SEQUENCING & PROTOCOL MANUAL

Supervisor™ Controller, WS Controller™, Sullair Touch Screen (STS) Controller

Including Supervisor II Deluxe Controller

⚠ SAFETY WARNING

Users are required to read the entire User Manual before handling or using the product. Keep the User Manual in a safe place for future reference.

WARRANTY NOTICE

Failure to follow the instructions and procedures in this manual, or misuse of this equipment, will **void** its warranty.

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The information in this manual is current as of its publication date and applies to the controllers indicated on this cover until next revision of this manual or release of a replacement manual.

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Section 1
Safety

WARNING

The operator should be familiar with all safety measures as described in the Supervisor™ Controller, Supervisor™ II Deluxe, WS Controller™, or Sullair Touch Screen (STS) Controller User Manual (whichever pertains).

WARNING

Machines should be off-line and not running when making parameter changes. Unexpected machine operation may occur.

Notes:

Section 2
Introduction

2.1 Supervisor™ Controller, Supervisor™ II Deluxe Controller, WS Controller™ and Sullair Touch Screen (STS) Controller

NOTE

For information specific to the Supervisor Controller, Supervisor II Deluxe Controller, WS Controller or Sullair Touch Screen (STS) Controller, consult the User Manual for that specific controller model.

This manual describes sequencing of multiple compressors with Supervisor Controller, Supervisor II Deluxe Controller, WS Controller or Sullair Touch Screen (STS) Controller. The term “controller” is used to apply to any of the four devices; however, specific differences will be highlighted in the places where they apply. Although each controller differs considerably in individual compressor functions and user interface, they behave similarly in sequence capabilities. Any of the controllers can be mixed within a compressed air system consisting of multiple machines.

Refer to the specific controller User Manual for details on compressor operation and adjustment of the controller.

2.2 Sequenced compressor systems

Compressor sequencing refers to using multiple compressors to meet the demands for compressed air. This may be a simple duplex system or may consist of multiple compressors used in applications with widely varying demands. The main concept for all configurations is for the compressors to operate automatically when compressed air is needed and to automatically stop if not needed. A properly designed system can offer substantial reductions in operating cost over a single large compressor.

Many duplex systems are designed with one primary compressor accompanied by one spare compressor. This configuration allows the system to remain operational during maintenance of a machine. The controller efficiently runs the compressors to meet the varying demands during the day and runs the backup compressor only when needed.

The Supervisor Controller, Supervisor II Deluxe Controller, WS Controller and STS Controller all feature internal sequencing functions. Prior to 2009, Supervisor Controllers required a separate communications module for these features. The machines operate as a distributed control system (rather than a master-slave relationship) so the system remains operational even if a member is taken off-line. The Supervisor Controller, WS Controller and STS Controller can be configured with up to 16 machines in a sequence system. When one or more Supervisor II Deluxe Controllers are in the system, the maximum number of machines is eight. Refer to *Section 3* for details.

A system with one or more variable-speed or electronic spiral valve compressors offers additional opportunities for control. Refer to *Section 4* for details on sequencing with variable speed compressors.

Section 5 covers application of controllers in master-controlled systems.

Section 6 describes the operation of timers used in an internal sequencing system.

Section 7 contains technical details of the hardware and protocol used on the communication bus. Other equipment may monitor the communication bus for data and assessment of system performance.

Notes:

Section 3

Sequencing with Multiple Controllers

3.1 Normal operation

The Supervisor™ Controller, Supervisor™ II Deluxe Controller, WS Controller™ and STS Controller all feature internal functions that enable sequencing of multiple machines.

- To enable a Supervisor Controller in the system, press the START pad and REMOTE pad on the keypad.
- Enable the Supervisor II Deluxe Controller by pressing the AUTO pad.
- Enable the WS Controller by simply pressing the START pad.
- Enable the STS Controller by pressing the green start button.
- Stop any individual compressor by pressing the STOP pad or button for that unit. The remaining compressors will continue to operate as needed.

The Supervisor Controller has a Remote keypad on the display module that is used to enable and disable the controller from any sequencing mode currently programmed. When the Remote key is first pressed after sequencing has been programmed, the sequencing mode will be enabled and the REMOTE LED on the Display Module will illuminate. Pressing the Remote keypad again will turn off the LED and disable the sequencing mode. The compressor will then operate as though it is not in any sequencing mode. The process will be reversed when the Remote keypad is pressed again.

3.2 Compressor system

Internal controller sequencing is designed to operate a group of 2 – 16 compressors feeding a common header. As air demands change, the compressors will be controlled to deliver the required compressed air in an efficient manner. If a group of similar compressors is used, the controllers can be set up to automatically equalize run time. The controllers can also be configured for a desired order of compressor operation. The three modes of sequencing operation are described below:

SEQUENCE HOURS—The order a compressor is set to run in a sequence operation based on the machine's sequence hours. In this mode, machines are started and loaded depending on the SEQUENCE HOURS (Seq. Hrs) parameter. Typically the machine with the next lowest number of sequence hours will be the next in sequence to start and load. The sequence hours parameter is similar to run hours except that it can be changed. A machine taken out of sequence will be skipped and the machine with the next lowest number of hours in the sequence will be next to start and load. While Sequence Hours mode is active, digital inputs for Remote control are disabled and Rotate hours function is disabled.

COM NUM—In this mode, a machine is started and loaded depending on the COMMUNICATION NUMBER parameter assigned to the machine. Operation is exactly the same as the SEQUENCE HOURS method (see above) except the communications number is used to determine machine sequence instead of sequence hours. Typically, the machine having a com number that is one number higher than the previous started machine will be the next to start and load. A machine taken out of sequence will be skipped and the machine with the next consecutive comm number in the sequence will be next to start and load. Digital inputs for Remote control are disabled.

SEQUENCE HOURS with ROTATE Hours Enabled—This SEQUENCE hours configuration applies only to two-machine applications that supply a demand for only one machine. DO NOT enable this mode in systems with more than two machines (See ROTATE hours parameter setting for more information). Digital inputs for remote control are disabled.

WARNING

Do not enable the Rotate Hours mode when the above situation is **not** true.

Unexpected starts and stops may occur when manually starting or stopping a machine in the sequence.

3.3 Wiring and piping

Control signals are passed along a simple network cable (Belden 9842 or similar). This type of cable has two twisted pairs with a shield. Twisted pairs usually have one color-coded wire twisted with a black or white wire.

For Supervisor Controllers, one twisted pair is connected to SEQ+ and SEQ- on the Supervisor I/O module. Make sure that the color-coded wire is connected at SEQ+ and the white or black wire is connected at SEQ-. Both wires of the other twisted pair must be connected to COM. The wire shield must be connected to ground at one end only.

For Supervisor Controllers prior to 2009, one twisted pair is connected to ISO+ and ISO- on the Supervisor Comm module. Make sure that the color-coded wire is connected at ISO+ and the white or black wire is connected at ISO-. Both wires of the other twisted pair must be connected to ISO GND. The wire shield must be connected to ground at one end only.

For Supervisor II Deluxe Controllers, the color-coded wire is to be connected to J2-16 and the white or black wire to J2-17. Both wires of the other twisted pair are to be connected to J2-18.

For WS Controllers, connections may be made to either J11 or J12. The color-coded wire is connected to PF 485+ and the white or black wire connects to PF 485-. Both wires of the other twisted pair are to be connected to PF 485C.

For STS Controllers, the color-coded wire is to be connected to J18 RS485+ and the white or black wire connects to RS485-. Both wires of the other twisted pair are to be connected to Common.

For the most efficient operation in a sequential system, the P2 (line pressure) transducers of all machines should be connected to a common header, down stream of individual dryers, etc. Note that the dP1 (separator maintenance delta pressure) may need to be calibrated to take into account the extra pressure drop of the down stream equipment. Refer to *Section 3.11* for steps on calibrating the system pressure readings.

3.4 Machine preparation prior to sequencing

For each machine to be connected in the sequence:

1. Complete all machine startup procedures as required for stand-alone operation. Refer to the specific compressor operator and controller manual for each machine.
2. Calibrate the P2 signal for all machines to read the same pressure at the common header. Each controller must be calibrated to read the same P2 pressure (±1 psi) of the common header psi.
   - If necessary, recalibrate the P2 signal for each controller in the system. Refer to *Section 3.11* for procedure on pressure calibration.
3. Program each machine with a different COM ID number (i.e.1, 2, 3, etc.).
4. Set the following parameters the same for each machine.
   - UNLOAD psi
   - LOAD psi
   - BAUD RATE (Supervisor II only). Baud Rate for Supervisor and WS is fixed at 9600.
   - SEQUENCE mode (COM ID or HOURS)
   - LAST COM
   - LOWEST (minimum pressure before a machine is started)
   - RECOVER time (normally set at 10)
   - Leave ROTATE hours disabled except for the specific application described in *Section 3.8*.
   - Set all sequence hour parameters the same unless it is desired to force certain machines to initially run longer than others in the HOURS mode.
5. Start the machines for sequencing as described in *Section 3.1*. Machines will start immediately if the P2 system pressure is low. On a fully pressurized system the machines will go into a standby state until a demand is recognized.

