



ECET 4530

Industrial Motor Control

Relay Logic Example Problem



Introduction

The concept of **relay logic** involves the utilization of multiple relays that are wired together in a specific manner in order to create the interactive switching function that is required to provide the desired operational logic for a control circuit.

In addition to relays, relay logic circuits often incorporate a variety of other logic devices that also provide on/off switching functions, such as switches, pushbuttons and timers.

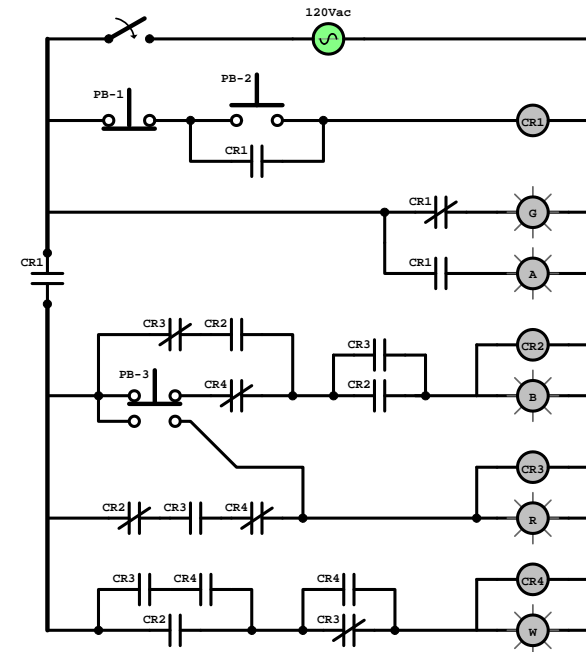


Introduction

This presentation provides a step-by-step analysis of the operation of a relay-logic control circuit that contains:

- Four **control relays**
- Three **pushbuttons**
- Five **indicator lamps**
- One **single-position switch**

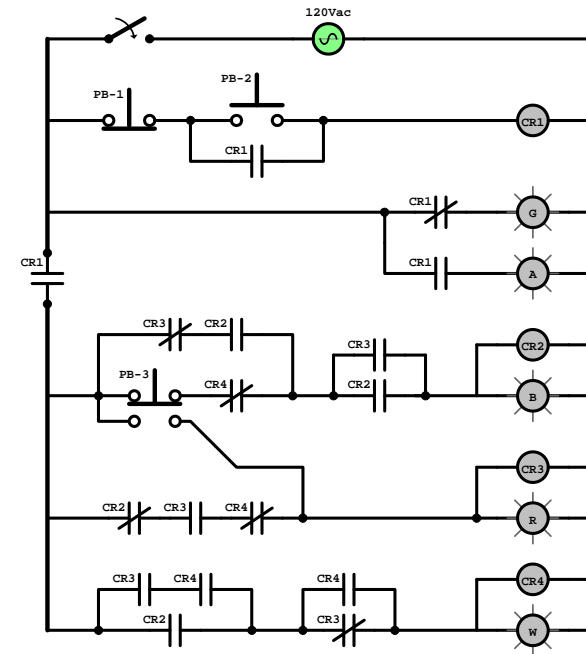
upon which a series of pushbutton presses and releases will be preformed.





Introduction

But, instead of simply just reading through this presentation and trying to follow along with the analysis, **it is suggested that the viewers of this presentation first attempt to predict the operation of the system step-by-step, and then utilize the analysis provided within to identify any points of confusion for which they might want to seek assistance.**

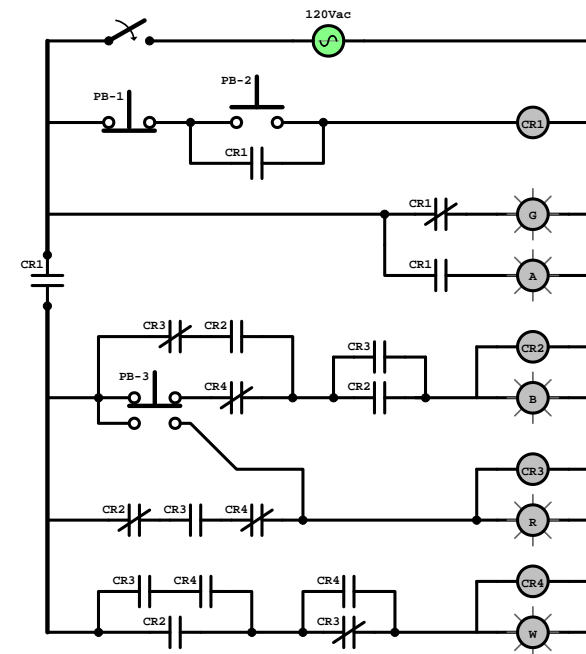




Introduction

Note that a **full-page** version of the **circuit** is provided at the end of this presentation.

Viewers may find it useful to print several copies of the circuit, upon which they can make notations to help keep track of the state of each relay as the steps are performed.





Determine the state of the indicator lamps after each step is performed:

Step 1: Flip Power Switch ON

Step 2: Press PB-2

Step 3: Release PB-2

Step 4: Press PB-3

Step 5: Release PB-3

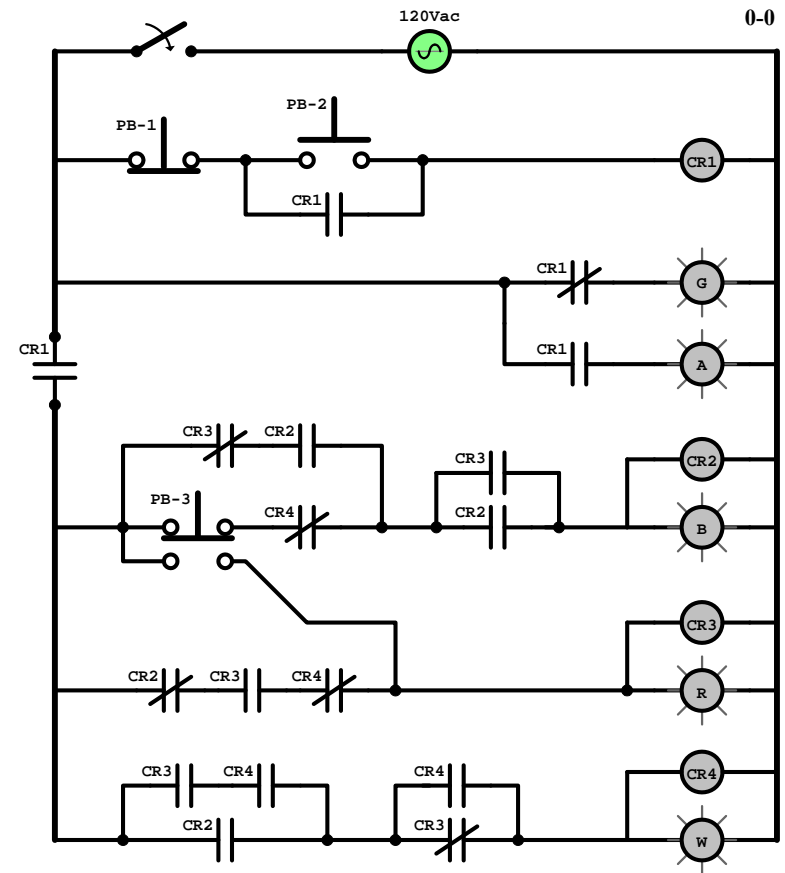
Step 6: Press PB-3 (2nd Time)

Step 7: Release PB-3 (2nd Time)

Step 8: Press PB-1

Step 9: Release PB-1

Step 10: Flip Power Switch OFF





Analysis Notes:

- Logic devices will always be shown in their normal positions.
- In order to identify the current state of each logic device, a green bar (■) will be placed behind a device if that device will allow the flow of current at a particular point in time, while a red bar (■) will be placed behind that device if it would prevent the flow of current.
- Since there is a delay between the time that a field coil is (de)energized and the time that its associated contacts actuate (drop-out), a change in the state of a relay's field coil will be shown as an independent event on one slide, after which the change of state of that relay's contacts will be shown on the next slide.
- To help identify which devices experience a change of state from slide to slide, a blue box (■) will be placed behind a device to denote a change of state compared to that displayed on the previous slide.
- After each step is performed and steady-state operation is achieved, the status of the indicator lamps will be summarized.



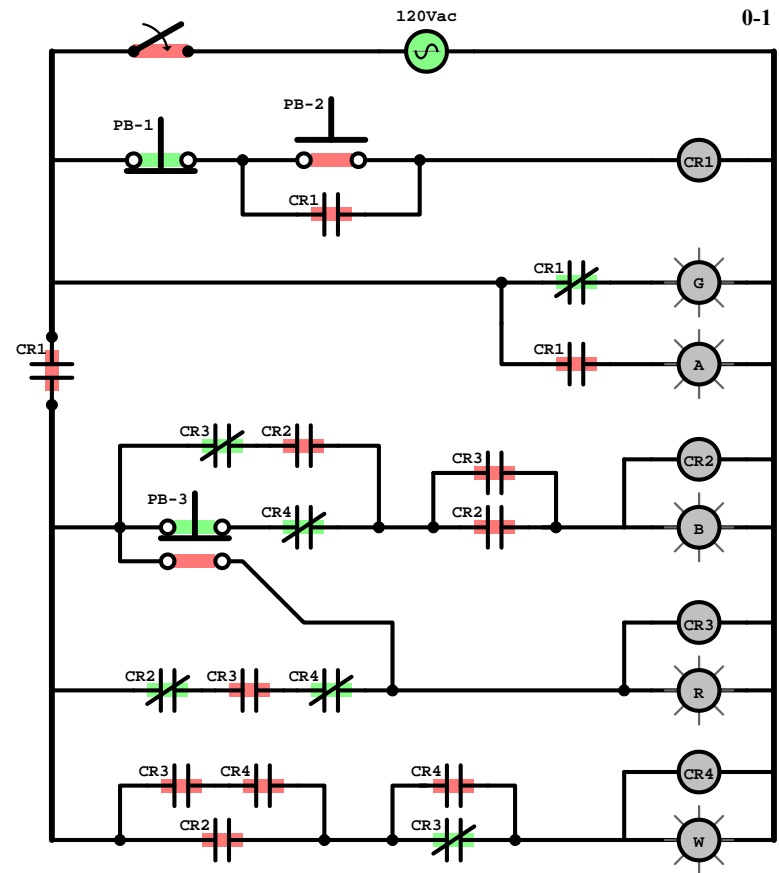
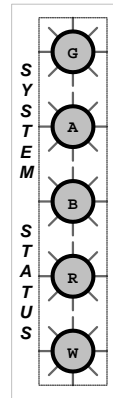
Initial system status with the Power Switch in the OFF position.

On: None

Off: Green
Amber
Blue
Red
White

The field coils will be colored grey whenever they are de-energized and green whenever they are energized

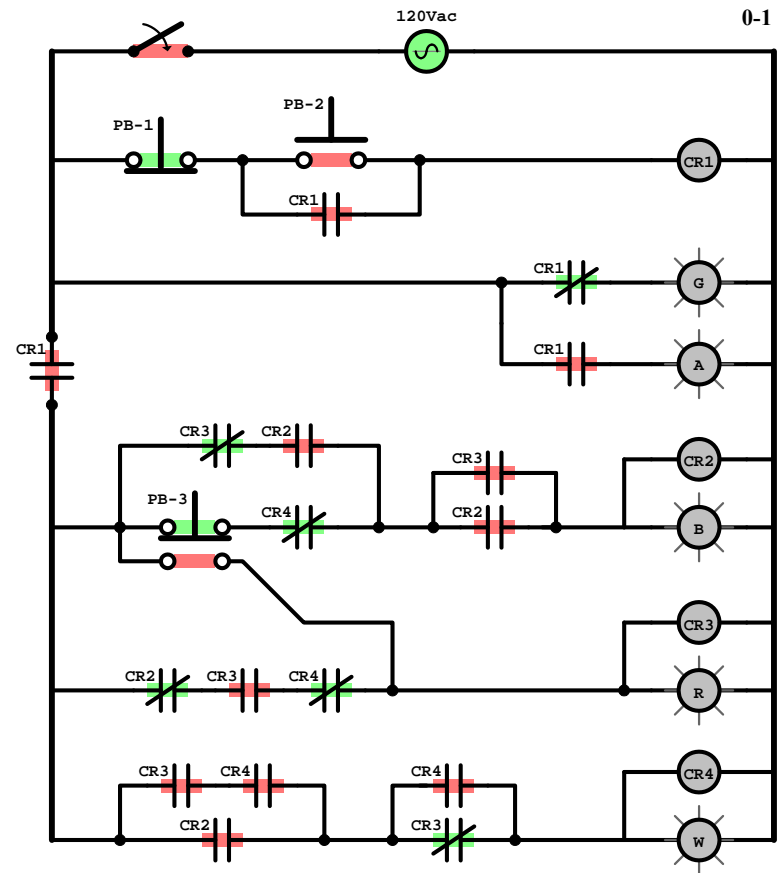
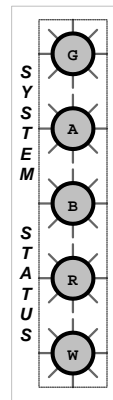
The indicator lamps will also be displayed together in this location for ease of viewing. Note that whenever a lamp is illuminated, the lamp symbol will change from grey to its stated color.





Step 1: Power Switch flipped ON

Attempt to predict the result before viewing the next slides.



