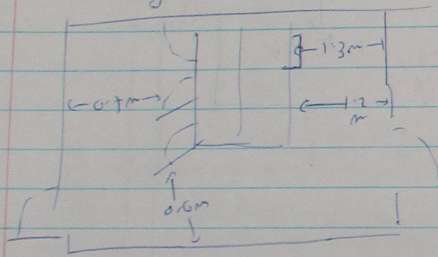


Yes  
 2.10.2 (a) Switch board shall be provided with adequate space ~~and~~ around the switch board on all sides where persons are to pass to enable all electrical equipment to be safely and effectively operated and adjusted and provided with sufficient exit facilities to enable a person to leave vicinity of a switch board under emergency condition.



Yes - (a.2.2 c(iii)) Doors of enclosure dedicated to switch boards not open in to a passage or narrow accessway shall be capable of being returned in the open position to prevent workers being advertently pushed towards the fire switch boards.

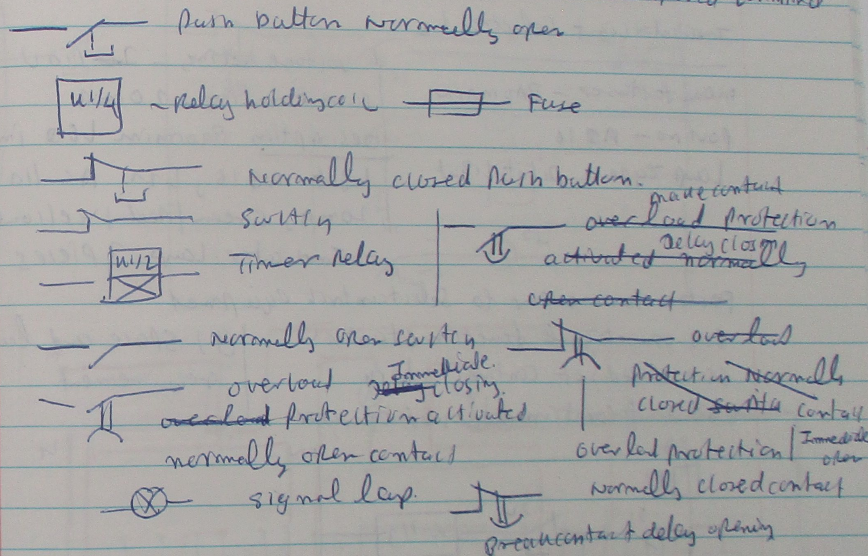
### Switch board equipment

- 3 x 100A HRG Fuse - Service Protective devices.
- 1 x Service Neutral line - for the connection of consumer's main neutral conductor.
- meter 1 - 6 to measure energy in DB1 - D70
- CT PT meter in panel - to measure energy for metered installation
- CB for DB1 - 6 to energize/deenergize DB1 - 56.

- 1 x main earth line - to provide earthing conductor main switches for Lift, Emergency fire pump
- 1 x DB main switches - to provide reliable supply to emergency services.

### EL0005 develop and connect electrical control circuits

1.1 Identify circuit diagrams symbols  
 Exposed Terminals - D/14 - measure before touching  
 Enclose the exposed terminal



### 1.3 select control equipment

Exposed Terminal D/H measure before touching  
 Push button S1  
 manufacturer - APCLE  
 Part no - 2 PLS X B2-HBN  
 Type ref no - NO  
 Voltage rating - 660V  
 Current Rating - 10A  
 Description - momentary push button switch Red/Green  
 1 NO, 1 NC, metal head 22mm

Relay K1  
 manufacturer - FINDB  
 Part no CAT no SS-34  
 Voltage rating 250V AC  
 Current Rating 5A (AC)  
 NO contact 4  
 NC contacts = 4  
 Description - miniature contact Relay  
 Plug in or solder connection

Push button Selection S<sub>2</sub>

manufacturer - Schneider Electric  
 Part no - XA2 EA3  
 Type no/nc - NO  
 voltage - 600V  
 current - 10A  
 Description - complete push button Easy Harmony XA2 Plastic Flush green 22mm Spring return unmarked 1 NO

Indicator Light Selection L<sub>2</sub>

manufacturer - Schneider Electric  
 part no - XBS AUB4  
 Lamp type - pilot light  
 voltage rating - 24V ac/dc  
 current rating -  
 Description - Pilot Light LED Red 22mm 24V ac/dc

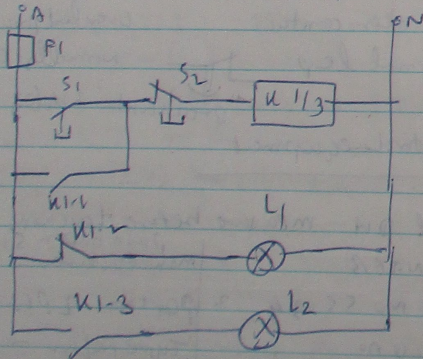
Indicator Light Selection L<sub>1</sub>

manufacturer - BAOMANN  
 part no - AD16  
 Lamp type - pilot light

voltage rating - 20/110V  
 current rating - 20mA  
 Description - Baomann LED Indicator light AD16, L<sub>22</sub> AC 110V 20mA, Green/Red/Yellow  
 Indicator Lamp 3 Pieces

Factor to consider to select control equipment

- (1) operational function of control
- (2) Space and layout requirement
- (3) Information needs of operator

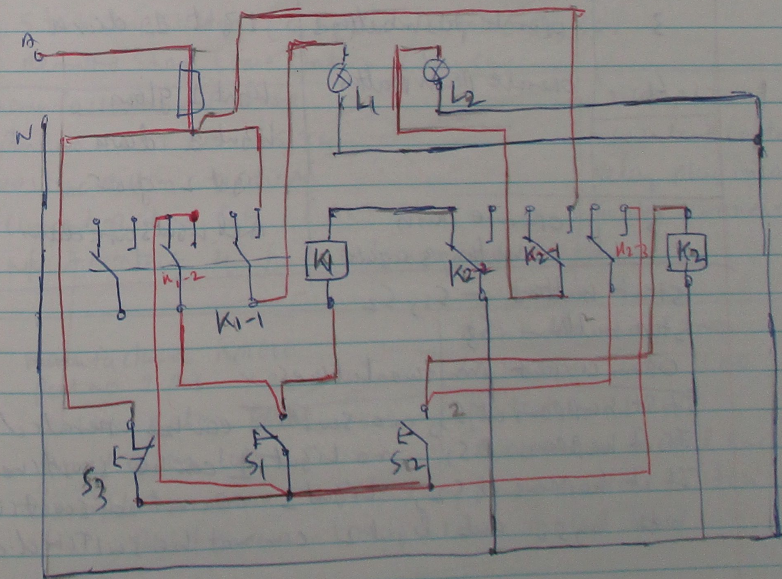
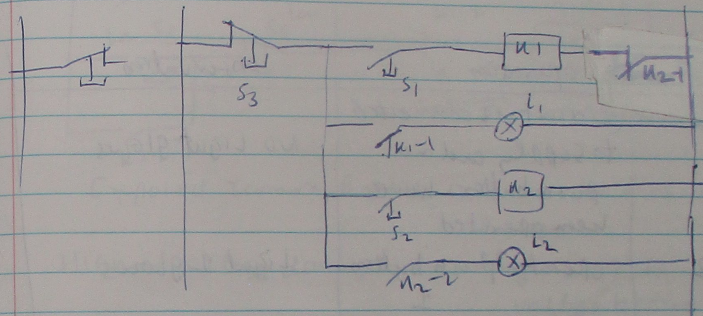


1.4 develop and connect a STOP-START circuit

Exposed terminal DIT measure before touching  
 Enclose terminal

Break contact of rail - DIT check voltage rating before touching

S<sub>1</sub> press M1 Energize L<sub>1</sub> on  
 S<sub>2</sub> press M2 Energize L<sub>1</sub> off L<sub>2</sub> energize  
 S<sub>3</sub> press - all deenergize



no	Item	manufacturer	Brief Description
1	S <sub>1</sub>	SCHNEIDER ELECTRIC	push button Spring Return NO
2	S <sub>2</sub>	SCHNEIDER ELECTRIC	push button Spring Return NO
3	S <sub>3</sub>	SCHNEIDER ELECTRIC	push button Spring Return NO
4	U <sub>1</sub>	FINDER	Relay 4 NO, 4 NC
5	U <sub>2</sub>	FINDER	Relay 4 NO, 4 NC
6	L <sub>1</sub>	Schneider Electric	pilot light
7	L <sub>2</sub>	Schneider Electric	pilot light

Step	operation	observation
1	circuit is connected to supply and no push buttons have been operated	No light glows
2	operate push button 1	Light 1 glows
3	operate push button 3	Light 1 dark
4	operate push button 1	Light 1 glows Light 1 dark Light 2 glow
5	operate push button 3 again	All lights are dark

Start buttons - S<sub>1</sub>, S<sub>2</sub>

Stop button - S<sub>3</sub>

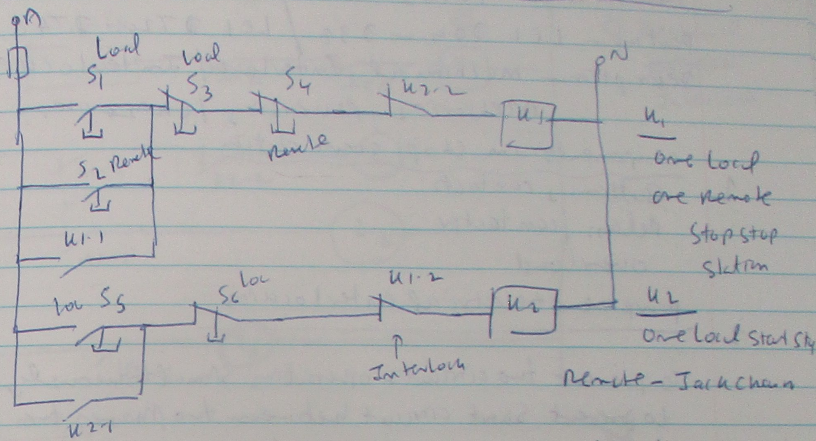
open circuit in two lines

If it happens at S<sub>3</sub>, no switch can be operated

If it happens at S<sub>1</sub>, no light 1 can be switched on

If it happens at S<sub>2</sub>, light 1 cannot be switched off by S<sub>2</sub> and light 2 cannot be switched on.

## 2-2 Select control device - STOP-START AND INTERLOCKING



Exposed Terminal D/H measure before touching  
enclose

Higher voltage damaging the relay coil D/H check coil voltage before connection

Start stop station 1 (S<sub>1</sub>, S<sub>3</sub>) Station 2 (S<sub>5</sub>, S<sub>6</sub>)

Remote Stop start station (S<sub>2</sub>, S<sub>4</sub>)

Relay Station	manufacturer - FINDER	Description
	Part no - CAT NO SS.34	miniature control
	voltage Rating 250V AC	Relay plug in or
	Current Rating 5A (AC)	solder connection
	NO at contact 4 / NC contact 4	

manufacturer - APPEC	push button INC 1NO
Part no 2-PLS X82-118N	contacts 1NC 1NO
voltage Rating 600V	protection IP65
Current Rating 10A	Enclosure - Metal Enclosure
Description - for momentary push button switch	
Red / Green 1NO 1NC metal Head	

# Mechanical Interlocking Device

Manufacturer TESYS

Part no - LCI 209 - 238 / LCI 2720 - 2740

Description - mechanical Interlock / Interlocking  
Accessories, Reversing / Changeover

Components in stop/start station

- Buttons, contacts
- Relays, contactor
- overload

purpose of electrical interlocking

- To prevent two circuits operating simultaneously and to prevent short circuit between two phases the wiring is arranged with the N.C. relay

- Typical Application of mechanical interlocking, motor reversing circuit  
Star/Delta starter  
plug braun control - CRH.

