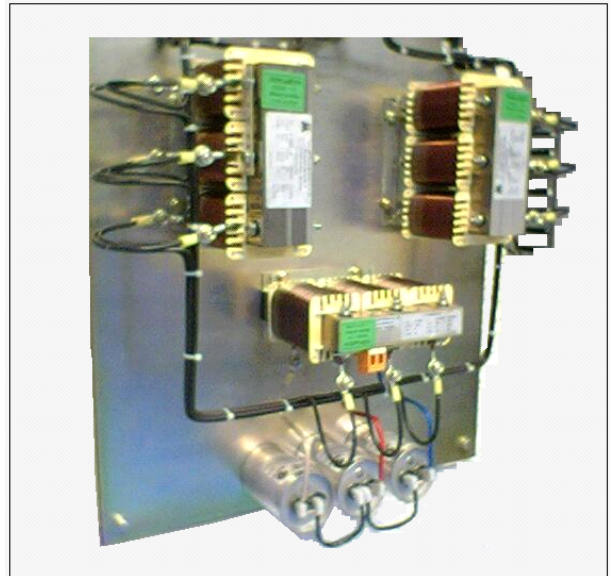


Low Pass Harmonic Filters



TimesOne™
The Energy Efficiency Company

For Users of Drives, Inverters, Rectifiers and UPS Equipment



Reduce harmonic current distortion

Reduce harmonic voltage distortion

Improve total power factor

Solve power quality problems

Meet IEEE-519

Guaranteed Results!

Solve Harmonics Problems Right at Their Source!



Type LPF

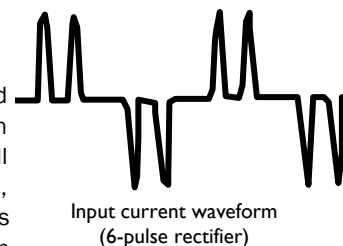


Sources of Harmonics

In recent years, it has become apparent that power electronics equipment is contributing to power system voltage distortion. These energy saving and power reliability products such as adjustable speed motor drives (ASD), and uninterruptible power supplies (UPS) do not draw current in the normal continuous and sinusoidal manner, but instead take discontinuous gulps of current. ASDs and UPSs often convert three phase AC input voltage to DC through the use of a full wave bridge rectifier consisting of six diodes (6-pulse rectifier). The pulsed current waveforms associated with six pulse rectifiers, contain not only a 60hz component but also multiple higher frequencies called harmonics.

Problems Caused by Harmonics

Effects of the distorted current included high peak current, elevated true rms (Trms) current and reduced total power factor. All together, this means lower system efficiency, increased burden on electrical equipment such as transformers, possible equipment malfunction or interference, as well as reduced equipment life. When one or more loads in a facility cause harmonic current distortion, the system voltage and current will also become distorted, and have an impact on other loads connected to the same power source. Facility managers have noticed that harmonics can have an adverse effect on equipment life. Elevated Trms current increases the I^2R losses which cause increased equipment heating, reducing the life of motors and transformers. When the continuous operating temperature of this equipment is increased by only 10 degrees Celsius, it's life expectancy decreases as much as fifty percent. Although you are employing energy saving equipment, you will not achieve the maximum energy savings due to the consumption of wasteful harmonic energy. In many cases, these same pieces of equipment intended to increase the reliability of the power supplied to their loads, may actually create power quality problems for other pieces of equipment supplied from the same voltage source.



IEEE - STD - 519

To minimize the impact of facility harmonic distortion on the utility power system and on neighboring facilities, IEEE-std-519 was developed and published in 1982. In 1992 it was updated and re-published. This standard provides recommended limits for total harmonic voltage and current distortion as well as for individual harmonic currents. The

I_{sc} / I_L	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	TDD-I
< 20	4.0	2.0	1.5	0.6	0.3	5%
20 < 50	7.0	3.5	2.5	1.0	0.5	8%
50 < 100	10.0	4.5	4.0	1.5	0.7	12%
100 < 1000	12.0	5.5	5.0	2.0	1.0	15%
1000 up	15.0	7.0	6.0	2.5	1.4	20%

following chart indicates the limits for current distortion imposed by this standard based upon the ratio of available short circuit current (I_{sc}) to the maximum demand load current (I_L). This analysis is typically performed at the point where a facility power system is connected to the electric utility power system. This point is referred to as the Point of Common Coupling or Point of Common Connection (PCC).

