

Universal Harmonic Filter (UHF)

*Energy Efficient 18-Pulse Performance
from standard 6-Pulse Variable Speed Drives*

Treats all major harmonics generated by Variable Speed Drives and other 3-phase rectifier loads (5th, 7th, 11th, 13th ...)

Easily applied to input of a single VSD
No need to phase shift against other VSD's
No need for costly harmonic studies

Suitable for application on multiple VSD's provided only VSD's are connected

Will meet IEEE 519 standard for both current and voltage distortion

Input current demand distortion < 8% over entire operating range

Power factor 0.98 lagging to 0.95 leading over the normal operating range

Compatible with engine generators since capacitive reactance is < 15% of rated kVA even under light loads

Will not resonate with other power system components or attract line side harmonics

Suppresses overvoltages caused by capacitor switching and other fast changing loads

Eliminates need for drive isolation transformers, AC line reactors and DC link chokes

Removal of harmonics improves overall system power factor

Saves energy by reducing upstream harmonic losses while operating at > 99% efficiency

Reduces RF Interference generated by VSD



The use of Variable Speed Drives and other static power conversion equipment has grown rapidly in recent years. With this growth has come concern over the level of current harmonics generated by such equipment. Harmonic currents and the voltage distortion these currents create can have devastating effects on a power distribution system and its connected equipment.

Present methods of harmonic treatment (line reactors, multi-pulsed systems, tuned or broadband passive filters and active filters) are often unreliable, moderately effective or too costly. The innovative LINEATOR™ is a proven advance in the area of passive harmonic mitigation. No other device on the market can meet the most stringent limits of IEEE STD 519 at an equivalent size and cost. When the application calls for a truly cost effective harmonic solution, the LINEATOR™ is the only logical choice.



Harmonic Treatment for Variable Speed Drives

The front-end rectifiers of 3-phase, 6-pulse static power convertors (AC-DC), such as those found in variable speed drives, are considered non-linear because they draw current in a non-sinusoidal manner. The current harmonics they generate are predominantly the 5th and 7th with 11th, 13th and other higher orders also present but at lower levels.

Power distribution systems that carry a heavy non-linear load component will often experience problems due to excessive harmonic currents. Problems that can arise include:

- Power factor correction capacitor failures
- Overheating cables, transformers and other distribution equipment
- Distortion of the voltage waveform (typically flat-topping) especially when operating on emergency standby generators
- False tripping of circuit breakers
- Premature failure of motors, generators and other rotating equipment
- Misoperation or component failure in PLC's, computers and other sensitive loads

HARMONIC TREATMENT OPTIONS

There are various methods presently available for treatment of VSD harmonics. Each has its advantages and disadvantages but none can achieve the price/performance level of the LINEATOR™.

Reactors and chokes are a relatively low cost solution but are only moderately effective (Table 1) and their high impedance can introduce troublesome voltage drops.

Conventional **tuned or trap filters**, as their name implies, require tuning to a specific harmonic frequency. Their effectiveness is marginal unless multiple tuned elements are incorporated. Also, they are prone to problems such as resonance with other system components, importation of harmonics from upstream non-linear loads and a leading power factor.

By treating a wider spectrum of harmonics, **broad-band filters** are more effective than tuned filters but can also be more expensive. Although they address some of the issues associated with tuned filters, they are not trouble-free. Specifically, their large capacitor banks create a leading power factor which has been known to cause excitation control problems with generators.

In **multi-pulsed systems**, the drive manufacturer will phase shift between multiple front-end rectifiers to cancel harmonics. Some 18 and 24 pulsed systems can achieve Total Harmonic Current Distortion (THID) of < 8%, but they have a larger footprint, lower efficiency and a higher cost.

Phase shifting transformers can be a very cost effective method of harmonic treatment but require multiple 6-pulse rectifier loads operating simultaneously. A quasi 12-pulse scheme (ie. cancellation of 5th & 7th harmonics) can be created by phase shifting one VSD against a second similar VSD. 18 and 24 pulse schemes require three and four VSD's respectively.

Active filters treat harmonics by measuring the level of harmonic current present in the system and injecting currents of opposite polarity to cancel them. Excellent performance can be achieved, but reliability is sometimes an issue. Also, high cost and low efficiencies normally makes their use prohibitive.

The LINEATOR™ will treat all of the major harmonics and achieve results previously only attainable through active filtering or multi-pulse systems 18 or higher. Table 1 shows actual test results comparing the harmonics generated by a 60 HP VSD with various passive harmonic treatments. The LINEATOR™ reduced current distortion by more than 10x and brought the power factor to unity. The net result is essentially a linear load, with harmonics no longer at a level for concern.

Compare Performance !

Table 1: Performance comparison of various passive harmonic treatments.

	6-Pulse Rectifier, PWM VSD	With 3% AC Line Reactor	12-Pulse VSD	With MIRUS LINEATOR™
Input Current Waveform				
Input Current Harmonic Spectrum				
Total Harmonic Current Distortion (THID)	72.9%	35.6%	9.3%	5.8%
Power Factor	0.79 Lag	0.90 Lag	0.98 Lag	0.99 Lag

Advantages of the LINEATOR™ over other Passive Filters

The LINEATOR™ is a purely passive device consisting of a revolutionary new inductor combined with a relatively small capacitor bank. Its innovative design achieves cancellation of all the major harmonic currents (including AM Band RFI) generated by VSD's and other similar 3-phase, 6-pulse rectifier loads. The resulting THID is reduced to < 8% and often as low as 5%. Although referred to as a filter, the LINEATOR™ exhibits none of the problems that plague conventional filters.

