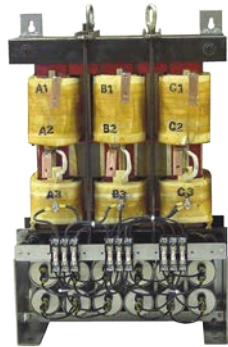




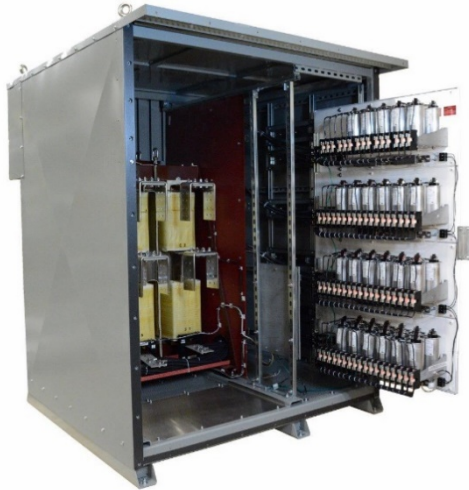
Available Models and Options for MIRUS Passive Harmonic Filters

Various Models of Lineator AUHF Wide Spectrum Passive Harmonic Filter

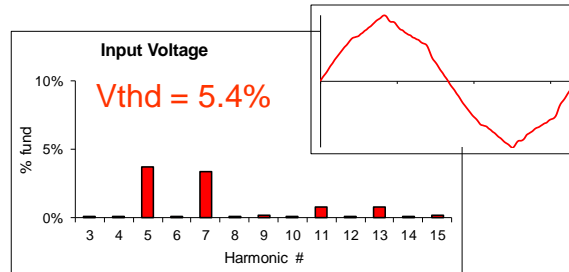
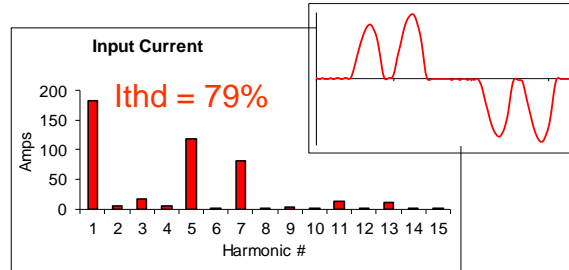


PRODUCTS	APPLICATIONS
LINEATOR™ AUHF 3-Phase Passive Harmonic Mitigation Filters for line side harmonics from VSD non-linear loads	Reduces harmonics generated by Variable Speed Drives to meet the limits of IEEE Std 519, EN 50160, IEC 61000-3-12, G5/4, and GB/T 15459. Exceeds 18-pulse performance, in a smaller footprint, at lower cost and without sacrificing energy efficiency. Free 'SOLV' computer simulation software simplifies harmonic compliance analysis.
AUHF-HP	High Performance (<5% ITHD). Ideal for meeting specifications where current harmonic must meet less than 5%.
AUHF-HP2	High Performance (<5% ITHD). Designed specifically for EC Fans and other high efficiency, integrated permanent magnet motor technology with low DC bus capacitance.
AUHF-ED	For extreme environments, such as excessive background voltage distortion (up to 12% VTHD), high ambient (up to 55°C) or high elevation (above 3000 ft).
AUHF-MOS	Marine Duty and Offshore Specific Lineator. Designed for harsh environments and addresses all marine certifying body requirements.
AUHF-L	Liquid Cooled Lineator Harmonic filter designed for smaller footprint and optimized for use with liquid cooled drives/equipment.
ATL	All-in-one Autotransformer and Harmonic filter. For applications when the VSD voltage rating is different from the service voltage. Combines the proven harmonic mitigating performance of the Lineator™ AUHF with step-down or step-up voltage transformation.
SUHF:	Passive filters for 3-ph VSDs when only 1-ph power is available.
· 1Q3	Creates partial or quasi 3 rd phase. Reduces the need for VSD derating.
· 1T1	For 1 phase 2-wire in and 1 phase 2-wire out applications.

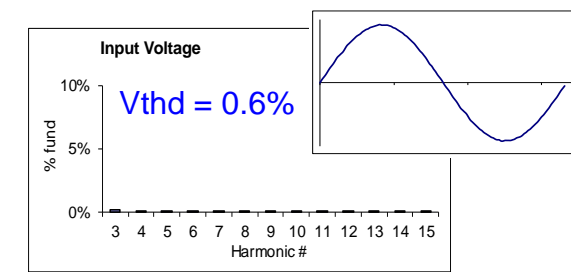
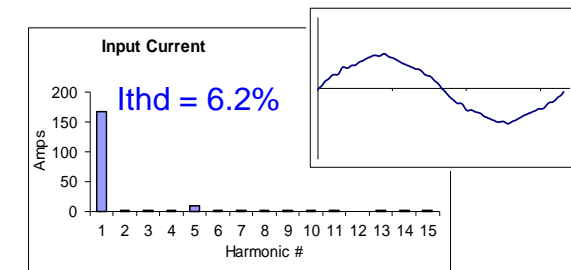
Passive Wide Spectrum Harmonic Filter – Lineator AUHF



Without Harmonic Treatment



With LINEATOR AUHF



- Input harmonic filter for VSDs
- Better than 18-pulse or AFE performance with 6-pulse VSD
- ‘Real-World Guarantee’
- Meets IEEE and IEC harmonic limits
- Near unity power factor
- Generator compatible
- Highest efficiency solution

