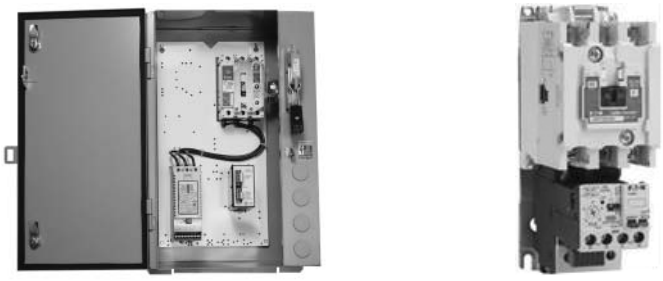
Motor Starters and Contactors—Low Voltage

Contents

Specifications:

See Eaton's *Product Specification Guide*, available on CD or on the Web.

CSI Format:	1995	2010
	Sections 16481, 16484, 16485, 16902	**Sections 26 29 13.11, 26 29 13.13, 26 29 13.15, 26 29 05**



Enclosed S801 Soft Start and Freedom NEMA Starter with C440 Electronic Overload Relay

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MS Manual Starters

Maximum 1 hp, 120/277 Volts Single-Phase

General Purpose Type 1 Enclosed MS Starter

Application Description

MS manual single-phase starters are designed to give positive, accurate, trouble-free overload protection to single-phase motors rated up to 1 hp. Typical applications are fans, machine tools, motors, HVAC, and so on.

Table 30.1-1. MS Ratings

Volts	hp	Poles
120/240V, 277 Vac	1	1 or 2
120/240 Vdc	1	2
240 Vdc	1/4	1
32 Vdc	1/4	1 or 2

Enclosures

- Type 1: General Purpose
- Type 1: Flush Mounted, General Purpose
- Type 3, 4, 5: Watertight
- Type 7D: Class I, Group D Hazardous Locations
- Type 9E, F, G: Class II, Groups E, F, G Hazardous Locations
- Red pilot light available for NEMA® 1, factory-installed or field-installed kit

Typical Specifications

Manual single-phase starters shall be Eaton's Type MS or approved equal for motors rated not greater than 1 hp. They shall be built and tested in accordance with the applicable NEMA standards.

The starter shall have a "quick-make, quick-break" toggle mechanism. The overload shall have a field adjustment allowing up to ±10% variance in ratings of the nominal heater value.

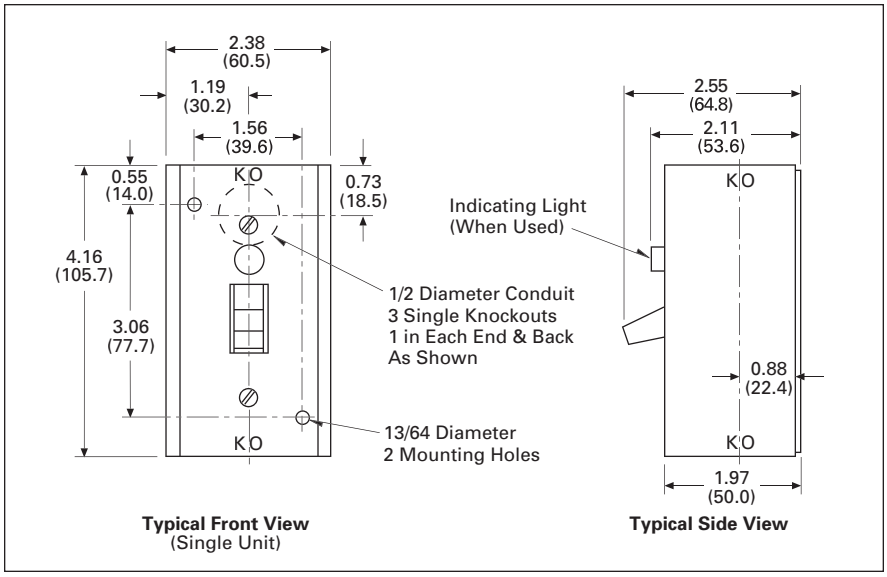

Figure 30.1-1. Type 1 Enclosures (Boxes and Covers)

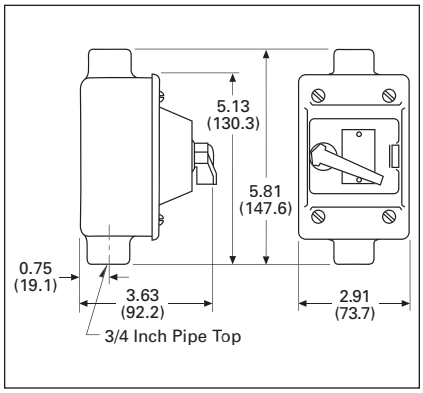

Figure 30.1-2. Watertight (Cast Aluminum)

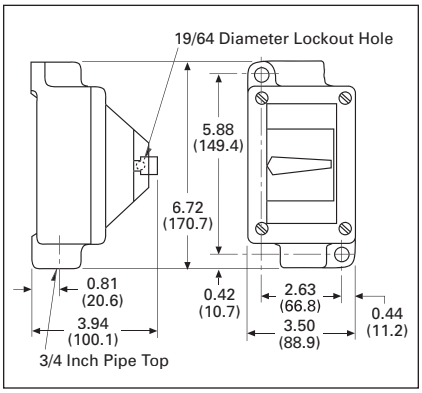

Figure 30.1-3. Hazardous Location (Cast Aluminum)

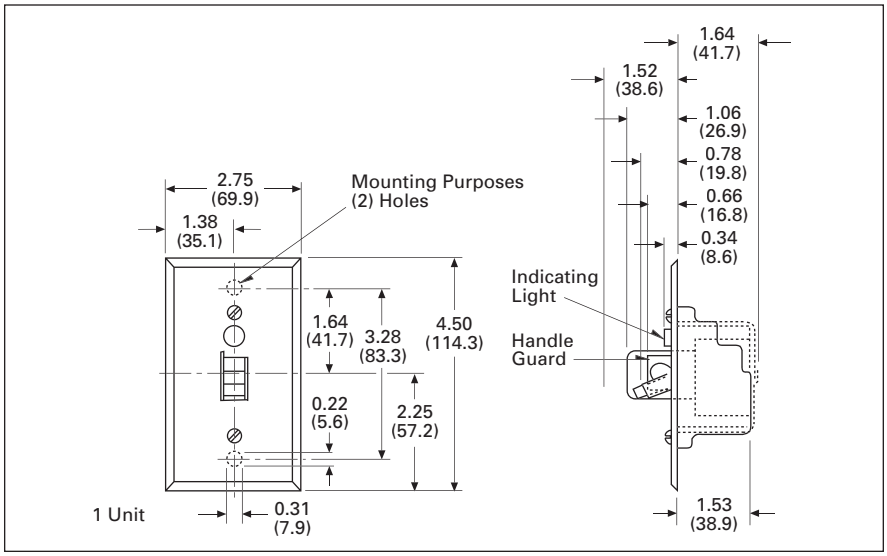

Figure 30.1-4. Flush Plates

Dimensions in inches. Not to be used for construction purposes unless approved.

30

Type B100

Maximum 10 hp, 600 Volts

General Purpose Type 1 Enclosed B100 Starter

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Enclosures

- Type 1: General Purpose
- Type 4: Stainless Steel, Watertight
- Type 7: Class I, Group D Hazardous Locations
- Type 9: Class II, Groups E, F, G Hazardous Locations
- Type 12: Dust-tight Industrial Use

Table 30.1-2. B100 Ratings

NEMA Size	Maximum Horsepower		
	115 Vac	200-230 Vac	460-575 Vac
Two-Pole, Single-Phase AC			
M-0	1	2	—
M-1	2	3	—
M-1P(1-1/2)	3	5	—
Three-Pole, Three-Phase AC			
M-0	2	3	5
M-1	3	7-1/2	10

Typical Specifications

All three-phase manual starters and single-phase starters rated above 1 hp shall be Eaton's Type B100 or approved equal. They shall be built and tested in accordance with the applicable NEMA standards.

The starter must feature contact operation that is "quick-make, quick-break" and cannot be teased into a partially open condition. There must be a provision that blocks the closure of the contacts while the line terminals are exposed. Operating handle or buttons must clearly show by their position whether unit is ON, OFF or TRIPPED.

Application Description

Eaton's B100 manual starter can be used on non-reversing applications up to10 hp, 600 Vac. It features a three-pole block overload relay that uses A200 starter heaters, straight-through wiring, and will accept auxiliary contacts.

B100 starters are available as toggle or pushbutton-operated open and Type 1 enclosed devices, or toggle-operated in Type 4, 7, 9 and 12 enclosures with padlocking provision as standard. Red pilot lights and one auxiliary contact are available as options.

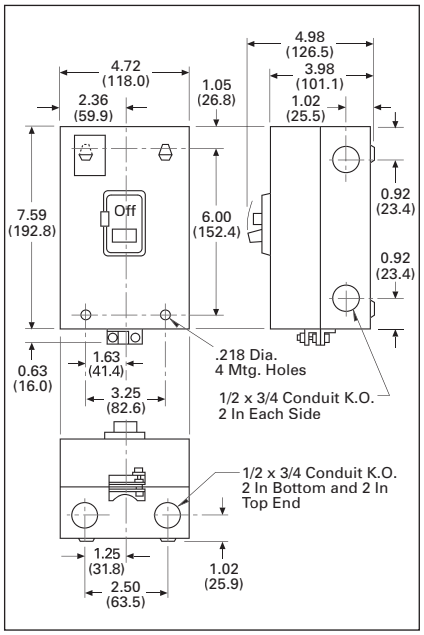


Figure 30.1-5. Type 1 Enclosed

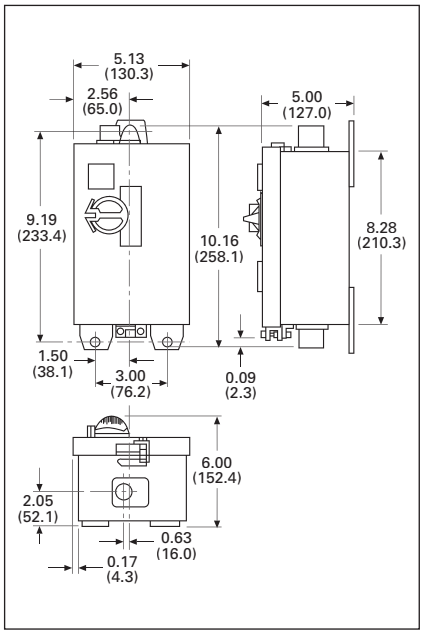


Figure 30.1-7. Type 4 Enclosed

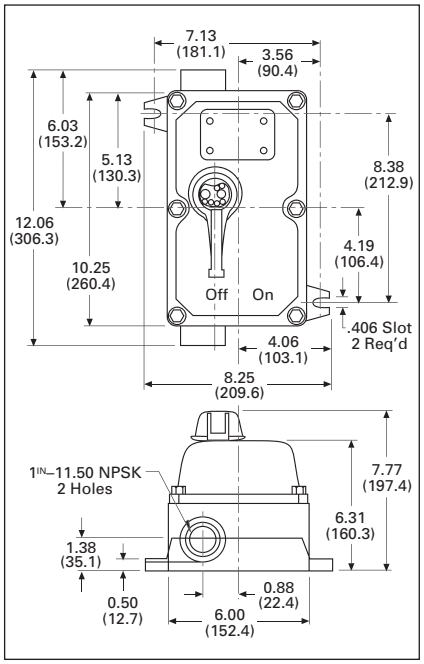


Figure 30.1-6. Type 7/9 Enclosed

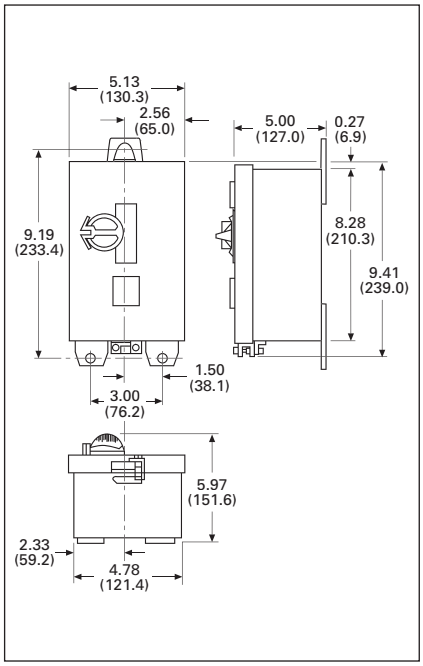


Figure 30.1-8. Type 12 Enclosed

Dimensions in inches. Not to be used for construction purposes unless approved.

Non-Combination Lighting Contactors

60 Ampere, Five-Pole Electrically Held

30 Ampere, 12-Pole Mechanically Held

30 Ampere, Four-Pole Magnetically Latched

General Description

Lighting contactors are designed to provide a safe, convenient means for local or remote switching of tungsten (incandescent filament) or ballast (fluorescent and mercury arc) lamp loads. They are also suitable for other loads such as low pressure and high pressure sodium lamp loads and other non-motor (resistive) loads. They are not recommended for most sign flashing loads.

These lighting contactors are designed to withstand the large initial inrush currents of tungsten lamp loads without contact welding. The full family of lighting contactors does not require derating.

Application Description

Loads:

Ballast Lamps—Fluorescent, mercury vapor, metal halide sodium vapor, quartz—600V maximum.

Filament Lamps—Incandescent, infrared, heating—480V maximum, line-to-line; 277V maximum line-to-neutral.

Resistance Heating—Radiant and convection heating, furnaces and ovens.

Typical Specifications

Electrically Held Lighting Contactors— Eaton's CN35 or approved equal are rated for lighting loads of 10–300A. They are built and tested in accordance with applicable NEMA standards.

Mechanically Held Lighting Contactors— Eaton's C30CNM or approved equal are rated for lighting loads of 30A. They shall be capable of being supplied in a 2–12 pole single unit configuration.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contacts welding. The contactor is capable of being operated such that it will not switch to "OFF" during the control power circuit power failures.

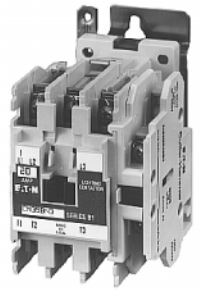
Magnetically Latched Lighting Contactors—A202 or approved equal are rated for lighting loads of 30–4000A. Magnetically latched enclosed combination lighting contactors are Type ECL12 (breaker) or ECL13 (fusible) or approved equal for loads up to 30–200A when integral short-circuit protection is required.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contacts welding. The contactors are capable of being "mechanically held" via a magnetic latch design using a permanent magnet. The contactor is operated by a RUN signal and a STOP signal preventing the contactor from switching to "OFF" during control circuit power failure.

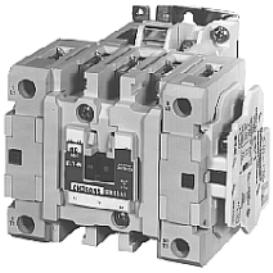
Table 30.2-1. Lighting Contactor Comparison

Ampere Rating	Number of Poles	Electrically Held	Mechanically Held	Magnetically Latched
10	2, 3, 4	**CN35**	—	—
20	2, 3, 4, 6, 9, 12	**CN35**	—	—
30	2, 3, 4, 5, 6, 9, 12	**CN35**	—	—
30	1–12	**C30CNE**	**C30CNM**	—
30	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
60	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
60	2, 3, 4, 5	**CN35**	—	—
100	2, 3, 4, 5	**CN35**	—	—
100	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
200	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
200	2, 3, 4, 5	**CN35**	—	—
300	2, 3, 4, 5	**CN35**	—	—
300	2, 3	—	—	**A202**
400	2, 3	—	—	**A202**

CN35-Open (ECL03-Enclosed)



20 Ampere



60 Ampere

General Description

Lighting contactors are designed to handle the switching of tungsten (incandescent filament) or ballast (fluorescent and mercury arc) lamp loads as well as other non-motor (resistive) loads. Ratings of 10–400A, 1–12 poles, open or NEMA 1, 3R, 4/4X and 12 enclosed.

Application Description

Loads:

Ballast Lamps—Fluorescent, mercury vapor, sodium vapor, quartz—600V maximum.

Filament Lamps—Incandescent, infrared, heating—480V maximum.

Resistance Heating—Radiant and convection heating, furnaces and ovens.

Cover Control—See Enclosed Control Product Guide PG.3.02.T.E start-stop and hand-off-auto only.

Enclosures

Open, NEMA Type 1, 3R, 4/4X and 12.

Auxiliary Contacts

Eaton's CN35 lighting contactors include a NO maintaining auxiliary contact mounted on right-hand side (on 10A, two- and three-pole devices, auxiliary contact occupies 4th power pole position—no increase in width). Enclosed devices include a NO auxiliary contact only on the right-hand contactor. The 10–60A devices will accept additional auxiliary contacts on the top and/or sides. The 100–400A sizes will accept side-mounted auxiliaries only.

Typical Specifications

Electrically-held lighting contactors are Eaton Type CN35 or ELC03, or approved equal for lighting loads of 10–300A. They are built and tested in accordance with applicable NEMA standards.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. Contactors are capable of accepting up to 8 auxiliary contacts—top and/or side up to 60A and side only up to 400A. Contactors are capable of being operated by AC or DC control.

Table 30.2-2. Ratings—CN35 AC Lighting Contactors—Electrically Held

Maximum Ampere Rating ①	Number of Poles
10	2, 3, 4
20	2, 3, 4, 6, 9, 12
30	2, 3, 4, 5, 6, 9, 12
60	2, 3, 4 ②, 5 ②
100, 200, 300	2, 3, 4, 5
400	2, 3

① Listed ampere ratings are based on a maximum load voltage of 480V for tungsten lamp applications and 600V for ballast or mercury vapor type applications.

② Additional power poles mounted on side(s) of contactor.

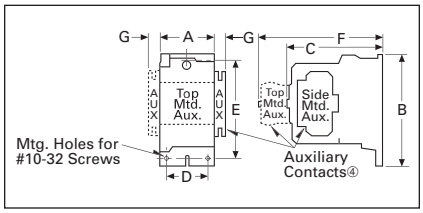


Figure 30.2-1. Open Type

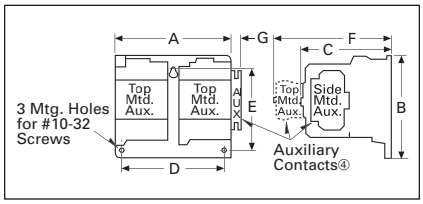


Figure 30.2-2. Open Type, 20–30A Sizes, Four–Six Poles

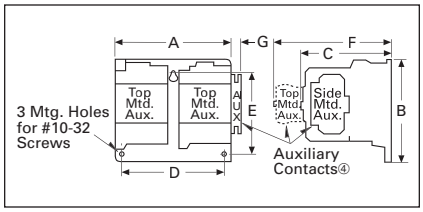


Figure 30.2-3. Open Type, 20–30A Sizes, Four–Six Poles

③ See "Auxiliary Contacts" for type and location of auxiliary contacts supplied.

Table 30.2-3. Approximate Dimensions and Shipping Weights

Ampere Rating	Number of Poles	Dimensions in Inches (mm)							Shipping Weight Lbs (kg)
		Wide A	High B	Deep C	Mounting D ④	Mounting E	F	G	
Open Type									
10	2–4	2.00 (50.8)	3.88 (98.5)	3.49 (88.6)	1.50 (38.1)	3.38 (85.9)	4.90 (124.5)	0.54 (13.7)	1.4 (0.63)
20–30	2–3	2.00 (50.8)	3.88 (98.5)	3.49 (88.6)	1.50 (38.1)	3.38 (85.9)	4.90 (124.5)	0.54 (13.7)	1.45 (0.65)
20–30	4–6	4.20 (106.7)	4.35 (110.5)	3.52 (89.4)	3.50 (88.9)	3.86 (98.0)	4.90 (124.5)	0.54 (13.7)	2.9 (1.3)
20–30	9	10.50 (266.7)	5.75 (146.0)	4.52 (114.8)	4.50 (114.3)	5.00 (127.0)	—	—	4.35 (1.96)
20–30	12	10.50 (266.7)	5.75 (146.0)	4.52 (114.8)	4.50 (114.3)	5.00 (127.0)	—	—	5.8 (2.6)
60	2–3	2.56 (65.1)	5.05 (128.3)	4.44 (112.8)	2.00 (50.8)	4.50 (114.3)	5.80 (147.3)	0.54 (13.7)	3.4 (1.53)
60	4	3.46 (87.8)	5.05 (128.3)	4.44 (112.8)	2.00 (50.8)	4.50 (114.3)	5.80 (147.3)	0.54 (13.7)	3.5 (1.57)
60	5	4.36 (110.7)	5.05 (128.3)	4.44 (112.8)	2.00 (50.8)	4.50 (114.3)	5.80 (147.3)	0.54 (13.7)	3.55 (1.59)
100	2–3	3.54 (89.9)	7.17 (182.1)	5.94 (150.9)	3.00 (76.2)	6.63 (168.4)	—	0.54 (13.7)	9 (4.1)
200	2–3	7.05 (179.1)	9.11 (231.4)	7.25 (184.2)	6.00 (152.4)	8.50 (215.9)	—	—	20 (9.0)
300	2–3	7.05 (179.1)	13.12 (333.2)	7.78 (184.2)	6.00 (152.4)	12.50 (317.5)	—	—	23 (10.35)

④ Center mounting slot at bottom on 10–30A sizes only.

Enclosed Box Selection

Table 30.2-4. Type 1 Non-combination Lighting Contactors—Electrically Held—CN35

Ampere Size (Poles)		Box No.	Shipping Weight Lbs (kg)
Contactors—without Control Power Transformers			
10 A	(2P, 3P, 4P)	1	5 (2.3)
10A	(2P, 3P, 4P, 5P, 6P) w/top adders	2	7.3 (3.3)
10A	(9P, 10P, 12P, 20P)	3	9.5 (4.3)
20A	(2P, 3P)	1	5.2 (2.4)
20A	(2P, 3P, 4P, 5P, 6P) w/top adders & 6P w/o top adder	2	7.3 (3.3)
20A	(9P, 10P, 12P, 20P)	3	9 (4.1)
20A	(9P, 12P) w/top adders	3	9.3 (4.2)
30A	(2P, 3P)	1	5.3 (2.4)
30A	(2P, 3P, 4P) w/top adders	2	7.3 (3.3)
30A	(5P, 6P)	3	9.0 (4.1)
30A	(5P, 6P) w/top adders	3	9.2 (4.2)
30A	(9P, 10P, 12P, 20P)	3	9.5 (4.3)
30A	(9P, 12P) w/top adders	3	9.7 (4.4)
60A	(2P, 3P)	1	7 (3.2)
60A	(2P, 3P) w/top adders	3	9.8 (4.4)
60A	(4P, 5P, 6P, 9P, 10P, 12P)	3	9.5 (4.3)
60A	(4P, 5P) w/top adders	3	10 (4.5)
100A	(2P, 3P)	4	35 (16)
100A	(4P, 5P, 6P, 9P)	4	60 (27)
200A	(2P, 3P)	4	70 (32)
200A	(4P, 5P, 6P)	10	133 (60)
300A	(2P, 3P)	10	113 (51)
300A	(4P, 5P, 6P)	10	136 (62)
400A	(2P, 3P)	10	125 (57)
Contactors—with Control Power Transformers			
10A	(2P, 3P, 4P)	2	11 (5.0)
10A	(2P, 3P, 4P, 5P, 6P, 9P, 10P, 12P, 20P) w/top adders	3	13.1 (5.9)
20A	(2P, 3P, 4P, 6P)	2	11 (5.0)
20A	(2P, 3P, 4P, 5P, 6P) w/ top adders	3	13.1 (5.9)
20A	(9P, 10P, 12P, 20P)	3	13.5 (6.1)
20A	(9P, 12P) w/top adders	3	13.5 (6.1)
30A	(2P, 3P, 4P)	2	12 (5.4)
30A	(2P, 3P, 4P) w/top adders	3	13.1 (5.9)
30A	(5P, 6P)	2	12.5 (5.7)
30A	(5P, 6P) w/top adders	3	13.5 (6.1)
30A	(9P, 10P, 12P, 20P)	3	13.9 (6.3)
30A	(9P, 12P) w/top adders	3	14.1 (6.4)
60A	(2P, 3P)	2	12.8 (5.8)
60A	(2P, 3P) w/top adders	3	14 (6.4)
60A	(4P, 5P, 6P, 9P, 10P, 12P)	3	14 (6.4)
60A	(4P, 5P) w/top adders	3	14.2 (6.4)
100A	(2P, 3P)	4	39 (18)
100A	(4P, 5P, 6P, 9P)	4	67 (30)
200A	(2P, 3P)	10	117 (53)
200A	(4P, 5P, 6P)	10	140 (64)
300A	(2P, 3P)	10	120 (54)
300A	(4P, 5P, 6P)	10	143 (65)
400A	(2P, 3P)	10	132 (60)

Table 30.2-5. Type 3R, 4/4X, 12 Non-combination Lighting Contactors—Electrically Held—CN35

Ampere Size (Poles)		Box No.	Shipping Weight Lbs (kg)
Contactors—without Control Power Transformers			
10A	(2P, 3P, 4P, 5P, 6P)	5	12 (5.4)
10A	(9P, 10P, 12P, 20P)	7	20 (9.1)
20A	(2P, 3P, 4P, 5P)	5	12 (5.4)
20A	(6P)	5	14 (6.4)
20A	(9P, 10P, 12P, 20P)	7	20 (9.1)
30A	(2P, 3P, 4P)	5	13 (5.9)
30A	(5P, 6P)	6	14 (6.4)
30A	(9P, 10P, 12P, 20P)	7	20 (9.1)
60A	(2P, 3P, 4P)	5	13 (5.9)
60A	(5P, 6P)	6	16 (7.3)
60A	(9P, 10P, 12P)	7	22 (10)
100A	(2P, 3P)	8	49 (22)
100A	(4P, 5P, 6P, 9P)	8	57 (26)
200A	(2P, 3P)	8	110 (50)
300A	(2P, 3P)	10	113 (51)
400A	(2P, 3P)	10	125 57)
Contactors—with Control Power Transformers			
10A	(2P, 3P, 4P, 5P, 6P)	5	16 (7.3)
10A	(9P, 10P, 12P, 20P)	7	20 (9)
20A	(2P, 3P, 4P, 5P)	5	16 (7.3)
20A	(6P, 9P, 10P, 12P, 20P)	7	24 (11)
30A	(2P, 3P, 4P)	6	18 (8.2)
30A	(5P, 6P)	6	18 (8.2)
30A	(9P, 10P, 12P, 20P)	7	24 (11)
60A	(2P, 3P)	6	21 (10)
60A	(4P, 5P, 6P)	6	23 (10)
60A	(9P, 10P, 12P)	7	22 (10)
100A	(2P, 3P)	8	56 (25)
100A	(4P, 5P, 6P, 9P)	8	64 (29)
200A	(2P, 3P)	8	117 (53)
300A	(2P, 3P)	10	120 (54)
400A	(2P, 3P)	10	132 (60)

Table 30.2-6. Type 1 Combination Lighting Contactors

Ampere Size		Box No.	Shipping Weight Lbs (kg)
Electrically Held—3P Only—with or without Control Power Transformers			
30A		A	35 (16)
60A		A	36 (16)
100A		C	65 (30)
200A	with disconnect switch	D	110 (50)
200A	with thermal-magnetic breaker	E	150 (68)
300A		E	160 (73)
400A		E	170 (77)

Table 30.2-7. Type 3R, 4/4X, 12 Combination Lighting Contactors

Ampere Size (Device)		Box No.	Shipping Weight Lbs (kg)
Electrically Held—3P Only—with or without Control Power Transformers			
30A		A	35 (16)
60A		A	36 (16)
100A		C	65 (30)
200A	with disconnect switch	D	110 (50)
200A	with thermal-magnetic breaker	E	150 (68)
300A		E	160 (73)
400A		E	170 (77)

For enclosure box dimensions, refer to Page 30.6-3.

Table 30.2-8. AC Magnet Coil Data

Description	Contactor Catalog Number/Size							
	CN35AN 10A	CN35BN 20A	CN35DN 30A	CN35GN 60A	CN35KN 100A	CN35NN 200A	CN35SN 300A	CN35TN 400A
Frame size	45 mm	45 mm	45 mm	65 mm	90 mm	180 mm	180 mm	180 mm
AC Magnet Coil Data								
Pickup volts—cold	74%	74%	74%	74%	72%	75%	75%	75%
Pickup volts—hot	78%	78%	78%	78%	76%	77%	77%	77%
Pickup voltamperes	100	100	100	230	390	1158	1158	1158
Pickup watts	65	65	65	95	112	240	240	240
Sealed voltamperes	10	10	10	28	49.8	100	100	100
Sealed watts	3.1	3.1	3.1	7.8	13	27.2	27.2	27.2
Dropout volts—cold	45%	45%	45%	49%	50%	63%	63%	63%
Dropout volts—hot	46%	46%	46%	50%	52%	64%	64%	64%
Pickup time (ms)	12	12	12	20	14	23	23	23
Dropout time (ms)	12	12	12	14	11	15	15	15
Coil operating range	–15% to +10%							
Magnet coil data UL listed rating	Class 130 (B)—105°C Temperature Rate							
Operating temperature	–20° to +65°C							
Maximum operating altitude	6000							
Mechanical life	20,000,000			10,000,000	6,000,000	5,000,000	5,000,000	5,000,000
Wire Range Power terminals	12–16 stranded, 12–14 solid Cu	12–16 stranded, 12–14 solid Cu	8–16 stranded 10 –14 solid Cu	3–14 (upper) &/or 6–14 (lower) Stranded or solid Cu	1/0–14 Cu	350 kcmil–6 Cu	350 kcmil–8 Cu	600 kcmil–2/0 Cu
Control Terminals	12–16 Stranded 12–14 Solid Cu							
Contact Kit Part No.								
Two-pole	N/A	N/A	N/A	6-65-7	6-43-5	6-44	6-45	6-45
Three-Pole	N/A	N/A	N/A	6-65-8	6-43-6	6-44-2	6-45-2	6-45-2
Auxiliary contact rating	A600, P300 See **Page 30.2-5**							

Table 30.2-9. dc Magnet Coil Data

Description	Contactor Catalog Number/Size							
	CN35AN 10A	CN35BN 20A	CN35DN 30A	CN35GN 60A	CN35KN 100A	CN35NN 200A	CN35SN 300A	CN35TN 400A
Frame size	45 mm	45 mm	45 mm	65 mm	90 mm	180 mm	180 mm	180 mm
Volts	24V							
DC Magnet Coil Data								
Pickup volts—hot	80%	80%	80%	60%	61%	61%	61%	67%
Pickup voltamperes	3.2	3.2	3.2	6.2	12.0	12.0	12.0	18
Pickup watts	76.8	76.8	76.8	88.4	288.0	288.0	288.0	400.0
Sealed voltamperes	0.14	0.14	0.14	0.21	0.20	0.20	0.20	0.22
Sealed watts	3.36	3.36	3.36	4.96	4.75	4.75	4.75	5.3
Dropout volts—hot	60%	60%	60%	29%	22%	22%	22%	25%
Pickup time (ms)	22	22	22	20	38	38	38	53
Dropout time (ms)	17	17	17	13	14	14	14	14
Maximum operating altitude	3600							2400

- **UL Insulation Rating**—Class 130 (B), 105°C temperature rise
- **Operational Limits**—85–110% of rated voltage for AC coils and 80%–110% of rated voltage for DC coils

Coil Data Notes

P.U. = Pickup time is the average time taken from closing of the coil circuit to main contact touch.

D.O. = Dropout time is the average time taken from opening of the coil circuit to main contact separation.

Cold = Coil data with a cold coil.

Hot = Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 Vac or 24 Vdc magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

Type C30CNM—Open (ECC—Enclosed)

C30CNM

General Description

Eaton's C30CNM 30A mechanically held lighting contactors are designed for industrial, commercial and outdoor lighting applications where efficient control is required. The mechanically held operation ensures that the contactor will not switch to OFF during control power failure. It also ensures the removal of coil from the circuit for noise-free operation and the elimination of all coil losses after the contactor is latched. The control module microprocessor validates the control signal before operation, so it will not respond to momentary voltage spikes of noise. The operation command has a built-in 0.4 second delay to avoid multiple short-term commands that can cause contact fatigue or failure. Also, the feedback loop prevents the contactor from getting out of sequence with switches, even after power failures.

Typical Specifications

Mechanically held lighting contactors are Eaton Type C30CNM or approved equal and are rated for lighting loads of 30A. They are capable of being supplied in a 2–12 pole single unit configuration.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. The contactor is capable of being operated such that it will not switch to OFF during control circuit power failures.

Operation

Three-wire control is the choice for use with momentary devices allowing operation from multiple locations. A momentary pulse of energy operates the contactor while a second pulse on an alternate leg returns the contactor to its original state.

Two-wire control is the choice for single output automatic operation or for operation from single-pole devices. When voltage is applied to the input terminals the contactor is latched into position (coil is removed from the circuit while control voltage is continuously supplied). When control voltage is removed, the latch is disengaged and the contactor is returned to its original state.

Technical Data and Specifications

Main Power Poles

Table 30.2-10. Maximum AC Voltage and Ampere Ratings

Load Type	Amps Continuous	Poles	
		Single-Phase	Three-Phase
Ballast	30	347 Vac	600 Vac
General use	30	600 Vac	600 Vac
Tungsten	20	277 Vac	480 Vac
AC resistive	30	600 Vac	600 Vac

Table 30.2-11. Maximum Horsepower Rating

Normal Starting Duty	
Volts	Horsepower
Single-Pole, Single-Phase	
110–120	1
220–240	2
Three-Pole, Three-Phase	
200–208	3
220–240	5
440–480	10
550–600	15

Table 30.2-12. Control Module

Input Voltage	Steady-State Current at Rated Voltage (mA)	Maximum VA
12–24 Vdc	42	2
24 Vac	80	5
115–120 Vac	83	12
200–277 Vac	91	30

Table 30.2-13. Other Control Module Characteristics

Description	Specification
Minimum pulse duration (Three-wire control module)	250 ms
Maximum allowable Leakage current	1.8 mA
EMI	35 V/m
Surge transient peak	6 kV
Frequency range	40–70 Hz

Auxiliary Contacts Rating:

- 600A, 24 Vdc, 24 VA

Ambient Temperature:

- –13 to 104°F (–25 to 40°C)

Mounting Position:

- Vertical three-point mounting only

Coil:

- Inrush 248 VA
- Sealed 28 VA

Wire Size

Table 30.2-14. Wire Specifications

Component	Number of Cables	Wire Range (Solid or Stranded)	Wire Temp.
Power Poles	1	14–8 AWG	75°C Cu
	2	14–8 AWG ①	75°C Cu
Coil	1 or 2	18–14 AWG	60°/75°C Cu
Control Module	1	22–12 AWG	60°/75°C Cu
Auxiliary Contacts	1 or 2	22–12 AWG	60°/75°C Cu

① 8 AWG stranded only.

Enclosed Box Selection

Table 30.2-15. Type 1 Non-combination Lighting Contactors—C30CN ②

Ampere Size (Poles)	Box No.	Shipping Weight Lbs (kg)
Lighting Contactors—without Control Power Transformers		
30A (2–12)	2	9 (4.1)
Lighting Contactors—with Control Power Transformers		
30A (2–12)	3	13.5 (5.9)

② Consult factory for combination enclosures.

Table 30.2-16. Type 3R, 4X and 12 Non-combination Lighting Contactors—C30CN ③

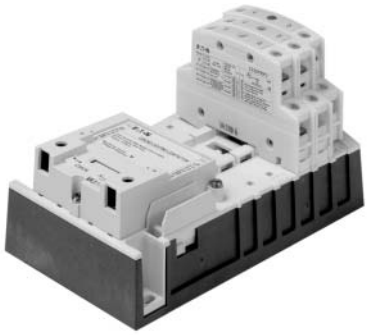
Ampere Size (Poles)	Box No.	Shipping Weight Lbs (kg)
Lighting Contactors—without Control Power Transformers		
30A (2–12)	6	14 (6.4)
Lighting Contactors—with Control Power Transformers		
30A (2–12)	7	20 (9.1)

③ Consult factory for combination enclosures.

For enclosure box dimensions, refer to Page 30.6-3.

Components

Electrically Held Base Contactor



Electrically Held Base Contactor

The C30CNE20_0 electrically held base contactor contains a 2NO power pole as standard and will allow the addition of power poles to build an electrically held contactor up to 12 poles maximum. A mechanically held module kit can also be added to convert the electrically held contactor into a mechanically held contactor in the field.

Table 30.2-17. Electrically Held Base Contactor

Power Poles	Catalog Number ①
2NO	**C30CNE200**

① When ordering, select required contactor by Catalog Number and replace the magnet coil alpha designation in the Catalog Number (...) with the proper Code Suffix from **Table 30.2-18**.

Table 30.2-18. Coil Base Voltage (Digit 8)

Voltage (Digit 8)	Code Suffix
115–120V 60 Hz/110V 50 Hz	A
230–240V 60 Hz/220V 50 Hz	B
460–480V 60 Hz/440V 50 Hz	C
575–600V 60 Hz/550V 50 Hz	D
200–208V 60 Hz	E
265–277V 60 Hz/240V 50 Hz	H
24V 60 Hz/20V 50 Hz	T
28V 60Hz/24V 50 Hz	V
347V 60 Hz	X

Power Poles

Power Poles

The C30CNM contactor accepts up to a maximum six single- or double-pole (or combinations) power poles. These can be used to form up to:

- 12NO poles maximum when six double-poles are used in NO positions (1–6) or 8NC poles maximum with four double-poles in the NC position (1–4) and 4NO poles with two double-poles in the 2NO positions (5–6)

Table 30.2-19. Power Poles

Power Poles	Catalog Number
Single-pole	**C320PRP1**
Double-pole	**C320PRP2**

Mechanically Held Module Kits

Conversion Kits

These kits are for converting electrically held contactors to mechanically held units. Kits include control module, latch, latch cover and auxiliary contacts plus installation instructions. Conversion kits are suitable for coil voltages of 277V and below.

Table 30.2-20. Mechanically Held Module Kits

Coil Volts	Control Volts	Catalog Number
Two-Wire		
24–277 Vac	110–120 Vac	**C320MH2WA0**
	200–277 Vac	**C320MH2WH0**
	24 Vac	**C320MH2WT0**
	12–24 Vdc	**C320MH2WT1**
Three-Wire		
24–277 Vac	110–120 Vac	**C320MH3WA0**
	200–277 Vac	**C320MH3WH0**
	24 Vac	**C320MH3WT0**
	12–24 Vdc	**C320MH3WT1**

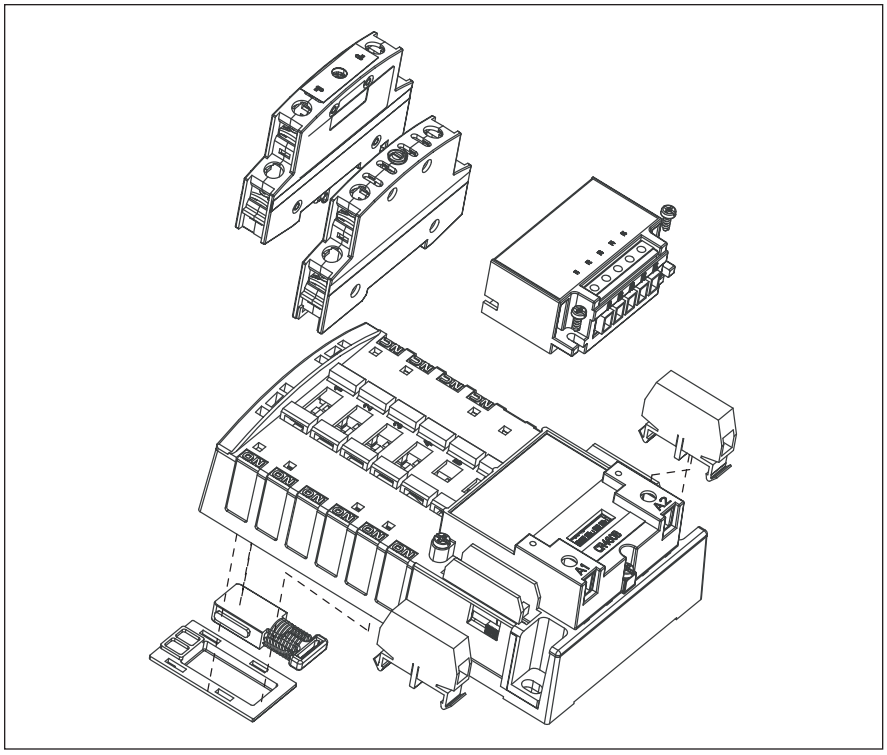


Figure 30.2-4. C30CNM Components—Exploded View

Auxiliary Contacts

Auxiliary Contacts

A mechanically held contactor with a two-wire control module uses 1NC auxiliary contact as standard for the control wiring circuit. The mechanically held contactor with a three-wire control module uses 1NO–1NC auxiliary contacts as standard for the control wiring circuit. See **Table 30.2-21** for possible additional auxiliary contact configurations.

