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300 Series design and installation considerations

Logic rules

1. Fan in is one unit load.

2. Fan out is ten unit loads (TRUE AND NOT).

3. All unused inputs of OR gates are at logic 0 (broken wire protection). Therefore, they may be left floating or connected to +5.7 VDC.

4. All unused inputs of AND gates are at logic 0 (broken wire protection). Therefore, they must be connected to DC common or to one of the active inputs of the gate to satisfy all input conditions for a logic 1 output on the TRUE output.

Suggested practices

1. It is suggested that a clear shatterproof window be installed in the control panel door in front of the 300 Series racks. This makes it possible for operating and maintenance personnel to use the exclusive Numa-Logic pictorial display for isolating machine pilot device malfunctions without opening the cabinet door. This eliminates the need to disconnect the main power and shut down the machine.

2. It is common practice to use red wire for AC and blue wire for DC. Therefore, it is suggested that this color coding be used in wiring 300 Series panels.

3. When selecting rack sizes, it is suggested that 10% to 20% spare terminal and module capacity be provided to allow for changes and/or additions.

4. It is suggested that the electrical interlock feature be wired as described in Section 4 to provide either machine or individual mechanical function shut down, as desired, whenever a module is removed from its rack.

Mechanical considerations

1. Rack stacking is limited to seven high on Swing Racks and three high on Drop Racks as described in Section 4.

2. Different racks for different types of modules are not required. All Numa-Logic 300 Series modules fit any Numa-Logic 300 Series rack.

3. Each input and output circuit requires one terminal. For procedure on how to select the proper rack with sufficient terminal capacity, refer to Section 4.

Consideration of related components

Output loadings

The designer must consider the inrush as well as the steady state loadings of all output devices, such as starters and solenoids, to properly select the required Numa-Logic 300 Series output modules. Data on 300 Series module capabilities are given in Section 6 — Component Data.

Example:
A Westinghouse size one starter, catalog number A200 M1CAC, has a 160 VA inrush and a 25 VA holding, which at 120V is 1.33A inrush and 0.208A holding. (See Westinghouse Catalog 25-000.

A 300 Series Quad AC output module, catalog number NL320L, is rated 15A (1875 VA) at 0.1 seconds inrush and 1.25A (150 VA) continuous at 125 VAC and 85°C (185°F). It can be seen, therefore, that a NL320L module can handle this load at 85°C ambient.

Solenoids and other types of loads can be checked in a similar manner by comparing the manufacturer's data with the appropriate Numa-Logic 300 Series Component Data.

Transformer power requirements

For control transformer power requirements, see Power Supply specification sheets in Section 6.

Preparing the drawing set

Solid state diagrams differ from relay ladder diagrams. On a ladder diagram, the input and output devices are intermixed with the logic. On a solid state diagram, however, the input pilot devices are located on the left vertical buss, the output devices on the right vertical buss, and the logic is in between. Therefore, the solid state diagram can be read from left to right, almost like written text.

In addition to the schematic diagram, a complete solid state drawing set usually includes a rack layout, a power-up schematic, a panel layout and a wire-wrap list. This format facilitates the preparation of the required drawings in a logical sequence as shown in the following check list.

Drawing set check list

1. Control schematic
- **a.** Draw inputs.
- **b.** Draw outputs.
- **c.** Draw logic.
- **d.** Add interconnection codes.
- **e.** Label module and gate numbers.

2. Rack layout.
- **a.** Make drawing of front of rack.
- **b.** Prepare cross reference location table.
- **c.** Draw bussing diagram.

3. Power-up schematic.
- **a.** Prepare schematic drawing.

4. Panel layout.
- **a.** Prepare panel layout drawing.

5. Wire-wrap list
- **a.** Detail bussing connections.
- **b.** Detail terminal block connections.
- **c.** Detail module connections.

There are many ways such a drawing set can be prepared and the reader may have a specific preference. The following description of one good format may be helpful.

