

AUTOMATIC SORTING MACHINE USING DELTA PLC

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Abstract— Automating every sector of industry is an important step toward increasing efficiency and reducing human related errors, here we try to automate the sorting process by using PLC. In many industries job pieces of various sizes are moved on same conveyor belt these need to separate at various locations in the manufacturing line. For this purpose we are using the automated process which is used to sort the materials which are of different sizes. After completion of manufacturing the products automatically move on the conveyor belts. Sensors at different places sense and detect the job pieces of different sizes. They get sorted at different places based upon their sizes. For sensing the material infrared sensors are used. The entire process is controlled by the program dumped in PLC. This paper is based on delta plc. Delta plc is a basic type of plc used for small scale applications. It has 8 inputs and 6 outputs. It has a 24v input slot which acts as a power source for delta plc. It also has a USB slot which is used to run the program on the plc. A very commonly used method of programming PLC's is based on the use of ladder diagrams. Writing a program is the equivalent to drawing a switching circuit. The ladder diagram consists of two vertical lines representing the power rails. Circuits are connected as horizontal lines, that is, the rungs of the ladder, between these two vertical lines. In drawing a ladder diagram, certain conventions are adopted

Keywords— DVP-SS2, barcode sorter system, sorting machine, optical character recognition, programmable logic controller.

1. I. INTRODUCTION

In many industries sorting the materials of different sizes is difficult. For this purpose we need more human efficiency to sort the materials. For this purpose we are using the automated process which is used to sort the materials which are of different sizes. After completion of manufacturing the product they automatically move on the conveyor belts. Here we are using sensors at different places which detect and sense the materials of different sizes. They get sorted at different places based upon their sizes and they are placed in their respected containers or boxes. For sensing the material we are using infrared sensors which are so sensitive. All these process is controlled and handled by PLC. Automating every sector of industry is an important step toward increasing efficiency and reducing human related errors, here we try to automate the sorting process by using PLC.

In many industries job pieces of various sizes are moved on same conveyor belt these need to separate at various locations in the manufacturing line. For this purpose we are using the automated process which is used to sort the materials which are of different sizes. After completion of manufacturing the products automatically move on the conveyor belts. Sensors at different places sense and detect the job pieces of different sizes. They get sorted at different places based upon their sizes. For sensing the material infrared sensors are used. The entire process is controlled by the program dumped in PLC.

II. DELTA PLC

In this paper, we have used a Delta DVP 14SS2 PLC which is one of the several models available from the plethora of PLCs offered by DELTA. Delta DVP-SS2 series PLCs. DVP-SS2 series PLCs include one 12-point PLC, and two 14-point PLCs. A DVP-SS2 series PLC provides various instructions and the size of the program memory in it is 8k steps. It is able to connect to all DVP-S series extension modules, including digital I/O (max. 480 I/O points) and analog modules (for A/D, D/A conversion and temperature measurement). 4 groups of high-speed (10 kHz) pulse output satisfy all kinds of applications. DVP-SS2 is small in size, and can be install easily. Users do not have to install any batteries in DVP-SS2 series PLCs. The PLC programs and the latched data are stored in the flash memories. This instruction sheet only provides introductory information on electrical specifications, general specifications, installation and wiring. For detailed information on programming and instructions, please refer to "DVP-SS2 Operation Manual: Programming". For information about optional peripherals, please see individual product instruction sheet enclosed with DVP-SS2.

III. SPECIFICATIONS

MPU points: 14(8DI+6DO)

Max I/O points: 494(14+480)

Program capacity: 8k steps

COM port: Built-in RS-232 & RS-485 ports, compatible with Modbus ASCII/RTU protocol. It can be master or slave. High-Speed Pulse Output Supports 4 points (Y0 ~ Y3) of independent high-speed (max. 10kHz) pulse output Supports PID Auto-tuning; DVP-SS2 saves parameters automatically after the PID auto temperature tuning is completed.

