

MAC10 – FFU CONTROL SYSTEM

February 2007



ENVIRCOTM

C O R P O R A T I O N

Innovators in clean air technology

“Smart” MAC 10 XL

AC Control Built-In

Now in Stock!!!

- “Smart-FFU” Solid State Speed Control
- Standard 2 x 4 format



<VariPhase Inside>



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MAC10 part numbers

120 V 11111-055

220V 11111-056

277V 11111-057

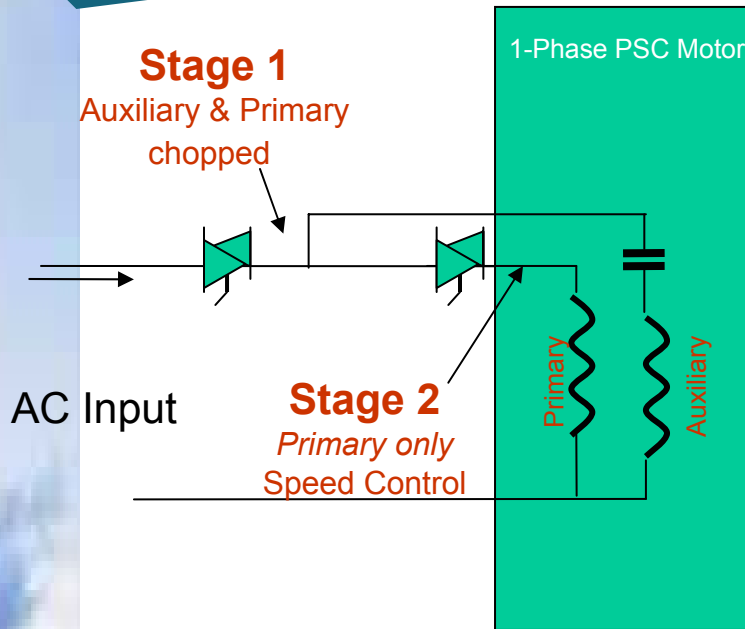


AirCare VariPhase™ μ-Processor Based AC Motor Controller Offers

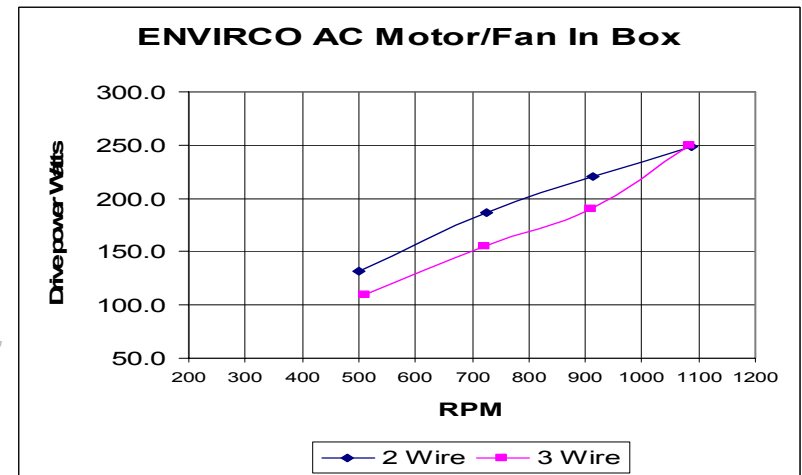
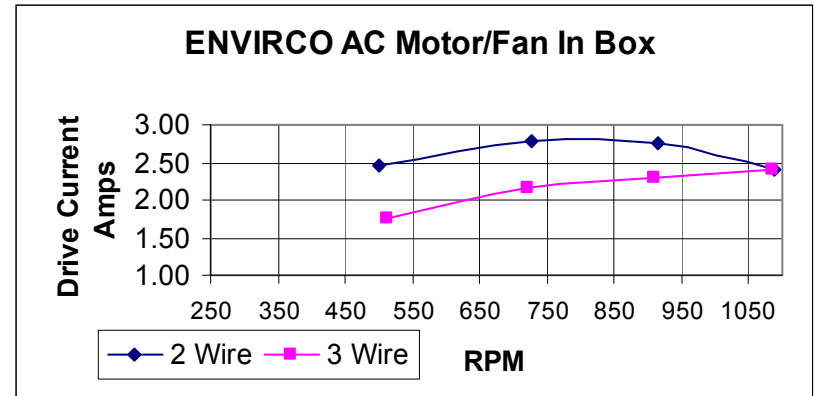
- Linear speed control
- Increased efficiency
- Reduced system noise
- User programmable soft-start function
- Integrated error reporting
 - eg, differential pressure switch
- Minimum motor speed setting
- Closed-loop system controls w/ PID
- Network interface – MODBUS
- ‘Plug and Play’ installation



