When more than one swing rack is stacked in a panel, the racks may be labeled Rack A, Rack B, Rack C, etc. Assuming that two racks are being used, for example, each having five terminal strips, the first five strips should be labeled TB1A through TB5A. The second five strips should be labeled TB1B through TB5B. See Figure 3-9 for the complete labeling of the input, logic and output elements for stacked racks and multiple door panels.

For large multiple door control panels, the rack and terminal strip identification is repeated for each panel door. Assuming that two solid state doors with seven racks each are being used, the first seven racks would be labeled Door 1 Rack A through Rack G. The second seven racks would be labeled Door 2 Rack A through Rack G. The drawing set then is organized by panel doors.

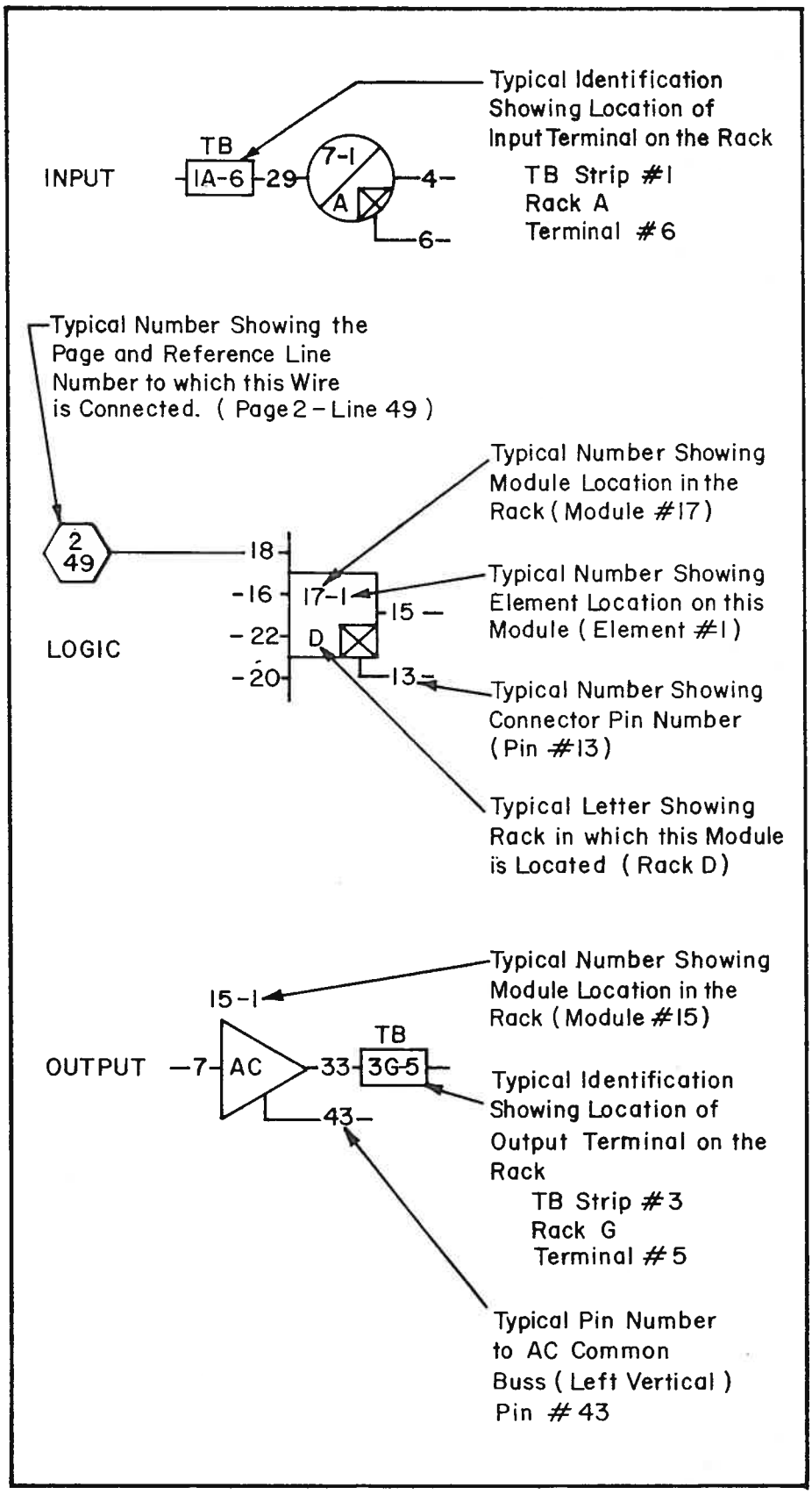


Figure 3-9: Complete labeling for stacked racks and multiple door panels.

Draw rack layout

The rack layout is usually the second drawing to be made in the set. It consists of three parts:

1. A to-scale drawing of the front of the rack, including detail drawings of each module faceplate lens. Mylar masters may be used to simplify drawings.
2. A cross reference table detailing the location on the schematic of each solid state circuit in each module of the rack.
3. A wiring diagram showing all bussing connections of the total rack. Mylar masters may be used to simplify drawings.

If there is more than one rack for the system, a complete rack layout drawing is made for each rack.

