Equipment Utilization Chart

The following equipment is required to perform the exercises in this manual.

Equipment		Exercise																			
Model	Description	1-1	1-2	1-3	1-4	1-5	2-1	2-2	3-1	3-2	3-3	3-4	3-5	4-1	4-2	4-3	5-1	5-2	6-1	6-2	6-3
3103	Industrial Controls Mobile Workstation	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1
3110	Push Buttons		1	2	2					1		2	2	1	1	2				2	
3111	Selector Switches		1		1	1			1	1					1	1	1	1	1		
3114	Emergency Button	1							1	1		1	1	1	1	1	1	1		1	1
3115	Pilot Lights	1	1	2	2							1	1						1		
3119	Dual Contactors				1							1				1				1	
3125	Lockout Module	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1
3126	Manual Starter			1		1					1	1		1			1	1			1
3127	Contactor				1	1	1		1	1		1	1	1	1		1				1
3130	Control Relay				1		1								1	1					
3131	Overload Relay					1			1	1		1	1	1	1	1				1	
3132	Time Relay																		1	1	1
3137	Fuse Holder	1				1															
3138	Control Transformer	1	1	1	1	1			1	1		1	1	1	1	1	1	1	1	1	1
3140	Cam Switch			1		1					1										
3147	Inertia Wheel								1	1	1	1	1	1	1	1				1	1
3150	Starting Resistors					1											1				1
3176-A	Brake Motor						1		1	1	1	1	1	1	1	1	1	1		1	1
3186	Soft Starter																	1			
3196	AC Power Supply	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1
8951	Connection Leads	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1
N/A	AC Voltmeter[1]	1							1								1	1			
N/A	AC Clamp Ammeter[1]					1			1								1				
N/A	Ohmmeter[1]	1	1																		
N/A	Chronometer					1								1				1	1	1	
N/A	Fuses	1				1															

Model 38707 multimeter can be used in all exercises involving a voltmeter, a clamp ammeter, or an ohmmeter.

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Diagram Symbols

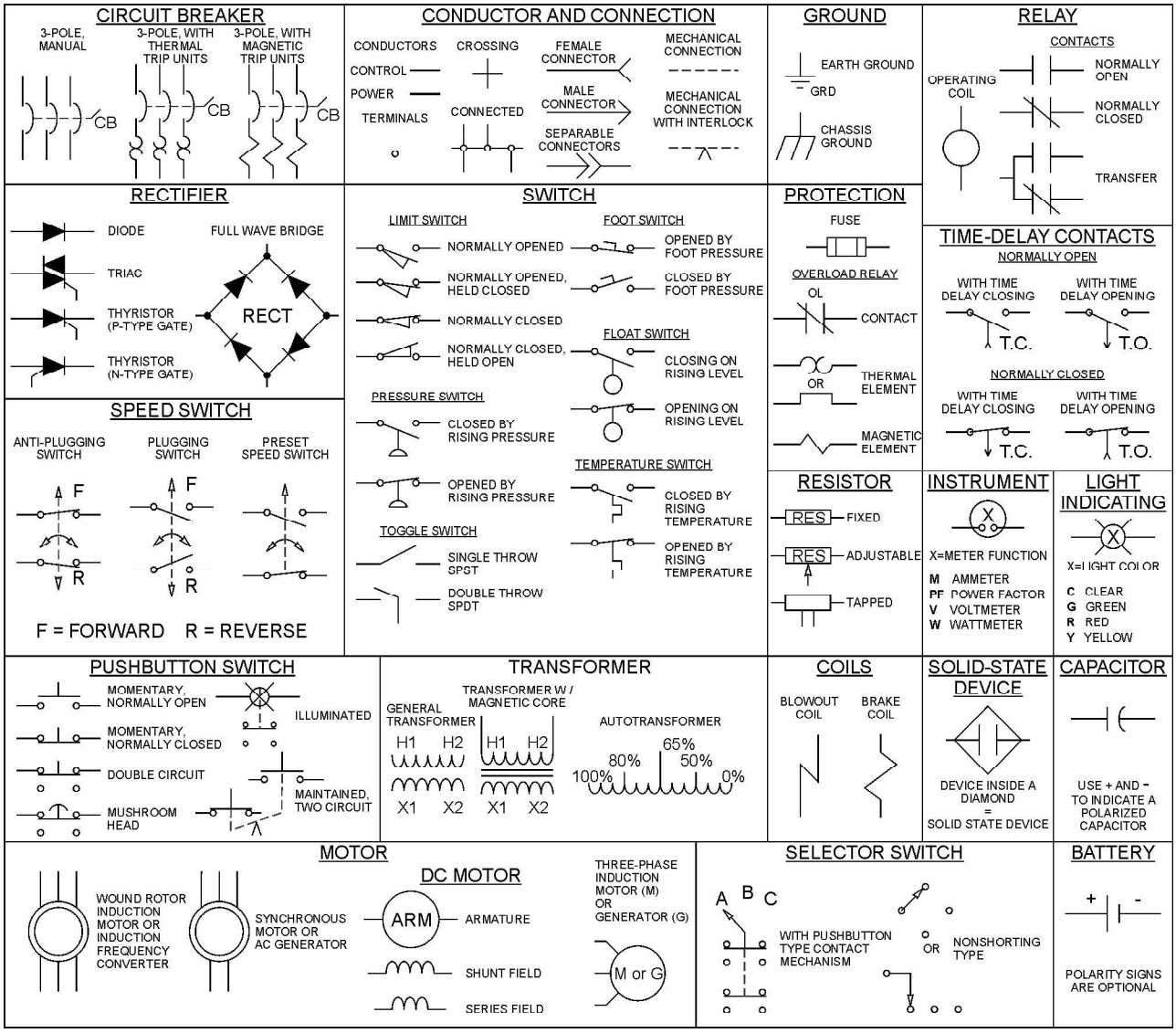

Figure B-1. NEMA symbols.

Table B-1. Device designations.

Function or device	Designation	Function or device	Designation
Accelerating	A	Overload	OL
Ammeter	AM	Overvoltage	OV
Braking	B	Plugging or Potentiometer	P
Capacitor, Capacitance	C or CAP	Power Factor Meter	PFM
Circuit Breaker	CB	Pressure Switch	PS
Closing Coil	CC	Push Button	PB
Control Relay	CR	Reactor, Reactance	X
Current Transformer	CT	Rectifier	REC
Demand Meter	DM	Resistor, Resistance	R or RES
Diode	D	Reverse	R or REV
Disconnect Switch	DS or DISC	Rheostat	RH
Dynamic Braking	DB	Selector Switch	SS
Field Accelerating	FA	Silicon Controlled Rectifier	SCR
Field Contactor	FC	Solenoid Valve	SV
Field Decelerating	FD	Squirrel Cage	SC
Field-Loss	FL	Starting Contactor	S
Forward	F, FWD, or FORW	Suppressor	SU
Frequency Meter	FM	Tachometer Generator	TACH
Fuse	FU	Terminal Block or Board	TB
Ground Protective	GP	Time-Delay Closing Contact	TC or TDC
Holding Coil	HC	Time-Delay Opening Contact	TO or TDO
Hoist	H	Time Relay	TR
Jog	J	Transformer	T
Latch Coil	LC	Transistor	Q
Limit Switch	LS	Trip Coil	TC
Lower	L	Unlatch Coil	ULC
Main Contactor	M	Undervoltage	UV
Master Control Relay	MCR	Voltmeter	VM
Master Switch	MS	Watthour Meter	WHM
Overcurrent	OC	Wattmeter	WM

