





OPERATOR AND METERING PANELS

Unit spaces can be used to provide metering and/or operator's panels in the motor control center itself. Arrangement and dimensions will vary depending on the quantity and type of the devices required. Normally, fuse blocks, terminal blocks, current and potential transformers, etc., can be mounted on a base within the unit space. Meters, pilot lights, pushbuttons, switches, etc., can be mounted on the door. Suitable locations and adequate space should be provided so that wiring is simplified and there is no interference between door and base mounted components. The following devices are often specified.

- Pushbuttons, selector switches, pilot lights.
- Ammeters, voltmeters, and other instruments (panel or switchboard type).
- Instrument and transfer switches
- Electronic power meter
- Control relays
- Timing relays (pneumatic, motor-operated, or electronic)

These panels will be UL Labeled providing all the components are UL Listed for use in motor control centers.

RELAY PANELS

Relay panels can be furnished from 1 space unit to 6 space units with full width doors. The amount of vertical space required is generally determined by the number of terminal board points required or relay type used; when in doubt allow for a double vertical row of terminal boards.

These panels will be UL Labeled providing all the components are UL Listed for use in motor control centers.

SINGLE VERTICAL ROW OF T.B.'s						DOUBLE VERTICAL ROW OF T.B.'s				
Space Units	Maximum No. of T.B. Points	Horizontal Width for Component Mounting		Maximum No. of Std. 4-Pole Relays		Maximum No. of T.B. Points	Horizontal Width for Component Mounting		Maximum No of Std. 4-Pole Relays	
SECTION WIDTH		20"W	24"W	20"W	24"W		20"W	24"W	20"W	24"W
1	12	11 1/2"	14 1/2"	6	8	24	6"	7 1/2"	3	4
1 1/2	24	11 1/2"	14 1/2"	12	16	48	6"	7 1/2"	6	8
2	30	11 1/2"	14 1/2"	18	24	60	6"	7 1/2"	9	12
2 1/2	42	11 1/2"	14 1/2"	24	32	84	6"	7 1/2"	12	16
3	48	11 1/2"	14 1/2"	36	48	96	6"	7 1/2"	18	24
3 1/2	60	11 1/2"	14 1/2"	42	56	120	6"	7 1/2"	21	28
4	72	11 1/2"	14 1/2"	48	64	144	6"	7 1/2"	24	32
4 1/2	78	11 1/2"	14 1/2"	54	72	156	6"	7 1/2"	27	36
5	90	11 1/2"	14 1/2"	60	80	180	6"	7 1/2"	30	40
5 1/2	96	11 1/2"	14 1/2"	66	88	192	6"	7 1/2"	33	44
6	108	11 1/2"	14 1/2"	72	96	216	6"	7 1/2"	36	48

ALTERNATOR RELAY PANELS

Consists of two motor alternator circuit using two control relays and a latching relay. Requires minimum 1 space unit height.



Spectra Series™ and 8000-Line Motor Control Centers

Miscellaneous Units

LIGHTING AND DISTRIBUTION PANELBOARDS

The following panelboards are available for mounting in motor control centers. Type AL and AQ Panelboards with main circuit breakers are normally provided. Type AE and AD panels require a feeder unit for the main CB, which then feeds the M.L.O. panel.

Panel Type	System Voltage (Maximum)	Branch			Interrupting Rating ② RMS Symmetrical Amps (in thousands)
		Type	Poles①	Ampere Rating	
A Series Type AL	120/240 VAC	THQL	1	15-70	10
		THQL	2	15-100	10
		THHQL	1	15-70	22
		THHQL	2	15-125	22
		TXQL	1,2	15-30	65
		THQL	2,3	15-100	10
	240 VAC	THHQL	2,3	15-100	22
		THQL	3	15-30	65
A Series Type AQ		120/240 VAC	THQB-GF	1,2	15-30
	THQB		1	15-70	10
	THQB		2	15-100	10
	THHQB-GF		1	15-30	22
	THHQB		1	15-70	22
	THHQB		2	15-100	22
	240 VAC	TXQB	1,2	15-30	65
		THQB	1,2	15-100	10
A Series Type AE 4 Wire	120 VAC	TEY	1	15-100	65
	240 VAC	TEY	2,3	15-100	65
	277 VAC	TEY	1	15-100	14
	480/277 VAC Max.	TEY	2,3	15-100	14
A Series Type AD 3 Wire	277 VAC	TED	1	15-100	14
		TED4	1	15-50	14
		THED	1	15-30	65
	480 VAC	TED4	2	15-100	14
		TED4,6	3	15-150	14
		THED4	2	15-100	25
		THED4	3	110-150	25
		THED6	3	15-150	25
	600 VAC	TED6	3	15-150	14
		THED6	3	15-150	18

- ① Two-pole THED breakers require a 3-pole space.
- ② Equipment rating is equal to the lowest interrupting rating of any circuit breaker installed.

