25 KG INGOT HEIGHT
CONTROL SYSTEM

BY

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requirements for the
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METAL PRODUCTS

25 Kg Ingot Height Control System

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This thesis represents an industrial project to control the size of 25kg aluminium ingot as it is being cast, on the No.1 ingot machine in the Metal Products MRU, Comalco Aluminium Bell Bay. The project consisted of the proposal, design, install and commission of an Ingot Height Control System. The result of the project is a system which has reduced physical scrap (in terms of bundle weight) by 1450 tonnes year to date (y.t.d.).
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1. INTRODUCTION

1.1 Ingot Casting Facilities

Molten aluminium is supplied from Potrooms and stored prior to casting in holding furnaces. Two furnaces are available, an electric furnace No.6 and an oil fired furnace No.7 for the No.1 ingot machine facility. The No.6 Tilting Furnace has a capacity of 40 tonnes of molten aluminium, and the No.7 fixed furnace has a capacity of 15 tonnes. The metal is maintained at temperature between 700 and 750°C.

The No.6 tilting furnace mechanism consists of two hydraulic lifting rams attached to the furnace, and lift the furnace about two pivot points adjacent to where the aluminium is discharged. As the furnace is lifted the aluminium is discharged to the feed launders for the casting machine.

1.2 Details of Ingots To be Cast

The ingot casting machine comprises of a continuous loop of 92 cast iron moulds (ingot size nominal 22.7 kg's) mounted on twin strands of conveyor chain driven by a variable speed electric motor, the speed of which is adjusted to provide control over the filling of the moulds at the initial start of the cast and the cast rate. Mould filling is automatically controlled during the cast by the ingot height control system. The casting machine is fed from a 40 tonne capacity tilting furnace, or a 15 tonne fixed furnace, via a rotary distribution tundish geared to the casting machine drive. The metal temperature when it enters the mould is typically around 720°C. Typical cast rates are in the order of 9-11 tonnes/hour (the cast rate being limited by the length of the casting machine).
The ingots are then cooled by passing over water sprays. The ingot moulds are pivoted along their leading edge such that as the moulds pass their points of balance when moving around the conveyor head sprockets, they flop downwards and strike two solid fixed anvils which provide the necessary ejection blow and propel the ingot downwards onto a curved plate and delivered (ingot skin temperature of up to 550°C) onto another cooling conveyor. The ingots are cooled further by water sprays above the cooling conveyor. The ingots exit the cooling conveyor at around 60°C. Ingots are then aligned in preparation for stacking on an automated stacking system. The stacking system comprises of two Staubli electric robots, which stack the ingots in predetermined bundle sizes and configurations.

**Mean Actual Ingot Dimensions**

<table>
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<tr>
<th>Dimension</th>
<th>Value</th>
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<tbody>
<tr>
<td>Overall length</td>
<td>828 mm</td>
</tr>
<tr>
<td>Overall width</td>
<td>210 mm</td>
</tr>
<tr>
<td>Overall height</td>
<td>80 mm</td>
</tr>
<tr>
<td>Average mass</td>
<td>22.7 kg</td>
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2.0 DISCUSSION

This project is as a result of poor metal flow control from No. 6 and No.7 furnaces to the No. 1 ingot casting machine in Metal Products. The requirement is to control the furnaces from their full to empty state with absolute minimum ingot size variation.

There was no launder level control systems on any of the furnaces in Metal Products at Bell Bay to assist the operator in maintaining constant metal flow. With such primitive tilt control, and no level control, reliable consistency could not be expected from the operator, as each has different heuristics.

Previously metal flow control was based on an operator assessment of the molten metal height in the moulds, the furnace then tilted up or down to achieve the desired mould metal level. This form of control was very operator dependent and compounded in difficulty by a fluctuation in mould levels in the casting belt.

The previous tilt control consisted of a proportional flow control valve adjusted by the operator by means of a potentiometer, to raise the furnace according to the metal flow. The problem with this method was the metal flow from the furnace varies as the furnace is raised necessitating constant adjustment by the operator.

There was a tendency for the metal flow to reduce during a cast which would require a corresponding reduction in belt speed. This is not desirable as it reduces the capacity of the casting machine.

The result of the above deficiencies, required constant operator adjustment of the proportional control or basic tilt on/off control to achieve the desired
metal flow. Either method cannot maintain the level variations at the accuracy required. The level variations were of the order of 3-7 mm at best. To that end it was proposed to automate the metal flow process by means of launder level and ingot height control.

3.0 OBJECTIVES

The objective of the project was to accurately and consistently control the quantity of aluminium supplied to each mould during the ingot casting process, from the No.6 tilting furnace and the No.7 fixed furnace to No. 1 ingot casting machine, see Fig.1.

The project consisted of three stages,

3.1 Stage 1

The aim was to control the No.6 furnace tilt from the full to empty state with the absolute minimum launder level variation for the entire cast, in order to achieve a consistent flow rate, see Fig.2.

3.2 Stage 2

The aim was to utilise an ingot height measurement system to automate the actuation of the weir based on feedback of the ingot height, and to gain an understanding of the process, see Fig.3.

3.3 Stage 3

The aim was to control the No.7 furnace tap hole plug assembly automatically from the full to empty state with the absolute minimum launder level variation for the entire cast, in order to achieve a consistent flow rate, see Fig.2.
Figure 1 No.1 INGOT MACHINE METAL FLOW CONTROL
Figure 2  LAUNDER LEVEL CONTROL LOOP
Figure 3  INGOT HEIGHT CONTROL LOOP
4.0 BENEFITS

The benefits of the control system are as follows:

4.1 Financial

Prior to installation of the ingot height control system, 10% of 22-kg ingot produced was out of specification (London Metal Exchange, LME) physically.

With 53 597 tonnes of 22-kg ingot production planned for 1992-93 this equates to 5360 tonnes of metal which can not be offered on the LME.

The out of specification ingot produced year to date (y.t.d.) is 0.49% out of the No.6 Furnace and 1.7% out of the No.7 Furnace. Resulting in a payback period of less than 6 months.

4.2 Safety (Launder Overflow Prevention)

Metal spill from the No.6 furnace or launder arrangement could be detrimental to 22-kg ingot production. Due to the close proximity of control panels (for furnace and ingot casting machine), it is necessary to ensure that metal spill from ingot production does not occur. With the launder monitoring system currently installed there has been no metal overflows from this facility.

The design, is such that if the launder level were to exceed a preset value the furnace tilt would be disabled and/or the furnace dropped back. There are two systems in place, the first is the analogue signal of the metal level, the second is a proximity switch. Either system is capable of disabling the furnace tilt, or lowering the furnace.
4.3 Future

With the function of real time displays (trending, histograms, etc.) and data capture a basic understanding of the process can now be attained, evaluated and a course of action taken to further improve the system.

The system, now that it has been developed and proven, is being utilised at other casting facilities within Metal Products.

Modifying the No.7 Tap hole so that the plug remains submerged would ensure that the freezing of the tap hole does not occur, ensuring a consistent and predictable flow of metal.

4.4 General

Now that a more consistent ingot is obtained, tolerances within the robot stacking system have been minimised to obtain tighter packed bundles. The benefit being, bundles when strapped remain tight when transported, thereby reducing the existing problems of loose strapping.

With metal flow control the cast rate is more steady, as flow fluctuations from the furnace have been minimised from the furnace full to empty state.

a) improve casting speed
b) improve (minimise) operator control
c) fewer reject ingots,
d) tighter packed bundles, that will maintain their stability throughout transportation,
e) safety (launder overflow prevention)
f) gain an understanding of the process
A short explanation of each benefit:

a) Improve casting speed
The options when the furnace was less than half full and the metal flow rate begins to reduce, was to slow the casting conveyor accordingly or increase operator control of the furnace tilt as the cast continues. The results being, a slower cast rate or more metal flow fluctuations and larger ingot variance. With launder level control the cast speed can be maintained at a fixed rate with minimal flow fluctuations.

b) Improve (minimise) operator control
On completion of stage 1, the operator no longer controls the furnace tilt, and operation of the weir once set can be left alone. This results in a regulated flow of metal for the entire cast, leaving the only control required by the operator, is minimal belt speed variation.

On completion of stage 2 once the cast is underway, minimal operator control is required i.e. the system is a closed loop whereby the system will "tune" itself automatically to maintain a fixed ingot height.

c) Fewer reject ingots,
Bringing the system under control as mentioned above, improves the dimensional uniformity of each ingot.

d) Tighter packed bundles,
Once a more consistent ingot is obtained, tolerances within the robot stacking system are minimised to obtain a tighter packed bundle.
The result being, that bundles when strapped will remain tight when transported, thereby reducing the problems of loose strapping.

e) Safety (launder overflow prevention)
The design is such that if the launder level were to exceed a preset setpoint, the output to the hydraulic proportional valve is zero (4 mA), thereby disabling the furnace tilt. If the launder level sensor fails, there is a high level proximity switch on the sensor mechanism which detects an abnormally high level in the launder causing the hydraulics to be disabled from tilting further, whether the system is in automatic or manual. The high level proximity switch will override all tilting actions when it is "made". This minimises the possibility of metal spill from the launder, previously no such safety feature was installed.

f) Gain an understanding of the process
With the function of real time displays (trending, histograms, etc.) and data capture a basic understanding of the process can be attained and evaluated and a course of action taken to improve the system.
5.0 SCOPE

5.1 Stage 1
- Install a weir in the launder
- Install launder level control
- Weir actuation to be by operator

Crucial to achieving good ingot consistency is the maintenance of a consistent head of metal behind a weir in the launder.

Installation of a weir also has the benefits of allowing the furnace tilt and launder level control to be a closed loop i.e. not acted upon by the operator and the cast speed to be maintained. Currently the cast speed is reduced near the end of a cast as metal flow decreases i.e. it is easier to control the belt speed than the furnace tilt to maintain ingot consistency.

The furnace tilt is governed by the launder level (irrespective of the weir position). Once a constant launder level is obtained and the weir position set for a fixed flow, only minor cast belt speed adjustments at the start of the cast need to be made by the operator to obtain the desired ingot size, see Fig.2.

5.2 Stage 2
- Install ingot height measurement system
- Automate weir or belt speed control

Install an ingot height measurement and display system. This has the advantage of displaying ingot height and trending information to the operator/supervisor with the facility to record cast data for supervisor/operator or technical evaluation of the process, see Fig.3.
The ingot height information is also used in the feedback loop to automatically control the actuation according to ingot height. The system will then be a closed loop, (i.e. system actions will be met with system reactions) requiring minimal operator interaction.

5.3 Stage 3

- Install new tap hole flow control device in No.7 furnace.
The liquid metal flow to the casting machine is controlled by a motorised regulating bar assembly, see Fig.2.

To ensure accurate control over the full range of metal flow, a special refractory tap-out block with a replaceable nozzle insert is incorporated into the furnace refractory lining.

The control device mounting bracket is attached to the side of the launder casing and incorporates the following:
- regulating bar guide system
- activating lever assembly
- manual emergency override lever
- electric actuator

The regulating bar assembly consists of an adjustable round bar with a graphite cone fitted to the lower end to enable control of the metal flow. A counterweight is fitted to the top end to ensure accurate positioning during the operation.

To ensure good sealing of the furnace tap hole nozzle when not casting, a separate manual stop bar assembly is used. A ceramic fibre cone is fitted over the graphite plug on the stop bar assembly.

Automatic control of the electric actuator is by means of the launder float control system developed in Stage 1.
6.0 CASTING SYSTEM OVERVIEW

6.1 Launder Level Control

6.1.1 Furnace Tilt Control

The discharge of molten aluminium from the furnace must be regulated in order to maintain a constant flow to the casting belt.

The furnace tilt is controlled by means of a feedback loop from a capacitance sensor in the discharge launder. The capacitor sensor indicates the metal level to the PLC. The PLC using this input signal, actuates a proportional valve which controls the supply of hydraulic fluid to the lifting rams. Fluid is supplied to the rams until the metal reaches the desired launder level setpoint, where upon the flow is inhibited.

This is a PID controller designed to maintain a constant head of metal in the discharge launder.

6.1.2 Molten Metal Flow

Despite maintaining a fixed head of metal in the launder, flow fluctuations from the furnace do occur when tilting. A secondary flow control device regulates this flow of metal from the launder into the tundish.

The secondary flow control device comprises of a weir situated such that the metal flows beneath it, (as underpour to minimise dross formation). The height of the weir was controlled by the operator in stage 1 and automatically controlled by the ingot height measuring system in stage 2. With a regulated flow from the launder it is possible to control the metal level in the moulds by weir actuation.
6.2 Ingot Height Measurement Control System

6.2.1 Molten Metal Height Detection

Molten metal height in each mould is measured by a capacitance level sensor positioned above the moving casting belt, and close to the skimming operator. As the mould position in the belt can vary vertically the metal height is expressed relative to a reference point on that mould i.e. the mould hinge. As the moulds are continuously moving under the capacitive sensor a snap shot of the height of the mould hinge is taken when it is directly under the sensor. Similarly the level of the molten metal at the centre of the mould is achieved by taking a snap shot. With a fixed ingot mould size, and subtracting the height of the metal from the height of the hinge a corresponding ingot height is achieved. The ingot height is averaged for a sub group size of 3 moulds (selectable 1-4). A point, representing the running sub-group average of the last 3 ingots, is then automatically plotted on a VDU trend display.

Accurate real time data can thus be used with confidence by the operator to maintain ingot height uniformity throughout the cast.
7.0 PROCESS CONTROL INSTRUMENTATION AND MECHANISMS

The development of this project comprised 3 stages:

7.1 Stage 1 (Furnace tilt control loop)

Development of PLC Software for Furnace No.6 Launder Level Control

The program developed controls all actions of the tilting furnace from temperature to doors and primarily an automatic/manual tilt control. The tilt automatic tilt control is basically a PID loop, the process variable being the actual launder level the setpoint determined by the operator and the output the signal to the hydraulic proportional valve.

Installation of:-

7.1.1 Retrofit Of PLC 2 to PLC 5

The Allen Bradley PLC 2 utilised on the furnace was unsuitable for the proposed application due its limited maths capabilities (no PID or floating point maths facilities) and poor networking and programming features, and was therefore replaced completely utilising an Allen Bradley PLC5 controller.

7.1.2 Hydraulic Proportional Valve Controller

The hydraulic proportional valve (Hydraulic Controls) and controller is used to tilt the furnace at a variable rate. Actuation of the valve is via a 4-20mA signal from the PLC, which is fed into an amplifier card for a variable voltage output signal to the proportional valve.
Figure 4. Capacitive Launder Metal Level Measurement

Figure 5. Capacitive Ingot Metal Level Measurement
7.1.3 Launder Level Sensor

The Launder level sensor comprises of a capacitive sensor (Endress & Hauser) with a large disc fitted to a probe, and fixed permanently to the launder steelwork. A float, pivot arm and steel disc make up the moving section of the sensor. As the launder level increases the gap between the two steel plates decreases and the capacitance increases. An insert within the probe converts the signal from capacitance to frequency. A separate controller converts this frequency to 4-20mA signal corresponding to the launder height. Scaling of the launder level is carried out within the PID instruction.

7.1.4 Operator Controlled Weir Via a Motorised (Variable Speed) Drive

A variable speed drive (Allen Bradley) in association with a 3 phase, 415V, 0.75kW motor and 15:1 gearbox ratio is used as the actuator for the weir. The weir actuation for fast, slow, raise and lower presets are setup within the variable speed drive. All control commands (Fast, Slow, Raise and Lower) are directed through the PLC and then output to the variable speed drive.

7.2 Stage 2 (Ingot height control loop)

7.2.1 Installation of Ingot Height Sensor.

The ingot height sensor (Delavan Hot Prox 620) is a capacitive sensor used to measure the molten metal level in the moulds. It is a capacitance sensor, designed to measure changes of capacitance to earth as they occur. The molten metal surface and the mould edge act as earthed plates similar to one plate in a parallel plate.
capacitor. The sensor being the other plate. Any change in level would appear to the sensor as a change in distance between the plates. The resultant change of capacitance will vary the frequency of a variable oscillator located in the pre-amplifier in the rear of the sensor. The frequency signal is transmitted to the converter and converted to a voltage. Within the recommended ranges the output voltage (or current) will be linear and proportional to the distance changes. The sensor measuring plate is guarded to prevent false signals from other objects or surfaces not in the desired sensing area.

7.2.2 Development of PLC Software for Ingot Height Measurement and Automated Weir Control

Snapshots are taken of the height of the mould hinge as it passes under the sensor and again at the centre of the ingot. The height of the hinge is subtracted from the height of the molten ingot, the difference is then subtracted from the total height of the mould, to yield the actual ingot size see Fig.6. A running average of the size of the most recent ingot and the two preceding (sub-group of 3 ingots) it, is calculated to obtain a value for comparison with the setpoint see Fig.7. A sub-group of 3 was selected to minimise tampering and overreaction of the system due to delays in the process, i.e. definite trends are obtained and reacted to by the controller. Controlling to each individual ingot height resulted in higher standard deviations about the 980kg setpoint. The sub-group however is user selectable from 1-4 ingots. The location of the sensor relative to the position of the weir is approximately 5 ingots or 30seconds. Therefore when the PLC has
 Thực hiện đo lường độ cao dòng chảy:

- **Scan of Mould Edge Height**: Đo độ cao bên cạnh khuôn.
- **Scan of Metal Level in Mould**: Đo độ cao phương tiện trong khuôn.
- **Sensor Head (Maximum Value)**: Đầu cảm biến (giá trị tối đa).

**Fig.6 Real Time Display of Sensor Output**

**Ingot Size** = \( c - (b-a) \)

Dimension \( c = 100 \text{ mm} \)
Figure 7  INGOT HEIGHT CONTROL - SAMPLE DETERMINATION
called for the weir to raise/lower the consequences of this action (in terms of increased/decreased metal flow) will only be seen by the sensor some 30 seconds later, the system will then measure the height of the next two sub-groups i.e. another 12 seconds, the result is a delay of 42 seconds before the system will make a change to the weir position again. Once the sub-group average height has been determined it is compared with the ingot height setpoint (80mm or 91% of mould capacity) see Figs. 8, 9 & 10. There is a deadband around the setpoint of 2%, where there is no action taken by the system. If the process variable PV (ingot height) is 93%<PV<94% for longer than 50 seconds the weir will be lowered down for a .12 second pulse. If the PV>94% for 50 seconds the weir is lowered down for a pulse of .14 seconds. If the process variable PV (ingot height) is 87.5%<PV<89% for longer than 50 seconds the weir will be raised up for a .12 second pulse. If the PV<87.5% for 50 seconds the weir is raised up for a pulse of .14 seconds, see Fig.11 & 12.

An improvement to the system would be to relocate the sensor adjacent to the tundish to minimise delays in the system.

Development of computer software designed to extract ingot height information (and any other relevant cast data) from sensors for display and technical evaluation. Data for each cast is archived to the computer through the Citect software. The ingot heights, launder levels and cast speed are recorded for each cast automatically when the cast is in progress.
Figure 8  INGOT HEIGHT CONTROL - TRENDING
Figure 9  INGOT HEIGHT CONTROL - FLOWCHART
Figure 10  INGOT HEIGHT CONTROL - PLC ADDRESS VALUES
Figure 11  INGOT HEIGHT CONTROL - PLC ADDRESSES
**Figure 12 INGOT HEIGHT CONTROL - WEIR CONTROL**
7.3 Stage 3 (Furnace tap-hole control loop)

Development of PLC Software for Furnace No.7 Tap Hole and Launder Level Control.

Utilising the launder level control system sensor, developed in stage 1. The electric actuator installed relies on pulse duration to determine how far the tap hole plug is moved into or out of the tap hole, 2 contacts determine in which direction the actuator operates. The same control philosophy as stage 2 is utilised, whereby the launder level process variable is compared to the launder level setpoint, and depending on the error between the two determines the movement of the actuator. A recognised problem with this facility is the location of the tap hole relative to the launder, the tap hole is above the metal level in the launder where it is prone to freezing of the metal. Such freezing causes non repeatability in the system, the result is an improved metal flow but not consistent enough to maintain metal levels to the accuracy of the tilting furnace. An improvement to the system would be to locate the tap hole so that it is submerged in the launder metal, the graphite material of the tap plug lends itself to this type of application.

7.4 Stage 4 (Data integration - Under Investigation)

Full integration of software with Metal Products proposed data acquisition/supervisory control system, to provide multiple user access to historical data for statistical analysis.

Possible integration with the Metcon system. Metcon is mainframe based program used to audit the amount of metal which enters the casting shop as molten metal and what leaves the casting shop as product.
8.0 SOFTWARE DEVELOPMENT

8.1 Stage 1 Launder Level Control Software Development
To enable the technical evaluation of the launder level sensor to proceed and to identify how it may be best utilised, it is necessary to develop PLC and computer software capable of capturing the sensor data and to perform basic statistical calculations and display functions. See Files 4,7,8 PLC program listing.

8.2 Stage 2 Ingot Height Control Software Development
The second stage of software development allows for full automation of the metal flow i.e. launder and ingot height control, see Files 8,10,12 PLC program listing.
Also available is the facility for operator and supervisor access. It is envisaged that provision be made for the operator to key in the cast number and for data acquisition to be automatic once molten metal appears in the moulds (Metcon System).
The software provides the supervisor/operator with an option to view a whole cast at the completion that cast. This will provide instant feedback of the systems ability to control ingot size, see File 13 PLC program listing.
All data storage and display options are accessed from a keyboard via an industrial computer. Data may be backed up and archived to floppy disk, or printed for later analysis.

8.3 Stage 3 Furnace Tap Hole Control Software Development
Utilising the launder level signal as an input to a control loop to determine actuation response for the tap hole flow control. A variable pulse output to the actuator is used to determine how far it is moved and a direction signal, see File 11 PLC program listing.
8.4 Stage 4 Data Integration Software Development

The final stage of software development will be to fully integrate the control system with the Metal Products Data Acquisition/Supervisory Control system.

Data may be backed up and archived on a VAX providing the facility of data retrieval and display from all terminals connected to the network.

The facility of integrating the cast information to Metcon (if this facility is required) is currently under investigation.

9.0 INGOT HEIGHT SENSING

9.1 Description

Molten metal height in each mould is measured by a capacitance level sensor positioned above the casting conveyor. As the mould position in the conveyor can vary vertically the metal height is expressed relative to a reference point on that mould i.e. the edge of the mould. The metal height is averaged over a sub-group size of the last three moulds. The latest sub-group value is then plotted on the ingot height trend chart.

