Tittel på leksjonen

Kompetansemål:

- utføre arbeid på automatiserte anlegg fagmessig, nøyaktig og i overensstemmelse med krav til helse, miljø og sikkerhet og rutiner for kvalitetssikring og internkontroll
- utføre risikovurdering og vurdere tiltak for ivaretakelse av person- og maskinsikkerhet
- vurdere hvilke regelverk og normer som gjelder for arbeidet som skal utføres og anvende dette
- planlegge, utføre, vurdere kvalitet, sluttkontrollere og dokumentere arbeidet
- planlegge, programmere, montere og idriftsette programmerbare styresystemer
- endre og tilpasse skjermbilder for grensesnitt mellom menneske og maskin
- anvende ulike elektroniske kommunikasjonssystemer i automatiserte anlegg
- vurdere datasikkerhet i automatiserte anlegg
- tegne, lese og forklare instrumenterte prosessflytskjemaer og bruke annen relevant dokumentasjon for automatiserte anlegg
- montere, konfigurere, kalibrere og idriftsettelse digitale og analoge målesystemer
- idriftsette og optimalisere regulatorer basert på prosessbehov
- montere og idriftsette ulike typer pådragsorganer med tilhørende forstillingselementer og hjelpeutstyr
- programmere, idriftsette samt gjøre rede for roboters funksjon og anvendelse i produksjonsanlegg
- måle fysiske størrelser i automatiserte anlegg
- feilsøke og rette feil i automatiserte anlegg
- bruke gjeldende regelverk og normer for elektriske installasjoner på maskiner
- bruke gjeldende regelverk og normer for installasjon av elektroniske kommunikasjonssystemer
- beskrive ulike vedlikeholdssystemer og -rutiner knyttet til automatiserte anlegg, og anvende et av disse
- redegjøre for bedriftens organisasjonsoppbygging og bedriftens verdiskapning i et samfunnsperspektiv
- dokumentere egen opplæring i automatiseringssystemer

Læringsmål

- Kunne
- Kunne

Forkunnskaper

-

Teori

afgv.pdf - Programmerbare Logiske Styringer - Inngangs- og utgangs tilkoblinger (IO-er)

Øvingsoppgaver til leksjon - følger neste side

Innlevering til leksjon - Det er ingen innlevering til leksjonen.

Oppgaver

Oppgave 1

The most basic type of real-world input to a PLC is a *discrete* (on/off) input. Each discrete input channel on a PLC is associated with a single bit in the PLC's memory. Use the PLC programming software on your personal computer to "connect" to your PLC, then locate the facility within this software that allows you to monitor the status of your PLC's discrete input bits.

Actuate the switches connected to your PLC's discrete input channels while watching the status of the respective bits. Based on what you see, what does a "1" bit status signify, and what does a "0" bit status signify?

Suggestions for Socratic discussion

- How does your PLC address discrete input bits? In other words, what is the convention it uses to label these bits, and distinguish them from each other?
- How does the programming software for your PLC provide access to discrete input bit status?

PLC comparison:

- Allen-Bradley Logix 5000: the *Controller Tags* folder (typically on the left-hand pane of the programming window set) lists all the tag names defined for the PLC project, allowing you to view the real-time status of them all. Discrete inputs do not have specific input channel tag names, as tag names are user-defined in the Logix5000 PLC series.
- Allen-Bradley PLC-5, SLC 500, and MicroLogix: the *Data Files* listing (typically on the left-hand pane of the programming window set) lists all the data files within that PLC's memory. Opening a data file window allows you to view the real-time status of these data points. Discrete inputs are the `I` file addresses (e.g. `I:0/2`, `I:3/5`, etc.). The letter "`I`" represents "input," the first number represents the slot in which the input card is plugged, and the last number represents the bit within that data element (a 16-bit word) corresponding to the input card.
- Siemens S7-200: the *Status Chart* window allows the user to custom-configure a table showing the real-time values of multiple addresses within the PLC's memory. Discrete inputs are the `I` memory addresses (e.g. `I0.1`, `I1.5`, etc.).
- Koyo (Automation Direct) DirectLogic and CLICK: the *Data View* window allows the user to custom-configure a table showing the real-time values of multiple addresses within the PLC's memory. Discrete inputs are the `X` memory addresses (e.g. `X1`, `X2`, etc.).

file i01876

Oppgave 2

Suppose you need to connect an Allen-Bradley CompactLogix PLC discrete output card (part 1769-OB16) channel to the "Start" discrete input of an Allen-Bradley PowerFlex 4 VFD. Identify which terminals on the PLC need to be connected to which control terminals on the VFD, assuming the use of channel #3 on the PLC output card.
file i01875

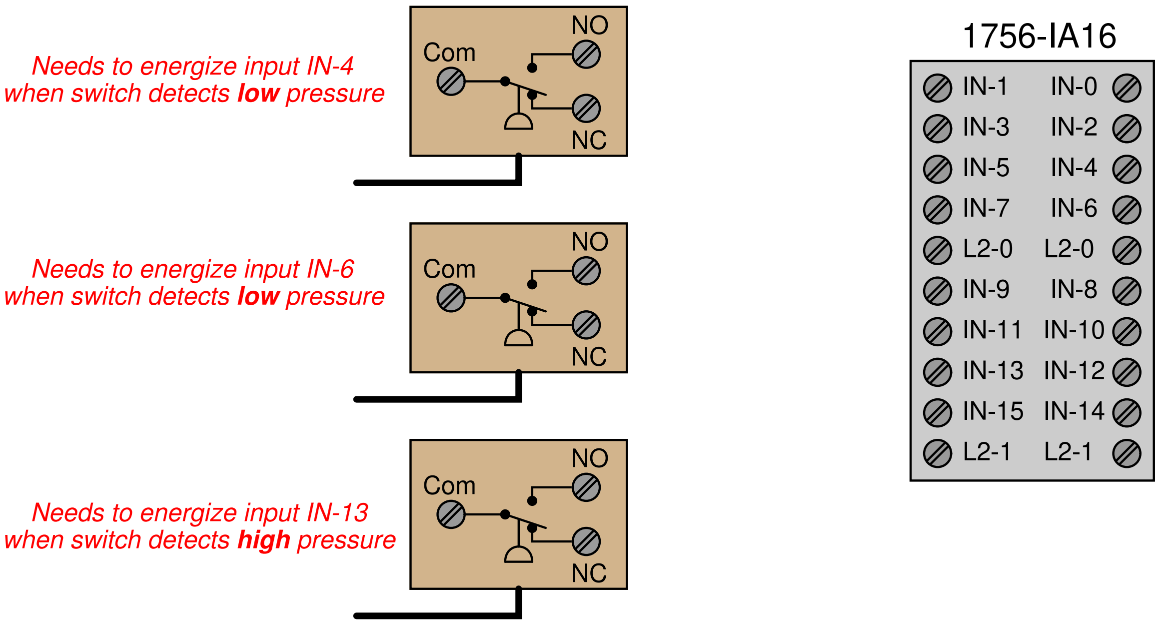
Oppgave 3

The Allen-Bradley Logix5000 family of PLCs has the option of a model 1756-IB16D DC "diagnostic" input card, where each discrete input device (switch) is supposed to be wired such that it has a 14.3 kΩ resistor connected in parallel with it.

Examine the internal schematic for a typical channel on this input card, as well as the sample wiring diagram showing how switches are supposed to be connected to the inputs of this card, and identify how this card provides "diagnostic" information above and beyond the basic recognition of switch status. Note: you may find Allen-Bradley's document called *"1756 ControlLogix I/O Modules"* (publication 1756-TD002A-EN-E, May 2009) helpful in answering this question.
file i02039

Oppgave 4

Anta at du har fått i oppdrag å koble disse tre trykkbrterene til DI-ene IN-4, IN-6 og IN-13 på en Allen-Bradley model 1756-IA16.

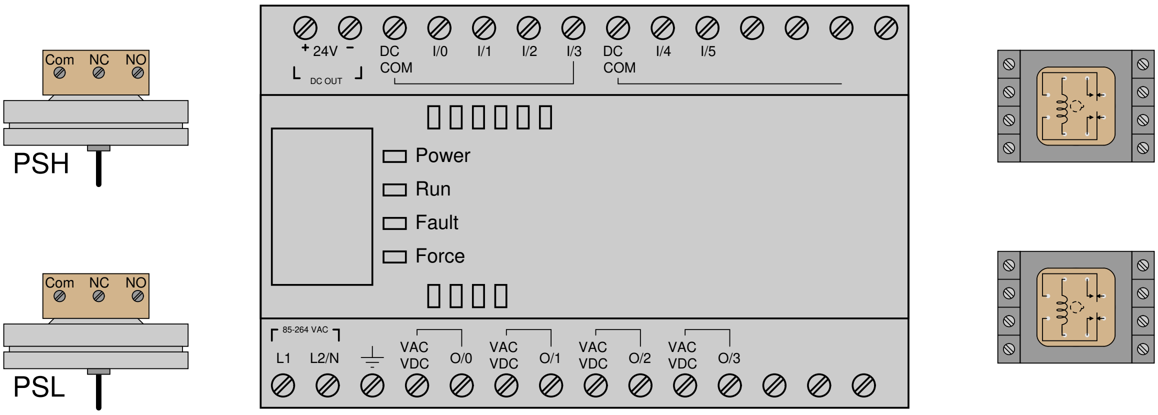


Tegn inn de nødvendige koblingene for at trykkbryterene skal virke på de spesifiserte DI-ene. Ta med eventuelt nødvendige spenningskilder.

Tips: Det kan hjelpe deg om du søker opp et dokument som kalles *"1756 ControlLogix I/O Modules"*(publication 1756-TD002A-EN-E, May 2009)
file i02060

Oppgave 5

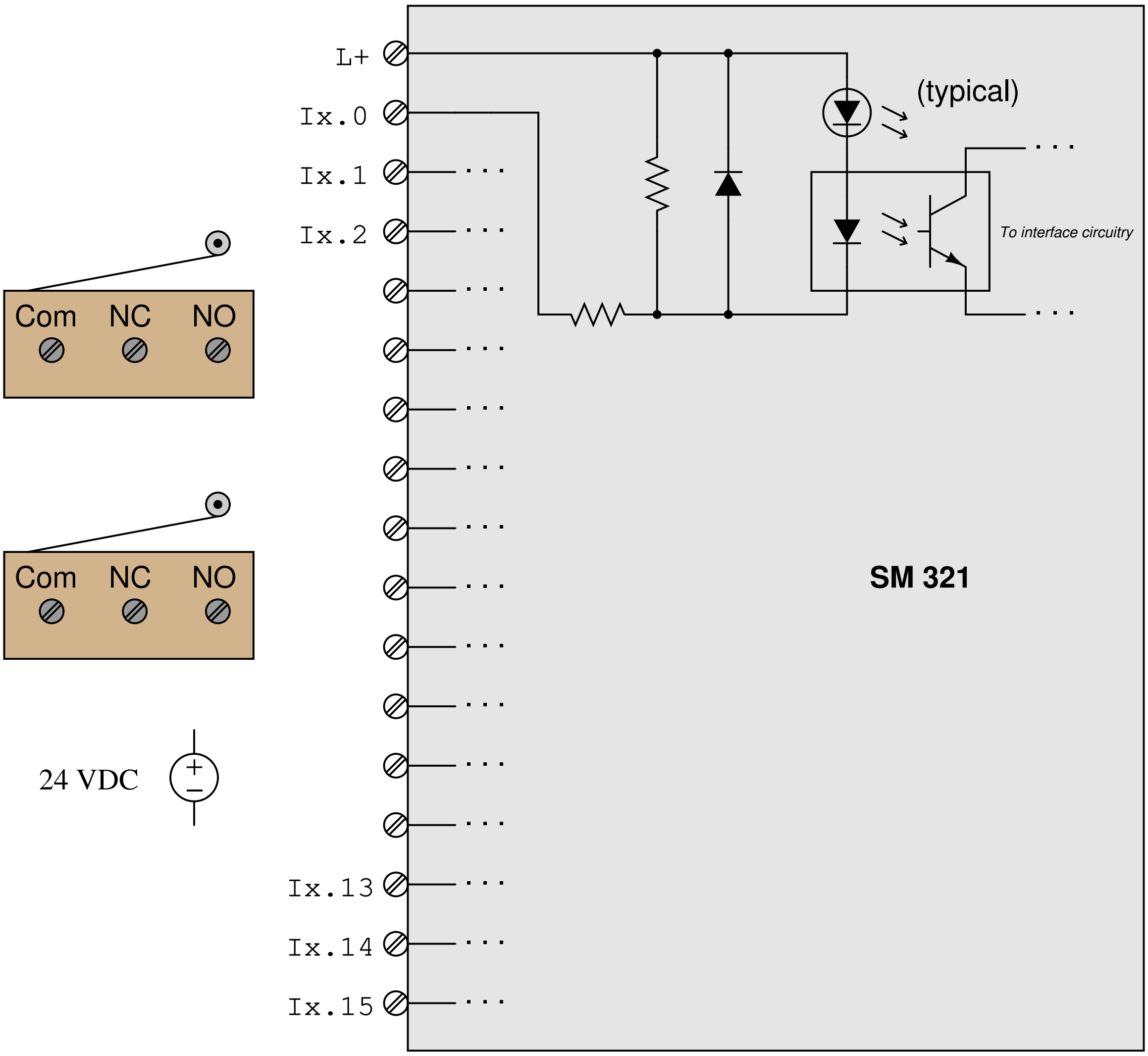
Tegn inn de nødvendige koblingene for å koble to trykkbrytere og to relespoler til en Allen-Bradley MicroLogix 1000 PLC(model 1761-L10BWA, med 6 DI-er som enten er sourcing eller sinking, og 4 DO med potensialfrie kontakter.) Være nøye med å koble bryterene sånn at di *source* til PLS inngangene. (Prassure Switch Low til `I/2` og Preassure Switch High til `I/5`. Begge bruker Normalt Open kontakten. Koble relespolene slir at PLS-en *source* strøm til utgangene.(`O/0` og `O/1`):



file i02379

Oppgave 6

To endebrytere skal tilkobles h.h.v. `Ix.5` og `Ix.11` på en Siemens SM-321 DI inngangsmodul.(model 6ES7321-1BL00-0AA0) Tegn de nødvendige koblingene. Det internekoblingsskjemaet for (`Ix.0`) vises som en referanse for alle inngangene. Tegn de nødvendige koblingene som er nødvendig for tilkobling av endebryterene.