Table 30.2-21. Auxiliary Contact Configurations

Two-Wire	Three-Wire
None 1NO (single-pole) 2NO (double-pole)	None 1NC (double-pole) 1NO (double-pole)
1NC (double-pole) 1NO–1NC (NO single-pole NC double-pole) 2NO–1NC (double pole)	1NO–1NC (double-pole) — —

Table 30.2-22. Auxiliary Contact Blocks

Auxiliary Block	Catalog Number
Single-pole	**C320AMH1**
Double-pole	**C320AMH2**

Replacement Parts

Magnetic Coils for the Base Contactor

Magnetic Coils

Table 30.2-23. Magnetic Coils

Coil Voltage	Catalog Number
115–120V 60 Hz/110V 50 Hz	**9-3242-1**
230–240V 60 Hz/220V 50 Hz	**9-3242-2**
460–480V 60 Hz/440V 50 Hz	**9-3242-3**
575–600V 60 Hz/550V 50 Hz	**9-3242-4**
200–208V 60 Hz	**9-3242-5**
265–277V 60 Hz/240V 50 Hz	**9-3242-6**
24V 60 Hz/20V 50 Hz	**9-3242-7**
28V 60 Hz/24V 50 Hz	**9-3242-8**
347V 60 Hz	**9-3242-9**

30

Wiring Diagrams

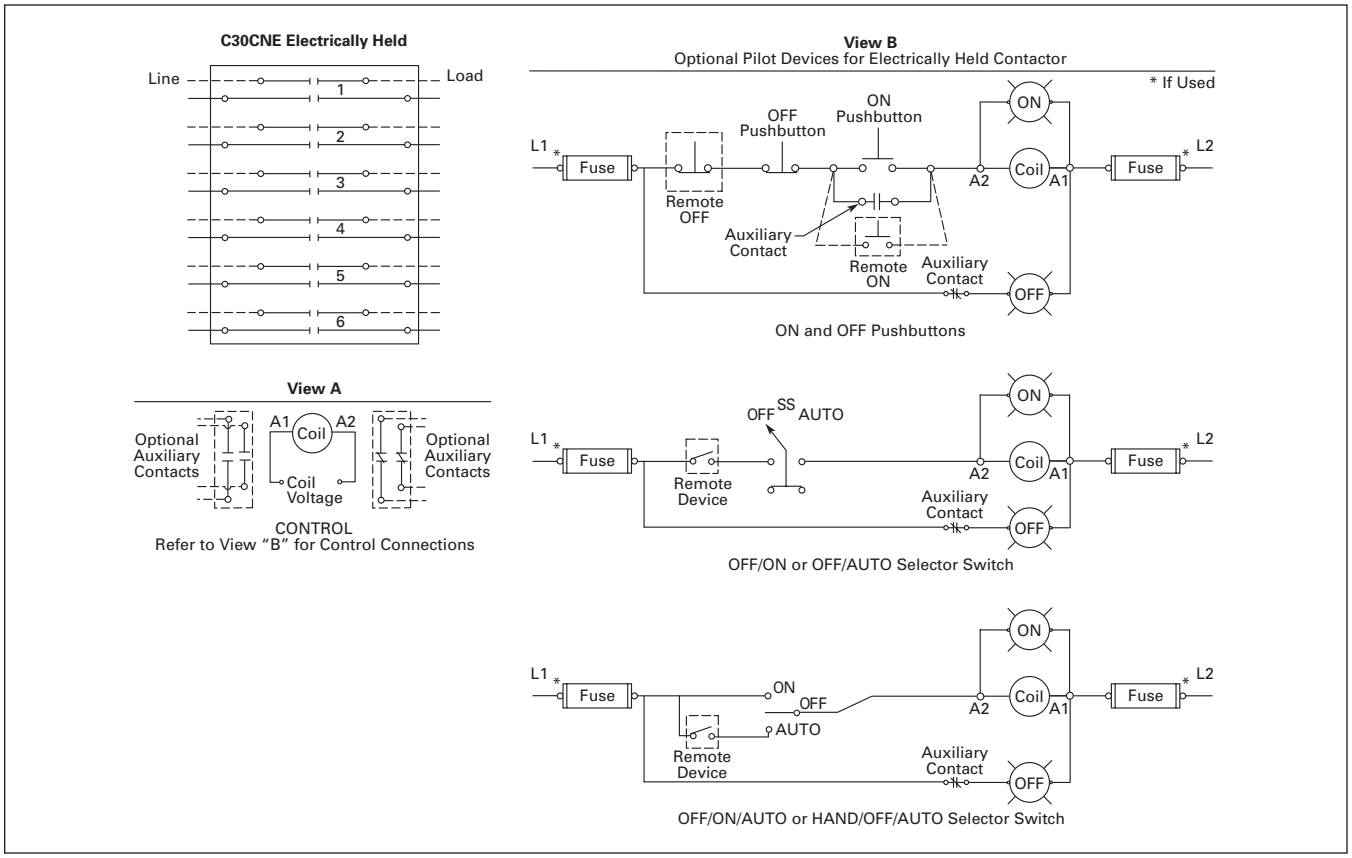


Figure 30.2-5. C30CNM Wiring Diagram

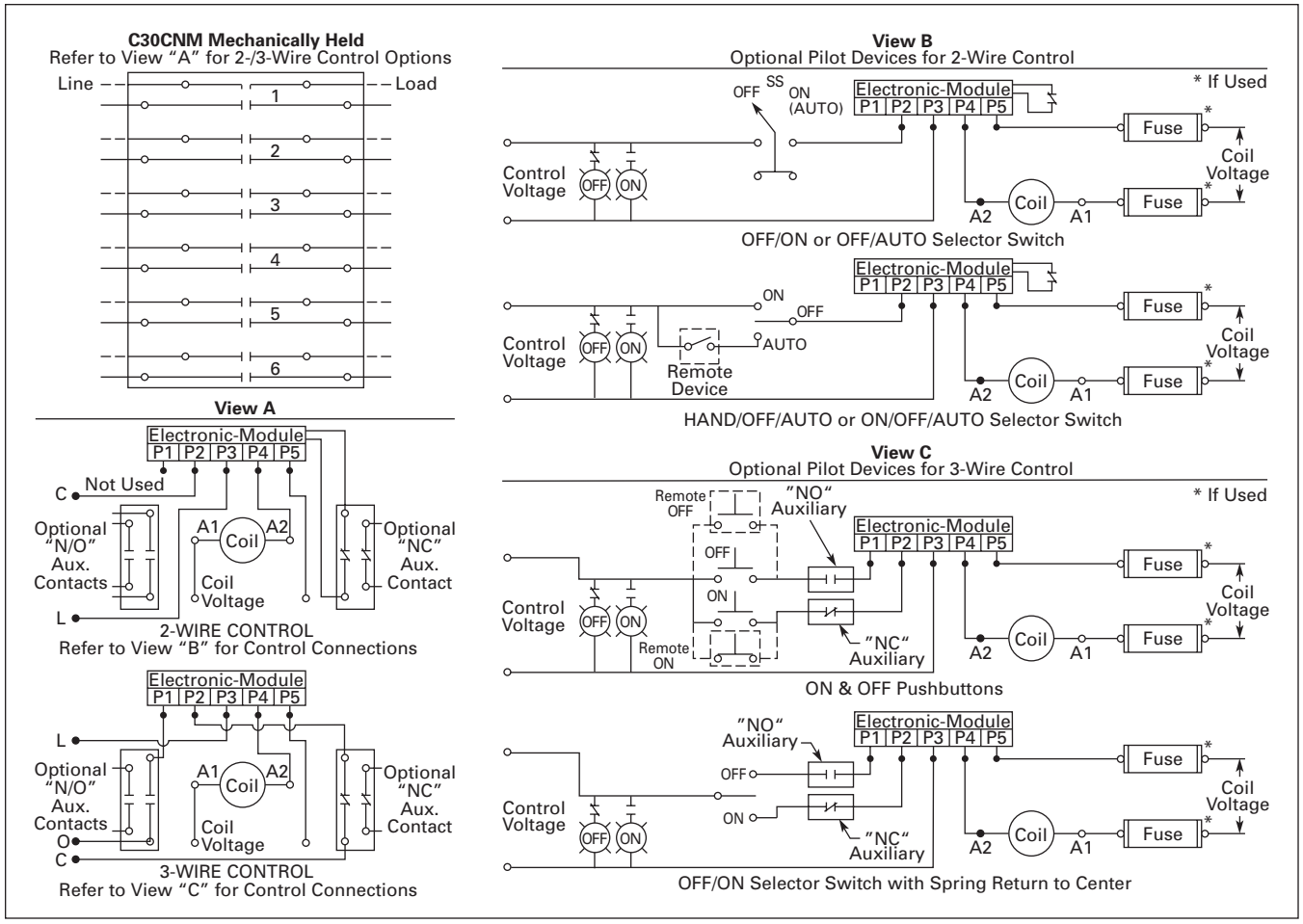


Figure 30.2-6. C30CNM Wiring Diagram

Dimensions

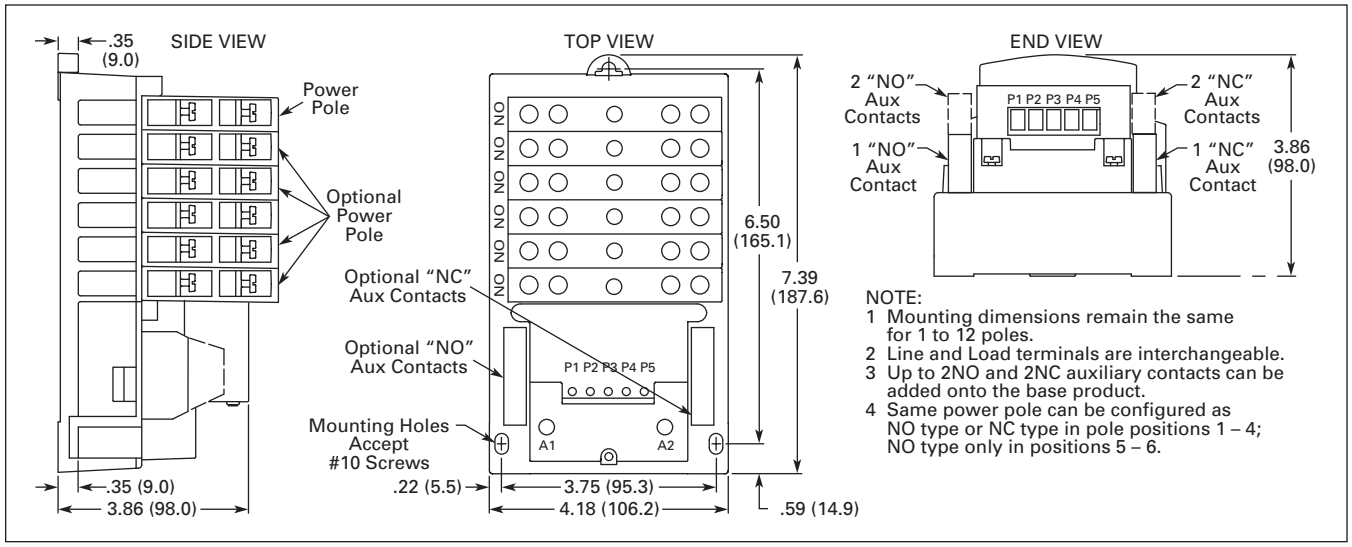
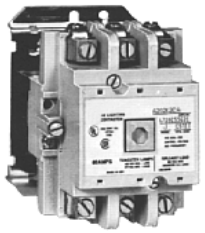


Figure 30.2-7. Approximate Dimensions in Inches (mm)

A202–Open (ECL04–Enclosed)



60 Ampere Size

General Description

AC lighting contactors provide a safe convenient means for local or remote switching of relatively large tungsten, fluorescent or mercury arc lamp loads. They are also suitable for low pressure and high pressure sodium lamp loads.

These lighting contactors are designed to withstand the large initial inrush currents of tungsten lamp loads without contact welding. They are full rated and do not require derating as do standard motor control contactors.

Operation (Magnetic Latch)

A permanent magnet is built into the contactor structure that will maintain the contactor in its energized state indefinitely without using control power. When energized, a DC current is applied to the latch coil producing a magnetic field that reinforces the polarity of the permanent magnet, pulling in the contactor. The current to the coil is disconnected by the coil clearing interlock. In order to drop out the contactor, it is necessary to apply a field through the STOP coil in the reverse direction to the permanent magnet. This momentarily cancels the magnetic attraction and the contactor drops out.

Enclosures

Open and NEMA Types 1, 3R, 4X and 12.

Specifications

- Terminals:
  - All except 30A devices . . . . . Al/Cu
  - 30A devices . . . . . Cu only
- Ballast load 600 Vac, breaking all lines
- Tungsten lamp loads, maximum volts:
  - Line-to-line. . . . . 480 Vac
  - Line-to-neutral. . . . . 277 Vac

Typical Specifications

Magnetically-held lighting contactors are Eaton's Type A202 or approved equal for lighting loads of 30–400A. Magnetically-held combination lighting contactors are Type ECL15 (breaker) or ECL13 (fusible) or approved equal for loads of 30–200A when integral short circuit protection is required.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contacts welding. The contactors are capable of being "magnetically held" via a magnetic latch design using a permanent magnet. The contactor shall be operated by a RUN signal and a STOP signal preventing the contactor from switching to "OFF" during control circuit power failures.

Table 30.2-24. Ratings—Latched AC Lighting Contactors

Holding Circuit Auxiliary Contact or Pushbutton Station not Included	
Continuous Amperes (Enclosed)	**Number of Poles**
30	2, 3, 4, 5, 6, 8, 10, 12
60	2, 3, 4, 5, 6, 8, 10, 12
100	2, 3, 4, 5, 6, 8, 10, 12
200	2, 3, 4, 5, 6, 8, 10, 12
300	2, 3
400	2, 3

Table 30.2-25. Non-Combination Lighting Contactors—6 to 12 Pole

Continuous Amperes (Enclosed)	Number of Poles	Pole Configuration	Dimensions in Inches (mm)	
			Open Type	
			Wide A	High B
30	6	3 x 3	7.13 (181.1)	4.46 (113.3)
	8	4 x 4	7.13 (181.1)	4.46 (113.3)
	10	5 x 5	10.63 (270.0)	4.46 (113.3)
	12	4 x 4 x 4	12.38 (314.5)	6.88 (174.8)
60	6	3 x 3	7.13 (181.1)	4.46 (113.3)
	8	4 x 4	10.63 (270.0)	4.46 (113.3)
	10	5 x 5	10.63 (270.0)	4.46 (113.3)
	12	5 x 5 x 2	15.00 (381.0)	6.88 (174.8)
100	6	3 x 3	9.75 (247.7)	6.88 (174.8)
	8	5 x 3	12.38 (314.5)	6.88 (174.8)
	10	5 x 5	15.00 (381.0)	6.88 (174.8)
	12	5 x 5 x 2	34.13 (866.9)	27.50 (698.5)
200	6	3 x 3	9.75 (247.7)	6.88 (174.8)
	8	5 x 3	12.38 (314.5)	6.88 (174.8)
	10	5 x 5	15.00 (381.0)	6.88 (174.8)
	12	5 x 5 x 2	34.13 (866.9)	27.50 (698.5)

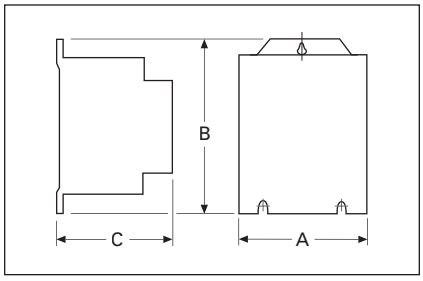


Figure 30.2-8. Open Type

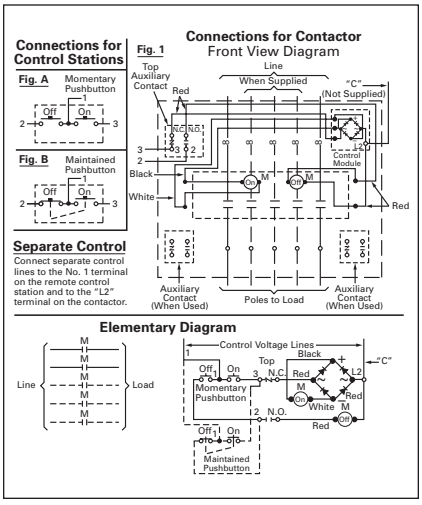


Figure 30.2-9. Connection Diagram

For enclosure box dimensions, refer to Page 30.6-3.

Enclosed Box Selection

Table 30.2-26. Type 1 Non-combination Lighting Contactors—Magnetically Latched—A202

Ampere Size (Poles)		Box No.	Shipping Weight Lbs (kg)
Contactors—without Control Power Transformers			
30A	(2P, 3P, 4P, 5P)	2	8.5 (3.9)
30A	(6P, 8P, 10P, 12P)	3	13 (5.9)
30A	(20P)	4	35 (16)
60A	(2P, 3P, 4P, 5P)	2	8.7 (3.9)
60A	(6P, 8P, 10P, 12P)	3	13.5 (6.1)
60A	(20P)	4	40 (18)
100A	(2P, 3P, 4P, 5P)	4	40 (18)
100A	(6P, 8P, 10P, 12P)	9	85 (39)
100A	(20P)	9	100 (45)
200A	(2P, 3P, 4P, 5P)	4	46 (21)
200A	(6P, 8P, 10P, 12P)	9	95 (43)
200A	(20P)	9	110 (50)
300A	(2P, 3P)	10	115 (52)
400A	(2P, 3P)	10	125 (57)
Contactors—with Control Power Transformers			
30A	(2P, 3P, 4P, 5P)	2	12.5 (5.7)
30A	(6P, 8P, 10P, 12P)	3	17 (7.7)
30A	(20P)	4	39 (18)
60A	(2P, 3P, 4P, 5P)	2	12.7 (5.8)
60A	(6P, 8P, 10P)	3	17.5 (7.9)
60A	(12P)	9	87 (39)
60A	(20P)	4	44 (20)
100A	(2P, 3P, 4P, 5P)	4	47 (21)
100A	(6P, 8P, 10P, 12P)	9	92 (42)
100A	(20P)	9	107 (49)
200A	(2P, 3P, 4P, 5P)	4	53 (24)
200A	(6P, 8P, 10P, 12P)	9	102 (46)
200A	(20P)	9	117 (53)
300A	(2P, 3P)	10	122 (55)
400A	(2P, 3P)	10	132 (60)

Table 30.2-27. Type 3R, 4/4X, 12 Non-combination Lighting Contactors—Magnetically Latched—A202

Ampere Size (Poles)		Box No.	Shipping Weight Lbs (kg)
Contactors—without Control Power Transformers			
30A	(2P, 3P, 4P, 5P)	5	13 (5.9)
30A	(6P, 8P, 10P, 12P)	7	21 (10)
30A	(20P)	8	46 (21)
60A	(2P, 3P, 4P, 5P)	5	14 (6.4)
60A	(6P, 8P, 10P, 12P)	7	22 (10)
60A	(20P)	8	48 (22)
100A	(2P, 3P, 4P, 5P)	8	50 (23)
100A	(6P, 8P, 10P,12P)	9	58 (26)
100A	(20P)	10	100 (45)
200A	(2P, 3P, 4P, 5P)	8	52 (24)
200A	(20P)	10	105 (48)
300A	(2P, 3P)	10	113 (51)
400A	(2P, 3P)	10	125 (57)
Contactors—with Control Power Transformers			
30A	(2P, 3P)	6	15 (6.8)
30A	(4P, 5P, 6P, 8P, 10P, 12P)	7	28 (13)
30A	(20P)	8	54 (25)
60A	(2P, 3P)	6	16 (7.3)
60A	(4P, 5P, 6P, 8P, 10P, 12P)	7	29 (13)
60A	(20P)	8	55 (25)
100A	(2P, 3P, 4P, 5P)	8	57 (26)
100A	(6P, 8P, 10P, 12P)	9	65 (30)
100A	(20P)	10	112 (51)
200A	(2P, 3P, 4P, 5P)	8	59 (27)
300A	(2P, 3P)	10	120 (54)
400A	(2P, 3P)	10	132 (60)

Table 30.2-28. Type 1 Combination Lighting Contactors

Ampere Size		Box No.	Shipping Weight Lbs (kg)
Magnetically Latched—Non-reversing (3P Only)—with or without Control Power Transformers			
30A		A	35 (16)
60A		A	36 (16)
100A		C	65 (30)
200A	with disconnect switch	D	110 (50)
200A	with thermal-magnetic breaker	E	150 (68)
300A		E	140 (64)
400A		E	190 (86)

Table 30.2-29. NEMA 3R, 4/4X, 12 Combination Lighting Contactors

Ampere Size		Box No.	Shipping Weight Lbs (kg)
Magnetically Latched—Non-reversing (3P Only)—with or without Control Power Transformers			
30A		A	35 (16)
60A		A	36 (16)
100A		C	65 (30)
200A	with disconnect switch	D	110 (50)
200A	with thermal-magnetic breaker	E	150 (68)
300A	with disconnect switch	72″	375 (170)
300A	with thermal-magnetic breaker	E	160 (73)
400A	with disconnect switch	72″	425 (193)
400A	with thermal-magnetic breaker	E	210 (95)

For enclosure box dimensions, refer to Page 30.6-3.

Combination Lighting Contactors

Types ECL12, ECL13, ECL14 and ECL15

General Description

Catalog Number ECL12, ECL13, ECL14 and ECL15 combination lighting contactors offer convenient installation of switching and overcurrent protection in a single enclosure. Combination lighting contactors are ideally suited for industrial and commercial lighting applications or where a lighting circuit may have to be disconnected for periodic maintenance. They may also be applied on resistance heating loads.

Typical Specifications

Magnetically latched combination lighting contactors are Eaton's Type ECL15 (breaker) or ECL13 (fusible) or approved equal for loads of 30–200A when integral short-circuit protection is required.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. The contactors are capable of being "magnetically held" via a magnetic latch design using a permanent magnet. The contactor shall be operated by a RUN signal and a STOP signal preventing the contactor from switching to "OFF" during control circuit power failures.

Electrically held combination lighting contactors are Eaton Type ECL14 (breaker) or ECL12 (fusible) or approved equal for loads of 30–400A when integral short-circuit protection is required.

These contactors shall be designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. Contactors shall be capable of accepting up to eight auxiliary contacts—top and/or side up to 60A and side only up to 400A. Contactors shall be capable of being operated by AC or DC control.

Features

- Disconnect devices—either a Series C circuit breaker or a fusible disconnect switch
- Handle mechanism—flange mounted
- UL listed
- UL service entrance approved for NEMA 3R outdoor enclosure
- Extra room for modifications such as a 24-hour time clock

Catalog Number Selection

Table 30.2-30. Enclosed Lighting Contactor Catalog Numbering System

EC L 12 D 1 A 3 E - X

Design
L = CN35 or A202 lighting contactor
C = C30CN lighting contactor

Modification Codes
(See PG03300001E)

Class
03 = Non-combination electrically held lighting contactor
04 = Non-combination mechanically held/magnetically latched lighting contactor
12 = Combination electrically held lighting contactor—fusible disconnect
13 = Combination magnetically latched lighting contactor—fusible disconnect
14 = Combination electrically held lighting contactor—thermal-magnetic circuit breaker
15 = Combination magnetically latched lighting contactor—thermal-magnetic circuit breaker

Disconnect Fuse Clip Ratings	
A = None	**J** = 200A/600V R
B = 30A/250V R	**K** = 400A/250V R
C = 30A/600V R	**L** = 400A/600V R
D = 60A/250V R	**M** = 600A/250V R
E = 30A/600V R	**N** = 600A/600V R
F = 100A/250V R	**P** = 800A/600V R
G = 100A/600V R	**T** = By description
H = 200A/250V R	

Thermal-Magnetic Breaker Ratings			
A = None	**F** = 60A	**J** = 300A	**M** = 800A
D = 20A	**G** = 100A	**K** = 400A	**T** = By description
E = 30A	**H** = 200A	**L** = 600A	

Ampere Size ②		
A = 10A	**D** = 60A	**G** = 300A
B = 20A	**E** = 100A	**H** = 400A
C = 30A	**F** = 200A	**J** = 600A

Number of Poles ①
1, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9** = Poles required
A = 10 Poles
B = 12 Poles
C = 20 Poles
Combination Devices = Three-pole only

Enclosure Types
1 = Type 1—General purpose
2 = Type 3R—Rainproof
3 = Type 4—Watertight (painted)
4 = Type 4X—Watertight (304-grade stainless steel)
6 = Type 7/9—Explosion proof
8 = Type 12—Dust-tight
9 = Type 4X—Watertight (316-grade stainless steel)

Coil Voltage		
A = 120/60 110/50	**K** = 240/50	**T** = 24/60
B = 240/60 220/50	**L** = 380/50	**U** = 24/50
C = 480/60 440/50	**M** = 415/50	**V** = 32/50
D = 600/60 550/50	**P** = 12 Vdc	**W** = 48/60
E = 208/60	**Q** = 24 Vdc	**X** = 104–120/60
G = 550/50	**R** = 48 Vdc	**Y** = 48/50
H = 277/60	**S** = 125 Vdc	**Z** = By description
J = 208–240/60		

① For normally closed poles, see PG03300001E.
② C30CN available in 30A only.

Table 30.2-31. Ratings—Latched ELC15 Series C Circuit Breaker Disconnect

Continuous Amperes (Enclosed)	Circuit Breaker	
	Ampere Rating	System Voltage
30	30	600
60	60	600
100	100	600
200	200	600

Table 30.2-32. ELC13—Fusible Disconnect Switch

Continuous Amperes (Enclosed)	Fuse Clip	
	Ampere Rating	System Voltage
30	30	250, 600
60	60	250, 600
100	100	250, 600
200	200	250, 600

Table 30.2-33. Ratings—Electrically-held ELC14 Series C Circuit Breaker Disconnect

Continuous Amperes (Enclosed)	Circuit Breaker	
	Ampere Rating	System Voltage
30	30	600
60	60	600
100	100	600
200	200	600
300	300	600
400 ①	400	600

① UL ballast and resistive ratings only.

Table 30.2-34. ELC12—Fusible Disconnect Switch

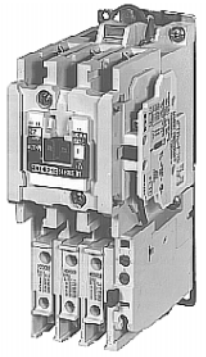
Continuous Amperes (Enclosed)	Fuse Clip	
	Ampere Rating	System Voltage
30	30	250, 600
60	60	250, 600
100	100	250, 600
200	200	250, 600
300	300	250, 600
400 ②	400	250, 600

② UL ballast and resistive ratings only.

Table 30.2-35. Factory Modifications

Description	Enclosure	Used On	
		Standard	Combination
Control transformers:	Any		
480 to 120V control transformer		■	■
100 VA extra capacity transformer		■	■
200 VA extra capacity transformer		■	■
240 to 120V control transformer with fuse in holder		■	■
208 to 120V control transformer with fuse in holder		■	■
415 to 110V control transformer with fuse in holder		■	■
277 to 120V control transformer with fuse in holder		■	■
Lightning arrester	Any		
Undervoltage relay			
On-off pushbutton		■	■
Hand-off-auto selector switch		■	■
Addition of photoelectric receptacle and relay with photo cell Installed (two-wire circuit)	—	■	■
24-hour time clock, 120V	—	■	■
24-hour time clock with day omission, 120V		■	■
7-day time clock, 120V		■	■
Cover plate for use in place of watertight hub on enclosure top		■	■

NEMA Motor Starters Freedom Series



NEMA AN16DN0AB
NEMA Size 1

General Description

The Freedom Series starters and contactors listed in this catalog feature a compact, space-saving design and high strength, impact and temperature-resistant insulating materials. Starters and contactors are available in the NEMA (National Electrical Manufacturers' Association) style. The NEMA devices are sized based on traditional NEMA classifications.

Features

Freedom NEMA

- Adjustable bimetallic ambient compensated overload relays with interchangeable heater packs—available in three basic sizes, covering applications up to 900 hp—reducing the number of different contactor/overload relay combinations that have to be stocked. Fixed heater overloads are optional
- Electronic overload relay (C440) available as a stand-alone unit and assembled with a Freedom contactor
- A full line of snap-on accessories—top and side mounted auxiliary contacts, solid-state and pneumatic timers, etc.
- Straight-through wiring—line lugs at top, load lugs at bottom
- Horizontal or vertical mounting on upright panel for application freedom
- Screw type power terminals have captive, backed-out self-lifting pressure plates with ± screws—reduced wiring time
- Accessible terminals for easy wiring. Optional fingerproof shields available to prevent electrical shock
- Top located coil terminals convenient and readily accessible. 45 mm contactor magnet coils have three terminals, permitting either top or diagonal wiring—easy to replace European or U.S. style starters or contactors without changing wiring layout
- Designed to meet or exceed NEMA, UL, CSA, VDE, BS and other international standards and listings
- American engineering—built by Eaton, using the latest in statistical process control methods to produce high quality, reliable products
- Sized based on standard NEMA classifications
- Easy coil change and inspectable/replaceable contacts
- Available in open and NEMA Type 1, 3R, 4/4X and 12 enclosures

Standards and Certifications

- Standard: Designed to meet or exceed UL, NEMA and CSA
- UL listed: UL File #E1491, Guide #NLDX—Open; UL File #E176513—Enclosed Combination Motor Controllers; UL File #E19224—Enclosed Non-Combination Motor Controllers; UL File #E195239—Enclosed Power Conversion Equipment
- CSA certified: CSA File #LR353, Class #321104 Open and NEMA 1 Enclosed

Certified Type 2 Coordination

Eaton's Freedom Series NEMA starters are now UL certified to achieve IEC 947 Type 2 coordination against 100,000A short-circuit fault currents. Any brand of properly selected fuse can be used. Type 2 coordination means that the starter will be suitable for further use following a short-circuit fault.

Short-Circuit Protection

Fuses and inverse-time circuit breakers may be selected per Article 430, Part D of the National Electrical Code® to protect motor branch circuits from fault conditions. If higher ratings or settings are required to start the motor, do not exceed the maximum as listed in Exception No. 2, Article 430.52.

NEMA Sizes 00-8

Table 30.3-1. AC Coil Data

NEMA Sizes	Motor Voltage	Maximum hp Rating	P.U. Volts		P.U.			Sealed			D.O. Volts		Maximum Operation Rate Operations/Hour	P.U. Time ms	D.O. Time ms
			Cold	Hot	VAR	VA	Watts	VAR	VA	Watts	Cold	Hot			
00	200 230 460 575	1-1/2 1-1/2 2 2	74%	78%	64	80	49	7.1	7.5	2.4	45%	46%	12,000	12	12
0	200 230 460 575	3 3 5 5	74%	78%	78	100	65	9.2	10	3.1	45%	46%	12,000	12	12
1	200 230 460 575	7-1/2 7-1/2 10 10	74%	78%	210	230	95	27	28	7.8	49%	50%	12,000	20	14
2	200 230 460 575	10 15 25 25	74%	78%	210	230	95	27	28	7.8	49%	50%	12,000	20	14
3	200 230 460 575	25 30 50 50	72%	76%	374	390	112	48	49.8	13	50%	52%	7200	14	11
4	200 230 460 575	40 50 100 100	73%	76%	1132	1158	240	96	100	27.2	54%	56%	2400	28	14
5	200 230 460 575	75 100 200 200	75%	77%	1132	1158	240	96	100	27.2	63%	64%	2400	25	13

General Coil Data

- **Coil Offering**—tape wound:
  - NEMA Sizes 00–0
  - UL insulation rating: Class 130 (B)
- **Coil Offering**—encapsulated:
  - NEMA Sizes 1–3
  - UL insulation rating: Class 130 (A)
- **Coil Offering**—encapsulated:
  - NEMA Sizes 4–5
  - UL insulation rating: Class 155 (F)
- **Operational Limits:**
  - 85% to 110% of rated voltage—AC
  - 80% to 110% of rated voltage—DC

Table 30.3-2. Coil Data Notes

Description	
P.U.	Pickup time is the average time taken from closing of the coil circuit to main contact touch.
D.O.	Dropout time is the average time taken from opening of the coil circuit to main contact separation.
Cold	Coil data with a cold coil.
Hot	Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 Vac or 24 Vdc magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

Table 30.3-3. DC Coil Data

NEMA Sizes	Motor Voltage	P.U.			Sealed		D.O. Volts (Hot)	P.U. Time ms	D.O. Time ms	Maximum Operation Rate Operations/Hour	Mechanical Life Millions
		Amperes	Watts	Volts (Hot)	Amperes	Watts					
00 and 0	12	6.4	76.8	80%	0.28	3.36	60%	22	17	3600	5
	24	3.2	76.8	80%	0.14	3.36	60%	22	17	3600	5
	48	1.6	76.8	80%	0.07	3.36	60%	22	17	3600	5
	120	0.64	76.8	80%	0.028	3.36	60%	22	17	3600	5
1 and 2	12	15.4	126	68%	0.42	4.98	30%	21	12	3600	2
	24	6.2	88.4	60%	0.21	4.96	29%	20	13	3600	2
	48	2.9	76.2	56%	0.11	5.04	28%	20	14	3600	2
	120	1.1	67.3	53%	0.041	4.87	29%	20	16	3600	2
3	12	24	293	65%	0.40	4.84	23%	39	14	3600	2
	24	12	288	61%	0.20	4.75	22%	38	14	3600	2
	48	6.1	295	62%	0.097	4.67	22%	37	14	3600	2
	120	2.5	298	61%	0.038	4.57	22%	37	16	3600	2
4 and 5	24	18	400	67%	0.22	5.3	25%	53	14	2400	2
	48	9.0	400	67%	0.11	5.2	25%	49	16	2400	2
	120	3.3	450	65%	0.05	5.4	28%	56	19	2400	2
	240	1.7	440	64%	0.02	4.9	26%	49	21	2400	2

General Coil Data

- **Coil Offering**—tape wound:
  - NEMA Sizes 00–0
  - UL insulation rating: Class 130 (B)
- **Coil Offering**—encapsulated:
  - NEMA Sizes 1–3
  - UL insulation rating: Class 130 (A)
- **Coil Offering**—encapsulated:
  - NEMA Sizes 4–5
  - UL insulation rating: Class 155 (F)
- **Operational Limits:**
  - 85% to 110% of rated voltage—AC
  - 80% to 110% of rated voltage—DC

Table 30.3-4. Coil Data Notes

Description	
P.U.	Pickup time is the average time taken from closing of the coil circuit to main contact touch.
D.O.	Dropout time is the average time taken from opening of the coil circuit to main contact separation.
Cold	Coil data with a cold coil.
Hot	Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 Vac or 24 Vdc magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

30

Table 30.3-5. Specifications—Sizes 00–3

Description	Contactor Catalog Number/Size				
	CN15A NEMA Size 00	**CN15B NEMA Size 0**	**CN15D NEMA Size 1**	**CN15G NEMA Size 2**	**CN15K NEMA Size 3**
Configuration Number of poles Auxiliary contacts, standard Add-on auxiliary contacts	 2, 3, 4 4th pole NO (1) Top (4) or side (4)	 2, 3 Side NO (1) Top (4) or side (3)	 2, 3, 4, 5 Side NO (1) Top (4) or side (3)	 2, 3, 4, 5 Side NO (1) Top (4) or side (3)	 2, 3 Side NO (1) Left side (4) or right side (3)
Frame size	45 mm	45 mm	65 mm	65 mm	90 mm
Maximum voltage rating	600 Vac	600 Vac	600 Vac	600 Vac	600 Vac
Continuous ampere ratings (I)	9A	18A	27A	45A	90A
Maximum horsepower (hp) Single-phase 115V 230V	 1/3 1	 1 2	 2 3	 3 7-1/2	 7-1/2 15
Three-phase 200V 230V 460V 575V	1-1/2 1-1/2 2 2	3 3 5 5	7-1/2 7-1/2 10 10	10 15 25 25	25 30 50 50
Coil operating range % of rated voltage	–15% to +10%	–15% to +10%	–15% to +10%	–15% to +10%	–15% to +10%
Operating temperature Maximum operating altitude in feet (m) Mechanical life	–20° to 65°C 6000 (1828) 20,000,000	–20° to 65°C 6000 (1828) 20,000,000	–20° to 65°C 6000 (1828) 10,000,000	–20° to 65°C 6000 (1828) 10,000,000	–20° to 65°C 6000 (1828) 6,000,000
Electrical life (480V/60 Hz) AC-3 AC-4	 4,000,000 90,000	 3,000,000 85,000	 5,000,000 200,000	 3,500,000 62,000	 1,700,000 80,000
Wire range Power terminals	12–16 stranded, 12–14 solid Cu	8–16 stranded, 10–14 solid Cu	8–14 stranded or solid Cu	2–14 (upper) and/or 6–14 (lower) stranded or solid Cu	1/0–14 Cu
Control terminals	12–16 stranded, 12–14 solid Cu	12–16 stranded, 12–14 solid Cu	12–16 stranded, 12–14 solid Cu	12–16 stranded, 12–14 solid Cu	12–16 stranded 12–14 solid Cu
Power terminal torque Line and load—lb-in	7	15	20	40 (14–8 AWG) 45 (6–4 AWG) 50 (3 AWG)	35 (14–10 AWG) 40 (8 AWG) 45 (6–4 AWG) 50 (3–1/0 AWG)
Auxiliary contact rating	A600, P300				

Table 30.3-6. Specifications—Sizes 4–5

Description	Contactor Catalog Number/Size	
	CN15N **NEMA Size 4**	**CN15S** **NEMA Size 5**
Configuration Number of poles Auxiliary contacts, standard Add-on auxiliary contacts	 2, 3 Side NO (1) Left side (3) or right side (4)	 2, 3 Side NO (1) Left side (3) or right side (4)
Frame size	180 mm	180 mm
Maximum voltage rating	600 Vac	600 Vac
Continuous ampere ratings (i)	135A	270A
Maximum horsepower (hp) Single-phase 115V 230V	 — —	 — —
Three-phase 200V 230V 460V 575V	 40 50 100 100	 75 100 200 200
Coil operating range % of rated voltage	–15% to +10%	–15% to +10%
Operating temperature Maximum operating altitude in feet (m) Mechanical life	–20° to 65°C 6000 (1828) 5,000,000	–20° to 65°C 6000 (1828) 5,000,000
Electrical life (480V/60 Hz) AC-3 AC-4	 800,000 70,000	 500,000 34,000
Wire range Power terminals	 Open—3/0–8 Cu; Enclosed—250 kcmil–6 Cu/Al	 750 kcmil—2 or (2) 250 kcmil–3/0 Cu/Al
Control terminals	12–16 stranded, 12–14 solid Cu	12–16 stranded, 12–14 solid Cu
Power terminal torque Line and load—lb-in	200	550
Auxiliary contact rating	A600, P300	

Table 30.3-7. 380V, 50 Hz Starters—Maximum hp Ratings

Description	NEMA Size					
	1	2	3	4	5	6
Maximum hp	10	25	50	75	150	300

Table 30.3-8. Motor FLA Current Ranges

Description	NEMA Size						
	1 ①	1	2	3	4	5	6
1.15 to 1.25 S.F.	0.47–3.81	3.15–27.00	3.15–45.00	9.90–90.00	9.90–135.00	38.30–270.00	38.30–540.00
1.0 S.F.	0.51–4.14	3.43–27.00	3.43–45.00	10.80–90.00	10.80–135.00	41.70–270.00	41.70–540.00

① Size 1 Lower Current Range for motor hp range 1/4 hp to 2 hp at 460V.

Table 30.3-9. Wire (75°C) Sizes—AWG or kcmil—NEMA Sizes 00–2—Open and Enclosed

NEMA Size	Cu Only
Power Terminals—Line	
00	#12–#16 stranded, #12–#14 solid
0	#8–#16 stranded, #10–#14 solid
1	#8–#14 stranded or solid
2	#3–#14 (upper) and/or #6–#14 (lower) stranded or solid ②

② Two compartment box lug.

Table 30.3-10. Overload Relay UL/CSA Contact Ratings Control Circuit ③

AC Volts	120V	240V	480V	600V
NC Contact B600				
Make and break amperes	30	15	7.5	6
Break amperes	3	1.5	0.75	0.6
Continuous amperes	5	5	5	5
NO Contact C600				
Make and break amperes	15	7.5	3.375	3
Break amperes	1.5	0.75	0.375	0.3
Continuous amperes	2.5	2.5	2.5	2.5

③ DC ratings cover Freedom Series coils only.

Table 30.3-11. Electronic Overload Relays up to 1500A

Description	Specification	
	45 mm	55 mm
Capacity		
Load terminals		
Terminal capacity	12–10 AWG (4–6 mm^2) 8–6 AWG (6–16 mm^2)	6–1 AWG (16–50 mm^2)
Tightening torque	20–25 lb-in (2.3–2.8 Nm) 25–30 lb-in (2.8–3.4 Nm)	25–30 lb-in (2.8–3.4 Nm)
Input, auxiliary contact and remote reset terminals		
Terminal capacity	2 x (18–12) AWG	2 x (18–12) AWG
Tightening torque	5.3 lb-in (0.8–1.2 Nm)	5.3 lb-in (0.8–1.2 Nm)
Voltages		
Insulation voltage U_i (three-phase)	690 Vac	690 Vac
Insulation voltage U_i (control)	500 Vac	500 Vac
Rated impulse withstand voltage	6000 Vac	6000 Vac
Overvoltage category/pollution degree	III/3	III/3

Table 30.3-12. Wire (75°C) Sizes—AWG or kcmil—NEMA Sizes 00–2 Open and Enclosed

Terminal	Wire Size ④	Catalog Number
Power Terminals—Load—Cu Only (Stranded or Solid)		
32A	14–6 AWG	**C306DN3B**
75A	14–2 AWG	**C306GN3B**
45A	14–6 AWG	**C396A_**

④ Minimum per NEC. Maximum wire size: Sizes 00–0 to 8 AWG and Sizes 1–2 to 2 AWG.

