Specification example

LASE project no.: xxxxx

TLP - Truck Lifting Prevention

Version 1.3

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1 Scope

This document describes the functions of the LASE measurement system with functions for Truck Lifting Prevention System (TLP) for ARMG cranes.

The TLP is a system which generates an alarm in case a trailer has been lifted up by the crane because one or more twist locks are still connected to the container.

1.1 Used symbols

The book symbol shows, that in the text is referred to additional documents or documentations of the respective manufacturer of the component

ATTENTION! - This symbol with the yellow triangle indicates dangers. Text passages marked with this symbol should be read very carefully and to be followed to avoid accidents!

The “i” symbol indicates text passages with special notes/information. This text passages should be read carefully.

1.2 Abbreviations

API	Application programming interface
ARMG	Automatic Rail Mounted Gantry Crane
ACRMG	Automatic Cantilever Rail Mounted Gantry Crane
CCS	Crane Control System
CS	Control System
Dll	Dynamic link library
IPC	Industrial Personal Computer
LCU	LASE Control Unit
PLC	Programmable Logic Controller
STS	Ship to Shore
TCP/IP	Transmission Control Protocol / Internet Protocol – network protocol
TLP	Truck Lifting Prevention
2D	2 dimensional
2D laser scanner	Individual laser scanner without swivel platform

2 Requirement

In some cases it might happen, that a Truck-trailer is lifted up by the hoist of the crane when one or more twist locks are still connected (or not completely loosened) to the corner castings of the container, positioned on the trailer.

A system is needed which detects the lifting of the trailer early enough. The system shall generate an alarm signal to stop the hoist movement, before serious damage or insures happen.

3 Solution

The LASE solution is a measurement system working with two 2D-Laser scanners, mounted at the gantry of the crane with vertical scan planes aligned towards the truck lane. In case the system detects a lifting of the trailer it is generating an alarm and forwards this alarm to the crane PLC.

To keep the system as simple as possible in standard configuration just digital in- and outputs are used. As an option a TCP/IP connection between the PLC and the LASE system is possible as well.

The system is based on the following hardware:

2 x 2D-Laser scanner LASE2000D

1 x Control Cabinet with LASE Control Unit, WAGO-DI/O Modules (optional - TCP/IP telegrams -), Power supplies, etc.

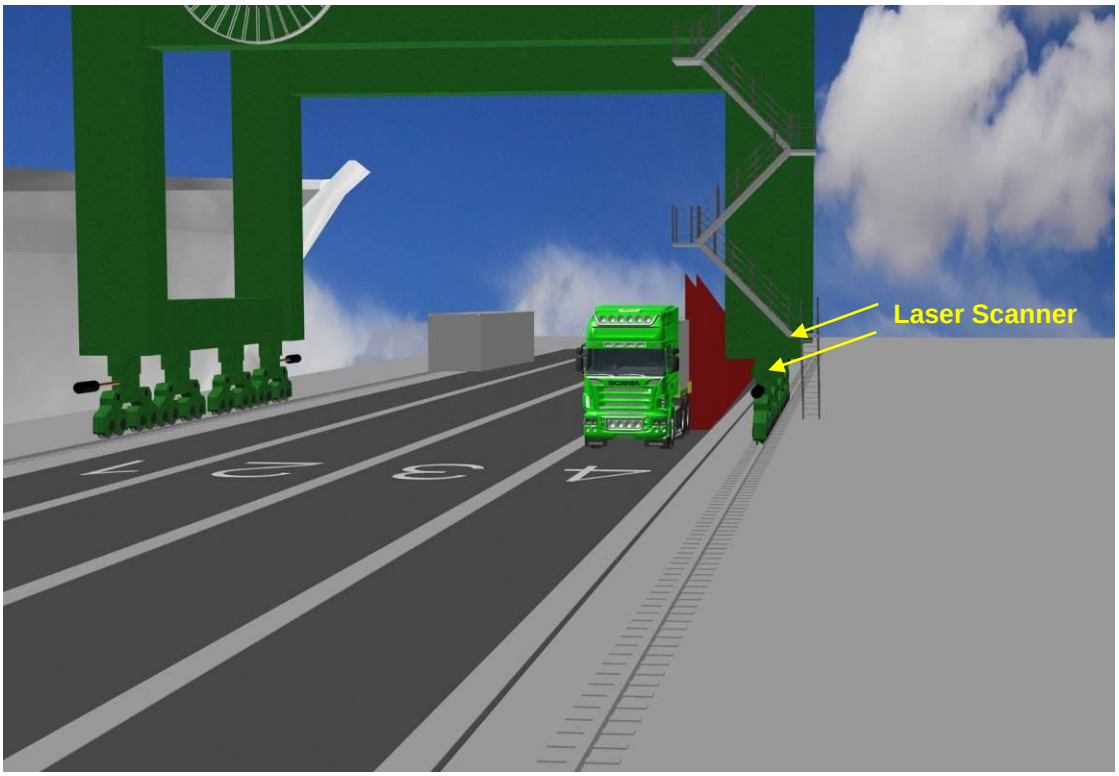

Figure 1: 2 x 2D-Laser scanner with scan panes

4 Hardware

The Lase measurement system consists of the following hardware components.