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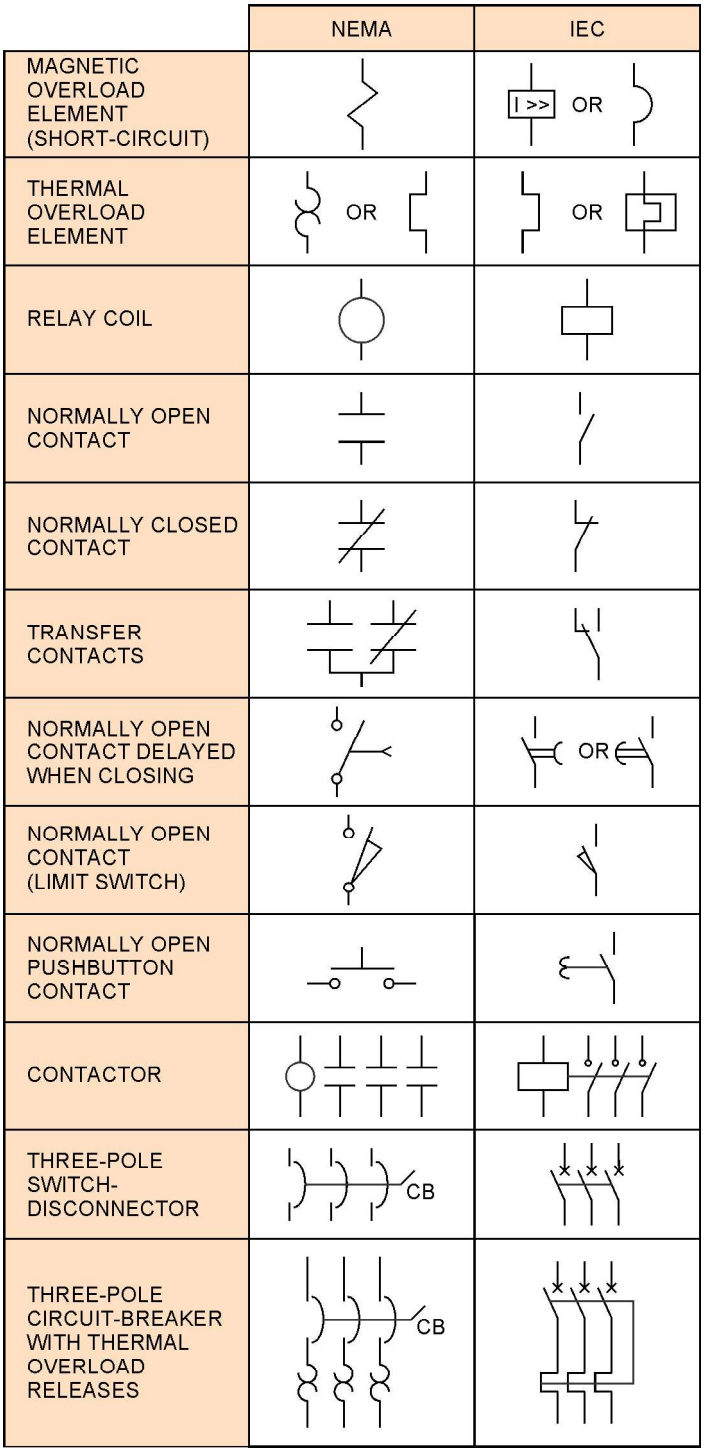
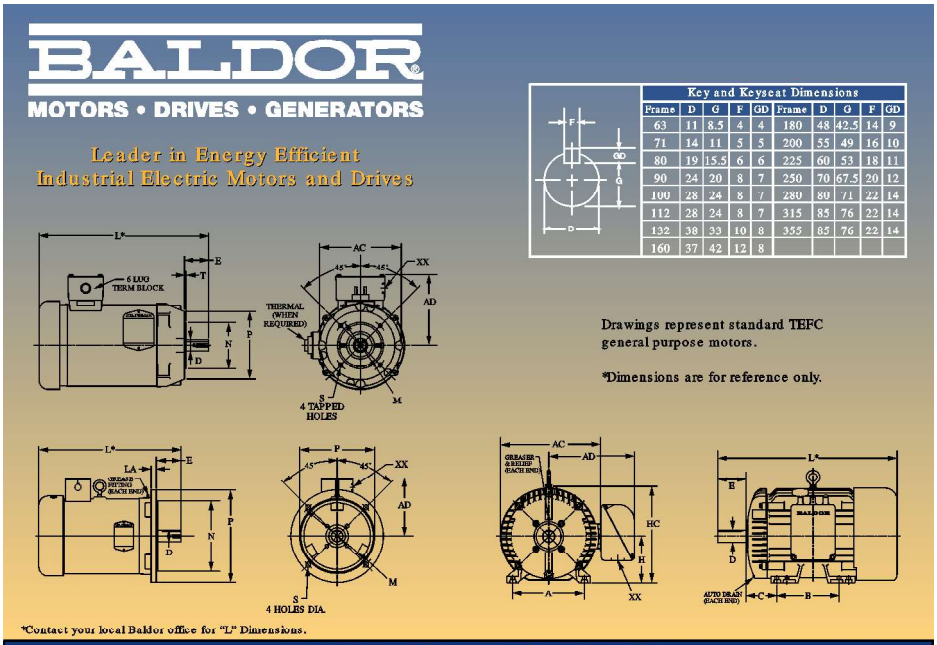


Figure B-2. Comparison of NEMA and IEC symbols.

Motor Frames Charts



Key and Keyseat Dimensions									
Frame	D	G	F	GD	Frame	D	G	F	GD
63	11	8.5	4	4	180	48	42.5	14	9
71	14	11	5	5	200	55	49	16	10
80	19	15.5	6	6	225	60	53	18	11
90	24	20	8	7	250	70	67.5	20	12
100	28	24	8	7	280	80	71	22	14
112	28	24	8	7	315	85	76	22	14
132	38	33	10	8	355	85	76	22	14
160	37	42	12	8					

IEC QUICK REFERENCE CHART

IEC Frame	Type	Foot Mounting				Shaft		B5 Flange						B14 Face					General				
		A	B	C	H	D	E	LA	M	N	P	S	T	M	N	P	S	T	L	AC	AD	HC	XX
63	300	100 3.937	80 3.150	40 1.570	63 2.480	11 .433	23 .906	8 .315	115 4.528	95 3.740	140 5.512	9 .354	3 .118	75 2.953	60 2.362	90 3.540	M5	2.5 0.98	*	119 4.690	102 4 116d 4.567d	121 4.760 136d 5.375d	15 .500 22d .890d
71	300 400	112 4.409	90 3.543	45 1.770	71 2.800	14 .551	30 1.181	8 .315	130 5.118	110 4.331	160 6.299	10 .393	3.5 .138	85 3.347	70 2.756	105 4.130	M6	2.5 .098	*	119 4.690 145d 5.690d	102 4	131 5.140 149d 5.880d	18 .690 21d .844d
80	400 500	125 4.921	100 3.937	50 1.969	80 3.150	19 .748	40 1.575	13 .500	165 6.496	130 5.118	200 7.874	11 .430	3.5 .138	100 3.937	80 3.150	120 4.724	M6	3 .118	*	145 5.690 168d 6.614d	116 4.510 130 5.120	152 6 162d 6.380d	22 .880 21d .844d
90	S L	140 5.511	100 3.937 125 4.921	56 2.205	90 3.543	24 .945	50 1.969	13 .500	165 6.496	130 5.118	200 7.874	12 .472	3.5 .138	115 4.530	95 3.740	140 5.512	M8	3 .118	*	168 6.614 144d 5.687d	130 5.120 107d 4.250d	173 6.810 165d 6.531d	22 .880 21d .844d
100	S L	160 6.300	112 4.409 140 5.512	63 2.480	100 3.937	28 1.102	60 2.362	14 .562	215 8.465	180 7.087	250 9.842	14 .560	4 .160	130 5.118	110 4.331	160 6.299	M8	3.5 .138	*	200 7.874	149 5.875 157d 6.060d	180 7.906 190d 9.440d	27 1.063
112	S M	190 7.480	114 4.488 140 5.512	70 2.760	112 4.409	28 1.102	60 2.362	14 .562	215 8.465	180 7.087	250 9.842	14 .560	4 .160	130 5.118	110 4.331	160 6.299	M8	3.5 .138	*	243 7.874	149 5.875	214 8.437	27 1.063
132	S M	216 8.504	140 5.512 178 7.008	89 3.504	132 5.197	38 1.496	80 3.150	14 .562	265 10.433	230 9.055	300 11.811	14 .560	4 .160	165 6.496	130 5.118	200 7.874	M8	3.5 .138	*	243 9.562	187 7.375	256 10.062	27 1.062
160	M L	254 10	210 8.268 254 10	108 4.252	160 6.299	42 1.654	110 4.331	20 .787	300 11.811	250 9.842	350 13.780	19 .748	5 .200	215 8.465	180 7.087	250 9.840	M12	4 .160	*	329 12.940	242 9.510	329 12.940	35 1.375
180	M L	279 10.984	241 9.488 279 10.984	121 4.764	180 7.087	48 1.890	110 4.331	20 .787	300 11.811	250 9.842	350 13.780	19 .748	5 .200		*					395 15.560	333 13.130	372 14.640	51 2.008
200	L M	318 12.520	267 10.512 305 12.008	133 5.236	200 7.874	55 2.165	110 4.331	27 1.062	350 13.799	300 11.811	400 15.748	19 .748	5 .200		*					441 17.375	359 14.125	416 16.375	63 2.500
225	S M	356 14.016	286 11.260 311 12.244	149 5.866	225 8.858	60 2.362	140 5.512	19 .748	400 15.748	350 13.780	450 17.716	19 .748	6 .236		*					495 19.488	383 15.079	483 19.016	63 2.500
250	S M	406 15.984	311 12.244 349 13.740	168 6.614	250 9.843	70 2.756	140 5.512												*	520 20.472	457 17.992	513 20.197	63 2.500
280	S M	457 17.992	368 14.488 419 16.496	190 7.485	280 11.025	80 3.150	170 6.693												*	616 24.252	497 19.567	581 22.874	63 2.500
315	S M	508 20	406 16 457 18	216 8.500	315 12.400	85 3.346	170 6.693												*	759 29.900	683 26.880	682 26.840	102 4
355	S L	610 24	500 19.690 630 24.800	254 10	355 13.980	85 3.346	170 6.693												*	759 29.900	683 26.880	719 28.320	102 4

