

AUTOMATISCHER LEIT COMPUTER (ALC)

INTRODUCTION:

- The high demands placed on the quality of the track geometry & the tight acceptance tolerances for tamping work require the highest degree of precision for the work processes.
- To meet these requirements, a guiding computer with specially developed software is used to control a tamping machine.
- The “Win-ALC” is the next generation of the well proven Plasser “ALC” track alignment computers.
- The system is designed as an addition to enhance and improve the performance of Plasser tamping machines lining and lifting systems.
- The program is not tailor made for one specific country but contains all the main elements for world wide applications.
- Our WinALC software is currently available in 17 different languages , including Japanese & Chinese.

OBJECTIVE:

- The WinALC software was developed with the objective of making its use as easy & efficient as possible for the machine operator.
- By using the windows user interface, operation is familiar & intuitive.
- Geometry and correction data can be input graphically or in table form or the data can be read in from storage media provided by the infrastructure operator.

HARDWARE:

- An industrial-grade panel PC is used as hardware, with the PC fitted straight onto the back of the display & the two forming a compact unit.
- Modern Core i7 processor
- 4 GB RAM
- 32 GB flash memory.
- USB port for external storage devices.
- High resolution 15' TFT panel with touch screen display.
- Stainless steel keyboard with integrated touch pad.

DISPLAY:

1. Monitor coverage
2. Clamping lever
3. Locking lever for monitor slope adjustment
4. Clamping lever for monitor slope adjustment



MODES OF OPERATION:

The automatic guiding computer (ALC) has two main areas of application:

- The guidance of the levelling and lining system according to known target geometry and
- The measuring of the actual track geometry with subsequent calculation of the improved course of the new track geometry.

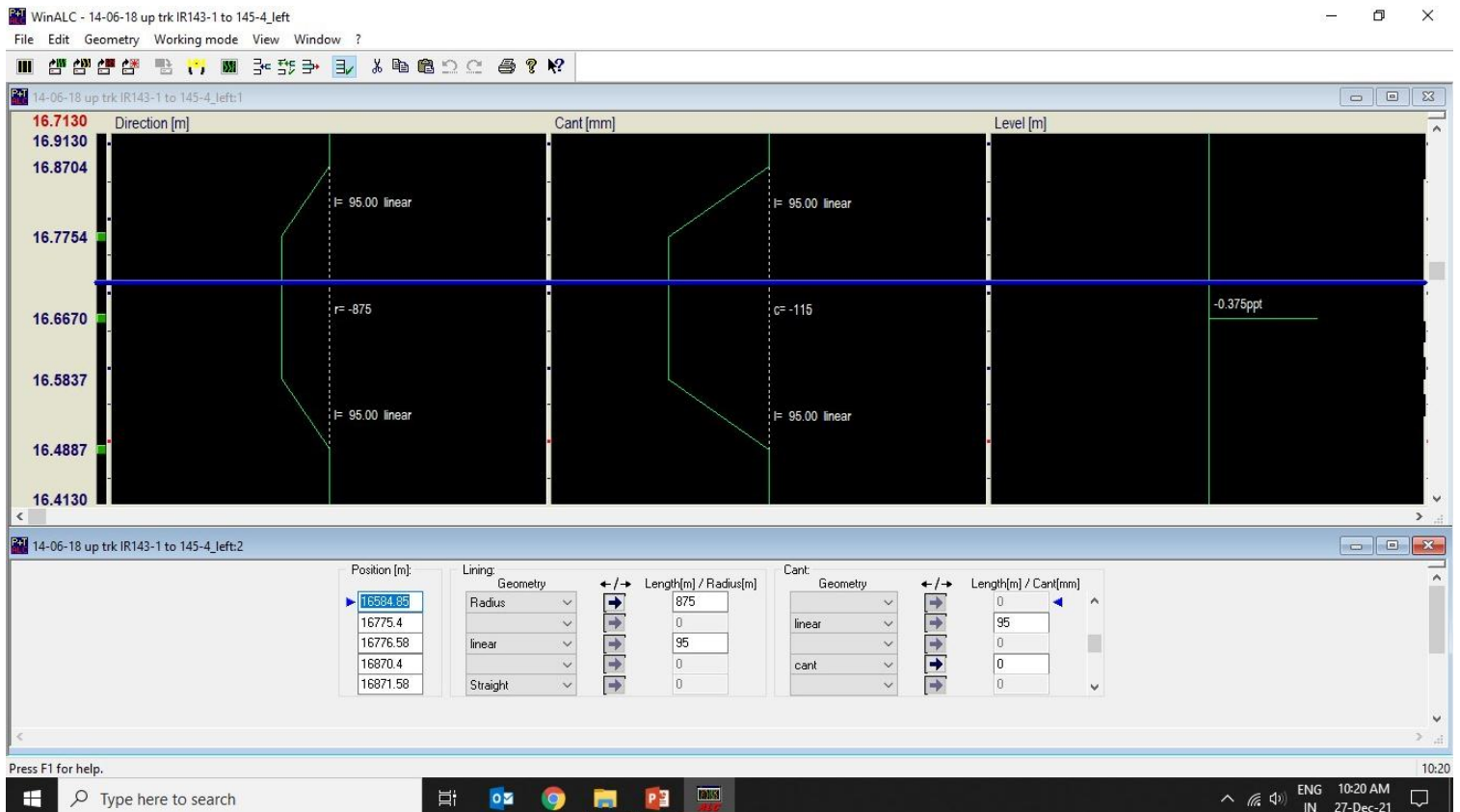
In case of known track geometry:

Prior to work the track geometry data is either keyed in manually or imported from a USB.

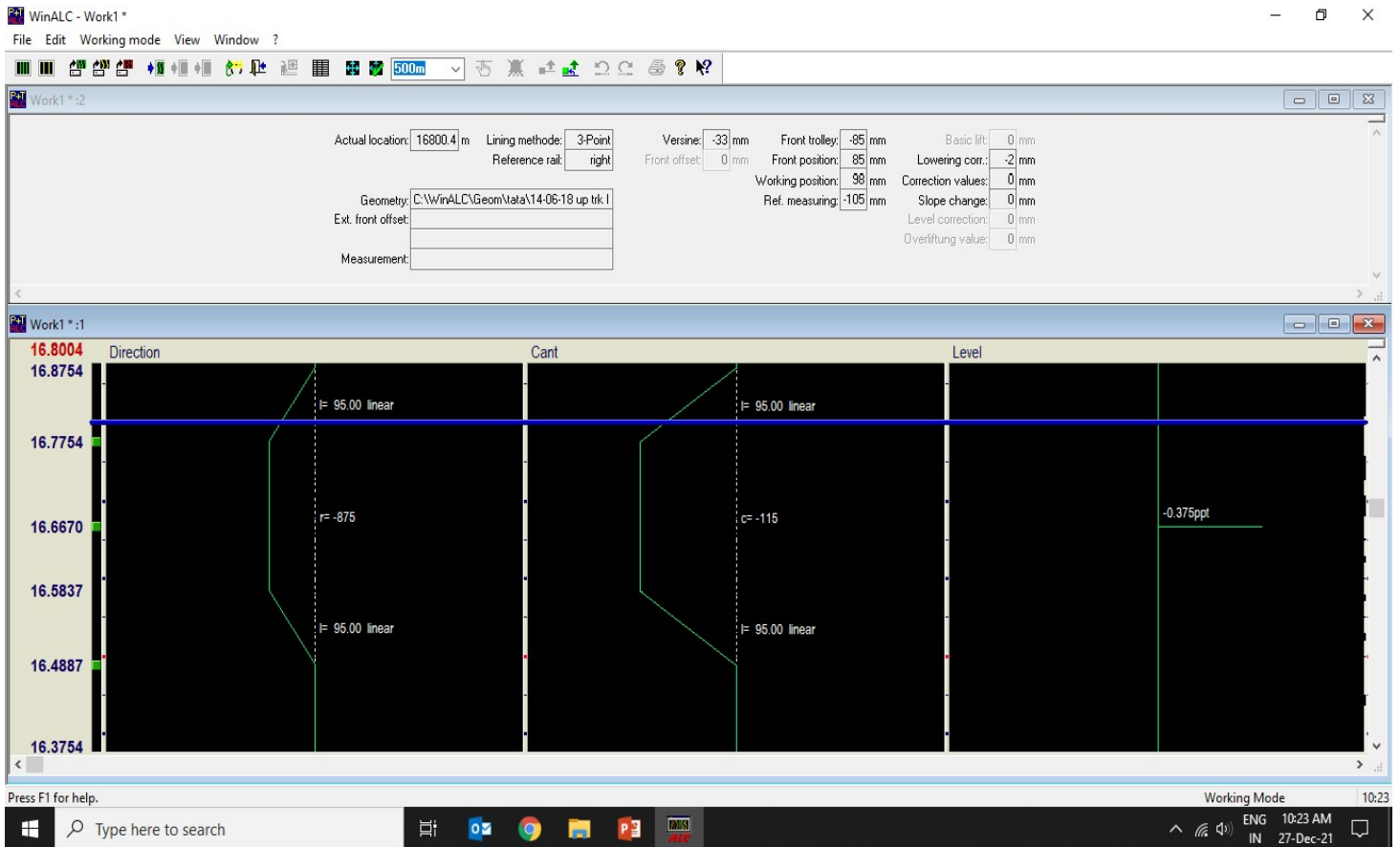
The main input data are:

- Kilometer position of the main points of the curve (start and end of transition, start of curve etc.
- Radii at these points.
- Superelevation at these points.
- Details of gradient changes (α , R_a).
- Path synchronization markers.

During track maintenance the graph moves on the monitor synchronously with the forward movement of the machine. The current position of the machine is shown as a fixed reference line.