The to-scale drawing of the front of the rack of this example is shown in Figure 3-10, for a 9-position rack. Both 18-position and 27-position racks are available.

Although this drawing is quite detailed, its preparation is relatively simple when the drawing aids described later are used.

For the layout of this drawing, follow the number assignments made to each solid state symbol on the schematic. Thus, the inputs numbered 1-X are located on the first module in the rack. The 2-X inputs are on the second module. The 4-input ANDs numbered 3-X are on the third module and so forth.

Inasmuch as the module faceplate lenses are a very important factor in all on-line troubleshooting, the input circuits are designated by the appropriate symbol for the input device (pushbutton, limit switch, etc.), rather than the solid state input symbol. The output circuits, likewise, show the symbols for the on-machine components (motors, solenoids, indicating lights). The mechanical function or work station also may be identified to facilitate machine troubleshooting.

The example shows a 9-position rack with only seven positions being used to control mechanical station 1. The two blank positions are handy for future additions or changes. If an 18-position, or 27-position rack were used, this drawing would also reflect all positions.

Note that the logic symbols are shown even for the unused circuits. The fact that the circuits are not being used is detailed on the cross reference table.

Later in this section the process will be discussed through which the drawing of the front of the rack can be used to make custom faceplate lenses. Figure 3-10 shows custom lenses in module positions 1, 2 and 7.

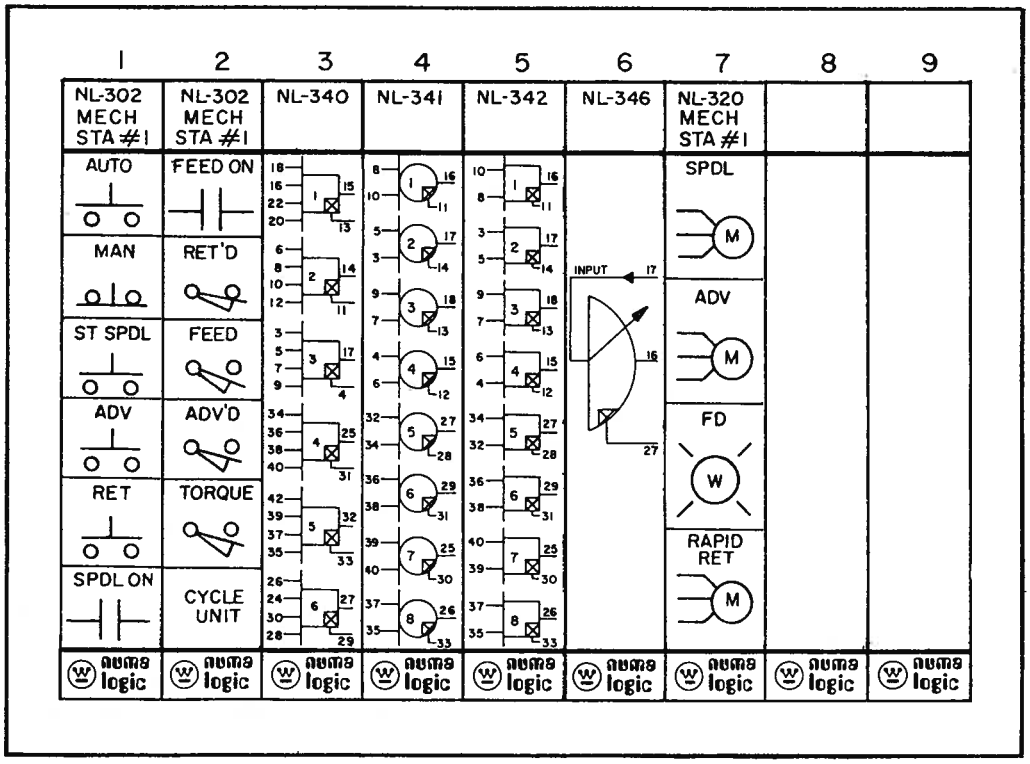
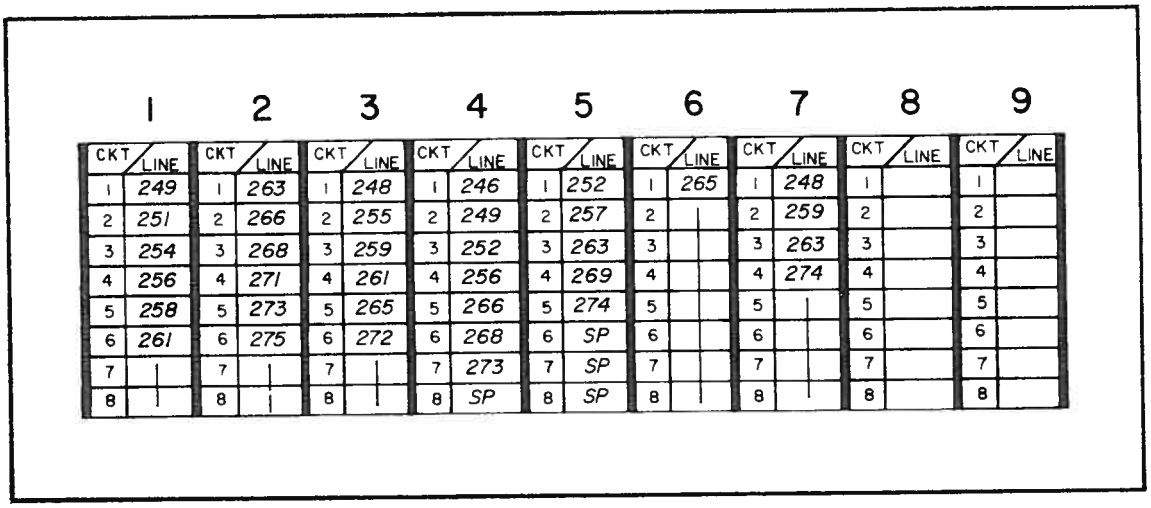


