Technical Offer
T1-15-XXX

Mould Level Control System (MLM) & ServoDrive Oscillation

Version: 01

Date: 25.04.2023

CLIENT: **general**

SELLER: **INTECO TBR casting technologies GmbH**
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VERSION HISTORY

Version	Date	Changes
01	2023-02-04	Technical description (ScW)

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1. AIM OF PROJECT

XXX is planning to install

- New MouldLevelMeasurement System (Radiometric System)
- ServoOscillation System

for the existing caster.

This offer covers the Technical Specification for the above mentioned components.

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2. MOULD LEVEL CONTROL SYSTEM (INTECO TBR)

INTECO TBR Mould Level Control System is a highly developed control system, which insures an accurate and stable mould level during the entire casting with all casting conditions and all formats.

The main advantages of INTECO Mould Level Control Solution are:

Casting Operation and Quality

- Rigid stopper rod mechanism for stable operation
- Automatic mould filling and start of cast function.
- Accurate and stable Mould Level Control under instable casting conditions for improved surface quality
- Accurate mould level stability for billets of ≤ +/- 2 mm with accurate measurement system.
- Break out detection and overflow protection
- Design of servo-actuator for fast reaction
- Electro-mechanical servo actuator will be installed on the tundish car (as existing hydraulic system) without the need to unplug/plug cables and connections.
- Manual mould level control with lever system (instead of potentiometer) for increased operational safety/reaction time and sensitivity for manual interference/control. Disabling of automatic control is performed by electrical disconnection (push-buttons with indicators)
- Increased operator safety by eliminating hydraulic system for stopper control on tundish car

Increased Sequence Length

- Automatic clogging detection and cleaning of stopper tip by flushing
- Anti-clogging function
- Anti-SEN wear function by variation of mould level as function of time

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Maintenance

The electro-mechanical servo actuator will be installed on the tundish car and not fixed to the tundish with junction boxes on the casting floor:

- No detachment of hot cables after each cast increases operational safety connections
- Testing of servo-drive in pre-heating condition and easy replacement on casting platform in rare case of malfunction
- No exposure to mechanical damages during tundish manipulation

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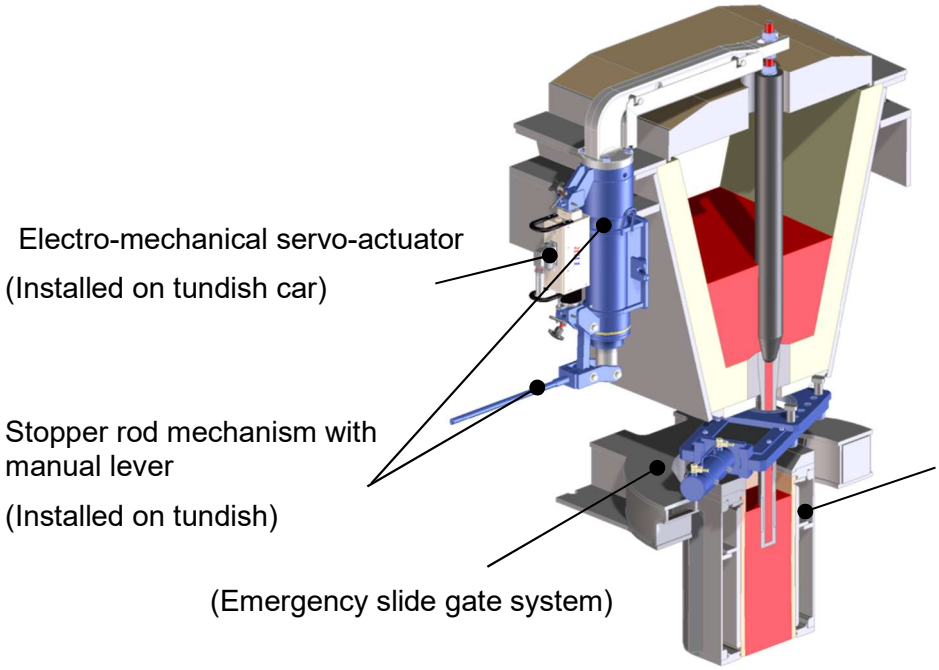
2.1 Introduction

The INTECO TBR mould level control solution is an advanced control system designed to ensure exact mould level control throughout the entire continuous casting process, regardless of the conditions, variations and disturbances. All equipment use state of the art technology.

The Mould Level Control System includes following main components:

- Stopper rod mechanism
- Electro-mechanical servo-actuator
- Mould Level Master (Software) - MLM



The solution is available for all stopper rod controlled continuous casting machines (billet, bloom, slab, thin-slab, beam blank, etc.).

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2.2 Stopper Rod Mechanism

The stopper rod mechanism responds precisely to the servo drive movements, which are transmitted directly to the head of the stopper rod.

In addition to the automatic control, the operator has the possibility to manually control with a manual lever.

The stopper rod mechanism includes facilities for precision guiding, adjustment and position locking of the stopper:

Main Features:

- Robust and rigid design, especially designed for heavy duty applications
- Precise and adjustable guiding
- Simple assembling and easy handling
- Arm-rotation for e.g. tundish cover manipulation

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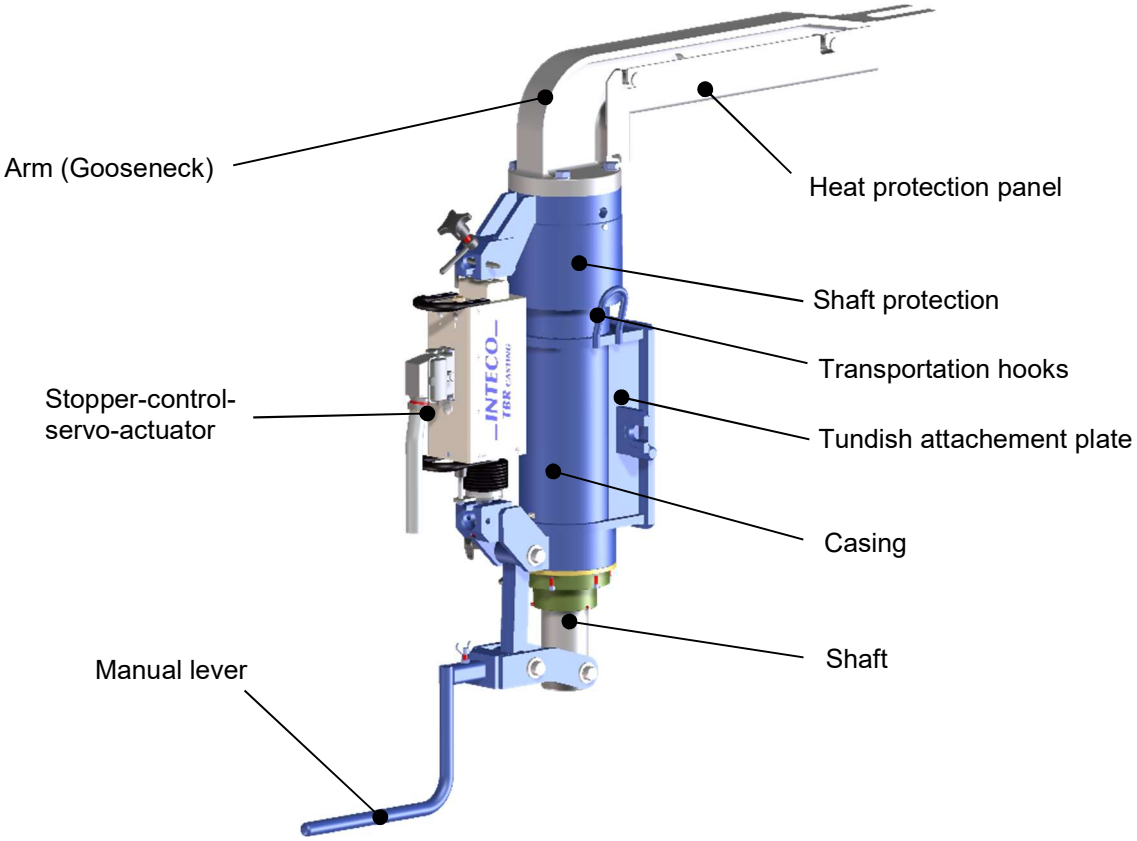

Stopper Rod Mechanism	
Design	Stopper rod mechanism with precise guidance system and heat protection for submerged casting technology.
Components	
Stopper Rod mechanism	Heavy-duty stopper rod mechanism for slab casters with weight balanced lever for manual control of the stopper rod. Mounting brackets for mounting suitable for mounting the automatic actuator.
Arm (Gooseneck)	Made of cast iron in order to meet the special requirements of stopper rod mechanisms regarding thermal conditions.

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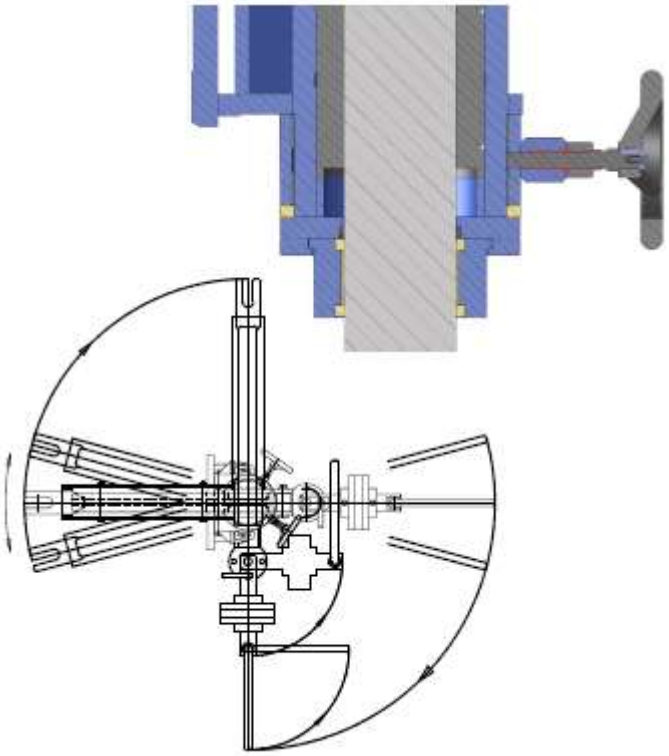
Stopper Adjustment	By use of the adjustment lever the stopper arm can be rotated around its axis to align the stopper arm to the tundish block or to allow tundish cover manipulation without removing the stopper rod mechanism. 

