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Ingenuity for life

SIMOVAC and SIMOVAC-AR

Medium-voltage controllers
2.3 kV - 6.9 kV

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SIMOVAC™ and SIMOVAC-AR™ - the latest generation of Siemens successful motor controls.

Siemens experience gained in 50+ years of supplying medium-voltage controllers in the U.S. has been captured in the design.

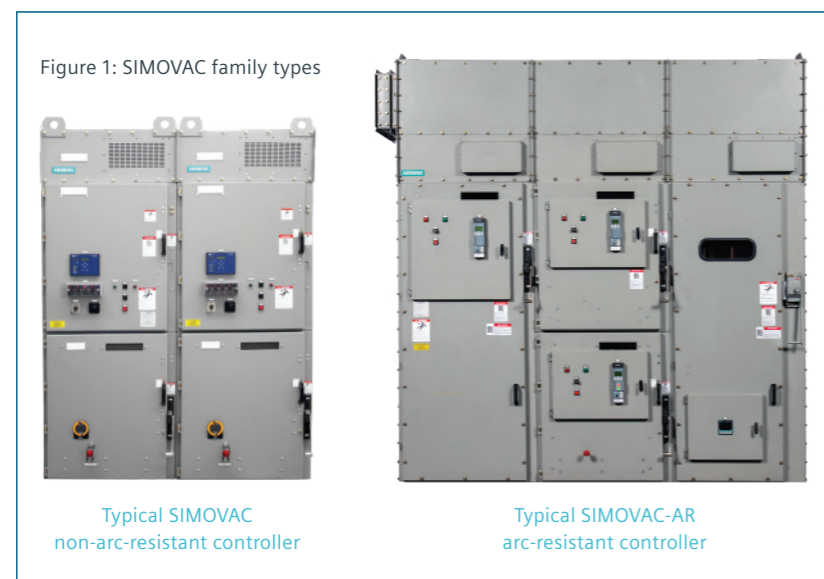


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Product overview

The SIMOVAC non-arc-resistant and SIMOVAC-AR arc-resistant controllers are the latest generation of Siemens' successful medium-voltage control family



Types of Siemens SIMOVAC controllers include:

- SIMOVAC non-arc-resistant medium-voltage controller (indoor or outdoor)
- SIMOVAC-AR arc-resistant medium-voltage controller (indoor).

The type SIMOVAC-AR equipment is classified as arc-resistant, as defined in ANSI/IEEE C37.20.7, and has been qualified in tests to carry a type 2B accessibility rating. These arc-resistant features provide an additional degree of protection to personnel in close proximity to the equipment in the event of an internal arcing fault while the equipment is operating under normal conditions. The enclosure withstands the pressures and elevated temperatures of an internal arcing fault and directs the hot gases and arc by-products into the top-mounted pressure relief channel (PRC). These arc by-products are then vented to the outside environment through an exhaust duct or plenum system.

Typical motor and feeder applications:

- Squirrel-cage induction motors (non-reversing, reversing, multi-speed or soft start)
- Transformer feeder
- Power bus feeders (tie).

Typical controller types:

- Full-voltage non-reversing (FVNR)
- Full-voltage reversing (FVR)
- Two-speed two winding (2S2W)
- Two-speed one winding (2S1W)
- Reduced-voltage autotransformer (RVAT)
- Solid-state reduced-voltage (or soft start) starter (SSRVS).

Siemens has provided medium-voltage controllers to users in the U.S., Canada, and around the world for construction, industrial, and utility projects for over 50 years. The Siemens SIMOVAC medium-voltage non-arc-resistant and SIMOVAC-AR arc-resistant controllers have a modular design incorporating up to two 12SVC400 (400 A) controllers, housed in a free-standing sheet steel enclosure. Each controller is UL 347 6th Edition class E2, equipped with three current-limiting fuses, a non-load-break isolating switch, and a fixed-mounted vacuum contactor (plug-in type optional for 12SVC400). The enclosure is designed for front access, allowing the equipment to be located with the rear of the equipment close to a non-combustible wall.

Technical ratings

Table 1: Controller assembly ratings

Maximum voltage kV	Short-circuit current class E2 ² kA	Insulation level (impulse) ³ kV	Main bus continuous current ¹ A	Short-time current duration (main bus)	Internal arc resistance (SIMOVAC-AR only)
5.0	63 ⁴	60	1,200, 2,000, 3,000, 4,000 ^{5, 6}	10 cycles (two seconds optional)	Accessibility type 2B 0.5 seconds
7.65	63 ⁴	60	1,200, 2,000, 3,000, 4,000 ^{5, 6}	10 cycles (two seconds optional)	Accessibility type 2B 0.5 seconds

- Footnotes:**
1. All main bus ratings are on a self-cooled, ventilated basis.
 2. Short-time duration for controllers without main bus is limited to contactor capability (with fuses).
 3. Insulation level is for the controller, with inductive transformers disconnected for testing (per UL 347).
 4. 50 kA with certain contactor/fuse combinations.
 5. Type 12 up to 2,000 A. Type 3R up to 3,000 A.
 6. 4,000 A is available for type 1 enclosure only.

Table 2: Controller maximum current capability

Controller type	Type 1 non-arc-resistant; type 2 non-arc-resistant; type 3 outdoor non-arc-resistant	Type 1 arc-resistant	Type 12 non-arc-resistant
Two-high compartment with 12SVC400 controller	340 A top 400 A bottom	340 A top 400 A bottom	340 A top 380 A bottom
One-high compartment with 12SVC400 controller	400 A top or bottom	400 A top or bottom	380 A top or bottom
One-high compartment with 12SVC800 controller	720 A	720 A	630 A

Table 3: Contactor/controller ratings

System voltage	Vacuum contactor	Enclosed continuous ampere rating ¹	Interrupting capacity		Motor horsepower rating (three phase)			Transformer loads ²		
			Unfused class E1	Fused class E2	Synchronous motors	Induction motors	Maximum motor fuse rating	Maximum three phase	Maximum fuse rating	
kV	Type	A	kA	kA	0.8 PF	1.0 PF	HP	kVA		
2.3	12SVC400	400	4.8	63 ³	1,500	1,750	1,500 ⁷	24R ³	1,500	450E ⁶
2.3	12SVC800	720	7.2	63 ⁴	3,000	3,500	3,000	57X ⁴	2,500	900E
4.0	12SVC400	400	4.8	63 ³	2,500	3,000	2,500 ⁸	24R ³	2,500	450E ⁶
4.0	12SVC800	720	7.2	63 ⁴	5,500	6,000	5,500	57X ⁴	5,000	900E
4.6	12SVC400	400	4.8	63 ³	3,000	3,500	3,000	24R ³	3,000	450E
4.6	12SVC800	720	7.2	63 ⁴	6,000	7,000	6,000	57X ⁴	5,000	900E
6.9	12SVC400	400	4.8	63 ⁵	4,000	5,000	4,000	18R ⁵	3,750	400E ⁶ -18R
6.9	12SVC800	720	7.2	63 ⁴	8,000	10,000	8,000	57X ⁴	4,000-6,000	750E-57X ⁴

- Footnotes:**
1. Refer to Controller maximum current capability table for further detail.
 2. Based on self-cooled transformer rating.
 3. With 24R fuse, interrupting capacity is 50 kA.
 4. With 48X or 57X fuse, interrupting capacity is 50 kA.
 5. Maximum fuse is 18R.
 6. Fuse shown will not permit transformer forced-cooling rating of 133 percent of self-cooled rating.
 7. For horsepower greater than 1,500, please consult factory.
 8. For horsepower greater than 2,500, please consult factory.

Construction

Enclosures

The Siemens SIMOVAC controller is an integrated system of contactors and components arranged for convenient access within a common enclosure consisting of one or more free-standing structural sections.

Available in the following enclosure types to meet the specific needs:

- Type 1 non-gasketed
- Type 1 gasketed (rear panels only)
- Type 2 drip resistant (non-arc-resistant only)
- Type 3R (non-arc-resistant only)
- Type 12 dust tight (non-arc-resistant only).

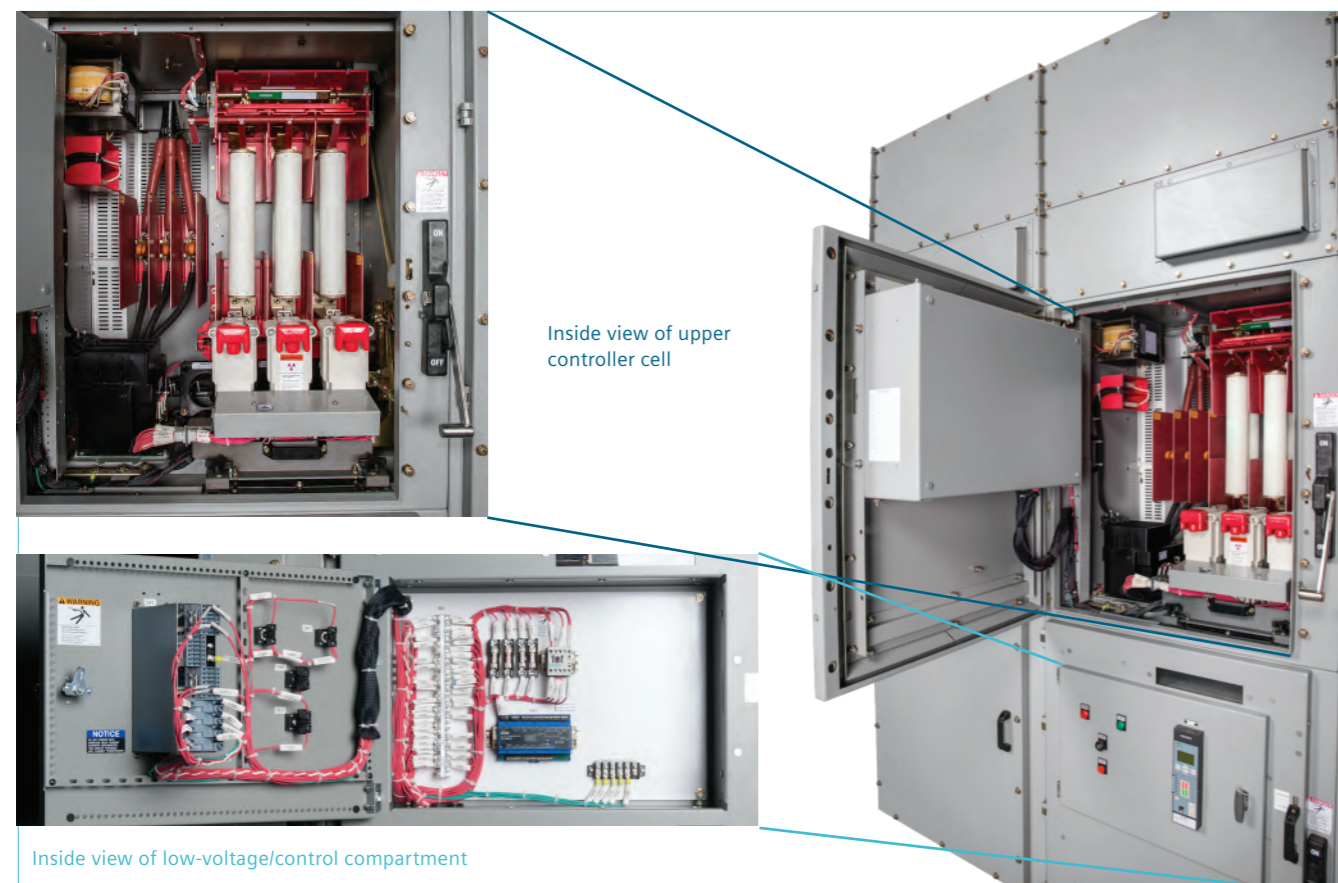
External finish is ANSI 61 light gray polyester, electrostatically applied.

Compartment segregation

Each controller assembly consists of four areas completely segregated from one another:

- Medium-voltage bus bar compartment
- Medium-voltage contactor compartment
- Low-voltage compartment
- Pressure relief channel (PRC) (arc-resistant only).

Figure 2: Typical 12SVC400 (400 A) SIMOVAC family types (SIMOVAC-AR shown)



SIMOVAC sections are normally 36" (914 mm) wide, 30" (762 mm) deep and 95" (2,413 mm) tall (for 4000 A main bus, add 7.25" (184 mm) to the height), while SIMOVAC-AR sections are 36" (914 mm) wide, 40" (1,016 mm) deep and 112" (2,845 mm) tall). The controllers can be arranged to meet specific customer needs and can be configured to accept up to two 12SVC400 (400 A) starters per vertical section.

1,200 A load-interrupter switch sections are similar but are 48" (1,218 mm) wide.

Outdoor non-arc-resistant controllers are similar except width increases 6" (152 mm) per section, height increases to 107.3" (2,725 mm), and depth increases to 37.4" (950 mm).

Medium-voltage bus bar compartment

The medium-voltage bus bar compartment is located on top of the section and isolated with grounded barriers. It encompasses the main horizontal bus bar range from 1,200 A through 4,000 A. The vertical bus bar in the rear of the vertical section to the medium-voltage compartments is rated up to 720 A.

Standard bus bar material is copper with silver-plated joints for electrical connections. Copper bus, with tin-plated joint surfaces, is also available as an option. Bus bars are insulated with an epoxy insulation applied by a fluidized bed method. Bus bar joints may be insulated with optional molded-insulation boots or tape.

The main bus compartment is equipped with covered vents. For a SIMOVAC-AR arc-resistant controller, vents are provided with pressure flaps that seal and control the hot gases and by-products inside the bus compartment during an internal arcing fault to achieve the arc-resistant rating and type 2B accessibility.

Figure 5: Bus compartment covered vents

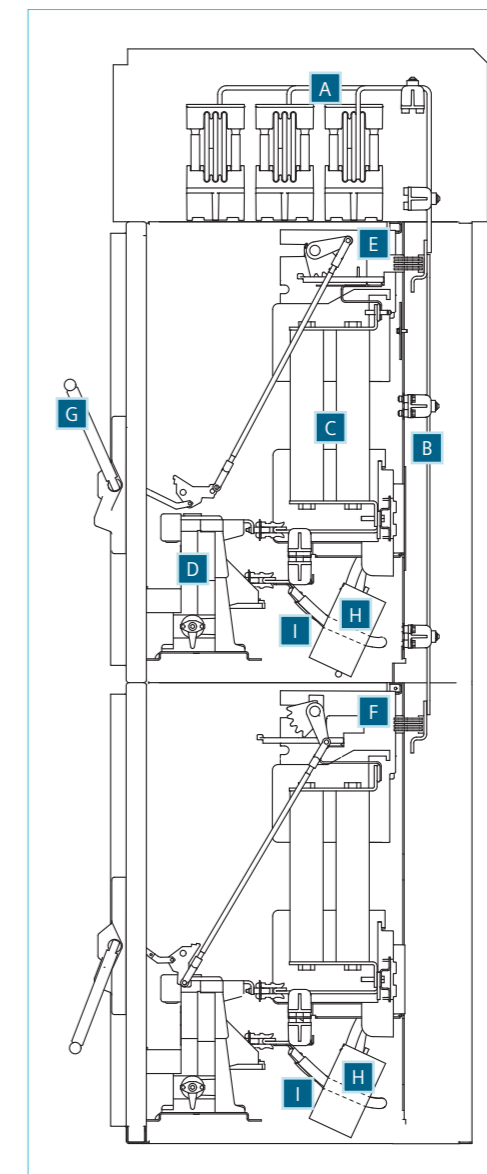
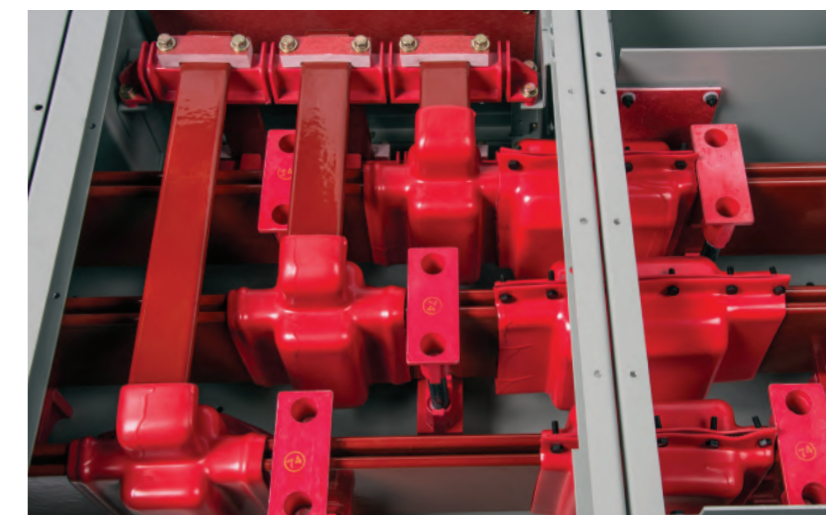


Figure 3: Controller arrangement

Item	Description
A	Main bus
B	Vertical bus
C	Bolt-in primary fuses
D	12SVC400 contactor (plug-in shown)
E	No-load isolating switch (shown closed)
F	No-load isolating switch (shown open)
G	Isolating switch operating handle
H	Phase current transformers
I	Load cables (internal) to user's terminal pads on left side of compartment

Figure 4: Horizontal and vertical bus bars with optical insulating boots for joints



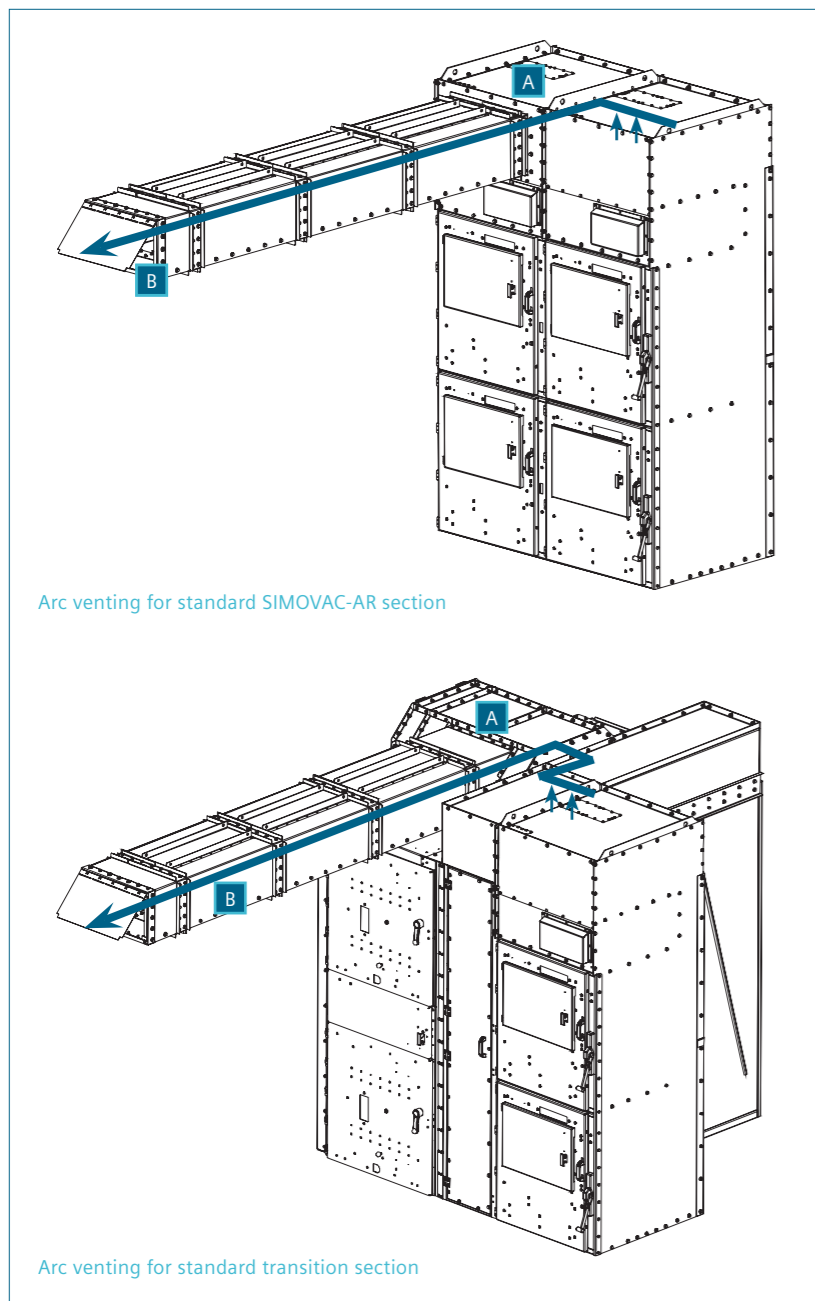


Figure 6: Typical exhaust plenum (duct) connection to PRC

Item	Description
A	Pressure relief channel
B	Exhaust plenum (duct)

Type SIMOVAC-AR equipment is classified as arc-resistant, as defined in ANSI/IEEE C37.20.7, and has additional features added to the basic design that have been qualified via testing to carry a type 2B accessibility rating. These arc-resistant features provide an additional degree of protection to personnel in close proximity to the equipment in the event of an internal arcing fault while the equipment is operating under normal conditions.

SIMOVAC-AR arc-resistant requires a minimum of two vertical sections, or alternatively, one vertical section of SIMOVAC-AR with common pressure relief channel (PRC) connected to type GM-SG-AR arc-resistant switchgear.

The equipment must be installed with at least 6" (152 mm) clearance between the sides and the rear of the enclosure and any adjacent walls, enclosures or equipment.

The enclosure withstands the pressures and elevated temperatures of an internal arcing fault and directs the hot gases and burning particulates into the top-mounted PRC. These arc by-products are then vented to the outside environment through an exhaust plenum system.

The PRC is provided on all SIMOVAC-AR arc-resistant assemblies. The PRC is assembled and installed at the factory, and requires no field assembly except for connections between shipping groups. The exhaust plenum (or duct) is provided separately, in modular shipping lengths (normally 36" (914 mm) long), and the shipping lengths are easily installed and connected together at the site.

In cases where a transition section is used to close couple SIMOVAC-AR controllers to Siemens type GM-SG-AR medium-voltage switchgear, the hot gases and burning particulates are directly exhausted into a common PRC for both SIMOVAC-AR controllers and GM-SG-AR switchgear, before being vented to the outside through a common exhaust plenum. Figure 6 shows an exhaust plenum for a SIMOVAC-AR lineup and for a SIMOVAC-AR section connected to type GM-SG-AR switchgear section with a transition section. This figure depicts the exhaust plenum connected to the front, but the plenum may be connected to either side or to the rear, or to the top of the PRC.

The exhaust plenum (duct) must be routed outside the equipment room and to an area where personnel will not be present when the equipment is energized.

If installation conditions do not allow for exhaust of arcing gases outside of the building, the area in the vicinity of the exhaust outlet must be kept clear in accordance with Figure 7.

Enclosures used to couple type SIMOVAC-AR controllers to other equipment (for example, transition sections, transformer throats, bus ducts, etc.) as well as specialized vertical sections within a lineup of type SIMOVAC-AR equipment that have not been qualified for resistance to internal arcing are not considered to be arc-resistant.

Medium-voltage 12SVC400 (400 A) compartment

The access to the medium-voltage 12SVC400 (400 A) controller contactor compartment is by means of a rugged 11-gauge formed sheet steel door with a single-handle operated six-point sliding latch. In accordance with UL 347, a combination of mechanical and electrical interlocks will not allow the compartment door to be opened when the isolating switch is in the ON (CLOSED) position. With the medium-voltage compartment door open, the user is completely isolated from medium voltage. In addition, the isolating switch cannot be operated except when the compartment door is closed.

For 12SVC800 (720 A) controllers, load-interrupter switches, incoming line sections, and other arrangements, the medium-voltage compartment doors are bolted closed.

Isolating switch

Siemens 400 A and 720 A isolating switches are three-pole manually-operated non-load-break isolating switches. These switches have the same overall design and mounting, but the conductor components change according to the ratings. The isolating switch is equipped with a vertically aligned stab on each phase to engage fingers that connect to the vertical bus when the switch is in the ON (CLOSED) or CONNECTED position.

During the closing operation, the isolating shutter is opened to expose the primary fingers connected to the vertical bus bars. In the open position, the load side of the switch is grounded, and the shutter is closed.

For visible indication of the position of the isolating switch, open and closed labels are positioned on the main gear drive shaft, and are visible from outside the enclosure through the viewing window.

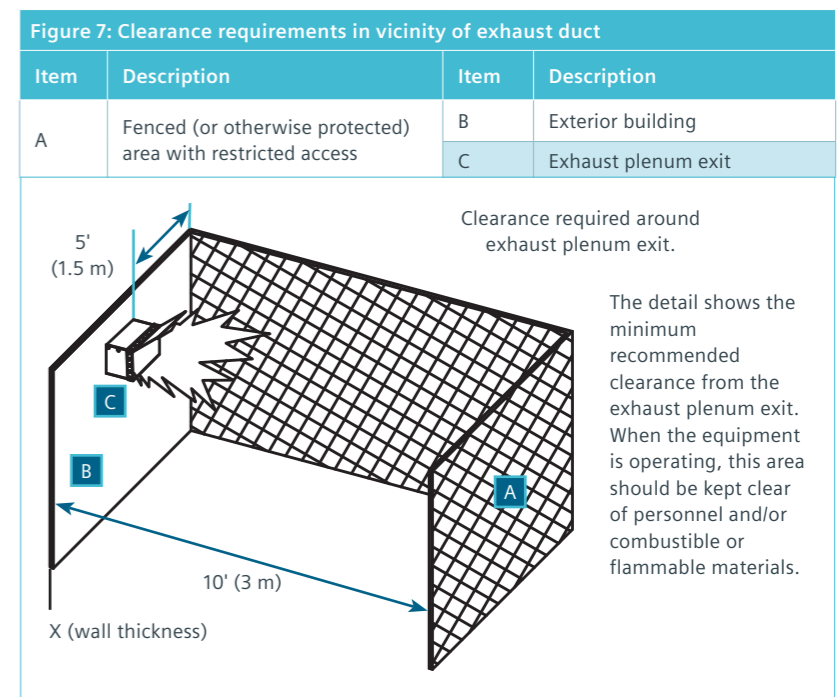


Figure 8: Low-voltage and medium-voltage compartment doors (400 A)



Figure 9: Isolating switch (shown in OPEN position)

Viewing window

The 2" (51 mm) x 10" (254 mm) viewing window located in the medium-voltage compartment door allows quick and easy verification of the opened and closed positions of the isolating switch by inspecting the OPEN and CLOSED labels positioned on the main gear drive shaft. Viewing isolating switch position does not require opening the low-voltage compartment door. Also, the isolating shutter is visible to provide additional verification that the switch is disconnected from the vertical bus and the compartment is safe to access.