4.1 2D-Laser scanner (LASE2000D-118)

The laser scanners out of the LASE 2000D-118 Series is a two-dimensional contactless distance measuring system designed for industrial environments.

2D profiles of the surrounding are scanned by a pulsed IR laser beam which is transmitted via a rotating mirror head. The 2D contour data of the scanned surroundings, which is figured in constant raw data, combines distance and angle values as delivered output by the scanner interface. The sensors transmit extremely short multiple light pulses, measures the running time of these pulses to the object and back and computes the distance. The measuring data will be sent over Ethernet in nearly real time. Innovative beam forming optics allow accurate object profiling and high measurement accuracy. Internal compensation assures measurement results which are independent of target color, reflectivity and temperature.

For operation, the modular LASE CEWS Application software is controlling the scanner and evaluating the scan data.

Figure 2: 2D-Laser Scanner LASE 2000D-C118

Description	value
Measuring range (at 10% remission)	26m (max 80m / 100% remission)
Min. Measurement Distance	0,7m
Measuring frequency	25 / 100Hz
Angle step (scanner)	0,1667 – 1°
Scan range	90°
Resolution	±3mm
Wave length Laser	Infra-red (905nm)
Laser Class	Class 1 (eye-safe), to EN/IEC 60825-1 and 21CFR 1040.10 and 1040.11
Power	24V DC
Interface Laser	Ethernet 100 Mbit/s
Weight	ca. 3,7Kg
Temperature range	-30 – +50°C (with heating)
Protection category	IEC IP 67

Table 1: Technical data LASE2000D-118

4.2 Sun/weather protection

To protect the scanner against direct sunlight, rain etc. an appropriate protection shield should be used. The light of the sun itself does not really influence the operation of the scanner. But to keep the working temperature of the scanner in a normal range and to avoid overheating we recommend installing such kind of weather protection.

The picture below is showing a weather protection from LASE portfolio. The protection shield is mounted at the same adjustment support as the scanner.

It's not allowed to do any welding work close to the 3D-scanner if installed.