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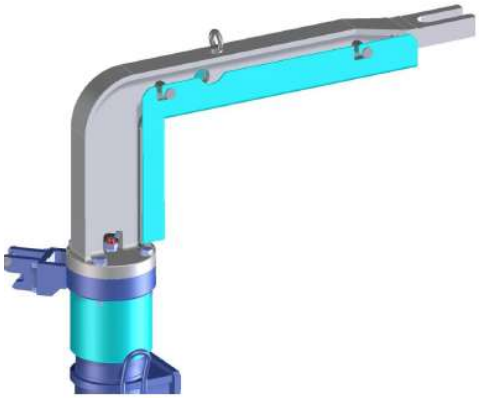
Heat and dust protection	A heat protection shield is placed around the stopper arm to prevent bending and/or distortion of the support arm by impact of heat during tundish preheating and casting.  The protection shield for the shaft is to prevent dust and splashes to enter the guide roller area.
Manual Lever	The counter weights are to balance the weight of the stopper support arm, the shaft and the actuator. This provides for the operator no need to apply strong force on manual operation of the stopper mechanism. For transport purposes, the handle bar and counterweight can be turned up to +/-90° and fixed by arresting bolt. 

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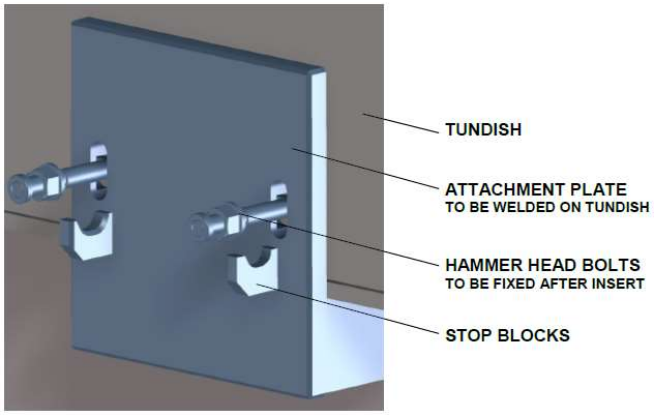
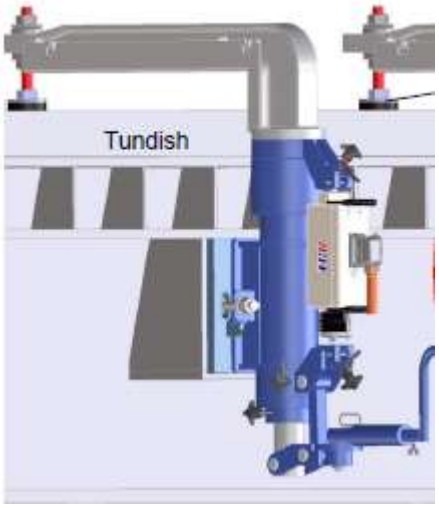
Fixation to tundish	The fixing elements are hammer head bolts of special design to facilitate attachment and removal of the stopper mechanism, by one hand only.

Technical data – Stopper Rod Mechanism

Operating Stroke (=Stroke of Actuator)	150 mm (max. stroke)
Stroke of mechanism	150 mm (max. stroke)
Opening	105 mm
Closing	45 mm
Dimensions, app. L x W x H	~1,4 x ~0,4 x ~1,6 m
Weight, app. SM11 (slab) SM21 (slab/bloom) SM31 (bloom/billet)	 ~600 kg ~500 kg ~400 kg
Design features: Guiding System lateral Stopper Adjustment	linear bearing unlimited - turnaround

Tundish Mounting Plate





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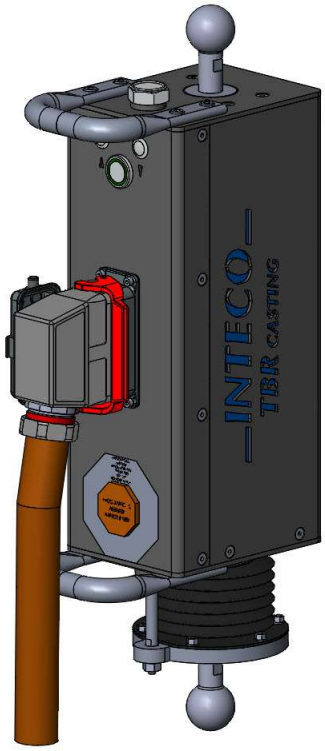
2.3 Stopper-Control - Servo-Actuator

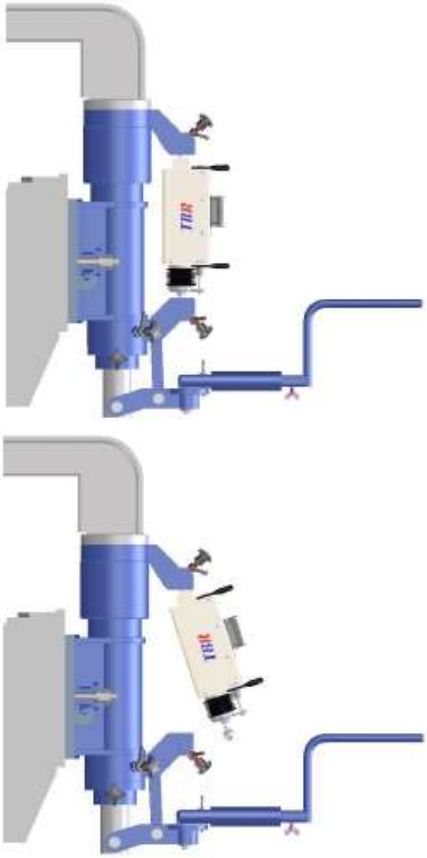
The stopper-control - servo-actuator transforms the signals from the MLM into exact stopper movements. The fast response time results in a significant improvement achieving precise mould level control.

Main Features:

- Rapid and precise performance - no backlash
- Electromechanical drive with servo-amplifier
- Quick fastener, easy handling
- Smaller size, lower weight



Electric-mechanical servo-actuator



Mounting of servo-actuator to stopper rod mechanism

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Stopper-Control - Servo-Actuator

Design

Equipped with two handles for handling to allow easy mount and dismount to the stopper rod mechanism.

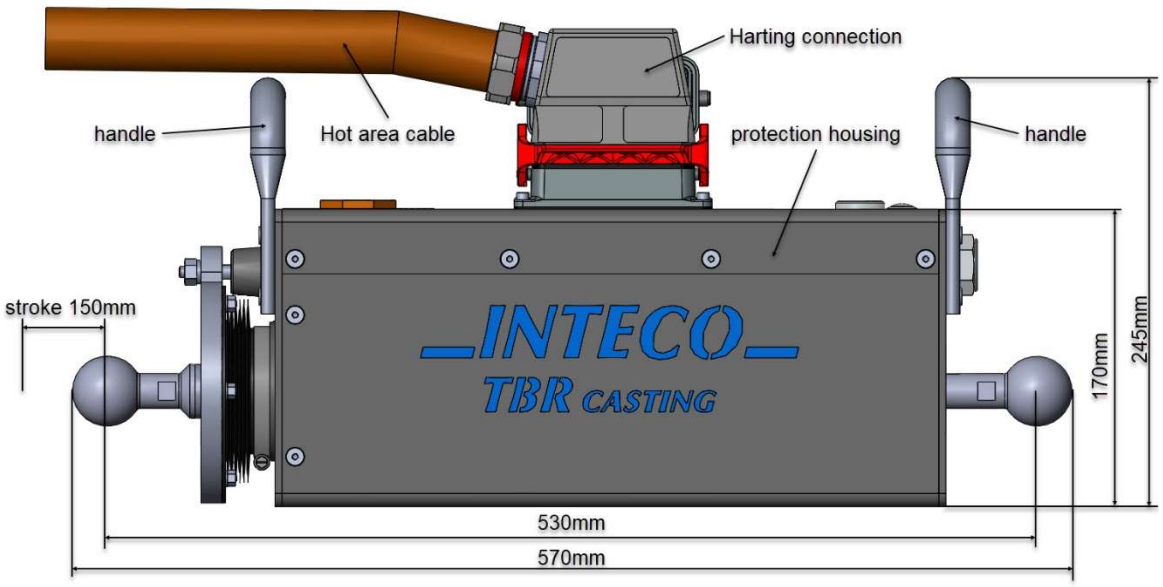
Low Internal friction rate to allow movement with a low starting or breakout force.

Manual control by hand lever for increased sensitivity in control. No mechanical clutch allows direct take-over from automatic control to manual control with lever.

