High Volume Low-Speed Fan

Comparison between Epoch 2.0 and MacroAir X Series HVLS Fans for Ø16 ft.

By

Falco eMotors

Executive Summary: A 34-point comparison made between Epoch 2.0 and MacroAir X Series HVLS fans. This paper recommends Epoch 2.0 fans for the high performance, efficiency, reliability, technology, lower cost of acquisition, operation and maintenance, and ready availability.

Abstract: This article presents a side by side comparison between Epoch 2.0 HVLS fans and MacroAir X Series HVLS fans. Published specifications and Website information are taken into consideration. Parameters such as motor power, blade diameter, fan speed, current consumption, input voltage, power factor, torque, motor weight, number of blades, installation, etc. compare between the various companies.

Introduction: Direct drive platforms for HVLS fans are gaining in popularity over the past few years. Several companies have launched their direct drive platforms since 2014, including MacroAir, BigAss, Greenheck, and Hunter, etc. Many of the attempts have been made by other HVLS fan companies to manufacture direct drive fans. Most are either in the development stage or have experimented with various available direct drive platforms. Most of the manufacturers have a deep understanding of the motor's characteristics and inverters required for HVLS fan performance. This paper limits its comparison between one types of Epoch 2.0 Ø16 ft. HVLS fan and MacroAir X Series Ø16 ft. HVLS Fan.

Epoch 2.0 Fans: Epoch 2.0 fans built using expanded diameter fractional slot permanent magnet synchronous motor (**EDFS-PMSM**) technology. The motor controlled using power factor corrected field-oriented controls with space vector modulation. Epoch 2.0 Fans have developed by Falco eMotors located in the state of Virginia, USA. The technology has

developed in collaboration with some central US and Canadian companies specializing in the sale of HVLS fans. The company has several fan models available from 6ft to 24ft based on Epoch 0.5, 1.0, 2.0 and 3.0 motor platform.

MacroAir X Series Fans: MacroAir has two fan platforms - Commercial and Industrial Grade. MacroAir, located in California, USA, does not manufacture its motors. Macroair's direct-drive motors manufactured by ETM (Electric Torque Machines), or some other manufacturers and Induction motors are standard off the shelf motors. This fan uses an AC induction motor with a sealed 2-stage helical gearbox. Motor controls are not power factor corrected and do not use field-oriented controls or space vector modulation, which are the latest state of the art controls. Table 1 below summarizes the two platforms.

Table 1: Summary of 16' HVLS/Industrial Fan Comparison

For Ø16 ft. (4.9m)	***Epoch 2.0***	***MacroAir X Series***
Diameter (ft./m)	6ft to 24ft	8ft to 24ft
1. Motor Technology	Latest Technology - EDFS-PMSM	*Transverse Flux - BLDC*

2. Controls	Power Factor Corrected, Field-oriented Controls with Space Vector Modulation (PFC + FOC + SVPWM)	*Scalar – BLDC Controls*
3. Input Power (hp)	1.5 hp Max	1.25 hp
4. Sound Level (dB) at Max Speed	<35	58
5. Torque (Nm)	140 Nm	54 Nm
6. Input Current (A) @208-240V Single Phase	4.5	6.1A
7. Power Factor Correction	Yes	No
8. Power Factor	0.99	<0.6
9. Smartphone Interface	Yes	No
10. Weight (kg/lbs)	72/158	87.1/192
11. RPM	95	90
12. Coverage Area (ft 2)	12,000	12,000 - doubtful because low torque produces low

		air flow with less area coverage
13. Air Flow (CFM)	4,00,000 – 4,50,000	Not Specified
14. Input Voltage Range	180 - 277V	208-240V Need Voltage Stabilizer
15. Dynamic Blade Adjustments	Yes	No
16. Analog Controls	Yes	No
17. Number of Blades	3 or 5	6
18. External VFD	Yes	Yes
19. Integrated Motor Inverter	Yes (Optional)	Yes
20. Blade Profile and Material	Airfoil Design / Anodized 6061-T6 Aluminum	Extruded Anodized Aluminum Airfoil
21. BACnet	Yes (Optional)	Yes
22. Fire Control Panel Integration	Yes	Yes
23. Building Management System Integration	Yes (Optional)	Yes