LEGEND
Metric (MM) Dimensions in Black
Inch Dimensions in Red
d = DC Motors
1 mm = .03937" 1" = 25.40 mm

Horizontal Shaft Arrangements

Vertical Shaft Arrangements

IP Protection - Baldor Enclosures

IP22 = Open Drip Proof AC or DC Motors.
IP54 = All standard TEFC AC and DC Motors.
IP55 = All TEFC Chemical Processing, Dirty Duty, and Washdown Duty Motors

BALDOR ELECTRIC COMPANY
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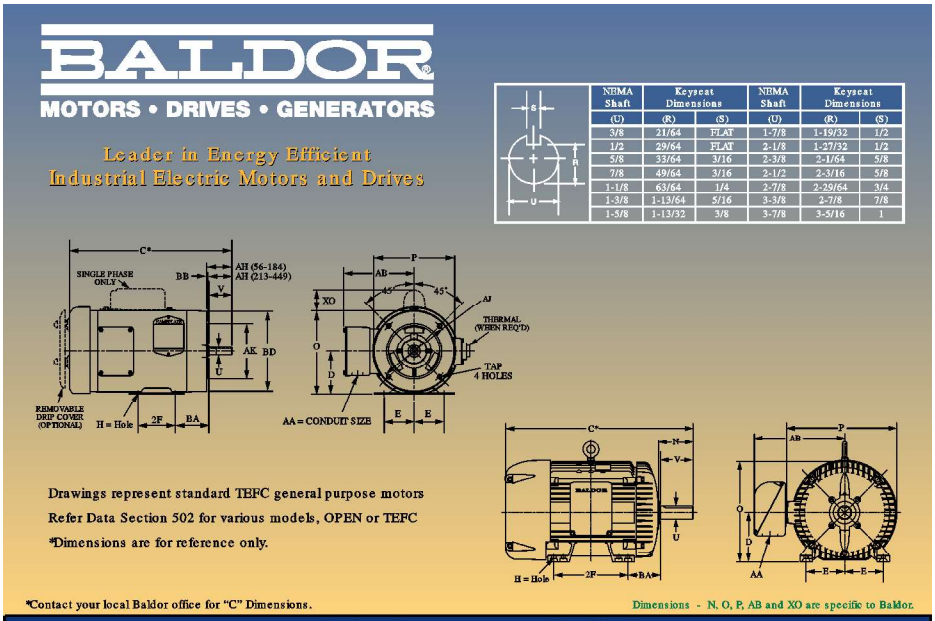
FORT SMITH, ARKANSAS
72902-2400 U.S.A.

SUMMARY OF IP PROTECTION NUMBERS

First # Protection Against Solid Objects	Second # Protection Against Liquids
IP TESTS	
0 NO PROTECTION	0 NO PROTECTION
1 Protection against solid objects up to 50 mm. (E.G. Accidental touch by hands.)	1 Protection against vertical drops of water. (E.G. Condensation.)
2 Protection against solid objects up to 12 mm. (E.G. Fingers)	2 Protection against falling water up to 15 degrees from the vertical.
3 Protection against solid objects over 2.5 mm. (E.G. Tools, Wires)	3 Protection against falling water up to 60 degrees from the vertical.
4 Protection against solid objects over 1 mm. (E.G. Tools, Wires, and Small Wires)	4 Protection against splashing water from all directions, limited ingress.
5 Protection against dust - limited ingress (No harmful deposits)	5 Protection against low pressure jets of water from all directions, limited ingress.
6 Totally protected against all dust.	6 Protection against strong jets of water. (E.G. Use on ship decks, limited ingress.)
	7 Protection against immersion.
	8 Protection against submersion.

Figure C-1. IEC motor dimension chart (Courtesy of Baldor Electric Company).



NEMA Shaft (U)	Keyseat Dimensions (R)	Keyseat Dimensions (S)	NEMA Shaft (U)	Keyseat Dimensions (R)	Keyseat Dimensions (S)
3/8	21/64	FLAT	1-7/8	1-19/32	1/2
1/2	29/64	FLAT	2-1/8	1-27/32	1/2
5/8	33/64	3/16	2-3/8	2-1/64	5/8
7/8	49/64	3/16	2-1/2	2-3/16	5/8
1-1/8	63/64	1/4	2-7/8	2-29/64	3/4
1-3/8	1-13/64	5/16	3-3/8	2-7/8	7/8
1-5/8	1-13/32	3/8	3-7/8	3-5/16	1

