Grid Solutions

LOW & MEDIUM VOLTAGE POWER FACTOR CORRECTION CAPACITORS, HARMONIC FILTERS AND LINE/LOAD REACTORS

240V through 4800V

Product Selection & Application Guide

Product Description

GE Vernova supplies Low Voltage and Medium Voltage fixed and automatically switched capacitors for power factor correction and harmonic mitigation, in the range of 240V through 13.2kV. GE Vernova also supplies active filtering equipment and line/load reactors for specific line and load applications.

GEM™ Series Fixed Capacitors

GEMATIC™ Series Automatically Switched Capacitors

GEMTRAP™ Series for Non-Linear Load Applications

GEM OFW Series for Outdoor Pumping

HWT Medium Voltage series Capacitors

GEMACTIVE™ Active Filter Equipment

GE Vernova Line/Load Reactors

GE Vernova Matrix Fixed Harmonic Filters

GE VERNOVA

Table of Contents

Capacitor Technology & Application

GEM Capacitors

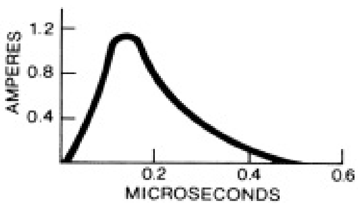
GE Vernova's GEM capacitors are manufactured with high-grade metallized polypropylene film. Low loss polypropylene film with metallized electrode provides smaller, lighter units. Dielectric self-healing characteristics, plus internal Pressure Sensitive Interrupters, result in a double assurance of safety. Multiple cell construction allows for complete flexibility in capacitor selection.

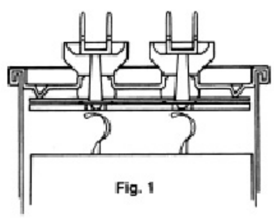
Instant "Self-Healing" Feature

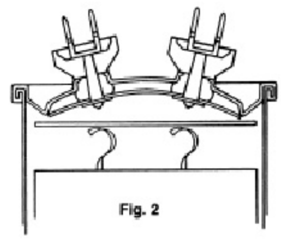
During a dielectric breakdown an arc occurs across the dielectric at the puncture. The thin metallized electrode will vaporize away from the puncture, then the arc self- extinguishes and bare polypropylene film remains, leaving the capacitor intact. This "self-healing" process is instantaneous - only 0.5 microseconds from initial fault current flow until clearing is complete.

Nuisance Fault and Cell Rupture Protected

The patented GE Vernova Pressure Sensitive Interrupter (PSI - Fig. 1), in conjunction with the self-clearing feature, helps protect against nuisance faults and cell rupture. This field proven feature interrupts capacitor current when internal pressure forces the cover up and breaks an undercover contact (see Fig. 2).







GE Vernova Film/Foil Capacitors

GE Vernova's Film/Foil capacitors offer an energy efficient polypropylene film dielectric. This heavy duty Film/Foil dielectric system is designed to handle unusual overvoltage and overcurrent without reducing capacitor life. The Film/Foil dielectric results in low watts per kVAR power consumption during capacitor operation. The 0.5 watts per kVAR losses and corresponding low internal heat generation mean low operating temperatures for the Film/Foil capacitor, a significant factor in extending capacitor life.

Facts About GE Vernova Low Voltage Capacitors

GE Vernova supplies a complete line of low & medium voltage capacitors for power factor correction

Where to Use

GE Vernova offers designs that are suitable for either indoor or outdoor use. Connection of the capacitors to the terminals of motors or other loads permits switching the load and capacitors as a unit, automatically keeping kilovar supply in step with kilovar requirement. Capacitors tied to a feeder or bus generally require a switching device. Individual units or groups of units in locations with restricted ventilation, are suitable for operation in maximum ambients of 46°C (115°F). The capacitors are suitable for energizing in temperatures as low as -40°C.

Environmental Compatibility of Liquid

GE Vernova dielectric systems use the proprietary Dielektrol® family of proven non-PCB biodegradable capacitor fluids specially blended to provide optimum performance. Dielektrol fluids are NGPA rated Class IIIB combustible.

National Electrical Code

The NEC®, prepared by the National Fire Protection Association, is widely used as the basis for determining the adequacy of electrical installations in the United States. The Code specifically deals with the fusing of capacitors under Article 460-8B. This Article requires low voltage capacitors to have over-current protection in all ungrounded conductors (except if connected on the load side of a motor overload protective device). Three phase capacitors fused only on two phases will not provide adequate protection if a line-toground fault should occur in the un-fused phase.

NEC Article 460 in paragraph 460-2 references capacitors containing flammable liquids, "Enclosing and Guarding". This states that "capacitors containing more than three gallons of flammable liquid shall be enclosed in vaults or outdoor fenced enclosures...". The code, therefore, permits indoor installation of capacitor cells containing less than three gallons of combustible liquid. All capacitors listed in this catalog contain less than three gallons of liquid.

Capacitor assemblies made up of several units may be installed indoors and, since no single unit contains more than three gallons of the liquid, the installations will be in compliance with the requirements of the NEC.

Line Fuses

Line fuses are available on both low voltage and medium voltage equipment. Customers should note NEC Article 460-8B to decide if fuses are required for a specific low voltage application.

Discharge Resistors

Each low voltage capacitor includes discharge resistors to drain residual capacitor voltage to 50 volts or less within one minute of de-energization.

The 2400, 4160 and 4800 volt units have discharge resistors that reduce the voltage to 50 volts or less within five minutes.

Long Life

Proven field service has confirmed long life demonstrated in comprehensive accelerated life tests, greater than 95 percent survival, 20 years in nonharmonic application.

Low Voltage Fixed Power Factor – GEM Unit

GEM Series Indoor and Outdoor Equipment

Fixed Single & Multi-Unit Assemblies

Product Information

- 240, 480, 600 volt ratings available
- 240V and 480V 3 phase units are Delta connected
- 600V units are Wye connected
- Additional voltages below 600 volts are available by de-rating (contact factory for details)
- UL Listed
- Discharge resistors reduce voltage to 50 volts or less within one minute
- Enclosure NEMA 3 & 12 (indoor dustproof and outdoor weatherproof)
- Factory installed fuses and blown fuse indicating lights (Optional)
- Pressure Sensitive Interrupter (PSI) in each cell
- Not for use in harmonic applications.

Description

GEM assemblies feature multiple capacitor cells with metallized polypropylene film dielectric which provides instantaneous self-healing action and reduced energy losses. Safety is provided with the patented GE Vernova internal Pressure Sensitive Interrupter (PSI) designed to sense the buildup of pressure if a fault occurs and to interrupt the internal electrical connections before the capacitor cell can rupture. GEM cells feature time-proven Dielektrol, a biodegradable NFPA Class IIIB dielectric fluid. GEM offers high reliability and long life and is suitable for operation over a temperature range of -40°C to 46°C.

Line Fuse/Blown Fuse Indicating Lights

When fuses are specified, GE Vernova provides 100 kAIC and 200 kAIC interrupting capacity fuses for up to 12.5 kVAR and larger ratings respectively. Blown fuse indicating lights are also an option. Order by appropriate BASIC CATALOG number plus the appropriate accessory SUFFIX for a complete catalog number.

Note: NEC Article 460-8B requires capacitors to have over- current protection in all ungrounded conductors (except if connected on the load side of a motor overload protective device). Three-phase capacitors fused only on two phases will not provide adequate protection if a line-to-ground fault should occur in the un-fused phase.

Mounting

GEM 65L800 series units are designed to be mounted upright on any level surface, such as a floor, top of a motor control center, or directly to any wall with brackets provided. 65L900 series require an adapter kit for wall mounting. Wall mounting catalog No. 186C323600005.

Line Connection and Cable Entrance

Entrance on Drawing size 1 units must be made through the right end panel. For all other sizes the entrance may be made through either end panel (after first punching out the appropriate size hole). Solderless connectors are provided on each phase.

Low Voltage Fixed Power Factor – GEM Unit

Fixed GEM Unit Selection Table - 240V - Three Phase & Single Phase

240 VOLT - 3 PHASE					240 VOLT - 1 PHASE				APPROXIMATE WEIGHT	
KVAR	BASE CATALOG NUMBER	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	Dwg	lbs	kg
1.0	65L800	TL1	TN1	TQ1	TX1	TY1	TZ1	1	9	4.1
1.5	65L801	TL1	TN1	TQ1	TX1	TY1	TZ1	1	9	4.1
2.0	65L802	TL1	TN1	TQ1	TX1	TY1	TZ1	1	9	4.1
2.5	65L803	TL1	TN1	TQ1	TX1	TY1	TZ1	1	9	4.1
3.0	65L804	TL1	TN1	TQ1	TX1	TY1	TZ1	1	9	4.1
4.0	65L805	TL1	TN1	TQ1	TX1	TY1	TZ1	1	10	4.5
5.0	65L806	TL1	TN1	TQ1	TX1	TY1	TZ1	1	10	4.5
6.0	65L807	TL1	TN1	TQ1	TX1	TY1	TZ1	1	11	5.0
7.5	65L808	TL1	TN1	TQ1	TX1	TY1	TZ1	1	15	6.8
10.0	65L809	TL1	TN1	TQ1	TX1	TY1	TZ1	1	15	6.8
12.5	65L810	TL2	TN2	TQ2	TX1	TY1	TZ1	1	19	8.6
15.0	65L811	TL2	TN2	TQ2	TX1	TY1	TZ1	2	19	8.6
17.5	65L812	TL2	TN2	TQ2	TX1	TY1	TZ1	2	22	10.0
20.0	65L813	TL2	TN2	TQ2	TX1	TY1	TZ1	2	22	10.0
22.5	65L814	TL2	TN2	TQ2	TX1	TY1	TZ1	2	32	14.5
25.0	65L815	TL2	TN2	TQ2	TX1	TY1	TZ1	2	32	14.5
27.5	65L816	TL2	TN2	TQ2	TX1	TY1	TZ1	3	32	14.5
30.0	65L817	TL2	TN2	TQ2	TX1	TY1	TZ1	3	32	14.5
32.5	65L818	TL2	TN2	TQ2	TX1	TY1	TZ1	3	36	16.4
35.0	65L819	TL2	TN2	TQ2	TX1	TY1	TZ1	3	38	17.3
37.5	65L820	TL2	TN2	TQ2	TX1	TY1	TZ1	3	38	17.3
40.0	65L821	TL2	TN2	TQ2	TX1	TY1	TZ1	3	38	17.3
42.5	65L822	TL2	TN2	TQ2	-	-	-	3	38	17.3
45.0	65L823	TL2	TN2	TQ2	-	-	-	3	38	17.3
47.5	65L824	TL2	TN2	TQ2	-	-	-	3	38	17.3
50.0	65L825	TL2	TN2	TQ2	-	-	-	3	38	17.3
55.0	65L904	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	87	39.5
60.0	65L905	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	87	39.5
65.0	65L906	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	87	39.5
70.0	65L907	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	89	40.5
75.0	65L908	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	89	40.5
80.0	65L909	TL 3	TN 3	TQ 3	TX2	TY2	TZ2	4	99	45.0
85.0	65L910	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	99	45.0
90.0	65L911	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	99	45.0
95.0	65L912	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	99	45.0
100.0	65L913	T L3	TN 3	TQ 3	TX2	TY2	TZ2	4	99	45.0
110.0	65L914	T L3	TN 3	TQ 3	TX2	TY2	TZ2	5	136	61.8
120.0	65L915	T L3	TN 3	TQ 3	TX2	TY2	TZ2	5	136	61.8
125.0	65L916	T L3	TN 3	TQ 3	TX2	TY2	TZ2	5	136	61.8

Fixed GEM Unit Selection Table - 240V - Three Phase & Single Phase (Cont'd)

240 VOLT - 3 PHASE					240 VOLT - 1 PHASE				APPROXIMATE WEIGHT	
KVAR	BASE CATALOG NUMBER	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	Dwg	lbs	kg
130.0	65L917	T L3	TN 3	TQ 3	TX2	TY2	TZ2	5	142	64.5
140.0	65L918	T L3	TN 3	TQ 3	TX2	TY2	TZ2	5	148	67.3
150.0	65L919	T L3	TN 3	TQ 3	TX2	TY2	TZ2	5	148	67.3
160.0	65L920	T L3	TN 3	TQ 3	TX2	TY2	TZ2	6	181	82.3
170.0	65L921	T L3	TN 3	TQ 3	TX2	TY2	TZ2	6	181	82.3
175.0	65L922	T L3	TN 3	TQ 3	TX2	TY2	TZ2	6	186	84.5
180.0	65L923	T L3	TN 3	TQ 3	TX2	TY2	TZ2	6	186	84.5
190.0	65L924	T L3	TN 3	TQ 3	TX2	TY2	TZ2	6	191	86.8
200.0	65L925	T L3	TN 3	TQ 3	TX2	TY2	TZ2	6	196	89.1
210.0	65L926	T L3	TN 3	TQ 3	TX2	TY2	TZ2	7	230	104.5
220.0	65L927	T L3	TN 3	TQ 3	TX2	TY2	TZ2	7	230	104.5
230.0	65L928	T L3	TN 3	TQ 3	TX2	TY2	TZ2	7	235	106.8
240.0	65L929	T L3	TN 3	TQ 3	TX2	TY2	TZ2	7	240	109.1
250.0	65L930	T L3	TN 3	TQ 3	TX2	TY2	TZ2	7	245	111.4

Low Voltage Fixed Power Factor – GEM Unit

Fixed GEM Unit Selection Table - 480V – Three Phase

(Contact Factory for Single Phase Product)

480 VOLT – 3 PHASE						WEIGHT	
kVAR	BASE CATALOG NUMBER	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	Dwg	lbs	kg
1.0	65L800	TA1	TC1	TE1	1	9	4.1
1.5	65L801	TA1	TC1	TE1	1	9	4.1
2.0	65L802	TA1	TC1	TE1	1	9	4.1
2.5	65L803	TA1	TC1	TE1	1	9	4.1
3.0	65L804	TA1	TC1	TE1	1	9	4.1
4.0	65L805	TA1	TC1	TE1	1	9	4.1
5.0	65L806	TA1	TC1	TE1	1	9	4.1
6.0	65L807	TA1	TC1	TE1	1	9	4.1
7.5	65L808	TA1	TC1	TE1	1	10	4.5
10.0	65L809	TA1	TC1	TE1	1	10	4.5
12.5	65L810	TA1	TC1	TE1	1	10	4.5
15.0	65L811	TA1	TC1	TE1	1	13	5.9
17.5	65L812	TA1	TC1	TE1	1	13	5.9
20.0	65L813	TA1	TC1	TE1	1	13	5.9
22.5	65L814	TA1	TC1	TE1	1	13	5.9
25.0	65L815	TA1	TC1	TE1	1	13	5.9
27.5	65L816	TA1	TC1	TE1	2	19	8.6
30.0	65L817	TA1	TC1	TE1	2	19	8.6
32.5	65L818	TA1	TC1	TE1	2	19	8.6
35.0	65L819	TA1	TC1	TE1	2	19	8.6
37.5	65L820	TA1	TC1	TE1	2	19	8.6
40.0	65L821	TA1	TC1	TE1	2	22	10.0
42.5	65L822	TA1	TC1	TE1	2	22	10.0
45.0	65L823	TA1	TC1	TE1	2	22	10.0
47.5	65L824	TA1	TC1	TE1	2	22	10.0
50.0	65L825	TA1	TC1	TE1	2	22	10.0
55.0	65L826	TA1	TC1	TE1	3	32	14.5
60.0	65L827	TA1	TC1	TE1	3	32	14.5
65.0	65L828	TA1	TC1	TE1	3	32	14.5
70.0	65L829	TA1	TC1	TE1	3	33	15.0
75.0	65L830	TA1	TC1	TE1	3	33	15.0
80.0	65L831	TA1	TC1	TE1	3	38	17.2
85.0	65L832	TA1	TC1	TE1	3	38	17.2

480 VOLT – 3 PHASE						WEIGHT	
kVAR	BASE CATALOG NUMBER	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	Dwg	lbs	kg
90.0	65L833	TA1	TC1	TE1	3	38	17.2
95.0	65L834	TA1	TC1	TE1	3	38	17.2
100.0	65L835	TA1	TC1	TE1	3	38	17.2
110.0	65L914	TA2	TC2	TE2	4	87	39.5
120.0	65L915	TA2	TC2	TE2	4	87	39.5
125.0	65L916	TA2	TC2	TE2	4	87	39.5
130.0	65L917	TA2	TC2	TE2	4	87	39.5
140.0	65L918	TA2	TC2	TE2	4	89	40.8
150.0	65L919	TA2	TC2	TE2	4	89	40.8
160.0	65L920	TA2	TC2	TE2	4	99	44.9
170.0	65L921	TA2	TC2	TE2	4	99	44.9
175.0	65L922	TA2	TC2	TE2	4	99	44.9
180.0	65L923	TA2	TC2	TE2	4	99	44.9
190.0	65L924	TA2	TC2	TE2	4	99	44.9
200.0	65L925	TA2	TC2	TE2	4	99	44.9
210.0	65L926	TA2	TC2	TE2	5	136	61.7
220.0	65L927	TA2	TC2	TE2	5	136	61.7
230.0	65L928	TA2	TC2	TE2	5	136	61.7
240.0	65L929	TA2	TC2	TE2	5	138	62.6
250.0	65L930	TA2	TC2	TE2	5	138	62.6
260.0	65L931	TA2	TC2	TE2	5	142	64.4
270.0	65L932	TA2	TC2	TE2	5	143	64.9
280.0	65L933	TA2	TC2	TE2	5	148	67.1
290.0	65L934	TA2	TC2	TE2	5	148	67.1
300.0	65L935	TA2	TC2	TE2	5	148	67.1
325.0	65L936	TA2	TC2	TE2	6	181	82.1
350.0	65L937	TA2	TC2	TE2	6	186	84.4
375.0	65L338	TA2	TC2	TE2	6	191	86.6
400.0	65L939	TA2	TC2	TE2	6	196	88.9
425.0	65L940	TA2	TC2	TE2	7	230	104.3
450.0	65L941	TA2	TC2	TE2	7	235	106.6
475.0	65L942	TA2	TC2	TE2	7	240	108.9
500.0	65L943	TA2	TC2	TE2	7	245	111.1

Fixed GEM Unit Selection Table - 600V – Three Phase

(Contact Factory for Single Phase Product)

600 VOLT -3 PHASE						APPROXIMATE WEIGHT	
kVAR	BASE CATALOG NUMBER	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	Dwg	lbs	kg
1.0	65L800	TF1	TH1	TK1	1	9	4.1
1.5	65L801	TF1	TH1	TK1	1	9	4.1
2.0	65L802	TF1	TH1	TK1	1	9	4.1
2.5	65L803	TF1	TH1	TK1	1	9	4.1
3.0	65L804	TF1	TH1	TK1	1	9	4.1
4.0	65L805	TF1	TH1	TK1	1	9	4.1
5.0	65L806	TF1	TH1	TK1	1	10	4.1
6.0	65L807	TF1	TH1	TK1	1	10	4.1
7.5	65L808	TF1	TH1	TK1	1	10	4.5
10.0	65L809	TF2	TH2	TK2	1	10	4.5
12.5	65L810	TF2	TH2	TK2	1	10	4.5
15.0	65L811	TF1	TH1	TK1	1	13	5.9
17.5	65L812	TF2	TH2	TK2	1	13	5.9
20.0	65L813	TF2	TH2	TK2	1	13	5.9
22.5	65L814	TF2	TH2	TK2	1	13	5.9
25.0	65L815	TF2	TH2	TK2	1	13	5.9
27.5	65L816	TF2	TH2	TK2	2	19	8.6
30.0	65L817	TF2	TH2	TK2	2	19	8.6
32.5	65L818	TF2	TH2	TK2	2	19	8.6
35.0	65L819	TF2	TH2	TK2	2	19	8.6
37.5	65L820	TF2	TH2	TK2	2	19	8.6
40.0	65L821	TF2	TH2	TK2	2	22	10.0
42.5	65L822	TF2	TH2	TK2	2	22	10.0
45.0	65L823	TF2	TH2	TK2	2	22	10.0
47.5	65L824	TF2	TH2	TK2	2	22	10.0
50.0	65L825	TF2	TH2	TK2	2	22	10.0
55.0	65L826	TF2	TH2	TK2	3	32	14.5
60.0	65L827	TF2	TH2	TK2	3	32	14.5
65.0	65L828	TF2	TH2	TK2	3	32	14.5
70.0	65L829	TF2	TH2	TK2	3	33	15.0
75.0	65L830	TF2	TH2	TK2	3	33	15.0
80.0	65L831	TF2	TH2	TK2	3	38	17.3
85.0	65L832	TF2	TH2	TK2	3	38	17.3

600 VOLT -3 PHASE						APPROXIMATE WEIGHT	
kVAR	BASE CATALOG NUMBER	SUFFIX (NO FUSES)	SUFFIX (FUSES)	SUFFIX (FUSES & LIGHTS)	Dwg	lbs	kg
90.0	65L833	TF2	TH2	TK2	3	38	17.3
95.0	65L834	TF2	TH2	TK2	3	38	17.3
100.0	65L835	TF2	TH2	TK2	3	38	17.3
110.0	65L914	TF3	TH3	TK3	4	87	39.5
120.0	65L915	TF3	TH3	TK3	4	87	39.5
125.0	65L916	TF3	TH3	TK3	4	87	39.5
130.0	65L917	TF3	TH3	TK3	4	87	39.5
140.0	65L918	TF3	TH3	TK3	4	89	40.5
150.0	65L919	TF3	TH3	TK3	4	99	40.5
160.0	65L920	TF3	TH3	TK3	4	99	45
170.0	65L921	TF3	TH3	TK3	4	99	45
175.0	65L922	TF3	TH3	TK3	4	99	45
180.0	65L923	TF3	TH3	TK3	4	99	45
190.0	65L924	TF3	TH3	TK3	4	99	45
200.0	65L925	TF3	TH3	TK3	4	99	45
210.0	65L326	TF3	TH3	TK3	5	136	61.8
220.0	65L927	TF3	TH3	TK3	5	136	61.8
230.0	65L928	TF3	TH3	TK3	5	136	61.8
240.0	65L929	TF3	TH3	TK3	5	138	62.7
250.0	65L930	TF3	TH3	TK3	5	138	62.7
260.0	65L931	TF3	TH3	TK3	5	142	64.5
270.0	65L932	TF3	TH3	TK3	5	143	65
280.0	65L933	TF3	TH3	TK3	5	148	67.3
290.0	65L934	TF3	TH3	TK3	5	148	67.3
300.0	65L935	TF3	TH3	TK3	6	148	67.3
325.0	65L936	TF3	TH3	TK3	6	181	82.3
350.0	65L937	TF3	TH3	TK3	6	186	84.5
375.0	65L938	TF3	TH3	TK3	6	191	86.8
400.0	65L939	TF3	TH3	TK3	6	196	89.1
425.0	65L940	TF3	TH3	TK3	7	230	104.5
450.0	65L941	TF3	TH3	TK3	7	235	106.8
475.0	65L942	TF3	TH3	TK3	7	240	109.1
500.0	65L943	TF3	TH3	TK3	7	245	111.4