3.5 System operation

The following example describes how non-VSD and non-ESV machines are started, fully loaded and unloaded by the sequencing mode selected. The Automatic mode provides the means for each machine to stop by timing out on its unload timer when the sequencing order indicates the machine is to be unloaded.

For this example three machines are in a system with the load pressure set at 100 psig (6.9 bar), unload limit pressure at 110 psig (7.6 bar), lowest pressure limit at 90 psig (6.2 bar), and Recovery Time at 10 seconds (default value). All machines are stopped.

1. When the pressure drops below 102 psig (7.6 bar) a timer starts counting down from 120 seconds, if the pressure continues to drop the timer will count down faster (increments will be shorter).
2. When the timer expires or the pressure drops below 90 psig (6.2 bar) the first (or next) machine in the sequence is started.
3. If the pressure does not go above 90 psig (6.2 bar) for 10 seconds (Recovery Time) the second (or next) machine in the sequence will start. This process will continue until all machines are started or loaded.
4. As machines are started and loaded, there will be only one machine that is modulating, the others will be forced to "FULL LOAD". The modulating (trim) machine will load at 2 psig (0.14 bar) above the load pressure parameter, 102 psig (7.03 bar) in this example, and unload at 2 psig (0.14 bar) below unload pressure parameter, 108 psig (7.4 bar) in this example. The reason for this narrow load/unload band is to keep all machines from loading and unloading at the same time.
5. If the pressure rises above the unload pressure -2 psig (0.14 bar) to 108 psig (7.4 bar) the trim machine will unload (display will read "UNLOADED") and the next machine in the sequence will switch from full load to trim.
6. If, after Recovery Time, the pressure is still above 108 psig (7.4 bar) then the current trim machine will unload. This process can continue until all machines are unloaded.
7. If the pressure falls below load pressure +2 psig (0.14 bar) or 102 psig (7.03 bar) the first machine in the sequence will load and operate as the trim machine.
8. If after the Recovery Time the pressure is still below 102 psig (7.03 bar) then the trim machine will go to full load and the next machine in the sequence will load and become the trim machine.

3.6 System setup and tuning

Table 3-1 lists settings for a system of low pressure (90 to 100 psig [6.2 to 6.9 bar]) machines used in a typical sequencing configuration. The Trim High & Low Setpoints are not user settable parameters. These values are calculated from the Unload and Load pressures. The Trim High Setpoint is 2 psi (0.14 bar) below the Unload pressure. The Trim Low Setpoint is 2 psi (0.14 bar) above the Load pressure

.

Table 3-1: Low pressure machine settings (typical)

Machine Setting	Value
Unload Pressure	100 psig (6.9 bar)
Trim High Setpoint (calculated parameter)	98 psig (6.8 bar)
Trim Low Setpoint (calculated parameter)	92 psig (6.3 bar)
Load Pressure	90 psig (6.2 bar)
Lowest pressure	85 psig (5.9 bar)
Recover time (seconds)	10

Note that the unload pressure is set to 100 psi (6.9 bar) and not 110 psi (7.6 bar) as is normal on a stand alone machine. A stand-alone machine set up at 100 psi (6.9 bar) to 110 psi (7.6 bar) starts to modulate above 100 psi (6.9 bar) and the horsepower is reduced. However, in a sequenced system a machine may be forced to full load, which would draw more than the rated horsepower above 100 psi (6.9 bar). Therefore, the modulation band of machines in a sequencing system should be set up to be 10 psi (0.7 bar) lower than their rated pressure.

All running machines in a sequence operate either at full load or unloaded except for one which is operated as the trim machine. The trim machine unloads when the line pressure rises above the Trim High setpoint.

Trim High and Trim Low setpoints signal the trim machine to unload before the fully loaded machines and load before the unloaded machines. Otherwise, all machines would load and unload at the same time.

LOWEST pressure parameter specifies the lowest pressure allowed before immediately starting a machine. A machine may also be started if the line pressure drops below the Trim Low setpoint for a determined period of time.

RECOVER time keeps multiple machines from loading, unloading or starting at the same time. A timer is reset when a machine loads, unloads or loads after a start. Decisions to load, unload or start another machine are deferred until the timer reaches the RECOVER time setpoint. Note that the timer starts when a machine is added or taken away from the system.

If the pressure recovers within the RECOVER time, and then at a later time the pressure drops below the Trim Low setpoint, the next machine in sequence will load immediately. The shorter the recovery time the more responsive the system to load changes. However, the system would be less energy efficient with shorter recovery times since the machines may not shut off as often. The more frequently a machine loads the less likely it is to stay unloaded and shut off after the Unload timer expires. Refer to Section 6 for details on Recovery Timers.

The RECOVER TIME has a default value of 10 seconds. This parameter may be adjusted in one second intervals from 2 to 59 seconds.

3.6.1 General sequencing rules

The following rules apply to load, unload and start of machines in a sequence. Note that the terms “highest” and “lowest” refer respectively to machines with the highest and lowest SEQ HRS or COM ID.

- **Rule 1:** Only the highest loaded machine will trim; the rest will be forced to full load.
- **Rule 2:** The trim machine will unload when the line pressure rises above the Trim High setpoint.
- **Rule 3:** The next highest loaded machine will then become the trim machine. If pressure remains above the Trim High setpoint, the new trim machine will unload after Recovery Time expires. This process will continue until enough machines are running and loaded to maintain proper system pressure.
- **Rule 4:** The lowest unloaded machine will load (trim) when the line pressure drops below the Trim Low setpoint. If the pressure remains below the Trim Low setpoint the next Unloaded or Sequence Stopped machine will load or start after the Recovery Timer expires. This process will continue until enough machines are running and loaded to maintain proper system pressure.
- **Rule 5:** The lowest stopped machine will start when the line pressure drops below the Trim Low setpoint, and after a variable time out period (up to 120 sec.). This time out is dependent on how far the line pressure is below the Trim Low setpoint. The farther the line pressure is below the setpoint the shorter the time to start.
- **Rule 6:** The lowest stopped machine will override the above variable time out feature and start when the line pressure drops below the Lowest Pressure setpoint, and after the recovery timer expires.

3.7 Changing sequence parameters

3.7.1 Supervisor sequence parameters

Perform the following steps to change sequence parameter settings using the Supervisor Controller:

1. Press the Down ↓ arrow key until the SEQUENCING menu is displayed.
2. Press Enter ↵.
3. Use the Up ↑ and Down ↓ arrow keys to navigate through the menu selections to the parameter to be edited.
4. Press Enter ↵ to select the parameter for editing.
5. If a numeric value is to be entered, Use the Right → and Left ← arrow keys to position the cursor over the number digit to be changed.
6. Use the Up ↑ and Down ↓ arrow keys to change the parameter value.
7. Press Enter ↵ to save the changed value.

3.7.2 Supervisor II Deluxe sequence parameters

Perform the following steps to change sequence parameter settings using the Supervisor II Deluxe Controller:

1. Push the Program PRG key until the top line of the display identifies the sequence parameter to be changed.
2. Press the Up ▲ arrow and/or Logo keys to increment the sequence parameter value or press the Down/Lamp Test ▼☼ key to decrement the value.
3. Push the Program PRG key to save the changed value. The next sequence parameter will then be displayed.

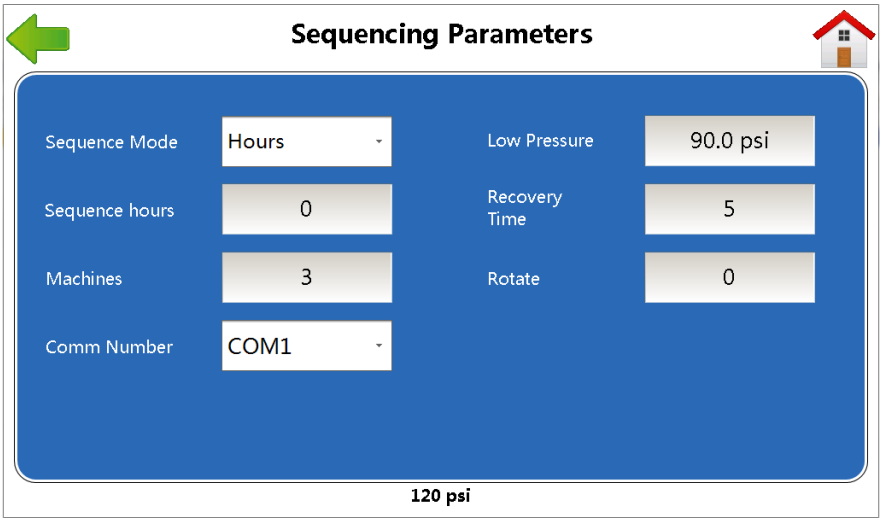

Figure 3-1: STS controller Sequencing Parameters screen

3.7.3 Changing sequence parameters—WS Controller

Refer to the *WS Controller PC User Interface Manual* for instructions on changing sequence parameters. The following sequence parameters can be changed at the WS PC User Interface:

Parameter	Options
Sequence by	Disabled, Remote, Slave, Hours, COM Number
Sequence hours	Integer value for sequence hours setting
Com number	1 – 16
Machines	1 – 16
Low press (PSI)	30 psi – 248 psi
Recover time	2 sec. – 60 sec.
Rotate	Integer value for number of rotate hours

3.7.4 Adjusting sequence parameters—STS Controller

To open the **Sequence Parameters** screen:

1. At the home screen, touch the configuration icon.
2. Touch the **Sequencing Settings** button.
3. Change parameter values (see *Figure 3-1*).
   - To change the **Sequence Mode** or **Comm Number**, touch its input box to display a drop-down list of available values, then touch a new value to select it.
   - To change any other parameter, touch its input box to display the numeric keypad, then type in the new value and touch Enter.

