



**DRIVE CENTRE**   
Industrial Automation Systems Integrators

57 Galaxy Blvd., Units 1 & 2, Toronto, ON M9W 5P1  
TEL: (416) 231-6767  
[www.drivecentre.ca](http://www.drivecentre.ca)

**MOS**  
Marine and Offshore Specific

# LINEATOR™

Advanced Universal Harmonic Filter



# Power Quality



## World leader in harmonic mitigation

Mirus International Inc. is the leading authority on harmonic mitigation and provides cost effective solutions for treating harmonic distortion on Marine Vessels. For over 15 years Mirus has been supplying to the marine and offshore industries with its globally recognized Lineator wide spectrum passive filter. With many thousands of Lineators operating around the world in sizes ranging from 5HP up to 3500HP (4kW to 2600kW but larger size available), there's no doubt why customers have chosen Mirus, a leading authority on harmonics, to source one of the most advanced and effective methods to mitigate harmonics.

## Approvals & Certification

Mirus International Inc. production facilities are fully audited and certified by the major classification societies. Our Lineator wide spectrum filter is ABS Type Approved and has been certified by many leading marine classification societies worldwide including LR and DNVGL.

## Marine

Since the advent of the Variable Speed Drive (VSD) many vessel and ship operators have benefited from the functionality, accuracy and energy efficiency they provide. With all the benefits VSD systems deliver, they are becoming more widely used, and as a result, many vessels and ships are experiencing more power quality issues than ever before.

Marine vessels use DC SCR drives as well as AC Variable Speed Drives on a diverse number of applications including thrusters, main propulsion drives, cranes, compressors, pumps, winches and conveyers on SUL vessels. Both can lead to electrical system problems if they are not applied correctly. The most common issues experienced with DC drives are harmonic distortion, line notching, voltage spikes and low generator displacement power factor. When using AC VSD's the primary problems observed are with relation to harmonic voltage distortion and common mode voltage (i.e. the VSD carrier frequency superimposed on the phase to ground voltages if the VSDs are not installed in strict compliance with EMC recommendations).



## Offshore

Offshore drilling and oil production platforms are now completely reliant on both DC SCR drives and AC VSDs for their operations. They are primarily used in applications such as mud pumps, draw-works, top drives, electrical submersible pumps (ESP), table drive and dynamic positioning thrusters. Common issues with Offshore electrical systems are very similar to that of the Marine systems. If not addressed they can lead to serious consequences.

## Power Quality Issues

In all marine and offshore sectors which utilize adjustable speed drives, power quality of the electrical system has become a very serious concern. Many installations have experienced issues due to VSDs as well as line notching and voltage spikes introduced by DC SCR drives. On weak AC power systems supplied by generators, the harmonic voltage distortion can be up to FOUR times that encountered on shore side utility systems with similar harmonic loading.

## Harmonics

In many cases, up to 85% of the load on a marine vessel or an offshore process are non-linear. This is mainly due to the existence of several variable speed drives which results in a Total Harmonic Voltage Distortion (THDv/THDu) of greater than 30% (even if AC reactors of 3% are installed). All VSD's come equipped with semiconductor rectifiers which draw current in a non-linear fashion causing harmonic distortion. The presence of current harmonics creates many issues in the electrical system of a marine vessel. The most common issues being excessive heating caused by additional  $I^2R$  losses, eddy current losses, skin effect, etc. in cables and equipment (e.g. generators, transformers and motors). Even more serious is the misoperation or failure of susceptible equipment due to voltage distortion resulting from the various frequency harmonic currents passing through the system impedance and leakage inductances.

## Meeting Safety Requirements

It is best practice and fundamentally important for the reliability, operational integrity and Safety Of Life At Sea (SOLAS) that engineers design the electrical systems for marine and offshore applications to include equipment to control harmonics.

# MOS Lineator



## The Mirus Lineator Advantage

The Mirus Lineator wide spectrum passive harmonic filter, a well proven method of mitigation in offshore and marine environments, still remains the best technical solution to treat harmonics. It not only addresses all requirements to meet full compliance of certifying body harmonic distortion 'rules' worldwide, it is guaranteed to outperform all other passive and active solutions. The Lineator is now available in a hardened version specifically designed for severe marine and offshore applications.