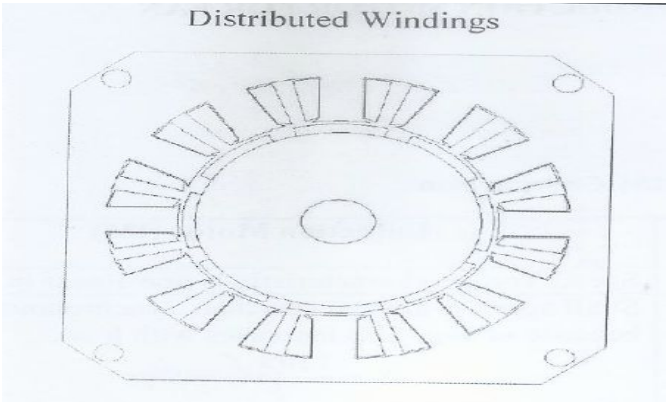
24. Touchscreen Console	Yes (Optional)	Yes
25. IP Rating	IP 65	IP 65
26. Design Safety Standards	UL507, UL1004, UL508C	UL507
27. Safety Certifications	UL 507, CE	UL 507
28. Life Expectancy	More than 100,000 Hours	Not Specified
29. Warranty	1-15 Years, Extended warranty is available	1-7 Years
30. Cost of Repair	Low	Very High
31. Lifetime Cost (OPEX)	Low	Very High
32. Forward and Reverse Operation	Yes	Yes
33. Optional color	Various accent colors (available)	Yes
34. Awards	CII	NO

Discussion on the Comparisons: In the table above, we have highlighted the various advantages for each of the companies. Let us discuss each of the items below.

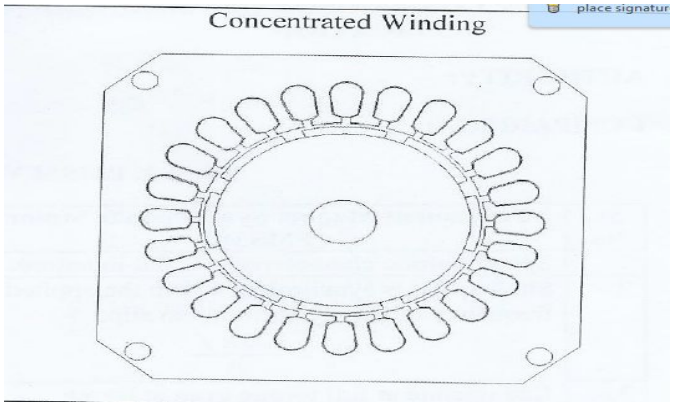
1. **Motor Technology:** Epoch fans are built using expanded diameter fractional slot permanent magnet synchronous motor technology (EDFS-PMSM) which helps to improve efficiency and reduce the cost of HVLS fans dramatically. MacroAir's fan uses ETM's transverse flux motor technology. Transverse flux technology benefits are as yet unsubstantiated in the known technical literature and the author's experience.

Falco Epoch 2.0 with Direct Drive PMSM motor

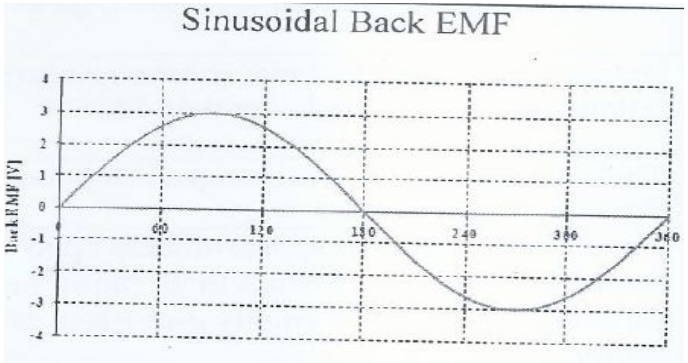
Macroair X Series with Heavy Induction Motor