3.8 Sequence parameter names

Listed below are names of sequence parameters that can be modified when sequencing is enabled. The controllers that use a parameter are listed in parenthesis following that parameter. Parameters that perform the same function but have different names on different controllers are separated by a comma. The WS Controller uses a PC interface to modify parameter values.

Sequence by (Supervisor & WS), **Sequence mode** (STS), **SEQUENCE** (S2 Deluxe)—Select the desired sequencing mode.

Sequence hours (Supervisor, WS & STS), **SEQ HRS** (S2 Deluxe)—The maximum value for sequence hours is 32767 for the Supervisor II Deluxe and 65535 for the other controllers. A rollover to zero will occur if that number is exceeded.

Com Number (Supervisor & WS), **Comm Number** (STS), **COM ID#** (S2 Deluxe)—Must be unique ID number for every machine in the system. If there are three machines in a system, for example, they must be numbered 1, 2 and 3. Up to 16 machines may be sequenced in systems using Supervisor, WS and STS controllers.

Systems containing one or more Supervisor II Deluxe controllers are limited to eight compressors in a sequence.

Machines (Supervisor, WS & STS), **LAST COM** (S2 Deluxe)—Set as the total number of machines in a system.

Low Press (Supervisor, WS & STS), **LOWEST** (S2 Deluxe)—Set as the lowest allowable pressure before a machine has to start. Normally this is 5 to 10 psi (0.3 to 0.7 bar) below the load pressure. If the system pressure drops below this limit then the machine with the lowest SEQ HRS or COM ID is started immediately. A machine will also start if the pressure is below the Trim Low Setpoint for a period of time. The length of this time period is 0 to 120 seconds depending on the pressure and is controlled by the Delayed Start Timer. The closer the pressure is to LOWEST pressure the shorter the time. For example if the pressure drops below the Trim Low Setpoint by 1 psi (0.07 bar), and remains there, a machine will start in 120 seconds. If the pressure drops near LOWEST PRESSURE then a machine will start after just a few seconds. Refer to Section 6 for details on Delayed Start Timer operation.

Recover Time (Supervisor, WS & STS), **RECOVER** (S2 Deluxe)—Recovery time. This parameter adds a delay between subsequent start, load and unload commands. Refer to Section 6 for further explanation of Sequencing Timer operation.

Rotate (Supervisor, WS & STS), **ROTATE** (S2 Deluxe**)**—Rotate time for two-machine systems only. The rotate parameter forces the trim machine to stop (allowing the other machine to start). The trim machine will stop when its sequencing hours are more than a stopped machine sequencing hours based on the rotate hours value.

NOTE

There are some systems where the trim machine never unloads or stops and the second machine is never required in normal sequence operation. This applies specifically to a two-machine system where one machine runs all the time and the other is used only for backup.

WARNING

Do not enable Rotate mode when more than two machines are connected in a sequence. Unexpected starts and stops may occur when manually starting or stopping a machine in the sequence for maintenance.

For example, consider a two-machine system with SEQUENCING hours of 1000 and ROTATE of 50 hours on each machine. If one machine is started and continuously loaded, it will run until it's sequence hours are 1050 (50 hours more than the stopped machine) then stop. The other machine will start and run until it's sequence hours are 1100 (50 more than the stopped machine) then stop, and so the machine will rotate back and forth every 100 hours.

BAUD RATE (S2 Deluxe)—All controllers in a system must be set to the same Baud Rate. The Supervisor and WS Controller baud rate is fixed at 9600 baud. The Supervisor II Deluxe allows adjustment of the serial communications baud rate, usually set to 9600.

3.9 System displays

3.9.1 System display—Supervisor™ Controller

The Supervisor Controller System Menu allows the user to observe the status of other compressors in a sequence. The option is useful when monitoring, troubleshooting and calibrating the compressor system. To access the System Menu and view the status of the machines:

1. Press the up arrow until the word “SYSTEM” appears on the bottom line of the display screen.
2. Press Enter.
3. Use the down and up arrows to scroll through the data relating to each machine in the sequence.

Data for the machines will appear in five columns across the display screen. The first column of the display shows the machine Comm numbers (#1 through the total number of machines in the system) set by parameter LAST COM. The second column shows the status (Stat) of each machine as noted in the following chart. The third column displays the machine sequence hours (Hrs) parameter. The fourth column shows the Capacity (Cap) at which the machine is delivering air. The heading of the

fifth column displays the highest P2 pressure in the system with the P2 pressure for each respective machine displayed down the column. Status letters appearing in lower case indicate the machine has a fault or warning.

The status letters that may appear on the Supervisor display are:

- B—Standby
- R—Remote or sequence stop
- E—E-Stop
- S—Starting
- F—Full Load
- T—Trim (loaded and modulating)
- L—Loaded
- U—Unloaded
- M—Manual stop
- X—Remote Disable (WS Controller only)

3.9.2 System display—Supervisor™ II Deluxe

The Supervisor II Deluxe SYSTEM menu allows the user to observe the status of other compressors in a sequence. The option is useful when monitoring, troubleshooting and calibrating the compressor system. To access the System Menu and view the status of the machines in the sequence:

1. While in the main display, push the Logo key.
2. Press the "Display" DSP key. The top line of the display will show the numbers 1 through the number of machines in the system (maximum of 8 for the Supervisor II). The second line shows the status of each machine. Status letters in lower case indicate the machine has a fault or warning.

The status letters that may appear on the Supervisor II Deluxe display are:

- B—Standby
- R—Remote or sequence stop
- E—E-Stop
- S—Starting
- F—Full Load
- T—Trim (loaded and modulating)
- L—Loaded
- U—Unloaded
- M—Manual stop
- X—Remote Disable (WS Controller only)

If the Up arrow key is pushed the system line pressure is displayed. If the Up arrow key is pushed again the line pressure and sequence hours of the first machine is displayed. If the Up arrow key is pushed again, data for the next machine is displayed. Subsequent press of the Up arrow key allows for viewing of data for each machine in the system. A press of the Lamp Test key reverts back to the preceding display.

3.9.3 System display—WS Controller™

The system display for monitoring sequencing of WS Controllers is accessed via the WS PC software program. See *Figure 3-2*. Refer to the *WSPC User Interface Manual* for steps to viewing parameter data of machines in a sequence.

Hours—Displays the sequence hours of a particular compressor. Sequence hours are the number of hours set for a machine to run in sequence. This parameter can be adjusted at the Adjustments Display to assign the compressor to run in a specific order in the sequence system. When the operating mode is set to **Automatic**, the machine with the lowest number of sequence hours will be the next to start and the machine with the highest number of sequence hours will be the next to stop.

PSI—Displays the output pressure of the related compressor. This may be displayed as BAR or Kpa depending on user profile preferences. This measurement is taken at the P2 pressure transducer of the compressor and may be a different value than the overall system pressure.

ACFM—Shows the capacity of the specific compressor. Capacity is the volume of air in cubic feet per minute (cfm) being delivered by the compressor.

Remote—Indicates whether the compressor operation is being controlled remotely (including sequencing control) or by the local controller only.

Service—Displays **Yes** when the compressor is in need of service. This indication is accompanied by either a service reminder or warning message to inform the user of the nature of the service required.