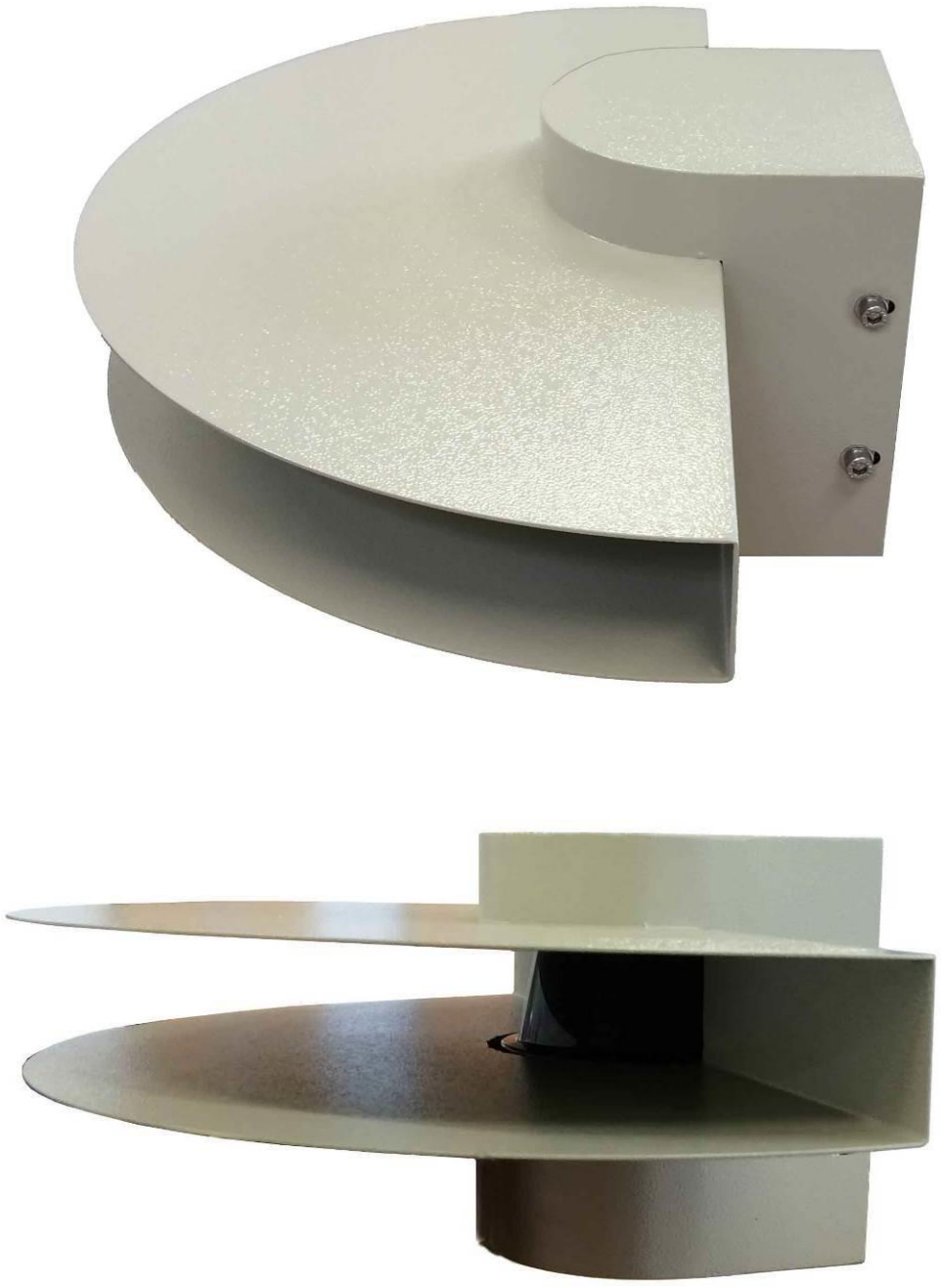

Figure 3: sun/weather protection

4.3 LASE Control Unit (LCU)

The LCU is a standard industrial PC (IPC). The LCU should be equipped with the state of the art technology with following performance data:

Component	Description
Operating system	Windows 7 32 Bit
Processor	Core-i Serie i3 or similar
RAM	4GB DDR3-RAM 1333/1066
Drives	HD 250GB 7200T/min 24/7 1 x CD/DVD
Grafik controller	External grafik adapter, no on-board graphic!! OpenGL 2.0 compatible 1GB RAM VGA / DVI etc.
Interfaces	2 x LAN RJ45 (Ethernet 100/1000 Mbps) 4 x USB 2.0

Table 2: Technical data LASE LCU

Due to the reason that the LASE application has to perform the TPS function nearly in real-time, it is **not** recommended to install any other application on the same IPC. It is also not recommended to use any virus scanner on the IPC because the virus scanner could block necessary resources which could cause delays in the data transmission. This could lead to dangerous situations.

4.4 Hardware overview

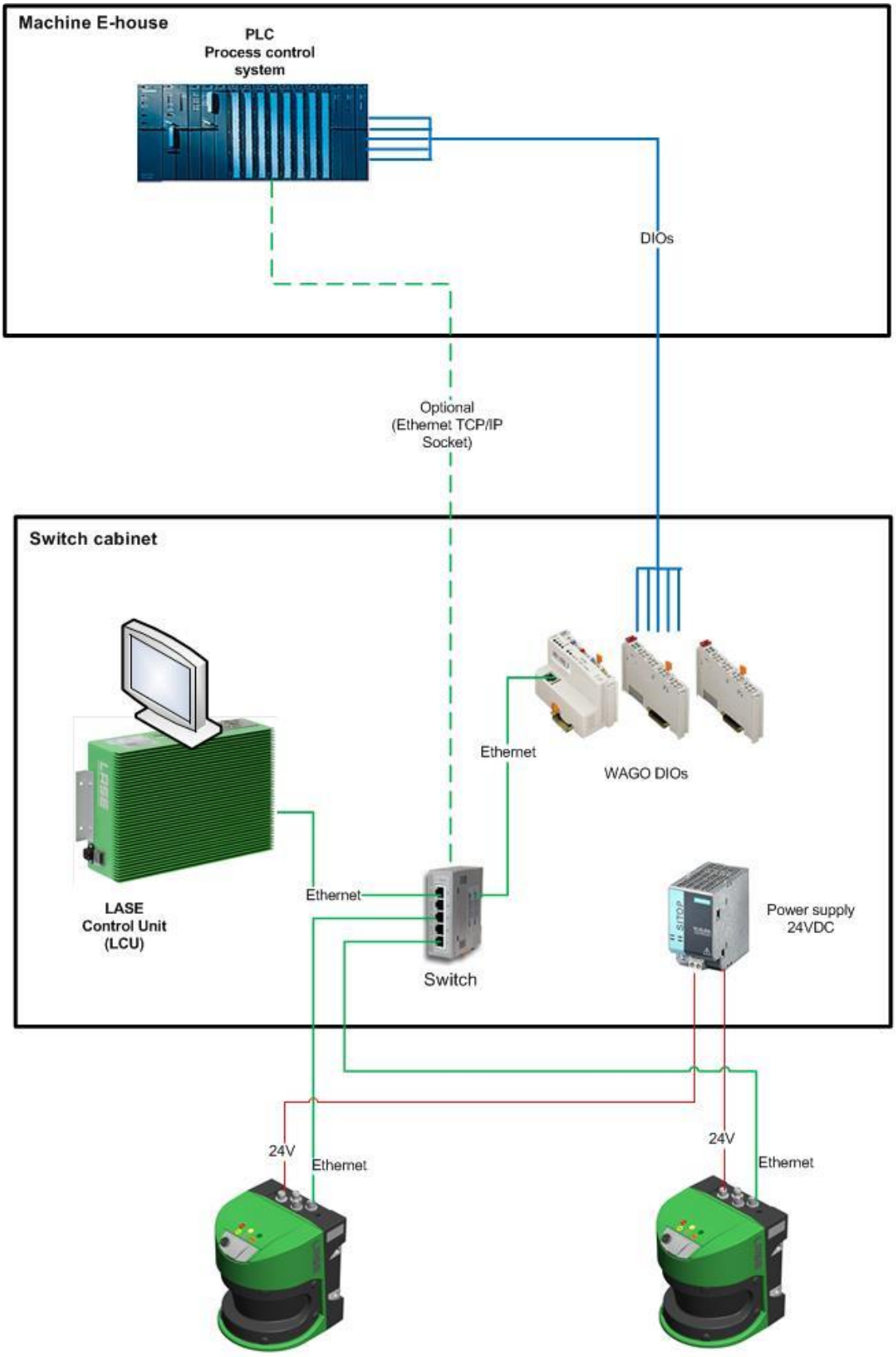

Figure 4: Hardware overview

5 Measurement system

5.1 General conditions

For a reliable and accurate working measurement system following general conditions is expected:

- **Temperature range:** **-20**°C to +50°C
- **Truck lane:** only the truck lane close to the gantry can be checked
- **Distance 2D-Scanner ➔ LCU** max. 60m
- **Container types** **20', 40', 45'**
  Standard,
  reefer,
  covered open top
- **Usage of TPS functions** Truck must be stopped
  Truck has stopped at crane center position !

5.2 Mounting position 2D-Scanner

The both 2D-Scanners must be mounted at an appropriate position at the gantry next to the truck lane. The alignment of the scan plane is vertical, in an angle of 90° to the travel direction of the crane (rails) and the scan plane is showing towards the truck lane.

To get a reliable and safety working system, two 2D-Scanners are used. The distance between the scanners should be as wide as possible, but less than the length of a 20' container. Both scanners should have the same distance from the crane center (trailer positioning point).

This configuration allows scanning (checking) the rising gap at 2 different places at the same time. This is increasing the reliability.

The drawing below shows the above mentioned points as a top view image:

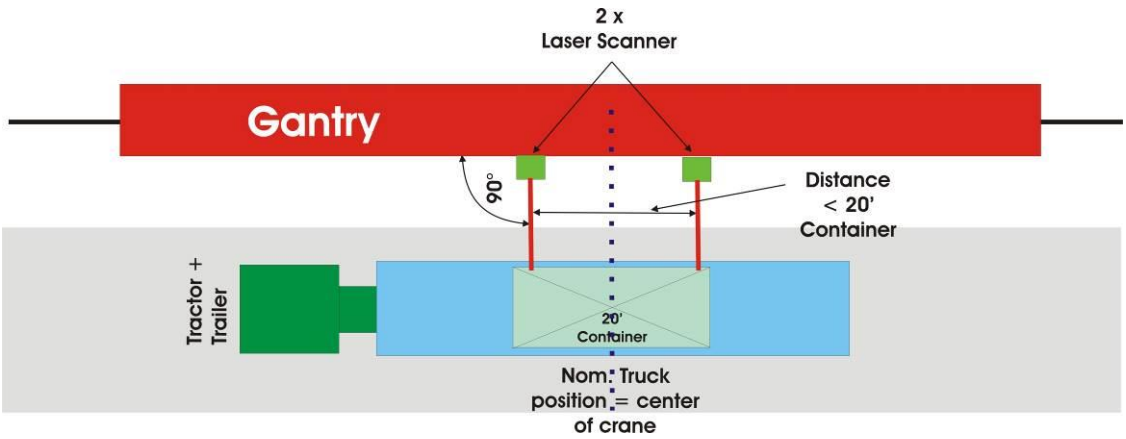

Figure 5: Top view - position/alignment of laser

The next drawing is showing the same situation from a different view. The scan planes are going horizontal and are running over the container, the trailer until the ground level. The scanner (origin) should be mounted in a height of the top edge of the trailers. If different trailers are used the mounting height should be approximately the height of the top edge of the most trailers.

In ideal case, when the container is hoisted up, the scanner can clearly detect the rising gap between the trailers top edge and the lower edge of the container. Due to the circumstance that 2 scanners are used the detection is more reliable.

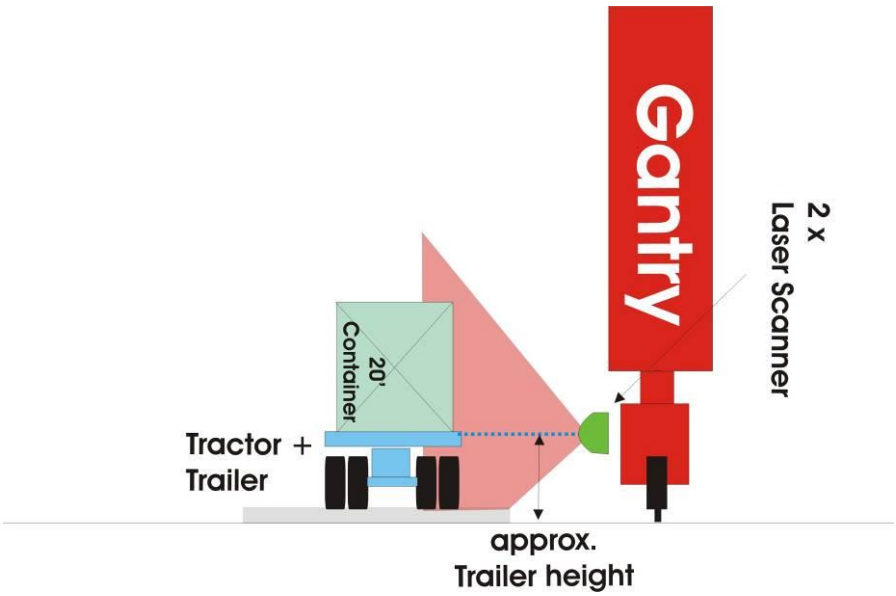

Figure 6: front view - position/alignment of laser

The scanners are equipped with an adjustment support which allows correcting/adjusting of all needed alignments in all directions.

