micro STM - Stop Time Measuring System

2nd upgraded generation

User's Manual



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1 Introduction

According to international standards all machines must be secured by a appropriate safety device to protect the operator against machine dangerous movements. These safety devices are usually safety curtain, safety scanner, emergency stop, two hand release or a foot switch.

Placement of these safety devices is critical and must be calculated based on machine stop time. Stop time Measurement System is designed to measure stop time and calculate safety distance. Measurement is done by measuring safety system reaction time after moving into safety equipment sensing area. To cover all machines movement speed changes during time and ensure optimal operator safety these measurements must be repeated periodically at least every 6 months.

Stop Time Measurement system consists of main measuring device, actuator, wire encoder and friction wheel encoder. Actuator mechanically moves into safety device sensing area after triggering and activate machine safety system. Wire encoder (or a friction wheel encoder) is attached to a moving part of the machine and measures movement velocity and direction. After machine stops, measuring device evaluates stop time and automatically calculate safety distance.

Many different kind of machines can be measured including presses, shears, welding machines, riveters, robots, conveyors and many others.

2 Main Features

2.1 Software

- Multilingual, simple and intuitive user interface
- Measurement statistics, automatic safety distance calculation according to EN 13855
- Open/Save measured data
- Import values from a text file
- Possibility to include user pictures in Pdf report to show measurement configuration
- Standalone Safety distance calculator
- Free software updates

2.2 Measuring device

- Easy and quick to use
- USB powered - no need for special power
- Very accurate, Microprocessor controlled, GPS calibrated
- 3- LED state indicator
- Stop determination based on standstill speed and/or direction change
- No need to interfere to machine safety circuits
- Small and compact size
- Durable Aluminum case
- Carrying case
- CE certificate
- Calibration protocol

2.3 Actuator

- Easy to use
- Universal build for measuring of all kind of safety devices
- Easy attachement
- Manual/Remote/Automatic release
- Three flag sizes (14mm, 30mm and 70mm)
- Flexible flag extension to easily bend to any position
- Magnetic base

2.4 Wire encoder

- Magnetic attachment pad
- Magnetic Base
- Can be used vertically or horizontally
- Extension cable for long distance measurement

2.5 Friction wheel encoder

- Enable to measure rotating movements
- Extension cable for long distance measurement

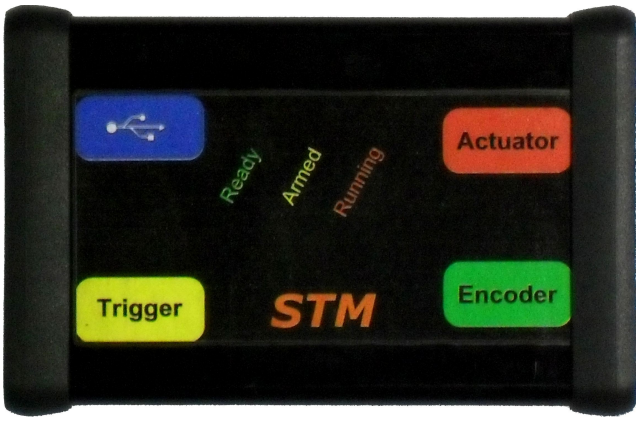
3 Package contents

- Carrying case
- Micro STM device
- USB Cable
- Remote Trigger
- Actuator
- Actuator extension with 3 flags (14mm, 30mm and 70mm)
- Adhesive gum for actuator attachment
- Wire Encoder
- Wire Encoder wire extension
- Friction Wheel Encoder
- Encoder extension cable
- Pen Stick with Software, drivers and user guide

4 Micro STM System Items detailed description

4.1 µSTM measuring device

Measuring device is connected to a PC via free USB port. Device can automatically control (trigger) the actuator based on specified conditions. Device also reads the signals from actuator (its position) and from wire encoder (speed and direction) to determine the stopping time. All the measurement is done inside the device and the result is then send to a PC and processed. There are just 3 LED diodes to signalize device state. All the settings are made form PC Software and stored in a device memory.



4.1.1 LED meanings

Green LED …..... Device connected to PC and ready.

Yellow LED …..... Device Armed - waiting for a Start signal to start measurement.

Yellow LED blinking …..... Device Armed, but actuator already released.
Please Move actuator to the right position.

Red LED …..... Measurement in progress.

Always ensure that STM device is in Armed mode (Yellow LED) before starting machine. It means device is ready and armed. Otherwise when not in armed mode, automatic trigger release will not work!

4.2 Actuator

Actuator is an automatic mechanic part which move into sensing area of a safety equipment and cause machine stop after either manual, remote or automatic trigger. After the actuator move into the safety equipment sensing area the measurement starts.

Actuator is designed with simplicity and universal use in mind. It has a mechanical button together with electromagnetic release.

It can be attached to any device and the flexible extension part can be bended to required shape. This allows easier attachment to a different safety equipment in a different places.

Actuator universal build and trigger control combination allows to use actuator to measure many different kind of safety equipment. It can also measure Emergency stop reaction by pushing an actuator button against Emergency stop.



Using actuator:

1) Move actuator front cylinder to the upper position.

2) Lock it by pushing cylinder at the back if needed. Some measurements require to have front cylinder unlocked (Two-Hand release)

4.2.1 Fixating actuator

Thanks to it's specific shape it is possible to use various methods of actuator attachment. Primary attachment method is to use adhesive gum. This method is easy to use, stick even on rough surfaces and is reusable. Actuator also have a magnetic base to be easily attached to the magnetic surface.

Take a piece of adhesive gum. Rub it in a hand for a while to warm up. Then apply adhesive gum on an actuator and attach actuator on a required place by slightly moving actuator from side to side while pushing against surface.