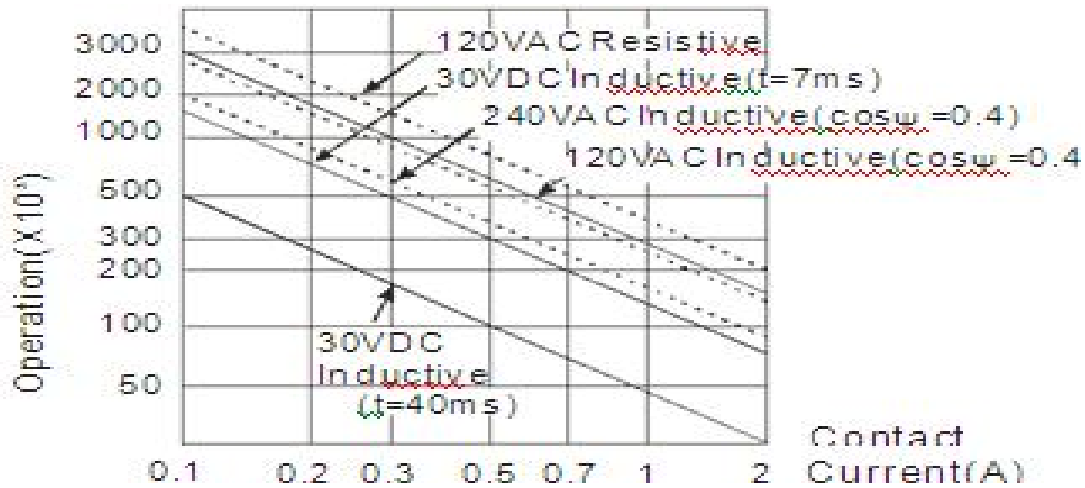
Electrical Specifications of Delta DVP-14SS2

| Item | Model | DVP14SS211R | DVP14SS211T | DVP12SS211S |
|-----------------------|-------|---|-------------|-------------|
| Power supply voltage | | 24VDC (-15% ~ 20%) (with counter-connection protection on the polarity of DC input power) DVPPS01(PS02): input 100-240VAC, output 24VDC/1A(PS02: 2A) | | |
| Inrush current | | Max. 7.5A@24VDC | | |
| Fuse capacity | | 1.85A/30VDC, Polyswitch | | |
| Power consumption | | 1.8W | | 1.5W |
| Power protection | | With counter-connection protection on the polarity of DC input power | | |
| Insulation resistance | | > 5MΩ (all I/O point-to-ground: 500VDC) | | |
| Noise immunity | | ESD (IEC 61131-2, IEC 61000-4-2): 8kVAir Discharge EFT (IEC 61131-2, IEC 61000-4-4): Power Line: 2kV, Digital I/O: 1kV, Analog & Communication I/O: 1kV RS (IEC 61131-2, IEC 61000-4-3): 26MHz ~ 1GHz, 10V/m | | |

| Item | Model | DVP14SS211R | DVP14SS211T | DVP12SS211S |
|------------------------------|-------|--|-------------|-------------|
| Grounding | | The diameter of grounding wire cannot be smaller than the wire diameter of terminals L and N (All DVP units should be grounded directly to the ground pole). | | |
| Operation / storage | | Operation: 0°C ~ 55°C (temp.), 50 ~ 95% (humidity), Pollution degree2 Storage: -25°C ~ 70°C (temp.), 5 ~ 95% (humidity) | | |
| Vibration / shock resistance | | International standards: IEC61131-2, IEC 68-2-6 (TEST Fc)/IEC61131-2 & IEC 68-2-27 (TEST Ea) | | |
| Weight (g) | | 97g | 82.5g | 90g |

| Items | Spec. | Input Point | |
|-----------------------|------------------------------|---|--------------------------|
| | | 24VDC (-15% ~ 20%) | single common port input |
| Input No. | | X0 ~ X3 | X4 ~ X7 |
| Input type | | DC (SINK or SOURCE) | |
| Input Current (± 10%) | | 24VDC, 5mA | |
| Input impedance | | 4.7kΩ | |
| Max. frequency | | 20kHz | 10kHz |
| Action level | <u>OffOn</u> <u>OnOff</u> | > 15VDC < 5VDC | |
| Response time | <u>OffOn</u> <u>OnOff</u> | < 10μs < 20μs | < 20μs < 50μs |
| Filter time | | Adjustable within 0 ~ 20ms by D1020 (Default: 10ms) | |

