47816909
Revision B
June 2023

XS-110 Controller User Manual

Product Information

EN Product Information

Save These Instructions

Ingersoll Rand

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Safety Information

Only allow Ingersoll Rand trained technicians to perform maintenance on these products. For additional information, contact Ingersoll Rand or nearest authorized distributor. The use of other than genuine Ingersoll Rand replacement parts may result in safety hazards, decreased performance, increased maintenance and will invalidate all warranties.

Original instructions are in English. Other languages are a translation of the original instructions. Refer the necessary documents from the Ingersoll Rand Office and the authorized distributor.

Explanation of Safety Signal Words

Throughout this manual there are steps and procedures which, if not followed, may result in a hazard. The following signal words are used toidentify the level of potential hazard.

Indicates an imminently hazardous situation that **will** result in **death or serious injury,** if the necessary measures are not taken.

Indicates a potentially hazardous situation that **could** result in **death or serious injury,** if the necessary measures are not taken.

Indicates a potentially hazardous situation that **might** result in **minor** or **moderate injury** or property damage, if the necessary measures are not taken.

Indicates information or a company policy that relates directly or indirectly to the safety of personnel or protection of property.

Note: Important Information

The following safety symbols are used in the manual. These safety symbols are kept in the appropriate areas of the compressor package, to alert users of thefollowing conditions:

 Equipment Starts Automatically	 Health Hazard – Explosive Release of Pressure
 Cutting of Finger or Hand Hazard – Rotating Impeller Blade	 High Voltage – Hazard of Shock, Burn, or Death Present until Electrical Power is Removed
 Cutting of Finger or Hand Hazard – Rotating Fan Blade	 Entanglement of Fingers or Hand/Rotating Shaft
 Asphyxiation Hazard – Poisonous Fumes or Toxic Gases in Compressed Air	 Burn Hazard – Hot surface

Prohibition/Mandatory Action Requirements

 Do not Operate Compressor with Guard Removed	 Lockout Electrical Equipment in De-Energized State
 Do Not Lift Equipment with Hook – No Lift Point	 Loud Noise Hazard – Wear Ear Protection
 Handle Package at Forklift Points Only	 Read the Operator's Manual Before Proceeding with Task

Safety Precautions

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious. Some general safety precautions are given below:

Failure to observe these notices will result in death or serious injury to personnel.

Keep fingers and clothing away from rotating fan, drive coupling/belting, etc.

Disconnect the compressor unit from its power source, lockout and tagout before working on the unit – this machine is automatically controlled and may start at any time.

Do not loosen or remove the enclosure or belt covers, or break any connections, etc., in the compressed air system until the unit is shut down and air pressure has been relieved.

Electrical shock can and may be fatal.

Perform all wiring in accordance with the National Electrical Code (NFPA-70) and any applicable local electrical codes. Wiring and electrical service must be performed only by qualified electricians.

Open main disconnect switch, lockout and tagout and check for voltage before working on or within the control panel or other electrical component.

Failure to observe these notices could result in damage to equipment.

Stop the unit if any repairs or adjustments on or around the compressor are required.

Do not use the air discharge from this unit for breathing – not suitable for human consumption.

An Excess Flow Valve should be installed on all compressed air supply hoses exceeding ½ inch.

Do not exceed the rated maximum pressure values shown on the nameplate.

Do not operate unit if safety devices are missing, disabled, or not operating properly. Check periodically. Never bypass safety devices.

1. Revision History

Version	Date	Notes
A	May 2023	Original Release
B	June 2023	Added screen shots throughout

2. General

The Ingersoll Rand XS Series of compressed air equipment controllers are the latest in advanced electronic controls research and development for air compressors and compressed air systems alike. The result of years of class leading engineering, the XS Series is designed to provide the most efficient and responsive control of your compressed air equipment while maintaining the intuitive user interface standard on all Ingersoll Rand compressed air equipment.

This manual describes the hardware and software that make up the XS Series of compressor control systems, as well provides guides for configuration, startup, and operation of your XS Series equipped rotary screw compressor.

2.1. Components and Layout

The XS-110 Compressor Control System (XS-110) is comprised of several individual components integrated to meet the requirements of the equipment or application being controlled. The type and count of components within the control system may vary, but at a minimum includethe display, I/O module, relays, devices, and sensors. This section briefly describes the main components that make up the XS-110.

2.1.1. Display Module

The display module is the primary control and processing component of the XS-110. The display module houses the main processor and memory for the system, as well as manages and interfaces with other components, modules, sensors, and ports installed throughout the control system. Mounted to the front of the display module, the faceplate includes a 110mm diagonal touchscreen and border as the user interface.

Figure 2.1.1: Display Example

2.1.2. Input/Output Module

The input/output module (IO module) included as part of the XS-110 is engineered to provide reliable, fast and efficient integration of external sensors, valves, and other devices with the display module. Customized specifically for Ingersoll Rand, the IO module houses a combination ofinputs and outputs designed to accommodate most IO requirements. An additional IO module can be stacked for more heavily instrumented applications.

Mounted in the compressor control panel, the IO module houses terminal block connections for landing device and sensor wiring, as well as communication and power wiring. All sensor and device values are monitored and controlled by the display module, although it does contain RS485 communication ports for customer connection and sequencing with multiple compressors. Details and specifications for the IO module can be found in a later section of this manual.

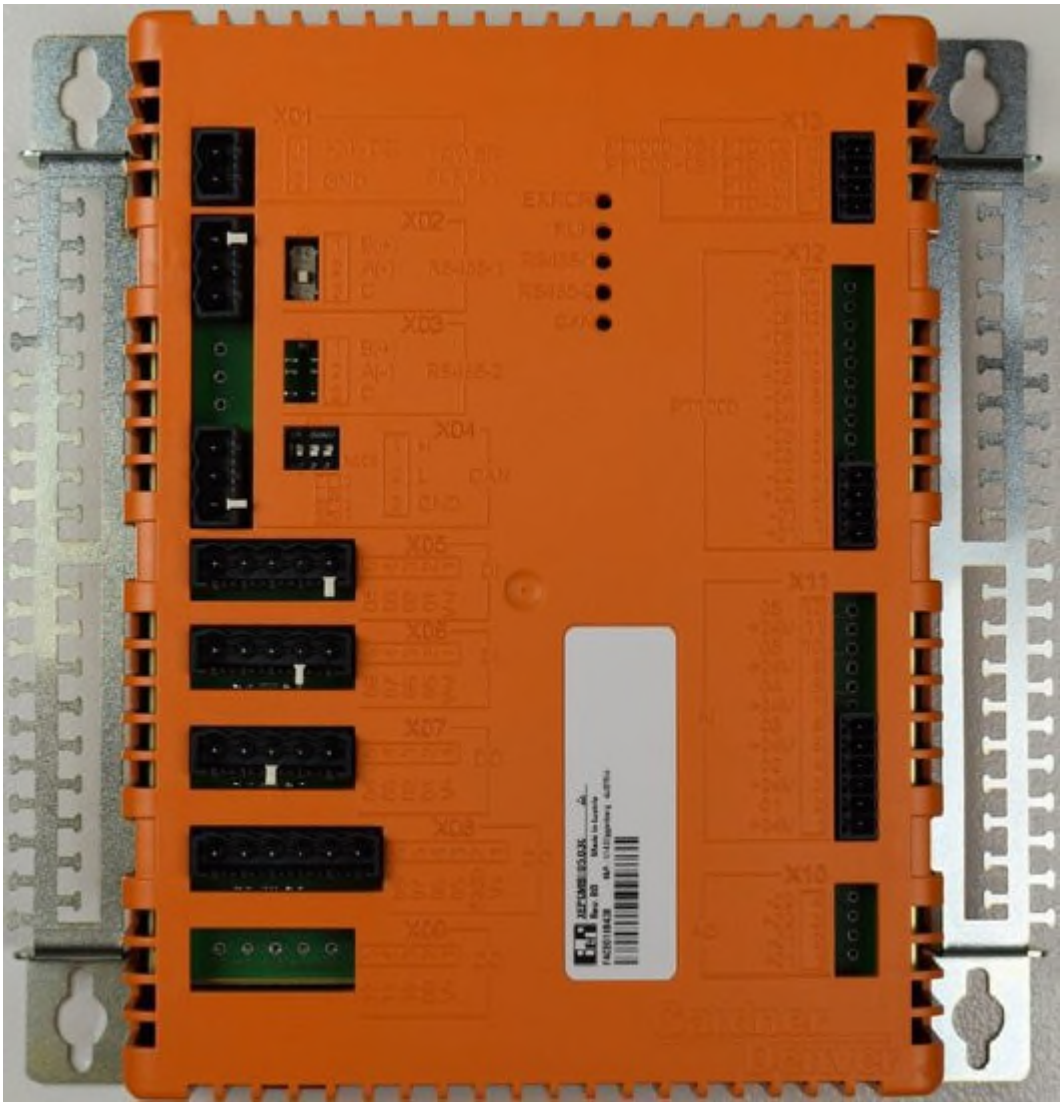

Figure 2.1.2: IO Module

2.1.3. Cellular Module

To provide the best-in-class reliability and performance from your compressed air equipment, Ingersoll Rand initiated an IoT (Internet of Things) based technical support program for all enabled devices. The program includes onboard and remote hardware and software designed to remotely support Ingersoll Rand equipment currently installed and operating in the field.

Note: No customer proprietary information is collected or transmitted through or by this program.

The FX-30 Cellular Modem implements IoT connectivity for various Ingersoll Rand control systems, including the XS-110. Although it has options for connection through USB, Serial and Ethernet, it currently utilizes the USB connection for the XS-110.

Once configured, the FX-30 provides machine operating data to Ingersoll Rand's Service Support team and is also available to the customer through a safe and secure portal.

Figure 2.1.3: FX-30 Cellular Modem

2.2. Features and Control Methods

The XS-110 is fully capable of controlling both rotary and reciprocating compressor technologies, including oil free rotary, oil flooded rotary, non-lubricated reciprocating, and externally lubricated compressor applications. In addition to its core capabilities, the XS-110 includes control of compressed air dryers as well as other integrated equipment included in the compressor package. This section summarizes the different control methodologies or algorithms incorporated into the XS-110.

3.1.1 Control Algorithms

The primary purpose of the air compressor is to provide compressed air within a specified pressure and flow range for the support and operation of pneumatic equipment or processes. Compressor control algorithms allow the user to control and monitor the air produced by the compressor, while simultaneously protecting the integrity of the compressor and the safety of the user.

In essence, the control algorithms are the logic behind the features and functions that make up the XS-110. From simple tasks to complex calculations or predictions, these algorithms analyze received input data. Then, depending on the type and critical nature of the data, a varying set of rules are applied that ultimately determine the resulting output.

A standard set of control algorithms are incorporated into the XS-110, which efficiently provide the following functionalities:

- Start and Stop Control (Includes Start Permissive Monitoring and Control),
- Manual and Automatic Load and Unload Control,
- Automatic Start and Stop Control,
- Primary and Secondary Pressure Control,
- Condensate Removal Control,
- Remote System Pressure Control,
- Power Outage Recovery Control,
- Scheduled Start and Stop Control,
- Integrated System Control,
- Cooling System Control,
- Integrated Air Dryer Control (TAS),
- Progressive Adaptive Control (PAC),
- Drive Motor Temperature Monitoring,
- Sensor Calibration and Diagnostics.

3. Quick Start

This section provides the basic information on the controller and serves as a quick guide to help the user interact and operate the machine. It focuses only on the common elements of the user interface and is intended for operators and maintenance personnel after initial setup and commissioning.

Initial setup and commissioning should always be performed by an authorized Ingersoll Rand distributor or a factory representative.

3.1. User Interface Elements

The user interface (UI) has common elements that are shared across all screens in the system. The user should get familiar with and understand these elements to improve interaction with the controller.

Figure 3.1: UI Home Screen

3.1.1 Navigation and Status Elements

The common status and navigation elements shown in the above given figure are described here. The UI can be separated into three (3) primary sections, each with a specific purpose. The sections are given as follows:

- The top bar is visible and accessible across all screens. It includes current screen location name, as well as houses the main menu, quick access shortcuts, and home screen tile view selection. It is worth noting the icons and menus are always accessible without regard to current screen location.
- Data or information displayed in the center region of the UI will vary based on the current screen location. This region serves as the primary location for reading operational values, making setpoint changes, and accessing log data and other safety/health related information.
- The bottom bar is visible and accessible across all screens and includes current machine operational information. It also includes user login access as well as start/stop and load/unload control buttons. It is worth noting the icons and menus are always accessible without regard to current screen location.

Note: Start and Stop buttons are permanently positioned in the top right corner of the UI screen.

3.1.1.1. UI Top Bar

The Top Bar persists across most screens and pages and includes the following features:

Figure 3.1.1.1: Top Bar

1. The Menu icon (three small horizontal lines) provides access to all the screens available for the logged in user type. The menu expands to provide a cascading navigation menu.
2. The current page location name is always visible to assist the user in navigating the many screens that make up the UI.
3. To conserve screen space, some menu items are hidden behind an expandable horizontal menu. Hidden menu selections can be accessed by selecting this expand arrow then pressing the desired menu item. Hidden menu items include
    - The List View Home Screen button, when pressed, changes the home screen to show operating data displayed in tabular form.
    - The Schematic View Home Screen button, when pressed, changes the home screen to show operating data displayed in process form.
    - The Lock Screen button, when pressed, provides additional safety by preventing commands and changes to be accepted by the controller. To make changes, unlock the screen by pressing the Lock Screen button again.
    - The Load and Unload Command button changes based on current operating status. If the compressor is running loaded, this button will depict an unload symbol and, when pressed, will unload the compressor. If the compressor is running unloaded, the button will depict a load symbol and, when pressed, will place the compressor in a state where it will load if required.
4. The Tile View icon allows the user to modify the Tile View Home screen. The UI main display region is organized in tiles of varying count and sizes. Pressing the Tile View icon while in another Home View (List or Schematic) will cause the Tile View to become active. Pressing the Tile View icon one or more times will cause the Tile View style to change between three (3) editable view styles. Refer to subsequent sections for more details regarding the Tile View selection and editing.
5. The start and stop buttons are located on the screen as soft buttons. When stopped, this button will be green as depicted above. Once running, the button will turn red and function as a stop button.

3.1.1.2. UI Bottom Bar

The Bottom Bar persists across most screens and pages and includes the following features:

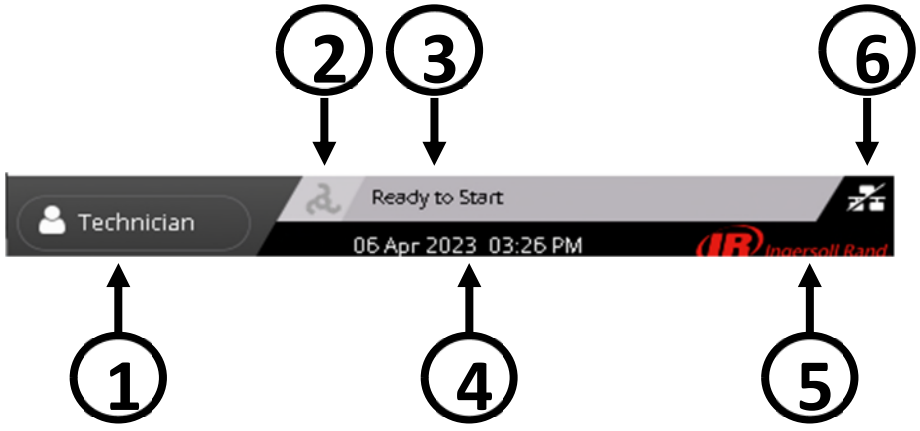

Figure 3.1.1.2: Bottom Bar

1. The User icon serves as a status icon, displaying the user currently logged into the controller. It also serves as the login button, providing access to the security login/logout screen.
2. The Motor Status icon is a visualization of the motor run status, affording the user a means to quickly identify run state with little effort.
3. Compressor Status provides a textual means of displaying a more detailed operating status of the compressor. Refer to subsequent

sections for more detail regarding compressor status.

4. The Load/Unload button allows the user to manually command the loaded state of the compressor. With the compressor running, the user can press this button to either load the compressor (if unloaded) or unload the compressor (if loaded). The text displayed on the button changes based on the current compressor run state.
5. Current Date and Time displays the real time clock incorporated into the controller. Date and Time can be adjusted in the settings menu.
6. The Ingersoll Rand logo doubles as a quick link to get back to the home screen.
7. The Communication Control Enabled icon provides a visual indication of the compressor showing whether the compressor is actively participating through remote control. A compressor enabled for remote control will display the icon without a line through it, whereas disabling remote control displays the icon with a line through it.

   Possible methods of remote control are as follows:
   - Sequence Controlled (either client or server),
   - Hardwired Remote Control (start, stop, load, and unload wherever applicable),
   - Communicated Remote Control (same as hardwired, but through communication),
   - Remote Pressure Setpoint Control.