0-1



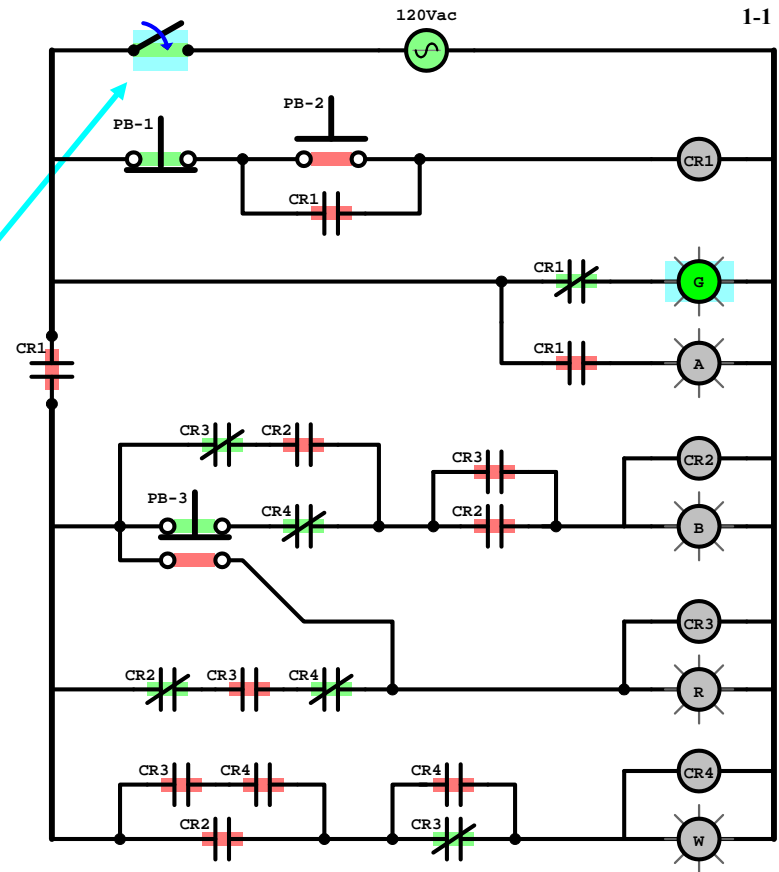
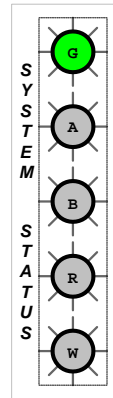
Step 1: Power Switch flipped ON

Result: Green Light ON

No additional changes in the system

A light-blue background denotes that the state of that device changed from the previous slide to the current slide.

I.e. – The “Power Switch” was in the OFF position and the Green Light was OFF in the previous slide.

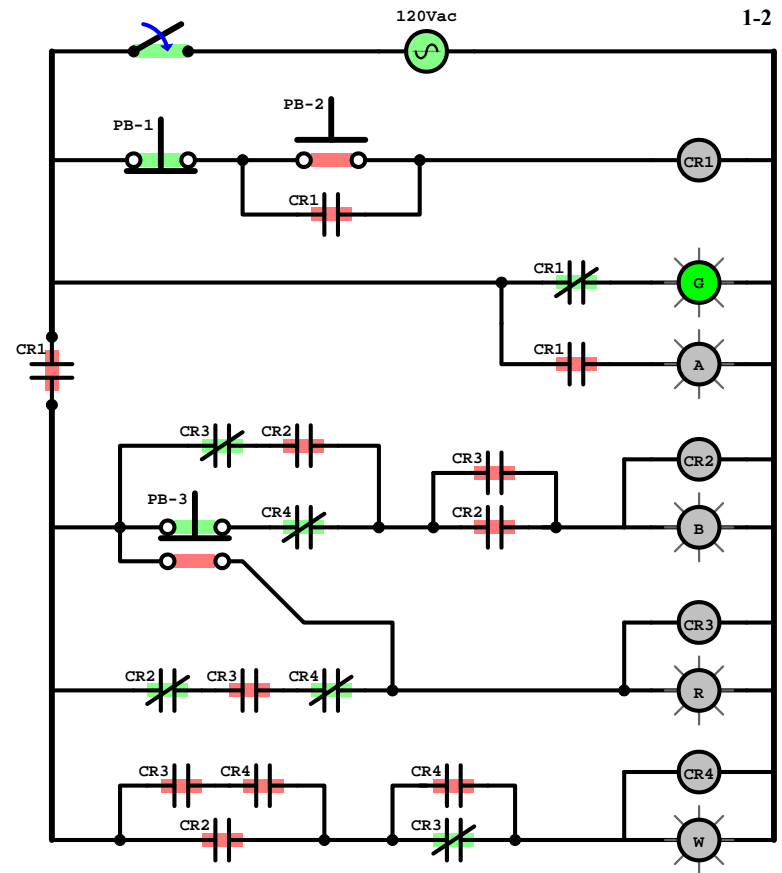
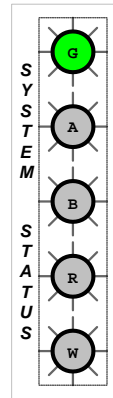




System status after the Power Switch is flipped ON:

On: Green

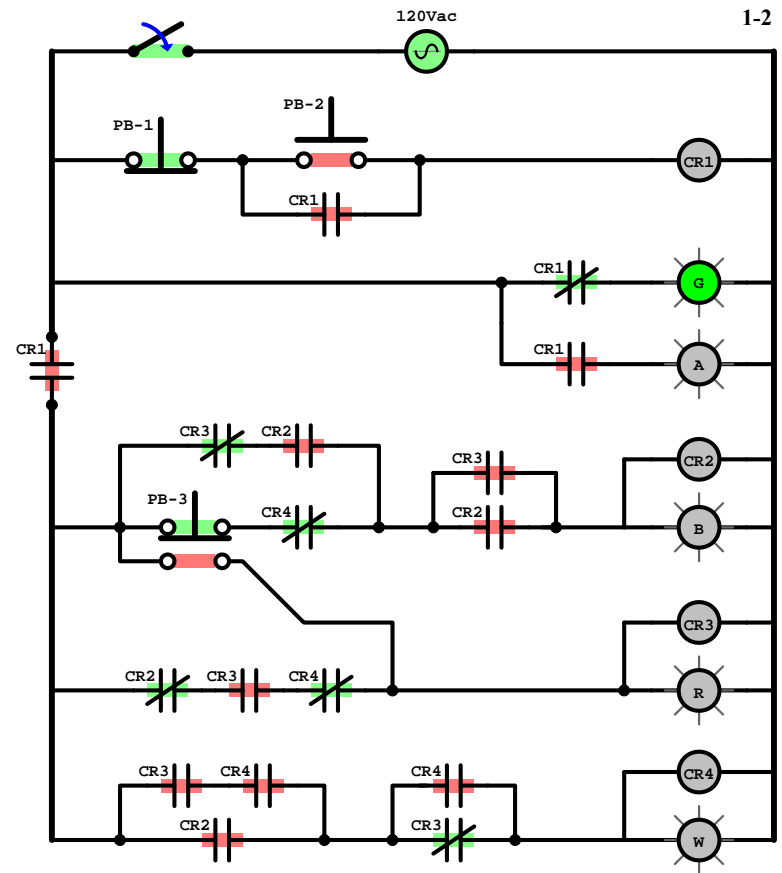
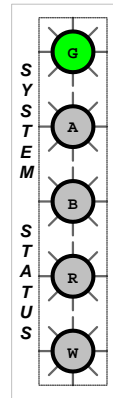
**Off: Amber
Blue
Red
White**





Step 2: PB-2 Pressed (and held in)

*Attempt to predict the
result before viewing the
next slides.*



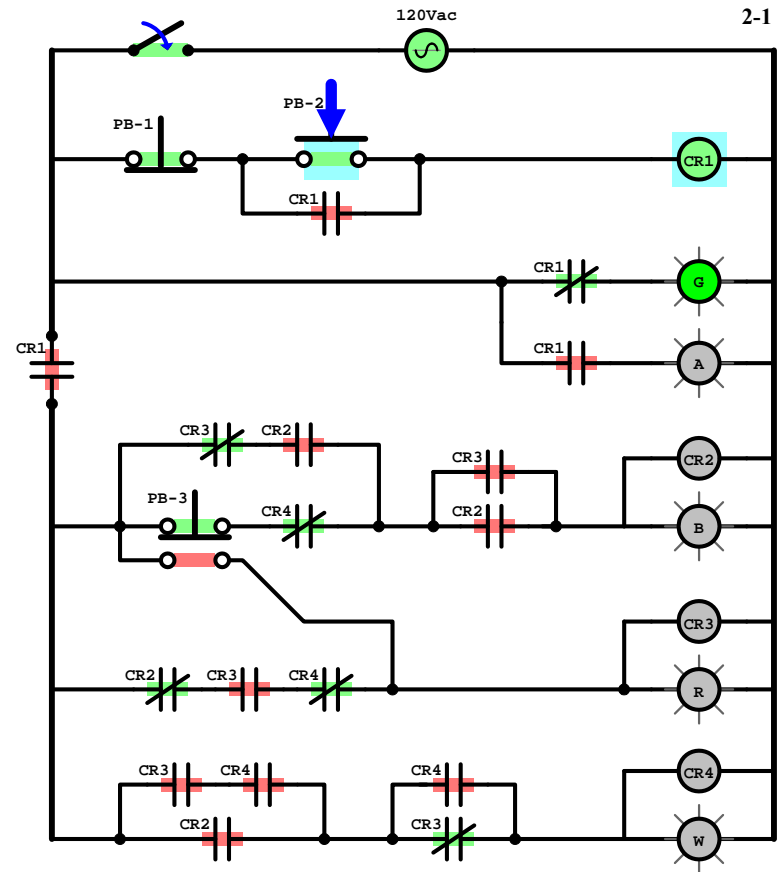
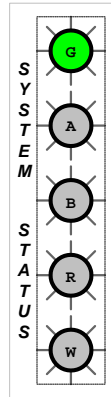


Step 2: PB-2 Pressed
(and held in)

Result: CR1 field coil
is energized...

The “...” denotes that there is a delay between the time when a field coil is (de)energized and the time that any additional events occur when its associated contacts actuate (drop-out).

I.e. – The CR1 field coil has been energized, but the CR1 contacts have yet to actuate; their actuation will be addressed in the next slide.





Step 2: PB-2 Pressed

(continued) (and held in)

Delay: After CR1 field coil is energized:

CR1 contacts change position

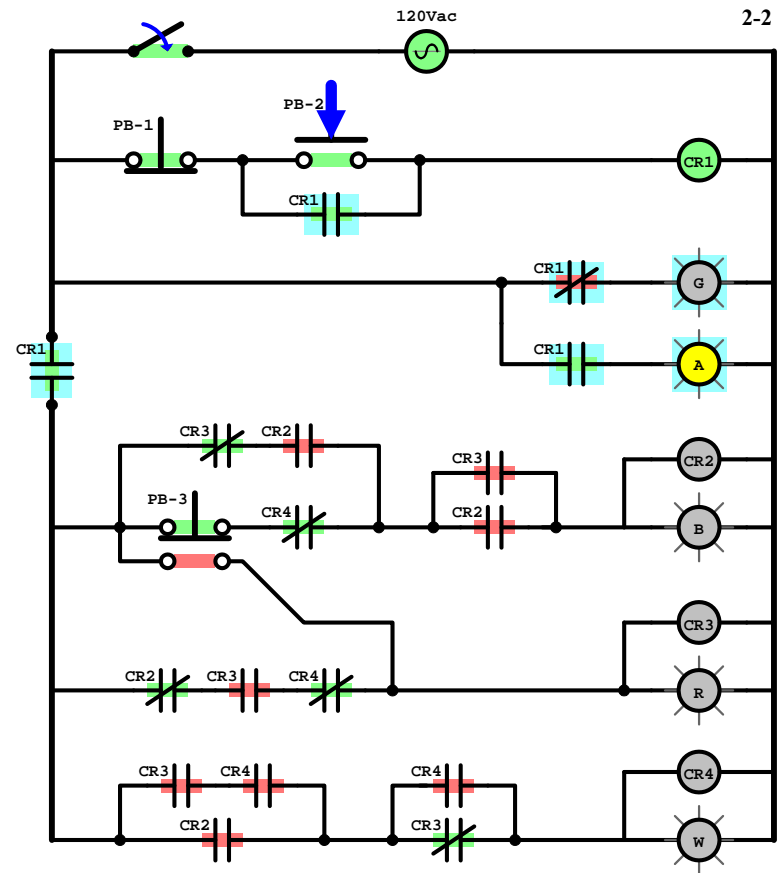
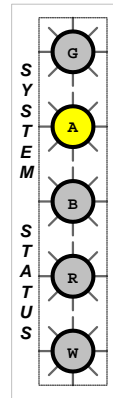
"which instantaneously causes"