Fixed GEM Unit Drawings

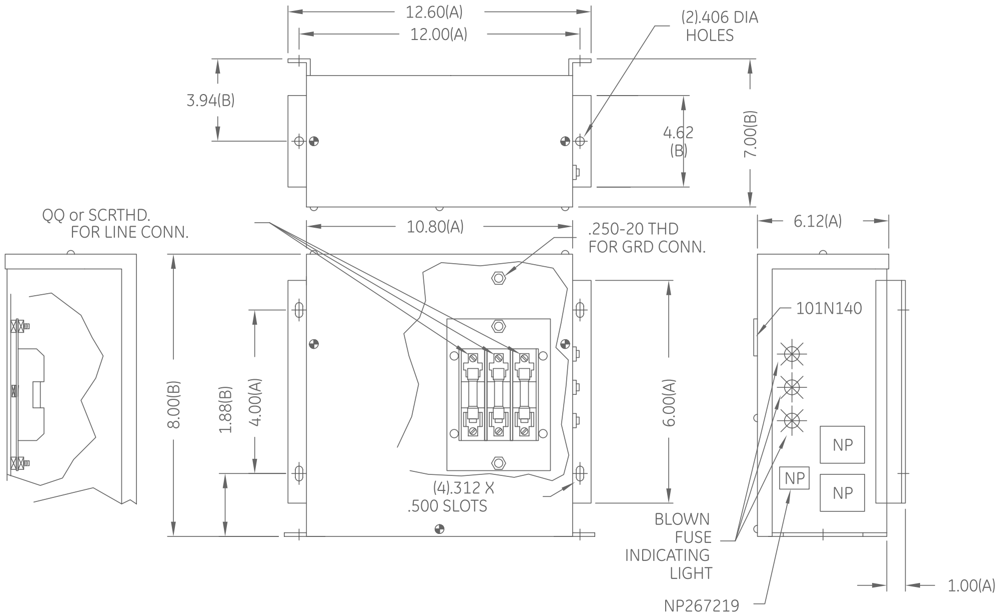


Figure 1

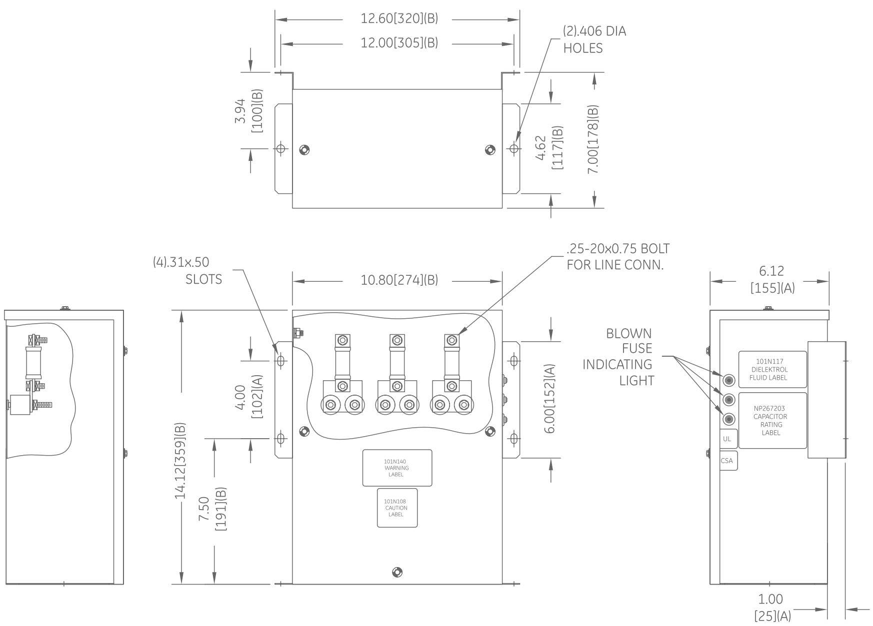


Figure 2

Fixed GEM Unit Drawings

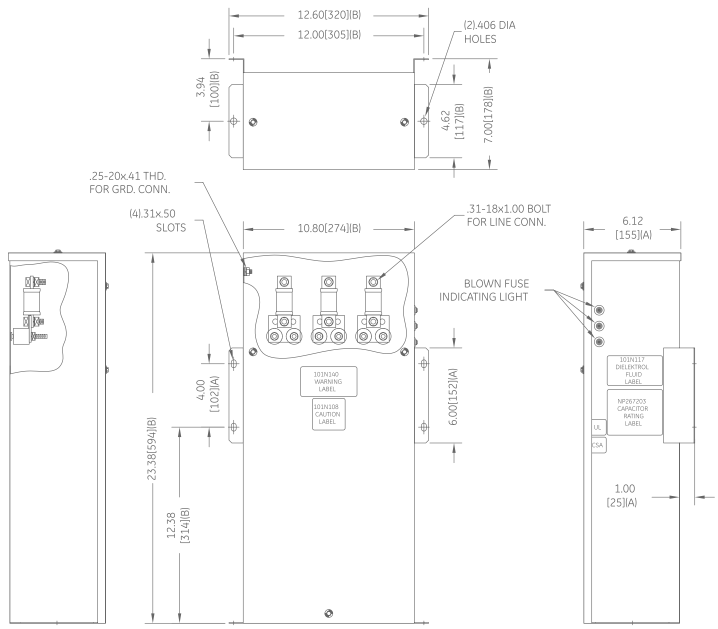


Figure 3

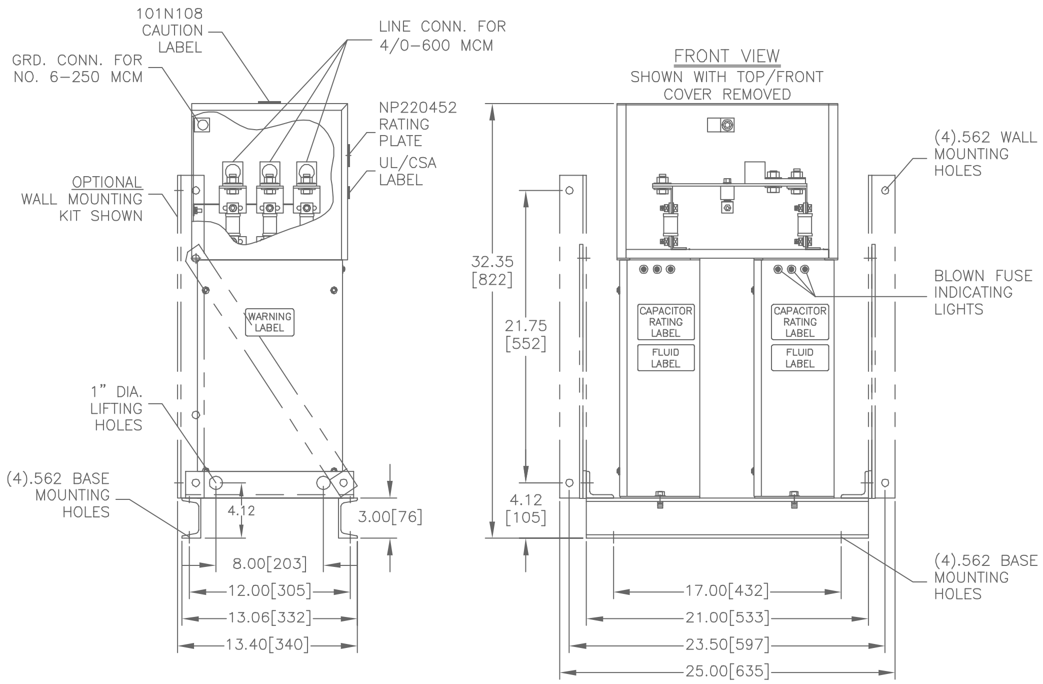


Figure 4

Fixed GEM Unit Drawings

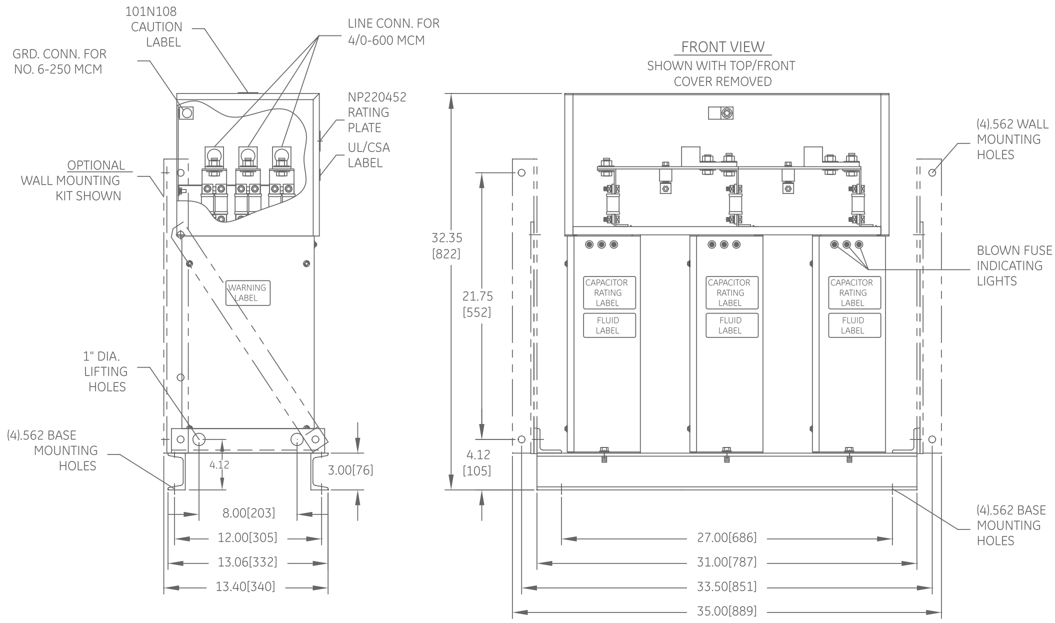


Figure 5

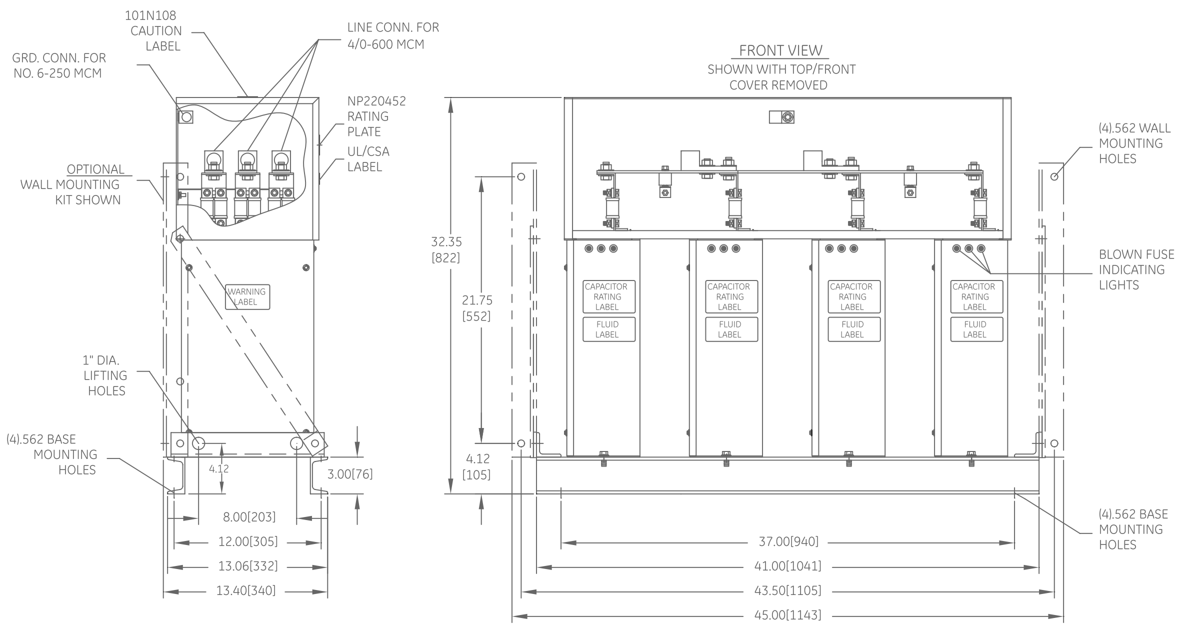


Figure 6

Fixed GEM Unit Drawings

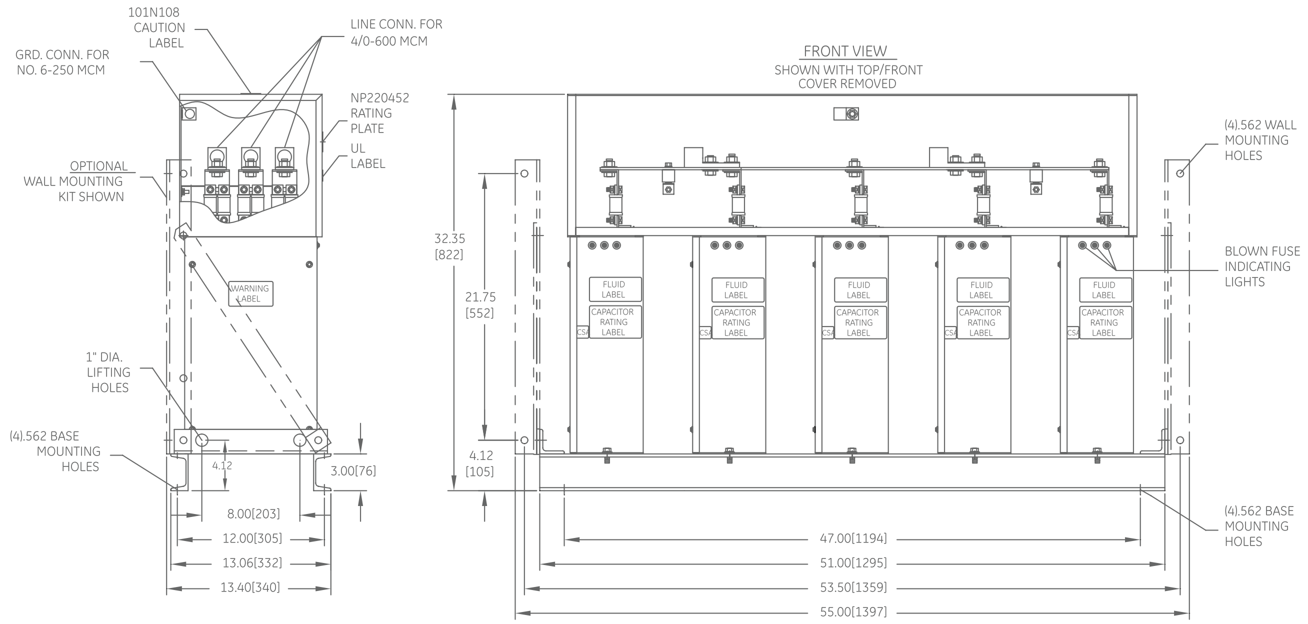


Figure 7

Low Voltage Fixed Power Factor – GEM OFW Units & Equipment

GEM OFW Series Motor and Pump Capacitors

Product Information

- 240, 480 volt ratings available
- Outdoor Weatherproof
- Three Phase Delta, 60Hz

Description

These Type GEM capacitors are designed primarily for the motor requirements of oil field and other pumping installations. Their application, however, may be extended to other motor applications installed indoor or outdoor. Type GEM OFW capacitors feature multiple cells which are assembled in parallel in a NEMA 3 enclosure. Each capacitor cell features the patented GE Vernova Pressure Sensitive Interrupter (PSI) that protects against cell rupture. The metallized polypropylene film dielectric system provides an instantaneous self-healing action and greatly reduced energy losses.

Discharge resistors are included to reduce voltage to 50 volts or less within one minute of de-energization. A 4 ft 4-conductor flexible cable is provided for easy installation.

Type GEM capacitors offer high reliability and long life. They are suitable for operation over a temperature range of –40°C to +46°C. GEM also features Dielektrol impregnant which is a biodegradable Class IIIB combustible fluid.

Note: These capacitors are not intended for use in harmonic environments.

Line Connection and Cable Entrance

A 4 ft. 4-conductor flexible cable with watertight connector is provided for easy installation.

Fixed GEM OFW Selection Table - 240V 480V Three Phase

(For dimensions please see Figure 1)

				A		B		APPROXIMATE WEIGHT	
VOLTS	kVAR	CATALOG NUMBER	CABLE SIZE	inches	mm	inches	mm	lbs	kg
240	1.0	65L550TL1	12	5.9	150	3.18	81	7.5	3.4
	1.5	65L551TL1	12	5.9	150	3.18	81	7.5	3.4
	2.0	65L552TL1	12	5.9	150	3.18	81	7.5	3.4
	2.5	65L553TL1	12	5.9	150	3.18	81	7.8	3.5
	3.0	65L554TL1	12	5.9	150	3.18	81	7.8	3.5
	4.0	65L555TL1	12	5.9	150	3.18	81	8.5	3.9
	5.0	65L556TL1	12	5.9	150	3.18	81	8.5	3.9
	6.0	65L557TL1	8	5.94	151	5.54	141	10.2	4.6
	7.5	65L558TL1	8	5.94	151	5.54	141	11.7	5.3
	10.0	65L559TL1	8	5.94	151	5.54	141	11.7	5.3
	12.5	65L560TL1	8	5.94	151	8.15	207	14.9	6.8
	15.0	65L561TL1	8	5.94	151	8.15	207	14.9	6.8
480	1.0	65L550TA1	12	5.9	150	3.18	81	7.5	3.4
	1.5	65L551TA1	12	5.9	150	3.18	81	7.5	3.4
	2.0	65L552TA1	12	5.9	150	3.18	81	7.5	3.4
	2.5	65L553TA1	12	5.9	150	3.18	81	7.5	3.4
	3.0	65L554TA1	12	5.9	150	3.18	81	7.5	3.4
	4.0	65L555TA1	12	5.9	150	3.18	81	7.5	3.4
	5.0	65L556TA1	12	5.9	150	3.18	81	7.5	3.4
	6.0	65L557TA1	12	5.9	150	3.18	81	7.8	3.5
	7.5	65L558TA1	12	5.9	150	3.18	81	8.5	3.9
	10.0	65L559TA1	12	5.9	150	3.18	81	8.5	3.9
	12.5	65L560TA1	12	5.9	150	3.18	81	8.5	3.9
	15.0	65L561TA1	8	5.94	151	5.54	141	11.7	5.3
	17.5	65L562TA1	8	5.94	151	5.54	141	11.7	5.3
	20.0	65L563TA1	8	5.94	151	5.54	141	11.7	5.3
	22.5	65L564TA1	8	5.94	151	5.54	141	11.7	5.3
	25.0	65L565TA1	8	5.94	151	5.54	141	11.7	5.3
	27.5	65L566TA1	8	5.94	151	8.15	207	14.9	6.8
	30.0	65L567TA1	8	5.94	151	8.15	207	14.9	6.8

GEM OFW Series Drawings

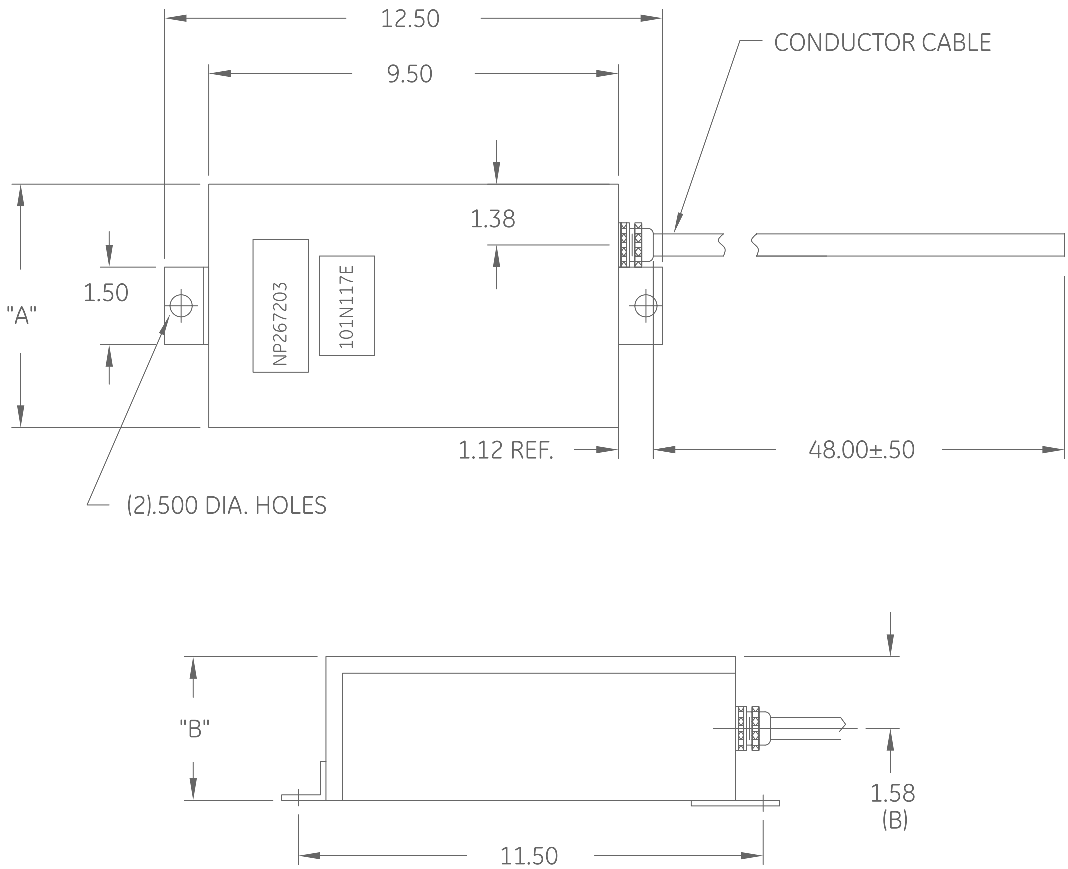


Figure 1

Type HWT Fixed Medium Voltage – Power Factor Correction Capacitors

Medium Voltage Fixed Capacitors

Product Information

- 2400, 4160, 4800, 6600, 7200, 12470, 13200 volt ratings available
- Additional voltages below 13.2kV are available by de-rating (contact factory for details)
- Indoor Dustproof and Outdoor Weatherproof
- Three Phase Delta, 60Hz
- Not for use in harmonic applications

Description

HWT's Film/Foil capacitors offer an energy efficient polypropylene film dielectric. This heavy duty conventional film dielectric system is designed to handle unusual overvoltages and overcurrents without reducing capacitor life. The Film/Foil dielectric results in low watts per kVAR power consumption during capacitor operation. The less than 0.2 watts per kVAR losses and corresponding low internal heat generation mean low operating temperatures for the Film/Foil capacitor, a significant factor in extending capacitor life. Film/Foil designs feature time-proven Dielektrol, a biodegradable NFPA Class IIIB dielectric fluid. This design offers high reliability and long life and is suitable for operation over a temperature range of -40°C to +46°C.