Table 30.3-13. Wire (75°C) Sizes—AWG or kcmil—NEMA Sizes 3–8—Open and Enclosed

NEMA Size	Wire Size
C306 Power Terminals—Line and Load	
3	10–14 AWG Al Cu
4	Open–#8–#3/0 Cu Enclosed–#6 250 kcmil–Al Cu
5	750 kcmil–#2 or (2) #3/0 250 kcmil–Al Cu

Table 30.3-14. C306 Control Terminals—Cu Only

Description
(2) #12–#16 stranded (2) #12–#14 solid

Electrical Life—AC-3 and AC-4 Utilization Categories

Life Load Curves

Eaton's Freedom Series NEMA contactors have been designed and manufactured for superior life performance in any worldwide application. All testing has been based on requirements as found in NEMA and UL standards and conducted by Eaton. Actual application life may vary depending on environmental conditions and application duty cycle.

Utilization Categories

AC-1—Non-inductive or slightly inductive loads, such as resistance furnaces and heating.

AC-2—Starting of slip-ring motors.

AC-3—Squirrel cage motors; starting, switching off motors during running.

AC-4—Squirrel cage motors; starting, plugging, inching or jogging.

Note: AC-3 tests are conducted at rated device currents and AC-4 tests are conducted at six times rated device currents. All tests have been run at 460V, 60 Hz.

Contactor Choice

- Decide what utilization category your application is and choose the appropriate curve
- Locate the intersection of the life-load curve of the appropriate contactor with the applications operational current (Ie), as found on the horizontal axis
- Read the estimated contact life along the vertical axis in number of operational cycles

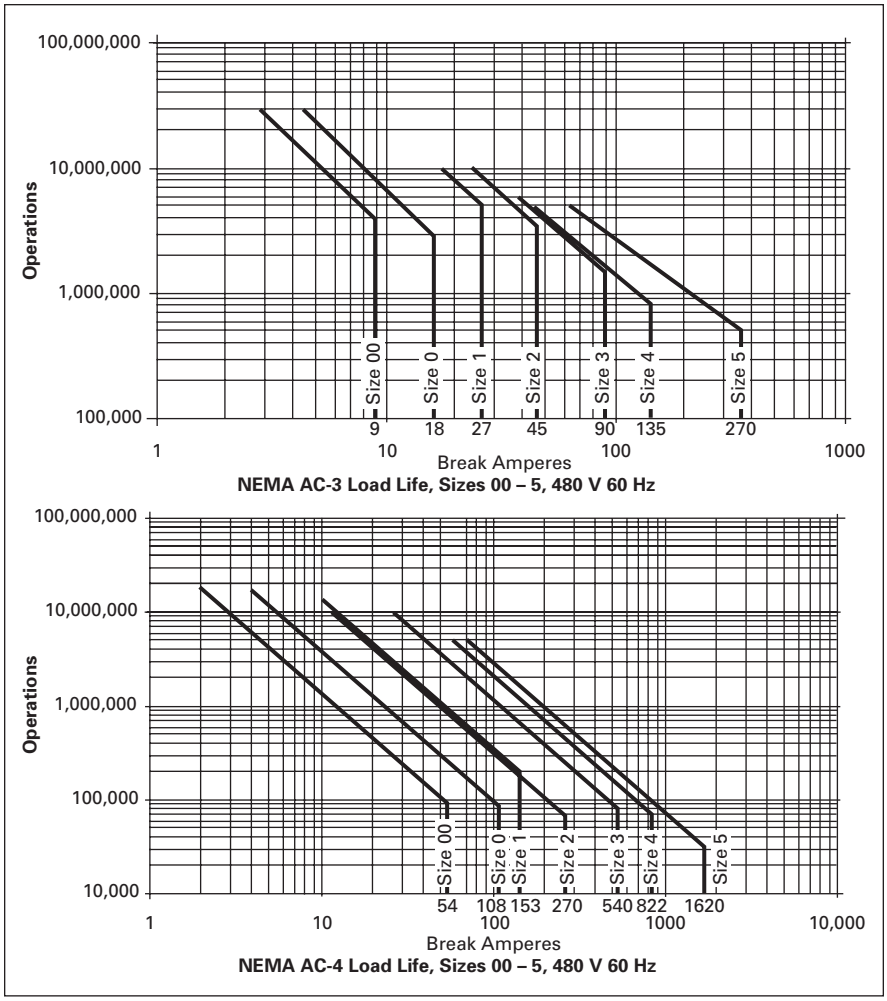


Figure 30.3-1. AC-3 and AC-4 Utilization Categories

30

Catalog Number Selection

Table 30.3-15. NEMA Freedom Line Enclosed Control Catalog Numbering System

E C N 22 2 1 A A F - __

Design
N = Freedom NEMA **2** = A200

Modification Codes
(See PG03300001E)

Class
01 = Non-reversing contactor—three-pole Non-reversing contactor—two-pole Non-reversing contactor—four-pole Non-reversing contactor—five-pole
02 = Reversing contactor—three-pole
05 = Non-combination non-reversing starter
06 = Non-combination reversing starter
07 = Non-combination non-reversing starter with CPT
08 = Non-combination single-phase non-reversing starter
16 = Combination non-reversing starter—fusible disconnect Combination non-reversing starter—non-fusible disconnect Special enclosure combination non-reversing starter fusible/non-fusible disconnect
17 = Combination reversing starter—fusible disconnect Combination reversing starter—non-fusible disconnect
18 = Combination reversing starter—fusible disconnect with CPT Combination reversing starter—non-fusible disconnect with CPT
22 = Combination non-reversing starter—circuit breaker Special enclosure combination non-reversing starter—circuit breaker
23 = Combination reversing starter—circuit breaker
24 = Combination non-reversing starter—circuit breaker with CPT

Cover Control
Type 1 non-combination All others E22 style combination (Contact Eaton)
Contactors
3 = Three-pole

Coil Voltage and/or Control Transformers
See **Table 30.3-16** and **Table 30.3-17**

NEMA Size		
A = Size 00	**3** = Size 3	**7** = Size 7
0 = Size 0	**4** = Size 4	**8** = Size 8
1 = Size 1	**5** = Size 5	**9** = Size 9
2 = Size 2	**6** = Size 6	

Disconnect Fuse Clip Ratings		
A = None	**G** = 100A/600V R	**N** = 600A/600V R
B = 30A/250V R	**H** = 200A/250V R	**P** = 800A/600V L
C = 30A/600V R	**J** = 200A/600V R	**Q** = 1200A/600V L
D = 60A/250V R	**K** = 400A/250V R	**R** = 1600A/600V L
E = 60A/600V R	**L** = 400A/600V R	**S** = 2000A/600V L
F = 100A/250V R	**M** = 600A/250V R	**T** = By description
HMCP/E or Breaker Ratings		
A = None	**H** = 150A	**R** = 3000A
B = 3A	**J** = 250A	**T** = By description
C = 7A	**K** = 400A	**5** = 3A ①
D = 15A	**L** = 600A	**6** = 7A ①
E = 30A	**M** = 800A	**7** = 15A ①
F = 50A	**N** = 1000A	**8** = 30A ①
W = 70A	**P** = 1200A	**9** = 50A ①
G = 100A	**Q** = 2000A	**I** = 100A ①

Enclosure Type
1 = Type 1—General purpose
2 = Type 3R—Rainproof
3 = Type 4—Watertight (painted steel)
4 = Type 4X—Watertight (304-Grade stainless steel)
5 = Type 4X—Corrosion (nonmetallic)
6 = Type 7/9—Bolted hazardous location
7 = Type 7/9—Threaded hazardous location
8 = Type 12—Dust-tight
9 = Type 4X—316-Grade stainless steel

① Use for Sizes 0–3, HMCP 600V applications only.

Table 30.3-16. Magnetic Coil Codes (System Voltage) ②

Code	Magnet Coil	Code	Magnet Coil	Code	Magnet Coil
A	120/60 110/50	**K**	240/50	**U**	24/50
B	240/60 220/50	**L**	380/50	**V**	32/50
C	460/60 440/50	**M**	415/50	**W**	48/60
D	575/60 550/50	**P**	12 Vdc	**X**	104–120/60
E	208/60	**Q**	24 Vdc	**Y**	48/50
G	550/50	**R**	48 Vdc	**Z**	By description
H	277/60	**S**	125 Vdc		
J	208–240/60	**T**	24/60		

② When control power transformer modification codes (**C1**–**C11**) are used or when starter class includes CPT (i.e., ECN07, 18) see **Table 30.3-17** for system voltage code.

Table 30.3-17. Control Power Transformer Codes (System Voltage)

Code	Primary	Secondary
B	240/480–220/440 wired for 240V	120/60–110/50
C	240/480–220/440 wired for 480V	120/60–110/50
D	600/60–550/50	120/60–110/50
E	208/60	120/60
H	277/60	120/60
L	380/50	110/50
M	415/50	110/50
Q	208/60	24
R	240/480–220/440 wired for 240V	24
S	240/480–220/440 wired for 480V	24
T	600/60	24
U	277/60	24
V	380/50	24
W	415/50	24
X	240/480/600 wired for 480V	120
Y	240/480/600 wired for 480V	24
Z	By description	

Enclosed Box Selection

Table 30.3-18. Type 1 Freedom Contactors

NEMA Size (Poles)	Box No.	Shipping Weight Lbs (kg)
Non-reversing Contactors—without Control Power Transformers		
00 (2P, 3P, 4P)	1	5.25 (2.4)
00 (2P, 3P, 4P) with top adders	2	7.3 (3.3)
0 (2P, 3P, 4P)	1	5.25 (2.4)
0 (2P, 3P, 4P) with top adders	2	7.3 (3.3)
0 (5P)	2	7.3 (3.3)
1 (2P, 3P)	1	7.9 (3.6)
1 (2P, 3P) with top adders	3	11 (5.0)
1 (4P, 5P)	2	8.3 (3.8)
2 (2P, 3P, 4P 5P)	2	8.5 (3.9)
3 (2P, 3P)	4	35 (16)
4 (2P, 3P)	4	47 (21)
5	10	113 (51)
6	F1E	325 (148)
7	F1E	①
8	F1E	①
9	F1E	①
Non-reversing Contactors—with Control Power Transformers		
00 (2P, 3P, 4P)	2	12 (5.4)
00 (2P, 3P, 4P, 5P) with top adders	3	15 (6.8)
0 (2P, 3P, 4P, 5P)	2	12 (5.4)
0 (2P, 3P, 4P, 5P) with top adders	3	15 (6.8)
1 (2P, 3P)	2	12.2 (5.5)
1 (2P, 3P) with top adders	3	12.5 (5.7)
1 (4P, 5P)	2	12.6 (5.7)
2 (2P, 3P, 4P, 5P)	2	12.8 (5.8)
3 (2P, 3P)	4	40 (18)
4 (2P, 3P)	4	52 (24)
5	10	120 (54)
6	F1E	335 (152)
7	F1E	①
8	F1E	①
9	F1E	①
Three-Pole Reversing Contactors—without Control Power Transformers		
00	2	7.8 (3.5)
0	2	8 (3.6)
1	3	11 (5.0)
2	3	12 (5.4)
3	4	67 (30)
4	4	154 (70)
5	10	170 (77)
6	F1E	425 (193)
7	F1E	①
8	F1E	①
9	F2E	①

① Consult factory.

Table 30.3-19. Type 3R, 4/4X, 12 Freedom Contactors

NEMA Size (Poles)	Box No.	Shipping Weight Lbs (kg)
Non-reversing Contactors—without Control Power Transformers		
00	5	14 (6.4)
0 (2P, 3P, 4P)	5	14 (6.4)
1 (2P, 3P, 4P, 5P)	5	15 (6.8)
2 (2P, 3P, 4P, 5P)	5	15.5 (7.0)
3 (2P, 3P)	8	45 (20)
4 (2P, 3P)	8	56 (25)
5	10	140 (64)
6	F1E	385 (175)
7	F1E	②
8	F1E	②
9	F1E	②
Non-reversing Contactors—with Control Power Transformers		
00	5	18 (8.2)
0 (2P, 3P, 4P)	5	18 (8.2)
1 (2P, 3P, 4P, 5P)	6	19 (8.6)
2 (2P, 3P, 4P, 5P)	6	19.5 (8.9)
3 (2P, 3P)	8	52 (24)
4 (2P, 3P)	8	63 (29)
5	10	147 (67)
6	F1E	405 (184)
7	F1E	②
8	F1E	②
9	F1E	②
Three-Pole Reversing Contactors—with or without Control Power Transformers		
00	6	18 (8.2)
0	6	18 (8.2)
1	6	19 (8.6)
2	6	19 (8.6)
3	8	47 (21)
4	9	69 (31)
5	10	170 (77)
6	F1E	495 (225)
7	F1E	②
8	F1E	②
9	F2E	②

② Consult factory.

Note: All Type 7 and 9, see PG03300001E.

Table 30.3-20. Type 1 Freedom Non-combination Starters

NEMA Size		Box No.	Shipping Weight Lbs (kg)
Non-reversing Starters—without Control Power Transformers			
00		1	7 (3.2)
00	with top adders/SSOL	2	10 (4.5)
0		1	7.1 (3.2)
0	with top adders/SSOL	2	10 (4.5)
1		1	7.9 (3.6)
1–2	with top adders/SSOL	3	11.5 (5.2)
2		2	8.5 (3.9)
3		4	35 (16)
4		4	47 (21)
5		10	139 (63)
6		F1E	360 (163)
7		F1E	③
8		F1E	③
9		F1E	③
Non-reversing Starters—with Control Power Transformers			
00		3	15 (6.8)
0		3	15 (6.8)
1		3	16 (7.3)
2		3	16.2 (7.4)
3		4	42 (19)
4		4	54 (25)
5		10	146 (66)
6		F1E	385 (175)
7		F1E	③
8		F1E	③
9		F1E	③
Reversing Starters—without Control Power Transformers			
00		2	8 (3.6)
0		2	8 (3.6)
0	with top adders	3	11 (5)
1		3	13 (5.9)
1	with top adders	3	13.4 (6.1)
2		3	15 (6.8)
3		4	43 (20)
4		9	65 (30)
5		10	165 (75)
6		F1E	450 (204)
7		F1E	③
8		F2E	③
9		F2E	③
Reversing Starters—with Control Power Transformers			
00	with top adders	3	15 (6.8)
0		3	15 (6.8)
1	with top adders	3	17 (7.7)
2		3	19 (8.6)
3		4	50 (23)
4		9	72 (33)
5		10	172 (78)
6		F1E	495 (225)
7		F1E	③
8		F2E	③
9		F2E	③

③ Consult factory.

***For enclosure box dimensions, refer to* Page 30.6-3.**

Table 30.3-21. Type 3R, 4/4X, 12 Freedom Non-combination Starters

NEMA Size / IEC Frame	Box No.	Shipping Weight Lbs (kg)
Non-reversing Starters— without Control Power Transformers		
0	5	14.3 (6.5)
1	5	15.3 (6.9)
2	7	16 (7.3)
3	8	46 (21)
4	8	60 (27)
5	10	150 (68)
6	F1E	415 (188)
7	F1E	①
8	F1E	①
9	F1E	①
Non-reversing Starters— with Control Power Transformers		
0	6	18 (8.2)
1	6	19 (8.6)
2	6	20 (9)
3	8	53 (24)
4	8	67 (30)
5	10	157 (71)
6	F1E	①
7	F1E	①
8	F1E	①
9	F1E	①
Reversing Starters— with or without Control Power Transformers		
0	7	18.5 (8.4)
1	7	19.5 (8.9)
2	7	21 (10)
3	8	48 (22)
4	9	72 (33)
5	10	175 (79)
6	F1E	525 (238)
7	F1E	①
8	F2E	①
9	F2E	①

① Consult factory.

Table 30.3-22. Type 1 Freedom Combination Starters

NEMA Size (Device)	Box No.	Shipping Weight Lbs (kg)
Non-reversing — with and without Control Power Transformers		
0	A	37 (17)
1	A	38 (17)
2	A	39 (18)
3	C	72 (33)
4 (HMCP)	C	90 (41)
4 (Disconnect switch)	D	150 (68)
5	E	180 (82)
6	F1E	435 (197)
7	F2E	②
8	F2E	②
9	F2E	②
Reversing — with and without Control Power Transformers		
0	B	42 (19)
1	B	43 (20)
2	B	44 (20)
3	C	84 (38)
4	D	173 (79)
5	F1E	②
6	F1E	550 (250)
7	F2E	②
8	F2E	②
9	②	②
Non-reversing—Oversized		
0–1–2	B	44 (20)

② Consult factory.

Table 30.3-23. Type 1 Freedom Non-reversing Combination Starters—Narrow Enclosure

NEMA Size	Box No.	Shipping Weight Lbs (kg)
NEMA 1 Enclosed		
0–1–2	I	35 (16)
NEMA 12 Enclosed		
0–1–2	I	36 (16)
NEMA 12 Enclosed with Safety Door Interlock		
0–1–2	I	37 (17)

Table 30.3-24. Type 3R, 4/4X, 12 Freedom Combination Starters

NEMA Size (Device)	Box No.	Shipping Weight Lbs (kg)
Non-reversing— with and without Control Power Transformers		
0	A	37 (17)
1	A	38 (17)
2	A	39 (18)
3	C	72 (33)
4 (HMCP)	C	90 (41)
4 (Disconnect switch)	D	150 (68)
5	E	180 (82)
6	F1E	435 (197)
7	F2E	③
8	F2E	③
9	F2E	③
Reversing— with and without Control Power Transformers		
0	B	42 (19)
1	B	43 (20)
2	B	44 (20)
3	C	84 (38)
4	D	173 (79)
5	E	550 (250)
6	F1E	③
7	F2E	③
8	F2E	③
9	③	③
Non-reversing—Oversized		
0–1–2	B	44 (20)

③ Consult factory.

For enclosure box dimensions, refer to **Page 30.6-3.**

C441 Motor Insight

C441 Motor Insight Overload and Monitoring Relay

General Description

Eaton's C441 Motor Insight®, the first product in the intelligent power control solutions family, is a highly configurable motor, load and line protection device with power monitoring, diagnostics and flexible communications, allowing the customer to save energy, optimize their maintenance schedules and configure greater system protection, thus reducing overall costs and downtime.

C441 Motor Insight is available in either a line-powered or 120 Vac control powered design, capable of monitoring voltages up to 660 Vac. Each of these units is available in a 1–9A or a 5–90A FLA model. With external CTs, C441 Motor Insight can protect motors up to 540A FLA. Available add-on accessories include communication modules for Modbus®, DeviceNet™ and PROFIBUS®, all with I/O options. For ease-of-use and operator safety, C441 Motor Insight offers a remote display that mounts easily with two 30 mm knockouts.

Features

Size/Range

- Broad FLA range of 1–540A
- Selectable trip class (5–30)
- Four operating voltage options
  - Line-powered from 240 Vac, 480 Vac, 600 Vac
  - Control-powered from 120 Vac

Motor Control

- Two output relays
  - One B300 Form C fault relay and one B300 ground fault shunt relay
  - Other relay configurations are available, including one Form A and one Form B SPST (fault and auxiliary relays) allowing programmable isolated relay behavior and unique voltages
- One external remote reset terminal
- Trip status indicator

Motor Protection

- Thermal overload
- Jam/stall protection
- Current level alarming
- Current imbalance
- Current phase loss
- Ground fault
- Phase reversal

Load Protection

- Undercurrent
- Low power (kW)
- High power (kW)

Line Protection

- Overvoltage
- Undervoltage
- Voltage imbalance
- Voltage phase loss

Monitoring Capabilities

- Current—average and phase rms
- Voltage—average and phase rms
- Power—motor kW
- Power factor
- Frequency
- Thermal capacity
- Run hours
- Ground fault current
- Current imbalance %
- Voltage imbalance %
- Motor starts
- Motor run hours

Options

- Type 1, 12 remote display
- Type 3R remote display kit
- Communication modules
  - Modbus
  - Modbus with I/O
  - DeviceNet with I/O
  - PROFIBUS with I/O
  - Modbus TCP with I/O (contact product line)
  - EtherNet/IP with I/O (contact product line)

Benefits

Reliability and Improved Uptime

- Advanced diagnostics allows for quick and accurate identification of the root source of a motor, pump or power quality fault; reducing troubleshooting time and the loss of productivity, reducing repeat faults due to misdiagnosis, and increasing process output and profitability
- Provides superior protection of motors and pumps before catastrophic failure occurs
- Increases profitability with greater process uptime and throughput, reduced costs per repair, reduced energy consumption and extended equipment life
- Adjustments to overload configuration can be made at any time

Safety

- IP 20 rated terminal blocks
- Terminal blocks are set back from the display to reduce operator shock hazard
- Remote display (optional) does not require that the operator open the panel to configure the device

Flexibility

- Communications modules
  - Offered in a variety of configurations
  - External snap-on modules provide support for multiple communications protocols
- Advanced power, voltage and current monitoring capabilities
- Communications modules and remote display can be used simultaneously
- Highly configurable fault and reset characteristics for numerous applications
- Fully programmable isolated fault and auxiliary relays

Ease of Use

- Bright LED display with easy-to-understand setting and references
- Powered from line voltage or 120 Vac control power
- Remote display powered from base unit
- Full word descriptions and units on user interface

Standards and Certifications

- cULus listed NKCR, NKCR7, 508
- UL 1053 applicable sections for ground fault detection
- CSA certified (Class 3211-02)
- CE
- NEMA
- IEC EN 60947-4-1
- RoHS

Product Selection

Table 30.3-25. C441 Motor Insight

Power Source	Monitoring Range	Current Range	Catalog Number
240 Vac (170–264)	170–264 Vac	1–9A 5–90A	**C441BA** **C441BB**
480 Vac (323–528)	323–528 Vac	1–9A 5–90A	**C441CA** **C441CB**
600 Vac (489–660)	489–660 Vac	1–9A 5–90A	**C441DA** **C441DB**
120 Vac (93.5–132)	170–660 Vac	1–9A 5–90A	**C4410109NOUI** **C4410590NOUI**

Table 30.3-26. C441 Motor Insight CT Multiplier and Wire Wrap Schedule

Catalog Number ①	Motor FLA	No. of Loops	No. of Conductors Through CT Primary	CT Multiplier Setting	External CT Kit Catalog Number ②
Current Range: 5–90A					
C441_B and C4410590NOUI	5–22.5A 6.67–30A	3 2	4 3	4 3	— —
	10–45A 20–90A	1 0	2 1	2 1	— —
Current Range: 1–9A					
C441_A and C4410109NOUI	1–5A 2–9A	1 0	2 1	2 1	— —
	60–135A 120–270A 240–540A	0 0 0	1 1 1	150–(150:5) 300–(300:5) 600–(600:5)	**C441CTKIT150** **C441CTKIT300** **C441CTKIT600**

① Underscore indicates Operating Voltage Code required.
Operating Voltage Codes:

Code	Voltage
B	240 Vac
C	480 Vac
D	600 Vac
<empty>	120 Vac control power

② Any manufacturer's CTs may be used.

Accessories

Table 30.3-27. Communication Modules

Description	I/O	Catalog Number
Modbus		
Modbus communication module	None	**C441M**
Modbus communication module 4IN/2OUT	120 Vac	**C441N**
	24 Vdc	**C441P**
DeviceNet		
DeviceNet communication module 4IN/2OUT	120 Vac	**C441K**
	24 Vdc	**C441L**
PROFIBUS		
PROFIBUS communication module 4IN/2OUT	120 Vac	**C441S**
	24 Vdc	**C441Q**
EtherNet/IP and Modbus TCP		
Ethernet-based communication module 4IN/2OUT	120 Vac	**C441R**
	24 Vdc	**C441T**

Type 3R Kit with Remote Display Mounted Inside

C441 Motor Insight offers several accessories for the customer's ease of use and safety:

- Types 1 and 12 remote display
- Type 3R remote display kit
- Mounting plate adapter

Features and Benefits

- Remote display unit:
  - Same user interface as the overload relay
  - Enhanced operator safety—operator can configure the overload without opening the enclosure door
- Type 3R kit mounts with standard 30 mm holes
- Mounting plate for retrofit in existing installations

Table 30.3-28. Type 3R Kit with Remote Display Mounted Inside

Description	Catalog Number
Remote display Types 1 and 12 (UL 508)	**C4411**
Type 3R kit for remote display (UL 508)	**C4413**
Conversion plate	**C441CMP1**

Communication Cables

The remote display requires a communication cable to connect to the C441 Motor Insight overload relay:

Table 30.3-29. Communication Cable Lengths

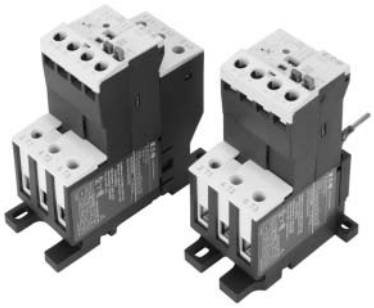
Length in Inches (meters)	Catalog Number
9.8 (0.25)	**D77E-QPIP25**
39.4 (1.0)	**D77E-QPIP100**
78.7 (2.0)	**D77E-QPIP200**
118.1 (3.0)	**D77E-QPIP300**

Table 30.3-30. Current Transformer Kits

Description	Catalog Number
Three 150:5 CTs to be used with C441 Motor Insight	**C441CTKIT150**
Three 300:5 CTs to be used with C441 Motor Insight	**C441CTKIT300**
Three 600:5 CTs to be used with C441 Motor Insight	**C441CTKIT600**

For more information about technical data and specifications as well as dimensions, see Volume 5—Motor Control and Protection, CA08100006E, Section 31.

C440/*XT* Electronic Overload Relay



C440/*XT* Electronic Overload Relay

General Description

Eaton's electronic overload relay (EOL) is the most compact, high-featured, economical product in its class. Designed on a global platform, the new EOL covers the entire power control spectrum, including NEMA, IEC and DP contactors. The NEMA and DP versions are offered with the *C440* designation while the IEC offering has the ***XT*** designation. The electronic design provides reliable, accurate and value-driven protection and communications capabilities in a single compact device. It is the flexible choice for any application requiring easy-to-use, reliable protection.

Eaton has a long history of innovations and product development in motor control and protection, including both traditional NEMA, as well as IEC control. It was from this experience that the C440 was developed, delivering new solutions to meet today's demands.

C440 is a self-powered electronic overload relay available up to 100A as a self-contained unit. With external CTs, C440 can protect motor up to 1500 FLA. Available add-on accessories include remote reset capability and communication modules with I/O for DeviceNet, PROFIBUS and Modbus.

Features

- Reliable, accurate, electronic motor protection
- Easy to select, install and maintain
- Compact size
- Flexible, intelligent design
- Global product offering—available with NEMA, IEC and DP power control

Size/Range

- Broad FLA range (0.33–1500A)
- Selectable trip class (10A, 10, 20, 30)
- Direct mounting to NEMA, IEC and DP contactors
- Most compact electronic overload in its class

Motor Control

- Two B600 alarm (NO) and fault (NC) contacts
- Test/Trip button

Motor Protection

- Thermal overload
- Phase loss
- Selectable (ON/OFF) phase imbalance
- Selectable (ON/OFF) ground fault

User Interface

- Large FLA selection dial
- Trip status indicator
- Operating mode LED
- DIP switch selectable trip class, phase imbalance and ground fault
- Selectable Auto/Manual reset

Feature Options

- Remote reset
  - ❑ 120 Vac
  - ❑ 24 Vac
  - ❑ 24 Vdc
- Tamper-proof cover
- Communications modules
  - ❑ Modbus RTU RS-485
  - ❑ DeviceNet with I/O
  - ❑ PROFIBUS with I/O
  - ❑ Modbus RTU with I/O (Q4 2010)
  - ❑ EtherNet/IP (planned)
  - ❑ Smartwire (planned)

Benefits

Reliability and Improved Uptime

- C440 provides the users with peace of mind knowing that their assets are protected with the highest level of motor protection and communication capability in its class
- Extends the life of plant assets with selectable motor protection features such as trip class, phase imbalance and ground fault
- Protects against unnecessary downtime by discovering changes in your system (line/load) with remote monitoring capabilities
- Status LED provides added assurance that valuable assets are protected by indicating the overload operational status

Flexibility

- Available with NEMA, IEC and DP contactors
- Improves return on investment by reducing inventory carrying costs with wide FLA adjustment (5:1) and selectable trip class
- Design incorporates built-in ground fault protection, thus eliminating the need for separate CTs and modules
- Flexible communication with optional I/O enables easy integration into plant management systems for remote monitoring and control
- Available as an open component and in enclosed control and motor control center assemblies

Monitoring Capabilities

- Individual phase currents rms
- Average three-phase current rms
- Thermal memory
- Fault indication (overload, phase loss, phase imbalance, ground fault)

Safety

- IP 20 rated terminal blocks
- Available in Eaton's industry-leading FlashGard MCCs
- Tested to the highest industry standards, such as UL, CSA, CE and IEC
- RoHS compliant

Standards and Certifications

- UL
- CSA
- CE
- NEMA
- IEC/EN 60947 VDE 0660
- ISO 13849-1 (EN954-1)
- RoHS
- ATEX directive 94/9/EC
- Equipment Group 2, Category 2

Product Selection

Table 30.3-31. *XT* Electronic Overload Relays

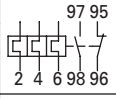
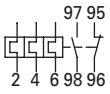
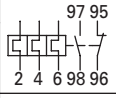
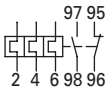
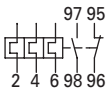
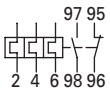
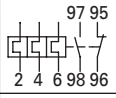
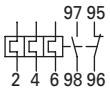
For Use with *XT* Contactor Frame	For Use with Contactor	Overload Range (Amps)	Contact Sequence	Frame Size	Auxiliary Contact Configuration	Type	Catalog Number
For Direct Mount to *XT* Contactors							
B	XTCE007B…, XTCE009B…, XTCE012B…, XTCE015B…	0.33–1.65		45 mm	NO-NC	ZEB12-1,65	**XTOE1P6BCS**
		1–5				ZEB12-5	**XTOE005BCS**
		4–20				ZEB12-20	**XTOE020BCS**
C	XTCE018C…, XTCE025C…, XTCE032C	0.33–1.65		45 mm	NO-NC	ZEB32-1,65	**XTOE1P6CCS**
		1–5				ZEB32-5	**XTOE005CCS**
		4–20				ZEB32-20	**XTOE020CCS**
		9–45				ZEB32-45	**XTOE045CCS**
D	XTCE040D…, XTCE050D…, XTCE065D…, XTCE072D…	9–45		45 mm	NO-NC	ZEB65-45	**XTOE045DCS**
		20–100		55 mm		ZEB65-100	**XTOE100DCS**
F, G	XTCE080F…, XTCE095F…, XTCE115G…, XTCE150G…, XTCE170G…	20–100		55 mm	NO-NC	ZEB150-100	**XTOE100GCS**
With Ground Fault for Direct Mount to *XT* Contactors							
B	XTCE007B…, XTCE009B…, XTCE012B…, XTCE015B…	0.33–1.65		45 mm	NO-NC	ZEB12-1.65-GF	**XTOE1P6BGS**
		1–5				ZEB12-5-GF	**XTOE005BGS**
		4–20				ZEB12-20-GF	**XTOE020BGS**
C	XTCE018C…, XTCE025C…, XTCE032C	0.33–1.65		45 mm	NO-NC	ZEB32-1.65-GF	**XTOE1P6CGS**
		1–5				ZEB32-5-GF	**XTOE005CGS**
		4–20				ZEB32-20-GF	**XTOE020CGS**
		9–45				ZEB32-45-GF	**XTOE045CGS**
D	XTCE040D…, XTCE050D…, XTCE065D…, XTCE072D…	9–45		45 mm	NO-NC	ZEB65-45-GF	**XTOE045DGS**
		20–100		55 mm		ZEB65-100-GF	**XTOE100DGS**
F, G	XTCE080F…, XTCE095F…, XTCE115G…, XTCE150G…, XTCE170G…	20–100		55 mm	NO-NC	ZEB150-100-GF	**XTOE100GGS**

Table 30.3-32. *XT* Electronic Overload Relays for use with Large Frame *XT* Contactors (L–R)

Use CTs and 1-5A ***XT*** overload relay. CT kit does not include overload relay (order separately).

XT Contactor Frame	For Use with IEC Contactor Ampere Range (AC-3)	CT Range (Amps)	Description	CT Kit Catalog Number	Terminal Size	Overload Relay Catalog Number	Overload Relay with Ground Fault Catalog Number
L, M	185–500A	60–300	300: 5 panel-mount CT kit with integrated lugs	**ZEB-XCT300**	750 kcmil (2) 250 kcmil 3/0 Cu/Al	**XTOE005CCSS**	**XTOE005CGSS**
M, N	300–820A	120–600	600: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT600**	(2) 750 kcmil 3/0 Cu/Al	**XTOE005CCSS**	**XTOE005CGSS**
N	580–1000A	200–1000	1000: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT1000**	(3) 750 kcmil 3/0 Cu/Al	**XTOE005CCSS**	**XTOE005CGSS**
R	1600A	300–1500	1500: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT1500**	(4) 750 kcmil 1/0 Cu/Al	**XTOE005CCSS**	**XTOE005CGSS**

Table 30.3-33. *XT* Electronic Overload Relays for Separate Mount

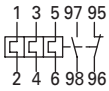
Overload Range (Amps)	Frame Size	Contact Sequence	Type	Overload Relay Catalog Number	Overload Relay with Ground Fault Catalog Number
Overload Relay					
0.33–1.65	45 mm		ZEB32-1.65/KK	**XTOE1P6CCSS**	**XTOE1P6CGSS**
1–5			ZEB32-5/KK	**XTOE005CCSS**	**XTOE005CGSS**
4–20			ZEB32-20/KK	**XTOE020CCSS**	**XTOE020CGSS**
9–45			ZEB32-45/KK	**XTOE045CCSS**	**XTOE045CGSS**
20–100	55 mm		ZEB150-100/KK	**XTOE100GCSS**	**XTOE100GGSS**

Table 30.3-34. C440 Electronic Overload Relays for Direct Mount to Freedom Series Contactors

For Use with Freedom NEMA Contactor Size	For Use with Contactor ①	Overload Range (Amps)	Standard Feature Set Catalog Number	Standard Feature Set with Ground Fault Catalog Number
00	CN15AN3_B	0.33–1.65	**C440A1A1P6SF00**	**C440A2A1P6SF00**
		1–5	**C440A1A005SF00**	**C440A2A005SF00**
		4–20	**C440A1A020SF00**	**C440A2A020SF00**
0	CN15BN3_B	0.33–1.65	**C440A1A1P6SF0**	**C440A2A1P6SF0**
		1–5	**C440A1A005SF0**	**C440A2A005SF0**
		4–20	**C440A1A020SF0**	**C440A2A020SF0**
1	CN15DN3_B	0.33–1.65	**C440A1A1P6SF1**	**C440A2A1P6SF1**
		1–5	**C440A1A005SF1**	**C440A2A005SF1**
		4–20	**C440A1A020SF1**	**C440A2A020SF1**
		9–45	**C440A1A045SF1**	**C440A2A045SF1**
2	CN15GN3_B	1–5	**C440A1A005SF2**	**C440A2A005SF2**
		4–20	**C440A1A020SF2**	**C440A2A020SF2**
		9–45	**C440A1A045SF2**	**C440A2A045SF2**
3	CN15KN3_	20–100	**C440B1A100SF3**	**C440B2A100SF3**

① CN15 contactor listed is non-reversing with a 120 Vac coil. For more options, see Volume 5—Motor Control and Protection, CA08100006E, Tab 33, Section 33.1.

Table 30.3-35. C440 Electronic Overload Relays for Use with NEMA Contactors Sizes 4–8
Use CTs and 1-5A C440 overload relay. CT kit does not include overload relay (order separately).

For Use with NEMA Contactor Size	CT Range (Amps)	Description	CT Kit Catalog Number	Terminal Size	Overload Relay Catalog Number	Overload Relay with Ground Fault Catalog Number
4 and 5	60–300	300: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT300**	750 kcmil (2) 250 kcmil 3/0 Cu/Al	**C440A1A005SAX**	**C440A2A005SAX**
6	120–600	600: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT600**	(2) 750 kcmil 3/0 Cu/Al	**C440A1A005SAX**	**C440A2A005SAX**
7	200–1000	1000: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT1000**	(3) 750 kcmil 3/0 Cu/Al	**C440A1A005SAX**	**C440A2A005SAX**
8	300–1500	1500: 5 panel-mount CT kit with integrated, pass-through holes	**ZEB-XCT1500**	(4) 750 kcmil 1/0 Cu/Al	**C440A1A005SAX**	**C440A2A005SAX**

Table 30.3-36. C440 Electronic Overload Relays for Separate Mount

Overload Range	Frame Size	Overload Relay Catalog Number	Overload Relay with Ground Fault Catalog Number
0.33–1.65	45 mm	**C440A1A1P6SAX**	**C440A2A1P6SAX**
1–5		**C440A1A005SAX**	**C440A2A005SAX**
4–20		**C440A1A020SAX**	**C440A2A020SAX**
9–45		**C440A1A045SAX**	**C440A2A045SAX**
20–100	55 mm	**C440B1A100SAX**	**C440B2A100SAX**

Table 30.3-37. Type AN19/59 Freedom Series Starters—Non-Reversing and Reversing

NEMA Size	Continuous Ampere Rating	Service Limit Current Rating (Amps)	Maximum UL Horsepower						Three-Pole Non-Reversing ①② Catalog Number	Three-Pole Reversing ①② Catalog Number
			Single-Phase		Three-Phase					
			115V	230V	208V	240V	480V	600V		
C440 Electronic Overload Relays										
00 0	9 18	11 21	1/3 1	1 2	1-1/2 3	1-1/2 3	2 5	2 5	**AN19AN0_ 5E _** **AN19BN0_ 5E _**	**AN59AN0_ 5E _** **AN59BN0_ 5E _**
1 2 3	27 45 90	32 52 104	2 3 —	3 7-1/2 —	7-1/2 10 25	7-1/2 15 30	10 25 50	10 25 50	**AN19DN0_ 5E _** **AN19GN0_ 5E _** **AN19KN0_ 5E _**	**AN59DN0_ 5E _** **AN59GN0_ 5E _** **AN59KN0_ 5E _**
4 ③ 5 ④	135 270	156 311	— —	— —	40 75	50 100	100 200	100 200	③ **AN19SN0_ 5E _**	③ **AN59SN0_ 5E _**
C440 with Ground Fault Electronic Overload Relays										
00 0	9 18	11 21	1/3 1	1 2	1-1/2 3	1-1/2 3	2 5	2 5	**AN19AN0_ 5G _** **AN19BN0_ 5G _**	**AN59AN0_ 5G _** **AN59BN0_ 5G _**
1 2 3	27 45 90	32 52 104	2 3 —	3 7-1/2 —	7-1/2 10 25	7-1/2 15 30	10 25 50	10 25 50	**AN19DN0_ 5G _** **AN19GN0_ 5G _** **AN19KN0_ 5G _**	**AN59DN0_ 5G _** **AN59GN0_ 5G _** **AN59KN0_ 5G _**
4 ③ 5 ④	135 270	156 311	— —	— —	40 75	50 100	100 200	100 200	③ **AN19SN0_ 5G _**	③ **AN59SN0_ 5G _**

① Underscore (_) indicates coils suffix required, see Coil Suffix table below.

② Underscore (_) indicates OLR designation required, see C440 FLA Range table below.

③ Starter not shipped as an assembled unit. Order NEMA Size 4 contactor (CN15NN3A) plus current transformers (ZEB-XCT300) and 1–5A C440 overload relay (C440A1A005SELAX or C440A2A005SELAX).

④ NEMA Size 5 starter available with 60–300A panel-mounted CTs. Starter shipped as an assembled unit with 1–5A C440 overload relay (C440A1A005SELAX or C440A2A005SELAX).

Table 30.3-38. Coil Suffix Codes

Suffix	Coil Volts and Hertz
A **B** **C**	120/60 or 110/50 240/60 or 220/50 480/60 or 440/50
D **E** **H**	600/60 or 550/50 208/60 277/60
J **K** **L**	208–240/60 240/50 380–415/50
N **T** **U**	550/50 24/60, 24/50 24/50
V **W** **Y**	32/50 48/60 48/50

Table 30.3-39. C440 FLA Range (FVNR and FVR Starters Only)

NEMA Size	OLR Code	FLA Range	OLR Code	FLA Rating
00	**1P6**	0.33–1.65A	**020**	4.0–20A
	005	1.0–5.0A	—	—
0	**1P6**	0.33–1.65A	**020**	4.0–20A
	005	1.0–5.0A	—	—
1	**1P6**	0.33–1.65A	**020**	4.0–20A
	005	1.0–5.0A	**045**	9.0–45A
2	**005**	1.0–5.0A	**045**	9.0–45A
	020	4.0–20A	—	—
3	**100**	20–100A	—	—
4 ⑤	**300**	—	—	60–300A
5 ⑤	**300**	60–300A	—	—

⑤ Starter not shipped as an assembled unit. Order NEMA Size 4 contactor (CN15NN3A) plus current transformers (ZEB-XCT300) and 1–5A C440 overload relay (C440A1A005SELAX or C440A2A005SELAX).