Green Light OFF

Amber Light ON

No additional changes in the system

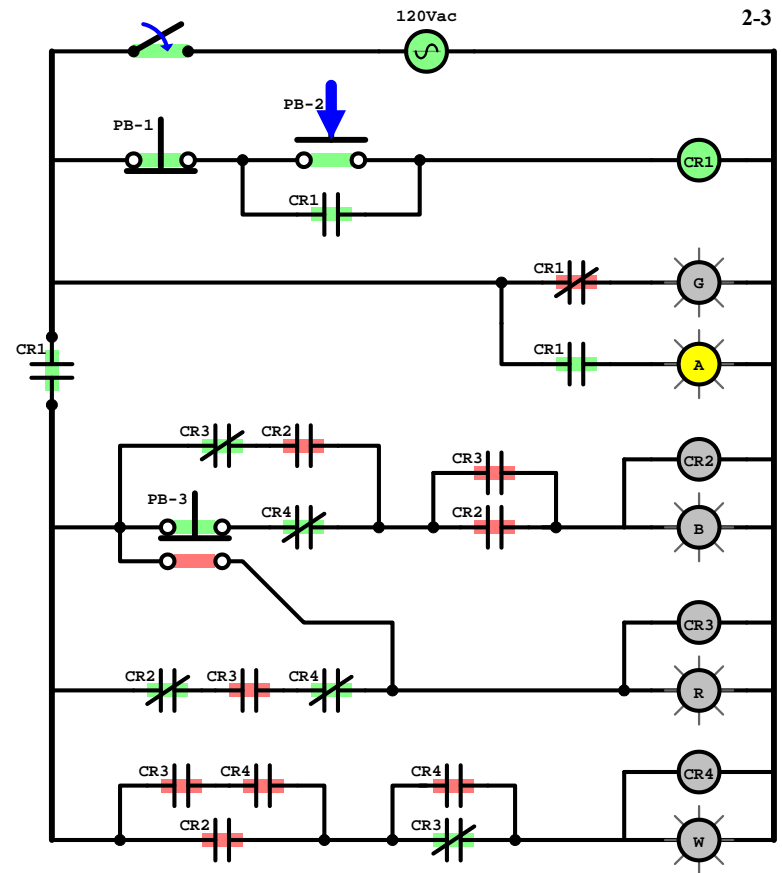
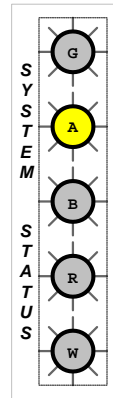




**System status after
PB-2 Pressed:**

On: Amber

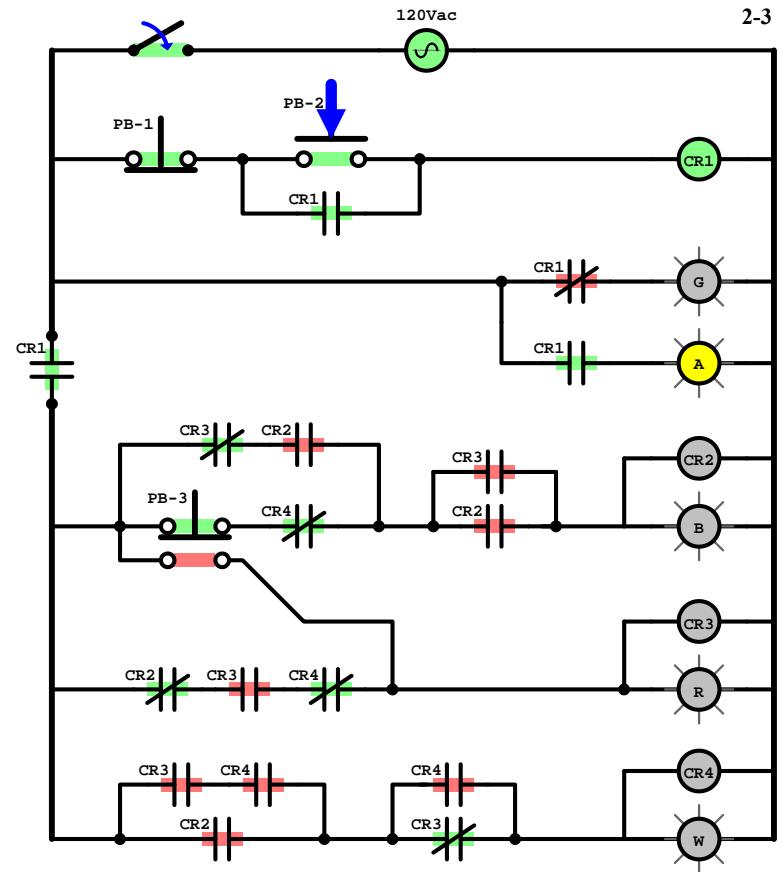
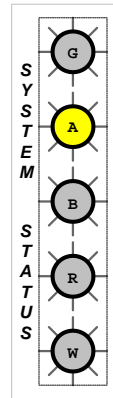
**Off: Green
Blue
Red
White**





Step 3: PB-2 Released

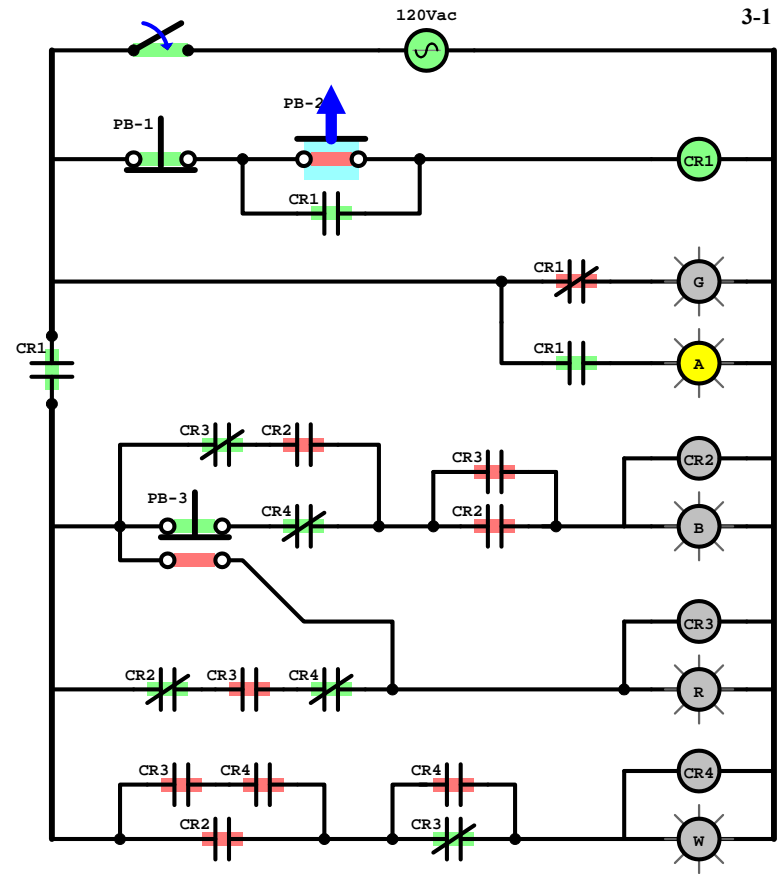
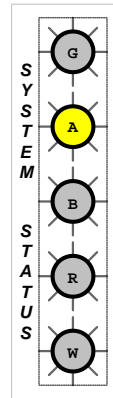
Attempt to predict the result before viewing the next slides.





Step 3: PB-2 Released

Result: No additional changes in the system

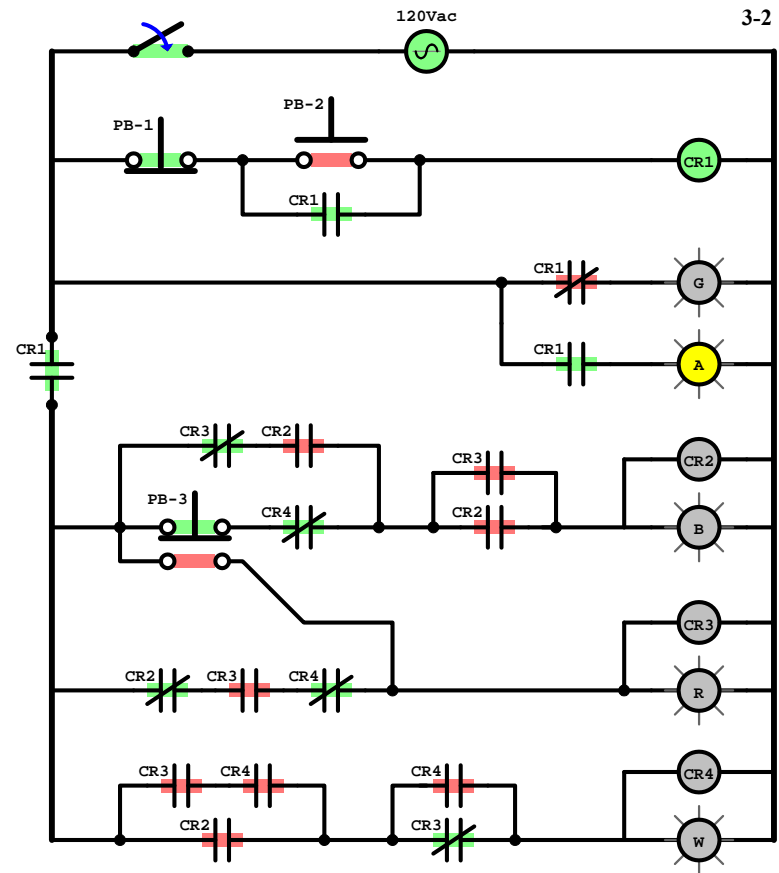
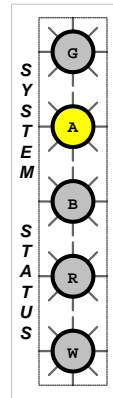




**System status after
PB-2 is Released:**

On: Amber

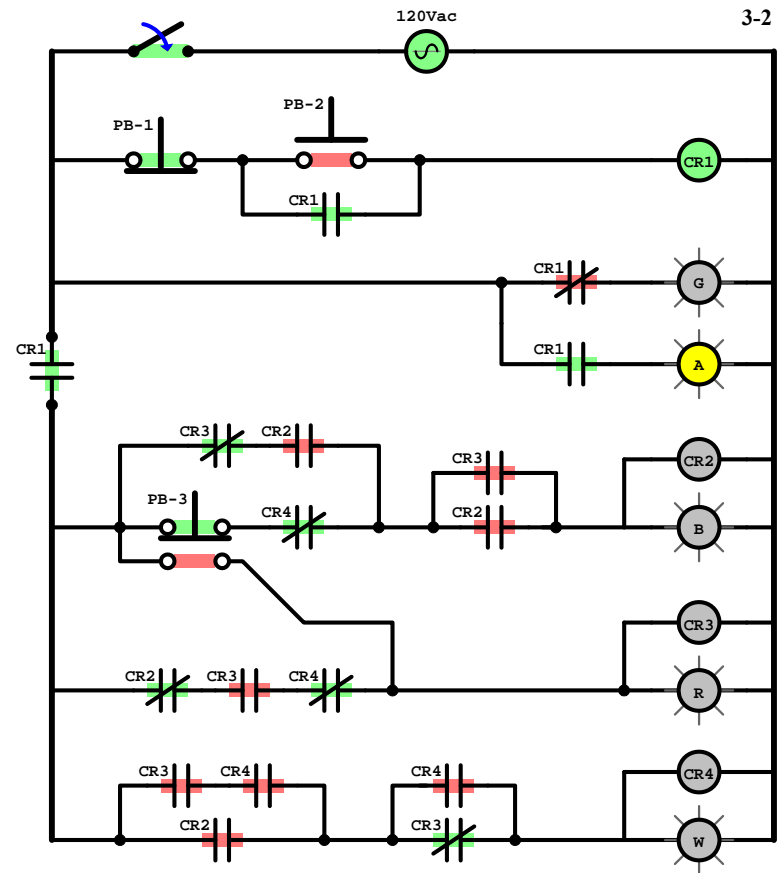
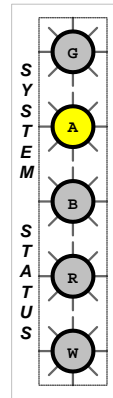
**Off: Green
Blue
Red
White**





Step 4: PB-3 Pressed (and held in)

*Attempt to predict the
result before viewing the
next slides.*



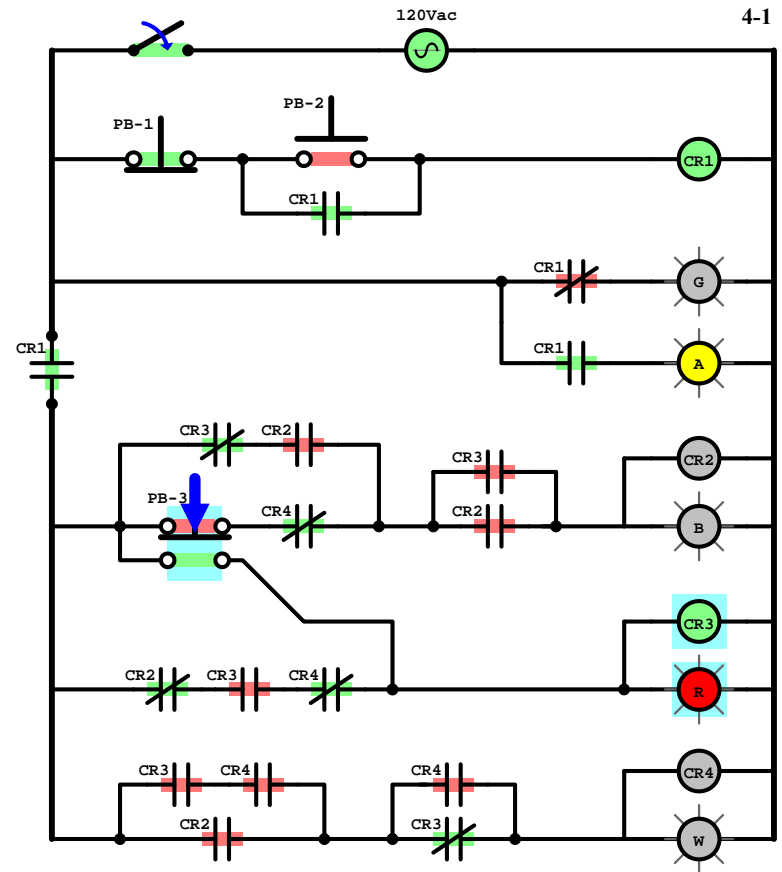
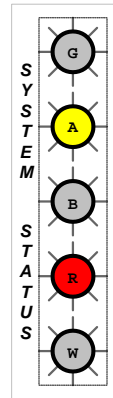


Step 4: PB-3 Pressed
(and held in)

Result: Red Light ON

"and simultaneously"

+
CR3 field coil
is energized...