NOTES:

Branch devices are plug-in for Type AL and bolt-on for AQ, AE and AD panelboards. Maximum of 42 circuits per panel.

Ground fault CB not available in AL panels.

Lighting panel main bus is rated 1000 amps per square inch, alternate 800 amps per square inch is available.

MCC SPACE UNITS

Number of Circuits	Panel Main Bus Rating (Amps)	Space Units③ AL, AQ	Space Units③ AE	UL Listed
12	100	2	2	X
12	225	2½	2	X
18	100	2½	2½	X
18	225	2½	2½	X
24	225	3	2½	X
24	400	4½	3½	X
30	225	3	3	X
30	400	4½	3½	X
36	225	3½	3	X
36	400	5	4	X
42	225	3½	3½	X
42	400	5	4	X

AD

Number of Circuits	Panel Main Bus Rating (Amps) (X)	Space Units③	UL Listed (X)
12	100	2½	
12	225	3	
18	100	3	
18	225	3½	
24	100	3	
24	225	3½	
30	100	3½	
30	225	4	
36	100	4	
36	225	4½	
42	100	4	
42	225	4½	

- ③ One space unit (X) equals 12-inch vertical height. M.L.O. panel does not include feeder space requirements. (see pg. C-5)

- The unit rating is the same as the lighting panel rating when:
- A. The lighting panel is mounted as a separate motor control center unit but not connected to any power source within the motor control center. This does not reduce or affect motor control center short-circuit rating. The lighting panel must have a main breaker.
 - B. The lighting panel is mounted as a separate motor control center unit and factory connected directly (with no intermediate transformer) to motor control center bus through a feeder. The panel series rating must equal or exceed motor control center short-circuit rating.
 - C. The lighting panel is mounted as a separate motor control center unit and factory connected to a transformer unit in the motor control center. This does not reduce or affect motor control center short-circuit rating.





DISTRIBUTION TRANSFORMERS

GENERAL

Open, dry-type transformers with primary thermal-magnetic circuit breaker or fusible switch with NEMA Class R (dual element) fuses are available in motor control center construction. The accompanying tables give both single- and three-phase transformers normally mounted in motor control centers for use in supplying separate-source control circuits, panelboards, and power external to the motor control center.

Space units shown includes space necessary for the primary disconnect. One space unit equals 12 inches of vertical height. If transformers with taps are required, refer to the factory.

Primary disconnects rated 225-amperes and less stab into the vertical bus. Higher ratings use bolted connections. Transformer secondary conductors are wired to a terminal board in the unit. One leg of 120-volt secondaries, the center point of 120/240-volt secondaries, and the Y-point of 3-phase secondaries are grounded unless otherwise specified.

NEC Article 450-3 covers transformer protection, other than motor control circuit transformers or special applications. The general requirements are:

Primary Protection Only

Primary Current	Primary Protection Rating
9 amps or more	125% or next higher standard rating per NEC Sect. 240-6
2 amps to 9 amps	167% maximum
Less than 2 amps	300% maximum

Primary and Secondary Protection

Secondary Current	Primary Prot. Rating	Sec. Prot. Rating
9 amps or more	250% maximum	125% or next higher standard rating
Less than 9 amps	250% maximum	167% maximum

The degree of protection required depends on the specific application. Select a transformer protective device which provides the required protection. Secondary protection in each ungrounded conductor can be provided if specified.

THREE-PHASE TRANSFORMERS (DELTA-Y)

FUSED SWITCH-100kA IC						CIRCUIT BREAKER					
KVA	Switch Size	Fuse Amps ④	Space Unit	UL Listed (X)	Notes	IC Rating (kA)		CB Trip ⑤	Space Unit	UL Listed (X)	Notes
						25	100				
380-120/208 VOLTS, 50 HERTZ											
3	30	7	2.5	X							
9	30	17.5	3	X		THED	THEDL	30	3	X	
30	60	60	6	X	①②	THED	THEDL	70	6	X	①②
45	200	90	6	X	③	THED	SEP	150	6	X	③
480-120/208 VOLTS, 60 HERTZ											
3	30	5.6	2.5	X							
9	30	15	3	X		THED	THEDL	20	3	X	
15	30	25	3	X		THED	THEDL	30	3	X	
30	60	45	6	X	①②	THED	THEDL	70	6	X	①②
45	200	70	6	X	③	THED	SEP	125	6	X	③
600-120/208 VOLTS, 60 HERTZ											
3	30	4.5	2.5	X							
9	30	12	3	X		THEDL	THEDL	20	3	X	
30	60	40	6	X	①②	THEDL	THEDL	70	6	X	①②
45	60	60	6	X	③	THEDL	THEDL	100	6	X	③