Optional Locations for Mitigation Equipment

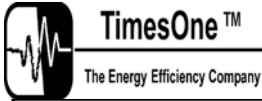
The objective of the standard can be met by applying harmonic mitigation equipment either at the PCC or at appropriate points downstream from the PCC. Applying harmonic filters near the PCC improves the power quality for all points upstream. The utility and other facilities connected to the same utility feed receive the benefit of improved power quality, but your facility does not.

Solve Harmonics Right at Their Source

TIMES ONE™ offers a full range of solutions for harmonic distortion. Our Low Pass Harmonic Filter is the ideal solution for minimizing harmonics right at the individual loads. This removes harmonics from all points up stream of these loads. When harmonic mitigation equipment is applied close to the individual harmonic producing loads, the power quality can be improved throughout the facility as well as upstream. For the purpose of improving the internal power quality, IEEE-std-519, 10.1 states that "within an industrial plant, the PCC is the point between the non-linear load and other loads." When the PCC is considered at an individual piece of equipment, the typical limits for harmonic current distortion are 8%, 12% or 15%. When you apply our Low Pass Harmonic Filter to an individual load or group of loads, the harmonic current distortion will typically be reduced to 5% or less.

Comprehensive Facility Analysis Available

TIMES ONE™ can also perform a comprehensive facility analysis for you. Typically we'll work directly from your single line diagram with consideration for any existing problems and your desired power quality objectives. We'll recommend the best technical and economical solution that will meet your objectives. Your potential benefits include: increased equipment life, reduced power losses, improved equipment operation, reduced equipment down time, and ultimately — *increased productivity and operating profits.*



Solve Harmonics Problems at Their Source!

Get these Benefits ...

- Reduce transformer and motor temperature**
= *Extend equipment life*
- Reduce true rms and peak current**
= *Eliminate disruptions caused by nuisance fuse and circuit breaker operation*
- Reduce KVA demand**
= *More power from existing power sources*
- Reduce facility power loss**
= *Energy cost savings*
- Eliminate equipment interference**
= *Improve equipment operation*
- Improve total power factor**
= *Reduce KVA consumption*
- Improve productivity and profits!**

Problems Solved by TIMES ONE™ Type LPF Harmonic Filters

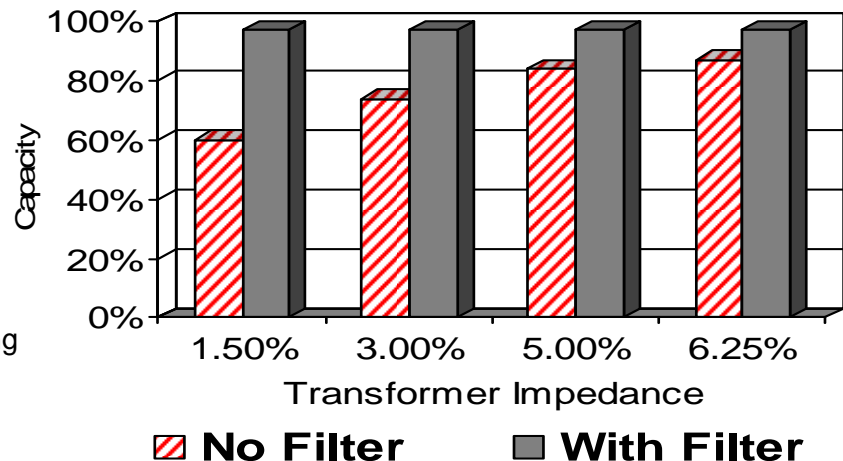
- Harmonic current distortion
- Harmonic voltage distortion
- Transformer over-loading
- Transformer over-heating
- Motor over-heating
- Nuisance fuse blowing
- Nuisance circuit breaker tripping
- Low total power factor
- Equipment interference
- Capacitor failure

LPF Maximizes the Power Available from Transformers and Generators

Harmonics increase the KVA burden on transformers and generators. The higher the harmonic distortion, the higher the true rms current and KVA demand.

TIMES ONE™ Low Pass Harmonic Filters will help you to get the most out of existing transformers and generators. By reducing harmonic current distortion to extremely low levels, current and KVA demand of existing loads are both reduced, freeing up capacity in your existing transformers or generators.