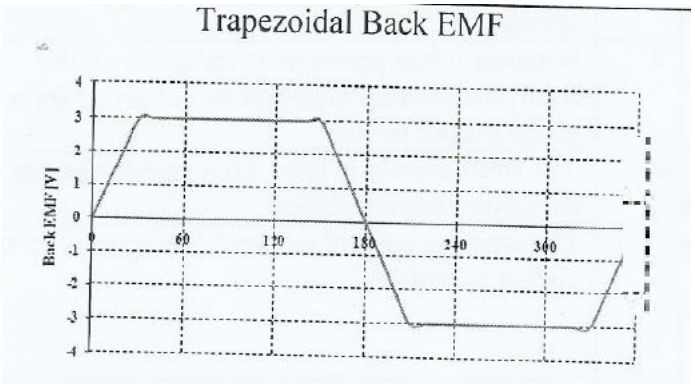
Distributed winding of OMSM motor



concentrated winding of BLDC motor



Sinusoidal Back EMF



Trapezoidal Back EMF

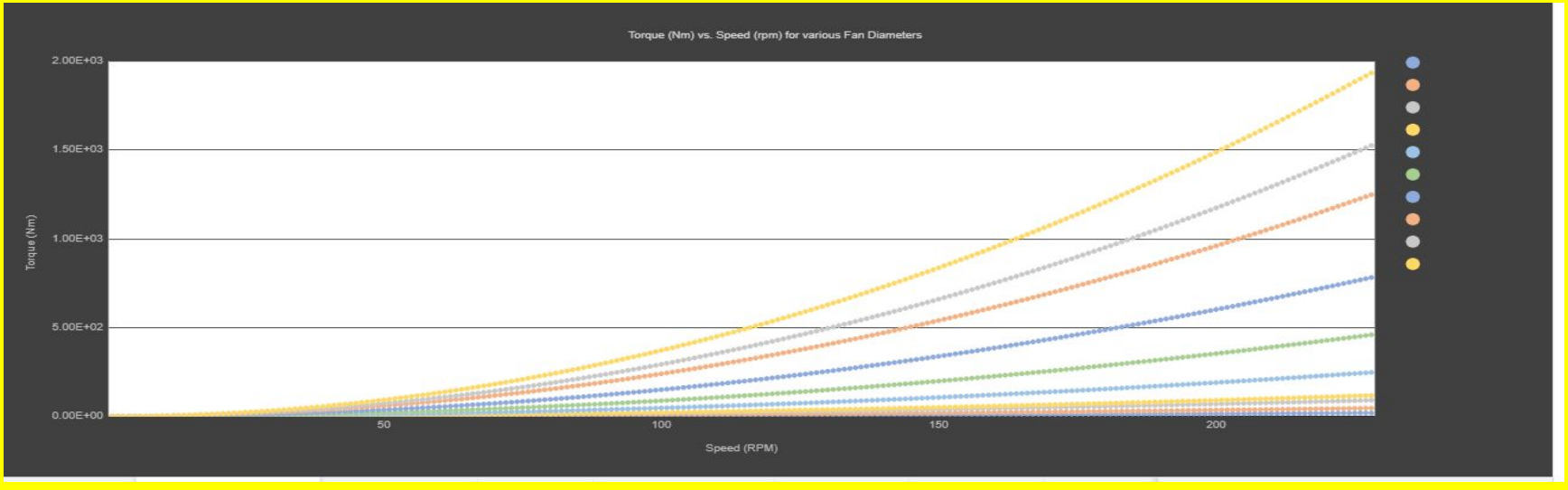
Difference in Gear less (Epoch 2.0) vs Geared (Macroair X series)

2. Control: Epoch 2.0 Fan use state of the art power factor corrected field-oriented control with space vector modulation, which further enhances efficiency. It significantly reduced the cost of manufacturing and operations. MacroAir's X Series fans use non-power factor corrected scalar controls for standard BLDC motors. These controls are known to draw utility current with very high harmonics causing significant loss of efficiency and increased operating cost.

3. **Power (Watts and hp):** The Output power of a fan is a good indicator of the amount of available airflow. Macroair X Series fan power is 1.25hp against Epoch 2.0 fan 1.5hp. Macroair X Series fans produce 20% less air than Epoch 2.0 fans.