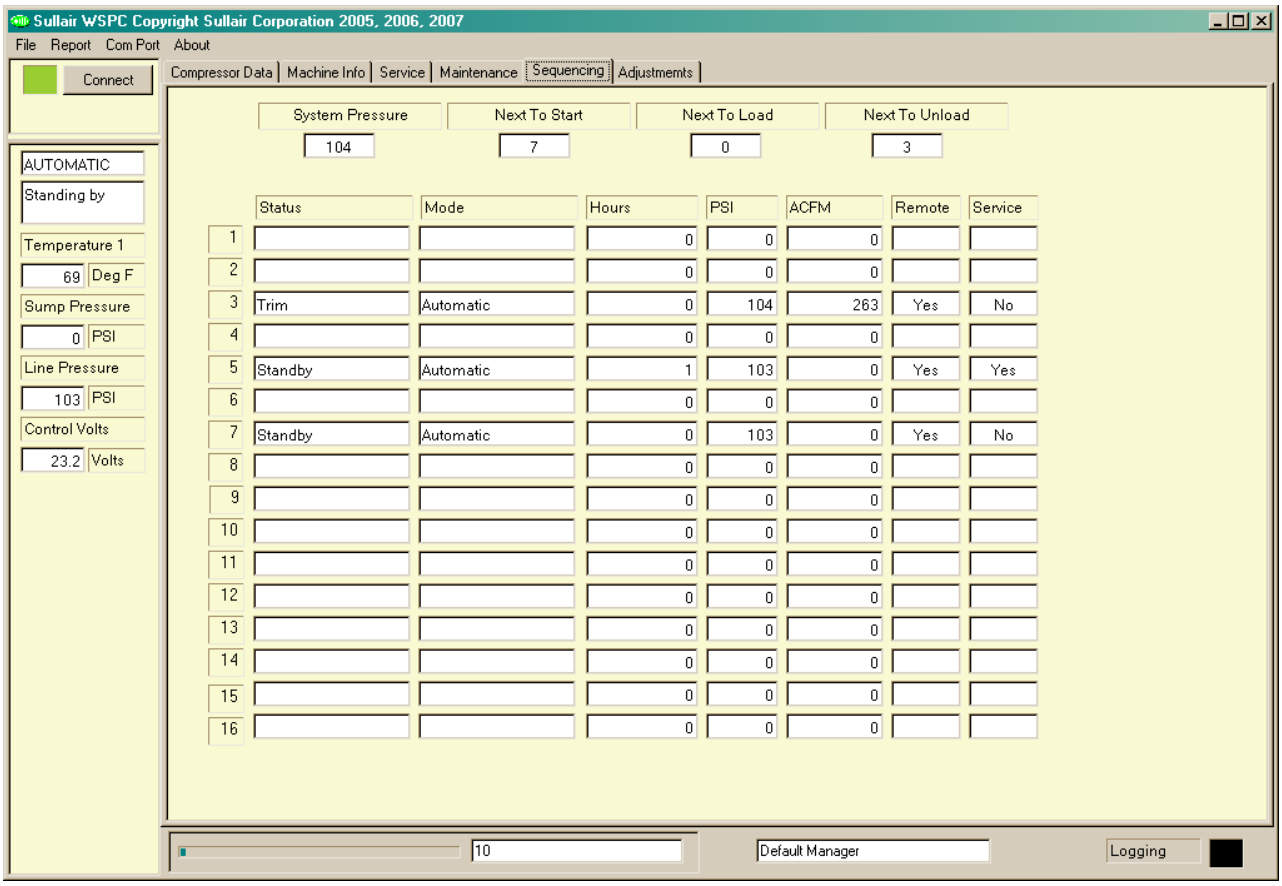

Figure 3-2: WS Controller sequence system display

3.9.4 System display—STS Controller

The status of compressors connected in sequence can be viewed at the Sequencing screen. See *Figure 3-3*.

The top line of the Sequence System Display shows the total system pressure. The sequence information contained in the table can display compressor data for up to sixteen machines in a sequence. The compressors are listed down the left side of the sequence information table in order of Com number. Refer to the Adjustments Display screen to verify the com number and sequencing mode of the current machine.

Status—Displays the operating state of each compressor in the sequence. The sequence state describes the operational role a machine is performing as a part of the sequence. The various states that may appear in the **Status** column are:

- **Starting**—Indicates the compressor is starting up.
- **Full Load**—Indicates the compressor is fully loaded.
- **Trim**—Indicates the compressor is operating as the trim machine in the sequence.
- **Loaded**—Indicates the compressor is running loaded.
- **Unloaded**—Indicates the compressor is running unloaded.
- **Manual Stop**—Indicates the compressor is stopped by the operator.
- **Remote Disable**—Indicates the compressor is removed from sequencing remotely.
- **Remote Stop**—Indicates the compressor has been stopped remotely.
- **Emergency Stop**—Indicates a compressor fault.

Mode—Displays the operating mode of each compressor in the sequence. The mode is the manner in which the machine's operation is being controlled. When running and operating normally, a compressor's operating mode will be either **Manual** or **Automatic** as selected by the user. Other modes are **Disabled** when the machine's operation has been stopped and **Faulted** when a fault has occurred.

Hours—Displays the sequence hours of a particular compressor. Sequence hours are the number of hours set for a machine to run in sequence. This parameter can be adjusted at the Adjustments Display to assign the compressor to run in a specific order in the sequence system. When the operating mode is set to **Automatic**, the machine with the lowest number of sequence hours will be the next to start and the machine with the highest number of sequence hours will be the next to stop.

PSI—Displays the output pressure of the related compressor. This may be displayed as BAR or Kpa depending on user profile preferences. This measurement is taken at the P2 pressure transducer of the compressor and may be a different value than the overall system pressure.

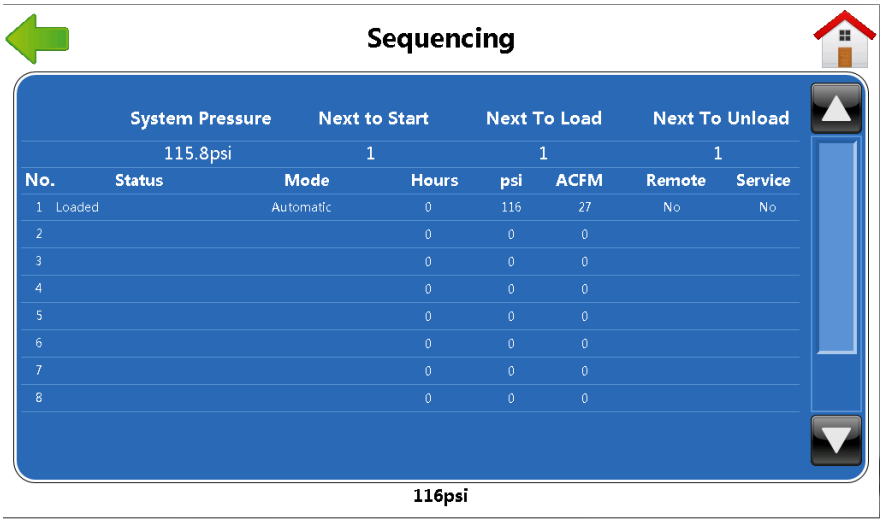

Figure 3-3: STS controller Sequencing screen

ACFM—Shows the capacity of the specific compressor. Capacity is the volume of air in cubic feet per minute (cfm) being delivered by the compressor.

Remote—Indicates whether the compressor operation is being controlled remotely (including sequencing control) or by the local controller only.

Service—Displays **Yes** when the compressor is in need of service. This indication is accompanied by either a service reminder or warning message to inform the user of the nature of the service required.

3.10 Removing a machine from sequence for maintenance

3.10.1 To temporarily disable a machine from sequencing for maintenance

1. Shut down the machine.
   - For the Supervisor Controller, the Supervisor II Deluxe Controller, and the WS Controller, press the STOP pad.
   - For the STS Controller, press the red stop button.
2. Remove power from the machine being serviced.
3. Apply the appropriate Lockout/Tagout procedure.

The rest of the networked machines will continue to sequence properly.

3.10.2 To restore a machine to the network

1. Restore power to the compressor.
2. Enable the controller.
   - To enable a Supervisor Controller in the system, press the START pad and REMOTE pad on the keypad.
   - Enable the Supervisor II Deluxe Controller by pressing the AUTO pad.
   - Enable the WS Controller by pressing the START pad.
   - Enable the STS Controller by pressing the green start button.

If the sequencing parameters have not been changed, the machine will sequence in at the appropriate time. A machine operating in Sequence Hours mode may be moved up or down in the sequencing start priority by revising that machine's sequence hours before enabling sequencing.

NOTE

When a machine is permanently removed from a sequence, the COM NUMBERS should be reassigned to the remaining machines and the LAST COM value must be changed to match the total number of machines still in the sequence.

NOTE

All program changes must be accomplished while the machine is manually stopped.

3.11 Calibration of P2 pressure transducers

Each individual compressor is equipped with a pressure transducer. Over time, it is possible that the reading from one machine's pressure transducer may read differently from another machine. Prior to sequencing and periodically, Controllers should be calibrated to reflect the same measurement of P2 pressure through out the system. Perform the calibration when the system is at a stable pressure.

3.11.1 Supervisor™ P2 pressure transducer calibration

Perform the following steps to calibrate the Supervisor Controller P2 pressure reading:

1. Measure the pressure using an independent certified gauge.
2. Enter the password to access the Supervisor Calibration menu.
   1. If the password is not equal to zero, navigate to the password line.
   2. Press the ENTER key.
   3. Enter a value that is four more than the existing number.
   4. Press the ENTER key. The number should go to zero.
   5. Repeat this process if a keying error occurs that does not release the password.
3. Change the calibration parameter for P2 so that the Pressure value at the Supervisor reads the same as the gauge.

1. Use the Down ↓ arrow key to navigate to the line that reads CAL P2. The display will show the current P2 reading and the calibration parameter (+7 to -7).
2. Press the ENTER ↵ key to adjust the value.
3. Use the Up ↑ arrow key to increase the reading and the Down ↓ arrow key to decrease the reading.
4. Press the ENTER ↵ key. The Enter key must be pressed after setting the calibration parameter to make it permanent.
5. Return to the main display by pressing ESC.

