CLASS 5840
REACTIVAR™ Medium Voltage Power Factor Capacitors Fixed: Fused and Unfused

The REACTIVAR Medium Voltage Fixed Power Factor Correction Capacitors from SQUARE D are constructed with environmentally friendly non-chlorinated biodegradable dielectric liquid.

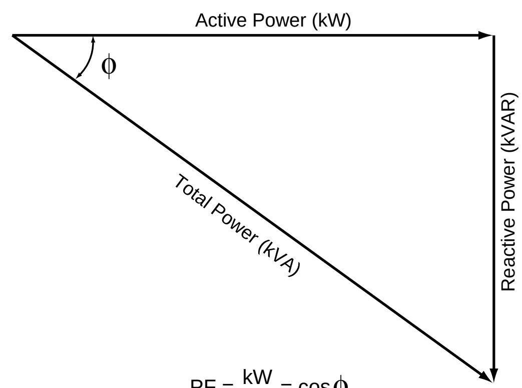
- Comprised of aluminium foil electrodes with a non-chlorinated biodegradable dielectric liquid and a polypropylene film
- Available up to 600 kVAR, 4,800 Volt (other ranges can be offered on request)
- The dielectric made solely of plastic film helps to greatly reduce dielectric losses
- Discharge resistor in each capacitor to bring voltage down to 50V in less than 5 minutes after de-energization
- Operating temperature ranges from -40°C to +45°C (-40°F to +113°F)
- Capacitors can be put into service at low temperatures without any special precautions. At higher temperatures, the temperature rise is very low so they can operate without any risks of modifying the insulation characteristics of the dielectric
- The dielectric liquid has very high chemical stability, dielectric strength and absorption capacity for gases generated during partial discharges. These intrinsic properties contribute to the exceptional life of the capacitors
- Large terminal chamber for easy cable connections. Ground lug, size 1/0 provided
- Available in Type 1/12 indoor and 3R outdoor enclosure types
- ASA 61 light gray finish
- Complies with NEMA, CSA and IEC standards

Most Utilities levy a penalty on consumers that draw high reactive power or have poor power factor. Improving the power factor has various economic and technical advantages. The economic advantages are to cut down on electricity bill by reducing excessive consumption of reactive power, to eliminate the need for oversizing of transformers, cables, switching and protection devices. The technical benefits are to increase power available at the secondary of the transformers, reduce voltage drop in MV distribution networks and reduce temperature rise in cables as they conducts less current.

The REACTIVAR Medium Voltage Capacitors (MVC) offered by SQUARE D are designed for installation on medium voltage distribution systems where the load does not change or the capacitor is switched with the load. They are best suited in electrical networks where there are no harmonics.

Federal Pioneer
Merlin Gerin
Modicon
Square D
Telemecanique

Schneider Electric



$$PF = \frac{kW}{kVA} = \cos\phi$$

Figure 1

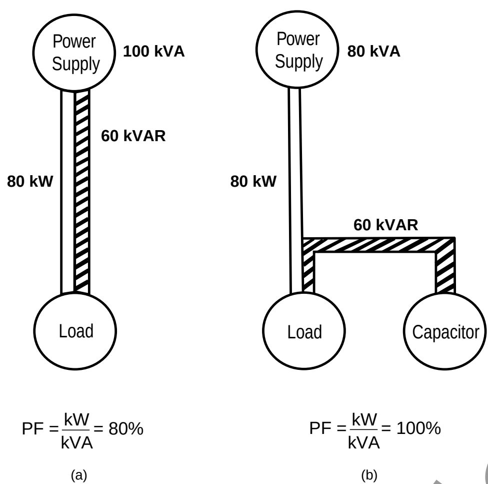


Figure 2

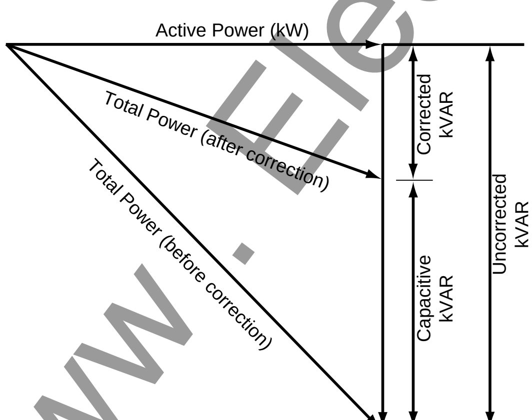


Figure 3

The total current required by inductive loads such as motors, transformers, and fluorescent lighting may be considered to be made up of two separate types of current.

Active current (or power producing current) is the current, which is converted into usual work such as turning a lathe, providing light or pumping water. The power produced by this component is the *kilowatt (kW)*.

Reactive current (also known as wattless, magnetizing or non-working current) is the current which provides the magnetic flux necessary for the operation of these loads but is not converted into useful work. The power produced by this component is the *kilovar (kVAR)*.

The *total current* is the current that is measured on an ammeter. It is the sum of both the active and the reactive components. The power produced by the total current is measured in *kilovolt amperes (kVA)*.

Power Triangle

The relations between the various power components and the system voltage are illustrated in the power triangle shown in *Figure 1*. From *Figure 1*, it is apparent that the active power component is in phase with the applied voltage while the reactive component occurs 90 degrees out of phase with the voltage.

