab *File info*.

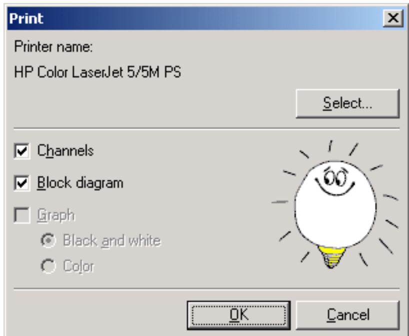


Properties for an idt-file.

Print

You can print the properties for channels or block diagrams plus the graph in color or black/white.

- Select *File* > *Print*.



Dialog box for print.

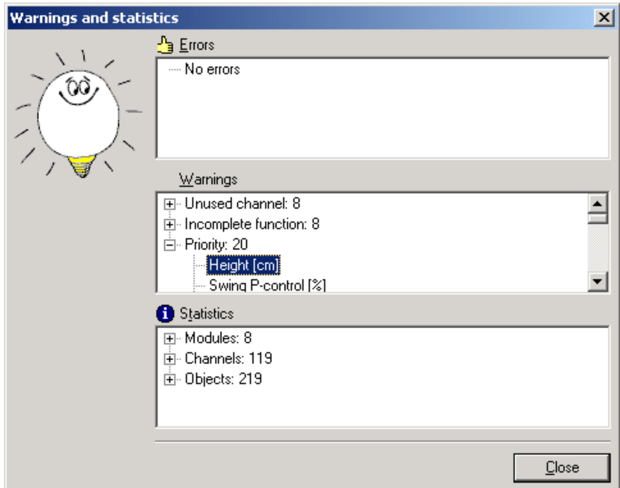
Print

Printer name	The name of the printer selected. By clicking on *Select*, the *Print Setup* dialog box is shown where you can select different printers and settings.
Channels	Check this box for printing the channels’ properties and functions.
Block diagram	Check this box for printing all block diagrams.
Graph	If you have a graph log, you can print it either in black/ white or color.

Warnings and statistics

IQANdevelop keeps statistics of used channels and objects and checks that the application is complete and correct regarding channels and functions.

- Select *System* > *Check application* to open the dialog box *Warnings and statistics* or press *F9*.



The dialog box for warnings and statistics.

Errors

Errors are fatal for the application, and have to be corrected before sending the application to the master.

Shared pin conflict	Channels that share the same physical connection. IQAN-XP2, for example, uses the same physical connections for several channel types. It is only possible to use one channel type at a time.
Too many channels. Max allowed is...	This messages is shown if you reach the maximum limit of channels.
Too many current and PWM outputs. Max...	This message is shown if you have used too many current and PWM outputs.
Transmission rate conflict	J1939 channels that have the same J1939 id must have the same transmission rate. See section SAE J1939, page 187.
Too many J1939 input/output ids. Max allowed is...	Max allowed J1939 ids for one IQAN-XT2 is 10. See section SAE J1939, page 187.

System cycle time not within limits for IQAN-XP	The IQAN-XP module can´t handle a system cycle time shorter than 50 ms (valid range is 50 - 75 ms). See section Other properties, page 106.
Engine speed channel missing	Feedback channel for *E-Gas out* is not selected.
E-Gas channel missing	Channel type *Engine load* is defined, but no *E-Gas out*.
SMS input, multiple match	Two or more SMS inputs have the same *Incoming message* specified. The master module cannot determine which channel to match with an incoming message, see section SMS input, page 165.

Warnings

Warnings indicates problems in the application. The application will probably work but maybe not as expected. It is possible to send the application with all the warnings to the IQAN system.

Unused channel	Defined channels that are not used in any function.
Unit mismatch	Channels don’t have the correct unit. For example command and feedback channels for a PID regulator should have the unit [%].
Incomplete function	The function for a current or digital output has no controlling or activating objects. Missing parameters in functions such as activating, command or feedback channel.
Missing names and units	Name and unit in one or both languages are missing.
Duplicate name	Two or more channels have the same name.
Priority	If a channel with lower priority is used in a function for a channel with a higher priority. See section Priority order for the channels, page 362.
Delay time not divisible by system cycle time	The delay time will be rounded towards zero to the nearest number divisible by the system cycle time. Example: System cycle time is 50 ms. If delay time is 175 ms it will be rounded to 150 ms.
Transmit rate not divisible by system cycle time	Same as above, but for J1939 channels.

Statistics

In the *Statistics* field, the number of channels and objects are shown.

7 Modules

This chapter deals with the following:

- IQAN modules
- system overview
- block diagram
- module properties

The IQAN system is based on adding necessary modules and thus designing your own control system.

IQANdevelop contains a system overview of the modules and their name and address in the application. This provides a quick overview of how you have designed your IQAN system.

In IQANdevelop, every module is presented as a block diagram where the different channels are represented. With the block diagram as a base, you can create functions and properties for each channel. The channels used in an application are provided with a name tag. In respective block diagram, you can also connect internal measure functions to every channel, see section Measuring and fault finding, on page 309.

All modules have properties like name and CAN-address but also specific properties like dither frequency for IQAN-XP2.

IQAN modules

The IQAN system is built on a flexible module thinking. The system consists of a master unit with built-in display and a number of expansion units and lever units. Communication takes place via the system's CAN-bus. More information on the different modules is found on separate product sheets.

Master modules

The master module is a central unit in the system. All communication is routed through the master. It also contains all non-module specific channels such as PID regulators, counters and math channels. All mathematical calculations take place in the master. There can only be one master in an IQAN system.

Module	Inputs	Outputs	Others
 IQAN-MDM	-	alarm	-
 IQAN-TOC8	voltage digital (on/off) frequency	alarm current digital (on/off) PWM	SAE J1939
 IQAN-TOC2	voltage digital (on/off)	current PWM	-

Expansion modules

The expansion modules are equipped differently with regard to inputs and outputs. Which modules you should select depends completely on the functionality you want. There can be several modules of each type in an IQAN system, depending on the master module and the expansion module type.

Module	Inputs	Outputs	Others
 IQAN-XP	voltage frequency	current digital (on/off)	-

 IQAN-XS	voltage digital (on/off)	digital (on/off)	-
 IQAN-XP2	voltage frequency	current digital (on/off) PWM	-
 IQAN-XT2	voltage frequency	current digital (on/off) PWM E-gas	SAE J1939
 IQAN-XR	voltage digital (on/off)	-	-

Levers

The levers use the CAN bus for communication. There are different kinds of levers, currently IQAN-LL and IQAN-LM. Both are called IQAN-Lx since they use the same electronics.

Module	Inputs	Outputs	Others
 IQAN-Lx	voltage digital (on/off)	digital (on/off)	directional analog (x, y, z)

System overview

On the first page, *System overview*, the system is presented as you have designed it with all the included modules.

System overview

The modules in an application are presented as follows: the master module is always positioned at the top of the page. The expansion modules and levers follow below.

If there is not sufficient space on the screen for all of the modules, use the scrolling arrows on the right side.

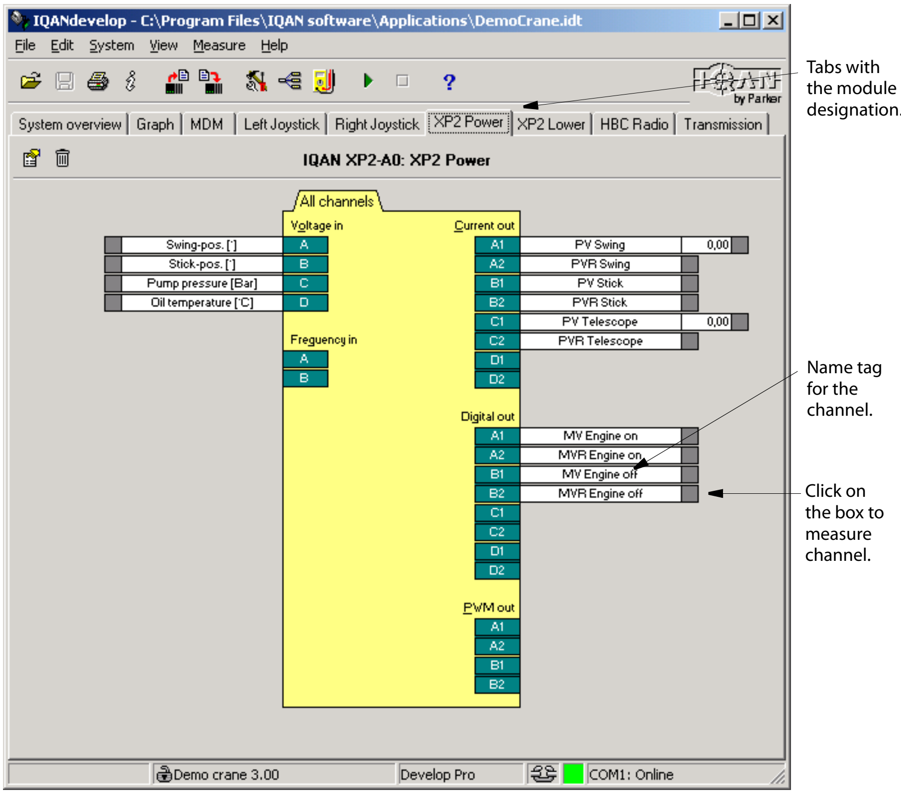
Module information

In the system overview, you get the following data on the modules:

- *Serial number:* the module’s serial number
- *Hardware version:* the module’s hardware version
- *Software version:* the module’s software version
- *Status:* different status messages (only displayed when measuring)

Block diagram

In IQANdevelop, the different modules are presented in the form of block diagrams. In respective block diagram, you get an overview of all the channels in the module.



Block diagram XP-A0.

Channel connections

The channel connections for the physical inputs and outputs are green while the connections for the internal channels are grey. Each is marked with a channel index in alphabetical order and 1 or 2 for primary or secondary connection.

Browsing between the different block diagrams

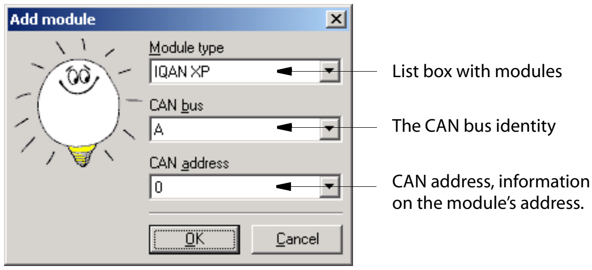
Every block diagram is presented in a page. To alternate between the different block diagrams, click on one of the tabs at the top of the window, or click on the module image in the *System overview*.

Tabs for activating the different block diagrams.

Creating a block diagram

Adding a module

To add a new module, select: *Edit > Add module.*



Adding a module to the application.

Module type	A list of modules that can be added to the application. The first module to add to a new application has to be a master module which is also the only module possible to select.
CAN bus	The existing CAN bus is identified with an A. Future master modules with support for multiple CAN buses will offer CAN bus B, C, etc.
CAN address	CAN address shows the module's corresponding address on the CAN bus. The CAN address is automatically incremented, but can be manually altered. It can also be changed later on.

Limitation of number of modules

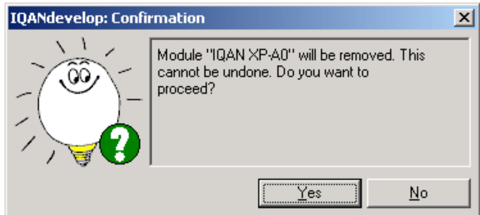
IQANdevelop checks that there are no more modules than the maximum number allowed of each type in the application. When the alternative disappears in the list box, no more modules of that type can be added.

Removing a module

One condition for removing a module is that it contains no channels in the block diagram. To delete channels, see section Deleting a channel, page 120.

- Open the block diagram for the module to be removed.

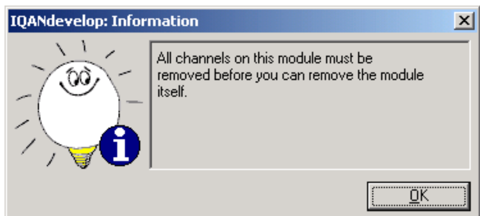
- Select: *Edit > Remove module*
  The following dialog box is displayed.



Dialog box Remove module.

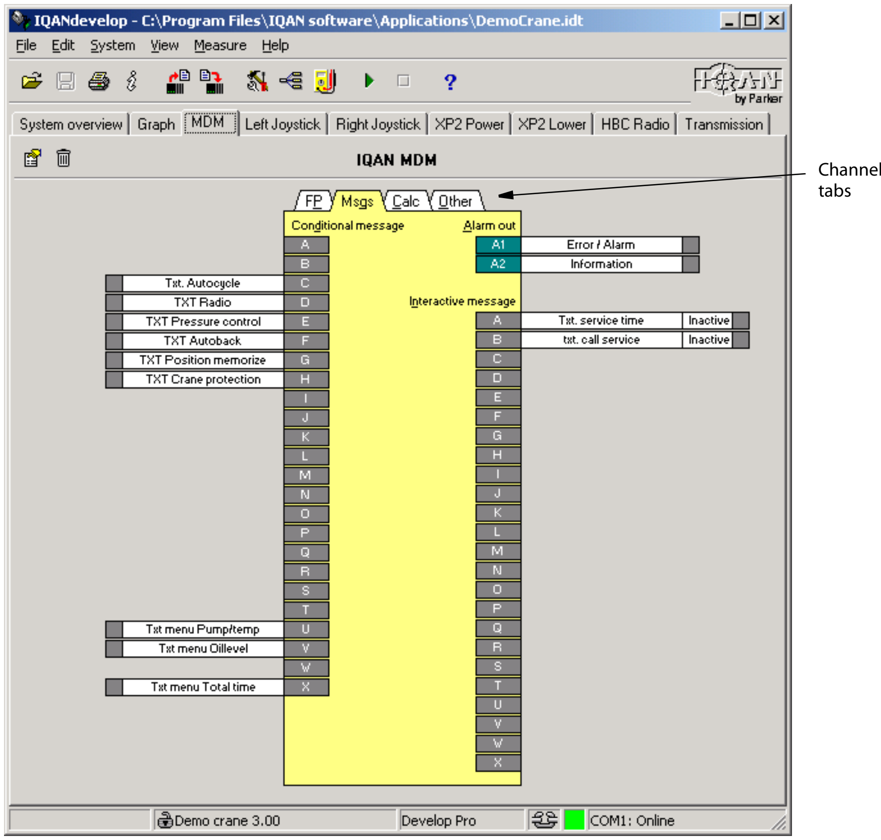
- Click *Yes* to remove the module or *No* to leave it there.

An information message is displayed if you try to delete a block diagram containing channels.



Channel tabs

All the module´s block diagram has channel tabs that sort the channels into groups. This will facilitate when you want to find a specific channel type in a block diagram.



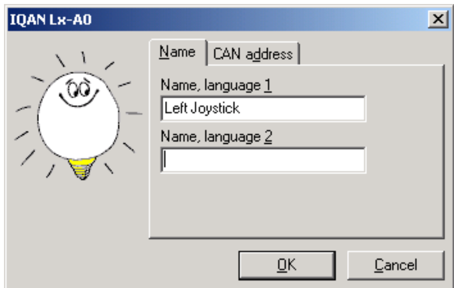
The IQAN-MDM module´s channel tabs.

- Click on the desired tab to show the different channels in the block diagram.

Module properties

By right-clicking on a module in the system overview or in its block diagram and selecting *Properties*, a dialog box opens where you can change the module's properties, such as name and address.

Naming the module



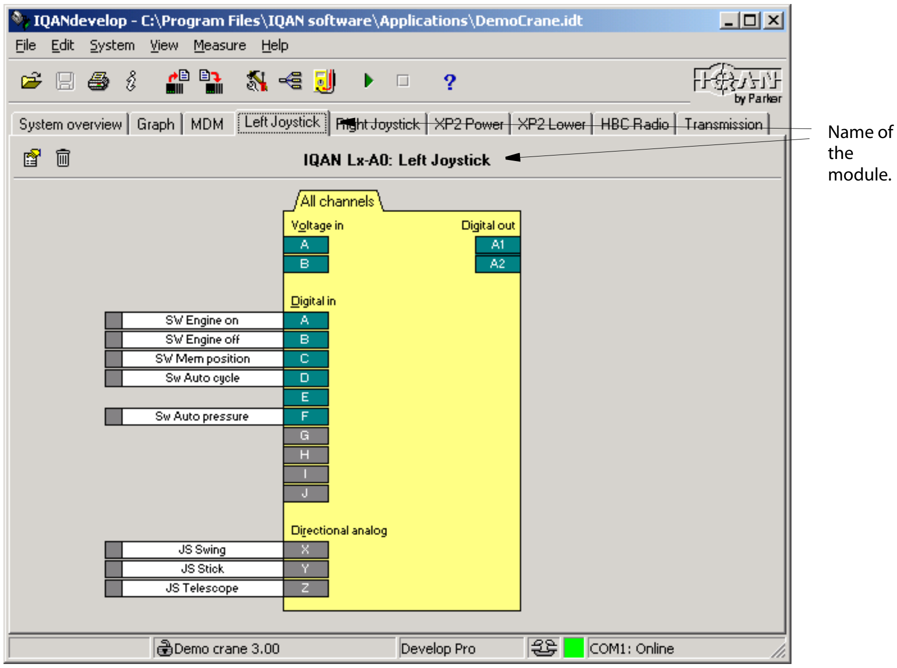
The tab for naming the module.

Name, language 1 Name, language 2	The module name in two different languages.

Function buttons

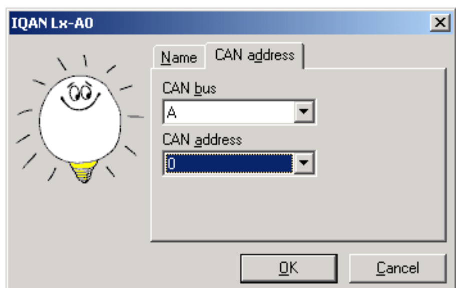
To store the new properties, click *OK*. The *Cancel* button closes the dialog box without applying the changes.

The module name is shown above the block diagram and on the tab for respective module. If you do not name the module, the module's original name and address are shown instead.



Named lever module.

Changing the module's CAN address



The tab for changing the CAN address.

CAN address	The module's CAN address. You can give the module a new address. If the new address is taken by another module of the same type it will switch address with that module.

ATTENTION

Be cautious when switching addresses between modules addressed with an Id-tag in the cabling, these modules also switch functions.

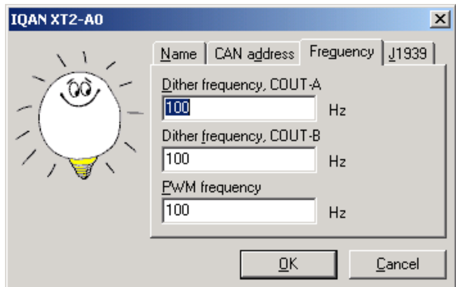
Frequency

Changing the dither frequency for current outputs

XP: The dither frequency is fixed (92 Hz) and cannot be changed.

TOC8, TOC2, XP2: The dither frequency is common for all current outputs. Adjust the frequency according to the specific load.

XT2: The current outputs can have individual dither frequencies.



The frequency tab for IQAN-XT2.

Dither frequency	Enter desired dither frequency for the current outputs. The frequency range is 25-150 Hz.

PWM frequency

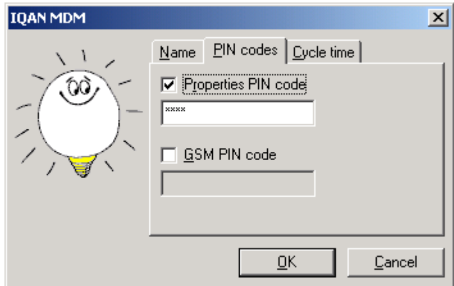
Some modules are equipped with PWM outputs (pulse width modulation). The PWM frequency is adjustable. For some modules there can be an alternative PWM frequency that can be selected by the module.

PWM frequency	Enter desired frequency for the PWM outputs. The frequency range is 25-2000 Hz for most modules.

For further information about the PWM output, see section PWM out, on page 175.

PIN codes

With the PIN codes you can prevent unauthorized people to use the *properties menu* in the IQAN master and/or to use the SIM-card in other modems or telephones. PIN codes are supported by all master modules.



The tab for the PIN codes.

Properties PIN code	This PIN code is used to prevent unauthorized people to use the Properties menu in the IQAN master. Check the box and enter a code.
GSM PIN code	This PIN code is for the modem´s SIM-card, (only for GSM modems). In this way the SIM-card can be prevented to be used by unauthorized people. Check the box and enter the PIN code in the field below. You will find the code in the SIM-card documentation.

Other properties

Other properties are system cycle time, error/event log handling and SMS handling.

System cycle time

The *cycle time* for an IQAN system can be set to 20-100 ms. The default value is 50 ms. If you need faster response times you can lower the value, or, if you need more processing power you should raise the value.

NOTE

Please be cautious when using a short system cycle time. Pay attention to the utilization. The utilization should not be over 75%. For further information about utilization, see section Module diagnostic, on page 159.

Log handling

When a log goes full, the default behavior is to delete the oldest records to create room for new errors/events. The 1000 latest records are always kept in the log.

You can override the default behavior by checking the boxes *Error/Event log handling, stop when full*. Now, when a log goes full, no more errors/events will be logged. When the log is emptied, see section Clear the error/event log, on page 292, logging will continue again.

The actual number of records in the error log and in the event log can be measured by using *module diagnostics*, see section Module diagnostic, on page 159.

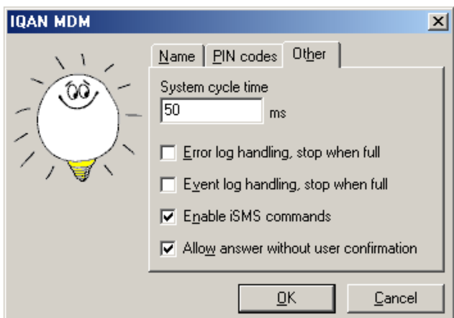
iSMS commands

The master module can handle incoming *i*SMS commands from external systems. The standard *i*SMS command syntax is described in Appendix D on page 368.

Auto answer

This feature only concerns master modules with a modem attached. Master modules with a display shows caller id when it detects an incoming call. The user can then choose to accept the call or not by pressing *OK* or *Cancel*. This behavior can be overridden by checking the box *Allow answer without user confirmation*. Please use this function carefully, the machine user will not be notified when someone is connecting to the machine via modem.

Master modules without any display always answer incoming calls automatically.



The tab for other module properties.

System cycle time	The default value for an IQAN system is 50 ms. The time can be 20-100 ms.
Error log handling, stop when full	Check this box to force the master to stop logging errors when the error log is full.
Event log handling, stop when full	Check this box to force the master to stop logging events when the event log is full.
Enable iSMS commands	Enables handling of incoming *i*SMS commands from external systems.

Allow answer without user confirmation	Normally, when you connect to an IQAN MDM via modem, the user most confirm the connection by pressing the OK button on the display. If you check this box, the MDM will answer the call without even notifying the user. The phone symbol in the MDM display will go off hook though.

NOTE

If you have an IQAN-XP module in your system, the system cycle time must be set to 50-75 ms.

J1939

For information about the J1939 module properties, see section SAE J1939 Diagnostic, page 188.

Module diagnostic

In earlier versions of IQANdevelop there was something called Module diagnostic. This has now been replaced by a new channel type, called *Module diagnostic*. For more information, see section Module diagnostic, on page 159.

8 Channels

This chapter deals with the following:

- channel types
- how to name the channels
- how to define the different channels' properties

The definition 'channels' is a collective name for the inputs and outputs found on the different IQAN modules. There are also channels internally in the system, to handle for example, text processing and mathematical calculations. The channels are used to collect and/or send data. In this chapter, we will present IQAN's analog, digital and internal channels.

The master unit's display can handle and present information in two different languages. You decide which of the two languages you wish to use. In this way the driver can get the information presented in one language while the service engineer can request the information in another language if so desired. There may also be drivers of different nationalities on the same machine.

To facilitate for design and any troubleshooting of the application, be consistent when you name the different channels. We will give you some recommendations on how to name the different channels with regard to their function, see section naming channels.

When you create an application, you begin by defining the different channels' properties. It is also important that you have defined the direction of motion for the machine's different movements. In the chapter, you will find recommendations for the selection of direction.

For example, properties are the name of the channel, calibration of signals such as voltage and current values, alarm limits and delay times. The properties are specific for each type of channel.

List of all channel types

Name	Short	Input/Output/ Internal/J1939	Analog/Digital value
Alarm output	ALRM	Output	Digital
Conditional message	CMSG	Internal	Digital
Current output	COUT	Output	Analog
Digital input	DIN	Input	Digital
Digital output	DOUT	Output	Digital
Directional analog	DAC	Internal	Analog
E-Gas output	EGAS	Output	Analog
E-Gas position input	EPOS	Input	Analog
Engine load	ELD	Internal	Analog
Event counter	ECNT	Internal	Analog
Event log	ELOG	Internal	Digital
Frequency input	FIN	Input	Analog
Function parameter	FP	Internal	Analog
Hour counter	HCNT	Internal	Analog
Integrating limiting	ILC	Internal	Analog
Interactive message	IMSG	Internal	Analog
Internal analog	IAC	Internal	Analog
Internal digital	IDC	Internal	Digital
J1939 Analog input	JAIN	J1939	Analog
J1939 Analog output	JAOUT	J1939	Analog
J1939 Diagnostic	JDGN	J1939	Analog
J1939 Digital input	JDIN	J1939	Digital
J1939 Digital output	JDOUT	J1939	Digital
J1939 E-Gas	JGAS	J1939	Analog
J1939 Lamp indicator	JLIC	J1939	Digital

Name	Short	Input/Output/ Internal/J1939	Analog/Digital value
Math analog	MAC	Internal	Analog
Math digital	MDC	Internal	Digital
Memorizing	MEM	Internal	Analog
Mode Selection	MSC	Internal	Analog
Module diagnostic	MDGN	Internal	Analog
PID-regulator	PID	Internal	Analog
Pulse width modulated output	PWM	Output	Analog
SMS input	SMSIN	Internal	Analog
SMS output	SMSOUT	Internal	Analog
State selection	SSC	Internal	Analog
Timer	TMR	Internal	Analog
Voltage input	VIN	Input	Analog

Inputs

A short presentation of the different physical input channels. For more information about the physical data for the inputs, see separate data sheet or instruction books for the modules.

Voltage in

The input signal at these inputs comes primarily from analog sensors and levers. The unscaled range is dependant on which module you use but is normally 0-5000mV, the scaled range is application dependent.

Digital in

Physical inputs with value low or high. They are mostly used for buttons, position sensors and guards.

Frequency in

Typical functions are speed measure or revolution measure. The unscaled range is 0-32000 Hz and the scaled range is application dependent.

E-gas Position

Use this channel if you want to measure or show the value of e.g the actuator positions. The unscaled value is 0-5000 mV and the scaled value is 0-100%. The E-gas out use this channel as the feedback value during regulation.

Internal channels

Directional analog channel

These channels are found on IQAN's lever modules. There is one channel for each lever direction, X, Y and Z. The value of each channel corresponds to -100% - 100%.

Internal analog channel

The internal analog channels are used primarily as input signals for the regulators but they can also be used for other purposes, e.g. when you create a function for a current output. The channel´s value is -100%- 100%.

Internal digital channel

With an internal digital channel, you can e.g delay a digital input signal, or group objects that you use together in several channels when you create functions. The channel´s state is either true or false.

EXAMPLE

A button has to be pressed down for a certain time before the function starts.

Mathematical analog channel

Using these channels, you can carry out mathematical calculations e.g. sine, cosine, plus, minus etc.

Mathematical digital channel

Using a mathematical digital channel, you can carry out relational and logical operations on input signals from other channels. The channel´s value is either true or false.

EXAMPLE

Performance of boolean operations

PID regulator

PID regulators are used to do closed loop control, e.g. a straight-lift function for a crane. The channel´s value is -100%- 100%.

Integrating limiting channel

This channel will normally be used as a limiting object in an analog output, e.g Current out or E-gas out. It is similar to a PID with only the integrating part enabled. The channel's range is 0 - 100%.

Conditional message

On the display, you can show messages for different situations, e.g. the oil pressure during operation or a warning message indicating overload. The channel can display up to two messages at the same time.

Interactive message

The message is shown when a certain condition is fulfilled. The value for the channel can be active or inactive, but also F1, F2, F3 or ESC, depending on the state of the display´s function buttons, i.e. you can use the buttons on the display module as digital inputs.

Event counter

With this channel type is it possible to count different events, e.g. how many times a specific alarm condition has been fulfilled. You can increase, decrease or reset the channel´s value. The range is 0-32000.

Memorizing channel

This channel type is used to memorize or accumulate the value of a defined input signal. The range is 0-32000.

EXAMPLE

On a wheel loader you need to control the total weight of the load. Use a memorizing channel to accumulate the weight of the load.

Event log channel

Use this channel type to log data for a channel at certain conditions. The data is stored in the errors/events log in the master and can be shown in IQANdevelop.

Timer

A timer channel can be used for timekeeping, delays, etc. The time range for a channel is 0-32000 s with a resolution of 50 ms. To lengthen this time, the timer channels can be connected sequentially.

Hour counter

The hour counter channels are used for time keeping at low time resolution, e.g. to measure a machine’s operation time before service. The time range is 0-32000 hours with a resolution of two minutes.

Mode selection channel

With this channel type you can automatically change "driver" mode when certain conditions are met. The value of the channel is 1-4.

State selection channel

This channel is used to control the states conditions in a "state machine" There can be up to eight states for a channel.

Module diagnostic channel

This channel is used to measure module diagnostics, such as *Supply voltage, Temperature* and *Utilization*.

Function parameters

Function parameters are used as adjustable constants in functions. You can adjust the function parameter values via the IQAN display or via IQANdevelop.

Engine load

This channel can be used to carry out power control for a diesel engine.

SMS input

Use this channel to read values from incoming messages via SMS (Short Message Service). Requires a SMS-capable GSM modem connected to the master module.

SMS output

Use this channel to send messages via SMS (Short Message Service) to external systems/GSM phones. Requires a SMS-capable GSM modem connected to the master module.

Outputs

A short presentation of the different physical output channels. For more information about the physical data for the outputs, see separate data sheet or instruction books for the modules.

Current out

The current outputs are analog and are used to e.g. control proportional valves. The unscaled range is -32000 - 32000 mA. The scaled range is -100% - 100%.

PWM out

PWM out, a pulse width modulation output to control pulsar valves. The channel's function is similar to the current outputs. The scaled range is -100% - 100%.

Digital out

Physical outputs with value low or high. These are mostly used to activate lamps, on/off valves or to pull relays.

On some modules the digital outputs have soft start and peak and hold functions to increase the valve's life time and reduce the heat release in the valve.

Alarm out

A physical output with value low or high. It is used to alert in different situations. A warning lamp or siren may be connected at the output.

E-gas output

You will find the E-gas out on the IQAN-XT2 module. With this channel you can create a regulation function to control e.g an actuator that is used to control the speed of a diesel engine. The channel´s scaled range is -100% - 100%.

Primary and secondary outputs

For most outputs, there are two channels, which enable you to control two different functions in the machine using the same output.
One channel has primary status and the other channel has secondary status. If the primary channel is active, the secondary channel cannot be activated at the same time. If both of the channels are active at the same time, this is indicated as incorrect, the output is closed and an error message is displayed.

For more information on this, see section Primary and secondary channel, on page 279.

NOTE

When using double functions, carefully check the affects of the functions on one another. Safety precautions should be taken.

EXAMPLE

A backhoe loader with turnable chair. When you turn the chair, you must invert the lever's directions so that the manoeuvring of the vehicle's steering will be correct. For this, you can use the current output's primary and secondary channels. If the chair is turned forward, the primary channel is used and if the chair is turned backward, the secondary channel is used. A switch in the chair indicates if the chair is turned forward or backward.

SAE J1939

There are some channel types used only during communication on the CAN-bus dedicated for the protocol SAE J1939. You find these channels on the IQAN-XT2.

J1939 Analog input

This channel type represents values from different analog sensors implemented in the diesel engine. For example fuel and oil temperature. The properties for a channel are documented in the specification for SAE J1939 or are supplied from the engine manufacturer.

J1939 Digital input

This channel type is used for on/off sensors in the diesel engine.

J1939 Throttle out

With this channel the IQAN system controls the speed of the diesel engine. This channel represent the engine´s command value. The unscaled channel range is 0-32000 rpm and the scaled range is 0-100%.

J1939 Lamp indicator

This channel is used to indicate an error situation. The manufacturer has specified which lamp will be activated and when according to a specific error. The value for the channel is either true or false.

J1939 Diagnostics

The channels for diagnostic is aimed to show diagnostic messages on the display. For example if there is some error in diesel engine, information about it will be sent to the IQAN system and a corresponding message will be presented on the display.

J1939 Analog output

Use this channel to send user-defined analog information on the CAN-bus, e.g sending load weight to an external weight logging system.

J1939 Digital output

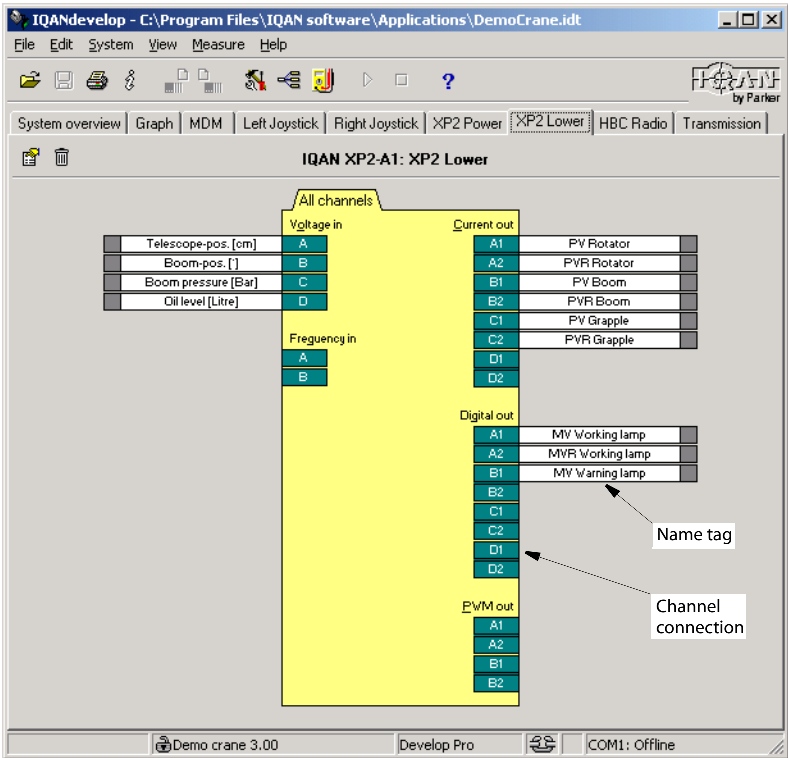
This is the same as J1939 Analog output, but digital information instead.

Creating a new channel

Adding a channel

To create an application you need to add all the channels that shall be included in the application.

- Right-click on the channel connection to be used.
  Select: *Add channel.*

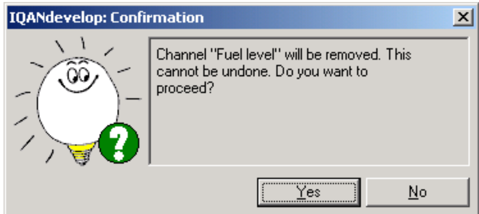


Creating a channel in the block diagram.

When a channel is created, its corresponding name tag is shown. The channel name is predefined as follows: *Channel type - Channel connection number: Module type - CAN address.* Example: COUT-A1:XP-A0.
The channel can now be given properties, see section Defining properties, on page 123.

Deleting a channel

- Right-click on the channel's connection and select: *Delete channel.*



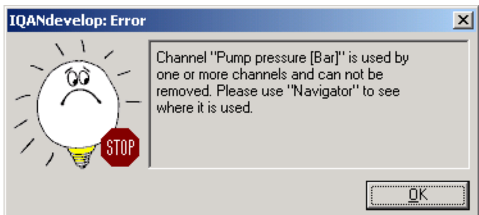
Dialog box to delete a channel.

- Click *Yes* to delete the channel or *No* to leave it there.

If a channel cannot be deleted

It is not possible to delete a channel that is used in an object.

The following message box is shown.



Message box that the channel cannot be deleted.

Moving a channel

It is possible to move channels between modules. In order to move a channel, there must be a channel of the same channel type available on the destination module.

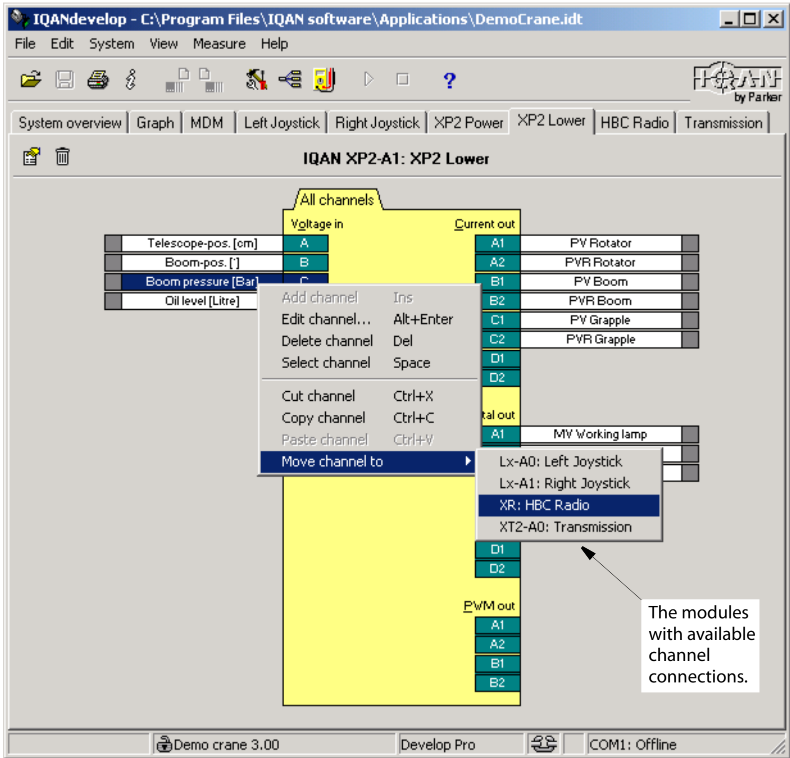
Moving a channel within the same module

To move a channel within the same module, click on the channel to be moved and drag it to another channel connection. If the new connection is already occupied, these channels simply change places.

Moving a channel to another module

- Click on the channel to be moved and select: *Edit* > *Move channel to* or right-click on the channel connection and select: *Move channel to*. The modules with available channel connections are shown in a menu.

- Select the channel's destination module in the menu.



Moving a channel to another module.

Confirming move of channel

When you move a channel, you receive a message to confirm that the channel will be moved. Click *Yes* or *No*.

NOTE

Consider that, if you move a channel with a predefined name (*Channel type - Channel connection number: Module type - CAN address*), this name goes with the channel.

Naming channels

When you name channels, it is important to keep to the same standard throughout the whole naming procedure. In reality, there is no right or wrong, but it should be apparent from the name how the channel works.

....a little recommendation when selecting names

For digital inputs and outputs, a good naming standard is to name the input and output after its active state.

EXAMPLE

A stop button should get the name Stop because the name applies when the input for the stop button is activated.

For a parking brake, it is often appropriate that you activate the output when you want it to release. Therefore the name of the output should be *Parking brake free*.

For analog inputs and outputs, we normally give names after function, for example, Oil pressure, Telescope, or Angle sensor, boom.

Direction of motion

You should be consistent when defining the direction.

Before you create an application for a machine, it is important to define the directions of movement for all moving components such as levers, lifting, crane turns, etc. Every movement has a positive direction and a negative direction.

The most important thing is to be consistent with the direction selection when you create an application, partly to facilitate things when documenting the application and partly when troubleshooting or rebuilding.

....a small recommendation when selecting direction

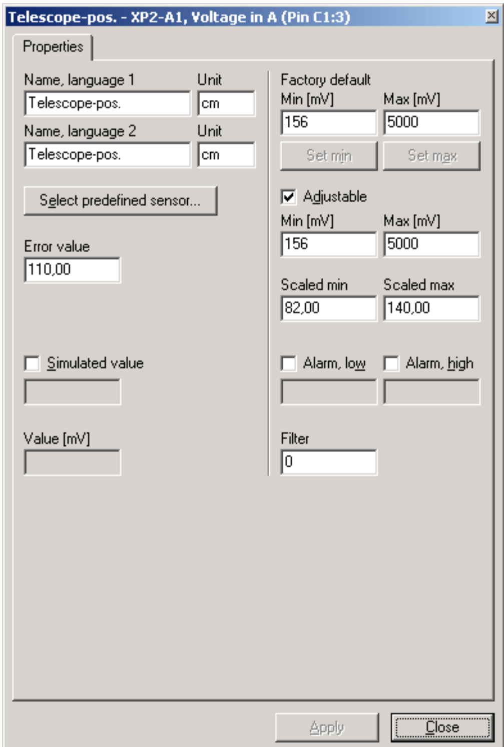
Up	Positive
Down	Negative
Forward	Positive
Reverse	Negative
Right	Positive
Left	Negative
Right turn	Positive
Left turn	Negative
Out	Positive
In	Negative

Defining properties

To use the inputs and outputs in an application, respective channel must be configured. You do this by providing the channel with properties. To define properties, open the dialog box for channel information. The dialog box looks different depending on which type of channel you select. For example, properties are name, calibration of signals such as voltage and current values and alarm limits.

Opening the dialog box channel information

- Select the channel's name tag in the block diagram and select: *View > Show channel info.*



Properties for voltage in.

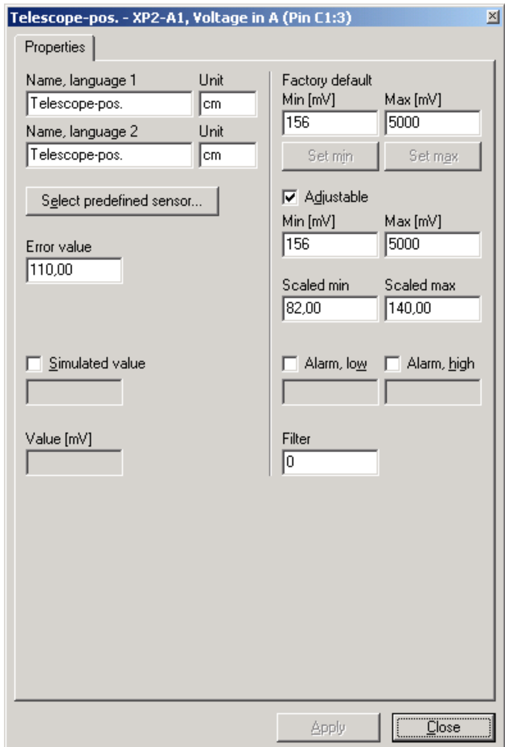
It is also possible to double-click on the name tag to open the dialog box.

Function buttons

To store the new properties, click *Apply.* The *Close* button closes the dialog box. Ensure that the properties have been stored before the dialog box is closed.

Voltage in

Under the *Properties* tab, you fill in the channel’s name and calibration values. The calibration adapts the IQAN system to the sensor’s zero-level. Properties also define what will happen if the channel takes on an invalid value or if an alarm will be activated when the value of the signal is at a defined level. It is also possible to read the channel’s current value during measurement or to simulate a value.



Properties for voltage in.

Name

Name, language 1 Name, language 2	The channel’s name in the two languages shown on the display.

Unit

Unit	The unit to be presented on the display together with the scaled value of the channel, e.g. °, *bar, liters, cm, etc.* You can also enter the unit in two languages.

ATTENTION

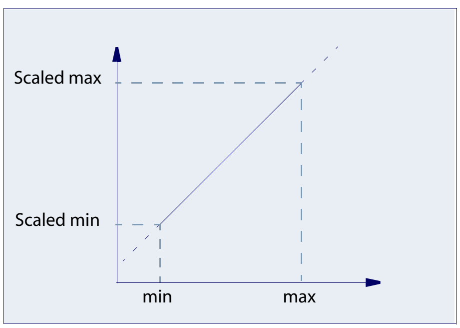
When you define a channel's properties for the two languages, it is important to remember that the unit can differ depending on language.

EXAMPLE

You cannot enter a temperature in °C for language 1 and °F for language 2. To do this, you need to adapt the channel's function as calculations with different units will give different results.

Calibrate and scale the input signal

Factory default Min [mV] Max [mV]	Voltage range for the input signal. Min = lowest voltage. Max = highest voltage.
Adjustable Min [mV] Max [mV]	To be able to adjust the value for *Min [mV]* and *Max [mV]* from the display, you must check the *Adjustable* box. This enables you to calibrate sensors from the display. For further information about the adjustable values, see section Adjustable values, on page 211.
Scaled min Scaled max	The input signal should be converted to a readable value for the operator. The value is presented on the display together with the defined unit. For example, at 0.8 V, the sensor will measure a pressure at 20 bar. See data sheet for respective sensor.



Scaling of the input signal.

Set min, set max

Set min Set max	To facilitate calibration of minimum voltage. E.g. calibration of the input when you have connected an analog position sensor for the telescope. Manoeuvre the telescope to its minimum position and click on Set min. The voltage from the sensor is measured and shown in the display Min [mV]. The same procedure applies for the maximum voltage when the telescope is in its maximal position. For this, the channel must be activated for measure. Click on the channel's measure flag.

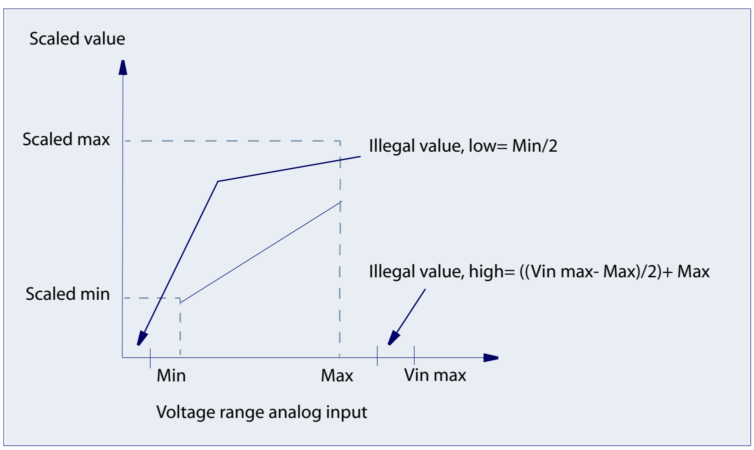
Measure and simulate

Consider personal safety when simulating. Appropriate safety precautions should be taken.

Value [mV]	Shows the current value for the channel during measure. This can be used when you calibrate the channel for each individual sensor.
Simulated value	Simulate a value on the channel. Check the box and enter a value in the field below. The channel will use this value instead of the actual measured value on the input.

Error value

Error value	If the channel's value is outside the specified voltage range, the illegal value is replaced by an error value. Enter a proper scaled value for the channel.



Detection of illegal value.

For the IQAN system to be able to detect errors such as short circuit or power failure, the signal's voltage value must be within the min and max limits as per the above diagram. If the signal level reaches the illegal range, a signal error is indicated. When an illegal value is detected, the value at the input is replaced with a fixed error value to avoid jeopardizing the machine's function. This error value is entered when you declare the channel's properties.

NOTE

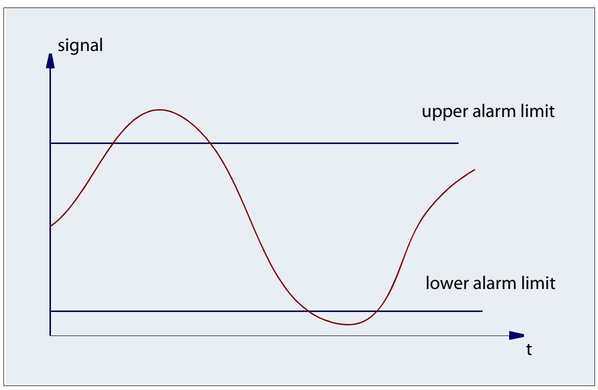
An illegal value can cause a faulty function on the machine. Carefully consider critical and dangerous situations when the input signal's value is incorrect and enter suitable replacement values.

Following messages are shown on the display.

- *Input error low,* if the value is under the specified value.
- *Input error high,* if the value is over the specified value.

Alarm

Alarm, low Alarm, high	The alarm is activated when the input signal passes a defined alarm limit. Select type of alarm by checking the boxes. In the field below, enter the level for the alarm limit. The alarm limit considers the scaled value. You can define both an upper and lower alarm limit for the channel. Alarm, low = when the signal drops below the lower alarm limit, the alarm is activated. Alarm, high = when the signal exceeds the upper alarm limit, the alarm is activated.



Definition of alarm limits.

If an alarm is activated, an alarm text is lit on the display. For the text to disappear, you must acknowledge by pressing a button to confirm that you have been informed of the alarm text. The alarm text also disappears when the alarm signal returns to normal, i.e. the alarm has disappeared.

