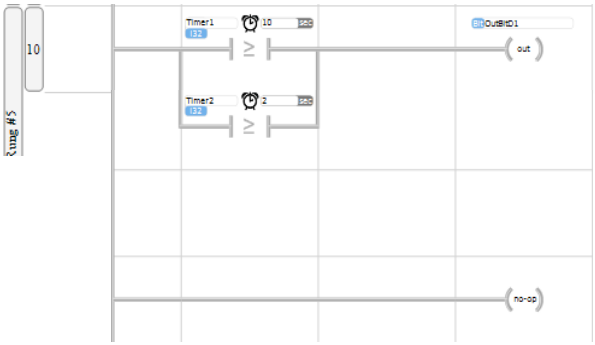
Programmable Logic Controllers:

Hands On Introduction to Industrial Controls

Class 2: PLC Bit Instruction Basics

March 28, 2017 – Don Wilcher



DesignNews

CEC CONTINUING EDUCATION CENTER

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PLC Bit Instruction Basics

Topics

- PLC Bit Instructions
- Introduction to Basic Logic Gates
- Setting up the Velocio "vBuilder" software (Ladder Logic)
- Hands-On Project: Bit Instruction – Logic Based Controllers

PLC Bit Instructions

Bit Instructions can be divided into two broad categories:

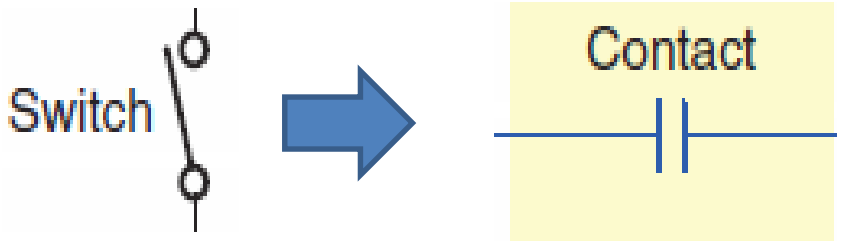
- Input
- Output

Input Instruction is a contact.

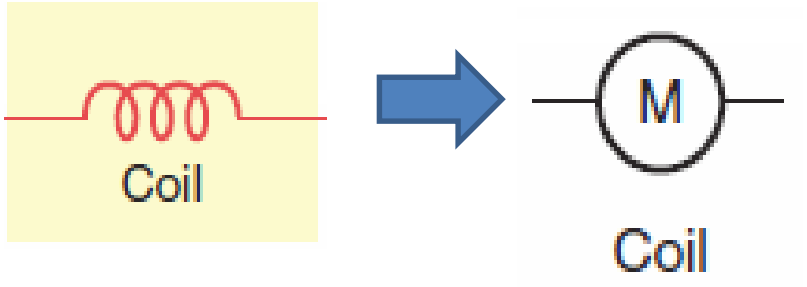
Output Instruction is a coil.

PLC Bit Instructions…

Input Instruction is a contact.



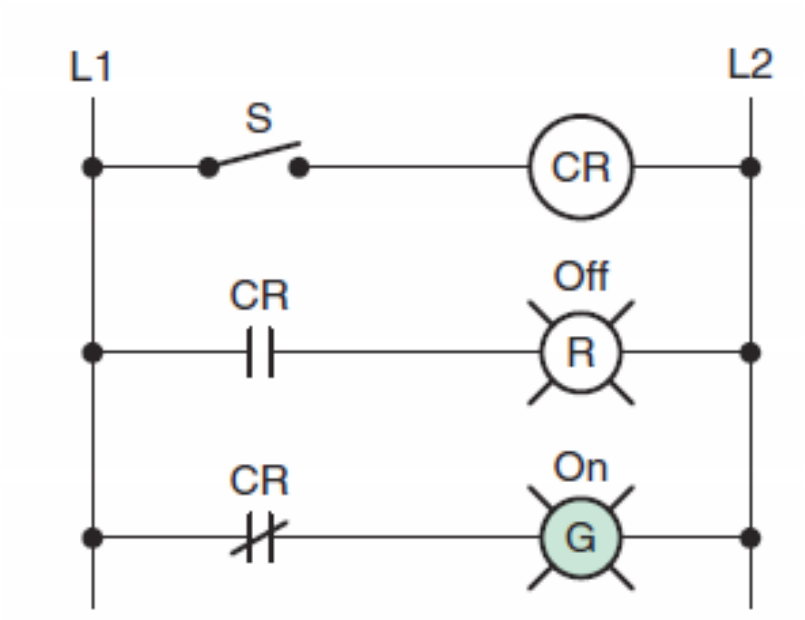
Output Instruction is a coil.



PLC Bit Instructions…

Contacts and Coils used in an Electrical Control Circuit.

Switch open and coil de-energized



Switch closed and coil energized

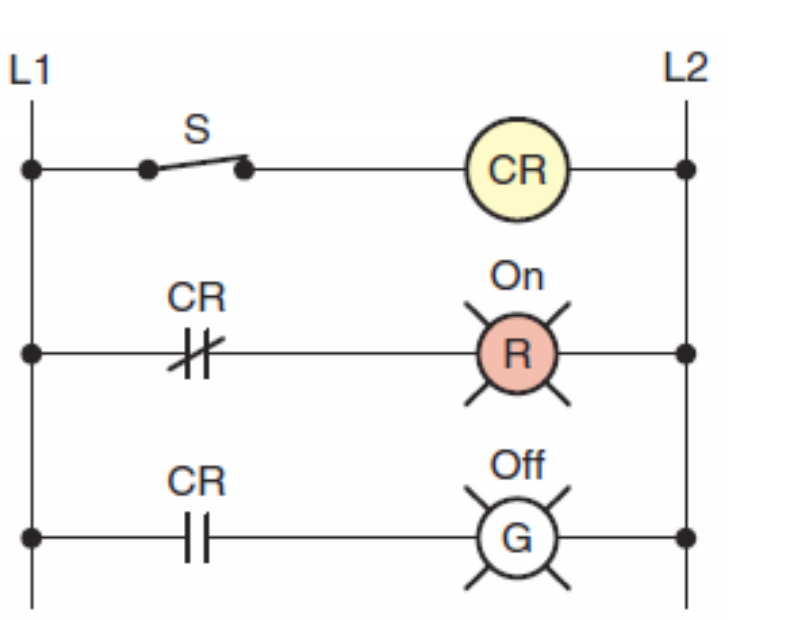


Image Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

Question 1

Input Instruction is coil and Output Instruction is contact.

a) **True**

b) **False**

PLC Bit Instructions…

When programming PLCs, the following bit instructions are used.

- **Examine If Closed (XIC)**
- **Examine If Open (XIO)**
- **Output Energize (OTE)**

Examine If Closed or ***Examine ON*** instruction is associated with a physical input being set to binary logic **1** with a voltage being present

PLC Bit Instructions…

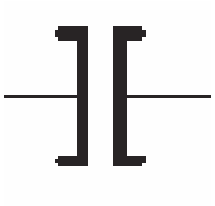
- **Examine If Closed (XIC)**
  Examine If Closed or ***Examine ON*** instruction is associated with a physical input being set to binary logic **1** with a voltage being present

- **Examine If Open (XIO)**
  Examine If Open or ***Examine OFF*** instruction is associated with a physical input being set to binary logic **0** with a no voltage being present.

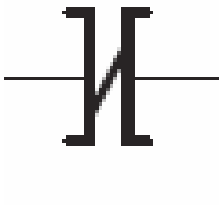
- **Output Energize (OTE)**
  Output Energize instruction is associated with a physical output being set to binary logic **1** with a voltage being present.