- ① Requires full depth of motor control center. Units cannot be mounted below or behind transformer.
- ② Requires 24-inch wide enclosure.
- ③ Requires 20-inch deep enclosure 24-inch wide. Units cannot be mounted below or behind transformer.
- ④ Sized for primary protection only. (Dual element fuses)
- ⑤ Sized for primary and secondary protection.



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SINGLE-PHASE TRANSFORMERS

FUSED SWITCH-100KA IC						CIRCUIT BREAKER					
KVA	Switch Size	Fuse Amps ④	Space Unit	UL Listed (X)	Notes	IC Rating (kA)		CB Trip ⑤	Space Unit	UL Listed (X)	Notes
						25	100				
240-120/240 VOLTS, 60 HERTZ											
0.50	30	3.2	1	X							
1	30	7	1	X							
3	30	15	1.5	X		THED	THEDL	30	1.5	X	
5	30	30	2	X		THED	THEDL	40	2	X	
10	60	60	2	X	①	THED	THEDL	70	2	X	①
15	200	80	4	X	①⑥⑦	THED	SEP⑧	150	3.5	X	①⑥
25	200	150	4	X	①⑥	THFK	SFP⑨	225	3	X	①⑥
37.5	200	200	6	X	③	THFK	SFP⑨	225	6	X	③
380-120/240 VOLTS, 50 HERTZ											
0.50	30	3.5	1	X							
1	30	4	1	X							
3	30	12	1.5	X		THED	THEDL	15	1.5	X	
10	60	35	2	X	①	THED	THEDL	50	2	X	①
15	60	50	2.5	X	①⑥	THED	THEDL	90	2.5	X	①⑥
25	200	90	4	X	①⑥⑦	THED	SEP⑧	150	3	X	①⑥
37.5	200	125	6	X	③	THED	SEP⑧	125	6	X	③
480-120/240 VOLTS, 60 HERTZ											
0.50	30	2.8	1	X							
1	30	3.5	1	X							
3	30	10	1.5	X		THED	THEDL	15	1.5	X	
5	30	12	2	X		THED	THEDL	20	2	X	
10	30	25	2	X	①	THED	THEDL	40	2	X	①
15	60	40	2.5	X	①⑥	THED	THEDL	50	2.5	X	①⑥
25	200	70	4	X	①⑥⑦	THED	SEP⑧	125	3	X	①⑥
37.5	200	100	6	X	③	THED	SEP⑧	125	6	X	③
600-120/240 VOLTS, 60 HERTZ											
0.50	30	2.5	1	X							
1	30	4	1	X							
3	30	8	1.5	X							
10	30	20	2	X	①	THEDL	THEDL	40	2	X	①
15	60	35	2.5	X	①⑥	THEDL	THEDL	50	2.5	X	①⑥
25	60	60	3	X	①⑥	THEDL	THEDL	100	3	X	①⑥
37.5	200	80	6	X	③	THEDL	THEDL	90	6	X	③

- ⑥ Requires 20" deep enclosure.
- ⑦ Delete 1SU for 65KAIC and below. (100A SW.)
- ⑧ Add 1/2 space unit.
- ⑨ Add 1 space unit.

E



POWER FACTOR CORRECTION CAPACITORS

DESCRIPTION

Motors and other inductive loads require two kinds of electrical current: Current which performs the actual work and reactive current which produces the magnetic fields necessary for the operation of inductive devices such as motors. Both types of currents produce system I^2R losses. Capacitors installed near inductive loads can be used to reduce the reactive currents which flow through much of the system, thereby reducing I^2R losses.

Low-voltage capacitors are generally three-phase units, delta-connected, and are protected by current limiting fuses. The fuses disconnect the capacitor in the event of an electrical short, providing service continuity for the system and reducing the possibility of rupturing the capacitor case.

