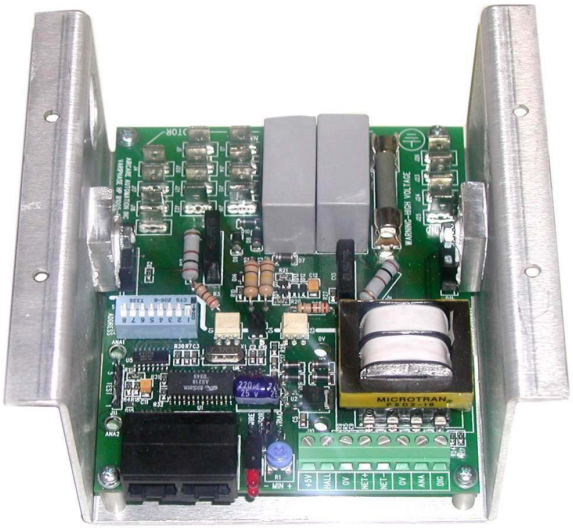
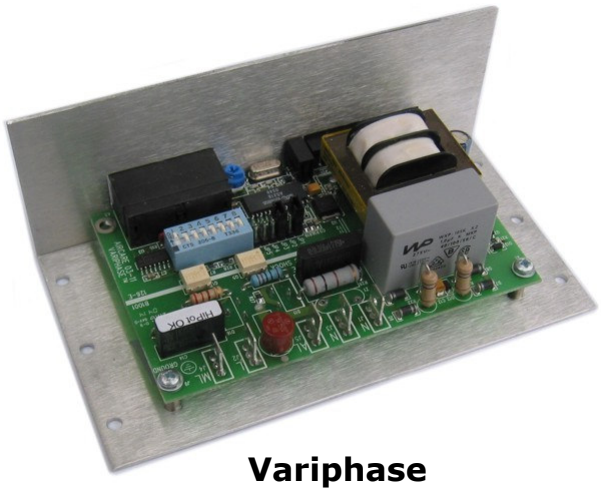
AirCare VariPhase™

User Manual



Variphase HP



Variphase

ACV1xxx Family of MODBUS® Equipped
Speed Controls for Fans and Blowers
2-14 Amperes

www.aircareautomation.com

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MODBUS® is a registered trademark of Schneider Automation

Product Overview

AirCare *Variphase*™ controls combine intelligent speed control with industry standard MODBUS® networking. The versatile design allows for either analog (0-5V or 20mA loop) or network speed control.

In network mode, each VariPhase™ unit is assigned a unique address. By linking Variphases together with networking cables, a Zone of up to 125 units can be built. Each unit can then be precisely controlled from a single AirCare Console™. Consoles models support up to 4 zones, or 500 Variphases in total.

For optimal efficiency and reduced acoustic noise, Variphase models include intelligent Auxiliary winding control using a 3rd wire to the motor. Permanent Split Capacitor (PSC) motor loads can be connected in three-wire mode, or wired conventionally for standard operation.

Variphase's closed-loop control capability supports a wide range of sensors including air-pressure, temperature and tachometers. In closed-loop mode, Variphase precisely adjusts motor speed using a PID loop to maintain a set-point.

Installing a distributed network of AirCare controls is simplified by flexible wiring options and diagnostic LEDs. AirCare can also be controlled from an analog signal source.

Variphases come in three form factors, depending on their current rating. Variphases rated at less than 2 amps are supplied as a board only and require 4 standoffs for mounting. From 3-6 amps, controls are supplied with a standard aluminum L-bracket that also serves as a heatsink. 16 amp Variphase's incorporate an extruded aluminum heatsink for robust thermal management. Optional covers provide NEMA1 level protection for all ratings.

Variphase HP has four sets of power terminals to simplify connection to up to four motors. In this configuration all four motors will be supplied with the same voltage and run at the same speed.

Variphase is a robust variable-voltage motor speed control. Internal algorithms precisely control motor voltage resulting in a wide speed range (typically 20-100%).

Part Numbers and Ratings

AirCare's Variphase line-up consists of 11 base part numbers covering ratings from 115V 1.7A to 277V 14A.

			Input / Max Output Voltage		
	Input/Output Current at 25°C (max)	**Ambient (max)**	**115Vac +/- 15%**	**230Vac +/- 15%**	**277Vac +/- 15%**
Variphase	**1.7 Amp**	25°C	ACV1021	ACV1022	
	3 Amp	40°C			ACV1033
	4 Amp	40°C	ACV1041	ACV1042	
	8 Amp	40°C	ACV1081	ACV1082	ACV1083
Variphase HP	**14 Amp**	25°C	ACV1141	ACV1142	ACV1143

- Refer to individual datasheets for complete information on model ratings.
- Some Variphase models have specific mounting requirements to achieve max current
- All parts operate from both 50Hz and 60Hz AC Line.
- 1.7 Amp models should be de-rated at 0.1 Amps per 3°C up to 40°C
- A 'U' suffix indicates UL listed product, other parts are UL recognized components

About this User Manual

This document contains information on installation and use of all Variphase models. For detailed voltage, current and temperature rating information, refer to individual datasheets. Separate Application notes provide additional information on Variphase configuration.

For detailed functional and configuration information for AirCare Variphase Controls refer the *Advanced Technical Manual*.

Safety

Important Information – please read first

- This product is an open frame design containing dangerous voltages. It should only be installed by trained personnel. The installer is responsible for ensuring that the control is safely installed for a particular application. Incorrect installation can result in a serious shock or fire hazard.
- Wiring should be checked before power is applied. Check that Low Voltage control wiring is sufficiently insulated from high voltage power wiring.
- The control is designed to operate up to 40ºC ambient temperature. Because factors such as airflow and orientation affect heat dissipation the installer should ensure that the heatsink does not exceed 70ºC worst case. Refer to individual datasheets for complete rating information.
- This control is not recognized for use as a motor protector. The attached motor must have its own recognized over-load protection device.
- The drive does not have over speed protection
- This product cannot be used in any equipment intended for life support.
- The type of motor control (on/off and speed) provided by this drive is not sufficient for safety-critical applications without additional mechanical/electrical interlocks.
- Where the control is approved as a recognized component, it is for use only in complete equipment where the acceptability of the combination is determined by an approved testing agency.

