

*ISO-flex*®

## Medium Voltage Controllers—Model 2

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**SQUARE D COMPANY**

Medium voltage controllers are recommended for motors above 200 H.P. to reduce the overall cost of an installation. Class 8198 medium voltage controllers utilize a single contactor size (NEMA Size H3, 5000 volts, 360 amps enclosed rating). This feature provides greater flexibility for field changes such as contactor interchangeability or change in

motor horsepower. It also provides increased contact life — especially for 200 amp applications, and reduces spare parts stocking to a minimum.

Medium voltage controllers are available for squirrel cage, wound rotor, and synchronous motors.

#### SQUIRREL CAGE MOTOR CONTROLLERS

The squirrel cage motor can be started by either applying full line voltage or reduced line voltage to the motor terminals. Auto-transformers or series reactors are usually applied for

reduced voltage starting. Line inrush current, motor inrush current and starting torque depend upon the method of starting. The following table summarizes the difference.

Type of Controller	Starting Characteristics In % of Full Load Values				Limitations	Advantages
	Voltage at Motor	Line Current	Motor Current	Starting Torque		
Across the Line (Full Voltage)	100	600	600	150	Draws highest current from line during starting, which affects: 1. LOAD: High starting torque results in sudden start for driven machine. May cause undue strain. 2. POWER SYSTEM CAPACITY: Limitations may prohibit high inrush current when starting large motor at full voltage. 3. MOTOR LOCATION: Line voltage drop due to inrush current when the motor is located at a considerable distance from power source may cause other controllers on the line to drop out.	1. Simplest 2. Least expensive and should be used when limitations indicated on left do not apply.
Primary Reactor	Taps: 50 65 80	300 390 480	300 390 480	25 42 64	1. Uses two contactors and a reactor. Hence, it costs more and requires more space than full voltage controllers. 2. Low power factor during starting.	1. Most economical reduced voltage controller for applications at 2300V and above. 2. Inherently closed transition type (motor is not disconnected from line during transition from reduced voltage starting to full voltage running). This reduces objectionable switching transients. 3. Voltage taps permit adjustment of starting voltage. 4. Suitable for long starting period.
*Auto-Transformer	Taps: 50 65 80	150 254 384	300 390 480	25 42 64	1. Uses three contactors and an autotransformer. Hence, it costs more and requires more space than primary reactor type. (Needs two vertical sections.) 2. Low power factor during starting.	1. Provides highest torque per ampere of line current. 2. Same as for primary reactor controller. 3. See Above. 4. Motor current is greater than line current during starting which produces same starting torque as in primary reactor controller but with reduced line current.

\* Two-Leg auto transformer (connected in open delta) is supplied as standard which meets most requirements. Three-Leg auto transformer (one leg per phase) which provides balanced currents during acceleration is available as an option.

#### SYNCHRONOUS MOTOR CONTROLLERS

Synchronous motor controllers are available as full voltage and reduced voltage types. The starting characteristics of a synchronous motor with a squirrel cage winding are essentially the same as those of a squirrel cage induction motor. Hence, the table above also applies to these starters.

A synchronous motor is ideally suited for constant speed loads such as blowers, gas compressors and crushers. Its ability to correct a lagging system power factor and its

inherent high efficiency are valuable assets.

Controllers for brushless synchronous motors are simpler in construction since controls for motor synchronization are mounted on the motor itself. There are no brushes (the d.c. exciter is mounted on the motor shaft) which makes it suitable for atmospheres where sparking from brushes is objectionable. Absence of brushes reduces maintenance and shutdown time.

#### WOUND ROTOR MOTOR CONTROLLERS

Wound rotor motor controllers are adaptable to applications requiring low starting currents and high starting torques, or for speed control. Typical applications are: conveyors, hoists, variable speed fans, etc.

Basically, a wound rotor motor controller includes primary control, which is the same as that of squirrel cage motor, and secondary control which includes external resistors and ac-

celeration contactors with time delay relays.

Since it is possible to introduce external secondary resistance, the control can be used to adjust starting and accelerating torques, starting current for low inrush, and running slip for speed control. With most of the rotor resistance external to the machine, little of the heat produced by high secondary currents is contained within the motor. This allows frequent starting or long acceleration times for high inertia loads.

#### LATCHED CONTACTORS

These devices can be used in place of metal clad circuit breakers for transformer disconnect, switching capacitor banks, controlling fire pumps, manual/automatic bus transfer schemes, or where the load remains energized for a long

period of time. Latched contactors remain closed under severe undervoltages or loss of power conditions to assure continuous power connection to the equipment. They can be tripped manually or electrically.



## GLOSSARY

Terminology	Two/Three High Construction	One High Construction
Vertical Section	A free standing unit available in NEMA-1, NEMA-1 with gasketed doors, NEMA-3 or NEMA-12 enclosures with or without horizontal bus. Dimensions: 42"W,35"D,90"H (NEMA-1&12, without horizontal bus) 42"W,35"D,100"H (NEMA-1&12 with horizontal bus) 49½"W,37½"D,106½"H (NEMA-3 with or without horizontal bus)	A free standing unit available in NEMA-1, NEMA-1 with gasketed doors, NEMA-3 or NEMA-12 enclosures with or without horizontal bus: Dimensions: 34"W,35"D,90"H (NEMA-1&12 without horizontal bus) 34"W,35"D,100"H (NEMA-1&12 with horizontal bus) 38"W,39¼"D,106½"H (NEMA-3 with or without horizontal bus)
Controller Cell	Each controller cell is 30" or 45" high, 42" wide, and 35" deep. Consists of four isolated compartments: 1. Low voltage compartment 2. Medium voltage contactor compartment 3. Line and vertical bus compartment 4. Load compartment	There is no distinction between vertical section and controller cell. The internal construction is different in one high design. The low voltage compartment is isolated from medium voltage area housing medium voltage contactor, line and load cables, and associated terminations.
Low Voltage Compartment	Contains drawout swing-open panel with meters and pilot devices mounted on the front door and control relays on the inside panel. Located at right front.	Located behind the top 45" door. Contains terminal blocks on left side wall, control relays on swing-open panel with meters and pilot devices mounted on the door.
Medium Voltage Contactor Compartment	Contains line and load connection box, contactor, contactor rail assembly and drawout handle. Located at left front with a hinged door.	These three compartments are not isolated from one another; but are part of a medium voltage compartment behind low voltage swing-open panel at the top and medium voltage contactor door in the bottom. Contains medium voltage contactor, frame assembly, current transformer assembly, line and load cable terminations and other medium voltage equipment. <b>There is no vertical bus</b> (cable is used instead).
Line and Vertical Bus Compartment	Contains line termination connection boxes and vertical bus. Located to the left and behind the medium voltage contactor compartment.	
Load Compartment	Contains current transformers and motor cable terminations for each controller. Located at the right, behind the low voltage compartment.	
Frame Assembly	Not Applicable.	Consists of 'L' shaped frame, contactor rails, drawout arms, and connection box assembly with line and load stabs.
Drawout Handle Assembly	Consists of drawout handle and drive rod which is connected to the drawout arm assembly at the <b>top</b> to rack contactor in and out of line and load stabs.	Consists of drawout handle and drive rod which is connected to the drawout arms in the <b>bottom</b> to rack contactor in and out of line and load stabs.
Unprepared Cell	An empty cell without hardware such as contactor rail assembly, drawout handle, and connection box assembly.	Not Available.
Prepared Cell	An unprepared cell that has been converted by adding hardware (such as drawout handle, connection box and contactor rail assemblies for a future controller to be field installed.	A vertical section with drawout handle and frame assemblies suitable for future controller to be field installed.
Service Ramps	Not Available. (Suggest using contactor lift-jack Type HJ-2, item 705, page 21)	Stored inside medium voltage contactor compartment door on a bracket. When the ramps are attached to the vertical section in front of contactor wheels, the contactor can be rolled out of enclosure onto the floor.

## UL LISTING

Class 8198 controllers are designed to meet UL Standard 347. Full voltage nonreversing controllers in two and three high construction are UL Listed. Other types of controllers have been submitted to UL for approval. For information concerning UL Listing consult factory.

The controllers meet NEMA Standard ICS-2-324, ANSI Standard C19.7 and requirements for certification by Canadian Standards Association.

# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

JANUARY, 1981

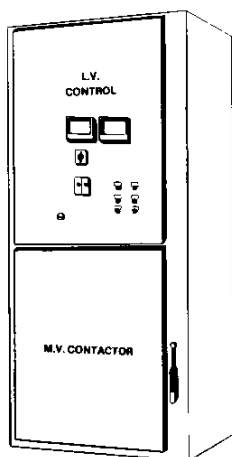
## SQUIRREL CAGE, FULL VOLTAGE, NON-REVERSING

ACROSS-THE-LINE STARTING

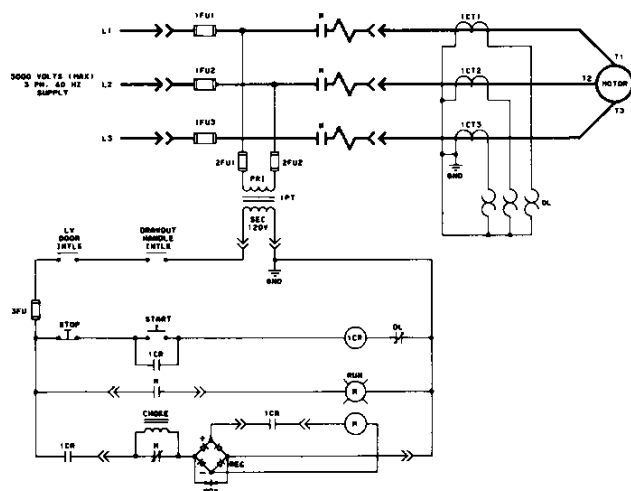
### ONE HIGH CONSTRUCTION

Class 8198 full voltage controllers are used when full starting torque and resulting inrush current are not objectionable to the motor. One high construction provides complete isolation for each controller and permits maximum space for adding optional power and control devices.

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT



**Figure 1**  
90" Enclosure With One Controller



**ELEMENTARY DIAGRAM**

Each controller price includes:

NEMA 1 enclosure

Drawout 360 amp, 3 pole, contactor assembly with:

Three current limiting power fuses

750 VA control transformer with primary fuses

Control circuit contacts (2 form C)

Low voltage controls with:

Control circuit fuse

Test circuit

Three melting alloy overload relays, externally reset

Contactor control cable

Illuminated start push button

Stop push button

Door electrical interlock

Frame assembly including line termination pads and draw out handle assembly

Three current transformers with load cable terminals

Service ramps (to roll contactor out of enclosure)

Maximum HP	Voltage	*Controller Type	Controller Price (Includes NEMA 1 Enclosure)	Prepared Cell Price (NEMA-1 Encl)
700	2200-2400 4000-4800	FC-11 FC-21	\$ 7600. 9900.	\$3300. 3300.
1000	2200-2400 4000-4800	FC-11 FC-21	9900. 9900.	3300. 3300.
1250	2200-2400 4000-4800	FC-11 FC-21	11100. 9900.	3300. 3300.
1500	2200-2400 4000-4800	FC-11 FC-21	11100. 12300.	3300. 3300.
2500	4000-4800	FC-21	12300.	3300.

\* See figure 1 for arrangement.

Refer to page 18 for prices to add power bus, ground bus and other enclosure modifications as required.

Refer to page 16 for price to convert prepared cell into controller.

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## TWO AND THREE HIGH CONSTRUCTION

Class 8198 full voltage controllers are used when full starting torque and resulting inrush current are not objectionable to the motor. Three high construction includes three controllers in one 90" high vertical section with each controller occupying a 30" cell. When more space is required for each controller, two high construction can be supplied with each controller occupying a 45" cell, in one 90" high section.

**Each controller price includes:**

NEMA 1 enclosure

Drawout 360 amp, 3 pole, contactor assembly with:  
Three current limiting power fuses  
750 VA control transformer with primary fuses  
Control circuit contacts (2 form C)

Low voltage controls with:

Control circuit fuse

### Test circuit

Three melting alloy overload relays, externally reset

**Contactor control cable**

### Illuminated start push button

Stop push button

Door electrical interlock

### Drawout handle and contactor rail assembly

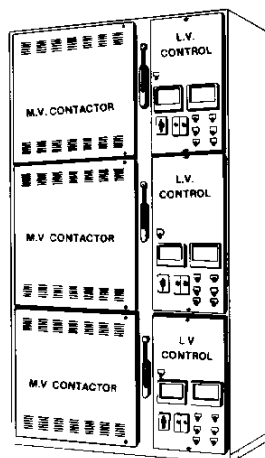
Connection box assembly with line and load stabs

Three current transformers with load cable terminals

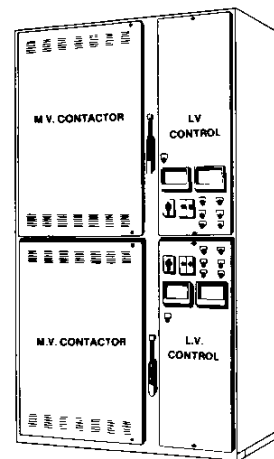
Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS



**90" Enclosure With  
Three Controllers—Each  
In A 30" Cell.**



### Figure 1

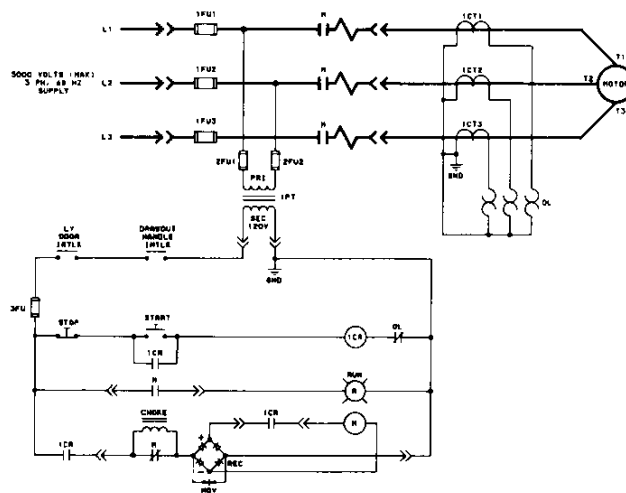
90" Enclosure With  
Two Controllers—Each  
In A 45" Cell.

