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# Upgradation of ECS of IR Track SGB Grinding Machine with Mitsubishi QPLC and Servo System

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**ABSTRACT:** The paper discusses the upgradation of Electronic Control System (ECS) of Inner Track (IR) bearing grinding machine with Mitsubishi PLC and servo system. The main objective is to reduce the down time of the machine, to improve the quality of the bearing, to reduce the cost of maintenance of the grinding machine. Grinding is used to finish work piece. As the accuracy in dimension in grinding is of the order of 0.25mm,in most application it tends to be a finishing operation and removes comparatively little metal ,about 0.25 to 0.50 mm depth. However, there are some roughing applications in which grinding removes high volumes of metal quite rapidly. Thus grinding is a diverse field. Down time is the one of the most important thing for any company. Downtime rise may be due to technical failure, machine adjustment, maintenance or non-availability of inputs such as materials, labour power. Average downtime is usually built into the price of goods produced, to recover its cost from the sales revenue. The aim of our system is to reduce the down time of the grinding machine i.e. to increase the productivity of bearings. Apart from down time, our objective is to improve the quality of the bearings. Quality defines the speed, precision and efficiency of bearings. Reduction of the cost of maintenance of the machine is also our prime objective. We meet our objective with the help of Mitsubishi PLC (Programmable Logic Controller) and Servo System.

**KEYWORDS:** Grinding Cycle, Mitsubishi PLC, Servo system, Down time.

## I.INTRODUCTION

This system is based on the up gradation of a grinding machine that carries out process of bore grinding on an inner ring of a bearing. This bearing consist of three basic component mainly inner ring, outer ring and tapper rollers. The need of any process holder is to satisfy the market requirements which are increasing day-by-day. To meet such requirements, it becomes tedious task for the maintenance department to keep the machines intact without affecting much production time. Considering the fact that the machines having older designs need more maintenance it is difficult to meet market requirements .Hence the machines need up gradation in order to improve production speed, quality of the product and to reduce maintenance time and cost. To achieve these goals one possible solution is to implement the current system using PLC which would make the current system

1. More efficient and reliable.
2. Improve flexibility of system and quality of the product.
3. Match the current production speed as maintenance time is required.

Today in this fast alarming we are living in the era which sounds for modern science and technology so to cope up with this hi-tech society necessity of up gradation arises. Ever more demanding more manufacturing system, new forms of communication and the need to integrate new technologies are pushing the performance limit of conventional PLC system.

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## II.LITERATURE SURVEY

Initially we studied about the machine cycle of the system. We came across, "Gain Scheduling Controller for Tool and Cutter Grinding Machine And its Comparison with Fixed Gain Control" published in IJIEEE. Before upgradation the system used stepper motor and MTC (Machine Tool Controller) as its controlling element. There are various disadvantages of MTC and stepper motor like once motor is not controlled well, it can easily cause resonance vibration. Also accuracy is less of stepper motor. Due to stepper motor it difficult to run the machine at higher speed. The parts of MTC are also outdated. The size of the MTC panel is too large. Fault detection is also difficult in MTC. Servo motor is able to overcome this disadvantages of stepper motor. Also with the help of Mitsubishi controller we can overcome the difficulties faced by MTC. Hence we are replacing our system with servo motor and Mitsubishi PLC.

## III.BLOCK DIAGRAM

The block diagram below gives the idea of the upgraded system. Proximity sensor detects the inner ring which comers through shaft. This information is given to PLC and according to the set program output signal is given to motor from PLC and hence motor id driven. There are various digital input given to Mitsubishi PLC from proximity sensors (inductive and capacitive). The digital outputs of the PLC are given to various motors which drive grinding wheel, dressing wheel. High frequency drive is used for driving grinding spindle. The block diagram of the upgraded system is as shown in figure 1.

