Original instructions

Smart

Safety and Motion Analyser Tool

ABB AB / Jokab Safety Varlabergsvägen 11, SE-434 39, Sweden
www.abb.com/lowvoltage

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1 General

1.1 Introduction

This manual describes the use of Smart and Smart Manager.

The Jokab Safety branded product with articlenumber beginning with 2TLJ is fully compatible with the ABB branded product with articlenumber beginning with 2TLA.

1.2 Description

Smart is a tool for measuring and analysing mainly moving machine parts, but also machine systems in general. Different sensors and transducers can be connected to Smart to measure movement and forces, and different stop units can be connected to be able to send stop signals to the system. Smart can also communicate with the machine system using digital I/O's. The program Smart Manager is used to control Smart.

2 Safety instructions

2.1 Important instructions

1. The equipment described in this manual should only be used by qualified personnel.
2. Service and repair of the equipment must be performed by the manufacturer and their authorised representative or laboratory.
3. It is recommended to send the equipment for control to the manufacturer or a test laboratory once every year.
4. To guarantee the accuracy of the safety distance calculated using Smart Manager the user must use appropriate values in the formula for the calculation, and the user must also make sure that the formula is valid for the machine.
5. The equipment must not be used for controlling the machine system for other scenarios than during test, and in those cases special consideration must be taken to the risks involved.

2.2 Prerequisites

Before the equipment is used this manual should be carefully read. Necessary knowledge of the machine system that is to be measured is required by any person using Smart.

3 Hardware

3.1 Smart Logger

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	Smart Logger
Article number:	2TLA070300R0100
Operating voltage:	24 VDC
Protection level:	IP 67
Accuracy	
Position:	+/- 0.1 mm
Stop distance:	+/- 1 mm
Response time:	max 1 ms
Physical data	
Size:	220 x 62 x 80 mm (L x W x H)
Weight:	0.5 kg
Connections	
Digital I/O:	8 inputs, 4 outputs (NPN OC)
Analogue inputs:	2 connections for 0/4-20 mA
Decoder:	1 connection for pulse sensor

Connections

The external sensors and stop units used for Smart Logger are connected to appropriate M12-connectors on top of the unit.

Separated power supplies

To prevent Smart Logger from being damaged by current and voltage levels from externally connected equipment, all inputs and outputs and external units have galvanic opto-isolation. For this reason the external units and I/O's are powered using a 24 VDC power supply (SM6) and the CPU in Smart Logger is powered by the computer via the USB-cable.

Communication with computer

Smart Logger communicates with the computer using the USB cable in the PC connector on top of the unit.

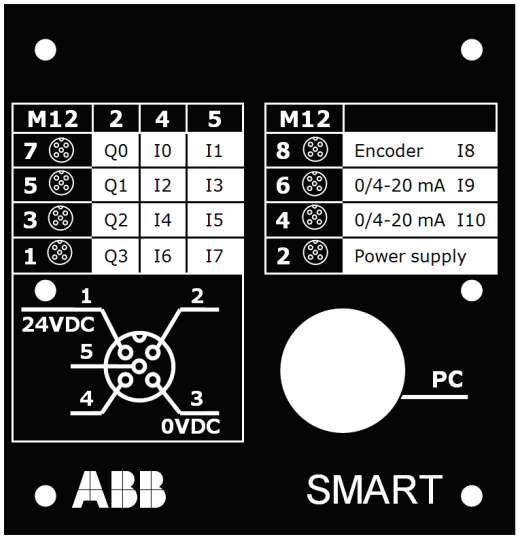
Starting Smart Logger

Make sure that Smart Logger is turned off before external units are connected. Start Smart Logger by connecting the USB cable to the computer and connecting the power supply.

The digital in and outputs are connected according to instructions on the panel on top of Smart Logger (see picture below).

Pin assignment for connectors

On the panel the pin assignment for the M12 connectors can be seen. The pin assignment is identical for all 8 connectors on Smart Logger. Please note that the connectors on the right side of the unit (connectors 2, 4, 6 and 8) are placed at a 90 degree angle.



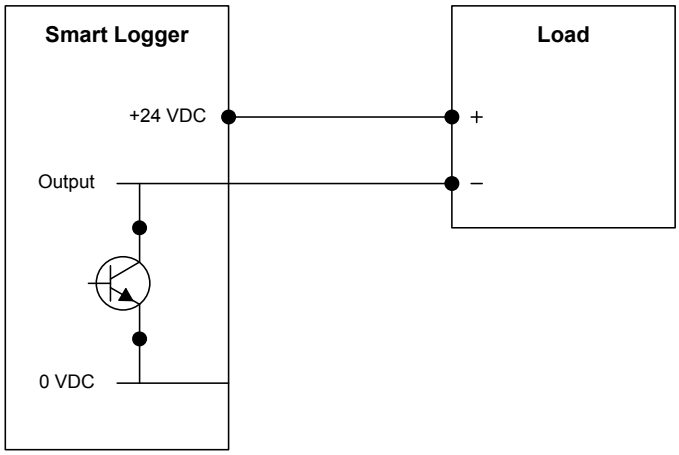
Power supply for external units

All connectors except no. 2 give 24 VDC on pin 1 and 0VDC on pin 3 for power supply of external units. The maximum current that can be provided is 300 mA.

I/O connectors

Please note that the out signals from Smart are called Q signals. The I/O connectors on the left side of the unit (connectors 7, 5, 3 and 1) have the signals Q0-Q3 on pin 2 of the respective connectors. The in signals I0-I7 are on pin 4 and 5 on the respective connectors according to the table on the panel on top of the unit.

The digital inputs are adapted to voltages of 0-24 VDC with a maximum current of 50 mA, where 0-1.5 VDC is regarded as a low input signal and 5-24 VDC is regarded as a high input signal. The digital outputs are current sinking (NPN open collector) and are connected to 24 VDC on the unit through an external load to give 24 VDC output to the external equipment (see picture to the right). The maximum allowed output current is 300 mA.



Pulse sensor

The pulse sensor is connected to connector 8 (input I8) with pulse signal A on pin 4 and pulse signal B on pin 5. Pin 2 is not used.

Analogue sensors

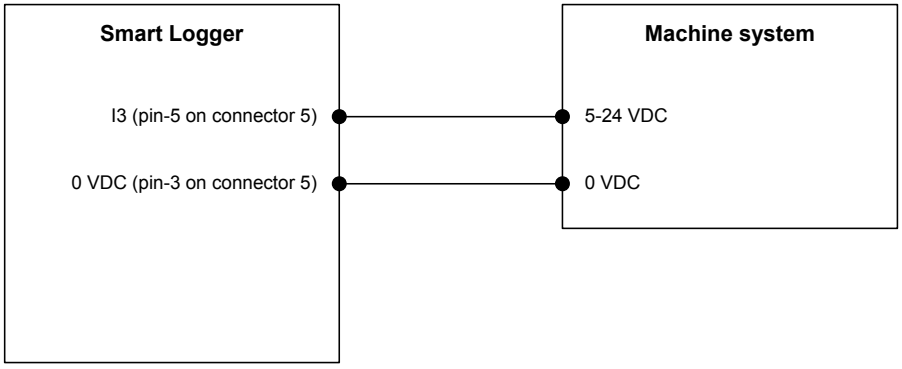
Analogue sensors are connected to connector 6 and 4 (input I9 and I10). Pin 5 is the current loop's plus connector and pin 4 is the current loop's minus connector. Pin 2 is not used.

Power supply

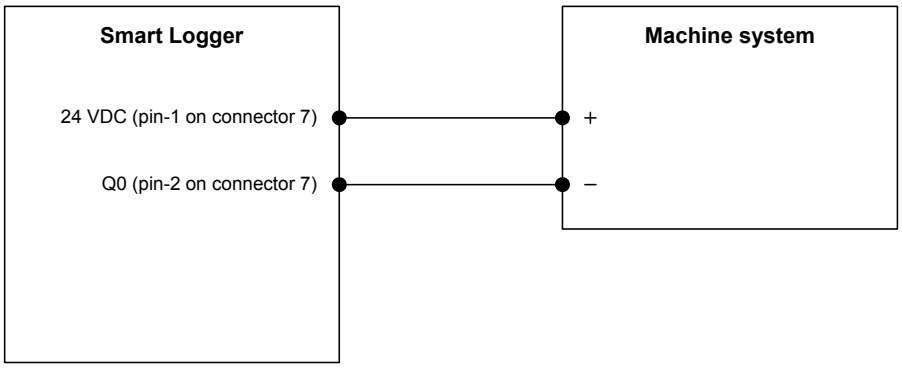
The power supply SM6 is connected to connector 2 with 24 VDC on pin 1 and 0VDC on pin 3. Pin 2, 4 and 5 are not used.

Connection examples

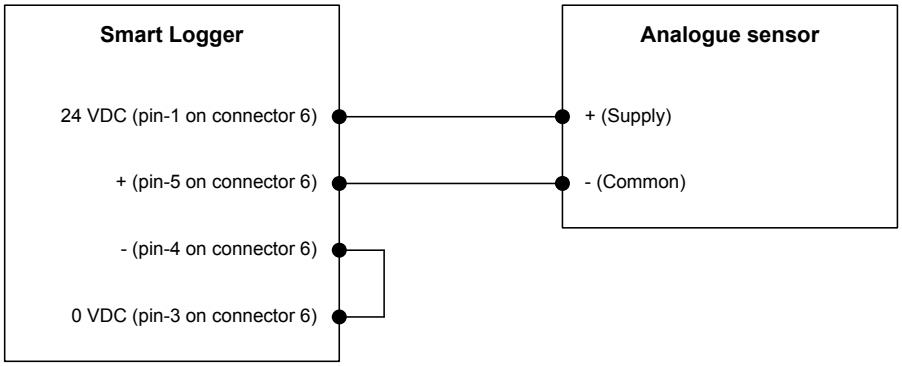
In signal to I3 from machine system



Out signal from Q0 to machine system



Connection of two-wire analogue sensor to I9



Pulse sensor

To measure motion, speed and position a pulse sensor (SM5/SM7) is connected to Smart Logger. The pulse sensors have a resolution of 0.1 mm, i.e. they send 10 pulses/mm. Based on incoming pulses Smart Logger calculates at which position the sensors are and at what speed they move.

Response time

The response time of Smart Logger is maximum 1 ms, i.e. from the moment a stop position is reached it can take at most 1 ms before a stop signal is given.

Measuring accuracy

The speed of the pulse sensor I8 is calculated based on a mean over 25 ms, which means that the stop time of a machine in most cases is correct, but in some special situations the actual stop time of the machine can be slightly less than the calculated stop time of the program. The used algorithm is specially adapted to be correct for slower machine speeds and is used as a safety aspect to guarantee that the stop time of a machine is never larger than that of the program.

Indication

Two LED’s on top of Smart Logger indicate power status. The LED marked PC indicates if Smarts CPU is powered by the PC and the LED marked 24 VDC indicates if the power supply for the external units is connected.

3.2 SM2 – Pushbutton unit

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	SM2
Article number:	2TLA070300R0200
Operating voltage:	Supplied from Smart Logger
Size:	100 x 50 x 25 mm (L x W x H)
Weight:	0.2 kg

Application

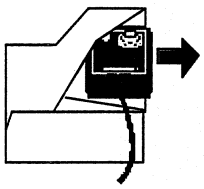
The SM2 stop unit is used together with Smart Logger to give a stop signal without electrical connection to machines or control systems. SM2 is connected to any of the I/O connectors on Smart Logger.

The pushbutton on the underside of SM2 initiates stop time or intermediate time measurement when it is pressed or released, depending on the settings of the New measurement form in Smart Manager. When the in signal of SM2 is set to be active high, the unit can be used to measure the stop times of emergency stops, program stops, safety mats, contact strips and the like. The ‘stop device’ is pushed by the means of the pushbutton on the underside of SM2. The stop timing will start when this pushbutton is pressed.

When the in signal of SM2 is set to be active low, the unit can be used for the measurement of stop times on two-hand units, and hold to run/enabling devices. Hold in for example one button on the two-hand unit by means of the pushbutton on the underside of SM2. The measurement starts when the pushbutton on SM2 is released, i.e. when the pushbutton on the two-hand unit is released.