Figure 3-10: To-scale drawing of front of 9-position rack.

The cross reference table for the example is shown in Figure 3-11. The module numbers are shown across the top. The position of each solid state circuit within the module is listed in the columns headed "CKT". The numbers in



	1		2		3		4		5		6		7		8		9	
CKT	LINE	CKT	LINE	CKT	LINE	CKT	LINE	CKT	LINE	CKT	LINE	CKT	LINE	CKT	LINE	CKT	LINE
1	249	1	263	1	248	1	246	1	252	1	265	1	248	1		1	
2	251	2	266	2	255	2	249	2	257	2		2	259	2		2	
3	254	3	268	3	259	3	252	3	263	3		3	263	3		3	
4	256	4	271	4	261	4	256	4	269	4		4	274	4		4	
5	258	5	273	5	265	5	266	5	274	5		5		5		5	
6	261	6	275	6	272	6	268	6	SP	6		6		6		6	
7		7		7		7	273	7	SP	7		7		7		7	
8		8		8		8	SP	8	SP	8		8		8		8	

Figure 3-11: Rack layout cross reference table.

the "LINE" columns correspond to the hex location symbols on the schematic. For example, Circuit 1 in Module 1 is the solid state input circuit shown on the schematic opposite hex locator 2/49.

Modules 1, 2 and 3 have only six circuits, so a vertical line is drawn through positions 7 and 8 indicating they are not part of the modules. Module C4 has eight circuits, but only seven are being used. The symbol "SP" is placed in the eighth position, indicating it is a spare.

Positions 8 and 9 in the rack are not used and thus are left blank. Future additions to the system can be accommodated here. In selecting rack sizes, it is always wise to leave at least 10% of the rack space unused for this purpose.

The last part of the rack layout sheet is the bussing drawing shown in Figure 3-12. This is a basic wiring diagram showing how the AC power, DC power and electrical interlocks are connected in the rack.

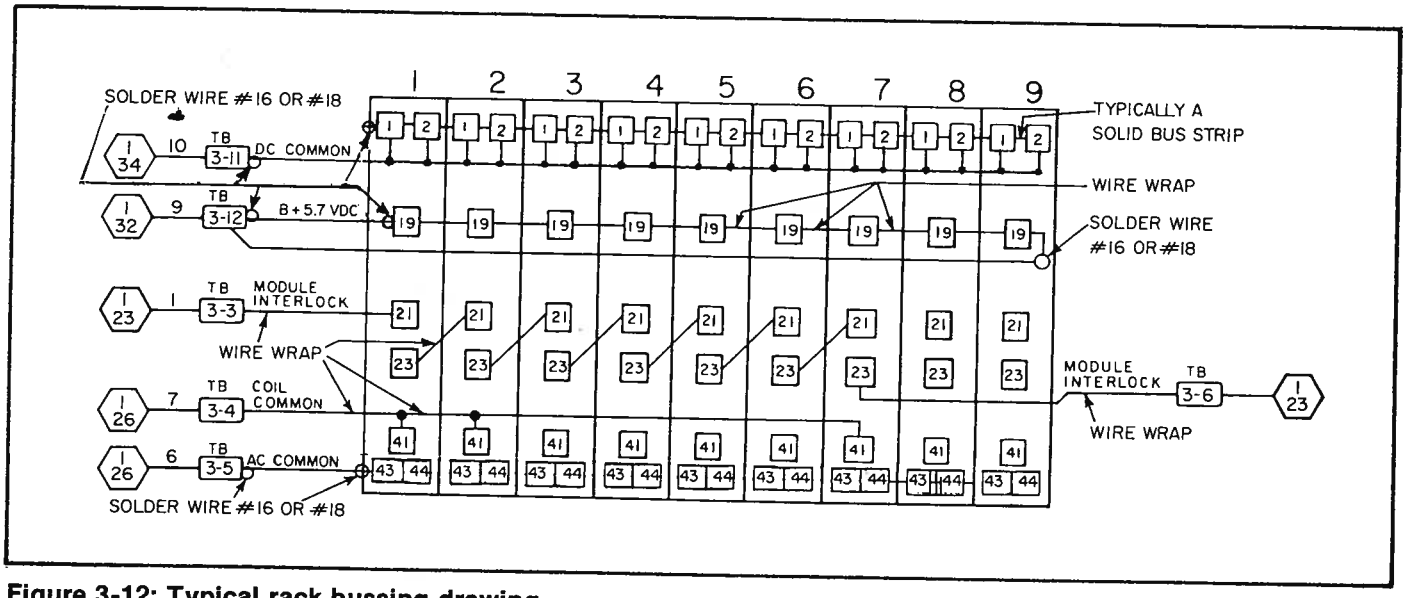


Figure 3-12: Typical rack bussing drawing.