4. Recheck the pressure to ensure the display reading is correct.

3.11.2 Supervisor™ II Deluxe P2 pressure transducer calibration

Perform the following steps to calibrate the Supervisor II Deluxe Controller pressure reading:

1. Measure the pressure using an independent certified gauge.
2. Enter the following special key sequence to enter the Calibration menu: Logo , Up arrow ▲, Display DSP, Lamp Test ▼☼, Program PRG.
3. Ensure that the first line of the display reads CAL P1, if not push the Display DSP key and enter the above key sequence again.
4. When the first line of the display reads CAL P1 push the Program PRG key. The first line of the display will then read CAL P2. The second line of the display will show the calibration parameter (range +7 to -7) and the current P2 pressure reading.
5. Change the calibration parameter for P2 so that the pressure value at the Controller reads the same as the gauge.
   1. Use the Up ▲ arrow key to increase the reading and the Lamp Test ▼☼ key to decrease the reading.
   2. Push the PROGRAM PRG key. The Program key must be pressed after setting the calibration parameter to make it permanent.
6. Recheck the pressure to ensure the display reading is correct.

3.11.3 WS Controller™ P2 pressure transducer calibration

Perform the following steps to calibrate the WS Controller pressure reading:

1. Calibrate the WS Controller P2 pressure using the WS PC User Interface. Refer to the *WS PC User Interface Manual* for details.
2. Recheck the pressure to ensure the display reading is correct.

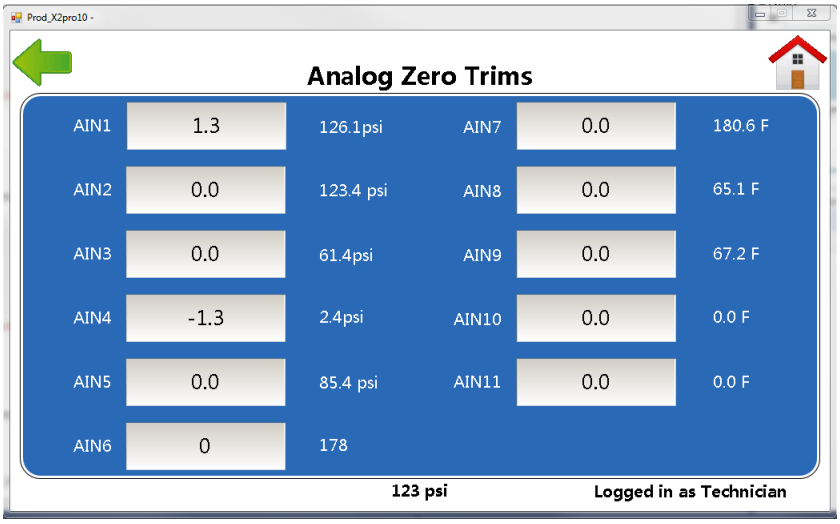

Figure 3-4: STS controller Analog Zero Trims

3.11.4 STS Controller P2 pressure transducer calibration

See *Figure 3-4*.

The user must be logged in as a technician to access the Analog Zero Trims.

1. The current P2 pressure reading I located to the right of the AIN2 editing box.
2. The current P2 offset will be in the AIN2 editing box and represents how much is being added to the pressure signal to yield the currently displayed value on the right.
3. Determine the new offset value.
4. The new value may be entered by selecting the AIN2 box and using the pop-up editor.

3.11.5 Full load feature

The full load feature energizes a solenoid valve on the machine that forces the base machine(s) to full load when being sequenced. Spiral valve machines may also require a relay that de-energizes the spiral control solenoid valve during full load mode.

3.12 How to access the Manual Unload

At the home screen, touch the menu button, then touch the **System Configuration** button, then touch the **Max Unload Settings** button.

NOTE

You must have a technician access level to see the **Max Unload Settings** button.

When you touch the **Manual Unload** button, a countdown timer will appear at the bottom of the screen showing how long remains until the machine returns to normal operation automatically. (You will see the **Manual Unload** button only when the machine is running.)

Normal operation can be resumed in three ways after you touch the **Manual Unload** button:

- Wait 30 minutes for normal operation to resume automatically.
- Touch the **Resume Normal Operation** button.
- Log out the machine.

Section 4

Sequencing with VSD and ESV Compressors

4.1 Variable speed drive and electronic spiral valve applications

A multiple-compressor system can be designed using a variable speed drive (VSD) or electronic spiral valve (ESV) compressor combined with other VSD, ESV or fixed speed compressors. The most efficient use of a VSD or ESV machine in sequencing is to set it up to always be the trim machine and always be running. This is accomplished using existing Sullair sequencing logic as explained in the following sections.

4.2 Setup for fixed speed machines and a VSD or ESV compressor

The fixed-speed machines in a mixed sequence system must always be set up for load/unload operation. If controlled with Supervisor II Deluxe controllers, the pressure regulator(s) must be made to have no effect by setting the system to operate below the effective range of the regulator(s). If controlled by the Supervisor Controller, WS Controllers or STS controllers, the controls may be programmed for Load/No load operation. In this configuration, the Full Load valve is energized any time the machine is running, thus defeating modulation. Alternately, the Full Load solenoid valve may be rewired to the Load output with any of the controllers (Supervisor Controller, Supervisor II Deluxe Controller, WS Controller or STS controller) to achieve the same results. **In all cases, care must be taken to not overload the compressors by limiting operation to pressures within the capability of the drive motor.**

See *Table 4-1* for suggested settings of compressors in a mixed sequence configuration. These settings are typical for a target system pressure of 99 psi at discharge of compressors.

Table 4-1: Mixed system settings (target pressure: 99 psi)

Parameter	VSD compressor settings	Fixed-speed compressor settings
Unload setpoint	104	102
Load delta	6	6
VSD or ESV setpoint	99	
Com #		COM#1, 2 (3, 4, etc.)
Lowest pressure		90

Since this machine is to always be the trim machine, no Full Load action is needed. The Max Speed input signal should be disabled unless more than one VSD or ESV machine is in the same sequence.

In this configuration, only the fixed-speed compressors are sequenced and the VSD or ESV machine is run with its sequencing disabled. The Sequence hours mode can then be used to automatically rotate the fixed-speed machines, or the fixed-speed machines may be sequenced based on Com #.

Depending on the application and system demands, the VSD or ESV compressor can either be run continuously or in the AUTO mode. This will allow the unload time to be minimize to as low as an immediate stop on unload.

This arrangement sets the VSD or ESV machine to always restart at a higher pressure than the fixed-speed machines thus forcing it to always operate as the trim machine. By adjusting the VSD or ESV Unload time in AUTO mode and the fixed-speed restart times, rapid cycling and hunting can be minimized.

The pressure regulator of a fixed-speed “L” (100 psi) compressor does not begin to throttle until 101 – 102 psi. As a result, the pressure regulator has no effect, and the machine will operate Load/Unload with or without the full load solenoid valve. The net result is that the VSD or

ESV compressor will always be running and able to modulate; the fixed-speed machines would come on and go off as needed but operate Load/Unload.

Note that the normal load delta becomes narrower while operating a sequenced system. The settings above will load at 97 and unload at 101 psi. The system will typically maintain 98 – 100 psi.

4.3 Setup for multiple VSD or ESV compressors

With pressure-controlled VSD circuits, configure all compressors by Sequence Hours or COM Number, as desired. Enable the Max. Speed Input function. All but one of the compressors will be full-loaded, thus limiting the pressure to the rated value of the machines.

With serial-controlled VSD or ESV circuits, configure all compressors by Sequence Hours or COM Number, as desired. The controllers allow all machines to run at reduced speeds to match delivery to demand. Unneeded machines will be stopped automatically. If the compressors are “L” (100 psi) machines, the target system pressure at discharge of compressors is 95 psi; set the program points as shown in *Table 4-2*.

Table 4-2: Multiple VSD or ESV system settings

Parameter	VSD compressor settings
Unload setpoint	102
Load delta	8
VSD and ESV setpoint	98
Lowest pressure	90
Recover time	10 sec.

Parameters may require adjustment based on system capacity and application.

Unload Setpoint should **never** be more than 2 psi above package rating.

Note that the normal load delta becomes narrower while operating a sequenced system; the settings above will load at 95 and unload at 101 psi. The system will typically maintain 97 – 99 psi.

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Section 5
Operation with Remote Controllers

5.1 Normal operation

The controllers are capable of operation from remote-control devices. Depending on system design, these may simply enable automatic operation, or may be responsible for loading the compressor. When a remote-controlled system is set up, each compressor must be programmed for remote sequencing and enabled locally.

The Supervisor™ Controller has a Remote keypad on the display module that is used to enable and disable the controller from any sequencing mode that is currently programmed.

When the Remote key is first pressed after sequencing has been programmed, it will enable REMOTE mode and the REMOTE LED will be lighted. Pressing the Remote key again will disable the sequencing mode and turn off the LED. The compressor will then operate as though it were not in any sequencing mode. The process will be reversed when the Remote key is pressed again.

