SIEMENS

Medium Voltage Controllers—Series 81000™

Selection and Application Guide

The Siemens Series 81000™ medium voltage motor controller is a modular design consisting of one or more contactors, each with three current-limiting fuses, all housed in a free-standing sheet steel enclosure. The enclosure is designed for front access, allowing the equipment to be located against a wall or back-to-back. Typical applications include:

- Squirrel-Cage Induction Motors (non-reversing, reversing, and multi-speed)
- Reduced Voltage Starters (auto-transformer or reactor type)
- Synchronous motors (brush or brush-less type)

  Wound Rotor Motors — with or without secondary control
- Transformer Feeders
- Capacitor Bank Feeders
- Power Bus Feeders (Tie)

The utilization voltage range for the controllers is 2300 to 7200 volts AC.

Contactors

E1 (Unfused) — NEMA refers to this unfused, magnetically-held device as a class E1 controller. All type 94H3 (360A) vacuum contactors are rated 7kA interrupting capacity at up to 7200 volts, while the 90H6 (720A) vacuum contactor is rated 10kA interrupting capacity up to 5000 volts.

E2 (Fused) Contactors — To meet interrupting capability required for NEMA Class E2 controllers, the 94H3 and 90H6 contactors are provided with primary current limiting fuses in all three phases. The resulting interrupting ratings are shown in the Table 1.

Standards

The key standards applicable to medium voltage controllers are:

- NEMA ICS2-324

  UL-347
- NEC (Article 710)

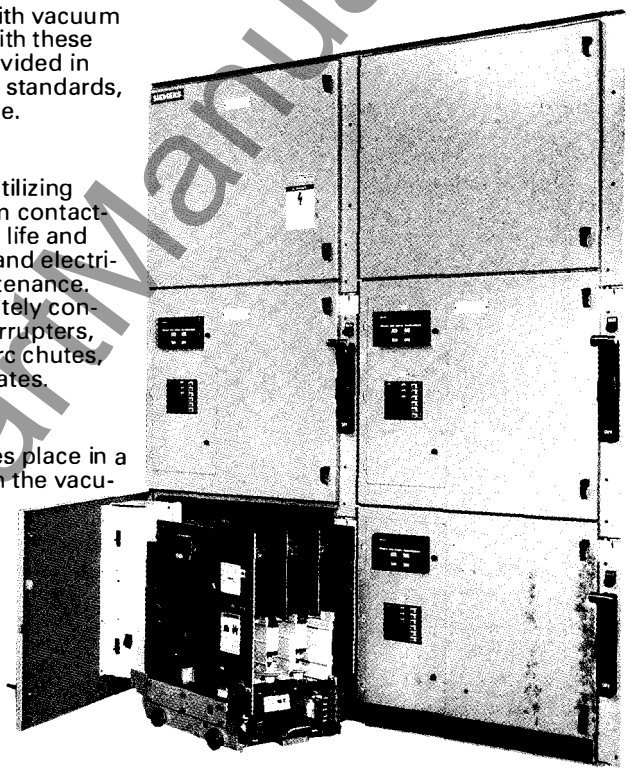
Series 81000 controllerswith vacuum contactors comply fully with these standards, and can be provided in compliance with specialty standards, such as the California Code.

Vacuum Technology

Series 81000 Controllers utilizing type 94H3 or 90H6 vacuum contactors offer extended service life and provide long mechanical and electrical life with minimal maintenance. Arc interruption is completely contained within vacuum interrupters, eliminating the need for arc chutes, blowout coils, and pole plates.

Extended Electrical Life

Since arc interruption takes place in a sealed environment within the vacuum interrupter, arcing times are very short. As a result, arc erosion of the contacts is minimal, and an operating life of 250,000 operations at rated load current is typical. This long life is unobtainable in traditional air magnetic designs.



Single-Phase Protection

The Siemens SAMMS-MV™ relay (optional) and the type 3UA overload relay (standard) are available in the Series 81000 control. Unlike conventional overload relays provided by other manufacturers, both the SAMMS-MV unit and the 3UA include single-phase protection as standard.

UL Listing

The Series 81000 control offers a broad range of UL listed controllers.

Power Fuses

The current limiting fuses used with the 94H3 vacuum contactors are ANSI Class "R" Type FM (up to 4800 volts) and Type A720R (over 4800 volts) rated for motor starting duty. Class "E" fuses, used for non-motor loads such as transformers and capacitor banks, can also be provided in Series 81000 controllers.

MVC-9011 (February, 1995)

Contents

General Construction

Siemens Advanced Motor Master System - (SAMMS-MV™)

The SAMMS-MV unit is a software-configured electronic motor control and overload protection device that incorporates protection tailored to the special characteristics of medium voltage motors. The SAMMS-MV system includes a microprocessor-based unit which receives signal inputs from a set of current transformers (either 3-1Ø or 1-3Ø) and power input from a 12 volt auxiliary transformer. To perform certain monitoring and setup activities, a hand-held communicator (HHC) is required. The SAMMS-MV device is a multi-functional system offering the following:

- Advanced Motor Protection For Medium Voltage Motors
- Pre-Programmed Control Circuits
- Standardized Control Panel With Input/Output Devices Replacing Conventional Pushbuttons, Pilot Lights, And Selector Switches
- Diagnostics
- Statistical Motor Data
- Real-Time Metering
- Local Display Of All Motor And Control Circuit Data
- Open Architecture Communications Using Siemens ACCESS™ System

Enclosures

Available in a variety of styles to meet most applications, enclosure types include:

- NEMA 1 Non-Gasketed
- NEMA 1 Gasketed
- NEMA 2 Dripproof
- NEMA 12 Dust-Tight
- NEMA 3R Non-Walk-in
- NEMA 3R Walk-in

External finish is ANSI 61 light gray polyester urethane, electrostatically applied. Special colors and finishes are optionally available.

Compartment Segregation

Each Series 81000 controller assembly consists of three areas completely segregated from one another:

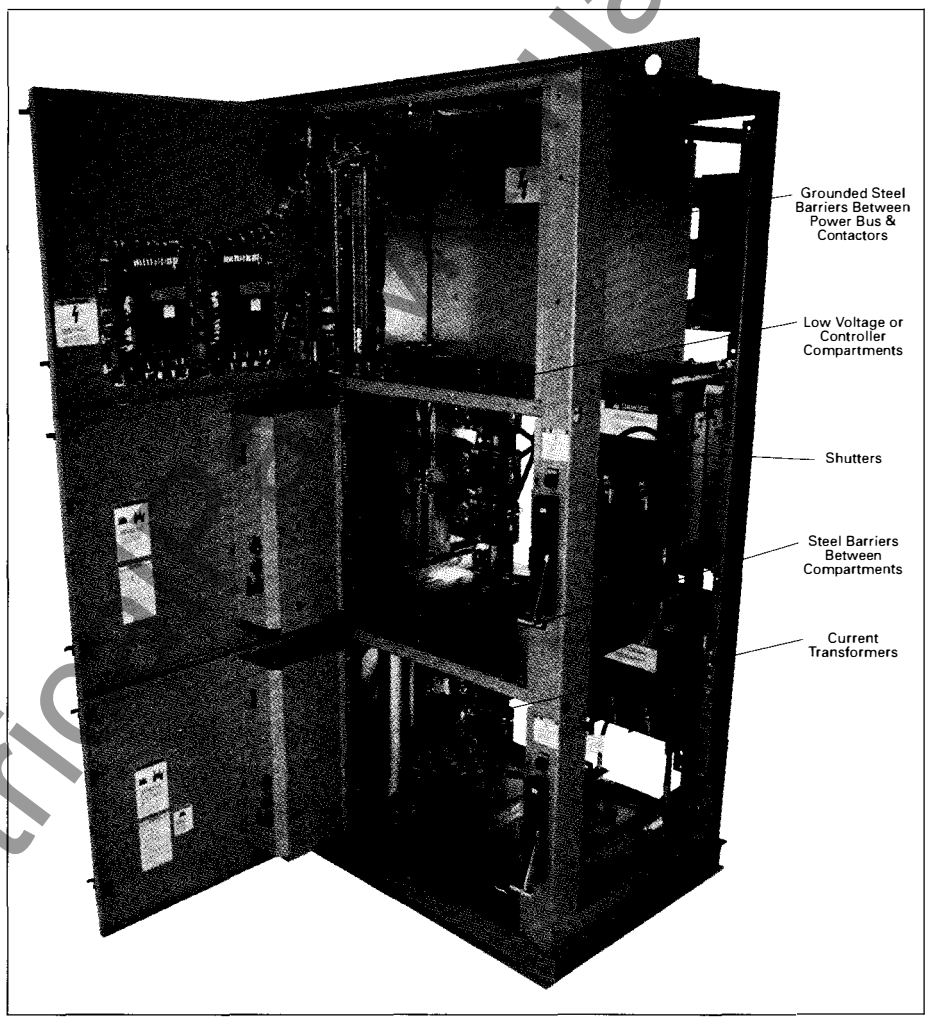
- Contactor Compartment
- Power Bus System (High Voltage)
- Low Voltage Section

Standard vertical structures consist of three 30 in. (762 mm) high compartments. One, two, or three controllers (depending on rating) may be included in one structure. When three controllers are required, the horizontal bus (including ground bus) is mounted in an additional top mounted 10 in. (254 mm) high bus compartment. An optional configuration (not shown) using two 45 in. (1143 mm) high compartments with top mounted bus is also available to comply with American Petroleum Institute specifications.

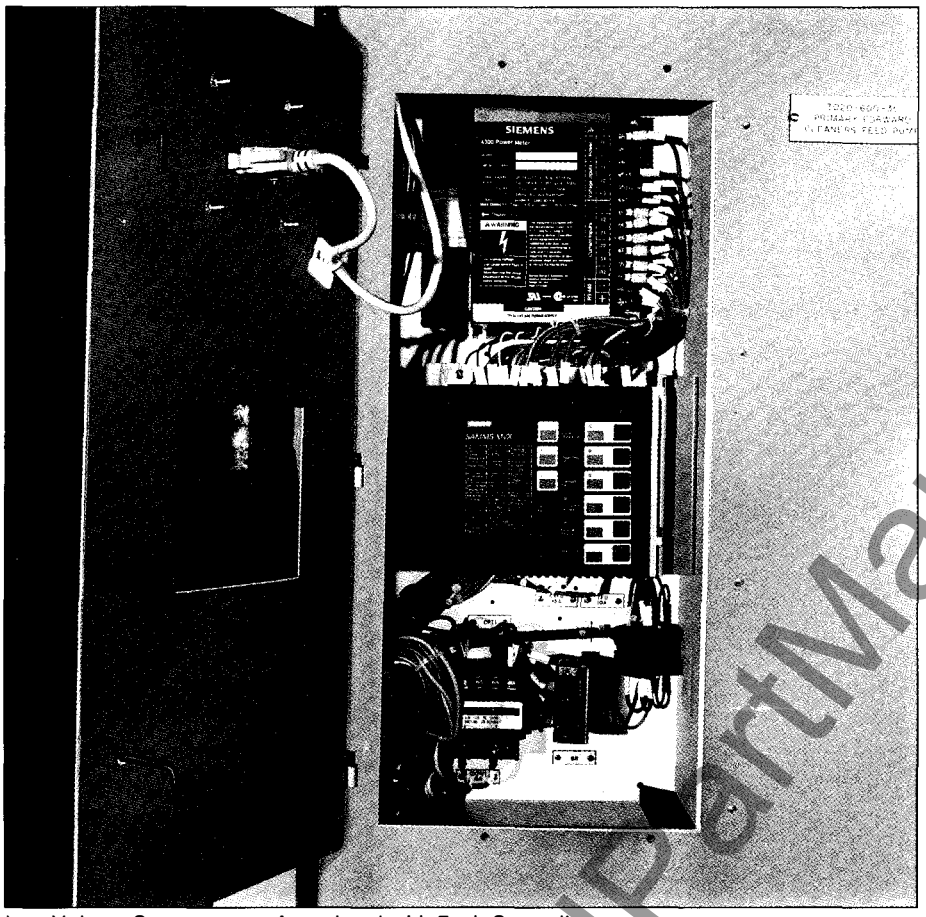
Table 1 — Series 81000™ Ratings①

System Voltage	Enclosed Continuous Ampere Rating	Contactor Type	Interrupting Capacity		Motor Horsepower Rating (3-Phase)				Transformer Loads	
					Synchronous Motors		Induction Motors	Maximum Motor Fuse Rating	Maximum 3-Phase kVA	Maximum Fuse Rating
			Unfused Class E1	Fused Class E2	0.8 PF	1.0 PF				
2300	360	94H35	7kA	200 MVA	1500	1750	1500	24R	1500	450E
2300	720	90H6	10kA	200 MVA	3000	3500	3000	57X	2000	600E
4000	360	94H35	7kA	350 MVA	2500	3000	2500	24R	2500	450E
4000	720	90H6	10kA	350 MVA	5500	6000	5500	57X	3500	600E
4600	360	94H35	7kA	400 MVA	2500	3000	2500	24R	2500	450E
4600	720	90H6	10kA	400 MVA	5500	6000	5500	57X	4000	600E
6900①	360	94H37	7kA	570 MVA	4000	5000	4000	24R	1500	200E

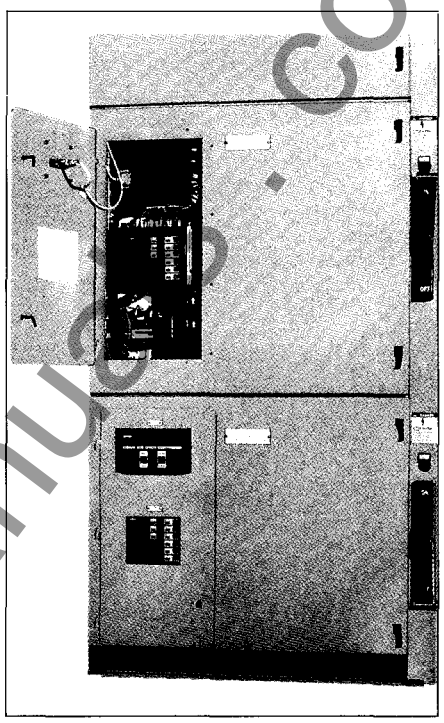
① Nominal motor voltage 6600V.



Construction



Low Voltage Compartment Associated with Each Controller



Door-in-Door Construction

Low Voltage Compartment
All active starter compartment front panels are provided with a "door-in-a-door" for access to the controller low voltage area. Devices normally mounted in this section include the SAMMS-MV or other overload relay, ammeter, control relays, timing relays, push-buttons, indicating lights, etc. Location within this section totally isolates the devices from any source of high voltage and allows access to these control components without interrupting service. Terminal blocks for control circuit wiring terminations are also accessible in this compartment.

