

Hoffman Controls

Complete Installation & Operating Instructions



CAUTION:

Failure to read and understand the accompanying instructions and diagrams prior to energizing the sequencer may result in permanent damage to the sequencer.

General

The Class II 890-DSQ microcontroller based universal sequencer provides a fully programmable platform to sequence multiple loads using SPDT relay closures. The multiple loads may consist of condenser fan motors, heating elements, compressors or other sequencing applications. The 890-DSQ Sequencer's versatility includes a wide range of input and output options. This universal sequencer can use 1) up to six (0-5 Vdc) temperature sensors or pressure transducer inputs or 2) a single 0-10 VDC input. The sequencer has three 0-10 VDC, EC motor speed control outputs which can be reconfigured as three 10 - 0 VDC motor speed outputs. There are also three, 17.5 volt (80Hz) PWM EC motor speed control outputs and up to six 24 VAC fixed staged outputs, with an additional six 24 VAC fixed staged outputs available on a separate expansion board (total of 12 fixed relay output stages).

The 890-DSQ can be setup as a traditional sequencer or as a true continuous vernier sequencer, when using continuously variable EC motors or SCRs as the (VS) variable stage. The sequencer can be operated locally, using the 5 push buttons and the information shown on the LCD screen or remotely using a Modbus RTU master control.

The 890-DSQ Series sequencers require 24 VAC (1 VA) to power the control.

IMPORTANT: When using the 890-DSQ Sequencer, select a transformer to meet the requirements of all the 24 VAC components being used.

Introduction

The 890-DSQ Series sequencer is typically used, in an A/C system, to sequence multiple condenser fan motors, on and off, to provide low ambient condenser control. The 890 has up to six temperature or pressure inputs that are used to sequence up to 12 fixed speed condenser fan motors or other loads.

A unique feature is that the 890 also provides PWM, and either 0-10 VDC or 10-0 VDC outputs that are used to drive variable speed EC fan motors. When the variable speed fans are present, the sequencer intelligently modifies the output to the variable speed fans so that, as the additional fixed speed fans are sequenced

890-DSQ Series Microprocessor Based Universal Sequencer

on or off, the overall effect is that the total fan outputs' airflow varies continuously over the entire range.

For example, when the next fixed speed fan is turned on, the variable speed fans drop in rpm to compensate for the additional fan. As the input continues to go up, the variable speed fans increase speed until the next fixed speed fan turns on, at which point the variable speed fan drops in rpm again. This process works in reverse as the input decreases. Hysteresis is also provided so that no short cycling of the fixed speed fans occur.

Setpoint Values

The 890-Series sequencers can utilize up to 2 sets of setpoint values, a primary set and a secondary set. Each set can utilize a maximum of 12 stage turn on and turn off values (24 set points). The primary set of setpoint values is the set typically used. The secondary set of setpoint values can be used, on demand, whenever the sequencer's "2ND" input terminal is connected to the adjacent "GND" terminal thru an external contact closure.

Description

The 890 Control consists of a Kydex covered PCB, on stand offs, with a 32 character LCD display and five push buttons. The sequencer can be manually operated by following the LCD's menu system and selecting the available options, parameters and numerical values, using the 5 push buttons. The LCD display routinely shows a Home Screen and, when selected, up to 6 mode screens and a small number of additional menu and submenu screens.

The LCD's Home Screen always displays the number of fixed relay output stages that are turned on, along with the selected maximum number of stages, and the currently used input's value (temperature, pressure or 0-10 VDC). When the VS (variable stage) option is selected, the Home Screen also displays a speed index (percent) of the continuously variable stage's EC motors speed or SCRs total output current, along with a number representing the total of all the relay stages and effective variable stages that are turned on (see **Mode 2.2**, page 4, for more info).

Due to the availability of various speed EC motors, the displayed EC motor speed is shown as a speed index, which is the percent of full speed (10%, 50%, 76% etc.) that the motor is operating at. For example: a 1075 rpm EC motor showing a speed index of 75 (%) would be running at 806 rpm.

The five push buttons (MODE, UP, DOWN, EXIT and ENTER) allow the installer to change 1) the number of output stages used, 2) the number of inputs used along with the input type (temperature, pressure or 0-10 VDC), 3) the selection of the used output stage's individual (primary & secondary) setpoint values, 4) the selection of the output stage's activation modes [LIFO, FIFO or Binary Encode] and 5) the three scaling percentages, used to match the sequencer's PWM and VDC output signal's parameters, to the variable stage EC motors' input signal's specifications.

The 890-DSQ Sequencer is available in 4 or 6 fixed stage models, with each model having an additional "variable stage output". The variable stage output consists of the "PWM" and "VDC" outputs and their associated "GND" terminals. There are three sets of "VDC" outputs and associated "GND" terminals and three sets of "PWM" (17.5 volt, 80 Hz) outputs and their associated "GND" terminals (12 terminals total).

A total of 3 continuously variable, VDC and/or PWM controlled, EC motors may be wired (in any combination) to the VDC and/or PWM output terminals. For heating applications, a maximum of 30 mA is available to operate the SCRs.

The 890-Series sequencer can be used for local, remote or a combination of both local and remote operation. Remote operation can be implemented, at any time, by using a Modbus RTU master computer to send the appropriate register data, listed in Tables 2A & 2B, on pages 15 & 16, to the 890-DSQ Series sequencer's internal data registers. The sequencer communicates via a 3 wire Modbus RTU connection to the Modbus RTU master computer. All of the 890-DSQ Sequencer's options, parameters and numerical values can be read and set remotely using the Modbus RTU connection. During remote operation, the Modbus master reads and writes to the 890-DSQ Sequencer's 76 internal data registers, using Modbus RTU commands 3, 6 and 16 (hexadecimal 10).

Pre-Installation Information/ Instruction

BUTTON LOCKOUT FEATURE: The 890-DSQ Sequencer is equipped with a push button lockout feature. This feature is **On** (enabled) by default, but can be turned **On** or **Off** using the menu system or remotely using the Modbus connection. If the lockout feature is enabled and the buttons are locked, the installer will not be able to operate the sequencer manually using the push buttons. The LCD screen will display "**Locked - Enter Code**" whenever a push button is pressed.

The buttons can be unlocked by simultaneously pressing and holding down these four push buttons: "**MODE, UP, EXIT** and **ENTER**" until after the word "**SUCCESS**" appears on the LCD screen (approximately 2 seconds). The buttons will now operate.

Unlocked buttons can be locked by simultaneously pressing and holding down the same four push buttons: "**MODE, UP, EXIT** and **ENTER**" *only until* the words "**Locked - Enter Code**" appear on the LCD screen. If the four buttons above are not released immediately when "**Locked - Enter Code**" appears, the word "**SUCCESS**" will appear on the LCD screen causing the buttons to remain unlocked.

When the lockout feature is enabled, unlocked buttons will self-lock after five (5) minutes of no button activity.

LCD BACKLIGHT FEATURE: The LCD's backlight will remain on while checking or updating the 890-DSQ Sequencer's selections using the push buttons. After five (5) minutes of push-button inactivity, the backlight will turn off. Pushing any button afterwards re-activates the backlight.

RELAY STAGE OUTPUT TEST FEATURE: The 890-DSQ Sequencer has a relay stage output test feature which allows the installer to sequentially turn on, then off, each stage to indi-

ually verify condenser fan or SCR operation (see **Operating Modes** section, **MODE 1**, on page 4).

INPUT SENSOR VALUE FEATURE: Each of the sequencer's used input sensor values (resistance in ohms or pressure in PSI) can be displayed, on the LCD, by pressing the **UP** button when the LCD's screen displays the Home Screen. The sensor values are shown across the screen from left to right. The first three (3) values are shown on the LCD screen's top line [input one (1) on the left side] and the last three (3) sensor values are shown on the bottom line [input four (4) on the left]. Unused input values are not displayed.

The 890-DSQ Sequencers come with a pre-programmed series of relay output stage setpoint (turn on & off) values. Each one of the relay's turn on and turn off values may be individually adjusted, either locally or remotely to suit a particular installation.


When a unique application requires the selection of different setpoints, other than the pre-programmed setpoints, the new setpoint values can be automatically calculated by the sequencer's microcontroller, using equal spacing between stages. Any or all of the pre-programmed setpoint values can also be updated, manually.

The selection of EC motors depends upon the end use of the EC motor. When the EC motors will be used as variable stage modulating motors they must be continuously variable EC motors that accept a 1) 0 - 10 Vdc, or 2) 10 - 0 Vdc or 3) 17.5 volt, 80 Hz PWM control signal. These continuously variable EC motors do not need to have the same horsepower and maximum rpm as the fixed rpm, staged PSC and EC motors. The ratio of max performance can be set in the controller. However, installing continuously variable EC motors that have the same size, line voltage, horsepower and maximum rpm as the fixed rpm, staged PSC motors, they are replacing, makes the installation simpler.

When the EC motors will be used as staging motors they should provide the same performance (size, line voltage, horsepower, maximum rpm and airflow) as the other staged motors.

When updating a bank of 4 or 6 PSC condenser fan motors to obtain continuous airflow across the condenser, two of the PSC motors should be replaced with two continuously variable EC motors, to supply enough modulating airflow, to achieve continuously smooth air-flow thru the condenser coils over the sequencer's full operating range.

When installing the 890-DSQ Sequencer in a heating system, and the continuous vernier capability will be implemented, size the VS (variable stage's) SCR with twice the KW capacity as a single fixed staged heater to ensure continuously smooth heating functionality.



IMPORTANT:

When using replacement EC motors, review the system's current protection device's capability to ensure the protection devices can handle the much larger in-rush current experienced during EC motor power up.

Operating Methods

A "You Tube" video covering the following operating methods and modes is available at **TBD**.

The 890 sequencer's operation is organized into two sections: local and remote, with each section containing the same selectable modes, menus, submenus, settings and numerical values.

The 890-DSQ Sequencer controls its operation by using the information stored within its microcontroller's 76 internal data registers. These data registers are numbered from 0 to 75, with each register's data contents representing a unique sequencer function or numerical value.

Each 890-DSQ sequencer's microcontroller is programmed, at the factory, with the internal register data needed for that sequencer's anticipated application. However, the pre-programmed data can be changed, during or after installation, by manually and/or remotely updating the microcontroller's internal register data.

Manually updating the internal register data is accomplished by viewing and then responding to the LCD screen's information and appropriately pressing one or more of the sequencer's five push buttons.

Manual operation starts with the LCD's Home Screen (**Figure 1**). The Home Screen displays the number of fixed relay stages turned on, along with the maximum number of selected stages, (**Stages On: 1/4**), along with the selected input type (**Tmp, PSI or VDC**) and that input's present value (**Tmp: 53.1**).