HARMONICS FROM OTHER SOURCES

As a parallel connected device, the conventional trap filter has no directional properties. It therefore, can easily be overloaded by attracting harmonics from upstream non-linear loads. The LINEATOR™, on the other hand, will present a high impedance to line side harmonics eliminating the possibility of inadvertent importation and overloading.

SYSTEM RESONANCE

At frequencies below its tuned frequency, a conventional filter will appear capacitive. This capacitance has the potential of resonating with the power systems natural inductance. When a filter is tuned to a higher order harmonic, such as the 11th, it could easily resonate at a lower harmonic frequency, such as the 5th or 7th. *The natural resonance frequency of the LINEATOR™ is below that of any predominant harmonic, therefore inadvertent resonance is avoided.*

LEADING POWER FACTOR

The large capacitor banks in both trap filters and broadband filters present a capacitive reactance to the system, especially under light loads. This can be a beneficial feature where inductive loads require a compensating reactance to improve a low displacement power factor. However, in most VSD applications, displacement power factor is quite high even though overall power factor is low due to the harmonic content. Compensation for inductive loads is not necessary and, in fact, can cause problems especially when supplied by an emergency standby generator. To address this, more sophisticated filters will be equipped with a mechanism for switching out the capacitors under light loads, increasing cost and complexity. Even under no load conditions, the capacitive reactance (KVAR) of the LINEATOR™ remains below 15% of it's kVA rating. This ensures compatibility with engine generators, without the need to switch out capacitors.

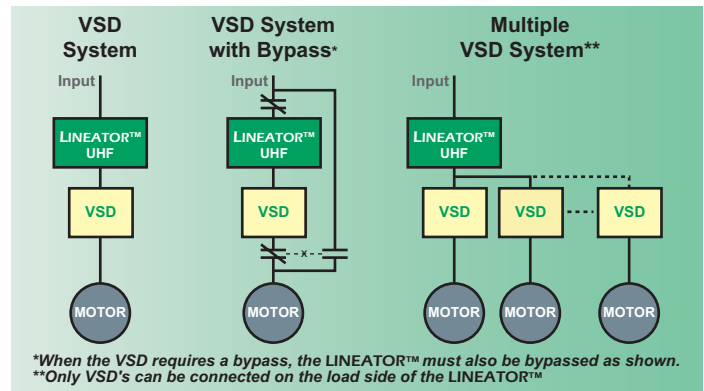


Figure 1: Single line diagrams of VSD systems with the LINEATOR™.

HARMONIC DISTORTION REDUCTION

The filtering effectiveness of a trap filter is dependent upon the amount of harmonics present at untuned frequencies as well as the residual at the tuned frequency. To obtain performance better than 15% THID, multiple tuned branches are often required. Broadband filters claim < 12% THID but require relatively large capacitor banks to achieve this. Even larger capacitors are required if further reduction in THID is desired. **The LINEATOR™ will reduce current distortion to < 8% and often achieves levels near 5% THID at full load.**

Eliminates Need for Drive Isolation Transformers

Poor field experiences have led many engineers to specify drive isolation transformers on every VSD installation. The belief is that by 'isolating' the drive from the supply many power related problems are eliminated. Although the inherent impedance and galvanic isolation of a drive isolation transformer will provide some protection for the drive against power induced problems, such as capacitor switching overvoltages and high frequency noise, it does very little to protect the supply bus from the harmonics generated by the drive. **The high let-through impedance of the LINEATOR™ will provide many of the same benefits as the drive isolation transformer, while also dramatically reducing the harmonics injected into the power system by the drive. It accomplishes this in a much smaller footprint and with improved efficiency. Therefore, the use of the LINEATOR™ will eliminate the need for drive isolation transformers. In addition, any upstream transformer providing voltage transformation will not need a K-factor rating.**



Universal Harmonic Filter (UHF)

General Specifications:

HP / kW rating:

Available for motor/drive system sizes up to 1500HP / 1100kW

Voltage:

Standard voltages up to 600V

Frequency:

60Hz (50Hz available)

Overload Capability:

Suitable for overload of 150% for 60 seconds every 10 minutes

Harmonics Treated:

5th, 7th, 11th, 13th,...