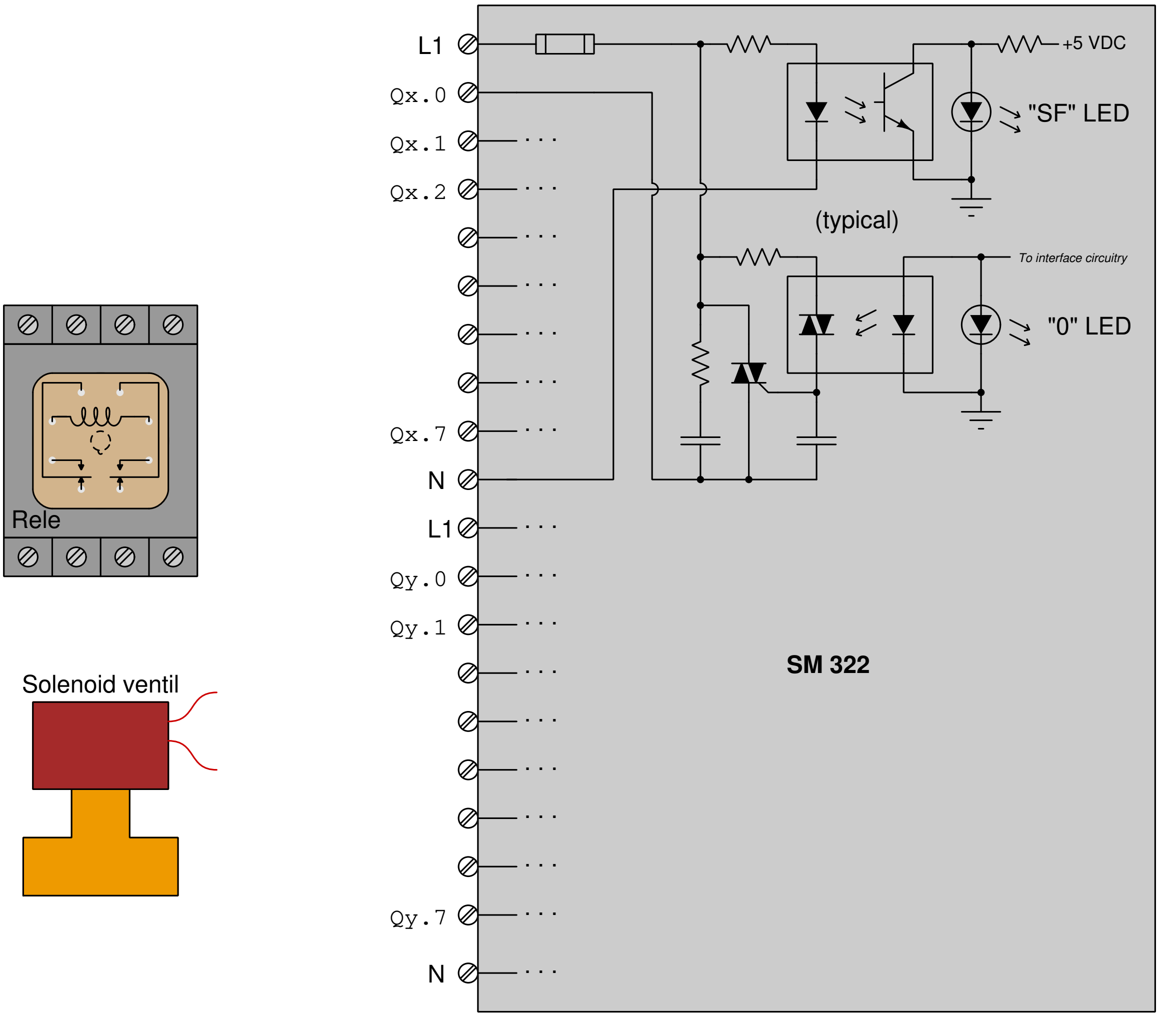


Er dette en *sinking* eller en *sourcing* DI modul? Tegn strømretning på alle ledere til IO-modulen.

file i02508

Oppgave 7

Tegn inn nødvendige koblinger for å koble en solenoid og en relespole til h.h.v. utgang `Qx.2` og `Qx.4` på en Siemens SM322 DO modul(model 6ES7322-1FH00-0AA0). Begge spolene har en normert spenning på 230VAC. Det interne skjemaet for den første utgangen vises som referanse. Her vises hvordan en TRIAC blir brukt som bryter for å gi spenning på de digitale utgangene.



Forklar også tretsen inni modulen virker, følge effektkretsen igjennom modulen.

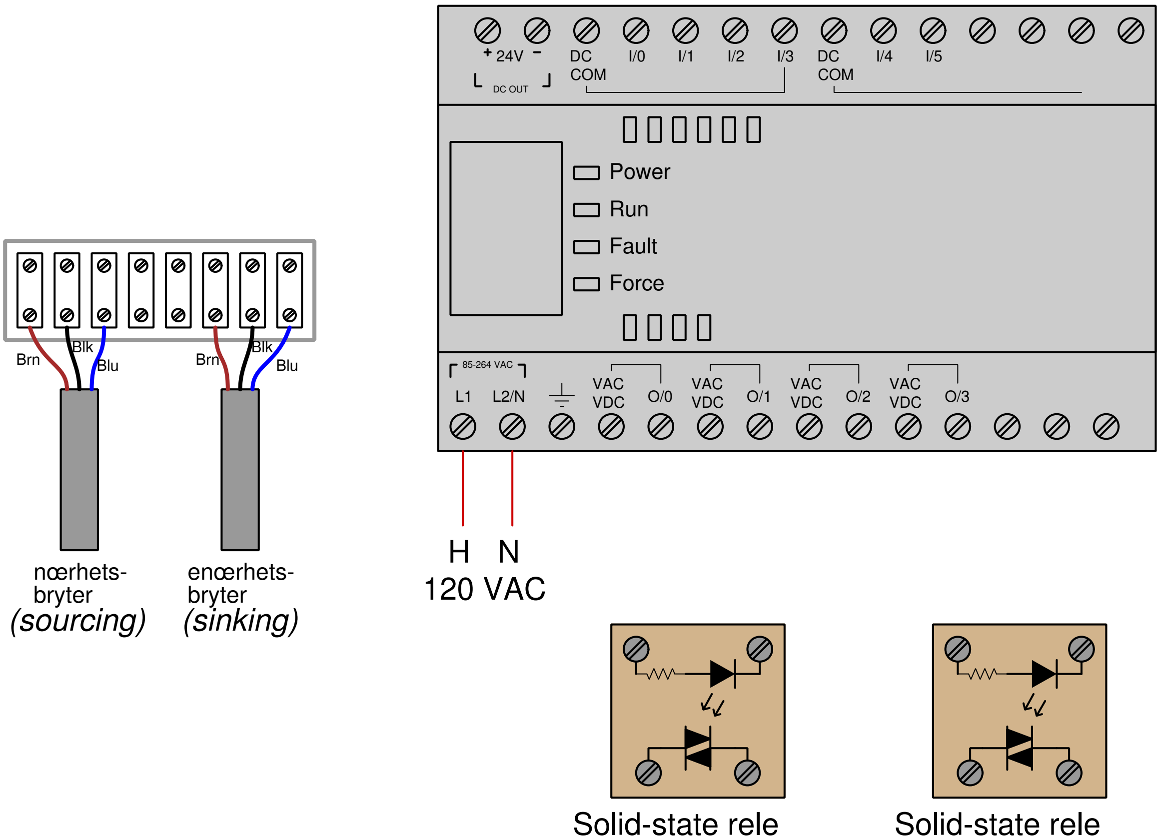
Suggestions for Socratic discussion

- What function does the "SF" LED perform, and what makes it turn on?

file i04246

Oppgave 8

Tegn inn de nødvendige koblingene for å koble to nærhetsbrytere og to solid-state releer til en Allen-Bradley MicroLogix 1000 PLC (model 1761-L10BWA, med 6 DI-er som kan være sourcing eller sinking og 4 DO med potensialfrie relekontakter. Koble nærhetsbryteren som er sourcing (PNP) til inngang `I:I/0`, bryteren som er sinking til `I:I/4`, og de to solid state-releene til `O:O/1` og `O:O/2`:



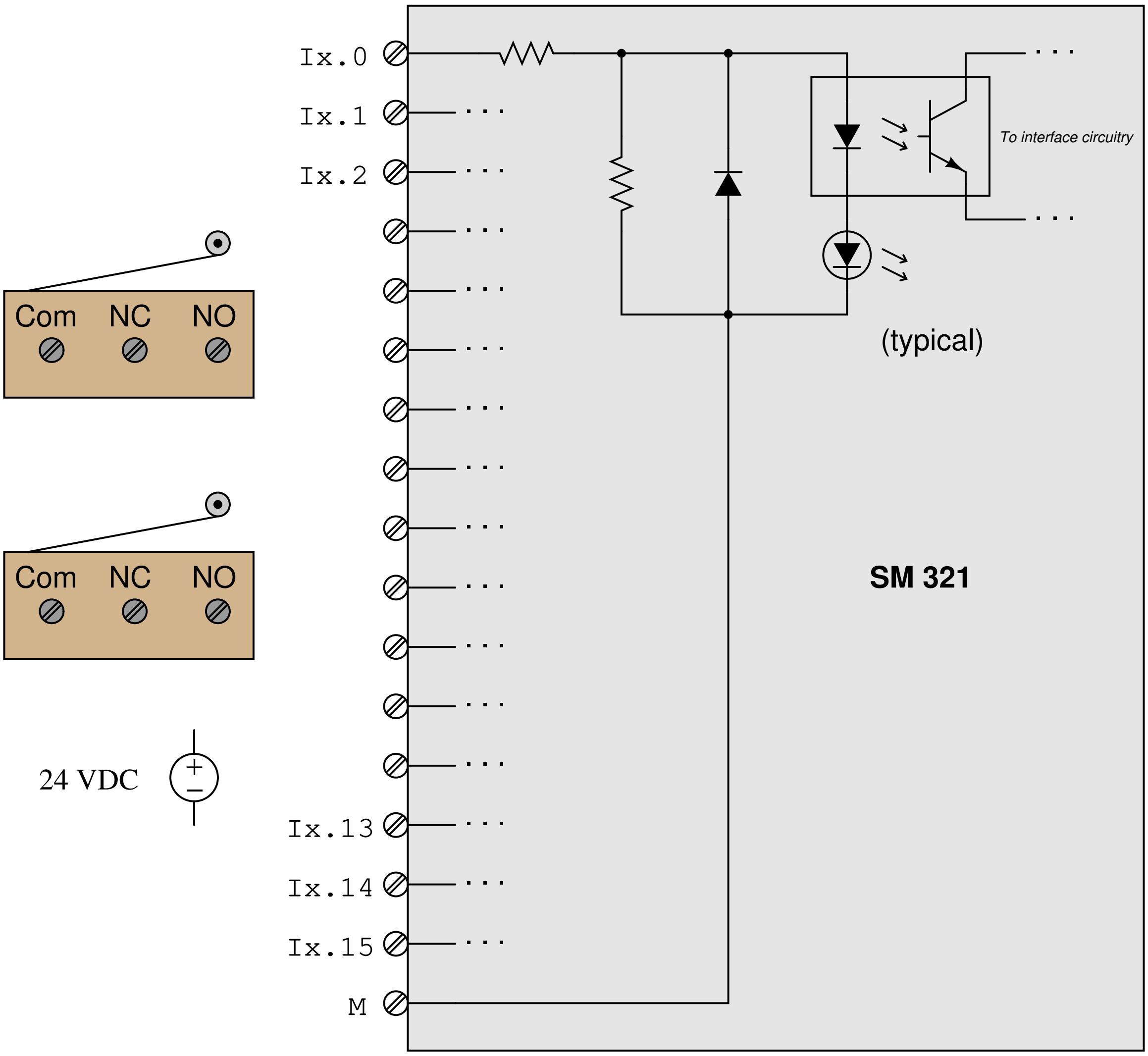
Suggestions for Socratic discussion

- What advantages do *solid-state* relays enjoy over their electromechanical counterparts?
- Can these solid-state relays switch DC, AC, or both?
- Identify how the behavior of a TRIAC differs from that of a bipolar or field-effect transistor.

file i04524

Oppgave 9

To endebrytere skal tilkobles h.h.v. `Ix.3` og `Ix.6` på en Siemens SM-321 DI inngangsmodul(model 6ES7321-1BL00-0AA0). Tegn de nødvendige koblingene. Det internekoblingsskjemaet for (`Ix.0`) vises som en referanse for alle inngangene. Tegn de nødvendige koblingene som er nødvendig for tilkobling av endebryterene.



Er dette en *sinking* eller en *sourcing* DI modul?

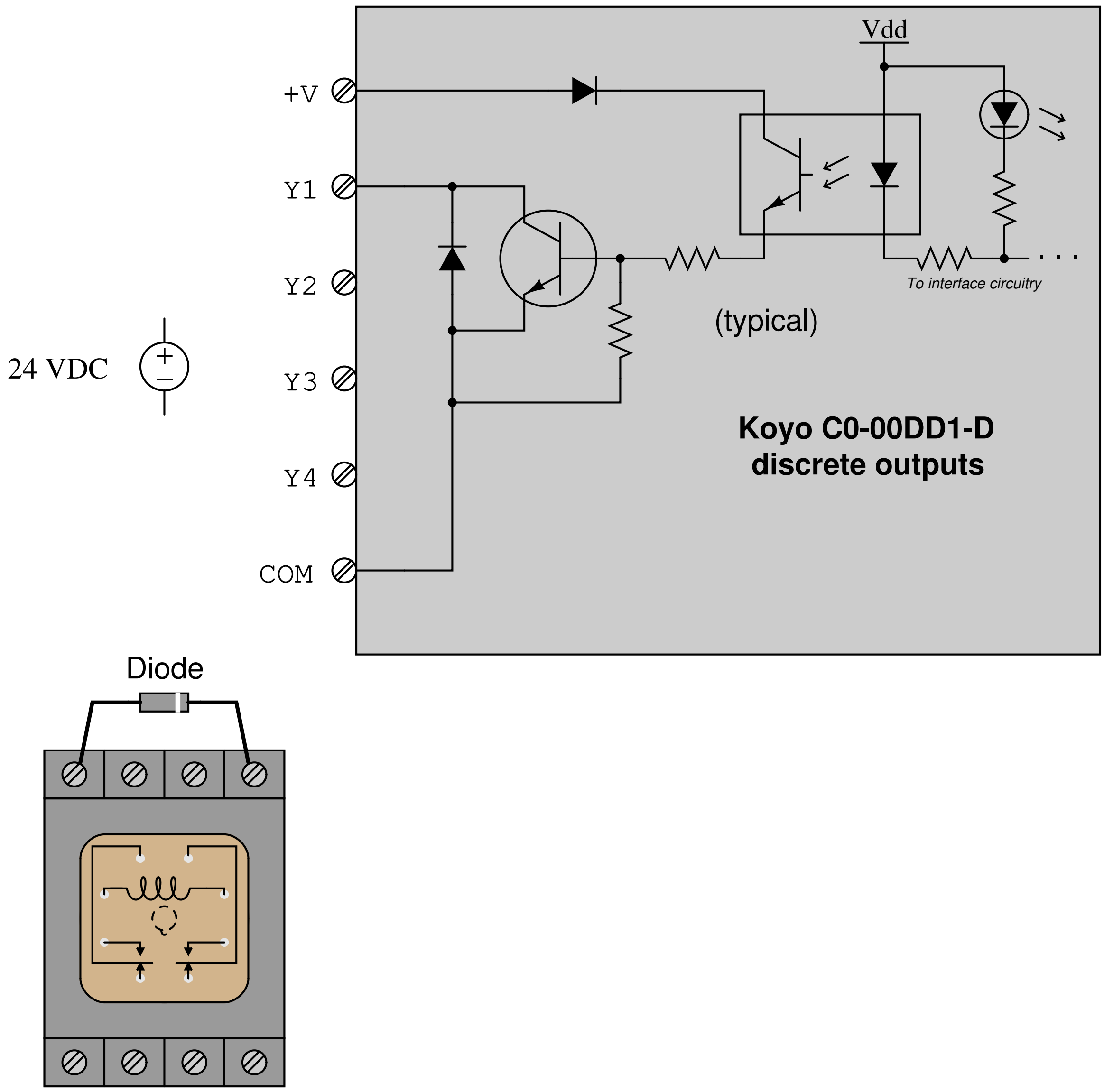
Suggestions for Socratic discussion

- If you have identified this module as sourcing, explain how its design would differ to make it *sinking*. If you have identified this module as sinking, explain how its design would differ to make it *sourcing*.
- Explain how this module's internal circuitry could be modified to allow it to source *or* sink current, instead of doing just one of these functions.

file i04536

Oppgave 10

Tegn de nødvendige koblingene for å tilkoble en relespole til den digitale utgangen `Y3` på en Koyo "CLICK" PLS model C0-00DD1-D. Det interne skjemaet for den første utgangen vises som en referanse for alle (`Y2` til `Y4`).