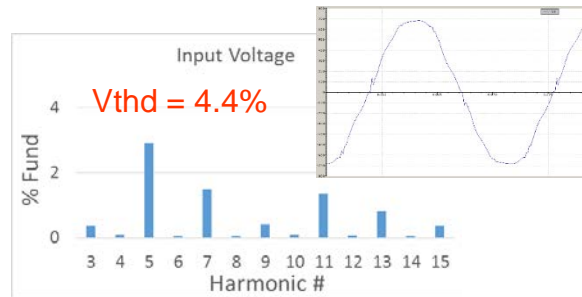
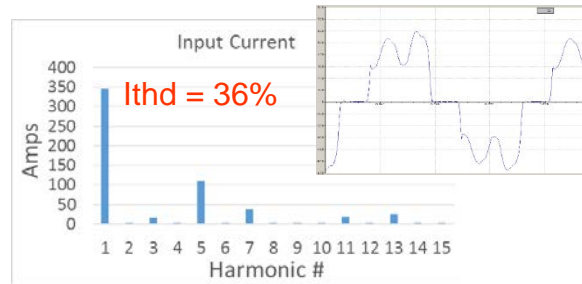
Load	Current Harmonics (Amps)										Ithd		Itdd		K-factor		PF	
	RMS		5th		7th		11th		13th		w/o	With	w/o	With	w/o	With	w/o	With
	w/o	With	w/o	With	w/o	With	w/o	With	w/o	With								
Full	233	168	118	9.0	80	0.6	12	2.2	12	1.5	79%	6.2%	79%	6.2%	15	1.5	- .75	1.00
75%	187	130	96	7.7	70	0.6	15	1.5	7	1.4	86%	7.0%	65%	5.3%	17	1.6	- .73	+ .99
50%	134	89	69	6.9	54	0.3	17	1.2	5	1.0	95%	9.0%	48%	4.5%	20	2.0	- .69	+ .95
25%	67	46	33	4.2	29	0.2	14	0.8	9	1.0	120%	11%	30%	2.8%	29	2.5	- .58	+ .83

Lineator AUHF-HP (High Performance)

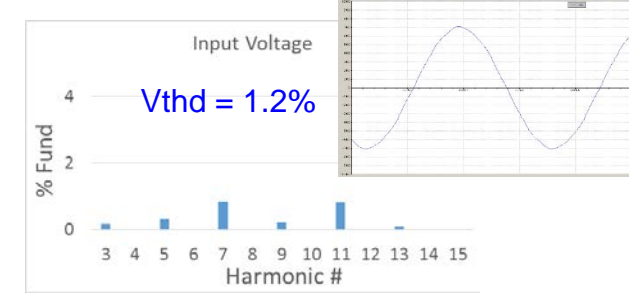
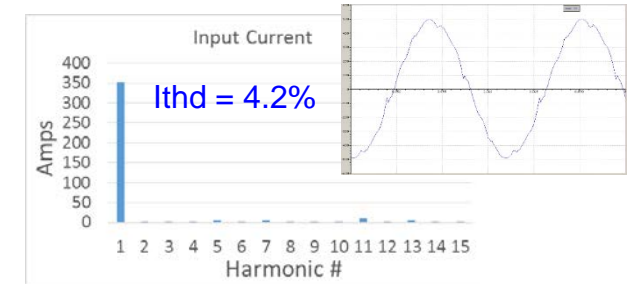


- < 5% iTDD provides best performance of any harmonic mitigation option
- Input tap allows for impedance adjustment, if necessary
- Exceeds IEEE and IEC harmonic limits
- Near unity power factor
- Generator compatible
- Highest efficiency solution

With Reactor



With LINEATOR AUHF-HP

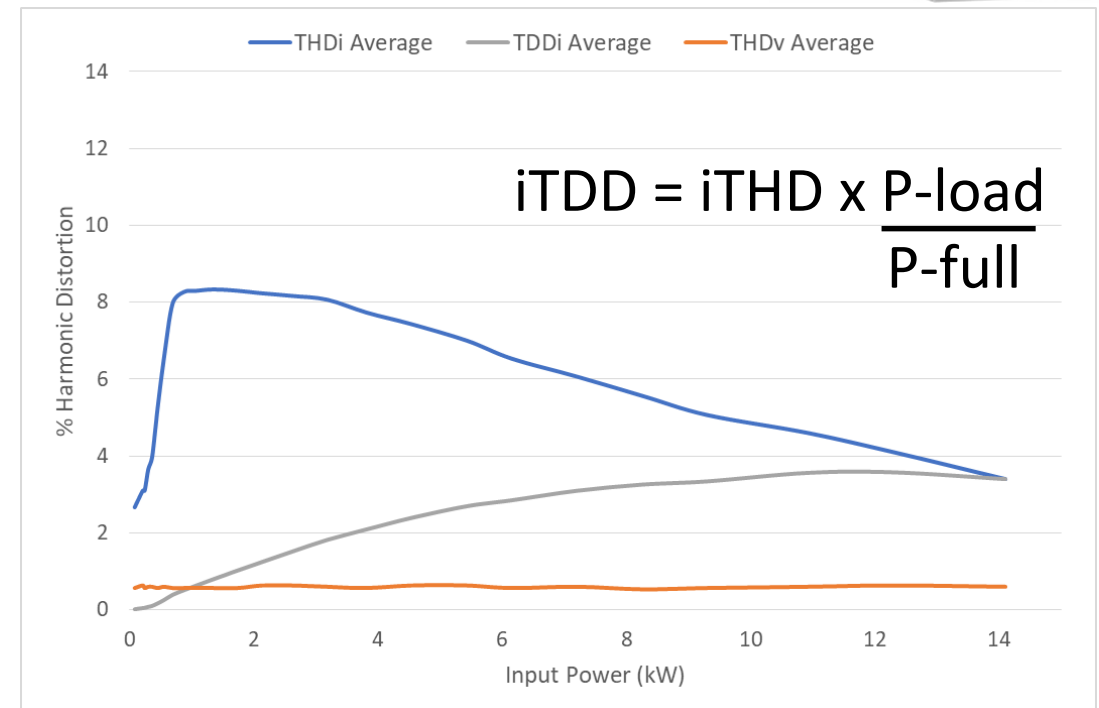
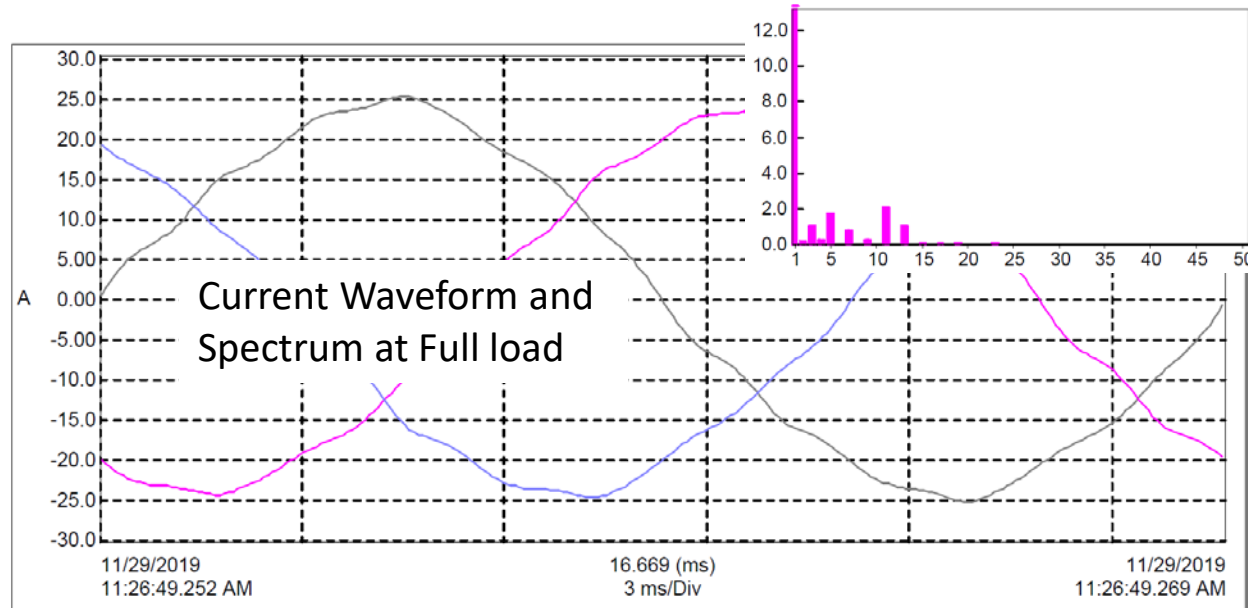