PLC Bit Instructions…

- **Examine If Closed (XIC) Bit Instruction**



- **Examine If Open (XIO) Bit Instruction**



- **Output Energize (OTE) Bit Instruction**

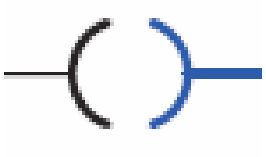
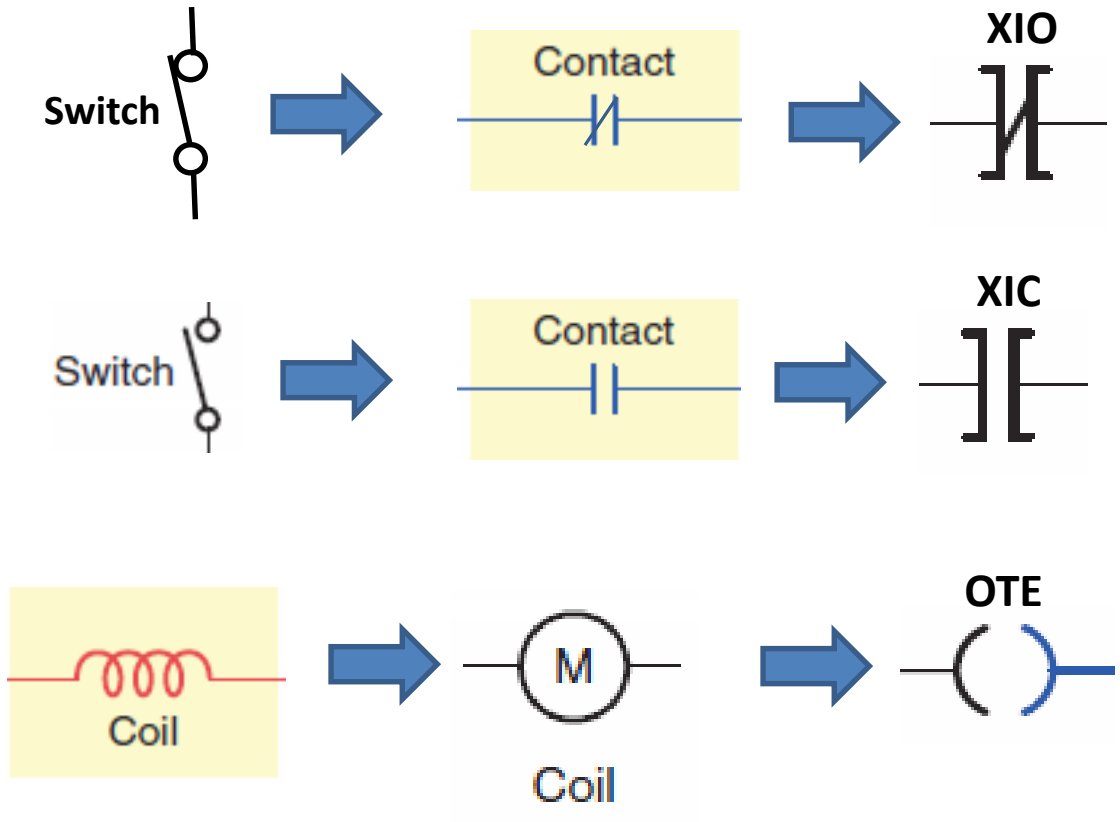


Image Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

PLC Bit Instructions…



Relationship between Electronic, Industrial Control Symbols and PLC Bit Instructions

PLC Bit Instructions…

PLC Bit Instructions are arranged in

- A series of logical rungs.
- The logical rungs operate based on the physical input and output binary values.
- The logical rungs are called a Ladder Logic Program.

Question 2

A Photoswitch wired to a PLC would use what type of Bit Instruction.

a) **XIO**

b) **XIC**

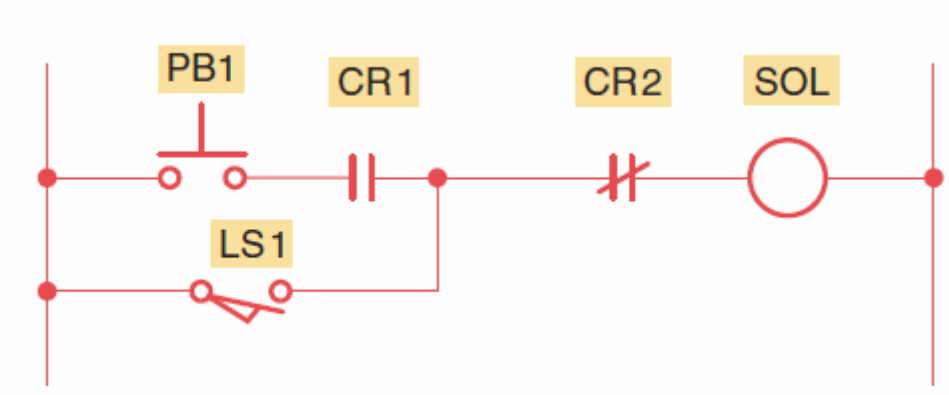
c) **a & b**

d) **OTE**

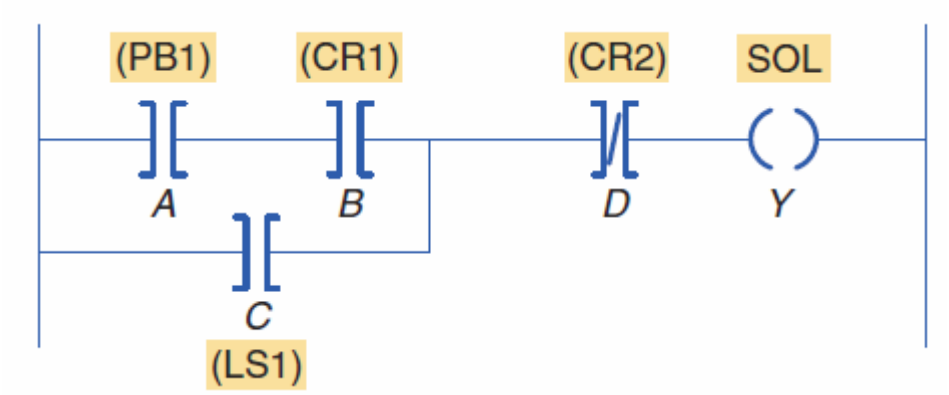
e) **None of the above**

PLC Bit Instructions…

Comparison of Hardwired Relay Control Circuit with Ladder Logic Program



Hardwired relay control circuit



Equivalent ladder diagram program

Image Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

PLC Bit Instructions…

***Ladder Logic* language is the most commonly used PLC programming language and is designed to mimic hardwired relay logic.**

Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

Question 3

On slide 13, CR2 represents what type of bit instruction.

a) **XIO**

b) **XIC**

c) **a & b**

d) **OTE**

e) **None of the above**

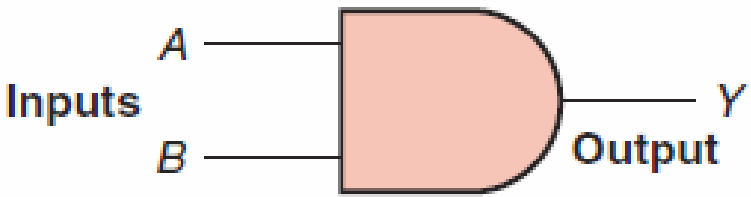
Introduction to Basic Logic Gates

A *logic gate* is a circuit with several inputs but only one output that is activated by particular combinations of input conditions.

Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

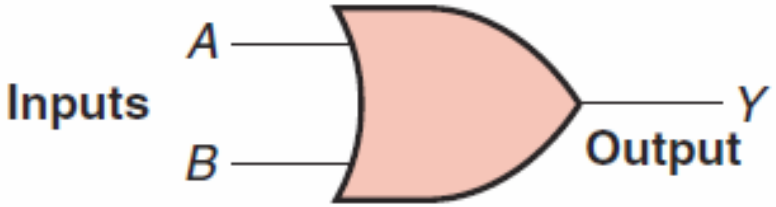
Introduction to Basic Logic Gates…

An AND gate is a device with two or more inputs and one output.



Two-input AND gate symbol

An OR gate can have any number of inputs but only one output.

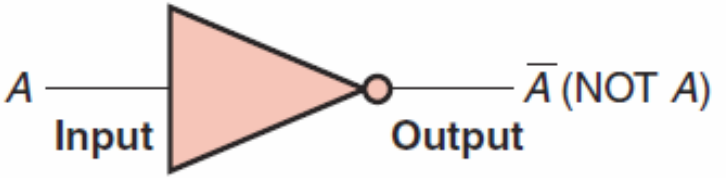


Two-input OR gate symbol

Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

Introduction to Basic Logic Gates…

The NOT function can have only one input.

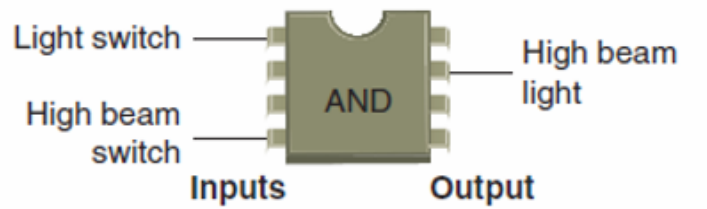


Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

Introduction to Basic Logic Gates…

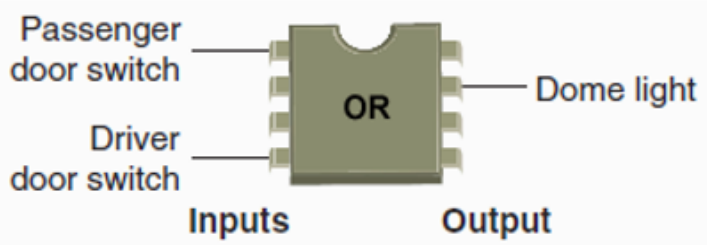
Practical Examples of Logic Gates:

Logical AND



The high beam light can be turned on only when the light switch AND the high beam switch are closed.