4. **Sound Level (dB) at Max Speed:** Because Epoch 2.0 Fans use EDFS-PMSM technology with PFC-FOC-SVPWM controls, the sound levels at max speed are less than 35dB as compared to MarcoAir's 58dB. We have the quietest fan in the world.

5. **Torque (Nm):** MacroAir X Series using an Induction motor that needs lots of power to operate, as its weight is also more than Epoch fan. The Torque given by Macroair is 54Nm, which is less against Epoch 2.0 HVLS fans for Ø16 ft. Because Torque is less, it produces less air. Please see the chart below: Chart of Torque vs. Speed



6. **Input Current (A):** MacroAir's fan draws five times more current i.e., 6.1A versus 4.5A against Epoch 2.0 Fans.

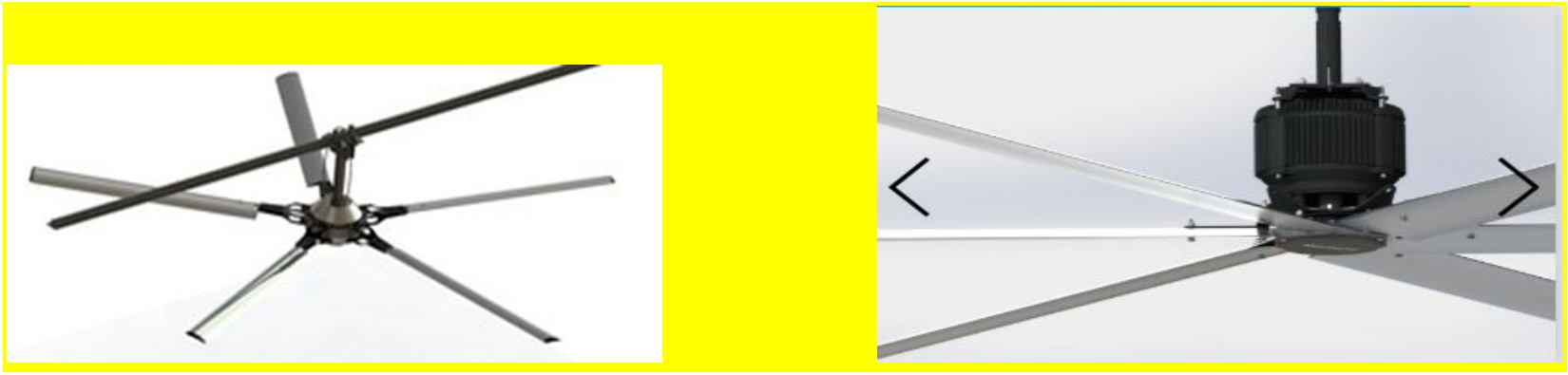
7. **Power Factor Correction:** There is no power factor correction built-in for MacroAir X Series fans causing substantial power consumption during the fan operation. Epoch 2.0 Fans have built-in power factor correction.

8. **Power Factor:** Epoch 2.0 Fans operate with a 0.97 to 0.99 power factor resulting in significant efficiency and cost savings. Such is not the case for MacroAir X Series fans. The input power factor is unknown and is assumed to be 0.7 to 0.8.

9. **Smartphone Interface:** MacroAir X Series fans do not have a Smartphone interface for running or data logging. Epoch 2.0 Fans can operate with a smartphone app.

Falco Epoch 2.0 Smartphone App

10. **Weight (kg/lbs):** MacroAir X Series fans weigh 91.63/202 vs. 72/158 for Epoch 2.0 fans. The weight difference indicates that Epoch 2.0 technology is lighter than Macroair's old technology.



Sleek design of Epoch 2.0

Heavy and bulky design of Macroair X Series fan

11. RPM: MacroAir X Series fans can operate at 85 rpm at room temperature. However, their fans derate, and their derating not specified in their datasheet. Epoch fans do not derate and run at 95 rpm throughout the operating temperature range.