Load	Current Harmonics (Amps)										I _{thd}		I _{tdd}		K-factor		PF	
	RMS		5th		7th		11th		13th		w/o	With	w/o	With	w/o	With	w/o	With
	w/o	With	w/o	With	w/o	With	w/o	With	w/o	With								
Full	369	352	110	5.0	37	4.9	19	9.5	25	6.1	36%	4.2%	36%	4.2%	8.9	1.5	0.94	0.98
75%	275	257	83	4.8	35	6.6	16	8.1	17	3.9	37%	5.2%	28%	3.9%	9.3	1.7	0.94	1.00
50%	188	171	67	3.5	27	5.7	5.6	5.6	14	3.9	44%	6.1%	22%	3.0%	10	2.2	0.92	1.00
30%	123	108	48	2.8	27	5.9	4.1	3.3	9.2	1.8	55%	7.8%	16%	2.4%	17	2.4	0.88	0.96
25%	109	92	55	2.4	34	5.8	5.3	2.7	7.3	1.8	77%	8.7%	19%	2.2%	17	2.6	0.79	0.93

Lineator AUHF-HP2 (High Performance for EC Fans and other Brushless DC Permanent Magnet Motors)

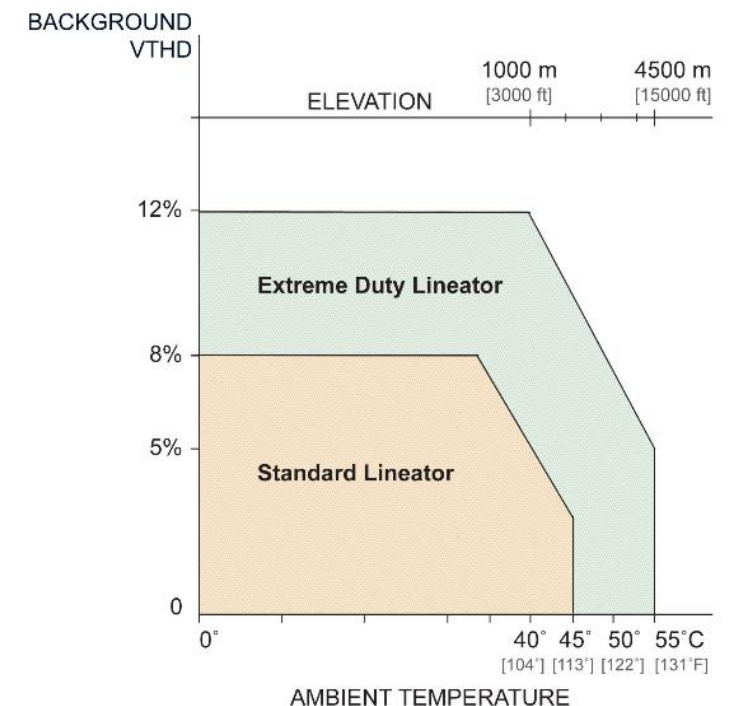


- Only passive filter solution compatible with EC Fans and other rectifier loads with extremely low DC bus capacitance
- Current distortion reduction to < 5% iTDD
- Reduces both low frequency and high frequency harmonics
- Allows energy savings potential of EC Fans to be realized without sacrificing power quality



Extreme Duty Lineator Filter is built to withstand the rigours of heavy industrial load structures and severe environmental conditions

- Excessive background voltage distortion (8% to 12% VTHD) (consult factory for higher levels)
- High ambient (up to 55° C) and elevation (above 3000 ft)
- Natural convention cooled (no fans or AC required)
- Available in Standard or High Performance HP models
- Configurable with all Lineator Options including CSP (Coordinated Surge Protection) for a full 5-yr warranty



The only passive filter that performs in high ambient, high elevation and high background voltage distortion environments without derating

Specifically Designed for Electrical Propulsion and other Critical VSD

Marine Systems:

- Proven performance of Lineator AUHF mitigates VSD harmonics to meet all Marine Certifying Body harmonic requirements
 - Models available for either diode or SCR bridges
- Equipped with monitoring and capacitor switching to meet Marine Certifying Body requirements for passive harmonic filters
- Will not introduce high frequency harmonics as do Active Frontend Drives and Parallel Active Filters



Features included as standard:

- InSight Power meters & contactor for capacitor monitoring & control
- Tin plated terminals and conformal coating on all electronics wiring
- Alarms for reactor over-temperature condition
- Easy access capacitors including draw-out in sizes above 2000HP
- Corrosion and water resistant enclosures



Lineator AUHF-L (Liquid Cooled)



Liquid Cooled Lineator is designed for reduced footprint in marine and other applications where space is at a premium:

- Cooling plate heat sinks machined of aircraft grade aluminum
- 316ss headers and compression fittings with seamless 316ss tubing
- Hydrostatic pressure tested to 2x operating pressure
- Designed for cooling fluid mixture of 10% ethylene glycol in demineralized water

3500HP Liquid-Cooled Lineator AUHF was paired with 6-pulse electric propulsion system VSDs to replace AFE systems that had failed on off-shore service vessels. ABS marine harmonic standards and IEEE 519 limits were met.



