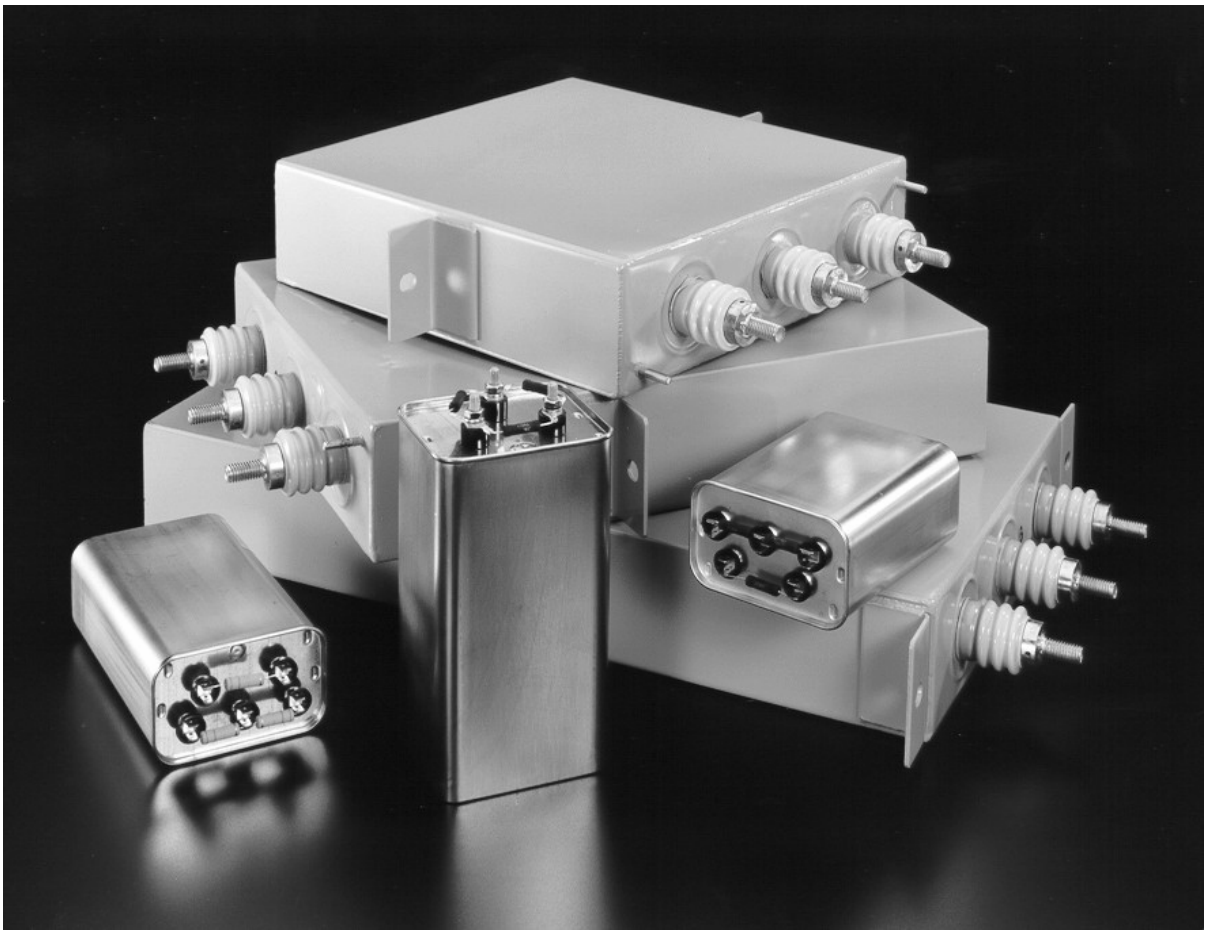
POWER SURVEY INTERNATIONAL INC.

Serving you since 1948

Low Voltage

POWER FACTOR CORRECTION

Capacitor Cells



…your source for ***Reliable Power Factor Correction***

Table of Contents

General

Standard reactive compensation capacitors are available from Power Survey in the following product categories:

AMP0 – Vacuum-impregnated metallized polypropylene, compact size.

MMP0 – Vacuum-impregnated metallized polypropylene, rugged welded case.

Available standard ratings at 60 Hertz for each respective category are shown in Table 1. Please consult the factory for other voltages and KVAR ratings.