Logical OR



The dome light will be turned on whenever the passenger door switch OR the driver door switch is activated.

Source: Programmable Logic Controllers, 4th Ed., McGraw Hill, 2011

Question 4

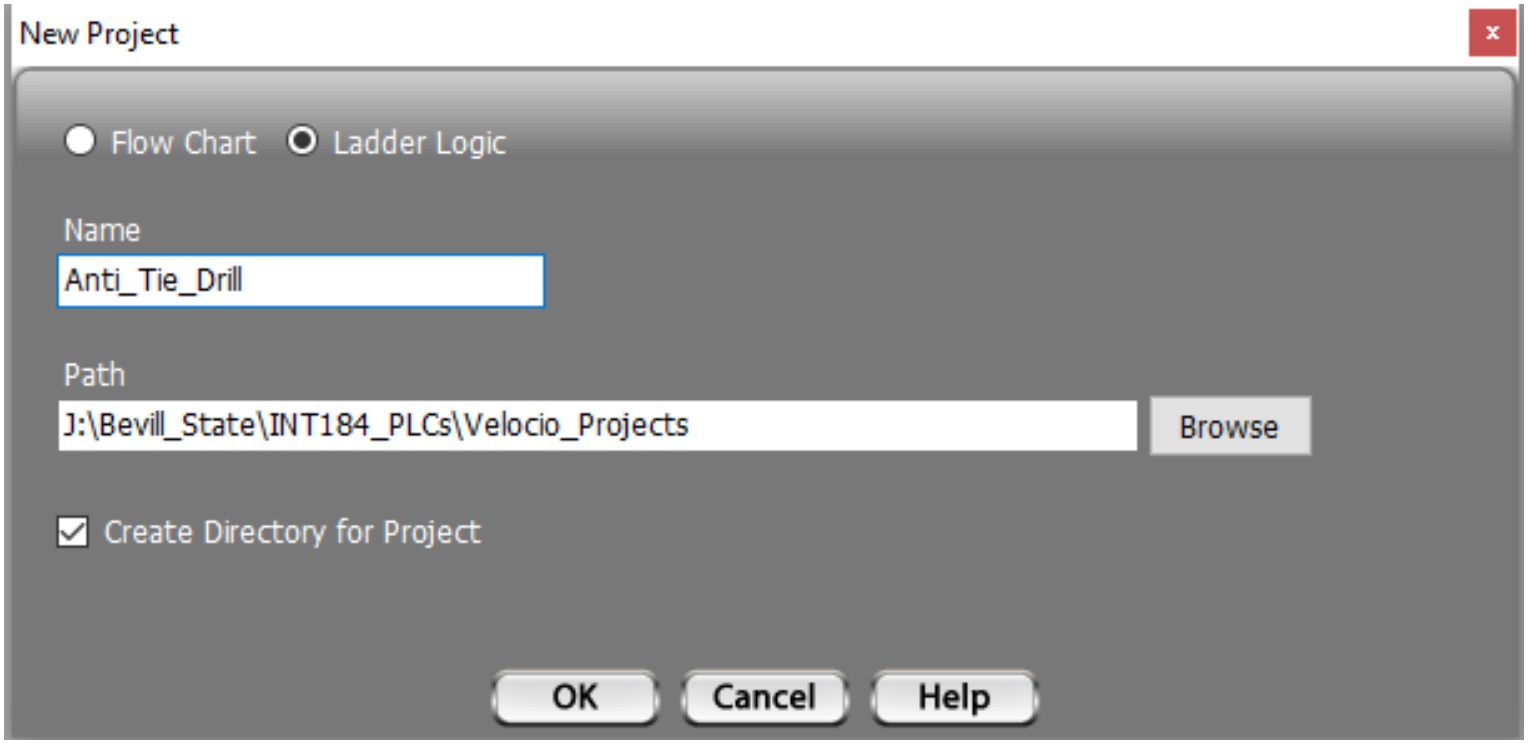
Provide a practical example of device or system that performs the NOT Function.

Setting Up the Velocio "vBuilder" Software (Ladder Logic)

Reference

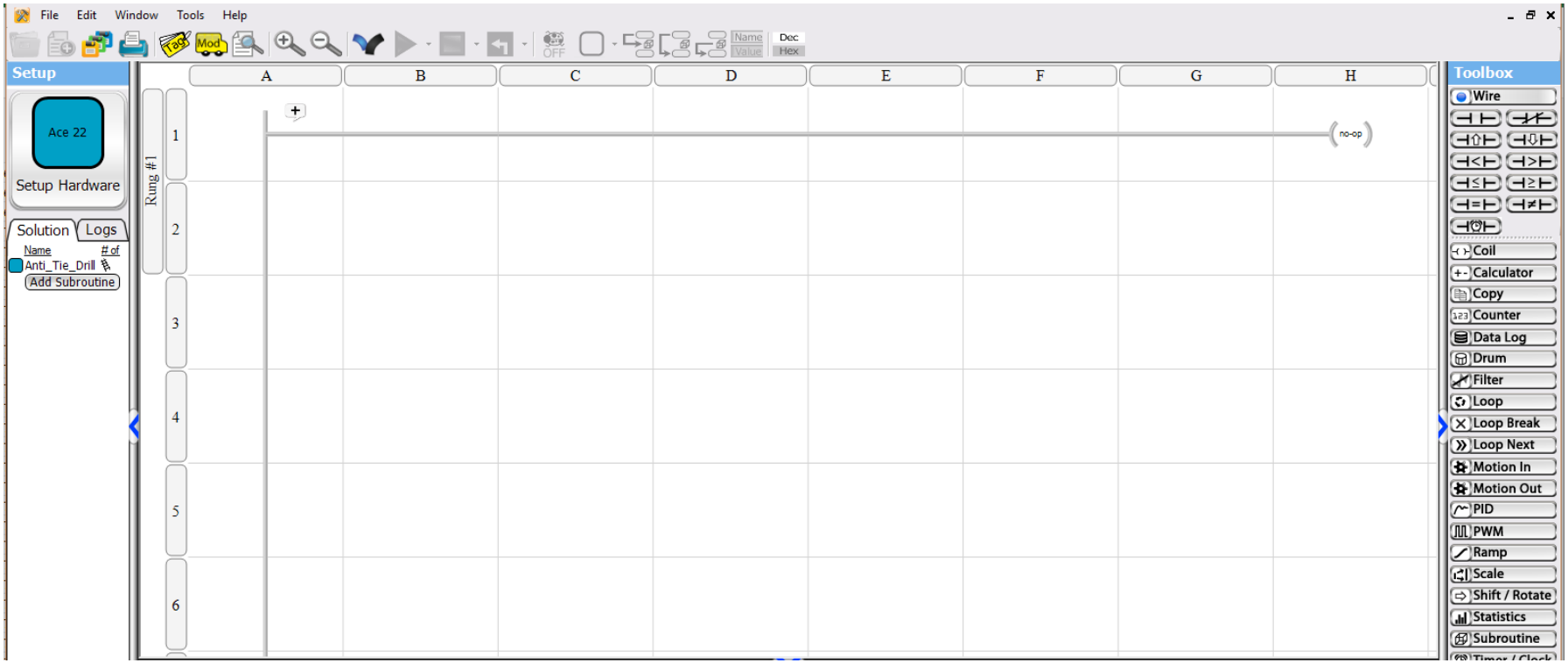
http://velocio.net/vbuilder/

Setting Up the Velocio "vBuilder" Software…



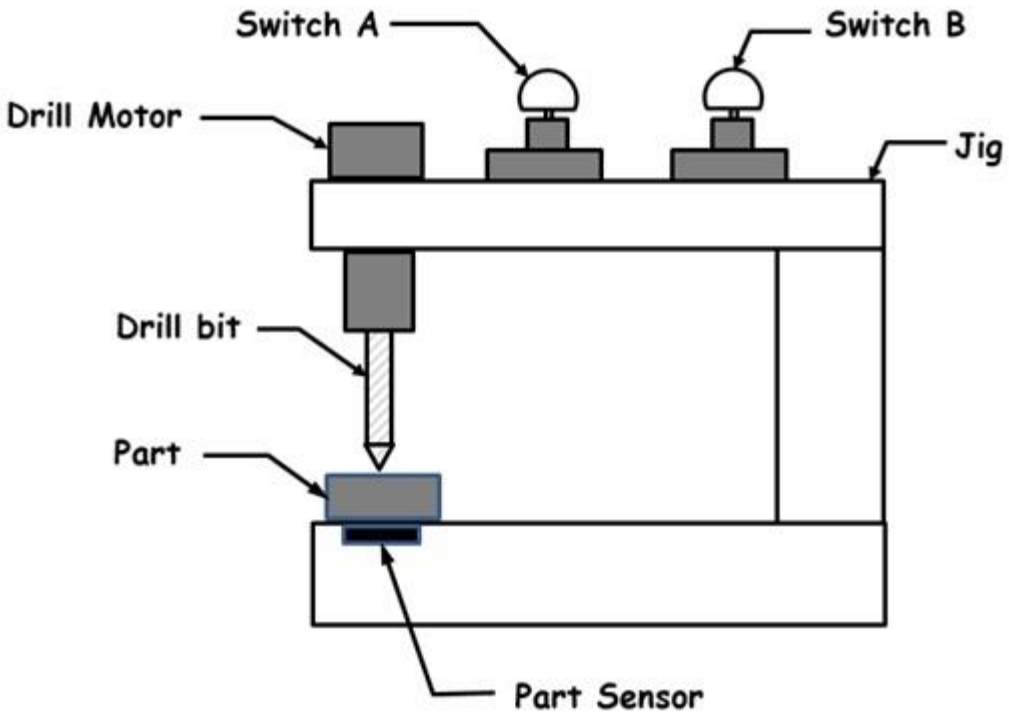
Creating the Ladder Logic program for a Anti-Tie Down Controller.