The following messages can be shown on the display:

- *Alarm low,* if the value drops below the specified value, below the alarm limit.
- *Alarm high,* if the value exceeds the specified value, above the alarm limit.

All the alarms are logged in the error log in the master for further information, see section Error/event log, on page 290.

Filtering the input signal

Filter	Use a filter to attain greater stability in the channel's signal. The value is entered in [%].

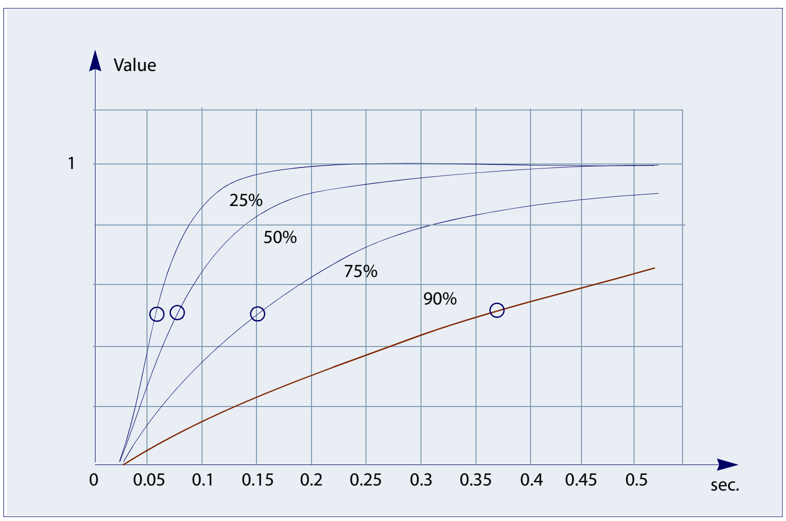
A signal which varies quickly, sometimes needs to be dampened.

EXAMPLE

The signal from the level meter in a fuel tank. When you drive in rugged terrain the fuel splashes around in the tank and the signal from the level meter becomes unstable. It can be a good idea to allow the signal to pass through a filter.

NOTE

It is important to point out that too strong a filter can affect the signal too much. If the channel is used for closed-loop regulation, it can become slow and self-induced oscillation can occur in the system.

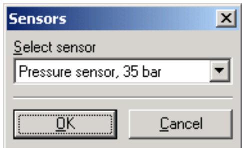


Step response for analog input signal.

The filter is not linear.

Predefined sensors...

- Via the *Select predefined sensor* button, you have access to a list with a number of named and calibrated input signals for different sensor types.
- Click in the list to see the whole list with calibrated signals. It is also possible to extend this list with your own input signals.



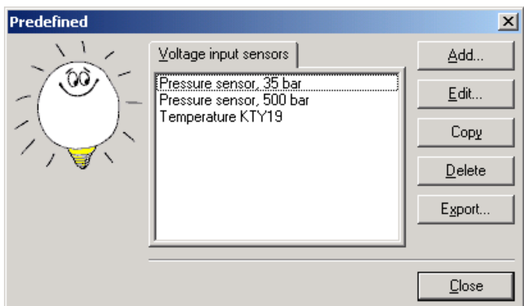
Predefined sensors list.

- Select a sensor and click *OK*. The *Cancel* button closes the dialog box without registering any selected alternatives.

Creating predefined sensors

It is possible to add sensors in "the sensor list".

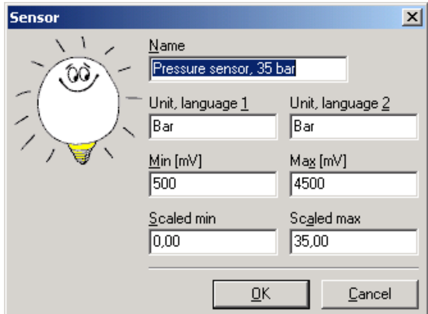
- Select: *File > Predefined.*



List with calibrated sensors.

Add a sensor

- Click on the *Add* button.



Add a sensor.

Name and unit

Name	Name of the sensor.
Unit	The unit to be presented on the display together with the scaled value of the channel. *E.g. °, bar, liters, cm, etc.* You can also enter the unit in two languages.

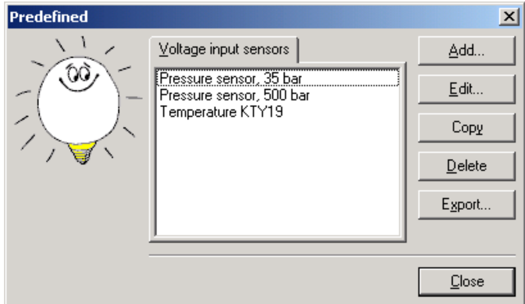
Calibrate and scale the input signal

Min [mV] Max [mV]	Voltage range for the input signal. Min = lowest voltage Max = highest voltage
Scaled max Scaled min	The input signal should be converted to a readable value for the operator. The value is presented on the display together with the defined unit. For example, at 1.5 V, the sensor will measure a volume at 65 liters. See data sheet for respective sensor.

Click *OK* to save changes. The *Cancel* button closes the dialog box without saving any changes.

Editing a sensor in the list

- Select the sensor and click on the *Edit* button.
  The dialog box for the sensor is opened.



List with calibrated sensors.

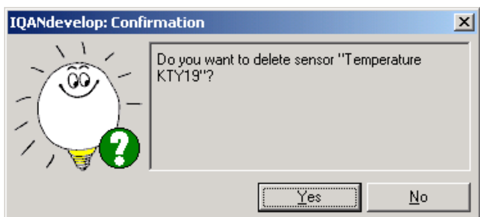
- Click *OK* to save changes. The *Cancel* button closes the dialog box without saving any changes.

Copy a sensor in the list

- Select the sensor and click on the *Copy* button.
- A copy of the selected sensor is created. It is named "Copy of <original name>".
- Edit the copied sensor. See above.

Delete a sensor in the list

- Select the sensor to be deleted in the list and click on the *Delete* button.



Message for deleting a sensor.

- Click *Yes* to delete the sensor or *No* to leave it there.

Export sensor list

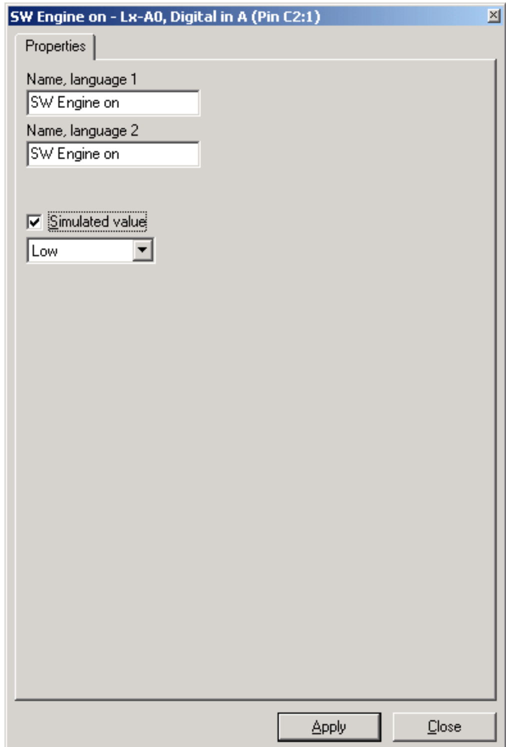
You can save a sensor in the sensor list as a .reg-file if you want to e.g use the sensor on another computer.

- Select a sensor in the list and click on the *Export* button. The sensor will be saved in a .reg file.

To import the sensor, double click on the .reg-file in the file manager. The sensor will be imported into Windows registry.

Digital in

Under the *Properties* tab, you fill in the channel’s name. It is also possible to simulate a value.



Properties for digital in.

Name

Name, language 1 Name, language 2	The channel’s name in the two languages shown on the display.

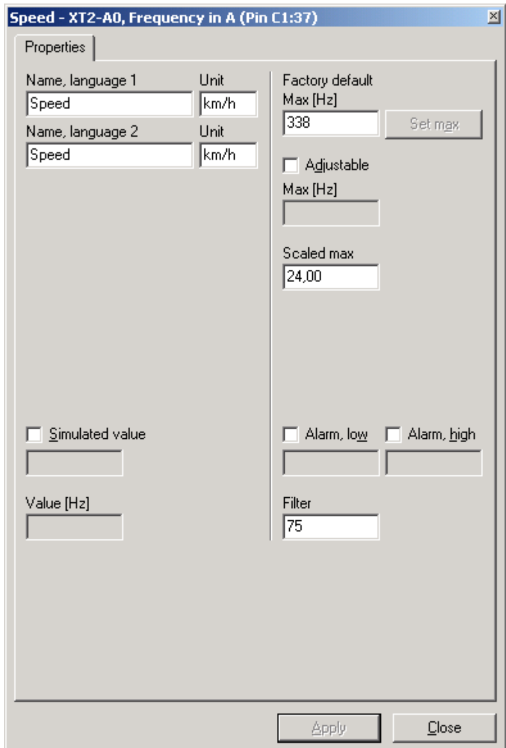
Measure and simulate

Simulated value	Simulate a value on the channel. Check the box and select a value in the field below. The channel will use this value instead of the actual measured value on the input.

Consider personal safety when simulating. Appropriate safety precautions should be taken.

Frequency in

Under the *Properties* tab, you can name the channel and enter the calibration values for the signal. It is possible to define if the alarm will be activated when the value of the channel reaches a level as well as filter the signal, read the channel's value or simulate a value.



Properties for frequency in.

Name and unit

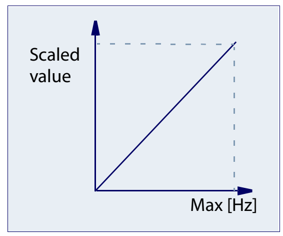
Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.
Unit	The unit to be presented on the display together with the scaled value of the channel.

Calibrate and scale the input signal

Factory default Max [Hz]	Maximum frequency at the input.
Adjustable Max [Hz]	If you wish to be able to adjust the value for *Max [Hz]* from the display, check the *Adjustable* box. For further information about the adjustable value, see section Adjustable values, on page 211.
Scaled max	The input signal should be converted to a readable value for the operator. The value is presented on the display together with the defined unit. For example, if the input signal is a speed, you present the value in km/h instead of the frequency value found on the channel.

EXAMPLE

To rescale frequency [Hz] to revolutions [rpm] for a diesel engine.
Assume max diesel engine revolution = 3000 rpm
Assume the number of cogs/engine rev. = 135
Frequency = (3000/60)* 135 = 6750 Hz



Set max

Set max	Set the maximum value for the frequency input. Let the sensor which is connected to the input generate the frequency which will correspond to the scaled value. Click on *Set max*. The frequency value is measured and entered in the Max [Hz] box. For this function, you must first activate the channel for measure. Click on the channel’s measure flag.

Trig level frequency signal IQAN-XP

Low, trig level High, trig level (pre-set)	As the frequency signal has different amplitudes depending on different types of sensors, you must define on which level the IQAN system will detect the signal to calculate the frequency. For example, frequency sensor with high signal amplitude should use high, trig level(=2.5 V). Passive inductive sensors with a low signal amplitude should use low trig level (=0.25 V). The IQAN system measures the time period between two flanks which are positive to one another. The frequency is then calculated from this. High trig level is pre-set.

Measure and simulate

Consider personal safety when simulating. Appropriate safety precautions should be taken.

Value [Hz]	Shows the current value for the channel. Can be used when calibrating the channel for a unique sensor.
Simulated value	Simulate a value on the channel. Check the box and enter a value in the field below. The channel will use this value instead of the actual measured value on the input.

Alarm

Alarm, low Alarm, high	If the alarm is to be activated when the input signal passes a defined alarm limit. Select type of alarm by checking the boxes. In the field below, you enter the level for the alarm limit. The alarm limit considers the scaled value. Alarm, low = when the signal drops below the lower alarm limit, the alarm is activated. Alarm, high = when the signal exceeds the upper alarm limit, the alarm is activated.

For further information, see section Alarm, on page 127.

Filtering the input signal

Filter	Use a filter to attain greater stability in the channel's signal. The value is entered in [%].

An analog signal which varies quickly can require dampening, for example, the revolutions signal from a diesel engine. The signal must pass through a filter.

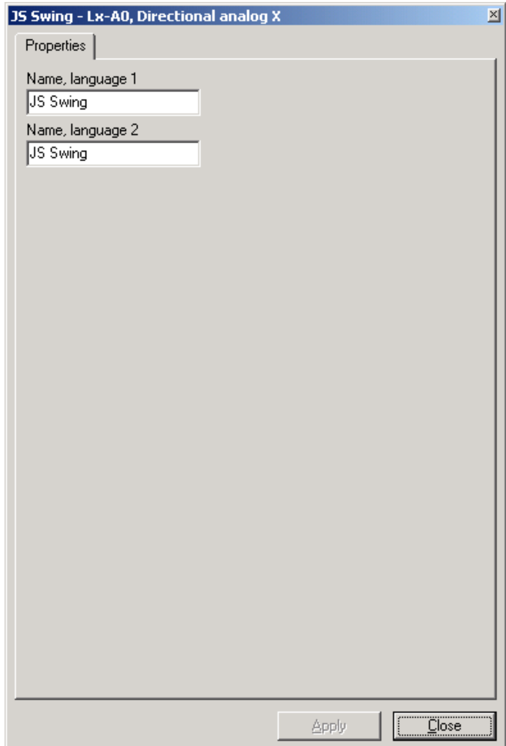
EXAMPLE

If you want to regulate the speed of manoeuvring of a crane turn as a function of how hard the diesel engine works, you would have a very unstable regulation. In this case, dampen the revolution signal from the diesel engine with a filter.

For further information, see section Filtering the input signal, on page 128.

Directional analog

The only property for a directional analog channel is the name. The channel has a default range of -100%- 100%.



Properties for directional analog channel

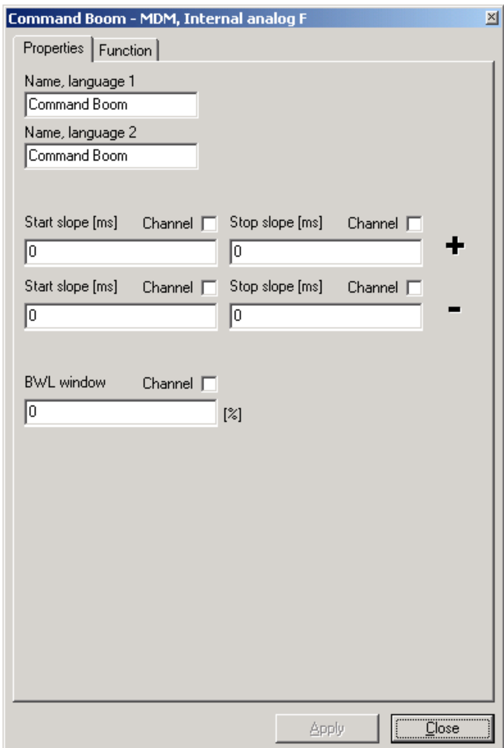
Name

Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Internal analog

Under the *Properties* tab, you can name the channel and enter the rise and fall time for the signal.

In addition you can define a *BWL (Band Width Limiting) window*. This function will decrease the frequency bandwidth of the output signal whenever the change of the output signal is smaller than *BWL window*. The bandwidth limit will decrease linearly with smaller changes. When the change of the signal is zero, the bandwidth will also be zero. When the signal change is larger than the window, no bandwidth limitation will be used. This function is particularly good to use for signals that are "nervous" but where a normal filter would decrease the overall dynamics of the signal, e.g joystick control for a crane function.



Properties internal analog.

Name

Name, language 1 Name, language 2	The channel's name in the two languages.

Slope times

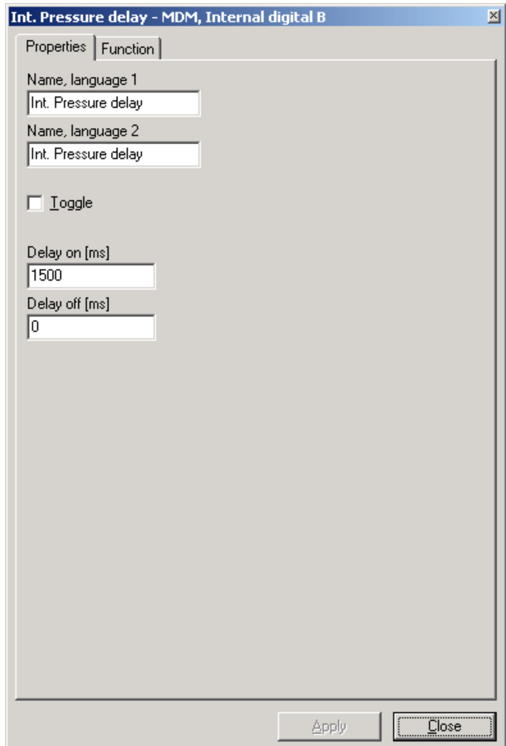
+/-	The values below are entered for positive and negative direction respectively.
Start slope [ms] Stop slope [ms]	Enter the time it should take for the value to rise from min to max and the time it should take for the value to fall from max to min.
Channel	Check the *Channel* box to select a channel as min and max for start or stop slopes.
BWL window [%]	Enter size of window for bandwidth limiting.

EXAMPLE

By using a internal analog channel it is possible to calculate different slopes for different situations.

Internal digital

Under the *Properties* tab, you fill in the channel's name. By using the *Delay, on/off* property, it is possible to delay the on/off transition of the signal.



Properties for internal digital.

Name

Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Delay on/off

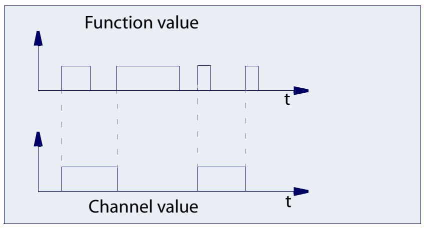
Delay, on [ms]	The time delay is given in [ms]. E.g. if you require a button to be pressed down for a certain time before a function starts. If the function is activated shorter time than the specified delay on time, the channel´s state will not be affected.

Delay, off [ms]	The time delay is given in [ms]. E.g. if you want a function to continue a time after you have released the button (the input signal has returned). If the function is blocked shorter time than the specified delay off time, the channel´s state will not be affected.

For further information about the delay on/off properties, see section Digital out, on page 177

Switch status for the output signal

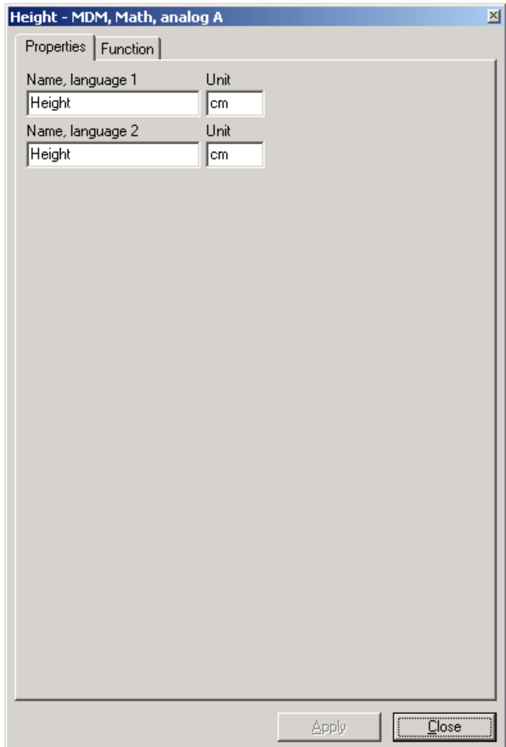
Toggle	The channel’s state will alternate between true and false for every activation of the channel. Every other time the state is true, every other time false.



Internal digital with toggle.

Mathematical analog

Under the *Properties* tab, you can name the channel and enter the unit for the channel value.



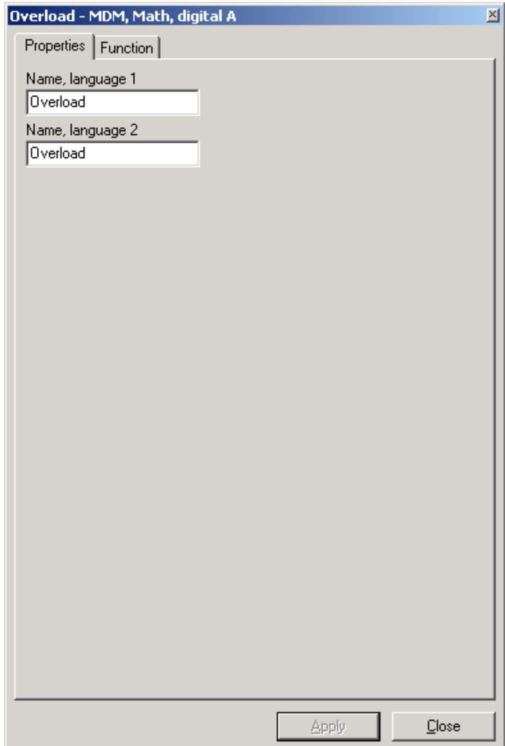
Properties for mathematical analog channel.

Name and unit

Name, language 1 Name, language 2	The channels's name in the two languages.
Unit	The unit to be presented on the display together with the value of the channel.

Mathematical digital

Under the *Properties* tab, you enter the name of the mathematical digital channel.



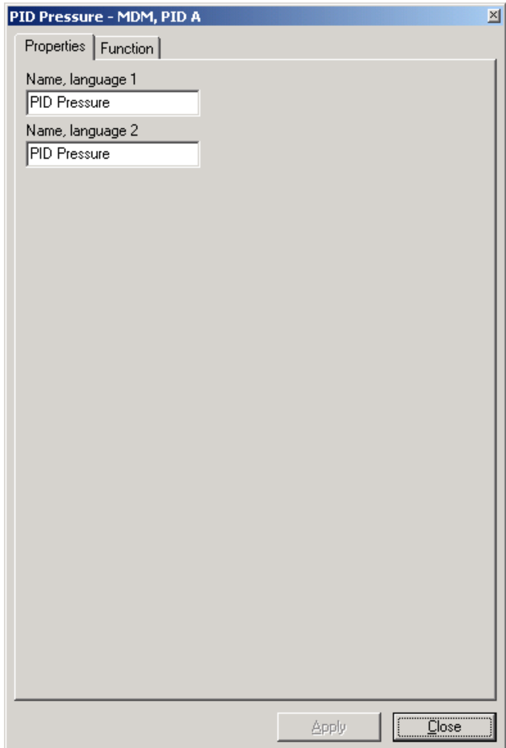
Properties for mathematical digital channel

Name

Name, language 1 Name, language 2	The channel's name in the two languages.

PID

Under the *Properties* tab, you enter the channel's name.



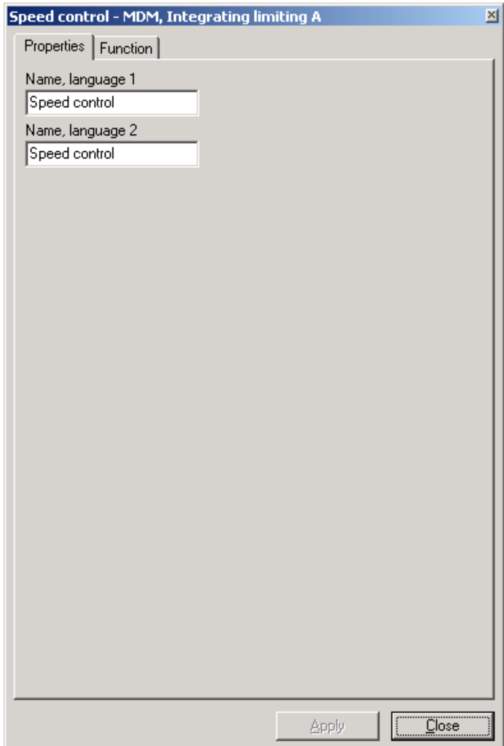
Properties for PID regulation.

Name

Name, language 1 Name, language 2	The channel's name in the two languages.

Integrating limiting

This channel is used for example to limit the power-pressure for diesel engine in different situations. The only property for this channel is the name.



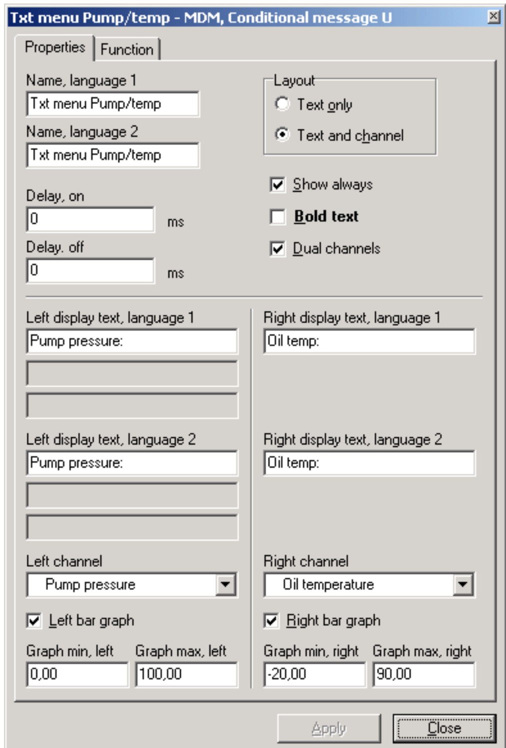
Properties for the Integrating limiting channel.

Name

Name, language 1 Name, language 2	The channel's name in the two languages.

Conditional message

With this channel type you can create messages that will be shown at certain conditions. A *conditional message channel* can show up to two messages or channel values at one time. There are also possibilities to always show a messages when the display is in operating mode.



Properties for the conditional message channel.

Name

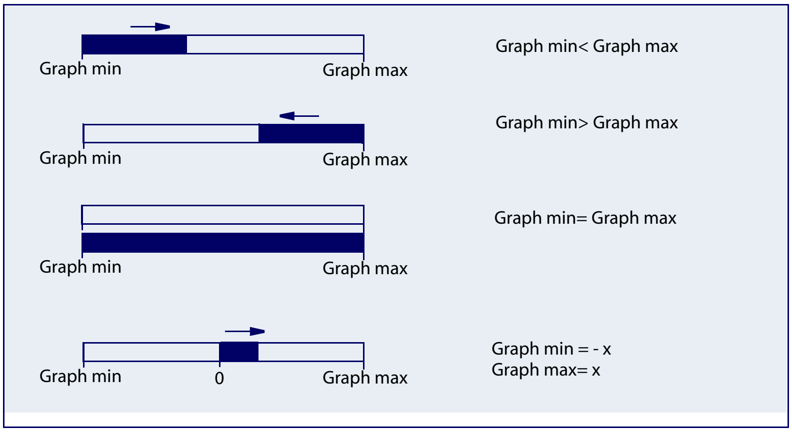
Name, language 1 Name, language 2	The channel's name in the two languages.

Layout

Text only	There is room for three rows of text on the display.
Text and channel	There is room for one text row and one row showing the value of a selected channel. If you choose to show only one channel, the name of the channel is also shown.
Channel	Select the channel to be shown with the text message. (Check the *Layout* alternative *Text and channel*)

Bar graph

Bar graph, left Bar graph, right	The channel´s value is presented as a bar graph on the display.
Graph min Graph max	Specify the limits for the bar graph.



The bar graph will act different dependent on how the limits are specified.

Display text left and right

Display text, language 1 Display text, language 2	The text message which is displayed when a certain condition has been fulfilled. The message can be shown in two languages. By checking the box *Show always* the message will always be shown when the display is in operating mode.
Dual channels	By checking this box two messages will be shown. One to the left and one to the right.

Text option

Bold text	The text will be written with bold font.

Show always

Show always	By checking the *Show always* box, you get an extra menu page in the display's operation mode, where the specified messages will be shown. Browse with the display buttons to manually select a page. If you also create a function for the channel, the menu page can be shown automatically when a certain condition is fulfilled.

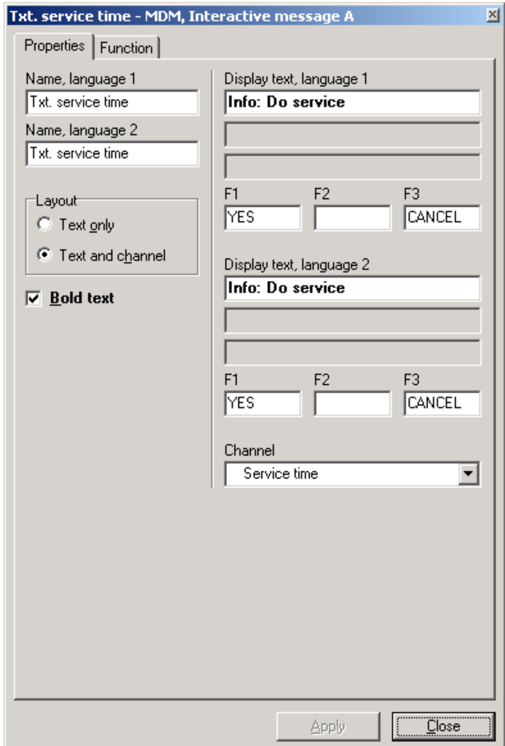
Delay on/off

Delay, on [ms]	*Delay, on* is entered in [ms]. If the function is activated shorter time than the specified delay on time, the channel´s state will not be affected.
Delay, off [ms]	*Delay, off* is entered in [ms]. If the function is blocked shorter time than the specified delay off time, the channel´s state will not be affected.

For further information about the Delay on/off, see section Digital out, on page 177.

Interactive message

This channel type is used to present messages that can be acknowledged with the function buttons on the IQAN display. This will give you an opportunity to create functions that depends on which button is pressed when the message is shown. On the properties page you can enter the text message and the text for the function buttons.



To create interactive messages on the display.

Name

Name, language 1 Name, language 2	The channel's name in the two languages.

Layout

Text only	There is room for three rows of text on the display.
Text and channel	There is room for one text row and one row showing the value of a selected channel. If you choose to show only one channel, the name of the channel is also shown.

Bold text	The text will be written with bold font.

Display text

Display text, language 1 Display text, language 2.	The text message which is displayed when a certain condition has been fulfilled. The message can be shown in two languages.
Channel	Select the channel to be shown with the text message. (Check the *Layout* alternative *Text and channel*).

Function button text

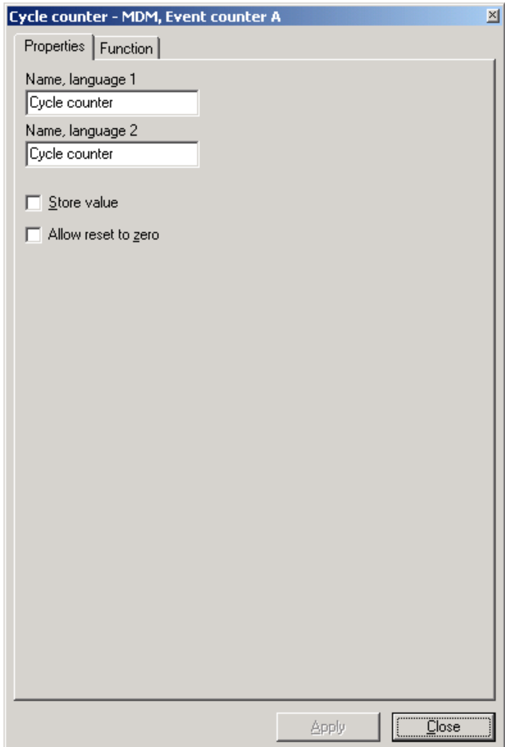
To be able to use a function button from the display you need to supply the button with a text. If a button doesn't have a text, the message can't be acknowledged by that button, i.e. the button is disabled.

NOTE

You must always take into consideration that the ESC-button can be pressed.

Event counter

This channel is used to count events. The range is 0-32000. The counter stops when it reaches 0 or 32000.



Properties for the channel event counter.

Name

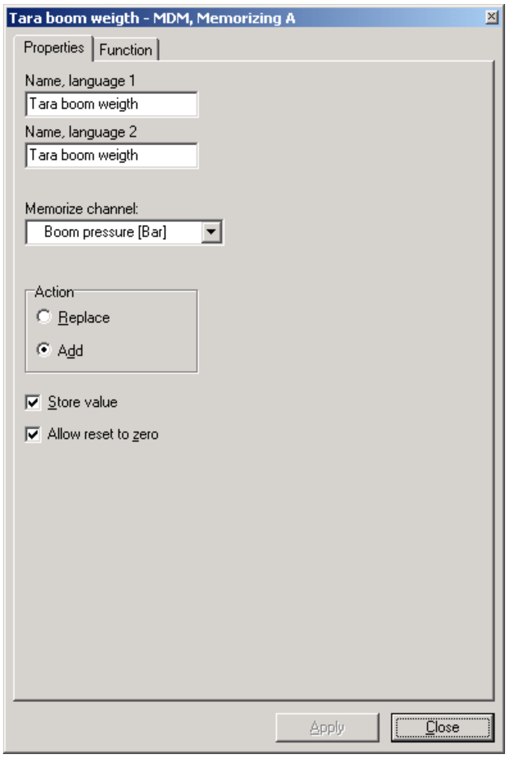
Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Store the counter's value

Store value	The channel value is stored in non-volatile memory. In this way, the value is stored even if you break the supply voltage to the system. Otherwise the value will be reset to zero at startup. See also section Stored values, page 212.
Allow reset to zero	The channel value can be reset to zero from the display or via *i*SMS, see Appendix D, page 368.

Memorizing

This channel type is used to memorize a channel´s value at certain conditions. The memorized value can either be replaced or added up by a new one. If you select to store the memorized value in the master´s memory it will remain unaffected when you break the supply voltage.



Properties for the Memorizing channel type.

Name

Name, language 1 Name, language 2	The channel’s name in the two languages shown on the display.

Channel to memorize

Memorize channel	Select the channel that you want to memorize.

Action

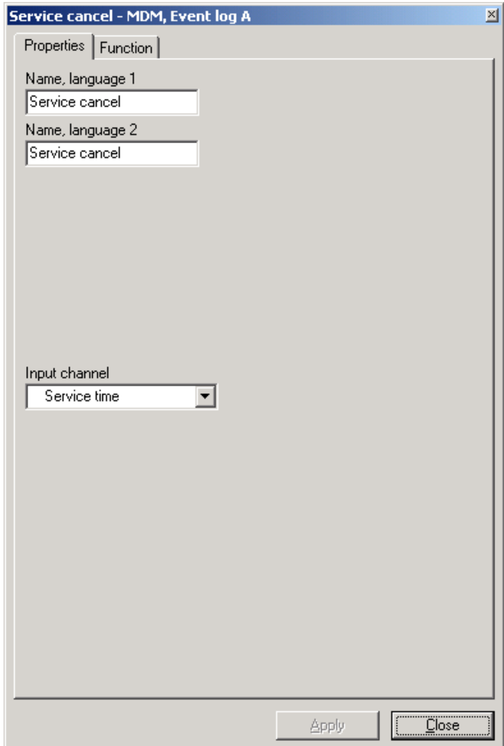
Replace	The memorized value is replaced by the current value.
Add	The current value is added to the memorized value.

Store value

Store value	The channel value is stored in non-volatile memory. In this way, the value is stored even if you break the supply voltage to the system. Otherwise the value will be reset to zero at startup. See also section Stored values, page 212.
Allow reset to zero	The channel value can be reset to zero from the display or via *i*SMS, see Appendix D, page 368.

Event log

The *Event log channel* is used to log a channel´s value at a specific event. When the *event log channel* is activated the time and the selected input channel´s value is stored in the event log.



Properties for the Event log channel.

Name

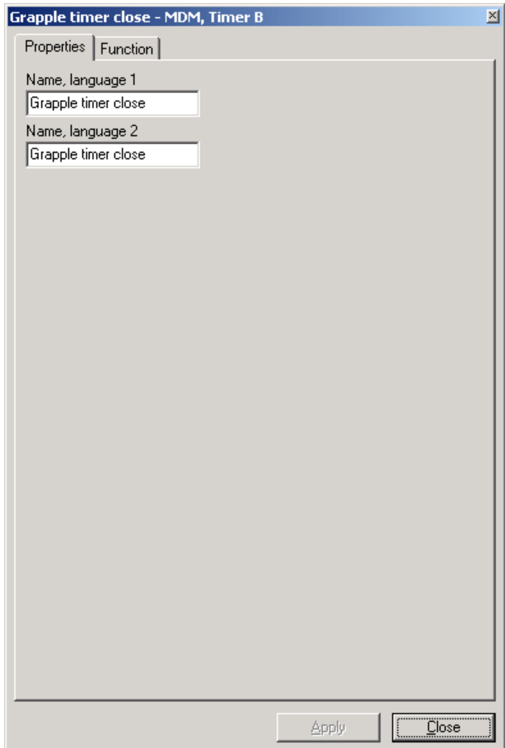
Name, language 1 Name, language 2	The channel's name in the two languages.

Channel to log

Input channel	Select the channel you want to log when the event log channel is activated.

Timer

The time range for a *timer* is 0-32000 s with a resolution of 50 ms. Under the *Properties* tab, you can name the channel.



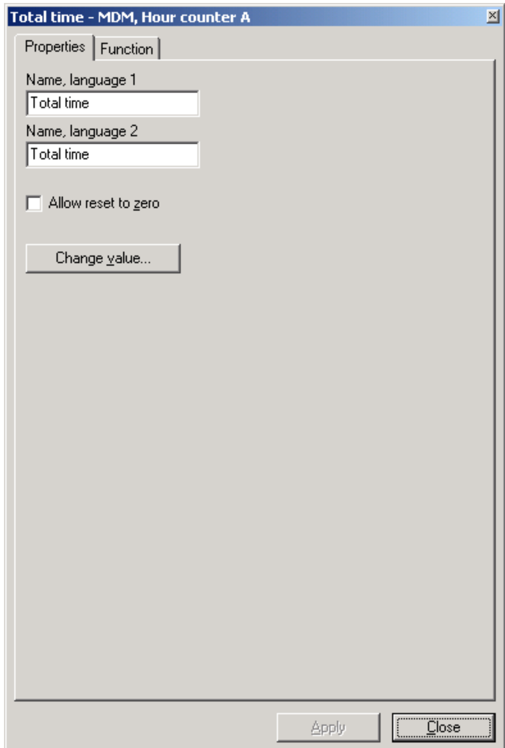
Properties for the timer channel.

Name

Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Hour counter

The range for an *hour counter* is 0-32000 hours with a resolution of 2 minutes. It is ideal for measuring e.g. the operating time for a machine or when you want to create functions for service interval.



Properties for hour counter.

Name

Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Allow reset to zero

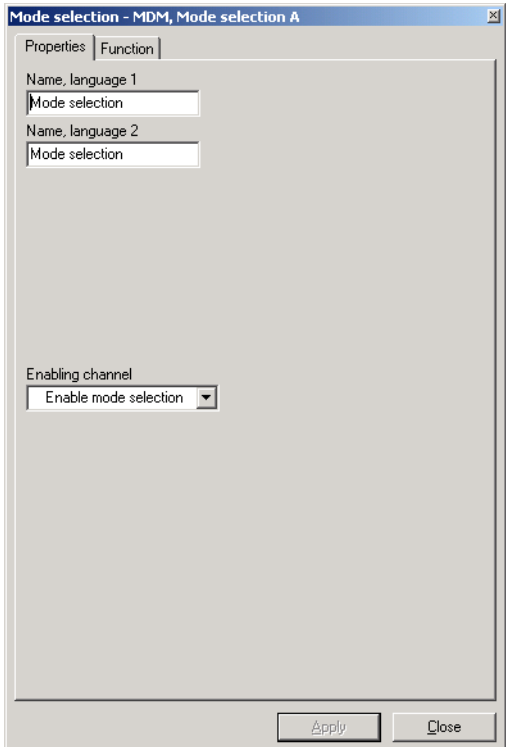
Allow reset to zero	This makes it possible to reset the hour counter to zero from the display and/or via *i*SMS, see Appendix D, page 368.

Change counter value

Change value	Click to change the hour counter's value. The current value is shown before you set a new value.

Mode selection

This channel is used to change the *operator mode* for one or more channels in the master. The channel´s value range is 1- 4 which corresponds to the four different modes.



Properties for the mode select channel.

Name

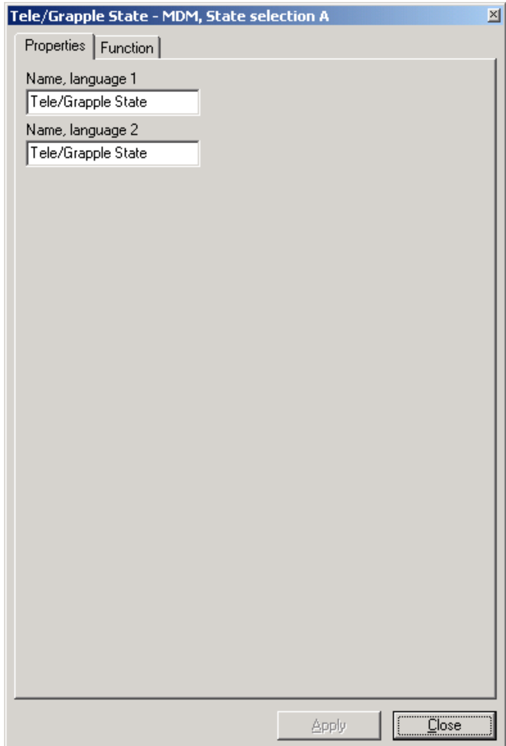
Name, language 1 Name, language 2	The channel’s name in the two languages.

Enabling channel

Enabling channel	Select a digital channel to enable auto mode. To always use auto mode, select *True*. If enabling channel is *false* then the manually selected mode is used, (i.e. the mode selection channel value equals manually selected mode), otherwise the function for this channel is used to select mode.

State selection

This channel type is used together with the multi function alternative for the output channels. With this channel combined with one or more outputs it is possible to create state machines.



Properties for the State selection channel.

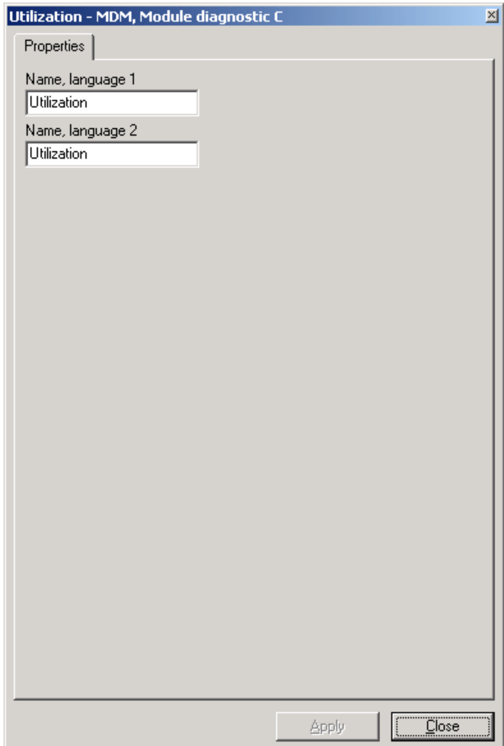
Name

Name, language 1 Name, language 2	The channel's name in the two languages.

For further information about the channel, see section State selection, on page 273.

Module diagnostic

This channel type is mainly intended to make it possible to measure internal channels in modules, such as temperature, supply voltage, etc. These channels can of course also be used in objects to build functions.



Properties for the Module diagnostic channel.

Name

Name, language 1 Name, language 2	The channel's name in two different languages.

These channels have different default names than other channel types to make it easier to interpret the value of each channel. The default name consists of the name specified in the table below plus the module index. You can change the name if you want to.

Default names

Module	Index	Name	Description
MDM	A	Temperature [°C]	Internal temperature
	B	Supply voltage [V]	Supply voltage
	C	Utilization [%]	System utilization, 0 - 100%. This value should never be higher than 75%. This value depends on what the application is executing, number of channels/objects and the system cycle time. For more information, see section System cycle time, on page 106.
	D	Error log count	Number of errors in the error log
	E	Event log count	Number of events in the event log
	F	SMS available	SMS (Short Message Service) is available in the current GSM network. If SMS is not available or there is no coverage, this channel is 0 (zero), otherwise 1.
	G	iSMS counter	Counts all incoming iSMS messages. Erroneous messages are also counted.
	H	Modem status	Indicates whether a modem is connected and offline or online. 0 = Not present 1 = Connected and offline 2 = Connected and online
	I	Weekday	Indicates the day of the week. 1=Monday, 7=Sunday.
	J	Real time clock	The actual time in hours and hundredths of an hour. E.g. 10.25 equals 10:15, 18.95 equals 18:57, etc.
TOC8	A	Temperature [°C]	Internal temperature
	B	Supply voltage [V]	Supply voltage

Module	Index	Name	Description
	C	Utilization [%]	See MDM.
	D	Ref. voltage A [V]	Should be 5.0 V
	E	Ref. voltage B [V]	Should be 5.0 V
	F	Error log count	Number of errors in the error log
	G	Event log count	Number of events in the event log
	H	SMS available	SMS (Short Message Service) is available in the current GSM network. If SMS is not available or there is no coverage, this channel is 0 (zero), otherwise 1.
	I	iSMS counter	Counts all incoming iSMS messages. Erroneous messages are also counted.
	J	Modem status	Indicates whether a modem is connected and offline or online. 0 = Not present 1 = Connected and offline 2 = Connected and online
TOC2	A	Supply voltage [V]	Supply voltage
	B	Reference voltage [V]	Should be 5.0 V
	C	VIN difference	Difference between VIN-A and VIN-B, scaled values.
	D	Encoder counter	Increases when the encoder is rotated clockwise and decreases when the encoder is rotated counterclockwise.
	E	Encoder button	Indicates whether the encoder push button is pressed or not. 0 = Not pressed 1 = Pressed
	F	Utilization [%]	See MDM.
XP	A	Temperature [°C]	Internal temperature

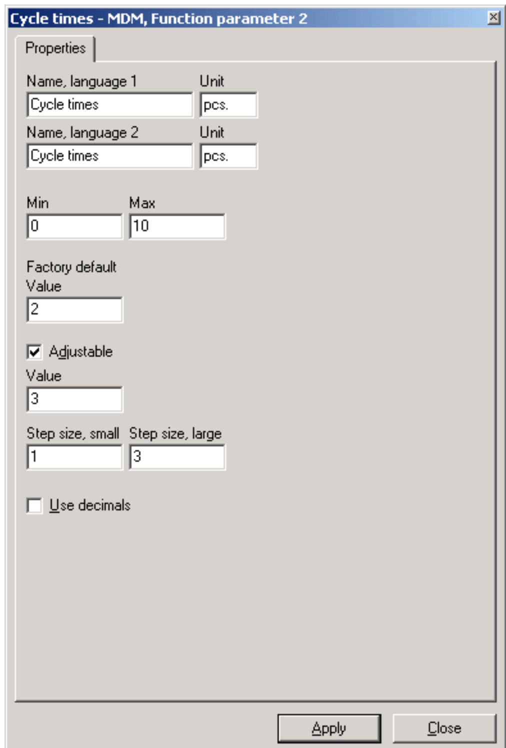
Module	Index	Name	Description
	B	Supply voltage [V]	Supply voltage
	C	Reference voltage [V]	Should be 5.0 V
XS	A	Reference voltage [V]	Should be 5.0 V
Lx	A	Temperature [°C]	Internal temperature
	B	Supply voltage [V]	Supply voltage
	C	Ref. voltage ext. [V]	External reference voltage. Should be 5.0 V
	D	Ref. volt. handle [V]	Internal reference voltage in handle. Should be 5.0 V
XP2	A	Temperature [°C]	Internal temperature
	B	Supply voltage [V]	Supply voltage
	C	Ref. voltage A [V]	Should be 5.0 V
	D	Ref. voltage B [V]	Should be 5.0 V
XT2	A	Temperature [°C]	Internal temperature
	B	Supply voltage [V]	Supply voltage
	C	Ref. voltage A [V]	Should be 5.0 V
	D	Ref. voltage B [V]	Should be 5.0 V
	E	CAN 2 activity	Indicates number of incoming CAN packages per cycle on the second CAN bus (J1939). Range is 0 - 15. Actual value can be higher than 15 if 15 is indicated.

Function parameters

When you develop an application for a machine, you often need to change or adapt a lot of values during a test. For example, you need to adapt the PID parameters during regulation or perhaps change a limit value for an object. The best way to do this is by entering these values as function parameters.

If several functions refer to the same parameter, for example number of revolutions, it is a good thing to use a function parameter for this value. In this way, the parameter's value only have to be changed in one place. The number of revolutions will then be updated automatically in every referred function and you do not have to worry about missing a function.

The parameter values can be changed via the display or in IQANdevelop.



Properties for a function parameter.

Name and unit

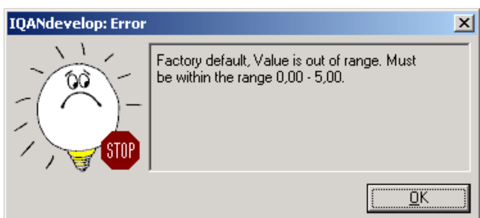
Name, language 1 Name, language 2	The function parameter's name in the two languages shown on the display.
Unit	The unit to be presented on the display together with the value of the function parameter.