		AMP0	AMD0	MMP0
Low Voltage	240 Vac	0.5 – 10	0.5 – 10	20 - 30
	480 Vac	0.5 – 25	0.5 – 25	25 – 100
	600 Vac	1.0 - 25	1.0 - 25	25 - 100
	750 Vac	-	-	50 – 100
	900 Vac	-	-	50 – 100
Medium Voltage	1040 Vac	-	-	25 – 200
	1200 Vac	-	-	25 – 200
	2400 Vac	-	-	25 – 200
	2770 Vac	-	-	25 – 200
	4160 Vac	-	-	25 – 200
	4800 Vac	-	-	25 - 200

Table 1: Standard Voltage and KVAR Ratings

Harmonic Distortion

Harmonic distortion is the resulting non-sinusoidal current waveform generated by a non-linear load. The most common non-linear load is a pulse rectifier, which is used in most switch mode power supplies, variable speed drives and uninterruptible power supplies. The distorted current waveform generates a distorted source voltage due to the system (electrical power system) impedance. A distorted waveform can be analyzed by decomposing it into a fundamental component (line frequency) and higher frequency components of varying amplitude.

The effects of harmonic distortion on metallized film capacitors are (1) higher operating temperature because of higher I^2R losses, and (2) higher voltage stress on the dielectric. Both of these factors will shorten the life of a capacitor dramatically.

All Power Survey Power Factor Correction capacitors are designed to handle harmonic currents, however, Power Survey also offers capacitors that are custom designed for systems with high harmonic distortion. By using our high-harmonic capacitors in your harmonic-rich application, you will have a more robust construction compared to using standard capacitors in the same application.

Part Numbering System

AMP0	012	5	F	3	3	S
1	2	3	4	5	6	7

1 Capacitor cell type: AMP0 or MMP0
2 Whole KVAR (3 digits)
3 KVAR in tenths (omit if n/a)
4 Voltage Code (line to line), see table 2
5 Number of Phases
6 Number of Terminals
7 Optional factory codes, if applicable

Ex: AMP00125F33S

AMP0, 12.5 KVAR, 480Vac, 3-Phase, 3-Terminal, S-studs

Standard Construction		High Harmonics	
Vac	Code	Vac	Code
240	D	480	C
480	F	600	I
600	H		
750	Z		
900	O		
1040	B		
1200	W		

Table 2: Standard Voltage Codes

Construction

All Power Survey Power Factor Capacitors are impregnated with a dielectric fluid to give added insulation, excellent corona protection and a moisture barrier. The dielectric fluid is considered a green (benign), environmentally friendly material. All capacitors are 100% leak tested.

Power Survey products **do not** contain PCBs.

The dry construction (AMD0) capacitor is impregnated with a combination of fluids that solidify and exhibit the same attributes as the wet capacitor. Both types have the same life rating and it is just a matter of preference and cost by the end user as to which is used.

Cover Terminals (600v and lower)

All low voltage cells are available either in three or five terminal configurations, specified by KVAR rating (see individual specifications). The medium voltage cells are not available with 5 terminals. The internal schematics for these terminal configurations are shown in Figure 1 and Figure 2. The standard five terminal designs can be connected with external components, as shown in Figure 3, to obtain a loss-of-kVAr feature. In this configuration, a neon indicator lamp will illuminate during a loss-of-fuse or a loss-of-capacitance condition.

Safety Features

Discharge resistors are placed internally on MMP0 and externally on AMP0 capacitor cells. The resistors are a safety feature that drains the voltage on the terminals once the unit is taken offline to less than 50 volts in one minute or less for cells rated up to 600 VAC or in 5 minutes or less for cells rated over 600 VAC. The resistors are sized for long life continuous operation at maximum-rated temperature.

Power Survey low-voltage capacitor cells have UL and C-UL recognized *pressure-sensitive circuit interrupters*. The circuit interrupters purpose is to safely remove the capacitor from service at end-of-life or under heavy fault conditions and still maintain case integrity. Power Survey low-voltage capacitor cells are listed for use with or without fuses at 10,000 amps available fault current (AFC rating).

Self-healing technology: in case of an overload, the self-healing properties of the low-loss metallized polypropylene will prevent permanent dielectric breakdown.

Mounting Orientation

All Power Survey power factor correction capacitor cells can be mounted in a vertical position with the terminals facing up or horizontally. The units should not be mounted upside down. For proper operation of the pressure interrupter, capacitors mounted in banks must have enough space between them to allow for heat ventilation and swelling. For minimum distance between units, see the table 3. In cases where brackets or mounting straps are used, there should only be enough pressure on the unit to hold it in place. See Table 3 for proper top and side clearances.