Under normal automatic operation if the trend goes out of the defined limits for 45 seconds the weir is automatically raised/lowered to increase/decrease the metal flow as required to bring the system back in control. The amount the weir raises/lowers is dependent on how far the trend is from the setpoint.
9.2 Principle of Sensor Operation

A Delavan Hot Prox 620 model CNR 200 is used to measure the molten metal level in the moulds. It is a capacitance sensor, designed to measure changes of capacitance to earth as they occur. The molten metal surface and the mould edge act as earthed plates similar to one plate in a parallel plate capacitor. The sensor being the other plate. Any change in level would appear to the sensor as a change in distance between the plates. The resultant change of capacitance will vary the frequency of a variable oscillator located in the pre-amplifier in the rear of the sensor. The frequency signal is transmitted to the converter and converted to a voltage. Within the recommended ranges the output voltage (or current) will be linear and proportional to the distance changes. The sensor measuring plate is guarded to prevent false signals from other objects or surfaces not in the desired sensing area.

9.3 Sensor Output

A maximum and minimum is associated with each ingot measured. For Control purposes in the software the maximum represents the surface furthermost away from the sensor (the molten metal surface), the minimum represents the closest surface (the mould edge).

However the raw input from the sensor is vice versa i.e. the maximum represents the surface closest to the sensor (the mould edge), the minimum represents the further most surface (the molten metal).
10.0 INSTALLATION & OPERATION OF SENSOR & TRANSMITTER

10.1 Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>240 VAC Nominal</td>
</tr>
<tr>
<td>Power/Frequency</td>
<td>10 Watts, 50 Hz</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>Transmitter +5°C to 50°C</td>
</tr>
<tr>
<td>Cooling Sensor</td>
<td>+ 94°C Maximum (pre-amp), forced air of instrument quality required. Requirements vary but supply must be adequate to maintain internal temperature below 94°C</td>
</tr>
<tr>
<td>Output Signal</td>
<td>0-10 VDC (optional -5V to +5V and 4-20mA)</td>
</tr>
<tr>
<td>Time Response</td>
<td>1 millisecond to 1000 milliseconds in 4 steps</td>
</tr>
<tr>
<td>Cable Length</td>
<td>6 metres, 6 conductor 150°C service temp</td>
</tr>
<tr>
<td>System Drift</td>
<td>100 minutes from room temperature to full heat 800°C process</td>
</tr>
<tr>
<td>Measured Drift</td>
<td>± 0.00127 mm/hour</td>
</tr>
<tr>
<td>Measuring Range</td>
<td></td>
</tr>
<tr>
<td>Sensor Size</td>
<td>50.8 mm</td>
</tr>
<tr>
<td>Maximum Range</td>
<td>178 mm</td>
</tr>
<tr>
<td>Stability</td>
<td>+ 0.05mm at 12 mm from Sensor</td>
</tr>
<tr>
<td>Deviation</td>
<td>1 % from 9.52mm to 76.2mm</td>
</tr>
</tbody>
</table>
10.2 Mechanical and Electrical Installation

Sensor Mounting:

10.2.1 The CNR Sensor uses 1-1/2" Pipe for mounting. This pipe is used to conduct air cooling to the sensor as well as contain the sensor cable.

10.2.2 Fasten the cable connector to the pre-amp by rotating the knurled fitting clockwise. (Note: That the connector has a keyway locater.) This connection should be finger tight, do not use a tool.

10.2.3 Connect Black wire from cable to internal ground lug located in 1-1/2" nipple.

10.3 Air Cooling Sensor:

Where the sensor is located it is exposed to elevated temperatures and it must be cooled by purging with air. Maximum pre-amplifier temperature is (94°C).

10.4 Temperature Sensor

An AD 590 Analog Device integrated circuit temperature transducer is potted into the sensor pre-amp. The range of this sensor is - 55°C to + 150°C with an output of 1 microamp/0 K. Terminal connections are located in the CR/85 Transmitter housing. This sensor is useful in determining the exact amount of purging air required to cool the pre-amplifier to LESS than 94°C.
11.0 SENSOR ARM

There are two major actions in the sensor arm designed, as safety features to prevent sensor damage.

11.1 The first is a hinge pin and bracket in the vertical plane. This allows the sensor to be swung to the conveyor side during maintenance.

11.2 The second consists of a pivot plate, which allows the sensor to pivot when contact is made. The sensor can only pivot in the same vertical plane as the direction of the casting conveyor. Once the obstruction has passed the sensor will pivot back to its original position automatically.

The sensor (pre-amplifier) cannot be exposed to temperatures in excess of 95°C. To ensure the sensor temperature is maintained below this level, compressed air of instrument quality is forced into the sensor arm and hence through the sensor thereby cooling it.

The braided tube is the air line.

The Anaconda conduit contains the sensor-transmitter cable.

See Comalco Drawing 21556
12.0 OPERATION

This section contains the calibration information for the Hot Prox/620 system utilising the CR/85 transmitter and the CNR 200 sensor.

12.1 Calibration / General

The controller outputs consist of 4-20mA loop, and a 0-10 volt or -5 to +5 volt output. All of these may have a positive slope called "Normal," or a negative slope called "Reverse." The output used on the Ingot Height Sensor is "Reverse." The Controller output utilised is 0-10 volts.

12.2 Calibration/Reverse Operation:

An increase in capacitance causes an increase in voltage (or current), i.e. a reduction in distance between sensor and subject causes an increase in output.

12.2.1 Set output switch to reverse position.

12.2.2 For voltage output instead of current, set "volts range" jumper to 0-10 volts or -5 to +5 volts as needed. The 4-20mA output is always energised.

12.2.3 Using a small screwdriver, set controls as follows:

OFFSET: OFFSET Switch to ZERO Position
SPAN: All Switches CLOSED
RESPONSE TIME: Switch #1 CLOSED, Switch #2,3,4 OPEN
12.2.4 Unlock OFFSET and SPAN potentiometers located on panel face by moving the small lever on each potentiometer counter clockwise to WHITE dot. Turn both potentiometers fully clockwise.

12.2.5 Set the shortest desired distance, ground-plane to sensor. Monitor 0-10 volts output:

A) Output is LESS than 10 Volts.
   Set "OFFSET" switch to "POSITIVE."

B) Output is GREATER than 10 Volts.
   Turn "OFFSET" potentiometer counter-clockwise until output equals 10 volts. Lock "OFFSET" potentiometer by moving lever to RED dot.

12.2.6 Set the longest desired distance, ground-plane to sensor. Monitor 0-10 volts output:

A) Output is GREATER than 0 Volts.
   Increase total number of open "SPAN" switches, one at a time until output is LESS than 0 volts.
   For example: Open switch #1, then #1 and 2, then #1, #2, #3 and if necessary, open all switches.
B) Output is LESS than 0 Volts.
   Turn "SPAN" potentiometer counter-clockwise until output voltage equals 0 Volts. Lock SPAN potentiometer by moving lever to RED dot.

12.2.7 Basic calibration is now complete. To set the response time, go to step 11.2.8.

12.2.8 A) Voltage (or current) output appears jittery or responds too fast:
   Increase response time by closing switches 2 through 4 until output is steady.

B) Voltage (or current) output appears sluggish or slow to respond:
   Decrease response time by opening switches 4 through 1 until output is responsive.

Calibration is now complete.
13.0 MAINTENANCE & SERVICE

13.1

Two Year Product Warranty:
Delavan Electronics, will replace, put in good operating condition, or purchase price refunded, at the option of DELAVAN, free of charges except transportation if defective in their manufacture or shipping, and if notice of said defect is received by Delevan within two years of shipment date.

NOTE: The location of the sensor is in an area where excessive temperatures are attainable, therefore it is necessary to ensure that the sensor is always receiving cooling air over the pre-amp. Because this is a variable not controlled by Delavan, the sensor warranty is limited. Each sensor pre-amp is marked with a temperature sensitive paint so that an individual unit can be examined to determine the exact temperature exposure. Preamp units that have experienced temperatures above 94°C will not be repaired under warranty.

Supplied locally by:

Sencon Pty. Ltd.
18 Innocent St
Kings Meadows

Telephone: 447 433
Attention: Peter Hingston.
14.0 RESULTS

<table>
<thead>
<tr>
<th></th>
<th>MEAN (kg)</th>
<th>$C_p$</th>
<th>$C_{pk}$</th>
<th>SD</th>
<th>Above Spec %</th>
<th>Below Spec %</th>
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</thead>
<tbody>
<tr>
<td>FURNACE 6</td>
<td>949</td>
<td>0.66</td>
<td>0.21</td>
<td>22.8</td>
<td>0.33</td>
<td>27.33</td>
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<tr>
<td>FURNACE 7</td>
<td>939</td>
<td>0.54</td>
<td>0.05</td>
<td>27.5</td>
<td>0.29</td>
<td>43.43</td>
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PRIOR TO INSTALLATION OF INGOT HEIGHT CONTROL SYSTEM

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<th></th>
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<th>SD</th>
<th>Above Spec %</th>
<th>Below Spec %</th>
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<td>0.96</td>
<td>0.96</td>
<td>15</td>
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<tr>
<td>FURNACE 7</td>
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<td>0.56</td>
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INGOT HEIGHT CONTROL SYSTEM INSTALLED

Table 1  Comparison Of Before And After Ingot Height Control System Installation
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<tr>
<th>Date</th>
<th>Mean</th>
<th>Cp</th>
<th>Cpk</th>
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<th>Above Spec %</th>
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<tr>
<td>15-30 Sep 92</td>
<td>977.4</td>
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<td>0.31</td>
<td>36</td>
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<td>1-31 Dec 92</td>
<td>967.1</td>
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<td>0.57</td>
<td>18.8</td>
<td>0</td>
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<td>0.79</td>
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<td>18.9</td>
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Overall - Furnaces 6 & 7

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<thead>
<tr>
<th>Date</th>
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<th>Cpk</th>
<th>SD</th>
<th>Above Spec %</th>
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<td>10-12 Feb 93</td>
<td>973.5</td>
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Furnace No.6

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<th>Cpk</th>
<th>SD</th>
<th>Above Spec %</th>
<th>Below Spec %</th>
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<td>979.9</td>
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<td>0.45</td>
<td>33.6</td>
<td>6.49</td>
<td>7.3</td>
</tr>
<tr>
<td>20-30 Nov 92</td>
<td>939.1</td>
<td>0.54</td>
<td>0.05</td>
<td>27.5</td>
<td>0.29</td>
<td>43.43</td>
</tr>
<tr>
<td>1-31 Dec 92</td>
<td>945.4</td>
<td>0.71</td>
<td>0.16</td>
<td>21.1</td>
<td>0</td>
<td>30.16</td>
</tr>
<tr>
<td>14-16 Jan 93</td>
<td>963.3</td>
<td>0.89</td>
<td>0.56</td>
<td>16.8</td>
<td>0</td>
<td>4.72</td>
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<td>24-26 Jan 93</td>
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<td>0.52</td>
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<td>10-12 Feb 93</td>
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<td>20.8</td>
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<td>16.67</td>
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<td>21-24 Mar 93</td>
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<td>0.74</td>
<td>0.45</td>
<td>20.1</td>
<td>0</td>
<td>8.82</td>
</tr>
</tbody>
</table>

Furnace No.7

London Metal Exchange Weight Tolerance Variation
Data Analysis 25kg Ingot Bundle Weights

Launder Level Control Commissioned 1/12/92
Ingot Height Control Commissioned 11/1/93
Furnace Tap Hole Control Commissioned 11/1/93

Table 2 Bundle Weight Variations Spot Checks
INGOT WEIGHT USING AUTO CONTROL

Date: 12-16-1992, 09:47:08

Company: COMALCO (BELL BAY) LIMITED
Plant: BELL BAY
Department: METAL PRODUCTS
Machine: NO.1 M/C
Operation: ROBOT WEIGHING
Part name: NO.6 FURNACE
Part Numbers: DAY SHIFT CASTS
Sample frequency: EACH
Units: KG

Characteristics: INGOT WEIGHT USING AUTO CONTROL

Descriptive Statistics

All (n=1)
117 data points

Mean = 973.2
Sigma Indiv = 16.0
Est. Sigma = 10.4
Coeff.Var. = 0.0

Min. Value = 925
Max. Value = 1008
Kurtosis = 0.041
Skewness = -0.352

Sigma Indiv = 16.0
Conf. Level = 95%

Interval = 7.0
Chi Squared = 3.384
deg. free. = 5
Normal

Above Spec = 0.00
Upper Spec = 1025.0
Above Spec = 0.06
Below Spec = 2.56
Nominal = 980.0
Below Spec = 0.86
Out of Spec = 2.56
Lower Spec = 935.0
Out of Spec = 0.92
Cpk = 0.79
Cr = 1.07
Z upper = 3.23
Cp = 0.94
Z lower = 2.38
Mean + 3s = 1021.4
Mean - 3s = 925.1

FIG. 3 Distribution of Bundle Weights 16/12/92
INGOT WEIGHT NO.6 FURNACE

Company: PQ Systems
Plant: Metal Products
Department: NO.1 M/C
Machine: Robot Weighing
Operation: INGOT WEIGHT No.6 Furnace

Date: 02-15-1993, 10:30:06

Part name: INGOT25
Part Numbers: BELL BAY
Sample frequency: each
Units: kg

Descriptive Statistics

1-169(n=1)
169 data points

Mean = 980.3
Sigma Indiv = 15.6
Est. Sigma = 9.9
Coef. Var. = 0.0

Min. Value = 933
Max. Value = 1018
Kurtosis = 0.055
Skewness = -0.070

Chi Squared = 6.559
deg. free. = 7
Conf. Level = 95%
Normal

Interval = 6.0
lower boundary

Actual %

Above Spec = 0.00
Below Spec = 0.59
Out of Spec = 0.59
Cpk = 0.96
Cp = 0.96
Mean + 3s = 1027.0
Mean - 3s = 933.6

Theoretical %

Upper Spec = 1025.0
Nominal = 980.0
Lower Spec = 935.0
Cr = 1.04
Z upper = 2.87
Z lower = 2.91

Capability Using Sigma Indiv

Above Spec = 0.21
Below Spec = 0.18
Out of Spec = 0.39

FIG. 4 Distribution of Bundle Weights 24-26/1/93
INGOT BUNDLE WEIGHT VARIATION
X BAR CONTROL CHART - JUNE 1993

TARGET WEIGHT = 980kg

LME Upper Weight Limit 1020kg
LME Lower Weight Limit 940kg

DATE

Figure 5
15.0 CONCLUSION

The Ingot Height Control System implemented, represents the first automated control of furnaces and ingot casting machine installed at any of the Comalco plants. The control system is to be adopted by Comalco Aluminium Boyne Smelter, utilised on a 20 tonne/hour casting machine. It is also the first time launder level control has been attempted on a fixed furnace, with encouraging results. Launder level control is now to be utilised on all furnaces in the casting shop. It is envisaged that with further modifications to the No.7 fixed furnace tap hole, and relocation of the ingot height sensor (to minimise time delays in the system), the production of any out of specification bundles will cease. The project was completed on time, within budget and performance specifications exceeded.
INGOT HEIGHT CONTROL SYSTEM

No. 7 FURNACE AUTOMATIC

No. 7 TAP PLUG IN

No. 7 TAP PLUG OUT

No.1/2 INGOT MACHINE

Spare

1:03/00

1:03/01

1:03/02

1:03/03

1:03/04

1:03/05

1:03/06

1:03/07

1:03/08

1:03/09

1:03/10

1:03/11

1:03/12

1:03/13

1:03/14

1:03/15

1:03/16

1:03/17

RACK 0

MODULE GROUP 3

24 VAC

TERMINAL INDEX

No. 7 Furnace Control Panel

No. 1 Ingot Machine Panel

PLC Panel

Ingot Machine Junction Box 2

NEUTRAL
INGOT HEIGHT CONTROL SYSTEM

240 VAC

AUTOMATIC LEVEL CONTROL

MAX. LAUNDER LEVEL

MIN. LAUNDER LEVEL

No.7 TAP PLUG IN ACTUATOR

No.7 TAP PLUG OUT ACTUATOR

No.7 TAP PLUG IN

No.7 TAP PLUG OUT

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

Spare

NEUTRAL

TERMINAL INDEX

- No.7 Furnace Control Panel
- No.1 Ingot Machine Panel
- PLC Panel
INGOT HEIGHT CONTROL SYSTEM

TERMINAL INDEX

- Metal Flow Control Panel
- PLC Panel
INGOT HEIGHT CONTROL
PLC/Citect Address, Descriptors & Values

N7:400  Ingot Height Setpoint  175
N7:401  Ingot Height High Side Deadband Range  45
N7:402  Ingot Height High Side Deadband Value  130
N7:403  Long/Short Pulse Discrimination (High Side) Range  30
N7:404  Long/Short Pulse High Side Value  100
N7:405  Ingot Height Lowside Deadband Range  -45
N7:406  Ingot Height Lowside Deadband Value  220
N7:407  Long/Short Pulse Discrimination (Low Side) Range  -30
N7:408  Long/Short Pulse Low Side Value  250
N7:410  Raise Weir Short Pulse Time  12
N7:411  Raise Weir Long Pulse Time  14
N7:412  Lower Weir Short Pulse Time  12
N7:413  Lower Weir Long Pulse Time  14

T4:35  Increase Ingot Height OFF Delay Control  55
T4:36  Raise Weir Pulse Timer  Variable
T4:37  Decrease Ingot Height OFF Delay Control  55
T4:38  Lower Weir Pulse Timer  Variable
CITECT ADDRESS

Ingot Height N20:01 (PLC VALUE : Variable 0-700)
    Raw Zero :0   Raw Full Scale :700
    Engineering Zero :65   Engineering Full Scale:100mm

Ingot Setpoint N20:02 (PLC VALUE : 525)
    Raw Zero :0   Raw Full Scale :700
    Engineering Zero :65   Engineering Full Scale:100mm

Ingot UCL N20:03 (PLC VALUE : 570)
    Raw Zero :0   Raw Full Scale :700
    Engineering Zero :65   Engineering Full Scale:100mm

Ingot LCL N20:04 (PLC VALUE : 480)
    Raw Zero :0   Raw Full Scale :700
    Engineering Zero :65   Engineering Full Scale:100m

Launder Level Setpoint N20:10 (PLC VALUE : 500)
    Raw Zero :0   Raw Full Scale :1000
    Engineering Zero :0   Engineering Full Scale:100m

Launder Level Height PV N20:11 (PLC VALUE : Variable 0-1000)
    Raw Zero :0   Raw Full Scale :1000
    Engineering Zero :65   Engineering Full Scale:100m

Furnace Proportional Valve 20:12 (PLC VALUE : Variable 0-1000)
    Raw Zero :0   Raw Full Scale :1000
    Engineering Zero :65   Engineering Full Scale:100%
## CITECT TREND TAGS

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<th>Trend Tag</th>
<th>Description</th>
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<tr>
<td>WEIR_OUTPUT</td>
<td>Not currently used</td>
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<tr>
<td>INGOT_LCL</td>
<td>Lower Control Limit for Ingot Height Control</td>
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<tr>
<td>INGOT_UCL</td>
<td>Upper Control Limit for Ingot Height Control</td>
</tr>
<tr>
<td>INGOT_SETPOINT</td>
<td>Setpoint for Desired Ingot Height</td>
</tr>
<tr>
<td>LEV_SP</td>
<td>Launder Level Control - Launder Height SP</td>
</tr>
<tr>
<td>LEV_PV</td>
<td>Launder Level Control - Launder Sensor PV</td>
</tr>
<tr>
<td>LEV_OP</td>
<td>Launder Level Control - O/P Sent to Furnace</td>
</tr>
</tbody>
</table>

## CITECT SCREEN FILES

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INGOTS</td>
<td>Ingot Height Trending Screen (Large Display)</td>
</tr>
<tr>
<td>LAUNDER</td>
<td>Launder Level/Ingot Height Trending Screen</td>
</tr>
<tr>
<td>STARTUP</td>
<td>Startup Page (Use when system is initialised)</td>
</tr>
</tbody>
</table>

## DIRECTORY LISTING OF FILES

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INGOTTREN.BMP</td>
<td>Ingot Height Trending Screen</td>
</tr>
<tr>
<td>LAUNDER.BMP</td>
<td>Launder Level/Ingot Height Trending Screen</td>
</tr>
<tr>
<td>STARTUP.BMP</td>
<td>Startup Page</td>
</tr>
</tbody>
</table>
WEIR VARIABLE SPEED DRIVE TERMINAL BLOCK CONNECTIONS
<table>
<thead>
<tr>
<th>MODE DESCRIPTION</th>
<th>SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Acceleration Time (secs)</td>
<td>1</td>
</tr>
<tr>
<td>2 Acceleration Time Multiplier</td>
<td>1</td>
</tr>
<tr>
<td>3 Deceleration Time (secs)</td>
<td>0.5</td>
</tr>
<tr>
<td>4 Deceleration Time Multiplier</td>
<td>1</td>
</tr>
<tr>
<td>5 Boost Level</td>
<td>A</td>
</tr>
<tr>
<td>6 Maximum Freq. &amp; V/Hz</td>
<td>100</td>
</tr>
<tr>
<td>7 DC Brake Time (secs)</td>
<td>0.2</td>
</tr>
<tr>
<td>8 DC Brake Level (%)</td>
<td>7</td>
</tr>
<tr>
<td>9 Restart Mode</td>
<td>1</td>
</tr>
<tr>
<td>10 Frequency Control (Local/Externaal)</td>
<td>1</td>
</tr>
<tr>
<td>11 External Frequency Signal Type</td>
<td>1</td>
</tr>
<tr>
<td>12 Start/Stop: Forward/Reverse (Local/External)</td>
<td>1</td>
</tr>
<tr>
<td>13 Local Reverse Lockout</td>
<td>0</td>
</tr>
<tr>
<td>14 Stop Mode (Coast/Ramp)</td>
<td>0</td>
</tr>
<tr>
<td>15 Acceleration Stall Prevention</td>
<td>1</td>
</tr>
<tr>
<td>16 Deceleration Stall Prevention</td>
<td>1</td>
</tr>
<tr>
<td>17 Minimum Frequency</td>
<td>0.5</td>
</tr>
<tr>
<td>18 Maximum Frequency</td>
<td>100</td>
</tr>
<tr>
<td>19 Jog Frequency</td>
<td>10</td>
</tr>
<tr>
<td>20 2nd Preset Frequency</td>
<td>15</td>
</tr>
<tr>
<td>21 3rd Preset Frequency</td>
<td>70</td>
</tr>
<tr>
<td>22 4th Preset Frequency</td>
<td>40</td>
</tr>
<tr>
<td>23 1st Skip Frequency</td>
<td>0</td>
</tr>
<tr>
<td>24 2nd Skip Frequency</td>
<td>0</td>
</tr>
<tr>
<td>25 3rd Skip Frequency</td>
<td>0</td>
</tr>
<tr>
<td>26 Skip Frequency Range</td>
<td>0</td>
</tr>
<tr>
<td>27 Select Preset Frequencies</td>
<td>0</td>
</tr>
<tr>
<td>28 2nd Acceleration Time Multiplier</td>
<td>1</td>
</tr>
<tr>
<td>29 2nd Deceleration Time Multiplier</td>
<td>1</td>
</tr>
<tr>
<td>30 Last Fault Information</td>
<td>-</td>
</tr>
<tr>
<td>31 Current Limit Function</td>
<td>4</td>
</tr>
</tbody>
</table>
### OPERATION MODE DISPLAY