## Lineator can be maintained 'on the run'

The Marine & Offshore Specific Lineator can be optionally configured for service and maintenance of the capacitors without powering down the reactor. A circuit breaker isolates the capacitor bank which is compartmentalized for safe access by qualified electrical staff. The system can temporarily operate on the reactor alone with reduced harmonic mitigation. This eliminates operational shut-downs thus ensuring your main propulsion, drilling operation and production is always up and running.

*Note that even with all capacitors disconnected, the performance of the Lineator reactor alone will be as good as a 12 pulse system so it "will get you home" every time.*

## Marine & Offshore Specific Construction

- Fortified IP rated enclosure built for 'real world' marine environments.
- Ambient ratings through 45°C nominal
- Two-part Marine grade powder coat
- Galvanneal paneling
- Tin plated terminals
- Internal bracing for vibration and shock resistance
- Stainless steel hardware
- Conformal coating on capacitors and electronic components for humidity resistance and corrosion protection

## Features and benefits

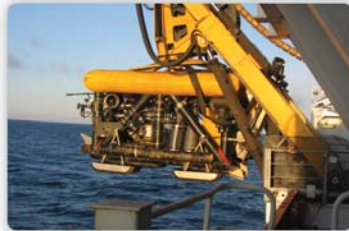
- High Performance Lineator Model achieves <5% I<sub>thd</sub> (THDi) at rated load
- Overvoltage and overcurrent detection
- Capacitor monitoring
- Condition based monitoring with automatic capacitor disconnect
- Voltage and current waveform sampling
- Programmable alarm setpoints
- Web based access via browser
- Assignable digital inputs and relay outputs
- Temperature thermocouple monitoring

## Options

- IP23 [Nema 3R], IP24, IP25, IP44 or IP45 Enclosure
  - Second meter for harmonic mitigation performance and power measurements
  - Local touchscreen display
  - Capacitor section isolation for capacitor replacement 'on the fly'
  - Capacitor switching contactor for multiple generator applications where capacitive reactance capability is low.
  - Water cooling to minimize footprint
- Note: Lineators are 12-15% kVAr compared to 28-40% kVAr for competitive filters. Lineators therefore do not normally require capacitor switching on generator derived supplies.*

# Applications

Marine and Offshore



Applications in the marine, drilling and offshore industries demand high performance, high reliability and safety. Mirus has developed the Marine & Offshore Specific Lineator model which delivers the requirements expected by the ship builders and owners and the Marine and Offshore regulating and classification bodies.

Due to the serious consequences of high harmonic voltage distortion and other related power quality issues, all classification bodies including the American Bureau of Shipping (ABS), Det Norske Veritas Germanischer Lloyd (DNVGL) and Lloyds Register of Shipping have mandatory harmonic voltage limits (rules) that must be met in order to attain classification and insurance. These harmonic voltage limits, usually 5-8% depending on the type of vessel, Mobile Offshore Drilling Units (MODUs) or offshore installation cannot be met without effective harmonic mitigation. The Marine and Offshore Specific Lineator guarantees full compliance with these limits without introducing the troublesome high frequency harmonics associated with active solutions such as active front end (AFE) AC Drives (VSDs with series active filters) and parallel connected active harmonic filters (which require AC reactors with each drive in order to function reliably and meet the harmonic mitigation performance targets).

In fact, the proven and reliable Lineator AUHF has been used to replace AFE systems on many marine applications where the AFE drives could not be made to operate properly. The high frequency harmonics they generated was causing their own misoperation and failure.

In addition, with the unique optional feature of maintenance 'on the run' by electrical staff (not necessarily specialist manufacturer's service engineers) it is possible to maintain the filters without the expensive inconvenience of stopping operations.