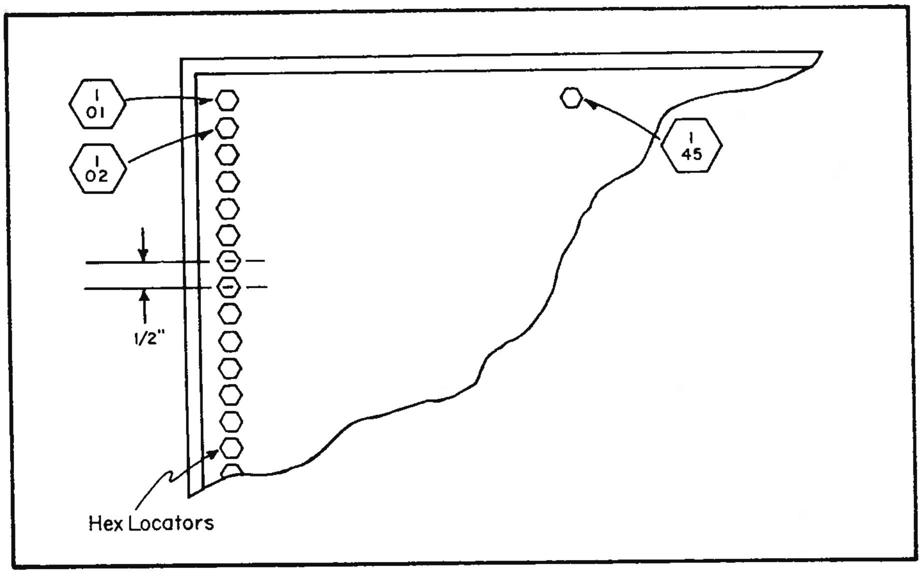

Figure 3-1: Location designation system.

Draw final solid state schematic

The original rough schematic that has been prepared covers the basic design, but a final schematic is needed to document all the numerous details (interconnections, wire numbers, module arrangement, etc.).

It is often impractical to draw the interconnections between separate drawings in the drawing set (i.e., between control schematic and power-up drawings). Also, it can be quite confusing to draw the actual interconnections between inputs and logic units in the control schematic. Therefore, an interconnection identification system is highly desirable.

Figure 3-1 shows one good approach. A series of identification numbers are first drawn down the left-hand margin of each sheet. In the illustration, hexagonals are used for symbolic reference. The top number in each hex designates the sheet number (1 — power-up, 2 — schematic, 3 — panel layout). The bottom number designates the location on the sheet. Thus, 1/29 designates location 29 on sheet 1. A good center-to-center distance between hexagonals is 1/2".

On the schematic sheet, all the inputs are drawn first as shown in Figure 3-2. A spacing of 1" between inputs allows ample room for all data and aligns the inputs with the corresponding location hexagonals. The exterior components (pushbuttons, contacts, limit switches) are drawn first, followed by rectangles designating the terminal blocks. Connected to these are the symbols for solid state inputs.

A horizontal line about 1-3/4" long is drawn at the outputs of each solid state input. This provides space to label each particular solid state input. The word descriptions are very useful in all analyses of the schematic.

A hex location symbol is placed at the end of each title line. These are left blank for the moment, but later will be filled in with the location code of the logic gate to which each is connected.

The logic circuits are drawn next. Inasmuch as logic circuits cascade, it is helpful if they are drawn in a symmetrical pattern. This is accomplished by locating logic gates on uniformly spaced vertical guidelines as shown in Figure 3-3. The spacing of these guidelines should be about 1-1/2". The left-hand guideline is placed about 2-1/2" from the location symbols of the inputs. A normal drawing allows space for four such guidelines.