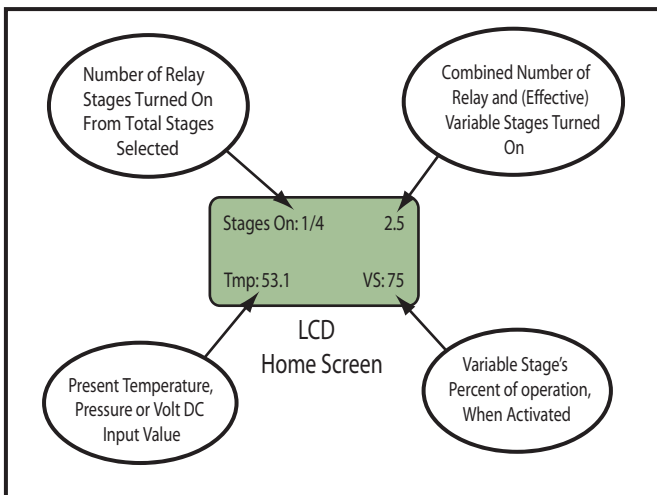


Figure 1
LCD Home Screen

When selected, the LCD's Home Screen also displays the variable stage's percent of operation (**VS: 75**) along with a number representing the total of all of the fixed relay stages and effective variable stages that are turned on (**2.5**). Refer to **Mode 2.2**, on pages 4 & 5, for a description of effective variable stage operation.

The sequencer's **MODE** button is used to sequentially cycle thru the LCD screen's six (6) available modes. Pressing the **MODE** button once advances the LCD's screen to the "To Test Fans Press Enter" screen (**Mode 1**). Slowly pressing the **MODE** button repeatedly, cycles the sequencer thru its six (6) available modes and

then back to the Home Screen.

Remotely updating the 890-DSQ Sequencer's internal register data requires connecting the sequencer to a Modbus RTU master computer that can send new register data to, and/or read current register data from, the 890 microcontroller's internal memory.

NOTE: Since the 890-DSQ's operation is controlled by the data stored within its internal registers, the sequencer provides the same identical operation whether the register data is changed locally (manually) or remotely.

In both local and remote operation the 890-DSQ Sequencer can be setup to select 1) fan testing, 2) traditional or continuous VS (variable stage) operation 3) the number and type of outputs used, 4) the number and type of inputs used, 5) the primary, and/or secondary setpoint values used, 6) the Modbus communication parameters and 7) 0 - 10 VDC or 10 - 0 VDC output selection.

Local Operation

Local operation uses the control's five push buttons (**MODE, UP, DOWN, EXIT & ENTER**) along with the LCD screen's information to display and select the sequencer's operating modes, menus, submenus, options and numerical values.

Each mode has several menus, with some menus having a number of submenus. Each press of the **MODE** button displays the next operating mode's title on the LCD screen. Pressing the **ENTER** button, while a particular operating mode's screen is visible on the LCD, displays that mode's first menu. Pressing the **ENTER** button again will display the next menu or submenu associated with that mode. The installer can update the displayed menu options and/or submenu options and numerical values by pressing the **UP** or **DOWN** buttons.

Whenever a **menu screen** is displayed, each press of the **UP** or **DOWN** buttons incrementally cycles thru that menu's available options. The **UP** button advances the displayed options in a forward direction while the **DOWN** button does the reverse.

Whenever a **submenu screen** is displayed, each press of the **UP** or **DOWN** buttons incrementally cycles thru that sub-menu's available options or numerical values. Pressing the **UP** button either 1) cycles forward thru the available options or 2) increases the displayed values. Pressing the **DOWN** button either 1) cycles backward thru the available options or 2) decreases the displayed values.

Once an option or numerical value has been updated, pressing the **ENTER** button, again, will save the new value and move the control's operation forward to the next submenu, menu or mode.



IMPORTANT:

After updating any information displayed on the LCD's screen, the installer MUST review ALL of the 890-DSQ Sequencer's mode, menu, submenu and numerical value options to 1) ensure that all of the operating parameters, needed for the application, have been correctly selected and 2) also ensure that any unneeded or undesired options or numerical values have not inadvertently been left selected.

Operating Methods Con't

Pressing the EXIT button, at any time, causes the control to return immediately to the Home Screen. However, any options or value changes that were not saved, by previously pressing the ENTER button, will be lost.

Remote Operation

Remote operation is accomplished by using a Modbus RTU master computer to communicate with the 890-DSQ Sequencer via the Modbus 3 wire connection. (The third wire is a common ground reference). During remote operation, the Modbus RTU master computer can read the information stored in 75 of the 890-DSQ Sequencer's 76 internal registers (Register 72 is a write only register). Refer to Tables 2A & 2B (pages 15 & 16) for a complete list of the registers, by number, and the required data range allowed for each register. The Modbus RTU master control can also write information to 65 of the 76 sequencer's internal registers (Registers 0-57 & 68-75). Registers 58 thru 67 are read only registers and therefore ignore any data written to them (see Modbus Operation section on pages 17 & 18).



IMPORTANT:

If any of the down loaded Modbus data is incorrect, the 890-DSQ Sequencer's microcontroller will change the incorrect data into software selected default values during the sequencer's next operating cycle. Therefore, after updating any data remotely, the operator ***MUST*** allow the 890-DSQ Sequencer to operate over its entire expected range (°F, PSI or VDC) before reviewing ALL of the data contained in each of the sequencer's 76 register addresses to 1) ensure that all of the operating parameters and numerical values, needed for the application, have been correctly selected and 2) also ensure that any unneeded or undesired options or numerical values have not inadvertently been left selected.

NOTE:

The Modbus RTU master control can only write data to 27 of the 890-DSQ Sequencer's registers at a time, and read data from 29 registers at a time, due to buffer size limitations in the sequencer's microcontroller.

NOTE:

Continue reading the following "Operating Modes" information to become familiar with the 890-DSQ Sequencer's operating characteristics.

Operating Modes

The following information is provided to identify and explain the 890-DSQ Sequencer's operational modes, menus, submenus, and numerical value options. The sequencer's MODE button is used to sequentially cycle thru the six (6) available modes displayed on the sequencer's LCD screen. Pressing the MODE button a seventh time returns the LCD to the Home Screen.

An 890-DSQ Operating Modes Chart (Figure 3, pages 10 & 11) is provided to allow the operator to track his/her progress thru the various LCD's screens. The Operating Modes Chart's information is viewed starting from the Home Screen, located at the top center of the chart, and continuing counter clockwise (to the left) around the chart.

NOTE: The 890-DSQ Operating Modes Chart information is presented in the same mode, menu and submenu order as the information presented on the LCD screen, when following the chart's information in a counter clockwise direction (to the left). Press the MODE button to begin.

MODE 1: *To Test Fans Press Enter.*

The contactor wiring and condenser fan or heating element wiring, connected to each relay output, can be sequentially tested in this mode by pressing the UP and DOWN buttons. Pressing the UP button turns on the next stage, while pressing the DOWN button turns off the last stage, that is currently on.

MODE 2: *Change output stage settings.*

The output stage settings can be changed from the preprogrammed stage options, by pressing the ENTER button when the above screen appears on the LCD. The LCD sequence's through the following 4 menu screens with each press of the ENTER button:

1) *Is Variable Stage Used? No*

The (VS) variable stage is used (activated) when continuously smooth airflow thru a condenser, or continuously variable current flow thru a heating system, is desired. Implementing the VS option requires connecting the sequencer's VDC and/or PWM output(s), to external SCRs or continuously variable speed EC motors. Press the UP or DOWN button to change the No to a Yes or vice versa. Then press the ENTER button to save the correct answer and advance to the LCD screen below.

2) *Variable Stage Ratio: 1.0*

When the VS (variable stage used) above is selected (Yes), this screen will appear. The variable stage ratio is used to set the ratio of the total variable stage capacity to that of a single fixed stage. In order to provide continuously smooth operation when using hysteresis, the ratio should be greater than 1.

This unique 890-DSQ feature provides PWM and VDC outputs that are used to drive variable speed EC motor fans or SCRs. When the variable speed fans or SCRs are present, the sequencer intelligently modifies the output to the variable speed fans or SCRs so that, as additional fixed speed fans or fixed heaters are sequenced on and off, the overall effect produces a continuously variable airflow (or current) over the entire system's range.

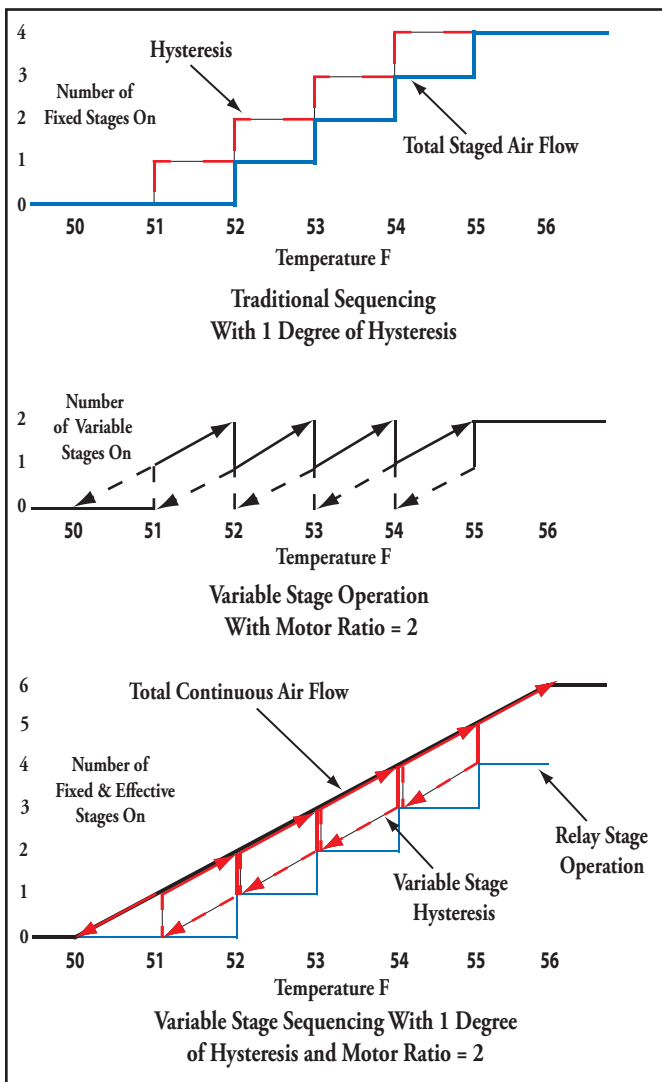


Figure 2
Traditional Vs Variable Stage Operation

Operating Modes Con't

A traditional sequencer's operation is shown, as a reference, at the top of Figure 2 (above). The 890-DSQ Sequencer's variable stage operation is depicted, on it's own, in the center of Figure 2, while the total sequencer's operation which produces a continuous output, is shown at the bottom of Figure 2.