Parameter values

Min	Minimum value for the parameter's adjustable range.
Max	Maximum value for the parameter's adjustable range.
Factory default Value	The factory default value for this function parameter. It must be a value between Min and Max.
Adjustable Value	Check if the value shall be adjustable from the display. Enter the value for this function parameter. This is the channel's value when it is adjustable, otherwise the factory default value is used. The operator can reset this value to the factory default value from the display. For more information, see section Adjustable values, on page 211.
Step size, small	When pressing the display button shortly, to adjust the function parameter's value, the value is adjusted with the value of the step size, small.
Step size, large	If you hold the display button pressed down, the function parameter's value is adjusted in large steps.
Use decimals	For some function parameters, decimals doesn't make sense, e.g counts, etc. In those cases leave this box unchecked. When checked, the parameter is presented with two decimals.

Entering a value outside given range

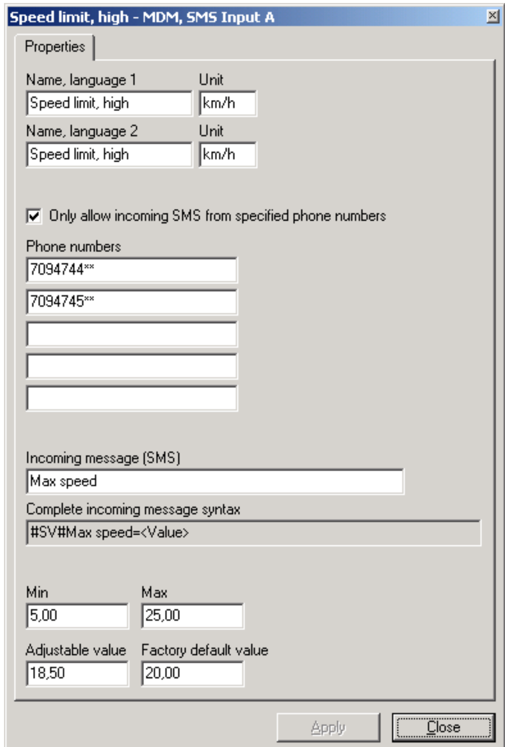
If you enter a value in the *Value* field which is outside the specified value limits min and max, the following message is displayed:



Error message when you have entered an illegal value.

SMS input

This channel receives it's value from an external system/GSM phone via SMS (Short Message Service). An SMS-capable GSM modem must be connected to the master module for this functionality.



SMS input Max speed.

Name and unit

Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.
Unit	The unit to be presented on the display together with the value of the channel.

SMS properties

Only allow incoming SMS from specified phone numbers	To accept incoming messages from approved phone numbers only, check this box. You can specify up to 5 phone numbers. If this box is not checked, any phone number is allowed to set the value for this channel.

Phone numbers	Phone numbers are matched backwards, i.e. you can choose not to specify country code and/or area code. An incoming phone number is allowed if the last digits in it matches the digits specified here. You can also use "wildcards" (*) at the end of the number. Wildcards matches any digit, 0-9. This can be useful if you want to allow a series of number. Example: 7094744** matches 0709474451, +46709474478 and 0046709474485.
Incoming message (SMS)	This is the user-definable text that has to match the incoming message. It can be used as a variable name, descriptive command and/or password. The text is case sensitive. See also below for complete message syntax.

Complete incoming message syntax	To the text specified above, prefix and suffix are added. The prefix is `#SV#` and the suffix is `=`. After the suffix, the value should be entered. The value must be an integer or floating point number. As decimal delimiter, both , and . is supported. The channel's value will be assigned this value if the incoming message is valid and matches the complete text.
	Example: *Max speed* matches incoming messages
	`#SV#Max speed=15.0`
	`#SV#Max speed=12`
	`#sv#Max speed=18,67`
	but does not match
	`#SV#max speed=15.0`
	`#SV#Max speed =12`

Parameter values

Min	Minimum value for the channel's adjustable range.
Max	Maximum value for the channel's adjustable range.
Adjustable value	The channel value. This is the value set via SMS.
Factory default value	The factory default value. This value is used when you reset the master to factory defaults. It must be a value between Min and Max.

Changing the channel's value

The channel's value can be changed in two ways. One way is to reset the master to factory defaults, which will set the value to the specified factory default value.

Another way is to send a message via SMS, using the syntax stated in the field *Complete incoming message syntax*, from an authorized phone number. The syntax follows the same rules that apply for *i*SMS, see Appendix D, page 368. This will set the channel's value to the value stated in the incoming message and a reply with the new channel value will be sent as an acknowledge to the sender.

A misspelled message or a message sent from a phone number that is not allowed will generate an error message. The error message is sent to the sender via SMS.

EXAMPLE

Incoming message	`#SV#Max speed=18.2`

Reply	`#SV#Max speed=18.2`
	`Value OK.`
	`Speed limit, high: 18.20 km/h`

Incoming message	`#SV#Max sped=18.2`
Reply	`#SV#Max sped=18.2` `No match.`
Incoming message	`#SV#Max speed=A8.2`
Reply	`#SV#Max speed=A8.2` `Syntax error.`
Phone number not allowed	`#SV#Max speed=18.2`
Reply	`#SV#Max speed=18.2` `Access denied.`
Out of range	`#SV#Max speed=28`

Reply	`#SV#Max speed=28`
	`Value out of range.`
	`Valid range: 5.00 - 25.00 km/h`

NOTE

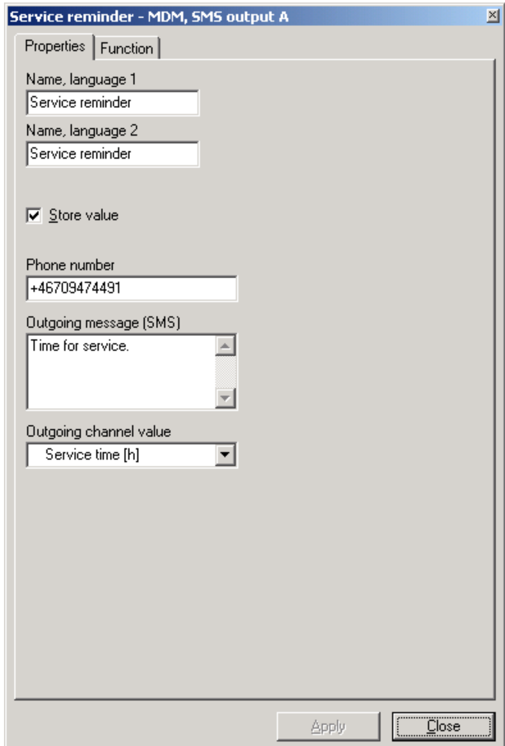
Incoming SMS messages are in practice handled once every 30 seconds, one at a time. Messages are stored on the SIM card until handled by IQAN. There is often also a delay in the GSM network before it reaches the recipient. This delay can vary between a few seconds up to several minutes.

Also, SMS outputs have higher priority, which means that if there are any pending SMS output messages they will be handled first.

SMS output

This channel sends messages to external systems/GSM phones via SMS (Short Message Service). An SMS-capable GSM modem must be connected to the master module for this functionality.

The message is sent when function value goes from *False* to *True*, see section SMS output, on page 270.



SMS output Service reminder.

Name

Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Store value

Store value	The channel value is stored in non-volatile memory. In this way, the value is stored even if you break the supply voltage to the system. Otherwise the value will be reset to zero at startup. See also section Stored values, page 212.

SMS properties

Phone number	Enter the phone number that should receive the message. Phone number can consist of + and digits 0-9. + is only allowed as the first character. Please check that your network operator supports + as a prefix for international calls before using this syntax.
Outgoing message (SMS)	Enter a text message that you want included in the SMS.
Outgoing channel value	Select a channel that you want included in the SMS. Channel name, value and unit is added at the end of the message. Select *None* if do not want to use this feature.

EXAMPLE

The channel described in the image above would result in the following message being sent to some Parker employee in Mölnlycke, Sweden:

```
Time for service.
Service time: 1500 h
```

NOTE

If *Outgoing message* starts with `#SV#` the SMS message is formatted a bit different. The channel name is not appended to the SMS message, only the channel value. This is to make it possible to set an SMS input on another machine.

EXAMPLE

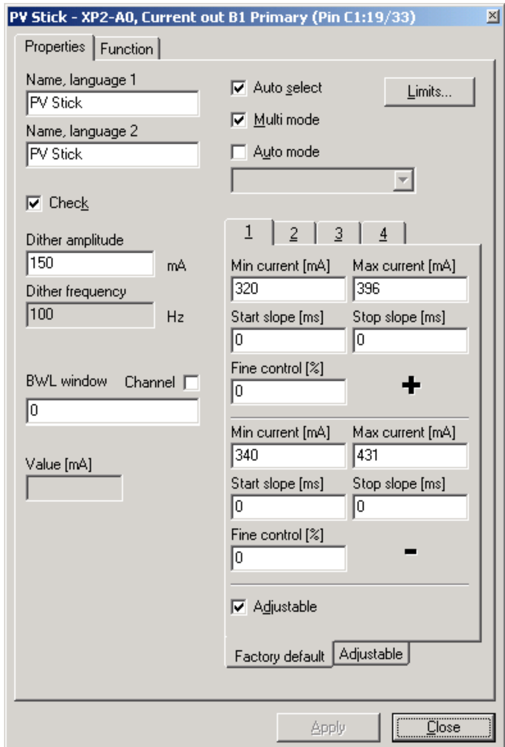
Outgoing message is `#SV#Max speed=` and an outgoing channel is selected. The SMS message sent is:

```
#SV#Max speed=15.0
```

As you can see, this message is a valid SMS input message and can therefor be used to communicate with a remote IQAN system via GSM.

Current out

Under the *Properties* tab, you can name the channel and calibrate the current output.



Properties for current out.

Name

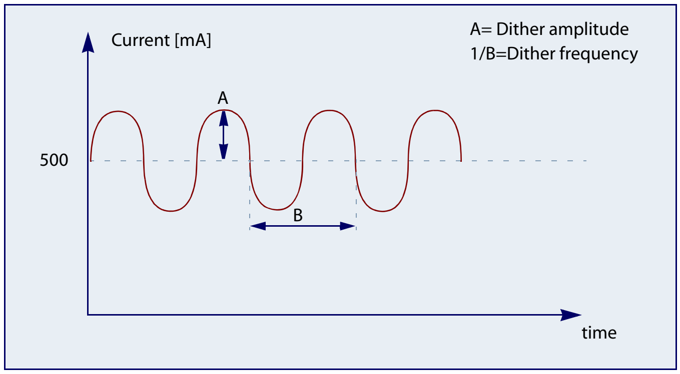
Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Current check

Check	The channel's real return current is measured and compared with the desired output value. If there is any deviation from desired value, an alarm is activated. When an alarm is activated, the display shows the text *Output error high* or *Output error low* depending on type of error.

Dither

Dither amplitude	The amplitude for the overlaid dither current, see below.
Dither frequency	The dither frequency for the module's current outputs. For some modules, the frequency cannot be adjusted. For further information, see section Module properties, on page 103.



The current signal at the output.

NOTE

If you use a primary and a secondary channel for an output, the dither amplitude can only be set for the primary channel. The secondary channel will use the same value as the primary.

BWL window

BWL window	Band Width Limiting window. Valid range: 0 - 100. For more information, see section Internal analog, on page 138.

Value

Value	Shows the output value in [mA] when the channel is measured.

Mode properties

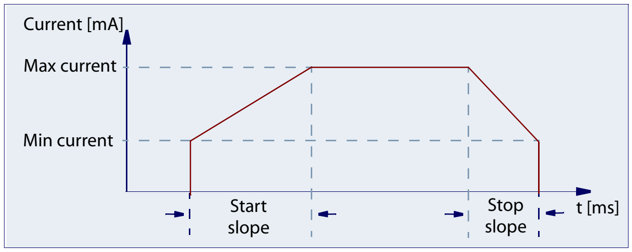
Auto select	Check this box for automatic trimming. When you trim current outputs via the display you will be given the option *Auto select,* which means that you select the channel to be trimmed by activating the output's function. E.g. if a lever is used to control an output, you only need to move the lever when you want to trim the current values for the corresponding output.
Multi mode	When this is checked, you have four different settings for currents, slope times and fine control, called operator modes.
Auto mode	Check the box and select the specific *Mode selection channel* that controls the selection of mode. With this functionality it is possible to control the active mode for this channel independent of the manually selected mode which controls all other outputs without auto mode. With auto mode enabled it is not possible to make this channel adjustable.
Adjustable	Check this box if you want the selected mode to be adjustable from the display. Each operator mode can individually be selected to be adjustable or not. For further information see section Adjustable values, on page 211.

Output characteristics

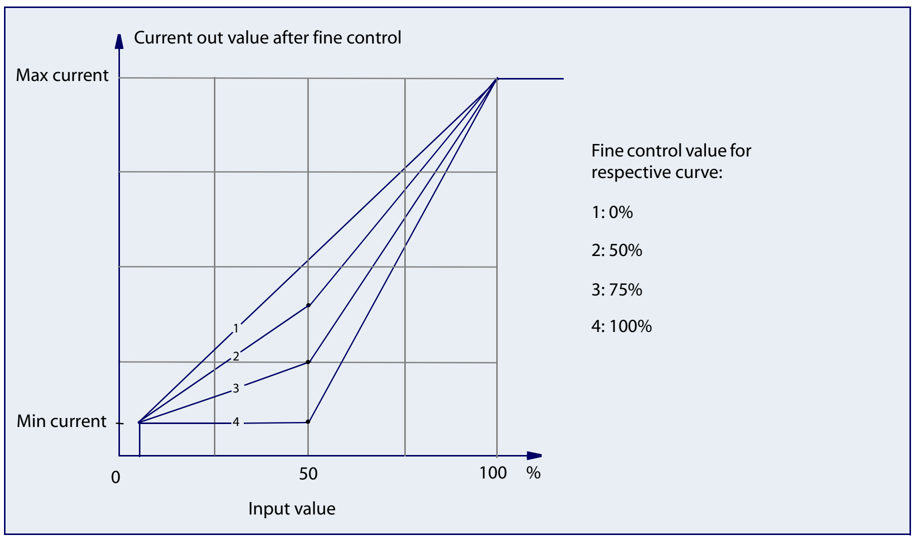
1, 2, 3, 4 (tabs)	Select operator mode. When multi mode is selected there are four tabs, otherwise only one.
Factory default, Adjustable (tabs)	Select the values you want to see/adjust. For further information see section Adjustable values, on page 211.
+/-	Positive and negative direction. For more information, see section Direction of motion, on page 122.
Min current [mA] Max current [mA]	Current range for the channel. Min current = minimum current that will be output on the channel (equals 0% output). Max current = maximum current that will be output on the channel (equals 100% output).

Consider that slope times that are too long can affect safety.

Start slope [ms] Stop slope [ms]	States how long it should take for the current to rise from minimum to maximum and fall from maximum to minimum.
Fine control [%]	Use fine control to get higher resolution of the output's low values.
Adjustable	Check this box if you want the selected mode to be adjustable from the display. In this way, the values for each operator mode may be adjusted.



Currents and slope times.



How a curve is affected by fine control.

With fine control, the value of the output signal will have a higher resolution up to the curve's breakpoint. After the breakpoint, the curve will become steeper, which means that the resolution will be lower than normal. The breakpoint for the curve is always at 50% of the input value.

EXAMPLE

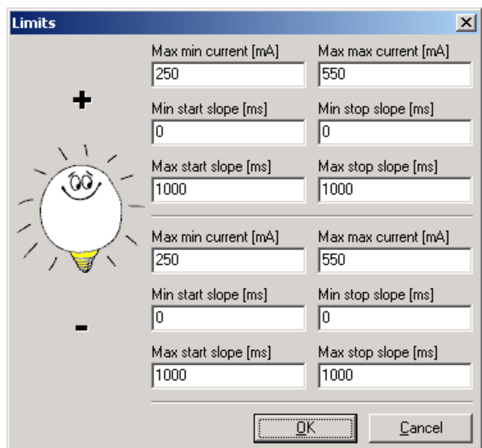
You want to move the tip on a 20 m long crane very exact. Use fine control to achieve a higher resolution at the output when you use small lever movements.

NOTE

At 100% fine control, the resolution will be so high that it feels as if nothing is happening at the output until the input value has passed the breakpoint at 50%. See the diagram.

Limits

Limits for currents and slope times. Click on the button to open the dialog box *Limits.*

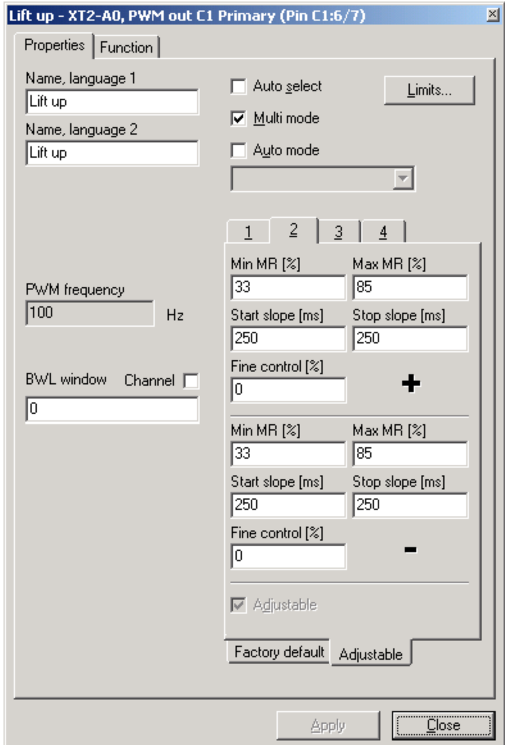


Limitation of the values for the current and slope times.

+/-	Positive/negative direction.
Max min current [mA]	Enter maximum min current for the output. The range for *Min current* will be: *0-Max min current*
Max max current [mA]	Enter maximum max current for the output. The range for *Max current* will be: *Min current-Max max current*
Min start slope [ms] Max start slope [ms]	Maximum and minimum values for the start slope.
Min stop slope [ms] Max stop slope [ms]	Maximum and minimum values for the stop slope.

PWM out

The properties for a PWM output is similar to a current output but instead of current, the PWM output has pulse width modulation ratio, called MR.

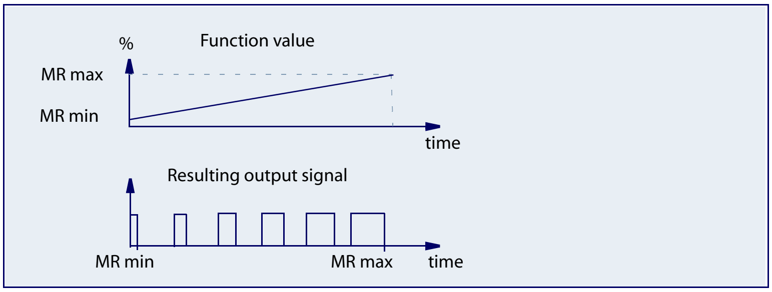


Properties PWM out.

PWM frequency

PWM frequency [Hz]	The PWM frequency. This value is common for all PWM outputs on one module. To change this value, see section Frequency, on page 105.

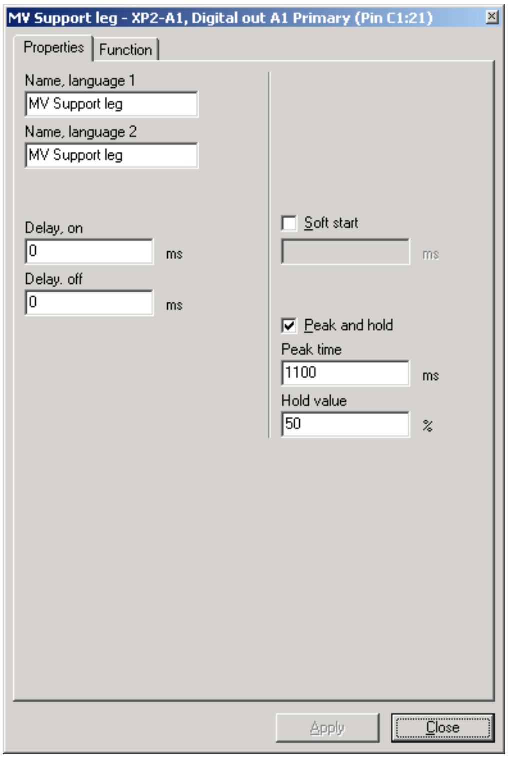
For information on the other properties, see section Current out, on page 170. MR is the value for the pulse width and is stated as % of the PWM pulse time.



The function for a PWM output.

Digital out

Under the *Properties* tab, you enter the channel's name. By using the *Delay, on/off* property, it is possible to delay the on/off transition of a signal. The properties soft start and Peak and hold are specific for certain modules.



Properties, digital out.

Name

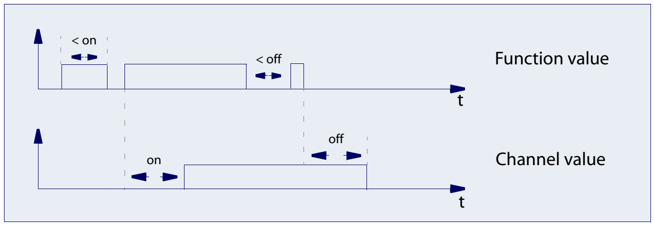
Name, language 1 Name, language 2	The channel's name in the two languages shown on the display.

Delay on/off

Delay, on [ms]	The channel is activated a certain time after a condition has been fulfilled. For example, if you want a function to start after a specified time, enter the time in the *Delay on* field.
Delay, off [ms]	The channel is active for a time after the condition is not longer fulfilled. For example, the channel remains active for a time after you have released the button.

NOTE

The channel value will not be affected if the channel's function is activated/ blocked a shorter time than you have specified for the *delay on* respective *delay off*. The delay on/off properties works as a debouncing filter.



Debounce filter for digital out.

Soft start/Peak and hold

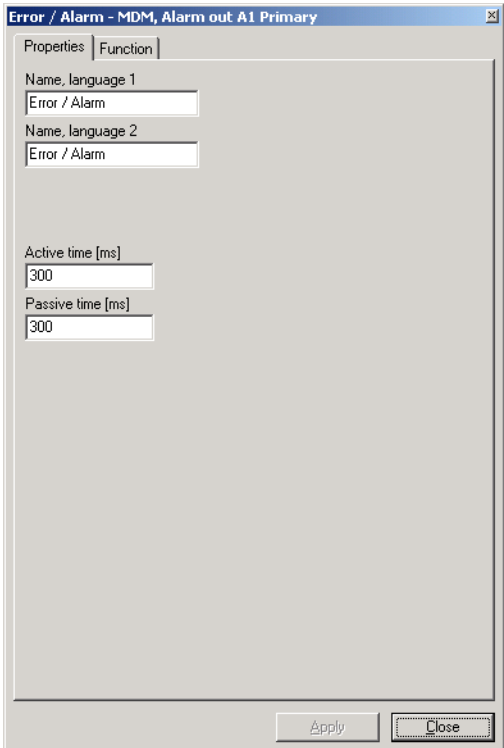
Soft start [ms]	To get a softer activation of an on/off valve function, you can use soft start. Check the box and enter the time for the output to rise from zero to full output.
Peak and hold	During *Peak time* the output functions as a normal digital output, i.e. *high*.
Peak time [ms] Hold value [%]	Thereafter, the output will function as a PWM output, with pulse width *Hold value*.

Both *Soft start* and *Peak and hold* use PWM to achieve their functionality. The frequency used is the same as the one used for the PWM outputs. For more information, see section PWM out, on page 175.

With *Peak and hold* you increase the magnet's life time. The valve may be equipped with a weaker cabling as you reduce the constant voltage on the magnet which also reduces the heat release.

Alarm out

Under the *Properties* tab, you can enter the channel’s name and also define the output’s pulse time to create a pulse train as long as the condition for the alarm is fulfilled.



Properties alarm out

Name

Name, language 1 Name, language 2	The channel’s name in the two languages shown on the display.

Alarm properties

Active time [ms] Passive time [ms]	Pulse times for the alarm signal. When the condition for the alarm is fulfilled, the output will be alternating active/passive. If you do not want an oscillating function for the alarm, enter a value for active time and 0 for passive time.

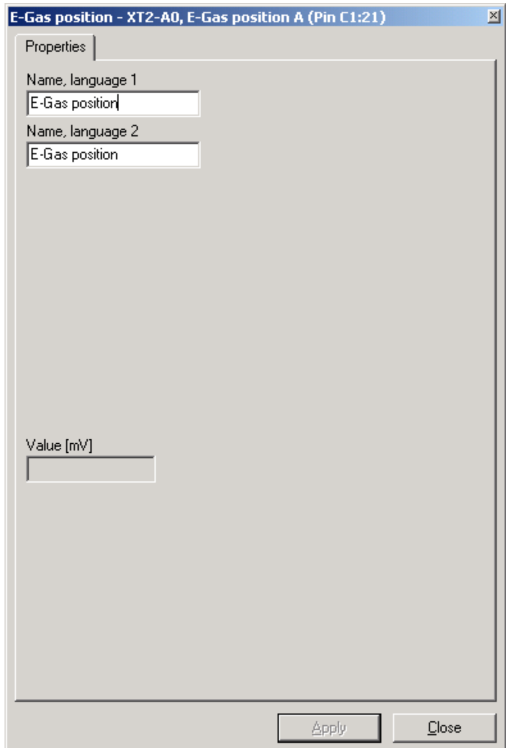
NOTE

The active/passive time properties only affect the physical output, not the channel value. The channel value is always the same as the function value.

If you do not create a function for the channel, only internal alarms will be indicated. Internal alarms use the properties for the primary alarm out, if it exists. If it does not exist, the internal alarms use pre-set properties.

E-Gas position

This channel is used to measure the actuator´s position when controlling the E-gas for a diesel engine. The channel has a dedicated pin on the IQAN-XT2 module. For further information, see instructions book for IQAN-XT2.



Properties for the channel E-gas position.

Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Measured value

Value [mV]	The measured value for the actuator´s position in [mV].

When do you need to use this channel...

When you create the function for the E-gas out, the E-gas position channel is used as the feedback value. Observe, the only thing you need to do is to connect the sensor to the input. You don’t need to add this channel in the block diagram. The IQAN-XT2 module handles this internally. You only have to add the channel if you want to measure or use the channel’s value.

Engine load

The engine load is automatically calculated in the XT2 unit. The output of this channel will be a value between -100% - 100%. The channel compares the actual engine speed with the theoretical speed decided by the position of the actuator according to the following algorithm:

$$Engineload = 100 - \frac{ActualSpeed \times 100}{TheoreticalSpeed}$$

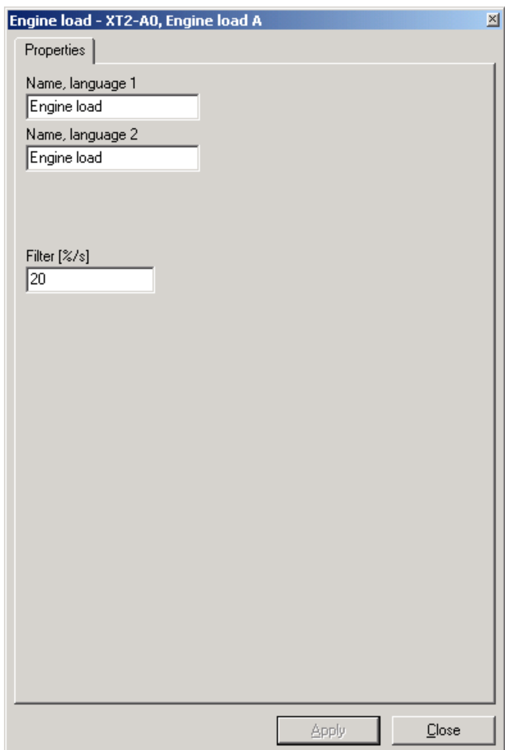
NOTE

If *Manual setup* is used, the *Theoretical speed* will be calculated as a linear function between *Min rpm* and *Max rpm* (see E-gas out).

If *Auto setup* is used, the *Theoretical speed* will be calculated as a function of the auto setup curve (see E-gas out).

If the engine is loaded, the output value will be a positive number between 0-100%. If brake energy is accumulated by the engine (e.g running downhill) the engine load will be a negative number.

If the *command value* for the engine speed increase or decrease faster than the diesel engine speed can be changed you may have to filter the output signal of this channel.



Properties for the channel Engine load.

Name

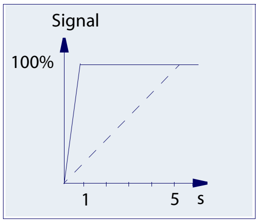
Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Filtering the input signal

Filter [%/s]	To attain slower changes in the channel´s signal. The value is entered in [%/s].

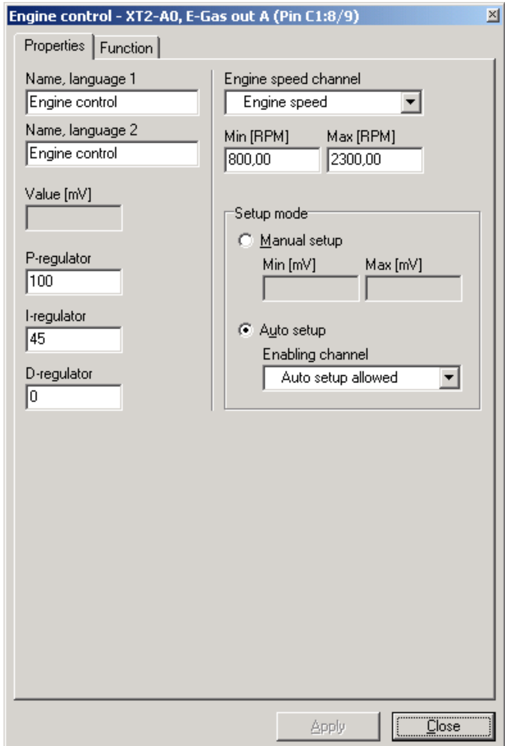
EXAMPLE

If you enter the filter value 20%/s and the *command value* for the engine speed increase 100% in one second, the filtered signal will reach 100% after 5 seconds.



E-Gas out

With this channel you can control the position of an actuator. The actuator controls the governor of the diesel engine´s injection pump. In this way the speed of the diesel engine can be controlled.



Properties for the channel E-gas out.

Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Measure

Value [MR]	The channel´s physical output value during measurement, -100 - 100%. The value unit is [MR], *Modulation Ratio*, since this is a PWM output.

Regulator parameters

P, I, D	Parameters for the regulator behavior. For further information, see section PID, on page 252.

Engine speed

Engine speed channel	Select the frequency input channel that measures the actual engine speed. The frequency channel must be scaled to [rpm]. This is the feedback value used by the PID-regulator.
Min [rpm] Max [rpm]	The minimum and maximum idle speed for the diesel engine.

Setup mode

Manual setup Min [mV] Max [mV]	With the *manual setup* the shifting motor is regulated using a linear curve. Enter the voltage value, [mV], for the shifting motor´s end positions.
Auto setup Enabling channel	If you have to take consideration to the characteristic of the diesel engine´s governor, use auto setup. Select an enabling channel to prevent that auto setup is performed in dangerous situations, e.g. when the machine moves or the gear box is not in neutral. If you don’t need to consider this, select *True*.

Auto setup

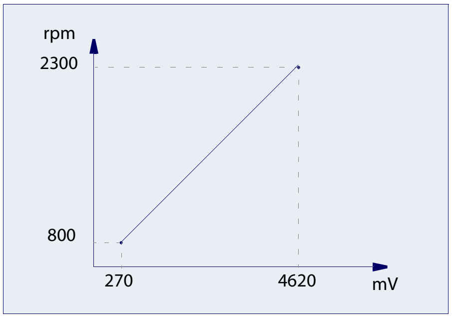
Auto setup tries to linearize the diesel engine characteristics. This can help you to create a better regulation of the engine speed. The auto setup is done by the master. You activate the auto setup from the master´s display. The diesel engine has to be running before you initiate auto setup.

If an enabling channel is selected, that channel’s value has to be *True* before the auto setup can be executed.

NOTE

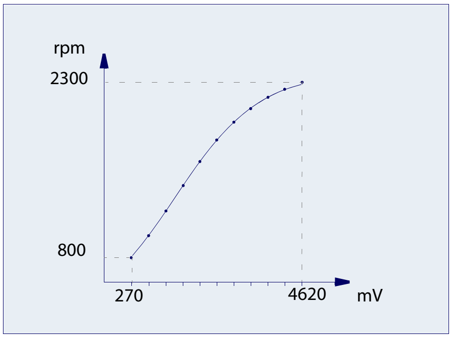
Make sure that the gear box is in neutral and that the brakes are activated before you start the auto setup. The diesel engine will run at max speed during the auto setup.

The master controls the actuator to the respective positions for the diesel engine´s low and high idle speed. At both speed positions the master measures and stores the E-gas position voltage values (=VIN-A, XT2).



The voltage range is divided into 10 parts.

(max [mV]- min [mV]) / 10 => (4620 - 270) / 10 = 435 [mV]



0: 270 mV (low idle speed)
1: 705 mV
2: 1140 mV
3: 1573 mV
4: 2010 mV
5: 2445 mV
6: 2880 mV
7: 3315 mV
8: 3750 mV
9: 4185 mV
10: 4620 mV (high idle speed)

Then the master controls the actuator into the different calculated positions. In each position the actual engine speed, *Engine speed channel*, is measured and stored. This will result in a characteristic curve like the one above.

After the setup is done, the master automatically goes back to normal operation mode. It will use the curve above to compensate for deviations and in that way linearize the engine.

Auto setup often needs to be done a few times every year, because the diesel engine changes characteristics.

SAE J1939

J1939 Id

All the messages on the SAE J1939 network must contain some data to identify the different messages. In IQANdevelop we say that all messages must have a *J1939 Id*.

You specify the J1939 Id by entering the parameters *Priority*, *Parameter group number (PGN)* and *Source address (SA)*. Then IQANdevelop calculates the J1939 Id automatically.

Priority

All ECU's connected to the SAE J1939 network has to forward any queued messages of higher priority before those with lower priority. The highest priority is 0 and the lowest is 7.

You will find the actual priority in the SAE J1939 specification or in the specification from the manufacturer. For proprietary messages the default priority is 6.

Parameter group number (PGN)

According to the SAE J1939 specification, all the parameters are grouped into specific groups. Each parameter group is one message on the CAN bus. For example, the parameters concerning *Engine temperature* such as oil and coolant temperature are grouped into one parameter group and sent in one message. Each parameter group has an identification number, a *Parameter Group Number, PGN*.

PGN is sometimes specified as two numbers, *PF (PGN Format)* and *PS (PGN Specific)*. PGN is calculated as follows: PGN = PF*256 + PS.

Parameter group numbers 61184 to 61439 and 65280 to 65535 are reserved for proprietary messages and can be used for your specific J1939 outputs. See SAE J1939-21 for more information.

Source Address (SA)

The source address is the sender´s address. If the IQAN system is the sender, the recommended address is 39.

J1939 Data

In IQANdevelop the second part of the message is called *J1939 Data*. A data field contains different kinds of data depending on the type of parameter. You will find the data in the manufacturer or SAE J1939 specifications.

Transmit rate

The transmit rate specifies how often a message for a specific parameter group will be sent on the SAE J1939 network. If a defined incoming message for some reason is not transmitted on time, the IQAN system indicates time-out.

SAE J1939 Diagnostic

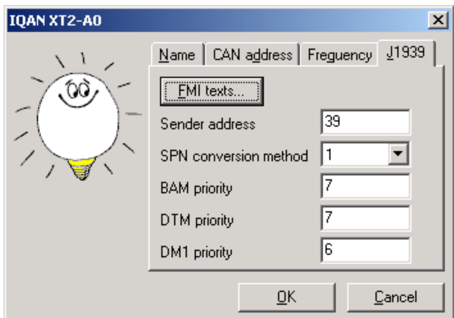
If an ECU on the J1939 network wants to report an error, it sends a diagnostic message. The message contains a *Suspect Parameter Number* and a *Failure Mode Identifier.*

Suspect parameter number (SPN)

The SPN is used to identify the parameter for which diagnostics are being reported. The SPNs are assigned to each individual parameter in a Parameter Group.

SPN Conversion method

For further information about the different *Conversions methods* we refer to SAE J1939-73 or the specification from the manufacturer. The TOC8 module will always use conversion method 4.



J1939 module properties.

Failure Mode Identifier (FMI)

The FMI defines the type of failure detected on the ECU, identified by an SPN. Note that the failure may not be an electrical failure but may instead be a subsystem failure or condition needing to be reported to the service engineer and maybe also to the operator. Each FMI is represented by a message that is presented on the display.

EXAMPLE

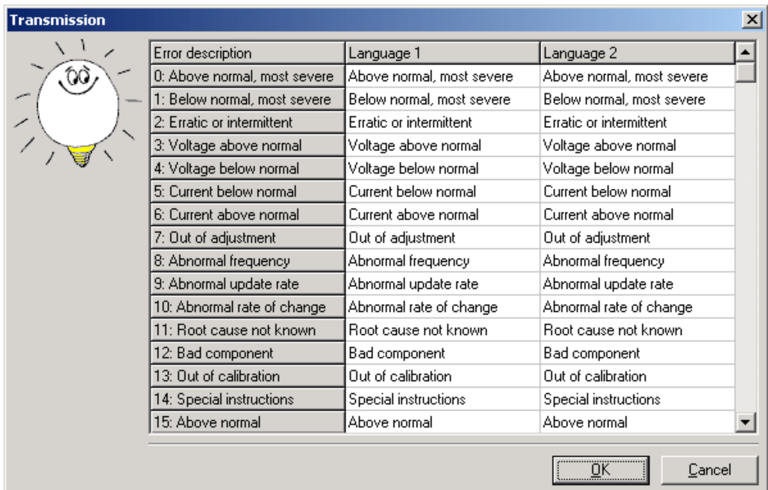
Engine oil pressure is too low. This is reported from the ECU with a SPN identifying the parameter, Engine oil pressure, and an FMI identifying the problem, below normal. In this case SPN is 100 and FMI is 17.

The following error message is shown on the display.
Engine oil pressure - Below normal

Change the FMI texts...

The texts are by default in English for both language 1 and language 2.

- Right-click on the IQAN-XT2 module and select Properties... and click on the tab J1939.
- To open the dialog box for the FMI texts, click on the button named *FMI texts...*
- Change the texts and click on *OK*. You will always see the original IQAN text in the grey part to the left.



Error description	Language 1	Language 2
0: Above normal, most severe	Above normal, most severe	Above normal, most severe
1: Below normal, most severe	Below normal, most severe	Below normal, most severe
2: Erratic or intermittent	Erratic or intermittent	Erratic or intermittent
3: Voltage above normal	Voltage above normal	Voltage above normal
4: Voltage below normal	Voltage below normal	Voltage below normal
5: Current below normal	Current below normal	Current below normal
6: Current above normal	Current above normal	Current above normal
7: Out of adjustment	Out of adjustment	Out of adjustment
8: Abnormal frequency	Abnormal frequency	Abnormal frequency
9: Abnormal update rate	Abnormal update rate	Abnormal update rate
10: Abnormal rate of change	Abnormal rate of change	Abnormal rate of change
11: Root cause not known	Root cause not known	Root cause not known
12: Bad component	Bad component	Bad component
13: Out of calibration	Out of calibration	Out of calibration
14: Special instructions	Special instructions	Special instructions
15: Above normal	Above normal	Above normal

Change the FMI texts.

Diagnostic messages priorities

There are three diagnostic messages specified by SAE J1939. These are BAM (Broadcast Announcement Message), DTM (Data Transfer Message) and DM1 (Diagnostic Message 1). The priority for each of these messages can be set in the J1939 module properties (see picture on page 188). The default values are set to the recommended default values in SAE J1939.

Sender address

The sender address is used by the module when J1939 messages are sent to other system. This identifies the IQAN module on the CAN bus and should be unique. The recommended address to use is 39 which corresponds to *Management computer #1* according to SAE J1939 Issued APR2000.

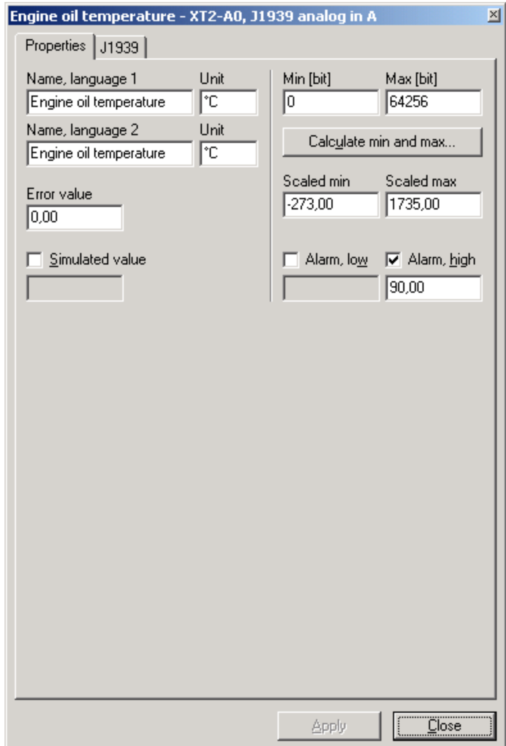
The TOC8 module will always use sender address 39.

...a tip about creating an application for an engine

If you only create the channels for a specific diesel engine and then save the idt-file, you can use that file as a template next time you need to create an application for that specific engine.

J1939 Analog in

This channel type is used for analog parameters in the SAE J1939.



Properties for the channel J1939 Analog in.

Name and unit

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.
Unit	The unit to be presented on the display together with the scaled value of the channel, e.g °C, bar, liter, etc. You can also enter the unit in two languages. The unit can be found in the SAE J1939 manufacturer specification.

Error value

Error value	If the channel indicates an error situation, the value is replaced by an error value. Enter a proper scaled value for the channel to be used when there is an error situation.

Consider personal safety when simulating. Appropriate safety precautions should be taken.

Simulated value

Simulated value	Simulate a value on the channel. Check the box and enter a value in the field below. The channel will use this value instead of the actual measured value on the input.

Scale the input signal

Min [bit] Max [bit]	Minimum bit value Maximum bit value. In the SAE J1939 specification you will only find scaled range and resolution. You need to calculate the values for the min and max. See example below.
Scaled min Scaled max	Enter the min and max value for the data range. E.g. The temperature range is -40- 210°C. Often is the min value given as offset. You find the values in the SAE J1939 manufacturer specification.

EXAMPLE

5.2.5.15 *Engine Oil Temperature*—Temperature of the engine lubricant.

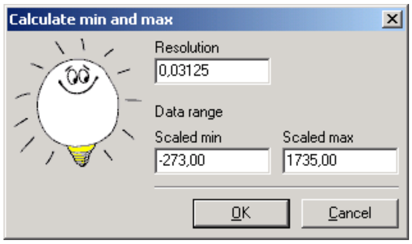
Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)

Scaled max- Scaled min/ Resolution => (1735 - (-273) / 0,03125) = 64256 bit

The calculation above gives:
Min [bit] = 0, Max [bit] = 64256
Scaled min = -273°C, Scaled max = 1735 °C

Calculate min and max...

IQANdevelop can help you to calculate the *Min [bit]* and *Max [bit]* values.



Click on the button Calculate min and max...

Resolution	The resolution is the degree of amplification. You will find the resolution value in the specification from the manufacturer.
Data range Scaled min Scaled max	This is the operation range for the input signal. Enter the scaled min and scaled max value that you find in the specification from the manufacturer.

Enter the values and click on *OK*. IQANdevelop calculates the values and closes the dialog box. You will find the calculated min and max values on the properties page.

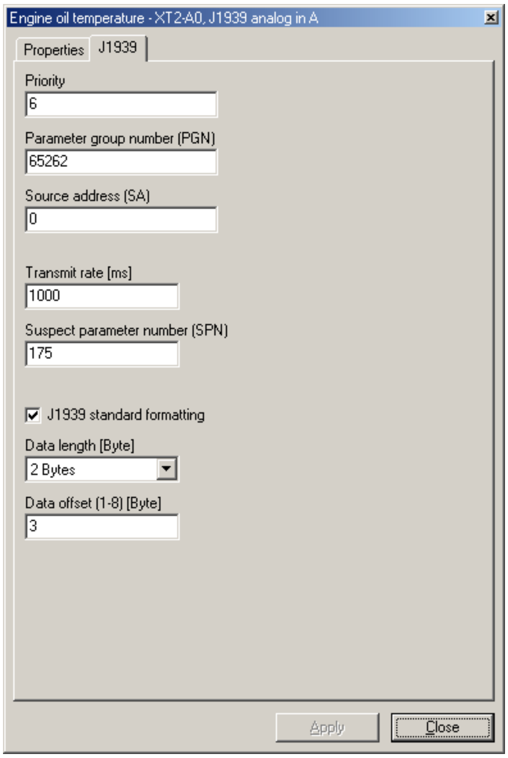
NOTE

The range for *scaled min* and *scaled max* is -32000 - 32000.

Alarm

Alarm, low Alarm, high	An alarm can be activated when the input signal passes a defined limit. Select type of alarm by checking the boxes. In the field below, you enter the level for the alarm limit. You can define both an upper and an lower alarm limit for the channel. Alarm, low = when the signal drops below the lower alarm limit, the alarm is activated. Alarm, high = when the signal exceeds the upper alarm limit, the alarm is activated. For further information about the alarm, see section Voltage in, on page 124.

J1939 properties



J1939 properties for the channel type J1939 Analog in.

J1939 Id

Priority	The priority of the parameter´s message.
Parameter group number (PGN)	The parameter´s group identity number.
Source Address (SA)	The sender address.

Transmit rate

Transmit rate [ms]	How often the message will be sent. If the message for some reason is not sent, the channel´s value will be replaced with *error value*. See the properties tab for the channel.

SPN

Suspect parameter number (SPN)	This number is for diagnostics. If a diagnostic message contains this SPN, the sender has detected a fault for this channel. The channel´s value will be replaced with the *error value*.

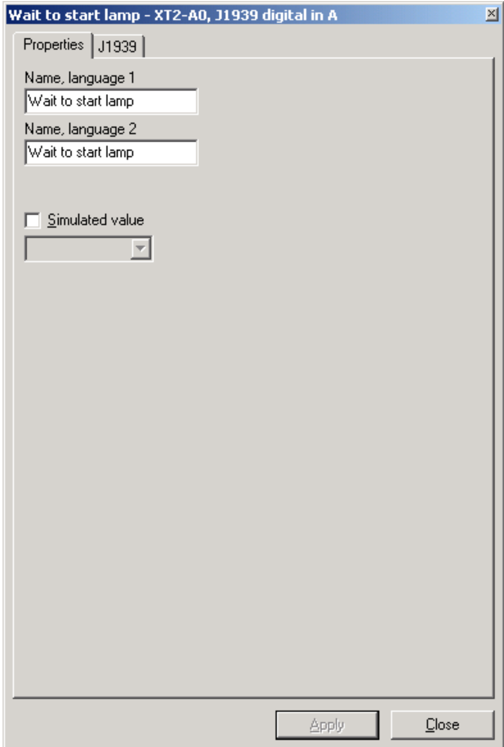
J1939 Data

You can choose to use SAE J1939 standard data types or you can specify your data using bit length and offset.

J1939 standard formatting checked	
Data length [Byte]	The length of the parameter´s data. 1, 2 or 4 bytes.
Data offset (1-8) [Byte]	The offset gives the actual parameter´s position. The data field is 8 bytes in total. Bytes are numbered from 1 to 8.
J1939 standard formatting not checked	
Data length [bit]	The length of the parameter´s data, 1-32 bits.
Data offset (1-64) [bit]	The offset gives the actual parameter´s position. The data field is 64 bits in total. Bits are numbered from 1 to 64.

J1939 Digital in

This channel type is used for digital J1939 parameters.



Properties for the channel J1939 Digital in.

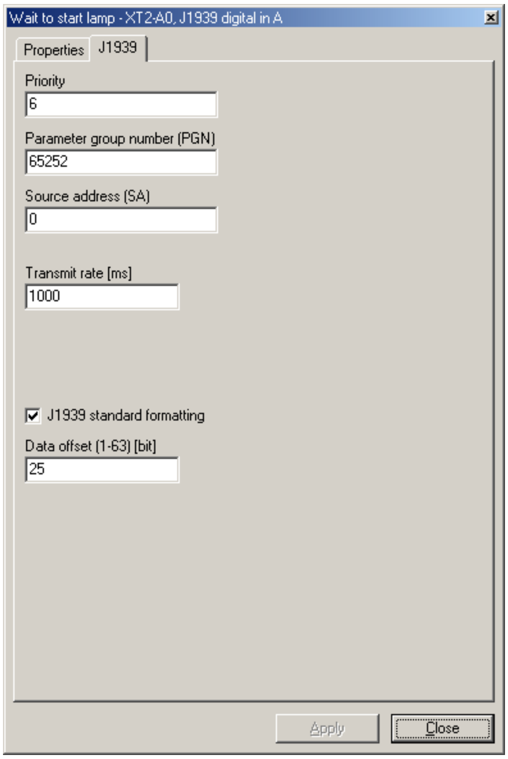
Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Simulated value

Simulated value	Simulate a value on the channel. Check the box and select a value in the field below. This value will be used instead of the actual measured value.

J1939 properties



J1939 properties for the channel J1939 Digital in.