Unique 3-Wire Topology for Phase Control

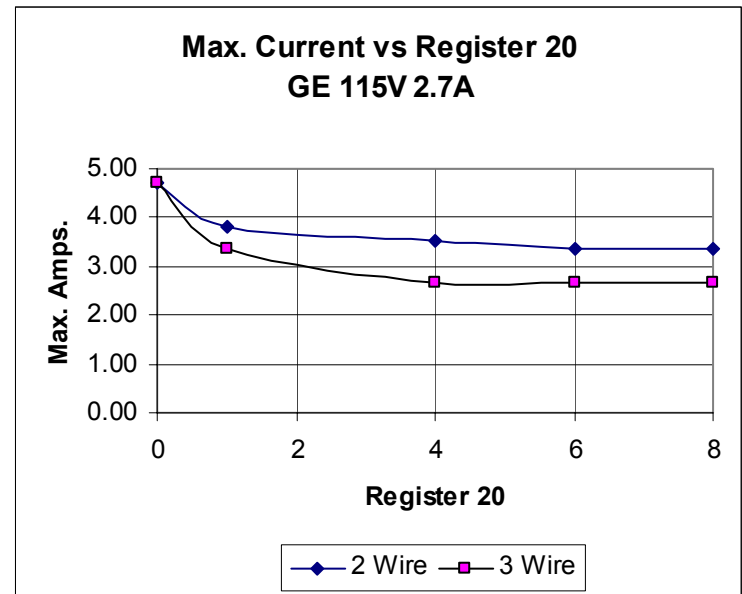
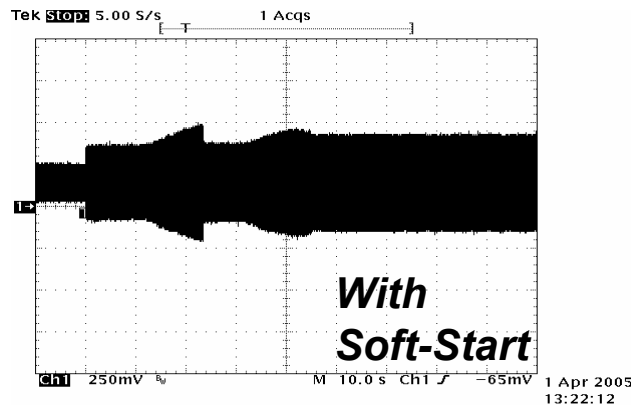
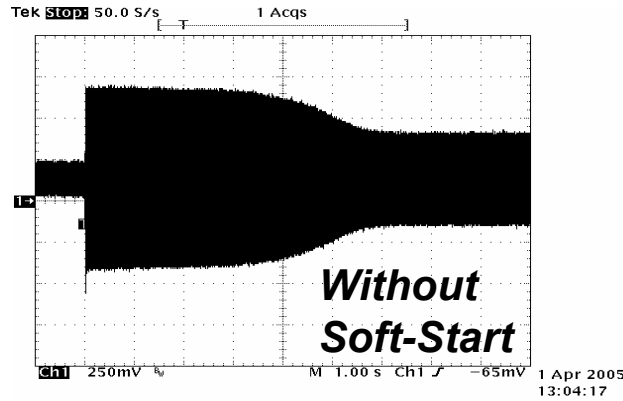


AirCare 3-wire topology:
reduces current rise in motor;
reduces motor heating;
reduces motor hum;
reduces power consumption.



Reduce Start-Up Currents by Half (or more)

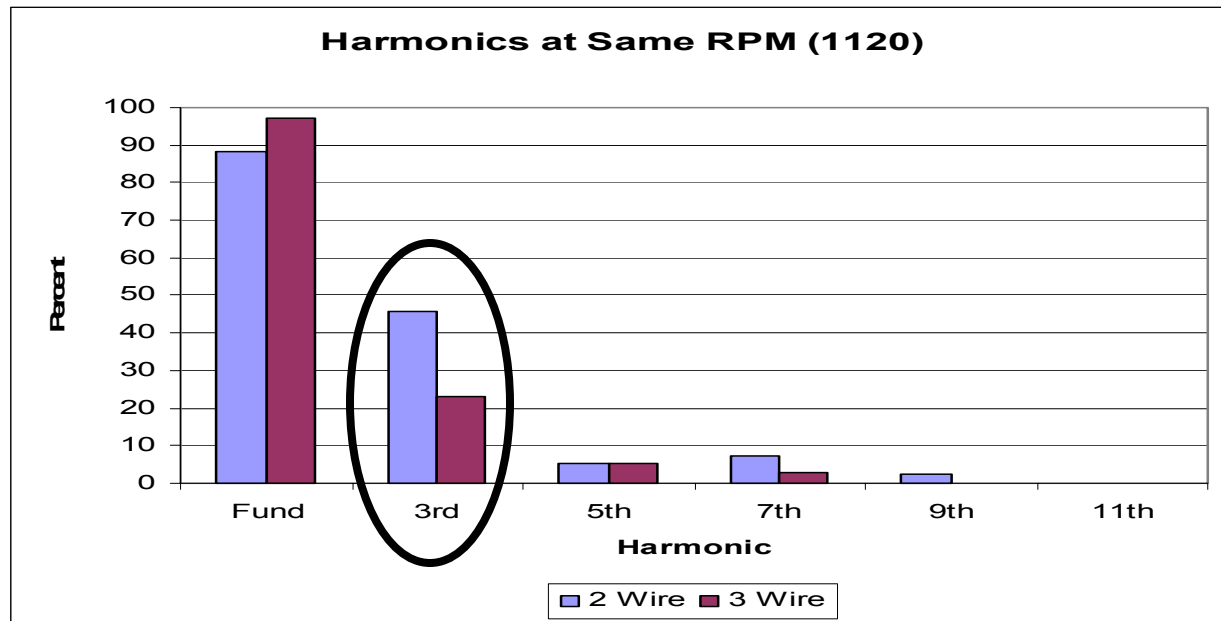
Soft-start saves significant installation costs and enhances long-term operating reliability.



Soft-Start – “Register” select Set-Up allows factory-set delay and rise time.