K-Factor Suitability:

Up to 20

Input K-Factor:

Reduced to < 1.5

Input Current Distortion:

< 8% at full load

Efficiency:

> 99%

Ventilation:

Convection air cooled

Winding Material:

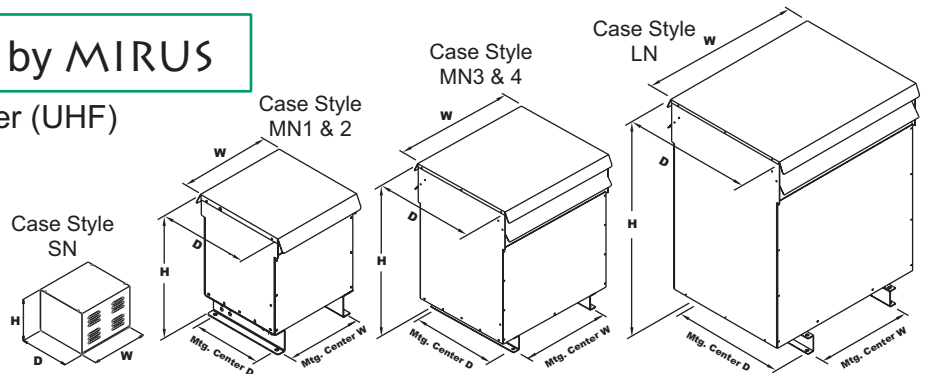
Copper

Enclosure:

NEMA 2 Grey (5 to 20HP)
NEMA 3R Grey (25 to 1500HP)

Options:

Nema 3R Enhanced (25 to 1500HP)
Wall Mtg. Kit: (5 to 125HP)



Case Style	H in.[mm]	W in.[mm]	D in.[mm]	Mtg. Hole Center W	Mtg. Hole Center D
SN2	12.00 [305]	14.00 [356]	14.00 [356]	10.00 [254]	10.50 [267]
MN1	22.00 [559]	16.75 [425]	15.00 [381]	13.75 [349]	13.00 [330]
MN2	29.00 [737]	21.50 [546]	19.50 [495]	17.00 [432]	17.50 [445]
MN3	38.00 [965]	26.00 [661]	21.00 [534]	21.50 [546]	19.00 [483]
MN4	41.00 [1041]	32.00 [813]	25.50 [648]	23.50 [597]	23.50 [597]
LN1	51.50 [1308]	39.50 [1003]	30.00 [762]	24.00 [610]	32.00 [813]
LN2	59.00 [1499]	48.50 [1232]	34.00 [864]	27.50 [699]	36.00 [915]
LN3	66.00 [1677]	51.50 [1308]	39.00 [991]	34.00 [864]	41.00 [1042]
LN6	70.00 [1778]	64.00 [1626]	40.00 [1016]	40.00 [1016]	42.00 [1067]

Motor Size	Lineator Rating		Losses	Enclosed		Open Style			
	HP	kW		Case Style	Weight*	Dimensions*	Weight*		
5	4	7	5	7.5	120	SN2	55 [25]	10.5 x 11 x 5	35 [16]
7.5	5.5	10	8	11	180	SN2	70 [32]	10.5 x 11 x 5.4	52 [24]
10	7.5	13	10	14	200	SN2	85 [38]	10.5 x 11 x 5.6	64 [29]
15	11	19	15	20	250	SN2	116 [52]	10.5 x 11 x 7	92 [42]
20	15	25	20	27	280	SN2	124 [56]	10.5 x 11 x 7.6	100 [45]
25	18.5	32	25	34	345	MN1	176 [80]	10.5 x 11 x 8	120 [54]
30	22	38	30	40	365	MN1	220 [100]	15 x 15.5 x 16	160 [73]
40	30	50	40	51	450	MN1	275 [125]	15 x 15.5 x 16	210 [95]
50	37.5	63	50	63	525	MN2	319 [145]	15 x 20 x 19.5	226 [103]
60	45	75	60	75	565	MN2	345 [157]	17 x 20 x 19.5	250 [113]
75	55	88	70	93	630	MN2	477 [217]	19 x 20 x 17.5	370 [168]
100	75	113	90	118	710	MN2	587 [266]	20 x 20 x 17.5	470 [213]
125	90	144	115	145	850	MN2	681 [286]	20 x 20 x 20	510 [231]
150	110	170	135	175	1100	MN3	743 [337]	23 x 25 x 19	560 [254]
200	150	225	180	220	1310	MN3	842 [382]	23 x 25 x 22	650 [295]
250	185	282	225	275	1650	MN4	1084 [491]	24 x 26 x 24	860 [390]
300	200	340	270	330	1960	MN4	1238 [561]	25 x 26 x 24	1000 [454]
350	250	397	320	385	2470	MN4	1502 [681]	27 x 26 x 24	1240 [562]
400	315	453	365	440	2775	LN1	1760 [798]	29 x 26 x 25	1350 [612]
500	400	565	455	550	3615	LN1	1925 [873]	32 x 26 x 25	1500 [680]
600	450	695	560	660	4620	LN2	2200 [953]	37 x 35 x 27	1800 [817]
700	500	800	640	770	5725	LN2	2600 [1180]	39 x 43 x 28	2300 [1043]
800	560	910	730	880	6600	LN2	3000 [1361]	39 x 44 x 30	2700 [1225]
900	630	1018	815	990	7425	LN3	3200 [1452]	40 x 46 x 30	2850 [1293]
1000	710	1130	905	1100	8150	LN3	3400 [1542]	40 x 48 x 30	3050 [1383]
1100	800	1300	1040	1210	9210	LN6	3650 [1656]	50 x 48 x 36	3300 [1497]
1200	900	1420	1135	1320	10380	LN6	3800 [1724]	50 x 52 x 36	3400 [1542]
1300	970	1500	1200	1430	10740	LN6	4050 [1837]	50 x 52 x 36	3650 [1656]
1400	1000	1610	1270	1540	11000	LN6	4350 [1973]	50 x 58 x 38	3950 [1792]
1500	1120	1725	1330	1650	11490	LN6	4600 [2087]	50 x 58 x 38	4200 [1905]

