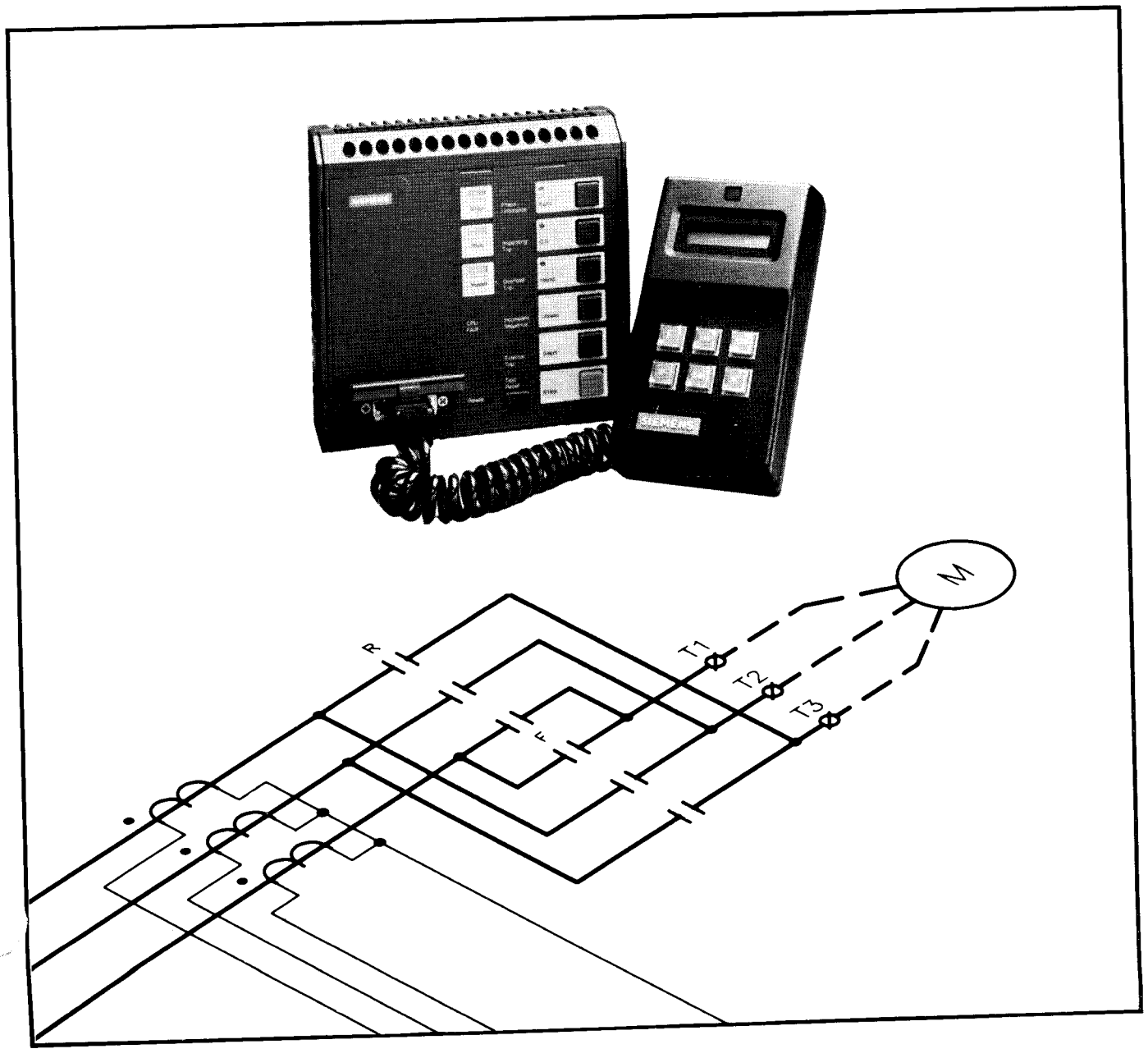
SIEMENS

SAMMS

Siemens Advanced Motor Master System

Technical Reference Manual



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NOTE

The information contained herein is general in nature and does not intend for specific application purposes. It does not relieve the user of responsibility to use sound practice in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence. Prices are subject to change without notice.

About This Manual

This manual introduces the reader to Siemens Advanced Motor Master System (SAMMS™). Use it now to learn the proper procedures for the installation, operation, and troubleshooting of the SAMMS. It may also be used later as a reference document.

This Manual Tells You:

- ☐ The basic functions of SAMMS, (Section 1).
- ☐ Technical specifications of SAMMS, its associated current transformers and control power transformers, (Section 1).
- ☐ Installation guidelines, (Section 2).
- ☐ Detailed operation covering each handheld communicator function, (Section 3).
- ☐ Principals of motor protection methods used in the SAMMS, (Section 3).
- ☐ Overview of motor control ladder diagrams, (Section 3).
- ☐ Communication methods, (Section 4).
- ☐ Troubleshooting guidelines, (Section 5).

How To Use This Manual

Read Section 1 to learn the basics and get started. Then continue on to Section 2 and use it as a guideline for installation. Return to Section 3 when you want to learn more details about the operation. Use Section 4 as a reference. Read Section 5 in case of trouble.

Turn to the first section to begin learning about SAMMS.

Contents

Figures

Tables

Section 1

INTRODUCTION

⚠ DANGER

HAZARDOUS VOLTAGE

Will cause severe injury, death or property damage.Turn off power supplying this equipment before any adjustments, servicing, wiring, parts replacement, or before any other act requiring physical contact with the electrical working components of this equipment is performed.

The successful and safe operation of SAMMS controllers is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance

Siemens Advanced Motor Master System (SAMMS) controllers are designed and built in accordance with the latest applicable provisions of the National Electric Code, Underwriters' Laboratories Standards and Procedures, NEMA Standards, and the National Electric Safety Code. These publications and this instruction manual should be thoroughly read and understood prior to beginning any work on this equipment.

These instructions are prepared as a guide to handling, installation, operation and maintenance of all type of SAMMS and Handheld Communicators. Since individual starters and controllers are designed for specific applications, the components and functions are dictated by the purchaser's specifications and needs.

Separate instructions covering components are not included in this publication, but are available upon request. The purchaser should read these instructions and determine applicability to his particular controller by referring to the nameplate data on the controller and to the electrical diagrams supplied with the controller.

KEEP THESE INSTRUCTIONS FOR FUTURE REFERENCE.

NOTE

Qualified Person
For the purpose of this manual, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

(a) **Is trained and authorized** to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

(b) **Is trained** in the proper care and use of protective equipment such as rubber gloves, hard hats, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

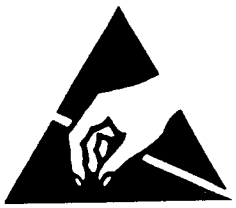
(c) **Is trained** in rendering first aid.

For the purpose of this manual and product labels;

DANGER indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

WARNING indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

CAUTION indicates minor personal injury or property damage can result if proper precautions are not taken.



The printed circuit boards in the equipment include Electrostatically Sensitive Devices. Before touching any printed circuit board, follow proper ESD control procedures.

DANGER

HAZARDOUS VOLTAGES

Will cause severe personal injury or death or property damage. Follow all safety precautions and instructions.

Safety Instructions

1. Only qualified personnel familiar with this equipment and the information supplied with it should be permitted to install, operate, troubleshoot, or repair the apparatus.

2. Installation of the equipment must be done in accordance with the National Electrical Code or any other applicable codes. Proper grounding, conductor sizing, and short circuit protection must be installed for safe operation.

3. During normal operation, keep all covers in place.

4. When performing visual inspections and maintenance, be sure the incoming AC power is turned off and locked out. The SAMMS and motor will have hazardous voltages present until the AC power is turned off.

5. This list does not represent an exhaustive survey of the steps necessary to insure safe operation of the equipment. Should further information be desired, or should particular problems arise which are not covered sufficiently for the purchasers' purposes, the matter should be referred to the local Siemens sales office.

Description

1.1 General

Siemens Advanced Motor Master System (SAMMS), Figure 1-1, is a software configured electronic motor control and overload protection device. The system consists of a microprocessor-based controller, a Hand-held Communicator (HHC) Figure 1-2, a current transformer and a control power transformer. SAMMS is a multi-functional device offering:

- Advanced Motor Protection
- Pre-programmed control circuits
- Standardized control panel with input/output devices replacing conventional push-buttons, pilot lights and selector switches
- Visual diagnostics
- Statistical motor data
- Real-time metering
- Local display of all motor and control circuit data
- Open architecture communications using the ACCESS™ local area network

☞ ***SAMMS does not replace the disconnect device (fused switch or circuit breaker) or the contactor.***

1.1.1 Advanced Motor Protection

Advanced motor protection is based on an algorithmic motor model that continuously calculates the motor winding and housing temperatures 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 a trip temperature value is reached. The model truly emulates the heating and cooling of the motor windings and provides protection against both transient and steady-state overload conditions.

1.1.2 Overload Protection

The motor model offers the following selection of overload classes:

- **SAMMS 3** Classes 2 through 23
- **SAMMS 2** Classes 5, 10, 15 and 20
- **SAMMS 1** Classes 10 and 20

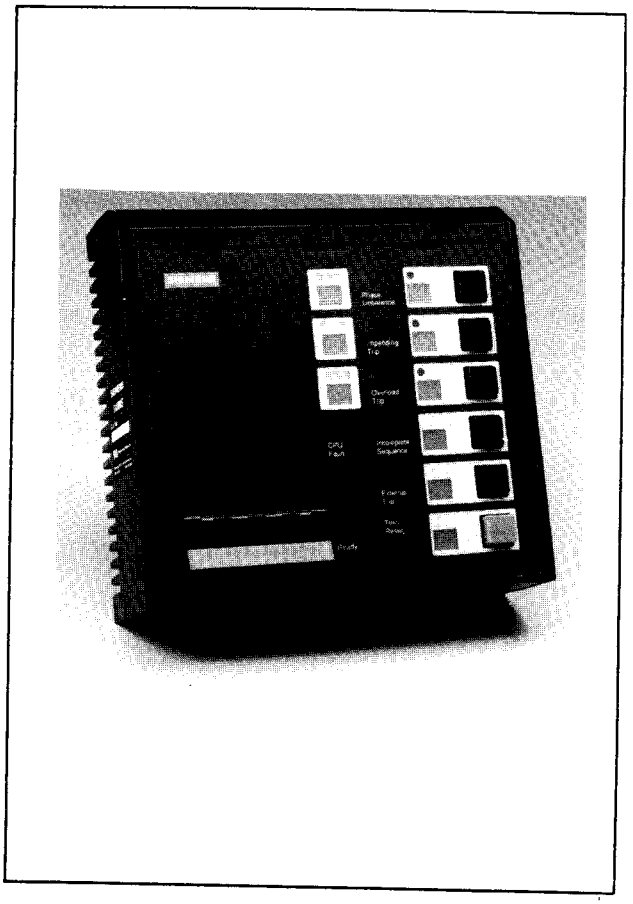


Figure 1-1 SAMMS

The more accurate protection offered by SAMMS units over bi-metal or eutectic thermal overload trip devices should prolong motor life, eliminate nuisance tripping for multiple restarts and allow for proper cool down time when the motor winding temperature reaches a critically high value.

1.1.3 Programmable Control Circuits

The SAMMS design is based on a standard hardware configuration that can be modified by programming the microprocessor, which in turn replaces conventional timers, overload relays, pushbuttons, and selector switches. A library of more than 70 typical control circuits has been developed to meet applications ranging from simple across-the-line starters to complicated reduced-voltage starters. The specified control circuit, (either from the library or a modified version), can be loaded into the microprocessor's memory in the factory or on site by using an IBM® compatible computer.

As an optional feature, an IBM compatible software package is available to develop highly specialized control circuits or to modify existing circuits. It's a powerful and user-friendly program that uses conventional engineering symbols in pull-down menus with a mouse to draw the ladder diagram on a CRT screen. Once the diagram is finished, the program translates it to microprocessor machine code and downloads it into the SAMMS memory.

1.1.4 Standardized Control Panel

The SAMMS accepts a maximum of four (4) remote inputs. They are compatible with all PLCs and electromechanical remote control devices that have a 120 volt input signal.

The front panel has two configurations depending on whether local or remote control is specified. When local control is required, three (3) light bars and six (6) buttons with lights and tactile feedback are provided and can be software configured for the various functions of the control circuit used. If remote control is specified, the buttons are not provided. Remote and local control can be specified on the same unit.

A test/reset button is provided for both configurations to allow resetting and testing of the overload function as well as testing the front panel lights.

1.1.5 Visual Diagnostics

The front panel of the SAMMS has 8 diagnostic LEDs providing information regarding conditions affecting the motor.

1.1.6 Statistical Motor Data

Statistical motor data is stored in the microprocessor memory and is displayed on the Handheld Communicator (HHC).

1.1.7 Real Time Metering

Real time metering data is displayed on the HHC.

1.1.8 Local Display of Motor and Control Circuits

Local display of motor and control circuit data are displayed on the front of the controller and the HHC.

1.1.9 Communications

Open architecture communication is provided through ACCESS™ local area network. Through ACCESS, SAMMS is capable of two-way communications to either a Local Display, Power Monitor Panel, or host computer. This ability allows for the control and monitoring of motors from a centralized location. All information available from SAMMS, such as diagnostics, statistical data, real time metering, and controller status can be communicated.

1.2 Models

SAMMS is available in three models to meet the various demands of industrial and commercial specifications and installations.

1.2.1 SAMMS 3

SAMMS 3 is designed for critical process control where downtime translates into unacceptable losses in production time and process material. It offers motor control and protection along with motor diagnostic and motor/driven equipment protection. Plant engineering and operating personnel will have access to important data enabling them to optimize motor driven equipment capabilities and maximize the process system output and facilitate maintenance.

1.2.2 SAMMS 2

SAMMS 2 offers motor diagnostics for preventive maintenance programs to avoid costly downtime while also lengthening motor and driven equipment life. With the SAMM's motor protection and diagnostics, maintenance engineers will have data such as total number of starts and trips, trip current, phase unbalance, and elapsed motor running time to establish effective motor control performance and service records.

1.2.3 SAMMS 1

SAMMS 1 is the answer to situations where quick turnaround time and installation are extremely important. SAMMS offers conventional protection for 0.3 to 540 amps along with a number of special features such as automatic restart, phase unbalance protection, and access to two OLRs with either Class 10 or 20. Last minute adjustment of motor parameters is no problem and will not impact delivery or installation.

1.3 OPERATIONAL

1.3.1 The Handheld Communicator (HHC)

The Handheld Communicator (HHC) permits the operator to monitor various motor operating conditions, such as instantaneous current and elapsed running time. It also allows the operator to monitor and alter various control and protection settings, such as on-delay time and overload class. The specific operations the HHC can perform are denoted as functions. The number of functions available depends not on the HHC but on the particular SAMMS connected to the HHC. The HHC has five control keys: FUNCTION, DISPLAY, UP, DOWN and ENTER. and a four-character, seven-segment liquid crystal display (LCD) for requesting and displaying various data.

The small size of the HHC and the accessibility of the HHC connector on the front panel of the SAMMS makes it easy for the operator to check many SAMMS units with one HHC. The HHC's retractile cable terminates in a DB-9 connector that plugs into its mate on the front panel of the SAMMS. Once the connection is made, communication between the SAMMS and the HHC is automatically effected and the desired function can be performed.

The HHC receives power and control from the SAMMS. When unplugged from a SAMMS, the HHC cannot retain or display data.

Figure 1-2 Handheld Communicator (HHC)

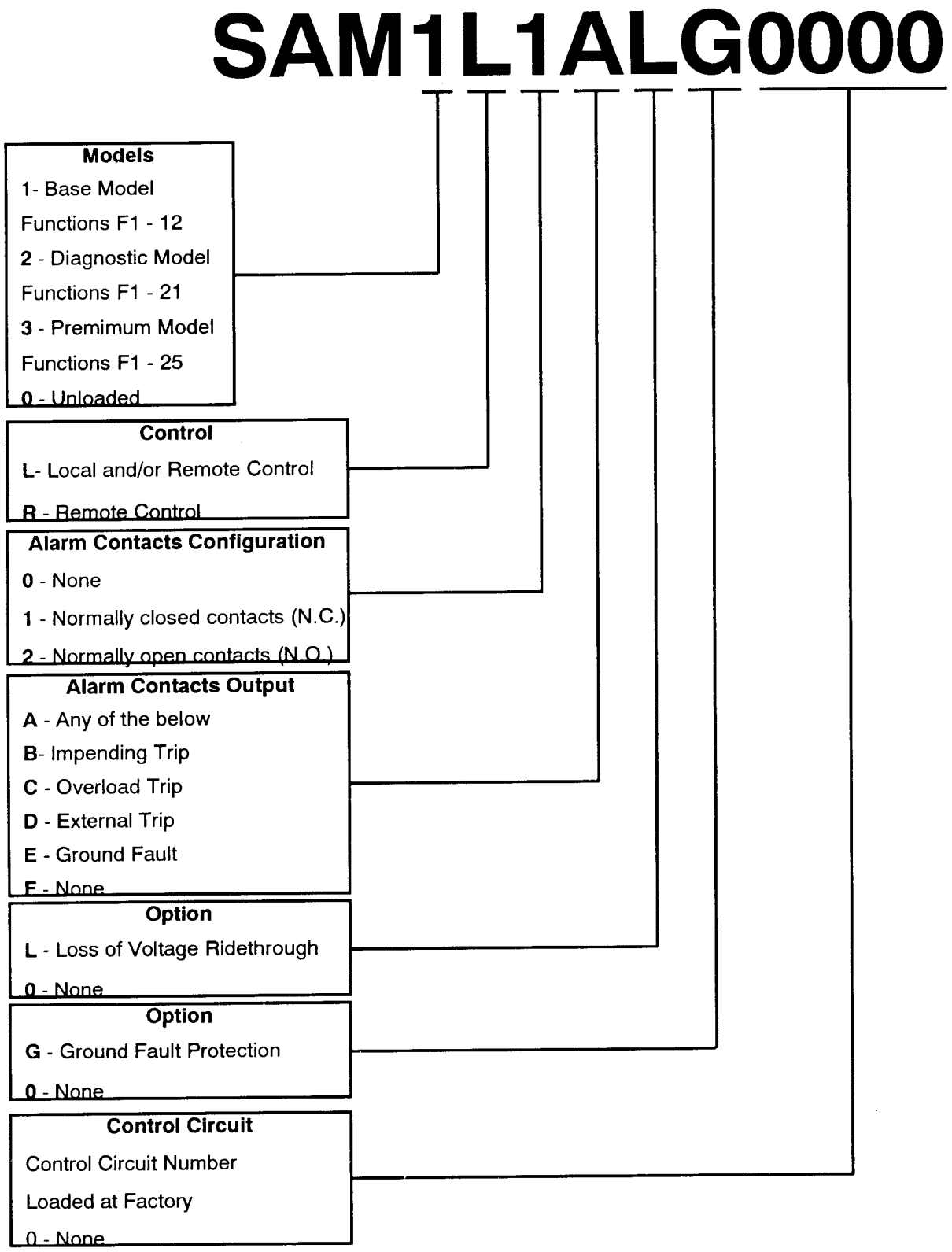


Figure 1-3. SAMMS Catalog Number

Table 1-1. SAMMS Functions

Function Number	Function	SAMMS3	SAMMS2	SAMMS1
F1	Control Circuit Number	*	*	*
F2	Size for overload No. 1	*	*	*
F3	Size for the low speed overload No. 2	*	*	*
F4	Full load current for OLR No. 1	*	*	*
F5	Full load current for OLR No. 2	*	*	*
F6	Service factor	*	*	*
F7	Overload trip class	*(1)	*(2)	*(3)
F8	Automatic reset	*	*	*
F9	Phase unbalance	*	*	*
F10	Time to restart	*	*	*
F11	Emergency restart	*	*	*
F12	Ground fault protection	*(6)	*(6)	*(6)
F13	Timer No. 1	*	*	
F14	Timer No. 2	*	*	
F15	Motor current	*(4)	*(5)	
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	*		
F24	Loss of load protection	*		
F25	Calculated motor winding temperature as % of full load temperature	*		

(1) Choice of Class 2 through 23 protection
(2) Choice of Classes 5, 10, 15, 20 protection
(3) Choice of Class 10 or 20 protection

(4) Displays average phase current or any of the three phase currents.
(5) Displays the average phase current
(6) Optional (disabled if not specified)

