UNIT 19

SHIFT REGISTERS

Objectives

Upon completion of this unit the student will be able to:

1. Describe the operation of a shift register.
2. Explain the application of a shift register.
3. Write a program using a shift register.
4. Enter a shift register program into the PLC.

Background

To understand a shift register it is necessary to understand a little about the working of the computer. A computer has many memory spaces in which it stores information. In a PLC these spaces are called addresses. Any given address stores the current state of the input, output or relay element associated with that address. An address holds one bit of information. This bit tells whether the element it represents is on or off. If the element represented by the bit is on, the bit is equal to 1, the element is off, the bit is equal to 0.

A shift register is made up of eight addresses or locations. a bit of information is placed into the end location and is moved (or shifted) one location at a time through the other seven locations, as illustrated in Figure 19-1. The addresses in the shift register must be sequential.

There are two bit shift instructions: Bit Shift Left (BSL) and Bit Shift Right (BSR). These are output instructions which load data into a bit array one time. The data is shifted through the array, then unloaded one bit at a time.

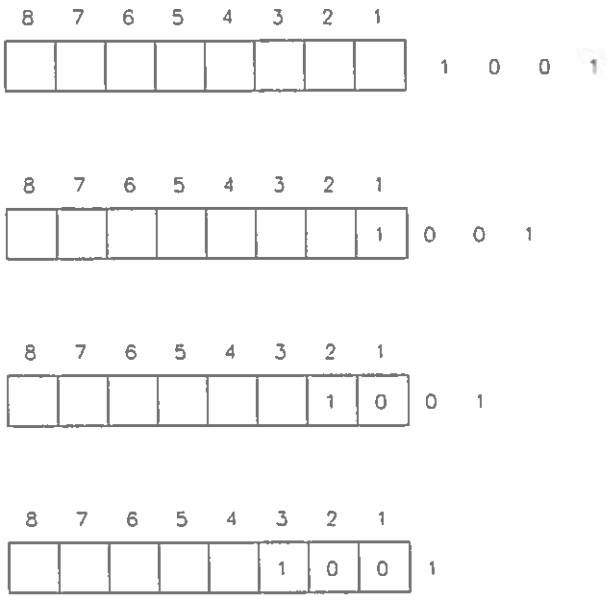


Figure 19-1
Operation of a Shift Register

After the information reaches the last address in the shift register it is shifted out and is lost (see Figure 19-2).

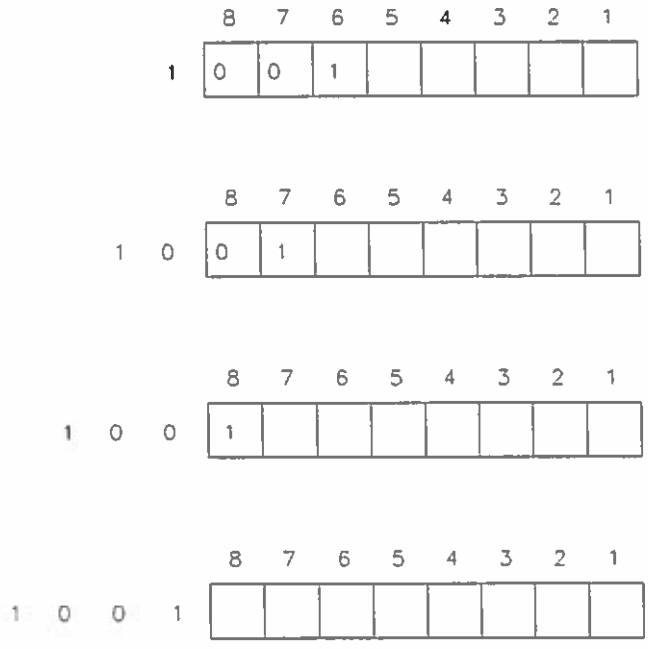


Figure 19-2
Data Leaving a Left Shift Register

Here the data enters the shift register on the right hand side at location 1. The data is shifted left, towards location 8. With the right shift register at location 8 and is shifted to the right, toward location 1. For Bit Shift Left, when the rung goes from FALSE to TRUE, the ENABLE bit (EN) is set and data is shifted to the right one bit at a time from high bit number to low bit number (descending order). The specified bit at the bit address is shifted into the last bit position. The first bit is shifted out of the array and stored in the UNLOAD bit (UL) in the status byte of the control element. The shift is completed in one scan.