To enable any Supervisor controlled machine in the system, press the Auto key and Remote key on the keypad. To enable Supervisor II Deluxe or WS Controller controlled machines, press the Start button. To enable an STS controlled machine, press the green start button.

Any Supervisor, Supervisor II Deluxe or WS Controller controler machine can be stopped by pressing the Stop key. An STS controller machines can be stopped by pressing the red stop button. The remaining machines in the system will continue to operate as needed.

5.2 Controls wiring and adjustment—Supervisor Controller

There are three inputs and one output that are enabled when in Remote mode:

Remote Stop/Start	Input D5
Remote Load/Unload	Input D6
Local/Master	Input D7
Local/Master	Output K8

Inputs D5, D6 and D7 are wired through customer furnished relay contacts to ground (Supervisor Signal GND). If D5 is open the machine will stop, and be held stopped. If D5 is grounded, the machine will be enabled to start.

Table 5-1 describes how the other inputs work:

Table 5-1: Control wiring inputs

Local/Master	Load/Unload	Operation
Open	Open	Normal load and unload
Open	Closed	Force unload
Closed	Open	Force load, unload at P1 max - 3
Closed	Closed	Force unload

The Local/Master Output (K8) is closed when the Local/Master Input is ON and the machine is not in Stop or E-stop. The Local/Master Output is a relay contact that can handle 250VAC at 10 amperes.

5.2.1 Changing parameter values—Supervisor

Perform the following steps to change parameter values using the Supervisor Controller:

1. Press the Down arrow key until SEQUENCING menu is displayed. Press Enter.
2. Use the Up and Down arrow keys to navigate through the menu selections to the parameter to be edited.

3. Press Enter to select the parameter for editing.
4. If a numeric value is to be entered, Use the Right and Left arrow keys to position the cursor over the number digit to be changed.
5. Use the Up and Down arrow keys to change the parameter value.
6. Press Enter to save the changed value.
7. Select the sequencing group, and adjust the "Sequence by" parameter.
8. Select the REMOTE mode.

This enables three digital inputs for Remote Start/Stop, Unload/Load and Master Control. These inputs are normally controlled by remote relay contacts or a PLC controller.

The Supervisor may then be interfaced with custom sequencing panels which provide signals for a 2-wire stop/start operation. The remaining adjustments in the sequencing group have no effect when in REMOTE mode.

5.3 Controls wiring and adjustment—Supervisor™ II Deluxe

There are three inputs and one output enabled in this mode:

Remote Start/Stop	Input D10	J3-19
Remote Load/Unload	Input D9	J3-18
Local/Master	Input D8	J3-17
Local/Master	Ouput K6	J1-14, 15

Inputs D8, D9 and D10 are wired through customer furnished relay contacts to ground (Supervisor II Deluxe Common J3-20).

If D10 is open the machine will stop, and be held stopped. If D10 is grounded the machine will be enabled to start. If remote start/stop is not needed then jumper D10 (J3-19) to GND (J3-20).

Table 5-2 describes how the other inputs work when D10 is connected to GND J3-20:

Table 5-2: Input functions: D10 connected to GND

Local/Master	Load/Unload	Operation
Open	Open	Normal load and unload
Open	Closed	Force unload
Closed	Open	Force load, unload at P1 max - 3
Closed	Closed	Force unload

The Local/Master Output is ON when the Local/Master Input is ON and the machine is not in Stop or E-stop. If the Local/Master Output is ON, the display will have two stars (**) in the middle of the bottom line. The Local/Master Output is a relay contact that can handle 250VAC at 8 amperes (J1-14 & J1-15).

5.3.1 Changing parameter values—Supervisor™ II Deluxe

Perform the following steps to change parameters on the Supervisor II Deluxe Controller:

1. Push the Program PRG key until the top line of the display identifies the parameter to be changed.
2. Press the Up arrow and/or Logo keys to increment the parameter value or press the Down/Lamp Test key to decrement the value.
3. Push the Program PRG key to save the changed value. The next parameter will then be displayed.
4. From the main screen, press the Program PRG key 9 times to access the sequence parameter. Adjust sequence.
5. Select the REMOTE sequencing mode.

This enables three digital inputs for Remote – Start/Stop, Unload/Load and Master Control. These inputs are normally controlled by remote relay contacts or a PLC controller. The controller may then be interfaced with custom sequencing panels which provide signals for a 2-wire stop/start operation.

5.4 Controls wiring and adjustment—WS Controller™

One input is enabled in this mode:

- Remote Load/Unload Input

This input consists of a simple two-wire control.

To enable this input, a switch is wired to terminals J4-Din7 and any J3-24V Supply. Using the WS Controller PC program, select the REMOTE sequence mode. This feature also works in the Sequence HOURS or Com NUMBER sequence modes of the WS Controller.

When the switch is closed, the compressor will unload. If it is in AUTOMATIC mode, the motor will stop after an unload period. When the switch is open, the compressor operates normally.

The WS Controller may be field configured to enable all the remote input and output functions described for the Supervisor Controller and Supervisor II Deluxe models plus additional capabilities. The additional inputs apply only in the REMOTE sequence mode. Enabling the additional inputs requires using the WS Controller PC User Interface to change the inputs and outputs from their normal factory defaults. Refer to the WS Controller PC User Interface Manual for instructions on changing these parameters.

5.5 Controls wiring and adjustment—STS Controller

The wiring connections on the STS IO module for remote sequencing are: J7-10 for the Remote/User Unload input, J7-11 for the Remote Stop input and J7-12 for Remote Master input.

Operation is the same as for the WS controller.

Notes:

Section 6

Sequencing Timers for Efficient Operation

6.1 Recovery time and Delayed Start timer

The Recovery Timer is used to keep machines from starting, loading or unloading all at the same time. The Delayed Start timer is used to keep machines from starting unnecessarily due to temporary load changes. These timers and the Lowest Pressure Parameter are used to tune a system so that it is energy efficient but still responds to system demand changes.

Delaying loading and starting of machines will make the system more efficient, but must be balanced against system demands. For example delaying the start of a machine will be more energy efficient but could cause system pressure to drop below desired levels.

The Recovery Timer is used in conjunction with the load and unload parameters. There are also two calculated parameters derived from the load and unload settings. These are the Sequencing Unload and Sequencing Load pressures. The Sequencing Unload pressure is 2 psi below the unload setting. The Sequencing Load pressure is 2 psi above the load setting.

For example, if the Unload Parameter is set to 110 and the Load Delta parameter is set to 10 then:

- 110 psi = Unload pressure; all machines unload above this pressure
- 108 psi = Sequencing unload pressure; trim machine unloads above this pressure
- 102 psi = Sequencing load pressure; next machine in sequence loads below this pressure
- 100 psi = Load pressure, all machines load below this pressure

If the system pressure goes above 110 (e.g. 111) for any reason, all machines will unload immediately (regardless of recovery timer). If the system pressure goes below 100 (e.g. 99) all running machines will load (regardless of recovery timer). The recovery timer only comes into play if the pressure is between 108 – 110 (for unloading), or 100 – 102 (for loading). The following examples will describe operation.

NOTE

Because of system delays caused by variables like filtering and communications, the actual recovery time may vary from 0 to 5 seconds from the time set for the Recovery timer. If, for example, the Recovery timer is set to 10 seconds, the actual recovery time will be from 10 to 15 seconds.

If system pressure drops below the Load Pressure setting, but is above the Lowest Pressure setting, then the Delayed Start Timer is used to time the start of the next machine in sequence. This timer starts at 120 seconds but will time out sooner if the pressure drops. The length of time is prorated over the difference between the Load Pressure setting and the Lowest Pressure setting.

For example:

- A compressor's Load pressure is 100 psi and the Lowest Pressure setting is 70 psi.
- If the System Pressure is above 100 and drops to (and stays at):
  - 99, the machine will start in about 120 seconds (2 minutes)
  - 85, the machine will start in about 60 seconds
  - 70, the machine will start in about 30 seconds
- Because of varying pressures and other delays these times are approximate.

6.2 Timer operation examples

The following examples show how the Recovery and Delayed Start timers function.

6.2.1 Example 1—Unload operation

Configuration:

- Three machines running and loaded
- The recovery timer set to 10 seconds
- The unload pressure is set at 110 on all three machines.

The sequence unload pressure will be 108 psi.

Machine	Status
1	Full load
2	Full load
3	Trim

If the pressure rises above the sequence unload pressure (108) the trim machine will unload and the next machine in sequence will trim.

Machine	Status
1	Full load
2	Trim
3	Unloaded

The new trim machine will wait for 10 seconds before unloading if the pressure stays at 109 or 110. If the pressure goes below 109 unloading will be unnecessary. If the pressure goes above 110 the machine will unload immediately (regardless of the recovery timer).

6.2.2 Example 2—Load operation

Suppose there are three machines running and, the recovery timer is set to 10 seconds and the load pressure is set at 100 on all three machines.

Configuration:

- Three machines running with two unloaded and one in trim
- The recovery timer set to 10 seconds
- The unload pressure is set at 100 on all three machines.

The sequencing load pressure will be 102.