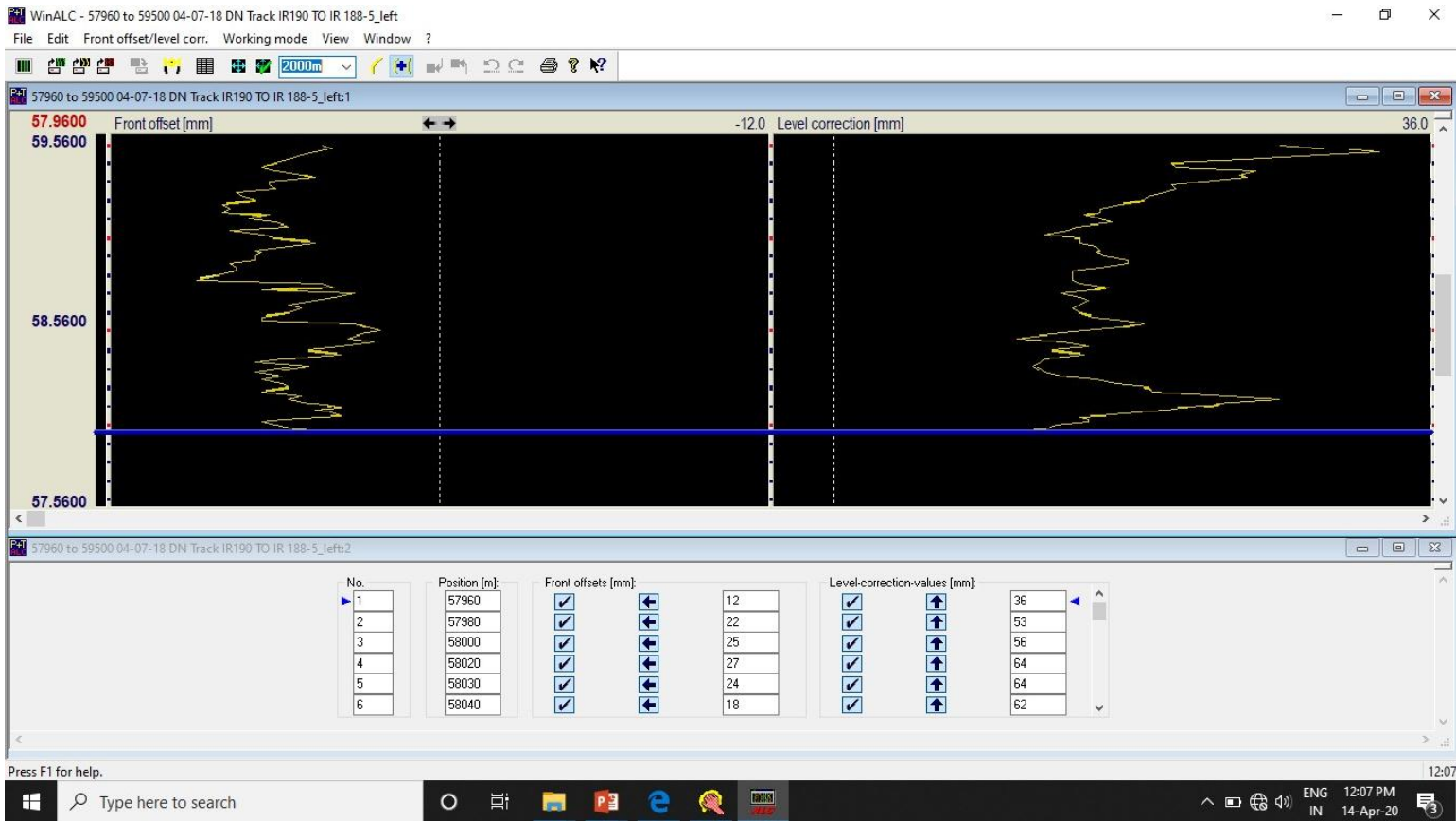


Working mode

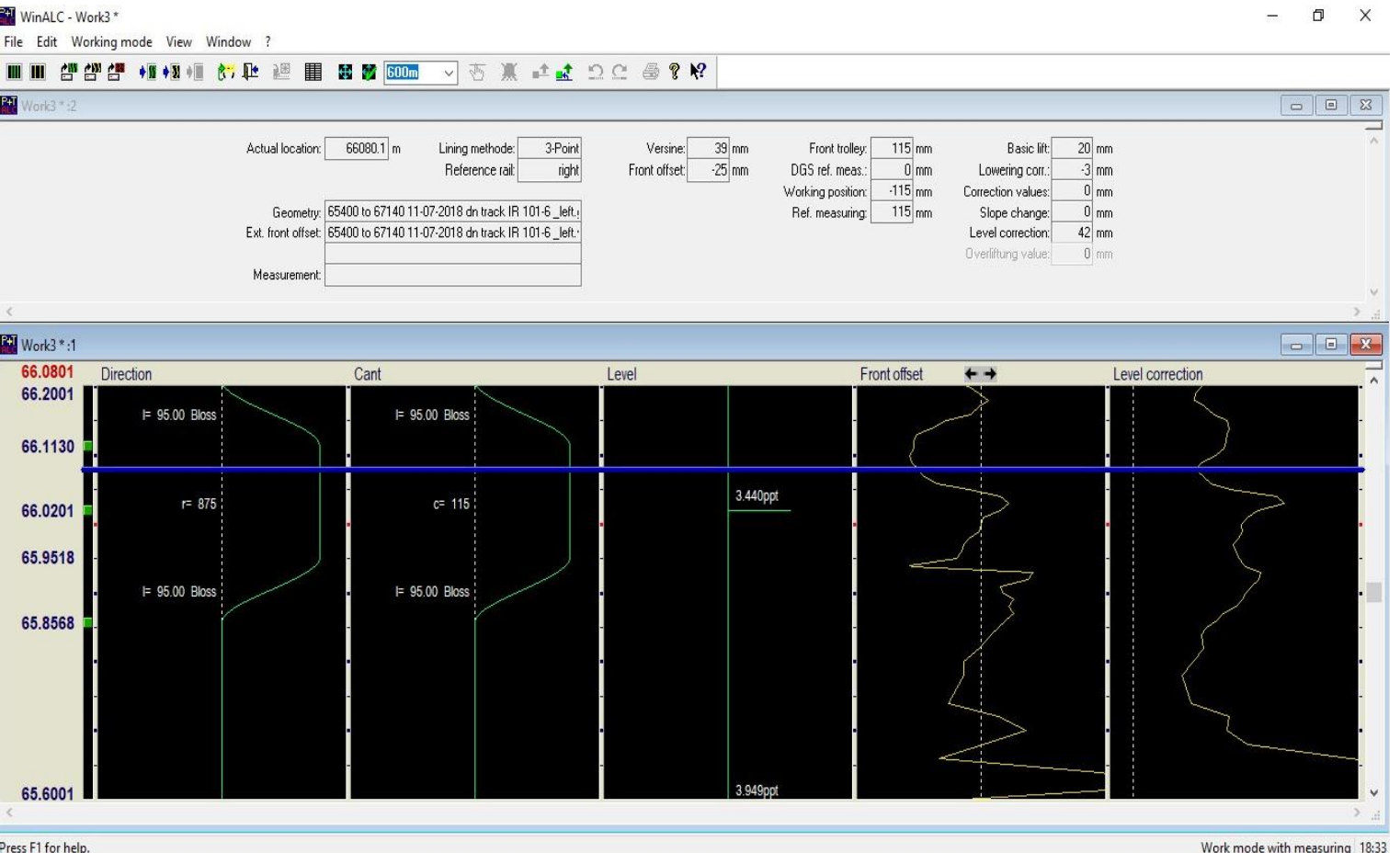


- When working according to the precision method (levelling and 3-point lining method), it is furthermore possible to feed the lifting values for longitudinal level and the displacement values for alignment into the ALC.
- These are either the result of a manual measurement or using the track survey trolley/car.
- Any data provided by the survey trolley/car can of course be entered into the ALC using USB.
- The computer can also assist the production of superelevation ramps by entering the basic lifting value and the crossfall of the ramp.

Front Offsets & Level Corrections



Complete Design Method:



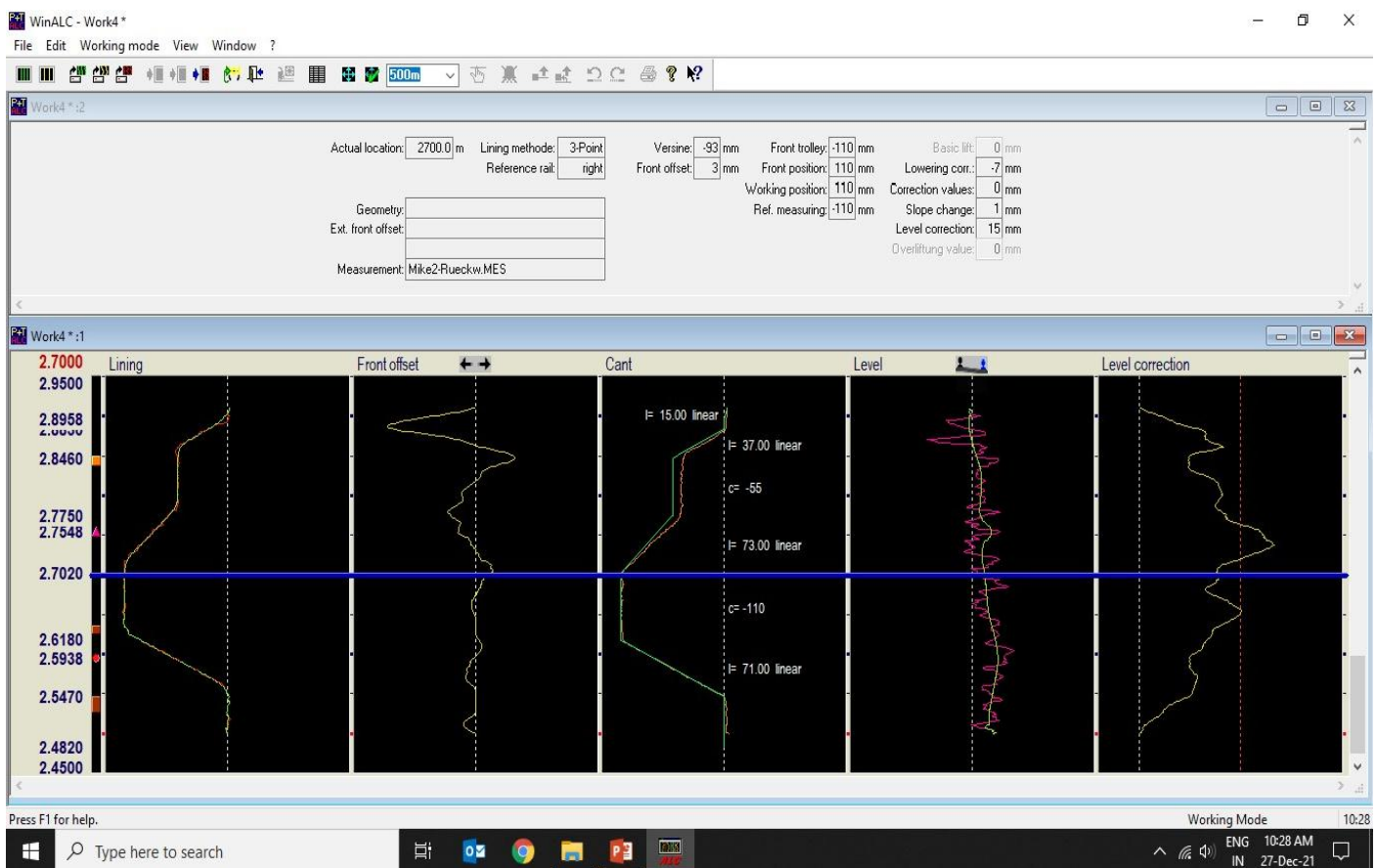
In case of Unknown track geometry:

Using the ALC it is possible to achieve an improved track geometry when its target geometry is unknown. Prior to the maintenance operations a measuring run is carried out.

During the measuring run not only the points of constraint as for instance bridges, level crossings, junction points, platform edges etc. but also fixed points are entered by pressing function keys. For all these points, it is possible to specify definitions in respect to the desired displacement and lifting values as well as the permissible tolerances.

After carrying out the calculations, the resulting main curve data and displacement values are displayed on the monitor. If the operator agrees with the data, the calculated target geometry will be stored. The track geometry correction is automatically controlled.