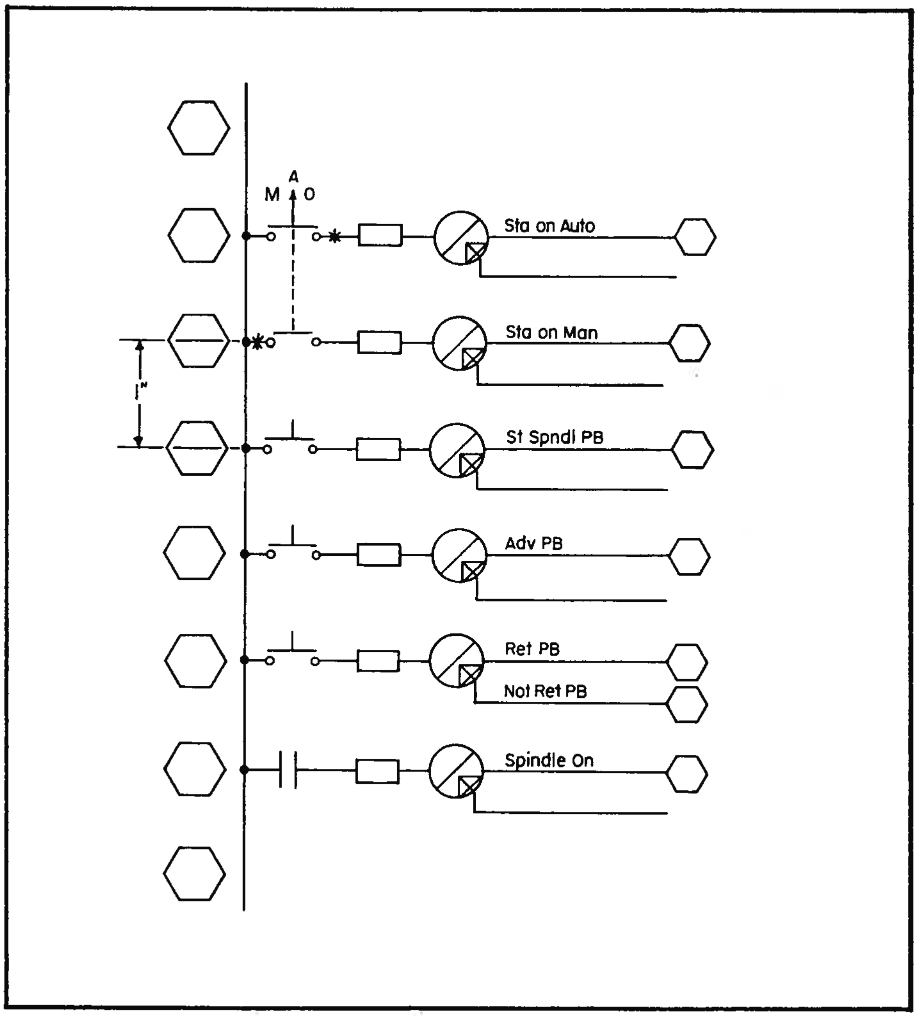

Figure 3-2: Inputs are drawn first.

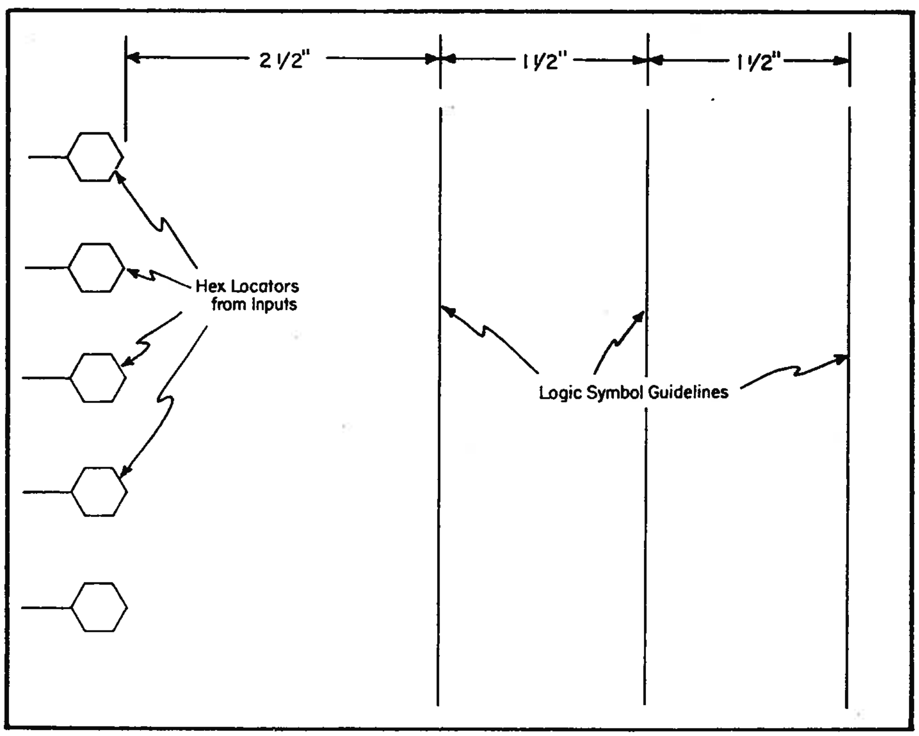

Figure 3-3: Location of logic symbol guidelines.