Line Terminals

Solderless connectors are provided on each phase:

ASSEMBLY	CONNECTOR SIZE
One unit	#10 - #4
Two unit	#14 - 1/0
Three unit	#6 - 250 MCM

Fuses

Protection is provided by 50,000 ampere interrupting capacity current limiting fuses. A pop-up button on the fuse gives visual indication of a blown fuse.

Mounting

HWT equipments are designed to be mounted upright on any level surface.

Complete HWT Assemblies Including Terminal Box, Fuses and Mounting Frame

	2400 VOLT ASSEMBLIES	4160 VOLT ASSEMBLIES	4800 VOLT ASSEMBLIES		WEIGHT		C		E	
kVAR RATING	CATALOG NUMBER	CATALOG NUMBER	CATALOG NUMBER	FIG NO.	lbs	kg	inches	mm	inches	mm
Individual Units - With Terminal Box and 3 Fuses per Unit										
25 50	37F0520431 37F0520432	37F0523431 37F0523432	37F0526431 37F0526432	1 1	64 64	29 29	27.68 27.68	703 703	6.96 6.96	177 177
75	37F0520433	37F0523433	37F0526433	1	64	29	27.68	703	6.96	177
100	37F0520434	37F0523434	37F0526434	1	69	31	29.44	748	8.71	221
125	37F0520435	37F0523435	37F0526435	1	76	35	30.18	767	9.46	240
150	37F0520436	37F0523436	37F0526443	1	81	37	32.68	830	11.96	304
175	37F0520438	37F0523438	37F0526445	1	86	39	33.35	847	12.63	321
200	37F0520437	37F0523437	37F0526444	1	92	42	33.35	847	12.63	321
225	37F0520439	37F0523439	37F0526446	1	103	47	36.06	916	18.33	466
250	37F0520440	37F0523440	37F0526447	1	103	47	36.06	916	18.33	466
275	37F0520441	37F0523441	37F0526448	1	114	52	39.06	992	18.33	466
300	-	37F0523442	37F0526449	1	114	52	39.06	992	18.33	466
Two Units Interconnected - With Terminal Box, 3 Fuses per Unit and Mounting Frame										
300	37F0521435	-	-	2	149	68	33.43	849	12.7	323
325	37F0521436	37F0524436	37F0527440	2	154	70	33.43	849	12.7	323
350	37F0521437	37F0524437	37F0527437	2	159	72	33.43	849	12.7	323
375	37F0521439	37F0524439	37F0527441	2	165	75	33.43	849	12.7	323
400	37F0521438	37F0524438	37F0527438	2	171	78	33.43	849	12.7	323
425	37F0521440	37F0524440	37F0527442	2	181	82	39.18	995	18.45	469
450	37F0521441	37F0524441	37F0527443	2	192	87	39.18	995	18.45	469
475	37F0521442	37F0524442	37F0527444	2	192	87	39.18	995	18.45	469
500	37F0521443	37F0524443	37F0527445	2	192	87	39.18	995	18.45	469
525	37F0521444	37F0524444	37F0527446	2	203	92	39.18	995	18.45	469
550	37F0521445	37F0524445	37F0527447	2	214	97	39.18	995	18.45	469
575	-	37F0524446	37F0527448	2	214	97	39.18	995	18.45	469
600	-	37F0524447	37F0527449	2	214	97	39.18	995	18.45	469
Three Units Interconnected - With Terminal Box, 3 Fuses per Unit and Mounting Frame										
575	37F0522442	-	-	3	248	113	33.43	849	12.7	323
600	37F0522441	-	-	3	254	115	33.43	849	12.7	323
625	37F0522443	37F0525443	37F0528442	3	265	120	39.18	995	18.45	469
650	37F0522444	37F0525444	37F0528443	3	276	125	39.18	995	18.45	469
675	37F0522445	37F0525445	37F0528444	3	287	130	39.18	995	18.45	469
700	37F0522446	37F0525446	37F0528445	3	298	130	39.18	995	18.45	469
725	37F0522447	37F0525447	37F0528446	3	298	130	39.18	995	18.45	469
750	37F0522448	37F0525448	37F0528447	3	298	130	39.18	995	18.45	469
775	37F0522449	37F0525449	37F0528448	3	309	135	39.18	995	18.45	469
800	37F0522450	37F0525450	37F0528449	3	320	140	39.18	995	18.45	469
825	-	37F0525451	37F0528450	3	331	145	39.18	995	18.45	469
850	-	37F0525452	37F0528451	3	331	145	39.18	995	18.45	469
875	-	37F0525453	37F0528452	3	331	145	39.18	995	18.45	469
900	-	37F0525454	37F0528453	3	331	145	39.18	995	18.45	469

- To order blown fuse lights, add “100” to the last 3 digits of the standard part number (Ex – 37F0525454 becomes 37F0525554)
- To order CSA Equipment, add “037” to the end of the standard part number (Ex – 37F0525454 becomes 37F0525454037)

Type HWT Fixed Medium Voltage Correction Capacitors Drawings

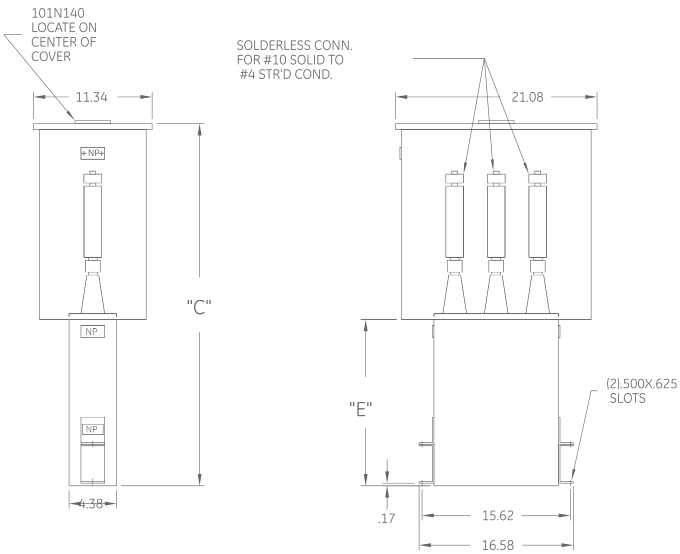


Figure 1

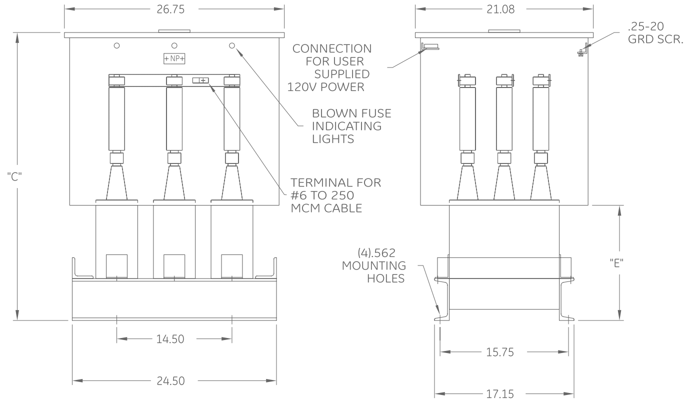


Figure 3

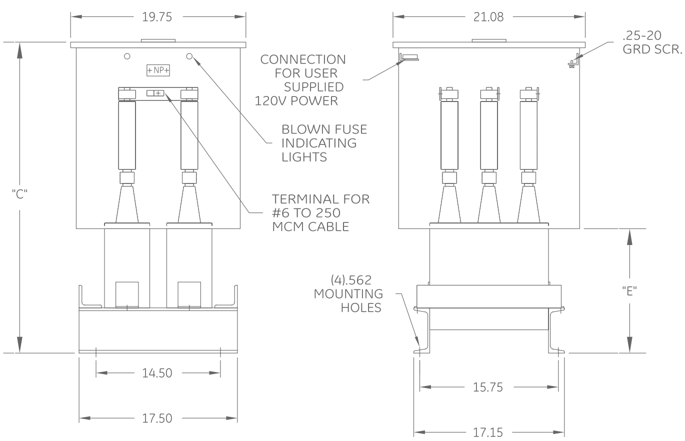


Figure 2

Individual HWT Units and Fuses

	2400 VOLTS			4160 VOLTS			4800 VOLTS		
kVAR	UNIT CATALOG NUMBER	FUSE CATALOG NUMBER	Amps	UNIT CATALOG NUMBER	FUSE CATALOG NUMBER	Amps	UNIT CATALOG NUMBER	FUSE CATALOG NUMBER	Amps
25	52L301WS60	115A161400653	35	52L302WS60	115A161400656	18	52L303WS61	115A161400656	18
50	51L301WS60	115A161400653	35	51L302WS60	115A161400656	18	51L303WS60	115A161400656	18
75	51L304WS60	115A161400653	35	51L305WS60	115A161400656	18	51L306WS60	115A161400656	18
100	54L303WS60	115A161400654	75	54L304WS60	115A161400658	50	54L305WS60	115A161400666	25
125	54L306WS60	115A161400654	75	54L307WS60	115A161400658	50	54L310WS60	115A161400666	25
150	54L308WS60	115A161400654	75	54L309WS60	115A161400658	50	54L403WS60	115A161400658	50
175	54L317WS60	115A161400654	75	54L313WS60	115A161400658	50	54L311WS60	115A161400658	50
200	58L302WS60	115A161400655	100	58L303WS60	115A161400658	50	58L424WS60	115A161400658	50
225	16L0153WS3	115A161400655	100	16L0156WS3	115A161400658	50	16L0160WS3	115A161400658	50
250	16L0154WS3	115A161400655	100	16L0157WS3	115A161400671	75	16L0161WS3	115A161400658	50
275	16L0155WS3	115A161400655	100	16L0158WS3	115A161400671	75	16L0162WS3	115A161400671	75
300	-	-	-	16L0159WS3	115A161400671	75	16L0163WS3	115A161400671	75

- Top and bottom fuse adapter kit is required for each fuse. One kit per fuse is needed and contains 1 top and 1 bottom fuse adapter. Catalog number for fuse adapter kit is 308A390100001.
- For CSA labeled capacitors, order with 037 suffix added (Ex – 54L304WS60 becomes 54L304WS60037)

Automatically Switched, Low Voltage Equipment – GEMATIC Compact

GEMATIC Compact

240 - 480 - 600 volts
3 phase
60 Hz

Description

GEMATIC multi-step power factor control equipment automatically maintains desired power factor level, adjusting to system load requirements in selected kVAR steps. The solid-state control responds to a current signal from the optional current trans- former and to a voltage signal from a potential transformer included in the equipment.

GEMATIC equipments feature capacitors with a metallized dielectric system providing a self-healing action and reduced energy losses. The biodegradable impregnant is a class IIIB combustible fluid. Discharge resistors reduce the voltage to 50 volts or less within one minute of de-energization. The capacitor cells are 3 phase and are designed for 110% of rated voltage, 135% of rated current, and, 135% of rated kVAR.

The power factor controller requires a CT signal for operation. The CT primary should be sized for the total phase current to be compensated (capacitor current and load current). Typically, the total phase current should be 50% to 80% of the CT primary rating. The CT secondary is rated 5A. The CT is connected to one phase of the equipment and the factory installed PT is connected across the other two phases.

Standard Equipment Features

- Correction to unity power factor, if desired
- UL and cUL listed
- NEMA 1, 12-gauge steel cabinet enclosure with ANSI® #70 light grey paint
- Dimensions are 25" W x 25"D x 90"H
- Removable lifting eyes
- Safety door interlock to prevent door from being opened while equipment is energized
- Microprocessor-based controller with built-in voltage and harmonic alarms provides safe and rapid indication of potential or real failure; Digital display of power factor, current, and capacitor step status

- Manual switching capability
- External current transformer connections provided
- 65 kAIC bracing (may be limited by breaker rating)
- Plated copper bus
- LED capacitor stage display
- Air core inductors to limit inrush currents and transients
- Industrial duty, UL recognized safety disconnect, metallized dielectric capacitors, less than 0.2 watts per kVAR losses employing 200 kAIC current limiting fuses in all 3 phases
- Designed to minimize installation time and costs
- Top entry
- Convection cooling - no fans required
- Ratings: 120 kVAR maximum at 240 volts 300 kVAR maximum at 480 and 600 volts

Optional Equipment Features

- Blown fuse indicator lights or push to test lights
- NEMA 3R cabinet available (contact factory)
- Bottom entry
- Split core current transformer
- Hand-off auto switches
- Molded case circuit breaker internally mounted with external operator
- Power on/off switch

GEMATIC Compact – 240-480-600 Volt-3 Phase – 60 Hz

VOLTS	kVAR	BASE CATALOG NUMBER	kVAR/STEP	BREAKER RATING	WEIGHT
240	40	37FJ2040D205	20	400	499
	60	37FJ3060D205	20	400	572
	80	37FJ4080D205	20	400	602
	100	37FJ5100D205	20	400	630
	120	37FJ6120D205	20	600	662
480	50	37FJ2050F255	25	400	499
	75	37FJ2075F255	25	400	499
	100	37FJ3100F255	25	400	542
	125	37FJ3125F255	25	400	565
	150	37FJ3150F505	50	400	572
	175	37FJ4175F255	25	400	595
	200	37FJ4200F505	50	400	602
	225	37FJ5225F255	25	600	625
	250	37FJ5250F505	50	600	630
	275	37FJ6275F255	25	600	655
	300	37FJ6300F505	50	600	662
600	50	37FJ2050H255	25	400	499
	75	37FJ2075H255	25	400	499
	100	37FJ3100H255	25	400	542
	125	37FJ3125H255	25	400	565
	150	37FJ3150H505	50	400	572
	175	37FJ4175H255	25	400	595
	200	37FJ4200H505	50	400	602
	225	37FJ5225H255	25	400	625
	250	37FJ5250H505	50	400	630
	275	37FJ6275H255	25	600	655
	300	37FJ6300H505	50	600	660

To order breaker or blown fuse lights or both options, see below:

SUFFIX LETTER	OPTION
L	Blown Fuse Lights
B	Breaker
R	Lights & Breaker

Note: Add only one suffix letter to the end of catalog numbers. Add breaker option below, after Suffix Letter Option.

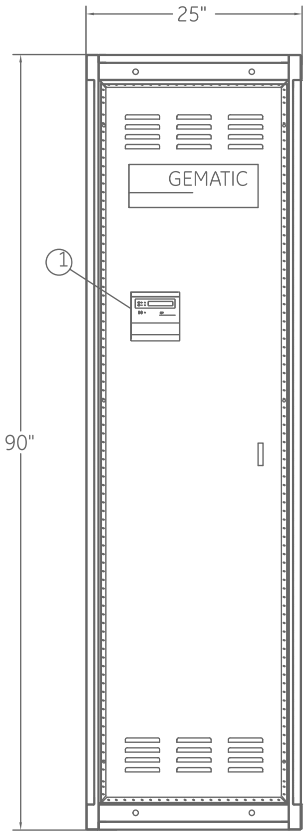
Breaker Options:

CURRENT RATING	kAIC RATING	CODE FOR STANDARD BREAKER OPTION
400	35	00003
600	35	00006

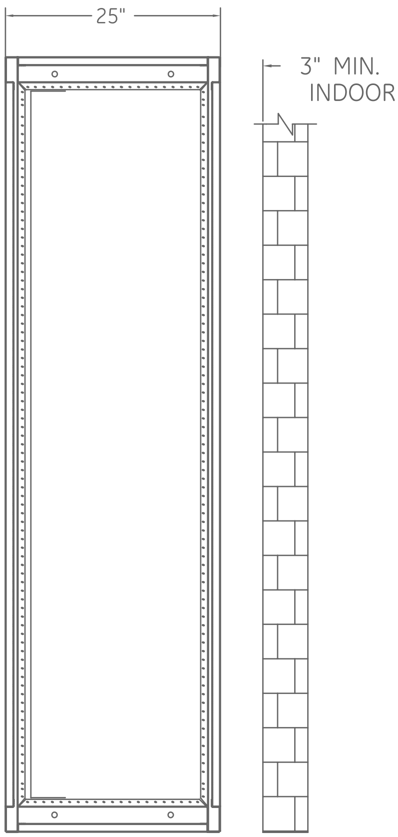
Note: Breaker Option suffix number goes after the Option Suffix Letter.

Automatically Switched GEMATIC Compact Drawings

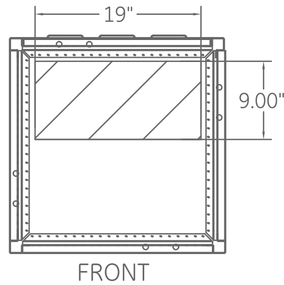
Front View



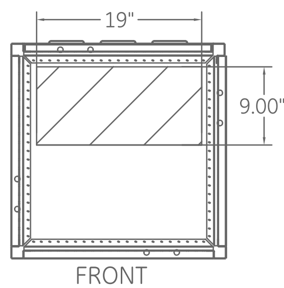
Side View

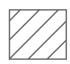


Top View



Bottom View




RECOMMENDED
ENTRANCE
LOCATIONS

Automatically Switched, Low Voltage Equipment – GEMATIC Select

GEMATIC Select

240 - 480 - 600 volts
3 phase
60 Hz

Description

GEMATIC multi-step power factor control equipment automatically maintains desired power factor level, adjusting to system load requirements in selected kVAR steps. The solid-state control responds to a current signal from the optional current trans- former and to a voltage signal from a potential transformer included in the equipment.

GEMATIC equipments feature capacitors with a metallized dielectric system providing a self-healing action and reduced energy losses. The biodegradable impregnant is a class IIIB combustible fluid. Discharge resistors reduce the voltage to 50 volts or less within one minute of de-energization. The capacitor cells are 3 phase and are designed for 110% of rated voltage, 135% of rated current, and, 135% of rated kVAR.

The power factor controller requires a CT signal for operation. The CT primary should be sized for the total phase current to be compensated (capacitor current and load current). Typically, the total phase current should be 50% to 80% of the CT primary rating. The CT secondary is rated 5A. The CT is connected to one phase of the equipment and the factory installed PT is connected across the other two phases.