3.1.1.3. UI Center Area (Main Data Display)

The center area is used to display various operational, configuration, and diagnostic information.

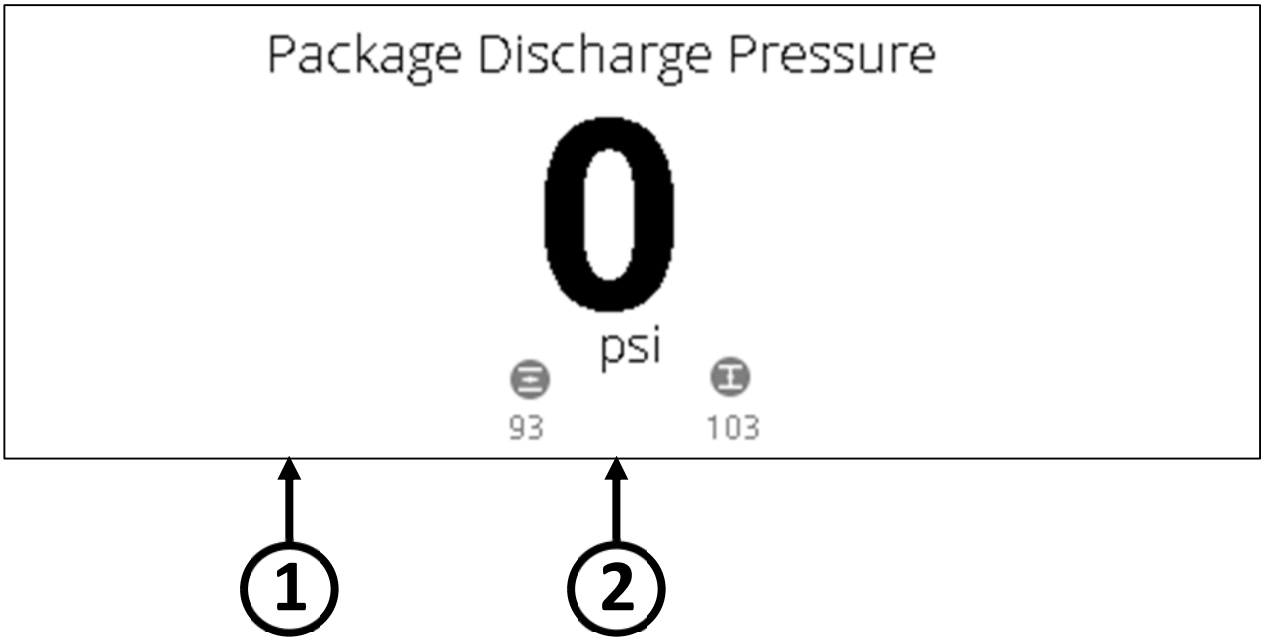

Figure 3.1.1.3: Main Data Display

1. The main display area is the primary location for displaying data, settings, lists, and other pertinent information to be shared with the user. This area will change as the user navigates through screens of the control system interface.
2. Actual data, as well as other related information, is displayed here and may include one or more components. Typically, there will be a title or descriptive name displayed in the top center of the screen.

3.1.1.4. Buttons and Switches

Buttons and switches are used throughout the UI for configuration and settings.

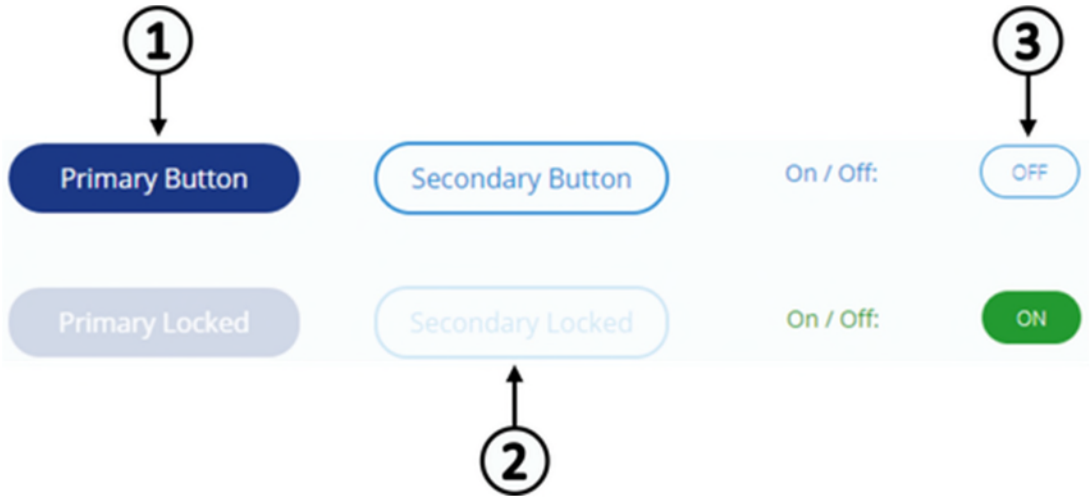

Figure 3.1.1.4: Buttons and Switches

1. Primary buttons are shown in a dark blue fill with white text and indicate the default or most common action(s) for the screen. In contrast, secondary buttons are outlined in blue with a white fill and blue text. Secondary buttons represent less common action(s) for a screen. As an , a settings screen may have a Save button shown as primary whereas the Cancel button is shown as secondary.
2. A locked or unavailable button is shown in its original color, although slightly greyed out showing it is present, but not accessible.
3. Switches are typically used to enable or disable settings or specific functionality and are accompanied to their left by their textual representation. While enabled, the switch displays the word “On” in white text with a green fill. A disabled switch displays the word “Off” in blue text with a white fill and blue border.

3.1.1.5. Horizontal and Vertical Scroll Elements

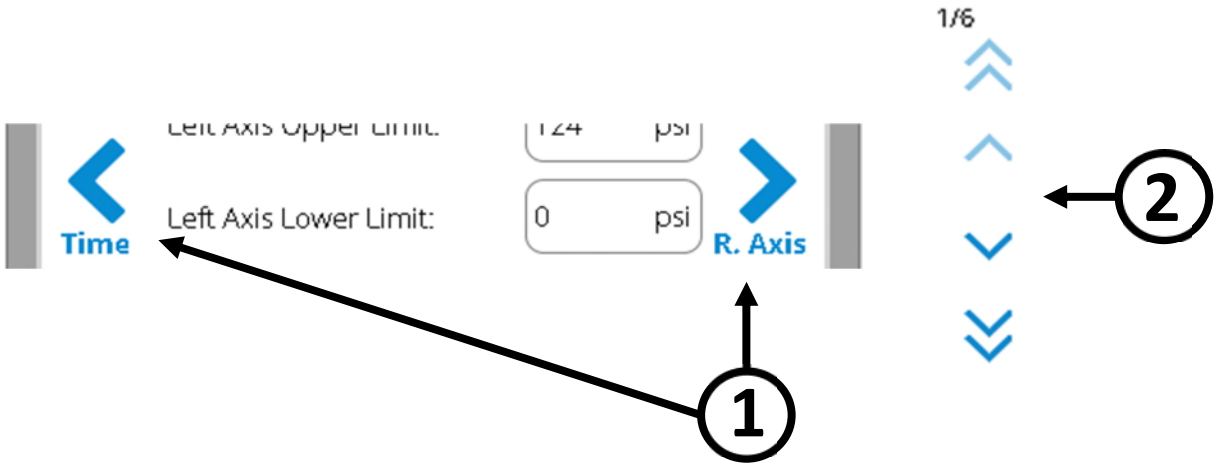

Figure 3.1.1.5: Scrolls (horizontal and vertical)

1. Horizontal scrolls are utilized in the UI to navigate through data and settings pages when more data is available than one screen can show. Shown with dark blue fill and text, the horizontal scroll is designed to loop through all available pages. Pressing a scroll arrow icon will move to display the next available page in the direction depicted by the icon.
2. Like the horizontal scroll, a vertical scroll bar in the form of up and down arrows will appear on the right side of the screen. Pressing a single arrow will move the user one page up or down (depending on which arrow was chosen), whereas pressing one of the double arrows will move to display the first or last page. The arrows will appear faded when the first or last page has been reached.

3.1.1.6. Settings and Input Elements

The control system uses several styles of elements for configuration and setting adjustment. The following describe these in more detail. Figure 3.1.1.6 provides an of a settings screen, including the various styles of menu options available. Depending on the configurationand options purchased with the air compressor control system, the settings section will vary in size and page count.

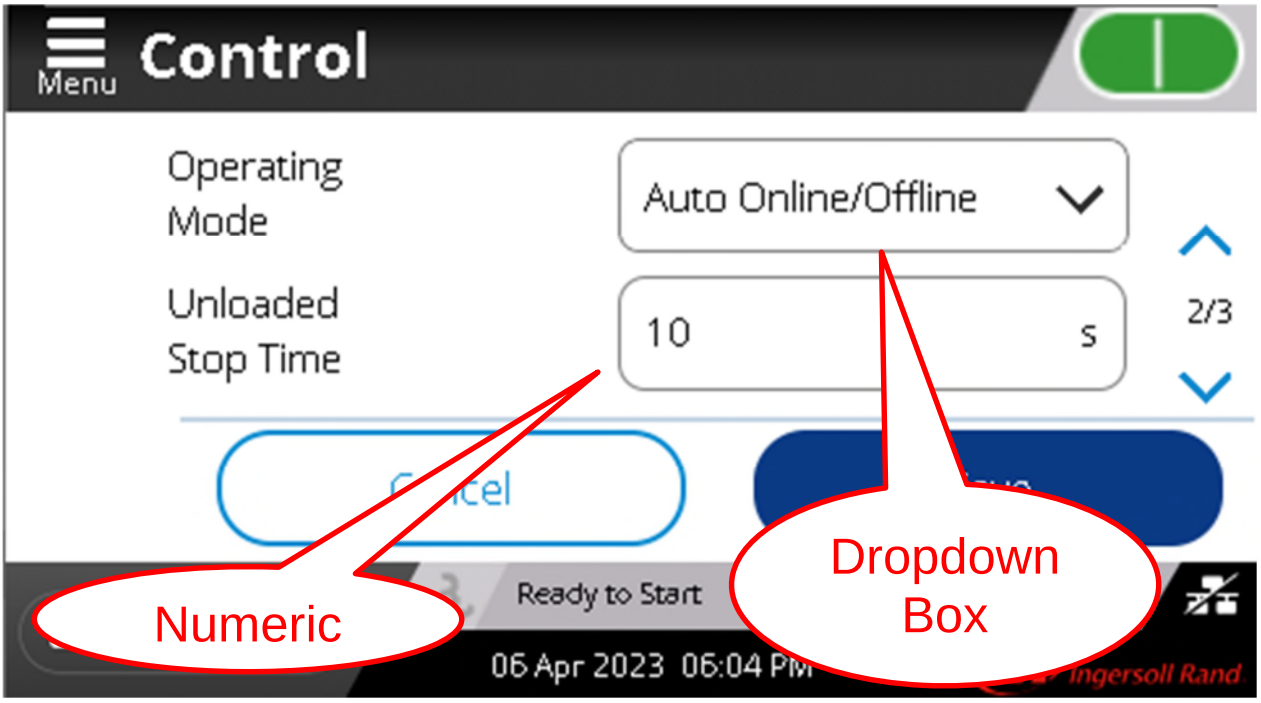

Figure 3.1.1.6-A: Settings Screen

If the setting field includes multiple choices, a drop-down box like Figure 3.1.1.6-B will provide a list of options for the user to select from.

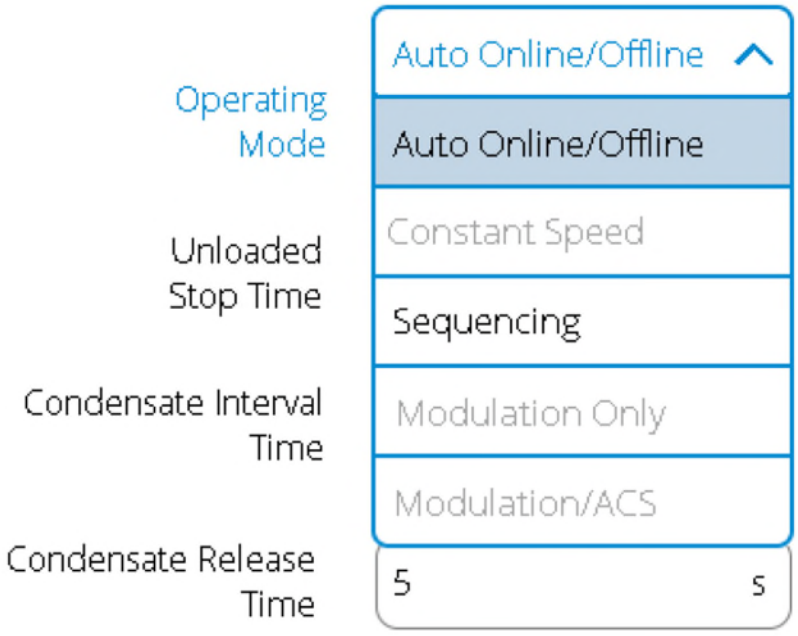

Figure 3.1.1.6-B: Drop Down

A numeric pad will pop up for adjusting or setting fields where a user is required to enter a physical value. In addition to the entry field, the numeric pad includes the valid range for the input.

The pad itself is intuitive and built on commonly applied principles, including backspace, cancel and save icons.

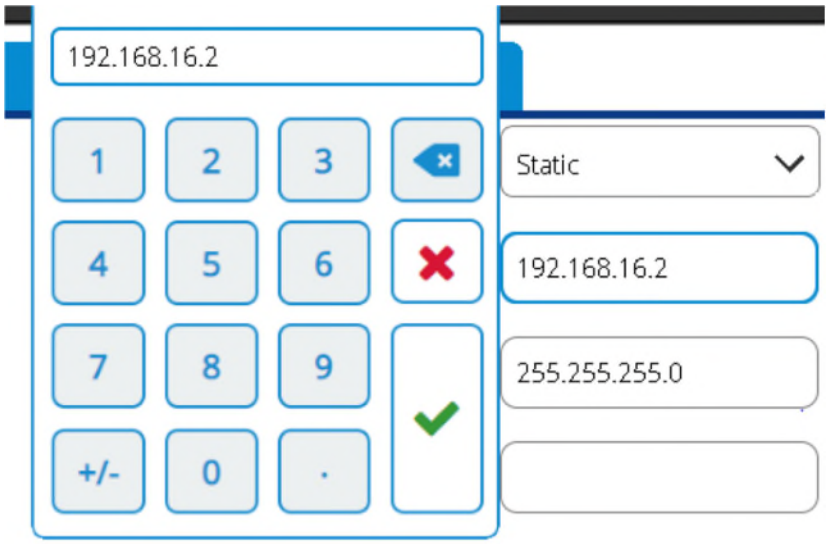

Figure 3.1.1.6-C: Numeric Pad

Like the numeric keypad, the control system includes a general textual keypad used for entering named values. Unlike the numeric keypad,the minimum and maximum character limit is not displayed on the keypad, however the minimum character count is 1 while the maximum is 20.

NOTE: Depending on available features and screen content, some lines of text will be shown truncated, even if under the maximum limit.

Figure 3.1.1.6-D: General Keypad

3.2. Home Screen

The Home Screen is the primary screen and typically includes the main information or data needed by the user for safe reliable operation of the compressor. The control system provides three (3) selectable Home Screen styles to choose from, each with the ability to allow some customization. Refer to 3.1.1.1 for more details.

- Tile View
  - Editable field selection,
  - Offers three tile styles to choose from (Single, Five, and Nine Tile).
- Schematic View
  - Editable properties within schematic.
- List View
  - Editable custom list,
  - Complete list.

Figure 3.2: Tile View Home Screen

3.2.1 Screen Saver

An optional screen saver has been included as part of the control system and can be enabled or disabled within the Configuration and Settings screens. With the screen saver feature enabled, and after 10 minutes of no human interaction, the screen saver will become active. While active, large icons showing compressor status, discharge temperature, and discharge pressure are displayed and allow visual confirmation of operation from adistance.