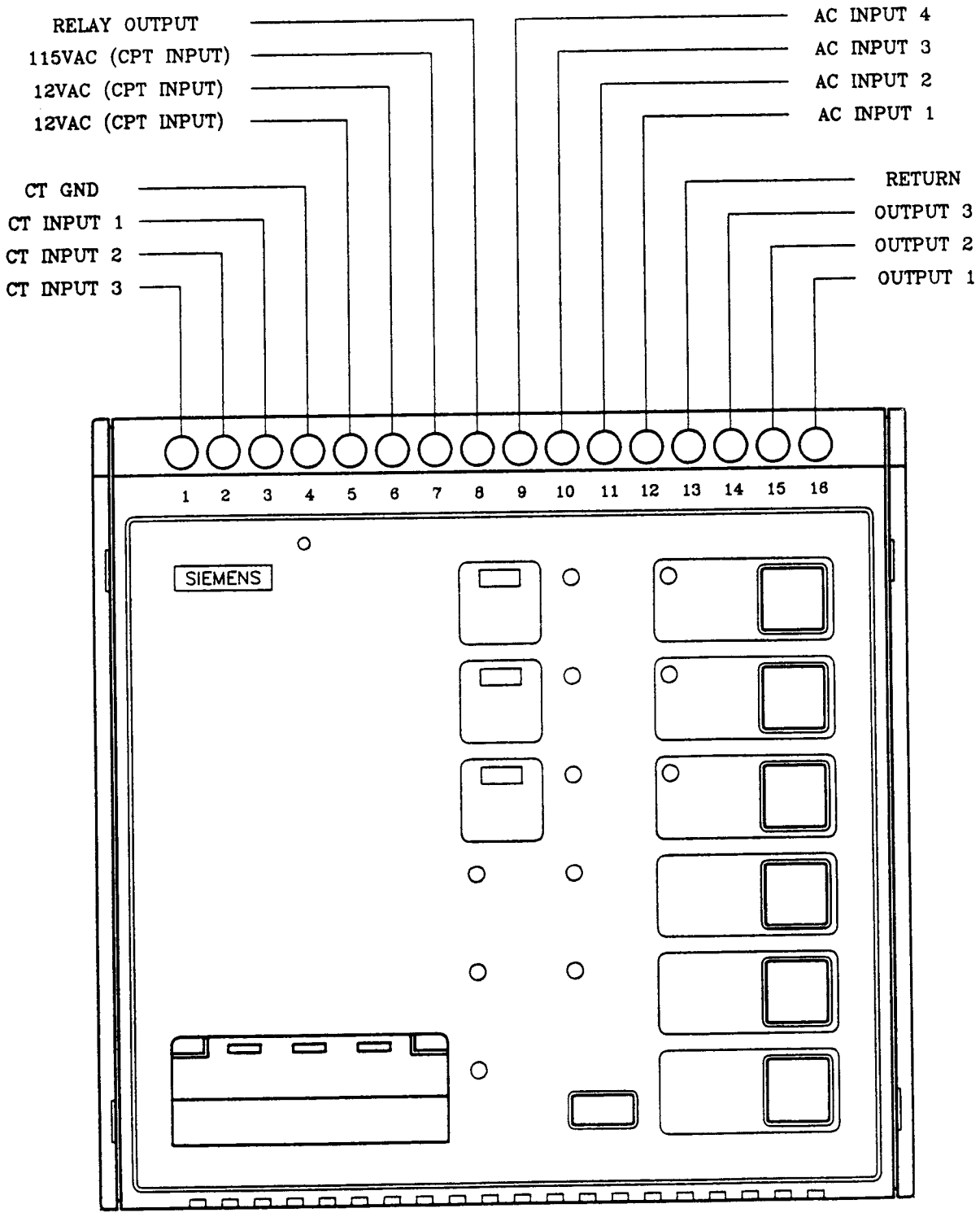
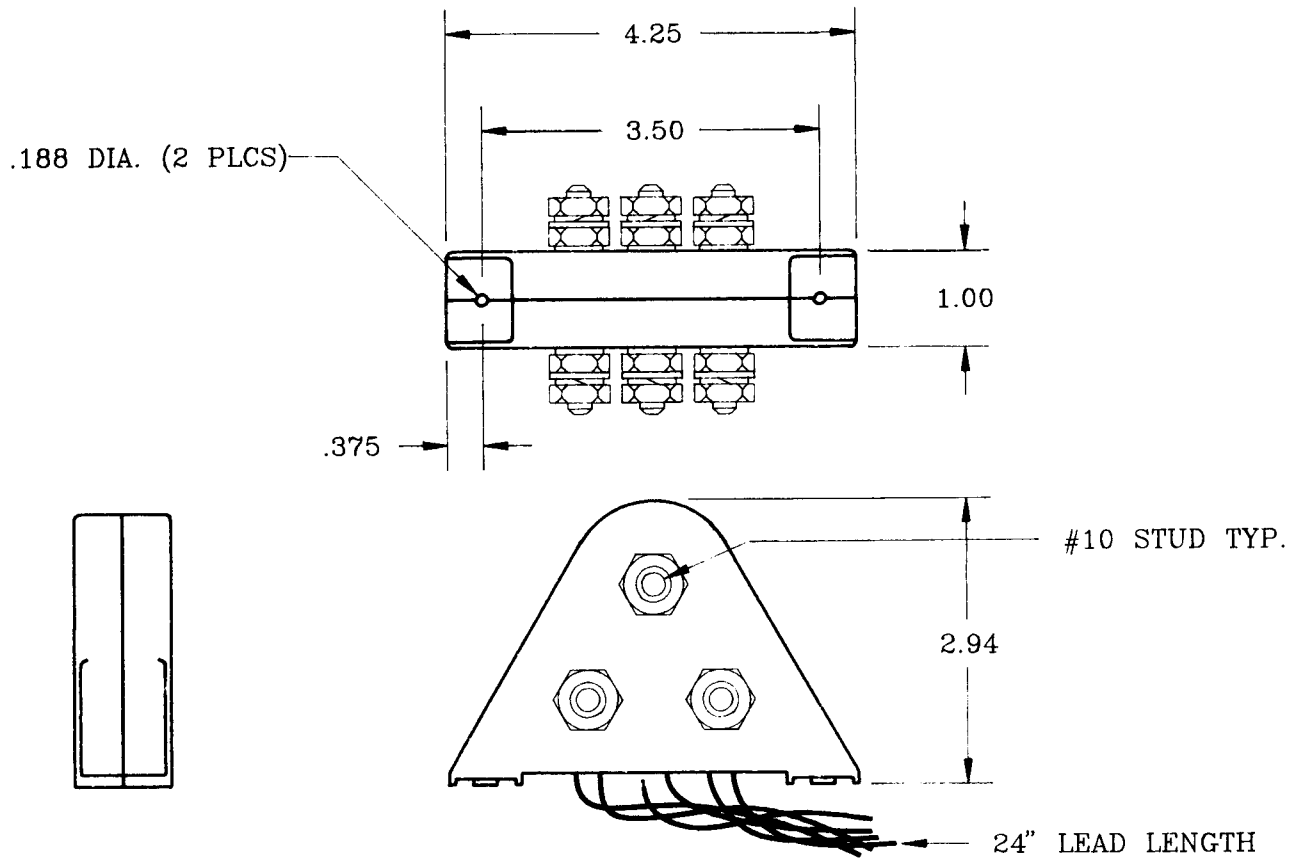
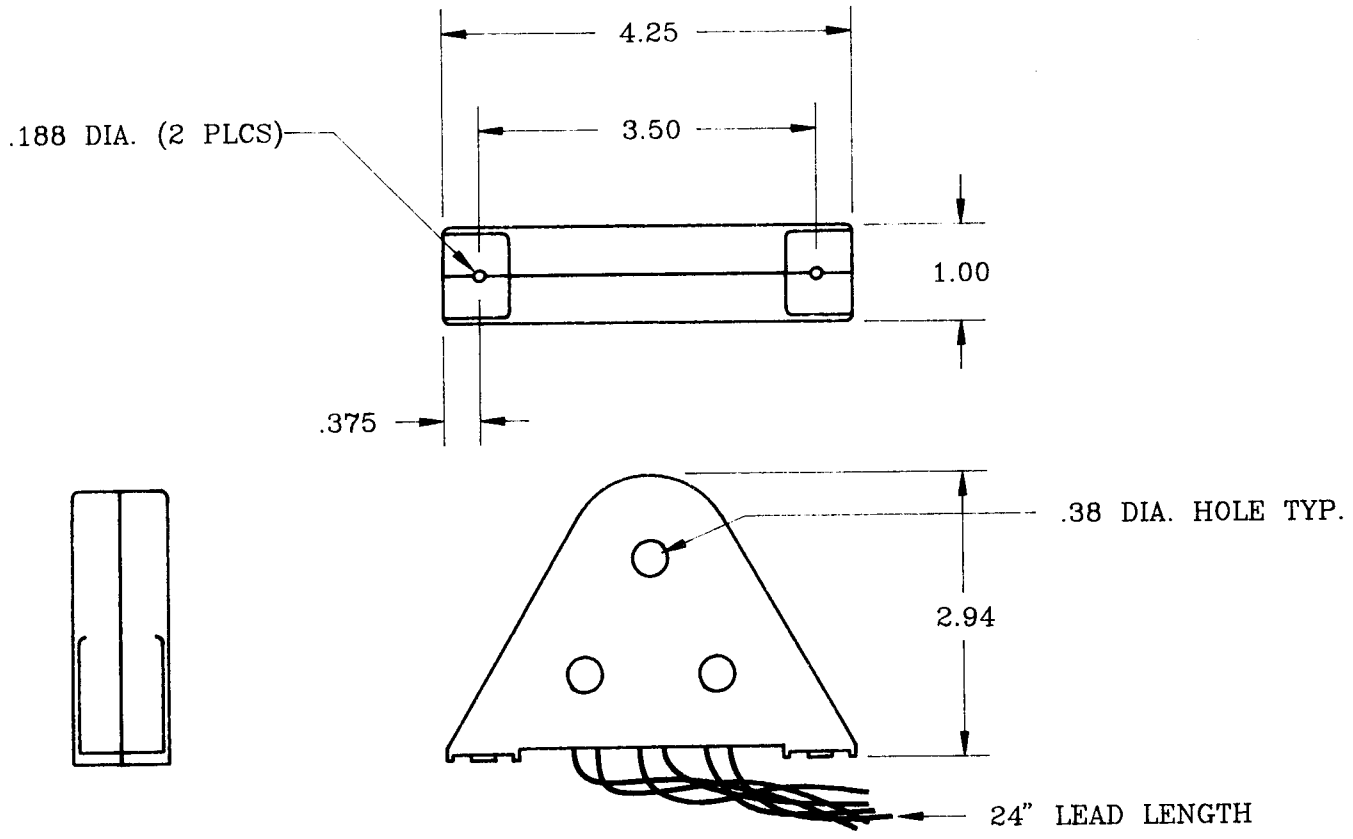


Figure 1-4. SAMMS Terminal Block Assignments



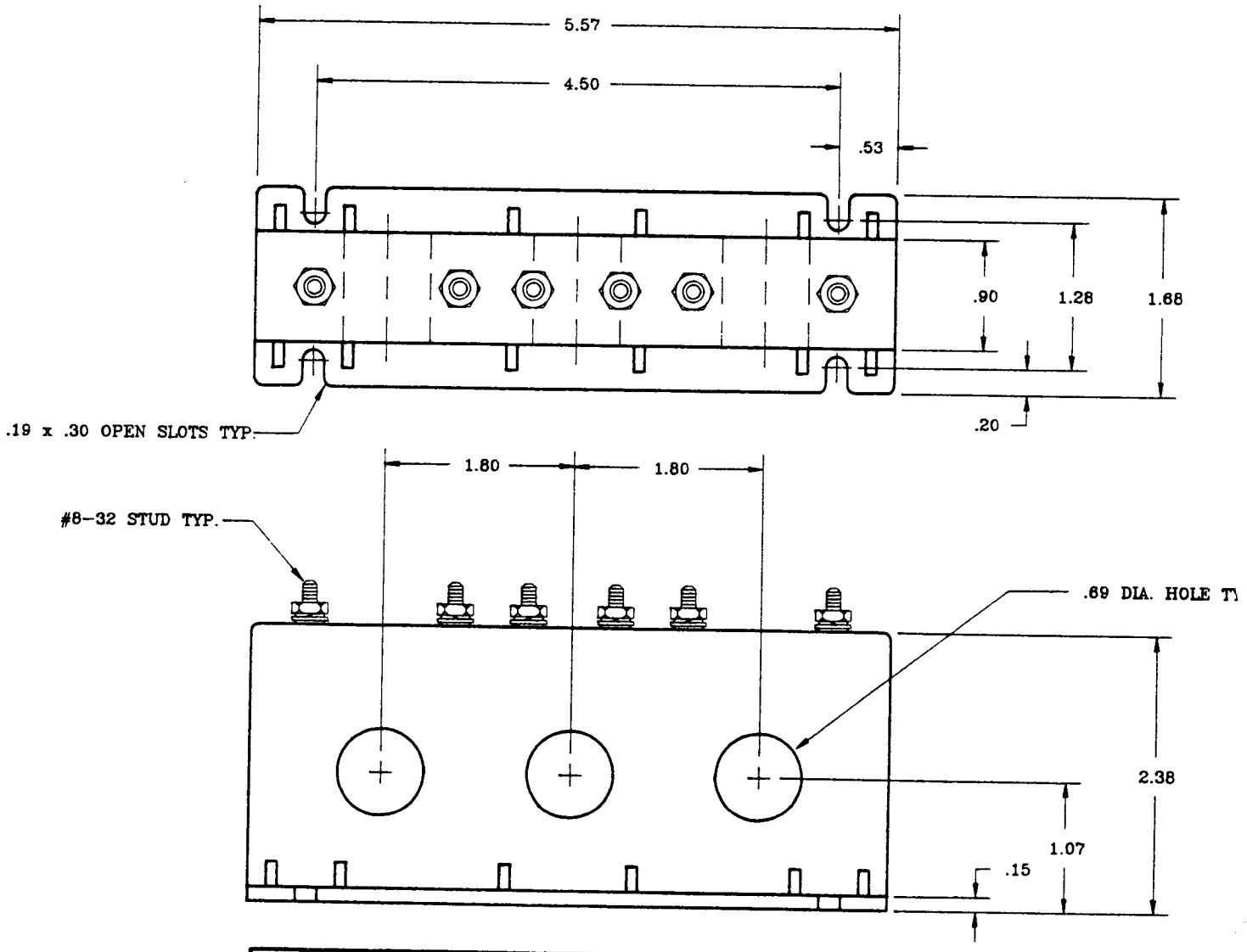
SIZE	CURRENT RANGE		SECONDARY OUTPUT	CATALOG NUMBER
	MIN	MAX	MAXIMUM	
1A	0.3A	1.5A	177mA	SAMMS 1A CT
1B	1.2A	6.0A	177mA	SAMMS 1B CT

Figure 1-5. SAMMS Size 1A & 1B Current Transformers



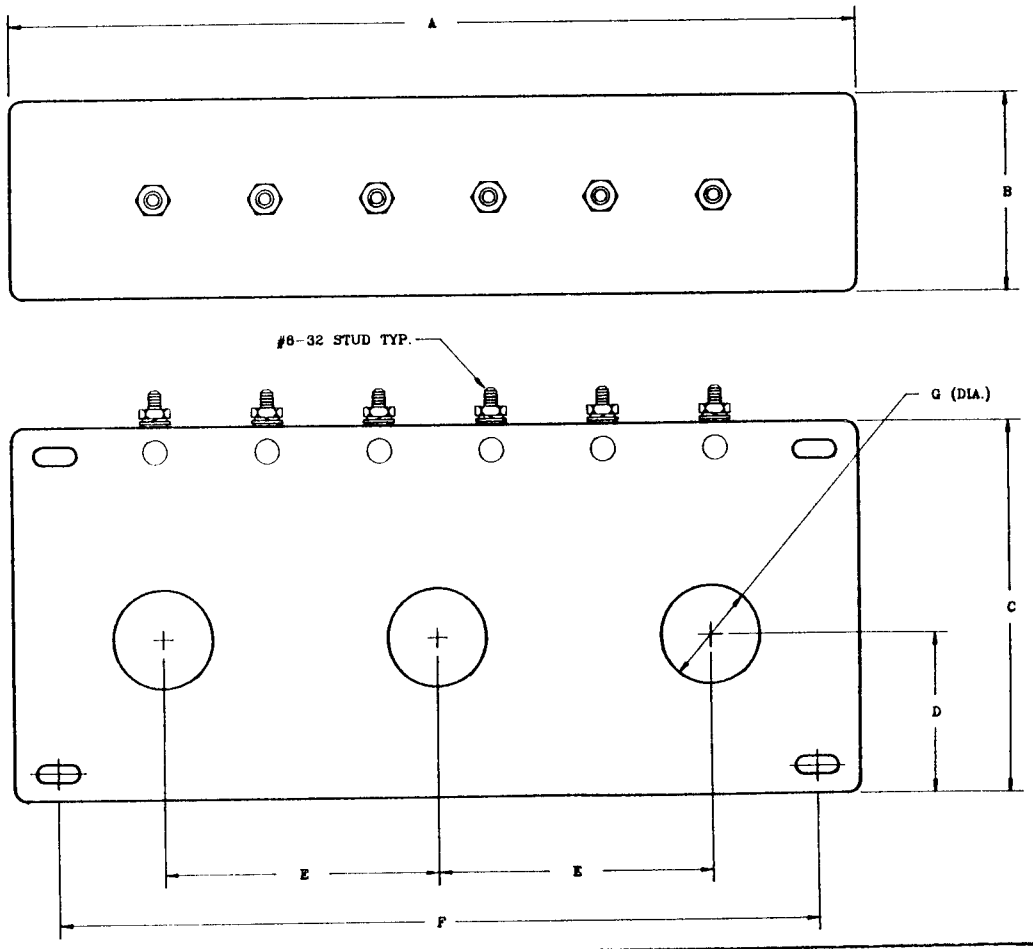
SIZE	CURRENT RANGE		SECONDARY OUTPUT	CATALOG NUMBER
	MIN	MAX	MAXIMUM	
1C	4.8A	24A	177mA	SAMMS 1C CT
2A	10.0A	36A	177mA	SAMMS 2A CT
2B	10.0A	45A	177mA	SAMMS 2B CT

Figure 1-6. SAMMS Size 1C,2A & 2B Current Transformers



SIZE	CURRENT RANGE		SECONDARY OUTPUT	CATALOG NUMBER
	MIN	MAX	MAXIMUM	
3	20.0A	90A	177mA	SAMMS 3 CT
4	40.0A	135A	177mA	SAMMS 4 CT

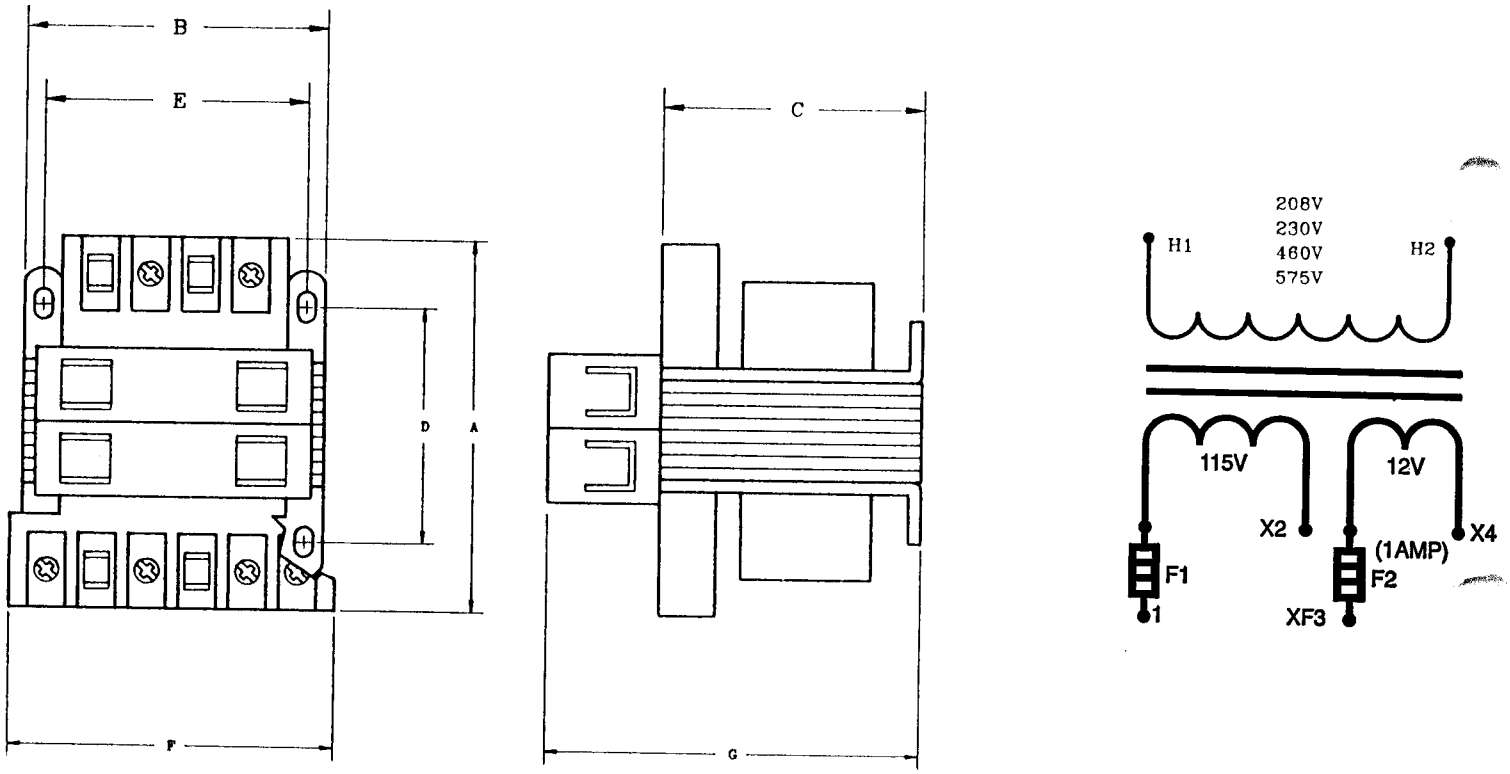
Figure 1-7. SAMMS Size 3 & 4 Current Transformers



DIM	SIZE	
	5	6
A	8.50	12.80
B	2.00	2.63
C	3.75	4.87
D	1.87	2.36
E	2.75	4.00
F	7.60	11.50
G	1.00	1.63

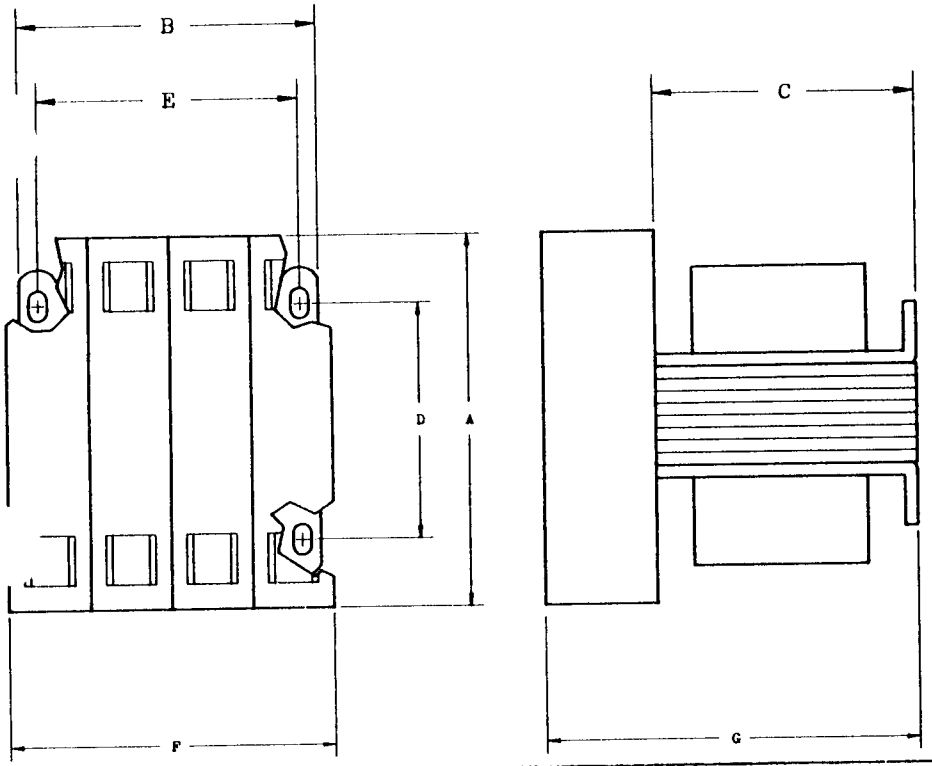
SIZE	CURRENT RANGE		SECONDARY OUTPUT	CATALOG NUMBER
	MIN	MAX	MAXIMUM	
5	80.0A	270A	177mA	SAMMS 5 CT
6	160.0A	540A	177mA	SAMMS 6 CT

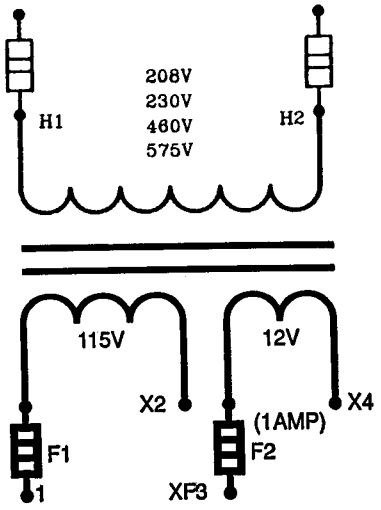
Figure 1-8. SAMMS Size 5 & 6 Current Transformers



SIZE	VA RATING	F1 (AMPS)	DIMENSIONS (INCHES)						
			A	B	C	D	E	F	G
1 & 2	45	.4	3.50	3.00	2.69	2.00	2.50		

Figure 1-9. SAMMS Control Power Transformers Sizes 1&2





SIZE	VA RATING	F1 (AMPS)	DIMENSIONS (INCHES)						
			A	B	C	D	E	F	G
3	100	1	3.88	3.38	2.88	2.38	2.81	3.38	4.13
4	200	2	4.00	4.50	3.75	2.50	3.75	3.38	5.00
5	500	5	5.00	5.25	4.75	4.25	4.38	3.38	5.00
6	750	7	6.50	5.25	4.75	5.75	4.38	3.38	6.00