AirCare 3-wire Topology reduces 3rd Harmonic

Quieter Operation

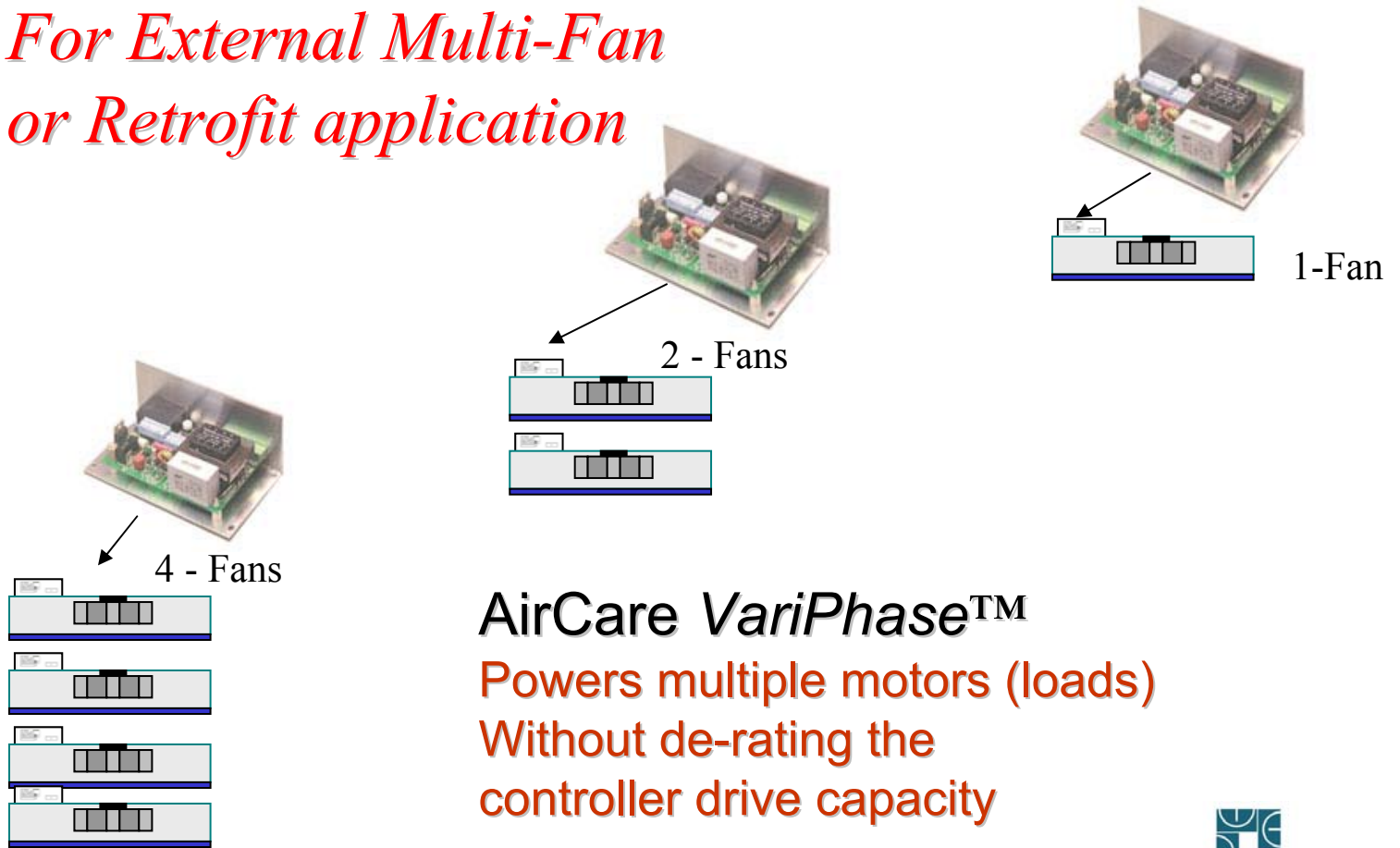


AirCare 3-wire design results in quieter and more efficient operation of the fan motor.

This is a result of significantly lower 3rd and higher harmonics compared to conventional controllers which use a 2-wire connection.

AirCare *VariPhase*TM – Multi-Fan Platform

*For External Multi-Fan
or Retrofit application*



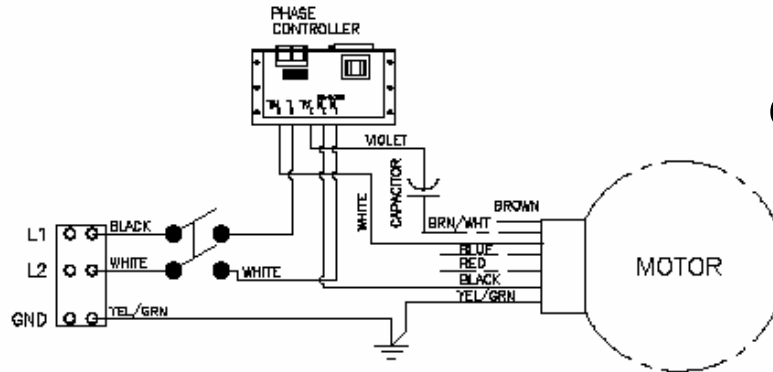
AirCare *VariPhase*TM

**Powers multiple motors (loads)
Without de-rating the
controller drive capacity**

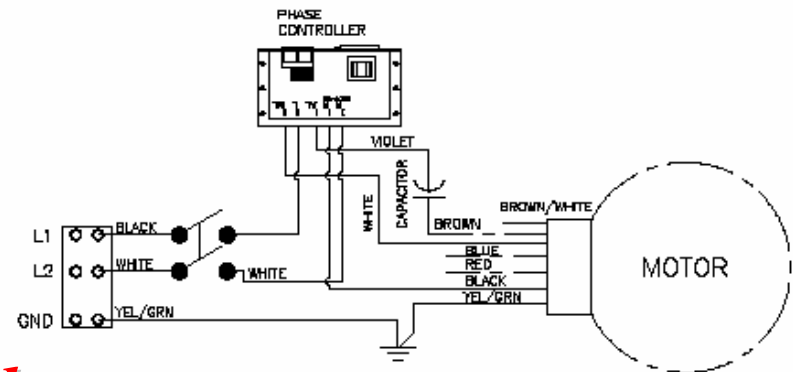
ENVIRCO MAC10 XL

3-wire connection

3-wire connection scheme uses existing motor connections without adding cost or complexity.