Compliance

AirCare Variphase products carry the following safety approvals. Model numbers not listed below are not presently agency approved.

Recognized Component
UL508c Power Conversion Equipment
CAN/CSA C22.2 No. 14-M91.
UL File number E241590.

ACV1021 ACV1022 ACV1033 ACV1041 ACV1042

UL Listed Device
UL508c Power Conversion Equipment
CAN/CSA C22.2 No. 14-M91.
UL File number E241590.

ACV1033U ACV1041U ACV1042U

Entela Certified Device
UL508c Power Conversion Equipment

ACV1081U ACV1082U ACV1083U

Installation

Because implementations vary, please read the relevant sections of this document thoroughly. Pay special attention to the safety warnings on Page 5.

The recommended procedure for installing and configuring a Variphase system is:

Networked System	Non-networked System
Select appropriate Variphase Model based on Voltage and Current Requirements (see Page 4)	Select appropriate Variphase Model based on Voltage and Current Requirements (see Page 4)
Select 2-wire or 3-wire motor control method (see Page 14-16)	Select 2-wire or 3-wire motor control method (see Page 14-16)
Select Control Console – Available separately from AirCare Automation Inc.	
Configure Option Jumpers (see Table 2)	Configure Option Jumpers (see Table 2)
Set each Variphase with a unique Modbus Address (see Page 8)	Mount and Enclose Variphase (see Page 19)
Mount and Enclose Variphase (see Page 19)	
Install Network Wiring (see Page 17)	Install Control Wiring from Potentiometer or other analog source (see Page 10-12)
Install Speed and/or Pressure Sensor if used (see Page 15 and application notes)	Install Speed Sensor (optional) (see Page 12 and application notes)
Install and check Power Wiring (see Page 14-16)	Install and check Power Wiring (see Page 14-16)
Power Up and Test	Power Up and Test

Table 1

Additional Information for Networked Systems

For large systems, we recommend testing small sub-systems before completing full-scale installation.

In some systems additional RS485 devices may be needed to resolve offsets in ground voltage and ambient noise. For large installations, consult AirCare Automation for advice on RS485 network configuration.