## 2-3 Develop and connect a STOP-START circuit with Electrical Interlocking

- Initial Energize L1 only if energize

- S1 or S3 Energize ~~S1~~ U1

U1 → Energize L2 deenergize L1

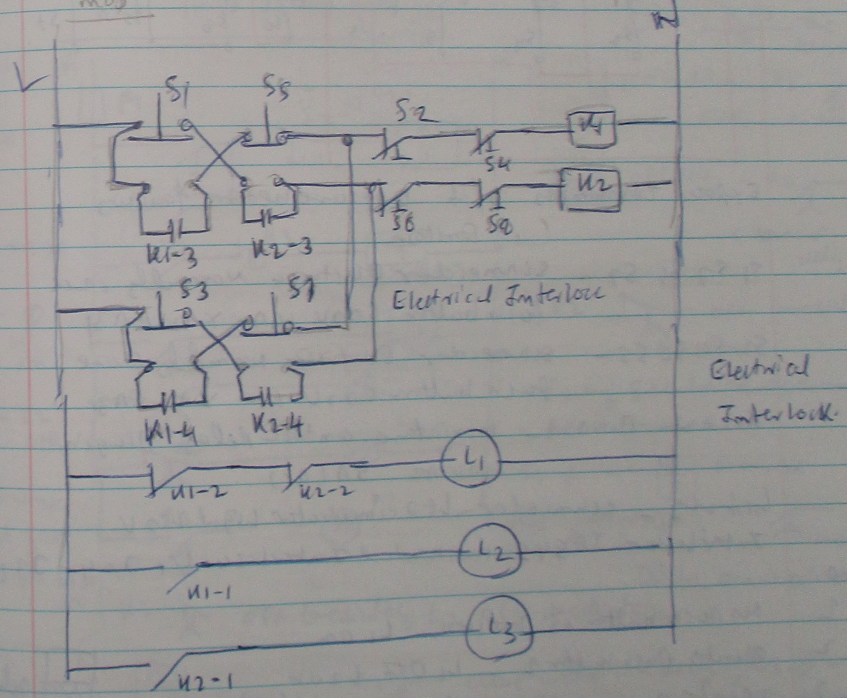
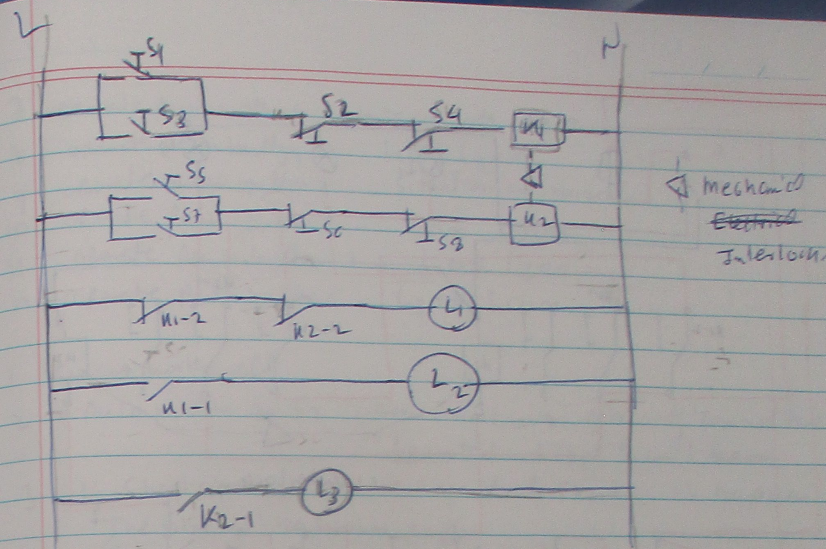
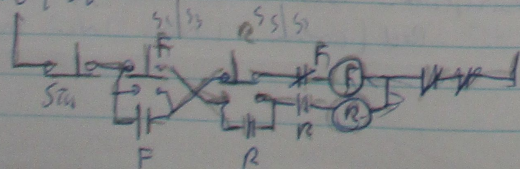
S2 S4 deenergize U1

S5 S7 - Energize U2

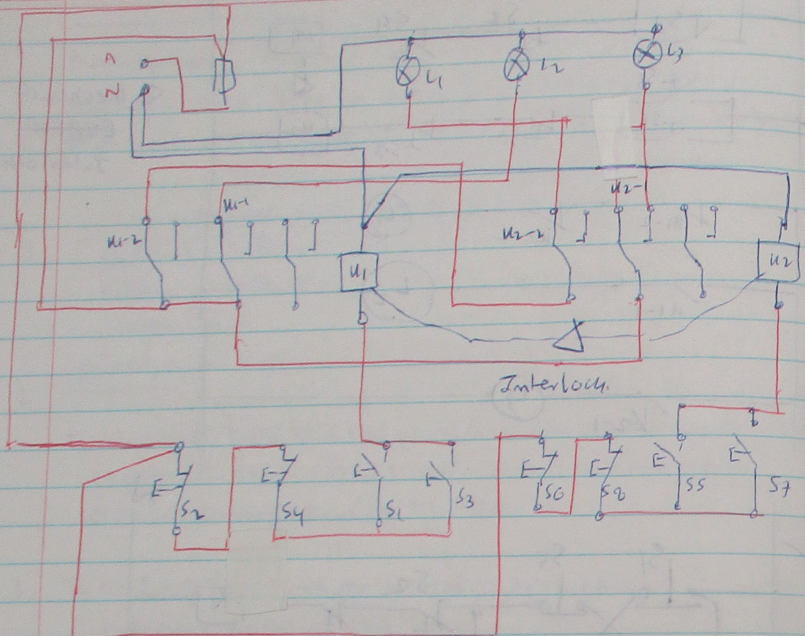
S6 or S8 - deenergize U2

U2 → L3 L1, OFF L1

the S6/S8 -



Electrical Interlock



Exposed terminals D/A measure before faulting  
 Enlase

S1 S2 S4 S7 - Schneider Electric normally open  
 push button 60sV 10A XA2 CA31

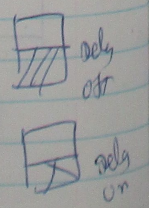
S2 S4 S6 S8 - Schneider Electric normally close  
 push button 60sV 10A XA2 CA31

U1 U2 - Pinaco - miniature control relay plug-in  
 250V AC SA(A1)

L1 L2 L3 - Schneider - LED indicator 250V

Interlock - TB45 manual Interlock L1 209-338

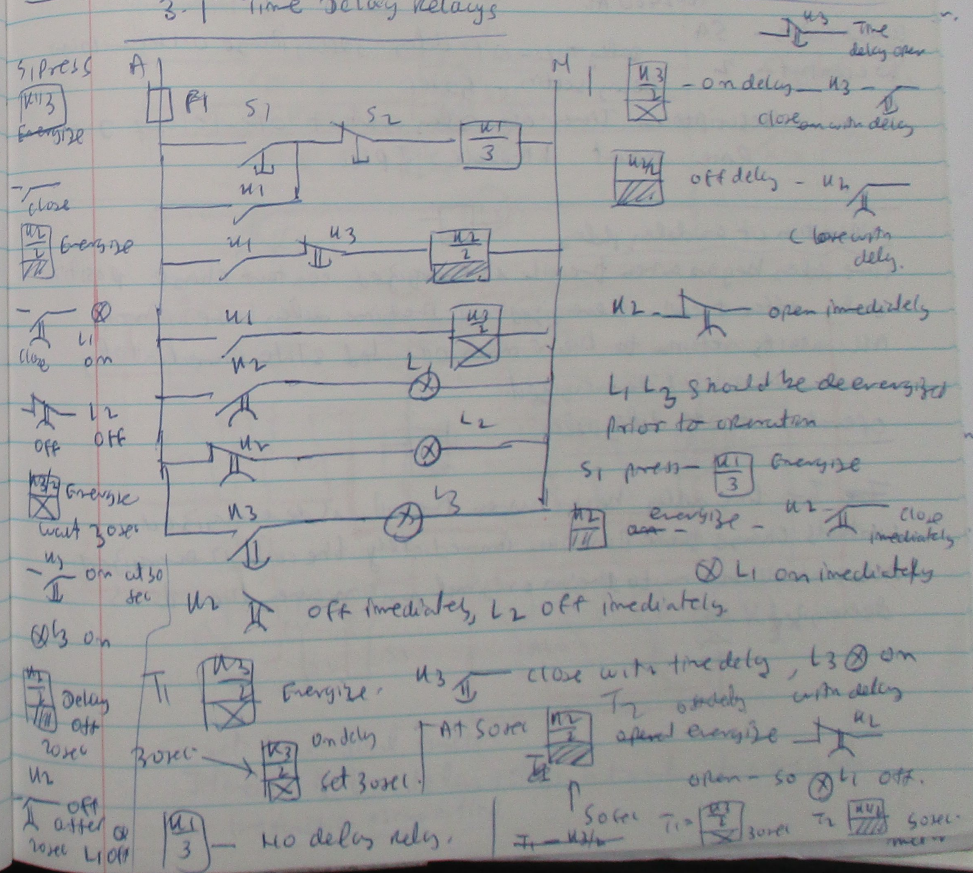
- Step
- 1 No push button is pressed - L1 on
  - 2 operate push button 1 - L1 off L2 on
  - 3 operate push button 2 - L2 off L1 on
  - 4 operate push button 3 - L1 off L2 on
  - 5 operate push button 5 - L1 off L3 on
  - 6 operate push button 4 - L3 off L1 on



- 7 operate push buttons again - L1 off L3 on
- 8 operate push button 2 - L1 off L3 on
- 9 operate push button 3 - Situation unchanged
- 10 operate push button 2 - L1 on L3 off
- 11 operate push button 7 - L1 off L3 on
- 12 operate push button 6 - L3 off L1 on

- 1 circuit works well
- 2 push button 2 open circuit -> circuit cannot be operated L1 but L2 will be on
- 3 L1 short circuit - Active - Neutral short will happen The fuse will be blown up.