Lineator ATL (Combined Autotransformer + Passive Harmonic Filter)



Used in Drive Applications where the Supply Voltage does not Match the ASD / Motor Voltage:

- All-in-one solution offers the smallest footprint and highest efficiency
- Built-in autotransformer provides voltage step-up or step-down
- All of the compatibility and performance benefits of the Lineator AUHF harmonic filter
- Available in standard, high performance or ED models and configurable with all Lineator options



Lineator AUHF-1Q3 and 1T1 (Harmonic Filters for 3-Ph VSDs when only 1-Ph is available)

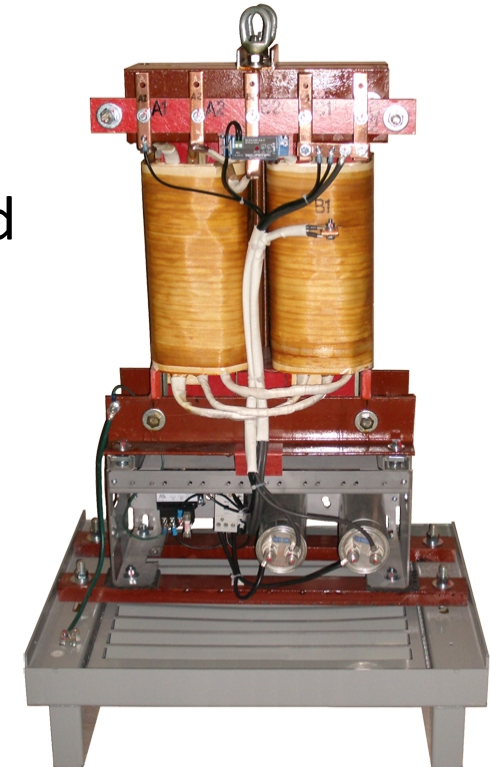


Mirus offers 2 Models of Harmonic Filters for VSD Applications when only 1-Phase Power is Available:

- VSDs are used to convert 1-ph to 3-ph for operation of 3-ph motors
- High levels of current distortion, including 3rd harmonic, are generated
- AUHF-1Q3 provides quasi 3-ph power to VSD to filter harmonics and reduce derating requirement (2-wires in, 3-wires out)
- AUHF-1T1 filters harmonics with 1-ph in and 1-ph out to VSD

	No Filter	With 1Q3	% Improvement
Current Distortion	63.8%	22.8%	64%
Voltage Distortion	5.2%	3.1%	40%
True PF	0.73	0.95	30%
kVAR	59	20	66%
kVA	84.5	65.1	23%
kW	63.5	62.0	3%

100HP Lineator
AUHF-1Q3
Performance



INVERSINE™ Advanced Universal Sinewave Filter (AUSF)



- Low pass sinewave filter for inverter PWM output
 - Reduces voltage distortion to $< 3\%$
 - Low Insertion loss and voltage drop ($< 2\%$)
- No damping resistors required
 - Cooler operation and higher efficiency than competitor filters
- Unique Common-mode filter option available
- Prevents
 - Transient over voltages at motor
 - Harmful effects of reflective waves
 - Additional motor losses
 - Excessive motor noise
 - Shaft voltage and bearing currents (CM option)
 - Need for Inverter duty motors or cables (CM option)

Common Mode Choke
(CMCHK Option)



Typical Applications: ESPs, Motor drive with long cable runs or multiple motors in parallel, shore to ship power

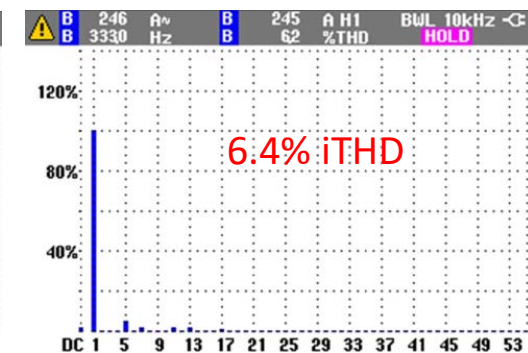
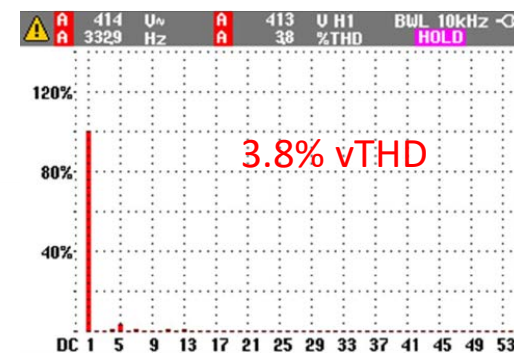
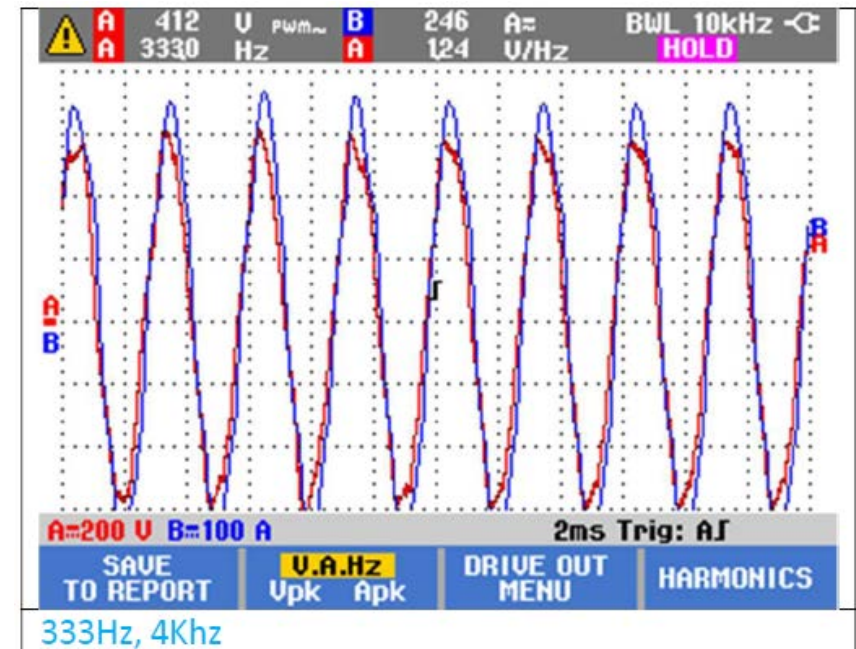
INVERSINE™ Advanced Universal High Frequency Sinewave Filter (AUSF)



