PowerCap Series

Low Voltage Capacitor and Harmonic Filter Banks

PFC Series

Harmonic Series

Filter Series

Main Contactor Unit (MCU)

Installation Manual

If you find information in this manual that is incorrect, misleading, or incomplete, we would appreciate your comments and suggestions.

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Contents

1 Safety Warnings and Instructions

IMPORTANT SAFETY INSTRUCTIONS
SAVE THESE INSTRUCTIONS

This manual contains important instructions to be followed during installation of this device.

DANGER

- The system contains **LETHAL VOLTAGES**. All repairs and service should be performed by **AUTHORIZED PERSONNEL ONLY.**
- Death, serious injury, or fire hazard may result from improper connection or operation of the supplied equipment. Read and understand this manual before connecting the PowerCap.

WARNING

- Verify that capacitors are discharged and electrically safe (0 V) by using a voltmeter to measure the phase-to-phase and phase-to-ground voltages on the capacitor terminals.
- This equipment may present an arc flash hazard. Personal Protection Equipment may be required. Refer to NFPA 70E for the section related to Standard for Electrical Safety in the Workplace.
- The PowerCap contains energy storage devices (capacitors) that can present a shock hazard with primary power disconnected. Capacitors remain charged until the internal discharge resistor bleeds off residual charge. Always wait a minimum of one (1) minute before touching a de-energized capacitor terminal. All local applicable safety and electrical standards and specifications in addition to the generally recognized codes of practice must be observed.

CAUTION

- Do not install or operation this system close to a gas or electric heat source.
- The operating environment should be maintained within the parameters stated in technical specifications of this manual.
- Keep area surrounding the PowerCap uncluttered, clean, and free from excessive moisture and atmospheric particulates.

2 PowerCap Series fixed capacitor for load-side compensation

- The PowerCap Series consists of fixed capacitor banks and filters (capacitor and reactor) in both NEMA 1 and NEMA 3R enclosures.

Series	Enclosure	kVAR range @ 480Vac or 600Vac	Mounting
PFC	A	2.5–25 kVAR	Wall or Floor
PFC	B	30–50kVAR	Wall or Floor
PFC	D	55–100kVAR	Wall or Floor
PFC	E	120–150kVAR	Wall or Floor
Harmonic	S	120–200kVAR	Floor
Harmonic	T	200–300kVAR	Floor
Filter	P	25–100kVAR	Floor
Filter	Q	110–200kVAR	Floor

- Description

  Power factor is the ratio of working power (kW) to apparent power (kVA). It measures how effectively electrical power is being used. A high-power factor (maximum 1.0) signals efficient utilization of electrical power, while a low power factor (below 0.85 – 0.90 depending on electrical utility) indicates poor utilization of electrical power.

  Many electrical utilities penalize customers with a power factor below a specific threshold detailed in the utility tariff (rates). By adding a power factor correction capacitor these penalties can be avoided by raising the power factor. In addition, a higher power factor can increase electrical system available capacity.

  The Powerside PowerCap Series correction capacitors are metalized polypropylene capacitors which offer self-healing features to extend the device life when subjected to potentially damaging transients. Segmentation of the metalized component serves to limit the amount of energy available during the self-healing process and will completely isolate the localized short circuit before it can grow to affect multiple layers of film.

  Options include blown fuse indicator (BFI), power-on light indicator, indoor/outdoor enclosure and detuned filter.

3 Installation

- Unpacking

  It is recommended to position the PowerCap as close as possible to the operating site before unpacking it to prevent damage due to shipping.

- Removing the shipping packaging

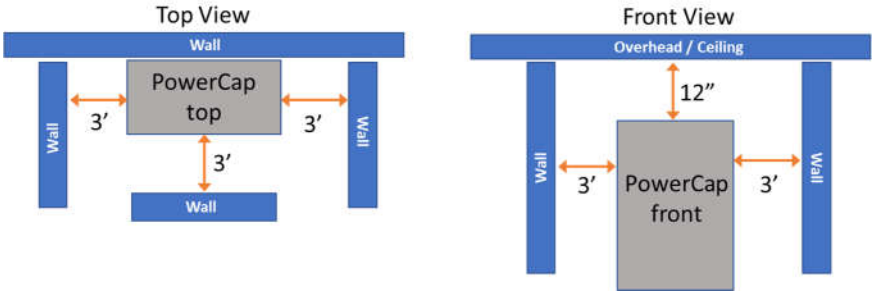
  Thoroughly inspect the shipping packaging and PowerCap for possible shipping damage.

- Inspection upon unpackaging
  - Inspect the enclosure for any dents or bent mounting brackets.
  - Verify NEMA type correction for location. See equipment label for type
    - Remove the PowerCap front panel (see enclosure-specific information in this manual) Inspect for loose materials
    - Inspect for loose wiring or connectors.
    - Inspect for bent or dented capacitor cells
  - If damage(s) are found, file a claim against the transportation company, and contact Powerside for service and the return material authorization (RMA) procedure. **Under no circumstances should a damaged PowerCap be energized prior to contacting Powerside.**

- Lifting

  To ensure personal safety, verify weight of the unit to ensure proper lifting techniques and weight limits. Use mechanical lifting aids where appropriate. Ensure the work area is clear of any trip hazards while lifting.