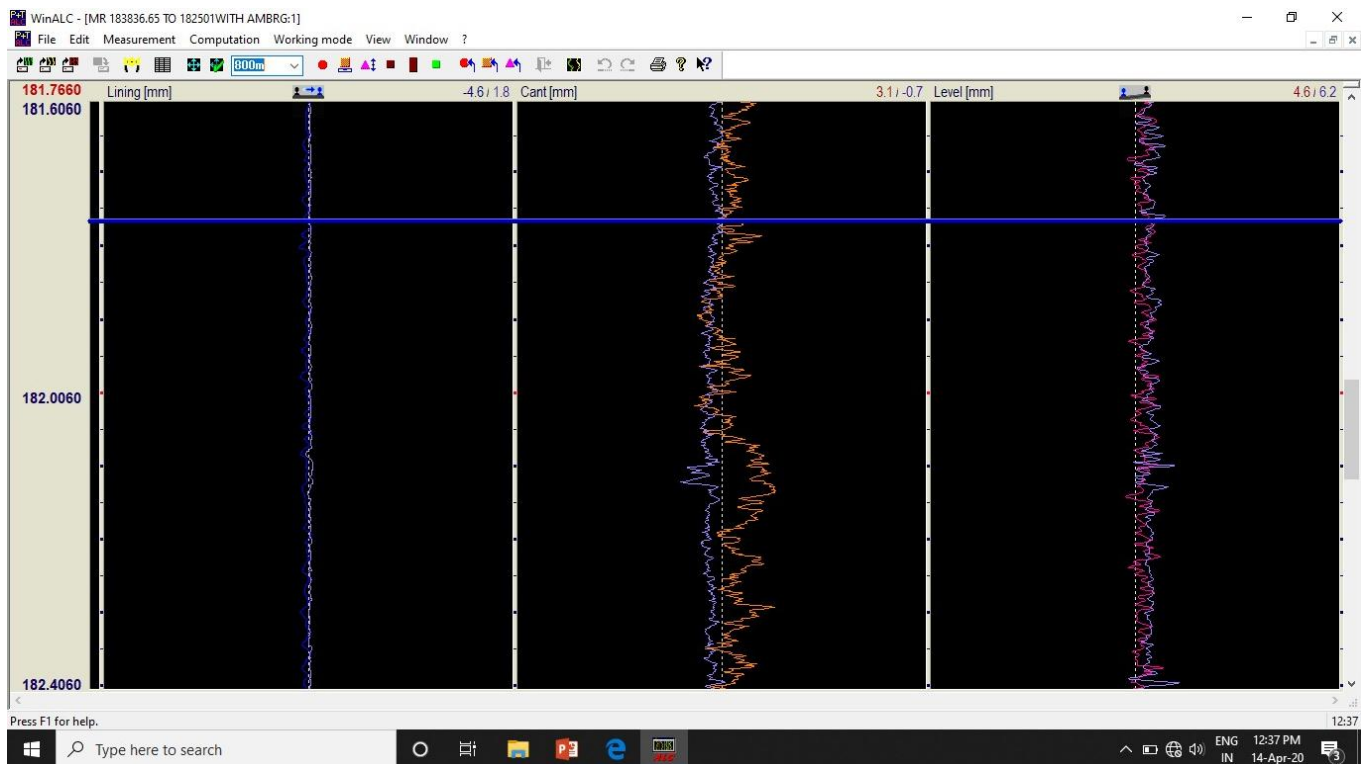
Working Mode:



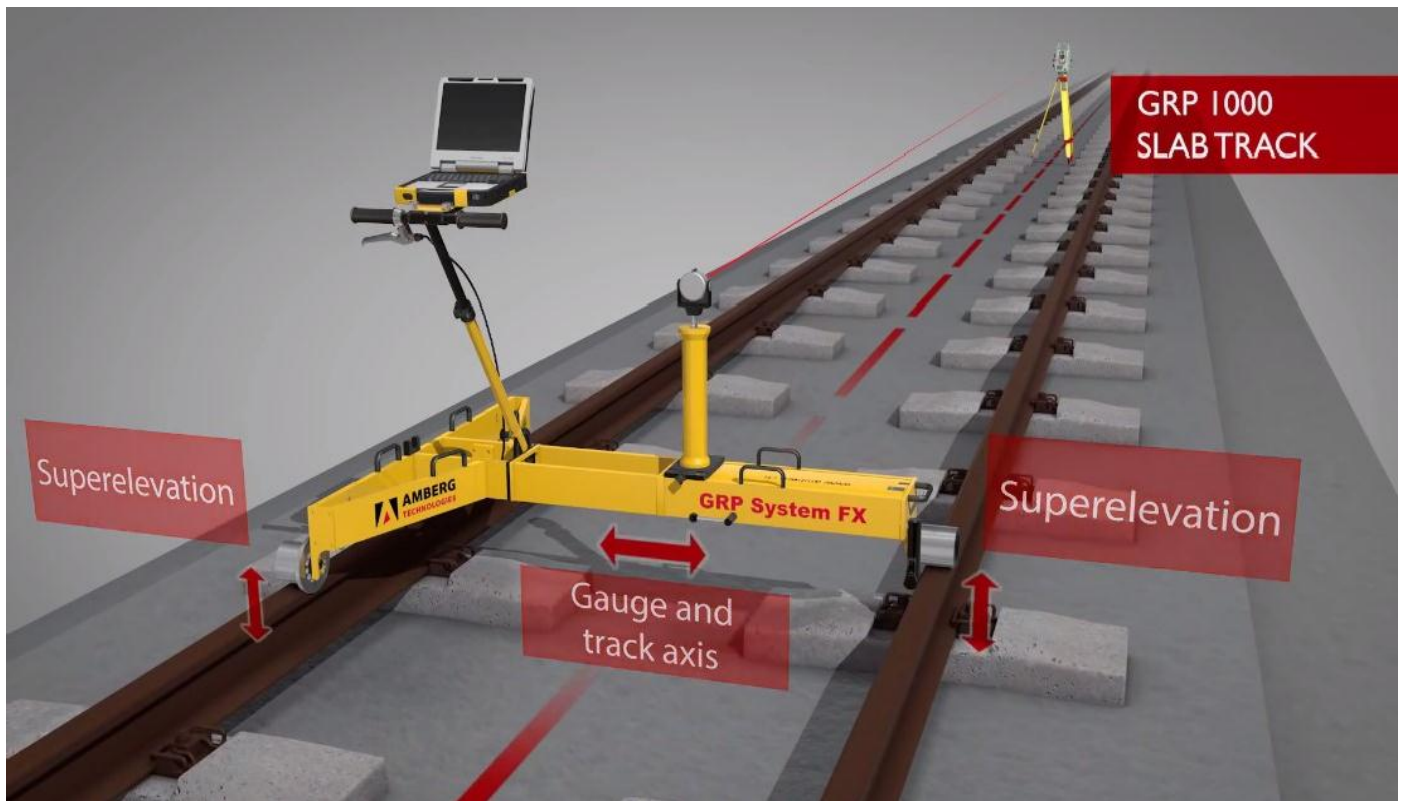
Can I compare before and after tamping parameters?

- Record post tamping parameters again after work.

- Procedure is the same as measuring run without any additional markings.
- Use merge command and both the graphs overlap.
- Care should be taken so that both graphs are in concurrence in length and location.
- The graphs are displayed one over the other in distinct different colours.
- Comparison can be done and machine performance can be studied.
- Merge is done using(control+M), or go to file and choose merge.



TRACK SURVEY TROLLEY:

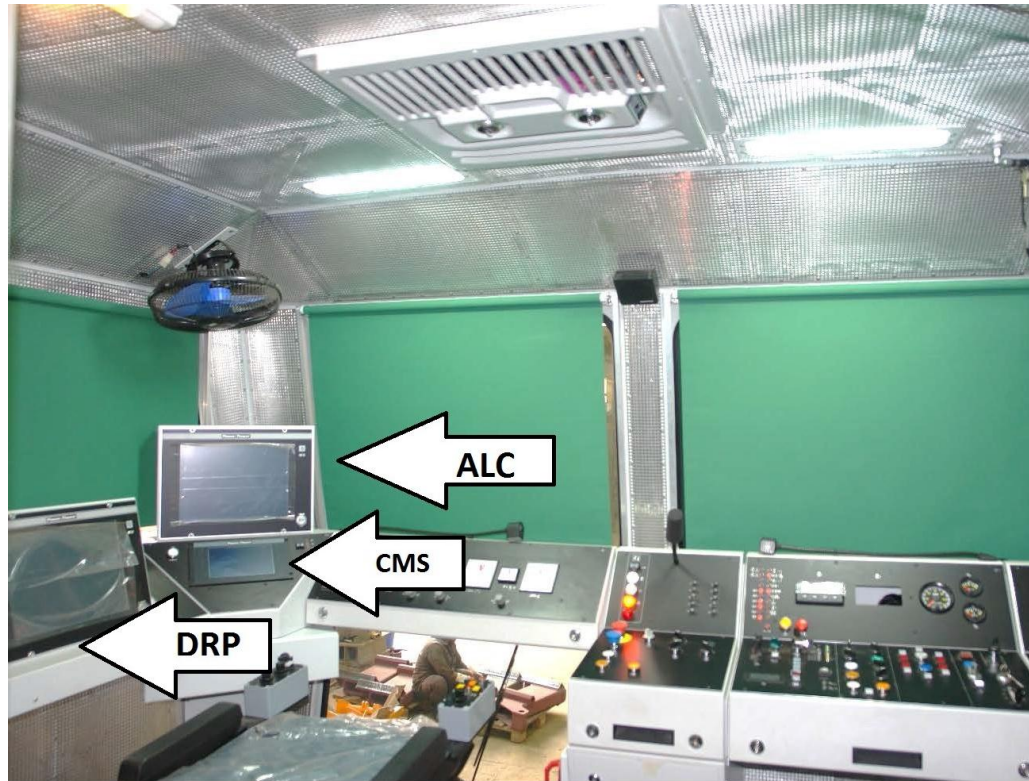


BENEFITS

- Robust hardware for the harsh environmental conditions on tamping machines (VIBRATIONS)
- Specially developed & constantly updated software.
- Varied uses depending on the track situation.
- Communication & exchange of data with other applications (e.g. DRP).
- Direct import of correction data values from various surveying trolleys (Trimble, Amberg, etc.)
- Results easily stored & printed

COMPUTER MEASURING SYSTEM- CMS

Front Cabin

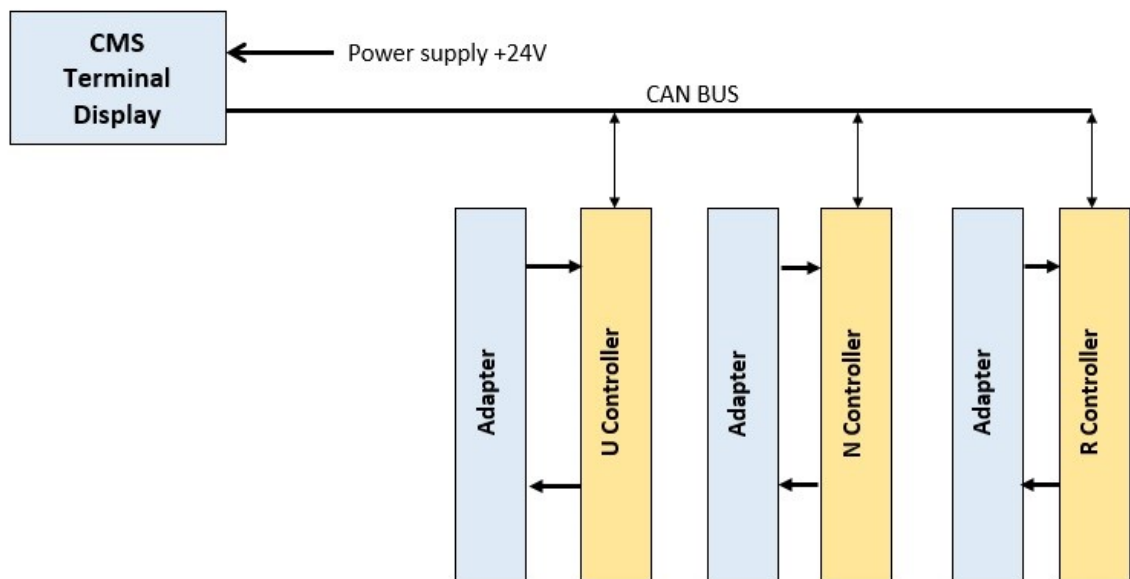


INTRODUCTION:

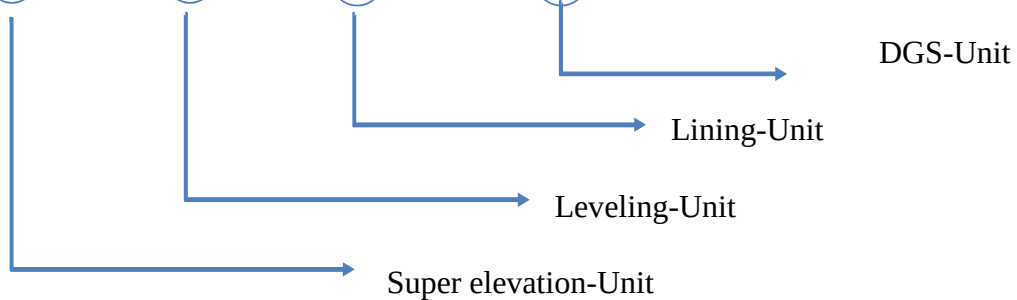
- CMS means Computer Measurement System.
- The analogue measurement system, which was in use up to now, was replaced by a new combined digital / analogue system developed on the base of our well-tried micro-controllers.
- This system comprises the lining unit, the levelling unit with super- elevation control and, if required, the combined laser receiver unit.
- The satellite compensation device (,SATCOM'), which is necessary on machines with continuous operation mode, has been integrated as well.
- CMS is a digitalised method of processing data which are received from various inputs.
- The output of it is used to control a valve for the designated operation.
- It is also used for indication purpose.
- CMS also displays real time track parameter data so that actual correction done can be evaluated.