<table>
<thead>
<tr>
<th>MODE</th>
<th>START/STOP FORWARD/REVERSE</th>
<th>FREQUENCY CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>LOCAL (CONTROL PANEL)</td>
<td>LOCAL (CONTROL PANEL)</td>
</tr>
<tr>
<td>LE</td>
<td>LOCAL (CONTROL PANEL)</td>
<td>EXTERNAL (CONTROL TB)</td>
</tr>
<tr>
<td>EL</td>
<td>EXTERNAL (CONTROL TB)</td>
<td>LOCAL (CONTROL PANEL)</td>
</tr>
<tr>
<td>EE</td>
<td>EXTERNAL (CONTROL TB)</td>
<td>EXTERNAL (CONTROL TB)</td>
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</table>

### FAULT DISPLAY

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC</td>
<td>OVER CURRENT</td>
</tr>
<tr>
<td>OL</td>
<td>OVER LOAD</td>
</tr>
<tr>
<td>OU</td>
<td>OVER VOLTAGE</td>
</tr>
<tr>
<td>LU</td>
<td>LOW VOLTAGE</td>
</tr>
<tr>
<td>OH</td>
<td>OVER TEMPERATURE</td>
</tr>
<tr>
<td>AU</td>
<td>AUX. INTERLOCK</td>
</tr>
<tr>
<td>OP</td>
<td>OPERATION ERROR</td>
</tr>
</tbody>
</table>

WEIR VARIABLE SPEED MODE DISPLAYS
Laundrette Water Level Sensor - Connections
<table>
<thead>
<tr>
<th>V0</th>
<th>Calibration Channel 1</th>
<th>H0</th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>H6</th>
<th>H7</th>
<th>H8</th>
<th>H9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Display Actual Measured Value</td>
<td>Empty Calibration</td>
<td>Full Calibration</td>
<td>Select Current 0 = 0...20 mA 1 = 4...20 mA</td>
<td>Output Damping (s)</td>
<td>Value for 4 mA or 0 mA</td>
<td>Value for 20 mA</td>
<td>Safety Alarm 0 = 10% 1 = 110% 2 = hold</td>
<td>Actual Measuring Frequency</td>
<td>Measured Value before linearization</td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td>Limit Value Channel 1</td>
<td>Relay 1 Switching Point</td>
<td>Relay 1 Fail-safe Mode 0 = min. 1 = max.</td>
<td>Relay 1 at Alarm 0 = de-energised 1 = as</td>
<td>Relay 1</td>
<td>Relay 2</td>
<td>Relay 2</td>
<td>Relay 2</td>
<td>Relay 2</td>
<td>Relay 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>as A&lt;sub&gt;1&lt;/sub&gt; 2 = f(A&lt;sub&gt;2&lt;/sub&gt;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 = f(A&lt;sub&gt;1&lt;/sub&gt;) 2 = f(A&lt;sub&gt;2&lt;/sub&gt;)</td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>Linearization Channel 1</td>
<td>0 = linear 1 = horizontal cylinder 2 = factory-set 3 = manual 4 = clear 3</td>
<td>Level Input Mode 0 = manual 1 = automatic</td>
<td>Table No. 1...30</td>
<td>Input Volume</td>
<td>Input Level</td>
<td>Next Table No.</td>
<td>Number of Factory-set Characteristic</td>
<td>Diameter for Horizontal Cylinder</td>
<td>Volume for Horizontal Cylinder</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td>Extended Calibration Channel 1</td>
<td>Calibration Mode 0 = level 1 = volume</td>
<td>Offset</td>
<td>Sensitivity</td>
<td>Zero Offset Value</td>
<td>Offset Electronic Insert</td>
<td>Sensitivity Electronic Insert</td>
<td>D/A Calibration 0 mA</td>
<td>D/A Calibration 20 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V8</td>
<td>Operating Mode</td>
<td>0 = FMC/FTC 1 = FMC only see V8H1</td>
<td>from V8H0 5 = Cal. Corr 6 = Sim./Cal. 1 7 = Sim. FTC</td>
<td>Switch Delay Time (s)</td>
<td>Sensor position for Cal. Corr.</td>
<td>Type of Sensor 0 = DL 17 Z 1 = EC 17</td>
<td>Calibration EC 17 Z 0 = free 1 = covered</td>
<td>Calibration EC 17 Z Switching Point 0.1...100 Hz</td>
<td>Factor for Calibration Correction</td>
<td>Actual Measuring Frequency FTC</td>
<td>Security Locking &lt; 670 or &gt; 679</td>
</tr>
<tr>
<td>V9</td>
<td>Service and Simulation</td>
<td>Display Actual Diagnostic Code</td>
<td>Display Previous Diagnostic Code</td>
<td>Instrument and Software No.</td>
<td>Address E + H Bus</td>
<td>Set to Default Values 670...679</td>
<td>Simulation Frequency</td>
<td>Simulation Level</td>
<td>Simulation Volume</td>
<td>Simulation Current</td>
<td></td>
</tr>
</tbody>
</table>

V,H = Position within matrix

↑ = Cursor position in display

+ = increase

- = decrease

E = Confirm input

™ = Connection with COMMULOG

□ Input

(Display = E<sub>i</sub>E<sub>2</sub> = Input 1, 2 A<sub>1</sub> = Anal. Output)

deutsche Ausführung siehe Rückseite
Function
Precision level measurement and control of hot liquids

Typical Uses
Electro magnetic casting
Precision indication and control of molten metal for electro magnetic casting and direct chill processes.

Trough level
Trough level sensing for control of tilting furnaces.

Features
Non-contact
The sensor does not touch the surface of the process material. No moving parts to wear or stick.

Precision
The HOT PROX/620 will measure level variables with long term accuracy of ±0.002 inches or better.

Response time
The minimum response time is less than 1 millisecond.

Electronically guarded
An electronic guarded sensing element prevents interaction to other objects or surfaces.

Non-magnetic material
The sensor is specifically designed to operate near electromagnetic force fields.

Air-cooled/high temperature
Provisions are made so the user can air cool the sensor when used in high temperature applications, and monitor the internal sensor temperature.

Principle of Operation
A typical HOT PROX/620 system consists of a sensor mounted near the process variable connected to the amplifier transmitter with special high temperature cable. The sensor is designed to measure changes of capacitance to ground as they occur. The process material would act as the grounded plate similar to a parallel plate capacitor. Any change in level would appear to the sensor as a change in distance between the plates.

\[ K = \text{Constant} \quad A = \text{Plate area} \quad C = KEA \]
\[ \varepsilon = \text{Dielectric constant of material between plates} \quad d = \text{Distance between plates} \]

The sensor utilizes a mechanically stable sensing plate that is parallel to the surface of the process being measured. Any variation of the distance between the sensor plate and the subject is detected. The resultant change of capacitance will vary the frequency of a variable oscillator located in the preamplifier on the rear of the sensor.

This signal is transmitted to the amplifier and the frequency is converted to a voltage. After processing, the output is available for control purposes. Within the recommended ranges the output voltage or current will be linear and proportional to the distance changes. The sensor measuring plate is guarded to prevent false signals from other objects or surfaces not in the desired sensing area.
SAFETY FIRST

In the maintenance and operation of mechanical equipment, SAFETY is the basic factor which must be considered at all times. Through the use of the proper clothes, tools and methods of handling, serious accidents causing injury to you or your fellow worker can be prevented.

Throughout this manual are listed a number of safety precautions. Study them carefully and follow them; also insist upon those working for you do the same. Remember, an accident is usually caused by someone's carelessness, neglect or oversight.

To prevent ignition of hazardous atmospheres, do not remove actuator cover while circuits are live.

CAUTION

INSTALLATION

1. Operate valve manually before installing actuator and place into open position.
2. If valve is equipped with mechanical position stops they should be removed, but care should be taken not to damage or remove necessary parts from the valve.
3. When actuator is supplied separately from valve, actuator will be shipped in valve open position and care should be taken to maintain proper alignment between the actuator and valve shafts. If actuator and valve shafts are not in correct alignment repeat operation number one (1) with correction as required.
4. Mount the actuator to the valve. The actuator is usually mounted parallel to the run of the pipe. Tighten all bolts and nuts evenly, taking care to center the actuator on the valve stem. It is often a good idea to cycle the actuator while the mounting bolts are somewhat loose. This will allow the unit to center itself.
5. Loosen socket set screw and remove the manual declutching knob (Models MAR-10, -25, -50 & -90 only).
6. Remove the hex head bolts located about the flange of the unit.
7. Wire per diagram, or if actuator is of special design, wiring diagram is included with unit. Wiring diagram is drawn with valve in open position. Use #18AWG stranded wire or better, for field hook-up.
8. Run unit from one extreme to the other several times.

REVERSIBLE WITH POTENTIOMETER

STANDARD WIRING DIAGRAMS

STANDARD UNIDIRECTIONAL*

NOTES:
1. SWITCH SHOWN FOR ILLUSTRATION ONLY.
2. ACTUATOR IS SHOWN IN OPEN POSITION.
3. MANUAL LOCKOUT SWITCH IS STANDARD ON UNITS MAR-10/MAR-400 AND DOESN'T FUNCTION OFF CAM SHOWN.
4. POWER TO TERMINAL "3" OPERATES UNIT INTO CLOSE POSITION (C.W. STD.).
5. POWER TO TERMINAL "2" Operates unit into open position (C.C.W. STD.).
6. WIRING FROM THE NORMALLY OPEN CONTACTS OF THE SWITCHES IS PROVIDED FOR LIGHT INDICATION.

NOTES:
1. SWITCH SHOWN FOR ILLUSTRATION ONLY.
2. ACTUATOR IS SHOWN IN OPEN POSITION.
3. MANUAL LOCKOUT SWITCH IS STANDARD ON UNITS MAR-10/MAR-400 AND DOESN'T FUNCTION OFF CAM SHOWN.
4. POWER TO TERMINAL "3" OPERATES UNIT INTO CLOSE POSITION (90° C.W. STD.).
5. POWER TO TERMINAL "2" OPERATES UNIT INTO OPEN POSITION (90° C.C.W. STD.).
6. WIRING FROM THE NORMALLY OPEN CONTACTS OF THE SWITCHES IS PROVIDED FOR LIGHT INDICATION.

*Except MAR which is not available with terminal strip. Light wiring is optional.
**CAUTION**

To prevent ignition of hazardous atmospheres, do not remove actuator cover while circuits are live.

**INSTALLATION CONT'N.**

9. Cam adjustments (if required), as follows:
   - To set open travel by adjusting cams:
     (a) Loosen clamping screw on cam "D" to give the cam a finger tight grip on shaft, rotate cam clockwise away from switch.
     (b) Manually operate valve to the proper "open" position.
     (c) Rotate cam "D" counter-clockwise against switch roller until switch just "breaks". You should hear a light clicking.
     (d) Tighten clamping screw. If travel is not correct, repeat steps (a), (b) and (c), or use the micro-adjustment cam.
   - To set close travel by adjusting cams:
     (a) Loosen clamping screw on cam "E" to give the cam a finger tight grip on shaft, rotate cam counter-clockwise away from the switch.
     (b) Manually operate valve to the proper "close" position.
     (c) Rotate cam "E" clockwise against switch roller until switch just "breaks". You should hear a light clicking.
     (d) Tighten clamping screw. If travel is not correct, repeat steps (a), (b) and (c), or use the micro-adjustment cam.

   **NOTE:** In the event that the above procedure does not give the necessary travel control, the micro-adjustment cam has to be repo-sitioned as follows:
   - To set open travel by adjusting switch plate:
     (a) Loosen pivot and micro-adjustment screws on switch "D".
     (b) In the event of actuator under-travel, rotate micro-adjustment cam to swing switch outward from the cam post.
     (c) In the event of actuator over-travel, swing switch into cam post.
     (d) Tighten pivot and micro-adjustment screws on switch "E".
   - To set close travel by adjusting switch plate:
     (a) Loosen pivot and micro-adjustment screws on switch "E".
     (b) In the event of actuator under-travel, rotate micro-adjustment cam to swing switch outward from cam post.
     (c) In the event of actuator over-travel, swing switch into cam post.
     (d) Tighten pivot and micro-adjustment screws on switch "E".

10. Replace cover and tighten all flange bolts.


12. Unit is now ready for automatic operation.

**TO MANUALLY OPERATE**

Models MA-4, -8, MAR-8, -9, -12, -24, -49 & -89:
- Manual operation is accomplished by use of an open end wrench on the hex stock coupling adapter.
- Direction of rotation and or position can be checked by indicator located on output shaft.
- Avoid turning beyond normal open/close travel.

Models MAR-10, -13, -25, -50 & -90:
- Pull the black "declutching knob" (A) all the way up and hold. Gently rock shaft back and forth with wrench to disengage, and rotate to desired position as indicated by the arrows. Actuator will automatically re-engage when "knob" is released and electrical power is applied.
- Avoid turning beyond normal open/close travel.

Models MAR-100, -120, -160, -250, -800, -1600 & -4000:
- Depress and rotate handwheel slowly until lower detent is felt to engage.
- Turn handwheel in desired direction (note markings on wheel and check position by indicator located on output shaft).
- Avoid turning beyond normal open/close travel.
- When handwheel is returned to raised position, normal operation is restored (see manual cut-out switch).

**Manual Cut-Off Switch:**
- When handwheel is depressed for manual operation, integral cut-off switch prevents injury due to unexpected restoration of power and is automatically reset when handwheel is returned to raised position.

**Potentiometer:** (optional) During initial field installation of actuators incorporating our standard potentiometer range, care must be taken to avoid overstepping the pre-set travel limits. This is to avoid damage to the potentiometer. R.C.S. has a very unique mounting bracket for holding the pot. such that even when the pre-set position is overshot, the pot. will not be damaged. However, good field installation practice would and should dictate the avoidance of this wherever possible to avoid any possible damage to the pot., also possibility of overtwist-
### Allen-Bradley Company
6200 Series Software
PLC-5 Programming Terminal Software
Release 4.4
Program Listing Report

Processor File: 06_6FNC
Wed Nov 10, 1993 - 3:38:19 pm

<table>
<thead>
<tr>
<th>REPORT OPTIONS</th>
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<td>Graphics Capabilities:</td>
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<td>Right Power Rail:</td>
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<td>Address Display:</td>
<td>SYMBOL</td>
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<td>Address Comments:</td>
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<td>Output Cross Reference:</td>
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<td>Ladder Cross Reference:</td>
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<td>2:0</td>
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<tr>
<td>Ending Rung:</td>
<td>999:32767</td>
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</table>
Jump to Subroutine No.3 (System Control)

+JSR--
+JUMP TO SUBROUTINE+

Prog file number 3
Input parameter
Return parameter

Jump to Subroutine No.4 (Hydraulic Control)

+JSR--
+JUMP TO SUBROUTINE+

Prog file number 4
Input parameter
Return parameter

Jump to Subroutine No.5 (Datataker Control)

+JSR--
+JUMP TO SUBROUTINE+

Prog file number 5
Input parameter
Return parameter

Jump to Subroutine No.6 (Alarming to see)

+JSR--
+JUMP TO SUBROUTINE+

Prog file number 6
Input parameter
Return parameter
Jump to Subroutine No.7 (Block Transfers)
+JSR------------------+
+JUMP TO SUBROUTINE+
Prog file number 7
Input parameter
Return parameter

Jump to Subroutine No.8 (PID Control)
+JSR------------------+
+JUMP TO SUBROUTINE+
Prog file number 8
Input parameter
Return parameter

Jump to Subroutine No.10
+JSR------------------+
+JUMP TO SUBROUTINE +
Prog file number 10
Input parameter
Return parameter

Jump to Subroutine No.11 (No.7 Furnace)
+JSR------------------+
+JUMP TO SUBROUTINE +
Prog file number 11
Input parameter
Return parameter
Program Listing Report  PLC-5/15  File 06_6FNC

Jump to Subroutine No.12 (Ingot Height)

+JSR-----------------------------+
+JUMP TO SUBROUTINE +
| Prog file number  12 |
| Input parameter |
| Return parameter |

Jump to Subroutine No.13 (Citect Control)

+JSR-----------------------------+
+JUMP TO SUBROUTINE +
| Prog file number  13 |
| Input parameter |
| Return parameter |

[END OF FILE]
Program Listing Report

Rung 3:0
Input: P/B
System
Start
Stop
I:010

Status:
System
Run
B3

Output:
System On
Indication
Lamp 0:020

Rung 3:1
Input: P/B
Lamp
Test
I:013

Status:
System
Run
B3

Output:
System Off
Indication
Lamp 0:020

Rung 3:2
Input: P/B
Lamp
Test
I:013

Status:
System
Run
B3

Rung 3:3
Input: P/B
Lamp
Test
I:013

Status:
System
Run
B3 T4:19

DISPLAY UPDATE TIMER
+TON-+-
+TIMER ON DELAY +- (EN)
Timer T4:19
Time base 1.0+- (DN)
Preset 2
Accum 0
Program Listing Report

PLC-5/15 File 06_6FNC

Rung 3:4

Status: System Run
B3 T4:19

[------] [-------] [------]

DISPLAY
MOVE DATA
TO DISPLAY

MOVE
Source N7:106
1762
Destination N7:251
1114

Rung 3:5

Status: System Run
B3 I:010 I:010

[-------] [-------] [-------]

Furnace Not Over Temp.
Elements Not Over Temp.

Rung 3:6

Input: Element No.1, not Tripped
I:010 I:010

Input: Element No.2, not Tripped
I:010 I:010

Input: Element No.3, not Tripped
I:010 I:010

Input: Element No.4, not Tripped
I:010 I:010

Input: Element No.5, not Tripped
I:010 I:010

Input: Element No.6, not Tripped
I:010 I:010

Input: Element No.7, not Tripped
I:010 I:010

Input: Element No.8, not Tripped
I:010 I:010

Input: Element No.9, not Tripped
I:010 I:010

Input: Element No.10, not Tripped
I:010 I:010

Input: Element No.11, not Tripped
I:010 I:010

Input: Element No.12, not Tripped
I:010 I:010

Input: Element No.13, not Tripped
I:010 I:010

Input: Element No.14, not Tripped
I:010 I:010

Input: Element No.15, not Tripped
I:010 I:010

Output: Furnace Elements Contact or

Rung 3:7

Status: Element 0/Current Aux 1.
B3

[-------] ( )

Status: Element 0/Current Aux 1.
B3

[-------] ( )

Status: Element 0/Current Aux 1.
B3

[-------] ( )

I:011 I:011 B3

I:011 I:011 B3

I:011 I:011 B3

I:011 I:011 B3

I:011 I:011 B3
### Rung 3:8

<table>
<thead>
<tr>
<th>Status:</th>
<th>Element</th>
<th>O/Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aux 2.</td>
<td>B3</td>
<td></td>
</tr>
</tbody>
</table>

**Input:**
- P/B Lamp Test I:013

**Output:**
- Indication

<table>
<thead>
<tr>
<th>Input: P/B</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp Test</td>
<td>B3</td>
</tr>
</tbody>
</table>

**Output:**
- Current

### Rung 3:9

<table>
<thead>
<tr>
<th>Status:</th>
<th>System</th>
<th>Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Furnace Elements</td>
<td>SCR Fault</td>
</tr>
<tr>
<td></td>
<td>Main Door Closed</td>
<td>Control Relay</td>
</tr>
<tr>
<td>B3</td>
<td>0:020</td>
<td>I:012</td>
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</tbody>
</table>

**Input:**
- SCR Blown Fuse

**Output:**
- SCR Contact Contactor

<table>
<thead>
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<th>Input:</th>
<th>Output:</th>
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</thead>
<tbody>
<tr>
<td>SCR Blown Fuse</td>
<td>SCR Contact Contactor</td>
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**Status:**
- Run B3

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### Rung 3:10

<table>
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<td>SCR Fault</td>
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<td>Run</td>
<td>Validate</td>
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**Timer:**
- TON: T4:14

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</table>

**Accum:**
- 0

---

**Event Log:**
- Timer Delay
- SCR Fault

---
### Rung 3:11

**Timer:**
- Validate
- SCR Fault
  
**T4:14**

**Input:**
- Main C/B
  - Closed
  
**Output:**
- DN
- SCR Blown
- Fuse
- Indication
- Lamp
- O:025

### Rung 3:12

**Input:**
- No.1 Ingot Station
  - Selected
  - Master
  - I:027
  
**Input:**
- P/B Lamp
  - Test
  - I:013

### Rung 3:13

**Input:**
- No.2 Ingot Station
  - Selected
  - Master
  - I:027

### Rung 3:14

**Status:**
- No.2 Ingot Station
  - Master
  - B3

### Rung 3:15

**Input:**
- Main Door
  - Closed
  - Prox.
  
<table>
<thead>
<tr>
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<td>I:027</td>
<td>B3</td>
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<tr>
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<td>Station</td>
<td>No.2 Ingot</td>
<td>System</td>
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<td>Master</td>
<td>Status:</td>
<td>Run</td>
</tr>
<tr>
<td>I:027</td>
<td>B3</td>
<td>B3</td>
<td></td>
</tr>
</tbody>
</table>