Each logic circuit feeds one output, so they are drawn in such groupings. Each circuit is located relative to the top and right-hand symbol as shown in Figure 3-4. A good spacing between circuits is 3/4". The right-hand symbol of each circuit is placed on the last guideline to the right. The vertical spacing between symbols in a circuit is a matter of judgment. As with the outputs of the solid state inputs, each logic input usually starts with a hex location symbol followed by a horizontal line to provide space for descriptive identification.

The solid state outputs are connected directly to the logic outputs as shown in Figure 3-5. Next in line are the rectangles for terminal blocks, followed by the exterior components (starter coils, contacts, indicating lights). Note that the solid state outputs also are lined up vertically, with their vertical guideline being about 1-1/2" to the right of the last logic symbol guideline.

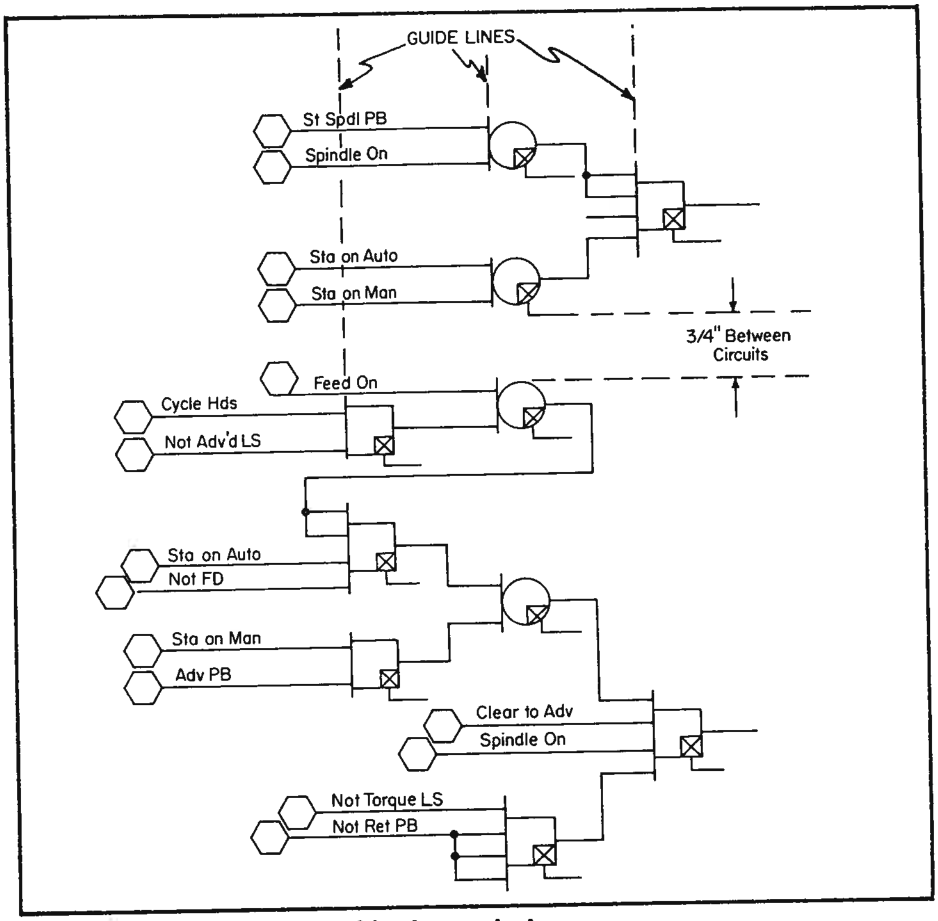

Figure 3-4: Arrangement of logic symbols.