J1939 Id

Priority	The priority of the parameter´s message.
Parameter group number (PGN)	The parameter´s group identity number.
Source Address (SA)	The sender address.

Transmit rate

Transmit rate [ms]	How often the message will be sent. If the message for some reason is not sent, the channel´s value will be set to *False*.

J1939 Data

J1939 standard formatting	When checked the standard bit length of 2 bits is used, otherwise 1 bit is used.
Data offset [bit]	The parameter´s bit position. Bits are numbered from 1 to 63.

EXAMPLE

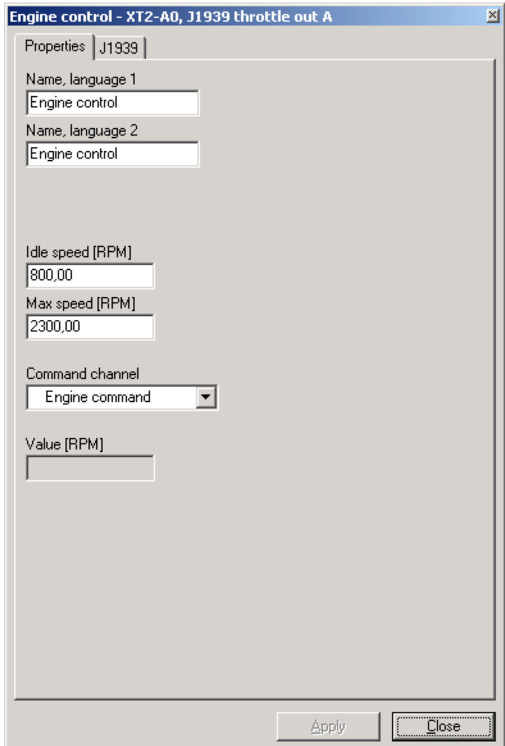
The parameter *Wait to start lamp* has it´s position in byte 4, at bit 1and 2.

You calculate the offset like this:
(Byte start position - 1) * 8 + Bit start position = Data offset [bit]

(4 - 1) * 8 + 1 = 25

J1939 throttle out

The channel is used to control the engine speed of a diesel engine that support the SAE J1939 protocol.



Properties for the channel J1939 Throttle out.

Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Engine speed range

Idle speed [RPM]	Minimum engine speed at no-load running. See the manufacturer specification for the engine.
Max speed [RPM]	Maximum engine speed at no-load running. See the manufacturer specification for the engine.

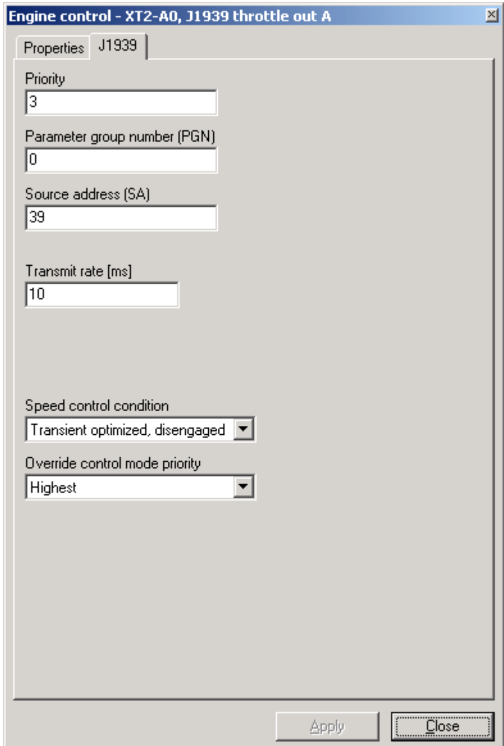
Command channel

Command channel	Select the channel that shall control the engine speed. The *command channel* must be analog (0-100%).

Measure

Value [RPM]	Shows the value in [RPM] for the channel during measurement.

J1939 properties



J1939 properties for the channel J1939 throttle out.

J1939 Id

Priority	The priority of the parameter´s message.
Parameter group number (PGN)	The parameter´s group identity number. Default value 0 (or destination address) according to SAE J1939 specification.
Source Address (SA)	The sender address. This is the same for all J1939 outputs and is specified in the module properties, see section Sender address, on page 189.

Transmit rate

Transmit rate (ms)	How often the command message will be sent.

J1939 Data

Speed control condition	Select one of the following: Transient optimized, disengaged Stability optimized, disengaged Stability optimized, engaged 1 Stability optimized, engaged 2
Override control mode priority	Select one of the following: Highest High Medium Low

For further information, look in the manufacturer specification for the engine.

J1939 Lamp indicator

In the protocol SAE J1939 there are four different lamp indicators; malfunction, red stop, amber warning and protect lamp.

In IQANdevelop there is a dedicated channel for each lamp.

Properties for the channel J1939 Lamp indicator.

Name

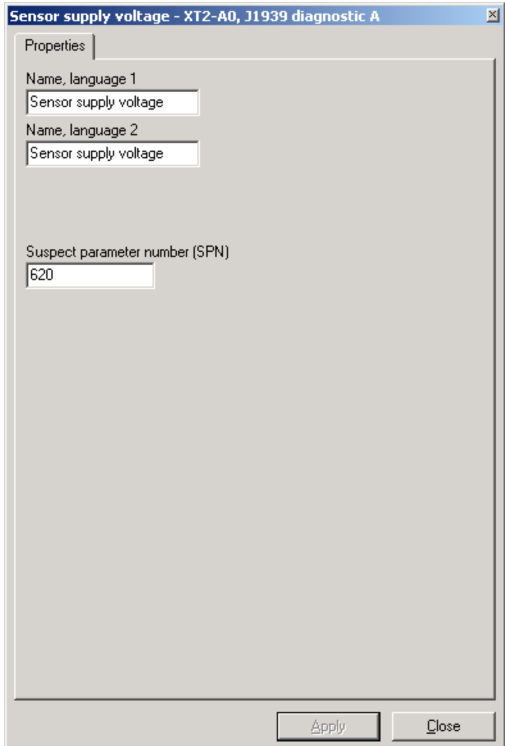
Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

In IQANdevelop the names for the different channel´s are predefined in accordance with the SAE J1939 protocol.

Index	Name	Description
A	Malfunction	Emission related errors
B	Red stop	Stop vehicle immediately
C	Amber warning	Stop vehicle
D	Protect	No warning, just an indicator

J1939 Diagnostic

This channel type is used to report diagnostic information.



Properties for a J1939 Diagnostic channel.

Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Identity

Suspect parameter number (SPN)	Enter the SPN from the engine manufacturer specification.

The channel´s value

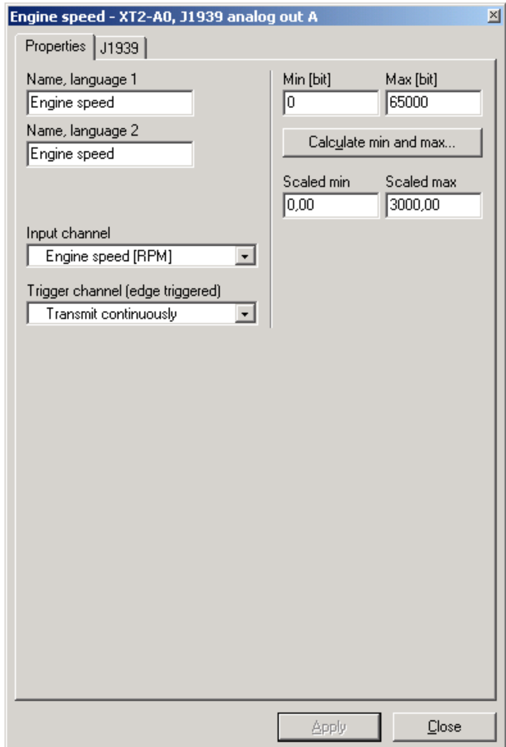
The channel´s value range is -1 - 31. If there are no errors active for that selected SPN the value is -1. Otherwise the value is the FMI number, 0 - 31.

You can use this in other functions when you want to take care of some specific condition.

EXAMPLE
The ECU checks the 5 Volt supply voltage for it’s sensors. The SPN for *Sensor supply voltage* is 620. It has two possible FMI numbers, 3 and 4, adherent to it. FMI 3 means open circuit or short to battery, and FMI 4 means short to ground.

J1939 Analog out

This channel type is used for sending analog values to external systems via CAN.



Properties for the channel J1939 Analog out.

Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Channels

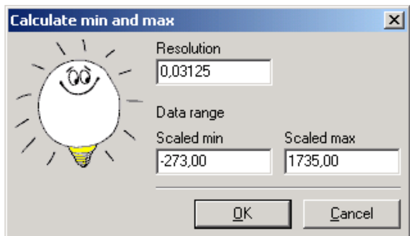
Input channel	The value of this input channel is scaled, inserted in a J1939 package and sent via CAN.
Trigger channel	Select *Transmit continuously* to send this value at the rate specified on the J1939 tab. Select a digital channel to transmit the value when that channel goes from low to high.

Scale the input signal

Min [bit] Max [bit]	Minimum bit value Maximum bit value. Similar to J1939 Analog in, see page 191.
Scaled min Scaled max	Enter the min and max value for the data range. E.g. The temperature range is -40- 210°C.

Calculate min and max...

IQANdevelop can help you to calculate the *Min [bit]* and *Max [bit]* values.



Click on the button Calculate min and max...

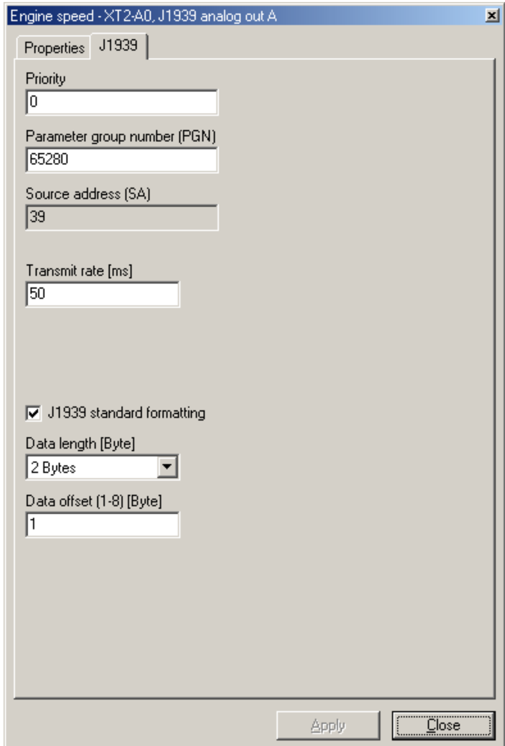
Resolution	The resolution is the degree of amplification.
Data range Scaled min Scaled max	This is the operation range for the input signal. Enter the scaled min and scaled max value for the input channel.

Enter the values and click on *OK*. IQANdevelop calculates the values and closes the dialog box. You will find the calculated min and max values on the properties page.

NOTE

The range for *scaled min* and *scaled max* is -32000 - 32000.

J1939 properties



J1939 properties for the channel type J1939 Analog out.

J1939 Id

Priority	The priority of the parameter´s message.
Parameter group number (PGN)	The parameter´s group identity number. Valid range is 65280 - 65535.
Source Address (SA)	The sender address. This is the same for all J1939 outputs and is specified in the module properties, see section Sender address, on page 189.

Transmit rate

Transmit rate [ms]	How often the message will be sent. This is only used when *Trigger channel* is set to *Transmit continuously*. See the properties tab for the channel.

J1939 Data

You can choose to use SAE J1939 standard data types or you can specify your data using bit length and offset.

J1939 standard formatting checked

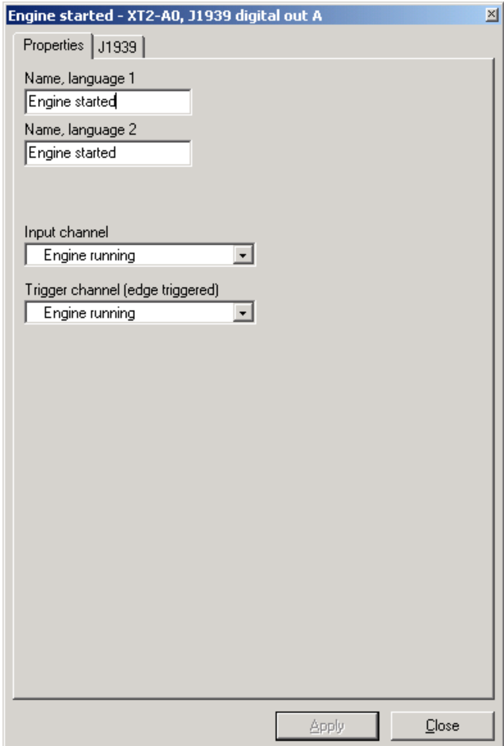
Data length [Byte]	The length of the parameter´s data. 1, 2 or 4 bytes.
Data offset (1-8) [Byte]	The offset gives the actual parameter´s position. The data field is 8 bytes in total. Bytes are numbered from 1 to 8.

J1939 standard formatting not checked

Data length [bit]	The length of the parameter´s data, 1-32 bits.
Data offset (1-64) [bit]	The offset gives the actual parameter´s position. The data field is 64 bits in total. Bits are numbered from 1 to 64.

J1939 Digital out

This channel type is used for sending digital values to external systems via CAN.



Properties for the channel J1939 Digital out.

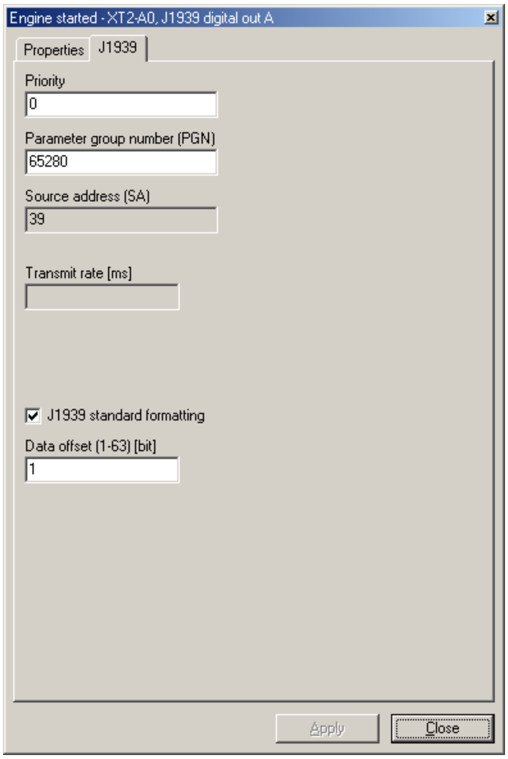
Name

Name, language 1 Name, language 2	The channel´s name in two languages shown on the display.

Channels

Input channel	The value of this input channel is scaled, inserted in a J1939 package and sent via CAN.
Trigger channel	Select *Transmit continuously* to send this value at the rate specified on the J1939 tab. Select a digital channel to transmit the value when that channel goes from low to high.

J1939 properties



J1939 properties for the channel J1939 Digital out.

J1939 Id

Priority	The priority of the parameter´s message.
Parameter group number (PGN)	The parameter´s group identity number. Valid range is 65280 - 65535.
Source Address (SA)	The sender address. This is the same for all J1939 outputs and is specified in the module properties, see section Sender address, on page 189.

Transmit rate

Transmit rate [ms]	How often the message will be sent. This is only used when *Trigger channel* is set to *Transmit continuously.* See the properties tab for the channel.

J1939 Data

J1939 standard formatting	When checked the standard bit length of 2 bits is used, otherwise 1 bit is used.
Data offset [bit]	The parameter´s bit position.

Adjustable values

The following channels have values that can be adjusted from the display or via *i*SMS, see Appendix D on page 368. For some channel types, to enable adjusting, you need to check the box *Adjustable* for each specific channel (and mode where applicable).

Channel type	Parameter	Adjustable via
Voltage in	Min [mV] Max [mV]	Display, *i*SMS
Frequency in	Max [Hz]	Display, *i*SMS
Current out (two directions)	Min current [mA] Max current [mA] Start slope [ms] Stop slope [ms] Fine control [%]	Display
PWM out (two directions)	Min MR [%] Max MR [%] Start slope [ms] Stop slope [ms] Fine control [%]	Display
Function parameter	Value	Display, *i*SMS
SMS input	Value	SMS

SMS input is not adjustable via the *i*SMS command `#SA#`, but uses it's own command `#SV#` which has a syntax similar to *i*SMS, see section SMS input, page 165.

Factory default/adjustable

Factory default corresponds to the application´s "original values". When you send the application to the master, the factory default values will be stored in a write protected area in the master´s memory. When you adjust a channel, the factory default values will not be affected, only the adjustable values.

Channels that have adjustable enabled use the adjustable values, all other channels use the factory default values. SMS inputs always use the adjustable value, the factory default value is only for initiation and resetting.

The operator can always reset an adjustable value to the corresponding factory default value. Therefore you should always enter a factory default value for all adjustable channels.

For all adjustable channel types, you will be able to see and/or change both the factory default and the adjustable values.

Copy properties

There are possibilities to copy either the factory default values to the adjustable or vice versa.

- Select *Edit > Copy properties...*

  > Factory default to adjustables.

  > Adjustables to factory default.

Stored values

The following channels have values that can be stored in non-volatile memory. For some channel types, to enable storing, you need to check the box *Store value* for each specific channel.

Channel type	Store value	Allow reset to zero
Hour counter	Yes	Check box
Event counter	Check box	Check box
Memorizing	Check box	Check box
SMS output	Check box	No

All stored values can be reset to zero when you download an application. This is recommended if the master don't have the same channels loaded as the ones in the application you are downloading.

Stored values can be reset to zero from the display if enabled in channel properties, see respective channel. *i*SMS can also be used to reset stored values if enabled, see Appendix D, page 368.

NOTE

Be careful when you design the function for these channels. The value is stored each time it changes, except for hour counters, they are stored once every second minute.

The memories used in IQAN modules have a maximum number of memory writes of approximately one million times for each channel. With a channel value changing ten times per second, the channel would only work for about 30 hours.

9 Functions and objects

This chapter deals with the following:

- the functions for different channels
- how to create functions
- safety in functions
- how to use the navigator

The function for a channel defines the output signal's value in different situations, e.g. how much current that will be output on a current output or the status for a digital output.

With the internal channels, you can create advanced mathematical functions, regulation functions and alarm functions.

It is possible to handle module or channel errors that occur in a function.

With the navigator, you get an overview of the channels used in a function.

Functions and objects

All movements in a machine is defined with a positive (+) and a negative (-) direction. This applies to control of proportional magnet valves, on/off valves as well as engines. For further information, see section Direction of motion, on page 122.

A function is created by so called objects. An object can be compared to a "black box" with one or several input signals and one output signal. The output signal's value is determined by the input signals and the box's function, that is how the input signals are treated in the box.

The objects are divided into *linear*, *conditional* and *mathematical* objects. The *linear* object's value is proportional to the input signal, we call it an *analog* value. The *conditional* object's value is either *false* or *true*, we call it a *digital* value.

Mathematical objects are used to create advanced mathematical functions. The object's output value can be either analog or digital.

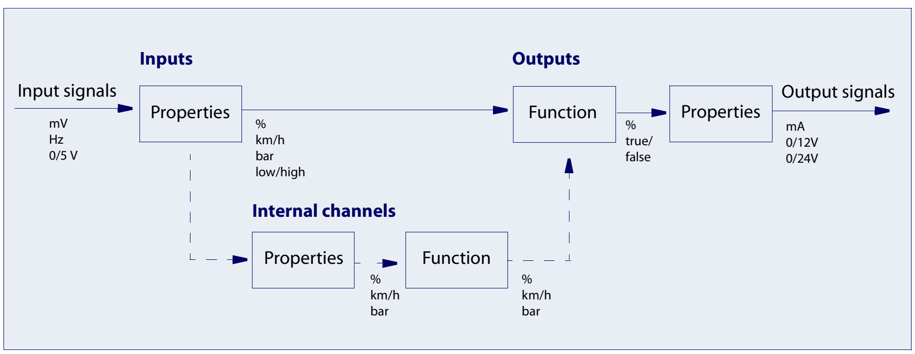
NOTE

When we talk about digital object values, they can only be *false* or *true*. Digital function (or channel) values however, can be either *false/true* or *low/high*. *Low/high* is used for the physical digital channels, i.e. digital in, digital out and alarm out. This is done to make it clear what the signal level is.

Analog values are all numbers within the range -32000 - 32000. For example, 25.17 °C, -72.60%, 52.1 bar, 1850 rpm, etc.

Properties and functions

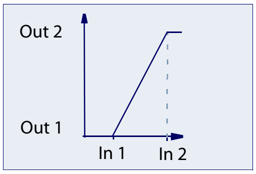
Shown below is a diagram of how the channels' properties and functions are treated.

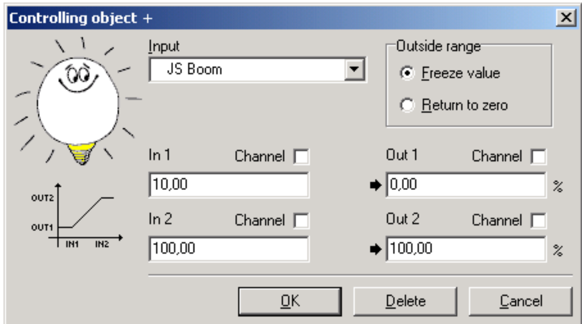


The channels' properties and functions.

Linear objects

Linear objects are defined by an input channel and two breakpoints. Between the two breakpoints there is a linear function based on the input signal.





Dialog box to add a linear object, in this case a controlling object.

Right-click in the channel list to view or select a channel in the pop-up list.

The object's function

Input	Select the channel that you want to use as input signal.
In 1 Out 1	*In 1* and *Out 1* define the first breakpoint for the object's function. If the object's input signal has the value *In 1*, the object's value will be *Out 1*. Enter a constant or check the *Channel* box to select a channel.
In 2 Out 2	*In 2* and *Out 2* define the second breakpoint for the object's function. At input value *In 2*, the object's value will be *Out 2*. Enter a constant or check the *Channel* box to select a channel.
Channel	Check this box to select channels as *In* and *Out* values.

If *Input* is a digital channel, *In 1* and *In 2* are fixed, *False* and *True*, and cannot be changed. Enter corresponding *Out* value for the two possible input values.

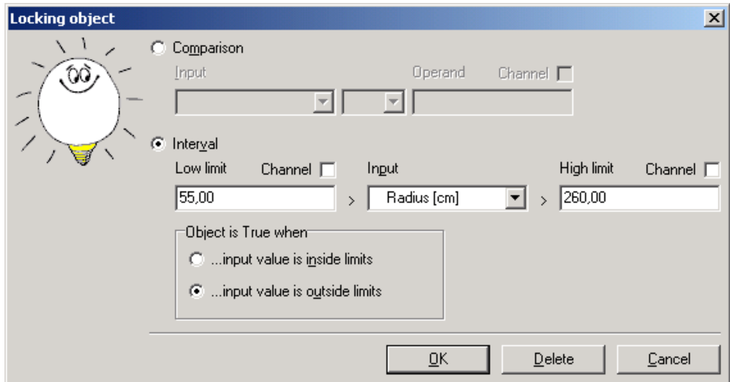
Outside range

Freeze value	The object's value will be frozen if the object's input signal is outside the range *In 1 - In 2*.
Return to zero Return to 100%	The value for a controlling or limiting object will be 0% or 100% if the object's input signal is outside the range *In 1 - In 2*.

Click *OK* to create the object. To delete an object, use the *Delete* button. *Cancel* closes the dialog box without creating any objects.

Conditional objects

For a conditional object, you can use one of the following conditions, comparison between the object's input signal and another value or check if the object's input signal is inside or outside a defined interval.



Locking object (interval definition).

Comparison

Input	The input signal for the object.
Operand	Comparison value or channel.
Channel	Check this box to select a channel as operand.

Input	Operator	Operand
True	n/a - The object's value is constantly *True*	
Digital I/O channel	= equal to <> not equal to	Constant (Low/High) Error Digital channel
Digital internal channel	= equal to <> not equal to	Constant (False/True) Error Digital channel
Analog channel	= equal to <> not equal to < less than > greater than	Analog constant (50 bar, 0%,...) Error Analog channel
Interactive message	Same as analog input	Constant (F1, F2,...) Error Analog channel

Mode selection channel State selection channel	Same as analog input	Constant, mode/state Error Analog channel

To compare the input signal with an error, see section Fail-safe functions, on page 276.

Interval

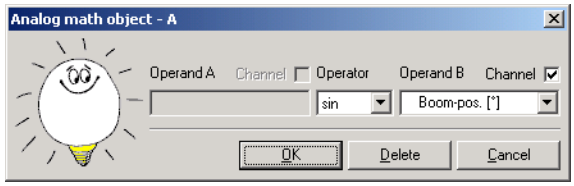
Input	The input signal for the object.
Low limit High limit	Define the interval for the object's input signal.
Channel	Check this box to select a channel as low or high limit.
Object is True when... ...channel value is inside limits ...channel value is outside limits	Select if the object shall be true when the object's input signal is inside or outside the interval.

Low limit	Input	High limit
Analog constant (50 bar, 0%, etc.) Analog channel	Analog channel	Analog constant (50 bar, 0%, etc.) Analog channel
Constant (F1, F2,...) Analog channel	Interactive message	Constant (F1, F2,...) Analog channel
Constant, mode/state Analog channel	Mode selection State selection	Constant, mode/state Analog channel

Click *OK* to create the object. To delete an object, use the *Delete* button. *Cancel* closes the dialog box without creating any objects.

Mathematical objects

A mathematical object is defined by an operator and one or two operands. There are two types of mathematical objects, digital and analog. The main difference is the available operators and the resulting value.



Mathematical expression for object A.

Operator	List with mathematical operators.
Operand A Operand B	Enter a constant or check the *Channel* box to select a channel in the list box as operand. For some operators, only operand B is used.
Channel	Check this box to select a channel or a previous expression as operand.

Analog mathematical objects

The resulting value is analog. Below is a list of all the available analog mathematical operations.

Operator	Number of operands	Operation
+	2	Addition
-	2	Subtraction
*	2	Multiplication
/	2	Division
MaxOf	2	The largest value of the two operands
MinOf	2	The smallest value of the two operands
abs	1	Absolute value
sqrt	1	Square root
sin	1	Sine (argument in degrees)
cos	1	Cosine (argument in degrees)
asin	1	Arc sine (result in degrees)
acos	1	Arc cosine (result in degrees)
tan	1	Tangent (argument in degrees)
atan	1	Arc tangent (result in degrees)

As operand, you can use any of the following:

- channel or constant
- an expression earlier in the function

When a digital channel is used in an analog mathematical object, the channel's value is converted to an analog value. *False* is converted to 0 and *True* is converted to 1.

EXAMPLE

If a button is activated and multiplied by 30, the result will be 30 (1*30). If the button is not activated, the result will be 0 (0*30).

A = DINA x 30

Digital mathematical objects

Digital mathematical objects have two operator types, logical and relational. The logical operators are *not, and, or* and *xor*. The relational operators are =, <>, < and >. The resulting value is digital, *false* or *true*.

Operator	Number of operands	Operand type	Operation
not	1	Digital channel	Negation
and	2	Digital channel	And
or	2	Digital channel	Or
xor	2	Digital channel	Exclusive or
=	2	Any channel or constant	Equal to
<>	2	Any channel or constant	Not equal to
<	2	Any channel or constant	Less than
>	2	Any channel or constant	Greater than

NOTE

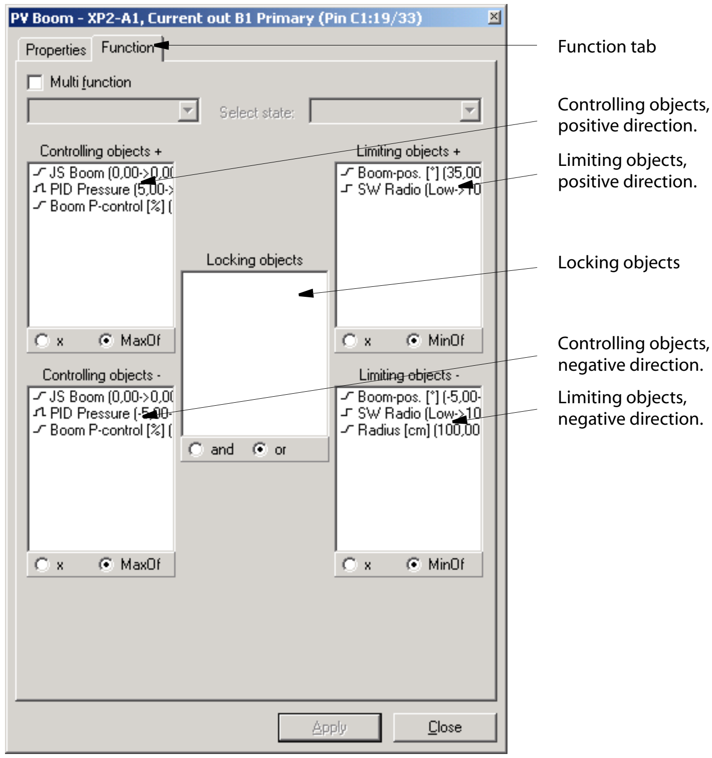
For all operators it is also possible to use a previous operation as operand.

Below is a list of how the logical operators are calculated.

Operator	Boolean expression	A	B	Result
not	$\overline{A}$	False True	n/a n/a	True False
and	A * B	False False True True	False True False True	False False False True
or	A + B	False False True True	False True False True	False True True True
xor	$A \oplus B = A*\overline{B} + \overline{A}*B$	False False True True	False True False True	False True True False

Current out

A current output has three types of objects that affect the output; *controlling*, *limiting* and *locking objects*. The channel value is the same as the function value, -100 - 100%.



The function page for a current output.

The controlling and limiting objects are linear and affect the output of the current proportionally. The object’s output signals state in [%] how much of the current that will be output. You enter the minimum and maximum current output under the properties tab.

EXAMPLE

Min current = 200 mA. Max current = 500 mA.

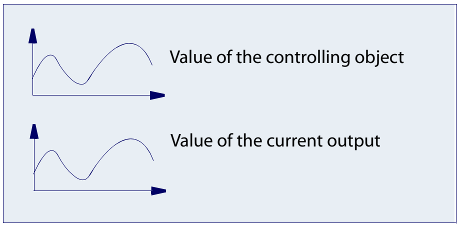
50% output gives 0.5(500 - 200) + 200 = 350 mA.
70% output gives 0.7(500 - 200) + 200 = 410 mA.

Locking objects are conditional, they consists of conditions to lock the current output´s value.

Controlling objects

The primary role of the controlling objects are to *control* the function for an output, that is how much current will be output. The value for a controlling object's output signal is between 0-100 %.

The controlling objects are generally made up of signals that the operator can influence himself, for example, the signal from a lever or a pedal.



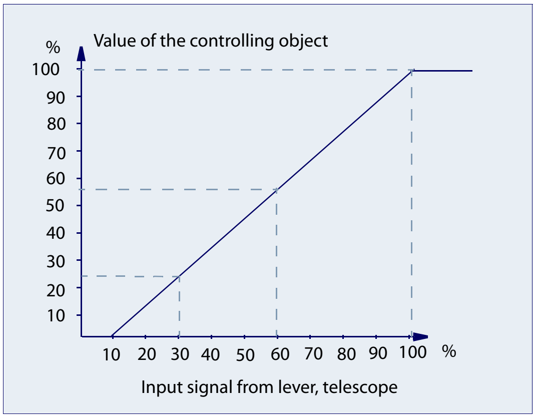
The current output's value is determined by a controlling object.

EXAMPLE

The telescope on a crane will be controlled by a lever. The speed of the telescope's movement shall be proportional to the lever stroke.

The functions will be as follows:

10% lever stroke gives 0% speed on the telescope (to create a dead-band)
100% lever stroke gives 100% speed on the telescope



The controlling object's value as a function of the input signal.

30% lever stroke gives the control value 24%.
60% lever stroke gives the control value 57%.
100% lever stroke gives the control value 100%.

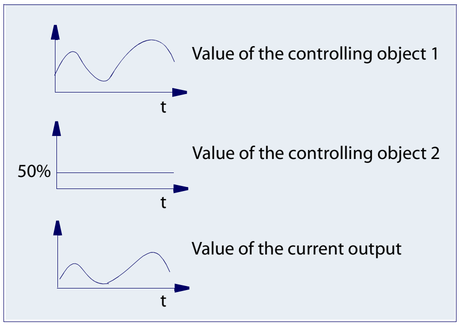
Several controlling objects

A function can consist of up to eight controlling objects for each direction. If the function consists of more than one controlling object, you can choose whether the objects, for each direction, shall be multiplied to one product or let the object with the highest value control the output current.

Multiplication of the controlling objects

The controlling objects' values are multiplied to one product which gives the control value to the output as per:

The controlling objects' value = Control1 x Control 2 x Control 3... Control 8

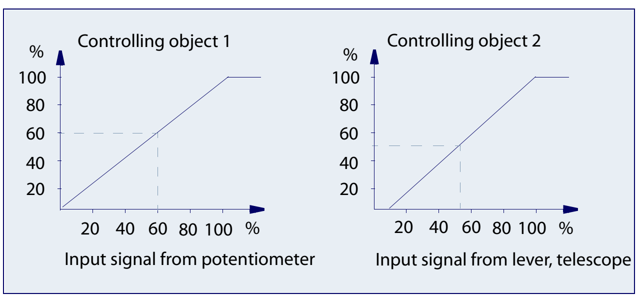


Two controlling objects to control the current output.

EXAMPLE

The telescope on a crane is controlled with a lever as per the previous example. In some situations, the operator may need to manoeuvre the telescope more exact. Then you need to reduce the speed but still use the whole lever actuation for the manoeuvring. The control is supplemented with a potentiometer to vary the maximum speed.

To solve this, you use two controlling objects for the function, one for the lever actuation and one for the potentiometer's input signal.



With the potentiometer set to 60%, object 1 = 60%
With a lever stroke of 55%, object 2 = 50%
The controlling objects = 0.6 * 0.5 = 0.3 => 30%

This means that the speed of the telescope's movement will be 30% of the maximum speed.

MaxOf

With MaxOf, the objects’ output signals are compared to each other. The object with the highest output signal controls the output according to:

The controlling objects’ value = MaxOf(Control 1, Control 2, Control 3 ... Control 8).

EXAMPLE

Sometimes a machine can be equipped with two levers which makes it possible to control the same function from two different spots, from the cabin and from some place outside the machine. In order to make this work you have to define the input signal from each lever as a controlling object in the function and activate *MaxOf*. In this way, the two objects will be compared. Thus: if you are inside the cabin, that lever will control the function and if you are outside the machine cabin that lever will control the function. In addition to this you will need another function to prevent both levers from controlling the same function at the same time, but we will deal with this problem later.

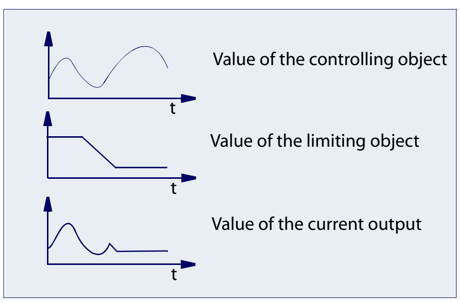
The pre-set alternative, to multiply the objects, is the most common way to control an output.

Limiting objects

Exactly as the name says, the purpose of a limiting object is to limit the current for the output. The object’s input signals are primarily signals from different sensors such as temperature, overload, etc.

The limiting objects are often used to make the functions for a machine safe in all situations and they have the highest priority of the current output’s three object types.

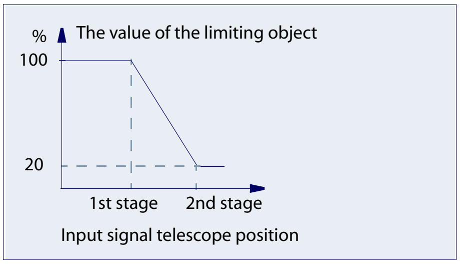
The output signal is between 0 - 100 % where 0 % corresponds to maximum limitation and 100 % corresponds to no limitation.



The controlling and limiting objects’ affect on the output signal.

EXAMPLE

An example where we use a limiting object is *end position dampening* for the manoeuvring of the telescope on a crane. When the telescope is "almost" at the end, the speed will be reduced for the telescope. To attain this function, you need to add a limiting object where the object's output signal is defined as per the diagram below:



End position dampening.

When the telescope passes the first stage "almost out", the limitation will begin. At the second stage, maximum limitation is attained. The telescope speed will not exceed 20% of the maximum speed after this point is reached.

Several limiting objects

If you use more than one limiting object for a current output, you can choose if the object with the lowest value, i.e. the highest limitation, shall be used for the output or if the objects' values shall be multiplied to one product to limit the output value. You can use up to eight limiting objects in each direction for one function.

MinOf

MinOf means that the object's output signals are compared to get the object with the highest limitation (the least value) to limit the current for the output.

The limiting objects' value = MinOf(Limiting 1, Limiting 2...Limiting 8).

Multiplication of the limiting objects

The objects' values are multiplied to one product to limit the output's value.

The limiting objects' value = Limiting 1 x Limiting 2...Limiting 8

Only default alternatives for the objects are described.

Controlling and limiting objects

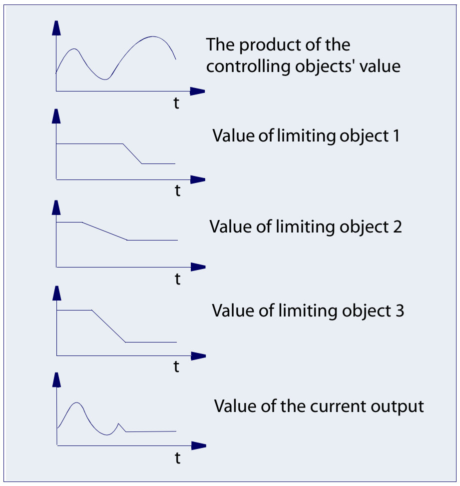
Normally, you use both controlling and limiting objects to create a function. The current output's value is determined as per the following equation:

The output value =MinOf(Controlling objects' value; Limiting objects' value)

The value for the controlling objects is compared to the limiting objects' value.

If the value for the controlling objects is *less than* the value for the limiting objects, the output's value is not affected by the limitation.

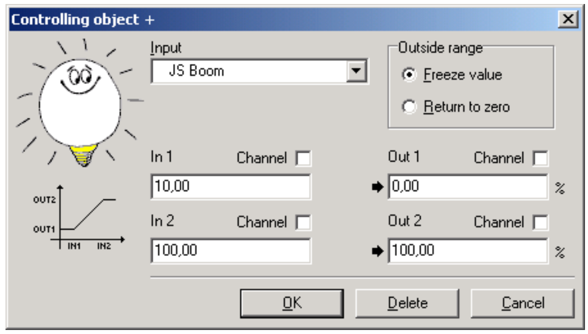
If the value for the controlling objects is *greater than* the value for the limiting objects, the limiting objects' value limits the output.



The controlling and limiting objects' affect on the current output.

Connected objects

If the input signal for a controlling or limiting object is outside the breakpoints *In 1* and *In 2*, see picture below, you can choose if the value for the object's output signal shall be frozen, that is keep its current value or if the object's output signal shall be reset to zero respective 100 %.

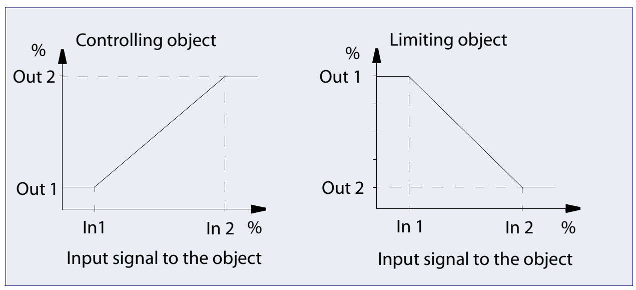


A linear object.

Freeze value

Freeze value is default. Below is an example of the purpose of freezing the output signal's value.

If the object's input signal is less than *In 1*, the object's output signal keeps the value *Out 1*. Also, if the input signal's value is greater than *In 2*, the output value will be frozen to *Out 2*.

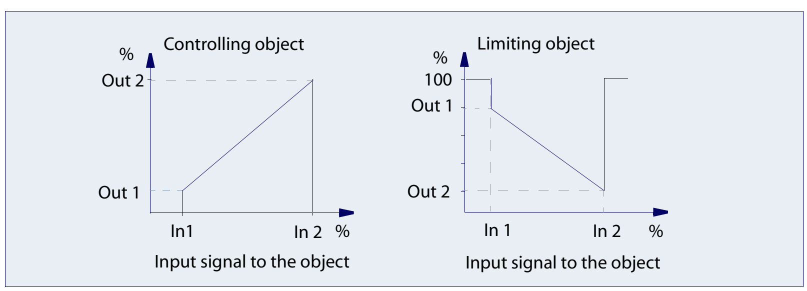


The objects' output signal will be frozen if the input signal is outside the breakpoints.

Return to zero/Return to 100%

With the *Return to zero* and *Return to 100%* options you can connect up to eight objects in order to get a graph with several breakpoints.

If the object's input signal is less than *In 1* or greater than *In 2*, the object's output signal will be reset to zero for a controlling object and reset to 100 % for a limiting object.

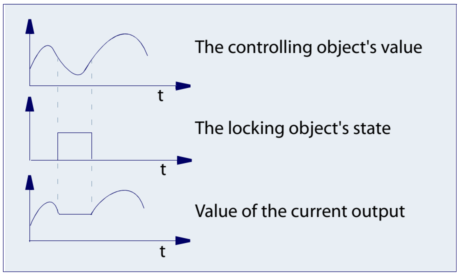


The objects' output signal will be reset to zero or 100 % if the input signal is outside the breakpoints.

Locking objects

The locking objects consist of conditions to lock the current output's value.

The locking objects have higher priority than the controlling objects. The limiting objects have the highest priority in order to limit a locking function.



The output's value is locked by a locking object.

EXAMPLE

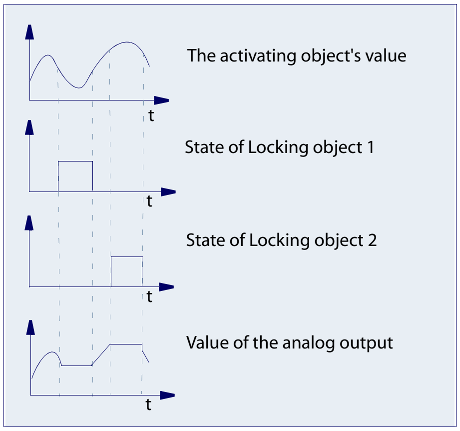
A typical locking function is the hold function for a hydraulic engine, for example, operation of a drill where the speed is controlled with a lever. A button locks the speed of the drill so that it runs constantly even when you release the lever.

Several locking objects

You can use up to eight locking objects for one function. If you have several locking objects, the output's state is determined by the following boolean equation:

OR: The locking objects' value = Locking1 + Locking2 + Locking3...Locking8.

Provided the state of at least one locking object is *true*, i.e. the locking object's condition is fulfilled, the output's value remains locked.



The output's value is locked by several locking objects.

AND: The locking objects' value = Locking1 * Locking2 * Locking3...Locking8.

To lock the output's value, all locking objects have to be *true*.

Creating a function

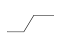
Under the *Function* tab in the dialog box *Channel information*, you create the current output's function.

Open function page

- Select the name tag for the channel in the block diagram and select: *View > Show channel info*. It is also possible to double-click on the name tag to open the dialog box *Channel information*.
- If the dialog box shows the page for the channel's *Properties,* click on the tab marked *Function* to activate the function page.

Symbols

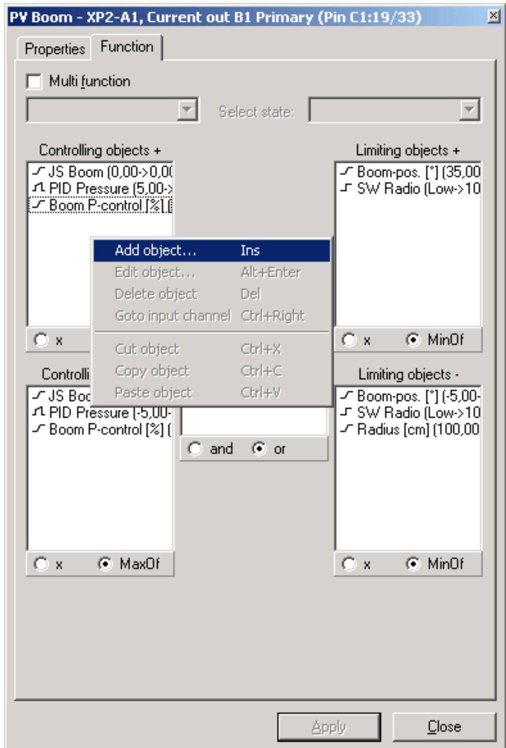
The following symbols are shown for linear objects on the function page:

	Freeze value, the input signal is an analog channel.
	Return to zero, controlling object. The input signal is an analog channel.
	Return to 100 %, limiting object. The input signal is an analog channel.
	Input signal from a digital channel.

Create a new object

- Right-click in the desired object box.

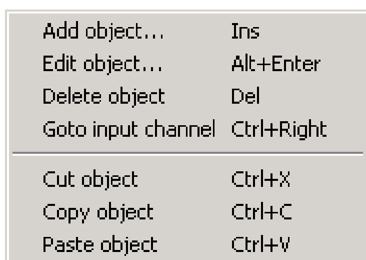
- A list with editing commands is opened. Select: *Add object*.



Creating a new object.

- A dialog box for the new object appears. For information on controlling and limiting objects, see section Linear objects, on page 214. For locking objects, see section Conditional objects, on page 216.
- Click *OK* to create the object.

There are other menu items in the popup menu also.



Popup menu for objects.

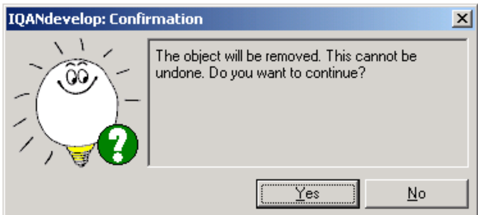
Editing objects

- Right-click on the object and select: *Edit object* or double-click on the object. The dialog box for the object opens.

- Do your changes and click *OK*. *Cancel* closes the dialog box without storing the changes. The *Delete* button deletes the current object for the function, see also next section.

Deleting objects

- Right-click on the object and select: *Delete object* in the editing menu.
- A dialog box opens to let you confirm that the selected object shall be deleted.



Confirmation dialog box to delete an object.

- Click *Yes* to delete the object or *No* to keep it.

Go to input channel

All objects has a shortcut to its input channel.

- Right-click on the object and select: *Goto input channel.*

The channel will be selected in the block diagram and the channel information dialog box will be updated with that channel.

Cut and paste

An object can be cut and then pasted in another object box.

- Right-click on the object and select: *Cut object*.
- Click in the object list box, where the object will be moved.
- Right-click and select: *Paste object.*

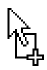
Copy

An object can be copied from one object list box to another.

- Right-click on the object and select: *Copy object*.
- Click in the object list box, where the object will be pasted.
- Right-click and select: *Paste object.*

Drag and drop to move an object

It is also possible to click on an object, hold the mouse button down and drag it to another object list box. You drop the object by releasing the mouse button.

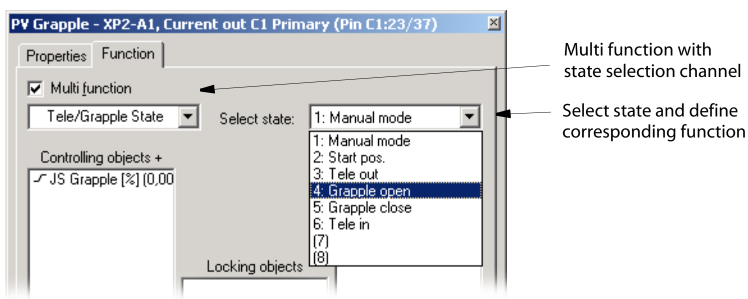
	The cursor symbol for dropping the object in another box.
	The cursor symbol shows that you cannot drop the object.
	The cursor symbol for *copy*. By pressing *Ctrl* when you drop the object, a copy is created.

NOTE

To move or copy an object, the object type needs to be the same as the type where it is pasted or dropped. You can of course move or copy an object to another channel if you want to.

Multiple functions

Each channel can have up to eight functions. Only one function is active at a time. The active function is selected with a *state selection* channel, see section State selection, on page 273. This is typically used to create *state machines*, e.g automatic sequences, gear box control, etc.



Function page for a current output using multiple functions.

Creating multiple functions

Activate multiple functions by checking the box *Multi function* and select a state selection channel in the list below. This is only possible when there is at least one state selection channel defined in the application.