Technical Data

Stroke	150 mm (max. stroke)
Nominal force	~ 7.4 kN
Weight	< 20 kg
Accuracy	0.01 mm
Operating temperature	5 - 60 °C, max. 80 °C

Design details



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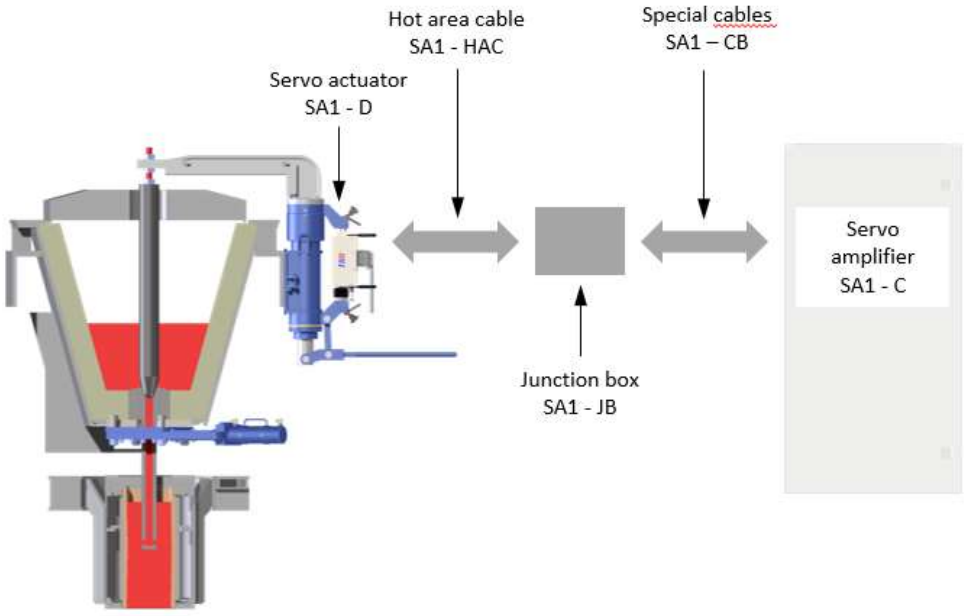
Stopper-Control - Servo-Actuator

Interface and additional components:

Interface	**SA1 - D**	Electro mechanical servo actuator
	SA1 – HAC	Hot Area Cable (length up to 5 m)
	SA1 - JB	Junction box
	SA1 - CB	Special cables (length up to 100 m)
	SA1 - C	Servo-amplifier with axis controller and included parameter setting software



Integration into Mould Level Control Solutions

Standard: ProfiNet
Possible: ProfiBus DP (DP-V0 & Dp-V1)
Possible: ProfiDrive (V3.0 Class 3 & 4)

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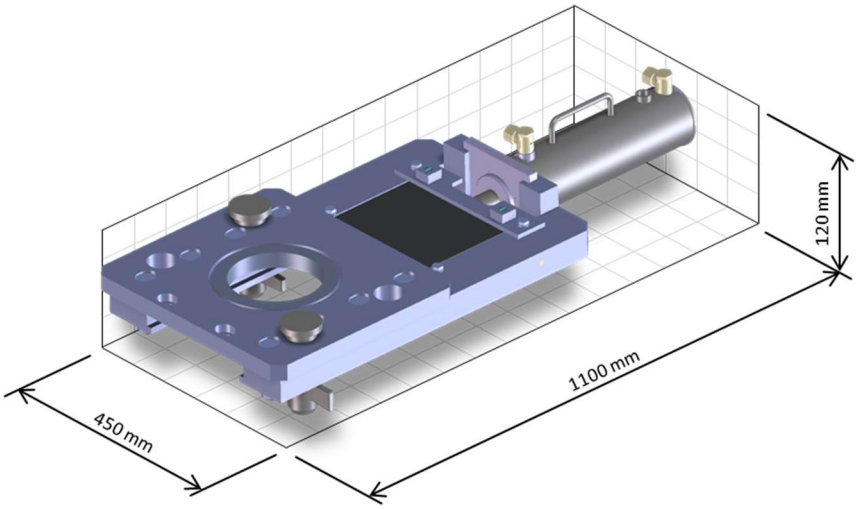
2.3.1 EMERGENCY SLIDE GATE

The Emergency slide gate is an optional safety equipment.

An emergency slide gate system ensures safe operation of a continuous casting machine. In case of a monobloc stopper failure it interrupts the steel flow by cutting the snorkel that shrouds the steel flow between the tundish and the mould.
It protects the casting equipment from damage which may be caused by leaky and worn-out stoppers, high mechanical load or too long heating-up. It increases the caster availability and reduces the maintenance costs.



The activation is done by a control valve which has to be triggered manually by the operating staff. The trigger for the control valve activates a hydraulic cylinder. This cylinder subsequently activates the knife which cuts the snorkel. The opening of the tundish is closed, the steel flow is stopped and the liquid steel solidifies in the mono-nozzle.

The slide gate is easy to mount, easy to maintain and easy to operate. It is bolted to the bottom of the tundish with two or four wedge bolts and can easily be centred thanks to the special design of the straight welding plate of the tundish.

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2.4 MLM – "Mould Level Master" Software

"Mould Level Master" – Mould Level Control	
Description	The Mould Level Master (MLM) is a highly sophisticated control program that minimizes mould level deviations under all conditions.
Main Features	
Casting, Operation and Quality	• Automatic mould filling and start of cast function. • Accurate and stable Mould Level Control under stable and instable casting conditions • Accurate mould level stability for billets of ≤ +/- 3 mm using common mould level detection with accurate measurement system system like: - eddy current - radiometric - ultrasonic etc. • Automatic detection and counteraction of mould level fluctuations due to bulging and waving (esp. for slab section sizes) • Break-out detection and overflow protection • Design of servo-actuator for fast reaction • Manual mould level control with lever system (instead of potentiometer) for increased operational safety/reaction time and sensitivity for manual interference/control. Disabling of automatic control is performed by electrical disconnection (push-buttons with indicators)
Increased Sequence Length	• Automatic clogging detection and cleaning of stopper tip by flushing • Anti-clogging function • Anti-SEN wear function by variation of mould level as function of time

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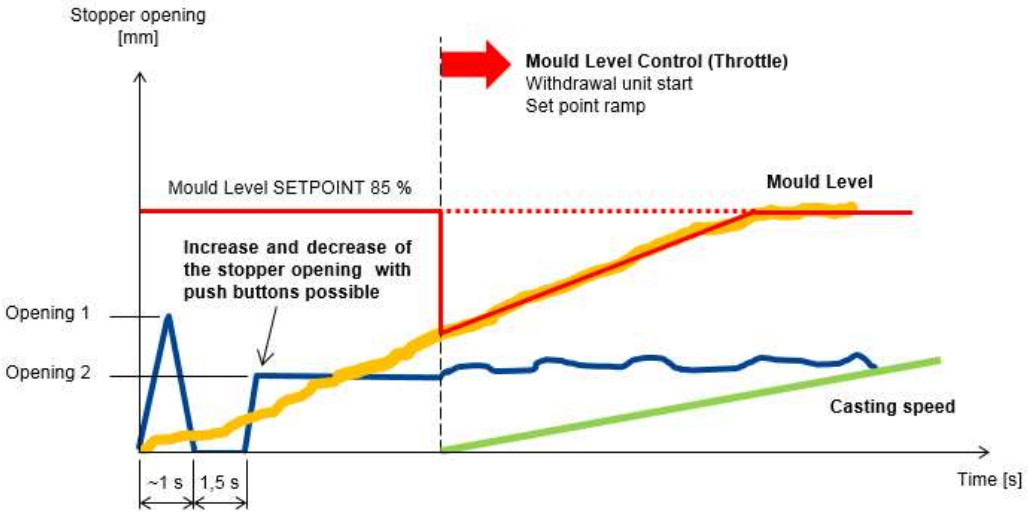
2.4.1 Automatic Mould Filling and Start of Cast

The automatic Start of Cast allows a controlled and reproducible filling of the mould and safe start of withdrawal. It is triggered by pressing the push-button for “Auto-Start” resulting in an initial opening of the stopper. The stopper opening position can be defined in the Start-of-Cast parameters with an array of opening storks and related opening times) and ends once a “Start-of-Cast Set-Point” (e.g. ML_{Start}=20%) has been detected by the mould level detection system. In case the mould filling time is “too long” or “too fast”, the stopper position could be manually altered by the "open" and "close" push buttons on the servo-actuator.

When the “Start-of-Cast Set Point” (e.g. ML_{Start}=20%) is reached, the initial stopper opening sequence is terminated and the mould level control according to the” start-of-cast” regulation parameters control the increase in mould level to the “Mould Level Set-Point” (e.g. ML_{nom}=70%) in a defined time (e.g. 15sec).

The automatic start of withdrawal and thus the start of cast can be defined according to a defined mould level (e.g. $ML_{WSU\text{-}tart}$=50%).

Once the nominal Mould Level Set-Point (e.g. ML_{nom}=70%) has been reached, the “Casting” mould level control parameters become active.



Schematic presentation of the auto-start function

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The auto start procedure has additionally a protection logic to avoid too fast filling (defined filling times) of the mould to prevent breakout conditions. I.E., in case the “Start-of-Cast Set-Point” (e.g. ML_{Start}=20%) is detected by the mould level measuring system below a defined minimum mould filling time, the stopper closes until the minimum mould filling time is reached and the automatic starts continues. This is esp. important for large section sizes (blooms) to form a good connection between bloom shell and starter piece to prevent premature disconnection at start of cast.
Thus, a reproducible start of casting can be achieved over the complete casting production.

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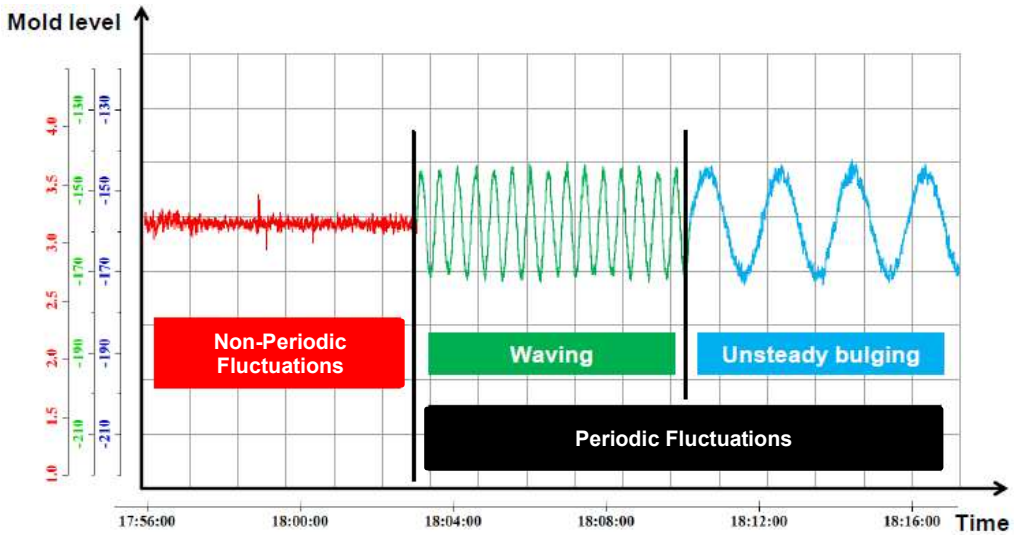
2.4.2 Detection of different Mould Level Variations

A highly sophisticated algorithm detects any variation in the mould level fluctuation and initiates the according counter-action.