HVLS Fan and Air Flow

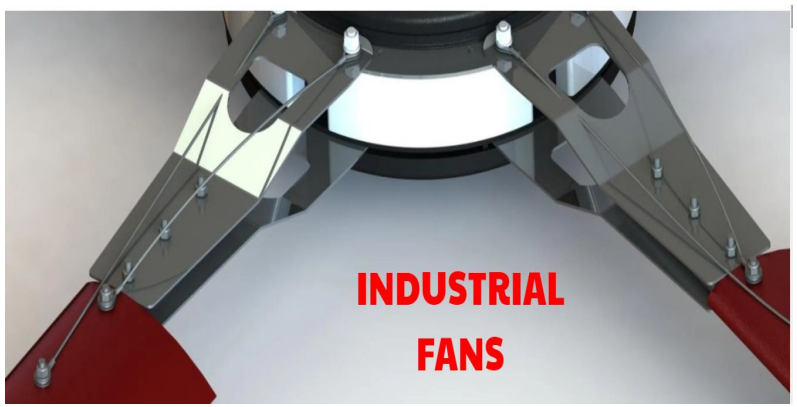
In HVLS fans generally, the volume of air supplied is given more weightage than the air-flow speed. According to the paper, effectiveness (cooling/destratification) of an HVLS fan is decide from the air velocity, not fan speed or CFM (volume of air displaced). The air velocity of the main jet flow is of more significance than the volume of air moved, which proved by using the ASHRAE thermal comfort tool. For air-flow of speed, 29.5 to 590.6 fpm needed to decrease the temperature of the skin of the workers working in the closed complex and reduce the temperature of the surrounding from 36 Celsius to 29 Celsius, Epoch 2.0 produces more than the required performance.

12. **Coverage Area (m2):** Epoch 2.0 Ø16 ft. Fan covers 12,000 sq. ft area, whereas Macoair X Series Ø16ft fan covers 12,000sq.ft area. We are doubtful about this figure because they state only 1hp power consumption. Less power produces less air.

13. Air Flow (m3/s): Epoch 2.0 fans produce the highest CFM 4, 00,000 to 4, 50,000CFM, MacroAir X Series has not disclosed the airflow figure. Epoch HVLS fans recorded the highest CFM amongst the competitors.

14. Input Voltage Range: The Input voltage range for the Epoch 2.0 Fans is substantially more comprehensive. Although Epoch 2.0 Fans can operate from 90 to 277V input without any damage to the controls, the performance guaranteed between 200 and 264V, single-phase input. MacroAir X Series fans have an input voltage range of 208 to 240VAC.

15. **Dynamic Blade Adjustments:** Epoch 2.0 Fans employ adjustable blade technology with droop down and uplift mechanism. Such blades can weather the rotational stresses efficiently as compared to stiff blades. MacroAir X Series uses rigid blades. Also, adjustable blades produce efficient and broader air-flow areas as speed increases as compared to rigid blades.



Falco Epoch 2.0 adjustable blades

Macroair X Series Rigid blades

16. Analog Controls: Epoch 2.0 Fans come with analog controls with a built-in speed regulator for ease of operation. Such power is not available with MacroAir. The Epoch 2.0fan controls also have a built-in circuit breaker for added safety protection. Macroair uses analog

remote control. 