Maximum HP	Volts	* Controller Type In		▶ Controller Price
		30" Cell	45" Cell	
700	2200-2400	FC-13	FC-12	<b>\$ 7600.</b>
	4000-4800	FC-23	FC-22	
1000	2200-2400	FC-13	FC-12	<b>9900.</b>
	4000-4800	FC-23	FC-22	
1250	2200-2400	FC-13	FC-12	<b>11100.</b>
	4000-4800	FC-23	FC-22	
1500	2200-2400	FC-13	FC-12	<b>11100.</b>
	4000-4800	FC-23	FC-22	
2500	4000-4800	FC-23	FC-22	<b>12300.</b>

\* See Figure 1 for arrangement and maximum number of controllers in a 90" high vertical section.

► Price includes 90" high NEMA 1 enclosure. Price each additional controller, in same vertical section, at above price.

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### ELEMENTARY DIAGRAM

# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## LATCHED CONTACTOR

JANUARY, 1981

### ONE, TWO AND THREE HIGH CONSTRUCTION

Class 8198 latched contactors remain closed on loss of power and are de-energized by use of a manual trip handle or an optional electrical solenoid release. Maximum of three latched contactors in one 90" high section can be supplied, with each occupying a 30" cell. When more space is required, two high or one high construction can be supplied with each latched contactor occupying a 45" cell or a 90" cell in a vertical section. These devices are used frequently for transformer disconnect, fire pumps and in automatic bus transfer schemes in place of metal clad circuit breakers or disconnect switches.

Each latched contactor price includes:

NEMA 1 enclosure

Drawout 360 amp, 3 pole, latch contactor assembly with:

Three current limiting power fuses  
750 VA control transformer with primary fuses  
Control circuit contacts (2 form C)

Low voltage controls with:

Control circuit fuse  
Test circuit  
Contactor control cable  
Manual trip handle  
Illuminated start push button  
Door electrical interlock  
Provisions for remote electrical trip

Drawout handle and contactor rail assembly

Connection box assembly with line and load stabs

Load cable terminals

Incoming line terminals when required

Three phase vertical bus for 2 & 3 high only (tin plated aluminum)

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS (2 & 3 HIGH ONLY)
- VERTICAL BUS (2 & 3 HIGH ONLY)

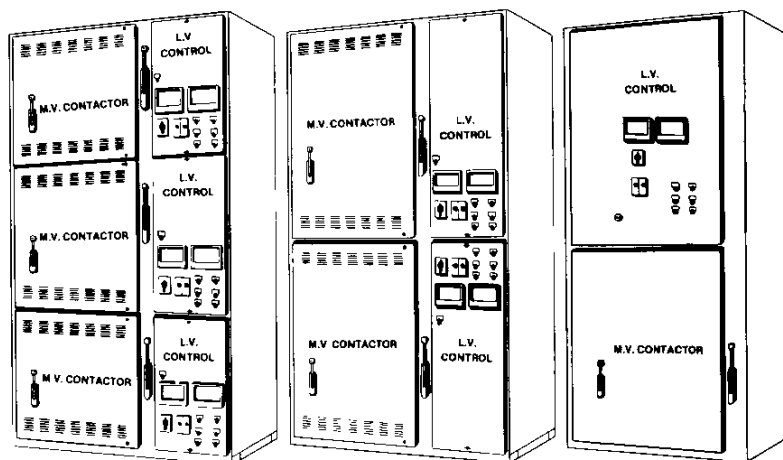


Figure 1

90" Enclosure With  
Three Latched Contactors,  
Each In A 30" Cell.

90" Enclosure With  
Two Latched Contactors,  
Each In A 45" Cell.

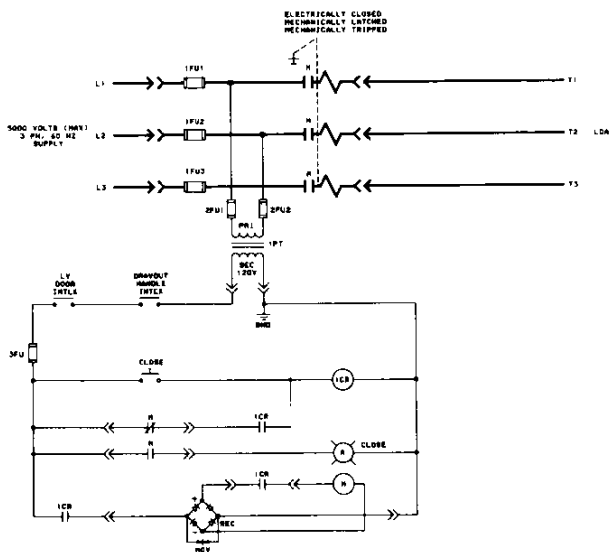
90" Enclosure  
With One Latched  
Contactor.

Maximum KVA	Volts	* Latched Contactor Type In:			Latched Contactor Price
		30" Cell	45" Cell	90" Cell	
500	2200-2400 4000-4800	FL-13 FL-23	FL-12 FL-22	FL-11 FL-21	\$ 7000. 9700.
700	2200-2400 4000-4800	FL-13 FL-23	FL-12 FL-22	FL-11 FL-21	7400. 9700.
1000	2200-2400 4000-4800	FL-13 FL-23	FL-12 FL-22	FL-11 FL-21	9700. 9700.
2000	4000-4800	FL-23	FL-22	FL-21	12100.
2500	4800	FL-23	FL-22	FL-21	12100.

\* See Figure 1 for arrangement and maximum number of contactors in an enclosure.

► Price includes 90" high NEMA 1 enclosure. Price each additional contactor in same vertical section, at above price.

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ELEMENTARY DIAGRAM



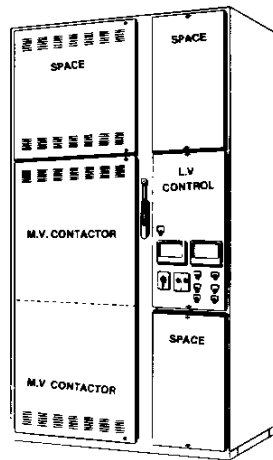
# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## SQUIRREL CAGE, FULL VOLTAGE, REVERSING

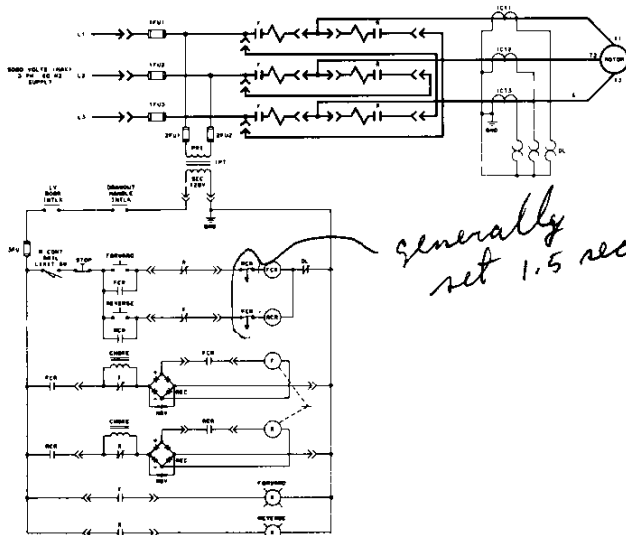
**CLASS**  
**8198**

Class 8198 full voltage reversing controllers are used to control motors being operated in forward and reverse directions, when full starting torque and resulting inrush current are not objectionable to the motor.

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS



**Figure 1**  
90" Enclosure With One Reversing Controller  
In Two 30" Cells.



**ELEMENTARY DIAGRAM**

Each controller price includes:

NEMA 1 enclosure

Two drawout 360 amp, 3 pole, contactor assemblies mechanically interlocked and equipped with:

Three current limiting power fuses (on one contactor only)

750 VA control transformer with primary fuses (on one contactor only)

Control circuit contacts (2 form C)

Low voltage controls with:

Control circuit fuse

Test circuit

Three melting alloy overload relays, externally reset

Contactor control cable

Illuminated forward-reverse push buttons

Stop push button

Door electrical interlock

Drawout handle and contactor rail assemblies

Two connection box assemblies with line and load stabs

Three current transformers with load cable terminals

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

Maximum HP	Volts	Controller Type	* Controller Price (Includes NEMA 1 Enclosure)
700	2200-2400	FCR-1	\$12300.
	4000-4800	FCR-2	15600.
1000	2200-2400	FCR-1	15600.
	4000-4800	FCR-2	15600.
1250	2200-2400	FCR-1	16800.
	4000-4800	FCR-2	15600.
1500	2200-2400	FCR-1	16800.
	4000-4800	FCR-2	18000.
2500	4000-4800	FCR-2	18000.

\* See Figure 1 for arrangement and number of 30" cells required for each reversing controller.

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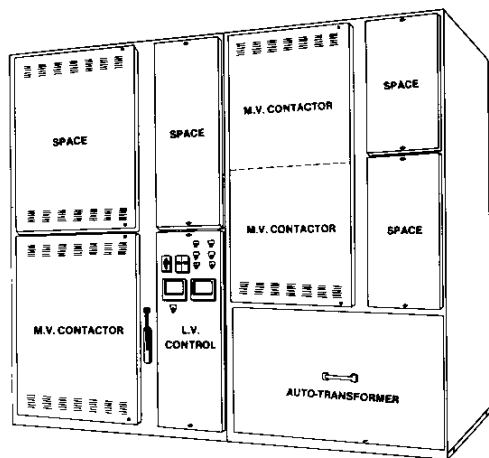
# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## SQUIRREL CAGE, REDUCED VOLTAGE, AUTOTRANSFORMER

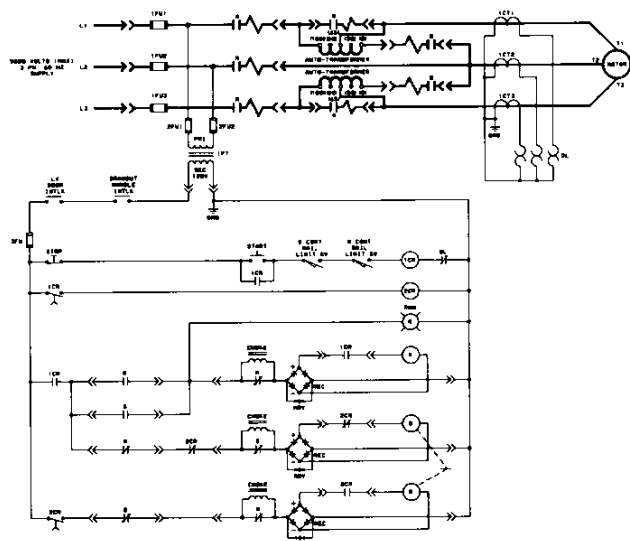
JANUARY, 1981

Class 8198 full closed-transition autotransformer controllers apply a reduced voltage to the motor through the use of an autotransformer. These controllers provide a maximum torque with a minimum of line current while providing taps to permit torque and line current to be varied.

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- CLOSED CIRCUIT TRANSITION
- VERTICAL BUS



**Figure 1**  
Two 90° Enclosures With  
One Autotransformer Controller



**ELEMENTARY DIAGRAM**

Each controller price includes:

### NEMA 1 enclosures

One drawout 360 amp, 3 pole, main contactor assembly with:

- Three current limiting power fuses
- 750 VA control transformer with primary fuses
- Control circuit contacts (2 form C)

Two drawout 360 amp, 2 pole contactor assemblies, mechanically interlocked and equipped with:

- Control circuit contacts

Low voltage controls with:

- Control circuit fuse
- Test circuit
- Three melting alloy overload relays, externally reset
- Contactor control cable
- Illuminated start push button
- Stop push button
- Door electrical interlock

Drawout handle and three contactor rail assemblies

Three connection box assemblies with line and load stabs

Three current transformers with load cable terminals

Autotransformer (NEMA medium duty) with 50%, 65% and 80% voltage taps

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum) when required

Maximum HP	Volts	Controller Type	*Controller Price (Includes NEMA 1 Enclosure)
100	2200-2400	RCA-1	\$22460.
	4000-4800	RCA-2	24760.
200	2200-2400	RCA-1	23460.
	4000-4800	RCA-2	25760.
400	2200-2400	RCA-1	24460.
	4000-4800	RCA-2	26760.
700	2200-2400	RCA-1	25660.
	4000-4800	RCA-2	28760.
1000	2000-2400	RCA-1	28160.
	4000-4800	RCA-2	30560.
1250	2200-2400	RCA-1	31560.
	4000-4800	RCA-2	31760.
1500	2200-2400	RCA-1	31960.
	4000-4800	RCA-2	35560.
1750	4000-4800	RCA-2	35560.
2000	4000-4800	RCA-2	37560.
2250	4000-4800	RCA-2	38760.
2500	4000-4800	RCA-2	39760.

\* See Figure 1 for arrangement and number of cells required for each autotransformer controller.

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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## SQUIRREL CAGE, REDUCED VOLTAGE, PRIMARY REACTOR

**CLASS**  
**8198**

Class 8198 primary reactor controller permit the starting of motors without the high inrush currents and voltage variations associated with full voltage starting.