In general, two different types of influences on the mould level are differentiated:

- Non periodic fluctuations
  - Standard mould level fluctuation
  - Clogging / unclogging (Alumina build-up and break-off)
  - Casting instabilities (slipping, signal issues)
  - Influences of mould powder addition
- Periodic fluctuations
  - Waving (small wavelength)
  - Unsteady Bulging (long wavelength)



Non-Periodic Fluctuations versus Periodic Fluctuations

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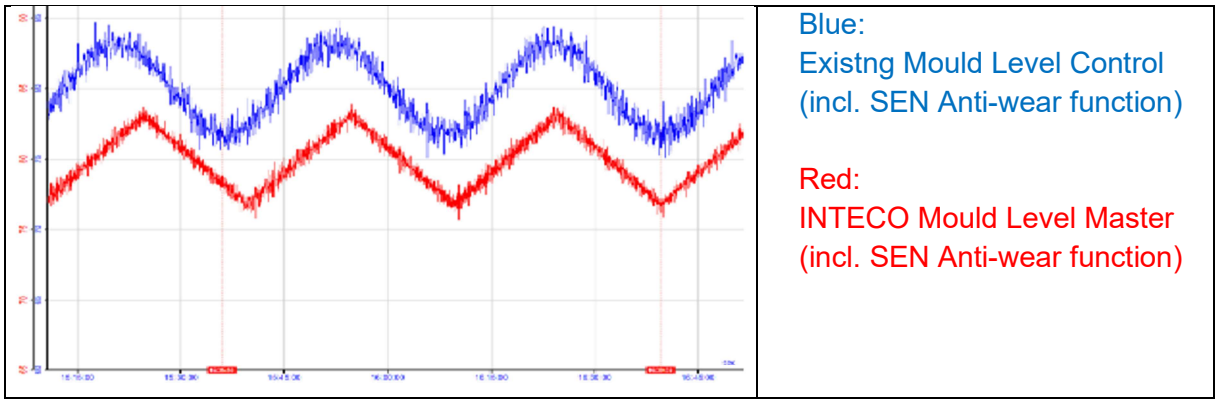
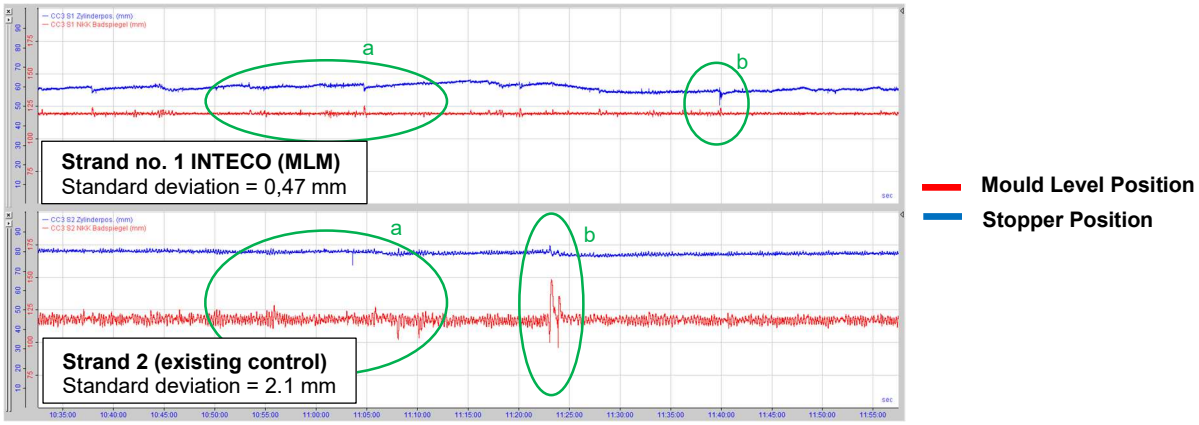
2.4.3 Accurate and stable Mould Level Control under stable and instable casting conditions - short periodic / non-periodic variations

The INTECO Mould Level Master (MLM) has proven improved mould level control during stable casting conditions and fast reaction time and mould level control during instable conditions (e.g. un-clogging).



Reference Plant A:



Reference Plant B: *Top: INTECO MLM – Bottom: Existing Mould Level Control*

- INTECO MLM: Improved Mould Level stability during stable casting conditions
- INTECO MLM: Improved reaction time with minimized mould level fluctuation during instable casting conditions.

A stable mould level is a key to cast of high quality steel grades. With the INTECO TBR Mould Level Control Solution a more stable mould level control has been proven which also provided besides quality aspects reduced risk concerning e.g. overflow and thus improve casting stability and operations.

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2.4.4 Anti-Bulging Master and Anti-Waving Master (esp. for slabs) – long periodic variations

The Mould Level Master has a special and patented detection logic, which detects and initiates counter-actions to stabilize periodic mould level fluctuations due to “unsteady bulging” and waving, and at the same time is designed to avoid synchronism between mould level deviation and stopper position, which would end up in growing instability on the mould level.
The detection logic is continuously active and analyzes the actual mould level. It indicates the occurrence of a periodic fluctuation on the flash button on the MOP. If the “Anti-Bulging” or “Anti-Waving” function is activated, an implemented algorithm automatically starts and dynamically tunes the regulation parameters according to the detection of either phenomenon to stabilize the mould level again and switches automatically back to standard regulation parameters once the periodic fluctuation is not detected anymore. If the “Anti-bulging” or “Anti-Waving” function is disabled, the operator can manually initiate these functions by pressing the flashing button on the MOP.
These functions are esp. beneficial for casting slabs or wide beam blanks section sizes.

Anti-Bulging Master

“Unsteady bulging” of the strand can occur due to ferro-static pressure of liquid steel acting on the solidified shell between the segment rollers.
Mould level instability due to “unsteady bulging” can be trigger, influenced and amplified by certain conditions:

- Chemical composition (e.g. peritectic grades)
- specific casting speed
- given roll geometry and alginment
- secondary cooling water and condition
- strand temperature

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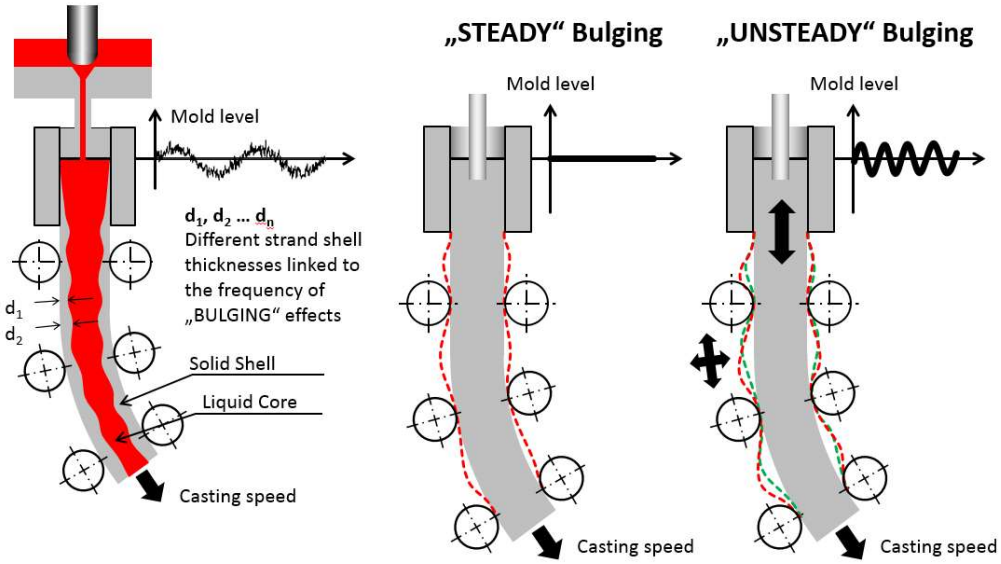
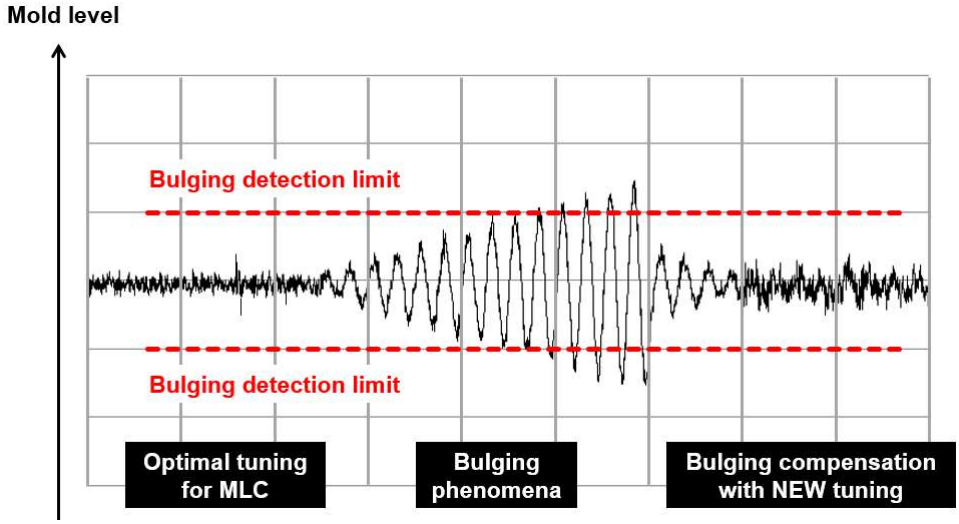
Anti-Waving Master

Waving in the mould is characterized by a higher frequency of mould level fluctuations compared to unsteady bulging.



Schematic presentation of difference between ‘steady’ and ‘unsteady’ bulging

An example of the counter-action against “unsteady bulging” or waving fluctuations is shown in the picture below.



Elimination of the bulging fluctuations by using of Mould Level Master

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2.4.5 Automatic clogging functions: Anti-Clogging Master and Flushing

Mould Level Master has implemented special functions next to sophisticated and very fast logic, which decreases the effect of clogging of the stopper tip and, if required, a flushing function can be initiated to clean the stopper tip from clogging.