6 Function of TLP

6.1 General

The TLP function has to be triggered by the PLC. All internal sub-functions are then controlled by the applications state machine autarky.

In the standard configuration the simple communication between PLC and LASE system is realized via digital IN & OUTsignals. There are signals which are switching the LASE system active, starting the measurements and signals indicating warnings or an alarm.

6.2 Truck lifting check

When the LASE system was triggered by the PLC, it is tracking the upper edge of the hoisted container, as also the lower edge from the trailer chassis. Additionally it is checking, whether a gap between the trailer and the container occurs. In case only one scanner is detecting a rising gap or, if there is a significant difference between both rising gaps, the system generates an alarm. Also, if the lower edge from chassis will lift up in same way as the upper container edge.

The first shown cases below (20' container) are probably the worst cases, especially if only one laser scanner would been used. One scanner would have its scan plane probably at the center of the crane. The gap between the trailer and the container, by lifting up the trailer, is quite too small. By using of 2pcs. of laser scanners, the gap would be measured outside of the center line – near to the front and rear container head. Here the rising gap would be much larger and more reliable to detect. By using of 2 scanners, our system can detect much more critical cases of incorrect container lifting's.

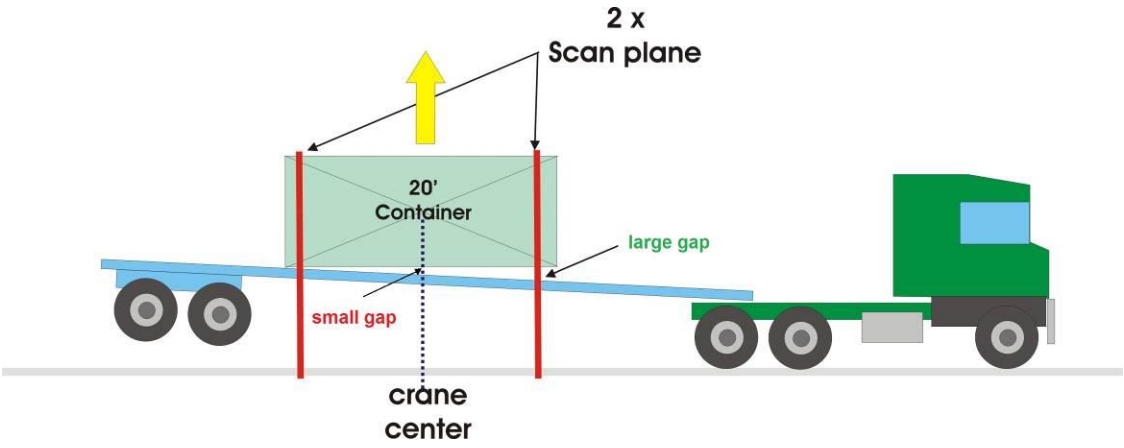

Figure 7: Trailer lift – 20' center position, end fixed

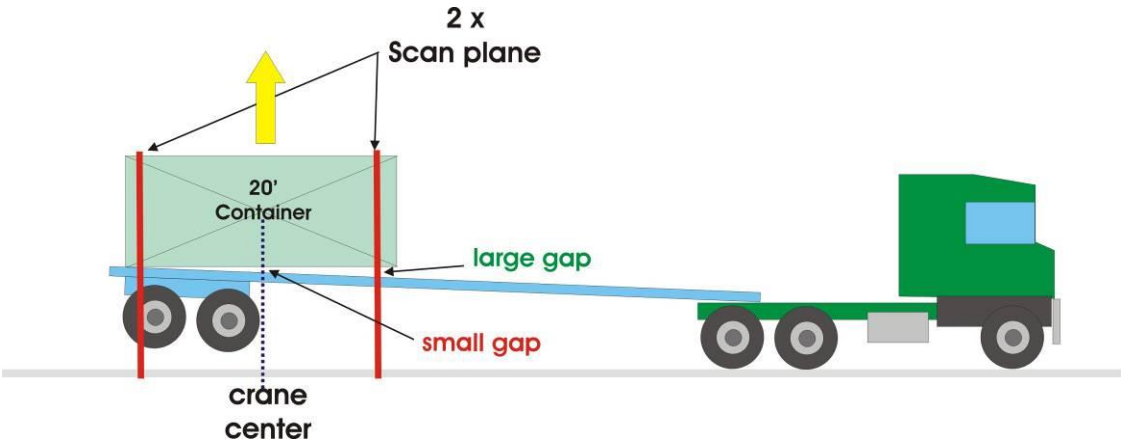

Figure 8: Trailer lift – 20’ rear position, end fixed

The 20’ container in front position would show a similar behaviour. The next drawing is showing the situation when the container is still connected to the trailer at its front end.