The terminal numbers shown (1, 2, 19, 21, 23, 41, 43 and 44) are always used for bussing on all racks. The only thing that differs is the manner in which they are interconnected.

The DC common line is always brought into Terminal 1 of the first module in the rack. The module interconnections are always the same, being accomplished by a one-piece bussing strip. The bussing strip distributes power to pins 1 and 2 of all modules. NOTE: It is not recommended to tie DC common (pins 1 and 2) to panel or earth ground.

The +5.7 VDC line is always brought into Terminal 19 of the first module. Interconnections on Terminals 19 are made for all modules in the rack. NOTE: Each rack must have a return wire (#16 or #18) from Pin 19 of the last module back to the terminal used as the source of +5.7 VDC power.

The electrical module interlock line is always brought into Terminal 21 of the first module. The interconnections between Terminals 23 and 21 go from Module 1 to 2 to 3 and on through the last active module. The other side of the module interlock line is brought out of the last active module on Terminal 23.

The L2 (neutral) line is connected to terminal 41 of each input and output module, in this case Modules, 1, 2 and 7.

The L1 (hot) line is brought into Terminals 43 and 44 of the first module.

The lines into and out of the rack are connected to Terminal blocks as shown. As mentioned before, these are assigned to the last terminal strip in the group —#3 in the example.

The hex locator symbols designate the location of each of these lines on the power-up drawing (sheet #1). These are left blank until the power-up drawing is prepared.

Draw power-up sheet

The power-up drawing includes the branch circuit from which all power is obtained, all the electric motors used on the equipment being controlled, the motor starters, and the start of the control circuit from the main transformer through the DC power supply. See Figures 3-13 and 3-14.

The portion of the drawing showing the branch circuit, the motors and the motor starters is quite straightforward, using the same approach as with a relay control system. In the example, a 480-volt, 3-phase, 60 Hz branch circuit is used to feed three AC 3-phase motors. Two starters are

