



FINAL REPORT FOR  
DUAL SUMP-PUMP CONTROLLER

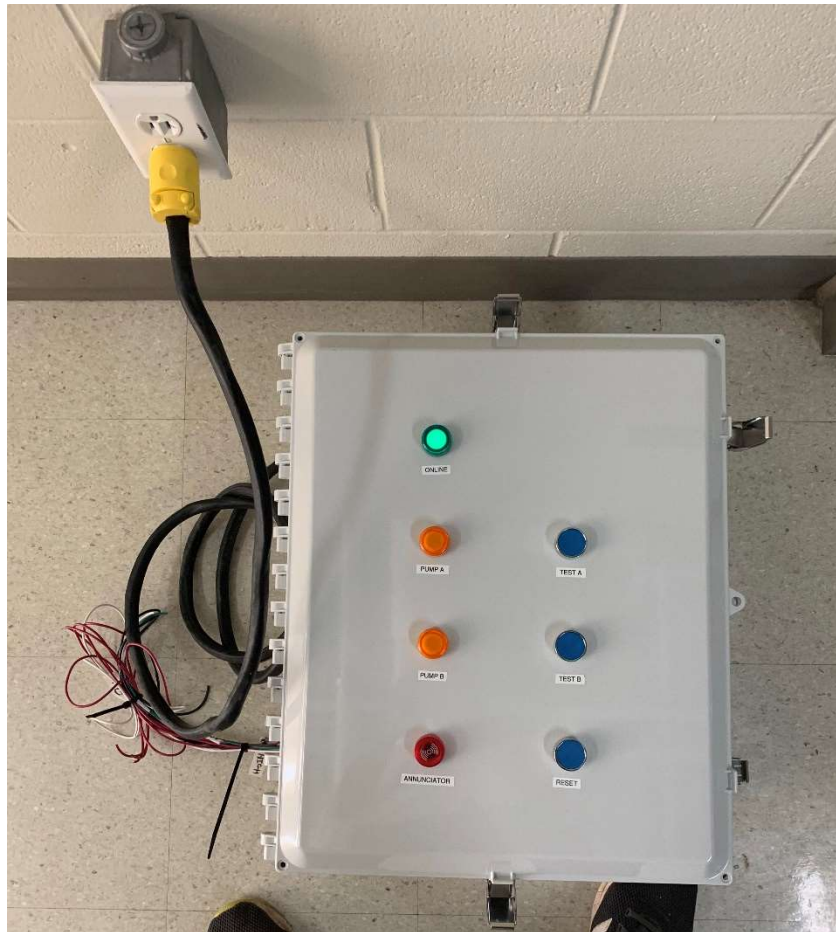
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ELECTRONICS ENGINEERING  
TECHNOLOGY (INDUSTRIAL)

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Electronics Engineering Technology  
(Industrial)



**Preliminary Report for  
Dual Sump-Pump Controller**

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May 25, 2021, EET

# Abstract

The Dual Sump-Pump Controller was designed to solve an issue brought up by countryside homeowners where water is collected from rain and melting snow in the sump, which is in the basement. A pump that is fixed inside the sump sends this collected water to the water reservoir. However, specific faults in a pump such as objects stuck in the shaft, mechanical float switch error, and continuous operation fail. As a result, the whole basement flooded with water. In the solution, Dual Sump-Pump Controller controls and monitor two pumps according to water levels (LOW, HIGH, and CRITICAL HIGH) and protect each pump from overload and underload situations. In addition, this device informs the user about the critical condition (where the basement is about to start flooding) by a buzzer. Also, three fuses were used in the circuit, which provides extra protection.

Furthermore, on the front side of the panel, four LED indicators (ONLINE, PUMP A, PUMP B, ANNUNCIATOR) and three push button switches (TEST A, TEST B, RESET) exists, which make this device more user friendly. After installment, the user can connect the pump and adjust current tripping points according to the steps mentioned in this report.

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# 1 Introduction

This project builds to solve an issue facing by many people having a sump pump in their house(basement). The pump available in the market is not working effectively. Sometimes the basement is flooded with water and, in some cases, a pump suffering from dry run conditions. This project provides a solution to these situations by controlling two pumps connected to it according to water levels (LOW-level, HIGH level, CRITICAL HIGH level). Also, there is an indicator for each pump that shows ongoing operation (ON, OFF, FAULT) on the pump. If the user wants to test whether the pump is working, testing for each pump is available by simply pushing the push button. An annunciator [1] informs users in a critical situation (if water remains above the CRITICAL HIGH level for few minutes). These are the advantages that make this project different from one existing in the market. There is no product available in the market that protects the device from under load and overload, and it is possible with Dual sump-pump Controller. Writing this report aims to sufficiently inform the user of all functions, operations, and troubleshooting techniques. In-depth Details such as block diagrams, wiring diagrams, and datasheets will be helpful to the technician who wants to troubleshoot the fault. In other words, this report works as a user manual for a Dual sump-pump controller.

## 2.0 Functional Overview

Detailed functionality of the Dual sump-pump Controller has been covered in this content. First, as described in *Appendix B: Block Diagram*. PLC is in the center of the diagram, which has an input supply voltage of 120VAC. There are three safety fuses in this circuit. One of them (primary, 20A) protects the entire system. The remaining two fuses (secondary, 10A) protect individual pumps. Overall, this system monitors, protect, and controls two pumps connected to it according to water level and fault detected by current sensors. Two pushbutton switches connected to CONTACTOR A and CONTACTOR B named TEST PUMP A and TEST PUMP B, respectively. Which allows the users to check the pump is working or not in OFF mode as well.

## 2.1 Fuse

Fuse's job is to protect the System and part of the System from overload. There are three fuses used in this project. The first connected next to supply (120 VAC) is called primary fuse (*Figure 1: Fuse (20A)*), which protects the entire system, and the other two fuses before contactors (A & B) is known as secondary fuse which saves individual pump (A/B) system.



Figure 1: Fuse (20A)

## 2.2 Water Levels

In this project, water levels were created by simply connecting conductive electrodes at a different height in the sump. There are three primary water levels: **LOW level, HIGH level, and CRITICAL HIGH level.** As mentioned in *Figure 10: Dimension of Sump and water levels* the LOW level at 4", the HIGH level at 20", and CRITICAL HIGH level at 23" height from the bottom of the sump. PLC using these water levels as input, and according to the program (ladder logic), turns on or off with the help of contactors. Apart from these levels, an electrode is connected at the bottom of the sump (named COMMON), 24 VDC from PLC.

The primary function of the LOW level is to protect pumps from dry run conditions. LOW level is an input for PLC, which acts as a stop switch (concept of stop switch) logic to pump A and pump B (See *Appendix E: Code*, network 5 & 13). When the water reaches below low level, both pumps will be turned off, and pumps would always be at some water level. A HIGH level will allow PLC to turn ON contactor A (pump A) with *2.5 Status Indicators (Q0.0, Q0.1)* (pump A status indicator). If water reaches a CRITICAL HIGH level, then PLC turns ON pump B and pump A (Pump A not ON by High level). At this level, both pumps forcing out water from the sump.

## 2.3 Reset (I0.3)

This input (*Figure 2: Reset (push button)*) introduced for two main reasons:

1. Once the annunciator starts emitting noise and flashing light, inform the user about a critical situation. The user is now well informed about this situation, and if the user wants to stop the annunciator, press the RESET button for 5 seconds.



Figure 2: Reset (push button)

2. When current sensors detect fault (underload/overload), then PLC turns OFF that load (pump A or pump B), and 2.5 Status Indicators (Q0.0, Q0.1) start flashing (Fault mode). Now, the user wants to check whether the fault is apparent or not to make sure that they press the REST button for a moment.

#### 2.4 Current Sensors (I0.4, I0.5, I0.6, I0.7)

These sensors connected to the PLC input terminal and hot wire of load (pump A and pump B) pass through the hole on it as shown in (*Appendix C: Wiring Diagram*), and The working principle of these sensors is based on a current transformer (C.T.). These sensors (*Figure 3: Current sensors*) protect load connected across contactor from overload and underload by opening contactor terminals. The sensor works



Figure 3: Current sensors

only when the contactor is ON. These sensors' trip points would be adjustable (if in future user change pump). Inputs I0.4 and I0.5 of PLC save pump A (load connected across contactor A) from overload and underload, respectively. Also, Inputs I0.6 and I0.7 of PLC save pump B (load connected across contactor B) from overload and underload, respectively.

#### 2.5 Status Indicators (Q0.0, Q0.1)

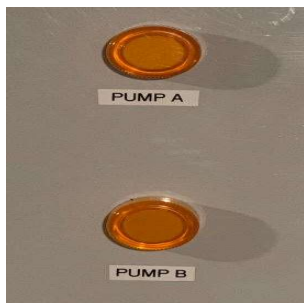


Figure 4: LED status indicator

Indicate the pump's current operation (or status), and it is attached to the front of the panel. Using single *LED indicators (ECX1053-120, ECX1052-120)*, this project saves multiple input terminals and a program line.

Yellow color LED light (has supply voltage 120 VAC) shows ongoing PUMP A and PUMP B operation. During OFF (*Figure 4: LED status indicator*) mode, this status indicator stays off. However, during ON mode, light laminate with full lamination, and during FAULT (overload /underload), this indicator starts flashing [2].

## 2.6 System Enable Indicator (Q0.2)

When this indicator (*LED indicators (ECX1053-120, ECX1052-120)*) is ON (full illumination), it shows the System is Enable, and the input supply (120 VAC) is ok. It can be said that the System is Disable when this indicator is OFF (*Figure 5: Enable indicator*).



Figure 5: Enable indicator

## 2.7 Test Pump (A & B)



Figure 7: TEST PUMP A and B (pushbutton)

It allows the user to check the functionality of the pump manually (without interfering with PLC logic) at any time and situation by simply pressing *Push Button (GCX1104)*, as showing in *Figure 7: TEST PUMP A and B (pushbutton)*.

Also, help the user while replacing the pump and setting current tripping points on current sensors.



Figure 6: Contactors

## 2.8 Contactor (A & B)

This works as an interference device for PLC and pump. PLC controls (ON/OFF) pumps with the help of this contactor (*Figure 6: Contactors*).

## 2.9 Annunciator (Q0.5)



Figure 8: Annunciator

It informs the user about the critical situation (if the water stays above the necessary High level for more than 2 minutes) by flashing light and periodic buzzer (*Figure 8: Annunciator*).

### 3. Technical Description

#### Physical and user interaction description

It is a fully automatic controller which required the least amount of user interference. The regular



Figure 9: Front side of the panel

operation is performed according to water levels detected by PLC. The operation order could be more transparent by looking Figure 9: Front side of the panel, the COMMON electrode located at the bottom of the sump, 24V D.C. from PLC and LOW level fixed at around 4 inches of height from the bottom of the sump. The HIGH and CRITICAL HIGH levels were located about 20 inches and 24 inches, respectively. When the sump starts filling with water and reaches a HIGH level, it will turn on the PUMP A and its indicator if the input water force is more than PUMP A's

toughing capacity, the water level increases. Once it reaches the CRITICAL HIGH level, PUMP B will be additionally joined to complete operation. In addition to this, if water goes above CRITICAL HIGH level or stays there for more than 2 minutes, the user will be notified by ANNUNCIATOR. When water starts decreasing below the HIGH level, PUMP B will be stopped, and PUMP A works standalone. Once this water level reaches below the LOW level, PUMP A will be destroyed, and there is some amount of water stays in the sump to protect pumps from dry-run conditions.

There is a RESET button on the front side (Figure 9: Front side of the panel) of the board, which stops the annunciator (press for 5 seconds when it's ON) and reset

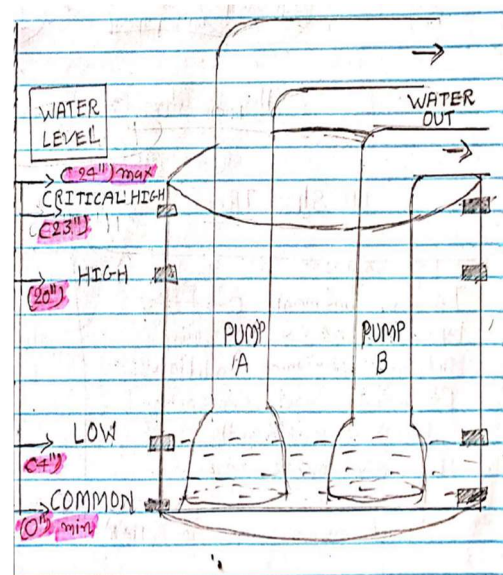


Figure 10: Dimension of Sump and water levels



the load (after clearing the fault, press it for a moment). TEST A and TEST B will allow users to check the pump's functionality and help users while replacing the pump.

### Electrical/Electronics description

In this project, seven segments were used (located on the front panel), which works as user interference. Three of them are momentary push button (Appendix G: Datasheets), where 2 TEST button connects 120VAC supply and pump (there is no interference of PLC), and a RESET button is working as an input (I0.3) of PLC. Moreover, as mentioned in the block diagram (Appendix B: Block Diagram), annunciator (O0.5) and three other indicators (PUMP A (O0.0), PUMP B (O0.1), ONLINE (O0.2)) are connected to output PLC which is 120VAC input supply rated.

No specific sensors used in this project measure water level; the conductivity of water is used to do it. The inputs I0.0, I0.1, and I0.2 are the water levels LOW, HIGH, and CRITICAL HIGH defined in this project. All three water levels connected at different heights using conductive wire and at the very bottom of sump COMMON are located, which is +24VDC come from PLC. As the number of waters increases in the sump, it works as a conductive layer for this water level and connects electrically. So as the amount of conductive material is more, it gives better results.

Contactors (*2.8 Contactor (A & B)*) are the medium of the device between PLC and pumps. This contractor works according to the PLC ladder logic and can be operated with TEST buttons (*2.7 Test Pump (A & B)*). TEST button provides a 120VAC supply if it is pressed and hold. The PLC logic is defined to operate PUMP A at the HIGH level of water and both pumps at the CRITICAL HIGH station. When the water level decreases and reaches below HIGH level, PLC will turn OFF PUMP B, and the remaining operation is done with PUMPA. Once the water level goes below the LOW level, both pumps' safety stops and keeps some water in the sump.

Annunciator (*2.9 Annunciator (Q0.5)*) is the device that informs the user about a critical situation in which water stays above the CRITICAL HIGH level for more than 2 minutes. The name annunciator has been given to it because of its functionality, flashing light, and making noise. In addition, the system enables the indicator to show PLC status, either ON or OFF. The logic behind both functions has been defined in the code. Network 17 offers the reason behind the ONLINE (*2.6 System Enable Indicator (Q0.2)*) indicator and network 18 to 22 defined for annunciator.



The output of the current sensors goes to PLC input which is normally closed. Four sensors connected in the system protect both pumps from overload (A.H. and B.H.) and under load (A.L and B.L). The working phenomenon behind these sensors is the same as the current transformer, which works on EMF principal. According to set current tripping points, when these sensors detect the threshold current, send a signal to PLC, and according to the program, PLC controls contactors of the pump.

#### Analysis or Software description

For programming as an IDE (Integrated development environment) project, STEP 7 Micro WIN 32 has been used, which works only in Windows 98 Operating System device. To install windows 98 in the latest system, one should download and install Oracle V.M. Virtual Box manager (<https://www.virtualbox.org/wiki/Downloads>). It allows working on windows 98 in the current O.S. Once all these steps are done, the windows will look like *Figure 11: STEP 7 Micro WIN 32 installed in Windows 98 O.S.* (also shows the first version of ladder logic). Additionally, suppose there is no DB-9 plug available in someone's computer. In that case, one should buy a USB to the serial port cable, which is available on

[https://www.amazon.ca/dp/B01NCAQRM9/ref=sspa\\_dk\\_detail\\_0?psc=1&pd\\_rd\\_i=B01NCAQRM9&pd\\_rd\\_w=Lp8yL&pf\\_rd\\_p=2c17e944-5508-41c9-9e34-6115f0c88f84&pd\\_rd\\_wg=Do65E&pf\\_rd\\_r=7GR01QXRM61QT9VYCMCT&pd\\_rd\\_r=a06b228e-3d84-4fd4-9f6e-](https://www.amazon.ca/dp/B01NCAQRM9/ref=sspa_dk_detail_0?psc=1&pd_rd_i=B01NCAQRM9&pd_rd_w=Lp8yL&pf_rd_p=2c17e944-5508-41c9-9e34-6115f0c88f84&pd_rd_wg=Do65E&pf_rd_r=7GR01QXRM61QT9VYCMCT&pd_rd_r=a06b228e-3d84-4fd4-9f6e-)

[975ef11d88df&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUFWS0hRS1RaRzFPM08mZW5jcnlwdGVkSWQ9QTEwMjk1NzExQ0hBTzQ4V1JVNng2JmVuY3J5cHRlZEFkSWQ9QTAwNzAxNTAxQUE4QUYyTU5QIY1JndpZGdldE5hbWU9c3BfZGV0YWlsJmFjdGlvbj1jbGlja1JlZGlzZW50JmRvTm90TG9nQ2xpY2s9dHJlZQ==](https://www.amazon.ca/dp/B01NCAQRM9/ref=sspa_dk_detail_0?psc=1&pd_rd_i=B01NCAQRM9&pd_rd_w=Lp8yL&pf_rd_p=2c17e944-5508-41c9-9e34-6115f0c88f84&pd_rd_wg=Do65E&pf_rd_r=7GR01QXRM61QT9VYCMCT&pd_rd_r=a06b228e-3d84-4fd4-9f6e-975ef11d88df&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUFWS0hRS1RaRzFPM08mZW5jcnlwdGVkSWQ9QTEwMjk1NzExQ0hBTzQ4V1JVNng2JmVuY3J5cHRlZEFkSWQ9QTAwNzAxNTAxQUE4QUYyTU5QIY1JndpZGdldE5hbWU9c3BfZGV0YWlsJmFjdGlvbj1jbGlja1JlZGlzZW50JmRvTm90TG9nQ2xpY2s9dHJlZQ==).The code for this project is given in Appendix E:

Code section. All the rungs and instructions defined and the table mentioned in this section show data of inputs and output of PLC. Network 17 in the program stands for system enable indicator, which states that the siemens ladder logic does not use coil instruction without any input instruction. There is no Status file available like Allen broadly (RSlogic), so to blink, the LED light program was defined in three lines. In this program, Network 6,7, and 8 to flash pump A indicator and Network 14, 16, and 17 are determined to blink pump B. Network 1 to 5 controllers the PUMP A, Network 9 to 13 stands for PUMP B Network 18 to 22 define for annunciator.

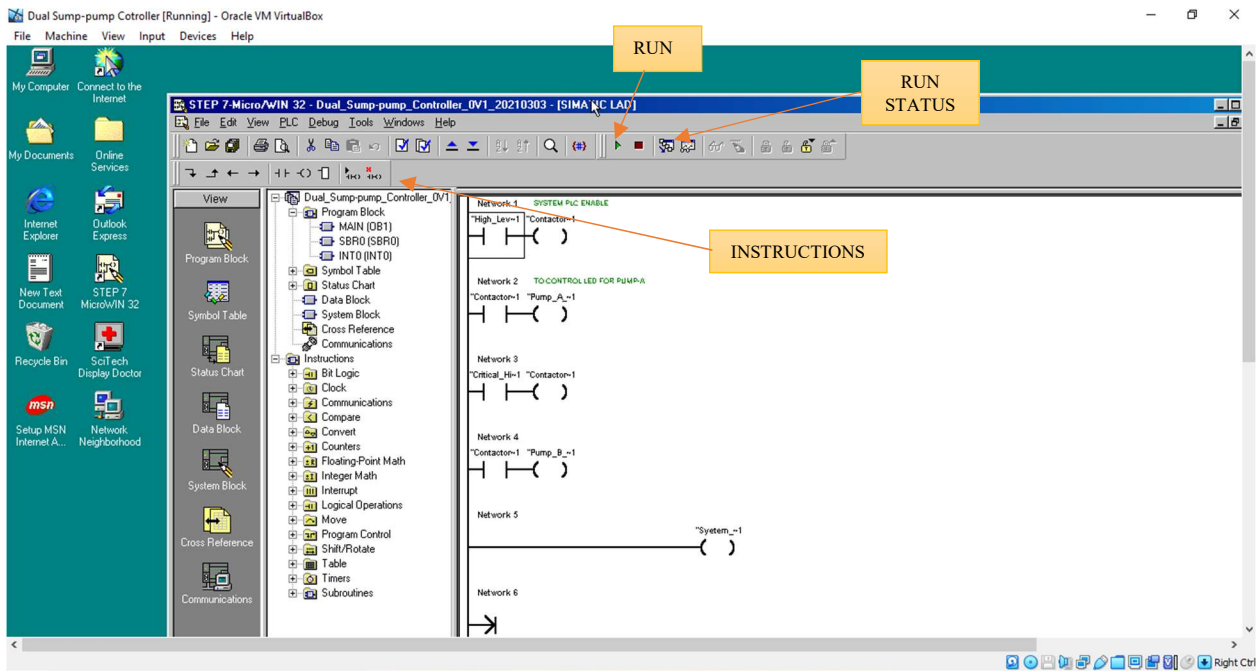


Figure 11: STEP 7 Micro WIN 32 installed in Windows 98 O.S.

## 4. Testing and Results

There are two tests performed on this project. The first is the Current sensors calibration test, and the second is the RESET function test.

The first test has been performed to define the bracket for the pump. The frame means overload current limit and underload current limit. For example, the pump currently connected in the system consumes 6.7A ( $I_{FL}$ ) current under normal condition (operation in water, *Figure 12: Current under normal load*). However, when the pump is sucking air, it consumes 7.20A ( $I_{NL}$ ) current, and when an object stuck in the shaft and shaft stops moving (block rotor current), the pump consumes 9.02A ( $I_{BL}$ ). By observing this result, it can be concluded that if the pump runs under the limit of 6A to 7.10A would be protected from electrical fault all time. So, this pump bracket is 6A to 7.10A.



Figure 12: Current under normal load

To calibrate this bracket on this system, one does not need a multimeter; plug in the pump and press the TEST (*Figure 7: TEST PUMP A and B (pushbutton)*) button for that pump and hold it. Then,

open the panel and observe the input signal on PLC. Considering calibration for PUMPA, on A.H. (pump A upper limit), turn POT clockwise until light doesn't show up on the I0.4 indicator, and when the light glows, turn another half in the same direction. For lower limit, Adjust POT on A.L. (pump A lower) and rotate counter-clockwise until light OFF on I0.5 on PLC. Once the I0.5 indicator turns off, turn another half in the same direction. Now, current sensors are calibrated and ready for operation, release the TEST button and close the enclosure.

The second test performed on RESET functionality, the RESET (2.3 Reset (I0.3)) button designed to perform two tasks. The first task is to stop the annunciator. To accomplish this, pumps were disconnected from the receptacle then water keeps above the critical high-level surface using an external water tank (Figure 14: 1000-liter water tank). While this process time has been recorded for two minutes after two minutes annunciator starts, and to stop it press the RESET button for five seconds. Then, wait for another 2 minutes to make sure the annunciator doesn't turn on.

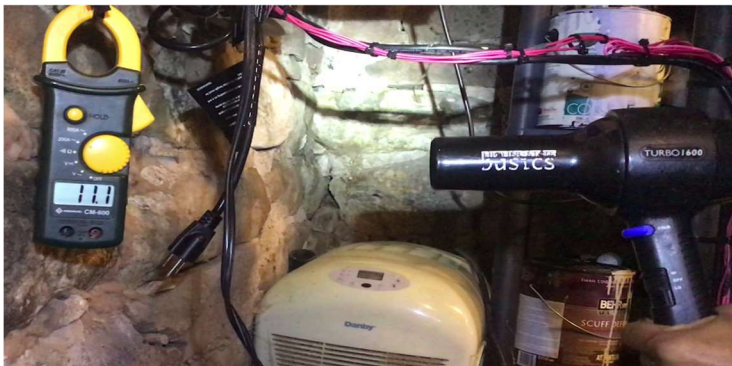


Figure 13: Hairdryer measurement

The second part of this test required the same tools as the first part. To do this, fill out the sump with the help of an external water tank (Figure 14: 1000-liter water tank). After this, plugin nominal load, pump, and press the reset button for a moment, and the



Figure 15: Critical situation (Annunciator ON)



Figure 14: 1000-liter water tank

system, will accept this calibrated load. Repeat these steps for PUMP A) and make sure water remains until CRITICAL HIGH level. At this moment, both pumps start functioning. Next, remove the plug of PUMP B to perform the test in no-load condition. Now, current sensors detect this fault, and PLC will turn off the supply for PUMP B. The pump indicator starts blinking, and to continue with this operation, press the RESET button for a moment. If there is a fault system will not allow operating this pump. Also, perform this with the help of a hairdryer consuming 11.1 A (Overload condition, *Figure 13: Hairdryer measurement*). After this, plugin nominal load, pump, and press the reset button for a moment, and the system, will accept this calibrated load. Repeat these steps for PUMP A.

## 5 Conclusion

This project is now ready to install in users' houses to provide them better service from one available market by monitoring and controlling two pumps. The idea was initiated by an issue facing by the homeowners (especially from the countryside) whose basement got flooded because of a failure in the pump. The dual sump-pump controller allows pumps to perform according to water levels (LOW level, HIGH level, CRITICAL HIGH level), and it also saves pumps from dry-run condition. In addition, for safety, there are replaceable fuses and current sensors which protect the pump from overload and underload condition. Moreover, Indicators, Test Buttons, and an annunciator are mounted to the panel's front, making this system more user-friendly. However, there was an issue regarding PLC logic and current sensors. Therefore, the RESET button was introduced in the circuit, which works as user input. When a fault is detected and the pump stops functioning because of the fault, this RESET button allows checking to run normally. On the flip side, the initial cost is high compared to the pumps available on the market. Still, this controller works effectively with zero errors and protects the pump from multiple faults, increasing the pump's life span and reducing running costs. As such, it can be said that the initial price is high for this project, but lower maintenance fees and a reliable working process will be helpful to the users over the long term.