BROAD OCEAN MOTOR WIRING DIAGRAM



G.E. WIRING DIAGRAM

***Rewire Existing/Stock
MAC10 Standard in minutes!!!***

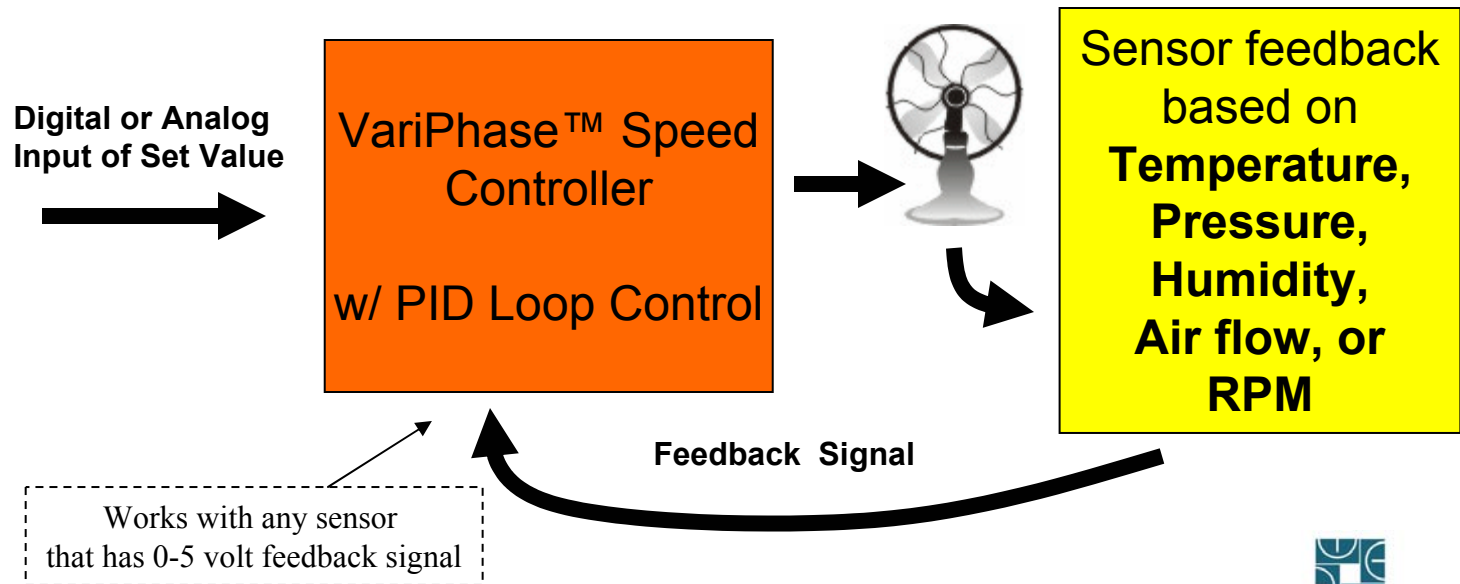


CLOSED LOOP CONTROL

Flexible Feedback with PID loop

AC Solution

AirCare VariPhase™ employs an adjustable PID algorithm to ensure stable and optimal control of fan speed based on feedback from a wide range of conventional sensors.



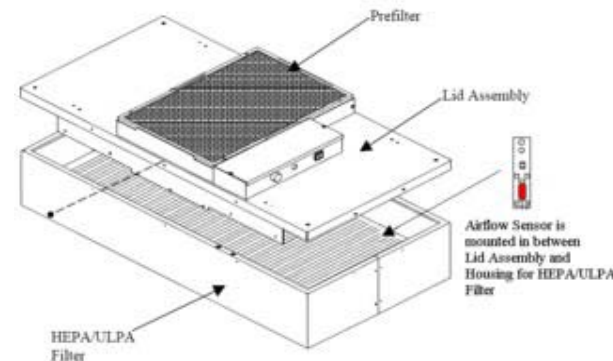
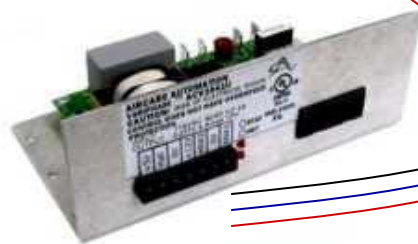
AirCare's Air Flow Sensor for Closed-Loop Speed Control