Increased use of energy efficient Permanent Magnet Motors has introduced a demand for VSD sinewave filters up to 400Hz:

- Inversine AUSF is available in models up to 400Hz
- Sinewave filters for these applications require unique designs and higher minimum switching frequencies
 - For example, a 350Hz filter can only be applied to a VSD operating at 4 kHz or higher switching frequency
- PWM output restored to near sinewave

300HP, 350Hz
Inversine AUSF
Performance



Available Options for Lineator AUHF and Inversine AUSF



Lineator AUHF:

- InSight Monitor
 - Performance and/or Capacitor monitoring
- Capacitor Contactor
- Coordinated Surge Protection (CSP)
- Open Style and Enclosure configurations including increased dust and water protection
- Terminal tin plating, conformal coating protection and enclosures for corrosive environments

Inversine AUSF:

- Common-mode Choke
- Coordinated Surge Protection (CSP)
- Open Style and Enclosure configurations including increased dust and water protection
- Terminal tin plating, conformal coating protection and enclosures for corrosive environments



InSight – Power Monitor

- Voltage and current Waveform Sampling
- Overvoltage and Overcurrent detection
- Power Quality Monitoring
- Capacitor Bank monitoring
- Embedded AC Waveform Viewer to see real-time voltage and current waveforms
- Standard Ethernet connection for easy network integration
- Web based software included

ABS Rules for Building and Classing Steel Vessels (2015)
 Part 4, Ch.3, Sec.2
 9.23 Protection of Harmonic Filter Circuits Associated with Electric Propulsion (2014)

ABS Rules for Building and Classing Mobile Offshore Drilling Units (2015)
 Part 4, Ch.3, Sec.2
 9.19 Protection of Harmonic Filter Circuits (2014)

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



InSight – Web based Software



InSight™ Power Meter Alarm Monitor
16 Jan 2014 - 8:37:08

Menu: Voltages | Meter Select: Performance | Alarms: CLEAR

	Ph-Ph	%THD	Peak	Hz
L12	499.5 _V	0.3%	708.3 _V	60.0 Hz
L23	500.4 _V	0.6%	707.5 _V	60.0 Hz
L31	499.9 _V	0.7%	708.5 _V	60.0 Hz
Avg	499.9 _V	0.5%		

Imbalance: 0.1%

InSight™ Power Meter Alarm Monitor
16 Jan 2014 - 8:45:49

Menu: Scope | Meter Select: Performance | Alarms: CLEAR

THDv (L1): 0.6% THDv (L2): 0.5% THDv (L3): 0.5%

Legend: V L1, V L2, V L3, I L1, I L2, I L3, I LN

InSight™ Power Meter Alarm Monitor
16 Jan 2014 - 8:42:50

Menu: Harmonics | Meter Select: Performance | Alarms: CLEAR

THDv (L1): 0.6% THDv (L2): 0.7% THDv (L3): 0.8%
THDi (L1): 2.1% THDi (L2): 2.1% THDi (L3): 2.1%

Harmonic Distortion

Legend: V L12, V L31, V L23, 1-21, 22-42, RMS, Fund., I L1, I L2, I L3, 43-64, Full, %THD

InSight™ Power Meter Alarm Monitor
16 Jan 2014 - 8:59:19

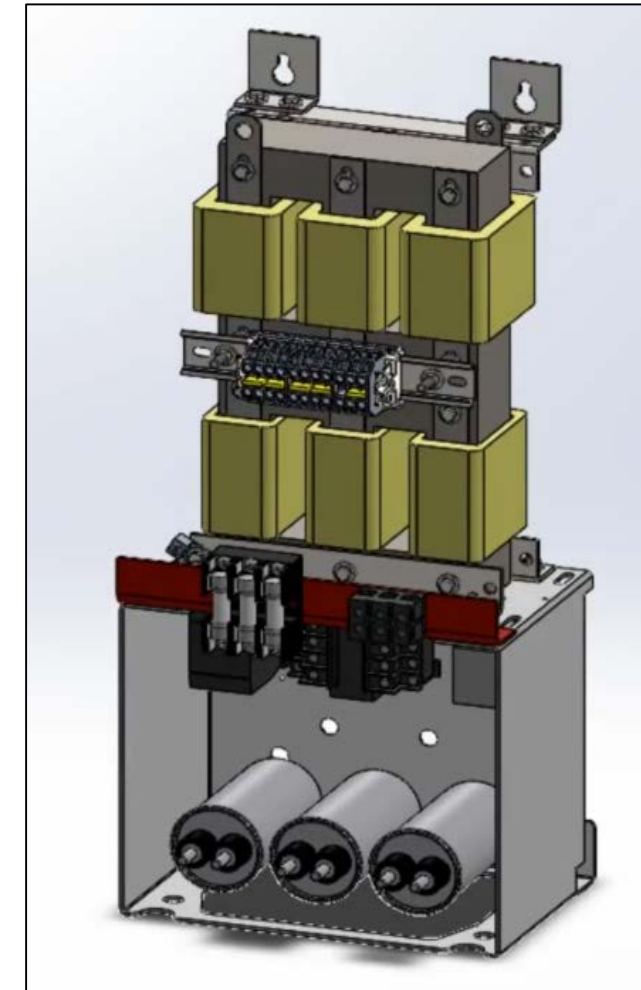
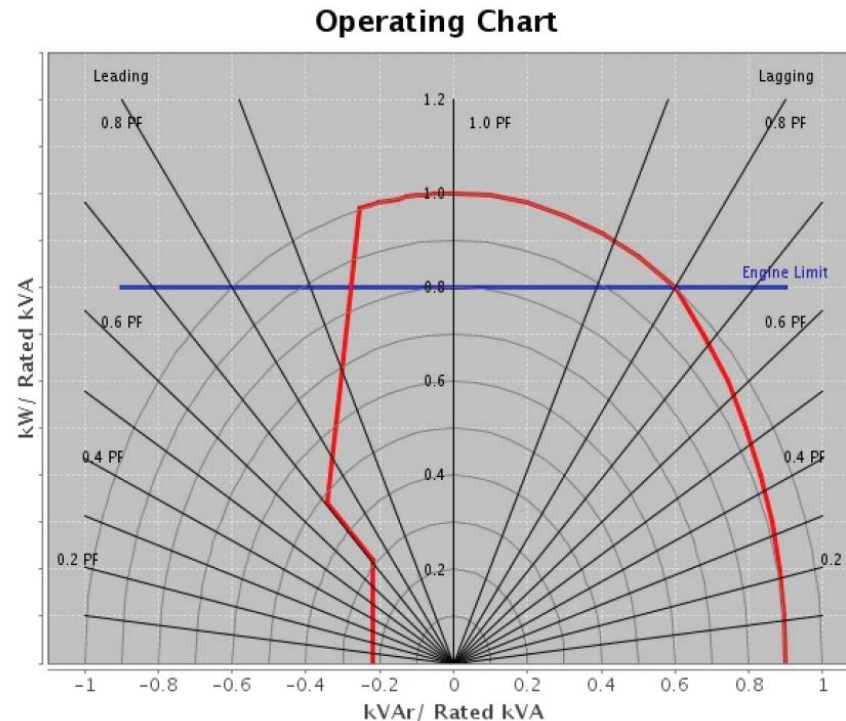
Menu: I/O Status | Meter Select: Performance | Alarms: CLEAR