Analog Control of Epoch 2.0 HVLS fan

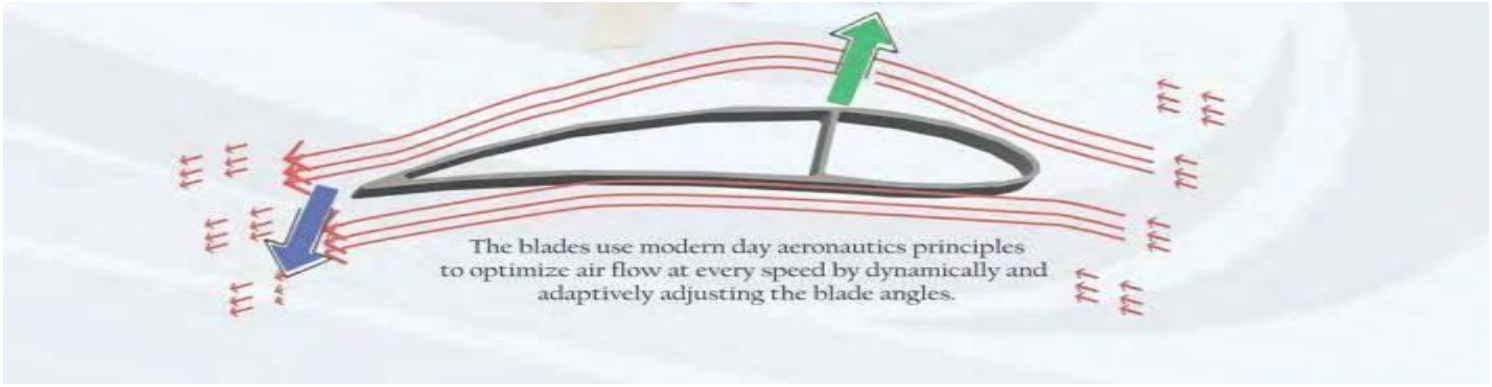
Macroair X Series Digital control

17. Number of Blades: Epoch 2.0 Fans come with 5-blades as compared to MacroAir six blades. Because of the built-in de-rating in MacroAir X Series fans, MacroAir X Series uses 6-blades to minimize the power consumption. However, that also drastically reduces the air-flow. Six blades can produce good air-flow, but they also create noise and even sound harmonics, which cannot cancel. Epoch's use of 5 fans produces good air-flow without producing harmful sound harmonics and turbulence resulting in high efficiency.

18. **External VFD:** Both the fans have an external VFD.

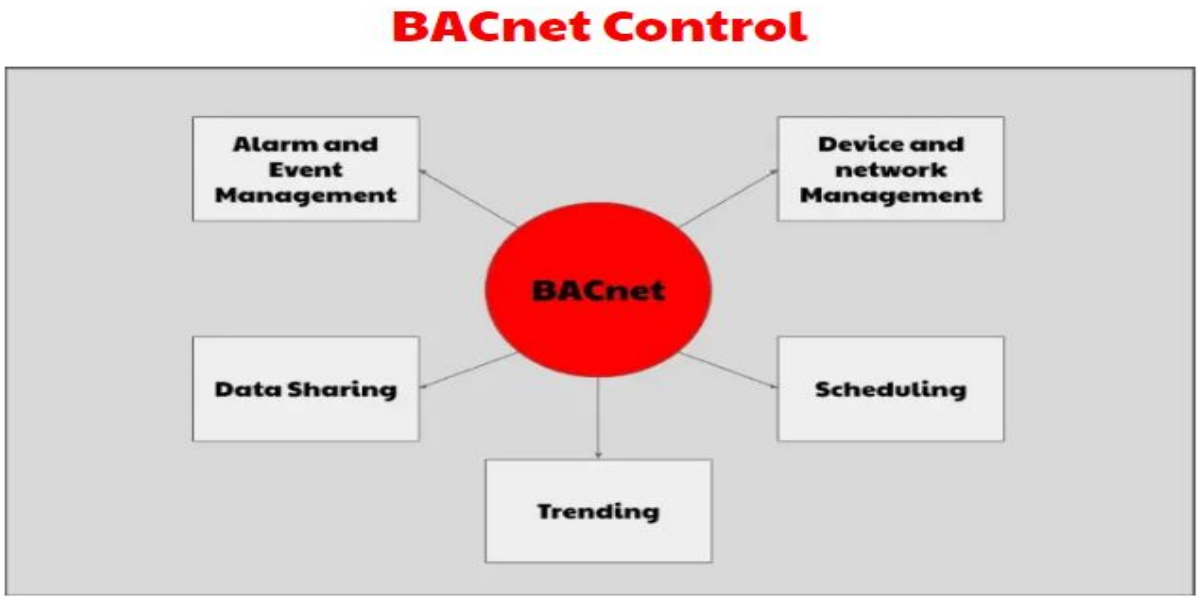
19. **Integrated Motor Inverter:** MacroAir X Series fans come with integrated controls. Epoch 2.0 Fans are available with updated built-in controls. The issue with the Macroair X Series integrated controls is that motor heating drastically lowers the electronics. Especially when the fan's full speed is required, MacroAir X Series controls can begin to slow down the rate with increased motor heating. As the summer temperatures rise, MacroAir X Series fans run slower.