	Side to Side Clearance	Clearance Above Terminals
AMP0 / AMD0	0.5”	1.0”
MMP0-LV	1.5”	1.0”
MMP0-MV	1.5”	3.0”

Table 3: Suggested Mounting Clearances

Warranty Information

Power Survey warrants the product for 18 months from the time of shipment or 12 months from the time the unit(s) are put in service, whichever comes first.

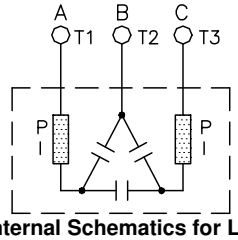


Figure 1: Internal Schematics for Low Voltage Three-Terminal Capacitors

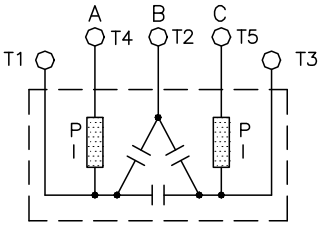


Figure 2: Internal Schematics for Five-Terminal Capacitors

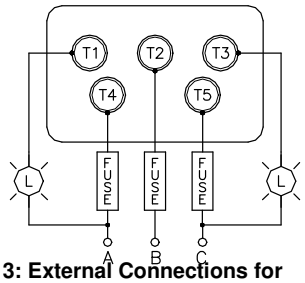


Figure 3: External Connections for Loss-of-kVAr Option

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Reactive Power Compensation Capacitor Specification

AMP0 – 240 to 600 VAC Three-Phase and Single-Phase

Electrical Characteristics		
Rated Voltages		240 Vac, 480 Vac, 600 Vac
Rated Frequency		60 Hertz
Capacitor Type		Fluid Impregnated
Dielectric System		Self-Healing Metallized Polypropylene
Impregnation Fluid		Non-PCB, non-toxic, Biodegradable, Class III Combustible Fluid
Capacitor Connection – 3 phase		Internal Delta Connection
Capacitance Tolerance		-0% to +15%
Discharge Device		External resistors reduce voltage to < 50v with in 1 minute of de-enerization
Over Current		
Standard		135% x rated current continuous, includes harmonic currents
High Harmonic		150% x rated current continuous, includes harmonic currents
Over Voltage		
Standard		110% x rated voltage continuous
High Harmonic		120% x rated voltage continuous
Total Losses		< 0.5 Watts / KVAR at 60 Hertz, 25°C
Design Service Life		200,000 Hours
Mechanical Characteristics		
Enclosure Type		Drawn steel rectangular can
Terminals		
5 terminal cover		¼" male quick connect, 15 KVAR and below
3 terminal cover		¼"-20 male threaded stud, 20 In-lbs max. fastening torque
Loss of KVAR feature		Standard with 5 terminal cover only
Environmental Characteristics		
Operating Temperature		-40°C to + 46°C, -40°F to + 115°F, with Natural convection cooling
Storage Temperature		-40°C to + 85°C, -40°F to +185°F
Maximum Altitude		2000 Meters above sea level
Humidity		0 – 95% non-condensing
Standards		**Certifications**
UL 810		UL Recognized – CYTW2
C22.2 No. 190 Canadian Standards		cUL Recognized – CYTW8
IEC 831		

Consult Factory for Single Phase, 50 Hertz Applications and Custom Options

FIG. 1
(SUFFIX "35")

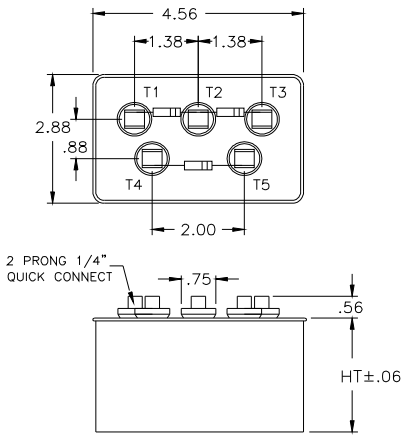
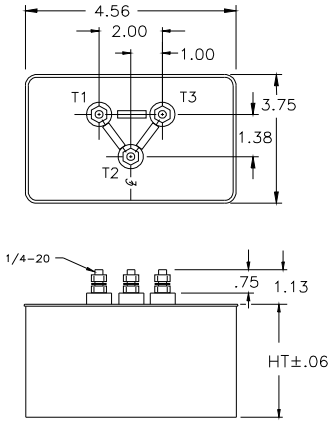


