

Hoffman Controls

Complete Installation & Operating Instructions



CAUTION:

Failure to read and understand the accompanying instructions and diagrams prior to energizing the 890 Sequencer may result in permanent damage to the sequencer.

General

The Class II 890-DSQ micro controller 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 also has three 0-10 VDC, EC motor speed control outputs which can be re-configured as three 10 - 0 VDC motor speed outputs. There are 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 three (3) PWM, or three (3) 0-10 VDC or three (3) 10-0 VDC outputs that are used to drive continuously 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 on or off, the overall effect is that the total fan outputs' airflow varies continuously over the

890-DSQ Series Microprocessor Based Universal Sequencer

entire range. Typically, a mix of PSC and continuously variable speed EC powered motors are used within the same condenser bank.

The advantage of continuously variable airflow is that the head pressure can be more accurately maintained than by only switching the condenser fan motors on and off.

The 890-DSQ Sequencer's variable stage operates as follows: When the next fixed speed fan is turned on, the variable speed fans drop in rpm to compensate for the additional fixed speed fan. As the sensor 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 fans drop in rpm again. This process also works in reverse as the input decreases. Hysteresis is also provided so that no short cycling of the fixed speed fans occur.

Set point Values

The 890-Series sequencers can utilize up to two (2) sets of set point 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 set point values is the set typically used. The secondary set of set point 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 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 percent of 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.)

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 variable speed 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 fixed stages used, 2) the number of inputs used along with the input

Description Con't

type (temperature, pressure or 0-10 VDC), 3) the selection of the used fixed stage's individual (primary or secondary) set point values, 4) the selection of the fixed 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 a 6 fixed stage model, with 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 16 & 17, 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 **Off** (disabled) 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**" appears 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 FIXED STAGE TEST FEATURE: The 890-DSQ Sequencer has a relay fixed stage test feature which allows the installer to sequentially turn on, then turn off, each stage to individually 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 (temperature in °F 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) sensor 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 sensor four (4) on the left]. Unused input values are not displayed.

The 890-DSQ Sequencers come with a pre-programmed series of fixed relay stage set point values (turn on & off). 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 set points, other than the pre-programmed set points, a new set of set point values can be automatically calculated by the sequencer's micro controller, using equal spacing between stages. Any or all of the programmed set point values can 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 SCR to ensure continuously smooth heating functionality.

Pre-Installation Information/ Instruction Con't



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 line voltage power up.

Operating Methods

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 micro controller'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 micro controller 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 micro controller'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**).

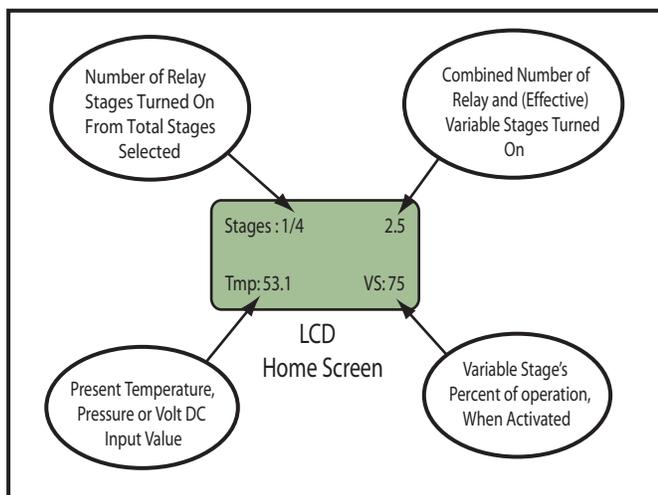


Figure 1
LCD Home Screen

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 micro controller'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 set point 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 value. Pressing the **DOWN** button either 1) cycles backward thru the available options or 2) decreases the displayed value.

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.

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.

Operating Methods Con't



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.

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 16 & 17) for a complete list of the registers, by number, and the required data range allowed for each register. The Modbus RTU master computer 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 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.

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 seven (7) available modes displayed on the sequencer's LCD screen. Pressing the **MODE** button an eighth 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 Operating Modes Chart, and continuing counter clockwise (to the left) around the chart.

NOTE: The **Figure 3, 890-DSQ Operating Modes Chart**, (on pages 10 & 11) 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 pre-programmed stage options, by pressing the **ENTER** button when the above screen appears on the **LCD**. The **LCD** screen 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, rated at twice the current capacity of the largest heating coil, 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 *Is 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.