Machine	Status
1	Trim
2	Unloaded (next machine in sequence)
3	Unloaded

If the pressure drops below the sequence load pressure (102) the next machine in sequence (2) will load and be the trim machine, and the previously trimming machine (1) will go to full load.

Machine	Status
1	Full load
2	Trim
3	Unloaded (next machine in sequence)

The next machine in sequence will wait for 10 seconds before loading if the pressure stays at 101 or 100. If the pressure goes above 101 loading will be unnecessary. If the pressure goes below 100 the machine will load immediately (regardless of the recovery timer).

6.2.3 Example 3—Starting example

Pressure drops below lowest pressure setting:

Machines will start when the system pressure drops below the Lowest Pressure setting, or when system pressure drops below the load setting for a period of time determined by the Delayed Start timer. The following example shows operation when the pressure drops below the Lowest Pressure setting. A later example will show how the Delayed Start timer works (i.e. the pressure is below the Load setting but above the Lowest Pressure setting).

Configuration:

- Three machines running with one in trim and two are stopped
- The Lowest Pressure setting is 70 psi.

Machine	Status
1	Trim
2	Stopped (next machine in sequence)
3	Stopped

If the system pressure drops below the lowest pressure setting (70) the next machine in sequence (2) will start and trim, the previously trimming machine (1) will go to full load.

Machine	Status
1	Full load
2	Trim
3	Stopped (next machine in sequence)

The next machine in sequence will wait for 10 seconds before starting if the pressure stays below 70. If the pressure goes above 70 the machine will start after the Delayed Start timer expires (explained later).

6.2.4 Example 4—Starting example

Pressure between lowest and load pressure setting:

The Delayed Start timer comes into play only when the system pressure is below the Sequencing Load pressure setting but still above the Lowest Pressure setting. This timer value is prorated between the Sequence Load pressure and Lowest Pressure.

Example, the Load Pressure is 100 and the Lowest Pressure is 70.

- If System Pressure is above 101 and drops to (and stays at):
  - 99, the machine will start in about 2 minutes.
  - 85, the machine will start in about 1 minute.
  - 70, the machine will start in about 30 seconds.

Configuration:

- Three machines running with one in trim and two are stopped
- The Lowest Pressure setting is 70 psi.

Machine	Status
1	Trim
2	Stopped (next machine in sequence)
3	Stopped

If the system pressure drops below the Sequence Load pressure (102) but is above the Lowest Pressure (70), the next machine in sequence (2) will start and trim, and the previously trimming machine (1) will go to full load after the Delay Start timer expires. If the pressure is at 85 then the machine will start in about 1 minute as noted above.

Machine	Status
1	Full load
2	Trim
3	Stopped (next machine in sequence)

If the system pressure stays below the Sequence Load pressure then the next machine in sequence (3) will start after the Delay Start timer expires. If the pressure is at 85 then the machine will start in about 1 minute as noted above.

Machine	Status
1	Full load
2	Full load

6.3 Sequencing times summary

Table 6-1 provides a summary of the sequencing timer operation described in the preceding examples.

Table 6-1: **Sequencing timer example summary**

Event	Pressure	Sequence timer result
Unload pressure	110	All machines unload above this pressure regardless of Recovery timer
Recovery timer	108 – 110	Trim machine will unload after Recovery timer
Sequencing unload pressure	108	Trim machine unloads above this pressure, Recovery timer starts
Sequencing load pressure	102	Next machine in sequence loads below this pressure, Recovery timer starts
Recovery timer active	100 – 102	Next machine in sequence loads after Recovery
Load pressure	100	All machines load below this pressure, Start Delay
Start delay timer active	70 – 99	Next machine in sequence starts after Start Delay timer expires
Lowest Pressure	70	Next machine in sequence starts immediately regardless of Start Delay timer

Notes:

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Section 7
Controller Communication Protocol

7.1 Recovery time and Delayed Start timer—overview

Communications connections are internal features of the Supervisor II Deluxe, Supervisor, WS Controller and the STS controller. A separate communications module is added to older Supervisor controllers for any external communications. Most features are common to each controller, unless specifically noted below. The communications link is a RS-485 (two-wire) serial line. The following three parameters must be set correctly to be able to communicate through this link.

COM ID#—Unique number for each machine on the link.

BAUDRATE (Supervisor II only)—Must be the same for all machines (default is 9600). Supervisor and WS controllers are fixed at 9600 baud.

SEQUENCE—Sequencing mode. Full descriptions of sequencing operation is provided in preceding sections of this manual. The function of the SEQUENCE link is specified by setting the Sequence parameter as follows:

DISABLED, REMOTE—Responds to status and parameter change queries.

HOURS, COM ID#—Broadcasts net status message about once per second, responds to status and parameter change queries during monitor time slot. In this manner, the controller for each machine receives the status of every other machine in the system. Sequencing decisions are made individually by each controller based on the status of all machines in the sequencing system. Collisions (communication conflicts) on the serial channel are avoided by a time slice scheme (See *Section 7.4* for more information on time slicing).

7.2 Advantages of broadcast mode

Some advantages of using a broadcast communication configuration are listed below.

- System operation is not dependent on a single master controller.
- Because there is no master, the number of messages are decreased to half (thus decreasing response time). In master/slave mode, a message is sent from the master to a machine to request status, then the machine must send a status message back to the master. In broadcast mode, each machine sends it's status approximately once per second to all other machines in the system.
- When a machine goes off line or on line there is no need for the controller to poll for a new master.
- Individual machines may be taken off line or put on line with no effect on communications.
    - This is useful for maintenance or when a machine is to be controlled manually. When a machine is stopped, its controller continues to sends net status messages to the other machines in the system. When the machine is DISABLED it will not send net status messages but will respond to status and parameter change messages.
- Because decisions are made locally, the response of the system is very efficient—less than one second for trimming, loading and unloading. A machine requires only one second plus starting time to begin running.
- There are no extra communications for monitoring. Since each machine sends its status every second, the monitor does not need to send messages. However, the monitor may send messages to get other status or change parameters.
- The monitor does not need to be continuously connected. A monitor may be connected or disconnected at any time without affecting the system operation.

7.3 RS-485 serial channel

The half-duplex RS-485 serial connection is a “party line” type channel, meaning any device on the channel may transmit or receive over the same connection. The transmitters and receivers are differential type that use two wires and a ground. These components have excellent noise immunity because the receiver measures the relative voltage between two signals, not between a signal and ground (as is the case with RS-232 channels). If noise occurs on both lines it will be rejected by the receiver.

The ground is used to keep the receiver from floating too high above the transmitter. A “one” signal is transmitted as 5 volts on the + line and 0 volts on the - line. A “zero” signal is transmitted as 0 volts on the + line and 5 volts on the - line. The transmitters are tri-state, meaning they can drive the transmission line to a one (5 volts), zero (0 volts) or be turned off (high impedance). All transmitters except one must be in tri-state mode. This prevents damage to the transmitters and the transmission from being garbled.

7.4 Time slicing of the RS-485 serial channel

When the sequencing mode is set to HOURS or COM ID# the machines will broadcast their status (net status message) about once per second. Time is sliced into periods (up to 17 maximum), one for each machine and one for a monitor. A machine will only send a net status message during it’s time slice (see *Table 7-1* below).

Table 7-1: RS-485 time slice

Time slot	COM ID#	Time out
0	Monitor	0.6 sec
1	1	0.1 sec
2	2	0.1 sec
3	3	0.1 sec
…	…	…

The number of machine time slots is determined by the LAST COM parameter. The controllers establish the current time slot by either receiving messages or timing out. The last member sends a monitor enable message, which begins slot 0, without waiting for higher number slots. During time slot 0, a monitor may send a message, typically a status request or parameter change message. A message that is sent by the monitor may need a response from one of the machines. This response must come before the time out period (0.5 sec).

When a machine comes on line, it waits for an initial timeout period of 1.5 + 1.5 times the COM ID# seconds. If a monitor enabled message is received during the initial timeout period, then the time slot is established by the machine’s COM ID#. If no messages are received within the initial timeout period, the machine initiates a new cycle.

7.5 Message format

Messages are RS-485 half-duplex, 9600 baud, 8 bit, 1 stop bit, no parity. Control characters are used to frame a message. These characters mark the start of the message and the end of the message.

All messages have the following format:

- **STX**—Start of text. Signifies the start of a message. (0x02)
- **##**—Two character COM number
- **m**—One character message type
- **d**—Data, one to several characters long. Multiple items are separated by commas.
- **xx**—Two character checksum, based on all characters after STX
- **CR**—Carriage return. CR-LF signifies end of a message. (0x13)
- **LF**—Line feed. CR-LF signifies end of a message. (0x10)

In the examples presented in the following section, STX, CR, and LF are not shown.

7.6 Message types

Messages follow the forms listed in *Table 7-2* below. Details of the data types within the messages are listed in *Section 7.7: Data types*. “N” & “M” messages are broadcast by controllers in a sequenced system.

Remaining exchanges may be initiated by a monitor or master on non-sequenced systems, or during the time immediately following a monitor enable in a sequenced system.