* Approximate Values

Product Code:

UHF - HP - VVV - Hz - Dn - En - O

Motor Horsepower
5 to 1500 HP

Frequency
50 or 60 Hz

Enclosure

E0 = No Enclosure
E1 = Nema 2 (5 to 20HP)
Nema 3R Ventilated (25 to 1500HP)

Line Voltage
All standard voltages up to 600 VAC

Load Type
D0 = Diode Bridge Rectifier
DL = DBR with AC Line Reactor
DD = DBR with DC Choke

Optional

E = Nema 3R Enhanced (25 to 1500HP)
W = Enclosure Wall Mtg. Kit (5 to 125HP)



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6805 Invader Cres., Unit #12
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Canada L5T 2K6

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Email: mirus@mirusinternational.com
Website: www.mirusinternational.com



UHF-PS01-C1
Effective: May 2003

PART 1 - GENERAL

- 1.1 All PWM AC Variable Frequency Drives of [30] hp and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of harmonic distortion.**
- .1 The harmonic mitigation equipment and all of its components shall be manufactured and tested in accordance with the latest applicable standards of UL, CSA and NEMA.
 - .2 Demonstration of compatibility between the harmonic mitigation equipment and the VFD must be available upon request.
 - .3 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a period of 12 months from the date of start-up or 18 months from the date of shipment.
 - .4 Factory Performance Testing: Manufacturer must be capable of factory testing for harmonic mitigating performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of quotation.
 - .5 Subject to compliance with all of the contract documents and specifications, the acceptable product and manufacturer is: LINEATOR™ UHF, by MIRUS International Inc. (905) 565-6900, Toll Free: (888) 866-4787

PART 2 - PRODUCT**2.1 Key Requirements:**

- .1 The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.).
- .2 The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
- .3 Harmonic mitigation shall be by passive inductor/capacitor network. Active electronic components shall not be used.
- .4 Power factor shall be .98 lagging to .95 leading in operating range from full to half load.
- .5 To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR), which is greater than 15% of its kVA rating.
- .6 The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
- .7 The harmonic mitigation equipment in combination with the Variable Frequency Drive shall meet all requirements as outlined in the 1992 edition of IEEE std 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals to the harmonic mitigation equipment.
- .8 Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE std 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
- .9 Total Demand Distortion (TDD) of the current at the input terminals of the harmonic mitigation equipment shall not exceed the limits as defined in Table 10.3 of IEEE std 519. For Isc/IL ratio < 20, TDD must be less than 5%. For all other Isc/IL ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits. For single-phase applications, the TDD must not exceed 12%.
- .10 The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.

2.2 Basic Requirements:

- .1 All wiring shall be copper.
- .2 Insulation class: 220°C system. Temperature rise: 130°C
- .3 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.
- .4 Ventilated, sprinkler proof NEMA-3R enclosure.

2.3 Other Requirements:

- .1 [OPTION] Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

PART 3 - EXECUTION**3.1 Installation**

- .1 The harmonic mitigation equipment shall be handled, stored and installed in accordance with the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual. Installation shall comply with all applicable codes.

3.2 Acceptance

- .1 [OPTION] Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.

GENERAL SPECIFICATIONS:

HP / kW RATING

Available for motor/drive system sizes up to 1500HP / 1100kW

VOLTAGE

Standard voltages up to 600V

FREQUENCY

60Hz (50Hz available)

OVERLOAD CAPABILITY

Suitable for overload of 150% for 60 seconds every 10 minutes

HARMONICS TREATED

5th, 7th, 11th, 13th, ...

K-FACTOR SUITABILITY

Up to 20

INPUT K-FACTOR

Reduced to <1.5

INPUT CURRENT DISTORTION

< 8% @ Full Load

EFFICIENCY

> 99% @ Full Load

ELEVATION

≤ 3300ft [1000m] above sea level

VENTILATION

Convection air cooled

WINDING MATERIAL

Copper

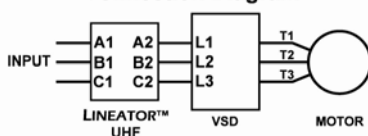
ENCLOSURE

Type: NEMA-2 (5 to 20HP)
NEMA-3R (25 to 1500HP)
Paint: Polyester powder coated
Colour: ANSI 61 Grey, [Orange]

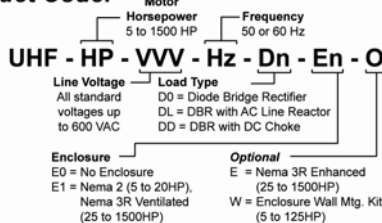
OPTIONS:

Nema 3R Enhanced (25 to 1500HP)
Wall Mtg. Kit: (5 to 125HP)