- Installation Clearance



- Verify Electrical Ratings

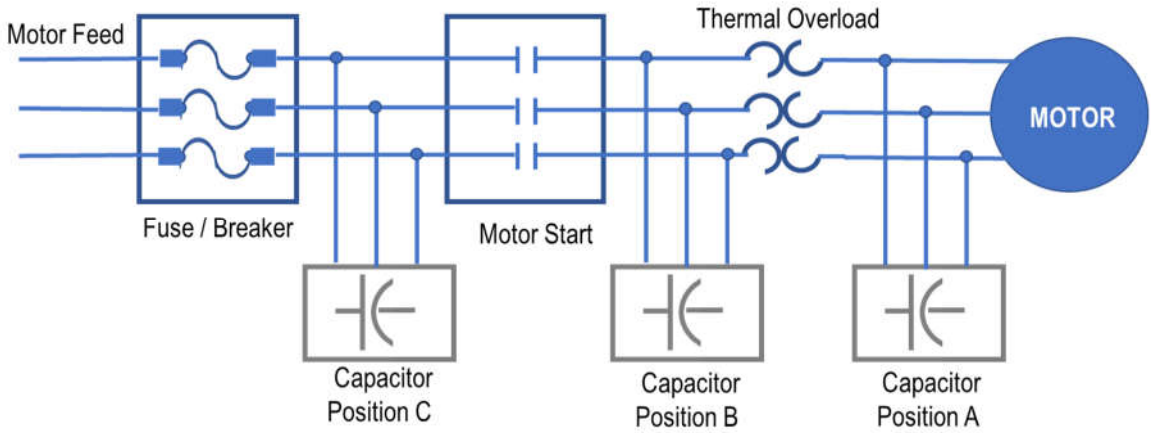
  Confirm that the PowerCap nameplate voltage rating is suitable for the supply line voltage. In case of a ratings mismatch contact Powerside before installation. Note that capacitors can operate at a maximum of 110 percent over the nameplate rated voltage.

- Electrical Wiring

  The system must be connected through an electrical disconnect switch or an over current protection device. **Refer to national and local electric codes (NFPA 70 or CSA C22.1) for acceptable external wiring practices. See recommended ampacity ratings in Section 5.**

Power leads inside the enclosure should be without kinks or loops. Leads length should be such that no strain is applied to the power lead connectors. Terminal block connections should be tightened to the specified torque rating that is indicated near power distribution block.

- Typical Installing Locations at the motor load



Locating Capacitor at Motor Circuits

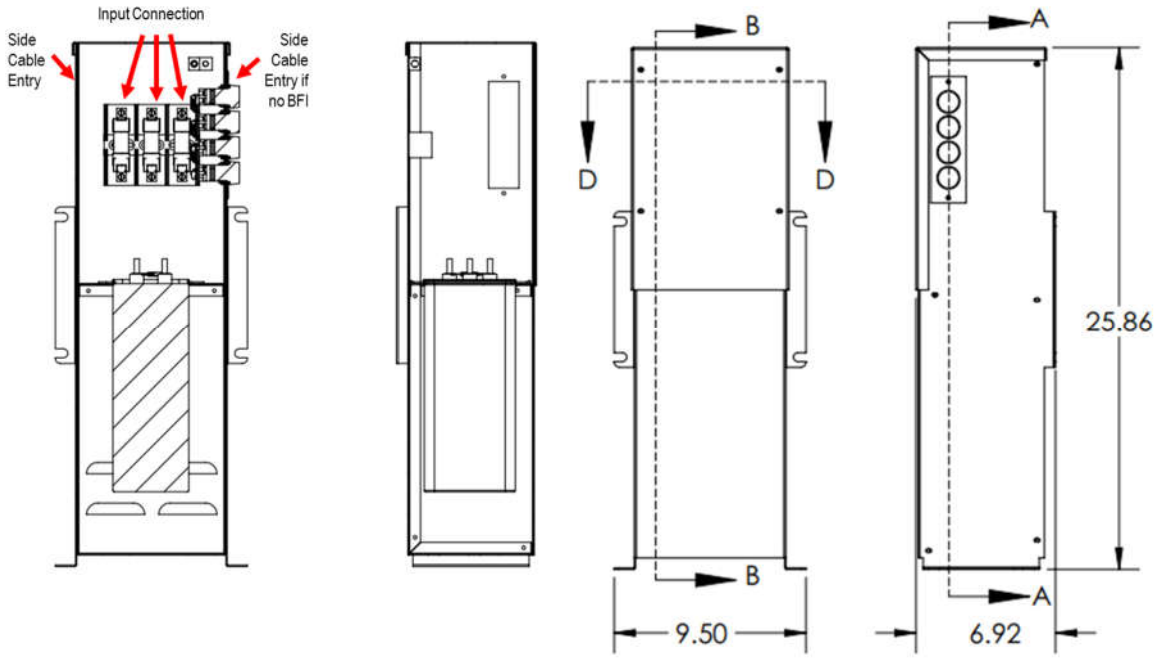
CAUTION: As per IEEE std 141, section 8.9.2, **never** connect a PowerCap shunt to a motor (capacitor position A or B) when the following conditions are true:

1- Solid-state starters are used.
2- Open transition starters are used.
3- The motor is subject to repetitive switching, jogging, inching or plugging.
4- Multi-speed motor is used.
5- Reversing motor is used.
6- High-inertia load may drive the motor.