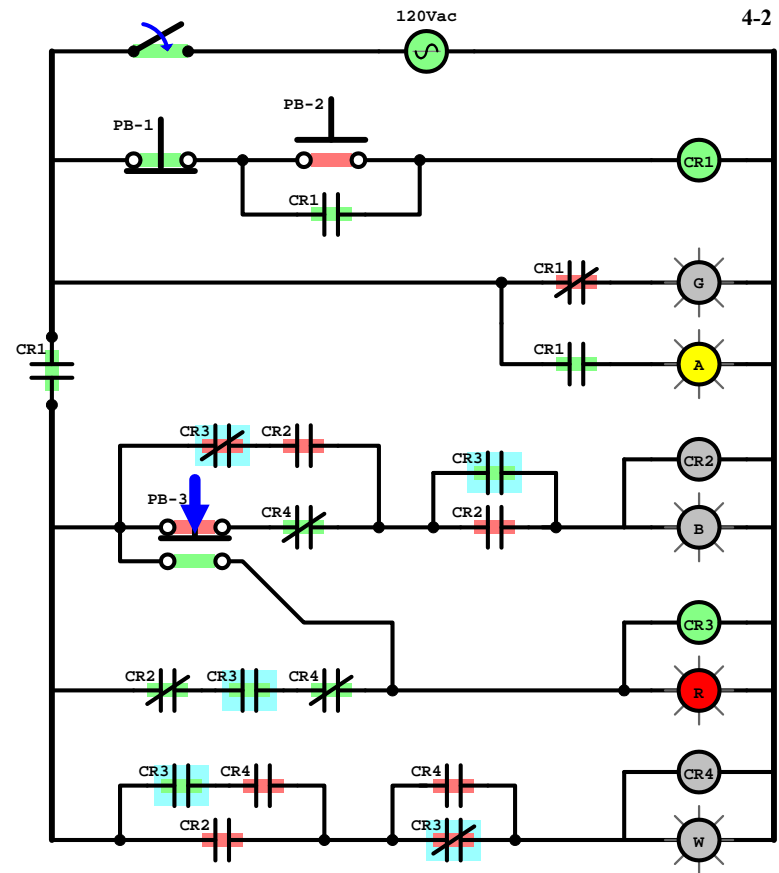
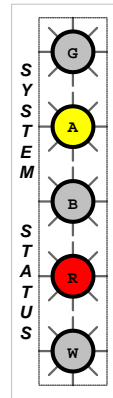
Step 4: PB-3 Pressed

(continued) (and held in)

Result: After CR3 field coil is energized:

CR3 contacts
change position

No additional
changes in
the system

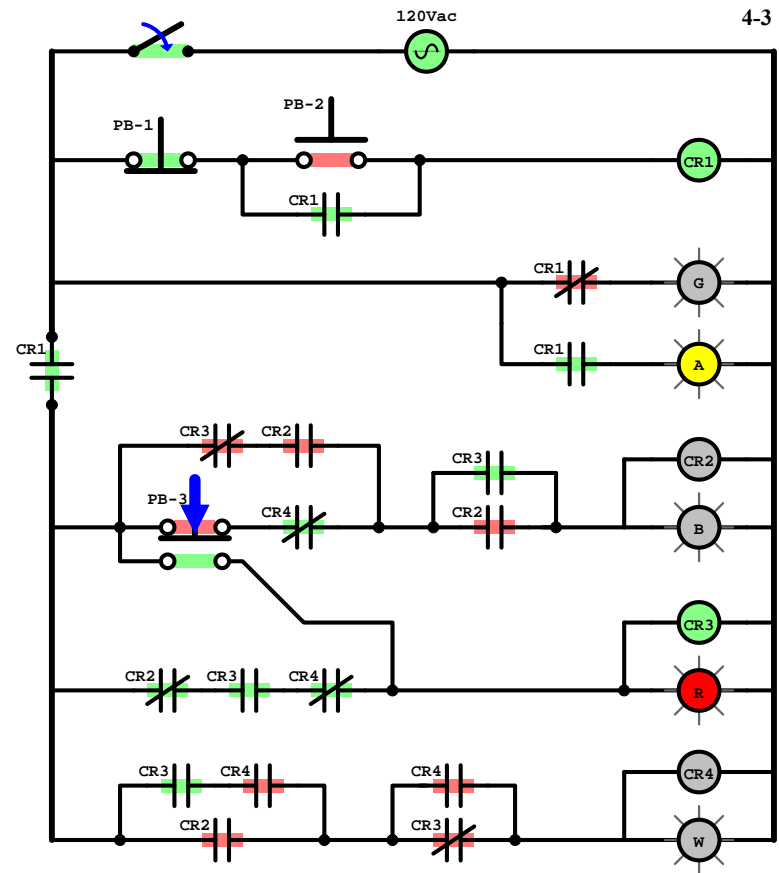
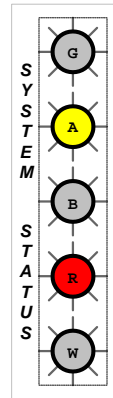




**System status after
PB-3 is Pressed:**

**On: Amber
Red**

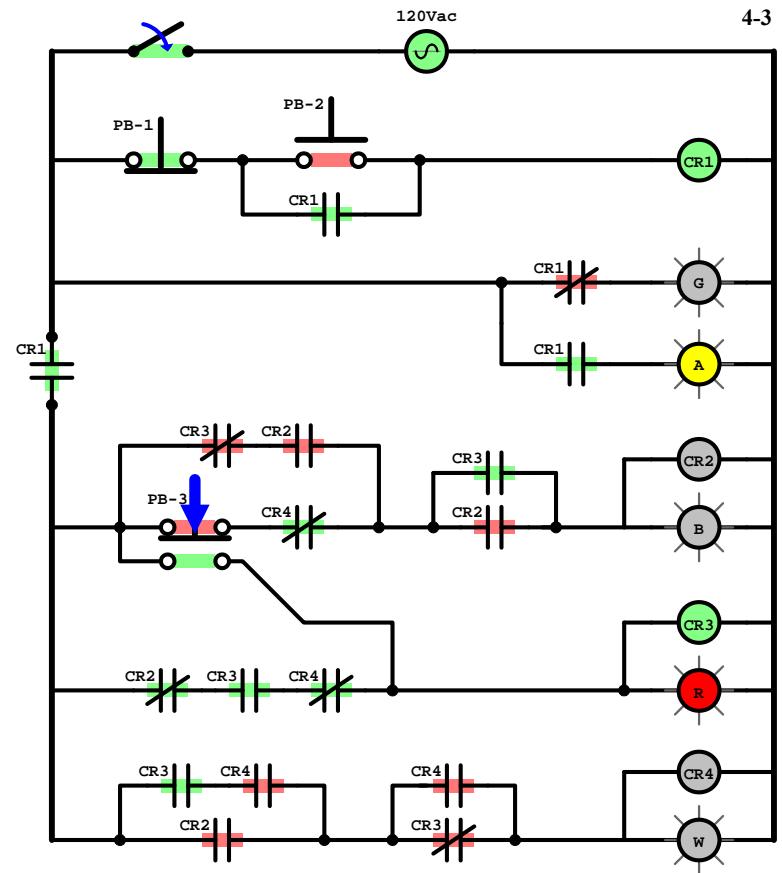
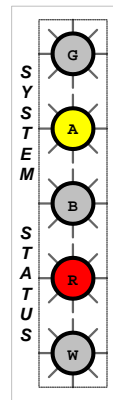
**Off: Green
Blue
White**





Step 5: PB-3 Released

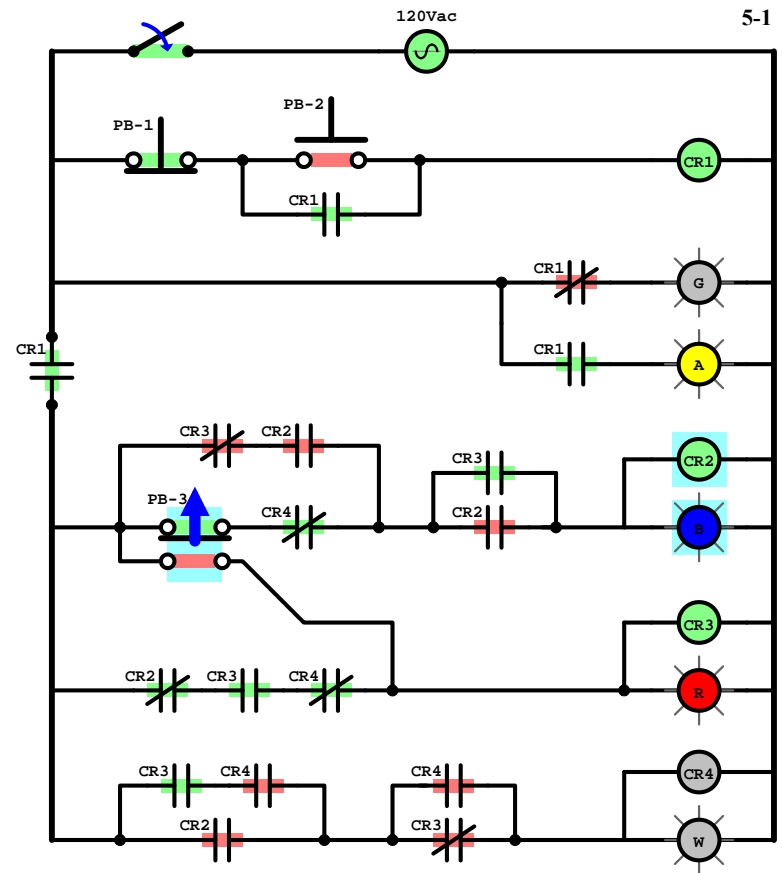
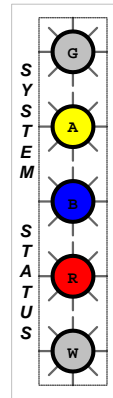
Attempt to predict the result before viewing the next slides.





Step 5: PB-3 Released

Result: Blue Light ON
+
CR2 field coil is energized...





Step 5: PB-3 Released

(continued)

Result: After CR2 field coil is energized:

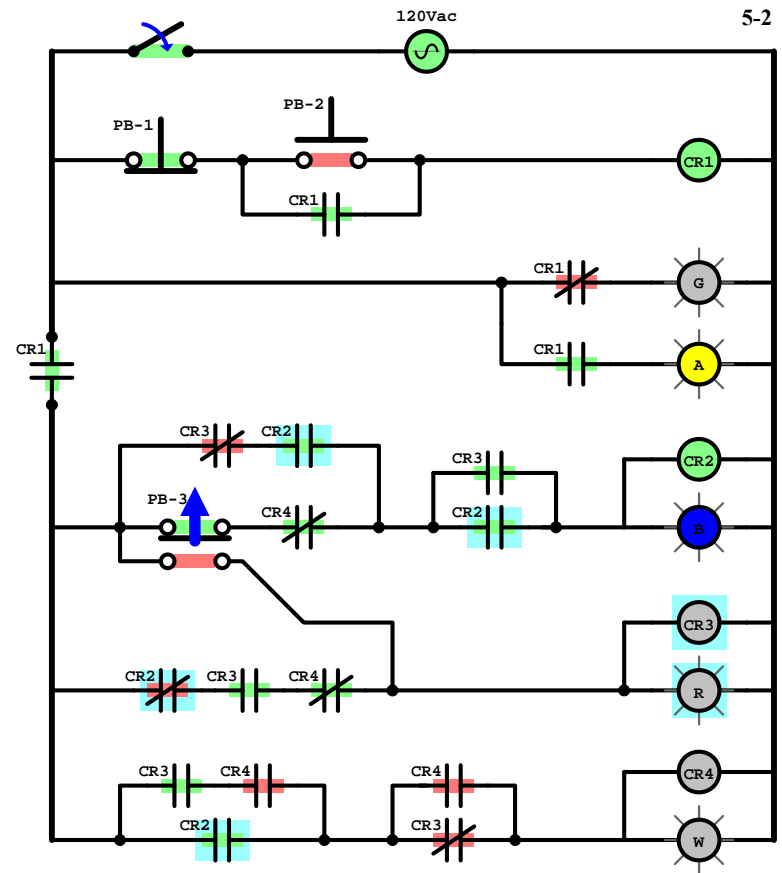
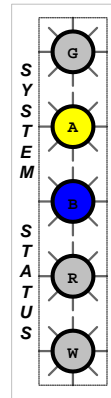
CR2 contacts
change position



Red Light OFF



CR3 field coil is de-energized...