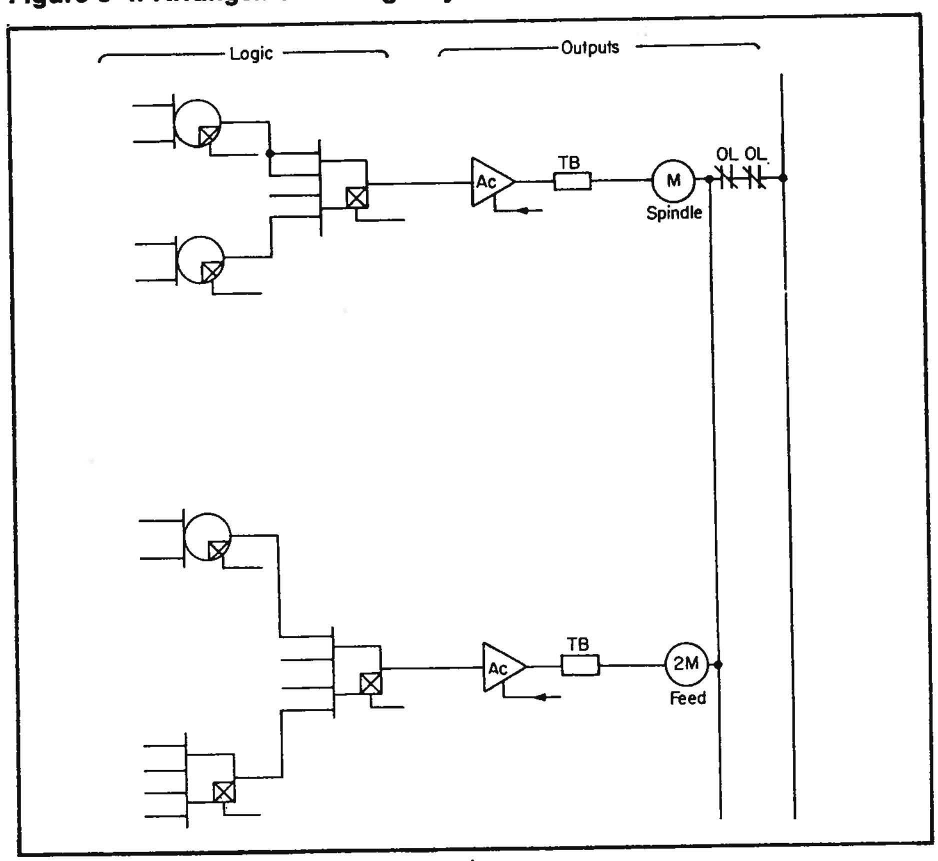

Figure 3-5: Arrangement of outputs.

With the symbols, interconnections and word descriptions in place, the next step is to fill in the hexes with the proper location codes. See Figure 3-6. Start