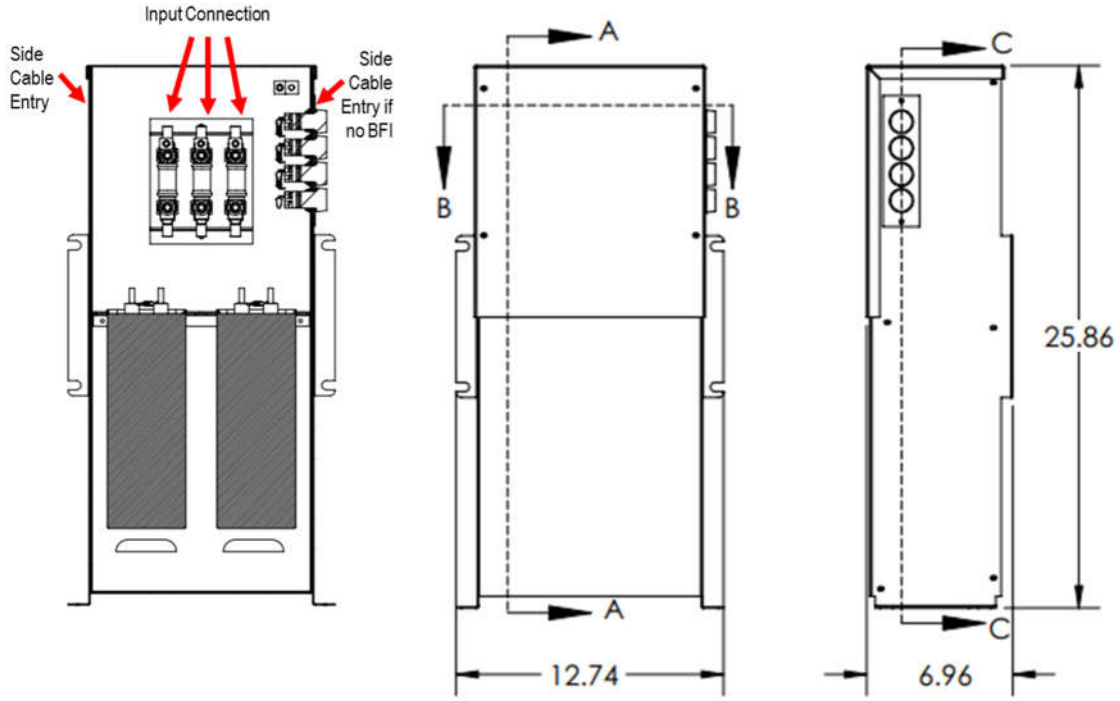
- **Capacitor position A: shunt capacitor at motor**
  New motor installations where the overload device can be sized with reduced current draw or with existing motors where no overload setting change is required.
- **Capacitor position B: shunt capacitor at overload device**
  Existing motors where overload device rating is higher than permitted by the NEC
- **Capacitor position C: shunt capacitor on the line side of the motor starter**
- **Capacitor position D: service feeder (not shown in graphic)**
  For applications with continuous inductive loads the fixed capacitor/filter may be installed on the service feeder. Note that for this application the overload protection device must be sized at a minimum of 135% from the capacitors current rating.