3.1 Time Delay Relays



Relay Selection (U1)

manufacturer - Finder  
 Part no - CATNO SS-34  
 Voltage rating - 250VDC  
 Contact Rating - 5A(AC)  
 NO contacts - 4  
 NC contacts - 4  
 Description - miniature control relay  
 Relay Plug in or Solder connection

manufacturer - Hager  
 Part no - E2W 002  
 Voltage ratings - 12-42V DC  
 12-240V AC

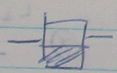
Contact Rating - 5A  
 NO contact - 2  
 Delay type - Off delay, delay range 0.1 sec - 10 sec  
 Delay setting - 50 sec  
 Description - Timer off delay contact open/close time  
 Rack mount 1 module IP40

Operation of On delay relay



Time delay begins when the coil is energized. Contact change position only after the coil is energized and the time delay has expired. All contacts return to their non-operated state immediately when the coil is de-energized.

Operation of Off delay relay



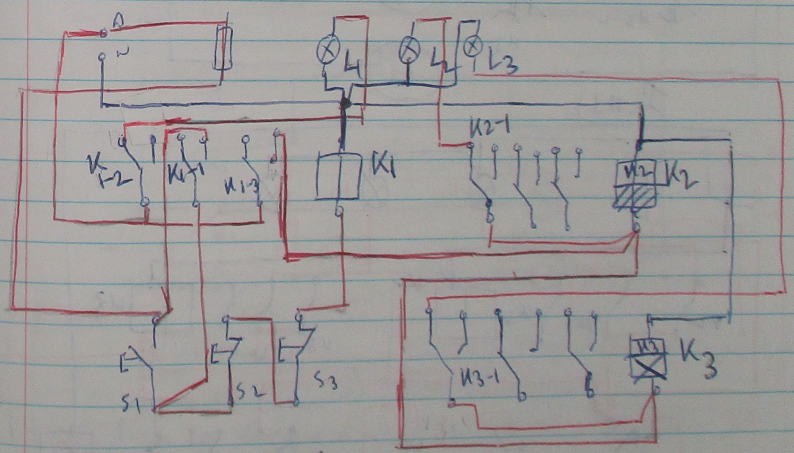
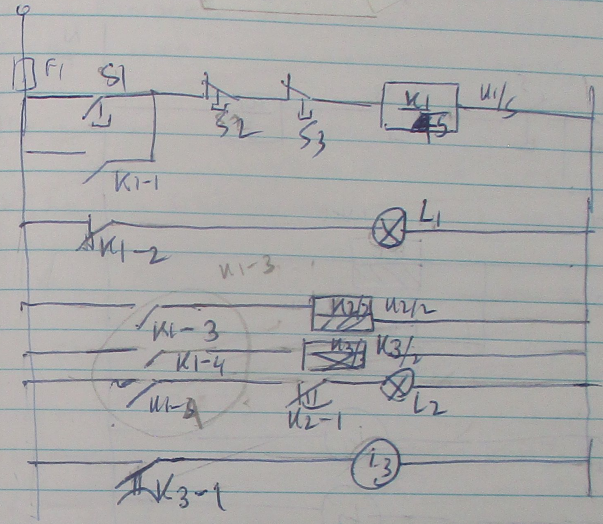
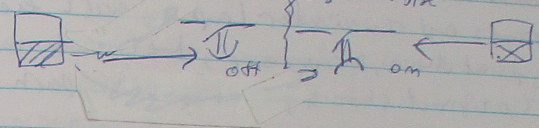
The time delay begins when the coil is de-energized. Contacts change their position immediately the coil is energized. All contacts return to their original position when the coil is de-energized.

Time Delay Relay Selection T1

U3/2 - on delay  
 manufacturer - NITP  
 Part no - DAA-01-C-m24  
 Voltage rating - 24V AC/DC - 240V AC  
 Contact Rating - 3A at AC 250V  
 NO contact - 3  
 NC contact - -  
 Delay type - on delay  
 Delay range 100ms - 10s  
 Delay setting - 30 sec  
 Description - Timer on delay 24V AC  
 240V AC supply 1 C-0  
 0.1 sec - 10s

3.2 develop and connect time delay circuit

Initial L1 Only is energized - start  
 S1 - L1 de-energize + L2 energize - L2 energize  
 L2 de-energize + L3 energize - L3 energize

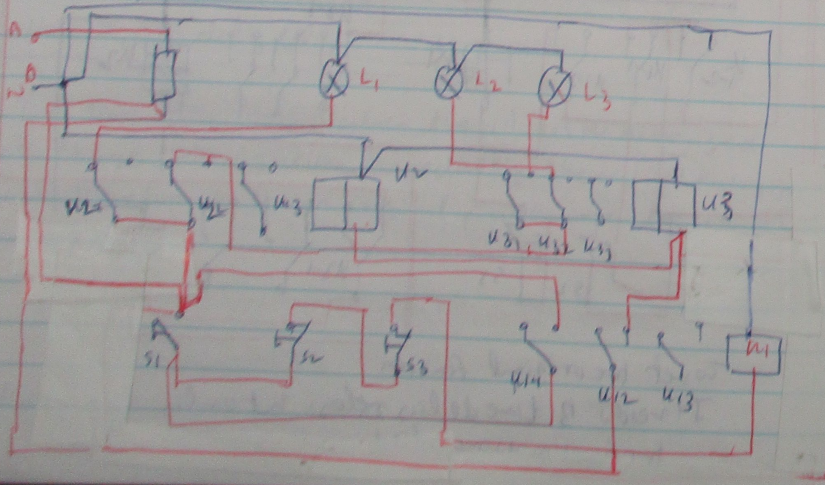
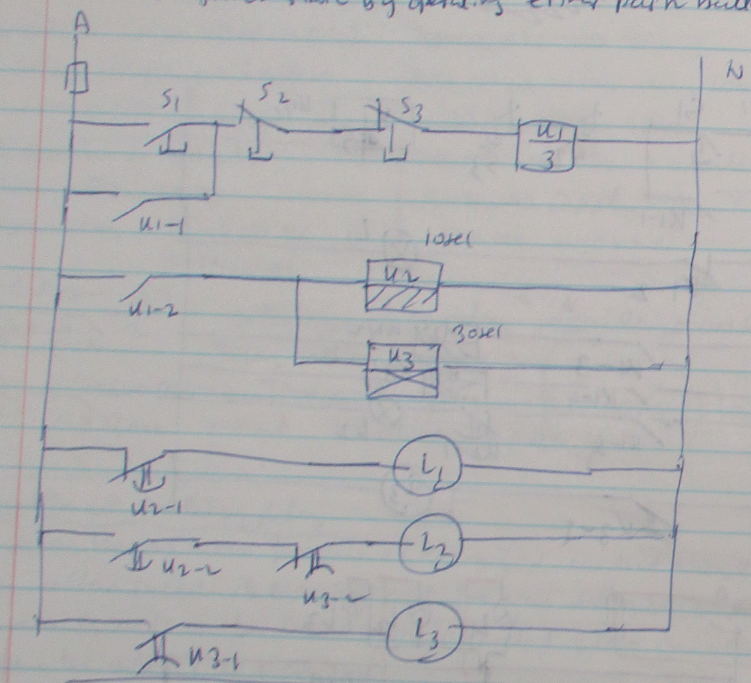


Reset to original function  
 It needs 3 time delay relays but only two are given  
 the function is modified.

operating push button  $S_1$  will cause 10 seconds time delay after which indicator lamp  $L_1$  will be de-energized and  $L_2$  will energize

Indicator lamp  $L_2$  will be energized after a further 20 seconds and Indicator lamp  $L_3$  will energize

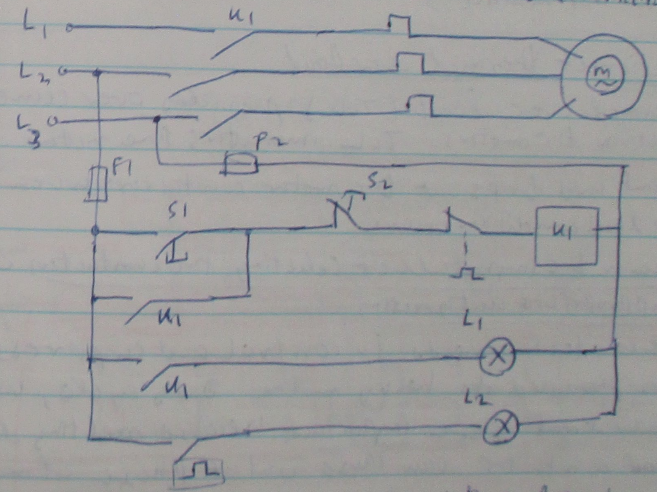
At any point during the sequence, the circuit can be returned to its original state by operating either push button  $S_2$  or  $S_3$



Exp. No	Terminal	D/A	measure before working, enclosure
1	S1	Schneider Electric	Normally open push button 600V 10A XAZ GA31
	S2/S3	Schneider Electric	Normally close push button 600V 10A XAZ GA31
	U1	FINDER	miniature control Relay 250V AC
	U2, U3	NUP	Timer on delay 24V DC, 240V AC supply, 0.1sec → 100 HR
	U3	Hager	Timer off delay contactor open/close Dim Rail mount 1P 40
	L1, L2, L3	Schneider electric	LED indicator L3W 250V

#### 4.2 Select control devices - contactors and thermal overload

Choose contactor / Thermal overload for contactor



3/4 motor requiring control and thermal protection is a 3.3 kW 440V, 50Hz squirrel-cage induction motor that will be subject to frequent starting and plug braking.

Contactor selection - U1  
 manufacturer - Siemens  
 Part no - 3RW3019-1BB14/3RM1  
 Voltage rating - 415V  
 Current - 17.6A  
 Duty - continuous  
 main contacts - 3  
 Auxiliary contact 1  
 Description - SIRIUS S20, 17.6A  
 7.5kW/400V 40°C  
 200-420V AC  
 110-230V AC/AC  
 Screw Terminals

Thermal over load selection  
 Tol  
 manufacturer - Siemens S20  
 Part no - 5TL921C  
 with zero 17mm  
 Thermobiten - 0  
 Voltage - 440V  
 Current - 10A  
 no contact -  
 no contact - 3  
 Description S20  
 Thermal over load  
 Relay 3p motor thermal  
 Protection Switch

contactor auxiliary contact module  
 (not applicable)

operation of Thermal over load

Thermal over load (Tol) provides over current protection for motors. Tol monitors the motor current and trips out the motor contactor when an over load condition occurs.

