

PART 1 – GENERAL

- 1.1 All PWM AC Variable Frequency Drives of [30] hp ([22] kW) and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of harmonic distortion.
- 1.2 The harmonic mitigation equipment and all of its components shall be manufactured to, tested, and labeled in accordance with the latest applicable standards of UL, CSA, CE, NEMA and ABS (for marine applications).
- 1.3 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a minimum of 3 years [OPTION: 5 years] from the date of shipment.
- 1.4 Manufacturer must perform a factory harmonic mitigation performance test on each filter utilizing actual variable frequency drive loads. Reliance on Type Testing and calculation alone is not acceptable.
- 1.5 Computer simulation must be provided to show compliance with this specification with a 2% background voltage distortion and 1% imbalance modeled to simulate real-world conditions, with waveform traces, IEEE519-1992 and IEEE519-2014 reports included.
- 1.6 Subject to compliance with all of the contract documents and specifications, the acceptable product and manufacturer is: LINEATOR™ AUHF, by MIRUS International Inc. (905) 494-1120, Toll Free: (888) 866-4787

PART 2 – PRODUCTS

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.). The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
- .2 Harmonic mitigation shall be by passive inductor/capacitor network. To prevent possibility of switching frequency resonance, active electronic components shall not be used.
- .3 Power factor shall be > 0.95 in operating range from 25% to full load.
- .4 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 kW rating for sizes ≥ 100HP and 20% for sizes ≤ 75HP.
- .5 Maximum voltage boost at no load must be < 3% of nominal line voltage.
- .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 IEEE std 519 (both 1992 and 2014 editions) 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 at the input terminals to the harmonic mitigation equipment.
- .8 Voltage Total Harmonic Distortion (VTHD) shall meet the requirements of IEEE std 519 (Table 10.2 in 1992 or Table 1 in 2014) by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%, while operating on either utility supply or generator supply. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
- .9 Current Total Demand Distortion (ITDD) at the input terminals of the harmonic mitigation equipment shall meet the limits as defined in IEEE Std. 519 (Table 10.3 in 1992 and Table 2 in 2014) but shall not exceed 8% [OPTION: 5%]. ITDD to include harmonics up to 100th. 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%.
- .10 Performance Guarantee: ITDD must be <8% with background voltage distortion up to 5% and voltage imbalance up to 3%. [OPTION: Additionally, ITDD must be <5% with background voltage distortion up to 2% and voltage imbalance up to 2%]. Must be capable of operating in voltage distortion environments up to 8% without derating.
- .11 [OPTION] Provide coordinated surge protection factory integrated into the harmonic filter to provide additional protection against voltage transients, spikes and surges. Inclusion of the coordinated surge protection must extend the warranty of the harmonic filter to 5 years. Surge protection must include:
 - i. Low impedance internal circuitry with very low let through levels coordinated below most harmonic filtered drive circuit withstand limits.
 - ii. LED status lights installed on the filter enclosure exterior.
 - iii. Two types of fusing: component level thermal fusing and phase level fault current fusing.
 - iv. Metal oxide varistor (MOV) design with fast reaction time (<1ns).
 - v. Compatibility with systems with SCCR rating up to [120kAIC] [200kAIC].
- .12 [OPTION] Provide real-time monitoring of [harmonic performance] [capacitance] [harmonic performance and capacitance] of the harmonic mitigation equipment. Monitoring must include:
 - i. Overvoltage and overcurrent, voltage and current imbalance, high distortion detection and alarm.
 - ii. Temperature monitoring of up to four locations inside the enclosure and field-adjustable alarm.
 - iii. Ethernet communication and Modbus TCP/IP compatibility
 - iv. Web based software accessible by any networked computer.
 - v. [OPTION]: [Local LCD display] [Local 7" capacitive touchscreen display]

2.2 Basic Requirements:

- .1 All wiring shall be copper. Aluminum conductors are not acceptable.
- .2 Insulation class: 220°C system. Temperature rise: 130°C over 50°C ambient. [Option: 130° rise over 55°C max. ambient without the need for deration for Extreme Duty applications]
- .3 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.
- .4 Ventilated, sprinkler proof E1 NEMA-3R. [OPTION: E1E NEMA-3R Enhanced outdoor] enclosure

2.3 Options:

1. 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. The report shall show compliance to the intent of the specification and contain a harmonic spectrum through the 50th harmonic (3kHz) as a minimum.

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. Site testing must be performed through the 50th harmonic, and show compliance of the harmonically mitigated load structure to IEEE519 Std's and this specification.