Standard Equipment Features

- Correction to unity power factor, if desired
- UL and cUL listed
- NEMA 1 steel cabinet enclosure with ANSI #70 light grey paint. Top entry, right side.
- Dimensions are 48” W x 24”D x 90”H
- Removable lifting eyes
- Safety door interlock to prevent door from being opened while equipment is energized
- Microprocessor-based controller with built-in voltage and harmonic alarms provides safe and rapid indication of potential or real failure. Digital display of power factor, current and capacitor step status
- Manual switching capability
- External current transformer connections provided

- 100 kAIC bracing (may be limited by breaker rating)
- Capacitor stage display
- Air core inductors to limit inrush currents and transients
- Industrial duty, metallized electrode capacitors, employing
- 200 kAIC current-limiting fuses in all 3 phases
- Plated copper bus
- Lockable door handle
- Designed to minimize installation time and costs.
- Convection cooling - no fans required
- Ratings: 300 kVAR maximum at 240 volts, 600 kVAR maximum at 480 and 600 volts

Optional Equipment Features

- Blown fuse indicator lights or push to test lights
- NEMA 4 cabinet available
- NEMA 12 cabinet available
- Split core current transformer
- Molded-case circuit breaker internally mounted with external operator
- Hands-off auto switches
- Power on/off switch with light
- Bottom entry (Entry location right side of enclosure)

GEMATIC Select – 240- 480- 600 Volts – 3 Phase- 60 Hz

VOLTS	kVAR	BASE CATALOG NUMBER	kVAR/ STEP	BREAKER RATING	WEIGHT
240	100	37FC4100D255	25	400	1050
	125	37FC5125D255	25	600	1099
	150	37FC6150D255	25	600	1149
	175	37FC7175D255	25	800	1198
	200	37FC8200D255	25	800	1248
	225	37FC9225D255	25	1000	1298
	250	37FCA250D255	25	1000	1347
	300	37FCC300D255	25	1200	1446
480	100	37FC3100F255	25	400	976
	125	37FC3125F255	25	400	988
	150	37FC3150F505	50	400	1000
	175	37FC4175F255	25	400	1038
	200	37FC4200F505	50	400	1050
	225	37FC5225F255	25	600	1085
	250	37FC5250F505	50	600	1099
	275	37FC6275F255	25	600	1136
	300	37FC6300F505	50	600	1149
	325	37FC7325F255	25	600	1186
	350	37FC7350F505	50	800	1198
	375	37FC8375F255	25	800	1235
	400	37FC8400F505	50	800	1248
	425	37FC9425F255	25	800	1285
	450	37FC9450F505	50	1000	1298
	475	37FCA475F255	25	1000	1334
	500	37FCA500F505	50	1000	1347
	525	37FCB525F255	25	1000	1384
	550	37FCB550F505	50	1200	1397
	575	37FCC575F255	25	1200	1433
	600	37FCC600F505	50	1200	1446

VOLTS	kVAR	BASE CATALOG NUMBER	kVAR/ STEP	BREAKER RATING	WEIGHT
600	100	37FC3100H255	25	400	976
	125	37FC3125H255	25	400	988
	150	37FC3150H505	50	400	1000
	175	37FC4175H255	25	400	1038
	200	37FC4200H505	50	400	1050
	225	37FC5225H255	25	400	1085
	250	37FC5250H505	50	400	1099
	275	37FC6275H255	25	400	1136
	300	37FC6300H505	50	600	1149
	325	37FC7325H255	25	600	1186
	350	37FC7350H505	50	600	1198
	375	37FC8375H255	25	600	1235
	400	37FC8400H505	50	600	1248
	425	37FC9425H255	25	800	1285
	450	37FC9450H505	50	800	1298
	475	37FCA475H255	25	800	1334
	500	37FCA500H505	50	800	1347
	525	37FCB525H255	25	800	1384
	550	37FCB550H505	50	800	1397
	575	37FCC575H255	25	1000	1433
	600	37FCC600H505	50	1000	1446

To order breaker or blown fuse lights or both options, see below:

SUFFIX LETTER	OPTION
L	Blown Fuse Lights
B	Breaker
R	Lights & Breaker

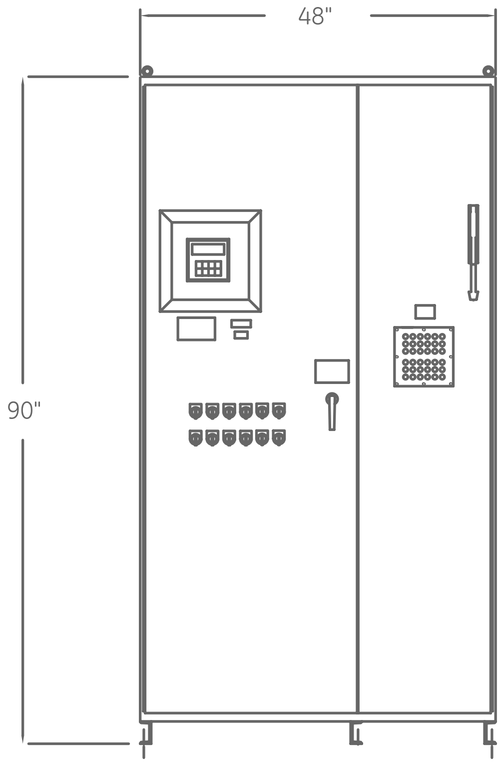
Note: Add only one suffix letter to the end of catalog numbers. Add breaker option below, after Suffix Letter Option.

Breaker Options:

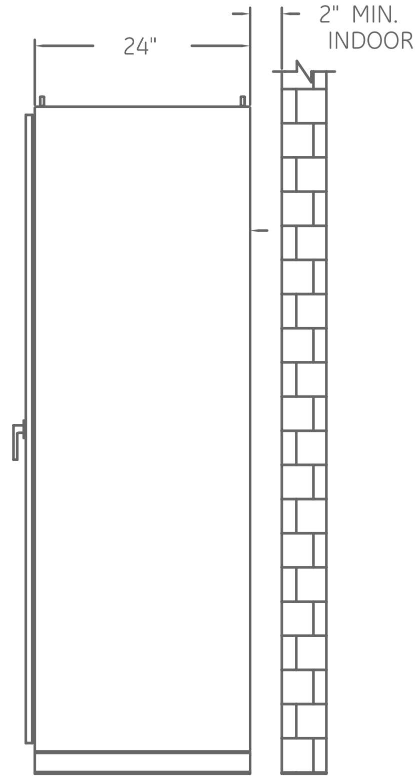
CURRENT RATING	kAIC RATING	CODE FOR STANDARD BREAKER OPTION
400	35	00003
600	35	00006
800	50	00009
1000	50	0000C
1200	50	0000F

Note: Breaker Option suffix number goes after the Option Suffix Letter. Additional step sizes available. Please contact factory.

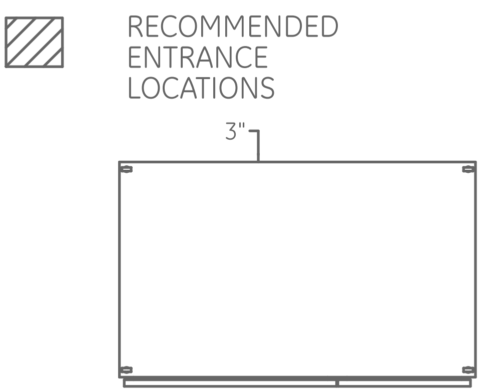
Automatically Switched GEMATIC Select Drawings



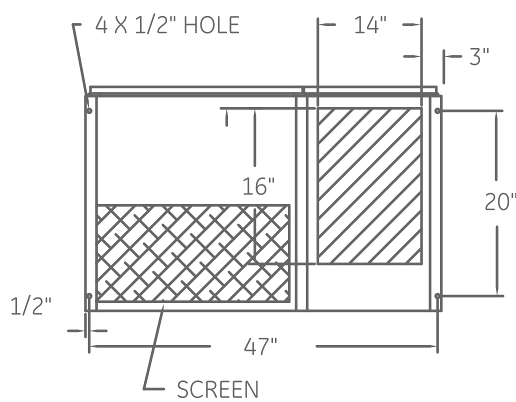
Front View



Side View



Top View



Bottom View

Automatically Switched, Low Voltage Equipment – GEMATIC Custom

GEMATIC Custom

240 - 480 - 600 volts
3 phase
60 Hz

Description

The GEMATIC Custom offers power factor correction with the flexibility of including harmonic filter reactors initially or adding them later if they are required.

Many of today's power systems require modern solutions to power factor correction. The rapid increase in variable speed drive use and other solid state devices has resulted in severe harmonic loads on power systems. GE Vernova has many years of experience in preventing the occurrence of non-sinusoidal resonance. Successful integration in tuned L-C networks solves the problem of parallel resonance.

GEMATIC Custom automatic power factor correction systems with 3-phase harmonic suppression reactors are application specific. Accordingly, each installation requires specific information to aid GE Vernova application engineers in designing each system to meet your requirements. This information should include, but not be limited to, kVAR requirements, transformer size and impedance, kVAsc of the transformer, and a harmonic profile of your system. Load characteristic at the time of the survey and worst case should also be included.

The GEMATIC Custom systems may be configured for the addition of harmonic suppression reactors in the future to meet the imminent needs of your system. This reduces initial investment and provides a readily made retrofit package. This system provides total flexibility in achieving maximum automatic power factor correction. Please contact the local GE Vernova sales office or the GE Vernova factory for any assistance with your particular power factor correction and harmonic suppression needs.

Standard Equipment Features

- Designed and built to "match and line up" with motor control centers and switchgear
- Industrial rated design and specifications
- Modular design permits sizing of cabinet to allow for future expansion requirements
- Correction to unity power factor, if desired
- NEMA 1 steel cabinet enclosure with ANSI #70 light grey paint, 12-gauge frame and 14-gauge panels
- Removable lifting eyes
- UL and cUL listed
- Microprocessor-based controller with built-in voltage, temperature, and harmonic alarms provides safe and rapid indication of potential or real failure; Digital display of power factor, current, and capacitor step status
- Manual switching capability
- External current transformer connections provided
- 100 kAIC bracing (may be limited by breaker rating)
- Plated copper bus
- Top entry, right hand feed
- Capacitor stage display
- Industrial duty, metallized electrode capacitors, employing 200 kAIC current-limiting fuses in all 3 phases
- Air core inductors to limit inrush currents and transients (Not required when tuned reactors are utilized)
- Designed to minimize installation time and costs
- Door interlock to prevent entry while system is energized
- Lockable door handle
- Convection cooling - no fans required

Optional Equipment Features

- Outdoor NEMA 3R enclosure
- Main breaker
- Iron core harmonic suppression reactors
- Reactor thermal alarm
- Blown fuse indicating lights or push to test lights
- Split core current transformer
- Molded case circuit breaker, internally mounted with external operator or system breaker
- Hands-off auto switches
- Reverse and bottom entry
- Power on/off switch

Custom System with Harmonic Suppression Reactors

Many of today's power systems require modern solutions to power factor correction. The rapid increase in non-linear load devices, such as variable speed drives, AC/DC drives, arc-furnaces, and welders, has resulted in severe harmonic loads on power systems.

GE Vernova has many years of experience in preventing the occurrence of nonsinusoidal resonance. Successful integration in tuned L-C networks solves the problem of parallel resonance.

The GEMATIC Custom automatic power factor correction systems with 3-phase harmonic suppression reactors are application-specific. Accordingly, each installation requires specific information to aid GE Vernova Application Engineers in designing a system to meet your requirements.

This information should include, but not be limited to, kVAR requirements, transformer size and impedance, KVAsc of the transformer, and a harmonic profile of your system. Load characteristics at the time of the survey and worst case should also be included.

The GEMATIC Custom systems may be configured for the addition of harmonic suppression reactors in the future to meet the imminent needs of your system. This reduces initial investment and provides a ready-made retrofit package.

The GEMATIC Custom system provides total flexibility in achieving maximum automatic power factor correction. Please contact GE Vernova for any assistance with your particular power factor correction and harmonic suppression needs.

VOLTS	TOTAL kVAR	BASE CATALOG NUMBER	kVAR/STEP	CIRCUIT BREAKER RATING	ENCLOSURE WIDTH (SECTIONS)	WEIGHT (WITHOUT REACTORS)	WEIGHT (WITH REACTORS)
240	100	38FP3100D255	25	400	1	1094	1634
	150	38FP6150D255	25	600	2	1223	2033
	200	38FP5200D255	25	800	2	1352	2432
	225	38FP5225D255	25	1000	2	1417	2632
	250	38FP5250D505	50	1000	2	1481	2831
	300	38FP6300D505	50	1000	2	1610	3230
480	200	38FP3200F505	50	600	1[1]	686	997
	250	38FP3250F505	50	600	1[1]	713	1071
	300	38FP3300FA05	100	600	1[1]	740	1145
	350	38FP4350F505	50	800	2	1067	1560
	400	38FP4400FA05	100	800	2	1094	1634
	450	38FP5450F505	50	1000	2	1132	1760
	500	38FP5500FA05	100	1000	2	1159	1834
	550	38FP6550F505	50	1200	2	1196	1959
	600	38FP6600FA05	100	1200	2	1223	2033
	650	38FP7650F505	50	1600	2[1]	1261	2159
	700	38FP7700FA05	100	1600	2[1]	1288	2233
	750	38FP8750F505	50	1600	3	1615	2648
	800	38FP8800FA05	100	1600	3	1642	2722
	850	38FP9850F505	50	1600	3	1680	2848
	900	38FP9900FA05	100	2000	3	1707	2922
	950	38FPA950F505	50	2000	3	1744	3047
	1000	38FPAA00FA05	100	2000	3	1771	3121
	1100	38FPBB00FA05	100	2500	3[1]	1836	3321
	1200	38FPCC00FA05	100	2500	4	2190	3810
	1300	38FPDD00FA05	100	2500	4	2255	4010
	1400	38FPEE00FA05	100	3000	4	2319	4209
	1500	38FPFF00FA05	100	3000	4[1]		

VOLTS	TOTAL kVAR	BASE CATALOG NUMBER	kVAR/STEP	CIRCUIT BREAKER RATING	ENCLOSURE WIDTH (SECTIONS)	WEIGHT (WITHOUT REACTORS)	WEIGHT (WITH REACTORS)
600	200	38FP3200H505	50	1000	1[1]	686	997
	250	38FP3250H505	50	1000	1[1]	713	1071
	300	38FP3300HA05	100	600	1[1]	740	1145
	350	38FP4350H505	50	600	2	1067	1560
	400	38FP4400HA05	100	600	2	1094	1634
	450	38FP5450H505	50	800	2	1132	1760
	500	38FP5500HA05	100	800	2	1159	1834
	550	38FP6550H505	50	800	2	1196	1959
	600	38FP6600HA05	100	1000	2	1223	2033
	650	38FP7650H505	50	1200	2[1]	1261	2159
	700	38FP7700HA05	100	1200	2[1]	1288	2233
	750	38FP8750H505	50	1200	3	1615	2648
	800	38FP8800HA05	100	1600	3	1642	2722
	850	38FP9850H505	50	1600	3	1680	2848
	900	38FP9900HA05	100	1600	3	1707	2922
	950	38FPA950H505	50	1600	3	1744	3047
	1000	38FPAA00HA05	100	2000	3	1771	3121
	1100	38FPBB00HA05	100	2000	3[1]	1836	3321
	1200	38FPCC00HA05	100	2000	4	2190	3810
	1300	38FPDD00HA05	100	2500	4	2255	4010
	1400	38FPEE00HA05	100	2500	4	2319	4209
	1500	38FPFF00HA05	100	2500	4[1]		

NOTE: For higher kVAR ratings, contact factory.

[1] Enclosure increases by one section when breaker option is included.

Explanation of Options

Selection Process

- Determine service voltage and Total kVAR required
- Determine enclosure type (NEMA 1 standard, NEMA 3R optional)

Options

- Determine if harmonic reactors are required and tuning point (contact factory for additional information)
- Determine if Circuit Breaker is required
- Decide if Blown Fuse Lights are desired
- Determine Cable Entry location (top right is standard)

For Optional Equipment listed in the GEMATIC Custom Application section, contact Factory for part number configuration.

SUFFIX LETTER	OPTION
L	Blown Fuse Lights
B	Breaker
F	Harmonic Reactors
R	Blown Fuse Lights and Breaker
G	Blown Fuse Lights and Reactors
W	Blown Fuse Lights, Breaker and Reactors
K	Breaker and Reactors

Note: Add only one suffix letter to the end of catalog numbers, based on the matrix above. If a breaker is one of those options, add breaker code after the suffix above. See codes to the right.

Breaker Options

CURRENT RATING	kAIC RATING	CODE FOR STANDARD BREAKER OPTION
400	35	00003
600	35	00006
800	50	00009
1000	50	0000C
1200	50	0000F
1600	65	0000L
2000	65	0000N
2500	100	0000Q
3000	100	0000T

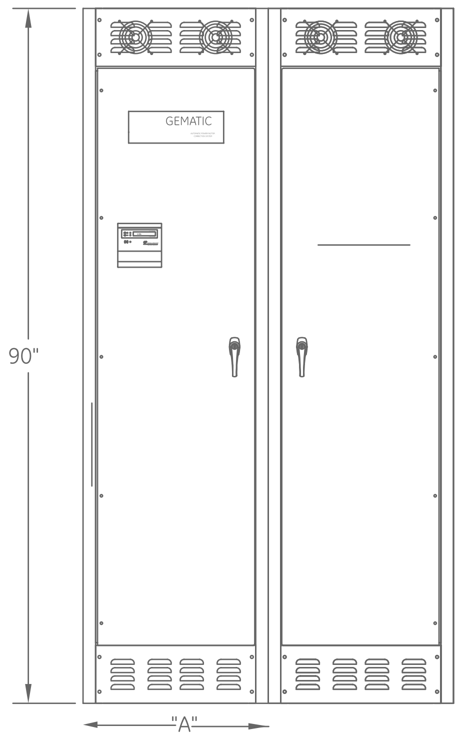
Note: Breaker Option suffix number goes after the Option Suffix Letter. Contact factory if higher kAIC rating is required.

For Reverse Service Entry change the last digit of the Basic Catalog Number from “5” to “7”.

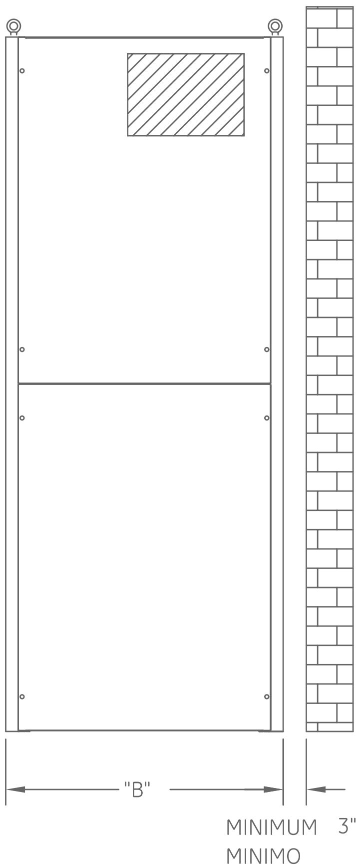
For Bottom Service Entry change Basic Catalog Number from “5” to “6”.

For Reverse Bottom Service Entry change Basic Catalog Number from “7” to “8”.

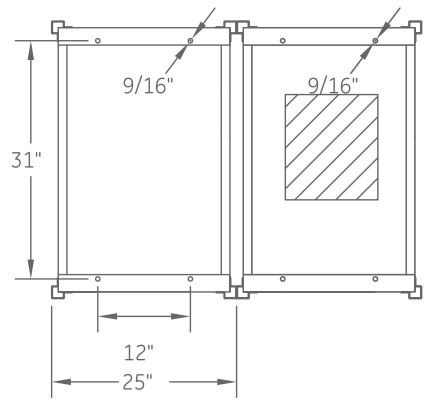
Automatically Switched GEMATIC Custom Drawings



Front View



Side View



Top View

ENCLOSURE SECTION DIMENSIONS (INCHES)	A	B
NEMA 1	25.0	35.0
NEMA 3R	24.0	36.0

CONDUIT ENTRANCE
for reference only

Automatically Switched, Low Voltage Equipment –
GEMATIC Quick Response

GEMATIC Quick Response

480 volts
3 phase
60 Hz

Description

- Ultra Fast Response (UFR): A real-time, transient-free system used to compensate extremely rapid loads within one cycle (typically 5-16 mSec)
- Fast Response (FR): A fast , transient-free system, used to compensate any load within 3-4 seconds.

Advantages

- Ultra Fast Response (UFR) and Fast Response (FR)
- Transient-free capacitor group switching, using electronic switching elements
- Prevent damage to sensitive electronic equipment
- Saves energy
- Harmonic filtration
- Accurate power factor control, even in the presence of harmonics
- Dramatically increases the life expectancy of switching elements and capacitors
- Considerably lower temperature rise of capacitors and inductors due to unique scan feature
- Built-in three phase network analyzer, measuring all network parameters including harmonics
- Unique self-testing and comprehensive reporting feature

- Power IQ
- Ultra Fast Response (UFR) (in addition to the above):
- Cycle-by-cycle reactive power compensation (total acquisition time of 5-16 mSec)
- Prevents voltage drop and flickering
- Used for Real Time applications, such as spot welding and motor startup
- Enhances capacity of local generator systems, such as diesel and windmill generators
- Combination of one to three single-phase systems available for unbalanced loads

Note

GEMATIC Quick Response equipment is a specialized product for specific environments. Contact the factory for application and quoting assistance.

Automatic Low Voltage Harmonic Filter – GEMActive

GEMActive Harmonic Filter

Product Information

- Dynamic current injection for harmonic cancellation and power factor correction
- Reduces harmonics for IEEE® 519 (1992) standard compliance
- Decreases harmonic related overheating of cables, switchgear and transformers
- Reduces downtime caused by nuisance thermal tripping of protective devices
- Increases electrical network reliability and reduces operating costs
- Compensates each phase independently
- UL and CSA approved
- Parallel connection allows for easy retrofit and installation of multiple units for large networks
- Filters to the 50th harmonic
- Filters entire network or specific loads depending on installation point
- Response to load fluctuations begins in 40 microseconds with 8 milliseconds for full response to step load changes
- IGBT based power electronic technology
- 50, 100 and 300A models for 208 to 480V, 50/60 Hz three phase networks

GE Vernova GEMActive reduces problematic harmonic levels and provides instantaneous power factor correction. Cost savings result from reduced downtime and maintenance. In addition, over-sizing of distribution equipment to provide for harmonics and poor power factor can be avoided. GE Vernova GEMActive dynamically corrects power quality by providing: Active Harmonic Filtration, Resonance Prevention, Power Factor Correction and Dynamic VAR Compensation.

The Harmonic Problem

Although power electronic loads and devices which have rapid and frequent load variations have become abundant due to their many process control related benefits, they have one major drawback in common: they produce harmonics. Harmonics may disrupt other loads and increase operating costs and lower the reliability of the electrical network. The current waveform required by power electronic loads is quite different than the sinusoidal voltage delivered by the utility. This 'non-linear' current draw (Figure 1) results in the creation of harmonics.

Symptoms of problematic harmonic levels include overheating of motors, drives, cables, thermal tripping of protective devices and logic faults of digital devices all of which can result in downtime. In addition the life span of many devices may be reduced by overheating. Furthermore, by reducing harmonic levels, the need to oversize transformers and cables to account for harmonic heating effects is lessened.

With this in mind, the IEEE 519-1992 recommended practice establishes limits on current distortion that individual facilities can feed back on to the utility grid. Many utilities enforce these limits and with the decrease in capital spending due to deregulation of the industry, many more utilities are expected to start to enforce these limits.