General Operation

Variphase Features

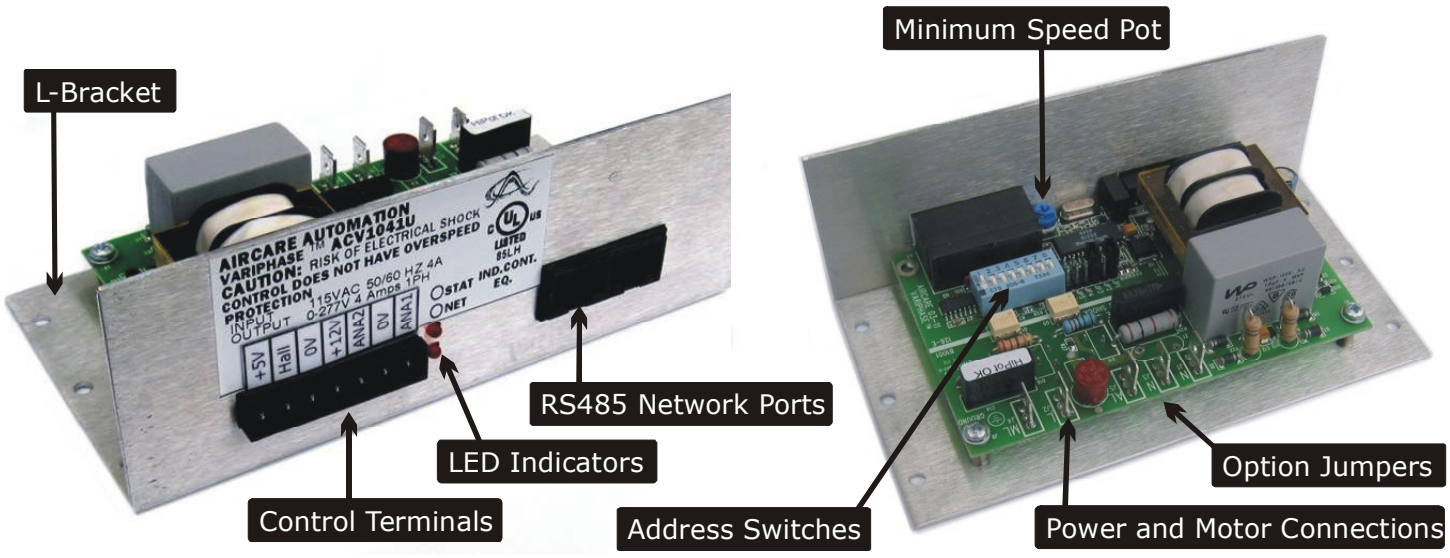


Figure 1

Variphase HP Features

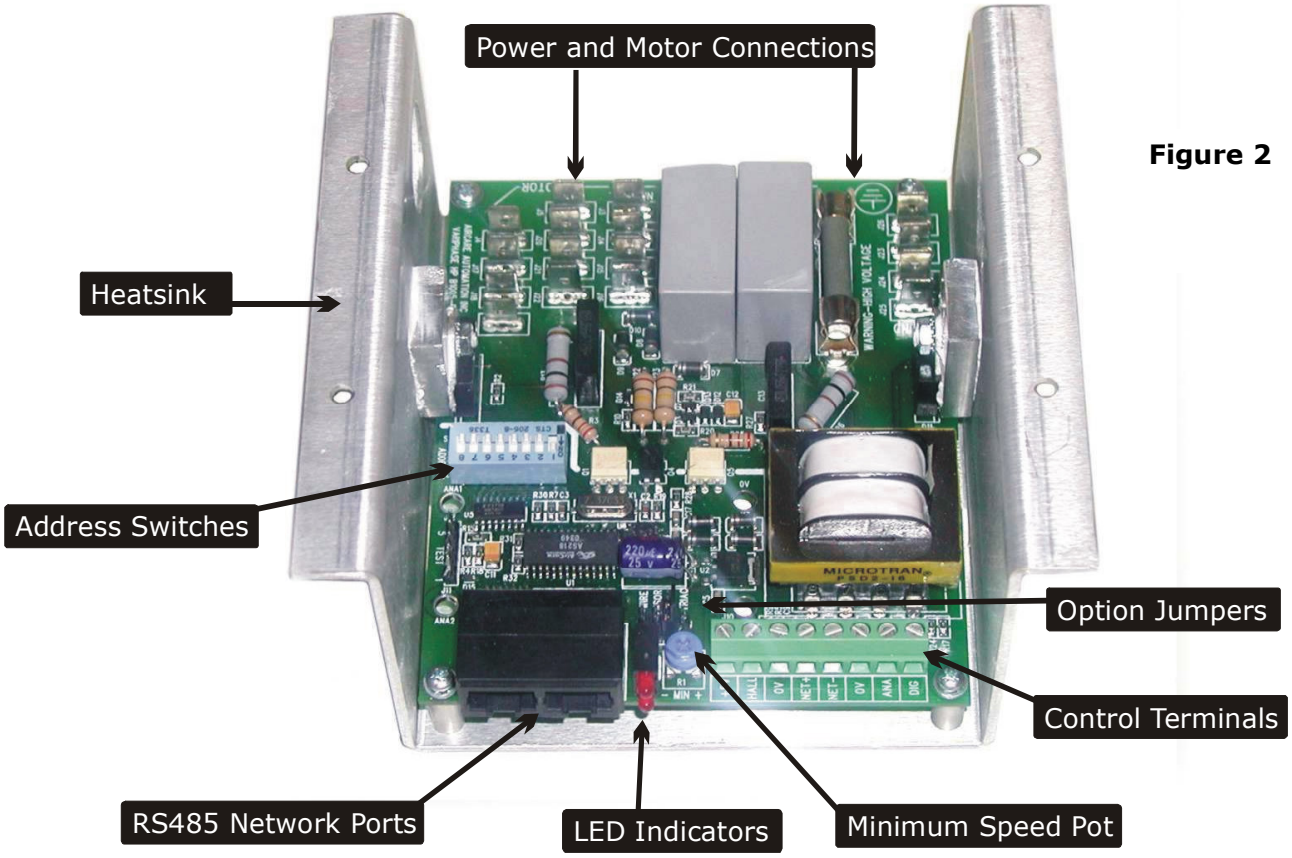


Figure 2

Control Mode Overview

Variphase operates in one of five selectable modes:

1. Networked Speed Control
2. Analog Speed Control
3. Networked Control with Tachometer Speed Regulation
4. Analog Control with Tachometer Speed Regulation
5. Analog Closed Loop Control

Speed regulation modes use an external Hall-effect sensor to provide a speed feedback signal from the motor. In this mode, Variphase will hold motor speed constant, even under varying load conditions. In networked mode it also allows the speed to be set in RPM units.

Modes are selected using Jumper Shunts JP1 and JP5, and by network commands from AirCare Consoles.

In Analog Closed Loop Control Mode, Variphase compares an Analog feedback signal to an Analog set-point and adjusts speed accordingly.

All Closed Loop control modes (Modes 3-5) use a fully programmable PID loop to allow response and stability adjustments.

An AirCare networked system requires a compatible Modbus host. In most cases this will be an AirCare Automation Console, but other Modbus devices can be used if configured correctly. Refer to the Network Specification section of this document for more information.

Option Jumpers

JP1	JP2	JP3	JP4	JP5	JP6
Analog	20mA	Baud	4-20mA	Regulate Speed	4-Wire

Table 2

Analog	Install jumper to select analog input speed control from either 0-5V or 4-20mA sources. When jumper position is open, the control responds to Modbus speed commands.
20mA	Install Jumper to enable current loop shunt on Analog Input 1. JP1 should also be closed to enable 4-20mA control. Leave switch open for 0-5V control.
Baud	Install jumper to select 9600 baud. Default is 1200.
4-20	Install jumper to enable 4-20mA loop on Analog Input 1. If jumper position is open, the 4mA offset will not be factored, resulting in a 0-20mA control range.
Regulate Speed	Install jumper to enable closed loop control using an external speed sensor. The sensor will be used to regulate the set speed in RPM. If jumper position is open, the sensor input will not be used for motor speed control but in network control mode, RPM will still be reported if a sensor is connected.
4-Wire	Fit Jumper to select 4-wire (RS422) communications. Default (jumper open) is 2-wire (RS485) communications.

Address DIP Switches

Each Variphase in a network must be set to a unique address between 1 and 127. There are 8 switches on the DIP switch block of which switch 1-7 are used for addressing. Switch 8 should be left in the OFF position (not used for addressing). Refer Figure 10 for switch position examples.

Address 0 is reserved for the Control Console (MODBUS master).

Note: Option jumpers and address settings are only checked by the VariPhase controller at power-up, so power must be cycled before any changes take effect.

Soft-Start

Normally the motor voltage responds immediately to a change in analog input signal. Some applications may require a soft-start to reduce start-up currents. To enable soft-start, set the Soft-Start bit in the Mode Register (Register 23). This register is non-volatile.

When enabled, soft-start will occur when the output changes from a stop to start, either by increasing the analog input from zero, or by the optional enable/disable signal.