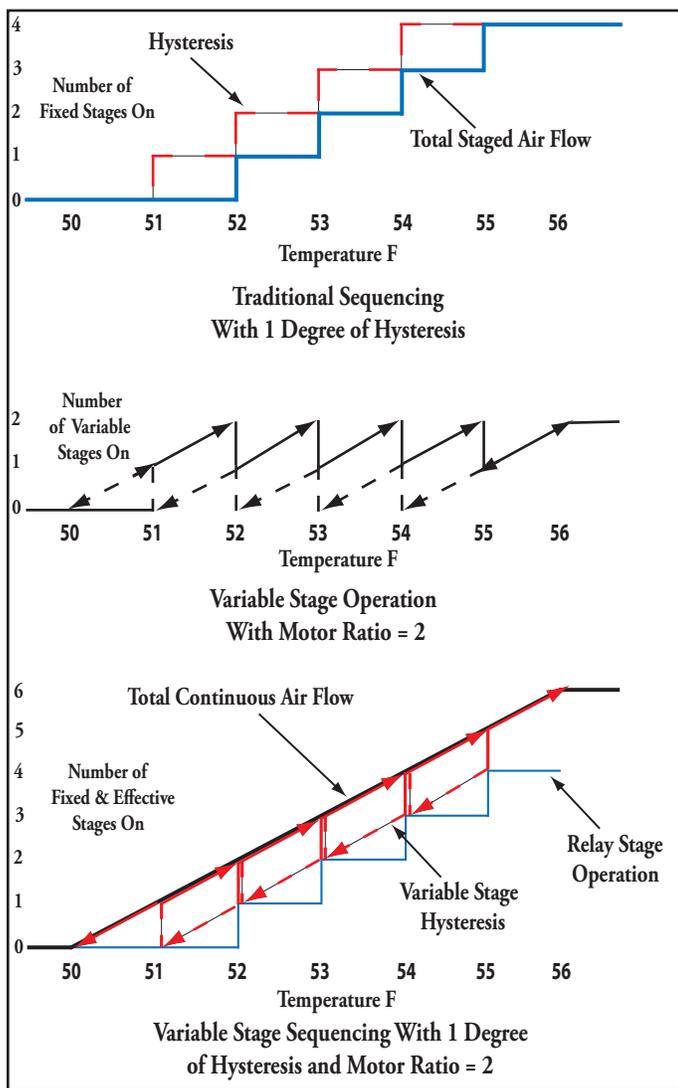


Figure 2
Traditional Vs Variable Stage Operation

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 fixed 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, to allow continuous increases or decreases in airflow without short cycling the fixed stages.

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 Home 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 the 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:

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

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's screens.

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 sensors or pressure transducer inputs. **NOTE:** The six temperature sensors and six pressure transducer inputs are ignored when the number of inputs is set to "0".

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 sensor or pressure transducer input is used. The installer must choose 1 of 4 possible ways to combine the temperature sensors or pressure transducer's input values. The four choices are; **Maximum**, **Second Highest**, **Average** or **Median**.

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

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

The **Median** option is chosen when the middle value of all used sensors or all used transducer 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: 95.0*

This screen appears when temperature sensor or pressure transducer inputs are selected. If any of the used temperature sensor or pressure transducer 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 set point values can be changed/updated, from the pre-programmed set point values, by pressing the ENTER button when the above screen appears on the LCD screen.

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 set point values automatically, see MODE 4.1 below. To manually update any or all of the set point 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 transducers 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 set points 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, **Set Stage On/Off Values Manual 1** (on 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 variable speed 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** (on page 7).

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 each of 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 set points (stage turn on and turn off) values manually, press the ENTER button.

a. Var Stage TurnOn

Temp/PSI/Volts: 50.0

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. If the variable stage is being used, 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. 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.



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.

e. Stage 2 Off Temp/PSI/Volts

61.5?

Use the UP and DOWN buttons to set the value at which Stage 2 turns off as the input falls. This **must be below** the value at which Stage 2 turns on. Otherwise the Stage 2 turn off value will default to 0.1 (°F, PSI or VDC) below the Stage 2 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 set points have been set.

MODE 5: Change Secondary Set Points

The 890-DSQ Series sequencers include a second set of set points 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 set point values can be changed when this menu is selected. The options available to select these secondary set point values are identical to the options used to set the primary set point values in MODE 4 above. Therefore, follow the MODE 4 instructions, when the number "2" is present on the LCD screen's menu or submenu text, to update the secondary set points using either **Auto** or **Manual** methods.

Operating Modes Con't

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 variable stage PWM and VDC output to match the variable stage's, continuously variable speed, 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 screen sequences thru the following menu and submenu screens, with each press of the ENTER button. Press the ENTER button to continue.

1) *Lockout Code Enabled?*

No

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 Parity

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 transducer(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 a ranged 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 VS 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.

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 VS 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.

Operating Modes Con't

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 sensor (or pressure transducer) 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 signal's 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.

This completes the Operating Modes section.