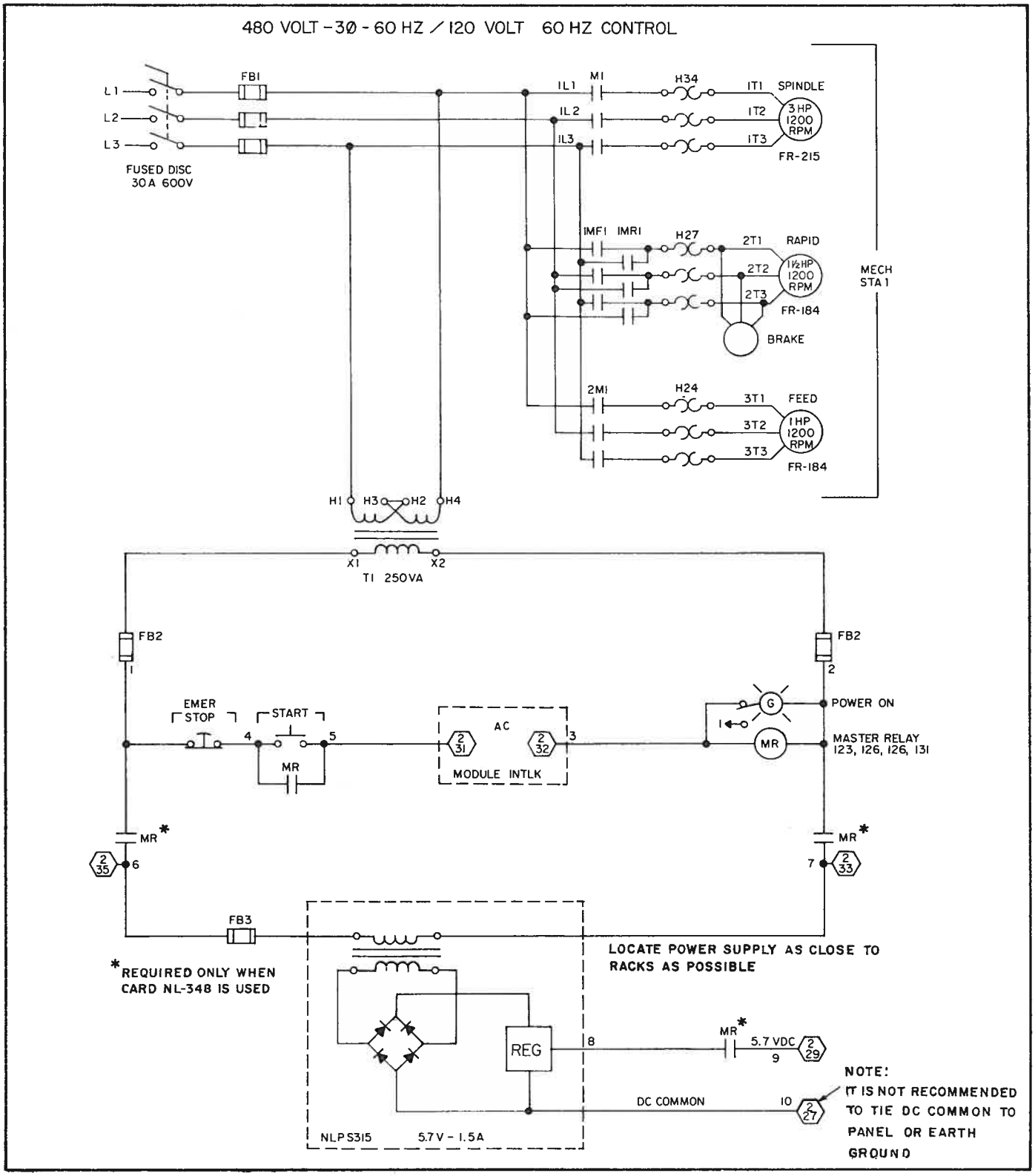


Figure 3-13: Typical power-up drawing with AC module interlock.

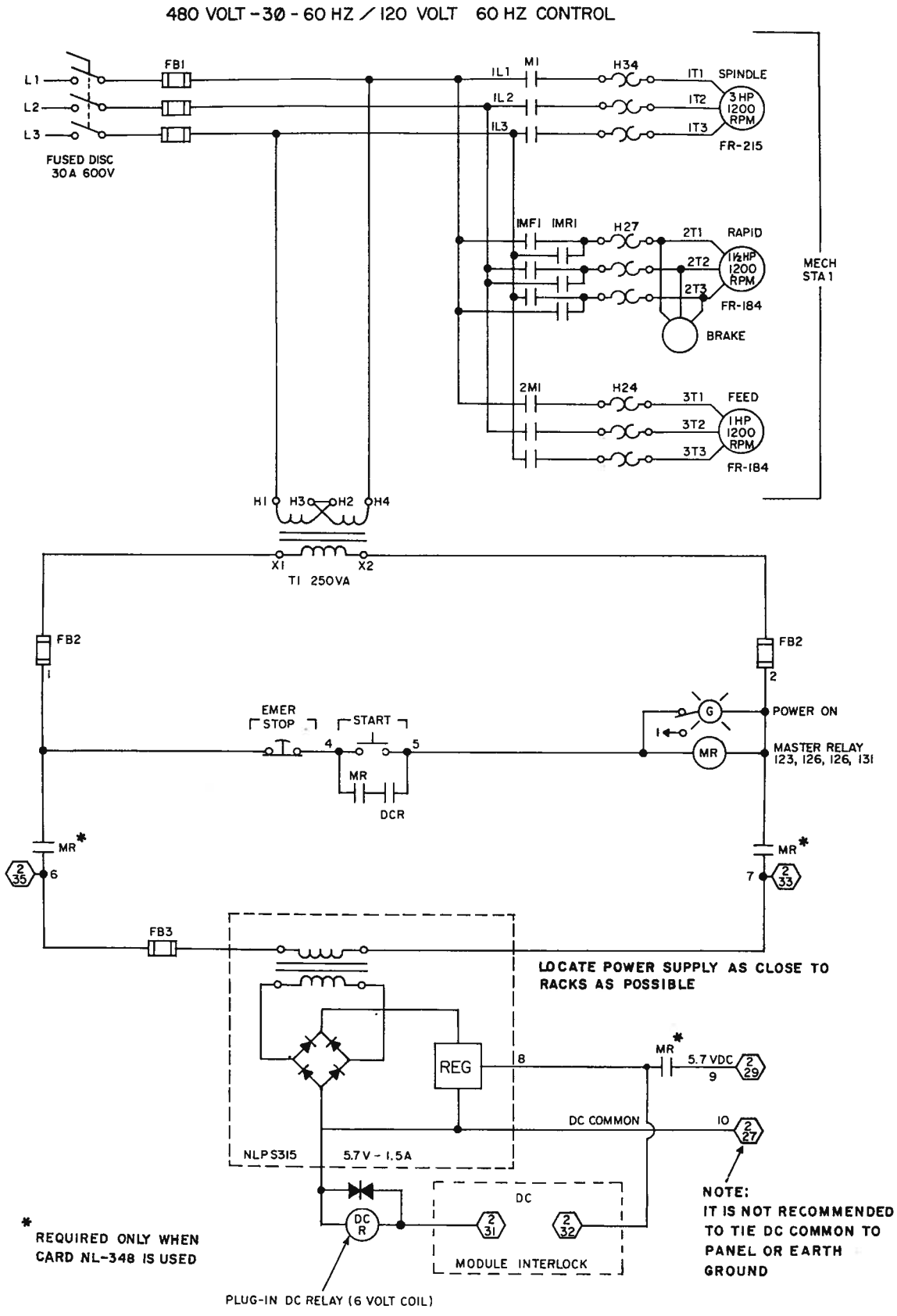


Figure 3-14: Typical power-up drawing with DC module interlock.

non-reversing and one is reversing. There is an overload relay heater for each phase on each motor.

The main control transformer reduces 480 volts to 120 volts. In this example, it is rated at 250 VA.