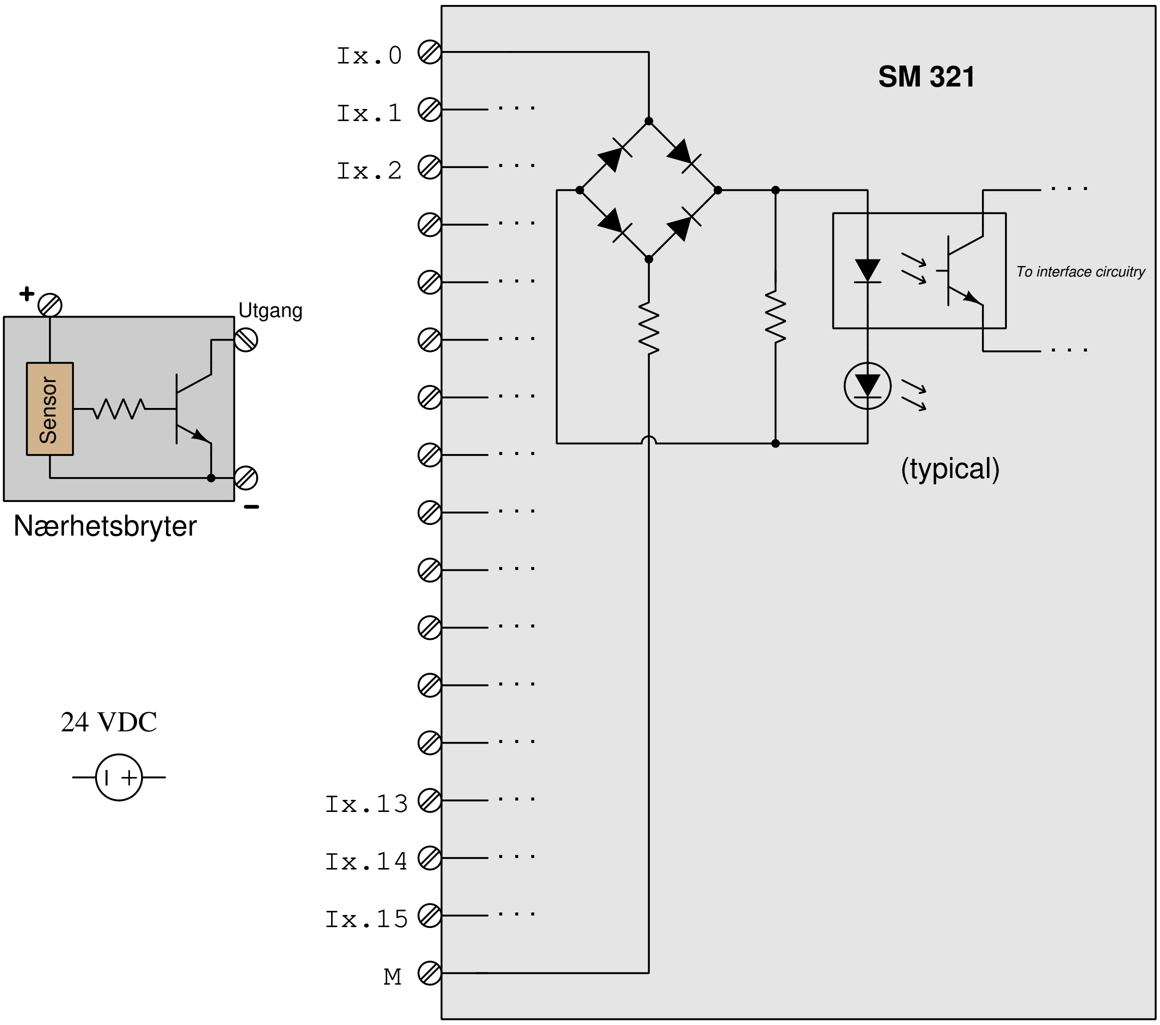


Avgjør om dette er en *sinking* eller en *sourcing* PLS utgang.

file i04537

Oppgave 11

Tegn inn koblingene som er nødvendige for å koble en nærhetsbryter til inngangkanal `Ix.8` på en Siemens SM 321 DI modul (model 6ES7321-1BP00-0AA0). Internt koblingskjema for en inngang (`Ix.0` vises som en referanse for alle innganger.

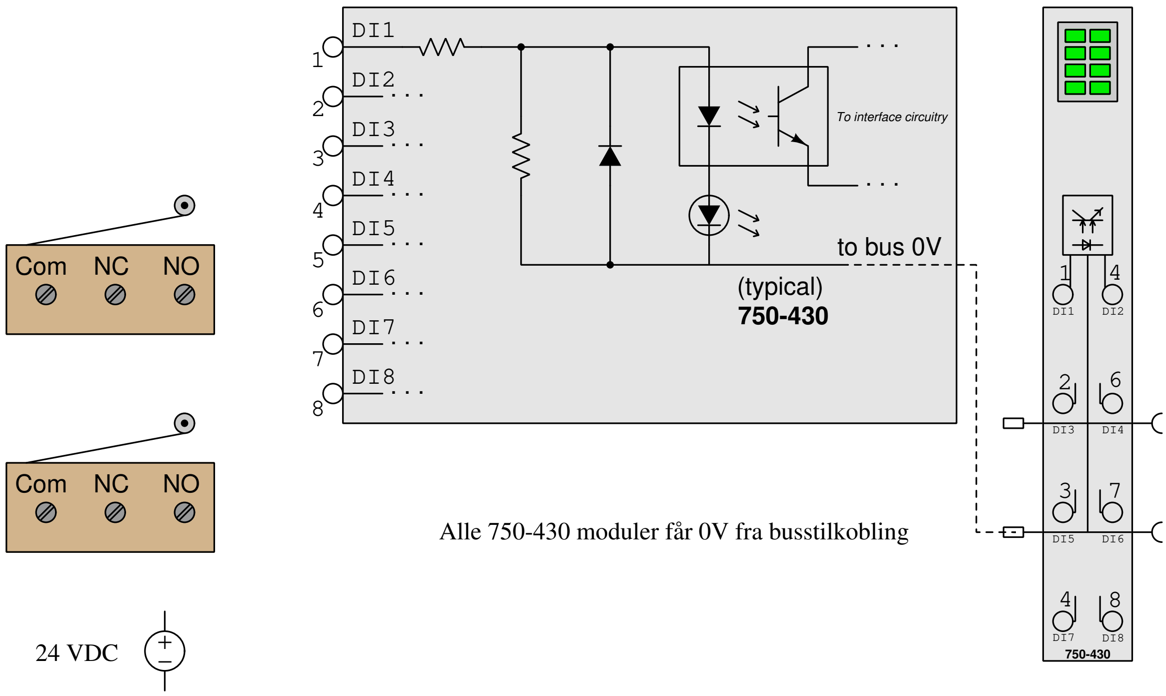


Finn ut om dette er en *sinking* eller en *sourcing* nærhetsbryter og strømretning for alle tilkoblinger til modulen.

file i04544

Oppgave 12

To endebrytere skal tilkobles h.h.v. `DI2` og `DI5` på en Wago 750-436 DI inngangsmodul. Tegn de nødvendige koblingene. Det internekoblingsskjemaet for (`DI1`) vises som en referanse for alle inngangene. Tegn de nødvendige koblingene som er nødvendig for tilkobling av endebryterene.



Er dette en *sinking* eller en *sourcing* DI modul?

Suggestions for Socratic discussion

- If you have identified this module as sourcing, explain how its design would differ to make it *sinking*. If you have identified this module as sinking, explain how its design would differ to make it *sourcing*.
- Explain how this module's internal circuitry could be modified to allow it to source *or* sink current, instead of doing just one of these functions.

file i04807

Oppgave 13

The most basic type of real-world output from a PLC is a *discrete* (on/off) output. Each discrete output channel on a PLC is associated with a single bit in the PLC's memory. Use the PLC programming software on your personal computer to "connect" to your PLC, then locate the facility within this software that allows you to monitor the status of your PLC's discrete output bits.

Use the "force" utility in the programming software to force different output bits to a "1" status. Based on what you see, what does a "1" bit status signify, and what does a "0" bit status signify?

Is there any visual indication that bits have been forced from their normal state(s) in your PLC? Note that "forcing" causes the PLC to output the values you specify, whether or not the programming in the PLC "wants" those bits to have those forced values!

Suggestions for Socratic discussion

- How does your PLC address discrete output bits? In other words, what is the convention it uses to label these bits, and distinguish them from each other?
- How does the programming software for your PLC provide access to discrete output bit status, and the ability to force them?
- Why would anyone ever wish to force an output bit in a PLC, especially if doing so overrides the logic programmed into the PLC?

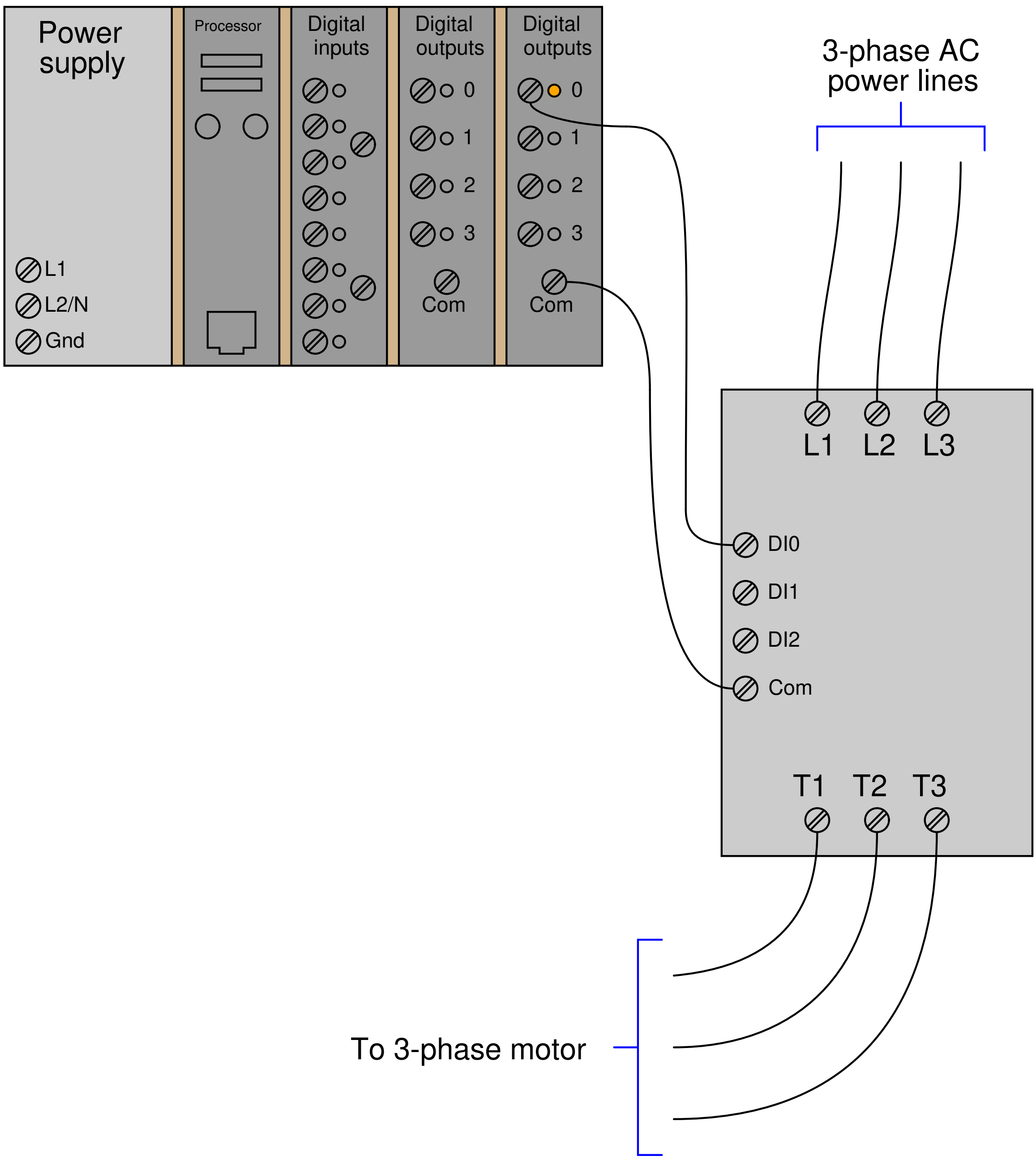
PLC comparison:

- Allen-Bradley Logix 5000: forces may be applied to specific tag names by right-clicking on the tag (in the program listing) and selecting the "Monitor" option. Discrete outputs do not have specific output channel tag names, as tag names are user-defined in the Logix5000 PLC series.
- Allen-Bradley PLC-5, SLC 500, and MicroLogix: the *Force Files* listing (typically on the left-hand pane of the programming window set) lists those data files within the PLC's memory liable to forcing by the user. Opening a force file window allows you to view and set the real-time status of these bits. Discrete outputs are the `O` file addresses (e.g. `O:0/7`, `O:6/2`, etc.). The letter "`O`" represents "output," the first number represents the slot in which the output card is plugged, and the last number represents the bit within that data element (a 16-bit word) corresponding to the output card.
- Siemens S7-200: the *Status Chart* window allows the user to custom-configure a table showing the real-time values of multiple addresses within the PLC's memory, and enabling the user to force the values of those addresses. Discrete outputs are the `Q` memory addresses (e.g. `Q0.4`, `Q1.2`, etc.).
- Koyo (Automation Direct) DirectLogic and CLICK: the *Override View* window allows the user to force variables within the PLC's memory. Discrete outputs are the `Y` memory addresses (e.g. `Y1`, `Y2`, etc.).

file i01877

Oppgave 14

A technician is troubleshooting a problem with a newly-installed PLC and variable-speed motor drive. One of the discrete (on/off) outputs of the PLC is connected to a discrete input on the drive, to tell the motor to either turn on or turn off. The PLC's discrete output is a *dry contact* type, meaning it is nothing more than an electromechanical relay contact inside the output card. The discrete inputs on the drive (DI0, DI1, and DI2) are logic gate inputs, internally "pulled up" with resistors so that the only thing needed to activate each input is to form a connection between the respective input and the common ("Com") terminal on the drive. The dry contact for PLC output 0 on the right-most output card is supposed to do just that, telling the drive when to start the motor:



The problem is, the motor does not start when the PLC tells it to. Now, the motor itself is brand-new, and the wiring between the motor and the drive is known to be good. A power check at the PLC and drive power terminals shows 117 volts AC between L1 and

L2/N (on the PLC) and 482 volts between each of the three phases (L1, L2, and L3) on the motor drive. The LED indicator for output 0 on the PLC card is lit, revealing that the PLC program at least is *trying* to activate the motor drive. This data suggests (but does not guarantee) that the problem lies either with the PLC hardware or the drive, and not with the power sources, motor wiring, motor, PLC inputs, or PLC program.