Digital Input	INPUT EXPRESSIONS	OUTPUT EXPRESSIONS
IE0	RLY1	RLY1 => IE6 + IE6 + IE7 + IE8 + + + +
IE1	OUT1	RLY2 =>
IE2	IOUT1	RLY3 =>
IE3	D14	RLY4 =>
IE4	RLY1	RLY5 => IE0 * IE2 + + + + + + + +
IE5	RLY2	OUT1 => IE0 * IE3 + IE0 * IE4 + IE0 * IE1 + + + + +
IE6	OV + SEQERR	OUT2 =>
IE7	ALRM_VRMS + ALRM_IRMS + ALRM_FREQ + ALRM_CAP + ALRM_VTHD + ALRM_ITHD + ALRM_V_IMBAL + ALRM_I_IMBAL	OUT3 =>
IE8	TC_1_LIM_1 + TC_2_LIM_1 + TC_3_LIM_1 + TC_4_LIM_1	
IE9		
IE10		
IE11		
IE12		
IE13		
IE14		
IE15		

Capacitor Switching Contactor Option (CONT)

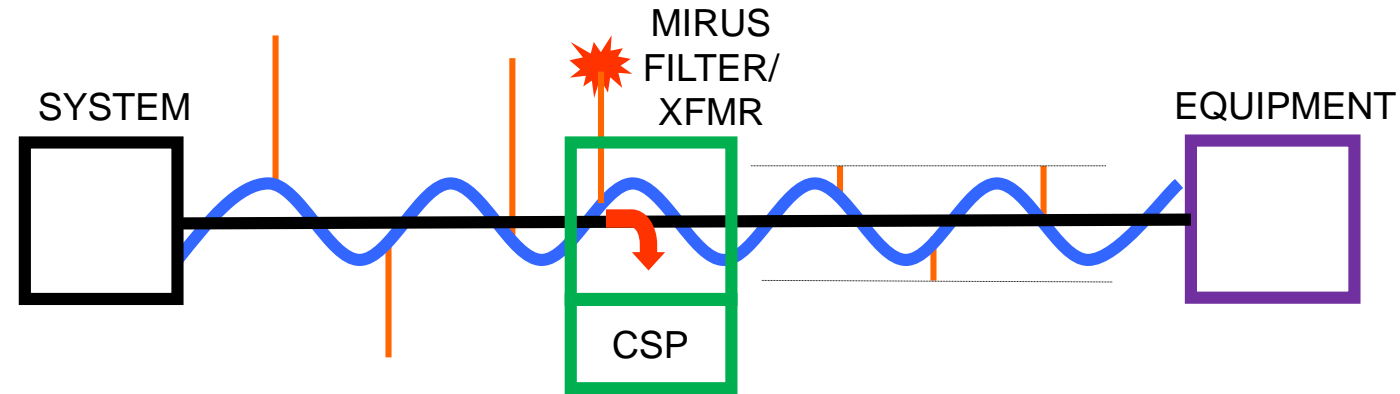


- Switches capacitors out of the harmonic filter circuit to completely remove all leading kVAR at light load or when the load is off
- No external voltage required for control
 - option includes control transformer, time delay relay, and terminal block for integration with permission circuit from the load
 - new option controls contactor automatically based on filter loading
- On generator applications, the generator's reactive power capability curve can be used to determine if contactor option is required



Available integrated Surge Suppression option for Filters and Transformers

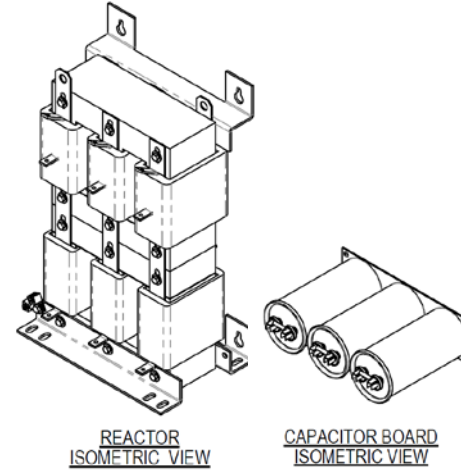
- Coordinated with filter impedance for effective equipment protection against surges and transients
- LED status lights on enclosure
- Fast reaction time
- Component level and phase level fault fusing
- 15 year unlimited free replacement of CSP component
- When factory installed on Lineator AUHF, the complete filter warranty is increased to 5 years



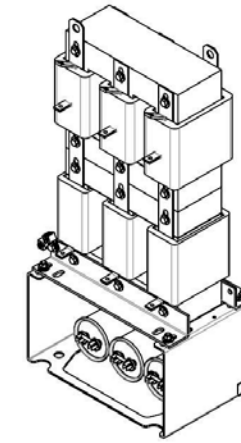
Open Style and Enclosure Options



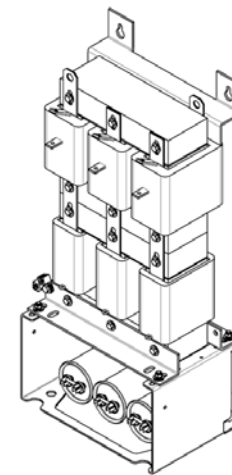
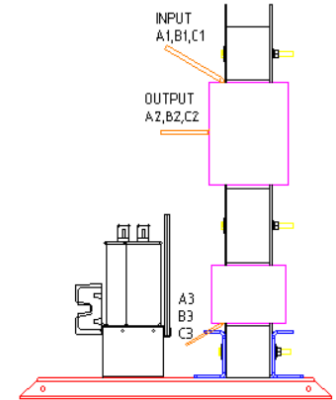
- 'EOM' Modular Style
 - Available for any standard voltage or size upon request
 - Provides the most flexibility in space planning
- 'EO' Floor Mount Style
 - Fully wired solution for floor mounting inside customer enclosure
- 'EOP' Panel Mount Style
 - Fully wired solution for panel mounting, available for any standard voltage up to 125HP
- 'E1' Indoor Enclosed NEMA-3R
 - Sprinkler proof, finger-safe enclosure
- 'E1E' Outdoor Enhanced NEMA-3R
 - Adds hoods and baffles to protect against splashing water and driving rain