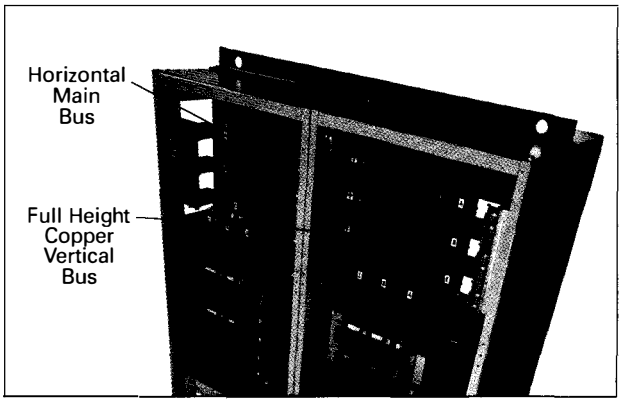
When extensive metering or special protective devices are required, the upper 30-in. (762 mm) high compartment can be used as a separate low voltage compartment in addition to the "door-in-a-door" low voltage compartment associated with each individual controller.

Power Bus
All power bus is isolated behind grounded steel barriers. Automatic shutters are provided to cover the line-side bus stabs whenever a starter door is opened. Horizontal bus ratings range from 600 through 3000 amperes and are further detailed in Table 2. Vertical tap buses in each section are rated 360, 540, or 720 amperes, depending on the application. Insulated bus and boots are available as options.

Table 2 — Series 81000 Bus Ratings

Type Bus	Continuous Amperes	Conductor Size in Inches (mm)	Conductor Material	Current Density (Amps/in²)
Main Horizontal	600	0.25 (6) × 3.00 (76)	Aluminum	800
	1000	0.375 (10) × 3.00 (76)		889
	1200	0.50 (13) × 3.00 (76)		800
	1000	0.25 (6) × 3.00 (76)	Copper	1333
	1200	0.375 (10) × 3.00 (76)		1067
	2000	(2) 0.375 (10) × 3.00 (76)		889
	3000 ①	(3) 0.50 (13) × 3.00 (76)		667
Vertical	360	0.25 (6) × 1.00 (25)		1440
	540	0.25 (6) × 1.50 (38)		1440
	720	0.50 (13) × 2.00 (51)		720
Ground	600	0.25 (6) × 2.00 (51)		1200

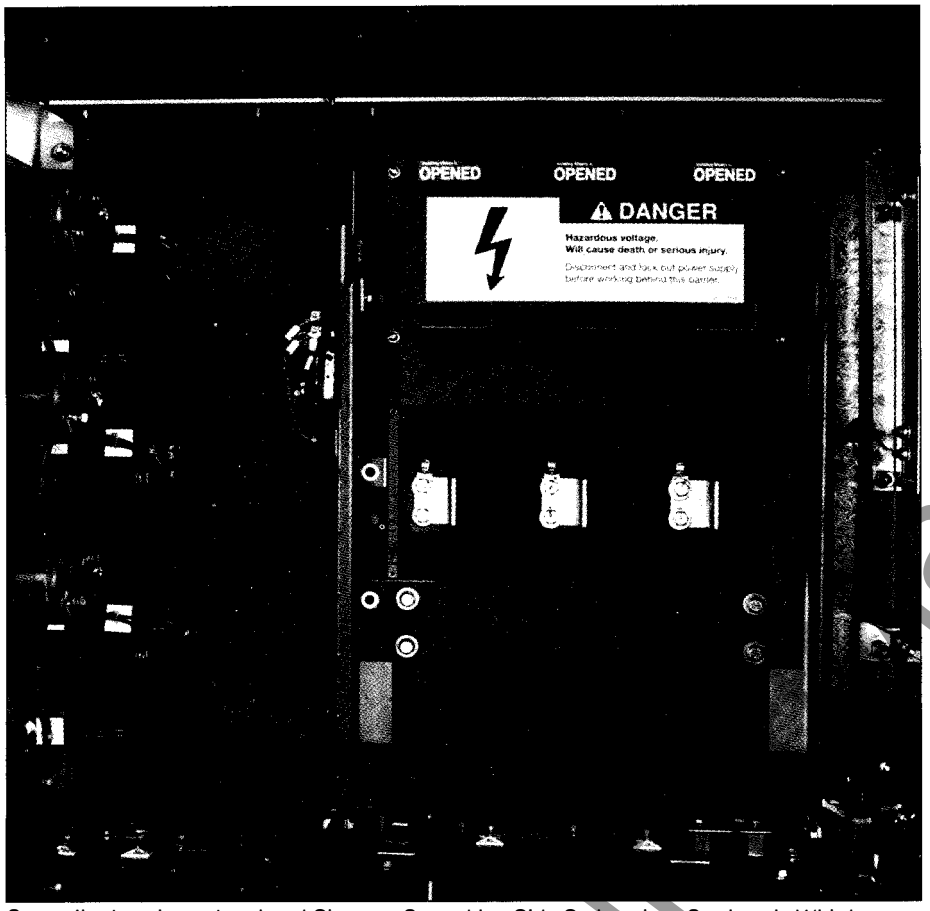
① 3000A bus must be located on top of unit.



Main and Vertical Bus Construction (shown with optional insulation)

Note: Direct in-line transitions to Siemens GM 5kV or 7kV switchgear are available if required.

Construction



Controller Interior — Insulated Shutters Cover Line Side Stabs when Carriage is Withdrawn

Isolation Disconnect (Drawout Mechanism)

The Series 81000 controllers use the complete contactor (or fuse carriage drawout assembly for 720A controllers) as the high voltage isolation switch, as described in NEMA 2-324.61.c. Horizontal forward and back movement of the drawout assembly simultaneously opens and closes the line and load disconnect contacts.

Because both line and load terminals are disconnected, there is no need for grounding the load side terminals in the open position. Non-conducting glass polyester barriers (shutters) completely isolate the stationary line terminals. The shutter mechanism is positively driven by the same linkage mechanism which moves the drawout carriage from the connected to the disconnected position.

The drawout operation is a simple one-step process. After the contactor is open (or de-energized), merely move the racking handle to the OFF position (disconnected), open the starter door, and the contactor is ready to be rolled out of the compartment.

Interlocking

A combination of mechanical and electrical interlocks are included to:

- Prevent forward and back movement of the drawout carriage (isolation switch), unless the contactor is de-energized or open.
- Prevent the opening of the high voltage compartment door, unless the drawout carriage (isolation switch) is in the disconnect position.
- Prevent the forward movement of the drawout carriage (isolation switch) to the connected position, unless the high voltage compartment door is closed.

Control Power Transformers

The basic controller includes as standard a 0.75kVA control power transformer mounted on the drawout carriage. Oversize ratings are available up to 3.25kVA.

Blown Fuse Trip Option

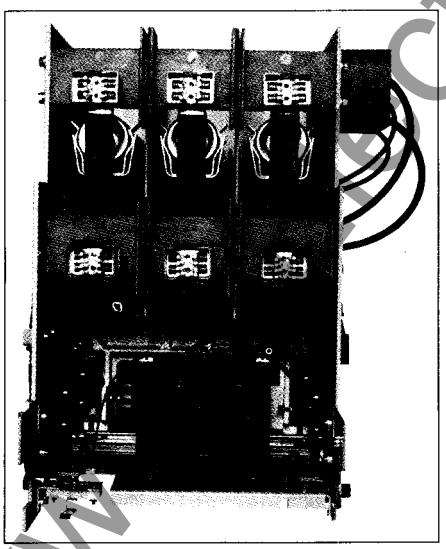
A blown fuse trip option can be supplied to open the contactor in the event of a blown primary power fuse. A contact which is actuated when a primary fuse operates can be used to open the contactor.

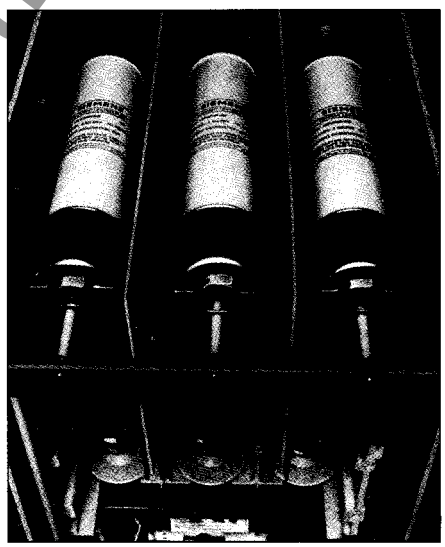
Latched Contactors

A latched version of the contactor is available for feeder applications. This keeps the contactor closed even when power to the coil has been removed. A typical application is as a transformer feeder where it is not desired that the controller open during a momentary loss of primary power.

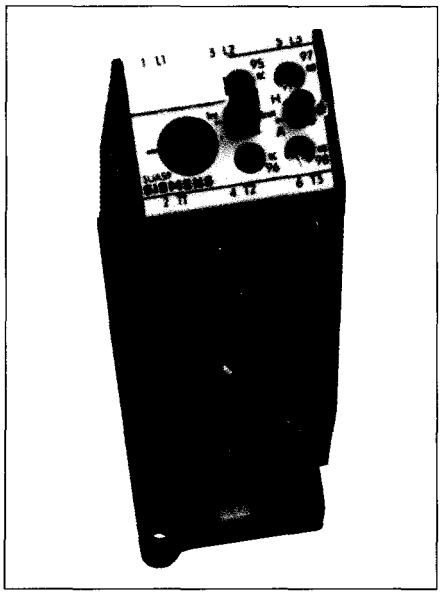
Test Circuit

Each Series 81000 controller is provided with a built-in test circuit for operation of the contactor from a remote source of control power and the "test-run" switch is set at the "test" position. This circuit will function only if the contactor is disconnected from its primary source of power and the "test-run" switch is set at the "test" position. It allows the maintenance and operation of the main contactor and low voltage control circuitry without requiring energizing the motor, or disconnecting any load cables.

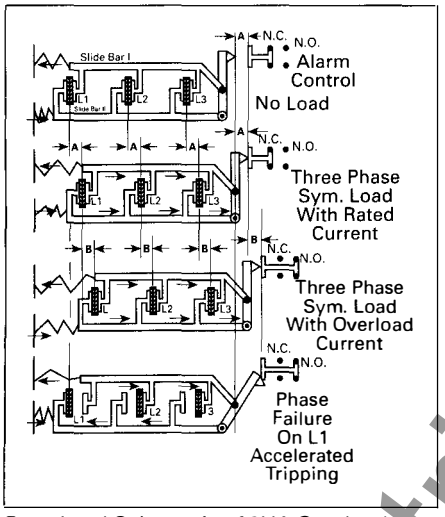

Control Power Transformer and CPT Fuses


Blown Fuse Trip Bar Option

Construction



Siemens 3UA Overload Relay

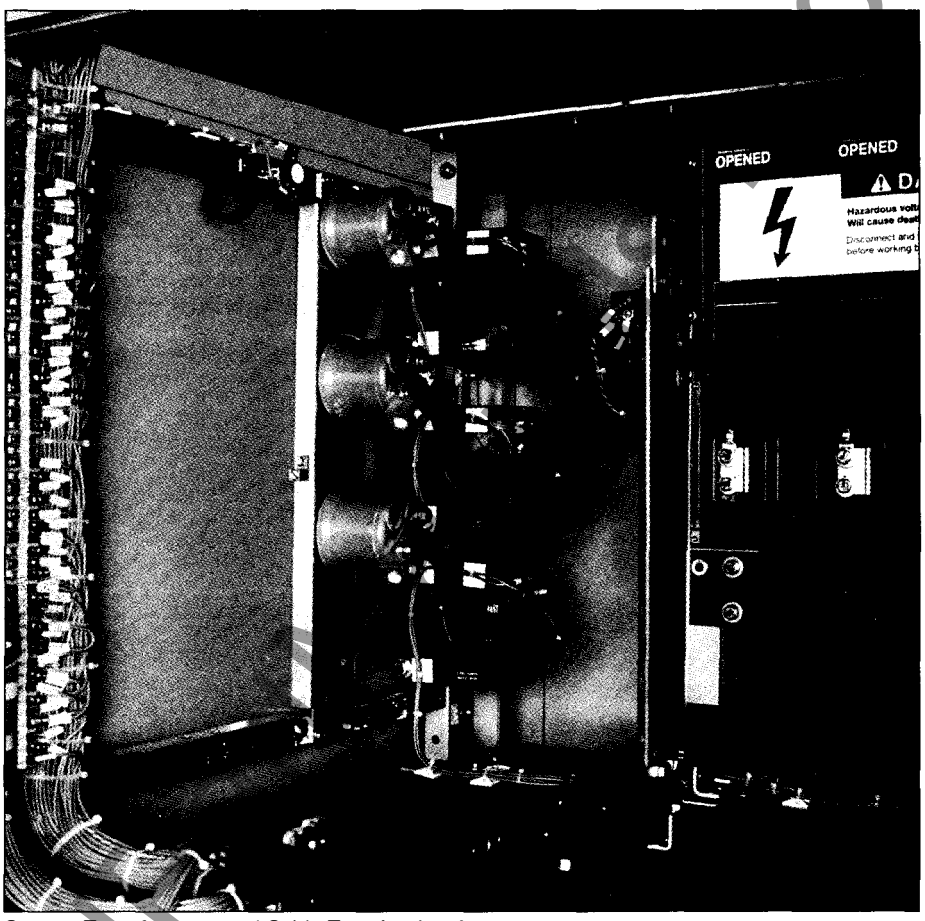


Functional Schematic of 3UA Overload Relay

Overload Protection — 3UA or 3UB
Running overcurrent (overload) protection for the motor must also be provided according to NEMA standards. This overload (or longtime) protection can be provided by the Siemens type 3UA (OLR) bimetallic thermal overload relay. This 3-phase adjustable relay provides inherent single phase protection and phase unbalance protection with NEMA class 10 tripping characteristics, providing optimum protection for motors having acceleration times of six seconds or less and hot allowable locked rotor times of five seconds or more. It is equipped with an isolated normally open contact to actuate a remote alarm in the event of an overload trip.

For applications which require longer acceleration times, Siemens offers the type 3UB solid-state overload relay, adjustable from NEMA class 5 up to NEMA class 30 tripping characteristics.

For unusual applications, solid state or switchgear type overcurrent relays are available.



Current Transformers and Cable Termination Area

Current Transformers
Starters using conventional overload relays are provided with current transformers mounted in the cable termination area of the controller compartment. These are used to drive the overload relay, ammeter, or other devices which require a current input.