Shift registers have many applications. In the industry they are used to keep track of where a part is located along a conveyor belt. An example of this would be a printing line with four printing machines (see Figure 19-3). Boxes come in on a conveyor belt in a random fashion. So, each machine does not always have a box in front of it. The conveyor increments once every 30 seconds, so every 30 seconds the PLC checks if there is a box waiting to come on the conveyor. When no box is present, the PLC puts a "0" into the shift register. If a box is waiting the PLC puts a "1" into the shift register.

The PLC then shifts the data one bit. At the same time it turns on the conveyor, Move all boxes and spaces to the next station, and shuts off the conveyor. If the register tells a machine it has a box in front of it, the machine prints the box. Otherwise the machine does not operate.

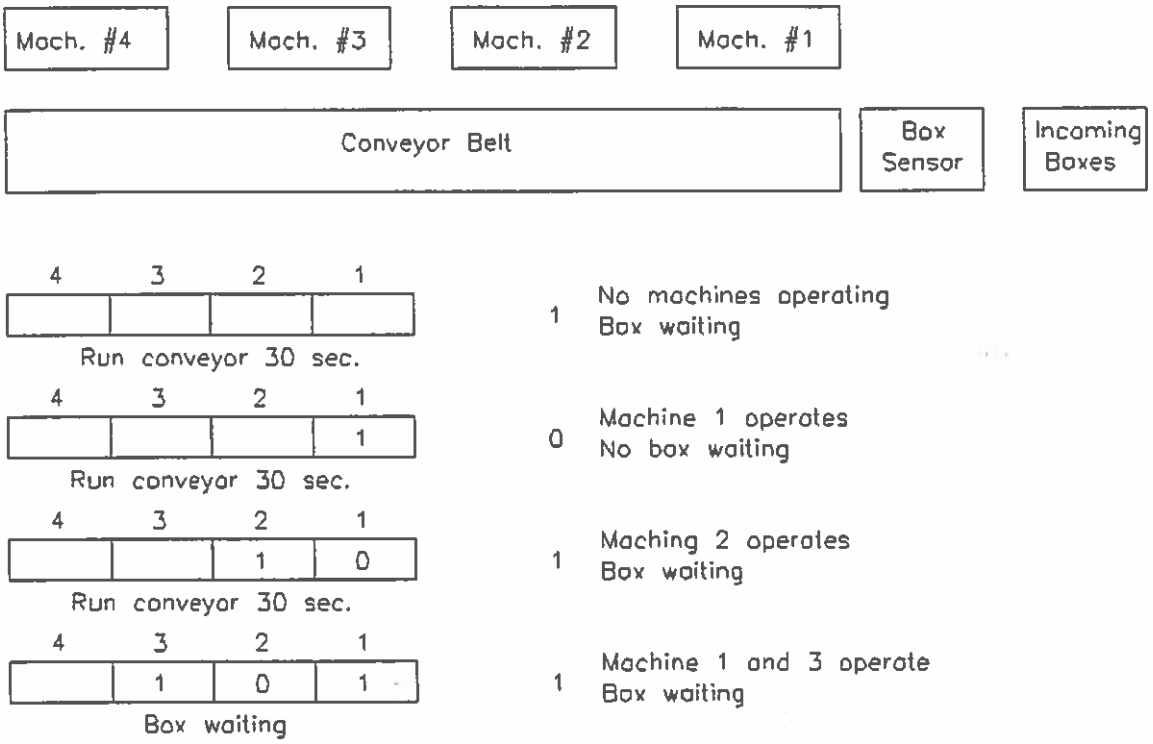


Figure 19-3
Printing Line Operation

Programming Keystrokes

Shift registers in the MicroLogix are made up of three components, a shift register, an event or time driven output sequencer, and a master control reset. The MCR is used to control when information can be shifted into the register. The sequencer is used to control the shift rate. Once an address has been used in a shift register, it cannot be used anywhere else in the program.

Entering Parameters

- File is the address of the bit array you want to manipulate. You must use the file indicator (#) in the bit array address.

- Control is the address of the control element that stores the status byte of the instruction, the size of the array (in number of bits), and the bit pointer (currently not used). Note that the control address should be used for any other instruction.

  The status byte of the control element is as follows.

  - EN The enable bit is set on a False-to-True transition of the rung and indicates the instruction is enabled.

  - DN The done bit, when set, indicates the bit array has shifted one position.