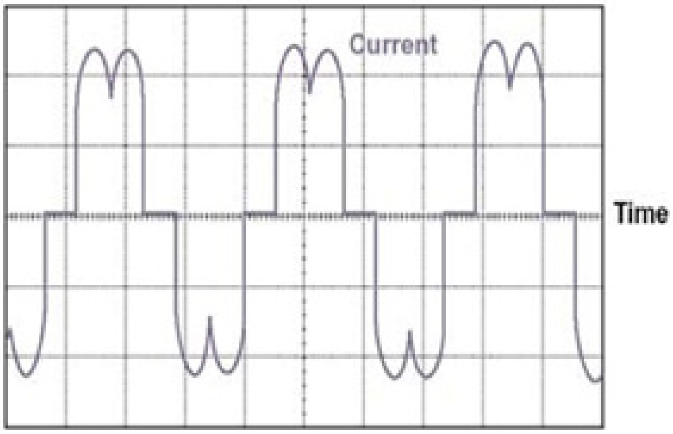


Figure 1 – Non-linear Current

Active Harmonic Filtering with GEMActive

The GE Vernova GEMActive cancels harmonics by dynamically injecting out of phase harmonic current. GEMActive installation will allow for compliance with IEEE 519 –1992 recommended harmonic limits. Reduced harmonic levels results in improved electrical network reliability and reduced operating costs. Nuisance tripping of protective devices and nuisance clearing of fuses due to harmonic heating effects is greatly reduced.

Overheating of motors, transformers, switchgear and cables is also reduced which increases their life expectancy and reduces maintenance costs. For new installations, over-sizing of distribution equipment to reduce harmonic susceptibility can be reconsidered.

GEMActive reduces current distortion that, in turn, reduces voltage distortion. Unlike passive devices, GEMActive is easy to install and cannot be overloaded. When required harmonic compensation exceeds capacity, GEMActive will simply supply its maximum continuously. Multiple GEMActive units can be connected in parallel to increase compensation.

Closed-loop control allows for high accuracy and self- adaptive harmonic control. GEMActive determines the harmonic compensation required by using current transformers to measure the network current. The GEMActive control logic removes the fundamental frequency component (50 or 60 Hz) from this waveform. The remaining waveform is then inverted and GEMActive fires its IGBTs to inject this waveform (Figure 2) on to the network to compensate for the harmonics. The result is a waveform with greatly reduced harmonic content as seen by the upstream electrical system (Figure 3).

The Resonance Problem

The interconnection of a large variety of devices on today's electrical networks can create resonant conditions which magnify harmonic currents (Figure 4). Resonance can cause serious problems such as excessive voltage distortion, nuisance fuse and circuit breaker operation, overvoltage tripping of drives, premature capacitor breakdown and insulation breakdown within motors, transformers and conductors.

GEMActive Eliminates Resonance

GE Vernova's GEMActive cancels harmonic current on the network to eliminate resonance conditions. By dynamically removing harmonics from the network no energy is present at the resonant frequency. The point of installation of GEMActive on the electrical network determines where the harmonic cancellation takes place.

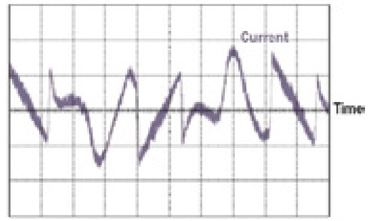


Figure 2 – GEMActive Injection Current

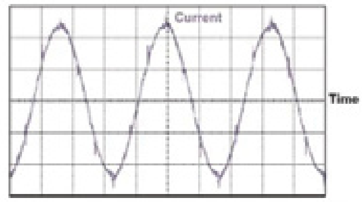


Figure 3 – Corrected current waveform

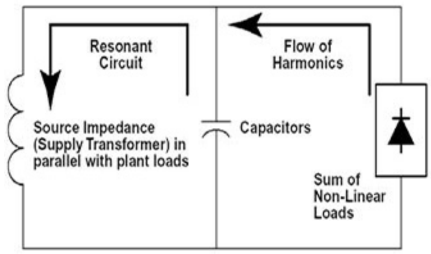


Figure 4 – Circuit formed from Capacitor in Parallel with Source Impedance (Supply Transformer)

Dynamic VAR Compensation by GEMActive

Large inductive inrush currents typically cause voltage sags that result in reduced productivity, poor process quality and possible downtime due to undervoltage tripping of devices.

GE Vernova's GEMActive is able to inject peak current at two and a half times its rms current rating for one cycle. For many applications this level of compensation eliminates visible flicker and improves voltage regulation resulting in better productivity and quality.

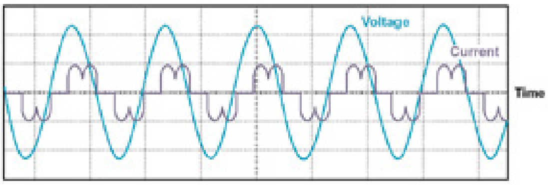


Figure 5 – Non-linear current waveform with poor power factor

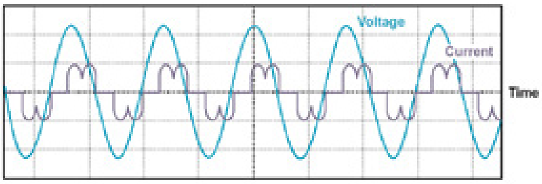


Figure 6 – Corrected current waveform with improved power factor F and reduced harmonic current after installing GEMActive

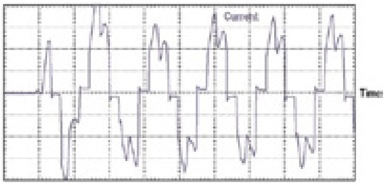


Figure 7 – Inrush current without GEMActive installed

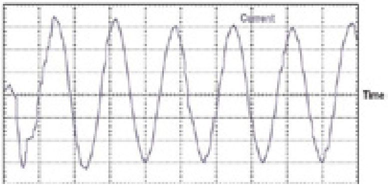
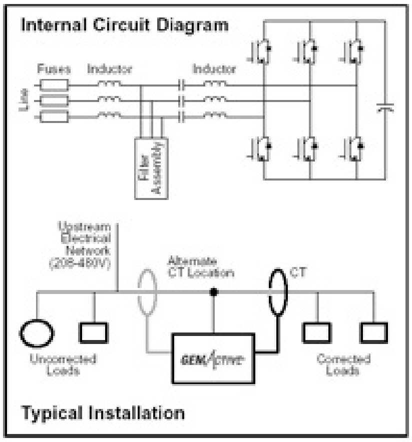


Figure 8 – Inrush current with GEMActive installed

GEMActive Sizing

A harmonic study is not required to select the size of the GEMActive installation. This is because when GEMActive is installed it becomes a lower impedance path for harmonics than the existing power supply. For sizing, please contact General Electric. To expedite the product selection process, please have a single line diagram and/or details of the application including sizes of transformers, non-linear and linear loads, and any existing filters and capacitors.



GEMActive Harmonic Filter

Fixed Low Voltage Harmonic Filter – GEMTRAP

GEMTRAP

240 - 480 - 600 volts
3 phase
60 Hz

Product Information:

- Three-phase, 60Hz
- 240, 480, 600 Volts
- NEMA 1 Enclosure
- Normally tuned for the 4.7th Harmonic
- Can be tuned to any desired frequency. Contact factory for more information.
- **Note: Do not apply Harmonic Filters without a detailed analysis of the power system.**

Application

The proliferation of electronic equipment used to improve efficiencies and provide more reliable performance causes harmonics on power systems. Equipment such as variable speed AC and DC drives, uninterruptible power supplies, switching power supplies and other solid state controls or devices inject non-linear components into what was a linear system. The application of power factor correction capacitor systems can create unwanted increases in harmonic voltage and current unless the capacitors are properly applied with reactors, in series with the capacitor, to suppress harmful harmonics.

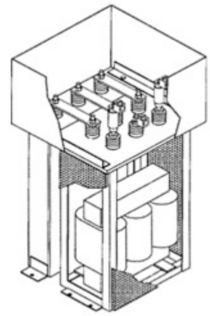
GE Vernova's line of fixed harmonic suppression capacitors permits the installation of power factor correction capacitors on systems with nonlinear components. The GEMTRAP system can be tuned to any desired frequency but is normally tuned to the fifth harmonic.

Design

The installation of this system is application specific. Contact the GE Vernova Sales office or the factory to ensure that the proper combination of capacitors and reactors is used. Misapplication may result without proper guidance.

Standards

NEMA, IEEE/ANSI, NEC



Ratings

- 240V, 5 to 60 kVAR-3 ph
- 480 V. 5 to 200 kVAR-3 ph
- 600 V; 10 to 200 kVAR-3ph

Equipment Construction

- Enclosure and wiring hood: Indoor/outdoor gasketed heavy gauge steel. Finished with a zinc rich primer and an ANSI #70, enamel overcoat. Louvered panels around reactors for protection and cooling.
- Mounting: Floor mounting.
- Capacitor Fuses:
  UL recognized, designed specifically for capacitor applications. Rated 600 VAC; 200kAIC. Fast acting and current limiting; provide protection from catastrophic failures. Three phase fusing standard.
- Aluminum Connecting Bus for Parallel Cells
- Input Connections: Listed Cu/Al Mechanical wire connectors, sized for kVAR requirements, mounted on top of bus for easy access.
- Harmonic Reactor

Options

- Blown fuse lights.
- Consult factory for larger kVAR requirements.
- Consult factory for custom applications

GEMTRAP Filters – 240- 480- 600 Volts – 3 Phase- 60 Hz

VOLTS	kVAR	BASE CATALOG NUMBER (ADD L TO THE END FOR BLOWN FUSE LIGHTS)	CAPACITORS W/REACTOR & 3-FUSES DRAWING	APPROXIMATE WEIGHT (lbs)
240	25	38FH1025D333F	1	195
	35	38FH2035D333F	2	341
	40	38FH2040D333F	2	346
	45	38FH2045D333F	2	351
	50	38FH2050D333F	2	356
480	25	38FH1025F333F	1	159
	30	38FH1030F333F	1	191
	40	38FH1040F333F	1	197
	50	38FH1050F333F	1	202
	75	38FH1075F333F	1	235
	80	38FH1080F333F	1	263
	100	38FH1100F333F	1	279
	120	38FH2120F333F	2	424
	125	38FH2125F333F	2	447
	140	38FH2140F333F	2	500
	150	38FH2150F333F	2	514
	175	38FH2175F333F	2	524
	200	38FH2200F333F	2	568
600	25	38FH1025H333F	1	159
	30	38FH1030H333F	1	191
	40	38FH1040H333F	1	196
	50	38FH1050H333F	1	196
	75	38FH1075H333F	1	245
	80	38FH1080H333F	1	248
	100	38FH1100H333F	1	271
	120	38FH2120H333F	2	484
	125	38FH2125H333F	2	487
	140	38FH2140H333F	2	495
	150	38FH2150H333F	2	500
	175	38FH2175H333F	2	526
	200	38FH2200H333F	2	552

GEMTRAP Fixed Filters Drawings

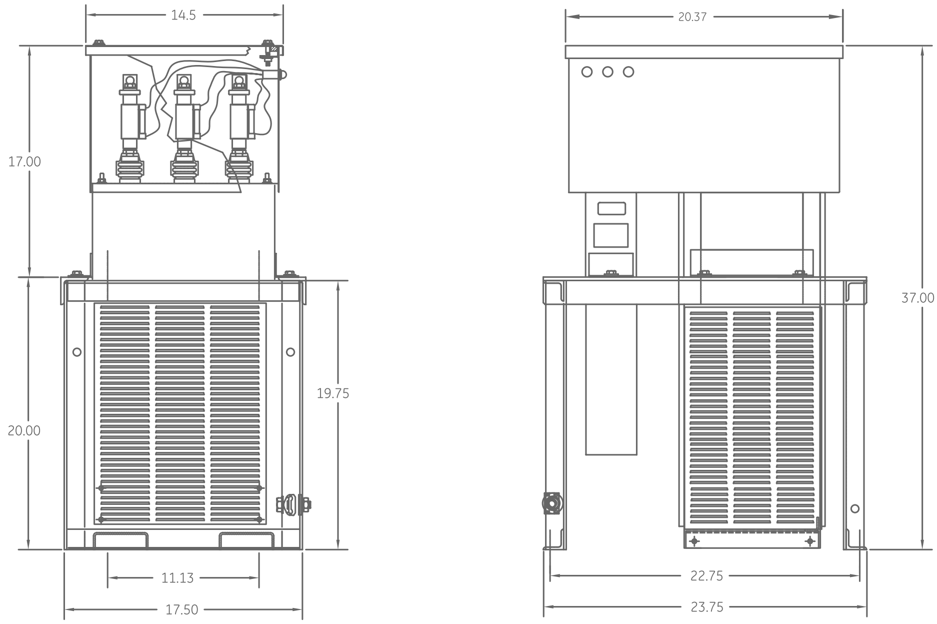


Figure 1

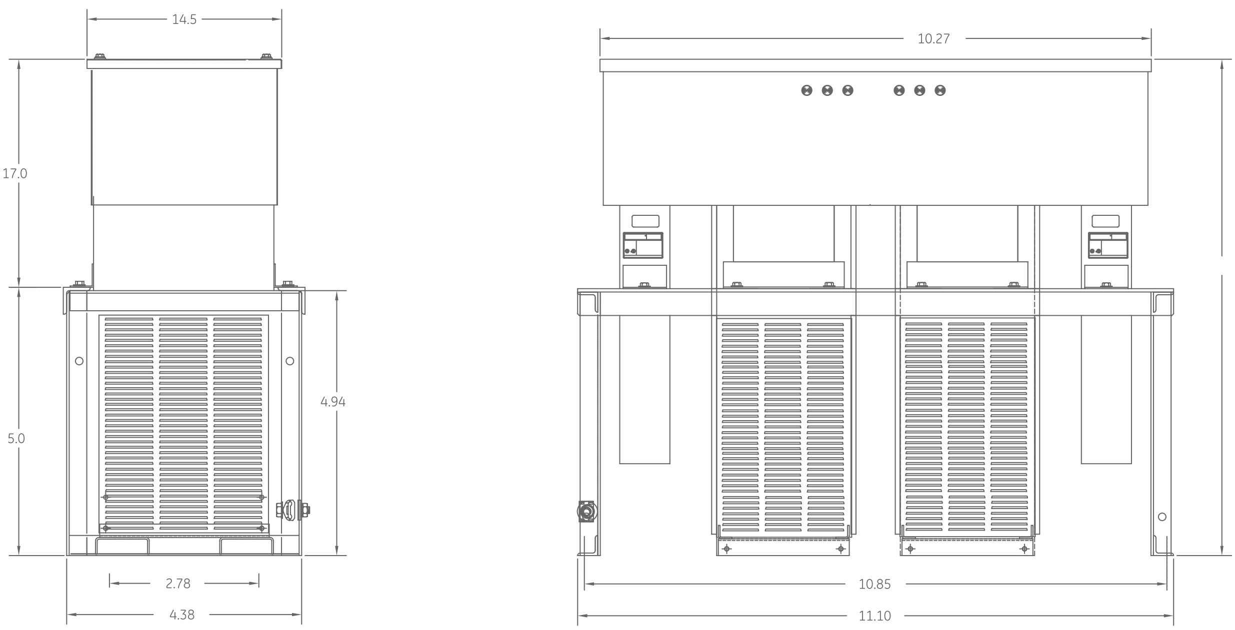


Figure 2

Low Voltage – Line/Load Reactors

Line/Load Reactors

Up to 600 Volts

Motor Protection

Reactors help to protect motors from the high peak voltages and fast rise times (dv/dt) which can be experienced in IGBT inverter applications when the distance between the inverter and motor is long.

Harmonic Reduction

Because all standard GE Vernova Line/Load reactors are compensated for harmonics (current and frequency), they are extremely effective at reducing the amount of harmonics which are produced by a drive/inverter. Use 5% impedance, harmonic compensated reactors for best reaction of harmonic distortion.

Voltage Spike Protection

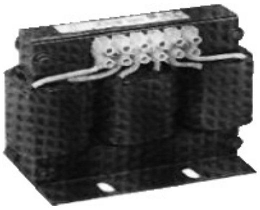
A 3% impedance reactor is very effective at protecting against damage to or nuisance tripping of AC voltage source inverters, due to voltage spikes. Voltage spikes on the AC power lines cause elevation of the DC Bus voltage which may cause the inverter to "trip-off" and indicate an over-voltage protection condition. Use reactors to absorb these line spikes and offer protection to the rectifiers and DC Bus capacitors while minimizing nuisance tripping of the inverter.

Agency Approvals

- GE Vernova line reactors are UL recognized.
- All UL approvals are for USA and Canada.
- UL-506 File #E191687 (1 amp-1200 amps)
- UL-508 File #E191686 (1 amp-1200 amps)
- All higher currents offer UL recognized insulation systems and construction.
- CE Marked

NEMA 1 Cabinets

All GE Vernova Line/Load Reactors are available as either open type or in a NEMA Type 1 general purpose enclosure. To order a reactor mounted in a cabinet simply change the second to last digit of the product number from "0" to "1". Example 37G 00802 becomes 37G 00812.



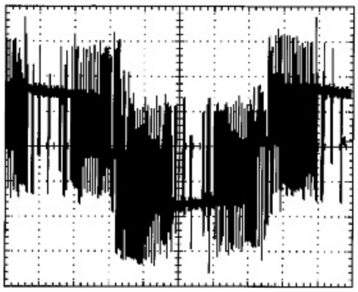


Figure 1 – Typical Distortion of PWM Inverter without Reactor

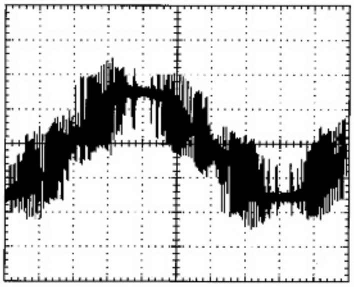


Figure 2 – Typical Distortion of PWM Inverter With 5% Reactor applied

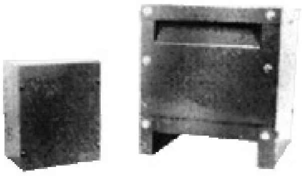


Figure 3 – NEMA 1 Cabinets

Selection Table*, 600 Volts, 50/60 Hertz (open frame type reactor)

VOLTAGE, 50/60 Hz	% IMPEDANCE	CATALOG NUMBER											
RATINGS	HP/kW	1.0/0.75	1.5/1.1	2.0/1.5	3.0/2.2	5.0/3.7	7.5/5.5	10/7.5	15/11	20/15	25/18.5	30/22	40/30
208	3%	37G00401	37G00801	37G00801	37G01201	37G00801	37G02501	37G03501	37G04501	37G05501	37G08001	37G10001	37G13001
	5%	37G00402	37G00802	37G00802	37G01202	37G00802	37G02502	37G03502	37G04502	37G05502	37G08002	37G10002	37G13002
240	3%	37G00401	37G00801	37G00801	37G01201	37G00801	37G02501	37G03501	37G04501	37G05501	37G08001	37G10001	37G13001
	5%	37G00402	37G00802	37G00802	37G01202	37G00802	37G02502	37G03502	37G04502	37G05502	37G08002	37G10002	37G13002
380	2%	37G00204	37G00402	37G00401	37G00802	37G00801	37G01201	37G01801	37G02501	37G03501	37G04501	37G04501	37G08001
	4%	37G00201	37G00404	37G00402	37G00803	37G00802	37G01202	37G01802	37G02502	37G03502	37G04502	37G04502	37G08002
400	2%	37G00201	37G00402	37G00402	37G00802	37G00801	37G01201	37G01801	37G02501	37G03501	37G04501	37G04501	37G05501
	4%	37G00202	37G00404	37G00403	37G00803	37G00802	37G01202	37G01802	37G02502	37G03502	37G04502	37G04502	37G05502
415	2%	37G00201	37G00402	37G00402	37G00802	37G00801	37G01201	37G01801	37G02501	37G03501	37G04501	37G04501	37G05501
	4%	37G00202	37G00404	37G00403	37G00803	37G00802	37G01202	37G01802	37G02502	37G03502	37G04502	37G04502	37G05502
480	3%	37G00201	37G00201	37G00402	37G00402	37G00802	37G01202	37G01802	37G02502	37G03502	37G03502	37G04502	37G05502
	5%	37G00202	37G00202	37G00403	37G00403	37G00803	37G01203	37G01803	37G02503	37G03503	37G03503	37G04503	37G05503
600	3%	37G00202	37G00202	37G00403	37G00403	37G00803	37G00802	37G01202	37G01802	37G02502	37G02502	37G03502	37G04502
	5%	37G00203	37G00203	37G00404	37G00404	37G00804	37G00803	37G01203	37G01803	37G02503	37G02503	37G03503	37G04503

For maximum continuous current ratings refer to Specifications on following page

VOLTAGE, 50/60 Hz	% IMPEDANCE														
RATINGS	HP/KW	50/ 37.5	60/45	75/55	100/75	125/93	150/112	200/150	250/187	300/225	350/262	400/ 300	500/ 375	600/ 450	750/ 550
208	3%	37G 16001	37G 20001B14	37G 25001B14	37G 32001B14	37G 40001B14	37G 50001	37G 60001	37G 75001	•	•	•	•	•	•
	5%	37G 16002	37G 20002B14	37G 25021B14	37G 32002B14	37G 40002B14	37G 50002	37G 60002	37G 75002	•	•	•	•	•	•
240	3%	37G 13001	37G 16001	37G 20001B14	37G 25001B14	37G 32001B14	37G 40001B14	37G 50001	37G 60001	37G 75001	•	•	•	•	•
	5%	37G 13002	37G 16002	37G 20002B14	37G 25021B14	37G 32002B14	37G 40002B14	37G 50002	37G 60002	37G 75002	•	•	•	•	•
380	2%	37G 08001	37G 10001	37G 10001	37G 16001	37G 20001B14	37G 25001B14	37G 32001B14	37G 40001B14	37G 40001B14	37G 75001	37G 60001	37G 75002	•	•
	4%	37G 08002	37G 10002	37G 10002	37G 16002	37G 20001B14	37G 25001B14	37G 32001B14	37G 40001B14	37G 40001B14	37G 75002	37G 60002	37G 75003	•	•
400	2%	37G 08001	37G 08001	37G 10001	37G 13001	37G 20002B14	37G 25002B14	37G 32002B14	37G 32001B14	37G 40001B14	37G 50001	37G 50002	37G 75002	•	•
	4%	37G 08002	37G 08002	37G 10002	37G 13002	37G 20003B14	37G 25003B14	37G 32003B14	37G 32002B14	37G 40002B14	37G 50002	37G 60003	37G 75003	•	•
415	2%	37G 08001	37G 08001	37G 10001	37G 13001	37G 20002B14	37G 20002B14	37G 25001B14	37G 32001B14	37G 40001B14	37G 50001	37G 50001	37G 75002	37G 75002	•
	4%	37G 08002	37G 08002	37G 10002	37G 13002	37G 20003B14	37G 20003B14	37G 25002B14	37G 32002B14	37G 40002B14	37G 50002	37G 50002	37G 75003	37G 75003	•
480	3%	37G 08002	37G 08002	37G 10002	37G 13002	37G 16002	37G 20002B14	37G 25002B14	37G 32002B14	37G 40002B14	37G 50002	37G 50002	37G 60002	37G 75002	•
	5%	37G 08003	37G 08003	37G 10003	37G 13003	37G 16003	37G 20003B14	37G 25003B14	37G 32003B14	37G 40003B14	37G 50003	37G 50003	37G 60003	37G 75003	•
600	3%	37G 05502	37G 08002	37G 08002	37G 10002	37G 13002	37G 16002	37G 20002B14	37G 20002B14	37G 32002B14	37G 40002B14	37G 40002B14	37G 50002	37G 60002	37G 75002
	5%	37G 05503	37G 08003	37G 08003	37G 10003	37G 13003	37G 16003	37G 20003B14	37G 20003B14	37G 32003B14	37G 40003B14	37G 40003B14	37G 50003	37G 60003	37G 75003