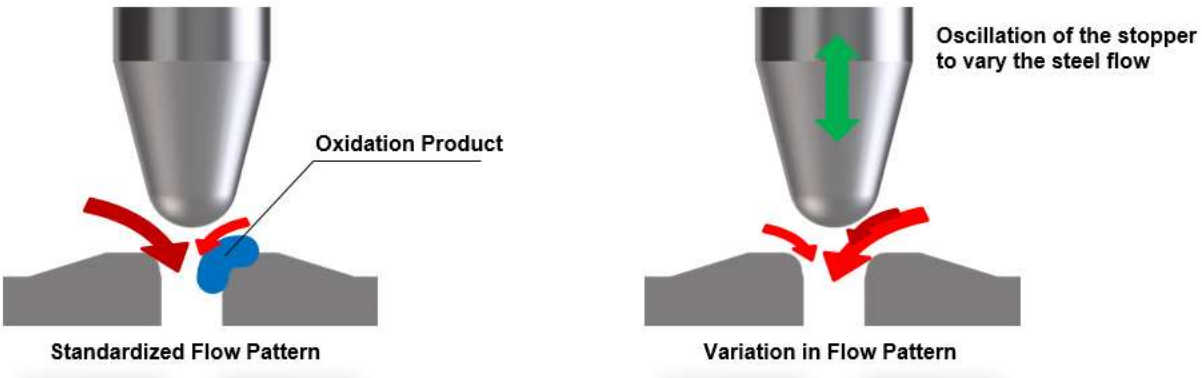
Anti-Clogging Master

This function reduces the clogging behavior by dithering of the stopper around the actual set-point. Period and amplitude of the dithering are set in such a way that the motor does not mismatch a synchronization phenomenon because of its mechanical/electrical inertia. Due to the high dithering/vibration speed, the average steel flow variation is zero and therefore does not affect the mould level stability. Due to the dithering movement the vortex effect in the SEN/SES will also be reduced, which additionally prevents the clogging effect. While running the “Anti-Clogging Master” the motor current is constantly monitored. If at any time the current exceeds a predefined value, the “Anti-clogging Master” is automatically disabled. This is to prevent the stopper tip from bottoming on the well nozzle in case of low stopper opening positions.

If the “”Anti-clogging Master” can run constantly during operation if enabled or manually activated by the push bottom on the MOP.

It can be switched off:

- by the operator pushing the push-bottom on the MOP.
- the current is over predefined value to protect the sevo-drive



Schematic presentation of anti-clogging

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Flushing

It is a function used to remove clogging (alumina build-up). The use of flushing produces macroscopic inclusion on the final product and therefore should be applied only when is absolutely required. If tracking system is available, the product can be marked for future conditioning. Flushing is initiated by a push bottom on the operator panel.

When the “Flushing” function is initiated the actual stopper position is memorized, than the stopper closes completely with max speed and torque in order to mechanically remove the alumina build-up by a “knock”. As soon as the tip of the rod touches the well nozzle (detected by motor current limit or safety timer), it goes back to the memorized position minus few mm and automatically start controlling again. In the next 20 seconds the stopper position, versus the memorized one, is checked and, if find less than memorized, (means clogging removed) the system is aborted, otherwise it will repeat the procedure, until operator exit by pushing the flushing push button (lamp off).

2.4.6 “Anti SES/SEN-Wear Master”

This function is used to increase the lifetime of SES/SEN and therefore to enable the casting of longer casting sequences. The mould level moves slowly with the predefine amplitude around the mould level set-point to distribute SES/SEN wearing over a certain height.

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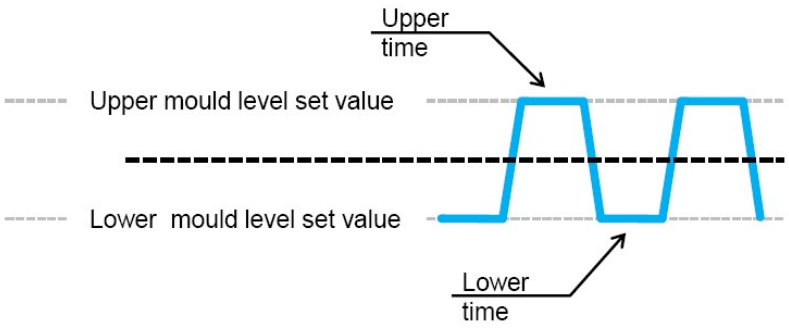

Schematic presentation the distribution of the submerged tube (SES/SEN) wearing

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2.4.7 High level protection - Overflow

When the mould level is detected to be ≥ 95 % for e.g. 2 seconds or after a mould level detection of 98% the stopper closes immediately to the fully closed position with max motor speed. In this case the stopper closes the nozzle and when the mould level decrease to e.g. 60 % the casting is continued automatically. The reaction from the operator site is not necessary.

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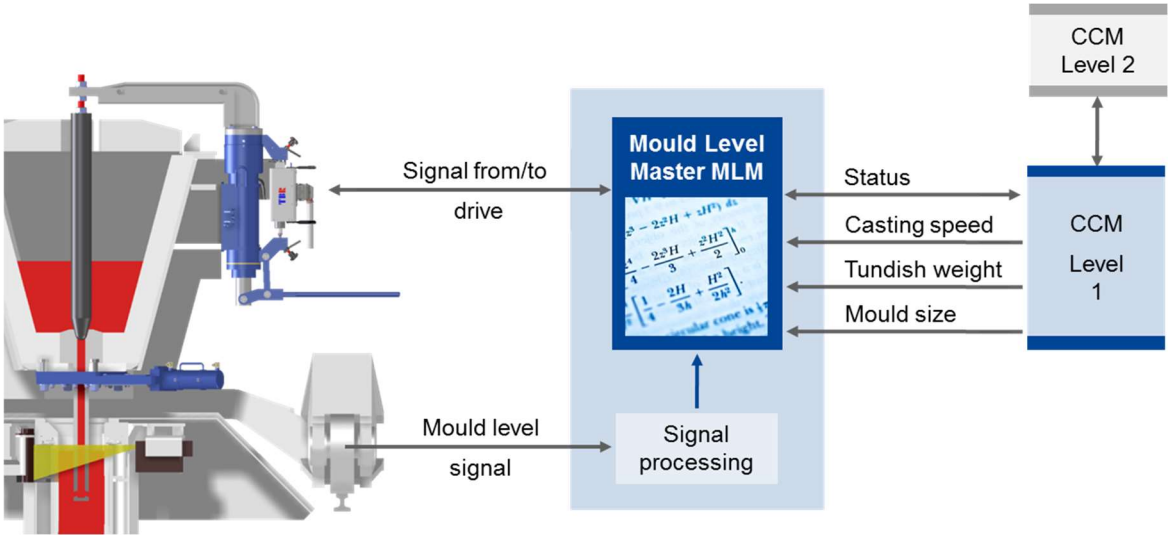
2.5 Electrics & Automation – Mould Level Control System

2.5.1 "Mould Level Master (MLM)" – Mould Level Control

Mould Level Controller for use with:

- Tundish stopper rod control for SEN casting
- Activation of emergency slide gate



Overview of "Mould Level Master" Mould Level Control

"Mould Level Master" – Mould Level Control	
Design	Package unit.
Interface to Level 1 Process Control System	Dedicated PLC unit with Field Bus connection to the Level 1 Process Control System.

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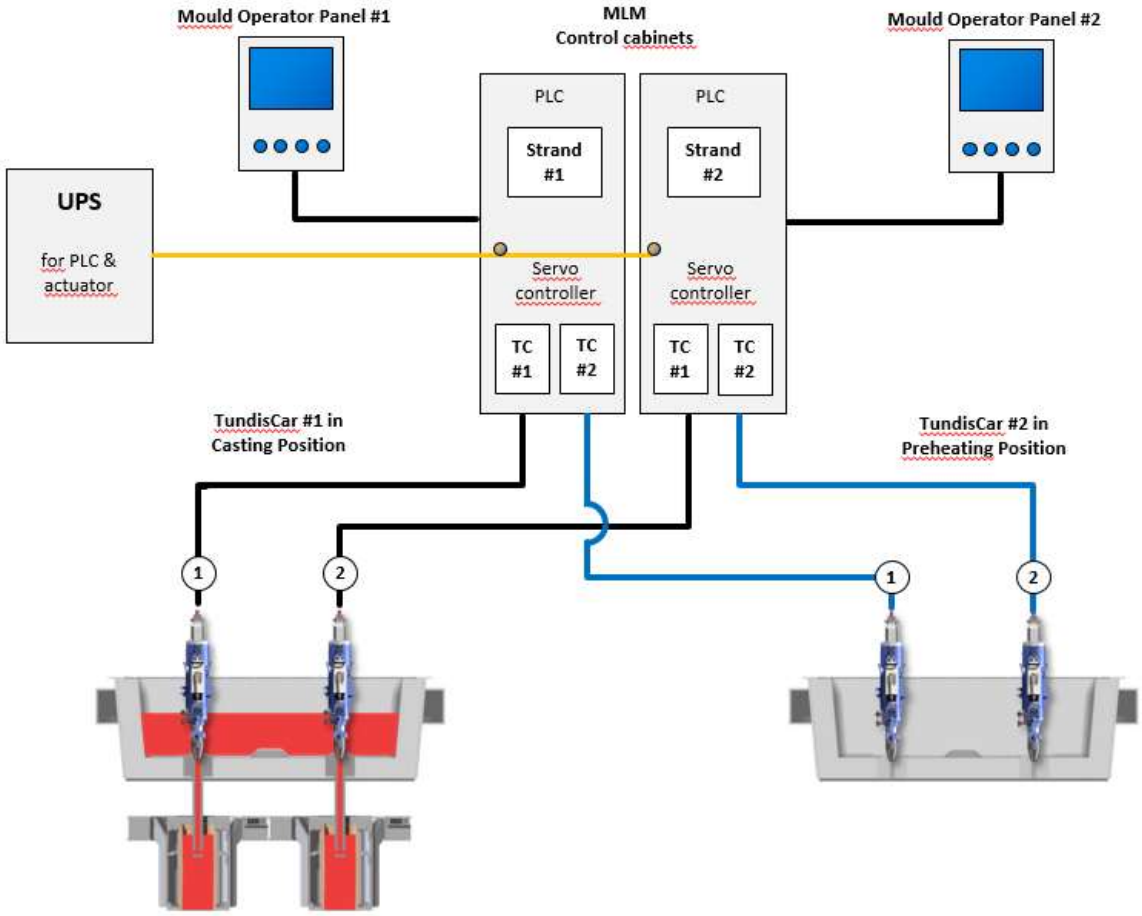
Hardware description