NEMA QUICK REFERENCE CHART

NEMA FRAME	D	E	2F	H	N	O	P	U	V	AA	AB	AH	AJ	AK	BA	BB	BD	XO	TAP
42	2-5/8	1-3/4	1-11/16	9/32 SLOT	1-1/2	5	4-11/16	3/8	1-1/8	3/8	4-1/32	1-5/16	3-3/4	3	2-1/16	1/8	4-5/8	1-9/16	1/4-20
48	3	2-1/8	2-3/4	11/32 SLOT	1-7/8	5-7/8	5-11/16	1/2	1-1/2	1/2	4-3/8	1-11/16	3-3/4	3	2-1/2	1/8	5-5/8	2-1/4	1/4-20
56	3-1/2	2-7/16	3	11/32	2-7/16	6-7/8	6-5/8	5/8	1-7/8	1/2	5	2-1/16	5-7/8	4-1/2	2-3/4	1/8	6-1/2	2-1/4	3/8-16
56H			5	SLOT	2-1/8														
143T	3-1/2	2-3/4	4	11/32	2-1/2	6-7/8	6-5/8	7/8	2-1/4	3/4	5-1/4	2-1/8	5-7/8	4-1/2	2-1/4	1/8	6-1/2	2-1/4	3/8-16
145T			5																
182			4-1/2		2-11/16	7		7/8	2-1/4			2-1/8	5-7/8	4-1/2		1/8	6-1/2		3/8-16
184	4-1/2	3-3/4	5-1/2	13/32	2-11/16	8-11/16	7-7/8	7/8	2-1/4	3/4	5-7/8	2-1/8	5-7/8	4-1/2	2-3/4	1/8	6-1/2	2-3/8	3/8-16
182T			4-1/2		3-9/16			1-1/8	2-3/4			2-5/8	7-1/4	8-1/2		1/4	9		1/2-13
184T			5-1/2		3-9/16			1-1/8	2-3/4			2-5/8	7-1/4	8-1/2		1/4	9		1/2-13
213			5-1/2		3-1/2			1-1/8	3		2	2-3/4							
215	5-1/4	4-1/4	7	13/32	3-1/2	10-1/4	9-9/16	1-1/8	3	3/4	7-3/8	2-3/4	7-1/4	8-1/2	3-1/2	1/4	9	2-3/4	1/2-13
213T			5-1/2		3-7/8			1-3/8	3-3/8			3-1/8							
215T			7		3-7/8			1-3/8	3-3/8			3-1/8							
254U			8-1/4		4-1/16			1-3/8	3-3/4			3-1/2							
256U	6-1/4	5	10	17/32	4-1/16	12-7/8	12-15/16	1-3/8	3-3/4	1	9-5/8	3-1/2	7-1/4	8-1/2	4-1/4	1/4	10	—	1/2-13
254T			8-1/4		4-5/16			1-5/8	4		3	-3/4							
256T			10		4-5/16			1-5/8	4		3	-3/4							
284U			9-1/2		5-1/8			1-5/8	4-7/8			4-5/8							
286U			11		5-1/8			1-5/8	4-7/8			4-5/8							
284T	7	5 1/2	9 1/2	17/32	4 7/8	14 5/8	14 5/8	1 7/8	4 5/8	1 1/2	13 1/8	4 3/8	9	10 1/2	4 3/4	1/4	11 1/4		1/2 13
286T			11		4-7/8			1-7/8	4-5/8			4-3/8							
284TS			9-1/2		3-3/8			1-5/8	3-1/4			3							
286TS			11		3-3/8			1-5/8	3-1/4			3							
324U			10-1/2		5-7/8			1-7/8	5-5/8			5-3/8							
326U			12		5-7/8			1-7/8	5-5/8			5-3/8							
324T	8	6-1/4	10-1/2	21/32	5-1/2	16-1/2	16-1/2	2-1/8	5-1/4	2	14-1/8	5	11	12-1/2	5-1/4	1/4	13-3/8	—	5/8-11
326T			12		5-1/2			2-1/8	5-1/4			5							
324TS			10-1/2		3-15/16			1-7/8	3-3/4			3-1/2							
326TS			12		3-15/16			1-7/8	3-3/4			3-1/2							
364U			13-1/4		6-3/4			2-1/8	6-3/8			6-1/8							
365U			12-1/4		6-3/4			2-1/8	6-3/8			6-1/8							
364T	9	7	11-1/4	21/32	6-1/4	18-1/2	18-1/4	2-3/8	5-7/8	2-1/2	15-1/16	5-5/8	11	12-1/2	5-7/8	1/4	13-3/8	—	5/8-11
365T			12-1/4		6-1/4			2-3/8	5-7/8			5-5/8							
364TS			11-1/4		4			1-7/8	3-3/4			3-1/2							
365TS			12-1/4		4			1-7/8	3-3/4			3-1/2							
404U			15-1/4		7-5/16			2-3/8	7-1/8			6-7/8							
405U			13-3/4		7-3/16			2-3/8	7-1/8			6-7/8							
404T	10	8	12-1/4	13/16	7-5/16	20-5/16	20-1/8	2-7/8	7-1/4	3	18	7	11	12-1/2	6-5/8	1/4	13-7/8	—	5/8-11
405T			13-3/4		7-5/16			2-7/8	7-1/4			7							
404TS			12-1/4		4-1/2			2-1/8	4-1/4			4							
405TS			13-3/4		4-1/2			2-1/8	4-1/4			4							
444U			14-1/2		8-5/8	22-7/8	22-3/8	2-7/8	8-5/8		19-9/16	8-3/8							
445U			16-1/2		8-5/8	22-7/8	22-3/8	2-7/8	8-5/8		19-9/16	8-3/8							
444T			14-1/2		8-1/2	22-7/8	22-3/8	3-3/8	8-1/2		19-9/16	8-1/4							
445T			16-1/2		8-1/2	22-7/8	22-3/8	3-3/8	8-1/2		19-9/16	8-1/4							
447T	11	9	20	13/16	8-15/16	22-15/16	23-3/4	3-3/8	8-1/2	3	21-11/16	8-1/4	14	16	7-1/2	1/4	16-3/4	—	5/8-11
449T			25		8-15/16	22-15/16	23-3/4	3-3/8	8-1/2		21-11/16	8-1/4							
444TS			14-1/2		5-3/16	22-7/8	22-3/8	2-3/8	4-3/4		19-9/16	4-1/2							
445TS			16-1/2		5-3/16	22-7/8	22-3/8	2-3/8	4-3/4		19-9/16	4-1/2							
447TS			20		4-15/16	22-15/16	23-3/4	2-3/8	4-3/4	4NPT	21-11/16	4-1/2							
449TS			25		4-15/16	22-15/16	23-3/4	2-3/8	4-3/4	4NPT	21-11/16	4-1/2							

5000 FRAME	D	E	2F	H	O	P	U	V	AA	AB	BA
5007S	12-1/2	10	22	15/16	26-27/32	30	2-1/2	6-1/2	4-NPT	26-7/8	8-1/2
5007L	12-1/2	10	22	15/16	26-27/32	30	3-7/8	11-1/8	4-NPT	26-7/8	8-1/2
5009S	12-1/2	10	28	15/16	26-27/32	30	2-1/2	6-1/2	4-NPT	26-7/8	8-1/2
5009L	12-1/2	10	28	15/16	26-27/32	30	3-7/8	11-1/8	4-NPT	26-7/8	8-1/2
5011S	12-1/2	10	36	15/16	26-27/32	30	2-1/2	6-1/2	4-NPT	26-7/8	8-1/2
5011L	12-1/2	10	36	15/16	26-27/32	30	3-7/8	11-1/8	4-NPT	26-7/8	8-1/2

NEMA C-Face	BA Dimensions
143-5TC	2-3/4
182-4TC	3-1/2
213-5TC	4-1/4
254-6TC	4-3/4

BALDOR ELECTRIC COMPANY
P.O. BOX 2400
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NEMA FRAMES PRIOR TO 1953							
Frame	D	E	F	N	U	V	BA
66	4-1/8	2-15/16	2-1/2	2-1/4	3/4	2-1/4	3-1/8
203	5	4	2-3/4	2-7/16	3/4	2	3-1/8
204			3-1/4				
224	5-1/2	4-1/2	3-3/8	3-1/4	1	3	3-1/2
225			3-3/4				
254	6-1/4	5	4-1/8	3-7/16	1-1/8	3-3/8	4-1/4
284	7	5-1/8	4-3/4	4-1/4	1-1/4	3-5/8	4-3/4
324	8	6-1/4	5-1/4	5-3/8	1-5/8	4-7/8	5-1/4
326			6				
364	9	7	5-5/8	5-5/8	1-7/8	5-3/8	5-7/8
365			6-1/8				
404	10	8	6-1/8	6-3/8	2-1/8	6-1/8	6-5/8
405			6-7/8				
444	11	9	7-1/4	7-1/8	2-3/8	6-7/8	7-1/2
445			8-1/4				
504	12-1/2	10	8	8-5/8	2-7/8	8-3/8	8-1/2
505			9				

Figure C-2. NEMA motor dimension chart (Courtesy of Baldor Electric Company).

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Basic Setup and Lockout/Tagout Procedures

This appendix contains the Basic Setup and Lockout/Tagout procedures specific to the Industrial Controls Training System. It is divided into four sections:

- Basic Setup procedure, explains the basic operations that must be performed at the beginning of the exercise procedures.
- Lockout/Tagout procedure (de-energizing procedure), describes the lockout/tagout procedure used to de-energize the training system before setting up a circuit.
- Energizing procedure, gives details on how to end a lockout/tagout procedure and energize the training system.
- Module identification, gives instructions on how to use the magnetic labels to identify the modules.

Basic setup procedure

This procedure is recommended at the beginning of every experiment involving the modules of the training system. It ensures that the system is safe prior to cabling specific circuits.

Figure D-1. AC Power Supply, Model 3196.

1. Make sure that the power switch located on your side of the AC Power Supply is set to the O position.

The AC Power Supply should already be installed in the Industrial Controls Mobile Workstation.

2. Install the Lockout module into the workstation.

Each time you install a module in the workstation, make sure that the fault switches located behind the module faceplate are set to the O position as shown in Figure D-2.