Figure 1-10. SAMMS Control Power Transformers Sizes 3-6

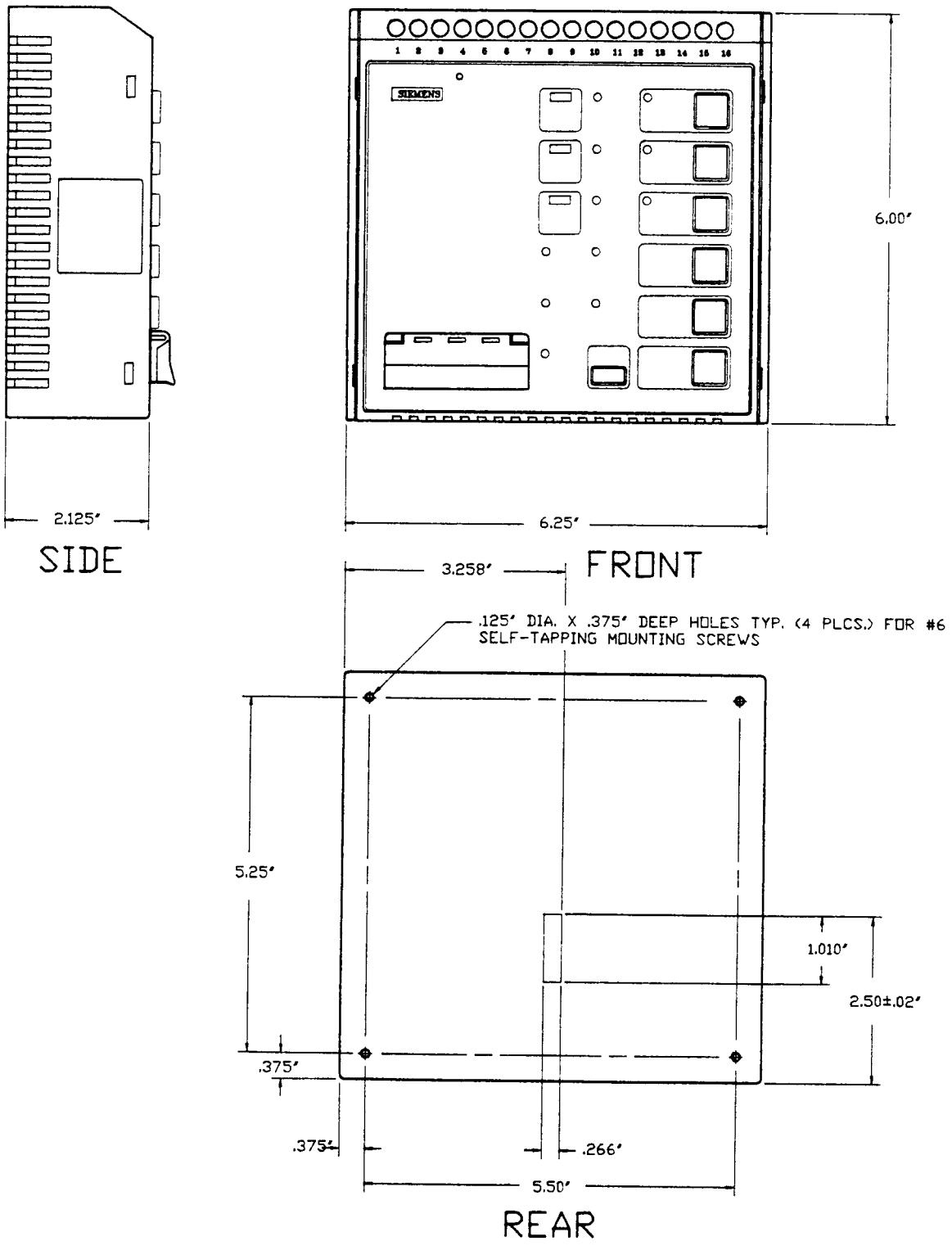
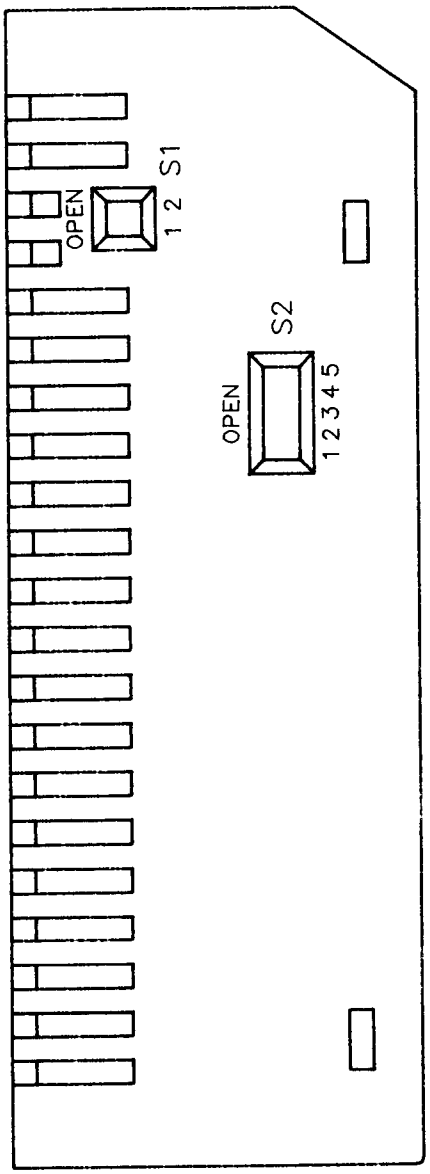


Figure 1-11. Overall Dimensions and Mounting Drawing



SWITCH #	FUNCTION	POSITION
S1 – 1	NORMALLY OPEN	
S1 – 2	NORMALLY CLOSED	
S2 – 1	ANY OF THE BELOW	
S2 – 2	IMPENDING TRIP	
S2 – 3	OVERLOAD TRIP	
S2 – 4	EXTERNAL TRIP	
S2 – 5	GROUND FAULT	

Figure 1-12. SAMMS Alarm Contact Configuration Switches

1.4 SAMMS Technical Specifications

1.4.1 Control Power Specifications

Unit powered by 10.4 VAC (+10%/-15%) supply

Power requirements: 4VA

Control Circuit inputs and outputs are 120 VAC (+10%/-15%)

Maximum output loading allowed for continuous operation:

- One Output Energized - 3.2A
- Two Outputs Energized - 2.2A each
- Three Outputs Energized - 1.5A each
- Input Leakage Current - 5mA

Frequency:

50 Hz: +4%
-5%
60Hz: ±5%

1.5 Motor Control Specifications

1.5.1 Inputs

- 6 Pushbuttons
- 4 Remote inputs

1.5.2 Outputs

- 3 Coil drivers
- 3 Light bars
- 1 Alarm contacts (optional)

1.5.3 Diagnostic LEDs

- Phase unbalance
- Impending trip
- Overload trip
- External trip
- Incomplete sequence
- Ground fault (optional)
- 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

Current Ranges	Overload Relay Size
0.3 - 1.5	1A
1.2 - 6.0	1B
4.8 - 24.0	1C
10.0 - 36.0	2A
10.0 - 45.0	2B*
20.0 - 90.0	3
40.0 - 135.0	4
80.0 - 270.0	5
160.0 - 540.0	6

* Required for 15HP motor at 230 volts only.

1.6 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
Control Relays:	8
Auxiliary contacts:	Software instantaneous contact

ACCESS™ local area network compatible.

ACCESS™ local area network compatible.

Loss of voltage
ridethrough time period:1 second

1.7 Overload Specifications

Overload classes:	Overload classes 2 through 23 with one second increments for SAMMS 3
	Overload Classes 5, 10, 15 and 20 for SAMMS 2
	Overload classes 10 and 20 for SAMMS 1
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 X I_{FLC} for motors with 1.00 service factors and 1.2 + 0.05 X I_{FLC} for motors with 1.15 service factor.
Tripping time:	20 minutes @ 1.15 X I_{FLC}

1.7.1 Mechanical Jam Protection

Sudden increase to twice the value of the motor running current and exceeding 200% of I_{FLC} in 700 milliseconds.

1.7.2 Loss Of Load Protection

Sudden decrease to 50% of motor running current in 700 milliseconds.

1.7.3 Process Current Warning

Settable from 0 to 100% of I_{FLC}

1.7.4 Accuracy

± 5% of overload trip curve values.

1.7.5 Phase Unbalance Protection

- Response time after 1 second
- Shifted trip threshold value at 40% phase unbalance

Motor I_{FLC}	Trip Threshold
0 to 2.5A	1.1 X I_{FLC}
2.6 to 40A	.9 X I_{FLC}
41 to 240A	.8 X I_{FLC}
> 240A	.7 X I_{FLC}

1.7.6 Equipment Ground Fault Protection

Pickup time: 1 second

Pickup current::

Overload Relay Size	Pickup Current
1A	1.5 amps
1b	5.0 amps
1C	5.0 amps
2A	10.0 amps
2b	10.0 amps
3	10.0 amps
4	10.0 amps
5	10.0 amps
6	20.0 amps

1.8 Statistical Data

1.8.1 Elapsed Motor Running Time

- X10
- Range: 0.0 to 6553 (65,536 hours)
- Unit Increments: 10 hours

1.8.2 Number Of Motor Starts

- X10
- Range: 0.0 to 6553 (65,536 starts)
- Unit Increments: 10 operations

1.8.3 Number Of Overload Trips

- Range: 0 to 9999
- Increments: 1 trip

1.8.4 Current Display

Overload Relay Size	Current Increments
1A	0.1A
1b	0.1A
1C	0.1A
2A	1A
2b	1A
3	1A
4	1A
5	1A
6	2A

1.9 Alarm Contacts

1.9.1 Alarm Contacts Configuration

- N.C.
- N.O.

1.9.2 Alarm Contacts Functions

- Any function listed below
- Impending Trip
- Overload Trip
- External Trip
- Ground Fault

1.10 Dimensions

SAMMS: 6.25-inches wide
6.00-inches high
2.125-inches deep

Handheld Communicator: 3.15-inches wide
5.7-inches high
1.37-inches deep

1.11 Environments

Operating temperature range: -25° C to +70° C

Storage Temperature: -40° C 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.

Contents

Figures

Section 2

INSTALLATION

2.1 Receiving

Thoroughly inspect the equipment before accepting shipment from the transportation company. Compare each item received against the packing slip. Report any shortage or damage promptly to the carrier. If any concealed loss or damage is discovered, file a claim immediately with the carrier requesting a complete inspection. Failure to file promptly may prevent you from collecting for the loss or damage. If required, assistance may be requested from the local Siemens office.

2.2 Storage

If the motor controller or the SAMMS unit will not be installed immediately, it should be stored in a clean, dry location at ambient temperatures from -40° C to 85° C. The surrounding air must be free of corrosive fumes or electrically conductive contaminants. Care must be taken to prevent condensation from forming within the equipment enclosure during storage.

⚠ CAUTION

Improper storage can cause equipment damage. Follow all storage instructions carefully. Failure to follow storage instructions will void warranty.

2.3 Installation Location and Mounting

The SAMMS unit and its associated devices are suitable for location in most industrial equipment environments. Unless designed for specific requirements and so stated in the purchase order documents, the SAMMS and its associated controller should be installed in an area where the following conditions exist:

- Ambient air must be free of dirt, combustible vapor, steam, electrically conductive or corrosive material.
- Clearance around the controller must be sufficient to provide access to the equipment for inspection and maintenance.

2.4 Wiring

2.4.1 General

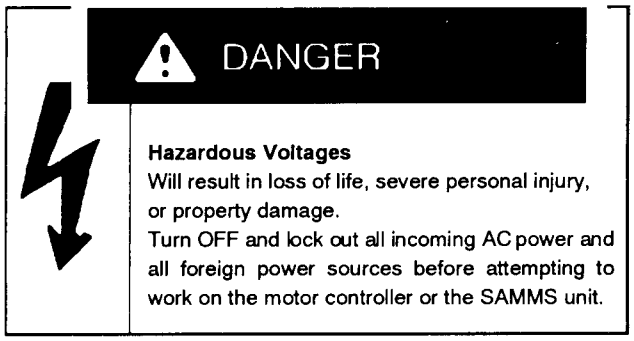
This section describes the general wiring and routing procedure as well as grounding to be followed when installing the SAMMS unit and its peripheral devices in a motor controller and in connecting the controller to the motor and its related machines.

The information listed here builds on other sections in this manual and will be unnecessarily difficult unless they are read first.

2.4.2 Schematic Diagram

When a SAMMS equipped motor controller is supplied by Siemens, the wiring between the SAMMS unit and the peripheral devices in the motor controller is factory installed. The schematic diagram includes the connection diagram between the SAMMS and its peripheral devices, the ladder diagram of the control circuit loaded to the SAMMS unit, and the equivalent electromechanical wiring diagram. A typical SAMMS connection diagram is shown in Figure 2-1.

When the motor controller is not supplied by Siemens, an equivalent electrical scheme should be developed by the original equipment manufacturer or retrofitter.



2.4.3 Wiring Guidelines

The following guidelines must be observed when installing the SAMMS unit and connecting it with its associated peripheral devices or machine. **Failure to follow these guidelines can cause pickup of unwanted signals resulting in erratic operation and damage to the SAMMS device.**

Guideline 1 Separate the low-voltage (115 VAC or less) from the high-voltage (460 VAC or higher) conductors as much as possible. If the low-voltage and the high-voltage wires must cross path, make sure the intersection is made at a right angle.

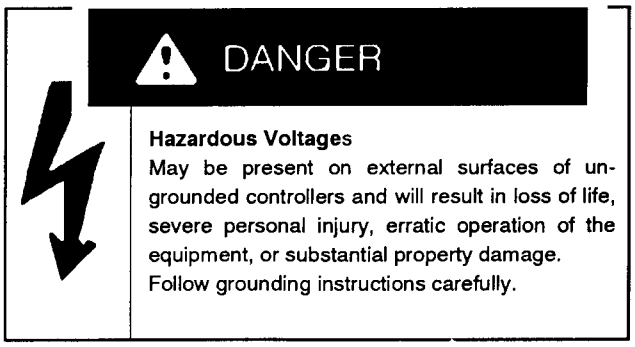
Guideline 2 To eliminate noise coupling, twist the connecting wires as shown in Figure 2-1. All twisted pairs or wrap wires should be constructed in such a way that a complete twist or wrap occurs every 2 inches.

Guideline 3 Place the low-voltage leads near the controller chassis.

Guideline 4 Any low-voltage control wiring routed outside the motor controller enclosure should be at least AWG No. 14 stranded copper wire.

Guideline 5 To avoid ground loops, each motor controller should be grounded at a single ground point. The grounding path to earth must be:

- permanent
- continuous
- able to safely conduct ground fault currents that may occur in the system to ground through minimum impedance.
- not carring any current under normal conditions.



Connect a ground bus to the chassis of each controller, or to the chassis of a vertical section containing the grounding electrode system (earth ground) through a grounding electrode conductor.

Refer to Article 250 of the *National Electrical Code* for information about the types and sizes of wire conductors and methods for safely grounding electrical equipment and components.

Figures 2-2 through 2-6 show an actual example of the wiring practices used by the factory in wiring a NEMA size 1 FVR motor control center unit.

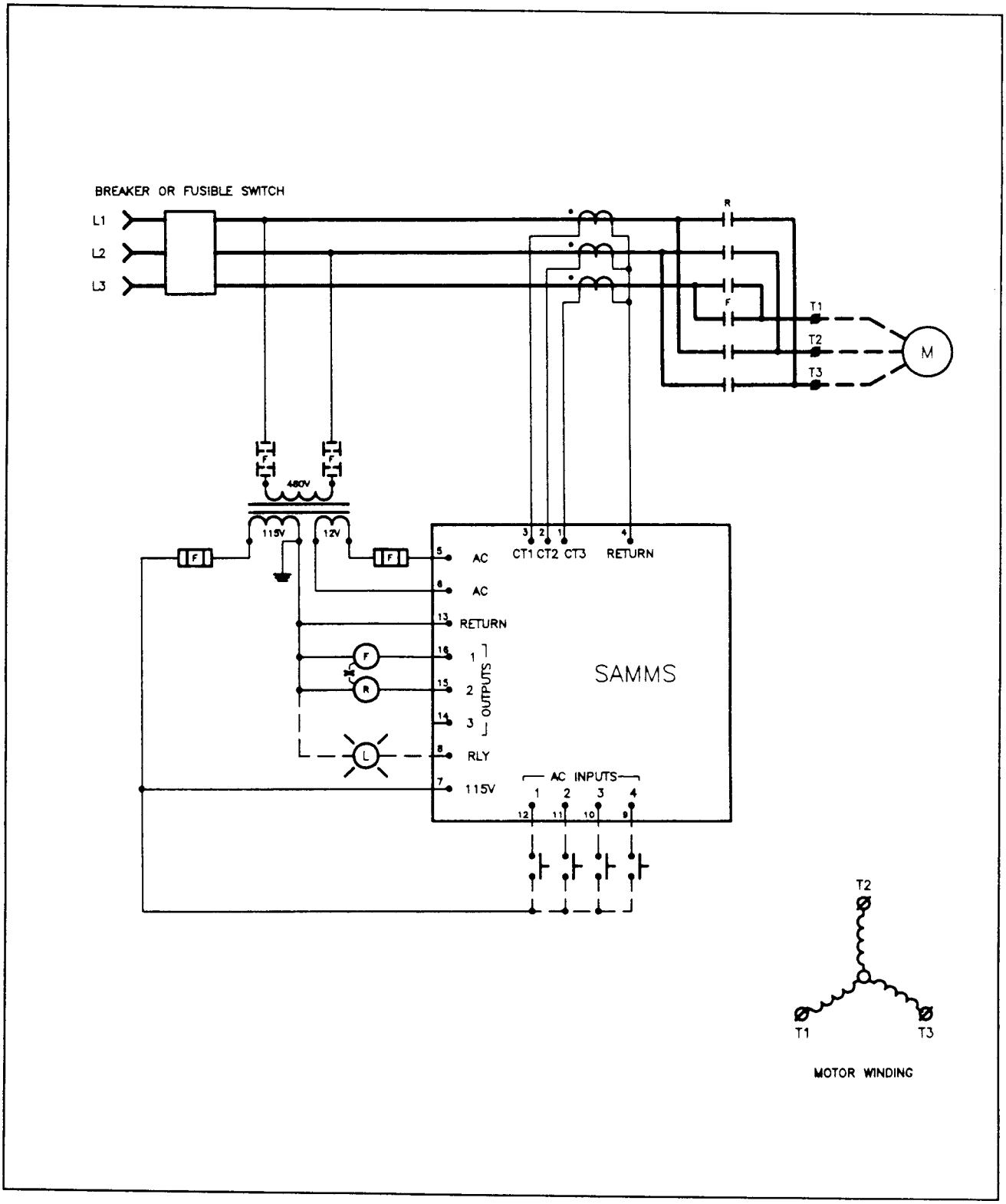


Figure 2-1. SAMMS Connection Diagram
Full Voltage Reversible

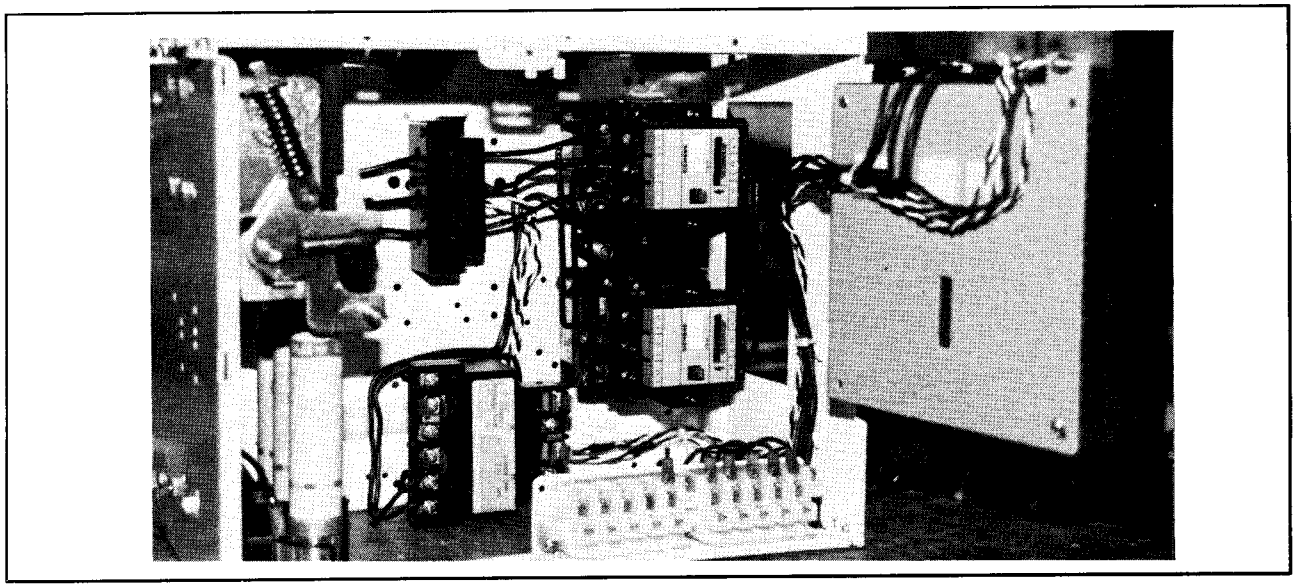


Figure 2-2. Current Transformer Wiring

1. Current Transformer and SAMMS Remote Input Power Wiring are shown. Each Current Transformer signal wire is twisted with its respective common wire (black & white wires). All input wires to the SAMMS are shown routed from customer terminal block.

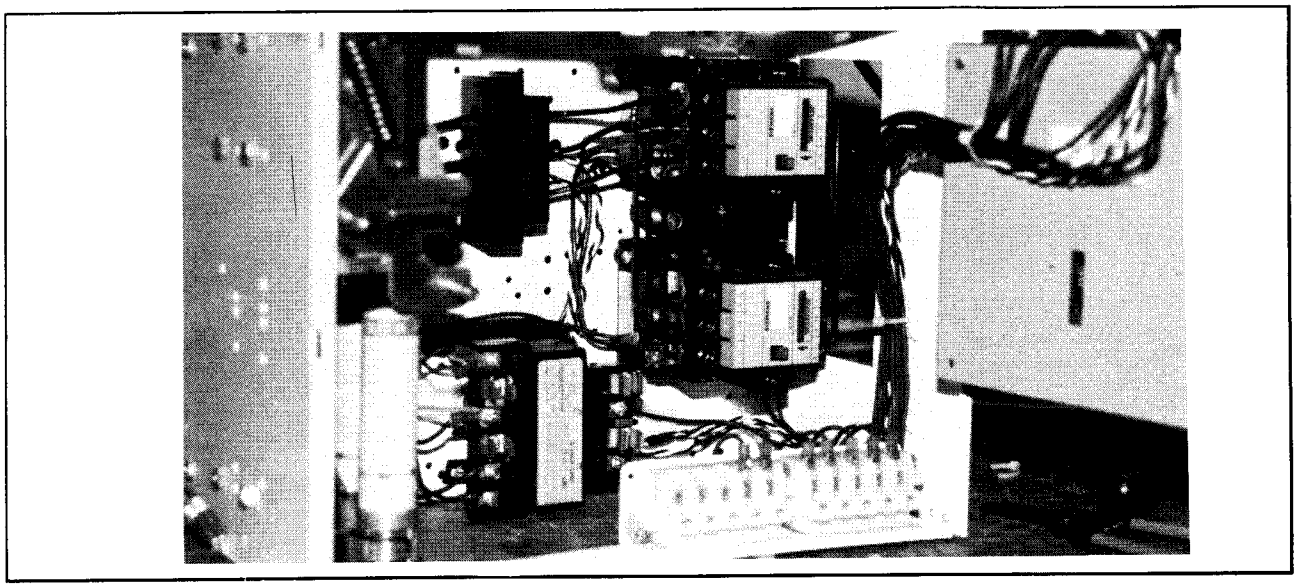


Figure 2-3. Contactor Coil Wiring

2. Contactor coil wires are run parallel and as close together and to the chassis of the controller as possible. Also route as far away from 460V lines as possible. If necessary, cross 460V lines only at right angles.

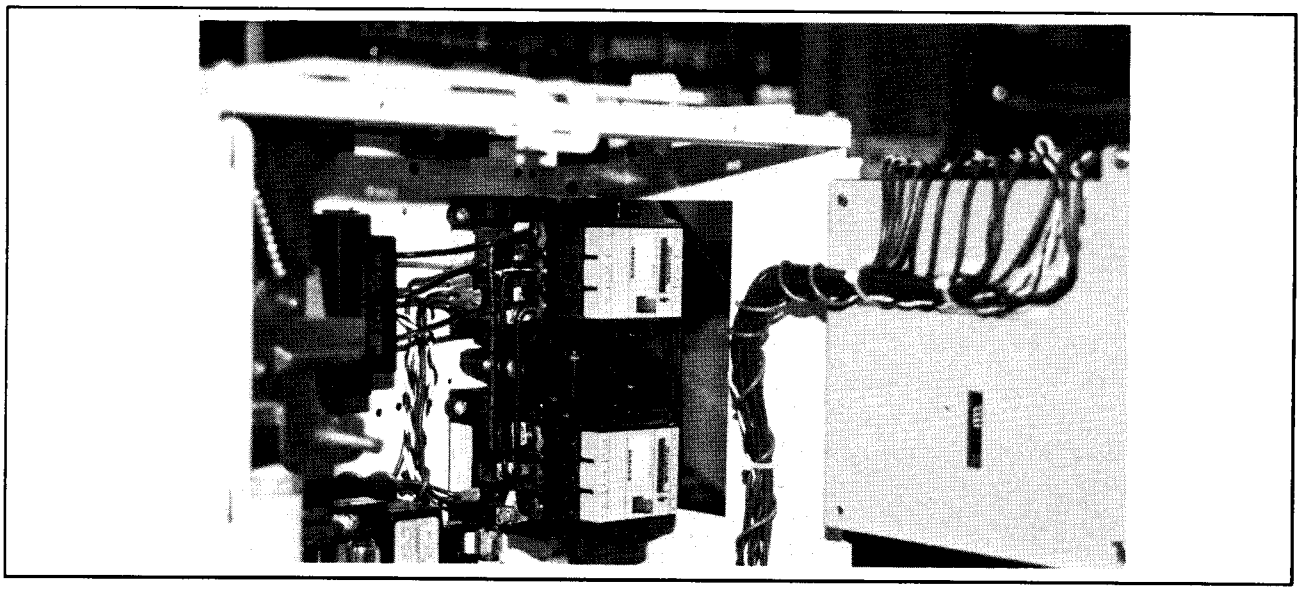


Figure 2-4. Ground Wire Connection

3. Different view of ground wrapped around wire bundle. Note Current Transformer twisted pairs (black & white), and 12V control power transformer wires.