Power Source Capacity Available when all loads are Non-Linear



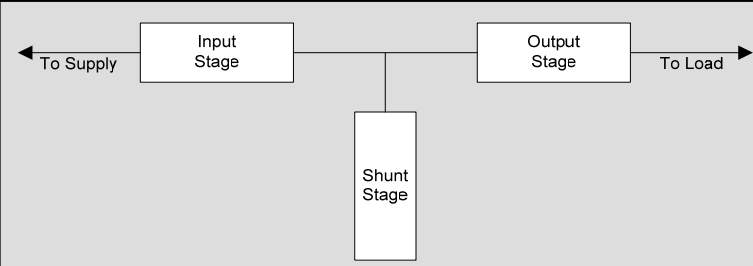
Since harmonic distortion reduces the total power factor, it causes energy efficiency to suffer and reduces the available capacity of power sources such as transformers, generators and conductors. As the percentage of non-linear load on a transformer increases, its available KVA capacity decreases.

Note: Type LPF harmonic filters meet the requirements of UL-508, IEEE-519, IEEE-1531 and the CE Low Voltage Directive. Design engineering and production are performed in a facility that is currently registered to ISO-9001:2000 by UL.

Low Pass Harmonic Filter Performance

Three Stages of Harmonic Filtering

TIMES ONE™ Low Pass Harmonic Filters (LPF) offer three stages of filtering that nearly eliminate the harmonics normally produced by three phase equipment using six pulse rectifiers. Our LPF is intended for adjustable speed drives, uninterruptible power supplies, and other rectifier controls, with any source impedance.



Input Stage

The purpose of this stage is to isolate the LPF from other harmonics sources connected to the same power source, prevent power system resonance and to provide series impedance that will reduce the spectrum of harmonics produced by the load. This stage also protects the load against voltage transients.

Output Stage

The output stage contains a precise amount of impedance that supplements the input stage impedance to minimize the amount of harmonics produced by the load. It also reduces the harmonic burden placed on the shunt stage, and prevents resonance between the shunt stage and the load.

Shunt Stage

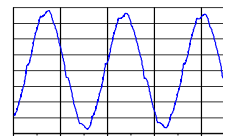
The shunt stage absorbs residual harmonics remaining after both the input and output stages have played their roles in reducing load harmonics. Our basic three stage filter design achieves anti-resonance operation of our shunt stage.

The input current waveform is a primary indicator of the relative harmonic current distortion. The nearer to a sine wave, the less distortion. The worst case scenario is when the power source impedance is low (ie: 1% or less). This results in very high distortion, increased true rms current and very high peak current.

The waveforms below illustrate the typical waveform to be expected for a VFD connected directly to the line with a source impedance of 1%, with a 5% impedance reactor, and with the TIMES ONE™ Low Pass Harmonic Filter. Notice that the LPF improves the current waveform to nearly a sine wave.

Actual Waveform Measurements

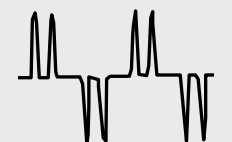
Motor drive (VFD) with **Low Pass Filter (LPF)**
Actual THD-I = 4.72%
 (Nearly a sine wave)



Motor drive, no filter, with line reactor
5% effective impedance
 Actual THD-I = 35.2%



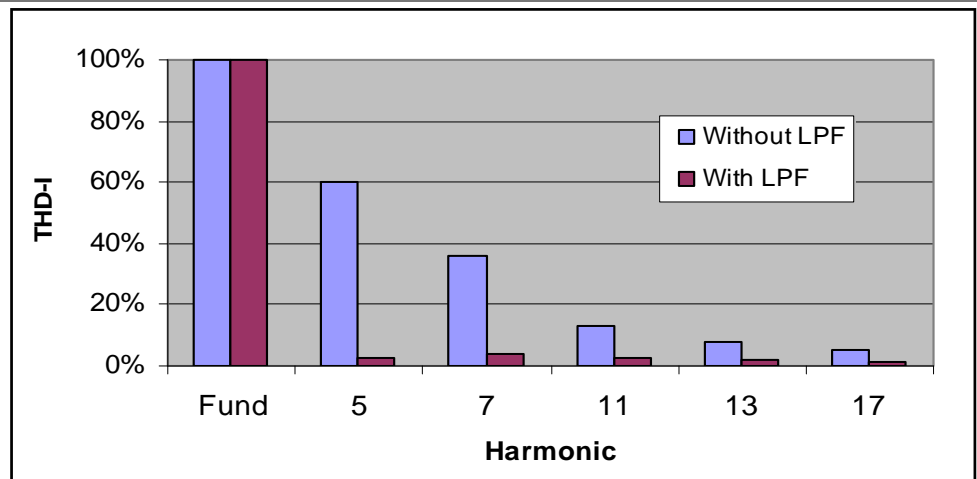
Motor drive, no filter, and with **0.5% effective source impedance**
 Actual THD-I = 99.9%



Comparison of residual harmonics for a drive with and without TIMES ONE™ Low Pass Harmonic

Harmonic Spectrum

This is an actual harmonic spectrum for a 6-pulse drive (VFD), operating at full load, and having an effective source impedance of 1% relative to the drive KVA rating.