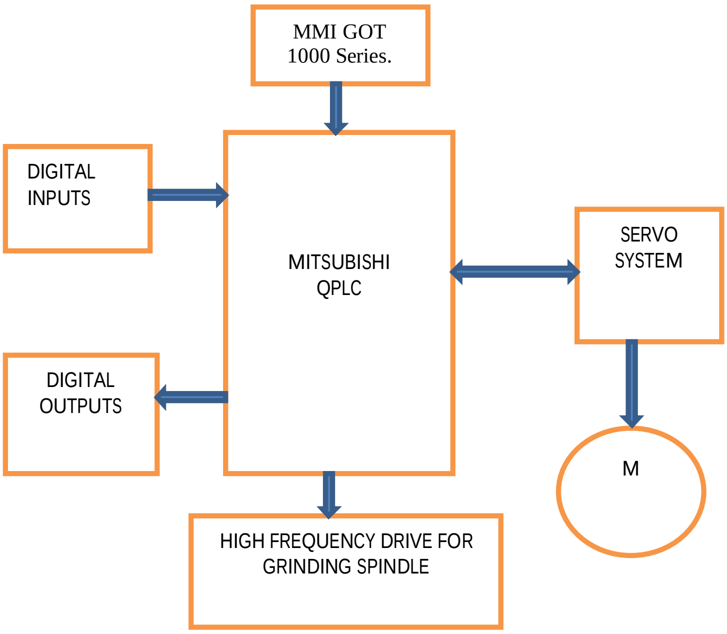


Fig. 1 Block Diagram of the system.

1) **MMI GOT Series**: Man machine interfaces are panels mounted devices that provide effective dialogue between the operator and machine .Equipped with programmable display and keys, MMI allows easy operation and monitoring in the production area. MMIs display operational and fault messages enable a machine specific parameters to be monitored and modified in suitable formats. MMI keeps the operator fully informed of the current status of operations of all times.

GOT1000 MMI can be directly connected to the MITSUBHISHI PLC via serial interface resulting in easy and quick installation. It also replaces the conventional push button panel and related wiring. MITSUBHISHI has introduces this series of touch screen terminals for effective communication between operator with machine.

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2) **DIGITAL INUTS**: There are various digital inputs like output from float sensors, inductive proximity switch, push button, selector switch.

3) **DIGITAL OUTPUTS:** Digital output to the Grinding wheel, Dressing wheel, servo motor.

4) **MITSUBISHI Q01 PLC**: It is the heart of the system. It controls the overall operations of the system. MITSUBISHI is a manufactures of world class PLC's indigenously. Use of PLC's are stressed for the following reasons:

1. Service availability is excellence
2. Maintenance required is less.
3. Spare part cost is less and readily available.

5) **SERVO SYSTEM:** A servo amplifier reads position data directly to perform operation. Data from a command unit (like a positioning module) is given to the servo amplifier which then controls the speed and rotation direction of servo motor and executes precision positioning. Also conveys the data back from the motor to the corresponding module.MR-J2S-100B is a general purpose servo amplifier with analog input and pulse train interface as a standard.

The output stage of all servo amplifiers is an analog circuit. The analog circuit provides a means to allow the voltage and current for the motor to be adjusted to control position, velocity and torque. The feedback and comparator stages can be any mixture of digital and analog devices. For example, if the feedback section uses a resolver, the output of this device is analog, so the section it works with is generally also analog. If the feedback device is an encoder, its output is digital, and the digital signal can be converted through a frequency-to-voltage converter so that the signal is usable in an analog circuit. Or it can be filtered and can use a digital value. The advent of microprocessors has allowed the digital values to be used through every part of the servo controller except the final output stage.

## IV.PLC (PROGRAMMABLE LOGIC CONTROLLER)

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of industrial processes, such as control of machinery on factory assembly lines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. The programmable logic controller (PLC) is a solid state equipment, basically designed to perform logical decision making for industrial control applications. The PLC is microprocessor based specialized computer that carries out functions of many types and levels of complexity. The use of PLC is related to process control and automation. Automation is basically the delegation of human control functions to technical equipment aimed towards achieving.

1. Higher productivity.
2. Superior quality of end product.
3. Efficient use of energy and raw material.
4. Improved safety in working condition.

When the first electronic machine controls were designed, they used relays to control the machine logic. A basic machine might need a wall covered in relays to control all of its functions. There are a few limitations to this type of control.

1. Relays fail.
2. The delay when the relay turns on/off.
3. There is an entire wall of relays to design/wire/troubleshoot.

