Control Components

Control components are the essential elements of a motor control center unit. Starters are the most common component, but units may also include a wide variety of other devices.

Starters

NEMA Starters

The motor starter is the heart of the unit. The ESP100 starter from Siemens is the first major technical advancement in NEMA rated motor starters in more than 20 years. It combines the rugged characteristics of a NEMA rated contactor with a solid state overload relay.

It offers the industrial user greater protection and added life for motors in heavy duty applications. The ESP100 is ideal for applications requiring dependability and durability.

Innova/Plus Overload Features

Front Removable Parts for Easier Accessibility

Parts may be removed from the starter without dismantling, disconnecting line or load wires, and without taking the control from the enclosure. Front-accessible, pressure-type electrical connectors are used throughout. All Innova/Plus arc box covers are removable by loosening two front accessible captive screws.

Fewer Moving Parts

Contacts in the Innova/Plus models are opened by a stainless steel spring-assisted gravity dropout that does not depend upon bell cranks or other mechanical linkages. The spring assures quick, precise opening of the contacts.

Pressure-Clamp Terminals

Starter terminals are designed for ease of wiring without bending or looping wires. All mounting screws and pressure terminals face clearly forward, making them easily accessible with a screwdriver.

Single Voltage Coil

Magnetic coils are carefully wound and then encapsulated in epoxy. Encapsulation waterproofs; promotes heat transfer; and resists electrical, mechanical, and thermal stresses.

Silver-Cadmium Oxide Double Break Contacts

Siemens silver-cadmium oxide contacts have high conductivity and superior resistance to welding and arc erosion. Double break contacts with large surface areas reduce resistance and heat. Each contact terminal assembly is completely isolated to prevent arcing when the contacts open. They are self-cleaning and require no maintenance.

Pilot Circuit Flexibility

Extra auxiliary contacts may be added to all starters. The contacts are front mounted. Starters accept up to four auxiliary contacts, two on each side.

Permanent Air Gap

A permanent air gap magnet significantly reduces the possibility of residual magnetism. It prevents the magnet and armature from hanging up, even after millions of operations.

![ESP100 Starter with Solid State Overload](image)
## Starter Sizes and Ratings

<table>
<thead>
<tr>
<th>Size of Starter</th>
<th>Continuous Carrying Current, Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enclosed*</td>
</tr>
<tr>
<td>NEMA Standard Size</td>
<td>NEMA</td>
</tr>
<tr>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>135</td>
</tr>
<tr>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td>6</td>
<td>540</td>
</tr>
</tbody>
</table>

* Rating for standard application. Consult factory for plugging or jogging rating.

### Innova/Plus

The Innova/Plus is the first across-the-line magnetic starter to offer both straight-through wiring and gravity drop-out without bell cranks or other mechanical linkages that limit mechanical life. The Innova/Plus achieves this combination of features through its 45 angle coil, magnet, armature, and contacts. This design provides these benefits. Innova/Plus Magnetic Starters are available in sizes 0, 1, 2, 3, and 4.

### Figure 2 - Size 1 Innova/Plus Starter

### Figure 3 - Less Contact Bounce

Contact bounce is virtually eliminated by the combination of the 45 degree angle and the wedge action contact configuration. Lower movable contacts close in a vertical position and upper movable contacts close in a horizontal position, thus creating opposing forces that negate contact bounce.

### Figure 4 - Faster Arc-Quenching

The direction of the arc is away from any metal components as the contacts are open. The arc is confined in the arc box chamber where it is safely dissipated.

### Figure 5 - Improved Contact Performance

Positive wedging action is created when moving parts close vertically and horizontally with stationary contacts. Such action results in cleaner contact surfaces, better electrical continuity and longer contact life.
Bimetal Ambient Compensated Thermal Overload
Bimetal ambient compensated overload relays protect both the motor and equipment by opening the control circuit when the motor experiences an overload condition. The bimetal overload relay may be set for either manual or automatic reset and can be supplied with standard Class 20 heater elements or optional Class 10 heater elements as required. An ambient compensated model of the bimetal overload is available.