FIG. 2
(SUFFIX "33S")



Reactive Power Compensation Capacitor Specification

AMP0 Series Capacitor Cells

240 VAC – 60 Hertz – 3 Phase					
Power Survey Part Number	KVAR Rating	Nominal Current (amps)	C_{ph} Nominal Capacitance (uF)	Can Size L x W x H (in.)	Approx Weight (lbs)
AMP00005D35	0.5	1.2	23.0	2.88 x 4.56 x 3.06	1.4
AMP0001D35	1.0	2.4	46.1	2.88 x 4.56 x 3.06	1.4
AMP00015D35	1.5	3.6	69.1	2.88 x 4.56 x 3.50	1.7
AMP0002D35	2.0	4.8	92.1	2.88 x 4.56 x 4.50	1.9
AMP00025D35	2.5	6.0	115.1	2.88 x 4.56 x 4.50	2.2
AMP0003D35	3.0	7.2	138.2	2.88 x 4.56 x 5.00	2.4
AMP0004D35	4.0	9.6	184.2	2.88 x 4.56 x 6.00	2.5
AMP0005D35	5.0	12.0	230.3	2.88 x 4.56 x 6.75	3.0
AMP0006D35	6.0	14.4	276.3	2.88 x 4.56 x 6.75	3.0
AMP00075D35	7.5	18.0	345.4	2.88 x 4.56 x 7.56	3.7
AMP0010D33S	10	24.1	460.4	3.75 x 4.56 x 8.63	5.2

480 VAC – 60 Hertz – 3 Phase					
Power Survey Part Number	KVAR Rating	Nominal Current (amps)	C_{ph} Nominal Capacitance (uF)	Can Size L x W x H (in.)	Approx Weight (lbs)
AMP00005F35	0.5	0.6	5.8	2.88 x 4.56 x 3.06	1.4
AMP0001F35	1.0	1.2	11.5	2.88 x 4.56 x 3.06	1.4
AMP00015F35	1.5	1.8	17.3	2.88 x 4.56 x 3.06	1.4
AMP0002F35	2.0	2.4	23.0	2.88 x 4.56 x 3.50	1.8
AMP00025F35	2.5	3.0	28.8	2.88 x 4.56 x 4.00	1.9
AMP0003F35	3.0	3.6	34.5	2.88 x 4.56 x 4.00	1.9
AMP0004F35	4.0	4.8	46.1	2.88 x 4.56 x 4.50	2.2
AMP0005F35	5.0	6.0	57.6	2.88 x 4.56 x 5.00	2.4
AMP0006F35	6.0	7.2	69.1	2.88 x 4.56 x 5.25	2.5
AMP00075F35	7.5	9.0	86.3	2.88 x 4.56 x 6.00	2.8
AMP0010F35	10.0	12.0	115.1	2.88 x 4.56 x 6.75	3.2
AMP00125F35	12.5	15.0	143.9	2.88 x 4.56 x 7.38	3.5
AMP0015F35	15.0	18.0	172.7	2.88 x 4.56 x 8.13	3.7
AMP0015F33S	15.0	18.0	172.7	3.75 x 4.56 x 7.00	4.3
AMP00167F33S	16.67	20.1	191.9	3.75 x 4.56 x 7.00	4.3
AMP00175F33S	17.5	21.0	201.5	3.75 x 4.56 x 7.3	4.1
AMP0020F33S	20.0	24.1	230.3	3.75 x 4.56 x 9.00	4.3
AMP00225F33S	22.5	27.1	259.0	3.75 x 4.56 x 9.00	5.2
AMP0025F33S	25.0	30.1	287.8	3.75 x 4.56 x 10.5	5.5
480 VAC High Harmonic Applications					
AMP00075C35	7.5	9.0	86.3	2.88 x 4.56 x 6.75	3.2
AMP0010C35	10.0	12.0	115.1	2.88 x 4.56 x 8.13	3.7
AMP00125C33S	12.5	15.0	143.9	3.75 x 4.56 x 7.00	4.3
AMP0015C33S	15.0	18.0	172.7	3.75 x 4.56 x 10.50	5.9
AMP00167C33S	16.67	20.1	191.9	3.75 x 4.56 x 10.50	6.0
AMP00175C33S	17.5	21.1	201.5	3.75 x 4.56 x 10.50	6.1
AMP0020C33S	20.0	24.1	230.3	3.75 x 4.56 x 10.50	6.3

Reactive Power Compensation Capacitor Specification

POWER SURVEY INTERNATIONAL INC.