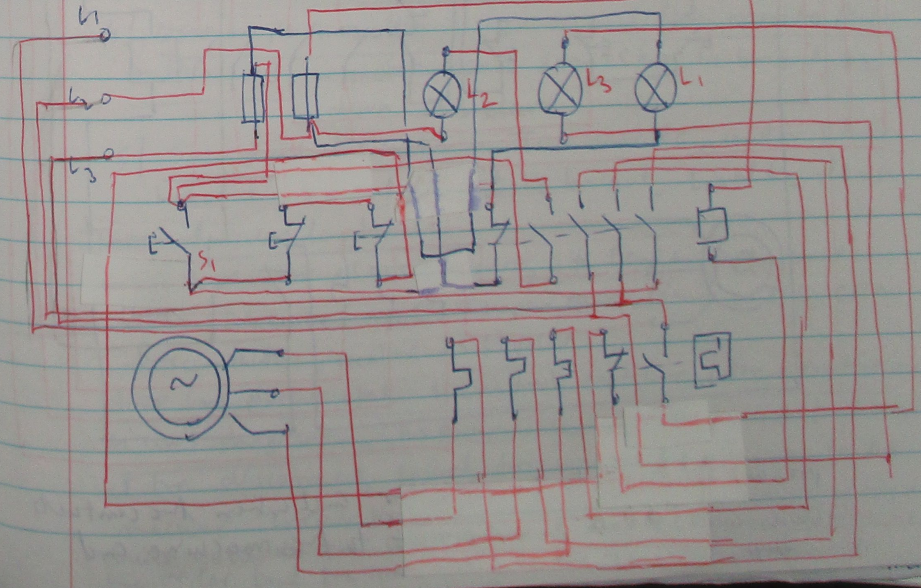
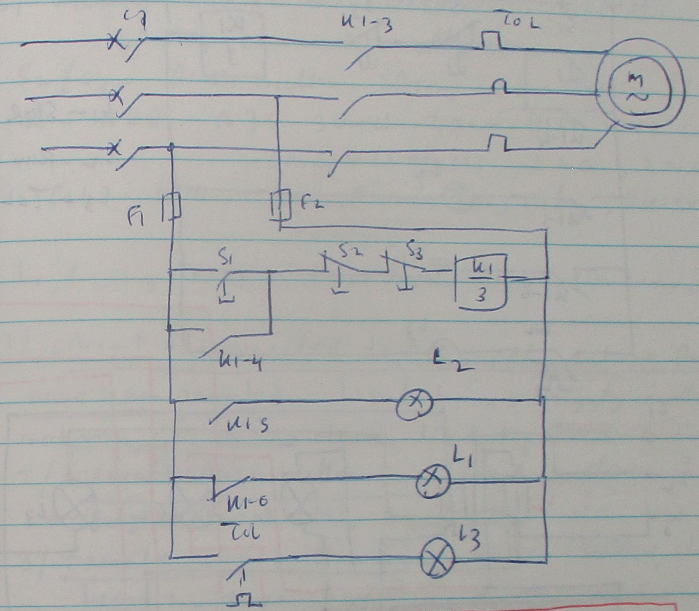
Explain the importance of selecting the contactor with an appropriate duty rating.

The contactor needs to control and suppress the arcs produced in heavy motor. Duty cycle, voltage and current ratings are important because melting down of contactor can cause out of phase of motor and can damage the motor.

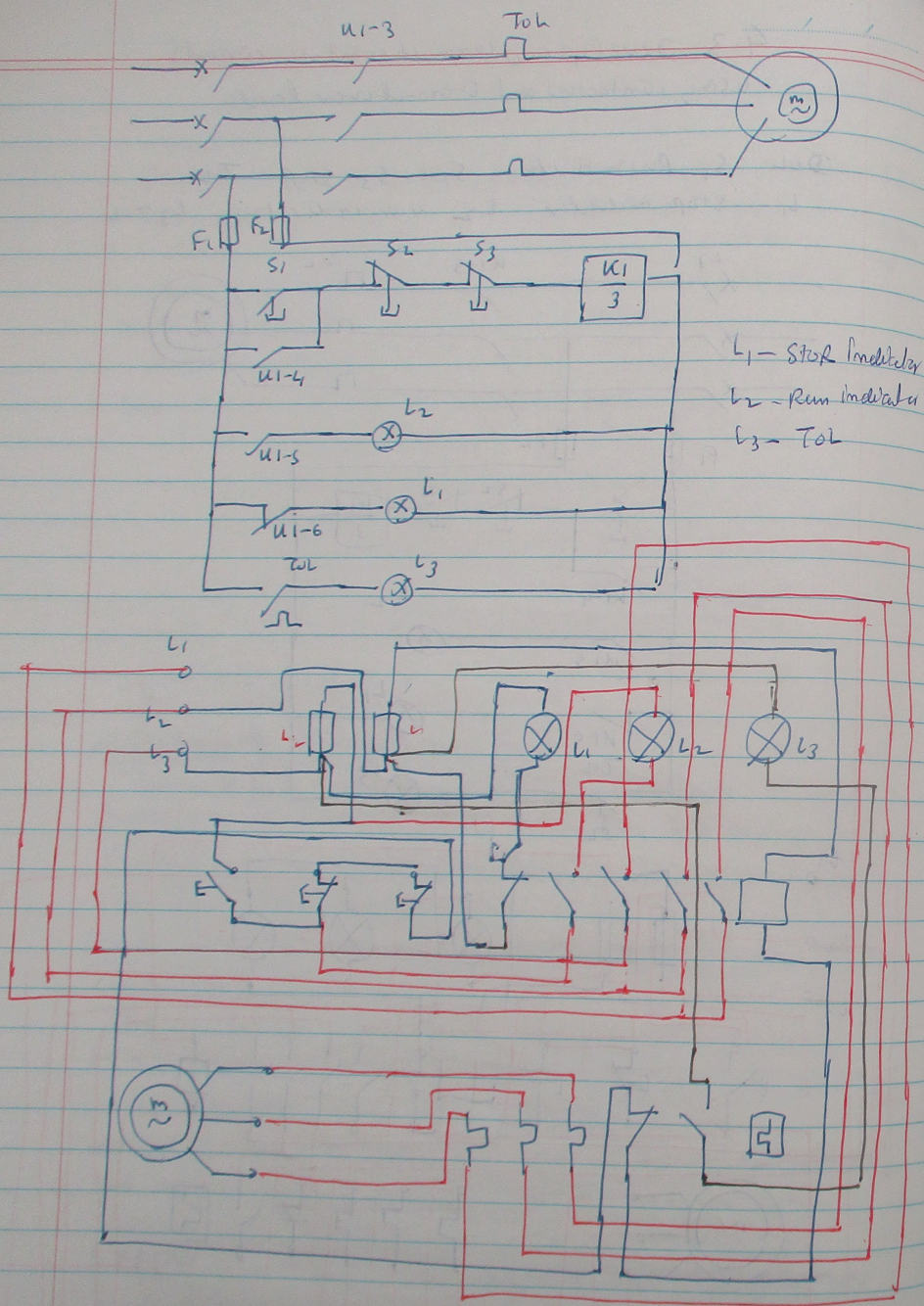
Exposed terminals DIT <sup>measure</sup> measure before touching  
 L-L fault 2/4. Check phase voltage connections.

4.3 Develop and connect control circuit using contactors and thermal over loads.

Stop, S1 push button S2 or S3 stop Tol.  
 L1 - stop indicator L2 run indicator L3 Tol







Provides the power to the controller and when the contacts close connect the power circuit to the machine and turns it on or off.

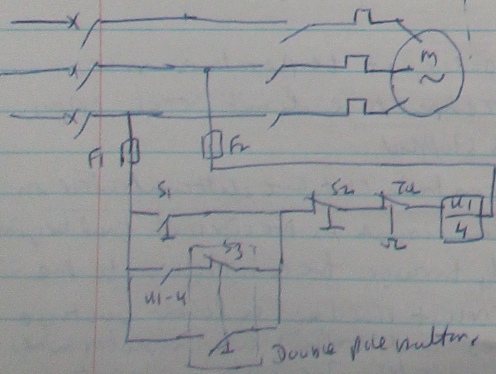
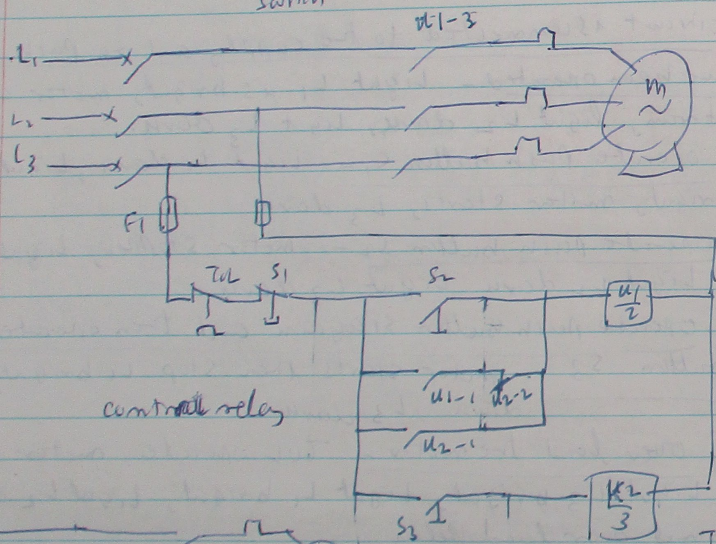
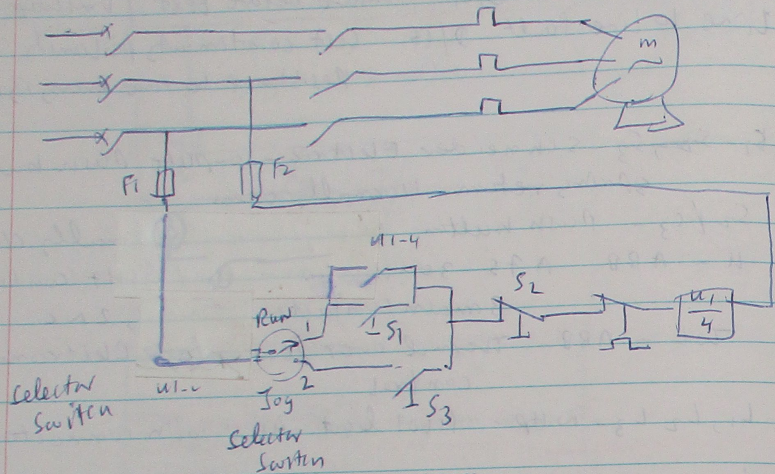
Exposed terminal D/I/T measure before test / Enclose  
 Line to Line fault D/I/T Test continuity, Polarity  
 Resistance before energizing.

- $S1$  -  ~~$S2$~~   $S3$  - Schneider Electric - complete Push button spring return Normally open
- $S2$  /  $S3$  - Push button Spring return Normally close
- $U$  - ABB AFS-30-11-40 - 415V Solid contact 3 main contacts, 2 NO, 2 NC
- ToL - ABB - Thermal over load relay, Electronics control
- $L1, L2, L3$  - NHP - Pilot light 415V with connected load.

- 1/ circuit is connected to the supply and no push buttons have been operated - Light  $L1$  is bright, motor does not run, light  $L2$  dark, light  $L3$  dark.
- 2/ operate push button  $S1$  - light  $L1$  dark, light  $L2$  bright, motor starts,  $L3$  dark
- 3/ operate push button  $S2$  - motor stopped, light  $L1$  bright, light  $L2$  dark, light  $L3$  dark
- 4/ operate push button  $S1$  again and then operate push button  $S3$  - motor starts then stop  $L1$  bright,  $L2$  dark,  $L3$  dark.
- 5/ over load the motor - ToL operate, motor stops, light  $L3$  bright, light  $L1$  bright, light  $L2$  dark.