• Consult Factory

* This table is suitable for selection of both input and output reactors because their harmonic compensation and IGBT protection allow them to be used in either application. Specific current and inductance ratings are indicated on the next page. Consult factory for any special applications (higher current, motor ratings different than the controller ratings, etc). Select GE Vernova Line/Load reactors based upon motor horsepower, (or kilowatts) and voltage. Verify that the motor full load ampere rating is within the fundamental ampere current rating of the reactor, and the drive/inverter is within the maximum continuous rating of the reactor. (See next page)

3 Phase Line/Load Reactor Specification Table
600 Volt, 50/60 Hertz (open frame type reactor)

OPEN FRAME CATALOG NUMBER	FUND. Amps	MAX. Amps	INDUCTANCE (mh)	WATTS LOSS	A mm/in	B mm/in	C mm/in	D mm/in	E mm/in	OPEN TYPE WEIGHT kg/lbs	NEMA 1 ENCL. STYLE[1]
37G00201	2	3	12.0	7.5	112/4.4	102/4.0	74/2.8	50/2.0	36/1.44	1.8/4	CAB-8
37G00202	2	3	20.0	11.3	112/4.4	102/4.0	74/2.9	50/2.0	36/1.44	1.8/4	CAB-8
37G00203	2	3	32.0	16	112/4.4	102/4.0	74/2.9	50/2.0	36/1.44	1.8/4	CAB-8
37G00204	2	3	6.0	10.7	112/4.4	102/4.0	69/2.7	44/1.73	36/1.44	1.4/3	CAB-8
37G00401	4	6	3.0	14.5	112/4.4	102/4.0	74/2.9	50/2.0	36/1.44	1.8/4	CAB-8
37G00402	4	6	6.5	20	112/4.4	102/4.0	74/2.9	50/2.0	36/1.44	2.3/4	CAB-8
37G00403	4	6	9.0	20	112/4.4	102/4.0	79/3.1	54/2.1	36/1.44	1.8/5	CAB-8
37G00404	4	6	12.0	21	112/4.4	102/4.0	91/3.6	66/2.6	36/1.44	2.7/6	CAB-8
37G00801	8	12	1.5	19.5	152/6.0	122/4.8	79/3.1	54/2.1	50/2.0	3.1/7	CAB-8
37G00802	8	12	3.0	29	152/6.0	122/4.8	79/3.1	54/2.1	50/2.0	3.2/8	CAB-8
37G00803	8	12	5.0	25.3	152/6.0	122/4.8	86/3.4	63/2.5	50/2.0	5.0/11	CAB-8
37G00804	8	12	7.5	28	152/6.0	122/4.8	86/3.4	63/2.5	50/2.0	5.9/13	CAB-8
37G01201	12	18	1.25	26	152/6.0	122/4.8	79/3.1	54/2.1	50/2.0	4.0/9	CAB-8
37G01202	12	18	2.5	31	152/6.0	122/4.8	79/3.1	54/2.1	50/2.0	4.5/10	CAB-8
37G01203	12	18	4.2	41	152/6.0	122/4.8	94/3.7	70/2.75	50/2.0	8.1/18	CAB-8
37G01801	18	27	0.8	36	152/6.0	122/4.8	79/3.1	54/2.1	50/2.0	4.0/9	CAB-8
37G01802	18	27	1.5	43	152/6.0	122/4.8	86/3.4	53/2.5	50/2.0	5.4/12	CAB-8
37G01803	18	27	2.5	43	183/7.2	145/5.7	97/3.8	66/2.6	76/3.0	7.3/16	CAB-13V
37G02501	25	37.5	0.5	48	183/7.2	142/5.6	86/3.4	60/2.3	76/3.0	5.0/11	CAB-13V
37G02502	25	37.5	1.2	52	183/7.2	142/5.6	86/3.4	60/2.3	76/3.0	6.3/14	CAB-13V
37G02503	25	37.5	0.8	61	183/7.2	145/5.7	97/3.8	66/2.6	76/3.0	8.1/18	CAB-13V
37G03501	35	52.5	0.4	49	183/7.2	142/5.6	97/3.8	66/2.6	76/3.0	6.3/14	CAB-13V
37G03502	35	52.5	0.8	54	183/7.2	145/5.7	97/3.8	66/2.6	76/3.0	7.3/16	CAB-13V
37G03503	35	52.5	1.2	54	229/9.0	178/7.0	122/4.8	80/3.2	76/3.0	14/30	CAB-13V
37G04501	45	67.5	0.3	54	229/9.0	178/7.0	122/4.8	80/3.2	76/3.0	10/23	CAB-13V
37G04502	45	67.5	0.7	62	229/9.0	178/7.0	122/4.8	80/3.2	76/3.0	13/28	CAB-13V
37G04503	45	67.5	1.2	65	229/9.0	178/7.0	136/5.3	93/3.6	76/3.0	18/39	CAB-13V
37G05501	55	82.5	0.26	64	229/9.0	178/7.0	122/4.8	80/3.2	76/3.0	11/24	CAB-13V
37G05502	55	82.5	0.50	67	229/9.0	178/7.0	122/4.8	80/3.2	76/3.0	12/27	CAB-13V
37G05503	55	82.5	0.85	71	229/9.0	178/7.0	142/5.6	99/3.9	76/3.0	18/41	CAB-13V
37G08001	80	120	0.20	82	274/10.8	208/8.2	142/5.6	88/3.5	92/3.6	19/43	CAB-13V
37G08002	80	120	0.40	86	274/10.8	211/8.3	142/5.6	88/3.5	92/3.6	23/51	CAB-13V
37G08003	80	120	0.70	96	274/10.8	213/8.4	160/6.3	117/4.6	82/3.6	25/55	CAB-13V

[1] To order a reactor in a NEMA 1 enclosure, change the 7th digit in the part number from “0” to “1”.

3 Phase Line/Load Reactor Specification Table
600 Volt, 50/60 Hertz (open frame type reactor Cont'd)

OPEN FRAME CATALOG NUMBER	FUND. Amps	MAX. Amps	INDUCTANCE (mh)	WATTS LOSS	A mm/in	B mm/in	C mm/in	D mm/in	E mm/in	OPEN TYPE WEIGHT kg/lbs	NEMA 1 ENCL. STYLE[1]
37G10001	100	150	0.15	94	274/10.8	211/8.3	142/5.6	88/3.5	92/3.6	21/47	CAB-13V
37G10002	100	150	0.30	84	274/10.8	208/8.2	147/5.8	93/3.6	92/3.6	23/51	CAB-13V
37G10003	100	150	0.45	108	274/10.8	213/8.4	160/6.3	106/4.2	92/3.6	33/74	CAB-13V
37G13001	130	195	0.10	108	229/9.0	179/7.04	124/4.9	80/3.16	76/3	13/29	CAB-13V
37G13002	130	195	0.20	180	274/10.8	213/8.4	171/6.75	93/3.66	92/3.63	26/57	CAB-13V
37G13003	130	195	0.30	128	274/10.8	213/8.4	184/7.25	106/4.16	92/3.63	29/64	CAB-13V
37G16001	160	240	0.075	116	274/10.8	213/8.4	146/5.75	80/3.16	92/3.63	18/40	CAB-13V
37G16002	160	240	0.150	149	274/10.8	213/8.4	152/6	88/3.47	92/3.63	22/50	CAB-13V
37G16003	160	240	0.230	138	274/10.8	213/8.4	181/7.13	106/4.16	92/3.63	31/67	CAB-13V
37G20001B14	200	300	0.055	124	274/10.8	213/8.4	152/6	106/4.16	92/3.63	22/48	CAB-13V
37G20002B14	200	300	0.110	168	274/10.8	213/8.4	216/8.5	112/4.41	92/3.63	31/67	CAB-13V
37G20003B14	200	300	0.185	146	274/10.8	267/10.5	237/9.35	150/5.91	92/3.63	46/100	CAB-13V
37G25001B14	250	375	0.045	154	274/10.8	208/8.17	184/7.25	106/4.16	92/3.63	31/68	CAB-13V
37G25002B14	250	375	0.090	231	366/14.4	356/14	210/8.25	131/5.16	117/4.6	49/106	CAB-17V
37G25003B14	250	375	0.150	219	366/14.4	356/14	288/11.35	148/5.82	117/4.6	64/140	CAB-17V
37G32001B14	320	480	0.040	224	366/14.4	356/14	168/6.6	129/5.07	117/4.6	50/110	CAB-17V
37G32002B14	320	480	0.075	264	375/14.75	356/14	257/10.13	149/5.88	117/4.6	57/125	CAB-17V
37G32003B14	320	480	0.125	351	366/14.4	356/14	330/13	181/7.13	117/4.6	86/190	CAB-17V
37G40001B14	400	600	0.030	231	366/14.4	356/14	254/10	131/5.16	117/4.6	46/100	CAB-17V
37G40002B14	400	600	0.060	333	394/15.5	356/14	292/11.5	172/6.76	117/4.6	71/155	CAB-17V
37G40003B14	400	600	0.105	293	394/15.5	356/14	368/14.5	184/7.26	117/4.6	91/200	CAB-17V
37G50001B14	500	750	0.025	266	394/15.5	356/14	267/10.5	140/5.5	117/4.6	55/120	CAB-17V
37G50002	500	750	0.050	340	394/15.5	356/14	330/13	172/6.76	117/4.6	82/180	CAB-1726C
37G50003	500	700	0.085	422	394/15.5	356/14	375/14.75	248/9.76	117/4.6	132/290	CAB-1726C
37G60001	600	900	0.020	307	394/15.5	356/14	279/11	168/6.66	117/4.6	73/160	CAB-1726C
37G60002	600	900	0.040	414	394/15.5	356/14	356/14	172/6.76	117/4.6	96/210	CAB-1726C
37G60003	600	840	0.065	406	394/15.5	356/14	394/15.5	235/9.26	117/4.6	132/290	CAB-1726C
37G75001	750	1125	0.015	427	559/22	508/20	254/10	168/6.63	183/7.2	91/200	CAB-30B26C
37G75002	750	1125	0.029	630	559/22	508/20	317/12.5	197/7.76	183/7.2	141/310	CAB-30B26C
37G75003	750	1125	0.048	552	559/22	508/20	376/14.8	242/9.51	183/7.2	183/400	CAB-30B26C

[1] To order a reactor in a NEMA 1 enclosure, change the 7th digit in the part number from "0" to "1".

Low Voltage – Matrix Broadband Harmonic Filters

Matrix Broadband Harmonic Filters

Description

Matrix Harmonic filters provide broadband reduction of harmonics. Matrix Harmonic Filters not only offer better performance over other broad band filtering and 18-pulse harmonic reduction techniques, they are also suitable for a wider range of applications. Matrix Harmonic Filters can be installed in either variable or constant torque drive applications and can be applied on either diode or SCR rectifiers. For any application other than variable torque applications, it is suggested that you contact the factory for filter selection.

Typical Applications

Use Matrix Harmonic filters to minimize harmonic current distortion in these and other 6-pulse rectifier applications:

- Fans and Pumps
- Water Treatment Facilities
- HVAC Systems
- AC or DC Motor Drives
- Rectifier type welders
- Induction Heating Equipment
- UPS Equipment
- Elevators

Matrix Filter enables most AC drive systems to comply with the voltage and current distortion limits outlined in IEEE 519. A complete harmonic analysis and product selection tool is available on the internet. Go to geelectrical.com and select Products, select Capacitors, choose Matrix Harmonic Filter and then select Energy Savings Calculator and Harmonic Estimator.

Matrix Harmonic Filters are multi-stage low pass filters specially configured to avoid the attraction of harmonics from other sources on a shared power system. Matrix filters will not cause power system resonance. However, the configuration of the filter requires that only drives or equivalent loads be loaded on the output of a Matrix harmonic filter. One filter can be used with multiple drives. However, if there is a drive bypass circuit, there must be one filter per drive and the filter and drive combination must be bypassed.

Matrix Harmonic Filters are available in a NEMA 1, NEMA 3R or as a modular design preassembled onto panels for subsequent assembly into customer supplied cabinet.

Product Specifications

- Input Voltage 480 Volts +/– 10%
- Ambient Temperature:
- Storage – 40°C to 90°C
- Operating – 40°C to 40°C
- Altitude: 1000 meters maximum
- UL approved – File E191686 for U.S. and Canada

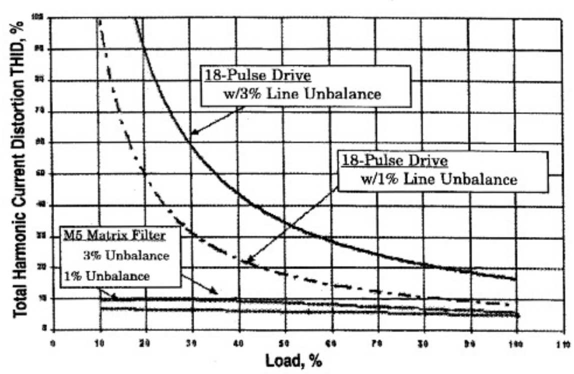
Minimum System Requirements to Achieve Performance Levels

- Source Impedance: 1.5% minimum to 5% maximum
- System voltage: 480 volts (line to line) +/– 10%
- Frequency: 60 Hz +/– .75 Hz
- Balanced Line Voltage: within 1%
- Background Voltage Distortion: 0% THVD

The Matrix D Filters typically achieve 5% THID at full load and guarantee worst case current distortion at any load between 0% and 100%, will be 8% THID or less at the filter input terminals. The Matrix D Series is typically used in place of applications requiring harmonic mitigation associated with 12- or 18-pulse rectifiers.

The chart below compares the performance of Matrix D Filters to 18-pulse rectifiers in real world applications, which include line voltage unbalance of 1% to 3% and loading conditions from 0% to 100%.

Matrix D Filter performs better than 18-pulse in normal operating conditions.



Selection

Select Matrix filters based on the horsepower (or kilowatt) rating for the adjustable speed drive or the combined current rating of all motors to be connected to the load side of the filter.

For constant torque, DC drive or other applications consult factory for proper filter selection.

Source Impedance

If the source impedance is less than 1.5% impedance, it is required that an input reactor of at least 1.5% impedance be added in order to have guaranteed performance level.

For best value and performance it is recommended that a 3% line reactor be used whenever the source impedance is less than 1.5%.

Aids for Application – Power Factor Capacitors & Harmonic Filters

Function of Capacitors

Electric power has two components:

- **Active power,** which produces work.
- **Reactive power,** which is needed to generate magnetic fields required for operation of inductive electrical equipment, but performs no useful work.

Active power is measured in KW (1000 Watts)

Reactive power is measured in kVAR (1000 Volt-Amperes Reactive) Total power is measured in KVA (1000 Volts-Amperes) The ratio of working power to total power is called Power Factor. The function of Power Factor Correction Capacitors is to increase the power factor by supplying the reactive power when installed at or near inductive electrical equipment.

Equipment Causing Poor Power Factor

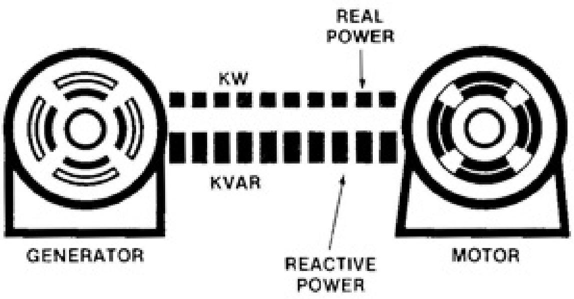
A great deal of equipment causes poor power factor. One of the worst offenders is lightly loaded induction equipment. Examples of this type of equipment, and their approximate power factors follow:

- 80% power factor or better: Air conditioners (correctly sized),pumps, centerless grinders, cold headers, upsetters, fans or blowers.
- 60% to 80% power factor: Induction furnaces, standard stamping machines, and weaving machines.
- 60% power factor and below: Single-stroke presses, automated machine tools, finish grinders, welders. When the above equipment functions within a facility, savings can be achieved by utilizing GE Vernova industrial capacitors.

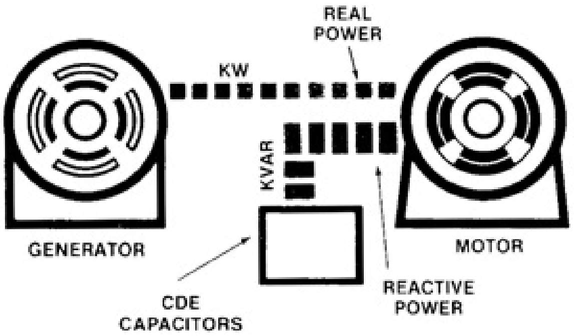
How Capacitors Save Money

Capacitors lower electrical costs two ways: In many areas, the electrical rate includes a penalty charge for low power factor. Installation of power capacitors on the electrical distribution system within a facility makes it unnecessary for the utility to supply the reactive power required by inductive electrical equipment. The savings the utility realizes in reduced generation, transmission, and distribution costs are passed on to the customer in the form of lower electrical bills.

The second source of savings derived through the use of power factor correction capacitors is in the form of increased KVA capacity in the electrical distribution system. Installation of capacitors to furnish the non-productive current requirements of the facility makes it possible to increase the connected load by as much as 20 percent without a corresponding increase in the size of the transformers, conductors, and protective devices making up the distribution system which services the load.



The figure above shows an induction motor operating under partially loaded conditions without Power Factor Correction. Here the feeder line must supply BOTH magnetizing (reactive) and active power.



The figure above shows the result of installing a capacitor near the same motor to supply the reactive power required to operate it. The total current requirement has been reduced to the value of the active power only, thus either reducing power cost or permitting the use of more electrical equipment on the same circuit.

Benefits of Power Factor Improvement

Power factor (PF) is the ratio of useful current to total current. It is also the ratio of useful power expressed in kilowatts (KW) to total power expressed in kilowatt-amperes (KVA). Power factor is usually expressed as a decimal or as a percentage.

$$PF = \frac{\text{Useful Power}}{\text{Total Power}}$$

Example: Kilowatts = 60 KW, KVA = 100 KVA

$$PF = \frac{60\text{ KW}}{100\text{ KVA}} = .60 = 60\%$$

The significant effect of improving the power factor of a circuit is to reduce the current flowing through that circuit which in turn results in the following benefits:

Benefit No. 1

Less Total Plant KVA for the Same KW Working Power

Dollar savings are very significant in areas where utility billing is affected by KVA usage.

kVA = √ 3 X kV X I	EXAMPLE: 600 kW WORKING POWER VS kVA REQUIRED				
POWER FACTOR	60%	70%	80%	90%	100%
ACTIVE POWER	600 km	600 km	600 km	600 km	600 km
REACTIVE POWER	800 kVAR	612 kVAR	450 kVAR	291 kVR	0 kVAR
TOTAL POWER	800 kVAR	612 kVAR	450 kVAR	291 kVR	0 kVAR

This allows for more efficient operation of plant transformers and “frees up” KVA for additional load. Cost avoidance can be significant.

Benefit No. 2

More KW Working Power for the Pame KVA Demand

Released system capacity allows for additional motors, lighting, etc. to be added without overloading existing distribution equipment.

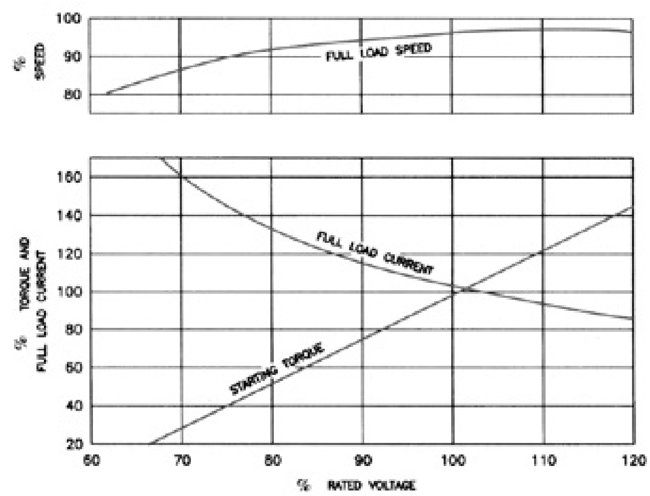
kW = kVA X PF	EXAMPLE: 600 kVA DEMAND VS AVAILABLE kW				
POWER FACTOR	60%	70%	80%	90%	100%
ACTIVE POWER	360 kW	420 kW	480 kW	540 kW	600 kW
REACTIVE POWER	480 kVAR	428 kVAR	360 kVAR	262 kVR	0 kVAR
TOTAL POWER	600 kVA	600 kVA	600 kVA	600 kVA	600 kVA

Benefit No. 3

Improved Voltage Regulation Due to Reduced Line Voltage Drop

This benefit will result in more efficient performance of motors and other electrical equipment.