A PLC overcomes these limitation, it is a machine controlled operation. The programmable logic controller is a solid state device designed to replace mechanical timers, counters and sequencers. High speed manufacturing required reliable control device that were smaller, consumes less power, featured fast switching and were quickly and easily changeable. This device must be able to withstand harsh industrial environment. A formal PLC definition comes from

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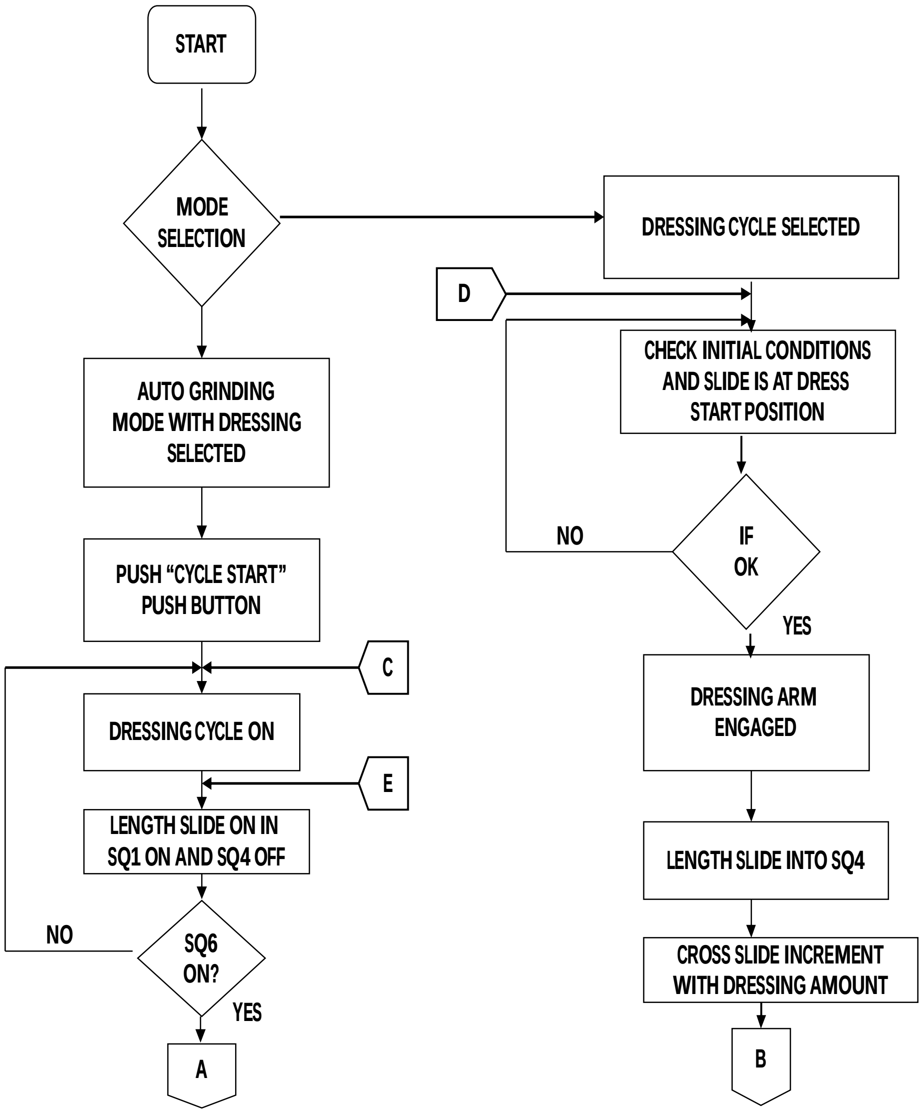
the National electrical manufacturers association. “A digitally operated electronic system which uses a programmable memory for the internal storage of instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic to control, through digital or analog input/output modules, various types of machines or processes”.

## V. FLOW CHART

The flow chart describes how the flow of grinding the bearing takes place. Grinding wheel grinds the bearing. But it also required to sharpen the blades of grinding wheel too. So dressing wheel sharpen the blades of grinding wheel. Initially mode selection is done whether to select grinding cycle or dressing cycle.