- It also displays any fault occurring in its system (Diagnosis).

CMS architecture



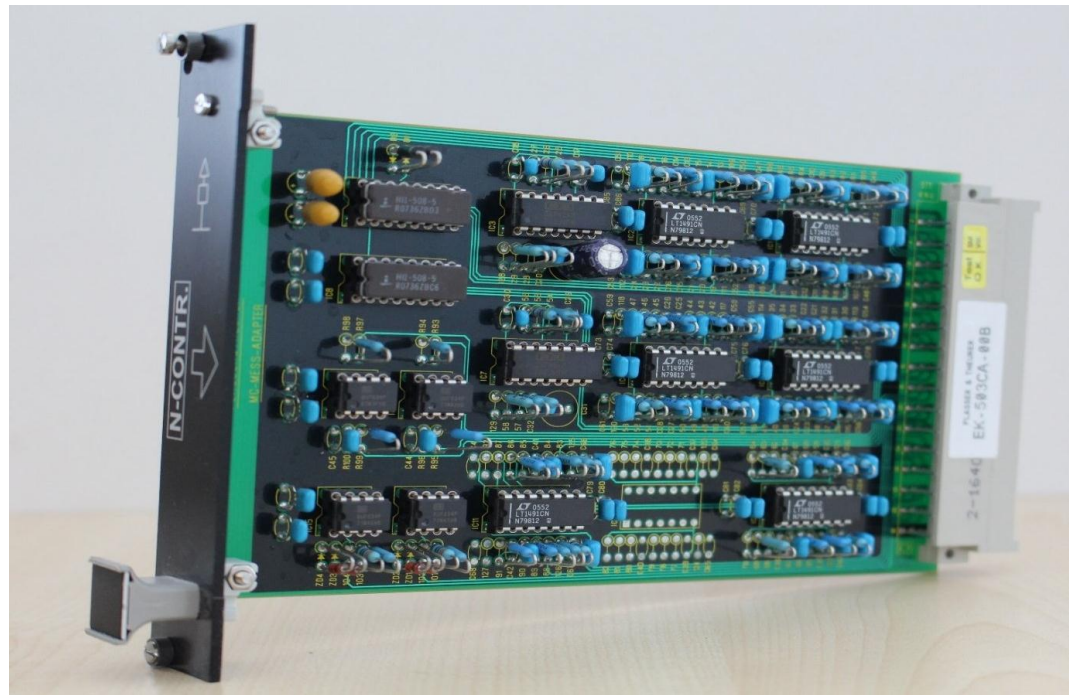
Structure of the CMS-system:



ADAPTERS:

- The CMS consist of three analogue adapter boards.
- It amplifies analogue signals received from various analogue inputs & sends to the microcontroller & vice versa.
- Equipped with 16 high-resistivity analogue inputs.
- Analogue inputs include measuring equipments (Transducers & pendulums), input potentiometers, ALC & correction value potentiometers.

The level adapter card connect all transducer and potentiometers to the leveling system.

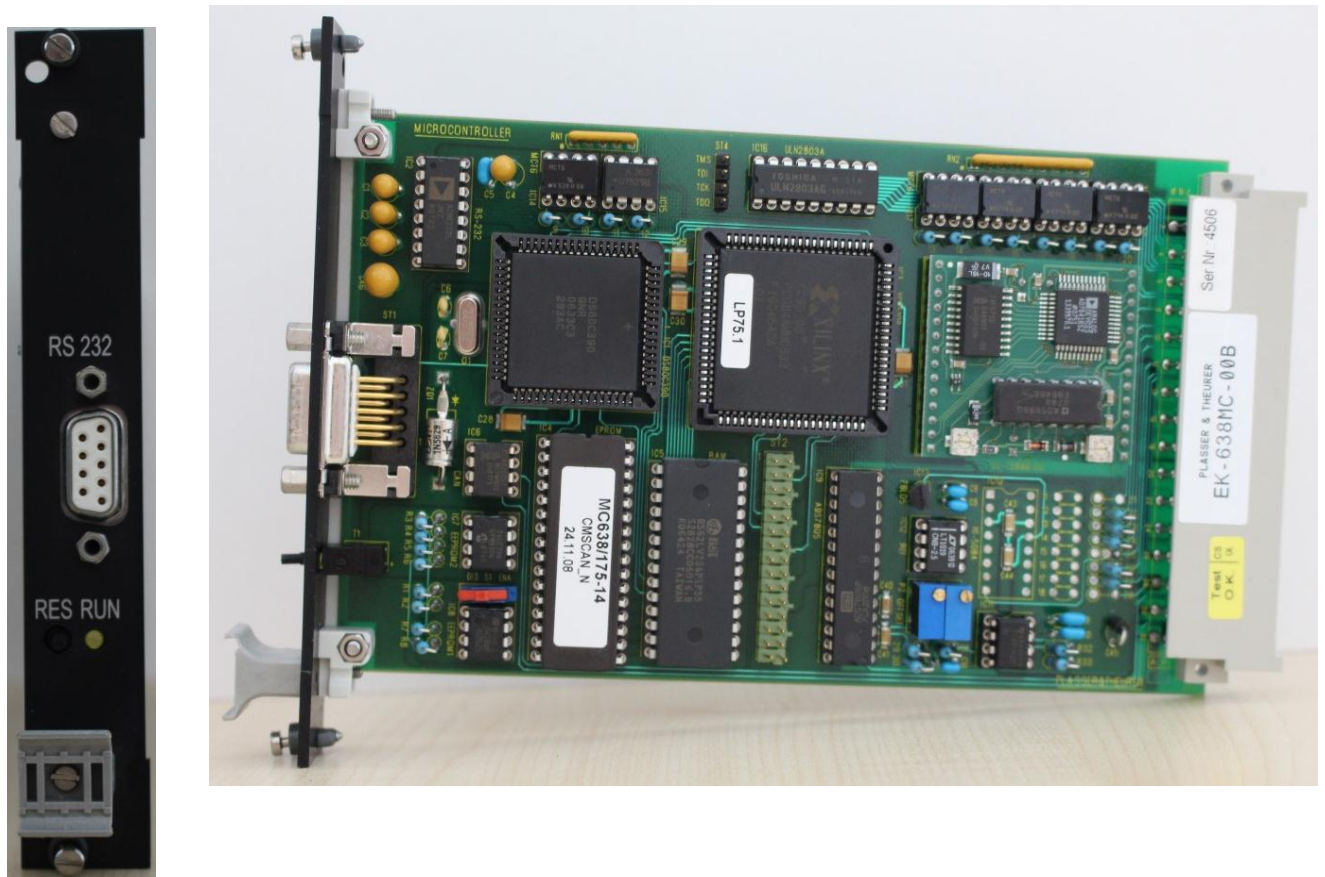


MICROCONTROLLERS:

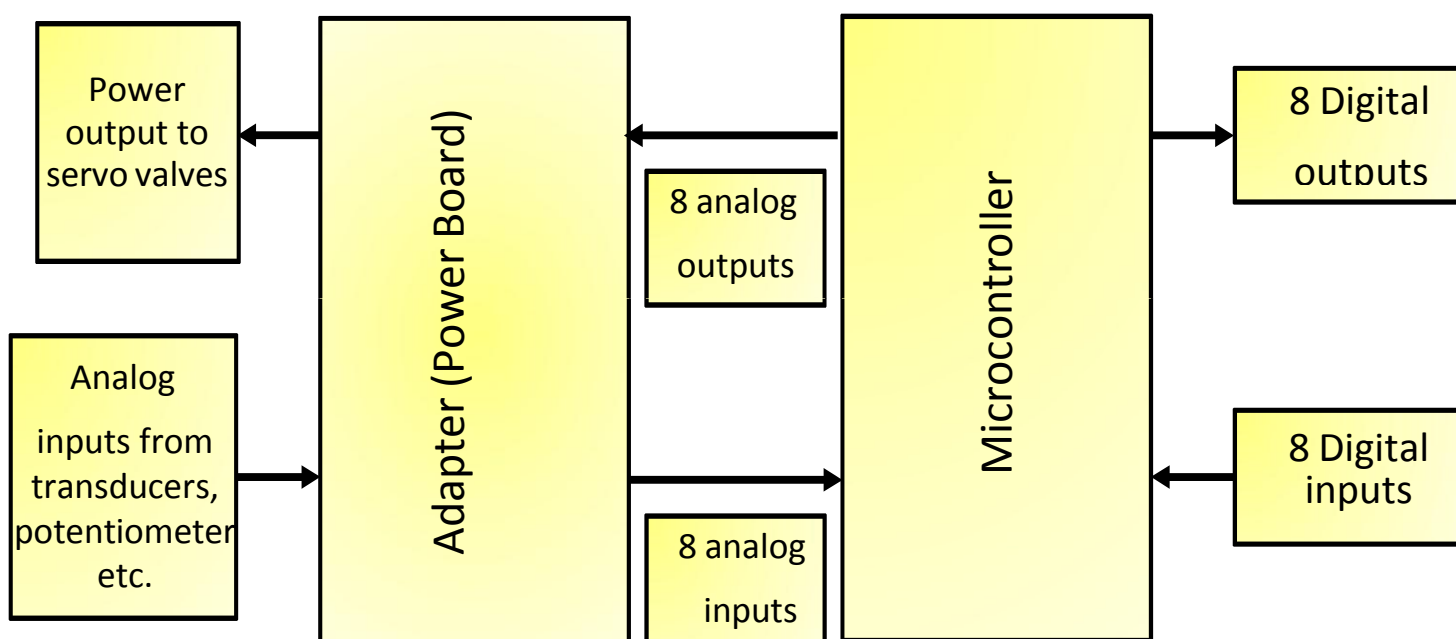
- The CMS consist of three digital microcontroller boards.
- Contains the software which are decisive for entire process.
- The microcontroller has both ADC & DAC.
- Equipped with 8 analogue outputs.
- The processor used works at 40Mhz.
- All MC's are connected to the control terminal & to one another via a CAN bus.

- Only the measurement set-up and distances are entered via the operator's terminal.
Reductions of defects, differences in versine etc., are automatically calculated by the respective controllers.

The processor board is the head of the respective measuring system.



SIGNAL FLOW DIAGRAM:



SIGNAL FLOW DIAGRAM:

- The processed data from microcontroller is again converted to analog signals & then used to control various associated valves.
- The outputs are led via a buffer amplifiers on the adapter board so as to minimize radio interference.
- Conversion of the output voltage of the MC card into the corresponding impressed current is also performed on the adapter card.

ADVANTAGES:

- The present model is android based and fully touch screen system.
- The credibility of this system is very high.
- Previous analog plates were prone to problem due to large number of potentiometers used.
- CMS system indicates to stop work if any input or any measuring device fails. Track is not disturbed. It also indicates which input is malfunctioning.



U Controller for pendulum inputs and cross-level tasks.



N Controller for levelling system and track lifting control.



R Controller for lining system and track alignment control.



L Controller (option for machines equipped with KHR laser)



D Controller (option for machines equipped with DTS units)

HOW TO OPERATE THE U (SUPER-ELEVATION) CONTROLLER VIA THE TERMINAL:

- When the system is started it shows the main mask of the U controller as the default screen. The control keys on the right hand side of the display are assigned to the individual CMS controllers. A control key showing green indicates which of the controllers is currently displayed.
- After the terminal has been switched on the start screen will be displayed for a short time.