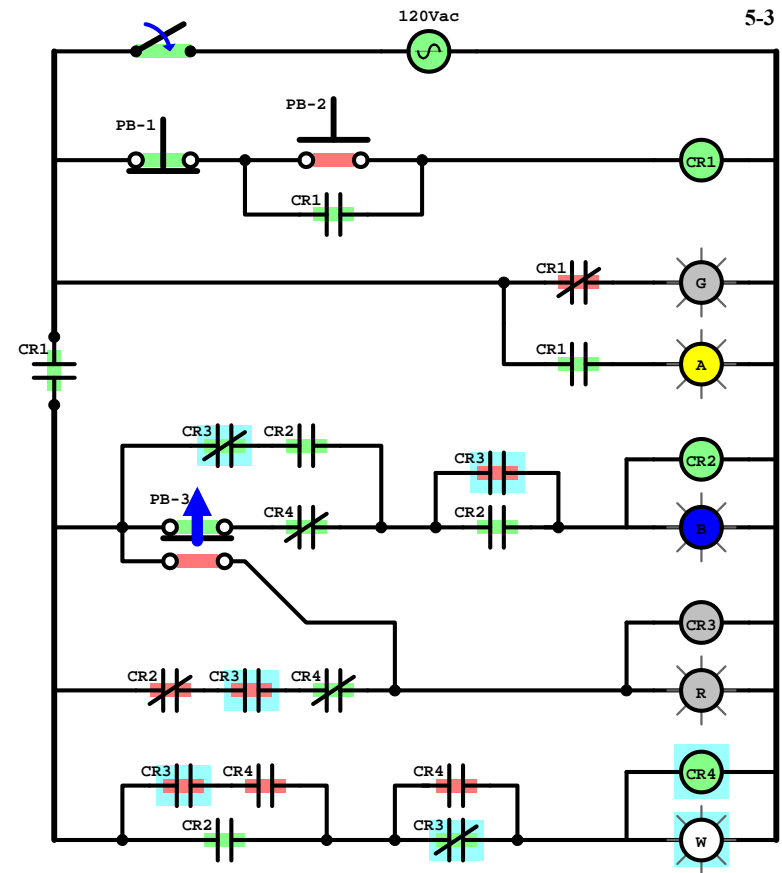
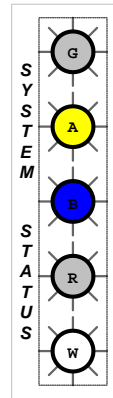


Step 5: PB-3 Released

(continued)

Result: After CR3 field coil is de-energized:

CR3 contacts
change position
↓
White Light ON
+
CR4 field coil is energized...





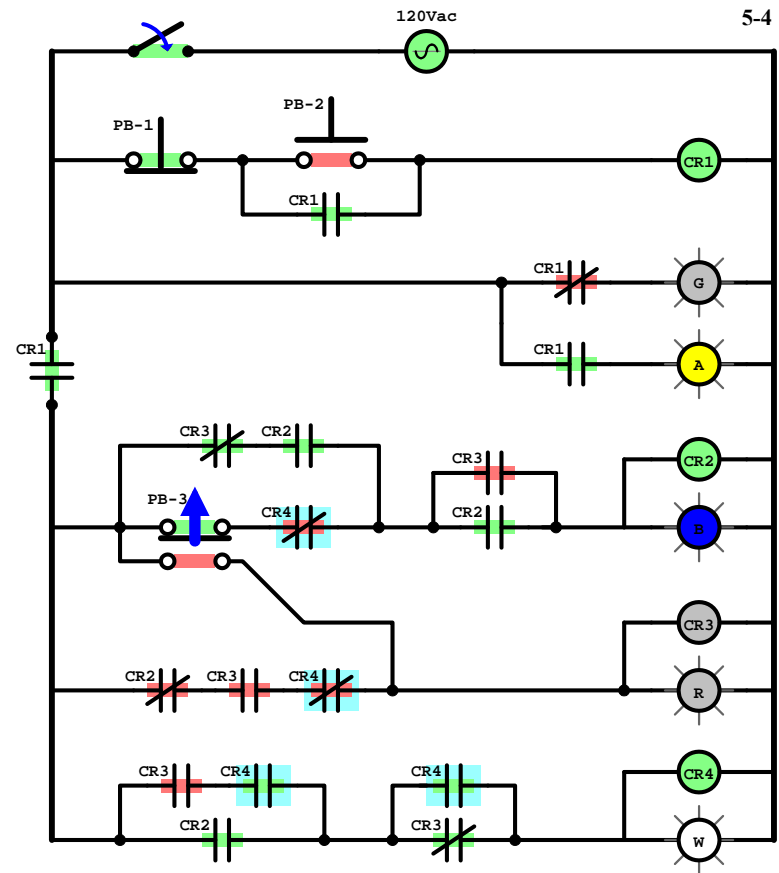
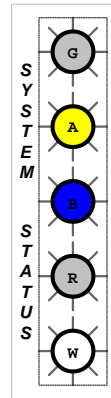
Step 5: PB-3 Released

(continued)

Result: After CR4 field coil is energized:

CR4 contacts
change position

No additional
changes in
the system

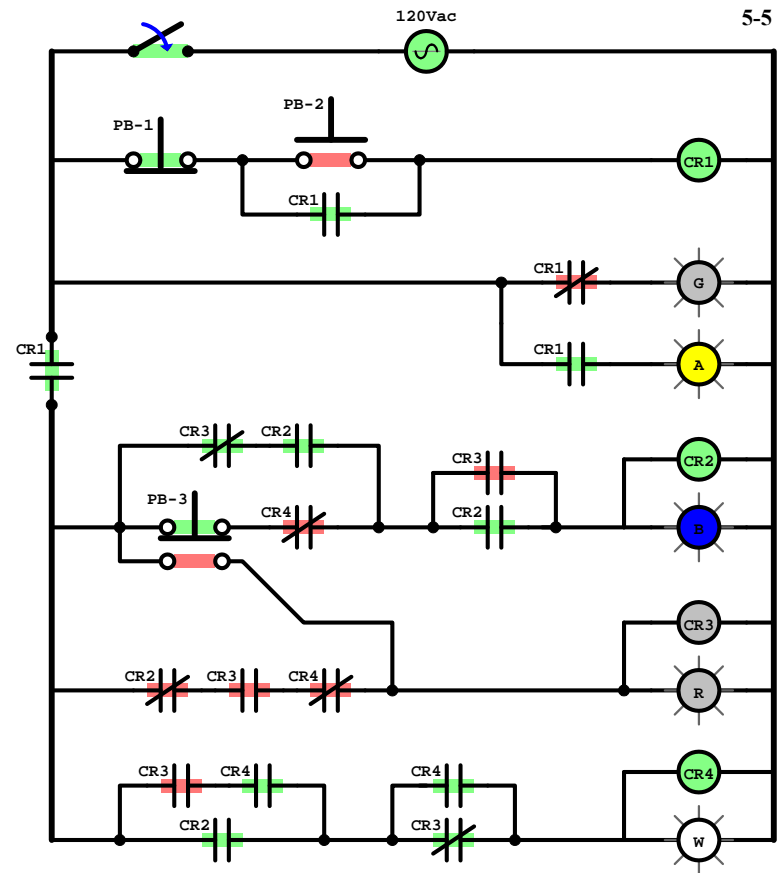
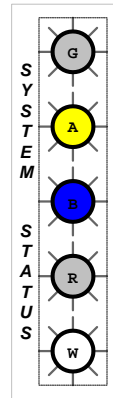




**System status after
PB-3 is Released:**

On: Amber
Blue
White

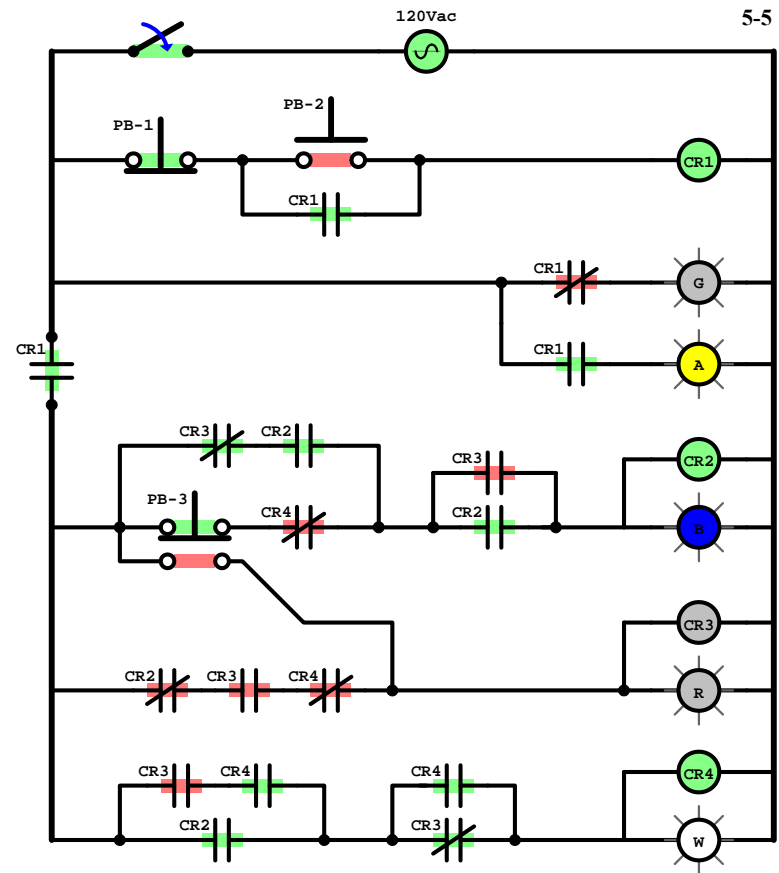
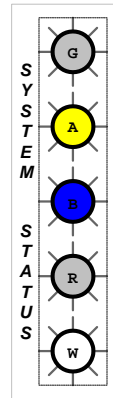
Off: Green
Red





Step 6: PB-3 Pressed (and held in 2nd time)

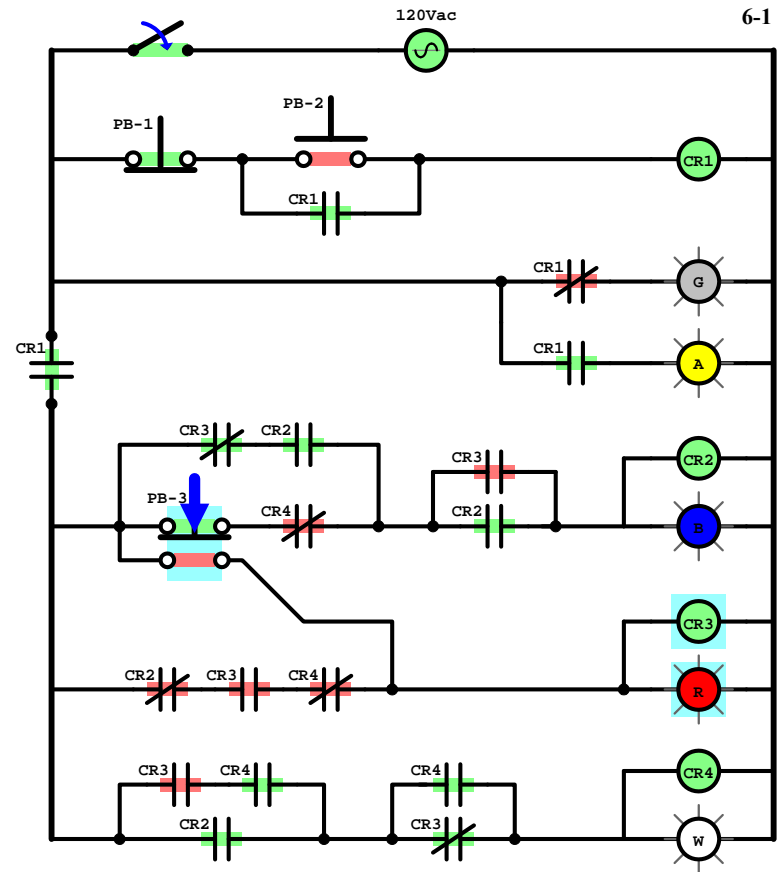
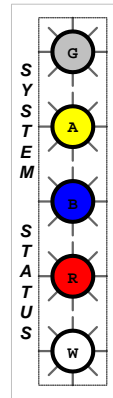
Attempt to predict the result before viewing the next slides.





Step 6: PB-3 Pressed
(and held in 2nd time)

Result: Red Light ON
+
CR3 field coil is energized...



6-1

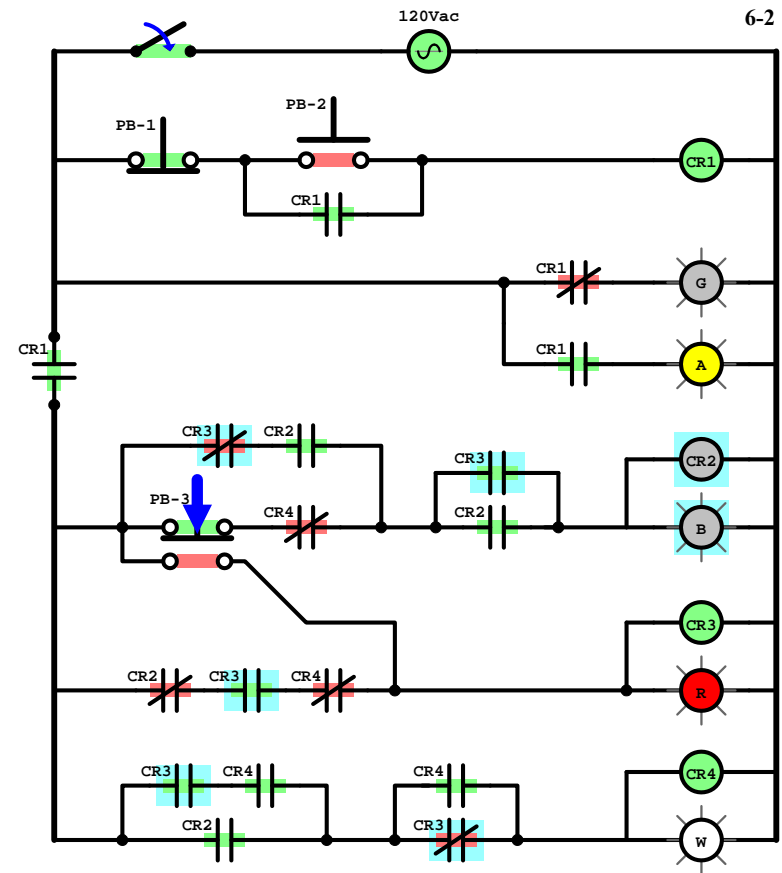
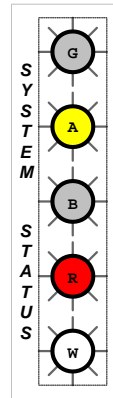


Step 6: PB-3 Pressed

(continued) (and held in 2nd time)

Result: After CR3 field coil is energized:

CR3 contacts
change position
↓
Blue Light OFF
+
CR2 field coil is de-energized...