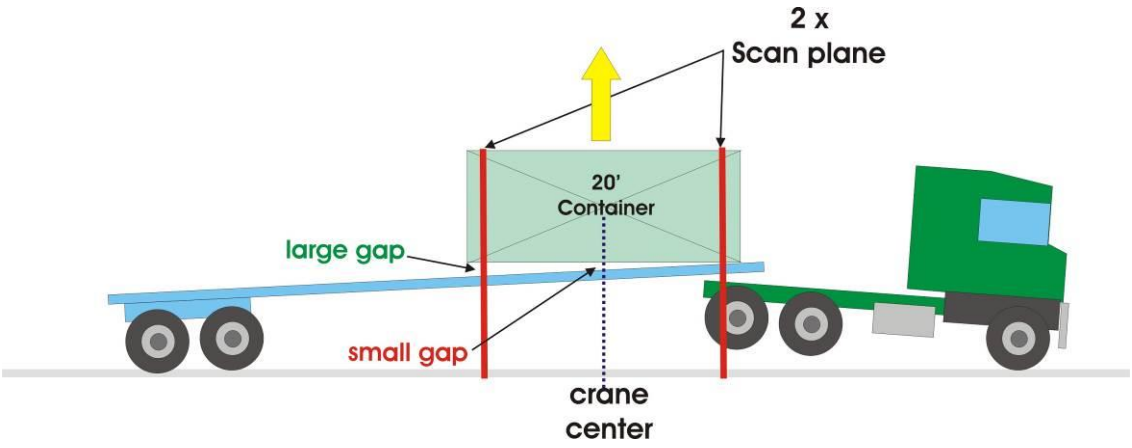

Figure 9: Trailer lift – 20’ front position, front fixed

The example below shows a situation with a 40’ container. This is also much easier to detect, in case, that the rising gap is larger and probably both scanners will clearly detect a gap.

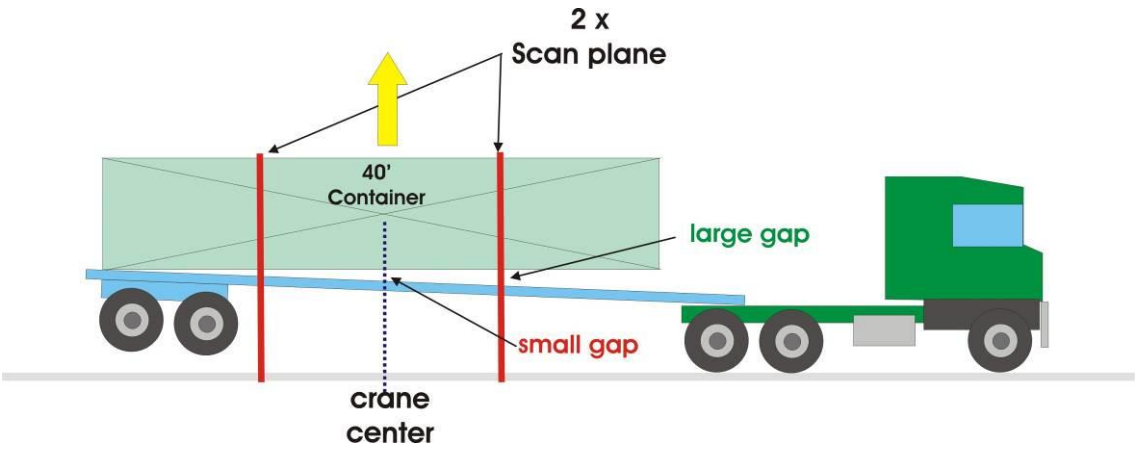

Figure 10: Trailer lift – 40’ center position, end fixed

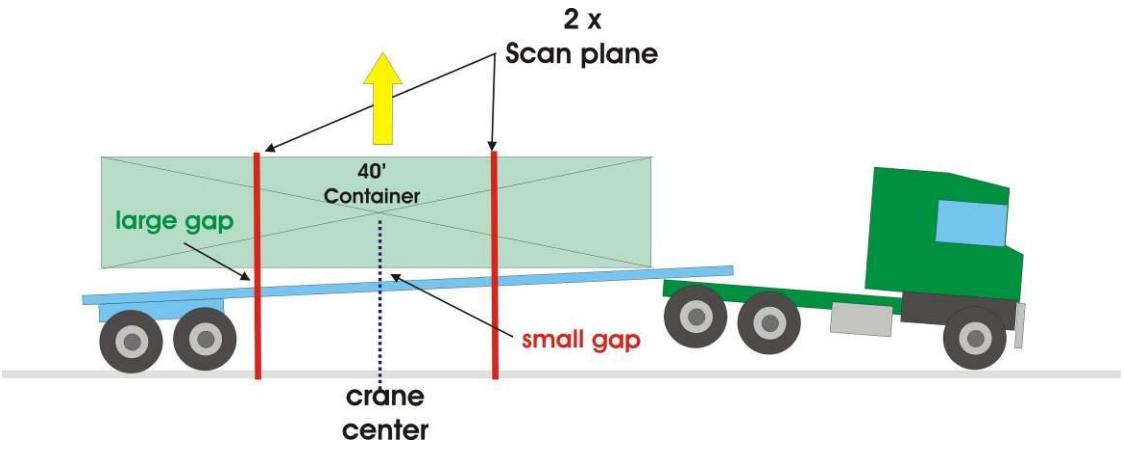

Figure 11: Trailer lift – 40’ center position, front fixed

6.3 Measurement Sequence

The internal sequence for TLP can be triggered the spreader is locked to the container and before the hoist movement starts.