## Typical Applications

- Drilling packages on MODUs (AC VSD, DC SCR or hybrid AC VSD and DC SCR based)
- Main propulsion drives for small naval and commercial vessels (AC VSD and DC SCR drives)
- Ballast, cooling, cargo unload/discharge and other pumps
- Conveyor systems for self-loading/unloading (SUL) and other specialist vessels
- Ventilation fans
- Electrical submersible pumps (ESPs)
- Compressors
- Draw-works
- Table drives
- Winches and cranes
- Remote Operated Vehicle (ROV) thruster and ancillary drives

# Onboard Monitoring

## Condition Based Maintenance

Poor electrical power presents real problems for the operation of electrical and electronic equipment, especially when combined with arduous environments encountered on ships, drilling rigs and other offshore installations. For this very reason every Marine and Offshore Specific Lineator comes equipped with an InSight™ Power Meter & Alarm Monitor. It is very important to have the ability to monitor the health of your equipment. The InSight™ system provides operators with essential information at the terminals of the filter thus ensuring they know whether the equipment is operating within its stated performance. It also provides notification whether any maintenance of the capacitors is required.

## InSight Protective Capacitor Monitoring System

The Marine & Offshore Specific Lineator incorporates an advanced diagnostic system which continuously monitors the following parameters:

- Capacitor current (rms and peak)
- Voltage (rms and peak)
- Capacitance values/phase
- Voltage and current imbalance
- Four temperature points

Extensive Alarm Monitoring on:

- Overvoltage and overcurrent
- Low capacitance values / imbalance per phase
- Voltage and current imbalance
- Over-temperature

ABS Rules for Building and Classing Steel Vessels (2015)  
Part 4, Ch.3, Sec.2

9.19 Protection of Harmonic Filter Circuits (2014)

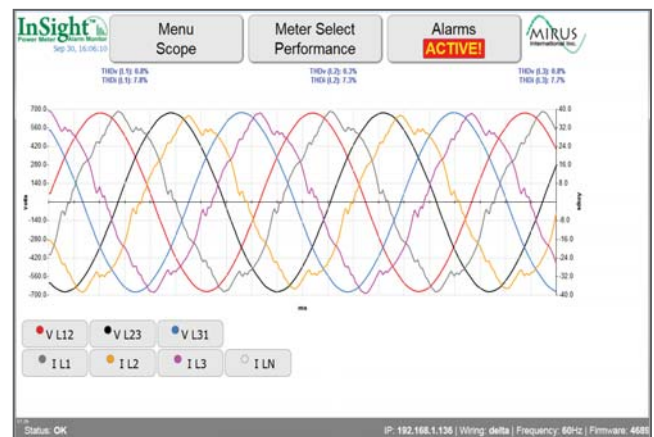
9.23 Protection of Harmonic Filter Circuits Associated with Electric Propulsion (2014)

*'Harmonic filters that contain capacitors are to have means of monitoring and of providing advance warning of capacitor(s) deterioration.'*



## Features

- Capacitor Bank monitoring
- Overvoltage and overcurrent detection
- Voltage and current waveform sampling
- Programmable alarm setpoints
- Web based access via browser
- Assignable digital inputs and relay outputs
- Temperature thermocouple monitoring
- Optional second meter for harmonic mitigation performance and power quality with harmonic spectrum display



# General Specifications

## Ordering Information

Model	Motor Horsepower	Line Voltage	Frequency	Load Type	Enclosure Type	Optional
<b>AUHF - HP - VVV - Hz - L - En - * * * *</b>						
Advanced Universal Harmonic Filter	5 to 3500	208 to 690 (VAC)	50 or 60	D <sup>(1)</sup> Diode Bridge Rectifier T <sup>(2)</sup> Thyristor Bridge Rectifier	M1 (IP23 - Nema3R) M24 (IP24) M25 (IP25) (Consult Factory for higher IP ratings)	* * * * M (Marine & Offshore) L (Liquid Cooled) E (Extreme Duty) H (High Performance)

- 'D' type AUHF is suitable for standard diode bridge and diode/SCR precharged front-end VSD's.
- 'T' type AUHF is suitable for DC drives, Current Source Inverters and other controlled rectifier loads.