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AMP0 Series Capacitor Cells

600 VAC – 60 Hertz – 3 Phase					
Power Survey Part Number	KVAR Rating	Nominal Current (amps)	C_{ph} Nominal Capacitance (uF)	Can Size L x W x H (in.)	Approx Weight (lbs)
AMP0001H35	1.0	1.0	7.4	2.88 x 4.56 x 3.06	1.4
AMP00015H35	1.5	1.4	11.1	2.88 x 4.56 x 3.06	1.4
AMP0002H35	2.0	1.9	14.7	2.88 x 4.56 x 3.50	1.8
AMP00025H35	2.5	2.4	18.4	2.88 x 4.56 x 4.00	1.9
AMP0003H35	3.0	2.9	22.1	2.88 x 4.56 x 4.00	1.9
AMP0004H35	4.0	3.8	29.5	2.88 x 4.56 x 4.50	2.2
AMP0005H35	5.0	4.8	36.8	2.88 x 4.56 x 5.00	2.4
AMP0006H35	6.0	5.8	44.2	2.88 x 4.56 x 6.00	2.5
AMP00075H35	7.5	7.2	55.3	2.88 x 4.56 x 6.00	2.8
AMP0010H35	10.0	9.6	73.7	2.88 x 4.56 x 6.75	3.2
AMP00125H35	12.5	12.0	92.1	2.88 x 4.56 x 7.38	3.5
AMP0015H35	15.0	14.4	110.5	2.88 x 4.56 x 8.13	3.9
AMP00167H33S	16.67	16.1	122.8	3.75 x 4.56 x 6.75	4.1
AMP00175H33S	17.5	16.8	128.9	3.75 x 4.56 x 7.3	4.1
AMP0020H33S	20.0	19.2	147.4	3.75 x 4.56 x 9.00	4.4
AMP00225H33S	22.5	21.7	165.8	3.75 x 4.56 x 9.00	5.4
AMP0025H33S	25.0	24.1	184.2	3.75 x 4.56 x 10.5	5.7
600 VAC High Harmonic Applications					
AMP0010I33S	10.0	9.6	73.7	3.75 x 4.56 x 6.00	3.5
AMP00125I33S	12.5	12.0	92.1	3.75 x 4.56 x 8.25	4.7
AMP0015I33S	15.0	14.4	110.5	3.75 x 4.56 x 9.00	5.2
AMP00167I33S	16.7	16.1	123.1	3.75 x 4.56 x 9.00	5.2
AMP00175I33S	17.5	16.8	128.9	3.75 x 4.56 x 10.50	5.5
AMP0020I33S	20.0	19.2	147.4	3.75 x 4.56 x 10.50	5.5

FIG. 1
(SUFFIX "35")

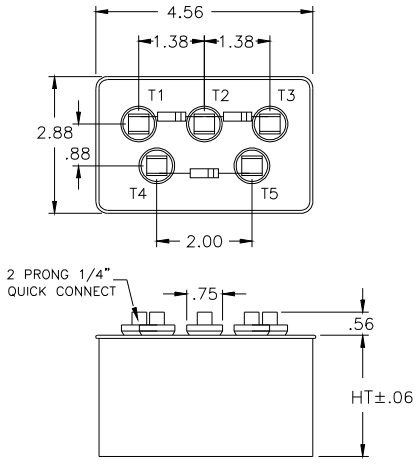
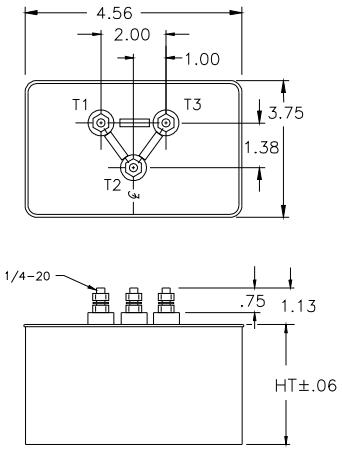


FIG. 2
(SUFFIX "33S")