Factory Default Settings

The 890-DSQ Sequencer's factory default settings are:

Test fans on = 0 (none).

Is variable stage used? No.

Number of fixed stages used = 4 relay output stages.

Stage on delay = 2 seconds.

Number of input stages used = 2 input stage.

Input combine rule = maximum.

Emergency on = 95 °F, 950 PSI or 9.5 VDC.

Change primary set points = No.

Change secondary set points = No.

Lockout enabled? No.

Modbus slave address = 1.

Modbus BAUD rate = Code 4 (19200).

Modbus parity = Even Parity.

Sensor type = Temperature.

Relay sequence = FILO.

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.



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.

HOME SCREEN

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

MODE Button
 To Test Fans
 Press ENTER

Fans On: 0
 Use UP/DOWN/EXIT

Locked
 Enter Code
 Failed Success

Built-in Test
 MODE

Simultaneously Press & Hold Down
 UP & EXIT.

Test: Press Enter
 Temp: 80.0

Change Temp/PSI/VDC
 1° F, 1 PSI or 1 Volt with
 UP and DOWN Buttons.
 Press MODE, Then EXIT
 to return to Home Screen.

Special Settings: MODB

MODE Button
 Change Output Stage Settings

Is Variable Stage
 Used? No
 Yes
 Variable Stage Ratio: 1.0
 Range = 1.0 to 12.0
 Number of Fixed Stages Used : 4
 Range = 0 to 12
 Stage's On Delay In Seconds: 2
 Range = 0.1 - 10.0

MODE Button
 Change Input Settings

Number of Inputs Used: 2
 Range 0 to 6
 Input Combine Rule:
 Maximum
 2nd Highest
 Average
 Median
 Emergency On
 Temp/Pres/Volts: 95.0
 Range = 0.0 - 115.0 Deg
 0.0 - 1000 PSI
 0.0 - 10 VDC

MODE Button
 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
 61.5
 Stage 1 Off Temp/PSI/Volts
 56
 Stage 12 Off Temp/PSI/Volts
 78
 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 (solid line)
- ENTER BUTTON (dashed line)
- UP or DOWN Button (dotted line)
- EXIT Button (dash-dot line)
- UP & EXIT Buttons (long-dashed line)

MODE Button
 Change Secondary Set Po

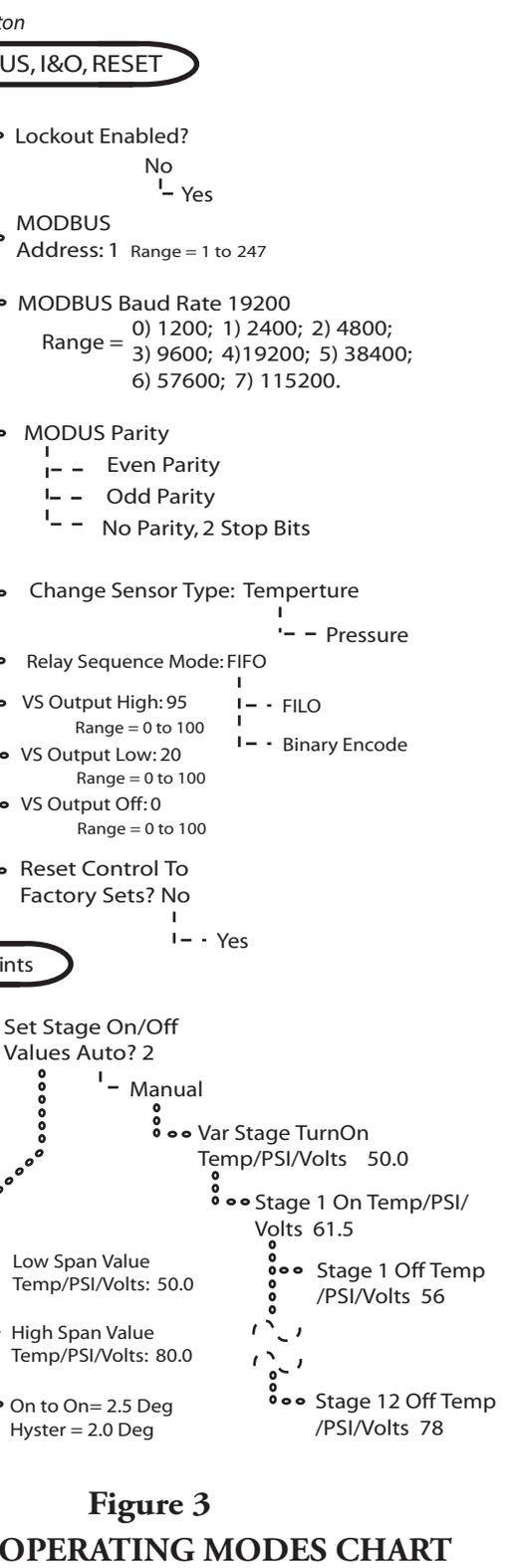


Figure 3

OPERATING MODES CHART

Installation Con't

NOTE:

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

The 890-DSQ Series Sequencers may be installed using a range of inputs, staged relay outputs, and continuously variable speed EC motors or SCR outputs. Refer to **Figures 5 thru 8**, (pages 12 thru 15), 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 set point 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.