General

When using the SM2 stop unit it is important that the correct procedure is carried out in order to obtain the best values possible without electrical connection to the machine. The quickest and most distinct movement possible should always be made, both during the actuation of stop devices, emergency stop buttons, and ”on” buttons with hold to run function, such as two-hand units. A quick movement minimizes the small time difference between the response of the stop device button and the button in the stop unit starting the measurement.

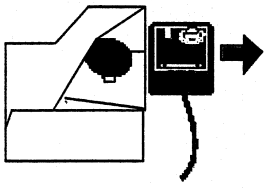


Indication

The LED on top of SM2 is for example used to give manual stop signal at the same position for a machine each time. The LED is lit by the output signal from Smart Logger to SM2, the conditions can be set in Smart Manager.

Measurement on two-hand device

The diagram to the right illustrates an appropriate movement during the measurement of stop times initiated by two-hand units with mushroom buttons. The SM2 stop unit should be drawn quickly and distinctly to the side, that is, at right angles to the inherent movement of the two-hand button.



3.3 SM3 – Relay unit

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	SM3
Article number:	2TLA070300R0300
Operating voltage:	Supplied from Smart Logger
Relay outputs:	2 NC 2 NO 6A/250 VAC
Size:	85 x 72 x 49 mm (L x W x H)
Weight:	0.2 kg

Application

The SM3 is used to give electrical stop signals to machines and control systems. It has screw connectors for ease of connection via standard connection wire.

Output contact status

The SM3 stop unit has two NC (normally closed) and two NO (normally open) relay contacts for connection to existing equipment. A NO contact implies that the outputs close when a stop signal is given from Smart.

The units NO outputs are connected to the stop inputs of program stops, safety mats and contact rails, etc. The NC outputs are connected to the stop inputs from gate switches, two-hand units, emergency stops, and three-position devices, etc. The maximum switching capacity of the outputs is 6A, 250 VAC.

Connection

SM3 is connected to any of the I/O connectors on Smart Logger.

Stop signal

The SM3 gives stop signals to machines and starts the timing in Smart Logger when the output signal of SM3 is set as the stop signal in Smart Manager.

3.4 SM5/1250 – Linear transducer

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	SM5/1250
Article number:	2TLA070300R0400
Operating voltage:	Supplied from Smart Logger
Stroke length:	1250 mm
Resolution:	0.1 mm (10 pulses/mm)
Max. speed:	5 m/s
Size:	106 x 88 x 100 mm (L x W x H)
Weight:	1.0 kg

Application

SM5 is used during stop timing to give the position and speed of a moving machine part (industrial robot arm, carriage, cutter, etc.) to Smart Logger.

The housing has three magnets in the base and three on one side so that it can easily be attached to different ferrous surfaces and machine parts, etc.

The wire can be applied to the moving machine part by means of a magnet or snap hook.

In order to achieve best results the sensor housing should be adjusted so that the machine movement takes place in line with the alignment of the wire.

The connection cable of SM5 is connected to the encoder connector (I8) on Smart Logger.

Operation

The transducer utilises a digital incremental pulse encoder with a resolution of 10 pulses/mm. Its two-channel pulse-train is evaluated by Smart Logger to determine the position, speed of movement, and direction of the moving machine part.

Caution! Never release the wire from the extended position, because the wire can break.

3.5 SM5/2500 – Linear transducer

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	SM5/2500
Article number:	2TLA070300R0500
Operating voltage:	Supplied from Smart Logger
Stroke length:	2500 mm
Resolution:	0.1 mm (10 pulses/mm)
Max. speed:	5 m/s
Size:	114 x 116 x 125 mm (L x W x H)
Weight:	1.4 kg

Application

SM5 is used during stop timing to give the position and speed of a moving machine part (industrial robot arm, carriage, cutter, etc.) to Smart Logger.

The housing has three magnets in the base and three on one side so that it can easily be attached to different ferrous surfaces and machine parts, etc.

The wire can be applied to the moving machine part by means of a magnet or snap hook.

In order to achieve best results the sensor housing should be adjusted so that the machine movement takes place in line with the alignment of the wire.

The connection cable of SM5 is connected to the encoder connector (I8) on Smart Logger.

Operation

The transducer utilises a digital incremental pulse encoder with a resolution of 10 pulses/mm. Its two-channel pulse-train is evaluated by Smart Logger to determine the position, speed of movement, and direction of the moving machine part.

Caution! Never release the wire from the extended position, because the wire can break.

3.6 SM7 – Rotating transducer

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	SM7
Article number:	2TLA070300R0700
Operating voltage:	Supplied from Smart Logger
Resolution:	0.1 mm (10 pulses/mm)
Max. speed:	5 m/s
Size:	Approximately 90 x 50 x 400 mm (L x W x H) with stand included.
Circumference of wheel:	125 mm
Weight:	1.7 kg including stand.

Application

The transducer SM7 is used for stop timing of rotational machinery parts (turning machine, paper machinery etc.).

The arms of the stand for SM7 are moved to a suitable position to ensure that the wheel is applied to the rotating part of the machinery. Turning the selector on the stand activates the magnetic foot. Maximum speed is 5 m/s, which equals 3000 rpm for the wheel.

In order to achieve the best results the axis of the wheel should be aligned with the axis of the rotating part. The rotating part should be cleaned to prevent slip and disturbances from dirt.

The connection cable of SM7 is connected to the encoder connector (I8) on Smart Logger.

Operation

The transducer utilises a digital incremental pulse encoder with a resolution of 10 pulses/mm. Its two-channel pulse-train is evaluated by Smart Logger to determine the position, speed of movement, and direction of the moving machine part. Note that all presented units are linear and can be transformed to rotational units using the circumference of the wheel (125 mm).

3.7 SM11 – Flag unit

Technical specifications	
Manufacturer:	ABB AB / JOKAB SAFETY
Designation:	SM11
Article number:	2TLA070300R1100
Batteries:	10 rechargeable 1.2 V NiMH batteries. Totally 12 V
Energy:	Maximum 1200 mAh. Normally enough for 200 cycles.
Ingress protection:	IP 40
Temperature:	Between 0°C and +45°C.
Connector:	Centre of load plug is negative.
Size:	145 x 85 x 37 mm (L x W x H) shaft: diameter 3 mm, length 45 mm.
Thread:	UNC ¼"-20, fitting standard camera tripods.
Weight:	0.6 kg

Operation

1. Connect the plug on SM11 to any of the I/O connectors on Smart Logger.
2. If the transducers SM5, SM7 or other triggering equipment are to be used, these units must also be connected via appropriate connectors on Smart Logger.
3. Fit a suitable flat piece of plastic or card into the slot in the stop flag spindle. This card should be made as small as possible in order to minimize time delays due to air resistance, however large enough to ensure interruption of the light curtain.
4. Attach the SM5 transducer wire magnets or SM7 to required moving machinery parts.
5. Start Smart Manager.
6. Set the conditions for activating SM11 in Smart Manager.
7. Switch on SM11 and position it so that when the flag is activated (rotated), it interrupts the light curtain.
8. Start the measurement in Smart Manager and then start the machine to be monitored.
9. When the required point on the machine cycle is reached for a machine stop to be made, the flag will rotate, interrupting the light curtain and stopping the machine. In order to ensure maximum safety the machine should then be switched off before any other action is taken, e.g. adjustment of sensors, flag, etc.
10. Repeat step 8 and 9 to obtain sufficient readings for statistical purposes.

Battery charging

1. The SM11 is equipped with 10 x 1.2V Ni-MH cells giving a total power of 12V 1200mAh. With fully charged batteries, the energy should be sufficient for at least 200 (max. 400) cycles. Please note that the battery power will fall slowly even when unit is not used.
2. When the battery voltage is low, the “Low Bat” LED is lit. The LED also makes a short duration flash when the flag is triggered; this is normal and not a reason for re-charging.
3. Before charging, the unit must first be disconnected from Smart Logger and switched off.
4. Only the battery charger provided (SM12 or SM14) should be used. Use of any other charger may cause damage to SM11 and batteries.
5. Charge for a minimum of 3 hours.
6. If the unit is frequently used it is recommended that the rechargeable batteries are replaced by the original equipment supplier or by its authorized representatives or test laboratories at least every 12 months.

Important

In order to optimize battery life the SM11 should be switched off when not in use. In order to ensure optimized performance batteries must be fully charged prior to stopping measurements be taken.

The SM11 stop flag unit is specifically designed to be used in conjunction with Smart Logger. Interfacing of this unit to other equipment may result in inaccurate timing and/or equipment malfunction.

Options

When delivered, the SM11 unit is factory set so that the start signal is sent when the flag has moved approx. 10°. The unit can be set to give a start signal when the flag has rotated approx. 80°. To set the unit to the required condition the internal jumpers JP3 and JP4 should be connected as follows:

Start signal generated at	JP3	JP4
10°	Pins 2 and 3 connected	Pins 2 and 3 connected
80°	Pins 1 and 2 connected	Pins 1 and 2 connected

The flag rotation of SM11 can be set to automatically reset after approximately 1500ms. This function is intended to help spare the batteries of SM11. This reset function is optional and can be changed by setting the internal jumper JP2 as shown in the table below:

Reset mode	JP2 setting
Manual (default)	Pins 1 and 2 not connected
Automatic	Pins 1 and 2 connected

A standard ¼” camera mounting fitting is provided permitting most types of tripods to be used.

3.8 Accessories

In addition to the I/O units described above there are a number of other units. Some of them are required for the system to operate, and some just simplify the measurement procedure.

Type	Article number	Description
Computer cable	2TLA070300R1500	USB cable required for communication between Smart Logger and the computer.
SM6	2TLA070300R0600	24 VDC power supply for Smart Logger.
SM9	2TLA070300R0900	Carrying case for Smart.
SM13	2TLA070300R2300	Battery pack for Smart Logger. Can be used instead of SM6 to make the system portable. Enough for 10 hours running time. SM13 is recharged using SM14.
SM14	2TLA070300R2400	Charger for SM11 and SM13.
Smart kit	2TLA070300R4300	Smart kit with SM6, computer cable and SM9
Extension cables	See product list at www.abb.com/lowvoltage	ABB/Jokab Safety's standard 5 pin extension cables can be used with Smart. Available in several different lengths.

4 Smart Manager

4.1 Installation

In order to use Smart the following needs to be installed on the supervising computer:

1. .NET Framework
2. Smart Manager
3. Drivers for communication with Smart Logger

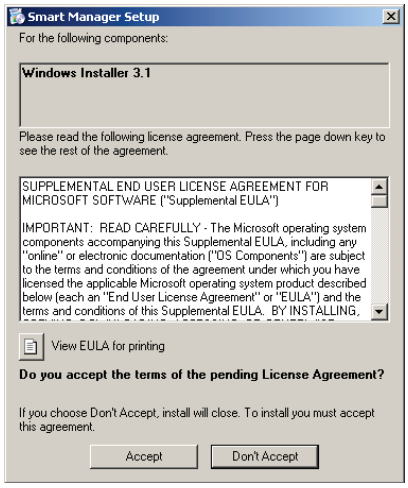
4.1.1 Installation of Smart Manager

Run the file Setup.exe to install Smart Manager.

Before installation the program checks if all necessary software to run Smart Manager is installed on the computer. The missing software will after your permission be downloaded if the computer is connected to internet.

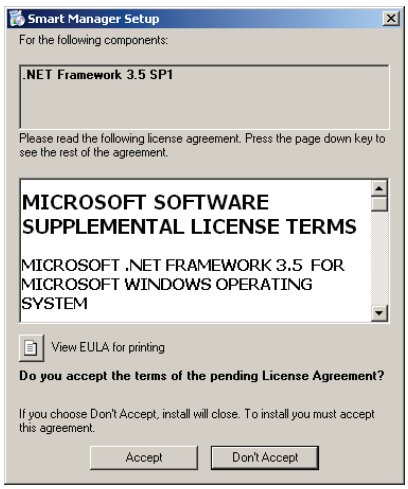
An internet connection is not necessary if you run the installation from a USB-stick from ABB Jokab Safety.

If Windows Installer 3.1 is not installed the window below will appear on the screen.