The usual sequence is as follows:

- Crane/Spreader is lowered target position/container on trailer
- PLC triggers (START) the TLP function
- TLP is activated and starts the measurement
- The LASE Software calculates on basis of the scan data whether a trailer is lifted up with the container or not
- In case a lift is detected the LASE system is generating an alarm and is sending the alarm to PLC
- PLC sends stop trigger if hoist has reached a certain position. Alternatively LASE is stopping the measurement when hoist has reached a certain position.

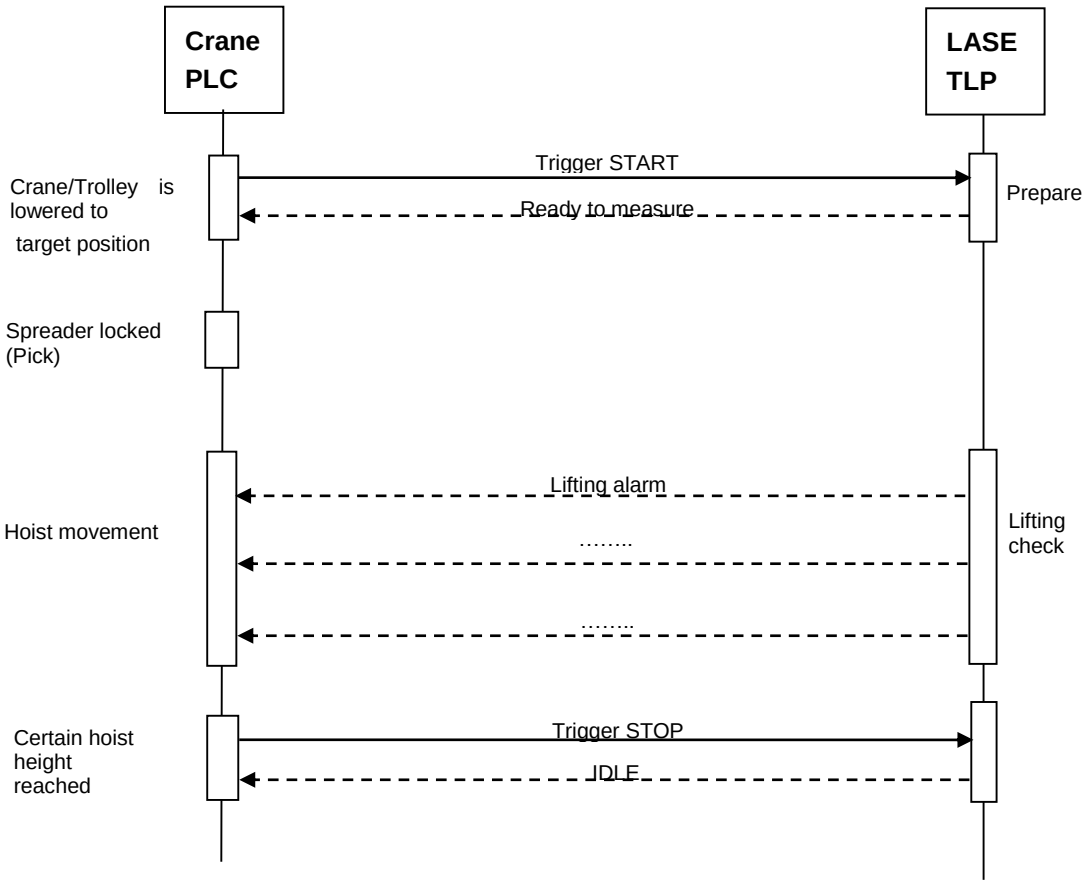

Figure 12: TLP sequence diagram

7 Communication

As mentioned the standard configuration provides a simple interface which is using just digital IN- and OUT switching signals for controlling the LASE system respectively for the warning and alarm indication.

As an option the system can be fitted with a TCP/IP interface, to handle more flexible.

7.1 Digital in-/outputs

Input:

- Activate system
- Start measurement (active until measurement shall stop)
- Etc.

Output:

- System active
- Measurement active
- Warning (e.g. scanner polluted)
- Lifting alarm

7.2 TCP/IP telegram (optional)

The communication between Crane control system (PLC) and the LASE measurement system can also use a TCP/IP Ethernet socket connection. Via this communication channel all necessary information are send via telegrams.

The TLP session setup requires that one of the communicating parties initiates session establishment (“client”) and the other party waits for and accepts incoming connections (“server”).

The LASE application acts as the server and the crane PLC is the initiating party.

The implicit content of the telegrams his defined in a separate document.

Input:

- Trigger START Measurement
- hoist position
- Container length
- Etc.

Output:

- Status (like system active, internal mode, scanner status etc.)
- Warnings
- Lifting alarm

8 Software

The software consists of the modular application framework LASE CEWS Basic and the project specific application core.