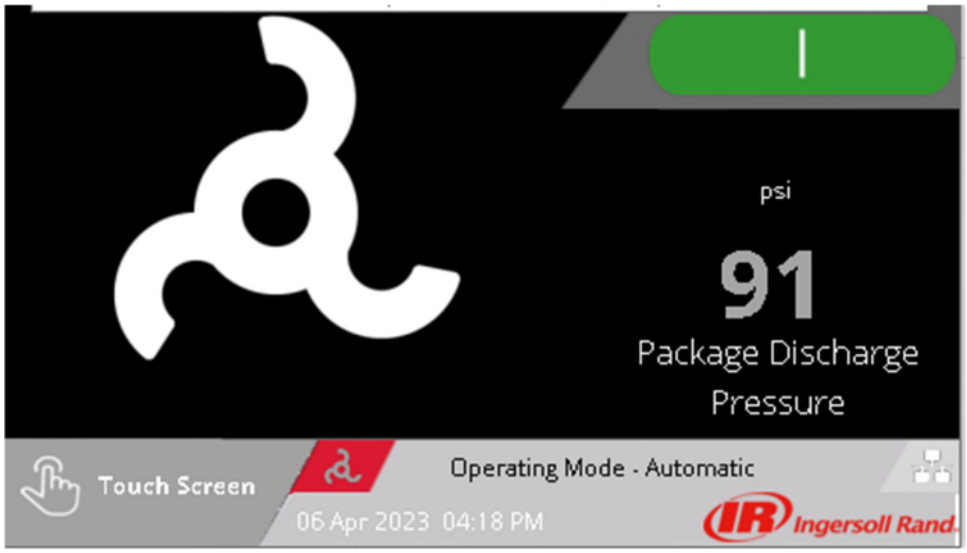

Figure 3.2.1 Screen Saver

3.3. Schematic and List Screens

In addition to the Tile View, the control system includes a Schematic View and List View, allowing data to be displayed in different perspectives. This concept provides the most comprehensive means of troubleshooting and diagnostics.

Although the Schematic View does not have many options or customization, the user is able to select components on the screen, causing the controller to navigate to a schematic view with focus on the component selected.

The List View is a tabular representation of the same compressor operating data discussed previously. With the List View active, the user can easily visualize several lines of data simultaneously, quickly identifying any suspect parameters or readings.

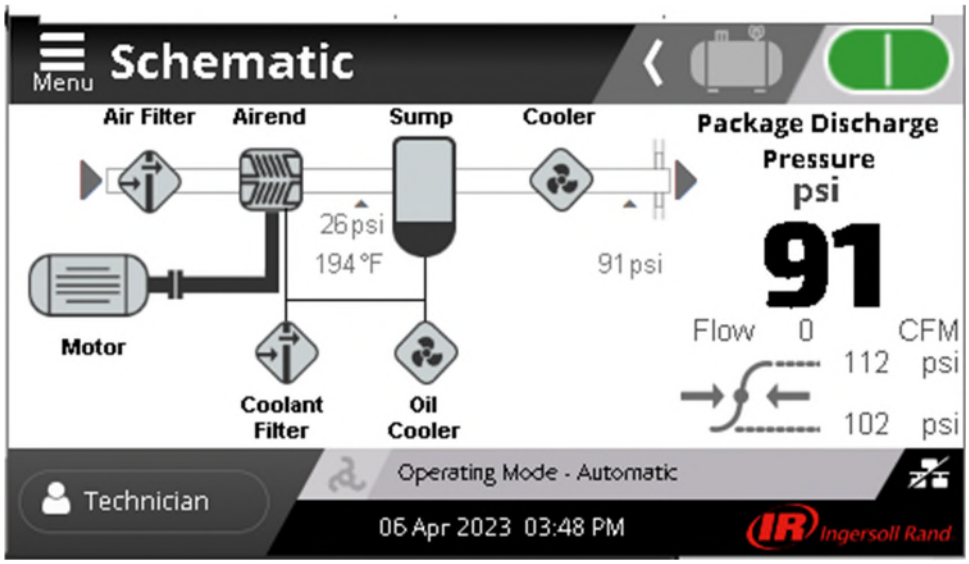

Figure 3.3-A: Schematic View

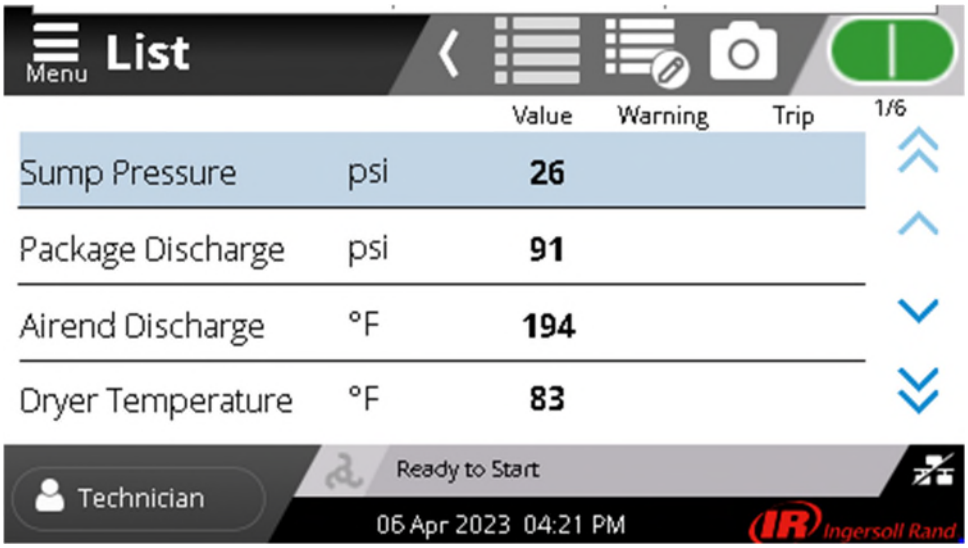

Figure 3.3-B: List View

3.4. Navigation Menu

The main navigation menu provides quick access to all screens in the control system. Access to specific sections or data may not be available depending on user permission at the time.

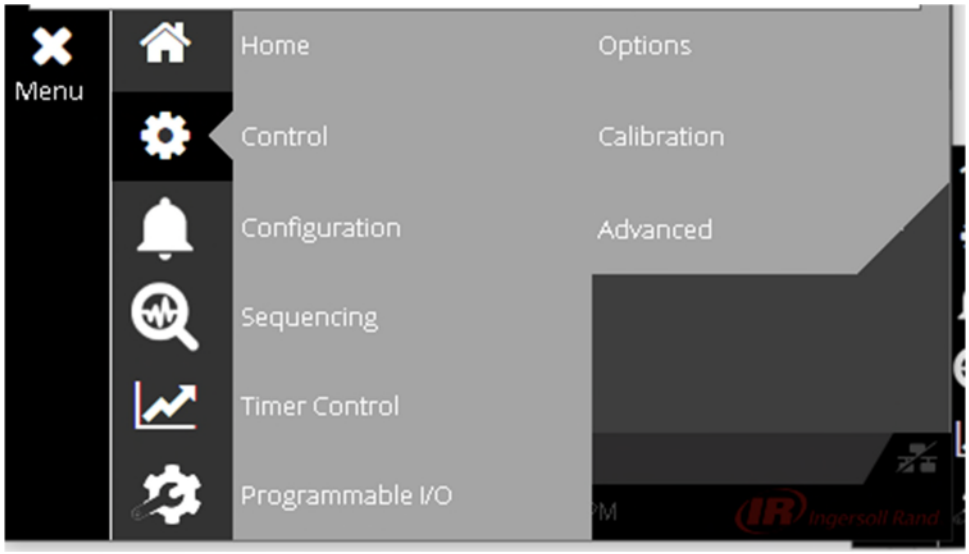

Figure 3.4: Navigation Menu

1. Once the menu is open, an “X” will appear at the top of the menu. Pressing this button will close the menu and return the user to the previously selected screen.
2. When pressed, the Home button will return the user to last selected Home screen (and close the menu).
3. Pressing the Settings button will navigate the user to the User Access menu for configuration
4. The Alarms button, when pressed, navigates the user to either the Alarm History page or Active Alarm page.
5. Pressing the Diagnostics button navigates the user to the Diagnostics menus.
6. When pressed, the Trends button navigates the user to the Trends start page.
7. Pressing the Service button will navigate the user to the Service display and timer settings page.

3.5. Logging In

Before making any changes to the settings on the controller, you must be logged in with an appropriate access level. The current active access levelis indicated by the “User” button located in the bottom left side of the Status Bar. Pressing this button will navigate the user to the Security/Login screen. (Refer to the following figures.)

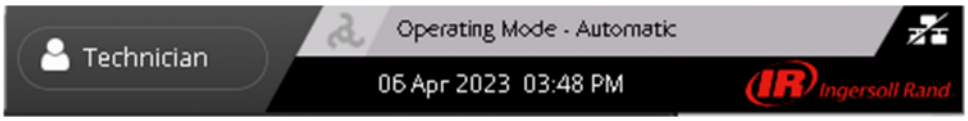

Figure 3.5-A: Current Access Level

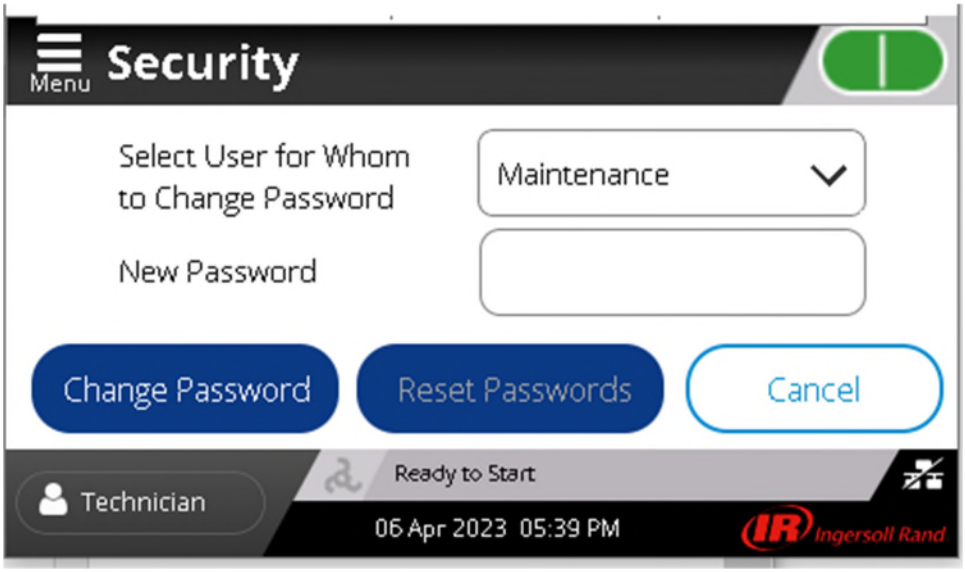

Figure 3.5-B: Security/Login Screen

3.5.1 Access Levels

Access to operation and configuration of the XS-110 is protected and controlled through three (3) fixed user classes, each with a predefined set of permissions based on the following assumptions:

User: The user class is the default and lowest level of access. Intended for personnel who may only need to start and stop the compressor, or review operating parameters, the user has the following limited permissions:

- Start (automatic) and stop the compressor (only if in a permissive state),
- Navigate through various screens (some screens may be hidden from user),
- Monitor operating parameters presented on screens.

Maintenance: The maintenance class is the most commonly accessed class, intended for end users charged with operating the compressor and maintaining the compressed air system for the facility. Building upon the user class, the maintenance class assumes all user permissions as well as the following additional permissions:

- Manual start, stop and control (load/unload) permission for the compressor,
- Reset service timers and operating alerts (warning and trips),
- Manual adjust pressure setpoints and related settings.

Technician: The technician class is intended primarily for personnel charged with maintaining and troubleshooting individual compressors and air system as a whole. This class, intended for facilities maintenance technicians, distributor technicians and other authorized service providers, inherits all lower level permissions and includes the following additional permissions:

- Access to diagnostic and calibration screens for sensors and other instruments ,
- Extract data and other diagnostic date from the controller,
- Configure factory setpoints and other operating parameters not accessible by a lower class ,
- Enabling option modules and software options,

- Update application software or firmware.

Factory: The factory class is intended for factory authorized personnel only. Similar to the previous classes, the factory class inherits all of the previous permissions along with any remaining restrictions to allow full access to all settings and features.

Please note the passwords can be changed from their default by accessing and using the “Adjustments” button on the screen once logged in.

As a best practice to ensure safe and reliable operation of your Ingersoll Rand compressor, all users should log out after completing any adjustments or work within the controller.

User Level	Default Password	Description
User	None	Default with limited access.
Maintenance	407	End user with basic settings and ability to reset alerts and service timers.
Technician	Contact Ingersoll Rand	Advanced access to settings and diagnostic tools. Intended for authorized service personnel.
Factory	Contact Ingersoll Rand	Full access to all settings and features. Password is randomly generated, contact Ingersoll Rand for assistance.

Figure 3.5.1: Access Default Passwords

3.6. Operating the Compressor

Figure 3.6.0 Status Bar and Messages

To preface this section of Quick Start, there are several steps required to prepare the control system and compressor for service prior to operation. It is recommended that all initial setup, configuration, and commissioning be performed by an authorized service provider. Contact your company representative or closest authorized distributor for more information.

This section assumes that all preparatory steps have been completed and the compressor is ready to be started. Further, thissection focuses on the basic overview of how to operate the controller and compressor and does not include all options and/or possible scenarios. For more details, refer to subsequent sections.

It is important for the user to have a basic understanding of the operating states incorporated and displayed on the controller status bar (bottom bar). The following states (with brief description) have been incorporated into the control logic:

State as Displayed	Description	
Not Ready	Not rotating and one or more permissive inputs not satisfied (physical or logical)	Emergency Stop button pressed
Ready to Start	Not rotating, but all start permissive inputs satisfied (physical and logical)	High temps returned to normal and trip reset

Starting	Ramping to speed from a start and may include alternate safety limits	Some sensors may be ignored during starting state due to range
Running Unloaded	Rotating at rated speed with minimum flow and internal pressure to support cooling	Minimum pressure check valve is closed while unloaded
Running Loaded	Rotating and contributing to system	Inlet valve open and contributing to system
Auto-Restart	Not rotating, but automatically start and load when pressure falls to load SP	Backup compressor during low consumption
Stopping	Stop button pressed (or other) and compressor coasting to a stop	Normal stop button pressed and compressor ramping down to stop
PORO Start	Automated start of compressor after power failure	Power failure from storm
Tripped	One or more safeties exceeded the trip value, causing the compressor to shutdown	High discharge temp trip

Figure 3.6.0.1 State Message Descriptions

3.6.1 Ready to Start

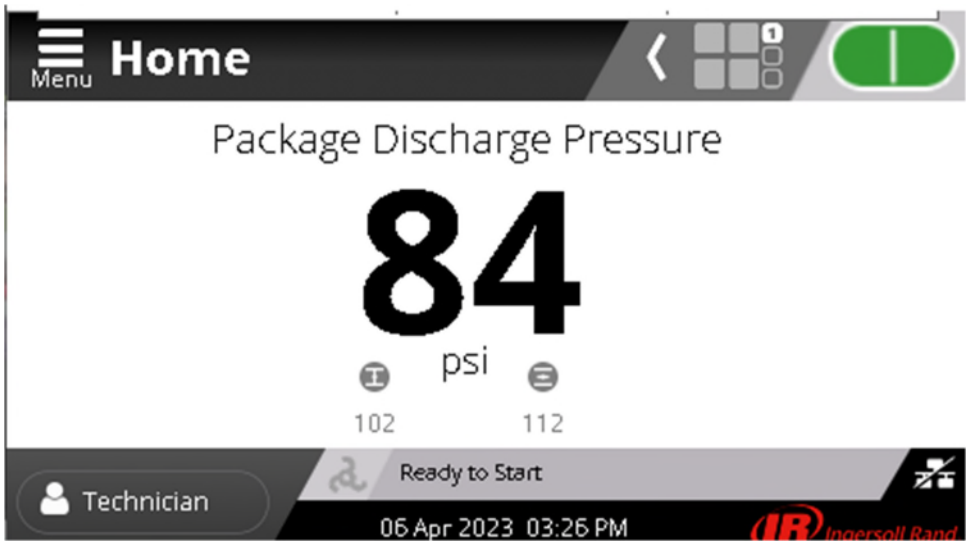

Figure 3.6.1: Ready to Start

Before starting the compressor for the first time, ensure all components are installed and mounted correctly, and that all safety requirements have been satisfied. Ensure all required valves or other isolation devices are in a safe position.

3.6.2 Starting the Compressor

Depending on which options are enabled within the controller, the XS-110 has the ability to receive and process start commands from many sources in addition to the start button located on the UI. This includes a variety of remote and automatic commands, however, regardless of the method used, the controller must be in a "Ready to Start" state (local or remote) and all external permissive requirements satisfied (where applicable). More details regarding remote control can be found in subsequent sections.

Once all requirements have been met, the user can then start the compressor using the start button on the UI. This will cause the compressor to transition to the starting state and begin the start sequence selected during commissioning.

If package discharge pressure is below the online pressure setpoint, the compressor will complete the selected starting procedure, then open the inlet valve and begin building pressure. For an empty system, or first time starting, the compressor is designed to maintain a minimum pressure within the compressor to ensure proper internal coolant flows.

If package pressure is above the online pressure setpoint, the compressor will complete the selected starting sequence then remain either unloaded and/or stop after the designated stop delay timer expires.