Accessories

Table 30.3-40. CT Kits

Description	Catalog Number
Safety Cover	
Clear Lexan® cover that mounts on top of the FLA dial and DIP switches when closed	**ZEB-XSC**
Reset Bar	
Assembles to the top of the overload to provide a larger target area for door-mounted reset operators	**ZEB-XRB**
Remote Reset	
Remote reset module (24 Vdc) ①	**C440-XCOM**
Remote reset module (120 Vac) ①	**ZEB-XRR-120**
Remote reset module (24 Vac) ①	**ZEB-XRR-24**

① Customer can wire remote-mounted button to reset module (i.e., 22 mm pushbutton, catalog number M22-D-B-GB14-K10).

Communication

The C440 is provided with two levels of communication capability.

Basic Communication via Expansion Module—Monitoring Only

Basic communication on the C440 is accomplished using an expansion module. The expansion module plugs into the expansion bay on the C440 overload relay, enabling communications with the overload via their Modbus RTU (RS-485) network. No additional parts are required.

Basic Communication—Modbus

Advanced Communication—Monitoring and Control

C440 also has the ability to communicate on industrial protocols such as DeviceNet, PROFIBUS, Modbus RTU and Modbus TCP, and Ethernet (planned) while providing control capability using I/O.

An expansion module (mentioned earlier) combined with a communication adapter and a communication module allows easy integration onto the customer's network.

Advanced Communication—Communication Module

The communication adapter comes standard with four inputs and two outputs (24 Vdc or 120 Vac) while providing the customer with flexible mounting options (DIN rail or panel).

For more information about technical data and specifications as well as dimensions, see Volume 5—Motor Control and Protection, CA08100006E, Section 31.

Advanced Communication—Communication Adapter with Communication Module

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Low Voltage Reduced Voltage

Starter Selection Guide

In general, the application will determine the type of starter required. In cases where more than one type starter will meet the application requirements, reference to the table below will show which starter is best suited for the application.

Table 30.4-1. Reduced Voltage Starting Characteristics and Index

Starter Type	Starting Characteristics Expressed in % of Rated Starting Values (Approximate)				Remarks	Page
	Motor Voltage	Motor Current	Line Current	Torque		
Autotransformer Class ECA42						30.4-2
80% Tap	80	80	67 ①	64	The adjustable voltage taps permit wide adjustment of characteristics in the field.	
65% Tap	65	65	45 ①	42		
50% Tap	50	50	28 ①	25		
Part winding Class ECA45	100	65	65	50	Requires part winding motor. A nine-lead 230/460V dual voltage motor may be used in 230V applications. Closed transition.	30.4-3
Wye-delta Class ECA48 Class ECA51	100	33	33	33	Requires delta wound motor with wye connections. Ideal for long accelerations. Closed transition is available.	30.4-4
Solid-state S801/811 S611 DS6/DS7	Ramps 0–100%	Adjustable 0–92%	Adjustable 0–92%	Adjustable 0–85%	Compatible with NEMA Design A, B or C motors. Adjustable ramp up and ramp down.	30.5-1 thru 30.5-49

① Includes autotransformer magnetizing current.

30

General Application

The following factors should be considered when applying reduced-voltage starters to a squirrel cage motor-driven load.

1. The motor characteristics that will satisfy the starting requirements of the load.
2. The source of power and the effect the motor starting current will have on the line voltage.
3. The load characteristics and the effect the motor starting torque will have on the driven parts during acceleration.

The starter protection required to protect the load, motor, starter, cables and power source during overload, undervoltage and fault conditions.

A typical NEMA B motor started with full voltage will develop as much as 150% full-load torque when started with a starting current of around 600% full-load current. These values may exceed the mechanical limitations of the load or electrical limitations of the source, or both.

A reduced-voltage or reduced-inrush starter will reduce both starting current and starting torque. Care must be taken when meeting power company limitations that the motor will produce sufficient torque to accelerate the load to near rated speed.

Part-winding starters are suited to low starting torque loads such as fans, blowers and m-g sets. Autotransformer starters should be used with "hard to start" loads such as reciprocating compressors, grinding mills, and pumps. Wye-delta starters are applicable to high inertia loads with long acceleration times which as centrifugal compressors and centrifuges.

All starters, in addition to overload protection, will provide either low voltage release or low voltage protection depending upon the pilot device used with the starter. Low voltage release, where power is applied to the motor after a power failure, can be obtained by using a two-wire pilot device (temperature, switch and so on). Low voltage protection, where power is not applied to the motor after a power failure until restarted by an operator, can be obtained by using three-wire control such as START STOP pushbuttons.

Closed transition wye-delta types require adequate ventilation to remove resistor heat.

Eaton also offers a line of solid-state reduced-voltage starters known as Easy-start.

Solid-state starters are ideally suited for many loads including conveyor applications since they provide controlled acceleration from zero to full load.

UL listing—Combination E176513, Non-Combination E19224.

Starting Characteristics

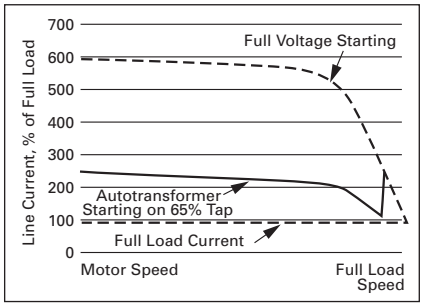

Figure 30.4-1. Autotransformer Starting

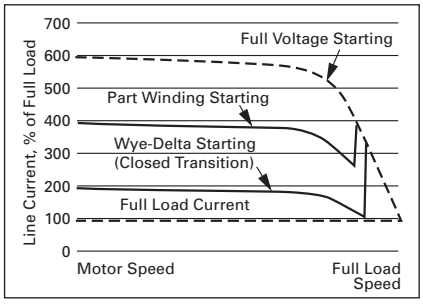

Figure 30.4-2. Wye-Delta or Part Winding Starting

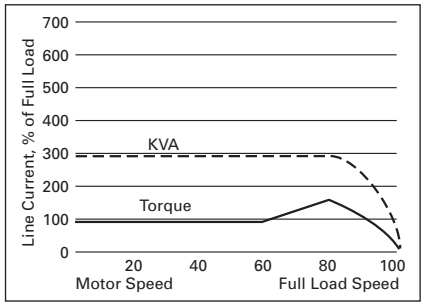

Figure 30.4-3. Solid-State Starter

General Description

Autotransformer type starters are the most widely used reduced-voltage starter because of their efficiency and flexibility. All power taken from the line, except transformer losses, is transmitted to the motor to accelerate the load. Taps on the transformer allow adjustment of the starting torque and inrush to meet the requirements of most applications. The following characteristics are produced by the three voltage taps:

Table 30.4-2. Starting Characteristics

Tap	Starting Torque % Locked Torque	Line Inrush % Locked Ampere
50% ①	25%	28% ②
65%	42%	45% ②
80%	64%	67% ②

① Not included 50 hp and below.
② Includes transformer magnetizing current.

Closed transition is standard on all sizes ensuring a smooth transition from reduced to full voltage. Since the motor is never disconnected from the line there is no interruption of line current which can cause a second inrush during transition.

Duty cycle of these starters is as follows: up to 200 hp, 15 seconds on each 4 minutes for 1 hour, repeated after 2 hours. Over 200 hp, three periods of 30 seconds ON, 30 seconds OFF repeated after 1 hour.

Design Features

Contactors—(1S) (2S) (Run)

A three-pole (1S) ③ and a three-pole contactor (2S) connect the motor to the auto-transformer for reduced-voltage starting (see **Table 30.4-3** for size).

A three-pole contactor (Run) bypasses the autotransformer and connects the motor for full-voltage across-the-line running (see **Table 30.4-3** for size).

Table 30.4-3. NEMA Contactor Size Guidelines within Autotransformer Starters

Maximum hp	NEMA Size			
	Starter	Contactor		
		Run	Starting	
			(1S) (3-Pole)	(2S) (3-Pole)
230V, 60 Hz				
15	2	2	2	2
30	3	3	3	3
50	4	4	4	4
100	5	5	5	5
200	6	6	6	6
300	7	7	6 ③	6
450	8	8	7 ③	7
460–575V, 60 Hz				
25	2	2	2	2
50	3	3	3	3
100	4	4	4	4
200	5	5	5	5
400	6	6	6	6
600	7	7	6 ③	6
900	8	8	7 ③	7

③ 1S is two-pole on sizes 7 and 8.

Operation (Refer to Schematic Diagram)

Closing the START button or other pilot device energizes the start contactor (1S). The interlock (1S) closes, energizing the timing relay (TR) and contactor (2S) which seal in through the interlock (2S). With the (1S) and (2S) contactors closed, the motor is connected through the autotransformer for reduced-voltage start. After a preset time interval, the (TR_{TO}) contacts time open, de-energizing contactor (1S) and connecting the autotransformer as a reactor in series with the motor. Interlock (1S) immediately energizes the run contactor (R) which seals in through its interlock (R). The run contacts are now closed, and the motor is running at full voltage. Start contactor (2S) and relay (TR) are de-energized when interlock (R) opens.

An overload, opening the STOP pushbutton or other pilot device de-energizes the (R) contactor removing the motor from the line.

Other Types

Autotransformer starters are also available in combination and reversing types.

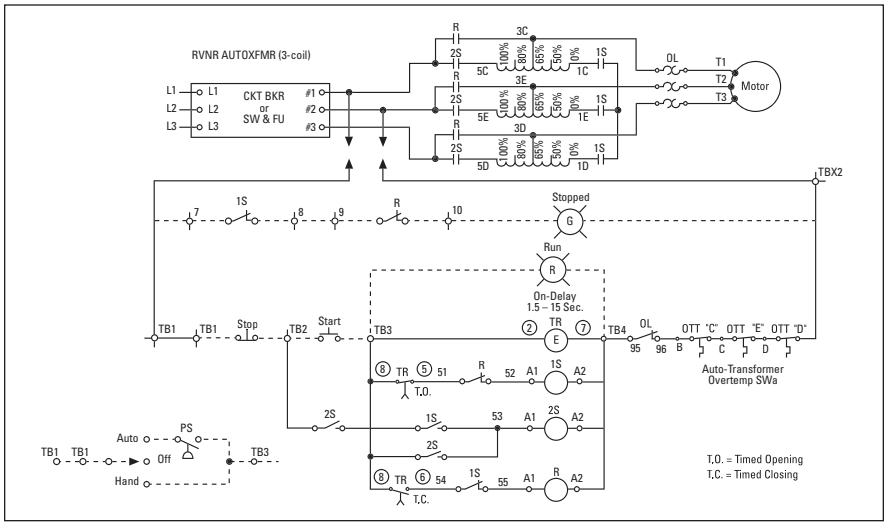

Figure 30.4-4. Typical Schematic Diagram

Table 30.4-4. Type 1, 3R, 4/4X, 12 Freedom Reduced Voltage Enclosures

Size	Type 1		Type 3R, 4X, 12	
	Box No.	Shipping Weight Lbs (kg)	Box No.	Shipping Weight Lbs (kg)
Class 42: Autotransformer—Non-combination **Class 43: Autotransformer—with Disconnect** **Class 44: Autotransformer—with HMCP**				
2–4	E2	124 (56)	E2	149 (68)
5	F1E	885 (402)	F1E	1010 (459)
6 ④	F1E	1220 (554)	F1E	1345 (611)
6 ③	F2E	1400 (636)	F2E	1525 (692)
7	F2E	⑤	F2E	⑤
8	F2E	⑤	F2E	⑤
9	⑤	⑤	⑤	⑤

④ Non-combination and breaker.
⑤ Consult factory.

For enclosure box dimensions, refer to Page 30.6-3.

General Description

Part-winding starting provides convenient, economical one-step acceleration at reduced current where the power company specifies a maximum or limits the increments of current drawn from the line. These starters can be used with nine-lead dual-voltage motors on the lower voltage and with special part-winding motors designed for any voltage. When used with dual-voltage motors, it should be established that the torque produced by the first half-winding will accelerate the load sufficiently so as not to produce a second undesirable inrush when the second half-winding is connected to the line. Most motors will produce a starting torque equal to between 1/2 to 2/3 of NEMA standard values with half of the winding energized and draw about 2/3 of normal line current inrush.

Design Features

Contactors—(1M) (2M)

A three-pole contactor (1M) connects only the first half-winding of the motor for reduced inrush current on starting (see table below for size). A three-pole contactor (2M) connects the second half-winding of the motor for running (see table below for size).

Table 30.4-5. NEMA Contactor Size Guidelines within Part Winding Starters

Maximum hp	NEMA Size		
	Starter	Contactor	
		(1M)	(2M)
230V, 60 Hz			
15	1 PW	1	1
25	2 PW	2	2
50	3 PW	3	3
75	4 PW	4	4
150	5 PW	5	5
300	6 PW	6	6
460–575V, 60 Hz			
15	1 PW	1	1
40	2 PW	2	2
75	3 PW	3	3
150	4 PW	4	4
350	5 PW	5	5
600	6 PW	6	6

Overload Relay—(OL)

Two three-pole Type B overload relays provide starting and running overcurrent protection.

Timing Relay—(TR)

An electrically operated pneumatic relay provides accurate, adjustable start-to-run transfer timing.

Other Types

Part-winding Type ECN45 starters are also available in combination (Type 46 and 47), reversing and three-point (primary resistor) types.

Operation (Refer to Schematic Diagram)

Closing the START button or other pilot device energizes the start contactor (1M) which seals in through its interlock (1M) and energizes the timer (TR). The (1M) contacts connect the first half-winding of the motor across the line. After a preset time interval, the timer (TR_{TC}) contact closes energizing contactor (2M). The (2M) contact connects the second half-winding of the motor across-the-line.

Opening the STOP button or other pilot device de-energizes contactors (1M), (2M) and timer (TR), removing the motor from the line.

Table 30.4-6. Contactor Sequence

Contactor	Start	Run
1M	●	●
2M	—	●

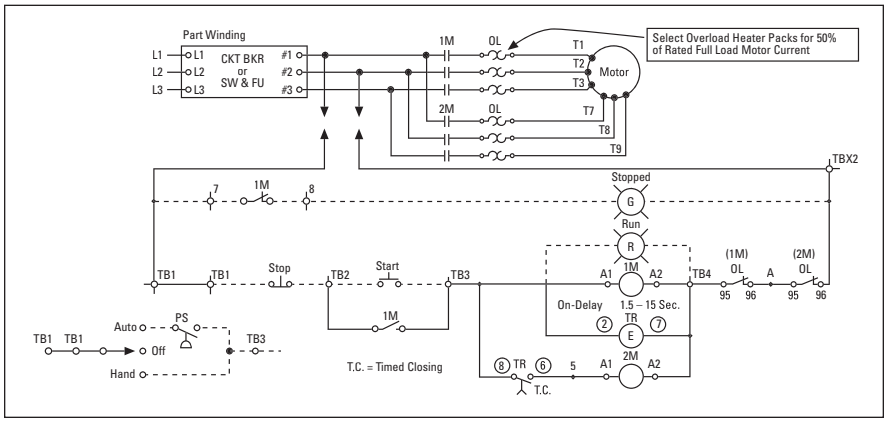

Figure 30.4-5. Typical Schematic Diagram

Table 30.4-7. Type 1, 3R, 4/4X, 12 Freedom Reduced Voltage Enclosures

Size	Type 1		Type 3R, 4X, 12	
	Box No.	Shipping Weight Lbs (kg)	Box No.	Shipping Weight Lbs (kg)
Class 45: Part Winding—Non-combination				
2PW	3	25 (11)	7	75 (34)
3PW–4PW	9	47 (21)	9	95 (43)
5PW	E	125 (47)	E	180 (82)
6PW	F1E	780 (354)	F1E	880 (400)
7PW	F2E	①	F2E	①
8PW	F2E	①	F2E	①
Class 46: Part Winding—with Disconnect **Class 47: Part Winding—with Thermal-Magnetic Trip Circuit Breaker**				
2PW	C	68 (31)	C	88 (40)
3PW	D	162 (74)	D	190 (86)
4PW	E	230 (104)	E	270 (123)
5PW	F1E	440 (200)	F1E	530 (241)
6PW ②	F1E	440 (200)	F1E	620 (281)
6PW ③	F2E	515 (234)	F2E	①
7PW	F2E	①	F2E	①
8PW	F2E	①	F2E	①

① Consult factory.
② Non-combination and breaker.
③ Fusible.

For enclosure box dimensions, refer to Page 30.6-3.

General Description

Wye-delta type starters are applied extensively to industrial air conditioning installations because they are particularly suited for starting motors driving high inertia loads with resulting long acceleration times. They are not, however, limited to this application. When six- or 12-lead delta-connected motors are started wye-connected, approximately 58% of line voltage is applied to each winding and the motor develops 33% of full-voltage starting torque and draws 33% of normal locked-rotor current from the line. When the motor is accelerated, it is reconnected for normal data operation.

Design Features

Contactors—(1S) (1M) (2S) (2M)

A three-pole contactor (1S) ① shorts the motor leads T4-T5-T6 during starting to connect motor in wye (see **Table 30.4-8** for size).

A three-pole contactor (1M) energizes motor leads T1-T2-T3 for both wye and delta connections (see **Table 30.4-8** for size).

A three-pole contactor (2S) connects resistors in series with the motor windings during the start-to-run transition period (see **Table 30.4-8** for size).

A three-pole contactor (2M) energizes the motor leads T4-T5-T6 during running to connect the motor in delta (see **Table 30.4-8** for size).

Table 30.4-8. NEMA Contactor Size Guidelines

Max. hp	NEMA Size				
	Starter	Contactor			
		(1M)	(2M)	(1S)	(2S)
230V, 60 Hz					
10	1 YD	1	1	1	1
25	2 YD	2	2	2	1
50	3 YD	3	3	3	1
75	4 YD	4	4	4	2
150	5 YD	5	5	4	3
300	6 YD	6	6	5	4
500	7 YD	7	7	6 ①	5
800	8 YD	8	8	7 ①	6
460–575V, 60 Hz					
15	1 YD	1	1	1	1
40	2 YD	2	2	2	1
75	3 YD	3	3	3	1
150	4 YD	4	4	4	2
300	5 YD	5	5	4	3
700	6 YD	6	6	5	4
1000	7 YD	7	7	6 ①	5
1500	8 YD	8	8	7 ①	6

① 1S is two-pole on sizes 7 and 8.

Operation (Refer to Schematic Diagram)

Closing the START button or other pilot device energizes contactor (1S) whose contacts connect the motor in a wye connection. Interlock (1S) closes, energizing contactor (1M) and timer (TR). The (1M) contacts energize the motor windings in a wye. After a preset time interval, timer (TR_{TC}) contact closes energizing contactor (2S). Interlock (2S) opens, dropping out contactor (1S). The motor is now energized in series with the resistors. Interlock (1S) closes, energizing contactor (2M), bypassing the resistors and energizing the delta connected motor at full voltage. Interlock opens, de-energizes the timer (TR) opening timer (TR_{TC}) thus energizing contactor (2S).

An overload, opening the STOP button or other pilot device de-energizes contactors (1M) and (2M), removing the motor from the line. (TRP) de-energizes and locks out the control circuit if the duty cycle of the transition resistors is exceeded.

Wye-delta Class ECN51 closed transition starters are also available in combination types and Class ECN48 open transition non-combination and combination starters.

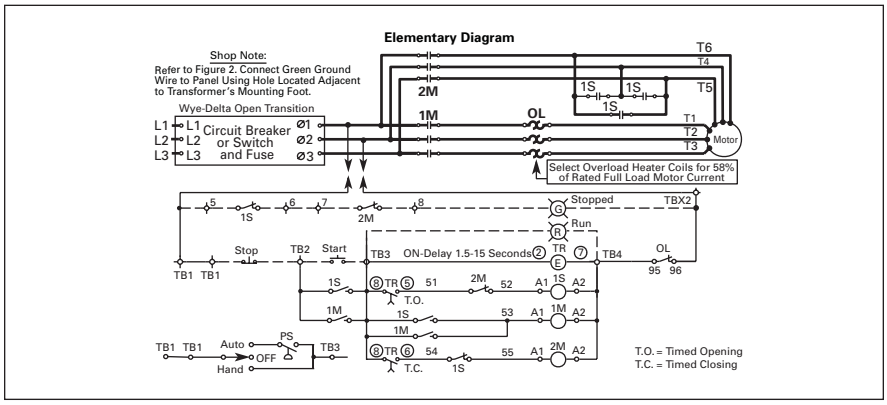

Figure 30.4-6. Wye-Delta—Open Transition

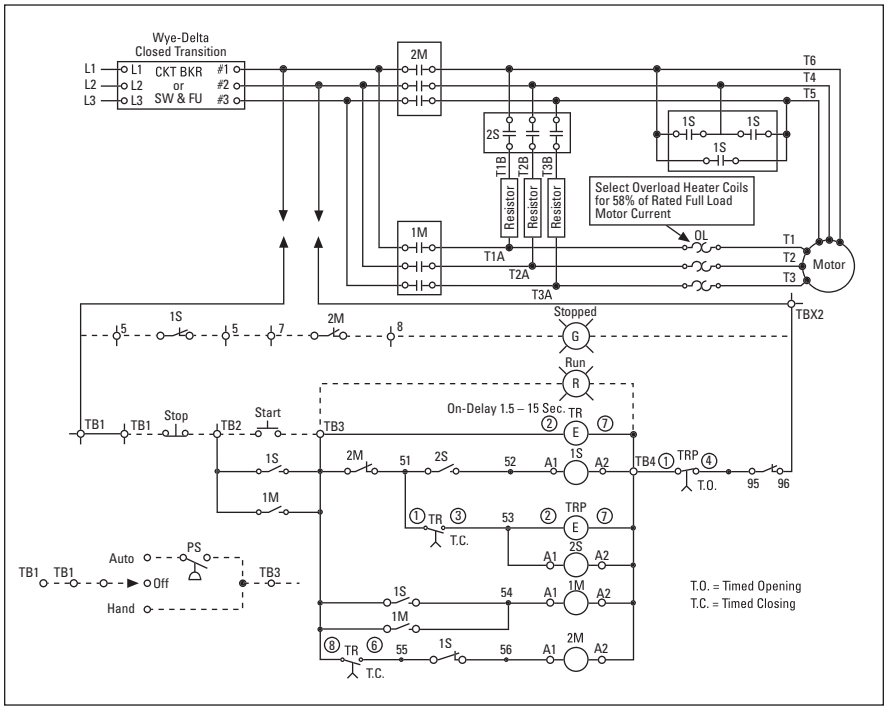

Figure 30.4-7. Wye-Delta—Closed Transition

Table 30.4-9. Type 1, 3R, 4/4X, 12 Freedom Reduced Voltage Enclosures

Size	Type 1		Type 3R, 4X, 12	
	Box No.	Shipping Weight Lbs (kg)	Box No.	Shipping Weight Lbs (kg)
Classes 48 & 51: Wye-Delta—Non-combination **Classes 49 & 52: Wye-Delta—with Disconnect** **Classes 50 & 53: Wye-Delta—with Thermal Magnetic Trip Circuit Breaker**				
2YD–4YD	E	185 (84)	E	225 (102)
5YD	F1E	605 (275)	F1E	705 (320)
6YD ①	F1E	635 (288)	F1E	735 (334)
6YD ②	F2E	715 (325)	F2E	830 (377)
7YD	F2E	③	F2E	③
8YD	F2E	③	F2E	③

① Non-combination and breaker.
② Fusible.
③ Consult factory.

30

For enclosure box dimensions, refer to Page 30.6-3.

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Solid-State Reduced Voltage Starters

Reduced Voltage Starters

General Description

Eaton offers a complete line of solid-state reduced voltage devices ranging from fractional horsepower applications to 1000A devices. The line comes in voltages from 200 to 600 Vac and operates on 50 or 60 Hz applications. Units can be ordered as open components or mounted in enclosures (NEMA 1, 3R, 4X and 12). Motor control center (MCC) mounting is also possible with units through 700 hp fitting inside of a standard MCC.

These soft starters provide reduced voltage starting of AC induction motors. Motor voltage is controlled by means of back-to-back SCRs (silicon controlled rectifiers) providing a smooth, stepless start (and stop) of the motor driven load.

For more information, please visit the Eaton Web site at **www.eaton.com/electrical**.

Designed to control acceleration and deceleration of three-phase motors, products are available from 0.25 to 50A and are suitable for mounting in a variety of enclosures including Type 1, 12, 3R, 4, 4X and 7/9.

Application Description

Eaton's soft starters can be applied in a wide array of customer applications. Typical benefits of soft starters include:

- Reduced starting torque stress on mechanical equipment, allowing longer life of belts, gears, pulleys and motor shafts commonly weakened during "across-the-line" starting
- Reduction of voltage drop during starting on weak utility systems where the performance of nearby equipment would be negatively affected
- Reduced inrush current during starting which can result in lower utility bills due to the reduction in peak current demand charges
- Smooth, stepless starting of a motor, allowing superior flexibility over typical electromechanical starting methods
- Ability to start large loads on backup generators during power outages
- Elimination of the water-hammer effect in hydraulic systems, which can help to eliminate additional pipe hangers and extend the life of the system, pumps, valves and gaskets

Typical Applications

- Centrifugal and screw compressors
- Material handling equipment
- Fans and blowers
- Pumps
- Cranes and hoists
- Food processing
- Machinery
- Rock crushers
- HVAC industry

Enclosure Types

Airborne particulate may be detrimental to starter performance and reliability, so caution must be exercised in choosing the enclosure best suited to the environment. The NEMA rating of the enclosure defines its ability to withstand the ingress of foreign particulate as described below:

NEMA 1

A general purpose, indoor-type enclosure.

NEMA 12

A dust-tight and drip-tight enclosure for indoor industrial applications.

NEMA 3R

Enclosures are intended for outdoor use, primarily to provide a degree of protection against falling rain, sleet and external ice formation.

NEMA 4

A watertight and dust-tight enclosure for either indoor or outdoor use.

NEMA 4X

Identical to NEMA 4, with the additional requirement that the enclosure be corrosion-proof as well.

NEMA 7/9

Enclosures capable of preventing the entrance of dust and withstanding pressure resulting from an internal explosion of specified gas.

Catalog Numbering System

Table 30.5-1. Solid-State Enclosed Control Catalog Numbering System

EC S 90 S 1 C A A

Type
S = Solid-state

Class
90 = Non-combination reduced voltage soft starter—S801
91 = Combination reduced voltage soft starter—fusible disconnect—S801
92 = Combination reduced voltage soft starter—circuit breaker—S801
93 = Non-combination reduced voltage soft starter—S811
94 = Combination reduced voltage soft starter—fusible disconnect—S811
95 = Combination reduced voltage soft starter—circuit breaker—S811

Amperes		
S801/S811		
Q = 37	**Z** = 240	**5** = 650
S = 66	**1** = 304	**6** = 720
V = 105	**2** = 360	**7** = 850
W = 135	**3** = 420	**8** = 1000
Y = 180	**4** = 500	

Enclosure Type
1 = Type 1
2 = Type 3R
3 = Type 4
4 = Type 4X (304-Grade SS)
6 = Type 7/9
8 = Type 12
9 = Type 4X (316-Grade SS)

Voltage	
B = 230V	**E** = 200V
C = 460V	**Q** = 24 Vdc
D = 575V	

Cover Control
See **Table 30.6-3** for options

Disconnect Fuse Clip Ratings		
A = None	**G** = 100A/600V R	**N** = 600A/600V R
B = 30A/250V R	**H** = 200A/250V R	**P** = 800A/600V L
C = 30A/600V R	**J** = 200A/600V R	**Q** = 1200A/600V L
D = 60A/250V R	**K** = 400A/250V R	**R** = 1600A/600V L
E = 60A/600V R	**L** = 400A/600V R	**S** = 2000A/600V L
F = 100A/250V R	**M** = 600A/250V R	**T** = By description
Breaker		
A = None	**F** = 50A	**K** = 400A
B = 3A	**W** = 70A	**L** = 600A
C = 7A	**G** = 100A	**P** = 1200A
D = 15A	**H** = 150A	**Q** = 1600A
E = 30A	**J** = 250A	

Table 30.5-2. Solid-State Product Comparison

Description	S801 Soft Starter	S811 Communicating Soft Starter
Maximum current range	1–1000A	1–1000A
Start type	Ramp or current limit	Ramp or current limit
Operating voltage	200–600 Vac	200–600 Vac
Operating frequency	47–63 Hz	47–63 Hz
Control voltage	24 Vdc	24 Vdc
Kick start	0–2 seconds adjustable	0–2 seconds adjustable
Ramp time range	0.5–180 seconds	0.5–180 seconds
Initial torque setting	0%–85%	0%–85%
Current limit setting	0%–550%	0%–550%
Soft stop	0–60 seconds	0–60 seconds
Pump control option	Yes	Yes
Overtemperature protection	Yes	Yes
Overload	Yes	Yes
Overload setting	30%–100%	30%–100%
Trip class setting	5, 10, 20 and 30	5, 10, 20 and 30
Phase loss/unbalance	Yes	Yes
Jam	Yes	Yes
Stall	Yes	Yes
Phase reversal	Yes	Yes
Jog	Yes	Yes
Extended start	Yes	Yes
LED status indication	Yes	LCD—Yes
LED fault indication	Yes	LCD—Yes

Table 30.5-3. Application and Environmental Considerations

The installation environment for a solid-state reduced voltage starter is of a prime concern. Conditions such as ambient temperature, altitude and the presence of corrosives or moisture must all be considered when choosing the appropriate starter size and enclosure type.

Description	S801 Soft Starter	S811 Communicating Soft Starter
Temperature—operating (No derating)	–25°C to 40°C	–30°C to 50°C
Current rating (50°C)	100%	100%
Limited duty cycle (50°C)	Fully rated	Fully rated
Current rating (60°C)	10% reduction	Consult factory
Limited duty cycle (60°C)	Continuous duty cycle at 90%	Consult factory
Temperature—storage	–40°C to 70°C	–50°C to 70°C
Altitude (meters)	2000	2000

Note: Consult factory for applications outside of these parameters for additional information and sizing requirements.

Multi-Motor Operation

The S801/S811 line can be used to control multiple motors if the following conditions are met:

- The current rating of the S801/S811 should be equal to or greater than the total of the individual motor full load amperes and the S801/S811 overload must be set for the cumulative full load amperes of the motors
- Individual motor overcurrent protection is provided by other devices
- The motors should not be mechanically coupled together, i.e., two motors on same shaft
- NEC and local code requirements for individual motor protection and branch short circuit protection are met
- Motors are closely matched in total load and size

Frequent Starting/Stopping

The number of starts and stops allowable depends upon many factors. The most important ones are:

1. Set level of the starting current limit
2. Start time
3. Run time
4. Off time before next start

The number of starts per hour is based on the current carrying capacity of the SCRs. A high start/stop duty may require the oversizing of a soft starter. If a high number of multiple starts occur, the starter may trip due to the overload protection for the motor or it may trip on overtemperature of the soft starter. In this situation, it is advisable to wait a period of 10 minutes before restarting to avoid damage to the soft starter and motor and allow the units to cool down. The motor manufacturer should be consulted about the effect of a high number of multiple starts on motor life.

Starting Torque

The reduced voltage applied to the motor results in reduced inrush current and a soft start. However, it reduces the starting torque of the motor. The relationship is as follows:

$$\frac{\text{Torque at reduced current}}{\text{Torque at full current}} = \frac{\text{Current at reduced voltage}^2}{\text{Current at full voltage}}$$

EXAMPLE: A 100 hp, 1800 RPM, 460V NEMA B motor draws six times full load amperes for starting, and starting torque is 150% of full load torque.

If the same motor were started with the S801 at 300% current limit, then the available torque would be:

$$\frac{300^2}{600} = \frac{90{,}000}{360{,}000} =$$

1/4 x 150% full load torque =

37.5% full load torque available

Heat Generation

Due to the voltage drop that occurs across a SCR, there is heat generated in the unit. For sizing an enclosure or box size for the soft starters, it is important to account for this heat generation.

The S801/S811 lines use a bypass contactor, so heat generation is minimized. During steady-state conditions, it generates about the same amount of heat as an across-the-line starter of the same size. During start and stopping ramps it will generate three watts of heat per ampere.

EXAMPLE: A 100 hp, 480V NEMA B motor has a full load current of 125 amperes. A typical soft start on this motor is 300% current limit for 40 seconds. The heat generation during this time period is:

125 amperes x 300% =
375 watts for 40 seconds

At the end of the ramp, the bypass contactor closes and total heat generation is reduced to much lower levels.

NEMA Design C and D Motors, Wound Rotor Motors

These motors are used due to their high starting torque characteristics. When high starting currents and high starting torques are required, it may be necessary to order the extended ramp option and oversize the soft starter to match the application requirements. Consult the factory for application considerations.

Solid-State Reduced Voltage Starters

Enclosed Box Selection

Table 30.5-4. Non-combination Solid-State Reduced Voltage

Rating	SSRV	Non-combination
		Box No. ①
37A	S801/S811	7A
66A	S801/S811	7A
105A	S801/S811	7A
135A	S801/S811	B1
180A	S801/S811	C
240A	S801/S811	②
304A	S801/S811	②
360A	S801/S811	②
420A	S801/S811	10
500A	S801/S811	10
650A	S801/S811	10
720A	S801/S811	10
850A	S801/S811	10
1000A	S801/S811	10

① Enclosure space will also accommodate for an DC Power Supply, two four-pole relays, CPT, and terminal blocks. Also includes space for a DNA module or MOV.

② Contact Eaton for Box Dimensions not shown in PG03300001E.

Note: All Type 7 and 9, see PG03300001E.

Table 30.5-5. Combination Solid-State Reduced Voltage

Rating	SSRV	Comb. with Fuses	Comb. with HMCP
		Box No. ③	Box No. ③
37A	S801/S811	B1	A1 ④
66A	S801/S811	C	A1
105A	S801/S811	D	B1
135A	S801/S811	D	C
180A	S801/S811	E	E
240A	S801/S811	F1E	E
304A	S801/S811	F1E	E
360A	S801/S811	F1E	E
420A	S801/S811	F1E	E
500A	S801/S811	F1E	E
650A	S801/S811	F1E	F1E
720A	S801/S811	F1E	F1E
850A	S801/S811	F1E	F1E
1000A	S801/S811	F1E	F1E

③ Enclosure space will also accommodate for an DC Power Supply, two four-pole relays, CPT, and terminal blocks. Also includes space for a DNA module or MOV.

④ Same as footnote ③, but CPT is not included. Upsize to B1 enclosure to include space for a CPT and a full voltage bypass contactor.

30

For enclosure box dimensions, refer to Page 30.6-3.

S801 Solid-State Reduced Voltage Soft Starter

S801 Reduced Voltage Soft Starters

General Description

Eaton's S801 line of reduced voltage soft starters is very compact, multi-functional, easy-to-install and easy-to-program. Designed to control acceleration and deceleration of three-phase motors, the line is available in current ranges from 12 to1000A and is suitable for mounting in motor control centers or in enclosed control (NEMA 1, 4, 4X and 12) applications.

This product line is designed to compete head-to-head with the high-end soft starter market, offering improved performance and dramatically smaller size versus the competition. By having the over-load functionality and bypass contactors built into the unit, it reduces the amount of wiring required during installation and offers huge space savings in the panel or enclosure. The product is also designed to be small enough to replace an existing across-the-line starter (NEMA or IEC) in the existing enclosure. This allows customers to upgrade their existing motor control centers and enclosed control by replacing the starter they have today with a soft starter, gaining the benefits of lower utility charges, longer component life and less stress on products and material systems. This size benefit allows users to save the expense of replacing the existing structure or adding a new one to house a much larger soft starter.

Application Description

The S801 line uses a total of six SCRs to control the motor (three matched pairs). The unit has a built-in overload that is adjustable from 30% to 100% of rating and can be set for Trip Class 5, 10, 20 or 30. It also provides additional protection for jam, stall, phase reversal, phase loss, overtemperature, under-voltage and so on. Along with the overload, the unit has a built-in run bypass contactor. This device is closed when the soft starter is up to speed providing a low impedance bypass for the SCRs and significantly reducing the amount of heat that is generated in the soft starter.

The S801 is designed to work with three-phase motors in a delta (three-lead) configuration. The S801 works with all motors from fractional horse-power up to motors requiring 1000A of steady-state current. The built-in over-load (in ranges from 12 to 1000A) and run bypass contactor makes installation and setup quick and easy. The overload also offers some advanced protective functions to give additional motor protection.

With the pump control option, it is the number one soft starter available for pumping applications. The unique soft stopping control provides a smooth transition for stopping a motor and eliminating the "water-hammer" effect that can damage pipes, valves and pumps.

Catalog Numbering System

Table 30.5-6. S801 Open Soft Starters Catalog Numbering System

S 801 N66 N 3 S

S = Soft Starter

801 = Non-combination Soft Starter

Ampacity Rating	
N37 = 37A	**U50** = 500A ②
N66 = 66A	**V36** = 360A
R10 = 105A	**V42** = 420A
R13 = 135A	**V50** = 500A
T18 = 180A	**V65** = 650A
T24 = 240A	**V72** = 720A
T30 = 304A	**V85** = 850A
U36 = 360A	**V10** = 1000A
U42 = 420A	

B = Level sensing
D = Inside the delta
L = Extended ramp start
S = Standard soft starter overload
W = Without CIM (control interface module)

3 = Three-pole device

N = No options
P = Pump control
V = 690V option ①

① Not available on U-Frame.
② U-Frame 500A unit does not have IEC Certification.

Features

- Built-in overload protection:
  - 30%–100% adjustment range
  - Trip Class 5, 10, 20 and 30
  - Jam
  - Stall
  - Phase reversal
  - Phase loss/unbalance
  - Shorted SCR detection
  - Overtemperature
- Selectable ramp or current limit start.
- Kick Start:
  - Adjustable from 0%–85% initial torque
  - 0–2.0 seconds adjustment time
- Ramp Start:
  - Adjustable from 0%–85% initial torque
  - 0.5–180 seconds adjustment time
- Current Limit Start:
  - Adjustable from 0%–550% FLA
  - 0.5–180 seconds adjustment time
- Soft Stop:
  - Adjustable from 0%–60 seconds
- Built-in run bypass contact
- 24 Vdc control
- IP20 finger protection
- Optional pump control

Standards and Certifications

- IEC 947 compliant
- EN 60947-4-2
- CE marked
- CSA certified
- UL listed

S801 Enclosed Soft Starter

Enclosed S801 Soft Starter

General Description

24 Vdc Control—S801 soft starters superiority begins with the control package that features 24 Vdc control running a digital signal processor, or DSP, and using a low impedance run circuit, all of which contribute to the S801 soft starter's safety, advanced functionality and compact size.

Built-in Overload Protection—With most wye-delta starters, many of the advanced features of the S801 are functions that must be added at the expense of cost and space. The S801 soft starter, for example, has built-in overload protection (overloads must be added to wye-delta starters). So, S801 soft starters are more compact, easier to wire and less costly than their wye-delta counterparts.

Reduced Power Consumption—The S801 soft starter costs less in terms of power consumption. An S801 soft starter also reduces line brown-outs and decreases overall energy usage. For example, an S801 soft starter controls peak power demand while a full-voltage starter can apply 600–800% FLA on startup.

Lower Starting Torque—System cost savings are significant with an S801 soft starter versus a full voltage starter. With an S801 soft starter, mechanical components can have longer life or be reduced in size because of lower starting torque values (250–500% FLA current with SSRV).

Fewer Mechanical Problems—Because an S801 soft starter reduces stress on a system by eliminating the jolts and violent speed variations that full-voltage starters introduce to a process, fewer mechanical breakdowns occur, improving the quality of the product and process.