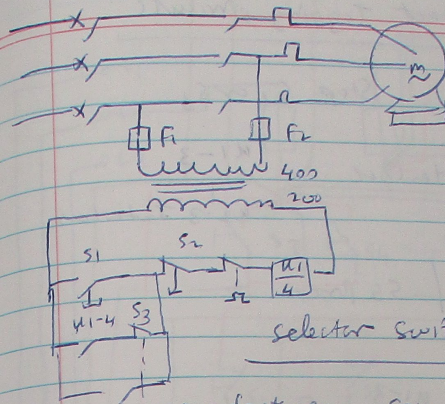
Thermal over load Relay  
 When the motor is overloaded, its temperature rises when it reaches ToL temperature limit, ToL opens the contacts, motor is stopped.  
 Star one power circuit & control circuit are differentiated in circuit diagram. The power circuit is the circuit that begins at the disconnect, travels through the controller to the machine. The control circuit could be a lower voltage which goes to the switches and relays which determines the order that the machine operates. The control circuit

S.1 Select control devices - jogging circuit



- Factors
- operational functions of the control
  - needs of control task
  - Information needs of operator
  - space layout requirements
  - Product features, capabilities of ZIP system
  - maintenance support, size of control
  - operating environment (Reliability)

0408/60103



Exposed terminals | 3-4 | measure before touching, Enclose line to line fault due to wrong connection & H check terminals and connections before energizing

selector switch selection S3

manufacturer - Schneider  
 part no - U1002 ULH  
 voltage rating - 690V  
 current rating - 10A  
 description - DPST 2 positions change over cam switch  
 690V AC.

push button selection S3

manufacturer - TAIYE DA  
 part no - ZB2-BE101C  
 voltage rating - 220V  
 current rating - 10A  
 contacts - 2 poles  
 description - Push button switch self reset, job round point Touch power, start switch NO NC switch 10A hole 22mm

motor selection		current	pd
power	voltage		
0.75kW	415V	2.38A	0.42
0.75kW	215V	2.38A	0.42

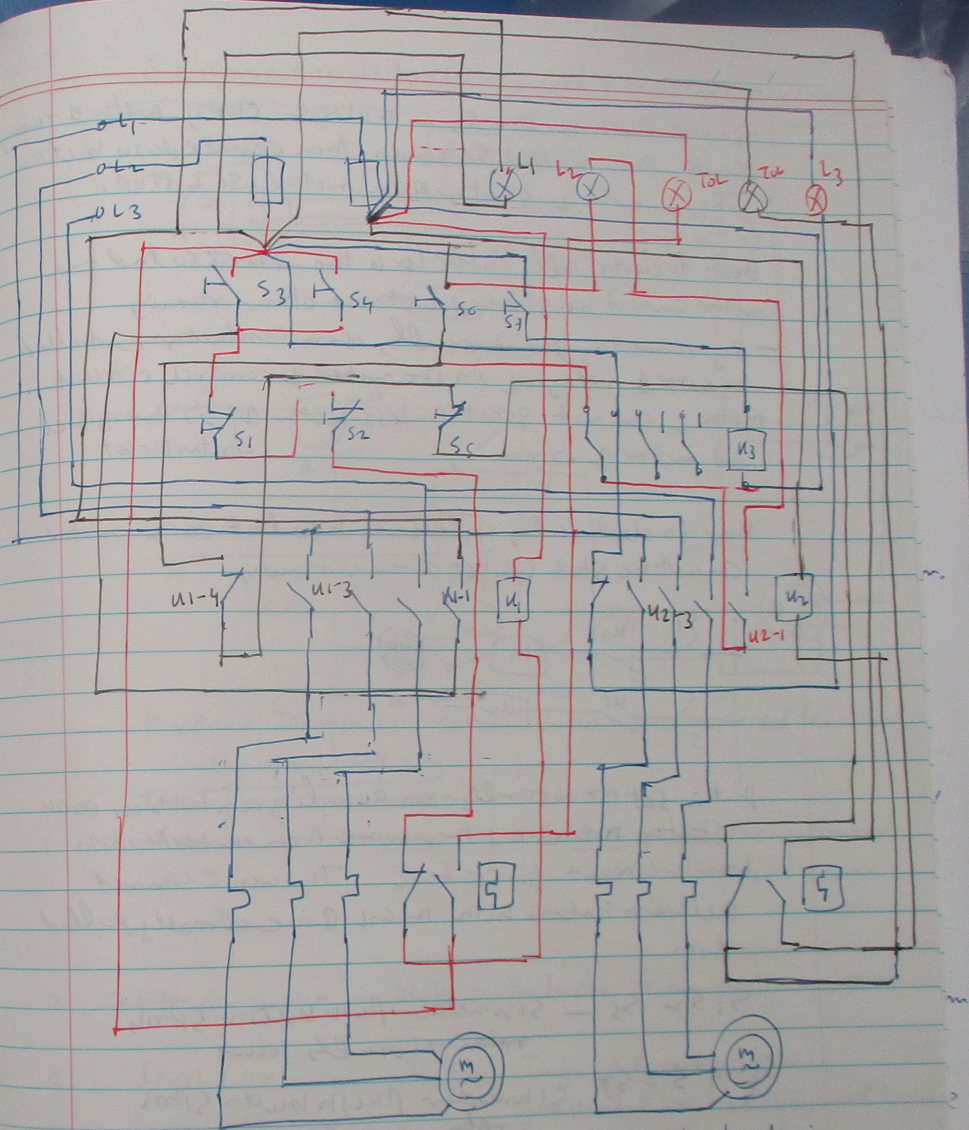
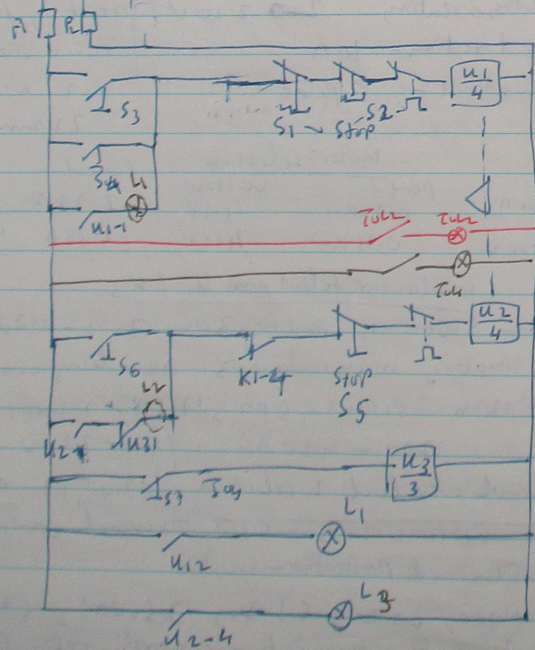
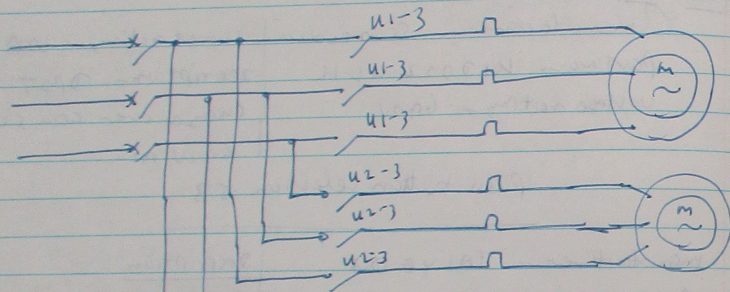
contactor selection U1/K3

manufacturer - SIEMENS, part no 3RW 303-1BB14, 415V, 17.6A  
 desc - cam timer, main contact 3, auxiliary contact 2  
 description - 3RW303-1BB14, 415V, 17.6A, 7.6kW, 400V, 400, 200-420V AC, 110-230V AC, 60A, screw terminal  
 thermal overload selection - 3RW303-1BB14, 415V, 17.6A  
 thermal protection switch

Relay - PINDAR, part no S3-34, 250VAC, 5A, 2 poles  
 main contact 4, miniature control relay Plug in or screw connection  
 availability of CAP

## S-2 Develop and connect Jogging circuits

motor 1 start - S3 or S4      Stop S1 or S5  
 L1 lock motor 1 run      u1-3  
 motor 2 connect start - Interlock      u2-3 Interlock  
 motor 2 start S6      u2-3  
 Stop S7  
 motor 1 stop - 2 Step / S5 process  
 Lock - motor 2 Run

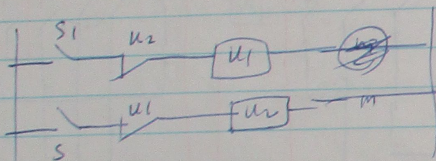


- 1 connect to supply, no push button press - Motor 1 is on
- 2 operate push button S3 - motor 1 starts
- 3 operate push button S1 - motor 1 stops
- 4 operate push button S6 - motor 2 starts  
motor 1 still running
- 5 operate push button S7 then S7 - motor 1 still running motor 2 can be jogged
- 6 push button S5 - motor 2 stops

operate push buttons - motor 2 stops, motor 1 running  
 operate push button S6 again then operate push button  
 S7 - motor 2 starts, Both motor 1 & 2 stop

How to electrically interlock two motors so that one  
 motor cannot be started without other running  
 - by connecting the normally open contactor controlled  
 by motor 2 relay coil in the motor 2 control circuit.  
 motor 2 cannot start unless motor 1 is energized  
 and motor 1 is running

How to electrically interlock so that each motor  
 cannot be start whilst other is running.



put a set of normally open auxiliary contacts on each  
 starter A & B and then wire them in series with  
 recoll circuit to starters. This way C cannot  
 pull in unless both A and B are already pulled  
 in

S1 S2 S5 - Schneider push button SPMS  
 return normally close

S3 S4 S6 S7 - Schneider push button SPMS  
 return normally open

U1 U2 U3 Finisar Relays L no 400

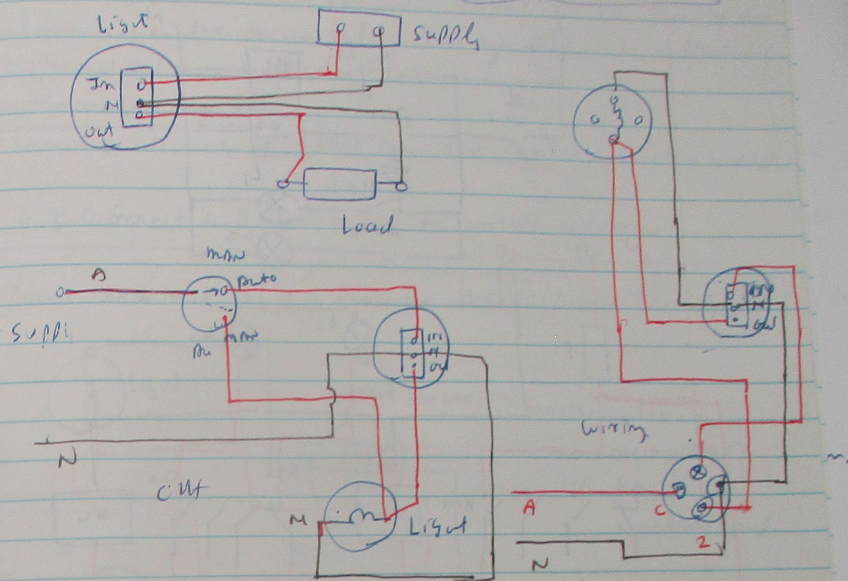
L1 L2 Schneider pilot light

T1 T2 SQR tremolok relay

Exposed terminal D14 Envelope

L-L fault - D14 properly check cables  
 not energizing

Get connect a photo electric cell to control a circuit



Exposed Terminals D14 Envelope the exposed terminal,  
 Equipment selection

Item	Manufacturer	Description
1 Light sensor	CLIPSAL	Infrared passive infrared 12m detection range 3wire 240V 10A
2 DETA Gang switch	DETA	Multiple 2ways switching options
3 Lapholcer	DETA	Tough polycarbonate base standard B22 size bayonet type