## 6 References

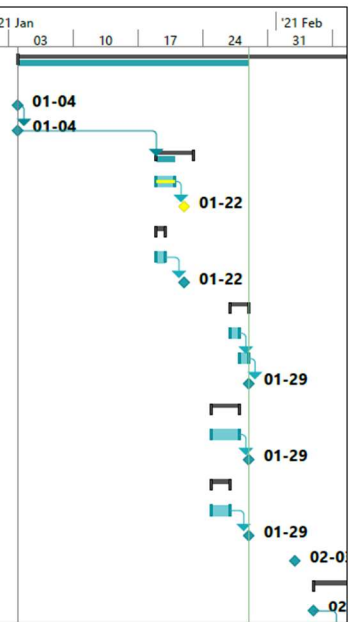
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## Appendix A: Gantt Chart



| ID | Task Mode | Task Name                        | Duration        | Start               | Finish              | 21 Jan |    |    |    |    | 21 Feb |
|----|-----------|----------------------------------|-----------------|---------------------|---------------------|--------|----|----|----|----|--------|
| 1  |           | <b>Dual Sump-pump Controller</b> | <b>110 days</b> | <b>Mon 21-01-04</b> | <b>Fri 21-06-04</b> | 27     | 03 | 10 | 17 | 24 | 31     |
| 2  |           | Project Start                    | 0 days          | Mon 21-01-04        | Mon 21-01-04        |        |    |    |    |    |        |
| 3  |           | Winter Term Day 1                | 0 days          | Mon 21-01-04        | Mon 21-01-04        |        |    |    |    |    |        |
| 4  | ✓         | Formal Proposal                  | 4 days          | Tue 21-01-19        | Fri 21-01-22        |        |    |    |    |    |        |
| 5  | ✓         | Write the memo                   | 2 days          | Tue 21-01-19        | Wed 21-01-20        |        |    |    |    |    |        |
| 6  | ✓         | Submit the memo                  | 0 days          | Fri 21-01-22        | Fri 21-01-22        |        |    |    |    |    |        |
| 7  |           | Risk Assessment                  | 1 day           | Tue 21-01-19        | Tue 21-01-19        |        |    |    |    |    |        |
| 8  |           | Complete the form                | 1 day           | Tue 21-01-19        | Tue 21-01-19        |        |    |    |    |    |        |
| 9  |           | Submit the form                  | 0 days          | Fri 21-01-22        | Fri 21-01-22        |        |    |    |    |    |        |
| 10 |           | Critical Approvals               | 2 days          | Wed 21-01-27        | Thu 21-01-28        |        |    |    |    |    |        |
| 11 |           | Complete the form                | 1 day           | Wed 21-01-27        | Wed 21-01-27        |        |    |    |    |    |        |
| 12 |           | Obtain Approvals                 | 1 day           | Thu 21-01-28        | Thu 21-01-28        |        |    |    |    |    |        |
| 13 |           | Submit form                      | 0 days          | Fri 21-01-29        | Fri 21-01-29        |        |    |    |    |    |        |
| 14 |           | Block Diagram                    | 3 days          | Mon 21-01-25        | Wed 21-01-27        |        |    |    |    |    |        |
| 15 |           | Create diagram                   | 3 days          | Mon 21-01-25        | Wed 21-01-27        |        |    |    |    |    |        |
| 16 |           | Submit diagram                   | 0 days          | Fri 21-01-29        | Fri 21-01-29        |        |    |    |    |    |        |
| 17 |           | Gantt Chart                      | 2 days          | Mon 21-01-25        | Tue 21-01-26        |        |    |    |    |    |        |
| 18 |           | Prepar Gantt chart               | 2 days          | Mon 21-01-25        | Tue 21-01-26        |        |    |    |    |    |        |
| 19 |           | Submit Gantt chart               | 0 days          | Fri 21-01-29        | Fri 21-01-29        |        |    |    |    |    |        |
| 20 |           | Start Physical Build             | 0 days          | Wed 21-02-03        | Wed 21-02-03        |        |    |    |    |    |        |
| 21 |           | Engineering Drawings             | 4 days          | Fri 21-02-05        | Wed 21-02-10        |        |    |    |    |    |        |
| 22 |           | First Draft                      | 0 days          | Fri 21-02-05        | Fri 21-02-05        |        |    |    |    |    |        |



|  |                    |  |                       |  |                    |
|--|--------------------|--|-----------------------|--|--------------------|
| Project: Dual Sump-pump Cont<br>Date: Fri 21-01-29 | Task               |  | Inactive Summary      |  | External Tasks     |
|  | Split              |  | Manual Task           |  | External Milestone |
|  | Milestone          |  | Duration-only         |  | Deadline           |
|  | Summary            |  | Manual Summary Rollup |  | Progress           |
|  | Project Summary    |  | Manual Summary        |  | Manual Progress    |
|  | Inactive Task      |  | Start-only            |  |                    |
|  | Inactive Milestone |  | Finish-only           |  |                    |

| ID | Task Mode | Task Name  | Duration | Start        | Finish       | 21 Jan |    |    |    |    | 21 Feb |
|----|-----------|--|----------|--------------|--------------|--------|----|----|----|----|--------|
| 23 |           | EDR Drawing Package Submission                           | 0 days   | Mon 21-02-08 | Mon 21-02-08 | 27     | 03 | 10 | 17 | 24 | 31     |
| 24 |           | Engineering Design review                                | 2 days   | Tue 21-02-09 | Wed 21-02-10 |        |    |    |    |    |        |
| 25 |           | Drawings and Parts List                                  | 0 days   | Thu 21-02-11 | Thu 21-02-11 |        |    |    |    |    |        |
| 26 |           | Mechanical Prototype Build Bing Integrated With Controls | 0 days   | Fri 21-03-05 | Fri 21-03-05 |        |    |    |    |    |        |
| 27 |           | Prototype Functionality Assesment                        | 5 days   | Mon 21-03-15 | Fri 21-03-19 |        |    |    |    |    |        |
| 28 |           | Logbook Evolution  | 5 days   | Mon 21-03-15 | Fri 21-03-19 |        |    |    |    |    |        |
| 29 |           | Final Mechanical Build Started                           | 0 days   | Mon 21-03-29 | Mon 21-03-29 |        |    |    |    |    |        |
| 30 |           | Review Current State of Build With Advisor               | 0 days   | Mon 21-04-05 | Mon 21-04-05 |        |    |    |    |    |        |
| 31 |           | Preliminary Report Submission                            | 0 days   | Wed 21-04-14 | Wed 21-04-14 |        |    |    |    |    |        |
| 32 |           | Mechanical Build   | 11 days  | Fri 21-04-16 | Fri 21-04-30 |        |    |    |    |    |        |
| 33 |           | Testing Memo Test Selection Form                         | 0 days   | Fri 21-04-30 | Fri 21-04-30 |        |    |    |    |    |        |
| 34 |           | Testing Memo   | 0 days   | Fri 21-05-07 | Fri 21-05-07 |        |    |    |    |    |        |
| 35 |           | Wiring Controls  | 0 days   | Fri 21-05-07 | Fri 21-05-07 |        |    |    |    |    |        |
| 36 |           | Mechanical Buils Working and Control System Working      | 0 days   | Mon 21-05-10 | Mon 21-05-10 |        |    |    |    |    |        |

|  |                    |  |                       |  |                    |
|--|--------------------|--|-----------------------|--|--------------------|
| Project: Dual Sump-pump Cont<br>Date: Fri 21-01-29 | Task               |  | Inactive Summary      |  | External Tasks     |
|  | Split              |  | Manual Task           |  | External Milestone |
|  | Milestone          |  | Duration-only         |  | Deadline           |
|  | Summary            |  | Manual Summary Rollup |  | Progress           |
|  | Project Summary    |  | Manual Summary        |  | Manual Progress    |
|  | Inactive Task      |  | Start-only            |  |                    |
|  | Inactive Milestone |  | Finish-only           |  |                    |

| ID | Task Mode | Task Name                    | Duration | Start        | Finish       | '21 Jan |    |    |    |    | '21 Feb |  |
|----|-----------|------------------------------|----------|--------------|--------------|---------|----|----|----|----|---------|--|
|    |           |                              |          |              |              | 27      | 03 | 10 | 17 | 24 | 31      |  |
| 37 |           | Testing Completed            | 0 days   | Fri 21-05-14 | Fri 21-05-14 |         |    |    |    |    |         |  |
| 38 |           | Completed Project Assessment | 4 days   | Mon 21-05-17 | Thu 21-05-20 |         |    |    |    |    |         |  |
| 39 |           | Senior project Symposium     | 4 days   | Mon 21-05-24 | Thu 21-05-27 |         |    |    |    |    |         |  |
| 40 |           | Fianl Report Submission      | 0 days   | Fri 21-06-04 | Fri 21-06-04 |         |    |    |    |    |         |  |

|  |                    |  |                       |  |                    |  |
|--|--------------------|--|-----------------------|--|--------------------|--|
| Project: Dual Sump-pump Cont<br>Date: Fri 21-01-29 | Task               |  | Inactive Summary      |  | External Tasks     |  |
|  | Split              |  | Manual Task           |  | External Milestone |  |
|  | Milestone          |  | Duration-only         |  | Deadline           |  |
|  | Summary            |  | Manual Summary Rollup |  | Progress           |  |
|  | Project Summary    |  | Manual Summary        |  | Manual Progress    |  |
|  | Inactive Task      |  | Start-only            |  |                    |  |
|  | Inactive Milestone |  | Finish-only           |  |                    |  |

Page 3

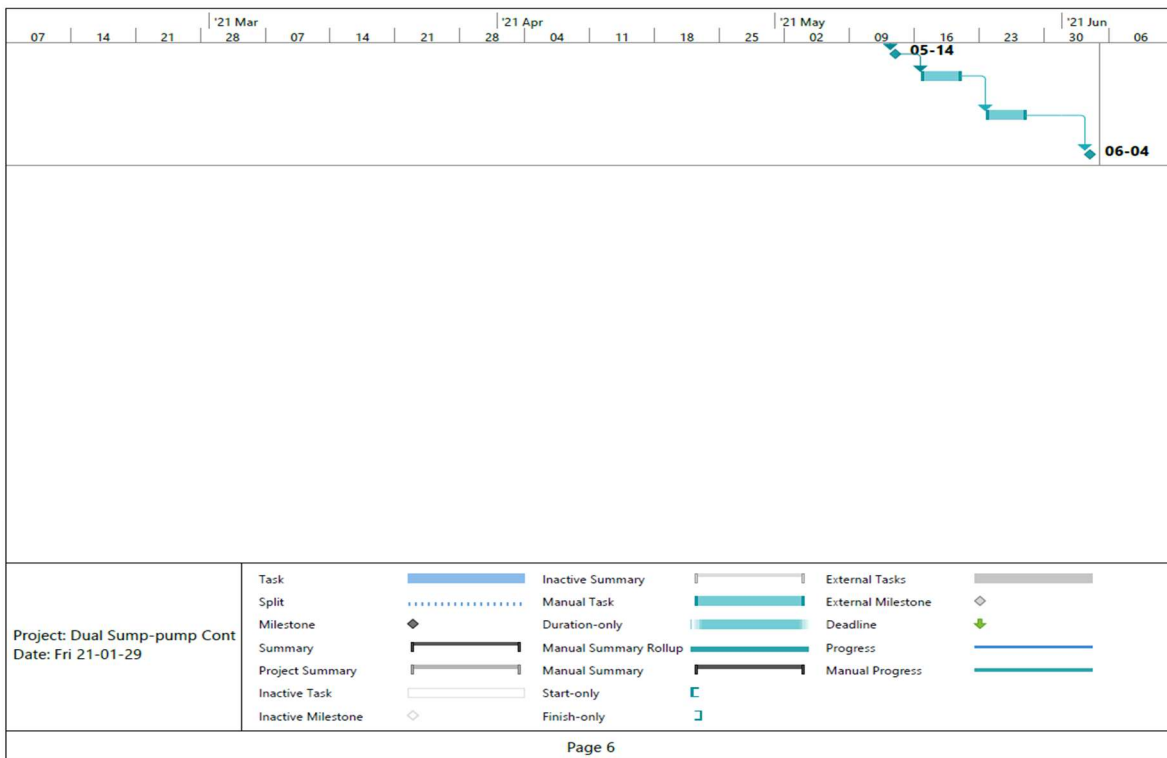
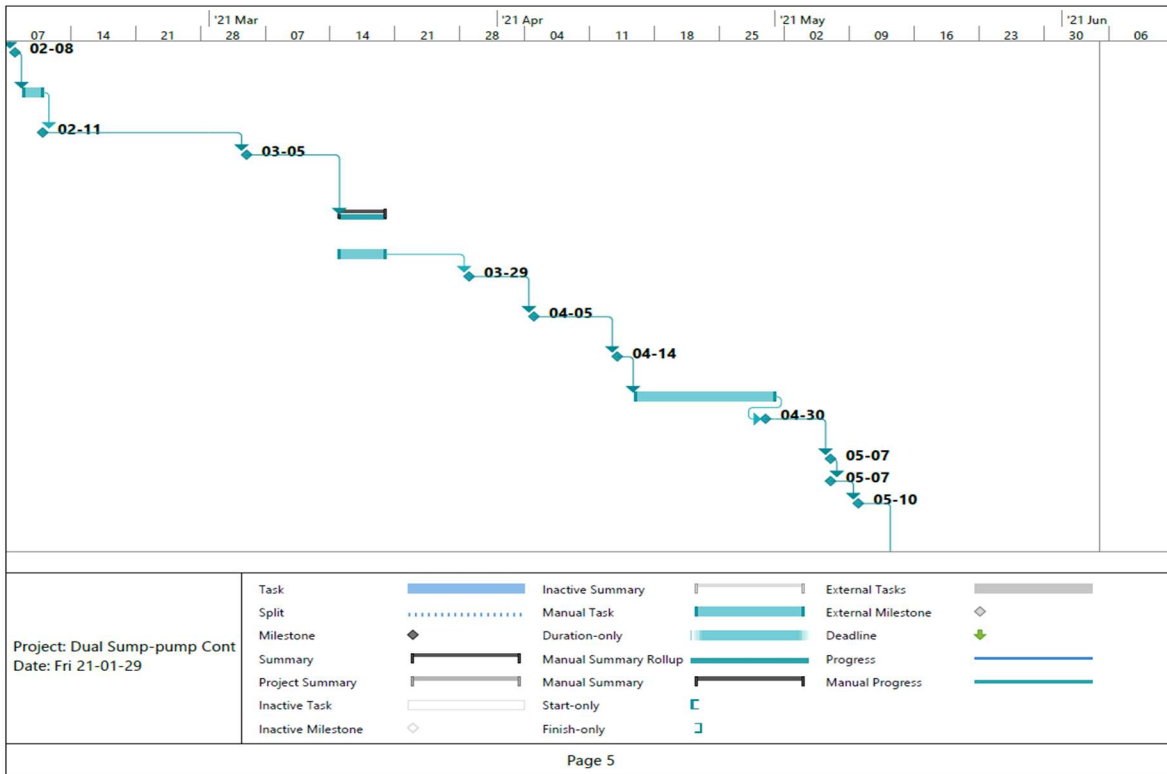
|  |  |  | '21 Mar |    |    |    | '21 Apr |    |    |    | '21 May |    |    |    | '21 Jun |    |    |    |    |    |
|--|--|--|---------|----|----|----|---------|----|----|----|---------|----|----|----|---------|----|----|----|----|----|
|  |  |  | 07      | 14 | 21 | 28 | 07      | 14 | 21 | 28 | 04      | 11 | 18 | 25 | 02      | 09 | 16 | 23 | 30 | 06 |
|  |  |  |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |    |    |

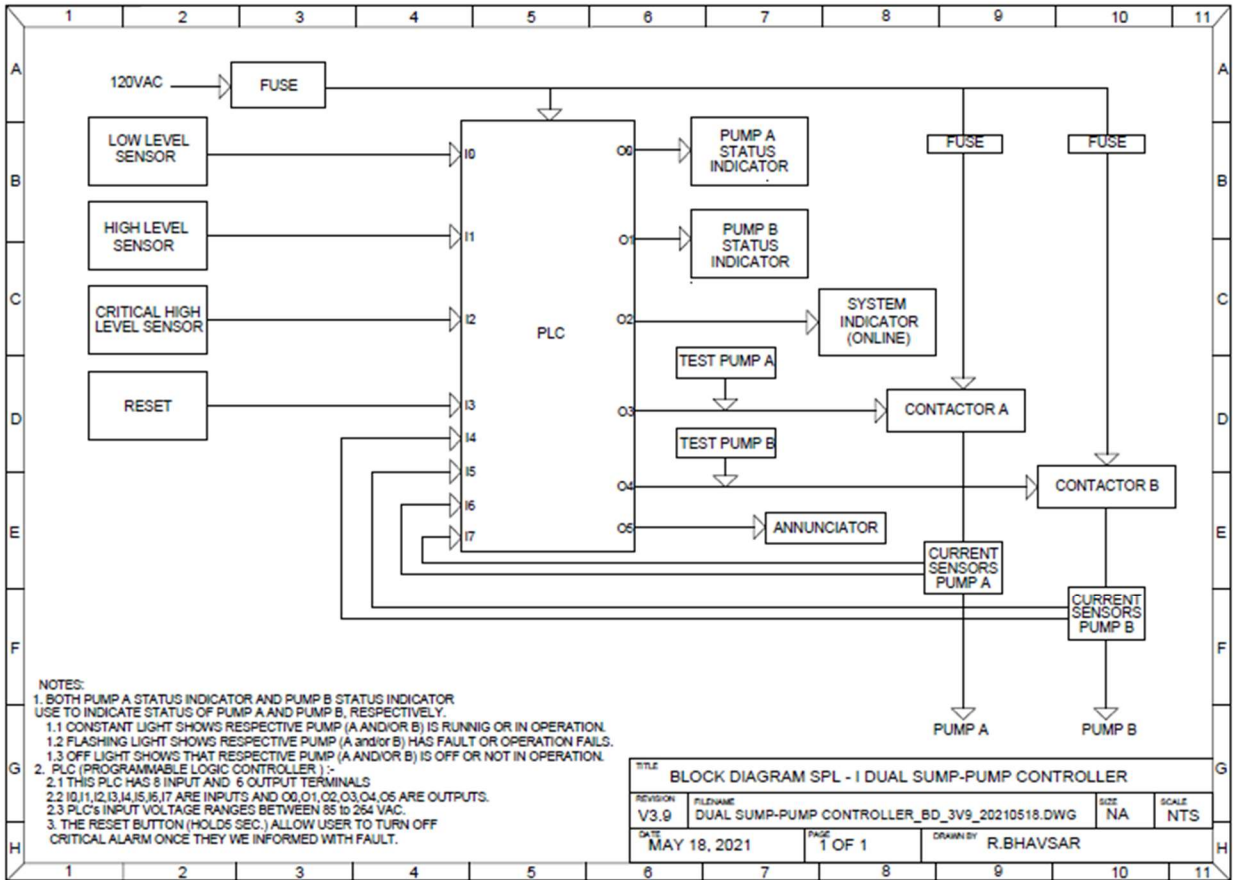
|  |                    |  |                       |  |                    |  |
|--|--------------------|--|-----------------------|--|--------------------|--|
| Project: Dual Sump-pump Cont<br>Date: Fri 21-01-29 | Task               |  | Inactive Summary      |  | External Tasks     |  |
|  | Split              |  | Manual Task           |  | External Milestone |  |
|  | Milestone          |  | Duration-only         |  | Deadline           |  |
|  | Summary            |  | Manual Summary Rollup |  | Progress           |  |
|  | Project Summary    |  | Manual Summary        |  | Manual Progress    |  |
|  | Inactive Task      |  | Start-only            |  |                    |  |
|  | Inactive Milestone |  | Finish-only           |  |                    |  |