Features and Benefits

- **Longer Life of System Equipment** — With the impressive list of control and protective functions, this new line of products is designed to significantly increase the protection it offers to system equipment (e.g., motors, belts, pumps and so on). The benefit of increased system equipment protection is longer life and longer system equipment uptime
- **Reduced Power Draw—**Power control features like Ramp Start, Current Limit Start and Jog Forward provide maximum flexibility in selecting start profiles, minimizing both mechanical and electrical stress while maximizing motor performance
- **Improved Safety—**S801 soft starters offer fingerproof deadfront construction, reducing the chance of electrical shock. With the use of 24 Vdc control power, pilot devices and relays can be operated more safely
- **System Cost Savings—**With improved reliability, longer life of system equipment, reduced power draw, space savings and improved safety, you enjoy the benefit of a significant improvement in system uptime and a reduction in system downtime resulting in overall system cost saving
- **Time Savings—**Time savings in using S801 soft starters are achieved through a quick and easy setup procedure, user-friendly operational design, the longer life of system equipment and improved safety
- **Productivity—**Overall, S801 soft starters significantly improve your productivity by saving you time and money. This is demonstrated by longer product life, longer runs between breakdowns and the ease of installation and operation

Standards and Certifications

Enclosed Control

- UL 508
- IEC 947-4-2
- EN 60947.2
- CE marked EMC/LV directives
- CSA–22.2

Schematic Diagram

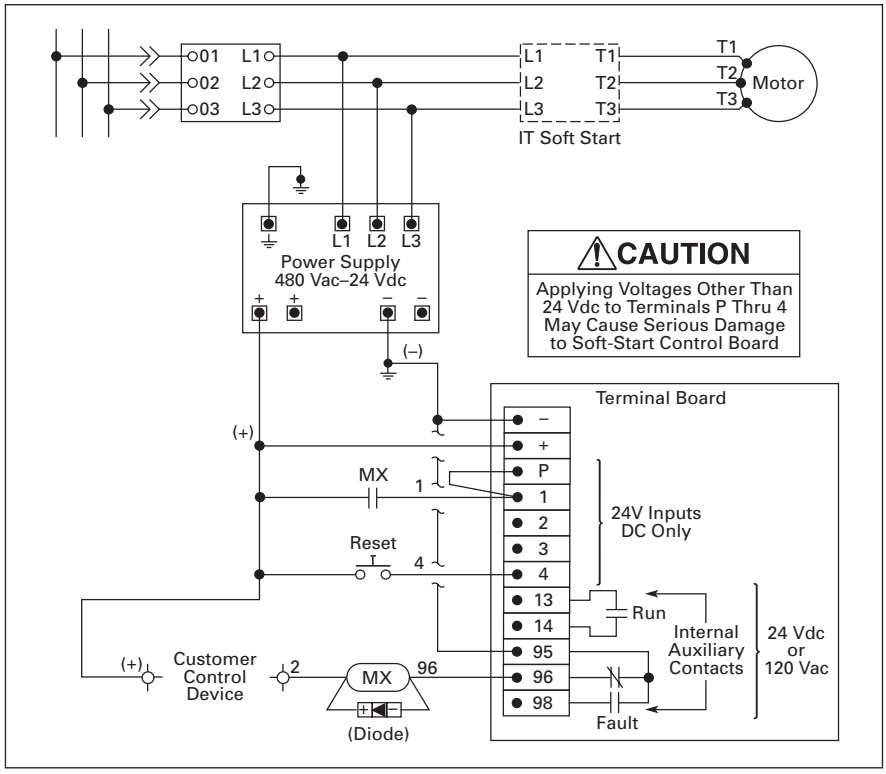


Figure 30.5-1. Wiring Diagram

Technical Data and Specifications

Base Ratings

Table 30.5-8 below is the base ratings for the S801 soft starter. The tables included in this catalog are meant to be a selection table for different applications, but to match a unit to your exact application, consult with your local Eaton representative or visit our Web site at **www.eaton.com/electrical**.

Table 30.5-7. Standard-Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft start	300%	30	3	50°C
vs. Full voltage	500%	10	3	50°C
vs. Wye-delta	350%	20	3	50°C
vs. 80% RVAT	480%	20	2	50°C
vs. 65% RVAT	390%	20	3	50°C
vs. 50% RVAT	300%	20.	4	50°C

Table 30.5-8. Standard-Duty Rating Open Soft Starters

Frame Size	Maximum Current	Three-Phase Motor											Catalog Number
		kW Rating (50 Hz)			hp Rating (60 Hz)								
		230	380–400	440	200V		230V		460V		575V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	37	10	18.5	18.5	10	10	10	10	25	20	30	30	**S801N37N3S**
	66	18.5	30	37	20	15	20	20	50	40	60	50	**S801N66N3S**
R	105	30	55	59	30	25	40	30	75	60	100	75	**S801R10N3S**
	135	40	63	80	40	30	50	40	100	75	125	100	**S801R13N3S**
T	180	51	90	110	60	50	60	60	150	125	150	150	**S801T18N3S**
	240	75	110	147	75	60	75	75	200	150	200	200	**S801T24N3S**
	304	90	160	185	100	75	100	100	250	200	300	250	**S801T30N3S**
U	360	110	185	220	125	100	150	125	300	250	350	300	**S801U36N3S**
	420	129	220	257	150	125	175	150	350	300	450	350	**S801U42N3S**
	500	150	257	300	150	150	200	150	400	350	500	450	**S801U50N3S** ①②
V	360	110	185	220	125	100	150	125	300	250	350	300	**S801V36N3S**
	420	129	220	257	150	125	175	150	350	300	450	350	**S801V42N3S**
	500	150	257	300	150	150	200	150	400	350	500	450	**S801V50N3S**
	650	200	355	425	250	200	250	200	500	450	600	500	**S801V65N3S**
	720	220	400	450	—	—	300	250	600	500	700	600	**S801V72N3S**
	850	257	475	500	—	—	350	300	700	600	900	700	**S801V85N3S**
	1000	315	560	600	—	—	400	350	800	700	1000	800	**S801V10N3S**

① 15 sec. start, 300% inrush, 40°C, 1 start every 15 minutes. If these start parameters are exceeded, please refer to 290 mm V-Frame, 500A starter.
② U-Frame 500A does not have IEC Certification.

Severe-Duty Ratings

Motor applications and customer needs come in many different varieties. With the standard and severe duty rating tables, we have attempted to provide guidelines on what the S801 soft starter is capable of. If the application falls under these categories, you can use these charts. For other applications, or when a question arises, contact Eaton Corporation to assist you in selecting the proper soft starter.

Table 30.5-9. Severe-Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft start	450%	30	4	50°C
vs. Full voltage	500%	10	10	50°C
vs. Wye-delta	350%	65	3	50°C
vs. 80% RVAT	480%	25	4	50°C
vs. 65% RVAT	390%	40	4	50°C
vs. 50% RVAT	300%	60	4	50°C

Table 30.5-10. Severe-Duty Rating Open Soft Starters

Frame Size	Maximum Current	Three-Phase Motor											Catalog Number
		kW Rating (50 Hz)			hp Rating (60 Hz)								
		230	380–400	440	200V		230V		460V		575V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	22	5.5	10	11	5	5	7-1/2	5	15	10	20	15	**S801N37N3S**
	42	11	18.5	22	10	10	15	10	30	25	40	30	**S801N66N3S**
R	65	15	30	33	15	15	20	15	50	40	50	50	**S801R10N3S**
	80	22	40	45	25	20	30	25	60	50	75	60	**S801R13N3S**
T	115	33	59	63	30	30	40	30	75	75	100	100	**S801T18N3S**
	150	45	80	90	50	40	50	50	100	100	150	125	**S801T24N3S**
	192	55	100	110	60	50	75	60	150	125	200	150	**S801T30N3S**
U	240	75	110	147	75	60	75	75	200	150	200	200	**S801U36N3S**
	305	90	160	185	100	75	100	100	250	200	300	250	**S801U42N3S**
	365	110	185	220	125	100	150	125	300	250	350	300	**S801U50N3S** ③
V	240	75	110	147	75	60	75	75	200	150	200	200	**S801V36N3S**
	305	90	160	185	100	75	100	100	250	200	300	250	**S801V42N3S**
	365	110	185	220	125	100	150	125	300	250	350	300	**S801V50N3S**
	420	129	220	257	150	125	150	150	350	300	450	350	**S801V65N3S**
	480	147	257	295	150	150	200	150	400	350	500	450	**S801V72N3S**
	525	160	280	335	150	150	200	150	450	350	500	450	**S801V85N3S**
	600	185	315	375	200	150	250	200	500	450	600	500	**S801V10N3S**

③ U-Frame 500A unit does not have IEC Certification.

S801 Solid-State Reduced Voltage Starter

Features

- Able to fit in place of existing starters
- Smallest unit on the market today
- Very easy to install, wire and program
- Reduces initial torque on motor and loads
- Able to control the maximum inrush current

Benefits

- Reduced wear on belts, gears, chains, clutches, shafts and bearings
- Allows for controlling the inrush current to the motor and reducing electrical charges due to peak energy demand
- Reduced inrush current leads to more stable power grid and can lower peak demand charges
- Elimination of water-hammer, which can reduce installed cost of pipe hangers and extend existing system life
- Less shock to product on conveyor lines and material handling gear
- 24 Vdc control enhances personnel and equipment safety

Table 30.5-11. Technical Data

Soft Starter (Partial Catalog Number)	S801 N37	S801 N66	S801 R10	S801 R13	S801 T18	S801 T24	S801 T30	S801 U36	S801 U42	S801 U50 ①	S801 V36	S801 V42	S801 V50	S801 V65	S801 V72	S801 V85	S801 V10
Maximum current capacity	37	66	105	135	180	240	304	360	420	500	360	420	500	650	720	850	1000
Dimensions in Inches (mm)																	
Width	2.60 (66.1)		4.38 (111.3)		7.65 (194.3)			7.73 (196.3)			11.04 (280.4)						
Height	7.38 (187.4)		7.92 (201.2)		12.71 (322.8)			12.72 (323.1)			16.57 (420.9)						
Depth	6.63 (168.4)		7.03 (178.6)		6.69 (169.9)			7.08 (179.9)			7.69 (195.3)						
Weight in lbs (kg)	5.80 (2.6)		10.50 (4.8)		48.00 (21.8)—with lugs 41.00 (18.6) —without lugs			48.00 (21.8)—with lugs 41.00 (18.6) —without lugs			103.00 (46.0)—with lugs 91.00 (41.4)—without lugs						
General Information																	
Bypass mechanical lifespan	10M																
Insulating voltage (Ui)	660V																
Ramp time range	0.5–180 seconds (0.5–360 seconds extended ramp)																
Resistance to vibration	3g																
Resistance to shock	15g																
Electrical Information																	
Operating voltage	200–600V																
Operating frequency	47–63 Hz																
Overload setting	30%–100%																
Trip class	5, 10, 20 and 30																
Cabling Capacity (IEC 947)																	
Number of conductors	1		1		1 or 2			—	—	—	2, 4 or 6						
Wire sizes	14–2		14–4/0		2/0 to 500 kcmil						2/0 to 500 kcmil						
Type of connectors	Box lug		Box lug		Add-on lug kit						Add-on lug kit						
Control Wiring (12-Pin)																	
Wire sizes in AWG	22–14																
Number of conductors (stranded)	2 (or one AWG 12)																
Torque requirements in lb-in.	3.5																
Solid, stranded or flexible maximum size in mm^2	3.31																
Control Power Requirements																	
Voltage range (24 V ± 10%)	21.6–26.4							—	—	—	21.6–26.4						
Steady state current amperes	1.0										1.4						
Inrush current amperes	10										10						
Ripple	1%										1%						
Relays (1) Class A and C																	
Voltage AC—maximum	240																
Voltage DC—maximum	120																
Amperes—maximum	3																
Environment																	
Temperature—operating	–30°C to 50°C (no derating) consult factory for operation >50°C																
Temperature—storage	–50°C to 70°C																
Altitude	<2000m—consult factory for operation >2000m																
Humidity	<95% noncondensing																
Operating position	Any																
Pollution degree (IEC 947-1)	3																
Impulse withstand voltage (IEC 947-4-1)	4000V																

① U-Frame 500A unit does not have IEC Certification.

S811 Solid-State Reduced Voltage Soft Starters

S811 Soft Starter

General Description

The S811 from Eaton offers all the popular features of the S801, but adds enhanced functionality with the new DIM (Digital Interface Module) and communications capabilities.

The S811 reduced voltage soft starter is very compact, multi-functional, easy to install and easy to program. Designed to control the acceleration and deceleration of three-phase motors up to 690V, the line is available from 11A through 1000A.

The S811 is designed to be a complete package combining the SCRs, bypass contactor and overload in one, very compact unit. The S811 is available as a component for panel mounting, in motor control centers or in enclosed control (NEMA Type 1, 3R, 4, 4X, 7/9 and 12).

Application Description

Designed to control the acceleration and deceleration of three-phase motors, the S811 soft starter uses silicon controlled rectifiers (SCRs) to control the voltage to soft start and soft stop the motor. After the motor is started, internal run bypass contactors close, resulting in the motor running directly across-the-line. The built-in solid-state overload protects the motor from overload conditions with sophisticated algorithms that model true motor heating, resulting in better motor protection and fewer nuisance trips. Advanced protective and diagnostic features reduce downtime.

A voltage ramp start or current limit start is available. Kick start is available in either starting mode. The soft stop option allows for a ramp stop time that is longer than the coast to stop time. The pump control option provides a smooth transition for starting and stopping a motor and eliminating the "water-hammer" effect that can damage pipes, valves and pumps.

The S811 offers an impressive array of advanced protective features. Not only are the protective features selectable, but many offer variable settings allowing the user to fine-tune the starter to meet specific system requirements.

The S811 has an easy to use Digital Interface Module (DIM) that allows the user to configure the device and to read system parameters. The DIM includes an LCD display and keypad to scroll through the various menus. The DIM allows the user to modify control parameters, enable or disable protections, set communication variables, monitor system parameters such as line voltages and currents, and access the fault queue.

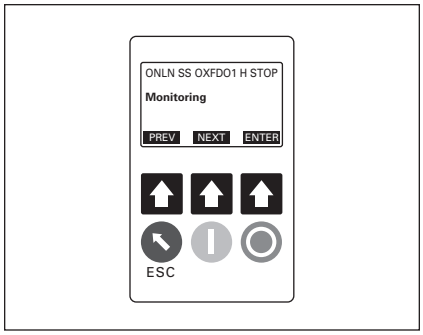


Figure 30.5-2. Digital Interface Module (DIM)

The DIM can be removed from the S811 and remote mounted. Kits are available to door mount the DIM, enabling users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door.

The S811 has built-in communications capabilities that enable the soft starter to be connected to a variety of networks, including DeviceNet™, Ethernet, Modbus® and PROFIBUS. Multiple control components can be connected to one Eaton gateway that concentrates data from the devices into a single node. Configuration is simple—a single press of the gateway's Auto Configuration button sets the system up for default operation. This automatically configures the I/O assemblies to the system devices.

The data from these devices are then assembled into a single input and output messages.

The S811 communication parameters can be configured with the DIM or through the network using CH Studio Component Manager. Advanced communication configuration settings provide the system integrator with powerful tools to facilitate system optimization.

Features and Benefits

- The DIM provides an intuitive, easy-to-use human interface with powerful configuration capabilities to maximize system performance
- Door or device mounted DIM enables users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door
- System operating parameters can be monitored enterprise-wide through a communications network. Increase uptime by providing data for process management and preventive diagnostics
- Run bypass mode greatly reduces internal heating created by the greater power dissipation in the SCRs. Bypass contactor directly connects the motor to the line and improves system efficiency by reducing internal power losses
- Internal solid-state overload protection provides accurate current measurement and trip settings. Sophisticated algorithms solve a series of differential equations that model true motor heating and cooling, resulting in superior motor overload protection while minimizing nuisance trips. Advanced selectable protective features safeguard the motor and system against a variety of system faults
- Internal run bypass contactors and overload protection eliminate the need for additional devices, reducing enclosure sizes, minimizing installation and wiring time and reducing overall assembly size and cost
- Wide range of overload FLA settings (31–100% of rated current) and a selectable trip class (5–30) offers users the flexibility to fine-tune the starter to match specific application requirements

- Variable ramp times and torque control settings provide unlimited starting configurations, allowing for maximum application flexibility
- Kick-start feature enables soft starting of high friction loads
- Soft stop control for applications where an abrupt stop of the load is not acceptable
- Pump control option with sophisticated pump algorithms on both starting and stopping that minimize the pressure surges that cause water hammer. The pump control option will maximize the life of the pump and piping systems while minimizing the downtime caused by system failure
- Six SCRs control all three motor phases, providing smooth acceleration and deceleration performance
- Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings
- Reduce the peak inrush current stress on the power system
- Minimize peak starting torque to diminish mechanical system wear and damage
- 24 Vdc control module enhances personnel and equipment safety.
- Removable, lockable control terminal block reduces maintenance costs. Also provides the opportunity for OEMs to reduce assembly and test costs by using pre-assembled wire harnesses

Protective Features

All protective features can be configured, enabled or disabled with the DIM or through the communications network.

Motor Overload

The S811 includes electronic overload protection as standard. The overload meets applicable requirements for a motor overload protective device. The overload protects the motor from over heat conditions with the use of sophisticated algorithms that model true motor heating, resulting in superior motor protection and fewer nuisance trips.

The S811 calculates a thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur removing power to the motor. Upon trip, the S811 stores the calculated motor heating value and will not allow a motor re-start until the motor has sufficiently cooled. This feature ensures the motor will not be damaged by repeated overload trip, reset and re-start cycles.

The thermal memory value can be monitored through the DIM or the communications network. The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs halting the process. Costly system downtime can be avoided.

The trip current is adjusted to match the specific application requirements by entering the motor nameplate full load current rating and trip class. The FLA adjustment includes a 3 to 1 adjustment range. The overload trip class is adjustable from class 5 through class 30. The overload is ambient temperature compensated—meaning its trip characteristics will not vary with changes in ambient temperature. The overload protection can be enabled, disabled, or disabled on start.

Short Circuit

The use of a short-circuit protective device in coordination with the S811 is required in branch motor circuits by most electrical codes. Short-circuit coordination ratings with both fuses and Eaton's molded case circuit breakers are available providing customers with design flexibility. The S811 has short circuit coordination ratings as an open component, an enclosed starter, and in a motor control center.

Jam

Excessive current and torque up to locked rotor levels can occur in a jam condition. The condition can result in stress and damage to the motor, load, mechanical system, and the electrical distribution system. Jam protection prevents the stress and damage from a jam during normal run. After the motor is started, a current greater than 300% FLA setting will cause the starter to trip on a jam fault.

Stall

Excessive current and torque up to locked rotor levels can occur in a stall condition. The condition can lead to an overload trip and result in stress and damage to the motor, load, mechanical system, and the electrical distribution system. Stall protection prevents stress and damage to a motor that has not come up to speed, or stalled after the soft start time. The S811 will trip to protect the system in the event that the motor did not get to the rated speed in the defined soft start period. A current greater than 200% FLA at the end of the soft start period will cause the starter to trip on a stall fault.

Pole Over Temperature

High ambient temperatures, extended ramp times and high duty cycle conditions may cause the S811 power pole conductors to reach a temperature that exceeds their thermal rating. The S811 is equipped with sensors that monitor the temperature of the power poles. Over temperature protection occurs if the device's thermal capacity is exceeded. The soft starter will trip in over temperature conditions, preventing device failure.

The device pole temperature value can be monitored through the DIM or the communications network. This feature can be of use in determining an impending over temperature trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system shutdown can be avoided.

Phase Loss

Loss of a phase can cause a significant increase in the current drawn in the remaining two phases. Phase loss can lead to motor damage before an eventual overload trip occurs. Phase loss is typically an indication of a failure in the electrical distribution system. The S811 will detect a phase loss and trip if any phase current drops below a preset value. The phase loss trip level is adjustable from 0% to 100% of the average of the other two phase levels with an adjustable trip delay of 0.1 to 60 seconds.

Phase Imbalance

Phase current or voltage imbalance can cause a significant increase in the current drawn in the remaining two phases. Phase imbalance can lead to motor damage before an eventual overload trip. Phase imbalance is typically an indication of a failure in the electrical distribution system or the motor. The S811 will detect both current and voltage phase imbalances and trip if any phase becomes imbalanced as compared to the average of the other two phases.

The phase current imbalance trip level is adjustable from 0% to 100% of the average of the current in the other two phases with an adjustable trip delay of 0.1 to 60 seconds.

The phase voltage imbalance trip level is adjustable from 0% to 100% of the average of the voltage in the other two phases with an adjustable trip delay of 0.1 to 60 seconds.

Reset Mode

The S811 can be set up for automatic or manual reset on trip. The manual reset mode requires the operator to physically press the RESET button located on the soft starter. The overload can be manually reset through the DIM or through the communications network. The overload can also be electrically reset by energizing a 24 Vdc input on the control terminal block.

The automatic reset mode allows the soft starter to be automatically reset as soon as the trip condition is no longer present. With the automatic reset mode, after the fault is no longer present, the motor will be restarted as soon as a valid start signal is present.

Phase Reversal

The S811 can determine if the proper line phase sequence is present by default. The device will trip if the line phase sequence is something other than A-B-C. The S811 can be configured to operate under reversed phase conditions (A-C-B).

Shorted SCR Detection

The S811 monitors the operation of the power poles and will trip under a shorted SCR condition.

Open SCR Detection

The S811 monitors the operation of the power poles and will trip under an open SCR condition.

Low Current

Low current conditions can be a result of a loss of load or a failure in the mechanical system. The S811 has low current protection that will trip if the average rms current falls below a preset value. The low current protection can be programmed as a percent of motor FLA from 0% to 100%.

Low Voltage

Low voltage conditions can result from disturbances in the electrical power distribution system. Low voltage conditions can cause a malfunction and damage to electrical equipment. The S811 has low voltage protection that will trip if the average rms voltage falls below a preset value. The low voltage protection can be programmed as a percent of nominal voltage from 1% to 99% with a trip delay of 0.1 to 60 seconds.

High Voltage

High voltage conditions can result from disturbances in the electrical power distribution system. High voltage conditions can cause malfunctions or failures of electrical equipment. The S811 has high voltage protection that will trip if the average rms voltage is greater than a preset value. The high voltage protection can be programmed as a percent of nominal voltage from 101% to 120% with a trip delay of 0.1 to 60 seconds.

Monitoring Capabilities

The S811 has an impressive array of system monitoring capabilities that allow users to access real time process and diagnostic data. This data can be viewed at the device with the DIM or through a communications network. Data over a communications network can provide valuable insight into the condition of the equipment and processes. Maintenance and production personnel can monitor critical operational and maintenance data from a central control station that can be located far away from the production facility. Process data can be monitored to determine system anomalies that may indicate a need for preventive maintenance or an impeding failure. Adjustments made through the communications network can reduce costs by minimizing the time traveling to the location where the motor controls are located. When faults do occur, real time fault data can assist maintenance in troubleshooting and planning repair resources. Remote reset signals can be given to tripped devices without the need for manual intervention by maintenance personnel.

Average Line Current

Provides the average of the three-phase rms line currents in amps, accurate to within 2%. Current data can be used to indicate a need for maintenance. Increased currents in a fixed load application can indicate a reduction in system efficiencies and performance, signifying system maintenance is due.

Average Pole Current

Provides the average of the three-phase rms pole currents in amps, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications, and will differ in inside-the-delta applications.

Average line current as a % FLA

Provides the average rms line current as a percentage of the S811 FLA setting.

Three-Phase Line Currents

Provides three rms phase line currents in amps, accurate to within 2%. Imbalances or changes in the relative phase current to one another can indicate anomalies in the motor or electrical distribution system.

Three-Phase Pole Currents

Provides three rms phase pole currents in amps, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications, and will differ in inside-the-delta applications.

Three-Phase Line Voltages

Provides the individual rms three-phase line voltages. Imbalances or changes in the relative phase voltage to one another can indicate anomalies in the motor or electrical distribution system. Voltage can be used to monitor electrical distribution system performance. Warnings, alarms and system actions to low or high voltage conditions can be implemented.

Percent Thermal Memory

Provides the real time calculated thermal memory value. The S811 calculates thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur, removing power to the motor.

The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system downtime can be avoided.

DC Control Voltage

Monitors level of the 24 Vdc control voltage. Fluctuations in control voltage can cause component malfunction and failure. System control voltage data can be used to implement warnings, alarms and system actions to low or high voltage conditions.

Pole Temperature

Increases in pole temperature are caused by increases in ambient temperature, start/stop times and start duty cycles. Changes in pole temperatures represent a change in system operating conditions. Identifying unexpected operating conditions or changes can prompt maintenance and aid in process evaluation activities.

Device Temperature

An increase in device temperature is a strong indication of an increase in ambient temperature. High ambient temperature operation can be identified with the device temperature data. Ambient temperature increases can be due to loss of enclosure cooling fans or blocked venting. High ambient temperatures will reduce the life of all electrical equipment in the enclosure.

Start Count

Start count data can be used to monitor system output, schedule preventative maintenance, identify system anomalies and identify changes in system operation.

Diagnostics

Fault Queue

Current fault and a fault queue containing the last nine system faults can be read through the DIM or communications network. Fault identification can minimize troubleshooting time and cost. The fault queue can be remotely accessed through a communications network to assist in planning maintenance resources. Thirty different faults can be identified by the S811.

Control Status

The S811 provides data that represents system conditions that can be read through the DIM or the communications network. This data identifies the status of the system and the control commands the system is requesting of the S811. This can be used for advanced troubleshooting and system integration activities.

Breaker Status

The S811 has provisions to read and display circuit breaker status. Eaton communicating cover control or other communicating protective device is required to take advantage of this feature.

User Manual

A comprehensive user manual is available and can be downloaded free of charge from **www.eaton.com/electrical** by performing a document search for MN03902002E.

Accessories

Surge Suppressors

A surge suppressor can mount on either the line or load side of the S811 soft starter. It is designed to clip the line voltage (or load side induced voltage).

Surge Suppressor

Surge Suppressor Mounted on a 200 mm Device

Table 30.5-12. Surge Suppressors

Description	Catalog Number
600V MOV for 65 mm and 110 mm units	**EMS38**
600V MOV for 200 mm and 290 mm units	**EMS39**
690V MOV for 200 mm and 290 mm units	**EMS41**

Catalog Numbering System

Table 30.5-13. S811 Open Soft Starters Catalog Numbering System

S 811 T 30 N 3 S

S = Soft starter

811 = Non-combination Soft Starter

Frame Size
- **N** = 65 mm
- **R** = 110 mm
- **T** = 200 mm
- **U** = 200 mm
- **V** = 290 mm

Ampacity Rating

37 = 37A	**36** = 360A
66 = 66A	**42** = 420A
10 = 105A	**50** = 500A ①
13 = 135A	**65** = 650A
18 = 180A	**72** = 720A
24 = 240A	**85** = 850A
30 = 304A	**10** = 1000A

N = No options
P = Pump control
V = 690V option (Frame T18 through V85) ②

3 = Three-pole device

S = Standard soft starter (configurable for edge or level control)
D = Inside-the-delta
L = Extended ramp start
W = Without DIM

① U-Frame 500A unit does not have IEC Certification.
② Not available in U-Frame.

Operation

Starting and Stopping Modes

The S811 has a variety of starting and stopping methods to provide superior performance in the most demanding applications. The motor can be started in either Voltage Ramp Start or Current Limit Start mode. Kick Start and Soft Stop are available within both starting modes.

Voltage Ramp Start

Provides a voltage ramp to the motor resulting in a constant torque increase. The most commonly used form of soft start, this start mode allows you to set the initial torque value and the duration of the ramp to full voltage conditions. Bypass contactors close after ramp time.

- Adjustable initial torque 0–85% of locked rotor torque
- Adjustable ramp time 0.5–180 seconds (can be extended with factory modification)

Current Limit Start

Limits the maximum current available to the motor during the start phase. This mode of soft starting is used when it becomes necessary to limit the maximum starting current due to long start times or to protect the motor. This start mode allows you to set the maximum starting current as a percentage of locked rotor current and the duration of the current limit. Bypass contactors close after current limit time.

- Maximum current of 0–85% locked rotor current
- Adjustable ramp time 0.5–180 seconds (can be extended with factory modification)

Kick Start

Selectable feature in both Voltage Ramp Start and Current Limit Start modes. Provides a current and torque "kick" for 0 to 2.0 seconds. This provides greater initial current to develop additional torque to break-away a high friction load.

- 0–85% of locked rotor torque
- 0–2.0 seconds duration

Soft Stop

Allows for a controlled stopping of a load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or load damage.

- Stop time = 0–60 seconds

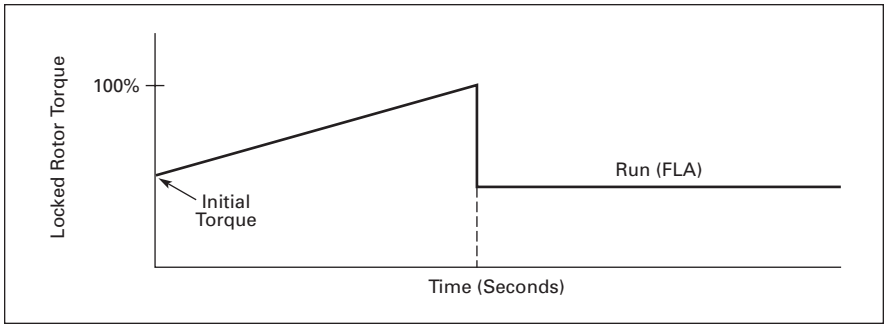


Figure 30.5-3. Starting Characteristics—Ramp Start

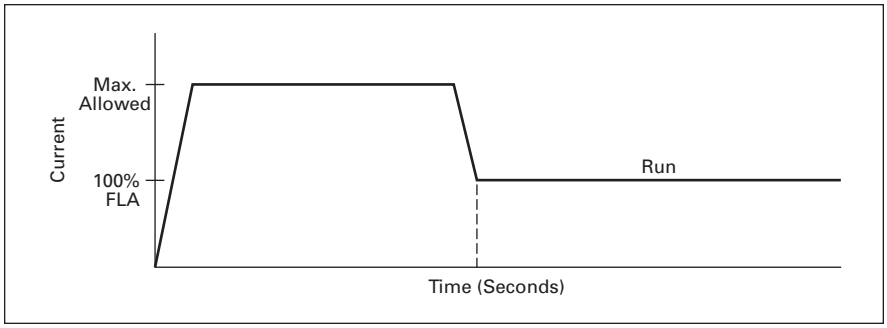


Figure 30.5-4. Starting Characteristics—Current Limit Start

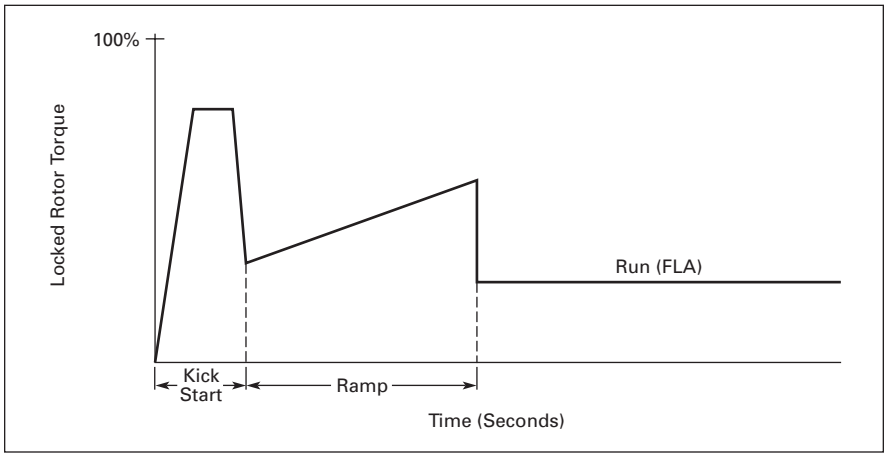


Figure 30.5-5. Starting Characteristics—Kick Start

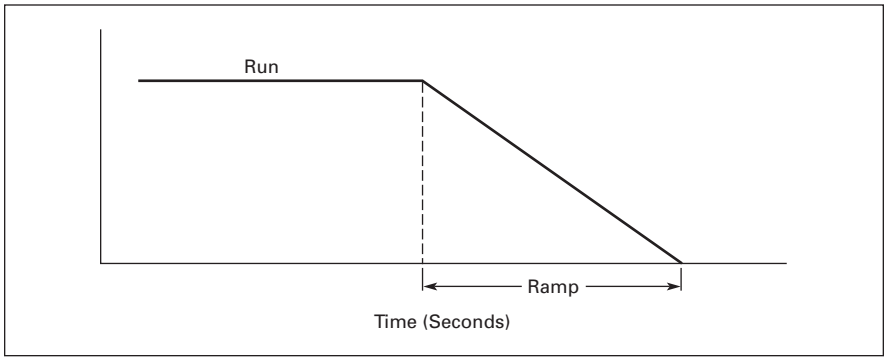


Figure 30.5-6. Starting Characteristics—Soft Stop

Product Selection

Motor applications and customer needs come in many different varieties. With the standard and severe duty rating tables, we have attempted to provide guidelines on what the S811 soft starter is capable of. If the application falls under these categories, you can use these charts. For other applications, or when a question arises, consult with your local Eaton Representative or call our Technical Resource Center at (877) ETN-CARE.

Table 30.5-14. Standard-Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft start	300%	30 sec.	3	50°C
vs. Full voltage	500%	10 sec.	3	50°C
vs. Wye-delta	350%	20 sec.	3	50°C
vs. 80% RVAT	480%	20 sec.	2	50°C
vs. 65% RVAT	390%	20 sec.	3	50°C
vs. 50% RVAT	300%	20 sec.	4	50°C

Table 30.5-15. Product Selection—Standard-Duty Rating Open Soft Starters

Frame Size	Max. Current	Three-Phase Motor											Catalog Number
		kW Rating (50 Hertz)			hp Rating (60 Hertz)								
		230	380–400	440	200V		230V		460V		575V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	37	10	18.5	18.5	10	10	10	10	25	20	30	30	**S811N37N3S**
	66	18.5	30	37	20	15	20	20	50	40	60	50	**S811N66N3S**
R	105	30	55	59	30	25	40	30	75	60	100	75	**S811R10N3S**
	135	40	63	80	40	30	50	40	100	75	125	100	**S811R13N3S**
T	180	51	90	110	60	50	60	60	150	125	150	150	**S811T18N3S**
	240	75	110	147	75	60	75	75	200	150	200	200	**S811T24N3S**
	304	90	160	185	100	75	100	100	250	200	300	250	**S811T30N3S**
U	360	110	185	220	125	100	150	125	300	250	350	300	**S811U36N3S**
	420	120	220	257	150	125	175	150	350	300	450	350	**S811U42N3S**
	500	150	257	300	150	150	200	150	400	350	500	450	**S811U50N3S** ①
V	360	110	185	220	125	100	150	125	300	250	350	300	**S811V36N3S**
	420	129	220	257	150	125	175	150	350	300	450	350	**S811V42N3S**
	500	150	257	300	150	150	200	150	400	350	500	450	**S811V50N3S**
	650	200	355	425	250	200	250	200	500	450	600	500	**S811V65N3S**
	720	220	400	450	—	—	300	250	600	500	700	600	**S811V72N3S**
	850	257	475	500	—	—	350	300	700	600	900	700	**S811V85N3S**
	1000	315	560	600	—	—	400	350	800	700	1000	800	**S811V10N3S**

① 500A rating does not have IEC Certification.

Table 30.5-16. Severe-Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft start	450%	30 sec.	4	50°C
vs. Full voltage	500%	10 sec.	10	50°C
vs. Wye-delta	350%	65 sec.	3	50°C
vs. 80% RVAT	480%	25 sec.	4	50°C
vs. 65% RVAT	390%	40 sec.	4	50°C
vs. 50% RVAT	300%	60 sec.	4	50°C

Table 30.5-17. Product Selection—Severe-Duty Rating Open Soft Starters

Frame Size	Maximum Current	Three-Phase Motor											Catalog Number
		kW Rating (50 Hertz)			hp Rating (60 Hertz)								
		230	380–400	440	200V		230V		460V		575V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	22 42	5.5 11	10 18.5	11 22	5 10	5 10	7-1/2 15	5 10	15 30	10 25	20 40	15 30	**S811N37N3S** **S811N66N3S**
R	65 80	15 22	30 40	33 45	15 25	15 20	20 30	15 25	50 60	40 50	50 75	50 60	**S811R10N3S** **S811R13N3S**
T	115 150 192	33 45 55	59 80 100	63 90 110	30 50 60	30 40 50	40 50 75	30 50 60	75 100 150	75 100 125	100 150 200	100 125 150	**S811T18N3S** **S811T24N3S** **S811T30N3S**
U	240 305	75 90	110 160	147 185	75 100	60 75	75 100	75 100	200 250	150 200	200 300	200 250	**S811U36N3S** **S811U42N3S**
V	240 305 365 420 480 525 600	75 90 110 129 147 160 185	110 160 185 220 257 280 315	147 185 220 257 295 335 375	75 100 125 150 150 150 200	60 75 100 125 150 150 150	75 100 150 150 200 200 250	75 100 125 150 150 150 200	200 250 300 350 400 450 500	150 200 250 300 350 350 450	200 300 350 450 500 500 600	200 250 300 350 450 450 500	**S811V36N3S** **S811V42N3S** **S811V50N3S** **S811V65N3S** **S811V72N3S** **S811V85N3S** **S811V10N3S**

Technical Data and Specifications

Table 30.5-18. Specifications—S811 Soft Starter

Soft Starter (Partial Catalog Number)	S811 N37	S811 N66	S811 R10	S811 R13	S811 T18	S811 T24	S811 T30	S811 U36	S811 U42	S811 U50 ①	S811 V36	S811 V42	S811 V50	S811 V65	S811 V72	S811 V85	S811 V10 ②
Maximum current capacity	37	66	105	135	180	240	304	360	420	500	360	420	500	650	720	850	1000
FLA range	11–37	20–66	32–105	42–135	56–180	75–240	95–304	112–360	131 – 420	156 – 500	112 – 360	131–420	156–500	203–650	225–720	265–580	320–1000
Dimensions																	
Width in inches (mm)	2.66 (67.6)		4.42 (112.2)		7.67 (194.8)			7.73 (196.3)			11.05 (280.6)						
Height in inches (mm)	7.38 (187.4)		7.92 (201.2)		12.71 (322.9)			12.72 (323.1)			16.57 (420.8)						
Depth in inches (mm)	6.48 (164.5)		6.64 (168.7)		6.39 (162.4)			7.08 (179.9)			7.35 (186.6)						
Weight in lbs (kg)	5.80 (2.6)		10.50 (4.8)		48.00 (21.8) with lugs 41.00 (18.6) without lugs			48.00 (21.8) with lugs 41.00 (18.6) without lugs			103.00 (46.8) with lugs 91.00 (41.4) without lugs						
General Information																	
Bypass mechanical lifespan	10 million																
Insulating voltage Ui	660V																
Ramp time range	0.5–180 seconds (0.5–360 seconds extended ramp)																
Resistance to vibration	3g																
Resistance to shock	15g																
Electrical Information																	
Operating voltage	200–600V																
Operating frequency	47–63 Hz																
Overload setting	30–100%																
Trip class	5, 10, 20 and 30																
Cabling Capacity (IEC 947)																	
Number of conductors	One		One		One or two			—	—	—	Two, four or six						
Wire sizes	14–2		14–4/0		4 AWG to 500 kcmil			—	—	—	2/0 to 500 kcmil						
Type of connectors	Box lug				Add-on lug kit												
Control Wiring (12-Pin)																	
Wire sizes in AWG	22–14																
Number of conductors (stranded)	Two (or one AWG 12)																
Torque requirements in lb-in	3.5																
Solid, stranded or flexible maximum size in mm^2	3.31																
Control Power Requirements																	
Voltage range (24V ± 10%)	21.6–26.4																
Steady state current amps	1.0		1.0		1.0			—	—	—	1.4						
Inrush current amps	10		10		10			—	—	—	10						
Ripple	1%																
Relays (1) Class A and C																	
Voltage AC—maximum	240																
Voltage DC—maximum	120																
Amperes—maximum	3																
Environment																	
Temperature—operating	–30 to +50°C (no derating) consult factory for operation > +50°C																
Temperature—storage	–50 to +70°C																
Altitude	<2000m—consult factory for operation > 2000m																
Humidity	<95% noncondensing																
Operating position	Any																
Pollution degree IEC 947-1	3																
Impulse withstand voltage IEC 947-4-1	6000V																

① U-Frame 500A unit does not have IEC Certification.
② UR Recognized Product.

S611 Solid-State Reduced Voltage Soft Starter

S611 Solid-State Soft Starter

General Description

Eaton revolutionized the reduced voltage control marketplace with its advanced feature set and user-friendly user interface module to enhance system performance and to reduce commissioning times. The S611 adds enhanced functionality with network communications, metering, monitoring and diagnostics capabilities.

The Eaton line of S611 reduced voltage soft starters is multi-functional, easy to install and easy to program. Designed to control the acceleration and deceleration of three-phase motors up to 600V, the line is available from 26 to 414A.

The S611 is designed to be a complete package, combining the SCRs, bypass contactor and overload in one compact unit.

Application Description

Designed to control the acceleration and deceleration of three-phase motors, the S611 soft starter uses silicon controlled rectifiers (SCRs) to control the voltage to soft start and soft stop the motor. After the motor is started, internal run bypass contactors close, resulting in the motor running directly across-the-line. The built-in solid-state overload protects the motor from overload conditions with sophisticated algorithms that model true motor heating, resulting in better motor protection and fewer nuisance trips. Advanced protective and diagnostic features reduce downtime.

A voltage ramp start or current limit start is available. Kick start is available in either starting mode. The soft stop option allows for a ramp stop time that is longer than the coast to stop time.

The pump control option provides a smooth transition for starting and stopping a motor and for eliminating the "water-hammer" effect that can damage pipes, valves and pumps.

The S611 offers an impressive array of advanced protective features. Not only are the protective features selectable, but many offer variable settings allowing the user to fine-tune the starter to meet specific system requirements.

The S611 has an easy-to-use user interface module (UI) that allows the user to configure the device and to read system parameters. The UI includes an LED display and a keypad to scroll through the various parameters. The UI allows the user to modify control parameters, enable or disable protections, set communication variables, monitor system parameters such as line voltages and currents, and access the fault queue.