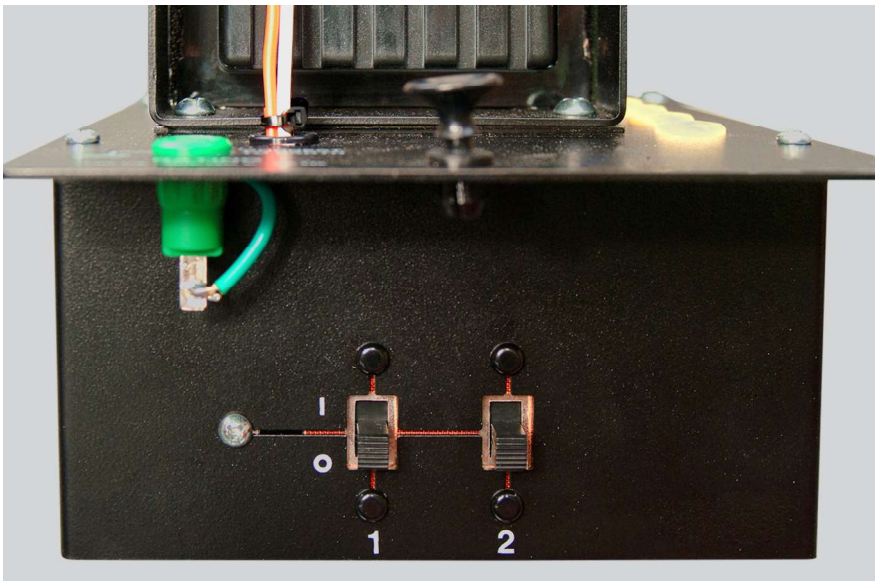

Figure D-2. Make sure that the fault switches are set to the O position.

3. Turn off the Lockout Module.

4. Connect the Lockout Module leads to the AC Power Supply module terminals, noting the phase sequence. See Figure D-3.

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Figure D-3. Lockout Module connected to the AC Power Supply module.

Lockout/Tagout procedure (de-energizing procedure)

1. Turn off the Lockout Module.

2. Install the lockout hasp and the student padlocks and tags on the Lockout Module. Ask the instructor to install the lab padlock and tag as well. Refer to Figure D-4 for details.

Figure D-4. Installation of padlocks and hasps.

3. Check that the Lockout Module switch cannot be opened. With a voltmeter, verify that no voltage is present between the Lockout Module output terminals to confirm that the circuit is de-energized. You may now set up your circuit.

Energizing procedure

1. Interconnect the ground terminal (green) of all AC modules with the ground terminal of the Lockout Module.

DC modules do not incorporate ground terminals.

2. Make sure the Security Guard is installed if you are using a motor.

3. Identify the modules with labels as described in the Module Identification section of this Appendix.

4. Once the connections have been made, ask for the instructor to check the circuit. When the circuit is correctly wired, notify all the people working around the workstation that the system will be energized.

5. Remove the lockout hasp, padlocks and tags.

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6. Turn on the AC Power Supply and Lockout Module, and return to your exercise.

Module identification

7. Once the setup is completed, identify all buttons, pilot lights, switches, etc, in accordance with the circuit schematic diagram. Place the magnetic labels on the module faceplates as shown in Figure D-5.

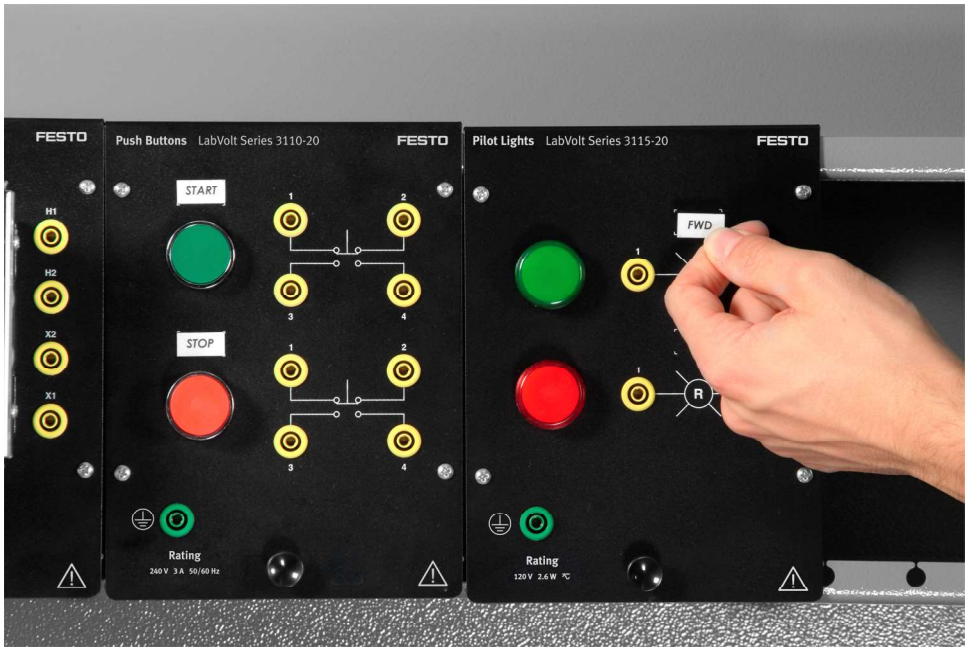

Figure D-5. Module identification.

For storing purposes, arrange the magnetic labels in alphabetic order on the vertical surface of the Industrial Controls Mobile Workstation as shown in Figure D-6.

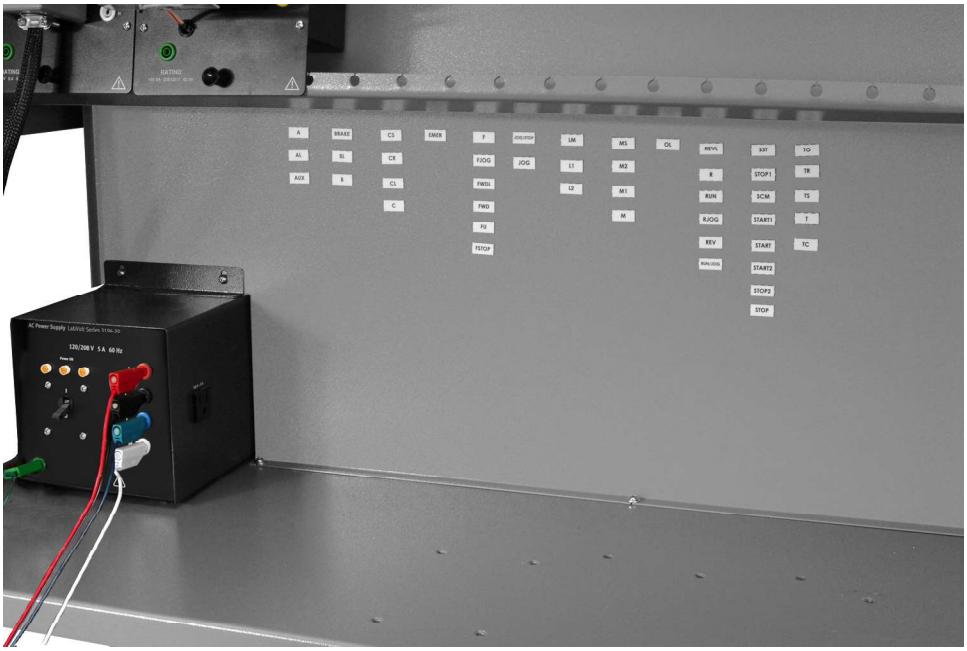

Figure D-6. Store the magnetic labels on the vertical surface of the Industrial Controls Mobile Workstation.

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Brake Motor, Inertia Wheel, and Safety Guard Installation

Installation of the brake motor on the mounting plate

To facilitate electrical connections, the Brake Motor should be installed at your left when facing the motors.

- Position and align the mounting plate over the four holes at the left of the Industrial Controls Mobile Workstation.
- Place the Brake Motor over the mounting plate.
- Fix the Brake Motor to the mounting plate of the workstation using hexagonal head screws with knurled nuts or with washers when placing the head of the screw on top. Figure E-1 shows the two fixing methods.