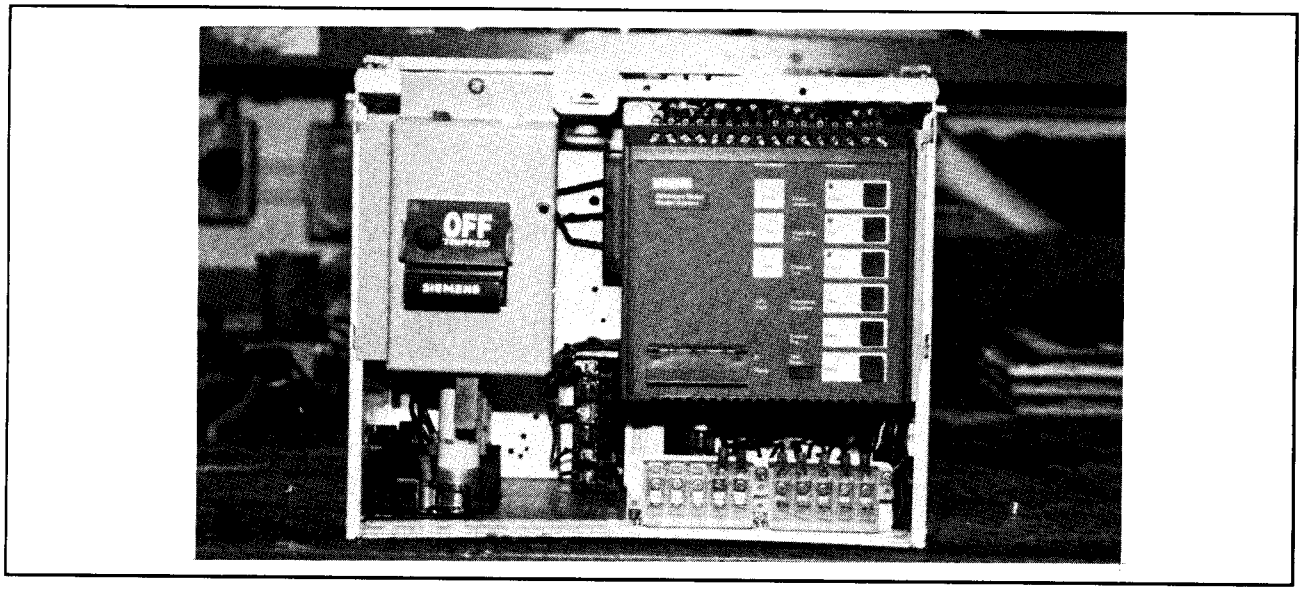


Figure 2-5. Overall View of Finished Controller

Finished SAMMS unit assembled and wired in 12-inch high motor control center unit.

Contents

Figures

Page

Tables

Section 3

OPERATION

3.1 Test/Reset Pushbutton

The Test/Reset pushbutton at the bottom center of the front panel of the SAMMS (Figure 3-1) is used to manually reset the SAMMS after a fault or a trip condition so that the motor can be restarted. The button may also be used to perform an overload relay test or a lamp test.

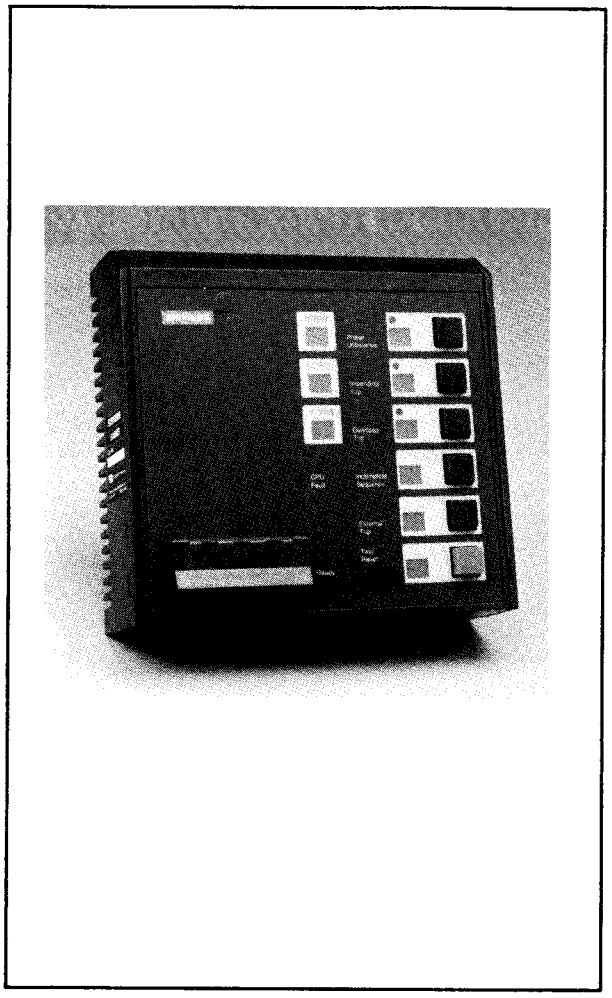


Figure 3-1. SAMMS Front View

3.2 Using the Test/Reset Button

3.2.1 Lamp Test

The diagnostic LEDs and the control LEDs and light bars on the front panel of the SAMMS are tested by the lamp test.

To perform a lamp test:

1. Press the Test/Reset pushbutton for one or two seconds.
2. Upon the release of the button, all the LEDs and light bars on the front panel are illuminated for two seconds.
3. If a fault or trip condition exists when the button is pressed, a reset rather than a lamp test is performed.

3.2.2 Overload Relay Test

An overload relay test can be performed whenever the motor is stopped.

To perform an overload relay test:

1. Press the Test/Reset pushbutton and maintain it for at least the class time set by HHC function F7. (If the button is released after being maintained for less than the class time, a lamp test is performed if no fault condition exists or a reset occurs in the event of a fault condition.)
2. When the class time is reached, the Overload Trip LED is illuminated as long as the Test/Reset button is depressed.
3. Release the button.
4. The Overload Trip LED goes off, and the Impending Trip LED and the Phase Unbalance LED are illuminated for two seconds.

5. If the SAMMS is tripped, it is automatically reset at the end of the overload relay test.

Overload Reset

To reset the SAMMS after a trip event:

1. Press the Test/Reset button.
2. Release the button
3. The alarm LEDs are reset and the motor can be restarted.

3.3 Motor Control

SAMMS can be configured to perform many motor starting and control functions -- from basic across-the-line to more complicated reversing, two-speed, and reduced-voltage starting. Executable code representing the ladder diagram for the user's control application is stored in the SAMMS memory. The conventional control logic defined by the wired interconnection of electromechanical timers, control relays, pushbuttons, selector switches, and pilot lights is replaced by the SAMMS unit and ladder diagram code. The SAMMS library of more than 70 standard ladder diagrams covers most applications. In addition to the standard ladders, custom ladder diagrams can be constructed to handle special applications.

3.4 Ladder Diagram Symbols

Symbols representing the input and output devices available in SAMMS are given in Figures 3-2 and 3-3. The circular symbols represent output devices such as contactor coil drivers, pilot LEDs on the front panel of the SAMMS, software time-delay relays, and software control relays. All other symbols represent input devices such as software auxiliary contacts, remote ac inputs, front-panel pushbuttons, and software timer instantaneous and timed contacts.

3.5 Output Devices

SAMMS has the following output devices available for the user:

1. **AC outputs** - Up to three ac coil drivers capable of driving contactors up to size 6 are available in the SAMMS.
2. **Control relays** - Eight software control relays are available and are especially helpful in local two-wire and other applications requiring maintained contacts.
3. **Timing relays** - Four software timing relays are available. All four of the timers can be configured as on-delay timers; only the two adjustable timers can be configured as either on-delay or off-delay timers. Timing relays TR1 and TR2 are the adjustable timers. Their delays can be set by the Handheld Communicator for any delay from 0 through 200 seconds. Timing relay TR3 is fixed for a 30 seconds delay; timing relay TR4 is fixed for a 1 second delay.

Timer	Type	Time
TR1	Programmable on-/off-delay	0 - 200 seconds
TR2	Programmable on-/off-delay	0 - 200 seconds
TR3	Fixed on-delay	1 second
TR4	Fixed on-delay	30 seconds

4. **Pilot LEDs** - Three light bars on the front panel of the SAMMS are available. Light bar L1 is reserved and must be used as the STOP or OFF LED. Light bars L2 and L3 can be configured at the user's discretion. Hand/Off/Auto LEDs corresponding to the Hand/Off/Auto pushbuttons on the front panel are also available. The Incomplete Sequence LED is also available for use in reduced-voltage applications or to verify contactor operation. (See Figure 3-4.)
5. **Flashing pilot LEDs** - Three flashing light bars are available to indicate various conditions, such as on-delay timing. In actuality, light bars L1-L3 are the flashing LEDs, but they are treated as different output devices for a flashing condition than for a constantly ON condition.

3.6 Input Devices

1. **Remote ac inputs** - Four remote ac inputs are available for remote control or auxiliary contacts.

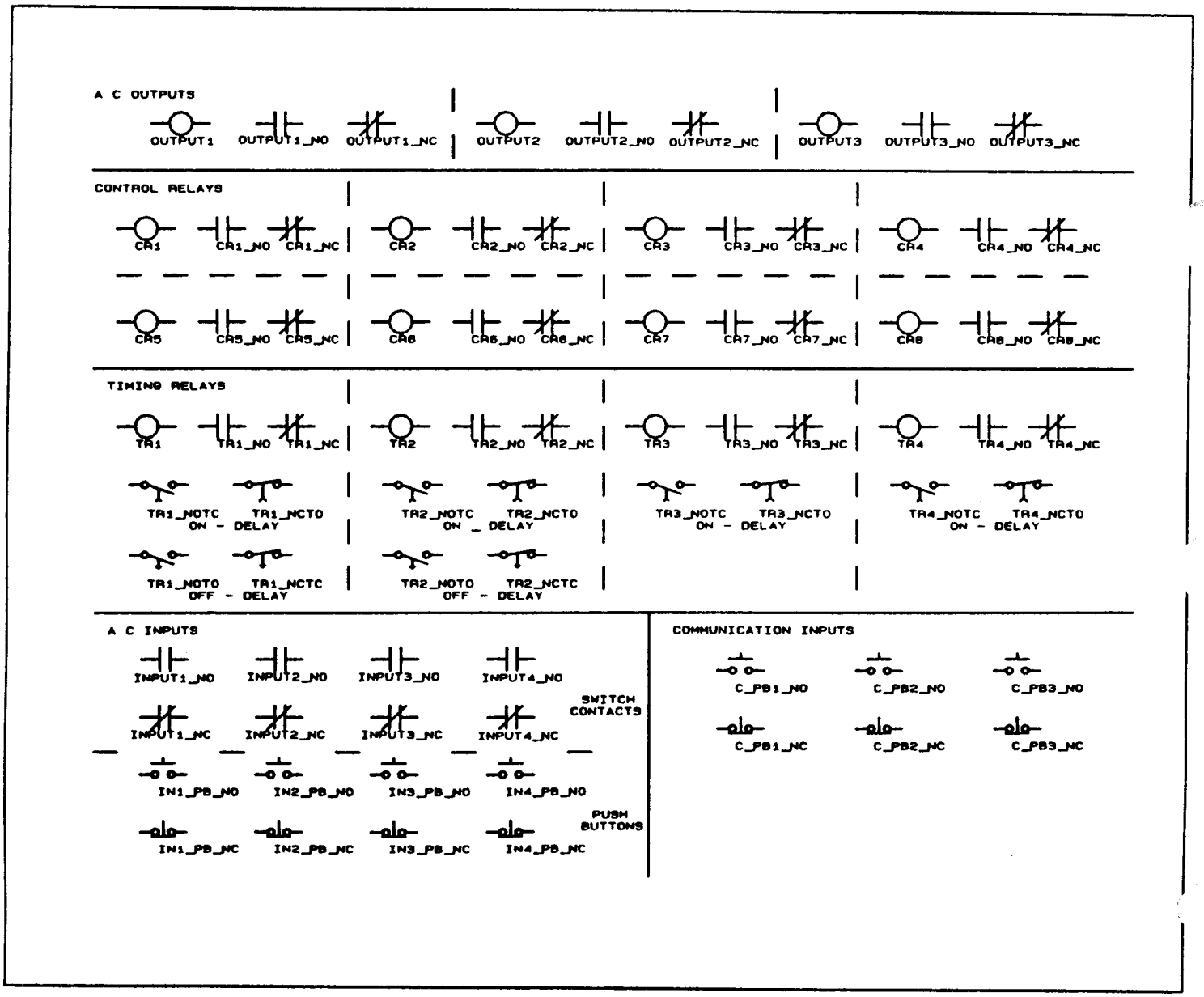


Figure 3-2. Ladder Symbols Part 1

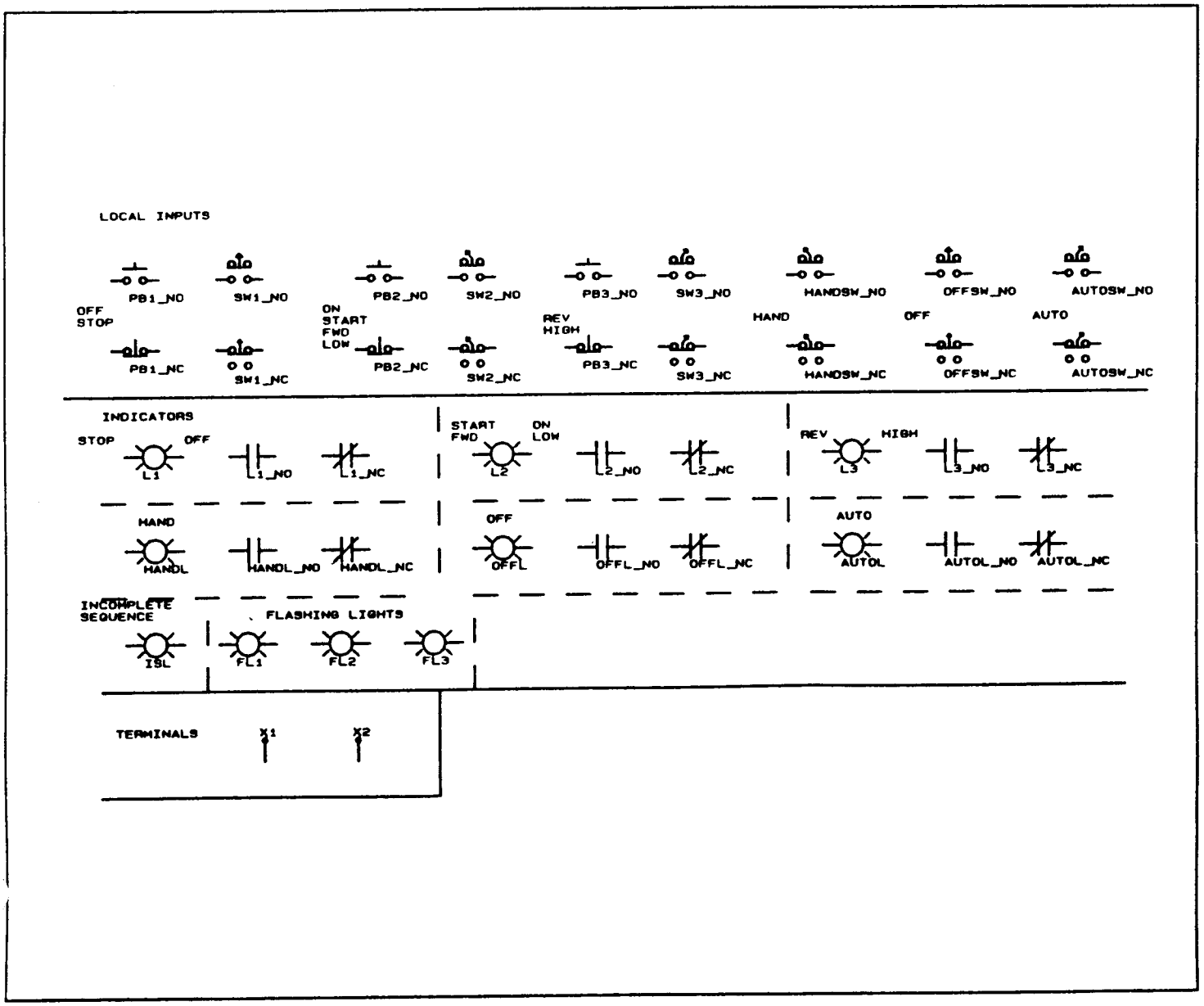


Figure 3-3. Ladder Symbols Part 2

2. **Front panel pushbuttons** - Six front-panel pushbuttons are available on the SAMMS for local control. Pushbutton PB1 must be used for stopping the motor. Three of the pushbuttons (PB4-PB6) must be used for the Hand/Off/Auto function, if applicable. The other two pushbuttons (PB2-PB3) can be configured at the user's discretion. (See Figure 3-4.)
3. **Software auxiliary contacts** - Any number of internal auxiliary normally-open (NO) or normally-closed (NC) contacts associated with each of the output devices are available. Through the SAMMS software, even the pilot LEDs have auxiliary contacts.
4. **Software timer inputs** - Each timer has an unlimited number of normally-open and normally-closed instantaneous contacts. Timers configured as on-delay timers have an unlimited supply of normally-open, timed-closed (NOTC) and normally-closed, timed-open (NCTO) contacts. Timers configured as off-delay timers have an unlimited supply of normally-open, timed-open (NOTO) and normally-closed, time-closed (NCTC) contacts.
5. **Communications inputs** - For special control applications, the SAMMS front-panel pushbuttons can be duplicated by inputs over the serial communications link. Input pushbutton devices representing serial inputs are among the ladder devices.

3.7 Library Of Standard Ladder Diagrams

The SAMMS library of more than 70 ladder diagrams covers most standard motor control applications. Table 3-1 (page 3-12) is a chart of the input and output assignments for the library of standard ladder diagrams. The library encompasses the following starter types:

- 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 (Sizes 2 Through 4)
- Reduced-voltage, Autotransformer (Sizes 5 and 6)
- Wye-delta, Open-transition
- Wye-delta, Closed-transition
- Full-voltage, Part-winding

For each starter type, the library includes seven control types:

- Local Two-wire
- Local Three-wire
- Local Three-wire, Remote Two-wire
- Local Two-wire, Remote Two-wire
- Local Three-wire, Remote Three-wire
- Remote Two-wire
- Remote Three-wire

The *SAMMS Standard Circuit Manual* is available for details on the library of standard ladder diagrams.

3.7.1 Custom Ladder Diagrams

For special motor control applications not covered by the library of standard ladders, custom ladders can be constructed using the SAMMS input and output devices and their associated symbols. Either Siemens can build custom ladders for the user's application or the user can design his own. For the user, an optional IBM-compatible software package can be purchased to develop custom ladder diagrams for special control applications. The package also includes the library of standard ladders. The software package also enables the user to reconfigure existing SAMMS units to meet changing plant needs. Details for constructing custom ladders and reconfiguring SAMMS units are given in the *SAMMS Custom Software Manual.*

3.8 Incomplete Sequence

Sometimes the motor contactors do not respond in a timely manner to start, stop, transition, speed or direction change commands from the controller. If the SAMMS does not detect motor current one second after

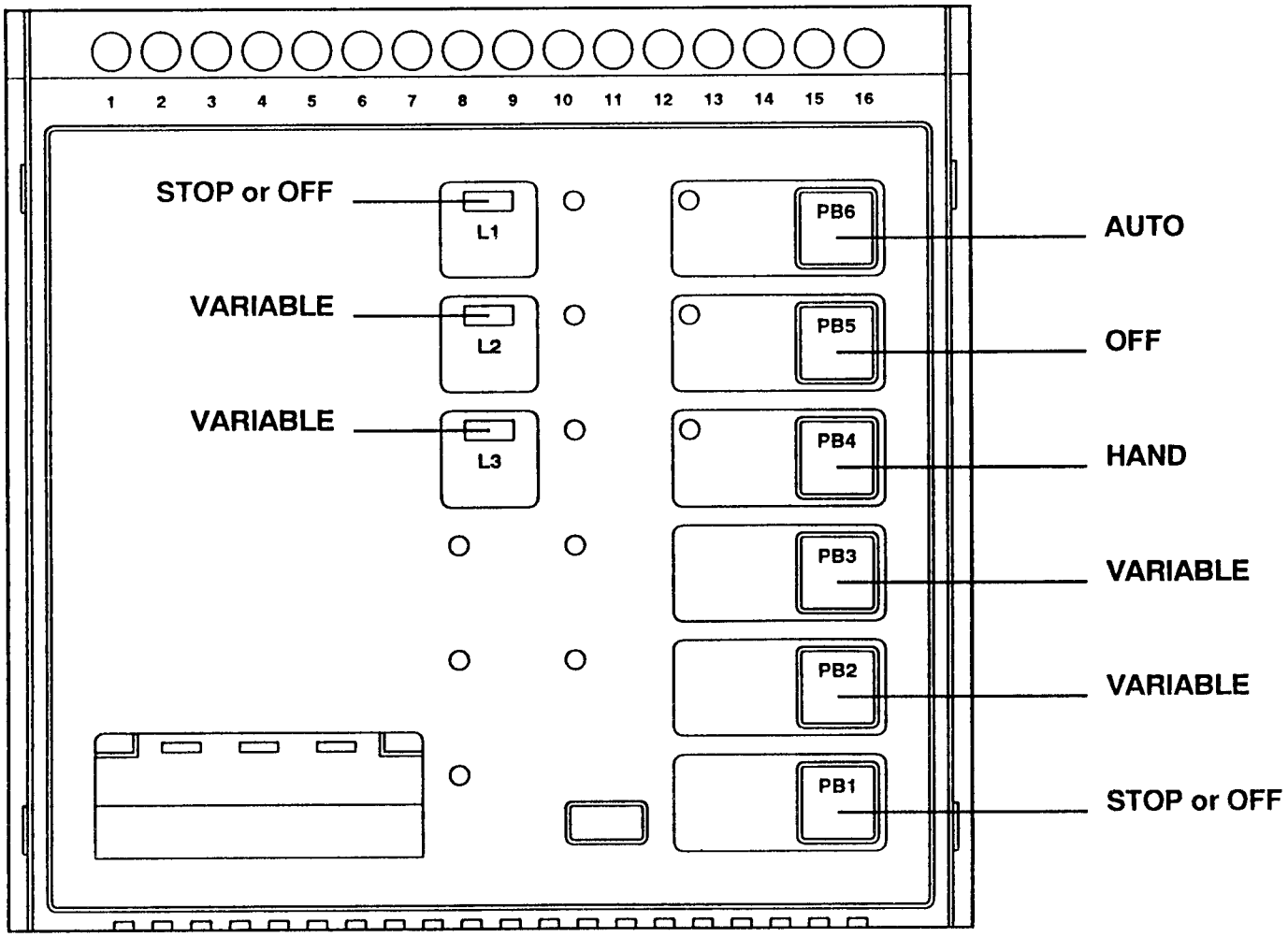
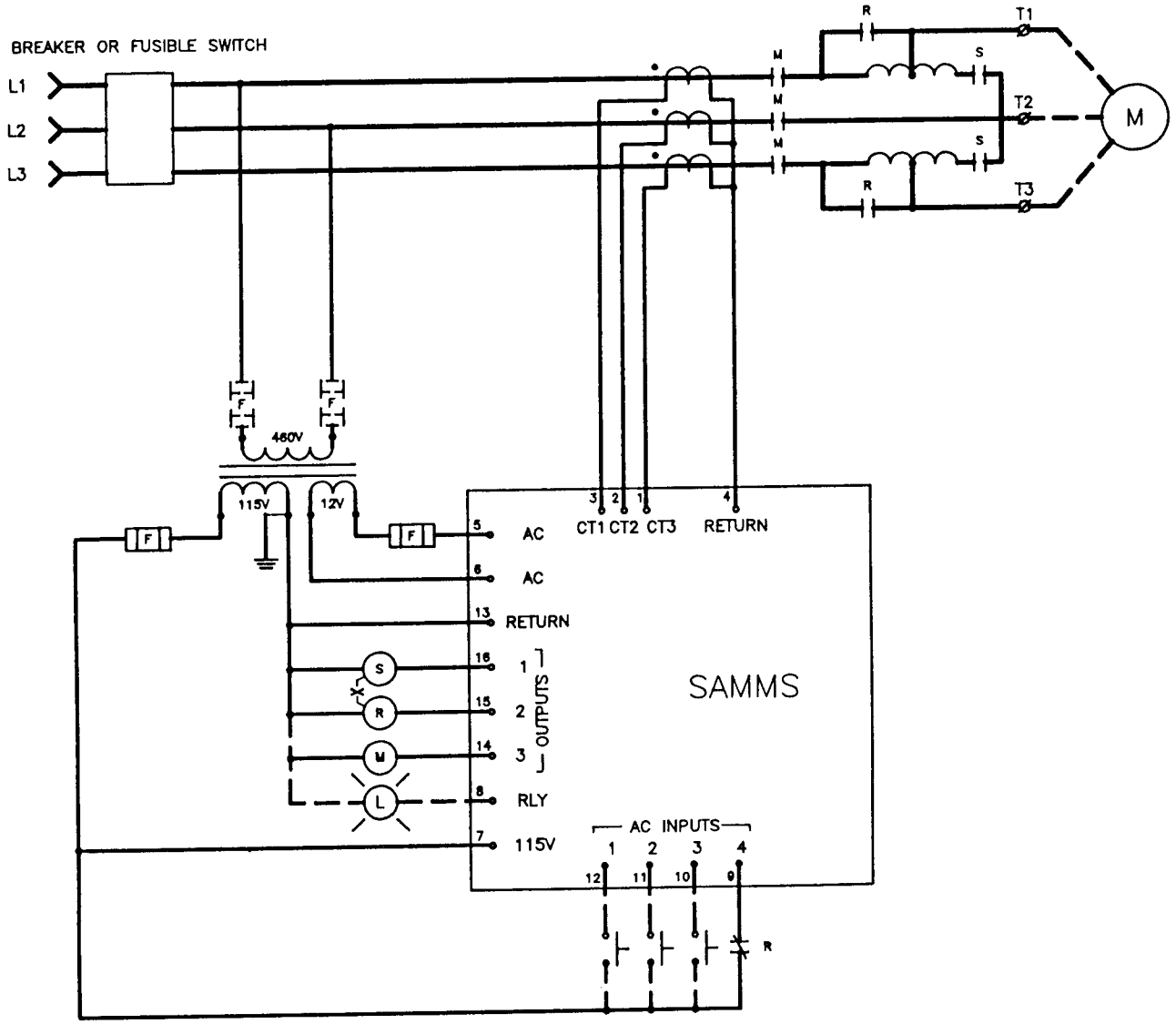