8.1 LASE CEWS Basic

The LASE CEWS Basic Module is the framework software of the LASE CEWS application core and consists of following modules:

- Communication module laser (parameterisation and data handling for following laser types (LASE 2000D, 2000T, 3000D-Series) following interfaces are usable according to the laser types – Ethernet TCP/IP, RS 422
- Communication module Input/Output, parameterisation and data handling for following Input/Output modules: SPS, Level 2 und Level 3 (further on request); following interfaces are supported: – Ethernet TCP/IP, Profibus (optional),
- Communication LASE CEWS application core measurement data processing and handover to the application core
- Data recorder function: all measurement- and process data are permanently and completely logged. For analysis- and simulation purposes the data can be written back into the program.
- Graphical operating surface: for a simple and intuitive usage of the measurement system, incl. status messages, result displays, controlling
- 2D- and 3D-Visualisation: For the visualisation and evaluation of the measurement data. Scan image in 2D- and 3D-images, zoom function, free selectable perspective
- Application parameter: dialogue guided input of the process parameters for hardware and software
- Error- and event lists: Logging and display of error and events for a quick diagnostics

8.2 LASE CEWS Application Core

The individual software consists of following functions for TLP:

- Truck lifting check
- Communication interface
- Calibration

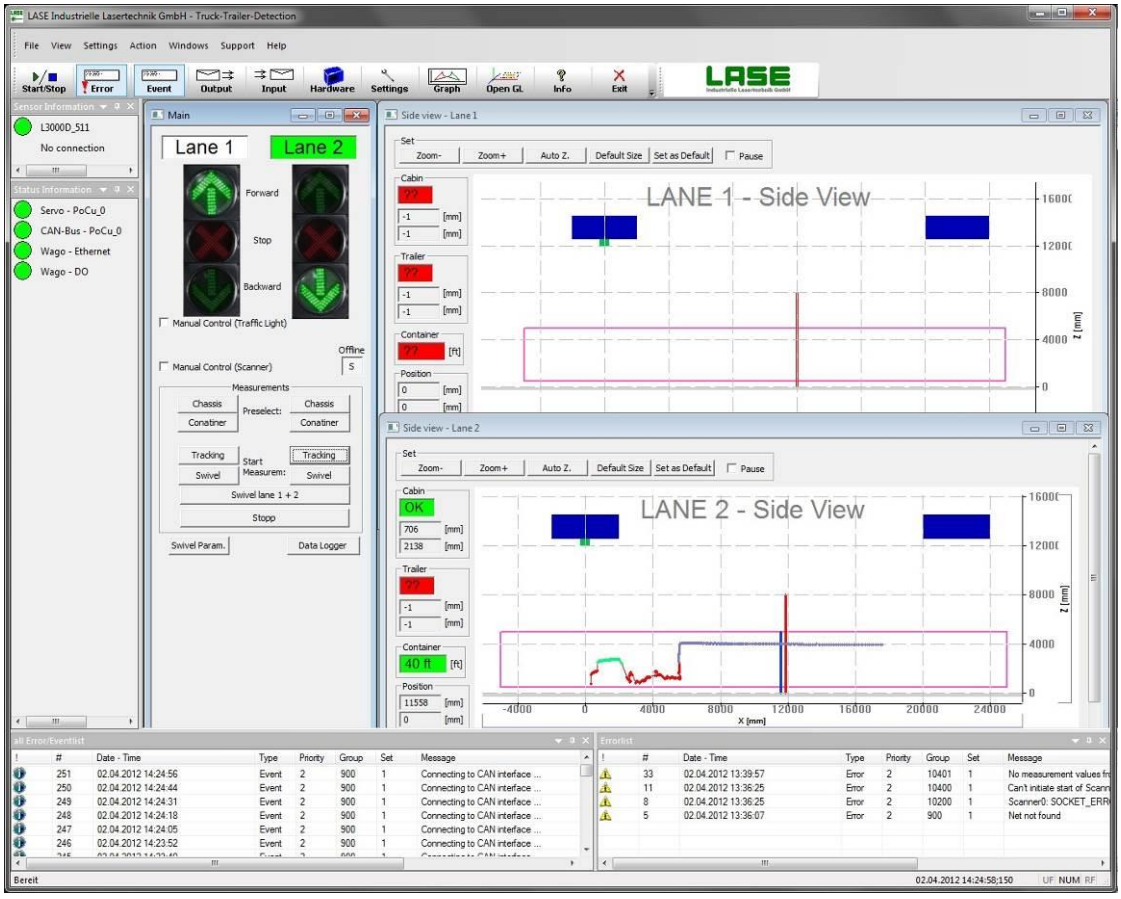

Figure 13: Software example from a truck positioning system on a STS

The above shown screenshot is from a truck positioning system. In general all LASE application are having the same look and feel. There is coloured status LEDs at the left hand side. These are shown for all connected hardware devices as well as for the interface connection. On the right hand side 2D-views are showing the current scan data of the connected laser scanners.

At the bottom tables are showing the event and error messages.

9 Delivery

9.1 Exclusion

- Mechanical ground construction, building, mounting and documentation
- Electrical construction, building, cabling and wiring to the existing PLC control
- Programming of the existing PLC control to activate our Measurement system
- Installation of the equipment
- Reference marker (by commissioning phase only)

For providing fast and effective commissioning we expect:

- Support during commissioning
- Remote Control Access during commissioning

9.2 Scope of delivery

Following items will be delivered or are included in the user manual:

- LASE TLP application user manual
- Guideline of mounting the Laser scanners
- Trouble shooting guideline
- Interface description