The AC portion of the control circuit includes the power on/off control and the AC connections to the solid state racks. The master relay applies AC power to the power supply through its MR contacts. Note there is an MR hold-in contact around the start pushbutton.

The "AC MODULE INTLK" block represents the electrical interlock connection with the racks. The hex symbols refer to the connection location on the bussing drawing. The two hex symbols just below the MR contacts also refer to the connection location on the bussing drawing. The module interlock also may be implemented with DC power as shown in Figure 3-14.

The DC power supply block includes a step-down transformer, a full-wave bridge rectifier and a regulator. The hex symbols at the end of the output lines refer to the connection location on the bussing drawing. The MR contact in the +5.7 VDC line is the contact of the master relay.

The interconnecting wires are labeled 1 through 10 as shown. Therefore, referring back to the solid state schematic (Figure 3-8) the numbering of the exterior interconnecting wires starts at 11.

Draw panel layout

The panel layout drawing consists of two parts: the layout of all the components on the inside of the rack, and the layout of the panel door. See Figure 3-15.

There are no particular rules to follow in laying out the rack. If the company has established panel layout practices, these should be followed. In the example, the 300 Series rack is located at the bottom with the three motor starters above. The circuit breakers, main transformer and master relay are located at the top. Wiring ducts are provided along the left-hand side, plus two horizontal runs between components. Normally, a stock panel is used. This one measures 42" x 36-1/2" x 10".

Care must be exercised in locating the Numa-Logic 300 Series racks to assure adequate swing out or swing down space, depending on the particular racks being used. Rack and clearance dimensions are listed in Section 6.

The light-emitting diode feature of Numa-Logic control permits most troubleshooting to be performed merely by visual inspection of the modules without opening the panel door. Therefore, a clear Plexiglass window should be provided in the panel door.

This window should be sized to permit unobstructed viewing of the full front of the Numa-Logic

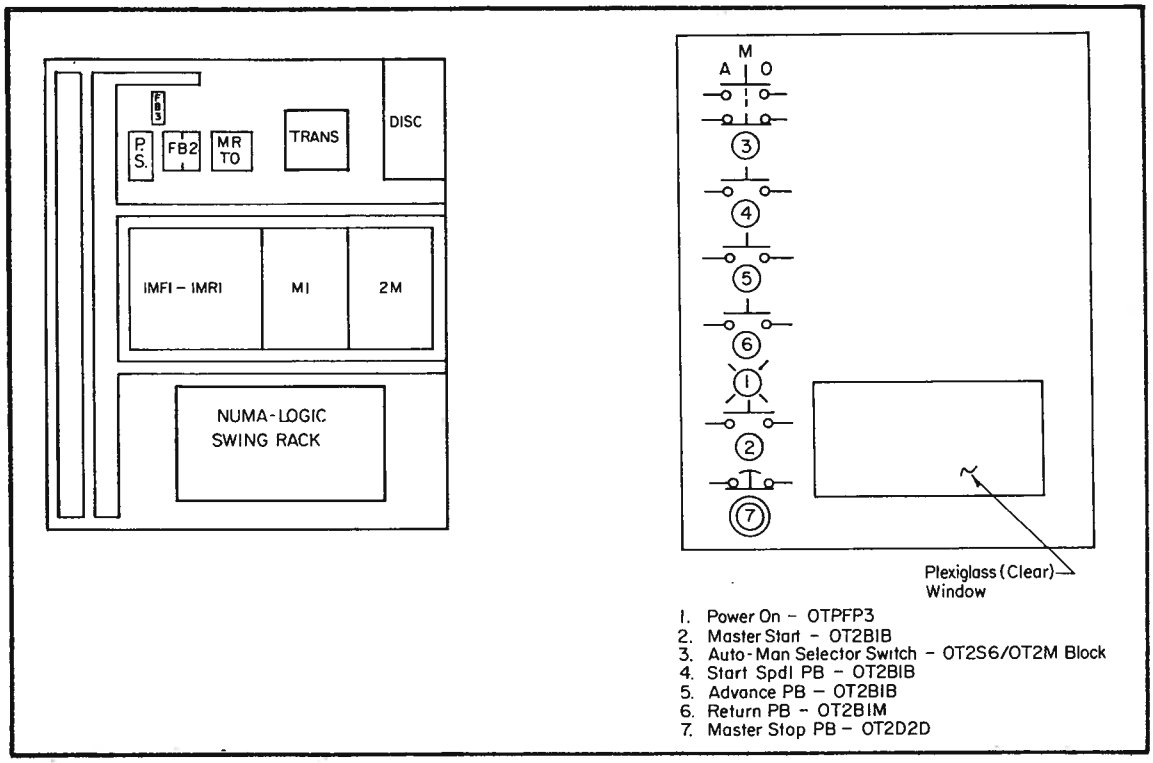


Figure 3-15: Typical panel layout drawing.

300 Series racks. Pushbuttons and indicating lights can be arranged on the panel door in any desired pattern.

Prepare bill of material

Preparing a detailed bill of material for a Numa-Logic 300 Series system is much the same as for a relay system. The bill of material for the example is shown in Figure 3-16.

The solid state portion of the system includes:

- Input modules
- Output modules
- Logic modules
- Racks
- DC power supply

Detailed descriptions and catalog numbers of all available components are listed in Westinghouse Descriptive Bulletin 16-350.