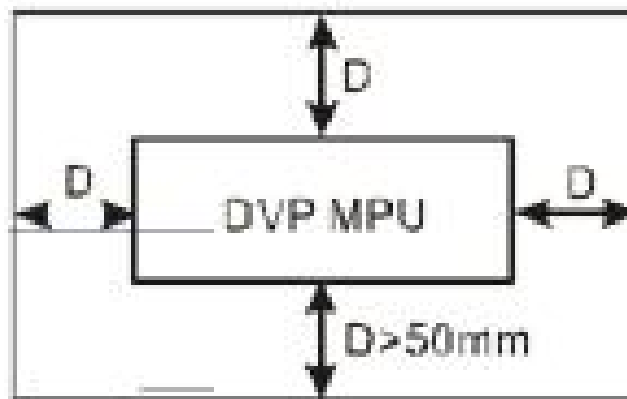
| Items | Spec. | Output Point | | |
|-----------------|------------------------------|-----------------------|-----------------------|--------|
| | | Relay | Transistor | |
| Output No. | | Y0 ~ Y5 | Y0 ~ Y3 | Y4, Y5 |
| Max. frequency | | 1Hz | 10kHz | 1kHz |
| Working voltage | | 250VAC, < 30VDC | 5 ~ 30VDC #1 | |
| Max. load | Resistive | 1.5A/1 point (5A/COM) | 0.5A/1 point (3A/COM) | |
| | Inductive | #2 | 15W (30VDC) | |
| | Lamp | 20WDC/100WAC | 2.5W (30VDC) | |
| Response time | <u>OffOn</u> <u>OnOff</u> | Approx. 10ms | 20μs | 100μs |
| | | | 30μs | 100μs |



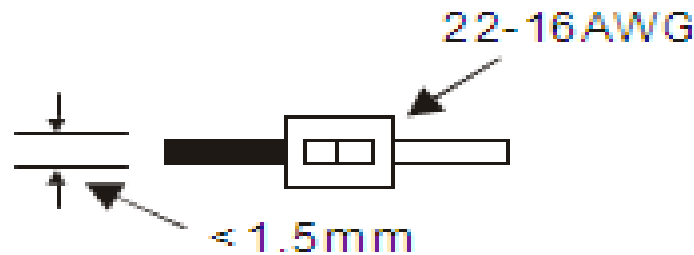
IV. INPUT / OUTPUT CONFIGURATIONS

| Model | Input | | Output | | I/O Configuration | | |
|----------|-------|---------------------|--------|------------------|---|---|---|
| | Point | Type | Point | Type | Relay | Transistor (NPN) | Transistor (PNP) |
| 14SS211R | 8 | DC (Sink Or Source) | 6 | Relay | S/S X0 X1 X2 X3 X4 X5 X6 X7 | S/S X0 X1 X2 X3 X4 X5 X6 X7 | S/S X0 X1 X2 X3 X4 X5 X6 X7 |
| 14SS211T | | | | Transistor (NPN) | C0 Y0 Y1 Y2 | UP ZP Y0 Y1 Y2 Y3 Y4 Y5 | UP ZP DA P/WM Y0 Y1 Y2 Y3 |
| 12SS211S | | | 4 | Transistor (PNP) | C1 Y3 Y4 Y5 | | Y0 Y1 Y2 Y3 |

V. DIMENSION & INSTALLATION

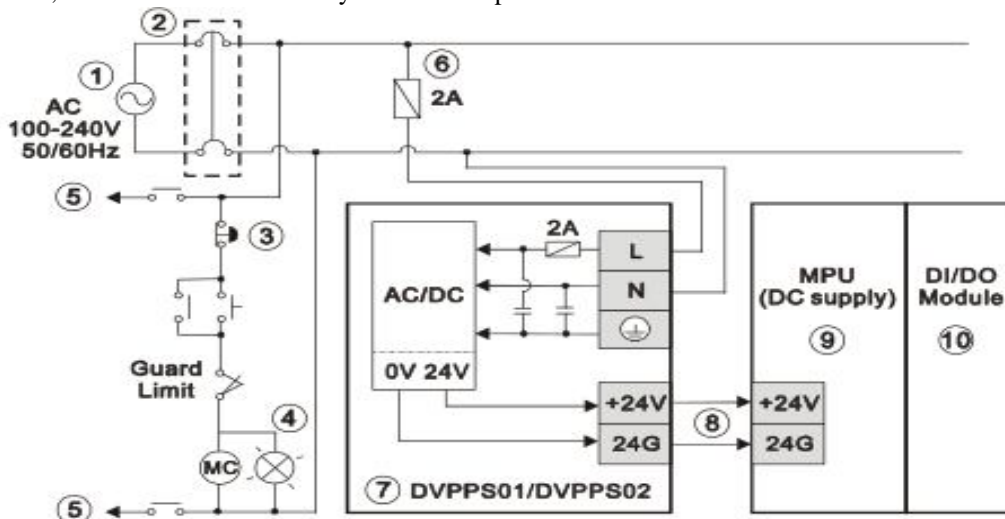


- Direct Mounting : Using M4 screw according to dimension of the product
- DIN Rail Mounting: When mounting a PLC to DIN rail we use the retaining clip to stop any side to side movement of the PLC and reduce the chances of wire being loose.
- Wiring: Using 22-16 AWG single or multiple core wire on I/O wiring terminals as shown in the figure below. PLC terminal screws should be tightened to 1.90 Kg -cm