WARNING:

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

- 2) Disconnect all factory wiring connecting the load (motors, SCRs etc.) to the line.
- 3) 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.

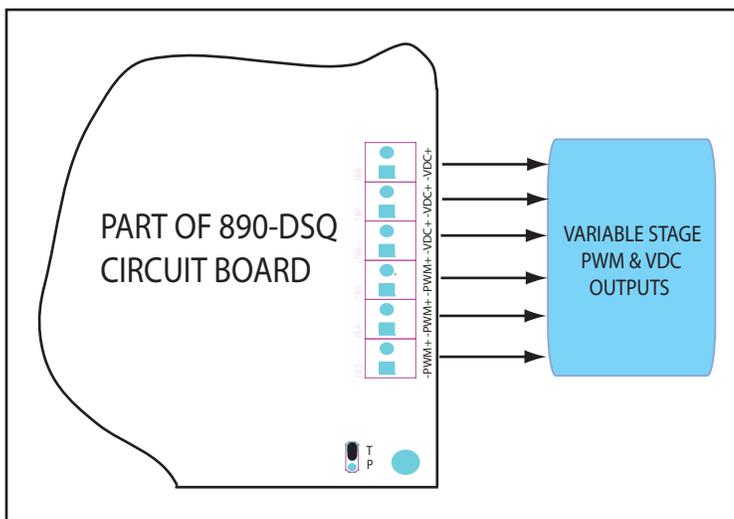


Figure 4

890-DSQ SEQUENCER'S VARIABLE STAGE OUTPUTS LOCATION

4) Refer to **Figure 5, 890-DSQ Wiring Diagram 1**, (on page 12) for applications using staged relay outputs with temperature sensor inputs. Also see **Figure 6, Liquid Line Temperature Sensor Mounting** (on page 13) for liquid line temperature sensor mounting.

- a. Mount temperature sensor on top of the liquid line where the line exits the condenser coil.