Each controller price includes:

NEMA 1 enclosure

Two drawout 360 amp, 3 pole, contactor assemblies with:

Three current limiting power fuses (on main contactor only)  
 750 VA control transformer with primary fuses (on main contactor only)

Low voltage controls with:

Control circuit fuse  
 Test circuit  
 Three melting alloy overload relays, externally reset  
 Contactor control cable  
 Illuminated start push button  
 Stop push button  
 Door electrical interlock

Drawout handle and two contactor rail assemblies

Two connection box assemblies with line and load stabs

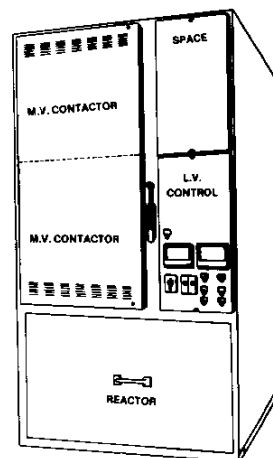
Three current transformers with load cable terminals

Primary reactor (NEMA medium duty) with 50%, 65% and 80% voltage taps

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

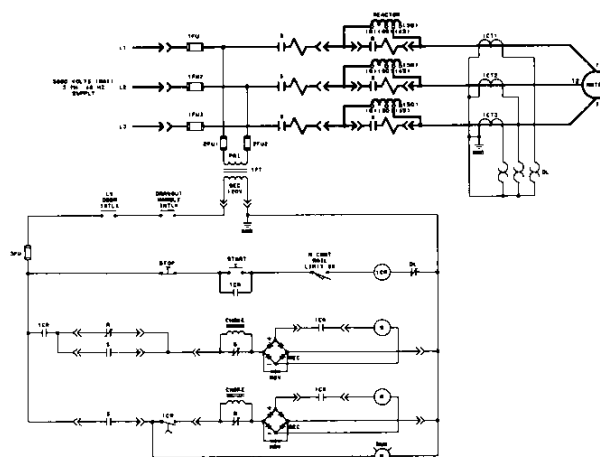
- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS



**Figure 1**  
 90" Enclosure With  
 One Reactor Controller

Maximum HP	Volts	Controller Type	* Controller Price (Includes NEMA 1 Enclosure)
100	2200-2400	RCR-1	<b>\$16560.</b>
	4000-4800	RCR-2	<b>18860.</b>
200	2200-2400	RCR-1	<b>17560.</b>
	4000-4800	RCR-2	<b>19860.</b>
400	2200-2400	RCR-1	<b>18560.</b>
	4000-4800	RCR-2	<b>20860.</b>
700	2200-2400	RCR-1	<b>19760.</b>
	4000-4800	RCR-2	<b>22860.</b>
1000	2200-2400	RCR-1	<b>22260.</b>
	4000-4800	RCR-2	<b>24660.</b>
1250	2200-2400	RCR-1	<b>25660.</b>
	4000-4800	RCR-2	<b>25860.</b>
1500	2200-2400	RCR-1	<b>26060.</b>
	4000-4800	RCR-2	<b>29660.</b>
1750	4000-4800	RCR-2	<b>30660.</b>
2000	4000-4800	RCR-2	<b>31660.</b>
2250	4000-4800	RCR-2	<b>32860.</b>
2500	4000-4800	RCR-2	<b>33860.</b>

\* See Figure 1 for arrangement and number of 30" cells required for each reactor controller.



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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## WOUND ROTOR, NON-REVERSING

JANUARY, 1981

### NEMA CLASS 135 STARTING DUTY RESISTORS

Class 8198 wound rotor (slip ring) controllers are used to achieve higher starting torque with lower current inrush by connecting external resistors in the rotor circuit during acceleration. NEMA class 135 resistors are used on low inertia drives, such as centrifugal pumps, blowers, cement mill grinders, and food plant mixers.

Each controller price includes:

NEMA 1 enclosures

Drawout 360 amp, 3 pole, contactor assembly with:

Three current limiting power fuses

750 VA control transformer with primary current limiting fuses

Control circuit contacts (2 form C)

Low voltage primary controls with:

Control circuit fuse

Test circuit

Three melting alloy overload relays, externally reset

Contactor control cable

Illuminated start push button

Stop push button

Door electrical interlock

Drawout handle and contactor rail assembly

Connection box assembly with line and load stabs

Three current transformers with load cable terminals

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

Set of 600V secondary acceleration contactors

Set of relays for time limit acceleration

Set of NEMA Class 135 starting duty resistors (see table A, page 11)

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS

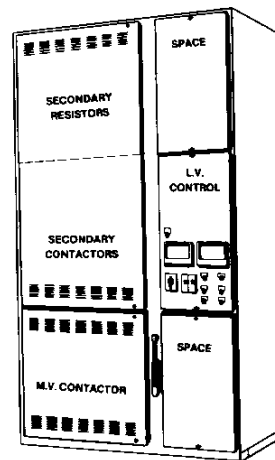
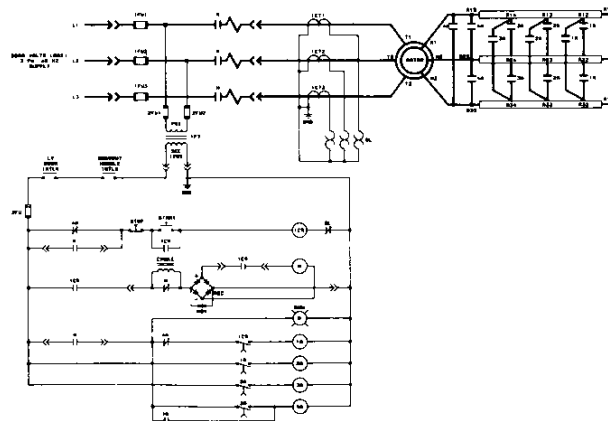


Figure 1  
90° Enclosure With One Wound Rotor  
Controller (Maximum 300 H.P.) In Three 30° Cells.

Max- imum HP	Volts	Controller Type	Controller Price ► (Includes NEMA 1 Enclosure)	Estimated Number of 90° High Vertical Sections		Number of Accel- eration Points *	Each Added Accel- eration Point
				42"W	32"W		
100	2200-2400 4000-4800	RWR-1 RWR-2	\$11675. 11675.	1	—	4	\$ 415. 415.
150	2200-2400 4000-4800	RWR-1 RWR-2	11855. 11855.	1	—	4	610. 610.
200	2200-2400 4000-4800	RWR-1 RWR-2	12665. 12665.	1	—	5	610. 610.
300	2200-2400 4000-4800	RWR-1 RWR-2	15075. 15075.	1	—	5	695. 695.
400	2200-2400 4000-4800	RWR-1 RWR-2	17630. 17630.	1	1	6	695. 695.
600	2200-2400 4000-4800	RWR-1 RWR-2	18175. 18175.	1	1	6	985. 985.
700	2200-2400 4000-4800	RWR-1 RWR-2	20900. 20900.	1	1	7	1485. 1485.
1000	2200-2400 4000-4800	RWR-1 RWR-2	23840. 23840.	1	1	7	1485. 1485.
1250	2200-2400 4000-4800	RWR-1 RWR-2	27740. 27740.	1	1	7	1485. 1485.
1500	2200-2400 4000-4800	RWR-1 RWR-2	33975. 33975.	1	2	7	3110. 3110.
1750	4000-4800	RWR-2	36820.	1	2	7	3110.
2000	4000-4800	RWR-2	40400.	1	2	7	3110.
2250	4000-4800	RWR-2	42830.	1	2	7	3110.
2500	4000-4800	RWR-2	44400.	1	2	7	3110.

\* Per NEMA Standard

► Based on maximum rotor (secondary) voltage of 600V.



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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## WOUND ROTOR, NON-REVERSING

**CLASS**  
**8198**

### NEMA CLASS 155 STARTING DUTY RESISTORS

Class 8198 wound rotor (slip ring) controllers are used to achieve higher starting torque with lower current inrush by connecting external resistors in the rotor circuit during acceleration. NEMA class 155 resistors are used on high inertia drives, such as conveyors and crushers.

Each controller price includes:

NEMA 1 enclosures

Drawout 360 amp, 3 pole, contactor assembly with:

Three current limiting power fuses

750 VA control transformer with primary current limiting fuses

Control circuit contacts

Low voltage primary controls with:

Control circuit fuse

Test circuit

Three melting alloy overload relays, externally reset

Contactor control cable

Illuminated start push button

Stop push button

Door electrical interlock

Drawout handle and contactor rail assembly

Connection box assembly with line and load stabs

Three current transformers with load cable terminals

Incoming line terminals when required

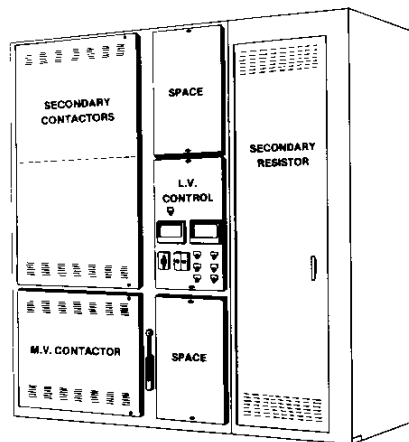
Three phase vertical bus (tin plated aluminum)

Set of 600V secondary acceleration contactors

Set of relays for time limit acceleration

Set of NEMA Class 155 starting duty resistors (see Table A)

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS



**Figure 1**  
90° Enclosure With One Wound Rotor  
Controller (Maximum 300 H.P.)

Max- imum HP	Volts	Controller Type	Controller Price — (Includes NEMA 1 Enclosure)	Estimated Number of 90° High Vertical Sections		Number of Acceler- ation Points*	Each Added Acceler- ation Point
				42" W	32" W		
100	2200-2400 4000-4800	RWR-1	\$11675.	1	—	4	\$ 415.
		RWR-2	11675.	1	—	4	415.
150	2200-2400 4000-4800	RWR-1	11855.	1	—	4	610.
		RWR-2	11855.	1	—	4	610.
200	2200-2400 4000-4800	RWR-1	12730.	1	1	5	610.
		RWR-2	12730.	1	1	5	610.
300	2200-2400 4000-4800	RWR-1	14090.	1	1	5	695.
		RWR-2	14090.	1	1	5	695.
400	2200-2400 4000-4800	RWR-1	19500.	1	1	6	695.
		RWR-2	19500.	1	1	6	695.
600	2200-2400 4000-4800	RWR-1	26350.	1	1	6	985.
		RWR-2	26350.	1	1	6	985.
700	2200-2400 4000-4800	RWR-1	29710.	1	1	7	1485.
		RWR-2	29710.	1	1	7	1485.
1000	2200-2400 4000-4800	RWR-1	33840.	1	2	7	1485.
		RWR-2	33840.	1	2	7	1485.
1250	2200-2400 4000-4800	RWR-1	46900.	1	2	7	1485.
		RWR-2	46900.	1	2	7	1485.
1500	2200-2400 4000-4800	RWR-1	68130.	1	3	7	3110.
		RWR-2	68130.	1	3	7	3110.
1750	4000-4800	RWR-1	54790.	1	3	7	3110.
		RWR-2	54790.	1	3	7	3110.
2000	4000-4800	RWR-1	59840.	1	3	7	3110.
		RWR-2	59840.	1	3	7	3110.
2250	4000-4800	RWR-1	67180.	1	4	7	3110.
		RWR-2	67180.	1	4	7	3110.

\* Per NEMA Standard

► Based on maximum rotor (secondary) voltage of 600V.

Wound rotor motor control can be supplied to satisfy special duty cycle requirements per Table A below for other than NEMA Class 135 and 155 starting duty resistor non-reversing applications listed in this catalog. Consult factory for pricing. Other special applications that must be referred to the factory for pricing include reverse-plugging, permanent slip resistors, and dynamic braking requirements.

**TABLE A**

NEMA Service Classification Of Resistors  
(Nonplugging Service And Without Dynamic Braking)

% of full load current on first starting point	NEMA class numbers					
	10 secs. on 70 secs. off	15 secs. on 75 secs. off	15 secs. on 45 secs. off	15 secs. on 30 secs. off	15 secs. on 15 secs. off	contin- uous duty
25	131	141	151	161	171	91
50	132	142	152	162	172	92
70	133	143	153	163	173	93
100	134	144	154	164	174	94
150	135	145	155	165	175	95
200 or over	136	146	156	166	176	96

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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## SYNCHRONOUS, FULL VOLTAGE, NON-REVERSING

JANUARY, 1981

Class 8198 synchronous motor controllers are used with motors where constant speed and plant power factor correction are desired. Some typical industrial applications are pulp and paper mills, lumber mills, rubber mills, metal rolling mills, gas compressors, centrifugal fans, blowers, generators, crushers and grinders.

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS

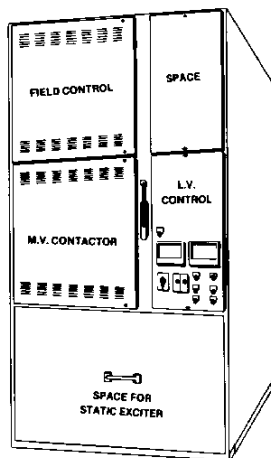
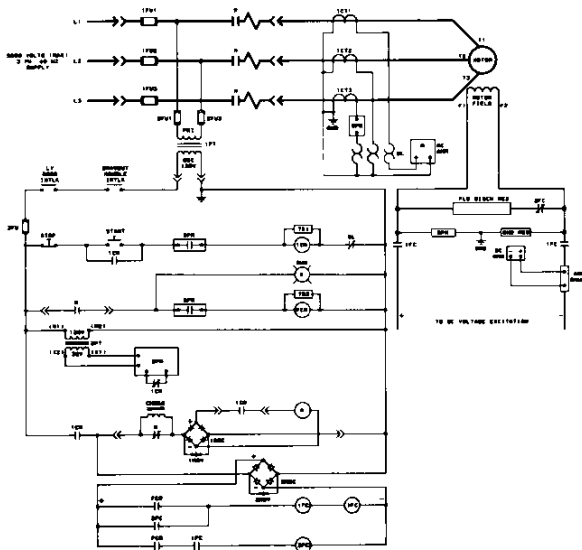


Figure 1  
90° Enclosure With One  
Synchronous Controller



ELEMENTARY DIAGRAM

Each controller price includes:

NEMA 1 enclosure

Drawout 360 amp, 3 pole, contactor assembly with:

- Three current limiting power fuses
- 750 VA control transformer with primary fuses
- Control circuit contacts (2 form C)

Low voltage controls with:

- Control circuit fuse
- Test circuit
- Three melting alloy overload relays, externally reset
- Contactor control cable
- Illuminated start push button
- Stop push button
- Door electrical interlock
- DC ammeter
- AC ammeter

Synchronous field control with:

- DC field contactor and field discharge circuit
- Field discharge resistor

Solid-state module for automatic synchronization and motor protection from:

- Stalled rotor condition
- Failure to accelerate to synchronous speed
- Loss of excitation
- Pull-out under excessive load

Drawout handle and contactor rail assembly

Connection box assembly with line and load stabs

Three current transformers with load cable terminals

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

Maximum HP		Volts	Controller Type	* Controller Price (Includes NEMA 1 Enclosure)
1.0 PF	0.8 PF			
900	700	2200-2400	FS-1	\$13300.
		4000-4800	FS-2	14600.
1250	1000	2200-2400	FS-1	14600.
		4000-4800	FS-2	14600.
1500	1250	2200-2400	FS-1	15800.
		4000-4800	FS-2	14600.
1750	1500	2200-2400	FS-1	16400.
		4000-4800	FS-2	17600.
3000	2500	4000-4800	FS-2	17800.