VI. POWER SUPPLY

- The power input of DVP-SS2 is DC. When operating DVP-SS2, please note the following points
- The power is connected to two terminals. 24V DC and 0V and the range of power is 20.4 – 28.8 V DC. If the power voltage is less than 20.4 V DC, the PLC will stop running and all outputs will be OFF and the error indicator will start blinking.
- Power shutdown for less than 10ms will not affect the operation of the PLC. However the shutdown that is too long or the drop of the power voltage will stop the operation of the PLC and all outputs will go OFF. When the power returns to normal status, the PLC will automatically resume the operation



| | |
|---|----------------------------------|
| ① AC power supply: 100 ~ 240VAC, 50/60Hz | ② Breaker |
| ③ Emergency stop: This button cuts off the system power supply when accidental emergency takes place. | |
| ④ Power indicator | ⑤ AC power supply load |
| ⑥ Power supply circuit protection fuse (2A) | ⑦ DVPSS01/DVPSS02 |
| ⑧ DC power supply output: 24VDC, 500mA | ⑨ DVP-PLC (main processing unit) |
| ⑩ Digital I/O module | |

There are 2 types of DC inputs, SINK and SOURCE

1. DC Signal – SINK mode

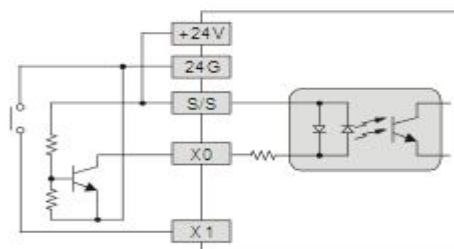


Fig : Input point loop equivalent circuit

2. DC Signal – SOURCE mode

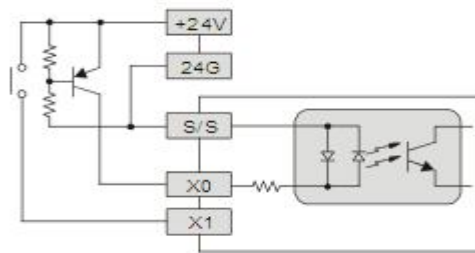
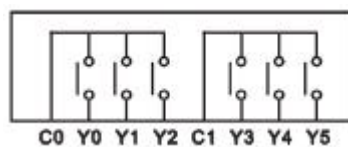


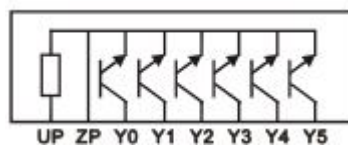
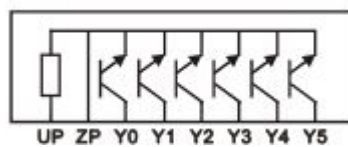
Fig : Input point loop equivalent SOURCE

VII. OUTPUT POINT WIRING

- DVP SS2 has two output modules in it, relay and transistor. Output terminals Y0, Y1 and Y2 of relay models use C0 common port. Y3, Y4 and Y5 use C1 common port. When the output points are enabled, their corresponding indicators on the front panel will be ON