ESP100 Overload
ESP100 solid state overload relays provide a simple and economical improvement compared to conventional thermal overload relays. Because ESP100 is self powered, there is no need to alter control circuit connections in order to take advantage of the benefits of ESP100 compared to thermal overload relays. The electronic circuitry contained in the ESP100 monitors only the current flowing to the motor and is unaffected by ambient temperature making ESP100 ambient insensitive. In addition to thermal overload protection, ESP100 also provides true phase loss protection by tripping in three seconds or less in the event of a phase loss. ESP100 features heaterless construction, wide current adjustment range, simple dial adjustment, thermal memory, 2% repeat tripping accuracy and an optional normally open or normally closed alarm contact.

3UF7 SIMOCODE PRO
SIMOCODE-PRO is a flexible modular motor management system for motors with constant speed in the low-voltage performance range. It optimizes the connection between the control system and motor starter, increases plant availability and allows significant savings to be made for the startup, operation and maintenance of a system.

When SIMOCODE Pro is installed in the low-voltage control cabinet, it is the intelligent interface between the higher level automation system and the motor starter and includes the following:

- Multifunctional, solid state full motor protection which is independent of the automation system.
- Flexible software instead of hardware for the motor control.
- Detailed operational, service and diagnostics data
- Open communication via PROFIBUS DP, the standard for field bus systems.

WARNING
Hazardous voltage. Can cause death, serious personal injury, or property damage.
Automatic reset will continue to reset on two-wire control. When not desired, use three-wire control.
Do not use manual trip button when relay is set in automatic reset position.
3UF7 SIMOCODE Pro
The SIMOCODE Pro "Basic Unit" includes four digital inputs and four relay outputs reducing the I/O count required external to the motor control center unit. Inputs on the SIMOCODE can be used to monitor the status of digital signals typically associated with a motor control unit such as pilot devices, float or pressure switches, vibration or zero speed sensors, etc. and communicate the status to the PROFIBUS master. Outputs can be used to control contactors, relays, pilot lights, etc. Onboard logic allows SIMOCODE to make critical process control decisions at the motor control unit reducing the amount of programming required at the PROFIBUS master. An optional expansion module adds eight input and four output points to the "basic unit". SIMOCODE also has an optional operator control module that includes three programmable push buttons and six programmable indicating LEDs.

Motor Circuit Protector (MCP)
The MCP operates on the magnetic principle with a current sensing coil in each of the three poles with the trip-point adjustable from the front. MCPs are the fastest devices available for clearing low level faults and offer circuit breaker features and convenience: resetable, quick-make quick-break, dead front, and protection against single phasing. MCPs are used as standard circuit protective devices on circuit breaker starters, Sizes 0 - 5. MCPs must be used with overloads. If no overloads are used, a thermal magnetic breaker must be substituted. MCPs are designed with a test-trip feature.
Starter Unit Components

Starter Unit Protective Devices
Starter units are available with two types of protective devices: fusible switches and motor circuit protectors (MCP).

Standard Disconnects
Standard fusible units use the following disconnects:

Siemens Visible Blade 30 - 200A
Siemens Molded Case Switch 400, 600A

Fuse Clips
Fuse clips for Sizes 0 - 5 starters are sized for Time-Delay dual element fuses, type RK.

Fuse clips are provided for fuses sized to protect unit and motor from short circuits. Overloads are used for motor running protection. Fuses in combination starters should not be sized for running protection. Use of non-time delay fuses may require a larger size fuse clip and switch size and more unit space. (See table, page G10 for recommended fuse sizes per HP for branch circuit protection.)

Optional fuse clips for Class J dimension time delay fuses do not require additional space.