Variphase will ramp to the new set-point at a rate determined by PID Rate Register (Register 20). Each bit in Register 20 represents 50ms for each percentage speed change. A value of 20, will give a soft-start of 1% / second (100 seconds to reach full-speed).

Soft-Start has no effect in closed-loop control modes.

Control Configuration Examples

Analog Speed Control Using Potentiometer

Overview

- An external potentiometer controls output from minimum to 100%.
- Adjust Minimum speed using on-board MIN speed trim pot and a screwdriver.
- Turning potentiometer to zero turns off motor.

Configuration

- Remove JP2, JP4 and JP5 (if installed)
- Install JP1 (Enables Analog Input)
- Do not make connection to ANA2.

Wiring

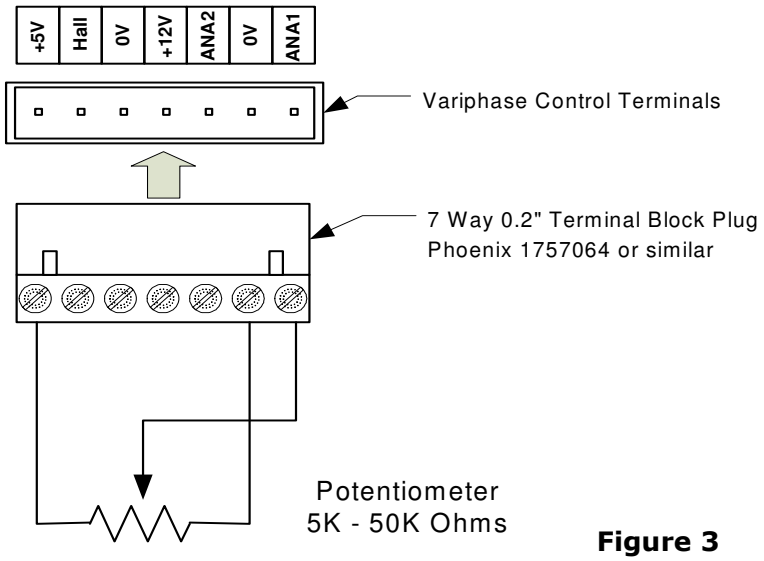


Figure 3

Analog Input Closed-Loop Control

Overview

- An external potentiometer controls set-point from 0% to 100%.
- Variphase automatically adjusts motor output to maintain set-point
- P, I and D parameters can be adjusted to configure closed-loop response
- Adjust Minimum Speed Pot to limit lowest motor voltage.
- Detail information is found in App Note 1007

Configuration

- Install JP1
- Remove JP5 (Tach/Hall Effect Sensor Jumper)
- Wire sensor feedback signal to Control Terminals (note – signal must not exceed 5.0V)
- Set Bit 3 in MODBUS Register 23 by writing a value of 8. Refer to the Advanced Technical Manual for full details.
- Use ACC1-PID Console to configure PID parameters

Wiring

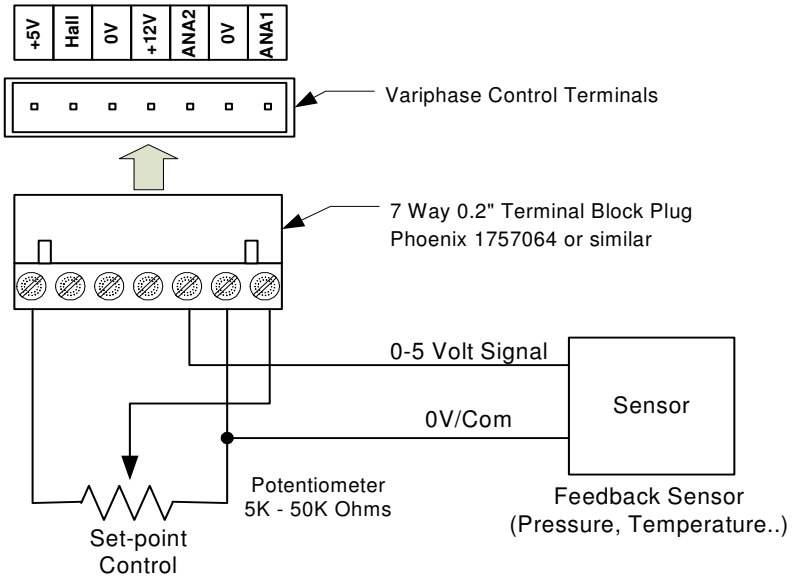


Figure 4

Analog Speed Control with Speed Regulation

Overview

- An external potentiometer controls set-point from 0% to 100%.
- 100% motor speed is set using Modbus Reg 13 (default is 1500 rpm)
- Variphase automatically adjusts motor output to maintain set-speed
- P, I and D parameters can be adjusted to configure closed-loop response
- Adjust Minimum Speed Pot to limit lowest motor voltage.

Configuration

- Install JP1
- Install JP5 (Enable Tach/Hall Effect Sensor Jumper)
- Wire tachometer feedback signal to control terminals
- Use ACC1-PID Console to configure PID parameters (optional)