Both the PLC and the motor drive are complex, programmable devices. The technician knows she could spend quite a bit of time diagnosing either of these devices trying to find a problem. Thus, it would be very helpful to know *which* of these devices is at fault so as to not waste troubleshooting time.

Devise a simple test for the technician to perform that will neatly divide the problem in half, telling her whether the PLC or the drive is at fault, and be sure to explain your reasoning.

Suggestions for Socratic discussion

- Is the PLC output card *sourcing* curren to or *sinking* current from the VFD in this system?
- If the problem lies within the PLC, where exactly do you think it might be found within the PLC? Do you think it could be a hardware problem, a software problem, or either?

file i02451

Oppgave 15

The manufacturing company you work for installs a PLC control system on its assembly line, counting the number of components produced every shift. For quite a while, the system works without any problems whatsoever, and then one day management decides to scrap a run of product mid-shift and start over. This is when they discover the system integrator they contracted to build and program the PLC system provided no way to reset the shift production counter except to wait until the shift is over.

An operations manager summons you to reset the counter for them. Identify at least two different ways you could reset the counter to meet their needs, as quickly as possible.
file i00182

Oppgave 16

The most basic type of real-world output from a PLC is a *discrete* (on/off) output. Each discrete output channel on a PLC is associated with a single bit in the PLC's memory. Use the PLC programming software on your personal computer to "connect" to your PLC, then locate the facility within this software that allows you to monitor the status of your PLC's discrete output bits.

Use the "force" utility in the programming software to force different output bits to a "1" status. Based on what you see, what does a "1" bit status signify, and what does a "0" bit status signify?

Is there any visual indication that bits have been forced from their normal state(s) in your PLC? Note that "forcing" causes the PLC to output the values you specify, whether or not the programming in the PLC "wants" those bits to have those forced values!

Suggestions for Socratic discussion

- How does your PLC address discrete output bits? In other words, what is the convention it uses to label these bits, and distinguish them from each other?
- How does the programming software for your PLC provide access to discrete output bit status, and the ability to force them?
- Why would anyone ever wish to force an output bit in a PLC, especially if doing so overrides the logic programmed into the PLC?

PLC comparison:

- Allen-Bradley Logix 5000: forces may be applied to specific tag names by right-clicking on the tag (in the program listing) and selecting the "Monitor" option. Discrete outputs do not have specific output channel tag names, as tag names are user-defined in the Logix5000 PLC series.
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- Koyo (Automation Direct) DirectLogic and CLICK: the *Override View* window allows the user to force variables within the PLC's memory. Discrete outputs are the `Y` memory addresses (e.g. `Y1`, `Y2`, etc.).

file i01877

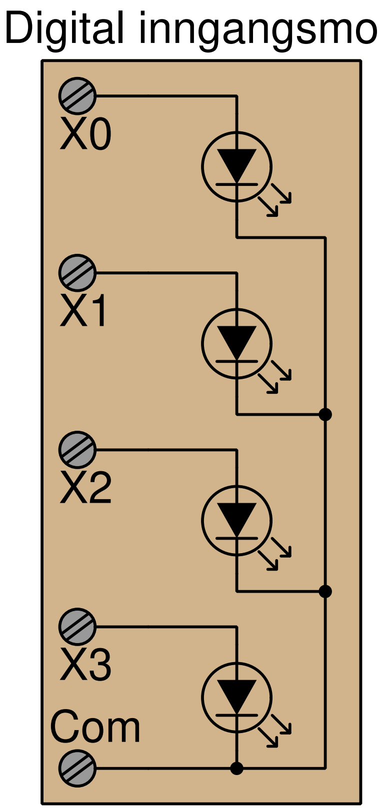
Oppgave 17

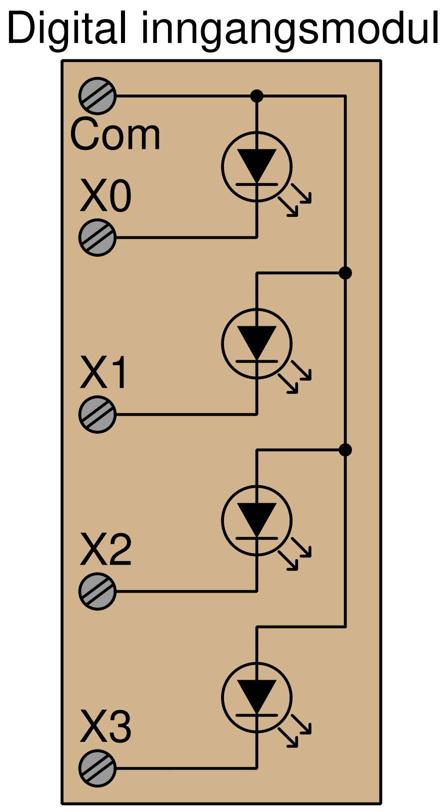
Suppose you need to connect an Allen-Bradley CompactLogix PLC discrete output card (part 1769-OB16) channel to the "Start" discrete input of an Allen-Bradley PowerFlex 4 VFD. Identify which terminals on the PLC need to be connected to which control terminals on the VFD, assuming the use of channel #3 on the PLC output card.
file i01875

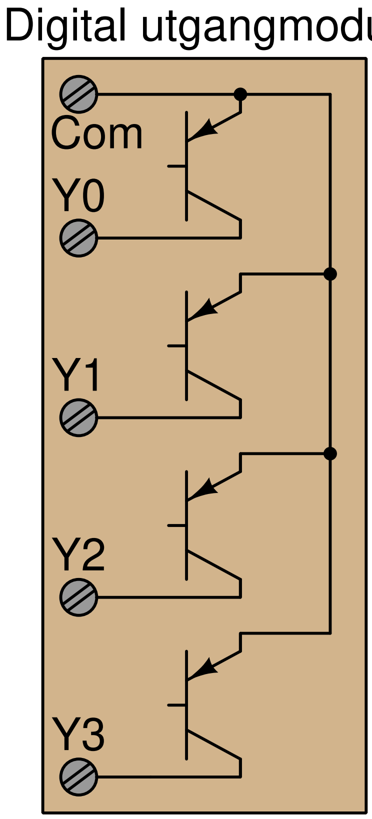
Oppgave 18

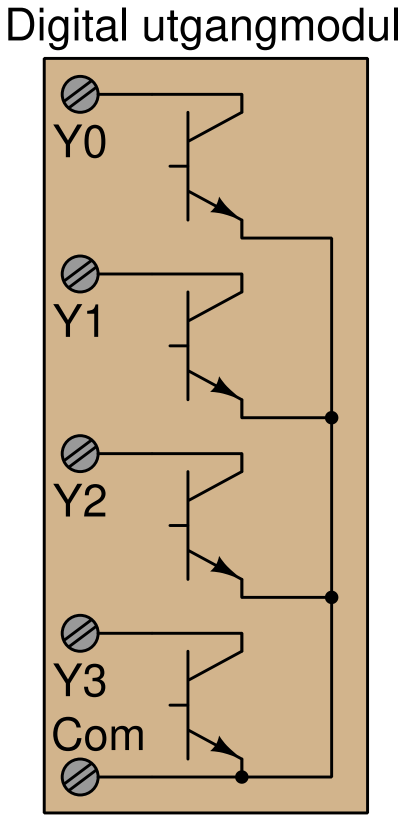
Digitale innganger på en PLS bruker ofte AC strømforsyning. AC inngangskretsen består som regel av en optokobler sammen med en likeretter med en stor motstand som største delen av spenningen skal legge seg over. Forklar hvordan denne kretsen virker.

DC DI-er på en PLS består generalt av en optokobler og led, mens DO-er som regel har en transistor. I de følgende skjemaene vises noen eksempler. Legg merke til forskjellene.









Finn ut om de ulike er inn- eller utganger og om de er *sourcing* eller *sinking*.

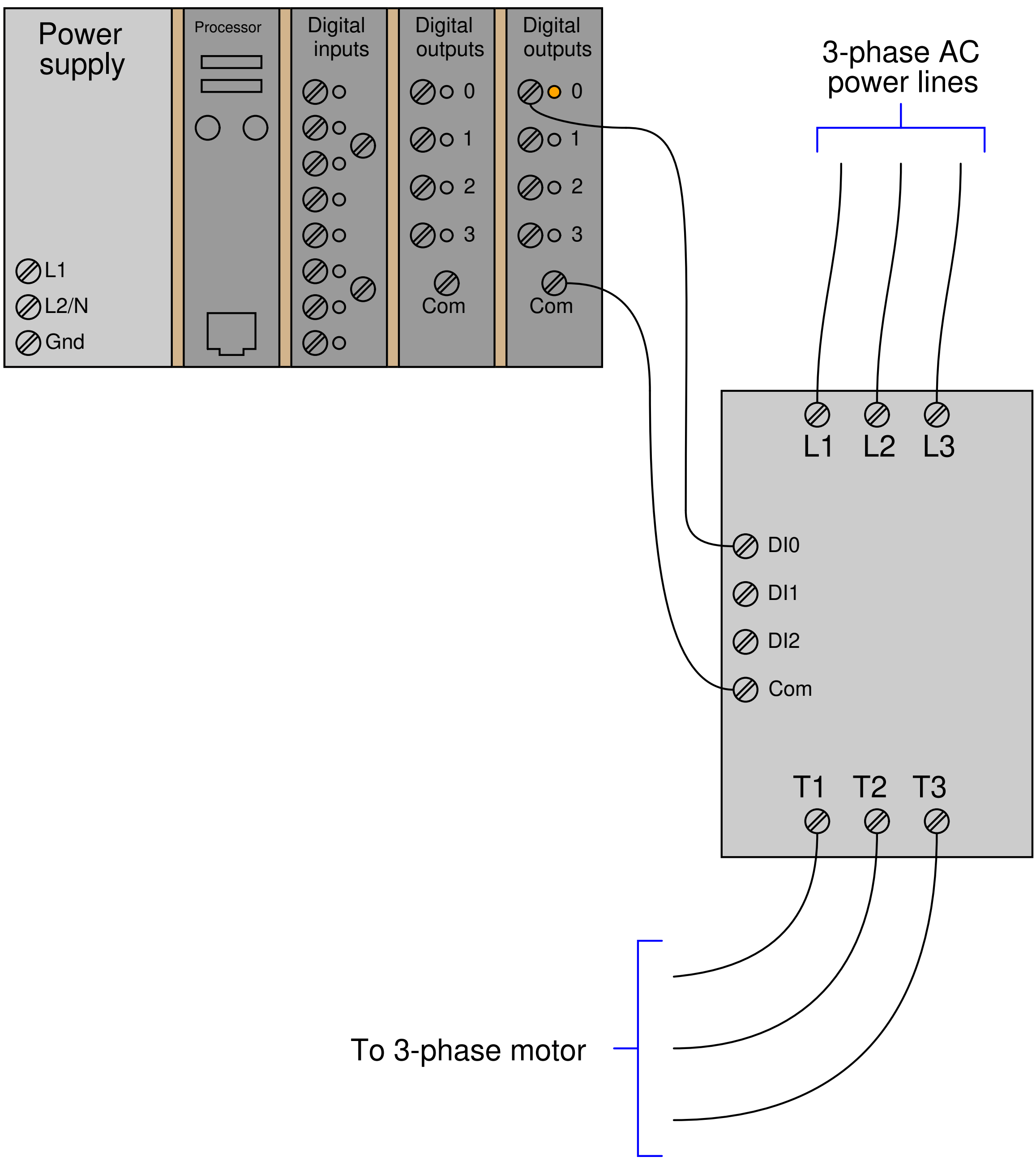
Suggestions for Socratic discussion

- Determine how real input and output devices (e.g. switches, solenoid coils) would need to be connected to the I/O terminals of these modules.

file i02359

Oppgave 19

A technician is troubleshooting a problem with a newly-installed PLC and variable-speed motor drive. One of the discrete (on/off) outputs of the PLC is connected to a discrete input on the drive, to tell the motor to either turn on or turn off. The PLC's discrete output is a *dry contact* type, meaning it is nothing more than an electromechanical relay contact inside the output card. The discrete inputs on the drive (DI0, DI1, and DI2) are logic gate inputs, internally "pulled up" with resistors so that the only thing needed to activate each input is to form a connection between the respective input and the common ("Com") terminal on the drive. The dry contact for PLC output 0 on the right-most output card is supposed to do just that, telling the drive when to start the motor:



The problem is, the motor does not start when the PLC tells it to. Now, the motor itself is brand-new, and the wiring between the motor and the drive is known to be good. A power check at the PLC and drive power terminals shows 117 volts AC between L1 and

L2/N (on the PLC) and 482 volts between each of the three phases (L1, L2, and L3) on the motor drive. The LED indicator for output 0 on the PLC card is lit, revealing that the PLC program at least is *trying* to activate the motor drive. This data suggests (but does not guarantee) that the problem lies either with the PLC hardware or the drive, and not with the power sources, motor wiring, motor, PLC inputs, or PLC program.

Both the PLC and the motor drive are complex, programmable devices. The technician knows she could spend quite a bit of time diagnosing either of these devices trying to find a problem. Thus, it would be very helpful to know *which* of these devices is at fault so as to not waste troubleshooting time.

Devise a simple test for the technician to perform that will neatly divide the problem in half, telling her whether the PLC or the drive is at fault, and be sure to explain your reasoning.