In dressing cycle mode initial conditions are checked and slide is moved at start position. Further dressing wheel is turned on with the help of motor and dressing of grinding wheel is performed.

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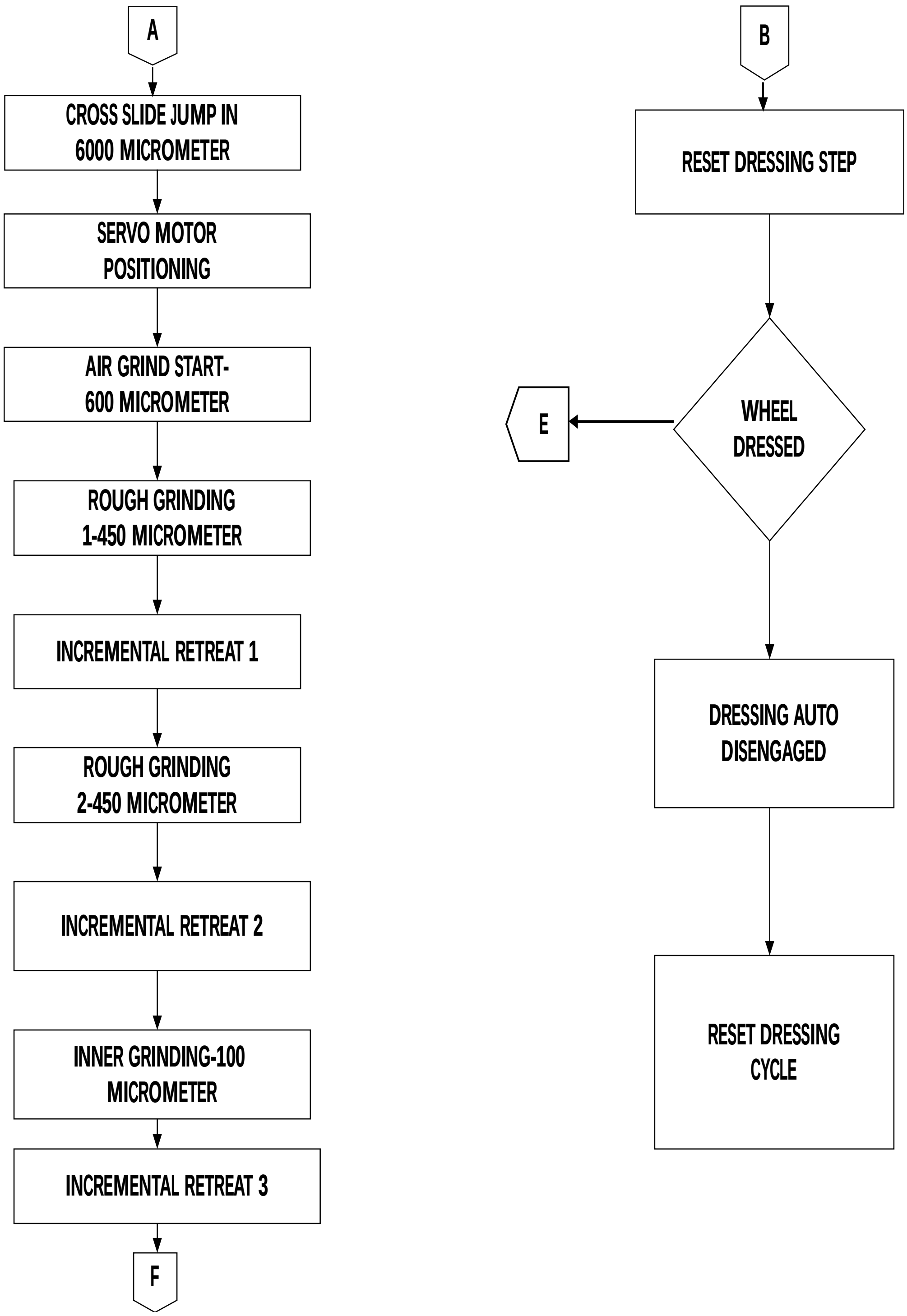
At position 'A' the grinding wheel is set to position which is now ready to grind the inner ring. At position 'B' dressing wheel is set to position to grind the grinding wheel and sharpen it. According to mode selection position 'A' and 'B' are the output.