When the sequencer's stages are activating, the variable speed EC motor (or SCR) ramps from a low rpm (or current) to full speed (or full current) before the next sequencer's fixed stage turns on. As the next fixed stage turns on, the variable stage's output immediately drops down the equivalent of one fixed stage. During stage deactivation, when the previous fixed stage turns off, the variable stage's output jumps up equivalent to one fixed stage. As the input continues to decrease, the variable stage's output ramps down equivalent to one fixed stage just before the, now current, fixed stage turns off. This combination of fixed stage and variable stage operation produces a continuously variable (fan rpm or SCR current) output.

Without hysteresis, the variable stage's airflow capacity or SCR's KW capacity would only need to be a little larger than a fixed A/C

stage's airflow or a fixed heater element's capacity, due to the electronic components variances in each fixed stage's turn and turn off tolerances.

With hysteresis, the EC motor's airflow capacity, or SCR's KW capacity, needs to be much larger than a single fixed stage's on and off values. The extra capacity provides enough EC motor speed, or SCR current variation, when more than one fixed stage turns off. Hysteresis is used to prevent short cycling by using a different turn-on and turn-off setpoint value.

When the variable stage ratio is more than 1.0, the 890's micro-controller uses the variable stage ratio's number as the number of effective stages to be added to the number of fixed stages selected. All of these effective stages are activated before the first fixed stage turns on. The total number of activated, effective and fixed stages is shown in the LCD screen's upper right corner.

Mathematical Formula

A mathematical formula can be used to calculate the size of the variable stage's ratio number needed for smooth continuous operation. This ratio number represents the comparison of the VS (variable stage's) capacity (airflow or KW), to a fixed stage's airflow or KW capacity. Typical ratios are 1.5 to 2.0 for 4 to 6 stage applications, respectively.

The installer may use the following formula to calculate the minimum size of the VS (variable stage) ratio:

$$\text{Variable Stage Ratio} = [1 + (\text{the hysteresis value} \div \text{the difference between stage turn on values})]$$

Examples:

- 1) When the hysteresis is 6 °F and the difference between stage turn on values is also 6 °F, then the

$$\text{Variable Stage Ratio} = [1 + (6 \text{ °F hysteresis} \div 6 \text{ °F})] = 2.0$$

- 2) When the hysteresis is 4 °F and the difference between stage turn on values is 8 °F, then the

$$\text{Variable Stage Ratio} = [1 + (4 \text{ °F hysteresis} \div 8 \text{ °F})] = 1.5$$

NOTE:

For practical reasons, a VS (variable stage) ratio of 2.0 works well for A/C condenser banks, containing 4 to 6 fan motors, or heating systems containing 4 to 6 fixed heating elements.

Use the UP and DOWN buttons to change the VS (variable stage) ratio's number to match the ratio of the total VS (variable stage) capacity to that of a single fixed stage. (The range is 1.0 to 12.0). Then press the ENTER button to store this value and continue to the menu below.

3) Number of used output stages: 6

Use the UP and DOWN buttons to select the number of relay output stages to be used. The range is 0 to 12 stages. When "0" is selected, only the VS (variable stage's) EC motors or SCR operation is activated (None of the fixed relay output stages are used when "0" is selected). Press the ENTER button when the answer is correct.

Operating Modes Con't

4) *Stage On Delay in seconds: 2*

Use the UP and DOWN buttons to change the delay after a previous relay stage turns on, until the next relay stage can turn on. The range is 0.0 to 10.0 seconds. (Entering 0.0 activates the relay stages as quickly as possible).

MODE 3: *Change Input Settings.*

In this mode, the number of input stages used, the sensor combination rule used (see MODE 3.2, below) and the Emergency On value can be changed/updated, from the pre-programmed value, by pressing the ENTER button when the above screen appears on the LCD.

The LCD sequences thru the following 3 menu screens with each press of the ENTER button:

1) *Number of Inputs Used: 1*

There are three types of input options available on the 890-DSQ Sequencer; temperature sensors, pressure transducers and the 0-10 VDC input. Use the UP and DOWN buttons to set the number of inputs used. (The range is 0 to 6).

When the number of inputs used is set to "0", the 0-10 VDC input is used instead of the six 0-5 VDC temperature or pressure sensor inputs. **NOTE:** The six temperature or pressure sensor inputs are ignored when the number of inputs is set to "0".

An external power supply capable of supplying enough current to operate the pressure transducers must be supplied by the installer when pressure transducers are used. The pressure transducers output signal must not exceed 5 VDC.

Press the ENTER button to store the value selected, for the number of inputs used, and proceed to the submenu below.

2) *Input Combination Rule: Maximum*

This screen is only displayed when more than a single temperature or pressure sensor input is used. The installer must choose 1 of 4 possible ways to combine the sensors' input values. The four choices are; **Maximum**, **Second Highest**, **Average** or **Median**.

The **Maximum** option is chosen when only the sensor with the highest input value will be used to control the sequencer's operation.

The **Second Highest** option is chosen when only the second highest sensor's input value will be used to control the sequencer's operation.

The **Average** option is chosen when the numerical average of all used sensors' input values will be used to control the sequencer's operation.

The **Median** option is chosen when the middle value of all used sensors' input values will be used to control the sequencer's operation.

Use the UP and DOWN buttons to sequentially display (cycle thru) each of the four combination rules. Then press the ENTER button when the desired rule is visible on the LCD screen, to store that combination rule and continue to the next menu.

3) *Emergency On Temp/Pres: 115*

This screen appears when temperature or pressure sensor inputs are selected. If any of the used temperature or pressure sensor input values reach or exceed the selected Emergency On value (max 115 °F or 1000 PSI), all of the remaining inactivated relay stages will turn on sequentially. Use the UP and DOWN buttons to select the desired Emergency On temperature then press the ENTER button to store the value and continue to the next mode below.

MODE 4: *Change Primary Set points*

The primary setpoint values can be changed/updated, from the pre-programmed setpoint values, by pressing the ENTER button when the above screen appears on the LCD.

When the number of fixed output stages is selected, the 890-DSQ Sequencer loads a pre-programmed set of turn-on and turn-off set points into the microcontroller's memory. The installer can use the pre-programmed set points or modify any or all of these set points as required by the application.

To change all of the setpoint values automatically, see MODE 4.1 below. To manually update any or all of the setpoint values individually, see MODE 4.2 on page 7.

The stage's turn on and turn off values are associated with one of the 3 input types; temperature, pressure or 0-10 VDC. The set point values are in °F when the inputs used are temperature sensors, PSI when the inputs used are pressure sensors or volts DC when the 0-10 VDC input is used.

The LCD sequences thru the following 3 menu screens with each press of the ENTER button:

1) *Set Stage On/Off Values Auto? 1*

This menu is used to automatically set all of the used stages' primary on and off values by uniformly distributing the stage's operation over a selectable span. The selectable span's low and high values are set in the first two submenus below. The third submenu displays the calculated stage turn on spacing and resulting stages' hysteresis. The number "1", in this menu's LCD screen, indicates the primary setpoints can be changed at this time. Press the ENTER button to start the automatic selection process.

OR

To independently set each stages' on and off values **manually**, press the UP or DOWN button once and then press the ENTER button to advance the LCD's screen to MODE 4.2 (page 7).

a. Low Span Value Temp/PSI/Volts: 50.0

Use the UP and DOWN buttons to change the low span's value (number) to match the lowest input value at which the unit will come on. If the VS (variable stage) **has not been selected**, this is the value at which stage 1 turns on. If the VS (variable stage) **has been selected**, this is the value at which the EC motors begin to increase speed from 0 rpm, or the SCR begins supplying current to the heater.

Press the ENTER button to store the low span's value and continue to submenu **b.** below.

Operating Modes Con't

b. High Span Value

Temp/PSI/Volts: 80.0

Use the UP and DOWN buttons to change the high span's value (number) to match the highest input value at which the unit has all the fixed relay stages on, plus the VS (variable stage) at 100% (if the VS is being used).

Press the ENTER button to store the high span's value and continue to submenu c. below.

c. On to On=2.0 Deg/PSI/Volts

Hyster= 1.0 Deg/PSI/Volts

This submenu displays the stage spacing between successive relay turn on values. This submenu also shows the current hysteresis value used for all the activated relay stages.

The first line on the LCD's screen shows the evenly spaced temperature, pressure or voltage differences between successive fixed stage turn on values, calculated by the microcontroller, using the high and low span values entered above.

The second line on the LCD's screen shows the current hysteresis value (in °F, PSI or volts DC) used for all the selected relay stages. The operator may change this hysteresis value by pressing the UP or DOWN buttons until the desired hysteresis value, used by all the selected (fixed) relay stages, is displayed on the LCD screen's second line. However, the selectable hysteresis values are limited due to the span size chosen in MODES 4.1a and 4.1b above.

NOTE: Hysteresis is used to prevent short cycling. It is the difference between each stage's turn on and turn off values. Press the ENTER button to save the hysteresis value and continue to menu 2 below.

2) Set Stage On/Off

Values Manual 1

To set any or all of the primary setpoint's (stage turn on and turn off) values manually, press the ENTER button.

a. Var Stage TurnOn

Temp/PSI/Volts: 50.0



IMPORTANT:

After updating any information displayed on the LCD's screen, the in-installer MUST review ALL of the 890-DSQ Sequencer's mode, menu, submenu and numerical value options to 1) ensure that all of the operating parameters, needed for the application, have been correctly selected and 2) also ensure that any unneeded or undesired options or numerical values have not inadvertently been left selected.

If VS (variable stage) operation is selected, this screen will appear. Use the UP and DOWN buttons to set the value at which the continuously variable EC motors, or SCRs, first begin to turn on. Press the ENTER button to save the value and continue to submenu b below.

b. Stage 1 On Temp/PSI/Volts

61.5?

Use the UP and DOWN buttons to set the value at which relay stage 1 turns on as the input rises. This value **must be above** the value at which the variable stage turns on. Otherwise the stage's turn on value will default to 0.2 (°F, PSI or Vdc) above the variable stage turn on value (if variable stage is being used). Press the ENTER button to continue.

c. Stage 1 Off Temp/PSI/Volts

56.0?