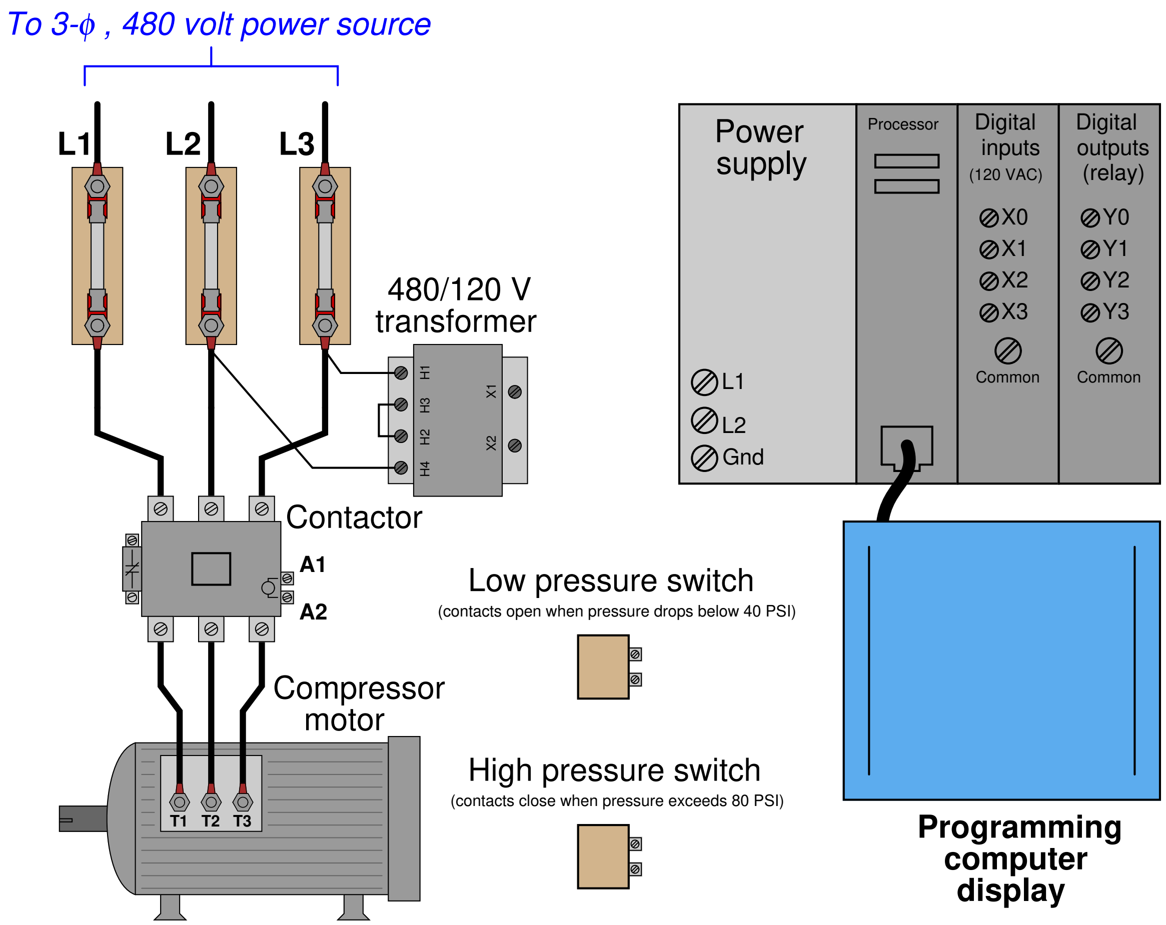
Suggestions for Socratic discussion

- Is the PLC output card *sourcing* curren to or *sinking* current from the VFD in this system?
- If the problem lies within the PLC, where exactly do you think it might be found within the PLC? Do you think it could be a hardware problem, a software problem, or either?

file i02451

Oppgave 20

Sketch wires in this diagram to show how a PLC could be connected to a couple of pressure switches and a motor contactor to control the starting and stopping of a three-phase air compressor motor. Note that both pressure switches are normally-open: the contacts are open at atmospheric pressure (0 PSIG), and close as pressure rises. One switch has a setting of 40 PSI, and controls when the motor starts. The other switch has a setting of 80 PSI, and controls when the motor stops.

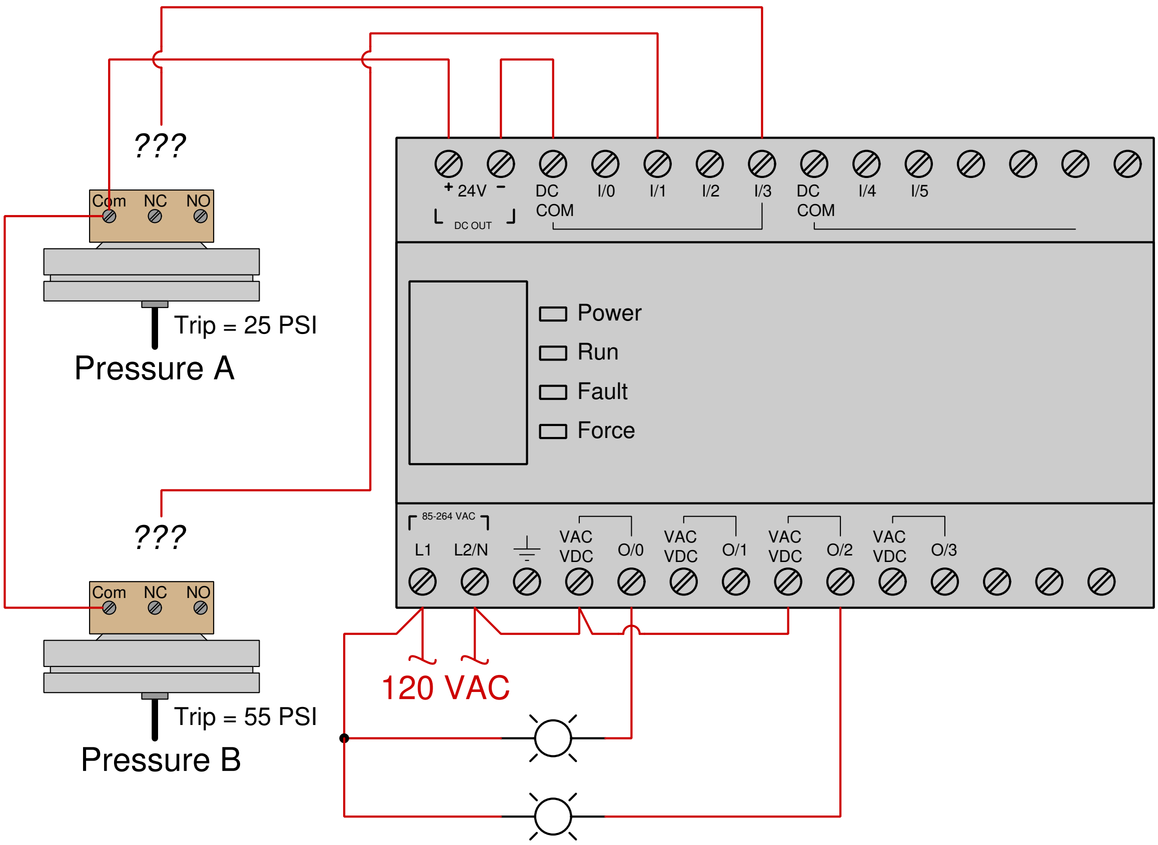


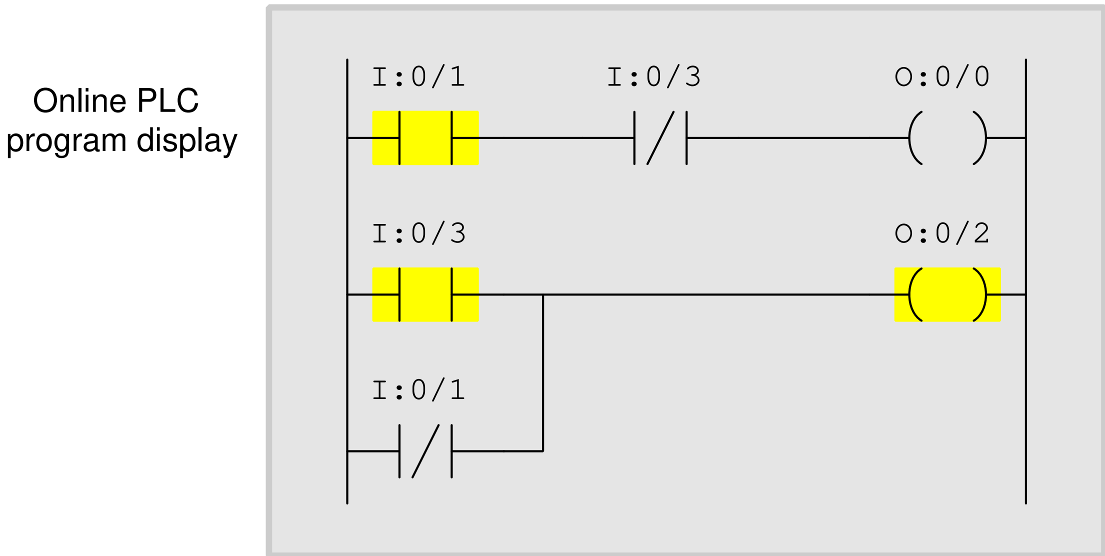
Also draw a simple ladder logic program in the computer display window for this compressor start/stop function.

file i02364

Oppgave 21

Choose the appropriate switch terminals to land wires connecting the two pressure switches to the PLC in order to satisfy the requirements of the "online" program display (showing color highlighting), assuming pressure A is 14 PSI and pressure B is 70 PSI:

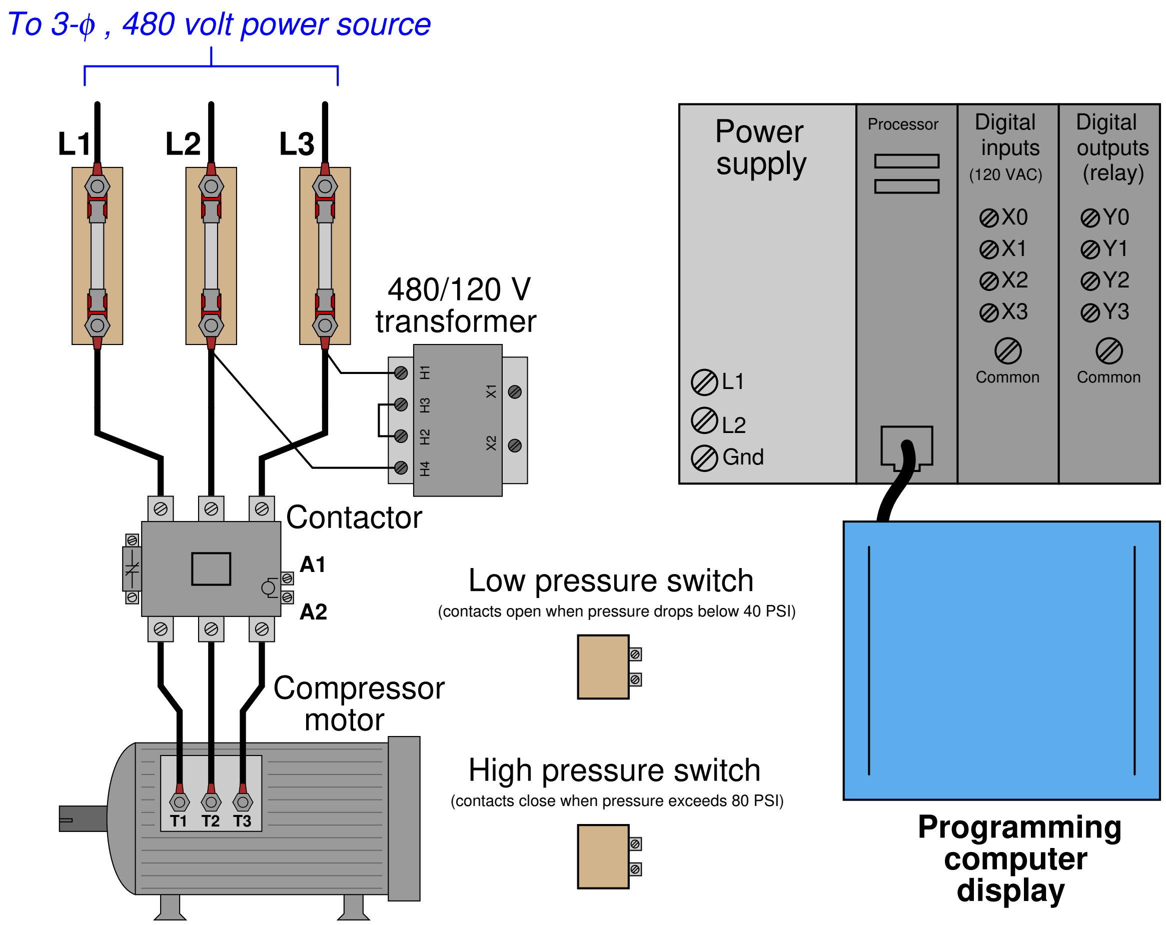




file i02882

Oppgave 22

Sketch wires in this diagram to show how a PLC could be connected to a couple of pressure switches and a motor contactor to control the starting and stopping of a three-phase air compressor motor. Note that both pressure switches are normally-open: the contacts are open at atmospheric pressure (0 PSIG), and close as pressure rises. One switch has a setting of 40 PSI, and controls when the motor starts. The other switch has a setting of 80 PSI, and controls when the motor stops.



Also draw a simple ladder logic program in the computer display window for this compressor start/stop function.

file i02364

Svar

Svar 1

Svar 2

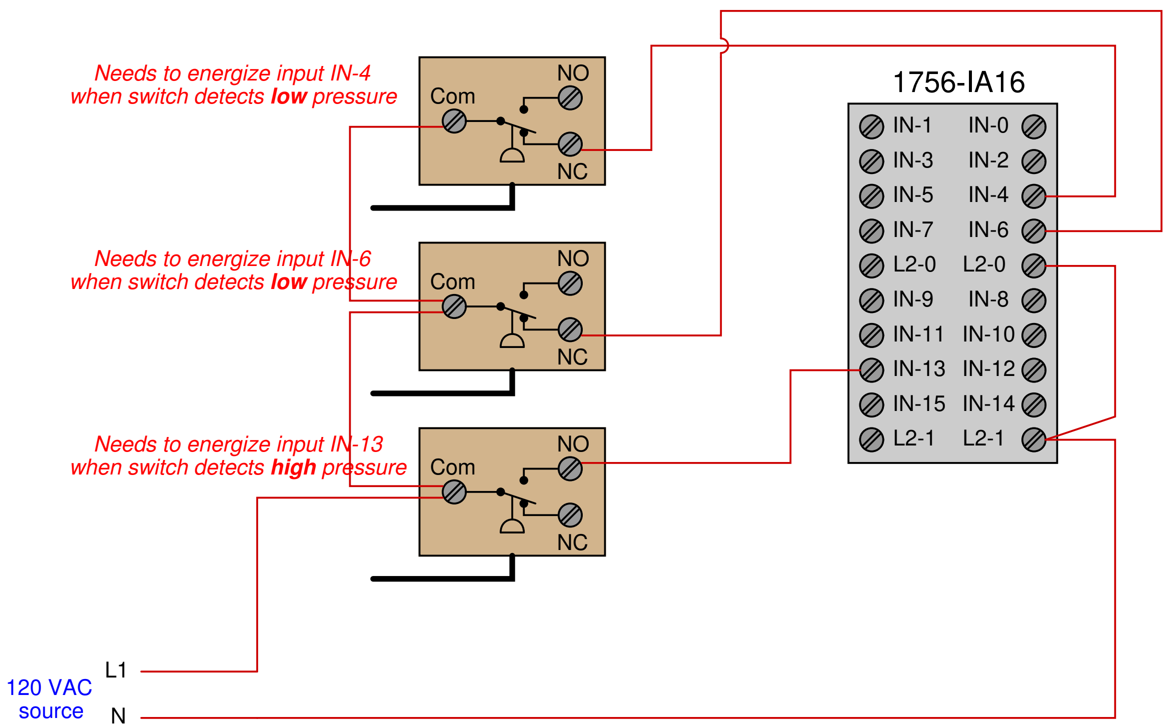
To answer this question, you are going to have to research the input and output connections for these specific devices, from the manufacturer's literature.