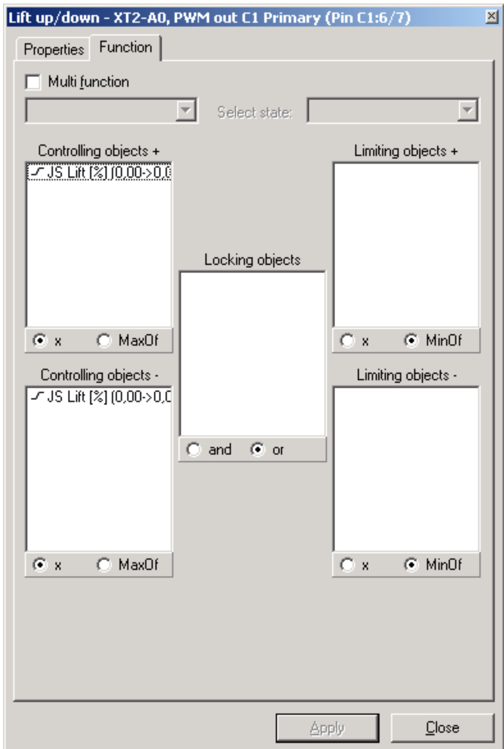
Select desired state and create your function for that state. Select the next state and create a new function. Do this for all your defined states, maximally eight.

Measuring multiple functions

When you measure a channel with multiple functions, the currently active function will be shown automatically. This means that the function page will continuously be updated as the state selection channel used changes it's value.

PWM out

The function for a PWM output is created in the same way as for a current output, see section Current out, on page 221. The channel value is the same as the function value, -100 - 100%.



The function page for a PWM output.

NOTE

For PWM outputs it is allowed to activate primary and secondary channel at the same time, provided that they are not activated in the same direction. This exception allows you to use the *primary channel/positive direction* to control one function and the *secondary channel/negative direction* to control something else. Since PWM outputs are often used to control functions with one direction only, like hydraulic motors or single solenoid valves, this feature will save outputs in your application.

Digital out

A function for a digital output consists of objects which determine when the output will change state from *low* to *high* and vice versa. The channel value is the same as the function value, i.e. *low* or *high*. The objects for a digital output are *conditional* and can be *activating, blocking* or *locking*.

Function page for a digital output.

Activating objects

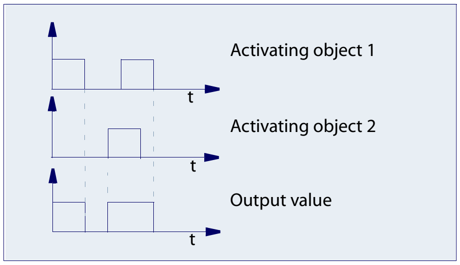
The *activating objects* are used to "start" a function, such as a windscreen wiper or a parking brake, where the activation takes place with a digital or analog signal, for example a button. The operator can often affect the object's input signal himself.

Several activating objects

A function can have up to eight activating objects. If you use several activating objects, the output's state is determined by one of the following boolean equations:

OR: The activating objects' value = Active1 + Active2 + Active3... Active8.

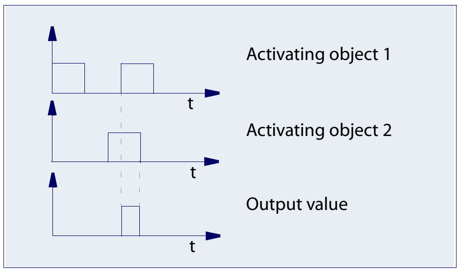
One of the objects' conditions being fulfilled is sufficient for the output to be activated.



Object 1 OR object 2.

AND: The activating objects' value = Active1 * Active2 * Active3... Active8.

To activate the output, all objects have to be *true*.



Object 1 AND object 2.

Blocking objects

The blocking object's input signal is used to "stop" a function. It can be a signal from an end position sensor or an emergency stop, etc. Blocking objects are used to make the function safe in different situations and have the highest priority of the three object types. This means that when a blocking object's condition is fulfilled, it affects the output regardless of whether the other objects' conditions are fulfilled.

When a blocking object becomes true, the digital output's turns *Low*. In this way, the output's function is blocked.

Several blocking objects

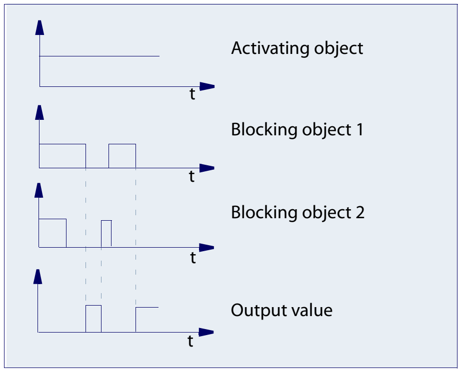
You can have up to eight blocking objects for one function. If you use several blocking objects, the output's value is determined by the following boolean equation:

OR: The blocking objects´ value = Block1 + Block2 + Block3... Block8

At least one blocking object's condition has to be fulfilled in order to block the output.

NOTE

We use boolean algebra for digital values (False/True), which means that + is the same as *or*.



Blocking object 1 OR blocking object 2.

AND: The blocking objects' value = Block1 *Block2 *Block3... Block8

All objects' conditions have to be fulfilled in order to block the output.

NOTE

We use boolean algebra for digital values (False/True), which means that * is the same as *and*.

Activating and blocking objects

Normally, you have both activating and blocking objects to create a function. In practice, this means that you always have to have at least one activating object to be able to block the output's function.

The digital output's value is determined by the following boolean equation:

Output value = (Value of the activating objects) * ($\overline{\text{Value of the blocking objects}}$)

The activating objects affect the output's state until a blocking object's condition start to apply.

NOTE

In boolean algebra, $\overline{\text{Value}}$ is the same as *not* Value.

Locking objects

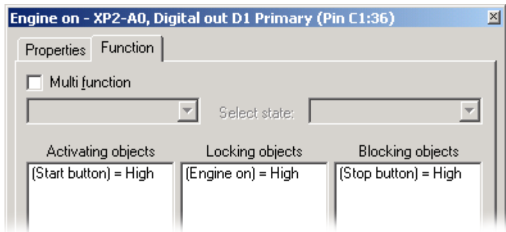
The locking objects are used to lock the digital output's value.

EXAMPLE

Start and stop function for a digital output, with non locking push buttons.

You have to press the start button to activate the digital output. To avoid having to keep the button pressed, we need to create a *hold function*.

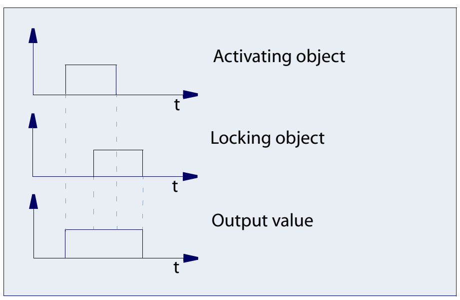
We use a *locking object*, where we select the digital output itself as input, see below. When the digital output is activated, the *locking object* becomes true and the digital output stays activated.



Hold function with a locking object.

Thereafter we create a blocking object where we use the stop button as the object´s input value. The blocking object has the highest priority so when you push the stop button the digital output will be blocked.

Locking objects have higher priority than the activating objects. The blocking objects have the highest priority to be able to block a locked function.



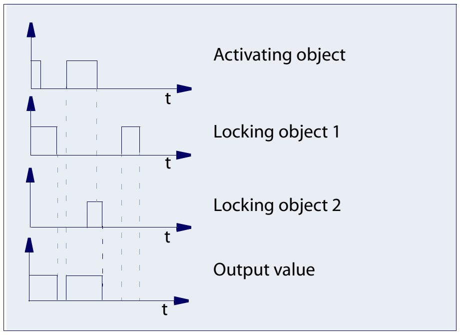
The output's value is locked by a locking object.

Several locking objects

You can use up to eight locking objects for one function. The locking objects' value is determined by one of the following boolean equations:

OR: Locking objects´ value = Locking 1+ Locking 2+ Locking 3...Locking 8.

At least one locking object needs to be true to lock the output.



The output's value is locked by one or several locking objects.

AND: Locking objects´ value = Locking 1 * Locking 2 * Locking 3...Locking 8.

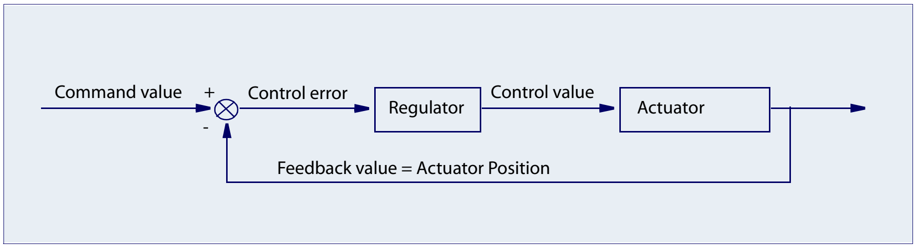
All locking objects have to be true to lock the digital output.

You create the function for a digital output in a similar way as you do for a current output, see section Creating a function, on page 229. For more information on conditional objects and how to create them, see section Conditional objects, on page 216.

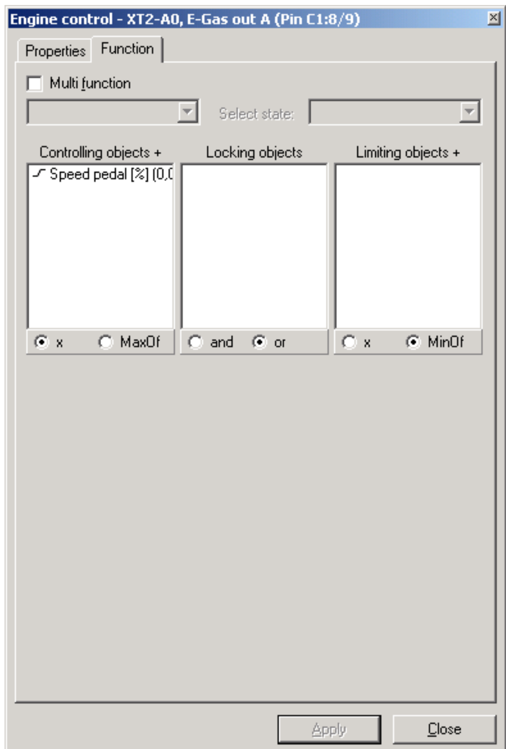
E-Gas out

The purpose with the E-gas out channel is to control the speed of a diesel engine, i.e. to adjust the position of the actuator that controls the injection pump of the engine. The IQAN-XT2 module has an internal PID-regulator.

The value for an E-gas output is the same as it's function value, the command value for the PID-regulator, 0-100%. Control value can be measured on the properties page. See picture below.



The PID-regulator for E-gas out in IQAN-XT2.



Create the command value function.

Controlling, limiting and locking objects

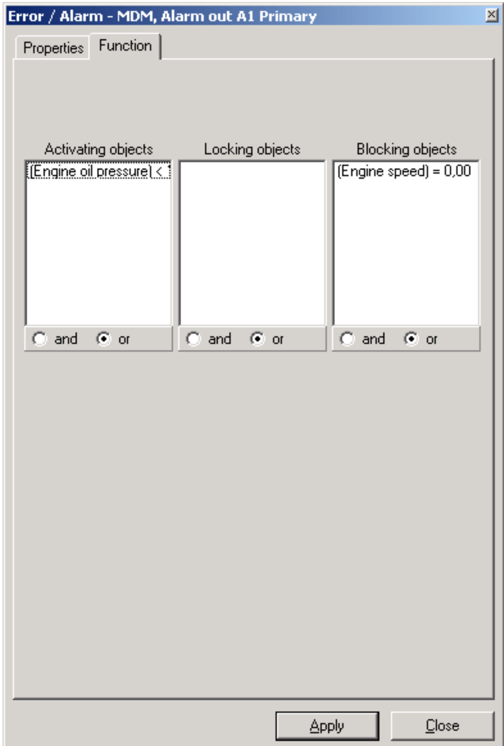
The objects for the E-gas out channel are used in the same way as for a current output. For further information about the object types, see section Current out, on page 221. For the E-gas channel there are only objects for one direction.

Feedback value

When you use the E-gas channel to control for example an actuator, IQAN-XT2 automatically uses the VIN A pin to measure the *feedback value* for the regulator. You need to connect the feedback signal to the dedicated pin on the module. For further information see Instruction book IQAN-XT2.

Alarm out

It is possible to connect warning lamps or sirens to an alarm output. The output is digital and functions in the same way as a digital output with its *activating*, *blocking* and *locking objects*.



Function page, Alarm out.

EXAMPLE

An alarm for low hydraulic pressure should only occur when the engine is on. You must use the input signal from the hydraulic pressure as an activating object and e.g. the input signal from the diesel engine speed as a blocking object so that the alarm output is blocked when the engine is not running.

Activating, blocking and locking objects

The activating, blocking and locking objects are used in the same way as for the digital outputs. For further information, see section Digital out, on page 235.

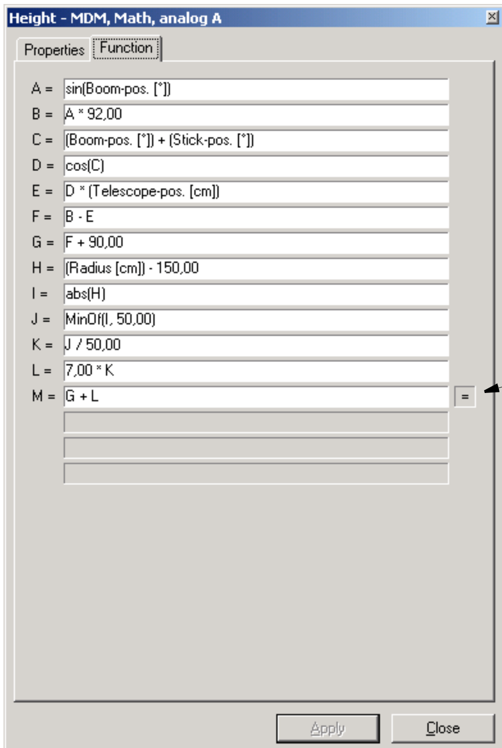
The output has a primary and a secondary channel connection. In this way, you can activate two alarms with different properties.

EXAMPLE

Connect a buzzer or siren to the alarm output. Use primary and secondary alarm to make them sound different by defining different pulse trains. In this way, you can recognize an alarm by it´s sound.

Mathematical analog

With a *mathematical analog channel* you can create advanced mathematical calculations for an application by building functions with mathematical expressions, so called mathematical objects. Even though the intermediate results can be of any value, the end result must be within -32000 - 32000. You can create up to 16 mathematical expressions. The result of the calculation is determined by the last expression. For available operations, see section Analog mathematical objects, on page 218.



The result of the calculation is determined by the last expression in the list. That row is marked with =.

Function page for a mathematical analog channel.

Splitting up a mathematical expression into sub-expressions

You cannot write the whole expression on one line. Instead you must split it up into sub-expressions. A line in the list can contain an expression with up to two operands.

$$\frac{VIN_A \times VIN_B + \sin(MAC_A) - 3}{VIN_C}$$

From the expression above, we create the following sub-expressions:

Object	Operation	Comment
A	$VIN_A \times VIN_B$	The values of the voltage inputs VIN_A and VIN_B are multiplied.
B	$\sin(MAC_A)$	Sine for the value of MAC_A. MAC_A is a mathematical analog channel.
C	$A + B$	The results of object A and object B are added. $VIN_A \times VIN_B + \sin(MAC_A)$
D	$C - 3$	The result of object C is subtracted by 3. $VIN_A \times VIN_B + \sin(MAC_A) - 3$
E	$D \div VIN_C$	The result of object D is divided by the value of the voltage input VIN_C. $\frac{VIN_A \times VIN_B + \sin(MAC_A) - 3}{VIN_C}$

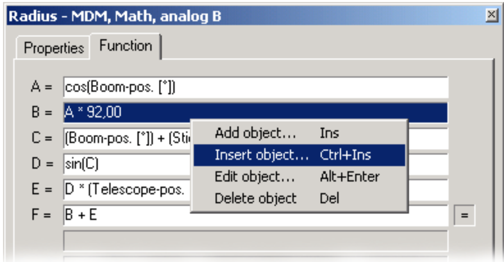
The value of object E is the channel’s output value, since object E is the last object.

NOTE
The value for the last object must be in the range -32000 - 32000.

Creating a function

Under the *Function* tab in the dialog box *Channel information*, you create the function.

- Select the name tag for the channel in the block diagram and select: *View > Show channel info*. It is also possible to double-click on the name tag to open the dialog box *Channel information*.
- If the dialog box shows the page for the channel’s *Properties,* click on the tab marked *Function* to activate the function page.
- Right-click on one of the rows. A popup menu appears.
- To add an object select *Add object* which adds an object at the first available row, or select *Insert object* to insert a new object at the selected row. When an object is inserted, all objects from that row and down are shifted downwards one row.



Popup menu for a mathematical analog channel.

- A dialog box for the new object is displayed. For information on this box, see section Mathematical objects, on page 217.
- Click *OK* to create the object.

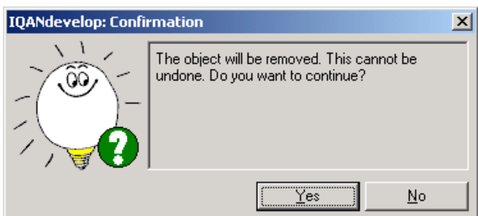
Editing an object

- Right-click on the object and select: *Edit object* or double-click on the object. The dialog box for the object is displayed.
- Click *OK* to save changes.

Deleting an object

You can delete an object if it is not used in the function. The list is compressed automatically so that a row in the middle of the list will never be empty.

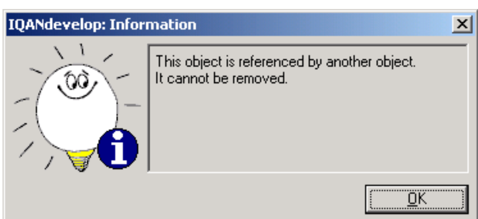
- Right-click on the object to be deleted and select: *Delete object.*



Confirm object removal.

- Click *Yes* to delete the object and *No* to keep it.

  If the object cannot be deleted, the following message box is shown:

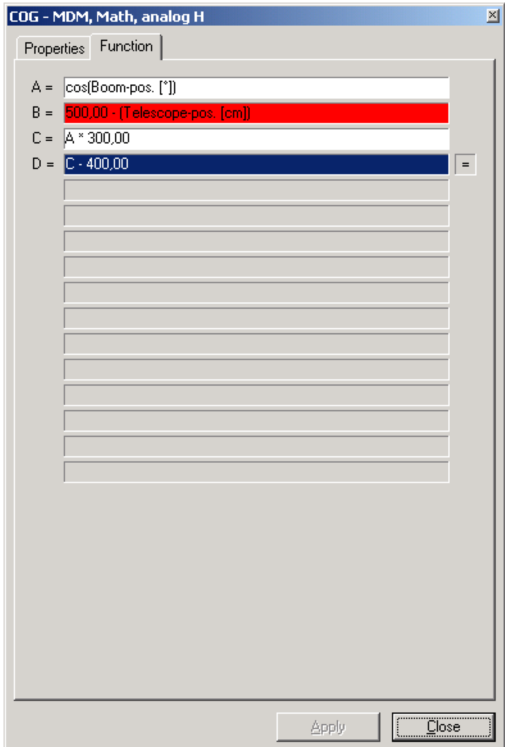


Object can not be deleted.

- Click *OK*.

Unused objects

If an object is not being used to affect the end result in the list, the corresponding row is marked with red.



An unused object in the function.

Mathematical digital

With a *mathematical digital* channel, you can create functions to carry out relational or logical operations. Relational operations can be carried out between channels, objects or constants. Logical operations can be carried out between digital channels or objects.

The function contains a number of mathematical expressions, objects, maximum 16 which are written in a list. The value of the output is determined by the last expression in the list. For available operations, see section Digital mathematical objects, on page 219.

The result from a mathematical digital channel is *true* or *false* and can be used to create functions for other channels.

Function page for mathematical digital channel.

Splitting up a mathematical expression into sub-expressions

$$\overline{(VIN_A > 20) \oplus (FIN_B < 1500)} + DIN_E$$

You cannot write the whole expression on one line. Instead you must split it up into sub-expressions. A line in the list can contain an expression with up to two operands.

From the expression above, we create the following sub-expressions in the list:

Object	Operation	Comment
A	$VIN_A > 20$	If the value of the voltage input, index A is greater than 20, the result is *true*, otherwise *false*.
B	$FIN_B < 1500$	If the value of the frequency input, index B is less than 1500, the result is *true*, otherwise *false*.
C	A xor B	If one operand is *true* and one is *false*, the result is *true*. If both are *false* or both are *true*, the result is *false*, see section Digital mathematical objects, on page 219.
D	not C	The result of object C is inverted.
E	D or DIN_E	If either the result of object D is *true* or the digital input, index E is *high*, the result from the mathematical channel will be *true*, otherwise it will be *false*.

The value of object E in the list is the channel's output value.

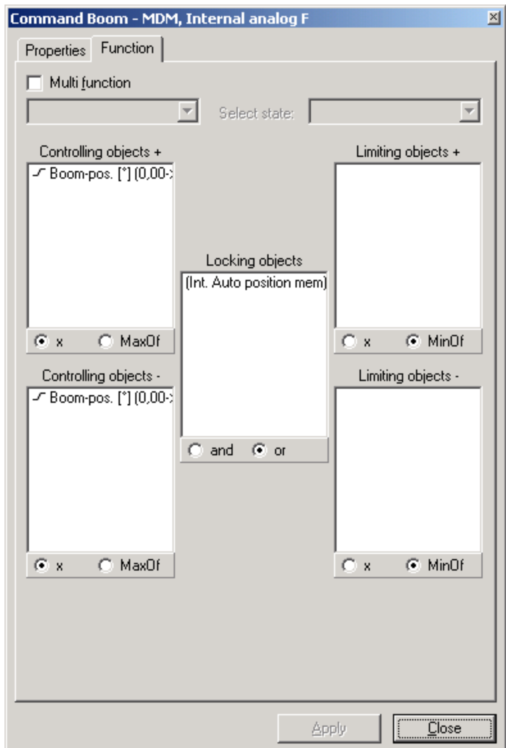
Creating a function

The function is created in the same way as you create the function for a *mathematical analog* channel, see section Creating a function, on page 245.

Internal analog

The function for an *internal analog* channel resembles the function for a current output. The channel's function consists of three types of objects, *controlling*, *limiting* and *locking*. The value of an internal analog channel is within the range -100 - 100%.

It is possible to use internal analog channels to extend the number of objects for a current output. By creating a function for an internal analog channel and thereafter using the internal channel as input signal for an object for a current output, you have access to more objects.



Function page for an internal analog channel.

For more information, see section Current out, on page 221.

Internal digital

The function for an *internal digital* channel is created in the same way as a digital output function with *activating*, *blocking* and *locking* objects. The value for an internal digital channel is digital, i.e. *false* or *true*.

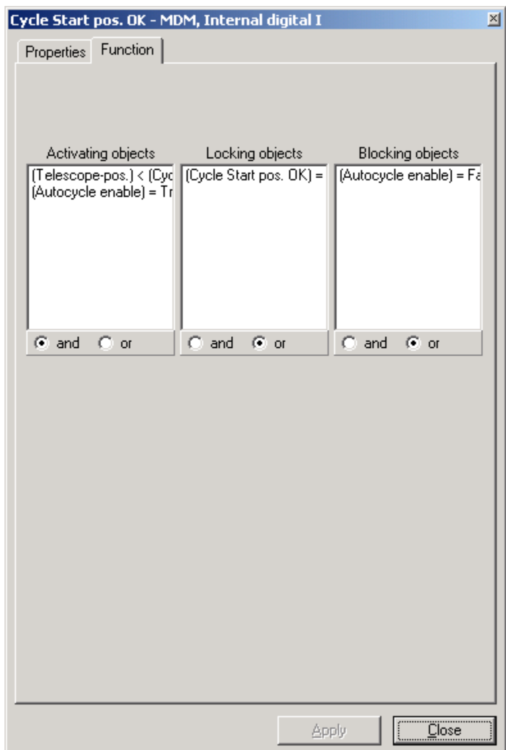
The internal channels are often used to group conditions for different situations.

EXAMPLE

Several outputs should be blocked when an alarm situation is active. The alarm situation can be caused by several input signals such as low hydraulic pressure, low brake pressure, etc.

Instead of adding a lot of blocking/limiting objects to every output in concern, you can put the blocking objects in an internal digital channel. After that, you use that internal digital channel as input signal to one blocking or limiting object for the channels to be blocked out at an alarm.

In this way, you reduce the total number of objects and achieve faster processing in the master. You also get a structured application.

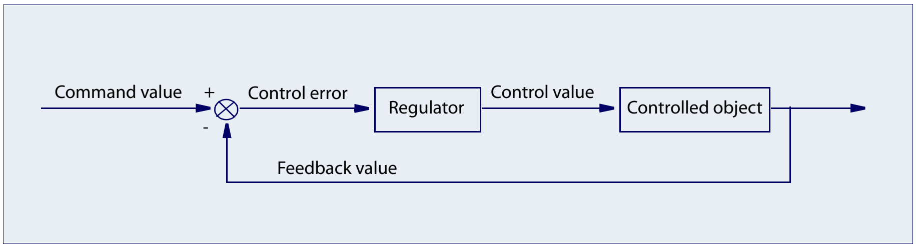


Function page for an internal digital channel.

For more information, see section Digital out, on page 235.

PID

With this channel type you can create feedback controls. The purpose of a feedback control system is to follow a command value with as little control error as possible.



Block diagram over a feedback control circuit.

The *command value* is the reference value that the regulator tries to follow.

The *feedback value* is the actual value measured at the controlled object and is used as a feedback signal.

The *control value* is the output value from this channel. The purpose of the *control value* is to run the controlled object (wheel-steering, straight lift, etc.) in the "correct direction" and thus reduce the control error.

Control error Δ = Command value - Feedback value

There is no such thing as a perfect regulator. It is necessary to compromise between accuracy and stability. There is a risk that a system will experience self-induced oscillation. With this in mind, you must select the correct type of regulation.

Different types of regulation

There are three ways to regulate so that the actual value follows the command value with the least control error possible.

Proportional regulation - P

The control value U_T is affected proportionally to deviations between the command value and the feedback value.

$$U_T = P \times \Delta_T$$

The control error Δ is measured at every point in time T and multiplied with a constant P so that the control value U_T is changed proportionally with the size of the control error. With proportional regulation, an error usually remains when the regulation is finished.

EXAMPLE

To regulate the bucket on a wheel loader, you can solve this with a P regulator. To measure the feedback value, use an inclinometer, gradient sensor, which measures the bucket's gradient. When you use a P regulator, the value of the current is proportional to the bucket gradient error, which is often sufficient for such a function.

Remember that a self-oscillating system can cause unnecessary risks for people and machine function.

When you trim a P regulator, you increase the P constant until the system has a tendency to self-oscillate and then reduce the value a bit.

Integrating regulation - I

$$U_T = I_x \oint_{(t=0)}^{(t=T)} \Delta_T$$

At the time T, the control error, Δ_T is added with previously measured control errors and then multiplied with a constant I.

With an integrating part, you get a more accurate regulation. With proportional regulation only, there is normally an error remaining between the command value and the feedback value when the regulation is complete. With an integrating regulation, however, there is a great risk of getting an unstable system.

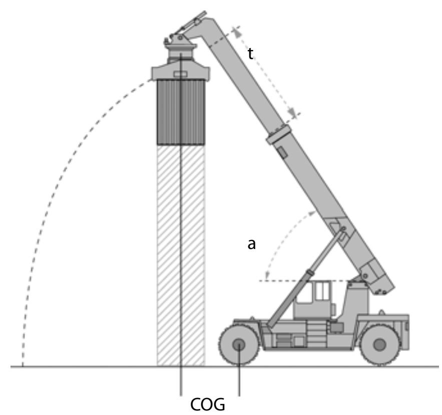
Here, you must compromise between the degree of accuracy and stability. You often use both proportional and integrating actions simultaneously, called PI regulation.

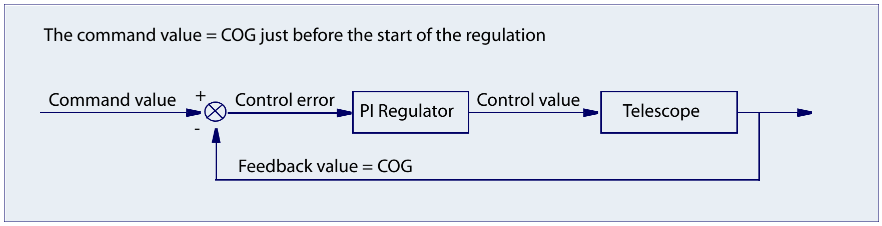
EXAMPLE

The straight lift function for a crane.

When the machine lifts a container, the COG (centre of gravity), i.e. the distance between the front wheels' centre to the middle of the load is held constant. When the boom angle increases, the telescope is extended so that the COG will be constant.

For this, you use a PI regulator to regulate the telescope.





Block diagram of the control system for the straight lift function.

On the lever used to manoeuvre the boom, there is a button to press when you want to use the straight lift function. When the button is pressed, the value of COG is stored so that it can be used as the command value for the regulator. When the straight lift function is activated, you cannot manoeuvre the telescope with the lever, instead the regulator controls the telescope in and out.

To get COG constant, we use a PI regulator where the integrating action is required so an error does not remain when the boom reaches its upper end.

Derivative regulation - D

The derivative regulation is not used often. It is used to prevent fast changes, "disturbances" in the regulation, for example, if the wheels in a feedback control are loaded less than normal which makes the control of the wheel angle faster. The feedback value is suddenly changed which the regulator must compensate for.

$$U_T = Dx(\Delta_T - \Delta_{(T-1)})$$

The control error at time T is compared with the control error in the previous measure and also multiplied with a constant D. If the difference between the control errors is too great, this is compensated for.

The derivative action is used together with a proportional regulation, called PD regulation. It is also possible to equip a PI regulator with the D action which will then be a PID regulator.

For a PID regulator, the following applies:

$$U_T = Px\Delta_T + I \oint_{(t=0)}^{(t=T)} \Delta_T - Dx(\Delta_T + \Delta_{(T-1)})$$

The simplest way to trim a regulator is by testing. Start with the P constant. Supplement with an I constant if necessary.

For more information on the different control techniques, we have to refer to books on the subject.

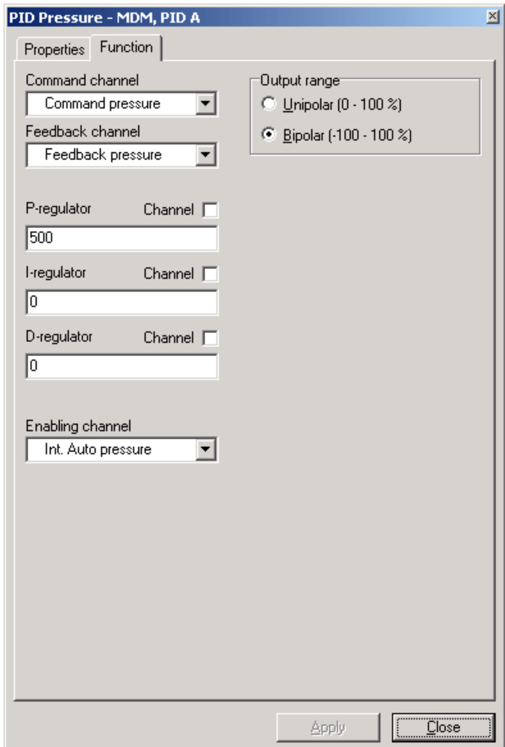
Creating the function

When creating the control function, you must enter the *command value* and the *feedback value* and also when the regulation will begin.

Open the function page

Select the name tag for the channel in the block diagram and select: *View > Show channel info.* It is also possible to double-click on the name tag to open the dialog box *Channel information*.

If the dialog box shows the page for the channel's *Properties,* click on the tab marked *Function* to activate the function page.



Function page for a PID channel.

Enabling channel	Select the channel which will activate the regulation. It must be a digital channel. If you select *True*, the regulator function will always be active.
Command channel	Select the channel that will be the command value.
Feedback channel	Select the channel that will be the feedback value.

Most analog channels can be used as *command* and *feedback* value.

NOTE

Do not use slopes and delays for the input channels that will be used as the PID regulator's *Command* value and *Feedback* value.

The value for command and feedback value must be in the range -100 - 100 %.

Output value range

Unipolar 0 - 100%	If the regulation only will be used in positive direction, e.g. a hydraulic engine.
Bipolar -100 - 100%	If the regulation will be used in both negative and positive direction, e.g. a crane swing.

PID parameters

The P, I and D parameters can be a constant or a channel. The value 0 gives no control action.

P regulator	The value of the constant which gives proportional regulation.
I regulator	The value of the constant which gives integrating regulation.
D regulator	The value of the constant which gives derivative regulation.

The following channels can be used as parameters:

- Function parameters
- Mathematical analog

NOTE

If you use a channel as parameter you have to make sure that the channel's value is within the range 0 - 1000.

Use the PID regulator to create other functions

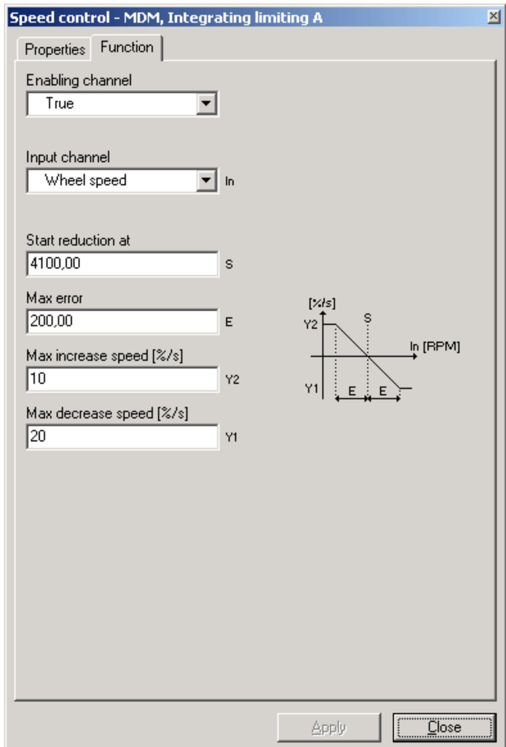
The channel for the regulator can be used to create other functions where the regulation is included as a parameter.

EXAMPLE

Feedback system for wheel-steering. By entering the PID regulator's channel as a controlling object for a current output, the wheels are controlled via the regulator.

Integrating limiting

This channel type is especially used for power regulation, max speed regulation and similar functions. The channel would normally be used in a limiting object in e.g a current output. The functionality of this channel could be compared to a PID regulator that only uses the I-part, and where the I-part varies depending on the value of the input channel. The output value will be between 0% to 100%, where 100% is the idle value.



Function page for Integrating limiting channel.

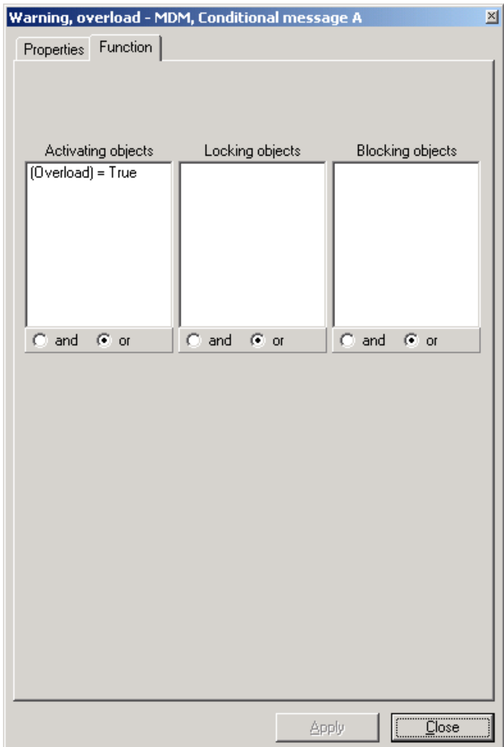
Start reduction at (S)	The value of the input channel where the reduction will start.
Max error (E)	
Max increase speed [%/s] (Y2)	Maximum increase speed when input value exceeds "Start reduction - Max error"
Max decrease speed [%/s] (Y1)	Maximum decrease speed when input value exceeds "Start reduction + Max error"

The best way to explain the channel is with an example. Lets say we control the diesel engine of a vehicle. The maximum speed of the transmission should not exceed 4100 RPM. If so we should decrease the position of the E-Gas actuator. With the input values shown below, the output value of this channel will decrease when the vehicle speed exceeds 4100 RPM. If it exceeds 4300 RPM the output value will decrease with the speed of 20%/second. When the vehicle speed is exactly 4100 RPM the output value will be stable at its latest value. And finally when the vehicle speed goes below 4100 RPM the output value will start to increase again.

Finally we will use this channel as a limiting object for the E-Gas output to achieve the max speed function.

Conditional message

The primary function for the *conditional message channel* is to present messages on the display. The channel value is the same as the function value, *false* or *true*. The function is built exactly like a digital output function, see section Digital out, on page 235.



Function page for a conditional message channel.

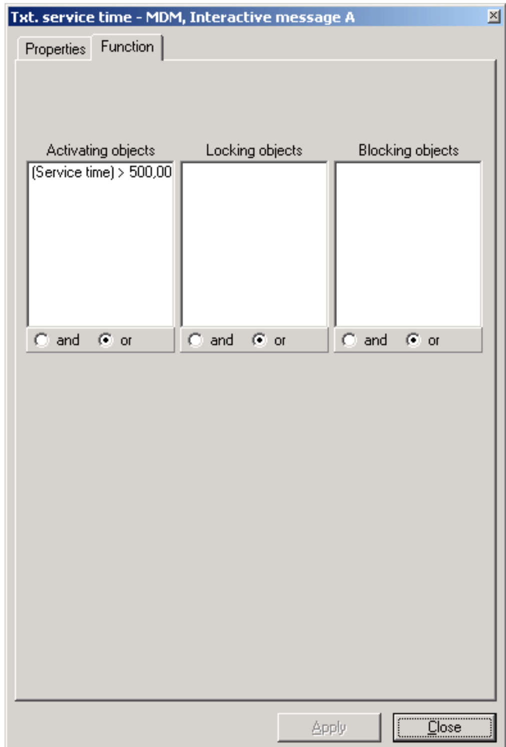
NOTE

If the *Show always* box is checked on the properties page, you don't need to create a function to activate the message. The message will always be available when the display is in operating mode, but the operator has to manually scroll to the message to be able to see it. To make the message pop up automatically when something happens, you should combine *show always* with a function.

If there are two conditional messages with active function at the same time, the one with highest priority will be shown.

Interactive message

This channel type is used to activate *interactive messages* on the display. This means that the driver can acknowledge the messages with the display´s function buttons F1, F2, F3 or the ESC-button.



Function page for an interactive message channel.

Activating, blocking and locking objects

The objects for a *interactive message channel* are used in the same way as for the digital outputs. For further information, see section Digital out, page 235.

The channel´s value

The channel value is not the same as the function value. The function value is *false* or *true* as for all digital functions, but the channel value is one of the following, *Inactive, Active, F1, F2, F3* or *ESC*. If the channel is used in an analog mathematical object, the value is converted to a number, 0 - 5.

Channel value	Numerical value	Description
Inactive	0	The channel is not visible, function value is *False*
Active	1	The channel is visible, function value is *True*

F1	2	F1 has been pressed and function value is *True*
F2	3	F2 has been pressed and function value is *True*
F3	4	F3 has been pressed and function value is *True*
ESC	5	ESC has been pressed and function value is *True*

The channel must be *Active* before it can be acknowledged by one of the display´s function buttons.

If one of the buttons F1, F2, F3 or ESC is pressed when the channel is *Active*, the displayed message will be removed and the channel´s value will change to the corresponding button value. This value will be kept until the function value changes to *False*, which sets the channel value to *Inactive*.

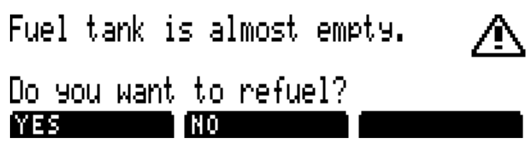
EXAMPLE

In a machine with two fuel tanks we want the driver to control the refueling. The machine has one ordinary fuel tank and one auxiliary fuel tank. When the ordinary tank is almost empty we want to refuel it from the auxiliary tank. We want to start the refueling pump.

We use the fuel level in the ordinary tank as an activating object for the interactive message.

Activating object: (Fuel level, ordinary tank [liter]) < 10

When the ordinary tank is almost empty, the following message is shown:



The driver can now decide if he wants to refuel by pressing YES [F1] or if he want to do it later by pressing NO [F2].

In the function for the refuel pump we use the *interactive message channel* as an input to an activating object.

Activating object: (Interactive message channel A) = F1: YES

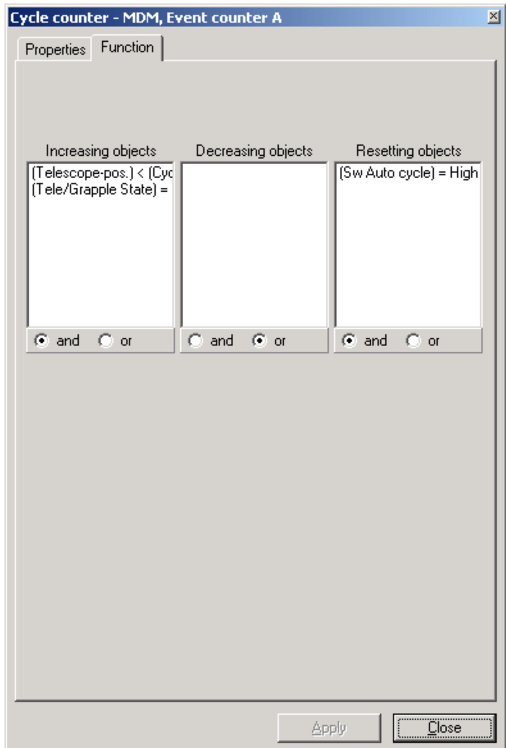
You need to lock the refuel pump with a locking object. Otherwise it will stop as soon as the fuel level in the ordinary tank is over 10 liters. You should also block the fuel pump when the ordinary tank is full or the auxiliary is empty.

NOTE

If F1, F2 or F3 are not enabled, they will not affect the channel value, but the ESC button is always enabled and will remove the displayed message and change the channel's value. Your functions should be able to handle this.

Event counter

The event counter's function is to count events. The function is created with *increasing*, *decreasing* and *resetting* objects. These objects are of type conditional.



Function page for an event counter.

Increasing and decreasing objects

Every time the object's value switches from *false* to *true*, the counter's value increases or decreases by one. The counter's lowest value is zero, the value cannot be negative and the highest is 32000.

NOTE

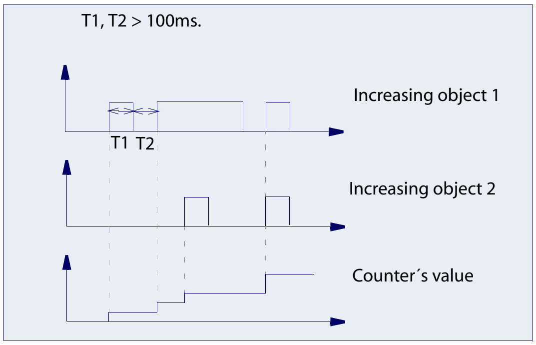
The counter counts on rising transitions.

Several objects

If you have several objects, you use one of the following two expressions to increase or decrease the counter's value.

OR: Counter increases/decreases = (Object 1 + Object 2 + Object 3 + ... + Object 8)

The counter increases/decreases for every object that becomes *true*. If two objects becomes *true* at the same time, the counter will increase/decrease two steps.



The counter´s value increases on a rising edge.

AND: Counter increases/decreases = (Object 1 * Object 2 * Object 3 * ... * Object 8)

All objects have to be *true* to change the counter's value. This means that if all objects are true, it only takes one of the objects to turn *false* and thereafter *true* again to change the counter's value.

Resetting objects

The resetting objects have the highest priority. Every time the objects' value switches from *false* to *true*, the counter's value is reset to zero. The counter's value remains zero until the objects' value turns *false* again.

Several resetting objects

You can use up to eight resetting objects for a counter. If you have several resetting objects you use one of the following boolean equations:

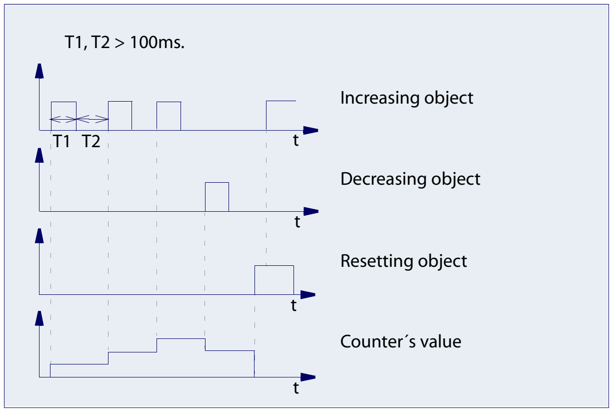
OR: The counter is reset to zero = (Reset 1 + Reset 2 + Reset 3...Reset 8)

If one or more objects are *true*, the counter is reset to zero.

AND: The counter is reset to zero = (Reset 1 * Reset 2 * Reset 3...Reset 8)

All objects have to be *true* to reset the counter's value to zero.

Below is an example of how the counter's objects affect the counter's value.



The counter's objects.

NOTE

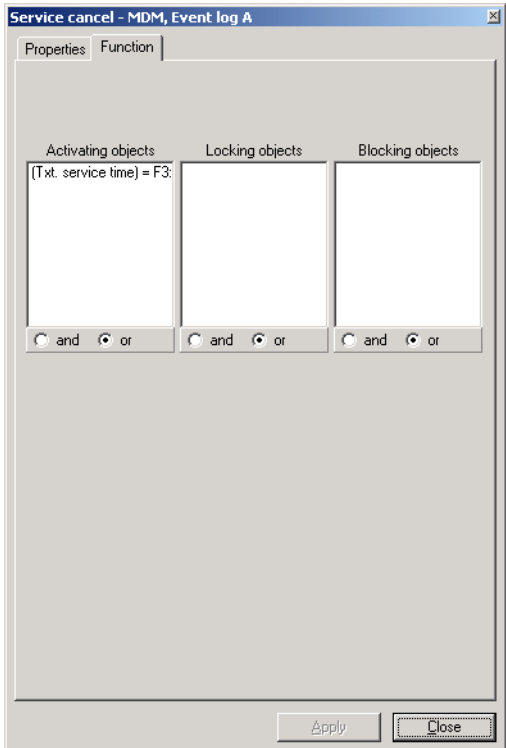
The pulse times T1 and T2 must be longer than 100 ms. See also section Stored values, page 212, if you have *Store value* enabled.

Creating a function

The function is created in the same way as you create a function for a digital output, see section Creating a function, on page 229. For more information on conditional objects and how to create them, see section Conditional objects, on page 216.

Event log

When the event log channel is activated the specified input channel´s value will be stored in the event log. Every event will be stored with channel name, value, date and time.



Function page for an event log channel.

The function is the same as a digital output function, see section Digital out, on page 235. The channel value is the same as the function value, *false* or *true*.

The function also decides when to log the value of the input channel in the event log. This is done when the function value switches from *false* to *true*, i.e. on the rising edge. To be able to log the value again, the function value must go *false* first.

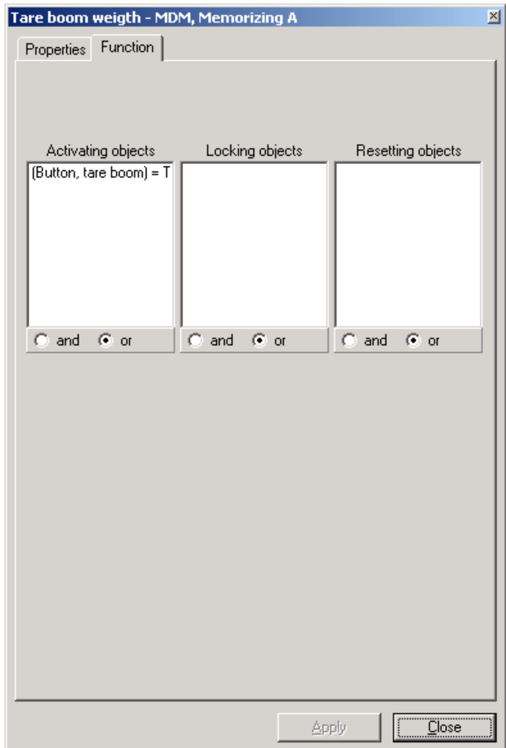
Events are logged in the same memory area as the error log. The maximum number of errors and events are 8000. For more information, see section Error/event log, on page 290.

NOTE

For modules that do not have any real time clock, e.g. IQAN-TOC8, the date and time is not logged.

Memorizing

A *memorizing channel* is similar to the memory function for a pocket calculator. It has activating, locking and resetting objects. These objects are of type conditional.



Function page for the memorizing channel type.