CT selection takes into consideration the burden and accuracy requirements which are appropriate for the specified instrumentation and protective devices. The secondary current rating is always 5 amperes. The primary current rating is selected so that the actual secondary current will be between 3 and 4 amperes with the motor (or other load) operating at full load.

Auxiliary Contacts
All contactors are supplied with two NO and two NC auxiliary contacts available for customer use. Extra contacts are available through the use of the MR relay or extra control relays.

Siemens Advanced Motor Master System — SAMMS-MV™

Siemens Series 81000 Medium Voltage Controllers are available with SAMMS-MV, the Siemens Advanced Motor Master System. The SAMMS-MV unit is a microprocessor based software configurable controller specifically designed for motor control applications. It provides all control logic and motor protection functions required for typical motor application. The SAMMS system eliminates the need for separate overload relays, timers, control relays, meters, auxiliary contacts, pushbuttons and pilot lights.

Configuration

Control Units using the SAMMS-MV system are equipped with current transformers, the SAMMS-MV unit, and a hand held communicator. The SAMMS unit is powered from the control power transformer on the contactor. The device is mounted in the low voltage compartment for each starter, and provides all pushbutton and indicator functions.

Protection Functions

- Overload protection (with ± 5% accuracy)
- Choice of 22 overload protection curves
- Phase loss / phase unbalance protection
- Impending overload trip alarm
- Lockout on thermal overload trip
- Undercurrent / loss of load protection
- Mechanical jam protection
- Process current (load current) alarm
- Hand-held communicator for flexibility and field changes

The SAMMS system offers programmable control logic, a design based on a standard hardware and electronic circuit configuration that may be modified by programming the controller's microprocessor. Typical motor control devices, such as timers, control relays, pushbuttons, and selector switches (traditionally located in the medium voltage controller, are replaced by SAMMS-MV software, and pushbuttons and indicators on the unit control panel. The SAMMS-MV controller can be programmed to provide over 40 different motor control circuit arrangements, and is a reliable and practical protection system for all medium voltage motors.

Starter Types

The SAMMS software library of more than 40 ladder diagrams covers most standard motor control applications. Starter types include:

- Across-the-line, non-reversing
- Across-the-line, reversing
- Two-speed, two-winding
- Two-speed, one-winding, constant or variable torque
- Two-speed, one-winding, constant horsepower
- Reduced-voltage, autotransformer or reactor

Table 3 is a listing of these standard circuits.

For special motor control applications not covered by the library of standard ladder diagrams, custom diagrams can be constructed using the SAMMS-MV input and output devices and their associated symbols. Siemens offers an IBM®-compatible software package to develop such custom diagrams.

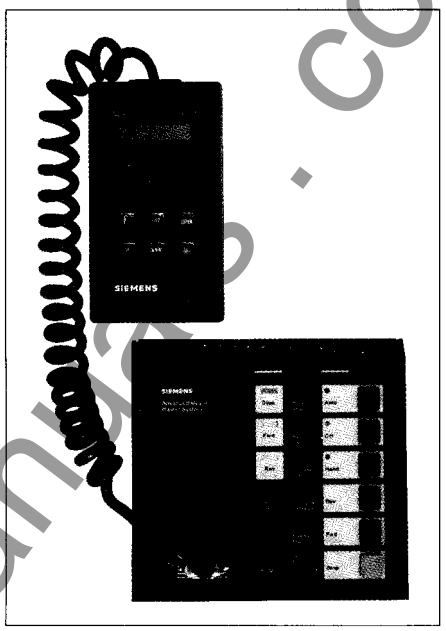


Table 3 — Standard Circuits for Starter Arrangements

	Starter Type						
Control Type	FVNR	FVR	2 Speed 2 Winding	2 Speed 1 Winding Constant or Variable Torque	2 Speed 1 Winding Constant HP	Autotransformer RVA	Reactor RVA
Local 2-Wire	✓	✓	✓	✓	✓	✓	✓
Local 3-Wire	✓	✓	✓	✓	✓	✓	✓
Local 3-Wire Remote 2-Wi	✓	✓	✓	✓	✓	✓	✓
Local/Remote 2-Wire	✓	✓	✓	✓	✓	✓	✓
Local/R mote 3-Wire	✓	✓	✓	✓	✓	✓	✓
Local/Remote 3-Wire Electrically Interlocked	—	✓	—	—	—	—	—
Remote 2-Wi	✓	✓	✓	✓	✓	✓	✓
Remot 3-Wir	✓	✓	✓	✓	✓	✓	✓

Siemens Advanced Motor Master System — SAMMS-MV™

Diagnostics
The SAMMS-MV controller provides visual diagnostics used to quickly determine the cause of motor problems. The front panel of the controller has eight diagnostic LED's to indicate:

- Current Phase Unbalance
- Impending Overload Trip
- Overload Trip
- External Trip
- Incomplete Sequence
- Ground Fault
- CPU Fault
- Ready (Control Power Status)

In addition, the SAMMS-MV device can provide, as an option, statistical motor data, including the total elapsed motor running time, number of starts, and the number of overload trips. This statistical data is stored in the microprocessor's non-volatile memory and displayed using the hand held communicator. The communicator can also be used as an ammeter to display any of the three phase motor currents.

Time / current characteristic curves for various conditions are shown in figures 1 through 4 on the next page.

For additional technical information on the SAMMS-MV unit, contact Siemens and request Bulletin SG-9109.

The SAMMS-MV Device Models
SAMMS-MV is available in two models: SAMMS-MVX and SAMMS-MVE. Each meets the various demands of industrial and commercial specifications and installations. Table 4 compares the functions of each model.

The SAMMS-MV device is designed for critical process control where prevention of downtime is critical. It offers motor control and protection along with motor diagnostic and motor-driven equipment protection. Engineering and operating personnel have access to important data enabling them to optimize motor-driven equipment capabilities, to maximize the process system output, and to facilitate maintenance.

SAMMS-MVX is a full function model, applicable to all control needs, from a simple across-the-line unit to a more complicated reduced voltage scheme. It includes all of the functions listed in Table 4. Any of the standard control circuits listed in Table 3 (previous page) or a custom circuit, may be downloaded.

SAMMS-MVE is a model of SAMMS-MV tailored to across-the-line (FVNR) applications. It provides all of the protective functions of the SAMMS-MVX device, except that it has no jam protection (F23), loss of load protection/alarm (F24), or process current warning (F22) functions. Functions F3 and F5 associated with two-speed applications are not available. No provision for automatic reset (F8) is provided. SAMMS-MVE accepts one remote input, and provides one output to actuate a single contactor. An alarm contact is not available with SAMMS-MVE.

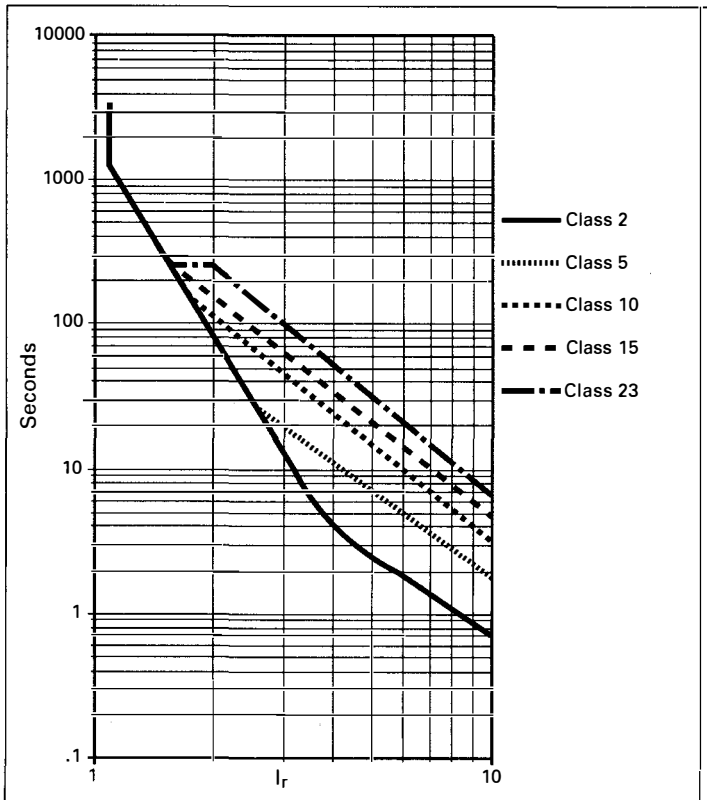
In addition to the standard features in the two models, all SAMMS-MV controllers have the following options available:

- Customizing Software. An IBM®-compatible application is available that allows the customer to develop customized control circuit logic, or to pick any standard control circuits that are pre-programmed.
- ACCESS™. The SAMMS-MV unit can be ordered ready for connection to a Siemens ACCESS data communication system. This open architecture network allows remote control and monitoring of the motors from a centralized point. All information available from SAMMS (such as diagnostics, statistical data, real time metering and controller status) can be communicated to a central host computer or other devices.

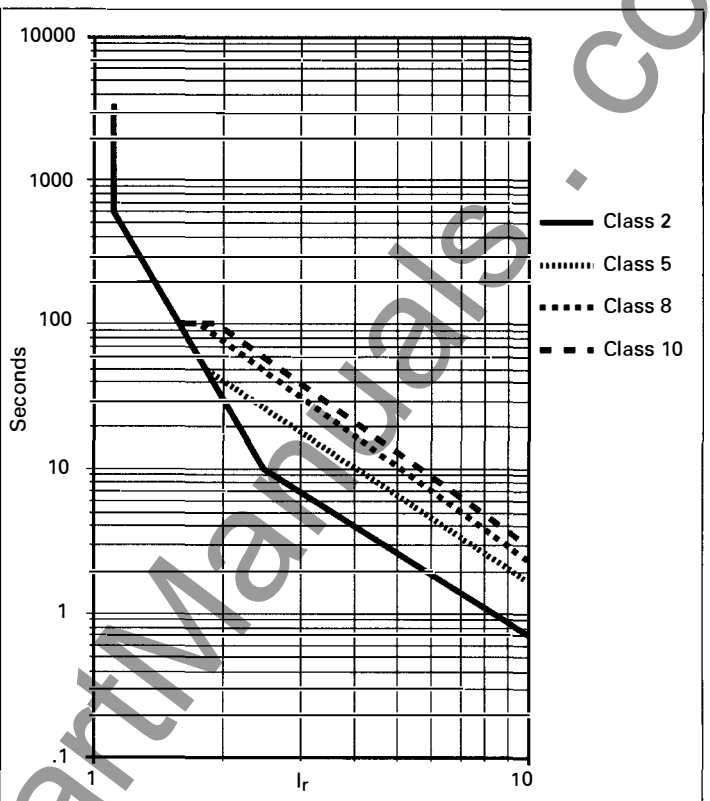
Table 4 — SAMMS-MV Functions and Models

Function Number	Function	Model	
		SAMMS-MVX	SAMMS-MVE
F0	Ambient Temperature	✓	✓
F1	Control Circuit Number	✓	✓
F2	Size for Overload No. 1	✓	✓
F3	Size for Overload No. 2 (low speed)	✓	—
F4	Full Load Current for OLR No. 1	✓	✓
F5	Full Load Current for OLR No. 2	✓	—
F6	Service Factor, and Type Motor	✓	✓
F6A	Motor Type	✓	✓
F7	Overload Trip Class, and Cold Stall Time (class 2-23)	✓	✓
F7A	Cold Stall Time	✓	✓
F8	Automatic Reset	✓	—
F9	Phase Unbalance	✓	✓
F10	Time to Restart	✓	✓
F11	Emergency Restart	✓	✓
F12	Ground Fault Protection or Warning	✓	✓
F12A	Ground Fault Pickup Current	✓	✓
F13	Timer No. 1	✓	✓
F14	Timer No. 2	✓	✓
F15	Motor Current	✓	✓
F16	Last Trip Current	✓	✓
F17	Percent Unbalance Current	✓	✓
F18	Total Elapsed Run-Time on Motor	✓	✓
F19	Total Number of Motor Starts	✓	✓
F20	Number of Overload Trips	✓	✓
F21	Reset Motor Data	✓	✓
F22	Set Process Current Warning	✓	—
F23	Jam Protection	✓	—
F23A	Jam Pickup Current	✓	—
F24	Loss of Load Protection or Warning	✓	—
F24A	Loss of Load Pickup Current	✓	—
F25	Motor Winding Temperature as % of Full Load Temp.	✓	✓
F26	Baud Rate	✓	✓
F27	Address	✓	✓

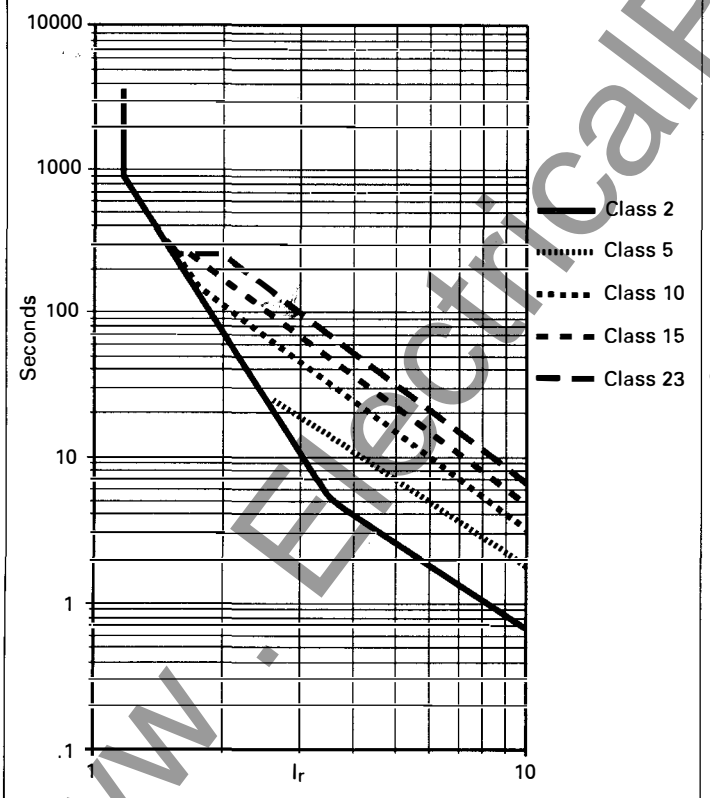
Time / Current Characteristic Curves



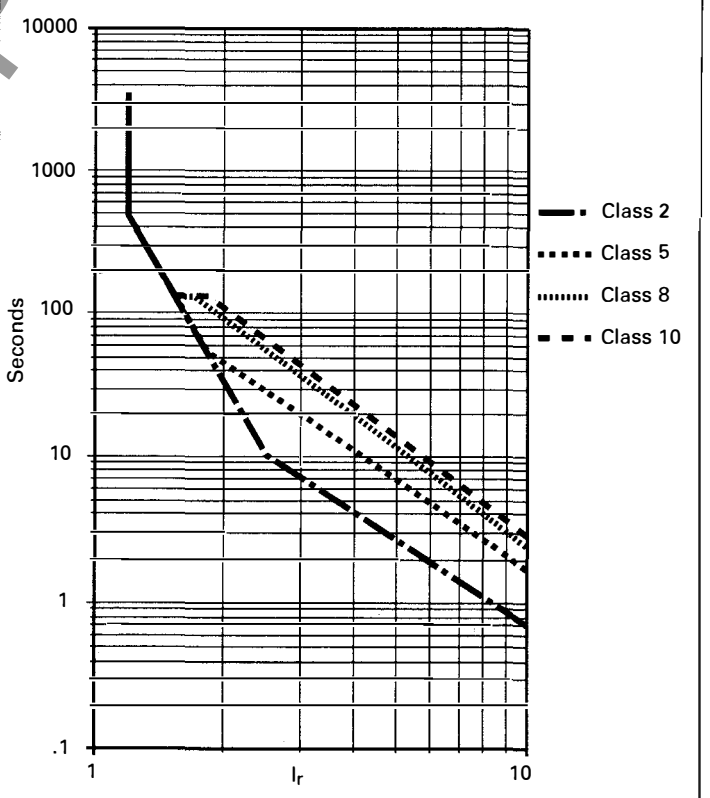
Service Factor 1.00 — Cold Motors **Figure 1**



Service Factor 1.00 — Warm Motors **Figure 2**



Service Factor 1.15 — Cold Motors **Figure 3**



Service Factor 1.15 — Warm Motors **Figure 4**

Advanced Protection for Medium-Voltage Motors

For advanced protection of medium voltage motors, the SAMMS-MV device uses a motor model algorithm that continually calculates the stator winding and housing temperature as well as the rotor temperature as a function of the motor RMS current. The motor model compares the calculated temperature to trip temperature values and provides a signal that trips the motor off line when the motor reaches a trip temperature value. The model closely emulates the heating and cooling of the motor windings as well as the rotor and provides protection against both transient and steady-state overload conditions.