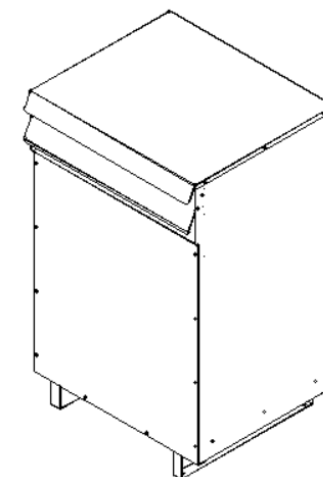
'EOM'



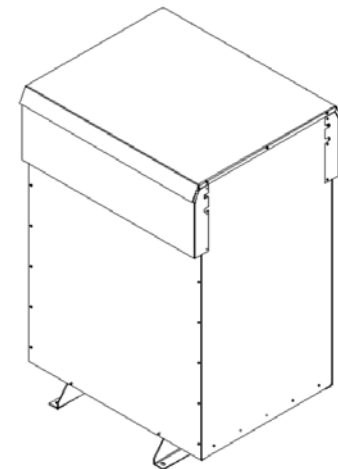
'EO'



'EOP'



'E1'



'E1E'

Tin Plating

- Applied to copper busbar for terminal corrosion protection

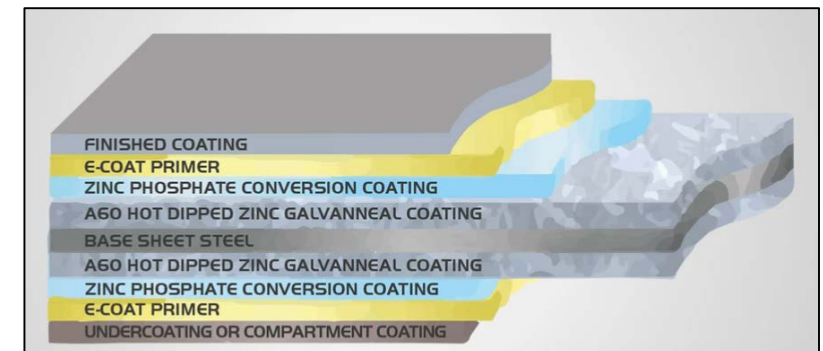


Conformal Coating

- Polymeric film is sprayed onto all exposed internal connections, including:
 - Capacitor Terminals
 - Wire Lugs
 - Fuse terminals
- Coating is not applied directly to fuseholder assemblies to ensure effective operation

Galvanneal and Galvanized Enclosures

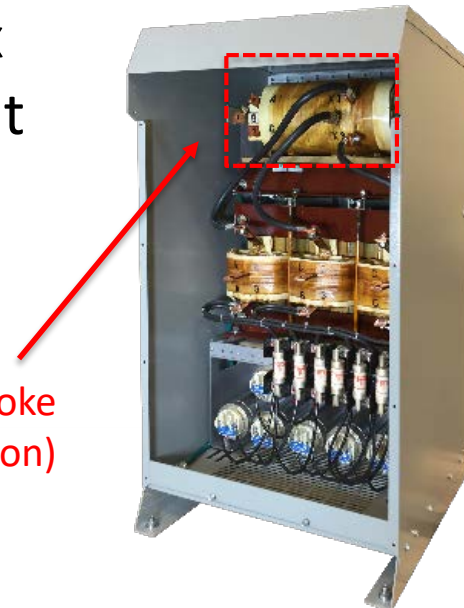
- Available as an option for any enclosure size or type
- Zinc coating applied to sheet steel before painting. Provides a deeper protection in corrosive environments than a two-part, zinc coated paint.
- Marine rated



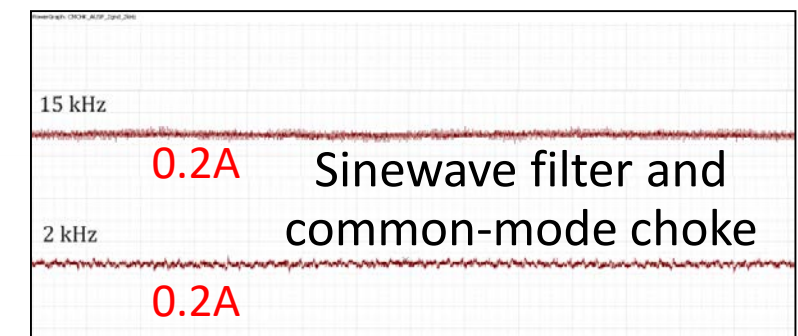
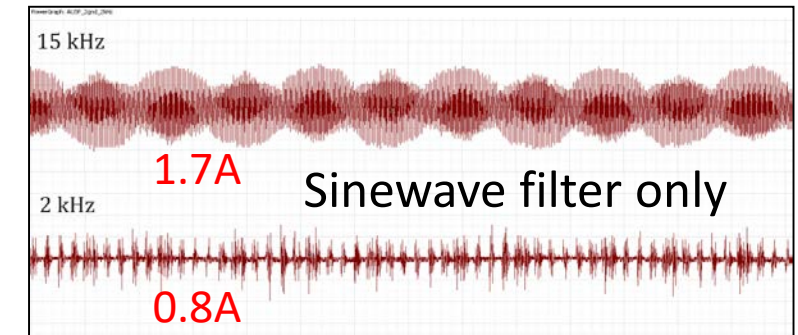
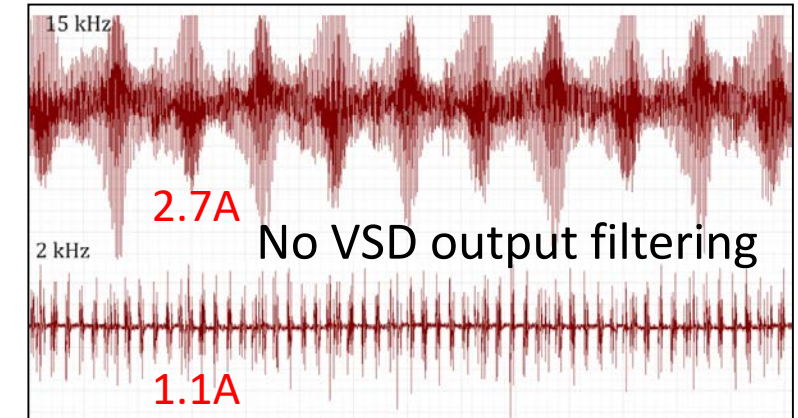
PWM operation of VSDs will introduce switching frequency common-mode voltage and current