### Rung 3:16

**Status:**
- No.1 Ingot Station
  - Master
  - B3

**Output:**
- Select
- No.2 M/C Tilt
- Relay
- O:025

### Rung 3:17

**Input:**
- Main Door
  - Closed
  - Prox.

### Rung 3:18

**Input:**
- Hot Metal Door
  - Closed
  - Prox.

### Rung 3:19

**Input:**
- Crucible Table
  - Home
  - Prox

### Rung 3:20

**Input:**
- Clear To Tilt
  - B3

### Rung 3:21

**Output:**
- Select
- No.2 M/C Tilt Relay
- O:025

### Rung 3:22

**Input:**
- Main Door
  - Closed
  - Prox.

### Rung 3:23

**Input:**
- Hot Metal Door
  - Closed
  - Prox.

### Rung 3:24

**Input:**
- Crucible Table
  - Home
  - Prox

### Rung 3:25

**Input:**
- Clear To Tilt
  - B3

### Rung 3:26

**Output:**
- Select
- No.2 M/C Tilt Relay
- O:025
Furnace
Lower Sw.
At No.1
Machine
1:012
I:012

Furnace 6
Lower Sw.
At No.2
Machine
1:027
I:027

Input:
Fast Tilt
Pushbutton
At No.1
Machine
I:012

Input:
Fast Tilt
Pushbutton
At No.2
Machine
I:027

Status:
No.2 Ingot
Station
Master
B3

Status:
No.1 Ingot
Station
Master
B3

Status:
Fast
Raise
Request

Input:
Furnace
Raise Sw.
At No.1
Machine
I:012

Input:
Furnace 6
Raise Sw.
At No.2
Machine
I:027

Input:
Automatic
Tilt No.6
Select At
No.2 M/C
Machine
I:027

Status:
Slow
Raise
Request

Timer:
Pulse
Raise
Furnace
T4:11

EN
Rung 3:18
Input: Furnace Raise Sw. At No.1 Machine I:012
Status: No.1 Ingot Station Master 06 B3

Input: Furnace 6 Raise Sw. At No.2 Machine I:027
Status: No.2 Ingot Station Master 12 B3

Input: Furnace 6 Raise Sw. At No.1 Machine I:012
Status: No.1 Ingot Station Master 05 06 128

Input: Furnace 6 Raise Sw. At No.2 Machine I:027
Status: No.2 Ingot Station Master 12 15 129

Input: Furnace Raise Sw. At No.1 Machine I:012
Status: No.1 Ingot Station Master 05 06 07 10 128 13 129 16
Status: Hold
Request B3
---( )---
114

Rung 3:19
Input:
Furnace
Lower Sw.
At No.1 Machine
I:012

Status: No.1 Ingot
Station
Master B3

15 129

Status: Lower
Request B3

---] [-----] [-----]

Status: No.2 Ingot
Station
Master

06 128

---] [-----] [-----]

Input:
Furnace 6
Lower Sw.
At No.2 Machine
I:027

---] [-----] [-----]

115
Program Listing Report

Rung 3:20

Status: Fast Raise Request
Input: Main Door Close Selector Switch B3
Input: Hot Metal Door Open Selector Switch 112
Input: Hot Metal Door Close Selector Switch 10
Input: No Fast Request

Rung 3:21

Status: No Hydraulic Request
Hot Metal Door Open Selector Switch B3 I:013 I:013
Input: Hot Metal Door Close Selector Switch 10
Input: Fast Raise Request

Rung 3:22

Status: No.1 Ingot Master Request
Fast Raise Request B3 B3
Input: No Fast Lamp At B3
Input: No.1 Ingot M/C 128
Input: P/B Lamp I:013
Input: ( )

Output: Fast Tilt Lamp At No.1 Ingot M/C 0:020
Status: | Status:
---|---
No.1 Ingot | Slow
Station | Raise
Master | Request
B3 | B3

Input: P/B
Lamp
Test
I:013

Status: | Status:
---|---
No.1 Ingot | Fast
Station | Raise
Master | Request
B3 | B3

Input: P/B
Lamp
Test
I:013

Status: | Status:
---|---
No.1 Ingot | Slow
Station | Raise
Master | Request
B3 | B3

Output:
Furnace
Lower Lamp
At No.1
Ingot M/C
O:020

Input: P/B
Lamp
Test
I:013

Status: | Status:
---|---
No.1 Ingot | Lower
Station | Lower
Master | Request
B3 | B3

Input: P/B
Lamp
Test
I:013

Output:
Furnace
Lower Lamp
At No.1
Ingot M/C
O:020
Program Listing Report

Wed Nov 10, 1993  Page  Rung 3:

Rung 3:29

Status: | Status:  
---|---
No.2 Ingot | Fast
Station | Raise
Master | Request
B3 | B3

---+---+---
129 | 112 | ---( )--

Status: | Status:  
---|---
No.2 Ingot | Slow
Station | Raise
Master | Request
B3 | B3

++-] [-----] [-----]
129 | 113 | +---+---+

Input: P/B
Lamp
Test
I:013

---+---+---

Rung 3:30

Input:  
Hot Metal
Door
Closed
Prox
I:013

---+---+---
03 | 15 | ---( )--

Input: P/B
Lamp
Test
I:013

++-] [-----]
16 | 16 | +---+---+

Rung 3:31

Status: | Status:  
---|---
No.2 Ingot | Lower
Station | Request
Master | Request
B3 | B3

++-] [-----] [-----]
129 | 115 | ---( )--

Input: P/B
Lamp
Test
I:013

++-] [-----]
16 | 16 | +---+---+

Output:
Furnace
Raise Lamp
At No.2 Ingot M/C
0:025

Output:
Hot Metal
Door
Indication Lamp
0:023

Output:
Furnace
Lower Lamp
At No.2 Ingot M/C
0:025

Output:
Furnace
Lower Lamp
At No.2 Ingot M/C
0:025
Rung 3:32

Status:  
No.2 Ingot Status:  
Station Hold  
Master Request  
B3 B3

Output:  
Furnace Hold Lamp  
At No.2 Ingot M/C  
0:025

Input: P/B Lamp Test  
I:013  
16

Rung 3:33

Status:  
Main Door Flash  
Closed Timer  
Prox. Bit  
I:012 B3

Output:  
Main Door Open Indication Lamp  
0:023

Input: P/B Lamp Test  
I:013  
16

Rung 3:34

Output:  
Main Door Open Indication Lamp  
0:023

Input: P/B Lamp Test  
I:013  
16

Rung 3:35

Output:  
Crucible Tilt Table Up Lamp  
0:023

Input: P/B Lamp Test  
I:013  
16
Program Listing Report

Rung 3: 36
Input:
Hot Metal
Door
Closed
Prox
I: 013

Output:
Hot Metal
Door
Indication
Lamp
O: 023

Rung 3: 37
Input: P/B
Lamp
Test
I: 013

[END OF FILE]
Rung 4:0

Input:
Hydraulic Oil Low Pressure
I:011

[-] [------] [------]

Timer:
Fast Unload Available

T4:8

DN

Status:
No Fast Hydraulic Request
B3

Rung 4:1

Status:
System Motor
Run Over/Load Level
B3 I:011 I:011

[-] [------] [------]/[------] [------] [------] [------] [------] [------] [------]

135 10 13 DN 15 11 12

Timer:
Output:
Hydraulic Pump Delay Motor
Off Contactor

T4:9 0:020

[-] [------] [------]

DN 11
Program Listing Report

Rung 4:2
Status:
No Fast
Hydraulic Request
B3

Status:
Slow Raise Request
B3

Input:
No.1 Tilt Cylinder Down
I:012

Output:
Hydraulic Motor Contactor
0:020

---] [------]

Rung 4:3
Output:
Hydraulic Motor Contactor
0:020

Input:
No.1 Tilt No.2 Tilt Cylinder Cylinder Down Down
I:012 I:012

---] [------]

Rung 4:4
Status:
Slow Raise Request
B3

Input:
No.1 Tilt No.2 Tilt Cylinder Cylinder Down Down
I:012 I:012

---] [------]
Rung 4:5

Output: Slow Tilt
        Speed Dump
        Solenoid

Timer:
        Slow
        Hydraulic
        Pump
        Available

T4:6  T4:10
0:021

Rung 4:6

Output:
        Slow Tilt
        Speed Dump
        Solenoid

O:021

Rung 4:7

Status:
        No Fast
        Hydraulic
        Request

B3

117

Timer:       Timer:
            Pulse
            Raise
            Furnace
            T4:11  T4:11

Rung 4:8

Output: Fast Tilt
        Speed Dump
        Solenoid

Timer:       Timer:
            Fast
            Hydraulic
            Unload
            Valve Off

T4:7  T4:10
0:020

---] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] [-----] 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Program Listing Report  

Rung 4:9
Output:  
Fast Tilt  
Speed Dump  
Solenoid

0:020

---] [----------] [-----] [-----] [-----]

16

Rung 4:10
Status:  
Lower  
Operation  
Request  
Auxiliary

B3  
B3

---] [----------] [-----] [-----] [-----]

115  
118

---] [----------] [-----] [-----] [-----]

115  
118

Timer:  
Fast  
Unload  
Available

+TON---------------------+
+TIMER ON DELAY +-(EN)
Timer  
T4:8  
Time base  
0.01+- (DN)
Preset  
50  
Accum  
0

---] [----------] [-----] [-----] [-----]

---] [----------] [-----] [-----] [-----]

Rung 4:11
Timer:
Pulse  
Raise
Timer  
T4:11

---] [----------] [-----] [-----] [-----]

DN

Rung 4:12

required to generate a pulse to a counter (works because of PLC scanning mode:

---] [----------] [-----] [-----] [-----]

---] [----------] [-----] [-----] [-----]

Status:  
Lower  
Operation  
Request  
Auxiliary

B3  

---] [----------] [-----] [-----] [-----]

115  
118
required to ensure hydraulics transfer To and From Lower mode activation of the pilot valves.

Counter: Change To/From Lower
C5:3 T4:8
DN DN

Status: Fast Unload Available
Fast Raise Available
Fast Raise Available

Output: Fast Tilt Solenoid

Status: Hold Request Request
Hold Request Request
Hold Request Request


Status: Air Bleed Valve Aux.
Air Bleed Valve Aux.
Air Bleed Valve Aux.
## Program Listing Report

### Rung 4:15

| Output:    | Status:      | Timer:     | Request: 
|------------|--------------|------------|----------
| Fast Tilt  | Lower        | T4:1       | B3       |
| Solenoid   | Request      | Available  |          |
| 0:021      | B3           | T4:1       | 115      |

### Rung 4:16

| Input:    | Output:     | Timer:    | Request: 
|-----------|-------------|-----------|----------
| Small Door| Fast Tilt   | T4:8      |          |
| Open      | Unload      | Available |          |
| Switch    | Open Prox   |          |          |
| I:013     | I:013       | T4:8      |          |
| 10        | 12          | DN        |          |

### Rung 4:17

| Input:    | Output:     | Timer:    | Request: 
|-----------|-------------|-----------|----------
| Small Door| Fast Tilt   | T4:8      |          |
| Close     | Unload      | Available |          |
| Switch    | Prox        |          |          |
| I:013     | I:013       | T4:8      |          |
| 11        | 13          | DN        |          |

### Rung 4:18

| Input:    | Output:     | Timer:    | Request: 
|-----------|-------------|-----------|----------
| Pour Spout| Fast Tilt   | T4:8      |          |
| Door Open | Unload      | Available |          |
| Selector  | Door Open   |           |          |
| Switch    | Prox        |           |          |
| I:013     | I:013       | T4:8      |          |
| 04        | 06          | DN        |          |
Rung 4:19

Input:
Pour Spout
Door Close
Selector Switch
I:013

Timer:
T4:8
0:021

Output:
Pour Spout
Door Close
Solenoid

Rung 4:20

Input:
Main Door
Open
Selector Switch
I:012

Timer:
T4:8
0:021

Output:
Unload
Available

Status:
O.K. To
Doors

Rung 4:21

Input:
Main Door
Open
Selector Switch
I:012

Status:
O.K. To
Doors

Output:
Main Door

Rung 4:22

Input:
Main Door
Close
Selector Switch
I:012

Timer:
T4:8
0:021

Output:
Unload
Available

Solenoid
Rung 4:23
Input:
  Crucible
  Table Home
  Prox
I:027

Rung 4:24
Input:
  Heat
  Sensor At
  Hot Metal
  Door
I:027

Rung 4:25
Input:
  Hot Metal
  Door Close
  Selector
Switch
I:013

Timer:
  Hold Hot Metal Door Open
+TOF-------------------+
+TIMER OFF DELAY +-(EN)
Timer T4:5
Time base 1.0+- (DN)
Preset 60
Accum 60
Program Listing Report

Rung 4:26
Status: | Status: | Output:
-------|--------|--------
Hot Metal | O.K. To | Hot Metal
Door Open | Operate | Door Open
Request | Doors | Solenoid

B3 B3

Status: O.K. To | Output: Hot Metal
Door Open | Door Open
Request | Doors | Solenoid

B3

0:021

137 119

Rung 4:27
Status: | Input: | Status:
-------|--------|--------
Hot Metal | Crucible | Hot Metal
Door | Table | Door Close
Man. | Closed | Request
Close | Prox | B3

I:013 I:027

131 03 01

Rung 4:28
Input: | Status: | Output:
-------|--------|--------
Inch | Furnace Up | Crucible
Furnace Up | O.K. To | Hot Metal
Pushbutton | Operate | Door Open

I:012 B3 I:013

07 119 02

Rung 4:29
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:30
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:31
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:32
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:33
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:34
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:35
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:36
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:37
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:38
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:39
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:40
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:41
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:42
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:43
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:44
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:45
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:46
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:47
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:48
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:49
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:50
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:51
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:52
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:53
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:54
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:55
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:56
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:57
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN

Rung 4:58
Input: | Input: | Output:
-------|--------|--------
Inch | Pushbutton | Crucible
Furnace Up | Operate | Door Open

I:012 B3

07 119 02

Rung 4:59
Timer: | Status: | Input: | Output:
-------|--------|--------|--------
Fast | Hot Metal | Crucible
Unload | Door Close | Tilt Up
Available | Doors | Solenoid

T4:8 B3

0:021

138 DN
Rung 4:30

Input: Go Home
Pushbutton

Input: Inch Furnace Up
Pushbutton

Input: Inch Furnace Down
Pushbutton

Input: Crucible Prox
Pushbutton

Status: Crucible Tilt Auto.
Down

B3

139

Rung 4:31

Input: Furnace Down
Pushbutton

Status: Crucible Tilt Auto.
Down

B3

139

Rung 4:32

Input: Crucible Tilter At 30 Degrees

Status: Crucible Tilt Auto.
Prox

B3

139

Rung 4:33

Input: No.1 Tilt Cylinder Down

Input: No.2 Tilt Cylinder Down

Input: Timer: Furnace Down

Timer: T4:15

+TON--+-

+TIMER ON DELAY +-(EN)

<table>
<thead>
<tr>
<th>Timer</th>
<th>T4:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time base</td>
<td>1.0+- (DN)</td>
</tr>
<tr>
<td>Preset</td>
<td>60</td>
</tr>
<tr>
<td>Accum</td>
<td>6</td>
</tr>
</tbody>
</table>

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Program Listing Report

Wed Nov 10, 1993
Page 0

Rung 4:34

Counter:
Bleed Off
Minute
Counter

+CTU

+COUNT UP

Furnace

T4:15

DN

Rung 4:35

Counter:
Bleed Off
Minute
Counter

+CTU

+COUNT UP

C5:1

Preset

60

Accum

28

Rung 4:36

Counter:
Bleed Off
Hour
Counter

+CTU

+COUNT UP

C5:1

Preset

8

Accum

6
Program Listing Report

Rung 4:37
Input:
No.1 Tilt Cylinder Down
I:012

Rung 4:38
Input:
No.2 Tilt Cylinder Down
I:012

Rung 4:39
Status:
Air Bleed Valve Aux.
B3

Rung 4:40
Status:
Air Bleed Valve Aux.
B3

Rung 4:41

[END OF FILE]
Rung 5:0
Input:
Main Door
Closed
Prox.
I:012
---]/[--
Output:
Metal door
Open
Datataker
Relay
0:025
15
---]/[---

Rung 5:1
Input:
Hot Metal
Door
Closed
Prox
I:013
---]/[--
Output:
Hot Metal
Door Open
Datataker
Relay
0:025
03
---]/[---

Rung 5:2

[END OF FILE]
Ingot M/C Fault Indication lamp

- [ ] [ ] [ ] [ ] [ ]

Status: Flash Timer Bit B3

Input: P/B Lamp Test I:013

- [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Status: Ingot M/C Fault Accepted B3

Output: Ingot M/C Fault Indication lamp O:023

- [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Status: Main C/B Fault Not Accepted B3

Input: Main C/B Closed

- [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Status: Main C/B Fault Not Accepted B3

Input: Alarm Accept Pushbutton

- [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Status: Main C/B Fault Accepted

Input: Alarm Reset Pushbutton

- [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Status: Main C/B Fault

Input: Alarm
Program Listing Report

Rung 6:6

Status: Main C/B Fault Not Accepted
B3

Status: Main C/B Fault Accepted
B3

Input: P/B
Lamp Test
I:013

Output: Main C/B
Tripped Indication Lamp
O:023

Rung 6:7

Status: Element
Elements O/Temp
Not Over Fault
Temp. Accepted
I:010 B3

Status: Element
O/Temp Fault Not Accepted
B3


### Rung 6:8

<table>
<thead>
<tr>
<th>Status:</th>
<th>Input:</th>
<th>Input:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element</td>
<td>Alarm</td>
<td>Alarm</td>
</tr>
<tr>
<td>O/Temp</td>
<td>Accept</td>
<td>Reset</td>
</tr>
<tr>
<td>Fault Not Accepted</td>
<td>Pushbutton</td>
<td>Pushbutton</td>
</tr>
</tbody>
</table>

#### B3
- Status: I:013
- Value: I:013

#### Timer
- Value: 50

### Rung 6:9

<table>
<thead>
<tr>
<th>Status:</th>
<th>Status:</th>
<th>Element</th>
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<tbody>
<tr>
<td>Element</td>
<td>Flash</td>
<td>O/Temp</td>
</tr>
<tr>
<td>O/Temp</td>
<td>Timer</td>
<td>Indicator</td>
</tr>
<tr>
<td>Fault Not Accepted</td>
<td>Bit</td>
<td></td>
</tr>
</tbody>
</table>

#### B3
- Status: B3
- Value: B3

#### P/B Lamp Test
- Value: I:013

### Additional Information
- Page: Rung 6
Program Listing Report

Rung 6:10

<table>
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<th>Status:</th>
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<tr>
<td>Furnace</td>
<td>Furnace</td>
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<tr>
<td>Over-Temp</td>
<td>Over-Temp</td>
</tr>
<tr>
<td>Not Over</td>
<td>Fault</td>
</tr>
<tr>
<td>Temp.</td>
<td>Accepted</td>
</tr>
<tr>
<td>I:010</td>
<td>B3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
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</table>

Rung 6:11

<table>
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<th>Input:</th>
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<tr>
<td>Furnace</td>
<td>Alarm</td>
<td>Alarm</td>
</tr>
<tr>
<td>Over-Temp</td>
<td>Accept</td>
<td>Reset</td>
</tr>
<tr>
<td>Fault Not</td>
<td>Pushbutton</td>
<td>Pushbutton</td>
</tr>
<tr>
<td>Accepted</td>
<td>B3</td>
<td>I:013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I:013</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</table>

Rung 6:12

<table>
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<tr>
<td>Furnace</td>
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<tr>
<td>Over-Temp</td>
</tr>
<tr>
<td>Fault</td>
</tr>
<tr>
<td>Accepted</td>
</tr>
<tr>
<td>B3</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Rung 6:13
Program Listing Report

Rung 6:12

<table>
<thead>
<tr>
<th>Status:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace</td>
<td>Furnace</td>
</tr>
<tr>
<td>Over-Temp</td>
<td>Over-Temp</td>
</tr>
<tr>
<td>Fault Not Timer</td>
<td>Indication</td>
</tr>
<tr>
<td>Accepted Bit</td>
<td>Lamp</td>
</tr>
</tbody>
</table>

---

B3: 0:023

---

Input: P/B
Lamp Test

I:013

---

Rung 6:13

<table>
<thead>
<tr>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element 1</td>
</tr>
<tr>
<td>No.1, not Fault</td>
</tr>
<tr>
<td>Tripped Accepted</td>
</tr>
</tbody>
</table>

I:010 B3

---

I:013

---

Rung 6:14

<table>
<thead>
<tr>
<th>Status:</th>
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<tbody>
<tr>
<td>Element 1</td>
</tr>
<tr>
<td>Fault Not</td>
</tr>
<tr>
<td>Accepted B3</td>
</tr>
</tbody>
</table>

I:013 I:013

---

Input: Alarm
Alarm Accept
Fault Not Pushbutton
Pushbutton Accepted

---

I:013 I:013

---

Status:
Element 1 Fault Accepted B3

---

5

---
Output:
Element 1
O/C Alarm
Indication
Lamp
0:022

Status:
Element 1
Fault
Accepted

Input:
P/B
Lamp
Test
I:013

Status:
Element 2
Fault Not
Accepted

Input:
Alarm
Accept
Pushbutton

Status:
Element 2
Fault
Accepted
B3
### Program Listing Report

**Rung 6:18**

<table>
<thead>
<tr>
<th>Status:</th>
<th>Status:</th>
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<tbody>
<tr>
<td>Element 2</td>
<td>Flash</td>
</tr>
<tr>
<td>Fault Not Accepted</td>
<td>Timer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>134</td>
</tr>
</tbody>
</table>

**Output:**
- Element 2
- O/C Alarm
- Indication Lamp
- 0:022

**Status:**
- Element 2
- Fault Not Accepted

**Input:**
- P/B Lamp Test
- I:013

**Rung 6:19**

<table>
<thead>
<tr>
<th>Input:</th>
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</thead>
<tbody>
<tr>
<td>Element No.3 not Tripped</td>
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</table>

<table>
<thead>
<tr>
<th>Status:</th>
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<tbody>
<tr>
<td>Element 3</td>
</tr>
<tr>
<td>Fault Not Accepted</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I:010</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>54</td>
</tr>
</tbody>
</table>