Figure 10: Typical controller configurations

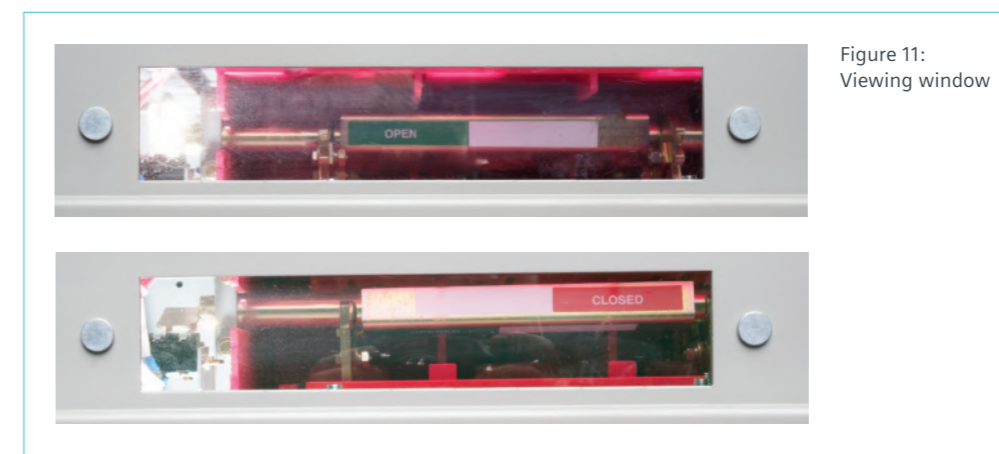
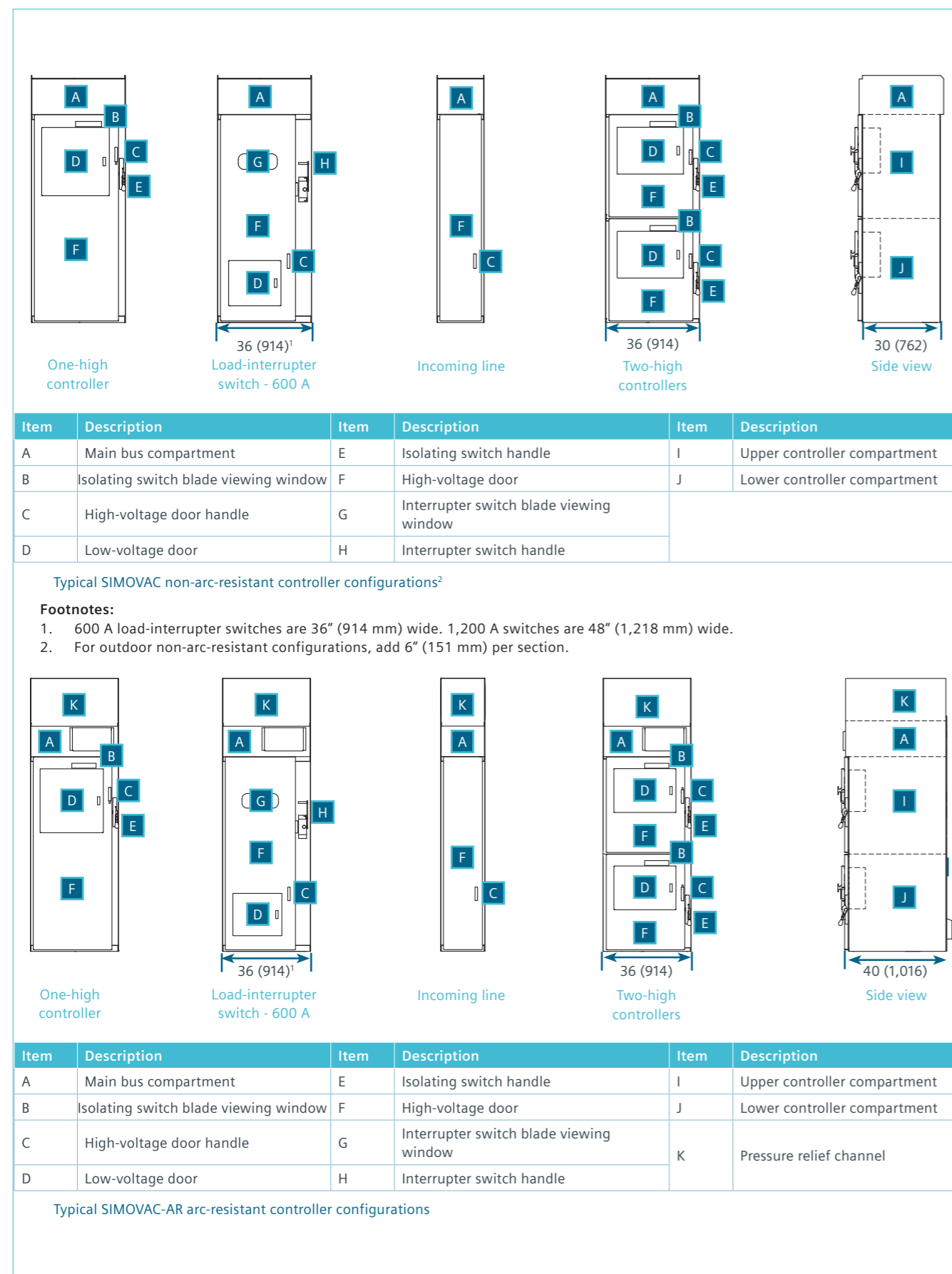


Figure 11: Viewing window

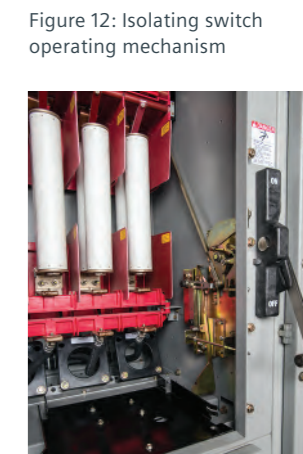


Figure 12: Isolating switch operating mechanism

Isolating switch operating handle and mechanical interlocks

Operation of the isolating switch is accomplished by using a mechanism actuated by an external, enclosure-mounted handle. Since the isolating switch is a non-load break type switch, interrupting loads or closing into a load is not allowed by the interlocks.

The switch handle is mechanically interlocked to the vacuum contactor such that the contactor must be in the open position before the switch handle can be moved either from the open position to the closed position or from the closed to the opened position.

The interlocks will not allow the compartment door to be opened when the isolating switch is in the ON (CLOSED) position. With the medium-voltage compartment door open, the interlock will not permit operation of the isolating switch in the CLOSED or OPEN positions. The handle can be locked in the open position with up to three padlocks.

For reduced-voltage autotransformer controllers, the door for the autotransformer section must be closed to permit operation of the isolating switch.

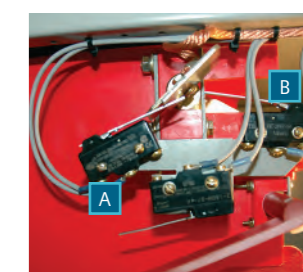
Test circuit

Each SIMOVAC controller is provided with a built-in test circuit for operation of the contactor from a remote source of control power when the isolating switch is open. It allows maintenance and operation of the main contactor and low-voltage control circuitry without disconnecting any load cables, and prevents back-energization of the CPT.

DSI switch (B in Figure 13) opens when the isolating switch is open, to disconnect CPT from the control circuit for testing.

DST switch (A in Figure 13) closes to connect control power from external source for testing. DST closes when isolating switch is open and grounded.

Figure 13: Isolating switch interlock (DSI) auxiliary switch and isolating test switch (DST) auxiliary switch



Item	Description
A	Disconnect test switch (DST)
B	Disconnect switch interlock (DSI)



Figure 14: Blown fuse trip mechanism (optional)

Blown fuse indication (standard) and blown fuse trip mechanism (optional)

An optional anti-single-phase trip mechanism is available. This option offers protection from single phasing due to a blown power fuse. The blown fuse trip mechanism is arranged so that the opening of one or more power fuses results in de-energizing the contactor main coil (for a non-latched contactor), thus causing the contactor to dropout. When a power fuse blows, a plunger extends from one end of the fuse. This plunger causes the spring-loaded trip bar to rotate, and actuates a micro-switch. A contact on the micro-switch opens at this time and de-energizes the contactor magnet coil. For latched contactors, the blown-fuse micro-switch closes a contact in the latch circuit to similarly cause the contactor to open. The plunger indication of a blown fuse is standard.

Low-voltage compartment

All starter compartment front panels are provided with a “door-in-door” for access to the controller low-voltage area. Devices normally mounted in this section can include such devices as a Siemens 9350 power meter, overload relay, ammeter, control relays, timing relays, push buttons, indicating lights, etc. Location within this section isolates the devices from any source of high voltage and allows access to these control devices without interrupting service. Terminal blocks for control circuit wiring terminations are also accessible in this compartment.

For SIMOVAC-AR arc-resistant controller, this compartment has been qualified as accessibility type 2B with low-voltage compartment door open.

For improved visibility, the entire low-voltage compartment is painted white.

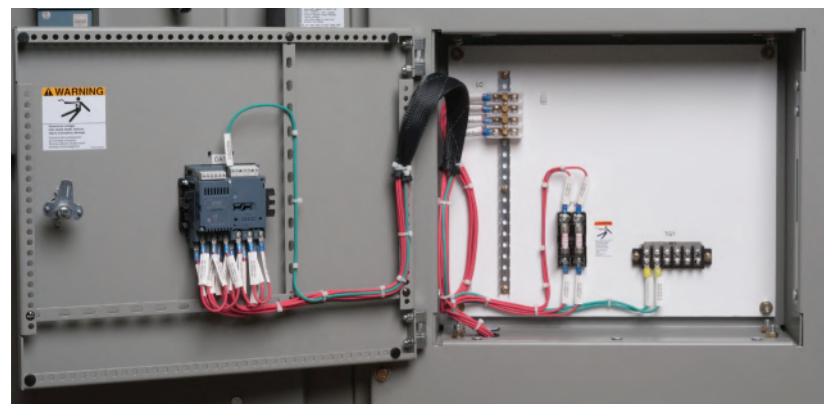
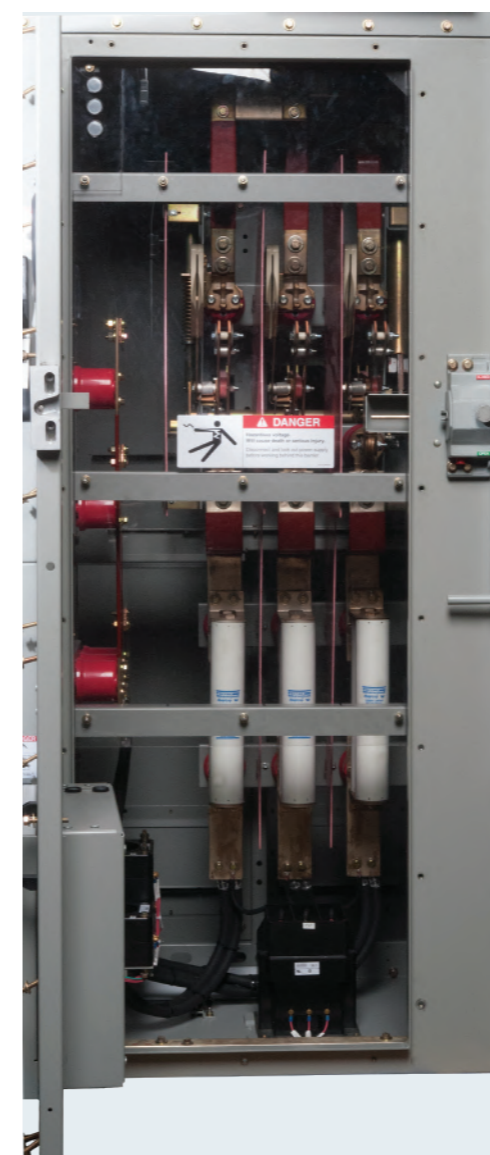


Figure 15: Low-voltage compartment

Figure 16: Fused load-interrupter switch unit (600 A)



Load-interrupter switch (LIS)

Figure 16 shows the manually operated, single-throw, gang-operated load-interrupter switch available in SIMOVAC and SIMOVAC-AR assemblies, rated either 600 A or 1,200 A. Quick-make, quick-break arcing blades combined with arc chutes provides positive, three-phase interruption of load currents. The switch uses a quick make/quick break stored-energy operator. The load-interrupter switch may be unfused or equipped with current-limiting fuses to provide short-circuit current interrupting capacity. Fuses are mounted below the switch. Table 4 shows the ratings for the load-interrupter switch.

The door and switch operating handle are mechanically interlocked to ensure the door cannot be opened with the switch closed and the switch cannot be closed with the door open. In addition, the switch is covered with a Lexan® barrier. The switches are fixed mounted and can be equipped with fixed-mounted fuses. 600 A load-interrupter switches, whether fused or non-fused, fit in a full height 36” (914 mm) wide section. 1,200 A load-interrupter switches, whether fused or non-fused, require a full-height 48” (1,218 mm) wide section.

Optional accessories for the load-interrupter switches include auxiliary contacts (2 NO and 2 NC) or blown fuse indicator. The switch ratings are detailed in Table 4.

Lexan is a registered trademark of Saudi Basic Industries Corporation (SABIC).

Table 4: Load-interrupter switch unit ratings

Switch rating A	Maximum voltage kV	Fused or unfused	Symmetrical kA
600	7.2	Unfused	25
600	5.0	Fused (≤ 450E)	63
600	7.2	Fused (≤ 400E)	63
1,200	7.2	Unfused	38
1,200	5.0	Fused (≤ 900E)	63
1,200	7.2	Fused (≤ 400E)	63



Figure 17: Reduced-voltage, autotransformer, non-reversing controller

Benefits of RVAT starting:

- Reduced torque shock damage on motor and driven load
- Increased motor and drive train reliability
- 50%, 65%, and 80% tap settings allow for flexible starting characteristics
- Easy to maintain
- Reduced hydraulic/mechanical problems
- Low-current starting limitations
- Increase starting torque
- Mechanical interlock between Run and Start contactor and between main and auxiliary high-voltage doors
- More experienced maintenance personnel available.

Reduced-voltage, autotransformer, non-reversing controller

Reduced-voltage, autotransformer, non-reversing controller in addition to Siemens solid-state, reduced-voltage (SSRV) controller consists of a main vacuum contactor, run vacuum contactor, starting vacuum contactor, and an autotransformer.

This traditional electro-mechanical approach to starting medium-voltage motors is rated for NEMA medium-duty applications. The simplified reduced-voltage starting method has been used for years and is highly familiar to users.

Motor data must be provided when ordering to ensure that the autotransformer is sized properly.

Reduced-voltage, autotransformer, non-reversing controller starting

This starting type introduces an autotransformer in the line ahead of the motor to step down the voltage applied to the motor terminals and thereby reduces the current drawn from the line upon starting.

- The standard three-coil autotransformer reduces the switching surge significantly by 57 percent.
- Available tap settings are 80%, 65%, and 50%.
- This starter type produces more line current to the motor during starting than other reduced-voltage starter types, while keeping the voltage low.
- Reduces overloading to the power system during the starting of the motor.
- Reduces the wear and tear on the equipment with reduced-starting torque.
- Cost-effective method for reduced-voltage starting.
- Preferred reduced-voltage starting method over primary resistor.
- Larger footprint as compared to the full-voltage, non-reversing controller.

Starting characteristics

The various taps on the autotransformer provide the option for different starting voltages. Higher voltage taps are used for applications that require high-starting torque, or to limit the accelerating period within the duty-cycle rating of the autotransformer. Controllers are normally set to the 65-percent voltage tap when they leave the factory.

Table 5: Starting characteristics

Tap setting ¹	% motor voltage	% motor current	% line current	% torque
80% tap	80	80	67	64
65% tap	65	65	45	42
50% tap	50	50	28	25

Footnote: 1. Factory set on 65%.

Starting-duty cycle

The autotransformers used in Siemens RVAT motor controllers are three coils and conform to UL 347 6th Edition for medium duty and are suitable for general motor starting service.

The starting duty cycle rating based on a temperature rise of 115 °C, 65% tap, with tap current 300% of motor full-load current and a power factor of 50% or less is as follows in table 6.

Table 6: Medium-duty starting cycle

Duty cycle	Description
ON	30 seconds
OFF	30 seconds
Starts	Two times (for a total of three cycles with first start from ambient)
ON	30 seconds
OFF	30 seconds
Repeat	Two times (for a total of three cycles)

Solid-state reduced-voltage starter (SSRVS) controllers¹

Solid-state reduced-voltage starter (SSRVS) controller consists of a main contactor, a silicon controller rectifier (SCR) chassis and a bypass contactor (rated for full-voltage starting).

The SSRVS controller provides the most flexible starting options, offering selectable current or voltage ramps. For emergency full-voltage starting, the bypass contactor can be used as an across-the-line starter by changing a control switch position.

As an option, the starter can be equipped with a permanent emergency across-the-line starting option including an additional set of current transformers (CTs), normal/emergency selector switch and a bimetallic overload relay. Repositioning power cables for this option is not required.

Benefits of SSRVS starting:

- Reduced torque shock damage on motor and driven load
- Increased motor and drive train reliability
- Starting kVA limitation
- Maintains future system flexibility
- Soft-start and soft-stop (for pumps) to control water hammer
- Reduced hydraulic/mechanical problems.

Footnote: 1. UL/cUL listing not available with SSRVS controllers with 12SVC800 (720 A) contactor.

SCR logic control

The SCR logic control incorporates the following standard protection, metering and parameter adjustments:

- Initial voltage (0 to 50 percent nominal voltage; 0 to 80 percent using extended setting)
- Current limit (100 to 400 percent of motor FLA standard; 100 to 700 percent using extended setting). Please contact Siemens representative for setting below 300 percent
- Overcurrent rating (400 percent - 30 seconds)
- Acceleration time (1 to 30 seconds standard; 1 to 90 seconds using extended setting)
- Deceleration time (0 to 30 seconds; 0 to 90 seconds using extended setting)
- Decel-final torque (0 to 10 percent sensitivity)
- Pump control - in addition to the standard start curve and torque curve, there are three selectable pump control curves and stop curves
- Pulse (kick) start (for pulse time less than 1 second, 70 to 700 percent of full-load amperes (FLA); for pulse time greater than 1 to 10 seconds, 70 to 400 percent of FLA)
- Undervoltage trip (50 to 90 percent, adjustable trip delay)
- Overvoltage trip (110 to 125 percent, adjustable trip delay 1 to 10 seconds)
- Undercurrent (load-loss) trip (0 percent equals off, 20 to 90 percent of motor FLA with adjustable trip delay adjustable from 1 to 40 seconds)
- Allowable restarts (0 to 10, adjustable time inhibit)
- Electronic overload (inverse time, two-stage programmable class 5 to 30); choose from either IEC or NEMA overload curves
- Electronic shear pin (100 to 850 percent of motor FLA with adjustable trip delay of 0 to 5 seconds)
- Phase loss (one or more phases missing with phase loss auto-reset feature)
- Shorted SCR (internal fault detected, operational after the start signal is initiated)

- Wrong connection (internal fault/motor connection, operational after the start signal is initiated)
- Starter over temperature (heat sink over temperature). Thermal sensors mounted on the heat sinks. Trips the starter when heat sink temperature rises above 185 °F (85 °C)
- Elapsed time meter, displays the motor total run time
- Time since last start
- Last start maximum current
- Starting time for last start
- Total number of starts
- Cause of last start
- Percentage of current at last trip
- Total number of trips
- RS 485 with Modbus remote terminal unit protocol (optional Profibus DO available)
- Opto-isolated inputs
- Number of relay outputs (3 form C)
- Analog output (programmable as 0-10 Vdc, or 4-20 mA, or 0-20 mA)
- Display (alphanumeric liquid-crystal display (LCD) - 2 lines x 16 characters)
- Non-volatile memory for programming and faults
- Programmable in four languages
- Residual ground-fault protection.



Figure 18: Solid-state reduced-voltage starter

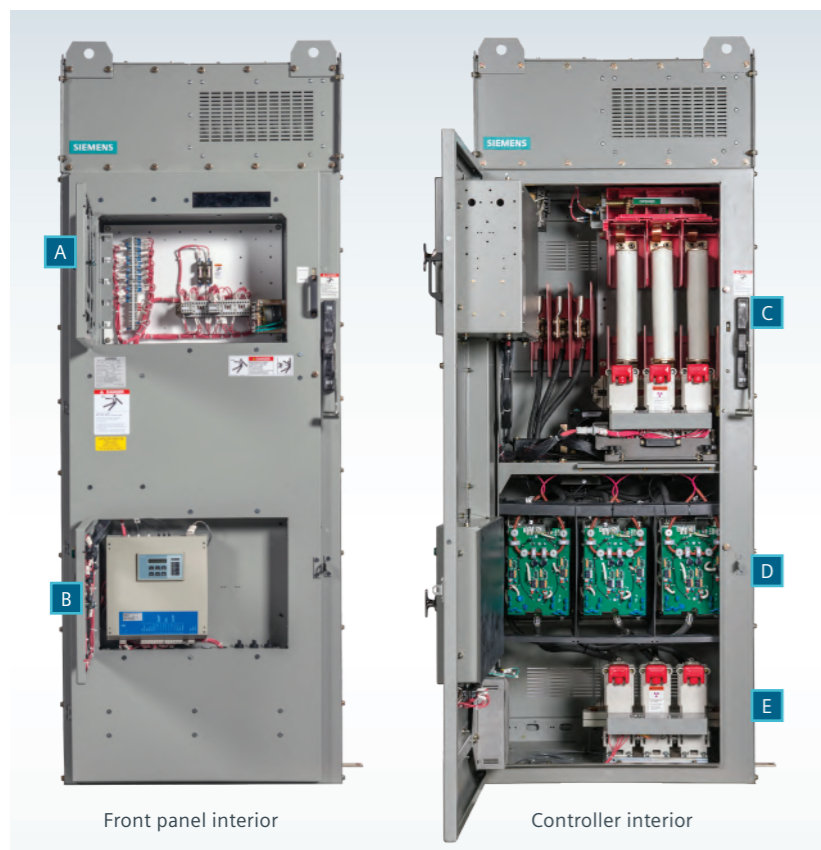


Figure 19: SSRV controller

Item	Description
A	Upper: control low-voltage compartment
B	Lower: control module for power section
C	Upper: isolating switch, power fuses, and main contactor
D	Middle: solid-state, reduced-voltage power section
E	Lower: bypass contactor

Auxiliary components

Current transformers (CTs)

Starters using conventional overload relays are provided with current transformers mounted in the cable termination area of the controller compartment. These are used to drive the overload relay, ammeter or other devices that require a current input. CT selection takes into consideration the burden and accuracy requirements that are appropriate for the specified instrumentation and protective devices. The secondary current rating is always 5 A. The primary current rating is selected so that the actual secondary current will be between 3 A and 4 A with the motor (or other load) operating at full load.

Applications at 7.65 kV or below use the type 81CT10 CT with standard accuracy rating as shown in Table 7. Higher accuracy class CT (type 81CT20) or higher burden CTs (type 81CT50) are also available as options as shown in Tables 8 and 9.

A SIMOVAC controller can be fitted with up to two standard accuracy CTs per phase in a 12SVC400 (400 A) medium-voltage compartment. Consult with factory for details.