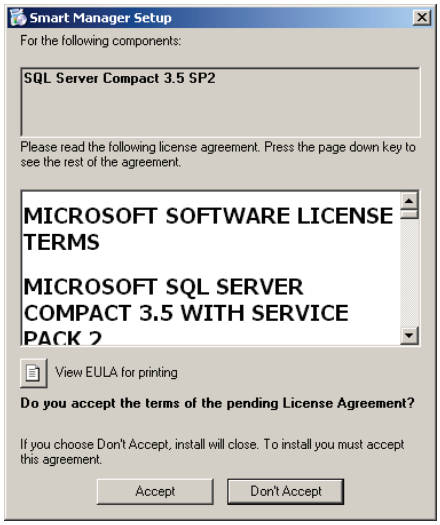
Click “Accept” to accept the installation.

If .NET Framework 3.5 SP1 or a later SP-version is not installed the window below will appear on the screen.



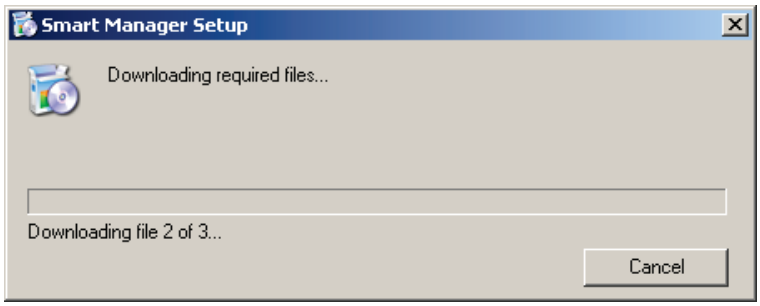
Click “Accept” to accept the installation.

If SQL Server Compact 3.5 SP2 is not installed the window below will appear on the screen.



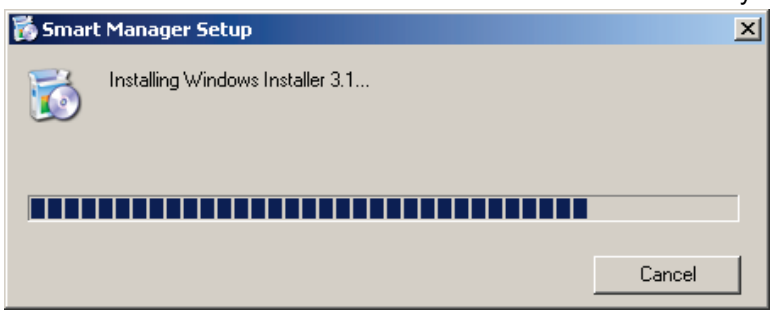
Click “Accept” to accept the installation.

Programs previously not installed will now be downloaded and installed.

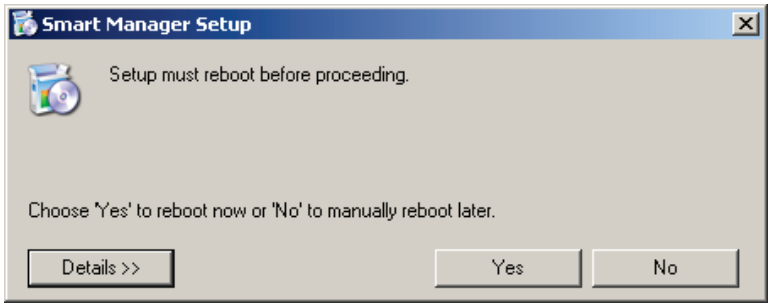


Windows Installer 3.1

If Windows Installer 3.1 is not installed the window below will appear on the screen. The computer will reboot after the software is downloaded. The installation starts automatically after the reboot.

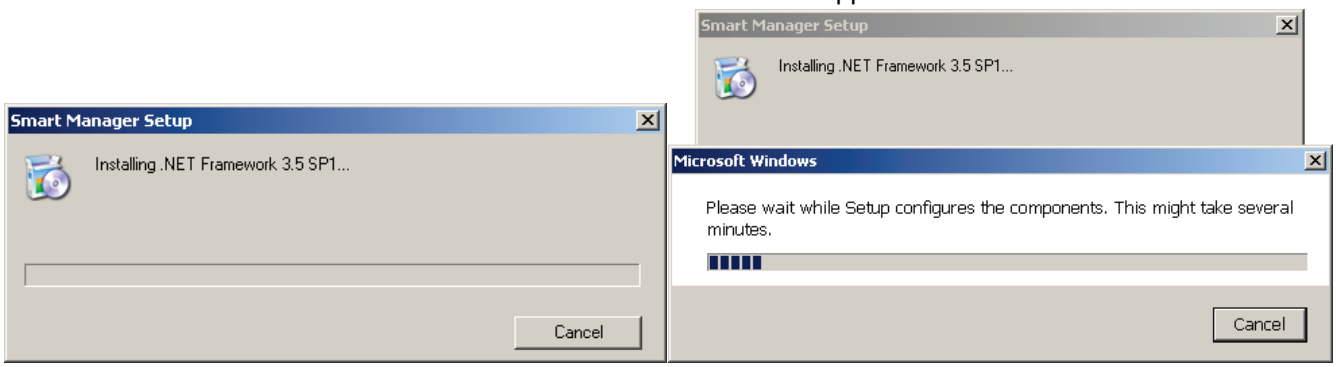


Click “Yes” to reboot the computer.



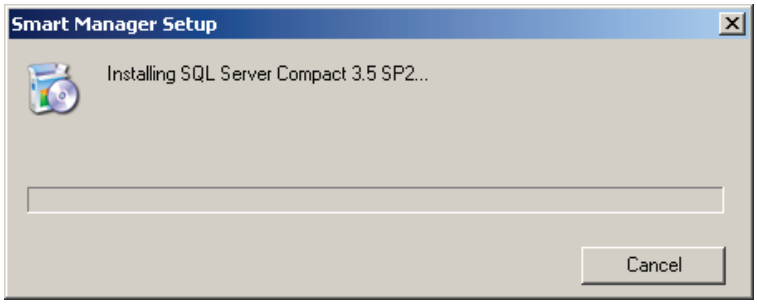
.NET Framework

If .NET Framework 3.5 SP1 is not installed the two window below will appear on the screen.

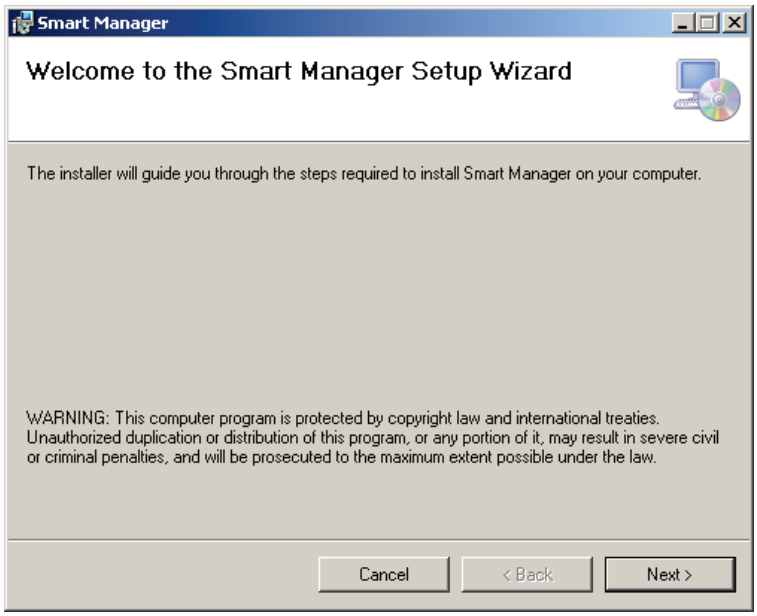


SQL Server Compact 3.5 SP2

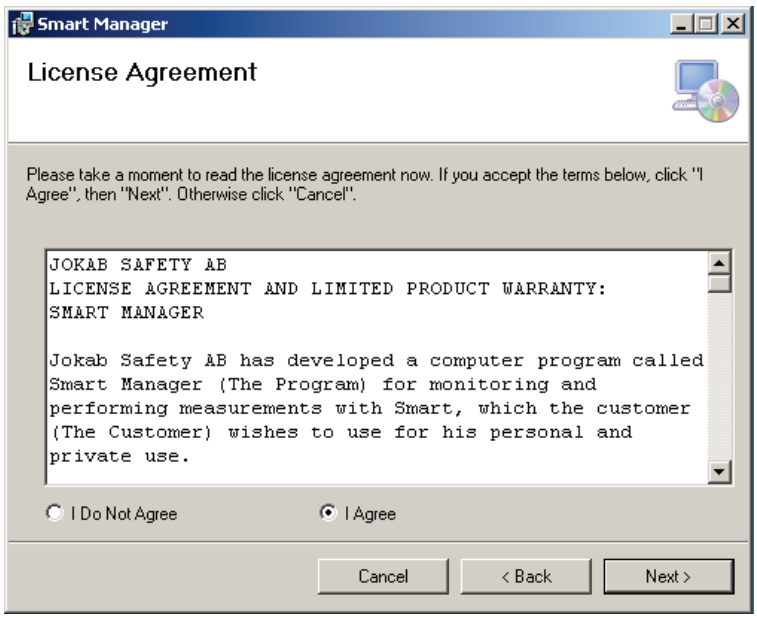
If SQL Server Compact 3.5 SP2 is not installed the window below will appear on the screen.



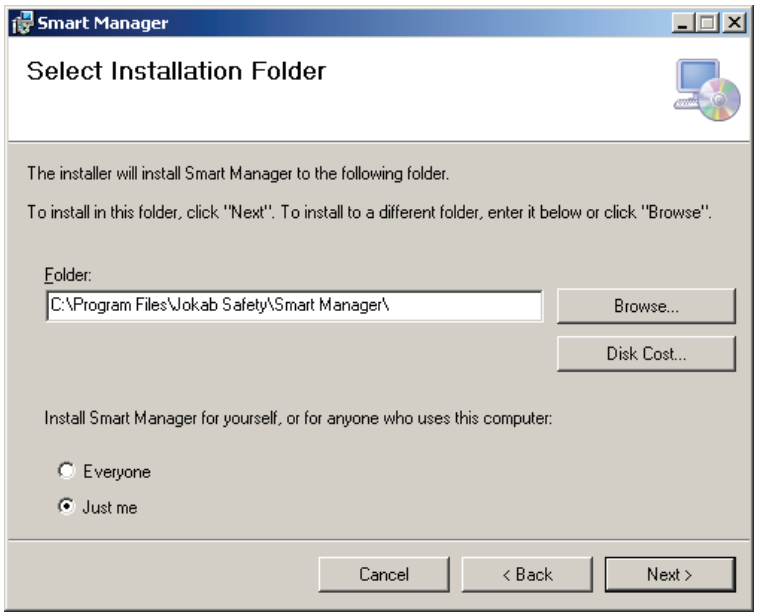
Installation



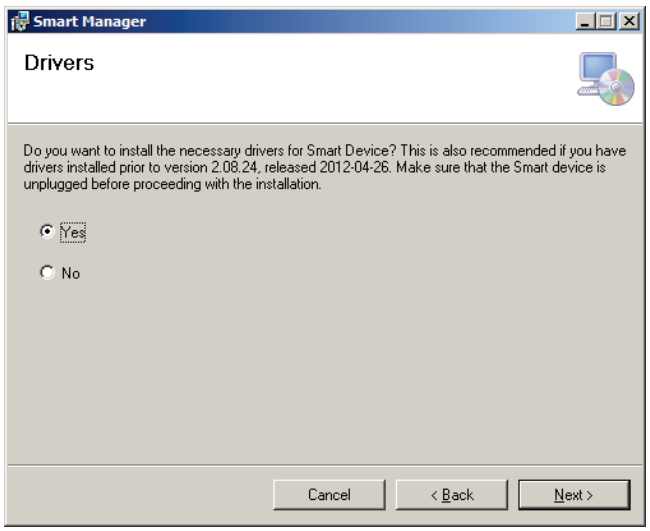
Click “Next”



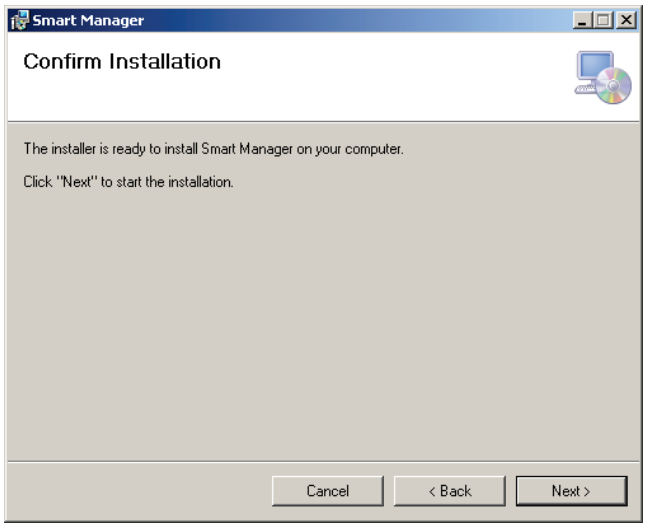
Read the license agreement. If you agree to the terms of the license agreement click “I agree” and “Next”.