Page 4

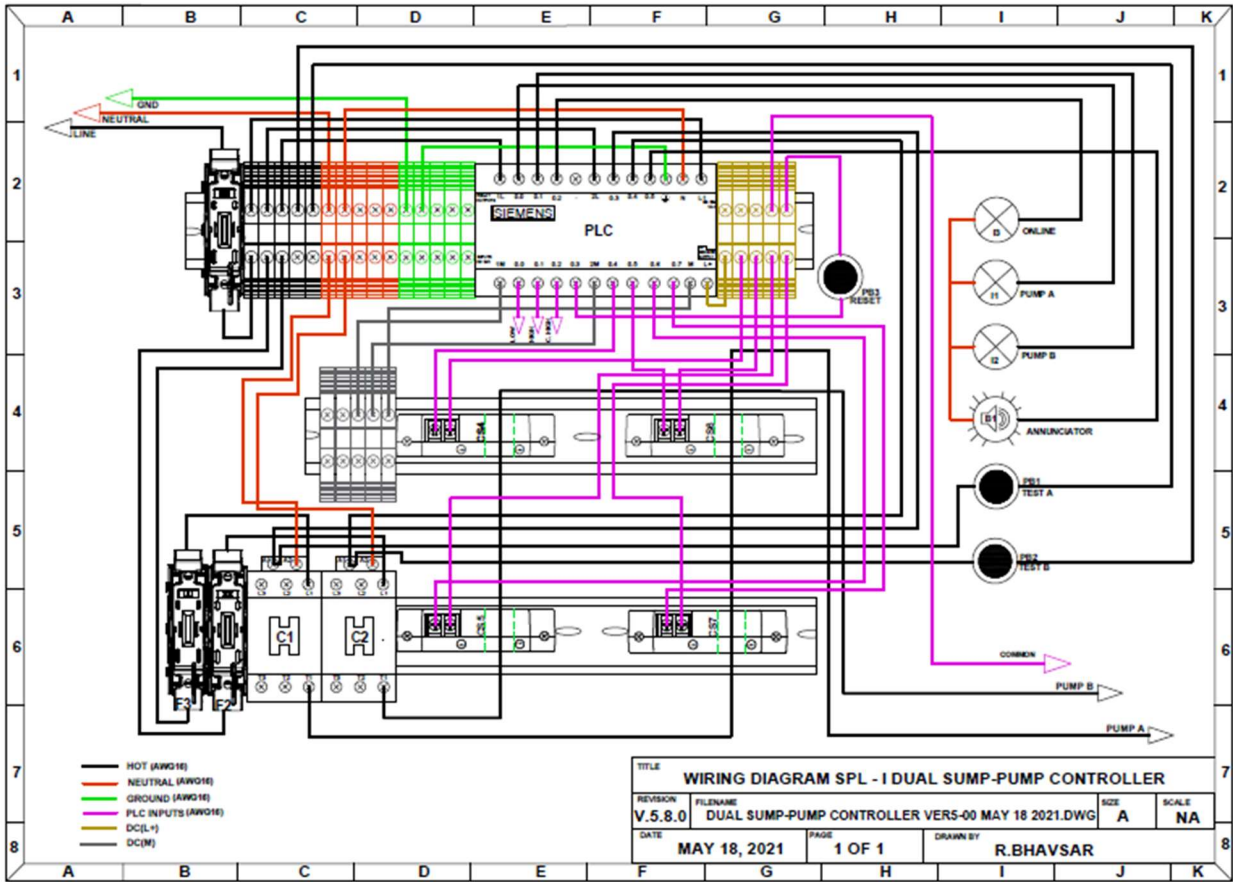




## Appendix B: Block Diagram



## Appendix C: Wiring Diagram



Appendix D: Parts List

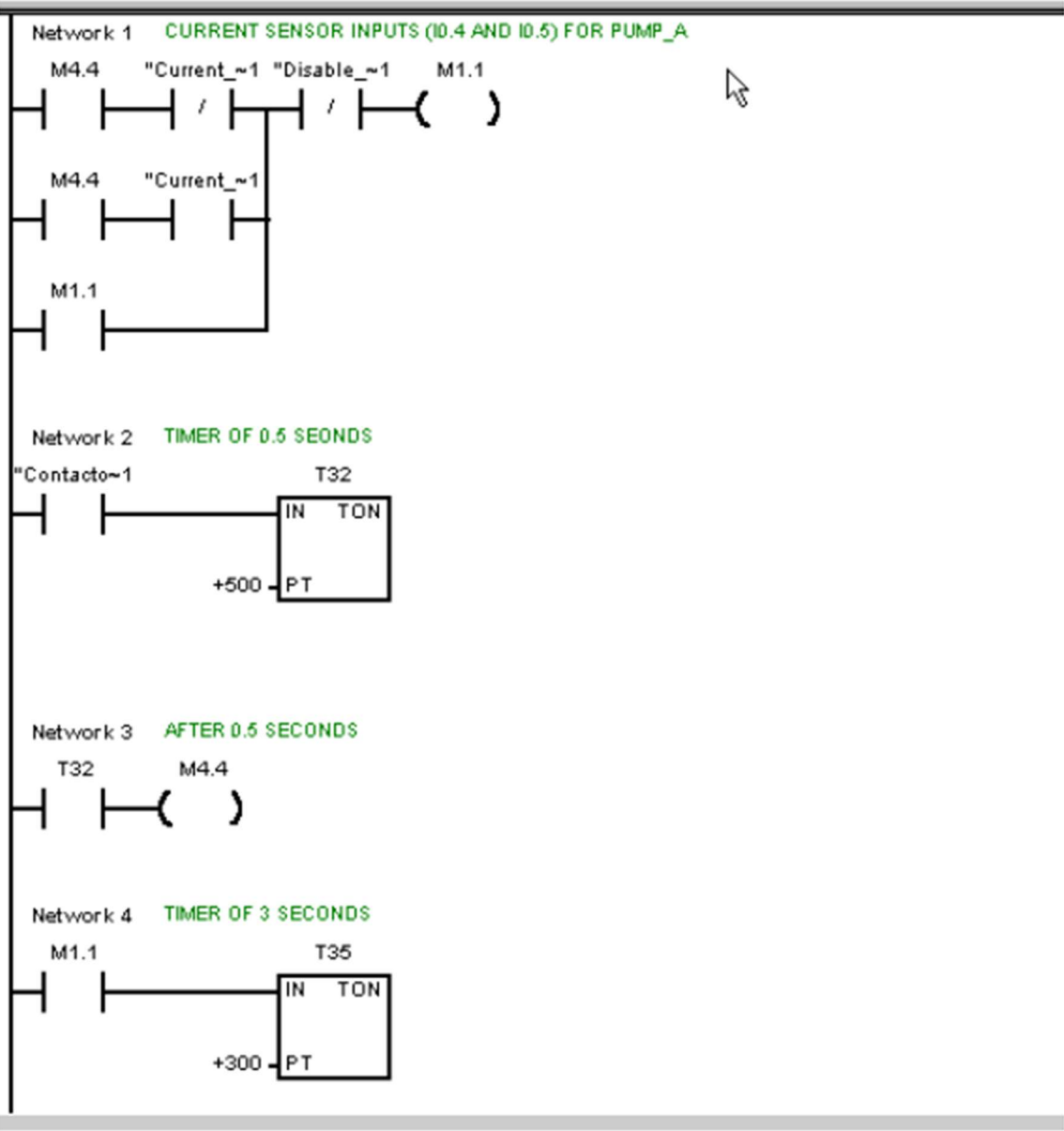
**PROJECT : DUAL SUMP-PUMP CONTROLLER**

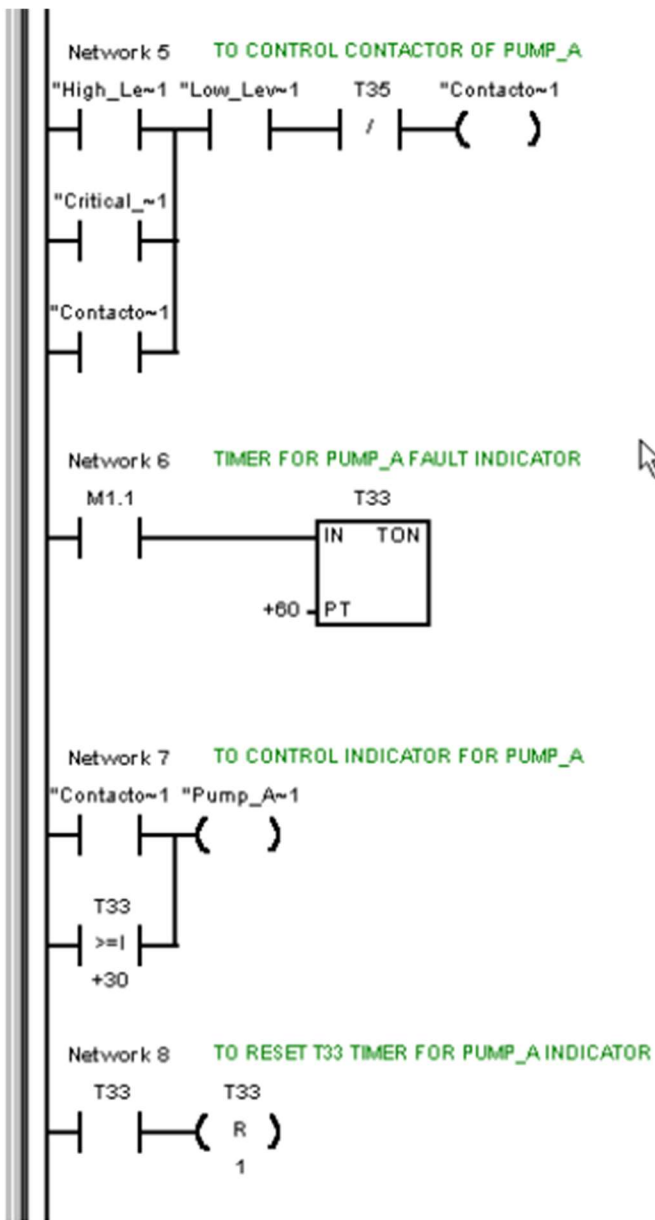
| REV: 8.00 |                                  | DATE: MAY 18, 2021 |                              | DRAWN BY: ROHAN BHAVSAR |                     |                             | SHEET 1 of 1       |           |             |
|-----------|----------------------------------|--------------------|------------------------------|-------------------------|---------------------|-----------------------------|--------------------|-----------|-------------|
| ITEM      | REF. DESIGNATOR OR ID ON DRAWING | QTY                | DESCRIPTION                  | MANUFACTURER            | MANUFACTURER PIN    | SUPPLIER                    | SUPPLIER PIN       | ITEM COST | TOTAL COST  |
| 1         | -                                | 1                  | DIN RAIL                     | DINNECTOR               | DN-R3SS1-2          | AUTOMATION DIRECT           | DN-R3SS1-2         | \$ 10.00  | \$ 5.00     |
| 2         | -                                | 5                  | TERMINAL_BLOCK               | KONNECT-IT              | KN-T12GRY-25        | AUTOMATION DIRECT           | KN-T12GRY-25       | \$ 6.75   | \$ 1.35     |
| 3         | -                                | 5                  | TERMINAL_BLOCK               | KONNECT-IT              | KN-T12BLK-25        | AUTOMATION DIRECT           | KN-T12BLK-25       | \$ 6.75   | \$ 1.35     |
| 4         | -                                | 5                  | TERMINAL_BLOCK               | KONNECT-IT              | KN-T12GRN-25        | AUTOMATION DIRECT           | KN-T12GRN-25       | \$ 6.75   | \$ 1.35     |
| 5         | -                                | 5                  | TERMINAL_BLOCK               | KONNECT-IT              | KN-T12YEL-25        | AUTOMATION DIRECT           | KN-T12YEL-25       | \$ 6.75   | \$ 1.35     |
| 6         | -                                | 5                  | TERMINAL_BLOCK               | KONNECT-IT              | KN-T12WHT-25        | AUTOMATION DIRECT           | KN-T12WHT-25       | \$ 6.75   | \$ 1.35     |
| 7         | -                                | 1                  | ENCLOSURE                    | ATTABOX                 | AH20168SS           | AUTOMATION DIRECT           | AH20168SS          | \$ 218.00 | \$ 218.00   |
| 8         | -                                | 2                  | FUSE                         | EDISON                  | MEQ10               | AUTOMATION DIRECT           | MEQ10              | \$ 84.00  | \$ 16.80    |
| 9         | -                                | 1                  | FUSE                         | EDISON                  | MEQ20               | AUTOMATION DIRECT           | MEQ20              | \$ 84.00  | \$ 8.40     |
| 10        | -                                | 4                  | SAPRATOR                     | AUTOMATION DIRECT       | KN-ST1WHT           | AUTOMATION DIRECT           | KN-ST1WHT          | \$ 3.00   | \$ 1.20     |
| 11        | -                                | 1                  | END COVER                    | AUTOMATION DIRECT       | KN-ECET6WHT         | AUTOMATION DIRECT           | KN-ECET6WHT        | \$ 2.00   | \$ 0.20     |
| 12        | -                                | 22                 | TOP COVER                    | AUTOMATION DIRECT       | KN-TC-1             | AUTOMATION DIRECT           | KN-TC-1            | \$ 6.75   | \$ 5.94     |
| 13        | -                                | 25                 | JUMPERS                      | AUTOMATION DIRECT       | KN-2J12             | AUTOMATION DIRECT           | KN-2J12            | \$ 8.25   | \$ 4.13     |
| 14        | -                                | 6                  | END BRACKETS                 | AUTOMATION DIRECT       | KN-EB4-10           | AUTOMATION DIRECT           | KN-EB-10           | \$ 3.00   | \$ 1.80     |
| 15        | -                                | 1                  | FINGURE CHANNEL              | AUTOMATION DIRECT       | T1-1022W-1          | AUTOMATION DIRECT           | T1-1022W-1         | \$ 19.50  | \$ 19.50    |
| 12        | -                                | 2                  | L16 3/8" LOOMEX/BX CONNECTOR | REXEL                   | THSL16              | ABB,INC                     | THSL16             | \$ 0.45   | \$ 0.90     |
| 13        | -                                | 1                  | NEMA 5-20 (PLUG)             | BRYANT                  | BRY336NP            | AUTOMATION DIRECT           | BRY336NP           | \$ 10.00  | \$ 10.00    |
| 14        | -                                | 6                  | DIN RAIL MOUNTING SCREW      | PHILIPS                 | 7985                | WURTH                       | 46510              | \$ 0.50   | \$ 3.00     |
| 15        | -                                | 1                  | CABLE                        | SOUTHWIRE               | SOOW-18-3BK-1       | AUTOMATION DIRECT           | SOOW-18-3BK-1      | \$ 0.43   | \$ 0.86     |
| 16        | B1                               | 1                  | ANUNCIATOR                   | AUTOMATION DIRECT       | ECX2071-127R        | AUTOMATION DIRECT           | ECX2071-127R       | \$ 9.25   | \$ 9.25     |
| 17        | C1,C2                            | 2                  | CONTACTOR                    | FUJI ELECTRIC           | SC-E02-110VAC       | AUTOMATION DIRECT           | SC-E02-110VAC      | \$ 17.00  | \$ 34.00    |
| 18        | CS1,CS2,CS3,CS4                  | 4                  | CURRENT SENSOR               | ACUAMP                  | ACS150-CE-F         | AUTOMATION DIRECT           | ACS150-CE-F        | \$ 67.00  | \$ 268.00   |
| 19        | F1,F2,F3                         | 3                  | FUSE BLOCK                   | BUSSMANN                | RM25030-1SR         | AUTOMATION DIRECT           | RM25030-1SR        | \$ 9.75   | \$ 29.25    |
| 20        | I1,I2                            | 2                  | YELLOW LED INDICATOR         | AUTOMATION DIRECT       | ECX1053-120         | AUTOMATION DIRECT           | ECX1053-120        | \$ 7.25   | \$ 14.50    |
| 21        | I3                               | 1                  | GREEN LED INDICATOR          | AUTOMATION DIRECT       | ECX1052-120         | AUTOMATION DIRECT           | ECX1052-120        | \$ 7.25   | \$ 7.25     |
| 22        | PB1,PB2,PB3                      | 3                  | PUSH BUTTON                  | AUTOMATION DIRECT       | GCX1104             | AUTOMATION DIRECT           | GCX1104            | \$ 7.25   | \$ 21.75    |
| 23        | PLC                              | 1                  | PLC                          | SIEMENSE                | 6ES7 212-1BA01-0XB0 | WORLD INDUSTRIAL AUTOMATION | 6ES7212-1BA01-0XB0 | \$ 557.88 | \$ 557.88   |
| 24        |                                  |                    |                              |                         |                     |                             |                    |           |             |
| 25        |                                  |                    |                              |                         |                     |                             |                    | Total=    | \$ 1,239.16 |

## Appendix E: Code

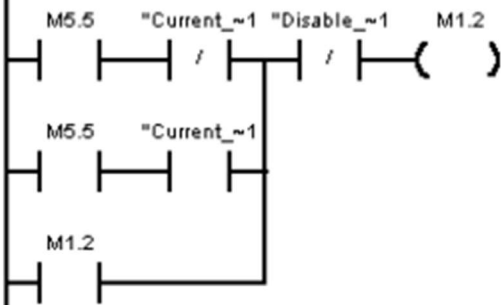


|    | <b>Name</b>             | <b>Address</b> |  |
|----|-------------------------|----------------|--|
| 1  | Pump_A_Status_Indicator | Q0.0           |  |
| 2  | Pump_B_Status_indicator | Q0.1           |  |
| 3  | Syetem_Enable_Indicator | Q0.2           |  |
| 4  | Contactor_A             | Q0.3           |  |
| 5  | Contactor_B             | Q0.4           |  |
| 6  | Annunciator             | Q0.5           |  |
| 7  | Low_Level_Sensor        | I0.0           |  |
| 8  | High_Level_Sensor       | I0.1           |  |
| 9  | Critical_High_Level_Sen | I0.2           |  |
| 10 | Disable_Annunciator     | I0.3           |  |
| 11 | Current_Sensor_Pump_A_0 | I0.4           |  |
| 12 | Current_Sensor_Pump_A_1 | I0.5           |  |
| 13 | Current_Sensor_Pump_B_0 | I0.6           |  |
| 14 | Current_Sensor_Pump_B_1 | I0.7           |  |
| 15 |                         |                |  |
| 16 |                         |                |  |
| 17 |                         |                |  |

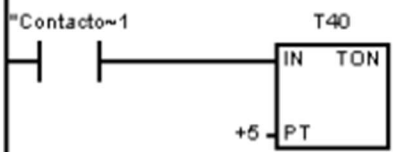




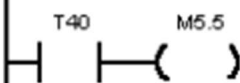
Network 9 CURRENT SENSOR INPUTS (I0.6 AND I0.7) FOR PUMP\_B



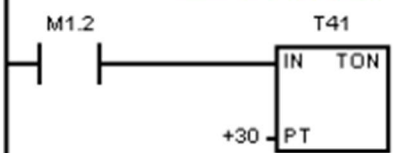
Network 10 TIMER OF 0.5 SECONDS

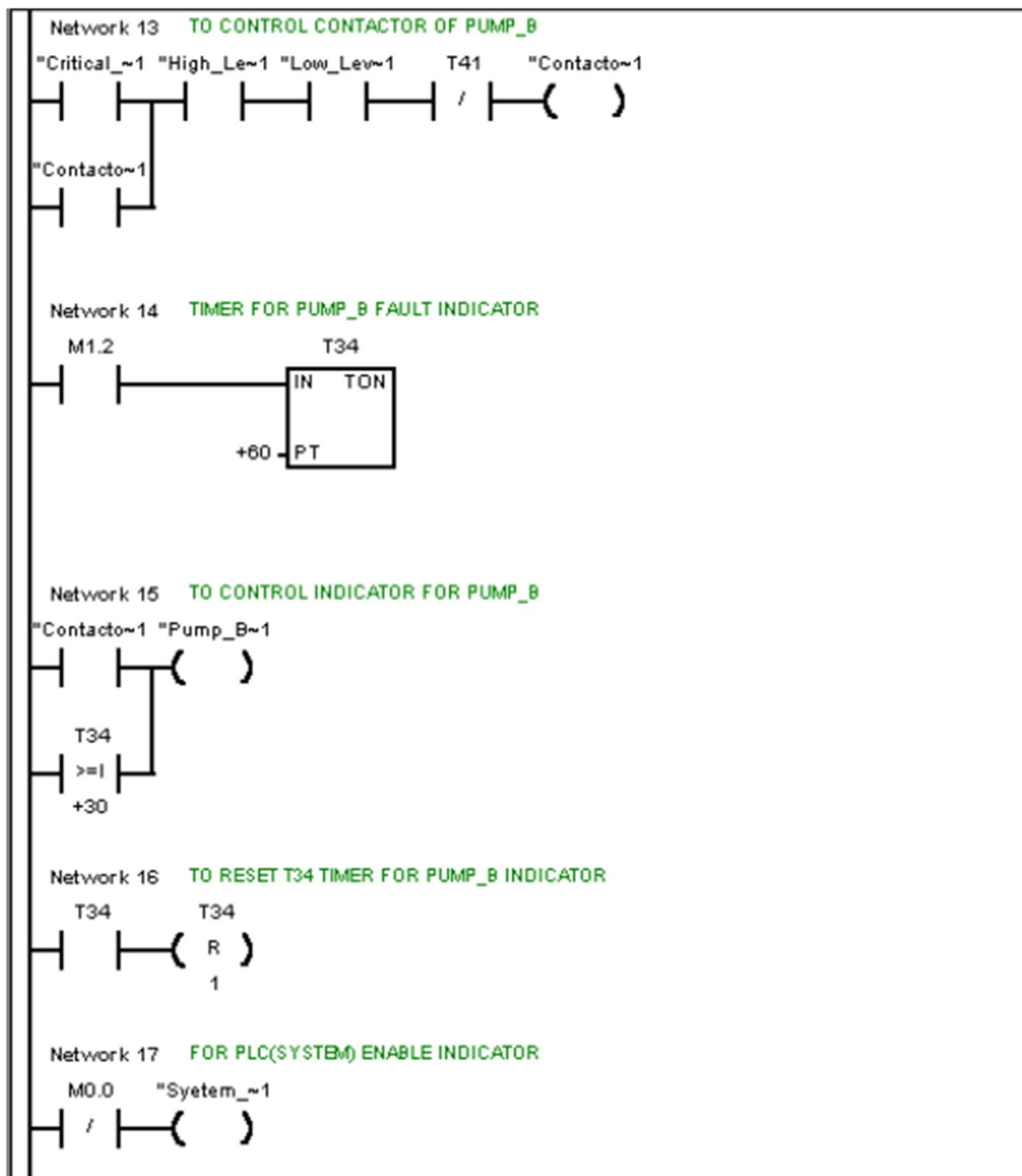


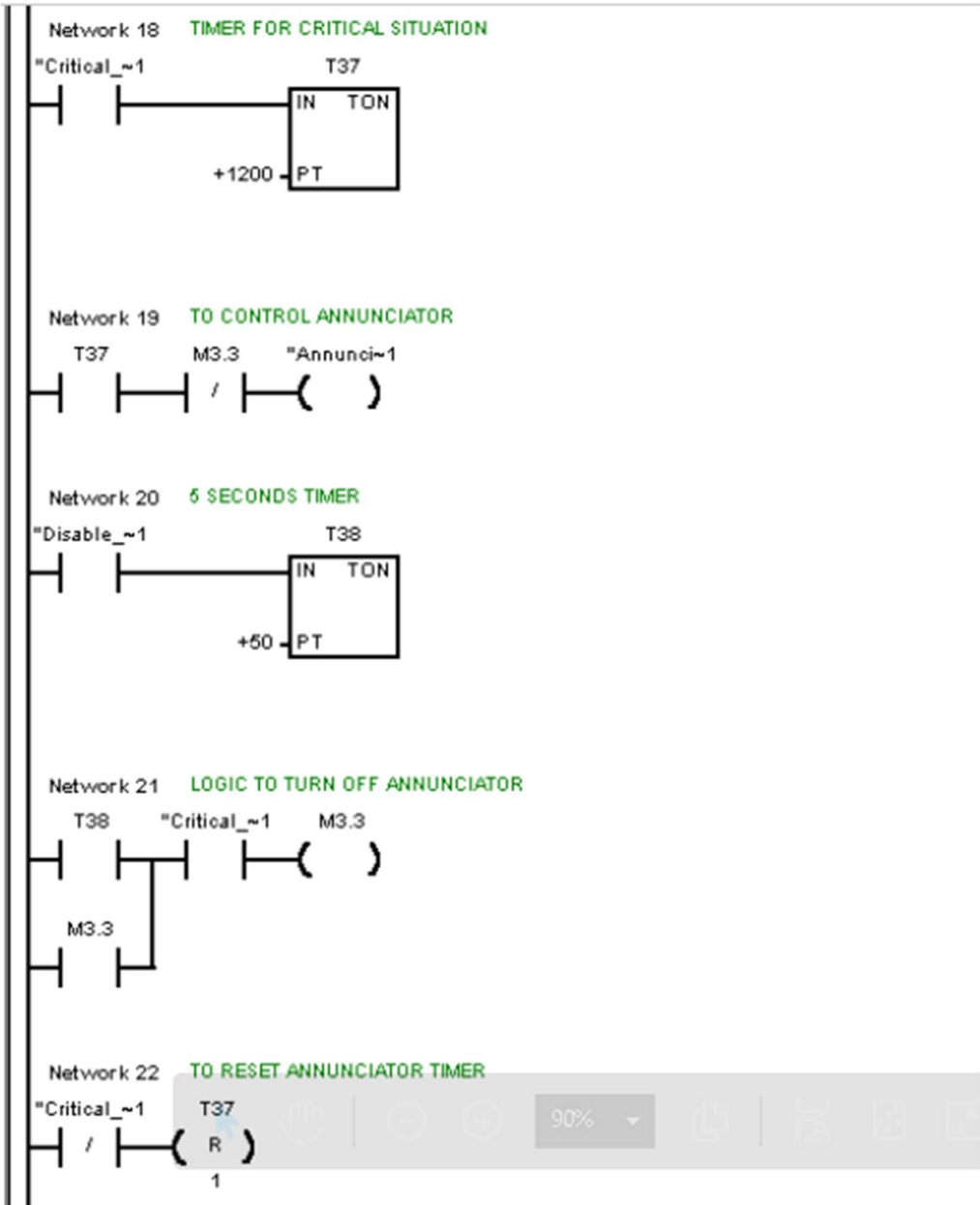
Network 11 AFTER 0.5 SECONDS



Network 12 TIMER OF 3 SECONDS







## Appendix F: Design Calculations

## Calculation of area for Panel

|  |  |  |
|--|--|--|
| <p style="text-align: center;"><u>Terminal blocks</u></p> $\begin{aligned} & (2 \times 5 \text{ mm}) (0.20") \\ + & (2 \times 45 \text{ mm}) (0.0") \\ \hline & 100 \text{ mm} \\ \times & (25) \\ \hline & \boxed{2500 \text{ mm}^2} \end{aligned}$ | <p style="text-align: center;"><u>3 LED</u></p> <p style="text-align: center;">LED indicator</p> $\begin{aligned} & 30 \text{ mm (D)} \\ \times & 2 \text{ pin} \\ \hline & 94.25 \\ \times & (3) \\ \hline & \boxed{282.74 \text{ mm}^2} \end{aligned}$ | <p style="text-align: center;"><u>1st P.B.</u></p> $\begin{aligned} & 40 \text{ mm} \\ \times & 30 \text{ mm} \\ \hline & 140 \text{ mm} \\ \times & (2) \\ \hline & \boxed{280 \text{ mm}^2} \end{aligned}$ |
|--|--|--|

|   |  |   |
|---|--|---|
| <p style="text-align: center;"><u>Buzzer</u></p> $\begin{aligned} & 30 \text{ mm (D)} \\ \times & (1) \text{ pin} \\ \hline & 94.25 \text{ mm} \end{aligned}$ | <p style="text-align: center;"><u>Connectors</u></p> $\begin{aligned} & 80 \text{ mm} \\ \times & 43 \text{ mm} \\ \hline & 246 \text{ mm} \\ \times & (2) \\ \hline & \boxed{492 \text{ mm}^2} \end{aligned}$ | <p style="text-align: center;"><u>Current Sensor</u></p> $\begin{aligned} & (2578.9) (3.53") \\ + & (2123.6) (1.15") \\ \hline & 226 \text{ mm} \\ \times & (4) \\ \hline & \boxed{904 \text{ mm}^2} \end{aligned}$ |
|---|--|---|

|   |  |
|---|--|
| <p style="text-align: center;"><u>Fuse block</u></p> $\begin{aligned} & 2 \times 25.7 (1.01") \\ + & 2 \times 90.1 (3.90") \\ \hline & 250 \text{ mm} \\ \times & (1) \\ \hline & \boxed{250 \text{ mm}^2} \end{aligned}$ | <p style="text-align: center;"><u>PLC</u></p> $\begin{aligned} & (2 \times 160) (6.3") \\ + & (2 \times 80) (3.15") \\ \hline & 480 \text{ mm} \\ \times & (1) \\ \hline & \boxed{480 \text{ mm}^2} \end{aligned}$ |
|---|--|

\* All dimension take from datasheet

$$\begin{aligned} \text{Total dimension} &= 5283 \text{ mm} \\ &= (207.99") \end{aligned}$$



## Appendix G: Datasheets

Fuse (MEQ20, MEQ10)

1 - 800 - 633 - 0405

For the latest prices, please check AutomationDirect.com.

# General Purpose Midget Class MEQ Fuses



## Features

- Compact dimensions
- Fiber tube construction
- Time-delay allows harmless inductive surges to pass without needless fuse opening

## Applications

- Supplemental protection of transformers, solenoids, and other high-inrush circuits
- For motor branch circuit applications, refer to EDCC fuses

## MEQ Specifications

### Time-Delay

Voltage Rating: MEQ - 500 VAC  
Ampere Rating: 0.25 - 30 Amps  
Interrupting Rating: 10,000 RMS Amps

### Agency Approvals

- (0.25 - 30) UL Listed, File E162443
- (0.25 - 30) CSA Certified C22.2, Part 59.2, LR700489
- CE Compliant

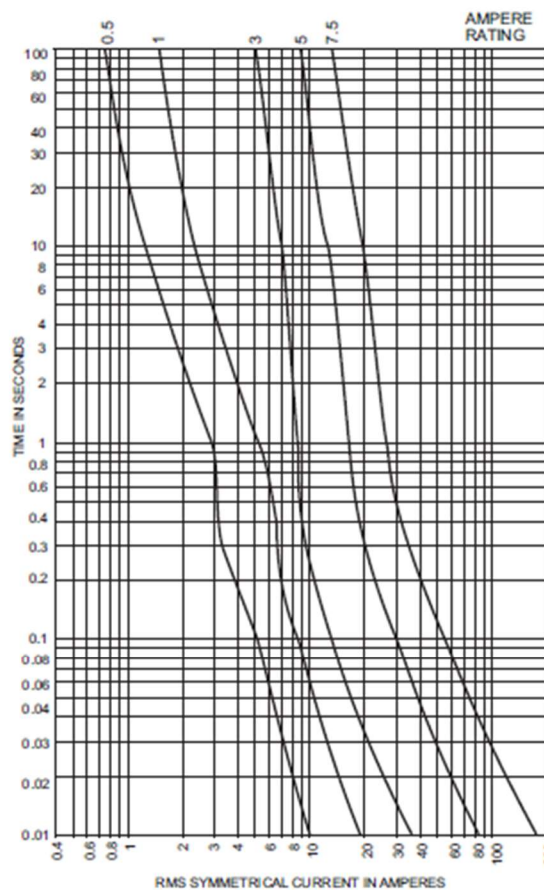


| MEQ General Purpose Midget Class Fuses |            |         |                |          |
|--|------------|---------|----------------|----------|
| Part Number                            | AMP Rating | Pcs/Pkg | Package Weight | Price    |
| MEQ-25                                 | 0.25       | 10      | 0.2 lb         | \$93.00  |
| MEQ-5                                  | 0.5        |         |                | \$87.00  |
| MEQ1                                   | 1          |         |                | \$84.00  |
| MEQ1-5                                 | 1.5        |         |                | \$87.00  |
| MEQ2                                   | 2          |         |                | \$84.00  |
| MEQ2-5                                 | 2.5        |         |                | \$87.00  |
| MEQ3                                   | 3          |         |                | \$84.00  |
| MEQ3-5                                 | 3.5        |         |                | \$93.00  |
| MEQ4                                   | 4          |         |                | \$84.00  |
| MEQ4-5                                 | 4.5        |         |                | \$101.00 |
| MEQ5                                   | 5          |         |                | \$84.00  |
| MEQ6                                   | 6          |         |                | \$84.00  |
| MEQ7                                   | 7          |         |                | \$87.00  |
| MEQ8                                   | 8          |         |                | \$84.00  |
| MEQ10                                  | 10         |         |                | \$84.00  |
| MEQ12                                  | 12         |         |                | \$84.00  |
| MEQ15                                  | 15         |         |                | \$84.00  |
| MEQ20                                  | 20         |         |                | \$84.00  |
| MEQ25                                  | 25         |         |                | \$84.00  |
| MEQ30                                  | 30         |         |                | \$84.00  |

| DIMENSIONS |              |             |
|------------|--------------|-------------|
| Amps       | Ferrule (in) | Length (in) |
| 0.25 - 30  | 13/32        | 1-1/2       |

| CROSS REFERENCE |          |       |            |
|-----------------|----------|-------|------------|
| EDISON          | BUSSMANN | GOULD | LITTELFUSE |
| MEQ             | FNQ      | ATQ   | FLO        |

Characteristic Curves

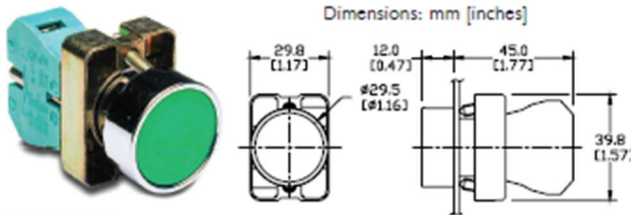


www.automationdirect.com

Circuit Protection tCPR-166

## GCX Series 22mm Metal Pushbuttons

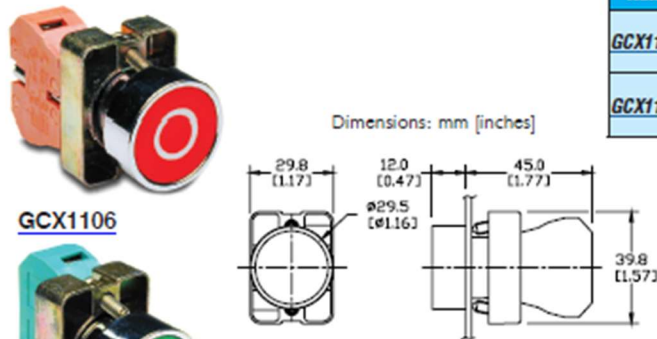
Momentary flush pushbuttons with protective metal ring (30mm dia. actuator)



**GCX1102**

| Part Number             | Color  | Price  | Description   |
|-------------------------|--------|--------|---|
| <a href="#">GCX1100</a> | Black  | \$7.25 | One N.O. contact block, 30mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1101</a> | Red    | \$7.25 | One N.C. contact block, 30mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1102</a> | Green  | \$7.25 | One N.O. contact block, 30mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1103</a> | Yellow | \$7.25 |   |
| <a href="#">GCX1104</a> | Blue   | \$7.25 |   |
| <a href="#">GCX1105</a> | White  | \$7.25 |   |

Momentary Flush ON/OFF pushbuttons with protective metal ring (30mm dia. actuator)

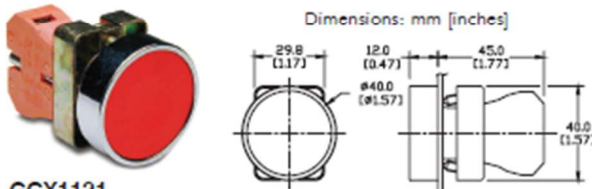


**GCX1106**

**GCX1107**

| Part Number             | Color                                  | Price  | Description   |
|-------------------------|--|--------|---|
| <a href="#">GCX1106</a> | Red with "Off" symbol (O) on actuator  | \$8.00 | One N.C. contact block, 30mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1107</a> | Green with "On" symbol (I) on actuator | \$8.00 | One N.O. contact block, 30mm dia. actuator, mounts in 22mm hole |

Momentary Pushbuttons with protective metal ring (40mm dia. actuator)



**GCX1121**

| Part Number             | Color  | Price  | Description   |
|-------------------------|--------|--------|---|
| <a href="#">GCX1120</a> | Black  | \$8.50 | One N.O. contact block, 40mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1121</a> | Red    | \$8.50 | One N.C. contact block, 40mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1122</a> | Green  | \$8.50 | One N.O. contact block, 40mm dia. actuator, mounts in 22mm hole |
| <a href="#">GCX1123</a> | Yellow | \$8.50 |   |
| <a href="#">GCX1124</a> | Blue   | \$8.50 |   |
| <a href="#">GCX1125</a> | White  | \$8.50 |   |

*Note: Protective silicone covers are not available for this pushbutton.*

For accessories, see 22mm Metal Pilot Device Accessories in this section.