4.2.2 Actuator setup for measuring light curtains



4.2.3 Actuator Setup for measuring Safety Scanner

4.2.4 Actuator setup for measuring Two hand

In this case the actuator is not load and locked. One of the two hand release is pushed with the actuator with adapter mounted. After the actuator is removed from a button, the measurement starts.



4.2.5 Actuator Setup for measuring E-Stop



Push the actuator button against E-stop button. After button is pressed, actuator is released and measurement start.

4.2.6 Actuator Setup for measuring Door

Push the actuator button against the door. After button is pressed, actuator is released and measurement start.

4.3 Wire Encoder

Encoder is attached to a moving part of the machine using magnetic clamp or a spring hook. It sends a speed and direction signal to a measuring device. It can be used for measurement of machines with linear movement. The Encoder has a magnetic base.



4.3.1 Using Encoder extension wire

Extension wire can be used to extend encoder wire length (not encoder pitch).

4.3.2 Encoder manipulation

- Do not let the measuring wire rewind without control (snap back).
- Do not pull the measuring wire over measuring range.
- Avoid banging and knocking the sensor
- Fed the measuring wire perpendicularly from the sensor housing.

4.4 Friction Wheel Encoder

Friction wheel encoder can be used for measuring stopping time of conveyor belts and other circular moving parts.



Wire encoder base can be used as a stand for a friction wheel encoder.



4.5 Remote Trigger

Remote trigger controller can be connected to measurement device and remotely release actuator at any time if actuator is load and locked.



5 PC Software installation

5.1 System Requirements

Operating system: MS Windows

1 free USB port

5.2 Software installation

There is no need to install the software. Simply just extract µSTM_vxx.xx.zip located in a "µSTM" directory on a supplied media to any directory on your computer. Only device drivers need to be installed.

You can always obtain newest version of a software on a www.microstm.com

5.3 Software Uninstallation

To uninstall Software just simply delete the program folder. The Software itself does not create any records in a system registry and anywhere else but application directory.

5.4 Drivers Installation

1) Connect your µSTM device to your PC by means of an interface cable (USB). In case the "Found New Hardware" or "Add New Hardware" wizard on your PC shows up, cancel it.
2) Run µSTM software and go to menu „Tools\install drivers". Or locate and run file "Drivers\Install\CDMxxxx_Setup.exe" in µSTM application directory.
3) Disconnect and connect your µSTM device again.

You can Always obtain newest drivers on a www.microstm.com

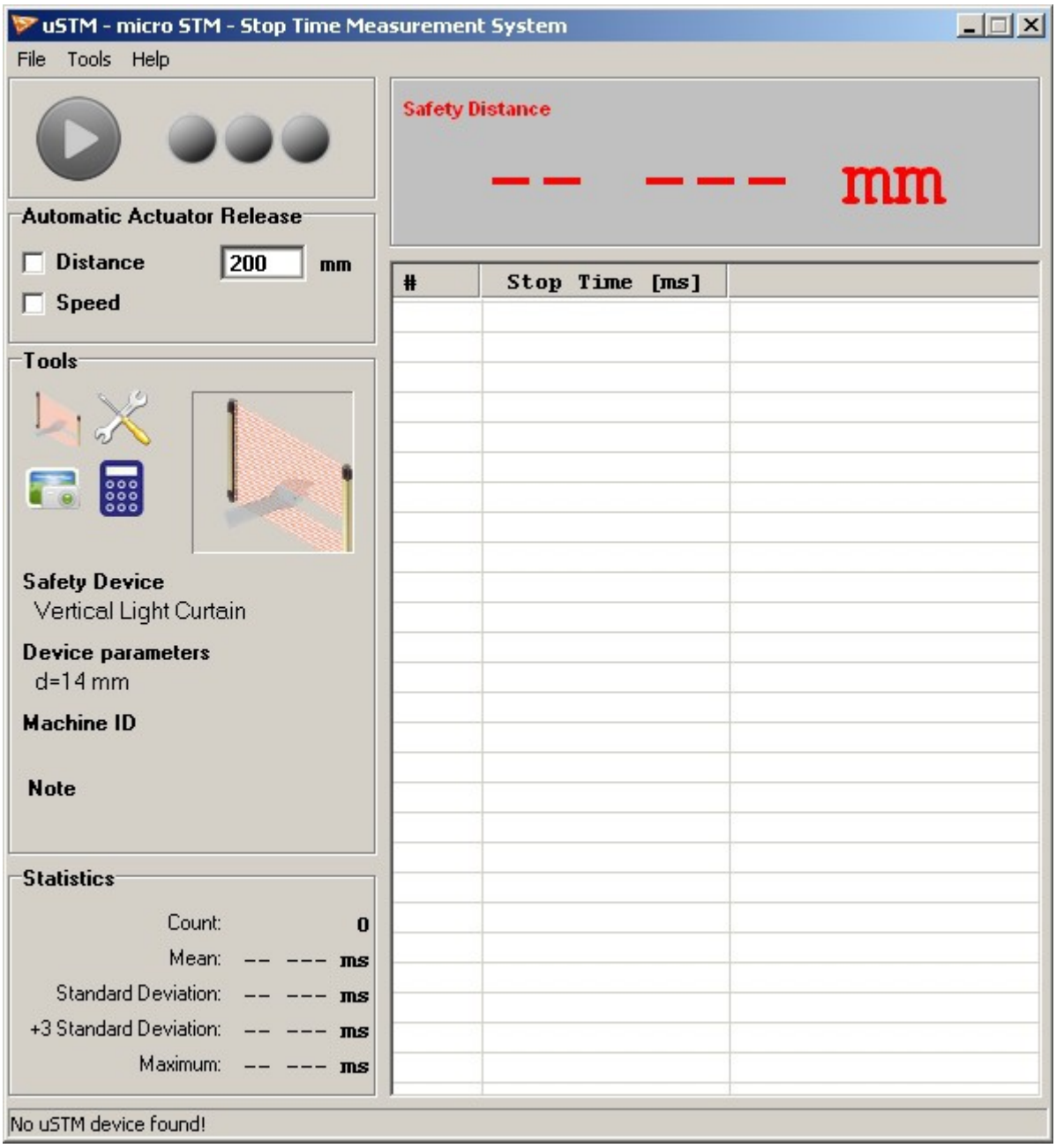
5.5 Drivers Uninstallation

To uninstall µSTM drivers locate and run file “Drivers\uninstall\Uninstall_drivers.bat” in µSTM application directory.