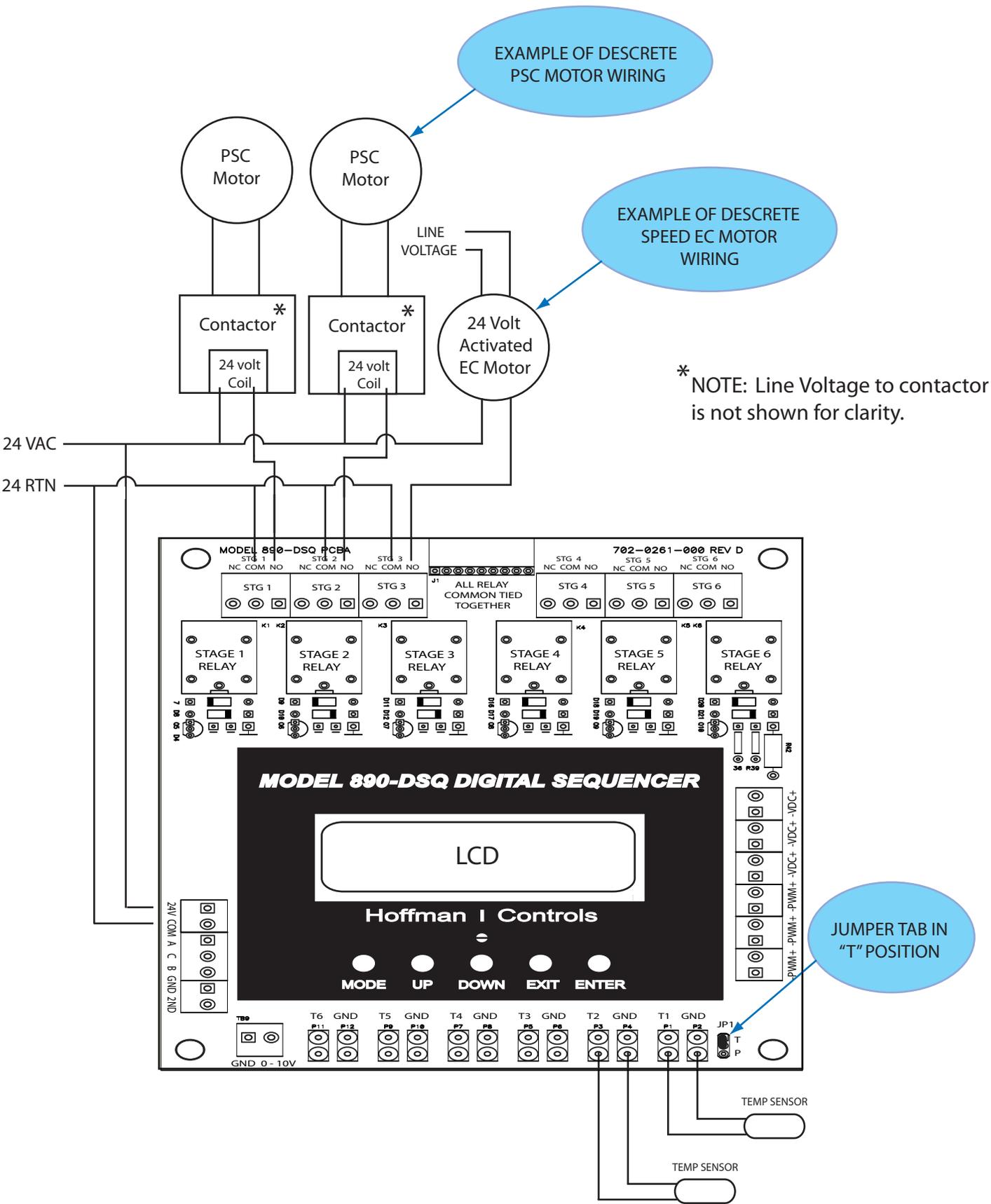


Figure 5
890-DSQ WIRING DIAGRAM 1

Installation Con't

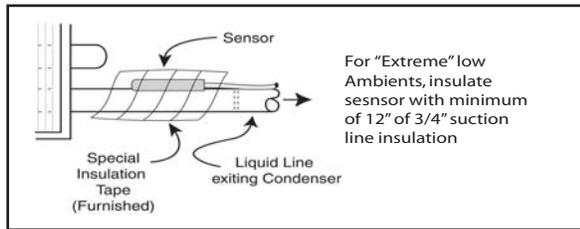


Figure 6
Liquid Line Temperature Sensor Mounting

- b. 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.
- 5) Refer to **Figure 7, 890-DSQ Wiring Diagram 2**, (on page 14) for applications using staged relay outputs with pressure transducer inputs.
- 6) Refer to **Figure 8, 890-DSQ Wiring Diagram 3**, (on page 15) for applications using Modbus, secondary set points, the 0-10 VDC input, and/or variable stage (VS) EC motors and SCRs.
- 7) When using variable speed EC motors, within a bank of 6 PSC condenser fan motors, the least time consuming way to replace two of the PSC motors, is with 2 variable speed EC motors, that have the same horsepower, line voltage, frame size and airflow as the replaced PSC motors.
- 8) When using SCRs to continuously modulate the current in a heating system, insert an SCR with **twice the current capability** that the heating element to be modulated has.
- 9) Install and wire the variable speed EC motors or SCRs per the manufacturers’s instructions.
- 10) 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 sensors and pressure transducers can not be used together, as inputs, on the same sequencer.
- 11) The 890-DSQ Sequencer is designed for low voltage (24 VAC) operation, including the 24 VAC relay stage output loads.
- 12) **When additional cable is required** —
 - a. Always use 22AWG (minimum) stranded, twisted pair cable properly insulated for outdoor applications.
 - b. Sensor or transducer cables, 0–10 VDC input wires, Modbus wires, and VDC / PWM output wires should not run in proximity, or be attached, to conduit carrying line voltage power wires.
- 13) This completes the 890-DSQ Sequencer’s installation.

Initial Sequencer Checkout

- Verify all wire connections are complete and correct for this application.
- Apply 24 VAC power to the 890-DSQ Sequencer.
- Perform all **Built-In Self Test** instructions (below).

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 sensor or pressure transducer 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.

To begin, press and hold the UP and EXIT buttons down simultaneously for about one (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 set point values.

However, the installer can now change the simulated temperature shown on the LCD screen’s bottom line. Each press of an UP or DOWN button will raise or lower the LCD 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 set points 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) To exit the Built-in-Self Test function, press the **MODE** button and then the **EXIT** button.