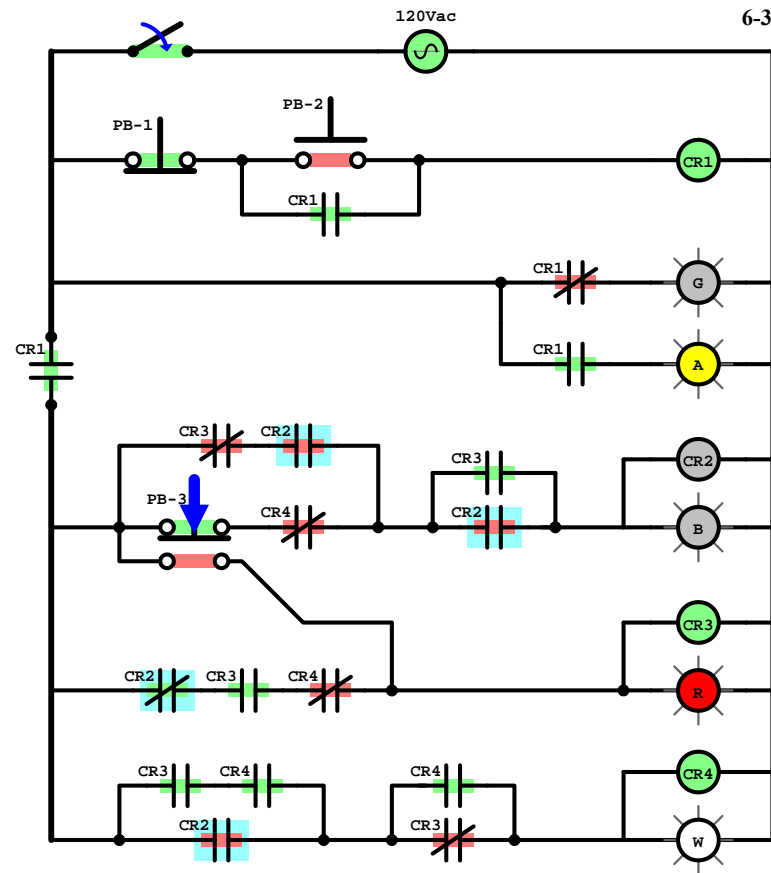
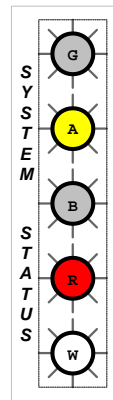
Step 6: PB-3 Pressed

(continued) (and held in 2nd time)

Result: After CR2 field coil is de-energized:

CR2 contacts
change position

No additional
changes in
the system

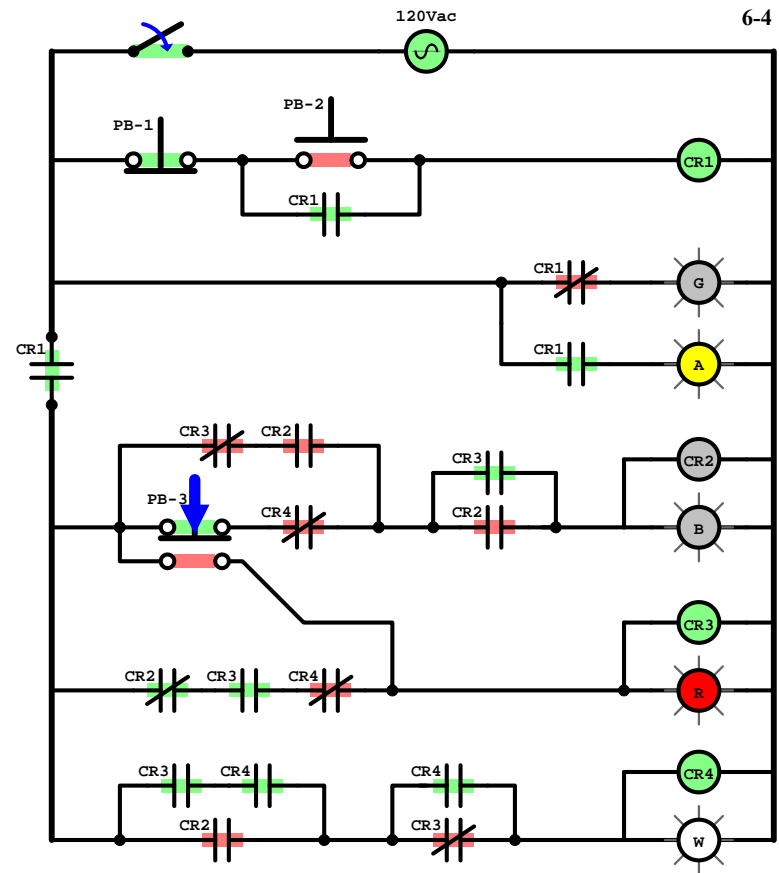
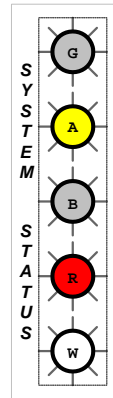




**System status after
PB-3 is Pressed:
(2nd time)**

**On: Amber
Red
White**

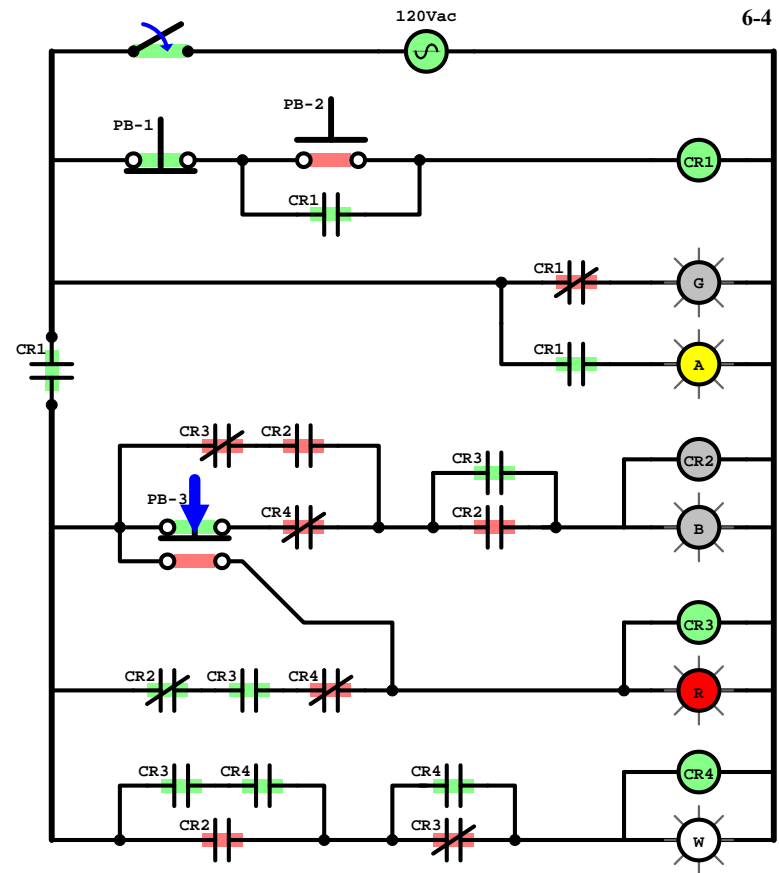
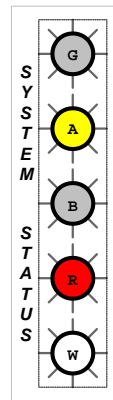
**Off: Green
Blue**





Step 7: PB-3 Released (2nd time)

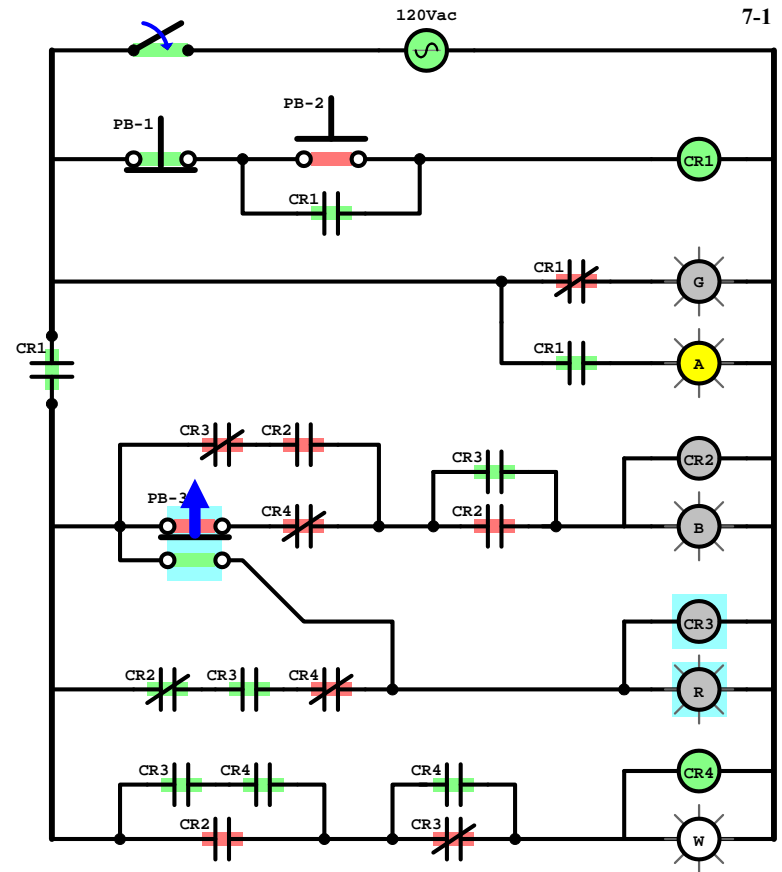
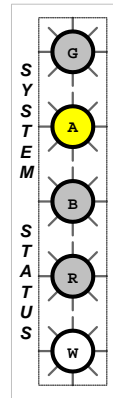
*Attempt to predict the
result before viewing the
next slides.*





Step 7: PB-3 Released
(2nd time)

Result: Red Light OFF
+
CR3 field coil is de-energized...



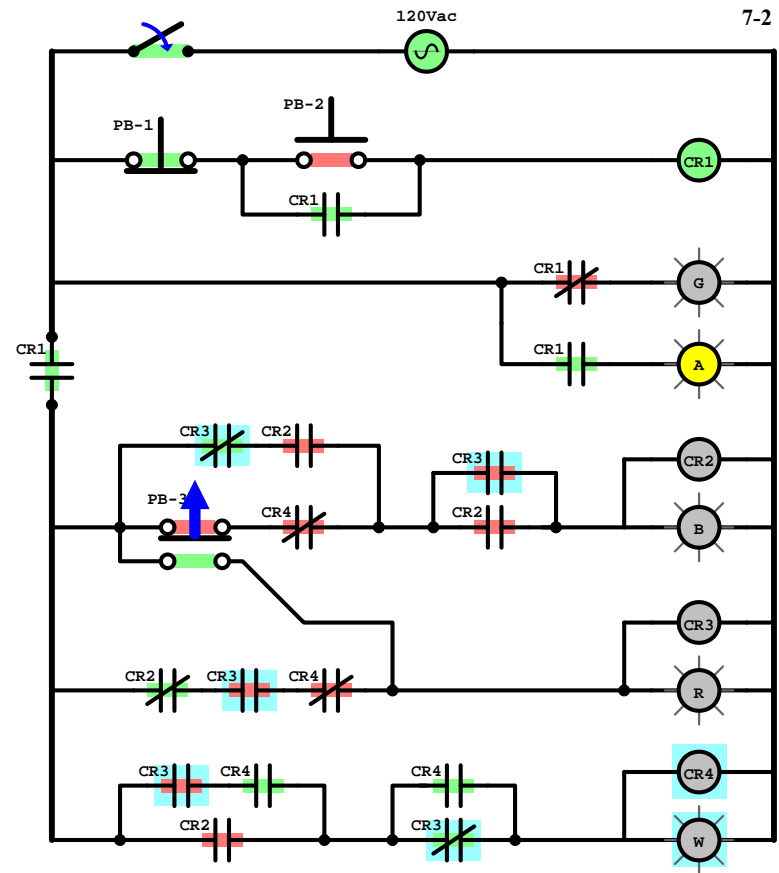
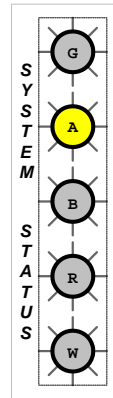


Step 7: PB-3 Released

(continued) (2nd time)

Result: After CR3 field coil is de-energized:

CR3 contacts
change position
↓
White Light OFF
+
CR4 field coil
is de-energized...