The equation that defines this relationship is:

$$\mathbf{kVA^2 = kW^2 + kVAR^2}$$

Power factor is the ratio of Real Power Consumed to Total Power Consumed (kW/kVA) and is in fact, a measure of efficiency. When the power factor reaches unity (as measured at the utility power meter), it can be said that the plant is operating at maximum efficiency. Depending on the local utility rate structure, a power factor below unity may result in higher utility power bills than are necessary.

Power Factor Correction

Power factor can be improved by either increasing the active power component or reducing the reactive component. Of course, increasing the active power component for the sole purpose of power factor correction would not be economically feasible. Thus, the only practical means for improving a systems power factor is to reduce the reactive power component.

One method of reducing this component is to provide reactive power locally at the load. This method will improve the power factor from the point where the reactive power source is connected back to the source. As an example, consider the load in *Figure 2a*. The total power required is 100 kVA of which 80 kW is active power and 60 kVAR is reactive power. If the reactive power is furnished locally *(Figure 2b)*, the power system has to carry 80 kVA (80 kW). Thus the power factor (from the point where the reactive power is locally supplied back to the source) is improved to unity.

Capacitors for Power Factor Correction

Properly selected, capacitors offer an ideal means for improving the power factor of an inductive load. When a capacitor is connected to an inductive load, it acts as a reactive power generator locally furnishing the necessary reactive current required by the inductive load. In fact, power factor capacitors are rated in kVAR to indicate their reactive power generating capability.

Capacitors are able to perform this function since they draw a leading current which will effectively cancel lagging inductive current, complete cancellation of the two current components occur and the reactive power component will be reduced to zero. This is illustrated in *Figure 3*.

The result of improved power factor is reduced utility demand resulting in lower utility demand charges, released system capacity and lower system losses.

PFC Selection for Individual Motors

1. Select a capacitor kVAR size from Table 1 to match motor HP and speed. From the tables below, select a capacitor catalog number that matches the kVAR rating and motor voltage. If an exact size is not available, select the next ***lower*** size. Capacitors selected from Table 1 will correct ***full load*** motor PF to approximately 95%.

2. Consult Square D/Schneider Electric for application of capacitors on motor frame types other than shown on Table 1.

3. When capacitors are applied on the load side of the motor overload protection device (as shown in Figure 5), reduce the overload trip setting by the percentage (%AR) value in Table 1.

4. When the motor is controlled by other than full voltage non-reversing across the line starters, locate the capacitors upstream from the controller. ***Do not*** apply capacitors on the load side of motor starters when motors are subject to reversing, inching, jogging or plugging, or that are multi-speed, open transition, solid state, or when the load may drive the motor such as with cranes or elevators. ***Never*** apply capacitors in the presence of variable frequency drives, welders, soft starters or other non-linear loads. See application note on page 5.

Suggested Capacitor Ratings (kVAR)

Motor Rating (HP)	Nominal Motor Speed											
	3600 RPM		1800 RPM		1200 RPM		900 RPM		720 RPM		600 RPM	
	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR
100	25	7	25	10	25	11	25	11	25	12	25	17
120	25	7	25	9	25	10	25	10	25	11	50	15
150	25	7	25	8	25	8	25	9	50	11	50	15
200	25	7	50	6	50	8	50	9	50	10	75	14
250	50	7	50	5	50	8	50	9	75	10	100	14
300	50	7	50	5	75	8	75	9	75	9	100	12
350	50	6	50	5	75	8	75	9	75	9	100	11
400	50	6	50	5	75	6	100	9	100	9	100	10
450	75	5	75	5	75	6	100	8	100	8	100	8
500	75	5	75	5	100	6	125	8	125	8	125	8
600	75	5	100	8	100	5	125	7	125	8	125	8
700	100	5	100	5	100	5	125	7	150	8	150	8
800	100	5	125	5	125	5	150	7	150	8	150	8
900	125	5	150	5	200	5	200	6	250	7	250	7
1000	150	5	200	5	250	5	250	6	250	7	250	7
1250	200	5	200	5	250	5	300	5	300	6	300	6

Table 1. Medium Voltage NEMA Class B Induction Motors

NOTE: The above table is to be used for NEMA Class B induction motors with FVNR starters only. For other motor types or starters, please contact the Square D/Schneider Electric for assistance.