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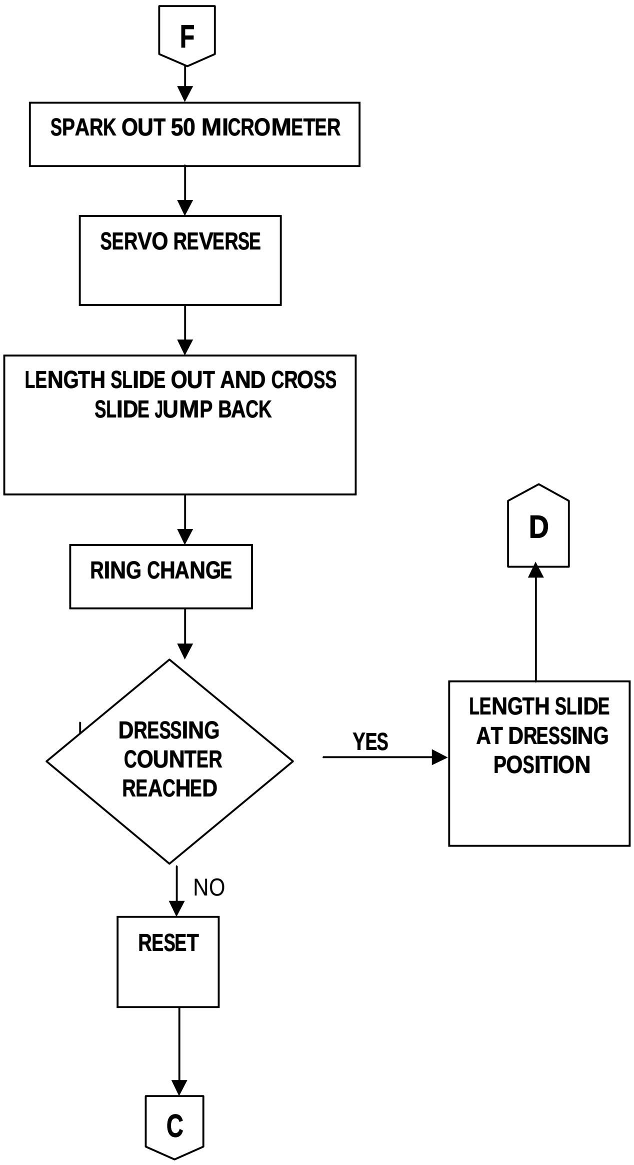
Once the grinding wheel is set at required position, the grinding action is performed on the inner ring of bearing like air grinding, rough grinding and inner grinding. Servo motor is also set on position. In the dressing wheel cycle, once the dressing of grinding wheel is done it is reset to the original position.




Once the spark out condition is reached to 50 micrometre reverse the servo drive. The ring is changed and the condition for dressing is checked. If no then the program is reset. If yes then the length slides are moved at the dressing position.

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## VI.RESULTS AND SIMULATION

The grinding cell permits the problem specific programming. The programming for the upgradation system was done in GX Developer software for Mitsubishi QPLC. Soft touch software was used to interface HMI and Mitsubishi QPLC. After upgradation the down time of the machine is reduced and the efficiency of the machine is enhanced. Also the maintenance cost of the machine is reduced and the quality of bearing is improved.

| Parameter | Measurement (Before) | Measurement (After) |
|---|---|---|
| Down Time | 16 minutes per day. | 2.9 minutes per day |

## VII.CONCLUSION

In this system we thus achieve the reliability of the system by making it more advanced which is achieved by replacing the stepper motor with servo motor.

The MITSUBISHI PLC offers high performance, flexibility and advanced feature. Scanning time and maintenance time of the system is thus reduced by using PLC. Thus leading to increase in production of bearings. The compactness required in system is achieved by upgrading the present system by MITSUBISHI PLC. Thus, the cycle time is reduced from mini second to Nano second thereby reducing the down time.

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