6 PC Software description

PC Software control measurement device and after measurement shows all the measured values and automatically calculate safety distance according to selected safety equipment type.

6.1 Main window





Start button – Set Device in Armed mode. Start button is enabled only when a STM device is connected.

Device states:



Device is ready. Measurement can be initiated by pressing Start button.



Device is Armed – waiting for Start signal from actuator.



Measurement in progress.

minimum distance calculation:

When less then 10 measurement no minimum distance is displayed

Actuator release conditions:

Measuring device can release trigger automatically according two conditions:

a) Distance the machine moved – after given distance the release will automatically move into safety device sensing area. You can enter distance in millimeters.

or/and

b) Machine speed – the measuring device is monitoring machine speed and after reaching constant speed point or slow down peak it automatically release the actuator.

Menu items:

New	Starting new measurement
Open	Open previously saved project file with a measured values, safety device settings and pictures.
Import Values...	Import any values from a text file. One value per line.

Text file Example:

```
123,45
238,41
121,23
```

Save as...	Save current project setting, values and pictures to a project file.
Generate Pdf Report	Generates Pdf measurement report

Tools:



Safety device select form



Settings form

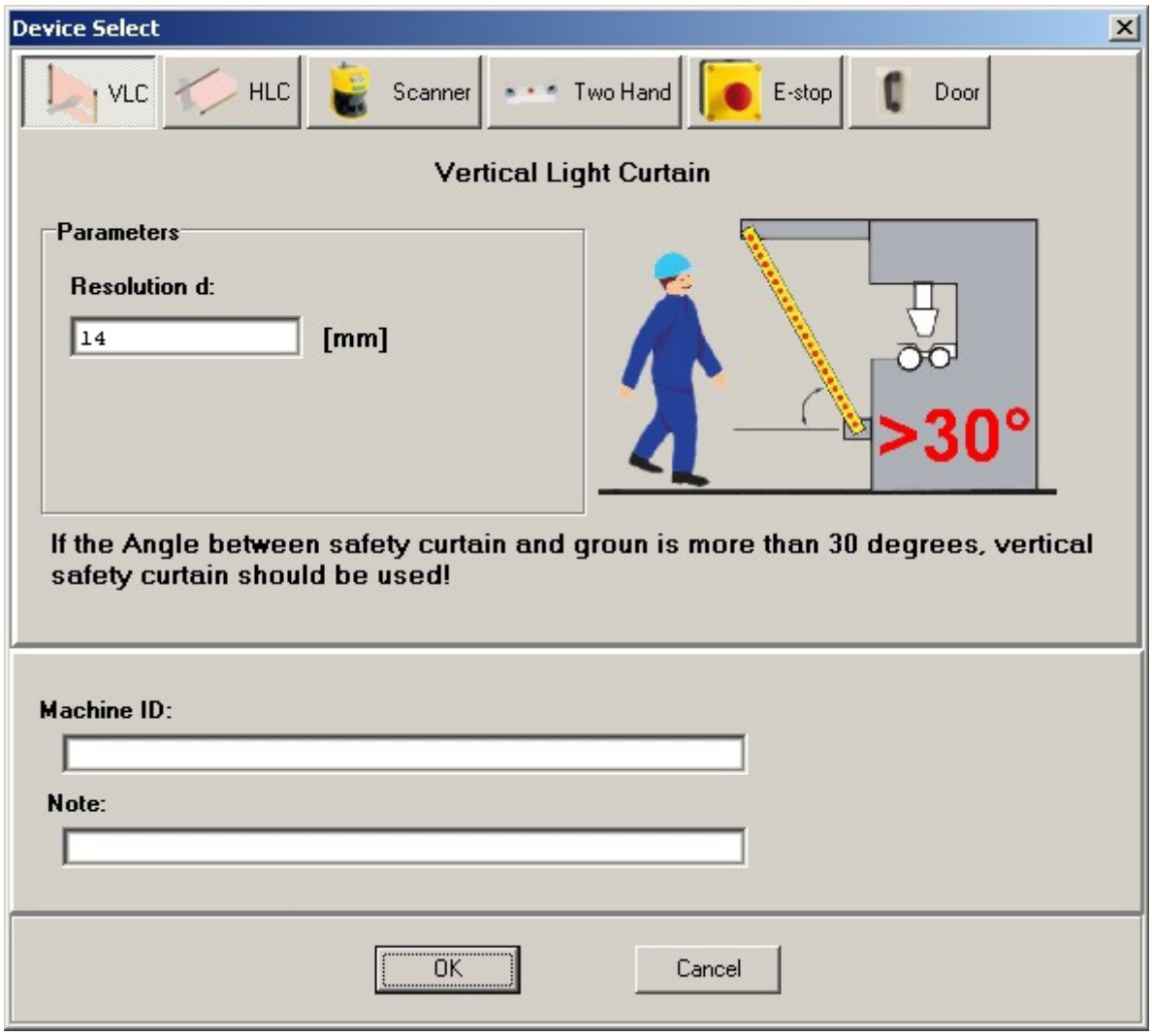


Open pictures to be included in Pdf report



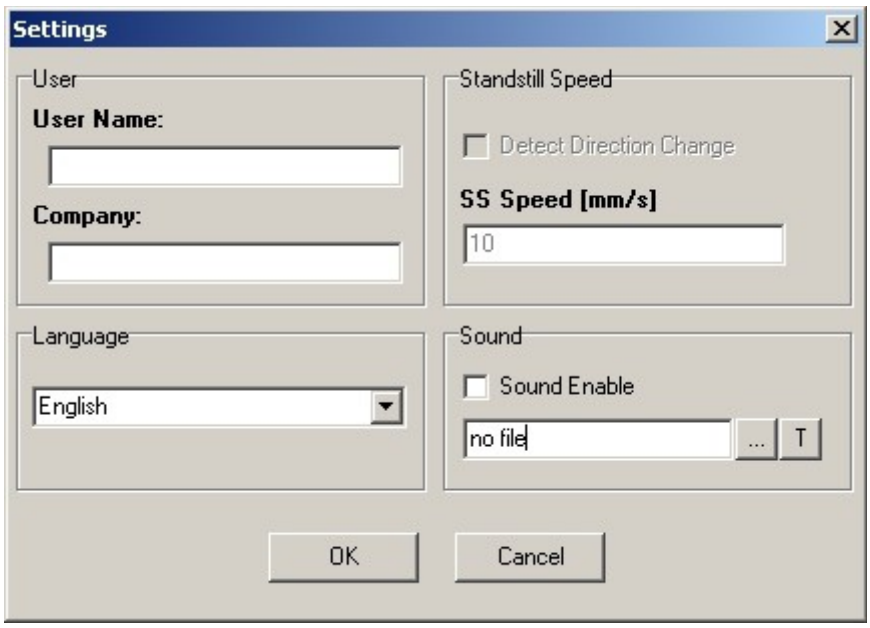
Stand alone safety distance calculator

6.2 Device Select Window



Be sure to choose right safety device before running any measurement. Safety distance calculation is based on selected safety device. You can also set machine identification name or number.

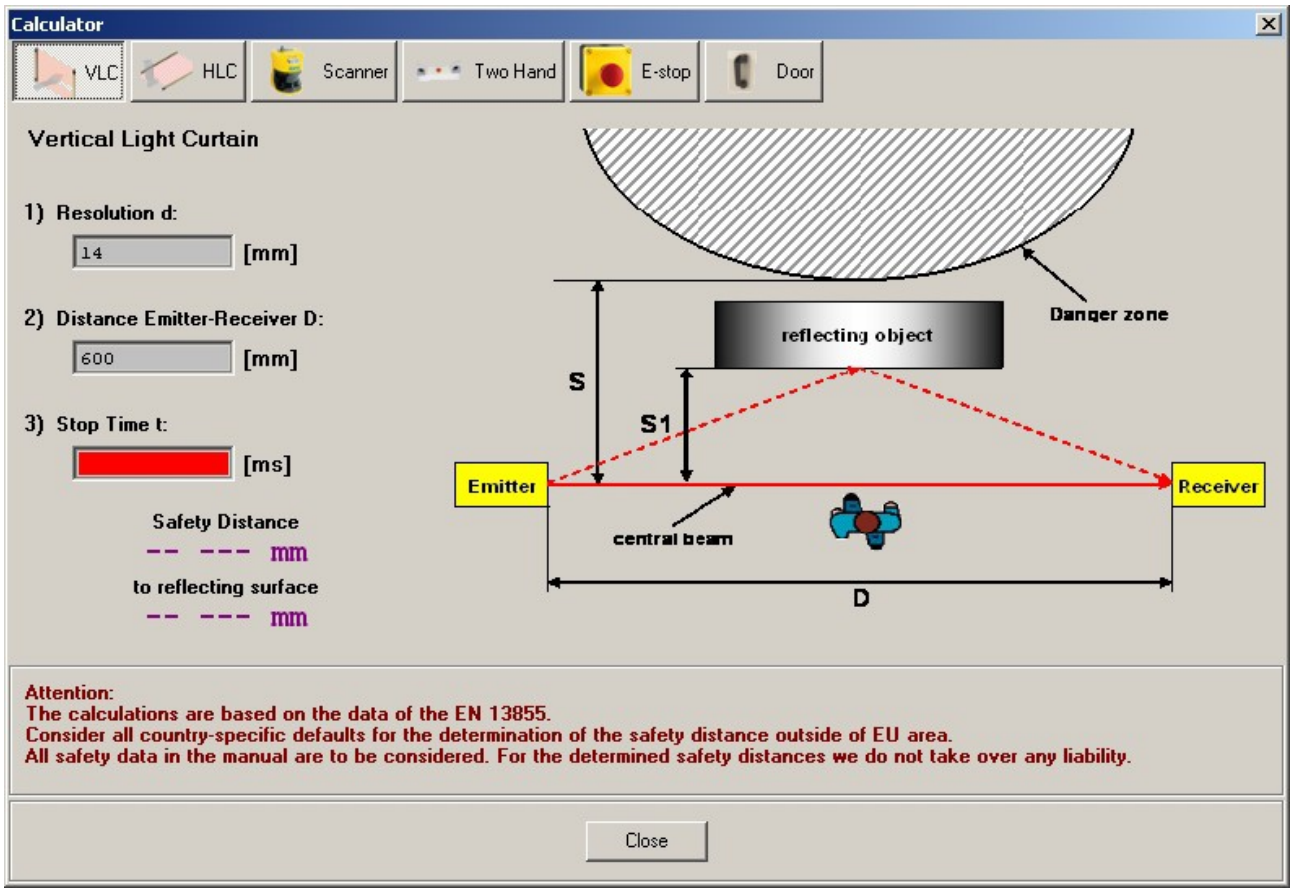
6.3 Settings Window



User Name	User name that appears in Pdf report
Company	Company name that appears in Pdf Report
Language	You can choose between different languages.
Detect Direction Change	Direction change is taken as a measurement stop condition.
SS Speed	standstill speed is fixed in value 10mm/s
Measurement sound	Selected sound file is played after each measurement if Sound Enable check box is checked.