  - ER The Error bit, when set, indicates the instruction detected an error such as entering a negative number for the length or position. Avoid using the output bit when this bit is set.

  - UL The unload bit stores the status of the bit exited from the array each time instruction is enabled.

  - Reset occurs after bit shift when input conditions go FALSE, that us EN, DN and ER bits are reset. The instructions invalidates all bits beyond the last bit in the array up to the next boundary word.

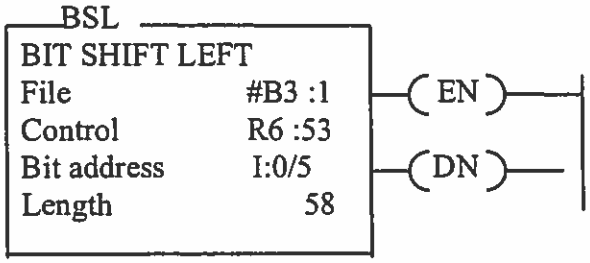
- Bit addresses is the address of the source bit. The status of this bit is inserted in either the first(lowest)bit portion (BSL) or last (highest)bit portion (BSR).

- Length (size of bit array) is the number of bits in the bit array, up to 2047 bits. A length value of 0 causes the input bit to be transferred to the UL bit.

Entering the instructions

Bit Shift Left (BSL)

Ladder representation:

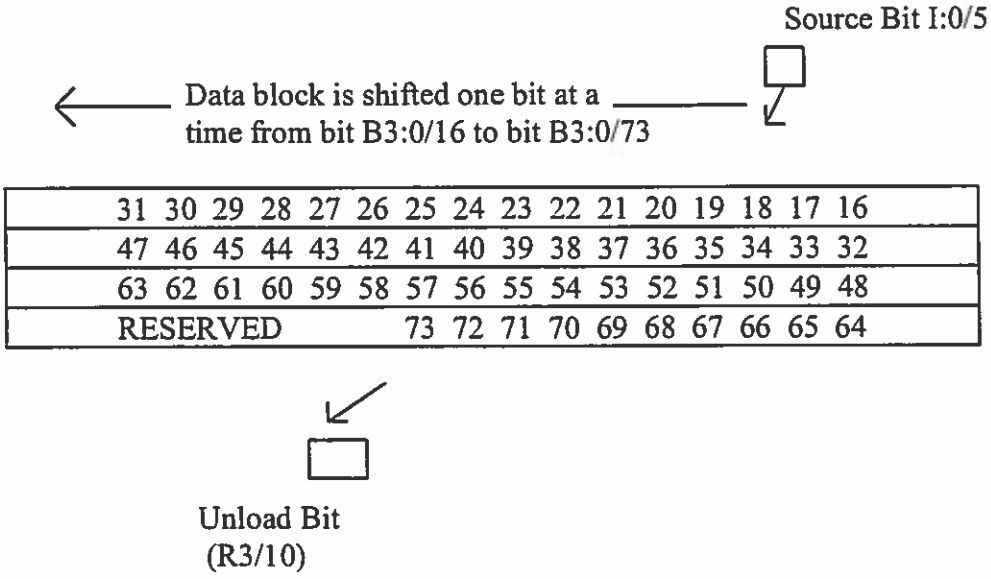


When the rung goes from false-to-true, the controller sets the enable bit (EN bit 15) and the data block is shifted to the left (to a higher bit number) one bit position. The specified bit at the bit address is shifted into the first bit position. The last bit is shifted out of the array and stored in the unload bit (UL bit 10). The shift is completed immediately.

To enter the function code, press

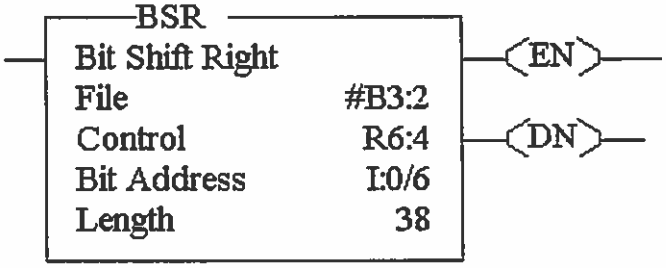
Bit Shift Left (BSL)

The Operation of the BSL instruction is shown in the figure below.