Product Offering

2400 Volt – 3 Phase / 60 Hz ◆

Capacitor kVAR Rating	Indoor Type 1 Enclosure		Indoor Type 12 Enclosure		Outdoor Type 3R Enclosure		Enclosure■	Rated Current [A]	Weight lb [kg]
	Fused▲	Unfused	Fused▲	Unfused	Fused▲	Unfused			
50	MVC24050F2	MVC24050	MVC24050DF2	MVC24050D	MVC24050RF2	MVC24050R	1	12.02	148(67)
75	MVC24075F2	MVC24075	MVC24075DF2	MVC24075D	MVC24075RF2	MVC24075R	1	18.04	150[68]
100	MVC24100F2	MVC24100	MVC24100DF2	MVC24100D	MVC24100RF2	MVC24100R	1	24.06	152[69]
125	MVC24125F2	MVC24125	MVC24125DF2	MVC24125D	MVC24125RF2	MVC24125R	1	30.07	163[74]
150	MVC24150F2	MVC24150	MVC24150DF2	MVC24150D	MVC24150RF2	MVC24150R	1	36.09	170[77]
175	MVC24175F2	MVC24175	MVC24175DF2	MVC24175D	MVC24175RF2	MVC24175R	1	42.10	181[82]
200	MVC24200F2	MVC24200	MVC24200DF2	MVC24200D	MVC24200RF2	MVC24200R	1	48.11	188[85]
225	MVC24225F2	MVC24225	MVC24225DF2	MVC24225D	MVC24225RF2	MVC24225R	1	54.13	197[89]
250	MVC24250F2	MVC24250	MVC24250DF2	MVC24250D	MVC24250RF2	MVC24250R	1	60.14	208[94]
275	MVC24275F2	MVC24275	MVC24275DF2	MVC24275D	MVC24275RF2	MVC24275R	2	66.16	291[132]
300	MVC24300F2	MVC24300	MVC24300DF2	MVC24300D	MVC24300RF2	MVC24300R	2	72.17	298[135]
325	MVC24325F2	MVC24325	MVC24325DF2	MVC24325D	MVC24325RF2	MVC24325R	2	78.19	309[140]
350	MVC24350F2	MVC24350	MVC24350DF2	MVC24350D	MVC24350RF2	MVC24350R	2	84.20	321[145]
375	MVC24375F2	MVC24375	MVC24375DF2	MVC24375D	MVC24375RF2	MVC24375R	2	90.21	327[148]
400	MVC24400F2	MVC24400	MVC24400DF2	MVC24400D	MVC24400RF2	MVC24400R	2	96.23	334[151]
425	MVC24425F2	MVC24425	MVC24425DF2	MVC24425D	MVC24425RF2	MVC24425R	2	102.24	343[155]
450	MVC24450F2	MVC24450	MVC24450DF2	MVC24450D	MVC24450RF2	MVC24450R	2	108.26	351[159]
475	MVC24475F2	MVC24475	MVC24475DF2	MVC24475D	MVC24475RF2	MVC24475R	2	114.27	363[164]
500	MVC24500F2	MVC24500	MVC24500DF2	MVC24500D	MVC24500RF2	MVC24500R	2	120.36	374[169]
525	MVC24525F2	MVC24525	MVC24525DF2	MVC24525D	MVC24525RF2	MVC24525R	3	126.30	460[209]
550	MVC24550F2	MVC24550	MVC24550DF2	MVC24550D	MVC24550RF2	MVC24550R	3	132.31	467[212]
575	MVC24575F2	MVC24575	MVC24575DF2	MVC24575D	MVC24575RF2	MVC24575R	3	138.33	475[216]
600	MVC24600F2	MVC24600	MVC24600DF2	MVC24600D	MVC24600RF2	MVC24600R	3	144.34	480[218]

◆ Consult PQc Group for other sizes, ratings or options.
▲ Two fuses per capacitor cell provided. For systems with 3 fuses consult PQc Group for details.
■ Dimensions are for systems with 2 fuses only. Refer to page 5 for details.

4160 Volt – 3 Phase/60 Hz ◆

Capacitor kVAR Rating	Indoor Type 1 Enclosure		Indoor Type 12 Enclosure		Outdoor Type 3R Enclosure		Enclosure■	Rated Current [A]	Weight lb [kg]
	Fused▲	Unfused	Fused▲	Unfused	Fused▲	Unfused			
50	MVC41050F2	MVC41050	MVC41050DF2	MVC41050D	MVC41050RF2	MVC41050R	1	6.94	148[67]
75	MVC41075F2	MVC41075	MVC41075DF2	MVC41075D	MVC41075RF2	MVC41075R	1	10.41	148[67]
100	MVC41100F2	MVC41100	MVC41100DF2	MVC41100D	MVC41100RF2	MVC41100R	1	13.88	150[68]
125	MVC41125F2	MVC41125	MVC41125DF2	MVC41125D	MVC41125RF2	MVC41125R	1	17.35	152[69]
150	MVC41150F2	MVC41150	MVC41150DF2	MVC41150D	MVC41150RF2	MVC41150R	1	20.82	161[73]
175	MVC41175F2	MVC41175	MVC41175DF2	MVC41175D	MVC41175RF2	MVC41175R	1	24.29	165[75]
200	MVC41200F2	MVC41200	MVC41200DF2	MVC41200D	MVC41200RF2	MVC41200R	1	27.72	172[78]
225	MVC41225F2	MVC41225	MVC41225DF2	MVC41225D	MVC41225RF2	MVC41225R	1	31.23	181[82]
250	MVC41250F2	MVC41250	MVC41250DF2	MVC41250D	MVC41250RF2	MVC41250R	1	34.70	187[85]
275	MVC41275F2	MVC41275	MVC41275DF2	MVC41275D	MVC41275RF2	MVC41275R	1	38.17	192[87]
300	MVC41300F2	MVC41300	MVC41300DF2	MVC41300D	MVC41300RF2	MVC41300R	1	41.64	199[90]
325	MVC41325F2	MVC41325	MVC41325DF2	MVC41325D	MVC41325RF2	MVC41325R	2	45.11	284[129]
350	MVC41350F2	MVC41350	MVC41350DF2	MVC41350D	MVC41350RF2	MVC41350R	2	48.58	289[131]
375	MVC41375F2	MVC41375	MVC41375DF2	MVC41375D	MVC41375RF2	MVC41375R	2	52.05	295[134]
400	MVC41400F2	MVC41400	MVC41400DF2	MVC41400D	MVC41400RF2	MVC41400R	2	55.52	302[137]
425	MVC41425F2	MVC41425	MVC41425DF2	MVC41425D	MVC41425RF2	MVC41425R	2	58.99	311[141]
450	MVC41450F2	MVC41450	MVC41450DF2	MVC41450D	MVC41450RF2	MVC41450R	2	62.46	320[145]
475	MVC41475F2	MVC41475	MVC41475DF2	MVC41475D	MVC41475RF2	MVC41475R	2	65.93	326[148]
500	MVC41500F2	MVC41500	MVC41500DF2	MVC41500D	MVC41500RF2	MVC41500R	2	69.40	333[151]
525	MVC41525F2	MVC41525	MVC41525DF2	MVC41525D	MVC41525RF2	MVC41525R	2	72.86	338[153]
550	MVC41550F2	MVC41550	MVC41550DF2	MVC41550D	MVC41550RF2	MVC41550R	2	76.33	343[155]
575	MVC41575F2	MVC41575	MVC41575DF2	MVC41575D	MVC41575RF2	MVC41575R	2	79.80	349[158]
600	MVC41600F2	MVC41600	MVC41600DF2	MVC41600D	MVC41600RF2	MVC41600R	2	83.27	356[161]