Figure 3-4. Assignment of Pushbuttons and Light Bars

Table 3-1. Standard Circuit Diagrams

STARTER TYPE	PROG BLK	CONTROL TYPE	INPUT ASSIGNMENTS:					
			PB1	PB2	PB3	PB4	PB5	PB6
FVNR	PB10	LOCAL 2-WIRE	OFF	ON				
FVNR	PB11	LOCAL 3-WIRE	STOP	START				
FVNR	PB12	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	START		HAND	OFF	AUTO
FVNR	PB13	LOCAL/REMOTE 2-WIRE	STOP			HAND	OFF	AUTO
FVNR	PB14	LOCAL/REMOTE 3-WIRE	STOP	START				
FVNR	PB15	REMOTE 2-WIRE						
FVNR	PB16	REMOTE 3-WIRE						
FVR	PB17	LOCAL 2-WIRE	OFF	FWD	REV			
FVR	PB18	LOCAL 3-WIRE	STOP	FWD	REV			
FVR	PB19	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	FWD	REV	HAND	OFF	AUTO
FVR	PB20	LOCAL/REMOTE 2-WIRE	STOP	FWD	REV	HAND	OFF	AUTO
FVR	PB21	LOCAL/REMOTE 3-WIRE	STOP	FWD	REV			
FVR	PB22	REMOTE 2-WIRE						
FVR	PB23	REMOTE 3-WIRE						
FVR	PB24	LOCAL/REMOTE 3-WIRE, ELECTRICALLY INTERLOCKED	STOP	FWD	REV			
2SPD, 2W	PB25	LOCAL 2-WIRE	OFF	LOW	HIGH			
2SPD, 2W	PB26	LOCAL 3-WIRE	STOP	LOW	HIGH			
2SPD, 2W	PB27	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	LOW	HIGH	HAND	OFF	AUTO
2SPD, 2W	PB28	LOCAL/REMOTE 2-WIRE	STOP	LOW	HIGH	HAND	OFF	AUTO
2SPD, 2W	PB29	LOCAL/REMOTE 3-WIRE	STOP	LOW	HIGH			
2SPD, 2W	PB30	REMOTE 2-WIRE						
2SPD, 2W	PB31	REMOTE 3-WIRE						
2SPD, 1W, CT OR VT	PB32	LOCAL 2-WIRE	OFF	LOW	HIGH			
2SPD, 1W, CT OR VT	PB33	LOCAL 3-WIRE	STOP	LOW	HIGH			
2SPD, 1W, CT OR VT	PB34	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	LOW	HIGH	HAND	OFF	AUTO
2SPD, 1W, CT OR VT	PB35	LOCAL/REMOTE 2-WIRE	STOP	LOW	HIGH	HAND	OFF	AUTO
2SPD, 1W, CT OR VT	PB36	LOCAL/REMOTE 3-WIRE	STOP	LOW	HIGH			
2SPD, 1W, CT OR VT	PB37	REMOTE 2-WIRE						
2SPD, 1W, CT OR VT	PB38	REMOTE 3-WIRE						
2SPD, 1W, CH	PB39	LOCAL 2-WIRE	OFF	LOW	HIGH			
2SPD, 1W, CH	PB40	LOCAL 3-WIRE	STOP	LOW	HIGH			
2SPD, 1W, CH	PB41	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	LOW	HIGH	HAND	OFF	AUTO
2SPD, 1W, CH	PB42	LOCAL/REMOTE 2-WIRE	STOP	LOW	HIGH	HAND	OFF	AUTO
2SPD, 1W, CH	PB43	LOCAL/REMOTE 3-WIRE	STOP	LOW	HIGH			
2SPD, 1W, CH	PB44	REMOTE 2-WIRE						
2SPD, 1W, CH	PB45	REMOTE 3-WIRE						
RVA, SIZES 2,3,&4	PB46	LOCAL 2-WIRE	OFF	ON				
RVA, SIZES 2,3,&4	PB47	LOCAL 3-WIRE	STOP	START				
RVA, SIZES 2,3,&4	PB48	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	START		HAND	OFF	AUTO
RVA, SIZES 2,3,&4	PB49	LOCAL/REMOTE 2-WIRE	STOP			HAND	OFF	AUTO
RVA, SIZES 2,3,&4	PB50	LOCAL/REMOTE 3-WIRE	STOP	START				
RVA, SIZES 2,3,&4	PB51	REMOTE 2-WIRE						
RVA, SIZES 2,3,&4	PB52	REMOTE 3-WIRE						
RVA, SIZES 5, & 6	PB53	LOCAL 2-WIRE	OFF	ON				
RVA, SIZES 5, & 6	PB54	LOCAL 3-WIRE	STOP	START				
RVA, SIZES 5, & 6	PB55	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	START		HAND	OFF	AUTO
RVA, SIZES 5, & 6	PB56	LOCAL/REMOTE 2-WIRE	STOP			HAND	OFF	AUTO
RVA, SIZES 5, & 6	PB57	LOCAL/REMOTE 3-WIRE	STOP	START				
RVA, SIZES 5, & 6	PB58	REMOTE 2-WIRE						
RVA, SIZES 5, & 6	PB59	REMOTE 3-WIRE						
YDC	PB60	LOCAL 2-WIRE	OFF	ON				
YDC	PB61	LOCAL 3-WIRE	STOP	START				
YDC	PB62	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	START		HAND	OFF	AUTO
YDC	PB63	LOCAL/REMOTE 2-WIRE	STOP			HAND	OFF	AUTO
YDC	PB64	LOCAL/REMOTE 3-WIRE	STOP	START				
YDC	PB65	REMOTE 2-WIRE						
YDC	PB66	REMOTE 3-WIRE						
YDO	PB67	LOCAL 2-WIRE	OFF	ON				
YDO	PB68	LOCAL 3-WIRE	STOP	START				
YDO	PB69	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	START		HAND	OFF	AUTO
YDO	PB70	LOCAL/REMOTE 2-WIRE	STOP			HAND	OFF	AUTO
YDO	PB71	LOCAL/REMOTE 3-WIRE	STOP	START				
YDO	PB72	REMOTE 2-WIRE						
YDO	PB73	REMOTE 3-WIRE						
PW	PB74	LOCAL 2-WIRE	OFF	ON				
PW	PB75	LOCAL 3-WIRE	STOP	START				
PW	PB76	LOCAL 3-WIRE, REMOTE 2-WIRE	STOP	START		HAND	OFF	AUTO
PW	PB77	LOCAL/REMOTE 2-WIRE	STOP			HAND	OFF	AUTO
PW	PB78	LOCAL/REMOTE 3-WIRE	STOP	START				
PW	PB79	REMOTE 2-WIRE						
PW	PB80	REMOTE 3-WIRE						



CONTACTOR SEQUENCE

CONTACTOR	START	TRANSITION	RUN
M	X	X	X
S	X		
R			X

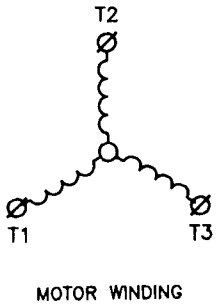


Figure 3-5. Connection Diagram for Reduced Voltage Autotransformer

after issuing a start command or if the SAMMS detects motor current one second after issuing a stop command, an Incomplete Sequence trip results. The motor contactors are opened and the Incomplete Sequence LED is illuminated solidly. In standard reduced-voltage autotransformer (RVA) and wye-delta, closed-transition starters, an incomplete sequence trip also occurs if the remote RUN seal-in contact wired to TB1 2pin 9 does not close within one second of the transition from starting to full-speed operation. This function can be disabled permanently when the device is configured at the factory, or it can be temporarily disabled by inserting the Handheld Communicator into the SAMMS device, using the FUNCTION, UP, DOWN buttons to select F1, then pressing the ENTER button for a period of one second.

3.9 Intelligent Reduced-Voltage Starting

Intelligent reduced-voltage starting is provided in all standard reduced-voltage autotransformer (RVA) and wye-delta, closed-transition starters. The advantage of this feature is that the transition from reduced to full voltage is determined by the magnitude of the actual motor current and not by a timer. In this way, the transition is optimized.

When a motor with intelligent reduced-voltage starting is started, a 30 second timer is energized. If the timer times out, the transition to full voltage commences as a fail-safe. If, before the 30 second timer times out, the motor current drops to below the full-load current setting, the transition commences.

The state of the RUN contactor, whose auxiliary contact is connected to Remote input 4 (TB1 pin 9), is checked one second after the transition. If the contactor is not closed, an incomplete sequence trip occurs. See Figure 3-5.

3.10 Ridethrough Upon Loss Of Power

If a motor is running and control power is lost, the motor restarts automatically with two-wire control as soon as power is restored. With three-wire control, however, the motor normally must be restarted manually. The optional ridethrough feature available with SAMMS allows three-wire controls to ride through power outages of up to one second. The feature is especially useful where the power system is subject to momentary interruptions. If, while the motor is running, power is lost to a three-wire control having the ridethrough option, the contactors are opened to prevent chattering and then reclosed automatically if power returns within one second.

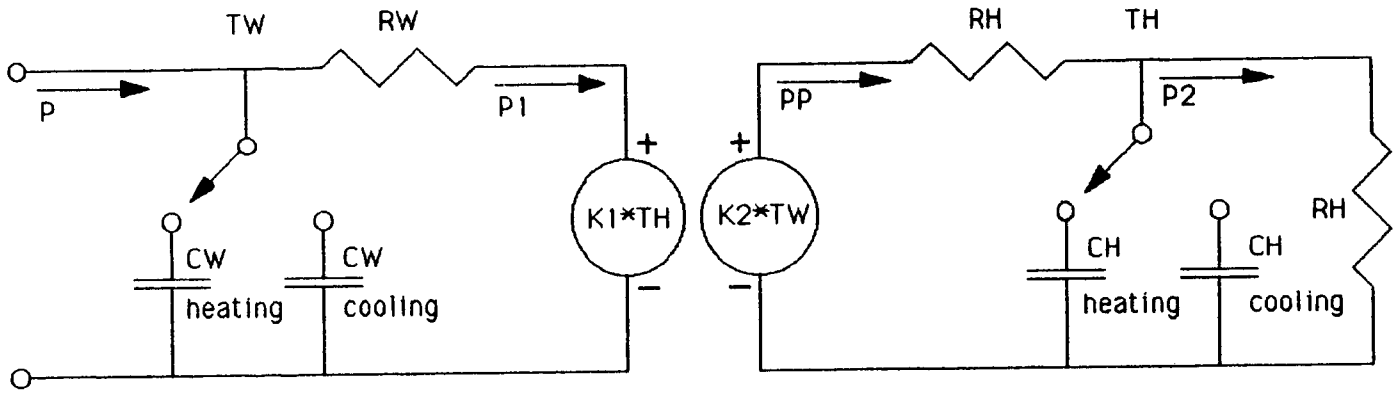
3.11 Overload Protection

The motor overload protection function is based on calculating the motor's winding and housing temperatures, using a digital simulation of the response of a two capacitor, two resistor electric circuit to emulate the thermal signature of the motor. See Figure 3-6.

These motor winding and housing temperatures are based on the motor load and time. These temperatures are compared to the allowable motor's winding or housing temperature rise under running overload conditions and to the maximum temperature limit allowed by the overload class selected under transient overload conditions. Based on this comparison, the motor is either stopped or allowed to run.

For example, the motor winding temperature is shown in Figure 3-7 for an assumed scenario, where the motor is started and run for a period of approximately 1000 seconds, then the motor is subjected to a running overload condition raising the winding temperature to the maximum allowable winding temperature resulting in an overload trip. At this temperature, the motor will not be allowed to start until the motor winding temperature is cooled down to the full load temperature. For a 10A motor, that will take approximately 500 seconds. The motor can then be started and run at full-load current.

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 by means of a mathematical function that depends on the ratio of the rms current to the full-load current set for the motor. 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 cases, on nameplate data entered for the particular motor being protected. Thus, unlike the method of protection in conventional overload relays, the motor model is



P	Input heat flow
CW	Winding capacitance
TW	Winding temperature
RW	Winding resistance
K1*TH	Housing temperature generator

PP	Input heat flow
CH	Housing capacitance
TH	Housing temperature
RH	Housing resistance
K2*TW	Winding temperature generator

Figure 3-6. Motor Model

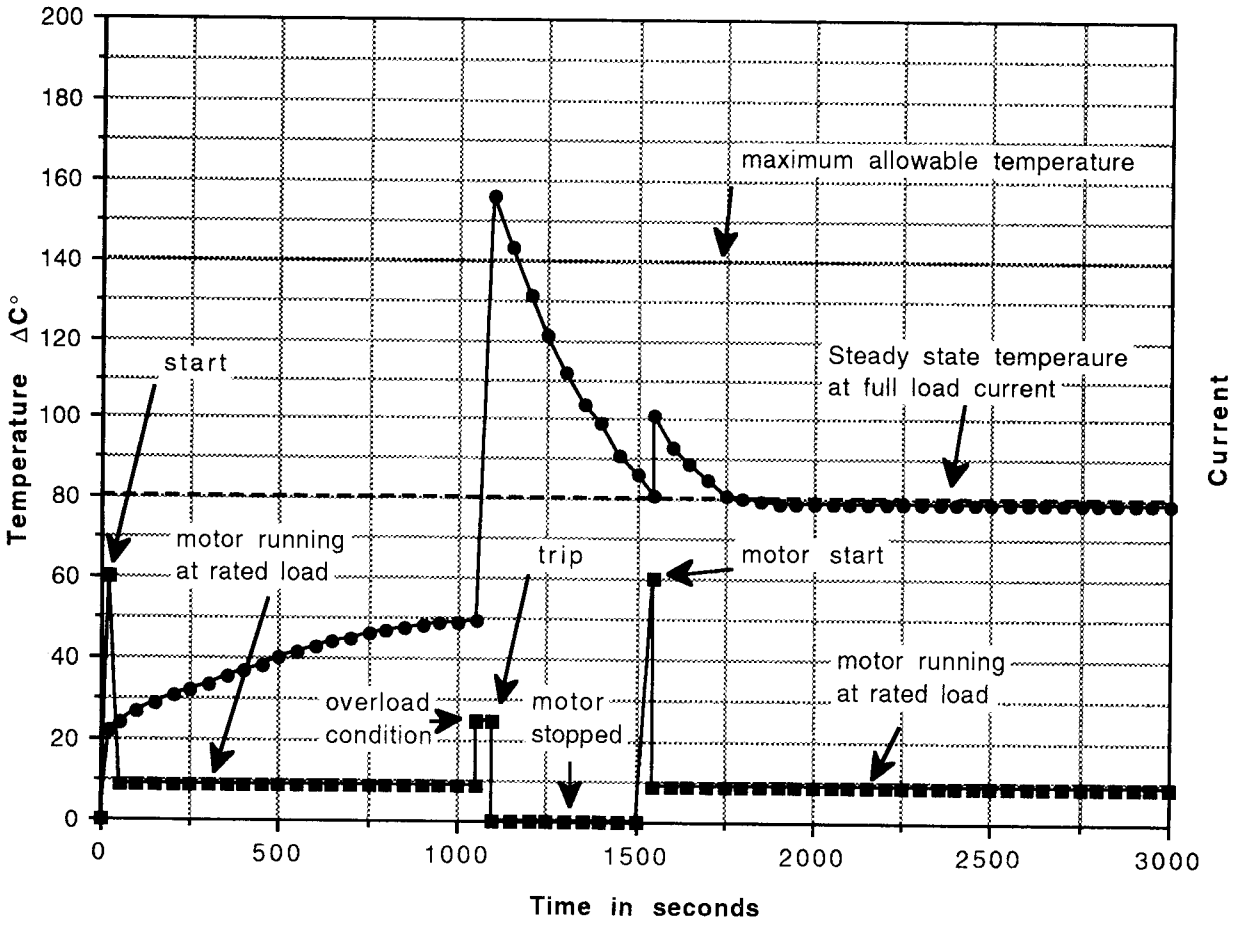


Figure 3-7. Motor Model Thermal Signature for a 10 A Motor

general enough to be used to protect many classes of motors, yet tunable enough to offer particular motors customized protection. Nameplate data to be entered to customize protection to the motor are the full-load current setting and the service factor.

3.12 Current Measurements

The overload protection afforded by the motor model in the SAMMS is ineffective without an accurate measurement of the load current. More specifically, the rms (root-mean-square) value of the load current provides the best measure of motor heating. In SAMMS, the true rms value of typical motor current waveforms, including the harmonic-rich waveforms inherent in multi-pulse ac drives is computed.

Figure 3-8 is a block diagram of one phase of the rms measurement system used in the SAMMS.

Once I_{rms} is calculated by accumulating the sum of 60 squared samples of the input currents, each sample being converted at a frequency fs. Thus, a digital value proportional to the rms value of the load current is calculated at a rate of $f_s/60$. This digital value is used in the motor model to predict heating of the motor.

In three-phase operations, each of the three phase currents is sampled and the rms value of each computed independently by separate 60-sample averagers.

3.13 Protection Curves And Overload Classes

The specific motor protection curve selected depends upon the overload class setting. The overload class is defined as the maximum tripping time in seconds for a current level of 600% of the full-load current. (The typical starting current level of motors is 600% of the full-load current.) For example, an overload class setting of 10 guarantees that a current of 600% will cause a trip in less than 10s. Specifically, the protection curves are designed to cause a trip in from 90%-100% of the class time for a current of 600%.

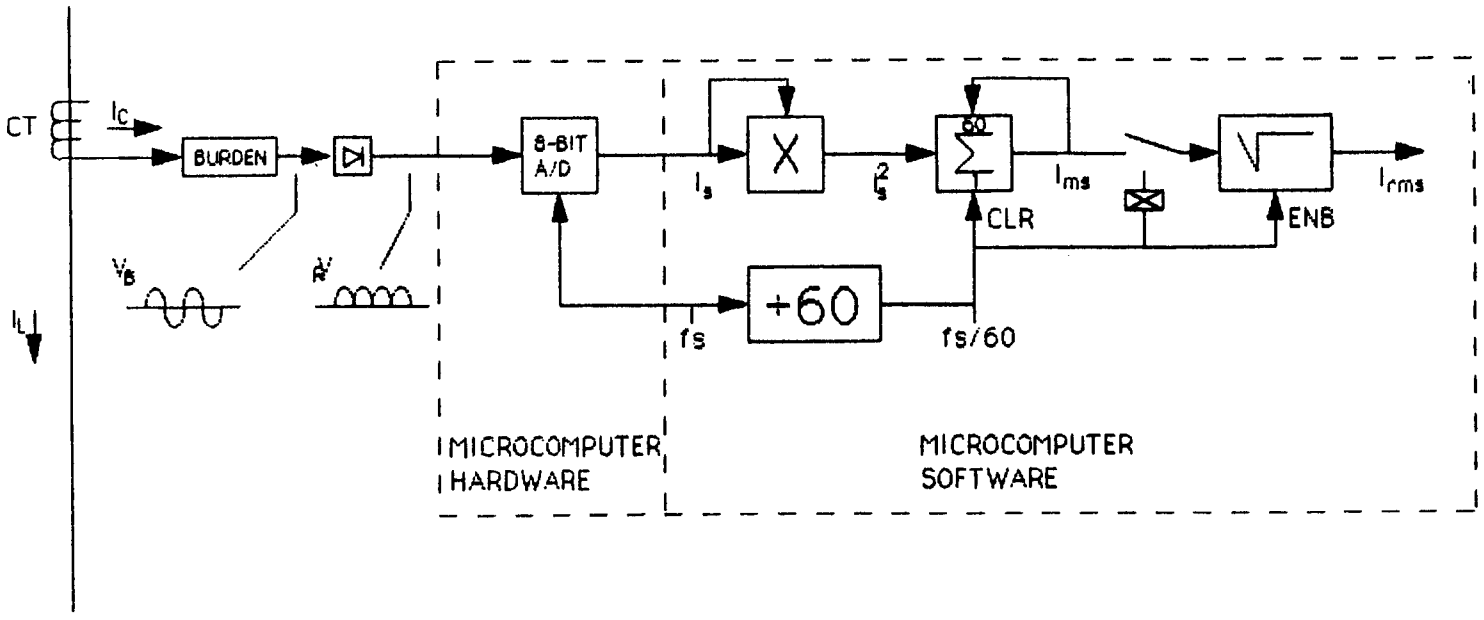


Figure 3-8. RMS Measurement System

The lowest overload class greater than or equal to the motor's starting time gives the best protection. Overload classes 2 through 23 are available in SAMMS 3; classes 5, 10, 15, and 20 are available with SAMMS 2; classes 10 and 20 are available with SAMMS 1. The range of protection curves are shown in Figures 3-9 through 3-12.

NOTE

For clarity, the time-current characteristic curves in this manual are shown with overload classes 2, 5, 10, 15 and 23 only. Use interpolation to derive values of other overload classes not shown.

3.14 Ultimate Trip Level And Service Factor

The ultimate trip level is the maximum continuous current that does not cause an overload trip. Any higher current applied indefinitely to an unprotected motor will ultimately damage it. The ultimate trip level for motors with a unity service factor is 110% of the full-load current setting. For motors with a service factor of 1.15, the ultimate trip level is 120%. A service factor of 1.00 or 1.15 can be selected with HHC function F6.

3.15 Phase Unbalance

Unbalanced three-phase voltages or loss of one phase can result in unbalanced currents being supplied to the motor. Unbalanced currents produce heat in the motor windings, decreasing the efficiency of the motor for a given load. The SAMMS measures the magnitude of the current unbalance as the maximum of the deviations of the three phase currents divided by the average of the three phase currents. In the case of the loss of a phase, the unbalance is 100% in a three-wire, ungrounded system.

If phase unbalance protection is enabled, current unbalances of between 20% and 40% cause the Phase Unbalance LED to flash as a warning. If the unbalance increases to above 40%, the Phase Unbalance LED is solidly illuminated and overload tripping is accelerated. The effect of an unbalance of greater than 40% is to shift the motor protection curve in the direction of faster tripping. The ultimate trip levels are adjusted as shown in Table 3-2. (See Figures 3-13 and 3-14 for examples of shifted motor protection curves.) Upon a trip, the Phase Unbalance remains illuminated along with the Overload Trip LED until reset.

Use the following steps to obtain the proper tripping time for specific motor load when the motor's phase unbalance exceeds 40%:

a) Divide the motor load by the motor full load current to obtain I_{ratio}.

b) Use Figure 3-15 to determine the correction factor as a function of the motor full load current.

c) Select the proper overload class curve for balanced loads from Figures 3-9 through 3-12.

d) To determine the new tripping time, divide I_{ratio} by the correction factor and read the proper tripping time.

Phase unbalance protection is enabled with HHC function F9.