Overload Protection

The SAMMS-MV device offers more accurate motor protection than traditional thermal overload and most electronic motor protection devices. This prolongs motor life by eliminating nuisance tripping for multiple restarts, and allowing for proper cool down time when the motor winding temperature or rotor temperature reaches a critically high value.

Medium-voltage motors are rotor limited under locked rotor conditions, and stator limited under running overload conditions. Additionally, the type of motor construction affects the thermal behavior of the rotor. For example, open drip-proof motors have significantly shorter cold stall times than totally enclosed fan-cooled motors. The motor protection algorithm in the SAMMS-MV device is designed specifically to provide rotor protection based on the type of motor construction, and to differentiate between a stalled rotor and a rotor accelerating to running speed.

The motor overload protection function is based on calculating the motor's winding, housing, and rotor temperatures. These temperatures are compared to the allowable temperature limits for the motor's winding, housing, and rotor. On the basis of this comparison, the SAMMS-MV device either stops the motor or allows it to run.

For example, consider the motor winding and rotor temperature rises

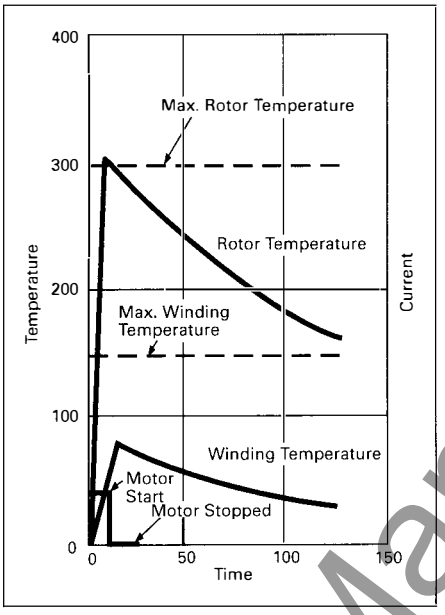


Figure 5 — Rotor and Winding Temperature During 10 Second Motor Stall

illustrated in Figure 5. The motor starts for 5 seconds and runs for a period of 2200 seconds. Then, the motor is subjected to a running overload condition that raises the winding temperature to the maximum allowable winding temperature rise resulting in an overload trip. At this temperature, the motor cannot start until the motor winding temperature cools down to the full-load temperature. The motor can then start and run at full-load current. Figure 6 depicts the temperature rise in the rotor and stator winding during a 10 second stall for an ODP motor. In this case, the rotor temperature rises at a rate faster than the winding temperature, and reaches the maximum allowable value resulting in a trip. In order to prevent damage to the motor, the SAMMS-MV unit will not allow the motor to start until the winding and the rotor temperature cools down to the full load temperature or less.

In the motor model, the greatest of the root mean square (RMS) current values for the motor phases is converted into a heat-like quantity. This is done by a mathematical function that depends on the ratio of the RMS current to the full-load current set for the mo-

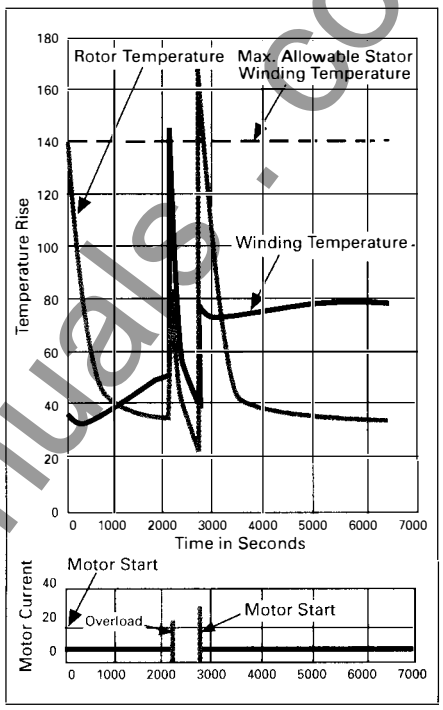


Figure 6 — ODP Motor Thermal Signature

tor. The function is based not only on ideal overload characteristics, but also on empirical motor data. The heat-like quantity is analogous to an input source of current to the electric-circuit analog. The exact values of the various elements in the circuit depend, in some case, on nameplate data entered for the particular motor being protected. Unlike the method of protection in conventional overload relays, the motor model is general enough to protect many classes of motors, yet sophisticated enough to offer customized protection to particular motors. To customize protection of the motor, the user need only indicate the following nameplate data:

- Full-load current setting (F4)
- Service factor (F6)
- Type of motor construction (Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (EFC) (F6)
- Cold stall time, if available (F7)
- Motor ambient temperature (F0)

94H3 360A Drawout Contactor

This vacuum contactor forms the centerpiece for the medium voltage controller itself. It is a wheeled assembly which racks onto or off of the primary stabs in the stationary housing. The supporting base consists of a bolted steel frame. The pushrods, contact support blocks, and other insulating parts are constructed of glass polyester. All insulating material that is in contact with high voltage current carrying parts is flame retardant and arc track resistant.

The distinctive features of the Siemens type 94H3 vacuum contactors are high reliability, long service life, compact dimensions, and ability to deal with most motor switching duties. Even service under severe operating duties or extreme environmental conditions presents no problem due to the use of vacuum interrupters. They are suitable for loads of many types, including motors, transformers, capacitors, and resistive loads.

In addition to the advantages of long mechanical and electrical life with low maintenance, the contacts are essentially immune to adverse atmospheric environments and are lighter in weight than traditional air-break contactors.

The vacuum contactor with single or double barrel power fuses can be installed in Series 81000 class E2 controllers of either one-, two-, or three-high construction.

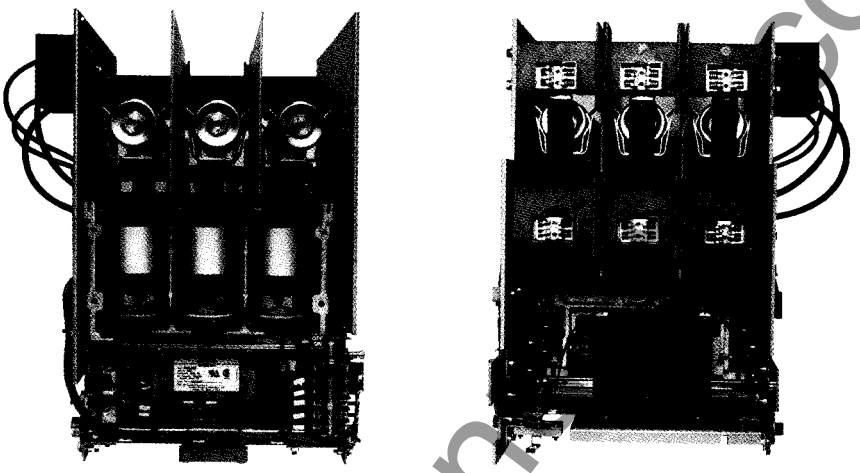
The Type 94H3 vacuum contactor consists of:

- a low voltage section containing the main coil drive and auxiliary contacts
- a medium voltage section housing the vacuum interrupters
- a support structure providing mounting for the power fuses, control transformer and primary fuses, and drawout finger assemblies.

Since arc interruption is accomplished completely within vacuum interrupters, arc chutes, blowout coils, and pole plates are not required. Stationary and movable power contacts are located inside the vacuum interrupters. A stainless steel bellows attached to the movable contact insures a complete seal and vacuum integrity. Because the contacts are sealed in the interrupter and have only a short travel, long mechanical and electrical life is achieved.

90H6 720 Vacuum Controller

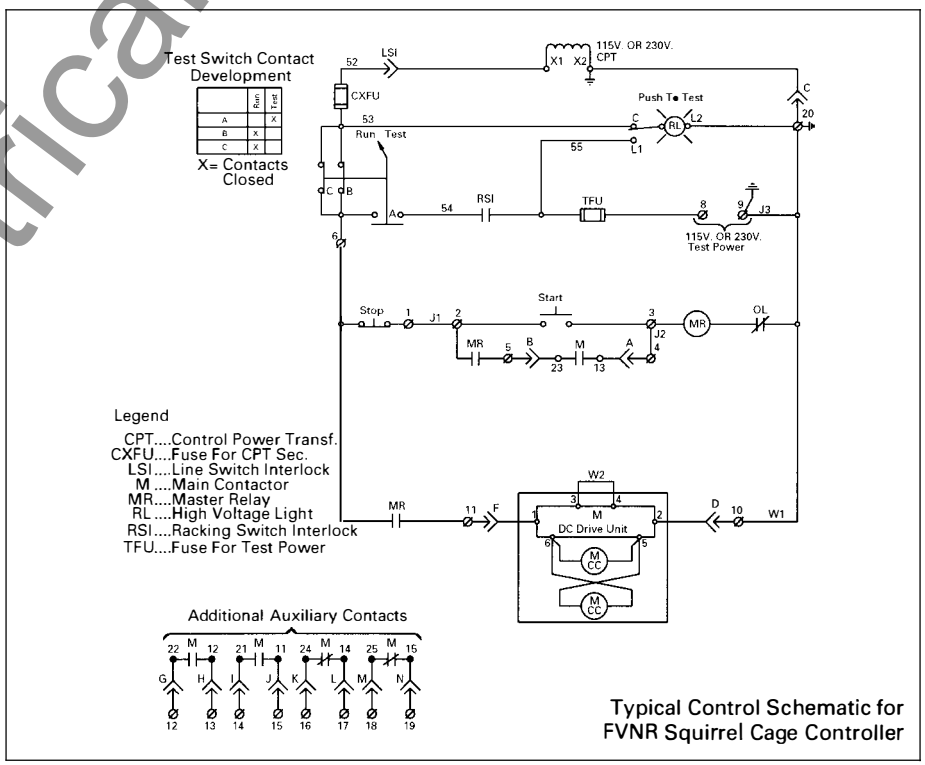
The 90H6 720 vacuum controllers employ a similar philosophy to the drawout 94H3 360A contactors, except that only the primary current limiting fuses are mounted on the drawout carriage. The contactor is stationary mounted, connected to the load stabs of the drawout cell with cables rated for 720 amperes. The use of the drawout fuse carriage preserves all of the advantages of drawout construction. The primary fuses used with the 720A controller for motor applications are type A500 fuses, 38R and 57X ("X"-rated).



94H3 360A Fused Vacuum Contactor

Table 5 — MVC Operating Data

Operating Data	Contactor Rated Control Voltage							
	94H35 or 94H37				90H6			
	AC		DC		AC		DC	
	115	230	125	250	115	230	125	250
Pickup Voltage	Hot — 85% Rated Cold — 70% Rated				81	161	88	175
Dropout Voltage	Hot — 50% Rated Cold — 40% Rated				46	92	50	100
Pickup Time	≤80 ms				120 ms			
Dropout Time	≤340 ms				≤30 ms			
Inrush Current (Amps)	5.8	2.9	5.6	2.8	10	5	10	5
Sealin (Holding) Current (Amps)	0.74	0.37	0.88	0.34	1.3	0.65	1.3	0.65

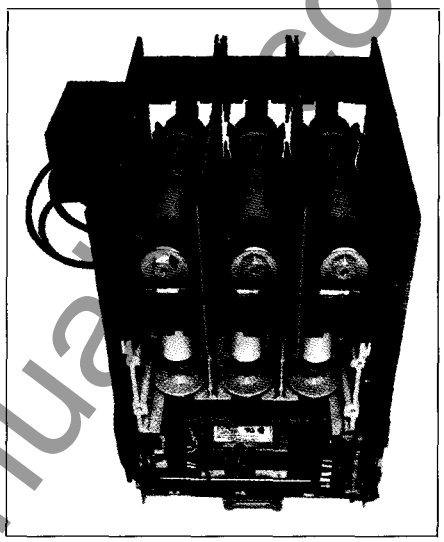


Typical Control Schematic for FVNR Squirrel Cage Controller

Fuse Application

Table 6 — Type FM Fuse Data

Maximum Design Voltage	Current Designation	Continuous Current at 40°C	Minimum Interrupting Capability	Interrupting Rating 50/60 Hz
5080	2R (1 barrel)	70	190	Single Phase 80kA RMS Asymmetrical (210MVA at 2.4kV) (415MVA at 4.8kV)
	3R	100	225	
	4R	130	330	
	6R	170	500	
	9R	200	740	
	12R	230	955	
	18R (2 barrel)	390	1440	
	24R	450	1910	
	38R	600	3000	
	57X (3 barrel)	900	4500	
7200	2R (1 barrel)	70	190	Single Phase 80kA RMS Asymmetrical (620MVA at 7.2kV)
	3R	100	225	
	4R	130	330	
	6R	170	500	
	9R	200	740	
	12R	230	955	
	18R (2 barrel)	390	1440	
	24R	450	1910	



Type FM Fuses Installed on 94H3 Contactor

For Non-Motor Loads

The principal application for ANSI "E" rated fuses in Series 81000 controllers is for non-rotating loads, such as transformer feeders. The following tabulation may be used for estimating which "E" rated fuse is appropriate for a particular 3 phase transformer application.