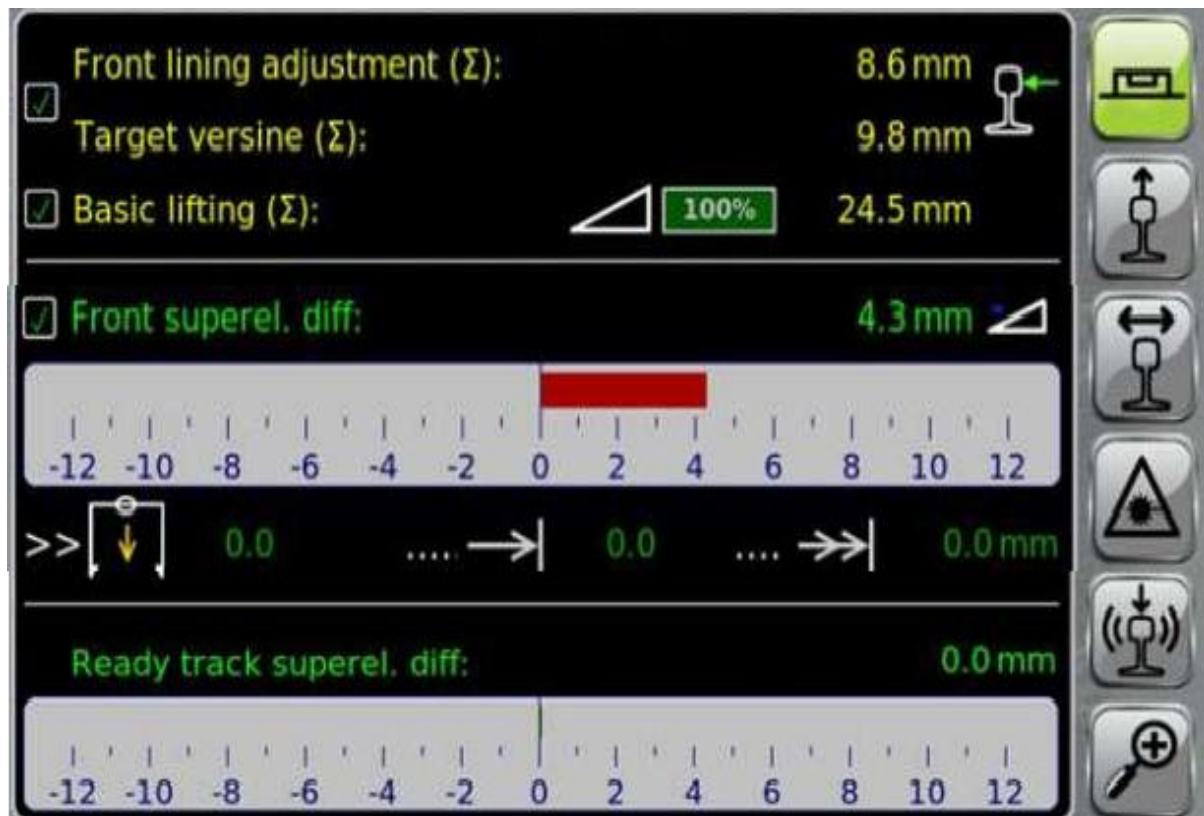
- Then the main indication appears and shows the most important values. By striking the MAGNIFYING GLASS key you may change between main and detailed indication.
- Normally, the display switch should be in ,U controller' position, as this position also indicates the most important values of the other controllers.
- When entering the service code, you will get into the service menu. While you are in the service menu, you cannot switch over to another controller!

Cross-level display (U-Controller) General View:

- 1) Total lining correction value, front
- 2) Total lining versine in the working position
- 3) Total basic lifting value, front
- 4) Super elevation difference, front

The difference is also shown for the following positions (delayed by a distance):

- a) Working position
- b) Rear of the tamping machine
- c) If applicable, ready track behind the DTS
- 5) Super elevation difference behind the tamping machine



Front lining adjustment indicates manual + alc values. Target versine indicates manual + alc values.

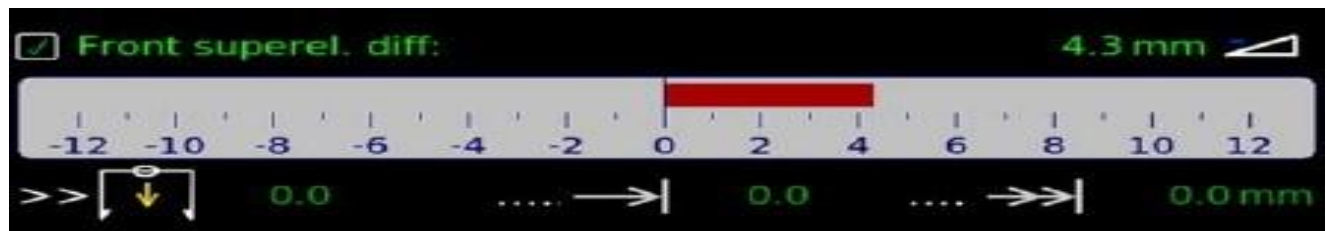
Basic lifting indicates manual + alc values.

Triangle  indicates ramp in, and triangle , indicates ramp out.

% indicates the amount of ramp taking place.

The **rail with arrow** indicates the datum rail chosen.

The colour shading indicates the error in track either left or right (front pendulum).

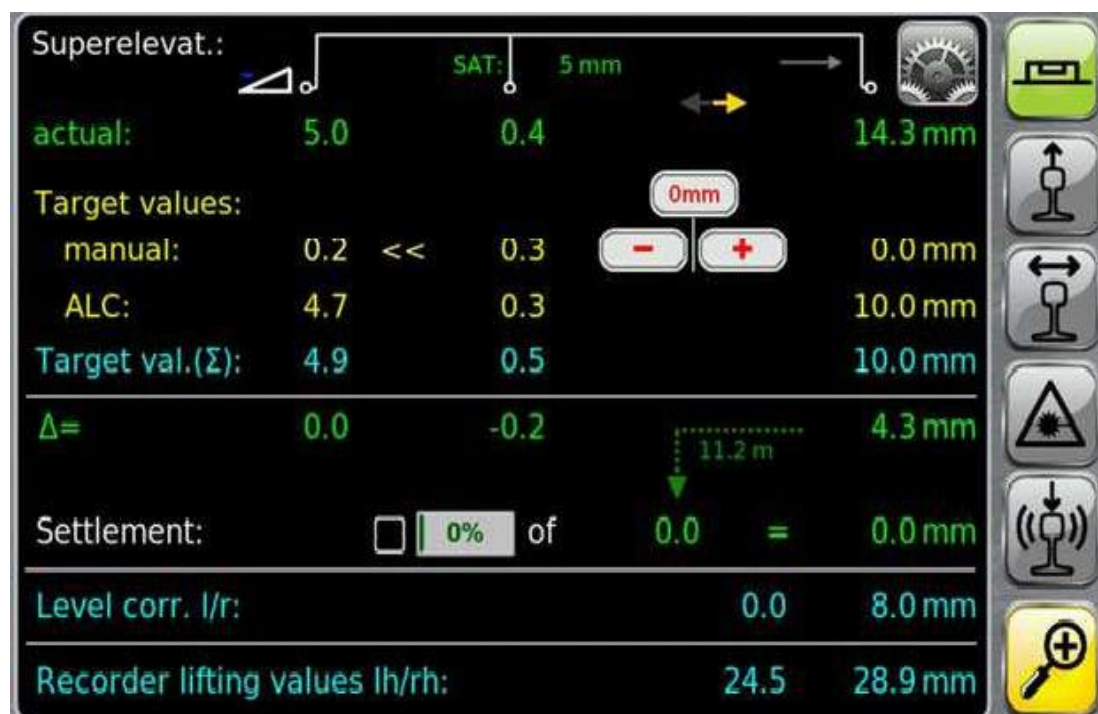


Its green up-to 1.5 mm, red from 1.5 to 12 mm, and more than 12mm it changes to pale red. It is also indicated in numerical in the top right corner.



The colour shading indicates the error in track either left or right (rear pendulum).

Cross-level display (U-Controller) Detailed View:



The upper half shows the respective target and actual values of the front and rear position, as well as of the working position. The currently high side is marked by a symbol.

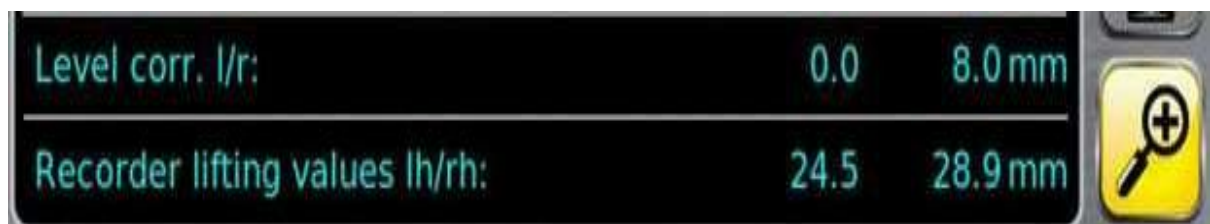
The target values are total values resulting from the ALC value and the manually superimposed value.

The manually superimposed value in the working position has to be displaced by the distance to the rear position (symbol <<). The respective proportions are indicated in the centre of the display.



In this case the front super elevation difference is displaced by the distance to the working position (here 11.2 m).

The settlement value potentiometer (0-100%) uses a percentage proportion for level correction during the levelling procedure. A tick indicates the "levelling & lining start" signal.



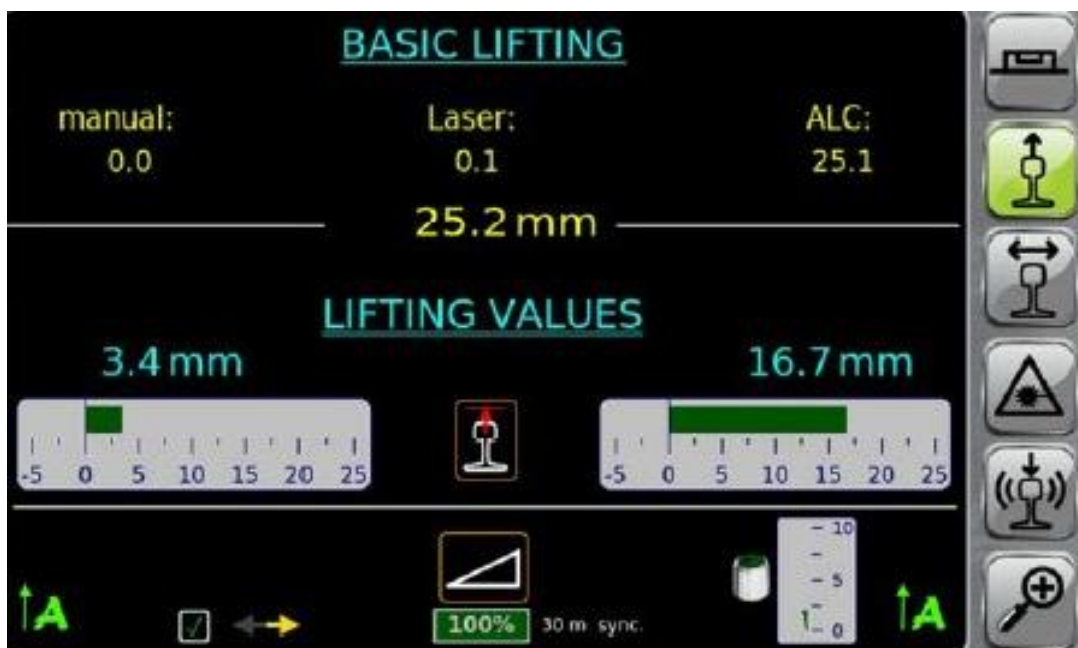
Level correction values (l. h./r. h.) are indicated below. These two values are calculated from the super elevation defect (of the high rail) and, if applicable, from the settlement value compensation (of the rail situated too low) and then transmitted as “super elevation correction values“ to the N controller for further processing.