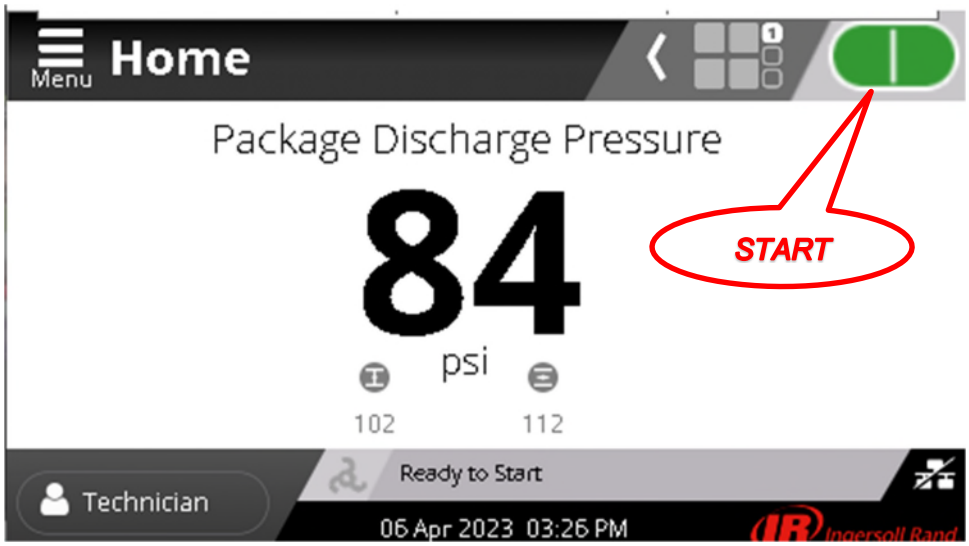

Figure 3.6.2: Start Button

3.6.3 Running the Compressor

After completion of the starting state, the compressor transitions into a running state based on the mode of operation and other options selected during commissioning. Although there are several modes of operation, this Quick Start section will be limited to the Automatic Online /Offline mode.

Figure 3.6.3: Running the Compressor

The first time the compressor starts, the control system will perform a test to determine whether the compressor is at minimum operating temperature. If the test fails, the compressor will not be allowed to load until it has adequately warmed up. Refer to subsequent sections for details regarding this and other available features.

With the compressor at operating temperature and no other action taken by the user, the control system transitions to a running loaded state, monitoring package discharge pressure and comparing it to setpoints entered during commissioning. Two setpoints are important to understand with this mode of operation, Online Pressure Setpoint and Offline Pressure Setpoint.

1. Online Pressure Setpoint is the pressure at which point the control system commands the compressor to load or provide compressed air. Note there are limitations to consider regarding the minimum or maximum setpoint allowed, as well as whether the compressor is or is not connected to some form of sequencer or system controls.
2. Offline Pressure Setpoint is the pressure at which point the control system commands the compressor to unload or stop (depending on compressor model and type). Similar to the previous setting, this setpoint has limitations that must be considered when making

adjustments.

While running in the loaded state, the compressor will cycle between the online and offline pressure setpoints, attempting to maintain pressurewithin this calculated pressure band. This cycle will continue until the control system receives an unload command, stop command, or experiences a trip event. Status messages displayed on the UI, provide the user indication of the current compressor operating state.

3.6.4 Stopping the Compressor

Stopping the compressor can also come from many sources, from manually pressing the stop button to receiving a stop command through a systemcontroller. The way in which the control system processes a stop command may vary depending on the source of it. Although there are multiplesources for this command, this section will focus on manually stopping the compressor by pressing the stop button on the UI.

The control system accepts a manual stop command immediately then begins processing it based on the type of starter configuration and current operating state. The compressor state at the time a stop command is received will have an effect on how the stop command is processed and amount of time it will take to go from when a stop command is received to when it physically stops rotating and returns to a ready state. Additionally, the compressor must run unloaded for the duration of a preset timer before being allowed to stop. This helps ensure the compressor is in a safe operating state prior to stopping.

Once the stopping process has completed, the control system will check the condition and status of the permissive inputs then return the compressor to a ready state if possible.

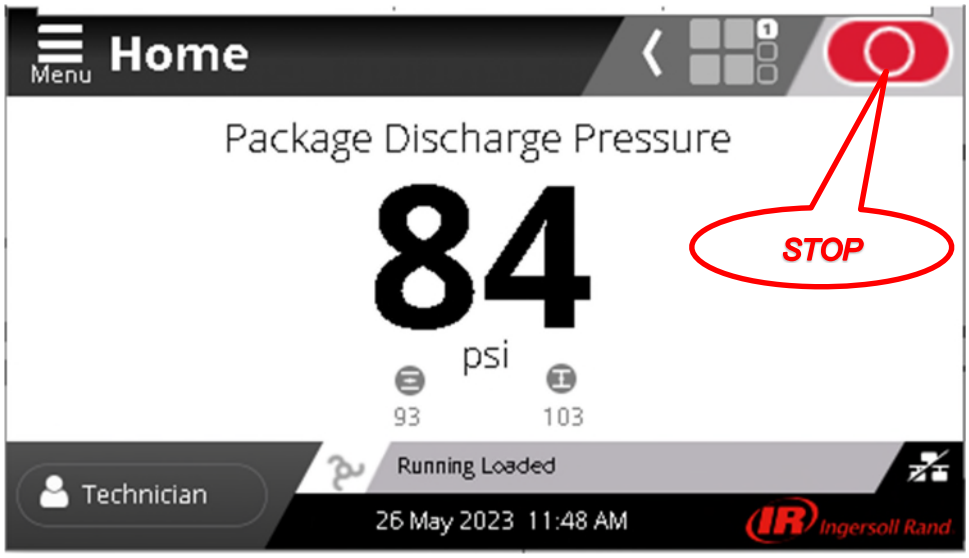

Figure 3.6.4: Stop Button

3.6.5 Emergency and Trip Stop

There are times when the compressor needs to be stopped immediately and without delay. One function of the control system is to monitor operating parameters. If a critical parameter exceeds a safe operating limit, the control system must be capable of stopping the compressor immediately. Additionally, the control system must be capable of acting if a user has an urgent need to stop the compressor immediately.

Figure 3.6.5-A: Trip Status Alert

The control system includes two conditions that can force the compressor to bypass normal stopping processes, immediately bringing the compressor to a stop:

1. One or more critical operating parameters exceeds safe limits, forcing the control system to trip and immediately bring the compressor to a stop.
2. In an emergency, a user can press the Emergency Stop button, forcing the compressor to bypass normal stopping processes and immediately bring the compressor to a stop.

> Note: pressing the Emergency Stop button is not considered a normal stopping process. It is mechanically hard on components, and is intended for emergency use only.

Once the compressor has come to a complete stop, and before it can be returned to service, the user must ensure all operating conditions have returned to normal before resetting the active trip.

In the event the emergency stop button was pressed, it must also be reset before resetting the active trip by turning it clockwise until the latching mechanism is released.

Figure 3.6.5-B: Emergency Stop

3.7. Active Alarms and Alarm History

Warning and trip events triggered during operation are recorded in a separate set of screens in the control system. These events are separated into two (2) categories, “Active Alarms” and “Alarm History”. They are accessible by pressing the Alarms menu button or selecting an active alarm notification on the main screen.

Regardless of location, alarm events are organized into two (2) categories, “Warnings” and “Trips”. Each event is time stamped when the event occurred, along with additional operating readings.

Warnings are considered cautionary events, indicating a problem that requires attention, yet not reaching a critical state. Warnings are indicated by a yellow filled equilateral triangle with an exclamation point written in black.

Trips are considered critical events, reaching a point where safety and/or reliability has been compromised and therefore shutting the compressor down before any further damage can occur. Trips are indicated by a red filled equilateral triangle with an exclamation point written in black.

View access to the Alarm screens is available to all levels of permission, however only users with maintenance or higher permissions are allowed to reset or clear active alarms.

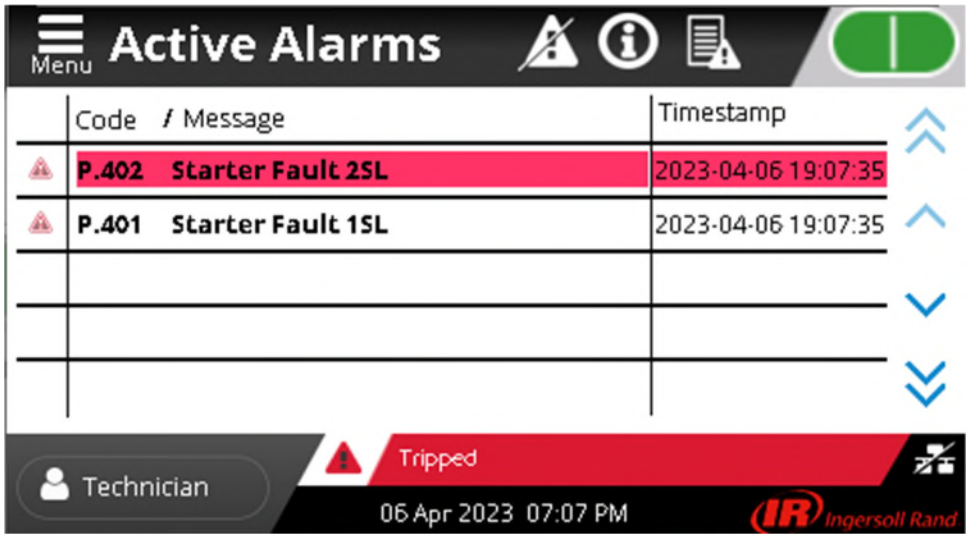

Figure 3.7-A: Active Alarms

The Active Alarm screen lists all warning and trip events not reset. Using the arrows on the right side of the screen, the user can navigate through the list, highlighting each event. With an event highlighted, the user can select the “Info” button to view machine condition data recorded at the time of the event. The user can then choose to reset the event by pressing the “Reset All” button or leave it in an active state until corrective action has been completed.

Once an active alarm has been reset, it is removed from the Active Alarm screen and placed into the Alarm History screen.

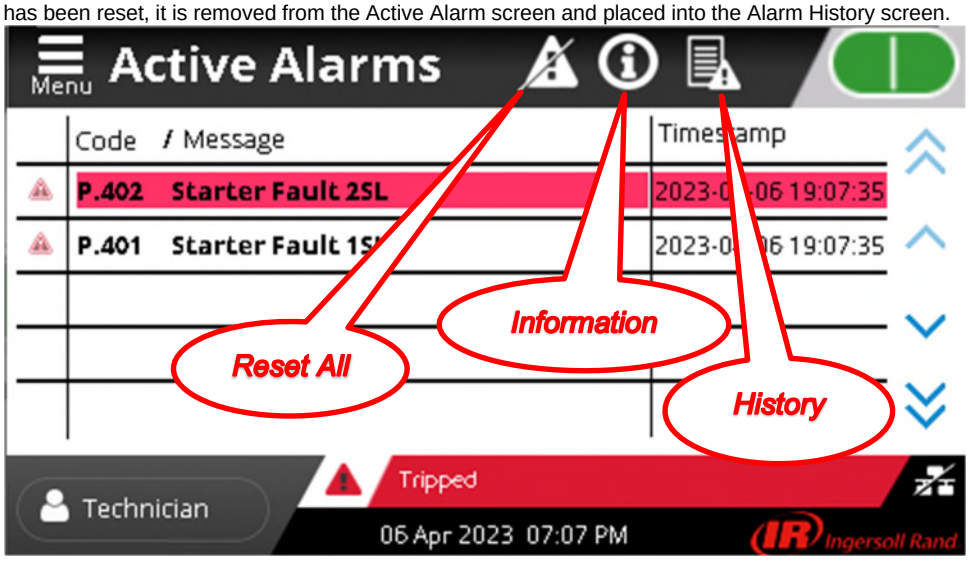

Figure 3.7-B: Active Alarms

As with any warning or trip event, the root cause must be identified and returned to normal before the control system will reset the warning or trip.

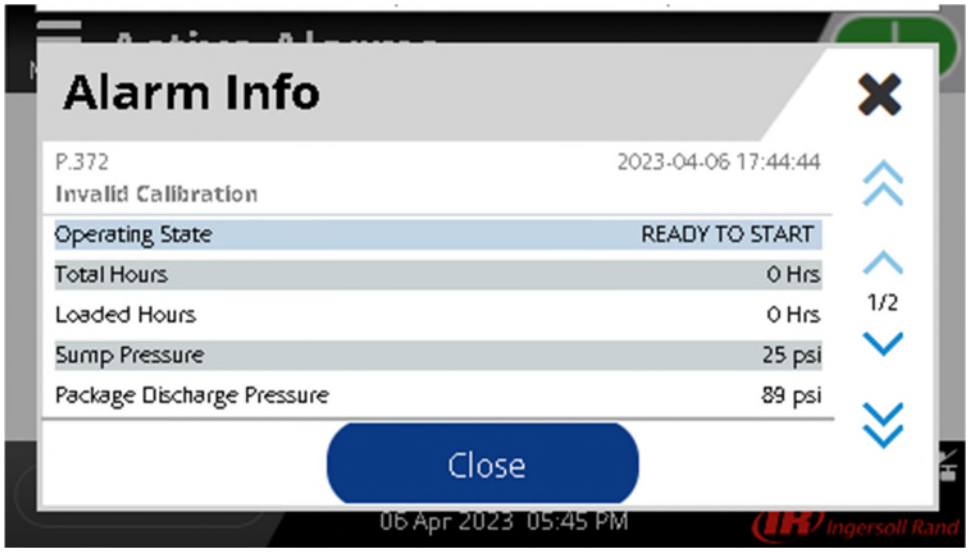

Figure 3.7-C: Alarm Info

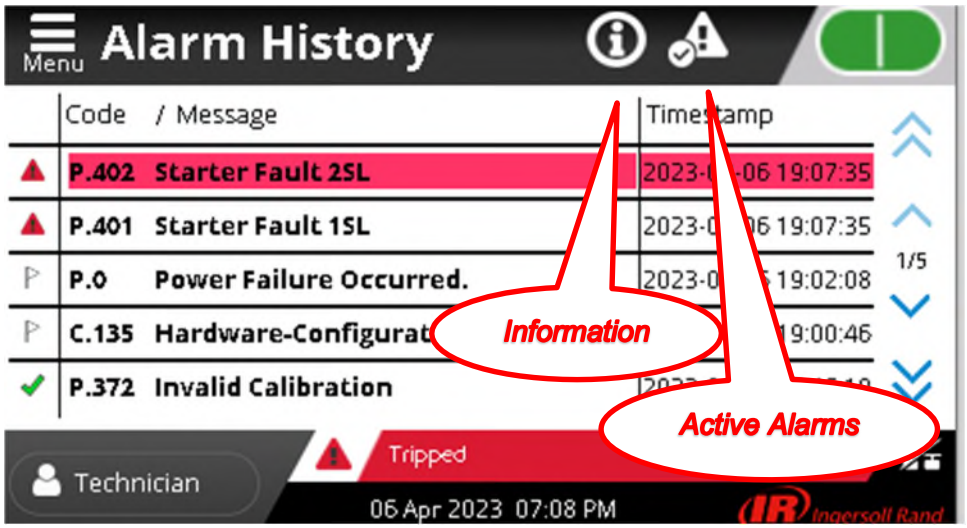

Figure 3.7-D: Alarm History

As discussed previously, once an active alarm has been reset, it is moved to and listed within the Alarm History screen. Listed events are arranged in descending order, starting on top with the most recently recorded event. To return to the Active Alarms screen, simply select the Active Alarms button located at the top of the page.

Machine condition captured at the time of the event will persist for the last 50 events and can be identified when selected by the inclusion of an "Info" button at the top of the screen. If a user selects an event, and an Info button appears, that event includes captured data. Further, if the user then presses the Info button, a pop-up screen will appear displaying a list of captured data at the time of the event.

4. Settings and Configuration

The control system installed on the compressor is pre-configured at the factory for testing purposes, however configuration and setting adjustments are required once installed at site and ready for commissioning. This section provides an overview of the various setting and configuration screens incorporated into the control system. Additionally, this section is formatted slightly different from other sections in an effort to provide a more simplified way to visualize and understand this somewhat complicated topic. This section includes instruction regarding editable screens throughout the control system UI.

Note that setting and configuration fields are protected by user access permission levels and may not be available to all users or may be in a read only state.

The following describes the way each section is organized:

Section Category (Initial Setup, Options, Operation, etc.)

1. Name | Screen Location (breadcrumb to screen),
2. Table of available settings (does not include the values - values are provided in an insert):
    a. Setting Name,
    b. Description,
    c. Permissions (H = Hidden, R = Read Only, RW = Read/Write).
3. Legend,
4. Notes,
5. Sample Screenshots (Listed as Figures.).

Save and Cancel buttons are located at the bottom of each editable screen. If no fields are editable to the user on the screen, the Save and Cancel buttons will be greyed out indicating that function is not available to the currently logged in user.