**Status:**
- Element 3
- Fault Not Accepted

**Input:**
- Alarm Accept Pushbutton

**Rung 6:20**

<table>
<thead>
<tr>
<th>Status:</th>
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<tbody>
<tr>
<td>Element 3</td>
</tr>
<tr>
<td>Fault Not Accepted</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>I:013</th>
<th>I:013</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>14</td>
<td>15</td>
</tr>
</tbody>
</table>

**Status:**
- Element 3
- Fault Not Accepted

**Input:**
- Alarm Accept Pushbutton

**Rung 6:20**

<table>
<thead>
<tr>
<th>Status:</th>
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<tbody>
<tr>
<td>Element 3</td>
</tr>
<tr>
<td>Fault Not Accepted</td>
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</table>

<table>
<thead>
<tr>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
</tr>
</tbody>
</table>

**Input:**
- Alarm Accept Pushbutton
### Program Listing Report

#### Rung 6:21

<table>
<thead>
<tr>
<th>Status:</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element 3</td>
<td>Flash</td>
</tr>
<tr>
<td>Fault Not Timer</td>
<td></td>
</tr>
<tr>
<td>Accepted B3</td>
<td>B3</td>
</tr>
</tbody>
</table>

- **Output:**
  - Element 3: 
  - O/C Alarm: 
  - Indication Lamp: 0:022

- **Input:**
  - P/B Lamp Test: I:013

#### Rung 6:22

<table>
<thead>
<tr>
<th>Input:</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element 4</td>
<td>Fault Not Accepted</td>
</tr>
<tr>
<td>No.4, not Fault</td>
<td>Accepted B3</td>
</tr>
<tr>
<td>I:010</td>
<td>B3</td>
</tr>
</tbody>
</table>

- **Status:**
  - Element 4 Fault Accepted B3

#### Rung 6:23

<table>
<thead>
<tr>
<th>Input: Alarm</th>
<th>Input: Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element 4</td>
<td>Fault</td>
</tr>
<tr>
<td>Fault Not Pushbutton Accepted</td>
<td>Pushbutton Accepted B3</td>
</tr>
<tr>
<td>B3 I:013</td>
<td>I:013</td>
</tr>
</tbody>
</table>

- **Status:**
  - Element 4 Fault Accepted B3

- **Input:**
  - Alarm Accept Pushbutton: I:013 I:013

- **Status:**
  - Element 4 Fault Accepted B3

- **Input:**
  - Alarm Accept Pushbutton: I:013 I:013
Rung 6: 24

Status:  Status:  
Element 4  Flash  
Fault Not Timer  
Accepted Bit  
B3  B3  
---] [-------] [-------]  
8  134  

Status:  Element 4  
Fault  
Accepted  
B3  
---] [-----------------+  
55  
Input: P/B  
Lamp  
Test  
I:013  
---] [-----------------+  
16  

Rung 6: 25

Input:  Status:  
Element  Element 5  
No. 5, not Fault  
Tripped Accepted  
I:010  B3  
---] [-------] [-------]  
15  56  

Status:  Element 5  
Fault Not Accepted  
B3  
---] [-------+  
9  

Rung 6: 26

Status:  Input:  Input:  
Element 5  Alarm  Alarm  
Fault Not Accept  Reset  
Accepted Pushbutton  Pushbutton  
B3  I:013  I:013  
---] [-------] [-------]  
9  14  15  

Status:  Element 5  
Fault Accepted  
B3  
---] [-----------------+  
56
Output:
Element 5
O/C Alarm
Indication
Lamp
0:022

---] [---------------]
| 9 134 |

Status:
Element 5
Fault
Accepted
B3

---] [---------------]
| 56 |

Input: P/B
Lamp
Test
I:013

---] [---------------]
| 16 |

Input: Status:
Element 6
No.6, not Fault
Tripped
I:010
B3

---] [---------------]
| 16 57 |

Status:
Element 6
Fault Not
Accepted
B3

---] [---------------]
| 10 |

Input: Status:
Alarm
Element 6
Alarm
Accept
Pushbutton
B3
I:013

---] [---------------]
| 10 14 15 |

Status:
Element 6
Fault
Accepted
B3

---] [---------------]
| 57 |
Output:
Element 6
O/C Alarm
Indication
Lamp
0:022

Status:
Element 6
Fault
Accepted
B3

Input: P/B
Lamp
Test
I:013

Status:
Element 7
Fault
Accepted
B3

Input:
Status:
Element 7
Alarm
Accept
Pushbutton
B3
I:013

Status:
Element 7
O/C Alarm
Indication
Lamp
0:022

Status:
Element 6
Fault
Accepted
B3

Status:
Element 7
Fault
Accepted
B3

Status:
Element 7
Fault
Accepted
B3

Status:
Element 7
Fault
Accepted
B3
Rung 6:33

Status:
Element 7
Fault
Accepted
B3

Input:
P/B Lamp Test
I:013

Rung 6:34

Status:
Element 8
Fault Not
Accepted
B3

Input:
Element No.8, not Tripped
I:011

Rung 6:35

Status:
Element 8
Fault
Accepted
B3

Input:
Alarm
Alarm Reset
I:013

Output:
Element 7
O/C Alarm
Lamp
Indication
Bit

0:022

--- Page 06 ---

Wed Nov 10, 1993
### Program Listing Report

**PLC-5/15**

**File 06_6FNC**

**Rung 6:36**

<table>
<thead>
<tr>
<th>Status: Element 8</th>
<th>Output: Element 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault Not Timer</td>
<td>O/C Alarm Indication</td>
</tr>
<tr>
<td>Accepted Bit B3</td>
<td>Lamp 0:022</td>
</tr>
</tbody>
</table>

---

**Status:** Element 8 Flash

---

**Input:** P/B Lamp Test

---

**Status:**

Element 8
Fault
Accepted

---

**Input:** Test

---

**Status:**

Element 8 Flash

---

**Input:** P/B Lamp Test

---

**Status:**

Element 8
Fault
Accepted

---

**Input:**

---

**Status:**

Element 9
Fault Not Accepted

---

**Input:**

---

**Status:**

Element 9 Fault Not Accepted

---

**Input:**

---

**Status:**

Element 9 Fault Not Accepted

---

**Input:**

---

**Status:**

Element 9 Fault Not Accepted

---

**Input:**

---

**Status:**

Element 9 Fault Not Accepted

---

**Input:**
Program Listing Report

<table>
<thead>
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<th>Status:</th>
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</thead>
<tbody>
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<tr>
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<td>Timer</td>
</tr>
<tr>
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<td>Bit</td>
</tr>
<tr>
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<td>B3</td>
</tr>
</tbody>
</table>

Rung 6:39

**Output:**

- Element 9 O/C Alarm Indication Lamp
  - 0:022

**Input:**

- P/B Lamp Test
- I:013

Rung 6:40

**Status:**

- Element 10 Fault Not Accepted
- I:011 B3

Rung 6:41

**Status:**

- Element 10 Fault Accepted
- I:013

**Input:**

- Alarm Accept Pushbutton
- B3 I:013 1:013

**Input:**

- Alarm Reset Pushbutton
- B3 17 14 15

Rung 6:42

**Status:**

- Element 10 Fault Accepted
- B3

**Output:**

- ( )--- 65

Rung 6:43

**Status:**

- Element 10 Fault Accepted
- B3

**Input:**

- Alarm Accept Pushbutton
- B3 17 14 15

**Input:**

- Alarm Reset Pushbutton
- B3 65
## Rung 6:45

**Output:**
- Element 11
- O/C Alarm
- Indication Lamp
- O:022

### Status:
- **Element 11 Flash**
- **Fault Not Timer**
- **Accepted Bit**

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>134</td>
</tr>
</tbody>
</table>

### Input:
- **P/B Lamp Test**
- **I:013**

### Status:
- **Element 11**
- **Fault Accepted**

### Input:
- **Alarm Test**
- **I:013**

### Status:
- **Element 11**
- **Fault**
- **Accepted**

### Input:
- **Alarm Accept Pushbutton**
- **I:013**

### Status:
- **Element 12**
- **Fault Not Accepted**

### Input:
- **Alarm Reset Pushbutton**
- **I:013**

### Status:
- **Element 12**
- **Fault**
- **Accepted**

### Input:
- **Alarm Accept Pushbutton**
- **I:013**

### Status:
- **Element 12**
- **Fault**
- **Accepted**

### Input:
- **Alarm Test**
- **I:013**

### Status:
- **Element 12**
- **Fault**
- **Accepted**

### Input:
- **Alarm Accept Pushbutton**
- **I:013**

### Status:
- **Element 12**
- **Fault**
- **Accepted**

### Input:
- **Alarm Accept Pushbutton**
- **I:013**

### Status:
- **Element 12**
- **Fault**
- **Accepted**

### Input:
- **Alarm Accept Pushbutton**
- **I:013**

### Status:
- **Element 12**
- **Fault**
- **Accepted**

### Input:
- **Alarm Accept Pushbutton**
- **I:013**
Status: Element 12
Fault Not Accepted B3

Status: Element 13
Fault Accepted B3

Output: Element 12
O/C Alarm
Indication

Input: P/B
Lamp
Test I:013

Status: Element 13
Fault Not Accepted B3

Input: Element No.13, not Tripped I:011

Status: Element 13
Fault Not Accepted B3

Input: Alarm Accept
Pushbutton

Status: Element 13
Fault Accepted B3

Status: Element 13
Fault

Program Listing Report
### Program Listing Report

**Rung 6:51**

<table>
<thead>
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<td>B3</td>
</tr>
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</table>

**Output:**

- Element 13 O/C Alarm
- Indication Lamp
- 0:022

**Input:** P/B Lamp Test I:013

### Rung 6:52

<table>
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<th>Status:</th>
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**Input:** Alarm Accept Pushbutton

### Rung 6:53

<table>
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<tbody>
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<tr>
<td>Accepted Bit</td>
<td>B3</td>
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</tbody>
</table>

**Input:** Alarm Accept Pushbutton

---

**Page:** 6

---

**File:** 06_6FNC
Program Listing Report

Rung 6:54

Output:
Status: Element 14 Flash
Fault Not Timer
Accepted Bit B3

---- [ ] [ ] [ ]

--- ] [ ------- +

Status:
Element 14 Fault
Accepted
B3

Input: P/B
Lamp
Test
I:013

---- [ ] [ ]

Rung 6:55

Input:
Element No.15, not Fault
Tripped Accepted
I:011 B3

---- ] [ --- ] [ --- ]

Status:
Element 15 Fault
Accepted
B3

---- [ ] [ ]

Rung 6:56

Status:
Alarm
Element 15 Accept
Fault Not Pushbutton
Accepted
B3 I:013 I:013

---- ] [ ] [ ]

Status:
Element 15 Fault
Accepted
B3

---- [ ] [ ]
Program Listing Report

Rung 6:57

Output:
Element 15
O/C Alarm
Indication
Lamp
O:022

Status:
Element 15
Flash
Timer

B3

----] [--------------------]

22 134

Status:
Element 15
Fault
Accepted
B3

----] [--------------------+

70

Input: P/B
Lamp
Test
I:013

----] [--------------------+

16

Rung 6:58

Status:
Hydraulics
Trip Fault
Not
Accepted
B3

----] [--------------------+

10 71

Status:
Hydraulics
Trip Fault
Not
Accepted
B3

----] [--------------------+

23

Rung 6:59

Status:
Hydraulics
Alarm
Trip Fault
Not
Accepted
B3

----] [----------------------]

I:013 I:013

----] [----------------------+

23 14 15

Status:
Hydraulics
Trip Fault
Accepted
B3

----] [----------------------+

71
Program Listing Report

Rung 6:60

Status:
Hydraulics
Trip Fault
Not
Accepted

Output:
Hydraulics
O/C Alarm
Indication
Lamp

B3

23

134

Rung 6:61

Input:
Hydraulic Oil Level
Oil Low
Level

Status:
Oil Level
Fault
Not Accepted

I:011

B3

16

Rung 6:62

Input:
Alarm

Status:
Alarm
Fault
Not Accepted

B3

I:013

I:013

24

14

15

24

17

17
## Program Listing Report

**Rung 6:63**

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<td>Lamp</td>
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**Rung 6:64**

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**Rung 6:65**

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**Rung 6:66**

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<td>B3</td>
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<tr>
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**Rung 6:67**

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<td>B3</td>
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<tr>
<td>Input:</td>
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<tr>
<td>Alarm</td>
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<td>Accept</td>
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**Rung 6:68**

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<td></td>
<td>B3</td>
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<tr>
<td>Input:</td>
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<td>Alarm</td>
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**Rung 6:69**

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<tr>
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<td>B3</td>
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<tr>
<td></td>
<td>B3</td>
</tr>
<tr>
<td>Input:</td>
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</tr>
<tr>
<td>Alarm</td>
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<td>Accept</td>
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**Rung 6:70**

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<td>Fault</td>
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<tr>
<td>Input:</td>
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<tr>
<td>Alarm</td>
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**Rung 6:71**

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<tr>
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<tr>
<td>Input:</td>
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<tr>
<td>Alarm</td>
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**Rung 6:72**

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<tr>
<td>Accepted</td>
<td>Fault</td>
</tr>
<tr>
<td>B3</td>
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</tr>
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<td></td>
<td>B3</td>
</tr>
<tr>
<td>Input:</td>
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<tr>
<td>Alarm</td>
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</tr>
<tr>
<td>Accept</td>
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<td>Pushbutton</td>
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**Rung 6:73**

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<tr>
<td>Accepted</td>
<td>Fault</td>
</tr>
<tr>
<td>B3</td>
<td>Accepted</td>
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<tr>
<td></td>
<td>B3</td>
</tr>
<tr>
<td>Input:</td>
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</tr>
<tr>
<td>Alarm</td>
<td></td>
</tr>
<tr>
<td>Accept</td>
<td></td>
</tr>
<tr>
<td>Pushbutton</td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---
Status: 

Oil Temp. Flash
Fault Not Timer
Accepted Bit

B3 B3 0:023

Output: 

Hyd. Oil
O/Temp.
Indication Lamp

---] [-------------------

25 134

Status:

Oil Temp
Fault
Accepted

B3

---] [-------------------

73

Input: P/B
Lamp Test
I:013

---] [-------------------

16

Status:

Fast Speed Fast Filt.
Filter Fault
Switch Accepted

I:011 B3

---] [-------------------

16 74

---] [-------------------

Input:

Hyd. Oil Status:
Fast Speed Fast Filt.
Filter Fault
Switch Accepted

I:011 B3

---] [-------------------

16 74

---] [-------------------

26

---] [-------------------

Input: Alarm Status:
Alarm Accept Fast Filt.
Reset Fault Accepted
Pushbutton B3

---] [-------------------

26 14 15

---] [-------------------

Status:

Fast Filt.
Fault
Accepted

B3

---] [-------------------

74

---] [-------------------

74
## Program Listing Report

### Rung 6:69

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<thead>
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<td>Fast Speed</td>
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<td>Fault Not Timer</td>
<td>Fault Accepted</td>
<td>Filt. Low</td>
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Status: Slow Flit. Fault Not Accepted B3

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<td>Slow Flit.</td>
<td>Fast Filt. Flash</td>
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<tr>
<td>B3</td>
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<td>Fault</td>
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Status: Slow Flit. Fault Accepted B3

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<td>Slow Flit.</td>
<td>Fast Filt. Flash</td>
</tr>
<tr>
<td>B3</td>
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<td>Fault</td>
</tr>
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Status: Slow Flit. Fault NotAccepted B3

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<td>Fast Filt. Flash</td>
</tr>
<tr>
<td>B3</td>
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<tr>
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Status: Slow Flit. Fault Accepted B3

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<td>Fast Filt. Flash</td>
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<tr>
<td>B3</td>
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</tr>
<tr>
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Status: Slow Flit. Fault Not Accepted B3

### Rung 6:70

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<th>Output:</th>
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<td>Slow Flit.</td>
<td>Fast Speed</td>
</tr>
<tr>
<td>Slow Speed Fault</td>
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<td>Flow</td>
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Status: Slow Flit. Fault Not Accepted B3

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<th>Output:</th>
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<td>Fast Filt. Flash</td>
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<tr>
<td>B3</td>
<td>Reset</td>
<td>Fault</td>
</tr>
<tr>
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Status: Slow Flit. Fault Accepted B3

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<tbody>
<tr>
<td>P/B Lamp Test</td>
<td>Slow Flit.</td>
<td>Fast Filt. Flash</td>
</tr>
<tr>
<td>B3</td>
<td>Reset</td>
<td>Fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accepted Bit</td>
</tr>
</tbody>
</table>

Status: Slow Flit. Fault Not Accepted B3

### Rung 6:71

<table>
<thead>
<tr>
<th>Input:</th>
<th>Status:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm Slow Filt. Accept</td>
<td>Fault</td>
<td>Slow Filt.</td>
</tr>
<tr>
<td>Fault Not Pushbutton</td>
<td>Accepted</td>
<td>Filt. Not</td>
</tr>
<tr>
<td>B3 I:013</td>
<td></td>
<td>Accepted</td>
</tr>
</tbody>
</table>

Status: Slow Flit. Fault Accepted B3

<table>
<thead>
<tr>
<th>Input:</th>
<th>Status:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/B Lamp Test</td>
<td>Slow Flit.</td>
<td>Fast Filt. Flash</td>
</tr>
<tr>
<td>B3</td>
<td>Reset</td>
<td>Fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accepted Bit</td>
</tr>
</tbody>
</table>

Status: Slow Flit. Fault Not Accepted B3

<table>
<thead>
<tr>
<th>Input:</th>
<th>Status:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/B Lamp Test</td>
<td>Slow Flit.</td>
<td>Fast Filt. Flash</td>
</tr>
<tr>
<td>B3</td>
<td>Reset</td>
<td>Fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accepted Bit</td>
</tr>
</tbody>
</table>

Status: Slow Flit. Fault Not Accepted B3
### Program Listing Report

**Rung 6:72**

<table>
<thead>
<tr>
<th>Status:</th>
<th>B3</th>
<th>Status:</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow Filt. Flash</td>
<td></td>
<td>Output:</td>
<td>Slow Speed</td>
</tr>
<tr>
<td>Fault Not Timer</td>
<td></td>
<td>Filt. Low</td>
<td></td>
</tr>
<tr>
<td>Accepted Bit</td>
<td></td>
<td>Flow</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td></td>
<td>Indication</td>
<td>O:023</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( )-</td>
<td>04</td>
</tr>
</tbody>
</table>

### Rung 6:73

<table>
<thead>
<tr>
<th>Input:</th>
<th>Status:</th>
<th>Status:</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD Lintel Water Flow</td>
<td>Water Flow</td>
<td>Water Flow</td>
<td>Water Flow</td>
</tr>
<tr>
<td>Water Low Fault</td>
<td>Fault Not Indicated</td>
<td>Fault Not Indicated</td>
<td></td>
</tr>
<tr>
<td>Flow Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I:012</td>
<td>B3</td>
<td>B3</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>80</td>
<td></td>
<td>( )-</td>
</tr>
</tbody>
</table>

### Rung 6:74

<table>
<thead>
<tr>
<th>Status:</th>
<th>Input: Alarm</th>
<th>Input: Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Flow</td>
<td>Accept</td>
<td>Pushbutton</td>
</tr>
<tr>
<td>Fault Not Indicated</td>
<td>B3</td>
<td>I:013</td>
</tr>
<tr>
<td>I:013</td>
<td></td>
<td>B3</td>
</tr>
<tr>
<td>32</td>
<td>14</td>
<td>15</td>
</tr>
</tbody>
</table>

### Rung 6:75

<table>
<thead>
<tr>
<th>Status:</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Flow</td>
<td>Water Flow</td>
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<tr>
<td>Fault Not Indicated</td>
<td>Fault Not Indicated</td>
</tr>
<tr>
<td>B3</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

### Rung 6:76

<table>
<thead>
<tr>
<th>Status:</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Flow</td>
<td>Water Flow</td>
</tr>
<tr>
<td>Fault</td>
<td>Fault</td>
</tr>
<tr>
<td>Accepted</td>
<td>Accepted</td>
</tr>
<tr>
<td>B3</td>
<td>B3</td>
</tr>
<tr>
<td>80</td>
<td>( )-</td>
</tr>
</tbody>
</table>
Rung 6:75

Status: Water Flow
Fault Not Indicated

B3 B3

Status: Water Flow
Fault Accepted
B3

Input: P/B
Lamp Test
I:013

Rung 6:76

Input: MD Lintel Water Temp
Water Fault O/Temp. Accepted
I:012 B3

Status: Water Temp
Fault Not Accepted B3

Rung 6:77

Status: Alarm
Water Temp Accept
Fault Not Pushbutton Accepted

B3 I:013 I:013

Status: Water Temp
Fault Accepted B3


Program Listing Report

Output:
- MD Lintel
- O/Temp
- Indication Lamp
- 0:023

Rung 6:78

Status: Status:
Water Temp Flash
Fault Not Timer
Accepted Bit

B3 B3

---] [-------------------]

33 134

Status: Water Temp
Fault
Accepted

B3

---] [-------------------]

81

Input: P/B
Lamp
Test
I:013

---] [-------------------]

16

Rung 6:79

Status: P.L.C.
Battery
Low Or
Failed

S:10 B3

---] [-------------------]

0 82

Status: PLC Batt.
Fault Not
Accepted

B3

---] [-------------------]

34

Rung 6:80

Status: Input: Input:
Alarm Alarm
PLC Batt. Accept Reset
Fault Not Pushbutton Pushbutton
Accepted

B3 I:013 I:013

---] [-------------------]

34 14 15

Status: PLC Fault
Accepted

B3

---] [-------------------]

82
Program Listing Report

Rung 6:81

Status: | Status: | Output: | P.L.C. Failure Indication Lamp
PLC Batt. | Flash | 0:023
Fault Not | Timer | |
Accepted | Bit | |
B3 | B3 | |

Input: P/B Lamp
Test
I:013

Rung 6:82

Status: | Status: | Input: | Alarm Accept SCRFuse
Timer: | SCR Fuse | | Fault
Validate | Fault | |
SCR Fault | Accepted | |
T4:14 | B3 | |

Status: | SCR Fuse Fault Not Accepted
SCR Fuse | | 83
Fault Not Accepted
Fault | B3 |

Rung 6:83

Status: | Status: | Input: | Alarm Accept SCRFuse
Input: | Alarm Reset | |
SCR Fuse | Accept | |
Fault Not | Pushbutton Pushbutton |
Accepted | |
B3 | I:013 I:013 |

Status: | SCR Fuse Fault Accepted
SCR Fuse | | 83
Fault | B3 |
Accepted | |

35 14 15
### Program Listing Report

**File**: 06_6FNC  
**Program**: PLC-5/15

#### Rung 6:84

<table>
<thead>
<tr>
<th>Status:</th>
<th>SCRs Fuses:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR Fuse</td>
<td>Flash</td>
<td>SCR Blown</td>
</tr>
<tr>
<td>Fault Not Timer</td>
<td></td>
<td>Fuse Mimic</td>
</tr>
<tr>
<td>Accepted Bit</td>
<td></td>
<td>O:024</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>134</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status:</th>
<th>SCRs Fuses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR Fuse</td>
<td></td>
</tr>
<tr>
<td>Fault</td>
<td></td>
</tr>
<tr>
<td>Accepted Bit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>P/B Lamp Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>I:013</td>
<td></td>
</tr>
</tbody>
</table>

#### Rung 6:85

<table>
<thead>
<tr>
<th>Timer:</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic Oil Low Pressure</td>
<td>Oil Press. Fault Not Accepted</td>
</tr>
<tr>
<td>Fault</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T4:2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN</td>
<td>84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status:</th>
<th>Oil Press.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault Not Accepted</td>
<td>B3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

#### Rung 6:86

<table>
<thead>
<tr>
<th>Input:</th>
<th>Input:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm</td>
<td>Alarm</td>
</tr>
<tr>
<td>Oil Press. Accept</td>
<td>Reset</td>
</tr>
<tr>
<td>Fault Not Pushbutton</td>
<td>Pushbutton</td>
</tr>
<tr>
<td>Accepted</td>
<td>B3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I:013</th>
<th>I:013</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status:</th>
<th>Oil Press.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault</td>
<td>Accepted</td>
</tr>
<tr>
<td>B3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status:</th>
<th>Oil Press.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault</td>
<td>Accepted</td>
</tr>
<tr>
<td>B3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
<td></td>
</tr>
</tbody>
</table>
Program Listing Report

Rung 6:87

Status: Oil Press. B3
Status: Flash
Fault Not Bit
Accepted B3

---] [--------] [--------] [--------] [--------] [--------] [--------] [--------]

36 134

Status:
Oil Press.
Fault
Accepted B3

Input: P/B Lamp Test

I:013

---] [--------]

16

Rung 6:88

Status:
System B3
Run

---] [--------]

135

Output:
Hyd. Oil Low Press.
Indication Lamp
0:023

Status:
Flash Timer Bit

B3

---] [--------]

84

Input: P/B Lamp Test

I:013

---] [--------]

16

---] [--------]

Timer:
Furnace Start Alarm Preset

+TON------

+TIMER ON DELAY +-(EN)

| Timer T4:13 |
| Time base 1.0+--(DN) |
| Preset 10 |
| Accum 0 |

+--------
This rung is used to arrange any existing alarms into Alarm buffer Words, read for a comparison to those existing before the alarm was present.