Bit Shift Right (BSR)

Ladder representation:

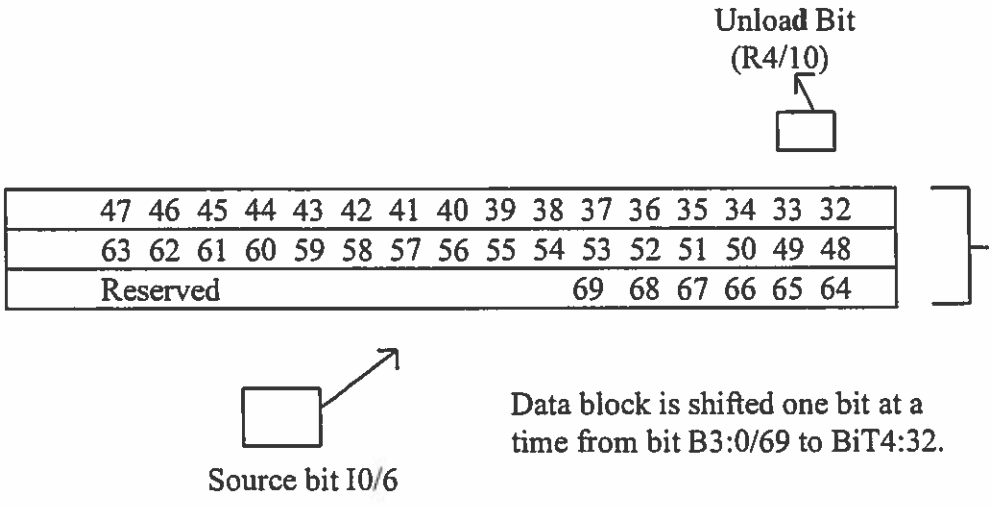


When the rung goes from false-to-true, the controller sets the enable bit (EN bit 15) and data block is shifted to the right (to a lower bit number) one bit position. The first bit is shifted out of the array and stored in the unload bit (UL bit 10). The shift is completed immediately.

To enter the function code, press:

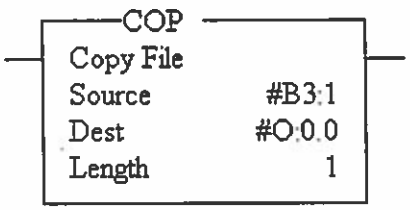
Bit Shift Right (BSR)

The operation of the BSR instruction is shown in the figure below.



File Copy Instruction

This is an output instruction that copies data from one location into another. The Destination file type determines the number of words the instruction transfers. For instance, if the destination file type is counter and the source file type is integer, three integer words will be transferred for each element in the counter type file. It uses no status bits. If an enable bit is needed, a parallel output using a storage address can be programmed. The below figure illustrates the format of a COPY instruction.



COP instruction

To enter the function code, press:

File Copy (COP)

File Copy instruction parameters include:

1. **Source:** This is the address of the file to be copied. The file indicator # must be useful in the address.

2. **Dest:** The destination starting address where the instruction stores the copy. The file indicator # must be used in the address.

3. **Length:** The number of elements in the file to be copied. If the destination file type is 3 words per element, a maximum length of 42 can be specified. If the
destination file type is 1 word per element, maximum length of 128 can be specified.

All elements are copied from the specified source file into the specified destination file each scan the rung is TRUE. Elements are copied in ascending order with no transformation of data. They are copied up to the specified number (length) or until the last element of the destination is reached, which occurs first.

If the destination is a timer, counter, or control file, the source words corresponding to the status words of the destination file must contain zeros. The file copy instruction will not write over a file boundary at the destination; therefore the starting address and length of the data block to be copied must be accurately specified or an error will be declared.

EXPERIMENT

Purpose

To program and operate an event and a time driven shift register.

Procedure

1. Make all common connections in Table 19-1.

Switch	Input	Light	Output
0	I:0/0	0	O:0/0
1	I:0/2	1	O:0/1
5	I:0/4	2	O:0/2
-	-	3	O:0/3
-	-	4	O:0/4
-	-	5	O:0/5

Table 19-1
Connections for Procedure

2. Enter the shift register program given in Figure 19-4. This is an event driven shift register, so enter the appropriate sequencer data.