Use the UP and DOWN buttons to set the value at which Stage 1 turns off as the input drops. This value **must be below** the value at which Stage 1 turns on. Otherwise, the stage 1 turn off value will default to 0.1 (°F, PSI or Vdc) below the Stage 1 turn on value. Press the ENTER button to continue.

d. Stage 2 On Temp/PSI/Volts

67.0?

Use the UP and DOWN buttons to set the value at which Stage 2 turns on as the input rises. This **must be above** the value at which Stage 1 turns on. Otherwise the Stage 2 turn on value will default to 0.2 (°F, PSI or Vdc) above the Stage 1 turn on value. Press the ENTER button to continue.

Continue to manually set the individual relay stage's on and off values, as described above, until the number of used output stages' primary setpoints have been set.

Example 1: Correct Stage 1 and Stage 2 setpoints:

Stage 1 turn-on = 60 °F

Stage 1 turn-off = 54 °F

Stage 2 turn-on = 68 °F

Stage 2 turn-off = 62 °F

Example 2: Correct Stage 1 and **incorrect** Stage 2 setpoints:

Stage 1 turn-on = 60 °F

Stage 1 turn-off = 54 °F

Stage 2 turn-on = 58 °F ←Typo

Stage 2 turn-off = 62 °F

In Example 2: the Stage 2 turn-on set point is below the Stage 1 turn-on set point due to a typographical error. Therefore, the 890-DSQ's microcontroller will substitute 60.2 °F for the Stage 2 turn-on point. The microcontroller will also substitute 60.1 °F for the Stage 2 turn-off setpoint since 62 °F is above 60.2 °F. **NOTE:** The microcontroller substituted set point values can ripple through all the remaining stage set point values. **Therefore, always double check all of the actual set point values stored in memory.**

Operating Modes Con't

MODE 5: *Change Secondary Setpoints*

The 890-DSQ Series sequencers include a second set of setpoints that can be stored and used when an application determined condition occurs. The sequencer will operate using the secondary set points when an external contact is closed, connecting the input terminal labeled "2ND" to the adjacent "GND" terminal. Press the ENTER button to begin setting the secondary set points.

The LCD screen will show "*Set Stage On/Off Values Auto 2*". The "2" indicates the 2nd (secondary) set of setpoint values can be changed when this menu is selected. The options available to select these secondary setpoint values are identical to the options used to set the primary setpoint values in MODE 4 above. Therefore, follow the MODE 4 instructions, when the number "2" is present to update the secondary setpoints using either **Auto** or **Manual** methods.

MODE 6: *Special Settings:*

MODBUS, I&O, RESET

This mode has 10 menus and is used to set the following options:

- Lockout code activation.
- Modbus slave's address, baud rate and parity.
- Input sensor type (temperature or pressure).
- Relay stage's sequence mode (FIFO, FILO or Binary Encode).
- Scale the sequencer's PWM and VDC output signals to match the variable stage EC motors' full speed, minimum speed and off percentages
- 10 - 0 Vdc output selection (by inverting the PWM and 0-10 VDC output signals).
- Reset the sequencer to factory settings.

The LCD sequences thru the following menu screens with each press of the ENTER button. Press the ENTER button to continue.

1) **Lockout Code Enabled?**

Yes

Use the UP or DOWN button to enable (activate) or disable (de-activate) the Lockout Code. The options are: "Yes" or "No". Then press the ENTER button to continue,

2) **MODBUS Address: 1**

Use the UP and DOWN buttons to set a unique Modbus slave address for this particular 890-DSQ Sequencer. (Range is 1 to 247). Then press the ENTER button to continue.

3) **MODBUS Baud Rate**

19200

Use the UP and DOWN buttons to select the Modbus baud rate. (The choices are 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200). When remotely setting the baud rate value, a number code, from 0 to 7, is used. Refer to TABLE 1, **Baud Rate Codes** below, to view the available 890-DSQ Sequencer's baud rates and their associated number codes. The default baud rate is 19200. Press the ENTER button after making your selection.

Code	Baud Rate	Code	Baud Rate
0	1200	4	19200
1	2400	5	38400
2	4800	6	57600
3	9600	7	115200

Baud Rate Codes

TABLE 1

4) **MODBUS Parity**

Even

Use the UP and DOWN buttons to set the Modbus parity. The choices are even parity, odd parity and no parity with 2 stop bits. Then press the ENTER button to save the selected parity and continue.

5) **Change Sensor Type**

Temperature

Use the UP and DOWN buttons to change the input sensor type. (Choices are temperature or pressure). When the sensor type is changed from temperature to pressure, or vice versa, the Emergency On value is reset to either the temperature based Emergency On value or the selected maximum pressure value. Press the ENTER button to save the selected sensor type and continue. If "pressure" is selected, then another menu appears, requesting the maximum pressure rating of the sensor(s) used. Select the appropriate value from 100 PSI to 1000 PSI.

6) **Relay Sequence Mode**

FILO

Use the UP and DOWN buttons to change the order in which the relay stages turn on and off. (Choices are FILO, FIFO and Binary Encode).

FILO mode means the last relay stage to turn on will be the first relay stage to turn off.

FIFO mode means the first stage to turn on will be the first stage to turn off. FIFO mode promotes even load operation (wear) by using each stage an equal amount of time, on average, by turning on whatever stage has been off the longest and turning off whatever stage has been on the longest.

Binary Encode mode uses the Base 2 number counting system. Binary encode mode is used when the sequenced loads are arranged in a 1, 2, 4 weighted ratio (Each load has twice the capacity of the previous load). This allows the sequencer to operate 7 stepped loads using only 3 relay output stages (or up to 12 sequencer loads using 4 relay stages).

Press the ENTER button to save the selected relay sequence and continue.

7) **VarFan SpdLimits OutputHigh: 95**

Scales the sequencer's PWM and VDC output signals to match the selected VS (variable stage) EC motor's full speed control signal's percentage. For example:

If the EC motor goes to full speed as the input signal rises to 92% PWM or 9.2 VDC, then the VarFan SpdLimits OutputHigh: number should be set at 92.

Operating Modes Con't

NOTE: The LCD's Home Screen will show "VS: 100" indicating the EC motor is running at 100% full speed. However, the PWM and VDC output signals will remain set at 92% PWM and 9.2 VDC as the sequencer's selected input signal continues to rise.

8) *VarFan SpdLimits OutputLow: 20*

Scales the sequencer's PWM and VDC output signals to match the selected VS (variable stage) EC motor's minimum (low) speed control signal's percentage.

For example:

If the EC motor goes to minimum speed as the motor's input signal drops to 15% PWM or 1.5 VDC, then the *VarFan SpdLimits OutputLow:* number should be set at 15.

NOTE: The LCD's Home Screen will show "VS: 0" indicating the EC motor is at lowest speed. However, the PWM and VDC output signals will remain set at 15% PWM and 1.5 VDC, until the *VarFan SpdLimits OutputOff:* value is reached (see **menu 9** below).

9) *VarFan SpdLimits OutputOff: 0*

Scales the sequencer's PWM and VDC output signals to match the selected VS (variable stage) EC motor's off percentage. When the sequencer's input temperature (or pressure) sensor value drops below the EC motor's turn on value (set in *MODE 4.1a or 4.2a*), the PWM and VDC output signals will linearly decrease from the *VarFan SpdLimits OutputLow:* value, to the *VarFan SpdLimits OutputOff:* value, over a 2 °F (or 2 PSI) span, to keep the EC motors from short cycling.

As the input sensor's value continues to decrease, the PWM and VDC output signals percentage will remain set at the *VarFan SpdLimits OutputOff:* value.

For example:

1) When the sequencer's VS (variable stage's) output signals are required to decrease to 0% PWM or 0 VDC to turn off the fan, the *VarFan SpdLimits OutputOff:* value must be set to "0".

2) When the sequencer's VS (variable stage's) output signals are required to decrease to 5% of their full capability, and remain at 5%, as the input signal continues to decrease, the *VarFan SpdLimits OutputOff:* value should be set to "5".

NOTE:

The LCD's Home Screen will continue to show "VS: 0", indicating the EC motor is still off. However, the PWM and VDC output signals will remain at the PWM and VDC percentages set by the *VarFan SpdLimits OutputOff:* value.

10-0 VDC Output Selection

When the variable stage EC motors require a 10-0 VDC control signal, the VDC output's 0-10 VDC signal can be inverted (changed to a 10-0 VDC signal) by doing the following: (This will also invert the PWM duty cycle)

1) Set the "VarFan SpdLimits OutputHigh:" value to a low number (usually between 0 and 15).

2) Set the "VarFan SpdLimits OutputLow:" value to a high number (usually between 80 and 90).

3) Set the "VarFan SpdLimits OutputOff:" value to the highest number (usually between 95 and 100).

For Example:

To set the EC motor's control signal for full speed at 0 Vdc, minimum speed at 7.7 Vdc and off at 9.5 Vdc, use:

VarFan SpdLimits OutputHigh: 0

VarFan SpdLimits OutputLow: 77

VarFan SpdLimits OutputOff: 95

Using motors with a 10-0 VDC input control signal provides a level of safety. If the EC motors using a 10-0 VDC input signal lose their control signal they will run at full speed.

10) *Reset Control To Factory Settings?*

No

Use the UP and DOWN buttons to change the No to a Yes, or vice versa. Then press the ENTER button when the answer is correct.

Factory Default Settings

The 890-DSQ Sequencer's default settings are:

Test fans on = 0 (none).

Is variable stage used? No.

Number of fixed stages used = 6 output stages.

Stage on delay = 2.0 seconds.

Number of input stages used = 2 input stages.

Input combine rule = maximum.

Emergency on = 95 F, 1000 PSI or 10 VDC.

Change primary setpoints = No.

Default Temperature set points for 4 & 6 Stages are:

4 Stages	ON	OFF
Stage 1 =	61.5	54
Stage 2 =	67	61.5
Stage 3 =	72.5	67
Stage 4 =	78	72.5

6 Stages	ON	OFF
Stage 1 =	50.5	45
Stage 2 =	56	50.5
Stage 3 =	61.5	56
Stage 4 =	67	61.5
Stage 5 =	72.5	67
Stage 6 =	78	72.5

Default 0-10 VDC set points for 4 & 6 Stages are:

4 Stages	ON	OFF
Stage 1 =	4.50	4.0
Stage 2 =	5.0	4.50
Stage 3 =	5.50	5.0
Stage 4 =	6.0	5.50

6 Stages	ON	OFF
Stage 1 =	4.50	4.0
Stage 2 =	5.0	4.50
Stage 3 =	5.50	5.0
Stage 4 =	6.0	5.50
Stage 5 =	6.50	6.0
Stage 6 =	7.0	6.50

HOME SCREEN

Stages On: 0/4 0.4
Temp: 51.8 VS: 17

MODE Button
To Test Fans
Press ENTER

Fans On: 2
Use UP/DOWN/EXIT

0 UP button turns stages on:
DOWN button turns stages off.

Locked Enter Code
Failed Success

Built-in Test MODE

Simultaneously Press & Hold Down UP & EXIT.