20. **Blade Profile and Material:** Blade profile and material for both the manufacturers are equivalent to airfoil blades and aluminum T6061 material.



Blade Configurations of Epoch HVLS fan

21. **BACnet:** Falco Epoch 2.0 fans have a BACnet control system. The Below figure will show its features. Macroair X Series fans do not provide this.



Falco Epoch 2.0 BACnet control features

22. **Fire Control Panel Integration:** Both the manufacturers have the Fire control panel system integration provision.

23. **Building Management System Integration:** Standard building management system integration is available from both the manufacturers.

24. **Touchscreen Console:** Standard touchscreen controls are available from both the manufacturers.

25. **IP Rating:** Both fans rated with an IP65 rating.

26. **Design Safety Standards:** Epoch 2.0 Fans designed for UL507, UL1004, and UL508C safety standards. MacroAir X Series fans intended for the UL507 safety standard.

27. **Safety Certifications:** Epoch 2.0 Fans have undergone safety testing at Intertek Laboratories in Dallas, Texas, USA. Epoch 2.0 Fans have UL507 and CE certification. Macroair fans have UL certification.

28. **Life Expectancy:** MacroAir X Series fans not disclosed life expectancy. Epoch 2.0 Fans have a life expectancy of more than 100,000 hours.

30. Cost of Repair: MacroAir X Series fans have a high cost of repair because of integrated controls. Integrated controls have lower life expectancy because of elevated temperatures of operation. Every repair requires expensive scissor lift or scaffolding, resulting in substantial downtime for the customer. Such is not the case for Epoch 2.0 Fans. Epoch 2.0 motor has a life expectancy of more than 100,000 hours, and because they are not de-rate due to overheating, controls last much longer than those MacroAir's controls.

31. **Lifetime Costs:** Lifetime costs for MacroAir X Series fans are incredibly high. Given the high-power consumption, the high cost of acquisition, the high cost of repair, and the likelihood of a failure due to de-rating, lifetime costs for MacroAir X Series fans are incredibly high.

32. **Forward and Reverse Operation:** Forward and Reverse operation is available from both the manufacturers.

29. **Warranty:** Epoch 2.0 Fans provides the highest warranty than the Macroair fan.

33. **Optional color:** Optional colors are available from both the manufacturers.

34. **Awards:** Falco eMotors got the most innovative company award i.e., CII award 2019 among the top organizations in India.

CII Award to Falco eMotors for the most innovative company 2019

Table 2: Power Factor Saving Calculator of 16' HVLS Industrial Fan in Comparison with Macroair fans

Power Saving Report for 16 Feet/ 01 fans

	Epoch	*Macroair*	Savings (₹)	Savings (USD)
Quantity	1	1		
Fan Diameter	16-ft	16-ft		
Pin (W)	950.00	1,100.00		
Pin (VA)	950.00	2,200.00		
Total W	950.00	1,100.00		
Total VA	950.00	2,200.00		
Operational Hours (Daily)	24.00	24.00		
Daily Power Consumption (kWh)	22.80	26.40		
Daily Power Consumption (kVAh)	22.80	52.80		
Cost/kWh (₹)	9.00	9.00		
Cost/kVAh (₹)	9.00	9.00		
Daily Cost (kWh) in ₹	₹205.20	₹237.60	₹32.40	$0.46
Daily Cost (kVAh) in ₹	₹205.20	₹475.20	₹270.00	$3.86
Operational Days (Monthly)	30	30		
Monthly Cost (kWh) in ₹	₹6,156.00	₹7,128.00	₹972.00	$13.89
Monthly Cost (kVAh) in ₹	₹6,156.00	₹14,256.00	₹8,100.00	$115.71
Operation Days (Yearly)	365	365		
Yearly Cost (kWh) in ₹	₹74,898.00	₹86,724.00	₹11,826.00	$168.94
Yearly Cost (kVAh) in ₹	₹74,898.00	₹173,448.00	₹98,550.00	$1,407.86

Conclusion: This paper recommends Epoch 2.0 Ø 16 ft. Fans for various reasons. Primary reasons being high performance, high efficiency, high reliability, high technology, lower cost of acquisition, operation and maintenance, and make in India availability.