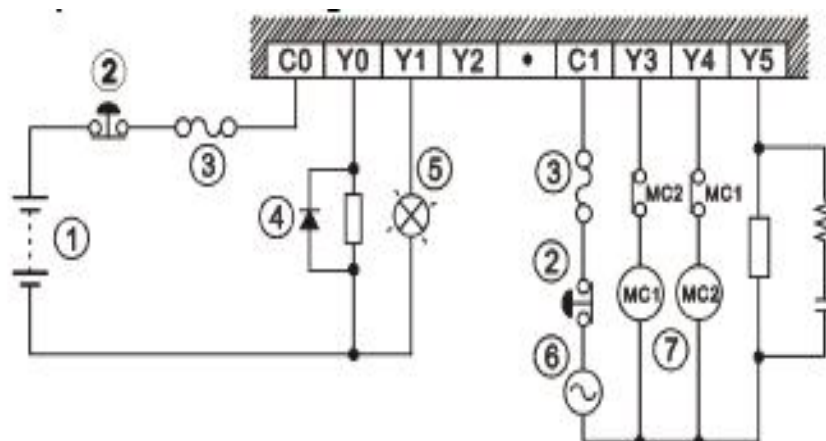


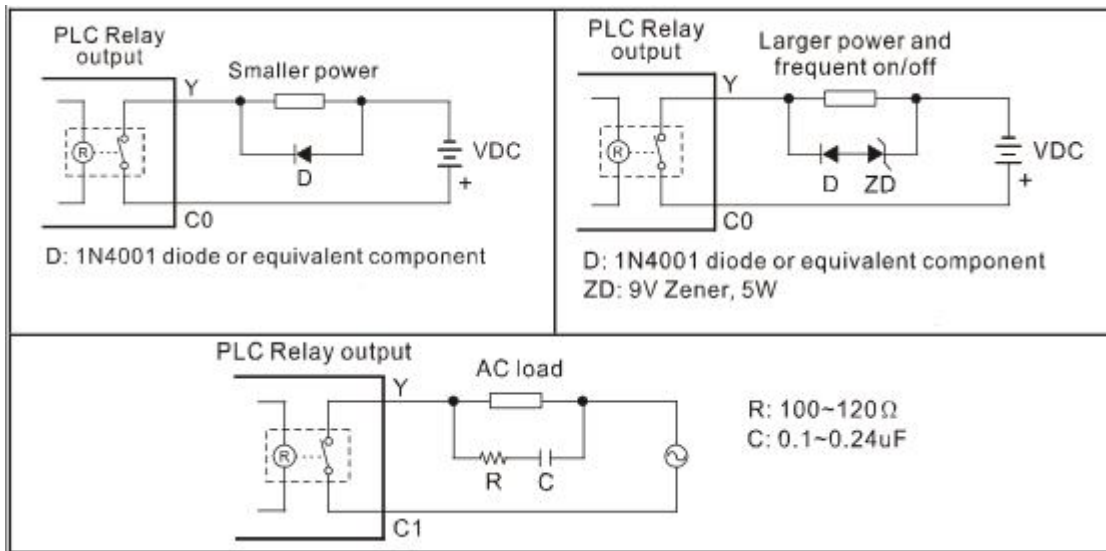
- The output terminals Y0-Y5 (NPN) of the transistor model are connected to the common terminals UP and ZP. The output terminals Y0-Y3 (PNP) model is connected to the terminals UP and ZP.



- Isolation circuit : the optical coupler is used to isolate signals between the circuit inside the PLC and input modules