Setting Up the Velocio "vBuilder" Software…



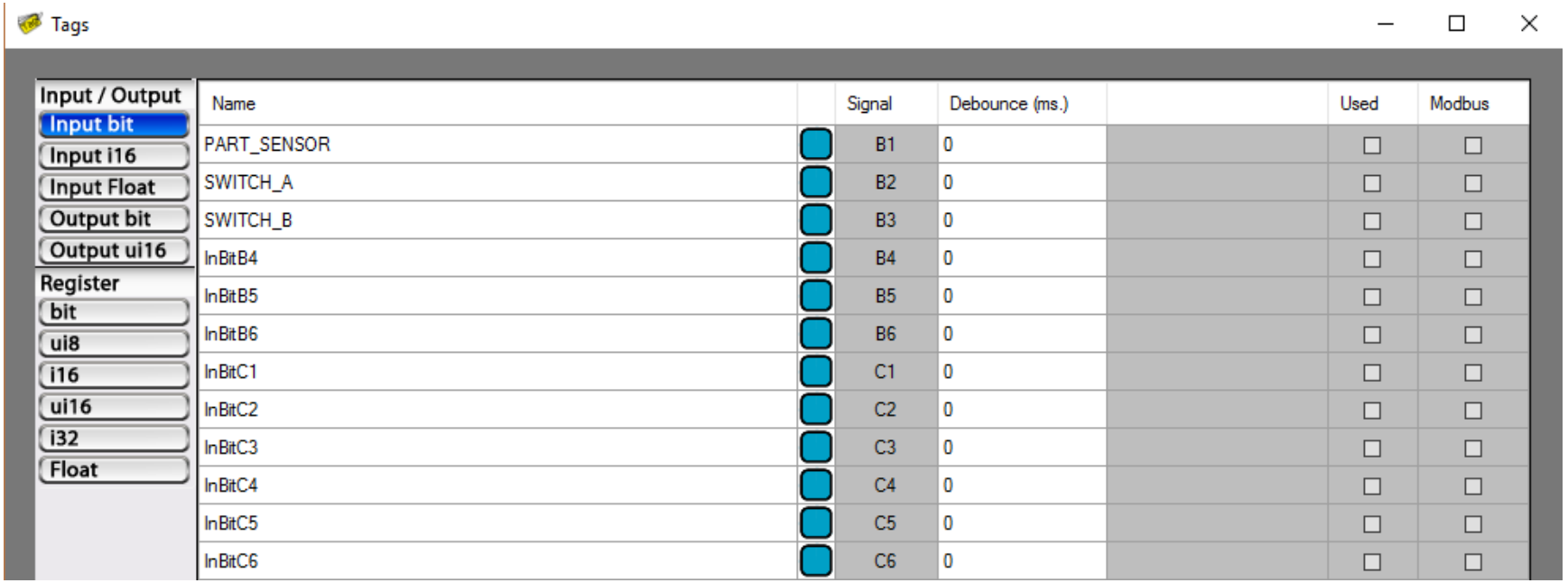
The Ace 22 PLC Hardware setup is complete.

Developing a PLC Ladder Logic Program for a Small Drill



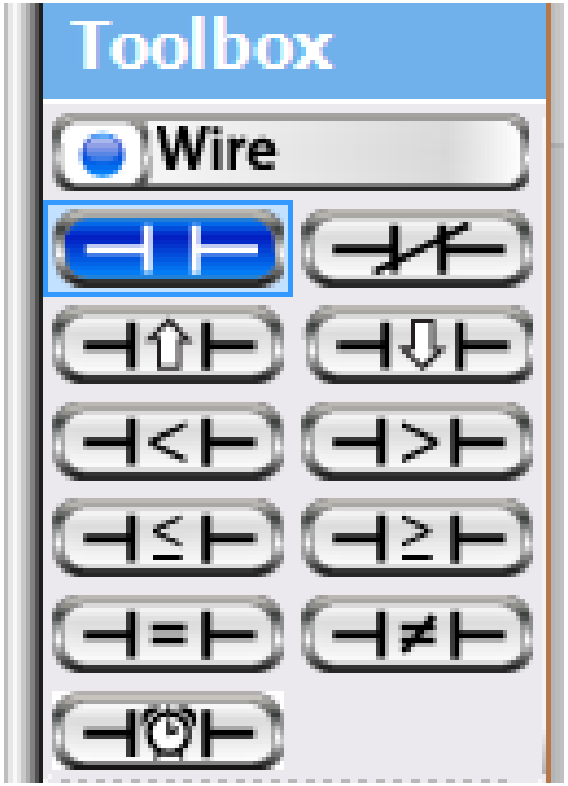
Small Drill Press with Anti-Tie Down Controls

Developing a PLC Ladder Logic Program for a Small Drill…



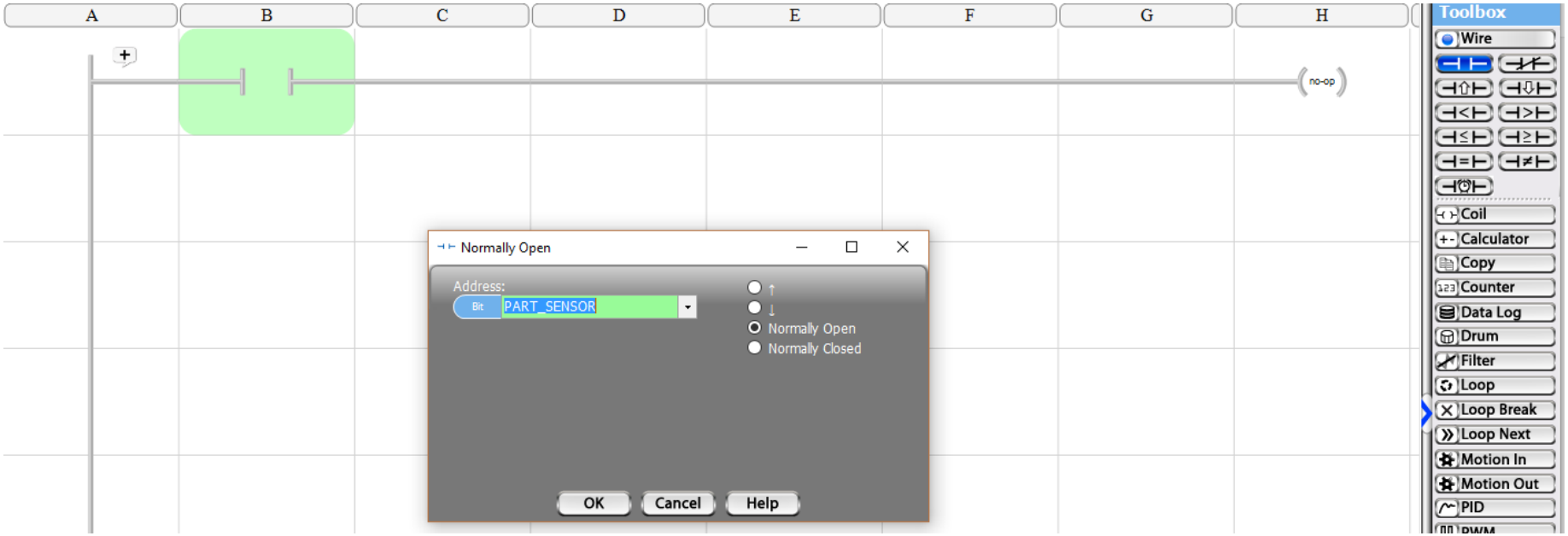
Creating Tags PART_SENSOR, SWITCH_A, AND SWITCH_B