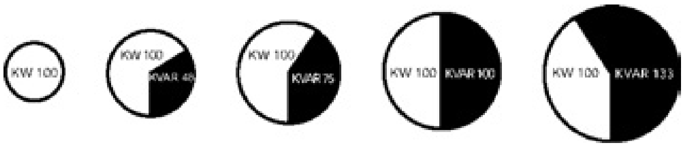
% voltage rise* = kVAR x %Z kVA of transformer ** with capacitor at the transformer Z = transformer impedance % from nameplate*	**Example: The graphs below depics what happens to the load speed and starting torque of a motor at various levels of rated voltage.**



Benefit No. 4

Reduction in Size of Transformers, Cables and Switchgear in New Installations – Thus Less Investment

$I = \dfrac{\text{kVA x 103}}{\sqrt{3}\ V}$	**Example: The figure below represents the increasing size of conductors required to carry the same 100 kW at various power factors.**



Benefit No. 5

Reduced Power Losses in Distribution Systems

Since the losses are proportionate to the square of the current, the formula at left applies.

% Reduction of Power Losses= $100\text{-}100 = \left[\dfrac{\text{original PF}}{\text{New PF}}\right]^2$	**Example: Improve powerfactor from 65% to 90%**

De-rating for V & f

$$kVAR_E = kVAR_R \left(\frac{V^2_A}{V_R}\right)\left(\frac{f_A}{f_R}\right)$$

$kVAR_E$ = Effective kVAR

$kVAR_R$ = Rated kVAR

V_A = Applied Voltage

V_R = Rated Voltage

f_A = Applied frequency

f_R = Rated frequency

Facts and Formulas

1. $PF = \cos\theta = \dfrac{KW}{KVA}$ (motor input)

2. $KW\ (\text{motor input}) = \dfrac{hp \times .746}{\%\ Eff.}$

3. $KVA = \dfrac{\sqrt{3} \times V \times I}{10^3}$ (three phase)

4. $KVA = \dfrac{V \times I}{1000}$ (single phase)

5. $KVA = \dfrac{KW}{PF} = \sqrt{(KW)^2 + (KVAR)^2}$

6. $I = \dfrac{KVA \times 10^3}{\sqrt{3}\ \ V}$ (three phase)

7. $I = \dfrac{KVA \times 10^3}{V}$ (single phase)

8. $KVAR = \dfrac{2\pi f C\,(KV)^2}{10^3}$

9. $C = \dfrac{KVAR \times 10^3}{(2\pi f)(KV)^2}$

10. $Xc = \dfrac{10^6}{(2\pi f)C}$

Legend:

K = 1000	*I = line current (amperes)*
W = watts	*Ic = capacitor current (amperes)*
V= volts	
A = amperes	*C = capacitance (microfarads)*
hp = horsepower	*f = frequency*
PF = power factor	*Xc= capacitive reactance*

Degree of Power Factor Improvement

As noted on page 49, power capacitors lower costs two ways. To determine how much improvement should be made to the existing power factor, one must analyze the potential benefits to be gained in each situation. If utility bill savings are a factor, it is recommended that the past 12 months' billings be reviewed and compared to potential billings at improved power factor levels. Since there are a variety of rate structures in existence, each case must be investigated separately. In general, where penalty clauses exist, the power factor should be raised to at least 95 percent.

Where relief of an overloaded distribution system is the major consideration, the degree of correction will depend upon the amount of relief required. In some instances, correction to unity may be economical.

Size of Capacitor Bank

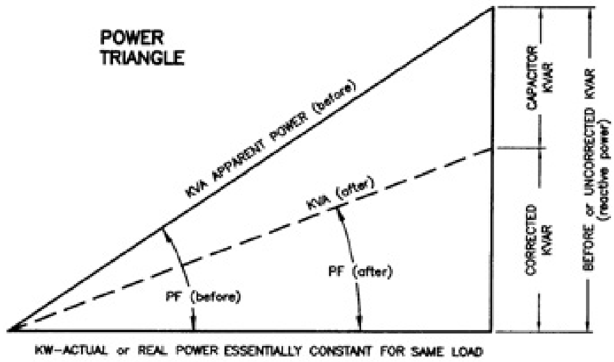
Where the size of the capacitor bank needed to improve power factor to the desired level (usually 95%) is not readily available from Motor Tables or by graphic determination, it can be calculated as shown on page 54 or by these formulae.

TO FIND	WHEN YOU KNOW	THREE–PHASE
Watts input to anything	Output, efficiency	Watts output % efficiency
Watts input to a motor	Horsepower, efficiency	hp x ,746 x LF / % efficiency
Horsepower PF (Output)	Current, voltage efficiency, power factor	1.73 x E x I x %eff, x / .746
Kilovolt-amperes	Current, voltage	1.73 x E x I / 1000
Kilowatts	Current, voltage, power factor	1.73 x E x I x PF / 1000
Amperes	Horsepower, voltage, efficiency, power factor	hp x .746 x LF / 1.73 x E x %eff, x PF
Amperes	Kilowatts, voltage, power factor	kw x 1000 / 1.73 x E x PF
Amperes	Kilovolt-amperes, voltage	kva x 1000 / 1.73 x E
Power factor	Watts, voltage, current	Watts / 1,73 x E x I
Power factor	Kilowatts, voltage, current	kw x 1000 / 1.73 x E x I

PF = power factor   E = volts   LF = load factor   I = current in amperes

Determining Your Capacitor Requirements

The total kVAR rating of capacitors required to improve a facility's power factor to any desired value may be calculated very easily by using several basic formulas and by applying the appropriate multiplier selected from Table 1 on page 54.



Examples:

1. A plant with a metered demand of 600 KW is operating at a 75% power factor. What capacitor kVAR is required to correct the present power factor to 95%?
   a. From Table 1, Multiplier to improve PF from 75% to 95% is .553
   b. Capacitor kVAR = KW x Table 1 Multiplier
   Capacitor kVAR = 600 x .553 = 331.8 say 330
2. A plant load of 425 KW has a total power requirement of 670 KVA. What size capacitor is required to improve the factor to 90%?
   a. Present PF = a. Present PF = kW/kVA = 425= .634/670 = 63.4% say 63%
   b. From Table 1, Multiplier to improve PF from 63% to 90% is .748
   c. Capacitor kVAR = KW x Table 1 Multiplier = 425 x .748 = 317.9 say 320 kVAR
3. A plant operating from a 480 volt system has a metered demand of 258 KW. The line current read by a clip-on ammeter is 420 amperes. What amount of capacitor kVAR is required to correct the present power factor to 90%?
   a. KVA = 1.73 x KV x I = 1.73 x .480 × 420 = 349 KVA
   a. Present PF = KW/KVA = 258/349 = 73.9 say 74% KVA
   b. From Table 1, Multiplier to improve PF from 74% to 90% is .425
   c. Capacitor kVAR = KW x Table 1 Multiplier = 258 x .425 = 109.6 say 110 kVAR

Table 1 - Sizing Capacitors for Electrical Systems

This table gives multipliers for KW to get the capacitor kVAR needed to increase from original to desired corrected power factor. Use the multipliers to size autoswitched or fixed capacitors for large loads.

ORIGINAL POWER FACTOR	DESIRED CORRECTED POWER FACTOR (%)																				
	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	1.200	1.470	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	0.434	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

Table 1 - Sizing Capacitors for Electrical Systems (Cont'd)

ORIGINAL POWER FACTOR	DESIRED CORRECTED POWER FACTOR (%)																				
	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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 Bill Savings

Poor power factor necessitates increased generation and transmission costs to provide the required amount of real power (KW). In order to equitably distribute these costs to the end user, many utilities utilize a rate structure that penalizes poor power factor.

To illustrate the power bill savings that can be obtained through capacitor installation, it is assumed that the utility serving a facility has the following rate schedule:

Sample Rate Schedule:

The billing demand is calculated such that a penalty is incurred for power factors below 90%.

Billing Demand = KW demand x .90

Demand Charge per Month:

First 10 KW	$5.25/KW Next
40 KW	$4.00/KW Next 100
KW	$3.50/KW Kxcess KW
	$2.75/KW

Utility Demand Charges Before Improvement
(see page 33, example 2)
Billing Demand = (425 KW x .90)/ .63 = 607.1 KW

Therefore our KW demand charges would be:

10 x $5.25	$52.50
40 x $4.00	$160.00
100 x $3.50	$350.00
457.1 x $2.75	$1257.03
	$1,819.53

Utility Demand Charges After Improvement:
Billing Demand = (425 KW x .90) /.90 = 425 KW

10 x $5.25	$52.50
40 x $4.00	$160.00
100 x $3.50	$350.00
275 x $2.75	$756.25
	$1,318.75

Savings per month = $1,819.53 - $1,318.75 = $500.78
Annual savings = $6,009.36

Payback Analysis:

Automatic Correction:
325 kvar, 480 volts, 25 kvar per step = 37FC7325F255
list price = $13,034 ÷ $6,009.36 = 2.2 year payback
(based on list price)

Fixed Correction:
325 kvar, 480 volts = 65L936TC2
list price = $3,009 ÷ $6,009.36 = approximately a 6 month payback (based on list price)

NOTE:

- KWH charges are not shown since the significant dollar savings in this example are in the demand rate structure.
- Due to variations in rate schedules throughout the country, it is impossible to provide an example of each schedule. Please check with your power company and local representative to determine your potential savings through power factor correction.

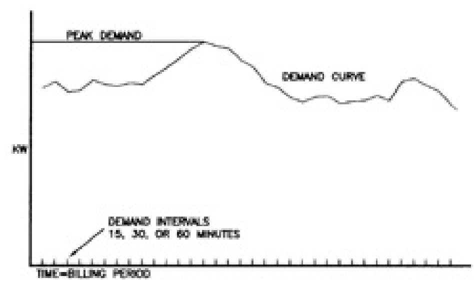
Factors That Affect Your Electric Bill

Energy Charge

- Number of kilowatt-hours used during the billing period.
- Number of kilovolt amperes (KVA) used during the billing period.

Demand Charge

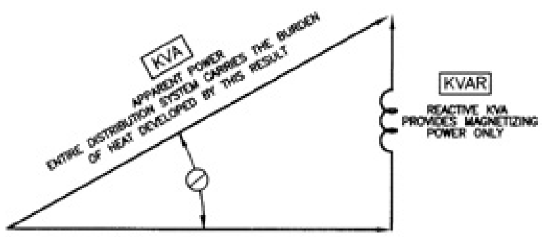
This charge compensates the utility for the capital investment required to serve the facility's peak load. Demand charges may be a large portion of the total electric bill, sometimes as high as 75%. Demand charges can be reduced by reducing energy peaks, reducing KVA, and improving power factor.



1 - Uncorrected KVA 2 - Corrected KVA

Power Factor Penalty Charge

A penalty imposed to encourage the user to improve power factor. Power companies usually impose a billing penalty when power factor (P.F.) drops below 90% - although this figure could be as high as 95%. In nearly all cases, the least expensive and most efficient method to reduce this charge is by adding capacitors.



Location of Power Capacitors

Methods of Wiring to Induction Motor Circuits

Capacitors may be connected to each motor and switched with it, as in Figures 1 and 2, in which case they are energized only when the motor is in operation, or they may be permanently connected to the line ahead of the motor starters as in Figure 3.

Power Capacitors afford Kilovar relief from their point of installation toward the power source.

1. The most economical location is directly across the terminals of larger motors thereby eliminating the cost of a separate switch. The capacitor ratings may be selected directly from Table 2 or Table 3, which require knowing only the type, horsepower rating, and speed of the motor. Reference to Figure 1 or 2 indicates the recommended location for new and existing motors. These capacitor ratings normally correct the motor no-load power factor to unity which in turn generally results in a full-load power factor of 94%-96%.
2. Where there are multiple motors with low horsepower ratings, or motors which do not run continuously, the capacitors should be connected directly to feeders in the facility through an appropriate switching device to serve as a disconnect for servicing, or light loads. Locations should be as far downstream in the facility as possible for maximum benefit.
3. Installations may be made at load centers when it is difficult to connect the capacitors directly across motor terminals or to feeders. Again, switching is a recommended practice.
4. If only power bill penalties are to be offset, the total capacitor requirement can be installed on the load side of metering equipment. Such a location does not increase the capacity of the facility distribution system.

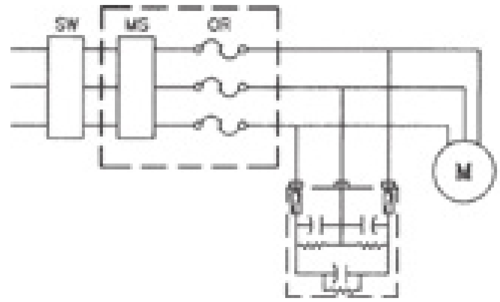


Figure 1 – *For new motor installations*

Capacitors are connected on the motor side of the thermal-overload relay. The Relay should be selected with a rating less than motor nameplate full-load current, commensurate with reduced line current effected by the capacitors. This reduction in line current, if not available from tables, may be determined by measuring line current with and without capacitors, or by calculation.

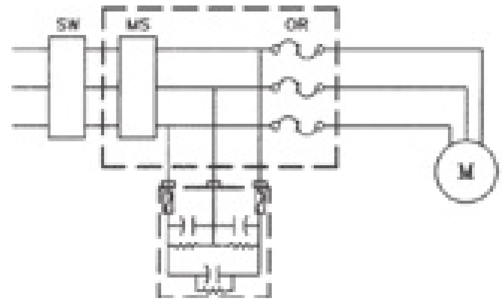


Figure 2 – *For existing motor installations*

Capacitors are connected to line side of thermal-overload relay. In this case the overload relay does not have to be resized.

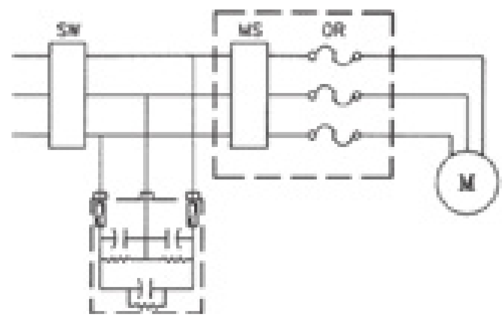


Figure 3

Capacitors are permanently connected to line, but with protection of a fusible safety switch or circuit breaker which eliminates a separate capacitor switch. To avoid nuisance blowing of the capacitor fuses, install the capacitors at this location when the motors are multiple speed, reversing, jogging, inching, or reduced voltage start.

Note: *In Figures 2 and 3, the thermal-overload relay does not require replacement since full motor current continues to flow through it.*

Legend:

SW	*Fusible safety switch or breaker.*
MS	*Motor Starter. OR Motor thermal- overload relay.*
C	*Dust-tight capacitor unit.*
M	*Motor.*
F	*Removable, high IC, one-time current limiting indicating fuses.*
R	*Discharge resistors.*

Table 2 - Suggested Maximum Capacitor Ratings for U-Frame NEMA Class B. Motors

(Use for high efficiency motors)

HP RATING	3600 RPM		1800 RPM		1200 RPM		900 RPM		720 RPM		600 RPM	
	kVAR	%AR	kVAR	%AR	kVAR	%AR	kVAR	%AR	kVAR	%AR	kVAR	%AR
3	1.5	14.0	1.5	15.0	1.5	20.0	2.0	27.0	2.5	35.0	3.5	41.0
5	2.0	12.0	2.0	13.0	2.0	17.0	3.0	25.0	4.0	32.0	4.5	37.0
7.5	2.5	11.0	2.5	12.0	3.0	15.0	4.0	22.0	5.5	30.0	6.0	34.0
10	3.0	10.0	3.0	11.0	3.5	14.0	5.0	21.0	6.5	27.0	7.5	31.0
15	4.0	9.0	4.0	10.0	5.0	13.0	6.5	18.0	8.0	23.0	9.5	27.0
20	5.0	9.0	5.0	10.0	5.0	11.0	7.5	18.0	10.0	20.0	10.0	25.0
25	5.0	6.0	5.0	8.0	7.5	11.0	7.5	13.0	10.0	20.0	10.0	21.0
30	5.0	5.0	5.0	8.0	7.5	11.0	10.0	15.0	15.0	22.0	15.0	25.0
40	7.5	8.0	10.0	8.0	10.0	10.0	15.0	16.0	15.0	18.0	15.0	20.0
50	10.0	7.0	10.0	8.0	10.0	9.0	15.0	12.0	20.0	15.0	25.0	22.0
60	10.0	6.0	10.0	8.0	15.0	10.0	15.0	11.0	20.0	15.0	25.0	20.0
75	15.0	7.0	15.0	8.0	15.0	9.0	20.0	11.0	30.0	15.0	40.0	20.0
100	20.0	8.0	20.0	8.0	25.0	9.0	30.0	11.0	40.0	14.0	45.0	18.0
125	20.0	6.0	25.0	7.0	30.0	9.0	30.0	10.0	45.0	14.0	50.0	17.0
150	30.0	6.0	30.0	7.0	35.0	9.0	40.0	10.0	50.0	17.0	60.0	17.0
200	40.0	6.0	40.0	7.0	45.0	8.0	55.0	11.0	60.0	12.0	75.0	17.0
250	45.0	5.0	45.0	6.0	60.0	9.0	70.0	10.0	75.0	12.0	100.0	17.0
300	50.0	5.0	50.0	6.0	75.0	9.0	75.0	9.0	80.0	12.0	105.0	17.0

Table 3 - Suggested Maximum Capacitor Ratings for T-Frame NEMA Class B. Motors

Applies to three-phase, 60 HZ motors when switched with capacitors as a single unit.

HP RATING	3600 RPM		1800 RPM		1200 RPM		900 RPM		720 RPM		600 RPM	
	kVAR	% LINE CURRENT REDUCTION	kVAR	% LINE CURRENT REDUCTION	kVAR	% LINE CURRENT REDUCTION	kVAR	% LINE CURRENT REDUCTION	kVAR	% LINE CURRENT REDUCTION	kVAR	% LINE CURRENT REDUCTION
3	1.5	14.0	1.5	23.0	2.5	28.0	3.0	38.0	3.0	40.0	4.0	40.0
5	2.0	14.0	2.5	22.0	3.0	26.0	4.0	31.0	4.0	40.0	5.0	40.0
7.5	2.5	14.0	3.0	20.0	4.0	21.0	5.0	28.0	5.0	38.0	6.0	45.0
10	4.0	14.0	4.0	18.0	5.0	21.0	6.0	27.0	7.5	36.0	8.0	38.0
15	5.0	12.0	5.0	18.0	6.0	20.0	7.5	24.0	8.0	32.0	10.0	34.0
20	6.0	12.0	6.0	17.0	7.5	19.0	9.0	23.0	10.0	29.0	12.0	30.0
25	7.5	12.0	7.5	17.0	8.0	19.0	10.0	23.0	12.0	25.0	18.0	30.0
30	8.0	11.0	8.0	16.0	10.0	19.0	14.0	22.0	15.0	24.0	22.5	30.0
40	12.0	12.0	13.0	15.0	16.0	19.0	18.0	21.0	22.5	24.0	25.0	30.0
50	15.0	12.0	18.0	15.0	20.0	19.0	22.5	21.0	24.0	24.0	30.0	30.0
60	18.0	12.0	21.0	14.0	22.5	17.0	26.0	20.0	30.0	22.0	35.0	28.0
75	20.0	12.0	23.0	14.0	25.0	15.0	28.0	17.0	33.0	14.0	40.0	19.0
100	22.5	11.0	30.0	14.0	30.0	12.0	35.0	16.0	40.0	15.0	45.0	17.0
125	25.0	10.0	36.0	12.0	35.0	12.0	42.0	14.0	45.0	15.0	50.0	17.0
150	30.0	10.0	42.0	12.0	40.0	12.0	52.5	14.0	52.5	14.0	60.0	17.0
200	35.0	10.0	50.0	11.0	50.0	10.0	65.0	13.0	68.0	13.0	90.0	17.0
250	40.0	11.0	60.0	10.0	62.5	10.0	82.0	13.0	87.5	13.0	100.0	17.0
300	45.0	11.0	68.0	10.0	75.0	12.0	100.0	14.0	100.0	13.0	120.0	17.0
350	50.0	12.0	75.0	8.0	90.0	12.0	120.0	13.0	120.0	13.0	135.0	15.0
400	75.0	10.0	80.0	8.0	100.0	12.0	130.0	13.0	140.0	13.0	150.0	15.0
450	80.0	8.0	90.0	8.0	120.0	10.0	140.0	12.0	160.0	14.0	160.0	15.0
500	100.0	8.0	120.0	9.0	150.0	12.0	160.0	12.0	180.0	13.0	180.0	15.0

Percent AR is the percent reduction in full-load line current due to capacitors, A capacitor located on the motor side of the overload relay reduces current through the relay, Therefore, a smaller relay may be necessary, The motor-overload relay should be selected on the basis of the motor full-load nameplate current reduced by the percent reduction in line current (percent AR) due to capacitors

The capacitor size specified in the above table will increase the full load power factor to 95% and larger sizes should not be used without consulting GE Vernova.

To calcqulate required kVAR for energy efficient motors (or any motor) use the following formula

$$kVAR = \frac{H,P, x\ ,746}{\%\ efficiency}\left(\frac{\sqrt{1-PF_0^2}}{PF_0^2} - \frac{\sqrt{1-PF_1^2}}{PF_1^2}\right)$$

PF_0 *Original Power Factor (supplied by manufacturer)*

PF_1 *Target Power Factor H.P. Motor Horsepower from nameplate*

% efficiency *Motor manufacturer nameplate*

Points to Consider when Sizing Capacitors

Two limiting factors must be considered when capacitors are to be switched with a motor as a unit. The first is overvoltage due to self-excitation, and the second is transient torques.

Self-excitation voltage: When a motor is disconnected from the line, it will normally rotate for a short time before coming to rest. A capacitor connected to this motor will still be supplying magnetizing current, which will excite the motor. Under these conditions, the motor and capacitor act like a generator and produce a certain voltage because of this “self-excitation”. The magnitude of the voltage that can be produced is determined by two things—the rating of the capacitor being used and the speed of the motor involved. It is not uncommon for this “self-excitation” voltage to reach 150% of rated voltage if too large a capacitor is being used.