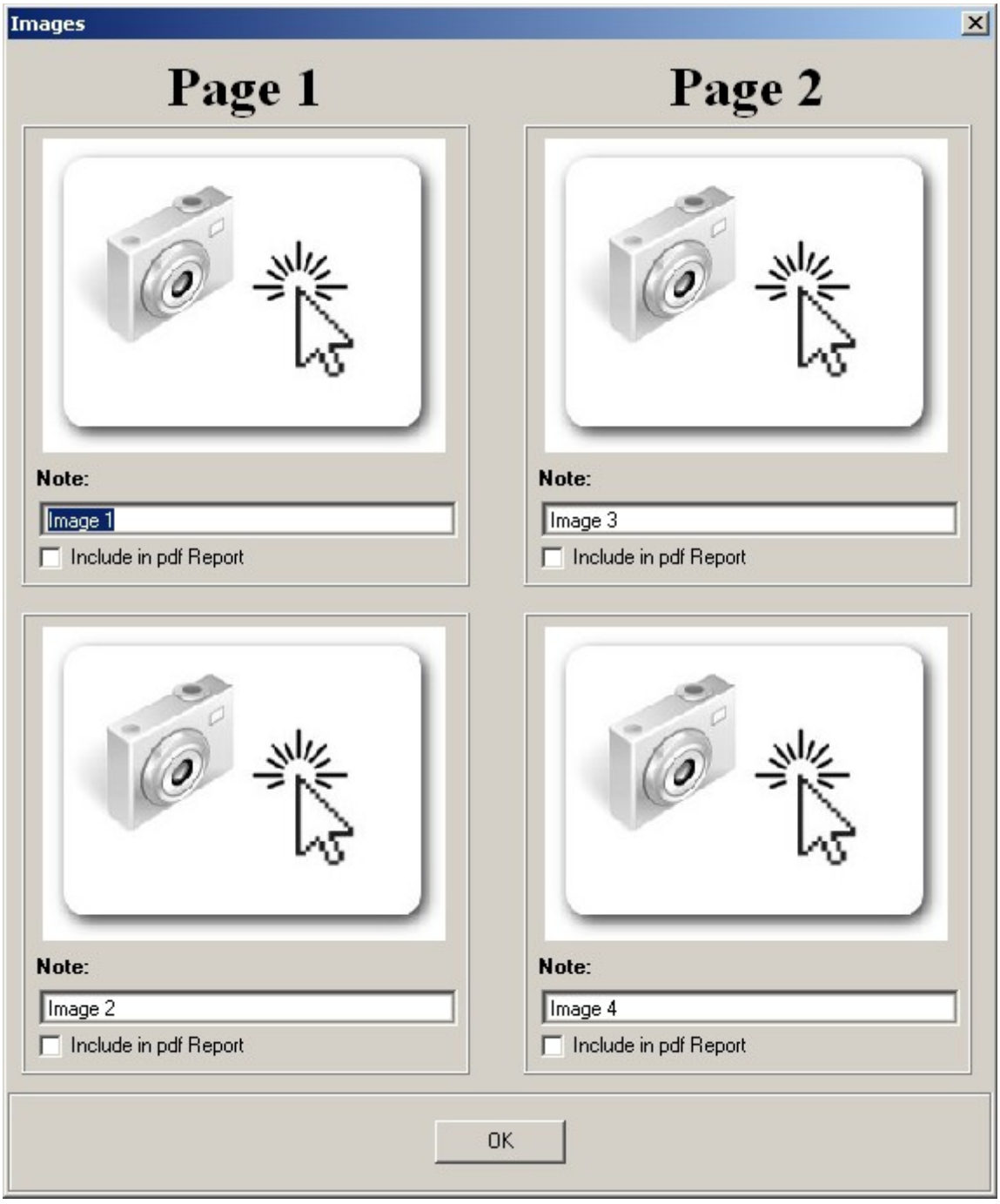
6.4 Calculator Window

Calculator calculate safety distance in millimeters for a given time in milliseconds.



Usage: Enter time value in the Time input filed. Calculated safety distance value will be displayed. Only valid values can be entered. Result is calculated immediately.

6.5 Pictures Window

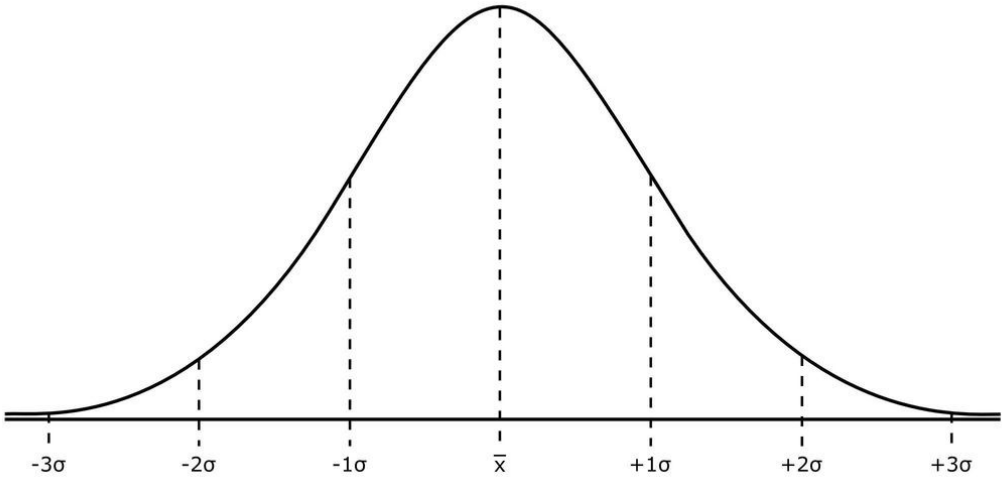


Up to four pictures can be selected and included into Pdf report together with picture description. Two pictures on page. After click into free area the open dialog is displayed.