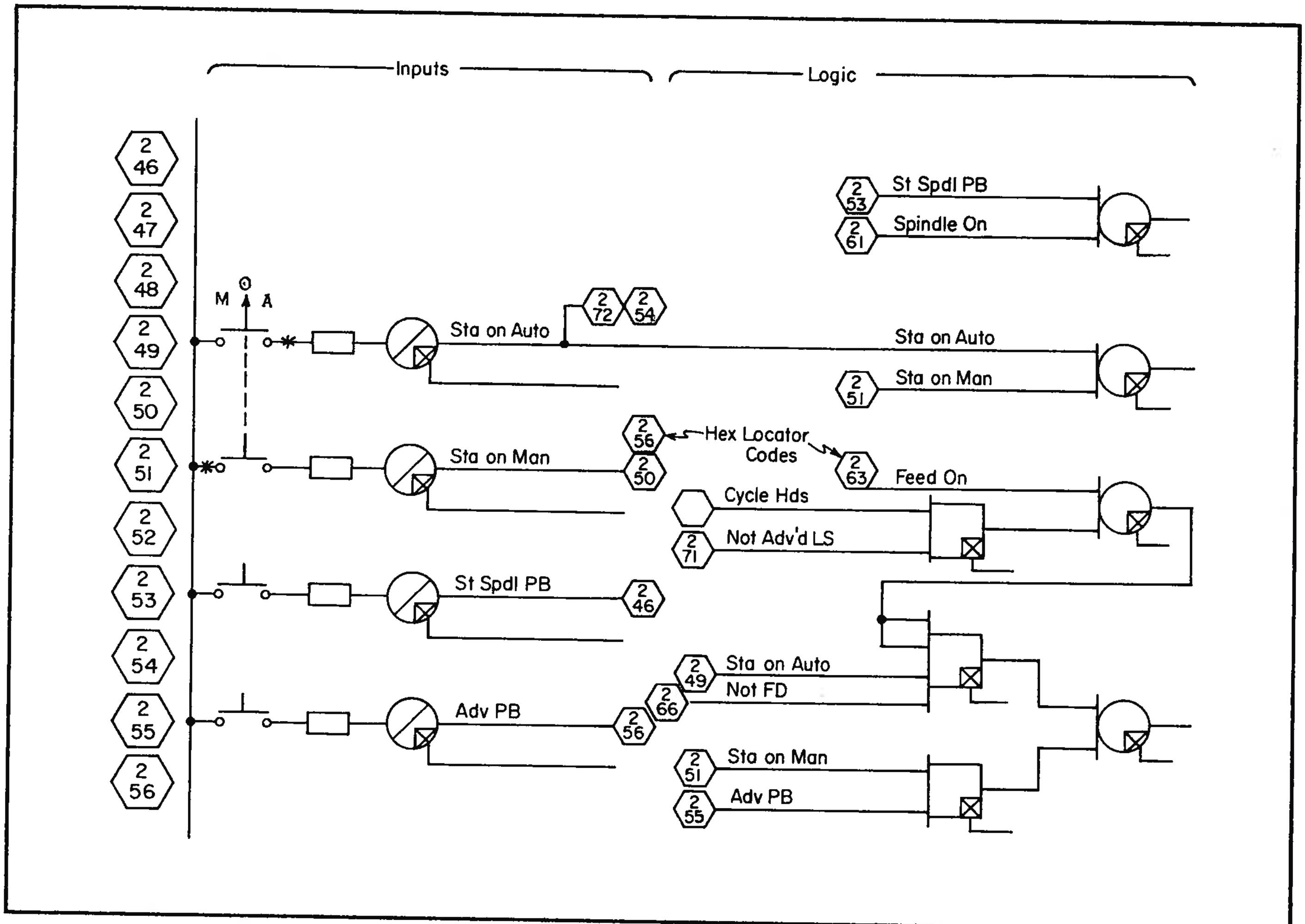

Figure 3-6: Completing location symbols.

with the hexes on the solid state inputs. In the illustration, the first solid state input "STA ON AUTO" is connected to:

- a 2-input OR at location 2/49.
- a 4-input AND at location 2/54.
- a 4-input AND at location 2/72.

Since the 2-input OR is in line at 2/49, only two additional hexes are needed and are labeled as shown. Note how the word descriptions help here. Continue this process until all the solid state input connections are identified.

Now go to the logic inputs and follow the same procedure. The location codes here are just the reverse. They indicate the solid state inputs to which the logic inputs are connected. For example, the first logic input in the illustration "ST SPDL PB" is connected to the third solid state input at location 2/53. Note that some of the logic outputs are also identified for interconnection.

Next, we want to identify each solid state symbol as to its location on a module. This is done by a two-part number designation (i.e., 3-2). The first digit designates the module location in the rack, the second digit designates the location of the circuit on the module.

As shown in Figure 3-7, count the number of each type of symbol and assign numbers in the order they appear on the drawing. In the example, there