Type LPF harmonic filters achieve less than 5% Total harmonic current distortion.

TIMES ONE™ Type LPF Harmonic Filters perform better because our LPF is designed for real life applications with virtually any source impedance. Furthermore, our reactors and capacitors have unique characteristics that enable our filter to achieve maximum reduction of harmonics.

Proprietary Reactor Design

Reactors have a major influence over the performance of harmonic filters. Optimum performance of any harmonic filter demands accurate and balanced phase to phase inductance in all three reactor coils. Additionally, both power loss and life expectancy are affected by the reactor's ability to handle harmonics with minimal power loss.

Reactors used in TIMES ONE™ Type LPF filters have inductance balanced within 1% to 3% between all three phases, (competitive products can be 5 to 15%). Our reactors are constructed with exclusive PolyGap™ core construction which strategically distributes the air gap into numerous tiny air gaps placed at precise locations within the core. PolyGap™ core construction achieves balanced phase inductance with negligible gap (fringing) losses and virtually eliminates stray magnetic flux. Reactors used as part of the shunt stage include an over temperature switch that may be used to send an alarm in the event the filter has been inadvertently overloaded. Reactors used in TIMES ONE™ Type LPF filters are tested with actual harmonics currents and are UL component recognized.



Exclusive Capacitor Design

Capacitors are the heart of any harmonic filter. Traditionally, they have been the first items to fail in a filter because their life is adversely affected by temperature, terminal voltage, and the true rms current that flows due to both fundamental and harmonic currents. TIMES ONE™ capacitors are specially designed and constructed for harmonic filter applications. They are designed with a physical geometry optimizes dissipation of heat in order to achieve the lowest possible internal temperature. Although our capacitors are designed for operation at temperatures up to 85 degrees Celcius, the normal operating temperature of our Type LPF filters is much lower resulting in life expectancy as high as 1,000,000 hours of operation (at 40C). Capacitors used in TIMES ONE™ Type LPF filters are UL component recognized.



Three Stage Filter

TIMES ONE™ combines the highest grade reactors and capacitors into a three stage filter that performs wide band filtering of virtually all harmonic frequencies produced by a typical 6-pulse rectifier. Our filters are engineered to deliver the highest performance in the most rigorous of applications. Our three stage approach to filtering enables our filter to be used on virtually any drive or UPS using 6-pulse rectification, whether supplied from a transformer, generator or distributed generation power source (inverter). Our LPF filters are suitable for :

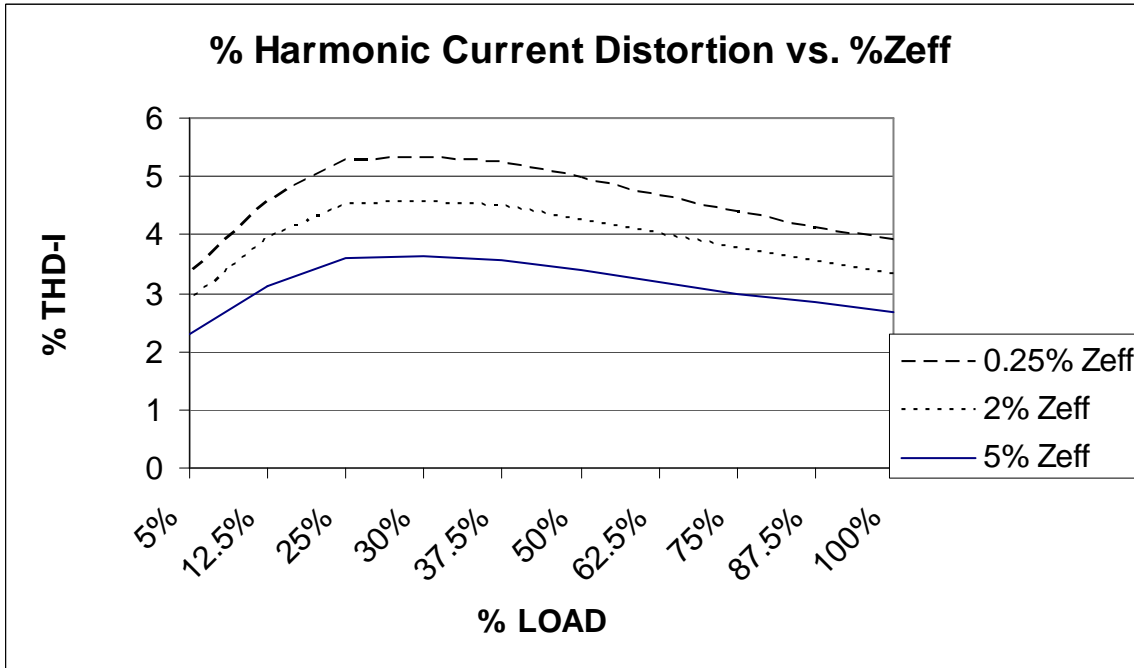
- Diode converter with or without internal inductance
- SCR converter with or without internal inductance
- Constant torque applications
- Variable torque applications
- Non-Linear loads supplied from inverter power sources