Table 7 — Typical Fuse Sizes for Transformer Protection

Transformer kVA	Fuse Size At: 2.4kV	4.16kV	4.8kV	6.9kV
45	25E	10E	10E	—
75	30E	15E	15E	10E
112.5	40E	20E	20E	15E
150	50E	30E	25E	20E
225	80E	40E	40E	25E
300	100E	65E	50E	40E
500	200E	100E	80E	65E
750	250E	150E	125E	100E
1000	400E	200E	200E	125E
1500	450E	300E	250E	200E
2000	—	400E	350E	—
2500	—	450E	400E	—
3000	—	—	450E	—

Note: Fuse sizes are based on 133% overload capacity, except 1500kVA at 2.4kV, 2500kVA at 4.16kV, and 3000kVA at 4.8kV.

Fuse ratings higher or lower than those listed in Table 7 may need to be employed if the transformer has unusual magnetizing (inrush) current characteristics, or for proper coordination with the secondary protective device (secondary fuse, low voltage circuit breaker trip device, overcurrent relay, etc.). Transformer overload capability may also have a bearing on fuse selection. However, this table is accurate for most typical transformer feeder applications.

The "E" rated fuses have the same interrupting current ratings as the type FM or A720R "R" rated fuses. Both are rated at 50kA symmetrical and 80kA asymmetrical interrupting.

All medium voltage controllers employ current limiting fuses for short circuit protection. The term "current limiting" derives from the operating characteristics of the fuse. Figure 7 shows graphically how, for maximum fault levels, the fuse operates within the first 1/4 cycle of short circuit current. This limits the energy "let-thru" well below peak values, thus providing "current limitation."

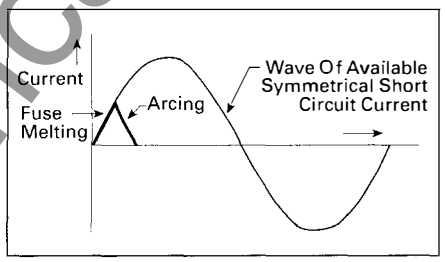


Figure 7 — Current Limiting Effect

Type FM or A720R fuses consist of a number of silver elements surrounded by inorganic sand and enclosed in a durable synthetic insulating tube. Silver plated copper ferrules form the conducting "cap" at each end of the fuse.

A mechanical indicator "pops-out" of the end of the ferrule if the fuse has operated. This provides a visual means for checking the condition of the fuse, and also acts to engage the optional blown fuse trip bar on the 94H3 contactor.

Current designations 2R through 24R (38R and 57X ("X"-rated) for fuses on 720A) are used to distinguish one fuse size from another within the same voltage rating. Ampere ratings are not used to identify medium voltage fuses, since fuse selection involves many different variables. Among these are motor locked rotor and running current, acceleration time, and the time current characteristics of the overload relay used.

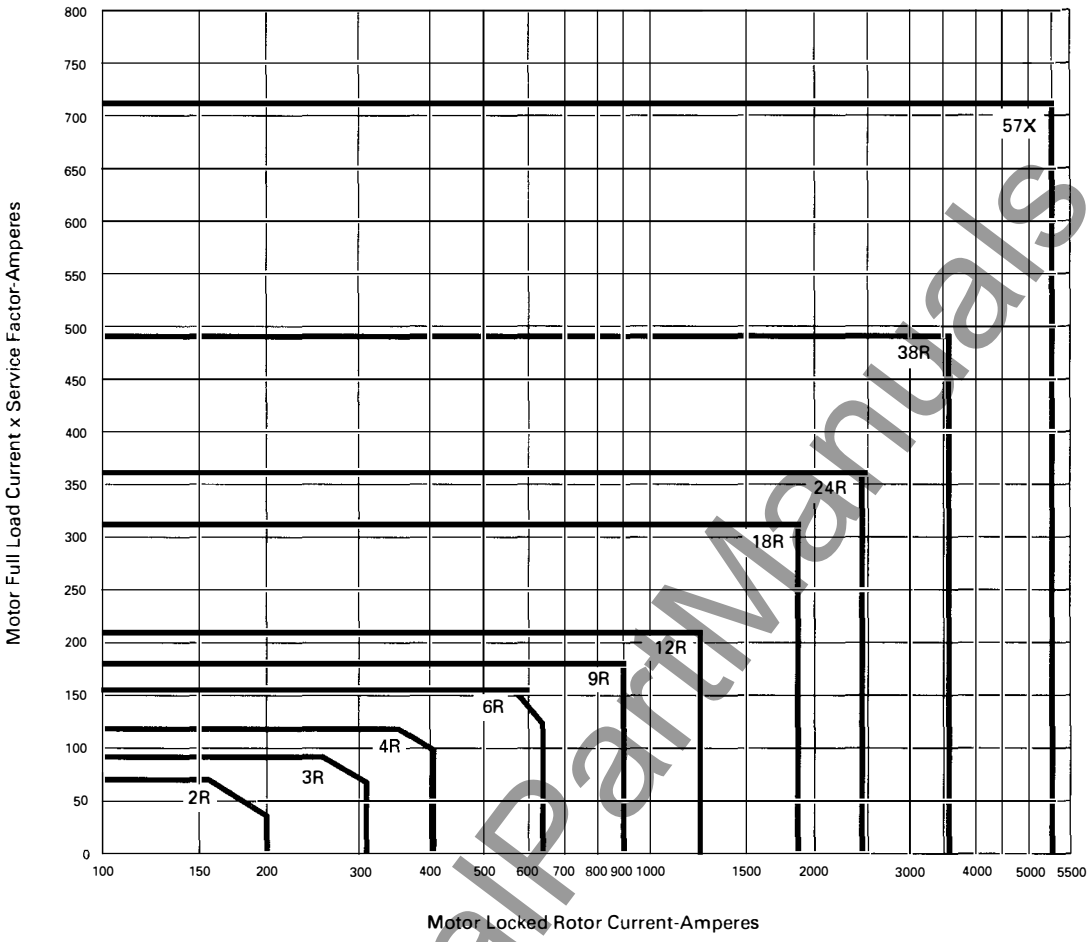
The fuses are installed on the top of the 94H3 vacuum contactor or on the drawout fuse carriage used with the 90H6 contactor. No fuse pullers or special tools are required to install or replace the fuses.

The charts on the next two pages provide detailed data for application of type FM or A720R "R" and "X" rated fuses, including

- Fuse Selection Chart
- Maximum Allowable Motor Acceleration Times
- Time / Current Curves, Minimum Melting Times
- Time / Current Curves, Total Clearing Times

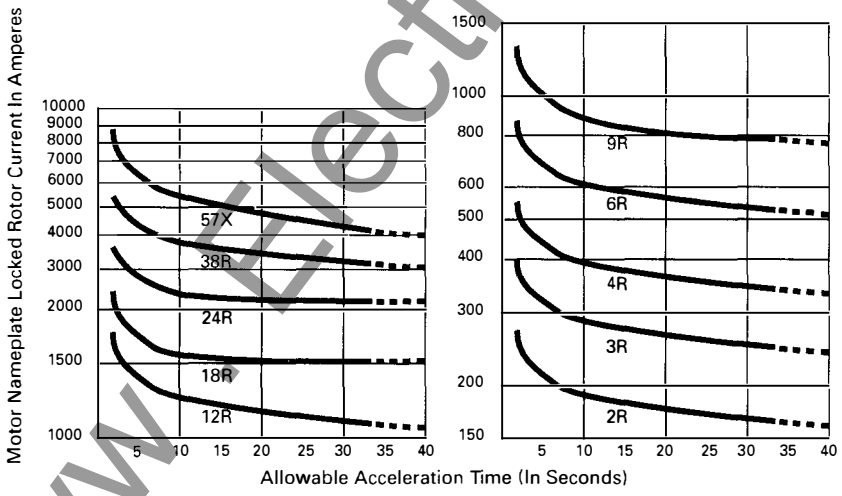
Fuse Application

Fuse Selection Guide



Fuse Selection Guide for Types FM, A500, and A720R Fuses for Siemens Series 81000 Controller with Type 3UA Overload Relay (NEMA Class 10). Based on Maximum Motor Accelerating Time of 10 Seconds.

Motor Acceleration Times



Note: Motors with acceleration times falling below the applicable fuse curve are permitted 2 consecutive starts as follows:

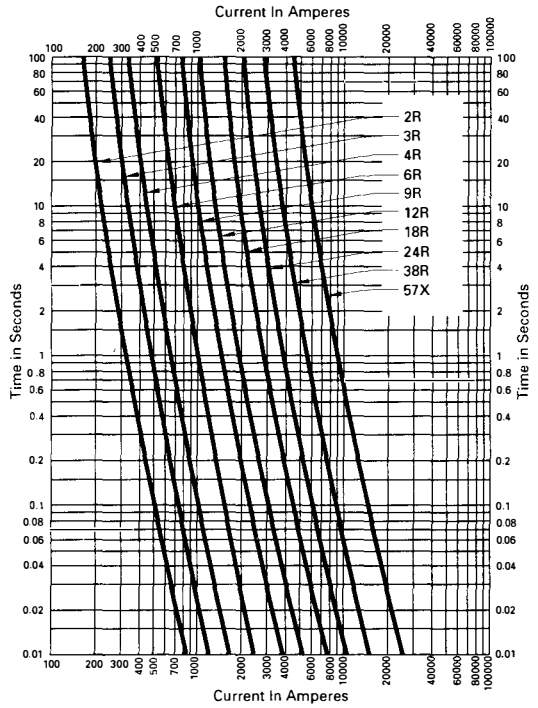
A) One Start from Ambient
B) A Coast to Stop
C) A Second Start

Maximum Allowable Motor Acceleration Times for Types FM, A500, and A720R Fuses

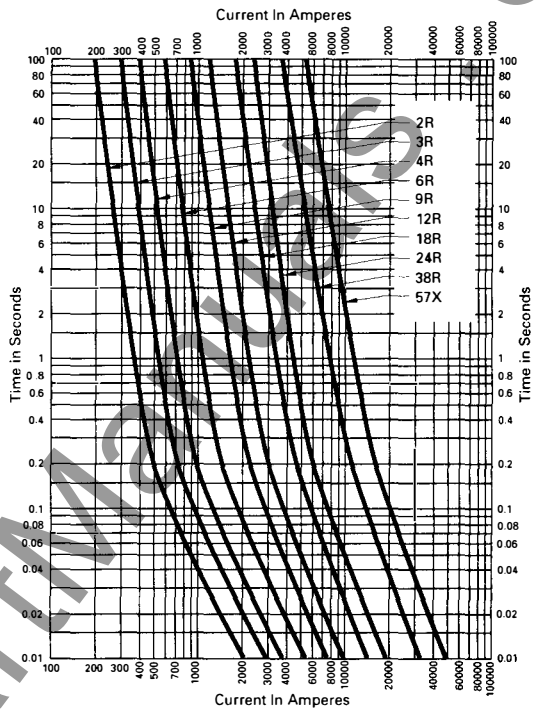
Fuse Application — Time / Current Characteristic Curves

Minimum Melting Time①	Total Clearing Time

2400 and 4800 Volts — Type FM (2R-24R), Type A500 (38R, 57X)

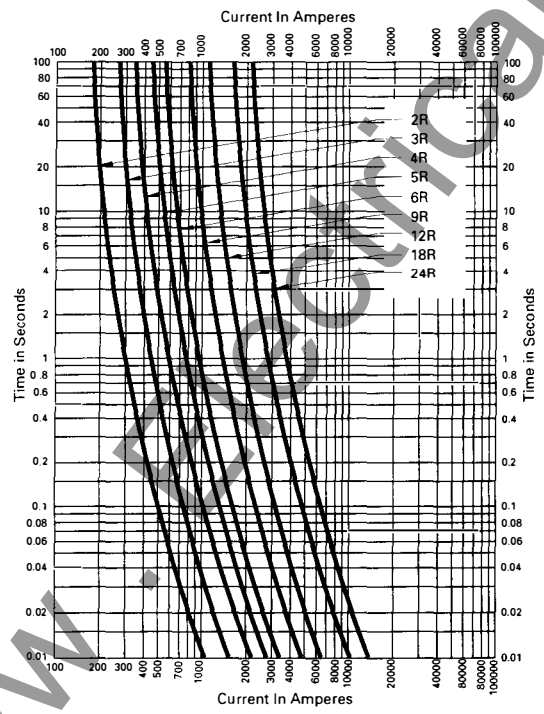


280121 (Rev. G)/
102657 (Rev. 0)

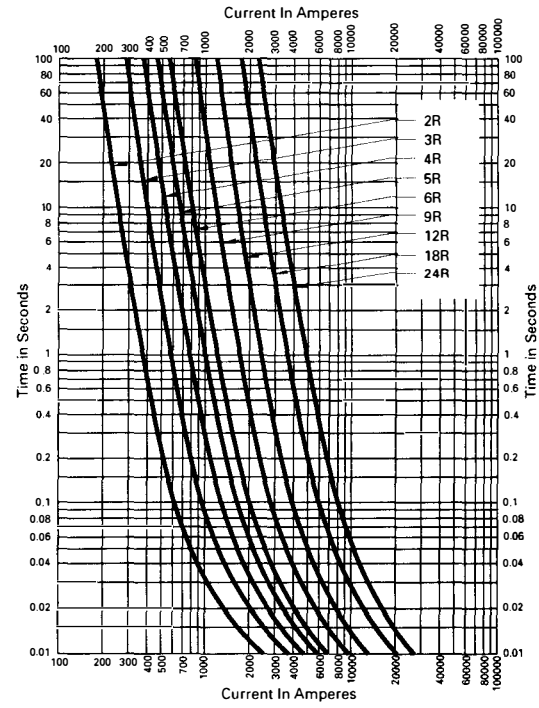


280121 (Rev. F)/
102656 (Rev. 0)

7200 Volts — Type A720R (2R-24R)



103813 (Rev. 0)