3 Mechanical—Dimensions and Cable Entry

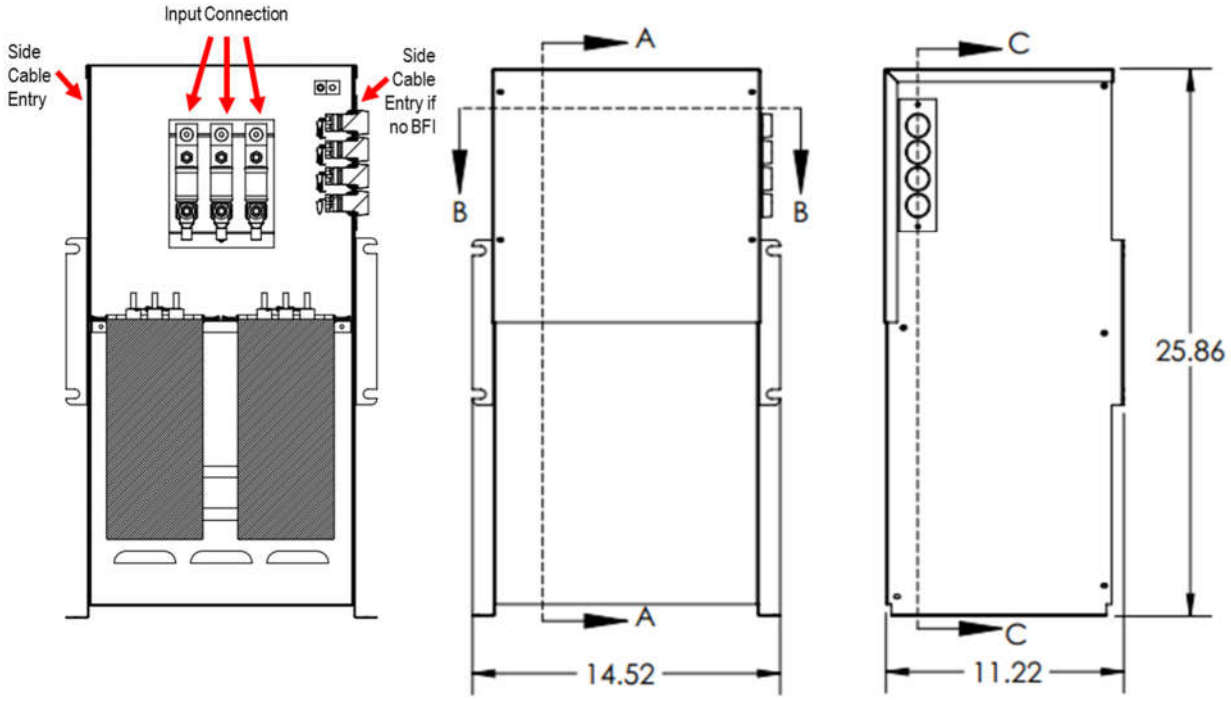
3.1 Enclosure Style A: 5—25 kVAR



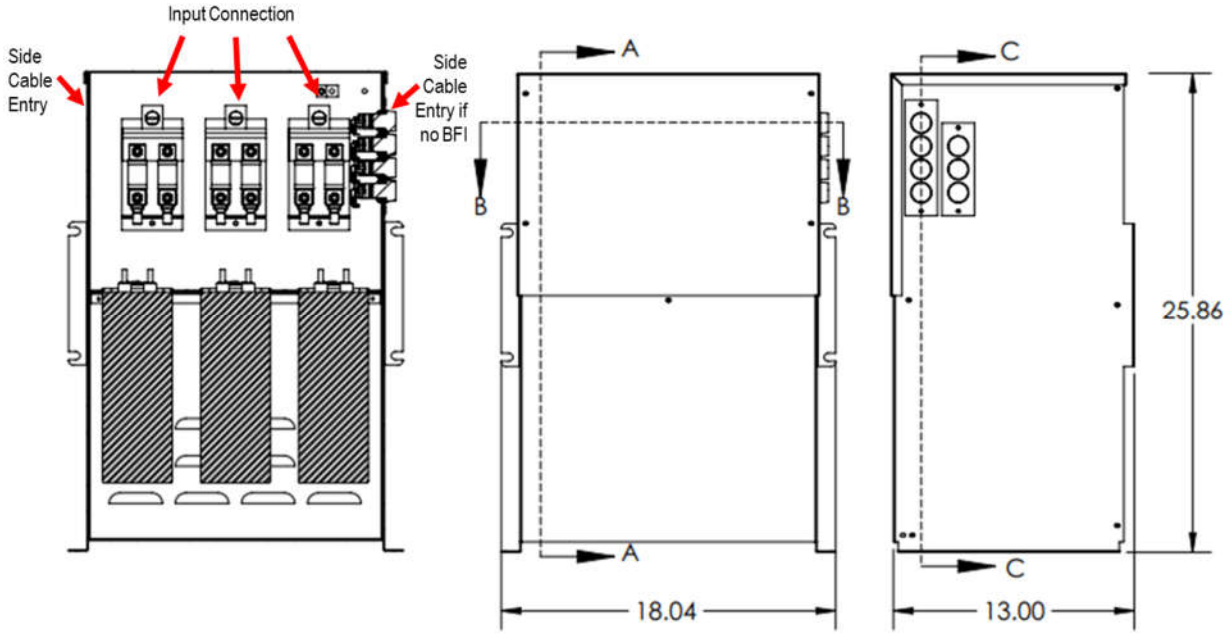
3.2 Enclosure Style B: 30—50 kVAR



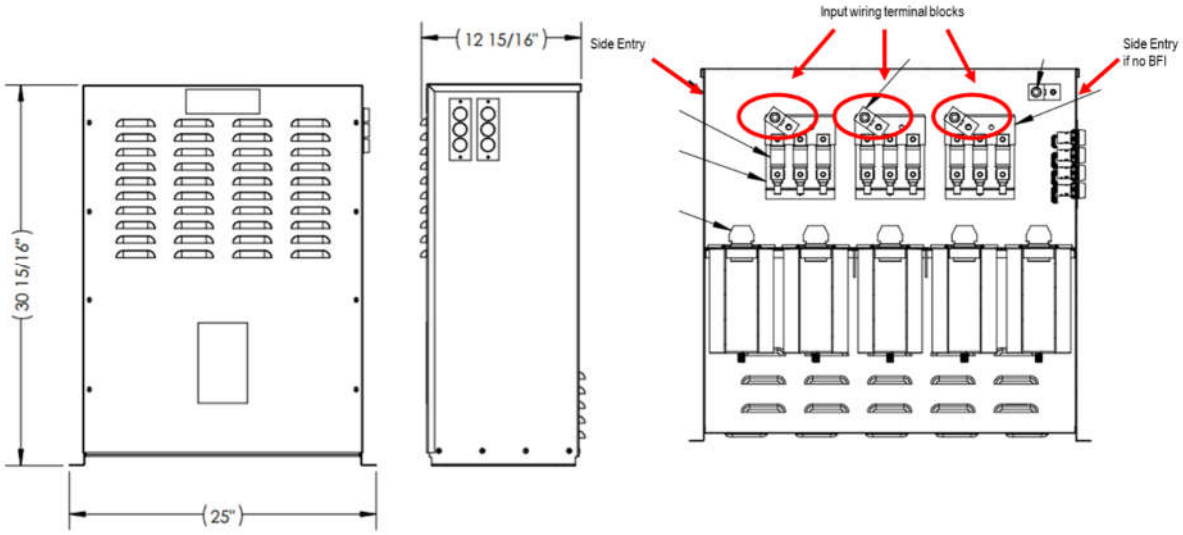
3.3 Enclosure Style D: 55—100 kVAR



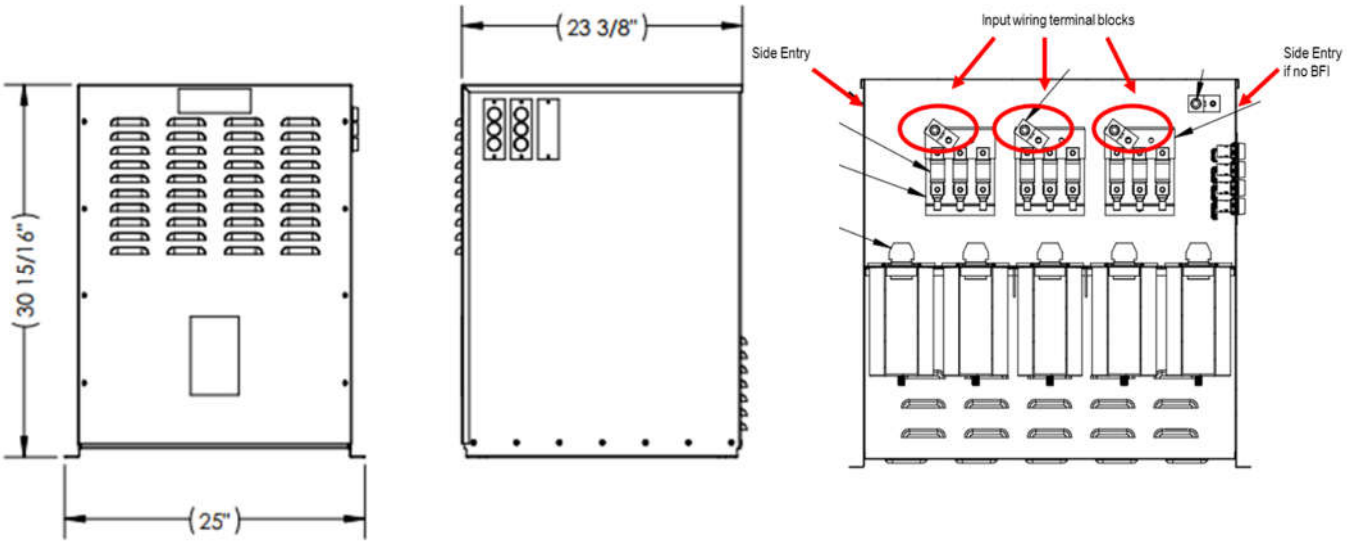
3.4 Enclosure Style E: 120—150 kVAR



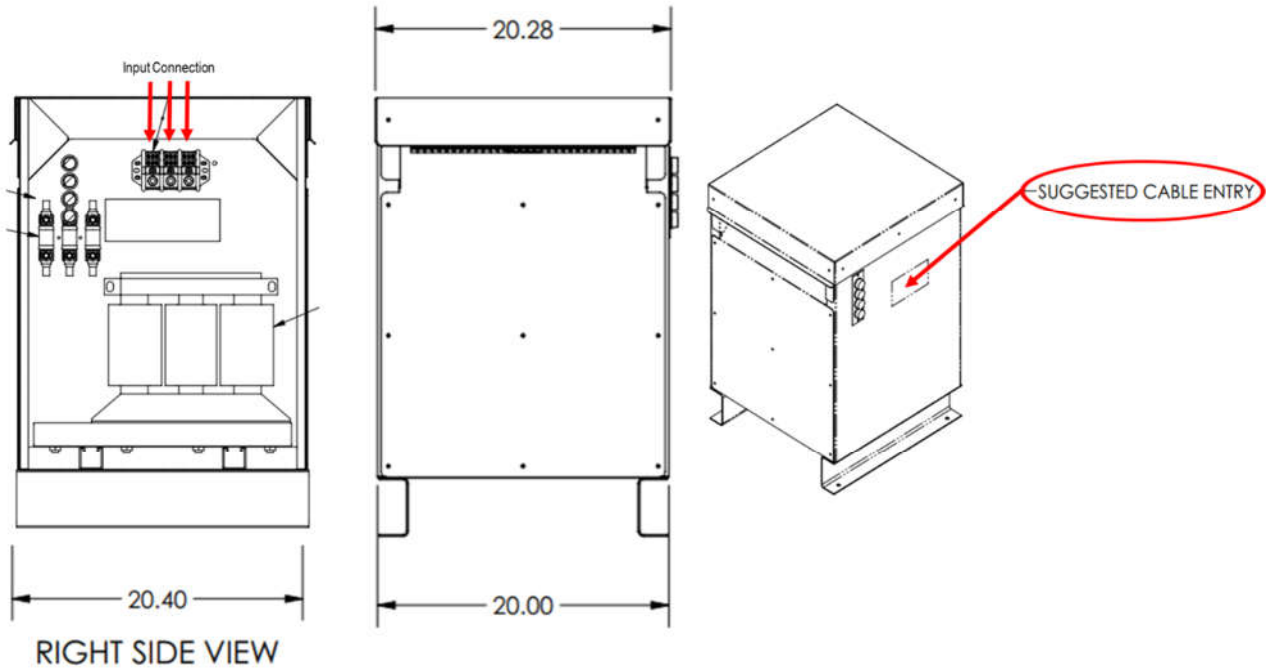
3.5 Enclosure Style S: 120—200 kVAR



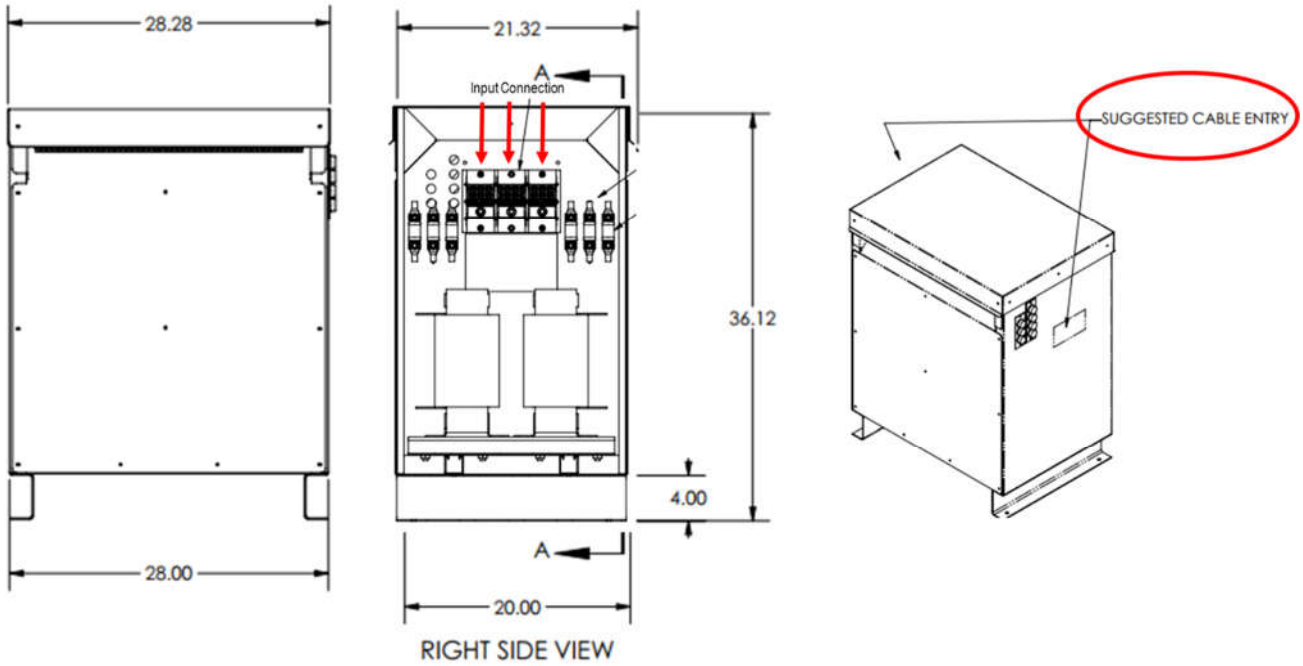
3.6 Enclosure Style T: 200—300 kVAR



3.7 Enclosure Style P: 25—100 kVAR Filter



3.8 Enclosures Style Q: 110—200 kVAR Filter



4 Inspection, Testing and Maintenance

- **INSPECTION / INTEGRITY CHECK**

  To verify application and installation, a test and inspection for electrical integrity should be made within 8 to 24 hours from the PowerCap being energized. Additional inspections should be made at a 12-month interval when service is lightly loaded as this produces the maximum service line voltage. **See this manual safety warning before proceeding.**

- **DEENERGIZE INSPECTION**

  _____ General visual inspection to both exterior and interior. Ensure there are no traces of overheating such as burnt spots, discoloring, melting or deformed materials.

  _____ Inspect capacitors cans for signs of bulging, leaks or deformation.

  _____ Clean the system inside and out of dust or other particulates using vacuum or compressed air if required

  _____ Check for loose or disconnected power cables or control wires.

  _____ Check electrical connections for proper torque

  _____ Clean ventilation openings and fan

  _____ Replace vent filters if applicable

  _____ Measure and record the capacitance of each step using a capacitance or multimeter.

  - For steps with multiple capacitors cells measure at a common point. For filters measure at the load side of the reactor (bottom lugs). For non-filtered measure it at the load side of the contactor.
  - Sum the reading for all phases (AB + AC + BC = capacitor total) and document in the worksheet
  - Compare to minimum top maximum range in Appendix Table 2

  _____ Measure and record fuse continuity using a volt or multimeter

- **ENERGIZED INSPECTION AND TESTING:**

  - Restore power by closing the upstream breaker
  - Blown Fuse Indicators (optional) will illuminate when the fault (blown fuse) occurs.
  - Using an infrared imager (if available) inspecting or loose connections or blow fuse. Test should be performed while load is active. Retorque as needed.
  - Using a voltmeter, verify fuse is not blown. Compare to blown fuse indicator if equipped.
  - Using a multimeter verify the following:
    - phase-to-phase voltage readings are balanced
    - maximum voltage rating of the capacitor are within the rating listed on the capacity rating plate
    - phase currents are balanced.

- Three-phase current *does not exceed 130% (PFC Series) and, 160% (Harmonic Series)* of the rated kVAR current. See table 5 for nominal current ratings.

- **SYSTEM MAINTENANCE**

  If the Integrity/System checks specify a failed capacitor, contact Powerside to verify the application and order a replacement capacitor.

5 Ampacity and Capacitance Tables

	240 Vac			480 Vac			600 Vac		
kVAR	Current	Fuse (min)	Switch (min)	Current	Fuse (min)	Switch (min)	Current	Fuse (min)	Switch (min)
0.5	1.2	3	30	-	-	-	-	-	-