# GCX Series 22mm Metal Pilot Devices

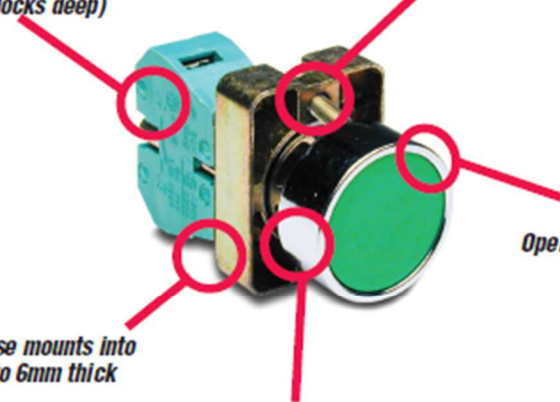
## Features

*Any combination of contact blocks is allowed, up to a total of six (two blocks wide and three blocks deep)*

*Secure mounting method eliminates twisting in mounting hole*

*Support base mounts into panels up to 6mm thick*

*Operators are protected to IP65*



*Chrome-plated alloy bezel is not only corrosion-resistant, but also attractive*

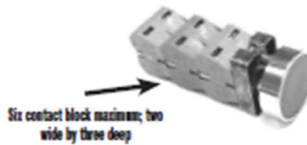
## Easy installation



To remove operator, press toward support base and twist counterclockwise.



To install switch, place support base against rear of panel (not shown here), insert the operator and twist clockwise until it clicks into place. Carefully tighten the securing screws. Do not over-tighten.



Six contact block maximum; two wide by three deep

*Self-cleaning silver contacts provide reliable, low-energy switching*

*Contacts rated A300 (Refer to E22 Series mounting/contact rating section for details)*



*Pressure plate wiring terminals for easy, secure wiring, accepting up to 14 AWG wire*

Minimum current rating 15mA @ 24Vdc

Clear contact block for illustration purposes. Clear contact blocks are not available for sale from AutomationDirect.

*All indicators offer side wire entry with back screw terminals for easy wiring*





Contactors (SC-E02-110VAC)

# Fuji Duo Series SC-E Contactors

## Features

- 5 to 100 hp at 480 VAC
- cULus and CSA approval, CE mark, meets JIS and IEC standards.
- Models SC-E02-xxx to SC-E4-xxx have 3-pole main circuits and come in three sizes with widths of 43 mm, 54 mm, and 67 mm.
- Models SC-E1-xxx to SC-E7-xxx employ a box terminal structure; allowing wires to be connected directly to the main circuit.
- Has a finger-protection terminal structure that prevents the exposure of live parts.
- Models SC-E5-xxx to SC-E7-xxx use a SUPERMAGNET™ (AC-input/DC-output operation) for high operating reliability and requires no surge suppressor.

## Small Size

- SC-E02-xxx to E05-xxx: 43mm wide
- SC-E1-xxx to E25-xxx: 54mm wide
- SC-E3-xxx, E4-xxx: 67mm wide
- SC-E5-xxx: 88mm wide



SC-E2S



SC-E7

## Safety

- Terminals with finger-touch protection (DIN 57106/VDE 0106 Teil100)

## Utility

- Box lug terminal construction
- Long electrical life
- Easy to wire

## Environmental

- Low power consumption
- Recycled thermoplastic resin used for plastic parts.
- The names of materials are indicated on all major parts to facilitate recycling

## Standards & Approvals

- UL listed, file E42419, Standard UL 508
- cUL listed, file E42419, Standard CSA C 22.2 No.14
- VDE 0660
- JIS C 8201-4-1
- IEC 60947-4-1 / EN 60947-4-1
- CE compliant

## Optional accessories

- Auxiliary contact blocks
- Coil surge suppression units
- Replacement coils for contactor sizes SC-E5 and larger

| SC-E Series Contactors Specifications - UL and CSA |         |   |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
|--|---------|---|---------------------|----------|----------|----------|---------------|----------|---------------------------------|---|-------------------|------------------------------|------------------|
| Model  | Price   | Nominal Coil Voltage  | Rated Capacity (HP) |          |          |          |               |          | Rated AC-3 Current (A) [note 1] | Rated AC-1 Thermal Current (A) [note 2] | SCCR Ratings (KA) | Rated Insulation Voltage (V) | Frame Width (mm) |
|  |         |   | 3-Phase Motor       |          |          |          | 1-Phase Motor |          |                                 |   |                   |                              |                  |
|  |         |   | 200V                | 220-240V | 440-480V | 550-600V | 100-120V      | 220-240V |                                 |   |                   |                              |                  |
| SC-E02-24 VAC                                      | \$17.00 | 24VAC   | 2                   | 2        | 5        | 5        | 1/3           | 1        | 9                               | 20                                      | 5                 | 690                          | 43               |
| SC-E02-110VAC                                      | \$17.00 | 110VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E02-220VAC                                      | \$17.00 | 220VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E02-440VAC                                      | \$17.00 | 440-480VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E02-500VAC                                      | \$17.00 | 500-550VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E02G-24VDC                                      | \$19.00 | 24VDC   |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E03-24 VAC                                      | \$21.50 | 24VAC   | 3                   | 3        | 7.5      | 7.5      | 1/2           | 2        | 12                              | 20                                      | 5                 | 690                          | 43               |
| SC-E03-110VAC                                      | \$21.50 | 110VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E03-220VAC                                      | \$21.50 | 220VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E03-440VAC                                      | \$21.50 | 440-480VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E03-500VAC                                      | retired | Please consider the Fuji Electric SC-E series as comparable replacement |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E03G-24VDC                                      | \$30.50 | 24VDC   | 3                   | 3        | 7.5      | 7.5      | 1/2           | 2        | 12                              | 20                                      |                   |                              |                  |
| SC-E04-24 VAC                                      | \$27.00 | 24VAC   | 5                   | 5        | 10       | 10       | 1             | 3        | 18                              | 25                                      | 5                 | 690                          | 43               |
| SC-E04-110VAC                                      | \$27.00 | 110VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E04-220VAC                                      | \$27.00 | 220VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E04-440VAC                                      | \$27.00 | 440-480VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E04-500VAC                                      | \$27.00 | 500-550VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E04G-24VDC                                      | \$37.50 | 24VDC   |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E05-24 VAC                                      | \$35.00 | 24VAC   | 5                   | 7.5      | 15       | 15       | 2             | 3        | 25                              | 32                                      | 5                 | 690                          | 43               |
| SC-E05-110VAC                                      | \$35.00 | 110VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E05-220VAC                                      | \$35.00 | 220VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E05-440VAC                                      | \$35.00 | 440-480VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E05-500VAC                                      | \$35.00 | 500-550VAC  |                     |          |          |          |               |          |                                 |   |                   |                              |                  |
| SC-E05G-24VDC                                      | \$45.00 | 24VDC   |                     |          |          |          |               |          |                                 |   |                   |                              |                  |

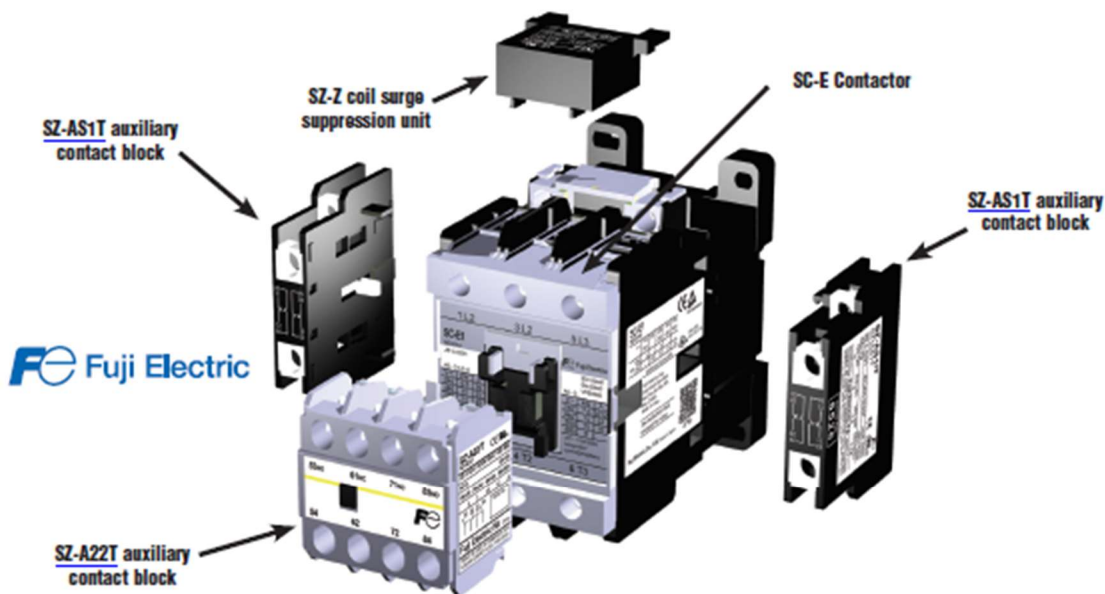
TABLE CONTINUED NEXT PAGE

Notes: 1. AC3 type loads consist of squirrel cage three-phase motors; occasional, limited jogging duty.  
 2. AC1 non-inductive or slightly inductive loads. Typically resistive loads (i.e. furnaces, ovens, etc.)

# Fuji Duo Series SC-E Contactors

## Accessories

Optional accessories



### Auxiliary contact blocks with terminal covers

Maximum auxiliary contact blocks: 2 side mounted (1 per side) OR 1 front mounted. The front and side blocks cannot be mounted together on the same contactor.



**SZ-A22T**



**SZ-A11T**



**SZ-AS1T**



**SZ-AS2T**

### Caution on use:

1. Front mounting auxiliary contact block and side mounting block cannot be attached to one contactor at the same time.
2. Only one front mounting block can be attached to one contactor.
3. Where interlock unit is already attached, side mounting auxiliary contact block can be attached on one side only.

| Auxiliary Contact Blocks with Terminal Covers |         |  |                |                    |                     |
|---|---------|--|----------------|--------------------|---------------------|
| Part Number                                   | Price   | Applicable Contactor   | Mounting       | Number of Contacts | Contact Arrangement |
| <b>SZ-A22T</b>                                | \$14.50 | SC-E02(G)-xxx to E4(G)-xxx   | Front mounting | 4                  | 2NO + 2NC           |
| <b>SZ-A20T</b>                                | \$9.00  |  |                | 2                  | 2NO                 |
| <b>SZ-A11T</b>                                | \$9.00  |  |                | 2                  | 1NO + 1NC           |
| <b>SZ-AS1T</b>                                | \$14.50 | SC-E5, E6, E7-xxx, SC-N4, N5, N6, N7, N8, N10, N11, N12, SC-E5(G)-xxx to E7(G)-xxx | Side mounting  | 2                  | 1NO + 1NC           |
| <b>SZ-AS2T</b>                                | \$14.50 |  |                | 2                  | 1NO + 1NC           |

| Accessory Auxiliary Contact Ratings - UL and CSA |           |             |             |                    |
|--|-----------|-------------|-------------|--------------------|
| NEMA ICS 5-2000 Ratings <small>(note 1)</small>  |           |             |             |                    |
| AC Ratings                                       |           |             | DC Ratings  |                    |
| Designation                                      | Making VA | Breaking VA | Designation | Making/Breaking VA |
| A600   | 7200      | 720         | Q300        | 69                 |

For more information, refer to Control Circuit Contact Electrical Ratings, page MRC-111

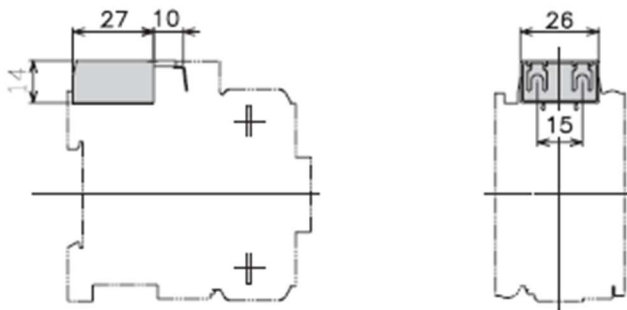
Accessory Auxiliary Contact Ratings - IEC and JIS continued on next page.

# Fuji Duo Series SC-E Contactors

## Dimensions (mm)

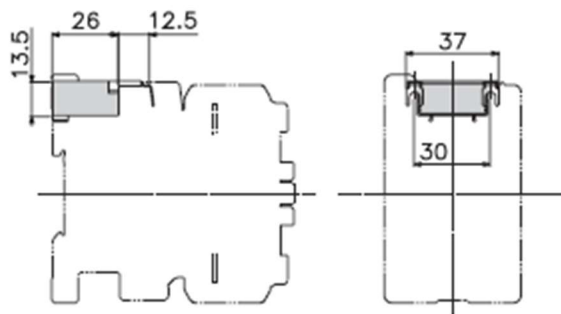
### Coil surge suppression units

#### SZ-Z1, Z2, Z4, Z5

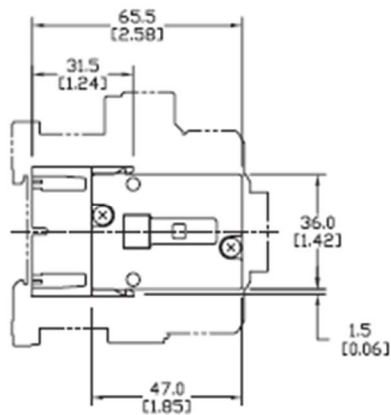


Weight: 14 g

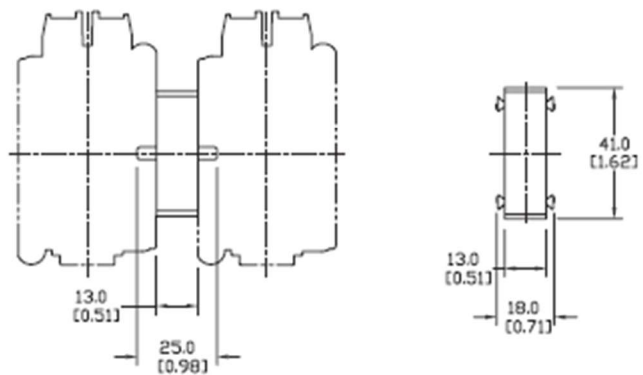
#### SZ-Z31, Z32, Z34, Z35, Z36, Z36, Z37



Weight: 15 g

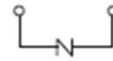


#### SZ-RM

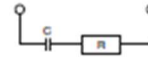


## Wiring diagrams

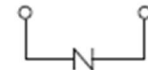
#### SC-E02 to E05-xxx + SZ-Z1, Z2 (Built-in varistor)



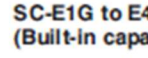
#### SC-E02 to E05-xxx + SZ-Z4, Z5 (Built-in capacitor/resistor)



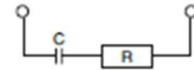
#### SC-E1 to E4-xxx + SZ-Z31, Z32 (Built-in varistor)



#### SC-E1 to E4-xxx + SZ-Z34, Z35 (Built-in capacitor/resistor)



#### SC-E1G to E4G-xxx + SZ-Z36, Z37 (Built-in capacitor/resistor)



## Annunciator (ECX2071-127R)

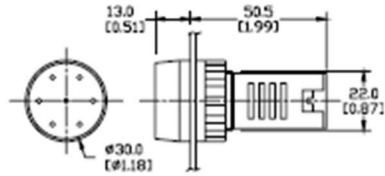
### Audible annunciator



- 80dB @ 10cm
- 25mA @ 24V
- Intermittent sound when energized
- IP20 before installation
- IP65 after installation

| Part Number         | Color | Price  | Description  |
|---------------------|-------|--------|--|
| <b>ECX2070-24</b>   | Black | \$7.25 | 22mm, 25mA audible (80dB at 10cm) buzzer annunciator. 24VAC/DC                                     |
| <b>ECX2070-127</b>  | Black | \$7.25 | 22mm, 25mA audible (80dB at 10cm) buzzer annunciator. 120VAC/DC                                    |
| <b>ECX2071-24R</b>  | Red   | \$9.25 | 22mm, 25mA audible (80dB at 10cm) buzzer annunciator with non-replaceable LED indicator. 24VAC/DC  |
| <b>ECX2071-127R</b> | Red   | \$9.25 | 22mm, 25mA audible (80dB at 10cm) buzzer annunciator with non-replaceable LED indicator. 120VAC/DC |

Dimensions: mm [inches]





# ACUAMP ACS150 Series AC Current Switches



ACS150 Series current operated switches combine a current transformer, signal conditioner and limit alarm into a single package for use in monitoring or proof of operation applications. Offering an adjustable setpoint range of 1 to 150 amps and universal, solid-state outputs, the self-powered ACS150 can be tailored to provide accurate and dependable digital indication of over-current conditions across a broad range of applications. The ACS150 is available in fixed-core and split-core models.

## Applications

### Electronic Proof of Flow

- Current operated switch eliminates the need for multiple pipe or duct penetrations.
- More reliable than electromechanical pressure or flow switches.

### Conveyors

- Detect jams and overloads; useful when interlocking multiple conveyor sections

### Heating Circuits

- Detect ON/OFF status; faster response times than with temperature sensors.

### Loss of Load Detective

- Detect belt or coupling breaks with fast response times

### Lighting Circuits

- Easier and faster than photocells

## Features

- Choose from:  
N.O. 0.15 A @ 240VAC or VDC or  
N.C. 0.20 A @ 135VAC or VDC output options.
- Status LED provides visual indication of setpoint trip and contact action.
- Self-powered operation cuts installation time and operating costs.
- Potentiometer-adjustable trip points speed start-up and allow for tailored operation.
- Choose either split core or fixed core enclosure style. Split core packages allow easy installation on existing systems; fixed core enclosures offer more compact package for OEM or new installations.
- Built-in mounting feet with optional 35mm DIN rail adapter available.
- Five-year warranty



| ACS150 AC Current Operated Switches |   |         |         |         |
|-------------------------------------|---|---------|---------|---------|
| Part Number                         | Description   | Pcs/Pkg | Wt (lb) | Price   |
| ACS150-AE-F                         | AcuAMP AC current switch, fixed core, 1-150A sensing range, 1-150A adjustable trip point, 15-turn potentiometer, solid state switch, N.O. output, 0.15A @ 240 VAC/VDC output rating.      | 1       | 0.30    | \$67.00 |
| ACS150-AE-S                         | AcuAMP AC current switch, split core, 1.75-150A sensing range, 1.75-150A adjustable trip point, 4-turn potentiometer, solid state switch, N.O. output, 0.15A @ 240 VAC/VDC output rating. | 1       | 0.35    | \$82.00 |
| ACS150-CE-F                         | AcuAMP AC current switch, fixed core, 1-150A sensing range, 1-150A adjustable trip point, 15-turn potentiometer, solid state switch, N.C. output, 0.2A @ 135 VAC/VDC output rating.       | 1       | 0.30    | \$67.00 |
| ACS150-CE-S                         | AcuAMP AC current switch, split core, 1.75-150A sensing range, 1.75-150A adjustable trip point, 4-turn potentiometer, solid state switch, N.C. output, 0.2A @ 135 VAC/VDC output rating.  | 1       | 0.35    | \$82.00 |
| Accessories                         |   |         |         |         |
| DRA-2B                              | 35mm DIN rail adapters, 1.70"x0.45"x0.83" [43.7x11.4x21.0 mm]   | 2       | 0.40    | \$3.75  |

| ACS150 Sensed Current Limits |              |            |            |            |
|------------------------------|--------------|------------|------------|------------|
| Type                         | Input Range  | Amps       |            |            |
|                              |              | Continuous | 6 Sec. max | 1 Sec. max |
| Fixed Core                   | 1 to 150A    | 150        | 400        | 1000       |
| Split Core                   | 1.75 to 150A | 150        | 400        | 1000       |

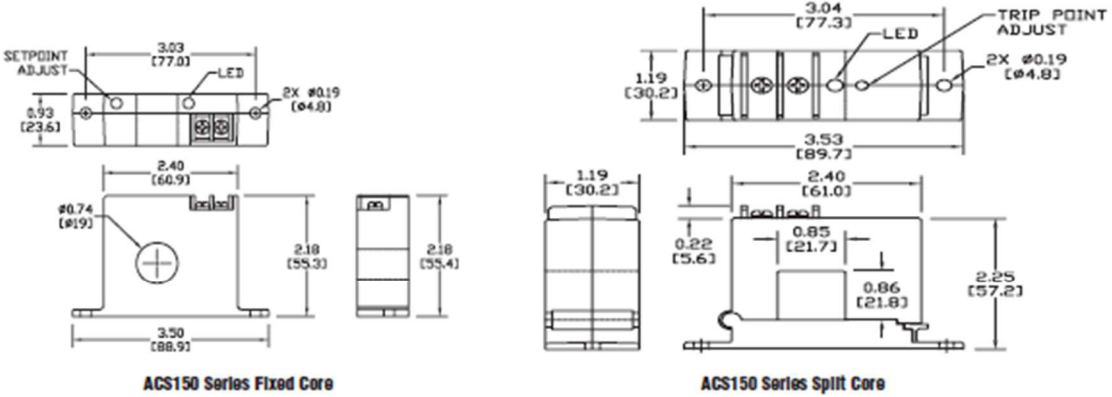
| ACS150 Series Specifications |   |
|------------------------------|---|
| Power Supply                 | None - Self-powered   |
| Output                       | Isolated solid-state switch   |
| Output Rating                | N.O. 0.15 A @ 240VAC or VDC<br>N.C. 0.20 A @ 135VAC or VDC          |
| Response Time                | 120ms   |
| Off State Leakage            | <10µA   |
| Setpoint (Trip Point)        | Fixed core: 1 to 150A. Split core: 1.75 to 150A                     |
| Hysteresis                   | 5% of Setpoint  |
| Setpoint (Trip Point) Adjust | Fixed core: 15-turn potentiometer; Split core: 4-turn potentiometer |
| Isolation Voltage            | UL listed to 1,270VAC. Tested to 5,000VAC (1 minute max)            |
| Frequency Range              | 6 to 100 Hz   |
| Case                         | UL 94V-0 flammability rated   |
| Environmental                | Operating Temperature: -58 to 149°F [-50 to 65°C]                   |
|                              | Relative Humidity: 0-95% RH, Non-condensing                         |
|                              | Pollution Degree 2  |
| Certifications               | Altitude to 2000 meters   |
|                              | cULus listed (E222847), CE  |



# ACS150 Series AC Current Switches

## Dimensions

Inches [mm]



ACS150 Series Fixed Core

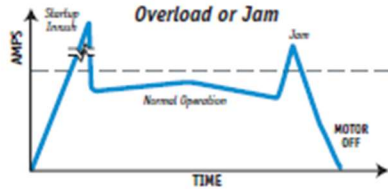
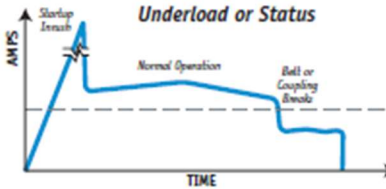
ACS150 Series Split Core

## Wiring

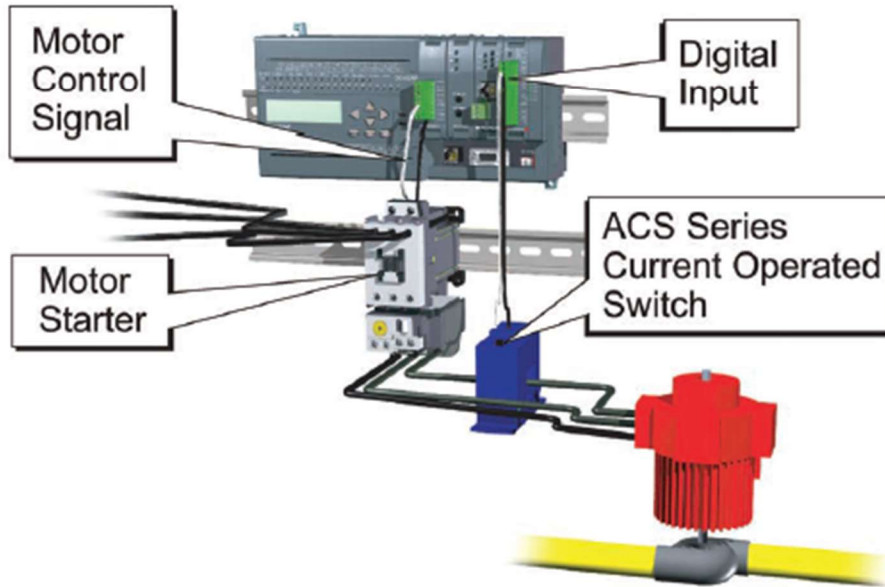
See our website [www.AutomationDirect.com](http://www.AutomationDirect.com) for complete Engineering drawings.



Terminals are #6 screws  
Use up to 14 AWG copper wire



## Application Example



# ACUAMP<sup>®</sup> AC Current Sensors, Switches and Transducers Application Guide

## Application Guide

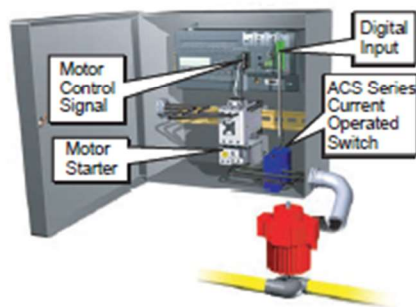
AcuAMP current sensors are a great fit for many applications including material handling, fan and pump applications, and heating systems. With current

transducers, current switches and current indicators, this sensor family gives you valuable data for processes ranging from monitoring loads to preventive maintenance. Models with the ability to read True RMS non-sinusoidal waveforms make it

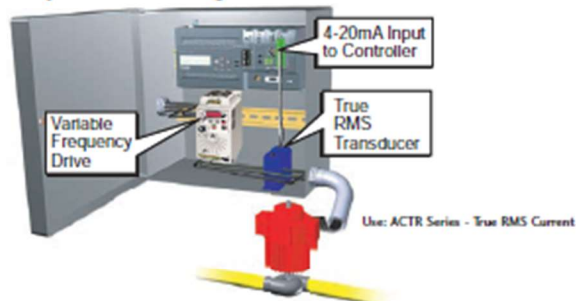
easy to monitor applications using variable frequency drives.

Use the application examples to help choose the best sensor model for your application.