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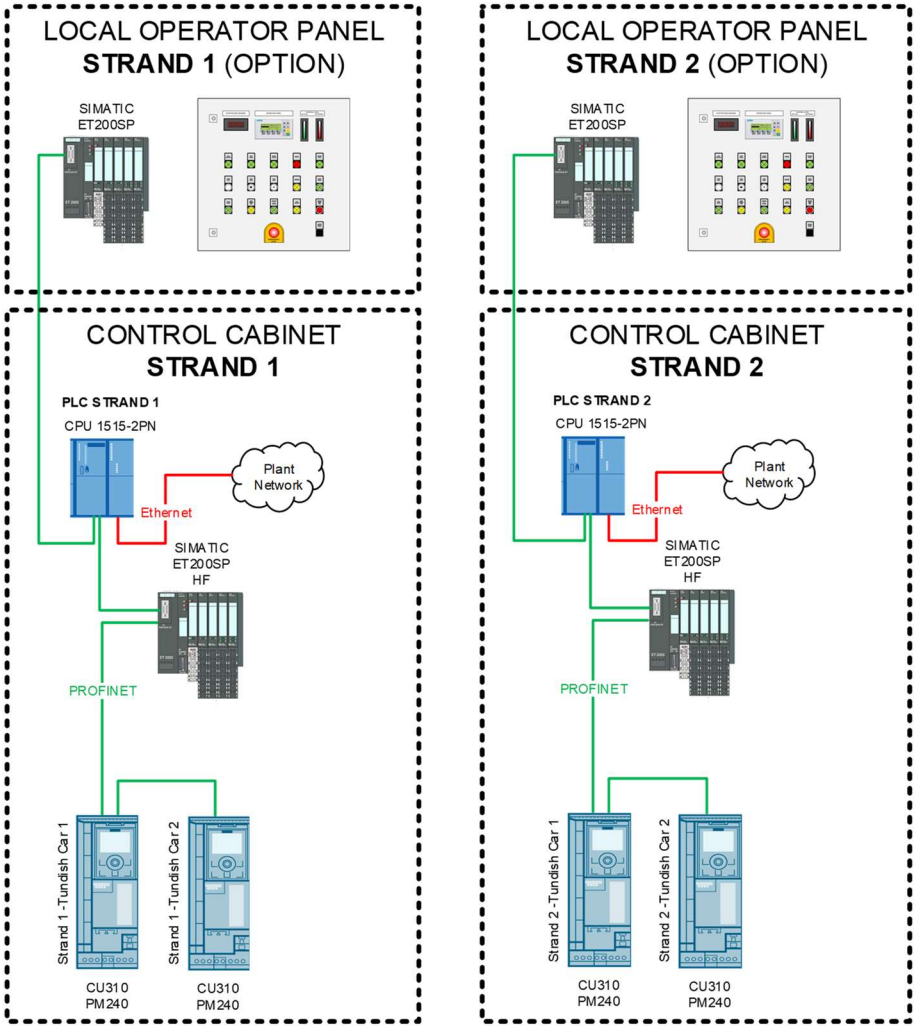
2.5.2 Automation configuration

The generally used automation standard interfaces iare ProfiNET and Ethernet. Other signal interfaces are also available if required (TCP/IP, data recording IBA, Level 2,...)



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2.5.3 Control Cabinet

MLM Components: Control Cabinet

Description	All required equipment for 1 strand is installed in 1 control cabinet. 1 MLM Controller, typically 1 Siemens S7-1500-Series PLC for each strand. 1 frequency converter for each actuator The basic equipment is always installed e.g. a main switch, circuit breakers, contactors and relays, motor protection switches, I/O modules communication modules (Siemens ProfiNet, etc	
Technical Data	Dimensions (width/height/depth)	800-1200/2000/600 mm
	Protection category	IP54
	Power supply	20 kVA per strand
	Main voltage	3 x 400 V, 50 Hz
	Control voltage	230 VAC 24 VDC
	UPS	20 kVA (per strand)

Implementation in existing automation system will be fulfilled from the SELLER.
The programming is done in TIA 16.

TIA software with the relevant version and license will be delivered from the BUYER.

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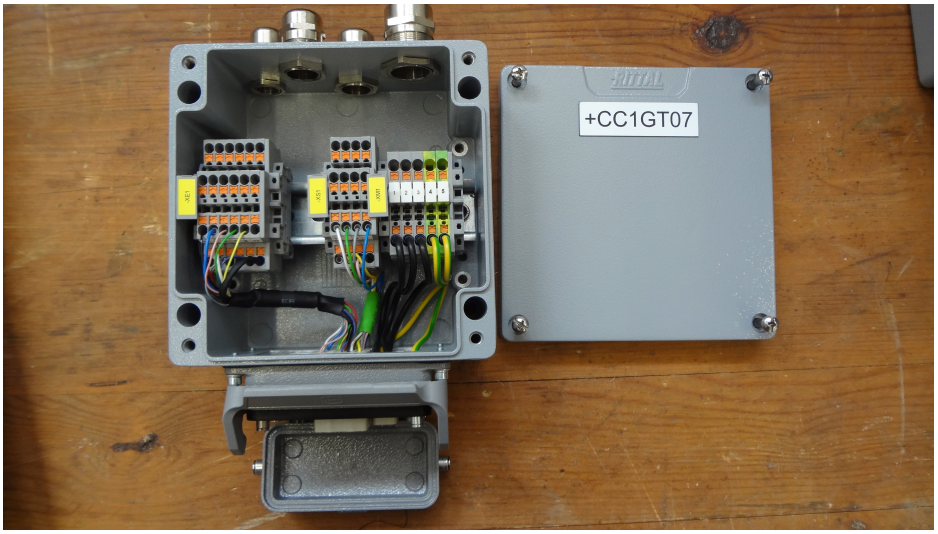
2.5.4 Junction box

Junction box is mounted on the tundish car (1 per strand).
Motor/encoder/control cables are installed from PLC-room to the Junction Box.
Junction box has on pressured air connection for servo actuator cooling.



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2.5.5 Hot Area cable

Is manufactured with HARTING-connectors on both sides and connects the servo-actuator with the junction box mounted on the tundish car.

2.5.6 Interconnecting cables

Consisting of:

Motor cable (100m)
Encoder cable (100m)
Control cable (100m)

2.5.7 UPS (Uninterruptible Power Supply)

20 kVA per strand to be foreseen as UPS

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2.5.8 Operator Panel (MOP)

The existing MOP will be reused and adaptions will be prepared from supplier and implemented on site.

Necessary new buttons and lights for stopper control will be designed and delivered from supplier. Buyer will install and commissioning will be done together.

2.5.9 Button

The following buttons are sorted according to their priority for the process.

Function	Requirement	Function Existing on MOP
Alarm (Acknowledge)	Obligatory	
Manual	Obligatory	
Auto	Obligatory	
End of Cast	Obligatory	
Stopper Close	Obligatory	
Auto Start	Obligatory	
Restart	Obligatory	
Stopper close	Recommended	
Anti-clogging Master	Recommended	
Flushing	Recommended	
Mould level set-point	Recommended	
Anti-bulging	Optional	
Anti-Waving	Optional	

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2.5.10 Communication Plant → MLM

All buttons (defined in Chapter 2) must be send to the MLM including the following signals:

Name	Type	Address
Tundish car 1 in casting position	Bool	
Tundish car 1 in preheating position	Bool	
Tundish car 2 in casting position	Bool	
Tundish car 2 in preheating position	Bool	
EmerOk	Bool	
CCM ready	Bool	
Strand close request	Bool	
Lamp test	Bool	
Activate set-point modulation	Bool	
Format[i]	Array [i] of Bool	
Set-point modulation period	Real	
Set-point modulation amplitude	Real	
Mould level set-point	Real	
Mould level actual	Real	
Tundish weight	Real	
Watchdog	Real/Int	

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2.5.11 Communication MLM → Plant

All MLM related functions of the MOP are sent to the plant including following signals:

Name	Type	Address	Comment
Automatic active	Bool		Information
End of cast	Bool		Event
Stopper ready to cast (Init Condition)	Bool		Information
Start withdrawal	Bool		Event
Stopper closed	Bool		Information
Clogging detected	Bool		Information
Flushing detected	Bool		Information
Overflow Prevention	Bool		Information
Drive ready	Bool		Information
Drive powered	Bool		Information
Drive error	Bool		Alarm
Calibration stopper NOK	Bool		Alarm
Car 1 lost	Bool		Alarm
Car 2 lost	Bool		Alarm
Stopper calibration done	Bool		Information
Alarm horn	Bool		Event
Mould level set-point internal	Real		Information
Motor temperature	Real		Information
Motor current	Real		Information
Stopper position actual	Real		Information
Stopper position set-point	Real		Information
Watchdog	Real/Int		Handshake

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2.5.12 Performance guarantees MLM

Guarantee Value

The mould level stability will be better or equal to

ΔML ≤ +/- 3,0 mm

for 95% of measurements (equal to a standard deviation of 1,5 mm).