Figure 21: Current transformers

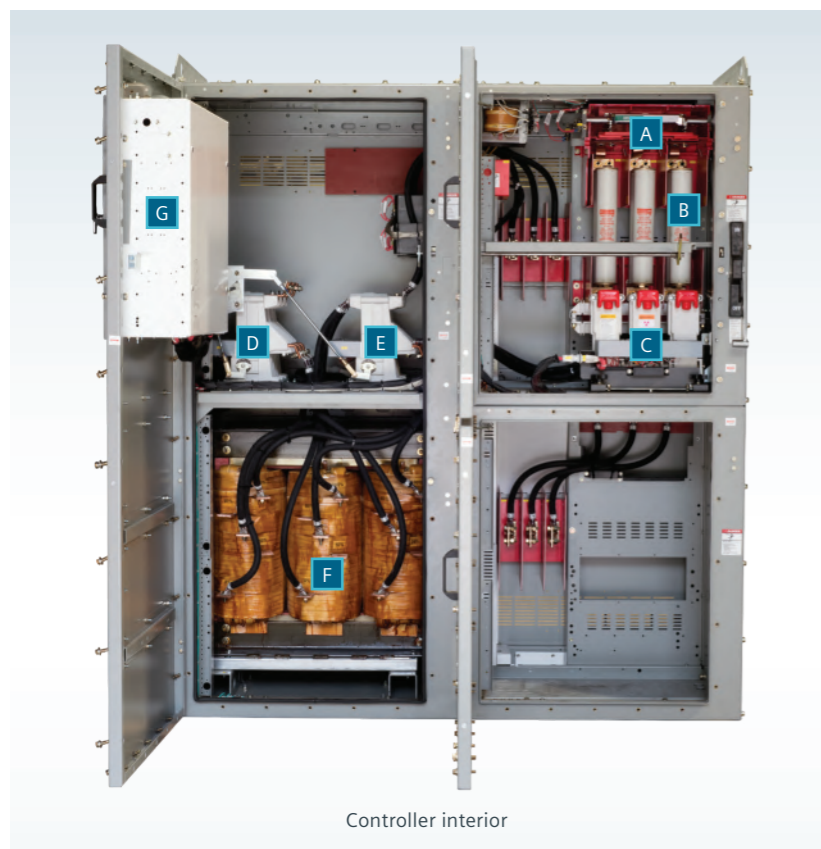
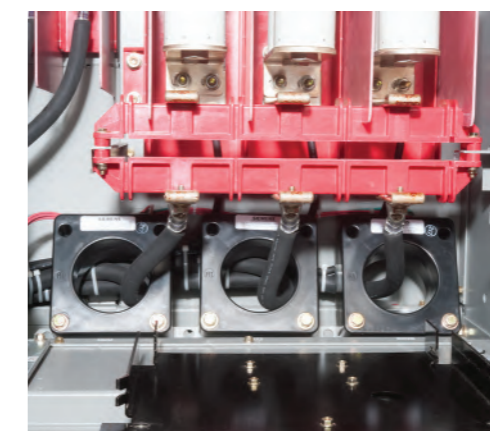


Figure 20: RVAT controller

Item	Description
A	Non-load isolation switch
B	Power fuses
C	Main contactor
D	Shorting contactor
E	Run contactor
F	Autotransformer
G	Low-voltage compartment

Table 7: Relay class C10 standard CTs, type 81CT10

Ratio	60 Hz metering accuracy at burden				Relay class	Used on
	B-0.1	B-0.2	B-0.5	B-0.9		
30:5	0.6	0.6	1.2	2.4	C08	12SVC400
40:5	0.3	0.6	0.6	1.2	C10	12SVC400
50:5	0.3	0.6	0.6	1.2	C10	12SVC400
75:5	0.3	0.3	0.3	0.6	C10	12SVC400
100:5	0.3	0.6	0.6	1.2	C10	12SVC400
150:5	0.3	0.3	0.3	0.6	C10	12SVC400
200:5	0.3	0.6	0.6	1.2	C10	12SVC400
250:5	0.3	0.3	0.6	1.2	C10	12SVC400
300:5	0.3	0.3	0.3	0.6	C10	12SVC400
400:5	0.3	0.3	0.3	0.3	C10	12SVC400
500:5	0.3	0.3	0.3	0.3	C20	12SVC400
600:5	0.3	0.3	0.3	0.3	C20	12SVC400
500:5	0.3	0.3	0.3	0.3	C20	12SVC800
600:5	0.3	0.3	0.3	0.3	C20	12SVC800
750:5	0.3	0.3	0.3	0.6	C20	12SVC800
800:5	0.3	0.3	0.3	0.3	C20	12SVC800
1,000:5	0.3	0.3	0.3	0.3	C10	12SVC800

Table 8: Relay class C20 optional CTs, type 81CT20

Ratio	60 Hz metering accuracy at burden				Relay class	Used on
	B-0.1	B-0.2	B-0.5	B-0.9		
25:5	0.6	0.6	1.2	2.4	C20	12SVC400
30:5	0.6	0.6	1.2	2.4	C20	12SVC400
40:5	0.6	0.6	0.6	1.2	C20	12SVC400
50:5	0.6	0.6	1.2	2.4	C20	12SVC400
75:5	0.6	0.6	1.2	2.4	C20	12SVC400
100:5	0.6	0.6	1.2	2.4	C20	12SVC400
150:5	0.6	0.6	1.2	2.4	C20	12SVC400
200:5	0.6	0.6	0.6	1.2	C20	12SVC400
250:5	0.3	0.3	0.6	1.2	C20	12SVC400
300:5	0.3	0.3	0.3	0.6	C20	12SVC400
400:5	0.3	0.3	0.3	0.6	C20	12SVC400
600:5	0.3	0.3	0.3	0.3	C20	12SVC400
600:5	0.3	0.3	0.3	0.3	C20	12SVC800
750:5	0.3	0.3	0.3	0.3	C20	12SVC800
800:5	0.3	0.3	0.3	0.3	C50	12SVC800
1,000:5	0.3	0.3	0.3	0.3	C50	12SVC800



Figure 22: Control power transformer mounted in the cell

Control power transformer (CPTs)

The basic controller includes as a standard, a 0.75 kVA CPT mounted in the medium-voltage compartment. This CPT is used to energize the magnetically-held contactor. It is located in the upper left area of each medium-voltage compartment as shown in Figure 22. Ratings are available up to 3 kVA as shown in Table 10.

Table 9: Relay class C50 optional CTs, type 81CT50

Ratio	60 Hz metering accuracy at burden				Relay class	Used on
	B-0.1	B-0.2	B-0.5	B-0.9		
25:5	0.3	0.6	1.2	1.2	C50	12SVC400
30:5	0.6	0.6	1.2	2.4	C50	12SVC400
40:5	0.3	0.3	0.6	0.6	C50	12SVC400
50:5	0.3	0.6	1.2	1.2	C50	12SVC400
75:5	0.3	0.6	1.2	1.2	C50	12SVC400
100:5	0.3	0.3	0.6	0.6	C50	12SVC400
150:5	0.3	0.6	1.2	1.2	C50	12SVC400
200:5	0.3	0.3	0.6	0.6	C50	12SVC400
250:5	0.3	0.3	0.6	1.2	C50	12SVC400
300:5	0.3	0.3	0.6	0.6	C50	12SVC400
400:5	0.3	0.3	0.3	0.3	C50	12SVC400
600:5	0.3	0.3	0.3	0.3	C50	12SVC400
600:5	0.3	0.3	0.3	0.3	C50	12SVC800
750:5	0.3	0.3	0.3	0.3	C50	12SVC800
800:5	0.3	0.3	0.3	0.3	C50	12SVC800
1,000:5	0.3	0.3	0.3	0.3	C50	12SVC800

Table 10: CPT fuse sizes

CPT kVA	Primary fuse rating					Secondary fuse rating	
	2.3 kV	3.3 kV	4.0 kV	4.6 kV	6.6 kV	115 V	230 V
0.75	1E	1E	1E	0.5E	1E	10 A	6.25 A
2.0	3E	2E	2E	2E	1E	20 A	10 A
3.0	4E	3E	2E	2E	2E	30 A	15 A

Voltage transformers (VTs)

Optional voltage transformers are available, of two general types.

A three-phase voltage transformer (with windings connected open-delta/open-delta) can be provided in a starter or feeder cell. These VTs are connected to the load side of the main power fuses in the cell, and are located in the general vicinity of the outgoing cable termination area, as shown in Figure 23. These VTs have ratings as shown in Table 11.

Since these VTs are connected to the starter or feeder circuit, they are disconnected when the isolating switch is switched to the OPEN position, and in this position the load side of the isolating switch is also grounded. The VTs include primary current limiting fuses, mounted on the top of the transformer assembly as shown in Figure 23. The voltage transformers are not accessible until the contactor is switched off, and the isolating switch is OPEN.

Voltage transformers are also available for connection to the incoming line or to the main bus of the assembly. These voltage transformers are connected to the source through an isolating switch of the same type as is used for controllers. The isolating switch must be OPEN (and load side grounded) in order to open the compartment door. The isolating switch cannot be closed unless the compartment door is closed.

The isolating switch position (OPEN (and grounded) or CLOSED) is visible through the viewing window in the same manner as for a starter or feeder contactor compartment.

The voltage transformer ratings for these VTs are shown in Table 12.

Table 11: Voltage transformer ratings for feeder connected VTs

Voltage class	Ratio	Accuracy class at 120 V secondary		VA thermal rating ¹	BIL rating
		W, X	Y		
5 kV	2,400:120	0.3	1.2	450	60 kV
5 kV	4,200:120	0.3	1.2	450	60 kV
5 kV	4,800:120	0.3	1.2	450	60 kV
7 kV	6,900:120	0.3	1.2	450	60 kV
7 kV	7,200:120	0.3	1.2	450	60 kV

Table 12: Voltage transformer ratings for incoming line or main bus VTs

Voltage class	Ratio	Accuracy class at 120 V secondary			VA thermal rating ¹	BIL rating
		W, X	Y	Y		
5 kV	2,400:120	0.3	0.6	1.2	400	45 kV
5 kV	4,200:120	0.3	0.6	1.2	400	45 kV
5 kV	4,800:120	0.3	0.6	1.2	400	45 kV
7 kV	6,900:120	0.3	0.6	1.2	1,000	45 kV
7 kV	7,200:120	0.3	0.6	1.2	1,000	45 kV



Figure 23: Voltage transformer arrangement in the feeder cell

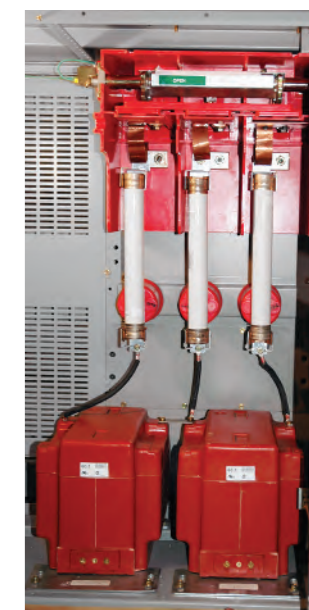


Figure 24: Voltage transformer for incoming line or main bus VTs

Table 11: Voltage transformer ratings for feeder connected VTs

Footnote:
1. 225 VA per winding, 55 °C ambient.

Table 12: Voltage transformer ratings for incoming line or main bus VTs

Footnote:
1. 55 °C ambient.

Smaller-size distribution transformers can be mounted in the same compartment as the isolating switch and primary fuses. Larger-size, single-phase distribution transformers and all three-phase distribution transformers are normally mounted in a lower compartment with the isolating switch and primary fuses located in the upper compartment of the vertical section. For distribution transformers with higher excitation currents, a load-interrupter switch or latched contactor may be used instead of an isolating switch. Refer to the drawings for the specific equipment for the actual arrangement.

Power factor correction capacitors (PFCCs) (optional)

Power factor correction capacitors (PFCCs) are available for installation in the SIMOVAC controllers. Addition of PFCCs requires one-high design of 12SVC400 (400 A) starters and an additional vertical section for 12SVC800 (720 A) controllers. When PFCCs are provided, they are normally switched on and off with the motor with the exception of solid-state reduced-voltage (SSRVS) controllers.

PFCCs are provided in three-phase sets complete with primary fuses. Sizes range from 25 kVAR to 300 kVAR.

Complete motor data must be provided for PFCC sizing, and the maximum allowable PFCC size has to be confirmed by the motor manufacturer.

Primary cable connections

The load-cable terminations for each controller are located in the left rear of the controller compartment and are fully accessible from the front of the equipment. SIMOVAC and SIMOVAC-AR controllers allow approximately 18" (457 mm) of clear cable termination space. The configuration accommodates cables with a maximum bend radius of 17" (432 mm). Each SIMOVAC 12SVC400 controller can accept one 500 kcmil or two 4/0 load cables per phase maximum.

Each SIMOVAC 12SVC800 controller can accept one 750 kcmil or two 500 kcmil load cables per phase maximum.

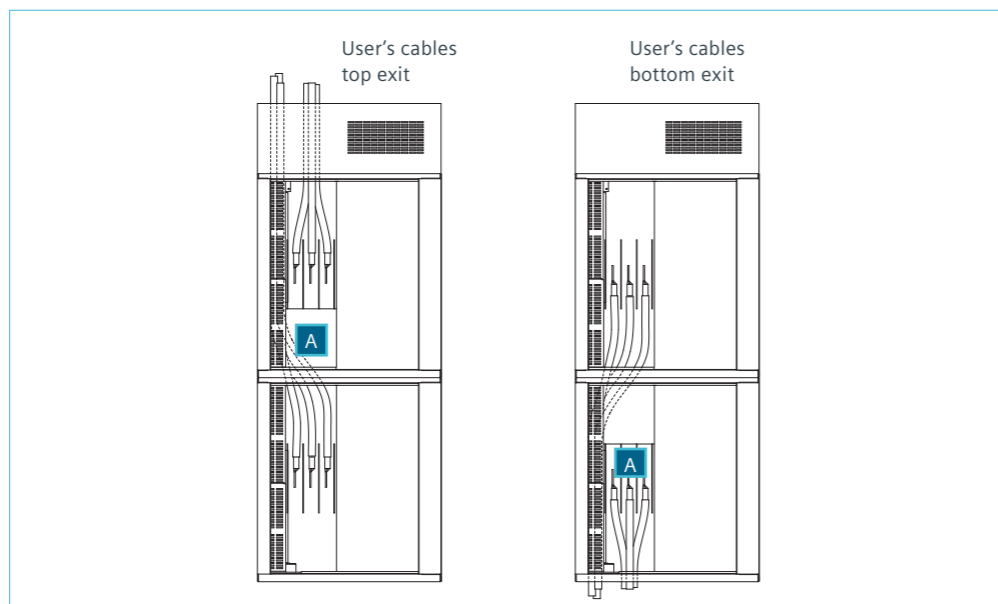
Figure 25 shows how cables are routed inside the units. Barriers are included for separating cables of one circuit from those of another circuit.

The locations where primary cable entrances are located (either on the top plate or floor plate as shown in Figure 36) have removable covers that must be prepared with conduit hubs or similar entrance fittings and reinstalled. The bottom cable entry cover plates are painted white for ease in identifying them. Figure 25 shows the routing of cables for stacked 12SVC400 SIMOVAC controllers.

Optionally, controllers can be provided with ball-type ground studs for use with commercially available grounding clamps. Figure 26 shows typical cable terminations, with optional ball-type grounding studs and with removable covers for the grounding studs.

Figure 25: Outgoing cable routing in SIMOVAC 12SVC400 (400 A) controllers)

Item	Description
A	Isolation barrier



Grounding

A common ground bus is incorporated in all sections for grounding the equipment during installation. The ground bus is accessible in the lower front area of the enclosure and in each controller compartment. Control and instrumentation circuits are grounded to the enclosure.

The ground bus includes provisions for connections of purchaser's shield conductors from external cables in each controller compartment. In addition, the assembly includes provisions for connection of the ground bus to the purchaser's ground grid in accordance with the National Electrical Code® (NFPA 70®).

Surge limiters

Surge limiters are sometimes furnished at the controller load terminals to limit transient overvoltages caused by multiple re-ignitions which may occur due to the use of vacuum interrupters under certain system conditions.



Figure 26: Typical outgoing connections

Item	Description
A	Purchaser's cables
B	Optional ground studs
C	Load cables to contactor (factory installed)

Motor protection



Type 3RU overload relay



Type 3RB overload relay

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

The SIPROTEC protective relay family includes many of the secondary ANSI functions, allowing the user to use one protective relay for motor protection applications. The SIPROTEC motor protection relays are highly flexible and offer the options described in Table 14.

Figure 27: Motor protection

Fault	Protection	ANSI number
Stator thermal overload	Stator thermal-overload protection	49
Rotor thermal overload during start:	<ul style="list-style-type: none"> Motor starting time supervision Restart inhibit 	<ul style="list-style-type: none"> 48 66, 49R
Ground fault	Ground-fault protection	50G, 64G, 67G
Short circuit	<ul style="list-style-type: none"> Overcurrent-time protection Current-differential protection 	<ul style="list-style-type: none"> 50, 51 87
Phase loss	Negative-sequence protection	46
Bearing overload	Temperature sensors (RTDs)	38
Overheating of plan on unloaded drives (pumps, compressors)	Undercurrent protection	37
Undervoltage	Undervoltage protection	27
Induction operation (of a synchronous machine)	Underexcitation (loss-of-field) protection	40

Function	Description	Type					
		7SJ60	7SK80	7SJ61	7SJ62	7UM61	7UM62
50/51	Overcurrent instantaneous	Yes	Yes	Yes	Yes	Yes	Yes
50N/51N	Ground-overcurrent instantaneous/time	Yes	Yes	Yes	Yes	Yes	Yes
51M	Load jam	----	Yes	Optional	Yes	----	----
51V	Voltage-controlled time	----	----	----	----	Yes	Yes
37	Undercurrent	----	Yes	Yes	Yes	----	Yes
87	Differential	----	----	----	----	----	Yes
87N	Ground differential	----	----	Yes	Yes	----	----
50BF	Breaker failure	----	Yes	Yes	Yes	Yes	Yes
46	Phase-balance (negative-sequence) current	Yes	Yes	Yes	Yes	Optional	Optional
67	Directional overcurrent	----	----	----	Yes	Yes	Yes
67N	Directional-ground overcurrent	----	Optional	----	Yes	Yes	Yes
32	Directional (reverse) power	----	Optional	----	----	Yes	Yes
27/59	Under/over voltage	----	Optional	----	Yes	Yes	Yes
47	Phase rotation	----	Optional	----	Yes	Yes	Yes
81U/O	Over/under frequency	----	Optional	----	Yes	Yes	Yes
59N	Ground overvoltage	----	Optional	----	Yes	Yes	Yes
40	Under excitation (loss of field)	----	----	----	----	Optional	Yes
24	Over excitation (volts per hertz)	----	----	----	----	Yes	Yes
48/14	Incomplete sequence/underspeed	Yes	Yes	Optional	Yes	Optional	Optional
66	Restart inhibit	----	Yes	Optional	Yes	Optional	Yes
86	Lockout	----	Yes	Yes	Yes	Yes	Yes
38	RTD monitoring	----	Optional ¹	Optional ¹	Optional ¹	----	Optional ¹
----	I/O binary inputs/binary outputs	3/1	3/5	3/4	8/8	7/12	7/15

Footnote:

- Optional with up to five RTD inputs in protective relay (type 7SK80 only) or up to 12 RTDs (using type 7SK80 relay plus two type 7XV5662 RTD units).

Figure 28: Type 7SK80 protective relay



Vacuum contactors



Figure 30: Type 12SVC800 vacuum contactor

SIMOVAC controllers use Siemens type 12SVC400 and 12SVC800 vacuum contactors. The vacuum contactors provide the advantage of long mechanical and electrical life with low maintenance and are essentially immune to adverse atmospheric environments.

Type 12SVC400 vacuum contactors

Figure 29 shows the 12SVC400 contactor. It is a modular design using high strength, molded-pole housings all on a common base for ease of handling. The modular concept allows for the control circuit module to be easily removed and quickly replaced with a spare module. A plug is located next to the handle to connect the umbilical cord from the controller compartment to the contactor to apply control power.

The type 12SVC400 (400 A) contactor is provided as fixed mounted (bolt in) as standard. An optional plug-in arrangement (shown in Figure 29) is also available.

Type 12SVC800 (720 A) vacuum contactors

Figure 30 shows the 12SVC800 contactor. This contactor provides the advantage of long mechanical and electrical life with low maintenance. The contactor has three main poles, each consisting of a sealed vacuum interrupter which is mounted on a track resistant insulating support molding. A stainless steel bellows attached to each movable contact ensures a complete seal and maintains vacuum integrity.

The type 12SVC800 contactors used in SIMOVAC controllers are fixed mounted only. The type 12SVC800 contactor is equipped with an ON/OFF indicator located on the right side of the contactor. The position of the main contacts of the contactor is indicated by a pointer that points to ON (red) or OFF (green).

Figure 29: Type 12SVC400 (400 A) vacuum contactor (plug-in shown)

Item	Description
A	Insulation boot
B	Line connection
C	Load connection

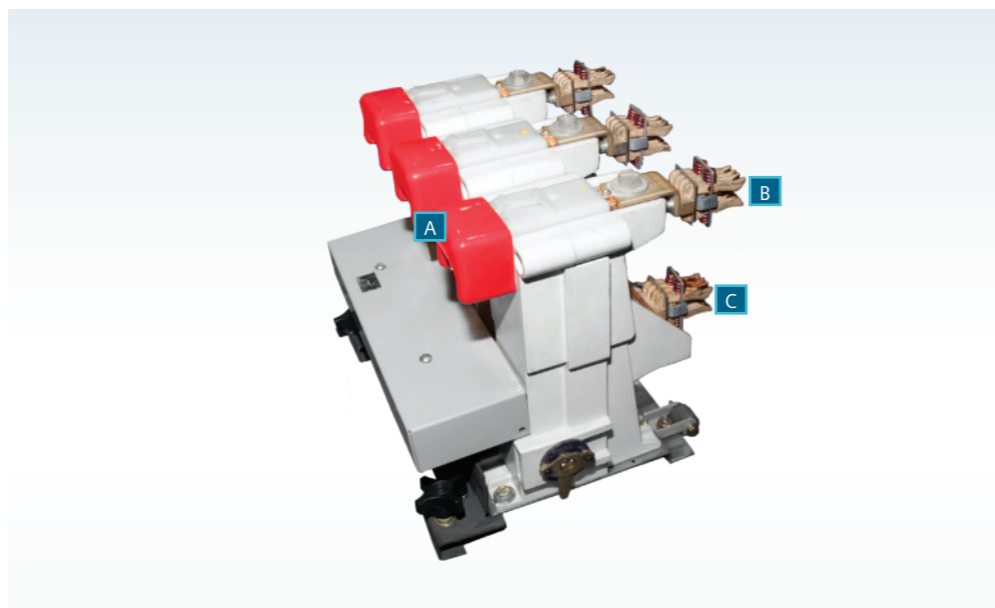


Table 15: 12SVC400 contactor operating data		
Item	Magnetically held	Latched
Rated voltage	7,200 V ⁵	7,200 V ⁵
Rated current	400 A	400 A
Permissible switching frequency	300/hour	300/hour
Mechanical life (number of operations)	750,000	150,000
Electrical life (number of operations)	400,000	400,000 ⁶
Closing time (average)	40 ms	40 ms
Minimum closing command duration	----	100 ms
Opening time (average) ²	90 ms	90 ms
Arcing time	10 to 20 ms	10 to 20 ms
Pick-up voltage ac or dc, nominal	85%	85%
Drop-out voltage ac or dc, nominal	70%	----
Minimum trip voltage	----	85% rated voltage
Rated control voltage	115 Vac/240 Vac; 125 Vdc/250 Vdc	115 Vac/240 Vac; 125 Vdc/250 Vdc
Coil circuit inrush	600 VA (ac)	600 VA (ac)
Coil circuit holding	7 VA (ac); 0.47 A (dc)	----
Tripping (latched opening release)	----	6.5 A
Auxiliary contact arrangement	3 NO + 3 NC	1 NO + 1 NC
Auxiliary relay contact rating	10 A, 600 V (NEMA class A600)	10 A, 600 V (NEMA class A600)
■ Continuous current	■ 10 A	■ 10 A
■ AC making/breaking	■ 7,200 VA not over 60 A/720 VA not over 6 A	■ 7,200 VA not over 60 A/720 VA not over 6 A
■ DC making/breaking	■ 10 A@24 V; 5 A@110 V; 0.9 A@125 V	■ 10 A@24 V; 5 A@110 V; 0.9 A@125 V
Maximum interrupting current (three operations)	4.8 kA	4.8 kA
Short-time current (rms)		
■ 30 seconds	■ 2,400 A	■ 2,400 A
■ 1 second	■ 6,000 A	■ 6,000 A
Standard service altitude	Up to 2,000 m (6,562 ft) above sea level	Up to 2,000 m (6,562 ft) above sea level
Optional service altitude	¹	¹
BIL	60 kV ⁴	60 kV ⁴
Dielectric strength (60 Hz)	³	³
Control voltages ac and dc	120/240 Vac and 125/250 Vdc	120/240 Vac and 125/250 Vdc
Control voltage options (latched opening release)	----	125 Vdc

Footnotes:

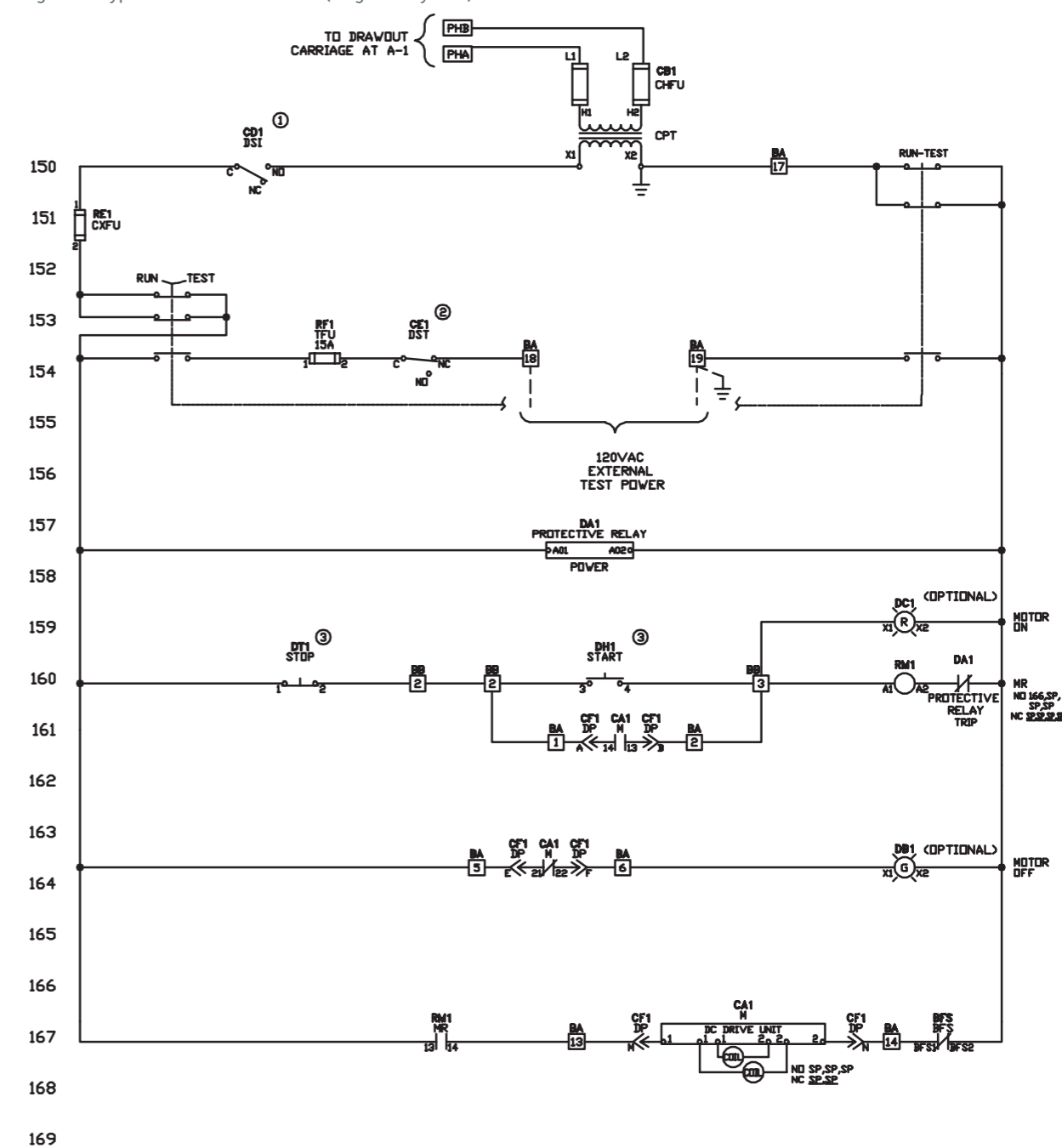
1. Consult factory.
2. Opening time = time from instant of application of the OPEN control pulse (for latched version) or removal of control power (for magnetically held version) to the instant of contact separation.
3. 2.0 kV + (2.25 x rated voltage) = 18.2 kV for 7.2 kV rated voltage.
4. Phase-ground and phase-phase, with vacuum contactor closed.
5. Maximum operating voltage 7.65 kV.
6. With latch replacement at 150,000 and 300,000.