Additionally, the recorder lifting values are displayed. The basic lifting value (+ front super elevation difference on the high side) are output to the recorder. If the ramp percentage amounts to 100%, the full basic lifting value is output to the recorder.

HOW TO OPERATE THE N (LEVELLING) CONTROLLER VIA THE TERMINAL:

- If the operator's terminal (*LCD and keyboard*) is connected to the N controller during starting of the MC, the display will show for several seconds all missing calibrations, if calibration has not yet been fully performed. This message may be bypassed by depressing the warning icons.
- Then the main indication appears and shows the most important values. By striking the magnifying glass key you may change between main and detailed indication.
- Normally, the display switch should be in ,U controller' position, as this position also indicates the most important values of the other controllers.
- When entering the service code, you will get into the service menu. While you are in the service menu, you cannot switch over to another controller!

LEVELLING DISPLAY (N- CONTROLLER) GENERAL VIEW:



The total basic lifting value consists of the following parts:
(+=lifting)

- a) manual input (pot.)
- b) laser controller target value
- c) ALC target value

The values indicated do not consider the reduction factor for ramps!

The availability of a laser and an ALC system can be set in service mode. If both are off, their inputs will not be read and the display shows only the manual-mode basic lifting value.



Both l. h/r. h lifting values are the difference between target lifting value and the levelling transducer value (including manual correction 1) in the working position. Except for the ramps, this corresponds to the readings of the l. h. and r. h. levelling instruments.

The lifting symbol with the central red line indicates that the lifting value limiting system is on. Pressing this symbol turns it off.



Furthermore, the current ramp condition, the set ramp length and the current position within the ramp (in %) are displayed.

The servo amplification potentiometer is displayed to the right of the ramp values. On its left the "levelling system enabling" signal and the running direction are shown.

If "asynchronous" has been set, the own ramp lengths are used. If not, the ramp lengths transferred via CAN bus from the R controller will be used (SYNC).

The ramp parameters can be temporarily changed by pressing the icon:

ramp mode:

asynchron

Initial/end ramp:

30

30 m

LEVELLING DISPLAY (N- CONTROLLER) DETAILED VIEW:

ALC settlement val.:	-3.0 mm		
Basic lifting (Σ) >> work.-pos.:	9.9 mm		
DGS settlement:	0.0 mm		
SAT: 385 mm	left:	right:	
Man. correction:	1.0	-0.0 mm	
Superel. corr. (auto crosslevel):	-0.1	8.4 mm	
target lifting val.:	7.8	15.7 mm	
☒ Level transducer:	-9.3	-6.7 mm	
Transducer corr.:	0.0	-0.2 mm	
System offset:	4.9	5.0 mm	
Levelling recording:	-14.2	-12.0 mm	
Result. lifting value:	-6.3	3.4 mm	

The detailed display shows the individual components of the lifting value. Target values are displayed in yellow, actual values in green.

The first value to be displayed is the ALC lowering value (correction in curves) (=- lowering).

Without this correction value too large a lifting value would be applied in curves and transition curves, as the transducer plates are inclined. This value is effective for both sides.

The total basic lifting value (see main indication) is shown here, as well. However, here the effective lifting value that has been converted for the working position is displayed.

Manual-mode correction: This is a correction value for the left or the right hand side. Depending on the correction mode (service menu / general settings) correction values between 0 – 3 (infinitely variable to both sides) and 0 – 5 mm (potentiometer with 1 mm divisions) and 0-10 mm can be used. This correction facility is located in the manual control panel near the operator's desks. Corrections can also be carried out during the lifting procedure!

Super elevation correction: These two levelling correction values are supplied by the U controller, they are made up from the automatic cross level adjustment (on the super elevated side) and, if applicable, from the cross level - settlement value compensation.

The respective **target lifting value** calculated from the values stated above is indicated below the horizontal line. In ramps, this value has to be corrected by the ramp factor indicated left of it. The value indicated, however, always equals 100%, i.e. the complete target lifting value.

target lifting val.:	7.8	15.7 mm	
☒ Level transducer:	-9.3	-6.7 mm	
Transducer corr.:	0.0	-0.2 mm	
System offset:	4.9	5.0 mm	
Levelling recording:	-14.2	-12.0 mm	
Result. lifting value:	-6.3	3.4 mm	

1. The first value to be displayed is the actual measured value of the respective **levelling transducer**. The green tick on the very left edge indicates that the "levelling system enabling" has been activated.
2. The **“transducer correction value”** for manual-mode correction of the level transducer zero points (± 5 mm). It is effective directly in the working position and is added to the respective levelling transducer values during an ALC record. It is located in the front cabin. This enables the zero point of the levelling transducers to be changed temporarily. This correction value is “frozen“ during the lifting procedure.
3. Finally, the **system offset** is taken into account (to be calibrated in the service menu). The sum calculated from levelling transducer, transducer correction and system offset is shown beneath the short horizontal line. This sum is used for ALC level recording during a measuring run.
4. The last line shows the **lifting value resulting** from the difference between actual and target values (+ = lifting). This value corresponds to the lifting value displayed in the main mask.
This indication does not take into account any ramp reduction!!

HOW TO OPERATE THE R (LINING) CONTROLLER VIA THE TERMINAL:

- If the operator's terminal (LCD and keyboard) is connected to the R controller during starting of the MC, the display will show for several seconds all missing calibrations, if calibration has not yet been fully performed (,0 offset means, e. g.: all transducers 3/R' that for 3-point and r.h. reference no zero offset has been adjusted - see calibration). This message may be bypassed by depressing the warning icon.
- Then the main indication appears and shows the most important values. By striking the magnifying glass key you may change between main and detailed indication.
- Normally, the display switch should be in ,U controller' position, as this position also indicates the most important values of the other controllers.
- When entering the service code, you will get into the service menu. While you are in the service menu, you cannot switch over to another controller!

LINING DISPLAY (R-CONTROLLER) GENERAL VIEW:



The total value of **manual and ALC versine value** is also indicated in the main mask of the U controller. If a satellite is provided, this sum is always converted to the actual satellite position.

The **lining displacement values** are related to front chord end and therefore have to be internally converted to the position of the lining value transducer.

Now the **lining value** indicated is calculated from the converted lining displacement value (Σ), the (corrected) target versine, the manual correction value, the super elevation correction in curves and the current value of the lining value transducer. It is valid for the working position (+ = r. h. lining: Symbol).

By pressing the limit monitoring icon next to the chart, this feature can be turned off. A green arrow indicates this fact.



The bottom line shows information on the ramp. On the figure shown the ramp length is 30 m long, the machine having covered 100% of the ramp; this means that the lining value is not suppressed.

The **servo amplification potentiometer** is displayed to the right of the ramp values. On its left the "lining system enabling" signal and the running direction are shown.

For manual-control lining icons in the last line of the display indicate this face. In automatic mode an A is displayed instead of an M.



LINING DISPLAY (R-CONTROLLER) DETAILED VIEW:

For 3-point lining the display shows the total target versine value for the front position as well as converted to the working position re (+ = r. h. lining).

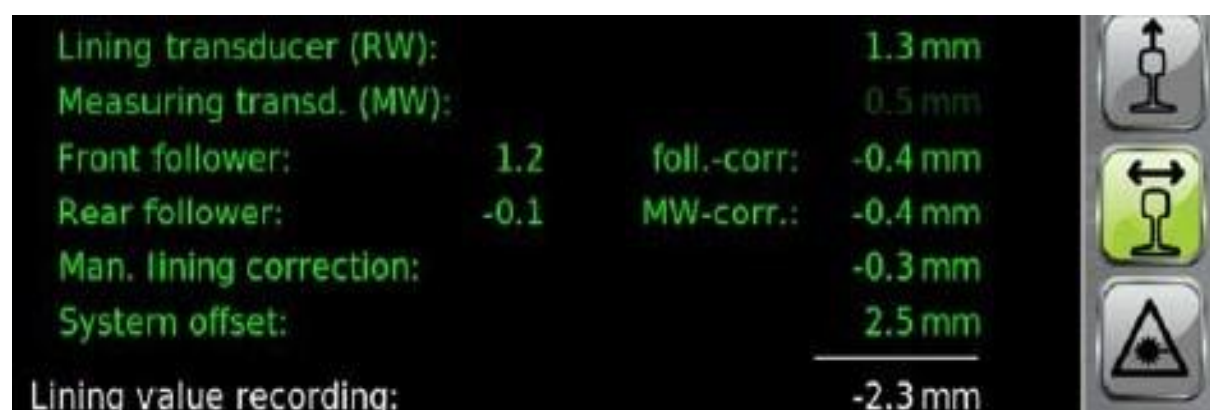
When 4-point lining is used, this place shows the total value of the transition curve.



Furthermore, the display shows the total value of the front lining displacement (yellow) and with conversion for the working position ().

The actual values of the lining and measurement transducers are displayed in green below the first horizontal line (- = chord to the left).

For a 4-point chord with 3-point lining activated the measurement transducer is regarded as rear follower which is why the display shows a measurement correction. Otherwise the display shows the rear follower, if available.

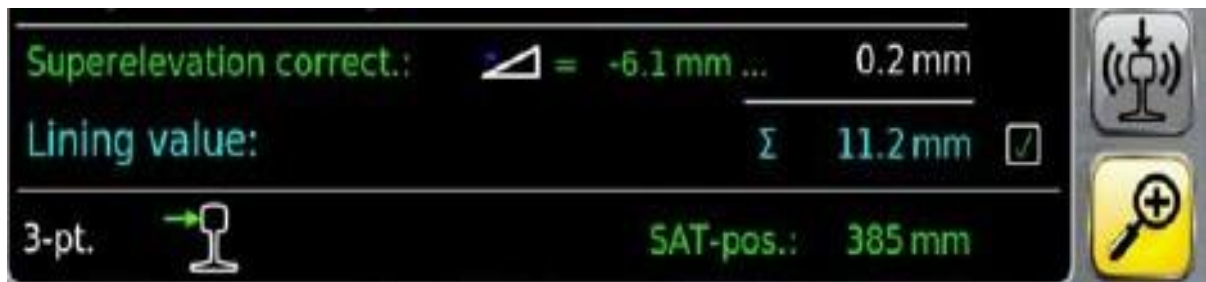


If followers are available (service menu entry), their respective excursion (+ = to the right) are displayed in the next line.

Together with the actual values the manual correction value is also displayed (± 5 mm). It can be used to influence the zero point of the lining transducer. In automatic mode, the reading-in procedure is frozen (during lining).

Another value displayed is the system offset that has been pre-set in the calibration menu.

The total value for an ALC recording is displayed beneath the short horizontal line. It consists of all actual values displayed above (+ = r. h. lining).



The value to be indicated is the correction value in curves on the basis of a pendulum excursion. The front pendulum value is transmitted by CAN from the U controller. This value directly influences the lining value in the working position.

The value shown beneath in blue is the lining value resulting from target and actual values. A tick next to it ☒ indicates whether the digital input “lining system enabling“ is active.

For continuous-action machines (setting: satellite "yes") the current satellite position is displayed beneath the last horizontal line. The satellite transducer value is led to the R controller only. The other CMS controllers receive the satellite position balanced by the R controller.

The indications below are the currently used lining method (3-point or 4-point) and an icon showing the reference side (trolleys to be pressed to the left / right).