Developing a PLC Ladder Logic Program for a Small Drill…



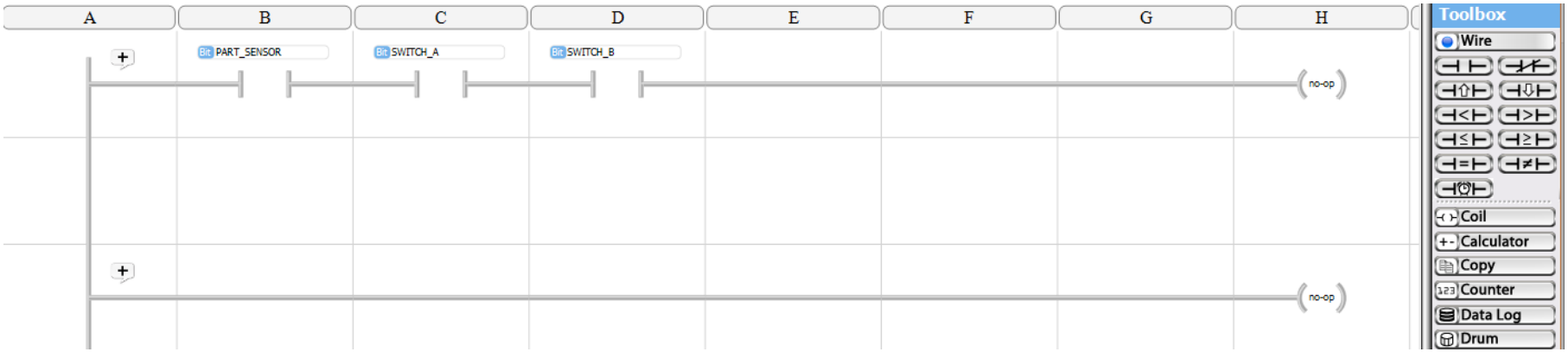
Three Normally Open Contacts (XIC) will be used in the program.

Developing a PLC Ladder Logic Program for a Small Drill…



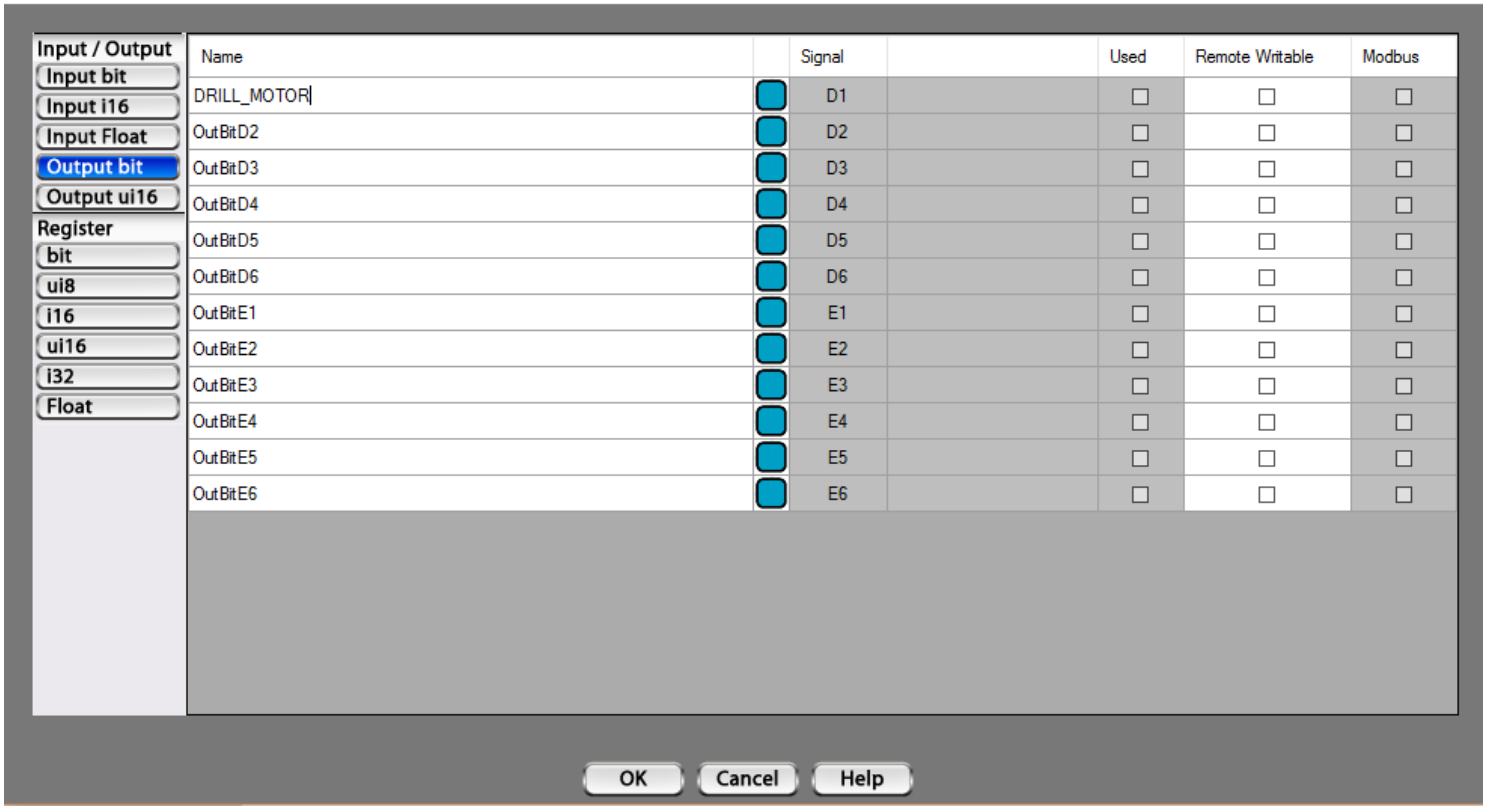
Select the PART_SENSOR Tag for the bit instruction.

Developing a PLC Ladder Logic Program for a Small Drill…



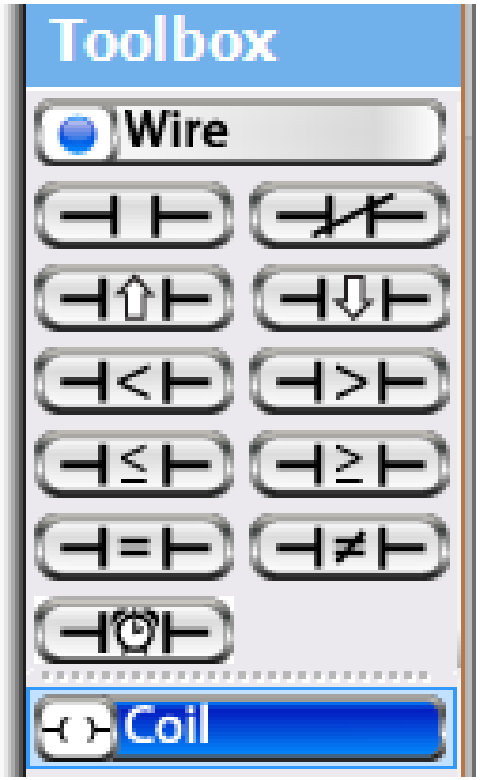
Select the remaining XIC bit instructions with their appropriate Tags and place them on the ladder logic rung.