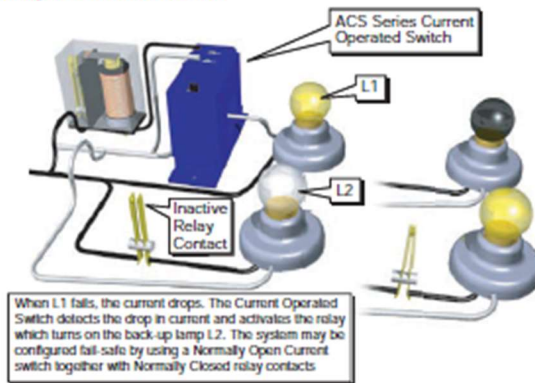
### Pump Jam & Suction Loss Protection



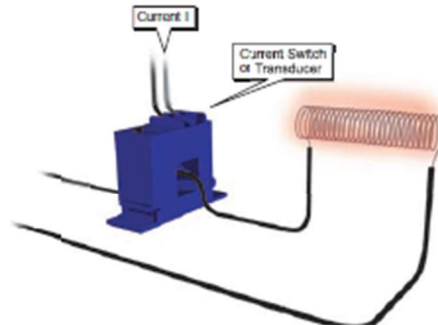
### Pump Load Monitoring



### Lamp Failure Detection



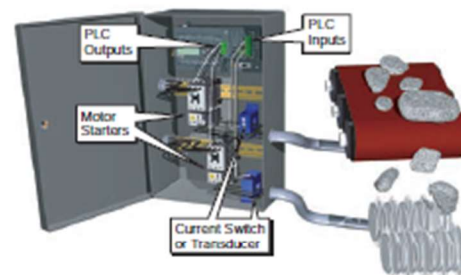
### Heater Life Prediction



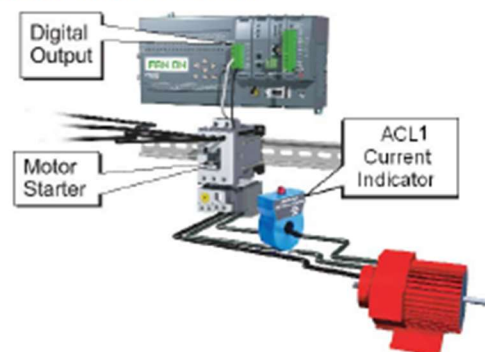
### Crusher/Grinder/Shredder Motor Interlocks

The performance of size reduction equipment like crushers or grinders can be optimized by controlling the in-feed in order to:

- Help prevent jamming
- Improve the uniformity of the resultant product
- Enhance overall production efficiency



### Electric Motor Load Status





### A.3 CPU 212 AC Power Supply, DC Inputs, Relay Outputs

**Order Number: 6ES7 212-1BA01-0XB0**

| General Features                              |  | Input Points                |   |
|---|--|-----------------------------|---|
| Physical size (L x W x D)                     | 160 x 80 x 62 mm<br>(6.3 x 3.15 x 2.44 in.)  | Input type (IEC 1131-2)     | Type 1 sinking                                  |
| Weight  | 0.4 kg (0.9 lbs.)  | ON state range              | 15-30 VDC, 4 mA minimum<br>35 VDC, 500 ms surge |
| Power dissipation                             | 6 W  | ON state nominal            | 24 VDC, 7 mA                                    |
| User program size/storage                     | 512 words/EEPROM   | OFF state maximum           | 5 VDC, 1 mA                                     |
| User data size/storage                        | 512 words/RAM  | Response time               | 10.0 to 10.7                                    |
| Data retention                                | 50 hr typical<br>(8 hr minimum at 40° C)   | Optical isolation           | 0.3 ms maximum<br>500 VAC, 1 min                |
| Local I/O <sup>1</sup>                        | 8 inputs/6 outputs   | Power Supply                |   |
| Maximum number of expansion modules           | 2  | Voltage/frequency range     | 85 to 264 VAC at 47 to 63 Hz                    |
| Digital I/O supported                         | 64 inputs/64 outputs   | Input current               | 4 VA typical, CPU only<br>50 VA maximum load    |
| Analog I/O supported                          | 16 inputs/16 outputs   | Holdup time                 | 20 ms minimum from<br>110 VAC                   |
| Boolean execution speed                       | 1.2 µs/instruction   | Inrush current              | 20 A peak at 264 VAC                            |
| Internal memory bits                          | 128  | Fusing (non-replaceable)    | 2 A, 250 V, slow blow                           |
| Timers  | 64 timers  | 5 VDC current               | 260 mA for CPU<br>340 mA for expansion I/O      |
| Counters                                      | 64 counters  | Isolated                    | Yes. Transformer, 1500 VAC,<br>1 min            |
| High-speed counters                           | 1 software (2 KHz max.)  | DC Sensor Supply            |   |
| Analog adjustments                            | 1  | Voltage range               | 20.4 to 28.8 VDC                                |
| Standards compliance                          | UL 508 CSA C22.2 142<br>FM Class I, Division 2<br>VDE 0160 compliant<br>CE compliant | Ripple/noise (<10MHz)       | 1 V peak-to-peak maximum                        |
| Output Points                                 |  | 24 VDC available current    | 180 mA  |
| Output type                                   | Relay, dry contact   | Short circuit current limit | < 600 mA  |
| Voltage range                                 | 5 to 30 VDC/250 VAC  | Isolated                    | No  |
| Maximum load current                          | 2 A/point, 6 A/common  |                             |   |
| Overcurrent surge                             | 7 A with contacts closed   |                             |   |
| Isolation resistance                          | 100 MΩ minimum (new)   |                             |   |
| Switching delay                               | 10 ms maximum  |                             |   |
| Lifetime                                      | 10,000,000 mechanical<br>100,000 with rated load                                     |                             |   |
| Contact resistance                            | 200 mΩ maximum (new)   |                             |   |
| Isolation                                     |  |                             |   |
| coil to contact                               | 1500 VAC, 1 min  |                             |   |
| contact to contact<br>(between open contacts) | 750 VAC, 1 min   |                             |   |
| Short circuit protection                      | None   |                             |   |

<sup>1</sup> The CPU reserves 8 process-image input and 8 process-image output image register points for local I/O.

## Provide Adequate Clearance for Cooling and Wiring

S7-200 devices are designed for natural convection cooling. For proper cooling, you must provide a clearance of at least 25 mm above and below the devices. Also, allow at least 75 mm of depth.

### Caution

For vertical mounting, the maximum allowable ambient temperature is reduced by 10 degrees C. Mount the S7-200 CPU below any expansion modules.

When planning your layout for the S7-200 system, allow enough clearance for the wiring and communications cable connections. For additional flexibility in configuring the layout of the S7-200 system, use the I/O expansion cable.

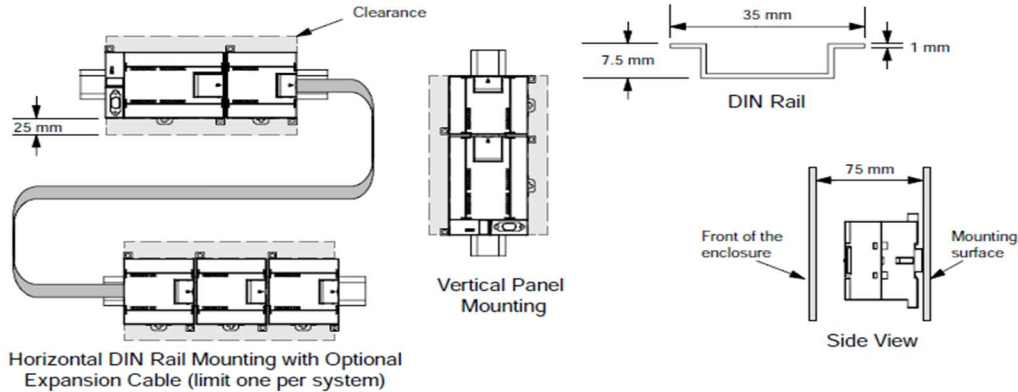


Figure 3-1 Mounting Methods, Orientation, and Clearance

## Mounting Dimensions

The S7-200 CPUs and expansion modules include mounting holes to facilitate installation on panels. Refer to Table 3-1 for the mounting dimensions.

Table 3-1 Mounting Dimensions

| S7-200 Module   | Width A  | Width B  |
|---|----------|----------|
| CPU 221 and CPU 222   | 90 mm    | 82 mm    |
| CPU 224   | 120.5 mm | 112.5 mm |
| CPU 224XP, CPU 224XPsi  | 140 mm   | 132 mm   |
| CPU 226   | 196 mm   | 188 mm   |
| Expansion modules: 4- and 8-point DC and Relay I/O (8I, 4Q, 8Q, 4I/4Q) and Analog Out (2 AQ)  | 46 mm    | 38 mm    |
| Expansion modules: 16-point digital I/O (16I, 8I/8Q), Analog I/O (4AI, 8AI, 4AQ, 4AI/1AQ), RTD, Thermocouple, PROFIBUS, Ethernet, Internet, AS-Interface, 8-point AC (8I and 8Q), Position, and Modem | 71.2 mm  | 63.2 mm  |
| Expansion modules: 32-point digital I/O (16I/16Q)   | 137.3 mm | 129.3 mm |
| Expansion modules: 64-point digital I/O (32I/32Q)   | 196 mm   | 188 mm   |

## Using Master and Slave Devices on a PROFIBUS Network

The S7-200 supports a master-slave network and can function as either a master or a slave in a PROFIBUS network, while STEP 7-Micro/WIN is always a master.

### Masters

A device that is a master on a network can initiate a request to another device on the network. A master can also respond to requests from other masters on the network. Typical master devices include STEP 7-Micro/WIN, human-machine interface devices such as a TD 200, and S7-300 or S7-400 PLCs. The S7-200 functions as a master when it is requesting information from another S7-200 (peer-to-peer communications).

### Slaves

A device that is configured as a slave can only respond to requests from a master device; a slave never initiates a request. For most networks, the S7-200 functions as a slave. As a slave device, the S7-200 responds to requests from a network master device, such as an operator panel or STEP 7-Micro/WIN.

## Setting the Baud Rate and Network Address

The speed that data is transmitted across the network is the baud rate, which is typically measured in units of kilobaud (kbaud) or megabaud (Mbaud). The baud rate measures how much data can be transmitted within a given amount of time. For example, a baud rate of 19.2 kbaud describes a transmission rate of 19,200 bits per second.

Every device that communicates over a given network must be configured to transmit data at the same baud rate. Therefore, the fastest baud rate for the network is determined by the slowest device connected to the network.

Table 7-1 lists the baud rates supported by the S7-200.

Table 7-1 Baud Rates Supported by the S7-200

| Network          | Baud Rate                |
|------------------|--------------------------|
| Standard Network | 9.6 kbaud to 187.5 kbaud |
| Using an EM 277  | 9.6 kbaud to 12 Mbaud    |
| Freeport Mode    | 1200 baud to 115.2 kbaud |

The network address is a unique number that you assign to each device on the network. The unique network address ensures that the data is transferred to or retrieved from the correct device. The S7-200 supports network addresses from 0 to 126. For an S7-200 with two ports, each port has a network address. Table 7-2 lists the default (factory) settings for the S7-200 devices.

Table 7-2 Default Addresses for S7-200 Devices

| S7-200 Device           | Default Address |
|-------------------------|-----------------|
| STEP 7-Micro/WIN        | 0               |
| HMI (TD 200, TP, or OP) | 1               |
| S7-200 CPU              | 2               |



# Bit Logic Instructions

## Contacts

### Standard Contacts

The Normally Open contact instructions (LD, A, and O) and Normally Closed contact instructions (LDN, AN, ON) obtain the referenced value from the memory or from the process-image register. The standard contact instructions obtain the referenced value from the memory (or process-image register if the data type is I or Q).

The Normally Open contact is closed (on) when the bit is equal to 1, and the Normally Closed contact is closed (on) when the bit is equal to 0. In FBD, inputs to both the And and Or boxes can be expanded to a maximum of 32 inputs. In STL, the Normally Open instructions Load, AND, or OR the bit value of the address bit to the top of the stack, and the Normally Closed instructions Load, AND, or OR the logical NOT of the bit value to the top of the stack.

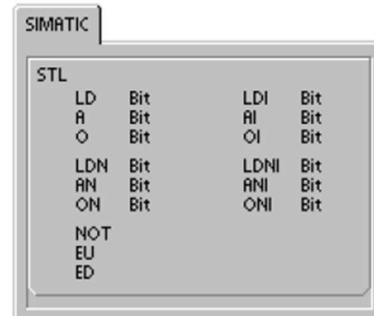
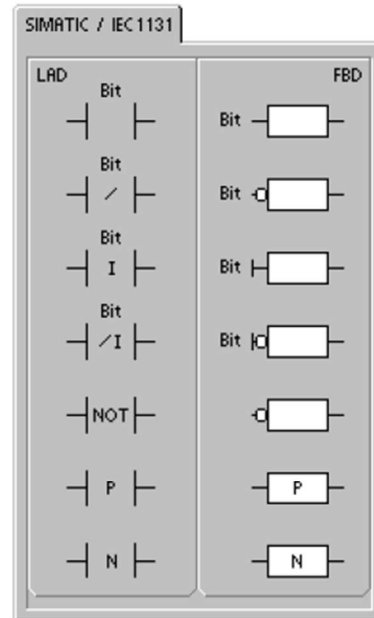
### Immediate Contacts

An immediate contact does not rely on the S7-200 scan cycle to update; it updates immediately. The Normally Open Immediate contact instructions (LDI, AI, and OI) and Normally Closed Immediate contact instructions (LDNI, ANI, and ONI) obtain the physical input value when the instruction is executed, but the process-image register is not updated.

The Normally Open Immediate contact is closed (on) when the physical input point (bit) is 1, and the Normally Closed Immediate contact is closed (on) when the physical input point (bit) is 0. The Normally Open instructions immediately Load, AND, or OR the physical input value to the top of the stack, and the Normally Closed instructions immediately Load, AND, or OR the logical NOT of the value of the physical input point to the top of the stack.

### NOT Instruction

The Not instruction (NOT) changes the state of power flow input (that is, it changes the value on the top of the stack from 0 to 1 or from 1 to 0).



## Coils

### Output

The Output instruction (=) writes the new value for the output bit to the process-image register. When the Output instruction is executed, the S7-200 turns the output bit in the process-image register on or off. For LAD and FBD, the specified bit is set equal to power flow. For STL, the value on the top of the stack is copied to the specified bit.

### Output Immediate

The Output Immediate instruction (=I) writes the new value to both the physical output and the corresponding process-image register location when the instruction is executed.

When the Output Immediate instruction is executed, the physical output point (Bit) is immediately set equal to power flow. For STL, the instruction immediately copies the value on the top of the stack to the specified physical output bit (STL). The "I" indicates an immediate reference; the new value is written to both the physical output and the corresponding process-image register location when the instruction is executed. This differs from the non-immediate references, which write the new value to the process-image register only.

### Set and Reset

The Set (S) and Reset (R) instructions set (turn on) or reset (turn off) the specified number of points (N), starting at the specified address (Bit). You can set or reset from 1 to 255 points.

If the Reset instruction specifies either a timer bit (T) or counter bit (C), the instruction resets the timer or counter bit and clears the current value of the timer or counter.

#### Error conditions that set ENO = 0

- 0006 (indirect address)
- 0091 (operand out of range)

### Set Immediate and Reset Immediate

The Set Immediate and Reset Immediate instructions immediately set (turn on) or immediately reset (turn off) the number of points (N), starting at specified address (Bit). You can set or reset from 1 to 128 points immediately.

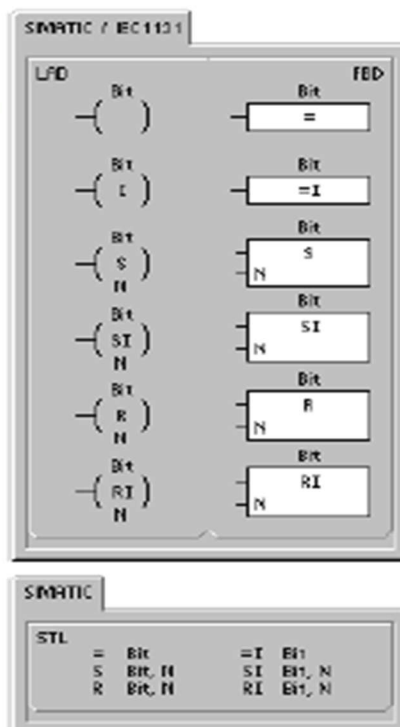
The "I" indicates an immediate reference; when the instruction is executed, the new value is written to both the physical output point and the corresponding process-image register location. This differs from the non-immediate references, which write the new value to the process-image register only.

#### Error conditions that set ENO = 0

- 0006 (indirect address)
- 0091 (operand out of range)

Table 6-4 Valid Operands for the Bit Logic Output Instructions

| Inputs/Outputs  | Data Type | Operands   |
|-----------------|-----------|--|
| Bit             | BOOL      | I, Q, V, M, SM, S, T, C, L                               |
| Bit (immediate) | BOOL      | Q  |
| N               | BYTE      | IB, QB, VB, MB, SMB, SB, LB, AC, *VD, *LD, *AC, Constant |





# Timer Instructions

## SIMATIC Timer Instructions

### On-Delay Timer

### Retentive On-Delay Timer

The On-Delay Timer (TON) and Retentive On-Delay Timer (TONR) instructions count time when the enabling input is on. The timer number (Txx) determines the resolution of the timer, and the resolution is now shown in the instruction box.

### Off-Delay Timer

The Off-Delay Timer (TOF) is used to delay turning an output off for a fixed period of time after the input turns off. The timer number (Txx) determines the resolution of the timer, and the resolution is now shown in the instruction box.

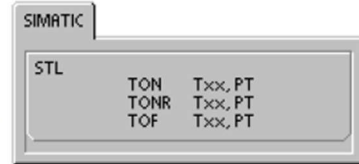
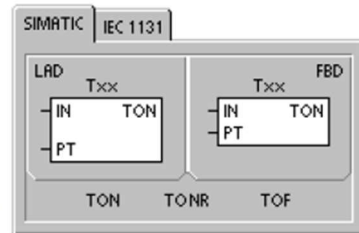


Table 6-72 Valid Operands for the SIMATIC Timer Instructions

| Inputs/Outputs | Data Types | Operands  |
|----------------|------------|---|
| Txx            | WORD       | Constant (T0 to T255)   |
| IN             | BOOL       | I, Q, V, M, SM, S, T, C, L, Power Flow                              |
| PT             | INT        | IW, QW, VW, MW, SMW, SW, T, C, LW, AC, AIW, *VD, *LD, *AC, Constant |



### Tip

You cannot share the same timer number (Txx) for an off-delay timer (TOF) and an on-delay timer (TON). For example, you cannot have both a TON T32 and a TOF T32.

As shown in Table 6-73, the three types of timers perform different types of timing tasks:

- You can use a TON for timing a single interval.
- You can use a TONR for accumulating a number of timed intervals.
- You can use a TOF for extending time past an off (or false) condition, such as for cooling a motor after it is turned off.

# Counter Instructions

## SIMATIC Counter Instructions

### Count Up Counter

The Count Up instruction (CTU) counts up from the current value each time the count up (CU) input makes the transition from off to on. When the current value Cxx is greater than or equal to the preset value PV, the counter bit Cxx turns on. The counter is reset when the Reset (R) input turns on, or when the Reset instruction is executed. The counter stops counting when it reaches the maximum value (32,767).

STL operation :

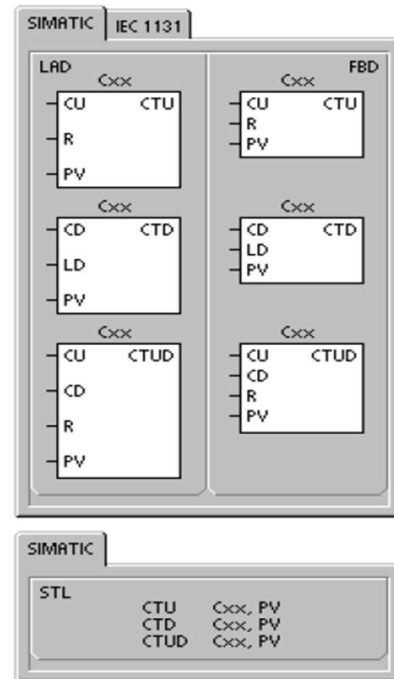
- Reset input: Top of stack
- Count Up input: Value loaded in the second stack location

### Count Down Counter

The Count Down instruction (CTD) counts down from the current value of that counter each time the count down (CD) input makes the transition from off to on. When the current value Cxx is equal to 0, the counter bit Cxx turns on. The counter resets the counter bit Cxx and loads the current value with the preset value PV when the load input LD turns on. The counter stops upon reaching zero, and the counter bit Cxx turns on.

STL operation:

- Load input: Top of stack
- Count Down input: Value loaded in the second stack location.



## Count Up/Down Counter

The Count Up/Down instruction (CTUD) counts up each time the count up (CU) input makes the transition from off to on, and counts down each time the count down (CD) input makes the transition from off to on. The current value Cxx of the counter maintains the current count. The preset value PV is compared to the current value each time the counter instruction is executed.

Upon reaching maximum value (32,767), the next rising edge at the count up input causes the current count to wrap around to the minimum value (-32,768). On reaching the minimum value (-32,768), the next rising edge at the count down input causes the current count to wrap around to the maximum value (32,767).

When the current value Cxx is greater than or equal to the preset value PV, the counter bit Cxx turns on. Otherwise, the counter bit turns off. The counter is reset when the Reset (R) input turns on, or when the Reset instruction is executed.

STL operation:

- Reset input: Top of stack
- Count Down input: Value loaded in the second stack location
- Count Up input: Value loaded in the third stack location

Table 6-22 Valid Operands for the SIMATIC Counter Instructions

| Inputs/Outputs | Data Types | Operands  |
|----------------|------------|---|
| Cxx            | WORD       | Constant (C0 to C255)   |
| CU, CD, LD, R  | BOOL       | I, Q, V, M, SM, S, T, C, L, Power Flow                              |
| PV             | INT        | IW, QW, VW, MW, SMW, SW, LW, T, C, AC, AIW, *VD, *LD, *AC, Constant |

# Math Instructions

## Add, Subtract, Multiply, and Divide Instructions

### Add

$$IN1 + IN2 = OUT$$

*LAD and FBD*

$$IN1 + OUT = OUT$$

### Subtract

$$IN1 - IN2 = OUT \quad \textit{LAD and}$$

$$OUT - IN1 = OUT \quad \textit{STL}$$

The Add Integer (+I) or Subtract Integer (-I) instructions add or subtract two 16-bit integers to produce a 16-bit result. The Add Double Integer (+D) or Subtract Double Integer (-D) instructions add or subtract two 32-bit integers to produce a 32-bit result. The Add Real (+R) and Subtract Real (-R) instructions add or subtract two 32-bit real numbers to produce a 32-bit real number result.

### Multiply

$$IN1 * IN2 = OUT$$

*LAD and FBD*

$$IN1 * OUT = OUT$$

### Divide

$$IN1 / IN2 = OUT \quad \textit{LAD and}$$

$$OUT / IN1 = OUT \quad \textit{STL}$$

The Multiply Integer (\*I) or Divide Integer (/I) instructions multiply or divide two 16-bit integers to produce a 16-bit result. (For division, no remainder is kept.) The Multiply Double Integer (\*D) or Divide Double Integer (/D) instructions multiply or divide two 32-bit integers to produce a 32-bit result. (For division, no remainder is kept.) The Multiply Real (\*R) or Divide Real (/R) instructions multiply or divide two 32-bit real numbers to produce a 32-bit real number result.

### SM Bits and ENO

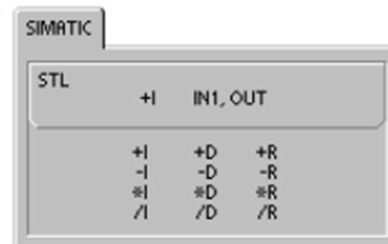
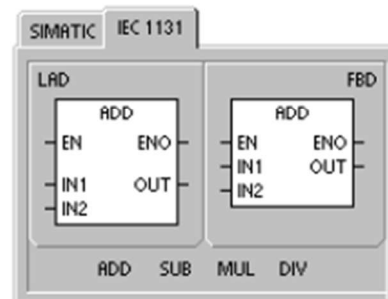
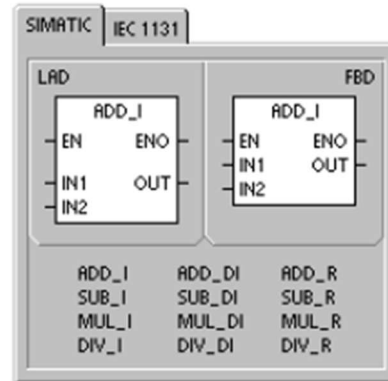
SM1.1 indicates overflow errors and illegal values. If SM1.1 is set, then the status of SM1.0 and SM1.2 is not valid and the original input operands are not altered. If SM1.1 and SM1.3 are not set, then the math operation has completed with a valid result and SM1.0 and SM1.2 contain valid status. If SM1.3 is set during a divide operation, then the other math status bits are left unchanged.

#### Error conditions that set ENO = 0

- SM1.1 (overflow)
- SM1.3 (divide by zero)
- 0006 (indirect address)

#### Special Memory bits affected

- SM1.0 (zero)
- SM1.1 (overflow, illegal value generated during the operation, or illegal input parameter found)
- SM1.2 (negative)
- SM1.3 (divide by zero)



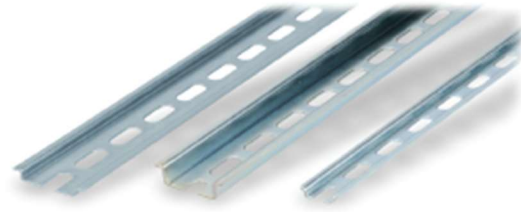
# DIN Rail (DN-R35S1-2)

1-800-633-0405

For the latest prices, please check AutomationDirect.com.

## Accessories

### Steel DIN Rails Features



#### 35mm wide

- Available in 1-meter lengths
- 7.5 mm-high rails primarily used to mount terminal blocks, relays, timers and small PLCs such as the DL05, DL06, DL105, DL205, CLICK, and Productivity3000
- 15mm-high rails for mounting larger and heavier components such as contactors and larger PLCs

#### 15mm wide

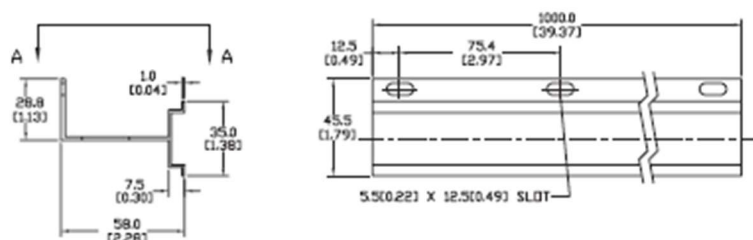
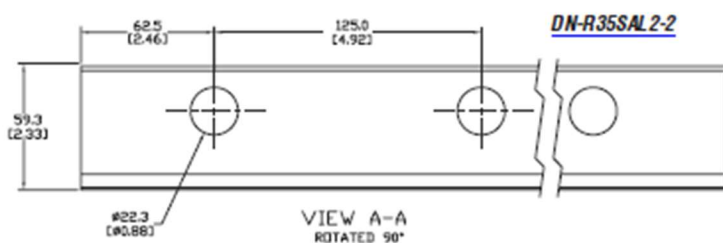
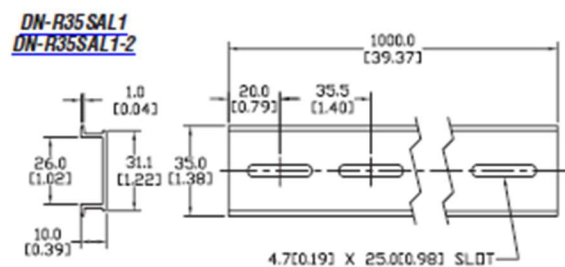
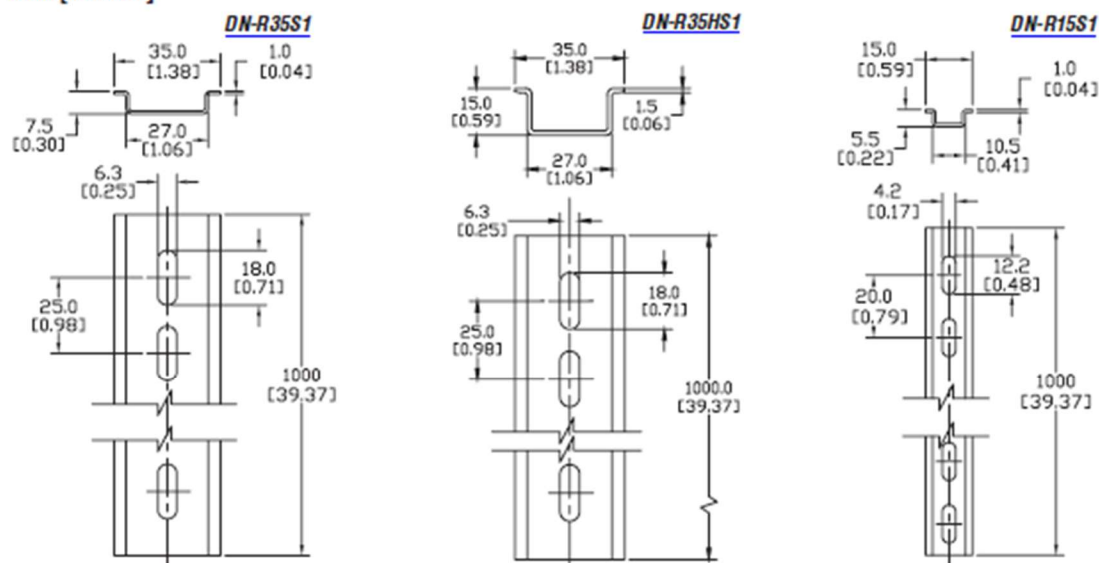
- Available in 1-meter lengths
- DN-R15S1 exclusively for mounting mini terminal blocks such as the [DN-M10-A](#)

|                                       | Part Number   | Pcs/Pkg | Price/Pkg | Part Number  | Pcs/Pkg | Price/Pkg | Part Number  | Pcs/Pkg | Price/Pkg |
|---------------------------------------|---|---------|-----------|--|---------|-----------|--|---------|-----------|
| <b>DIN Rail</b>                       | <b>DN-R35S1</b>   | 10      | \$32.50   | <b>DN-R35HS1</b>   | 10      | \$57.00   | <b>DN-R15S1</b>  | 10      | \$29.50   |
|                                       | <b>DN-R35S1-2</b>   | 2       | \$10.00   | <b>DN-R35HS1-2</b>   | 2       | \$15.00   | <b>DN-R15S1-2</b>  | 2       | \$9.50    |
| <b>Steel DIN Rails Specifications</b> |   |         |           |  |         |           |  |         |           |
| <b>Description</b>                    | DINector DIN rail, slotted, 35mm, 7.5mm height, 1m length, plated steel. Package of 10. |         |           | DINector DIN rail, slotted, 35mm, 15mm height, 1m length, plated steel. Package of 10. |         |           | DINector DIN rail, slotted, 15mm, 5.5mm height, 1m length, plated steel. Package of 2. |         |           |
| <b>Plating</b>                        | Zinc-plated and chromated   |         |           |  |         |           |  |         |           |
| <b>International Standards</b>        | EN 60715, RoHS  |         |           |  |         |           |  |         |           |
| <b>Suggested Mounting Screw Type</b>  | M6  |         |           | M6   |         |           | M4   |         |           |



# DINnectors Accessories

## Dimensions mm [inches]



## Fuse Block (EHM1DU)

1-800-633-0405

# Modular Fuse Holders for Class CC & Midget Class Fuses

For the latest prices, please check AutomationDirect.com.