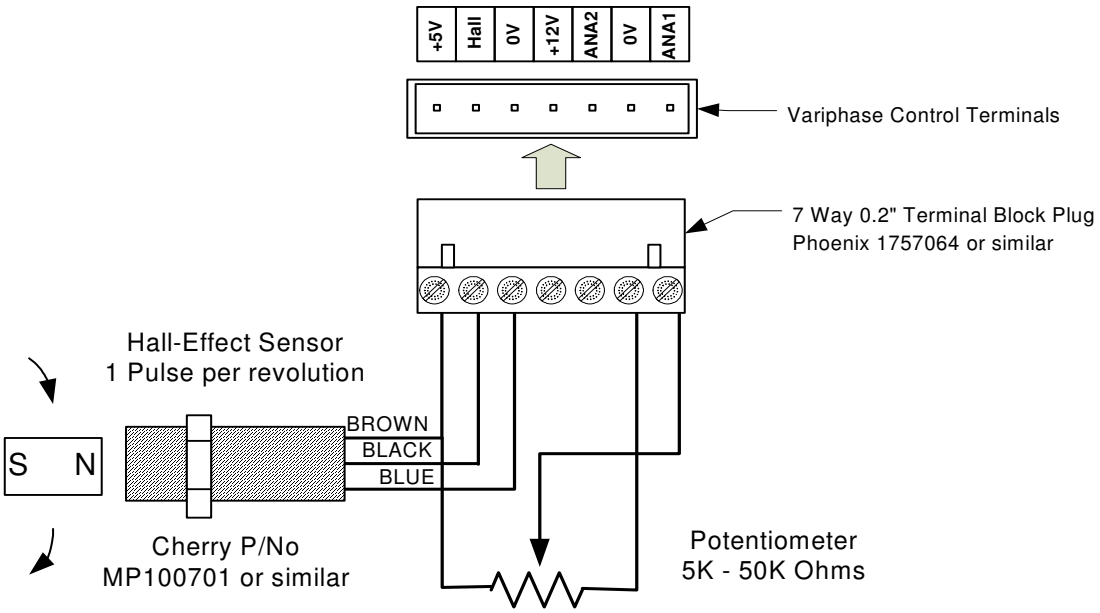


Figure 5

Troubleshooting

LED Indicators

The NET Led shows all network activity (RS485 mode) or receive data activity (RS422 mode). With no bus activity this Led should be OFF.

If the NET Led is on-continuously, it is likely that the network connections are transposed (i.e. signals in the RS485 differential pair are swapped).

The STAT Led flashes steadily when the motor is stopped. When the motor is running, the STAT Led is on steadily. In addition, anytime the control responds to a Modbus message the Led flickers briefly.

Diagnosing Other Faults

Most Variphase models have an internal fuse. Excessive load current will cause the fuse to fault and the unit will be non-functional and non-responsive to network communications. The fuse is NOT field replaceable.

If the motor does not start or run smoothly, check power wiring to the motor. This is especially important in 3-wire operation, where the auxilliary winding is driven independently.

Electrical Wiring and Specifications

Control Terminal Connections

1	2	3	4	5	6	7
+5V Out	Hall Sensor Signal	0V (GND)	+12V Out	Analog Input 2	0V (GND)	Analog Input 1

Table 3

Mating Part for Control Connector : Phoenix 5.08mm Terminal Block Plug #1757064

Power Connections

ML	AL	L	MN	N
AC Line to Motor	AC Line to Motor Aux	AC Line Input	Neutral to Motor	AC Neutral Input

Table 4

Power Wiring for Variphase 2-8 Amp Models

3 wire motor connection

Use this diagram with PSC motors for optimal efficiency and lowest noise.