Developing a PLC Ladder Logic Program for a Small Drill…



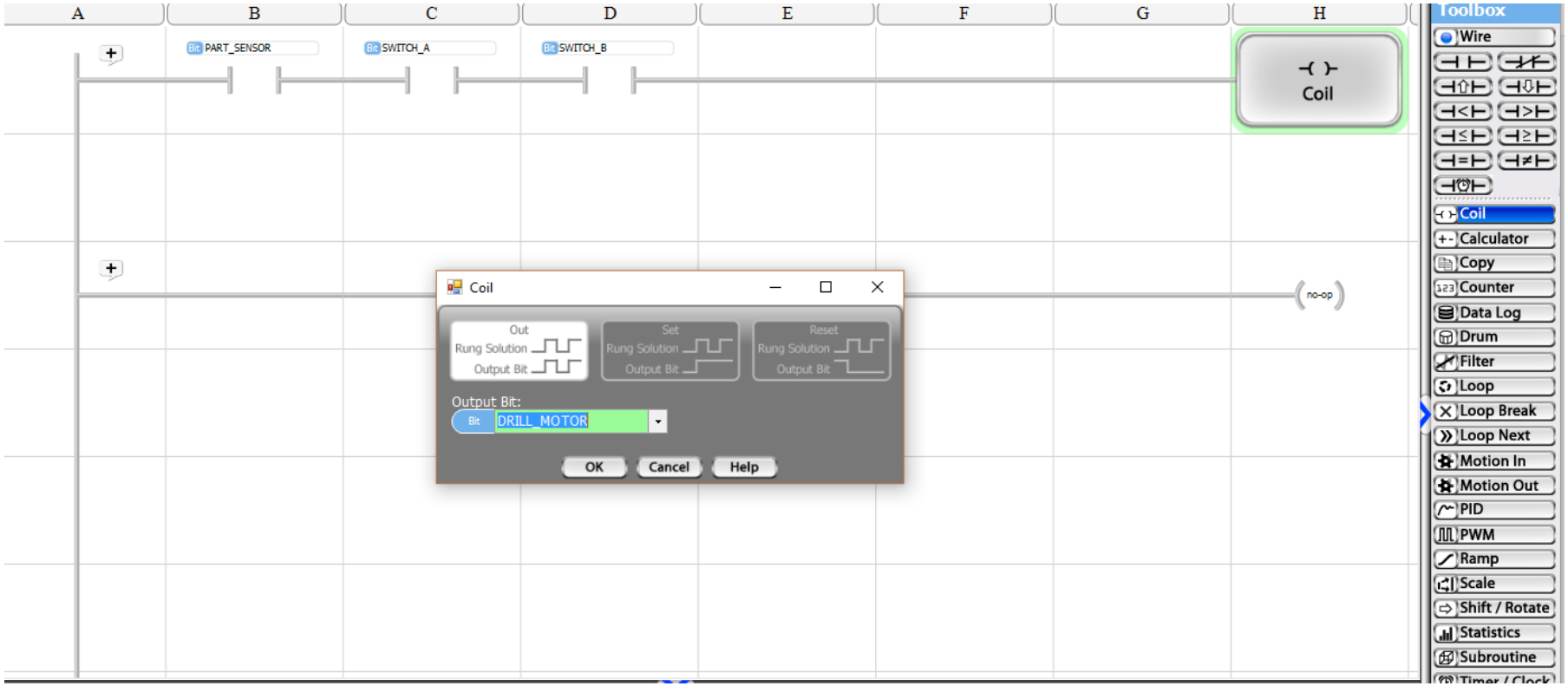
Creating Tag DRILL_MOTOR

Developing a PLC Ladder Logic Program for a Small Drill…



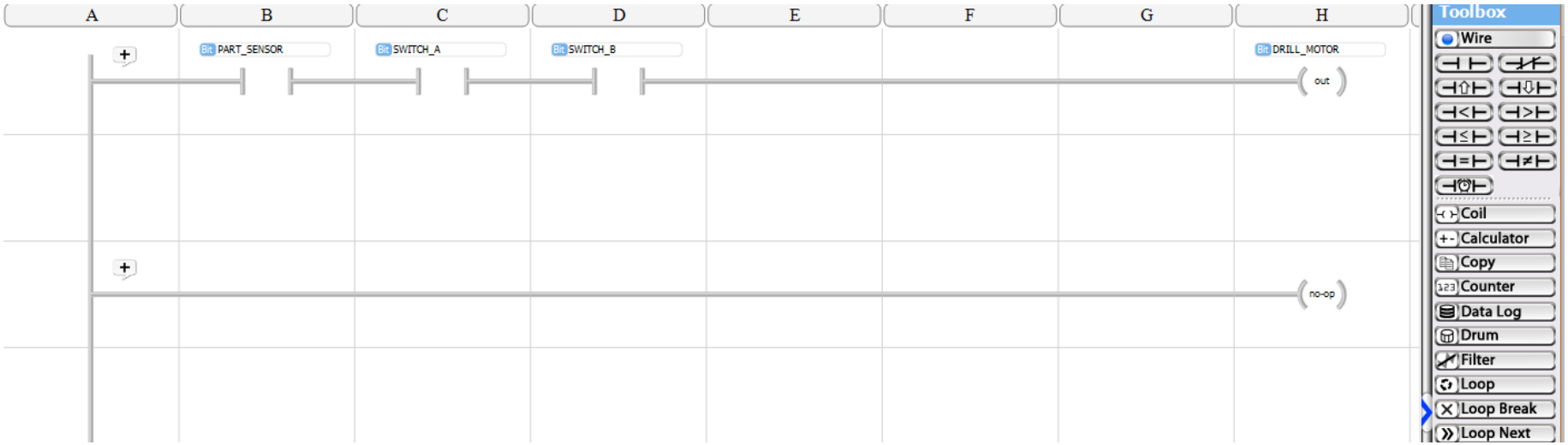
One coil (OTE) will be used in the program.

Developing a PLC Ladder Logic Program for a Small Drill…



Select the DRILL_MOTOR Tag for the OTE bit instruction.

Developing a PLC Ladder Logic Program for a Small Drill…

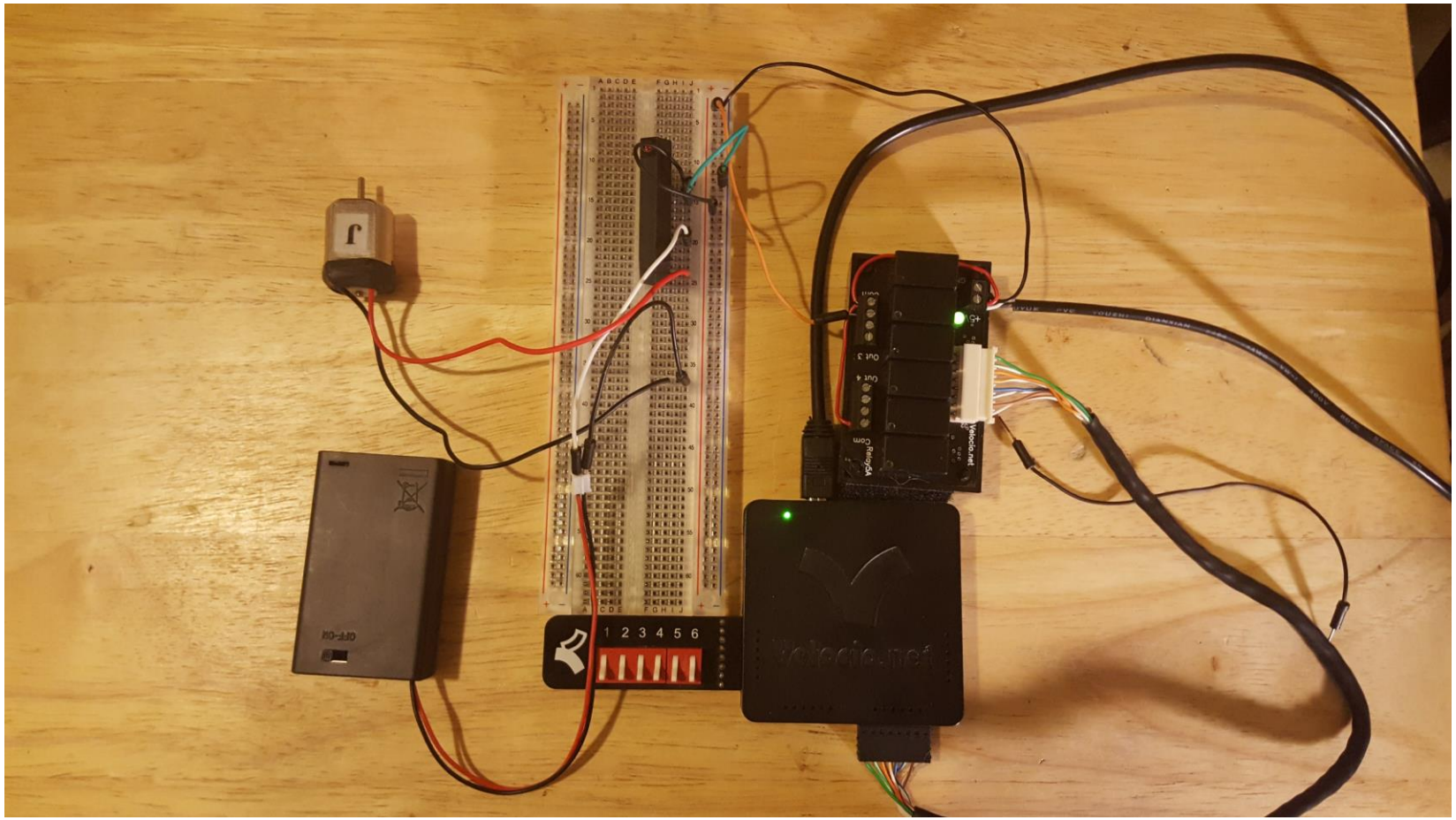


The Anti Tie Down Controller PLC Ladder Logic is completed.