Test: Press Enter
Tmp: 80.0

Change Temp/PSI/VDC
1 F, 1 PSI or 1 Volt with UP and DOWN Buttons

Special Settings: MODBU

Change Output Stage Settings

- Is Variable Stage Used? Yes
- No
- Variable Stage Ratio: 1.0
 Range = 1.0 to 12.0
- Number of Fixed Stages Used : 6
 Range = 0 to 12
- Stage's On Delay In Seconds: 2
 Range = 0.1 - 10.0

Change Input Settings

- Number of Inputs Used: 1
 Range 0 to 6
- Input Combine Rule:
 - Maximum
 - 2nd Highest
 - Average
 - Median
- Emergency On Temp/Pres/Volts: 115.0
 Range = 0.0 - 115.0 Deg
 0.0 - 1000 PSI
 0.0 - 10 VDC

Change Primary Set Points

- Set Stage On/Off Values Auto? 1
 - Manual
 - Var Stage TurnOn Temp/PSI/Volts 50.0
 - Stage 1 On Temp/PSI/Volts 55.0
 - Stage 1 Off Temp/PSI/Volts 53.0
 - Stage 12 Off Temp/PSI/Volts 78.0
- Low Span Value Temp/PSI/Volts: 50.0
- High Span Value Temp/PSI/Volts: 80.0
- On to On= 2.5 Deg
Hyster = 2.0 Deg

LINE TYPE LEGEND

- MODE Button →
- ENTER BUTTON|
- UP or DOWN Button - - - - -
- EXIT Button *****
- UP & EXIT Buttons - - - - -

Change Secondary Set Poi

on

US, I&O, RESET

Lockout Enabled?
Yes
No

MODBUS
Address: 1 Range = 1 to 247

MODBUS Baud Rate 19200
Range = 0) 1200; 1) 2400; 2) 4800;
3) 9600; 4) 19200; 5) 38400;
6) 57600; 7) 115200.

MODBUS Parity
Even Parity
Odd Parity
No Parity, 2 Stop Bits

Change Sensor Type: Temperature
Pressure

Relay Sequence Mode: FIFO
VS Output High: 95 Range = 0 to 100
VS Output Low: 20 Range = 0 to 100
VS Output Off: 5 Range = 0 to 100
FILO
Binary Encode

Reset Control To
Factory Sets? No
Yes

nts

Set Stage On/Off
Values Auto? 2
Manual
Var Stage TurnOn
Temp/PSI/Volts 60.0
Stage 1 On Temp/PSI/
Volts 65.0
Stage 1 Off Temp
/PSI/Volts 63.0
Low Span Value
Temp/PSI/Volts: 60.0
High Span Value
Temp/PSI/Volts: 94.0
On to On= 2.5 Deg
Hyster = 2.0 Deg
Stage 12 Off Temp
/PSI/Volts 78.0

Figure 3

OPERATING MODES CHART

Factory Default Settings Con't

- Change secondary setpoints = **No**.
- Default secondary set points are the same as the primary set points.
- Lockout enabled? **No**.
- Modbus slave address = **1**.
- Modbus BAUD rate = Code 4 (19200).
- Modbus parity = **even**.
- Sensor type = **Temperature**.
- Relay sequence = **FILO**.
- VS Output High = **95%**
- VS Output Low = **20%**
- VS Output Off = **0%**
- Reset control to factory sets? **No**.

Installation

! IMPORTANT:
Do not install the sequencer in an airtight compartment, on a vibrating surface or near/on heat generating sources.

NOTE:
The 890-DSQ Sequencer is conformally coated but must be protected from moisture and condensation if installed in high humidity areas or outdoors.

! IMPORTANT:
The 890-DSQ Sequencer's relay output stages are only designed for low voltage (24 VAC) operation. Operating the relay output stages at higher voltages may result in permanent damage to the sequencer.

The 890-DSQ Series sequencers may be installed using a range of inputs, staged relay outputs, and continuously variable EC motors or SCR outputs. Refer to **Figures 5 thru 8**, (pages 12 thru 14), for the appropriate wiring diagram(s) for this application. More than one wiring diagram's information may be required when installing the 1) Modbus connection, 2) secondary setpoint contact closure, 3) 0 - 10 VDC input or 4) VS (variable stage) EC motors or SCRs.

1. Wiring must comply with local and national electrical codes.
2. Disconnect all factory wiring connecting the load (motors, SCRs etc.) to the line.

Installation Con't



WARNING:

Disconnect power from the condenser fan motors and heating system to ensure the motors and heater elements are electrically disabled prior to installation.

- Refer to **Figure 4, Location of 890-DSQ Sequencer's Variable Stage Output**, below, for the location of the sequencer's variable stage's PWM and VDC output terminals.

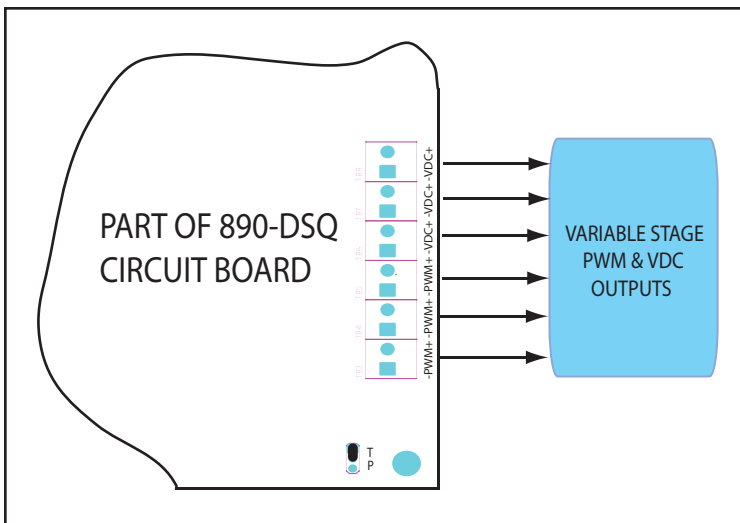


Figure 4

890-DSQ SEQUENCER'S VARIABLE STAGE OUTPUTS LOCATION

- Refer to **Figure 5, 890-DSQ Wiring Diagram 1**, (on page 13) for applications using staged relay outputs with temperature sensor inputs. Also see **Figure 8** (below) for liquid line temperature sensor mounting.
 - Mount temperature sensor on top of the liquid line where the line exits the condenser coil.

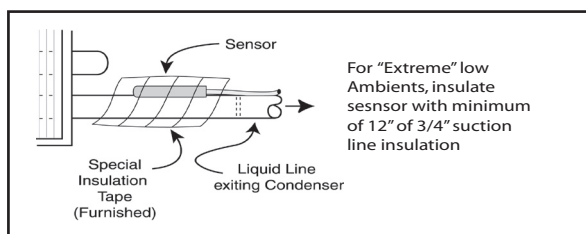


Figure 8

Liquid Line Temperature Sensor Mounting

- Fasten sensor firmly, **only using tape provided**. Make sure the metal tab "heat sink" on the sensor makes firm contact with the liquid line tubing.

NOTE: Using hose clamps or tie wraps to secure the sensor's metal tab to the liquid line will break the sensor's internal resistor. **Use only the provided waterproof tape** to secure the sensor to the liquid line.

- Refer to **Figure 6, 890-DSQ Wiring Diagram 2**, (on page 13) for applications using staged relay outputs with pressure sensor inputs.
- Refer to **Figure 7, 890-DSQ Wiring Diagram 3**, (on page 14) for applications using Modbus, secondary setpoints, the 0-10 VDC input, and/or variable stage EC motors and SCRs.
- When using the variable stage EC motors, within a bank of 6 PSC condenser fan motors, replace two of the PSC motors with 2 variable stage EC motors that have the same horsepower, line voltage, frame size and airflow as the replaced PSC motors.
- Install and wire the EC motors or SCRs per the manufacturer's instructions.
- Wire the 890-DSQ Sequencer per the wiring diagrams appropriate for this installation. More than one wiring diagram's information may be used, depending upon the application.

NOTE: Temperature and pressure sensors can not be used together, as inputs, on the same sequencer.
- The 890-DSQ Sequencer is designed for low voltage (24 VAC) operation, including the 24 VAC relay stage output loads.
- When additional cable is required** —
 - Always use 22AWG (minimum) stranded, twisted pair cable properly insulated for outdoor applications.
 - Sensor cables, 0–10 VDC input, Modbus, VDC and PWM output wires should not run in proximity, or be attached, to conduit carrying line voltage power wires.
- This completes the 890-DSQ Sequencer's installation.

Initial Checkout Procedure

- Verify all wire connections are correct for this application.
- Apply 24 VAC power to the 890-DSQ Sequencer.
- Verify all Fan or heater element relay stages work correctly by following the **MODE 1** text on page 4.
- Perform all **Built-In Self Test** instructions on pages 12 & 13.
- Remove 24 VAC from the sequencer.

Built-In Self Test

The **Built-In Self Test** function can only be operated in manual mode, and only simulates the value of a temperature or pressure sensor or a voltage depending on the input mode currently selected. The **Built-In Self Test** allows the installer to use the sequencer's UP and DOWN buttons to simulate the input value.