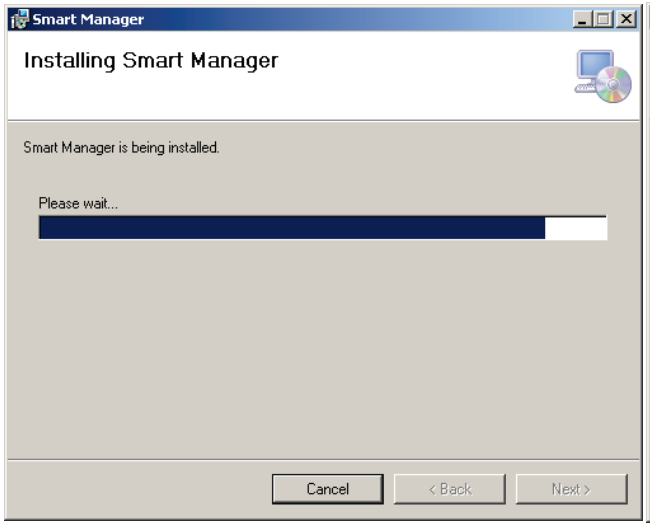
Choose where to install the program. Click “Browse” to change folder. Select whether Smart Manager is to be available for one or all user. Click “Next”.

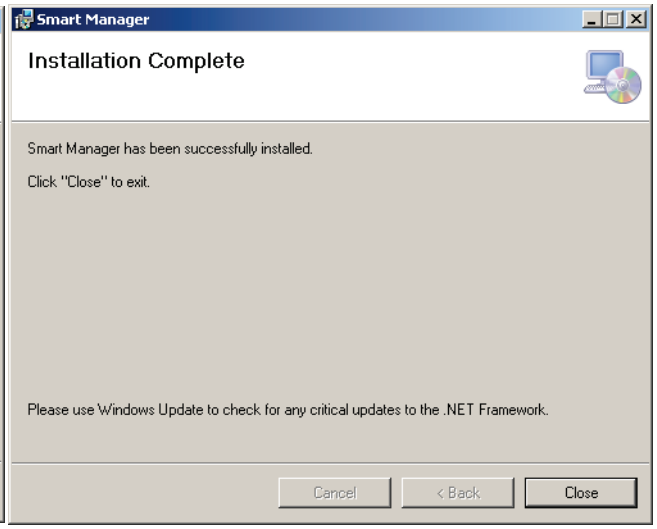


Select if the drivers for Smart Logger is to be installed. This is recommended even if a previous installation of Smart Manager is installed on your computer.



Click “Next” to start the installation.

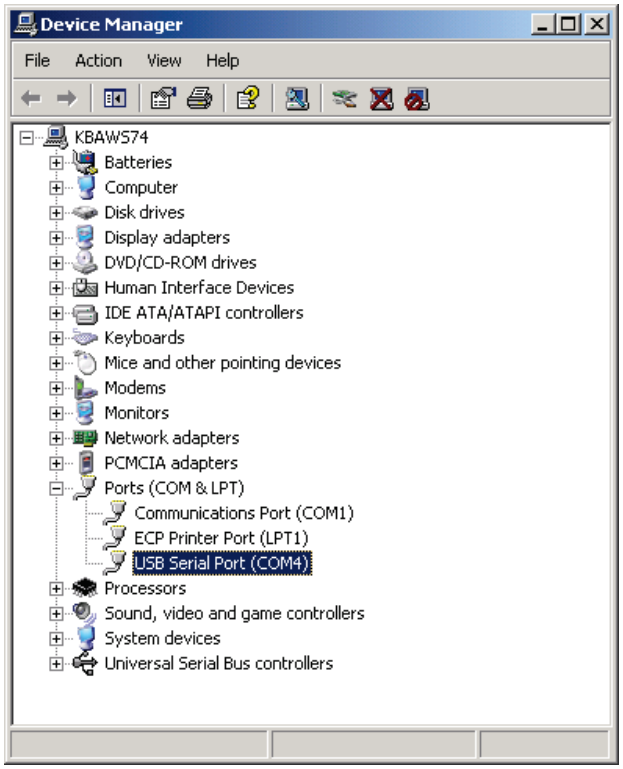




Click “Close” to complete the installation.

4.1.2 Smart Loggers COM port number

If you need to find out which COM port Smart Logger is assigned to, do the following:
Plug Smart Logger to the computer. Click on the Windows Start button, type Device Manager in the search field and click on Device Manager in the search results. Smart Logger appears as an extra COM port named "USB Serial Port" and the port number is in parentheses under "Ports".



4.2 The first time you start Smart Manager

License

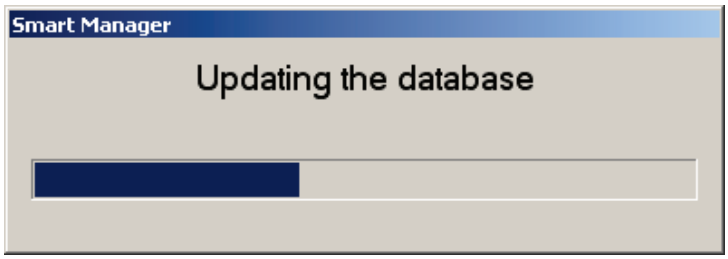
If it's the first time Smart Manager is started or if you haven't supplied any license key for Smart, you will be prompted for a license key on start up of Smart Manager.

Enter your license key and click on "OK".

If you don't have any license key you can run Smart Manager in demo mode by clicking the "DEMO" button. In demo mode you cannot perform measurements or communicate with a Smart, but you can view existing measurements and make printouts and calculations.

Ask for a license key from your local ABB contact in connection with the purchase of Smart Manager.

NB! If you have updated from Smart Manager 1.3 (or earlier) to Smart Manager 1.4 (or later), there will be an update of the database at the first upstart of the program. This update can take several minutes if the database is large.



4.3 Quick guide to perform a measurement

Follow these steps to perform a measurement:

1. Connect Smart to the computer.
2. Start Smart Manager.
3. Click on "New Measurement".
4. Connect transducers to the machine. Reset transducers and stop units if necessary and set signals to correct start mode.
5. Enter the conditions for the measurement.
6. Start the measurement by clicking "Start Measurement"
7. Start the machine.

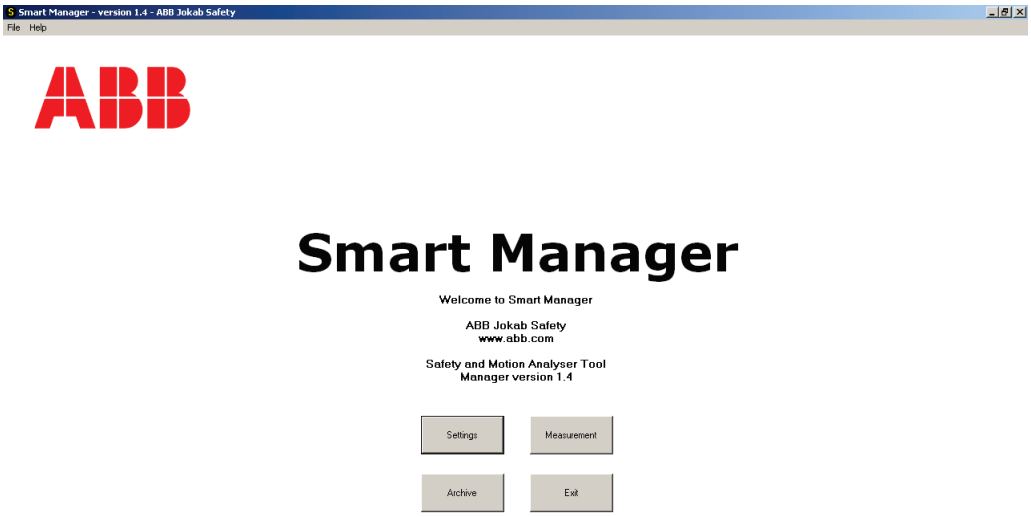
4.4 Menu system

The program uses a number of different forms:

Main menu	The main menu is shown on start up. From here you can reach the different main functions of the program.
New measurement	From the new measurement form a measurement is performed. Information about the current status of Smart Logger is shown and the setup of a measurement can be chosen.
Graph	On the graph form a graph of the measurement is shown and from here you can get details of the measurement and compare it to other measurements.
Calculations	On the calculations form different calculations can be performed to get a stop time based on several measurements and calculate safety distance from the machine.
Save	From here a measurement can be saved.
Archive	A list of the saved measurements is displayed. Measurements can be loaded to the graph form and imported/exported to and from the program.
Settings	Here you can chose how to connect Smart Logger to the computer, what language to use and what safety standards that should be used for the calculations.

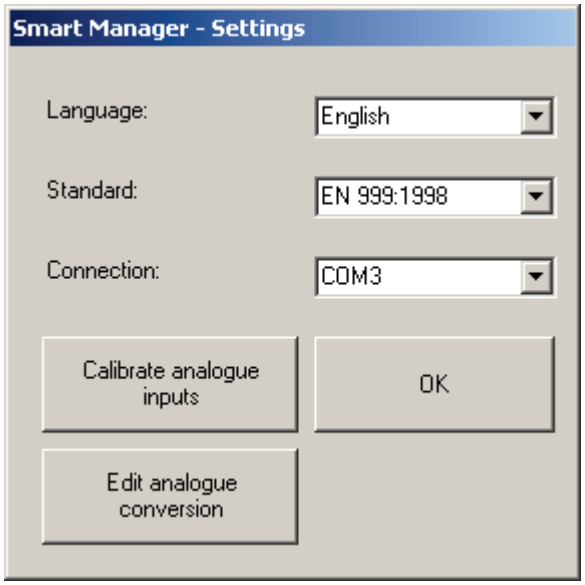
Main menu

When the program is started the main menu is shown. Here you can chose to start a new measurement (New) or load an existing (Archive). You can also change the settings of the program (Settings).



4.5 Settings

The settings form is reached from the main menu.



Select language

“Language” selects the language for messages and texts in Smart Manager.

Standard

”Standard” selects the standards used for the safety distance calculations.

Communication port

”Connection” states which communications port the computer uses to communicate with Smart Logger. If you have problems getting connection to Smart Logger, you can see which comport you should use in Windows Device Manager. Smart Logger is displayed under Ports as ’USB Serial Port’.

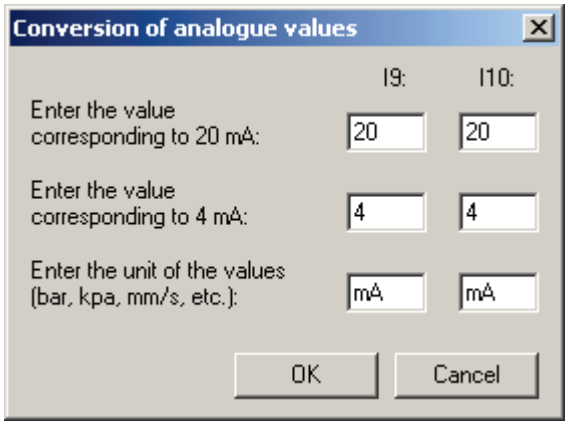
The button ”Calibrate analogue input” displays a form where the analogue input for Smart can be calibrated.

The button “Edit analogue conversion” shows a form where the analogue input can be converted to show any units and values when displayed in the graph.

The button “OK” closes the form.

4.6 Edit the analogue conversion

To change how the analogue values are displayed in the graph you can either click on the button “Edit analogue conversion” in the settings form (see chapter 4.5) or click on “Options” – “Edit analogue conversion” in the graph form (see chapter 4.9). A small form is shown where the conversion of the analogue values can be edited.



In the upper textboxes the values corresponding to 20 mA are entered.

In the middle textboxes the values corresponding to 4 mA are entered.