<table>
<thead>
<tr>
<th>Alarm Buffer Word No.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>+MVM</td>
</tr>
<tr>
<td>+MOVE WITH MASK</td>
</tr>
<tr>
<td>Source</td>
</tr>
<tr>
<td>B3:0</td>
</tr>
<tr>
<td>0000000000000000</td>
</tr>
<tr>
<td>Mask</td>
</tr>
<tr>
<td>1FFE</td>
</tr>
<tr>
<td>Destination</td>
</tr>
<tr>
<td>N7:20</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alarm Buffer Word No.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>+MVM</td>
</tr>
<tr>
<td>+MOVE WITH MASK</td>
</tr>
<tr>
<td>Source</td>
</tr>
<tr>
<td>B3:1</td>
</tr>
<tr>
<td>1111000000000000</td>
</tr>
<tr>
<td>Mask</td>
</tr>
<tr>
<td>FFFFF</td>
</tr>
<tr>
<td>Destination</td>
</tr>
<tr>
<td>N7:21</td>
</tr>
<tr>
<td>-4096</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>+MVM</td>
</tr>
<tr>
<td>+MOVE WITH MASK</td>
</tr>
<tr>
<td>Source</td>
</tr>
<tr>
<td>B3:2</td>
</tr>
<tr>
<td>0000000000000000</td>
</tr>
<tr>
<td>Mask</td>
</tr>
<tr>
<td>001F</td>
</tr>
<tr>
<td>Destination</td>
</tr>
<tr>
<td>N7:22</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>
Input:
Alarm
Accept
Pushbutton

I:013

14

Alarm
Buffer
Word No.4

+MVM

MOVE WITH MASK

Source: B3:0
0000000000000000
Mask: 1FFE
Destination: N7:23
0

Alarm
Buffer
Word No.5

+MVM

MOVE WITH MASK

Source: B3:1
1111000000000000
Mask: FFFF
Destination: N7:24
-4096

Alarm
Buffer
Word No.6

+MVM

MOVE WITH MASK

Source: B3:2
0000000000000000
Mask: 001F
Destination: N7:25
0
Program Listing Report

Rung 6:91

Alarm Buffer
Word No.1

+NEQ-------------------+
++NOT EQUAL
Source A N7:20
0
Source B N7:23
0

---------------------------------

Rung 6:92

+NEQ-------------------+
++NOT EQUAL
Source A N7:21
0
Source B N7:24
-4096

---------------------------------

[END OF FILE]
Program Listing Report

Rung 7:0

<table>
<thead>
<tr>
<th>Blk Trans.</th>
<th>Block Transfer Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack</td>
<td>00</td>
</tr>
<tr>
<td>Group</td>
<td>0+</td>
</tr>
<tr>
<td>Module</td>
<td>0</td>
</tr>
<tr>
<td>Control block</td>
<td>N9:0+</td>
</tr>
<tr>
<td>Data file</td>
<td>N7:100</td>
</tr>
<tr>
<td>Length</td>
<td>0</td>
</tr>
<tr>
<td>Continuous</td>
<td>N</td>
</tr>
</tbody>
</table>

Rung 7:1

<table>
<thead>
<tr>
<th>Blk Trans.</th>
<th>Block Transfer Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack</td>
<td>00</td>
</tr>
<tr>
<td>Group</td>
<td>0+</td>
</tr>
<tr>
<td>Module</td>
<td>0</td>
</tr>
<tr>
<td>Control block</td>
<td>N9:50+</td>
</tr>
<tr>
<td>Data file</td>
<td>N7:150</td>
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<tr>
<td>Length</td>
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<tr>
<td>Continuous</td>
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Rung 7:2

<table>
<thead>
<tr>
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<th>Block Transfer Read</th>
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</thead>
<tbody>
<tr>
<td>Rack</td>
<td>00</td>
</tr>
<tr>
<td>Group</td>
<td>1+</td>
</tr>
<tr>
<td>Module</td>
<td>0</td>
</tr>
<tr>
<td>Control block</td>
<td>N9:100+</td>
</tr>
<tr>
<td>Data file</td>
<td>N7:200</td>
</tr>
<tr>
<td>Length</td>
<td>0</td>
</tr>
<tr>
<td>Continuous</td>
<td>N</td>
</tr>
</tbody>
</table>
Program Listing Report

Rung 7:3
BTR | BTW
ANA. OUTPUT | ANA. OUTPUT
RACK 0 | RACK 0
MOD. 1 | MOD. 1
ENABLED | ENABLED
N9:100  N9:150

Rung 7:4

------------------------- [END OF FILE]-------------------------

BTW
Blk Trans.
Write to
Analog
Output
Module

+BTW- -------------------+
+BLOCK TRANSFER WRITE +-(EN)
| Rack 00|
| Group 1+(DN)|
| Module 0|
| Control block N9:150-(ER)|
| Data file N7:250|
| Length 0|
| Continuous N|

+-----------------------------------+
Program Listing Report  

PLC-5/15  
File 06_6FNC  

Rung 8:0

<table>
<thead>
<tr>
<th>Input:</th>
<th>No.1 Ingot Tilt</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic</td>
<td>Select At</td>
<td>No.1 M/C</td>
</tr>
</tbody>
</table>

| XIO |
| I:027 |

Status:  
Manual  
Control  
Selected  
No.1

Rung 8:1

<table>
<thead>
<tr>
<th>Input:</th>
<th>No.1 Ingot Tilt</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic</td>
<td>Select At</td>
<td>No.1 M/C</td>
</tr>
</tbody>
</table>

| XIO |
| I:027 |

Status:  
Manual  
Control  
Selected  
No.1

Rung 8:2

<table>
<thead>
<tr>
<th>Input:</th>
<th>No.1 Ingot Tilt</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>Select At</td>
<td>No.1 M/C</td>
</tr>
</tbody>
</table>

| XIO |
| I:027 |

Status:  
Manual  
Control  
Selected  
No.1

Rung 8:3

<table>
<thead>
<tr>
<th>Input:</th>
<th>No.1 Ingot Tilt</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic</td>
<td>Select At</td>
<td>No.1 M/C</td>
</tr>
</tbody>
</table>

| XIO |
| I:027 |

Status:  
Manual  
Control  
Selected  
No.1

Input:  
No.1 Ingot Station Selected  
I:027  
05  
07  
10  

Input:  
No.2 Ingot Station Selected  
I:027  
06  
07  
10  

Input:  
No.2 Ingot Station Selected  
I:027  
06  
07  
10  

Input:  
No.1 Ingot Station Selected  
I:027  
05  
07  
10  

--- [-----] [-----] [-----] [-----] 

--- [-----] [-----] [-----] [-----] 

--- [-----] [-----] [-----] [-----] 

--- [-----] [-----] [-----] [-----] 

--- [-----] [-----] [-----] [-----] 

--- [-----] [-----] [-----] [-----] 

--- [-----] [-----] [-----] [-----]
Rung 8:4
  Status: Manual
  Control Selected
  No.1 [ ]

  B3

Rung 8:5
  Status: Manual
  Control Selected
  No.2 [ ]

  B3

Rung 8:6
  This rung is used to move the calculated PID control output to the applicable analogue output control area.
  Status: Analogue
  Control output Selected
  Channel 1

  No.1 M/C [ ]

  Aux. Relay

  B3

  +MOV- +MOVE +

  Source N7:105
  3520
  Destination N7:250
  0

Rung 8:7
  This rung is used to present an Analogue Input from the Launder Level Sensor to the P.I.D. Control Instruction.
  Input: No.6
  Status: Manual
  Automatic
  Tilt
  Select At
  No.1 M/C
  XIO

  I:027 [ ]

  B3

  +MOV- +MOVE +

  Source N7:104
  4095
  Destination N7:0
  4095
This rung is used to convert the Launder Level Signal present on Input No. 1:00/00, to a corresponding Output Level used to control the "Tilt Rate" of No. 6 Furnace.

Status:
System Run

+PID +PID

<table>
<thead>
<tr>
<th>Control block</th>
<th>N7:50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process variable</td>
<td>N7:0</td>
</tr>
<tr>
<td>Tieback</td>
<td>N7:5</td>
</tr>
<tr>
<td>Control variable</td>
<td>N7:10</td>
</tr>
</tbody>
</table>

PID Control
Enabled Bit
N7:50

This rung is used to control the P.I.D. "Control Output Word" when the P.I.D. Instruction has been disabled. It reduces the output signal to Zero to ensure that the tilting of the furnace will respond in a predictable manner.
This rung is used to move the calculated PID control output to the applicable analogue output control area.

Status:
- Manual
- Control: Analogue
- Selected: Channel 1
- Aux. Relay: B3

Rung 8:11

---] / [----------------------------------]
142

Rung 8:11

[END OF FILE]

FILE 9 IS NOT TYPE LADDER
**LAUNDER LEVEL CONTROL**

<table>
<thead>
<tr>
<th>Input:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Launder</td>
<td>Max. Level</td>
</tr>
<tr>
<td>Maximum</td>
<td>In Launder</td>
</tr>
<tr>
<td>Metal</td>
<td>Indicator</td>
</tr>
<tr>
<td>Level Prox</td>
<td>0:005</td>
</tr>
<tr>
<td>I:002</td>
<td>-()---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Launder</td>
<td>Min. Level</td>
</tr>
<tr>
<td>Minimum</td>
<td>In Launder</td>
</tr>
<tr>
<td>Metal</td>
<td>Indicator</td>
</tr>
<tr>
<td>Level Prox</td>
<td>0:005</td>
</tr>
<tr>
<td>I:002</td>
<td>-()---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.6</td>
<td>Launder</td>
</tr>
<tr>
<td>Automatic</td>
<td>Level in</td>
</tr>
<tr>
<td>Tilt</td>
<td>Automatic Control</td>
</tr>
<tr>
<td>Select At</td>
<td>Indicator</td>
</tr>
<tr>
<td>No.1 M/C</td>
<td>XIO</td>
</tr>
<tr>
<td>I:012</td>
<td>0:005</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Speed</td>
<td>Drive</td>
</tr>
<tr>
<td>Drive</td>
<td>Start</td>
</tr>
<tr>
<td>Fault</td>
<td>0:026</td>
</tr>
<tr>
<td>B3</td>
<td>0:026</td>
</tr>
<tr>
<td>I:002</td>
<td>-()---</td>
</tr>
</tbody>
</table>

---
Program Listing Report

Rung 10:6

<table>
<thead>
<tr>
<th>Input:</th>
<th>Input:</th>
<th>Input:</th>
<th>Output:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir Lower</td>
<td>Weir Fully</td>
<td>Weir Fast</td>
<td>Weir</td>
<td></td>
</tr>
<tr>
<td>Pushbutton</td>
<td>Closed</td>
<td>Speed</td>
<td>Speed</td>
<td></td>
</tr>
<tr>
<td>Prox</td>
<td></td>
<td>Selector Slow</td>
<td>Slow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switch</td>
<td>Fast</td>
<td></td>
</tr>
<tr>
<td>I:002</td>
<td>I:002</td>
<td>I:002</td>
<td>0:026</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Program Listing Report

Rung 10:7

<table>
<thead>
<tr>
<th>Input:</th>
<th>Input:</th>
<th>Input:</th>
<th>Output:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir Lower</td>
<td>Weir Fully</td>
<td>Weir Slow</td>
<td>Weir</td>
<td></td>
</tr>
<tr>
<td>Pushbutton</td>
<td>Closed</td>
<td>Speed</td>
<td>Speed</td>
<td></td>
</tr>
<tr>
<td>Prox</td>
<td></td>
<td>Selector Slow</td>
<td>Slow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switch</td>
<td>Fast</td>
<td></td>
</tr>
<tr>
<td>I:002</td>
<td>I:002</td>
<td>I:002</td>
<td>0:026</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Program Listing Report

Input:
Weir Raise
Pushbutton
I:002

Program Listing Report

Input:
Automatic Control Select. SW
I:002

Program Listing Report

<table>
<thead>
<tr>
<th>Input:</th>
<th>Input:</th>
<th>Input:</th>
<th>Output:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMER:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weir Increase Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Control On Delay Select. SW Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I:002</td>
<td>T4:36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Program Listing Report

<table>
<thead>
<tr>
<th>Input:</th>
<th>Input:</th>
<th>Input:</th>
<th>Output:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMER:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weir Decrease Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Control On Delay Select. SW Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I:002</td>
<td>T4:38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rung 10:8</td>
<td>Input:</td>
<td>Input:</td>
<td>Output:</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>-------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Weir Raise</td>
<td>Weir Open</td>
<td>Weir Lower</td>
<td>Weir</td>
<td></td>
</tr>
<tr>
<td>Pushbutton</td>
<td>Maximum</td>
<td>Pushbutton</td>
<td>Raise/Lower</td>
<td></td>
</tr>
<tr>
<td>I:002</td>
<td>I:002</td>
<td>I:002</td>
<td>O:026</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>STATUS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir</td>
<td>Auto Ingot</td>
</tr>
<tr>
<td>Automatic</td>
<td>Height</td>
</tr>
<tr>
<td>Control</td>
<td>RAISE WEIR</td>
</tr>
<tr>
<td>Select. SW</td>
<td>CONTROL</td>
</tr>
<tr>
<td>I:002</td>
<td>B3</td>
</tr>
</tbody>
</table>

| Rung 10:9 |----------|------|------|------|
|----------|--------|-----|-----|
| 12 | 183 | 04 | 02 | 05 | 02 |

---[END OF FILE]---
Program Listing Report

Rung 11:0

Input:  
- Cast No.7 Tap Plug
- Through IN P/B at No.1
- No.2 Ingot at No.1
- Machine
  - I:003 I:002

Output:  
- Tap Plug OUT
- Actuator
  - O:005

---] [----] [----] [----] [----]
  03 14

Input:  
- Cast No.7 Tap Plug
- Through IN P/B at No.1
- No.2 Ingot at No.2
- Machine
  - I:003 I:003

---] [----------] [--------]
  03 01

Input:  
- Tap Plug IN
- P/B at 7
- Furnace
  - I:002

---] [----------] [--------]
  16

STATUS:  
- Automatic Decrease
- Level Launder
- Control Level from
- Engage No.7 Furnace
  - B3 T4:30

---] [--------] [------]
  184 TT

Rung 11:1

Output:  
- Tap Plug IN
- Actuator
  - O:005

---] [-----] [-----]
  05

Output:  
- Tap Plug IN
- Indicator
  - O:005

---] [-----] [-----]
  06
Program Listing Report

Rung 11:2

Input:
- Cast No.7 Tap Plug
- Through OUT P/B
- No.2 Ingot at No.1 Machine

<table>
<thead>
<tr>
<th>No.</th>
<th>1:003 I:002</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:005</td>
<td>0:005</td>
</tr>
</tbody>
</table>

Output:
- Tap Plug IN Actuator
- Tap Plug OUT Actuator

---

Input:
- Cast No.7 Tap Plug
- Through OUT P/B
- No.2 Ingot at No.2 Machine

<table>
<thead>
<tr>
<th>No.</th>
<th>1:003 I:003</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:005</td>
<td>0:005</td>
</tr>
</tbody>
</table>

Output:
- Tap Plug IN Actuator
- Tap Plug OUT Actuator

---

Input:
- Tap Plug OUT P/B at No.7 Furnace

<table>
<thead>
<tr>
<th>No.</th>
<th>1:002</th>
</tr>
</thead>
</table>

Output:
- Tap Plug OUT Indicator

---

STATUS:
- Automatic Level Control Engage B3

<table>
<thead>
<tr>
<th>No.</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>184</td>
<td>TT</td>
</tr>
</tbody>
</table>

Timer:
- Tap Plug Brake Control

T4:20

---

Rung 11:3

Output:
- Tap Plug OUT Actuator

<table>
<thead>
<tr>
<th>No.</th>
<th>0:005</th>
</tr>
</thead>
</table>

---

Output:
- Tap Plug OUT Indicator

<table>
<thead>
<tr>
<th>No.</th>
<th>0:005</th>
</tr>
</thead>
<tbody>
<tr>
<td>07</td>
<td></td>
</tr>
<tr>
<td>Rung 11:4</td>
<td>Input: No.7</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>I:027</td>
<td>I:003</td>
</tr>
</tbody>
</table>
Launder
Level
Scaled
Input
Value

+GRT---------------------+
++GREATER THAN
+---1-------------------+
Source A N7:300 1000
Source B N7:320 800

+LES---------------------+
++LESS THAN
+---1-------------------+
Source A N7:300 1000
Source B N7:321 100

Input:
Launder
Maximum
Metal
Level Prox
I:002

Input:
Launder
Minimum
Metal
Level Prox
I:002

Input:
Automatic
Level
Select At
No.1 M/C
I:027
Rung 11:6
This rung is used to convert the Analogue Signal seen from the Launder Level, to a number between 0 - 1000. (i.e. Scaling this input as would be done within the P.I.D.Instruction).

This "Scaled value" is then compared to the resident Launder Level Setpoint bound and set within the Launder Level Control P.I.D. Instruction, to ensure similar Launder Levels are supplied irrespective which Furnace is used.

<table>
<thead>
<tr>
<th>Launder Level</th>
<th>Scaled Input Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>+DIV Source A</td>
<td>N7:104 4095</td>
</tr>
<tr>
<td>Source B</td>
<td>4.095000</td>
</tr>
<tr>
<td>Destination N7:300</td>
<td>1000</td>
</tr>
</tbody>
</table>

Rung 11:7

<table>
<thead>
<tr>
<th>Launder Level</th>
<th>Upper Control Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ADD Source A</td>
<td>N7:306 475</td>
</tr>
<tr>
<td>Source B</td>
<td>N7:307 75</td>
</tr>
<tr>
<td>Destination N7:308</td>
<td>550</td>
</tr>
</tbody>
</table>

Rung 11:8
This rung is used to allow an "Upper Control Deadband Limit" to be set. This is to reduce the effects of Launder level "Hunting".

<table>
<thead>
<tr>
<th>Launder Level</th>
<th>Deadband Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ADD Source A</td>
<td>N7:52</td>
</tr>
<tr>
<td>Source B</td>
<td>N7:305</td>
</tr>
<tr>
<td>Destination N7:306</td>
<td>475</td>
</tr>
</tbody>
</table>
This rung is used to Set a "Lower Control Deadband Limit". It is used in conjunction with the rung above to reduce any "Hunting" in the Launder Level.