Svar 3

The purpose of the parallel-connected 14.3 kΩ resistor is to provide a path for current to each connected channel of the input card even when the discrete switch is in the open state. The card has *two* optocoupling devices per channel: one for detecting this "leakage" current and another for detecting the full-on current when the switch closes. Thus, the card has the ability to monitor wiring continuity even when the field switch device is in the "off" state.

The leakage current range necessary for diagnostic monitoring of input wiring is between 1.2 mA and 1.5 mA inclusive. In order for the card to detect a full-on condition, the current must lie within the range of 2 mA (10 VDC) to 13 mA (30 VDC).

Svar 4

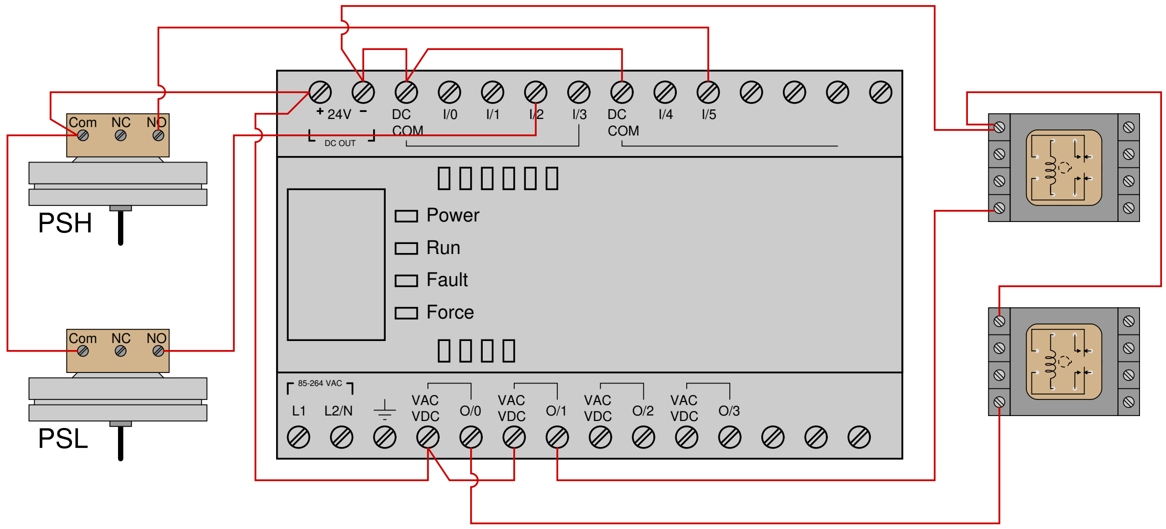


Svar 5

Remember that "sourcing" means a device is sending current *out* through the channel wire (conventional flow notation), while "sinking" means a device is taking current *in* through the channel wire. We ignore current through any "Common" conductors when we define source and sink, choosing only to reference conductors attached to specific input or output terminals of the device.

In order for the process switches to source current to the PLC input channels, these switches must both connect to the positive pole of the DC power supply. In other words, they must be "high side" switches, sending current (conventional flow notation) to the PLC input terminals.

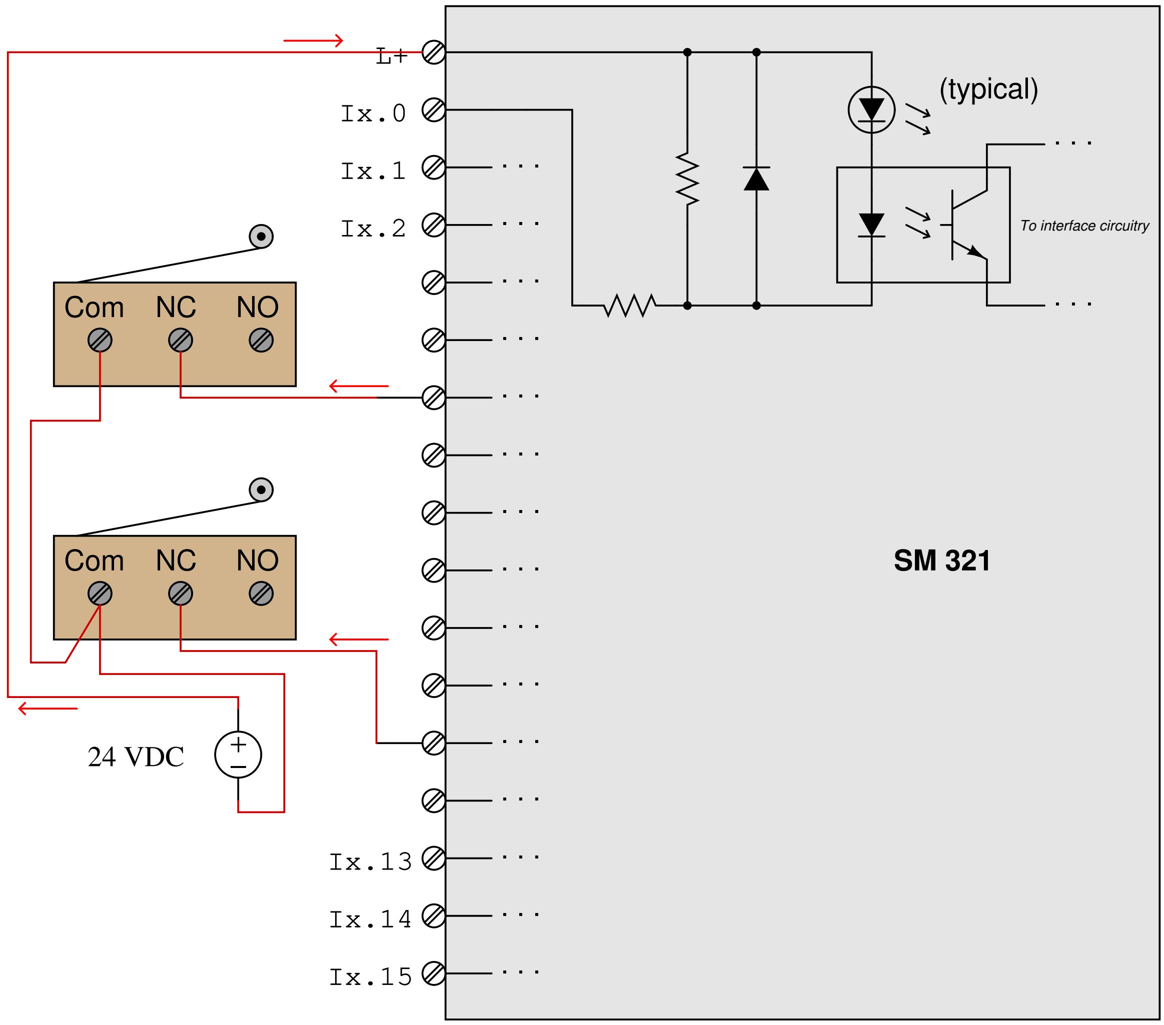
Likewise, in order for the PLC outputs to source current to the relay coils, the output contacts must both connect to the positive pole of the DC power supply.



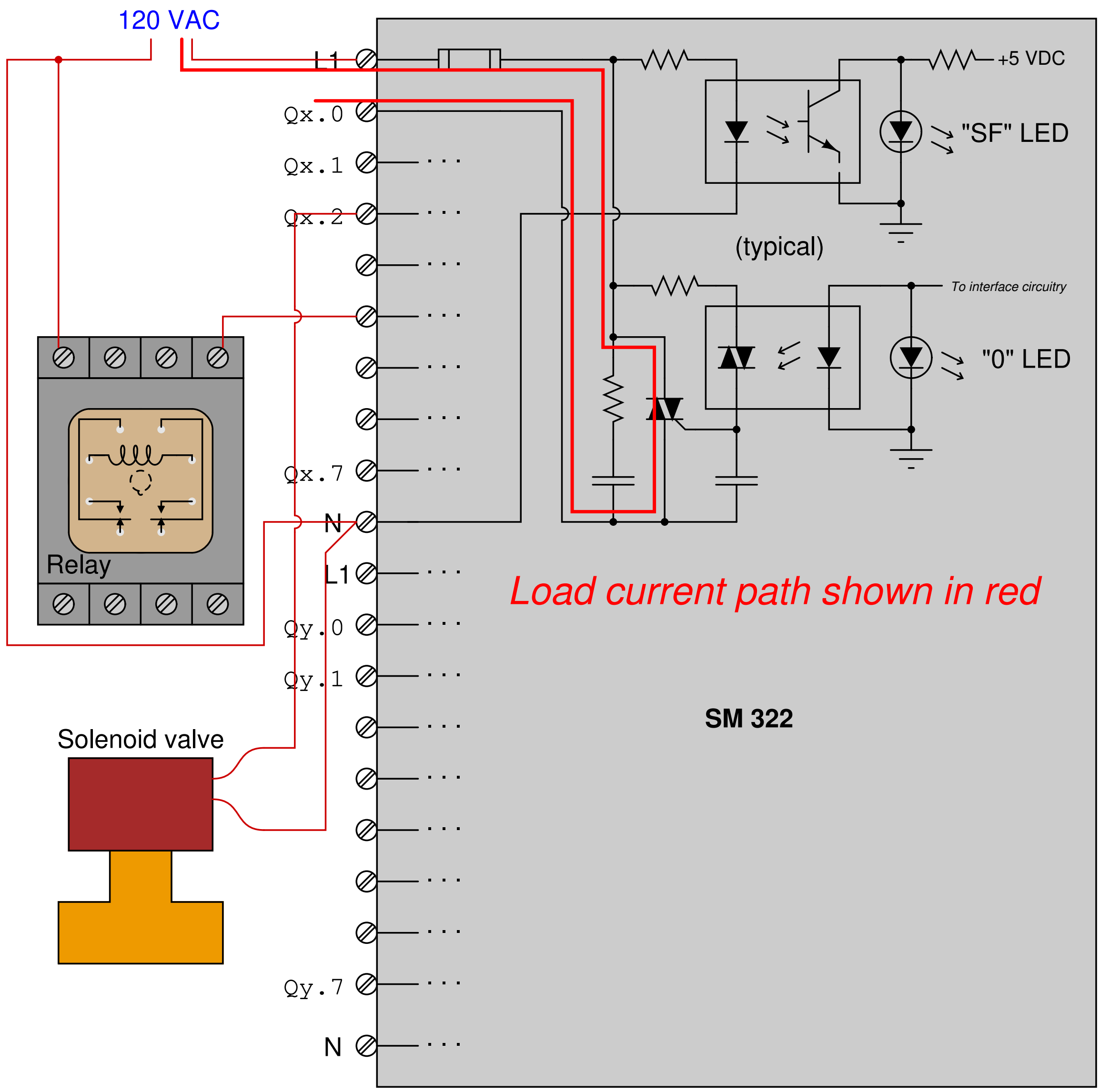
Svar 6

This is an *input* PLC card, and so it receives electric current from a sensing device (e.g. a limit switch) to tell the PLC's microprocessor whether the sensor has been triggered or not. Looking at the input card's internal circuitry, we see an optocoupler (LED and phototransistor) used to connect the interface circuitry with the real-world sensor signal. In order to turn this phototransistor on, the LED must become forward-biased.

In order for the photocoupler's LED to become forward-biased, we must have direct current flowing downward through it (conventional flow notation). This tells us the necessary direction of sensor current into the card: current enters in the L+ terminal, exiting the respective I/O channel terminal. Since the L+ terminal is the "common" terminal for all 16 inputs on this particular card, it must be connected to the positive pole of a DC power supply. Each limit switch must then be connected to the DC supply's negative pole, sinking current from the respective channels of the input card:



This particular input card is the *sourcing* type (arrows drawn in the direction of conventional flow).