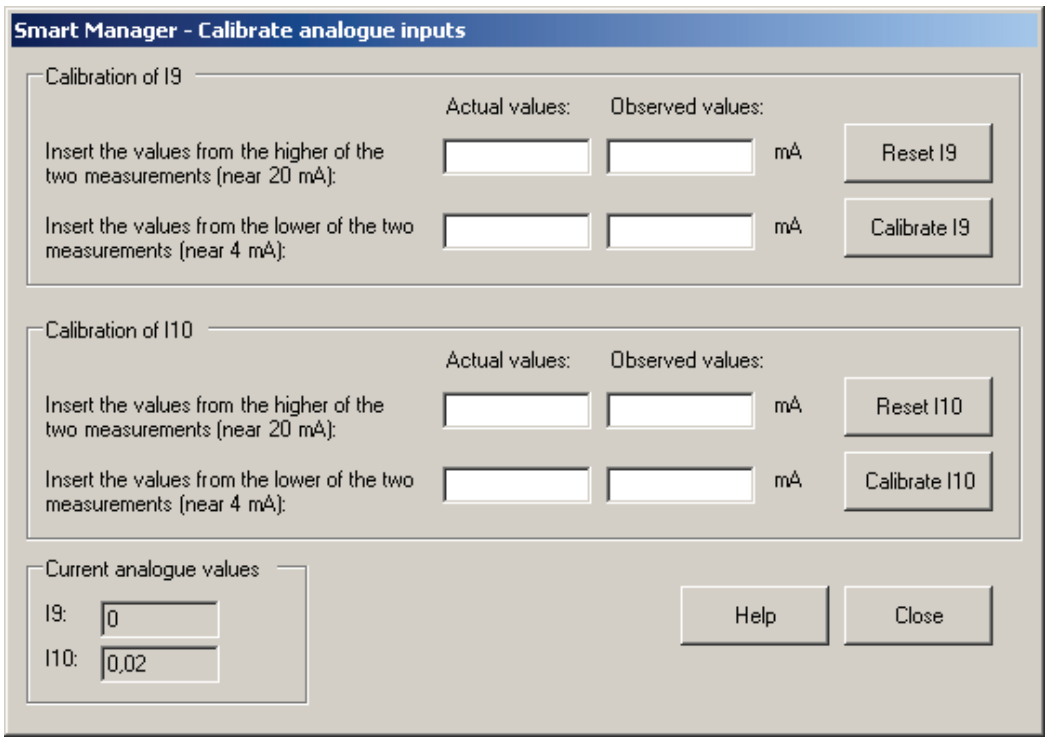
In the bottom textboxes the units of the analogue values are entered.

The button ”OK” saves the changes and closes the form.

The button “Cancel” closes the form without saving the changes.

4.7 Calibrating the analogue input

The form for calibrating the analogue values is reached from the settings form by clicking “Calibrate analogue input”.



In the top frame (Calibration of I9) the analogue input I9 can be calibrated. In the frame below (calibration of I10) the analogue input I10 can be calibrated. In the bottom left frame (Current analogue values) the current values of the analogue input is displayed. The button “Help” shows a text describing how to calibrate the analogue inputs and the button “Exit” closes the form.

To calibrate the analogue input you need a power source that can produce two different, well known and precise currents between 0 and 20 mA. For best results the larger of the two currents should be as close to 20 mA as possible, and the smaller current as close to 4 mA as possible.

Calibration of I9:

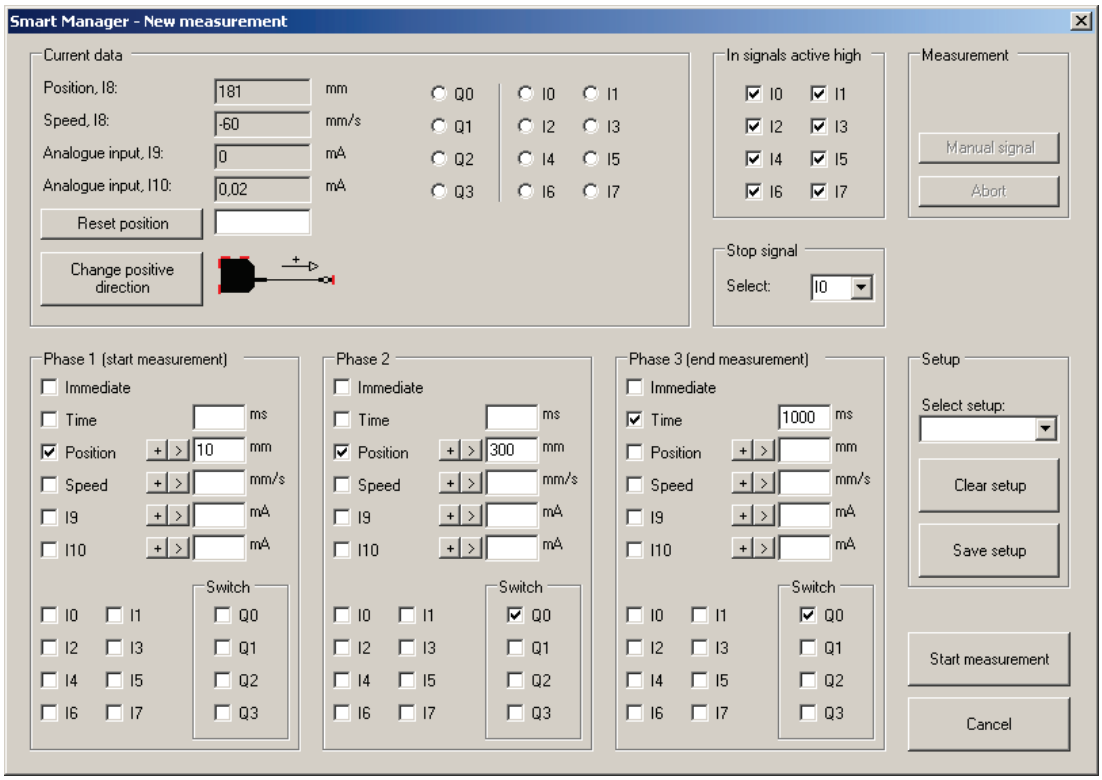
1. Click the button ”Reset I9”. This resets any previous calibrations and restores the default calibration of I9.
2. Connect the larger of the two currents to I9.
3. Enter the known larger current in the top left textbox in the top frame.
4. Read Smart’s value of the current in the bottom left frame and enter it in the upper right textbox in the top frame.
5. Connect the smaller of the two currents to I9.
6. Enter the known smaller current in the lower left textbox in the top frame.
7. Read Smart’s value of the current in the bottom left frame and enter it in the lower right textbox in the top frame.
8. Click on the button ”Calibration of I9” to calibrate I9.
9. Check that Smart’s value of the current is correct in the bottom left frame.

Calibration of I10:

The same procedure as for I9 but in the frame ”Calibration of I10” instead.

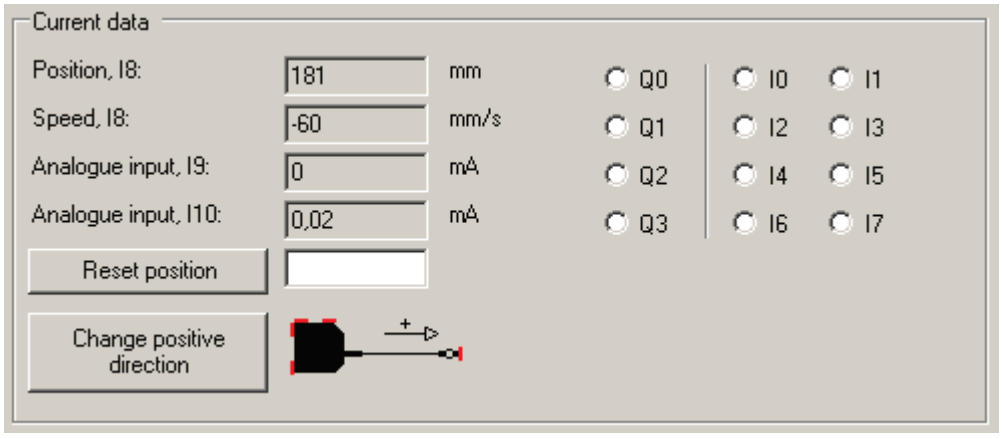
4.8 Performing a measurement

When clicking “New” in the main menu the New measurement form is displayed. From here the current status of the system can be seen and the information needed to perform a measurement can be entered.



Current data

The top left frame (Current data) shows the current inputs and outputs of Smart.



”Position, I8” shows the current position for the transducer on I8 in mm.

”Speed, I8” shows the current speed of the transducer in mm/s.

”Analogue input, I9” shows the current value for the analogue input on I9.

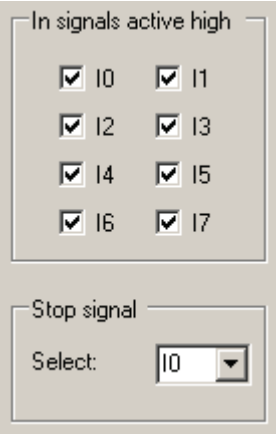
”Analogue input, I10” shows the current value for the analogue input on I10.

The position encoder can be reset to zero with the button ”Reset position”. If the position needs to be changed to a specific value you can enter the value at which the position should be set to zero in the textbox to the right before resetting the position. If the current position for instance is 15 mm too large you enter ‘15’ in the textbox before pressing the reset button.

With the button “Change positive direction” the direction of increasing position is changed. Current positive direction is displayed in the picture to the right of the button.

Q0 – Q3 shows the values of the digital out signals. A black tick indicates that the signal is high. By clicking on the signals the values are toggled.

I0 – I7 shows the values of the digital in signals. A black tick indicates that the signal is high.



Choosing the active mode for in signals

The frame ”In signals active high” displays whether the digital in signals are active high or active low. A check in the checkbox indicates that the signal is active high. No check indicates that the signal is active low.

In the frame ”Stop signal” one of the in signals is selected as the stop signal. This signal is then used to indicate the starting point for the calculations.

During a measurement

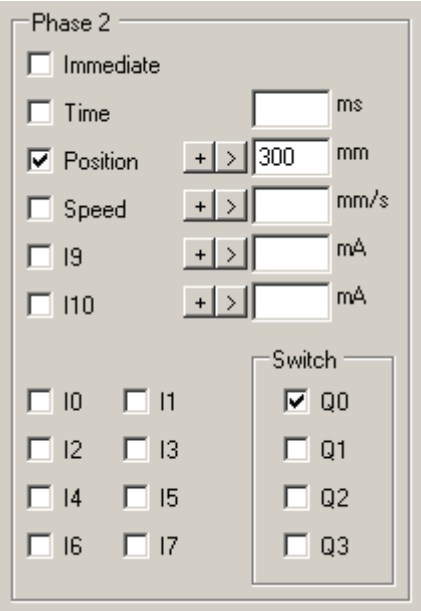
The top right frame (Measurement) is activated when a measurement has started.

With the button “Manual signal” a signal is given to Smart which tells it to consider the conditions of the current measurement phase as fulfilled and move on to the next phase, regardless of whether the conditions have been met or not.

The button “Abort” aborts the current measurement.

The measurement phases

In the three bottom frames the conditions for the three different measurement phases are selected.



The frame ”Phase 1” states the conditions for the measurement to start. The frame ”Phase 2” states the conditions to change the out signals during the measurement. (Note that the out signals can be changed in all three phases.) The frame ”Phase 3” states the conditions for the measurement to end.

Activating phases

It is sufficient that one of the selected conditions in a frame is met to activate the phase. The measure-ment phases are activated in order, i.e. the conditions for one phase are not checked before any of the conditions in the previous phase is met. Please note that at least one condition in each phase must be met for a measurement to be completed. That means if one of the phases never get any of its conditions met, the measurement will never end.