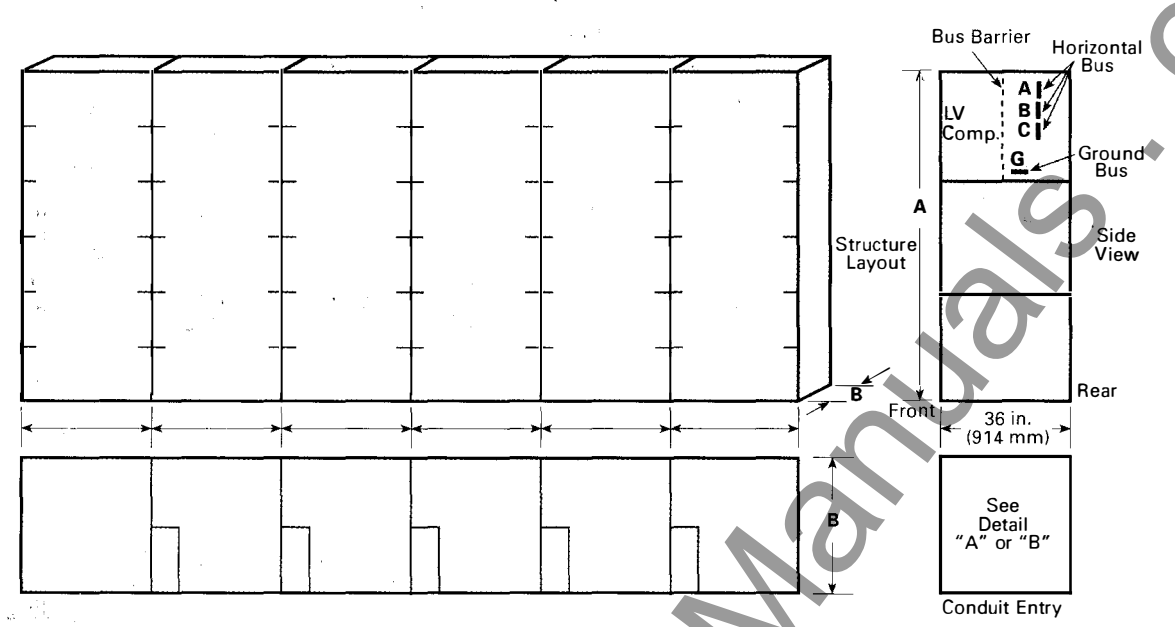


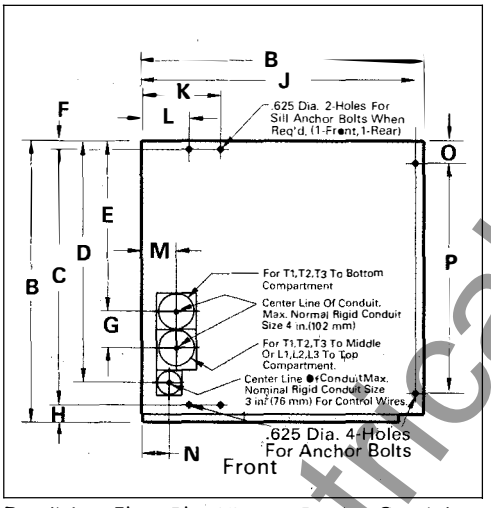
103814 (Rev. 0)

① These fuses are designed to interrupt short circuit currents greater than or equal to the current value shown at the 100 seconds minimum melting time. Protective devices in series must be coordinated wth fuse characteristics to interrupt lower currents.

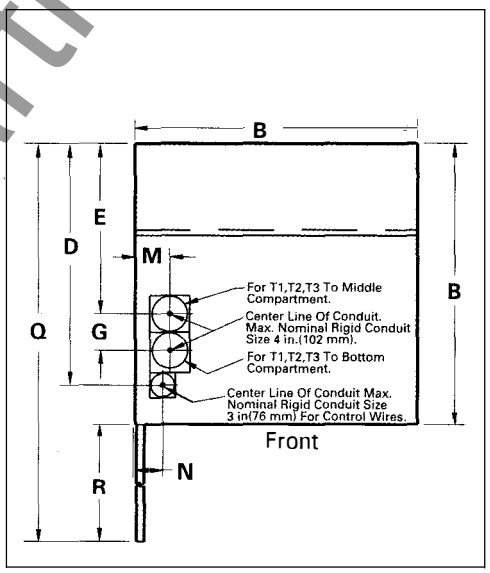
Dimensions and Weights

Typical Floor Plan Details for Class E2 Medium Voltage Controllers





Detail A — Floor Plan View — Bottom Conduit Entry



Detail B — Floor Plan View — Conduit Entry Top

Table 8 — MVC Floor Plan Dimensions in inches (mm)

A	B	C	D	E	F	G	H	J
90.00 (2286)	36.00 (914)	32.75 (832)	31.00 (787)	21.88 (556)	1.12 (28)	4.68 (119)	2.13 (54)	34.94 (887)

K	L	M	N	O	P	Q	R
10.06 (256)	6.06 (154)	4.42 (112)	3.50 (89)	2.87 (73)	29.50 (749)	68.50 (1740)	32.50 (826)

Dimensions and Weights

Table 9 — Series 81000™ Dimensions and Weights

Controller		Number of Contactors	Approximate Installation Dimensions in Inches (mm)					Approx. Shipping Weight With Contactors in lbs. (kg)		Layout Arrangement Figure (See Next 2 Pages)
			Enclosure					Enclosure		
			NEMA 1, 1A, or 12			NEMA 3R				
						Walk-in	Non-Walk-in			
Type	Rating		Height	Width	Depth	Width		NEMA 1 or 12	NEMA 3R	
Induction Full Voltage Non-Reversing	5kV 360A	1	90 (2286)	36 (914)	36 (914)	42 (1067)	42 (1067)	1400 (636)	1600 (727)	1
	5kV 720A							1600 (727)	1800 (818)	2
	7kV 360A							1500 (682)	1700 (773)	3
Induction Reduced Voltage-Reactor Non-Reversing	5kV 360A	2		60/72 (1524/1829)		78 (1981)	78 (1981)	4000/6800 (1818/3090)	4400/7200 (2000/3273)	4
	5kV 720A			96/108 (2438/2743)		114 (2896)	120 (3048)	7400/8800 (3364/4000)	7800/9200 (3545/4182)	5
	7kV 360A			96/108 (2438/2743)		114 (2896)	120 (3048)	4600/7400 (2091/3364)	5000/7800 (2273/3545)	6
Induction Reduced Voltage-Autotransformer Non-Reversing	5kV 360A	3		60/72 (1524/1829)		78 (1981)	78 (1981)	4200/7000 (1909/3182)	4600/7400 (2091/3364)	7
	5kV 720A			96/108 (2438/2743)		114 (2896)	120 (3048)	7600/9000 (3455/4091)	8200/9600 (3727/4364)	8
	7kV 360A			96/108 (2438/2743)		114 (2896)	120 (3048)	4800/7600 (2182/3455)	5400/8200 (2455/3727)	9
Induction Full Voltage Reversing	5kV 360A			36 (914)		42 (1067)	42 (1067)	1800 (818)	2000 (909)	10
	5kV 720A			72 (1829)		78 (1981)	78 (1981)	3200 (1455)	3600 (1636)	11
	7kV 360A			36 (914)		42 (1067)	42 (1067)	2000 (909)	2200 (1000)	12
Synchronous (Brush Type) Full Voltage Non-Reversing	5kV 360A	1		60/72 (1524/1829)		78 (1981)	78 (1981)	2000 (909)	2400 (1091)	13
	5kV 720A			72/84 (1829/2134)		78/114 (1981/2896)	78/120 (1981/3048)	2200 (1000)	2600 (1182)	14
	7kV 360A			72/84 (1829/2134)		78/114 (1981/2896)	78/120 (1981/3048)	2100 (955)	2500 (1136)	15
Synchronous (Brush Type) Reduced Voltage-Autotransformer Non-Reversing	5kV 360A	3		84/108 (2134/2743)		114 (2896)	120 (3048)	5100/7900 (2318/3591)	5700/8500 (2591/3864)	16
	5kV 720A			132/144 (3353/3658)		150 (3810)	156 (3962)	8500/9900 (3864/4500)	9300/10700 (4227/4864)	17
	7kV 360A			132/144 (3353/3658)		150 (3810)	156 (3962)	5700/8500 (2591/3864)	6500/9300 (2955/4227)	18
Induction Full Voltage 2-Speed, 2-Winding	5kV 360A	2		36 (914)		42 (1067)	42 (1067)	1800 (818)	2000 (909)	19
	5kV 720A			72 (1829)		78 (1981)	78 (1981)	3200 (1455)	3600 (1636)	20
	7kV 360A			72 (1829)		78 (1981)	78 (1981)	3000 (1364)	3400 (1545)	21
Induction Full Voltage 2-Speed, 1-Winding	5kV 360A			36 (914)		42 (1067)	42 (1067)	2000 (909)	2200 (1000)	22
	5kV 720A	3	①	①	①	①	①	①	①	23
	7kV 360A		90 (2286)	72 (1829)	36 (914)	78 (1981)	78 (1981)	3300 (1500)	3700 (1682)	24
Latched Contactor	5kV 360A	1		36 (914)		42 (1067)	42 (1067)	1400 (636)	1600 (727)	1
	5kV 720A							1600 (727)	1800 (818)	2
	7kV 360A							1500 (682)	1700 (773)	3
LBS-unfused 600A or 1200A	5kV	—						1400 (636)	1600 (727)	25
LBS-600A fused (to 450E)	7kV							1400 (636)	1600 (727)	25
LBS-1200A fused (to 1100E)	5kV			72 (1829)		78 (1981)	78 (1981)	2200 (1000)	2600 (1182)	26
	7kV							2200 (1000)	2600 (1182)	26
Incoming Line Main Lugs Only	5kV			18/24/36 (357/610/914)		42 (1067)	42 (1067)	600 (273)	600 (273)	27
	7kV							600 (273)	600 (273)	27

Note: All Dimensions and weights are for estimating purposes only—not for construction.
Indoor enclosures are 90 in. (2286 mm) high (100 in. (2540 mm) with top mounted bus) and 36 in. (914 mm) deep.
NEMA 3R Walk-in Enclosures are 107 in. (2718 mm) high by 101 in. (2565 mm) deep.
NEMA 3R Non-Walk-in Enclosures are 100 in. (2540 mm) high by 47 in. (1194 mm) deep.
① Consult Siemens.

Dimensions and Weights

Typical Layout Arrangements

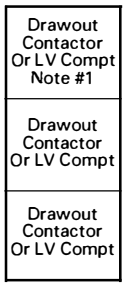


Figure 1
5kV 360A XLF

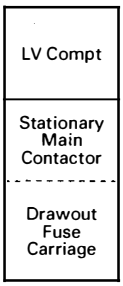


Figure 2
5kV 720A XLF

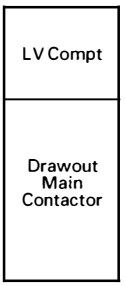


Figure 3
7kV 360A XLF

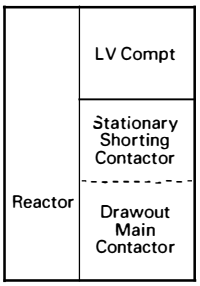


Figure 4
5kV 360A RVRF

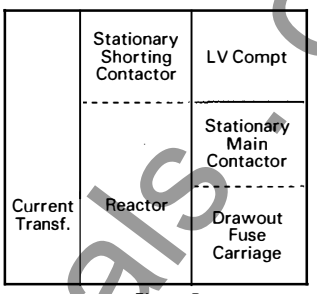


Figure 5
5kV 720A RVRF

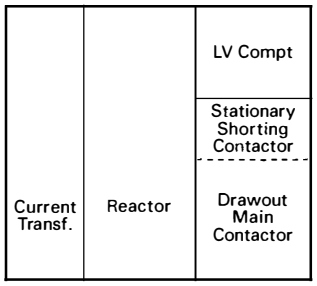


Figure 6
7kV 360A RVRF

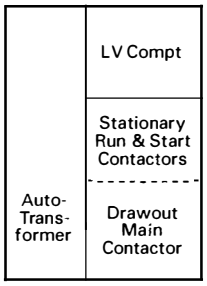


Figure 7
5kV 360A RVAF

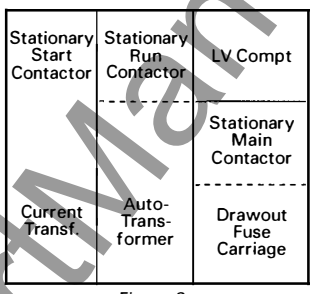


Figure 8
5kV 720A RVAF

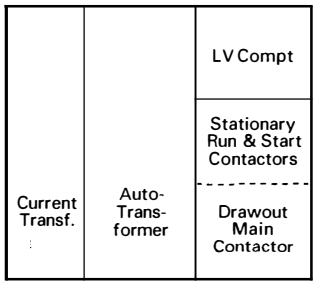


Figure 9
7kV 360A RVAF

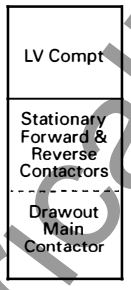


Figure 10
5kV 360A XRF

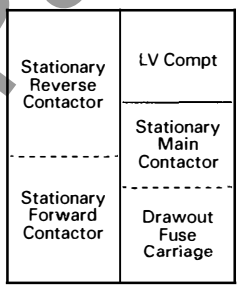


Figure 11
5kV 720A XRF

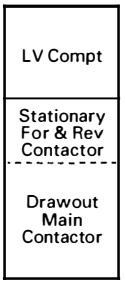


Figure 12
7kV 360A XRF

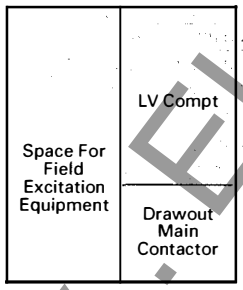


Figure 13
5kV 360A XLFS

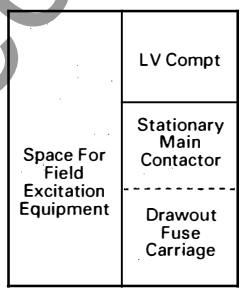


Figure 14
5kV 720A XLFS

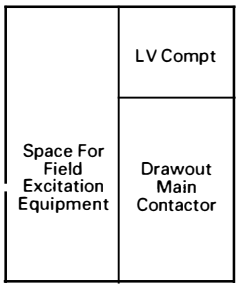


Figure 15
7kV 360A XLFS

Notes — see facing page.