Connection Diagram

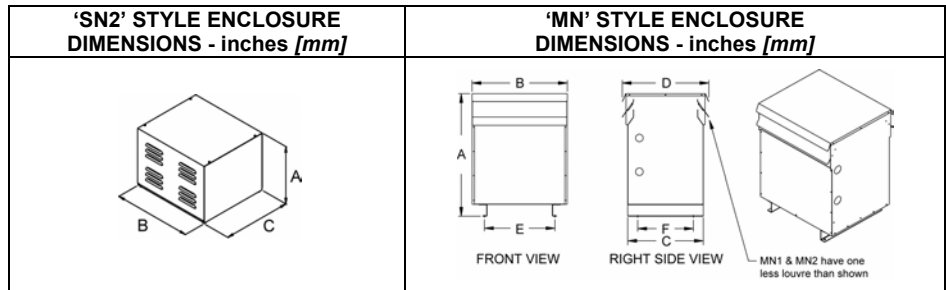


Product Code:



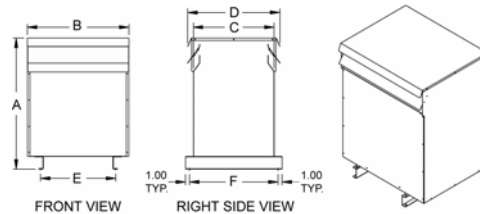
Notes:

- Estimated Values.
- For additional information refer to: Typical Specifications, Internal Layout and Connection Diagrams.
- For larger sizes and other enclosure types contact Mirus.
- Specifications are subject to change without notice.



CASE STYLE	A	B	C	D	E	F
SN2	12.00 [305]	14.00 [356]	14.00 [356]	n/a	n/a	n/a
MN1	22.00 [559]	16.75 [425]	15.00 [381]	19.00 [483]	13.75 [349]	13.00 [330]
MN2	29.00 [737]	21.50 [546]	19.50 [495]	23.50 [597]	17.00 [432]	17.50 [445]
MN3	38.00 [965]	26.00 [661]	21.00 [534]	25.00 [635]	21.50 [546]	19.00 [483]
MN4	41.00 [1041]	32.00 [813]	25.50 [648]	29.50 [749]	23.50 [597]	23.50 [597]

'LN' STYLE ENCLOSURE DIMENSIONS - inches [mm]



CASE STYLE	A	B	C	D	E	F
LN1	51.50 [1308]	39.50 [1003]	30.00 [762]	34.00 [864]	24.00 [610]	32.00 [813]
LN2	59.00 [1499]	48.50 [1232]	34.00 [864]	38.00 [965]	27.50 [699]	36.00 [915]
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LN6	70.00 [1778]	64.00 [1626]	40.00 [1016]	44.00 [1118]	40.00 [1016]	42.00 [1067]

Motor Size		Lineator Rating			Losses	Enclosed		Open Style	
HP	kW	Input Amps 480V 3Ph/60Hz	600V 3Ph/60Hz	Output kVA	Full Load Watts ^[1]	Case Style	Weight lb [kg] ^[1]	Dim. H"xW"xD" ^[1]	Weight lb [kg] ^[1]
5	4	7	5	7.5	120	SN2	55 [25]	10.5x11x5	35 [16]
7.5	5.5	10	8	11	180	SN2	72 [32]	10.5x11x5.4	52 [24]
10	7.5	13	10	14	200	SN2	85 [38]	10.5x11x5.6	64 [29]
15	11	19	15	20	250	SN2	116 [52]	10.5x11x7	92 [42]
20	15	25	20	27	280	SN2	124 [56]	10.5x11x7.6	100 [45]
25	18.5	32	25	34	345	MN1	176 [80]	10.5x11x8	120 [54]
30	22	38	30	40	365	MN1	220 [100]	15x15.5x16	160 [73]
40	30	50	40	51	450	MN1	275 [125]	15x15.5x16	210 [95]
50	37.5	63	50	63	525	MN2	319 [145]	15x20x19.5	226 [103]
60	45	75	60	75	565	MN2	345 [157]	17x20x19.5	250 [113]
75	55	88	70	93	630	MN2	477 [217]	19x20x17.5	370 [168]
100	75	113	90	118	710	MN2	587 [266]	20x20x17.5	470 [213]
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400	315	453	365	440	2775	LN1	1760 [798]	29x26x25	1350 [612]
500	400	565	455	550	3615	LN1	1925 [873]	32x26x25	1500 [680]
600	450	695	560	660	4620	LN2	2200 [953]	37x35x27	1800 [817]
700	500	800	640	770	5725	LN2	2600 [1180]	39x43x28	2300 [1043]
800	560	910	730	880	6600	LN2	3000 [1361]	39x44x30	2700 [1225]
900	630	1018	815	990	7425	LN3	3200 [1452]	40x46x30	2850 [1293]
1000	710	1130	905	1100	8150	LN3	3400 [1542]	40x48x30	3050 [1383]
1100	800	1300	1040	1210	9210	LN6	3650 [1656]	50x48x36	3300 [1497]
1200	900	1420	1135	1320	10380	LN6	3800 [1724]	50x52x36	3400 [1542]
1300	970	1500	1200	1430	10740	LN6	4050 [1837]	50x52x36	3650 [1656]
1400	1000	1610	1270	1540	11000	LN6	4350 [1973]	50x58x38	3950 [1792]
1500	1120	1725	1330	1650	11490	LN6	4600 [2087]	50x58x38	4200 [1905]