\* See Figure 1 for arrangement and number of 30" cells required for each controller.

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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## SYNCHRONOUS, BRUSHLESS, FULL VOLTAGE

**CLASS**  
**8198**

Class 8198 synchronous brushless motor controllers are used for synchronous motors required in explosive atmospheres. Brushless motors have the same advantages as regular synchronous motors, in addition to less maintenance, since there are no brushes.

Each controller price includes:

NEMA 1 enclosure

Drawout 360 amp, 3 pole, contactor assembly with:

Three current limiting power fuses  
 750 VA control transformer with primary fuses  
 Control circuit contacts (2 form C)

Low voltage controls with:

Control circuit fuse  
 Test circuit  
 Three melting alloy overload relays, externally reset  
 Contactor control cable  
 Illuminated start push button  
 Stop push button  
 Door electrical interlock  
 DC ammeter  
 AC ammeter

Brushless synchronous field control with:

Exciter field contactor  
 Incomplete sequence relay  
 DC power supply for exciter field with thyrite protector  
 Powerstat for field adjustment  
 Exciter field loss relay  
 Pull out relay

Drawout handle and contactor rail assembly

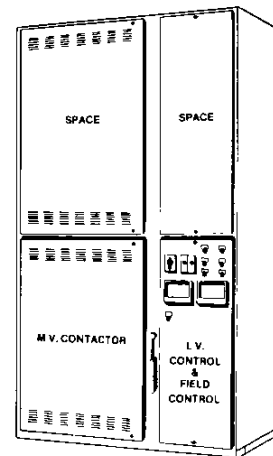
Connection box assembly with line and load stabs

Three current transformers with load cable terminals

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

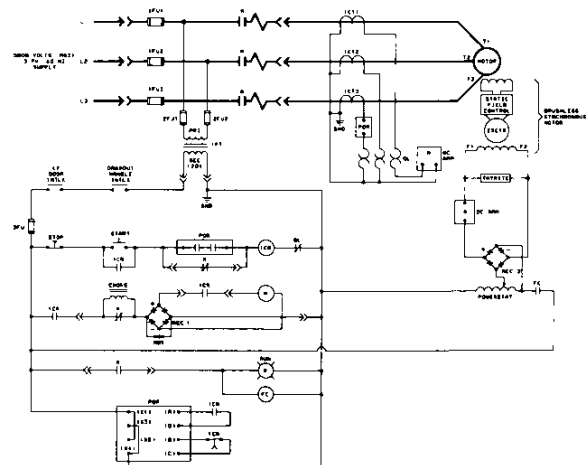
- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS



**Figure 1**  
 90" Enclosure With One Synchronous,  
 Brushless Controller

Maximum HP		Volts	Controller Type	*Controller Price (Includes NEMA 1 Enclosure)
1.0 PF	0.8 PF			
900	700	2200-2400	FSB-1	<b>\$10600.</b>
		4000-4800	FSB-2	<b>12900.</b>
1250	1000	2200-2400	FSB-1	<b>12900.</b>
		4000-4800	FSB-2	<b>12900.</b>
1500	1250	2200-2400	FSB-1	<b>14100.</b>
		4000-4800	FSB-2	<b>12900.</b>
1750	1500	2200-2400	FSB-1	<b>14100.</b>
		4000-4800	FSB-2	<b>15300.</b>
3000	2500	4000-4800	FSB-2	<b>15300.</b>

\* See Figure 1 for arrangement and number of 30" cells required for each controller.



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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## SYNCHRONOUS, REDUCED VOLTAGE, AUTOTRANSFORMER

JANUARY, 1981

Class 8198 autotransformer controllers apply a reduced voltage to the motor through the use of an autotransformer. These controllers provide a maximum torque with a minimum of line current while providing taps to permit torque and line current to be varied. Further, these controllers are used where constant speed and plant power factor correction are desired.

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS

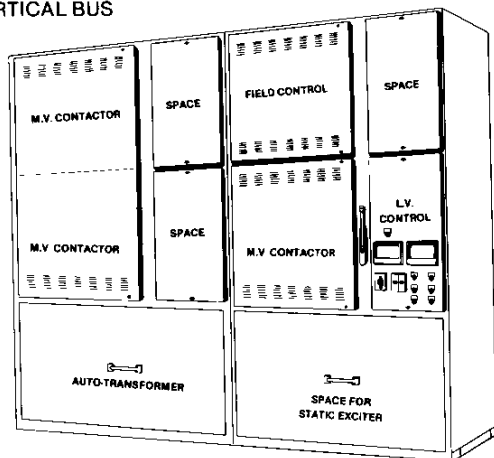
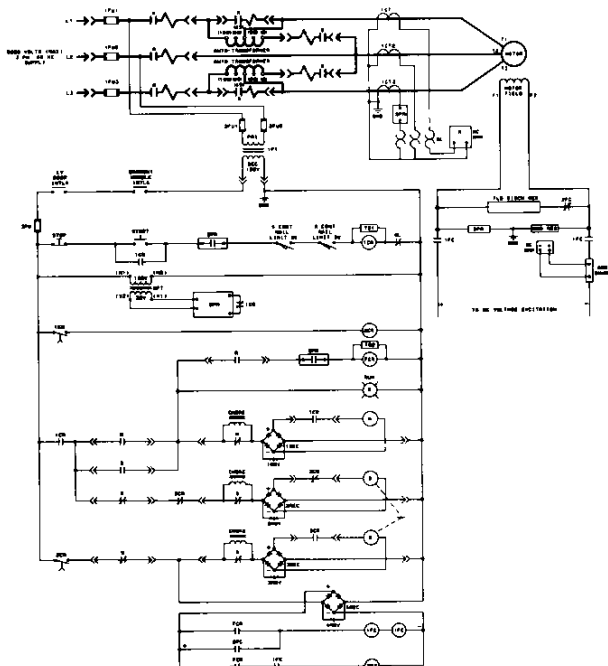


Figure 1  
Two 90° Enclosures With One Synchronous  
Autotransformer Controller



ELEMENTARY DIAGRAM

Each controller price includes:

- NEMA 1 enclosure
- One drawout 360 amp, 3 pole, contactor assembly with:
  - Three current limiting power fuses
  - 750 VA control transformer with primary fuses
  - Control circuit contacts (2 form C)
- Two drawout 360 amp, 3 pole, contactor assemblies mechanically interlocked and equipped with:
  - Control circuit contacts (2 form C)
- Low voltage controls with:
  - Control circuit fuse
  - Test circuit
  - Three melting alloy overload relays, externally reset
  - Contactor control cable
  - Illuminated start push button
  - Stop push button
  - Door electrical interlock
  - DC ammeter
  - AC ammeter
- Synchronous field panel with:
  - DC field contactor and field discharge circuit
  - Field discharge resistor
- Solid-state module for automatic synchronization and motor protection from:
  - Stalled rotor condition
  - Failure to accelerate to synchronous speed
  - Loss of excitation
  - Pull-out under excessive load
- Drawout handle and three contactor rail assemblies
- Three connection box assemblies with line and load stabs
- Three current transformers with load cable terminals
- Autotransformer (NEMA medium duty) with 50%, 65% and 80% voltage taps
- Incoming line terminals when required
- Three phase vertical bus (tin plated aluminum) when required

Maximum HP		Volts	Controller Type	*Controller Price (Includes NEMA 1 Enclosure)
1.0 PF	0.8 PF			
125	100	2200-2400	RSA-1	\$25100.
		4000-4800	RSA-2	26900.
250	200	2200-2400	RSA-1	26100.
		4000-4800	RSA-2	27700.
500	400	2200-2400	RSA-1	27100.
		4000-4800	RSA-2	28900.
900	700	2200-2400	RSA-1	29500.
		4000-4800	RSA-2	30900.
1250	1000	2200-2400	RSA-1	30300.
		4000-4800	RSA-2	32700.
1500	1250	2200-2400	RSA-1	33700.
		4000-4800	RSA-2	33900.
1750	1500	2200-2400	RSA-1	34500.
		4000-4800	RSA-2	38300.
2000	1750	4000-4800	RSA-2	39700.
		4000-4800	RSA-2	40700.
2500	2000	4000-4800	RSA-2	40700.
		4000-4800	RSA-2	42700.
3000	2500	4000-4800	RSA-2	42700.
		4000-4800	RSA-2	42700.

\* See Figure 1 for arrangement and number of 30" cells required for each controller.

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# MEDIUM VOLTAGE CONTROLLERS — MODEL 2 SYNCHRONOUS, REDUCED VOLTAGE, PRIMARY REACTOR

**CLASS**  
**8198**

Class 8198 primary reactor synchronous motor controllers are used for drives where maximum efficiencies are required and when full starting torque and resulting inrush current are objectionable to the system. Further, these controllers are used where constant speed and plant power factor correction are desired.

Each controller price includes:

NEMA 1 enclosure

Two drawout 360 amp, 3 pole, contactor assemblies with:  
 Three current limiting power fuses (on main contactor only)  
 750 VA control transformer with primary fuses (on main contactor only)  
 Control circuit contacts (2 form C)

Low voltage controls with:

Control circuit fuse  
 Test circuit  
 Three melting alloy overload relays, externally reset  
 Contactor control cable  
 Illuminated start push button  
 Stop push button  
 Door electrical interlock  
 DC ammeter  
 AC ammeter

Synchronous field control with:

DC field contactor and field discharge circuit  
 Field discharge resistor

Solid-state module for automatic synchronization and motor protection from:

Stalled rotor condition  
 Failure to accelerate to synchronous speed  
 Loss of excitation  
 Pull-out under excessive load.

Drawout handle and two contactor rail assemblies

Two connection box assemblies with line and load stabs

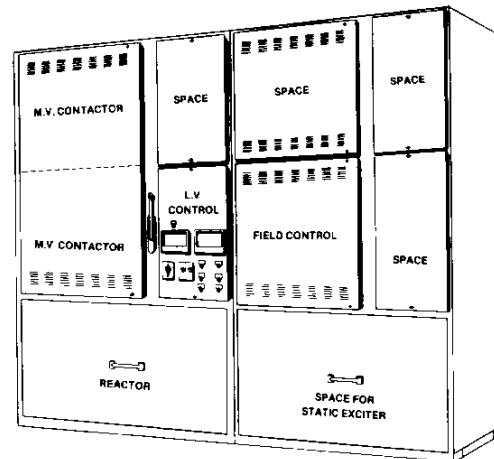
Three current transformers with load cable terminals

Primary reactor (NEMA medium duty) with 50%, 65% and 80% voltage taps

Incoming line terminals when required

Three phase vertical bus (tin plated aluminum)

- MOTOR CONTROL CENTER CONSTRUCTION
- AIR BREAK, MAXIMUM 5000 VOLTS
- NEMA CLASS E2 (FUSED)
- 50 MVA CONTACTOR
- ISOLATED LOW VOLTAGE COMPARTMENT
- ISOLATED MEDIUM VOLTAGE COMPARTMENT
- SEPARATE LINE AND LOAD COMPARTMENTS
- VERTICAL BUS



**Figure 1**  
 Two 90° Enclosures With One Synchronous  
 Primary Reactor Controller In Four 30° Cells

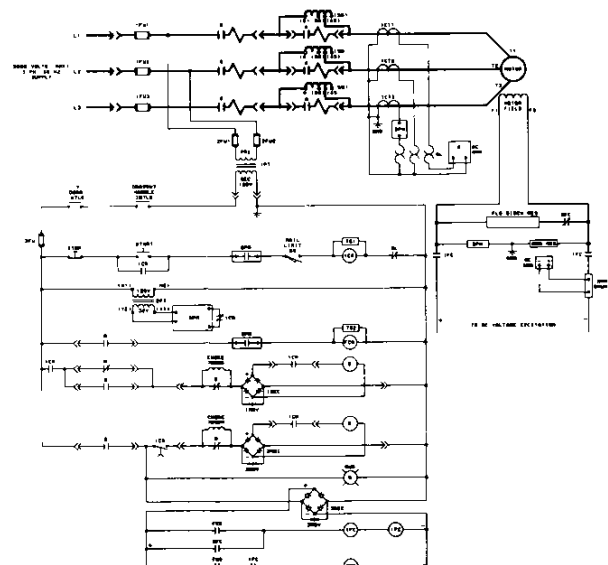
Maximum HP		Volts	Controller Type	*Controller Price (Includes NEMA 1 Enclosure)
1.0 PF	0.8 PF			
125	100	2200-2400 4000-4800	RSR-1 RSR-2	\$20700. 23000.
250	200	2200-2400 4000-4800	RSR-1 RSR-2	21700. 24000.
500	400	2200-2400 4000-4800	RSR-1 RSR-2	22700. 25200.
—	700	2200-2400 4000-4800	RSR-1 RSR-2	23700. 27200.
900	—	2200-2400 4000-4800	RSR-1 RSR-2	24900. 27600.
1250	1000	2200-2400 4000-4800	RSR-1 RSR-2	26600. 29000.
1500	1250	2200-2400 4000-4800	RSR-1 RSR-2	30000. 30200.
1750	1500	2200-2400 4000-4800	RSR-1 RSR-2	31000. 34600.
2000	1750	4000-4800	RSR-2	35800.
2500	2000	4000-4800	RSR-2	36800.
3000	2500	4000-4800	RSR-2	39000.

\* See Figure 1 for arrangement and number of 30° cells required for each controller

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**SQUARE D COMPANY**

**D3A DISCOUNT**



**ELEMENTARY DIAGRAM**

# **MEDIUM VOLTAGE CONTROLLERS — MODEL 2** **SQUIRREL CAGE CONTROLLERS: EQUIPMENT FOR FUTURE ADDITIONS**

JANUARY, 1981

Class 8198 full voltage non-reversing squirrel cage controllers can be supplied without enclosures for field mounting in existing Square D medium voltage motor control centers. For two and three high construction if the cell is empty (unprepared), convert it into a "prepared cell" by installing the hardware as described under (A). Install the controller components for a prepared cell as described under (B). When specified, the "prepared cell" can be installed at the factory when ordered with other controllers.