7 Safety Calculations

7.1 Determining values for safety distance calculations

Safety Calculations are based on EN 13855/2010. A statistical way of covering 99,730% of all measured values in normally distributed measurement values is to calculate the mean value ± 3 standard deviations. At least 10 measurements are required to calculate minimum distance. The highest measured value or the mean plus three standard deviations, whichever is the greater, is used in calculation of the minimum distance.



Pict. 1: Normal distribution curve.

Calculation of mean value:

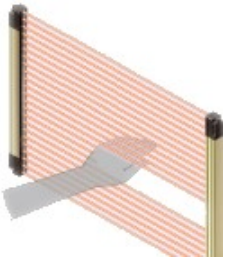
$$\bar{x} = \frac{1}{N} \sum_{i=1}^{N} x_i$$

Calculation of standard deviation

$$\sigma = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} (x_i - \bar{x})^2}$$

If $\bar{x} + 3\sigma$ is greater than measured maximal value then $\bar{x} + 3\sigma$ value is used for safety distance calculation. Else maximal measured value is used.

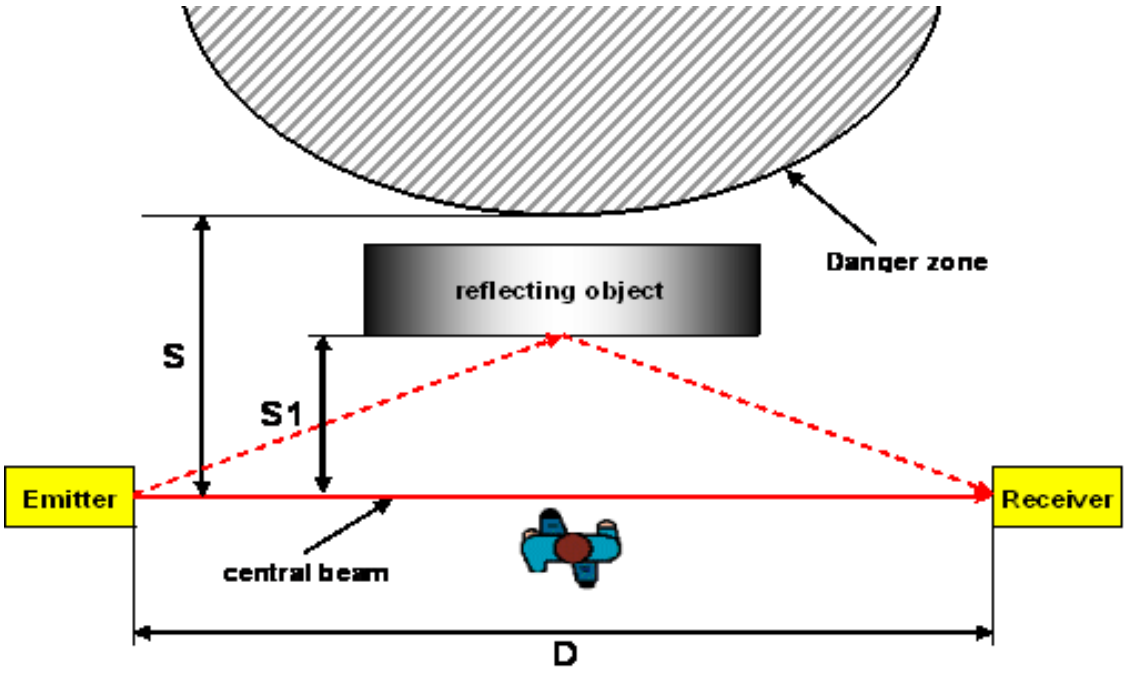
7.2 Vertical light curtain (VLC)



Input values:

d – light curtain resolution [mm]

T – Measured machine after running time [ms]



Safety distance to the danger zone S

where resolution d is <= 40 mm then

S = **2000** * **T** + **8** * (d – **14**) [mm]

S minimal value is 100 mm.

if the value **S** > 500 mm then

S = **1600** * **T** + **8** * (d – **14**) [mm]

only if result is still >=500 otherwise equation for S<40mm is used.

S minimal value is 500 mm.

where resolution d is >40 mm and d≤ 70 mm then

S = **1600** * **T** + **850** [mm]

S minimal value is 500 mm.



Electro-sensitive protective equipment with a sensor detection capability of >40 mm and <= 70mm diameter do not detect intrusion of the hands and, therefore, shall only be used where risk assessment indicates that detection of intrusion of the hands is not necessary.

Safety distance to reflecting surface S1

value S1 is calculated based on the following table:

distance emitter - receiver D [m]		
min	**max**	**minimum distance S1 [mm]**
>0,2	<=0,3	130
>0,3	<=0,4	175
>0,4	<=0,5	220
>0,5	<=0,7	310
>0,7	<=0,10	440
>0,10	<=0,15	660
>0,15		tan 2,5º * D [m]

Tab. 1: Safety distance to reflecting surface calculation.

7.2.1 Light Grids – Multiple separate beams

Arrangements of 2, 3 or 4 separate beams can be used to detect intrusion of the whole body into the hazard zone but are not suitable for detecting parts of the body (e.g. hands or fingers).