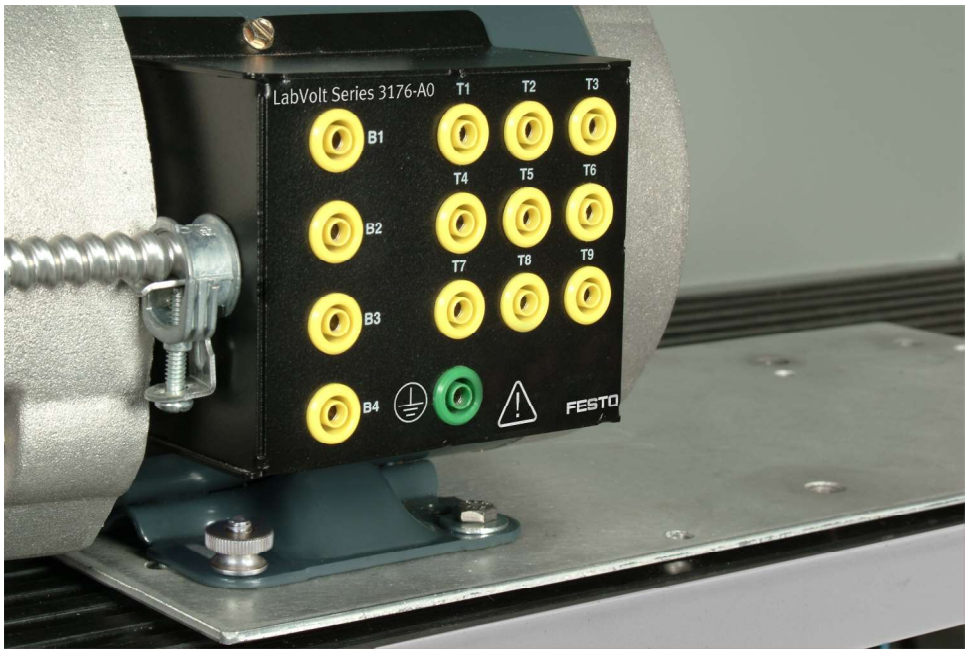

Figure E-1. Install the Brake Motor on the mounting plate.

Installation of the inertia wheel on the brake motor shaft

- Install a 3/16 x 3/16 key in the shaft keyseat (at the extremity of the shaft).
- Slide the Inertia Wheel over the Brake Motor shaft taking care of aligning the Inertia Wheel keyway with the key (see Figure E-2).

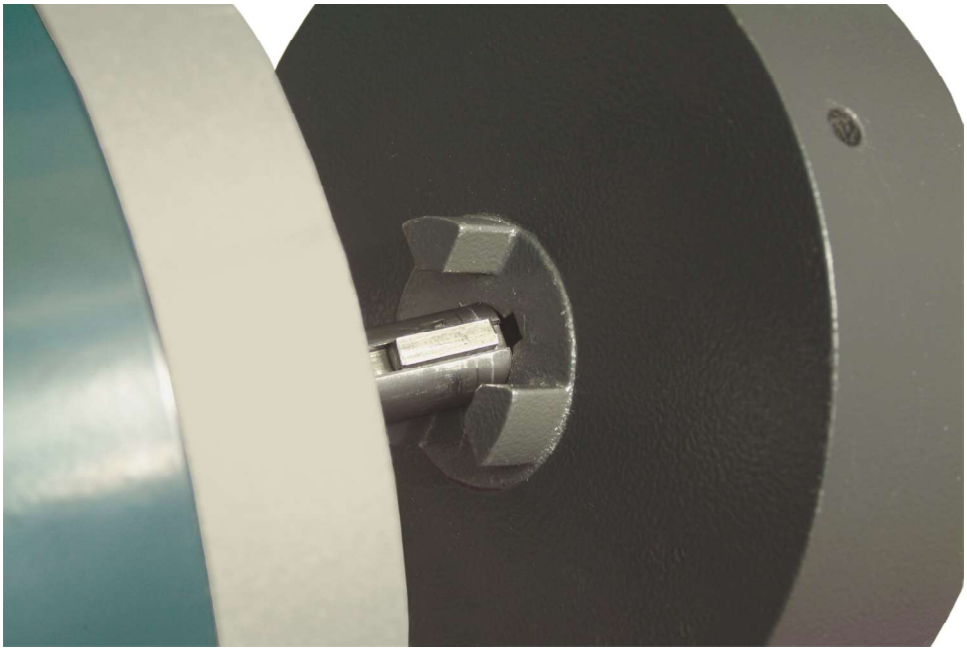

Figure E-2. Align the Inertia Wheel keyway with the key.

- Tighten the setscrew with a hexagonal key as shown in Figure E-3.

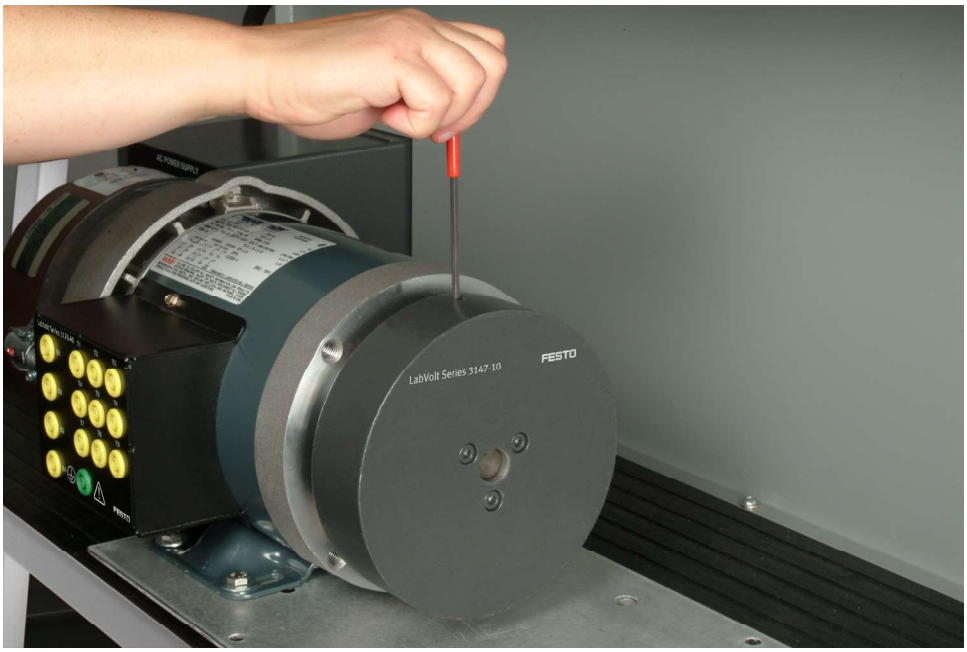

Figure E-3. Tighten the setscrew with a hexagonal key.

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Installation of the safety guard

- Install the Safety Guard over the Inertia Wheel as shown in Figure E-4. Press the push-locks (4) once the Safety Guard is placed.

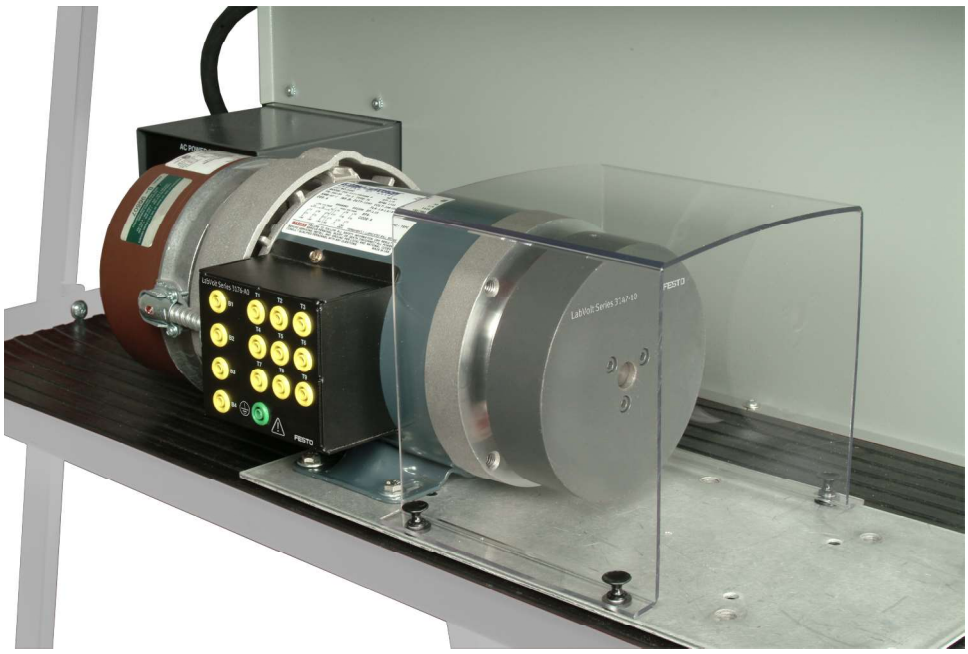

Figure E-4. Installation of the Safety Guard.