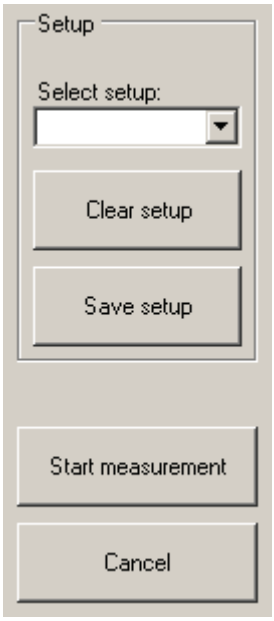
The conditions of a phase

These are the functions of the 14 conditions in each phase:

Immediate	the phase is activated without delay or checking of any conditions. (For “Phase 1” this means immediately when “Start measurement” is pressed.)
Time	the phase is activated when the entered time has elapsed, measured from the time that the conditions in the previous phase were met. If the checkbox isn’t marked the condition is ignored.
Position	the phase is activated when the set condition for the position is met. The button “+”/-“ shows if the direction of movement should be positive or negative for the condition to be met. The button “>”/”<” shows if the position should be larger or smaller than the entered value for the condition to be met. If the checkbox isn’t marked the condition is ignored.
Speed	the phase is activated when the set condition for the speed is met. The button “+”/-“ shows if the speed should be positive or negative for the condition to be met. The button “>”/”<” shows if the speed should be larger or smaller than the entered value for the condition to be met. If the checkbox isn’t marked the condition is ignored.
I9	the phase is activated when the set condition for the analogue input I9 is met. The button “+”/-“ shows if the change in the analogue value (the derivative) should be positive or negative for the condition to be met. The button “>”/”<” shows if the analogue value should be larger or smaller than the entered value for the condition to be met. If the checkbox isn’t marked the condition is ignored.
I10	same as above, but for I10.
I0-I7	the phase is activated if the checked signal is/becomes active (See above for determination of active high/active low.)

The out signals of a phase

By checking one of the out signals Q0-Q3 in the “Switch” frame, that signal switches value when the set condition for the phase is met.



Setup

In the frame ”Setup” the setup of the measurement can be changed.

The drop list ”Select setup” contains previously saved measurement setups that are loaded when selected.

The button ”Clear setup” clears all current checkboxes and entered values for the setup.

The button ”Save setup” opens a form where the current setup can be saved for future use.

Starting a measurement

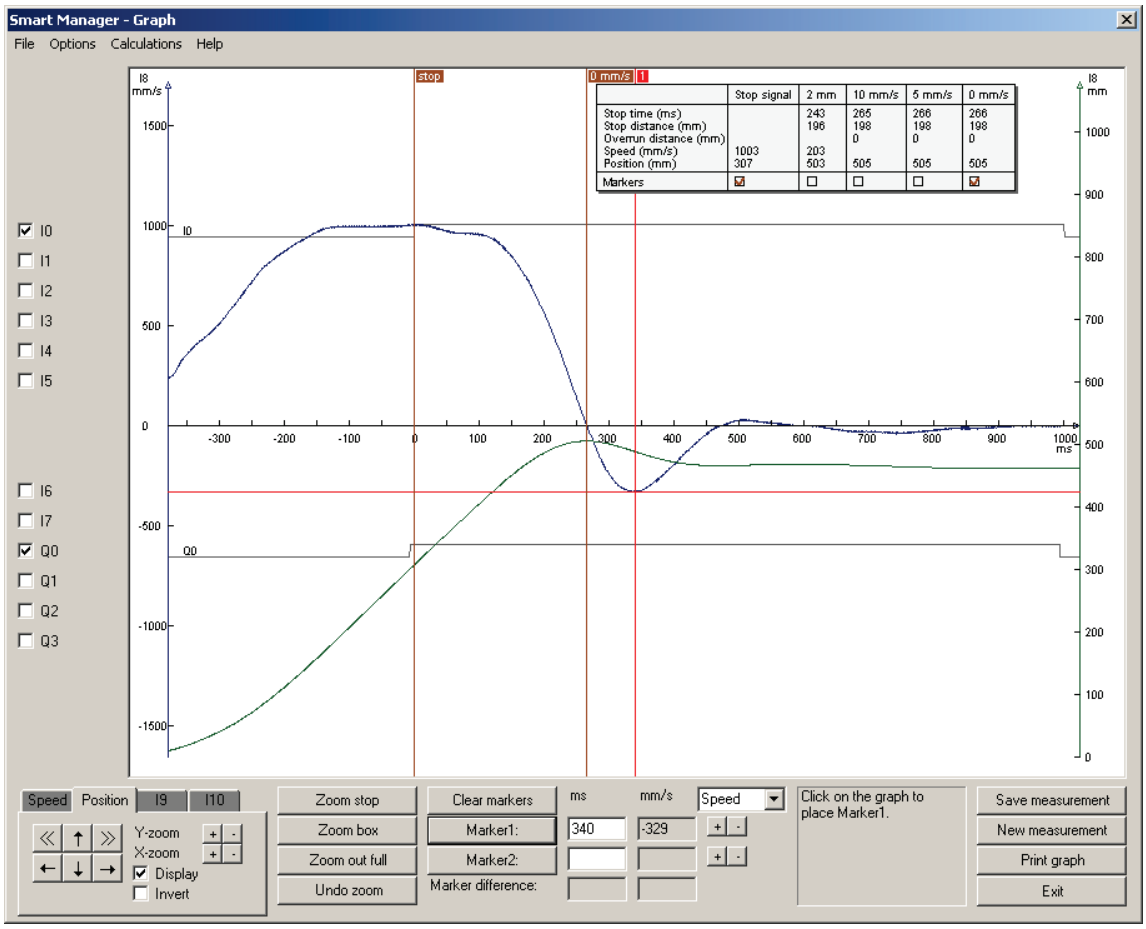
A measurement is started with the button “Start measurement”.

This sets the system in a state where the conditions in phase 1 are monitored. It’s not until any of these conditions are met that any data is recorded.

The button “Cancel” closes the form.

4.9 Displaying measurements

When a measurement has been performed or loaded from the database the graph form is displayed. Here one can see how the speed, position and analogue values have changed during the measurement.



X- and Y-axes

Time is shown along the x-axis. If Smart has received a positive signal from the selected stop signal, that signal marks the time zero (0). The time before that signal is regarded as negative time. If no stop signal has been received the time zero is the start of the measurement. Speed, position and analogue values are shown along the y-axis. Be sure to read from the correct y-axis when several graphs are shown at the same time in the graph window.

Stop time data

If the stop time can be calculated a table containing stop time data is shown in the top right corner of the graph window.

	Stop signal	2 mm	10 mm/s	5 mm/s	0 mm/s
Stop time (ms)		243	265	266	266
Stop distance (mm)		196	198	198	198
Overrun distance (mm)			0	0	0
Speed (mm/s)	1003	203			
Position (mm)	307	503	505	505	505
Markers	☑	☐	☐	☐	☑

The column ”Stop signal” shows the speed and position at the moment the stop signal was given.
The column ”2 mm” shows the stop time and stop distance calculated from the stop signal to the position 2 mm before the movement ceased. The column also contains the speed and position at 2 mm before stand still.

The centre column shows values for an adjustable stop speed. 10 mm/s is default but values between 0 and 99 mm/s can be selected. The column shows stop time, stop distance and position calculated from the stop signal to the moment when the speed falls below the selected stop time. The overrun distance is the distance the machine has moved in the same direction after the speed fell below the selected stop speed. If the overrun distance is positive it is displayed in red digits in the table.

The column ”5 mm/s” shows the same as the previous column but for 5 mm/s and the column “0 mm/s” shows the same as the two previous columns but for 0 mm/s, i.e. when the machine has completely ceased to move or started moving backwards.

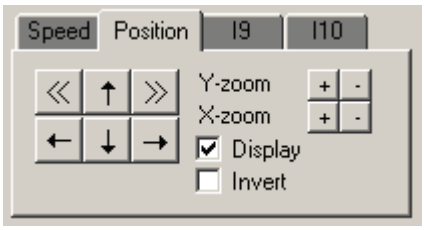
By clicking in the squares in the bottom of each column a marker is placed in the graph to show where in the measurement this occurred.

Different ways of calculating the stop time

The reason the table has different ways of calculating stop times is that these ways are currently being discussed in standardization committees for some types of machinery. Normally the difference in time between the different ways of calculating the stop time is not more than a few ms for faster moving machines e.g. eccentric presses. For slower moving machines the stop times can differ a lot more, however with a much shorter stop distance. The last two mm a machine moves are in most cases not a dangerous movement and can often be excluded from the stop time calculation to get a reasonable stop time in relation to the risk. Which of these ways to use for the calculation is dependent on the machine, its speed of movement, the risk assessment and authorities.

Digital in and out signals

Along the left side of the graph window checkboxes are shown for the digital in and out signals. By checking a checkbox that signal is displayed in the graph.



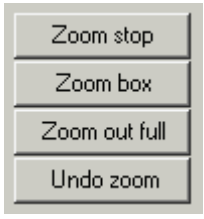
Controlling the graph

The tabs in the bottom left corner are used to zoom in and out and to move the graph. The bright tab indicates which tab is selected.

The arrows move the graph window. Up/down affects the selected graph. Right/left affects all visible graphs. With the double arrows the window is moved to the beginning or end of the measurement. The buttons ”Y-zoom” ”+” and ”-” zooms along the y-axis for the selected graph. The buttons ”X-zoom” ”+” and ”-” zooms along the x-axis for all graphs. The checkbox “display” must be checked in order for the selected graph to be shown in the graph window. If the checkbox “Invert” is checked the selected graph is inverted around the x-axis.

Zooming

The buttons to the right of the tabs can also be used to zoom.

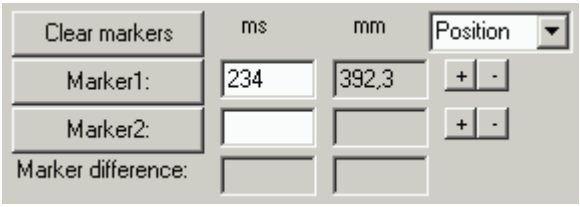


The button ”Zoom stop” zooms in on the stop area of the graph, if it exists in the measurement. With the button ”Zoom box” a specific area of the graph can be zoomed using the mouse cursor. The button ”Zoom out full” zooms out so that all of the measurement in visible in the graph window.

The button “Undo zoom” cancels the last zoom and displays the previous zoom.

Markers

In the centre under the graph window the two custom markers are controlled.



The button ”Clear markers” removes all markers from the graph window.

By clicking ”Marker1” and then clicking in the graph window a marker is placed in the graph. The same goes for ”Marker2”.

In the textbox to the right of the marker button the x-value where the marker was placed is shown in ms. A marker can also be placed by entering a value in this textbox. The y-value of the marker is shown in the grey textbox to the right. By choosing a graph in the drop list the markers are placed on that graph and the values in the textboxes and units are changed accordingly.

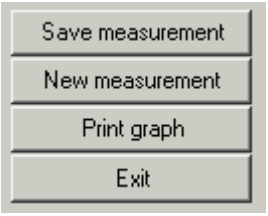
In the two bottom textboxes (Marker difference) the difference between the markers are shown both in time and y-values. By clicking “+” and “-“ the markers are moved one step (one ms) forwards or backwards in the measurement.

Messages

The large grey textbox displays messages from the program.

Controlling a measurement

The button “Save Measurement” shows a form where measurement information can be entered and the measurement can be saved (see chapter 4.12). The button “New measurement” closes the current graph and opens a new measurement form with the same settings as the current graph. The button “Print graph” opens a form where the current graph window can be printed together with measurement information. The button “Exit” closes the graph form.



Menu

In the menu on top of the graph form four selections are visible: ”File”, ”Options”, ”Calculations” and ”Help”.

Under ”File” the same alternatives as the four buttons in the lower right corner can be found. Under ”Options” are the following alternatives:

- ”Edit analogue conversion” shows a form where the values and units of the analogue input can be selected. (See chapter 4.6)
- ”Change signal names” shows a form where the digital in and out signals can be renamed.
- ”Layers” shows a form where the current graph window can be saved as a template and used to compare with other measurements. (See chapter 4.11)
- “Zoom to layer” places the graphs axis to the same as layers.
- ”Manual zoom” displays a form where the zoom can be manually adjusted after exact numbers. (See chapter 4.11)
- With ”Change custom stop speed” the custom stop speed can be selected.
- By unchecking ”Display stop time data” the table with stop time data is hidden in the graph window.
- By checking ”Use marker labels” the labels that help to tell the different markers apart are shown.
- By checking ”Use analogue conversion” the selected analogue conversion is used in the graph. (See above).