- Enabled = ON
- Disabled = OFF

If phase unbalance protection is enabled, HHC function F17 displays the percentage of current unbalance. Both functions display OFF if phase unbalance protection is disabled. Phase unbalance protection is permanently disabled at the factory for single-phase motor applications.

Table 3-2. Ultimate Trip Levels for Phase Unbalances

Motor Full-load Current	Ultimate Trip Level	
	Service factor 1.00	*Service Factor 1.15*
0 - 2.5A	110%	120%
2.6 - 40A	88%	96%
41 - 240A	80%	87%
above 240A	73%	80%

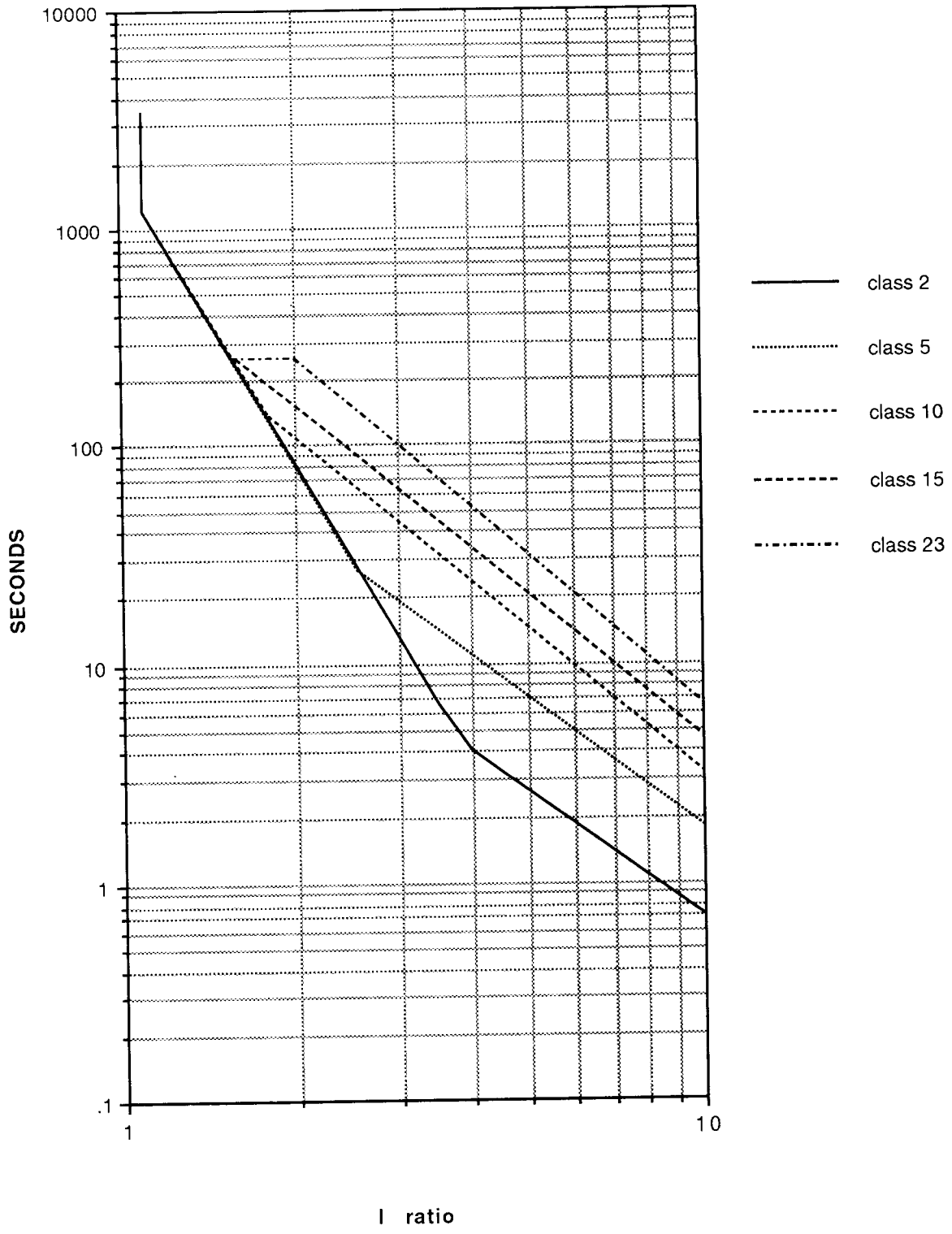


Figure 3-9.Time-Current Characteristic Curves for Cold Motors with Service Factor 1.00

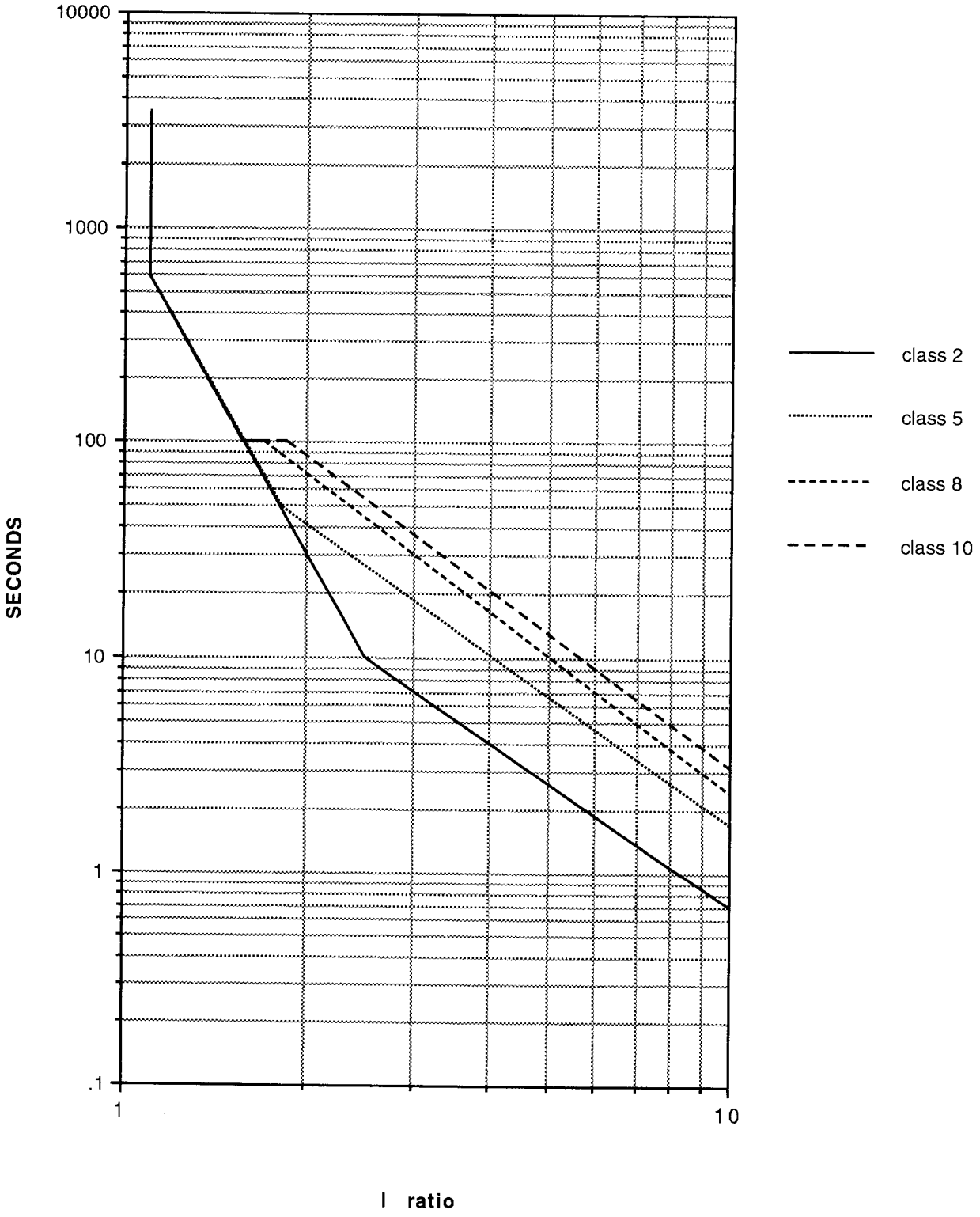


Figure 3-10. Time-Current Characteristic Curves for Warm Motors with Service Factor 1.00

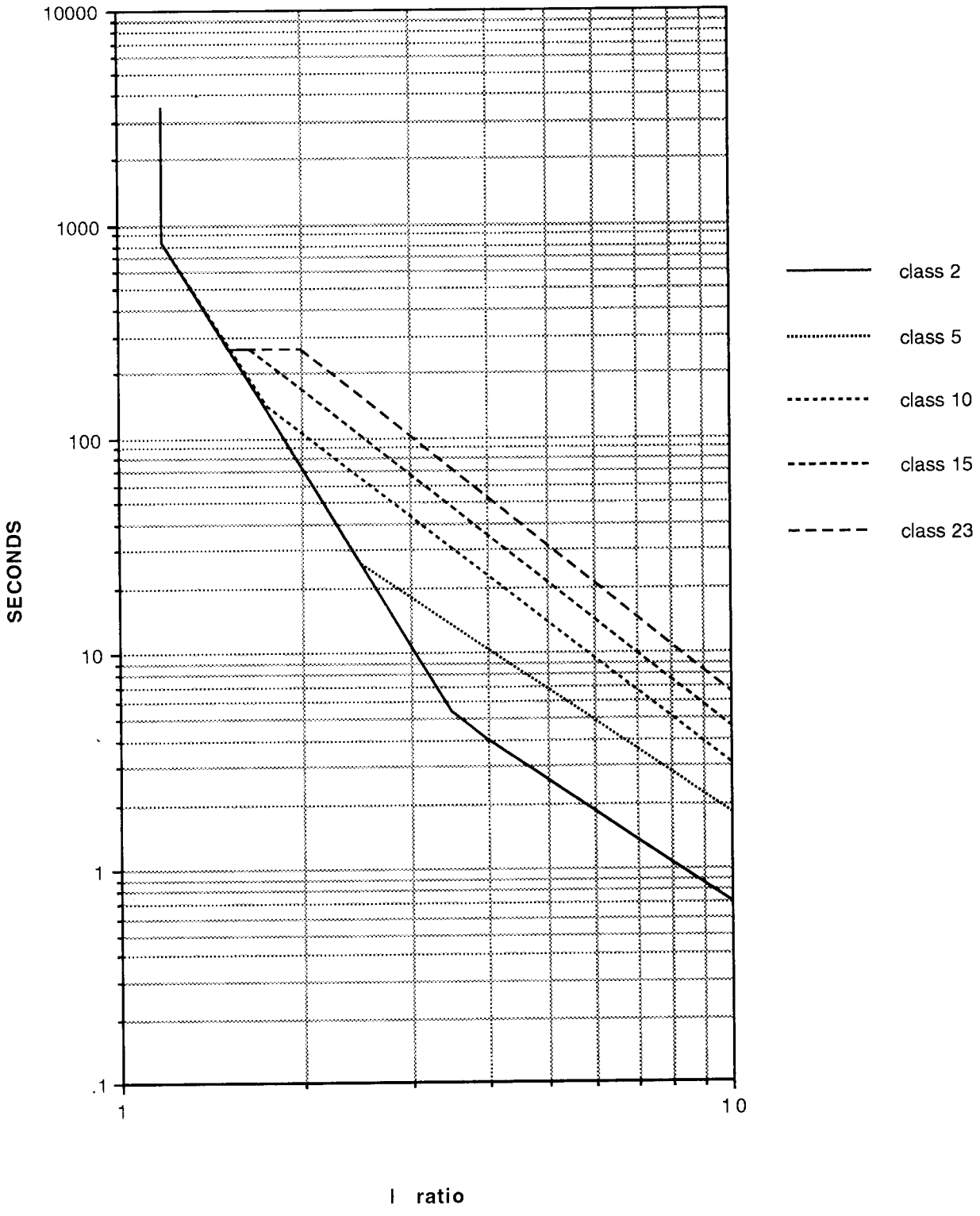


Figure 3-11. Time-Current Characteristic Curves for Cold Motors with Service Factor 1.15

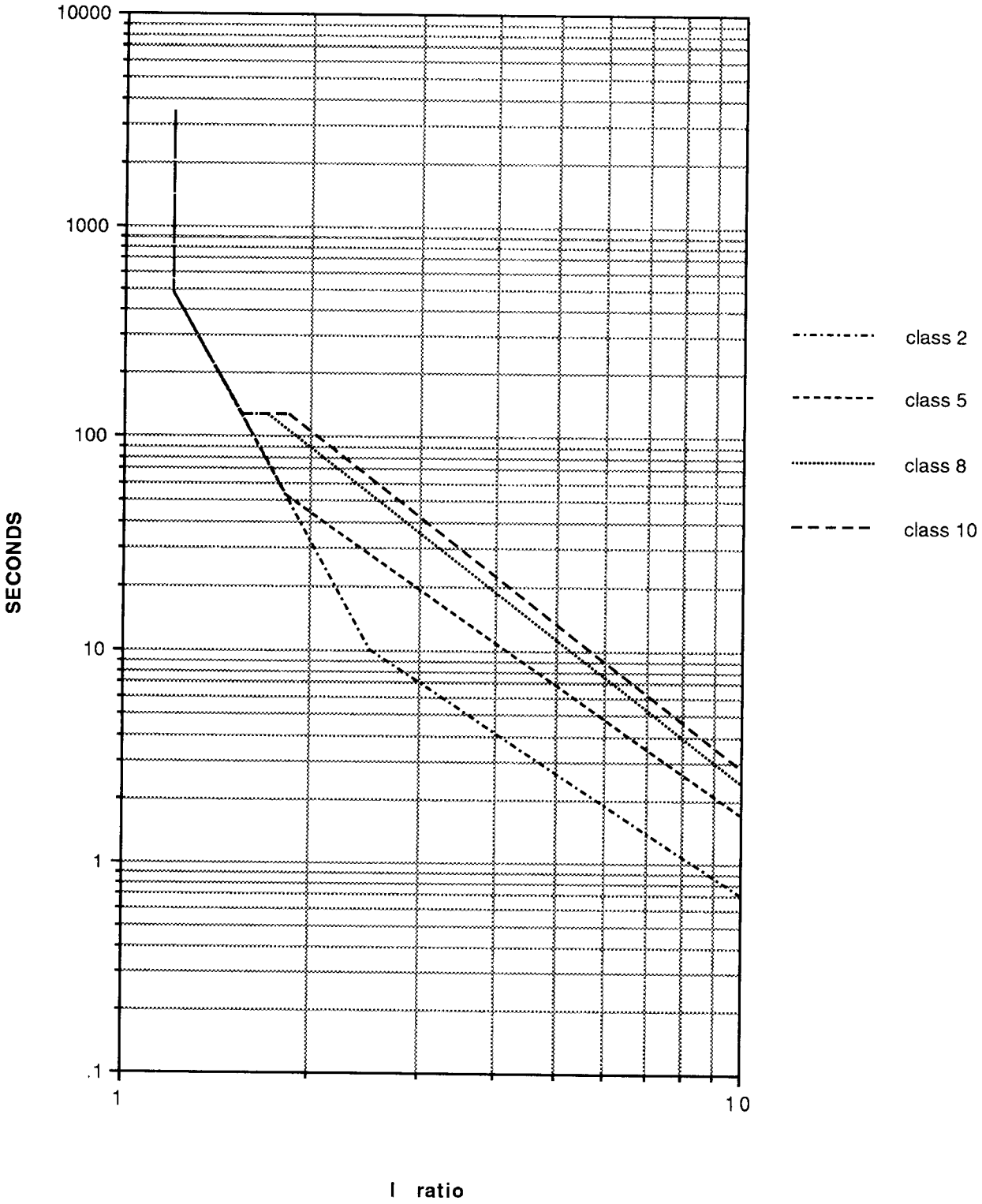


Figure 3-12. Time-Current Characteristic Curves for Warm Motors with Service Factor 1.15

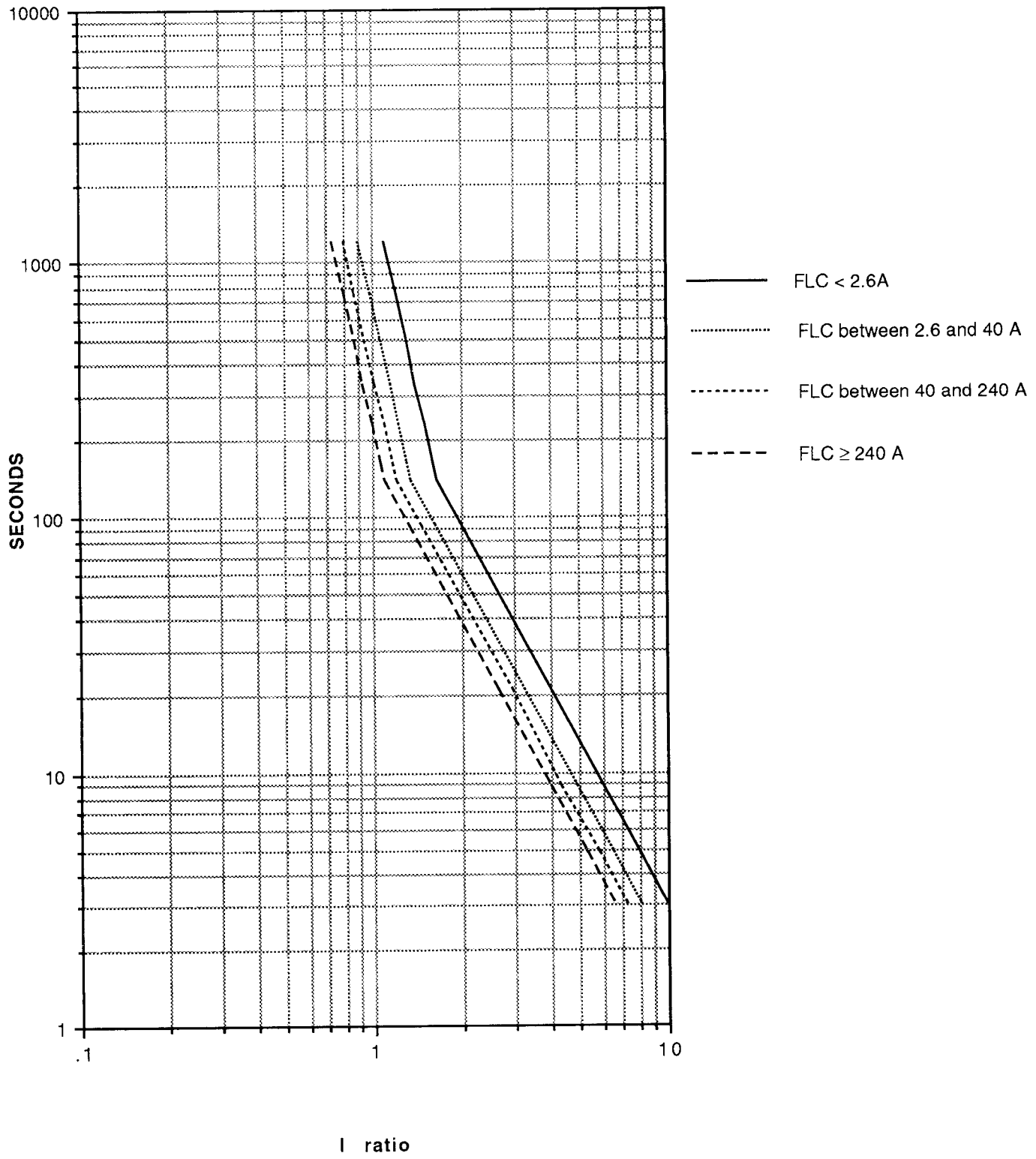


Figure 3-13. Effect of Phase Unbalance exceeding 40% on Motors rated 2.6 to 240 A Overload Class 10, Cold Condition, Service Factor 1.0

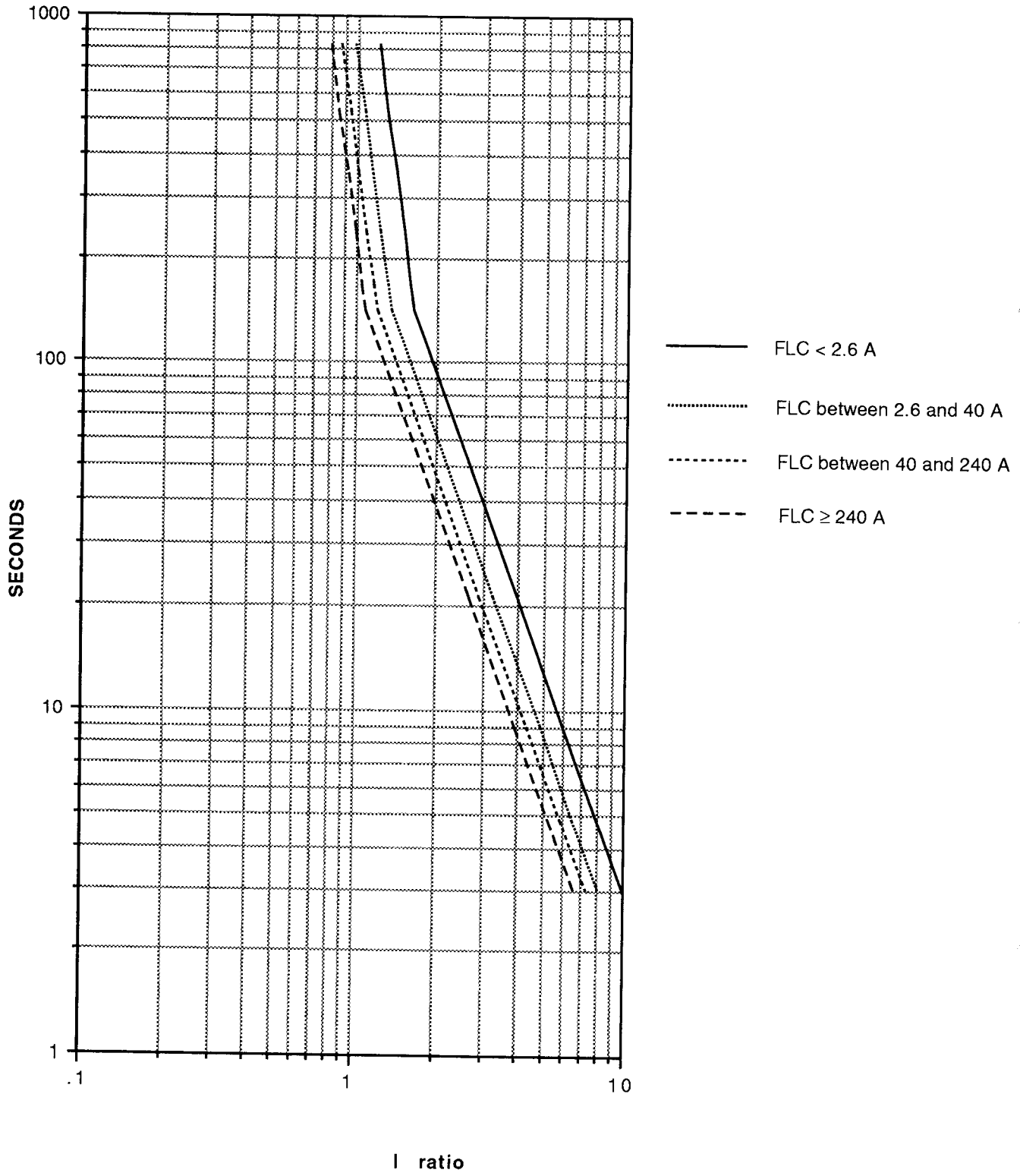


Figure 3-14. Effect of Phase Unbalance exceeding 40% on Motors rated 2.6 to 240 A Overload Class 10, Cold Condition, Service Factor 1.15

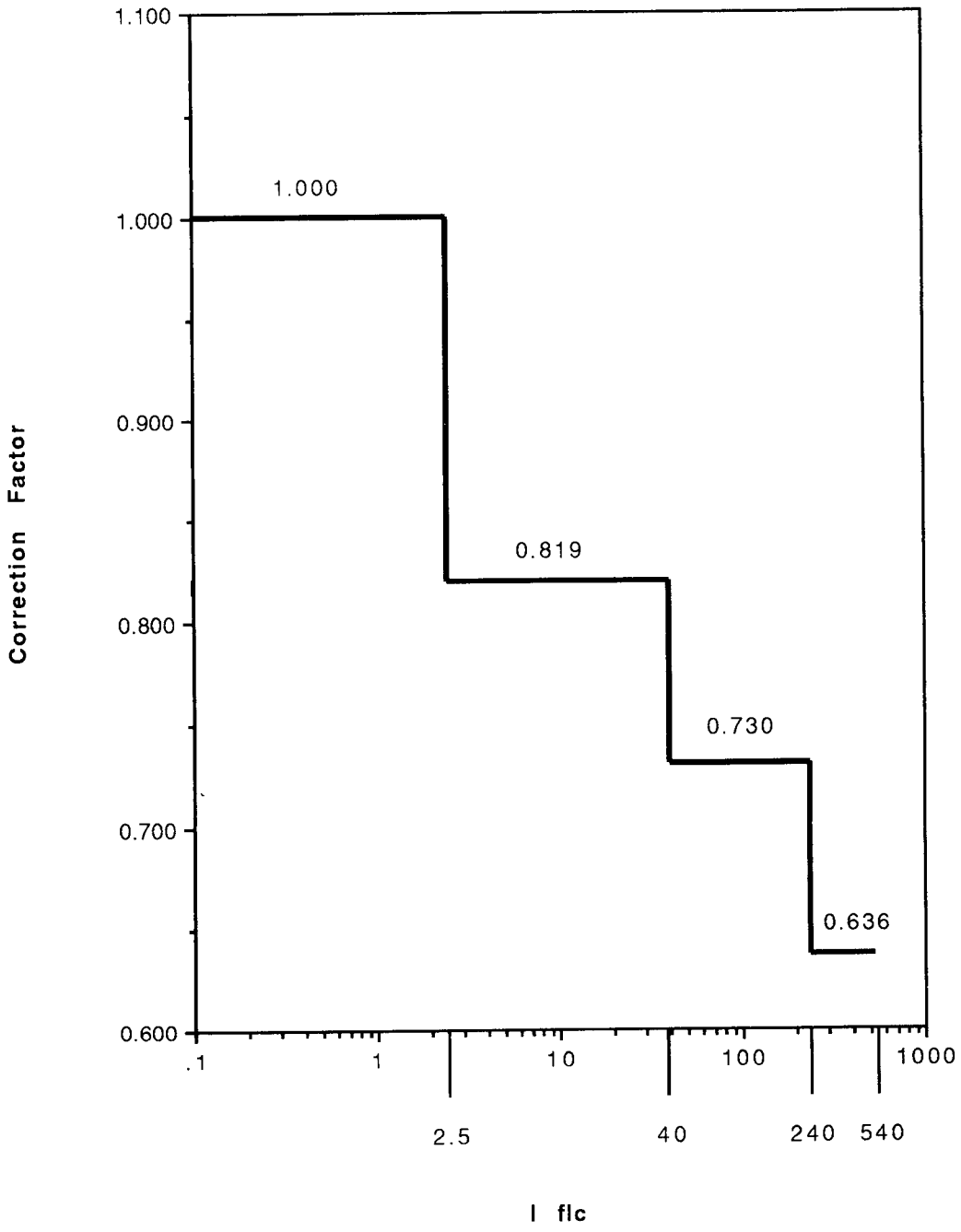


Figure 3-15. Corrections for Phase Unbalance Above 40%

3.16 Dual Overload Protection

Because the high-speed and low-speed currents differ in two-speed motors, different full-load current settings are often required. In such applications, the full-load current for high-speed operation should be selected with HHC function F4 and for low-speed with function F5.