To Change the Lower Limit: Vary the value Set in Data Table Address N7:304

\[
\text{Laundry Level} \quad \text{Deadband Lower Limit}
\]

+\text{SUBTRACT} +
Source A N7:52
500
Source B N7:304
-5
Destination N7:303
505

Rung 11:10

Laundry Level Lower Control Limit

\[
\text{GRT} + \text{LIM} + \text{GREATER THAN} \quad \text{LIMIT TEST (CIRC)}
\]

Source A N7:300
1000
Source B N7:306
475

\[
\text{Low limit N7:306} \quad \text{475}
\]

\[
\text{Test N7:300} \quad \text{1000}
\]

\[
\text{High limit N7:308} \quad \text{550}
\]

---

STATUS:
Slow Movement Control (Hi Side) B3

\[
\text{Source A N7:300} \quad \text{Low limit N7:306} \quad \text{475}
\]

\[
\text{Source B N7:306} \quad \text{Test N7:300} \quad \text{1000}
\]

\[
\text{High limit N7:308} \quad \text{550}
\]
<table>
<thead>
<tr>
<th>Source A</th>
<th>Source B</th>
<th>Low limit</th>
<th>Test</th>
<th>High limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:300</td>
<td>N7:303</td>
<td>1000</td>
<td>505</td>
<td>1000</td>
</tr>
</tbody>
</table>

**STATUS:** Slow Movement Control (Lo Side) B3

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:310</td>
<td>T4:30.PRE 200</td>
</tr>
</tbody>
</table>

**STATUS:** Timer: Increase Movement Control B3

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:311</td>
<td>T4:30.PRE 200</td>
</tr>
</tbody>
</table>

**STATUS:** Timer: Increase Movement Control B3

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:312</td>
<td>T4:31.PRE 175</td>
</tr>
</tbody>
</table>

**STATUS:** Slow Movement Control (Hi Side) B3

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:310</td>
<td>T4:30.PRE 200</td>
</tr>
</tbody>
</table>

**STATUS:** Timer: Decrease Movement Control B3

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:311</td>
<td>T4:30.PRE 200</td>
</tr>
</tbody>
</table>

**STATUS:** Timer: Decrease Movement Control B3

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7:312</td>
<td>T4:31.PRE 175</td>
</tr>
</tbody>
</table>
Program Listing Report

Rung 11:16

STATUS: 
Slow Movement Control (Lo Side) 

B3 

177

Rung 11:17

Timer: 
Decrease Launder Level from No.7 Furnace T4:30

++--] [----+

DN

Timer: 
Decrease Level Control Off T4:29

++--] [----+

TT

Rung 11:18

If the Level is above the Setpoint Deadband Upper Limit, the Furnace Tap Plug is controlled to reduce the flow of metal. This controlling is done using the "on" time of this timer. To alter this change the preset value in this timer.

STATUS: 
Automatic Level Scaled Control Engage B3 

+GEQ------------------------ T4:29 T4:30 T4:31

184 Source A N7:300 TT DN TT

Source B N7:306 475

------------------------

+------------------------

+------------------------
Timer: Increase
Launder
Level from No. 7 Fnce

TON-------------+

TIMER ON DELAY +- (EN) -+

Timer T4:31
Time base 0.01+- (DN)
Preset 175
Accum 0

---

Rung 11:19
This rung is used to Increase the flow of metal when the Launder Level is less than the Setpoint Lower Deadband Limit.

To alter this change the preset value of this timer.

STATUS: Launder Timer: Increase Decrease
Automatic Level Increase Decrease
Level Scaled Level Launder Launder
Control Input Control Level from Level from
Engage Value Off No. 7 Fnce No. 7 Fnce

B3 +LEQ-------------+ T4:32 T4:31 T4:30
---] [LESS THAN OR EQUAL+-] /[-------]/[-------]/[-------]/[-------]

184 Source A N7:300 TT DN TT
Source B N7:303 1000
505

+------------------+
Program Listing Report

Timer:
Increase
Launder
Level from
No. 7 Rinse

T4:31

+--] [-----+
DN

Timer:
Increase
Level
Control
Off

T4:32

++--] [-----+
TT

Rung 11:20

Rung 11:21

--------- [END OF FILE] ---------
Program Listing Report

Rung 12:0
Input: Sensor at Ingot Mold
       Leading Edge
I:003 B3

---] [--- [ONS] ---] [--- [ONS] ---]
   06 178

Rung 12:1
Input: Sensor at Ingot Mold
       Centre
I:003 B3

---] [--- [ONS] ---] [--- [ONS] ---]
   05 179

STATUS: Ingot
        Mould
        Edge
        Height
        Buffer
+MOV-+MOVE+
Source N7:107 4080
Destination N7:340 4046

Difference between Ingot & Mould Buffer
+SUB+
++SUBTRACT++
Source A N7:340 4046
Source B N7:341 3751
Destination N7:342 295
Program Listing Report

Rung 12:2

This rung is used to "stack" the number of values from the Ingot Sensor. To modify the reaction time of the system, alter the "length" within the Control Word of this FIFO, via the data table.

---

<table>
<thead>
<tr>
<th>Control</th>
<th>Ingot</th>
<th>Height</th>
<th>Control</th>
<th>FIFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status:</td>
<td>Oneshot</td>
<td>Height</td>
<td>Status:</td>
<td>FIFO</td>
</tr>
<tr>
<td>B3</td>
<td>Oneshot</td>
<td>Height</td>
<td>Control</td>
<td>FIFO</td>
</tr>
<tr>
<td></td>
<td>Ingot</td>
<td>Height</td>
<td>Load</td>
<td>FIFO</td>
</tr>
<tr>
<td>179</td>
<td>Ingot</td>
<td>Height</td>
<td>Load</td>
<td>FIFO</td>
</tr>
</tbody>
</table>

---

Rung 12:3

Control: Ingot Height Averaging FIFO

Control: Ingot Height Averaging FIFO Len.

---

Source A R6:0.POS 1
| Source A R6:0.LEN 3
| Source B 1
| Destination N7:365 277

---

Source A R6:0.POS 1
| Source A R6:0.LEN 3
| Source B 1
| Destination N7:365 277

---

Source A R6:0.POS 1
| Source A R6:0.LEN 3
| Source B 1
| Destination N7:365 277

---

Source A R6:0.POS 1
| Source A R6:0.LEN 3
| Source B 1
| Destination N7:365 277

---

Source A R6:0.POS 1
| Source A R6:0.LEN 3
| Source B 1
| Destination N7:365 277
This rung is used to average the ingot depths, this is stored for use to determine whether there is to be a resulting action from the Weir to increase or decrease the flow of aluminium into the Tundish.

<table>
<thead>
<tr>
<th>Control:</th>
<th>Control:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingot</td>
<td>Ingot</td>
</tr>
<tr>
<td>Height</td>
<td>Height</td>
</tr>
<tr>
<td>Averaging</td>
<td>Averaging</td>
</tr>
<tr>
<td>FIFO</td>
<td>FIFO Len.</td>
</tr>
</tbody>
</table>

+---+---+-+  +---+---+-+  +---+---+-+  +---+---+-+  
| +EQU-+---+-+  +EQU-+---+-+  +ADD-+---+-+  +ADD-+---+-+  
| +EQUAL +---+-+  +EQUAL +---+-+  +-+DIV-+---+-+  ++DIVIDE+---+-+  
| Source A R6:0.POS | Source A R6:0.LEN | Source A N7:350 | 295 |
| 1                 | 3                 | Source B N7:351 | 228 |
| Source B          | Source B          | Destination N7:360 | 523 |
| 2                 | 2                 |                  |     |

+---+---+-+  +---+---+-+  +---+---+-+  +---+---+-+  
| +ADD-+---+-+  +ADD-+---+-+  +DIV-+---+-+  ++DIVIDE+---+-+  
| Source A N7:360 | 523 |
| Source B 2     | 2 |
| Destination N7:365 | 277 |
This rung is used to average the ingot depths, this is stored for use to determine whether there is to be a resulting action from the Weir to increase or decrease the flow of aluminium into the Tundish.

<table>
<thead>
<tr>
<th>Ingot Height</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer 1</td>
<td></td>
</tr>
<tr>
<td>Source A N7:350</td>
<td>295</td>
</tr>
<tr>
<td>Source B N7:351</td>
<td>228</td>
</tr>
<tr>
<td>Destination N7:360</td>
<td>523</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ingot Height</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer 2</td>
<td></td>
</tr>
<tr>
<td>Source A N7:360</td>
<td>523</td>
</tr>
<tr>
<td>Source B N7:352</td>
<td>308</td>
</tr>
<tr>
<td>Destination N7:361</td>
<td>831</td>
</tr>
</tbody>
</table>

Control:
Averaged Ingot Height

| Source A N7:361 | 831 |
| Source B 3     |     |
| Destination N7:365 | 277 |
Rung 12:6
This rung is used to reset the FIFO after the stack is filled.

Control:
- Ingot
- Height
- Averaging
- FIFO Len.

```
+EQU
+EQUAL
Source A R6:0.LEN 3
Source B R6:0.POS 1
```

Rung 12:7
The following rungs are used to control the Deadband and Control Limits used by the Ingot Height Control system. To alter the Ingot height, modify the current value located within the Data File; N7:400.

```
Ingot Height S/point Hi Side Deadband
+ADD
ADD
Source A N7:400 170
Source B N7:401 -30
Destination N7:402 140
```

Rung 12:8
Ingot Height Lo S/point Deadband Control
+SUB-------------------+
+SUBTRACT +
Source A N7:400 170
Source B N7:405 -30
Destination N7:406 200

Ingot Height Long/Short Pulse Lo Limit
+SUB-------------------+
+SUBTRACT +
Source A N7:406 200
Source B N7:407 -30
Destination N7:408 230

Control: Control:
Averaged Averaged
Ingot Ingot
Height Height
+LES-------------------+ +LIM-------------------+
+LESS THAN +LIMIT TEST (CIRC) +
Source A N7:365 277 140
Source B N7:402 140 277
Low limit N7:402 140
Test N7:365 277
High limit N7:404 110

STATUS: Lower Weir Short Pulse Control B3
180
Program Listing Report

Rung 12:12

<table>
<thead>
<tr>
<th>Control:</th>
<th>Averaged</th>
<th>Ingot</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATUS:</td>
<td>Auto Ingot</td>
<td>Height</td>
<td>Control</td>
</tr>
<tr>
<td>LOWER WEIR</td>
<td>B3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+LES---------------------+
+LESS THAN
Source A N7:365 277
Source B N7:402 140

Rung 12:13

<table>
<thead>
<tr>
<th>Control:</th>
<th>Averaged</th>
<th>Ingot</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATUS:</td>
<td>Raise Weir</td>
<td>Short</td>
<td>Pulse</td>
</tr>
<tr>
<td>Control</td>
<td>B3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+GRT---------------------+
+GREATER THAN
Source A N7:365 277
Source B N7:406 200

Rung 12:14

<table>
<thead>
<tr>
<th>Control:</th>
<th>Averaged</th>
<th>Ingot</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATUS:</td>
<td>Auto Ingot</td>
<td>Height</td>
<td>Control</td>
</tr>
<tr>
<td>RAISE WEIR \ CONTROL</td>
<td>B3</td>
<td></td>
<td></td>
</tr>
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+GRT---------------------+
+GREATER THAN
Source A N7:365 277
Source B N7:406 200

Rung 12:15

<table>
<thead>
<tr>
<th>STATUS:</th>
<th>Raise Weir</th>
<th>Auto Ingot</th>
<th>Short</th>
<th>Pulse</th>
<th>RAISE WEIR</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>B3</td>
<td>B3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STATUS:</th>
<th>TIMER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>Height</td>
</tr>
<tr>
<td>Control</td>
<td>Preset</td>
</tr>
</tbody>
</table>

+MOV---------------------+
+MOVE
Source N7:410 12
Destination T4:36.PRE 14
Program Listing Report

Rung 12:16

STATUS:
Raise Weir  Auto Ingot
Short  Height
Pulse  RAISE WEIR
Control  CONTROL

B3  B3

------------------------
181  183

Rung 12:17

STATUS:
Lower Weir  Auto Ingot
Short  Height
Pulse  Control
Control  LOWER WEIR

B3  B3

------------------------
180  182

Rung 12:18

STATUS:
Lower Weir  Auto Ingot
Short  Height
Pulse  Control
Control  LOWER WEIR

B3  B3

------------------------
180  182

Rung 12:19

TIMER:
Increase Height
Off Delay Control

T4:36

------------------------
DN

TIMER:
Increase Ingot Hght Level
Off Delay

T4:35

------------------------
TT
Program Listing Report  
PLC-5/15  File 06_FNC  
Rung 12:20

<table>
<thead>
<tr>
<th>Input:</th>
<th>Control:</th>
<th>Timer:</th>
<th>Timer:</th>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir</td>
<td>Averaged</td>
<td>Increase</td>
<td>Decrease</td>
<td>Decrease</td>
</tr>
<tr>
<td>Automatic</td>
<td>Ingot</td>
<td>Height</td>
<td>On Delay</td>
<td>Off Delay</td>
</tr>
<tr>
<td>Control Select. SW</td>
<td>Height</td>
<td>Off Delay</td>
<td>Control</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>Control:</th>
<th>Timer:</th>
<th>Timer:</th>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I:002</td>
<td>+GREATER THAN OR EQUAL</td>
<td>T4:35</td>
<td>T4:37</td>
<td>T4:38</td>
</tr>
<tr>
<td>12</td>
<td>Source A</td>
<td>N7:365</td>
<td>TT</td>
<td>TT</td>
</tr>
<tr>
<td>Source B</td>
<td>N7:406</td>
<td>277</td>
<td>TT</td>
<td>TT</td>
</tr>
</tbody>
</table>

**TIMER:**
Increase  
Ingot Hght  
On Delay  
Timer  
+TON-------------------------+  
+TIMER ON DELAY + (EN) +  
| Timer | T4:36  |
| Time base | 0.01+(DN)  |
| Preset | 14  |
| Accum | 0  |

**Rung 12:21**

<table>
<thead>
<tr>
<th>Input:</th>
<th>Control:</th>
<th>Timer:</th>
<th>Timer:</th>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir</td>
<td>Averaged</td>
<td>Decrease</td>
<td>Height</td>
<td>On Delay\</td>
</tr>
<tr>
<td>Automatic</td>
<td>Ingot</td>
<td>Height</td>
<td>Off Delay</td>
<td>Control</td>
</tr>
<tr>
<td>Control Select. SW</td>
<td>Height</td>
<td>Control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>Control:</th>
<th>Timer:</th>
<th>Timer:</th>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I:002</td>
<td>LESS THAN OR EQUAL</td>
<td>T4:37</td>
<td>T4:38</td>
<td>T4:42</td>
</tr>
<tr>
<td>12</td>
<td>Source A</td>
<td>N7:365</td>
<td>TT</td>
<td>TT</td>
</tr>
<tr>
<td>Source B</td>
<td>N7:406</td>
<td>277</td>
<td>TT</td>
<td>TT</td>
</tr>
</tbody>
</table>

**TIMER:**
Decrease  
Height  
On Delay  
Control  
+TON-------------------------+  
+TIMER ON DELAY + (EN) +  
| Timer | T4:37  |
| Time base | 1.0+(DN)  |
| Preset | 55  |
| Accum | 0  |

**Rung 12:22**

<table>
<thead>
<tr>
<th>Input:</th>
<th>Control:</th>
<th>Timer:</th>
<th>Timer:</th>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir</td>
<td>Averaged</td>
<td>Increase</td>
<td>Height</td>
<td>On Delay\</td>
</tr>
<tr>
<td>Automatic</td>
<td>Ingot</td>
<td>Height</td>
<td>Off Delay</td>
<td>Control</td>
</tr>
<tr>
<td>Control Select. SW</td>
<td>Height</td>
<td>Control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input:</th>
<th>Control:</th>
<th>Timer:</th>
<th>Timer:</th>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I:002</td>
<td>LESS THAN OR EQUAL</td>
<td>T4:37</td>
<td>T4:38</td>
<td>T4:42</td>
</tr>
<tr>
<td>12</td>
<td>Source A</td>
<td>N7:365</td>
<td>TT</td>
<td>TT</td>
</tr>
<tr>
<td>Source B</td>
<td>N7:406</td>
<td>277</td>
<td>TT</td>
<td>TT</td>
</tr>
</tbody>
</table>

**TIMER:**
Increase  
Ingot Hght  
On Delay  
Timer  
+TON-------------------------+  
+TIMER ON DELAY + (EN) +  
<p>| Timer | T4:36  |
| Time base | 0.01+(DN)  |
| Preset | 14  |
| Accum | 0  |</p>
<table>
<thead>
<tr>
<th>TIMER:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td></td>
</tr>
<tr>
<td>On Delay</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>TON---------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>TIMER ON DELAY</td>
<td>-(EN)</td>
</tr>
<tr>
<td>Timer</td>
<td>T4:38</td>
</tr>
<tr>
<td>Time base</td>
<td>0.01</td>
</tr>
<tr>
<td>Preset</td>
<td>12</td>
</tr>
<tr>
<td>Accum</td>
<td>0</td>
</tr>
</tbody>
</table>

Rung 12:23

-----------------------------------------------------------
| [END OF FILE] |
The maximum value for ingot height as read by the ingot sensor is 2070, the value of the actual ingot height is subtracted from it to obtain the actual ingot height. The scale of 0-2070 corresponds to 0-100%.

Citect: Averaged Ingot Height
+SUBTRACT +
| Source A      | N7:415 |
| Source B      | N7:365 |
| Destination   | N7:30  |

The ingot height obtained above the trends on Citect are too compressed, to improve this the value of 1370 is subtracted from the actual ingot height, so that the actual ingot height is now in the range of 0-700 for ingot heights of 65-100%

Citect: Ingot height as sent to Citect
+GREATER THAN +SUBTRACT +
| Source A      | N7:30  |
| Source B      | N7:34  |

Citect: UCL Upper Control Limit for Ingots
+MOVE +
| Source       | N7:36  |
| Destination  | N20:3  |
If the ingot height is less than 1400 on the 0-2070 scale it can be considered undersize, and a constant value will be displayed on Citect which is out of the control range.

The maximum value for ingot height as read by the Ingot Sensor is 2070 (on a scale of 0-4095) the value of 175 is subtracted from it to obtain the setpoint desired. A value of 1895 corresponds to an ingot height of 76mm.
Program Listing Report

PLC-5/15

File 06_6FNC

Rung 13:6

From the ingot height setpoint obtained above the trends on Citect are to be compressed, to improve this the value of 1370 is subtracted from the previous setpoint. So that the scale becomes 0-700 for ingot heights of 65% to 100% instead of 0-2070 for ingot heights of 0-100%.

<table>
<thead>
<tr>
<th>Source A</th>
<th>N7:31</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1900</td>
</tr>
<tr>
<td>Source B</td>
<td>1370</td>
</tr>
<tr>
<td>Destination</td>
<td>N20:2</td>
</tr>
<tr>
<td></td>
<td>530</td>
</tr>
</tbody>
</table>

Rung 13:7

The launder level control system setpoint can be in the range of 0-1000. The value in N7:52 is the setpoint required and is determined in the PID loop. The Destination N20:10 is the address where Citect looks for the setpoint.

<table>
<thead>
<tr>
<th>Source</th>
<th>N7:52</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Destination</td>
<td>N20:10</td>
</tr>
<tr>
<td></td>
<td>500</td>
</tr>
</tbody>
</table>

Rung 13:8

The launder level process variable (actual launder metal level) can be anywhere in the range of 0-1000. The value in the destination is the value of the launder metal level sent to Citect display.

<table>
<thead>
<tr>
<th>Source</th>
<th>N7:300</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>Destination</td>
<td>N20:11</td>
</tr>
<tr>
<td></td>
<td>1000</td>
</tr>
</tbody>
</table>
The output value sent to the proportional valve to tilt the furnace is contained in address N7:66 and is in the range of 0-100%, the value is also sent to the Citect Display.

Citect:
- Furnace
- Hydraulics
- Proportional Valve

```
+MOV-----------------------+
MOVE
Source N7:66
| 0
Destination N20:12
| 0
```

This timer is used to "Reverse" the Tap Plug movement. This is to ensure prompt stopping of the stroke when the insert action is used.