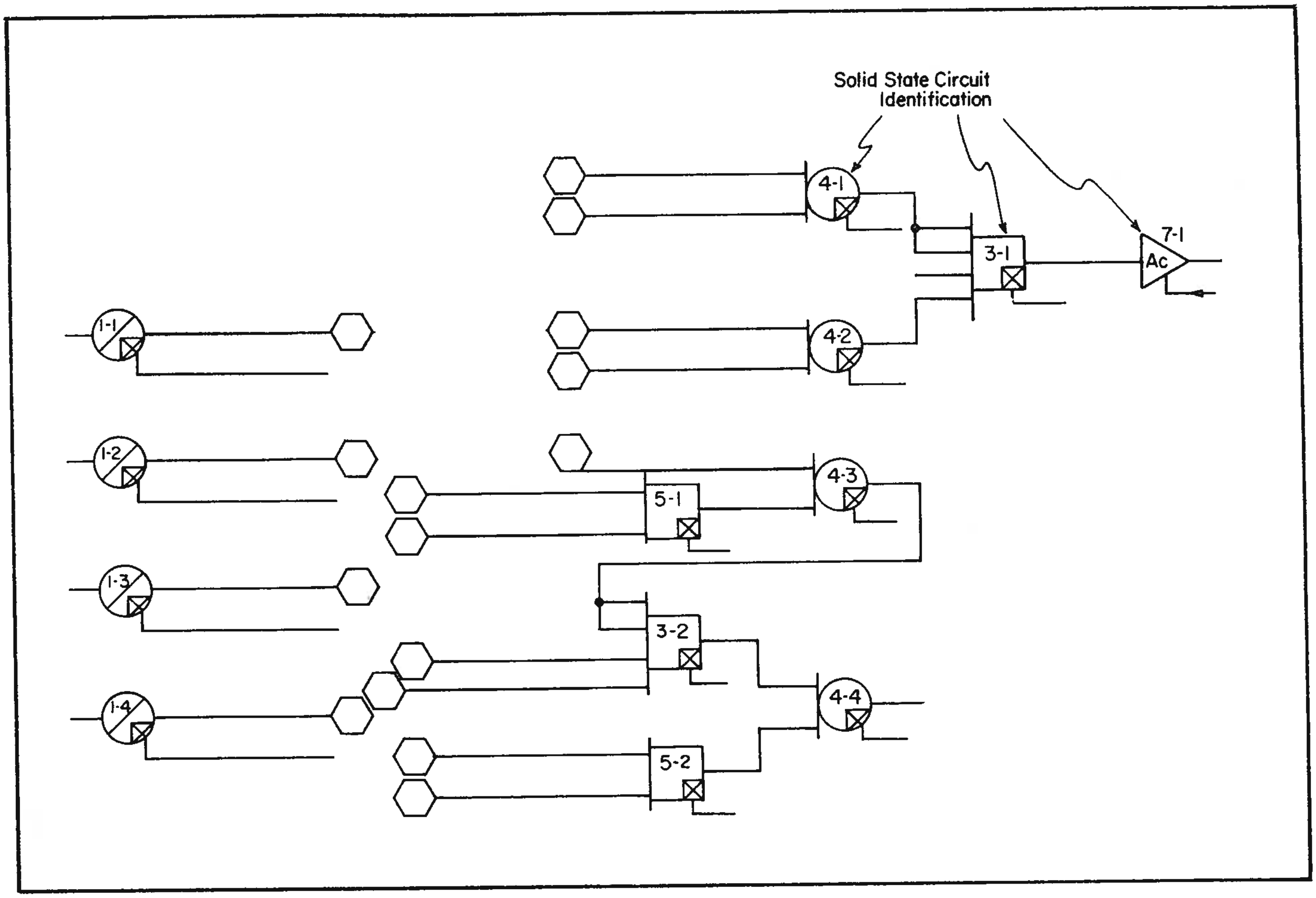

Figure 3-7: Labeling solid state symbols.

are twelve solid state inputs. The Component Data sheets (in Section 6 of the manual) for the input modules specify that each input module under 250 V contains six circuits.Therefore, two modules are needed. The first symbol is labeled 1-1, the second 1-2, and so on through 1-6. The seventh symbol starts the second module, so it is labeled 2-1, and so forth.

The 2-input ANDs, 4-input ANDs, 2-input ORs, 4-input ORs and all other types of solid state symbols are numbered in the same fashion. In the example, the 4-input ANDs are scheduled for Module 3 and there are six symbols — just enough for one module. Module 4 contains all the 2-input ORs but there are only seven used so that one spare circuit is left on this module. There are three spares on the 2-input AND module, because only five gates are needed. The OFF DELAY TIMER is scheduled for Module 6 and the four solid state outputs for Module 7.

The input and output connections of each solid state symbol must now be labeled. This is needed to facilitate wiring the assembled panel. See Figure 3-8.

There is a pre-established designation for each connection which is detailed on the appropriate specification sheets. For example, the input connection to the first circuit in the AC input module is always connection 29. The TRUE output is always 4 and the NOT output is always 6. Therefore, in order to label all input and output connections properly, refer to the specification sheets and follow the numbers as designated.

Please note that the exterior connections to the terminal blocks are labeled also. This step, however, cannot be completed until the power-up sheet is completed, because this numbering sequence starts here. In the example, connections 1 through 10 are on the power-up sheet. Therefore, the connection from the first pushbutton to TB 1-1 starts at 11. From there on, the exterior connections are numbered in sequence.

Figure 3-8 also shows the method of numbering the terminal blocks (1-1, 1-2, etc.). To perform this step, you must know the number of terminal blocks. The number of strips in each rack must also be determined. Therefore, this step cannot be completed until after the racks have been selected. The rack Component Data sheets in Section 6 detail terminal block arrangements.

In the example, a 9-position Swing Rack is used, as will be seen later. The Component Data sheet specifies that this rack has three terminal strips and each strip has eight positions.