Reactive Power Compensation Capacitor Specification

MMP0 - 240 to 600 VAC Three-Phase and Single Phase

Electrical Characteristics		
Rated Voltages		240 Vac, 480 Vac, 600 Vac
Rated Frequency		60 Hertz
Capacitor Type		Fluid Impregnated
Dielectric System		Self-Healing Metallized Polypropylene
Impregnation Fluid		Non-PCB, non-toxic, Biodegradable, Class III Combustible Fluid
Capacitor Connection – 3 phase		Internal Delta Connection
Capacitance Tolerance		-0% to +15%
Discharge Device		Internal resistors reduce voltage to < 50v with in 1 minute of de-enerization
Over Current		
Standard		135% x rated current continuous, includes harmonic currents
High Harmonic		150% x rated current continuous, includes harmonic currents
Over Voltage		
Standard		110% x rated voltage continuous
High Harmonic		125% x rated voltage continuous
Total Losses		< 0.5 Watts / KVAR at 60 Hertz, 25℃
Design Service Life		200,000 Hours Continuous Duty
Mechanical Characteristics		
Enclosure Type		Heavy gage Welded Steel Construction
Finish		Light gray paint, ANSI #61. UL approved for Outdoor Usage
Mounting		Heavy gage brackets, mounting holes 2 x ½" x $^{5}/_{8}$" slots
Terminals		½"-13 Brass Studs – 160 in/lbs fastening torque, 30 kV BIL
Loss of KVAR feature		Optional
Environmental Characteristics		
Operating Temperature		-40℃ to + 46℃, -40℉ to + 115℉, with Natural convection cooling
Storage Temperature		-40℃ to + 85℃, -40℉ to +185℉
Maximum Altitude		2000 Meters above sea level
Humidity		0 – 95% non-condensing
Standards		**Certifications**
UL 810		UL Recognized – CYTW2
C22.2 No. 190 Canadian Standards		cUL Recognized – CYTW8
ANSI/IEEE 18		
NEMA CP-1		
IEC 831		

Consult Factory for Single Phase, 50 Hertz Applications, Custom Options and Alternate Bracket Locations.

Reactive Power Compensation Capacitor Specification
MMP0 Series Capacitor Cells

POWER SURVEY INTERNATIONAL INC.

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240 VAC – 60 Hertz – 3 Phase					
Power Survey Part Number	KVAR Rating	Nominal Current (amps)	C_{ph} Nominal Capacitance (uF)	Can Size L x W x H (in.)	Approx Weight (lbs)
MMP0020D33	20	48.1	921.0	3.75 x 13.5 x 11.5	26.1
MMP0025D33	25	60.1	1151.3	3.75 x 13.5 x 13.5	31.3
MMP0030D33	30	72.2	1381.6	3.75 x 13.5 x 15.5	36.5