Other filters may look similar, but lack the exclusive design characteristics, construction techniques and overall performance of our reactors and capacitors. While others may use less series inductance, in the interest of lowering their costs, TIMES ONE™ puts the ideal inductance into each filter in order to achieve superior performance over the entire load range and enabling our Type LPF filter to be used with virtually any power source.

Type LPF filters provide three stages of filtering to perform wide band attenuation of normal harmonic frequencies associated with balanced three phase loads that use 6-pulse rectifiers (such as adjustable speed drives, UPS, frequency converters, etc.). For properly selected and applied LPF filters, the total harmonic current distortion at the filter input terminals will normally be 5% THD-I or less and will always be 8% THD-I or less. The distortion at the utility metering point can be well under 5% THD-I when other linear loads are operating. Actual distortion levels may increase slightly for unbalanced line voltage and when voltage distortion is caused by other loads.

Performance Specifications

The key benefit of the Low Pass Harmonic Filter (LPF) is low residual harmonic current distortion with good voltage regulation. Each is fully described in the following graphs. The LPF is suitable for use with any source impedance (no need to add more reactors to meet a minimum impedance level). Residual distortion and output voltage will both vary with effective source impedance (%Zeff) as shown.



Current Distortion

The chart to the left illustrates the typical current distortion expected at various loading conditions.

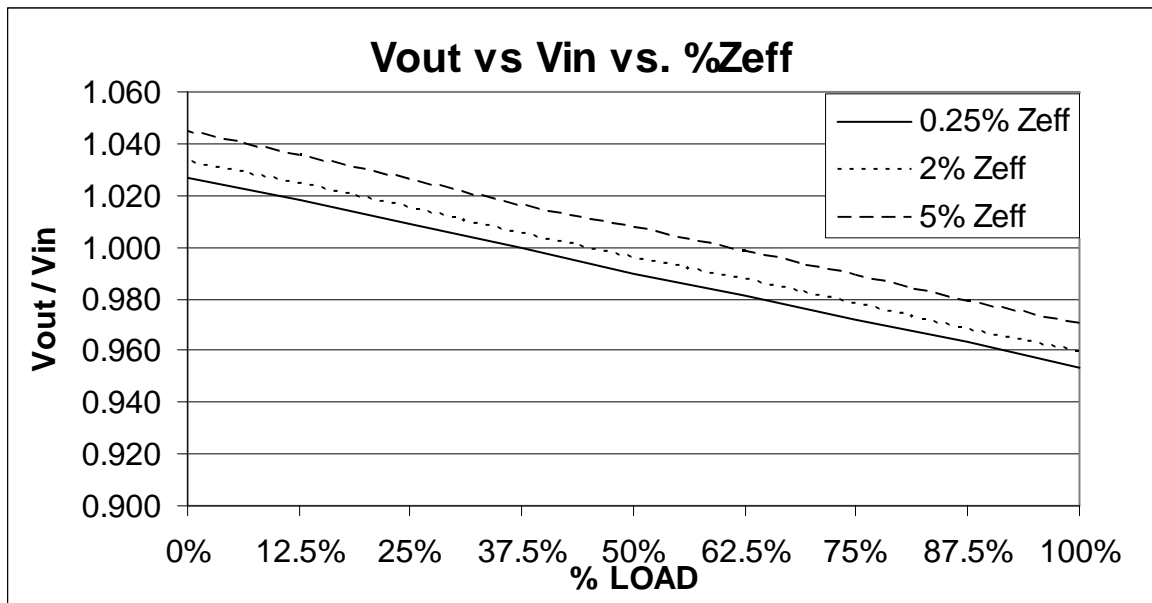
These distortion levels can be achieved with ideal conditions and have been attained in real life applications where supply voltages were balanced and power system voltage distortion was minimal.