Dimensions and Weights

Typical Layout Arrangements

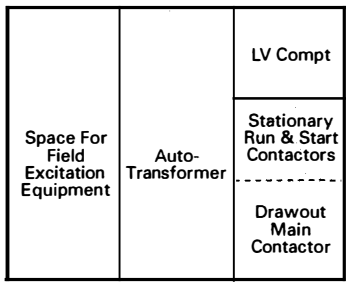


Figure 16
5kV 360A RVASF

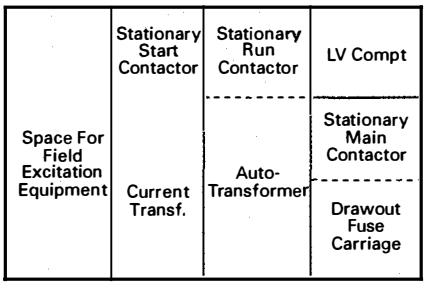


Figure 17
5kV 720A RVASF

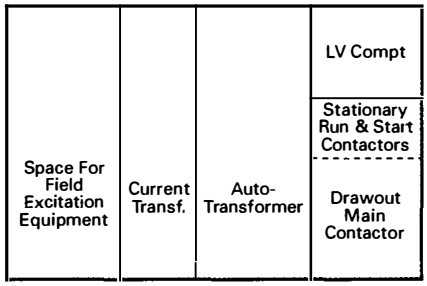


Figure 18
7kV 360A RVASF

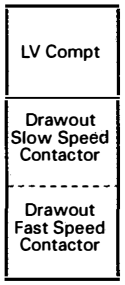


Figure 19
5kV 360A 2S2WF

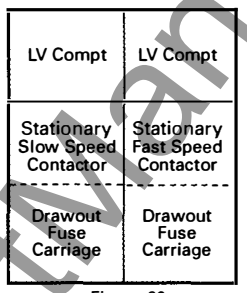


Figure 20
5kV 720A 2S2WF

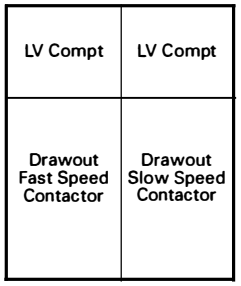


Figure 21
7kV 360A 2S2WF

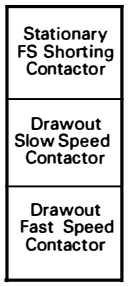


Figure 22
5kV 360A 2S1WF

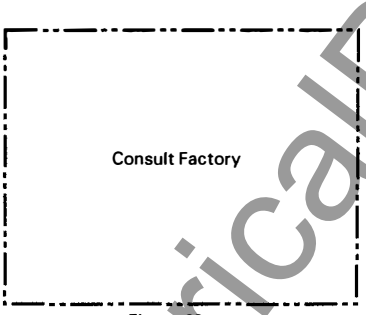


Figure 23
5kV 720A 2S1WF

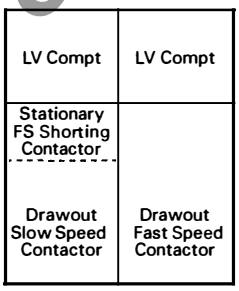


Figure 24
7kV 360A 2S1WF

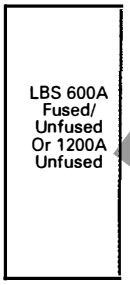


Figure 25
LBS Fused Or Unfused

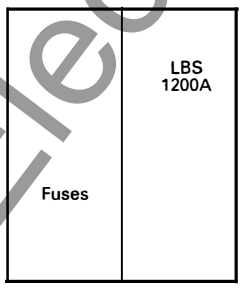


Figure 26
LBS 1200A Fused

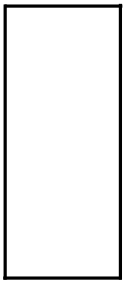


Figure 27
Incoming Line

Notes for Layout Arrangements on this and previous page

1. When upper cell is used for a drawout contactor, horizontal main bus (if required) is mounted on top of unit, adding 10 (254 mm) to height of indoor structure.
2. Weights and dimensions of reactor and autotransformer controllers vary as motor size increases.
3. For static exciter with any brush-type synchronous controller with synchronizing and protection module, add one 90 in. (2286 mm) H x 24 in. (610 mm) or 36 in. (914 mm) W x 36 in. (914 mm) D auxiliary unit.
4. Metering and protective device space requirements may warrant addition of a 90 in. (2286 mm) H x 24 in. (610 mm) or 36 in. (914 mm) W x 36 in. (914 mm) D auxiliary unit.
5. Power factor correction capacitors: when used with a FVNR controller, the capacitors take the same space as an additional controller, i.e. ⅓ of a vertical structure.
6. Surge protection: consists of 3-phase station class surge arrestors and surge capacitors, and requires a 24 in. (610 mm) W auxiliary incoming line section for mounting.
7. Type 3EF1 surge limiters can be provided with any controller with no affect on layout or dimensions.
8. Special metering and relaying: a wide variety of current and voltage sensing relays, metering devices, and similar equipment is available. Normally, the top ⅓ of the structure will be devoted to a low voltage section housing these devices, and the middle and lower cells will each house a FVNR starter.
9. For two-speed controllers, configurations shown are for standard constant- or variable-torque motors. Consult Siemens for other applications.

Standard Controller Components

FVNR — Full Voltage, Non-Reversing, Squirrel Cage Starter
containing the following components:

1 – 360A 3-pole drawout contactor
3 – Power current limiting fuses
1 – ¾kVA control transformer with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 1NC auxiliary contacts)
1① – Start / Stop pushbutton
1① – 3-phase ambient compensated thermal overload relay
1① – Externally mounted overload reset button
3 – Current transformers (or 1-3Ø)
1 – Test switch and circuit
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

FVR — Full Voltage, Reversing, Squirrel Cage Starter
containing the following components:

1 – 360A pole drawout contactor
2 – 360A 3-pole stationary contactors
3 – Power current limiting fuses
1 – 0.75kVA control transformer with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 1NC auxiliary contacts)
1① – Forward / Off / Reverse switch
1① – 3-phase ambient compensated thermal overload relay
1① – Externally mounted overload reset button
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

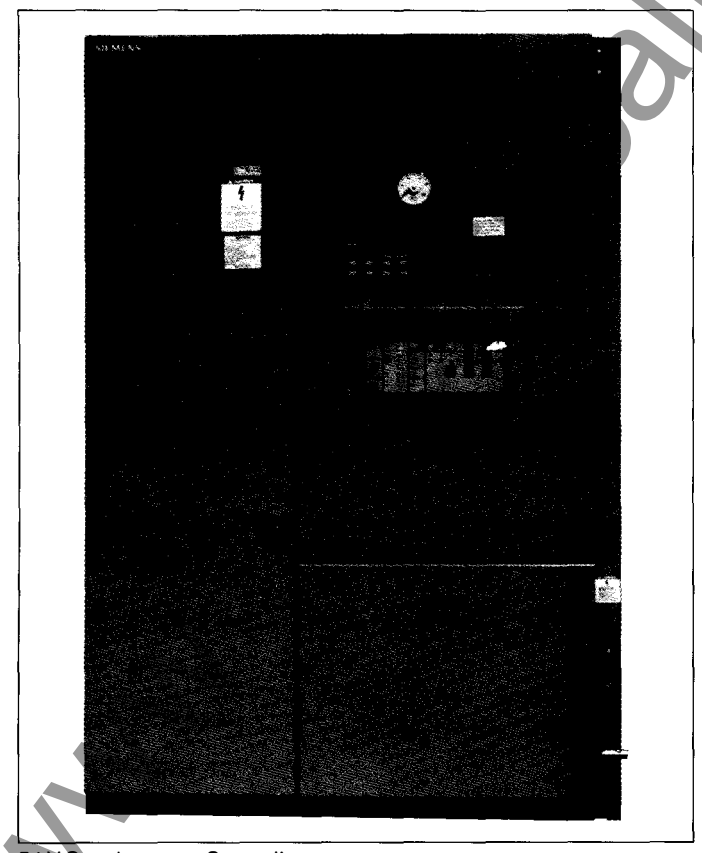
① Components which are functionally replaced when SAMMS-MV unit is used.

RVATNR — Reduced Voltage, Auto-transformer, Non-Reversing, Squirrel Cage Starter
containing the following components:

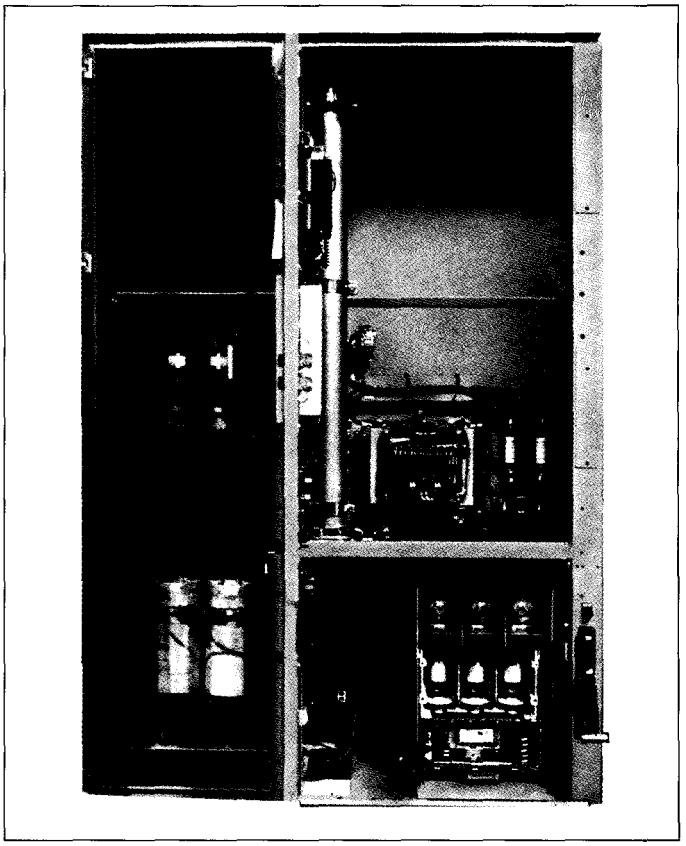
1 – 360A 3-pole drawout contactor
2 – 360A 3-pole stationary contactors
3 – Power current limiting fuses
1 – Auto-transformer with 50, 65 and 80% voltage taps, mounted in a 24 in. (610 mm) or 36 in. (914 mm) wide auxiliary structure
1① – Automatic transfer timing relay
1 – 0.75kVA control transformer with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 1NC auxiliary contacts)
1① – Start / Stop pushbutton
1① – 3-phase ambient compensated thermal overload relay
1① – Incomplete sequence relay
1① – Externally mounted overload reset button
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

RVPRNR — Reduced Voltage Primary Reactor, Non-Reversing, Squirrel Cage Starter
containing the following components:

1 – 360A 3-pole drawout contactor
1 – 360A 3-pole stationary contactor
3 – Power current limiting fuses
1 – Primary reactor with 50, 65 and 80% voltage taps, mounted in a 24 in. (610 mm) or 36 in. (914 mm) wide auxiliary structure
1① – Automatic transfer timing relay
1 – 0.75kVA control transformer with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 1NC auxiliary contacts)
1① – Start / Stop pushbutton
1① – 3-phase ambient compensated thermal overload relay
1① – Incomplete sequence relay
1① – Externally mounted overload reset button
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – Contactor position indicator light
1 – Drawout (racking) mechanism



5 kV Synchronous Controller



5 kV Synchronous Controller (Doors open)

Standard Controller Component

FVMLNR — Full Voltage, Mechanically Latched, Electrically Tripped, Non-Reversing Controller, Fused
containing the following components:

1 – 360A 3-pole drawout latched contactor
3 – Power current limiting fuses
1 – 0.75kVA control transformer with 2 primary and 1 secondary current limiting fuses
1 – Master control relay (3NO and 1NC auxiliary contacts)
1 – Close pushbutton
1 – Open pushbutton
1 – Overcurrent relay, 3 phase
1 – Manual trip external operator button
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

FVSNR — Full Voltage, Synchronous (Brush Type), Non-Reversing Starter
containing the following components:

1 – 360A 3-pole drawout contactor
3 – Power current limiting fuses
1 – 0.75kVA control transformer with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 3NC auxiliary contacts)
1① – Start / Stop pushbutton
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – AC ammeter
1 – DC ammeter
1 – Solid State Synchronizing and Protection System, with DC exciter transformer
1 – Field exciter
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

RVSPRNR — Reduced Voltage, Synchronous (Brush Type), Primary Reactor, Non-Reversing Starter
containing the following components:

1 – 360A 3-pole drawout contactor
1 – 360A 3-pole stationary contactor
3 – Power current limiting fuses
1 – ¾kVA control transformer with 2 primary and 1 secondary current limiting fuses
1 – Primary reactor with 50, 65 and 80% voltage taps
1① – Master control relay (3NO and 1NC auxiliary contacts)
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – AC ammeter
1 – DC ammeter
1 – Solid State Synchronizing and Protection System, with DC exciter transformer
1 – Field exciter
1 – Automatic transfer timing relay
1① – Incomplete sequence relay
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

RVSATNR — Reduced Voltage, Synchronous (Brush Type), Auto-transformer, Non-Reversing Starter
containing the following components:

1 – 360A 3-pole drawout contactor
2 – 360A 3-pole stationary contactors
3 – Power current limiting fuses
1 – Auto-transformer with 50, 65 and 80% voltage taps
1① – Automatic transfer timing relay
1 – ¾kVA control transformer with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 1NC auxiliary contacts)
1① – Start / Stop pushbutton
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – AC ammeter
1 – DC ammeter
1 – Solid State Synchronizing and Protection System, with DC exciter transformer
1 – Field exciter
1① – Incomplete sequence relay
1 – Contactor position indicator light
1 – Drawout (racking) mechanism

FVSNR-Full Voltage, Brushless Synchronous, Non-Reversing Starter
containing the following components:

1 – 360A 3-pole drawout contactor
3 – Power current limiting fuses
1 – Control transformer (sized per exciter rating), with 2 primary and 1 secondary current limiting fuses
1① – Master control relay (3NO and 1NC auxiliary contacts)
1① – Start / Stop pushbutton
1① – 3-phase ambient compensated thermal overload relay
1① – Externally operated overload reset button
3 – Current transformers (or 1-3Ø)
1 – Test switch & circuit
1 – DC (rectified single-phase) power supply
1 – Variable transformer for exciter-field adjustment
1 – Power factor relay (pullout protection)
1 – AC ammeter (optional)
1 – DC ammeter (optional)
1 – Exciter field application timing relay
1 – Contactor position indicator light
1 – Drawout (racking) mechanism
1① – Incomplete sequence relay

① Components which are functionally replaced when SAMMS-MV unit is used.