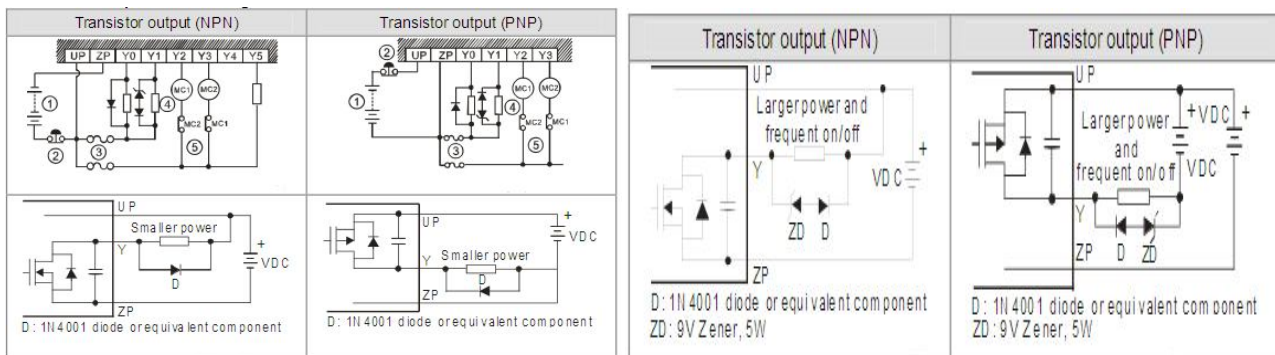
VIII. RELAY OUTPUT CIRCUIT WIRING





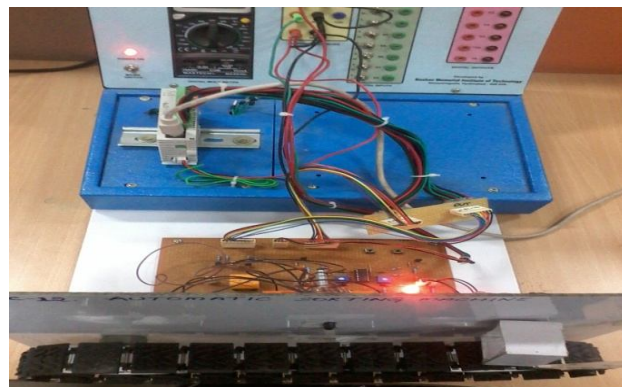
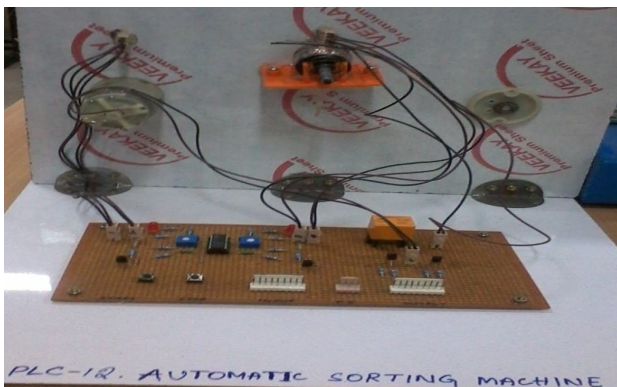
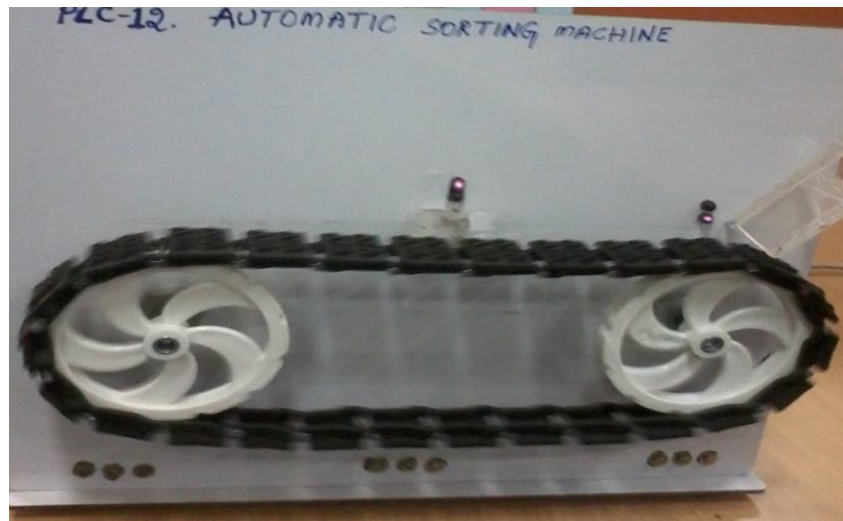
- 1 – DC power supply
- 2 - Emergency stop: using external switch
- 3 – Fuse: Uses 5-10 A fuses at the shared terminal of the output contacts to protect the output circuit
- 4 – Transient voltage suppressor: Extends the life span of contact
 - Diode suppression of DC load : Used when in smaller power
 - Diode + zener suppression of DC load : Used when in larger power and frequent ON/OFF
- 5 – Incandescent Light
- 6 – AC power supply
- 7 – Manually exclusive output , for example Y3 and Y4 control the forward running and reverses running of the motor, forming an interlock with the external circuit along with the PLC internal program to ensure safe protection in case of any unexpected errors.
- 8 – Absorber – Reduces the interference on AC load

IX. TRANSISTOR OUTPUT CIRCUIT WIRING



- 1 – DC power supply
 - 2 – Emergency stop
 - 3– Circuit protection fuse
 - 4 – The output of the transistor model is “open collector”: If Y0/Y1 is set to pulse output, the output current has to be bigger than 0.1 A to ensure normal operation of the model.
 - Diode suppression is used in the smaller power and diode + zener is used in larger power and frequent On/Off
 - 5 – Manually exclusive output – for example Y2 and Y3 control the forward running and reverse running of the motor forming an interlock for the external circuit together with the PLC internal program to ensure safe protection in case of unexpected errors
- This paper is based on delta plc. Delta plc is a basic type of plc used for small scale applications. It has 8 inputs and 6 outputs. It has a 24v input slot which acts as a power source for delta plc. It also has a USB slot which is used to run the program on the plc.

X. EXPERIMENTAL SET UP



XI. CONCLUSION

Implementing of Delta PLC for shorting of machine has greatly reduced the complexity involved in completing this project .Every production unit of mass production can make use of this kind of system. Many more industries can be identified for the application of this system.

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