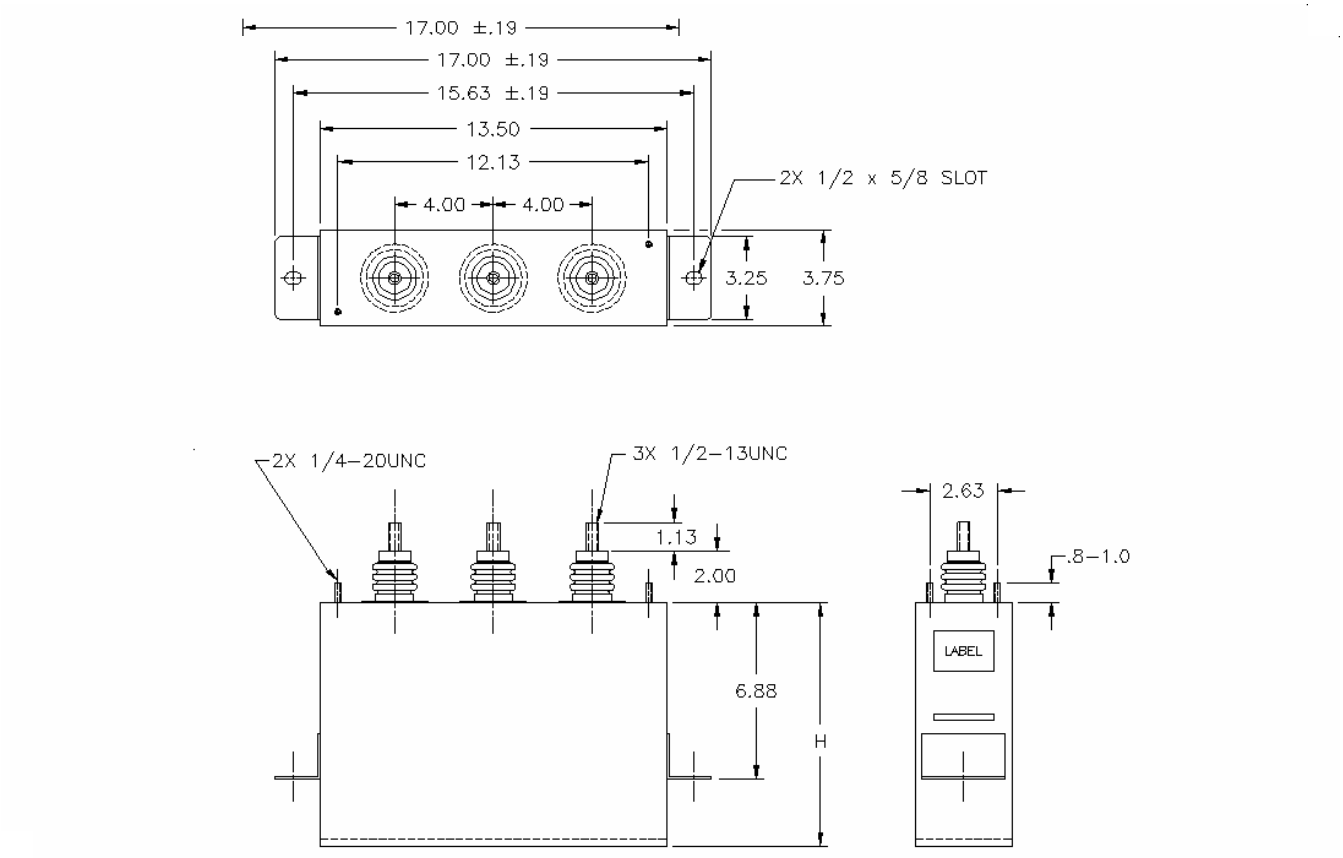
480 VAC – 60 Hertz – 3 Phase					
Power Survey Part Number	KVAR Rating	Nominal Current (amps)	C_{ph} Nominal Capacitance (uF)	Can Size L x W x H (in.)	Approx Weight (lbs)
MMP0025F33	25	30.1	287.8	3.75 x 13.5 x 8.50	21.4
MMP0030F33	30	36.1	345.4	3.75 x 13.5 x 9.50	23.5
MMP0035F33	35	42.1	403.0	3.75 x 13.5 x 11.50	28.1
MMP0040F33	40	48.1	460.5	3.75 x 13.5 x 11.50	28.3
MMP0045F33	45	54.1	518.1	3.75 x 13.5 x 13.50	32.2
MMP0050F33	50	60.1	575.6	3.75 x 13.5 x 13.50	32.3
MMP0060F33	60	72.2	690.8	3.75 x 13.5 x 15.50	36.4
MMP0075F33	75	90.2	863.5	3.75 x 13.5 x 18.50	43.1
MMP0080F33	80	96.2	921.0	3.75 x 13.5 x 19.50	44.6
MMP0090F33	90	108.3	1036.2	3.75 x 13.5 x 20.50	45.9
MMP0100F33	100	120.3	1151.3	3.75 x 13.5 x 24.00	55.3
480 VAC High Harmonic Applications					
MMP0025C33	25	30.1	287.8	3.75 x 13.5 x 8.50	21.4
MMP0050C33	50	60.1	575.6	3.75 x 13.5 x 13.50	32.3
MMP0075C33	75	90.2	863.5	3.75 x 13.5 x 18.50	43.1
MMP0100C33	100	120.3	1151.3	3.75 x 13.5 x 24.00	55.3

Reactive Power Compensation Capacitor Specification

MMP0 Series Capacitor Cells

600 VAC – 60 Hertz – 3 Phase High Harmonic					
Power Survey Part Number	KVAR Rating	Nominal Current (amps)	C_{ph} Nominal Capacitance (uF)	Can Size L x W x H (in.)	Approx Weight (lbs)
MMP0025I33	25	24.1	184.2	3.75 x 13.5 x 8.50	21.4
MMP0030I33	30	28.9	221.0	3.75 x 13.5 x 9.50	23.5
MMP0035I33	35	33.7	257.9	3.75 x 13.5 x 11.50	28.1
MMP0040I33	40	38.5	294.7	3.75 x 13.5 x 11.50	28.3
MMP0045I33	45	43.3	331.6	3.75 x 13.5 x 13.50	32.2
MMP0050I33	50	48.1	368.4	3.75 x 13.5 x 13.50	32.3
MMP0060I33	60	57.7	442.1	3.75 x 13.5 x 15.50	36.4
MMP0075I33	75	72.2	552.6	3.75 x 13.5 x 18.50	43.1
MMP0080I33	80	77.0	589.5	3.75 x 13.5 x 19.50	44.6
MMP0090I33	90	86.6	663.1	3.75 x 13.5 x 20.50	45.9
MMP0100I33	100	96.2	736.8	3.75 x 13.5 x 24.00	55.3

Consult Factory for Single Phase, 50 Hertz Applications, Custom Options and Alternate Bracket Locations.