Table 16: 12SVC800 contactor operating data		
Item	Magnetically held	Latched
Rated voltage	7,200 V ⁵	7,200 V ⁵
Rated current	720 A	720 A
Permissible switching frequency	600/hour	600/hour
Mechanical life (number of operations)	1,000,000	200,000
Electrical life (number of operations)	200,000	200,000
Closing time (average)	80 to 100 ms	80 to 100 ms
Minimum closing command duration	----	100 ms
Opening time (average) ²	40 to 45 ms	40 to 45 ms
Arcing time	10 ms or less	10 ms or less
Pick-up voltage ac or dc, nominal	85% rated (hot); 70% rated (cold)	85% rated (hot); 70% rated (cold)
Drop-out voltage ac or dc, nominal	50% rated (hot); 40% rated (cold)	----
Minimum trip voltage	----	85% rated voltage
Rated control voltage	115 Vac/240 Vac; 125 Vdc/250 Vdc	115 Vac/240 Vac; 125 Vdc/250 Vdc
Coil circuit inrush	800 VA	875 VA
Coil circuit holding	48 VA	----
Tripping (latched opening release)	----	6.5 A
Auxiliary contact arrangement	3 NO + 3 NC	1 NO + 1 NC
Auxiliary relay contact rating	10 A, 600 V (NEMA class A600)	10 A, 600 V (NEMA class A600)
■ Continuous current	■ 10 A	■ 10 A
■ AC making/breaking	■ 7,200 VA not over 60 A/720 VA not over 6 A	■ 7,200 VA not over 60 A/720 VA not over 6 A
■ DC making/breaking	■ 10 A@24 V; 5 A@110 V; 0.9 A@125 V	■ 10 A@24 V; 5 A@110 V; 0.9 A@125 V
Maximum interrupting current (three operations)	7.2 kA	7.2 kA
Short-time current (rms)		
■ 30 seconds	■ 4,320 A	■ 4,320 A
■ 1 second	■ 10,800 A	■ 10,800 A
Standard service altitude	Up to 1,000 m (3,281 ft) above sea level	Up to 1,000 m (3,281 ft) above sea level
Optional service altitude	1	1
BIL	60 kV ⁴	60 kV ⁴
Dielectric strength (60 Hz)	3	3
Control voltages ac and dc	120/240 Vac and 125/250 Vdc	120/240 Vac and 125/250 Vdc
Control voltage options (latched opening release)	----	125 Vdc

Footnotes:

1. Consult factory.
2. Opening time = time from instant of application of the OPEN control pulse (for latched version) or removal of control power (for magnetically held version) to the instant of contact separation.
3. $2.0 \text{ kV} + (2.25 \times \text{rated voltage}) = 18.2 \text{ kV}$ for 7.2 kV rated voltage.
4. Phase-ground and phase-phase, with vacuum contactor closed.
5. Maximum operating voltage 7.65 kV.

Figure 31: Type FVNR starter schematic (magnetically held)

**Footnotes:**

1. DSI opens to disconnect control circuit when isolating switch is open. DSI shown with isolating switch in open position.
2. DST closes to connect test power to control circuit when isolating switch is open and grounded. DST is shown with isolating switch in open position.
3. If a remote pushbutton station is used, connect 'START' between terminals 2 and 3. Remove jumper J1 from terminals 1 and 2, and connect 'STOP' between terminals 1 and 2.

Fuse applications



Figure 32: Power fuses

Power fuses (current limiting)

ANSI R-rated (or X-rated) fuses are used for motor starting duty in up to 7.2 kV class E2 controllers and for transformer protection when an E-rated fuse is not available. ANSI E-rated fuses are used for most other applications.

These contactors can be used with 5 kV or 7.2 kV (as appropriate) power fuses rated 2R up to 57X, or with E-rated fuses up to 450E (for type 12SVC400) and up to 900E (for type 12SVC800).

Type 12SVC800 contactors with single-barrel, double-barrel or triple-barrel fuses are in one-high controllers while type 12SVC400 contactors with single or double barrel fuses are in two-high controllers.

All fuses are bolt-in type.

Maximum design voltage kV	Current designation	Continuous current at 40 °C	Minimum interrupting capability	Interrupting rating 50/60 Hz
5,080	2R (one barrel)	70	190	63 kA
5,080	3R	100	225	63 kA
5,080	4R	130	330	63 kA
5,080	6R	170	500	63 kA
5,080	9R	200	740	63 kA
5,080	12R	230	955	63 kA
5,080	18R (two barrel)	390	1,440	63 kA
5,080	24R	450	1,910	50 kA
5,080	32R	600	2,500	63 kA
5,080	38R	700	3,100	63 kA
5,080	48X (three barrel)	750	3,500	50 kA
5,080	57X	900	4,500	50 kA
7,200	2R (one barrel)	70	190	63 kA
7,200	3R	100	225	63 kA
7,200	4R	130	330	63 kA
7,200	6R	170	500	63 kA
7,200	9R	200	740	63 kA
7,200	12R	230	955	63 kA
7,200	18R (two barrel)	390	1,440	63 kA
7,200	24R	450	1,910	63 kA
7,200	32R	600	2,500	63 kA
7,200	38R	700	3,100	63 kA
7,200	48X (three barrel)	750	3,500	50 kA
7,200	57X	900	4,500	50 kA

Horsepower ³	2.3 kV ¹			4.16 kV ¹			6.9 kV ¹		
	FLA ^{2,6}	Fuse size ⁵	CT ratio	FLA ^{2,6}	Fuse size ⁵	CT ratio	FLA ^{2,6}	Fuse size ⁵	CT ratio
60	16.5	2R	25:5	----	----	----	----	----	----
75	19.7	2R	25:5	----	----	----	----	----	----
100	25.8	2R	40:5	----	----	----	----	----	----
125	31.0	3R	50:5	----	----	----	----	----	----
150	36.6	3R	50:5	20.3	2R	40:5	----	----	----
200	47.3	4R	75:5	26.3	2R	40:5	15.9	2R	25:5
250	58.3	4R	100:5	32.3	3R	50:5	21.0	2R	30:5
300	69.6	6R	100:5	38.6	3R	75:5	24.5	2R	40:5
350	81.0	6R	150:5	44.9	4R	75:5	29.0	3R	40:5
400	91.1	9R	150:5	50.5	4R	75:5	32.5	3R	50:5
450	102	9R	150:5	56.5	4R	75:5	36.0	3R	50:5
500	113	9R	150:5	62.5	6R	100:5	40.0	3R	75:5
600	134	12R	200:5	74.6	6R	100:5	48.0	4R	75:5
700	156	12R	300:5	86.5	6R	150:5	56.0	4R	75:5
800	177	12R	300:5	98.3	9R	150:5	63.0	6R	100:5
900	199	18R	300:5	110	9R	150:5	67.5	6R	100:5
1,000	220	18R	300:5	122	12R	200:5	77	6R	100:5
1,250	275	24R ⁷	400:5	152	12R	200:5	96	9R	150:5
1,500	328	24R ⁷	600:5	182	12R	300:5	112	9R	150:5
1,750	382	32R	600:5	212	18R	300:5	130	12R	200:5
2,000	436	38R	800:5	241	18R	400:5	153	12R	200:5
2,250	490	38R	800:5	271	24R ⁷	400:5	171	12R	250:5
2,500	534	48X ⁷	800:5	300	24R ⁷	400:5	188	12R	250:5
3,000	626	57X ⁷	1,000:5	359	32R	600:5	224	18R	300:5
3,500	----	----	----	418	38R	600:5	262	24R	400:5
4,000	----	----	----	477	38R	800:5	299	24R	400:5
4,500	----	----	----	550	48X ⁷	800:5	316	32R	500:5
5,000	----	----	----	626	57X ⁷	1,000:5	355	32R	500:5
5,500	----	----	----	678 ⁸	57X ⁷	1,000:5	395	38R	600:5

Footnotes:

1. Three-phase, 60 Hz.
2. Full-load current is abbreviated FLA.
3. Horsepower is abbreviated HP.
4. Consult Siemens for motor sizes or voltages not shown.
5. Fuse sizes are based on enclosed continuous current rating, one start from ambient, a coast to stop and a second start, with accelerating time of 7 s.
6. Fuse sizes are shown to accommodate a service factor of 1.15.
7. Limited to equipment rated up to 50 kA.
8. A service factor of 1.0.

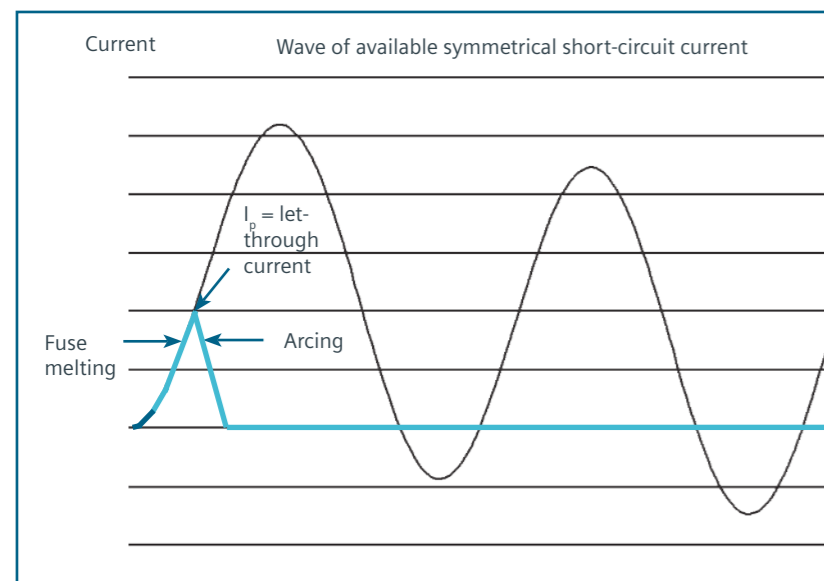


Figure 33: Current-limiting effect

Transformer kVA three phase	Fuse size ¹	2.4 kV	4.16 kV	4.8 kV	6.9 kV
45	20E	10E	10E	----	----
75	30E	15E	15E	10E	10E
112.5	40E	20E	20E	15E	15E
150	50E	30E	25E	20E	20E
225	80E	40E	40E	25E	25E
300	100E	65E	50E	40E	40E
500	200E	100E	100E	65E	65E
750	300E	150E ²	150E	100E ²	100E ²
1,000	400E ²	200E ²	200E	125E ²	125E ²
1,500	450E ²	300E ²	250E ²	200E ²	200E ²
2,000	----	400E ²	350E ²	250E ²	250E ²
2,500	----	450E ²	450E ²	300E ²	300E ²

Footnotes:

1. Fuse sizes (except in footnote 2) are based on 133 percent fan-cooled capability for the transformers of 500 kVA or more.
2. Fuse sizes are based on self-cooled capability of transformer.

Non-motor loads

The principal application for ANSI E-rated fuses in SIMOVAC family controllers is for non-rotating loads, such as transformer feeders. The following tabulation may be used for estimating the E-rated fuse appropriate for a particular three-phase transformer application.

Fuse ratings higher or lower than those listed in Table 19 may need to be employed if the transformer has unusual magnetizing (inrush) current characteristics, or for proper coordination with the secondary protective device (for example, secondary fuse, low-voltage circuit breaker trip device, overcurrent relay, etc.). Transformer overload capability may also have a bearing on fuse selection. However, this table is accurate for most typical transformer feeder applications.

E-rated and R-rated fuses are available for most applications to 50 kA, and selected sizes or voltages of fuses are also available at 63 kA. High continuous-current fuses (for instance, 750E or 900E) are type BHCL, and interrupting current is 63 kA.

All medium-voltage class E2 controllers employ current-limiting fuses for short-circuit protection. The term "current limiting" is derived from the operating characteristics of the fuse. Figure 33 graphically shows how, for maximum fault levels, the fuse operates within the first one-quarter cycle of short-circuit current. This limits the energy let thru well below peak values, thus providing current limitation.

Starter fuse and current transformer (CT) information

Typical information on starter fuse and CT ratings is shown in Table 18. This information is based on typical motor data (NEMA B, code F, 1.0 SF). Actual motor data may vary depending on motor manufacturer and design.

Actual fuse and CT ratings will be sized based on motor FLA, service factor, acceleration time and locked rotor information. Actual motor data is required for order entry.

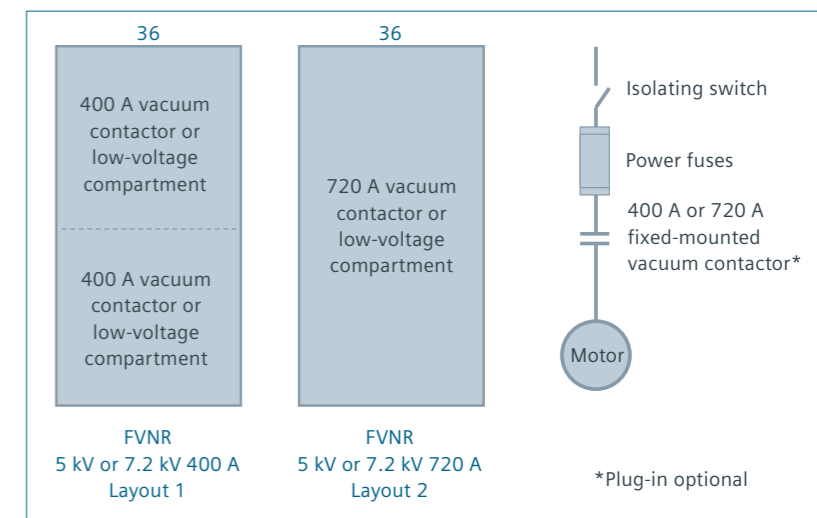
Typical controller specifications

Non-arc-resistant and arc-resistant full-voltage, non-reversing, squirrel-cage 12SVC400 (400 A) or 12SVC800 (720 A) controller (FVNR) includes:

- Fixed-mounted vacuum contactor
- Optional plug-in type (12SVC400 only)
- Three current-limiting power fuses
- One 0.75 kVA control transformer with two primary and one secondary current-limiting fuses
- Three current transformers
- One master control relay (three NO and one NC auxiliary contacts)
- Two start/stop push buttons
- One three-phase ambient compensated thermal overload relay
- Multi-function microprocessor-based motor protection (optional)
- One externally mounted overload reset button
- One test switch and circuit
- Non-load-break isolating switch with isolating shutter system, external operating handle and interlocked to prohibit user access to an energized medium-voltage compartment.

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
2. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
3. For 12SVC400 (400 A), weights are based on two FVNR controller per vertical section.
4. Add 390 lbs (180 kg) for SIMOVAC-AR arc-resistant controller.
5. Add 340 lbs (155 kg) for SIMOVAC-AR arc-resistant controller.
6. Add 6" (152 mm) width per section for outdoor (non-arc-resistant). Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
7. Add 710 lbs (322 kg) per section for outdoor controller (non-arc-resistant).
8. Maximum shipping group is four vertical sections.



Horsepower	Ampere rating A	Interrupting rating kA	Dimensions in inches (mm) ⁸			Weight in lbs (kg) ^{3,7}	Layout
			Height ^{1,9}	Width ⁵	Depth ²		
2.2 kV to 2.4 kV FVNR							
250	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
700	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
1,500	400	50	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
2,250	720	63	95 (2,413)	36 (915)	30 (762)	1,690 (770) ⁵	2
3,000	720	50	95 (2,413)	36 (915)	30 (762)	1,690 (770) ⁵	2
4.0 kV to 4.8 kV FVNR							
450	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
1,250	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
2,500	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
3,500	720	63	95 (2,413)	36 (915)	30 (762)	1,690 (770) ⁵	2
5,500	720	50	95 (2,413)	36 (915)	30 (762)	1,690 (770) ⁵	2
7.2 kV FVNR							
800	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
2,000	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
4,000	400	63	95 (2,413)	36 (915)	30 (762)	1,980 (900) ⁴	1
5,500	720	63	95 (2,413)	36 (915)	30 (762)	1,690 (770) ⁵	2

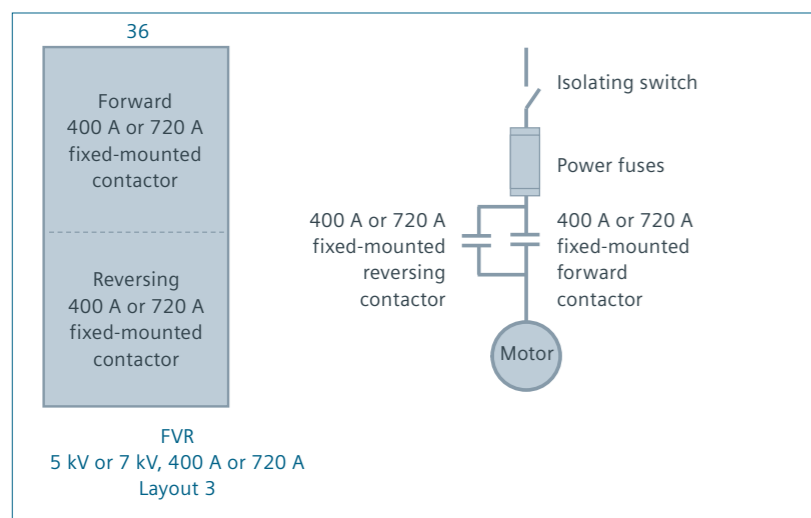
9. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.

Table 21: FVR dimensions

Horse-power	Ampere rating A	Interrupting rating kA	Dimensions in inches (mm) ⁸			Weight in lbs (kg) ^{3,7}	Layout
			Height ^{1,9}	Width ⁶	Depth ²		
2.2 kV to 2.4 kV FNR							
250	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
700	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
1,500	400	50	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
2,250	720	63	95 (2,413)	36 (915)	30 (762)	1,510 (685) ⁵	3
3,000	720	50	95 (2,413)	36 (915)	30 (762)	1,510 (685) ⁵	3
4.0 kV to 4.8 kV FVR							
450	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
1,250	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
2,500	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
3,500	720	63	95 (2,413)	36 (915)	30 (762)	1,510 (685) ⁵	3
5,500	720	50	95 (2,413)	36 (915)	30 (762)	1,510 (685) ⁵	3
7.2 kV FVR							
800	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
2,000	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
4,000	400	63	95 (2,413)	36 (915)	30 (762)	1,310 (595) ⁴	3
5,500	720	63	95 (2,413)	36 (915)	30 (762)	1,510 (685) ⁵	3

Footnotes:

- Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
- Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
- For 12SVC400 (400 A), weights are based on two FVNR controller per vertical section.
- Add 390 lbs (180 kg) for SIMOVAC-AR arc-resistant controller.
- Add 340 lbs (155 kg) for SIMOVAC-AR arc-resistant controller.
- Add 6" (152 mm) width per section for outdoor (non-arc-resistant) controller. Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
- Add 710 lbs (322 kg) per section for outdoor controller (non-arc-resistant).
- Maximum shipping group is four vertical sections.
- For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.



Non-arc-resistant and arc-resistant full-voltage, reversing, squirrel-cage 12SVC400 (400 A) or 12SVC800 (720 A) controller (FVR) includes:

- Two fixed-mounted vacuum contactors
- Three current-limiting power fuses
- One 0.75 kVA control transformer with two primary and one secondary current-limiting fuses
- Three current transformers
- Two master control relays (three NO and one NC auxiliary contacts)
- Two start/stop push buttons
- Two three-phase ambient compensated thermal overload relays
- Two externally mounted overload reset buttons
- Multi-function microprocessor-based motor protection (optional)
- One test switch and circuit
- Non-load-break isolating switch with isolating shutter system, external operating handle and interlocked to prohibit user access to an energized medium-voltage compartment
- Cable lugs.

Non-arc-resistant and arc-resistant full-voltage, non-reversing, two-speed, two winding 12SVC400 (400 A) or 12SVC800 (720 A) controller (2S2W) includes:

- Two fixed-mounted vacuum contactors
- Three current-limiting power fuses
- One 0.75 kVA control transformer with two primary and one secondary current-limiting fuses
- Six current transformers
- Two master control relays (three NO and one NC auxiliary contacts)
- Two start/stop push buttons
- Two auxiliary relays – interlocking
- Two three-phase ambient compensated thermal overload relays
- Multi-function microprocessor-based motor protection (optional)
- Two externally mounted overload reset buttons
- One test switch and circuit
- Non-load-break isolating switch with isolating shutter system, external operating handle and interlocked to prohibit user access to an energized medium-voltage compartment
- Cable lugs.

Table 22: 2S2W dimensions

Horse-power	Ampere rating A	Interrupting rating kA	Dimensions in inches (mm) ⁸			Weight in lbs (kg) ^{3,7}	Layout
			Height ^{1,9}	Width ⁶	Depth ²		
2.2 kV to 2.4 kV 2S2W							
250	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
700	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
1,500	400	50	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
2,250	720	63	95 (2,413)	72 (1,830)	30 (762)	2,710 (1,235) ⁵	4
3,000	720	50	95 (2,413)	72 (1,830)	30 (762)	2,710 (1,235) ⁵	4
4.0 kV to 4.8 kV 2S2W							
450	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
1,250	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
2,500	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
3,500	720	63	95 (2,413)	72 (1,830)	30 (762)	2,710 (1,235) ⁵	4
5,500	720	50	95 (2,413)	72 (1,830)	30 (762)	2,710 (1,235) ⁵	4
7.2 kV 2S2W							
800	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
2,000	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
4,000	400	63	95 (2,413)	72 (1,830)	30 (762)	2,670 (1,215) ⁴	4
5,500	720	63	95 (2,413)	72 (1,830)	30 (762)	2,710 (1,235) ⁵	4

Footnotes:

- Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
- Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
- Weights are based on one 2S2W controller in two vertical sections.
- Add 680 lbs (310 kg) for SIMOVAC-AR arc-resistant controller.
- Add 730 lbs (330 kg) for SIMOVAC-AR arc-resistant controller.
- Add 6" (152 mm) width per section for outdoor (non-arc-resistant). Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
- Add 1,420 lbs (644 kg) for two-section controller for outdoor (non-arc-resistant).
- Maximum shipping group is four vertical sections.
- For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.

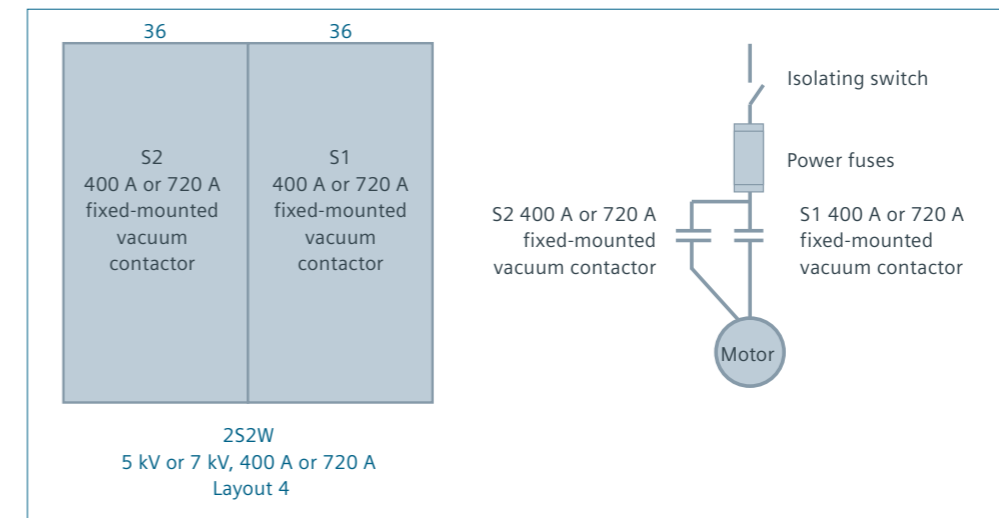


Table 23: 2S1W dimensions

Horsepower	Ampere rating A	Interrupting rating kA	Dimensions in inches (mm) ⁸			Weight in lbs (kg) ^{3,7}	Layout
			Height ^{1,9}	Width ⁶	Depth ²		
2.2 kV to 2.4 kV 2S1W							
250	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
700	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
1,500	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
2,250	720	63	95 (2,413)	72 (1,830)	30 (762)	2,790 (1,270) ⁵	5
3,000	720	63	95 (2,413)	72 (1,830)	30 (762)	2,790 (1,270) ⁵	5
4.0 kV to 4.8 kV 2S1W							
450	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
1,250	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
2,500	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
3,500	720	63	95 (2,413)	72 (1,830)	30 (762)	2,790 (1,270) ⁵	5
5,500	720	63	95 (2,413)	72 (1,830)	30 (762)	2,790 (1,270) ⁵	5
7.2 kV 2S1W							
800	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
2,000	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
4,000	400	63	95 (2,413)	72 (1,830)	30 (762)	2,740 (1,245) ⁴	5
5,500	720	63	95 (2,413)	72 (1,830)	30 (762)	2,790 (1,270) ⁵	5

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
2. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
3. Weights are based on one 2S1W controller in two vertical sections.
4. Add 680 lbs (310 kg) for SIMOVAC-AR arc-resistant controller.
5. Add 730 lbs (330 kg) for SIMOVAC-AR arc-resistant controller.
6. Add 12" (304 mm) width per section for outdoor (non-arc-resistant) controller. Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
7. Add 1,420 lbs (644 kg) for two-section controller for outdoor (non-arc-resistant).
8. Maximum shipping group is four vertical sections.
9. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.

Non-arc-resistant and arc-resistant full-voltage, non-reversing, two-speed, one winding 12SVC400 (400 A) or 12SVC800 (720 A) controller (2S1W) includes:

- Three fixed-mounted vacuum contactors
- Three current-limiting power fuses
- One 0.75 kVA control transformer with two primary and one secondary current-limiting fuses
- Six current transformers
- Two master control relays (three NO and one NC auxiliary contacts)
- Two start/stop push buttons
- Two auxiliary relays – interlocking
- Two three-phase ambient compensated thermal overload relays
- Multi-function microprocessor-based motor protection (optional)
- Two externally mounted overload reset buttons
- One test switch and circuit
- Non-load-break isolating switch with isolating shutter system, external operating handle and interlocked to prohibit user access to an energized medium-voltage compartment
- Cable lugs.

Full-voltage, mechanically latched, electrically tripped, non-reversing, 12SVC400 (400 A) or 12SVC800 (720 A) controller (FVMLNR) includes:

- One fixed-mounted vacuum contactor
- Optional plug-in type (12SVC400 only)
- Three current-limiting power fuses
- One 0.75 kVA control transformer with two primary and one secondary current-limiting fuses
- Three current transformers
- One master control relay (three NO and one NC auxiliary contacts)
- One close push button
- One open push button
- One three-phase overcurrent relay
- Multi-function microprocessor-based motor protection (optional)
- One test switch and circuit
- Non-load-break isolating switch with isolating shutter system, external operating handle and interlocked to prohibit user access to an energized medium-voltage compartment
- Cable lugs.