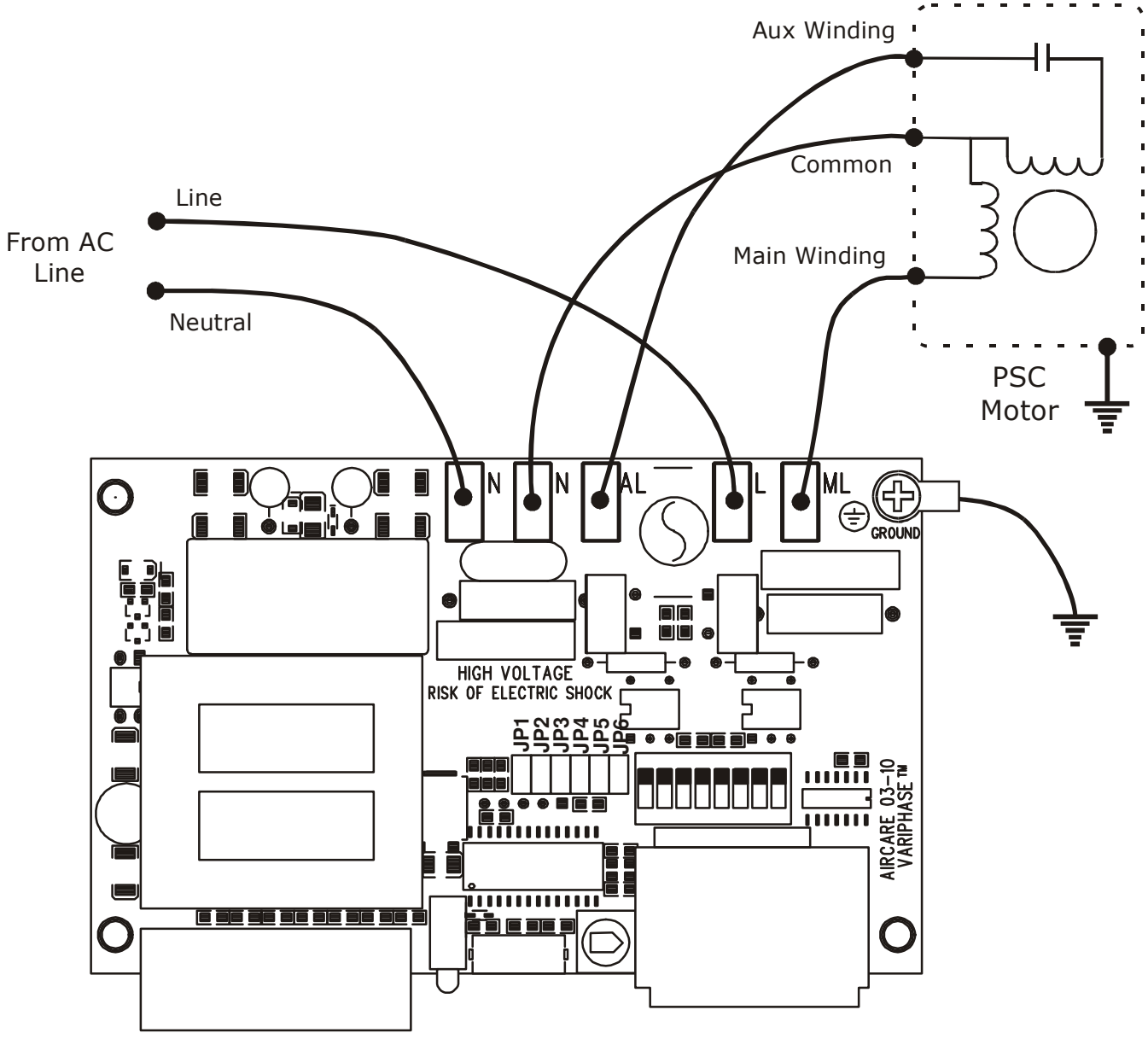


Figure 6

Power Wiring Diagram – 2 wire Motor Connection

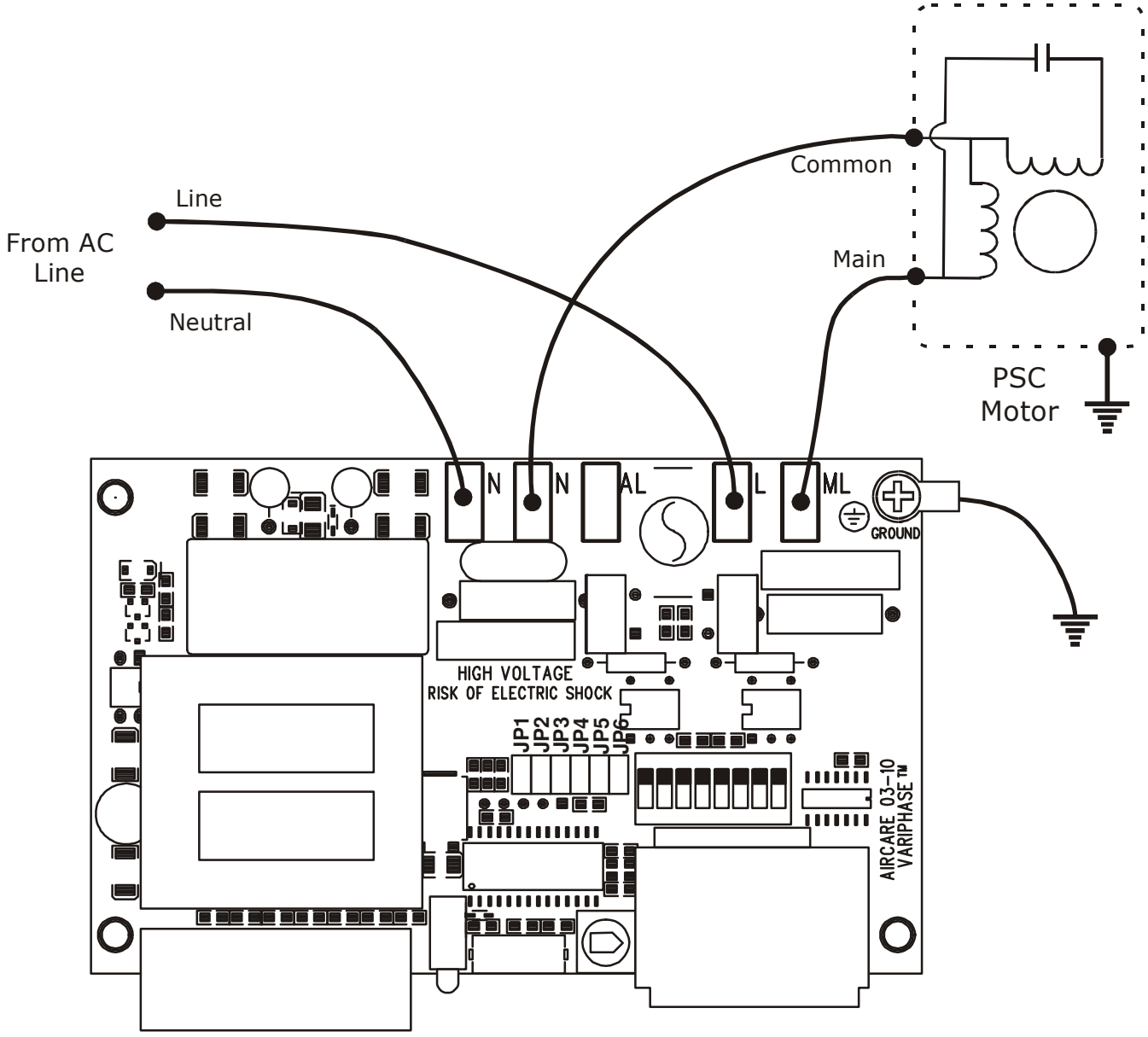


Figure 7

Power Wiring for Variphase HP Models

3 wire motor connection

Use this diagram with PSC motors for optimal efficiency and lowest noise.