Detailed data on other Westinghouse components can be found in catalog sections and Descriptive Bulletins which can be obtained from your local Westinghouse representative.

Prepare wire-wrap list

A complete wire-wrap list can be prepared to aid the assembly technician in wiring the racks and panel. It is divided into three parts:

1. Bussing connections
2. Terminal block connections
3. Module connections

QTY.	NAME	DESCRIPTION	MFG.
			WEST
1	PB	PB6 #OT2D2D MUSHROOM HD	
3	PB	M.S. 1 ST. SPDL. 1 & ADV. #OT2B1B	
2	PB	#OT2B1M	
1	PB	RET. #OT2B9B	
1		AUTO-MAN. SSI 3 POS	
		#OT256 / OT2M BLOCK	
1	LAMP	POWER ON #OTPFP3	
1	P.S	5.7 VDC 1.5 AMP #NLPS315	
1	RACK	9 POSITION SWING RACK	
		#NLRS 309 A	
2	MODULE	NL-302L AC INPUT	
1		NL-320L AC OUTPUT	
1		NL-340L 4 INPUT AND	
1		NL-341L 2 INPUT OR	
1		NL-342L 2 INPUT AND	
1		NL-343L 4 INPUT OR	
1		NL-346L ADJ. TIMER	
2		FRN-4 FB2	
3		FRS-12 FB1	
1		FRN-.5 FB3	
1	PNL	NEMA 12 ENCLOSURE	
		42" X 36½ X 10"	
1 LOT	TERM	300 V	WEST.
1 LOT	TERM	600 V	
1	DISC	#DS161 30 AMP	
1		#PL 29-520 HANDLE MECHANISM	
1		A200 MICAC SIZE #1 MOTOR STARTER	
1		#A210 MICAC FWD.-REV. SIZE #1	
		MOTOR STARTER	
3	HEATERS	H34	
3	"	H27	
3	"	H24	
1	TRANS	TRANSFORMER 250VA	WEST.

Figure 3-16: Typical bill of material.

WIRE	FROM	TO	NOTES
	1 - 1	C 7 - 1	1 Buss
	1 - 43	7 - 43	1 Buss
	TB - 1	-	18 Ga Red
	TB - 2	-	18 Ga Red
	TB5 - 3	1 - 21	18 Ga Red
	TB5 - 4	1 - 41	18 Ga Red
	TB5 - 5	1 - 43	18 Ga Red
	TB5 - 6	7 - 23	18 Ga Red
	TB - 7	-	18 Ga Red
	TB - 8	-	18 Ga Red
	TB - 9	-	18 Ga Red
	TB - 10	-	18 Ga Red
	TB5 - 11	1 - 1	18 Ga Blue
	TB5 - 12	1 - 19	18 Ga Blue
	1 - 19	2 - 19	22 Ga Blue
	2 - 19	3 - 19	
	3 - 19	4 - 19	
	4 - 19	5 - 19	
	5 - 19	6 - 19	
	6 - 19	7 - 19	
	7 - 19	8 - 19	

Figure 3-17: Typical bussing wire-wrap list

WIRE	FROM	TO	NOTES
	TB1 - 1	1 - 29	
	1 - 2	1 - 31	
	1 - 3	1 - 37	
	1 - 4	1 - 33	
	1 - 5	1 - 35	
	1 - 6	1 - 39	
	1 - 7	2 - 29	
	1 - 8	2 - 31	
	1 - 9	2 - 37	
	1 - 10	2 - 33	
	1 - 11	2 - 35	
	1 - 12	2 - 39	
	TB2 - 1	7 - 33	
	2 - 2	7 - 35	
	2 - 3	7 - 37	
	2 - 4	7 - 39	
	- 5	-	
	- 6	-	
	- 7	-	
	- 8	-	
	- 9	-	
	-10	-	
	-11	-	

Figure 3-18: Typical terminal block wire-wrap list

WIRE	FROM	TO	NOTES
	1 - 4	4 - 5	
	4 - 5	3 - 10	
	3 - 10	3 - 24	
	1 - 9	4 - 3	
	4 - 3	5 - 3	
	1 - 16	4 - 8	
	1 - 13	5 - 5	
	1 - 15	4 - 40	
	1 - 17	3 - 36	
	3 - 36	3 - 38	
	1 - 26	3 - 30	

Figure 3-19: Typical module wire-wrap list

Figure 3-17 illustrates the bussing connection list for the example. Note that this is a master sheet with most of the codes already filled in. All that is required is to add the completion numbers that apply to the particular system.

These connection codes are obtained from the bussing drawing. By way of example, the DC common connections are:

- from 1-1 to 7-1 — buss
- from TB5-11 to 1-1 — gauge Blue

Note that the exterior wires are 18 gauge and the interior wires are 22 gauge.

The terminal block connection list is shown in Figure 3-18. This covers all the terminal block connections shown on the solid state schematic. Referring to the example schematic (Figure 3-8), connection 29 from the terminal block to the first solid state input at location 2/49 is indicated on the wire-wrap list as:

- from TB-1 to 1-29.