◆ Consult PQc Group for other sizes, ratings or options.
▲ Two fuses per capacitor cell provided. For systems with 3 fuses consult PQc Group for details.
■ Dimensions are for systems with 2 fuses only. Refer to page 5 for details.

4800 Volt – 3 Phase/60 Hz ◆

Capacitor kVAR Rating	Indoor Type 1 Enclosure		Indoor Type 12 Enclosure		Outdoor Type 3R Enclosure		Enclosure■	Rated Current [A]	Weight lb [kg]
	Fused▲	Unfused	Fused▲	Unfused	Fused▲	Unfused			
50	MVC48050F2	MVC48050	MVC48050DF2	MVC48050D	MVC48050RF2	MVC48050R	1	6.01	148[67]
75	MVC48075F2	MVC48075	MVC48075DF2	MVC48075D	MVC48075RF2	MVC48075R	1	9.02	148[67]
100	MVC48100F2	MVC48100	MVC48100DF2	MVC48100D	MVC48100RF2	MVC48100R	1	12.03	150[68]
125	MVC48125F2	MVC48125	MVC48125DF2	MVC48125D	MVC48125RF2	MVC48125R	1	15.04	154[70]
150	MVC48150F2	MVC48150	MVC48150DF2	MVC48150D	MVC48150RF2	MVC48150R	1	18.04	161[73]
175	MVC48175F2	MVC48175	MVC48175DF2	MVC48175D	MVC48175RF2	MVC48175R	1	21.05	170[77]
200	MVC48200F2	MVC48200	MVC48200DF2	MVC48200D	MVC48200RF2	MVC48200R	1	24.06	176[80]
225	MVC48225F2	MVC48225	MVC48225DF2	MVC48225D	MVC48225RF2	MVC48225R	1	27.06	185[84]
250	MVC48250F2	MVC48250	MVC48250DF2	MVC48250D	MVC48250RF2	MVC48250R	1	30.07	192[87]
275	MVC48275F2	MVC48275	MVC48275DF2	MVC48275D	MVC48275RF2	MVC48275R	1	33.07	198[90]
300	MVC48300F2	MVC48300	MVC48300DF2	MVC48300D	MVC48300RF2	MVC48300R	1	36.09	203[92]
325	MVC48325F2	MVC48325	MVC48325DF2	MVC48325D	MVC48325RF2	MVC48325R	2	39.09	289[131]
350	MVC48350F2	MVC48350	MVC48350DF2	MVC48350D	MVC48350RF2	MVC48350R	2	42.10	298[135]
375	MVC48375F2	MVC48375	MVC48375DF2	MVC48375D	MVC48375RF2	MVC48375R	2	45.11	304[138]
400	MVC48400F2	MVC48400	MVC48400DF2	MVC48400D	MVC48400RF2	MVC48400R	2	48.11	311[141]
425	MVC48425F2	MVC48425	MVC48425DF2	MVC48425D	MVC48425RF2	MVC48425R	2	51.12	320[145]
450	MVC48450F2	MVC48450	MVC48450DF2	MVC48450D	MVC48450RF2	MVC48450R	2	54.13	329[149]
475	MVC48475F2	MVC48475	MVC48475DF2	MVC48475D	MVC48475RF2	MVC48475R	2	57.14	335[152]
500	MVC48500F2	MVC48500	MVC48500DF2	MVC48500D	MVC48500RF2	MVC48500R	2	60.14	342[155]
525	MVC48525F2	MVC48525	MVC48525DF2	MVC48525D	MVC48525RF2	MVC48525R	2	63.15	348[158]
550	MVC48550F2	MVC48550	MVC48550DF2	MVC48550D	MVC48550RF2	MVC48550R	2	66.16	355[161]
575	MVC48575F2	MVC48575	MVC48575DF2	MVC48575D	MVC48575RF2	MVC48575R	2	69.17	359[163]
600	MVC48600F2	MVC48600	MVC48600DF2	MVC48600D	MVC48600RF2	MVC48600R	2	72.17	364[165]

◆ Consult PQc Group for other sizes, ratings or options.
▲ Two fuses per capacitor cell provided. For systems with 3 fuses consult PQc Group for details.
■ Dimensions are for systems with 2 fuses only. Refer to page 5 for details.