Timer:
- Decrease
- Launder
- Level from
- No. 7 Furnace

```
T4:30
```

Oneshot:
- Sensor at Ingot Mold Centre
  - B3
- 150
### Program Listing Report

#### Rung 13: 12

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIM</td>
<td>LIMIT TEST (CIRC)</td>
<td></td>
</tr>
<tr>
<td>Low limit</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>T4:20.ACC</td>
<td></td>
</tr>
<tr>
<td>High limit</td>
<td>220</td>
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#### Rung 13: 13

<table>
<thead>
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<th>Description</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
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<td>LIMIT TEST (CIRC)</td>
<td></td>
</tr>
<tr>
<td>Low limit</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>T4:20.ACC</td>
<td></td>
</tr>
<tr>
<td>High limit</td>
<td>330</td>
<td></td>
</tr>
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</table>

#### Rung 13: 14

<table>
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<th>Limits</th>
</tr>
</thead>
<tbody>
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<td>LIMIT TEST (CIRC)</td>
<td></td>
</tr>
<tr>
<td>Low limit</td>
<td>340</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>T4:20.ACC</td>
<td></td>
</tr>
<tr>
<td>High limit</td>
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</tr>
</tbody>
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#### Rung 13: 15

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<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIM</td>
<td>LIMIT TEST (CIRC)</td>
<td></td>
</tr>
<tr>
<td>Low limit</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>T4:20.ACC</td>
<td></td>
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<tr>
<td>High limit</td>
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#### Rung 13: 16

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<th>Limits</th>
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</tr>
<tr>
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</tr>
<tr>
<td>Test</td>
<td>T4:20.ACC</td>
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</tr>
<tr>
<td>High limit</td>
<td>660</td>
<td></td>
</tr>
</tbody>
</table>
Rung 13:17
Oneshot:
Sensor at
Ingot Mold
Centre
B3
---]/[-------------------( )---
150

Rung 13:18
B3
---]/[-------------------( )---
151

Rung 13:19
B3
---]/[-------------------( )---
152

Rung 13:20
B3
---]/[-------------------( )---
153

Rung 13:21
B3
---]/[-------------------( )---
154

Rung 13:22
B3
---]/[-------------------( )---
155

Rung 13:23

[END OF FILE]
Allen-Bradley Company
6200 Series Software
PLC-5 Programming Terminal Software
Release 4.4
Cross Reference Report

Processor File: 06_6FNC
Wed Nov 10, 1993 - 3:38:49 pm

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<tr>
<td>Address</td>
<td>Symbol / Instruction</td>
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<td>----------------------</td>
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<tr>
<td>-JSR- 2:0</td>
<td>Jump to Subroutine No.3</td>
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<td>Jump to Subroutine No.4</td>
</tr>
<tr>
<td>-JSR- 2:2</td>
<td>Jump to Subroutine No.5</td>
</tr>
<tr>
<td>-JSR- 2:3</td>
<td>Jump to Subroutine No.6</td>
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<tr>
<td>-JSR- 2:4</td>
<td>Jump to Subroutine No.7</td>
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<td>Jump to Subroutine No.13</td>
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**Status:**
- Ingot M/C Fault Not Accepted
- Main C/B Fault Not Accepted
- Element 0/Temp Fault Not Accepted
- Furnace Over-Temp Fault Not Accepted
- Element 1 Fault Not Accepted
- Element 2 Fault Not Accepted
- Element 3 Fault Not Accepted
- Element 4 Fault Not Accepted
- Element 5 Fault Not Accepted
- Element 6 Fault Not Accepted
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<td>[-] - 3:15</td>
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<td>3/137</td>
<td>Status: Hot Metal Door Open Request</td>
<td>[-] - 4:26</td>
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Address Symbol / Instruction Program File Number: Rung Number  

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Status: Manual Control Selected Aux. Relay  

3/143 -]/[- 8:9  
-()- 8:8  

Spare bit on the side  

3/150 -]/[- 13:17  
-()- 13:11  

Oneshot: Sensor at Ingot Mold Centre  

3/151 -]/[- 13:18  
-()- 13:12  

3/152 -]/[- 13:19  
-()- 13:13  

3/153 -]/[- 13:20  
-()- 13:14  

3/154 -]/[- 13:21  
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3/155 -]/[- 13:22  
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STATUS: Slow Movement Control (Lo Side)  

3/160 -()- 13:17  
3/161 -()- 13:18  
3/162 -()- 13:19  
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STATUS: Slow Movement Control (Hi Side)  

3/176 -] 11:13  
-] [ ] 11:14  
-() 11:11  

STATUS: Slow Movement Control (Lo Side)  

3/177 -] 11:15  
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STATUS: Oneshot At Leading Edge of Mold  

3/178 -ONS- 12:0  
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STATUS: Oneshot Sensor at Centre of Mold
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<td>Input: Element No.10, not Tripped</td>
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<td>MOV 8:6</td>
<td>Launder Level PID Control block</td>
</tr>
<tr>
<td>7:5</td>
<td>PID 8:7</td>
<td>Launder Level PID Control block</td>
</tr>
<tr>
<td>7:10</td>
<td>MOV 8:9 8:10</td>
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</tr>
<tr>
<td></td>
<td>PID 8:7</td>
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<tr>
<td>7:20</td>
<td>MVM 6:89</td>
<td>Alarm Buffer Word No.1</td>
</tr>
<tr>
<td>7:21</td>
<td>NEQ 6:91</td>
<td>Alarm Buffer Word No.2</td>
</tr>
<tr>
<td>7:22</td>
<td>MVM 6:89</td>
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<tr>
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<td>NEQ 6:91</td>
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### Address | Symbol / Instruction | Comment / Program File Number: Rung Number
---|---|---
7:23 | -MVM- 6:90 -NEQ- 6:91 | Alarm Buffer Word No.4
7:24 | -MVM- 6:90 -NEQ- 6:91 | Alarm Buffer Word No.5
7:25 | -MVM- 6:90 -NEQ- 6:91 | Alarm Buffer Word No.6
7:31 | -SUB- 13:5 13:6 | Ingot Height Control Setpoint
7:34 | -GRT- 13:1 | 
7:35 | -LES- 13:4 | 
7:36 | -MOV- 13:2 | Ingot Height Upper Control Limit
7:37 | -MOV- 13:3 | Ingot Height Lower Control Limit
7:39 | -MOV- 8:9 | 
7:40 | -MOV- 13:4 | 
7:50 | -PID- 8:7 | 
7:50/15 | - (U) - 8:7 | 
7:66 | -MOV- 13:9 | 
7:100 | -BTR- 7:0 | 
7:104 | -DIV- 11:6 -MOV- 8:6 | 
7:105 | -MOV- 8:5 | 
7:106 | -MOV- 3:4 | 
7:107 | -MOV- 12:0 12:1 | 
7:150 | -BTW- 7:1 | 

Launder Level PID Control block

PID Control Enabled Bit
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<th>Symbol / Instruction</th>
<th>Comment / Program File Number:Rung Number</th>
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<td>7:200</td>
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<tr>
<td>7:250</td>
<td>-BTW- 7:3</td>
<td>MOVE DATA TO DISPLAY</td>
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<tr>
<td>7:251</td>
<td>-MOV- 8:5 8:10</td>
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<tr>
<td>7:300</td>
<td>-DIV- 11:6</td>
<td>Launder Level Scaled Input Value</td>
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<tr>
<td></td>
<td>-GEQ- 11:18</td>
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<td>-GRT- 11:5 11:11</td>
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<td>-LEQ- 11:19</td>
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<td>-LES- 11:5 11:12</td>
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<td></td>
<td>-LIM- 11:11 11:12</td>
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<td>-MOV- 13:8</td>
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<tr>
<td>7:301</td>
<td>-LIM- 11:12</td>
<td>Launder Level Lower Control Limit</td>
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<td>-SUB- 11:10</td>
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<td>7:302</td>
<td>-SUB- 11:10</td>
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<td>7:303</td>
<td>-LEQ- 11:19</td>
<td>Launder Level Deadband Lower Limit</td>
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<td>-LES- 11:12</td>
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<td>-LIM- 11:12</td>
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<td>-SUB- 11:9 11:10</td>
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<td>7:304</td>
<td>-SUB- 11:9</td>
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<td>7:305</td>
<td>-ADD- 11:8</td>
<td>Launder Level Deadband Upper Limit</td>
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<td>7:306</td>
<td>-ADD- 11:7 11:8</td>
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<td>-GEQ- 11:18</td>
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<td>-GRT- 11:11</td>
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<td>-LIM- 11:11</td>
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<td>7:307</td>
<td>-ADD- 11:7</td>
<td>Launder Level Upper Control Limit</td>
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<td>7:308</td>
<td>-ADD- 11:7</td>
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<td>-LIM- 11:11</td>
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<td>7:310</td>
<td>-MOV- 11:13</td>
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<td>7:311</td>
<td>-MOV- 11:14</td>
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<td>7:312</td>
<td>-MOV- 11:15</td>
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<td>7:313</td>
<td>-MOV- 11:16</td>
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<td>7:320</td>
<td>-GRT- 11:5</td>
<td>Auto Level Control High Limit Cut Out Buffer</td>
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<tr>
<td>Address</td>
<td>Symbol / Instruction</td>
<td>Comment / Program File Number: Rung Number</td>
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<tr>
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<td>7:321</td>
<td>-LES-</td>
<td>Auto Level Control Low Limit Cut Out Buffer</td>
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<tr>
<td>7:340</td>
<td>-MOV-</td>
<td>Ingot Mould Edge Height Buffer</td>
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<td>-SUB-</td>
<td>Ingot Height in Mould Buffer</td>
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<tr>
<td>7:342</td>
<td>-FPL-</td>
<td>Difference between Ingot &amp; Mould Buffer</td>
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<td>-SUB-</td>
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<td>7:350</td>
<td>-ADD-</td>
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<tr>
<td>7:351</td>
<td>-ADD-</td>
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<tr>
<td>7:352</td>
<td>-ADD-</td>
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<td>7:360</td>
<td>-ADD-</td>
<td>Ingot Height Result Buffer 1</td>
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<td>-DIV-</td>
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<td>7:361</td>
<td>-ADD-</td>
<td>Ingot Height Result Buffer 2</td>
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<td>-DIV-</td>
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<td>7:365</td>
<td>-DIV-</td>
<td>Control: Averaged Ingot Height</td>
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<tr>
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<td>-GEQ-</td>
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<tr>
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<td>-LEQ-</td>
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<td>-LES-</td>
<td></td>
</tr>
<tr>
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<td>-LIM-</td>
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<td>-MOV-</td>
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<td>-SUB-</td>
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<td>7:400</td>
<td>-ADD-</td>
<td>Ingot Height Setpoint Control Buffer</td>
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<td>-SUB-</td>
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<td>7:401</td>
<td>-ADD-</td>
<td>Ingot Height S/point DB Hi Adjust Buffer</td>
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<td>-ADD-</td>
<td>Ingot Height S/point Hi Side Deadband</td>
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<td>7:402</td>
<td>-ADD-</td>
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<tr>
<td></td>
<td>-LEQ-</td>
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</tr>
<tr>
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<td>-LES-</td>
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<td>-LIM-</td>
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<tr>
<td>7:403</td>
<td>-ADD-</td>
<td>Ingot Height Slow/Fast Hi Adjust Buffer</td>
</tr>
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<td></td>
<td>-ADD-</td>
<td>Ingot Height Long/Short Pulse Hi Limit</td>
</tr>
</tbody>
</table>
### Ingot Height S/point DB Lo Adjust Buffer
- **Address**: 7:405
- **Symbol/Instruction**: -SUB-
- **Instruction Program File Number**: 12:9
- **Rung Number**: 7:405
- **Comment**: Ingot Height S/point DB Lo Adjust Buffer

### Ingot Height Lo S/point Deadband Control
- **Address**: 7:406
- **Symbol/Instruction**: -GEQ-, -GRT-, -LIM-, -SUB-
- **Instruction Program File Number**: 12:20 12:13 12:14 12:12 12:10
- **Rung Number**: 7:406
- **Comment**: Ingot Height Lo S/point Deadband Control

### Ingot Height Slow/Fast Lo Adjust Buffer
- **Address**: 7:407
- **Symbol/Instruction**: -SUB-
- **Instruction Program File Number**: 12:10
- **Rung Number**: 7:407
- **Comment**: Ingot Height Slow/Fast Lo Adjust Buffer

### Ingot Height Long/Short Pulse Lo Limit
- **Address**: 7:408
- **Symbol/Instruction**: -LIM-, -SUB-
- **Instruction Program File Number**: 12:13 12:10
- **Rung Number**: 7:408
- **Comment**: Ingot Height Long/Short Pulse Lo Limit

### Ingot Hght Slow Control Preset (Hi side)
- **Address**: 7:410
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 12:15
- **Rung Number**: 7:410
- **Comment**: Ingot Hght Slow Control Preset (Hi side)

### Ingot Hght Fast Control Preset (Hi Side)
- **Address**: 7:411
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 12:16
- **Rung Number**: 7:411
- **Comment**: Ingot Hght Fast Control Preset (Hi Side)

### Ingot Hght Slow Control Preset (Lo Side)
- **Address**: 7:412
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 12:17
- **Rung Number**: 7:412
- **Comment**: Ingot Hght Slow Control Preset (Lo Side)

### Ingot Hght Fast Control Preset (Lo Side)
- **Address**: 7:413
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 12:18
- **Rung Number**: 7:413
- **Comment**: Ingot Hght Fast Control Preset (Lo Side)

### Elk Trans. Read Instruct. for Analog In Module
- **Address**: 7:415
- **Symbol/Instruction**: -SUB-
- **Instruction Program File Number**: 13:0 13:5
- **Rung Number**: 7:415
- **Comment**: Elk Trans. Read Instruct. for Analog In Module

### BTR ANA. INPUT RACK 0 MOD.0 ENABLED
- **Address**: 9:0
- **Symbol/Instruction**: -BTR-
- **Instruction Program File Number**: 7:0
- **Rung Number**: 9:0
- **Comment**: BTR ANA. INPUT RACK 0 MOD.0 ENABLED

### Blk Trans. Write To Analog Input Mod.
- **Address**: 9:0/15
- **Symbol/Instruction**: -]/[-
- **Instruction Program File Number**: 7:0 7:1
- **Rung Number**: 9:0/15
- **Comment**: Blk Trans. Write To Analog Input Mod.

### BTW ANA. INPUT RACK 0 MOD.0 ENABLED
- **Address**: 9:50
- **Symbol/Instruction**: -BTW-
- **Instruction Program File Number**: 7:1
- **Rung Number**: 9:50
- **Comment**: BTW ANA. INPUT RACK 0 MOD.0 ENABLED

### Blk Trans. Read for Analog Output Module
- **Address**: 9:100
- **Symbol/Instruction**: -BTR-
- **Instruction Program File Number**: 7:2
- **Rung Number**: 9:100
- **Comment**: Blk Trans. Read for Analog Output Module

### BTR ANA.OUTPUT RACK 0 MOD. 1 ENABLED
- **Address**: 9:100/15
- **Symbol/Instruction**: -]/[-
- **Instruction Program File Number**: 7:2 7:3
- **Rung Number**: 9:100/15
- **Comment**: BTR ANA.OUTPUT RACK 0 MOD. 1 ENABLED

### Blk Trans. Write to Analog Output Module
- **Address**: 9:150
- **Symbol/Instruction**: -BTW-
- **Instruction Program File Number**: 7:3
- **Rung Number**: 9:150
- **Comment**: Blk Trans. Write to Analog Output Module

### BTW ANA.OUTPUT RACK 0 MOD.1 ENABLED
- **Address**: 9:150/15
- **Symbol/Instruction**: -]/[-
- **Instruction Program File Number**: 7:2 7:3
- **Rung Number**: 9:150/15
- **Comment**: BTW ANA.OUTPUT RACK 0 MOD.1 ENABLED

### Ingot height as sent to Citect
- **Address**: 0:1
- **Symbol/Instruction**: -MOV-, -SUB-
- **Instruction Program File Number**: 13:4 13:1
- **Rung Number**: 0:1
- **Comment**: Ingot height as sent to Citect

### Ingot Height Setpoint as sent to Citect
- **Address**: 0:2
- **Symbol/Instruction**: -SUB-
- **Instruction Program File Number**: 13:6
- **Rung Number**: 0:2
- **Comment**: Ingot Height Setpoint as sent to Citect

### Citect:UCL Upper Control Limit for Ingots
- **Address**: 0:3
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 13:2
- **Rung Number**: 0:3
- **Comment**: Citect:UCL Upper Control Limit for Ingots

### Citect:LCL Lower Control Limit for Ingots
- **Address**: 0:4
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 13:3
- **Rung Number**: 0:4
- **Comment**: Citect:LCL Lower Control Limit for Ingots

### Citect: Launder Level Setpoint
- **Address**: 0:10
- **Symbol/Instruction**: -MOV-
- **Instruction Program File Number**: 13:7
- **Rung Number**: 0:10
- **Comment**: Citect: Launder Level Setpoint
20:11  -MOV-  13:8  
20:12  -MOV-  13:9  
:005/00  -()-  10:2  
:005/01  -()-  10:0  
:005/02  -()-  10:1  
:005/03  -()-  10:5  
:005/05  -[]-[[-  11:1  
:005/06  -()-  11:1  
:005/07  -()-  11:3  
:005/14  -[]-[-  11:3  
:020/00  -()-  3:2  
:020/01  -()-  3:1  
:020/05  -()-  3:9  
:020/10  -()-  3:8  
:020/11  -[]-[[-  4:3  
:020/13  -()-  4:1  
:020/14  -[]-[[-  8:8  
:020/16  -()-  4:15  
:020/17  -()-  3:22  

Citect: Launder Level PV Value
Citect: Furnace Hydraulics Prootional Valve
Launder Level in Automatic Control Indicator
Output: Max. Level In Launder Indicator
Output: Min. Level In Launder Indicator
Output: Variable Speed Drive Fault
Output: Tap Plug IN Actuator
Output: Tap Plug IN Indicator
Output: Tap Plug OUT Indicator
Output: Tap Plug OUT Actuator
Output: System Off Indication Lamp
Output: System On Indication Lamp
Output: Furnace Elements Contactor
Output: Element O/Current Indication Lamp
Output: Hydraulic Motor Contactor
Output: Furnace Raise Solenoid
Output: Furnace Raise Lamp At No.1 Ingot M/C
Output: Furnace Lower Lamp At No.1 Ingot M/C
Output: Fast Tilt Speed Dump Solenoid
Output: Fast Tilt Lamp At No.1 Ingot M/C
Output: Slow Tilt Speed Dump Solenoid

Output: Slow Tilt Lamp At No.2 Ingot M/C

Output: Furnace Hold Lamp At No.1 Ingot M/C

Output: Fast Tilt Solenoid

Output: Main Door Open Solenoid

Output: Main Door Close Solenoid

Output: Hot Metal Door Open Solenoid

Output: Hot Metal Door Close Solenoid

Output: Pour Spout Door Open Solenoid

Output: Pour Spout Door Close Solenoid

Output: Small Door Open Solenoid

Output: Small Door Close Solenoid

Output: Alarm Horn

Output: SCR Control Relay

Output: Crucible Tilt Up Solenoid

Output: Furnace Auto Air Bleed Valve

Output: Element 1 O/C Alarm Indication Lamp

Output: Element 2 O/C Alarm Indication Lamp

Output: Element 3 O/C Alarm Indication Lamp

Output: Element 4 O/C Alarm Indication Lamp

Output: Element 5 O/C Alarm Indication Lamp

Output: Element 6 O/C Alarm Indication Lamp

Output: Element 7 O/C Alarm Indication Lamp
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<tr>
<th>Address</th>
<th>Symbol / Instruction</th>
<th>Comment / Program File Number: Rung Number</th>
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<td>022/07</td>
<td>-() -</td>
<td>Output: Element 8 O/C Alarm Indication Lamp</td>
</tr>
<tr>
<td>022/10</td>
<td>-() -</td>
<td>Output: Element 9 O/C Alarm Indication Lamp</td>
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<tr>
<td>022/11</td>
<td>-() -</td>
<td>Output: Element 10 O/C Alarm Indication Lamp</td>
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<tr>
<td>022/12</td>
<td>-() -</td>
<td>Output: Element 11 O/C Alarm Indication Lamp</td>
</tr>
<tr>
<td>022/13</td>
<td>-() -</td>
<td>Output: Element 12 O/C Alarm Indication Lamp</td>
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<tr>
<td>022/14</td>
<td>-() -</td>
<td>Output: Element 13 O/C Alarm Indication Lamp</td>
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<tr>
<td>022/15</td>
<td>-() -</td>
<td>Output: Element 14 O/C Alarm Indication Lamp</td>
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<tr>
<td>022/16</td>
<td>-() -</td>
<td>Output: Element 15 O/C Alarm Indication Lamp</td>
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<tr>
<td>022/17</td>
<td>-() -</td>
<td>Output: Hydraulics O/C Alarm Indication Lamp</td>
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<tr>
<td>023/00</td>
<td>-() -</td>
<td>Output: Hyd. Oil Low Level Indication Lamp</td>
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<tr>
<td>023/01</td>
<td>-() -</td>
<td>Output: Hyd. Oil Low Press. Indication Lamp</td>
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<tr>
<td>023/02</td>
<td>-() -</td>
<td>Output: Hyd. Oil O/Temp. Indication Lamp</td>
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<tr>
<td>023/03</td>
<td>-() -</td>
<td>Output: Fast Speed Filt. Low Flow Indication</td>
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<td>023/04</td>
<td>-() -</td>
<td>Output: Slow Speed Filt. Low Flow Indication</td>
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<tr>
<td>023/06</td>
<td>-() -</td>
<td>Output: MD Lintel Low Flow Indication Lamp</td>
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<tr>
<td>023/07</td>
<td>-() -</td>
<td>Output: MD Lintel O/Temp Indication Lamp</td>
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<td>023/10</td>
<td>-() -</td>
<td>Output: P.L.C. Failure Indication Lamp</td>
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<tr>
<td>023/11</td>
<td>-() -</td>
<td>Output: Ingot M/C Fault Indication lamp</td>
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<td>023/12</td>
<td>-() -</td>
<td>Output: Element O/Temp Indication</td>
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<tr>
<td>023/13</td>
<td>-() -</td>
<td>Output: Furnace Over-Temp Indication Lamp</td>
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<tr>
<td>023/14</td>
<td>-() -</td>
<td>Output: Main Door Open Indication Lamp</td>
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<tr>
<td>023/15</td>
<td>-() -</td>
<td>Output: Hot Metal Door Indication Lamp</td>
</tr>
<tr>
<td>023/16</td>
<td>-() -</td>
<td>Output: Main C/B Tripped Indication Lamp</td>
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<tr>
<td>023/17</td>
<td>-() -</td>
<td>Output: Cruc. Tilt Table Up Lamp</td>
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<td>-() -</td>
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<td>0:024/00</td>
<td>-( )- 6:84</td>
<td>Output: SCR Blown Fuse Mimic</td>
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<tr>
<td>0:025/00</td>
<td>-( )- 3:11</td>
<td>Output: SCR Blown Fuse Indication Lamp</td>
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<td>0:025/01</td>
<td>-( )- 3:34</td>
<td>Output: Main Door Open Mimic Indication Lamp</td>
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<td>0:025/02</td>
<td>-( )- 5:0</td>
<td>Output: Metal door Open Datataker Relay</td>
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<td>-( )- 5:1</td>
<td>Output: Hot Metal Door Open Datataker Relay</td>
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<td>0:025/04</td>
<td>-( )- 3:14</td>
<td>Output: Select No.2 M/C Tilt Relay</td>
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<td>0:025/05</td>
<td>-( )- 3:31</td>
<td>Output: Furnace Lower Lamp At No.2 Ingot M/C</td>
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<tr>
<td>0:025/06</td>
<td>-( )- 3:27</td>
<td>Output: Furnace Fast Tilt At No.2 Ingot M/C</td>
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<tr>
<td>0:025/07</td>
<td>-( )- 3:28</td>
<td>Output: Furnace Slow Tilt At No.2 Ingot M/C</td>
</tr>
<tr>
<td>0:025/08</td>
<td>-( )- 3:32</td>
<td>Output: Furnace Hold Lamp At No.2 Ingot M/C</td>
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<tr>
<td>0:025/09</td>
<td>-( )- 3:29</td>
<td>Output: Furnace Raise Lamp At No.2 Ingot M/C</td>
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<tr>
<td>0:025/10</td>
<td>-( )- 4:31</td>
<td>Output: Crucible Tilt Down Solenoid</td>
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<tr>
<td>0:025/11</td>
<td>-( )- 4:32</td>
<td>Output: Bail Arm Lock Solenoid</td>
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<td>0:025/12</td>
<td>-( )- 10:6</td>
<td>Output: Weir Speed Slow</td>
</tr>
<tr>
<td>0:026/00</td>
<td>-( )- 10:7</td>
<td>Output: Weir Speed Fast</td>
</tr>
<tr>
<td>0:026/01</td>
<td>-( )- 10:8</td>
<td>Output: Weir Raise/ Lower</td>
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<td>-( )- 10:4</td>
<td>Output: Variable Speed Drive Stop</td>
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<td>-( )- 10:5</td>
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<td>Control: Ingot Height Control FIFO</td>
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INT COMPLETE.
Press a function key