PART 1 - GENERAL

- 1.1 All PWM AC Variable Frequency Drives of [30] hp and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of harmonic distortion.**
- .1 The harmonic mitigation equipment and all of its components shall be manufactured and tested in accordance with the latest applicable standards of UL, CSA and NEMA.
 - .2 Demonstration of compatibility between the harmonic mitigation equipment and the VFD must be available upon request.
 - .3 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a period of 12 months from the date of startup or 18 months from the date of shipment.
 - .4 Factory Performance Testing: Manufacturer must be capable of factory testing for harmonic mitigating performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of quotation.
 - .5 Subject to compliance with all of the contract documents and specifications, the following manufacturers and products are acceptable:
 - .1 MIRUS International Inc. LINEATOR™ Universal Harmonic Filter
 - .2 18 pulse configuration in: Toshiba, Robicon Clean Power Series, Cutler Hammer CP9000, ABB

PART 2 - PRODUCT**2.1 Key Requirements:**

- .1 The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.).
- .2 The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
- .3 Harmonic mitigation shall be by passive inductor/capacitor network or internal phase shifting transformer. Active electronic components shall not be used.
- .4 Power factor shall be .98 lagging to .95 leading in operating range from full to half load.
- .5 To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR) which is greater than 15% of its kVA rating.
- .6 The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
- .7 The harmonic mitigation equipment in combination with the Variable Frequency Drive shall meet all requirements as outlined in the 1992 edition of IEEE std 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals to the harmonic mitigation equipment.
- .8 Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE std 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
- .9 Total Demand Distortion (TDD) of the current at the input terminals of the harmonic mitigation equipment shall not exceed the limits as defined in Table 10.3 of IEEE std 519. For Isc/IL ratio < 20, TDD must be less than 5%. For all other Isc/IL ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits. For single-phase applications, the TDD must not exceed 12%.
- .10 The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.

2.2 Basic Requirements:

- .1 All wiring shall be copper.
- .2 Insulation class: 220°C system. Temperature rise: 130°C
- .3 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.
- .4 Ventilated, sprinkler proof NEMA-3R enclosure.

2.3 Other Requirements:

- .1 [OPTION] Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

PART 3 - EXECUTION**3.1 Installation**

- .1 The harmonic mitigation equipment shall be handled, stored and installed in accordance with the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual. Installation shall comply with all applicable codes.

3.2 Acceptance

- .1 [Option] Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.

LINEATOR™

Single Phase Universal Harmonic Filter (SUHF)
(Patent Pending)

1 Q 3™

Standard 3-phase Variable Frequency Drives are often used as phase converters to supply 3-phase motors when only 1-phase power is available on remote locations such as farms, golf courses, oil and gas fields and residential areas for water and waste water systems.

The Lineator-1Q3™ has been designed to address this application by accepting 1-phase input and supplying a quasi 3-phase supply to the VFD. This will significantly lower both input harmonic current distortion (by up to 10x) and DC ripple current within the VFD. Reducing the ripple current allows for less derating of the VFD which, in many cases, will offset the cost of the Lineator-1Q3™.

The only passive harmonic filter for 3-phase VFD's operating on 1-phase supply

Treats all major harmonics generated by 3-phase Variable Frequency Drives when fed by 1-phase power (3rd, 5th, 7th, 9th, 11th, 13th ...)

Easily applied at the VFD input

10x reduction in DC ripple current lowers the need to derate VFD (1 size instead of 2x)

Helps meet IEEE 519 standard for both current and voltage distortion

Input current demand distortion < 12% over entire operating range (10x reduction)

Compatible with engine generators since capacitive reactance is < 20% of rated kVA even under light loads

Will not resonate with other power system components or attract line side harmonics

Suppresses overvoltages caused by capacitor switching and other fast changing loads



General Specifications:

HP / KW RATING

Available for motor/drive system sizes up to 150HP / 110kW

VOLTAGE

Standard voltages up to 600V

FREQUENCY

60Hz (50Hz available)

HARMONICS TREATED

3rd, 5th, 7th, 9th, 11th, 13th,...

K-FACTOR SUITABILITY

Up to 20

INPUT K-FACTOR

Reduced to < 1.5

INPUT CURRENT DISTORTION

< 12% @ Full Load

EFFICIENCY

> 99%

ELEVATION

≤ 3300ft [1000m] above sea level

VENTILATION

Convection air cooled

WINDING MATERIAL

Copper

ENCLOSURE

NEMA 2 Grey (5 to 20HP)

NEMA 3R Grey (25 to 150HP)

OPTIONS

Nema 3R Enhanced (25 to 150HP)

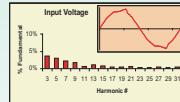
Wall Mtg. Kit: (5 to 125HP)