Actual distortion may be higher if voltage is unbalanced or distorted, and for applications other than 6-pulse voltage source converters.

Voltage Regulation

TIMES ONE™ Low Pass Harmonic Filters perform with very good regulation of output voltage. The highest output voltage will be experienced at no load conditions, and the lowest output voltage will be at full load.

The typical range of voltage will be within +/- 5% of system voltage. As illustrated in the chart to the right, actual voltage can vary slightly based upon the effective source impedance.



General Specifications: (For use at input to 6-pulse rectifier type VFD or UPS)

System Voltage:	Rated Voltage +/- 10%
System Frequency:	Rated Frequency +/- 1 Hz
Maximum Current:	Rated Current (continuous)
Temporary Overload:	150% x Rated Current (one minute)
Minimum Impedance:	Suitable for use with any source impedance
Harmonic Distortion:	5% Typical Total Harmonic Current Distortion 8% THD-I Guaranteed, 5% TDD Guaranteed.

Selection is easy!

Type LPF filters are suitable for 6-pulse rectified, non-linear loads only. LPF filters are not intended for use with linear loads. Select the appropriate LPF based on your application type.

Variable Torque: (Fans and pumps operated by variable frequency drives)

Determine the total load (horsepower, KW or current) rating. Select the appropriate filter based on either HP, KW or full load current.

Constant Torque: (Non-fan and pump applications)

Determine the maximum current (ampere) requirement. Select the appropriate filter based on the maximum required current in amperes. Example: a 100HP, 124FLA motor drive, to be operated temporarily at 130% over current requires a filter rated for at least 161 amps (proper selection is LPF 125 - 480N1).

Other electrical ratings: Consult factory for other frequency, voltage or current ratings.

SCR Phase Control applications: Consult factory.

Medium Voltage Filters: Consult factory.

Other special requirements: Contact factory.

Optional Enclosure Styles

Choose from a wide variety of industrial enclosure styles including Nema 1, Nema 3R, Nema 12, open panel (chassis) or loose components for your own panel assembly. Type LPF products are available with enclosures that are suitable for either wall mounting or floor standing