Table 24: FVMLNR dimensions

Ampere rating A	Interrupting rating kA	Dimensions in inches (mm) ⁸			Weight in lbs (kg) ^{3,7}	Layout
		Height ^{1,9}	Width ⁶	Depth ²		
400	63	95 (2,413)	36 (915)	30 (762)	2,740 (1,245) ⁴	6
720	63	95 (2,413)	36 (915)	30 (762)	1,710 (775) ⁵	7

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
2. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
3. For 12SVC400, weights are based on two controllers per vertical section.
4. Add 390 lbs (180 kg) for SIMOVAC-AR arc-resistant controller.
5. Add 340 lbs (155 kg) for SIMOVAC-AR arc-resistant controller.
6. Add 6" (152 mm) width per section for outdoor (non-arc-resistant) controller. Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
7. Add 710 lbs (322 kg) per section controller for outdoor (non-arc-resistant).
8. Maximum shipping group is four vertical sections.
9. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.

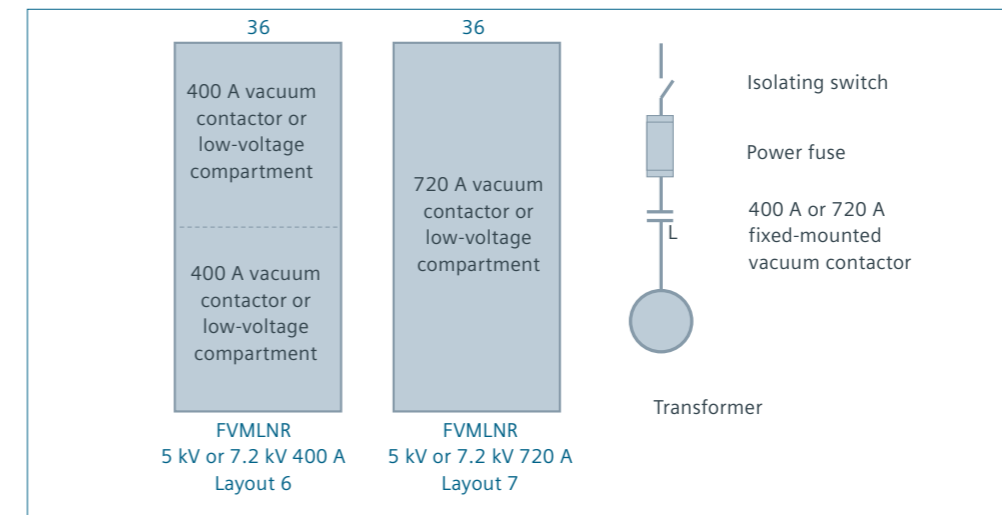
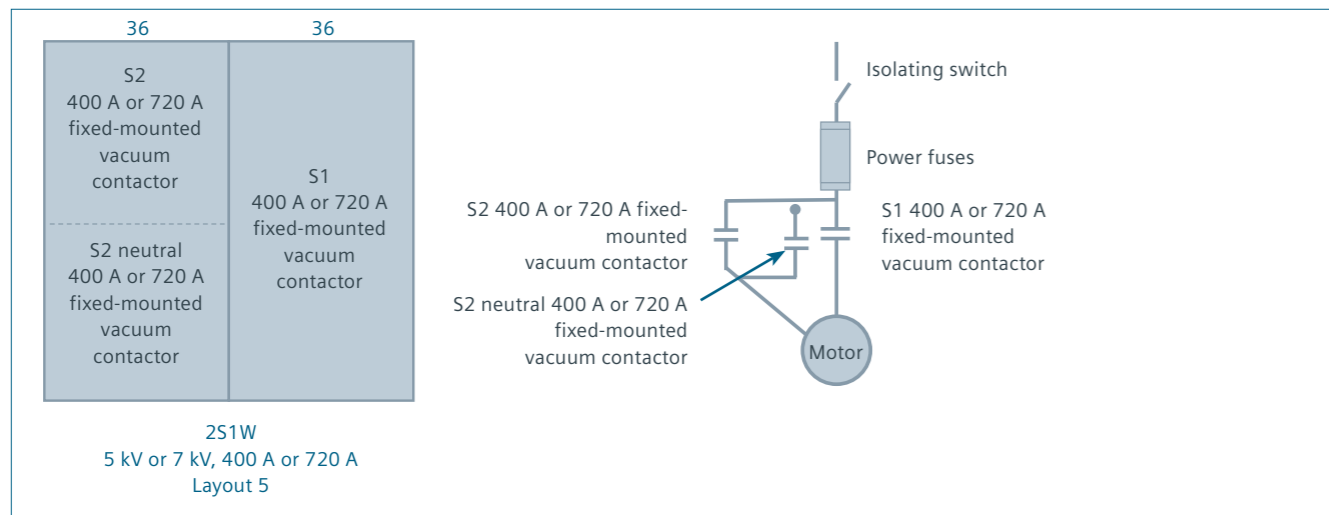
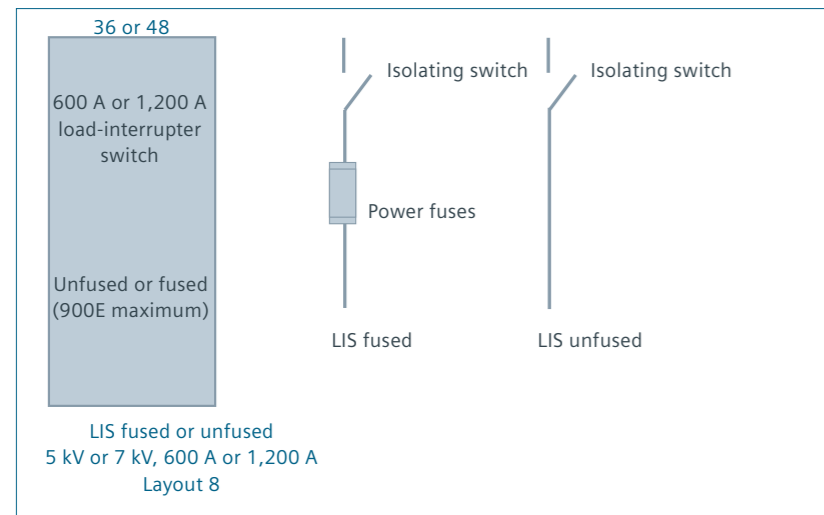


Table 25: LIS dimensions

Fuse size	Interrupting rating kA	Dimensions in inches (mm) ⁷			Weight in lbs (kg) ^{3,6}	Layout
		Height ^{1,9}	Width ⁵	Depth ²		
600 A (7.2 kV maximum) LIS						
None	25	95 (2,413)	36 (915)	30 (762)	1,540 (700) ⁴	8
150E	63	95 (2,413)	36 (915)	30 (762)	1,540 (700) ⁴	8
250E	63	95 (2,413)	36 (915)	30 (762)	1,540 (700) ⁴	8
300E	63	95 (2,413)	36 (915)	30 (762)	1,540 (700) ⁴	8
450E	63 ⁸	95 (2,413)	36 (915)	30 (762)	1,540 (700) ⁴	8
600E	25	95 (2,413)	36 (915)	30 (762)	1,540 (700) ⁴	8
1,200 A (7.2 kV maximum) LIS						
None	38	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
150E	63	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
250E	63	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
300E	63	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
450E	63 ⁸	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
600E	63 ⁸	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
750E	63 ⁸	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8
900E	63 ⁸	95 (2,413)	48 (1,218)	30 (762)	1,870 (850) ⁴	8

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
2. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
3. Weights are for fused versions.
4. Add 455 lbs (205 kg) for SIMOVAC-AR arc-resistant controller.
5. Add 6" (152 mm) width per section for outdoor (non-arc-resistant) controller. Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
6. Add 710 lbs (322 kg) per 36" (915 mm) section or 1,040 lbs (472 kg) per 48" (1,218 mm) for outdoor (non-arc-resistant).
7. Maximum shipping group is four vertical sections.
8. Maximum fuse size for 7.2 kV is 400E.
9. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.



Non-arc-resistant and arc-resistant, load-interrupter, fused or unfused, 600 A or 1,200 A switch (LIS) includes:

- One manually operated, single-throw, gang-operated, load-interrupter switch rated 600 A or 1,200 A
- Three current-limiting power fuses (fused versions only)
- Provision for current transformer (optional)
- Provision for three fixed-mounted voltage transformers (optional)
- Low-voltage compartment
- Cable lugs.

Non-arc-resistant and arc-resistant reduced-voltage autotransformer, non-reversing 12SVC400 (400 A) or 12SVC800 (720 A) (RVAT) controllers include:

- One fixed-mounted main vacuum contactor
- Optional plug-in type (12SVC400 main contactor only)
- Run contactor
- Shorting contactor
- Three primary current-limiting power fixed-mounted fuses
- One 0.75 kVA control transformer with primary current-limiting fuses
- Three current transformers
- One master control relay (three NO and one NC auxiliary contacts)
- Two start/stop push buttons
- One three-phase ambient compensated thermal overload relay
- Incomplete sequence relay
- One externally mounted overload reset buttons
- Multi-function microprocessor-based motor protection (optional)
- One test switch and circuit
- One medium-duty autotransformer
- Non-load-break isolating switch with isolating shutter system, external operating handle and interlocked to prohibit user access to an energized medium-voltage compartment
- Cable lugs.

Table 26: RVAT dimensions

Maximum LRA ¹¹	Horsepower ¹¹	Ampere rating A	Interrupting rating kA ¹²	Dimensions in inches (mm) ¹⁰			Weight in lbs (kg) ^{4,9}	Layout
				Height ^{1,2,12}	Width ⁸	Depth ³		
2.3 kV								
738	500	400	63	80 (2,038)	72 (1,829)	30 (762)	2,899 (1,315) ^{5,6}	9,11
1,404	1,000	400	63	80 (2,038)	72 (1,829)	30 (762)	3,085 (1,399) ^{5,6}	9,11
2,052	1,500	400	63	80 (2,038)	72 (1,829)	30 (762)	3,278 (1,487) ^{5,6}	9,11
2,610	2,000	400	63	80 (2,038)	72 (1,829)	30 (762)	3,933 (1,784) ^{5,6}	9,11
3,882	3,000	720	63	95 (2,413)	84 (2,134)	30 (762)	5,168 (2,344) ⁷	10,11
4.16 kV								
228	300	400	63	80 (2,038)	72 (1,829)	30 (762)	2,550 (1,157) ^{5,6}	9,11
306	400	400	63	80 (2,038)	72 (1,829)	30 (762)	2,681 (1,216) ^{5,6}	9,11
402	500	400	63	80 (2,038)	72 (1,829)	30 (762)	2,796 (1,268) ^{5,6}	9,11
618	800	400	63	80 (2,038)	72 (1,829)	30 (762)	2,990 (1,356) ^{5,6}	9,11
696	900	400	63	80 (2,038)	72 (1,829)	30 (762)	3,370 (1,529) ^{5,6}	9,11
930	1,250	400	63	80 (2,038)	72 (1,829)	30 (762)	3,479 (1,578) ^{5,6}	9,11
1,086	1,500	400	63	80 (2,038)	72 (1,829)	30 (762)	3,537 (1,604) ^{5,6}	9,11
1,440	2,000	400	63	80 (2,038)	72 (1,829)	30 (762)	4,150 (1,882) ^{5,6}	9,11
1,620	2,250	400	63	80 (2,038)	72 (1,829)	30 (762)	4,221 (1,915) ^{5,6}	9,11
2,510	3,500	720	63	95 (2,413)	84 (2,134)	30 (762)	6,283 (2,850) ⁷	10,11
3,670	5,000	720	63	95 (2,413)	84 (2,134)	30 (762)	6,283 (2,850) ⁷	10,11

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller.
2. Add 14.73" (376mm) for height of SIMOVAC if bus bar compartment included.
3. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
4. Weights are for complete controller in two vertical sections.
5. Add 152 lbs (70 kg) for bus bar compartments.
6. Add 680 lbs (310 kg) for SIMOVAC-AR arc-resistant controller.
7. Add 1,140 lbs (517 kg) for SIMOVAC-AR arc-resistant controller.
8. Add 6" (152 mm) width per section for outdoor (non-arc-resistant) controller. Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
9. Add 1,420 lbs (644 kg) for 400 A controller (layout 1), or 1,900 lbs (862 kg) for 720 A controller (layout 2) for outdoor (non-arc-resistant).
10. Maximum shipping group is two vertical sections.
11. Consult factory for other ratings.
12. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.

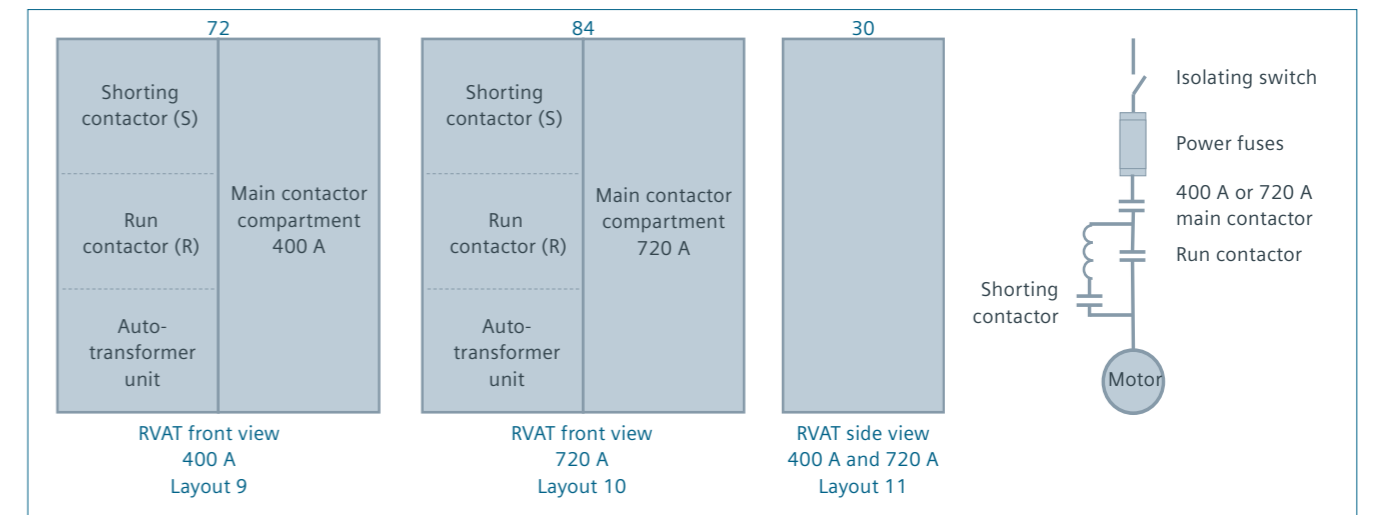
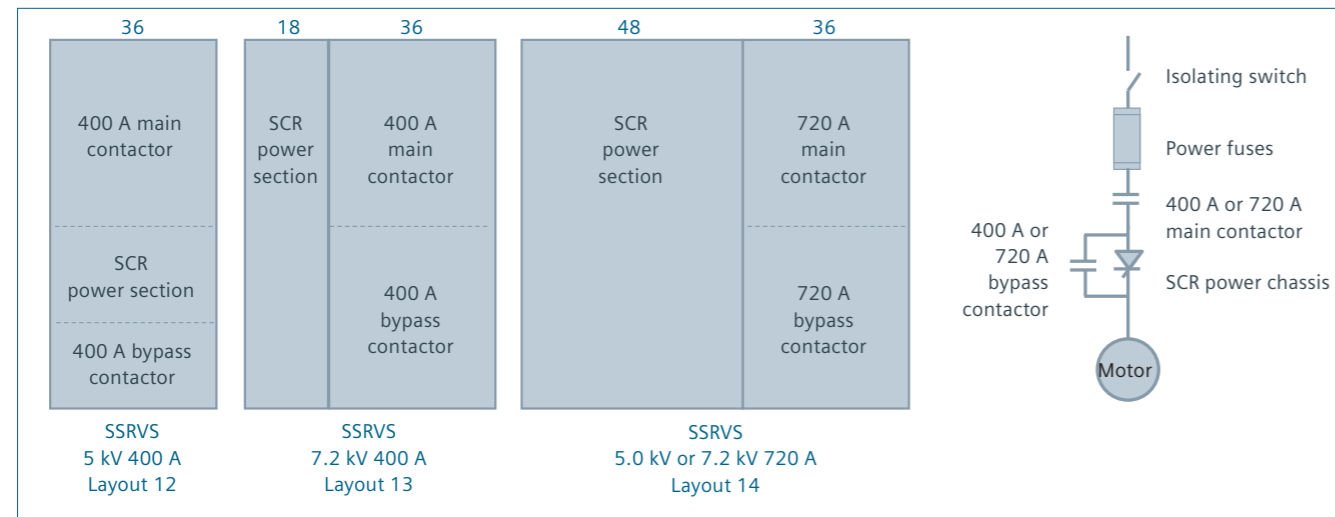


Table 27: SSRVS dimensions⁹

Horsepower	Ampere rating A	Inter-rupting rating kA	Dimensions in inches (mm) ⁸			Weight in lbs (kg) ³	Layout
			Height ^{1,11}	Width	Depth ²		
2.3 kV to 2.4 kV SSRVS							
600	155	63	95 (2,413)	36 (914)	30 (762) ⁴	1,833 (832)	12
1,200	288	63	95 (2,413)	36 (914)	30 (762) ⁴	1,833 (832)	12
1,500	400	50	95 (2,413)	36 (914)	30 (762) ⁴	1,833 (832)	12
2,750	600 ¹⁰	63	95 (2,413)	84 (2,134)	30 (762) ⁶	3,453 (1,566)	14
3,000	720 ¹⁰	50	95 (2,413)	84 (2,134)	30 (762) ⁶	3,453 (1,566)	14
4.0 kV to 4.8 kV SSRVS							
1,000	155	63	95 (2,413)	36 (914)	30 (762) ⁴	1,833 (832)	12
2,250	288	63	95 (2,413)	36 (914)	30 (762) ⁴	1,833 (832)	12
3,000	400	63	95 (2,413)	84 (2,134)	30 (762) ⁶	3,453 (1,566)	14
4,500	600 ¹⁰	63	95 (2,413)	84 (2,134)	30 (762) ⁶	3,453 (1,566)	14
5,500	720 ¹⁰	50	95 (2,413)	84 (2,134)	30 (762) ⁶	3,453 (1,566)	14
6.6 kV to 6.9 kV SSRVS							
2,000	155	63	95 (2,413)	54 (1,372)	30 (762) ⁵	2,488 (1,128)	13
3,500	288	63	95 (2,413)	54 (1,372)	30 (762) ⁵	2,488 (1,128)	13
5,000	400	63	95 (2,413)	54 (1,372)	30 (762) ⁵	2,488 (1,128)	14
6,750	600 ¹⁰	50	95 (2,413)	84 (2,134)	30 (762) ⁶	3,453 (1,566)	14

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
2. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
3. Weights are for complete controller in one or two vertical sections.
4. Add 455 lbs (205 kg) for SIMOVAC-AR arc-resistant controller.
5. Add 730 lbs (330 kg) for SIMOVAC-AR arc-resistant controller.
6. Add 1,140 lbs (517 kg) for SIMOVAC-AR arc-resistant controller.
7. Add 6" (152 mm) width per section for outdoor (non-arc-resistant) controller. Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
8. Add 710 lbs (322 kg) for single-section controller (layout 9), 1,420 lbs (644 kg) for two-section controller (layout 10), or 1,750 lbs (794 kg) for two-section controller (layout 11) for outdoor (non-arc-resistant).
9. Maximum shipping group is four vertical sections.
10. UL/cUL listing not available with SSRVS controllers with 12SVC800 (720 A) contactor.
11. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.



Non-arc-resistant and arc-resistant, solid-state, reduced-voltage, non-reversing 12SVC400 (400 A) or 12SVC800 (720 A) controllers include:

- One fixed-mounted main vacuum contactor
- Optional plug-in type (12SVC400 main contactor only)
- One three-pole fixed-mounted bypass vacuum contactor
- Three primary current-limiting power fixed-mounted fuses
- One 2 kVA control transformer with primary current-limiting fuses
- One solid-state SCR power section
- One door-mounted soft-start LCD and keypad
- Three current transformers
- One test switch and circuit
- Cable lugs.

Non-arc-resistant and arc-resistant, incoming line cable section includes:

- Incoming cable arrangement for top or bottom entry
- Provision for low-voltage panel in door
- Provision for three current transformers (optional)
- Provision for three fixed-mounted voltage transformers (optional)
- Provision for three surge arresters (optional)
- Lug pads with provision for cable lugs.
- Cable lugs (optional).

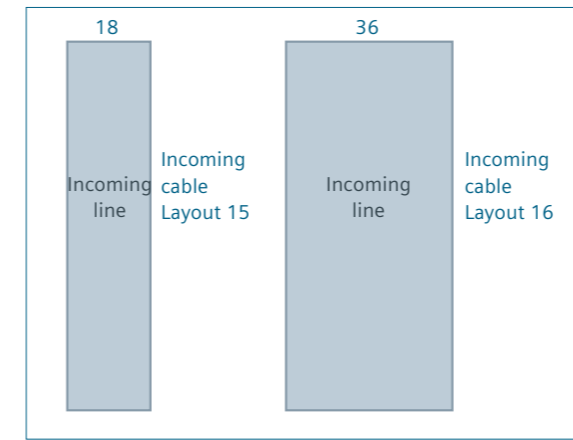


Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers

Item	Configuration	Page
A	One-high indoor arc-resistant controller	44
B	One-high indoor non-arc-resistant controller	44
C	Two-high indoor arc-resistant controller	45
D	Two-high indoor non-arc-resistant controller	45
E	Load-interrupter arc-resistant switch 600 A	46
F	Load-interrupter non-arc-resistant switch 600 A	46
G	Load-interrupter arc-resistant switch 1,200 A 48" (1,219 mm)	47
H	Load-interrupter non-arc-resistant switch 1,200 A 48" (1,219 mm)	47
I	Incoming line arc-resistant 18" (457 mm)	48
J	Incoming line non-arc-resistant 18" (457 mm)	48
K	Incoming line arc-resistant 36" (914 mm)	49
L	Incoming line non-arc-resistant 36" (914 mm)	49
M	Reduced-voltage auto-transformer non-arc-resistant 400 A	50
N	Reduced-voltage auto-transformer arc-resistant 400 A	50
O	Reduced-voltage auto-transformer non-arc-resistant 720 A	51
P	Reduced-voltage auto-transformer arc-resistant 720 A	51
Q	Solid-state reduced-voltage arc-resistant up to 5 kV	52
R	Solid-state reduced-voltage non-arc-resistant up to 5 kV	52
S	Solid-state reduced-voltage arc-resistant up to 7.2 kV - 400 A	53
T	Solid-state reduced-voltage non-arc-resistant up to 7.2 kV - 400 A	54
U	Solid-state reduced-voltage arc-resistant up to 7.2 kV - 720 A	55
V	Solid-state reduced-voltage non-arc-resistant up to 7.2 kV - 720 A	56
W	Outdoor 42" (1,067 mm) structure	57
X	Outdoor incoming line 42" (1,067 mm) structure	58
Y	Outdoor 54" (1,372 mm) structure for load-interrupter switch or solid-state reduced-voltage controller	59