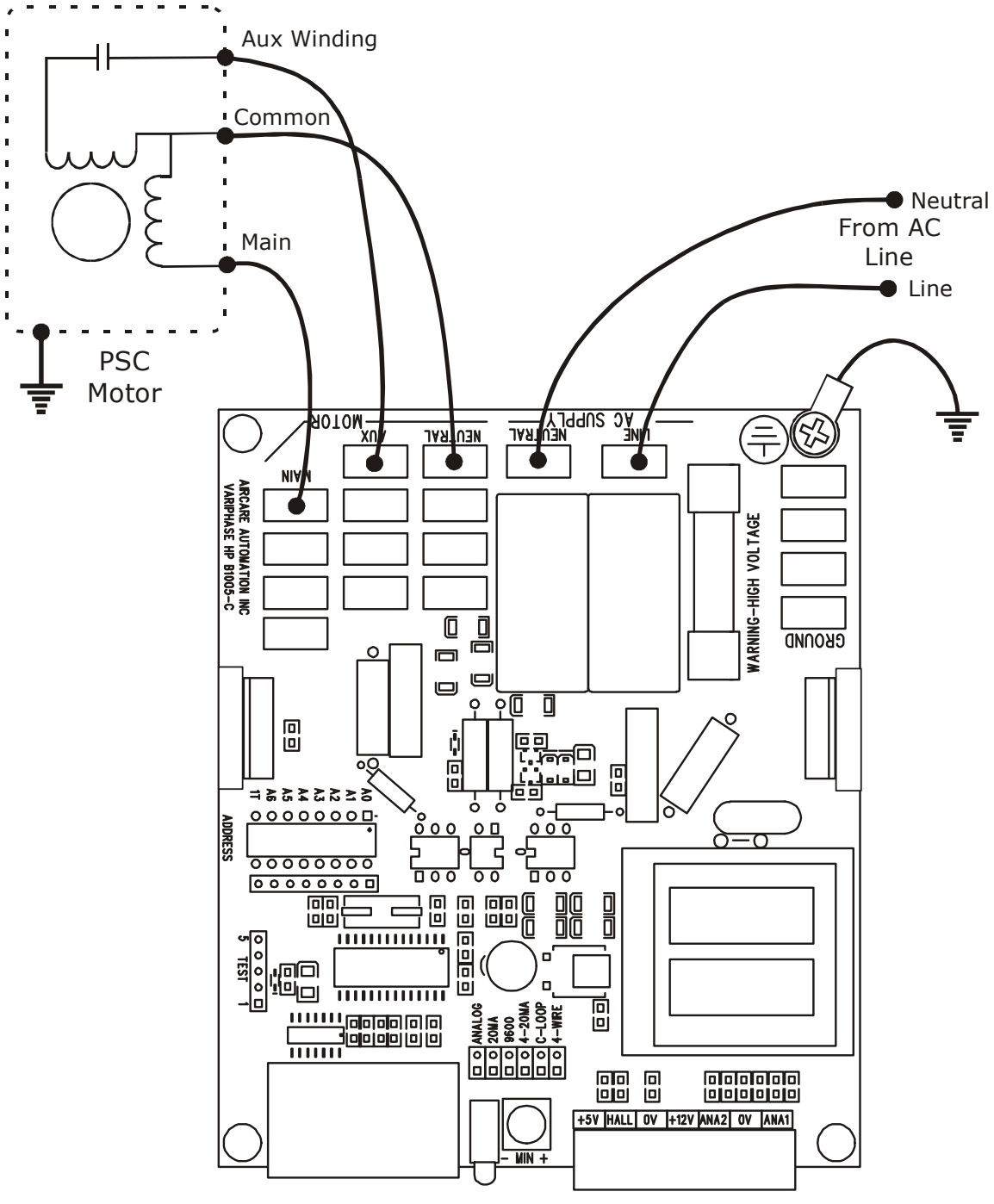
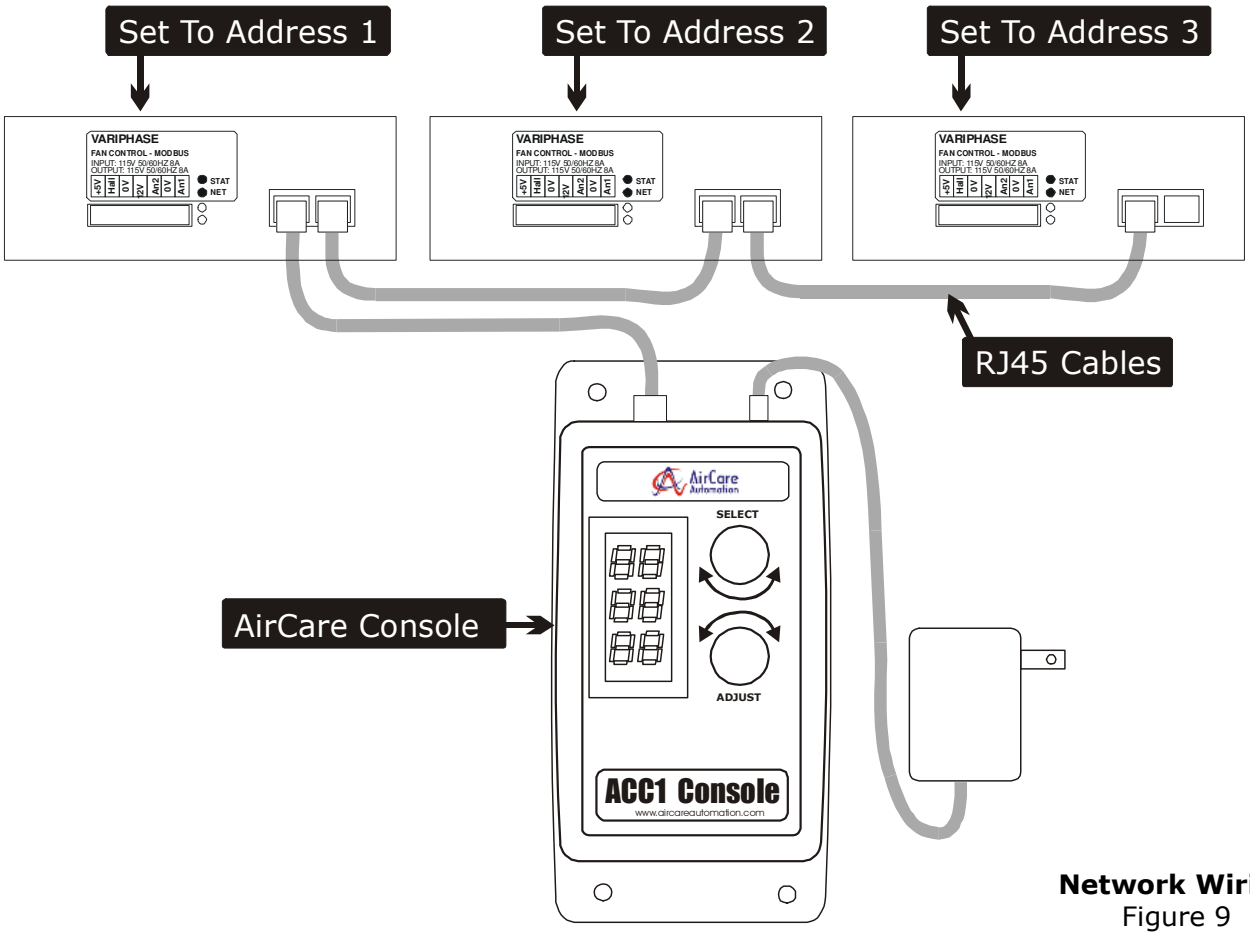