### Features

- EHCC Series: High SCCR rated, UL Listed CC holder with indicator option for 600VAC/DC
- EHM Series: UL Recognized midget holders
- Minimum 90VAC/DC required for illumination
- Rated for use with 75°C or 90°C wire, fine stranded wire, spade terminals and comb-bus bars. Use any higher temperature rated wire with appropriate derating.
- Complete range of UL Listed and high SCCR rated 1-phase and 3-phase finger-safe comb-bus bars and power feed lugs
- Polyester material is UL 94V0 rated, self extinguishing
- Multi-phase connections available for ganging up to 4 poles\*
- Mounts on 35 mm DIN rail
- IP20 rated
- Spade terminals are accepted (Max width-10mm, Min ID of slot 4mm Max ID of slot 5mm)
- Wire ferrules may not be used.

### Agency Approvals/Standards Class CC

- UL File E300536  
Guide IZLT Listed
- CSA File 47235, Class 6225-01
- CE Compliant
- RoHS, Reach

### Agency Approvals/Standards Midget

- UL File E300536  
IZLT2 Recognized
- CSA File 47235, Class 6225-30
- IEC 60269-2
- CE Compliant
- RoHS, Reach

### Application

- EHM: Edison MCL, MOL, MEQ, MEN, or midget fuses
- EHCC: Edison HCLR, HCTR, EDCC fuses, or class CC fuses

| Modular Fuse Holder Selection Table |                             |                          |      |                     |                                |                          |                        |          |                                  |                      |          |          |
|-------------------------------------|-----------------------------|--------------------------|------|---------------------|--------------------------------|--------------------------|------------------------|----------|----------------------------------|----------------------|----------|----------|
| Series Size                         | Max Voltage & Current       | IEC                      | UL   | Phase Configuration | Fuse Holder Without Indication | Box Qty.                 | Pkg. Wt. (lb.)         | Price    | Fuse Holder with NEON Indication | Product Weight (lb.) | Box Qty. | Price    |
| EHM Midget Class                    | UL 600V/30A<br>IEC 690V/32A | •                        | •    | 1 pole              | <a href="#">EHM1DU</a>         | 1                        | 0.12                   | \$9.50   | <a href="#">EHM1DU</a>           | 0.12                 | 1        | \$12.50  |
|                                     |                             |                          |      |                     | <a href="#">EHM1DU-12</a>      | 12                       | 1.42                   | \$97.00  | <a href="#">EHM1DU-12</a>        | 1.42                 | 12       | \$129.00 |
|                                     |                             |                          |      | 2 pole              | <a href="#">EHM2DU</a>         | 1                        | 0.24                   | \$19.50  | <a href="#">EHM2DU</a>           | 0.24                 | 1        | \$25.50  |
|                                     | <a href="#">EHM2DU-6</a>    | 6                        | 1.42 |                     | \$101.00                       | <a href="#">EHM2DU-6</a> | 1.42                   | 6        | \$132.00                         |                      |          |          |
|                                     | 3 pole                      | <a href="#">EHM3DU</a>   | 1    |                     | 0.36                           | \$30.00                  | <a href="#">EHM3DU</a> | 0.36     | 1                                | \$40.50              |          |          |
|                                     |                             | <a href="#">EHM3DU-4</a> | 4    | 1.42                | \$102.00                       | <a href="#">EHM3DU-4</a> | 1.42                   | 4        | \$136.00                         |                      |          |          |
| EHCC Class CC                       | UL 600V/30A                 | ••                       | ••   | 1 pole              | <a href="#">EHCC1DU</a>        | 1                        | 0.12                   | \$11.00  | <a href="#">EHCC1DIU</a>         | 0.12                 | 1        | \$14.50  |
|                                     |                             |                          |      |                     | <a href="#">EHCC1DU-12</a>     | 12                       | 1.42                   | \$114.00 | <a href="#">EHCC1DIU-12</a>      | 1.42                 | 12       | \$148.00 |
|                                     |                             |                          |      | 2 pole              | <a href="#">EHCC2DU</a>        | 1                        | 0.24                   | \$23.00  | <a href="#">EHCC2DIU</a>         | 0.24                 | 1        | \$30.00  |
|                                     |                             |                          |      |                     | <a href="#">EHCC2DU-6</a>      | 6                        | 1.42                   | \$117.00 | <a href="#">EHCC2DIU-6</a>       | 1.42                 | 6        | \$152.00 |
|                                     |                             |                          |      | 3 pole              | <a href="#">EHCC3DU</a>        | 1                        | 0.36                   | \$34.50  | <a href="#">EHCC3DIU</a>         | 0.36                 | 1        | \$45.50  |
|                                     |                             |                          |      |                     | <a href="#">EHCC3DU-4</a>      | 4                        | 1.42                   | \$118.00 | <a href="#">EHCC3DIU-4</a>       | 1.42                 | 4        | \$153.00 |

\* To add additional poles, see multi-pole connection kit [JY-L](#) in accessories. One [JY-L](#) kit is sufficient to gang up to 4 poles.  
• UL Recognized, CSA  
•• UL Listed, CSA

# Modular Fuse Holders for Class CC & Midget Class Fuses



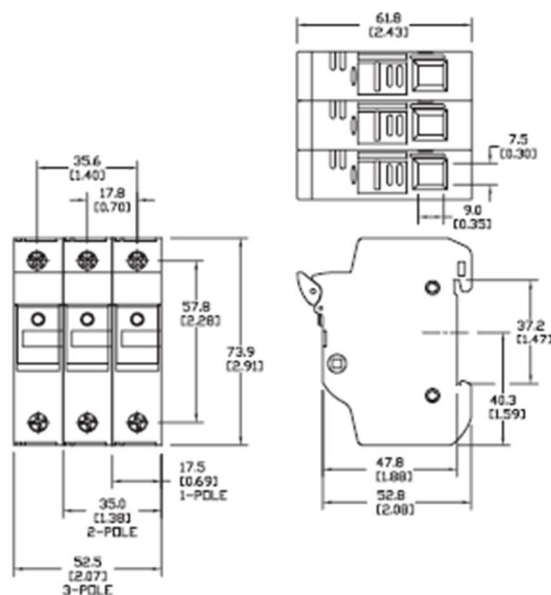
| Modular Fuse Holder Specifications |                             |                            |                                 |                 |                                    |                            |   |               |  |                            |
|------------------------------------|-----------------------------|----------------------------|---------------------------------|-----------------|------------------------------------|----------------------------|---|---------------|--|----------------------------|
| Part Number w/o Indication         | Part Number w/ Indication   | Holder Size                | Max Voltage & Current           | Number of poles | Wire Range                         | Maximum Torque             | Operating Temperature                             | SCCR Rating   | Terminal Rating  | Flammability Rating        |
| <a href="#">EHM1DU</a>             | <a href="#">EHM1DIU</a>     | EHM Midget Class and 10x38 | UL/CSA 600V/30A<br>IEC 690V/32A | 1               | 18-4 AWG (0.8-21 mm <sup>2</sup> ) | 30 lb-in (3.4 N-m) maximum | -20°C to +90°C<br>-4°F to 194°F (indicating)      | 100kA rms sym | Solid, Stranded, Fine stranded, Spade lug, Comb-bus bar, Single and dual wire, 75°C and 90°C Cu wire | UL 94V0 self-extinguishing |
| <a href="#">EHM1DU-12</a>          | <a href="#">EHM1DIU-12</a>  |                            |                                 | 2               |                                    |                            |   |               |  |                            |
| <a href="#">EHM2DU</a>             | <a href="#">EHM2DIU</a>     |                            |                                 | 3               |                                    |                            |   |               |  |                            |
| <a href="#">EHM2DU-6</a>           | <a href="#">EHM2DIU-6</a>   |                            |                                 |                 |                                    |                            |   |               |  |                            |
| <a href="#">EHM3DU</a>             | <a href="#">EHM3DIU</a>     |                            |                                 |                 |                                    |                            |   |               |  |                            |
| <a href="#">EHM3DU-4</a>           | <a href="#">EHM3DIU-4</a>   |                            |                                 |                 |                                    |                            |   |               |  |                            |
| <a href="#">EHCC1DU</a>            | <a href="#">EHCC1DIU</a>    | EHCC Class CC              | UL/CSA 600V/30A                 | 1               |                                    |                            | -20°C to +120°C<br>-4°F to 248°F (non-indicating) | 200kA rms sym |  |                            |
| <a href="#">EHCC1DU-12</a>         | <a href="#">EHCC1DIU-12</a> |                            |                                 | 2               |                                    |                            |   |               |  |                            |
| <a href="#">EHCC2DU</a>            | <a href="#">EHCC2DIU</a>    |                            |                                 | 3               |                                    |                            |   |               |  |                            |
| <a href="#">EHCC2DU-6</a>          | <a href="#">EHCC2DIU-6</a>  |                            |                                 |                 |                                    |                            |   |               |  |                            |
| <a href="#">EHCC3DU</a>            | <a href="#">EHCC3DIU</a>    |                            |                                 |                 |                                    |                            |   |               |  |                            |
| <a href="#">EHCC3DU-4</a>          | <a href="#">EHCC3DIU-4</a>  |                            |                                 |                 |                                    |                            |   |               |  |                            |

| CHCC and EHM Wire Range, Type and Torque |                         |                      |                    |
|--|-------------------------|----------------------|--------------------|
| Wire Range                               | Conductor Type          | Number of Conductors | Torque             |
| 18-14 AWG (0.8-2.0 mm <sup>2</sup> )     | Solid, Stranded         | Single               | 20 lb-in (2.3 N-m) |
| 18-16 AWG (0.8-1.3 mm <sup>2</sup> )     |                         | Dual                 | 25 lb-in (2.8 N-m) |
| 14-10 AWG (2.0-5.2 mm <sup>2</sup> )     |                         |                      |                    |
| 12-10 AWG (3.3-5.2 mm <sup>2</sup> )     | Stranded, Fine Stranded | Single               | 30 lb-in (3.4 N-m) |
| 8-4 AWG (8.3-21.1 mm <sup>2</sup> )      |                         |                      |                    |
| 18-14 AWG (0.8-2.0 mm <sup>2</sup> )     | Spade Terminal          |                      |                    |
| N/A                                      | Comb Bus                |                      |                    |

## Fuse Holder Dimensions

mm [inches]

### EHM Midget Class / EHCC Class CC





# ECX Series 22mm Plastic Indicator Lights

## Plastic incandescent indicator lights



**ECX1051-24**

These indicators have a key to prevent rotation when mounted.

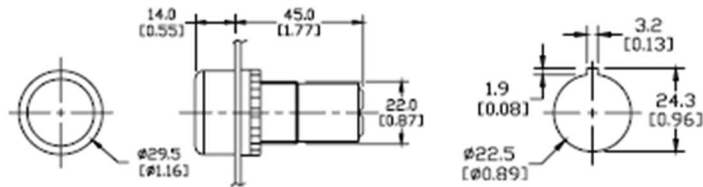
12 models available:

- Available in six colors
- 24V and 120V models
- Incandescent bulbs included
- Accepts LED replacement lamps
- Monoblock design for easy mounting
- Side wire entry with back screw terminals for easy wiring and maintenance
- IP20 rated before Installation
- IP65 rated after Installation

*Note: When using LED replacement lamps with these indicators, it may be necessary to remove the frosted diffuser for enhanced illumination.*

| Part Number                 | Lamp Color | Price  | Description   | Replacement Incandescent Bulb           | Replacement Lamp                        |
|-----------------------------|------------|--------|---|---|---|
| <a href="#">ECX1051-24</a>  | Red        | \$6.00 | 22mm monoblock incandescent indicator light, 24VDC/VAC  | <a href="#">ECX1902-5</a><br>5/pkg 80mA | <a href="#">ECX1911-2</a><br>2/pkg 25mA |
| <a href="#">ECX1051-120</a> | Red        | \$7.25 | 22mm monoblock incandescent indicator light, 120VDC/VAC | <a href="#">ECX1904-5</a><br>5/pkg 20mA | <a href="#">ECX1921-2</a><br>2/pkg 5mA  |
| <a href="#">ECX1052-24</a>  | Green      | \$6.00 | 22mm monoblock incandescent indicator light, 24VDC/VAC  | <a href="#">ECX1902-5</a><br>5/pkg 80mA | <a href="#">ECX1912-2</a><br>2/pkg 25mA |
| <a href="#">ECX1052-120</a> | Green      | \$7.25 | 22mm monoblock incandescent indicator light, 120VDC/VAC | <a href="#">ECX1904-5</a><br>5/pkg 20mA | <a href="#">ECX1922-2</a><br>2/pkg 5mA  |
| <a href="#">ECX1053-24</a>  | Yellow     | \$6.00 | 22mm monoblock incandescent indicator light, 24VDC/VAC  | <a href="#">ECX1902-5</a><br>5/pkg 80mA | <a href="#">ECX1913-2</a><br>2/pkg 25mA |
| <a href="#">ECX1053-120</a> | Yellow     | \$7.25 | 22mm monoblock incandescent indicator light, 120VDC/VAC | <a href="#">ECX1904-5</a><br>5/pkg 20mA | <a href="#">ECX1923-2</a><br>2/pkg 5mA  |
| <a href="#">ECX1054-24</a>  | Blue       | \$6.00 | 22mm monoblock incandescent indicator light, 24VDC/VAC  | <a href="#">ECX1902-5</a><br>5/pkg 80mA | <a href="#">ECX1914-2</a><br>2/pkg 25mA |
| <a href="#">ECX1054-120</a> | Blue       | \$7.25 | 22mm monoblock incandescent indicator light, 120VDC/VAC | <a href="#">ECX1904-5</a><br>5/pkg 20mA | <a href="#">ECX1924-2</a><br>2/pkg 5mA  |
| <a href="#">ECX1055-24</a>  | Clear      | \$6.00 | 22mm monoblock incandescent indicator light, 24VDC/VAC  | <a href="#">ECX1902-5</a><br>5/pkg 80mA | <a href="#">ECX1915-2</a><br>2/pkg 25mA |
| <a href="#">ECX1055-120</a> | Clear      | \$7.25 | 22mm monoblock incandescent indicator light, 120VDC/VAC | <a href="#">ECX1904-5</a><br>5/pkg 20mA | <a href="#">ECX1925-2</a><br>2/pkg 5mA  |
| <a href="#">ECX1056-24</a>  | White      | \$6.00 | 22mm monoblock incandescent indicator light, 24VDC/VAC  | <a href="#">ECX1902-5</a><br>5/pkg 80mA | <a href="#">ECX1915-2</a><br>2/pkg 25mA |
| <a href="#">ECX1056-120</a> | White      | \$7.25 | 22mm monoblock incandescent indicator light, 120VDC/VAC | <a href="#">ECX1904-5</a><br>5/pkg 20mA | <a href="#">ECX1925-2</a><br>2/pkg 5mA  |

Dimensions: mm [inches]



## Plastic LED indicator lights

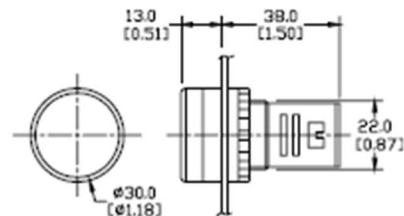


10 models available:

- Available in five colors
- 24V and 120V models
- Non-replaceable LEDs
- Side wire entry with back screw terminals for easy wiring and maintenance
- IP20 rated before Installation
- IP65 rated after Installation
- 16mA @ 127V, 18mA @ 24V

| Part Number                  | Lamp Color | Price  | Description  |
|------------------------------|------------|--------|--|
| <a href="#">ECX2051-24L</a>  | Red        | \$5.50 | 22mm non-metal monoblock LED indicator light, 24VDC/VAC  |
| <a href="#">ECX2051-127L</a> | Red        | \$6.75 | 22mm non-metal monoblock LED indicator light, 120VDC/VAC |
| <a href="#">ECX2052-24L</a>  | Green      | \$5.50 | 22mm non-metal monoblock LED indicator light, 24VDC/VAC  |
| <a href="#">ECX2052-127L</a> | Green      | \$6.75 | 22mm non-metal monoblock LED indicator light, 120VDC/VAC |
| <a href="#">ECX2053-24L</a>  | Yellow     | \$5.50 | 22mm non-metal monoblock LED indicator light, 24VDC/VAC  |
| <a href="#">ECX2053-127L</a> | Yellow     | \$6.75 | 22mm non-metal monoblock LED indicator light, 120VDC/VAC |
| <a href="#">ECX2054-24L</a>  | Blue       | \$9.25 | 22mm non-metal monoblock LED indicator light, 24VDC/VAC  |
| <a href="#">ECX2054-127L</a> | Blue       | \$9.25 | 22mm non-metal monoblock LED indicator light, 120VDC/VAC |
| <a href="#">ECX2055-24L</a>  | Clear      | \$9.25 | 22mm non-metal monoblock LED indicator light, 24VDC/VAC  |
| <a href="#">ECX2055-127L</a> | Clear      | \$9.25 | 22mm non-metal monoblock LED indicator light, 120VDC/VAC |

Dimensions: mm [inches]



For accessories, see 22mm Plastic Pilot Device Accessories in this section.



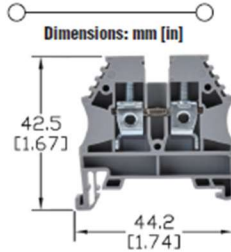
1-800-633-0405

For the latest prices, please check AutomationDirect.com.

# Single-Level Terminal Blocks



- Screw connection terminal
- UL E179129 (For copper wire only. One conductor in terminal only.)
- VDE (IEC 60947-7-1)
- CE (EN 60947-7-1)
- \* For 600V application see UL online file usage Group D



See our website: [www.AutomationDirect.com](http://www.AutomationDirect.com) for complete engineering drawings

| Ordering Information |              |      |         |              |      |         |             |      |         |
|----------------------|--------------|------|---------|--------------|------|---------|-------------|------|---------|
| Colors               | Part Number  | Qty. | Price   | Part Number  | Qty. | Price   | Part Number | Qty. | Price   |
| Gray                 | KN-T12GRY    | 100  | \$23.50 | KN-T10GRY    | 100  | \$27.00 | KN-T8GRY    | 100  | \$53.00 |
|                      | KN-T12GRY-25 | 25   | \$6.75  | KN-T10GRY-25 | 25   | \$7.25  | KN-T8GRY-25 | 25   | \$15.00 |
| Blue                 | KN-T12BLU    | 100  | \$23.50 | KN-T10BLU    | 100  | \$27.00 | KN-T8BLU    | 100  | \$53.00 |
|                      | KN-T12BLU-25 | 25   | \$6.75  | KN-T10BLU-25 | 25   | \$7.25  | KN-T8BLU-25 | 25   | \$15.00 |
| Brown                | KN-T12BRN    | 100  | \$23.50 | KN-T10BRN    | 100  | \$27.00 | KN-T8BRN    | 100  | \$53.00 |
|                      | KN-T12BRN-25 | 25   | \$6.75  | KN-T10BRN-25 | 25   | \$7.25  | KN-T8BRN-25 | 25   | \$15.00 |
| Black                | KN-T12BLK    | 100  | \$23.50 | KN-T10BLK    | 100  | \$27.00 | KN-T8BLK    | 100  | \$53.00 |
|                      | KN-T12BLK-25 | 25   | \$6.75  | KN-T10BLK-25 | 25   | \$7.25  | KN-T8BLK-25 | 25   | \$15.00 |
| Green                | KN-T12GRN    | 100  | \$23.50 | KN-T10GRN    | 100  | \$27.00 | KN-T8GRN    | 100  | \$53.00 |
|                      | KN-T12GRN-25 | 25   | \$6.75  | KN-T10GRN-25 | 25   | \$7.25  | KN-T8GRN-25 | 25   | \$15.00 |
| Orange               | KN-T12ORG    | 100  | \$23.50 | KN-T10ORG    | 100  | \$27.00 | KN-T8ORG    | 100  | \$53.00 |
|                      | KN-T12ORG-25 | 25   | \$6.75  | KN-T10ORG-25 | 25   | \$7.25  | KN-T8ORG-25 | 25   | \$15.00 |
| Red                  | KN-T12RED    | 100  | \$23.50 | KN-T10RED    | 100  | \$27.00 | KN-T8RED    | 100  | \$53.00 |
|                      | KN-T12RED-25 | 25   | \$6.75  | KN-T10RED-25 | 25   | \$7.25  | KN-T8RED-25 | 25   | \$15.00 |
| Yellow               | KN-T12YEL    | 100  | \$23.50 | KN-T10YEL    | 100  | \$27.00 | KN-T8YEL    | 100  | \$53.00 |
|                      | KN-T12YEL-25 | 25   | \$6.75  | KN-T10YEL-25 | 25   | \$7.25  | KN-T8YEL-25 | 25   | \$15.00 |
| White                | KN-T12WHT    | 100  | \$23.50 | KN-T10WHT    | 100  | \$27.00 | KN-T8WHT    | 100  | \$53.00 |
|                      | KN-T12WHT-25 | 25   | \$6.75  | KN-T10WHT-25 | 25   | \$7.25  | KN-T8WHT-25 | 25   | \$15.00 |

| Technical Specifications |  |     |                     |                     |     |                  |                     |     |                  |
|--------------------------|--|-----|---------------------|---------------------|-----|------------------|---------------------|-----|------------------|
| Model                    | KN-T12   |     |                     | KN-T10              |     |                  | KN-T8               |     |                  |
| Width                    | 5mm [0.20 in]  |     |                     | 6mm [0.24 in]       |     |                  | 8mm [0.31 in]       |     |                  |
| Stripping Length         | 10mm [0.39 in]   |     |                     | 10mm [0.39 in]      |     |                  | 12mm [0.47 in]      |     |                  |
| Tightening Torque        | 0.4 N-m [3.5 lb-in]  |     |                     | 0.5 N-m [4.4 lb-in] |     |                  | 0.8 N-m [7.1 lb-in] |     |                  |
| Density                  | 200/m [60 pcs/ft]  |     |                     | 166/m [50 pcs/ft]   |     |                  | 125/m [38 pcs/ft]   |     |                  |
| UL/CSA Approval          | 600V   | 20A | 26-12 AWG           | *300V               | 30A | 26-10 AWG        | *300V               | 50A | 26-8 AWG         |
| VDE Approval             | 750V   | 24A | 2.5 mm <sup>2</sup> | 750V                | 32A | 4mm <sup>2</sup> | 630V                | 41A | 6mm <sup>2</sup> |
| CE Conformity            | 750V   | 24A | 2.5 mm <sup>2</sup> | 750V                | 32A | 4mm <sup>2</sup> | 630V                | 41A | 6mm <sup>2</sup> |
| SCCR Rating              | 100kA  |     |                     | 100kA               |     |                  | 100kA               |     |                  |
| Operating Temperature    | Ambient air temperature: -67°F to 185°F [-55°C to 85°C], Relative humidity: 50% max at 104°F [40°C] and 90% max at 68°F [20°C] |     |                     |                     |     |                  |                     |     |                  |
| Material                 | Current Bar: Copper Alloy / Housing: Polyamide 66 / Screw: Zinc Plated Steel   |     |                     |                     |     |                  |                     |     |                  |
| DIN Rail Width           | 35mm   |     |                     |                     |     |                  |                     |     |                  |

| Accessories                          |                           |               |         |              |               |         |                        |               |         |         |
|--------------------------------------|---------------------------|---------------|---------|--------------|---------------|---------|------------------------|---------------|---------|---------|
| End Covers<br>(International colors) | Gray                      | KN-ECT6GRY    | 100/pkg | \$17.50      | KN-ECT6GRY    | 100/pkg | \$17.50                | KN-ECT6GRY    | 100/pkg | \$17.50 |
|                                      |                           | KN-ECT6GRY-25 | 25/pkg  | \$4.00       | KN-ECT6GRY-25 | 25/pkg  | \$4.00                 | KN-ECT6GRY-25 | 25/pkg  | \$4.00  |
|                                      | Blue                      | KN-ECT6BLU    | 10/pkg  | \$2.00       | KN-ECT6BLU    | 10/pkg  | \$2.00                 | KN-ECT6BLU    | 10/pkg  | \$2.00  |
|                                      | Brown                     | KN-ECT6BRN    |         |              | KN-ECT6BRN    |         |                        | KN-ECT6BRN    |         |         |
|                                      | Black                     | KN-ECT6BLK    |         |              | KN-ECT6BLK    |         |                        | KN-ECT6BLK    |         |         |
|                                      | Green                     | KN-ECT6GRN    |         |              | KN-ECT6GRN    |         |                        | KN-ECT6GRN    |         |         |
|                                      | Orange                    | KN-ECT6ORG    |         |              | KN-ECT6ORG    |         |                        | KN-ECT6ORG    |         |         |
|                                      | Red                       | KN-ECT6RED    |         |              | KN-ECT6RED    |         |                        | KN-ECT6RED    |         |         |
|                                      | Yellow                    | KN-ECT6YEL    |         |              | KN-ECT6YEL    |         |                        | KN-ECT6YEL    |         |         |
| White                                | KN-ECT6WHT                | KN-ECT6WHT    |         |              | KN-ECT6WHT    |         |                        |               |         |         |
| Separators<br>(International colors) | Gray                      | KN-ST1GRY     | 25/pkg  | \$8.25       | KN-ST1GRY     | 25/pkg  | \$8.25                 | KN-ST1GRY     | 25/pkg  | \$8.25  |
|                                      | Blue                      | KN-ST1BLU     | 10/pkg  | \$3.00       | KN-ST1BLU     | 10/pkg  | \$3.00                 | KN-ST1BLU     | 10/pkg  | \$3.00  |
|                                      | Brown                     | KN-ST1BRN     |         |              | KN-ST1BRN     |         |                        | KN-ST1BRN     |         |         |
|                                      | Black                     | KN-ST1BLK     |         |              | KN-ST1BLK     |         |                        | KN-ST1BLK     |         |         |
|                                      | Green                     | KN-ST1GRN     |         |              | KN-ST1GRN     |         |                        | KN-ST1GRN     |         |         |
|                                      | Orange                    | KN-ST1ORG     |         |              | KN-ST1ORG     |         |                        | KN-ST1ORG     |         |         |
|                                      | Red                       | KN-ST1RED     |         |              | KN-ST1RED     |         |                        | KN-ST1RED     |         |         |
|                                      | Yellow                    | KN-ST1YEL     |         |              | KN-ST1YEL     |         |                        | KN-ST1YEL     |         |         |
|                                      | White                     | KN-ST1WHT     |         |              | KN-ST1WHT     |         |                        | KN-ST1WHT     |         |         |
| Jumpers                              | 2-pole                    | KN-2J12       | 25/pkg  | \$8.25       | KN-2J10       | 25/pkg  | \$11.50                | KN-2J8        | 25/pkg  | \$12.00 |
|                                      | 3-pole                    | KN-3J12       | 20/pkg  | \$10.00      | KN-3J10       | 20/pkg  | \$14.00                | KN-3J8        | 20/pkg  | \$15.00 |
|                                      | 4-pole                    | KN-4J12       | 15/pkg  | \$12.00      | KN-4J10       | 15/pkg  | \$14.00                | KN-4J8        | 15/pkg  | \$14.50 |
|                                      | 10-pole                   | KN-10J12      | 5/pkg   | \$8.25       | KN-10J10      | 5/pkg   | \$10.00                | KN-10J8       | 5/pkg   | \$11.50 |
|                                      | Comb-type jumper / 2-pole | KN-2JCC12     | 25/pkg  | \$11.00      | KN-2JCC10     | 25/pkg  | \$21.50                | KN-2JCC8      | 25/pkg  | \$22.50 |
| Top Cover / Blank                    | KN-TC-1                   | 25/pkg        | \$6.75  | KN-TC-1      | 25/pkg        | \$6.75  | KN-TC-1                | 25/pkg        | \$6.75  |         |
| Top Cover / Symbol                   | KN-TC-1S                  | 25/pkg        | \$9.25  | KN-TC-1S     | 25/pkg        | \$9.25  | KN-TC-1S               | 25/pkg        | \$9.25  |         |
| Marking Tags                         | KN-L5 Series              |               |         | KN-L5 Series |               |         | KN-L5 / KN-L6P5 Series |               |         |         |

# KONNECT-IT® Accessories



## Multi-Pole Jumper Bars

Multi-pole jumper bars provide terminal block connection flexibility. Screw-down connection jumpers feature all-metal construction and can be installed quickly just by tightening the screws. Screwless comb-style jumpers are also available. See next page for the larger J1/O jumper installation instructions.