AC Solution

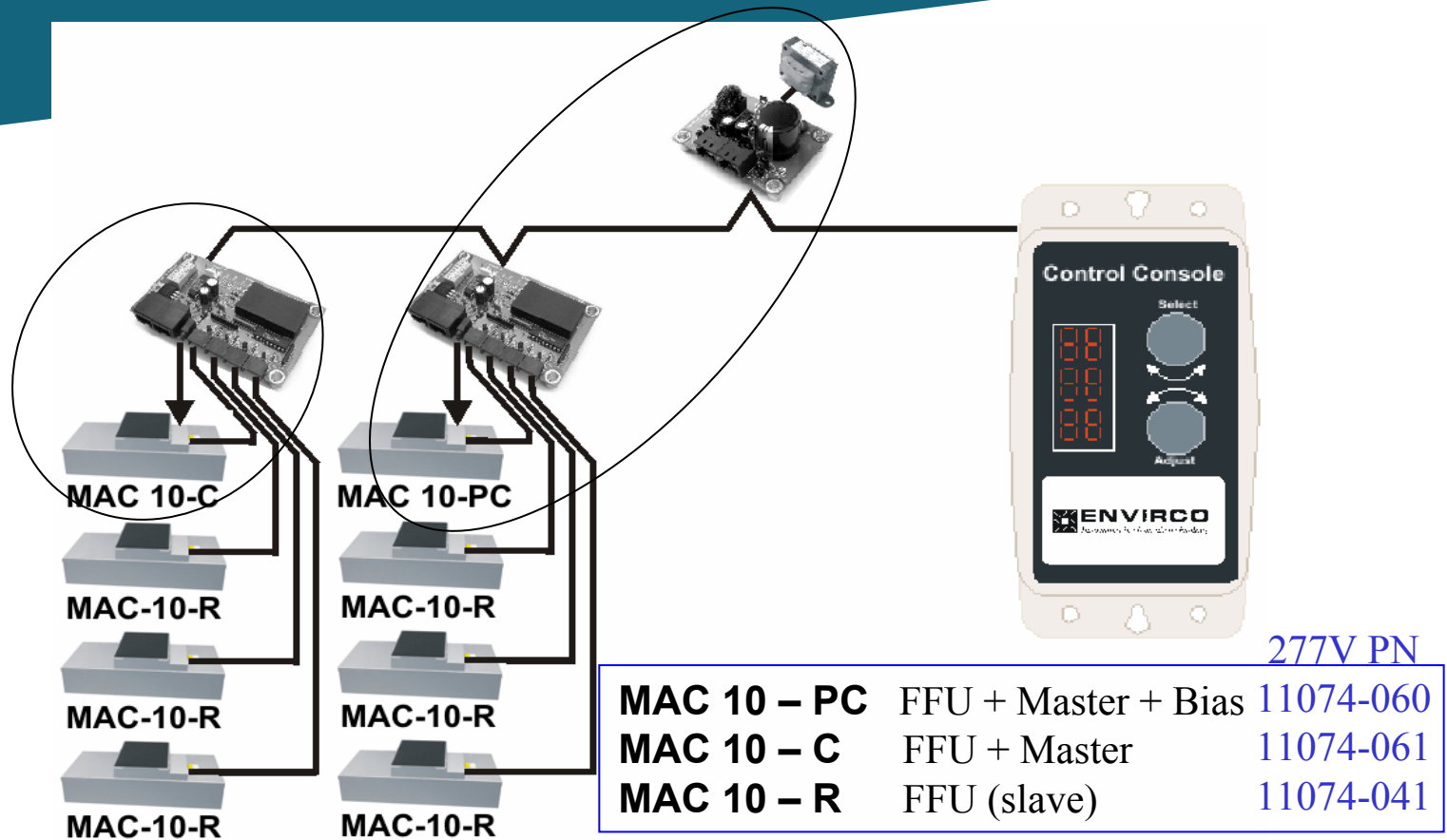
The ultimate low-cost solution for advanced sensing & control in FFUs.



AirCare's air flow sensor w/ sender connects directly to the Variphase controller via twisted pair cable.



Mac 10 IQ Smart System Part Number



System Reqts.

3 – MAC10-R for every group of 4 FFU's

1 – MAC10-C for every group of 4 FFU's

1 – MAC10-PC replaces MAC10-C for groups of 16 FFU

Ask about 120V and 220V smart IQ part numbers



AirCare EC Motor Controllers for the MAC 10 IQ

EC Solution

- **ACM1004**: Control interface module up to 4 GE-EC motors (MAC 10 IQ FFUs) on MODBUS LAN.