Enclosure Dimensions

	Height(H)		Depth (D)		Mounting(℄)	
	IN	(mm)	IN	(mm)	IN	(mm)
1	46.53	1182	12.72	323	8.50	216
2	46.53	1182	22.72	577	18.50	470
3	46.53	1182	32.72	831	28.50	724

Note: Dimensions are approximate maximums only. Do not use for construction. For actual dimensions, please contact local Square D/Schneider Electric sales office.

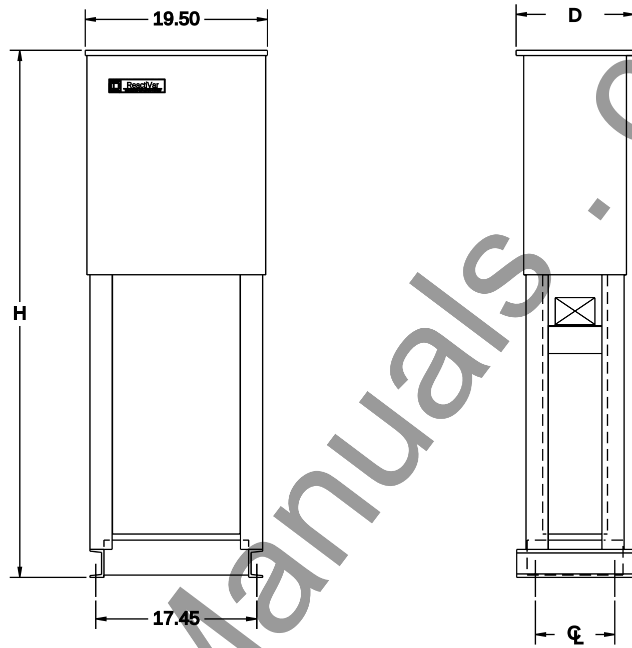


Figure 4. Typical MVC Capacitor Bank Dimensions.

Application Notes:

1. Harmonics

All capacitors are a low impedance path for harmonic currents produced by non-linear loads such as variable frequency drives, motor soft starters, welders, computers, PLC's, robotics and other electronic equipment. These harmonic currents can be drawn into the capacitor causing it to overheat, shortening its life and possibly preventing proper operation. Furthermore, the resonant circuit formed by the capacitor in parallel with the system inductance (transformers and motors) can magnify harmonic currents and voltages which can cause nuisance fuse operation and/or damage electrical equipment.

2. Motor Starters

The MVC Fixed capacitor banks are designed for power factor correction of induction motors equipped with Full Voltage Non-Reversing starters (FVNR). Note that overcurrent (OC) protection relay setting must be reduced by the %AR value indicated in the Table 1.
MVC capacitor applications associated with motors controlled by other than FVNR starters require special considerations. Please contact Square D/Schneider Electric for application assistance.

3. Back-To-Back Capacitor Switching

Multiple fixed motor capacitor applications located on the same bus can produce potentially damaging high inrush currents. The worst case scenario is realized when all capacitor banks are energized and the final uncharged bank is closed. Because of very low impedance of the uncharged capacitor, a large magnitude, high frequency inrush current will flow from each charged capacitor bank into the switched bank. These inrush currents may cause capacitor fuse blowing and may result in switch contact welding. To reduce inrush current stress, current limiting (inrush) reactors need to be used. Alternatively, centralized automatic capacitor banks may be utilized.

4. Overvoltage

Caution should be exercised when applying large amount of reactive compensation as fixed (i.e. permanently connected to the power network). Capacitors left energized when the load is turned off will create sustained overvoltage resulting in possible damages to sensitive control equipment.

For applications which require multiple fixed capacitor systems, large fixed banks, power factor correction in harmonic-rich environment, or installations associated with special motor starters, consult Square D/Schneider Electric PQc Group for assistance.

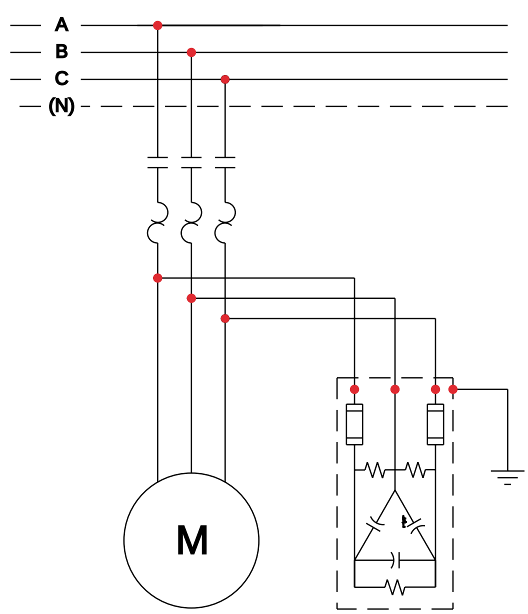


Figure 5. Typical Wiring Diagram (FVNR Starter).

Selecting an Automatic Capacitor Size

The following table is used to determine the capacitor kVAR required to improve PF of a single load or entire power system. Actual power factor, peak kilowatt demand and desired PF are required. The best source for this information is the monthly utility bill or other local monitoring equipment. A calculation of each month's data for a 12-month period is recommended to determine the maximum kVAR required.