Test Procedure:

- 2 sequences will be cast in submerged casting mode
- The mould level analysed according to measurements taken from the HMI or equivalent analysis system
- The section sizes to be cast will be mutually agreed

Precondition:

- Radio-metric mould level measuring system

  The ratio between the counts for empty calibration (0%) and full calibration (100%) shall be larger than 15.

$$\frac{Counts_{(0\%)}}{Counts_{(100\%)}} > 15$$

  The full calibration will be performed with a calibration block prior to the test sequence
  The empty calibration will be performed before start of cast, after the tundish has been placed and lowered in casting position with the SEN/SES fully immerged into the mould at ~ 100mm from nominal mould level position

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- Times of process instabilities influencing but not contributed to the mould level control system shall be excluded from the analysis:
    - Clogging during casting with abnormalities and/or required “stopper flushing” procedures
    - Tundish working level dropping below 80% of nominal tundish working level (excessive long ladle exchange / waiting for new ladle)
    - First 5min after start of cast
    - Last 5 min before stopper closing at end of cast
    - Dummy bar disconnection
    - Mould level fluctuations due to manual mould powder feeding

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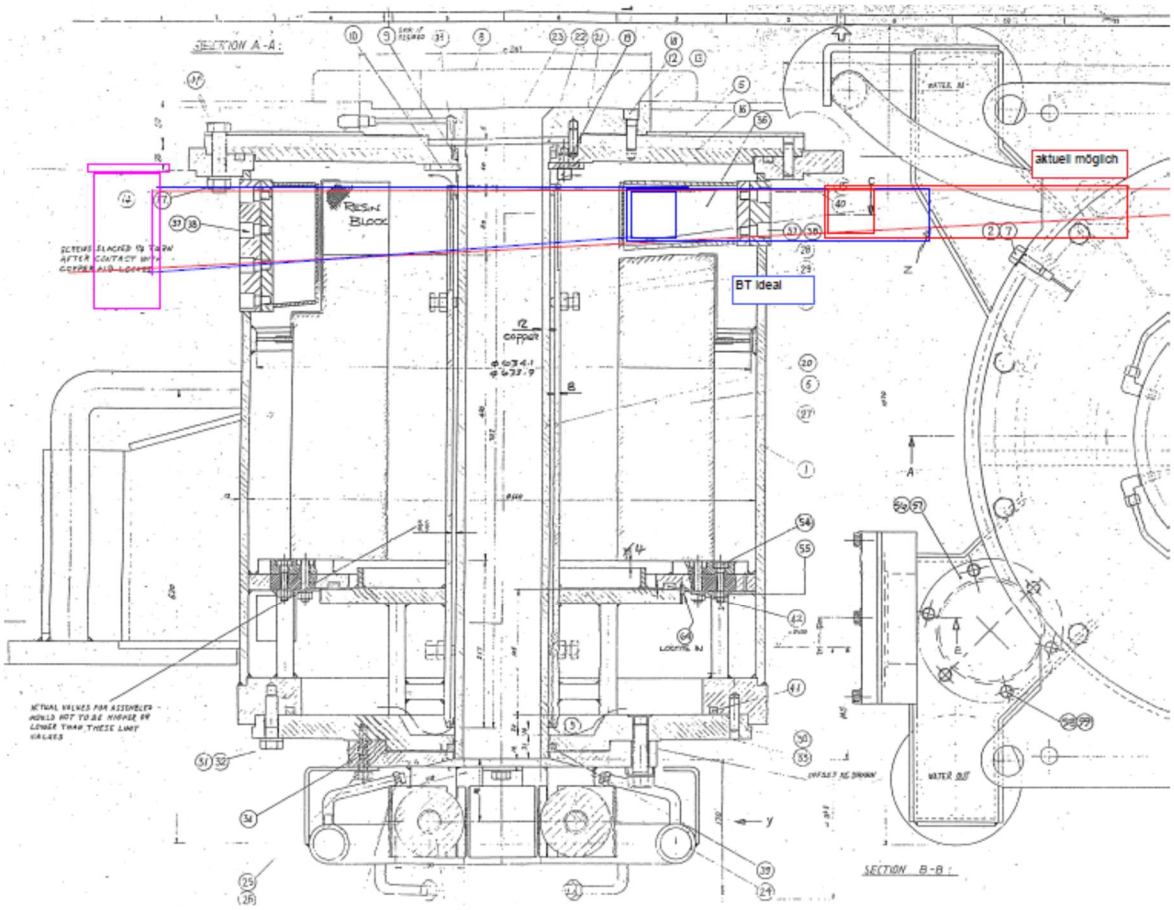
3. MOULD LEVEL MEAUSURING SYSTEM

Radiometric system shall be renewed and received drawings from moulds 140x140 and 300x142 were studied together with Berthold.

With the available mould design, an upfront check was done and the installation is feasable:



Within a project execution, INTECO together with Berthold will design the installation and the possible counts per sections will be studied and maximised.

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Adaptions on existing moulds will be informed to MPI and shall be prepared from customer. This will be reductions on steel sheet thickness etc.

Supports for holding the source and scintillator will be arranged and delivered from INTECO/Berthold.

Radiometric equipment package includes:

- LB 452 castXpert, first channel, 90-264C AC
- Connection Cable for GAMMAcast Detectors, 10 m, Heat Protection 10 m, Straight, HeavyCon
- Junction box with Connector
- LB 6739-03 CsI 25/50, without water cooling SCINTILLATOR
- Rod source Cs-137 6660 MBq (180 mCi) / active length 120 mm / 1 part
- Shielding for Mould Level Measurement, nom. dia., 159, Stainless Steel Design, max. length 500 mm

Radiometric source is considered for maximum rates according

e.g. UK regulations with < 7,5 µSv/h

Considered for budgetary offer and to be optimized:

- Copper thickness: 2 x 12 mm
- Steel jackets: 2 x ~ 12 mm
- Water gap: ~ 2x 130 mm

Theoretical number of counts with empty calibrations ~ 15.000 cps

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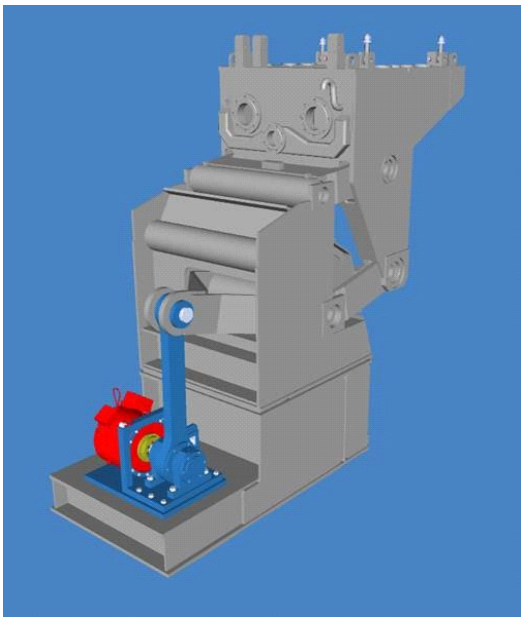
4. MOULD OSCILLATION SYSTEM

4.1 Mould Oscillation System

4.1.1 Mould oscillation Frame

Existing oscillator frame can be used and a servo-drive actuator with excentric unit will be added.

Mould oscillator frame (existing)	
Design	Oscillation system with compact design of oscillation table Welded steel structure with internal water cooling
Drive system	Servo-drive system with excentric unit



Mould oscillation with servo drive system (for reference)

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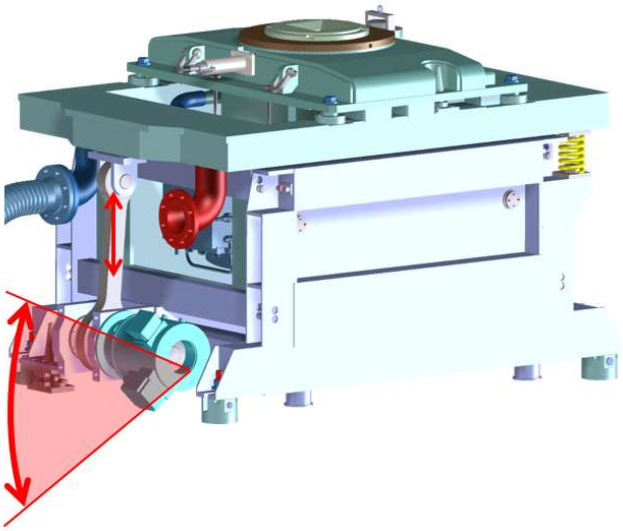
4.1.2 Servo drive oscillation system

The servo-oscillator combines the advantages of the hydraulic drive with those of modern servo-drive technology – eliminating the disadvantages of a hydraulic system.



Servo drive oscillation system

The eccentric of this novel electro-mechanical oscillation is driven by a backlash free servo-drive, the oscillating movement is performed by alternating the direction of rotation of the servo-drive. As the angle of rotation is a variable, the frequency, stroke and shape of the oscillation movement can be altered on-line.

The actuator is exchangeable for flexibility and ease of maintenance. Due to the characteristics of a servo-drive, high accelerations are feasible

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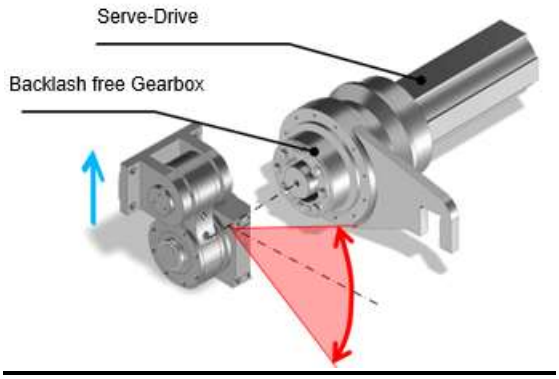
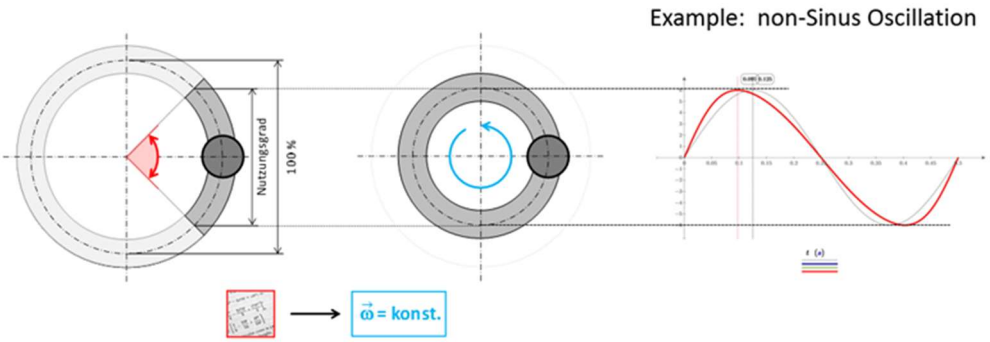