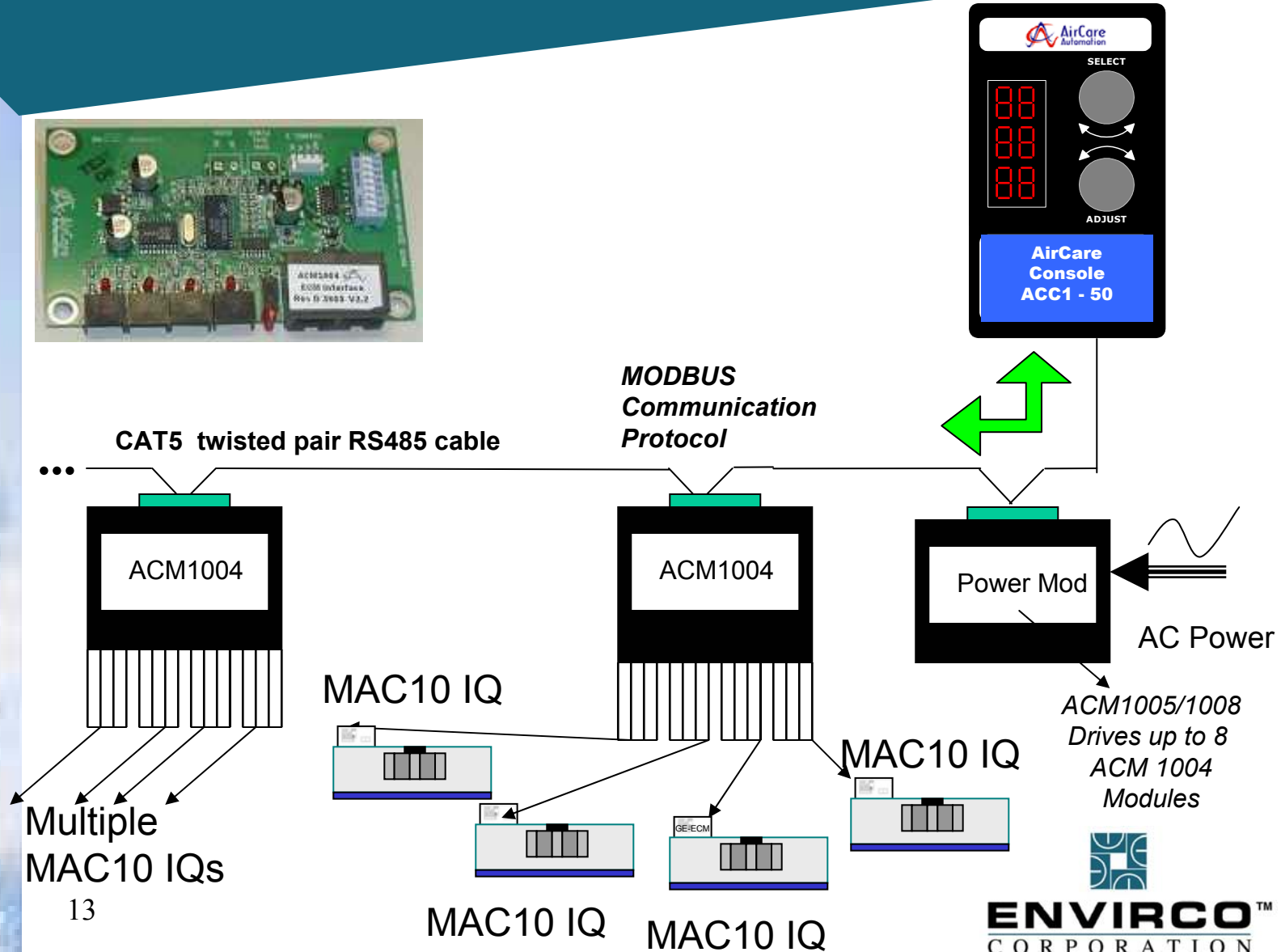


- **ACM1014**: Closed-loop control module for a single MAC10 IQ on MODBUS LAN.



ACM1004: GE-ECM Interface Module

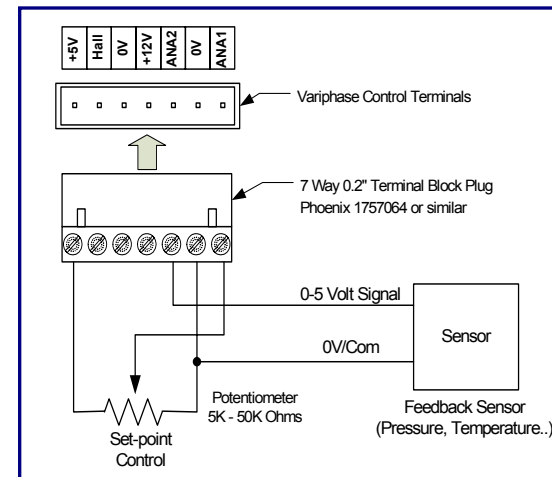
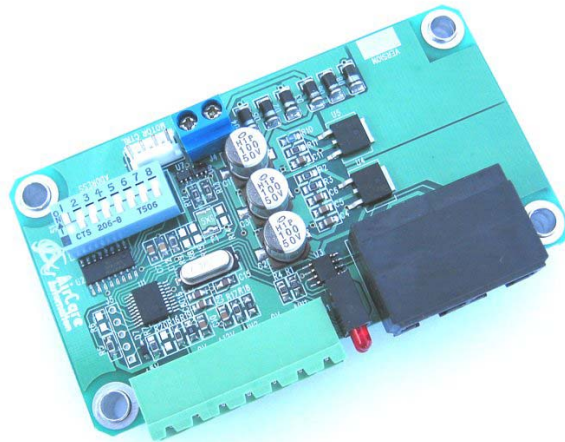
EC Solution



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ACM1014: Closed-Loop GE-ECM Control ^{EC Solution} for the MAC 10 IQ

Single Channel ECM Control to interface with GE-ECM motors



ACM1014 provides dedicated control of Each FFU, providing analog
Or digital interface and local closed loop self-correction mode.

ACM1014 enables FFU operation as:

- ❖ Manual Control of FFU using low-cost speed potentiometer
- ❖ Closed loop control of the FFU using external sensor
- ❖ Network Control and interaction using MODBUS protocol

Network Control Options

- AirCare Consoles™
 - ACC1-1 global command
 - ACC1- xxx 1-zone
 - ACC2- xxx 2-4 zones
- Peripheral Options
 - ACM1007 Hi/Lo
 - ACM1007 Emerg. Shut-down
 - ACM1009 Alarm Relay



AirCare Small System Network Product Family

LAN
Solution

- Supports small network “groupings” of 1 to 500 units
- Based on industry standard MODBUS protocol
- ‘Plug and play’ design
- Easy to master user interface
- Features and functions tailored to clean room applications
- Consists of:
 - ACC1-xxx, ACC2-xxx consoles for network control
 - ACMxxxx peripheral modules for external interface

AirCare Small System-Console Family ACC1 & ACC2

LAN
Solution



ACC1 – xxx
Single-Zone Console
10, 25, 50, 125 address
(also ACC1-1 global control)

ACC2 – xxx
1 – 4 Zone Console
125, 250, 375, 500 address



AirCare Small System Network Functions Tailored to Clean Room Applications

LAN
Solution

- Individual Fan Speed Setting
- Global Set Back (one step back for all fans in % for each zone)
- Global Emergency Shut-down (one step shut-down of cleanroom)
- Network Monitoring & Alarm-Relay Driver (error detection and alarm trip)
 - Differential Pressure Switch (AC - normal open/closed monitoring)
 - RPM monitoring (GE-EC motor monitors rpm activity)
- Global Speed Settings (easy set-up with global commands)
- User-Level Enable via Code Access (Four (4) Access Levels of Control)