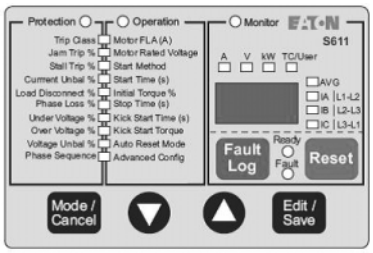


Figure 30.5-7. User Interface

The UI can be removed from the S611 and be remote mounted. Kits are available to door mount the UI, enabling users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door. This will help eliminate the possibility of an arc flash incident.

Communications

The S611 has built-in communication capabilities through two communications ports to connect the soft starter to a variety of networks, including Modbus (native), DeviceNet™ and PROFIBUS.

The S611 communication parameters can be configured with the UI. Advanced communication configuration settings provide the system integrator with powerful tools to facilitate system optimization.

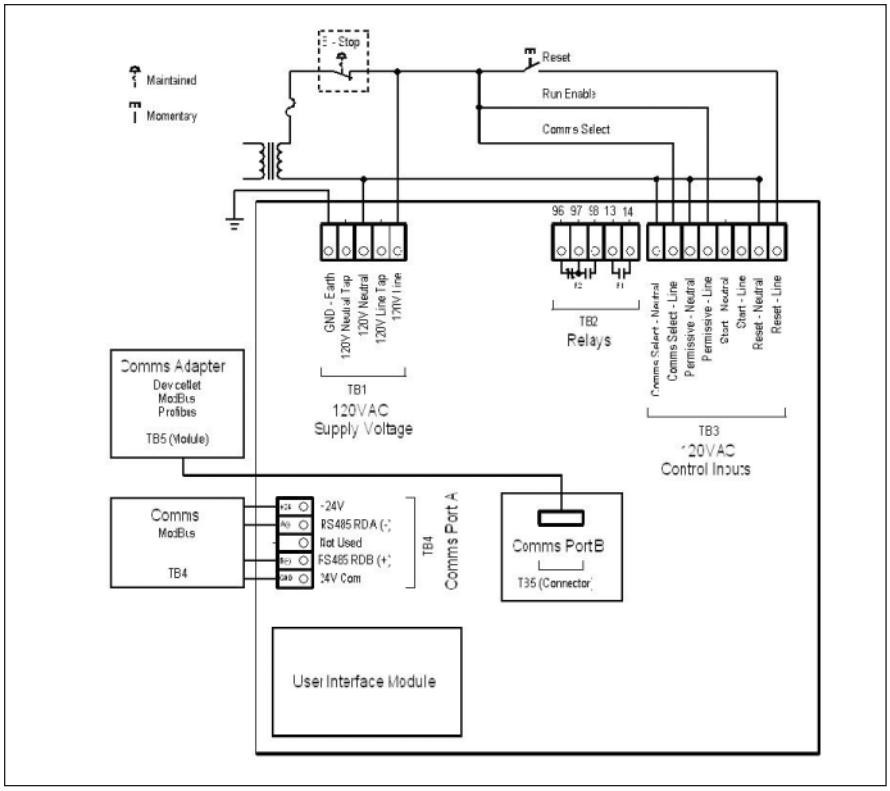


Figure 30.5-8. Control Wiring Diagram

Table 30.5-19. Network Communications Reference

Description	Style Number	Catalog Number
Modbus communication adapter without I/O	3-2372-001A	**C441M**
Modbus communication adapter with 120 Vac I/O	3-2372-003B	**C441N**
Modbus communication adapter with 24 Vdc I/O	3-2372-004B	**C441P**
DeviceNet communication adapter with 120 Vac I/O	3-2372-001B	**C441K**
DeviceNet communication adapter with 24 Vdc I/O	3-2372-002B	**C441L**
PROFIBUS communication adapter with 120 Vac I/O	3-2398-001B	**C441S**
PROFIBUS communication adapter with 24 Vdc I/O	3-2398-002B	**C441Q**

Features and Benefits

- The UI (user interface module) provides an intuitive, easy-to-use human interface with powerful configuration capabilities to maximize system performance
- Door or device mounted UI enables users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door, eliminating the possibility of an arc flash incident
- System operating parameters can be monitored enterprise-wide through a communications network. Increase uptime by providing data for process management and preventive diagnostics
- Run Bypass mode greatly reduces internal heating created by the greater power dissipation in the SCRs. Bypass contactor directly connects the motor to the line and improves system efficiency by reducing internal power losses
- Internal solid-state overload protection provides accurate current measurement and trip settings. Sophisticated algorithms solve a series of differential equations that model true motor heating and cooling, resulting in superior motor overload protection while minimizing nuisance trips. Advanced selectable protective features safeguard the motor and system against a variety of system faults
- Internal run bypass contactors and overload protection eliminate the need for additional devices, reducing enclosure sizes, minimizing installation and wiring time, and reducing overall assembly size and cost
- Wide range of overload FLA settings (50–100% of rated frame current) and a selectable trip class (5–30) offers users the flexibility to fine-tune the starter to match specific application requirements
- Variable ramp times and torque control settings provide unlimited starting configurations, allowing for maximum application flexibility
- Kick-start feature enables soft starting of high friction loads
- Soft stop control for applications where an abrupt stop of the load is not acceptable
- Pump control option with sophisticated pump algorithms on both starting and stopping that minimize the pressure surges that cause water hammer. The pump control option will maximize the life of the pump and piping systems while minimizing the downtime caused by system failure
- Six SCRs control all three motor phases, providing smooth acceleration and deceleration performance
- Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings
- Reduce the peak inrush current's stress on the power system
- Minimize peak starting torque to diminish mechanical system wear and damage
- 120 Vac control voltage enhances ease of connections

Protective Features

All protective features can be configured, enabled or disabled with the UI or through the communications network.

Motor Overload

The S611 includes electronic overload protection as standard. The overload meets applicable requirements for a motor overload protective device. The overload protects the motor from overheat conditions with the use of sophisticated algorithms that model true motor heating, resulting in superior motor protection and fewer nuisance trips.

The S611 calculates a thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur removing power to the motor. Upon trip, the S611 stores the calculated motor heating value and will not allow a motor re-start until the motor has sufficiently cooled. This feature ensures the motor will not be damaged by repeated overload trip, reset and re-start cycles.

The thermal memory value can be monitored through the UI or the communications network. The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs halting the process. Costly system downtime can be avoided.

The trip current is adjusted to match the specific application requirements by entering the motor nameplate full load current rating and trip class. The FLA adjustment includes a 2 to 1 adjustment range. The overload trip class is adjustable from class 5 through class 30. The overload is ambient temperature compensated—meaning its trip characteristics will not vary with changes in ambient temperature. The overload protection can be enabled, disabled, or disabled on start.

Short Circuit

The use of a short-circuit protective device in coordination with the S611 is required in branch motor circuits by most electrical codes. Short-circuit coordination ratings with both fuses and Eaton molded-case circuit breakers are available providing customers with design flexibility. The S611 has short-circuit coordination ratings as an open component, an enclosed starter, and in a motor control center.

Jam

Excessive current and torque up to locked rotor levels can occur in a jam condition. The condition can result in stress and damage to the motor, load, mechanical system and the electrical distribution system. Jam protection prevents the stress and damage from a jam during normal run. After the motor is started, a current greater than 300% FLA setting will cause the starter to trip on a jam fault.

Stall

Excessive current and torque up to locked rotor levels can occur in a stall condition. The condition can lead to an overload trip and can result in stress and damage to the motor, load, mechanical system and the electrical distribution system. Stall protection prevents stress and damage to a motor that has not come up to speed, or stalled after the soft start time. The S611 will trip to protect the system in the event that the motor did not get to the rated speed in the defined soft start period. A current greater than 200% FLA at the end of the soft start period will cause the starter to trip on a stall fault.

Pole Over Temperature

High ambient temperatures, extended ramp times and high duty cycle conditions may cause the S611 power pole conductors to reach a temperature that exceeds their thermal rating. The S611 is equipped with sensors that monitor the temperature of the power poles. Overtemperature protection occurs if the device's thermal capacity is exceeded. The soft starter will trip in overtemperature conditions, preventing device failure.

The device pole temperature value can be monitored through the UI or the communications network. This feature can be of use in determining an impending overtemperature trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system shutdown can be avoided.

Phase Loss

Loss of a phase can cause a significant increase in the current drawn in the remaining two phases. Phase loss can lead to motor damage before an eventual overload trip occurs. Phase loss is typically an indication of a failure in the electrical distribution system. The S611 will detect a phase loss and trip if any phase current drops below a preset value. The phase loss trip level is adjustable from 0% to 100% of the average of the other two phase levels with an adjustable trip delay of 0.1–60 seconds.

Phase Imbalance

Phase current or voltage imbalance can cause a significant increase in the current drawn in the remaining two phases. Phase imbalance can lead to motor damage before an eventual overload trip. Phase imbalance is typically an indication of a failure in the electrical distribution system or the motor. The S611 will detect both current and voltage phase imbalances and trip if any phase becomes imbalanced as compared to the average of the other two phases.

The phase current imbalance trip level is adjustable from 0% to 100% of the average of the current in the other two phases with an adjustable trip delay of 0.1–60 seconds.

The phase voltage imbalance trip level is adjustable from 0% to 100% of the average of the voltage in the other two phases with an adjustable trip delay of 0.1–60 seconds.

Reset Mode

The S611 can be set up for automatic or manual reset on trip. The manual reset mode requires the operator to physically press the RESET button located on the soft starter. The overload can be manually reset through the UI or through the communications network.

The automatic reset mode allows the soft starter to be automatically reset as soon as the trip condition is no longer present. With the automatic reset mode, after the fault is no longer present, the motor will be restarted as soon as a valid start signal is present.

Phase Reversal

The S611 can determine if the proper line phase sequence is present by default. The device will trip if the line phase sequence is something other than A-B-C. The S611 can be configured to operate under reversed phase conditions (A-C-B).

Shorted SCR Detection

The S611 monitors the operation of the power poles and will trip under a shorted SCR condition.

Open SCR Detection

The S611 monitors the operation of the power poles and will trip under an open SCR condition.

Low Current

Low current conditions can be a result of a loss of load or a failure in the mechanical system. The S611 has low current protection that will trip if the average rms current falls below a preset value. The low current protection can be programmed as a percent of motor FLA from 0% to 100%.

Low Voltage

Low voltage conditions can result from disturbances in the electrical power distribution system. Low voltage conditions can cause a malfunction and damage to electrical equipment. The S611 has low voltage protection that will trip if the average rms voltage falls below a preset value. The low voltage protection can be programmed as a percent of nominal voltage from 1% to 99% with a trip delay of 0.1–60 seconds.

High Voltage

High voltage conditions can result from disturbances in the electrical power distribution system. High voltage conditions can cause malfunctions or failures of electrical equipment. The S611 has high voltage protection that will trip if the average rms voltage is greater than a preset value. The high voltage protection can be programmed as a percent of nominal voltage from 101% to 120% with a trip delay of 0.1–60 seconds.

Monitoring Capabilities

The S611 has an impressive array of system monitoring capabilities that allow users to access real-time process and diagnostic data. This data can be viewed at the device with the UI or through a communications network. Data over a communications network can provide valuable insight into the condition of the equipment and processes. Maintenance and production personnel can monitor critical operational and maintenance data from a central control station that can be located far away from the production facility. Process data can be monitored to determine system anomalies that may indicate a need for preventive maintenance or an impeding failure.

Adjustments made through the communications network can reduce costs by minimizing the time traveling to the location where the motor controls are located. When faults do occur, real-time fault data can assist maintenance in troubleshooting and planning repair resources. Remote reset signals can be given to tripped devices without the need for manual intervention by maintenance personnel.

Average Line Current

Provides the average of the three phase rms line currents in amperes, accurate to within 2%. Current data can be used to indicate a need for maintenance. Increased currents in a fixed load application can indicate a reduction in system efficiencies and performance, signifying system maintenance is due.

Average Pole Current

Provides the average of the three-phase rms pole currents in amperes, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications, and will differ in inside-the-delta applications.

Average Line Current as a % FLA

Provides the average rms line current as a percentage of the S611 FLA setting.

Three-Phase Line Currents

Provides three rms phase line currents in amperes, accurate to within 2%. Imbalances or changes in the relative phase current to one another can indicate anomalies in the motor or the electrical distribution system.

Three-Phase Pole Currents

Provides three rms phase pole currents in amperes, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications.

Three-Phase Line Voltages

Provides the individual rms three-phase line voltages. Imbalances or changes in the relative phase voltage to one another can indicate anomalies in the motor or the electrical distribution system. Voltage can be used to monitor electrical distribution system performance.

Warnings, alarms and system actions to low or high voltage conditions can be implemented.

Percent Thermal Memory

Provides the real-time calculated thermal memory value. The S611 calculates thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur, removing power to the motor.

The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system downtime can be avoided.

Pole Temperature

Increases in pole temperature are caused by increases in ambient temperature, start/stop times and start duty cycles. Changes in pole temperatures represent a change in system operating conditions. Identifying unexpected operating conditions or changes can prompt maintenance and aid in process evaluation activities.

Power Monitoring

S611 does monitor the power and it can be displayed on the UI.

Diagnostics

Fault Queue

Current fault and a fault queue containing the last nine system faults can be read through the UI or the communications network. Fault identification can minimize trouble-shooting time and cost, and prevent arc flash incidents. The fault queue can be remotely accessed through a communications network to assist in planning maintenance resources. 30 different faults can be identified by the S611.

Control Status

The S611 provides data that represents system conditions that can be read through the UI or the communications network. This data identifies the status of the system and the control commands the system is requesting of the S611. This can be used for advanced troubleshooting and system integration activities.

Operation

Starting and Stopping Modes

The S611 has a variety of starting and stopping methods to provide superior performance in the most demanding applications. The motor can be started in either Voltage Ramp Start or Current Limit Start mode. Kick Start and Soft Stop are available within both starting modes.

Voltage Ramp Start

Provides a voltage ramp to the motor resulting in a constant torque increase. The most commonly used form of soft start, this start mode allows you to set the initial torque value and the duration of the ramp to full voltage conditions. Bypass contactors close after ramp time.

- Adjustable initial torque 0–85% of locked rotor torque
- Adjustable ramp time 0.5–180 seconds (can be extended with factory modification)

Current Limit Start

Limits the maximum current available to the motor during the start phase. This mode of soft starting is used when it becomes necessary to limit the maximum starting current due to long start times or to protect the motor. This start mode allows you to set the maximum starting current as a percentage of locked rotor current and the duration of the current limit. Bypass contactors close after current limit time.

- Maximum current of 0–85% locked rotor current
- Adjustable ramp time 0.5–180 seconds (can be extended with factory modification)

Kick Start

Selectable feature in both Voltage Ramp Start and Current Limit Start modes. Provides a current and torque "kick" for 0–2.0 seconds. This provides greater initial current to develop additional torque to break-away a high friction load.

- 0–85% of locked rotor torque
- 0–2.0 seconds duration

Soft Stop

Allows for a controlled stopping of a load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or load damage.

- Stop time = 0–60 seconds

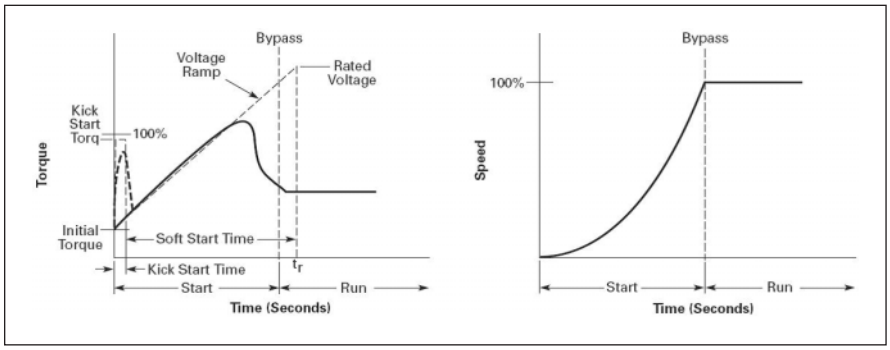


Figure 30.5-9. Ramp Start

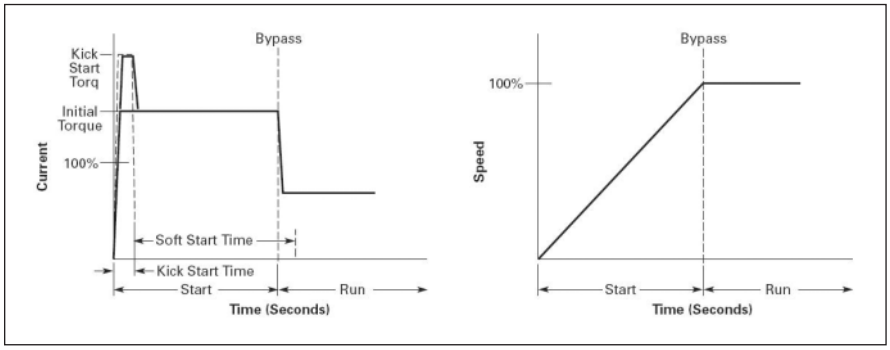


Figure 30.5-10. Current Limit Start

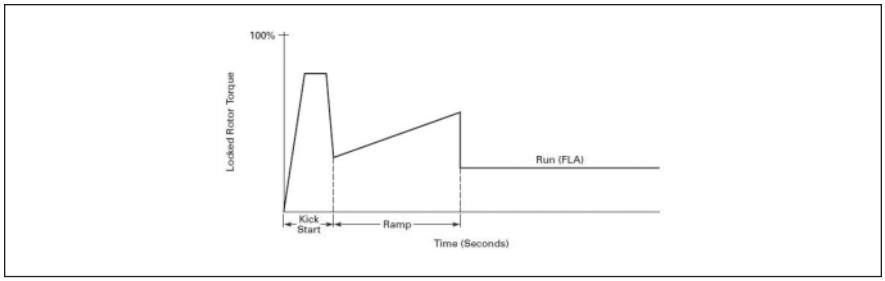


Figure 30.5-11. Kick Start Graphic

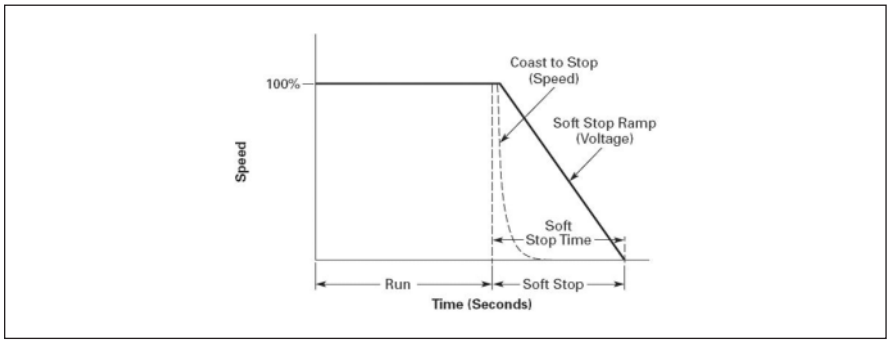


Figure 30.5-12. Stop Ramp Graphic

Edge and Level Sensing Control

Edge or level sensing is selected with the Start Control parameter in the Advanced Configuration Menu. Factory default is level sensing.

Edge Sensing

Edge sensing requires 120 Vac power be momentarily applied to the Start terminal (with the Permissive terminal 120 Vac) to initiate a start under all conditions. After a stop or fault occurs, the 120 Vac must be removed, then reapplied to pin 1 before another start can occur. This control configuration should be used when restarting of the motor after a fault or stop must be supervised manually or as a part of a control scheme. The cycling of 120 Vac power to the Permissive terminal before starting is required regardless of the position of the auto reset parameter.

Level Sensing

Level sensing will enable a motor to restart after a fault is cleared without cycling 120 Vac to the Permissive terminal as long as:

- Permissive terminal is supplied with 120 Vac
- The auto reset parameter is set to enabled
- All faults have cleared or have been reset

This control configuration should be used where it is desirable to restart a motor after a fault without additional manual or automatic control. An example of this condition would be on a remote pumping station where it is desirable to automatically restart a pump after a power outage without operator intervention.

If the auto reset feature is used, CAUTION must be exercised to ensure that any restart occurs in a safe manner.

Product Selection

Motor applications and customer needs come in many different varieties. The standard and severe-duty rating tables provide guidelines on what the soft starter is capable of. If the application falls under these categories, use these charts. For other applications, or when a question arises, consult a local Eaton Representative or call the Eaton Technical Resource Center.

Table 30.5-20. S611 Horsepower Ratings—300% FLA at 15 Seconds at 50°C

Maximum Current Amperes	60 Hz								Catalog Number
	200V		230V		460V		575–600V		
	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	
52	15	10	15	15	40	30	50	40	S611A052N3S
65	20	15	20	20	50	40	60	50	S611A065N3S
77	20	20	25	20	60	50	75	60	S611A077N3S
99	30	25	30	30	75	60	100	75	S611B099N3S
125	40	30	40	40	100	75	125	100	S611B125N3S
156	50	40	60	50	125	100	150	125	S611C156N3S
180	60	50	60	60	150	125	150	150	S611C180N3S
242	75	60	75	75	200	150	250	200	S611D242N3S
302	100	75	100	100	250	200	350	250	S611E302N3S
361	125	100	150	125	300	250	350	300	S611E361N3S
414	150	125	N/A	150	350	250	450	350	S611F414N3S

Options

30

Pump Control

For pump control option, change the 9th digit in the Catalog Number to P.

Table 30.5-21. S611 Horsepower Ratings—Pump Control Option

Maximum Current Amperes	60 Hz								Catalog Number
	200V		230V		460V		575–600V		
	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	1.0 SF	1.15 SV	
52	15	10	15	15	40	30	50	40	S611A052P3S
65	20	15	20	20	50	40	60	50	S611A065P3S
77	20	20	25	20	60	50	75	60	S611A077P3S
99	30	25	30	30	75	60	100	75	S611B099P3S
125	40	30	40	40	100	75	125	100	S611B125P3S
156	50	40	60	50	125	100	150	125	S611C156P3S
180	60	50	60	60	150	125	150	150	S611C180P3S
242	75	60	75	75	200	150	250	200	S611D242P3S
302	100	75	100	100	250	200	350	250	S611E302P3S
361	125	100	150	125	300	250	350	300	S611E361P3S
414	150	125	N/A	150	350	250	450	350	S611F414P3S

Standards and Certifications

- IEC 60947-4-2
- UL listed
- CSA certified (3211 06)

Technical Data and Specifications

Table 30.5-22. Specifications—S611 Solid-State Soft Starter

Soft Starter (Partial Catalog Number)	S611A052	S611A065	S611A072	S611B099	S611B125	S611C156	S611C180	S611D242	S611E302	S611E361	S611F414
Maximum current capacity	52	65	77	99	125	156	180	242	302	361	414
FLA range	26–52	32.5–65	38.5–77	48–99	62.5–125	78–156	90–180	120–242	151–302	180.5–361	207–414
Dimensions—Inches (mm)											
Width	11.58 (294.1)			11.58 (294.1)		11.58 (294.1)		11.58 (294.1)	17.56 (446.0)		17.56 (446.0)
Height	19.45 (494.0)			19.45 (494.0)		20.83 (529.1)		20.83 (529.1)	31.15 (791.2)		31.15 (791.2)
Depth	7.46 (189.5)			7.46 (189.5)		8.37 (212.6)		8.37 (212.6)	9.54 (242.3)		9.54 (242.3)
Weight in lbs (kg)	24 (11)			24 (11)		33 (15)		38 (15)	86 (39)		102 (46)
General Information											
Bypass mechanical lifespan	10 million										
Insulating voltage	660V										
Ramp time range	0.5–180 seconds										
Resistance to vibration	1g										
Resistance to shock	Meets ITSA standards										
Electrical Information											
Operating voltage	130–600V										
Operating frequency	47–63 Hz										
Overload setting (frame)	50–100% FLA										
Trip class	5, 10, 20 and 30										
Cabling Capacity (IEC 947)											
Number of conductors	One	One	One	One	One	One	One	One	Two	Two	Two
Wire sizes	14–2/0	14–2/0	14–2/0	14–2/0	2–600 kcmil	2–600 kcmil	2–600 kcmil	2–600 kcmil	2–600 kcmil	2–600 kcmil	2–600 kcmil
Type of connectors	Lug										
Control Wiring											
Wire sizes in AWG	22–12										
Number of conductors	Two (or one 12–14 AWG)										
Torque requirements	3.5 lb-in										
Maximum size	12 AWG										
Control Power Requirements											
Voltage range (24V ±10%)	108–132										
Steady-state current amperes	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.75	0.75	0.75	—
Inrush current amperes	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	—
Ripple	1%										
Relays (1) Class A and C											
Voltage AC—maximum	120										
Voltage DC—maximum	24										
Amperes—maximum	3										
Environment											
Temperature—operating	–20 to +50°C										
Temperature—storage	–40 to +85°C										
Altitude	<2000m, derate 0.5% per 100m >2000m										
Humidity	<95% noncondensing										
Operating position	Vertical, line side up										
Pollution degree IEC 947-1	3										
Impulse withstand voltage IEC 947-4-1	6000V										

DS6 Soft Start Controllers

DS6 Soft Start Controllers

General Description

Eaton's DS6 line of reduced voltage solid-state soft start controllers is very compact, multi-functional, easy to install and easy to commission. Designed to control the acceleration and deceleration of three-phase motors, the device is available for current ranges from 40 to 180A.

Application Description

With its small size, it can easily fit in place of existing soft starters, wye-delta starters, or across-the-line NEMA and IEC starters. This feature allows easy upgrades to existing systems. The product is designed to be wired in the three-phase line feeding the three motor input leads as is done for normal across-the-line starting. The starter uses silicon controlled rectifiers (SCRs) to ramp the voltage to the motor, providing smooth acceleration and deceleration of the load. After the motor is started, the internal run bypass contactor closes, resulting in the motor running directly across-the-line. Internal run bypass significantly reduces the heat generated as compared to non-bypass starters. The soft stop option allows for a ramp stop time that may be longer than the coast-to-stop time. An external over-load protection is needed.

Operation

Voltage Ramp Start

This start method provides a voltage ramp to the motor, resulting in a constant torque increase. This most commonly used form of soft start mode allows you to set the initial voltage value and the duration of the ramp to full voltage conditions.

Bypass contactor(s) close after ramp time has elapsed.

- Adjustable initial voltage 30–92% of full voltage
- Adjustable ramp time 1–30 seconds

Soft Stop

Allows for a controlled stopping of load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or product damage. Setting the soft stop time to a value of 0 turns off this feature.

- Soft stop time = 0–30 seconds

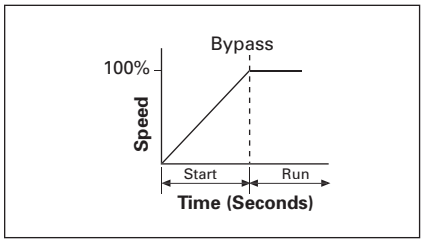


Figure 30.5-13. Start Ramp

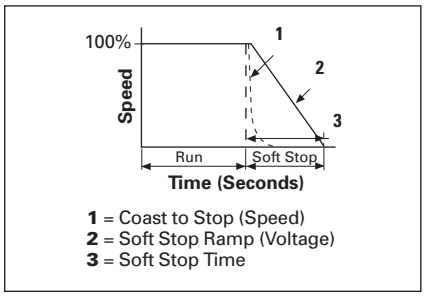


Figure 30.5-14. Stop Ramp

Features and Benefits

- Run Bypass mode greatly reduces internal heating created by the power dissipation across the SCRs. The bypass contactor directly connects the motor to the line and improves system efficiency by reducing internal power losses
- Less heat minimizes enclosure size and cooling requirements, and maximizes the life of all devices in the enclosure
- LED displays device status and provides fault indication
- Variable ramp times and voltage control (torque control) settings provide unlimited starting configurations, allowing for maximum application flexibility
- Soft stop control suits applications where an abrupt stop of the load is not acceptable. Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings
- Minimizes the peak inrush current's stress on the power system
- Manages peak starting torque to diminish mechanical system wear and damage
- 24 Vdc control module enhances personnel and equipment safety

Protective Features

- There are two auxiliary relays—
  - First relay is a TOR relay that closes when the TOR is achieved (internal bypass relays close)
  - The second relay is a RUN relay that closes when the RUN signal is initiated and opens when RUN signal is removed. It remains closed during stop ramp time, if set to a value greater than 0. The RUN relay will also open if a fault occurs
- Mains connection—The mains connection is monitored for an open condition and/or undervoltage
- Motor connection—The motor connection is monitored for an open condition
- SCR faults—SCR performance is monitored during the ramp cycle for proper operation
- Heat sink over/under temperature—High ambient temperatures, extended ramp times and high duty cycle conditions may cause the DS6 to exceed its thermal rating. When temperature goes under –5°C, unit will trip as well. The DS6 is equipped with sensors that monitor the temperature of the device. The soft starter will trip in over/under temperature conditions, preventing device failure
- Bypass relay—The DS6 can detect if the bypass relay fails to close after the ramp start or opens while the motor is running. The DS6 will trip on a bypass dropout fault if either of these conditions occur. The device does not start when bypass relay is closed and start signal is applied
- 24 Vdc low voltage—If the control voltage falls below 20 Vdc at any time during operation, the unit will fault

Standards and Certifications

- IEC 60947-4-2
- EN 60947-4-2
- UL listed (E251034)
- CSA certified
- CE marked
- C-Tick

Additional Information

- Instruction Leaflet IL03901001E

Product Selection

DS6 Soft Start Horsepower Ratings

Please refer to Application Note AP03900001E for additional information on proper size selection.

**Table 30.5-23. DS6 Soft Start Controllers—Horsepower Ratings—
10 Second Ramp, 1 Start per Hour, 300% Current Limit at 40°C**

Rated Current Amperes	Motor Power (hp) 200V	230V	460V	Maximum Allowable Breaker Size ①	Maximum Allowable Fuse Size ①	Recommended XTOB Overload	Recommended C440 Overload	Catalog Number
40	10	10	30	HFD3150L	150A Class RK5	XTOB040DC1 ②	C440A1A045SAX	**DS6-34DSX041N0-N**
52	15	20	40	HFD3200L	200A Class RK5	XTOB057DC1 ②	C440B1A100SAX	**DS6-34DSX055N0-N**
65	20	25	50	HJD3250	200A Class RK5	XTOB065DC1 ②	C440B1A100SAX	**DS6-34DSX068N0-N**
77	25	30	60	HKD3300	300A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX081N0-N**
96	30	30	75	HKD3350	350A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX099N0-N**
124	40	50	100	HKD3400	500A Class RK5	XTOB125GC1S	C440A1A005SAX ④	**DS6-34DSX134N0-N**
156	50	60	125	HLD3450	500A Class RK5	XTOB160LC1 ③	C440A1A005SAX ④	**DS6-34DSX161N0-N**
180	60	75	150	HLD3500	500A Class RK5	XTOB220LC1 ③	C440A1A005SAX ④	**DS6-34DSX196N0-N**

① Maximum values may be higher than allowed per NEC 430.52 and UL 508A 31.1.
② XTOBXDIND panel mounting adapter must be used with this overload.
③ XTOBXTLL line and load lugs must be used with this overload.
④ ZEB-XCT300 current transformer must be used with this overload.

Table 30.5-24. 10 Second Ramp, 1 Start per Hour, 400% Current Limit at 40°C

Rated Current Amperes	Motor Power (hp) 200V	230V	460V	Maximum Allowable Breaker Size ⑤	Maximum Allowable Fuse Size ⑤	Recommended XTOB Overload	Recommended C440 Overload	Catalog Number
27	7.5	10	20	HFD3150L	150A Class RK5	XTOB040DC1	C440A1A045SAX	**DS6-34DSX041NO-N**
34	10	10	30	HFD3200L	200A Class RK5	XTOB040DC1	C440A1A045SAX	**DS6-34DSX055NO-N**
40	15	15	30	HJD3250	200A Class RK5	XTOB057DC1 ⑥	C440A1A045SAX	**DS6-34DSX068NO-N**
52	15	20	40	HKD3300	300A Class RK5	XTOB057DC1 ⑥	C440B1A100SAX	**DS6-34DSX081NO-N**
65	20	25	50	HKD3350	350A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX099NO-N**
80	30	30	75	HKD3350	500A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX134NO-N**
96	30	40	75	HLD3450	500A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX161NO-N**
124	40	50	100	HLD3500	500A Class RK5	XTOB150GC1S	C440A1A005SAX ⑦	**DS6-34DSX196NO-N**

⑤ Maximum values may be higher than allowed per NEC 430.52 and UL 508A 31.1.
⑥ XTOBXDIND panel mounting adapter must be used with this overload.
⑦ ZEB-XCT300 current transformer must be used with this overload.

DS6 Soft Start kW Ratings

Please refer to Application Note AP03900001E for additional information on proper size selection.

Table 30.5-25. DS6 Soft Start Controllers—kW Ratings According to IEC 60947-4-2—10 Second Ramp, 1 Start per Hour, 300% Current Limit at 40°C

Rated Current Amperes	Motor Power (kW) 230V	Motor Power (kW) 400V	Maximum Allowable Breaker Size ①	Maximum Allowable Fuse Size ①	Recommended XTOB Overload	Recommended C440 Overload	Catalog Number
41	11	22	HFD3150L	150A Class RK5	XTOB057DC1 ②	C440A1A045SAX	**DS6-34DSX041N0-N**
55	15	30	HFD3200L	200A Class RK5	XTOB057DC1 ②	C440B1A100SAX	**DS6-34DSX055N0-N**
68	15	37	HJD3250	200A Class RK5	XTOB070GC1 ②	C440B1A100SAX	**DS6-34DSX068N0-N**
81	22	45	HKD3300	300A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX081N0-N**
99	30	55	HKD3350	350A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX099N0-N**
134	30	75	HKD3400	500A Class RK5	XTOB150GC1S	C440A1A005SAX ④	**DS6-34DSX134N0-N**
160	45	90	HLD3450	500A Class RK5	XTOB160LC1 ③	C440A1A005SAX ④	**DS6-34DSX161N0-N**
196	55	110	HLD3500	500A Class RK5	XTOB220LC1 ③	C440A1A005SAX ④	**DS6-34DSX196N0-N**

① Maximum values may be higher than allowed per NEC 430.52 and UL 508A 31.1.
② XTOBXDIND panel mounting adapter must be used with this overload.
③ XTOBXTLL line and load lugs must be used with this overload.
④ ZEB-XCT300 current transformer must be used with this overload.

Table 30.5-26. 10 Second Ramp, 1 Start per Hour, 400% Current Limit at 40°C

Rated Current Amperes	Motor Power (kW) 230V	Motor Power (kW) 400V	Maximum Allowable Breaker Size ⑤	Maximum Allowable Fuse Size ⑤	Recommended XTOB Overload	Recommended C440 Overload	Catalog Number
28.8	7.5	11	HFD3150L	150A Class RK5	XTOB040DC1	C440A1A045SAX	**DS6-34DSX041NO-N**
37.5	11	18.5	HFD3200L	200A Class RK5	XTOB040DC1	C440A1A045SAX	**DS6-34DSX055NO-N**
46	11	22	HJD3250	200A Class RK5	XTOB057DC1 ⑥	C440B1A100SAX	**DS6-34DSX068NO-N**
56	15	30	HKD3300	300A Class RK5	XTOB065DC1 ⑥	C440B1A100SAX	**DS6-34DSX081NO-N**
68	18.5	37	HKD3350	350A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX099NO-N**
90	22	45	HKD3350	500A Class RK5	XTOB100GC1S	C440B1A100SAX	**DS6-34DSX134NO-N**
106	30	55	HLD3450	500A Class RK5	XTOB160LC1 ⑦	C440A1A005SAX ⑧	**DS6-34DSX161NO-N**
134	37	75	HLD3500	500A Class RK5	XTOB160LC1 ⑦	C440A1A005SAX ⑧	**DS6-34DSX196NO-N**

⑤ Maximum values may be higher than allowed per NEC 430.52 and UL 508A 31.1.
⑥ XTOBXDIND panel mounting adapter must be used with this overload.
⑦ XTOBXTLL line and load lugs must be used with this overload.
⑧ ZEB-XCT300 current transformer must be used with this overload.

Considerations

1. Either XTOB, C306 or C440 series or equivalent overload protection devices may be selected.
2. Contactor is optional for normal applications. It is recommended for mains isolation.

Power Supply

Eaton's PSG and ELC power supplies are recommended as a compact and low-cost source for 24 Vdc power. The light-weight, DIN rail mounted devices have a wide input voltage range, and robust screw terminals make these power supplies easy to install and use. These power supplies are available in 1A and 2A models.