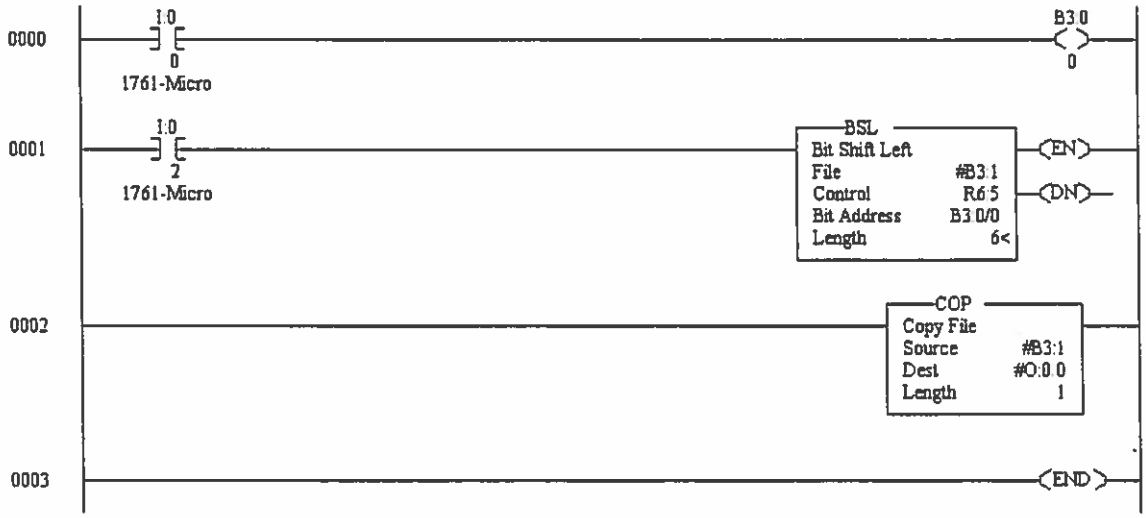


Figure 19-4
Program for Procedure

3. Press and hold switch 0. While switch 0 is held down, press and release switch 1 three times. Then release switch 0 and press switch 1 twice.

4. Observe the conditions of the output LEDs and the output devices.

   a. Describe what you see on the LEDs and lights.

   Output LEDs O:0/2, O:0/3 and O:0/4 are lit. Lights 2,3 and 4 are also it.

   b. Is this a shift left or shift right type register?

   Shift left type

   c. How do you know?

   Although the LEDs and lights shift the display of the data to the right, a shift register beginning with the lower address in its output group is always a shift left type.

   d. Which input sets the bit and which input shifts the bit?

   Input I:0/0 sets the bit. Input I:0/2 shifts the bit.

5. Press and hold switch 0. While holding switch 0, press switch (1) once. release switch 0 and press switch 1 again.

   a. How many bits of data have you entered into the shift register?

   7

b. What happens to the data when it is shifted to output element O/6 and O/7?

The data is available in internal relays O/6 and O/7 but it is not used in this program.

6. Press and hold switch 0. While switch 0 is held down, slowly press and release switch 1 four times. Observe the lights as you press and release switch 1. Release switch 0 and press switch 1 twice more.

a. How many bits of data have you entered into the shift register?

11

b. What happens to the data after it is shifted out of output element O/7?

The data leaves the shift register and CPU memory. So it is no longer available for use by the PLC.

7. Reverse the operation of the shift register by changing the shift register by changing the shift register address to O/7. Use editing functions as for any other element address change.