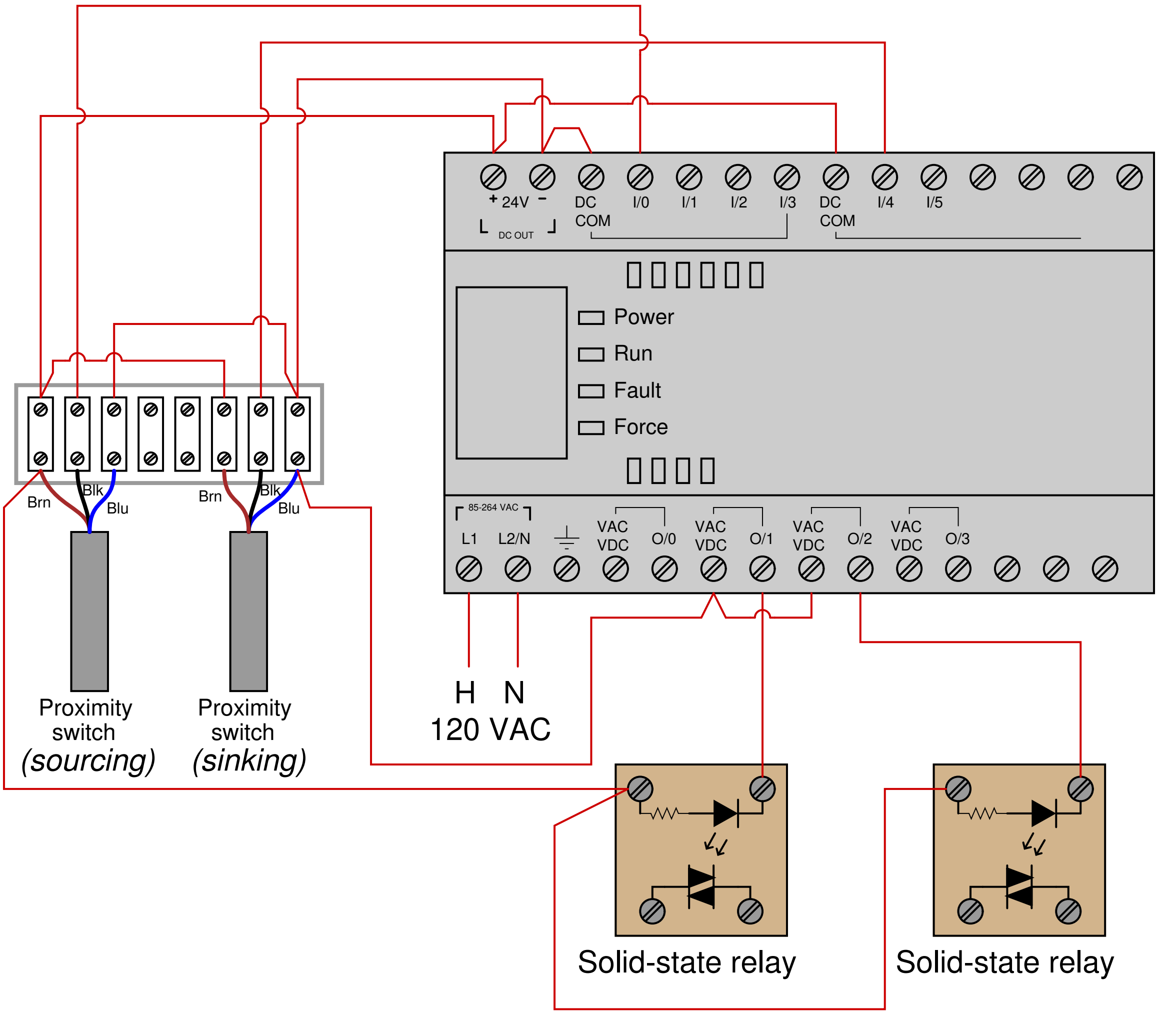
120 VAC
L1
Qx.0
Qx.1
Qx.2
Qx.7
N
L1
Qy.0
Qy.1
Qy.7
N
+5 VDC
"SF" LED
(typical)
To interface circuitry
"0" LED
Relay
Solenoid valve
Load current path shown in red
SM 322

Svar 8

Note: standard electronic proximity switch wiring color codes are as follows:

- **Brown** = Positive (+) DC supply
- **Blue** = Negative (−) DC supply
- **Black** = Signal output

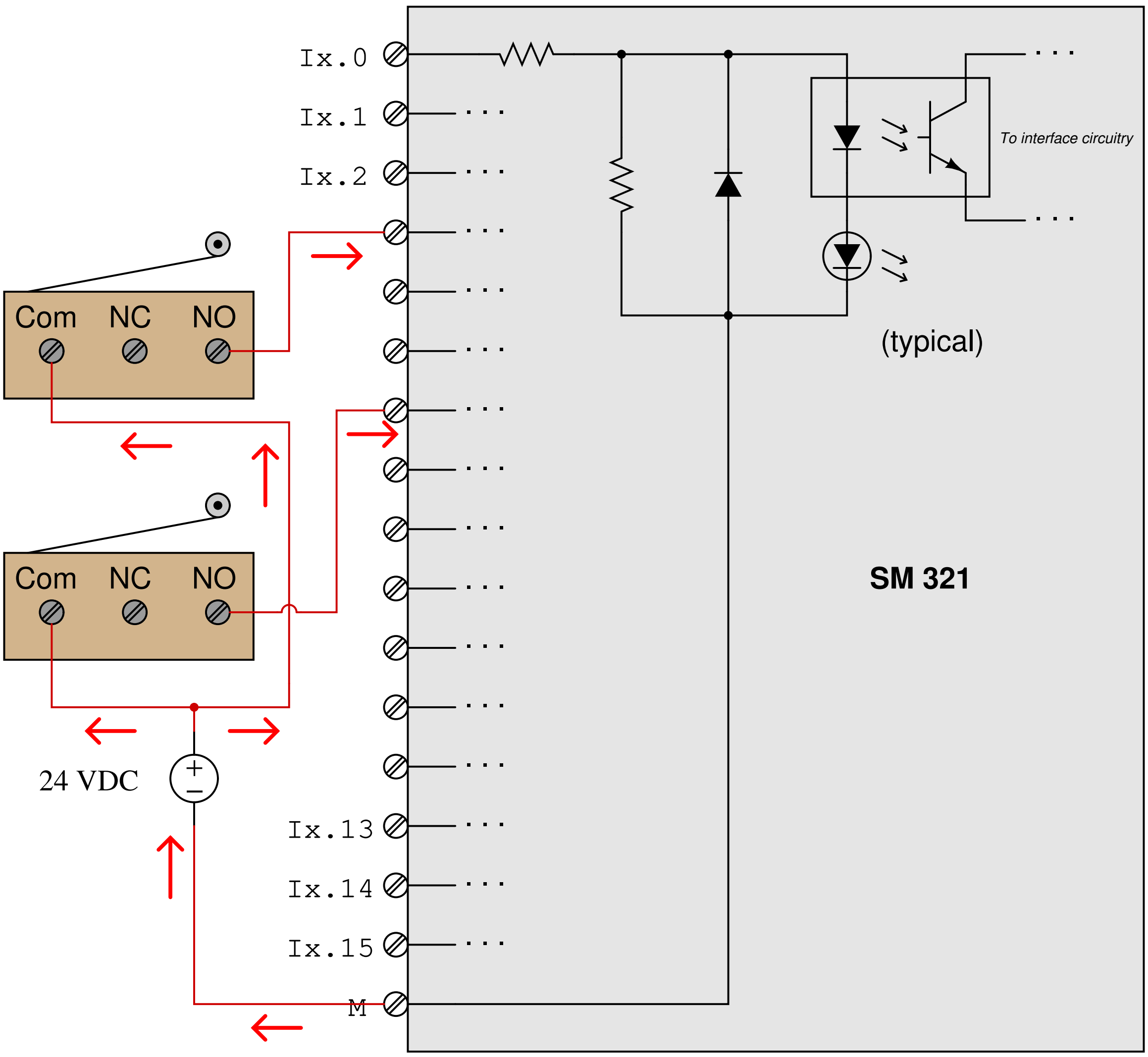
This is just one possible solution:



Note that this solution shows the two solid-state relays connected to the PLC output such that the PLC *sinks* current from the relays. Since no instructions were given on wiring the PLC outputs, this is just one possible solution out of many.

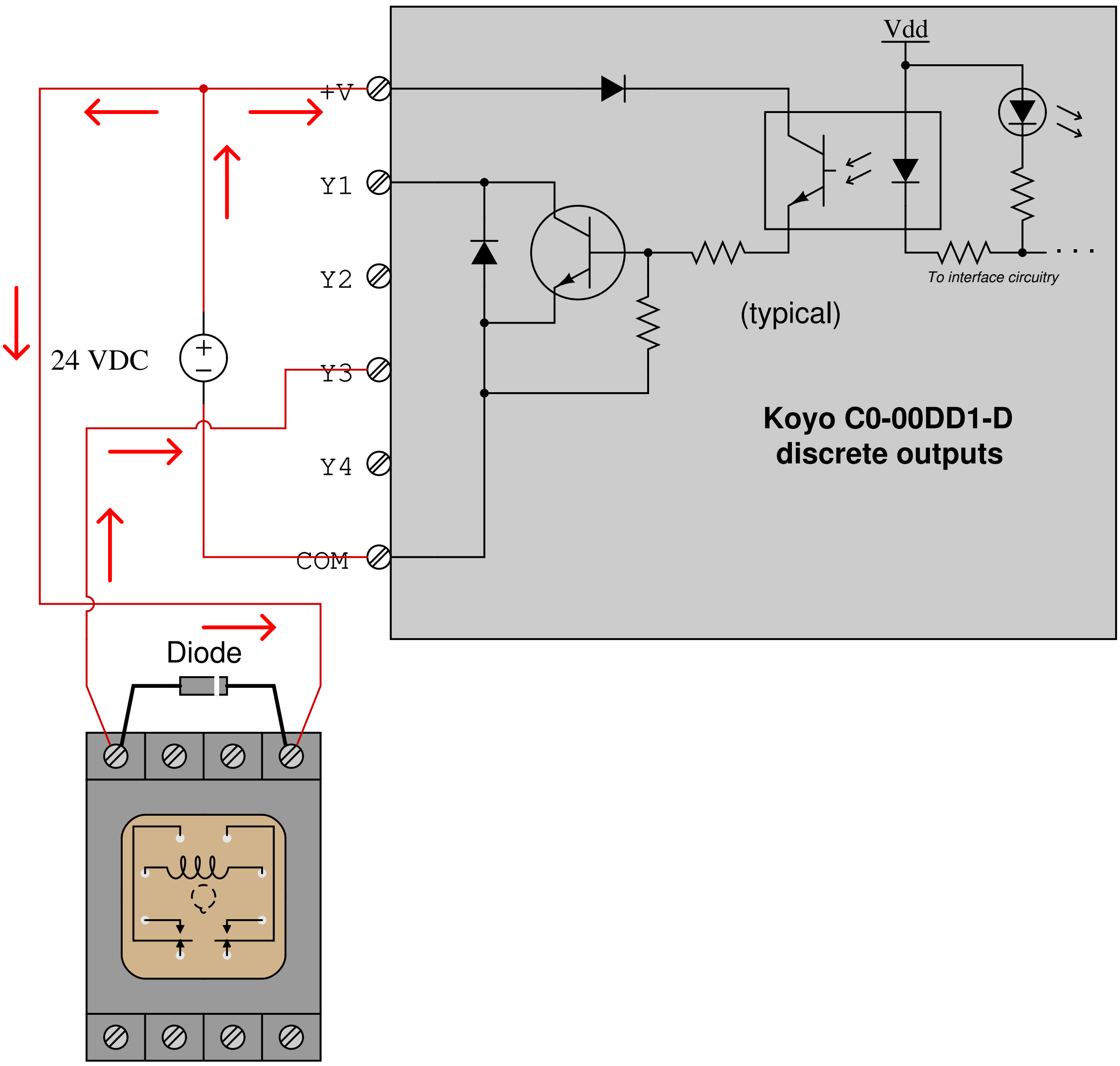
Svar 9

This particular input module *sinks* current from the limit switches (arrows drawn in the direction of conventional flow):



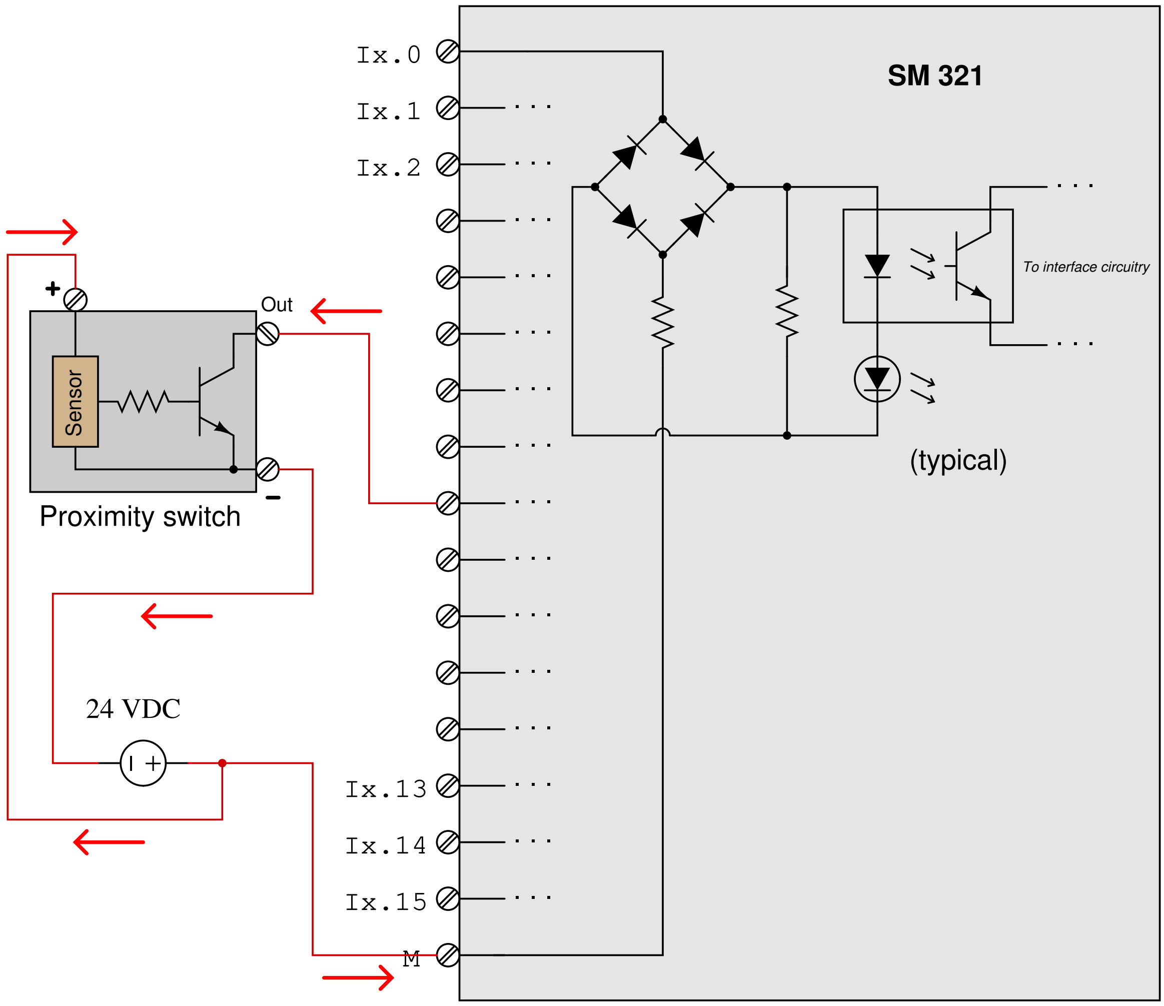
Svar 10

This particular output module *sinks* current from the loads (arrows drawn in the direction of conventional flow):