Standard Switch Sizes Used on Plug-In Units

(Horsepower Rated)

<table>
<thead>
<tr>
<th>Starter Size</th>
<th>Amps</th>
<th>Let Through $I^2T \times 10^6$ Siemens</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>30</td>
<td>.05</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>.20</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>.50</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Solid-State Controls

As an industrial technology company, Siemens Controls is capable of providing a wide variety of solid-state devices in motor control centers. Typical components may include Softstart Controllers, Variable Frequency Drives, and Programmable Logic Controllers.

The TIASTAR motor control center is designed to mount these, and many other user specified solid state controls.

Programmable Logic Controllers
A full line of PLC's can be mounted in the TIASTAR motor control center.

Siemens has the flexibility and expertise to provide a wide variety of configurations to meet user specified requirements for programmable logic control applications.

Figure 10 - S7-300 Programmable Logic Controller

Control Power Transformers (CPTs)
Control power transformers for Sizes 0 - 6 are dual primary single secondary, encapsulated type, with K type secondary fuses mounted on the transformer. Dual primary fuses are supplied on all CPTs larger than 50VA.

Temperatures rise: 55C
Maximum Ambient: 50C
Class A Insulation
UL/CSA Recognized Component
50/60 Hz rated

Figure 11 - Control Power Transformer
Soft-Start Controllers
Siemens soft-start controllers and starters incorporate the latest in solid-state technology to provide precise control in the starting of AC induction motors. Solid-state reduced voltage starting allows motor voltage to be gradually applied, reducing potentially damaging high inrush currents and starting torques.

These controls are easy to set up, operate, troubleshoot and repair. They are fully adjustable for any application and with voltage ramp capability, can handle varying loads.

Soft-start controllers can lower operating costs by reducing downtime due to equipment maintenance and repair; and minimize product and drive system damage caused by hard physical starts or stops. Siemens Soft-Start controllers with the energy saving feature conserve energy during lightly loaded conditions by reducing the motor voltage and current.

Variable Speed Drives
MICROMASTER drives are built to be the inverter of choice for their innovative design, simplicity, technology and workmanship. They offer an impressive array of performance and flexibility features not common in standard general purpose drives. These drives are available with Sensorless Vector Control that provides the ultimate in torque-developing power to tame any tough application.

MICROMASTER drives are available with horsepower ratings up to 125HP (variable torque) or 100HP (constant torque) at 480VAC.

Master drives (6SE70) provide engineered AC drive solutions to complex applications such as paper machines and metal rolling lines. Master drive features include: DC injection breaking, Master drives with ratings of up to 250HP Constant Torque, or 300HP Variable Torque at 480VAC can be installed in Siemens Motor Control Centers.

Coming Soon:
Siemens Sinamics drives will be available in motor control centers.
### Standard Control Transformer Sizes in VA

<table>
<thead>
<tr>
<th>Starter Size</th>
<th>FVNR</th>
<th>PW</th>
<th>Wye</th>
<th>Delta</th>
<th>2S1W</th>
<th>2S2W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50</td>
<td>150</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

These CPT sizes will allow for the use of a pilot light.

### Excess Capacity CPT VA Rating FVNR Starter Standard Size VA Rating

<table>
<thead>
<tr>
<th>Starter Size</th>
<th>FVNR Standard VA Rating</th>
<th>Excess Capacity Above Starter Required</th>
<th>VA Rating Required For 100 VA Extra</th>
<th>Inrush Requirement VA</th>
<th>Inrush Capacity of Standard Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50</td>
<td>25</td>
<td>150</td>
<td>218</td>
<td>218</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>25</td>
<td>150</td>
<td>218</td>
<td>218</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>24</td>
<td>150</td>
<td>218</td>
<td>218</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
<td>124</td>
<td>250</td>
<td>310</td>
<td>1130</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>75</td>
<td>250</td>
<td>957</td>
<td>1130</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>25</td>
<td>150</td>
<td>133</td>
<td>218</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>90</td>
<td>250</td>
<td>350</td>
<td>1130</td>
</tr>
</tbody>
</table>