AirCare Small System Network System Features

LAN
Solution

- Supports small networks
 - ACC1 - 1 zone global, 10, 25, 50 and 125 address control
 - ACC2 - up to 4 zones with 125 addresses per zone
- MODBUS LAN fieldbus
 - Industry standard for small network architectures
 - Open-access standard: easy adaptation to custom systems
 - Gateways available to other common fieldbus systems
- True 'Plug and Play' Design
 - Self-initiating network set-up and device recognition
 - No install configuration required
 - No complex parameter programming
- Simple User Interface
- Easy wall-mount / robust-housing

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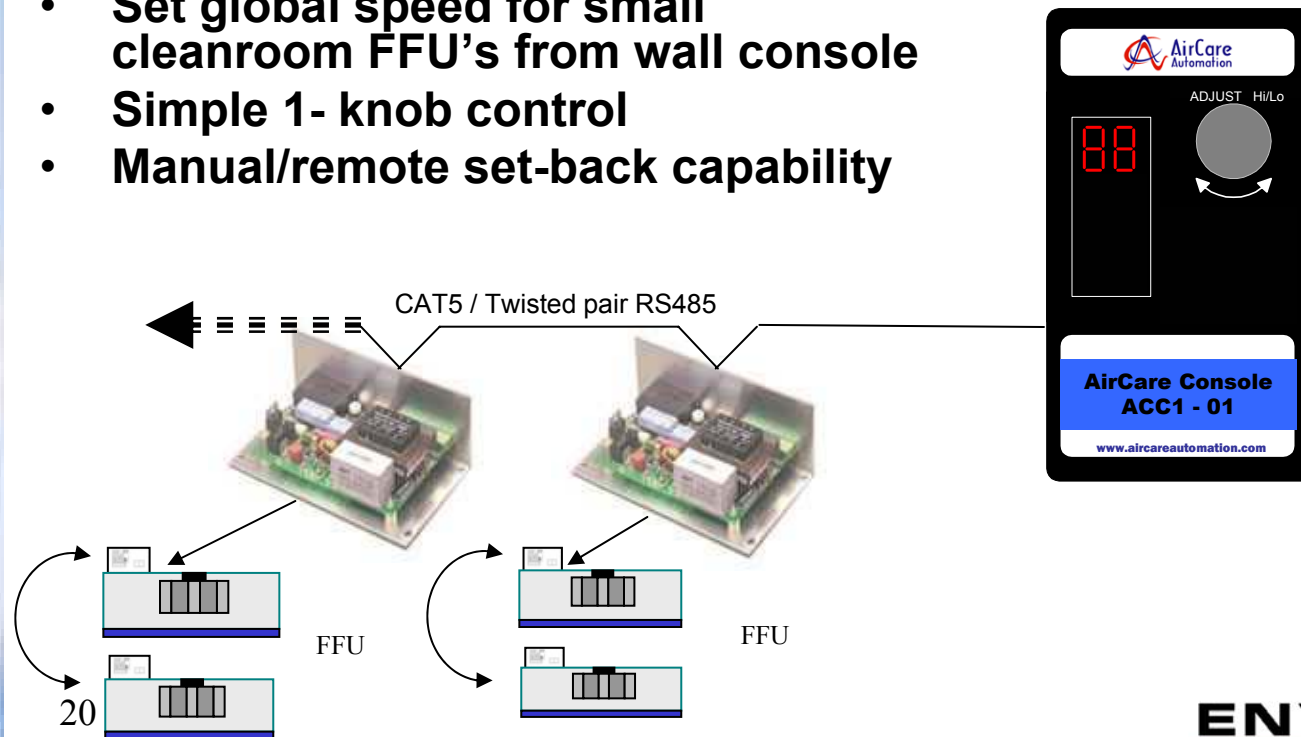
AirCare Small System-Console Family

ACC1-1: Global Network Control

LAN
Solution

ACC1-1 Console provides lowest cost solution for simple global control of AirCare networked fan controllers.

- **Set global speed for small cleanroom FFU's from wall console**
- **Simple 1- knob control**
- **Manual/remote set-back capability**



AirCare Small System Network

Peripheral Modules: Building Management Interface

LAN
Solution

- ACM1007: Remote **High-Low** Interface
 - manual activation or interface to Building Management System
- ACM1007: Remote **Emergency Shut-Down** Interface
 - (manual activation, BMS interface)
- ACM1009: Alarm Relay Driver Interface (set off alarm)
 - (manual, BMS interface)
- AirCare System Information Protocol Option
 - (BMS interface)

Cost Savings Analysis

- **Cost Adders:**
 - Console cost adder
 - ACV1xxx VariPhase Units (1, 2 or 4 FFU per VariPhase)
 - Installation Cost Adder
- **Savings Expectations:**
 - Installation Cost
 - Reduced number of power grids/breakers
 - Balancing Cost – reset/adjust Cleanroom
 - Speed adjustment and room certification
 - Run-energy savings
 - 3-wire reduced power consumption at lower speeds
 - Set-Back Energy Savings
 - Fan set-back saves energy in each fan and extends filter life.

“Smart” Small Cleanroom Systems pay for themselves rapidly and enhance performance

Installation – Electrical Wiring Cost Impact

Initial Calculation - 5-6 FFU units

- loading per AC line if you use plate rating

[assumes MAC10 XL – 115V AC , 3.0 ampere rating]

[AC line – 20 Ampere breaker max. current draw]

PROBLEMS

1) Max. run current at 85% speed=3.5 Ampere (above plate rating)

lose 1 unit – need to design to worst case current

2) Start up current > 5 ampere per fan

lose 1 more unit!! – using 20A rating at start-up; still support only 5

Real Loading – 3-4 FFU units

AirCare VariPhase Benefit – 5-6 fans

Soft-Start keeps peak current below 3.2 amperes.