MVC Specifications Checklist

■ **Enclosure**

☐ NEMA 1 ☐ NEMA 1 Gasketed
☐ NEMA 2 ☐ NEMA 12
☐ NEMA 3R ☐ Walk-In
☐ Non-Walk-In

■ **Power Supply**

☐ 2300V ☐ 4160V ☐ Other
_____Hz,_____Phase,_____Wire

■ **Incoming Feeders**

Cable Size_____, # Per Phase_____
☐ Top Entry ☐ Bottom Entry
☐ Shielded ☐ Non-Shielded
☐ Bus Transition or Bus Duct
Lug Type_____

■ **Main Disconnect**

Type____
Rating____
☐ Fused ☐ Non-Fused
☐ None Required

■ **Bus**

Horizontal Main Bus Amps:
☐ 600 ☐ 1000 ☐ 1200
☐ 2000 ☐ 3000
Material: ☐ Copper ☐ Alum.
☐ Tin-Plated ☐ Silver-Plated
Ground Bus:
☐ 600 Amp Copper ☐ Other
☐ None Required

■ **Load Cables**

☐ Top Entry ☐ Bottom Entry
Lug Type____

■ **Terminal Blocks And Wiring**

☐ Fixed-Mounted ☐ Pull-Apart
☐ Clamp-Type ☐ Screw-Type
☐ AWM Control Wire (Standard)
☐ SIS Control Wire
Wire-Markers: ☐ Yes ☐ No
Wires Marked At: ☐ One End
☐ Both Ends
☐ Adhesive Type ☐ Sleeve-Type

Optional Devices

■ **Metering (Incoming):**

☐ VM ☐ AM ☐ WHM
☐ AM / VM Selector Switch
☐ Panel-Type ☐ SWBD-Type
☐ CT's ☐ VT's
☐ Surge Arrestor
☐ Surge Capacitor
☐ Other_____

■ **Starter Accessories:**

CPT ☐ ¾ KVA (STD) ☐ 1½ KVA
☐ 2KVA ☐ 2½ KVA ☐ 3¼ KVA
☐ 115V AC Secondary
☐ 230V AC Secondary
☐ Power Factor Correction Capacitors
Size:_____
☐ AM ☐ VM ☐ AMS ☐ VMS
Other_____
☐ Blown-Fuse Trip Bar

■ **Protective Relaying:**

For Motor Overload Protection:
☐ 3UA (OLR) (STD)
☐ Static Multifunction (specify type)
☐ SAMMS-MV
Other Current Relays:
☐ Ground Fault ☐ Phase Unbalance
☐ Open Phase/Phase Reversal
☐ Overcurrent: ☐ Timed ☐ Inst.
☐ Neg. Sequence ☐ Differential
Voltage Relays:
☐ Undervoltage ☐ Phase Reversal
☐ Phase Sequence ☐ Phase Unbalance
☐ Other_____
Relays to Be:
☐ Industrial Class ☐ Switchgear Class
Miscellaneous:
☐ Pilot Lights ☐ Red ☐ Green
☐ Push button ☐ Selector Switch

_____
_____
_____

Medium Voltage Controllers — Series 81000™

Guide Form Specifications

This specification covers the design, manufacture, assembly and testing of (5000) (7200) volt class E2 controllers. These controllers shall be provided complete as specified herein, and shall be Siemens Series 81000 or Engineer-approved equal.

1. Codes and Standards

A. This equipment will be designed and constructed in accordance with applicable sections of NEMA, ANSI, and The National Electrical Code. Additionally, the controllers will comply with the requirements of UL 347 and shall bear the UL label whenever possible.

II. General Structural Requirements

A. Each controller lineup shall consist of one or more freestanding vertical sections and shall be so designed as to allow additions of individual starters and / or vertical sections in the field.

B. Individual vertical sections will be capable of up to 3-high mounting of drawout contactor assemblies.

C. Each section will be fabricated from minimum 11-gauge steel for the frame, and minimum 12-gauge construction for all doors. Typical dimensions will be 90 in. (229 mm) high, 36 in. (914 mm) wide and 36 in. (914 mm) deep.

D. All sections will be dead front construction and will utilize sheet steel barriers for isolation of the power bus compartments from the drawout contactor area. A sliding shutter mechanism shall act automatically to cover the line side stab connections whenever the contactor is racked off the bus. The rear of each section shall be provided with a two-piece removable barrier for ease of access.

III. Power Bus

A. A continuous 3-phase horizontal power bus will extend the entire length of each lineup. Horizontal bus rating will be as detailed on the attached MVC checksheet.

B. Each vertical section housing a drawout contactor or fuse carriage will also be provided with a full-height copper vertical bus rated 360, 540, or 720 amps continuous. Bus plating will be the same as that provided for the horizontal power bus.

C. A continuous horizontal ground bus will be provided when specified on purchaser's drawings. This bus will be copper with a minimum rating of 600 amps.

D. All power bus will be readily accessible from the front.

IV. Incoming Line Compartment

A. Each medium voltage control lineup will be provided with an incoming line compartment for termination of primary power feeder cables. This section will be as detailed on attached checksheet.

B. Additional incoming service details plus incoming metering and / or relaying requirements will be as detailed on attached documents and drawings.

V. Enclosure Type

A. Enclosure type will be as specified on the attached MVC checksheet.

VI. Controller Assemblies

A. Each controller shall consist of a magnetically held contactor, primary fuses for short circuit protection, and an overload relay for motor overload protection. The overload relay should provide running single-phase protection and an isolated NO alarm contact. The overload relay should be Siemens type 3UA (OLR) or approved equal.

B. The controller assembly will include both line and load side stab fingers, thereby allowing the complete removal of the drawout unit without disconnecting any power cabling.

C. The minimum short circuit rating of the fused assembly will be 50kA symmetrical / 80kA asymmetrical. The primary protective fuses should be ANSI class "R" (class "X" for 57X size) for motor starting duty, and class "E" for transformer or capacitor feeder duty. All fuses shall have an interrupting rating of at least 80,000 amps asymmetrical. Fuses shall be Siemens Type FM or A720R or Engineer-approved equal.

D. All contactors will utilize a vacuum main contact design to insure extended operating life. Minimum electrical life of main contacts will be 250,000 operations.

E. A control power transformer will be provided with each controller to provide single-phase power for the contactor holding coil and other auxiliary devices as specified. The CPT secondary will be rated 115V AC. Minimum transformer size will be 750 VA, and each CPT will be provided with two primary current-limiting fuses.

F. An electrical interlock will be provided to automatically open the CPT secondary whenever the contactor is racked out.

G. The racking mechanism for each controller shall be so designed such that it is impossible to rack the drawout carriage on or off the bus unless the contactor is either de-energized, or open. Likewise, the mechanism must prevent opening of the compartment door unless the drawout carriage is withdrawn (in the OFF position). This operating handle must clearly indicate the ON and OFF positions of the controller, and must be capable of being padlocked in the OFF position.

H. As an added feature, each controller shall be provided with an externally visible red indicating light which is illuminated whenever the contactor is racked onto the bus.

J. Within the door of each controller compartment, a low voltage section will be provided. This low voltage compartment must have a separate door accessible from the front of the controller, and must totally isolate all low voltage control circuitry from the high voltage compartment. Terminal blocks for termination of purchaser's low voltage control circuits should be accessible in this compartment, as well as the overload relay and any other low voltage devices. Additionally, the low voltage compartment door will be provided with an externally operable overload reset button.

VII. Equipment Finish

A. All external controller parts will be properly cleaned and degreased before being provided with an electrostatically applied ANSI-61 light gray polyester urethane finish. Interior sheet steel will be painted in a similar fashion, or will be provided as heavy galvanized construction for corrosion protection.

VIII. Miscellaneous

A. Additional details are as shown on the attached "Medium Voltage Controller Checksheet" and additional drawings.

Technical Specifications

Control Power Specification
Unit powered by 12.0 VAC (+10%/−15%) supply

Power requirements: 4 VA
Control Circuit inputs and outputs are 120 VAC (+10%/−15%)
Maximum output loading allowed for continuous operation:
- Each output Energized – 1.0A
- Input Leakage Current – 5mA

Frequency:
50 Hz: +4% / −5%, 60 Hz: ±5%

Motor Control Specifications
Inputs
- 6 Pushbuttons
- 4 Remote inputs

Outputs
- Coil drivers — 3 (SAMMS-MVX), 2 (SAMMS-MVE)
- Light bars — 3 (SAMMS-MVX), 2 (SAMMS-MVE)
- 1 Alarm contact

Diagnostics LEDs
- Phase unbalance
- Impending trip
- Overload trip
- External trip
- Incomplete sequence
- Ground fault
- CPU fault
- Ready
- Light bar flashes (Timer timing)
- Impending trip LED flashes (Motor Temperature warning)
  Overload trip LED flashes (Motor temperature too high)
- CPU LED On (Momentary loss of voltage)
- Overload test button/reset button

Table 10

Size	Current Ranges
H3A	18 – 72
H3B	60 – 240
H3C	192 – 400
H6	320 – 720

Control Circuits
SAMMS-MVE: Seven preprogrammed circuits for control of FVNR machines, field selectable using Handheld Communicator. Also accepts one custom circuit downloaded from a personal computer.

SAMMS-MVX: Accepts one standard or custom circuit downloaded from a personal computer.

Software Configured Control Devices

Timers:	4
Timing range:	Timers 1 & 2: 0 – 200 seconds selectable Timer 3: 1 second fixed value Timer 4: 30 seconds – fixed value
Timer auxiliary contacts:	Software instantaneous contacts and timed contacts
Software Control Relays:	8 (Software)
Auxiliary contacts:	Software instantaneous contact

ACCESS local area network compatible.
Loss of voltage ridethrough time period: 1 second (SAMMS-MVX only)

Overload Specifications

Overload classes:	Overload classes 2 through 23 with one second increments.
Trip characteristics:	Tripping time at 6 X I_{FLC} equals 95% (+5% / −10%) of the overload class. Tripping at 1.5 X I_{FLC} within 2 minutes for warm condition for all classes.
Tripping threshold:	1.1 + 0.05 − 0.00 X I_{FLC} for motors with 1.00 service factors and 1.2 + 0.05 − 0.00 X I_{FLC} for motors with 1.15 service factor.

Mechanical Jam Protection (SAMMS-MVX only)
Sudden increase to twice the value of the motor running current and exceeding 200% of I_{FLC} in 360 milliseconds.

Loss of Load Protection (SAMMS-MVX only)
Sudden decrease to 50% of motor running current in 360 milliseconds.

Process Current Warning (SAMMS-MVX only)
Settable from 0 to 100% of I_{FLC}

Accuracy
±5% of overload trip curve values.

Phase Unbalance Protection
- Response time after 1 second
- Shifted trip threshold value at 40% phase unbalance to 0.9 x I_{FLC}

Equipment Ground Fault Protection
Pickup time: 1 second
Pickup current:

Table 11

Size	Pickup Current
H3A, H3B, H3C	7A-I_{FLC}
H6	7A-I_{FLC}

Statistical Data
Elapsed Motor Running Time
- X10
- Range: 0.0 to 6553 (65,536 hours)
- Unit increments: 10 hours

Number of Motor Starts
- X10
- Range: 0.0 to 6553 (65,536 starts)
- Unit increments: 10 operations

Number of Overload Trips
- Range: 0 to 9999
- Increments: 1 trip

Current Display
Table 12

Overload Relay Size	Current Increments in Amperes
H3A, H3B, H3C	1.0
H6	2.0

Alarm Contact (SAMMS-MVX Only)
Alarm Contacts Configuration
- N.C.
- N.O. } selectable

Alarm Contacts Functions
- Any function listed below
- Impending Trip
- Overload Trip
- External Trip
- Ground Fault

Dimensions
SAMMS-MV: 6.25-in. (159 mm) wide
6.00-in. (152 mm) high
2.125-in. (54 mm) deep
Handheld Communicator:
3.15-in. (80 mm) wide
5.7-in. (145 mm) high
1.37-in. (35 mm) deep

Environments
Operating temperature range: −25° to +70°C
Storage Temperature: −40° to +85°C
Relative Humidity: 5 to 95% non-condensing
Altitude: 6600 ft.
Vibration: 5 g's at a frequency range of 10 to 60 hertz.

Siemens Advanced Motor Master System — SAMMS-MV™

Guide Form Specifications

The following specification may be added to the appropriate section of motor control equipment specifications to guarantee that important features and functions of the SAMMS-MV™ system are provided.

Each medium voltage motor controller shall be provided with a microprocessor-based motor control and protection device. Motor protection shall be based on the calculated temperature of the motor windings and rotor as a function of the motor RMS current and the motor winding and rotor cooling and heating time constants. The minimum acceptable accuracy level for overload protection shall be plus or minus 5% during motor starting and running conditions. The following motor protection features shall be provided:

- Flexibility to change the motor protection settings without replacing heater elements.
- Eliminate nuisance tripping by allowing the maximum number of motor starts without damage to the motor insulation.
- Motor lockout on thermal overload trip.
- Ground fault protection.
- Accurate protection for the rotor of medium voltage machines.
- Phase loss and phase unbalance protection.
- Impending trip alarm.
- Choice of Class 2 through 23 (in one second increments) overload protection curves to match the motor characteristics and provide stall protection.
- (Optional) Process current (load current) alarm.
- (Optional) Mechanical jam protection.
- (Optional) Undercurrent / loss of load protection or alarm.

The device shall offer programmable control logic. Local control devices such as timers, control relays, pushbuttons and selector switches are replaced by software and the standard pushbuttons and lights on the device control panel.

Diagnostic LED's shall provide visual status of the condition of the controller and the motor including current phase unbalance, impending overload trip, overload trip, external trip, incomplete sequence, CPU failure, ready (control power) and ground fault. A reset / test button shall be provided to allow resetting and testing of the overload function as well as testing the control panel LEDs.

Statistical motor data including the elapsed motor running time, number of starts and number of overload trips, are stored in the microprocessor's memory and are displayed using the hand-held communicator. The hand-held communicator can also be used as an amp meter to display the average phase current, or the average of all three-phase motor currents.

The following optional features shall be provided:

- Voltage interrupt ride through (up to one second).
- (Optional) Capability to accept RTD inputs.
- Custom circuit software: Include an IBM compatible software package to allow development of customized control circuits from over seventy standard circuits and the ability to download a control circuit and motor parameters in the field.
- Standard circuit software: Include an IBM compatible software package to allow selection of over forty standard control circuits and the ability to download the selected circuit and motor parameters in the field.
- Backup software: Include an IBM compatible software package to allow the exact motor parameters and control circuits as originally specified from the factory to be downloaded into a spare SAMMS to backup multiple applications in the field.
- Provisions for communications to a host computer or the power monitor panel using the ACCESS™ local area network.
- Convertible N.O. / N.C. alarm contact which can be programmed to indicate impending trip, overload trip, external trip, ground fault trip, or any of the above.

The microprocessor-based protection and control device shall be Siemens Advanced Motor Master System: SAMMS-MVE, SAMMS-MVX or engineer-approved equal.

SIEMENS

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