COMPUTER WORKING SYSTEM- CWS



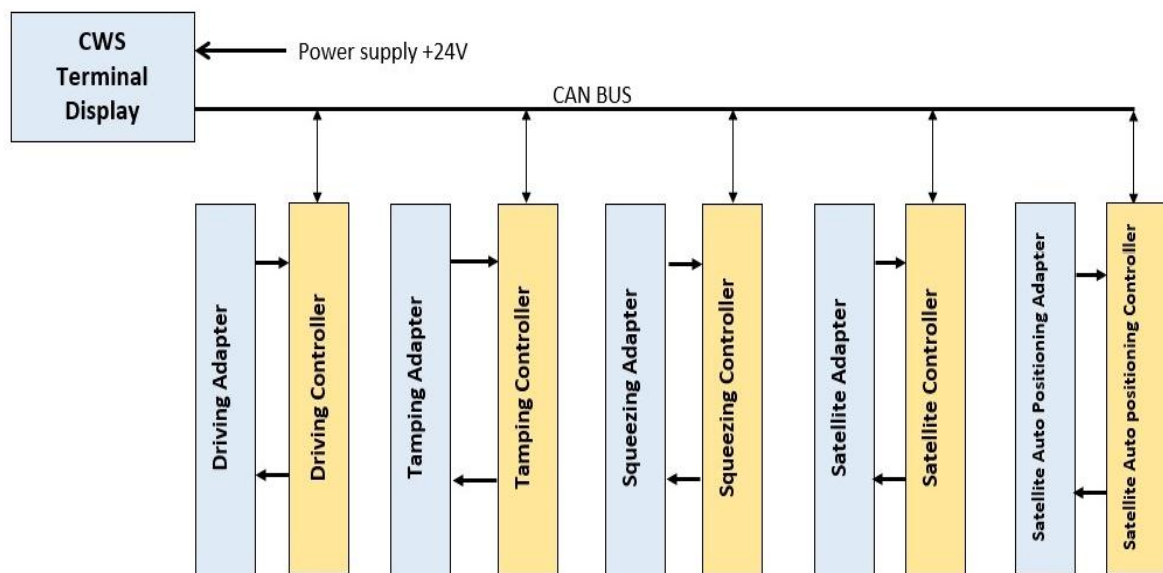
Working Cabin



INTRODUCTION:

- CWS is used for controlling the working system of machine i.e. control the flow of current for proportional valves associated with tamping, driving and satellite.
- CWS is a digitalised method of processing data which are received from various inputs.
- The output of it is used to control a valve for the designated operation.
- It is also used for indication purpose.
- CWS also displays real time data of working system of machine (driving, tamping, squeezing and satellite) so that actual correction done can be evaluated.
- It can also be used to identify any faults occurring in its system (Diagnose).

CWS architecture



Driving control (optionally including automotive regulator and gas adjustment)



Proportional unit lowering and proportional pressure adjustment



Proportional satellite movement, forwards / backwards (only for continuous working mode drive units)

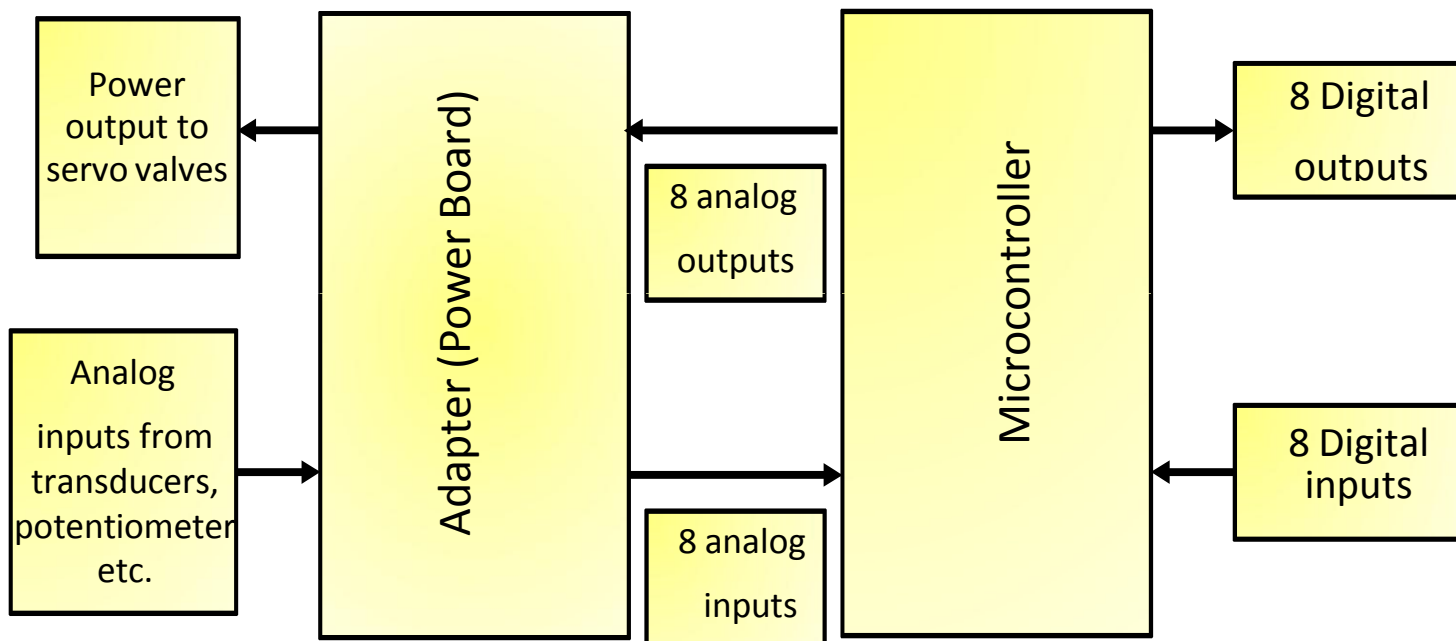


Automatic machine positioning (only for continuous-action machines)



Not used at the moment

SIGNAL FLOW DIAGRAM:



ADAPTERS:

- The CWS consist of five analogue adapter boards.
- Equipped with 16 high-resistivity analogue inputs.
- Analogue inputs include measuring equipment (Transducers), input potentiometers, correction value potentiometers.
- The processed data from microcontroller is again converted to analog signals & then used to control various associated valves.
- The outputs are led via buffer amplifiers on the adapter board so as to minimize radio interference.
- Conversion of the output voltage of the MC card into the corresponding impressed current is also performed on the adapter card.

MICROCONTROLLERS:

- The MC board is identical with the one used in the CMS system.
- The microcontroller has both ADC & DAC.
- The CWS consist of five digital microcontroller boards for each (depending on machine type).
- Contains the software which are decisive for entire process.
- Equipped with 8 analogue outputs.
- The processor used works at 40Mhz.
- All MC's are connected to the control terminal and to one another via a CAN bus.

ADVANTAGES:

- User friendly
- The present model is android based and fully touch screen system.
- The credibility of this system is very high.
- Previous analog plates were prone to problem due to large number of potentiometers used.
- CWS system indicates to stop work if any input or any measuring device fails. It also indicates which input is malfunctioning.

PLASSER & THEURER CWS WORKING SYSTEM:



Driving mode controller or 'F' controller

F Controller operation via terminal:



The detailed display shows all the relevant inputs and outputs:-

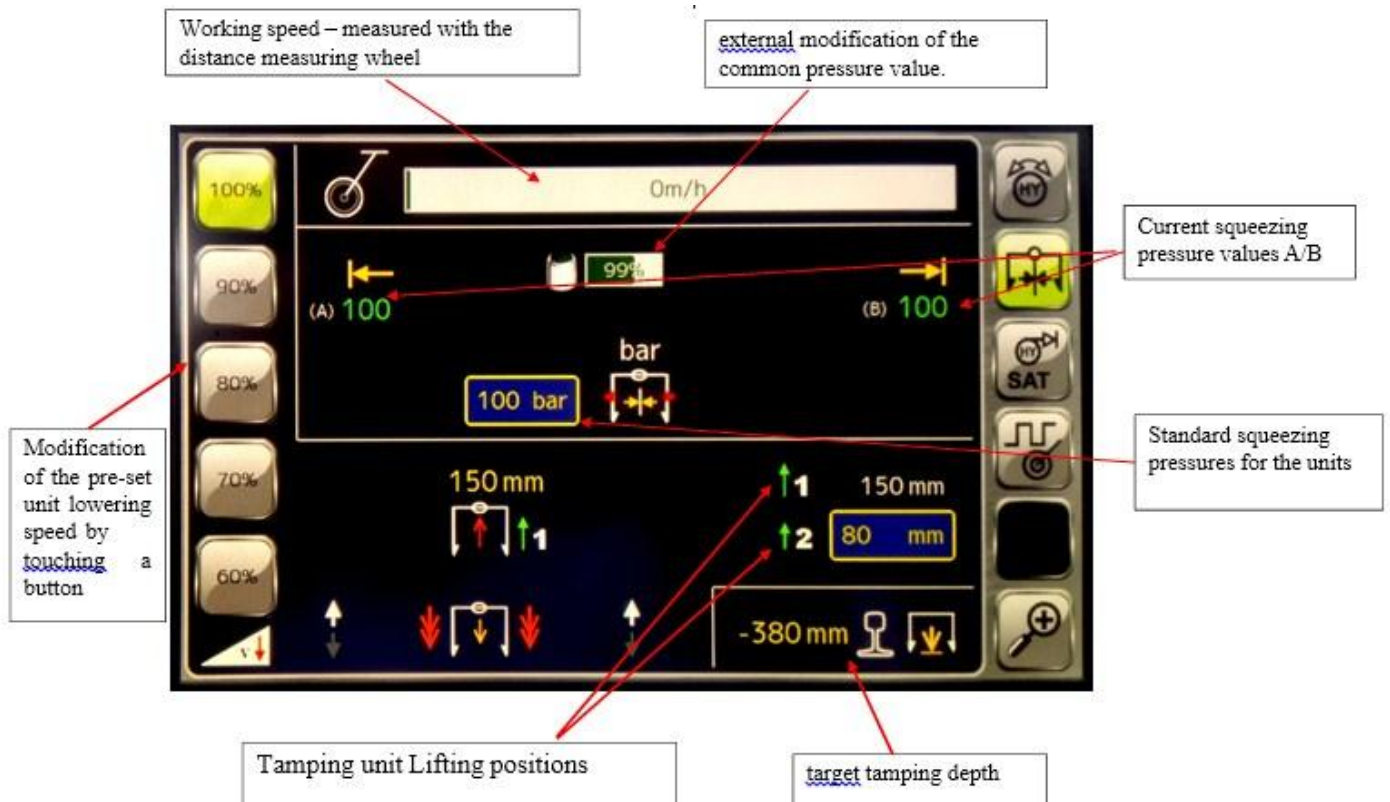


PLASSER & THEURER CWS WORKING SYSTEM:



Proportional pressure controller or 'PD' controller

PD Controller operation via terminal:



This detailed view also displays the details of the proportional-lowering board

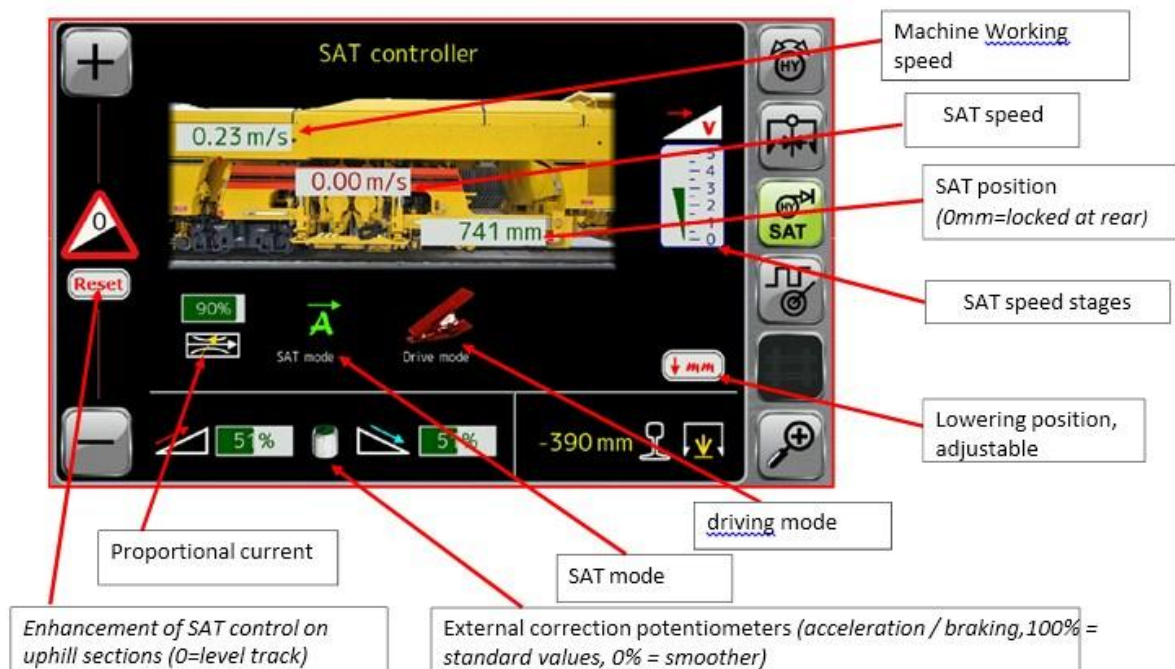


PLASSER & THEURER CWS WORKING SYSTEM



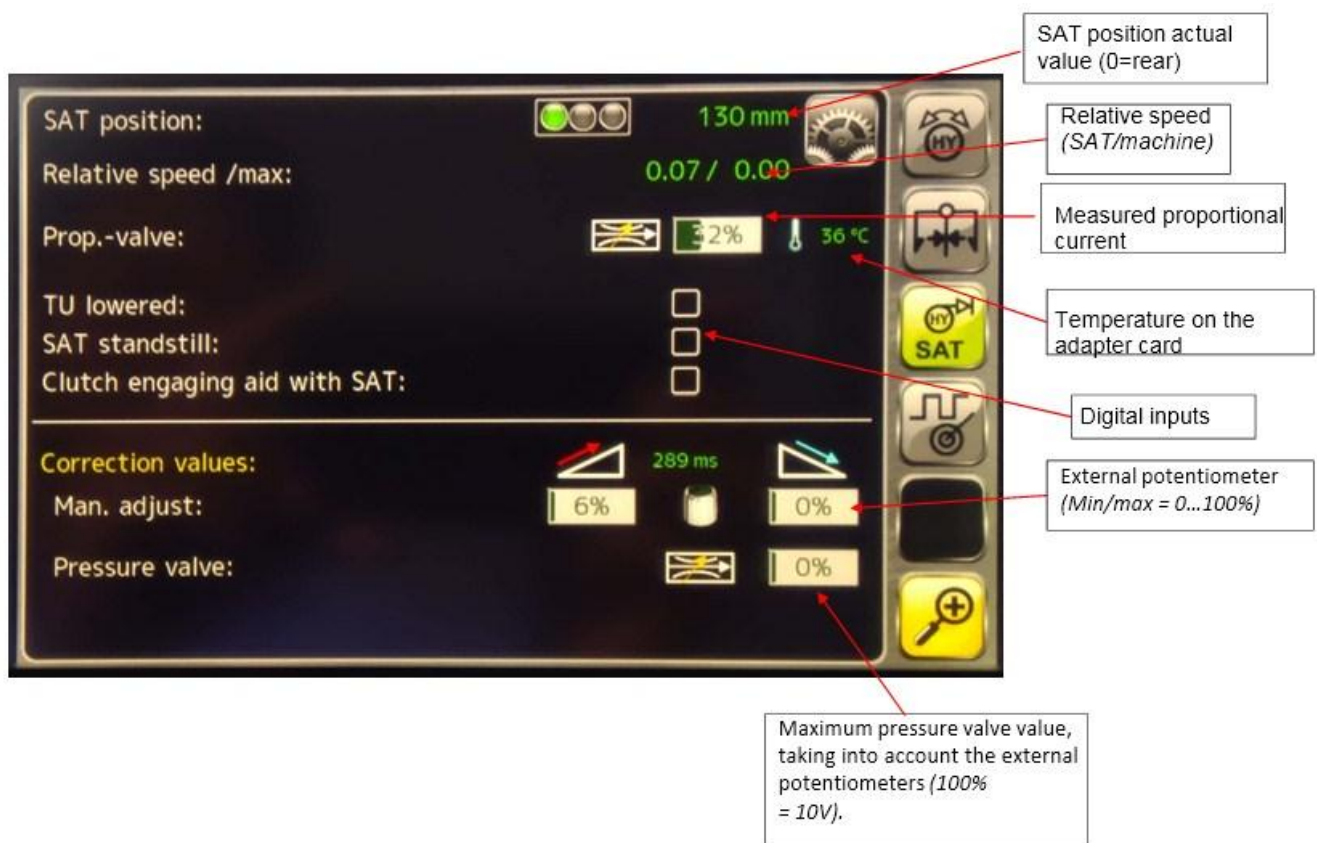
Satellite controller

SAT Controller operation via terminal:



SAT modes:

SAT Home Position	
Automatic Mode (SAT Forward Movement)	
SAT Moving Backward In Manual Mode	
SAT Moving Forward In Manual Mode	



DATA RECORDING PROCESSOR (DRP)



WHAT IS DRP ?

- The new Plasser & Theurer track recording system is known as DRP (Data Recording Processor).
- The DRP is designed as a system for recording track parameters, in order to document the quality of the track achieved by the tamping machine after working.
- Thus the quality of track parameter achieved by the machine and the effort taken by the operator for retaining them can be documented.
- Also, by comparing the measurement values against predefined limits for the individual parameters, it is possible to evaluate and classify the measurement results.

OVERVIEW

- The individual measurement parameters are provided by measuring transducers as an analogue signal, which is read in by the DRP system at equidistant intervals (e.g. 0.25 m) and, after a high-resolution analogue- to-digital conversion, is recorded and saved in digital form.
- The DRP can be used to perform measurements or open existing measurements and are displayed graphically online on a screen monitor, and can be printed out on a standard printer in A4 format.
- The stored measurement data can be transferred via a USB stick to other computers for further analysis.

- The display of the D1 profiles for alignment and level will make it easier to assess the track geometry.
- Standard deviations are calculated for the D1 profiles for alignment and level. They, too, assist in the assessment of the track geometry.
- Reports allow the evaluation of limits that have been exceeded and also supply information about the track quality.

PARAMETERS MEASURED BY DRP ON OUR MACHINES

Measurement parameters can be selected in two ways:

- Configuration 1- Track parameter recording before & after working.
- Configuration 2- Track parameter recording during working.

Configuration 1

The following parameters can be recorded by using this configuration.

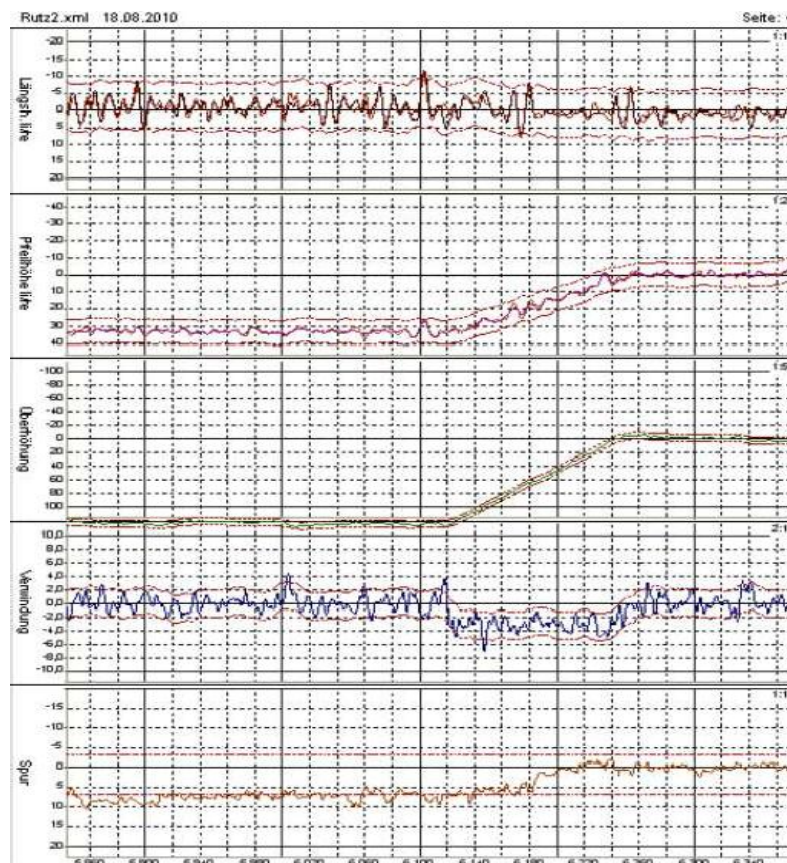
1. Cant.
2. Twist.
3. Lining versine (in mm) L.H./ R.H.
4. Longitudinal level (in mm) of L.H. rail.
5. Longitudinal level (in mm) of R.H. rail.
6. Longitudinal level D1 (in mm) of R.H. rail.
7. Longitudinal level D1 (in mm) of L.H. rail.
8. Track gauge error (optional).

Configuration 2

The following parameters can be recorded by using this configuration.

1. Cant.
2. Twist.
3. Squeezing time.
4. Tamping depth.
5. Lifting value (in mm) of L.H rail.
6. Lifting value (in mm) of R.H rail.
7. Track gauge error (optional).

Example of a graph printout



The values can be printed out on a standard printer in A4 format.

- The values of the parameters are displayed as a continuous line.
- The value can be read directly at any spot.
- The limit values are marked as a tolerance band in the graphic display.

REPORT OF TOLERANCES EXCEEDED

A Separate limit can be defined in each speed classes, for the following parameters, both for newly constructed track & for maintenance work.

A minimum or a maximum limit value can be defined.

These limit values are marked as a tolerance band in the graphic display. If measurement values exceed the limits, they will be logged accordingly in the evaluations (Reports).

Reports can be generated which list all positions where the permitted limits for a parameter have been exceeded.

Report: Toleranzüberschreitung							
Strecke, Gleis: kostloc: plan1, 1 Km: 26,400 - -774,002 Gleisklasse: RPD - 60 km/h				Arbeit/Material: Instandhaltung Datum: 04.06.2008 10:54:30 Dateiname: kostloc: plan1-V2.00.xml			
km in	Rechts			Links			
	Stellb. differenz	Ph.Dif. Ander.	Richtung D1	Stellb. differenz	Verwindung	Längshöhe	Höhe D1
	±7.0	±6.0	±1.0	±5.0	±1.5	±7.0	±2.7
0.081.0				0.4.1			
0.084.0				0.4.2			
-1.012.7		147.2					
-1.013.7		147.2					
-1.012.5					2-1.3	1-0.0	
-1.012.8					2-1.3	1-0.0	
-1.011.5							0+0.0
-1.008.0	0+10.2						
-1.008.5				1+10.0			
-1.008.5				1+10.4			
-1.008.8				1+10.4			
-1.005.7		2+0.8	5-0.4		4+4.4	2+0.5	
-1.005.8							4+2.2
-1.001.2			0+0.0		4-0.5		
-1.000.2		1+5.8				2-11.7	
-1.000.5							6+2.1
-1.000.5	0+0.8						
-1.000.0				10+11.8			
-1.000.0					0+0.2		
-1.204.7						1-7.2	
-1.204.7						1-7.2	
-1.204.2							0+0.4

Figure 16: Example of the report of tolerances exceeded

Description of the individual columns in the report:

The **report header** is taken from the input table of the measurement.

Parameter columns: Lists the individual parameters.

Tolerance columns: Abbreviations of parameters and the limits used.

Position column: This column shows the position where the maximum value has been reached.