Figure 4.0: Save and Cancel

3.1. Initial Setup Settings

The Initial Setup category focuses on those screens and fields most likely to be edited only once during commissioning. There are many settings required during commissioning, most of which must be performed by an authorized service provider with technician or higher access permission. The following table includes initial setup settings available for the maintenance and lower permission.

4.1.1 Locale

Name: Locale | Location: Settings>Configuration>Locale

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Language	Choose display language from available languages	R	RW
UOM Temperature	Choose display units for temperature measurements	R	RW
UOM Pressure	Choose display units for pressure measurements	R	RW
UOM Flow	Choose display units for flow measurements	R	RW

Legend:

UOM = Unit of Measure, H = Hidden, R = Read Only, RW = Read and Write Notes:

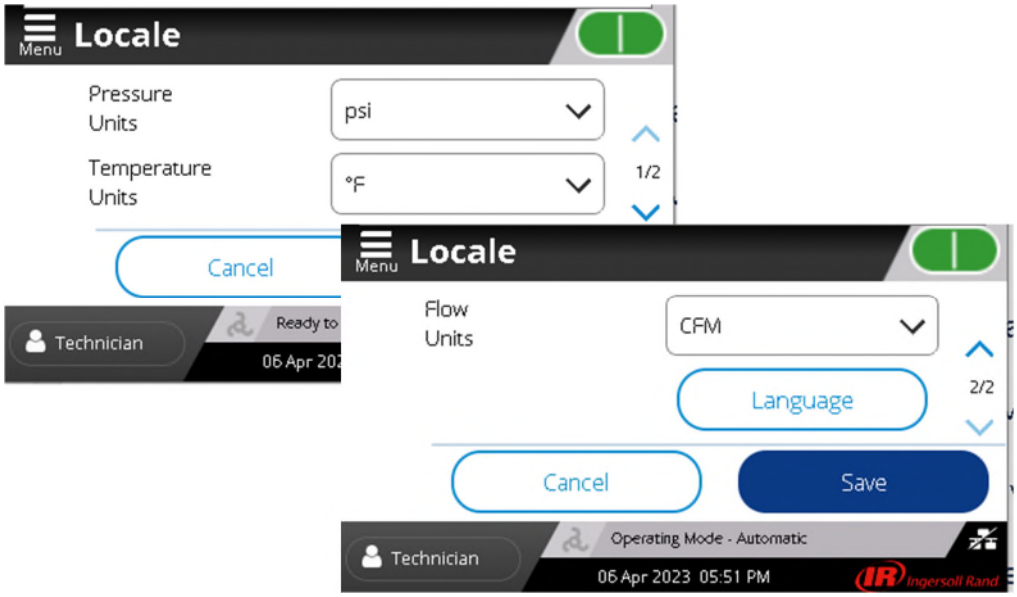

Figure 4.1.1: Locale

4.1.2 Date & Time

Name: Date & Time | Location: Settings>Configuration>Date & Time

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Month	Calendar month	R	RW
Day	Calendar day	R	RW
Year	Calendar year	R	RW
Hour	Hour (24 hour format)	R	RW
Minute	Minute	R	RW
Second	Second	R	RW
Time Zone	Relative to the physical location of the compressor	R	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

The correct Time Zone is important for synchronizing events and trends.

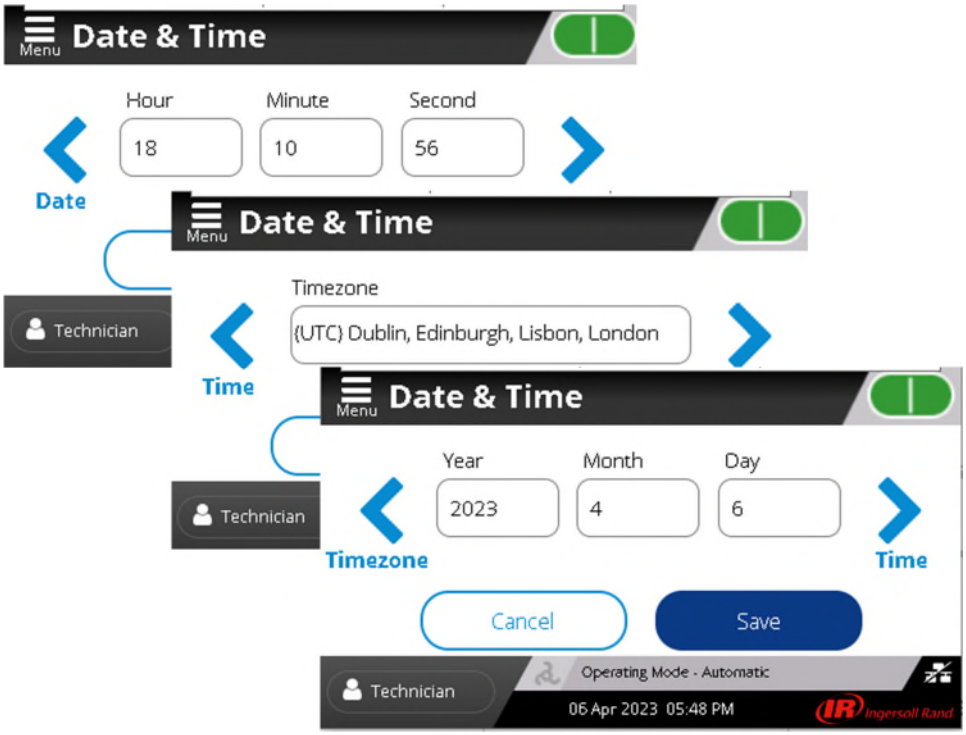

Figure 4.1.2: Date and Time

4.1.3 Security

Name: Security

Location: Settings>Configuration>Security

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Change Password	Change the password for the logged in user only. (no other administrative rights)	H	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Maintenance user only has the rights to change their password.

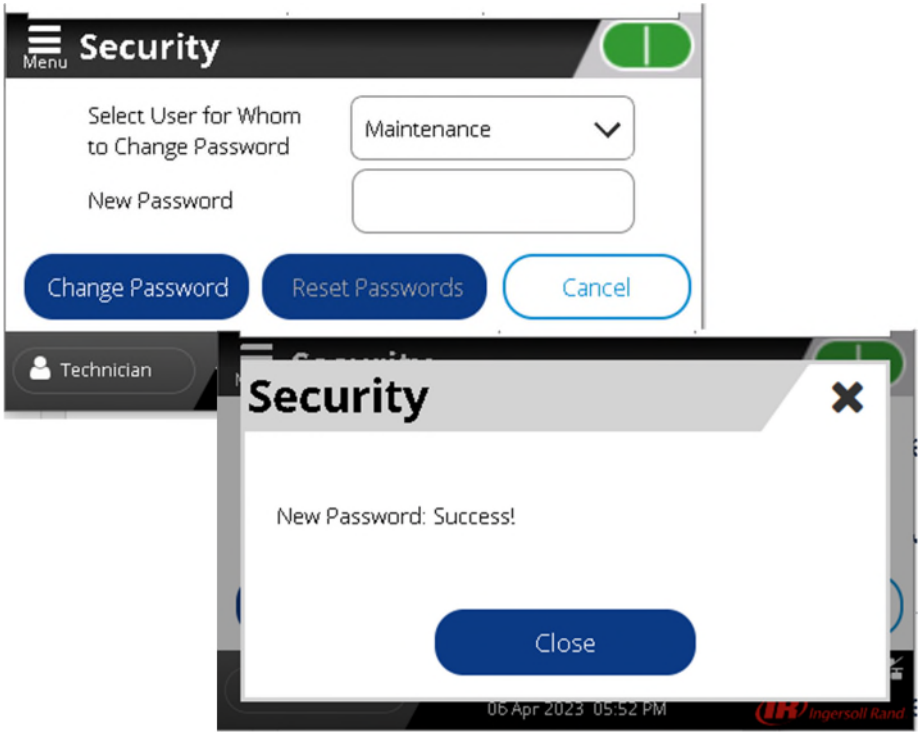

Figure 4.1.3: Security

4.1.4 Communication

The Communication configuration settings screens include all communication protocols available to the maintenance and user class. In an effort to ensure reliable connectivity, it is highly recommended to limit access to, and adjustment of, these settings to trained and authorized personnel only.

4.1.4.1. Ethernet Communication

Name: Ethernet

Location: Settings>Configuration>Communication>Ethernet

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Ethernet Configuration Mode	DHCP or Static (all other fields will be greyed out if DHCP is selected)	R	RW
IP Address	Enter a valid IP address (for static entries)	R	RW
Subnet Mask	Enter a valid Subnet Mask (for static entries)	R	RW
Gateway	Enter a valid Gateway (for static entries)	R	RW

Legend:

DHCP = Dynamic Host Communication Protocol, H = Hidden, R = Read Only, RW = Read Write

Notes:

Static entries require a valid IP address to be connected and updated by network management for proper operation.

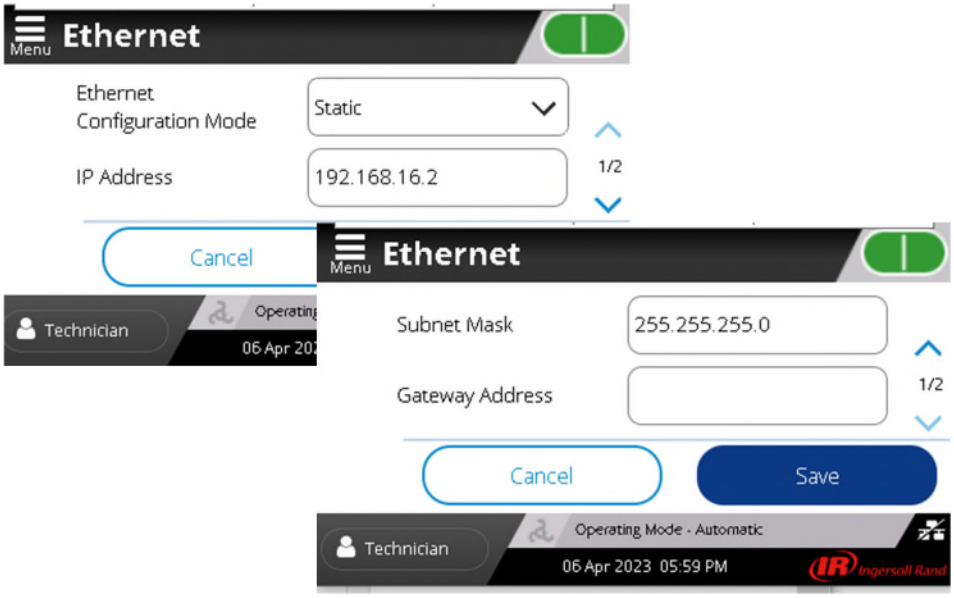

Figure 4.1.4.1: Ethernet

4.1.4.2. Serial Communication

Name: Serial

Location: Settings>Configuration>Communication>RS485

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Mode	Selection of available modes for a specific port, including named sequencer and typical Modbus serial modes	R	RW
Baud Rate	Select available baud rate for the connection (applies to Modbus selections only)	R	RW
Node ID	Select a unique node ID for each device on the serial bus	R	RW
Byte Swap	Check box enabled by default. Flips the order in which Modbus data is stored and transmitted (Big-Endian v Little Endian)	R	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

All configurable serial ports are disabled by default and must be enabled, configured by an authorized user. All ports have similar settings options. The given table reflects any selected serial port. Ports dedicated to internal functions are pre-configured and are not editable by the user.

Several Modes are available, some of which are specific to integral compressor control and sequencing. Refer to subsequent sections for more detail. However, some modes require elevated permissions to access. For details regarding those selections, contact your local Ingersoll Rand representative.
Modbus Client and Server are new terms to define the relationship between devices connected within a communication bus. In the context of this controller, these terms are defined as:
A **Client** initiates queries and commands to one or more servers, whereas a **Server** can only receive queries and commands from a single client (and respond accordingly).

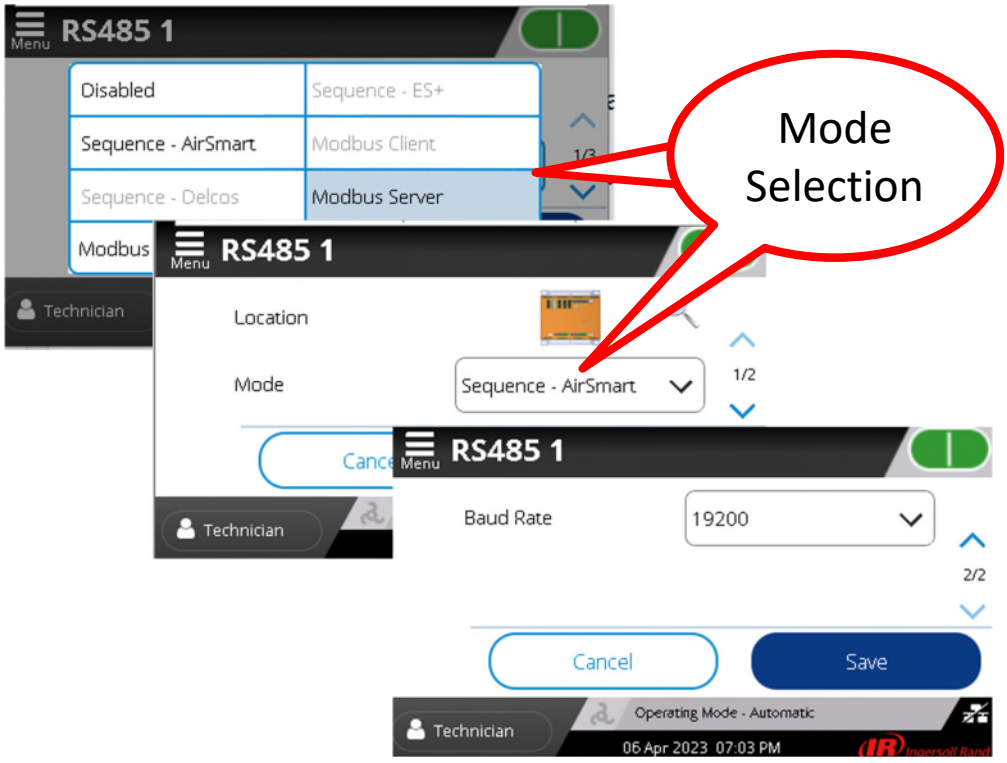

Figure 4.1.4.2: Serial

3.2. Control and Option Settings

The Control and Option Settings category includes a wide range of setting screens and fields focused on the day-to-day operation of the compressor. Most screens and fields in this category are available to the maintenance class with “Read Only” visibility for the user class.

4.2.1. Control Settings

Name: Control

Location: Settings>Control

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Operating Mode	Select the load/unload method to use for daily operation	R	RW
Unload Stop Time	Delay timer between unload and automatic stop (starts upon unload and stops compressor when timer expires)	R	RW
Condensate Interval Time	Interval time between energizing the condensate trap solenoid valve	R	RW
Condensate Release Time	Amount of time the control system holds the condensate trap open while energized	R	RW
p1 Pressure Band (Primary)	Primary online/offline pressure setpoints for loading and unloading the compressor	R	RW
p2 Pressure Band (Secondary)	Secondary online/offline pressure setpoints for use while running as lag compressor.	R	RW
Starter Time	Transition or trip delay time for getting the compressor through the starting stage of operation	R	RW
p2 Timer Enable	Enables/disables delay timer for switching to the secondary pressure band	R	RW
Max Modulation Pressure	Maximum allowed pressure while in running in Modulation mode (unloads when reaches this limit)	R	RW
Interstage Condensate Trip Time	Delay time before unit trips on high interstage condensate level	R	RW
Package Condensate Trip Time	Delay time before unit trips on high package condensate level	R	RW
Interstage Condensate Release Time	Amount of time the interstage condensate trap is to remain open	R	RW
Package Condensate Release Time	Amount of time the package condensate trap is to remain open	R	RW
Interstage Condensate Stop Release Time	Amount of time the interstage condensate trap is to remain closed	R	RW
Package Condensate Stop Release Time	Amount of time the package condensate trap is to remain closed	R	RW
Condensate Type	Type of condensate traps implemented on compressor	R	RW
Max 1st Stage Temperature	Maximum stage 1 temperature safety limit	R	RW
Max 2nd Stage Temperature	Maximum stage 2 temperature safety limit	R	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Depending on the application installed, some settings may not be available.