Figure 8

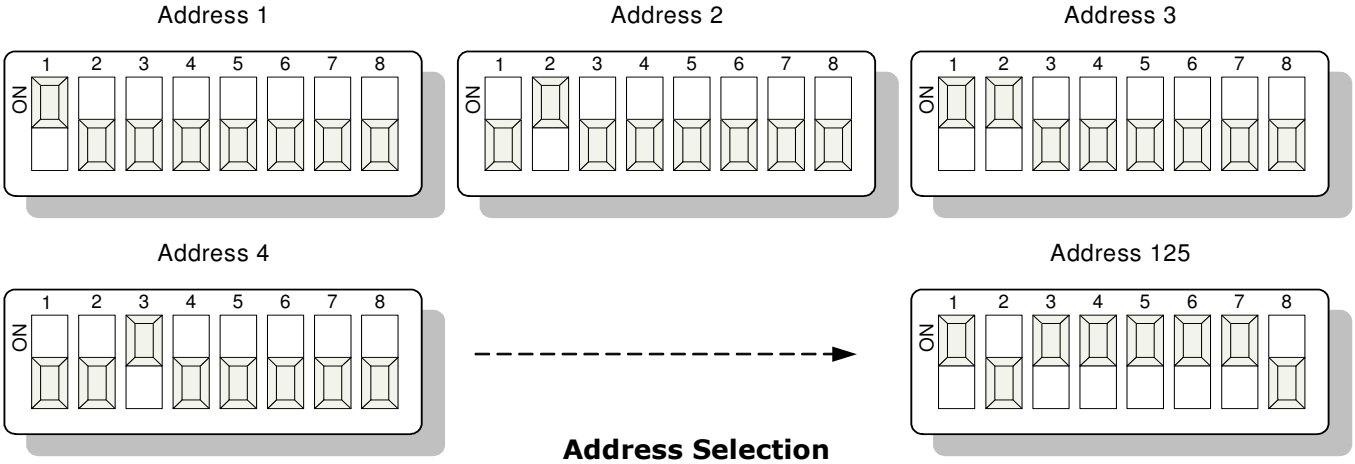
Network Communications

Building a network of Variphase Controls is easy:

- Daisy-chain units together using standard RJ-45 patch cables (available from AirCare)
- Configure each unit to a unique address
- Add an AirCare Console and apply power



Network Wiring
Figure 9



Address Selection
Figure 10

Register Definition Summary

These definitions are provided for background information only. When using AirCare Consoles, there is normally no need to access Variphase Modbus registers.

Register	Function	Type
1	Motor Start/Stop	R/W
2	Motor Speed (0-100%)	R/W
3	P Value	R/W
4	I Value	R/W
5	D Value	R/W
6	Motor Speed (RPM)	R
7	Analog 1 Input Level (0-1023)	R
8	Minimum Speed Pot Position (0-1023)	R
9	System Flags	R
10	Default Speed (0-100%)	R/W
11	Firmware Version	R
12	Triac Phase Angle	R
13	Max Speed (750-3600rpm)	R/W
14	Default Motor Start/Stop	R/W
15	Group 1 Address	R/W
16	Group 2 Address	R/W
17	Number of Good Packets	R/W
18	Number of Bad Packets	R/W
19	Triac off Period	R/W
20	PID Interval	R/W
21	Tach Filter	R/W
22	Compensation Table	R/W
23	Mode Control	R/W
24	Analog 2 Input Level (0-1023)	R
26	Comm Watchdog Count	R/W
100	Product ID	R

Table 5

Mechanical Specifications

Installation

Variphase must be mounted in an enclosure that provides electrical, safety and environmental protection (not required for NEMA1 option). Variphase must be mounted in a Pollution Degree 2 environment as defined in UL508C.

> *Normally, only non-conductive pollution occurs, however temporary conductivity is expected. Pollution degree 2 is obtainable by reducing possibilities of conductive pollution and reducing possibilities of condensation or high humidity*

This can normally be achieved by mounting Variphase in a suitable enclosure and locating it so it will not be affected by condensation. The mounting position and method must also meet UL508c requirements for electrical spacings.

Refer to Variphase Datasheets for Mechanical Dimensions.

Variphase 8 Amp (ACV108x) and Variphase 14 Amp (ACV114x) models have special mounting requirements when operated at or near full-load rating. Under these conditions, they must be securely mounted to an aluminum surface with an area of at least 1sqft. This provides additional heat dissipation. Refer to individual datasheets for specific requirements.

Hall Sensor for Speed Sensing and Regulation

Closed-loop control (or speed sensing in open-loop mode) requires a hall-effect sensor to monitor fan rotation. The hall-effect sensor should be located so that a magnet, mounted on the impeller or shaft, passes it once every revolution. A slotted switch can also be used by following the instructions in the relevant application note.

Frequently Asked Questions

Q. In Analog Control Modes, does the network interface still function?
A. Yes. The network connection can still be used to monitor Variphase parameters and set certain parameters.

Q. Can an AirCare console read actual motor speed in all Control Modes?
A. Yes. Provided a Hall-effect Tach Sensor is installed.