KN-10J12



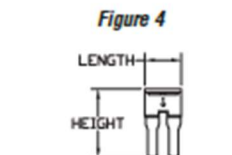
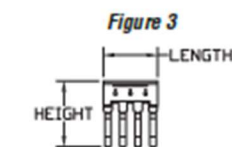
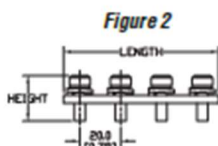
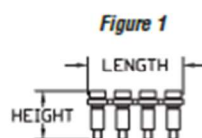
KN-2JM12



KN-2JCC8



| Multi-Pole Jumper Bars Ordering Information |             |         |             |                    |             |                      |              |            |  |   |
|---|-------------|---------|-------------|--------------------|-------------|----------------------|--------------|------------|--|---|
| Type  | Part Number | Price   | Pcs/<br>Pkg | Number<br>of Poles | Ratings     | Dimensions - mm [in] |              |            | Fig.   | Works<br>With   |
|   |             |         |             |                    |             | Height               | Length       | Width      |  |   |
| Screw-down connection                       | KN-2J12     | \$8.25  | 25          | 2                  | 750V 24A    | 15.8 [0.62]          | 10.1 [0.40]  | 4.4 [0.17] | 1  | KN-T12<br>KN-D12<br>KN-D12X<br>KN-D12DR1<br>KN-D12LEU |
|   | KN-3J12     | \$10.00 | 20          | 3                  | 750V 24A    |                      | 15.3 [0.60]  |            |  |   |
|   | KN-4J12     | \$12.00 | 15          | 4                  | 750V 24A    |                      | 20.4 [0.80]  |            |  |   |
|   | KN-10J12    | \$8.25  | 5           | 10                 | 750V 24A    | 15.5 [0.61]          | 51.1 [2.01]  | 6.0 [0.24] | 1  | KN-T10<br>KN-D10<br>KN-D10X<br>KN-D10DR1<br>KN-D10LEU |
|   | KN-2J10     | \$11.50 | 25          | 2                  | 750V 32A    |                      | 10.8 [0.43]  |            |  |   |
|   | KN-3J10     | \$14.00 | 20          | 3                  | 750V 32A    |                      | 17.0 [0.67]  |            |  |   |
|   | KN-4J10     | \$14.00 | 15          | 4                  | 750V 32A    | 15.5 [0.61]          | 23.0 [0.91]  | 6.0 [0.24] | 1  | KN-T8   |
|   | KN-10J10    | \$10.00 | 5           | 10                 | 750V 32A    |                      | 59.0 [2.32]  |            |  |   |
|   | KN-2J8      | \$12.00 | 25          | 2                  | 630V 41A    |                      | 14.3 [0.56]  |            |  |   |
|   | KN-3J8      | \$15.00 | 20          | 3                  | 630V 41A    | 15.5 [0.61]          | 22.3 [0.88]  | 6.0 [0.24] | 1  | KN-T8   |
|   | KN-4J8      | \$14.50 | 15          | 4                  | 630V 41A    |                      | 30.3 [1.19]  |            |  |   |
|   | KN-10J8     | \$11.50 | 5           | 10                 | 630V 41A    |                      | 78.3 [3.08]  |            |  |   |
|   | KN-2J6      | \$15.50 | 25          | 2                  | 630V 57A    | 15.5 [0.61]          | 18.0 [0.71]  | 6.0 [0.24] | 1  | KN-T6   |
|   | KN-3J6      | \$16.50 | 20          | 3                  | 630V 57A    |                      | 28.0 [1.10]  |            |  |   |
|   | KN-4J6      | \$16.50 | 15          | 4                  | 630V 57A    |                      | 38.0 [1.50]  |            |  |   |
|   | KN-10J6     | \$12.50 | 5           | 10                 | 630V 57A    | 23.0 [0.91]          | 98.0 [3.86]  | 6.0 [0.24] | 1  | KN-T4   |
|   | KN-2J4      | \$24.00 | 25          | 2                  | 750V 76A    |                      | 21.0 [0.83]  |            |  |   |
|   | KN-3J4      | \$25.50 | 20          | 3                  | 750V 76A    |                      | 33.0 [1.30]  |            |  |   |
|   | KN-4J4      | \$25.50 | 15          | 4                  | 750V 76A    | 21.0 [0.83]          | 45.0 [1.77]  | 8.0 [0.31] | 1  | KN-T2   |
|   | KN-10J4     | \$20.50 | 5           | 10                 | 750V 76A    |                      | 117.0 [4.61] |            |  |   |
| KN-2J2                                      | \$24.50     | 25      | 2           | 750V 125A          | 29.0 [1.14] |                      |              |            |  |   |
| KN-3J2                                      | \$27.00     | 20      | 3           | 750V 125A          | 21.0 [0.83] | 45.0 [1.77]          | 8.0 [0.31]   | 1          | KN-T2  |   |
| KN-4J2                                      | \$27.00     | 15      | 4           | 750V 125A          |             | 61.0 [2.40]          |              |            |  |   |
| KN-10J2                                     | \$20.50     | 5       | 10          | 750V 125A          |             | 157.0 [6.18]         |              |            |  |   |
| KN-2J1/O                                    | \$7.75      | 5       | 2           | 1000V 150A         | 22.3 [0.88] | 36.0 [1.42]          | 12.0 [0.47]  | 2          | KN-T1/O  |   |
| KN-3J1/O                                    | \$12.50     | 5       | 3           | 1000V 150A         |             | 56.0 [2.20]          |              |            |  |   |
| KN-4J1/O                                    | \$16.50     | 5       | 4           | 1000V 150A         |             | 76.0 [2.99]          |              |            |  |   |
| KN-2JTL12                                   | \$12.50     | 25      | 2           | 440V 24A           | 15.5 [0.61] | 11.0 [0.43]          | 4.4 [0.17]   | 1          | KN-DG12<br>KN-TG12<br>KN-TL14<br>KN-TL14S<br>KN-TL14SLN<br>KN-TL14SP |   |
| KN-3JTL12                                   | \$16.00     | 20      | 3           | 440V 24A           |             | 17.0 [0.67]          |              |            |  |   |
| KN-4JTL12                                   | \$14.50     | 15      | 4           | 440V 24A           |             | 23.0 [0.91]          |              |            |  |   |
| KN-10JTL12                                  | \$12.50     | 5       | 10          | 440V 24A           |             | 59.0 [2.32]          |              |            |  |   |
| Push-in Connection                          | KN-2JM10    | \$7.75  | 25          | 2                  | 750V 32A    | 23.2 [0.91]          | 9.5 [0.37]   | 2.7 [0.11] | 3  | KN-M10<br>KN-KBD10                                    |
|   | KN-3JM10    | \$9.25  | 20          | 3                  | 750V 32A    |                      | 15.5 [0.61]  |            |  |   |
|   | KN-4JM10    | \$11.00 | 15          | 4                  | 750V 32A    |                      | 21.5 [0.85]  |            |  |   |
|   | KN-10JM10   | \$10.00 | 5           | 10                 | 750V 32A    | 21.7 [0.85]          | 57.5 [2.26]  | 2.3 [0.09] | 3  | KN-M12<br>KN-T12SP4                                   |
|   | KN-2JM12    | \$7.25  | 25          | 2                  | 750V 24A    |                      | 8.0 [0.31]   |            |  |   |
|   | KN-3JM12    | \$8.25  | 20          | 3                  | 750V 24A    |                      | 13.0 [0.51]  |            |  |   |
| KN-4JM12                                    | \$8.25      | 15      | 4           | 750V 24A           | 21.7 [0.85] | 18.0 [0.71]          | 2.3 [0.09]   | 3          | KN-M12<br>KN-T12SP4  |   |
| KN-10JM12                                   | \$9.25      | 5       | 10          | 750V 24A           |             | 48.0 [1.89]          |              |            |  |   |
| Screwless Comb-style                        | KN-2JCC12   | \$11.00 | 25          | 2                  | 750V 24A    | 23.7 [0.93]          | 8.0 [0.31]   | 2.8 [0.11] | 4  | KN-T12<br>KN-T10<br>KN-T8<br>KN-T6                    |
|   | KN-2JCC10   | \$21.50 | 25          |                    | 750V 32A    | 24.7 [0.97]          | 9.5 [0.37]   |            |  |   |
|   | KN-2JCC8    | \$22.50 | 25          |                    | 630V 41A    | 25.6 [1.01]          | 13.5 [0.53]  |            |  |   |
|   | KN-2JCC6    | \$24.50 | 25          |                    | 630V 57A    | 26.7 [1.05]          | 16.0 [0.63]  |            |  |   |



Please visit our website  
www.AutomationDirect.com  
for complete engineering drawings.

Note: Screwless Comb-Style jumpers are designed to be connected under the conductor clamp.



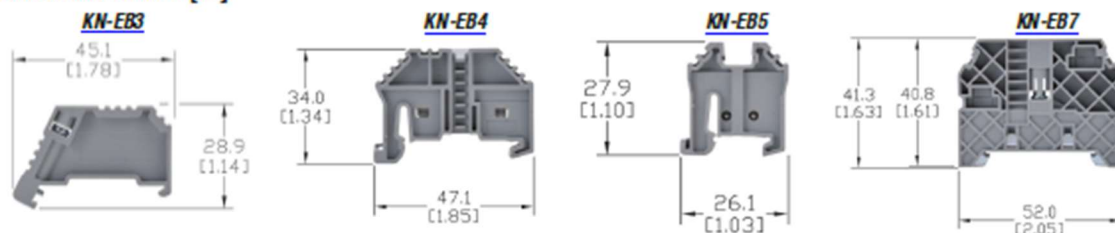
# KONNECT-IT® Accessories



## End Brackets

End brackets prevent terminal blocks and other DIN rail mount components and devices from moving laterally on the rail. They are constructed from polyamide 66 and available in configurations for 35mm and 15mm DIN rails.

### Dimensions mm [in]



| End Brackets Ordering Information |   |         |         |                       |         |         |                       |         |         |                        |        |         |
|-----------------------------------|---|---------|---------|-----------------------|---------|---------|-----------------------|---------|---------|------------------------|--------|---------|
| Gray End Brackets                 | KN-EB3  | 100/pkg | \$32.50 | KN-EB4                | 100/pkg | \$34.00 | KN-EB5                | 100/pkg | \$48.50 | KN-EB7                 | 50/pkg | \$34.00 |
|                                   | KN-EB3-10   | 10/pkg  | \$4.00  | KN-EB4-10             | 10/pkg  | \$3.00  | KN-EB5-10             | 10/pkg  | \$5.50  | KN-EB7-10              | 10/pkg | \$6.75  |
| Technical Specifications          |   |         |         |                       |         |         |                       |         |         |                        |        |         |
| Description                       | Screw-type end bracket  |         |         | Screwless end bracket |         |         | Screwless end bracket |         |         | Screw-type end bracket |        |         |
| Bracket Width                     | 8 mm [0.31 in]  |         |         | 8 mm [0.31 in]        |         |         | 8 mm [0.31 in]        |         |         | 10 mm [0.39 in]        |        |         |
| DIN Rail Width                    | 35 mm   |         |         | 35 mm                 |         |         | 15 mm                 |         |         | 35 mm                  |        |         |
| Material                          | Housing: Polyamide 66 / Clamping Connector: Zinc Plated Steel |         |         |                       |         |         |                       |         |         |                        |        |         |
| End Bracket Accessories           |   |         |         |                       |         |         |                       |         |         |                        |        |         |
| Label Holder                      | —   | —       | —       | KN-MA-1               | 25/pkg  | \$14.00 | —                     | —       | —       | KN-MA-2                | 50/pkg | \$36.50 |
| Marking Tags                      | —   | —       | —       | KN-MA-1-10            | 10/pkg  | \$6.75  | —                     | —       | —       | KN-MA-2-10             | 10/pkg | \$8.25  |
|                                   | KN-L5 Series or KN-L6P5 Series                                |         |         |                       |         |         |                       |         |         |                        |        |         |

## End Covers

End covers are used to cover the open side of sectional DIN rail mount terminal blocks. They should be used at the end of an assembly of identical terminal blocks or whenever there is a change in the physical size of the terminal block.  
Material: Polyamide 66



| End Covers Ordering Information |        |                                |                                    |                                |                  |             |              |                                |                    |                                |          |                                |           |                                |                  |    |        |
|---------------------------------|--------|--------------------------------|------------------------------------|--------------------------------|------------------|-------------|--------------|--------------------------------|--------------------|--------------------------------|----------|--------------------------------|-----------|--------------------------------|------------------|----|--------|
| Part Number                     | Color  | Dimensions HxLxW mm [in]       | Suitable for                       | Pcs/Pkg                        | Price            | Part Number | Color        | Dimensions HxLxW mm [in]       | Suitable for       | Pcs/Pkg                        | Price    |                                |           |                                |                  |    |        |
| KN-ECT6GRY                      | gray   | 34.0x42.7x1.3 [1.34x1.68x0.05] | KN-T12<br>KN-T10<br>KN-T8<br>KN-T6 | 100                            | \$17.50          | KN-ECDOORG  | orange       | 48.2x63.2x1.3 [1.90x2.49x0.05] | KN-D10<br>KN-D12   | 10                             | \$4.00   |                                |           |                                |                  |    |        |
| KN-ECT6GRY-25                   | gray   |                                |                                    | 25                             | \$4.00           | KN-ECDDRED  | red          |                                |                    |                                |          |                                |           |                                |                  |    |        |
| KN-ECT6BLU                      | blue   |                                |                                    | 48.2x63.2x1.3 [1.90x2.49x0.05] | KN-D10<br>KN-D12 | 10          | \$2.00       | KN-ECDYEL                      | yellow             | 54.7x87.1x1.3 [2.15x3.43x0.05] | KN-TL14  | 10                             | \$2.50    |                                |                  |    |        |
| KN-ECT6BLK                      | black  |                                |                                    |                                |                  |             |              | KN-ECTL                        | gray               |                                |          |                                |           |                                |                  |    |        |
| KN-ECT6BRN                      | brown  |                                |                                    |                                |                  |             |              | KN-ECTLS                       | gray               | 54.7x72.8x1.2 [2.15x2.87x0.05] | KN-TL14S | 10                             | \$3.00    |                                |                  |    |        |
| KN-ECT6GRN                      | green  |                                |                                    |                                |                  |             |              | KN-ECDG12                      | gray               | 48.0x71.4x1.2 [1.89x2.81x0.05] | KN-DG12  | 10                             | \$3.00    |                                |                  |    |        |
| KN-ECT6ORG                      | orange |                                |                                    |                                |                  |             |              | KN-ECTG12                      | gray               | 62.5x87.5x1.2 [2.46x3.44x0.05] | KN-TG12  | 10                             | \$3.00    |                                |                  |    |        |
| KN-ECT6RED                      | red    |                                |                                    |                                |                  |             |              | 28.1x27.0x3.0 [1.11x1.06x0.12] | KN-M12<br>KN-M10   | 100                            | \$37.50  | KN-ECMGRY                      | gray      | 28.1x27.0x3.0 [1.11x1.06x0.12] | KN-M12<br>KN-M10 | 10 | \$4.00 |
| KN-ECT6WHT                      | white  |                                |                                    |                                |                  |             |              |                                |                    |                                |          | KN-ECMGRY-10                   | gray      |                                |                  |    |        |
| KN-ECT6YEL                      | yellow |                                |                                    |                                |                  |             |              |                                |                    |                                |          | KN-ECMBLU                      | blue      |                                |                  |    |        |
| KN-ECT4GRY                      | gray   | 45.7x52.8x1.2 [1.80x2.08x0.05] | KN-T4                              | 25                             | \$8.25           | KN-ECMGRN   | green/yellow | 28.1x27.0x3.0 [1.11x1.06x0.12] | KN-MG12<br>KN-MG10 | 10                             | \$4.00   |                                |           |                                |                  |    |        |
| KN-ECT4BLU                      | blue   |                                |                                    | 10                             | \$3.50           | KN-ECG12SP4 | green/yellow |                                |                    |                                |          | 39.7x57.1x1.2 [1.56x2.25x0.05] | KN-G12SP4 | 10                             | \$3.00           |    |        |
| KN-ECDOGRY                      | gray   | 48.2x63.2x1.3 [1.90x2.49x0.05] | KN-D10<br>KN-D12                   | 10                             | \$4.00           | KN-ECT12SP4 | gray         | 39.7x57.1x1.2 [1.56x2.25x0.05] | KN-T12SP4          | 25                             | \$7.75   |                                |           |                                |                  |    |        |
| KN-ECDBLU                       | blue   |                                |                                    |                                |                  | KN-ECF10    | gray         |                                |                    |                                |          | 27.3x59.6x1.2 [1.07x2.35x0.05] | KN-F10    | 25                             | \$9.75           |    |        |
| KN-ECDBLK                       | black  |                                |                                    |                                |                  | KN-ECKBD    | gray         | 37.1x53.5x1.2 [1.46x2.11x0.05] | KN-KDB10           | 10                             | \$4.00   |                                |           |                                |                  |    |        |
| KN-ECDOGRN                      | green  |                                |                                    |                                |                  |             |              |                                |                    |                                |          |                                |           |                                |                  |    |        |

# KONNECT-IT® Accessories

## Separators

Separators are used to segment banks of terminal blocks. Allows you to maintain a single row of terminal blocks, but have separate power source clusters.



| Separators Ordering Information |        |                                    |                      |             |            |         |         |
|---------------------------------|--------|------------------------------------|----------------------|-------------|------------|---------|---------|
| Part Number                     | Color  | Works With                         | Dimensions - mm [in] |             |            | Pcs/Pkg | Price   |
|                                 |        |                                    | Height               | Length      | Thickness  |         |         |
| KN-ST1GRY                       | Gray   | KN-T12<br>KN-T10<br>KN-T8<br>KN-T6 | 39.0 [1.54]          | 42.5 [1.67] | 1.2 [0.05] | 25      | \$8.25  |
| KN-ST1BLU                       | Blue   |                                    |                      |             |            | 10      | \$3.00  |
| KN-ST1BLK                       | Black  |                                    |                      |             |            |         |         |
| KN-ST1BRN                       | Brown  |                                    |                      |             |            |         |         |
| KN-ST1GRN                       | Green  |                                    |                      |             |            |         |         |
| KN-ST1ORG                       | Orange |                                    |                      |             |            |         |         |
| KN-ST1RED                       | Red    |                                    |                      |             |            |         |         |
| KN-ST1WHT                       | White  |                                    |                      |             |            |         |         |
| KN-ST1YEL                       | Yellow |                                    |                      |             |            |         |         |
| KN-ST2GRY                       | Gray   | KN-T4                              | 52.5 [2.07]          | 50.5 [1.99] | 1.5 [0.06] | 25      | \$11.00 |
| KN-ST2BLU                       | Blue   | KN-T2                              | 62.6 [2.46]          | 53.1 [2.09] | 1.5 [0.06] | 10      | \$5.50  |
| KN-ST3GRY                       | Gray   |                                    |                      |             |            | 10      | \$5.50  |
| KN-ST3BLU                       | Blue   |                                    |                      |             |            | 10      | \$5.50  |

KN-ST1GRY



## Top Covers and Label Holders

| Top Covers and Label Holders Ordering Information |  |                                    |                      |             |             |         |         |
|---|--|------------------------------------|----------------------|-------------|-------------|---------|---------|
| Part Number                                       | Description  | Works With                         | Dimensions - mm [in] |             |             | Pcs/Pkg | Price   |
|   |  |                                    | Height               | Length      | Width       |         |         |
| KN-TC-1   | Top cover for Konnect-It terminal block, blank, white  | KN-T12<br>KN-T10<br>KN-T8<br>KN-T6 | 6.8 [0.27]           | 29.0 [1.14] | 5.8 [0.23]  | 25      | \$6.75  |
| KN-TC-1S  | Top cover for Konnect-It terminal block, printed electric symbol, white  | KN-T12<br>KN-T10<br>KN-T8<br>KN-T6 | 7.3 [0.29]           | 35.8 [1.41] | 9.0 [0.35]  | 25      | \$9.25  |
| KN-TC-2   | Top cover for Konnect-It terminal block, blank, white  | KN-T4<br>KN-T2                     |                      |             |             | 25      | \$17.00 |
| KN-TC-2S  | Top cover for Konnect-It terminal block, printed electric symbol, white  | KN-T4<br>KN-T2                     | 25                   | \$17.00     |             |         |         |
| KN-MA-1   | Label holder for terminal block group. Label media not included. Adhesive label: Apply on top. Max label dimensions: 7 x 44 mm (0.28 x 1.73 in). | KN-EB4                             | 46.2 [1.82]          | 46.0 [1.81] | 11.4 [0.45] | 25      | \$14.00 |
| KN-MA-1-10  |  |                                    | 10                   | \$6.75      |             |         |         |
| KN-MA-2   | Label holder for terminal block group. Label media not included. Adhesive label: Apply on top. Max label dimensions: 7 x 44 mm (0.28 x 1.73 in). | KN-EB7                             | 37.5 [1.48]          | 46.2 [1.82] | 9.5 [0.37]  | 50      | \$36.50 |
| KN-MA-2-10  |  |                                    | 10                   | \$8.25      |             |         |         |
| KN-MA-3   | Top mounting marking tag adapter for terminal block. Holds up to (4) L5x5 tags   | KN-T4<br>KN-T2                     | 9.3 [0.36]           | 36.0 [1.42] | 9.0 [0.35]  | 25      | \$9.25  |
| KN-MA-4   | Top mounting marking tag adapter for terminal block. Holds up to (4) L5x5 tags   | KN-T12<br>KN-T10<br>KN-T8<br>KN-T6 | 9.0 [0.35]           | 29.0 [1.14] | 5.7 [0.22]  | 25      | \$8.25  |
| KN-MA-5   | Label holder for terminal block group. Label media included. Max label dimensions: 10 x 38mm (0.39 x 1.50 in). Thickness 0.30 mm (0.01 in)       | Attaches to any 35mm DIN rail      | 46.4 [1.83]          | 44.5 [1.75] | 10.0 [0.39] | 50      | \$29.50 |
| KN-MA-5-25  |  |                                    |                      |             |             | 25      | \$18.00 |

KN-MA-1



KN-MA-2



KN-MA-5



KN-TC-1 / KN-TC-2



KN-TC-1S / KN-TC-2S



KN-MA-3



KN-MA-4



## Appendix H: Marking Sheets

ELTE1035 Senior Project 1: Drawing and Parts List – Wiring diagram

Student: BHAUSAR, ROHAN

Report title: DUAL SUMP PUMP CONTR.