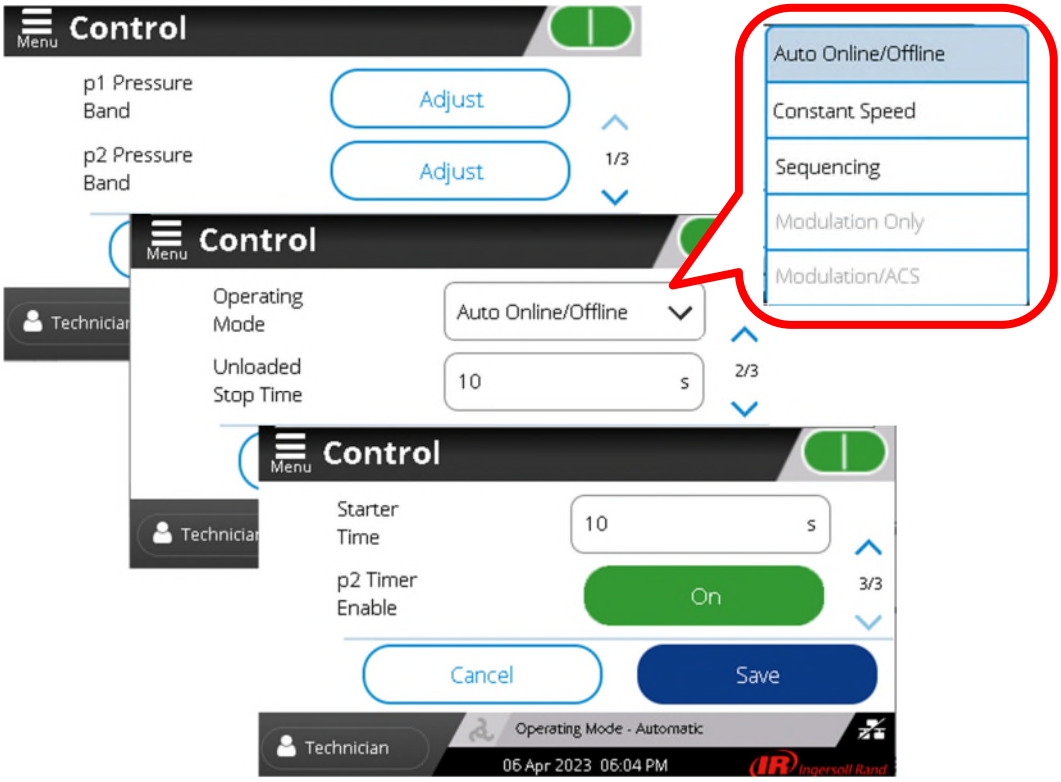

Figure 4.2.1: Control Settings

4.2.2. Option Settings

Name: Options

Location: Settings>Options

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Auto Restart Time	Amount of time the compressor must run in an unloaded state before stopping in auto restart mode	R	RW
Auto Restart Delay Time	Delay time before compressor can restart when commanded to in auto restart mode	R	RW
Remote Start/Stop	Enable/disable remote start/stop functionality	R	RW
Enable Timer Control	Enable/disable timed start/stop mode	R	RW
Enable PORO	Enable/disable Power Outage Restart Option	R	RW
PORO Time	Delay time before restarting a compressor recovering from a power outage with PORO enabled	R	RW
High Dust Filter	Enable/disable high dust filter settings (accommodates increased pressure drop)	R	RW
Bolt-On VSD	Enable/disable accommodations for bolt on VFD drives	R	RW
Remote Pressure	Enable/disable remote pressure input	R	RW
Comm Control (Communication)	Enable/disable control of compressor through communication (Modbus, Sequencing, etc…)	R	RW
Enable True Running Output	Enable/disable feature that indicates compressor is in a running state even when stopped in auto restart	R	RW
Trip Indication	Enable/disable feature providing external indication when unit trips	R	RW
Warning Indication	Enable/disable feature providing external indication when unit has a warning	R	RW
Low Ambient Temperature	Enable/disable accommodations for low ambient applications	R	RW

Enable Inlet Position Test	Enable/disable feature that tests the inlet position	R	RW
Hot Discharge	Enable/disable feature providing accommodations for a compressor without an after cooler	R	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Depending on application installed, some options may not be available.

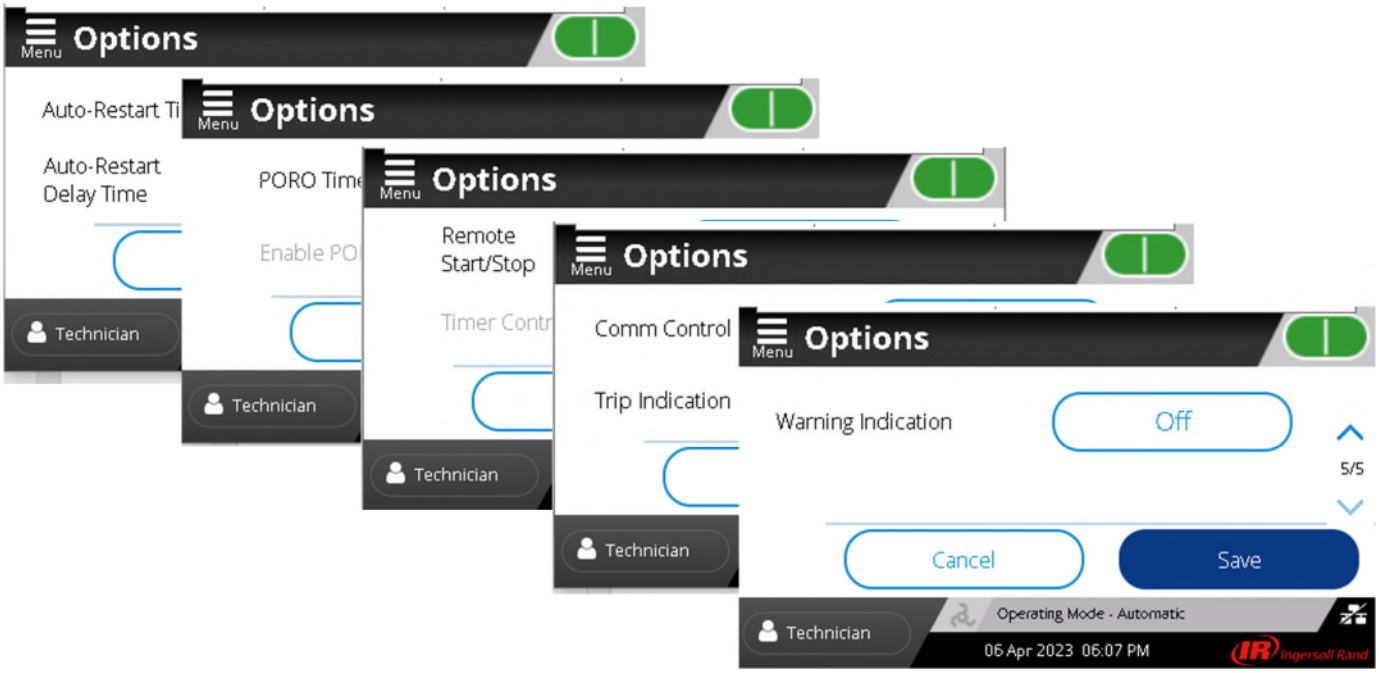

Figure 4.2.2: Option Settings

4.2.3. Calibration Settings

Name: Calibration | Location: Settings>Calibration

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Analog Input 1	Calibrate range of designated analog input	H	RW
Analog Input 2	Calibrate range of designated analog input	H	RW
Analog Input 3	Calibrate range of designated analog input	H	RW
Analog Input (*n*)	Calibrate range of designated analog input	H	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Analog input count will vary depending on application and features installed.

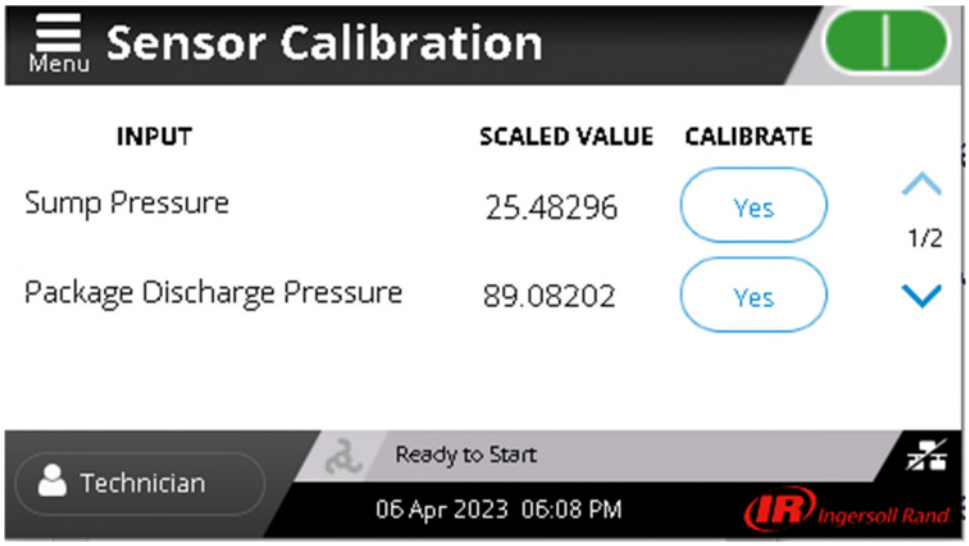

Figure 4.2.3: Calibration Settings

4.2.4. Programmable I/O Settings

Name: Programmable IO

Location: Settings>Programmable IO

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Digital inputs	Configure available digital inputs: Remote Load Enable, Remote Load, Remote Start, Remote Stop, Phase Monitor Trip, Auxiliary 1 and 2	R	RW
Digital outputs	Configure available digital outputs for warning and trip indication	R	RW
Temperature inputs	No configuration (disabled)	R	RW
Analog inputs	Configure sequencer system pressure	R	RW
Analog outputs	No configuration (disabled)	R	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Depending on application, some features may not be available

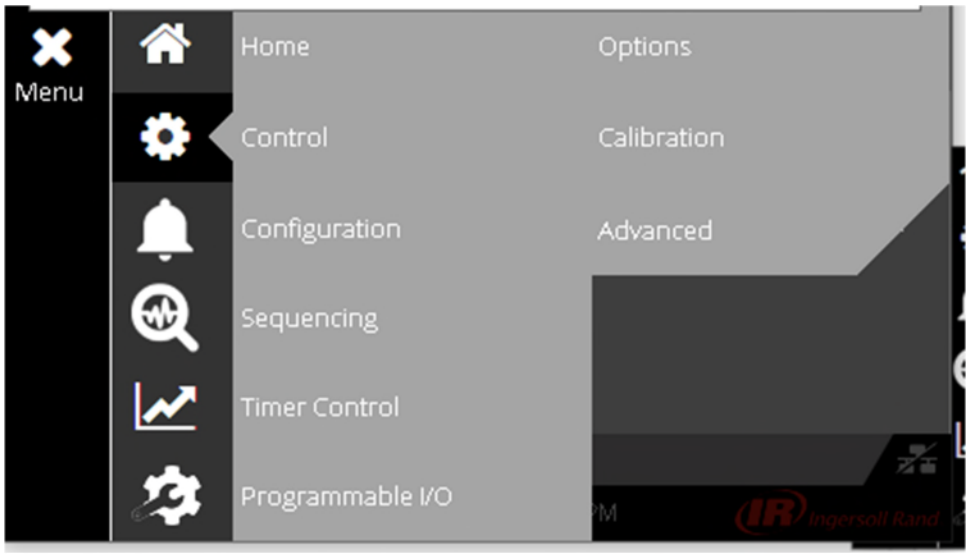

Figure 4.2.4: Programmable IO

4.2.5. Timer Control (Scheduled Start/Stop & Press Band p2)

Name: Timer Control

Location: Settings>Timer Control

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Date and Time	Link to the date and time described in a previous section. This link is a short-cut	R	RW
Timer Start/Stop Configuration Button	Navigate to Timer Start/Stop screen	R	RW
Press Band p2 Configuration Button	Navigate to Press Band P2 screen	R	RW

Timer Start/Stop or Press Band p2	Description	User Rights	Maintenance Rights
Set Channel 1 (On/Off)	Select to edit and enable/disable schedule 1	R	RW
Set Channel 2 (On/Off)	Select to edit and enable/disable schedule 2	R	RW
Set Channel 3 (On/Off)	Select to edit and enable/disable schedule 3	R	RW
Set Channel 4 (On/Off)	Select to edit and enable/disable schedule 4	R	RW
Set Channel 5 (On/Off)	Select to edit and enable/disable schedule 5	R	RW
Set Channel 6 (On/Off)	Select to edit and enable/disable schedule 6	R	RW
Set Channel 7 (On/Off)	Select to edit and enable/disable schedule 7	R	RW
Set Channel 8 (On/Off)	Select to edit and enable/disable schedule 9	R	R

Channel Settings	Description	User Rights	Maintenance Rights
Start Hour	Select and enter the hour to start the compressor (24hr clock, 0-23hr)	R	RW
Start Minutes	Select and enter the minutes to start the compressor (0-59min)	R	RW
Stop Hour	Select and enter the hour to stop the compressor (24hr clock, 0-24hr)	R	RW
Stop Minute	Select and enter the minutes to stop the compressor (0-59min)	R	RW

Day of the Week	Enable/disable desired active day of the week	R	RW
Delete Channel	Delete schedule	R	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write, PORO/SS = Power Outage Restart Option / Scheduled Start-Stop

Notes:

Scheduled Start-Stop and Press Band p2 share similar screens, settings, and work in the same fashion. Configuration allows for either or both features to be active at any given time. Timer Control (Scheduled Start-Stop) is only available if PORO/SS options are enabled (refer to previous section). Any channels with overlapping time will be considered one continuous timer value.

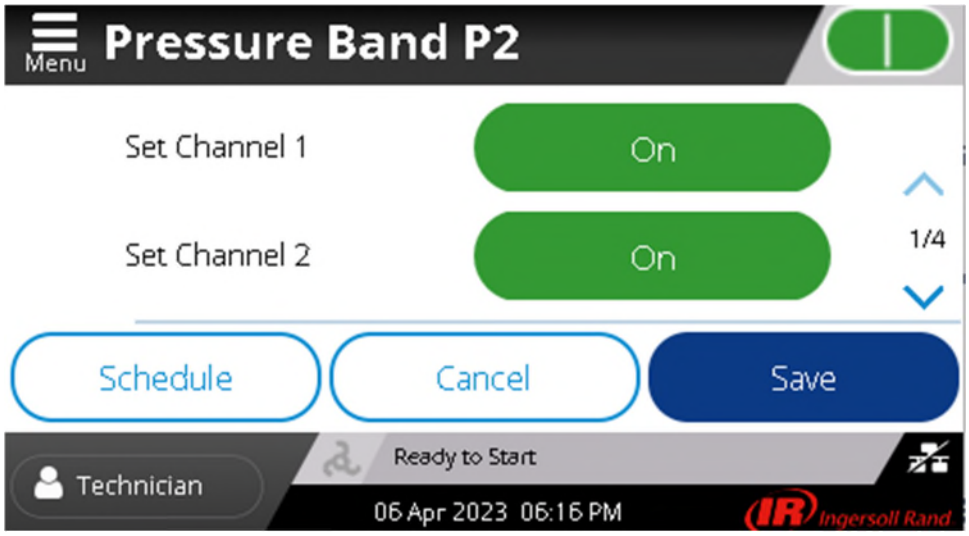

Figure 4.2.5-A: Configuration

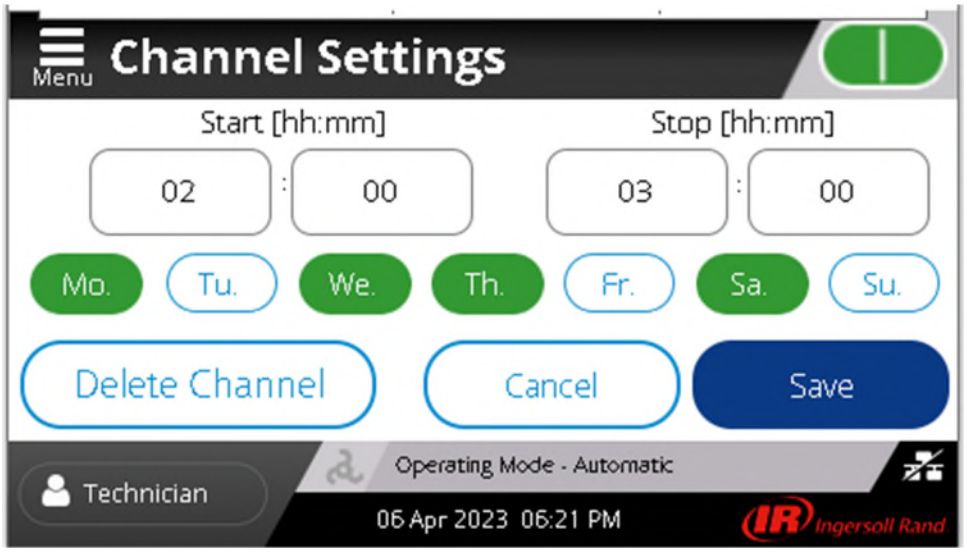

Figure 4.2.5-B: Channel Settings

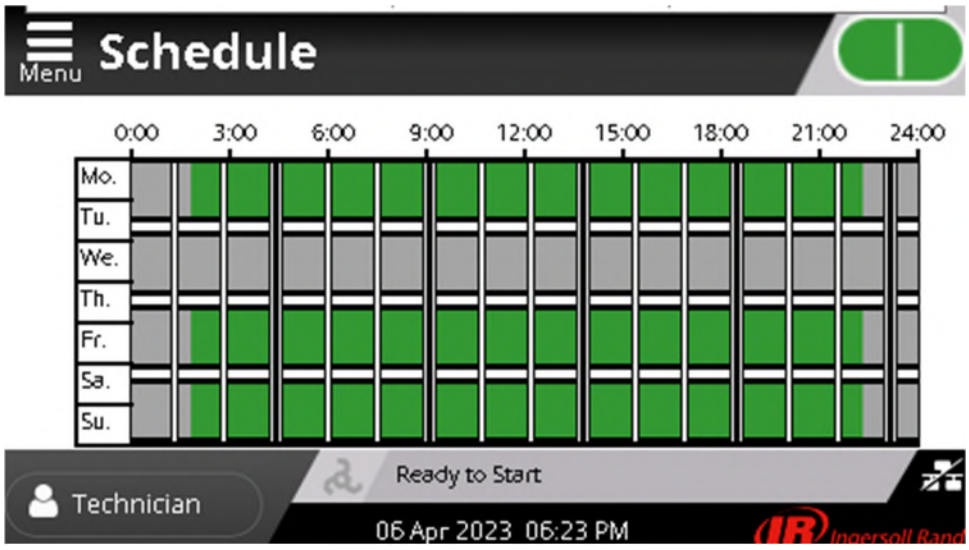

Figure 4.2.5-C: Schedule Overview

5. Viewing Data

Operating the compressor can seem overwhelming or too complicated due to the many features, settings, and options that can be incorporated into it. Proper organization and presentation of data reduces the complexity associated with operating the compressor, and makes navigating the controller more intuitive.