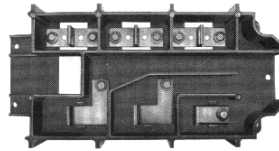
## **(A) HARDWARE TO CONVERT UNPREPARED CELL INTO A PREPARED CELL** **(FOR TWO HIGH AND THREE HIGH CONSTRUCTION ONLY)**

Hardware price (to convert empty cell into prepared cell) includes:

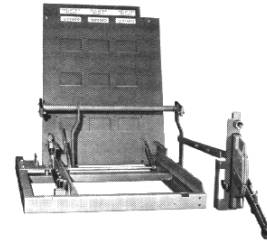
- Connection box assembly with line and load stabs and shutter
- Contactor rail assembly
- Drawout handle and linkage assembly

Maximum HP	Volts	Hardware Price Factory Installed	Hardware Price For Field Installation
700 to 1500	2200-2400	\$1000.	\$700.
700 to 2500	4000-4800	1000.	700.

► For price of a prepared cell for one high construction refer to page 4.



Connection Box

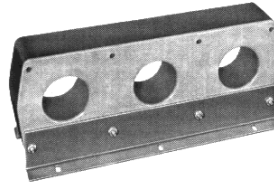


Contactor Rail Assembly  
 Drawout Handle And Linkage  
 Assembly, And Shutter  
 Plates (in rear).

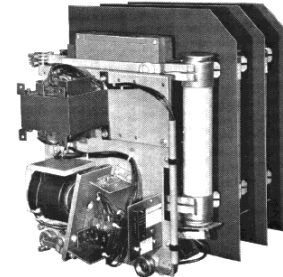
## **(B) CONTROLLER COMPONENTS TO CONVERT EXISTING PREPARED CELL INTO COMPLETE CONTROLLER:**

Controller components price (for prepared cell) includes:

- Drawout 360 amp, 3 pole, contactor assembly with:
  - Three current limiting power fuses
  - 750 VA control transformer with primary fuses
  - Control circuit contacts
- Low voltage control assembly with:
  - Control circuit fuse
  - Test circuit
  - Three melting alloy overload relays, externally reset
  - Contactor control cable
  - Illuminated start push button
  - Stop push button
  - Door electrical interlock
- Three current transformers and cable to controller connection box
- Service ramps (for one high construction only)

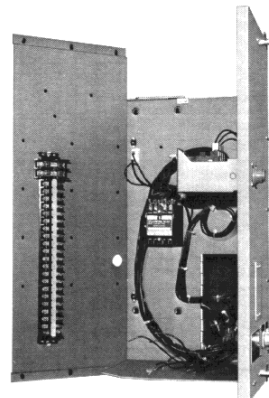


Current Transformer  
 Assembly (Standard)



Medium Voltage Contactor  
 With Power Fuses.

Maximum HP	Volts	Controller Components Type For			Controller Components Price
		30" Cell	45" Cell	90" Cell	
700	2200-2400 4000-4800	FC-130 FC-230	FC-120 FC-220	FC-110 FC-210	\$ 6600. 8900.
1000	2200-2400 4000-4800	FC-130 FC-230	FC-120 FC-220	FC-110 FC-210	8900. 8900.
1250	2200-2400 4000-4800	FC-130 FC-230	FC-120 FC-220	FC-110 FC-210	10100. 8900.
1500	2200-2400 4000-4800	FC-130 FC-230	FC-120 FC-220	FC-110 FC-210	10100. 11300.
2500	4000-4800	FC-230	FC-220	FC-210	11300.



Two Or Three High Construction:  
 Low Voltage Control  
 Assembly: Swing Open  
 Panel (right), Inside Panel  
 (left). \*

\*For one high construction, the low voltage control assembly will consist of terminal strip panel, relay panel assembly and door mounted components.

Ordering Information . . . . . Page 26  
 Modifications . . . . . Pages 18-21  
 Application Information . . . . . Pages 22-23





Class 8198 controllers are available for applications other than those listed on the previous pages. Given below is a partial list of special controllers. Consult factory for pricing.

**CHILLERS:** Require special modifications to satisfy specific chiller manufacturers' control requirements such as magnetic overload relays, instrument current transformers, a dedicated current transformer with output resistor for load sensing, minimum 1.5KVA control transformer plus others.

**TRANSFER SCHEMES:** For transferring power from normal to one or more emergency sources. These transfer schemes operate in manual, semi-automatic or automatic modes as required.

**MULTI-SPEED CONTROLLERS:** two speed, three speed or part-winding types are available.

**CAPACITOR SWITCHING:** To improve lagging power factor in industrial/commercial applications where large number of induction motors are connected. Maximum capacitor ratings that can be switched are 1100KVAR at 2400 volts and 1900KVAR at 4160 volts.

**TEST STANDS:** Ideal for motor and original equipment manufacturers to test motors covering a wide range of horsepower by simple control circuit selectivity of current transformer ratios and overload relay heater sizes. Test stands are available for full voltage and reduced voltage applications.

For 5KV controller kits (to be used by manufacturers fabricating their own sheet metal enclosures) and 54" high 5KV controllers refer to catalog 8196.

### PRICING INSTRUCTIONS (FOR MOTOR CONTROL CENTER CONSTRUCTION)

1. Prepare a sketch to determine the number of vertical sections required (similar to fig. 1). The space required for each controller is shown in the sketch on the price sheet. Some modifications need additional space. See page 18 for limitations.
2. Prepare a table as shown in the example below.
3. Price the equipment from appropriate price sheets.

#### PRICING EXAMPLE:

System: 4160V, 3 Phase, 60 Hz., grounded.

Starter		Description	Price
Cell Location	Type		
1A (45")	Future	Prepared Cell (page 16) 400 H.P. NEMA-1 Encl. (page 5) 700 H.P., NEMA-1 Encl. (page 9)	\$ 1000.
1B (45")	FC-22		9900.
2A, 2B, 2C (30" each)	RCR-2		22860.
Modifications			
Item # (Page 18-21)	Quantity		
104 (1)	2	NEMA-12 Encl.	\$1100 ea.
202 B(1)	2	1000A Copper Power Bus	\$1015 ea.
203 (2)	2	Copper Ground Bus	\$ 190 ea.
382 (1)	1	Ground Fault Relay (for 700 H.P. Starter)	855.
401	2	Ammeter	\$ 396 ea.
TOTAL LIST			\$40017.

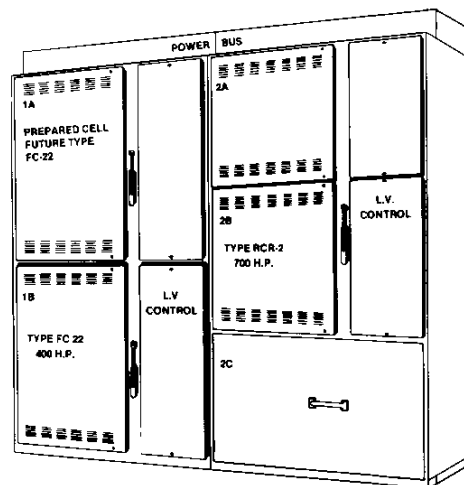


Figure 1  
Medium Voltage Motor Control Center  
in NEMA 12 Enclosure.

# 5KV CONTROLLERS — MODEL 2

## ADDITIONS & MODIFICATIONS

JANUARY, 1981

### SPACE AVAILABLE IN MEDIUM VOLTAGE AND LOW VOLTAGE COMPARTMENT

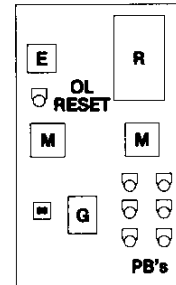
Listed below is the maximum number of different devices which can be mounted in low voltage relay compartment and on the low voltage compartment door. Devices are identified in "space requirements" column of modifications listing (pages 18 thru 21).

Device	Maximum Number Which Can Be Mounted On . . .					
	Low Voltage Compartment Door			Low Voltage Relay Panel		
	30" Cell (Three High)	45" Cell (Two High)	45" Cell (One High)	30" Cell (Three High)	45" Cell (Two High)	45" Cell (One High)
CR	—	—	—	6	8	12
E	1	1	1	—	—	—
G	1	1	1	—	—	—
M	2	2	2	—	—	—
PB	6	10	11	—	—	—
R	1	2	1	—	—	—
S	—	—	—	2	2	2
SS	1	1	2	—	—	—

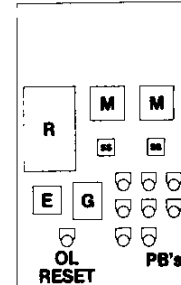
If space requirements per controller are more than as indicated above, consult factory.

• See "space requirement" column in modification listing for device identification.

Note: For one high controller 30" space exists behind the low voltage compartment to mount various medium voltage components.



Low Voltage  
Compartment Door  
Of A Typical 30" Cell



Low Voltage  
Compartment Door  
Of A Typical  
One High Controller

Item Number	Description	Space Requirements	Price	Item Number	Description	Space Requirements	Price
<b>ENCLOSURE MODIFICATIONS:</b>				<b>II. Cross-over &amp; Corner Bus, Insulation For Bus &amp; Lugs.</b>			
101	Gasketed doors for 90" high NEMA 1 enclosure	....	\$ 360.	204	Cross-over bus (for back to back line-ups) A. Tin plated aluminum (1) 1000A (2) 2000A	....	\$ 2080. 3420.
102	NEMA 3 enclosure (in place of NEMA 1) (1) 2 & 3 high (2) 1 high	....	3600. 2200.		B. Tin plated copper (1) 1000A (2) 2000A	....	2130. 3720.
103	NEMA 3 walk-in enclosure	....	contact factory	205	Corner Bus (for connecting line-ups at 90°) A. Tin plated aluminum (1) 1000A (2) 2000A	....	3325. 3650.
104	NEMA 12 enclosure (in place of NEMA 1) 90" high (1) 2 & 3 high (2) 1 high	....	1100. 660.		B. Tin plated copper (1) 1000A (2) 2000A	....	3515. 3890.
105	Bottom steel mounting channel (1 1/2" high)	....	200.	206	Insulation for bus (Al or Cu) A. Vertical bus B. Horizontal bus	....	485. 760.
106	Steel bottom plate for NEMA 1 enclosure (2 & 3 high)	....	200.		(1) 1000A (2) 2000A	....	1140.
107	Weatherproof undercoating	....	150. per vert. section		C. Cross-over bus (1) 1000A (2) 2000A	....	860. 1540.
108	Load cable isolation	....	500. per controller		D. Corner bus (1) 1000A (2) 2000A	....	1215. 2295.
109	Key interlock (mechanical) per cylinder	....	332.	207	Compression type copper lugs (a set of 3) in place of box type (aluminum) lugs for line and load termination (1) Max. 350 MCM (2) Max. 750 MCM	....	90. 150.
110	Special paint (any color, baked enamel) (a) Single coat (exterior only, in place of standard ASA-49)	....	200.	208	Potheads (for terminating paper insulated cables)	....	Consult factory
	(b) Two coats of paint (standard ASA-49)	....	320.				
	(c) Primer on NEMA-1 & 12 Enclosure	....	320.	209	<b>III. Power Factor Capacitors, Surge Capacitors And Lightning Arrestors.</b>		
111	Cable pull box (Top hat)	....	740.		Power factor corrective capacitors 3 phase with fuses. 25KVAR	15"	1330.
<b>AUXILIARY, INCOMING LINE AND METERING SECTIONS (NEMA 1):</b>					50KVAR	15"	1550.
121	Type ICLC-1 Incoming Line or Metering Compartment, 30" or 45" cell	....	610.		75KVAR	15"	1750.
122	Type AUX-1 Auxiliary section, 90" high	....	1820.		100KVAR	15"	2040.
123	Type VSCC-1, Incoming line section (26"W, 35"D, 100"H) with: A. Tin plated aluminum bus (1) 1000A (2) 2000A	....	2260. 2740.		125KVAR	15"	2280.
	B. Tin plated copper bus (1) 1000A (2) 2000A	....	2310. 2840.		150KVAR	30"	2400.
<b>TRANSITION SECTIONS (NEMA-1)</b>					200 KVAR	30"	2640.
131	Type VSBC-1 (26"W, 35"D, 100"H) with: A. Tin plated aluminum bus (1) 1000A (2) 2000A	....	3400. 4040.		250KVAR	30"	3200.
	B. Tin plated copper bus (1) 1000A (2) 2000A	....	3600. 4400.	210	Surge capacitor, 3 phase ■ (1) 2200-2400 volts (2) 4000-4160 volts (3) 4600-4800 volts	30" 30" 30"	1380. 1580. 2100.
132	Type VSCB-2 (26"W, 70"D, 100"H) for back to back arrangement with: A. Tin plated aluminum bus (1) 1000A (2) 2000A	....	5800. 6800.	211	Lightning arrestors, 3 phase ■ A. Distribution Type: (1) 3000 volts (2) 6000 volts	30" 30"	1700. 1920.
	B. Tin plated copper bus (1) 1000A (2) 2000A	....	6200. 7680.		B. Station Type: (1) 3000 volts	30"	2100.
<b>POWER CIRCUIT MODIFICATIONS:</b>					■ For optimum protection, items 210 & 211 should be mounted at the motor terminals. When this is not practical, these can be mounted in the MCC		
<b>I. Vertical, Horizontal &amp; Ground Bus</b>							
201	Vertical Bus: (1) Tin plated aluminum (750A) (2) Tin plated copper (1000A)	....	No charge 280.				
202	Horizontal Bus: A. Tin plated aluminum (1) 1000A (2) 2000A	....	800. 1425.				
	B. Tin plated copper (1) 1000A (2) 2000A	....	1015. 1650.				
203	Ground bus: (1) Tin plated aluminum (2) Bare copper (3) Tin plated copper	....	150. 190. 240.				