Example: How much kVAR is required to correct an entire system to a 90% power factor when the peak kilowatt demand month was 620 kW at a 65% power factor?

Use the formula: **kVAR = kW x kW FACTOR**

From the kW-FACTOR TABLE below, find the FACTOR that applies to a system with an original PF of 65% and a desired PF of 90%. This FACTOR is read to be 0.685.

Therefore: **kVAR = 620 x .685 = 425 kVAR**

$$\textbf{kWFactor} = \tan(\text{acos}(PF_{ORG})) - \tan(\text{acos}(PF_{COR}))$$

kW-Factor Table

Desired PF in Percent

Original PF in Percent

	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
50	0.982	1.008	1.034	1.060	1.086	1.112	1.139	1.165	1.192	1.220	1.248	1.276	1.306	1.337	1.369	1.403	1.440	1.481	1.529	1.590	1.732
51	0.937	0.963	0.989	1.015	1.041	1.067	1.093	1.120	1.147	1.174	1.202	1.231	1.261	1.291	1.324	1.358	1.395	1.436	1.484	1.544	1.687
52	0.893	0.919	0.945	0.971	0.997	1.023	1.049	1.076	1.103	1.130	1.158	1.187	1.217	1.247	1.280	1.314	1.351	1.392	1.440	1.500	1.643
53	0.850	0.876	0.902	0.928	0.954	0.980	1.007	1.033	1.060	1.088	1.116	1.144	1.174	1.205	1.237	1.271	1.308	1.349	1.397	1.458	1.600
54	0.809	0.835	0.861	0.887	0.913	0.939	0.965	0.992	1.019	1.046	1.074	1.103	1.133	1.163	1.196	1.230	1.267	1.308	1.356	1.416	1.559
55	0.768	0.794	0.820	0.846	0.873	0.899	0.925	0.952	0.979	1.006	1.034	1.063	1.092	1.123	1.156	1.190	1.227	1.268	1.315	1.376	1.518
56	0.729	0.755	0.781	0.807	0.834	0.860	0.886	0.913	0.940	0.967	0.995	1.024	1.053	1.084	1.116	1.151	1.188	1.229	1.276	1.337	1.479
57	0.691	0.717	0.743	0.769	0.796	0.822	0.848	0.875	0.902	0.929	0.957	0.986	1.015	1.046	1.079	1.113	1.150	1.191	1.238	1.299	1.441
58	0.655	0.681	0.707	0.733	0.759	0.785	0.811	0.838	0.865	0.892	0.920	0.949	0.979	1.009	1.042	1.076	1.113	1.154	1.201	1.262	1.405
59	0.618	0.644	0.670	0.696	0.723	0.749	0.775	0.802	0.829	0.856	0.884	0.913	0.942	0.973	1.006	1.040	1.077	1.118	1.165	1.226	1.368
60	0.583	0.609	0.635	0.661	0.687	0.714	0.740	0.767	0.794	0.821	0.849	0.878	0.907	0.938	0.970	1.005	1.042	1.083	1.130	1.191	1.333
61	0.549	0.575	0.601	0.627	0.653	0.679	0.706	0.732	0.759	0.787	0.815	0.843	0.873	0.904	0.936	0.970	1.007	1.048	1.096	1.157	1.299
62	0.515	0.541	0.567	0.593	0.620	0.646	0.672	0.699	0.726	0.753	0.781	0.810	0.839	0.870	0.903	0.937	0.974	1.015	1.062	1.123	1.265
63	0.483	0.509	0.535	0.561	0.587	0.613	0.639	0.666	0.693	0.720	0.748	0.777	0.807	0.837	0.870	0.904	0.941	0.982	1.030	1.090	1.233
64	0.451	0.477	0.503	0.529	0.555	0.581	0.607	0.634	0.661	0.688	0.716	0.745	0.775	0.805	0.838	0.872	0.909	0.950	0.998	1.058	1.201
65	0.419	0.445	0.471	0.497	0.523	0.549	0.576	0.602	0.629	0.657	0.685	0.714	0.743	0.774	0.806	0.840	0.877	0.919	0.966	1.027	1.169
66	0.388	0.414	0.440	0.466	0.492	0.519	0.545	0.572	0.599	0.626	0.654	0.683	0.712	0.743	0.775	0.810	0.847	0.888	0.935	0.996	1.138
67	0.358	0.384	0.410	0.436	0.462	0.488	0.515	0.541	0.568	0.596	0.624	0.652	0.682	0.713	0.745	0.779	0.816	0.857	0.905	0.966	1.108
68	0.328	0.354	0.380	0.406	0.432	0.459	0.485	0.512	0.539	0.566	0.594	0.623	0.652	0.683	0.715	0.750	0.787	0.828	0.875	0.936	1.078
69	0.299	0.325	0.351	0.377	0.403	0.429	0.456	0.482	0.509	0.537	0.565	0.593	0.623	0.654	0.686	0.720	0.757	0.798	0.846	0.907	1.049
70	0.270	0.296	0.322	0.348	0.374	0.400	0.427	0.453	0.480	0.508	0.536	0.565	0.594	0.625	0.657	0.692	0.729	0.770	0.817	0.878	1.020
71	0.242	0.268	0.294	0.320	0.346	0.372	0.398	0.425	0.452	0.480	0.508	0.536	0.566	0.597	0.629	0.663	0.700	0.741	0.789	0.849	0.992
72	0.214	0.240	0.266	0.292	0.318	0.344	0.370	0.397	0.424	0.452	0.480	0.508	0.538	0.569	0.601	0.635	0.672	0.713	0.761	0.821	0.964
73	0.186	0.212	0.238	0.264	0.290	0.316	0.343	0.370	0.396	0.424	0.452	0.481	0.510	0.541	0.573	0.608	0.645	0.686	0.733	0.794	0.936
74	0.159	0.185	0.211	0.237	0.263	0.289	0.316	0.342	0.369	0.397	0.425	0.453	0.483	0.514	0.546	0.580	0.617	0.658	0.706	0.766	0.909
75	0.132	0.158	0.184	0.210	0.236	0.262	0.289	0.315	0.342	0.370	0.398	0.426	0.456	0.487	0.519	0.553	0.590	0.631	0.679	0.739	0.882
76	0.105	0.131	0.157	0.183	0.209	0.235	0.262	0.288	0.315	0.343	0.371	0.400	0.429	0.460	0.492	0.526	0.563	0.605	0.652	0.713	0.855
77	0.079	0.105	0.131	0.157	0.183	0.209	0.235	0.262	0.289	0.316	0.344	0.373	0.403	0.433	0.466	0.500	0.537	0.578	0.626	0.686	0.829
78	0.052	0.078	0.104	0.130	0.156	0.183	0.209	0.236	0.263	0.290	0.318	0.347	0.376	0.407	0.439	0.474	0.511	0.552	0.599	0.660	0.802
79	0.026	0.052	0.078	0.104	0.130	0.156	0.183	0.209	0.236	0.264	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.634	0.776
80	0.000	0.026	0.052	0.078	0.104	0.130	0.157	0.183	0.210	0.238	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.608	0.750
81		0.000	0.026	0.052	0.078	0.104	0.131	0.157	0.184	0.212	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581	0.724
82			0.000	0.026	0.052	0.078	0.105	0.131	0.158	0.186	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.556	0.698
83				0.000	0.026	0.052	0.079	0.105	0.132	0.160	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.530	0.672
84					0.000	0.026	0.053	0.079	0.106	0.134	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503	0.646
85						0.000	0.026	0.053	0.080	0.107	0.135	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477	0.620
86							0.000	0.027	0.054	0.081	0.109	0.138	0.167	0.198	0.230	0.265	0.302	0.343	0.390	0.451	0.593
87								0.000	0.027	0.054	0.082	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424	0.567
88									0.000	0.027	0.055	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397	0.540
89										0.000	0.028	0.057	0.086	0.117	0.149	0.184	0.221	0.262	0.309	0.370	0.512
90											0.000	0.029	0.058	0.089	0.121	0.156	0.193	0.234	0.281	0.342	0.484
91												0.000	0.030	0.060	0.093	0.127	0.164	0.205	0.253	0.313	0.456
92													0.000	0.031	0.063	0.097	0.134	0.175	0.223	0.284	0.426
93														0.000	0.032	0.067	0.104	0.145	0.192	0.253	0.395
94															0.000	0.034	0.071	0.112	0.160	0.220	0.363
95																0.000	0.037	0.078	0.126	0.186	0.329
96																	0.000	0.041	0.089	0.149	0.292
97																		0.000	0.048	0.108	0.251
98																			0.000	0.061	0.203
99																				0.000	0.142
100																					0.000