The controller was designed with users in mind by providing accessible and relative screens that present operational data in an informative and useful way. Innovative, yet practical methods of visualizing real time data, as well as clear, concise indication of critical issues or problems provides users and maintenance personnel the tools they need to effectively manage these complex assets.

This section provides instruction on what, where and how to edit those screens that present and track operating data.

3.1. Home Screen Editing

Name: Edit Metric

Location: Home

Available Fields:

Selection Name	Description	User Rights	Maintenance Rights
Edit Icon (located on tile)	Press this icon to navigate to the Edit Metric screen for editing the tile. Each tile has an individual edit icon.	H	RW
List of Available Parameters	Select one parameter from the list to be displayed on the tile	H	RW
Save and Cancel	Press one of these buttons to either save the edit or revert to the previous selection	H	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

List of available parameters will vary depending on application and instruments included. Parameters with warning or trip limits will also include a bar graph and change color if one or more limits are exceeded. Discharge Pressure will also display setpoints.

Figure 5.1-A: Home Screen

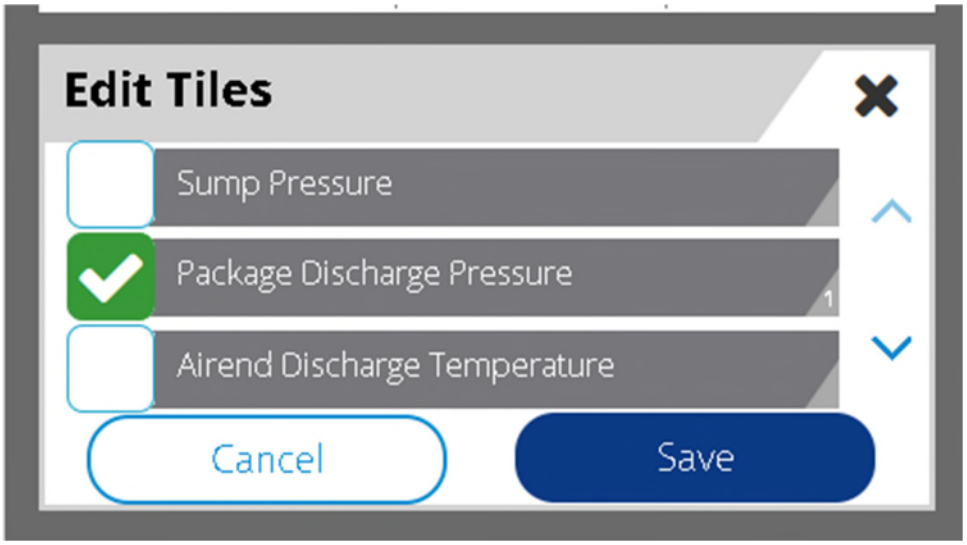

Figure 5.1-B: Edit Tiles Screen

3.2. Trends Screen Editing

Name: Trends

Location: Trends (Main Menu Item)

Available Fields:

Main Trend View Setting	Description	User Rights	Maintenance Rights
Left Y-Axis Drop Down	Drop down box providing access to the available selection of parameters to chart	RW	RW
Right Y-Axis Drop Down	Drop down box providing access to the available selection of parameters to chart	RW	RW
Graph Setup	Press this button to access and edit parameters that control presentation of data in the chart	RW	RW
Return to Current	Press this button to return the chart to its original date/time and scaling settings	RW	RW
Arrow Keys <<, <, >, >>	Press these keys to move the value cursor forward or reverse in time	RW	RW

Graph Setup View	Description	User Rights	Maintenance Rights
Left Y-Axis Upper Limit	Drop down box providing access to the available selection of parameters to chart. No restriction to limit value	RW	RW
Left Y-Axis Lower Limit	Drop down box providing access to the available selection of parameters to chart. No restriction to limit value	RW	RW
Right Y-Axis Upper Limit	Drop down box providing access to the available selection of parameters to chart. No restriction to limit value	RW	RW
Right Y-Axis Lower Limit	Drop down box providing access to the available selection of parameters to chart. No restriction to limit value	RW	RW
Date/Time (with Edit)	Current start date for chart. Press Edit button to modify start date	RW	RW
Time Span	Total chart length (time) for display on screen. Available times: Default is 300 sec (5 min), 1 hr, 3 hrs, 6 hrs, 12 hrs	RW	RW
Save and Cancel	Save chart or cancel and return to the previous screen	RW	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Only those parameters installed and made available for trending are shown in the drop down boxes. A maximum 30 days of data is stored on the controller.

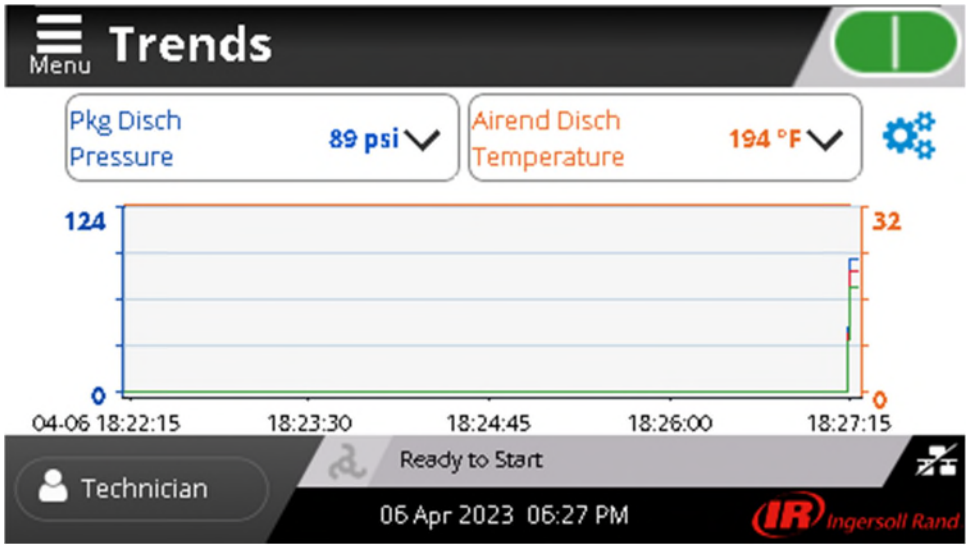

Figure 5.2-A: Trend View

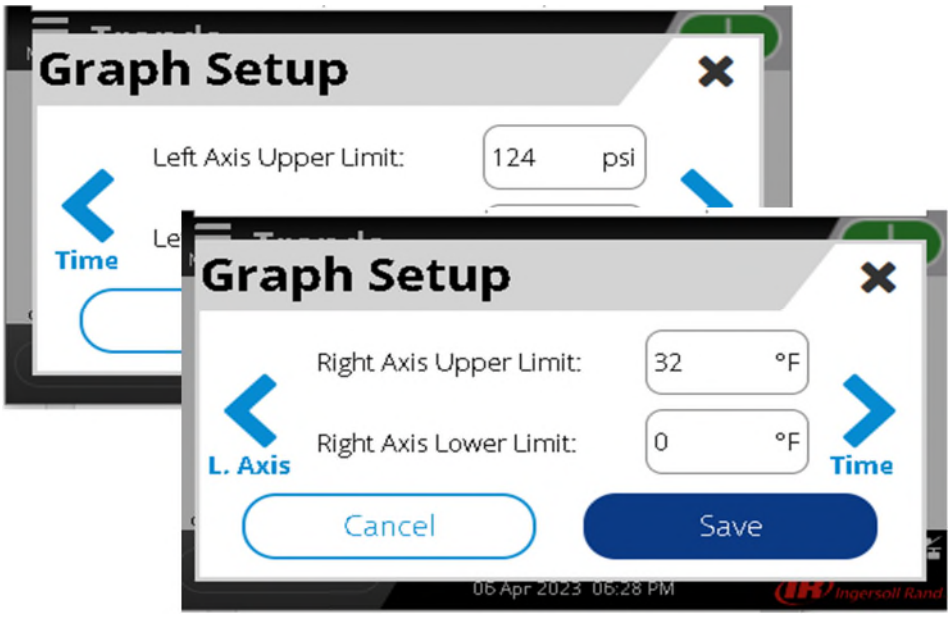

Figure 5.2-B: Graph Setup

3.3. List View Editing

Name: List View Edit

Location: Home

Available Fields:

Setting Name	Description	User Rights	Maintenance Rights
Edit Custom List	Press this button while in Custom List View to navigate to the Customized List editing screen	H	RW
Snapshot	Press this button to take and store snapshot of the current list readings	RW	RW
Custom List Navigation Arrows	Scroll through and select the parameters to display in the custom list view	H	RW
Custom List Selection Arrows	Use these arrows to add to or remove parameters from custom list view	H	RW
Sort Arrows for Selected List	Use the sort arrows in the selected parameters list to organize the list as desired	H	RW
Save and Cancel	Select Save to save the new list or Cancel to revert back to the previous list	H	RW

Legend:

H = Hidden, R = Read Only, RW = Read Write

Notes:

Only those parameters installed and available for list view will be displayed in the custom list.

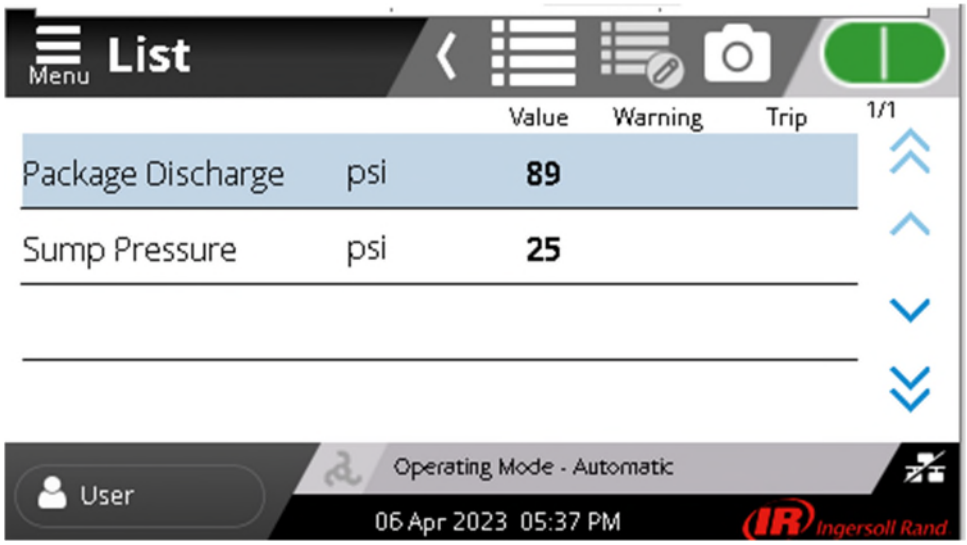

Figure 5.3-A: Custom List View

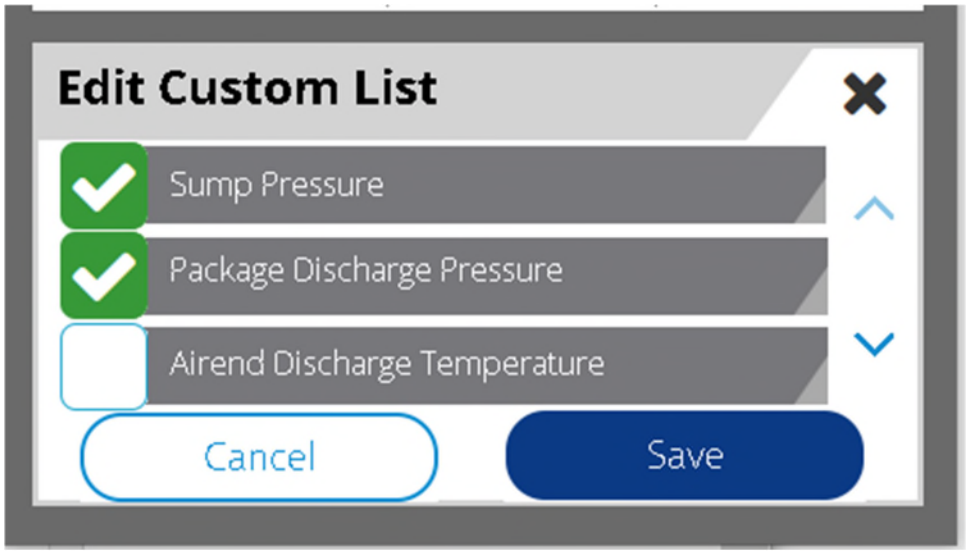

Figure 5.3-B: Edit Custom List

3.4. Service Dashboard

In addition to the Home and Trends screens, the Service Dashboard provides users and maintenance personnel information on the remaining life of the various filters and coolant installed on the compressor (consumables). With this information, maintenance can be scheduled in advance, minimizing unexpected downtime and costly repairs.

The “Service Dashboard” is visible to all users, although editing and resetting service alerts are hidden to the user and maintenance permission class. Within the dashboard, each consumable item is shown as a horizontal bar graph depicting the life and any associated limits.

Additionally, service counters are provided to track the life cycle of components that may have a definitive life span. Limits are applied to these components as well to inform users when components become aged and may begin experiencing failure.

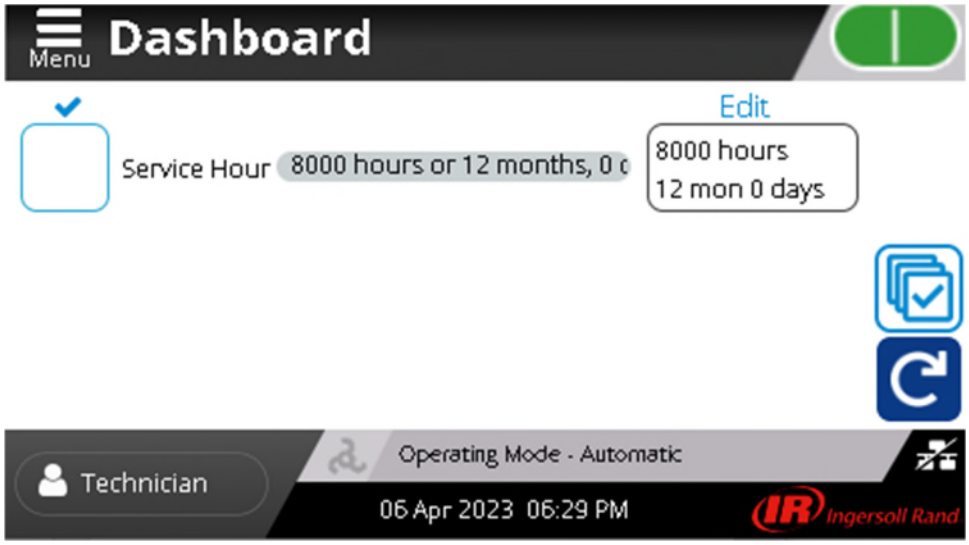

Figure 5.4-A: Service Dashboard

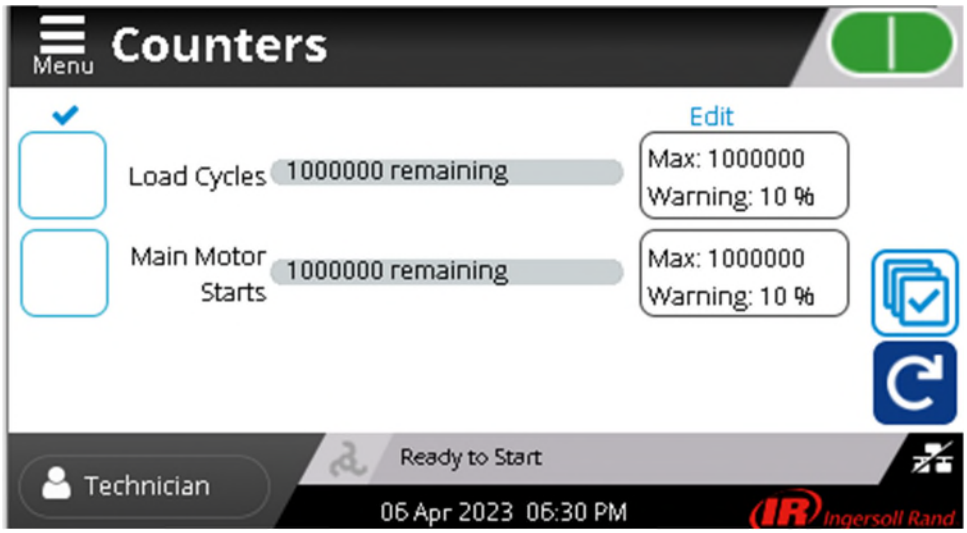

Figure 5.4-B: Counters Dashboard

3.5. Web Interface

The Web Interface serves as a portal or remote user interface option for users looking to gain access to the compressor from an office desktop or off-site location. Using the Ethernet connection explained earlier, the web interface relies on those configuration settings for connectivity. Refer to the subsequent section for more details.