Open Panel



Nema 12
Wall
Mount

Nema 1 or 12
Industrial
Enclosure



Nema 1
Floor
Standing



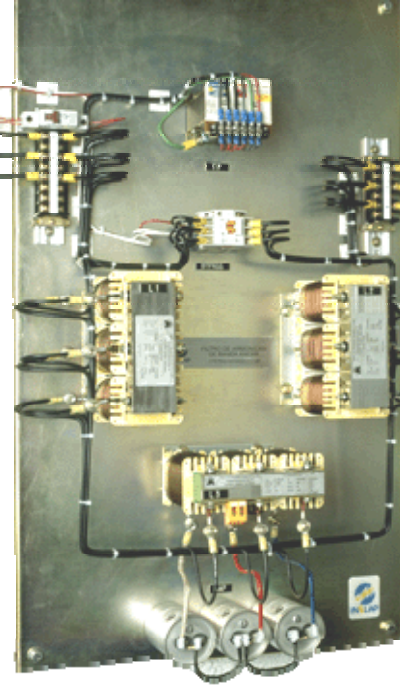
440 - 480 Volt, 60Hz Selection Table

HP	KW	Max Load Amps	Catalog Number	Watts Loss	Efficiency %
2	1.5	4	LPF 2 - 480 N1	80	94.6
4	3	6.6	LPF 4 - 480 N1	131	95.6
5	3.7	8.0	LPF 5 - 480 N1	131	96.5
7.5	5.5	12.8	LPF 7.5 - 480 N1	192	96.5
10	7.5	19	LPF 10 - 480 N1	252	96.6
15	11	24	LPF 15 - 480 N1	283	97.4
20	15	31	LPF 20 - 480 N1	314	97.9
25	18.5	39	LPF 25 - 480 N1	375	97.9
30	22	48	LPF 30 - 480 N1	416	98.1
40	30	61	LPF 40 - 480 N1	458	98.4
50	37	72	LPF 50 - 480 N1	500	98.6
60	45	84	LPF 60 - 480 N1	562	98.7
75	55	102	LPF 75 - 480 N1	645	98.8
100	75	138	LPF 100 - 480 N1	810	98.9
125	93	175	LPF 125 - 480 N1	1005	98.9
150	112	210	LPF 150 - 480 N1	1190	98.9
200	150	286	LPF 200 - 480 N1	1410	99.0
250	186	334	LPF 250 - 480 N1	1520	99.1
300	225	406	LPF 300 - 480 N1	1830	99.1
350	261	478	LPF 350 - 480 N1	2050	99.1
400	300	550	LPF 400 - 480 N1	2380	99.2
450	335	619	LPF 450 - 480 N1	2650	99.2
500	373	667	LPF 500 - 480 N1	2900	99.2

Standard Modifications Available:

- Capacitor cut-out contactor
- Filter bypass system
- VFD & filter combined bypass system
- Hybrid filters with PFC
- Others as required.

Low Pass Harmonic Filter
 with
 Current sensing relay and
 Capacitor cut-out contactor



Open Panel type with current sensing relay and capacitor cut-out contactor.

This version can improve power factor at light load and at no-load conditions. The capacitor cut-out modification utilizes an adjustable current sensing relay to monitor output circuit current and to disconnect the capacitor when output circuit current falls below a pre-set level.

TIMES ONE™ Low Pass Harmonic Filters are supplied with field wiring terminal blocks for easy connection of customer input and output wiring.

208 Volt, 60Hz Selection Table

HP	KW	Max Load Amps	Catalog Number	Watts Loss	Efficiency %
1	.75	5.2	LPF 1 - 208 N1	61	91.8
1.5	1.1	7.8	LPF 1.5 -208 N1	81	92.7
2	1.5	10.3	LPF 2 -208 N1	111	92.6
3	2.2	12.5	LPF 3 -208 N1	111	94.9
4	3	17.7	LPF 4 -208 N1	142	95.2
6	4.5	26	LPF 6 -208 N1	192	95.7
7.5	5.5	34	LPF 7.5 - 080 N1	263	95.2
15	11	52	LPF 15 -208 N1	373	96.6
20	15	69	LPF 20 - 208 N1	367	97.5
25	18.5	86	LPF 25 - 208 N1	459	97.5
30	22	103	LPF 30 - 208N1	500	97.7
35	26	129	LPF 35 - 208N1	577	97.7
45	33	164	LPF 45 - 208 N1	669	97.9
55	41	190	LPF 55 - 208 N1	691	98.3
70	52	242	LPF 70 - 208 N1	824	98.4
90	67	311	LPF 90 - 208 N1	1018	97.0
115	85	388	LPF 115 - 208 N1	1153	98.6
135	100	448	LPF 135 - 208 N1	1287	98.7
190	141	603	LPF 190 - 208 N1	1668	98.8

220 - 240 Volt, 60Hz Selection Table

HP	KW	Max Load Amps	Catalog Number	Watts Loss	Efficiency %
1	.75	4.5	LPF 1 - 240 N1	61	91.8
1.5	1.1	6.9	LPF 1.5 -240 N1	81	92.6
2	1.5	9.1	LPF 2 -240 N1	111	92.6
3	2.2	10.8	LPF 3 -240 N1	111	94.9
5	3.7	15.2	LPF 5 -240 N1	141	96.1
7.5	5.5	22.7	LPF 7.5 -240 N1	192	96.5
10	7.5	30	LPF 10 - 240 N1	262	96.5
15	11	45	LPF 15 -240 N1	372	96.6
20	15	60	LPF 20 - 240 N1	384	97.4
25	18.5	75	LPF 25 - 240 N1	455	97.5
30	22	91	LPF 30 - 240N1	496	97.7
40	30	113	LPF 40 - 240N1	578	98.0
50	37	144	LPF 50 - 240 N1	670	98.1
60	45	166	LPF 60 - 240 N1	692	98.4
75	55	212	LPF 75 - 240 N1	825	98.5
100	75	272	LPF 100 - 240 N1	1010	98.6
120	90	341	LPF 120 - 240 N1	1154	98.7
150	110	394	LPF 150 - 240 N1	1290	98.8
200	150	530	LPF 200 - 240 N1	1670	98.8

Customized filters available:

TIMES ONE™ can customize any harmonic filter to meet your exact needs.