Mould oscillation with servo drive system



Non-Sinus oscillation

Oscillation characteristics	
Oscillation curve	Sinusoidal and non-sinus
Frequency	Max. – 250 cycles per minute.
Stroke	0 - 10 mm (0 - +/- 5 mm)
Online adjustment	Frequency, stroke, oscillation form

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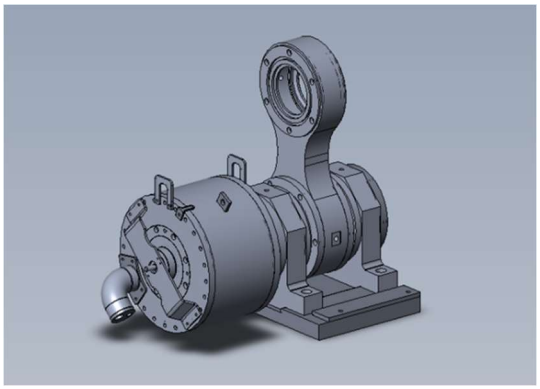

Figure: Drive with excentric unit (for reference)

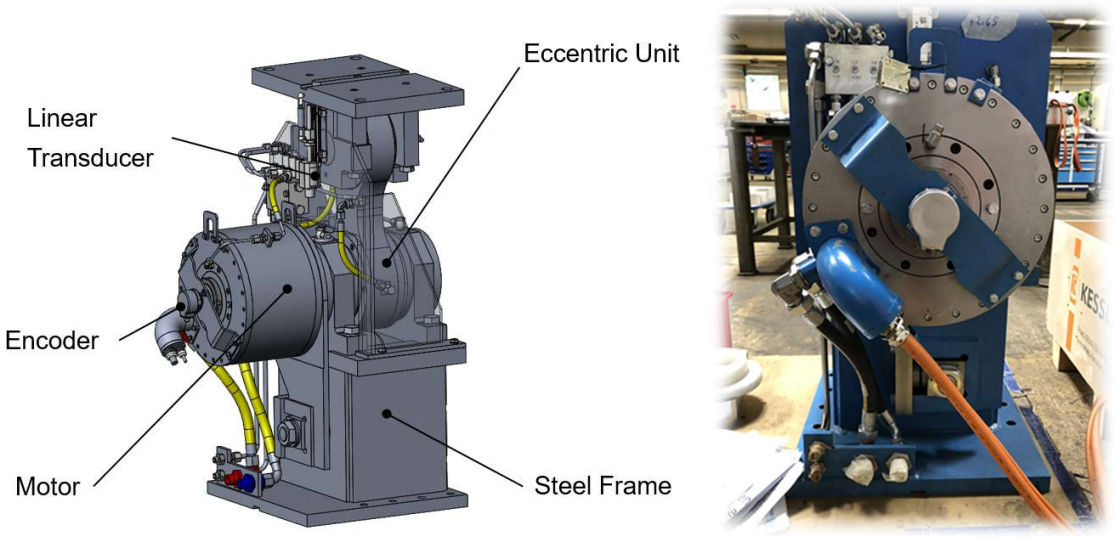

Figure: Drive with excentric unit and encoder (for reference, executed for SegmentCaster in Tandem technology)

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4.1.3 SERVO MOULD OSCILLATION

Existing mould oscillator design will be used. The BUYER will re-furbish the exisitng oscillator frame units into full functionality.
INTECO proposes to upgrade existing mechanism by supplying new servo motor drive.

Function principle
The motor works like a normal synchronous motor. The required speed is dependent on the frequency. Because of the large number of poles high torque at very low speed is produced.
No gears are needed because the rotor is directly coupled to the shaft to be turned.
This combination is, in connection with the pre-loaded ball bearings, absolutely free of play.
The rigidity of the drive is increased dramatically, combined with higher power, precision, angular speed and acceleration.
Compared with conventional motor-gear combinations, the servo motor has significantly higher acceleration and speed values. The zero backlash result from its conception.
Design, manufacture and assembly of machines equipped with servo motors are much easier compared to conventional technology.
In combination with suitable encoders the motors can be positioned accurately.
Today‘s available fast and powerful computing systems enable control circuits which meet the demands of casting.

More than that the use of servomotor allows to have all advantages of hydraulic oscillation without using hydraulic itself.

Main Features
- Improved surface quality
- Improved process stability
- Brushless and maintenance free / low maintenance
- Direct drive
- High level of control
- Low mass, Low inertia, high dynamics
- The installation can be realized very easily and adapted to existing design
- Oscillation system with servo-drive
- Stroke: In-line adjustable by angle of rotation
- Frequency: In-line adjustable by speed of rotation
- Shape: In-line adjustable by dynamic speed variation of rotation

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4.2 ELECTRICAL EQUIPMENT

4.2.1 Control package for Servo-Drive Oscillator

Dedicated controller unit for the motion control of the Hydraulic Oscillator.

“Oscillation Master” – Servo drive Oscillation Control

Continuous Oscillation Control with:

Motion control of the Oscillator as to the set oscillation pattern.

Online adjustment of stroke, frequency and curve shape.

Interface to Level 1

Dedicated Controller unit via ProfiNet connection to the Level 1 Process Control System to the existing strand PLC.

Existing strand PLC will send information via interface to the oscillation PLC according the casting-recipe

- Stroke
- Frequency
- Alpha (for sinus / non-sinus)

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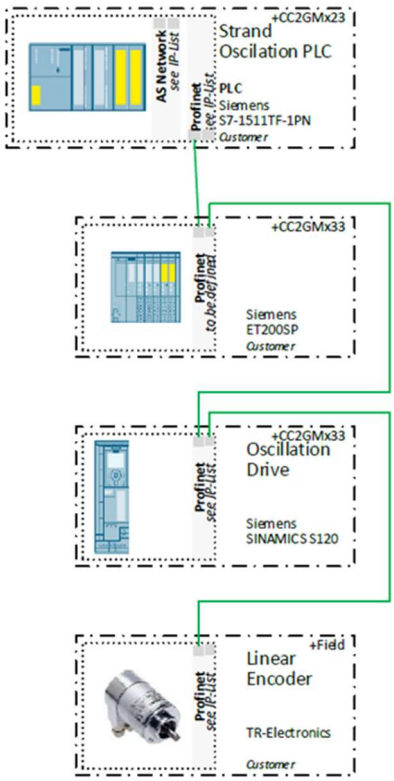

Overview of “Mould Oscillation Control” (For Reference)

CPU & software:

SIEMENS S7-1500
SIEMENS TIA16 software

Communication L1 to oscillation PLC:

Via ProfiNet

Cabinet dimension:

L x B x H 600 x 800 x 2.000 mm (without socket)

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5. TERMINOLOGY AND DEFINITION OF BD, BE, DE

5.1 Basic Data

Basic Data (as far as applicable)	
Basic Structure and Mechanical Equipment	Layout and sectional drawings to show basic configuration with: 1. Take Over Points 2. Position of main equipment. 3. Overall dimensions of foundations, buildings, rooms and concrete structures. 4. Overall dimensions of main equipment and equipment interfacing with others. 5. Estimated elevations of equipment and main platforms. 6. Dimensions required for the technological process.
Electrical and Automation Equipment	1. Power consumption data. 2. Design basis with applicable standards and codes. 3. Preliminary hardware configuration of automation system.
Electrical and Automation Equipment	Utilities and Instrumentation Preliminary block diagrams and process flow sheets (P & I diagrams) showing Take Over Points and related utility data at the T.O.P.

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5.2 Basic Engineering

Basic Engineering (as far as applicable)	
Basic Structure	1. Load data for foundations and steel structure, including maximum allowable tolerances. 2. Any special requirements to civil works or steel structure. <u>Civil Works:</u> 3. General / architectural layout 3. Foundation arrangement and section drawings. 4. Foundation plan drawings. 5. Anchor bolt arrangement. 6. Drawings of anchor and embedded steel parts.
Equipment	1. General layout 2. Outline drawings of main equipment showing main data and dimensions. 3. Material specification for main parts. 4. Applicable standards. 5. Basic Engineering drawings of equipment where Detail Engineering is Buyer's supply.
Utilities and Instrumentation	1. Block diagrams and process flow sheets (P & I diagrams) showing Take Over Points and related utility data at the T.O.P. 2. General arrangement of equipment in rooms. 3. Main pipe routing. 4. Specification for pipe materials and piping.

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Basic Engineering (as far as applicable)	
Electrical and Automation Equipment	1. Guideline for identification system. 2. Motor & component list. 3. Instrument list. 5. General definition of interfaces to existing or other equipment. 6. Single-line diagram of low voltage power distribution system. 7. Basic layout of control panels and control desks. 8. Layout drawings showing general arrangement of equipment in rooms. 9. Location drawing of control panels and control desks. <u>Cables & Installation Material:</u> 11. Specification of cables.

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5.3 Detail Engineering

Detail Engineering (as far as applicable)	
Basic Structure	Civil Works: 1. Reinforcement drawings. 2. Sheathing drawings. Steel Structure: 3. Arrangement drawings for the steel structure with indication of selected sections and showing important structural details. 4. Detail drawings for manufacturing of steel structure.
Equipment	1. Assembly drawings. 2. Detail drawings for manufacturing of equipment supplied by the Buyer where the Detail Engineering is the Seller's supply. 3. Bill of material including weights and specification of materials. 4. List of spare parts.
Utilities and Instrumentation	1. Drawings for interconnecting piping. 2. Lubrication list.
Electrical and Automation Equipment	1. Functional specification. 2. Interface design specification. 3. Arrangement drawings of cabinets. 4. Arrangement drawings of equipment in rooms. 5. Circuit diagrams. 6. Terminal drawings. 7. Catalogue pages of selected instrumentation. 8. Catalogue pages of selected field devices. 9. List of parts (bill of material). 10. List of spare parts. Cables & Installation Materials: 11. Cable list. 12. Interconnection wiring diagrams.
Consumables	1. Guide drawings for refractory materials. 2. List of consumables.

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