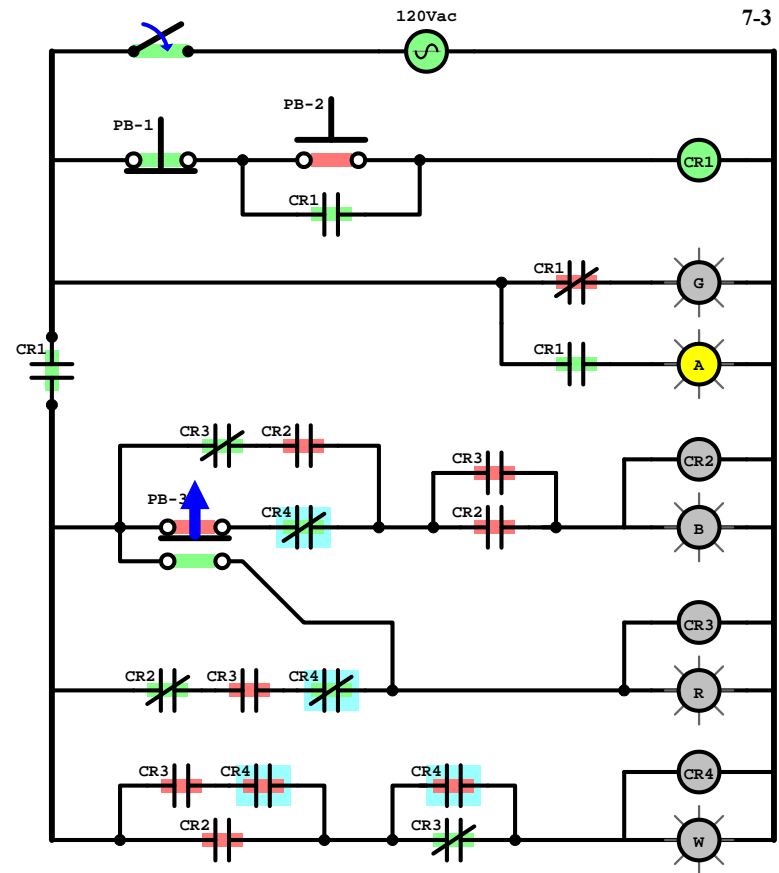
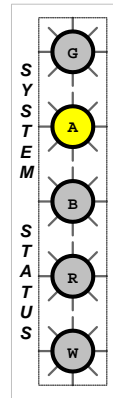
Step 7: PB-3 Released

(continued) (2nd time)

Result: After CR4 field coil is de-energized:

CR4 contacts
change position

No additional
changes in
the system

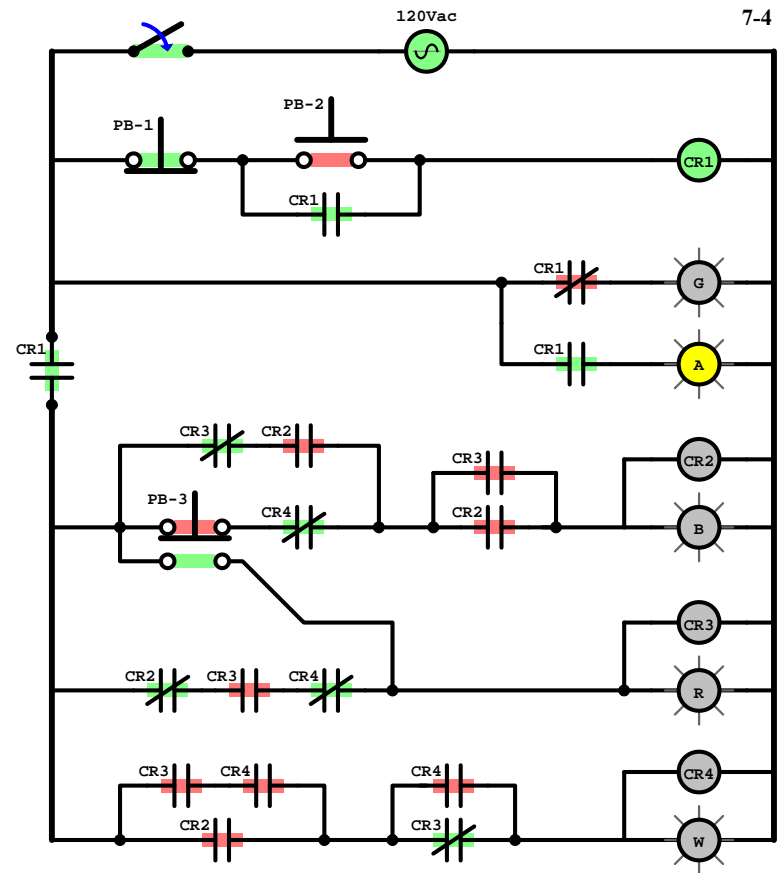
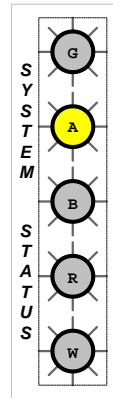




System status after
PB-3 is Released:
(2nd time)

On: Amber

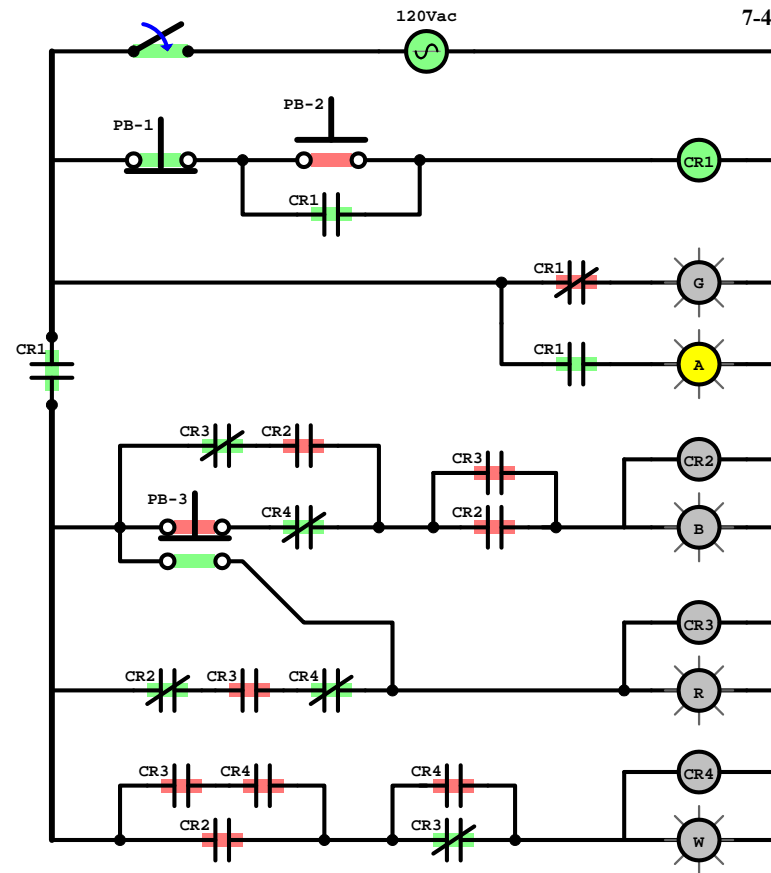
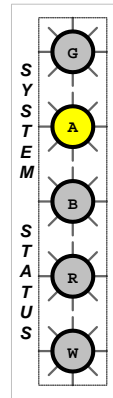
Off: Green
Blue
Red
White





Step 8: PB-1 Pressed (and held in)

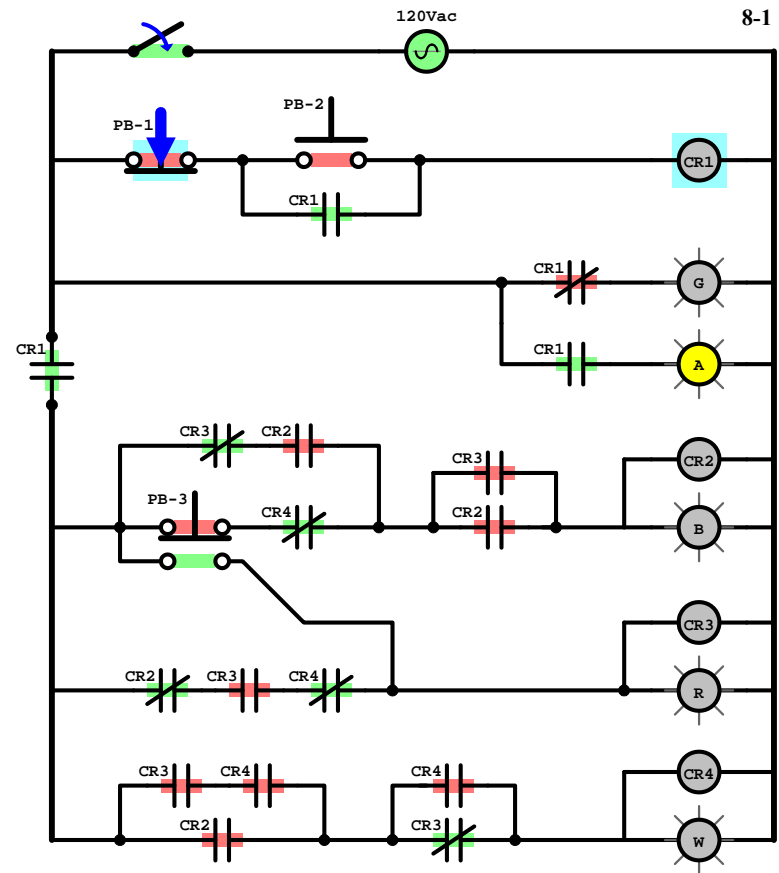
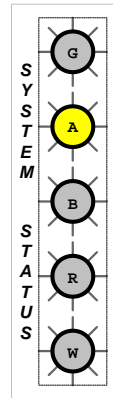
*Attempt to predict the
result before viewing the
next slides.*





Step 8: PB-1 Pressed
(and held in)

Result: CR1 field coil is de-energized...





Step 8: PB-1 Pressed

(continued) (and held in)

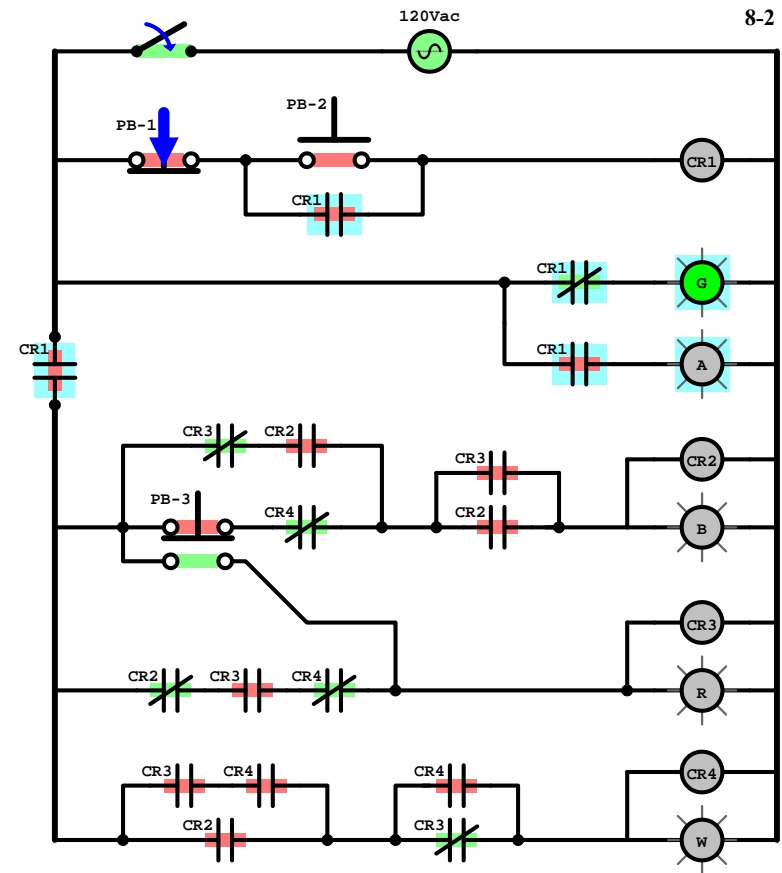
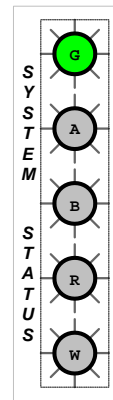
Result: After CR1 field coil is de-energized:

CR1 contacts
change position



Green Light ON
Amber Light OFF

No additional
changes in
the system



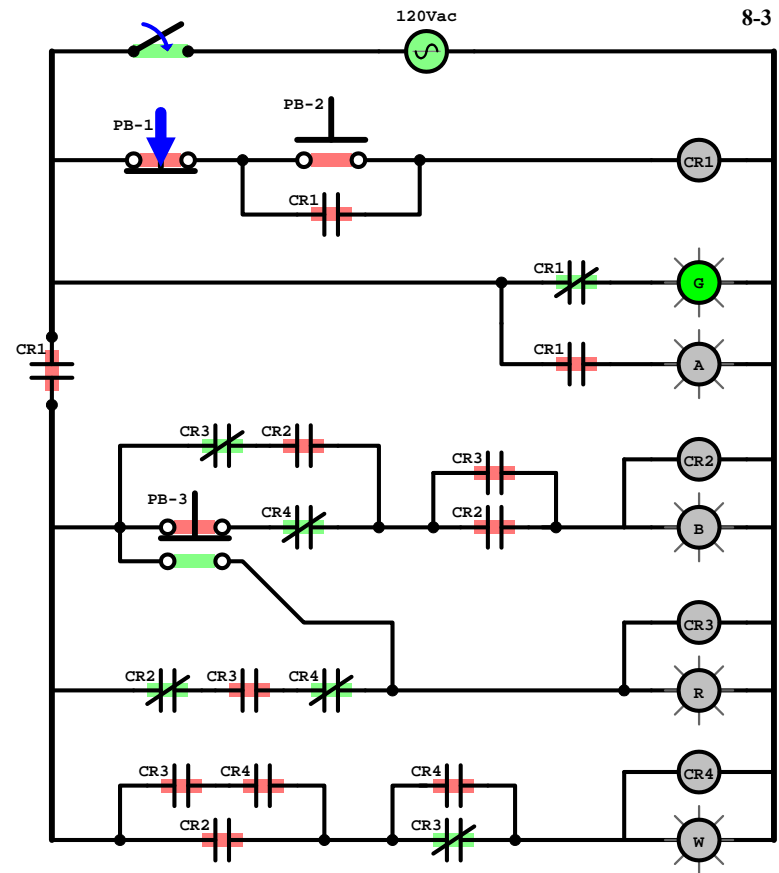
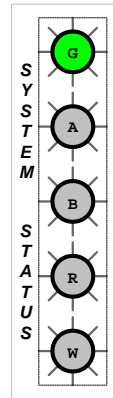
8-2