Power Factor Correction Benefits

The application of shunt capacitors to industrial power systems has several benefits:

1. Reduction of kVA Demand

Many Utilities incorporate penalty clauses associated with low power factor levels. Low power factor (i.e. low network efficiency) increases kVA Demand. Capacitors reduce reactive requirements thus decreasing net magnitude of the kVA or kVAR demand.

The equation below can be used to calculate effective kVA magnitude associated with capacitor application.

$$kVA = \sqrt{(kW)^2 + (kVAR_{IND} - kVAR_{CAP})^2}$$

2. Gains in System Capacity

Higher than required kVA Demand directly translates into higher than required current (I) load. Network distribution devices such as transformers, switchgear, bus and cables carry higher than necessary currents with the net effect of operation at higher temperatures. In many cases these components are thermally overloaded and cannot support any load additions. Capacitor applications reduce net load current magnitude. Less current means less load on transformers, switchgear and feeder circuits. Capacitor application can release system capacity and postpone or avoid very costly distribution network upgrades otherwise required to serve additional load.

The percentage line current reduction can be approximated from

$$\%\Delta I = 100 \times \left[1 - \left(\frac{PF_{ORG}}{PF_{COR}}\right)\right]$$

3. Voltage Regulation

Low voltage levels prevent motors, lights, and control equipment from proper operation. Capacitors support and rise voltage levels along feeders improving performance of motors and control circuits.