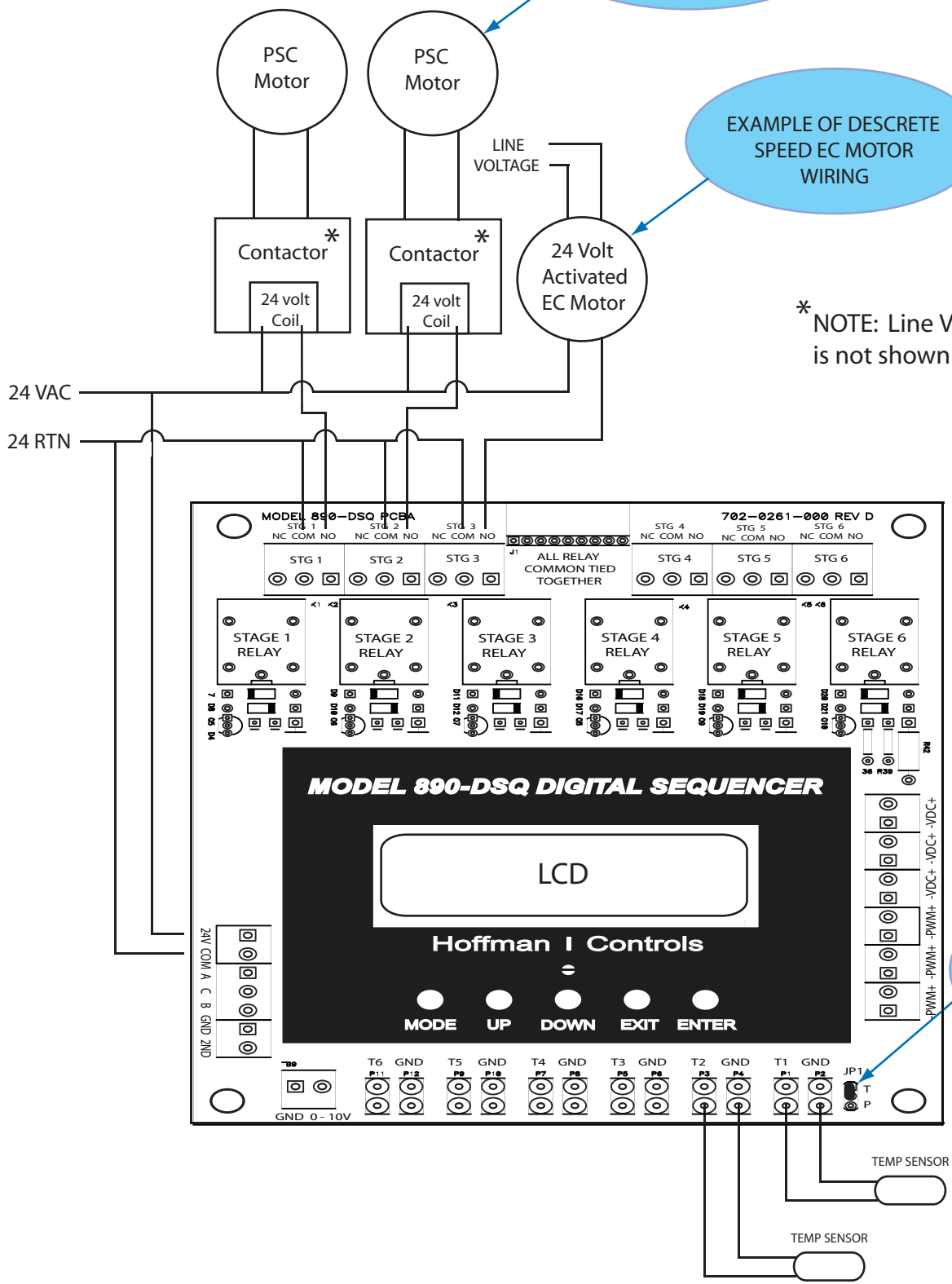
For the rest of this section, the simulated input will be assumed to be temperature.

Continued on page 17

EXAMPLE OF DESCRETE PSC MOTOR WIRING

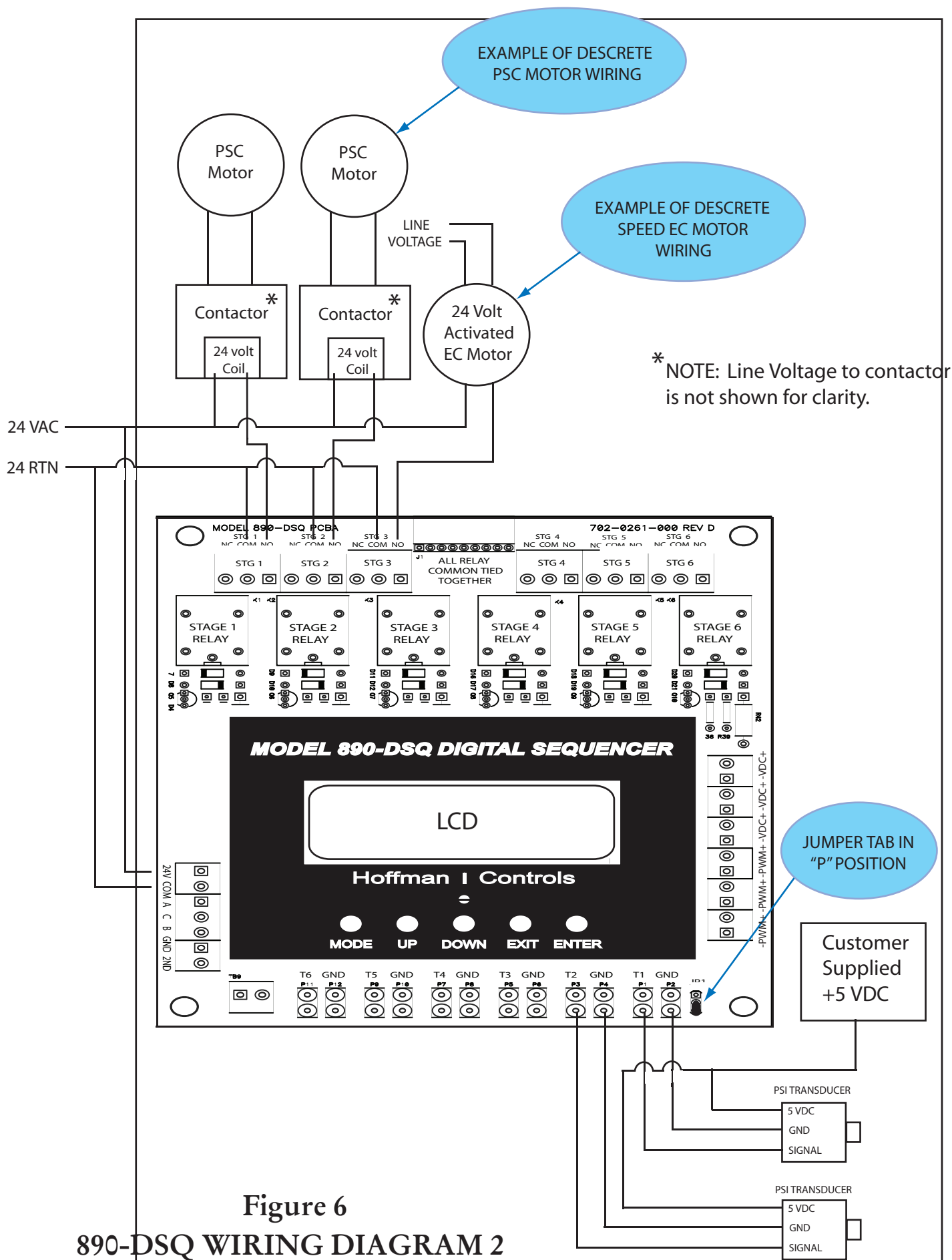
EXAMPLE OF DESCRETE SPEED EC MOTOR WIRING

* NOTE: Line Voltage to contactor is not shown for clarity.



JUMPER TAB IN "T" POSITION

Figure 5
890-DSQ WIRING DIAGRAM 1



REGISTER NUMBER	16 BIT REGISTER FUNCTION	REGISTER TYPE
0	EC motor or SCR Turn-On Temp, PSI or Volts. (All values times 10)	Read & Write
1	Stage 1 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
2	Stage 2 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
3	Stage 3 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
4	Stage 4 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
5	Stage 5 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
6	Stage 6 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
7	Stage 7 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
8	Stage 8 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
9	Stage 9 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
10	Stage 10 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
11	Stage 11 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
12	Stage 12 On Temp(°F), PSI or Volts. (All values times 10)	Read & Write
13	Stage 1 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
14	Stage 2 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
15	Stage 3 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
16	Stage 4 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
17	Stage 5 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
18	Stage 6 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
19	Stage 7 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
20	Stage 8 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
21	Stage 9 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
22	Stage 10 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
23	Stage 11 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
24	Stage 12 Off Temp(°F), PSI or Volts. (All values times 10)	Read & Write
25	Emergency On Temp(°F) or PSI (Both values times 10)	Read & Write
26	Variable Stage Ratio (Variable Stage Flow / Fixed Stage Flow)	Read & Write
27	Number of Used Stages	Read & Write
28	Number of 0-5 VDC Inputs Used (Temperature or Pressure)	Read & Write
29	Input Combination Rule: 1=Maximum, 2=Second Highest, 3=Average, 4=Median	Read & Write
30	Use Lockout Code (0= No, 1= Yes)	Read & Write
31	EC motor or SCR [Secondary Setpoint] Turn-On Temp, PSI or Volts. (All values times 10)	Read & Write
32	Stage 1 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
33	Stage 2 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
34	Stage 3 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
35	Stage 4 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
36	Stage 5 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
37	Stage 6 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
38	Stage 7 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
39	Stage 8 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
40	Stage 9 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
41	Stage 10 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write

MODBUS Registers for the 890-DSQ Sequencer

TABLE 2A

REGISTER NUMBER	16 BIT REGISTER FUNCTION	REGISTER TYPE
42	Stage 11 On Temp(°F), PSI or Volts [Secondary Setpoint] (All values times 10)	Read & Write
43	Stage 12 On Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
44	Stage 1 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
45	Stage 2 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
46	Stage 3 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
47	Stage 4 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
48	Stage 5 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
49	Stage 6 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
50	Stage 7 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
51	Stage 8 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
52	Stage 9 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
53	Stage 10 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
54	Stage 11 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
55	Stage 12 Off Temp(°F), PSI, Volts [Secondary Setpoint] (All values times 10)	Read & Write
56	Stage On Delay (Since Previous Stage Turned On) in Seconds (All values times 10)	Read & Write
57	Modbus Address (Range 1 - 247)	Read & Write
58	Number of Fixed Stages That Are On (Range 0 - 12)	Read Only
59	0-5 VDC Input #1 Value (Temperature [°F], Pressure[PSI] or Volts DC all values times 10)	Read Only
60	0-5 VDC Input #2 Value (Temperature [°F], Pressure[PSI] or Volts DC all values times 10)	Read Only
61	0-5 VDC Input #3 Value (Temperature [°F], Pressure[PSI] or Volts DC all values times 10)	Read Only
62	0-5 VDC Input #4 Value (Temperature [°F], Pressure[PSI] or Volts DC all values times 10)	Read Only
63	0-5 VDC Input #5 Value (Temperature [°F], Pressure[PSI] or Volts DC all values times 10)	Read Only
64	0-5 VDC Input #6 Value (Temperature [°F], Pressure[PSI] or Volts DC all values times 10)	Read Only
65	Use secondary set points, 2ND terminal is grounded. (0 = not used, 1 = selected)	Read Only
66	0-10 VDC Input Value times 10, rounded to nearest 0.1 Vdc.	Read Only
67	PWM Output Signal Value in % (Range 0% to 100%)	Read Only
68	Relay output mode (0 = FILO, 1 = FIFO, 2 = Binary Encode)	Read & Write
69	Pressure sensor full scale (0 is temp sensor, 1 is 100 PSI, 2 is 200 PSI up to 10 is 1000 PSI.)	Read & Write
70	Modbus baud rate code (0 = 1200; 1 = 2400; 2 = 4800; 3 = 9600; 4 = 19,200; 5 = 38,400; 6 = 57,600 and 7 = 115,200)	Read & Write
71	Modbus parity code (38 is even, 54 is odd and 14 is no parity with 2 stop bits)	Read & Write
72	If true (non-zero), reset sequencer to factory settings.	Write Only
73	High speed output (Range 0 to 100) PWM duty cycle or 0-10 VDC (100 is 10.0 VDC)	Read & Write
74	Low speed output (Range 0 to 100). A low speed output greater than high speed output means as the voltage goes up, the speed goes down. (See 10 - 0 VDC Output section, page 9)	Read & Write
75	Output for motor off (Range 0 to 100). Example: 5 means PWM is 5% and VDC = 0.5 VDC	Read & Write

MODBUS Registers for the 890-DSQ Sequencer
TABLE 2B

Built-In Self Test Con't

To begin, press and hold the UP and EXIT buttons down simultaneously for about 1 second. While continuing to hold both buttons down, press the ENTER button and then release all three buttons at once. The 890's LCD will display what appears to be the Home Screen (Figure 1, page 3) and the relays stages may start turning on, depending on the sequencer's selected setpoint values.