Harmonic Treatment and Cost Savings

Typical Application

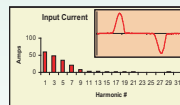


- Excess ripple current requires drive derating of 2x



V_{thd} = 5.8%

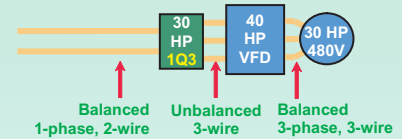
at input of VFD



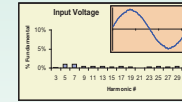
I_{thd} = 109%

- Estimated cost of 60HP VFD = \$ 4,650

Application with Lineator-1Q3™

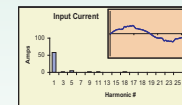


- Reduced ripple current allows for only 1 size derating



V_{thd} = 2.0%

at input of 1Q3



I_{thd} = 9.8%

- Estimated cost of 30HP 1Q3 \$ 1,866

40HP VFD \$ 2,390

Total \$ 4,256

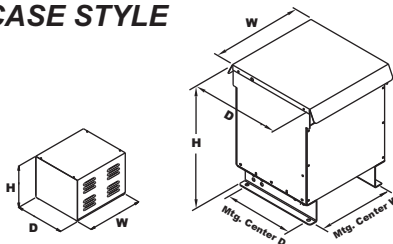
ORDERING INFORMATION

Model	Motor Horsepower	Line Voltage	Frequency	Load Type	Enclosure Type	Optional
SUHF - HP - VVV - Hz - Dn - En - O						
Single Phase	5	240	60	D0	E0	E
Universal	to	480		Diode Bridge Rectifier	No Enclosure	Nema 3R Enhanced
Harmonic Filter	150	600 (VAC)		DL DBR with AC Line Reactor DD DBR with DC Choke	E1 Nema 2 (5 to 20HP) Nema 3R Ventilated (25 to 150HP)	(25 to 150HP) W Enclosure Wall Mtg. Kit (5 to 125HP)

TECHNICAL DATA

Motor Size	Lineator Rating					Losses Full Load Watts*	Enclosed		Open Style	
	HP	kW	Input Amps (3ph/60Hz) 240VAC	480VAC	600VAC		Case Style	Weight* lbs [kg]	Dimensions* H" x W" x D"	Weight* lbs [kg]
5	4	23	12	9	7.5	120	SN2	45 [21]	10 x 11 x 10	35 [16]
7.5	5.5	33	17	13	11	180	SN2	55 [25]	10 x 11 x 10.5	45 [20]
10	7.5	45	23	18	14	200	SN2	70 [32]	10 x 11 x 10.5	60 [27]
15	11	68	34	26	20	250	SN2	90 [41]	10 x 11 x 12	80 [36]
20	15	90	45	35	27	280	MN1	145 [66]	10 x 11 x 14	105 [48]
25	18.5	111	56	44	34	345	MN1	165 [75]	11 x 15 x 15	125 [57]
30	22	137	68	52	40	365	MN1	215 [98]	12 x 15 x 17	175 [79]
40	30	180	90	70	51	450	MN2	285 [129]	13 x 20 x 18	225 [102]
50	37.5	202	110	87	63	525	MN2	315 [143]	15 x 20 x 19	255 [116]
60	45	255	130	105	75	565	MN2	335 [152]	18 x 20 x 19	275 [125]
75	55	300	152	130	93	630	MN2	375 [170]	19 x 20 x 20	315 [143]
100	75	420	210	175	118	710	MN2	435 [197]	20 x 20 x 20	375 [170]
125	90	520	260	220	145	850	MN3	515 [234]	21 x 25 x 21	455 [206]
150	110	590	295	260	175	1100	MN3	575 [261]	21 x 25 x 22	505 [229]

CASE STYLE



DIMENSIONS

Case Style	H in.[mm]	W in.[mm]	D in.[mm]	Mtg. Hole Center W	Mtg. Hole Center D
SN2	12.00 [305]	14.00 [356]	14.00 [356]	10.00 [254]	10.50 [267]
MN1	22.00 [559]	16.75 [425]	15.00 [381]	13.75 [349]	13.00 [330]
MN2	29.00 [737]	21.50 [546]	19.50 [495]	17.00 [432]	17.50 [445]



* Approximate Values

MIRUS International Inc.
6805 Invader Cres., Unit #12
Mississauga, Ontario
Canada L5T 2K6

Tel:(905) 565-6900 Fax:(905) 565-6911
Toll Free: 1-888-TO MIRUS
Email: mirus@mirusinternational.com
Website: www.mirusinternational.com



SUHF-PS01-A
Effective: March 2004

PART 1 - GENERAL**1.1 Single phase to quasi 3-phase harmonic filter for 3-phase PWM AC Variable Frequency Drives being supplied with single phase voltage.**

- .1 The harmonic mitigation equipment and all of its components shall be manufactured and tested in accordance with the latest applicable standards of UL, CSA and NEMA.
- .2 Demonstration of compatibility between the harmonic mitigation equipment and the VFD must be available upon request.
- .3 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a period of 12 months from the date of start-up or 18 months from the date of shipment.
- .4 Factory Performance Testing: Manufacturer must be capable of factory testing for harmonic mitigating performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of quotation.
- .5 Subject to compliance with all of the contract documents and specifications, the acceptable product and manufacturer is: LINEATOR-1Q3™ SUHF, by MIRUS International Inc. (905) 565-6900, Toll Free: (888) 866-4787

PART 2 - PRODUCT**2.1 Key Requirements:**

- .1 The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load when supplied with single phase voltage (3rd, 5th, 7th, 9th, 11th, 13th, etc.). Total Harmonic Current Distortion shall be reduced by more than 10x when compared to a VFD without harmonic treatment and shall be less than 12% when measured at the input terminals of the harmonic mitigation equipment under full load operation.
- .2 The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
- .3 Harmonic mitigation shall be by passive inductor/capacitor network. Active electronic components shall not be used.
- .4 Power factor shall be .98 lagging to .95 leading in operating range from full to half load.
- .5 To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR), which is greater than 20% of its kVA rating.
- .6 The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
- .7 The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.