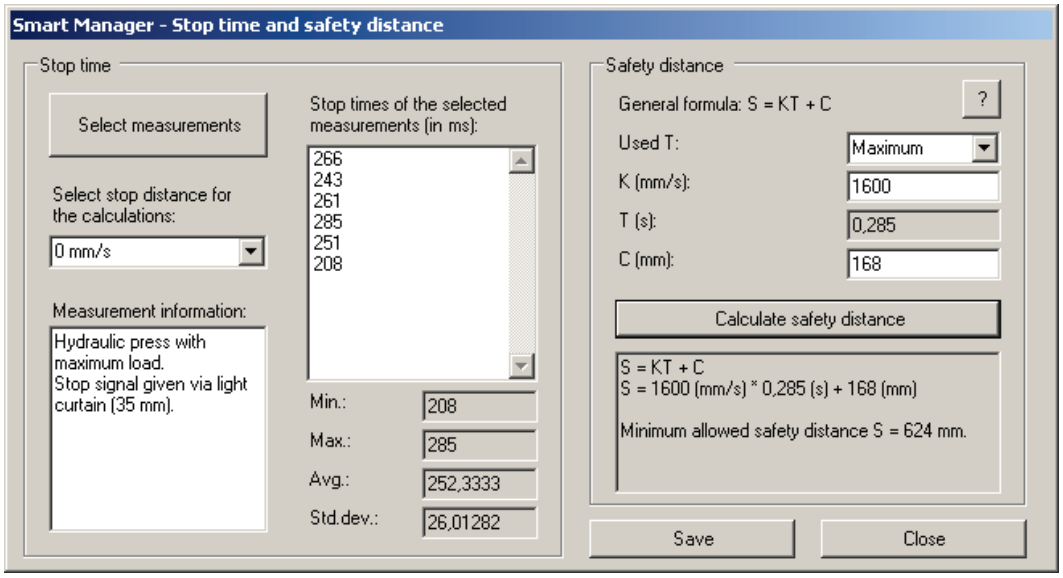
Under ”Calculations” the following alternatives can be found:

- ”Statistics” displays some statistics from the measurement, for instance the stroke length of the machine and min. and max. values for the graphs.
- ”Stop time and safety distance” shows a form where the stop time can be calculated based on multiple measurements and the minimum allowed safety distance for the machine can be calculated.

Under ”Help” information about the program version can be found.

4.10 Calculating stop time and safety distance

To calculate stop time and safety distance based on multiple measurements all measurements must first be saved to the database (see chapter 4.12). After that you click on “Calculations” – “Stop time and safety distance” in the menu of the graph form (see chapter 4.9). A form is shown where the information required for the calculations can be entered.



Stop time

Information about the stop time calculation is shown in the left frame (Stop time).

With the button ”Select measurements” a form is shown where you can select which measurements to use in the calculations. With the droplist ”Select stop distance for the calculations” one of the ways to calculate stop time is selected. Information about the measurement can be entered in the textbox ”Measurement information”. The list to the right displays the stop times of the selected measurements. If no measurements have been selected the stop time of the current measurement is shown. Beneath the list the minimum, maximum, average and standard deviation of the stop times in the list are displayed.

Safety distance

The right frame (Safety distance) holds the information about the safety distance. By entering the values of the variables in the formula, the minimum allowed safety distance can be calculated.

The button “?” displays information about the formula used to calculate the minimum allowed safety distance. Which of the calculated stop times that should be used is selected in the drop list “Used T”. In the textboxes below the values of the variables K, T and C are entered. By clicking the button “Calculate safety distance” the minimum allowed safety distance is calculated and displayed in the textbox below the button.

The button “Save” saves the selected stop times and safety distance calculations to the measurement in the database. The button “Close” closes the form.

Formula for calculating the minimum safety distance

The calculation of the minimum safety distance is performed in accordance with the standard EN ISO 13855 where the general formula for the minimum distance from the danger zone is:

S = K x T + C

where

S is the minimum distance in millimetres, from the danger zone to the detection point, line, plane or zone;

K is a parameter in millimetres per second, derived from data on approach speeds of the body or parts of the body;

T is the overall system stopping performance in seconds;

C is an additional distance in millimetres, based on intrusion towards the danger zone prior to actuation of the protective equipment.

The overall system stopping performance T comprises a minimum of two phases:

$T = t_1 + t_2$

where

T is the overall system stopping performance;

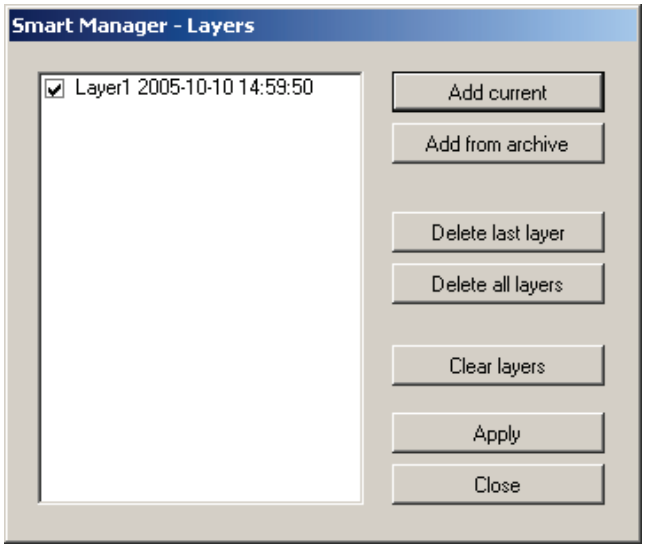
t_1 is the maximum time between the actuation of the sensing function and the output signal switching devices being in the off state;

t_2 is the maximum response time of the machine, i.e. the time required to stop the machine or remove the risks after receiving the output signal from the protective equipment. t_2 is influenced by various factors e.g. temperature, switching time of valves, ageing of components.

4.11 Compare measurements

To compare measurements they are drawn as different layers in the graph form. The current measurement is shown in colour and the layers beneath are shown in grey. Click on “Options” – “Layers” in the graph form, and a new form will show, where you can choose to add or remove measurements from the layers.

In the list to the left all added layers are displayed. The layers are displayed with a number and the measurement date. In front of the measurement is a checkbox which indicates if the layer should be displayed in the graph window or not.



The button ”Add current” adds the current measurement as a new layer.

The button “Delete last layer” removes the last layer from the list.

The button “Add from archive” adds the old measurement as a new layer.

The button ”Delete all layers” removes all layers from the list.

The button ”Clear layers” unchecks all layers in the list so that they are not displayed in the graph window.

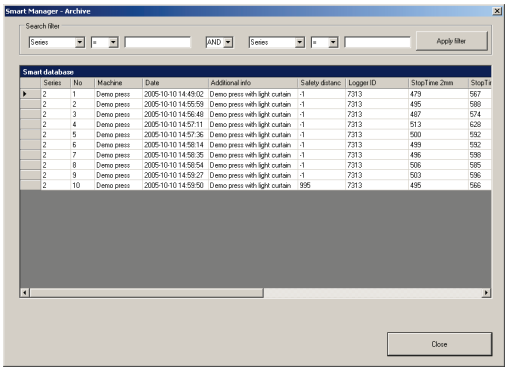
With the button ”Apply” the current settings are accepted and applied to the graph window.

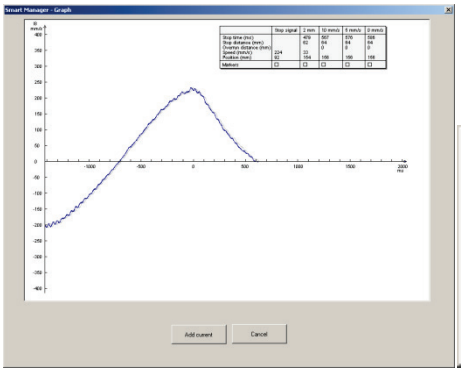
The button “Exit” closes the form.

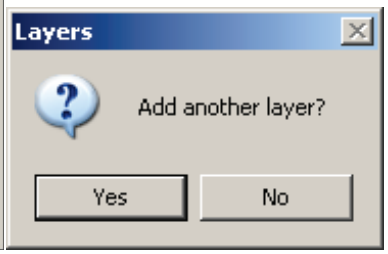
When a new layer is added to the list on top of another layer, the zoom is automatically adjusted after the existing layer so that the measurements can be compared.

This is how you compare measurements:

1. Save the measurements you want to compare to the database.
2. Load a measurement you want in the background from the database.
3. Adjust the zoom for the area of the graphs that you want to compare.
4. Add the measurement as a layer by clicking on “Options” – “Layers” in the menu and click on “Add current”, “Apply” and “Exit”.
5. Then click “Add from archive”.
6. Select the measurement you want to add as a layer from the database.
7. If the measurement is correct click “Add current”.
8. Choose if you want to add more layers. If yes, repeat steps 6 to 8.
9. Finish by choosing not add more layers. Then the first graph will appear.

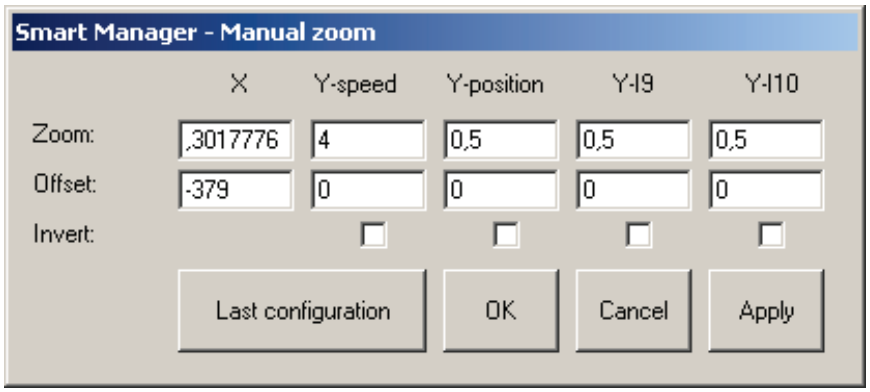






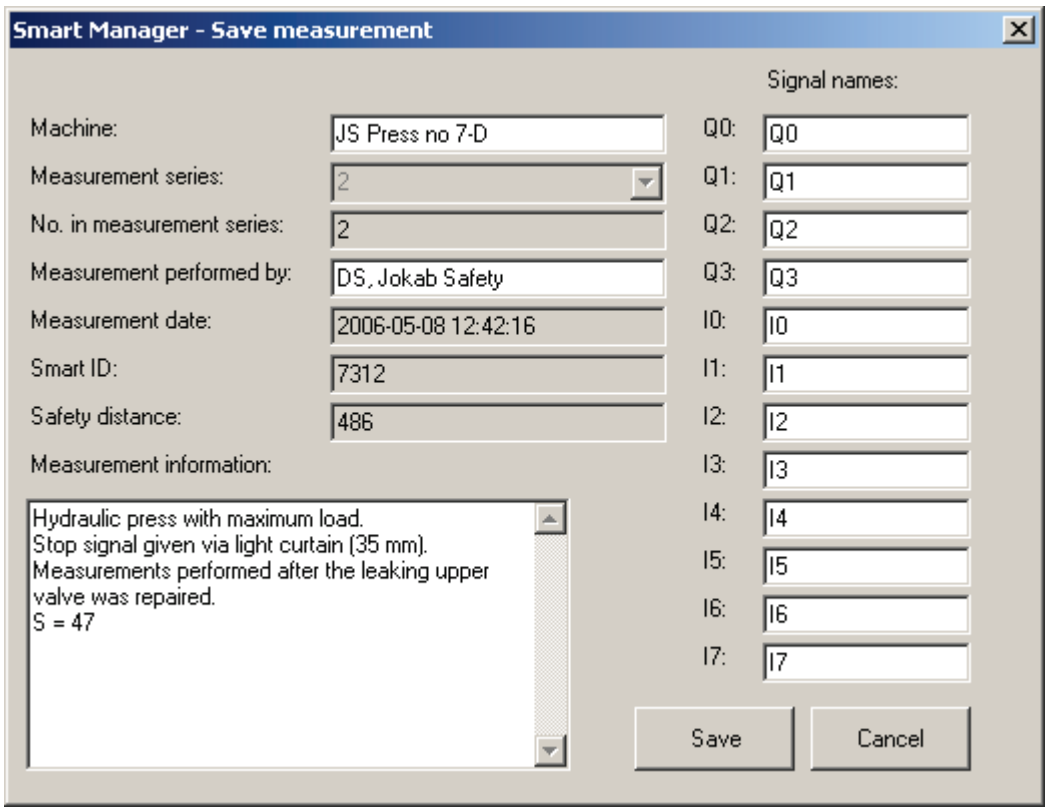
Manual zoom

There is also the possibility to manually adjust the zoom by clicking “Options” – “Manual zoom” in the menu of the graph form. A small form is then shown where the zoom can be specified. If a layer has been saved before, the same zoom can be set by clicking the button “Last configuration” and then “Apply”.