Table 30.5-27. Power Supply Selection

Description	Catalog Number
85–264V input and 24V output	**ELC-PS01**
380–480V input and 24V output	**PSS25F**
100–240 Vac input and 24 Vdc output	**PSG60E**
380–480 Vac input and 24 Vdc output	**PSG60F**

Technical Data and Specifications

Table 30.5-28. DS6 Soft Start Controllers

Description	Unit	DS6-34DSX041N0-N	DS6-34DSX055N0-N	DS6-34DSX068N0-N	DS6-34DSX081N0-N
General					
Standards	—	IEC/EN 60947-4-2	IEC/EN 60947-4-2	IEC/EN 60947-4-2	IEC/EN 60947-4-2
Certifications		UL/CE/C-Tick/CSA	UL/CE/C-Tick/CSA	UL/CE/C-Tick/CSA	UL/CE/C-Tick/CSA
Ambient temperature (operation)	°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C
Ambient temperature (storage)	°C	–25 to +55°C	–25 to +55°C	–25 to +55°C	–25 to +55°C
Altitude	—	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m
Installation	—	Vertical	Vertical	Vertical	Vertical
Protection degree	—	IP20	IP20	IP20	IP20
Protection against contact	—	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)
Overvoltage category/ pollution degree	—	II/2	II/2	II/2	II/2
Shock resistance	—	8g/11 ms	8g/11 ms	8g/11 ms	8g/11 ms
Vibration resistance according to EN 60721-3-2	—	2M2	2M2	2M2	2M2
Dimensions in inches (mm) (W x H x D)	—	3.66 x 6.89 x 5.47 (93.0 x 175.0 x 138.9)	3.66 x 6.89 x 5.47 (93.0 x 175.0 x 138.9)	3.66 x 6.89 x 5.47 (93.0 x 175.0 x 138.9)	3.66 x 6.89 x 5.47 (93.0 x 175.0 x 138.9)
Weight in lbs (kg)	—	4.00 (1.8)	4.00 (1.8)	4.00 (1.8)	4.00 (1.8)
Main Circuit					
Rated operation voltage	V	200–460 Vac	200–460 Vac	200–460 Vac	200–460 Vac
Mains frequency	Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Rated impulse withstand voltage	U_{imp} 1.2/ 50 µs	4 kV	4 kV	4 kV	4 kV
Rated operation current	I_e	40	52	65	77
Motor Power Ratings					
200V	hp	10	15	20	25
230V	hp	10	20	25	30
460V	hp	30	40	50	60
230V	kW	11	15	15	22
400V	kW	22	30	37	45
Overload cycle according to EN 60947-4-2	—	40A: AC53a; 3–5; 75–10	52A: AC53a; 3–5; 75–10	65A: AC53a; 3–5; 75–10	77A: AC53a; 3–5; 75–10

Table 30.5-28. DS6 Soft Start Controllers (Continued)

Description	Unit	DS6-34DSX041N0-N	DS6-34DSX055N0-N	DS6-34DSX068N0-N	DS6-34DSX081N0-N
Wire Specifications					
Power terminals (box terminals) Single conductor Terminal torque	 AWG lb-in	 12–2/0 53–80	 12–2/0 53–80	 12–2/0 53–80	 12–2/0 53–80
Control signals Single conductor Terminal torque	 AWG lb-in	 16 min. 3.5	 16 min. 3.5	 16 min. 3.5	 16 min. 3.5
Power Section					
Rated impulse withstand voltage	U_{imp} 1.2/ 50 µs	4 kV	4 kV	4 kV	4 kV
Control Commands					
Supply voltage control board Nominal voltage Nominal current ramp, TOR Current peak (closing shorting contactors)	U_s Vdc mA	 +24 Vdc +10%/–15% 65 600 mA/50 ms	 +24 Vdc +10%/–15% 65 600 mA/50 ms	 +24 Vdc +10%/–15% 65 600 mA/50 ms	 +24 Vdc +10%/–15% 65 600 mA/50 ms
Voltage to the control terminals (rated control voltage) DC driven	 —	 +24 Vdc +10%/–15%	 +24 Vdc +10%/–15%	 +24 Vdc +10%/–15%	 +24 Vdc +10%/–15%
Input current at 24 Vdc	mA	14	14	14	14
Relay Outputs					
Number of relays	—	2 (TOR, ready)	2 (TOR, ready)	2 (TOR, ready)	2 (TOR, ready)
Maximum voltage	V	250 Vac, 60 Vdc	250 Vac, 60 Vdc	250 Vac, 60 Vdc	250 Vac, 60 Vdc
Maximum current	A	3A, resistive	3A, resistive	3A, resistive	3A, resistive
Soft Start Functions					
Ramp times Start ramp Stop ramp	 s s	 1–30 0–30	 1–30 0–30	 1–30 0–30	 1–30 0–30
Initial voltage % line voltage	—	30–92%	30–92%	30–92%	30–92%

Table 30.5-28. DS6 Soft Start Controllers (Continued)

Description	Unit	DS6-34DSX099N0-N	DS6-34DSX134N0-N	DS6-34DSX161N0-N	DS6-34DSX196N0-N
General					
Standards	—	IEC/EN 60947-4-2	IEC/EN 60947-4-2	IEC/EN 60947-4-2	IEC/EN 60947-4-2
Certifications/marking	—	UL/CE/C-Tick/CSA	UL/CE/C-Tick/CSA	UL/CE/C-Tick/CSA	UL/CE/C-Tick/CSA
Ambient temperature (operation)	°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celsius to 60°C
Ambient temperature (storage)	°C	–25 to +55°C	–25 to +55°C	–25 to +55°C	–25 to +55°C
Altitude	—	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 1% of rated current per 100m to a maximum of 2000m
Installation	—	Vertical	Vertical	Vertical	Vertical
Protection degree	—	IP20	IP20	IP20	IP20
Protection against contact	—	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)
Overvoltage category/ pollution degree	—	II/2	II/2	II/2	II/2
Shock resistance	—	8g/11 ms	8g/11 ms	8g/11 ms	8g/11 ms
Vibration resistance according to EN 60721-3-2	—	2M2	2M2	2M2	2M2
Dimensions in inches (mm) (W x H x D)	—	3.66 x 6.89 x 5.47 (93.0 x 175.0 x 138.9)	4.25 x 8.46 x 7.01 (108.0 x 214.9 x 178.1)	4.25 x 8.46 x 7.01 (108.0 x 214.9 x 178.1)	4.25 x 8.46 x 7.01 (108.0 x 214.9 x 178.1)
Weight in lbs (kg)	—	4.00 (1.8)	8.16 (3.7)	8.16 (3.7)	8.16 (3.7)
Main Circuit					
Rated operation voltage	V	200–460 Vac	200–460 Vac	200–460 Vac	200–460 Vac
Mains frequency	Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Rated impulse withstand voltage	U_{imp} 1.2/ 50 µs	4 kV	4 kV	4 kV	4 kV
Rated operation current	I_e	96	124	156	180
Motor Power Ratings					
200V	hp	30	40	50	60
230V	hp	30	50	60	75
460V	hp	75	100	125	150
230V	kW	30	30	45	55
400V	kW	55	75	90	110
Overload cycle according to EN 60947-4-2	—	96A: AC53a; 3–5; 75–10	124A: AC53a; 3–5; 75–10	156A: AC53a; 3–5; 75–10	180A: AC53a; 3–5; 75–10

Table 30.5-28. DS6 Soft Start Controllers (Continued)

Description	Unit	DS6-34DSX099N0-N	DS6-34DSX134N0-N	DS6-34DSX161N0-N	DS6-34DSX196N0-N
Wire Specifications					
Power terminals (box terminals) Single conductor Terminal torque	 AWG lb-in	 12–2/0 53–80	 12 AWG–350 kcmil 44–123	 12 AWG–350 kcmil 44–123	 12 AWG–350 kcmil 44–123
Control signals Single conductor Terminal torque	 AWG lb-in	 16 min. 3.5	 16 min. 3.5	 16 min. 3.5	 16 min. 3.5
Power Section					
Rated impulse withstand voltage	U_{imp} 1.2/ 50 µs	4 kV	4 kV	4 kV	4 kV
Control Commands					
Supply voltage control board Nominal voltage Nominal current ramp, TOR Current peak (closing shorting contactors)	U_s Vdc mA	 +24 Vdc +10%/–15% 65 600 mA/50 ms	 +24 Vdc +10%/–15% 65 600 mA/50 ms	 +24 Vdc +10%/–15% 65 600 mA/50 ms	 +24 Vdc +10%/–15% 65 600 mA/50 ms
Voltage to the control terminals (rated control voltage) DC driven	 —	 +24 Vdc +10%/–15%	 +24 Vdc +10%/–15%	 +24 Vdc +10%/–15%	 +24 Vdc +10%/–15%
Input current at 24 Vdc	mA	14	14	14	14
Relay Outputs					
Number of relays	—	2 (TOR, ready)	2 (TOR, ready)	2 (TOR, ready)	2 (TOR, ready)
Maximum voltage	V	250 Vac, 60 Vdc	250 Vac, 60 Vdc	250 Vac, 60 Vdc	250 Vac, 60 Vdc
Maximum current	A	3A, resistive	3A, resistive	3A, resistive	3A, resistive
Soft Start Functions					
Ramp times Start ramp Stop ramp	 s s	 1–30 0–30	 1–30 0–30	 1–30 0–30	 1–30 0–30
Initial voltage % line voltage	—	30–92%	30–92%	30–92%	30–92%

Dimensions—Approximate Dimensions in Inches (mm)

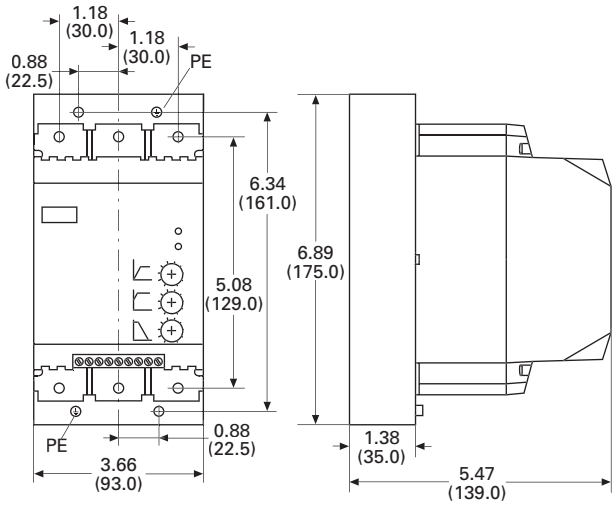


Figure 30.5-15. 25–75 hp Models

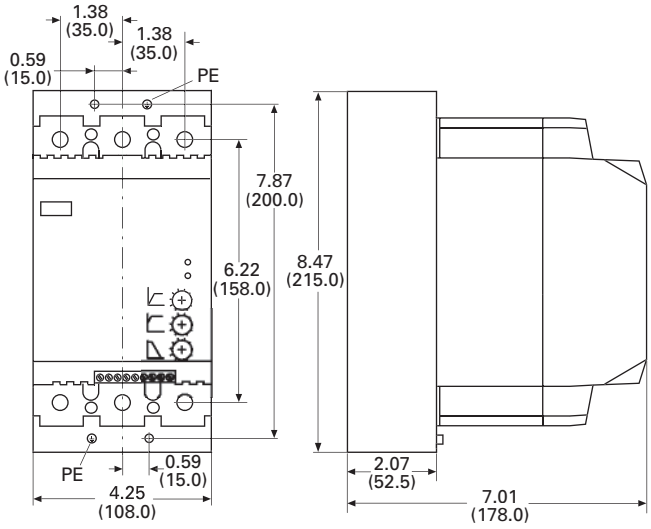


Figure 30.5-16. 100–150 hp Models

DS7 Soft Start Controllers

DS7 Soft Start Controllers

General Description

Eaton's DS7 line of reduced voltage solid-state soft start controllers is very compact, multi-functional, easy to install and easy to commission. Designed to control the acceleration and deceleration of three-phase motors, the device is available for current ranges from 4–32A in four frame sizes.

Application Description

With its small size, it can easily fit in place of existing soft starters, wye-delta starters, or across-the-line NEMA® and IEC starters. This feature allows easy upgrades to existing systems. The product is designed to be wired in the three-phase line feeding the three motor input leads as is done for normal across-the-line starting. The starter uses silicon controlled rectifiers (SCRs) to ramp the voltage to the motor, providing smooth acceleration and deceleration of the load. After the motor is started, the internal run bypass relay closes, resulting in the motor running directly across-the-line. Internal run bypass significantly reduces the heat generated as compared to non-bypass starters. The soft stop option allows for a ramp stop time that may be longer than the coast-to-stop time. An external overload protection relay is needed.

Operation

Voltage Ramp Start

This start method provides a voltage ramp to the motor, resulting in a constant torque increase. This most commonly used form of soft start mode allows you to set the initial voltage value and the duration of the ramp to full voltage conditions.

- Adjustable initial voltage 30–92% of full voltage (120/230 Vac control voltage)
- Adjustable initial voltage 30–100% of full voltage (24 Vac/Vdc control voltage)
- Adjustable ramp time 1–30 seconds
- Bypass relays close at the end the ramp time (TOR)

Soft Stop

Allows for a controlled stopping of load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or product damage. Setting the soft stop time to a value of 0 turns off this feature.

- Soft stop time = 0–30 seconds

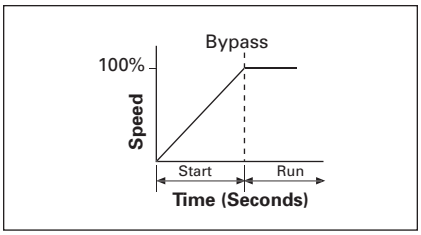


Figure 30.5-17. Start Ramp

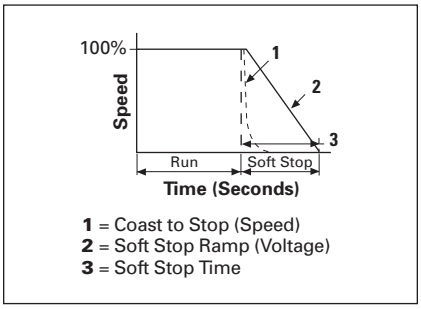


Figure 30.5-18. Stop Ramp

Auxiliary Contacts

Auxiliary contacts are provided to indicate soft start controller status.

Frame Size 1 (4A to 12A)—One Relay

The auxiliary relay indicates when the soft starter is at Top-of-Ramp (TOR).

Frame Size 2 (16A to 32A)—Two Relays

One auxiliary relay indicates when the soft starter is at Top-of-Ramp (TOR).

One auxiliary relay indicates that a RUN command is present, including start ramp, bypass and stop ramp times.

30

Features and Benefits

- Run bypass mode greatly reduces internal heating created by the power dissipation across the SCRs. The bypass relay directly connects the motor to the line and improves system efficiency by reducing internal power losses
- Less heat minimizes enclosure size and cooling requirements, and maximizes the life of all devices in the enclosure
- LED displays device status and provides fault indication
- Variable ramp times and voltage control (torque control) settings provide unlimited starting configurations, allowing for maximum application flexibility
- Soft stop control suits applications where an abrupt stop of the load is not acceptable. Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings
- Minimizes the peak inrush current's stress on the power system. Peak starting torque can be managed to diminish mechanical system wear and damage
- 24 Vac/Vdc control voltage enhances personnel and equipment safety. 120/230 Vac control voltage is also available
- Auxiliary relays indicate status of the soft start controllers
  - The TOR relay is active until motor stop command is received and/or the soft start controller detects a fault condition
  - RUN relay is active during the start ramp, bypass and stop ramp

Protective Features

- Mains connection—The mains connection is monitored for a phase loss and/or undervoltage during ramp up
- Motor connection—The motor connection is monitored for an open condition during the ramp
- SCR faults—SCR performance is monitored during the ramp cycle for proper operation
- Heat sink over/under temperature—High ambient temperatures, extended ramp times and high duty cycle conditions may cause the DS7 to exceed its thermal rating. When temperature goes under –5°C, unit will trip as well. The DS7 is equipped with sensors that monitor the temperature of the device. The soft starter will trip in over/under temperature conditions, preventing device failure
- Warning is indicated for an over-temperature condition for the next start
- Bypass relay
  - The DS7 can detect if the bypass relay fails to close after the ramp start or opens while the motor is running
  - The DS7 will also detect a condition whereas the bypass relay is closed when the RUN command is given
  - The DS7 will trip on a bypass dropout fault if either of these conditions occur

Standards and Certifications

- IEC 60947-4-2
- EN 60947-4-2
- UL listed
- CSA certified
- CE marked
- C-Tick

Additional Information

- Instruction Leaflet IL03901001E

Product Selection

DS7 Soft Start Horsepower Ratings

Please refer to Application Note AP03901006E for additional information on proper size selection.

Table 30.5-29. DS7 Soft Start Controllers—Horsepower Ratings—10 Second Ramp, One Start per Hour, 300% Current Limit at 40°C ①

Rated Current Amperes	Motor Power (hp) 200V	230V	480V	Maximum Allowable Breaker Size	Maximum Allowable Fuse Size	Recommended XTOB Overload (Direct Connect) ②	Recommended XTOE Overload ②	MMP ②	Connection Kit to MMP	Catalog Number
3.7	0.75	0.75	2	HFD3015	15A Class RK5	XTOB004BC1	XTOE005BCS	XTPR004BC1	XTPAXTPCB	**DS7-340SX004NO-N** ④ **DS7-342SX004NO-N** ⑤
6.9	1.5	2	3	HFD3015	15A Class RK5	XTOB006BC1 ③	XTOE020BCS	XTPR6P3BC1	XTPAXTPCB	**DS7-340SX007NO-N** ④ **DS7-342SX007NO-N** ⑤
7.8	2	2	5	HFD3020	20A Class RK5	XTOB010BC1	XTOE020BCS	XTPR010BC1	XTPAXTPCB	**DS7-340SX009NO-N** ④ **DS7-342SX009NO-N** ⑤
11	3	3	7.5	HFD3030	20A Class RK5	XTOB012BC1	XTOE020BCS	XTPR012BC1	XTPAXTPCB	**DS7-340SX012NO-N** ④ **DS7-342SX012NO-N** ⑤
15.2	3	5	10	HFD3035	25A Class RK5	XTOB016CC1	XTOE020CCS	XTPR016BC1	XTPAXTPCC	**DS7-340SX016NO-N** ④ **DS7-342SX016NO-N** ⑤
22	5	7.5	15	HFD3060	40A Class RK5	XTOB024CC1	XTOE045CCS	XTPR025BC1	XTPAXTPCC	**DS7-340SX024NO-N** ④ **DS7-342SX024NO-N** ⑤
32	7.5	10	20	HFD3070	50A Class RK5	XTOB032CC1	XTOE045CCS	XTPR032BC1	XTPAXTPCC	**DS7-340SX032NO-N** ④ **DS7-342SX032NO-N** ⑤

① Actual motor FLAs vary. Verify these devices cover the motor specific FLA.
② Selections are based on motor FLA value at 480V.
③ Not to be used with 230V.
④ 24 Vac/Vdc device.
⑤ 120/230 Vac device.

Table 30.5-30. DS7 Soft Start Controllers—Horsepower Ratings—10 Second Ramp, One Start per Hour, 400% Current Limit at 40°C ⑥

Rated Current Amperes	Motor Power (hp) 200V	230V	480V	Maximum Allowable Breaker Size	Maximum Allowable Fuse Size	Recommended XTOB Overload (Direct Connect) ⑦	Recommended XTOE Overload ⑦	MMP ⑦	Connection Kit to MMP	Catalog Number
3	0.5	0.5	1.5	HFD3015	15A Class RK5	XTOB004BC1	XTOE005BCS	XTPR004BC1	XTPAXTPCB	**DS7-340SX004NO-N** ⑨ **DS7-342SX004NO-N** ⑩
4.8	1	1	3	HFD3015	15A Class RK5	XTOB006BC1 ⑧	XTOE020BCS	XTPR6P3BC1	XTPAXTPCB	**DS7-340SX007NO-N** ⑨ **DS7-342SX007NO-N** ⑩
6.9	1.5	2	3	HFD3020	20A Class RK5	XTOB006BC1	XTOE020BCS	XTPR6P3BC1	XTPAXTPCB	**DS7-340SX009NO-N** ⑨ **DS7-342SX009NO-N** ⑩
9	2	2	5	HFD3030	20A Class RK5	XTOB010BC1	XTOE020BCS	XTPR010BC1	XTPAXTPCB	**DS7-340SX012NO-N** ⑨ **DS7-342SX012NO-N** ⑩
11	3	3	7.5	HFD3035	25A Class RK5	XTOB016CC1	XTOE020CCS	XTPR016BC1	XTPAXTPCC	**DS7-340SX016NO-N** ⑨ **DS7-342SX016NO-N** ⑩
17.5	5	5	10	HFD3060	40A Class RK5	XTOB016CC1	XTOE045CCS	XTPR016BC1	XTPAXTPCC	**DS7-340SX024NO-N** ⑨ **DS7-342SX024NO-N** ⑩
22	5	7.5	15	HFD3070	50A Class RK5	XTOB024CC1	XTOE045CCS	XTPR025BC1	XTPAXTPCC	**DS7-340SX032NO-N** ⑨ **DS7-342SX032NO-N** ⑩

⑥ Actual motor FLAs vary. Verify these devices cover the motor specific FLA.
⑦ Selections are based on motor FLA value at 480V.
⑧ Not to be used with 230V.
⑨ 24 Vac/Vdc device.
⑩ 120/230 Vac device.

DS7 Soft Start kW Ratings

Please refer to Application Note AP03901006E for additional information on proper size selection.

Table 30.5-31. DS7 Soft Start Controllers—kW Ratings According to IEC 60947-4-2—10 Second Ramp, One Start per Hour, 300% Current Limit at 40°C ①

Rated Current Amperes	Motor Power (kW) 230V	Motor Power (kW) 400V	Maximum Allowable Breaker Size	Maximum Allowable Fuse Size	Recommended XTOB Overload (Direct Connect) ②	Recommended XTOE Overload ②	MMP ②	Connection Kit to MMP	Catalog Number
3.8	0.75	1.5	HFD3015	15A Class RK5	XTOB004BC1	XTOE005BCS	XTPR004BC1	XTPAXTPCB	**DS7-340SX004NO-N** ④ **DS7-342SX004NO-N** ⑤
7	1.5	3	HFD3015	15A Class RK5	XTOB006BC1 ③	XTOE020BCS	XTPR6P3BC1	XTPAXTPCB	**DS7-340SX007NO-N** ④ **DS7-342SX007NO-N** ⑤
9	2.2	4	HFD3020	20A Class RK5	XTOB010BC1	XTOE020BCS	XTPR010BC1	XTPAXTPCB	**DS7-340SX009NO-N** ④ **DS7-342SX009NO-N** ⑤
12	3	5.5	HFD3030	20A Class RK5	XTOB012BC1	XTOE020BCS	XTPR012BC1	XTPAXTPCB	**DS7-340SX012NO-N** ④ **DS7-342SX012NO-N** ⑤
16	4	7.5	HFD3035	25A Class RK5	XTOB016CC1	XTOE020CCS	XTPR016BC1	XTPAXTPCC	**DS7-340SX016NO-N** ④ **DS7-342SX016NO-N** ⑤
24	5.5	11	HFD3060	40A Class RK5	XTOB024CC1	XTOE045CCS	XTPR025BC1	XTPAXTPCC	**DS7-340SX024NO-N** ④ **DS7-342SX024NO-N** ⑤
32	7.5	15	HFD3070	50A Class RK5	XTOB032CC1	XTOE045CCS	XTPR032BC1	XTPAXTPCC	**DS7-340SX032NO-N** ④ **DS7-342SX032NO-N** ⑤

① Actual motor FLAs vary. Verify these devices cover the motor specific FLA.
② Selections are based on motor FLA value at 480V.
③ Not to be used with 230V.
④ 24 Vac/Vdc device.
⑤ 120/230 Vac device.

Table 30.5-32. DS7 Soft Start Controllers—kW Ratings According to IEC 60947-4-2—10 Second Ramp, One Start per Hour, 400% Current Limit at 40°C ⑥

Rated Current Amperes	Motor Power (kW) 230V	Motor Power (kW) 400V	Maximum Allowable Breaker Size	Maximum Allowable Fuse Size	Recommended XTOB Overload (Direct Connect) ⑦	Recommended XTOE Overload ⑦	MMP ⑦	Connection Kit to MMP	Catalog Number
2.5	0.33	1	HFD3015	15A Class RK5	XTOB004BC1	XTOE005BCS	XTPR004BC1	XTPAXTPCB	**DS7-340SX004NO-N** ⑨ **DS7-342SX004NO-N** ⑩
3.8	0.75	1.5	HFD3015	15A Class RK5	XTOB006BC1 ⑧	XTOE020BCS	XTPR6P3BC1	XTPAXTPCB	**DS7-340SX007NO-N** ⑨ **DS7-342SX007NO-N** ⑩
7	1.5	3	HFD3020	20A Class RK5	XTOB006BC1	XTOE020BCS	XTPR6P3BC1	XTPAXTPCB	**DS7-340SX009NO-N** ⑨ **DS7-342SX009NO-N** ⑩
9	2.2	4	HFD3030	20A Class RK5	XTOB010BC1	XTOE020BCS	XTPR010BC1	XTPAXTPCB	**DS7-340SX012NO-N** ⑨ **DS7-342SX012NO-N** ⑩
12	3	5.5	HFD3035	25A Class RK5	XTOB016CC1	XTOE020CCS	XTPR016BC1	XTPAXTPCC	**DS7-340SX016NO-N** ⑨ **DS7-342SX016NO-N** ⑩
16	4	7.5	HFD3060	40A Class RK5	XTOB016CC1	XTOE045CCS	XTPR016BC1	XTPAXTPCC	**DS7-340SX024NO-N** ⑨ **DS7-342SX024NO-N** ⑩
24	5.5	11	HFD3070	50A Class RK5	XTOB024CC1	XTOE045CCS	XTPR025BC1	XTPAXTPCC	**DS7-340SX032NO-N** ⑨ **DS7-342SX032NO-N** ⑩

⑥ Actual motor FLAs vary. Verify these devices cover the motor specific FLA.
⑦ Selections are based on motor FLA value at 480V.
⑧ Not to be used with 230V.
⑨ 24 Vac/Vdc device.
⑩ 120/230 Vac device.

Considerations

1. Either XTOB or XTOE or equivalent overload protection devices may be selected. In addition, manual motor protectors—MMP series can also be considered.
2. Isolation contactor is required for mains isolation.

24 Vdc Control Power

Eaton's ELC power supplies are recommended as a compact and low-cost source for 24 Vdc power. The light-weight, DIN rail mounted devices have a wide input voltage range and robust screw terminals make these power supplies easy to install and use. These power supplies are available in 1A and 2A models.

AC Control Power

24, 120 or 230 Vac may be used for control power in accordance with the model requirements.

Table 30.5-33. DC Power Supply Selection

Description	Catalog Number
85–264V input and 24V output	**ELC-PS01**
380–480V input and 24V output	**PSS25F**

Technical Data and Specifications

Table 30.5-34. DS7 Soft Start Controllers

Rated Control Circuit					
Voltage 24 Vac/Vdc Voltage 110/230 Vac	**Unit**	**DS7-340SX004NO-N DS7-342SX004NO-N**	**DS7-340SX007NO-N DS7-342SX007NO-N**	**DS7-340SX009NO-N DS7-342SX009NO-N**	**DS7-340SX012NO-N DS7-342SX012NO-N**
General					
Standards	—	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking
Certifications/marking	—	UL/CE/CSA/C-Tick	UL/CE/CSA/C-Tick	UL/CE/CSA/C-Tick	UL/CE/CSA/C-Tick
Ambient temperature (operation)	°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C
Ambient temperature (storage)	°C	–25 to 55°C	–25 to 55°C	–25 to 55°C	–25 to 55°C
Altitude	—	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m
Installation	—	Vertical	Vertical	Vertical	Vertical
Protection class	—	IP20	IP20	IP20	IP20
Protection class applies to the front and operator control and display elements. Protection type from all sides is IP00.	—	With optional covers from the NZM range, protection type IP40 from all sides can be achieved	With optional covers from the NZM range, protection type IP40 from all sides can be achieved	With optional covers from the NZM range, protection type IP40 from all sides can be achieved	With optional covers from the NZM range, protection type IP40 from all sides can be achieved
Busbar tag shroud	—	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)
Overvoltage category/ pollution degree	—	II/2	II/2	II/2	II/2
Shock resistance	—	8g/11 ms	8g/11 ms	8g/11 ms	8g/11 ms
Vibration resistance according to EN 60721-3-2	—	2M2	2M2	2M2	2M2
Mean heat dissipation at rated duty cycle	W	0.2	0.35	0.35	0.6
Radio interference	—	B	B	B	B
Dimensions (W x H x D)	mm	45 x 130 x 95	45 x 130 x 95	45 x 130 x 95	45 x 130 x 95
	in	1.77 x 5.12 x 3.74	1.77 x 5.12 x 3.74	1.77 x 5.12 x 3.74	1.77 x 5.12 x 3.74
Weight	kg	0.35	0.35	0.35	0.35
	lb	0.77	0.77	0.77	0.77
Main Circuit					
Rated operational voltage	V	230–460 Vac	230–460 Vac	230–460 Vac	230–460 Vac
Mains frequency	Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Rated operation current AC 53	I_e	4	7	9	12
Motor Power Ratings					
200V	hp	0.75	1.5	2	3
230V	hp	0.75	2	2	5
480V	hp	2	3	5	10
230V	kW	0.75	1.5	2.2	3
400V	kW	1.5	3	4	5.5
Overload cycle according to EN 60947-4-2	—	4A: AC53a; 3-5; 75-10	7A: AC53a; 3-5; 75-10	9A: AC53a; 3-5; 75-10	12A: AC53a; 3-5; 75-10

Table 30.5-34. DS7 Soft Start Controllers (Continued)

Rated Control Circuit					
Voltage 24 Vac/Vdc Voltage 110/230 Vac	**Unit**	**DS7-340SX004NO-N DS7-342SX004NO-N**	**DS7-340SX007NO-N DS7-342SX007NO-N**	**DS7-340SX009NO-N DS7-342SX009NO-N**	**DS7-340SX012NO-N DS7-342SX012NO-N**
Wire Specifications					
Power terminals Single conductor—solid or stranded Terminal torque	 AWG lb-in	 18–10 11	 18–10 11	 18–10 11	 18–10 11
Control signals Single conductor—solid or stranded Terminal torque	 AWG lb-in	 18–10 11	 18–10 11	 18–10 11	 18–10 11
Power Section					
Rated impulse withstand voltage	U_{imp} 1.2/ 50 µs	4 kV	4 kV	4 kV	4 kV
Rated insulation voltage	—	500	500	500	500
Control Commands—Vac/Vdc					
Supply voltage control board U_S nominal	Vdc	20.4–26.4	20.4–26.4	20.4–26.4	20.4–26.4
Current consumption at 24 Vac/Vdc	mA	1.6	1.6	1.6	1.6
Pickup voltage	—	+17.3 to +27	+17.3 to +27	+17.3 to +27	+17.3 to +27
Dropout voltage	—	+3 to 0	+3 to 0	+3 to 0	+3 to 0
Relay Outputs					
Number of relays	—	1 (TOR)	1 (TOR)	1 (TOR)	1 (TOR)
Maximum voltage	Vac	250	250	250	250
Maximum current	A	1A	1A	1A	1A
Soft Start Functions					
Ramp times Start ramp Stop ramp	 s s	 1–30 0–30	 1–30 0–30	 1–30 0–30	 1–30 0–30
Initial voltage % line voltage	—	30–100%	30–100%	30–100%	30–100%
Control Commands—Vac					
Supply voltage control board U_S nominal	Vac	102–253	102–253	102–253	102–253
Current consumption at 24 Vac/Vdc	mA	4	4	4	4
Pickup voltage	Vac	102–230	102–230	102–230	102–230
Dropout voltage	Vac	0–28	0–28	0–28	0–28
Relay Outputs					
Number of relays	—	1 (TOR)	1 (TOR)	1 (TOR)	1 (TOR)
Maximum voltage	Vac	250	250	250	250
Maximum current	A	3A	3A	3A	3A
Soft Start Functions					
Ramp times Start ramp Stop ramp	 s s	 1–30 0–30	 1–30 0–30	 1–30 0–30	 1–30 0–30
Initial voltage % line voltage	—	30–92%	30–92%	30–92%	30–92%

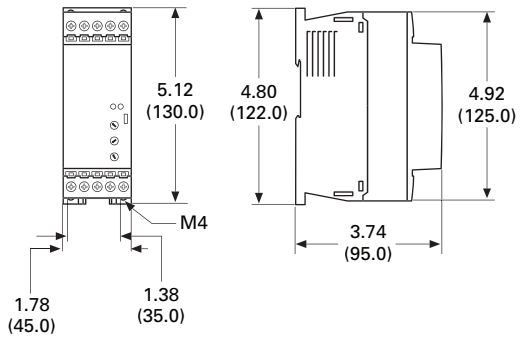
Table 30.5-34. DS7 Soft Start Controllers (Continued)

Rated Control Circuit				
Voltage 24 Vac/Vdc Voltage 110/230 Vac	**Unit**	**DS7-340SX016NO-N DS7-342SX016NO-N**	**DS7-340SX024NO-N DS7-342SX024NO-N**	**DS7-340SX032NO-N DS7-342SX032NO-N**
General				
Standards	—	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking	IEC/EN 60947-4-2; GB14048.6; UL508; CSA-C22.2 No 0-M91; CSA-C22.2 No 14-05 CE marking
Certifications/marking	—	UL/CE/CSA/C-Tick	UL/CE/CSA/C-Tick	UL/CE/CSA/C-Tick
Ambient temperature (operation)	°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C	0 to 40°C, above 40°C derate linearly by 1% of rated current per Celcius to 60°C
Ambient temperature (storage)	°C	–25 to 55°C	–25 to 55°C	–25 to 55°C
Altitude	—	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m	0–1000m, above 1000m derate linearly by 2.5% of rated current per 100m to a maximum of 2000m
Installation	—	Vertical	Vertical	Vertical
Protection class	—	IP20	IP20	IP20
Protection class applies to the front and operator control and display elements. Protection type from all sides is IP00.	—	With optional covers from the NZM range, protection type IP40 from all sides can be achieved	With optional covers from the NZM range, protection type IP40 from all sides can be achieved	With optional covers from the NZM range, protection type IP40 from all sides can be achieved
Busbar tag shroud	—	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)	Back of hand and finger-proof (from front face)
Overvoltage category/ pollution degree	—	II/2	II/2	II/2
Shock resistance	—	8g/11 ms	8g/11 ms	8g/11 ms
Vibration resistance according to EN 60721-3-2	—	2M2	2M2	2M2
Mean heat dissipation at rated duty cycle	W	0.8	1.1	1.5
Radio interference	—	B	B	B
Dimensions (W x H x D)	mm	45 x 150 x 118	45 x 150 x 118	45 x 150 x 118
	in	1.77 x 5.12 x 3.74	1.77 x 5.12 x 3.74	1.77 x 5.12 x 3.74
Weight	kg	0.4	0.4	0.4
	lb	0.88	0.88	0.88
Main Circuit				
Rated operational voltage	V	230–460 Vac	230–460 Vac	230–460 Vac
Mains frequency	Hz	50/60 Hz	50/60 Hz	50/60 Hz
Rated operation current AC 53	I_e	16	24	32
Motor Power Ratings				
200V	hp	3	5	10
230V	hp	5	7.5	10
480V	hp	10	15	25
230V	kW	4	5.5	7.5
400V	kW	7.5	11	15
Overload cycle according to EN 60947-4-2	—	16A: AC53a; 3-5; 75-10	24A: AC53a; 3-5; 75-10	32A: AC53a; 3-5; 75-10

Table 30.5-34. DS7 Soft Start Controllers (Continued)

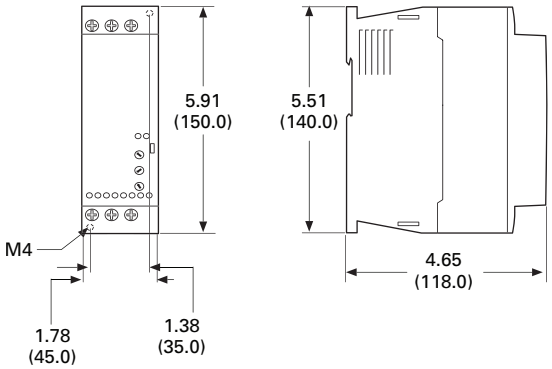
Rated Control Circuit				
Voltage 24 Vac/Vdc Voltage 110/230 Vac	**Unit**	**DS7-340SX016NO-N DS7-342SX016NO-N**	**DS7-340SX024NO-N DS7-342SX024NO-N**	**DS7-340SX032NO-N DS7-342SX032NO-N**
Wire Specifications				
Power terminals Single conductor—solid or stranded Terminal torque	 AWG lb-in	 18–6 11	 18–6 11	 18–6 11
Control Signals Single conductor—solid or stranded Terminal torque	 AWG lb-in	 18–10 11	 18–10 11	 18–10 11
Power Section				
Rated impulse withstand voltage	U_{imp} 1.2/ 50 µs	4 kV	4 kV	4 kV
Rated insulation voltage	—	500	500	500
Control Commands—Vac/Vdc				
Supply voltage control board U_S nominal	Vdc	20.4–26.4	20.4–26.4	20.4–26.4
Current consumption at 24 Vac/Vdc	mA	1.6	1.6	1.6
Pickup voltage	—	+17.3 to +27	+17.3 to +27	+17.3 to +27
Dropout voltage	—	+3 to 0	+3 to 0	+3 to 0
Relay Outputs				
Number of relays	—	2 (TOR, Ready)	2 (TOR, Ready)	2 (TOR, Ready)
Maximum voltage	Vac	250	250	250
Maximum current	A	1A	1A	1A
Soft Start Functions				
Ramp times Start ramp Stop ramp	 s s	 1–30 0–30	 1–30 0–30	 1–30 0–30
Initial voltage % line voltage	—	30–100%	30–100%	30–100%
Control Commands—Vac				
Supply voltage control board U_S nominal	Vac	102–253	102–253	102–253
Current consumption at 102–253 Vac	mA	4	4	4
Pickup voltage	Vac	102–230	102–230	102–230
Dropout voltage	Vac	0–28	0–28	0–28
Relay Outputs				
Number of relays	—	2 (TOR, Run)	2 (TOR, Run)	2 (TOR, Run)
Maximum voltage	Vac	250	250	250
Maximum current	A	3A	3A	3A
Soft Start Functions				
Ramp times Start ramp Stop ramp	 s s	 1–30 0–30	 1–30 0–30	 1–30 0–30
Initial voltage % line voltage	—	30–92%	30–92%	30–92%

Dimensions—Approximate Dimensions in Inches (mm)



Catalog Numbers	
DS7-340SX004N0-N	DS7-342SX004N0-N
DS7-340SX007N0-N	DS7-342SX007N0-N
DS7-340SX009N0-N	DS7-342SX009N0-N
DS7-340SX012N0-N	DS7-342SX012N0-N

Figure 30.5-19. Frame Size 1



Catalog Numbers	
DS7-340SX016N0-N	DS7-342SX016N0-N
DS7-340SX024N0-N	DS7-342SX024N0-N
DS7-340SX032N0-N	DS7-342SX032N0-N

Figure 30.5-20. Frame Size 2

PSG Series DC Power Supplies

PSG Series

General Description

Eaton's PSG Series of power supplies is designed to be a high-performance, high-quality line of products covering a majority of 24 Vdc control applications. With global certifications, compact size and an impressive operating temperature range, the PSG Series fits a wide variety of applications at a competitive price.

Eight models are offered, from 2.5A up to 20A with both single- and three-phase input voltage models available.

Application Description

The PSG Series is a line of general-purpose power supplies for use in a wide variety of industrial control applications. Applications include communication networks, sensors, PLCs and many other electrical systems.

Each model is equipped with a rugged metal housing, heavy-duty screw terminals and a variety of protection features, making the PSG one of the most versatile industrial power supply lines on the market.

Features, Benefits and Functions

- Universal input voltages: 85–264 Vac for single-phase units, 320–575 Vac for three-phase units
- Rugged aluminum housing stands up to harsh environments
- Current surge (power boost) of 1.5 times nominal current for 1 second allows branch protection and powering of high pickup loads
- Wide operating temperature range: –20°C to +75°C (derating above 50°C)
- Adjustable DC voltage output
- LED indicating light for DC OK simplifies troubleshooting
- Compact size, with common depth and height across all models, allows for common panel depths and family consistency
- MTBF up to 800,000 hours ensures uptime and reliability
- Heavy-duty screw terminals with finger-safe protective cover allow use of ring-lug terminals
- All-metal DIN rail mounting hardware
- Class 1, Division 2 hazardous location rated

Standards and Certifications

- UL/cUL listed—UL 508 (industrial control equipment)
- cURus—UL 60950-1
- IEC
- EN
- German safety
- CSA certified (contact Eaton for certification dates and status)
- CE marked
- RoHS compliant

Product Selection

Table 30.5-35. Power Supply—Single-Phase

Description	Catalog Number
85–264 Vac input, 24 Vdc/2.5A output	**PSG60E**
85–264 Vac input, 24 Vdc/5A output	**PSG120E**
85–264 Vac input, 24 Vdc/10A output	**PSG240E**
85–264 Vac input, 24 Vdc/20A output	**PSG480E**

Table 30.5-36. Power Supply—Three-Phase

Description	Catalog Number
320–575 Vac input, 24 Vdc/2.5A output	**PSG60F**
320–575 Vac input, 24 Vdc/5A output	**PSG120F**
320–575 Vac input, 24 Vdc/10A output	**PSG240F**
320–575 Vac input, 24 Vdc/20A output	**PSG480F**

Technical Data and Specifications

Table 30.5-37. PSG Series DC Power Supplies

Capacity	PSG60E 60W	PSG120E 120W	PSG240E 240W	PSG480E 480W	PSG60F 60W	PSG120F 120W	PSG240F 240W	PSG480F 480W
Input								
Nominal voltage	100–240 Vac	100–240 Vac	100–240 Vac	100–240 Vac	3 x 400–500 Vac	3 x 400–500 Vac	3 x 400–500 Vac	3 x 400–500 Vac
Voltage range	②	②	②	②	③	③	③	③
Frequency	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)	47–63 Hz (0 Hz at DC input)
Nominal current ①	1.1A	1.4A	2.9A	5.7A	0.3A	0.5A	0.8A	1.6A
Inrush current limitation ①	30A	<80A	N/A	N/A	<30A	<30A	<40A	<50A
Mains buffering at nominal load (typ.) ①	>20 ms	>35 ms	>20 ms	>20 ms	>30 ms	>35 ms	>35 ms	>20 ms
Turn-on time	<2.5 sec	<1 sec	<1 sec	<1 sec	<2 sec	<1 sec	<1 sec	<1 sec
Internal fuse	T3.15 AH/250V	T3.15 AH/250V	T6.3AH/250V	F10H/250V	3.15AH/500V	3.15AH/500V	3.15AH/500V	3.15AH/500V
External fusing	6A, 10A or 16A	6A, 10A or 16A	10A or 16A	10A or 16A	3 x circuit breakers 6A, 10A or 16A	3 x circuit breakers 6A, 10A or 16A	3 x circuit breakers 6A, 10A or 16A	3 x circuit breakers 6A, 10A or 16A
Leakage current	<1 mA	<1 mA	<3.5 mA	<1 mA	<3.5 mA	<3.5 mA	<3.5 mA	<3.5 mA
Output								
Nominal output voltage	24 Vdc ± 2%	24 Vdc ± 2%	24 Vdc ± 2%	24 Vdc ± 2%	24 Vdc ± 2%	24 Vdc ± 2%	24 Vdc ± 2%	24 Vdc ± 2%
Adjustment range	22–28 Vdc	22–28 Vdc	22–28 Vdc	22–28 Vdc	22–28 Vdc	22–28 Vdc	22–28 Vdc	22–28 Vdc
Nominal current	2.5A	5A	10A	20A	2.5A	5A	10A	20A
Startup with capacitive loads	Max. 8000 µF	Max. 10,000 µF	Max. 10,000 µF	Max. 10,000 µF	Max. 10,000 µF	Max. 10,000 µF	Max. 10,000 µF	Max. 10,000 µF
Max. power dissipation idling nominal load approx.	10W	22.5W	42.5W	72W	9W	18W	36W	72W
Efficiency (at 400 Vac and nominal values)	>85% typ	>84% typ	>84% typ	>86% typ	>86% at 3 x 400 Vac; >85% at 3 x 500 Vac	>86% at 3 x 400 Vac; >85% at 3 x 500 Vac	>86% at 3 x 400 Vac; >85% at 3 x 500 Vac	>86% at 3 x 400 Vac; >85% at 3 x 500 Vac
Current surge (at 24 Vdc)	3.75A	7.5A	15A	30A	3.75A	7.5A	15A	30A
Current surge time/ cycle	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)	1 sec. (at 10-sec. intervals)
Residual ripple/peak switching (20 MHz)	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp	<50 mV/ <240 mVpp
Parallel operation	With O-ring Diode	With O-ring Diode	With O-ring Diode	With O-ring Diode	With O-ring Diode	With O-ring Diode	With O-ring Diode	With O-ring Diode
Galvanic Isolation								
Input/output	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)	4 kVAC (type test)/3 kVAC (routine test)
Input/ground	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)	1.5 kVAC (type test)/1.5 kVAC (routine test)
Output/ground	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)	1.5 kVAC (type test)/500 Vac (routine test)

① Ratings for single-phase models are at 115 Vac; three-phase models are at 400 Vac.
② 85–264 Vac (DC input range 120–375 Vdc).
③ 320–575 Vac (DC input range 450–800 Vdc).