CAPACITORS SWITCHED WITH THE MOTOR

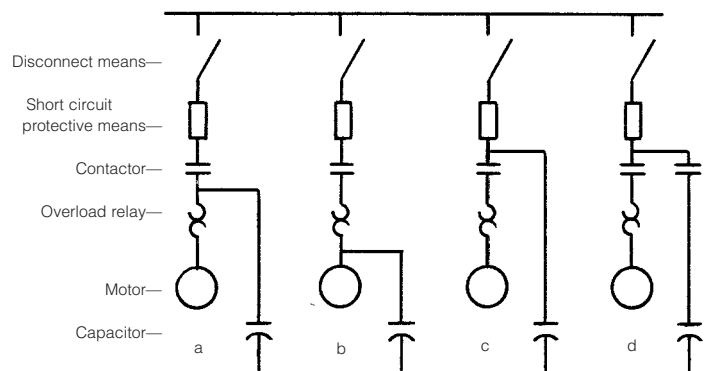
Capacitors used for power factor correction should be selected using the motor manufacturer's application data.

When the capacitor is connected ahead of the overload relay (sketch a, c, or d), the overload current elements should be selected using the full-load motor current and service factor values specified on the nameplate of the motor. When the capacitor is connected on the load side of the overload heaters (sketch b), lower rated heaters are required, since the overload relay in this case will respond to the vector sum of the motor and capacitor currents. Capacitors must not exceed the maximum KVAR recommended by the motor manufacturer for switching with the specific motor selected. The Capacitor Department, Hudson Falls, NY, has published tables showing maximum capacitance and percent ampere reduction for specific GE motors.

Power factor correction capacitors should be switched by a separate contactor (sketch d) under any of the following conditions:

- High inertia load.
- Open circuit transition reduced voltage starting.
- Wye-delta motor.
- Reversing or frequently jogged motor.
- Multispeed motor (2SIW, 2S2W, etc.).

Power factor correction capacitors should not be connected to the load side of solid state starters and drives. It should be noted that two-speed motor starters require separate contactors to switch in capacitors after a time-delay in order to avoid possible motor damage while the capacitors discharge. For the same reason, Wye-Delta starters have the capacitors applied after the delta connection has been made.





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SELECTION OF POWER FACTOR CORRECTION CAPACITORS

The following table is provided as a guide. Consult motor manufacturer for actual capacitor KVAR values.

Typical Capacitor Ratings^①

Horsepower Rating	High Efficiency and Older Design (Pre "T-Frame")		"T Frame" NEMA Design "B" Motors	
	Capacitor KVAR	Current Reduction %	Capacitor KVAR	Current Reduction %
3	1½	15	1½	23
5	2	13	2½	22
7½	2½	12	3	20
10	3	11	4	18
15	4	10	5	18
20	5	10	6	17
25	6	10	7½	17
30	7½	10	8	16
40	9	9	15	17
50	11	9	17½	15
60	15	9	20	15
75	15	8	25	14
100	20	8	30	14
125	27½	8	35	12
150	30	8	40	12
200	37½	8	50	11

① For use with 1800 rpm, 3-phase, 60 Hz classification B motors, to raise full-load power factor to approximately 95 percent.

MCC Space Units Required	Maximum KVAR			UL Listed (X)
	240V	480V	600V	
1X	1½ thru 4 6, 8, 11, 12	20	20	X
1½ X	5, 7½, 9, 10 15 thru 22½	50	45	X

One space unit X equals 12 inches of vertical height. Space required is for capacitor only. Add space for switching device as needed.

In front-mounted configurations utilizing the 20-inch deep enclosure, capacitors may be mounted in the rear 10 inches of space behind the vertical bus. Rear access to the motor control center is required for servicing the capacitors.

Optional 240- and 480-volt blown fuse indicating lights are available. Visible through unit door.

SWITCHING CAPACITORS SEPARATELY

When a group of motors are so operated that some run while others are idle, a single capacitor bank (containing a number of individual units) can be connected to the motor control center bus to supply kilovars to the group. In these instances, a separate switching device is needed for the capacitors. The interrupting rating of the switching device should be at least as great as the short-circuit current available. Cable must be capable of at least 135 percent rated capacitor current. Switching device selections in the following tabulation are based on the continuous current of the capacitors.

- Low-Voltage Power Circuit Breakers 135%
- Fuses and Fusible Switches 165%
- Molded-Case Circuit Breakers 150%

Recommended Switching Device

KVAR	Switch with Class J (In Amperes)	Molded Case Circuit Breaker (In Amperes)
240 VOLTS, 60 HERTZ		
2½	10	15
5	20	20
7½	30	30
10	40	40
15	60	60
20	80	80
27½	125	100
30	125	110
37½	175	150
480 VOLTS, 60 HERTZ		
5	10	15
7½	15	15
10	20	20
15	30	30
20	40	40
25	50	50
27½	60	50
30	60	60
37½	80	70