- Sinewave filter will provide some reduction in common-mode but more is often needed especially with long motor cable runs
- Combination of sinewave filter with common-mode choke option can provide up to 10x reduction in common-mode current
- Prevents shaft voltage and bearing currents and the need for inverter duty motors or cables

Common Mode Choke
(CMCHK Option)

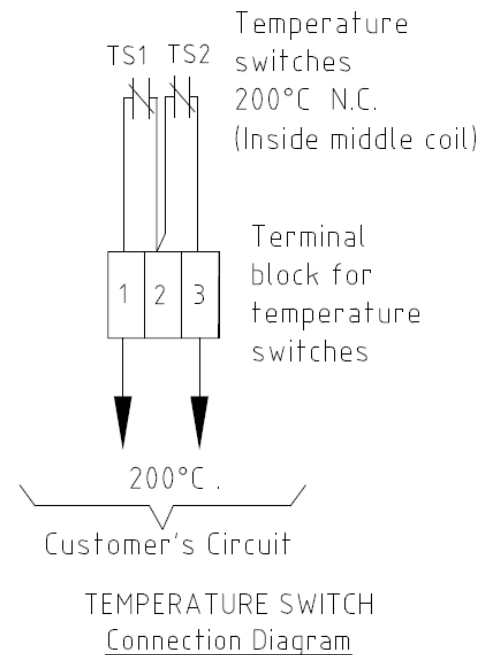


Common-mode Current of 7.5HP VSD



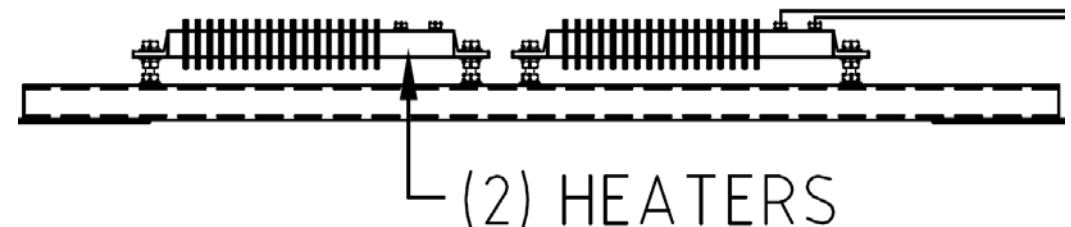
Thermal Switches:

- Provide indication of an over-temperature condition inside the reactor coils at a factory installed terminal block
- Different combinations of temp switches at 170 deg C or 200 deg C are available
- Thermal switches are provided as standard on all AUHF's sized 500HP and greater

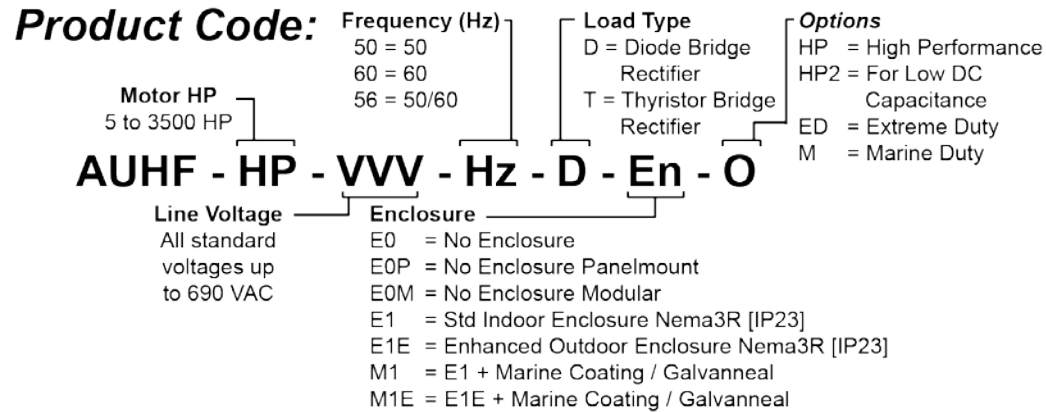


Space Heater:

- Installed at the bottom of the enclosure to provide a heat source when storing in extremely cold environments
- Separate power supply for heater allows for critical components to be heated even when there is no power to the harmonic filter



Lineator AUHF Types and Options



AUHF
or
ATL

Application:

- Diode Bridge Rectifier (Type D)
- Thyristor Bridge Rectifier (Type T)

Type:

- Standard
- HP (High Performance)
- ED (Extreme Duty)
- HP-ED (High Performance + Extreme Duty)
- HP2 (For Low DC Capacitance, EC fans)

ENCLOSURE OPTIONS

Environmental Rating:

- Open Style (E0)
- Open Style Modular (E0M)
- Indoor Enclosed (E1)
- Outdoor Enclosed (E1E)
- IP54+ *contact factory

Materials/Paint:

- Standard Powdercoat
- Marine Coating/Galvanneal
- Stainless Steel
- Other:
 - Hinged Door
 - Bottom Access

ADDITIONAL OPTIONS

- InSight Monitor
 - Capacitor Monitor
 - Performance Monitor
 - Dual Monitor
 - No Display
 - Standard Display
 - 7" Touchscreen
 - 2 Thermocouples
 - 4 Thermocouples
- Capacitor Switching Contactor
- Coordinated Surge Suppression (CSP)
 - Standard kA/mode
 - High kA/mode

*refer to datasheet for additional details
- Terminal Tin Plating & Conformal Coating
- Temperature Switches
 - Warning (170°C on Center Coil)
 - Alarm (200°C on Center Coil)
 - Other _____
- Space Heater
- Liquid Cooled Reactor (L)
- Marine Duty (MOS Lineator) Package

Thank You



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