The next part of the wire-wrap list is the module connections. Care must be taken to assure that all connections are listed. All the needed data is contained on the schematic. It is good practice to first list all the connections between the solid state inputs and the logic gates. Second, list all the connections between logic gates starting at the top of the schematic and working down. Last, list all the connections between solid state outputs and the last gate in each logic circuit.

In the example shown in Figure 3-19, the first line, from 1-4 to 4-5, is the connection from solid state input 1-1 at location 2/49 (Figure 3-8) to the 2-input OR 4-2 at location 2/49. The three hex locators on the output of this solid state input indicate that three connections are required. Do not, however, start at connector 1-4 each time. Instead, proceed from 1-4 to 4-5 at location 2/49; from 4-5 to 3-10 at location 2/55, and from 3-10 at location 2/72 to 3-24. This eliminates the possibility of overloading any one connector. A maximum of three wires per connector is the usual practical limit.

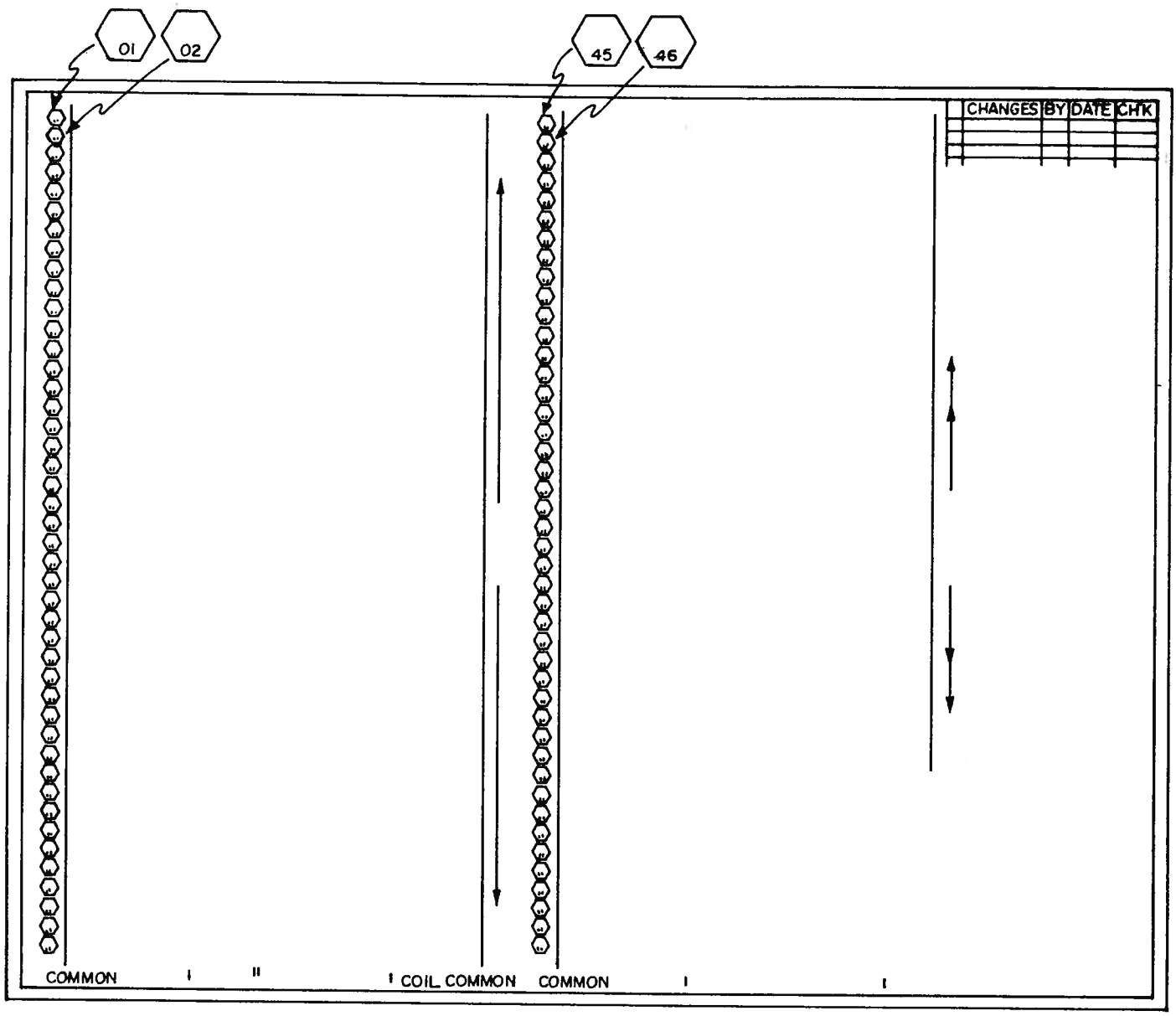


Figure 3-20: Numa-Logic master drawing sheets.

Using Numa-Logic 300 Series drawing aids

To save time in preparing the drawing set, consider using the Numa-Logic 300 Series drawing aids. These include:

- Master drawing sheets (See Figure 3-20).
- Master drawing of the rack layout and bussing for 9, 18 or 27-position racks.
- Photo positives for standard faceplates.
- Control logic symbols drawing template.