Staff advisor: R. BROOD

Date marked: 2021.04.13

| Assessed item   | Instructions: Assign mark based on these guidelines.  | Notes / explanation / page number  |
|---|---|--|
| Format:<br>Drawing: <u>7</u> (10)<br>Parts list: <u>4</u> (5)                       | <b>Drawing: Assess out of 10 based on:</b><br><input checked="" type="checkbox"/> Title <input checked="" type="checkbox"/> Title all caps<br><input checked="" type="checkbox"/> Version <input checked="" type="checkbox"/> Date of last revision<br><input checked="" type="checkbox"/> Filename <input checked="" type="checkbox"/> Page number (x of y)<br><input checked="" type="checkbox"/> Scale/page size <input checked="" type="checkbox"/> Name (drawn by)<br><input checked="" type="checkbox"/> Not too sparse/small/big <input checked="" type="checkbox"/> Not to crowded<br><input checked="" type="checkbox"/> Not grey scale <input checked="" type="checkbox"/> Multiple page if and only if needed<br><b>Parts list: Assess a mark out of 5 based on:</b><br><input checked="" type="checkbox"/> Use of standard template <input checked="" type="checkbox"/> Landscape<br><input checked="" type="checkbox"/> Project title <input checked="" type="checkbox"/> Name (drawn by)<br><input checked="" type="checkbox"/> Revision <input checked="" type="checkbox"/> Date | Print in black & white. Legend does not have meaning without colour. - Revise. |
| Complexity: <u>4</u> (5)  | <b>Wiring diagrams: Assess a mark out of 5 by estimating number of components, wires, specification notes, wire type and length, etc. Custom drawn symbols count double or triple if done well.</b><br>5 – Over 50, Above average complexity<br>4 – About 40, good, complex project<br>1-2 – A very simplistic wiring diagram   | P.L. Screens?<br>Strain relief?  |
| Completeness<br>Drawing: <u>5</u> (5)<br>Parts list: <u>3</u> (5)                   | <b>Drawing: Assess a mark out of 5 based on completeness</b><br>5 – No missing components, parts, wiring, connectors<br>3-4 – Missing one or two parts etc.<br>3 – Missing connection to power source. Or computer etc.<br>1-2 – Needs a lot of work<br><b>Parts list: Assess a mark out of 5 based on completeness</b><br>5 – All parts on project represented on parts list, plus other req.<br>3-4 A few less obvious omissions such as laptop, usb cable<br>3 – Missing major parts – power supply, enclosure etc.<br>1-2 – Parts list need a lot of work   | Air buzzers are audible. Remove.<br>Contactor – spelling                       |
| Correctness to standards<br>Drawing: <u>7</u> (10)<br>Parts list: <u>4</u> (5)      | <b>Wiring diagrams: Assess a mark out of 10 based on the following:</b><br><input checked="" type="checkbox"/> Comp./parts have reference designators<br><input checked="" type="checkbox"/> Comp./parts have terminals identified<br><input checked="" type="checkbox"/> Oriented towards connecting / how to hook up<br><input checked="" type="checkbox"/> Wire color <input checked="" type="checkbox"/> Wire type <input checked="" type="checkbox"/> Wire gauge?<br><input checked="" type="checkbox"/> Grounding issues addressed chassis<br><input checked="" type="checkbox"/> Custom parts drawn well <input type="checkbox"/> Standard symbols<br><input checked="" type="checkbox"/> Notes <input checked="" type="checkbox"/> PLC-upside-down<br><input checked="" type="checkbox"/> Other<br><b>Parts list: Assess a mark out of 5 based on correctness</b><br><input checked="" type="checkbox"/> All caps <input checked="" type="checkbox"/> Alphabetical order<br><input checked="" type="checkbox"/> Suppliers <input checked="" type="checkbox"/> Part numbers              | Indicate wire gauge using note.<br>Alphabetize.                                |
| Other: <u>5</u> (5)   | <b>Other items:</b><br><input checked="" type="checkbox"/> Marked multiple times with steady improvement<br><input checked="" type="checkbox"/> Well thought out custom parts and components<br><input checked="" type="checkbox"/> Independent work <input checked="" type="checkbox"/> Self taught drawing package features<br><input type="checkbox"/> Other   |  |
| Total: <u>39</u> (Out of 100)<br><span style="margin-left: 100px;"><u>50</u></span> | Total is sum of all items   |  |

**Instructor notes:**  
 Write explanatory notes on this page for ease of CTAB auditor who may not have access to marked up copies of remitted student work.  
 Half marks are allowed. Assign a mark of 0 for any missing items.  
 Make 2 copies: Original to staff advisor. Copy 1 to student. Copy 2 to SPL coordinating instructor for CTAB auditing purposes.

ver 1.0 Feb 19, 2020



**ELTE1035 Senior Project 1: Project Proposal marking sheet**

Student: Blauser, Rohan Project name: Scrap pump controller  
 Staff advisor: L. Booroo Date marked: 2021.02.03

| Assessed item   | Instructions  | Notes / explanation / page number |
|---|---|-----------------------------------|
| <b>Memo appearance</b><br>Format: <u>5</u> (5)<br>Style: <u>5</u> (5)   | <b>Format: One page formal memo with header, body, attach.:</b><br>5-All sections present and professional looking<br>4-Minor grammar, spelling, formatting issue<br>3-Meets minimum requirements.<br>2,1-Missing items, not memo format, or not professional<br>0-Not initialed<br><b>Style</b><br>5-Exemplary, professional<br>4-Persuasive and communicates technical enthusiasm<br>3-Technical sales pitch as opposed to project request<br>2, 1-Fluffy, non-technical language |                                   |
| <b>Project title:</b> <u>5</u> (5)  | <b>Title: Creative, short, descriptive</b><br>5-Creative, descriptive and elicits interest<br>4-Descriptive of project<br>3-Communicates basic concept of project<br>2,1-Name but little or no idea what it is<br>0-Title missing   |                                   |
| <b>Items:</b><br>To: From: cc: <u>2</u> (2)<br>Date: <u>2</u> (2)<br>Re: <u>2</u> (2)<br>Purpose of memo: <u>0</u> (2)<br>Purpose or project: <u>2</u> (2)<br>Project scope: <u>1</u> (2)<br>State meet deadlines: <u>2</u> (2)<br>Estimated cost: <u>2</u> (2)<br>Req. approval in words: <u>2</u> (2)<br>Req. app. signature line: <u>2</u> (2) | <b>The memo required a number of individual items</b><br>2-Item present and correct<br>1-Present but incomplete or other issue<br>0-Not present   |                                   |
| <b>Attachments:</b> <u>5</u> (5)  | <b>Attachments need to show some depth of research and analysis about the project.</b><br>5-Appropriate and linked to body of memo to support the project proposal.<br>4-Appropriate but not referenced well in body of memo<br>3-Support components of project but not project as a whole<br>3-Excessive, waste paper.<br>2,1-Insufficient to support project request<br>0-Not present   |                                   |
| <b>Critical requirements:</b><br>Initialed: <u>N</u> (Yes or No)<br>On Time: <u>Y</u> (Yes or No)   | It is critical that the memo be initialed and remitted on time.<br>A "No" for either results in a mark of 0 for the memo.   |                                   |
| Approval: <u>Y</u> (Yes or No)<br>Instructor initials: <u>RB</u>  | Approval for the project is granted by signing the project proposal and also by indicating "Yes" and initialing.  |                                   |
| Total: <u>0</u><br>Out of: <u>40</u>  | Total is out of 40  |                                   |

Note to student: A mark of 0 does not mean the project is not approved. Likewise a passing mark on the project proposal does not grant approval for the project. Unapproved projects are dealt with on a case by case basis as soon as possible in the term.

Notes to instructor:  
 Write explanatory notes on this page for ease of CTAB auditors who may not have access to marked up copies of remitted student work.  
 Half marks are allowed. Assign a mark of 0 for any missing item.  
 Make 2 copies: Original to staff advisor. Copy 1 to student. Copy 2 to SPL coordinating instructor for CTAB auditing purposes. Enter marks in Brightspace.

Rev 2.01 Jan 15, 2018

## Appendix I: Marked Drawing

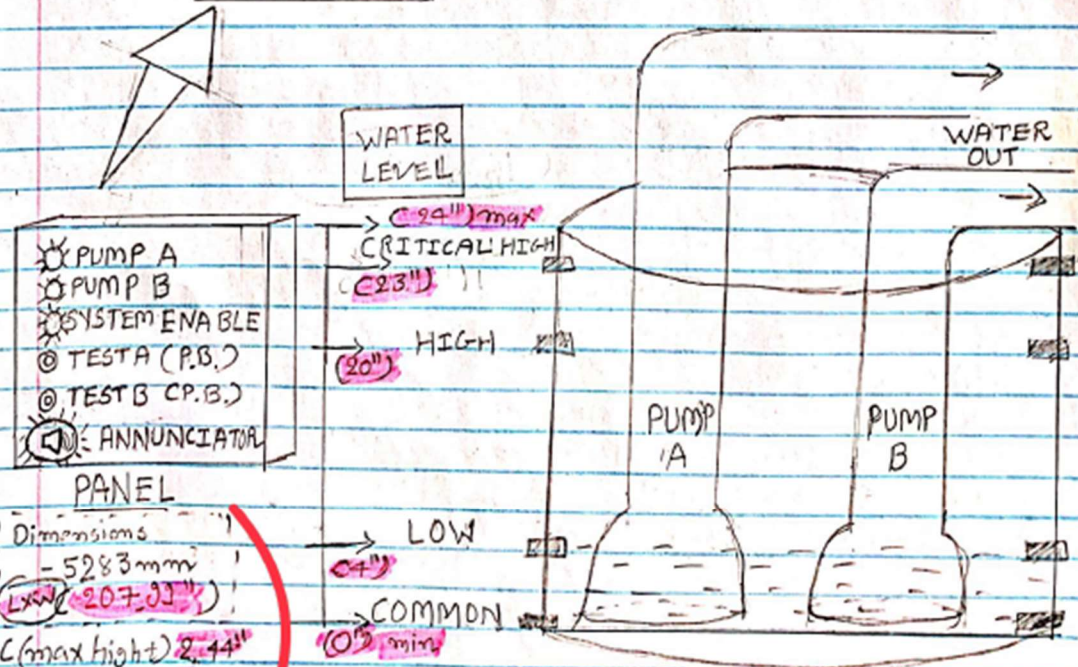
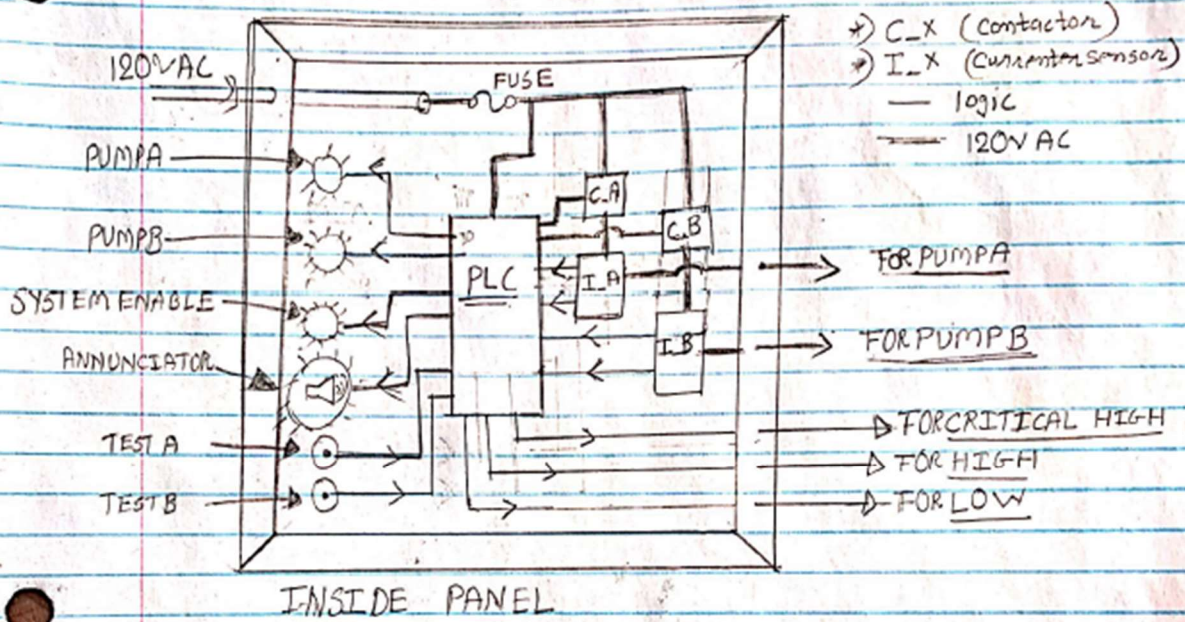


Roham Bhanusa

# DUAL SUMP-PUMP CONTROLLER

Conceptual drawing V2.0

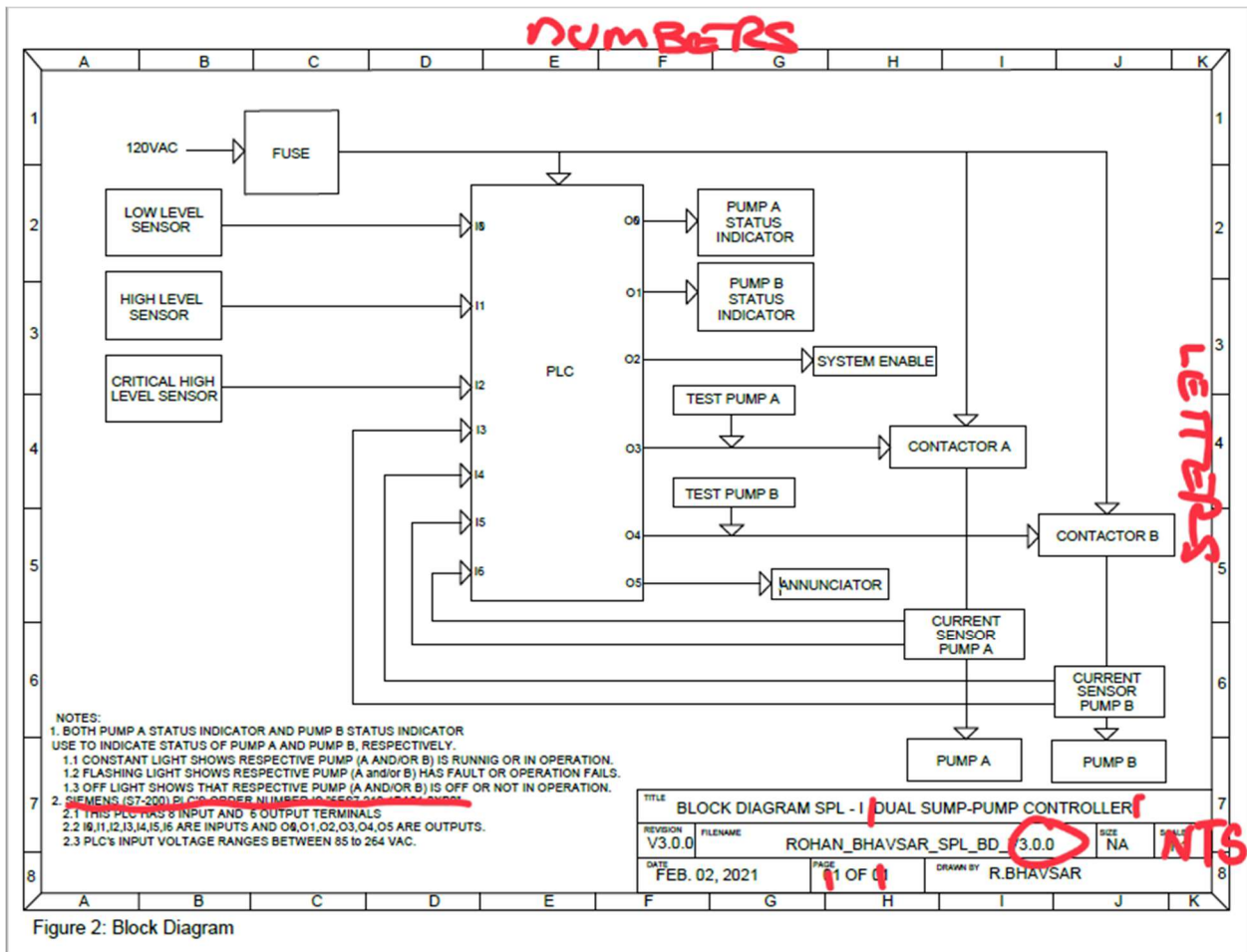
FEB. 07, 2021



Dimensions  
 - 5283mm  
 - 2070mm  
 - PLC (max height) 2.44"  
 - Total depth 3.0"

**METRIC OR IMP.  
 NOT BOTH.**

Figure 1: Conceptual Drawing



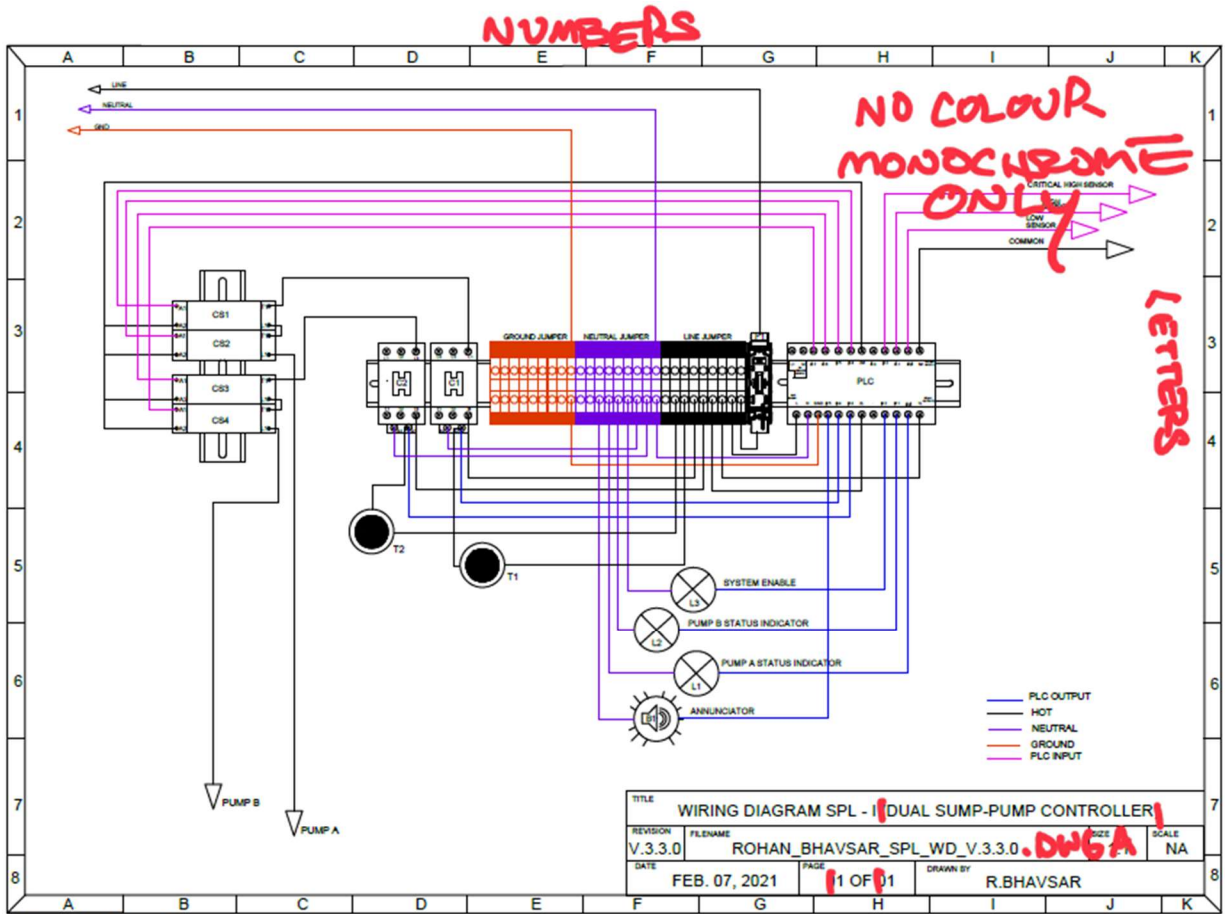


Figure 3: Wiring Diagram

NOT SPL PARTS LIST TEMPLATE

| PROJECT : DUAL SUMP-PUMP CONTROLLER |                                  |                     |                      |                         |                     |                             |                    |              |            |
|-------------------------------------|----------------------------------|---------------------|----------------------|-------------------------|---------------------|-----------------------------|--------------------|--------------|------------|
| REV: 5.00                           |                                  | DATE: Feb. 07, 2021 |                      | DRAWN BY: ROHAN BHAVSAR |                     |                             |                    | SHEET 1 of 1 |            |
| ITEM                                | REF. DESIGNATOR OR ID ON DRAWING | QTY                 | DESCRIPTION          | MANUFACTURER            | MANUFACTURER PIN    | SUPPLIER                    | SUPPLIER P/N       | ITEM COST    | TOTAL COST |
| 1                                   | B1                               | 1                   | AUDIBLE BUZZER       | AUTOMATION DIRECT       | ECX2071-127R        | AUTOMATION DIRECT           | ECX2071-127R       | \$ 9.26      | \$ 9.26    |
| 2                                   | C1                               | 2                   | COTACTOR             | FUJI ELECTRIC           | 8C-E02-110VAC       | AUTOMATION DIRECT           | 8C-E02-110VAC      | \$ 17.00     | \$ 34.00   |
| 3                                   | L1,L2                            | 2                   | YELLOW LED INDICATOR | AUTOMATION DIRECT       | ECX1063-120         | AUTOMATION DIRECT           | ECX1063-120        | \$ 7.26      | \$ 14.60   |
| 4                                   | PLC                              | 1                   | PLC                  | SIEMENS                 | 6ES7 212-1BA01-0XB0 | WORLD INDUSTRIAL AUTOMATION | 6ES7212-1BA01-0XB0 | \$ 567.88    | \$ 567.88  |
| 6                                   | C01,C02,C03,C04                  | 4                   | CURRENT SENSOR       | ACUAMP                  | ACS160-CE-F         | AUTOMATION DIRECT           | ACS160-CE-F        | \$ 67.00     | \$ 268.00  |
| 8                                   | T1,T2                            | 2                   | PUSH BUTTON          | AUTOMATION DIRECT       | GCX3194-120L        | AUTOMATION DIRECT           | GCX3194-120L       | \$ 21.60     | \$ 43.00   |
| 7                                   | L3                               | 1                   | GREEN LED INDICATOR  | AUTOMATION DIRECT       | ECX1062-120         | AUTOMATION DIRECT           | ECX1062-120        | \$ 7.26      | \$ 7.26    |
| 8                                   | F1                               | 1                   | FUSE BLOCK           | BUSSMANN                | RM26030-15R         | AUTOMATION DIRECT           | RM26030-15R        | \$ 9.76      | \$ 9.76    |
| 9                                   | NA                               | NA                  | DIN RAIL             | DINNECTOR               | DN-R3631-2          | AUTOMATION DIRECT           | DN-R3631-2         | \$ 10.00     | \$ 10.00   |
| 10                                  | NA                               | NA                  | TERMINAL BLOCK       | KONNECT-IT              | KN-T120RY-26        | AUTOMATION DIRECT           | KN-T120RY-26       | \$ 8.76      | \$ 8.76    |

Figure 4: Part list



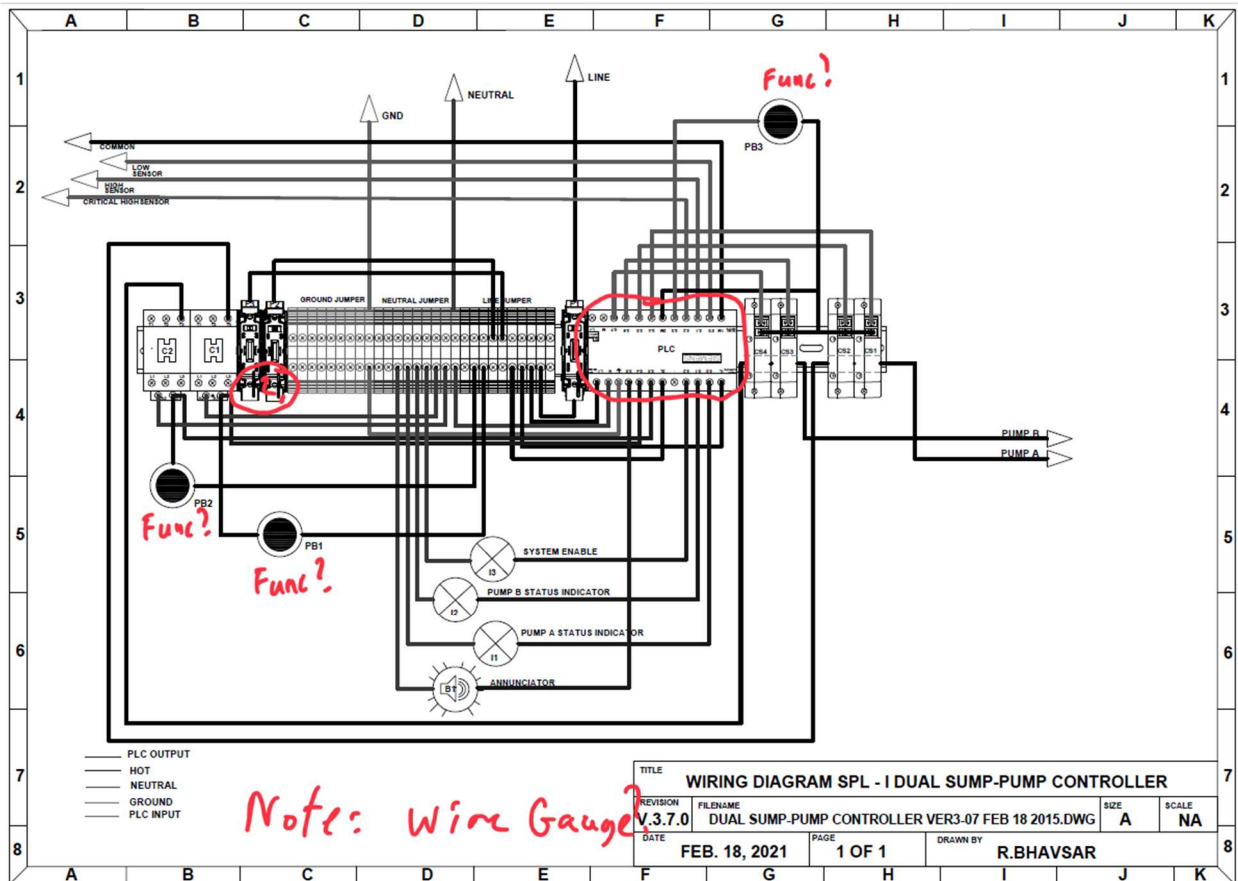


Figure 3: Wiring Diagram

| PROJECT : DUAL SUMP-PUMP CONTROLLER |                                  |                         |                      |                   |                     |                             |                    |           |            |
|-------------------------------------|----------------------------------|-------------------------|----------------------|-------------------|---------------------|-----------------------------|--------------------|-----------|------------|
| REV: 6.00                           | DATE: FEB. 15, 2021              | DRAWN BY: ROHAN BHAVSAR |                      | SHEET 1 of 1      |                     |                             |                    |           |            |
| ITEM                                | REF. DESIGNATOR OR ID ON DRAWING | QTY                     | DESCRIPTION          | MANUFACTURER      | MANUFACTURER P/N    | SUPPLIER                    | SUPPLIER P/N       | ITEM COST | TOTAL COST |
| 1                                   | B1                               | 1                       | AUDIBLE BUZZER       | AUTOMATION DIRECT | ECX2071-127R        | AUTOMATION DIRECT           | ECX2071-127R       | \$ 9.25   | \$ 9.25    |
| 2                                   | C1                               | 2                       | COILACTOR 5F         | FUJI ELECTRIC     | SC-E02-110VAC       | AUTOMATION DIRECT           | SC-E02-110VAC      | \$ 17.00  | \$ 34.00   |
| 5                                   | CS1,CS2,CS3,CS4                  | 4                       | CURRENT SENSOR       | ACUAMP            | ACS150-CE-F         | AUTOMATION DIRECT           | ACS150-CE-F        | \$ 67.00  | \$ 268.00  |
| 9                                   |                                  | 2                       | DIN RAIL             | DINNECTOR         | DN-R35S1-2          | AUTOMATION DIRECT           | DN-R35S1-2         | \$ 10.00  | \$ 10.00   |
| 8                                   | F1                               | 1                       | FUSE BLOCK           | BUSSMANN          | RM25030-1SR         | AUTOMATION DIRECT           | RM25030-1SR        | \$ 9.75   | \$ 9.75    |
| 7                                   | D                                | 1                       | GREEN LED INDICATOR  | AUTOMATION DIRECT | ECX1052-120         | AUTOMATION DIRECT           | ECX1052-120        | \$ 7.25   | \$ 7.25    |
| 4                                   | PLC                              | 1                       | PLC                  | SIEMENS           | 6ES7 212-1BA01-0XB0 | WORLD INDUSTRIAL AUTOMATION | 6ES7212-1BA01-0XB0 | \$ 557.88 | \$ 557.88  |
| 6                                   | PB1, PB2                         | 2                       | PUSH BUTTON          | AUTOMATION DIRECT | GCX1104             | AUTOMATION DIRECT           | GCX1104            | \$ 7.25   | \$ 14.50   |
| 11                                  | PB3                              | 1                       | PUSH BUTTON          | AUTOMATION DIRECT | GCX1104             | AUTOMATION DIRECT           | GCX1104            | \$ 7.25   | \$ 7.25    |
| 10                                  |                                  | 3                       | TERMINAL BLOCK       | KONNECT-IT        | KN-T12GRY-25        | AUTOMATION DIRECT           | KN-T12GRY-25       | \$ 6.75   | \$ 20.25   |
| 3                                   | I1, I2                           | 2                       | YELLOW LED INDICATOR | AUTOMATION DIRECT | ECX1053-120         | AUTOMATION DIRECT           | ECX1053-120        | \$ 7.25   | \$ 14.50   |
| 12                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 13                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 14                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 15                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 16                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 17                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 18                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 19                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 20                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 21                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 22                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 23                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 24                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 25                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 26                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 27                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 28                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 29                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 30                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 31                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 32                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 33                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 34                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 35                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 36                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 37                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 38                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 39                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |
| 40                                  |                                  |                         |                      |                   |                     |                             |                    |           |            |

Figure 4: Part list