Table 28: Incoming line cable section dimensions

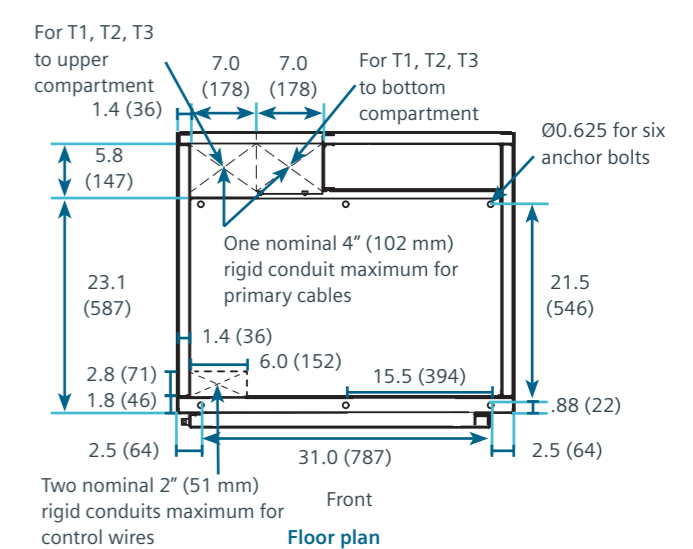
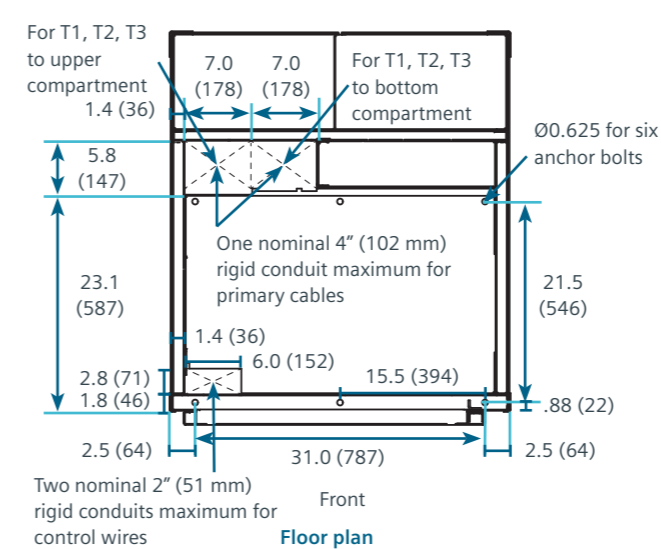
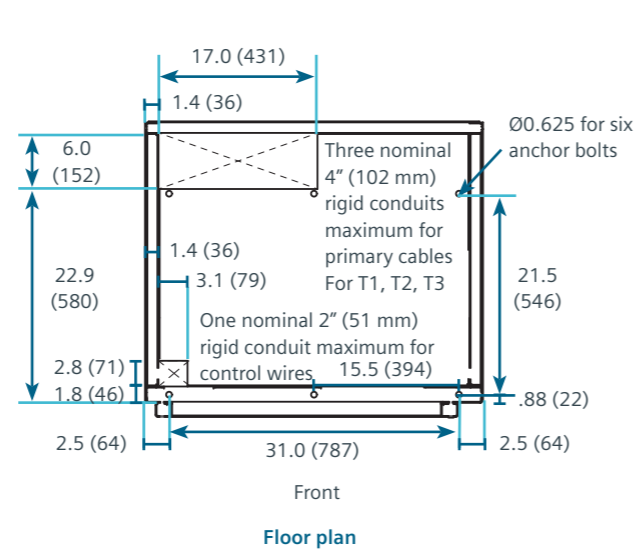
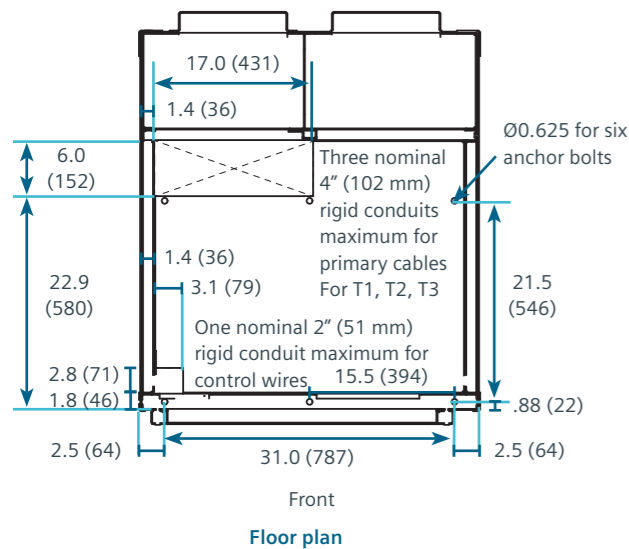
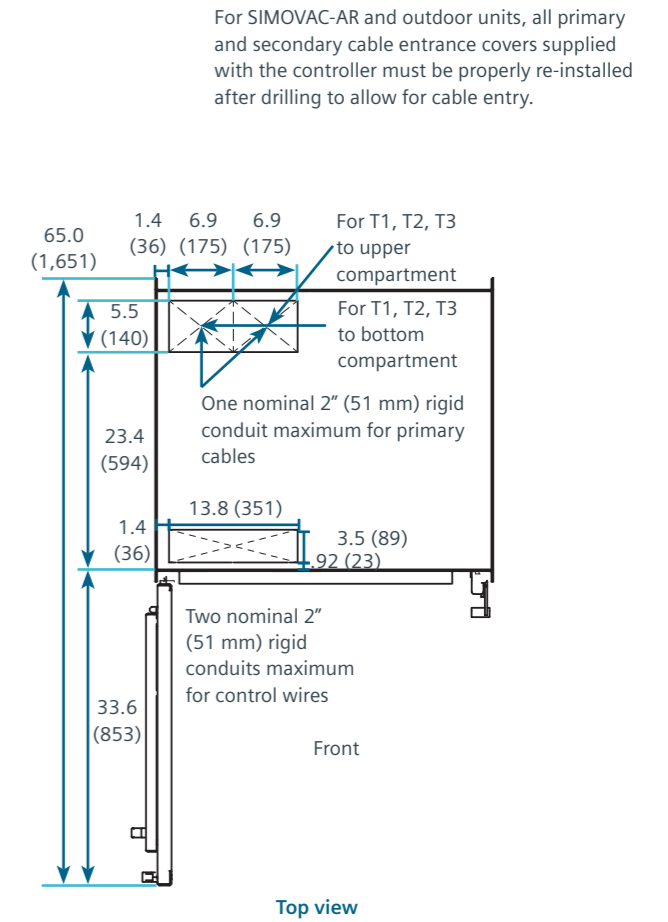
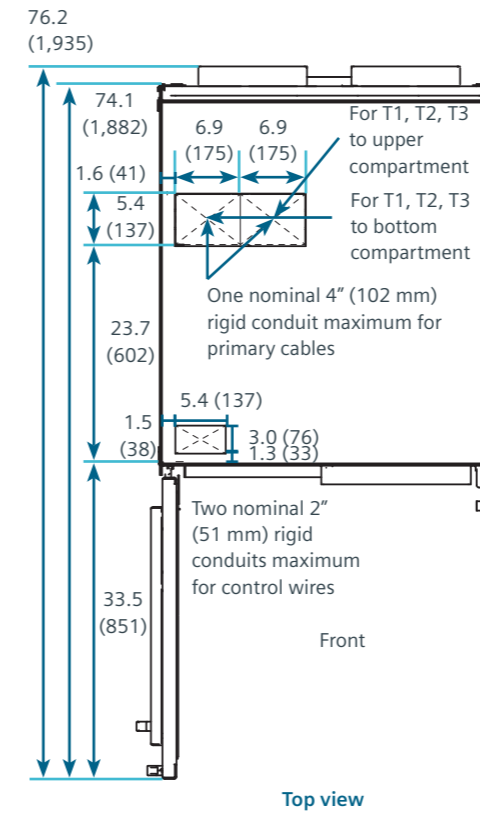
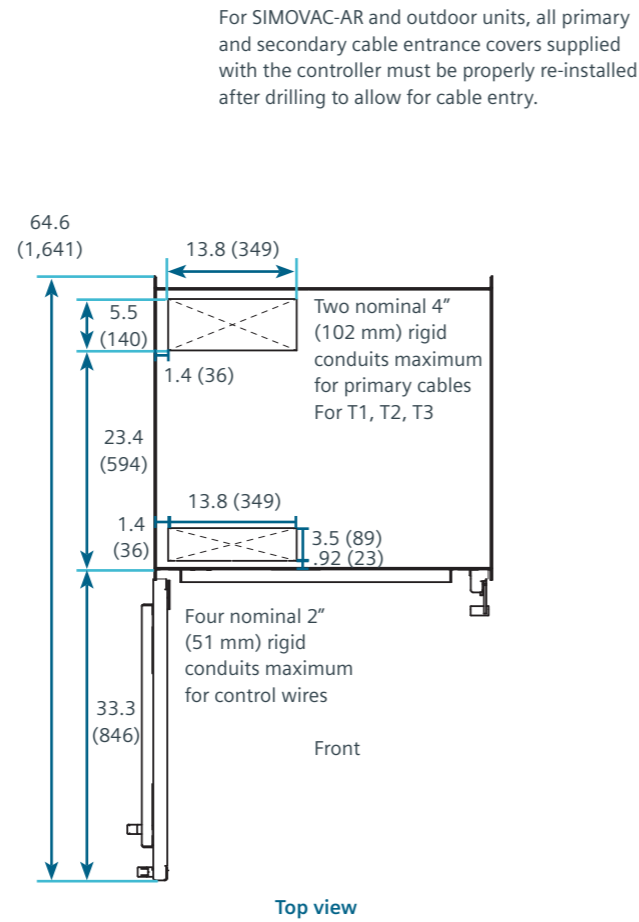
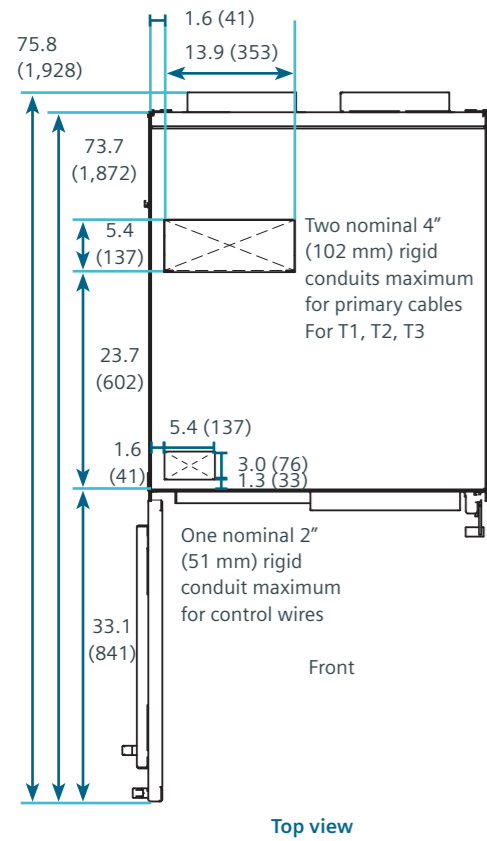
Maximum bus rating A	Provision for auxiliary	Dimensions in inches (mm) ⁹		Weight in lbs (kg)	Layout
		Height ^{1,6,10}	Depth ²		
18" (457 mm) wide					
1,200	³	95 (2,413)	30 (762)	600 (272) ⁷	15
2,000	³	95 (2,413)	30 (762)	655 (297) ⁷	15
36" (915 mm) wide					
1,200	^{3,4,5}	95 (2,413)	30 (762)	845 (383) ⁸	16
2,000	^{3,4,5}	95 (2,413)	30 (762)	951 (431) ⁸	16
3,000	^{3,4,5}	95 (2,413)	30 (762)	1,094 (496) ⁸	16
4,000	^{3,4,5}	95 (2,413)	30 (762)	1,239 (562) ⁸	16

Footnotes:

1. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
2. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
3. Provisions for surge arresters (optional).
4. Provisions for three current transformers, three voltage transformers and surge arresters (optional).
5. Provision for low-voltage compartment (optional).
6. Add 6" (152 mm) width per section for outdoor (non-arc-resistant). Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
7. Add 290 lbs (132 kg) for SIMOVAC-AR arc-resistant incoming line 18" (457 mm) wide.
8. Add 452 lbs (205 kg) for SIMOVAC-AR arc-resistant incoming line 36" (914 mm) wide.
9. Maximum shipping group is four vertical sections.
10. For non-arc-resistant structures with 4,000 A main bus, add 7.25" (184 mm) to the overall height and 75 lbs (35 kg) to the total weight per section.

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



Configuration A: One-high indoor arc-resistant controller

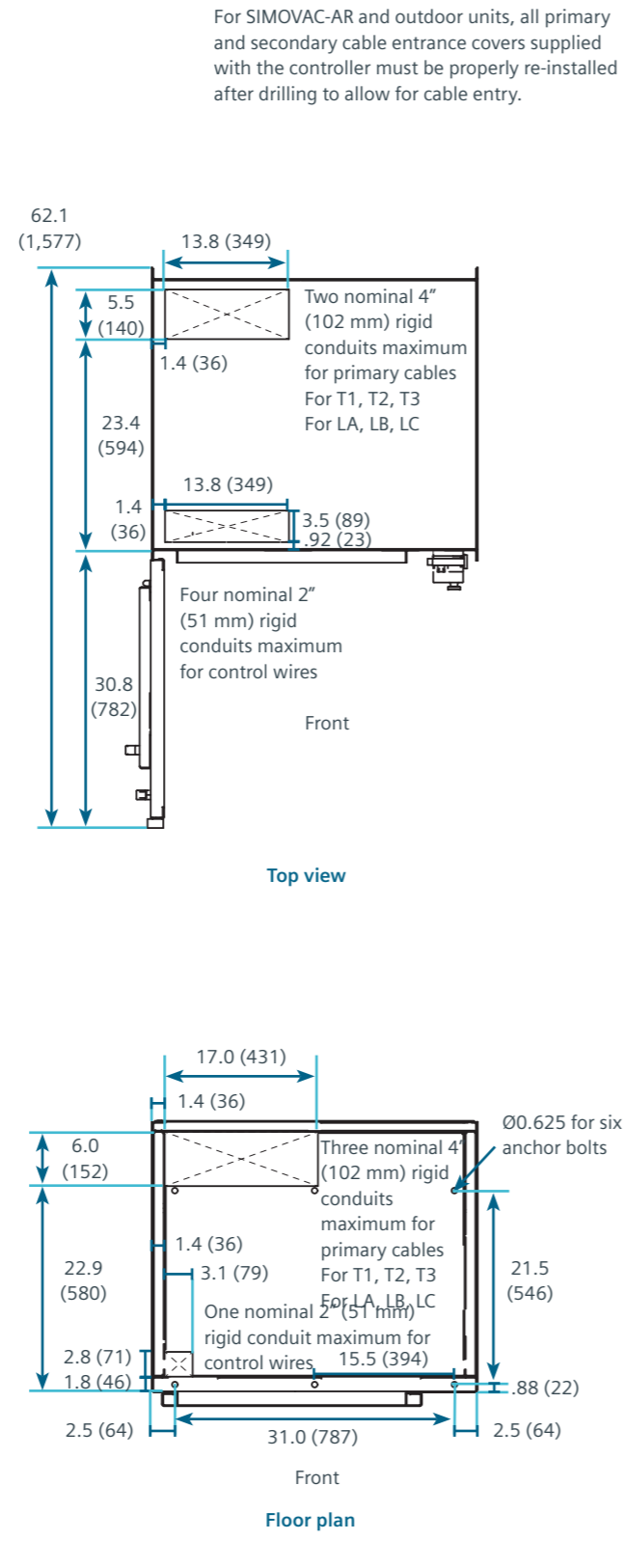
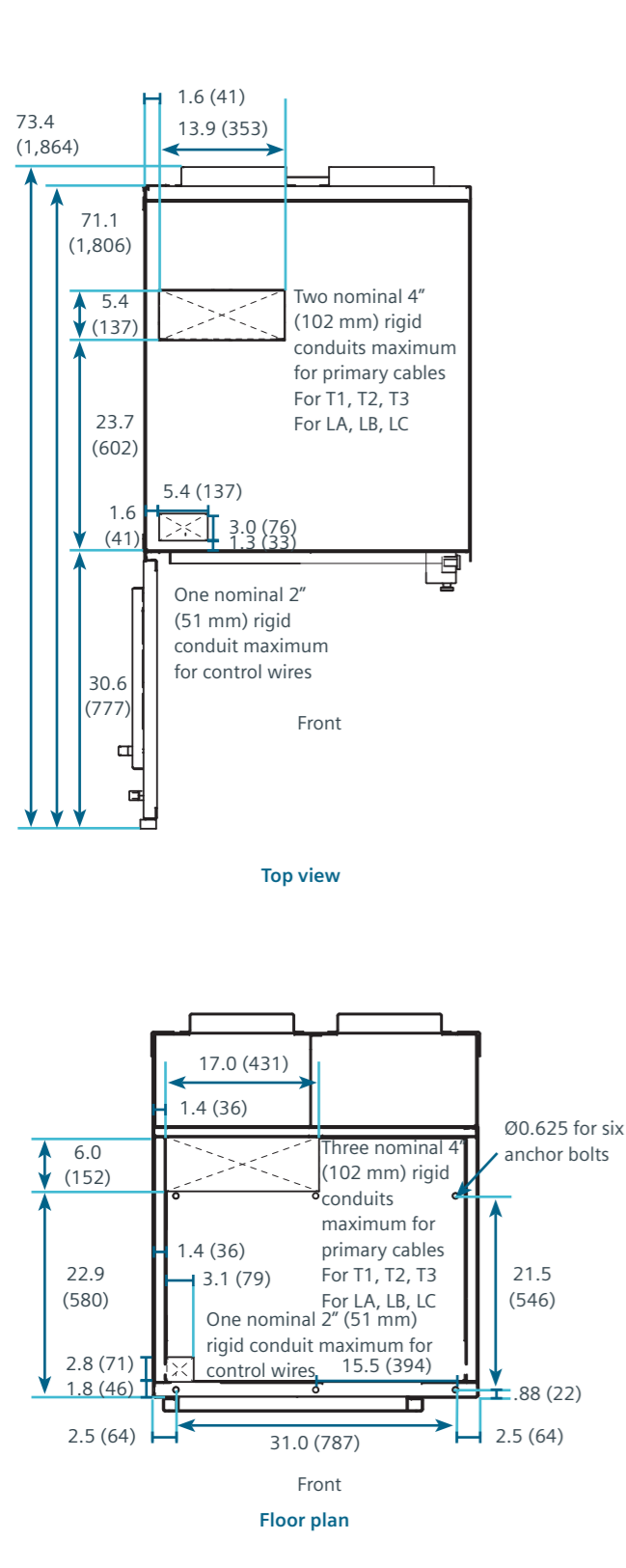
Configuration B: One-high indoor non-arc-resistant controller

Configuration C: Two-high indoor arc-resistant controller

Configuration D: Two-high indoor non-arc-resistant controller

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

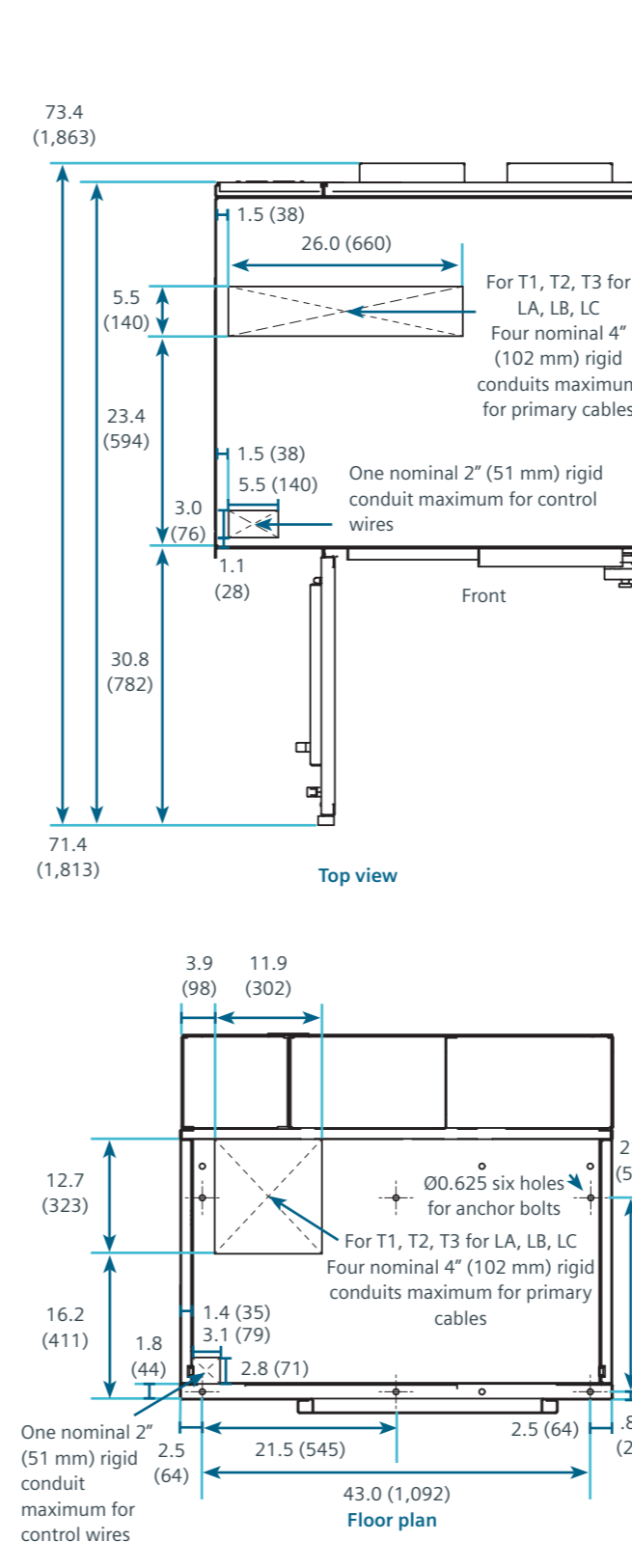
Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



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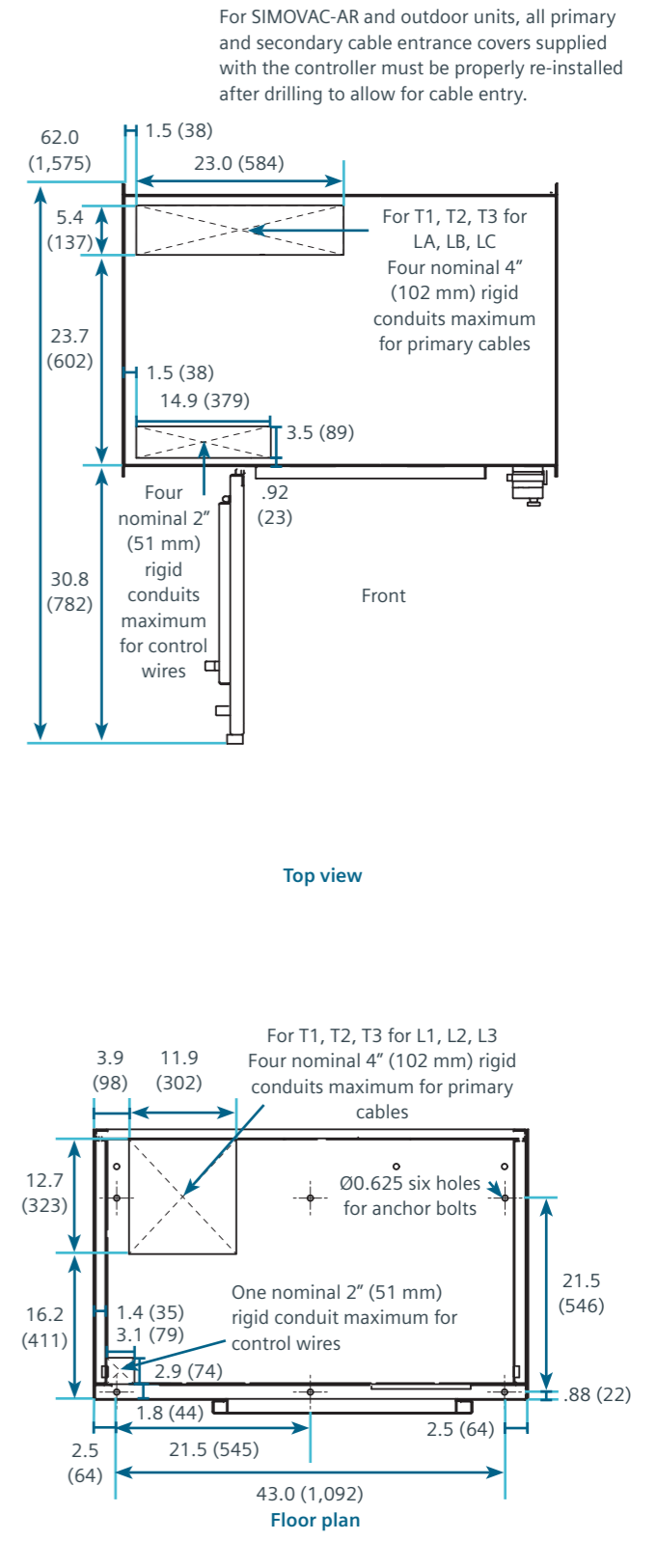
Configuration E: Load-interrupter arc-resistant switch 600 A

Configuration F: Load-interrupter non-arc-resistant switch 600 A



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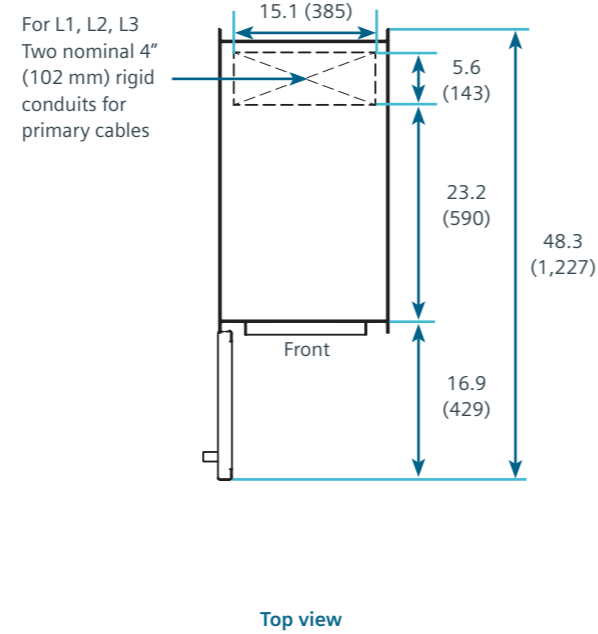
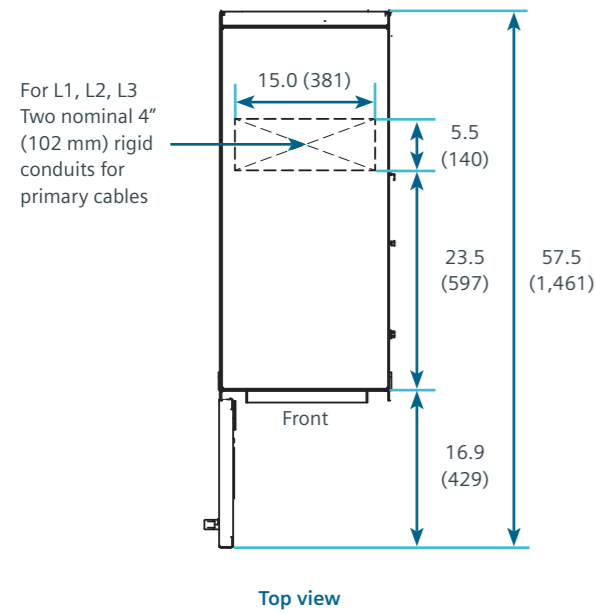
Configuration G: Load-interrupter arc-resistant switch 1,200 A 48" (1,219 mm)



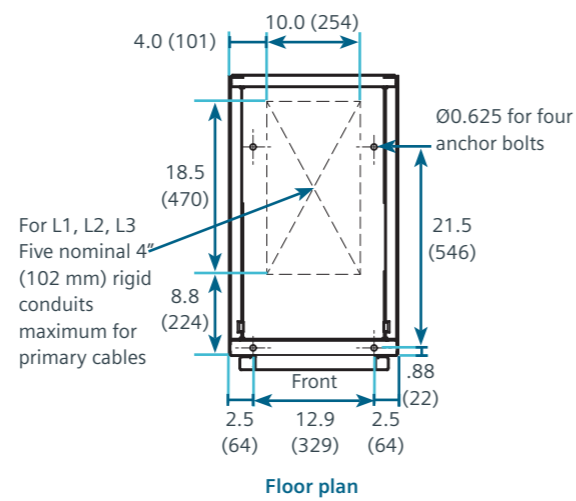
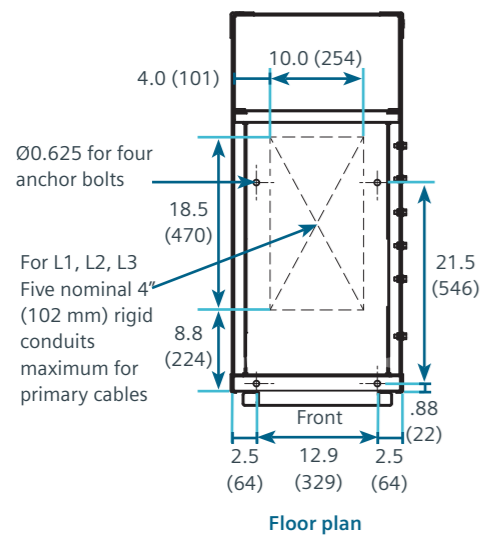
Configuration H: Load-interrupter non-arc-resistant switch 48" 1,200 A (1,219 mm)

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



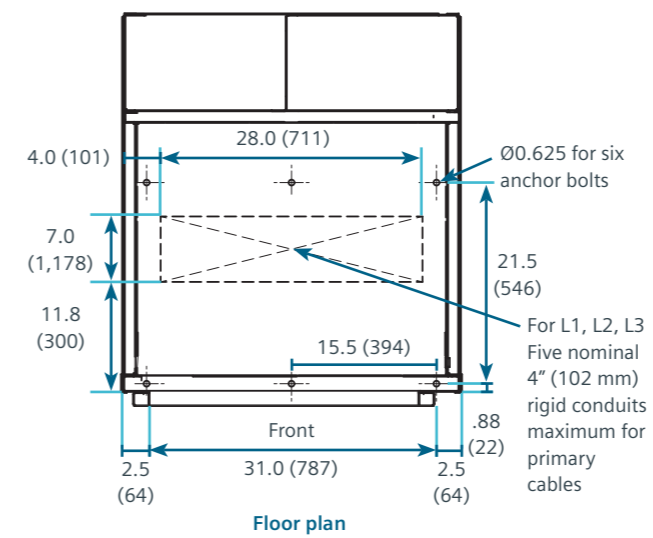
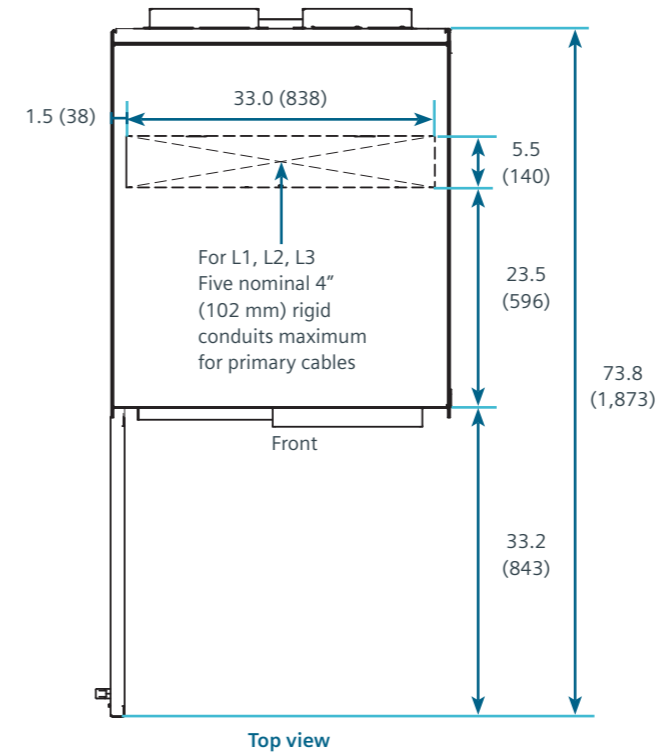
For SIMOVAC-AR and outdoor units, all primary and secondary cable entrance covers supplied with the controller must be properly re-installed after drilling to allow for cable entry.