3.17 Jam Protection

Certain mechanical loads, especially those containing gears, are susceptible to jamming. Jam protection is effective in preventing damage to the motor and the driven equipment by quickly tripping the motor off line in the event of a jam. If jam protection is enabled, the jam trip level is fixed at 200% of full-load current. Jam protection is locked out for 5 times the overload class after a start or a speed or direction change, if the current at least doubles to above 200% in less than 700ms., the motor is tripped off line and the External Trip LED on the front panel of the SAMMS is solidly illuminated. (See Figure 3-16.) Jam protection is enabled with HHC function F23.

- Enabled = ON
- Disabled = OFF

3.18 Loss Of Load Protection/Warning

If the running current of the motor suddenly drops in 700ms or less below 50% of its steady-state level, a loss of load has occurred. Such a loss of load could be due to a broken belt or loss of back pressure in a pump. Loss of load detection is locked out for five times the overload class time after a start or a direction or speed change. (See Figure 3-16). Either loss of load protection or warning is selected with HHC function F24.

- Protection = ON
- Warning = OFF

With protection selected, detection of a loss of load causes the motor to be tripped off line and the External Trip LED to be illuminated solidly. With warning selected, the motor is not tripped and the External Trip LED flashes until the current returns to its former steady-state level or higher.

3.19 Process Current Warning

It is often convenient to have an indication that the load current is above its normal operating level so that the process can be checked and, if necessary, adjusted. The process current warning level can be set from 1% to 100% of the full-load current with HHC function F22. (Process current warning may also be turned off.) As long as the motor running current exceeds the process current warning level, the External Trip LED flashes. Process current warning is locked out for five times the class time after a start or a direction or speed change.

3.20 Stall Protection

By selecting the overload class slightly greater than or equivalent to the motor's starting time, the motor model defines an energy I^2t value, where I equals 600% of the motor's full load current and t equals the overload class selected.

If the amount of energy exerted by the motor during stall or under locked rotor condition exceeds the amount of energy defined by the overload class selected, the SAMMS unit will trip, thus protecting the motor's winding against excessive heat build up. For most motors, the maximum stall time is limited from 23 to 35 seconds.

For example, a typical motor starts within 3 to 4 seconds. By selecting an overload class 4 or 5, the motor can be started safely either hot or cold, and without nuisance tripping while providing protection against stall time exceeding 4 or 5 seconds, assuming the locked rotor current equals 600% of the motor's full load current.

3.21 Repetitive Starts

The motor model allows repetitive starts without nuisance tripping while protecting the motor against overload and stall conditions. Repetitive starts are allowed as long as the following two conditions are met.

1. The energy exerted by the motor during start does not exceed the energy defined by the overload class selected.
2. The motor winding temperature does not exceed the maximum temperature allowed.

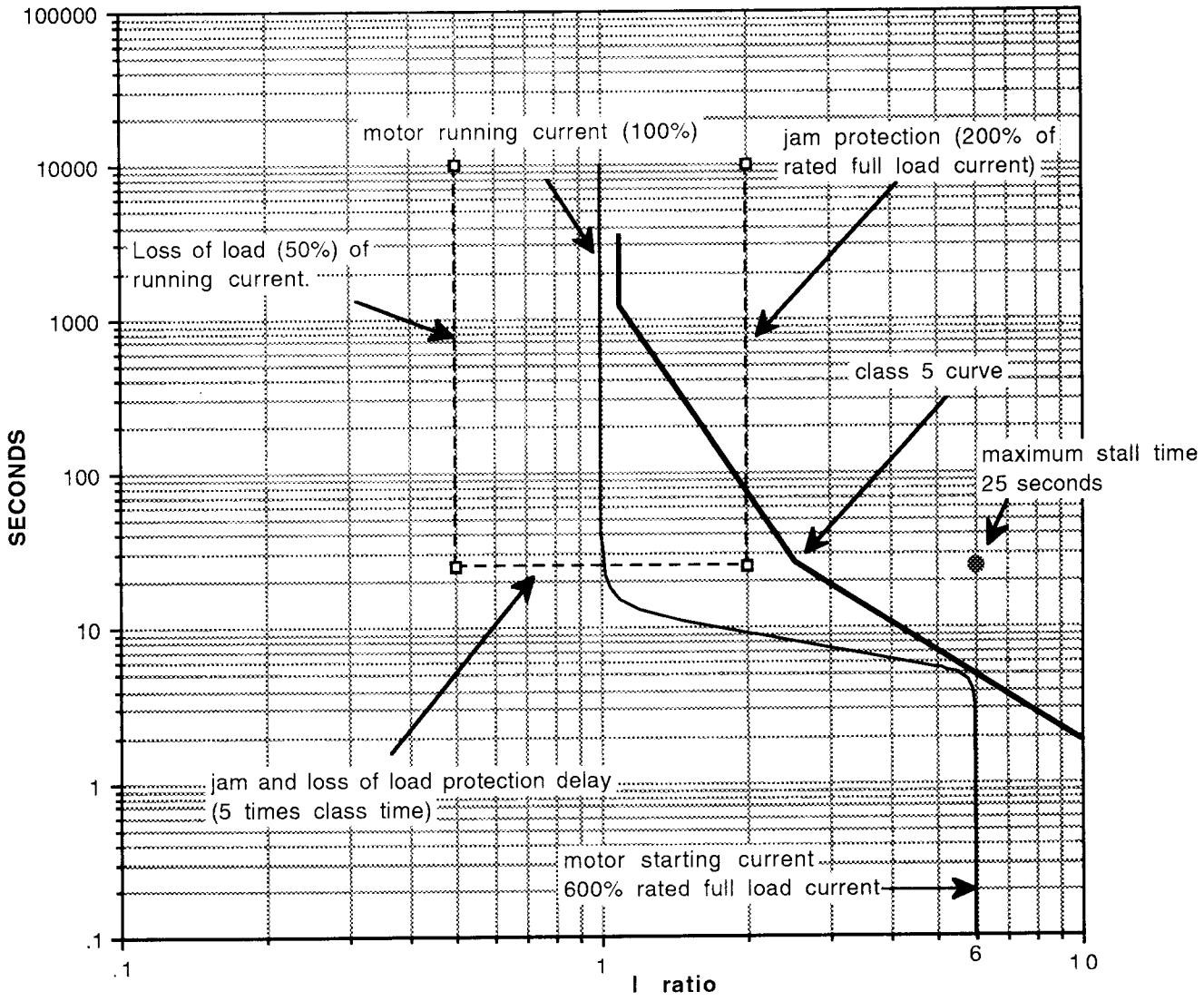


Figure 3-16. Motor Protection Curve

For example, a motor starting from cold condition could have 5 or more typical starts of 3 to 4 seconds without nuisance tripping and without damaging the motor insulation.

3.22 Start Inhibit

When the motor winding temperature reaches the maximum value allowed, the SAMMS unit will trip. If a restart is attempted the overload LED will flash and the motor won't start until the motor winding temperature is cooled down to the full load temperature. F25 displays the motor winding temperature as a percentage of the full load temperature, and F10 displays the time to enable restart in seconds.

3.23 Cool Down Time Constants

The motor time constant is a function of the motor size. The values listed in Table 3-4 are used in the motor model.

Table 3-3. Temperature Rise Boundary Parameters

Boundary Parameters	Insulation B	Class F	% FLC Temperature
Steady State Temperature rise at full load current	80°C	105°C	100%
Maximum allowed winding temperature	140°C	185°C	175%

Table 3-4. Cooling Time Constants

Motor Condition	Delta Temperature	Full Load Current		
		0.3-9.0 A	9.1-65A	651-540A
Stopped	140°C to 80°C	700s	1200s	2000s
Stopped	80°C to 29°C	1750s	5500s	9100s
Running Idle	80°C to 39.4°C	600s	1800s	2800s

3.24 Normalized Temperature Rise for Class B and Class F Insulation

Steady state and maximum winding temperatures are functions of the motor's insulation class. In this motor model, normalized temperature rise for both class B and Class F insulation are utilized. The motor winding temperature is displayed as a percentage of the steady state full load current temperature. See Table 3-3.

3.25 Ground Fault Detection

In SAMMS units with optional ground fault detection, HHC function F12 selects ground fault protection or warning.

- Protection = ON
- Warning = OFF

A ground fault is detected if the fault current exceeds the pickup level for one second. If protection is selected, the motor is tripped and the Ground Fault LED is solidly illuminated until reset. If warning is selected, the Ground Fault LED flashes as long as the fault current exceeds the pickup level. (Pickup levels for each overload size is listed in Table 3-5.) Ground fault detection is locked out for one second following a start.

Ground fault detection requires no additional external circuitry or transformers. SAMMS ground fault detection is not available for grounded, three-phase systems or single-phase applications.

Table 3-5. Ground Fault Pickup Current Level

Size	Pickup current
1A	1.5A
1B	5A
1C	5A
2A	10A
2B	10A
3	10A
4	10A
5	10A
6	20A

⚠ WARNING

Automatic reset

Can cause severe personal injury, death or property damage.

Automatic reset should not be used with two wire control or where automatic resetting of the SAMMS device would restore power to the motor endangering personnel or equipment.

3.26 Autoreset after a Trip

To restart the motor after a trip or a fault, the SAMMS must first be reset. One way to reset the SAMMS is to press the TEST/RESET button on the front panel. Another way is to enable autoreset with HHC function F8

- Enabled = ON
- Disabled = OFF

With autoreset enabled, overload and external trips are automatically reset in 30s after the trip. Once reset, the SAMMS can restart the motor, unless the motor windings have reached their maximum temperature and have not cooled down to the full-load level. Resetting after a trip does not interrupt or otherwise affect the ongoing motor thermal computations.

⚠ CAUTION

Emergency Restart

The use of this function may result in permanent damage or in reducing the life of the motor's winding insulation.

3.27 Emergency Restarting

In certain critical applications, it may be desirable to restart a hot motor even though restarting will damage or destroy the motor. An emergency restart is defined as a motor start after an overload trip on maximum allowable winding temperature, but before cooling to the full-load temperature level (100%). In other words, an emergency restart is a start before the restart time displayed by HHC function F10 has reached zero.

With the emergency restart function enabled (HHC function F11), the motor can be restarted regardless of the residual heat in its windings. If an emergency restart is performed, the winding and housing temperatures in the motor model computations are reset to zero. Any time the motor is started, whether an emergency restart or a normal start, the emergency restart function F11 is automatically reset to disabled.

- Enabled = ON
- Disabled = OFF

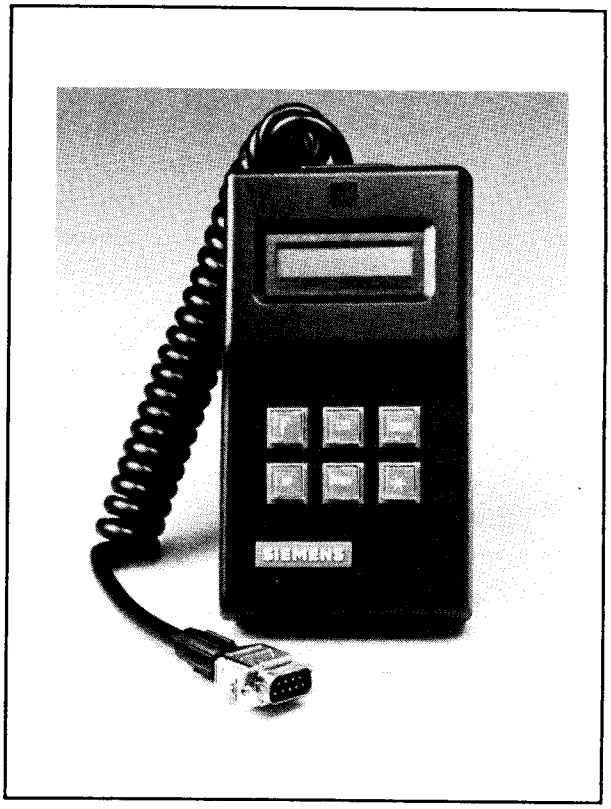


Figure 3-17. Handheld Communicator

3.28 Using The HHC Keys

3.28.1 FUNCTION Key

When the FUNCTION key is pressed, the Handheld Communicator (HHC) (Figure 3-17) goes into the function mode and displays the number of the selected function preceded by F. With the HHC in the function mode, the UP and DOWN keys can be used to step from one function to another.

3.28.2 DISPLAY Key

When the DISPLAY key is pressed, the HHC goes into the display mode and displays the value corresponding to the selected function. If the selected function is a set point, the value displayed is the actual setting. If the selected function is a measured quantity, the value displayed is the value of the measured quantity.

In the display mode, the UP and DOWN keys can be used to step through the range of possible set points for the selected function. Pressing the DISPLAY key returns the active setting to the display.

In four instances, the DISPLAY key is disabled, making the corresponding functions inoperative:

1. In a SAMMS without optional ground fault detection, the DISPLAY key has no effect for F12.
2. In a SAMMS with the display of current disabled at the factory, the DISPLAY key has no effect for F15 and F16.
3. For a single-phase motor, the DISPLAY key has no effect for F9.
4. In a SAMMS with autoreset disabled at the factory, the DISPLAY key has no effect for F8.

3.28.3 UP and DOWN Keys

The UP and DOWN keys are used to step through the functions when the HHC is in the function mode and through the displayed values for the selected function when the HHC is in the display mode. The key can be used in three ways:

1. **Single step** - press the key and release it.
2. **Slow scroll** - press the key and maintain it no longer than a few seconds.
3. **Fast scroll** - press the key and maintain it for longer than about five steps.

The operation of the UP and DOWN keys in the function and display modes is as follows:

1. In the function mode, the UP key increments the function number and the DOWN key decrements the function number. If **F1** is displayed, pressing the DOWN key rolls the function over to the highest-numbered function, e.g., **F12** for SAMMS1, **F21** for the SAMMS2, or **F25** for SAMMS3. Likewise, if the highest-numbered function is displayed, pressing the UP key rolls the selected function to **F1**.
2. In the display mode, the UP and DOWN keys are used to step through the range of settings for each set point function. In the case of SAMMS3, the UP and DOWN keys are also used to step through the individual line currents and the average line current of F15. Just as the UP and DOWN keys cause the function numbers to roll over, so they also cause the range of settings to roll over. **(Even though the value in the display may change with the UP and DOWN keys, the setting is only changed by the ENTER key. Pressing the DISPLAY key always returns the active setting to the display.)**

3.28.4 ENTER Key

Settings are changed only with the ENTER key. The ENTER key is disabled under the following conditions:

1. The ENTER key is disabled while the display is in the function, as opposed to the display, mode.
2. For non-setting functions that merely display some parameter, the ENTER key is disabled.
3. **To prevent settings from being changed while the motor is running, the ENTER key is disabled while the motor is running.**

The general procedure for changing a setting follows, using the specific example of changing the full-load current setting from 112A to 57A.

1. Press the FUNCTION key. The display shows the number of the function most recently selected, e.g., **F9**.
2. Use the UP or DOWN key to step or scroll to the desired function. When the desired function is reached, the display shows, for example, **F4**.
3. Press the DISPLAY key. The display shows the active setting for the selected function, e.g., **112**, representing a full-load current setting of 112A for a motor controlled by a size 4 contactor.
4. Use the UP or DOWN key to step or scroll to the desired setting. When the desired setting is reached, the display shows, for example, **57**, for 57A.
5. To view the active setting, press the DISPLAY key, and **112** will reappear on the display. Step 4 must then be repeated to return to the desired setting.
6. To enter the desired setting, e.g., **57**, which is being displayed, press the ENTER key. The display blanks while the ENTER key is depressed, and the setting is changed. Pressing the DISPLAY key causes the display to show the new setting, e.g., **57**.

7. To go on to other functions, press the FUNCTION key. The display will show, in the example, **F4**. Pressing the UP and DOWN keys steps through the function numbers, because the SAMMS is again in the function mode.

3.29 Using The HHC Functions

Following is a description of the 25 HHC functions and how to use them. The version of the SAMMS determines the available functions:

SAMMS Version	Functions
SAMMS 1	F1 - F12
SAMMS 2	F1 - F21
SAMMS 3	F1 - F25

3.29.1 F1 Display Control Circuit Number

1. Press the DISPLAY key to view the control circuit number programmed at the factory. The circuit numbers range from 0 through 9999.
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.2 F2 Display Size for Overload Relay #1

1. Press the DISPLAY key to view the size programmed at the factory for overload relay #1. Overload relay #1 is used to protect single-speed motors and two-speed motors running on high speed. The possible values are: 1A, 1B, 1C, 2A, 2B, 3, 4, 5, and 6.
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.3 F3 Display Size for Overload Relay #2

1. Press the DISPLAY key to view the size programmed at the factory for overload relay #2. Overload relay #2 is used to protect two-speed motors running on low speed. The possible values are: 1A, 1B, 1C, 2A, 2B, 3, 4, 5, 6, and OFF. OFF is displayed for single-speed motors.
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.4 F4 Select Full-load Current for Overload Relay #1

1. Press the DISPLAY key to view the active full-load current setting for overload relay #1. The range of possible settings and the factory default value depend on the size displayed in F2 as follows:

Overload Relay Size	Setting Range	Step	Default
1A	0.3 - 1.5A	0.1A	0.3A
1B	1.2 - 6.0A	0.1A	1.2A
1C	4.8 - 24.0A	0.1A	4.8A
2A	10 - 36A	1A	10A
2B	10 - 45A	1A	10A
3	20 - 90A	1A	20A
4	40 - 135A	1A	40A
5	80 - 270A	1A	80A
6	160 - 540A	2A	160A

2. To change the setting, press the UP or DOWN key to scroll through the range of settings until the selected setting is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.5 F5 Select Full-load Current for Overload Relay #2

1. Press the DISPLAY key to view the active full-load current setting for overload relay #2. The

range of possible settings and the factory default value depend on the size displayed in F3. The values are similar to those shown in paragraph 3.29.4.

2. If the control is not a two-speed control, OFF is displayed, and the UP, DOWN, and ENTER keys are disabled. Proceed to Step 5.
3. To change the setting, press the UP or DOWN key to scroll through the range of settings until the selected setting is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
4. If an incorrect selection is made, repeat Step 3.
5. Press the FUNCTION key to proceed to other functions.

3.29.6 F6 Select Service Factor

1. Press the DISPLAY key to view the active service factor, 1.0 or 1.15. The factory default is 1.15. The effect of a service factor of 1.15 is to adjust the overload trip thresholds up by 15% over their values for a service factor of 1.0, resulting in more margin before tripping.
2. To change the setting, press the UP or DOWN key to alternate between the two choices until the selected value is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.7 F7 Select Overload Trip Class

1. Press the DISPLAY key to view the active trip class. The trip class is the time in seconds it takes the overload relay to trip for a starting current of 600% of the full-load current setting. The range of possible values depends on the SAMMS version as follows:

Version	Range	Step	Default
SAMMS1	10 - 20	10	10
SAMMS2	5 - 20	5	10
SAMMS3	2 - 23	1	10

2. To change the setting, press the UP or DOWN key to scroll through the range of settings until the selected setting is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.8 F8 Enable/Disable Autoreset

1. Press the DISPLAY key to view the active autoreset setting (ON or OFF). If autoreset is ON, the SAMMS is automatically reset 30s after an overload or external trip, at which time the motor can be restarted. If autoreset is OFF, the overload relay must be manually reset with the TEST/RESET button before the motor can be restarted. The factory default is OFF.
2. To change the setting, press the UP or DOWN key to select the new setting. Press the ENTER key. If the selected setting is ON, proceed to Step 4.
3. If the selected setting is OFF, the display blanks while the ENTER key is depressed. When the key is released, the setting is changed to OFF. Proceed to Step 5.
4. If the selected setting is ON, **SUrE** is displayed when the ENTER key is released. The ENTER key must then be pressed again to make the change to ON.

NOTE

The reason for displaying SUrE and requiring a second depression of the ENTER key is that the motor can restart immediately after an overload trip if autoreset is ON.

⚠ WARNING

Automatic reset

Can cause severe personal injury, death or property damage.

Automatic reset should not be used with two wire control or where automatic resetting of the SAMMS device would restore power to the motor endangering personnel or equipment.

5. If an incorrect selection is made, proceed to Step 2.
6. Press the FUNCTION key to proceed to other functions.

3.29.9 F9 Enable/Disable Phase Unbalance Protection

1. Press the DISPLAY key to view the active phase unbalance protection setting (ON or OFF). (For a single-phase motor, the DISPLAY key has no effect; **F9** remains in the display.) The factory default setting is ON, except for single-phase motors.

   a) When phase unbalance protection is enabled (ON), current unbalances of greater than 40% accelerate overload tripping. The Phase Unbalance LED flashes for unbalances from 20% to 40%; it remains solidly illuminated for unbalances greater than 40%.

   b) When phase unbalance protection is disabled (OFF), the Phase Unbalance LED remains off, unbalanced conditions have no effect on protection, and F17 (Display Unbalanced Current) displays OFF. Phase Unbalance Protection is OFF for single-phase motors.

2. To change the setting, press the UP or DOWN key to alternate between the two choices until the selected value is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.10 F10 Display Time to Restart

1. Press the DISPLAY key to view the time to restart (in seconds), i.e., the time remaining until the motor can be restarted. The time to restart counts down while the motor is cooling from the maximum winding temperature allowed to the steady-state, full-load winding temperature. As long as the time to restart is not zero, the motor cannot be restarted, except by an emergency restart. (See F11.) The display is always zero if the motor is not in a start inhibit mode.
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.11 F11 Enable/Disable Emergency Restarting

1. Press the DISPLAY key to view the emergency restart setting (ON or OFF). With emergency restart enabled (ON), the motor can be restarted after the overload relay is reset (manually or automatically) even though the time to reset is not zero. Upon an emergency restart, the motor conditions are reset to zero to simulate a completely cold start. Any motor start, whether emergency or normal, disables the emergency restart function (F11 is automatically set to OFF). It must be re-enabled if needed. The factory default is OFF.