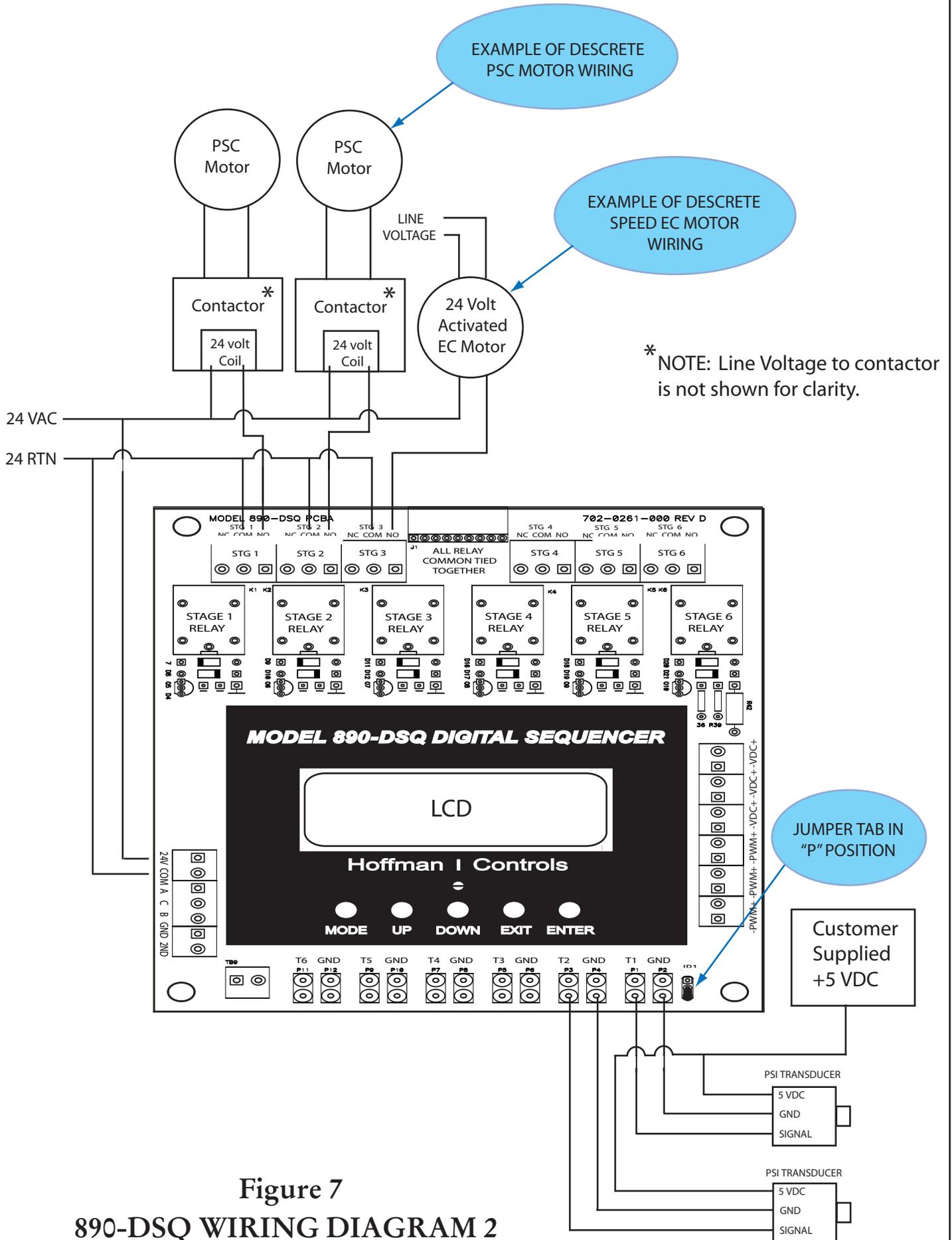


Figure 7
890-DSQ WIRING DIAGRAM 2

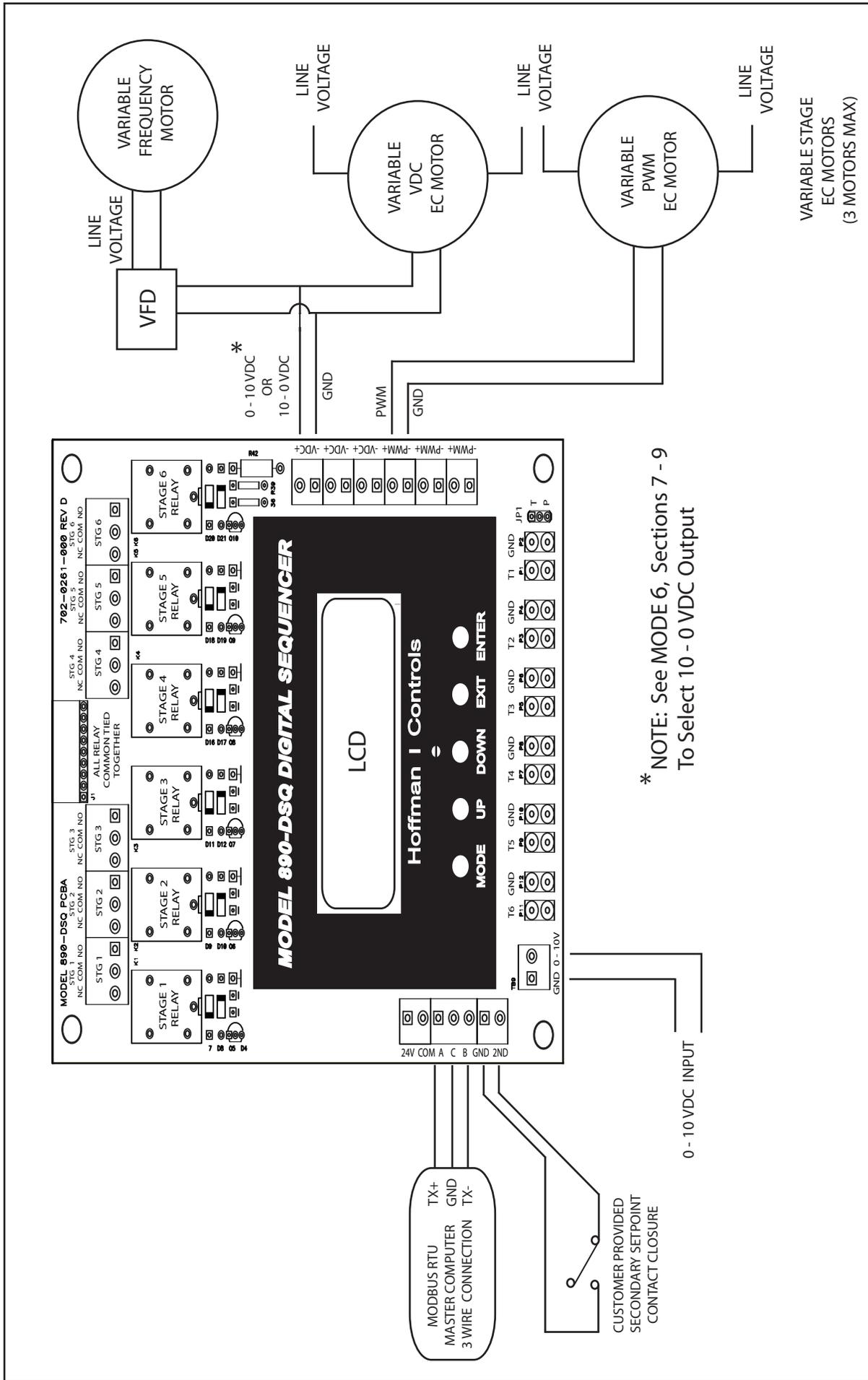


Figure 8

890-DSQ WIRING DIAGRAM 3

REGISTER NUMBER	MODBUS 16 BIT REGISTER FUNCTION	REGISTER TYPE
0	VS EC motor or SCR Turn-On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
1	Stage 1, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
2	Stage 2, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
3	Stage 3, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
4	Stage 4, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
5	Stage 5, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
6	Stage 6, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
7	Stage 7, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
8	Stage 8, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
9	Stage 9, Primary set point's On Temp (°F), PSI or Volts DC. (All values times 10)	Read & Write
10	Stage 10, Primary set point's On Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
11	Stage 11, Primary set point's On Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
12	Stage 12, Primary set point's On Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
13	Stage 1, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
14	Stage 2, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
15	Stage 3, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
16	Stage 4, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
17	Stage 5, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
18	Stage 6, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
19	Stage 7, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
20	Stage 8, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
21	Stage 9, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
22	Stage 10, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
23	Stage 11, Primary set point's Off Temp (°F), PSI or Volts DC.(All values times 10)	Read & Write
24	Stage 12, Primary set point's Off Temp (°F), PSI or Volts DC.(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 Fixed Stages Used	Read & Write
28	Number of 0-5 VDC Inputs Used (Temperature (°F) or Pressure (PSI))	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	Secondary set point's EC motor or SCR Turn-On Temp (°F), PSI or Volts DC. (values times 10)	Read & Write
32	Stage 1, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
33	Stage 2, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
34	Stage 3, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
35	Stage 4, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
36	Stage 5, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
37	Stage 6, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
38	Stage 7, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
39	Stage 8, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
40	Stage 9, Secondary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write