3 Starter supplied with interposing relay(s)

### Fuse Selection - Control PowerTransformer

<table>
<thead>
<tr>
<th>Transformer VA</th>
<th>24V Secondary Fuse Size</th>
<th>120V Secondary Fuse Size</th>
<th>240V Secondary Fuse Size</th>
<th>480V Primary Fuse Size</th>
<th>240V Primary Fuse Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>32/10</td>
<td>6/10</td>
<td>3/10</td>
<td>1/2</td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>11/2</td>
<td>3</td>
</tr>
<tr>
<td>250</td>
<td>12</td>
<td>32/10</td>
<td>16/10</td>
<td>21/2</td>
<td>5</td>
</tr>
</tbody>
</table>
Pilot Controls

Pilot Devices
TIASTAR motor control centers are supplied with either 22mm or 30mm pilot devices as required by the users specification. Pilot devices are installed in a door mounted, formed metal, pilot device panel that will hold up to four devices.

3SB3 22mm Plastic
Siemens 3SB3 plastic pilot devices are UL listed and CSA certified and feature an IP66 or NEMA 4X environmental rating making them suitable for any motor control center installation. Heavy duty contact blocks have an A600 rating (10 amps continuous). Selector switches utilize a positive action indexing to assure proper operation. The standard pilot light includes a 120V full voltage lamp. An optional 120V high intensity LED lamp is optional. 22mm transformer type pilot lights are not available in Siemens motor control centers.

Class 52 30mm Metal
Siemens Class 52 chrome pilot devices are optional on TIASTAR motor control centers. Class 52 pilot devices are UL listed and CSA certified and have a NEMA 4 environmental rating. Contact blocks are rated for 10A continuous at 600VAV (NEMA A600.) Selector switches utilize a positive action indexing to assure proper operation. The standard pilot light includes a 6.3 volt secondary transformer to increase lamp life. High intensity LED lamps are optional for all 30mm pilot lights.

Figure 14- Push Buttons, Pilot Lights and Selector Switches

Figure 15- Push Buttons, Pilot Lights and Selector Switches
Relays

Where required to meet specific applications, a variety of control relays and timers are supplied in Siemens motor control centers.

3RH11
Compact size and a variety of contact configurations provide for application flexibility. Relay mounted options include auxiliary contact blocks, surge suppressors and timers.

3RP15 Timing Relay
Solid state timing relays with 1 SPDT contact or 2 SPDT contacts, single or switchable time ranges, contact state indication by LED, voltage indication by LED.

Actuator-Sensor-Interface (AS-Interface)
Siemens motor control centers utilize AS-Interface Slimline Modules to reduce the amount of interconnection wiring required between motor control center units and a PLC. Slimline modules incorporate all of the communication benefits of AS-Interface in a physical package that uses screw terminations rather than the vampire connections found on most AS-Interface devices.
Terminal Blocks and Wiring

Control Terminal Blocks
Screw-mounted stationary control terminals are standard for both type B* and C* units. All terminal blocks are located at the right front of the unit for access from the vertical wireway.

Unit control terminal blocks are:
- White in color
- 600 volt rated
- BoxType with Tang (wire clamped between tang and collar)
- Wire range #22 to #8 CU-AI
- Supplied with White Marking Strip

Terminals supplied in groups of 3 as required for application.

Standard terminal block mounting allows for a maximum of 15 terminal points for control.

* See Definitions for NEMA classes and types of wiring.

Swing Plate
A swing plate for terminal blocks on 12” thru 48” units is another exclusive Siemens Controls feature. By having the terminal blocks pivot out into the vertical wireway, it allows greater wiring accessibility. The swing plate and terminal blocks are pivoted back into the unit when not being worked on.