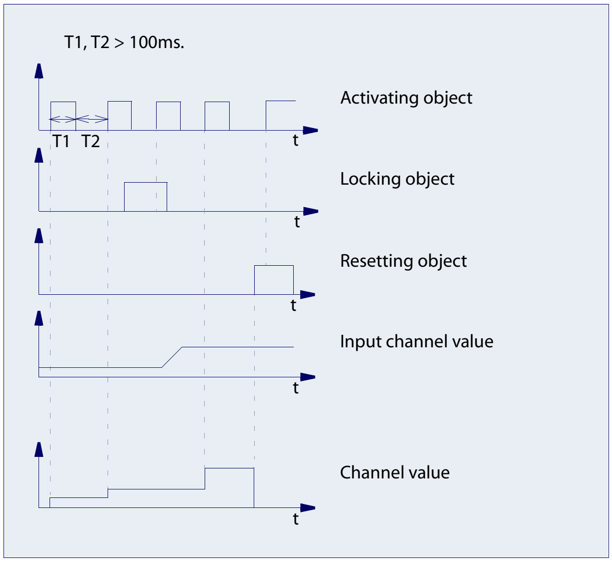
Activating and locking objects

The activating and locking objects together defines the function for when to memorize the value for the input channel. This is the same function as a digital output, except it does not have any blocking objects.

When the value from the activating and locking objects switches from *false* to *true*, the input channel is memorized. The old value is either replaced by the input channel value, or the input channel value is added to the old value, see section Memorizing, on page 152. Thus, the channel value is the latest memorized value or the sum of all memorized values.

Resetting objects

The resetting objects are used in the same way as for the *event counter channel*. They are mainly needed when you are using accumulative memorizing. For further information, see section Resetting objects, on page 263.



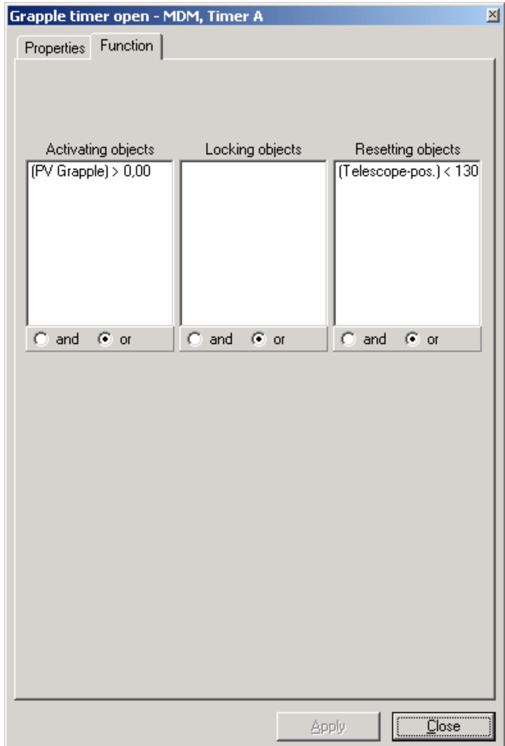
Accumulating memorizing channel (Action = Add).

NOTE

See also section Stored values, page 212, if you have *Store value* enabled.

Timer

A timer has *activating*, *locking* and *resetting objects*, like a memorizing channel, but the function is a bit different.



Function page for a timer.

Activating objects

When the value from the activating objects is *true*, the timer is active. It works just like a stop-watch. The value is 0 - 32000 seconds and the resolution is the same as the system cycle time, (pre-set to 50 ms), see section Other properties, on page 106.

Locking objects

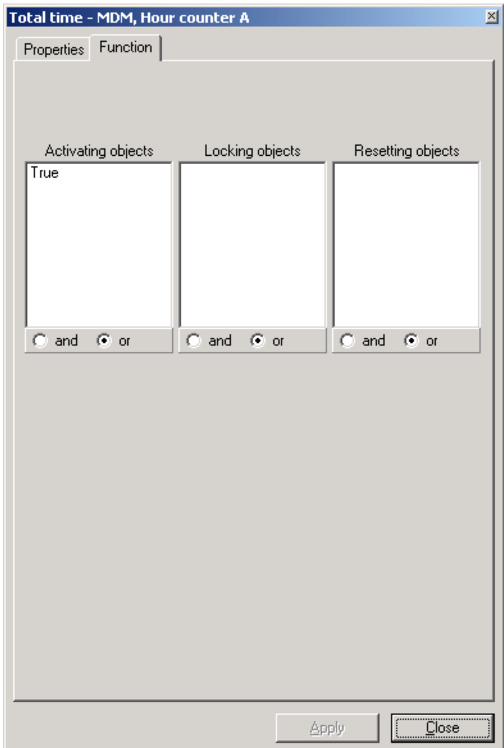
The locking objects have higher priority than the activating objects. When the value from the locking objects is *true*, the timer is stopped.

Resetting objects

The resetting objects have highest priority. When the value from the resetting objects is *true*, the timer is reset to zero.

Hour counter

The hour counter is used to e.g. measure a machine's operating time. The channel can either be set to zero by a resetting object or by the driver via the display. An hour counter can count up to 32000 hours and the resolution is 2 minutes.



Function page for an hour counter.

Activating and locking objects

The activating and locking objects together defines the function for when the hour counter is active. This is the same function as a digital output, except it does not have any blocking objects.

When the value from the activating and locking objects is *true*, the hour counter is active and increases it's value every other minute. The value is 0 - 32000 hours and the resolution is 2 minutes.

Resetting objects

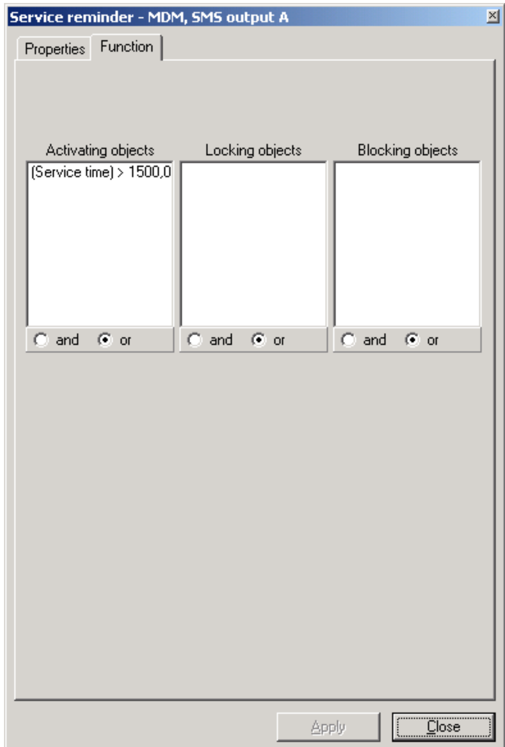
The resetting objects have highest priority and are used in the same way as for the *event counter channel*. For further information, see section Resetting objects, on page 263.

SMS output

This channel sends messages to external systems/GSM phones via SMS (Short Message Service). An SMS-capable GSM modem must be connected to the master module for this functionality.

The message is sent when function value goes from *False* to *True*. The function value has to become *False* again before a new message can be sent.

The channel value is the same as the function value.



Function page for an SMS output.

Activating, locking and blocking objects

The objects for an *SMS output channel* are used in the same way as for a *digital output channel*. For further information, see section Digital out, page 235.

NOTE

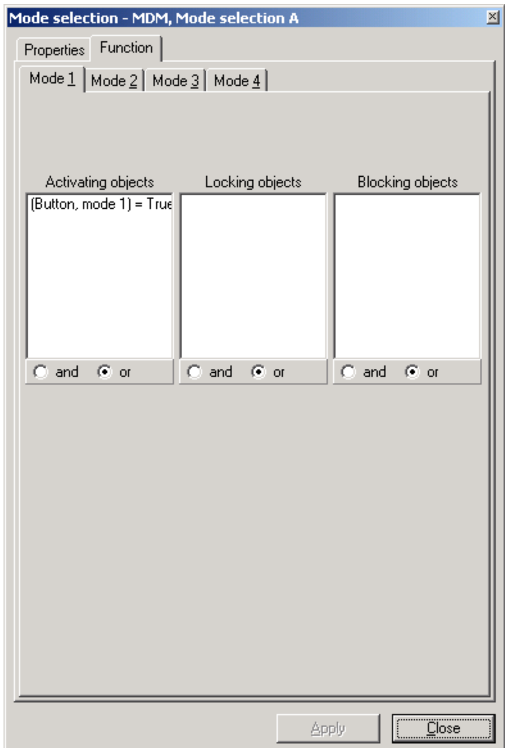
SMS messages are in practice sent once every 30 seconds, one at a time. This means that if four SMS output channels are activated at the same time, the last SMS message is delayed up to two minutes before it is actually sent. There is often also a delay in the GSM network before it reaches the recipient. This delay can vary between a few seconds up to several minutes.

If an SMS output is activated again before the previous SMS message generated by that channel is sent, the new message will replace the old one, i.e. there can only be one message per SMS output in queue at a time.

Mode selection

With this channel you can change *operator mode* for one or many channels automatically. Currently there are two channel types that can use multiple operator modes, *Current out* and *PWM out*.

Manual operator mode selection is still valid for all channels not using auto mode selection. For information on how to activate auto mode on an output, see section Current out, on page 170.



Function page for the mode selection channel, mode 1.

Mode tabs

The tabs are numbered 1- 4, one tab for each mode. On each tab there is a function with activating, locking and blocking objects, just like a digital output.

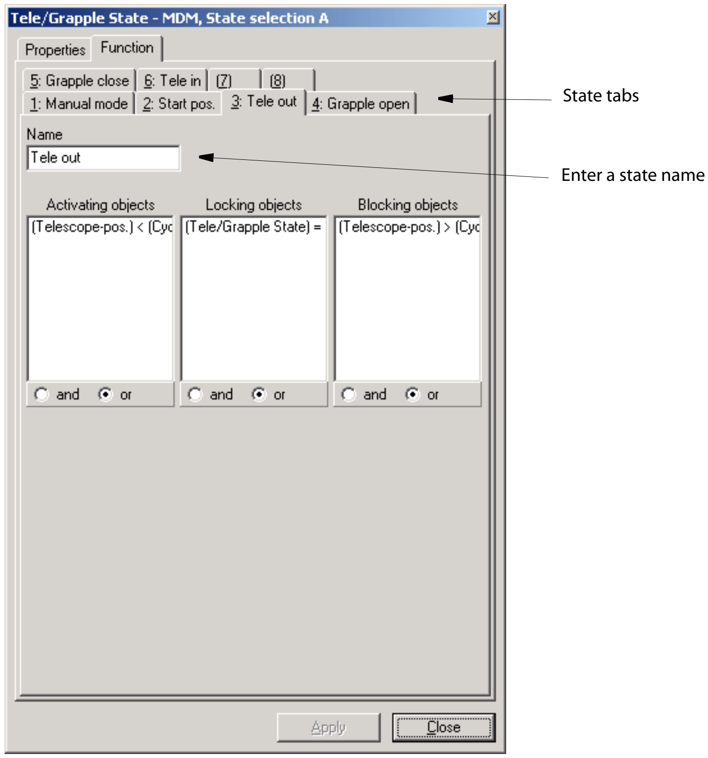
The functions are calculated one by one, starting with the function for mode 1. If the first function is *true*, then the channel's value is 1, i.e. mode 1 is selected, otherwise it continues with the function for mode 2, etc.

It can happen that all functions are *false*. In that case the channel's value is 1 by default. For information on how each function works, see section Digital out, on page 235.

State selection

With this channel you can create a state machine that can be used to control the state for one or more channels. Currently there are four channel types that can use states, *Current out, PWM out, Digital out* and *E-Gas out*.

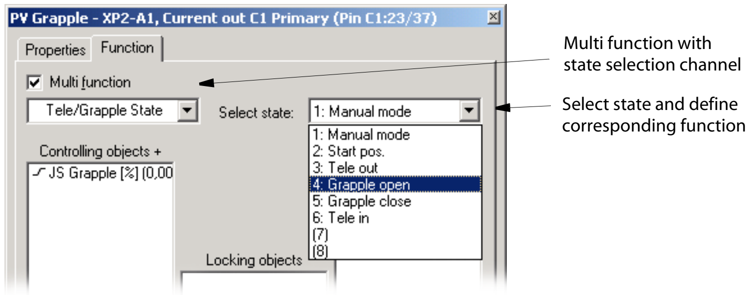
The state selection channel is very similar to the mode selection channel. This channel's value is 0 - 8, where 0 indicates no active state.



Function page for the state selection channel, state 3.

Multiple functions on outputs

When you activate multiple functions on an output, that output can have up to eight functions, one for each state.



Function page for a current output using multiple functions.

State tabs

The tabs are numbered 1- 8, one tab for each state. On each tab there is a function with activating, locking and blocking objects, just like a digital output.

The functions are calculated one by one, starting with the function for state 1. If the first function is *true*, then the state selected will be 1, otherwise it continues with the function for state 2, etc.

NOTE

It is important to remember that all states are always calculated. That is, even if the 3:rd state is true, the output value will be three, but the rest of the states will at least be calculated. The only way this can be used, is to use the locking objects to lock the state itself.

It can happen that all functions are *false*. In that case the channel's value is 0, i.e. no state is selected. For information on how each function works, see section Digital out, on page 235.

EXAMPLE

A typical function where you can use the *State selection channel* is to do a sequence for emptying a container with a front-loader vehicle.

Actual states

Use a *State selection channel* to create the states.

State 1: Start sequence/Lock the container

State 1 is activated by pressing a button. State 1 is finished when locking sensor is activated.

State 2: Levelling

Levelling is finished when inclinometer indicates that everything is OK.

State 3: Weight measurement

Finished when weighing system indicates so.

State 4: Lift and empty

Application dependant.

State 5: Tare weight measurement

Finished when weighing system indicates so.

State 6: Finished

In this example the activating object for all states should be the button. This means that in theory all states are simultaneously active. But as previously explained, the output value of the channel, will be the first *true* state. For each state the conditions that should end the state would be placed as blocking objects.

The sequence will then automatically go from *State 1*, through all the states up to *State 6*.

The states can then be used either for *Multiple functions* in *Digital/Current outputs*, or as logical expressions in digital objects.

Fail-safe functions

In this chapter we want to show the possibility to create safe functions when there are errors in the system.

If an error occurs, for example; a sensor is short-circuit to ground or the master loses contact with a module, you can handle these errors in the channels' functions.

The different channel types varies in functionality as shown below.

Create safe functions with conditional objects

By using *conditional* objects it is possible to handle errors.
The following conditions can be used.

Condition	Description
(Channel) = Error	*Voltage input:* Lost contact with module Error low condition (e.g short circuit to ground) Error high condition (e.g short circuit to battery) Vref error condition *Current output:* Lost contact with module Error low condition (Open load) Error high condition (Overload) *PWM output/Digital output:* Lost contact with module Error high condition (Overload) *Other channel types:* Lost contact with module
(Channel) <> Error	*True* if none of the above errors are indicated for that channel.
(Channel) < Error	*Voltage input:* Error low condition (e.g short circuit to ground) *Current output:* Error low condition (Open load) *Other channel types:* Does not support this operator

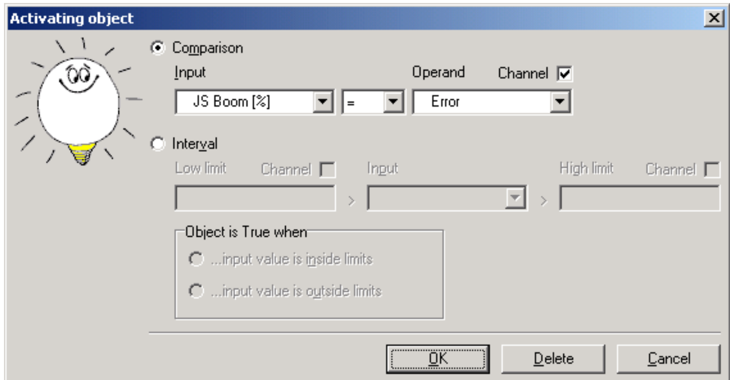
(Channel) > Error	*Voltage input:* Error high condition (e.g short circuit to battery) *Current output:* Error high condition (Overload) *Other channel types:* Does not support this operator

If you want to create a function for a channel that doesn't use conditional objects, for example analog or mathematical channels, you have to use an *internal digital channel* where you create the function to take care of the actual error. Thereafter the internal digital channel can be used as input to a linear or mathematical object.

EXAMPLE

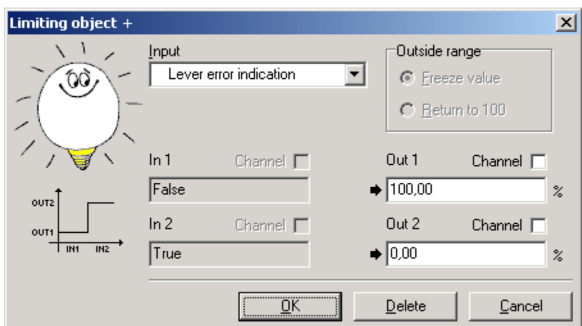
A lever is used to control the current output for a boom. If an error is indicated for the lever signal, the function for the current output will be limited. To solve this, we use an internal digital channel called *"Lever error indication"* to handle the error.

An activating object is added to the internal digital channel.



Activating object for an error on the lever, JS Boom.

We will then use the internal digital channel as input to a limiting object for the current output. Remember to create one limiting object for each direction.



Output is blocked if an error is detected.

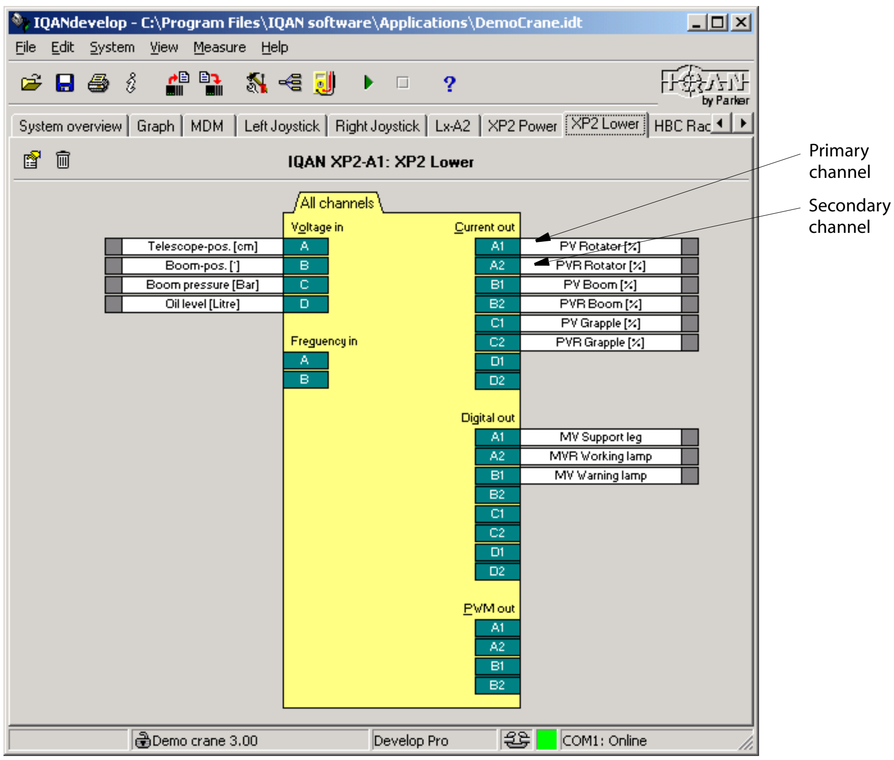
Primary and secondary channel

The channel connections for most outputs, are split up into two channels, one primary and one secondary channel. They both control the same pin but can have different properties and/or function.

Both the primary and secondary channel is calculated. If both are active, a *dual function* error is activated and the channels are deactivated. Even if slope times are defined for the channels, they will not be used and the output value will immediately return to zero.

NOTE

For PWM outputs it is allowed to activate primary and secondary channel at the same time, provided that they are not activated in the same direction. This exception allows you to use the *primary channel/positive direction* to control one function and the *secondary channel/negative direction* to control something else. Since PWM outputs are often used to control functions with one direction only, like hydraulic motors or single solenoid valves, this feature will save outputs in your application.



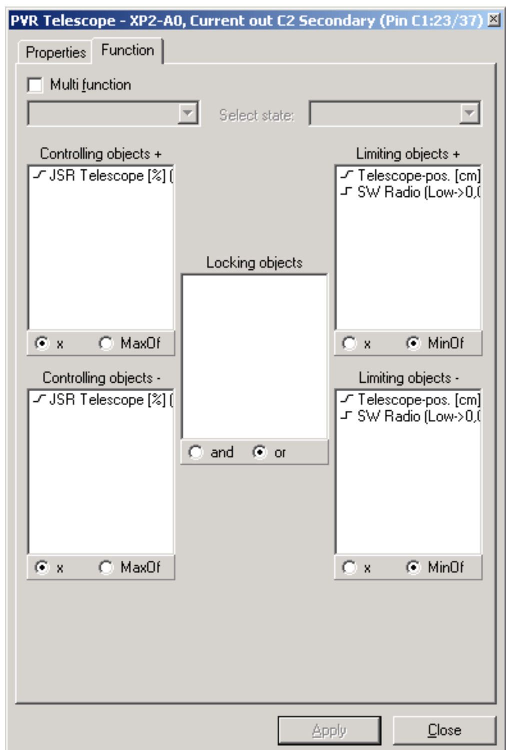
Primary and secondary channel, Current out A.

Primary and secondary channel can be used when you want to control the same output from two different places on a machine, control an output manually/via a feedback control (PID regulator) or when you want to control two different functions with one output (the functions can of course not be used at the same time).

EXAMPLE

A crane can be controlled from the cabin or from a radio control, IQAN-XR. We use the primary crane outputs for cabin control and the secondary crane outputs for radio control. A switch for cabin/radio control is used to make sure that the primary and secondary channels are not active simultaneously.

We show the function page for the secondary telescope output as an example. This function have two limiting objects in each direction, the first is for end damping and the second is for determining if we are in radio control mode.

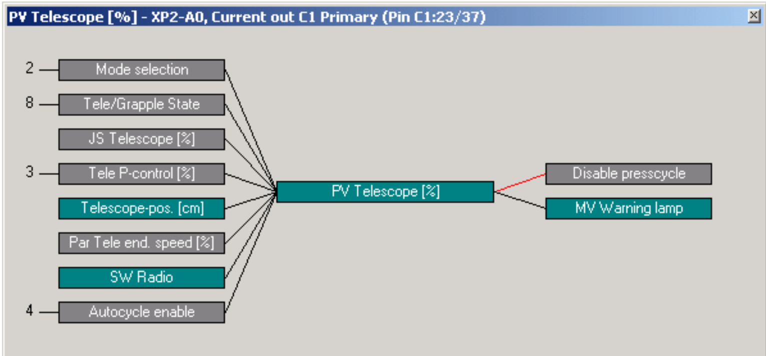


NOTE

Make sure that there are no situations where both the primary and secondary functions are active (except for PWM outputs, see above).

Using the navigator

The *navigator* is a tool to help you navigate within your application. It shows the selected channel, all used channels and all channels that use the selected channel. You get an overview of the channel structure in the functions, like a flow chart. Select a desired channel in the block diagram and select: *View > Show Navigator.*



Navigator showing current output, PV telescope.

The channels are represented by blocks in the navigator. The inputs and outputs are green. All internal channels' blocks are grey.

The selected channel is positioned in the middle, with the channels using it to the right and the used channels to the left.

Navigating

The navigator starts from the channel selected when you opened the navigator. To switch channel, click on a block in the navigator or on a channel in the block diagrams.

A number is sometimes shown to the left or right of the channels. This is the number of channels that use/is used by the channel connected to the number. No number means no channels (0).

To close the Navigator, select: *View > Hide Navigator.*

Red line

If a channel use another channel with lower priority, the linking line is red. For more information about priority, see Appendix B, on page 362.

10 Properties IQANdevelop

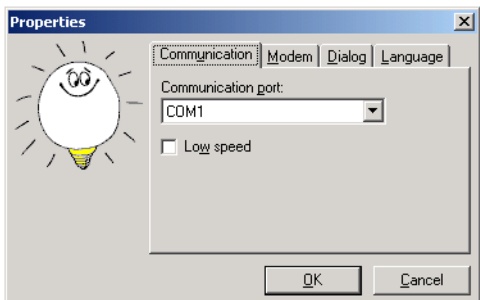
In the *Properties* dialog box for IQANdevelop, there are four tabs, *Communication*, *Modem*, *Dialog* and *Language*. This chapter describes the different properties found on these tabs.

- Select: *File > Properties.*
- Click on one of the tabs *Communication*, *Modem*, *Dialog* or *Language* to enter desired settings.

Communication

The communication between the PC and the IQAN system is serial and the communication interface is RS-232.

When you have connected the PC with the IQAN system, a green status lamp lights up in IQANdevelop's status bar, to indicate that the connection is OK. If the lamp does not light up, you may have selected the wrong communication port.

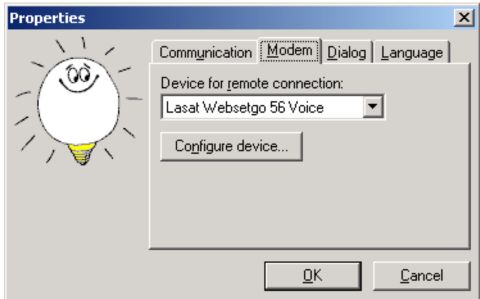


Select communication port and speed.

Communication port	You can choose between eight different COM-ports. Select the communication port that you use to connect to the master module.
Low speed	On older computers, high communication speed can cause problems. If you suspect this is the case for your computer, check the *Low speed* box to use a lower communication speed.

Modem

If you want to communicate with a remote IQAN system via a modem you need to specify what modem you will use.



Select your modem in the list.

Device for remote connection	Select the modem you want to use for communication with a remote IQAN system. If the modem you want to use isn't in the list, it is probably not installed correctly. See Windows® help for more information on installing modems. For further information about remote communication, see section Modem, on page 297.
Configure device	Click this button to go to Windows settings for the selected mode.

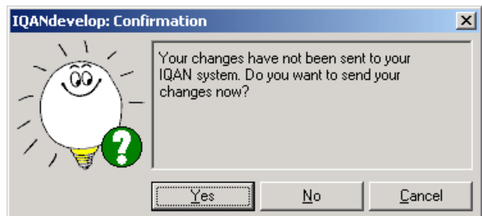
Dialog

The *dialog* tab contains properties regarding dialog boxes.

The dialog tab.

Warn if data not sent

With this checked, you will get a warning if you close a changed application that has not been sent to IQAN.

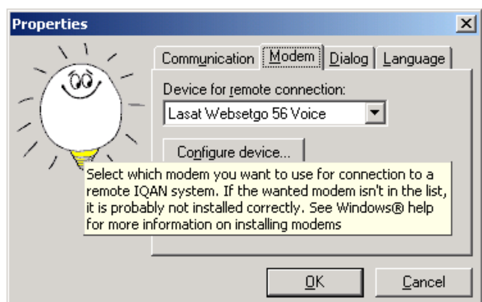


Use sound effects for messages

Removed.

Show IQ hints in dialog boxes

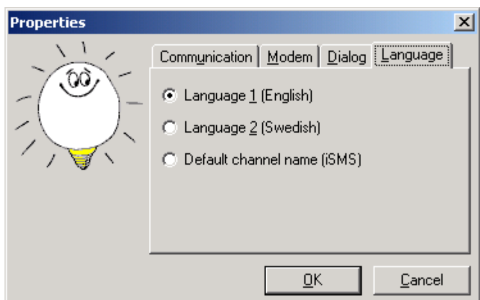
Check this box to get help in the dialog boxes. To see the help text for a specific dialog box, position the mouse over IQ and he will try to help you.



Satellite windows always on top	Check if you want the *channel information* dialog box, the *navigator* and the *multimeter* to always be on top of the main window. If you do not check this box, these windows will only be on top when they are active. They are hidden behind the main window until you activate them. By pressing *F11/F12*, you can browse between the open windows.
Don't show splash screen at startup	When IQANdevelop starts, a splash screen is shown. Check this box to disable the splash screen. 

Language

Under the *Language* tab, you select if you want *Language 1*, *Language 2* or *Default channel name* to be shown in IQANdevelop's block diagrams, navigator, multimeter and graph.



Select language to show in IQANdevelop.

Default channel name can be useful to see the names used by *i*SMS, see Appendix D, page 368.

11 System communication

Send application

Before sending an application to the master, the dialog box *Send application* is shown. In the dialog box you will find similar information as in the dialog box for Warnings and statistics. For further information, see section Warnings and statistics, on page 93.

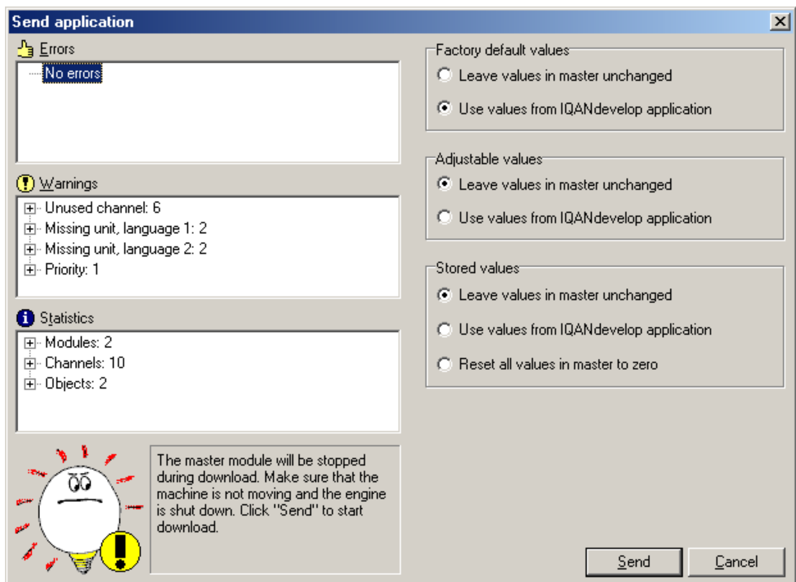
NOTE

Errors must be corrected before the application can be sent.

To communicate with the master, the lamp in the status field has to give a green light. For further information, see section The status bar, on page 88.

Send the application to the master

- Select: *System* > *Send application* or click on the *Send* button in the tool bar. The shortcut key for sending data is *F2*.



Dialog box Send application.

Factory default values

Voltage input, Frequency input, Function parameter, Current output, PWM output and SMS input.

Leave values in master unchanged	Leaves the factory default values in the master unchanged.
Use values from IQANdevelop application	Replaces the factory default values in the master with the ones specified in the application you are about to send. This is the default option.

Adjustable values

Voltage input, Frequency input, Function parameter, Current output, PWM output and SMS input.

Leave values in master unchanged	Leaves the adjustable values in the master unchanged. This is the default option.
Use values from IQANdevelop application	Replaces the adjustable values in the master with the ones specified in the application you are about to send.

Stored values

Hour counter, Event counter, Memorizing and SMS output.

Leave values in master unchanged	Leaves the stored values in the master unchanged. This is the default option. Use this option when you are updating an application.
Use values from IQANdevelop application	Replaces the stored values in the master with the ones specified in the application you are about to send. You cannot set stored values manually in IQANdevelop, but you can get them from another master module by getting the application. Use this option to move stored values from one master to another, e.g. when you have to exchange the master module in a machine.
Reset all values in master to zero	Resets all stored values to zero.

For further information about the factory default and adjustable parameters, see section Adjustable values, on page 211, and for information on stored values, see section Stored values, on page 212.

Sending data

To send the application, click on *Send*. A message box will show the download progress.

Download progress.

Abort transmission

If the transmission has to be stopped, click *Abort transmission.*

NOTE

When cancelling the transmission, there is no application in the master.

Get application

To view, measure or change an application in a master, you need to get it from the master to IQANdevelop first. All application information, such as modules, channels and objects are uploaded.

To get an application

- Select: *System* > *Get* or click on the *Get* button in the tool bar. The shortcut key for getting data is *F3*.

The application is received.

...a recommendation

Always get the application before you start measure to be certain that the measure occurs at the correct channel.

Factory default and adjustable parameters

When you get the application from the master you will get both the *factory default* and *adjustable* properties, if there are any. For further information about the factory default and adjustable parameters, see section Adjustable values, on page 211.

Error/event log

There is an *error log* and an *event* log in the master unit. In the error log, all the system errors that the master detects, as well as all the user defined alarms are stored. User-defined events are stored in the event log, see section Event log, on page 154.

Each log can store a maximum of 2000 records each. When a log is full, the oldest records are deleted to create space for new records. The 1000 latest records are always kept in memory.

You can also force the master to stop logging errors and/or events when the corresponding log is full, instead of deleting old records. This is described in section Log handling, page 106.

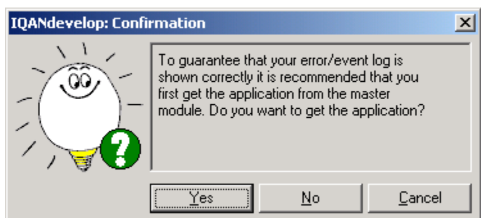
On the master modules it is possible to measure record count for the logs. This is done with the channel type *Module diagnostic*, see section Module diagnostic, page 159.

OBSERVE

When updating vmAC, all the stored errors and events in the master are erased.

Getting the error/event log

- To get the error/event log from the master select: *System* > *Get error/event log*.
- If you have an application open in IQANdevelop, the following dialog box will be shown.



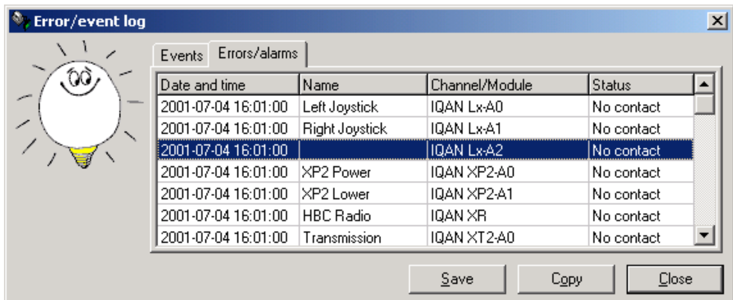
Dialog box Get error/event log.

- Select *Yes* to get the application and the error/event log. This is the recommended alternative.
  If you know that you already have the correct application open in IQANdevelop, it is safe to select *No*. This will upload the error/event log only and merge it with your application.

Error/event log presented in IQANdevelop

Each log is presented on it's own tab. They are named *Events* and *Errors/alarms*.

Every error/alarm or event is represented with a row in the list. You can choose yourself how you want the list to be sorted. Click on the header that you want to sort by.
The column width can be adjusted by placing the mouse pointer between two columns on the header and then click and drag the column divider to desired position.



The error/event log in IQANdevelop.

Columns

Date and time	The date and time of the alarm/error or event is displayed in the left column. Note: For modules that do not have any real time clock, e.g. IQAN-TOC8, the date and time is not logged.
Name	The name of the channel/module that the alarm/error or event refers to.
Channel/Module	Information about the channel connection or module.
Status	Only for errors/alarms. Type of alarm/error.
Value	Only for events. Channel value when logged.

Saving the error/event log

You can choose to save the error/event log as an .ide-file. Click on *Save* to do this. The whole list will be saved together with the complete application.

It is also possible to save the logs as a .txt-file. Select text file in the save dialog box, *Save as type*. The file extension must be .txt.

Opening the error log

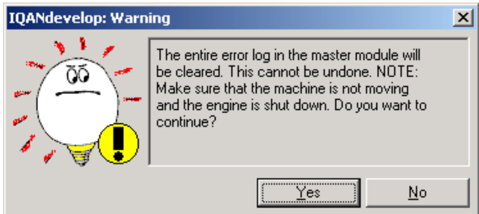
You open the error/event log by selecting: *File* > *Open*. After that you select the file that you want to open.

Copying the error/event log

The entire error log or event log can be copied to the *Windows clipboard*, and thereafter pasted into e.g. Excel or Word. Click on *Copy*. Only the currently displayed log is copied.

Clear the error/event log

To clear the error log or event log in the master, select: *System > Clear error log* or *System > Clear event log*.



Warning message before clearing the error log.

Update vmAC

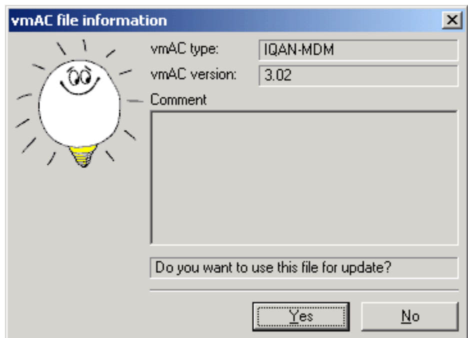
When you update the vmAC (virtual machine for Application Control), you are updating the operating system in an IQAN module. The vmAC files are distributed from our web site. You start by downloading the file to your PC.

The vmAC file has the file extension .ido (IQAN operating system).

With regard to safety, you can not upgrade the vmAC via modem connection.

To upgrade a module with a new operating system

- Select: *System > Update vmAC...*
- Select the file and click *Open*. An information dialog box is displayed.



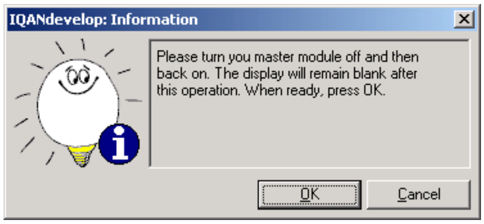
Information about the .ido-file.

vmAC type	The module type that the file is intended for.
vmAC version	The vmAC version.
Comments	Information about important changes. This message shall always be read before the vmAC is downloaded to the IQAN module.

- Select *Yes* to update the vmAC.

  A control is done to ensure correct module type before the download starts. If you try to download a vmAC designed for another module type you will get an error message.

  The version is also checked. If the version in the master is the same or newer than the one being downloaded, you will get a warning message that needs to be confirmed. The vmAC you have selected must also be compatible with your IQANdevelop version. If it isn't, an error message is displayed.
- Thereafter the download starts. Follow the instructions as displayed in the dialog box, i.e. restart your IQAN system and then click *OK*.



Confirm restart of master module.

NOTE

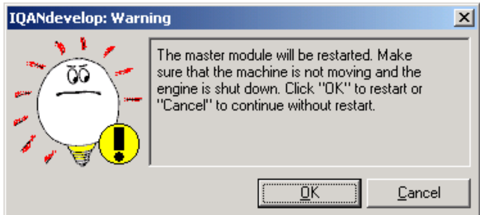
If you are updating an MDM, the display will be black until the download is completed.

If there is an application in the master when updating vmAC, IQANdevelop starts to get the application and ends with sending it back to the master. Adjustable parameters are restored to the values they had before the update. All stored values, such as hour counters, event counters, etc. are also restored.

Restart master

Via the *System* menu, you can restart the master unit without breaking the supply voltage.

- To restart, select: *System* > *Restart master.*



Confirm restart of master module.

Set clock

You can set the date and time in the IQAN system via IQANdevelop. The clock in the PC is used as a reference.

- Select: *System* > *Set clock*.

Display control

With the display control function is it possible to control the IQAN-MDM display via IQANdevelop.

If you push one of the MDM buttons in IQANdevelop, the IQAN-MDM display will be updated immediately. You will see when the driver pushes the buttons, since the display control updates continuously.

To open the display control dialog box, select *System* > *Display control.*

Display control dialog box.

Buttons

Save	Saves the display content as a bitmap file, *.bmp. The IQAN-MDM front is not saved.
Copy	Copies the display content to Windows clipboard so that you can paste it into another program, e.g. Microsoft Word, etc. The IQAN-MDM front is not copied. Use *Alt+PrtSc* to copy the complete window.
Start/Stop	Starts or stops updating the display content.
Close	Closes the dialog box.

Modem

By connecting a modem to your PC, you can communicate with a remote IQAN system. It is possible to send and get applications, measure and chat.

Start by installing the modem to your PC, follow installation instructions that comes with the modem. For information about what modem you should use, see section Choosing a modem, on page 366. Also, check that a modem is connected to the IQAN system.

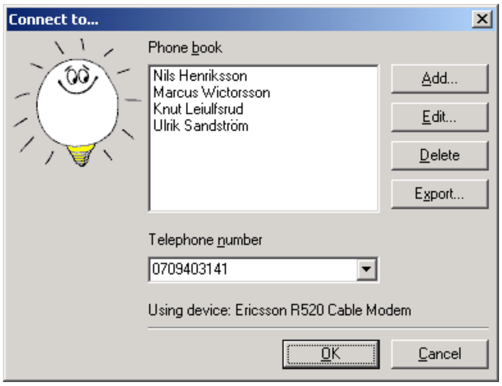
Select modem

- Select: *File > Properties...* to open the dialog box *Properties...*
- Select modem in the list box *Device for remote connection* under the *Modem* tab.

Connect via modem

In the *System* menu you will find the command for connecting via modem.

- Select: *System > Connect via modem.*



Dialog box to call another modem.

Connection properties

Phone book	A list with names of contacts. Click on the name to contact and its phone number will be shown in the *Telephone number* field.
Telephone number	Enter the phone number to the remote modem or select one of the previously called numbers by selecting in the drop-down list box.

- Click *OK* to connect. A dialog box shows how the modem is trying to connect with the remote IQAN system.

- Wait for user confirmation. This step depends on which master module is used and also module properties in some cases, see section Auto answer, on page 107.
- Start communicating. You have access to almost all the functions in IQANdevelop that you have when you use a direct connection.

Phone book

To add a contact in the phone book click *Add*. If you want to *Edit* or *Delete* a contact, select the contact in the phone book before you click at the button.

Edit the phone book.

Export phone book

You can save the phone book if you want to use it on another computer. The file extension is .reg.

Import phone book

To import, double-click on the .reg-file in the file manager. The names in the .reg-file will be added to the Windows registry. If a name already exist in the register, that record will be replaced.

No contact with the modem

If the modem fails to contact, it will automatically try again after 60 seconds.

Disconnect

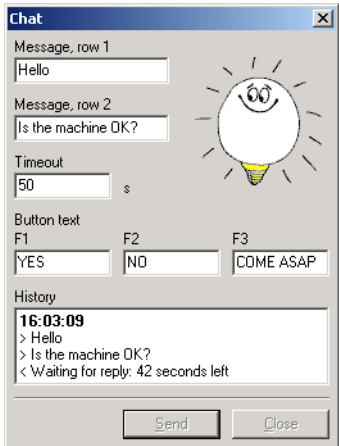
When you no longer are using the modem, you should disconnect it.

- Select: *System* > *Disconnect.*

Chat

Through the modem you can chat with the IQAN user by sending short messages.

- Select: *System* > *Chat* to open the dialog box.



Dialog box for chat.

Chat

Message, row 1 Message, row 2	The messages has to be split up in two rows, maximum 20 characters/row.
Timeout	How soon the IQAN operator has to answer the question (in seconds). If the answer is not received within the time limit, the system times out. In this way, the PC will not be occupied waiting for an answer. Enter 0 to send a message without requiring the operator to reply. The buttons are not used.
Button text	The operator answers by using the function keys *F1*, *F2* and *F3*. In order to do this, the buttons have to be provided with answer alternatives.
History	History over questions and answers that has been sent.

The message as shown in IQAN-MDM.

12 Access

In this chapter, we will be treating the following:

- application codes
- licence number
- access levels

IQANdevelop can be used for several purposes with regard to a machine application.

The main purpose is to create different applications but there is also a measure system for fault-finding for use both at the design stage and out on the field.

We have prepared some different access levels where, for example, the designer can extend the application by several functions for a machine while the service personnel can only edit or send existing application files for the IQAN system. There is also a lowest level where, in general, it is only possible to view the different application parameters. All levels can of course use the measuring capabilities of IQANdevelop.

The access level is determined by a licence number. A licence number is not needed for the lowest access level.

You can protect your application from unauthorized users by creating an application code which must be entered when opening the application file in IQANdevelop or collecting the application from the IQAN system.

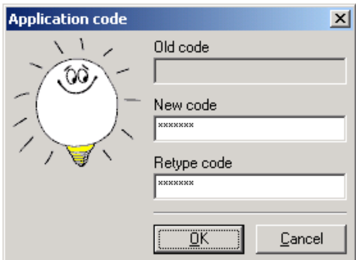
Application code

It is possible to protect an application by adding a code which must be entered when opening that application or uploading it from an IQAN system.

Once you have entered an application code to open a protected application file, IQANdevelop remembers it so you don't have to enter the same code again during that session. If you restart IQANdevelop, you must enter the code again.

Add application code

- Open the application to be protected by the application code.
- Select: *File> Application code*.



Add an application code.

Old code	Enter the old (current) application code in the field. If there is no old code, the field is disabled.
New code	Enter the new application code.
Retype code	Enter the new code again to verify it.

- Click *OK* to save. *Cancel* closes the dialog box without saving changes.

If you enter an illegal code in the *Old code* field or the *Retype code* field, an error message is displayed giving information on what is wrong.

If the application is protected with an application code a locked padlock symbol will indicate this in the status bar.

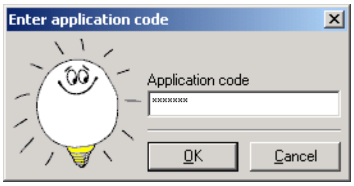
Application is protected by an application code.

Deleting an application code

You can delete a code in the *Application code* dialog box. Enter the old code in the field *Old code* but do not enter any code in the *New code* and *Retype code* fields. Click *OK* to save.

Opening a protected application

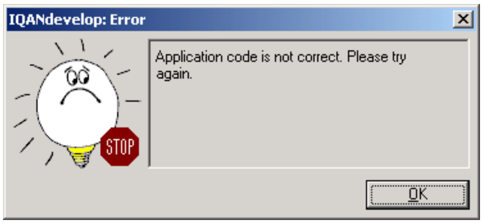
When you open or upload a protected application, you must enter the code to be able to access the application. You only need to enter the code the first time you open the application after IQANdevelop has started.



Enter application code.

Incorrect code

If you enter an incorrect code, an error message is displayed.



Incorrect application code.

Click *OK* and try again.

Licence number

The access level is determined by a licence number that is entered at installation. Previously a hardware key was used for this purpose. You can exchange your hardware key for a licence number instead. This is done by sending your hardware key to Parker and we will send you a licence number in return.

If you do not have a licence, you will get the lowest access level, *Read*.

The licence number is logged in the master module when an application is downloaded. This way, you can always see who did the last application download in a particular master module. Of course, you must keep track of which person uses which licence number.

A typical licence number looks like this: 4C7271-0841-05-365A

Access level

For IQANdevelop, there are four different access levels *Develop pro, Develop*, *Change* and *Read*. *Develop pro* and *Develop* are the highest levels in which you create the application for the machine. Access level *Develop pro* have unlimited access to all functions in IQANdevelop, plus IQANsimulate. With the *Develop* level, you don’t have access IQANsimulate or to all internal channels. The ones you don’t have access to are marked with a red padlock symbol in the block diagram.

In the *Change* level, you can edit applications (to a certain extent) and in the lowest level *Read*, you can generally only read application parameters. In all four levels, you have access to IQANdevelop's measurement system to carry out fault-finding on the system.

The access levels are as follows:

Function	Read	Change	Develop	Develop pro
Measure channels	•	•	•	•
See channel/module properties	•	•	•	•
See application info	•	•	•	•
Print block diagram	•	•	•	•
Get application from IQAN	•	•	•	•
Open/Save files	•	•	•	•
Get error/event log	•	•	•	•
Clear error/event log		•	•	•
See function/object		•[a]	•	•

Print channels/warnings	•	•	•
Change channel/module properties	•[b]	•	•
Change application comment	•	•	•
Change application languages	•	•	•
Send application to IQAN	•	•	•
Update vmAC	•	•	•
Add and delete channels/modules		•	•
Change application info		•	•
Change function/object		•	•
Set application code		•	•
Access to all functions in IQANdevelop			•
Access to IQANsimulate			•

a. User defined, see section Application information, page 89.
b. Properties that affect application functionality can not be changed.

You can run IQANdevelop with a lower access level than your licence. For further information, see section Run IQANdevelop with lower access level, on page 307.

Storing application codes

It is possible to store application codes in an encrypted file. This enables you to open a protected application without entering the application code. If the correct application code is stored in your application code file, it will be used to open the protected application.

Remember to document the application code.

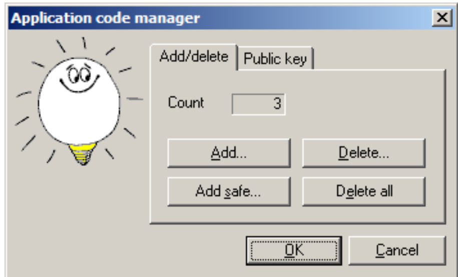
The file will only work for the user that added the application codes in it. This means that there is no risk of unauthorized personnel getting hold of the file and thereby access to your applications.

It is advisable to document the application code for different applications. A lost application code means that you will not be able to get access to that application anymore.

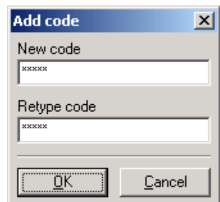
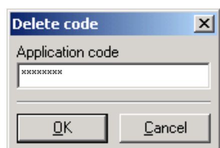
Storing application codes in a file is a very safe way to distribute application codes to many persons. You don’t have to tell the application codes to anyone, since they are stored in an encrypted file. There is no way to read the actual application codes stored in a file, not even for yourself.