Transient torques: Perhaps even more important than overvoltage is the transient torques that can occur if the motor happens to close back into the line before coming to a complete rest. If the motor is still rotating and acting as a generator, the resulting transient torque may be as much as 20 times the full load torque. Because of transient torque and overload considerations, most motor manufacturers provide recommendations concerning the maximum capacitor kVAR that should be switched with a given motor. These recommendations are conservative enough to avoid endangering the motor, and will ordinarily result in a corrected power factor of approximately 95-98% at full load.

To avoid nuisance blowing of fuses when capacitors are connected directly across the motor terminals:

- Motors should not be subject to plugging or reversing duty.
- Motors should not be operated such that rapid restarting occurs.

Switching Capacitors

The National Electrical Code requires that power capacitors, other than those directly connected across motor terminals, have separate disconnecting means to permit their removal from the circuit as a regular operating procedure, or for maintenance purposes. The Code also requires that the continuous current carrying capacity of the disconnecting device and of the capacitor circuit conductors shall be not less than 135 percent of the rated current of the capacitor. Since power capacitors for industrial service are designed for use in an ambient temperature of 46°C (115°F) maximum, the cables and disconnecting devices should also be selected for this ambient operation.

The data in Table 4 on page 51 is predicated on these conditions.

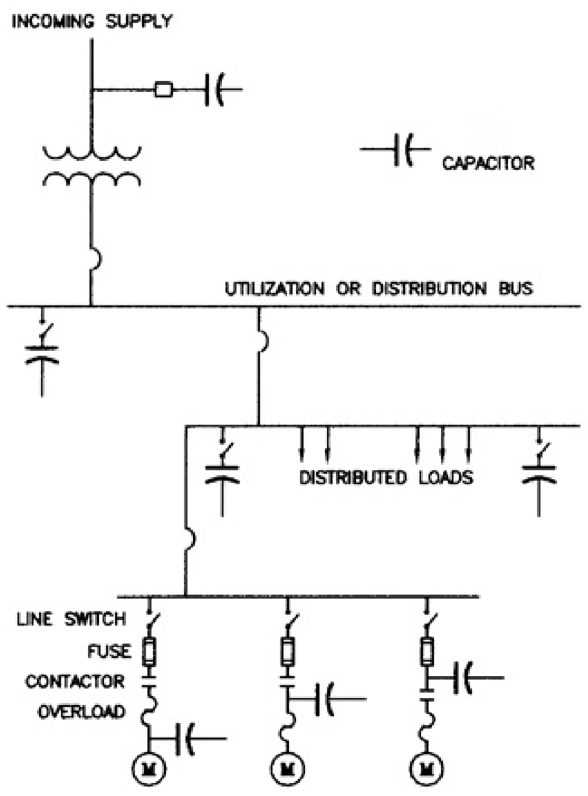


Table 4 - Suggested Wire Sizes for Capacitor Installations

The cable sizes indicated in this table are based on 135% of rated current in accordance with NEC 460.

240 VOLT, 3 PHASE						480 VOLT, 3 PHASE						600 VOLT, 3 PHASE					
CAP. RATING kVAR	CAP. Amps	75ºC MIN. CABLE SIZES*	90ºC MIN. CABLE SIZES*	SAFETY SWITCH		CAP. RATING kVAR	CAP. Amps	75ºC MIN. CABLE SIZES*	90ºC MIN. CABLE SIZES*	SAFETY SWITCH		CAP. RATING kVAR	CAP. Amps	75ºC MIN. CABLE SIZES*	90ºC MIN. CABLE SIZES*	SAFETY SWITCH	
				RATING Amps	FUSE Amps					RATING Amps	FUSE Amps					RATING Amps	FUSE Amps
0.5	1	14	14	30	3	0.5	1	14	14	30	1	0.5	-	14	14	30	1
1.0	2	14	14	30	5	1	1	14	14	30	3	1	1	14	14	30	3
2.0	5	14	14	30	10	1.5	2	14	14	30	3	1.5	1	14	14	30	3
2.5	6	14	14	30	10	2.0	2	14	14	30	6	2.0	2	14	14	30	3
3.0	7	14	14	30	15	2.5	3	14	14	30	6	2.5	2	14	14	30	5
4.0	10	12	12	30	20	3.0	4	14	14	30	6	3.0	3	14	14	30	5
5.0	12	12	12	30	20	4.0	5	14	14	30	10	4.0	4	14	14	30	6
6.0	14	10	10	30	25	5.0	6	14	14	30	10	5.0	5	14	14	30	10
7.5	18	10	10	30	30	6.0	7	14	14	30	15	6.0	6	14	14	30	10
8.0	19	8	8	60	35	7.5	9	14	14	30	15	7.5	7	14	14	30	15
10.0	24	8	8	60	40	8.0	10	12	12	30	20	8.0	8	12	12	30	15
12.5	30	8	8	60	50	10.0	12	12	12	30	20	10.0	10	12	12	30	20
15.0	36	6	6	60	60	12.5	15	10	10	30	25	12.5	12	10	10	30	20
17.5	42	4	4	100	75	15.0	18	10	10	30	30	15.0	14	10	10	30	25
20.0	48	4	4	100	80	17.5	21	8	8	60	35	17.5	17	8	8	30	30
22.5	54	3	3	100	90	20.0	24	8	8	60	40	20.0	19	8	8	60	35
25.0	60	3	3	100	100	22.5	27	8	8	60	50	22.5	22	8	8	60	40
27.5	66	1	2	200	125	25.0	30	8	8	60	50	25.0	24	8	8	60	40
30.0	72	1	2	200	125	27.5	33	6	6	60	60	27.5	26	6	6	60	45
35.0	84	1/0	1	200	150	30.0	36	6	6	60	60	30.0	29	6	6	60	50
40.0	96	2/0	2/0	200	175	35.0	42	4	6	100	70	35.0	34	6	6	60	60
45.0	108	3/0	3/0	200	200	40.0	48	4	4	100	80	40.0	38	4	6	100	70
50.0	120	3/0	3/0	200	200	45.0	54	3	4	100	90	45.0	43	4	4	100	80
60.0	144	250	4/0	400	250	50.0	60	3	3	100	100	50.0	48	4	4	100	80
75.0	180	350	300	400	300	60.0	72	3	3	200	110	60.0	58	3	3	100	100
100.0	241	2 × 3/0	3 × 3/0	400	400	75.0	90	1/0	1	200	150	75.0	72	1	2	200	125
125.0	301	2 × 250	2 × 4/0	600	500	100.0	120	3/0	2/0	200	200	100.0	96	1/0	1	200	150
150.0	361	2 × 350	2 × 300	600	600	125.0	150	250	4/0	400	250	125.0	120	3/0	3/0	200	200
175.0	421	2 × 500	2 × 350	800	700	150.0	180	350	300	400	300	150.0	144	250	4/0	400	250
200.0	481	2 × 600	2 × 500	800	800	175.0	210	500	350	400	350	175.0	168	350	300	400	300
225.0	541	3 × 350	3 × 300	1200	900	200.0	241	2 × 3/0	2 × 3/0	400	400	200.0	192	500	350	400	350
250.0	601	3 × 350	3 × 350	1200	1000	225.0	271	2 × 3/0	2 × 3/0	400	400	225.0	217	2 × 3/0	2 × 3/0	400	400
275.0	662	4 × 300	3 × 400	1200	1100	250.0	301	2 × 250	2 × 4/0	600	500	250.0	241	2 × 3/0	2 × 3/0	400	400
300.0	722	4 × 350	3 × 500	1200	1250	275.0	331	2 × 250	2 × 4/0	600	500	275.0	265	2 × 4/0	2 × 3/0	600	450

Table 4 - Suggested Wire Sizes for Capacitor Installations

The cable sizes indicated in this table are based on 135% of rated current in accordance with NEC 460.

240 VOLT, 3 PHASE						480 VOLT, 3 PHASE						600 VOLT, 3 PHASE					
CAP. RATING kVAR	CAP. Amps	75ºC MIN. CABLE SIZES*	90ºC MIN. CABLE SIZES*	SAFETY SWITCH		CAP. RATING kVAR	CAP. Amps	75ºC MIN. CABLE SIZES*	90ºC MIN. CABLE SIZES*	SAFETY SWITCH		CAP. RATING kVAR	CAP. Amps	75ºC MIN. CABLE SIZES*	90ºC MIN. CABLE SIZES*	SAFETY SWITCH	
				RATING Amps	FUSE Amps					RATING Amps	FUSE Amps					RATING Amps	FUSE Amps
						300.0	361	2 × 350	2 × 300	600	600	300.0	289	2 × 250	2 × 4/0	600	500
						325.0	391	2 × 500	2 × 350	800	700	325.0	313	2 × 250	2 × 4/1	600	500
						350.0	421	2 × 500	2 × 350	800	700	350.0	337	2 × 350	2 × 300	600	600
						375.0	451	2 × 600	2 × 500	800	800	375.0	361	2 × 350	2 × 300	600	600
						400.0	481	2 × 600	2 × 500	800	800	400.0	385	2 × 500	2 × 350	800	700
						425.0	511	2 × 350	2 × 300	1200	900	425.0	409	2 × 500	2 × 350	800	700
						450.0	541	2 × 350	2 × 300	1200	900	450.0	433	2 × 500	2 × 400	800	750
						475.0	571	2 × 350	2 × 300	1200	900	475.0	457	2 × 500	2 × 400	800	750
						500.0	601	3 × 400	3 × 350	1200	1000	500.0	481	2 × 600	2 × 500	1200	800
						525.0	631	3 × 400	3 × 350	1200	1000	525.0	505	2 × 600	2 × 500	1200	800
						550.0	662	4 × 300	3 × 400	1200	1100	550.0	529	3 × 350	2 × 600	1200	900
						575.0	692	4 × 350	3 × 500	1200	1200	575.0	553	3 × 350	2 × 600	1200	900
						600.0	722	4 × 350	3 × 500	1200	1200	600.0	577	3 × 400	3 × 350	1200	1000

** Rating based on 90°C rated wire, Not more than three single conductors are allowed in a raceway with 30°C ambient. For higher ambient temperatures, consult the National Electrical Code Table 310-16 (correction factor for ambient over 30°C). Rated current is based on operation at rated voltage, frequency, and kVAR.*

Understanding Harmonics

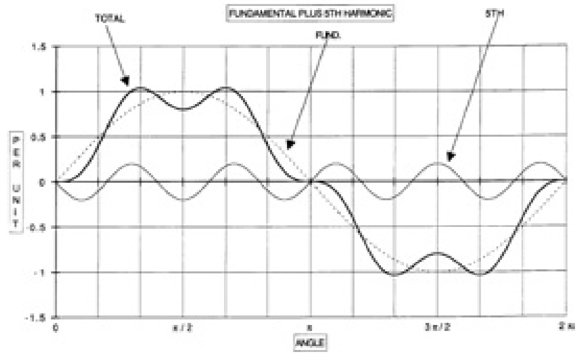
Harmonics are multiples of the fundamental frequency distortions found in electrical power, subjected to continuous disturbances. In a 60 Hz electrical system,

300 Hz is the 5th harmonic, 420 Hz is the 7th harmonic, and so on. These harmonics are created by the increased use of non-linear devices such as UPS systems, solid state variable speed motor drives, rectifiers, welders, arc furnaces, fluorescent ballasts, and personal computers. The source of these harmonics may be internal or external. Individual harmonic frequencies will vary in amplitude and phase angle, depending on the harmonic source. Variable speed drives are usually referred to by the number of rectifiers in the system. The most common are six (rectifiers) and twelve (rectifiers) pulse drives.

Harmonic Resonance occurs when the capacitor reactance and the system reactance are equal. If this occurs, large harmonic currents will circulate between transformer and capacitor. These currents will result in greater voltage distortion. This provides a higher voltage across the capacitor and potentially harmful currents through all capacitor equipment. Harmonic resonance may occur at any frequency but the 5th, 7th, 11th and 13th are the frequencies with which we are most concerned. If total bus load exceeds 15-20% of harmonic generation load, the potential for a resonance condition is high. Some indicators of resonance are overheating, frequent circuit breaker tripping, unexplained fuse operation, capacitor failure, electronic equipment malfunction, flickering lights and telephone interference.

Conquering Harmonic Resonance can be accomplished by: (1) adding or subtracting capacitance from the system to move the parallel resonance frequency to one that is not deleterious; (2) adding tuned harmonic suppression reactors in series with the capacitor to prevent resonance; (3) altering the size of non-linear devices. It is important that the tuned frequency, for the 5th harmonic, be at approximately the 4.7th harmonic to account for tolerance in manufacturing and to remove the largest offending portion of the 5th harmonic. Parallel resonance will occur around the 4th harmonic, at a much lower amplitude and in an area that does no harm to the system or capacitor. Tuning lower than 282 Hz is not efficient in removing large portions of the offending harmonic.

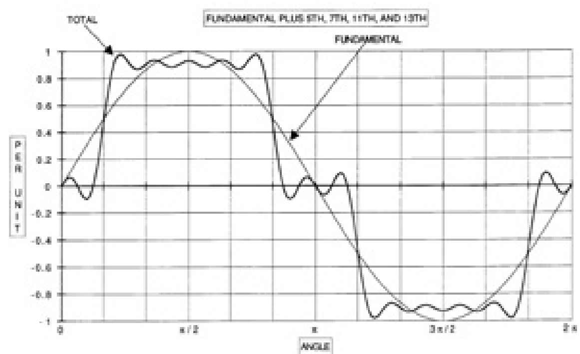
Considerations of how power factor correction capacitors affect a system are of utmost importance. In systems with more than 15-20% of harmonic loads, a harmonic survey should be performed to indicate potential problem areas. Readings taken over changing load conditions at potential capacitor locations are most useful in determining the types of systems best employed to accomplish the ultimate harmonic suppression, power factor improvement, kVA reduction and other goals.



Graph 1

Applying Power Factor Correction in a Harmonic Environment

The use of capacitors has long been accepted as the most practical solution to low power factor problems in power systems. Modern capacitors are a reliable, maintenance free, inexpensive source of VAR's needed in inductive circuits to synchronize the voltage and current waveforms. In the past, the application of capacitors was straightforward; all that was required was a knowledge of KW (or KVA), existing power factor, and target power factor. In recent years, however, this practice has been complicated by the proliferation of non-linear loads.



Graph 2

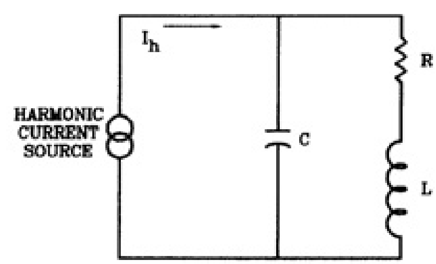


Figure 3

Applying Power Factor Correction in a Harmonic Environment (continued)

The Source of the Problem

One of the most widely used solid state motor controls is the six-pulse drive. These devices represent a non-linear impedance to the power source, drawing a quasi-square wave alternating current rich in harmonics. For six-pulse Drives, the characteristic harmonics are: 5, 7, 11, 13 ,17, 19,...., the higher order harmonics are not usually troublesome because their magnitude is progressively smaller. **Graphs 1 and 2** show the total distortion when one or more harmonics are added to the fundamental.

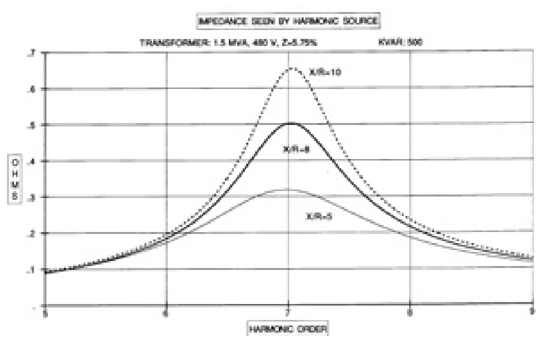
Harmonic Resonance

When a capacitor bank is added to a power system, it is effectively connected in parallel with the system's impedance, which is primarily inductive. As far as the harmonic source is concerned, it sees a capacitor in parallel with an inductor. **Figure 3** shows the model circuit for this system on a per phase basis. Resistor 'R' represents the inevitable system losses.

The harmonic source is represented as a constant current source, since it behaves as such.

Since the capacitive (XC) and inductive (XL) reactances are frequency dependent (as frequency increases, XC decreases and XL increases), there is a frequency at which these two parameters will be equal; this frequency is called the system's natural resonant frequency. At this frequency, the system's impedance appears to the harmonic source to be very large. Therefore, a harmonic current at the resonant frequency flowing through this impedance will result in a very large harmonic voltage as derived by Ohm's Law (V = I Z).

A large harmonic voltage will in turn result in a much larger harmonic current exchange between the capacitor bank and the system impedance. This secondary harmonic current may be many orders of magnitude larger than the generated harmonic current, resulting in nuisance operation of circuit breakers or fuses that happen to be in the path of this current. The degree of magnification is determined by the system resistance. Since the generated harmonic current is considered to be constant for a given frequency, then the harmonic voltage will be proportional to the impedance. Consequently, the frequency response of the impedance is a good indication of the system's susceptibility to harmonic resonance.



Graph 4

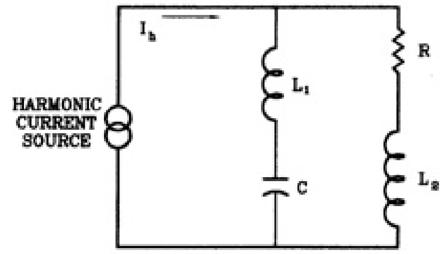


Figure 5

Graph 4 is the impedance plot, as seen by the harmonic source in figure 3, for a typical system consisting of 500 kVAR connected to a 1500 KVA, 480 volt transformer. (While impedance magnitudes are dependent on system resistance, resonant frequency is primarily a function of inductance (L) and capacitance (C).) The quick and simple way to calculate the system's harmonic resonance is through the following relationship derived from the system's reactances

$$h = \sqrt{KVAR}$$

where:

h = harmonic order

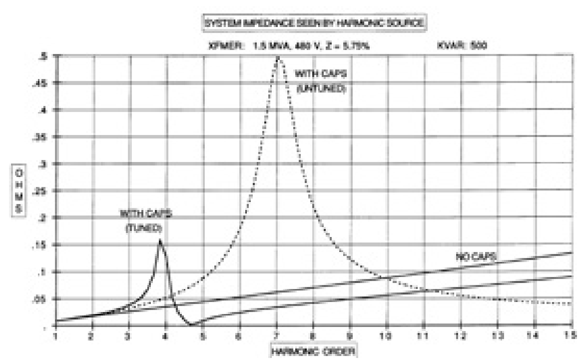
KVAsc = KVA = available short Zpu circuit volt amps at point of capacitor bank installation

kVAR = capacitor bank size

This calculation, even though it does not take into account upstream system impedance, is reasonably accurate for most applications since the bulk of the impedance is contributed by the transformer itself.

Detuning the Circuit

The most effective solution to this problem consists of series tuning the capacitor bank to the lowest offending harmonic, usually the 5th. This is done by introducing an inductor in series with the capacitor as shown in **figure 5.**



Graph 5

Applying Power Factor Correction in a Harmonic Environment (continued)

The impedance versus frequency plot, as seen by the harmonic source, is shown in figure a; the original impedance response (untuned) is shown for comparison.

The minimum impedance occurs at the series resonant point, the 4.7th harmonic, while the peak represents a parallel resonance due to the capacitor and the two inductors. Harmonic currents generated at or near the series resonant frequency (such as the 5th) will flow to the trap harmlessly, provided the capacitor and reactor are sized properly to withstand the additional stresses. These currents are simply following the path of least impedance. The system will not resonate above this frequency since it is inductive. This approach will accomplish two objectives. On the line side of the capacitor filter bank, system power factor is corrected and harmonic voltage distortion is reduced. Harmonic voltage (Vh) is the result of a harmonic current (Ih) flowing through the system impedance (Zh), i.e. Ohm's Law (Vh = Ih x Zh).

By reducing the system impedance (Zh) we can reduce the harmonic voltage (Vh) even though the harmonic current (Ih) remains the same.

When the main objective is to reduce harmonic distortion, the engineer will consider the use of more filter stages, each tuned to the next higher harmonic (7^{th}, 11^{th}, . . .). In some cases, where harmonic currents are excessive, the use of capacitors rated at the next higher voltage may be required. In most cases, GE Vernova capacitors are run at rated voltage and will maintain their twenty year life expectancy.

The GE Vernova Power Quality Engineering Department is available to assist you with system analysis.

Harmonic Survey Data Form

As we continue to receive more requests for application assistance as to the mitigation of harmonics we ask you to send us survey data as shown in the illustration below. The complexities are increasing and as such we are not looking for reams of data but rather summary format so that hopefully, responses can be made in a timely fashion. Additional information and/or procedures to keep in mind::

1. Submit 1-Line diagram.
2. Measurements (metering) should be taken at the point where the capacitors are to be located within the system. If capacitors are present on the system, they should be dis-engaged during metering.
3. Metering should be conducted during typical peak load conditions.
4. Snapshots are just that. They are indicators of possible severe or acceptable harmonic conditions & may not reflect an accurate picture. Metering should be conducted over a time period to insure all loads have been engaged. We then have a better opportunity to appraise the overall system dynamics to the best of our ability.
5. The most important harmonics we need are 5^{th}, 7^{th}, 11^{th}, 13^{th}, 17^{th} and 19^{th}.

Harmonic Analysis - Field Survey Data

DATE: ____________________

FACILITY: ____________________

TRANSFORMER NAMEPLATE: ____________________

KVA: ____________________

PRIMARY VOLTAGE: ____________________

SECONDARY VOLTAGE: ____________________

3 PHASE FAULT CURRENT (if available): ____________________

IMPEDANCE: ____________________

MAXIMUM THD - CURRENT: ____________________ RMS

MAXIMUM THD - VOLTAGE: ____________________

FACILITY LAYOUT: 1 - LINE

CAPACITORS TO BE ADDED: ____________________

VOLTAGE: ____________________ kVAR: ____________________

EXISTING CAPACITORS: Y: __________ N: __________

ADDITIONAL REMARKS: ____________________

____

____

____

____

GE VERNOVA LOCATION: ____________________

HARMONIC	% OF FUND.	I (RMS)	REMARKS
1- Fund.	100		
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

For more information, visit
gevernova.com/grid-solutions

GE VERNOVA

GEP-974I
English
251013