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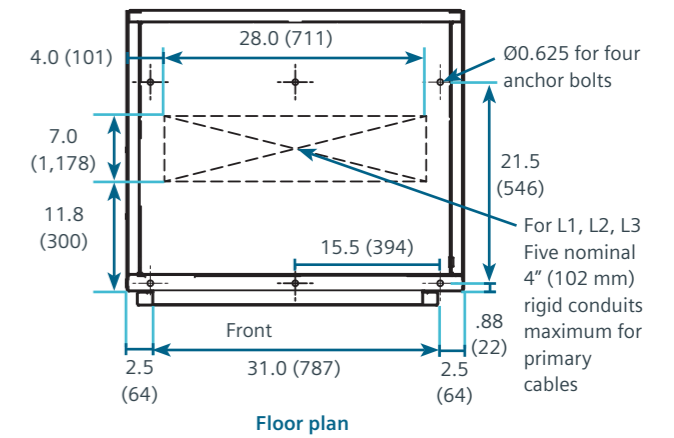
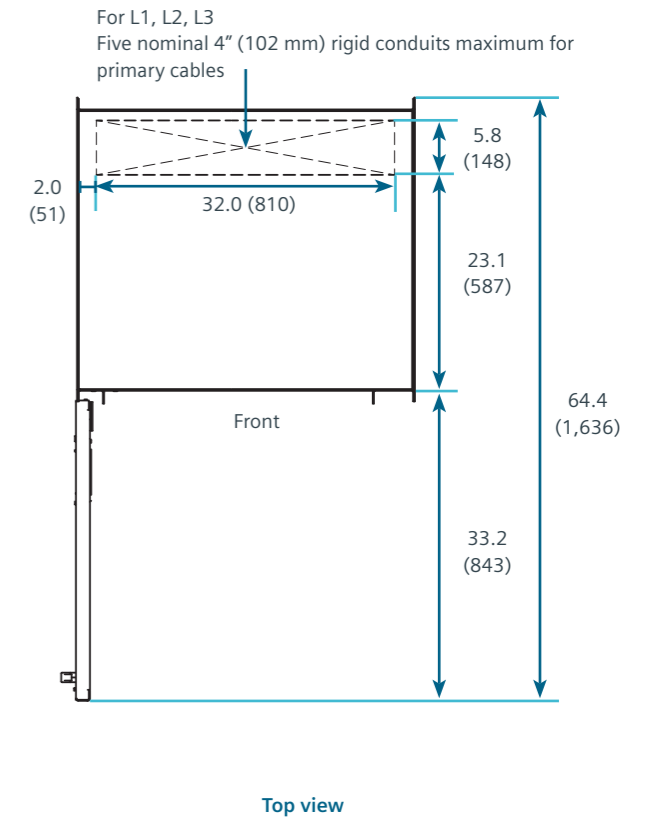
Configuration I: Incoming line arc-resistant 18" (457 mm)

Configuration J: Incoming line non-arc-resistant 18" (457 mm)



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Configuration K: Incoming line arc-resistant 36" (914 mm)

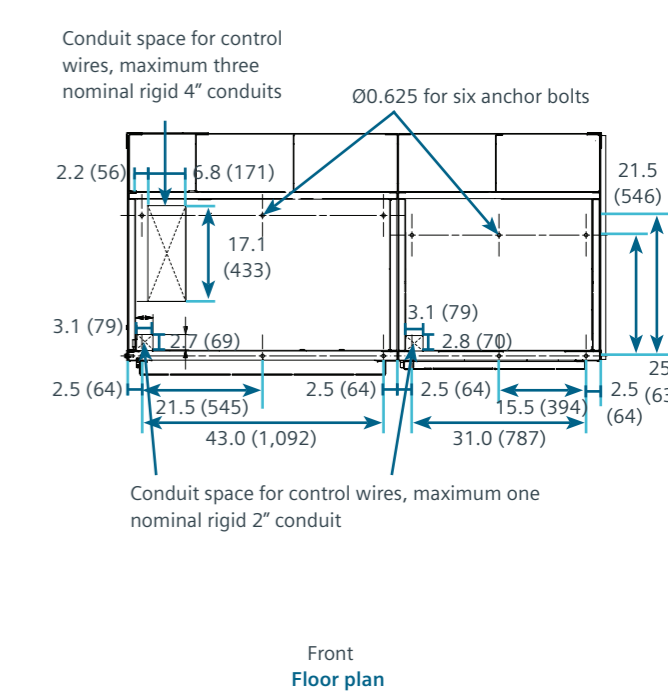
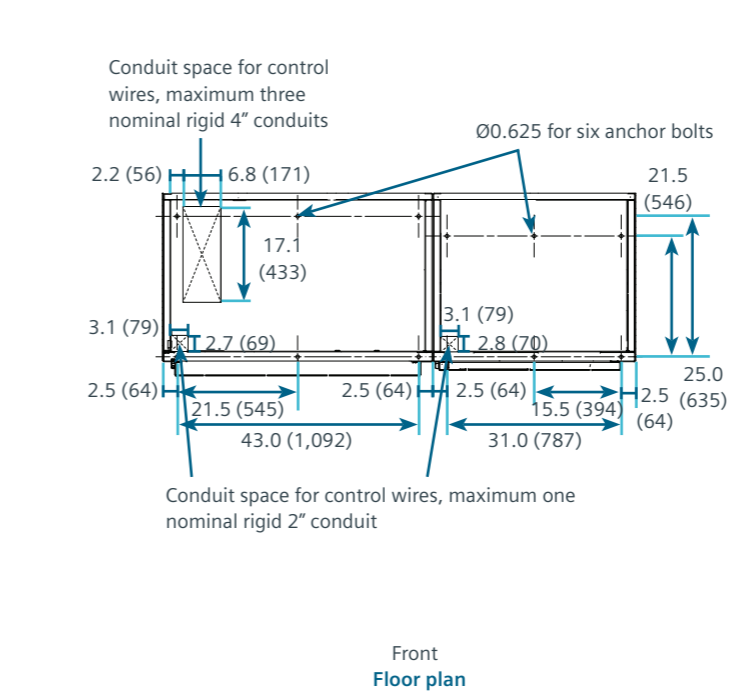
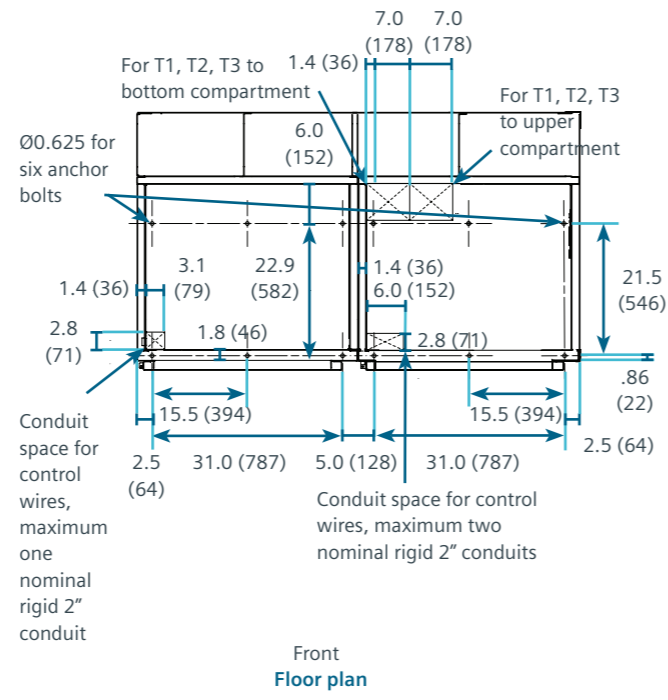
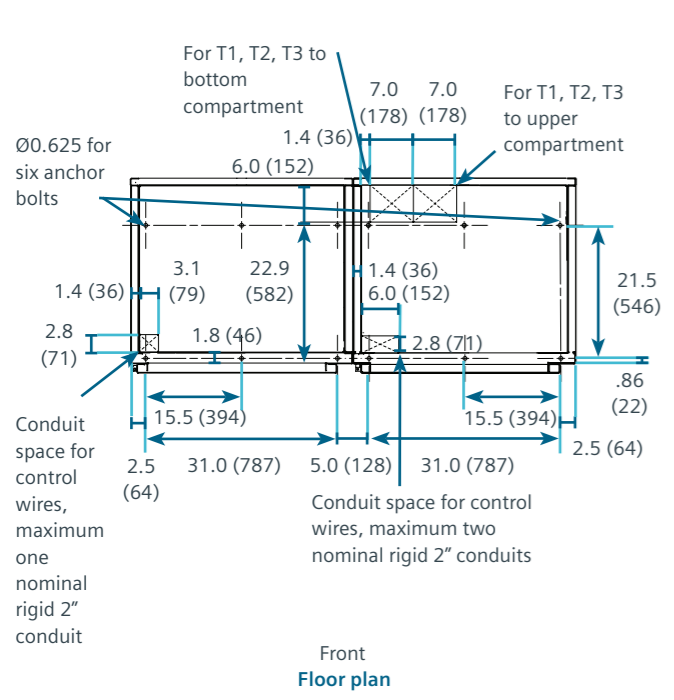
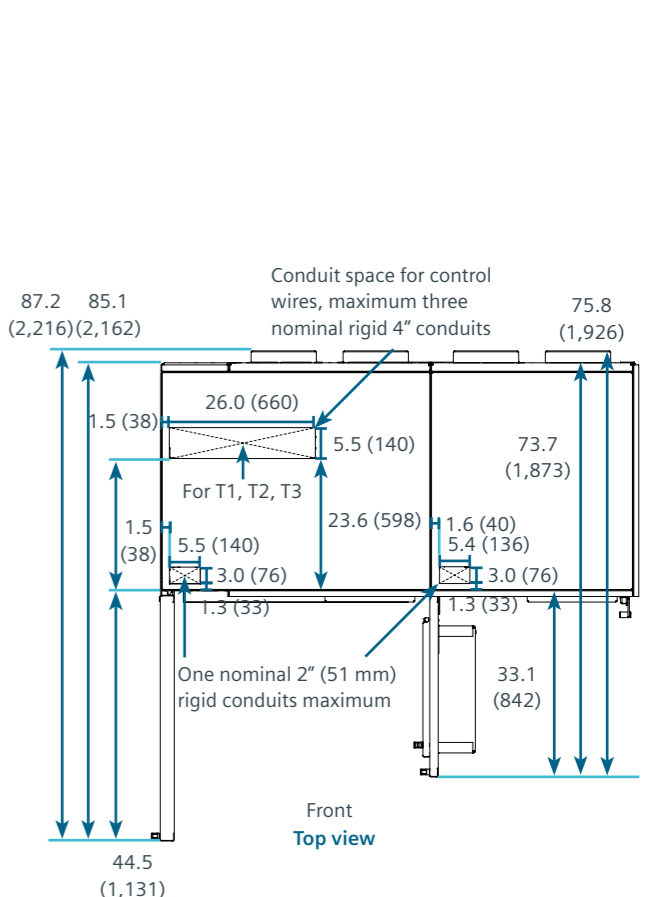
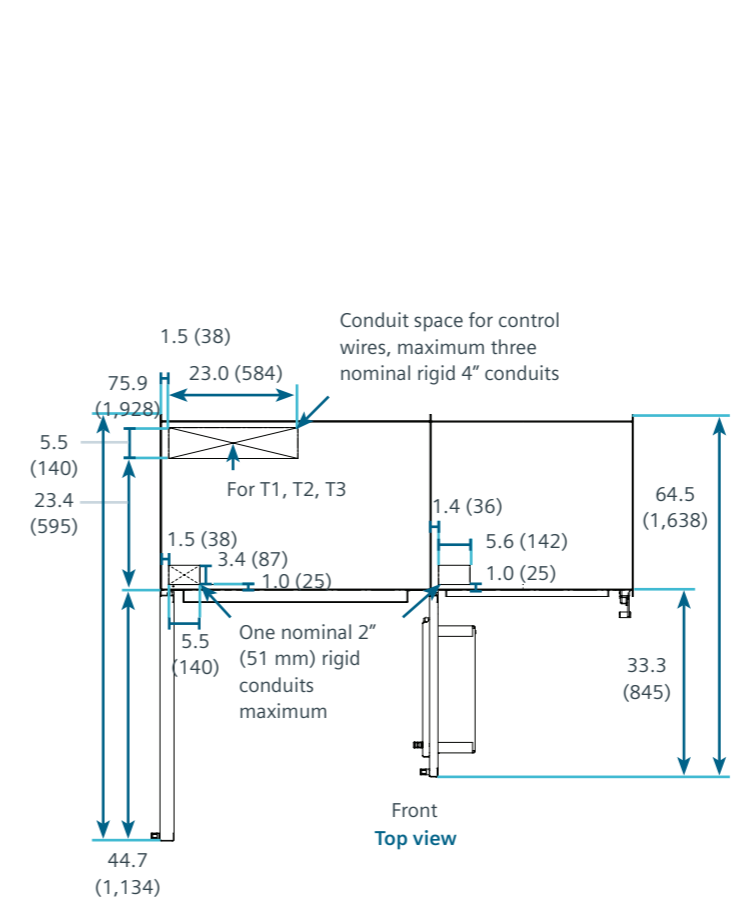
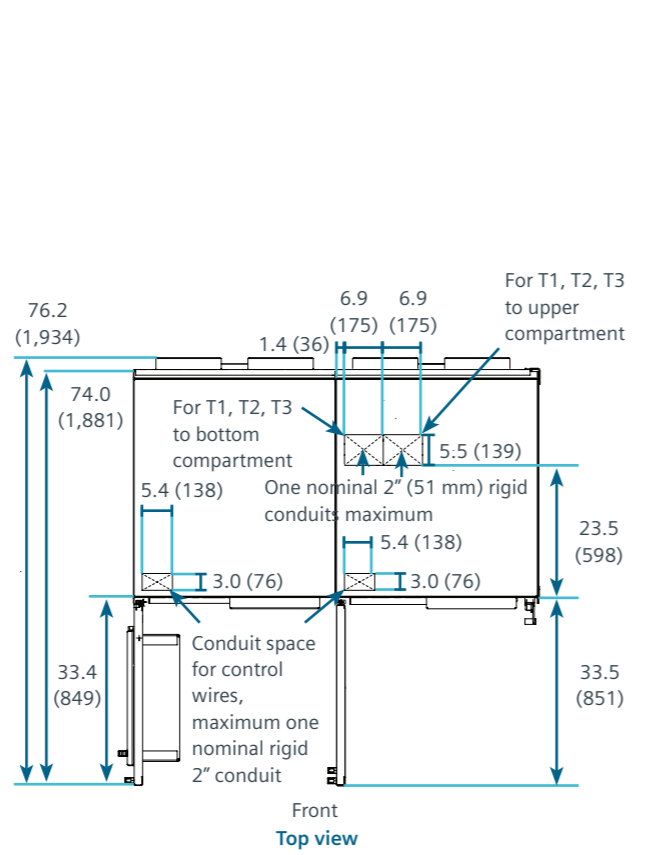
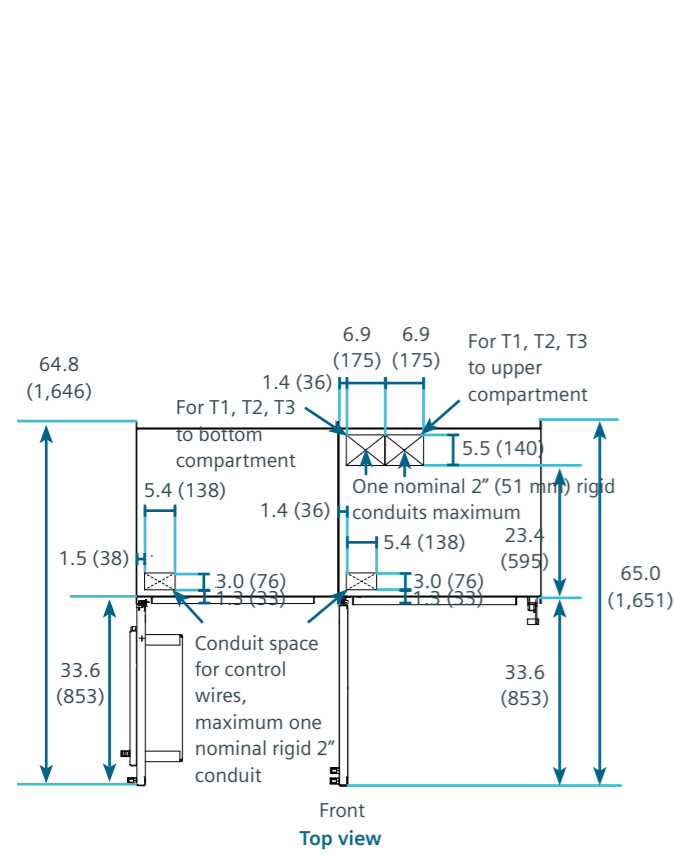


For SIMOVAC-AR and outdoor units, all primary and secondary cable entrance covers supplied with the controller must be properly re-installed after drilling to allow for cable entry.

Configuration L: Incoming line non-arc-resistant 36" (914 mm)

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

Figure 36: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



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Configuration M: Reduced-voltage auto-transformer non-arc-resistant 400 A

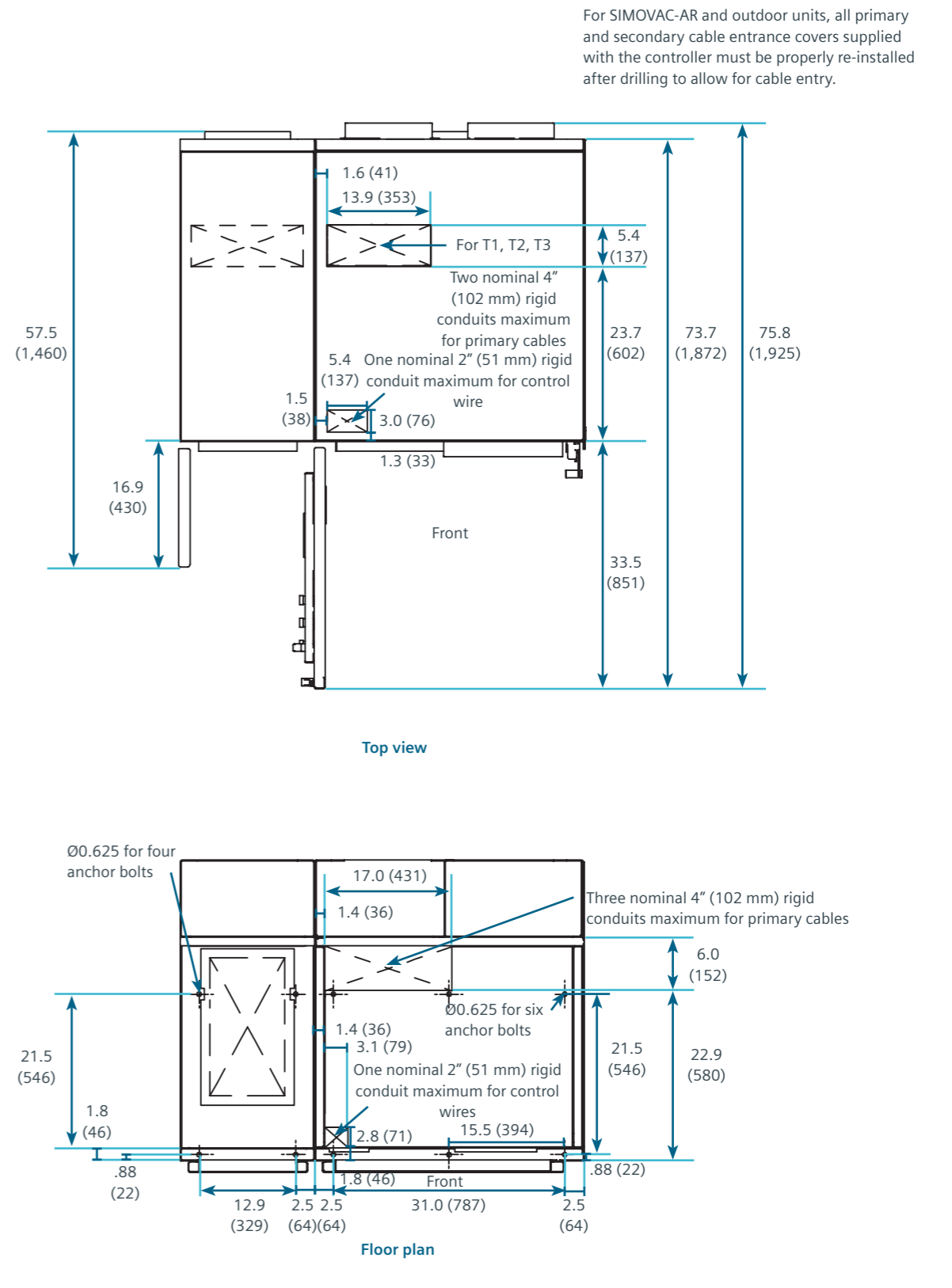
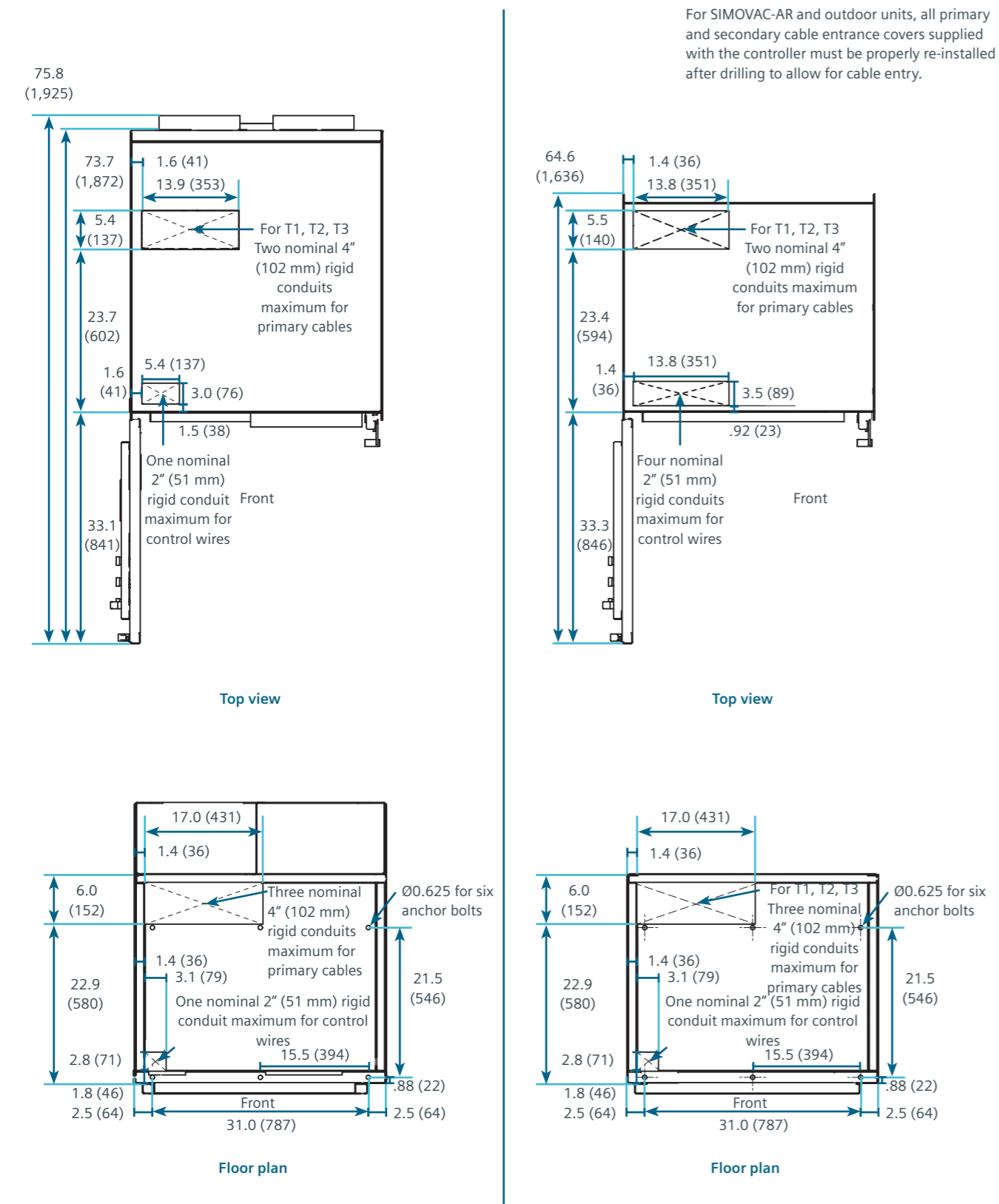
Configuration N: Reduced-voltage auto-transformer arc-resistant 400 A