Add and delete application codes

Open the dialog box for adding or deleting application codes by selecting *File > Application code manager.*



Add or delete application codes.

Count	Number of application codes stored in the file. For security reasons, you can not see the actual codes.
Add...	Adds an application code to the file. You must enter the new code twice. 
Add safe...	Adds a safe application code to the file. See next section for more information on safe application codes.
Delete...	Deletes an application code. You must enter the application code that you want to delete. 
Delete all	Delete all application codes in the file.
OK	Saves your changes and closes this dialog box.
Cancel	Close this dialog box without saving any changes.

Safe application codes

A safe application code is an application code that is encrypted with your public key. This means that it can only be used by yourself and can therefor be safely sent via e.g. email. No one can read the actual application code from a safe application code, not even yourself.

To get a safe application code you must first give your public key to the person who knows the real application code. That person then encrypts the real application code with your public key and gets a safe application code, which he/she can send back to you. You must then add it to your application code file to be able to use. See the previous section for a description of how to do that.

Your public key can be accessed from *File > Application code manager > Public key.*

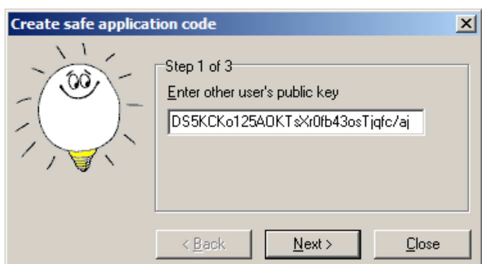
Your public key.

Send the public key via email by clicking *Send as mail* which will start your email program, or copy it to the clipboard by clicking *Copy.*

Creating safe application codes

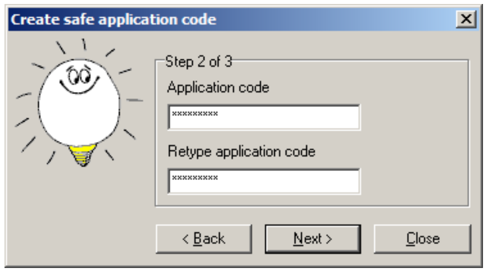
To create a safe application code, select *File > Create safe code*.

- Select: *File > Create safe code*.



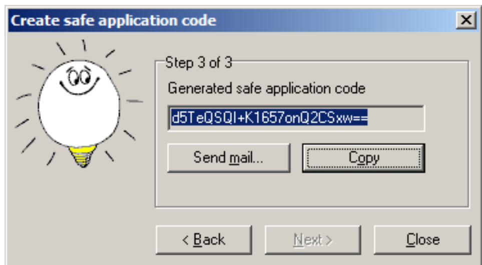
Enter public key.

- Enter the other user's public key that you have received and click *Next*.



Enter application code twice.

- Enter the real application code twice and click *Next*.



The safe application code.

- Send the safe application code via email by clicking *Send mail* or copy it to the clipboard by clicking *Copy*.
- Close the dialog box or go back and create another one by clicking *Back*.

Run IQANdevelop with lower access level

Sometimes you may want to run IQANdevelop with a lower access level than your licence. This is possible to do with the help of command line parameters.

Command line parameter	Description
/read	Starts IQANdevelop with access level *read*.
/change	Starts IQANdevelop with access level *change*.
/develop	Starts IQANdevelop with access level *develop*.

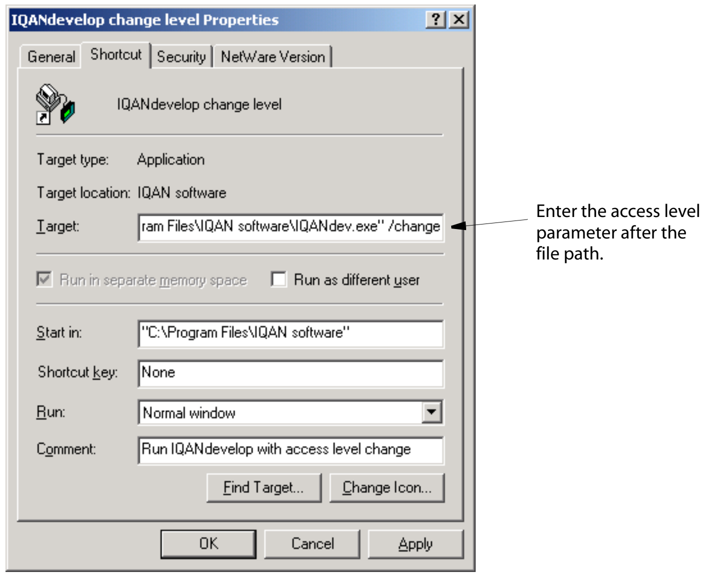
It is of course not possible to get a higher access level than your licence.

EXAMPLE

We will create an IQANdevelop shortcut with the access level *Change*.

- Create a shortcut of IQANdevelop and rename it to *IQANdevelop change level*. See Windows help file for information on how to do this.

- Right-click on the shortcut and select *Properties*.
- Click on the tab *Shortcut.*
- Enter */change* after the file path in the *Target box.*



- Click *OK* to save.
- Double click on the *IQANdevelop change level* icon to run IQANdevelop. You will find the actual access level in the status bar.

13 Measuring and fault finding

This chapter deals with the following:

- measuring with the block diagram
- measuring with the multimeter
- measuring with the graph
- measuring objects

IQANdevelop has an advanced measuring system where you can measure on all channels.

You can measure in all block diagrams by clicking on a measure flag where the measured value is shown when you have started the measuring.

You can also measure with the multimeter function or have the measured values presented in the form of a graph.

It is possible to measure on all channels, both external and internal.

If you want to measure on several channels on different modules at the same time, it is advisable to use the multimeter where all "selected" channels are shown in a list.

For more of an overview, you can get the channel's measured values drawn up in a graph. In this way, you can also save a measure to study it later.

If you use the graph when measuring, you can *trigger* on a channel, i.e. you can enter when you want to start and stop a measure and have statistics carried out on a logged measure curve.

When troubleshooting, sometimes you need to take a closer look at the output signals. Then you can measure on the different objects.

Before you start to measure, get the application from the IQAN system.

Before you measure, you should get the application from IQAN.

Measuring in a block diagram

Before you measure, get the application from IQAN.

Measuring channels from the block diagram

In every block diagram, you can measure the different channels' values. The channels' name tags are equipped with grey boxes. If you click on the grey box for respective channel, a measure flag with the measured value is shown. More than one channel can be measured at the same time.

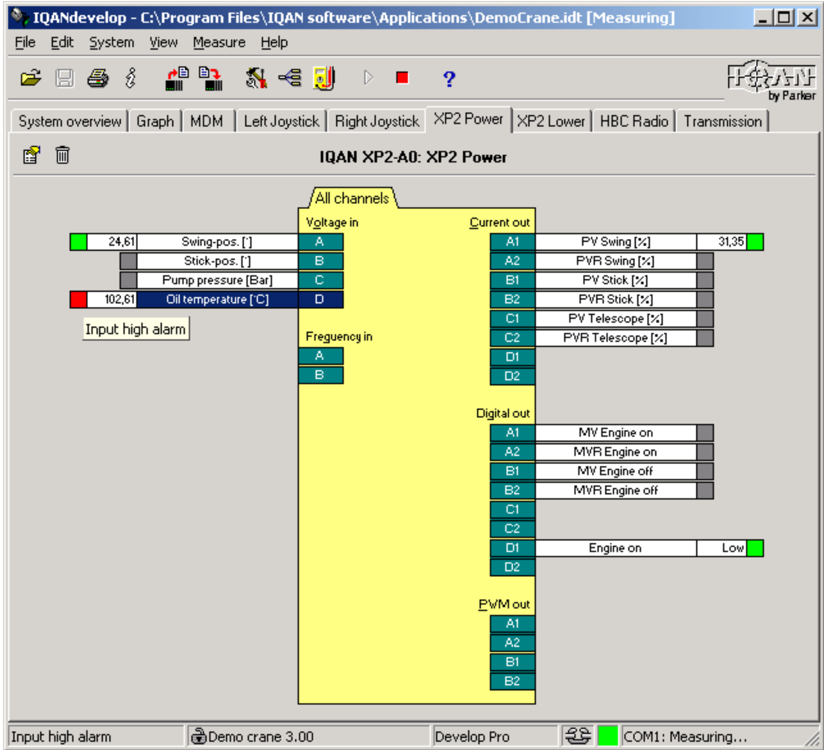
When measure is in progress, the grey box color shifts and the channel's status is shown:

- green means that the measured value is OK
- yellow shows that you have entered a simulated value for the channel or that this channel is locked
- red indicates an error, for example that the value is outside permitted limits or alarm limits.

By holding the mouse pointer over a channel's measure flag during measurement a yellow text box shows the channel's error message.

Start the measure by selecting: *Measure > Start measure*, press the function key *F4* or use the button *Start measure* in the tool bar.

Stop the measure by selecting: *Measure > Stop measure*, press function button *F4* or use the button *Stop measure* in the tool bar.



Measurement in the block diagram.

NOTE

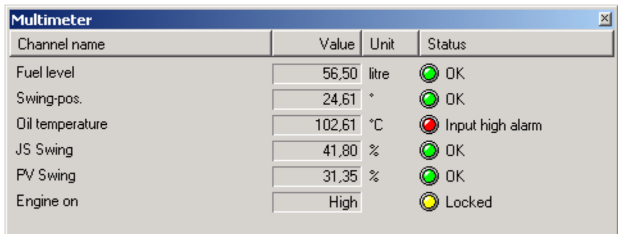
You can only use the *stop command* if you have started a measure.

Measuring with the multimeter

Measuring channels in the multimeter window

Often, you want to measure several channels from different block diagrams at the same time. In IQANdevelop, there is a multimeter window where you can compose your own collection of channels.

Begin by selecting the channels in the block diagrams by clicking on the name tags' grey boxes. To open the multimeter window, click on the *Multimeter* button in the tool bar or select: *View > Show multimeter.* The following window is opened.



Multimeter window.

The channel types are shown as per IQANdevelop's priority ordering, see Appendix B, on page 362. Every line has a corresponding channel. For every channel, a channel name is shown, scaled measure value, unit and status.

If the number of channels don't fit in the measure window, the window is provided with a scroll bar on the right hand side. It is also possible to change the size of the window by taking the edge of the window with the mouse and dragging it to the desired size.

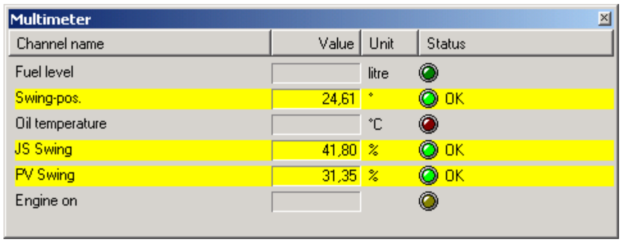
Lamp indication

The lamp for status is grey until measuring starts, then the color changes to green, yellow or red. For color explanations, see section Measuring in a block diagram, page 310.

Highlight channels

The multimeter defaults, measures on all channel that the window contains. If you want to select a few of them to measure on, you can *highlight* those channels. In that way, IQANdevelop only measures on the highlighted channels.

Right-click on desired channel and select *Highlight*. The channel´s will be marked with a yellow line.
To deselect a channel, right-click on it again and select *Highlight*. It is possible to select/deselect the channels when measuring is in progress.



The channels activated for measuring.

Shortcut to a channel in the block diagram

It is possible to *go to* a selected channel in the block diagram. All channels in the multimeter window has a *shortcut* to its position in the block diagram. Right-click on the channel in the multimeter window and select *Go to*. IQANdevelop will immediately show you the block diagram with the selected channel.

Start/Stop measure

To start measure, select: *Measure* > *Start measure*, press the function key *F4* or use the button *Start measure* in the tool bar.

Stop measure by clicking on the *Stop* button in the tool bar or press the function key *F4*.

Delete channel

To delete a channel from the multimeter window, click on its grey box on the name tag in the block diagram, or right-click on the channel in the multimeter window and select *Deselect*.

Reset all selected channels

The command *Measure* > *Reset selected* resets the block diagrams so that no channels are selected for measure, or right-click in the multimeter window and select *Deselect all*.

Close the multimeter window

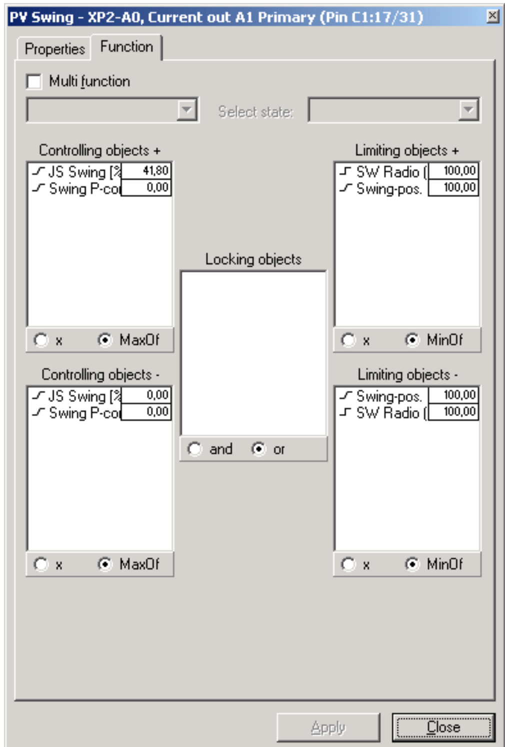
To close the multimeter window, select: *View* > *Hide multimeter* or click on the *Close* button in the top right hand corner of the window.

Open/Save settings

It is possible to have more than one setting with channels for measure. You save every setting and can later open the desired setting for measure. For further information, see section Save measured data, on page 327.

Measuring objects

In a channel’s function page, you can see the objects’ measured values during measurement.



Measuring objects for a current output.

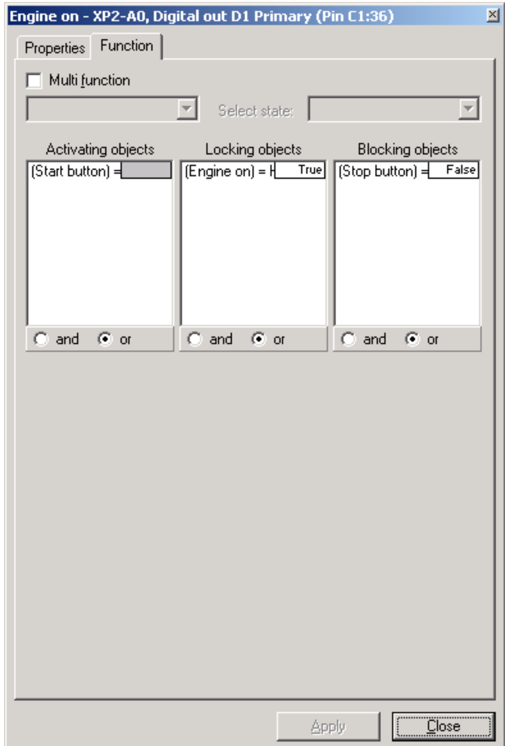
Grey measuring boxes

When the master unit is calculating the objects, *lazy evaluation* is practiced. This means that the master, depending on the function’s objects, only calculates the objects when necessary. For further information, see section Lazy evaluation, page 375.

If an object is not calculated, the value box is grey.

NOTE

Measuring of objects is not possible on IQAN-TOC2.



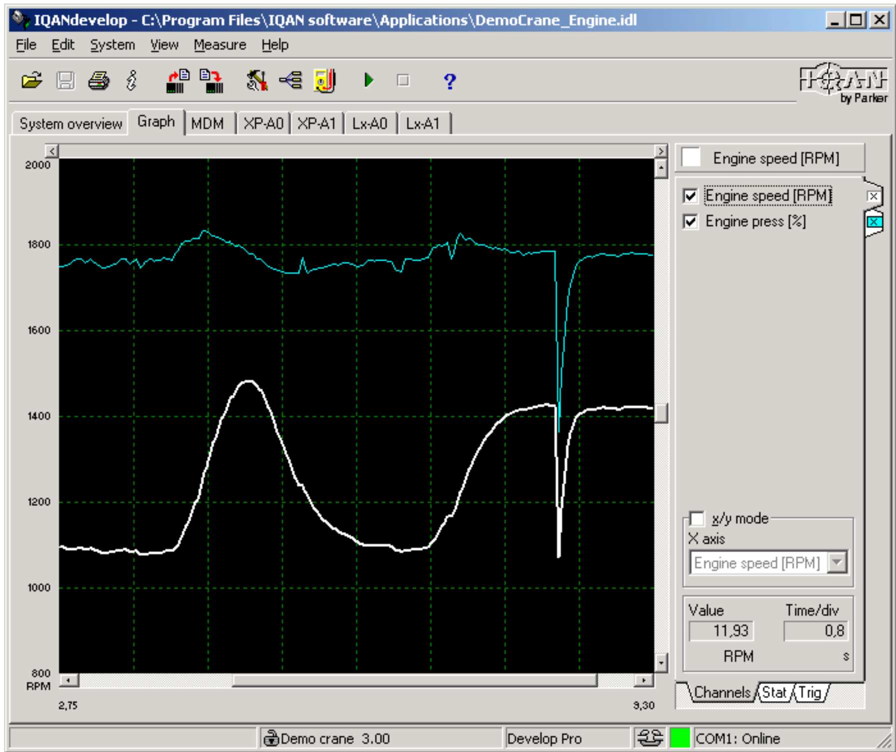
If an object is not calculated in the master, the value box is grey.

Multiple functions

If a channel has multiple functions, the currently active function is automatically displayed. The state name is also changed accordingly.

Measuring with the graph

The graph handles both time measuring and XY-measuring. On the page *Graph*, a window is shown where the measured values from the channels are presented as graphic curves. To open the graph page, click on its tab in the upper left corner.



The graph page.

The page consists of two parts:

- the measurement window where the curves are drawn
- channel information window, containing the channels' names and data

The measurement window

The measurement window shows measured data in the form of curves. You can present a maximum of ten curves at the same time. The curves are color-coded, i.e. all curves have different colors so that you can tell them apart.

The measurement window's X axis shows the time for the measure. You can zoom in on the window to view a smaller period of time, see section Zooming in/out, on page 324.

The measurement window’s Y axis shows the amplitude for the curves. The scale for one curve at a time is shown, see section Active channel, on page 317.

The measurement window is equipped with a grid to facilitate reading. The grid resolution in the X direction can be read in the channel information window under the *Channels* tab or the *Stat* tab, see section Channels, on page 318 or see section Statistics, on page 319.

The curves are drawn from left to right. When the curve has reached the right edge, the window is cleared and the continuation of the curve is drawn from the left again. After the measurement has finished, the complete measurement is presented.

Clear log

If you have made a log, you first have to reset all measured values before you can select new channels for measure from the block diagram. Select: *Measure > Clear log*.

Active channel

You can select to have access to more specific measuring data for one channel at a time, the *"active channel"*. This means that the scale on the Y axis is adapted to the *active channel’s* values and that the channel’s data is shown in the channel information section. The name of the *active channel* is presented above the channel information section.

The curve for the *active channel* is drawn with a thicker line in the window. You select which channel will be *active* by clicking on its curve in the measurement window or on its color-coded tab in the channel information window.

Channel information section

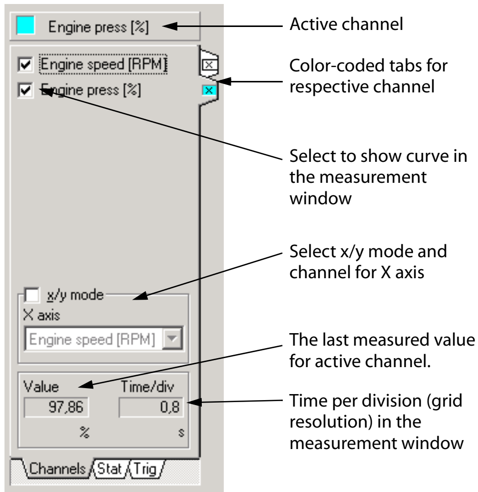
The channel information section consists of three tabs with different information.

- Channels
- Statistics
- Trig

Channels

Under the channels tab, there is a list with the channels you have selected to measure on. The channel types are shown as per IQANdevelop's priority ordering, see Appendix B, on page 362.

There is space for a maximum of 10 channels in the list. Every channel has its color which is shown on a tab after respective channel name.



The channel tab in the channel information section.

By clicking on one of the color-coded tabs, the channel information section and the measurement window are adapted to show information on this channel. This channel will then become the *active channel*. In the window, the scale on the Y axis is changed so that it fits the channel's values.

By checking the boxes before the channels' names you select which channels you want to be visible in the measurement window. A visible channel is also shown with an x in the color-coded tab.

All channels in the list are measured and logged even if they are not visible. In this way, you can select them and study them at a later occasion.

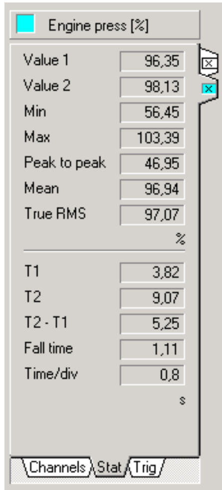
If you want to view your measured data in a x/y-diagram, i.e. use one of the measured channels as the X axis, check the box *x/y mode*. Select the X axis channel in the drop down list below.

At the bottom, on the *Channels* tab, there is information on:

- The last measured value for the *active channel* (only relevant when measuring).
- Time resolution for the measurement window's grid.

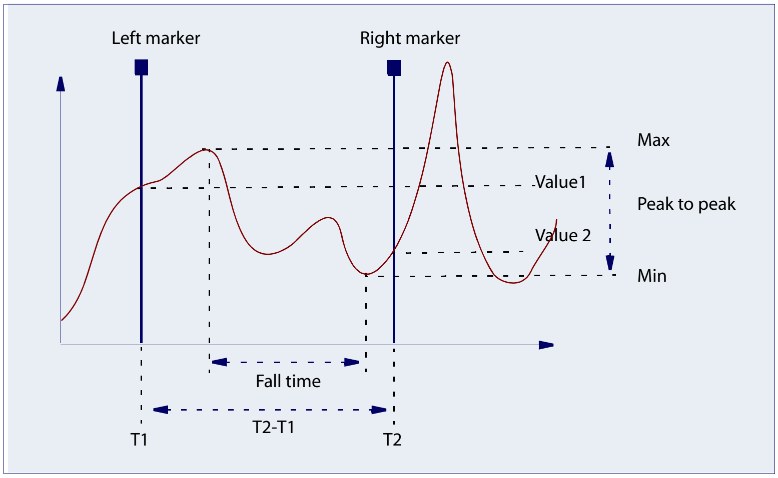
Statistics

Under the *Stat* tab, the *active channel's* statistical values are shown. These values are generated using markers which you position along on the curve, see section Markers, on page 322.



The Stat tab in the channel information section.

Value1	The curve's value at the left marker position.
Value 2	The curve's value at the right marker position.
Min	The curve's lowest value between the markers.
Max	The curve's highest value between the markers.
Peak to peak	The difference between *Min* and *Max*.
Mean	Mean value between the markers.
True RMS	Mean value between the markers. Calculation carried out as per true RMS.
T1	Left marker position on the X axis.
T2	Right marker position on the X axis.
T2-T1	Time between the markers.
Rise time/Fall time	Time between *Min* and *Max* positions. The headings alternate between *Rise time* and *Fall time* depending on which value is first.
Time/div	Time resolution in the measurement window's grid.



Explanation of statistical values under the Stat tab.

Trig

With the trigger functionality it is possible to start and stop the measure at certain predetermined conditions.

The Trig tab in the channel information section.

In the example picture above, the measuring starts automatically when the value for *Engine press [%]* drops below 100%. Measured data before this occurs is also saved, in this case 5 seconds before. The measuring will then continue for 3 minutes and after that stopped automatically. The start trigger will only work once, after it has been fulfilled it has to be activated again by starting the measurement.

Trigger on this channel

Trigger on this channel	Select a channel and check this box to enable the trigger functionality. You can only trigger on one channel.

Start condition

The settings for start condition are only available when *Trigger on this channel* is checked.

Slope	Select slope type for the start condition. *Positive slope*, the measuring starts when the signal exceeds entered level. *Negative slope*, the measuring starts when the signal drops below entered level. *None*, the measuring is started manually. Useful when you only want a stop condition.
Level	Enter the level for the start trigger.
Offset	Use offset when you want to be able to see the signal's curve before the trigger condition is fulfilled. The offset time is 0-15 seconds.

Stop condition

The settings for stop condition are only applicable when *Trigger on this channel* is checked. A stop condition can either be given as a slope condition or as a time condition.

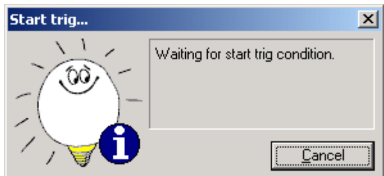
Slope	Select slope type for the stop condition. *Positive slope*, the measuring stops when the signal exceeds entered level. *Negative slope*, the measuring stops when the signal drops below entered level. *None*, the measuring is stopped manually or after a specified time.
Level	Enter the level for the stop trigger.
Offset	Use offset when you want to save data a short time after the trigger condition is fulfilled. The offset time is 0-15 seconds.
Stop after	By checking this box, the measuring will be stopped automatically after a specified time. This disables the slope condition. Enter how long you want to measure in the fields below.

Starting and stopping measuring

To measure channels graphically, you must first select which channels will be measured. For a more detailed description, see section Measuring in a block diagram, on page 310.

- To start a measurement, select: *Measure* > *Start measure,* click the *Start measure* button in the tool bar or press the function key *F4*.

If a start condition has been entered on the tab *Trig,* the measurement will start when the start condition is fulfilled. A message is displayed to inform you about this.



- To stop a measure manually, select*:* *Measure* > *Stop measure,* click the *Stop measure* button in the tool bar or press the function key *F4*.

If a stop condition has been entered on the tab *Trig*, the measure will be stopped when the condition is fulfilled or the time has expired.

Markers

To read the value and times from a curve in the measurement window, there are two markers which can be positioned along the X axis. By selecting the *Stat* tab in the channel information section, you can find out different measured data, see section Statistics, on page 319.

Moving markers

The markers are two vertical lines which can be moved along the X axis. You move the marker by positioning the mouse pointer on the handle and hold the left mouse button down as you drag the marker line to the desired position where you release the mouse button. You can move both markers at the same time by holding down <*Shift* > while you move one of the markers. Also, a marker can be positioned at the beginning/end by clicking on it while holding down <*Ctrl*>.

Shortcut key to move the markers

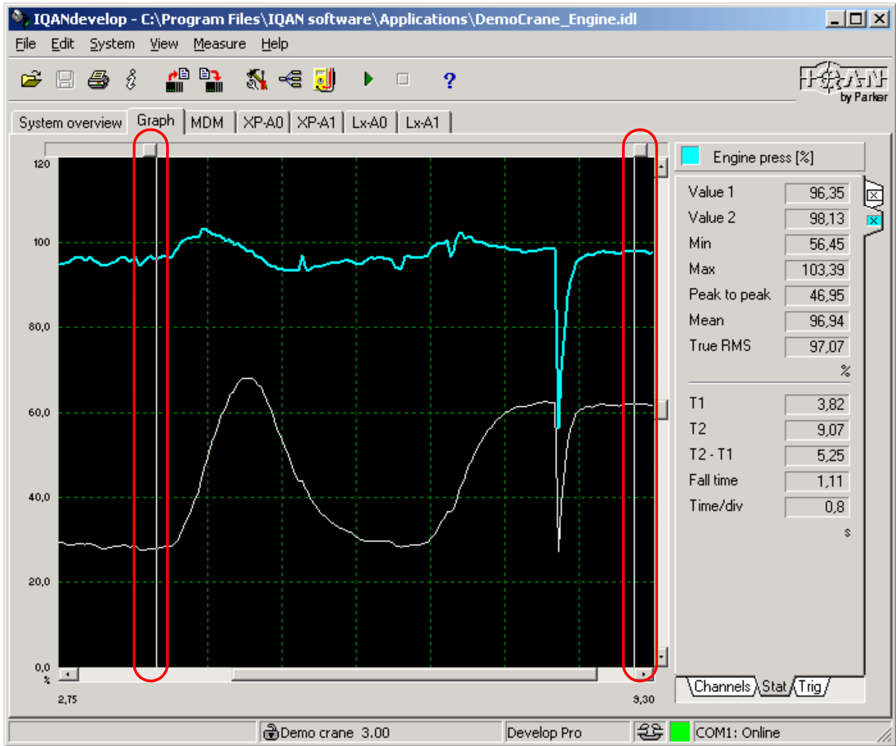
First select the marker.

F11	Move the marker in the graph to the left.
F12	Move the marker in the graph to the right.

Shift + F11 Shift + F12	Moves both of the markers to the left and the right respectively. It is sufficient that you mark one of them.

Locking the markers

The markers can be locked in their positions. Right-click in the measurement window and select: *Lock left/right cursor.*

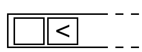
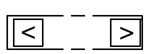
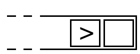


The markers in the measurement window.

Keeping track of the markers when zooming

When only a limited part of the diagram is presented, the markers can fall outside the displayed area. The markers' handles show in which direction each marker lies.

The marker's position

	Both markers are to the left on the X axis.
	The markers are on either side of the measurement window.
	Both markers are to the right on the X axis.

Zooming in/out

You can zoom in on (enlarge) parts of the measure window to study the graph in detail.

Defining a zoom area

You can easily select a section of the curve to be enlarged. Select an area by holding the left mouse button down while guiding the cursor over the desired enlargement area. A *zoom area* is built around what will be enlarged.

Zoom in time only

Position the markers on either side of the area to be shown. Right-click in the measurement window and select: *View range between cursors*.

Another way to do it is to define a zoom area with the mouse as described in the section above while holding the <*Shift*> key down.

Zoom out

To view the complete curves again, right-click in the measurement window and select: *Zoom out*. You can also zoom out by selecting: *Measure > Zoom out* or use the short command *Ctrl+M*.

Pan in X and Y directions

Using the horizontal scroll bar along the lower edge, you can move the measurement window in the X direction and using the vertical scroll bar on the right side, you can pan the measurement window in the Y direction.

Move a curve along the Y axis

If the curves are positioned onto one another, you can move the *active channel's* curve in the Y direction. Use the vertical scroll bar on the right in the measurement window whilst holding the <*Ctrl*> key down.

Glitch detect

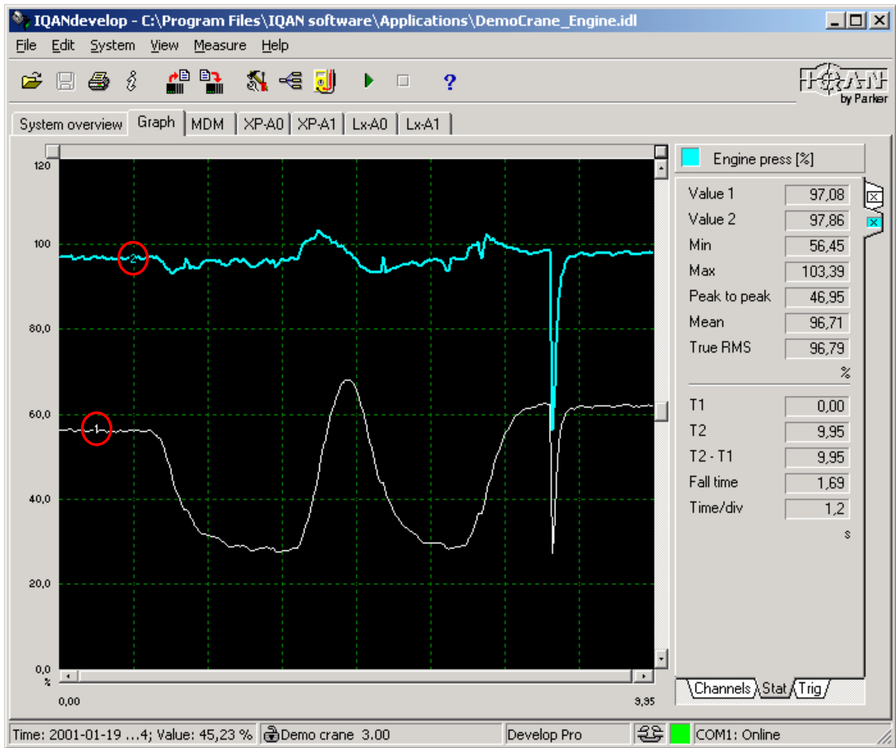
Glitch detect can be useful to detect short pulses or glitches in a large log. Without glitch detect IQANdevelop uses mean value calculation when presenting large amount of data on the screen.

With glitch detect IQANdevelop presents min and max values in each point instead of the mean value. This makes it possible to easily find glitches in very large logs.

To enable glitch detect, right-click in the measurement window and select *Glitch detect.* To disable, right-click and select *Glitch detect* once again.

Print tags

Print tags are used to be able to identify the curves on a printout when you do not have access to a color printer.



Print tags.

Print tags means that every curve is marked with a number which corresponds to the channel's position in the channel list.

Create print tags

Print tags are created by right-clicking in the measurement window and selecting: *Create print tags* or select: *Measure* > *Create print tags.*

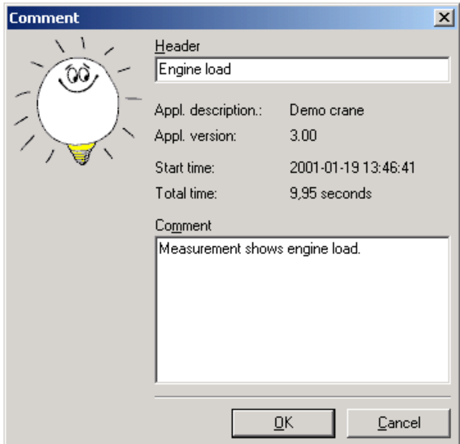
The print tag for *active channel* can be positioned anywhere on the curve. Position the marker on desired position in the X direction, hold the <*Ctrl*> key down and click.

Remove print tags

Remove print tags by right-clicking in the measurement window and select: *Remove print tags* or select: *Measure* > *Remove print tags.*

Adding a comment

You can add comments for a specific measurement. This will then be printed out with the measurement data.



Dialog box for input of your own comments.

The dialog box for comments contains the following:

Header	Identifies the measurement. The header can consist of a maximum of 25 characters.
Appl. description	Application description. This is entered via *File* > *Info,* see section Application information, on page 89.
Version	Application version. This is entered via *File* > *Info*.
Date/time	Date and time when the measure started.
Total time	The length of the measured data.
Comment	You can enter a comment of maximum 250 characters.

To store information and comments, click *OK*. The *Cancel* button closes the dialog box without storing any changes.

Print measured data

You can print measurements you have carried out. To print, select: *File* > *Print*. When you are using the zoom function, the zoomed window is printed.

Copy measured data to another program

It is possible to copy measured data to another program, e.g. Microsoft Excel or Microsoft Word. After a measure, select *Edit* > *Copy.* Measured data is copied as text, i.e. you get the measured values for the curves in a table. In Excel, you can then create your own diagrams.

Save measured data

After a measure has been carried out, the measured data can be saved as a data file. Saved data can be read and shown at a later occasion. Select: *File > Save as*. The file is saved with the suffix .idl.

The size of the file depends on how many channels the measure has been carried out on. When measuring 10 channels (i.e. the maximum number of channels), approx. 47 kB/min is stored (approx. 2.7 MB/h). The maximum time for measure is limited by how much internal memory you have available. When the internal memory is full a message is shown and the measure is cancelled.

Show measured data previously saved

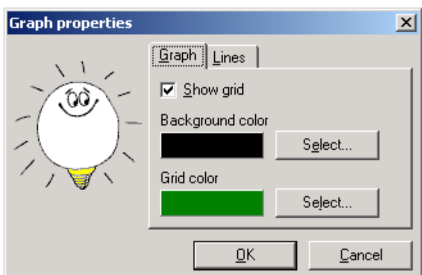
Measured data saved to a data file from a previous measurement can be opened and shown again. Get measured data from a saved data file by selecting: *File > Open* or click the *Open* button in the tool bar.

Settings of graph properties

You can set up your measure window yourself with regard to color settings and if you want the grid to be shown or not.

Right-click in the measurement window and select: *Graph properties* or select: *Measure > Graph properties...*

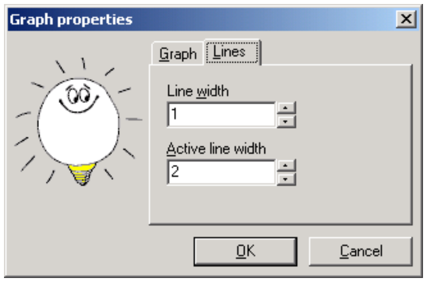
Graph properties



Dialog box for graph properties.

Show grid	Check to show a grid in the measurement window.
Background color	The measurement window's background color. Click on *Select*, to show the dialog box for color selection.
Grid color	The grid's color. Click on *Select*, to show the dialog box for color selection.

Line width

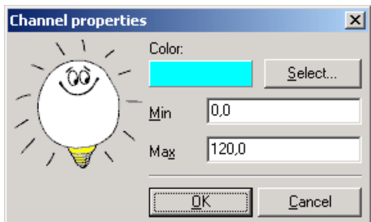


The Lines tab in the dialog box Graph properties.

Line width	Enter the line width of the curves in the measurement window (except active curve). There are four different thicknesses.
Active line width	Enter the *active channel's* line width. There are four different thicknesses.

Channel properties

To change a channel's properties, click on desired channel tab in the channel information and select: *Measure* > *Channel properties* or right-click on desired channel name in the channel list. The following dialog box is shown.



Channel properties

Color	The color which the curve is drawn with. If you click on *Select*, the dialog box for color selection is shown.
Min	The lower value for the scale on the Y axis.
Max	The higher value for the scale on the Y axis.

14 IQANsimulate

IQANsimulate is a tool for simulating expansion modules for IQAN™ control systems.

IQANsimulate is a Windows®-based program that uses CAN to communicate with the master module, IQAN-MDM. The master module cannot tell any difference between IQANsimulate and real expansion modules.

You use the same application file as the one that is downloaded into the master module. If you don't have the application as a file you can get it from the master with IQANdevelop.

Install the CAN card before IQANsimulate

Installation

Before you install IQANsimulate, please install a National Instruments CAN card in your computer. IQANsimulate will not work without the CAN card. Follow the instructions in National Instruments' installation guide.

NOTE

When you are in the process of verifying your installation of the CAN card, make sure you assign the name CAN0 to the CAN card.

Installing IQANsimulate

IQANsimulate can be installed via CD or via the Internet, www.iqan.com. IQANsimulate is included in the common IQAN software installation.

...from a CD-ROM

Follow these instructions to install IQANsimulate from a CD-ROM:

- Insert the CD into your computer's CD-ROM unit. The installation program starts automatically. If not, open the CD-ROM unit in the Explorer and double-click on Install.exe.
- Follow the instructions in the installation program. If you do not understand something, click on the *Next* > button or press *Enter* to continue the installation.
- When the installation is complete, click on *Exit.* Start IQANsimulate from the *Start* menu under *Programs->IQAN software.*

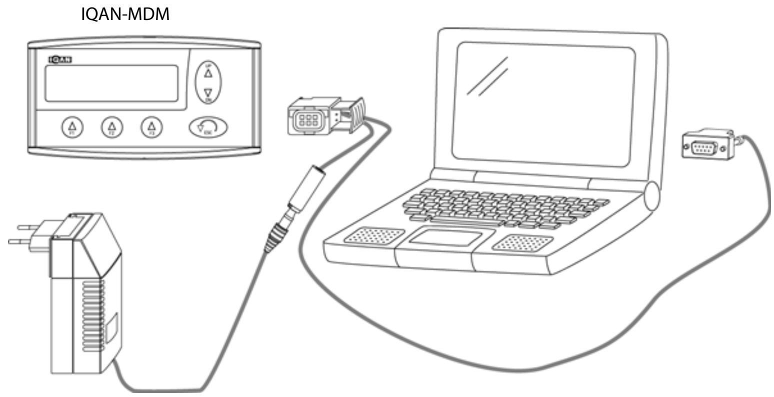
...via the Internet

You can always download the latest upgrade of IQANsimulate from our home page, www.iqan.com.

Be careful not to mix up the CAN port with the serial port!

Connecting the CAN cable

Connect the CAN cable between the National Instruments CAN card in your computer and the IQAN-MDM as shown by the figure. Connect the ac/dc converter to a power outlet. If you are simulating a TOC8 system you will have to connect your TOC8 instead.

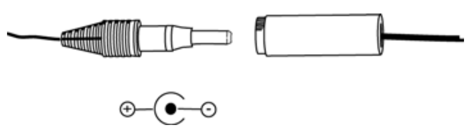


Schematic illustration of how to connect your system.

The size of the ac/dc converter is determined by your system configuration. If you are connecting a master solely, see the corresponding data sheet for the correct power rating. The publication number for the IQAN-MDM data sheet is HY17-8317/UK

NOTE

The ac/dc converter must have a dc-plug (Ø2,1mm) with the following configuration:



Configuration for dc-plug.

Safety regulations

This chapter contains regulations to improve safety when you use IQANsimulate.

This is what a warning symbol looks like!

Warning symbol

Note that all warning symbols in the manual also refer to safety precautions.

Testing the application for machine

Although IQANsimulate is used to verify the functionality on IQAN applications, running the application in IQANsimulate does not guarantee a fault free application.

A risk assessment should be carried out with regard to function and unpredictable occurrences. We refer to the standard for the Machine directives.

ATTENTION

IQANsimulate shall NOT be used in conjunction with real expansion units mounted in a machine.

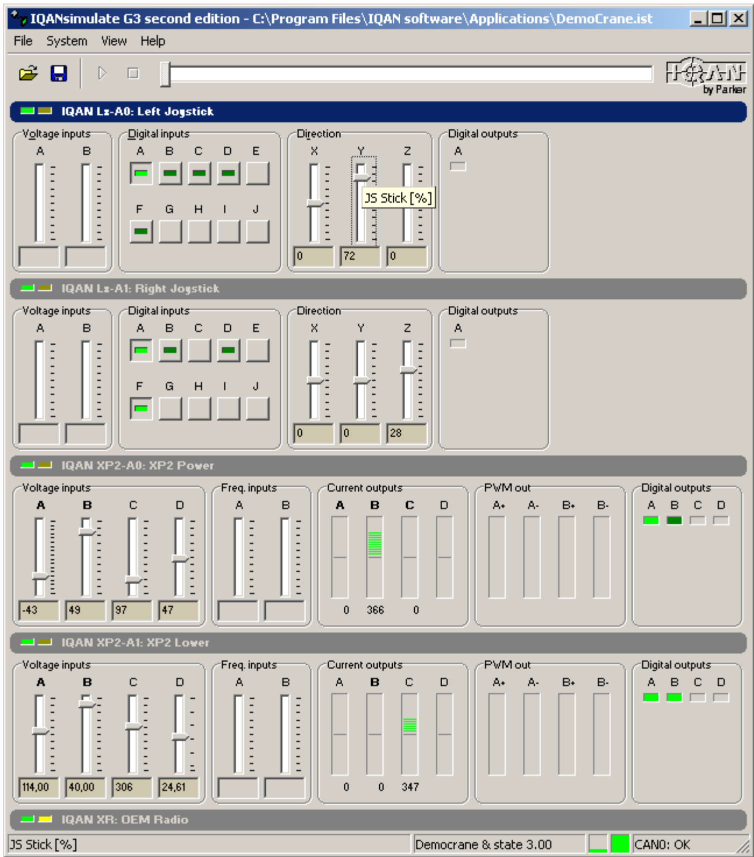
ALWAYS CONSIDER SAFETY WHEN DEVELOPING AND TESTING THE APPLICATION.

Getting started

The main window

IQANsimulate is a tool for simulating expansion modules for IQAN control systems. Each expansion module is represented by a module panel. For further information about the module panels, see section The module panels, page 337.

IQANsimulate is an excellent tool for testing and evaluating your application. You are able to interact with the master unit in real time and can verify the response from the modules.



The main window in IQANsimulate.

In the main window, you find all the commands in the drop-down menus in the menu bar.

At the bottom of the window, there is a status bar which shows application description, channel name and communication status.

The menu bar

File

Under the *File* menu, there are the usual functions, such as *Open* and *Save*, but also special functions as *Import/Export Settings* and *Automatic Update*.

Open	Ctrl+O	Opens an applications. File types that can be opened: .iqt, .idt, .ist, .idl.
Save	Ctrl+S	Saves the application as an IQANsimulate file (.ist-file).
Save as		Saves the application with desired file name.
Import settings	Ctrl+I	Import settings, such as momentary buttons and channel values, see Import and export settings, page 345.
Export settings	Ctrl+E	Export settings to a settings file (.iss-file), see Import and export settings, page 345.
Use Automatic Update		Check for automatic updates of applications being downloaded with IQANdevelop, see Automatic update, page 346.
Exit	Alt+F4	Exits the program.

System

Under the *System* menu, you will find system integrating functions.

Start playback	F4	Starts playback of a log file.
Link to Excel	Ins	Adds a link to Excel.
Reset all links		Resets all Excel links.
Update IQANdevelop	F2	Focus IQANdevelop on the selected channel.
Restart master		Restarts the MDM module without breaking the power.
Reacquire TOC8		Enables the TOC8 module to communicate with IQANsimulate.

View

Under the *View* menu, there are functions concerning the visual layout.

Language 1		Select language 1 for presentation of channel names in module panels.
Language 2		Select language 2.
View links		Show the current links to Excel.
Adjust Window	Ctrl+A	Adjusts the main window for a perfect fit to the modules.
Minimize Window	Ctrl+M	Minimizes all the modules and adjusts the window to accommodate the new size.
Reset All Errors	Ctrl+R	Reset all simulated error values in IQAN simulate, see Automatic update, page 346

Help

Under the *Help* menu, there are functions to get help in different ways.

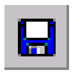
Contents	F1	Launches the user manual as on-line documentation in digital format.
About...		Information box about IQANsimulate. Shown here is e.g. information about the licence and the program version.

The tool bar

The tool bar contains buttons for file managing and the playback function.

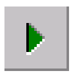
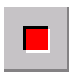
File functions

The buttons for the file functions contain the usual *Open*, *Save* functions.

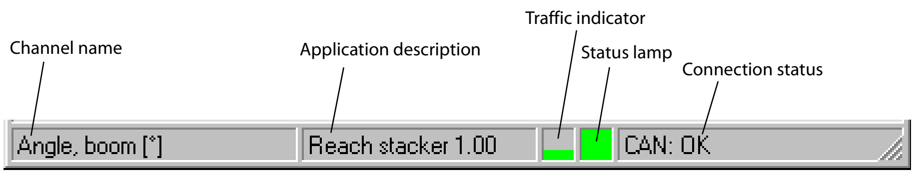
	Open an existing application.
	Save application.

Playback functions

With these buttons, you can start or stop the playback of a log file. Use the *Progress bar* to manually change the playback position.

	Start playback. The button is enabled when there is a log file open.
	Stop playback. The button is enabled when playback is in progress.

The status bar



The status bar consists of five smaller fields where diverse information is shown.

In the first field from the left, the name of the selected channel is shown.

The name of the present application is shown in the second field.

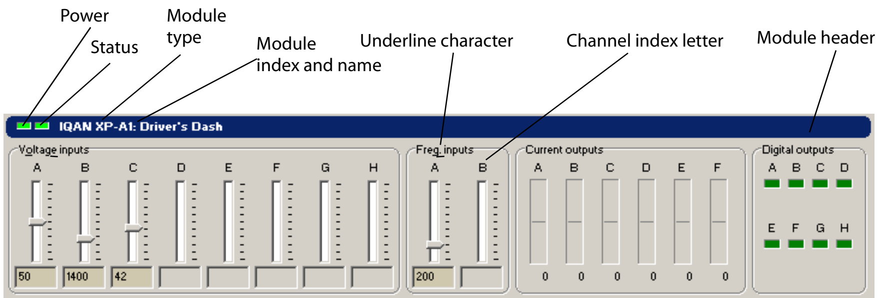
The third field indicates any traffic coming in on the CAN bus.

The fourth and fifth field show status for the connection to the master. During connection, the status lamp in the fourth field is green. If no messages are received from the master module this lamp will turn yellow. To close the connection, click on the status lamp. By clicking it again, the connection will reopen.

The module panels

General

Each expansion module in an IQAN system is represented by a panel in the main window. The module panel contains controls for every input channel and indicators for every output channel on the module.



XP module.

Module header

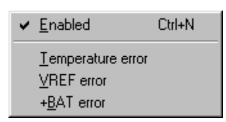
At the top of the panel, the module header indicates whether that panel has focus. Module type and index are also shown. To the left in the header field there are two lamps that display the module power and status. The left lamp shows power status, green equals on. The right lamp can be either green, yellow or red depending on module type and status, see section Error and status codes, page 349.

Minimizing the panel

You can minimize/maximize a panel in two different ways:

- by double-clicking on the header of the module
- with <Ctrl+Space>

Disabling modules



Enable/disable a module by right-clicking inside the module header and selecting *Enabled* in the popup menu. This is equivalent to turning the power on and off on a physical module as it stops responding to the system when it is disabled. This can also be done with <Ctrl+N>.