Useful Equations for Power Factor Correction and Harmonic Distortion (Balanced Phase Loads)

$$PF = \cos(\varphi) = \frac{kW}{kVA}$$

$$kVA = \frac{kW}{PF} = \sqrt{kW^2 + kVAr^2}$$

$$kVA = \frac{V_L \times I_L}{1000} \quad \text{Single-Phase}$$

$$kVA = \frac{\sqrt{3} \times V_L \times I_L}{1000} \quad \text{Three-Phase}$$

$$kVAr = \frac{2\pi \times f \times C_{ph} \times V_{\phi}^{\,2}}{1 \times 10^3}$$

$$kVAr_E = kVAr_R \times \left(\frac{V_A}{V_R}\right)^2 \times \left(\frac{f_A}{f_R}\right)$$

KVAR De-rating for Voltage & Frequency

$$kVAr = \frac{HP \times 0.746}{\eta}\left(\sqrt{\frac{1 - PF_0^{\,2}}{PF_0^{\,2}}} - \sqrt{\frac{1 - PF_T^{\,2}}{PF_T^{\,2}}}\right)$$

$$THD = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^{\,2}}}{I_1} \times 100\%$$

$$I_{RMS} = \sqrt{I_1^{\,2} + \sum_{h=2}^{\infty} I_h^{\,2}}$$

$$\%\,\text{Voltage Rise} = \frac{KVAR \times \%Z}{\text{Transformer KVA}}$$

$$KW = KVA \times PF$$

$$\%\,\text{Power Loss Reduction} = 100 - 100\left(\frac{PF_O}{PF_T}\right)^2$$

$$C_{ph} = \frac{KVAR \times 10^3}{(2\pi f)(KV)^2}$$

$$X_C = \frac{10^6}{(2\pi f C)}$$

$$I_{\Phi} = \frac{KVAR \times 10^3}{\sqrt{3} \times V_L} \quad \text{Three Phase}$$

$$I_{\Phi} = \frac{KVAR \times 10^3}{V_L} \quad \text{Single Phase}$$

$$KW\,(\text{Motor Input}) = \frac{Hp \times .746}{\%Eff}$$

For Δ-Connected Capacitors:

$C_{TOT} = 3 \times C_{ph}$

$V_L = V_\phi$

$I_L = \sqrt{3} \times I_\phi$

For Y-Connected Capacitors:

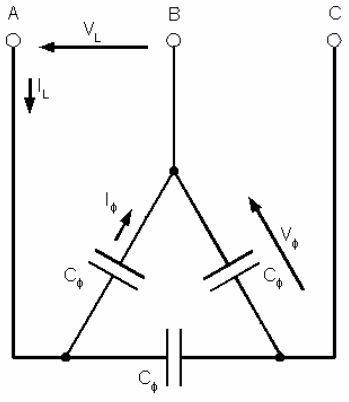
$C_{TOT} = 3 \times C_{ph}$

$V_L = \sqrt{3} \times V_\phi$

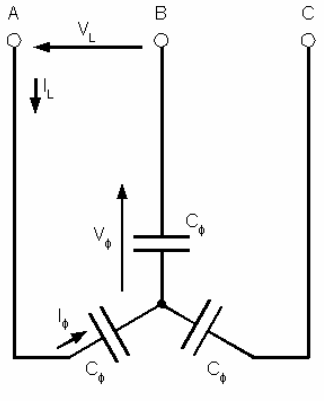
$I_L = I_\phi$

Legend

V_ϕ	- Phase voltage
V_A	- Applied line voltage
V_R	- Rated line voltage
I_L	- Line current
I_ϕ	- Phase current
I_h	- Harmonic current of order h
I_1	- Current at fundamental frequency
I_{RMS}	- Root-mean-square value of current
f	- Frequency
f_A	- Applied frequency
f_R	- Rated frequency
C_{TOT}	- Total capacitance in μF
C_{ph}	- Phase capacitance in μF
HP	- Horsepower
PF_0	- Initial power factor
PF_T	- Target power factor
η	- Motor efficiency
THD	- Total harmonic distortion
Xc	- Capacative Reactance
Z	- Transformer Impedance



Delta Connection



Wye Connection