# MEDIUM VOLTAGE STARTERS — MODEL 2

## ADDITIONS AND MODIFICATIONS

**CLASS**  
**8198**

Item Number	Description	Space Requirements	Price	Item Number	Description	Space Requirements	Price
	<b>CONTROL CIRCUIT MODIFICATIONS:</b>						
	<b>I. Control Transformers</b>						
301	750VA, 60KV BIL rated control transformer (in place of standard transformer) 120V secondary	►	\$ 536.	349	Contactor control circuit contacts: Three contact blocks, each with 1 N.O. & 1 N.C. contacts form C.	---	\$ 128.
302	Two 750 VA control transformers (connected in open delta for 3 phase, 120 volt output)	►	416.	350	Resistor used as load sensing device for air-conditioners	* CR	120. each
303	1.5KVA control transformer (in place of standard transformer) 120-240V secondary	►	416.	351	14 gauge control wires in place of std. 16 gauge wires	---	80. per controller
304	2.5KVA control transformer (in place of standard transformer) 120-240V secondary	►	782.		<b>VI. Control Relays, Timers, etc.</b>		
305	3KVA control transformer (in place of standard transformer), separately mounted from the contactor 120-240V secondary	15"	856.	361	Control relay, 4 pole	* CR	152.
306	Omission of standard control circuit transformer: Deduct: (1) 2200-2400 V (2) 4000-4800 V	---	256. 444.	362	Control relay, 8 pole	* CR	232.
307	120/240V, 300VA control transformer	* S	150.	363	Mechanically latched control relay (maximum 4 pole)	* CR	180.
308	5KVA Transformer 2400/120-240V, 1 phase 60 Hz. (1) Without primary disconnect (2) With primary disconnect	30" 30"	1890. 2560.	364	Pneumatic timer	* CR	200.
309	5KVA Transformer 4160/120-240V, 1 phase 60 Hz. (1) Without primary disconnect (2) With primary disconnect	30" 30"	1990. 2660.	365	Motor driven timer	S	352.
	<b>II. Potential Transformers</b>			366	Incomplete sequence timer	* CR	384.
311	Potential transformer, instrument type (1) 2200-2400V 60 cycles (2) 2200-2400V 60 cycles	15" 15"	576. 776.		<b>VII. Protective Devices</b>		
312	Drawout mechanism for each potential transformer (for item 311)	30"	600.		<b>A. Overload, Overcurrent And instantaneous</b>		
313	Primary disconnect (for item 311)	30"	340. per pole	371	Thermal overload relay, 3 pole, bimetallic ambient temperature compensated, with standard C.T.s	■	No charge
314	Contactor 3rd stabs (set of 3)	----	300.	372	N.O. alarm circuit contact on overload relay (not available on magnetic overload relays)	----	50. per starter
315	Potential circuit cabling (This is required when one set of P.T.s is used for more than one starter)	----	180. per starter	373	Magnetic overload relays (requires instrument type C.T.s item 323)	■	110. per pole
	<b>III. Current Transformers</b>			374	Solid state overcurrent relay (3 phase)	R	1352.
321	Additional current transformer (donut type)	----	260.	375	Switchboard type overcurrent or instantaneous relay (requires instrument type C.T.s, item 323)	R	1020. per pole
322	Additional instrument type C.T. (1) 400/5 Maximum (2) 600/5 Maximum (3) 1200/5 Maximum	----	405. each 460. each 620. each	376	Undercurrent relay (adjustable) 3-phase	R	200.
323	Set of three instrument type current transformers in place of donut type C.T.s <b>NOTE:</b> Instrument type C.T.s must be used for all requirements other than Thermal overload relays and ammeters.	----	690.	377	Locked rotor overload (stalled rotor protection)	* R	542. per pole
324	Current transformer protection: Thyrite	■	120. each		<b>B. Undervoltage, Phase Sequence</b>		
	<b>IV. Space Heaters (300 Watts for one high; 125 Watts for two/three high)</b>			378	Instantaneous undervoltage protection (std.)	----	No charge
331	Cabinet space heater wired to normally closed contact.	■	140. per controller	379	Time delay undervoltage circuit 1. With timing relays	CR	280.
332	Cabinet space heater (with manual ON-OFF switch).	■	214. per controller		2. With resistor-capacitor network	CR	Consult factory
333	Cabinet space heater with thermal switch for temperature regulation.	■	288. per controller	380	Undervoltage relay (solid state, adjustable)	S	920.
	<b>V. Miscellaneous (Test-Switch, Safety Interlocks, etc.)</b>			381	Phase sequence voltage relay (switchboard type)	S	920.
341	"Test-Normal" selector switch	* CR	90.		<b>C. Ground Fault</b>		
342	Circuit breaker in place of low voltage control fuse	* CR	94.	382	Ground fault protection for grounded system including donut type C.T. (Manual reset) (1) Without test circuit (2) With test circuit	* G * G	855. 1500.
343	Additional circuit breaker, 2 pole, 120/240V, 15A, A.C. for control circuit	* CR	104.	383	Ground fault detection for ungrounded system (1) 2400V (2) 4160V	30" 30"	1900. 2500.
344	Control circuit cabling, including 120V disconnect switch (This is required when control circuit power is obtained from separate source, rather than integrally mounted control transformer)	----	290. per controller	384	Ground fault detection & protection for ungrounded system (1) 2400V (2) 4160V	30" 30"	2200. 2800.
345	Extra control wires (for external circuit) connected to terminal strip	----	20. each		<b>D. Reverse Phase, Phase Failure/Unbalance</b>		
346	Door operated electrical interlock	----	60.	385	Anti-single phase trip bar (operating through blown fuse indicator)	----	460.
347	Limit switch (mounted on contactor rail)	----	60.	386	Reverse phase—phase failure relay (requires instrument type current transformers—item 323)	* R	860.
348	Electrical release for latched contactor	----	200.	387	Phase balance current relay (requires instrument type current transformers—item 323) 3-phase.	15"	1590.
				388	<b>E. Differential</b> Differential current relay, 3-phase (does not include C.T.s) (1) For 3 C.T. scheme, use 3 window type C.T.s at Motor (2) For 6 C.T. scheme, use 3 dedicated C.T.s in the control and 3 matched C.T.s at motor (use item 322)	30"	1590. 3180.

\* See Page 18 for various devices which can be mounted in low voltage compartment.

► Mounted on the medium voltage contactor.

■ Space already exists in the controller.

Item Number	Description	Space Requirements	Price	Item Number	Description	Space Requirements	Price
	<b>F. Temperature Monitoring Devices</b>				<b>PILOT DEVICES MOUNTED ON DOOR</b>		
389	Temperature relay: monitors one preselected 10, 100, or 120 ohm Resistance Temperature Detector (RTD) located in motor winding or motor bearing. (1) Induction disc type (2) Solid state type (3) Temperature meter relay (indicating type) (4) Mounting & Wiring (relay supplied by customer)	R S  R ....	<b>\$1470.</b> <b>1470.</b>  <b>720.</b> <b>140.</b>	501	Hand-Off-Auto (or local/remote) selector	* PB	<b>\$ 60.</b>
				502	Indicating light (specify color)	* PB	<b>60.</b>
				503	Push-to-Test indicating light	* PB	<b>90.</b>
				504	Other pushbutton units (price per operator)	* PB	<b>60.</b>
				505	Maintained contact push button	* PB	<b>120.</b>
				506	Pistol grip selector switch (On-Off)	* PB	<b>204.</b>
390	Six position RTD selector switch (to be used with item 389)	2 PB	<b>408.</b>		<b>SYNCHRONOUS MOTOR STARTER MODIFICATIONS:</b>		
	<b>G. Solid state Multi function Relays</b>				<b>I. Equipment for Field Excitation:</b>		
391	Multifunction module with following protective functions. Overload Stalled rotor Current unbalance Ground fault (for grounded system, includes window C.T.) Over temperature (single RTD, winding or bearing)	R	<b>3750.</b>	601	Motor field resistor or rheostat if an existing shop source is supplying direct current at a fixed voltage, adjustment of the field excitation can be made by means of a resistor (with adjustable taps) or a rheostat in series with the field. Select KW requirement from exciter selection table. (See page 19) (1) 1.0 KW (2) 1.5 KW (3) 2.0 KW (4) 3.0 KW (5) 5.0 KW (6) 7.5 KW (7) 10.0 KW (8) 15.0 KW (9) 20.0 KW	■ ■ ■ ■ ■ ■ ■ ■ ■ ■	<b>190.</b> <b>202.</b> <b>238.</b> <b>280.</b> <b>510.</b> <b>610.</b> <b>816.</b> <b>1080.</b> <b>1200.</b>
392	Multifunction programmable module with following protective functions: Overload Stalled rotor Current unbalance/open phase Phase reversal Ground fault (for grounded system, includes window C.T.) Over temperature (monitors 6 winding RTDs and 2 bearing RTDs simultaneously)	R	<b>6170.</b>	602	Exciter field rheostat if a separate motor-generator (M-G) set is used to supply the motor field excitation, the exciter field rheostat is used to adjust the generator voltage. Rheostat is mounted in door of starter. (1) Drilling only for customer's rheostat (2) Mounting and wiring of customer's rheostat (3) Rheostat supplied, mounted and wired	■ ■ ■	<b>No charge</b> <b>100.</b> <b>200.</b>
	<b>METERING EQUIPMENT (MOUNTED ON DOOR)</b>						
401	AC ammeter—standard (90° scale)	* M	<b>396.</b>				
402	AC ammeter switchboard type (180° or 250° scale)	* M	<b>476.</b>	603	Static exciter consisting of 3 phase fused transformer, silicon rectifiers and surge protective device connected to the load-side of contactor.		
403	Recording type ac ammeter	Contact factory	<b>1790.</b>		The static exciter package provides ac to dc power conversion required for individual synchronous motor field excitation. No field rheostat or resistors required since voltage adjustment can be made on the static exciter transformer by changing taps.		
404 +	Ammeter transfer switch	* SS	<b>204.</b>		Input: 2300/4160 volts, 3 phase, 60 Hz. Output: 125 or 250V DC		
405	AC voltmeter—standard (90° scale)	* M	<b>396.</b>		Select KW requirement from exciter selection table (see page 19): 2200-2400 V (1) 1.0 KW (2) 2.0 KW (3) 3.0 KW (4) 4.5 KW (5) 6.5 KW (6) 9.0 KW (7) 13.0 KW (8) 17.0 KW (9) 21.0 KW (10) 25.0 KW 4000-4600 V (11) 1.0 KW (12) 2.0 KW (13) 3.0 KW (14) 4.5 KW (15) 6.5 KW (16) 9.0 KW (17) 13.0 KW (18) 17.0 KW (19) 21.0 KW (20) 25.0 KW	30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30" 30"	<b>2590.</b> <b>2980.</b> <b>3270.</b> <b>3780.</b> <b>4410.</b> <b>5120.</b> <b>6700.</b> <b>7460.</b> <b>Consult factory</b> <b>Consult factory</b>
406	AC voltmeter—switchboard type (180° or 250° scale)	* M	<b>476.</b>				
407	Recording type ac voltmeter (requires P.T. item 311)	Contact factory	<b>1790.</b>				
408	DC voltmeter	* M	<b>420.</b>				
409 +	Voltmeter transfer switch (requires 2 P.T.s)	* SS	<b>204.</b>	604	Exciter motor starter (1) NEMA Size 1 (2) NEMA Size 1	■ ■	<b>324.</b> <b>464.</b>
410	Watt-hour meter (drawout type). Requires 2 P.T.s (item 311) and instrument type C.T.s (item 322 or 323)	* R	<b>1030.</b>				
411	Watt-hour meter with demand register. Requires 2 P.T.s (item 311) and instrument type C.T.s (item 322 or 323)	* R	<b>1240.</b>	605	D.C. cabling to feed more than one synchronous motor field from a single source (1) 250 amps 2 wire per section (2) 500 amps 2 wire section (3) Fused disconnect switch with discharge circuit (required for each starter connected to separate dc excitation source)	■ ■ .... ....	<b>150.</b> <b>300.</b>
412	Wattmeter. Requires 2 P.T.s (item 311) and instrument type C.T.s (item 322 or 323)	* M	<b>1120.</b>				
413	Recording type wattmeter. Requires 2 P.T.s (item 311) and instrument type C.T.s (item 322 or 323)	Contact factory	<b>2430.</b>				
414	Varmeter. Requires 2 P.T.s (item 311) and instrument type C.T.s (item 322 or 323)	* M	<b>1120.</b>				
415	Power factor meter. Requires 2 P.T.s (item 311) and instrument type C.T.s (item 322 or 323)	* M	<b>1120.</b>				
416	Frequency meter	* M	<b>780.</b>				
417	Elapsed time meter	* E	<b>166.</b>				
418	Operation counter	* M	<b>238.</b>				
419	Test blocks (1) 4 pole (2) 5 pole (3) 8 pole (4) 10 pole	* M * M *2M *2M	<b>148.</b> <b>212.</b> <b>296.</b> <b>370.</b>				
420	Current transducer (used for remote metering)	* S	<b>580.</b>				
421	Voltage Transducer (used for remote metering)	* S	<b>580.</b>				
422	Watts Transducer (used for remote metering)	* S	<b>1290.</b>				

\* See Page 18 for various devices which can be mounted in low voltage compartment.  
 ■ Space already exists in the controller.