**System status after
PB-1 is Pressed:**

**On: Amber
Red**

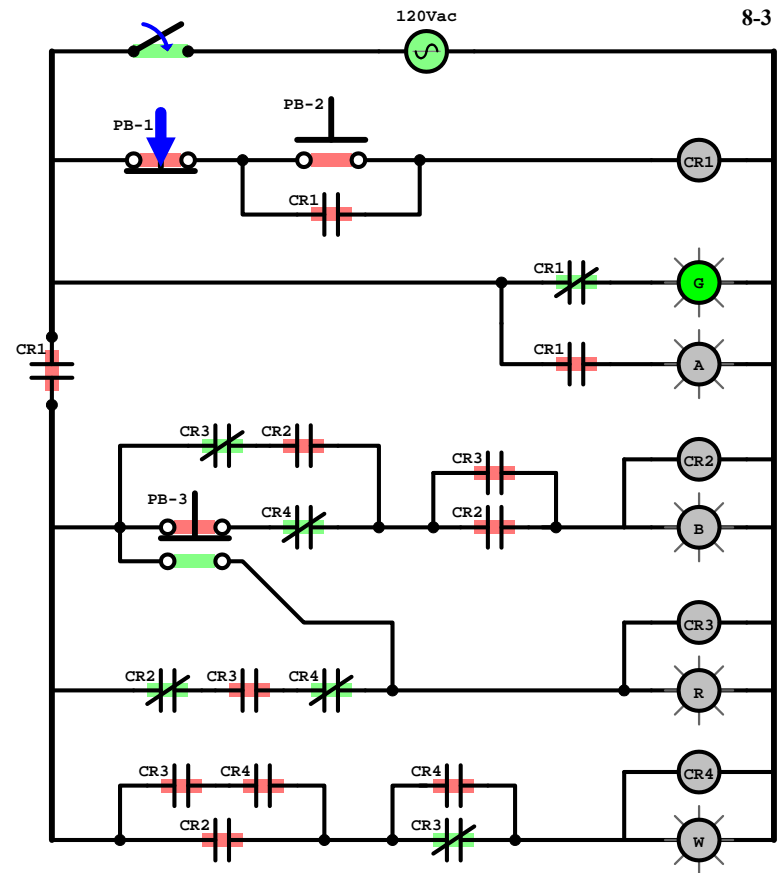
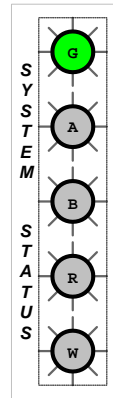
**Off: Green
Blue
White**





Step 9: PB-1 Released

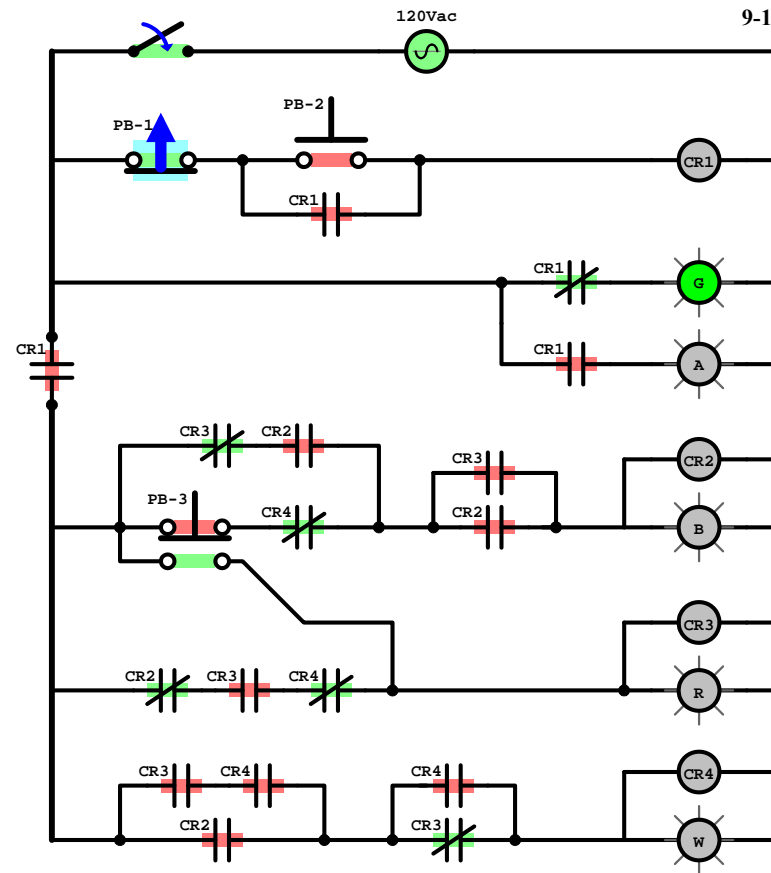
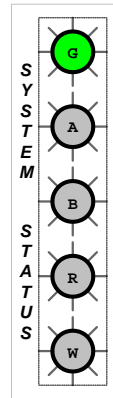
Attempt to predict the result before viewing the next slides.





Step 9: PB-1 Released

Result: No additional changes in the system

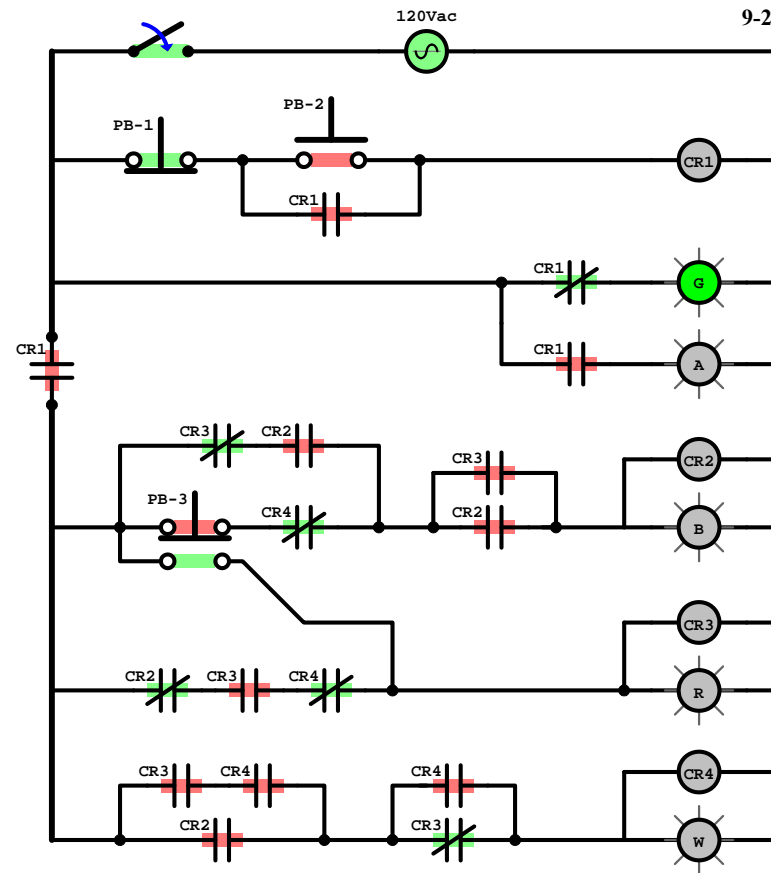
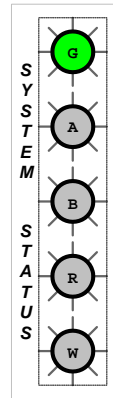




**System status after
PB-1 is Released:**

On: Green

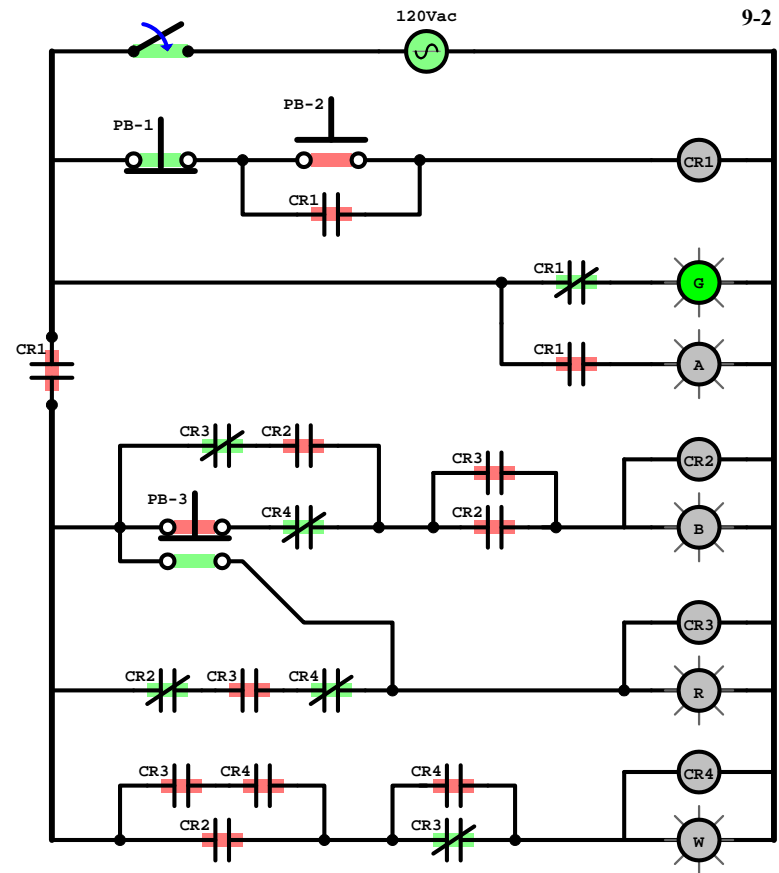
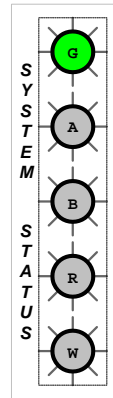
**Off: Amber
Blue
Red
White**





Step 10: Power Switch flipped OFF

*Attempt to predict the
result before viewing the
next slides.*

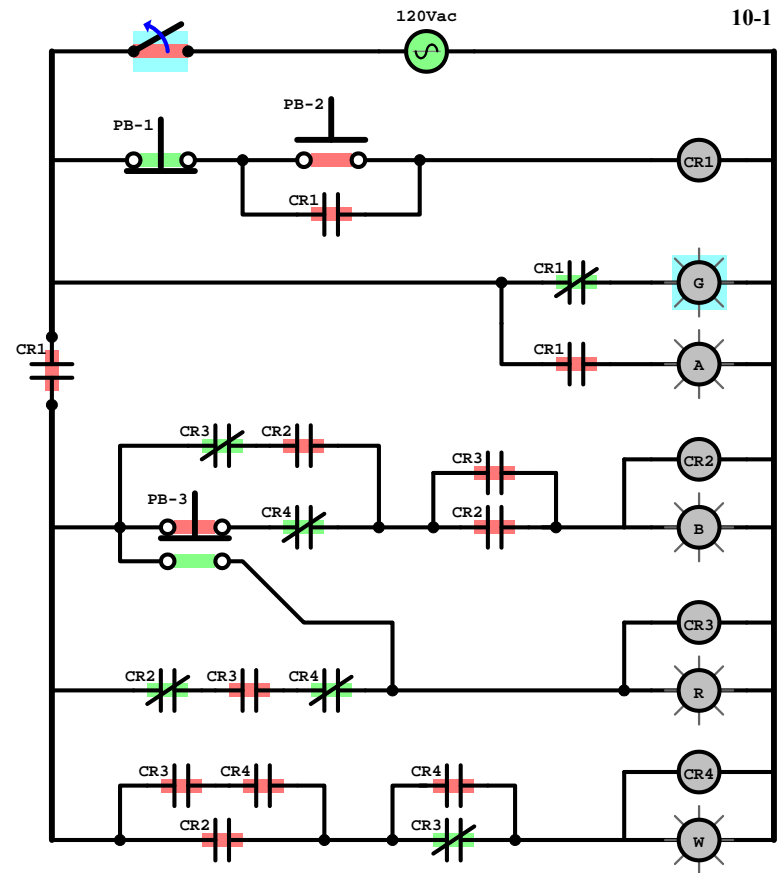
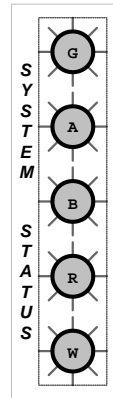




Step 10: Power Switch flipped OFF

Result: Green Light OFF

No additional changes in the system





System status after the power switch is flipped OFF:

On: None

**Off: Green
Amber
Blue
Red
White**