3-wire operation keeps Max. current to plate rating

AirCare VariPhase™ allows more fans per AC breaker line;

Saving significant installation and electrician fees

TRIAC Control Energy Savings Payback

For a 50 controller w/o setback mode (one speed 24/7)

	<u>2 Wire Energy Saved</u>	<u>3 Wire Energy Saved</u>
Work saved watts=	25W	50W
Work hrs/wk=	168 hrs	168 hrs
Reduced kWh/wk=	10.0kWh	14.2kWh
Reduced kWh/yr=	520.0kWh	738.4kWh
\$ Saved/FFU/yr=	\$32.76	\$65.52
Utility \$/yr saved=	\$1,638.00	\$3,276.00

Work Hours Data

<u>High speed:</u>	<u>2wire</u>	<u>3wire</u>
% speed=	82%	82%
% power=	90%	80%
watts=	225	200

Reference Data

cost/kWh= \$0.15
full power= 250W



Energy Savings Payback w/Setback

For 50 controller w/console system - 9hr/day, 5day/wk operation

<u>Saved</u>	<u>2 Wire Energy Saved</u>	<u>3 Wire Energy</u>
Work saved watts=	25W	50W
Work hrs/wk=	45 hrs	45 hrs
Non work saved watts=	72.5W	97.5W
Reduced kWh/wk=	123 hrs	123 hrs
Reduced kWh/wk=	10.0kWh	14.2kWh
Reduced kWh/yr=	520.0kWh	738.4kWh
\$ Saved/FFU/yr=	\$78.00	\$110.76
Utility \$/yr saved=	\$3,900.00	\$5,538.00

Work Hours Data

<u>High speed:</u>	<u>2wire</u>	<u>3wire</u>
% speed=	82%	82%
% power=	90%	80%
watts=	225	200

Non Work Hours Data

<u>Low speed</u>	<u>2wire</u>	<u>3wire</u>
% speed=	64%	64%
% power=	71%	61%
watts=	177.5	152.5

Reference Data
 cost/kWh= \$0.15
 full power= 250W



MAC 10 IQ Energy ROI

energy cost comparison													
UNIT	COST	POWER											
XL 2x4	\$600.00	220	<table border="1"> <tr> <td>Step 1</td> <td>Enter the customer cost of each unit</td> </tr> <tr> <td>Step 2</td> <td>Enter the power consumption of each unit</td> </tr> <tr> <td>Step 3</td> <td>Enter the number of units in the job (for unit cost just enter a 1).</td> </tr> <tr> <td>Step 4</td> <td>Cell C8 gives the additional capital cost for the unit(s).</td> </tr> <tr> <td>Step 5</td> <td>Determine the customers cost of energy and enter the lable at that cost. Compare the energy savings in each column to determine the estimated payback period. If the additional cost is greater than all three columns then the payback exceeds 18 months.</td> </tr> </table>	Step 1	Enter the customer cost of each unit	Step 2	Enter the power consumption of each unit	Step 3	Enter the number of units in the job (for unit cost just enter a 1).	Step 4	Cell C8 gives the additional capital cost for the unit(s).	Step 5	Determine the customers cost of energy and enter the lable at that cost. Compare the energy savings in each column to determine the estimated payback period. If the additional cost is greater than all three columns then the payback exceeds 18 months.
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IQ 2x4	\$850.00	100											
No of Units	(\$250.00)	120											
1	(\$250.00)	← ADDITIONAL COST											

	6 MONTHS	12 MONTHS	18 MONTHS
	OP HRS	OP HRS	OP HRS
	4380	8760	13140
	KWH SAVED	KWH SAVED	KWH SAVED
ELEC COST	525.6	1051.2	1576.8
(\$/kwh)	ENERGY SAVINGS		
\$0.02	\$10.51	\$21.02	\$31.54
\$0.03	\$15.77	\$31.54	\$47.30
\$0.04	\$21.02	\$42.05	\$63.07
\$0.05	\$26.28	\$52.56	\$78.84
\$0.06	\$31.54	\$63.07	\$94.61
\$0.07	\$36.79	\$73.58	\$110.38
\$0.08	\$42.05	\$84.10	\$126.14
\$0.09	\$47.30	\$94.61	\$141.91
\$0.10	\$52.56	\$105.12	\$157.68
\$0.11	\$57.82	\$115.63	\$173.45
\$0.12	\$63.07	\$126.14	\$189.22
26 \$0.13	\$68.33	\$136.66	\$204.98
\$0.14	\$73.58	\$147.17	\$220.75
\$0.15	\$78.84	\$157.68	\$236.52



“Smart” Cleanroom Benefits

- **Low Cost Network System**
 - Out-of-the-Box system solution control FFU from wall console
 - Re-configure/adjust FFU’s to meet room certification in minutes
- **Energy Savings**
 - Lower power usage at lower speed
 - Optimize fan speeds so do not waste energy by overdriving cleanroom
 - Set back FFU’s during off hours [one command set-back option]
 - Saves energy
 - Extends filter life (lowers filter replacement cost)
- **Improved Performance during speed reduction**
 - Linear speed adjustments – easy change
 - Eliminates current increase during speed reduction
 - Reduces “hum” of motor significantly during reduction
- **Reduced 3rd Harmonic for same airflow**
- **Reduced installation/ run cost**
 - Electrical wiring installation reduced with soft-start and 3-wire
 - Balancing and certification adjustments done quickly
 - Motor and filter life extended
 - Optimized air flow control uses only the power needed (energy conservation).