However, the installer can now change the simulated temperature shown on the LCD screen's second line. Each press of an UP or DOWN button will raise or lower the displayed temperature by 1.0 °F

The 890-DSQ's operation can be verified by observing each fixed stage's turn on and turn off temperature, displayed on the LCD's screen and indicated by each stage's LED. When selected, the VS (variable stage's) operation can also be verified.

When using the **Built-In Self Test** function:

- 1) Verify the fixed relay stages turn on and off at the correct temperatures, for the application, by observing the LCD screen's displayed temperature along with each stage's indicator LED.
- 2) If selected, verify the 2nd set of setpoints work correctly.
- 3) If selected, verify the VS (variable stage) EC motors (or SCRs) turn on and reach full speed (or full current) at the correct temperatures.
- 4) Press the EXIT button to end the Built-in Test Mode.

Modbus Operation



IMPORTANT:

After remotely updating any information the remote operator MUST review ALL of the 890-DSQ Sequencer's mode, menu, submenu and numerical value options to 1) ensure that all of the operating parameters, needed for the application, have been correctly selected and 2) also ensure that any unneeded or undesired options or numerical values have not inadvertently been left selected.

To update any or all of the 890-DSQ Sequencer's mode, menu and submenu parameters and numerical values remotely, using the Modbus RTU connection, proceed with the following steps:

- Set MODBUS RTU address, baud rate and parity for each 890-DSQ slave sequencer installed.
- Write to each slave using the TABLE 2A & TABLE 2B information (pages 15 & 16) to select the 890-DSQ Sequencer's internal register numbers and associated data, as required, to set up the sequencer's operating parameters and numerical values.

NOTE: Reliable operation is obtained only when using the data values described in the **Operating Modes** section (pages 4 thru 9) or shown in Figure 3 (pages 10 & 11).

- Use Modbus RTU command 3 to read data from individual or multiple internal sequencer registers.
- Use Modbus RTU command 6 to write data to an individual internal sequencer register.
- Use Modbus RTU command 16 (hexadecimal 10) to write data to individual or multiple internal sequencer registers.
- Observe the 890-DSQ Sequencer's operation, thru an entire system's cycle, to ensure correct operation.
- Recheck all Modbus register data and verify the data is correct.



IMPORTANT:

Remotely viewing or updating the 890-DSQ's register data can only occur when the sequencer's Home Screen is displayed on the LCD. If an installer is simultaneously observing or updating the 890-DSQ's menu, submenu or numerical values manually, the installer must return to the LCD's Home Screen before a remote update can be preformed.

Sequencer Re-calibration

If re-calibration of the sequencer's settings or numerical values are required, due to the particulars of the application, proceed with the following steps:

1. Power up loads (motors, heating elements etc.) and 890-DSQ Sequencer.
2. Determine if local, remote or a combination of both local and remote operation is to be used.
 - a) When local operation is desired, enter the Lockout Code then use the sequencer's five (5) push buttons and the LCD screen's information to select the settings and numerical values made available by each mode, menu and submenu screen. Follow the **Operating Methods** and **Operating Modes** sections (pages 3 thru 9) to update the settings and numerical values.
 - b) When remote operation is desired, follow the **Modbus Operation** section (pages 17 & 18) and the **Operating Modes** section (pages 4 thru 9), along with TABLES 2A and 2B, to update the settings and numerical values.

Recalibration Con't

- c) When a combination of both local and remote operation is desired, follow the instructions in a) and b) above. Local or remote operation can be used to initially operate the system. The installer can then observe and monitor the system's operation, and locally update any parameters that allow the Sequencer to provide the best operation for the application.

Final Sequencer Checkout

Reconnect any previously removed wires, apply 24 VAC power to the 890-DSQ Sequencer and observe the system's operation. If the system works correctly, no operational updates are needed.

If the system does not work optimally, determine the specific cause for the anomaly and fix it. When the anomaly's solution involves an update to the 890-DSQ Sequencer's parameters, follow the **Operating Modes** instructions (pages 4 thru 9) to update the specific parameter(s) needed to achieve the best possible system operation. After the update(s) have been made, observe the entire system's operation again, to verify the update(s) worked.

Operating Tips

The speed at which the LCD screen's values change is variable. Holding the UP or DOWN button down causes the displayed value to change slowly at first and then speed up noticeably. When making large value changes hold the button down until the displayed number is close to the desired value. Then release the button, wait 1 second, and press the button down again to slowly reach the desired value.

NOTE: If the installer has previously selected the 10-0 Vdc output option (**Mode 6.9**), he/she must deselect the 10-0 Vdc option, before changing the Variable Stage Used? option back to **No**. Otherwise, the PWM and VDC outputs will continue using the 10-0 VDC option.