Inputs are assigned to the first one or two strips and outputs to the next strip(s) in line. The power bus connections (not shown here) are always assigned to the last strip. Therefore, the input terminal blocks are numbered 1-1 through 1-8. The first digit designates the strip number and the second digit designates the position on the strip. For this example, the AC outputs were assigned to the second terminal strip and were numbered 2-1 through 2-4. As depicted in Figure 3-12, the power terminal locations have been assigned to strip 3.

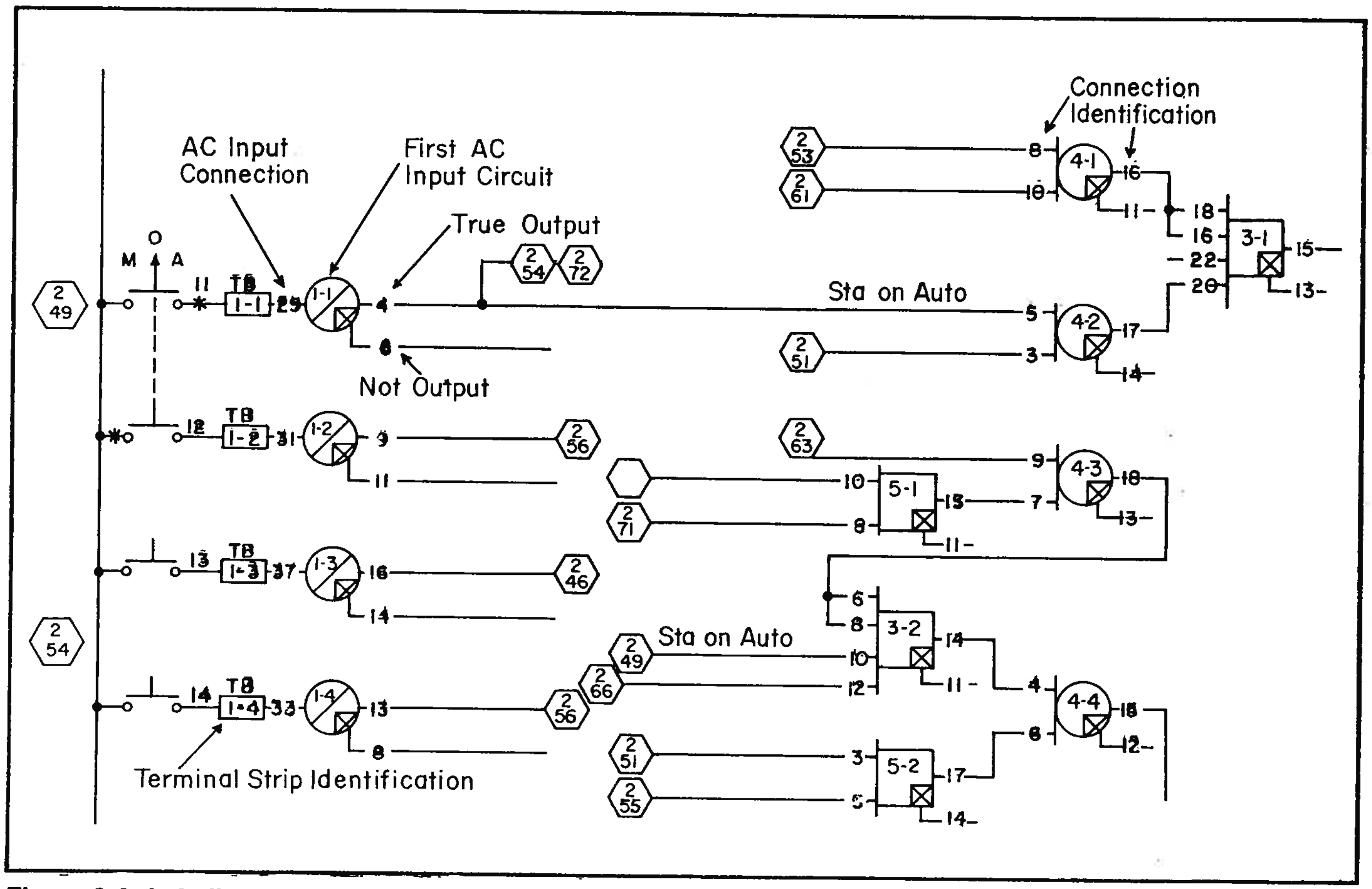

Figure 3-8: Labeling input and output connections.