2. To change the setting, press the UP or DOWN key to select the new setting. Press the ENTER key. If the selected setting is ON, proceed to Step 4.
3. If the selected setting is OFF, the display blanks while the ENTER key is depressed. When the key is released, the setting is changed to OFF. Proceed to Step 5.
4. If the selected setting is ON, **SUrE** is displayed when the ENTER key is released. The ENTER key must then be pressed again to make the change to ON.

NOTE

The reason for displaying SUrE and requiring a second depression of the ENTER key is that the motor can be damaged if restarted before it is allowed to cool.

5. If an incorrect selection is made, proceed to Step 2.
6. Press the FUNCTION key to proceed to other functions.

3.29.12 F12 Select Ground Fault Protection or Warning

1. Press the DISPLAY Key to view the active setting. If the SAMMS does not have ground fault detection, the DISPLAY key has no effect (**F12** remains in the display). If the SAMMS has ground fault detection, the two choices are protection (ON) and warning (OFF). The factory default setting is warning (OFF).

   a) When warning (OFF) is selected, the Ground Fault LED flashes if the ground current increases beyond the pickup level for the particular size. The LED stops flashing as soon as the current drops below the pickup level.

   b) When protection (ON) is selected, a ground current above the pickup level results in a trip. The motor is stopped and the Ground Fault LED is illuminated solidly. A reset must follow before the motor can be restarted.

   c) The fixed pickup levels are as follows:

Overload RelaySize	PICKUP CURRENT
1A	1.5A
1B	5A
1C	5A
2A	10A
2B	10A
3	10A
4	10A
5	10A
6	20A

2. To change the setting, press the UP or DOWN key to alternate between the two choices until the selected value is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.13 F13 Set Programmable Timer #1

1. Press the DISPLAY key to view the active setting for timer #1. The timer may be adjusted from 0 - 200 seconds in one-second steps. OFF is displayed for a setting of 0 seconds. If the timer is not used in the control circuit, OFF is displayed and the UP, DOWN, and ENTER keys are disabled. The default setting is OFF.
2. To change the setting, press the UP or DOWN key to scroll through the range of settings until the selected setting is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.14 F14 Set Programmable Timer #2

1. Press the DISPLAY key to view the active setting for timer #2. The timer may be adjusted from 0 - 200s in one-second steps. OFF is displayed for a setting of 0s. If the timer is not used in the control circuit, OFF is displayed and the UP, DOWN, and ENTER keys are disabled. The default setting is OFF.
2. To change the setting, press the UP or DOWN key to scroll through the range of settings until the selected setting is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.15 F15 Display Current (SAMMS 2)

1. Press the DISPLAY key to view the average instantaneous line current. For sizes 1A, 1B, and 1C, the current is displayed to the nearest 0.1 amp for currents less than 100 amps; for 100 amps and above, currents are displayed to the nearest 1 amp. For sizes 2A and above, currents are displayed to the nearest 1 amp. **For wye-delta starters, the current displayed is 1.732 times the average CT current. For full-voltage, part-winding starters, the DISPLAY key is disabled.**
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.16 F15 Display Current (SAMMS 3)

1. Press the DISPLAY key to view the instantaneous line currents or the average instantaneous line current. The display shows the phase designator (**A**, **B**, or **C**) in the left-most character followed by three significant digits of the value of the current. For the average instantaneous line current, four significant digits are displayed without a phase designator. For full-voltage, part-winding starters, the DISPLAY key is disabled.
   a) For sizes 3 and above, individual line currents 1000 amps and above, which, including the phase designator, overflow the four-character display, are displayed as three dashes following the phase designator, e.g., **A---**. No such problem exists with the average line current, because no phase designator is displayed.
   b) For sizes 1A, 1B, and 1C, the current is displayed to the nearest 0.1 amp for currents less than 100 amps; for 100 amps and above, currents are displayed to the nearest 1 amp. For sizes 2A and above, currents are displayed to the nearest 1 amp.
2. To view another line current, press the UP or DOWN key to scroll through the four selections.
3. The ENTER key is disabled.
4. Press the FUNCTION key to proceed to other functions.

3.29.17 F16 Display Trip Current

1. Press the DISPLAY key to view the value of the current that caused the most recent trip.
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.18 F17 Display Current Unbalance

1. Press the DISPLAY key to view the percentage current unbalance. If unbalance protection is disabled (F9 OFF) or for single-phase motors, OFF is displayed. The percentage unbalance is the ratio of the greatest deviation of the three phase currents to the average of the three phase currents expressed as a percentage.
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.19 F18 Display Total Elapsed Run Time of the Motor

1. Press the DISPLAY key to view the total elapsed running time of the motor. The run time is displayed in **tens of hours** as follows:

Actual Number of Hours	Displayed Time
0	0.0
9999	999.9
10000	1000
65535	6553
65536	0.0 (roll over)

The displayed value does not increment until a full hour or, for elapsed times greater than 10000hr, a full ten hours have elapsed. Internally, however, the elapsed time is maintained to the nearest 0.1second.

NOTE

The value can be reset to zero with F21.

2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.20 F19 Display Number of Motor Starts

1. Press the DISPLAY key to view the number of motor starts. The number of starts is displayed in **tens of starts** as follows:

Actual Number of Starts	Displayed Number
0	0.0
9999	999.9
10000	1000
65535	6553
65536	0.0 (roll over)

NOTE

The value can be reset to zero with F21.

2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.21 F20 Display Number of Overload Trips

1. Press the DISPLAY key to view the number of overload trips, up to 9999.

NOTE

The value can be reset to zero with F21.

2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

3.29.22 F21 Reset Motor Data

1. To reset the elapsed running time, the number of starts, and the number of overload trips to zero, first press the DISPLAY key. **CLr** is displayed.
2. Next press the ENTER key, which causes **SUrE** to be displayed.
3. Finally, press ENTER again to zero the motor data.
4. At any point, the DISPLAY key can be pressed to return to Step 1.
5. Press the FUNCTION key to proceed to other functions.
6. The UP and DOWN keys are disabled.

3.29.23 F22 Select Process Current Warning Level

1. Press the DISPLAY key to view the active process current level. The value represents the percentage of the full-load current setting above which a motor current causes the External Trip LED to flash. The function is disabled for five times the class time after starting, or a speed or direction changes. The range of settings is in 1% increments from zero (OFF) through 100. The factory default is OFF.
2. To change the setting, press the UP or DOWN key to scroll through the range of settings until the selected setting is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.

3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.24 F23 Enable/Disable Jam Protection

1. Press the DISPLAY key to view the active jam protection setting (ON or OFF). If jam protection is enabled (ON) and the motor running current doubles and increases to 200% of the full-load current setting, the motor is tripped off line and the External Trip LED is solidly illuminated. The increase must occur within about 700ms. The function is disabled for five times the class time after starting, or a speed or direction changes. The default setting is ON.
2. To change the setting, press the UP or DOWN key to alternate between the two choices until the selected value is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.25 F24 Select Loss of Load Protection or Warning

1. Press the DISPLAY key to view the active loss of load setting: protection (ON) or warning (OFF). If loss of load protection (ON) is selected and the motor current drops to below 50% of its previous steady-state value within about 700ms, the External Trip LED is illuminated and the contactor tripped. If loss of load warning (OFF) is selected, instead of tripping, the SAMMS flashes the External Trip LED until the current returns to its previous steady-state level. The function is disabled for five times the class time after starting, speed or direction change. The default setting is warning (OFF).
2. To change the setting, press the UP or DOWN key to alternate between the two choices until the selected value is displayed. Press the ENTER key to change the active setting to the selected value. The display blanks while the ENTER key is depressed.
3. If an incorrect selection is made, repeat Step 2.
4. Press the FUNCTION key to proceed to other functions.

3.29.26 F25 Display Percentage of Motor Winding Temperature

1. Press the DISPLAY key to view the temperature of the motor windings as a percentage of the steady-state, full-load winding temperature. (The maximum allowable winding temperature is 175%.)
2. The UP, DOWN, and ENTER keys are disabled.
3. Press the FUNCTION key to proceed to other functions.

Table 3-6. SAMMS 3, SAMMS 2 and SAMMS 1 Functions

Function Number	Function Description	Range	Step Size	Default Value
F1	Display the control circuit number.	0-9999	1	N/A
F2	Display the size for single speed controller, or the high-speed size for two-speed motor controllers.	1A, 1B, 1C, 2A, 2B, 3, 4, 5, 6	As shown	N/A
F3	Display the low-speed size for two-speed controller. F3 is OFF for single-speed motor controllers.	1A, 1B, 1C, 2A, 2B, 3, 4, 5, 6, OFF	As shown	N/A
F4	Select the full-load current setting for the size for single - speed motor controller or the high-speed size for two-speed motor controllers.	1A: 0.3 - 1.5A 1B: 1.2 - 6A 1C: 4.8 - 24A 2A: 10 - 36A 2B: 10 - 45A 3: 20 - 90A 4: 40 - 135A 5: 80 - 270A 6: 160- 540A	0.1A 0.1A 0.1A 1A 1A 1A 1A 1A 2A	0.3A 1.2A 4.8A 10A 10A 20A 40A 80A 160A
F5	Select the full-load current setting for the low-speed size for two-speed motor controllers. F5 is OFF for single-speed motor controllers.	1A: 0.3- 1.5A 1B: 1.2 - 6A 1C: 4.8- 24A 2A: 10 - 36A 2B: 10 - 45A 3: 20 - 90A 4: 40 - 135A 5: 80 - 270A 6: 160- 540A OFF	0.1A 0.1A 0.1A 1A 1A 1A 1A 1A 2A N/A	0.3A 1.2A 4.8A 10A 10A 20A 40A 80A 160A OFF
F6	Select the service factor.	1 or 1.15	N/A	1.15
F7	Select the overload trip class. The range depends on the version.	SAMMS 1: 10-20 SAMMS 2: 5-20 SAMMS 3: 2-23	10 5 1	10 10 10
F8	Enable/disable autoreset of overload and external trips.	ON/OFF	N/A	OFF
F9	Enable/disable phase unbalance protection. F9 disabled for single-phase motors.	ON/OFF	N/A	ON
F10	Display the time to wait until the motor can be restarted. Applies after an overload trip with the winding temperature above the maximum allowed for restarting.	0 - 3425 seconds	1s	N/A
F11	Enable/disable the emergency restart capability.	ON/OFF	N/A	OFF
F12	Select ground fault protection or warning. ON means protection; OFF means warning. F12 disabled if no ground fault option.	ON/OFF	N/A	OFF
F13	Set programmable timer #1.	OFF - 200 seconds	1 second	OFF
F14	Set programmable timer #2.	OFF - 200 seconds	1 second	OFF

Table 3-6. (cont.) SAMMS 3, SAMMS 2 and SAMMS 1 Functions

Function Number	Function Description	Range	Step Size	Default Value
F15	Display the instantaneous line current. For the SAMMS 3 only the average line current is displayed and the individual line currents are displayed. F15 disabled for full-voltage part-winding starters.	1A: 0.0 - 16.8A 1B: 0.0 - 67.1A 1C: 0.0 - 99.9A 100- 268A 2A: 0.0 - 402A 2B: 0.0 - 503A 3: 0.0 - 1006A 4: 0.0 - 1509A 5: 0.0 - 3018A 6: 0.0 - 6036A	0.1A 0.1A 0.1A 1A 1A 1A 1A 1A 1A 1A	N/A
F16	Display the most recent trip current. F16 disabled for reduced-voltage part-winding starters.	1A: 0.0 - 16.8A 1B: 0.0 - 67.1A 1C: 0.0 - 99.9A 100- 268A 2A: 0.0 - 402A 2B: 0.0 - 503A 3: 0.0 - 1006A 4: 0.0 - 1509A 5: 0.0 - 3018A 6: 0.0 - 6036A	0.1A 0.1A 0.1A 1A 1A 1A 1A 1A 1A 1A	N/A
F17	Display the instantaneous current unbalance. OFF is displayed if unbalanced protection is OFF.	0 - 100% OFF	1%	N/A
F18	Display the elapsed motor running time in tens of hours.	0.0 - 6553x10hr	0.1x10hr up to 999.9, 1x10hr up to 6553	N/A
F19	Display the number of motor starts in tens of hours.	0.0 - 6553x10	0.1x10 up to 999.9, 1x10 up to 6553	N/A
F20	Display the number of overload trips.	0-9999	1	N/A
F21	Reset motor data. Zeroes the elapsed running time the number of starts and the number of overload trips.	N/A	N/A	N/A
F22	Select the process current warning level.	OFF - 100%	1%	OFF
F23	Enable/disable jam protection.	ON/OFF	N/A	ON
F24	Select loss of load protection or warning. ON means protection; OFF means warning.	ON/OFF	N/A	OFF
F25	Display the motor winding temperature as a percentage of the steady-state full-load temperature.	0 - 175%	1%	N/A

Contents

Figures

Section 4

COMMUNICATIONS

4.1 Communications

The SAMMS can communicate with intelligent devices connected to it through the rear-panel serial communications connector. The SAMMS communicates over a full-duplex asynchronous serial link with a standard NRZ (non-return to zero) format (one start bit, eight data bits, no parity, and one stop bit). Communication rates of 4800 and 9600 baud are available. When coupled with the appropriate external Communications Module, the SAMMS can be made compatible with RS-232- or RS-485-type communications links.

Although any intelligent device with a serial port, such as a personal computer, can be programmed to communicate with the SAMMS, the Communications Modules and the messages and protocols are designed to interface directly with the Siemens ACCESS™ system via either the Power Monitor or the Multiplexer/Translator. Two standard message formats are available from the factory: one for the Power Monitor and the other for the Multiplexer Translator.

ACCESS™ is a communications system designed by Siemens to supervise entire electrical distribution systems. Through ACCESS™, individual intelligent field devices such as SAMMS can be monitored and controlled from one or more locations in the plant. Examples of various connection options are shown in Figure 4-1.

The Power Monitor provides real-time access to important operating conditions on industrial ac power systems. The Power Monitor can communicate with up to 192 field devices that may include SAMMS units, power meters, and Static Trip units. Communications between Power Monitor and SAMMS is over an RS-485 data link at either 4800 or 9600 baud. Each device on the link has its own unique address to distinguish it from the other devices. Each SAMMS is connected to the Power Monitor through an RS-485 Communications Module.

The Power Monitor's graphics display screen permits the user to monitor such SAMMS operating conditions as current, phase unbalance, motor winding thermal capacity, control status, and settings. With the Power Monitor's membrane keypad, the user can change SAMMS settings just as with the Handheld Communicator. The user can also select alarm limits for logging. Each device connected to the Power Monitor has its own set of screens detailing appropriate operating conditions.

The Multiplexer/Translator is another means for interconnecting intelligent field devices into ACCESS™. In applications wherein the full capability of the Power Monitor is not needed or faster access to SAMMS data is desirable, a Multiplexer/Translator can be used. Up to eight SAMMS devices can be connected to a Multiplexer/Translator. Communications is at 9600 baud via the Expansion Plug *EP*. The Multiplexer/Translator may even be connected into ACCESS™ by means of a Power Monitor.

The SAMMS control function may be reprogrammed at the factory by Siemens or at the plant by the customer with a PC/AT personal computer, including a keyboard and monitor, that runs the Siemens Custom Circuits Software program. The Programmer communicates with one SAMMS at a time over an RS-232-type link through one of the Programmer's COM ports and a Download Module. Unlike the Power Monitor Panel (PMP), which communicates with the SAMMS while it is controlling a motor, the PC/AT is used to change the operation of the SAMMS. Consequently, the coil driver outputs should be disconnected from the contactor coils during communications with the Programmer.

The Programmer permits the user to retrieve a standard control ladder diagram from the Siemens Library of Standard Control Circuits or to construct a custom ladder. The Programmer also prompts the user for other customizing configuration information, which is downloaded into the SAMMS along with the ladder diagram. Default settings can also be downloaded together with the ladders.

The Programmer is used at the factory to customize each SAMMS to fit the customer's order. Customers can also be provided with a custom circuits software package to allow them to alter the ladder diagrams of individual SAMMS units on site as applications change. The Siemens Software package can be purchased separately to run on available PC/AT computers. Details on using the Programmer are in the Custom Programming Manual.

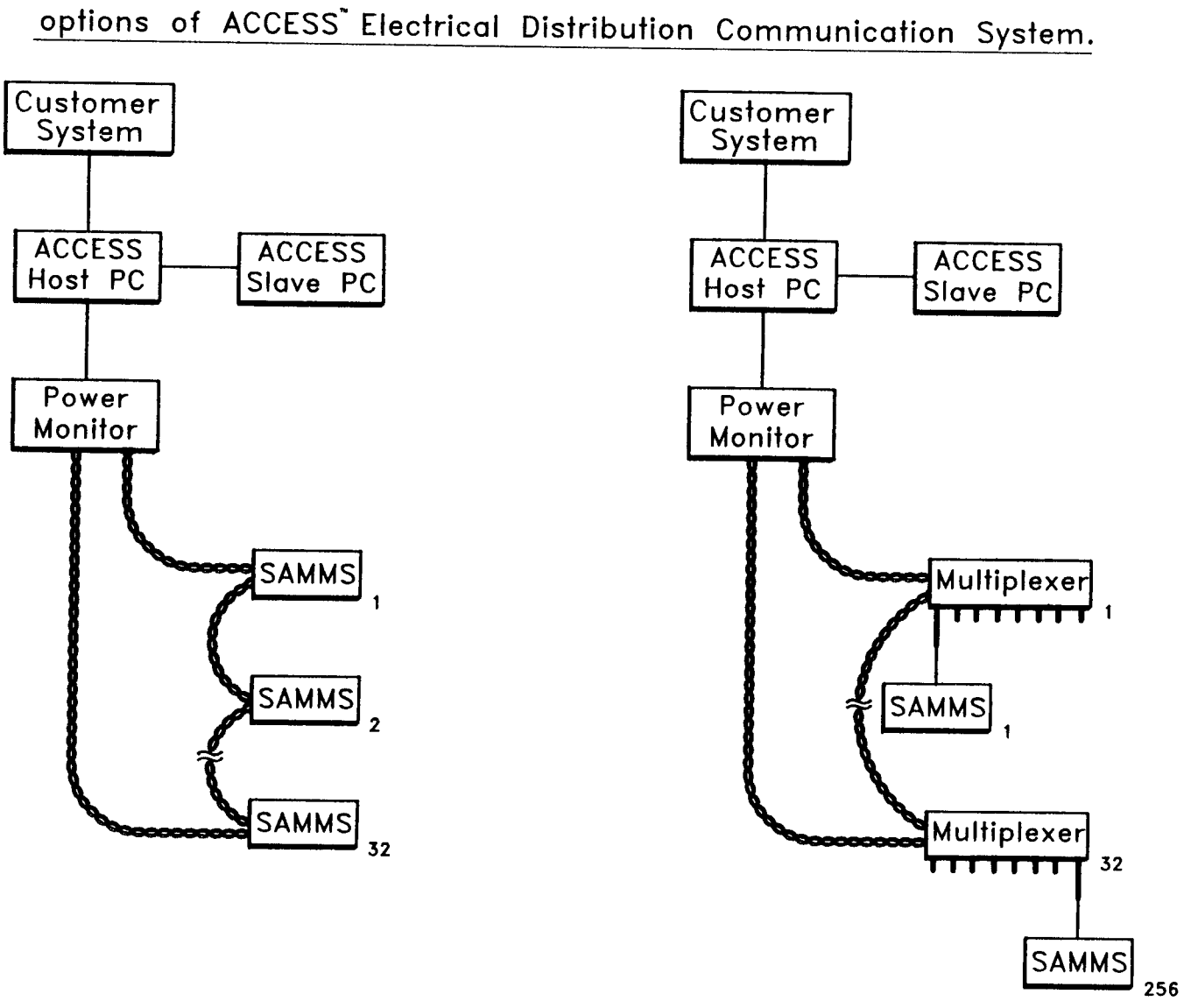


Figure 4-1 SAMMS Connection Examples

Tables

Section 5

TROUBLESHOOTING

Table 5-1. Troubleshooting Chart

Condition	Main Cause	Remedy
Phase unbalance	Phase unbalance LED is illuminated if current unbalance exceeds 40%, or flashes if current unbalance is between 20 and 40%. Current unbalance may be due to voltage or load unbalance.	☐ Correct cause of voltage or load unbalance ☐ Verify current transformer secondary voltage is unbalanced at SAMMS terminals 1, 2, and 3 with reference to 4.
Overload Trip	Indicates motor exceeded winding temperature threshold.	☐ First verify that the full load current F4, and service factor F6 on the HHC matches the fill load current and the service factor on the motor nameplate. ☐ If motor tripped during start, increment the overload class one step, and start again. If still unsuccessful, the motor's rotor may be locked or stalled. Correct motor malfunction before starting again. ☐ If the motor tripped after running for a period more than the overload class selected, the trip may be due to a running overload such as excessive loading on a conveyor belt or bad berings. Remove the cause of the overload before starting the motor again. F16 on HHC displays the overload trip current value.
Incomplete Sequence	Indicates the SAMMS unit does not detect current one second after a start command, or detects current one second after a stop command.	☐ If the unit trips one second after start, verify current transformer secondary input is present in the range of 100 mVAC to 3.54 VAC at terminals 1, 2, and 3 with reference to 4 and the coil voltage at terminals 14, 15, or 16 with reference to 13 is 115VAC when the motor is started. Verify 115VAC at terminals 7 with reference to 13. Correct conditions if necessary. If unit continues to trip call Siemens. ☐ If the unit trips one second after a stop command, verify the contactor is open, if contactor is not functioning properly, repair or replace. ☐ Verify operation of mechanical interlock, replace or adjust. ☐ Verify absence of voltage at terminals 1, 2 and 3 with reference to 4, and at terminals 14, 15, or 16 with reference to 13. If voltage is present, define the source and reconnect so that the motor current only passes through the current transformer.

Condition	Main Cause	Remedy
External Trip	If the external trip LED is solidly illuminated and the motor is stopped, it indicates jam or loss of load conditions.	☐ Jam conditions, such as a blocked conveyor belt or gear train cause a sudden increase in motor current which can damage the motor's insulation in a short period of time. ☐ Loss of load conditions, such as a broken blade of an impeller or loss of back pressure of a pump result in a sudden decrease in motor current. In either case, the reason for the external trip should be determined and remedied before starting the motor again. If the external trip LED flashes and the motor continues to run, it indicates loss of load warning or process current warning.
CPU Fault	Indicates programming error or low voltage condition.	☐ Verify voltage between terminals 5 and 6 is more than 10 VAC. If fault persists, call Siemens.
Ground Fault	Indicates the ground fault current exceeded the threshold. The ground fault LED illuminates solidly and the motor stops if ground fault **protection** was selected, or it flashes and the motor continues to run if ground fault **warning** was selected.	☐ The cause of the ground fault should be determined and removed before resuming motor use.
Not Ready Light	Usually indicates lack of control power.	☐ Verify the presence of 12 VAC between terminals 5 and 6 of the SAMMS unit. ☐ If control power is not present, check the control power fuses or the control power transformer and replace if defective. ☐ If control power is present, push the RESET button to test lights and unit. If the Ready light does not illuminate, call Siemens.
Improper Remote Operation	Indicates connection or operator error.	☐ Verify the SAMMS unit is in the Auto mode. ☐ Verify 115 VAC input at SAMMS terminals 9, 10, 11 and 12 with reference to 13, and at terminal 7 with reference to 13. ☐ If remote operation is intermittent, verify connections are made in a manner to avoid noise interference. Refer to Section 2 of this manual for instructions.
Improper Alarm Contact Operation	Indicates connection error.	☐ Verify 115 VAC at terminals 7 and 8 with reference to 13.

Condition	Main Cause	Remedy
Improper Light Operation	Usually indicates programming error.	☐ Perform Lamp test by pressing RESET button. ☐ Verify ladder diagram.
Improper Local Operation	Operator error.	☐ Verify SAMMS in local mode.
Improper Contactor Operation	Connection error.	☐ Verify 115 VAC at terminal 7 with reference to 13, and at output terminals 14, 15, or 16 with reference to 13 when the motor is started.
Cannot Change HHC Settings	Usually indicates motor is running.	☐ Change parameters after motor is stopped.
Improper SAMMS Operation	Usually indicates improper grounding, or noise interference.	☐ Refer to Section 2 of this manual for instructions.

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