The voltage rise realized with the installation of capacitors is approximated from

$$\%\Delta V = \frac{kVAR_{CAP} \times \%Z_{TX}}{kVA_{TX}}$$

where $\%Z_{TX}$ - transformer impedance in %
kVA_{TX} - nominal transformer kVA rating

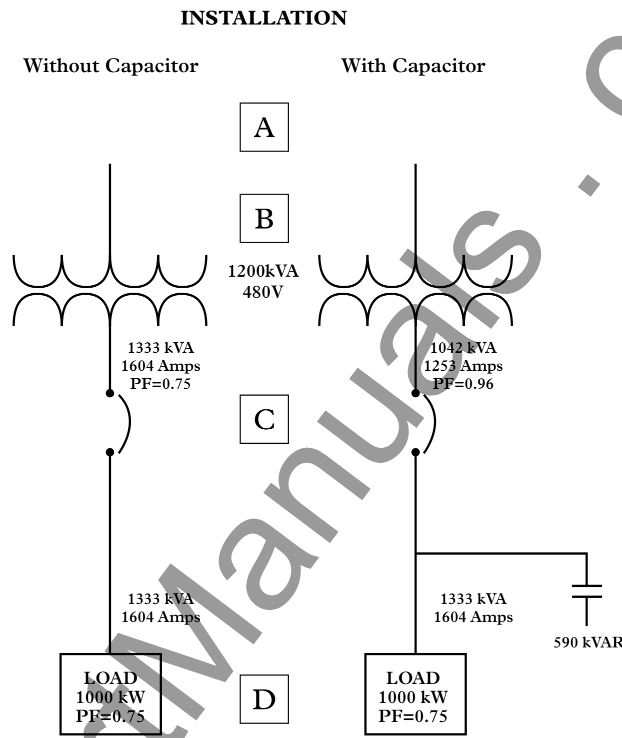
4. Line Loss Reduction

Since capacitor applications reduce line current therefore I^2R losses decrease as well. The reduction in power system losses is estimated from

$$\%\Delta P_L = 100 \times \left[1 - \left(\frac{PF_{ORG}}{PF_{COR}}\right)^2\right]$$

NOTE: reduction in current magnitude and losses is realized upstream from the capacitor connection. Current magnitudes and power losses remain unchanged between capacitor connection and the load.

EXAMPLE:



A. WITHOUT CAPACITORS

- Utility supplies reactive power
- Payment for higher consumed kVA (kVAR) Demand

WITH CAPACITORS

- Utility supplies negligible portion of required reactive power
- Greatly reduced kVA (kVAR) Demand
- Power factor penalty reduced or eliminated

B. WITHOUT CAPACITORS

- Transformer overload due to 1333 kVA of load

WITH CAPACITORS

- Transformer not overloaded
- 13% capacity available

C. WITHOUT CAPACITORS

- Switchgear, breakers and feeders must handle 1604 Amps of current
- Line losses proportional to the square of the current - I^2R

WITH CAPACITORS

- Switchgear, breakers and feeders must handle only 1253 Amps of current
- Reduced line losses due to lower current magnitude

D. WITHOUT & WITH CAPACITORS

- Power factor and current magnitude remain unchanged

Technical Specifications:

Type:	welded steel tank, liquid design, self-healing
Dielectric:	non-chlorinated biodegradable dielectric liquid and polypropylene film
Internal connection:	3 phase, Delta connected
Tolerance on capacitance:	-5% / +15%
Discharge mechanism:	resistor, 1 per phase
Discharge time:	< 50 V in 5 minutes
Losses at 20°C after stabilization (average):	0.16 W /kVAR (including discharge resistors)
Rated voltage (V_N):	2400 V, 4160 V, 4800 V
Rated frequency:	60 Hz
Insulation level:	12 kV RMS, 75 kV BIL
Continuous overvoltage:	1.1 x V_N (rated voltage) for 12 hours a day
Continuous overcurrent:	1.3 x I_N (rated current)
Temperature range:	-40°C to +45°C
Highest mean over: 24 hours:	35°C
1 year:	25°C
Other Conditions:	consult Square D/Schneider Electric
Standards:	IEC 60871, 1 and 2
	CSA C22-2 N° 190-M1985
	NEMA CP1
Capacitor Tank	welded steel, thickness 1.5 mm (16 gauge)
Indoor:	wash primer, grey vinyl paint
Outdoor:	shot blasting, zinc coating 80 µm, wash primer, vinyl paint
Enclosure: Indoor & Outdoor:	14 Gauge steel, wash primer, light grey ASA 61.

Note: For other Voltage Ratings and 50 Hz frequency consult PQc Group.

Other products and services:

- REACTIVAR LV Fixed Capacitors (**Class 5810**)
- AV4000 and AV5000 LV standard automatic capacitor banks for power factor correction of electrical networks with less than 15% non-linear load content (**Class 5830**)
- AV6000 LV Anti-resonant bank for power factor correction in harmonic rich environments (**Class 5860**)
- AV7000 LV Harmonic filters for removal of harmonics (**Class 5860**)
- AT5000 standard and AT6000 Anti-resonant (de-tuned) LV Transient Free Systems (**Class 5870**)
- AV9000 LV Real Time Systems for improved voltage regulation and power factor correction of highly cyclical loads (**Class 5880**)
- AccuSine PCS Active Harmonic Filters (**Class 5820**)
- Hybrid Filters with Active and Passive Elements
- Medium Voltage Metal Enclosed Capacitors up to 15 kV (**Class 5841**)
- Medium Voltage Real Time and Transient Free Systems up to 15 kV
- Electronic Sag Protector - Voltage Sag Support Device (**Class 5826**)
- Zero Threshold Surge Suppressor (480/600 Volt)
- Engineering services available:
  – Size and rating assistance
  – Harmonic Analysis
  – Computer simulations
  – Commissioning
  – Service contracts

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