2.2 Basic Requirements:

- .1 All wiring shall be copper.
- .2 Insulation class: 220°C system. Temperature rise: 130°C
- .3 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.
- .4 Ventilated, sprinkler proof NEMA-3R enclosure.

2.3 Other Requirements:

- .1 [OPTION] Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

PART 3 - EXECUTION**3.1 Installation**

- .1 The harmonic mitigation equipment shall be handled, stored and installed in accordance with the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual. Installation shall comply with all applicable codes.

3.2 Acceptance

- .1 [OPTION] Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.

GENERAL SPECIFICATIONS:

HP / kW RATING

Available for motor/drive system sizes up to 150HP / 110kW

VOLTAGE

Standard voltages up to 600V

FREQUENCY

60Hz (50Hz available)

HARMONICS TREATED

3th, 5th, 7th, 9th, 11th, 13th, ...

K-FACTOR SUITABILITY

Up to 20

INPUT K-FACTOR

Reduced to <1.5

INPUT CURRENT DISTORTION

<12% @ Full Load

EFFICIENCY

> 99% @ Full Load

ELEVATION

≤ 3300ft [1000m] above sea level

VENTILATION

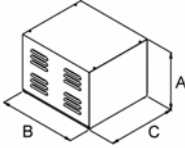
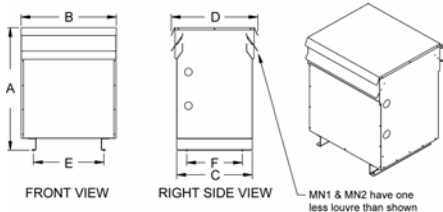
Convection air cooled

WINDING MATERIAL

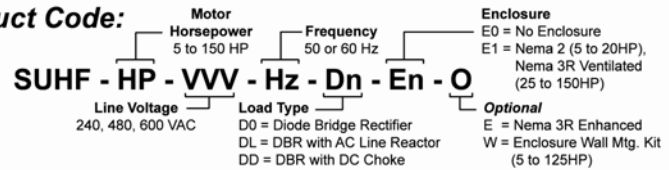
Copper

ENCLOSURE

Type: NEMA-2 (5 to 20HP)
NEMA-3R (25 to 150HP)
Paint: Polyester powder coated
Colour: ANSI 61 Grey, [Orange]

'SN2' STYLE ENCLOSURE DIMENSIONS - inches [mm]		'MN' STYLE ENCLOSURE DIMENSIONS - inches [mm]				
						
CASE STYLE	A	B	C	D	E	F
SN2	12.00 [305]	14.00 [356]	14.00 [356]	n/a	n/a	n/a
MN1	22.00 [559]	16.75 [425]	15.00 [381]	19.00 [483]	13.75 [349]	13.00 [330]
MN2	29.00 [737]	21.50 [546]	19.50 [495]	23.50 [597]	17.00 [432]	17.50 [445]
MN3	38.00 [965]	26.00 [661]	21.00 [534]	25.00 [635]	21.50 [546]	19.00 [483]

Product Code:



OPTIONS:

Nema 3R Enhanced (25 to 150HP)
Wall Mtg. Kit: (5 to 125HP)

Motor Size		Lineator-1Q3™ Rating				Losses	Enclosed		Open Style	
HP	kW	Input Amps			Output kVA	Full Load Watts ^[1]	Case Style	Weight lb [kg] ^[1]	Dim. H"xW"xD" ^[1]	Weight lb [kg] ^[1]
		240V 1Ph/60Hz	480V 1Ph/60Hz	600V 1Ph/60Hz						
5	4	23	12	9	7.5	120	SN2	45 [21]	10x11x10	35 [16]
7.5	5.5	33	17	13	11	180	SN2	55 [25]	10x11x10.5	45 [20]
10	7.5	45	23	18	14	200	SN2	70 [32]	10x11x10.5	60 [27]
15	11	68	34	26	20	250	SN2	90 [41]	10x11x12	80 [36]
20	15	90	45	35	27	280	MN1	145 [66]	10x11x14	105 [48]
25	18.5	111	56	44	34	345	MN1	165 [75]	11x15x15	125 [57]
30	22	137	68	52	40	365	MN1	215 [98]	12x15x17	175 [79]
40	30	180	90	70	51	450	MN2	285 [129]	13x20x18	225 [102]
50	37.5	202	110	87	63	525	MN2	315 [143]	15x20x19	255 [116]
60	45	255	130	105	75	565	MN2	335 [152]	18x20x19	275 [125]
75	55	300	152	130	93	630	MN2	375 [170]	19x20x20	315 [143]
100	75	420	210	175	118	710	MN2	435 [197]	20x20x20	375 [170]
125	90	520	260	220	145	850	MN3	515 [234]	21x25x21	455 [206]
150	110	590	295	260	175	1100	MN3	575 [261]	21x25x22	505 [229]

Notes:

1. Estimated Values.
2. For additional information refer to: Typical Specifications, Internal Layout and Connection Diagrams.
3. For larger sizes and other enclosure types contact Mirus.
4. Specifications are subject to change without notice.