1	2.4	6	30	1.2	3	30	1.4	3	30
1.5	3.5	6	30	1.8	3	30	1.4	3	30
2	4.8	10	30	2.4	6	30	1.9	6	30
2.5	6	10	30	3	6	30	2.4	6	30
3	7.2	15	30	3.6	6	30	2.9	6	30
4	9.6	20	30	4.8	10	30	3.8	10	30
5	12	20	30	6	10	30	4.8	10	30
6	14	25	30	7.2	15	30	5.8	10	30
7.5	18	30	30	9	15	30	7.2	15	30
8	19	35	60	9.6	20	30	7.7	15	30
10	24	40	60	12	20	30	9.6	30	30
12.5	30	50	60	15	25	30	12	20	30
15	36	60	60	18	30	30	14	25	30
17.5	42	80	100	21	40	60	17	30	30
20	48	80	100	24	40	60	19	35	60
22.5	54	100	100	27	50	60	22	40	60
25	60	100	100	30	50	60	24	40	60
30	72	125	200	36	60	60	29	50	60
35	84	150	200	42	80	100	34	60	60
40	96	175	200	48	80	100	38	80	100
45	108	200	200	54	100	100	43	90	100
50	120	200	200	60	100	100	48	100	100
60	144	250	400	72	125	200	58	100	100
75	180	300	400	90	150	200	72	125	200
80	190	350	400	96	175	200	77	150	200
90	216	400	400	108	200	200	86	150	200
100	241	400	400	120	200	200	96	175	200
120	289	500	600	144	200	200	115	200	200
125	300	500	600	150	250	400	120	200	200
150	360	600	600	180	300	400	144	250	400
180	432	750	800	216	400	400	173	300	400
200	481	800	800	241	400	400	192	350	400
240	-	-	-	289	500	600	231	400	400
250	-	-	-	300	500	600	241	400	400
300	-	-	-	361	600	600	289	500	600
360	-	-	-	432	750	800	346	600	600
400	-	-	-	480	800	800	384	650	800

Note: Fuses furnished within the capacitor assembly may be rated at a higher value than shown in Table 1 above. The table is correct for field installations and reflects Powerside's suggested rating for overcurrent protection and disconnect means. in compliance with the National Electrical Code (NFPA 70)

Table1. Recommended fuses and breaker rating plug for 3-phase, 60 Hz PowerCap PFC, Harmonic and Filter Series.