cut set to manual control - circuit can be on for manually

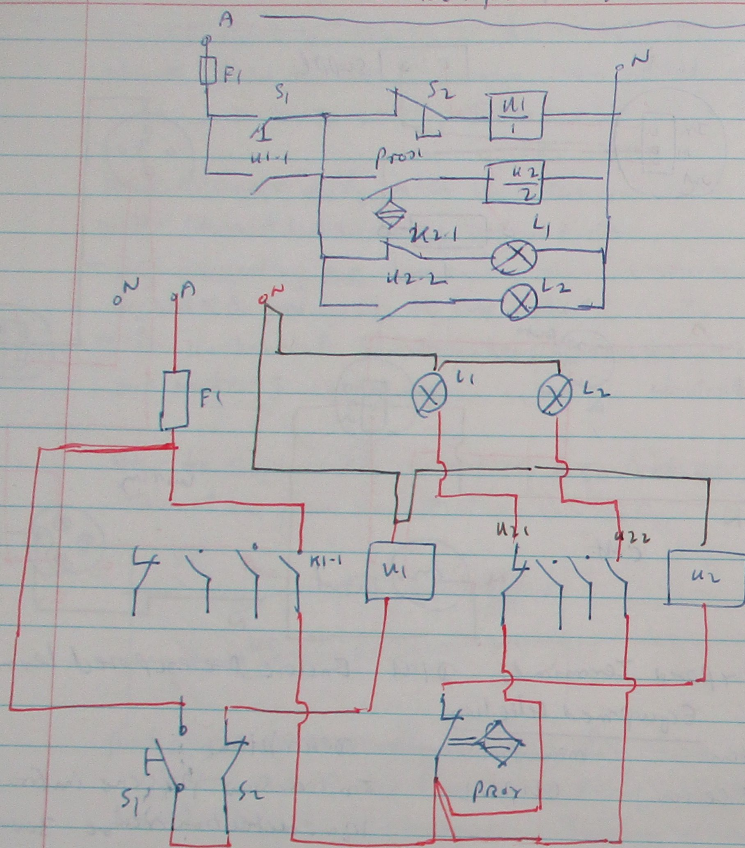
no light impacts on operation of the circuit.

circuit set to automatic control - when light falls on the charge sensor  
 it impacts on circuit operation.

Security lighting control - The light switch can be on when a person  
 enters the premise

Street lighting control - where there is no sun, the street lights can be on  
 automatically. when the sun rises up, it will shut  
 down

6.2 connect proximity switches to <sup>control a</sup> motor circuit



1. circuit connected to the supply with no push buttons operated - Indicator light L1 energized & U1 coil voltage 24V U2 coil voltage 0V
2. Push button S1 is operated, no object within the range of proximity sensor L1 No L2 Yes U1 coil 24V U2 coil 24V
3. An object is brought within the range of the proximity sensor L1 Yes L2 No U1 coil voltage 24V U2 coil voltage 0V
4. The object is removed from the range of the proximity sensor L1 No L2 Yes U1 coil 24V U2 coil 24V
5. Push button S2 is operated L1 Yes L2 No U1 coil 0V U2 coil 0V

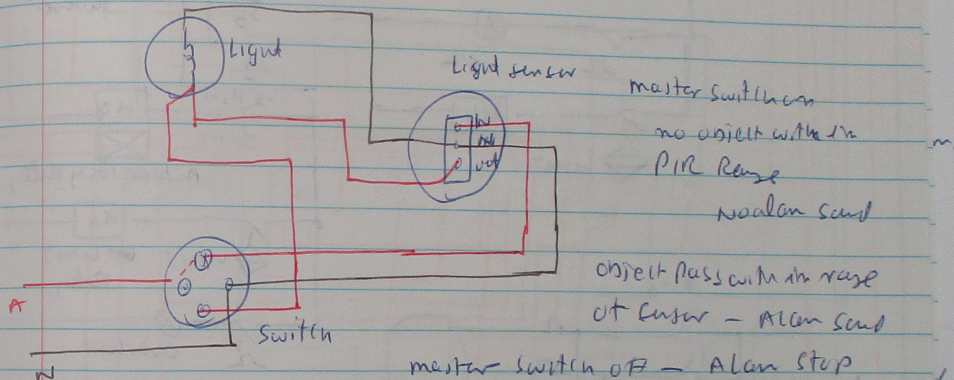
Security Door Alarm sensor

The security door alarm sensor is applied to sound the alarm when the person enters the premise at either the motor control system

Limit switch is installed in motor control switch board.

6.3 connect a PIR detector to control a circuit

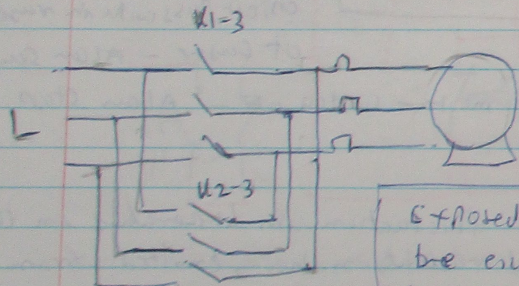
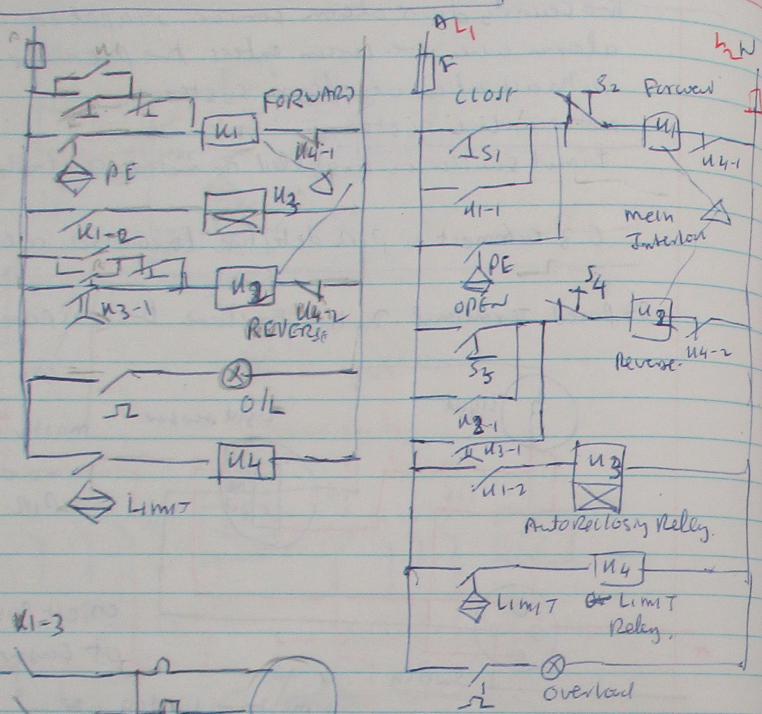
Exposed terminal DIT Enclose the exposed terminal



PIR sensor operation

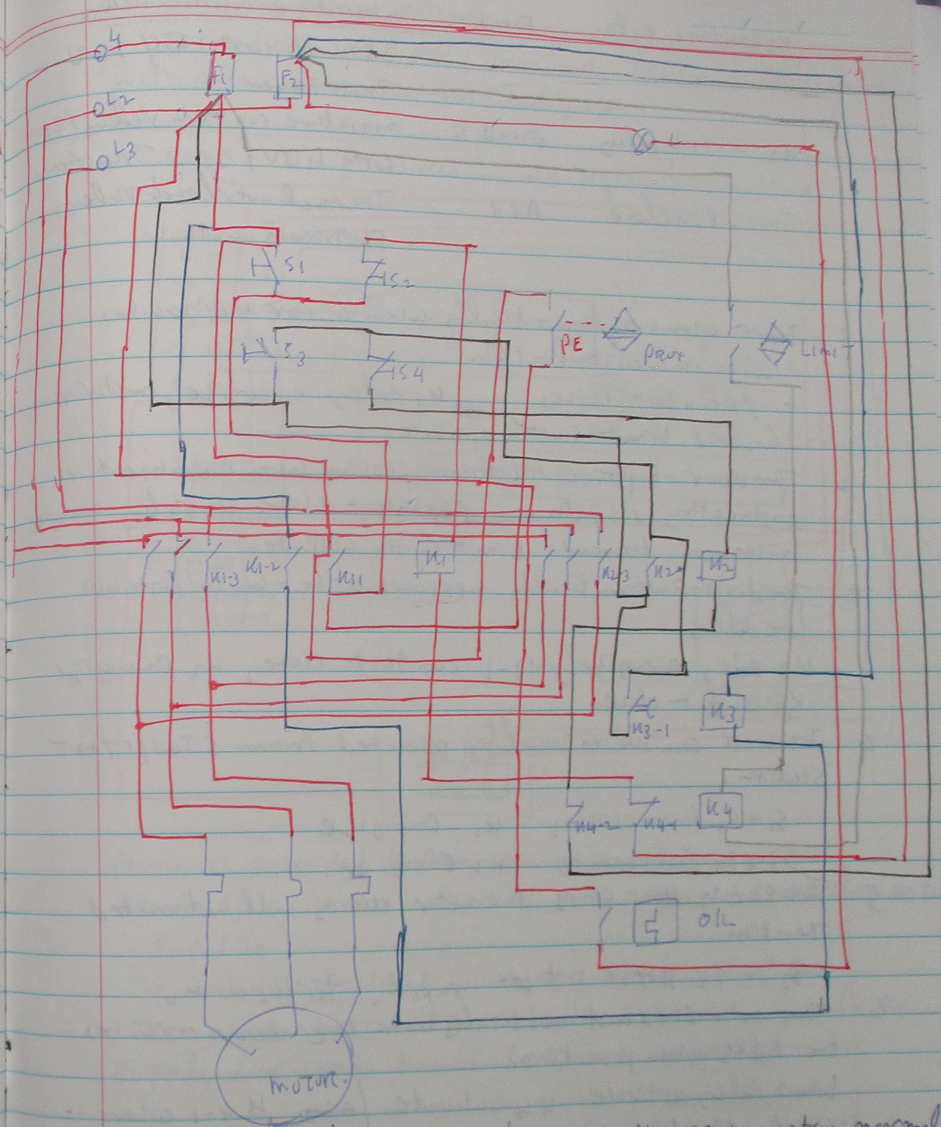
PIR sensor detects fluctuation in temperature in the form of infrared radiation being emitted from an object within a range commonly used motion detector for automated lighting system and alarm.

6.4 - select and connect contact devices



6+Noted Terminal D14 Enclose  
 be exposed terminal  
 L-L fault D14 carefully check  
 and trace the circuit.