Svar 11

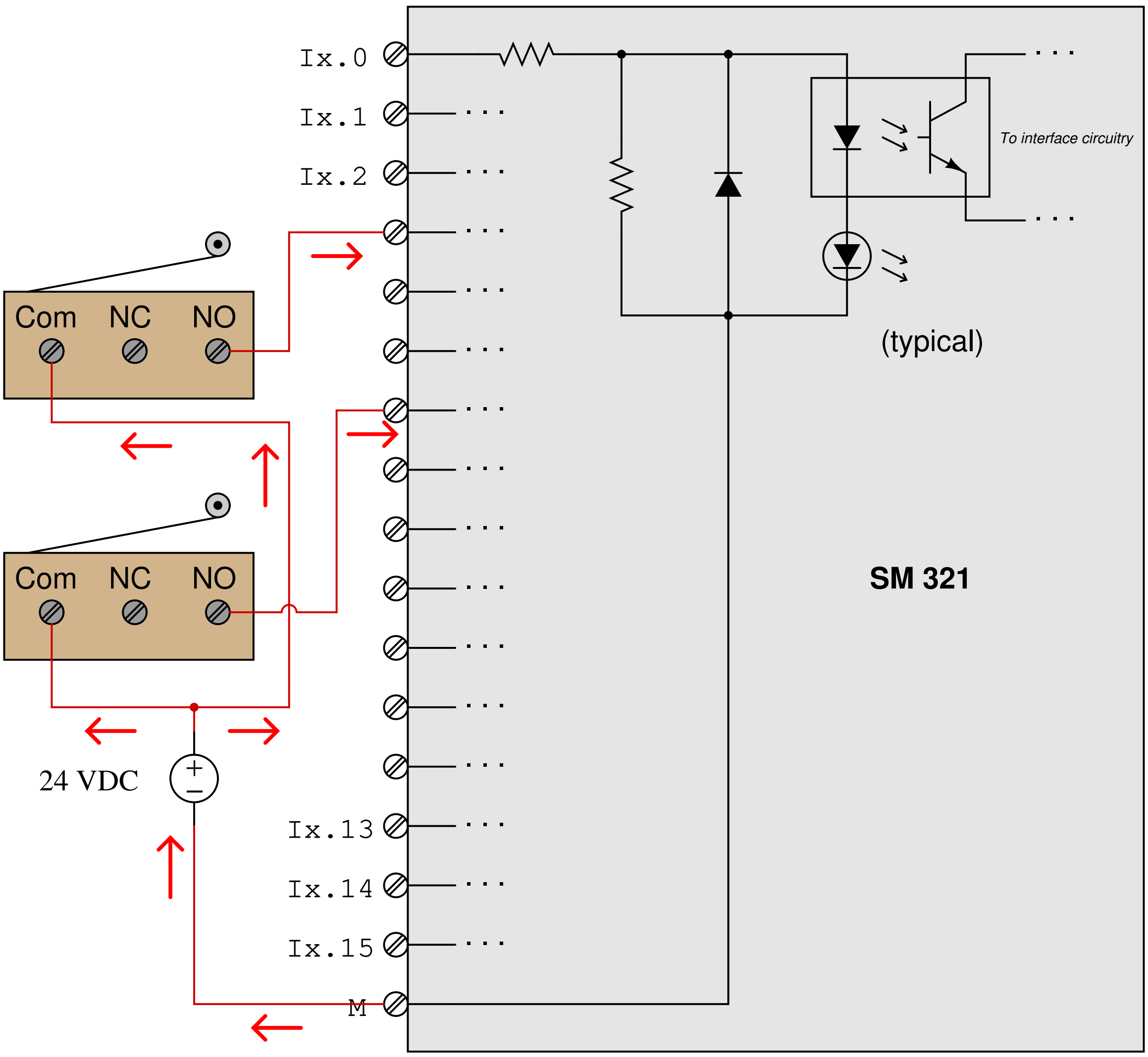
This particular proximity switch *sinks* current from the input module (arrows drawn in the direction of conventional flow):



Note that the PLC input card has the ability to either source or sink current at each input, owing to the full-wave bridge rectifier which guarantees the optocoupler's LED will receive current in the correct direction no matter how current may enter or exit the input terminal.

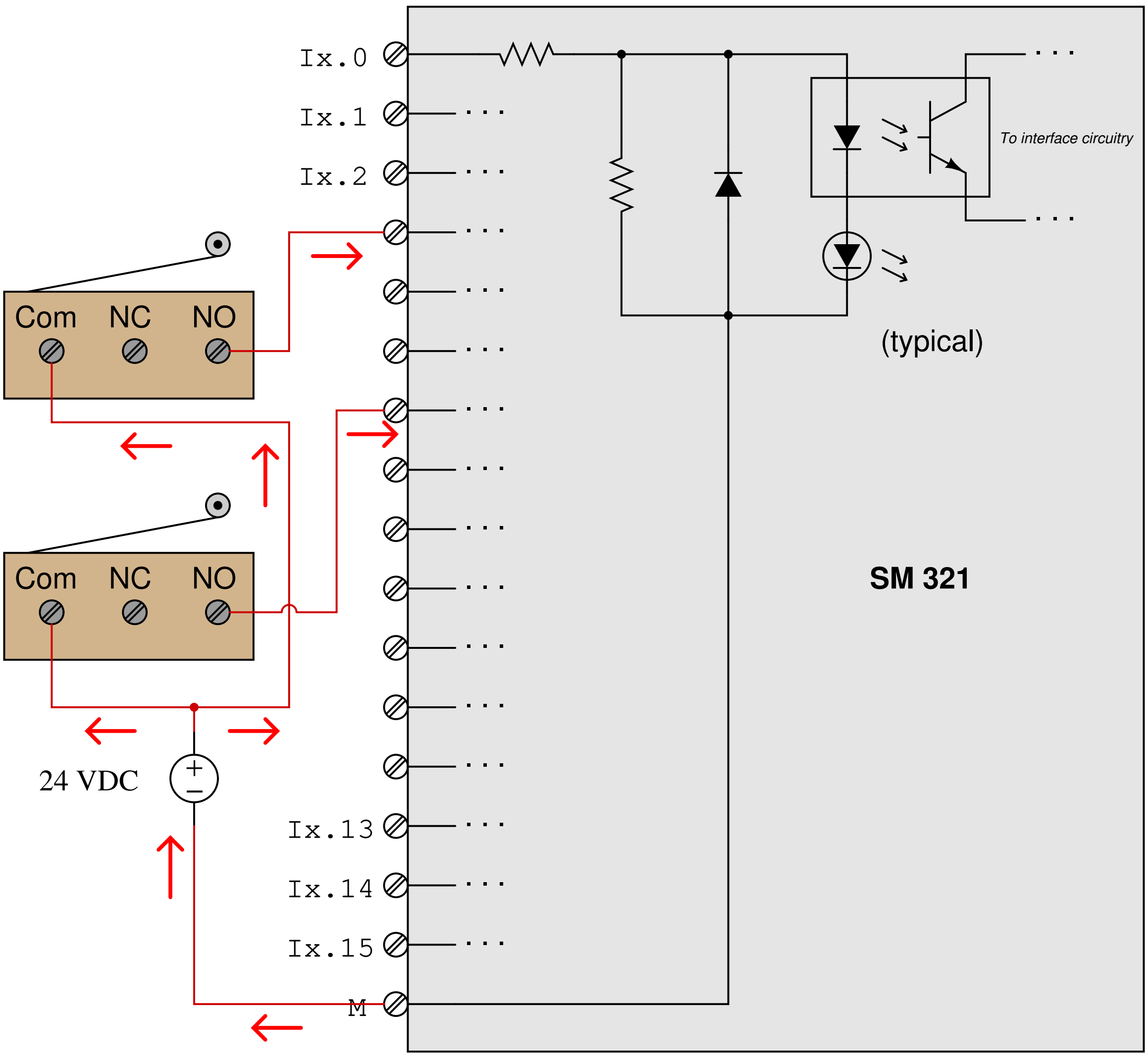
Svar 12

This particular input module *sinks* current from the limit switches (arrows drawn in the direction of conventional flow):



Svar 13

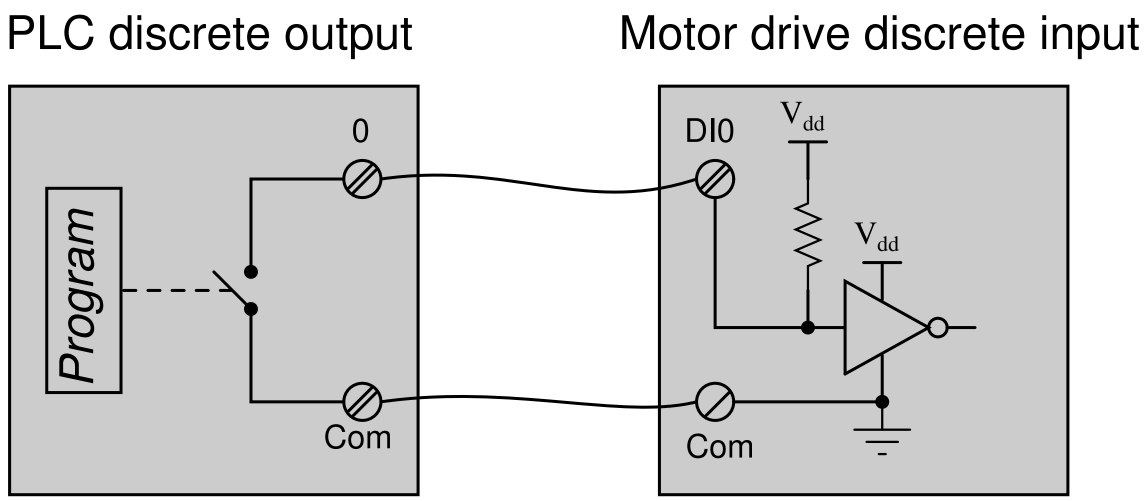
This particular input module *sinks* current from the limit switches (arrows drawn in the direction of conventional flow):



Svar 14

Svar 15

Here is a schematic diagram to help you formulate an answer:



Svar 16

Svar 17

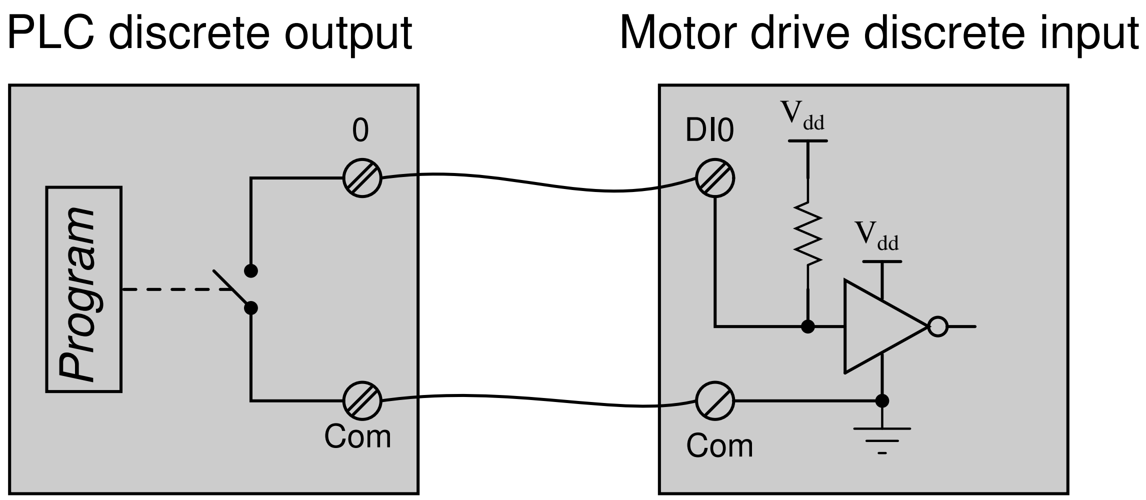
Svar 18

To answer this question, you are going to have to research the input and output connections for these specific devices, from the manufacturer's literature.

Svar 19

Svar 20

Here is a schematic diagram to help you formulate an answer:



Svar 21

This is a graded question – no answers or hints given!

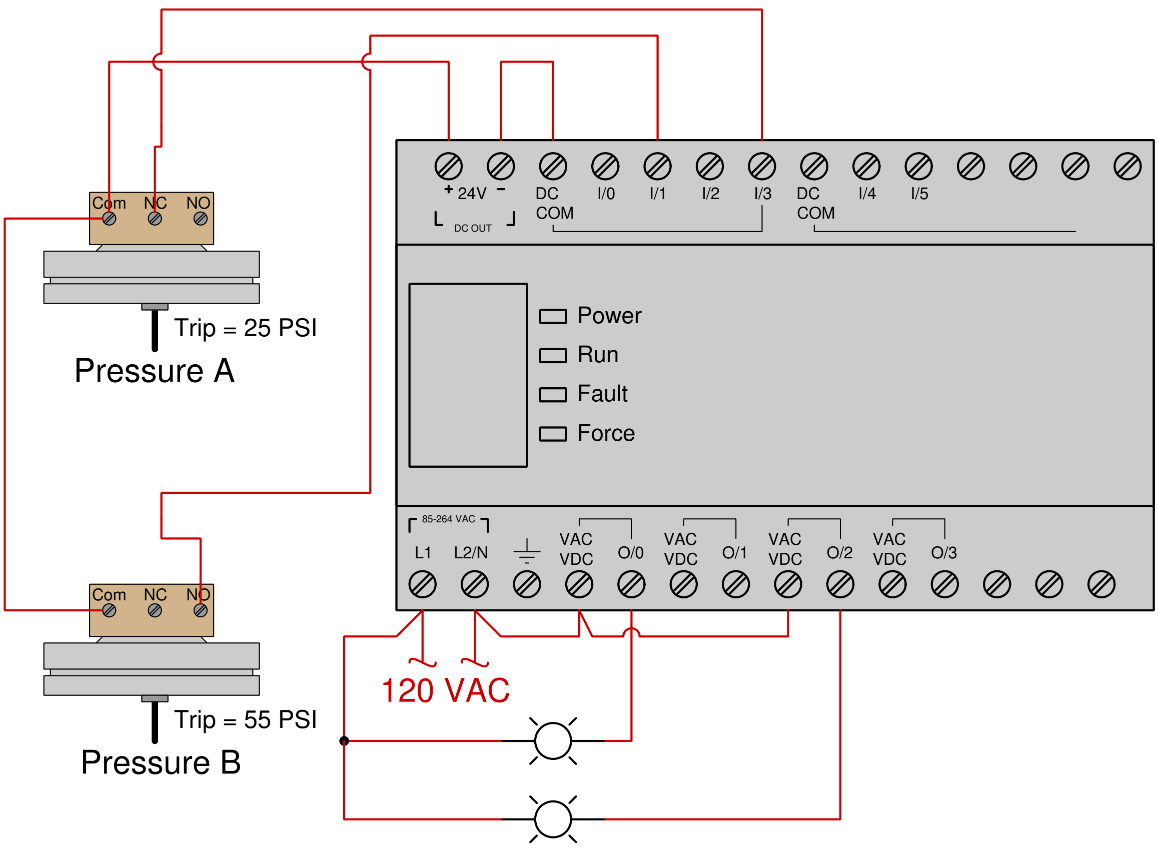
Svar 22

Color in the online program display reveals a path for "virtual power" in the ladder-logic "circuit". This means every colored "contact" is in its closed state, while every uncolored "contact" is in its open state. Since we see that only the normally-open "contact" instructions are colored while all the normally-closed "contact" instructions are uncolored, we know that all bit states must be one (1).

A "one" (1) input bit state is caused by real electrical power applied to that PLC input channel. This means both inputs must be energized by pressure switches that are *closed*.

Since pressure switch A is experiencing a pressure of only 14 PSI (below the trip threshold of 25 PSI), it must be in its resting state. Thus, we must wire its *normally-closed (NC)* contact to channel `I:0/3` of the PLC.

Since pressure switch B is experiencing a pressure of 70 PSI (above the trip threshold of 55 PSI), it must be in its actuated state. Thus, we must wire its *normally-open (NO)* contact to channel `I:0/1` of the PLC.



Svar 23

This is a graded question – no answers or hints given!