	208 Vac (μF)		240 Vac (μF)		480 Vac (μF)		600 Vac (μF)	
kVAR	Min	Max	Min	Max	Min	Max	Min	Max
0.5	15.3	17.6	11.5	13.2	2.9	3.3	1.8	2.1
1.0	30.7	35.3	23	26.5	5.8	6.6	3.7	4.2
1.5	46	52.9	34.5	39.7	8.6	9.9	5.5	6.4
2.0	61.3	70.5	46.1	53	11.5	13.2	7.4	8.5
3.0	92	105.8	69.1	79.4	17.3	19.9	11.1	12.7
4.0	122.6	141	92.1	105.9	23	26.5	14.7	16.9
5.0	153.3	176.3	115.1	132.4	28.8	33.1	18.4	21.2
7.5	229.9	264.4	172.7	198.6	43.2	49.6	27.6	31.8
10.0	306.6	352.5	230.3	264.8	57.6	66.2	36.8	42.4
12.5	383.2	440.7	287.8	331	72	82.7	46.1	53
15.0	459.8	528.8	345.4	397.2	86.3	99.3	55.3	63.6
17.5	536.5	616.9	403	463.4	100.7	115.8	64.5	74.1
20.0	613.1	705.1	460.5	529.6	115.1	132.4	73.7	84.7
22.5	689.8	793.2	518.1	595.8	129.5	148.9	82.9	95.3
25.0	766.4	881.4	575.6	662	143.9	165.5	92.1	105.9
27.5	843	969.5	633.2	728.2	158.3	182	101.3	116.5
30.0	919.7	1057.6	690.8	794.4	172.7	198.6	110.5	127.1
35.0	1073	1233.9	805.9	926.8	201.5	231.7	128.9	148.3
40.0	1226.2	1410.2	921	1059.2	230.3	264.8	147.4	169.5
45.0	1379.5	1586.4	1036.1	1191.6	259	297.9	165.8	190.7
50.0	1532.8	1762.7	1151.3	1324	287.8	331	184.2	211.8
55.0	1686.1	1939	1266.4	1456.4	316.6	364.1	202.6	233
60.0	1839.3	2115.5	1391.6	1588.8	345.4	397.2	221	254.2
65.0	1992.6	2291.5	1496.7	1721.2	374.2	430.3	239.5	275.4
70.0	2145.9	2467.8	1611.8	1853.6	403	463.4	257.9	296.6
75.0	2299.2	2644.1	1726.9	1986	431.7	496.5	276.3	317.8
80.0	2452.5	2820.3	1842.1	2118.4	460.5	529.6	294.7	338.9
85.0	2605.7	2996.6	1957.2	2252.8	489.3	562.7	313.2	360.1
90.0	2759	3172.5	2072.3	2383.2	518.1	595.8	331.6	381.3
95.0	2912.3	3345.1	2187.5	2515.6	546.9	628.9	350	402.5
100.0	3065.6	3525.4	2302.6	2648	575.6	662	368.4	423.7

Table 2: Minimum and Maximum Total Capacitance (phase measurement: A-B + AC + BC = total) in μF

6 Product Specification

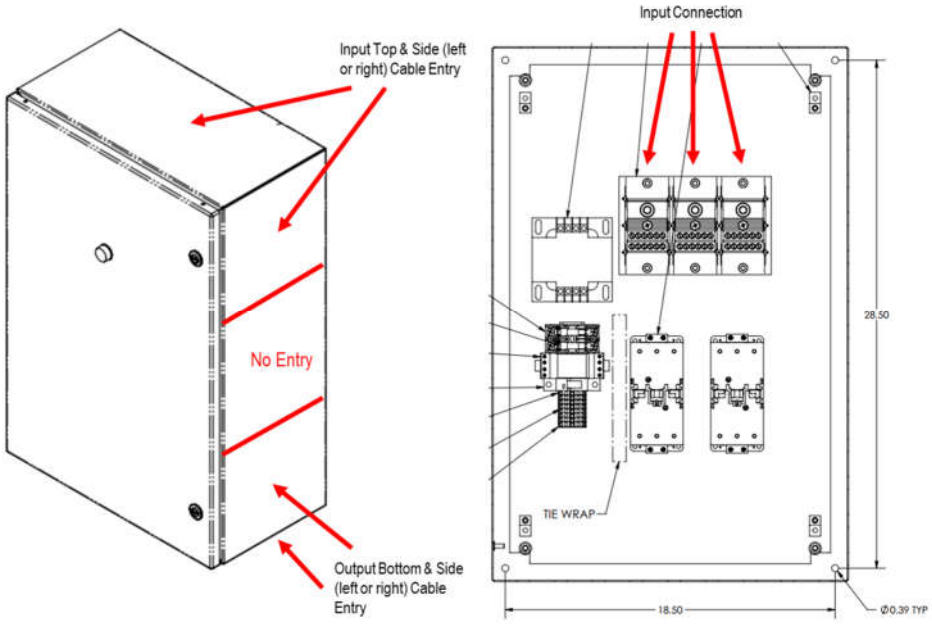
Series											
PowerCap Family	PFC			Harmonic			Filter			Main Contactor Unit	
Compensation type	Fixed Capacitor			Fixed Capacitor			Fixed Filter			N/A	
Capacity	2.5 - 150 kvar			120 - 300 kvar			25 - 200 kvar			2.5 - 200 kvar Switching	
Voltage	480V — 600 Vac			480V — 600 Vac			480V — 600 V			480V—600 Vac	
Maximum Steps	1			1			1			2	
Filter tuning	None			None			De-tuned			None	
Thermal protection	None			None			Over temperature on reactor core			None	
Reactor construction	N/A			N/A			PolyGap			N/A	
Network Harmonics	Low			Moderate			High			Low to High	
Load Characteristics	Fixed			Fixed			Fixed			Variable (step)	
Switching Type	None			None			None			Contactor	
Power factor controller	None			None			None			Adjustable time delay current relay	
Maximum continuous voltage	110% (130% for 1 min)			110% (130% for 1 min)			110% (130% for 1 min)			110%	
Maximum continuous current	135%			165%			165%			Consult Factory for application specific ratings	
Operating temperature F/C	-40° to 113° -40° to 45°			-40° to 140° -40° to 60°			-40° to 140° -40° to 60°			-40° to 140° -40° to 60°	
Maximum Altitude (ASL)	3,281 feet (1,000 m)			13,123 feet (4,000 m)			3,281 feet (1,000 m)			3,281 feet (1,000 m)	
Enclosure rating	NEMA 1 (optional 3R)			NEMA 3R			NEMA 3R			NEMA 4	
Mounting	Floor/Wall			Floor/Wall			Floor			Wall	
Capacitor Cells	Dry			Dry			Dry			N/A	
	Type	HxWxD	lb/kg	Type	HxWxD	lb/kg	Type	HxWxD	lb/kg	HxWxD	lb/kg
Enclosure Type, Dimensions in/mm, Weight lb/kg	A B D E	9.5x25.9x6.9 657x241x176 12.7x25.9x7 657x324x177 14.5x25.9x11.2 657x367x285 18.0x 25.9x13.0 657x458x330	25 11 37 17 17 60 27 85	S T	26.6x22.7x12.7 786x625x311 31x25x24.4 786x625x594	95 43 141 64	P Q	30.1x20.0x21.3 765x127x536 36.1x28.0x20.0 918x714x536	141 64 427 194	30x20x12 762x508x305	92 42