Brake Motor Characteristics

The characteristics of the Brake Motor are:

Ratings	208 V	380 V	415 V	380 V
Power source frequency (Hz)	60	50	50	60
Power rating (hp)	1/3	1/4	1/4	1/3
Full-load current (A)	1.5	0.7	0.8	0.77
Number of phases	3			
Service factor	1.15			
Enclosure type	TEFC			
Duty rating	CONT.			
Maximum ambient temperature (°C)	40			
Rotation speed (r/min)	1725	1425	1425	1725
Design code letter NEMA	B			
Locked rotor code letter	N			
Insulation class	B			

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Glossary

across-the-line starting	See DOL Starting.
affected employee	An employee whose duties are related to the machine or equipment in question but who is not performing the servicing or maintenance operations.
ambient temperature	The temperature of a medium such as air, water or earth into which the heat of the equipment is dissipated.
autotransformer	A single-winding transformer in which the primary coil is a fraction of the entire winding for voltage step up, or the secondary coil is a fraction of the entire winding for voltage step down.
cam switch	A type of contact switch that closes certain electrical contacts or combination of contacts at various positions of a cam.
connection diagram	See Wiring Diagram.
contact rating designations	Ratings (for example A600 or P300) giving an indication of the make and brake currents under a specified voltage.
contactor	A heavy-duty switching device used to establish and repeatedly interrupt an electrical power circuit.
control relay	An auxiliary relay that controls the operation of motor starters, contactors, switching solenoids, and other relays.
controller	A device or group of devices that governs, in a predetermined manner, the delivery of electric power to apparatus connected to it. (IEEE)
core (magnetic core)	The part of the magnetic structure around which the magnetizing winding is placed. (IEEE)
delta-connected circuit	A three-phase circuit that is mesh connected.
DOL (direct-on-line) starting	The process of starting a motor by connecting it directly to the supply at a rated voltage. (IEEE)
drum switch	A type of contact switch that closes certain electrical contacts or combination of contacts at various positions of a rotating cylinder or sector.
electromagnetic induction	The production of an electromotive force in a circuit by a change in the magnetic flux linking with that circuit. (IEEE)
electromechanical device	A device that is electrically operated and has mechanical motion such as relays, servos, etc. (IEEE)
elementary diagram	See Schematic Diagram.

energy source	Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.
energy-isolating device	A mechanism that prevents the transmission or release of energy and to which all locks or tags are attached.
float switch	A switch in which actuation of the contacts is affected when a float reaches a predetermined level. (IEC)
friction brake	Motor stopping method where shoes or pads come in contact with a wheel mounted on the motor shaft.
full-load ampere rating (FLA)	See Full-Load Current Rating (FLC).
full-load current rating (FLC)	The current required to produce full-load torque at the motor's rated voltage and speed.
full-voltage starting	See DOL Starting.
inching	See Jogging.
induction motor	An ac motor in which a primary winding on one member is connected to the power source and a polyphase secondary winding or a squirrel-cage secondary winding on the other member carries induced current. (IEEE)
inrush current	Initial surge of a current into a load before it attains normal operating condition.
interrupting capacity	The highest current at rated voltage that the device can interrupt. (IEEE)
jogging	Quickly repeated closure of a circuit to start a motor from rest for the purpose of accomplishing small movements of the driven machine.
limit switch	A switch that is operated by some part or motion of a power driven machine or equipment to alter the electric current associated with the machine or equipment. (ANSI)
lockout procedure	The placement of a lock on an energy-isolating device, in accordance with an established procedure, ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the lock is removed.
low-voltage protection	See Three-Wire Protection.
low-voltage release	See Two-Wire Control.
magnetic brake	See Friction Brake.
magnetic field	The space around a magnetic pole or magnetized body in which the magnetic force has an effect.
motor starter	Electric controller (comprising a contactor and an overload protection device) used to accelerate a motor from rest to normal speed and for stopping the motor.

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normally closed (NC) contact	Contact that is in a closed position when the operating magnet is de-energized.
normally open (NO) contact	Contact that is in an open position when the operating magnet is de-energized.
no-voltage protection	See Three-Wire Protection.
no-voltage release	See Two-Wire Control.
overload relay	A relay that responds to electric load and operates at a preset value of overload. (ANSI). Overload relays are usually current relays but they may be power, temperature, or other relays.
part-winding starting	Motor starting method where power is applied first to part of the motor coil windings. During normal operation, power is applied to all coil windings.
PLC (programmable logic controller)	A small computer that is programmed and reprogrammed to automatically control an industrial process or machine.
plugging	Motor braking method that uses the counter torque produced by connections reversal.
pressure switch	A switch in which actuation of the contacts is affected at a predetermined liquid or gas pressure. (IEC)
r/min (revolutions per minute)	The number of full rotations something makes in one minute.
relay	An electrical switch that opens and closes under the control of another electrical circuit.
rotor	The rotating member of a machine, including the shaft.
schematic diagram	A diagram that shows all circuit connections between components, by means of graphic symbols, without taking into account physical sizes, shapes, or locations of the items.
selector switch	A device that can provide several different contact arrangements by rotating a single switch.
service factor	Multiplier that is applied to the rated power to indicate the permissible power loading capacity designed into a motor.
solenoid	A tubular, current carrying coil that provides magnetic action to perform various work functions.
solid-state	Circuitry designed using integrated circuits (transistors, diodes, etc.), without any electromechanical devices, such as relays.
squirrel-cage induction motor	An induction motor in which a primary winding on one member (usually the stator) is connected to an alternating-current power source and a secondary cage winding on the other member (usually the rotor) carries alternating current produced by electromagnetic induction.

star-connected circuit	See Wye-Connected Circuit.
stator	The portion of a motor that includes and supports the stationary portion of the magnetic circuit and the associated winding and leads.
tagout procedure	The placement of a tag on an energy-isolating device, in accordance with an established procedure, to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tag is removed.
target table	Table used to indicate the contact condition of a device, depending on its states.
three-phase circuit	A combination of circuits energized by alternating electromotive forces that differ in phase by one third of a cycle; that is 120°. (ANSI)
three-wire control	A control function that utilizes a momentary-contact pilot device and a holding-circuit contact to provide undervoltage protection. (IEEE)
torque	The twisting or turning force which tends to produce rotation in a motor.
trigger	A pulse used to start or stop the operation of a circuit or device.
two-wire control	A control function that utilizes a maintained-contact type of pilot device to provide undervoltage release. (IEEE)
undervoltage protection	The effect of a device, dependant on the reduction or failure of voltage, to cause and maintain the interruption of power to the main circuit. (IEEE)
undervoltage release	The effect of a device, dependant on the reduction or failure of voltage, to cause the interruption of power to the main circuit, but not to prevent the reestablishment of the main circuit on return of voltage. (IEEE)
wiring diagram	A diagram that locates and identifies electrical devices, terminals, and interconnecting wiring in an assembly. (NEMA)
wye-connected circuit	A polyphase circuit in which all the current paths extend from a terminal or conductor.

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Fault Identification

Many modules of the training system are provided with hidden fault insertion switches. Fault insertion allows the students to develop troubleshooting skills. Troubleshooting will be seen later in the Industrial Controls Training System student manuals.

The following figures show the location of the faults in the circuit of each module.

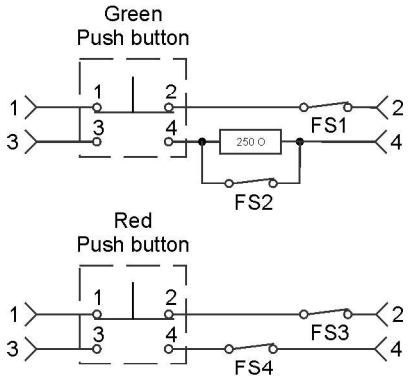

Figure H-1. Push-Button, Model 3110.