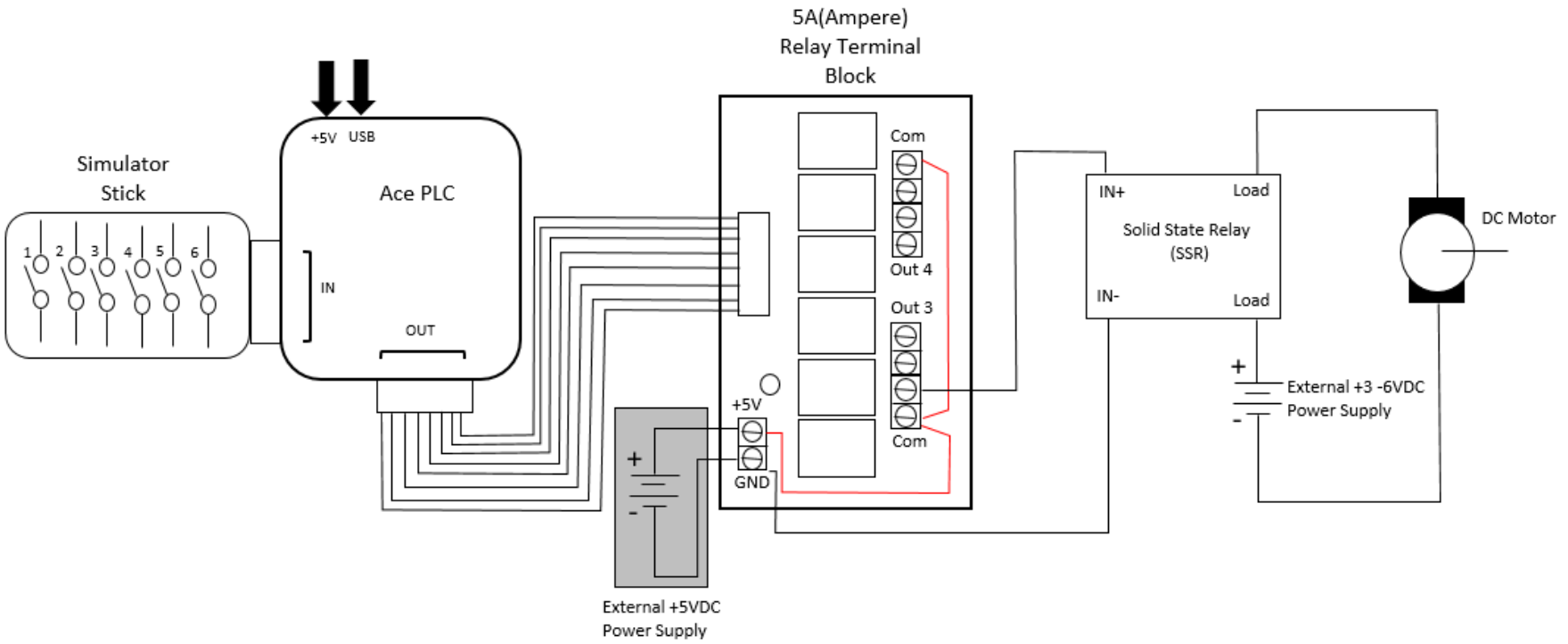
Question 5

What basic logic function will be performed by the Anti Tie down Controller?

Hands-On Project: Bit Instruction Based Logic Controller



Hands-On Project: Bit Instruction Based Logic Controller



Electrical Wiring Diagram

Solid State Relay (SSR) FAQs

SSRs are widely used in industrial control circuits for operating electric heaters, solenoid, motor, and lighting fixtures.

Advantages.

- small in size.
- fast switching speeds.
- can isolate low voltage/current circuits from high voltage/current electrical loads.

Solid State Relay (SSR) FAQs…

Disadvantage.

• small leakage that occurs when the SSR is turned off (de-energize). Device stays on (energize)

SSR Types.

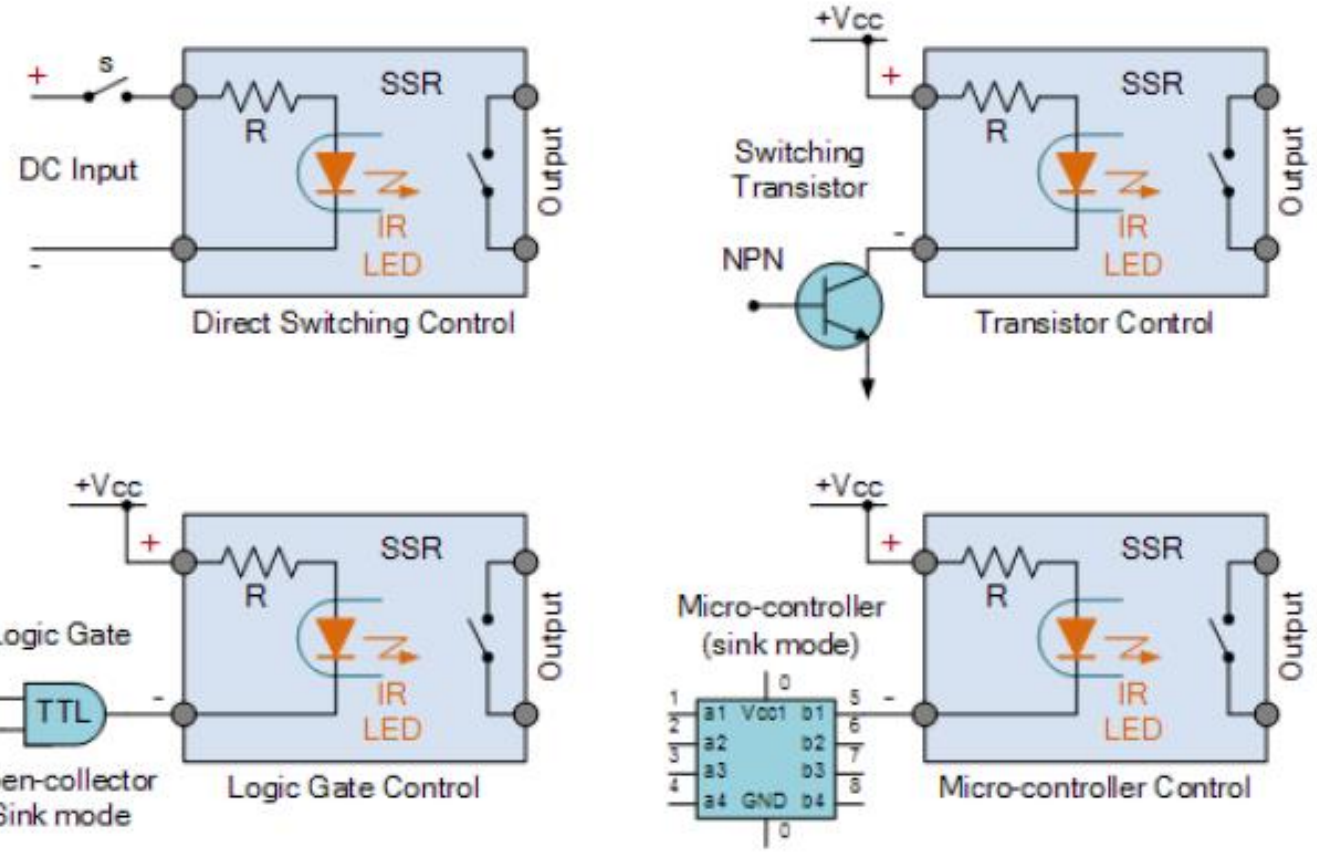
• AC or DC devices (input/output signals).

•Use an internal optical emitter –detector pair for isolating low voltage/current circuits from high voltage/current loads.

•BJTs, SCRs, or Triacs are commonly used as the switching components for output control.

Solid State Relay (SSR) FAQs…

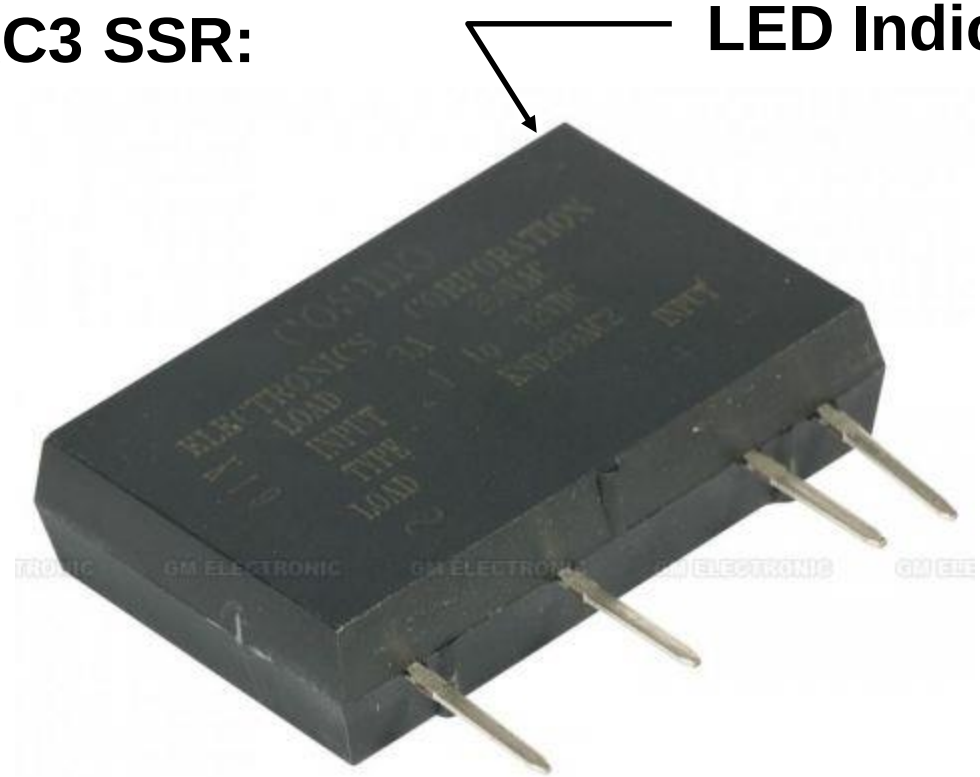
Solid State Relay DC Input Control Circuits:



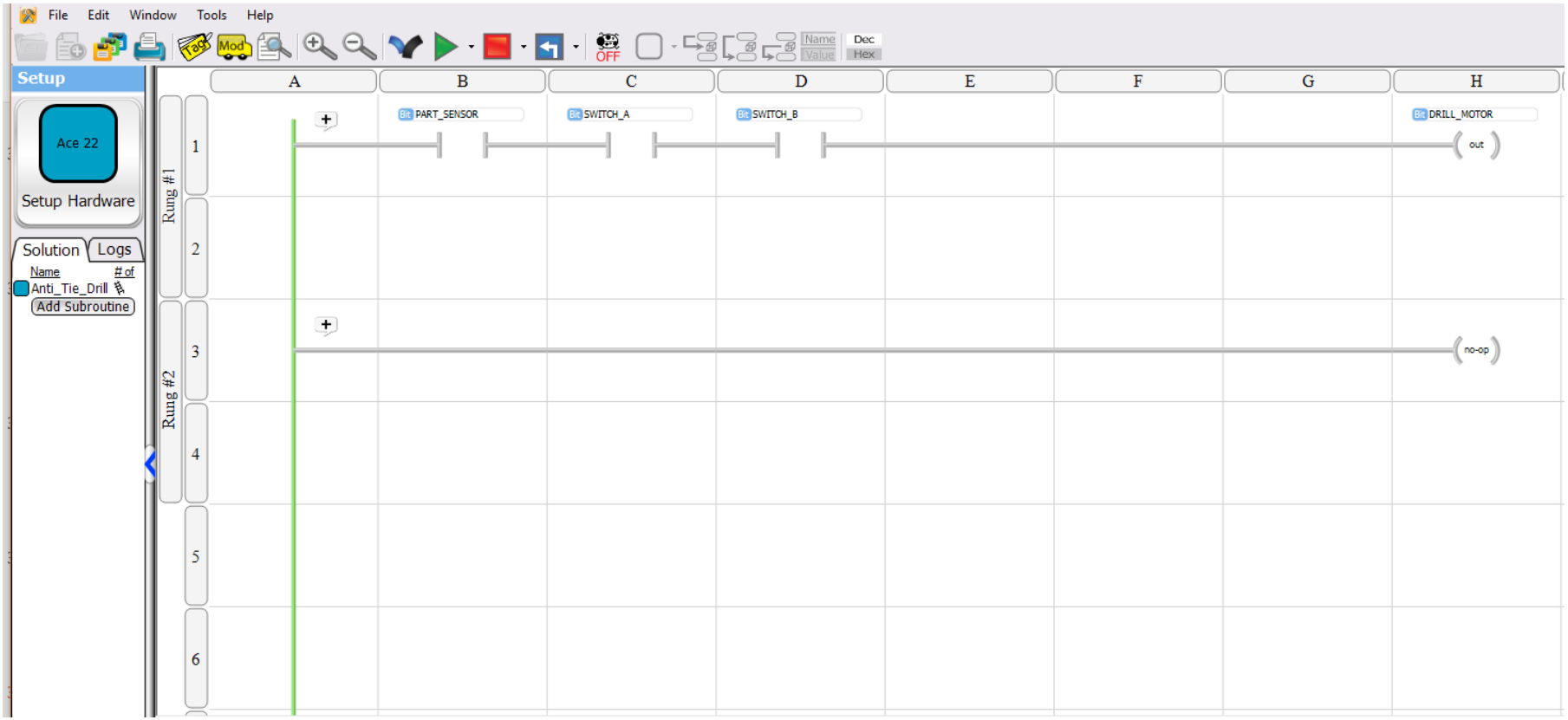
http://www.electronics-tutorials.ws/power/solid-state-relay.html

Solid State Relay (SSR) FAQs…

KSD203AC3 SSR:

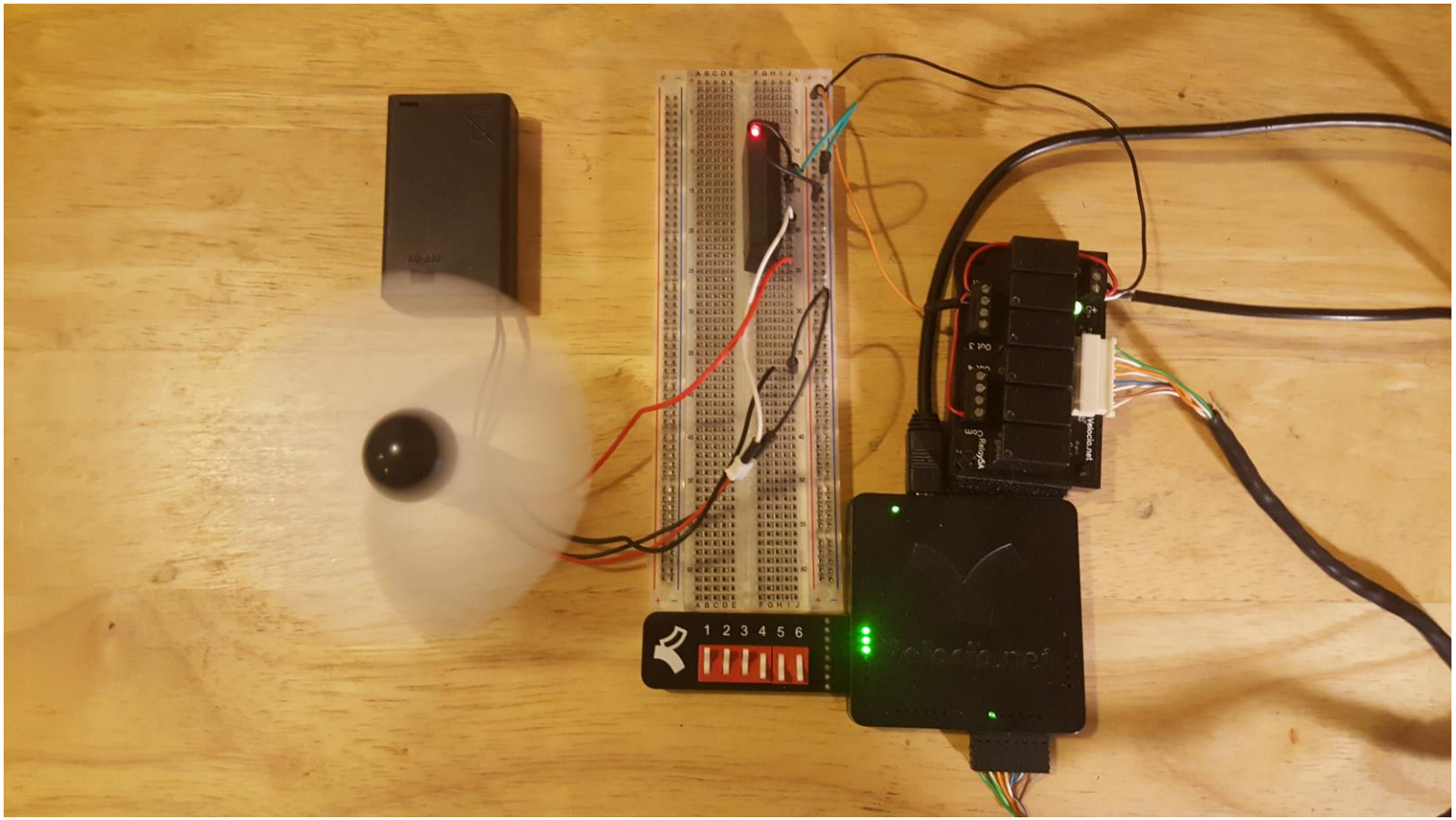


Running the Anti Tie Down Controller Ladder Logic Program



Click the "Green" run button to operate the Anti Tie Down Controller with the Simulator switch.

Running the Anti Tie Down Controller Ladder Logic Program



Anti-Tie Down Controller in operation!

Question 6

What disadvantage is presented by a SSR?