### HP / kW RATING:

Available for motor/drive system sizes up to 3500HP / 2600kW

### VOLTAGE:

Standard voltages up to 690V, 3-phase

### FREQUENCY:

50 or 60Hz

### 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 [<5% available]

### NO LOAD CAPACITIVE REACTANCE (kVAR) LEVELS:

5 to 75HP 15 to 20%  
100 to 3500HP 10 to 15%

### EFFICIENCY:

5 to 600HP >99%  
700 to 1800HP >99.2%  
2000 to 3500HP >99.4%

### ELEVATION:

3300ft [1000m] above sea level

### VENTILATION:

Convection air cooled

### ENCLOSURE:

NEMA 3R [IP23] standard  
Paint: Two-part Marine grade powder coated  
Color: ANSI 61 Grey

### OPTIONAL:

IP25, IP44, IP45  
DNVGL, BV or Lloyds Certification  
Extreme Duty ED Rating  
5 to 12% VTHD up to 55°C  
High Performance <5% THD(I)  
Liquid Cooled

## Rating Table

Motor Size		Lineator Rating (3-Phase)							Output kW
HP	kW	Input Amps							
		208V 60Hz	220/ 240V 50/60Hz	380/ 400V 50Hz	415/ 440V 50Hz	460/ 480V 60Hz	575/ 600V 60Hz	660/ 690V 50/60Hz	
5	4	14	13	8	7	7	5	5	4.5
7.5	5.5	20	18	11	10	9	7	6	6.3
10	7.5	27	24	14	13	12	10	8	8.5
15	11	40	36	21	19	17	14	12	13
20	15	53	48	28	25	23	18	16	17
25	18.5	66	60	35	32	29	23	20	21
30	22	79	72	42	38	34	28	24	25
40	30	105	95	55	51	46	37	32	34
50	37.5	131	119	69	63	57	45	40	42
60	45	158	143	83	76	69	55	48	51
75	55	196	178	103	95	85	68	59	63
100	75	260	236	137	125	113	90	79	84
125	90	323	294	170	156	141	112	98	104
150	110	388	353	204	187	169	135	118	125
200	150			274	250	226	180	158	168
250	185			340	312	281	225	196	209
300	200			410	374	337	270	235	251
350	250			475	436	395	315	275	292
400	315			565	520	470	375	325	349
500	400			720	660	595	475	415	443
600	450			810	740	670	535	470	499
700	500			940	865	780	625	545	579
800	560			1075	985	890	715	620	662
900	630			1200	1100	990	795	690	736
1000	710			1335	1220	1100	880	770	818
1100	800			1470	1340	1210	970	845	900
1200	900			1610	1470	1330	1060	925	987
1300	970			1735	1585	1430	1145	1000	1064
1400	1000			1870	1710	1540	1235	1075	1145
1500	1120			2000	1835	1650	1325	1155	1228
1600	1200			2145	1965	1770	1415	1235	1316
1800	1350			2410	2210	1990	1595	1390	1481
2000	1450			2670	2440	2200	1765	1535	1636
2300	1700			3065	2810	2530	2030	1765	1882
2500	1850			3335	3050	2755	2205	1920	2045
2800	2100			3750	3435	3100	2480	2160	2303
3000	2250			4020	3680	3320	2660	2315	2468
3500	2600			4265	3905	3855	3085	2685	2618

\* Consult factory for additional sizes up to 5000HP.





## Expect better. Call us.

To discuss how MIRUS can help you meet your power quality challenges, contact us at our head office:

MIRUS International Inc.  
31 Sun Pac Blvd.  
Brampton, Ontario  
Canada L6S 5P6

Tel: (905) 494-1120  
Fax: (905) 494-1140  
Toll-Free: 1-888-TO MIRUS (888-866-4787)  
[www.mirusinternational.com](http://www.mirusinternational.com)

苏州工厂联系方式:  
米瑞思电磁设备(苏州)有限公司  
中国江苏省苏州市高新区建林路出口加工  
区配套工业园5栋厂房  
邮编: 215011  
电话: (86) 0512-62696858  
传真: (86) 0512-62696266  
网站: [www.cn.mirusinternational.com](http://www.cn.mirusinternational.com)



## Harmonic and Energy Solutions

**Real-world performance  
for real-world loads.**