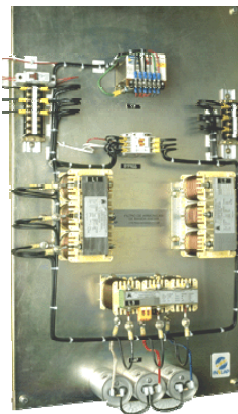
Typical options include power quality meter, filter bypass, capacitor cutout contactor, hybrid filter/power factor system.

380 - 415 Volt, 50Hz Selection Table

HP	KW	Max Load Amps	Catalog Number	Watts Loss	Efficiency %
2	1.5	4	LPF 2 - 400 N1	81	94.6
4	2.2	6.6	LPF 4 - 400 N1	121	94.5
5	3.7	11	LPF 5 - 400 N1	191	94.8
7.5	5.5	14	LPF 7.5 - 400 N1	212	96.1
10	7.5	19	LPF 10 - 400 N1	242	96.7
15	11	24	LPF 15 - 400 N1	303	97.2
20	15	31	LPF 20 - 400 N1	373	97.5
25	18.5	48	LPF 25 - 400 N1	414	97.7
30	22	61	LPF 30 - 400 N1	435	98.0
40	30	72	LPF 40 - 400 N1	526	98.2
50	37	84	LPF 50 - 400 N1	578	98.4
60	45	102	LPF 60 - 400 N1	682	98.4
75	55	138	LPF 75 - 400 N1	815	98.5
100	75	175	LPF 100 - 400 N1	1010	98.6
125	93	210	LPF 125 - 400 N1	1215	98.6
167	125	286	LPF 167 - 400 N1	1404	98.8
200	150	334	LPF 200 - 400 N1	1570	98.9
250	185	406	LPF 250 - 400 N1	1890	98.9
300	225	478	LPF 300 - 400 N1	2060	99.0
350	260	550	LPF 350 - 400 N1	2450	99.0

Standard Modifications Available:

- Capacitor cut-out contactor
- Filter bypass system
- VFD & filter combined bypass system
- Hybrid filters with PFC
- Others as required.



Open Panel type with current sensing relay and capacitor cut-out contactor.

This version can improve power factor at light load and at no-load conditions. The capacitor cut-out modification utilizes an adjustable current sensing relay to monitor output circuit current and to disconnect the capacitor when output circuit current falls below a pre-set level.



Harmonic Mitigation Solutions

That solve harmonic distortion right at the source!



Type of Solution	Harmonic Mitigating Reactor	Tuned 5th Harmonic Filter	Low Pass (Wide Band) Harmonic Filter	Dynamic Harmonic Filter	12 or 18 Pulse Rectifier Conversion Kit	Active Harmonic Filter
Configuration						
Current Waveform						
Harmonic Current Distortion	35% to 45% THD-I	15% to 25% THD-I	5% to 8% THD-I	15% to 25% THD-I	5% to 15% THD-I	5% THD-I
Basic Product Photo						

Comprehensive Solutions for Facility Power Quality Improvement

Facility power quality can degrade as non-linear loads (UPS, VFD, rectifiers, inverters, PCs, etc) are connected to a facility power system. Harmonics from each individual load have a cumulative effect on power system distortion and may cause unwanted interactions between various pieces of power electronic equipment as well as equipment malfunction or failure.

TIMES ONE™ can help you to restore and maintain high quality electrical power within your facility. Based on our analysis of your single line diagrams, power quality data, and your power quality disturbance history, we'll recommend the most economical solution to meet your power quality objectives.

Due to the variety of load types and ratings within a typical facility, the comprehensive approach to power quality generally requires the use of multiple harmonic mitigation technologies. TIMES ONE™ will examine the effects of individual non-linear loads on your overall power system quality and select the ideal technology for each of the major loads. Some loads may need nothing at all, while for other loads we will recommend the best economical solution that will enable us to achieve the desired facility power quality at the lowest cost.

There is no single solution that does it all. That's why TIMES ONE™ offers the most complete range of harmonic mitigation technology, as demonstrated by the chart above. We can apply the right solution at the right location to meet your budget for facility power quality.



TIMES ONE™ - for the right solution to Power Quality!

***Harmonic Filters
Power Factor Improvement
VAR Compensation***

Low, Medium & High Voltage equipment available!



TimesOne™

The Energy Efficiency Company