If the risk assessment indicates that multiple separate beams are appropriate, they shall be positioned at a minimum distance from the hazard zone in accordance with Equation:

S = **1600** * **T** + **850** [mm]

S minimal value is 500 mm.

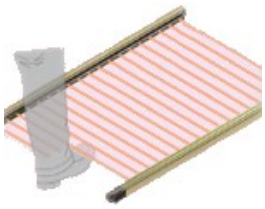
When using the light grids the following possibilities must be considered:

- to crawl under the lowest beam
- to reach over the top beam
- to reach in between two beams
- that the body passes between two beams

The beams should be installed at the following heights:

Number of beams	Height over the reference plane, e.g. ground
4	300, 600, 900, 1200
3	300, 700, 1100
2	400, 900

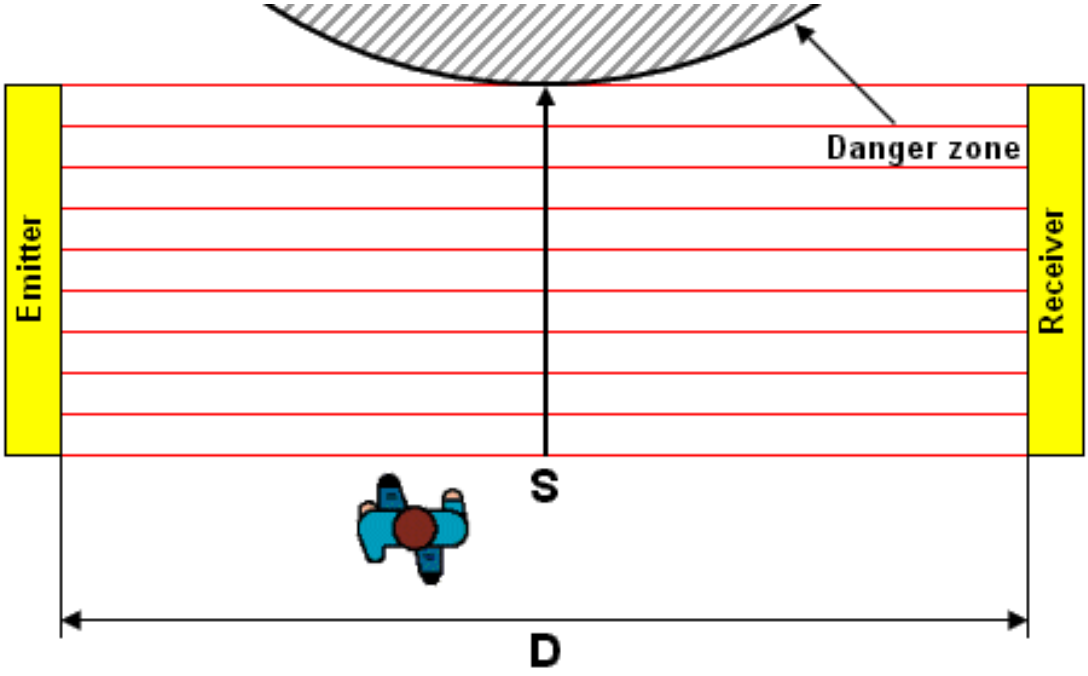
7.3 Horizontal light curtain (HLC)



Input values:

H – Height above the ground [mm]

T - Measured machine after running time [ms]



Safety distance to the danger zone S

S = 1600 * T + (1200 – 0,4*H)

S minimal value is 100 mm.

7.4 Scanner

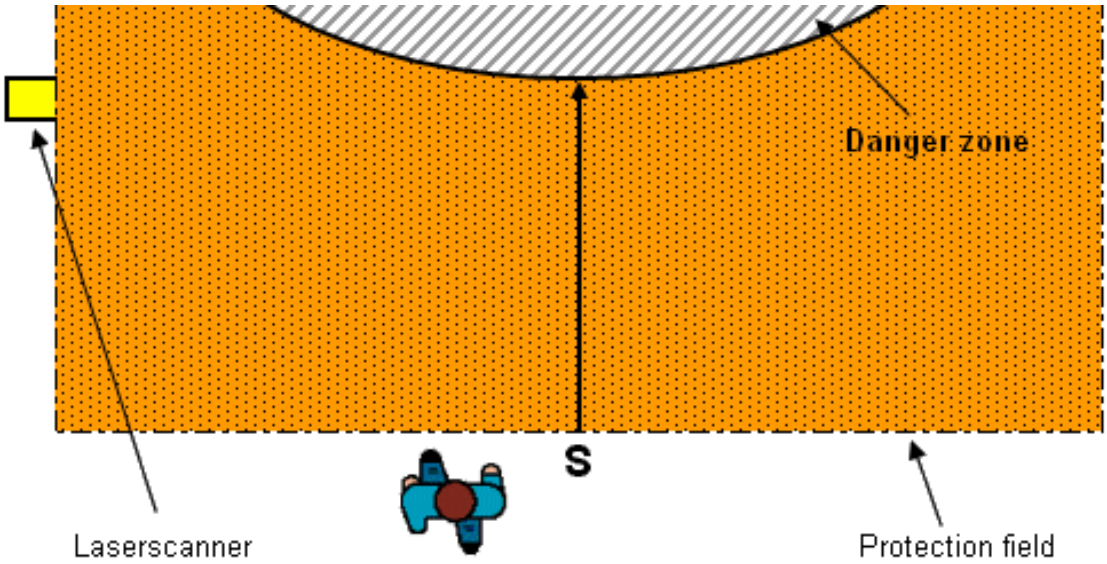


Input values:

d – Resolution [mm]

H – Distance floor to scanner [mm]

T - Measured machine after running time [ms]



Safety distance S calculations

C = **1200** – (**0.4** * **H**)

value **C** cannot be smaller then 850

S = **1600** * **T** + **100** + **C**;

S minimal value is 100mm

7.5 Two Hand



Safety distance S calculations

S = **1600 * T + 250** [mm]

S minimal value is 100 mm.