## MEDIUM VOLTAGE STARTERS — MODEL 2

**CLASS**  
**8198**

Item Number	Description	Space Requirements	Price	Item Number	Description	Space Requirements	Price
606	<b>II. Relays for Synchronous Motors</b> Field loss relay (detects if field circuit is open)	■	428.		separately refer to HI Repair & Component Parts Price List)		
	<b>ACCESSORY AND SPARES</b>				2300 V 4800 V FUSE SIZE		
					Max. H.P. 200 400 2R, 3R, 4R	....	162. each
					500 1000 6R, 9R	....	385. each
					700 1200 12R	....	385. each
					800 1500 18R	....	602. each
					1500 2500 24R	....	602. each
					Max. KVA 200 400 65E, 80E, 100E	....	193. each
					500 1000 125E, 150E, 200E	....	350. each
					1000 2000 300E, 375E	....	602. each
701	Spare contactor assembly consisting of: • 3-pole contactor with 2 NO and 2 NC auxiliary contacts • Power fuse clips (less fuses) • 750 VA control transformer complete with primary current limiting fuses • Wiring between control transformer, rectifier contactor coil and male separable connector mounted as integral part of contactor • Rectifier for d.c. coil	....	4700.	704	Control transformer primary fuse (2E, 3E, 4E & 5E)	....	65. each
702	Contactor test cord (to test contactor on bench)	....	178.	705	Control transformer secondary fuse (250V 10A, Max)	....	3. each
703	Spare fuses (the following prices are applicable for spare fuses purchased with the starter. When the fuses are purchased	....		706	Class 8198 type HJ-2 contactor lift jack for removing and transporting contactor	....	890.
					<b>MISCELLANEOUS</b>		
					Export Packing		
					(1) Below Deck (standard)		Consult factory
					(2) Above Deck (special)		

\* See Page 18 for various devices which can be mounted in low voltage compartment

### FIELD RHEOSTAT AND STATIC EXCITER SELECTION TABLES

#### KW RATINGS FOR 0.8 PF, 60 HERTZ MOTORS

Hp	Speed, Rpm																							
	1800	1200	900	720	600	514	450	400	360	327	300	277	257	240	225	200	180	164	150	138	129	120		
75	....	...	...	...	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	...		
100	....	...	...	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13		
125	....	...	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13		
150	....	...	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13		
200	...	4.5	4.5	4.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	13	13		
250	3.0	4.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	13	13	13	13		
300	3.0	4.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	13	17	17	17	17	17		
350	4.5	4.5	6.5	6.5	9.0	9.0	9.0	13	13	13	13	13	13	13	13	13	17	17	17	17	17	17		
400	4.5	6.5	6.5	6.5	9.0	9.0	13	13	13	13	13	13	13	13	13	17	17	17	17	17	17	17		
450	4.5	6.5	6.5	6.5	9.0	9.0	13	13	13	13	13	13	13	17	17	17	17	17	21	21	21	21		
500	4.5	6.5	6.5	9.0	9.0	9.0	13	13	13	13	13	13	17	17	17	17	17	21	21	21	21	21		
600	6.5	6.5	9.0	9.0	13	13	13	13	13	17	17	17	17	17	17	17	21	21	21	21	21	21		
700	6.5	9.0	9.0	9.0	13	13	13	13	17	17	17	17	17	17	17	21	21	21	21	25	25	25		
800	6.5	9.0	9.0	13	13	13	17	17	17	17	17	17	17	21	21	21	25	25	25	25	25	25		
900	6.5	9.0	13	13	13	17	17	17	17	17	21	21	21	21	21	25	25	25	25	25	25	25		
1000	9.0	9.0	13	13	13	17	17	17	17	21	21	21	21	21	21	25	25	25	25	25	25	25		
1250	9.0	13	13	13	17	17	21	21	21	21	21	25	25	25	25	25	33	33	33	33	33	33		
1500	13	13	17	17	17	17	21	21	25	25	25	25	25	25	25	33	33	33	33	33	33	40		
1750	13	13	17	17	21	21	25	25	25	25	25	25	33	33	33	33	33	33	33	40	40	40		
2000	13	17	17	21	21	25	25	33	33	33	33	33	33	33	33	33	40	40	40	40	40	40		
2250	13	17	21	21	25	25	33	33	33	33	33	33	33	33	33	40	40	40	40	40	40	40		
2500	17	17	21	21	25	25	33	33	33	33	33	33	40	40	40	40	40	40	40	40	40	50		
3000	17	21	25	25	33	33	33	33	40	40	40	40	40	40	40	50	50	50	50	50	50	50		

### KW RATINGS FOR 1.0 PF, 60 HERTZ MOTORS

Hp							Speed, Rpm																			
	1800	1200	900	720	600	514	450	400	360	327	300	277	257	240	225	200	180	164	150	138	129	120				
75	....	..	...		3.0	3.0	3.0	3.0	3.0	3.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	...				
100	....	..	...	2.0	3.0	3.0	3.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5				
125	....	..	3.0	3.0	3.0	3.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5				
150	....	..	3.0	3.0	3.0	4.5	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5				
200	...	3.0	3.0	3.0	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0				
250	2.0	3.0	3.0	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0				
300	2.0	3.0	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0				
350	3.0	3.0	4.5	4.5	4.0	6.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13				
400	3.0	3.0	4.5	4.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13	13				
450	3.0	4.5	4.5	4.5	6.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13				
500	3.0	4.5	4.5	4.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	17				
600	3.0	4.5	6.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	17	17	17				
700	4.5	4.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	13	13	17	17	17	17				
800	4.5	6.5	6.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	13	13	17	17	17	17	17				
900	4.5	6.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	17	17	17	17	17	17	17	17				
1000	4.5	6.5	9.0	9.0	9.0	9.0	13	13	13	13	13	13	13	13	17	17	17	17	17	17	21	21				
1250	6.5	6.5	9.0	13	13	13	13	13	13	13	13	13	17	17	17	17	17	17	21	21	21	21				
1500	6.5	9.0	9.0	13	13	13	13	13	13	17	17	17	17	17	17	21	21	21	21	21	21	21				
1750	9.0	9.0	13	13	13	13	13	17	17	17	17	17	17	17	21	21	21	21	21	25	25	25				
2000	9.0	13	13	13	13	17	17	17	17	17	21	21	21	21	21	25	25	25	25	25	25	25				
2250	9.0	13	13	13	17	17	17	17	21	21	21	21	21	21	25	25	25	25	25	25	25	25				
2500	13	13	13	17	17	17	21	21	21	21	21	21	25	25	25	25	33	33	33	33	33	33				
3000	13	13	17	17	17	21	21	21	25	25	25	25	25	25	33	33	33	33	33	33	33	33				

The above tables may be used to estimate the required KW ratings when the motor horsepower, speed and power factor are known. The preferred selection should be based upon the actual motor field data.

## APPLICATION DATA

## ENCLOSURE

- Structure** ..... #10 gauge
- Sheet Steel** ..... #12 gauge
- Paint Finish** ..... NEMA 1 and 12: One coat of medium gray (ANSI-49) baked enamel over rust resistant prepared surface to meet NEMA ICS 6-110.57 test procedure.
- ..... NEMA 3: Coating(s) of medium gray (ANSI-49) organic paint finish over rust resistant prepared surface to meet NEMA ICS 6-110.57 test procedure.
- Types** ..... NEMA 1, NEMA 1 with gasketing, NEMA 3, NEMA 12.

## INDIVIDUAL CONTROLLER MAXIMUM RATINGS

Utilization Voltage	2300V 60 Hertz	4000V 60 Hertz	4600V 60 Hertz
Squirrel Cage and Wound Rotor	1500 HP	2500 HP	2500 HP
Synchronous — .8 PF	1500 HP	2500 HP	2500 HP
Synchronous — 1.0 PF	1750 HP	3000 HP	3000 HP
Interrupting Rating	200 MVA	350 MVA	400 MVA
Basic Impulse Rating	60 KV	60 KV	60 KV

## POWER FUSES

- Location** ..... In front of contactor, integral part of contactor assembly.
- Type** ..... Current limiting, 12" centers.
- Interrupting Ratings** ... 50,000 amps symmetrical, 80,000 amps asymmetrical, 200MVA(sym) 2300V, 350MVA(sym) 4160V.

## INCOMING LINE CONNECTIONS

- Location** ..... \*Left rear of enclosure 5" wide x 8" deep, extends top to bottom of enclosure.
- Behind line terminal cover at top of frame assembly.
- Cables** ..... \*Supports for three cables, maximum 500 MCM.
- Maximum two 500 MCM cables per phase or one 750MCM cable per phase.
- Entrance** ..... Top or bottom feed.
- Termination** ..... a. Standard, box-type lugs for maximum 500MCM copper or aluminum cable.
- ..... b. Optional, lugs for 750MCM cable.
- Stress Cones** ..... Maximum size 7" for top or bottom feed.

## LOAD CABLE CONNECTIONS

- Location** ..... \*Right rear of enclosure: 13" wide x 22" deep extends top to bottom of enclosure

\* Two and three high only.

► One high only.

## LOAD CABLE CONNECTIONS (continued)

- Location** ..... \*Right rear of enclosure: 13" wide x 22" deep extends top to bottom of enclosure
- Right side of enclosure near the front.
- Cables** ..... \*Supports for nine cables, maximum 500MCM.
- Supports for three cables, maximum 500MCM.
- Entrance** ..... Top or bottom feed.
- Termination** ..... a. Box-type lugs for maximum 250-MCM cable. Lugs for 500MCM cable optional.
- ..... b. Directly on bar of C.T.s when bar type C.T.s are supplied.
- Stress Cones** ..... \*Maximum size 5" for top or bottom feed.
- Maximum size 7".

## BUS

- Location** ..... a. Horizontal bus across top in 10" high compartment.
- ..... b. Vertical bus down back.
- ..... c. Ground bus across bottom.

	Amps	Metal	Dimensions
Horizontal Bus Ratings	1000 1000 2000 2000	Cu Al Cu Al	3 x ¾ 3 ¼ x ¾ 2 (3 x ¾) 2 (3 ¼ x ¾)
Vertical Bus Ratings*	750 1000	Al Cu	2 x ½ 2 x ½
Ground Bus Ratings:			
(a) Continuous	375 500	Al Cu	2 x ¼ 2 x ¼
(b) Intermittent (Per UL)	3000 4000	Al Cu	2 x ¼ 2 x ¼

- Plating** ..... Tin plated aluminum or tin plated copper.
- Bracing** ..... 80,000 amp asymmetrical short circuit current.
- Insulation (Optional)** .. Heat shrink tubing with insulating boots over joints.

## CONTACTOR

- Location** ..... In separate isolated compartment.
- Construction** ..... Clapper type, line and load connection disconnected in drawn out position.
- Volts and Frequency** ... 5000V maximum, 50-60 Hertz.
- Current Ratings** ..... NEMA type H3, 360A enclosed.
- Interrupting Rating** ... 50MVA.
- Contact Tips** ..... Silver-tungsten carbide faced copper.
- Control Voltage** ..... 120V, 60 Hertz, single phase.
- Control Current** ..... a. Pickup 3.0 amps AC
- ..... b. Sealed 0.6 amps AC

**CONTACTOR (continued)**

- Coil Circuit Rectifier** . . . 12 Amps, 120 Volts, AC, full wave bridge silicon.
- DC Coil (a) Voltage** . . . 60V rated, 30V sealed.  
(b) **Current** . . . 0.72 amps sealed.
- Operating Time** . . . . . a. Pickup 12 to 13 cycles.  
b. Dropout 6 to 9 cycles.
- Auxiliary Contacts** . . . . a. Standard: 2 contact blocks, each 1 N.O. and 1 N.C. (form C) Contacts for customer use.  
Optional: Maximum of 5 contact blocks.  
b. Rating: (i) Continuous: 10 amps  
(ii) Interrupting (Inductive): 2.2 amps at 120V AC.
- Test Circuit** . . . . . Standard extension cord for testing starter in enclosure.

**CONTROL TRANSFORMER**

- Location** . . . . . Integral part of contactor or separate mounting for 3KVA.
- Rating (Contactor Mounted)** . . . . . a. Standard 750VA.  
b. Optional 1.5KVA, 2.5KVA.
- Accuracy** . . . . .  $\pm 2\%$  at 50% rated VA. Regulation 5%.
- Protection** . . . . . a. Primary: Two current limiting fuses.  
b. Secondary: One 6 amps fuse. Circuit breaker — optional.
- Ratios** . . . . . 2400/120, 3300/120, 4200/120, 4800/120.

**CURRENT TRANSFORMERS**

- Location** . . . . . \*In isolated load cable compartment.  
► In medium voltage compartment (left wall)

	Standard	Optional
Type	Donut	Instrument (Bar Type)
Accuracy & burden (a) Metering (b) Relaying	1.2B-0.2	0.3B-2.0 2.5T100
Ratios	25/5 through 1200/5	25/5 through 800/5

**OVERLOAD PROTECTION**

- Location** . . . . . Standard relays on low voltage compartment door.
- Standard Relays** . . . . . Square D Class 9065 Type SEO-5 melting alloy.
- Optional Relays** . . . . . a. Square D Class 9065 bimetallic Type SEO-6B temperature compensated or Type SEO-6B2 non-compensated.  
b. Magnetic type with oil dash pot.  
c. Switch gear or solid state type for special applications.

\* Two and three high only.

► One high only.

**Reset (thermal relays)** . . External hand operated.

**LOW VOLTAGE CONTROLS**

- Location** . . . . . Separate isolated compartment.
- Terminal Strip** . . . . . Wire #10 and smaller, 600V ratings.
- Wiring** . . . . . Standard: 600V, 16 gauge stranded.  
Optional: 600V, 14 gauge stranded.
- Push Buttons** . . . . . Class 9001, 10 amp, 600V ratings.
- Pilot Lights** . . . . . Class 9001 Type K, 120V (transformer operated).
- Standard Relays** . . . . . Class 8501 Type L, 10 amp, 600V

**MECHANICAL INTERLOCKING**

- Contactor** . . . . . a. Cannot engage line stabs with contacts closed.  
b. Cannot disengage line stabs with contacts closed.
- Drawout Handle** . . . . . a. Cannot move handle down to draw out contactor with contacts closed.  
b. Cannot move handle up to draw in contactor with either contactor closed or medium voltage door open.
- Medium Voltage Door** . a. Cannot open medium voltage door with drawout handle up.  
b. Drawout handle must be moved down to withdraw contactor from line and load stabs before medium voltage door can be opened.
- Shutters** . . . . . a. Shutters close after contactor disengages line and load stabs.  
b. Shutters open as contactor is drawn in to engage line and load stabs.
- Defeaters** . . . . . a. Defeat system will permit authorized personnel to open medium voltage door with contactor engaged to line and load. Note: A tool and two separate operations are required.  
b. Defeat system will permit authorized personnel to draw in contactor to line and load stabs with door open.