Table 7-2: Controller Message Types

Message type	Format	Example
N—Net status broadcast	##N19,2,23,17,18xx	01N0,115,2000,M,C88
Comments: Controller's broadcast status in stand-alone sequencing. Data fields are: 19—Capacity in cfm 2—P2 pressure in psig 23—Sequence time in hours 17—Run Status (See *Section 7.7: Data types*) 18—Mode (See *Section 7.7: Data types*)		
M—Monitor Enable broadcast	##Mxx	01M52
Comments: Controller's monitor enable in stand-alone sequencing. Time follows for queries by a monitor.		
I—Information Request	##Ixx	01I56
Comments: Monitor's request for controller information. The controller responds with i message type.		
i—Display Response	##i1,2,3,4,5,6,7,8,9,10,11, 12, 13,14,15,16,17,18xx	01i104,95,41,78,110,127,101,83, 186,3,2,0008,3C2,3C2,0,0,E,c26
Comments: The controller's response to a valid message type D request. 1—P1 pressure in psig 2—P2 pressure in psig 3—P3 pressure in psig 4—P4 pressure in psig 5—T1 temperature in deg F 6—T2 temperature in deg F 7—T3 temperature in deg F 8—T4 temperature in deg F 9—T5 temperature in deg F 10—eConnect ID number 11—Analog Shutdown (0 for Supervisor Controller, WS Controller or STS controller) 12—Digital Outputs 13—Digital Shutdown (0 for Supervisor Controller, WS Controller or STS controller) 14—Digital inputs 15—Total run time in hours 16—Total load time in hours 17—Run Status (See *Section 7.7: Data types*) 18—Mode (See *Section 7.7: Data types*)		
Q—Quick Status Request	##Qxx	01Q4E
Comments: Monitor request for data from slave controllers. Slave responds with q message type.		

Table 7-2: Controller Message Types

Message type	Format	Example
q—Quick Status Response	#q19,2,15,17,18xx	# 01q0,115,2000,M,C65
Comments: Controller's response of quick status. Data fields are: 19—Capacity in cfm 2—P2 pressure in psig 23—Sequence time in hours 17—Run Status (See *Section 7.7: Data types*) 18—Mode (See *Section 7.7: Data types*)		
G—Get parameter Request	##G22,xx	01G3,58
Comments: Monitor's request to change a parameter. The controller responds with g message type. 22—Parameter number (See *Section 7.7: Data types*)		
g—Get parameter Response	##g22,21xx	01g3,4A5
Comments: The controller's response to a valid message type G request. 22—Parameter number (See *Section 7.7: Data types*) 21—Value of the parameter (See *Section 7.7: Data types*) P—Put parameter Request ##P22,21,xx 01P3,4,90		
p—Put parameter Response	##p22,21xx	01p3,49C
Comments: The controller's response to a valid message type P request. 22—Parameter number (See *Section 7.7: Data types*) 21—Value of the parameter (See *Section 7.7: Data types* 6 for details)		
D—Display Request	##Dxx	01D5B
Comments: Monitor's request for controller's display. The controller responds with d message type.		
d—Display Response	##d20,20xx	01d E-STOP, 95 110B7
Comments: The controller's response to a valid message type D request. 20—Display alphanumeric string (See *Section 7.7: Data types*)		

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7.7 Data types

- 1—P1 pressure in psig, 1 to 3 digits
- 2—P2 pressure in psig, 1 to 3 digits
- 3—P3 pressure in psig, 1 to 3 digits
- 4—P4 pressure in psig, 1 to 3 digits
- 5—T1 temperature in deg F, 1 to 3 digits
- 6—T2 temperature in deg F, 1 to 3 digits
- 7—T3 temperature in deg F, 1 to 3 digits
- 8—T4 temperature in deg F, 1 to 3 digits
- 9—T5 temperature in deg F, 1 to 3 digits
- 10—eConnect ID number, 1 to 2 digits
- 11—Analog Shutdown (Supervisor II only)
  - 1 – 4: P1 – P4
  - 5 – 7: dP1 – dP3
  - 8 – 13: T1 – T6
- 12—Digital Outputs, 4 digit (bit0=K1, bit1=K2, etc.)
- 13—Digital Shutdown, 3 digit (bit0=D1, bit1=D2, etc.) (Supervisor II only)
- 14—Digital inputs, 3 digit (bit0=D1, bit1=D2, etc.)
- 15—Total run time in hours, 1 to 6 digits
- 16—Total load time in hours, 1 to 6 digits
- 17—Run Status, 1 character code:
  - E—E-Stop
  - M—Manual Stop
  - m—Manual Stop & Common Fault
  - R—Remote Stop
  - r—Remote Stop & Common Fault
  - B—Standby
  - b—Standby & Common Fault
  - S—Starting
  - s—Starting & Common Fault
  - U—Unloaded
  - u—Unloaded & Common Fault
  - L—Loaded
  - l—Loaded & Common Fault
  - T—Trim
  - t—Trim & Common Fault
  - F—Full Load
  - f—Full Load & Common Fault
  - X—Remote Disable (WS only)
  - x—Remote Disable & Common Fault (WS only)
- 18—Mode, 1 character code
  - A—Auto run mode, remote start/stop enabled
  - a—Auto run mode, remote start/stop disabled
  - C—Cont run mode, remote start/stop enabled
  - c—Cont run mode, remote start/stop disabled
- 19—Capacity in cfm, 1 to 4 digits
- 20—The Supervisor II sends two 8-character strings, corresponding to the top and lower line of the keypad display: e.g. "01d E-STOP, 95 110B7".
  - The Supervisor sends two 20-character strings, which are from the queue of the first four scrolling messages on line 2 of the display. On successive queries, Supervisor sends message A & B or message C & D; query twice to get all four messages. e.g. "02dT1 Discharge High, T2 Dry Side High 45".
  - The WS Controller and STS Controller send two 20-character strings similar in form to those of the Supervisor Controller. These are internally generated by the controller and are independent of the user interface of the machine.
- 21—Values for parameters may be from one digit to the length shown in Table 7-3 below. Actual minimum and maximums are software and model dependent. Refer to the controller's User Manual for further description.
- 22—Parameters are identified by parameter number over serial communications, as shown in *Table 7-3* below. The available parameters for the Supervisor II Deluxe are noted in the second column (with the heading "II"), the available parameters for the Supervisor are noted in the third column (with the heading "S") and the available parameters for and WS Controller and STS controller are noted in the fourth column (with the heading "WS/STS"). Text parameters 61 – 69 are not available through the external bus. Items are marked R for read and RW for read/write.
- 23—Sequence time in hours, 1 to 6 digits.

Table 7-3: Parameter descriptions

NetTag	II	S	WS/STS	Description	Digits	Units
3	RW	RW	RW	Language	n	list
4	RW			Units of measure	n	list
4		RW	RW	Temp units of measure	n	list
5	RW	RW	RW	Unload pressure	nnn	psi
6	RW	RW	RW	Load pressure delta	nn	psi
8	RW	RW	RW	Unload time	nn	min
9	RW	RW	RW	Wye-Delta Time	nn	sec
10	RW	RW	RW	Drain interval time	nn	min
11	RW	RW	RW	Drain time	nn	sec
12	RW	RW	RW	Restart time	nn	sec
18	RW	RW	RW	Sequence com number	nn	
19		RW	RW	eConnect ID	nn	
20	RW	RW	RW	Seq number of machines	nn	
21	RW	RW	RW	Sequence method	n	list
22	RW	RW	RW	Sequence hours	nnnnnn	hour
23	RW	RW	RW	Sequence lowest pressure	nnn	psi
24	RW	RW	RW	Sequence recover time	nn	sec
25	RW	RW	R	Machine max capacity	nnnnn	cfm
26	RW	RW	RW	Seq rotate time	nnn	hour
30		RW	RW	Modulate	n	y/n
31		RW	RW	Pressure units	n	list
32		RW	RW	VSD setpoint	nnn	psi
40	RW			T1 calibrate	n	
41	RW			T2 calibrate	n	
42	RW			T3 calibrate	n	
43	RW			T4 calibrate	n	
44	RW			T5 calibrate	n	
45	RW			T6 calbrate	n	
45		RW	RW	Pressure calibrate password	nnn	
46	RW	RW	RW	P1 calibrate	n	
47	RW	RW	RW	P2 calibrate	n	
48	RW	RW	RW	P3 calibrate	n	
49	RW	RW		P4 calibrate	n	
50	RW	RW		dP1 calibrate	n	
51	RW			P3 maximum	n	
54		RW		Maintenance warning	nnnn	hour
55		RW		Maintenance filter	nnnnn	hour
56		RW		Maintenance separator	nnnnn	hour
57		RW		Maintenance air filter	nnnnn	hour
58		RW		Maintenance oil	nnnnn	hour
59		RW		Maintenance oil analysis	nnnnn	hour
70	RW	RW		Parameter protection	n	y/n
71	RW	RW		Shutdown on warning	n	y/n
80		R	R	Load cycles (read only)	nnnnn	
81		R	R	Number of starts (read only)	nnnnn	
98		R	R	Run hours (read only)	nnnnn	hour
99		R	R	Load hours (read only)	nnnnn	hour

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