7.6 E-Stop



Safety distance S calculations

S = **1600 * T + 0** [mm]

S minimal value is 100 mm.

7.7 Door

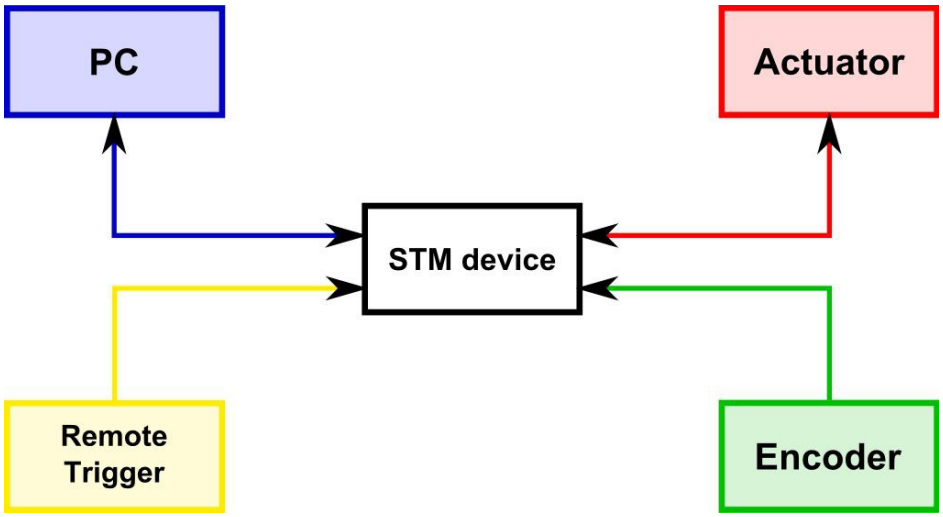
Safety distance S calculations

S = **1600 * T + 0** [mm]

S minimal value is 100 mm.

8 Measurement

8.1 Measurement block diagram



Encoder is attached to a moving part of the machine using magnetic clip or placed over a moving part in case of friction wheel encoder.

Actuator is attached near safety device protected area and after triggering it releases and move into safety device protected area. This forces machine to stop.

Stopping time is then measured based on signal from encoder and after machine stops then the safety distance is calculated.

8.2 Measurement setup

First get familiar with the machine function before making a measurement.

Some machines needs to be powered, but we strongly recommend to power off the machine before connecting the device and attaching actuator and encoder.

1. Connect µSTM Measuring Device to a free USB port on your PC.
2. Connect remote trigger to the device (Yellow Connector) if required.
3. Attach the actuator to safety device and connect it to the device (Red Connector)
4. Attach encoder using magnetic clamp or place over a moving part in case of friction wheel encoder and connect it to the device (Green Connector)
5. Start PC control software µSTM.exe
6. Setup actuator automatic release conditions if desired and press start button.
7. Run the machine.
8. After either automatic, remote or manual trigger the actuator is released and move into the sensing area of a safety equipment. In this point the measurement is started.
9. After machine stops the measured value is displayed in the list and safety distance calculated based on currently selected safety device.

You can repeat measurement from step 6 to acquire necessary count of measurements to get calculated safety distance. Minimum of 10 measurements is required to calculate safety distance. Safety distance calculations are described in a Safety Distance Calculations section.

9 Calibration

Stopping Measurement System is a very accurate device. Therefore one year calibration interval is recommended to ensure maximum accuracy. If a device is subjected to any mechanical shock then it should be calibrated immediatelly. Each device has a calibration certificate.

10 FAQs

Q: Why I see no safety distance calculated after making a measurement?

A: You need to take at least 10 measurements to calculate safety distance. See User's Manual Safety Calculations section.

Q: Why there is sometimes +3 standard deviation text underline and sometimes maximum time text is underline?

A: Underline identify current value used in safety distance calculation depending what value is larger. See User's Manual Safety Calculations section.

Q: Sometimes the software seems to not respond to the click on a Start button.

A: When the device is in armed mode, you cannot send another command and thus the start button and release setup is disabled until device finish measurement and measured value is received.

11 Technical Specification

11.1 µSTM device

Measuring Resolution:	0,1ms
Measurement range:	0 … 13 421,8 ms
Time base:	1,25MHz
Standstill speed detection:	0 … 80mm/s (10mm/s preset)
Stop Point Determination:	0 … 8 000 mm
Supply Voltage:	5V (from USB port)
Power consumption:	20mA
Dimensions (W x L x H):	86 x 57 x 26 mm
Weight:	100g

11.2 Remote trigger

cable length:	2,5m
Dimensions (W x L x H):	30 x 100 x 20 mm
Weight:	30g

11.3 Wire Encoder

Wire stroke:	1250mm (49,2 in)
Max. Acceleration:	5g
Measuring resolution:	8 imp./mm
Cable length:	2m (78,7 in)
Supply Voltage:	5V
Power consumption:	40mA
Dimensions (W x L x H):	50 x 40 x 80 mm
Weight:	600g

11.4 Actuator

Supply Voltage:	5V
Power consumption:	250mA
Cable length:	2,5m (98,4 in)
Dimensions (W x L x H):	40 x 200 x 40 mm
Weight:	300g

11.5 Friction Wheel Encoder

Supply Voltage:	5V
Measuring resolution:	8 imp./mm
Cable length:	2m (78,7 in)
Power consumption:	100mA
Max Shaft Speed:	6000 RPM
Axial/Radial Shaft Load:	2.5kg max
Dimensions (W x L x H):	40 x 80 x 65 mm
Weight:	150g

Specifications subject to change without notice.