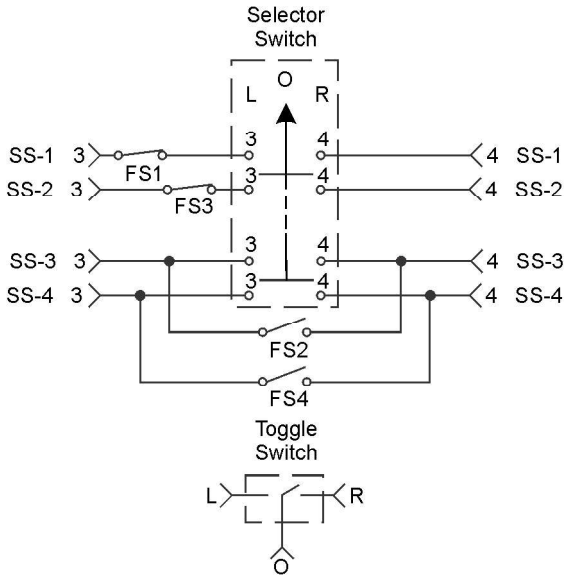

Figure H-2. Selector Switches, Model 3111.

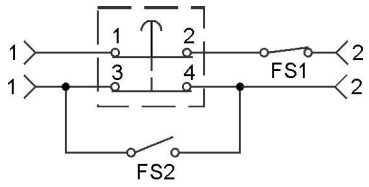

Figure H-3. Emergency Button, Model 3114.

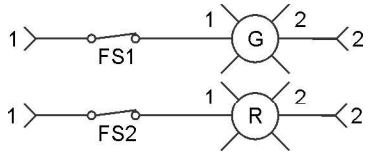

Figure H-4. Pilot Lights, Model 3115.

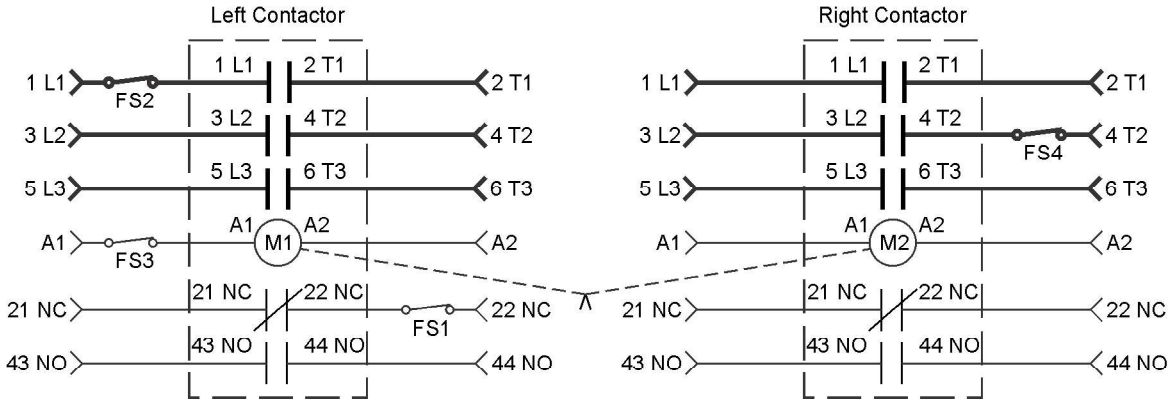

Figure H-5. Dual Contactors, Model 3119.

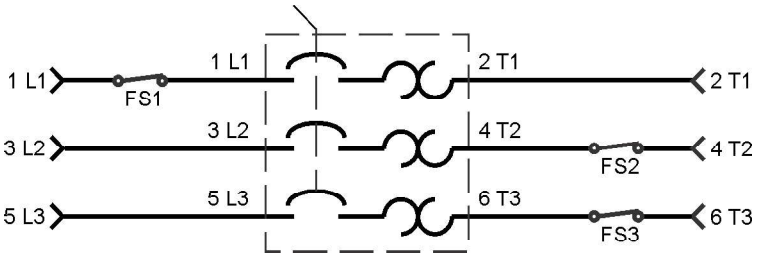

Figure H-6. Three-Phase Manual Starter, Model 3126.

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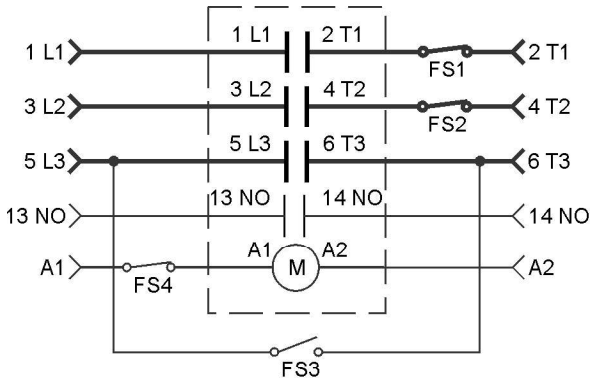

Figure H-7. Contactor, Model 3127.

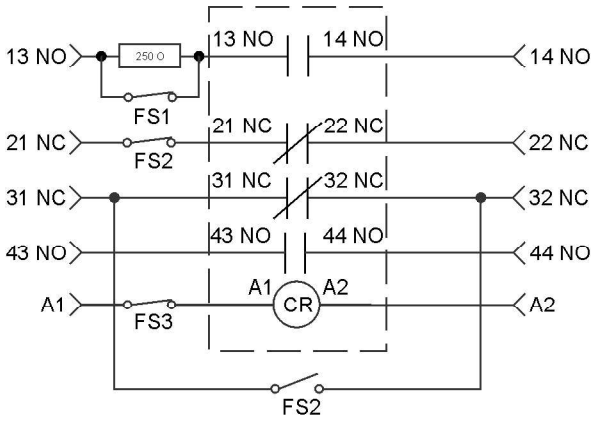

Figure H-8. Control Relay, Model 3130.

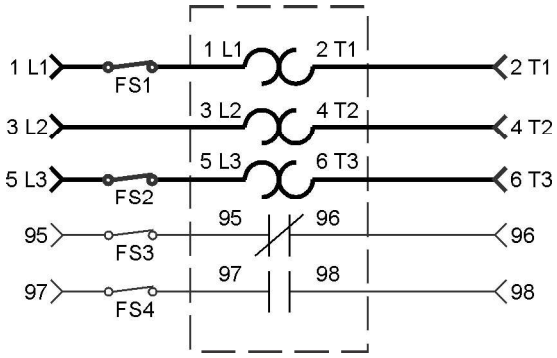

Figure H-9. Overload Relay, Model 3131.

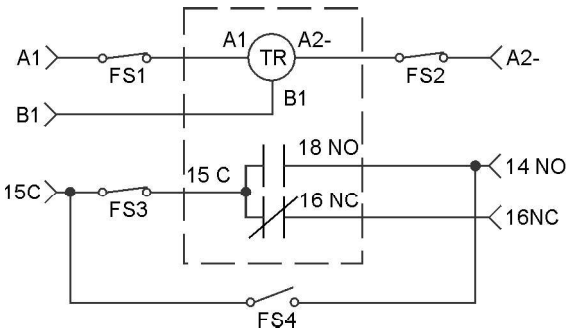

Figure H-10. Time Relay, Model 3132.

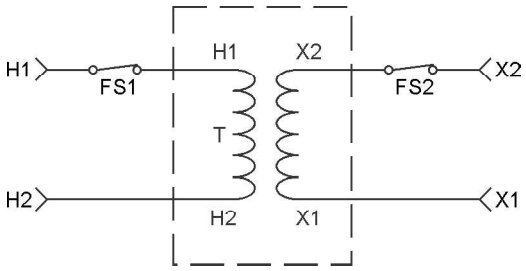

Figure H-11. Control Transformer, Model 3138.

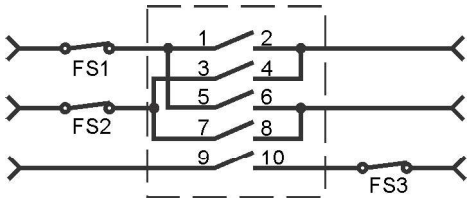

Figure H-12. Cam Switch, Model 3140.

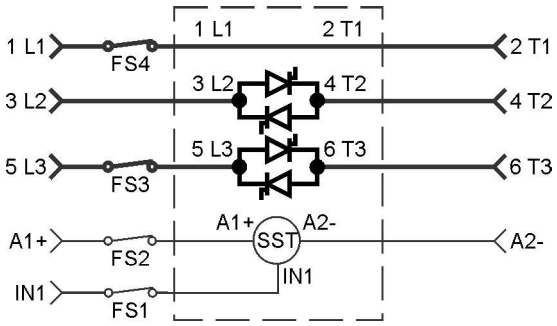

Figure H-13. Soft Starter, Model 3186.

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