Item	manufacturer	Brief Description
Light sensor	CLIPSON	Infrared scan possible infrared 1.6m detection Range
Limit switch	NUP	Safety Limit switch roller plunger snap action
Pilot Light	NUP	Pilot Light 41SD
S1 push button	Schneider	Push button spring return normally open
S2 push button	Schneider	Push button spring return normally close



S3 push button	Schneider	Push button spring return normally open
S4 push button	Schneider	Push button spring return normally close
K3 Timer on delay	NUP	Timer on delay 24vdc / 100vdc with 41S/24W transformer

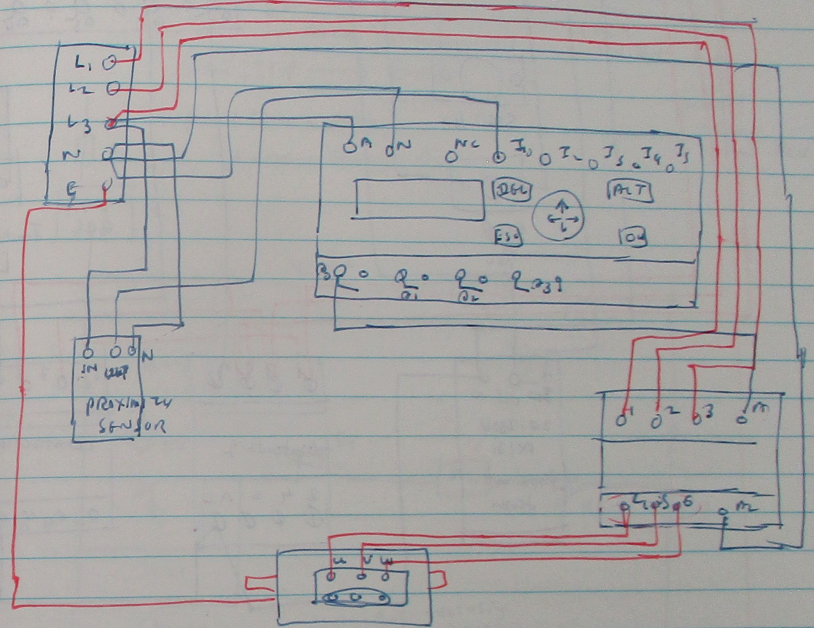
U1 control relay	FINDER	miniature control relay 250V AC with 415/250V Transformer
U2 control relay	FINDER	miniature control relay (250V with 415V/250V Transformer
Thermal overload	ABB	Thermal overload relay Electronics control

1. Door opens automatically when a car approaches with a distance of 4m  
- PE contact closes U1 relay energize, motor runs forward limit switch activate.
2. The door is prevented from closing when an object is obstructing its path. PE contact close U1 relay energize motor runs forward. Limit switch activate.
3. The door automatically recloses after an adjustable time delay.  
U3 relay energize, U3-1 contact close, U2 energize U2 contact close.
4. The door can be manually operated from STOP/START station.  
S1+S2 for closing U1 energize  
S3+S4 for opening U2 energize.
5. The stop button stops the motor during all automated operation  
S5 or S6 press cut off supply to U1 or U2
6. The motor stops automatically when the door reaches the fully open position.  
Limit relay activate U4 activate, U4-1 opens cut off the supply to U1
7. The motor stops automatically when the door reaches the fully closed position.  
Limit relay activates U4, activate, U4-2 opens, cut off supply to U2
8. Indicator light L1 indicates a motor overload, TOL contact closes overload lamp bright.

Alternative sensor circuit

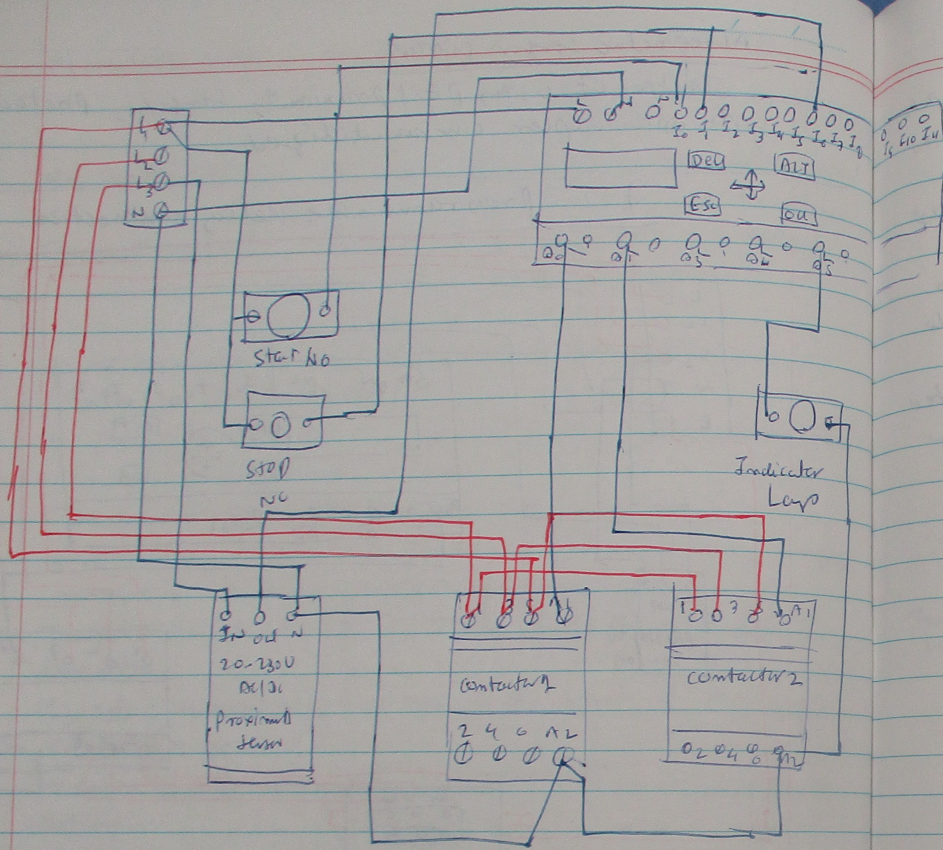
Instead of using PE (Proximity Sensor), photo diode with opto coupler can be utilized.

7-2 Programmable relay connection



Power is provided to Programmable relay  
Proximity device 1 is provided with power and connected to Input I0  
The coil of contactor 1 is connected to relay output C0  
The main contacts of the contactor are connected in the supply line contactors at the star connected 34 motor

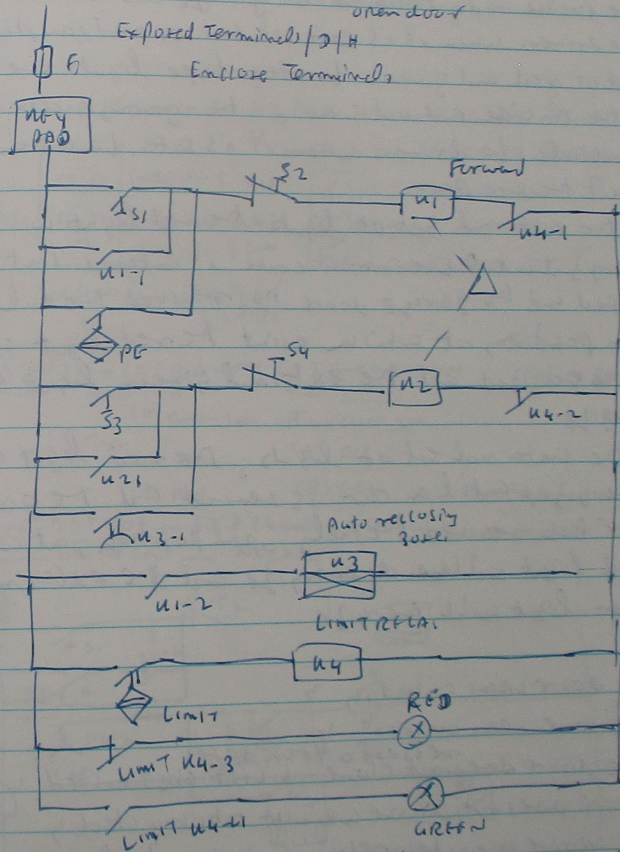
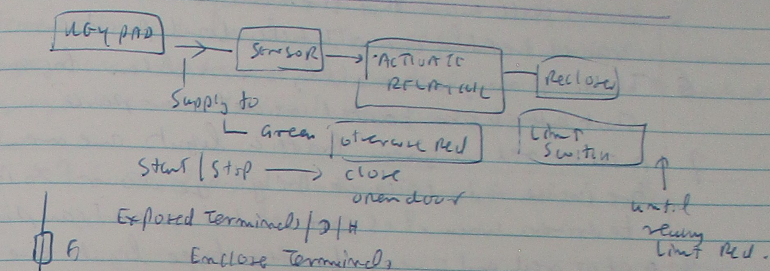
Risks	Supervision level	Risk	Control
Exposed Terminals	D	H	Enclose Terminal
L-L Fault	D	H	Carefully check reconnection.



Power is provided to the programmable relay  
 The START push button is connected to Input I0  
 The STOP push button is connected to Input I1  
 proximity device 1 is connected to relay output O0  
 The coil of contactor 2 is connected to the relay output O1  
 The indicator lamp is connected to the relay output O5  
 The ~~line~~ line sides of contactor 1 and 2 are connected to 3 $\phi$  supply

Input devices Start button, Stop button, sensor,  
 Limit switch, relay contact, Time contact  
Output devices Relays, contactor, lamp, valve, alarm  
 Actuators.

### 7-3 develop a ladder programmed relay programs



- 1/ Garage door can be opened from the outside when the operator enters a code into a key pad mounted on the wall.
- 2/ The garage door will be opened, when a car approaches the door from the inside.
- 3/ When ever the door is opened, it will not automatically reclose after 30 second.



- 4 The door will not close when an object is obstructing its path
- 5 Sensors will ensure that the motor stops when the door has reached the fully open and fully closed position.
- 6 The door may be manually overridden for emergency stop start button station located inside the car park.
- 7 A set of red and green traffic lights are mounted on the inside and outside of the garage door to indicate to drivers when it is safe to enter or exit the car park.
- 8 A set of red and green traffic type lights are mounted on the inside and outside of the garage door to indicate to drivers when it is safe to enter or exit the car park.
- 9 on the external set of lights the red light will be energized until the correct code is entered into the delay pad and the garage door has reached the fully open position, at which point the red light will be deenergized and the external green light will energize.
- 9 on the internal set of lights, the red light will be energized until a car is sensed and the garage door has reached the fully open position, at which point the red light will be deenergized and the external green light will energize.

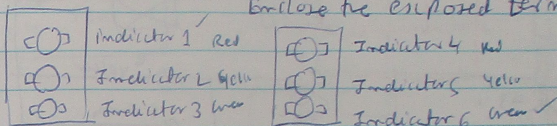
- 1) Garage door opens on entry ✓
- 2) Garage door opens on exit ✓
- 3) Garage door does not close when it is obstructed ✓
- 4) The door does not close when it is obstructed ✓
- 5) Garage door operates safely within its limits ✓
- 6) The door controls can be overridden by stop/start station ✓
- 7) The external traffic lights operate as specified ✓
- 8) The internal traffic lights operate as specified ✓

### Syntax

The syntax of a computer language is the rules that define the combinations of symbols that are to be correctly structured statements in that language. This applies to both to programming languages where the document represents source code and to markup languages where the document represents data.