4.12 Save measurements

The measurement can be saved by clicking the button “Save measurement” on the graph form. A new form is displayed where information about the measurement can be entered.



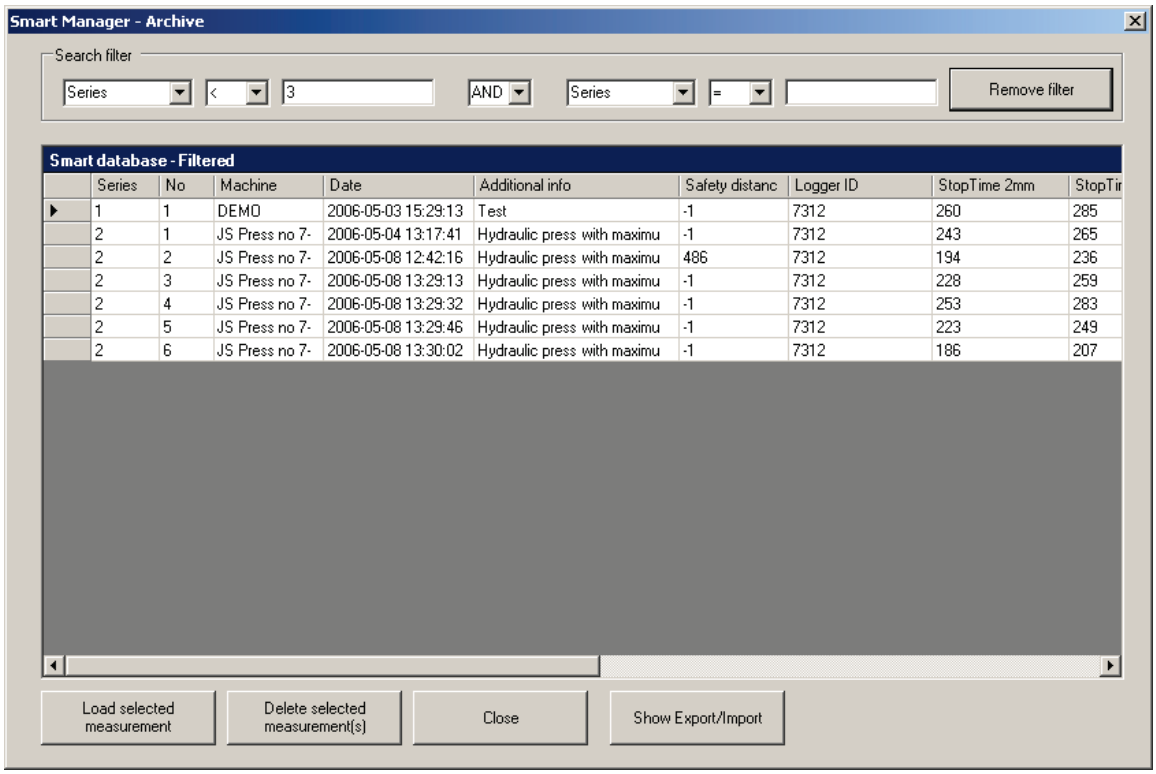
In the textbox “Machine” the name or type of machine can be entered. With the drop list “Measurement series” the measurement series that the measurement should belong to is selected. The textbox “No. in series” shows the number the measurement gets in the series.

In the textbox ”Measurement performed by” the person/company who performed the measurement is entered. The textbox ”Date” displays the date and time of the measurement. ”Smart hardware ID” shows the ID number of the Smart that the measurement was performed with. “Safety distance” shows the calculated safety distance for the measurement if it exists. Additional information about the measurement can be entered in the textbox “Measurement information”. The textboxes to the right shows the names of the digital in and out signals used for the measurement. The names can be changed before saving.

The button ”Save” saves the measurement to the database and the button ”Cancel” closes the form without saving.

4.13 Load measurements

To load a measurement from the database you click the button “Load” from the main menu. A form is shown which displays all measurements in the database.



Choose a measurement by clicking on it with the mouse pointer.

With the button “Load selected measurement” the selected measurement is loaded and the graph form is displayed. The button ”Delete selected measurement(s)” deletes the selected measurements from the database. The button “Exit” closes the form. The button ”Show Import/Export”/”Hide Import/Export” shows or hides the external database (see chapter 4.14).

With the filter function at the top of the page you can apply a filter to the database, displaying only the measurements you are interested in. A filter is created by selecting which column you want to filter on in the leftmost drop list, what type of condition you want in the next drop list, and what value you want for the condition in the following textbox. If you want to combine this condition with another one, you can continue selecting another condition in the other drop lists/textbox to the right.

To apply the filter, you click the button “Apply filter”. This makes the filter result visible in the table below. Note that the word “filtered” is added to the heading of the table when it shows filtered data. To remove a filter, click on the button in the filter frame, which changes name to “Remove filter” when a filter is active.

Examples of filters:

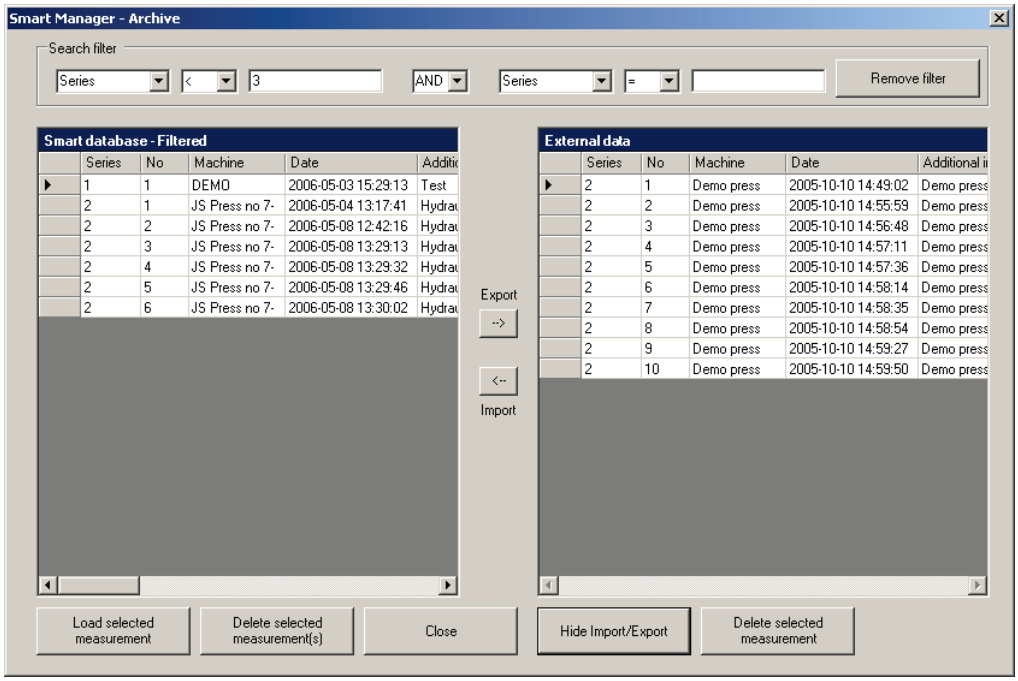
“No < 11 AND Series /= 14” displays all measurements with numbers less than 11 except those belonging to series 14.

“Machine LIKE press OR Date < 2005-01-01” displays all measurements where the machine name contains the word “press”. But it also displays all measurements (independent of machine names) that were made prior to the year 2005.

4.14 Importing and exporting measurements

To move measurements between databases/computers and also to make security backups of measurements an external database is used. The external database consists of three CSV files: Measurements.csv, Values.csv and Conditions.csv. CSV files (Comma Separated Values files) are a standardized type of text file where the information is separated by comma signs. These files can also be read by for instance Microsoft Excel.

The external database is reached from the start form by clicking on “Load” and then on ”Show Import/Export”. A new field is displayed to the right in the form.



The left field (Smart database) shows Smarts database, and the right field (External data) shows the external database which consists of the CSV files.

Export

To export measurements from Smarts database to the external database, you select the measurements you want to export in Smarts database and click on the button ”Export”. The measurements are then copied to the external database.

The three CSV files (Measurements.csv, Values.csv and Conditions.csv) can now be copied or moved to another computer and placed in the folder where Smart Manager was installed. Please note that you need all three files for the import/export to work properly. When you open the import/export function in Smart manager the measurements should be visible in the external database.

Import

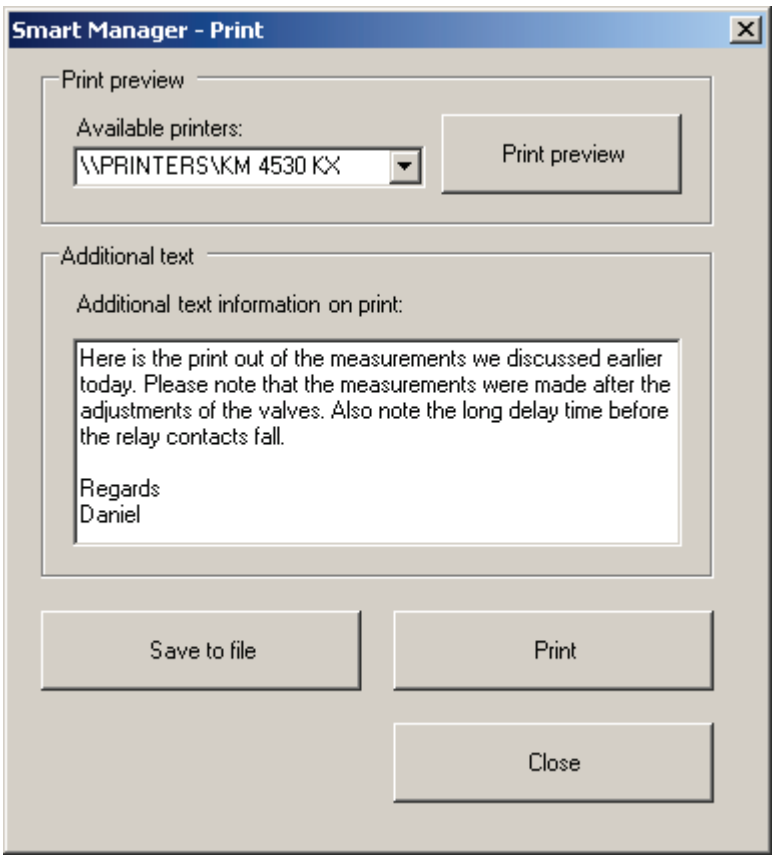
To import the measurements to Smarts database you select the measurements from the external database and click on the button “Import”. The measurements are then copied to Smarts database.

Measurements in the external database can be removed by selecting a measurement in the external database and click on the button ”Delete selected measurement” under the right field displaying the external database.

Large csv-files may cause problems. Therefore, only save a maximum of 80 measurements in the same external database.

4.15 Printing measurements

Measurements can be printed or saved as pictures from the print form. This form is reached from the graph form by clicking the button “Print graph”.



In the drop list “Available printers” you can choose between the installed printers on the computer and look at a print preview by clicking the button “Print preview”. In the text field in the frame “Additional text” additional information that should be on the print can be entered.

By clicking on the button “Save to file” you can save the graph as a picture instead of sending it to a printer. A new form is opened where you can select the file name, file type and where to save the file. There are three alternatives: Bmp, Jpg and Gif. Bmp files are uncompressed and take up large disc space. Jpg and Gif are formats that compress the images which reduce picture quality but take up much less disc space.

The button “Print” opens up a new form where you can select which printer to use and its properties. The button “Close” closes the form.

Company logotype on prints

In the top left corner of the print and the saved picture, there is a field intended for company logotypes. As a default ABB:s logotype is displayed. The picture that is shown is in Smart Managers installation folder and is called company_logo.bmp. Switch or change this file to a file with your own company logotype with the same file name (the formats .jpg or .gif also works). The field on the print is adjusted for a bitmap of 292 x 112 pixels.