**890-DSQ Sequencer's MODBUS Registers' Numbers
TABLE 2A**

REGISTER NUMBER	MODBUS 16 BIT REGISTER FUNCTION	REGISTER TYPE
41	Stage 10, Primary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
42	Stage 11, Primary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
43	Stage 12, Primary set point's On Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
44	Stage 1, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
45	Stage 2, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
46	Stage 3, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
47	Stage 4, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
48	Stage 5, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
49	Stage 6, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
50	Stage 7, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
51	Stage 8, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
52	Stage 9, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
53	Stage 10, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
54	Stage 11, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
55	Stage 12, Primary set point's Off Temp (°F), PSI or Volts DC (All values times 10)	Read & Write
56	Stage's 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	To use secondary set points, 2ND terminal is grounded. (0 = not used, 1 = selected)	Read Only
66	0-10 VDC Input Value are times 10, and rounded to nearest 0.1 VDC.	Read Only
67	PWM Output Signal Value is in percent (Range 0% to 100%)	Read Only
68	Relay sequencing mode (0 = FILO, 1 = FIFO, 2 = Binary Encode)	Read & Write
69	Pressure transducer 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

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:

- 1) Set MODBUS RTU address, baud rate and parity for each 890-DSQ slave sequencer installed.
- 2) Write to each slave using the **TABLE 2A & TABLE 2B** information (pages 16 & 17) 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).

- 3) Use Modbus RTU command 3 to read data from individual or multiple internal sequencer registers.
- 4) Use Modbus RTU command 6 to write data to an individual internal sequencer register.
- 5) Use Modbus RTU command 16 (hexadecimal 10) to write data to individual or multiple internal sequencer registers.
- 6) Recheck all Modbus register data, not just the changed data, and verify all the data is correct.
- 7) Observe the 890-DSQ Sequencer's operation, thru an entire system's cycle, to ensure correct operation.



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 890-DSQ 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, if needed, 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. Also follow the **Built In Test** Section (page 13).
 - b. When remote operation is desired, follow the **Modbus Operation** section (this page) and the **Operating Modes** section (pages 4 thru 9), along with **TABLES 2A and 2B** (pages on 16 & 17), to update the settings and numerical values.
 - c. When a combination of both local and remote operation is desired, follow the instructions in **2a)** and **2b)** 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 & verify the all the wiring is correct and complete. Apply line voltage to the motors (or SCRs and heating system), then 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 data registers, follow the **Operating Modes** instructions (pages 4 thru 9) to update the specific data register(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

Speed Adjustment

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.

Input Sensor Values Screen

An additional **Input Sensor Values** LCD screen is available and can be displayed by pressing and releasing the UP button when the Home Screen is present on the LCD. Pressing and releasing the UP button again returns the LCD to the Home Screen.

The **Input Sensor Values** screen displays the active input temperature sensor values in °F, rounded to the nearest °F, (no decimal point). In pressure mode, the active input transducers values are displayed in PSI, rounded to the nearest pound (no decimal point).

Figure 9, Input Sensor Values Screen (next column) shows the LCD screen when temperature sensors are used as inputs. Only the active temperature sensor values are shown on the screen. In this case, all six (6) temperature sensors have been installed and selected. Uninstalled or unselected temperature sensor or pressure transducer inputs are not shown on the **Input Sensor Values** screen. **NOTE:** The displayed temperature values are the actual temperatures in °F rounded to the nearest °F.

For example:

Displayed Value	Actual Temp
53	53.1°F
47	46.5°F

The top line of numbers in **Figure 9** shows the temperature inputs T1 thru T4. Temperature input T1 is on the far left of the top line on the LCD screen. Temperature input T4 is on the far right of the top line on the LCD screen. The bottom line of numbers, in **Figure 9**, starts with the actual maximum temperature, in °F (with decimal point) obtained from the active temperature sensors, followed by the T5 temperature input value and the T6 temperature input value without decimal points. A "T:" appears before the maximum temperature to indicate the LCD screen is displaying temperature sensor values. A "P:" appears on the LCD screen when pressure transducer values are being displayed on the LCD screen.



FIGURE 9
Input Sensor Values Screen

10-0 VDC NOTE:

If the installer has previously selected the 10-0 VDC output option (10-0 VDC Output Selection on page 9), he/she must deselect the 10-0 VDC option (also within 10-0 VDC Output Selection on page 9), before changing the "Is Variable Stage Used?" option (MODE 2.1 on page 4) back to No. Otherwise, the PWM and VDC outputs will continue using the 10-0 VDC option.

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 set point values used. 3. Incorrect relay sequencing mode selected. 4. Secondary set points accidentally activated. 	<ol style="list-style-type: none"> 1. Select correct input source. 2. Input correct set point values. 3. Select correct sequencing mode. 4. De-activate secondary set points.
Variable Stage's Variable speed EC Motors Will Not Operate	<ol style="list-style-type: none"> 1. Variable speed 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 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 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 set points chosen (primary or secondary). 6. Micro controller substituting set points 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 set points. 6. Correct set point values.

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