**ELECTRICAL INTERLOCKING**

- Low Voltage Door** . . . . a. Controller is de-energized when low voltage door is opened.  
b. Interlock may be defeated by authorized personnel to keep controller energized when low voltage door is opened. Note: Tool required.
- Drawout Handle** . . . . . Causes contactor to de-energize before drawout handle can be moved down to withdraw contactor.

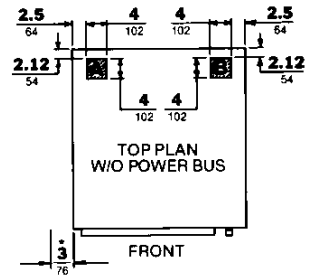
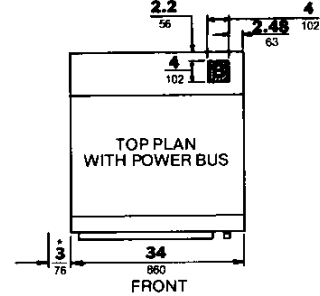
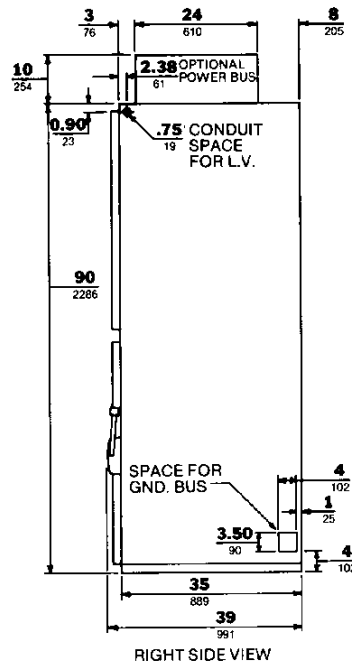
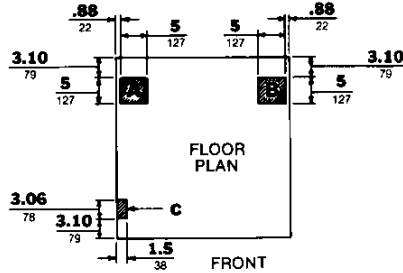
# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

JANUARY, 1981

## 1 HIGH ENCLOSURE DIMENSIONS

APPROXIMATE DIMENSIONS IN INCHES & MILLIMETERS — NOT FOR CONSTRUCTION

NEMA 1, 1 GASKETED AND 12 ENCLOSURES



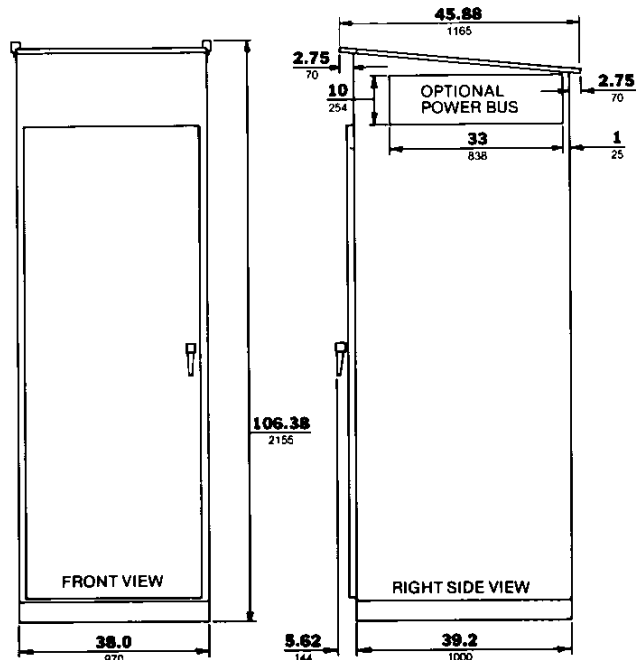
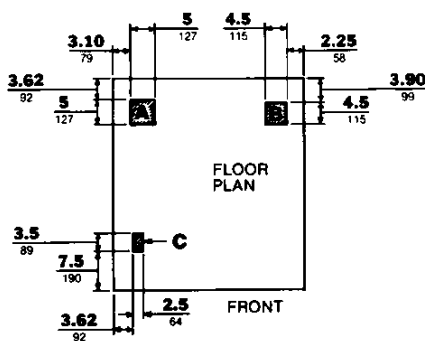
### Minimum Aisle Space:

5" minimum clearance to wall on left or right side for maximum door opening.

44 To remove contactor from the enclosure using  
1118 ramps stored inside of medium voltage compartment door.

## NEMA III ENCLOSURE (NON WALK-IN)

Conduit Area Code	
A	SPACE FOR MEDIUM VOLTAGE LINE CONDUIT
B	SPACE FOR MEDIUM VOLTAGE LOAD CONDUIT
C	SPACE FOR LOW VOLTAGE (CONTROL CIRCUIT) CONDUIT



Dual Dimensions:  
INCHES  
Millimeters



# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

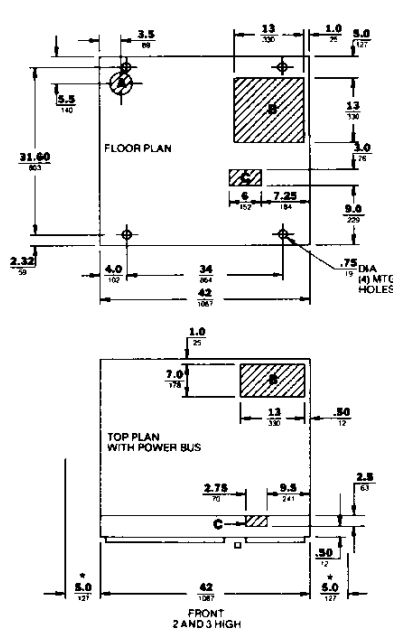
## 2 HIGH AND 3 HIGH ENCLOSURES

### DIMENSIONS

**CLASS**  
**8198**

APPROXIMATE DIMENSIONS IN INCHES & MILLIMETERS — NOT FOR CONSTRUCTION

NEMA 1, 1 GASKETED AND 12 ENCLOSURES

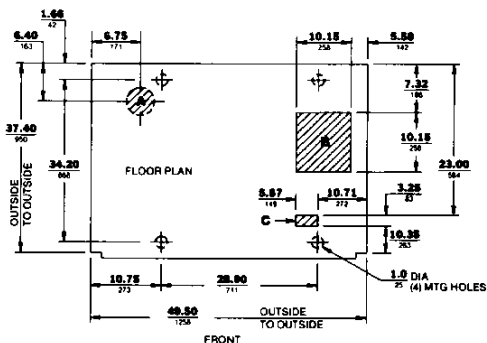


\* Minimum clearance to wall for maximum door opening.

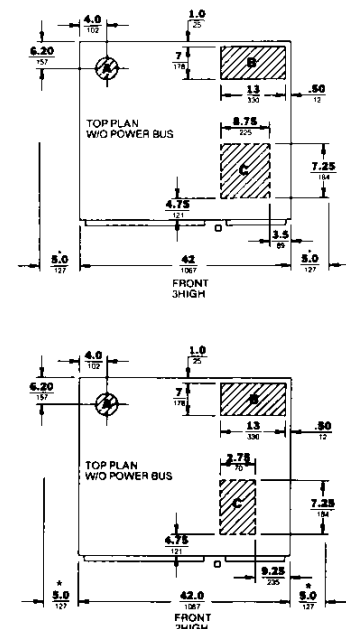
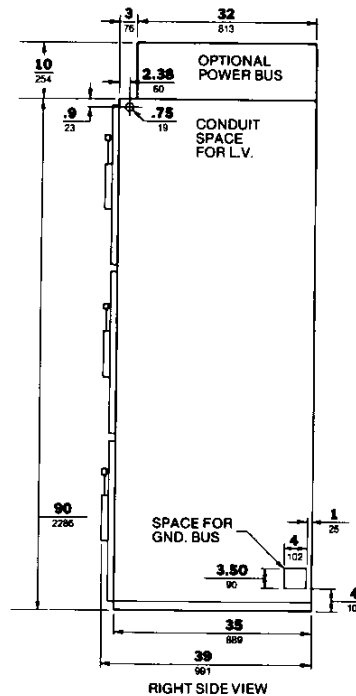
#### Minimum Aisle Space:

- 58** With Type HJ-2 Contactor Lift Jack  
1473
- 39** Without Type HJ-2 Contactor Lift Jack  
991

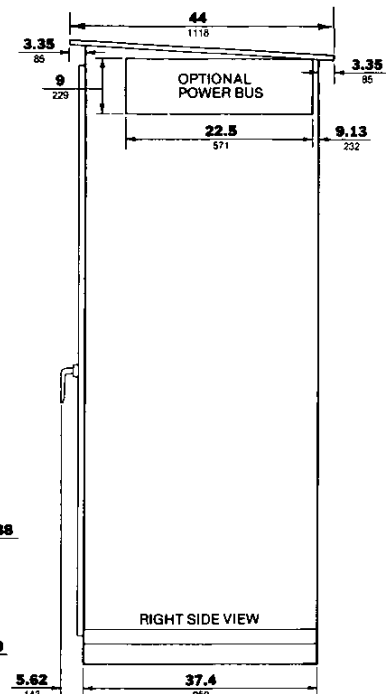
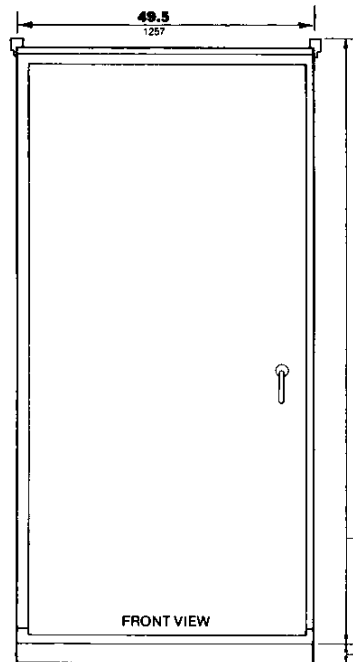
Conduit Area Code	
<b>A</b>	SPACE FOR MEDIUM VOLT-AGE LINE CONDUIT (MAXIMUM CONDUIT 5")
<b>B</b>	SPACE FOR MEDIUM VOLT-AGE LOAD CONDUIT
<b>C</b>	SPACE FOR LOW VOLTAGE (CONTROL CIRCUIT) CONDUIT



Dual Dimensions: **INCHES**  
Millimeters



#### NEMA III ENCLOSURE (NON WALK-IN)



# MEDIUM VOLTAGE CONTROLLERS — MODEL 2

## ORDERING INFORMATION AND SHIPPING WEIGHTS

JANUARY, 1981

### ORDERING INFORMATION

The following information is required for all controllers:

Class and Type

System: Voltage, phase, frequency, grounded or ungrounded.

Motor: HP, service factor, full load current, locked rotor current.

Line and Load Cables: Size and number per phase, shielded or unshielded, top or bottom entry.

Enclosure: NEMA Type: 1, 1 with gasketed doors, 3 or 12.

Construction: One, two or three high.

Modifications and Control Voltage.

Additional information is required for the following types of controllers:

Reduced Voltage Controllers:

Allowable locked rotor withstand time (Hot/Cold)

Acceleration time at reduced voltage

Controllers For Field Installation In Existing MCC:

Nameplate data of existing MCC including original factory order number.

Location in existing MCC where controller is to be installed.

Wound Rotor Motor Controllers:

Secondary voltage and current.

NEMA class of starting duty resistors.

Type of driven equipment, e.g. conveyor, pump, etc.

Minimum and maximum accelerating torque.

Speed-Torque characteristic curve.

Synchronous Motor Controllers:

Motor manufacturer, serial number and power factor of motor.

Motor field data (absolutely required upon entry of order).

(a) Rated field voltage, usually 125 or 250V dc

(b) Normal excitation current.

(c) Maximum excitation current.

(d) Induced field current with full voltage applied to stator at zero speed.

(e) Maximum allowable time on cage winding (without injury to cage) with locked rotor and full voltage applied to stator.

(f) Time required to accelerate motor with its connected load from zero to synchronous speed.

(g) Recommended ohms for field discharge resistor.

(h) Source of dc excitation, either: shop supply, motor generator set, excitation on motor shaft or static exciter.

### APPROXIMATE SHIPPING WEIGHTS

Weight Of Free-Standing Vertical Section Without Medium Voltage Contactor And Without Horizontal Power Bus

Enclosure	Weight	CONTROLLER TYPE										
		FC-11 FC-21 FL-11 FL-21	FC-12 * FC-13 * FC-22 * FC-23 *	FL-12 * FL-13 * FL-22 * FL-23 *	RCA-1▶ RCA-2▶	RCR-1▶ RCR-2▶	FCR-1 FCR-2	FS-1 FS-2 FSB-1 FSB-2	RSA-1▶ RSA-2▶	RSR-1▶ RSR-2▶	RWR-1,2 With	
											One 90° Section	Two 90° Sections
NEMA 1or 12	Lbs	800	1350	1350	3000-3600	1800-2400	1550	1450	3100-3700	3000-3600	2000	3600
	Kgs	363	612	612	1361-1633	816-1088	703	658	1406-1688	1361-1633	907	1636
NEMA 3	Lbs	1200	2150	2150	3800-4400	2600-3200	2350	2250	3900-4500	3800-4400	2800	4100
	Kgs	545	975	975	1723-1995	1179-1451	1065	1020	1769-2041	1723-1995	1270	1864
Number Of Medium Voltage Contactors Per Controller		1	1	1	3	2	2	1	3	2	1	1

\* For every additional controller in the same 90" high enclosure add 250 lbs (114 kgs) for components, plus the weight of medium voltage contactor.

► Prorate weight in proportion to horsepower.

Notes:

(1) Each medium voltage contactor weighs 400 lbs (182 kg).

(2) Horizontal power bus per vertical section weighs: 300 lbs (136 kgs).

(3) Medium voltage contactor is shipped inside enclosure for FC-11 and FC-21 controllers. For all other controllers, the contactor is shipped separately.

(4) Total weight of controller = (weight of enclosure) + (number of contactors x weight of each contactor) + (weight of horizontal power bus, if used).

(5) Hardware for unprepared cell weighs 150 lbs (68 kgs).

Dual Weights: **POUNDS**  
Kilograms