7 Main Contactor Unit

The Main Contactor Unit (MCU) provides the ability to connect/disconnect up to two (2) 100kVAR PowerCap power factor correction capacitors. Control is either by:

- Contactor Only (PC part number prefix):
  Allows control of a PowerCap capacitor bank or filter by an external application with 120Vac coil voltage for contactor control supplied externally by third parties or
- Contactor with time/current relay (PA part number prefix):
  Contactor controlled from adjustable time delay current relay. System requires the installation of a current transformer (CT) to measure the load to be power factor corrected. CT included (specify load amperage and type at time of order)

7.1 Wiring—Point of Entry and Dimensions



WARNING: In the case of a two-contactor unit, input feeder ampacity must equal the sum of the two capacitor units connected on the output.

WARNING: Do not parallel the ouptut of the contactor.

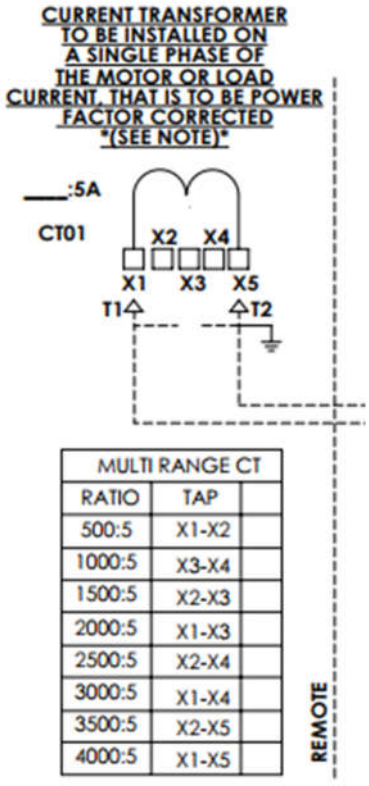
WARNING: Each contactor must be connected to its own separate capacitor unit.

7.2 Wiring—PC00 Series (contactor externally controlled and powered):

- Refer to supplied drawings for component locations
- Connect:
  - utility power to Power Distribution Block E01output connections of contactor K01 to capacitor unit 1 (maximum 100kVAR).

- Output connections of contactor K02 to capacitor unit 2 (if utilized) (maximum 100kVAR).
- Contactor coil control signal (externally provided, 120Vac) to Terminal Block X2 and X3.

7.3 Wiring—PA00 Series (contactor activation internally controlled and powered):



MULTI RANGE CT		
RATIO	TAP	
500:5	X1-X2	
1000:5	X3-X4	
1500:5	X2-X3	
2000:5	X1-X3	
2500:5	X2-X4	
3000:5	X1-X4	
3500:5	X2-X5	
4000:5	X1-X5	

- Install current transformer provided
- CT installation note: The current transformer (CT) must be installed on a single phase of the motor or load current to be power factor corrected. The CT stickers must be facing the incoming power and not the load.
- If a multi range CT is provided:
  - Tap the multi-range CT as show in the drawing (provided here and on the installation drawing) to the correct CT ratio (table provided here and in drawing) for the CT secondary (T1 &T2). For example, 500:5 = x1 (+)-X2, 1000:5 = x3 (+)-X4
- For all CT types:
  - The connection must be made from enclosure terminal T1 (+) to XX and T2 (-) to XX of the CT.
  - **WARNING: secondary of the CT must be connected to shorting block (terminal location T1 & T2) before energizing the system. An open circuit on the CT secondary may contain lethal voltages.**
  - Connect utility power to Power Distribution Block E01
  - Connect Output connections of Contactor K01 to capacitor unit 1 (maximum 100kVAR).
  - Connect Output connections of Contactor K02 to capacitor unit 2 (if utilized) (maximum 100kVAR).

7.4 Current Relay Factory Settings:

- "Trip delay" Tripping time 30s (max)
- "Inhibition time" Inhibition delay for external input or at power up 30s
- "Aut. reset delay" Not applicable for this configuration
- "Mode" A

Mode	Relay	Latch
A	Off	Off
B		On
C	On	Off
D		On

7.5 Current Relay Customer Settings:

- "Imax" Maximum current tripping threshold should be set to less than the full load as a percentage of the CT range. For example: Assuming a 500:5 CT with a 300A max load (300 is 60% of 500A) the Imax should be set to a value less than 60%.
- "Hysteresis" Maximum hysteresis threshold—set to 15% (recommended initial setting)

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