Stationary Terminal Blocks
Clamping the wire between a tang and a collar provides the following advantages:
1. No twisted off strands.
2. A constant locking torque keeps screws in position.
3. Hardened stainless steel clamping collar eliminates that stripped thread problems.
4. Large opening in clamping collar accommodates over-sized conductors.
5. Design permits deep entry of wire into lug.
6. Terminal blocks are also available with screw type terminals for ring tongue lugs.

Pull-Apart Terminal Blocks
Pull-apart terminal blocks are available. They have the same features as stationary blocks, except that they are pull-apart and interlock mechanically, providing a terminal block assembly in which individual groups are free to move to permit electrical separation while remaining coupled mechanically to the series.

Special Terminal Blocks
Special terminal blocks are available but may require additional unit space to mount.
Load Terminal Wire Ranges

<table>
<thead>
<tr>
<th>Starter Size</th>
<th>Wire Range Starter Load Terminal</th>
<th>* Maximum AWG</th>
<th>Power Terminal Block Wire Range</th>
<th>Stationary</th>
<th>Optional Pull-Apart</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>#14 to #8</td>
<td>#8</td>
<td>#22 to #8</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>#12 to #2</td>
<td>#6</td>
<td>#18 to #2</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>#8 to #2/0</td>
<td>#1</td>
<td>#14 to #2/0</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>#6 to 250MCM</td>
<td>2/0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>(1) #4 to 600MCM</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(2) #1/0 to (2) 250MCM</td>
<td>350MCM</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>#2 to (2) 600MCM</td>
<td>(2) 350MCM</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* To maintain proper bending space for load cables direct to the starter do not exceed max. wire gauge listed.

Load Terminal Blocks
If NEMA Type Bt wiring option is specified, load terminal blocks are supplied on units through Size 3 starters. Pull-apart load terminal blocks can be provided through Size 2. Size 3 starters will be supplied with stationary (non pull-apart) load terminal blocks. Load terminals are white in color.

Type C wiring
Type C wiring uses stationary type terminal blocks. Their standard location is in the top 12" horizontal wireway. C terminals may also be located in the bottom 6" horizontal wireway.

Three rows of terminals for control and load may be mounted at the top.

Space is available for 42 terminals per row for control and load. For each unit size 2, reduce 3 terminals per unit, due to larger load blocks. For each unit size 3, reduce 6 per unit.

The bottom wireway is limited to one row of terminals only. C terminals cannot be located in the same area as incoming lines. C terminals for a section with incoming lines, whether connected to main lugs or main disconnect, will be located in an adjacent section. C terminals will be restricted to two rows in a section with a print pocket.

Ground or neutral bus should not be located in the same area as C terminals because of restricted conduit room and the number of C terminals that can be mounted.

Type C terminals

Master Terminal Block Location

Figure 22 - Type “C” wiring terminal

Figure 23
Wiring Specifications

Control on Units
- 16 gauge
- 19 strand bonded copper
- 105C - 600V - PVC

Interconnection Control Wiring Between Units
- 14 gauge
- 19 strand copper
- 105C - 600V - PVC

Power Wiring - Sized to suit maximum HP rating of unit
- 12 gauge to 2 gauge
- 19 strand copper
- 105C - 600V - PVC

1 gauge to 500 MCM
- 19 strand to 37 strand copper
- 105C - 600V - PVC

Standard Color Coding of Wires
- AC Control (all voltages) . . . . . . . . . . . . . . . . Red
- DC Control (all voltages) . . . . . . . . . . . . . . . . Blue
- AC Power(all voltages) . . . . . . . . . . . . . . . . . Black
- Line Side CPT . . . . . . . . . . . . . . . . . . . . . . Black
- Equipment Ground . . . . . . . . . . . . . . . . . . . Green
- Current Carrying Neutral . . . . . . . . . . . . . White
- Interconnecting Control Wires Between Units . . . . . Red