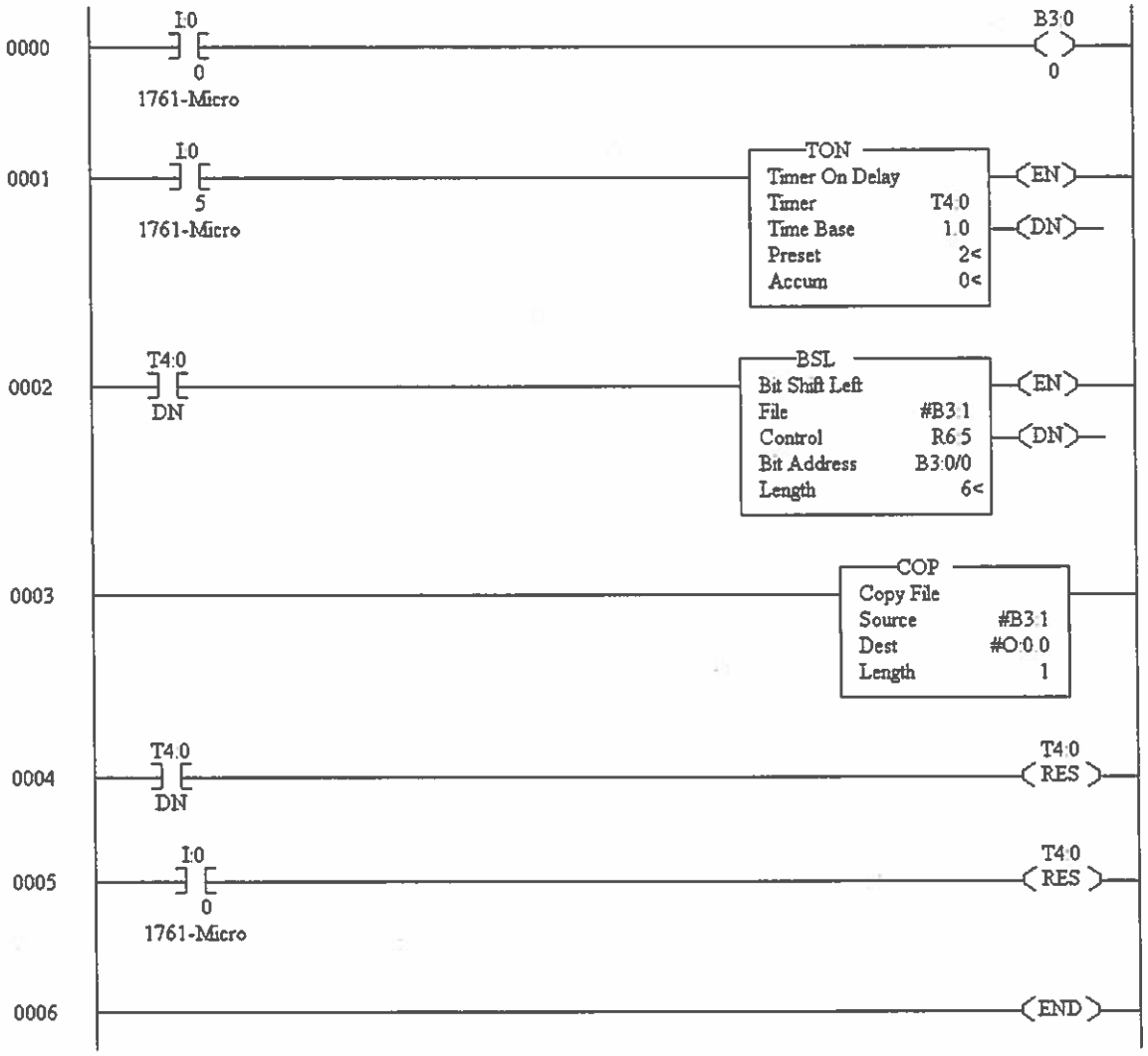
a. What type, left or right, is the new shift register?

Shift right type

b. How will the output devices operate now ?

The data will be displayed at output O:0/5 first. There will be no display during the first two shifts because output elements O/6 and O/7 do not control any output devices.

8. Enter and test the following program.



9. Press and hold switch 1 for varying lengths of time, up to 10 seconds or more; also, release switch 1 for varying lengths of time. Observe the lights as you do this.

a. What do you notice about the operation of a time driven shift register?

No matter how fast you press and release switch 0 the bits of data will always increment at 2 second intervals. If you can change the status of input I:0/0 in less than 2 seconds, the change will not be displayed in the shift register.

b. How does the operation of the time driven shift register compare to the operation of the event driven shift register?

In an event driven shift register, data is incremented only when the sequencer is activated for one scan element. In a time driven shift register, data is incremented automatically at the time interval preset in the sequencer.

10. When you have completed you experimentation with the time driven shift register, set aside your equipment. Then answer the Questions which follow.

Questions

1. What are the differences and similarities between left and right shift registers?

The shift registers use the same groups of output elements. They both enter data at the address designated in the ladder logic diagram. Both also lose all data at once it has left the designated group of addresses. A shift left type enters data at the lowest address in the group and exits data at the highest address. A shift right type enters at the highest address of the group and exits data at the lowest address.

2. What is a timer used for in a shift register program?

A timer is used to trigger a time driven shift register.

3. Explain the inputs controlling the BSL and BSR instructions ?

When the inputs controlling the BSR and BSL instructions are energized, the BSR/BSL reads the status of a specified bit. This status is shifted into the starting bit of the designated internal bit file. All other data in the file are shifted by one bit.

4. How is the COP instruction used in the example programs?

The copy instruction is used to copy data from the bit file to the output file.