### 7-5 Develop and connect Programmable relay control circuits

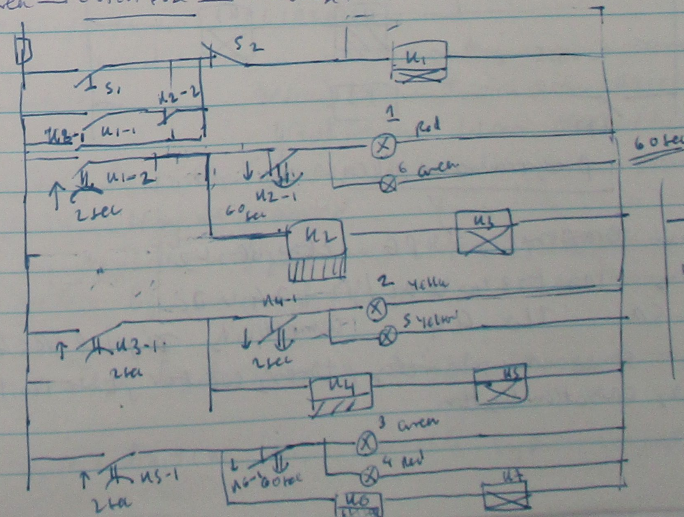
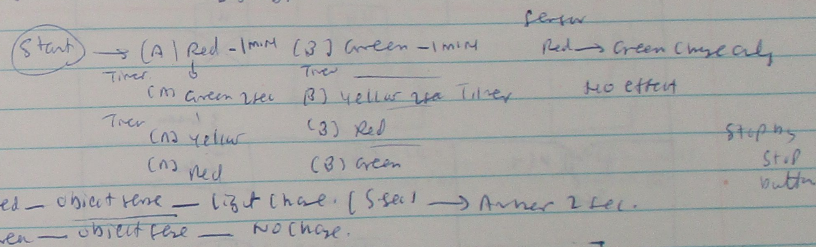
Exposed Terminals / 24H - measure before touching  
Enclose the exposed terminals.



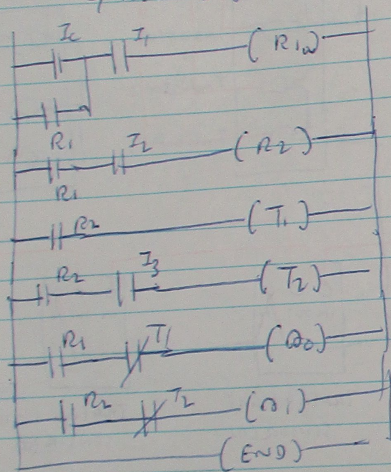
Traffic Light (A)

Southernly

Traffic Light (B)



- ① Press  $S_1$  , ② Indicator Light 1 - on + ③  
 After 60 sec - ④ Indicator Light 6 - on  
 ⑤ Indicator Light 2 - on  
 ⑥ Indicator Lights - on  
 After 2 sec  
 ⑦ Indicator Light 3 - on  
 ⑧ Indicator Light 4 - on  
 Press  $S_2$   
 All Lights - off



Exposed terminal D/H - Enclose terminal  
 wrong voltage D/H - use only 41-5V 3φ  
 Damaged motor  
 out of phase D/H - No loose terminal  
 motor body, keep leakage - D/H - measure body voltage  
 falling at motor on foot - D/H use safety shoe

## 8.2 connect a DOL motor starter

$$\frac{I_{Test}}{I_{St}} = \frac{V_{Test}}{V_{Start}}$$

$$\frac{T_{Test}}{T_{St}} = \frac{V_{Test}^2}{V_{Start}^2}$$

$$\frac{1.22}{I_{St}} = \frac{0.16}{0.3} \Rightarrow I_{St} = \frac{1.22}{0.53} = 2.3 \text{ A}$$

$$\frac{T_{Test}}{T_{St}} = \frac{1.22^2}{V_{Start}^2} \Rightarrow T_{St} = \frac{1.22^2}{0.3^2} = 16.7 \text{ N-m}$$

Practical Result  $I_{St} = 1.25 \text{ A}$  ,  $I_{run} = 0.26 \text{ A}$

$$\frac{T_{St}}{T_{run}} = \frac{I_{St}^2}{I_{run}^2}$$

$$\frac{T_{St}}{0.3} = \frac{1.25^2}{0.26^2} \Rightarrow T_{St} = \frac{0.3 \times 1.25^2}{0.26^2} = 6.9 \text{ N-m}$$

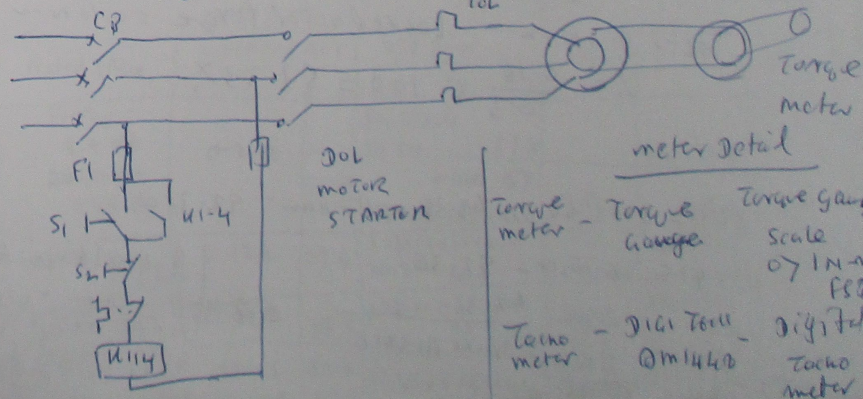
$$\frac{I_{Test}}{I_{St}} = \frac{T_{Test}}{T_{St}} \Rightarrow \frac{1.22}{I_{St}} = \frac{0.3}{1.87} \Rightarrow I_{St} = \frac{1.22}{1.36} = 0.89 \text{ A}$$

Phase = 3φ , Line voltage = 41-5V , output power = 44 watt  
 Power factor = 0.67 , frequency = 50 , Rated full load  
 current = 1.6A , Rated speed = 1365 RPM , connection Δ

Insulation class F

$$P_{out} = \frac{2 \pi N T}{60}$$

$$T = \frac{P_{out} \times 60}{2 \pi N} = \frac{44 \times 60}{2 \times 3.1416 \times 1365} = 0.3 \text{ N-m}$$



meter detail

Torque meter	Torque Gauge	Torque Gauge
Tacho meter	Digit Tach	Digit Tach
	@11440	@11440
	Scale	Scale
	07 IN-m	07 IN-m
	FSD	FSD
	Tacho meter	Tacho meter

Line current 1.6A, Rotor speed 1365 rpm

Locu rotor test voltage 41.5V

Locu rotor characteristics

Line current = 1.22 A Torque 0.16 N-m

No load test

$$I_{st} = 1.25 A \quad I_{run} = 0.26 A$$

Starting current calculation

$$\frac{I_{Test}}{I_{st}} = \frac{V_{Test}}{V_{start}} \quad \frac{T_{Test}}{T_{st}} = \frac{U_{Test}^2}{U_{st}^2}$$

$$\frac{I_{Test}^2}{I_{st}^2} = \frac{T_{Test}}{T_{st}} \rightarrow \frac{1.22^2}{1.25^2} = \frac{0.16}{T_{st}} \rightarrow T_{st} = 1.67 A$$

From practical,  $I_{st} = 1.25 A$ ,  $I_{run} = 0.26 A$

$$\frac{T_{st}}{T_{run}} = \frac{I_{st}^2}{I_{run}^2} \quad T_{run} = 0.3 N-m$$

$$T_{st} = 0.3 \times \frac{1.25^2}{0.26^2} = 6.9 N-m$$

DOL starting current as % of full load current

DOL starting current (practical) = 1.25 A

$$\% \text{ of full load current} = \frac{1.25}{1.6} \times 100 = 78.125\%$$

DOL starting torque as % of rated full load torque

$T_{FL} = 0.3 N-m$  Locked rotor torque = 0.16 N-m

$$\% = \frac{0.16}{0.3} \times 100 = 53.33\%$$

$$3I^2R = 3 \times 1.6^2 \times 0.3 = 46.38 \quad \text{op} = 44W - 92.36W$$

$$3I^2R = 41.5^2 \times 1.6 \times 10^{-3} = 92.36$$

$$\cos \phi = \frac{42.36}{92.36} = 0.8$$

$$T_s = \frac{P_{out}}{2\pi n} = \frac{6.95}{2\pi \times 1365} = 0.8$$

$$3 \times 41.5^2 \times 1.6 \times 10^{-3} = 44 \quad \cos \phi = 0.887$$

### 3.3 connect electrical soft starter

Exposed Terminal D/H - Enclose Terminal  
Wrong voltage damaging motor D/H use only 344.5V

out of phase D/H - no loose terminal

motor body Earth leakage D/H measure body voltage

Falling structure on foot D/H use safety shoe.

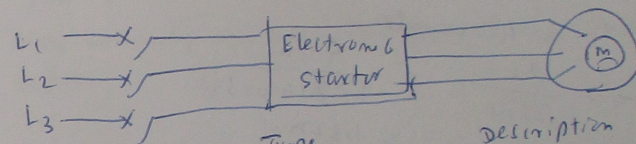
Phase = 3, Line voltage = 415V, output power = 44W

power factor = 0.67, frequency = 50, Rated full load

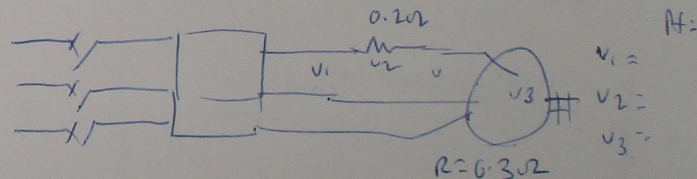
current = 1.6A, rated speed = 1365 rpm, connection  $\Delta$

Insulation class = F

$$T = \frac{P_{out} \times 60}{2\pi n} = \frac{44 \times 60}{2\pi \times 1365} = 0.3 N-m$$



Torque meter - Type torque gauge description Torque scale  $\rightarrow$  1N-m FSD  
Tachometer - DIGITECH - Digital Tacho meter QM144B



Rated Speed	Line Current	Input Power			3I <sup>2</sup> R	o/p	T
		V1	V2	V3			
20 Hz	0.2 A	16.32 V	0.05 A	6.7	3.02	6.954	0.018
30 Hz	0.12 A	25.9 V	0.02	4.3	3.12	4.02	0.018
40 Hz	0.17 A	33.3 V	0.03	7.24	3.14	7.29	0.018
50 Hz	0.21 A	39.1 V	0.04	11.3	3.14	10.46	0.018
60 Hz	0.24 A	44.2 V	0.05	14.09	3.14	13.9	0.018