Configuration O: Reduced-voltage auto-transformer non-arc-resistant 720 A

Configuration P: Reduced-voltage auto-transformer arc-resistant 720 A

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



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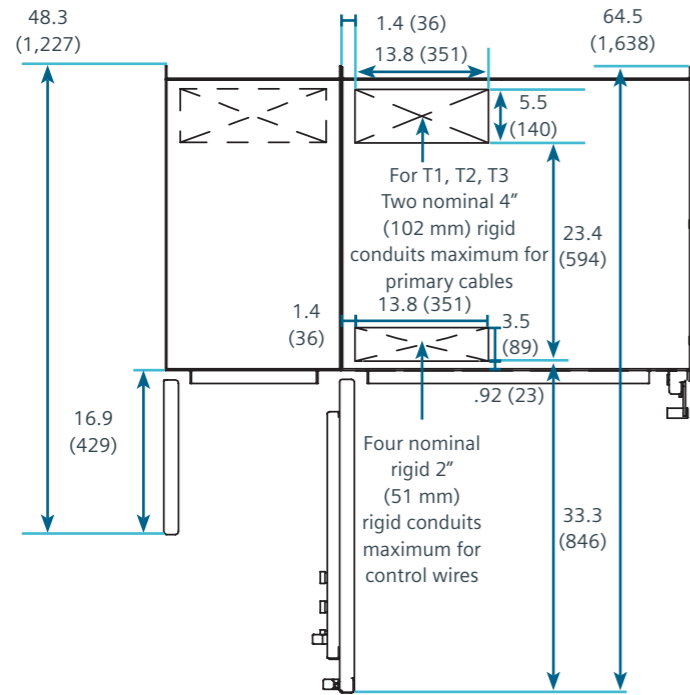
Configuration Q: Solid-state reduced-voltage arc-resistant up to 5 kV

Configuration R: Solid-state reduced-voltage non-arc-resistant up to 5 kV

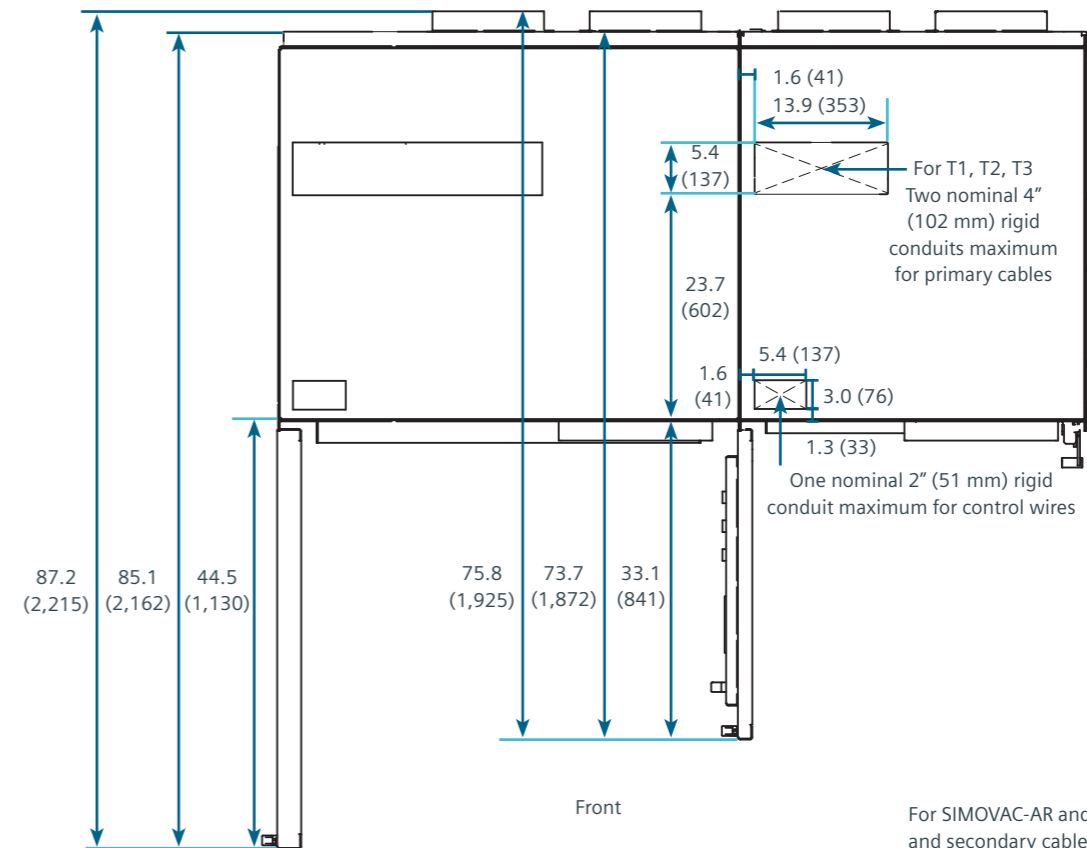
Configuration S: Solid-state reduced-voltage arc-resistant up to 7.2 kV - 400 A

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

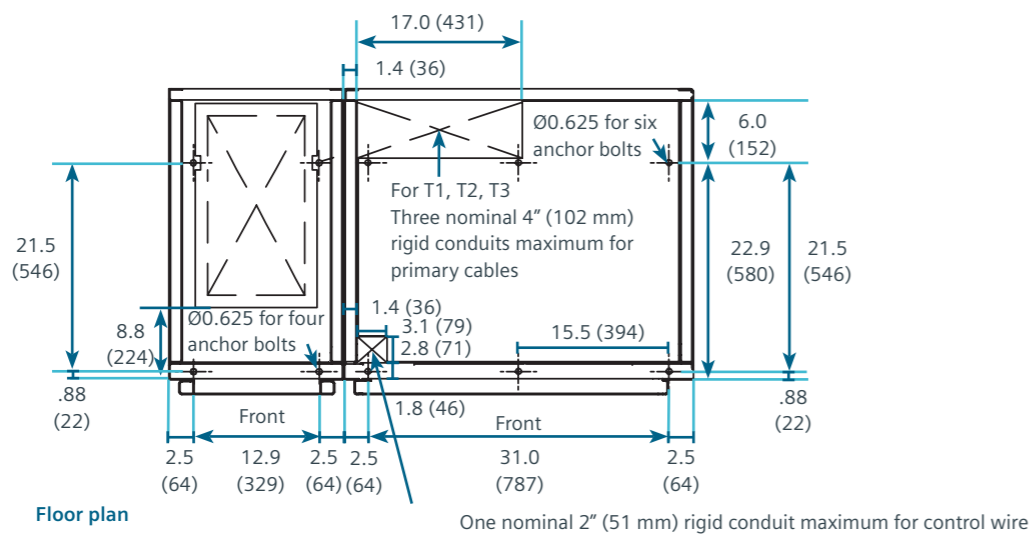


Front
Top view



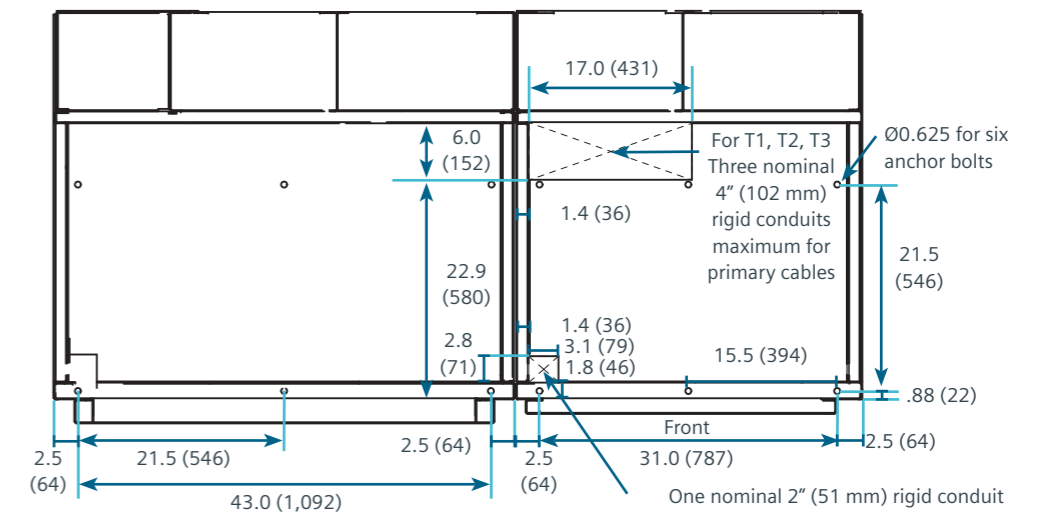
Front
Top view

For SIMOVAC-AR and outdoor units, all primary and secondary cable entrance covers supplied with the controller must be properly re-installed after drilling to allow for cable entry.



Floor plan

One nominal 2" (51 mm) rigid conduit maximum for control wire



Floor plan

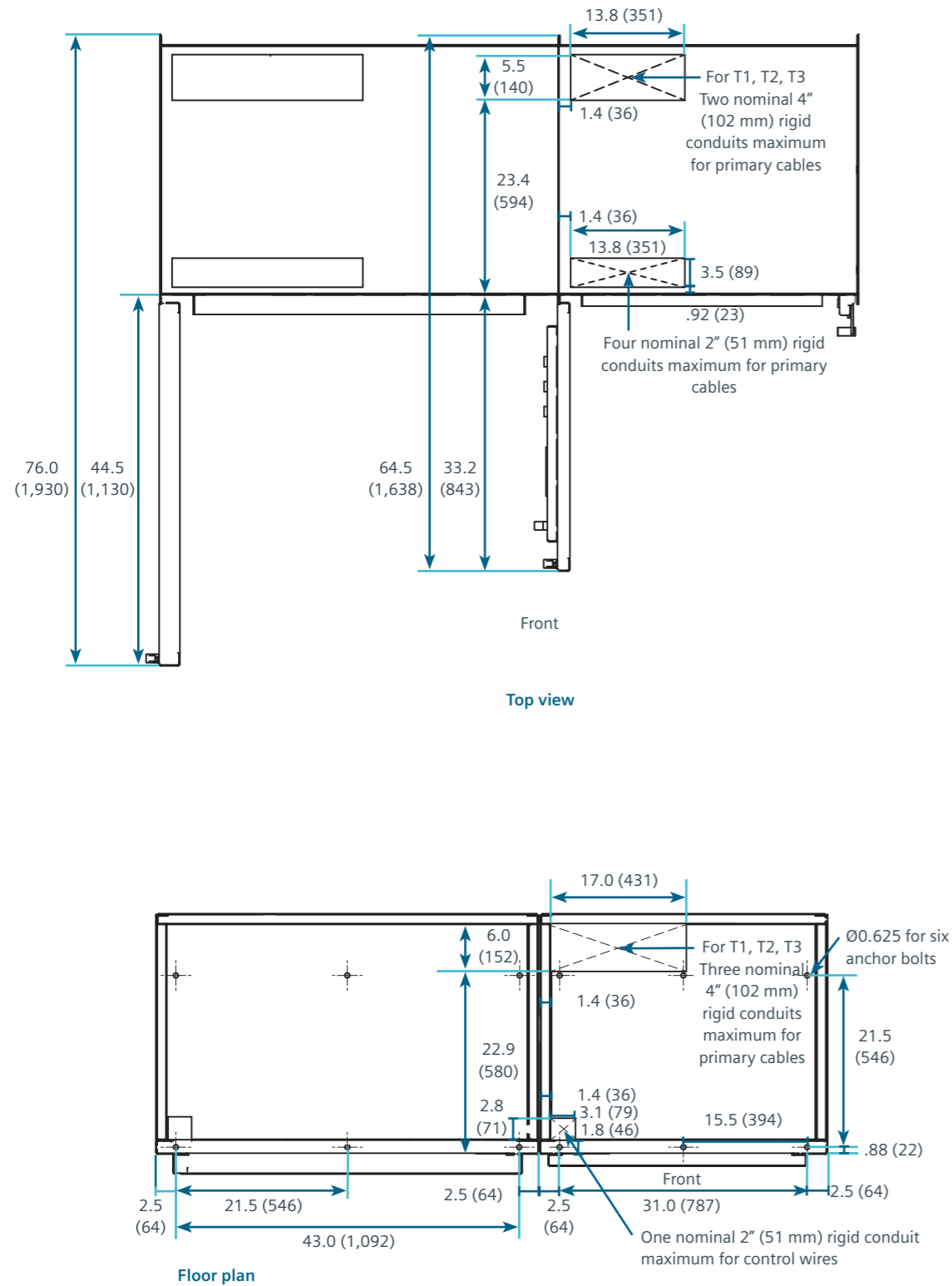
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Configuration T: Solid-state reduced-voltage non-arc-resistant up to 7.2 kV - 400 A

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Configuration U: Solid-state reduced-voltage arc-resistant up to 7.2 kV - 720 A

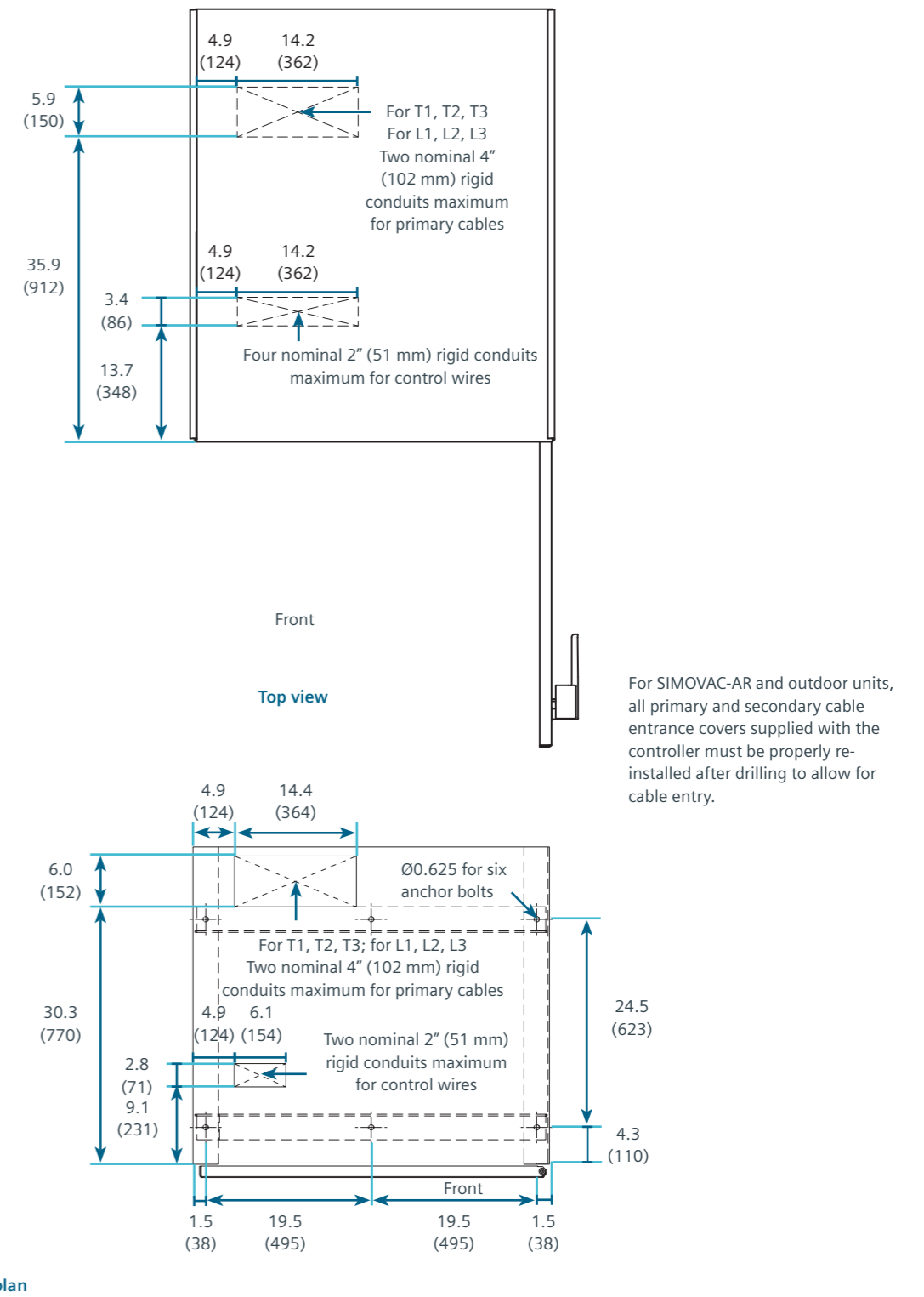
Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



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Configuration V: Solid-state reduced-voltage non-arc-resistant up to 7.2 kV - 720 A

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

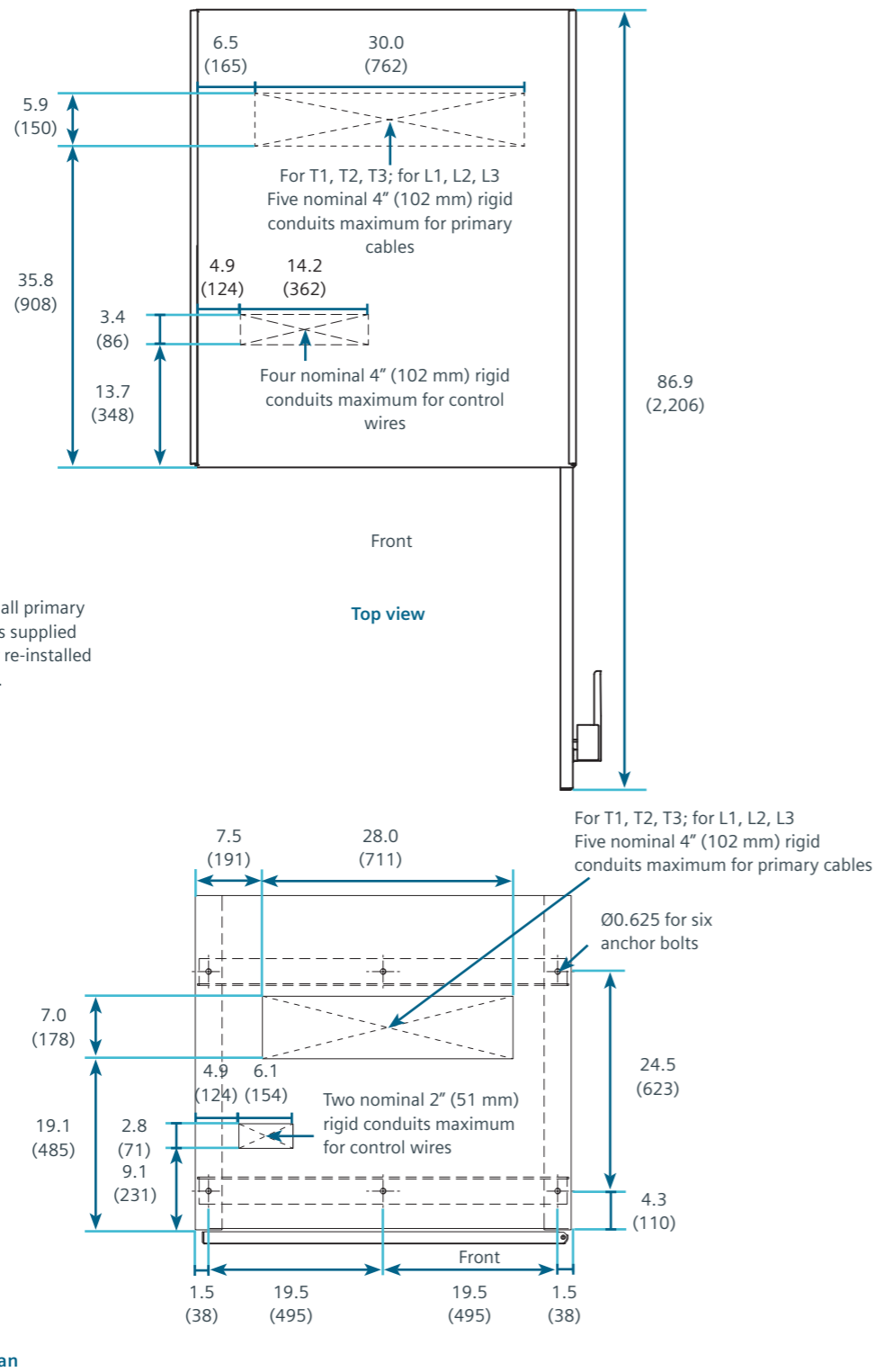


For SIMOVAC-AR and outdoor units, all primary and secondary cable entrance covers supplied with the controller must be properly re-installed after drilling to allow for cable entry.

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Configuration W: Outdoor 42" (1,067) structure

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)

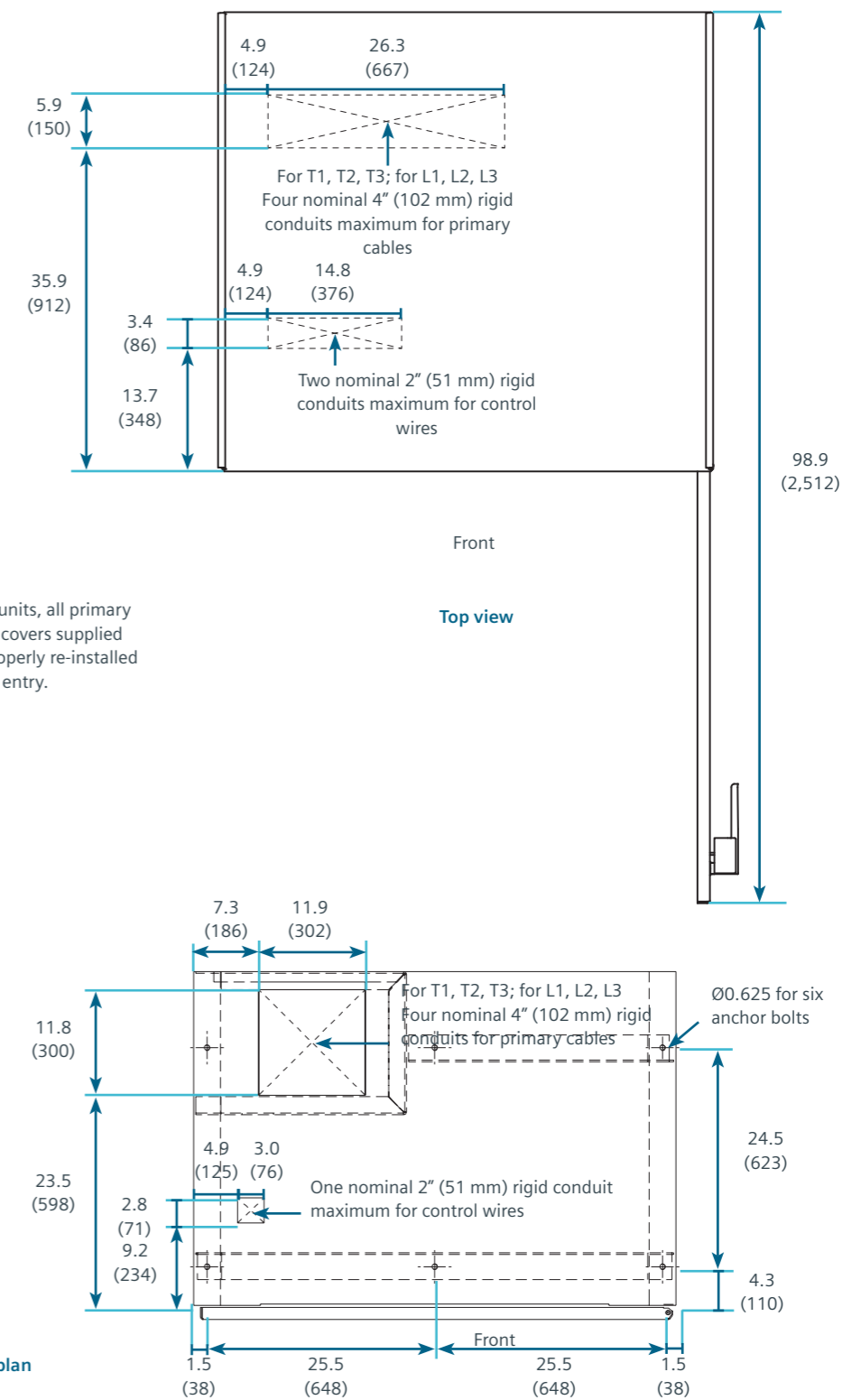


For SIMOVAC-AR and outdoor units, all primary and secondary cable entrance covers supplied with the controller must be properly re-installed after drilling to allow for cable entry.

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Configuration X: Outdoor incoming line 42" (1,067 mm) structure

Figure 34: Top view and typical floor plans for SIMOVAC and SIMOVAC-AR controllers (continued)



For SIMOVAC-AR and outdoor units, all primary and secondary cable entrance covers supplied with the controller must be properly re-installed after drilling to allow for cable entry.

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Configuration Y: Outdoor - 54" (1,372 mm) structure for load-interrupter switch or solid-state reduced-voltage controller

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