Navigating among the channels

Select a channel by clicking on the desired channel with the mouse or by pressing Tab to move between them. The name of the selected channel is displayed in the status bar.

If you want to go quickly to a certain group of input channels, use <Alt> + the underlined character in that certain group's name.

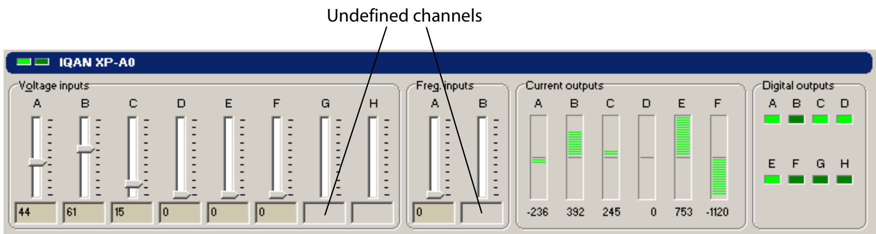
If you want to go quickly to a certain channel, use <Ctrl+Shift> + the channel index letter.

Appearance

The panels are modelled with all the capabilities of the real modules.

XP

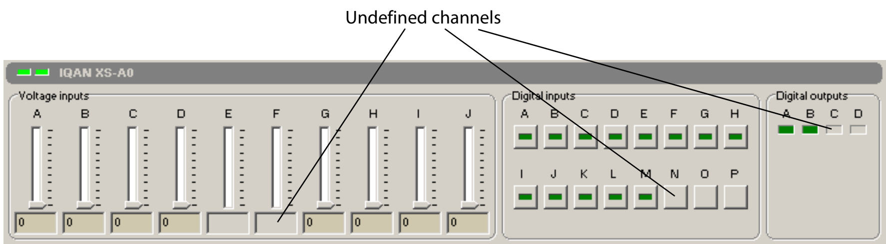
IQAN-XP has 8 voltage inputs, 2 frequency inputs, 6 current outputs and 8 digital outputs.



XP layout.

XS

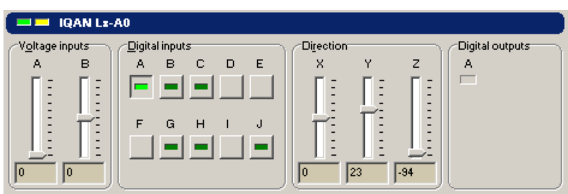
IQAN-XS has 10 voltage inputs, 16 digital inputs and 4 digital outputs.



XS layout.

Lx

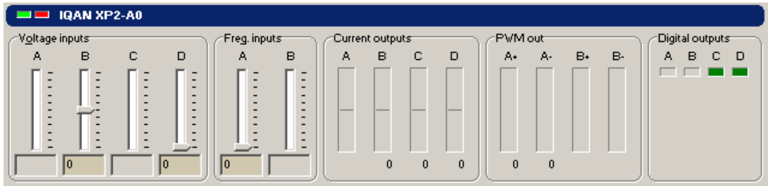
IQAN-Lx has 2 voltage inputs, 10 digital inputs, 3 directional inputs and 1 digital output.



Lx layout.

XP2

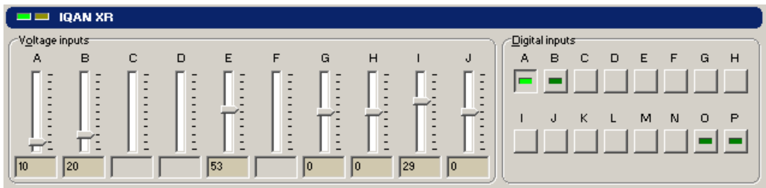
IQAN-XP2 has 4 voltage inputs, 2 frequency inputs, 4 current outputs, 2 pulse width modulation outputs and 4 digital outputs.



XP2 layout.

XR

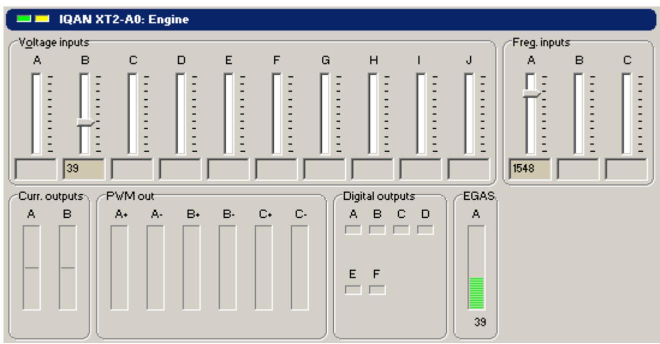
IQAN-XR has 10 voltage inputs and 16 digital inputs.



XR layout.

XT2

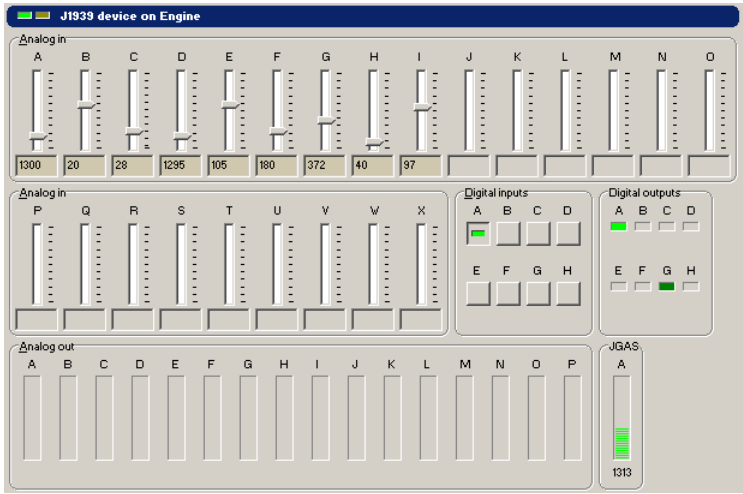
IQAN-XT2 has 10 voltage inputs, 3 frequency inputs, 2 current outputs, 3 pulse width modulation outputs, 6 digital outputs and 1 EGAS output.



XT2 layout.

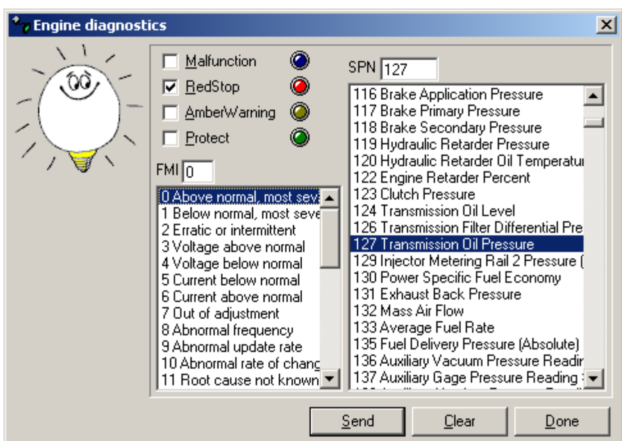
J1939

The J1939 module is not a physical module but a part of the IQAN-XT2. It is automatically created if any of the following J1939 channels are present. The J1939 module has 24 analog inputs, 8 digital inputs, 16 analog outputs, 8 digital outputs and one throttle out (JGAS).



J1939 layout.

You can simulate engine messages through the *Engine diagnostic...* popup menu alternative on the J1939 module. Select the FMI and SPN number you want to simulate and check the severity of the error. You must have one severity level selected in order to set an error. Press *Send* to send the message a set the error. Use the *Clear* button to clear the error flags and send a message clearing the error. Clearing the error can also be done by unchecking all the severity levels and pressing *Send* again.



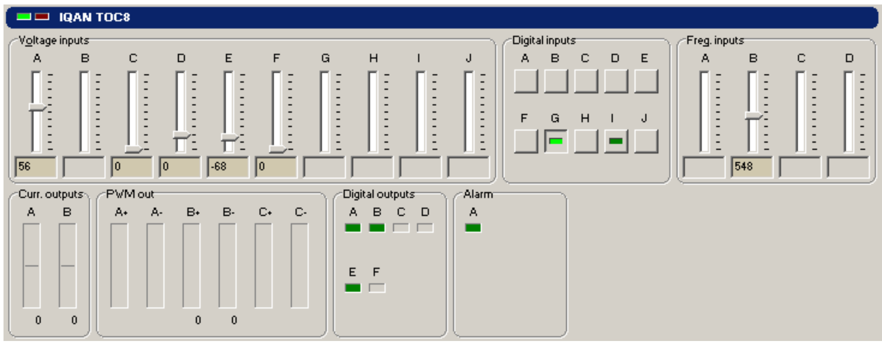
Engine diagnostic window.

NOTE

Not all engine manufacturer support all SPN numbers.

TOC8

IQAN-TOC8 has 10 voltage inputs, 10 digital inputs, 4 frequency inputs, 2 current outputs, 3 pulse width modulation outputs, 6 digital outputs and one alarm output.



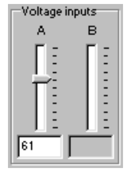
TOC8 layout.

The channels

Description of how to handle the different channel types in the program. Controls for channels that are undefined in the application are disabled. They are greyed out and insensitive to all manipulation.

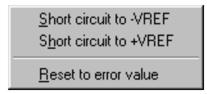
Inputs

Voltage inputs



A voltage input consists of a track bar and an edit box. The track bar is scaled according to the corresponding channel's scaled min and scaled max values. Set the value in one of the following ways:

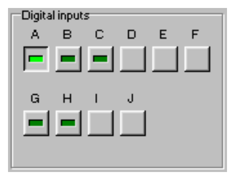
- move the slider with the mouse.
- press <*Arrow Up*>/<*Arrow Down*> keys or <*PageUp*>/<*PageDown*> for larger steps.
- type a value and press *Enter.*



Simulate short circuit to -VREF or +VREF by right-clicking on the voltage input and select *Short circuit to -VREF*/*Short circuit to +VREF* in the popup menu. Select again to remove short circuit. *Reset to error value* sets the voltage input to the defined error value.

If there is no slider and the edit box is greyed out, the channel is not defined in the present application.

Digital inputs

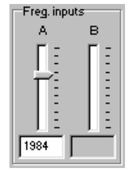


A digital input is represented by a button with a lamp. It can be activated and deactivated with the mouse or by pressing <Space>.

The button is by default alternate, which means that it locks in the bottom position when pushed. It can be set to momentary by right-clicking on the button and selecting *Momentary* in the popup menu that appears. Momentary means that the button is non locking.

If there is no lamp on the button, the channel is not defined in the present application.

Frequency inputs



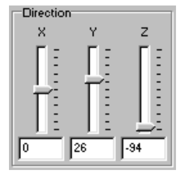
A frequency input consists of a track bar and an edit box. The track bar is scaled according to the corresponding channel's scaled max value.

Set the value in one of the following ways:

- move the slider with the mouse.
- press <*Arrow Up*>/<*Arrow Down*> keys or <*PageUp*>/<*PageDown*> for larger steps.
- type a value and press *Enter*.

If there is no slider and the edit box is greyed out, the channel is not defined in the present application.

Directional analog inputs



A directional analog input consists of a track bar and an edit box. The track bar is scaled from -100% to +100%. Set the value in one of the following ways:

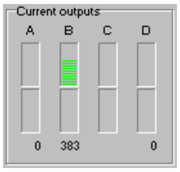
- move the slider with the mouse.
- press <*Arrow Up*>/<*Arrow Down*> keys or <*PageUp*>/<*PageDown*> for larger steps.
- type a value and press *Enter*.

The slider is by default not spring loaded, which means that it keeps its position when it is released. It can be set spring loaded by right-clicking on the slider and selecting *Spring loaded* in the popup menu that appears. Spring loaded means that the slider returns to zero when released.

If there is no slider and the edit box is greyed out, the channel is not defined in the present application.

Outputs

Current outputs



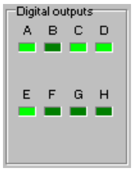
A current output consists of a bar graph and a label which shows the output value in mA. If the label is missing, the channel is not defined in the present application.

Simulate an overload or an open load by right-clicking on the current output and select *Overload/Open load* in the popup menu. In order to reset the *Overload* error you will have to zero the output value on the channel.

NOTE

Multi mode is not supported. Hence, settings for mode 1 apply.

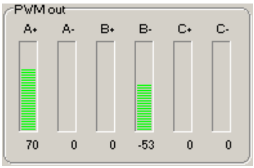
Digital outputs



A digital output is represented by a green lamp. High output is indicated with the lamp lit.

If the lamp is grey, the channel is not defined in the present application.

PWM outputs



A pulse width modulation output consists of two bar-graphs and labels which show the output value in percent. The dual functionality of the PWM output can be used independently, hence the two bar graphs per channel. If the value label is missing, the channel is not defined in the present application.

NOTE

Multi mode is not supported. Hence, settings for mode 1 apply.

You have to download the application from IQANdevelop before using IQANsimulate

Using IQANsimulate

In this section you will be given a description of how the program is intended to be used. This will help you get started with the program.

Preparation

First, you will need an application to simulate, created with IQANdevelop. Start IQANdevelop and open your application. Then download it to the master. Now, start IQANsimulate and open that same application.

Working procedure

IQANsimulate has now restarted your master unit and is communicating with it. Now is the time for you to start testing your functions. As you change the input values of the modules in IQANsimulate you will se how the outputs change in accordance with your functions.

If you find an error in your application, switch to IQANdevelop and review your function’s composition to find the error.

When you have found and corrected the error, save and download the application to the master unit again. Reopen the newly saved application in IQANsimulate again.

It is important that you save the changed application in IQANdevelop in order to reopen it with IQANsimulate.

ATTENTION

It is very important that you have the same application in the master unit as you have open in IQANsimulate. If you don’t have the same application in the master unit as you have in IQANsimulate, IQANsimulate will behave in an unpredictable manner.

Functions

Switch between the different panels by clicking on the panels’ headers. This is also done by using <Ctrl+Tab>, in the forward direction, and <Ctrl+Shift+Tab>, in the backward direction.

Import and export settings

These functions will help you to save and open settings that you have done in your application during your work with IQANsimulate. These functions operate on a settings file type. For more information on this file type, see , page 355. Typical use will be exporting settings before correcting errors in the application with IQANdevelop and later use import settings to quickly go ahead with testing again. The settings file also contains any Excel links that you might have.

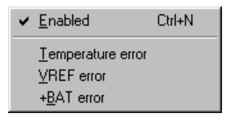
Automatic update

IQANsimulate is capable of synchronizing its current application to IQANdevelop when they are run on the same computer. Activate this feature by checking the *Use Automatic Update* menu item in the *File* menu. This allows IQANsimulate to automatically load any application that is gotten from or sent to the master with IQANdevelop.

Updating IQANdevelop

This function changes the selected channel in IQANdevelop to the one selected in IQANsimulate. This is especially useful together with the navigator in order to se how channels are interconnected to each other. The function is found in the *System* menu and on the channel's popup menu. This function is only available if you are running IQANdevelop at the same time.

Simulating module errors



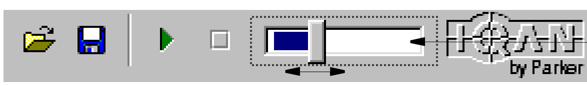
If you right-click in the header of a module you will get a popup menu with a number of errors that can be simulated. Selecting one of the errors will set the corresponding error on the module. Not all error types are available on all modules, see Error availability based on module type, page 349.

Resetting the module errors

Clearing a specific error is done by simply selecting that error again. To clear **all** simulated errors from **all** of the module panels, use the *Reset All Errors* function in the *View* menu. This can be useful if your application is not behaving as expected, see section Troubleshooting, page 353.

Playback

If you open a .idl file in IQANsimulate you can run a playback of the log. You start and stop the playback with the speed buttons or F4. Hereby you can watch the inputs as they change simultaneously. The master will change the outputs accordingly.



Progress bar

Use the progress bar to change position in the log file.

You may change the play back position by moving the handle in the progress bar. If you have the graph showing in IQANdevelop you can also follow the progress there. This function can be useful when troubleshooting your system.

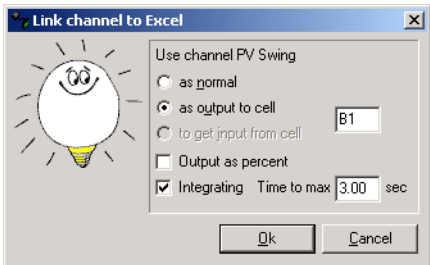
ATTENTION

IQANsimulate shall NOT be used in conjunction with real expansion units mounted in a machine.

Excel

If you have Microsoft Excel installed on your computer you can use it in conjunction with IQANsimulate to feed back channel values to an input channel in your application in IQANsimulate. Both input- and output channel values can be sent to the Excel spreadsheet, but only input channels can receive values from Excel.

Select a channel that you want to use in IQANsimulate. Select *System->Link to Excel* or use the popup menu of the channel to bring up the *Link channel to Excel* dialog window.



Select how you want to use the channel with Excel.

In this dialog you can choose to use the selected channel:

- as normal.
- as output to cell X.
- to get input from cell X.

Use as normal means that the selected channel will be disconnected from any Excel activity.

Use as output means that the value from the selected channel will be written to the Excel cell.

Use to get input means that the value from the Excel cell will be used as input to the selected channel.

Select the Excel cell you want to use by entering the cell reference in the edit box. A cell reference is composed by a letter and a number, e.g. A2, F13 etc. You can also select a cell in the spreadsheet in Excel, the cell reference in the edit box will then be updated to the selected one.

Output channels can only be used as output. E.g. a current output channel can only be used as an output to Excel. The last alternatives in the dialog window will then be unavailable.

The *Output as percent* check box only applies to current outputs and makes the output scale in percentage instead of absolute values. The output value then ranges from -100 to 100.

The *Integrating* check box makes the output channel integrated over time instead of showing the actual current or digital output. This option applies to digital and current outputs. The *Time to max* edit box determines the time it will take for the output to assume the maximum output value when the output is driven fully.

IMPORTANT

It is important that you have an equation in the spreadsheet that calculates the value that is used as input to a channel in order to make it work properly.

A channel that is used as output can contribute to many calculation in the Excel spreadsheet, but a channel that is used as input can only obtain its value from one Excel cell.

You can only use 20 channels as inputs.

If you want to remove all your Excel links select *System->Reset all links*.

Simulating a TOC8

In order to simulate a TOC8 module, you will, of course, need to have a TOC8 application. But you will also need to have a TOC8 hardware module connected to the CAN bus instead of an MDM. When the TOC8 is connected to the CAN bus and the TOC8 is powered and running in normal operation, indicated by a yellow blinking, you will need to reacquire the TOC8. To do this, select *System->Reacquire TOC8*. The TOC8 should now be blinking with a red light instead, indicating that the TOC8 is in simulate mode. Proceed as normal.

Error and status codes

The right lamp in the module header shows the status of the module with a flashing light. Not all codes listed apply to all modules, for example the XS-module does not have a temperature error, see table below.

Error availability based on module type

Error type	XP	XS	Lx	XP2	XR	XT2	TOC8
Temperature error	•		•	•		•	•
VREF error	•	•	•	•		•	•
+BAT error	•		•	•		•	•

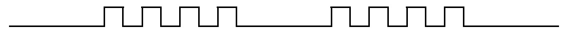
NOTE

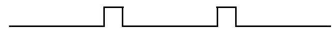
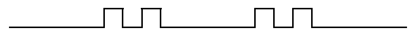
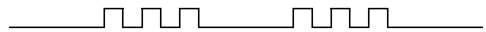
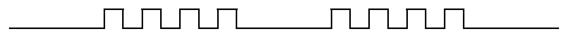
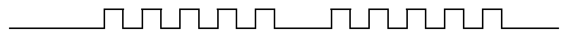
The XP2 and XT2 have 2 individual VREF's and their errors are simulated through the voltage inputs' popup menu.

XP- and XS-module

Status code	Blink (red light)
Normal (no error)	
I/O and voltage errors	
Low/High temperature	
CAN error	
VREF error	

Lx-, XP2- and XT2- module

Status code	Blink (yellow light)
Normal (no error)	
Freeze	
Test mode	

Error code	Blink (red light)
I/O and voltage errors	
Low/High temperature	
CAN error	
Hardware error	
Address error	
Software error	

XR-module

Status code	Blink (yellow light)
Normal (no error)	

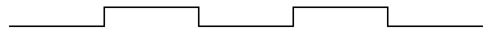
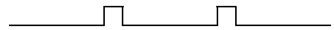
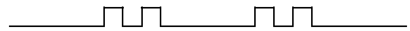
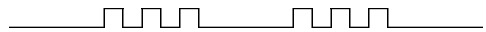
Error code	Blink (red light)
Radio error Emergency stop Battery low Address error CAN error	

NOTE

Because the XR-module is a 3rd party product and not obligated to have a status indicator, IQANsimulate indicates status according to the table above.

TOC8 module

Status code	Blink (yellow light)
Normal (no error)	

Error code	Blink (red light)
Normal (simulate mode)	
Input errors	
Output errors	
VREF error	
Voltage and checksum error	
Low/High temperature	

Application codes

In this chapter, we will be treating application codes.

IQANsimulate leans on the applications made with IQANdevelop and is therefore supporting application codes.

Application code

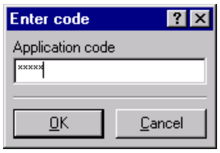
In IQANdevelop it is possible to protect an application from unauthorized users by creating an application code which must be entered when opening an existing application.

Opening a protected application

When you open a protected application in IQANsimulate, you must enter the code to be able to access the application. You only need to enter the code the first time you open the application after IQANsimulate has started. If you close IQANsimulate and then open the application again, you must enter the code again.

- Select: *File* > *Open.*
  Select the application file to be opened.

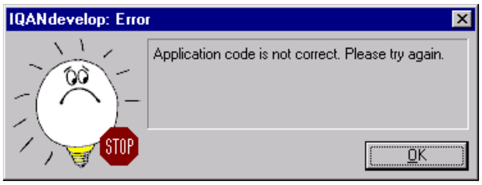
Before the application is opened, the following window is displayed.



Dialog box to enter the application code.

- Enter the code and then click on *OK*.

If you enter an incorrect code, an error message is displayed.



Error message for incorrect application code.

Storing application codes

Application codes can be stored in a file so you don't have to enter them every time you open a protected application. IQANsimulate uses the same file as IQANdevelop. See "Storing application codes" on page 304 for more information.

Troubleshooting

General troubleshooting when working with IQANsimulate. Please read National Instruments' documentation for troubleshooting the CAN interface.

No contact with master

Make sure that:

- the National Instruments CAN card is correctly installed. We refer to *NI-CAN diagnostics* that was installed with the CAN-card (see National Instruments' documentation).
- you are using the latest NI-CAN drivers, found at www.ni.com.
- if you are running on a laptop there is not any interrupt (IRQ) conflicts. It usually happens if you have an IR-port that is in use. Try disabling that one and restart.
- the cable is OK and connected (the CAN card has the same connector as the RS-232 port, 9-pin D-sub, do not mix them up).
- the master power is on.
- the correct application is downloaded to the master.

If you are experiencing that the CAN communication is not working although you have a green status lamp, try disconnect and reconnect the CAN bus, i.e. click the status lamp twice. Especially if the XP2 or the XT2 is offline try to restart the MDM by selecting *System->Restart master.*

Unstable contact with master

Make sure that:

- no other programs are running on your computer.
- your computer is fast enough, at least Pentium 100MHz for normal use, and at least Pentium III class for use with Excel.
- you have enough memory installed, at least 32 MByte.
- you are not running on batteries if you have a laptop (can slow down the computer).
- if you have to run on batteries, power management is off.
- the CAN bus is properly terminated (see National Instruments' documentation).

Application does not work as expected

Make sure that:

- both IQANsimulate and the master unit use the same application file.
- every input has a valid value.

- all modules are enabled.
- you are not simulating errors, such as low/high temperature.

Excel does not work (as expected)

Make sure that:

- you are using MS Excel 97.
- previous excel instances are not running in the background. This is done via the task manager. Quit IQANsimulate then terminate all processes called ’excel’ via the task manager. Restart IQANsimulate.
- your computer is fast enough. A Pentium III class computer is recommended for successful use with Excel in all cases.
- you are referencing the correct cell.
- you are not editing excel while integrating.

File types IQANsimulate

The settings file [.iss]

The settings file is used to save settings in IQANsimulate. These settings are saved for all of the channels on all of the modules.

The settings file, .iss, contains:

- application description
- module enabled
- module state: normal or minimized
- temperature error
- VREF error
- +BAT error
- voltage input states: normal or short circuit
- digital input states: normal or momentary
- current output states: normal, overload or open load
- directional input states: normal or springing
- channel values
- Excel links

The application and settings file [.ist]

The application and settings file is used to save the application and its settings in one file. Then you will have a set of settings that automatically always will apply when you open the application.

The application and settings file, .ist, contains:

- application data (same as an .idt-file, see IQANdevelop manual)
- settings (same as an .iss-file, see above)

ATTENTION

If you have opened an .idt file in IQANsimulate and saved it as an .ist file and then update the original .idt file with IQANdevelop, the .idt part in your .ist file will not be updated. Consider the export settings function as an alternative.

Shortcuts

Ctrl+A	adjusts the window to the current size of the modules
Ctrl+E	export the current settings to a file
Ctrl+I	import settings from a file
Ctrl+N	enables/disables the active module
Ctrl+O	opens a new application file
Ctrl+R	reset all simulated error values
Ctrl+S	saves the current application + settings
Ctrl+Space	minimizes/maximizes the active panel
Ctrl+Tab	changes the active panel to the following panel
Ctrl+Shift+Tab	changes the active panel to the previous panel
F2	focus IQANdevelop on the selected channel
F4	starts playback
Alt+F4	exits IQANsimulate
Ins	adds a link to Excel

Appendix A

Status-, warning- and error messages

In IQANdevelop, many status-, warning- and error messages are shown to give the most possible information about the situation.

The messages are color coded with respect to the seriousness of the message. If IQANdevelop shows an error message, the actual indicators such as measure flags and status lamps turns red:

Status messages	Grey
Ok messages	Green
Warning messages	Yellow
Error messages	Red

Grey status messages

Not evaluated	Not all objects are calculated due to the fact that the master uses lazy evaluation. For more information, see Appendix F, on page 373.
Status unknown	Applies to *Diagnostic for the module*. Upon detection of an error on one of the diagnosed values, *status unknown* is shown on the remaining values.

Green OK messages

OK	Everything is Ok.

Yellow warning messages

Simulated	The channel's value is simulated.
Locked	The channel's value is locked by a locking object.
Halted	Log is full, no more records will be stored before restart.
Low temperature	Low temperature for current module.
High temperature	High temperature for current module.
Critical temperature	The module's temperature is higher than the allowed maximum temperature.
Low supply voltage	Low supply voltage to the current module.
High supply voltage	High supply voltage to the current module.
Critical supply	The supply voltage is higher than the allowed maximum supply voltage.
RTC not connected	The real time clock in the master has no supply voltage.
Radio battery low	Applies to the *Radio module*. The battery voltage in the radio module is low.
X-axis error	Applies to *IQAN-Lx*. The signal from X-axis is erroneous.
Y-axis error	Applies to *IQAN-Lx*. The signal from Y-axis is erroneous.
Z-axis error	Applies to *IQAN-Lx*. The signal from Z-axis is erroneous.
Zero point inner error	Applies to *IQAN-Lx*. Internal error in the lever. Center position indicator is erroneous.
Zero point outer error	Applies to *IQAN-Lx*. Internal error in the lever. Center position indicator is erroneous.
Start block	Applies to *IQAN-Lx*.The start block in the lever is activated.
Utilization high	The utilization of the master module is high. Application may need to be optimized.

Red error messages

Input low alarm	The error message is shown if the input value falls below the low alarm limit.
Input high alarm	The error message is shown if the input value rises above the high alarm limit.
Input low error	Applies to *Voltage in*. Short-circuit to ground is the probable cause.
Input high error	Applies to *Voltage in*. Short-circuit to VBAT is the probable cause.
High frequency error	Applies to *Frequency in*. The frequency is too high and cannot be measured.
Output low	Applies to *Current out.* Assumed that *current check* is chosen, this message is shown if the return current is lower than the set value.
Output high	Applies to *Current out.* Assumed that *current check* is chosen, this message is shown if the return current is higher than the set value.
Dual direction	Applies to *Current out*. Both the positive and the negative direction is activated at the same time.
Dual function	Applies to all outputs. Activation of both the primary and the secondary output happen at the same time.
Division by zero	Applies to *Mathematical analog*. The error message is shown if division by zero occurs.
Calculation overflow	Applies to *Mathematical analog*. The error message is shown if the final result for the channel is too big.
Negative square root	Applies to *Mathematical analog*. The error message is shown if the square root of a negative number is requested.
Multiple modules with same address	Two or more modules on the same CAN bus have the same address.
Undefined channel	A new channel has been added and the application is not sent to the master.
Undefined module	A new module has been added and the application is not sent to the master.
Internal checksum error	Internal error in the current module.

No contact	The master has lost contact with the module.
Disabled	A module is disabled via the master’s display.
CAN bus polarity error	The +/- connections for the CAN bus have been mixed up. Obsolete.
CAN high, short circuit to GND	The connection CAN-H, on current module, has been short circuit to ground. Obsolete.
CAN high, short circuit to VBAT	The connection CAN-H, on current module, has been short circuit to the battery plus. Obsolete.
CAN low, short circuit to GND	The connection CAN-L, on current module, has been short circuit to ground. Obsolete.
CAN low, short circuit to VBAT	The connection CAN-L, on current module, has been short circuit to the battery plus. Obsolete.
VREF error	The reference voltage on current module is erroneous.
Sender/Receiver address error	Applies to the *Radio module*. The sender or receiver has wrong address.
General radio failure	Applies to the *Radio module*. Unspecified error is detected on the radio module.
Radio emergency stop	Applies to the *Radio module*. Emergency stop is detected on the radio module.
Channel specific error	Applies to J1939 channels. See manufacturer specification for more information.
Channel error	Applies to J1939 channels. See manufacturer specification for more information.
Channel not available	Applies to J1939 channels. See manufacturer specification for more information.
Channel time-out	Applies to J1939 channels. See manufacturer specification for more information.
Reserved	Applies to J1939 channels. See manufacturer specification for more information.
Active	Applies to *J1939 Lamp indicator*. Message is shown when lamp is lit.
VREF E-Gas error	Applies to *IQAN-XT2*.
E-Gas error	Applies to *IQAN-XT2*.

Utilization critical	The utilization of the master module is critical. Application must be optimized.

SAE J1939 messages

In IQANdevelop are all the below described error messages specified as red error messages.

FMI	J1939 standard error message
0	Above normal, most severe
1	Below normal, most severe
2	Erratic or intermittent
3	Voltage above normal
4	Voltage below normal
5	Current below normal
6	Current above normal
7	Out of adjustment
8	Abnormal frequency
9	Abnormal update rate
10	Abnormal rate of change
11	Root cause not known
12	Bad component
13	Out of calibration
14	Special instructions
15	Above normal
16	Above normal, severe
17	Below normal
18	Below normal, severe
19	Received data in error
20-30	Reserved
31	Not available

Appendix B

Priority order for the channels

All channels in an IQAN system are arranged in a certain order of treatment. First, the master unit reads the values of all input channels, thereafter all channels are treated and finally the values are sent out via the output channels.

Priority for the channels can cause "race conditions", i.e. a channel can use an "old value" for a calculation. These problems particularly concerns digital channels.

It is best to avoid using a channel with a lower priority to e.g. calculate a value for a channel with higher priority. It is the responsibility of the "developer" of the application to consider the priority order. Please use the *Navigator* or the *Check application* command to check your application for priority problems.

The channels are prioritized in the following order.

Priority	
1 (highest)	Channel type
2	Module type
3	Module CAN address
4 (lowest)	Channel index

The treatment order for the channels is determined from the four tables on the following pages.

- The master begins by checking and prioritizing the channel types, table 1.
- Thereafter, the module type where the channel type is located is checked. The master module follows the priority ordering in table 2.
- If there are several modules of the same type, these are distinguished as per table 3, by their CAN address.
- The last thing to be checked is the channel index which is prioritized as per table 4.

In this way, the master module works its way through all channels and then starts over from the beginning.

The conditional/interactive message with the highest priority is shown first on the display.

Channel type, table 1

Priority	Channel type
1 (highest)	Voltage in
2	Digital in
3	Frequency in
4	Directional analog
5	E-Gas position
6	Function parameter
7	J1939 Analog in
8	J1939 Digital in
9	Module diagnostic
10	J1939 Diagnostic
11	J1939 Lamp indicator
12	SMS input
13	Engine load
14	Mathematical analog
15	Mathematical digital
16	Internal analog
17	Internal digital
18	PID regulator
19	Event counter
20	Timer
21	Hour counter
22	Integrating limiting
23	State selection
24	Mode selection
25	Current output
26	PWM output

27	Digital output
28	Conditional message
29	Interactive message
30	E-Gas out
31	J1939 Throttle out
32	Alarm out
33	Event log
34	Memorizing
35	J1939 Analog output
36	J1939 Digital output
37 (lowest)	SMS output

Module type, table 2

Priority	Module type
1 (highest)	MDM
2	MDL
3	XP
4	XS
5	Lx
6	XP2
7	XR
8	TOC8
9 (lowest)	XT2

CAN address (module number), table 3

Priority	CAN address
(highest)	A0
	A1
	...
	B0
	B1
(lowest)	...

Channel index, table 4

Priority	Channel index
1 (highest)	A
2	B
3	C
4	...

Channel index for the outputs

Priority	Channel index
1 (highest)	A Primary
2	A Secondary
3	B Primary
4	B Secondary
5	...

Appendix C

Choosing a modem

Here are some general guidelines we can offer. Remember, these are only general guidelines. We have several modems in our lab that break one or more of these guidelines and still work fine. We also have a couple modems that follow all the rules and are problematic.

The guidelines presented here concerns the modems you connect on your PC side, not the modems you connect to the IQAN master module. For IQAN modem recommendations, see Remote diagnostics, Catalogue HY17-8372/UK.

We recommend avoiding Winmodems and RPI modems

These modems, otherwise known as software modems, offload some of the "smarts" of the modem to the host computer. They use software drivers to handle things like compression and error correction that are normally handled by the hardware/firmware in the modem. To be fair, these modems have a couple advantages – the drivers are easy to update, and the overall cost of the modem is lowered (the whole concept of a software modem probably came about as a result of the competition in the modem market).

In our view software modems have several disadvantages, for example:

- The host computer is forced to donate resources in support of the communications session (not only the CPU, but also memory, data bus, power and so on).
- Shifting these duties to software results in an overall loss of efficiency (custom hardware is better suited to handle this type of processing).
- They seldom work well with GSM modems, e.g. with Wavecom WMOD2B that we use with IQAN.

How can you tell if a modem is a software modem? Usually, you'll see "Winmodem" or "RPI" somewhere on the box.

We recommend using external modems

This is simply the best way to ensure you get a modem with all its brains intact. As far as we know, it's not practical to produce an external modem that uses drivers to handle things like error correction and compression. An external modem is also easier to monitor and troubleshoot (most have status indicator lights on the front panel).

We recommend using direct lines

... and not going through the company switchboard. If you have to go through the company switchboard, use an analog line. Also, make sure the switchboard doesn’t do any noise reduction on the line you will be using.

We recommend against "chasing the latest technology"

Modem makers often race to hit the market first with a new feature in order to gain market share. It often takes a little while to get new features reliable though, so the first few batches of modems sporting a brand new feature often aren't as reliable as subsequent batches will be.

We recommend getting a modem with the features you need

... and no more. In other words, if you need a modem strictly for data communication, why get a voice modem? This is a cost saving recommendation for the most part, but there's a certain "less can go wrong" issue also.

We recommend using well-known brands

It's tough to know for sure if the maker of your modem will still be around in a year or two in the event you need a new driver or support for your modem. The odds seem to be a bit better if you stick to an established brand.

Buy from a store with a reasonable return policy

This should allow you to test the modem in the environment you'll be using.

If you need to buy many modems for a project

... buy one or two first and test them thoroughly with the code you'll be using before committing the money for all of them. This only makes sense. If you're going to be buying a couple hundred modems, make sure you're getting modems that will work well in your situation.

If nothing else works

... try using a GSM modem on the PC side as well. Make sure that both modems have SIM cards from the same network operator.

Appendix D

iSMS syntax

There are several commands that can be sent to a remote IQAN system via SMS (Short Message Service). The command set is called *i*SMS. This requires a GSM modem with SMS capabilities connected to the remote master module.

*i*SMS is supported by all master modules. To activate *i*SMS, see section iSMS commands, page 107.

In the tables below, text and number values are indicated by `<Value description>`. Optional values are within `[]`. The value `<Channel id>` is entered as `<Channel type>-<Channel index>:<Module type>[-<Module index>]`, i.e Module index can be left out if there can only be one module of that type, e.g MDM.

The syntax is not case sensitive, which means you can enter all commands in lower-case letters also.

Interactive message

Displays a message on the driver display. The driver can have the option to reply by clicking one of the buttons specified. If no buttons are specified, the message will only be displayed, no reply is sent back to the sender.

Command	`#IM#<Text message>`
	`[#F1=<F1 button text>]`
	`[#F2=<F2 button text>]`
	`[#F3=<F3 button text>]`

Reply, button(s) specified	`#IM#<Text message>`
	`Reply: <Button>=<Button text>`
	or
	`#IM#<Text message>`
	`Reply: Timeout`

Reply, no buttons specified	No reply is sent.

Example	`#IM#How are you?#F1=Fine#F2=Bad`
	Reply:
	`#IM#How are you?`
	`Reply: F1=Fine`

Application info

Get application info.

Command	`#AI#`

Reply	`#AI#`
	`<Application description+version>`
	`<Comment>`

System info

Get module hardware and software versions.

Command	`#SI#`

Reply	`#SI#`
	`<Module type>[-<Module index>]:`
	`<HW version>/<SW version>`

Get value

Get any channel value.

Command	`#GV#<Channel id>`

Reply	`#GV#<Channel id>`
	`<Channel name>`
	`Value=<Value> [<Unit>]`

Example	`#GV#MAC-B:MDM`
	Reply:
	`#GV#MAC-B:MDM`
	`Total weight`
	`Value=29.45 ton`

Reset value

Resets a stored value to zero. For more information, see section Stored values, page 212.

Command	`#RV#<Channel id>`

Reply	`#RV#<Channel id>`
	`<Channel name>`
	`Value=0`

Example	`#RV#HCNT-B:MDM`
	Reply:
	`#RV#HCNT-B:MDM`
	`Service time`
	`Value=0`

Get adjustable parameter

Get all adjustable parameters for a channel. This command can be used for voltage inputs, frequency inputs and function parameters. For more information, see section Adjustable values, page 211.

Command	`#GA#<Channel id>`

Reply	`#GA#<Channel id>`
	`<Channel name>`
	`[Min=<Value> <Unit>]`
	`[Max=<Value> <Unit>]`
	`[Value=<Value> <Unit>]`

Example	`#GA#VIN-C:XT2-A0`
	Reply:
	`#GA#VIN-C:XT2-A0`
	`Pump pressure`
	`Min=896 mV`
	`Max=4458 mV`

Set adjustable parameter

Sets the value for an adjustable parameter. This command can be used for voltage inputs, frequency inputs and function parameters. For more information, see section Adjustable values, page 211.

Command	`#SA#[<PIN code>#]<Channel id>`
	`[#MIN=<Value>][#MAX=<Value>]`
	`[#VALUE=<Value>]`

Reply	`#SA#<Channel id>`
	`<Channel name>`
	`[Min=<Value> <Unit>]`
	`[Max=<Value> <Unit>]`
	`[Value=<Value> <Unit>]`

Example	`#SA#1234#FP-14:MDM#VALUE=43.5`
	Reply:
	`#SA#FP-14:MDM`
	`Max boom angle`
	`Value=43.50 °`

Appendix E

Recommendation of work method

In this section, we would like to present the work method we normally use when we create a function.

Vehicle steering for a forest machine

We have chosen to develop a vehicle steering to demonstrate the work method. The problem is split into two parts. In part A, we define simply what we want to achieve and in part B, we define the problem with a risk analysis.

Part A

What do we want to happen?

The vehicle steering will be controlled with a lever.

How will it work?

The steering will be controlled proportionally to the lever position.

What do we need to know?

The position of the lever.

Part B

In part B, we define the function after we have carried out risk analysis on our application.

What can happen?

Involuntary movement caused by electrical fault.

Lever control is used at the same time as the orbitrol.

The machine can tip over if the driver uses lever control at high speeds.

The operator may be unsure of whether the lever control is enabled or disabled.

How can this be avoided?

With a neutral position switch in the lever, or double inverted input signals from the lever, we can detect electrical faults.

By measuring the orbitrol pressure, we can detect when the steering wheel is being used, and block the lever control.

By reducing the maximum current at the output with regard to the vehicle's speed, the steering will be less sensitive at higher speeds.

With a lamp, you can indicate whether lever control is enabled or disabled.

What do we need to know?

The position of the lever.

The orbitrol pressure.

The speed of the vehicle.

Further safety actions can be needed depending on the vehicle steering's electrical, hydraulic and mechanical construction.

Appendix F

Optimizing the application

If you create a small application with just a few in- and outputs together with some simple functions, then you don't have to think about optimizing the application. On the other hand, if your functions are mathematically advanced and contain lots of objects, then it is time to think about optimizing the functions in your application.

NOTE

If the utilization of the master is raising above 75%, you should try to optimize your application. For more information on utilization, see section Module diagnostic, page 159.

over 75%	Utilization is high. You should try to optimize your application. The status lamp for the utilization turns yellow.
over 85%	Utilization is critical. Application must be optimized or functionality removed. The status lamp for the utilization turns red.

Group objects

If you have multiple objects that have the same functionality you should group these objects. For example, use an internal digital channel for this.

EXAMPLE

Blocking objects for a set of crane functions. You should only be able to manoeuvre the crane if the following conditions are fulfilled.

Hydraulic oil temperature < 70 °C.

The door is closed.

The seat switch is activated.

Instead of adding these three objects to all our crane outputs (swing, boom, telescope, grapple, etc.), we create an *internal digital channel* that we call *Starting block*. The channels function will be created with the above conditions as blocking objects. Then we use the channel *Starting block* as *limiting object* on the functions that control the crane outputs.

By grouping the objects, the master will only have to calculate the objects for one channel instead of once for each channel that uses the objects.

The above also simplifies the traceability in the application when debugging and when you need to make changes to an object you only need to do that in one place.

Lazy evaluation

The master uses so-called *lazy evaluation*. It is a method to minimize the execution time, the time it takes to calculate all the functions. *Lazy evaluation* means that the master only calculates the objects that are necessary.

Objects that are not calculated can be detected by measuring the objects, see section Measuring objects, on page 314.

Sort linear objects

Linear objects require more computational power than any other object. Therefore these objects need to be optimized the most.

If you have several objects of one type, you can reduce the computational time for the master by sorting them in a certain order. The following apply to multiplication of objects within the controlling and limiting object groups.

The objects' value = Object 1 * Object 2 * Object 3... * Object 8

If one of the objects above has the value 0%, the whole expression evaluates to 0%. *Lazy evaluation* implies that the result is set to 0% once the master encounters an object whose value is 0%. In this way, computational power is saved in the master unit as the rest of the expression does not need to be evaluated.
Put into practice, this means that when you create functions, sort the objects so that the objects that evaluate to 0% most often, are put at the top of the list.

When it comes to *controlling objects* and calculation of *MaxOf* the following applies:

The controlling objects' value = MaxOf(Controlling 1, Controlling 2..., Controlling 8)

When the master encounters an object that evaluates to 100%, the result is set to 100% by the master. Put into practice, this means that objects that evaluate to 100% most often, shall be put at the top of the list.

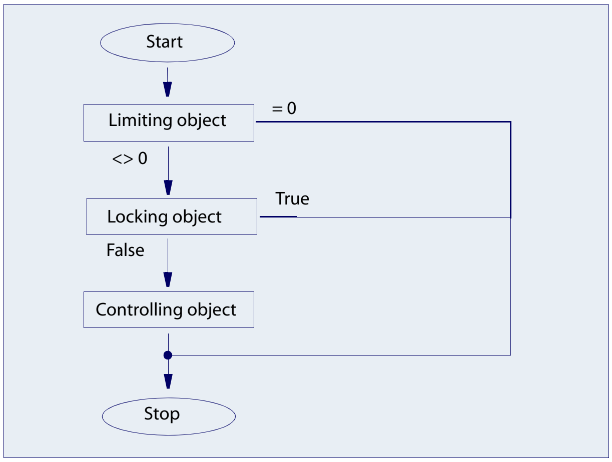
For *limiting objects* and calculation of *MinOf* the following applies:

The limiting objects' value = MinOf(Limiting 1, Limiting 2..., Limiting 8)

When the master encounters an object that evaluates to 0%, the result is set to 0% by the master. Put into practice, this means that objects that evaluate to 0% most often, shall be put at the top of the list.

Object type priority

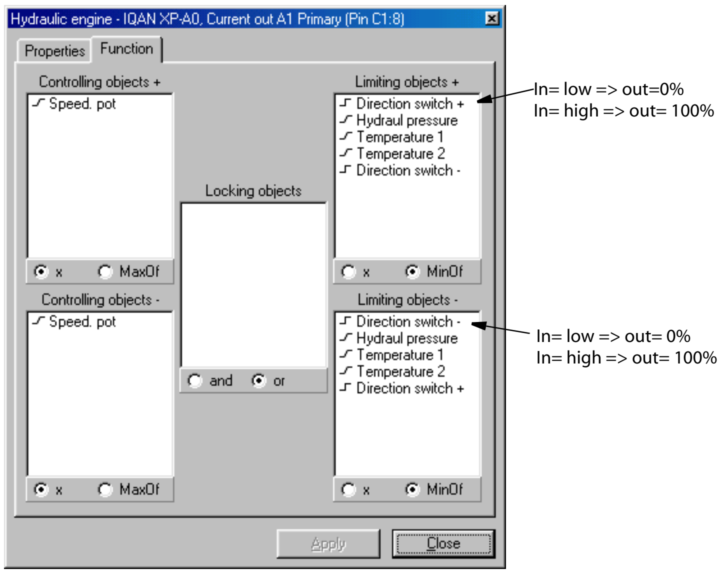
Even between the different object types there is a certain calculation order. By thinking of which object type you are using, you can shorten the master's computational time. The goal is for the master to get through the following path in the shortest time possible.



Calculation order for an analog output.

EXAMPLE

Control of the deplacement on a hydraulic engine. The engine speed is controlled 0-100% with the help of a potentiometer. The rotational direction is determined with a switch. An interlock will prevent the selection of both positive and negative direction at the same time. Further there is a sensor for measuring the hydraulic pressure and two sensors for measuring temperatures.



The function for controlling the hydraulic engine.

The master starts with computing the function for the output in the positive direction. If the direction switch is set to drive the engine in the negative direction, i.e. the limiting object *Direction switch* + equals 0%, then the output in the positive direction is set to 0%, consequently the master does not need to calculate the whole expression.

By sorting these kinds of interlocking objects to the top, the master does not always need to calculate all the objects within an object group.

Other object types shall be sorted accordingly.

A good advice is to group temperature and hydraulic pressure to one object, as described earlier, see section Group objects, page 374.

Sort conditional objects

The conditional objects does not demand as much computational power from the master as do the linear, but still it is a good idea to optimize these objects too.

The following is valid for computing the expression:

AND: The objects state = Object 1 and Object 2 and Object 3... and Object 8

If at least one of the objects is *false*, the whole expression evaluates to *false*. *Lazy evaluation* implies that once an object that evaluates to false is encountered the master stops calculating and thus saves computational power.

Put into practice, this means that objects that evaluate to *false* most often, shall be put at the top of the list.

The following is valid for computing the expression:

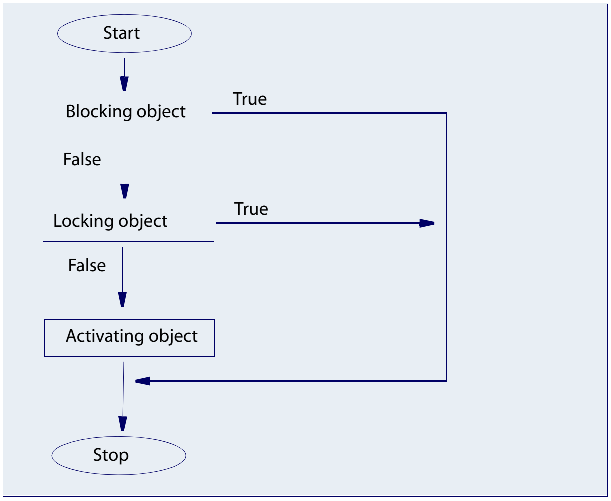
OR: The objects state = Object 1 or Object 2 or Object 3... or Object 8

If at least one of the objects is *true*, the whole expression evaluates to *true*.

Put into practice, this means that objects who evaluate to *true* most often, shall be put at the top of the list.

Object type priority

The following priority order applies when calculating the different conditional object types.



Calculation order for conditional objects.

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