Table 30.5-37. PSG Series DC Power Supplies (Continued)

Capacity	PSG60E 60W	PSG120E 120W	PSG240E 240W	PSG480E 480W	PSG60F 60W	PSG120F 120W	PSG240F 240W	PSG480F 480W
General/Physical Data								
Housing material	Aluminum (Al5052)	Aluminum (Al5052)	Aluminum (Al5052)	Aluminum (Al5052)	Aluminum (Al5052)	Aluminum (Al5052)	Aluminum (Al5052)	Aluminum (Al5052)
Signals	Green LED for DC OK	Green LED for DC OK	Green LED for DC OK	Green LED for DC OK	Green LED for DC OK	Green LED for DC OK	Green LED for DC OK	Green LED for DC OK
MTBF	>800,000 hrs	>800,000 hrs	>300,000 hrs	>300,000 hrs	>500,000 hrs	>500,000 hrs	>300,000 hrs	>300,000 hrs
Dimensions (L)	121 mm	121 mm	121 mm	121 mm	121 mm	121 mm	121 mm	121 mm
Dimensions (W)	32 mm	50 mm	85 mm	160 mm	70 mm	70 mm	85 mm	160 mm
Dimensions (H)	120 mm	115 mm	118.5 mm	115 mm	118.5 mm	118.5 mm	120.5 mm	115 mm
Weight (kg)	0.37	0.54	1.04	1.8	0.56	0.72	0.77	1.71
Operating temperature	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)	–20°C to +75°C (>50°C derating)
Storage temperature	–25°C to +85°C	–25°C to +85°C	–25°C to +85°C	–25°C to +85°C	–25°C to +85°C	–25°C to +85°C	–25°C to +85°C	–25°C to +85°C
Operating humidity	<95% RH, non-condensing	<95% RH, non-condensing	<95% RH, non-condensing	<95% RH, non-condensing	<95% RH, non-condensing	<95% RH, non-condensing	<95% RH, non-condensing	<95% RH, non-condensing
Vibration (operating)	①	①	①	①	①	①	①	①
Pollution degree	2	2	2	2	2	2	2	2
Climatic class	3K3 according to EN 60721	3K3 according to EN 60721	3K3 according to EN 60721	3K3 according to EN 60721	3K3 according to EN 60721	3K3 according to EN 60721	3K3 according to EN 60721	3K3 according to EN 60721
Safety and Protection								
Transient surge voltage	Varistor	Varistor	Varistor	Varistor	Varistor	Varistor	Varistor	Varistor
Surge voltage protection against internal surge	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Safety class	Class I with ground connection	Class I with ground connection	Class I with ground connection	Class I with ground connection	Class I with ground connection	Class I with ground connection	Class I with ground connection	Class I with ground connection
Shock	②	②	②	②	②	②	②	②

① 10 to 150 Hz, 0.35 mm acc. 50 m/s/s, single amplitude (5G max.) for 90 min. in each X, Y, Z direction, in acc. with IEC 68-2-6.
② 30G (300 m/s/s) in all directions according to IEC 68-2-27.

Power Derating Curves

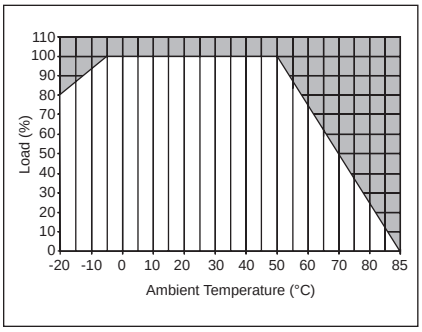


Figure 30.5-21. Vertical Mounting Position PSG60E

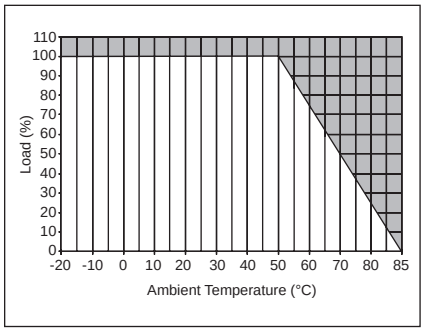


Figure 30.5-22. Vertical Mounting Position PSG60F, PSG120E, PSG120F, PSG480E, PSG480F

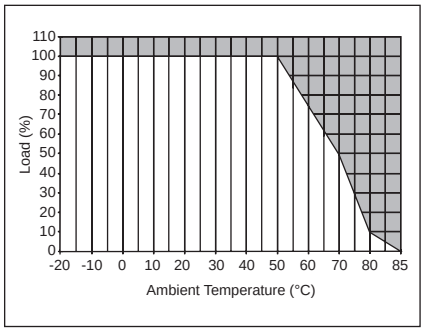


Figure 30.5-23. Vertical Mounting Position PSG240E, PSG240F

Dimensions—Approximate Dimensions in mm

Note: Dimensions are for reference only.

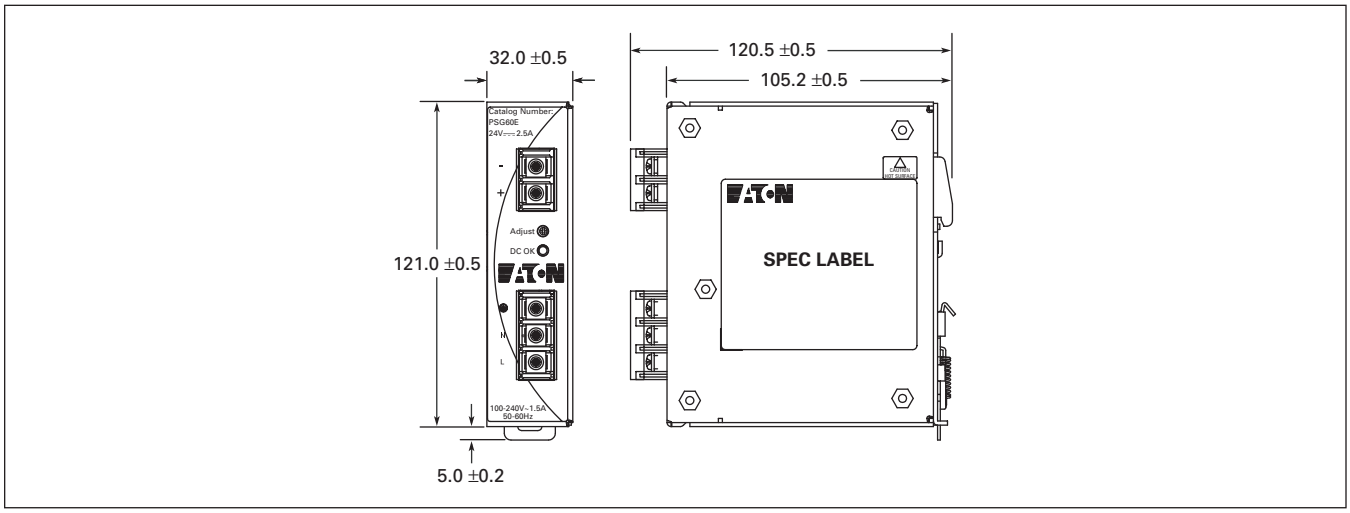


Figure 30.5-24. PSG60E

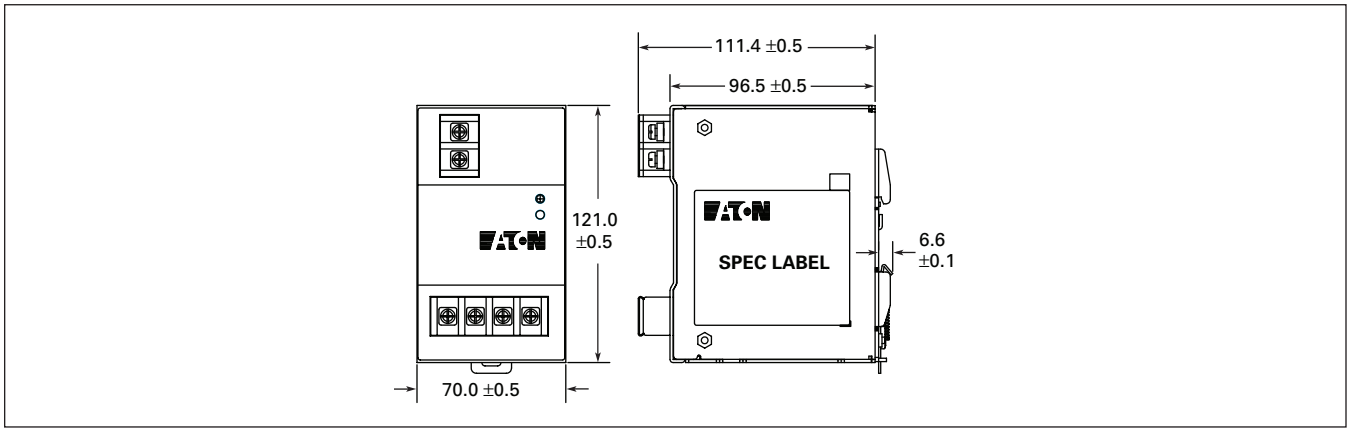


Figure 30.5-25. PSG60F

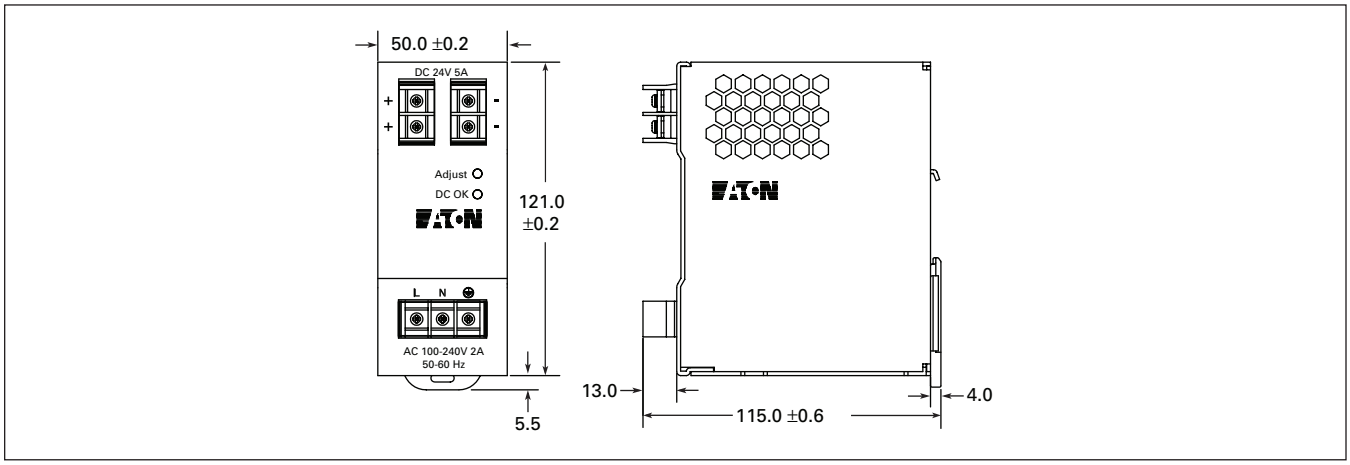


Figure 30.5-26. PSG120E

Dimensions—Approximate Dimensions in mm (Continued)

Note: Dimensions are for reference only.

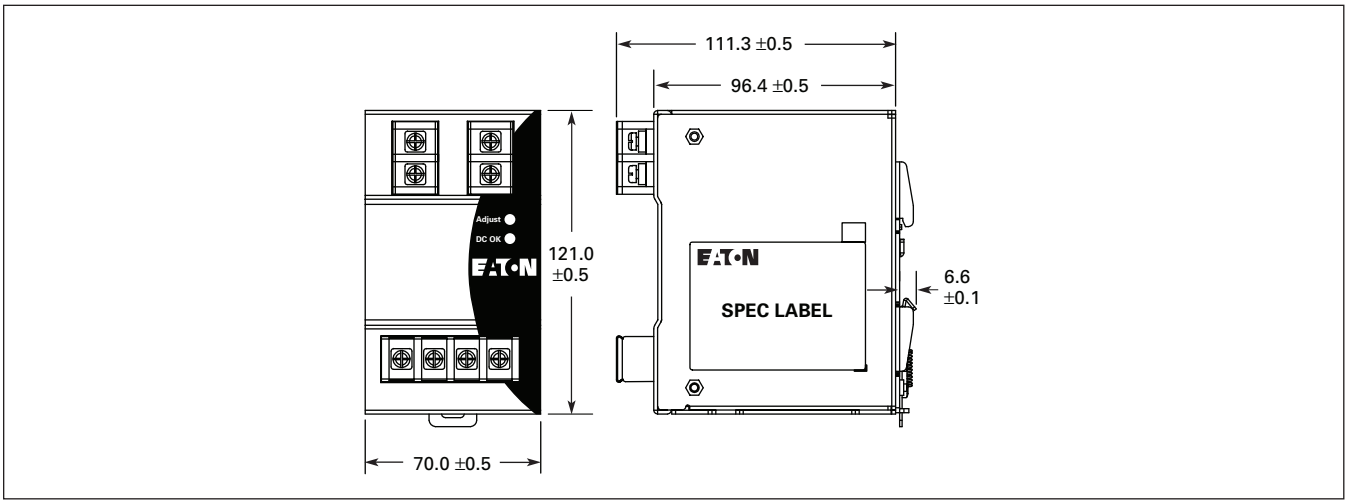


Figure 30.5-27. PSG120F

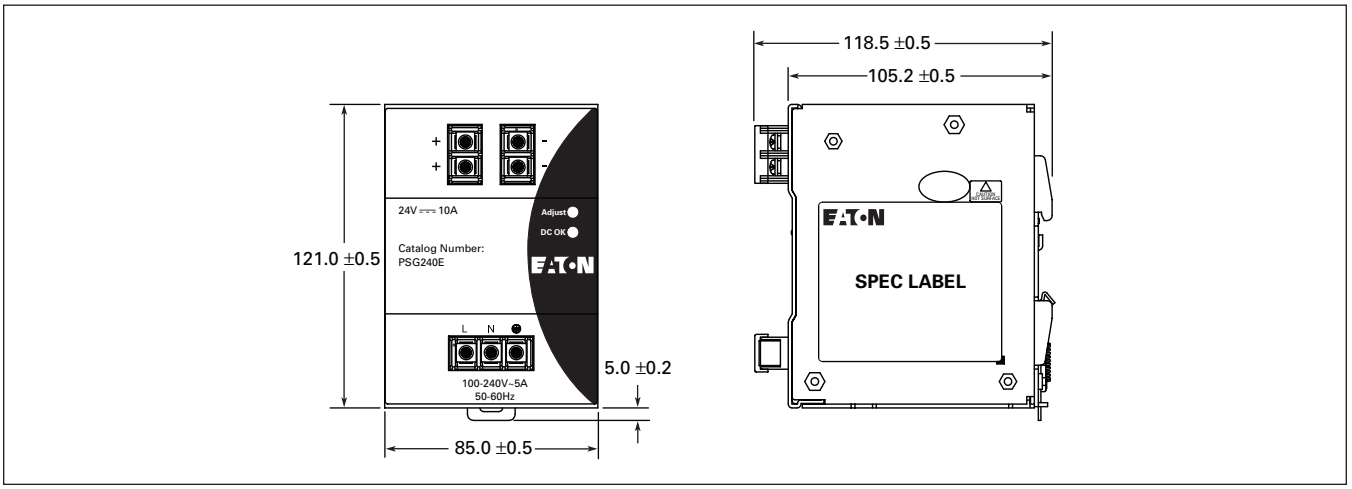


Figure 30.5-28. PSG240E

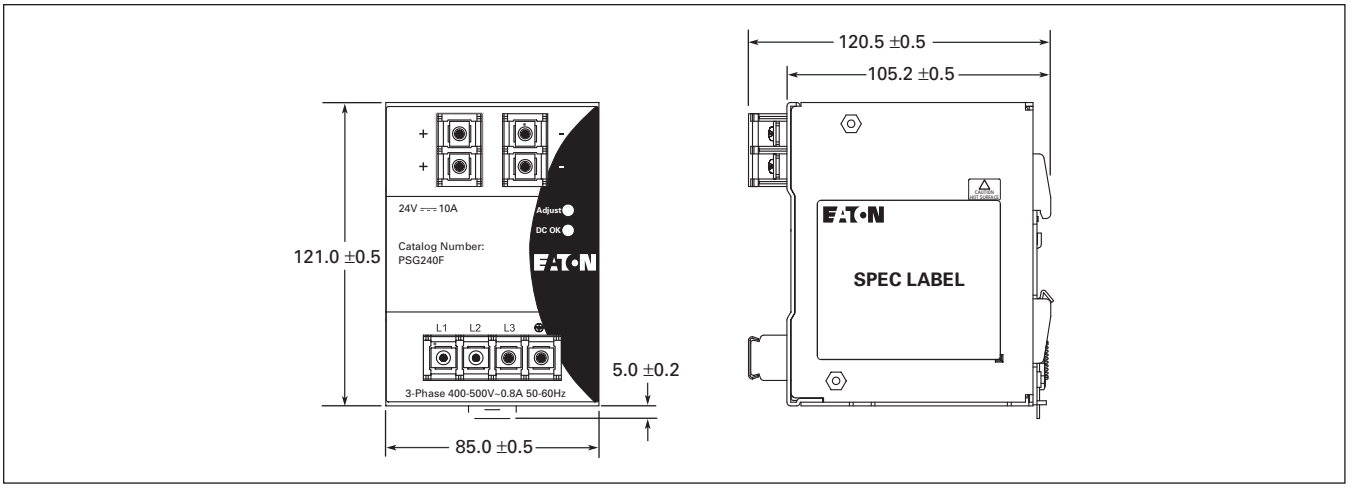


Figure 30.5-29. PSG240F

Dimensions—Approximate Dimensions in mm (Continued)

Note: Dimensions are for reference only.

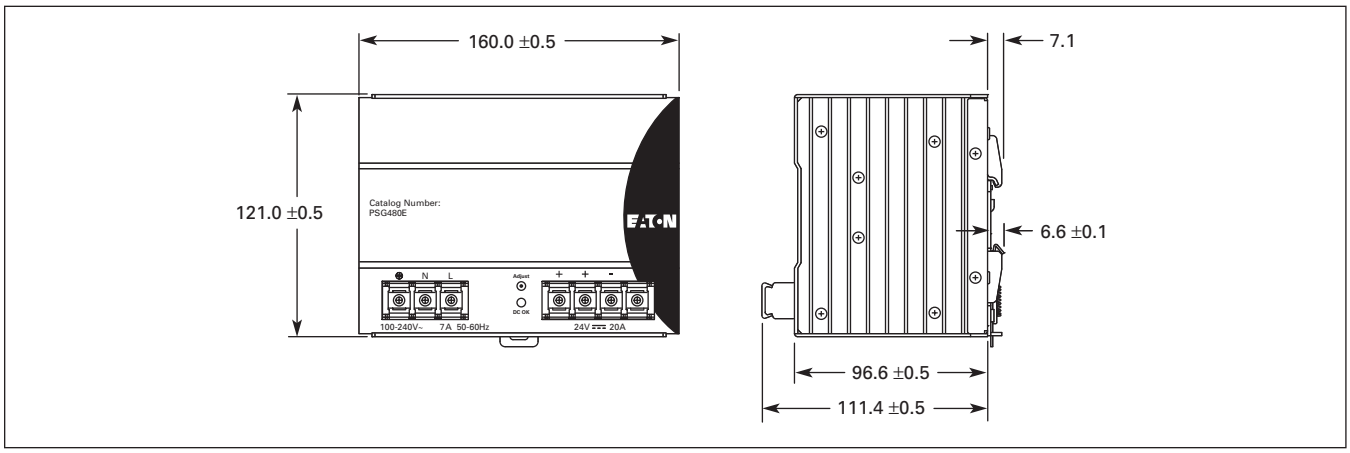


Figure 30.5-30. PSG480E

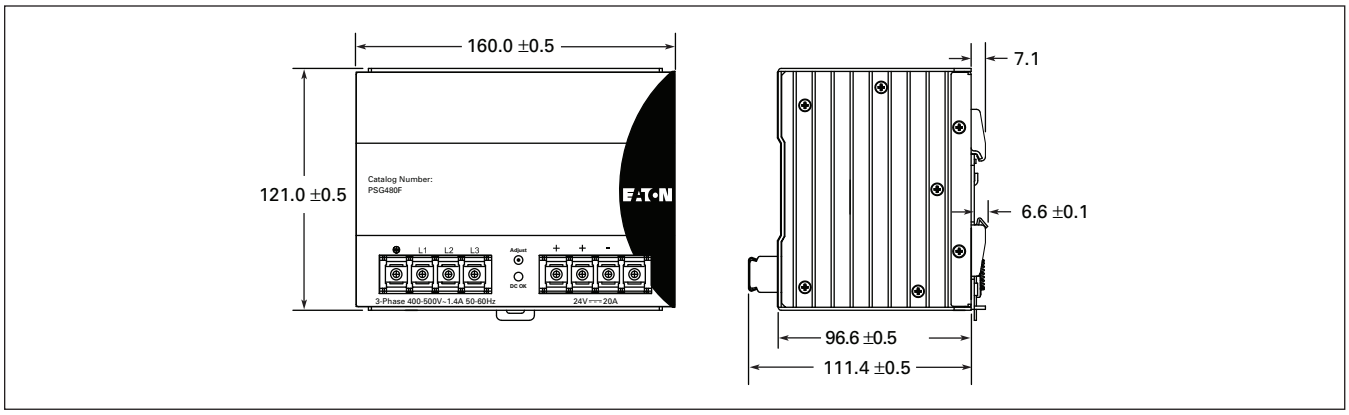


Figure 30.5-31. PSG480F

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General Information—Technical Reference

Enclosure Types

Enclosures provide mechanical and electrical protection for operator and equipment. Brief descriptions of the various types of Eaton's enclosures offered by Eaton are given below. See NEMA Standards Publication No. 250 for more comprehensive descriptions, definitions and/or test criteria.

Type 1

Type 1 (Conforms to IP40)—for Indoor Use

Suitable for most applications where unusual service conditions do not exist and where a measure of protection from accidental contact with enclosed equipment is required. Designed to meet tests for rod entry and rust resistance. Enclosure is sheet steel, treated to resist corrosion. Depending on the size, knockouts are provided on the top, bottom and sometimes on the side.

Type 3R

Type 3R (Conforms to IP52)—for Outdoor Use

Primarily intended for applications where falling rain, sleet or external ice formations are present. Gasketed cover. Designed to meet tests for rain, rod entry, external icing and rust resistance. Enclosure is sheet steel, treated to resist corrosion. Depending on the size, a blank cover plate is attached to the top (for a conduit hub) and knockouts are provided on the bottom.

Cover-mounted pilot device holes are provided and covered with hole plugs.

Type 4 (Conforms to IP65)—for Indoor or Outdoor Use

Provide measure of protection from splashing water, hose-directed water and wind blown dust or rain. Constructed of sheet steel with gasketed cover.

Designed to meet tests for hose-down, external icing and corrosion protection. When conduit connections are specified, enclosure has two watertight hubs (power) installed top and bottom or one control hub installed in bottom—depending on size.

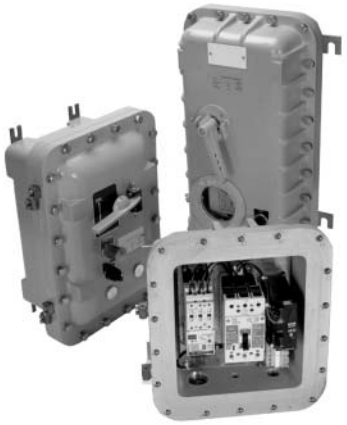
Cover-mounted pilot device holes are provided and covered with hole plugs.

Type 4X

Type 4X (Conforms to IP65)—for Indoor or Outdoor Use

Provide measure of protection from splashing water, hose-directed water, wind blown dust, rain and corrosion. Constructed of stainless steel with gasketed cover. Designed to meet same tests as Type 4 except enclosure must pass a 200-hour salt spray corrosion resistance test.

Provided as 304-grade stainless steel as standard. Select 316-grade option for improved corrosion resistance.



Type 7 & 9 Bolted

Type 7/9—for Hazardous Gas Locations

For use in Class I, Group B, C or D; Class II, Groups E, F and Class III indoor locations as defined in the National Electrical Code. Type 7/9 enclosures must withstand the pressure generated by explosion of internally trapped gases and be able to contain the explosion so that gases in the surrounding atmosphere are not ignited. Under normal operation, the surface temperature of the enclosure must be below the point where it could ignite explosive gases present in the surrounding atmosphere. Designed to meet explosion, temperature and hydrostatic design tests.

Type 12

Type 12—(Conforms to IP62)—for Indoor Use

Provide a degree of protection from dripping liquids (non-corrosive), falling dirt and dust. Designed to meet tests for drip, dust and rust resistance. Constructed of sheet steel. Hole plugs cover pilot device holes. There are no knockouts, hub cover plates or hubs installed.

Many Eaton Type 12 enclosures are suitable for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations as defined in the National Electrical Code.

Type 12—Safety Interlock

The Type 12 enclosure can be ordered with a safety interlock on the door that can be padlocked off. A vault-type door latch system is used. A tapered plate holds the gasketed door tight against the case edge to provide a positive seal. The special door interlock consists of the door handle and a screwdriver operated cover defeater.

The cover defeater and the disconnect interlock defeater are both recessed screwdriver operated devices which cannot be manipulated with other types of tools.

Table 30.6-1. IEC IP Index of Protection Ratings

1st Number	Description	2nd Number	Description
0	No protection	0	No protection
1	Protection against solid objects greater than 50 mm	1	Protection against vertically falling drops of water
2	Protection against solid objects greater than 12 mm	2	Protection against dripping water when tilted up to 15 degrees
3	Protection against solid objects greater than 2.5 mm	3	Protection against spraying water
4	Protection against solid objects greater than 1 mm	4	Protection against splashing water
5	Total protection against dust—limited ingress (dust protected)	5	Protection against water jets
6	Total protection against dust (dust-tight)	6	Protection against heavy seas
—	—	7	Protection against the effects of immersion
—	—	8	Protection against submersion

Table 30.6-2. NEMA Standard to IP Equivalence

Type	IP
1	40
3R	52
4	65
4X	65
12	62

Table 30.6-3. Enclosure Selection and Reference Chart—Box Dimensions in Inches (mm)

Box Designation	NEMA Enclosure Type	Width	Height	Depth
1	1	5.62 (142.7)	9.51 (241.6)	4.81 (122.2)
2	1	7.73 (196.3)	12.60 (320.0)	5.84 (148.3)
3	1	12.65 (321.3)	13.85 (351.8)	6.40 (162.6)
4	1	11.66 (296.2)	25.99 (660.1)	8.03 (204.0)
5	12, 3R, 4X	9.84 (250.0)	13.31 (338.1)	6.70 (170.2)
6	12, 3R, 4X	12.01 (305.1)	14.39 (365.5)	6.70 (170.2)
6A	12, 3R, 4X	12.01 (305.1)	14.39 (365.5)	8.44 (214.4)
7	12, 3R, 4X	12.26 (311.4)	14.37 (365.0)	6.70 (170.2)
7A	12, 3R, 4X	16.26 (413.0)	14.37 (365.0)	10.90 (276.9)
8	12, 3R, 4X	14.25 (362.0)	12.10 (307.3)	8.47 (215.1)
9	1, 12, 3R 4X	25.50 (647.7)	29.10 (739.1)	8.41 (213.6)
10	1, 12, 3R 4X	20.00 (508.0)	47.85 (1215.4)	10.48 (266.2)
A	1	10.50 (266.7)	27.06 (687.3)	6.66 (169.2)
A	12, 3R, 4X	10.50 (266.7)	28.98 (736.1)	6.66 (169.2)
A1	1	10.50 (266.7)	27.06 (687.3)	8.49 (215.6)
A1	12, 3R, 4X	10.50 (266.7)	28.98 (736.1)	8.49 (215.6)
B	1	15.50 (393.7)	23.06 (585.7)	6.66 (169.2)
B	12, 3R, 4X	15.50 (393.7)	24.98 (634.5)	6.66 (169.2)
B1	1	15.50 (393.7)	23.06 (585.7)	10.90 (276.9)
B1	12, 3R, 4X	15.50 (393.7)	24.98 (634.5)	10.90 (276.9)
C	1	20.50 (520.7)	30.50 (774.7)	8.44 (214.4)
C	12, 3R, 4X	20.50 (520.7)	32.36 (822.0)	8.44 (214.4)
D	1	29.50 (749.3)	35.00 (889.0)	8.75 (222.3)
D	12, 3R, 4X	29.50 (749.3)	38.10 (967.7)	8.75 (222.3)
E	1, 12, 3R, 4X	28.00 (711.2)	61.75 (1568.5)	10.68 (271.3)
F1E	1, 12, 3R, 4X	37.00 (940.0)	74.75 (1898.7)	19.25 (489.0)
F2E	1, 12, 3R, 4X	42.00 (1066.8)	92.90 (2360.0)	19.25 (489.0)
P1	1	8.50 (215.9)	32.98 (837.7)	6.66 (169.2)
P3	1	18.86 (479.0)	38.40 (975.4)	8.47 (215.1)
P5	1	21.00 (533.4)	48.40 (1229.4)	8.97 (227.8)
P7	1	28.80 (731.5)	60.58 (1538.7)	19.28 (489.7)
I	1, 12	8.62 (219.0)	27.06 (687.3)	6.66 (169.2)
J	1, 12, 3R	8.00 (203.2)	16.50 (419.1)	17.23 (437.6)
K	1, 12, 3R	8.00 (203.2)	19.50 (495.3)	7.23 (183.6)
L	1, 12, 3R	15.87 (403.1)	16.50 (419.1)	7.23 (183.6)
M	1, 12	15.87 (403.1)	24.50 (622.3)	7.23 (183.6)

Note: See Eaton's Enclosed Control guide or Web site for further details on enclosures.

Table 30.6-4. Noncombination Solid-State Reduced Voltage Box Dimensions

Ampere Rating	SSRV	Non-combination Box No. ①	Ampere Rating	SSRV	Non-combination Box No. ①
0.8–27	S752	6A ②	304	S801/S811	G1
37	S801/S811	7A	360	S801/S811	G1
50	S752	6A ②	420	S801/S811	10
66	S801/S811	7A	500	S801/S811	10
105	S801/S811	7A	650	S801/S811	10
135	S801/S811	B1	720	S801/S811	10
180	S801/S811	C	850	S801/S811	10
240	S801/S811	G1	1000	S801/S811	10

① Enclosure space will also accommodate for a DC Power Supply, two four-pole relays, a CPT and terminal blocks. Also includes space for a DNA module or MOV.

② Same as footnote ①, but CPT is not included. Upsize to 7A enclosure to include space for a CPT and a full voltage bypass contactor.

Table 30.6-5. Combination Solid-State Reduced Voltage Box Dimensions

Ampere Rating	SSRV	Comb. with Fuses Box No. ③	Comb. with HMCP Box No. ③	Ampere Rating	SSRV	Comb. with Fuses Box No. ③	Comb. with HMCP Box No. ③
0.8–27	S752	B1 ④	A1 ⑤	304	S801/S811	F1E	E
37	S801/S811	B1	A1 ⑤	360	S801/S811	F1E	E
50	S752	C	A1 ⑤	420	S801/S811	F1E	E
66	S801/S811	C	A1	500	S801/S811	F1E	E
105	S801/S811	D	B1	650	S801/S811	F1E	F1E
135	S801/S811	D	C	720	S801/S811	F1E	F1E
180	S801/S811	E	E	850	S801/S811	F1E	F1E
240	S801/S811	F1E	E	1000	S801/S811	F1E	F1E

③ Enclosure space will also accommodate for a DC Power Supply, two four-pole relays, a CPT and terminal blocks. Also includes space for a DNA module or MOV.

④ Enclosure may be reduced to an A1, with all space for all items as in footnote ③, excluding relays and CPTs.

⑤ Same as footnote ③, but CPT is not included. Upsize to B1 enclosure to include space for a CPT and a full voltage bypass contactor.

Note: For enclosure box dimensions, refer to table above.

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Group Control Multi-Pak

Multi-Pak Four Compartment Enclosure Showing Variety of Possible Equipment Module Combinations Available

Application Description

Eaton's Multi-Pak Group Control is designed to save time, space, and expense in installing motor control devices—whether for residential, commercial, or industrial buildings. The modular assembly allows versatile, on-the-job arrangement of Sizes 1 through 4 combination starters with ambient compensated relays, incoming or feeder circuit breakers or fusible disconnect switches, pushbuttons, control transformers, timers, relays, and fuses. The enclosures and separate, pre-wired modules are field-stocked and can be ordered individually, permitting field tailoring to suit the application.

Benefits

- Enclosures and pre-wired equipment modules are individually available from stock. Each shipping carton contains complete mounting and installation instructions
- Cuts installation time by 25 percent. The pre-wired modules can be installed easily, using only a screwdriver, at the job site
- Saves space over individually mounted control
- Can be wall or rack mounted
- Has flexible panel space for auxiliary control items. Barriers can be removed to provide oversized compartments
- Eliminates square duct or cable entrance box
- Simplifies wiring
- Permits quick, easy additions and rearrangements
- UL listed—E69852, Guide NITW

Enclosure Features

The Type 1 enclosures are partitioned into either four or six compartments, to hold combination starter modules, incoming or feeder circuit breakers, fusible switches, or other auxiliary devices. The barriers can be removed to provide oversized spaces. Each enclosure holds up to four Size 1 or 2 full-voltage, non-reversing combination starter modules; up to two Size 3 or 4 starter modules, or a combination of both size ranges.

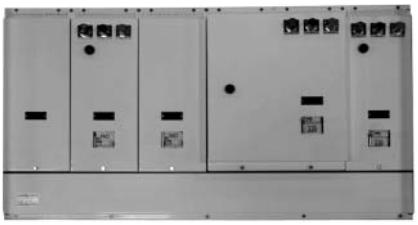
The compartments have hinged doors, interlocked to prevent opening when the breaker switch is in the ON position. The disconnect operating mechanism can be padlocked in the OFF position.

The Multi-Pak enclosure adapts easily to installation requirements. Multiple units can be arranged to suit the space available—horizontally on a single line or two-high. Knockouts are provided at the top, bottom and sides of the enclosures for conduit connection. Conduit can be installed and cables pulled as dictated by the construction schedule. Combination starter modules and incoming or feeder devices can be installed days, months or years later.

In addition to the barrier compartments, the enclosure contains two wiring troughs. The top section is a wireway fitted with three power terminal straps, each having terminals for extension to adjoining enclosures and to all four compartments. The incoming line and extension terminals are suitable for either copper or aluminum conductors, from No. 6 to 350 kcmil. At the bottom of the enclosure is another wiring trough for interconnecting wiring and outgoing cables.

Hinging of the front doors provides for easy access to each module. The doors are also gasketed with a fire-retardant material. Knockouts are provided on the doors for the mounting of pushbuttons and indicating lights.

The enclosure and wireway cover plates come in ASA-70 light gray enamel. An identification card retainer is mounted on each compartment door. A dust- and weather-resistant enclosure to house the Type 1 enclosure is also available.



Typical Six Compartment Multi-Pak After Assembly

Combination Starter Modules

Eaton's starter modules consist of a Class A200 magnetic line-starter, prewired with a motor circuit protector or a fusible DS disconnect switch on a panel. Full-voltage non-reversing and reversing, combination starters are available. An external reset button is mounted on the starter module door. With its versatile, modular design, the Multi-Pak starter permits a variety of motor control groupings. One module can contain many different arrangements of devices, such as combination linestarter with control transformers, and/or relays, or two feeder circuit breakers, or fusible switches.

The contactor design comprises a glass polyester case with silver-cadmium oxide alloy contacts, straight-through wiring, out-front terminals, molded coils, stainless steel kickout springs, U-type magnet, and a shock absorber baseplate.

The circuit breakers, equipped with adjustable magnetic trip elements, protect against short circuits. Standard three-pole, inverse-time, and ambient compensated thermal overload relays protect against overload.

Fusible switches are equipped to accept either 250V or 600V Class H, K, and R cartridges fuses, with capacities as listed by Underwriters Laboratories for overcurrent protection.

ON-OFF operating mechanisms are molded from an ABS fire-resistant material.

Components of each module have individual printed labels identifying size, voltage, ampere rating and so on. The labels also contain a schematic drawing reference number covering the wiring of the component contained in the module.

Technical Data

Dimensions and Wiring Arrangements

Four compartment enclosures are 32.00 inches (812.8 mm) wide, 26.00 inches (660.4 mm) high, and 7.00 inches (177.8 mm) deep with provisions for four-bolt wall mounting. Six compartment enclosures are an additional 16.00 (406.4) inches wide. Enclosures may be grouped together by nippling through knockouts provided.

Load and control conduits may enter at the top or bottom. Starter wiring diagram and overload heater installation instructions are attached to each starter door.

Dust and weather-resistant enclosures for four or six module units are available. These enclosures are 34.00 inches (863.6 mm) or 50.00 inches (1270.0 mm) wide, 31.00 inches (787.4 mm) high, and 11.75 inches (298.5 mm) deep.

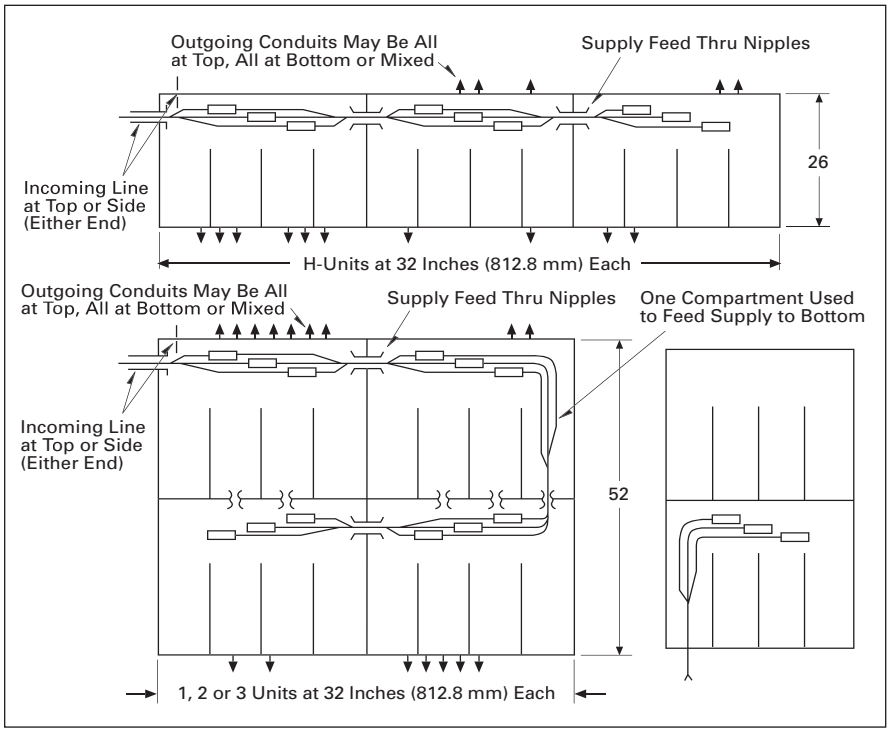


Figure 30.7-1. Wiring Arrangements

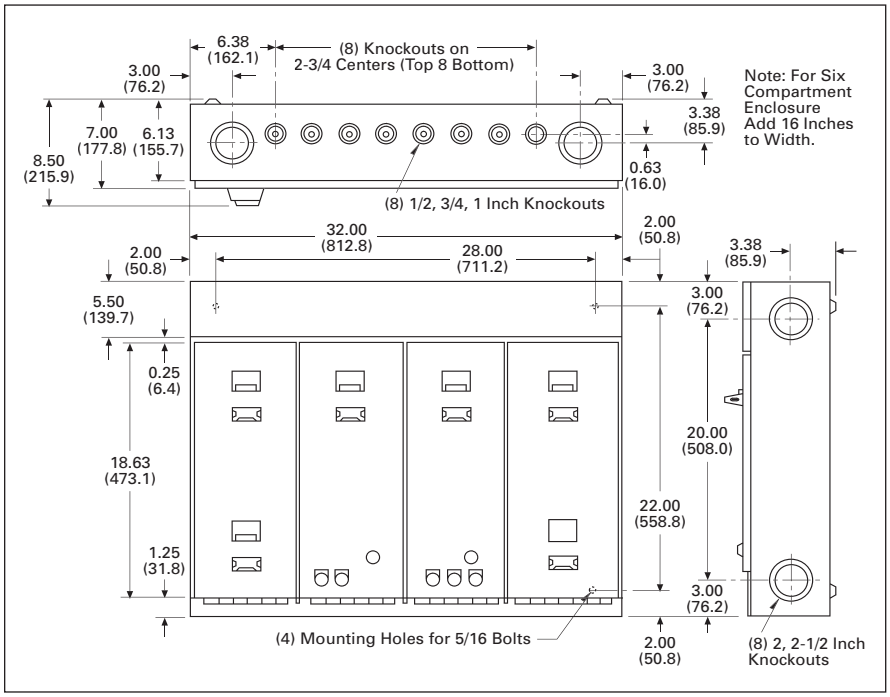


Figure 30.7-2. Type 1 Enclosures—Dimensions in Inches (mm)