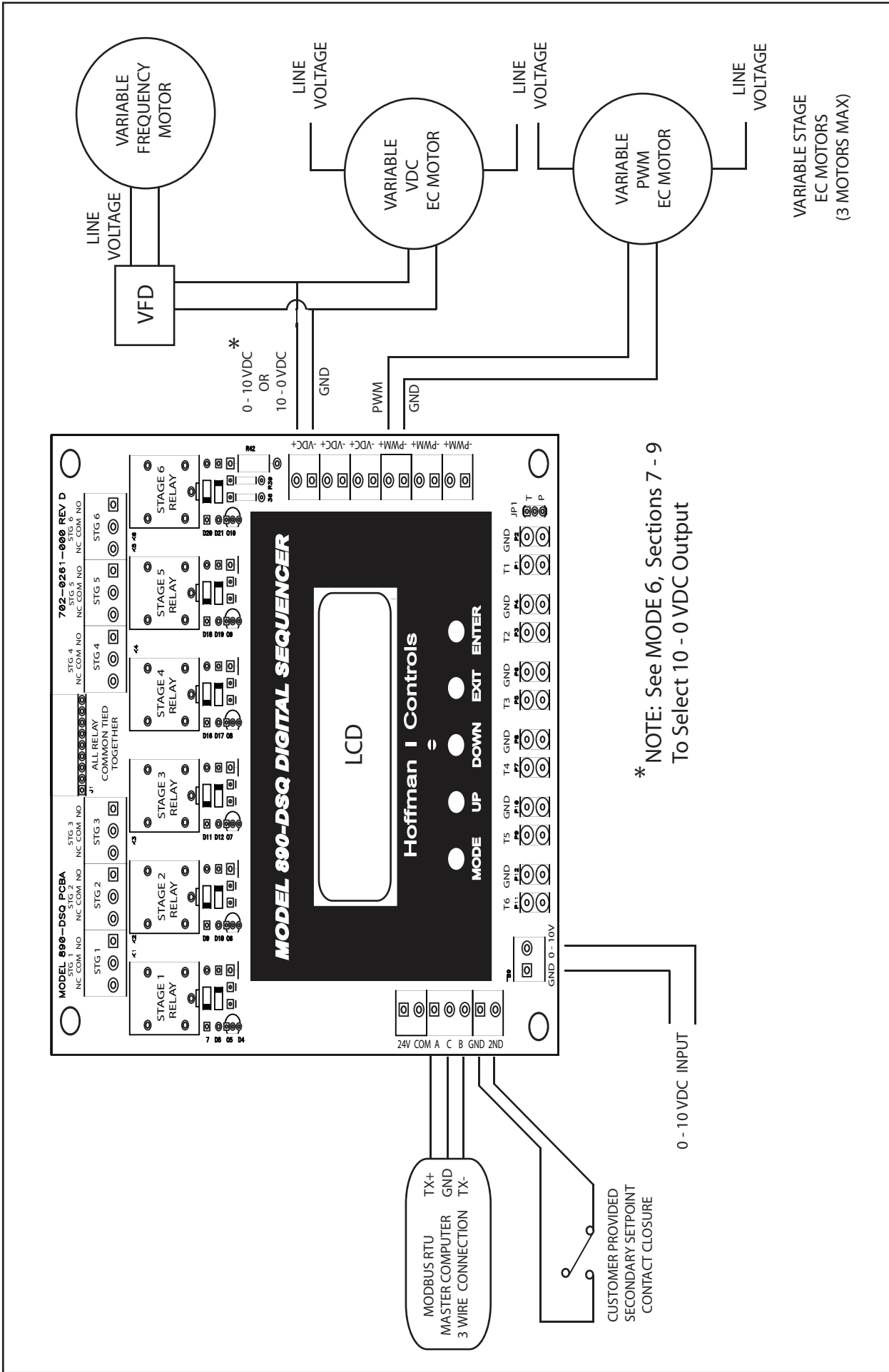


Figure 7
890-DSQ WIRING DIAGRAM 3

Troubleshooting Guide

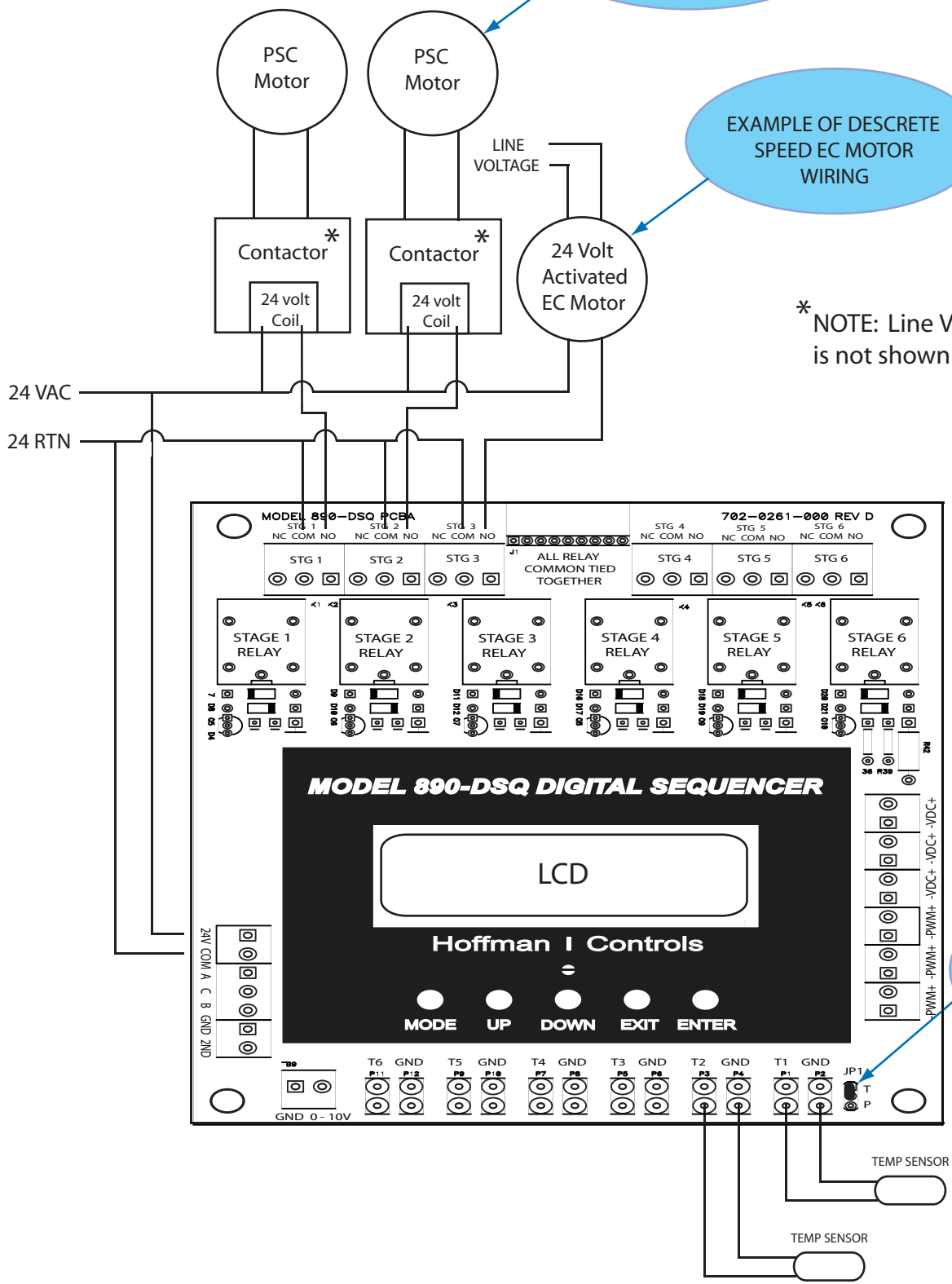
Condition	Cause	Solution
Relay Stages Will Not Activate	<ol style="list-style-type: none"> 1. Improper installation, sequencer not wired correctly. 2. Sequencer's relay stages have not been selected. 3. 0-10 VDC Input selected 4. Sequencer has been damaged 	<ol style="list-style-type: none"> 1. Check wiring, review instructions. 2. Select number of fixed relay stages used. 3. Deselect 0-10 VDC input 4. Replace sequencer
Relay Stages Not Activating Correctly	<ol style="list-style-type: none"> 1. Incorrect sequencer input selected. 2. Incorrect setpoint values used. 3. Incorrect relay sequencing mode selected. 4. Secondary setpoints accidentally activated. 	<ol style="list-style-type: none"> 1. Select correct input source. 2. Input correct setpoint values. 3. Select correct sequencing mode. 4. De-activate secondary setpoints.
Variable Stage EC Motor Will Not Operate	<ol style="list-style-type: none"> 1. EC Motor not wired correctly. 2. Selected EC motor is not a continuously variable speed motor. 3. Variable Stage operation not selected. 4. PWM operated EC motor wired to 0 - 10 VDC output. 5. 0 - 10 or 10 - 0 VDC operated EC motor wired to PWM output. 6. EC Motor "OFF" on internal overload. 7. EC Motor not wired correctly. Sequencer damaged. 	<ol style="list-style-type: none"> 1. Check wiring, review instructions. 2. Use continuously variable EC motor, 3. Select Variable Stage operation. 4. Wire EC motor to PWM output. 5. Wire EC motor to 0 - 10 VDC output. 6. Motor protected. 7. Replace sequencer.
Variable Stage EC Motor Will Not Modulate Properly	<ol style="list-style-type: none"> 1. 10-0 VDC operated EC motor being used. 2. Variable stage to fixed stage ratio number incorrect 3. EC motor not loaded correctly 4. PWM operated EC motor being used. 	<ol style="list-style-type: none"> 1. Set percentages for 10-0 VDC operation. 2. Recalculate / use correct ratio number. 3. Use proper fan blade. 4. Use correct control signal.
Modbus Operation Not Working Properly	<ol style="list-style-type: none"> 1. Improper installation, sequencer not wired correctly. 2. Incorrect master computer port selected. 3. Modbus GND wire not connected 4. Incorrect slave address, baud rate or parity selected. 5. Incorrect setpoints chosen (primary or secondary). 6. Microcontroller substituting setpoints for "incorrect" value. 	<ol style="list-style-type: none"> 1. Check wiring, review instructions. 2. Select correct port. 3. Install / connect GND wire 4. Select correct slave address, baud rate & parity. 5. Chose correct setpoints. 6. Correct setpoint values.

Hoffman|Controls

EXAMPLE OF DESCRETE PSC MOTOR WIRING

EXAMPLE OF DESCRETE SPEED EC MOTOR WIRING

* NOTE: Line Voltage to contactor is not shown for clarity.



JUMPER TAB IN "T" POSITION

Figure 5
890-DSQ WIRING DIAGRAM 1

Operating Methods Con't

Pressing the EXIT button, at any time, causes the control to return immediately to the Home Screen. However, any options or value changes that were not saved, by previously pressing the ENTER button, will be lost.

Remote Operation

Remote operation is accomplished by using a Modbus RTU master computer to communicate with the 890-DSQ Sequencer via the Modbus 3 wire connection. (The third wire is a common ground reference). During remote operation, the Modbus RTU master computer can read the information stored in 75 of the 890-DSQ Sequencer's 76 internal registers (Register 72 is a write only register). Refer to Tables 2A & 2B (pages 15 & 16) for a complete list of the registers, by number, and the required data range allowed for each register. The Modbus RTU master control can also write information to 65 of the 76 sequencer's internal registers (Registers 0-57 & 68-75). Registers 58 thru 67 are read only registers and therefore ignore any data written to them (see Modbus Operation section on pages 17 & 18).



IMPORTANT:

If any of the down loaded Modbus data is incorrect, the 890-DSQ Sequencer's microcontroller will change the incorrect data into software selected default values during the sequencer's next operating cycle. Therefore, after updating any data remotely, the operator ***MUST*** allow the 890-DSQ Sequencer to operate over its entire expected range (°F, PSI or VDC) before reviewing ALL of the data contained in each of the sequencer's 76 register addresses to 1) ensure that all of the operating parameters and numerical values, needed for the application, have been correctly selected and 2) also ensure that any unneeded or undesired options or numerical values have not inadvertently been left selected.

NOTE:

The Modbus RTU master control can only write data to 27 of the 890-DSQ Sequencer's registers at a time, and read data from 29 registers at a time, due to buffer size limitations in the sequencer's microcontroller.

NOTE:

Continue reading the following "Operating Modes" information to become familiar with the 890-DSQ Sequencer's operating characteristics.

Operating Modes

The following information is provided to identify and explain the 890-DSQ Sequencer's operational modes, menus, submenus, and numerical value options. The sequencer's MODE button is used to sequentially cycle thru the six (6) available modes displayed on the sequencer's LCD screen. Pressing the MODE button a seventh time returns the LCD to the Home Screen.

An 890-DSQ Operating Modes Chart (Figure 3, pages 10 & 11) is provided to allow the operator to track his/her progress thru the various LCD's screens. The Operating Modes Chart's information is viewed starting from the Home Screen, located at the top center of the chart, and continuing counter clockwise (to the left) around the chart.

NOTE: The 890-DSQ Operating Modes Chart information is presented in the same mode, menu and submenu order as the information presented on the LCD screen, when following the chart's information in a counter clockwise direction (to the left). Press the MODE button to begin.

MODE 1: *To Test Fans Press Enter.*

The contactor wiring and condenser fan or heating element wiring, connected to each relay output, can be sequentially tested in this mode by pressing the UP and DOWN buttons. Pressing the UP button turns on the next stage, while pressing the DOWN button turns off the last stage, that is currently on.

MODE 2: *Change output stage settings.*

The output stage settings can be changed from the preprogrammed stage options, by pressing the ENTER button when the above screen appears on the LCD. The LCD sequence's through the following 4 menu screens with each press of the ENTER button:

1) *Is Variable Stage Used? No*

The (VS) variable stage is used (activated) when continuously smooth airflow thru a condenser, or continuously variable current flow thru a heating system, is desired. Implementing the VS option requires connecting the sequencer's VDC and/or PWM output(s), to external SCRs or continuously variable speed EC motors. Press the UP or DOWN button to change the No to a Yes or vice versa. Then press the ENTER button to save the correct answer and advance to the LCD screen below.

2) *Variable Stage Ratio: 1.0*

When the VS (variable stage used) above is selected (Yes), this screen will appear. The variable stage ratio is used to set the ratio of the total variable stage capacity to that of a single fixed stage. In order to provide continuously smooth operation when using hysteresis, the ratio should be greater than 1.

This unique 890-DSQ feature provides PWM and VDC outputs that are used to drive variable speed EC motor fans or SCRs. When the variable speed fans or SCRs are present, the sequencer intelligently modifies the output to the variable speed fans or SCRs so that, as additional fixed speed fans or fixed heaters are sequenced on and off, the overall effect produces a continuously variable airflow (or current) over the entire system's range.