Connecting to and accessing the Web Interface has been configured to use the same login ID's and permissions as logging into the local UI. User creation or password modification is not available through this remote connection.

Remote commands, such as starting, stopping, loading and unloading, are available through the Web Interface, However the user must have the correct level of permission and the compressor controller must be enabled for control over communication. Failure to meet any of these requirements will cause the controller to ignore a remote command.

Although the Web Interface may appear graphically different, it displays much of the same information as the local UI. It provides consistent and standardized navigation, and adheres to the same rules as implemented in the local UI. Web-based functionality is also similar or enhanced. Users with a maintenance or high class have the ability to download logs and operating data through the Web Interface.

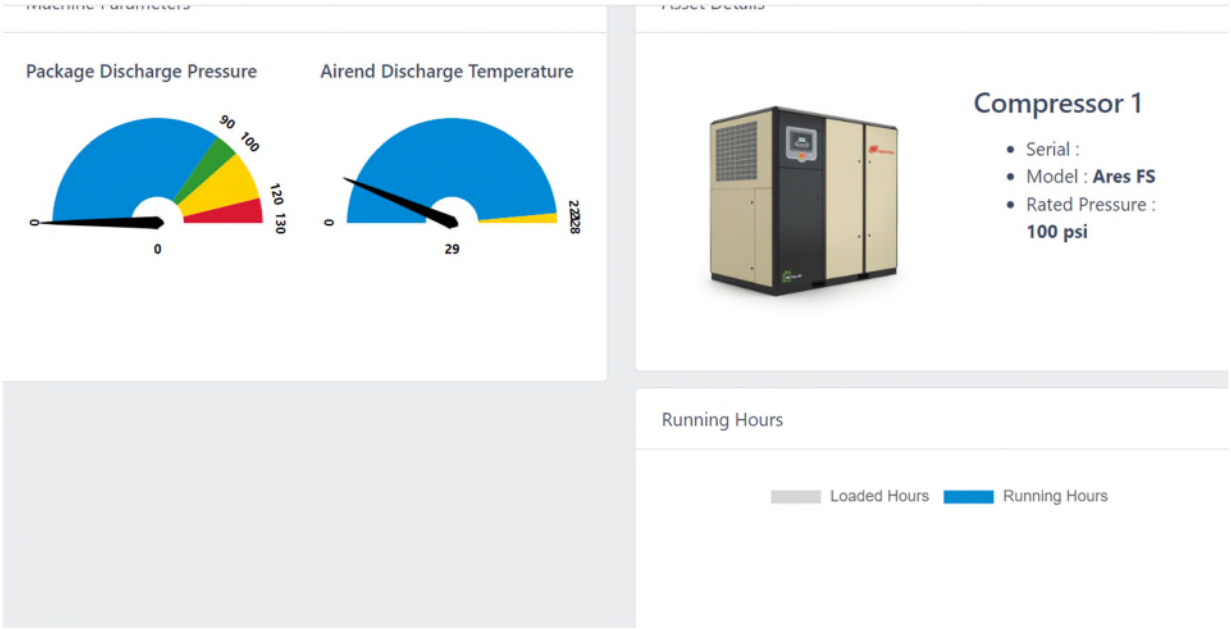

Figure 5.5-A: Main Compressor Dashboard

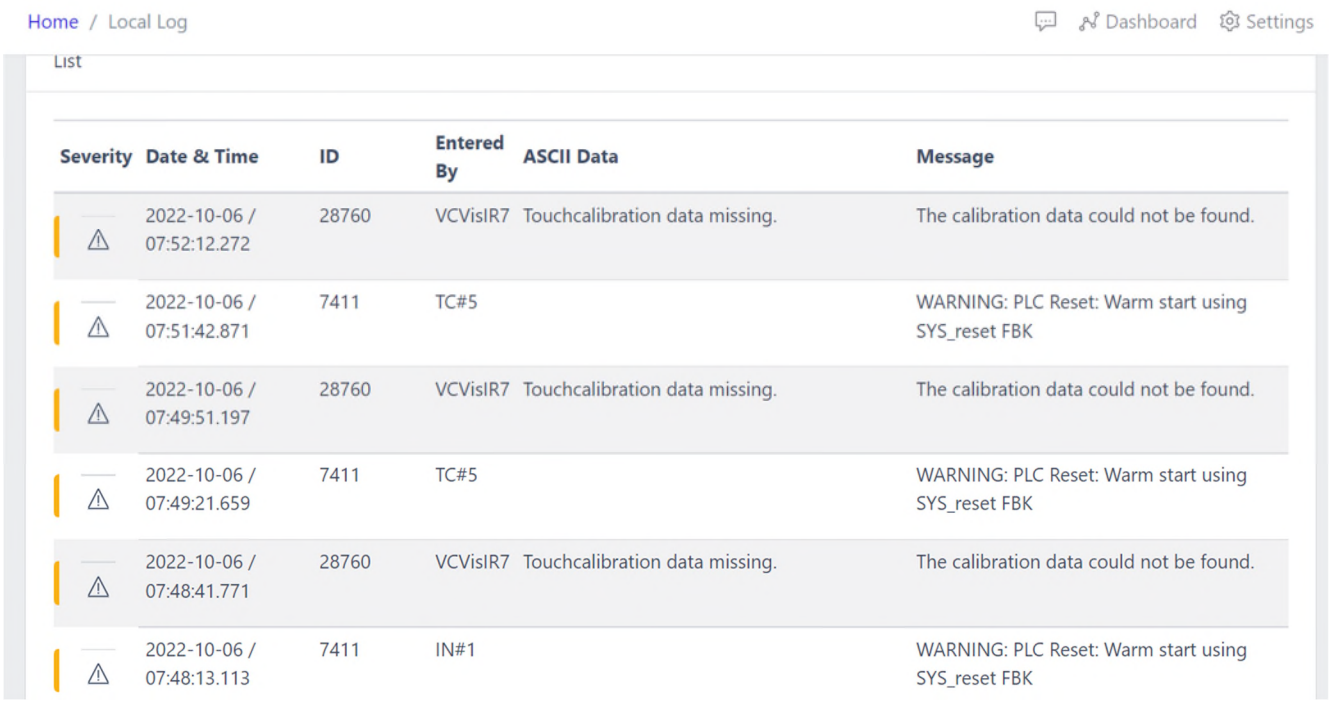

Figure 5.5-B: List View

6. Diagnostics

Diagnostics are a critical component of any reliable control system. The control system incorporates several methods of providing diagnostic information, including the local UI, web interface, and those covered by the installed IoT system.

This section focuses on the overview of the systems that make up the diagnostic suite.

3.1. Local UI Diagnostic

Diagnostic information located on the local control system offer the advantage of providing important detail and insight at the source, and with little delay. The diagnostic screens provided by the control system are organized and grouped into relative functions or duties. Note that only instrumentation installed and available on the control system will be shown in the screens.

Diagnostics have been provided for virtually all components controlled or monitored by the control system. Screenshots displayed below are s of way this data has been organized. Other components covered by some form of diagnostics include:

- General Information - Hours, Unit S/N and M/N, software and hardware versions, memory allocation, software, and firmware updates,
- Log Data - Audit, Event, Data Record, Trip Analysis, etc.,
- Communication and icon - Errors, Time Analysis, Versioning, etc.,
- Remote Control - All aspects of remote control and commands,
- Others depending on application (VSD).

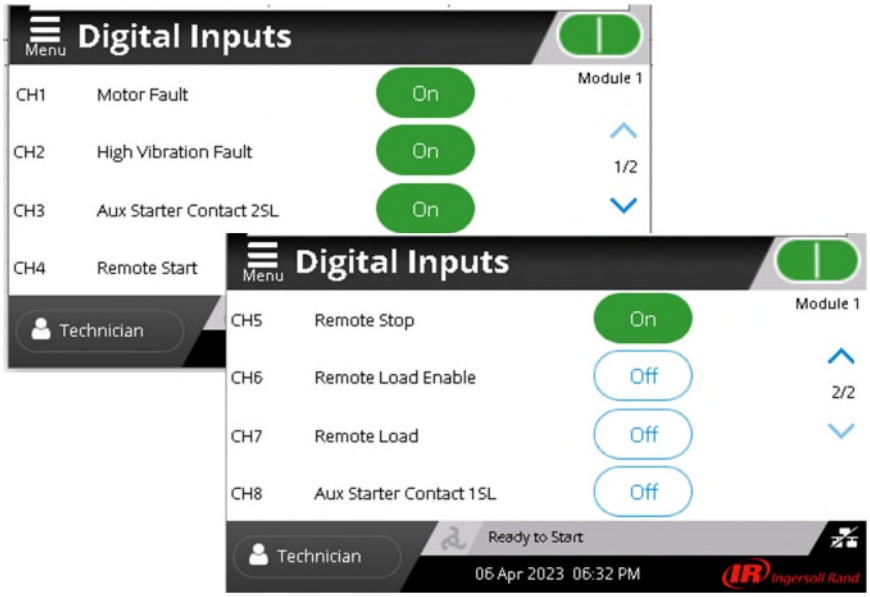

Figure 6.1-A: Local Diagnostic Screens

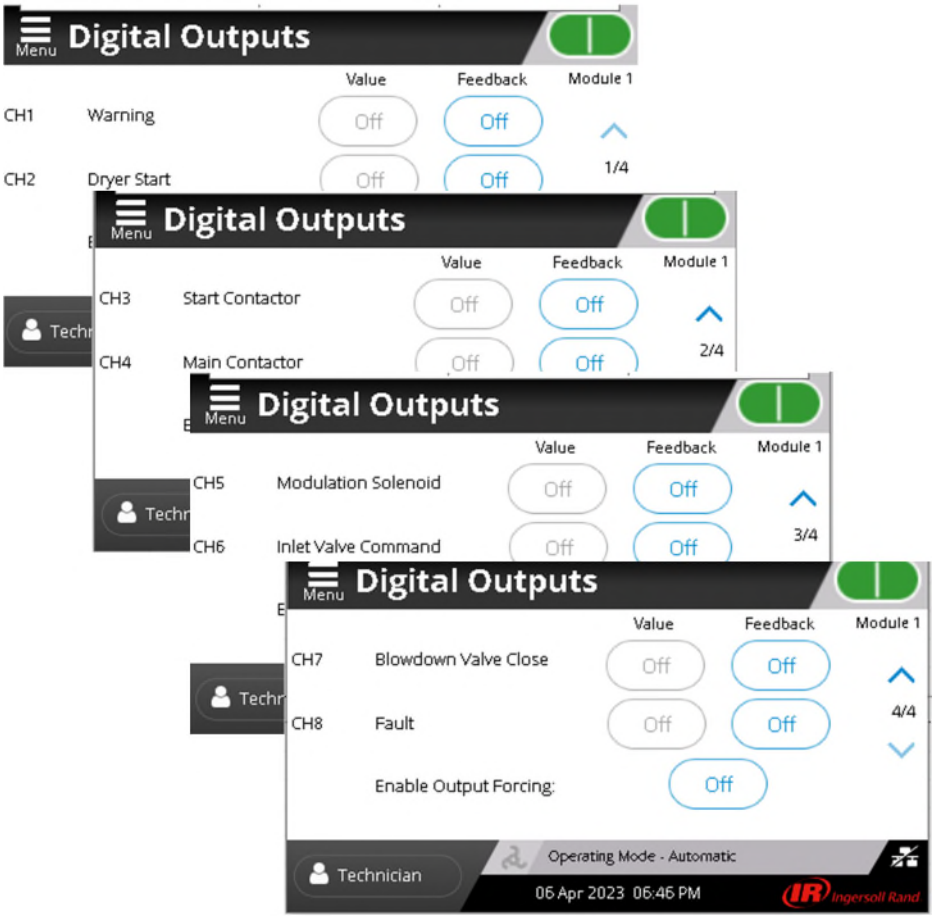

Figure 6.1-B: Local Diagnostic Screens

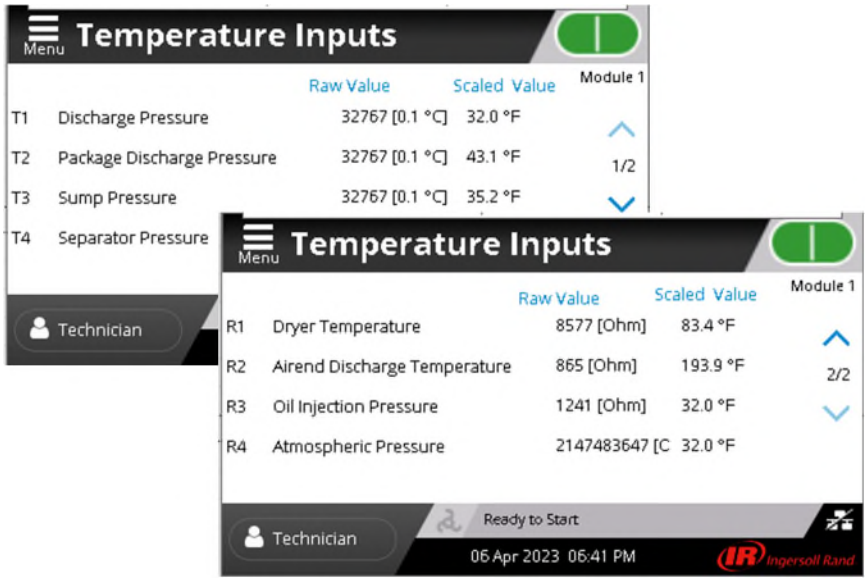

Figure 6.1-C: Local Diagnostic Screens

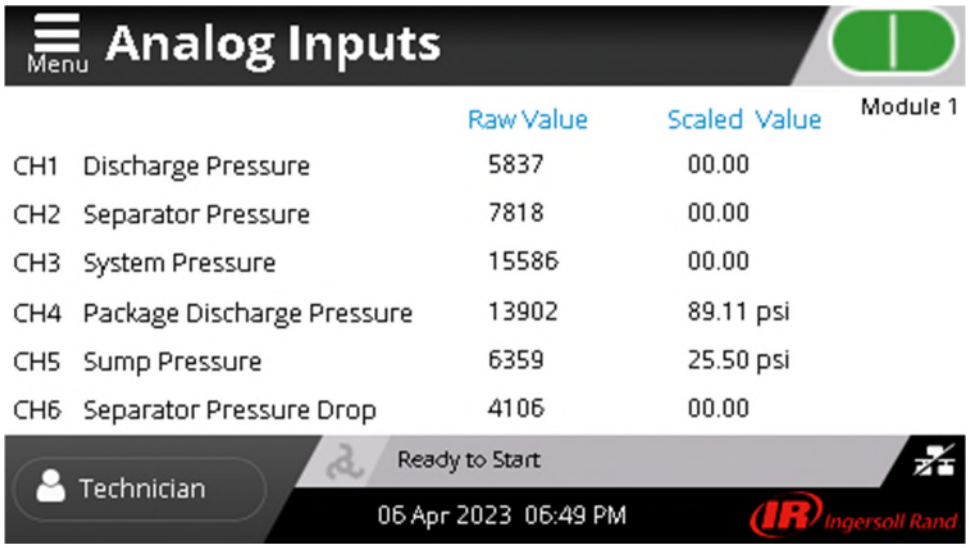

Figure 6.1-D: Local Diagnostic Screens

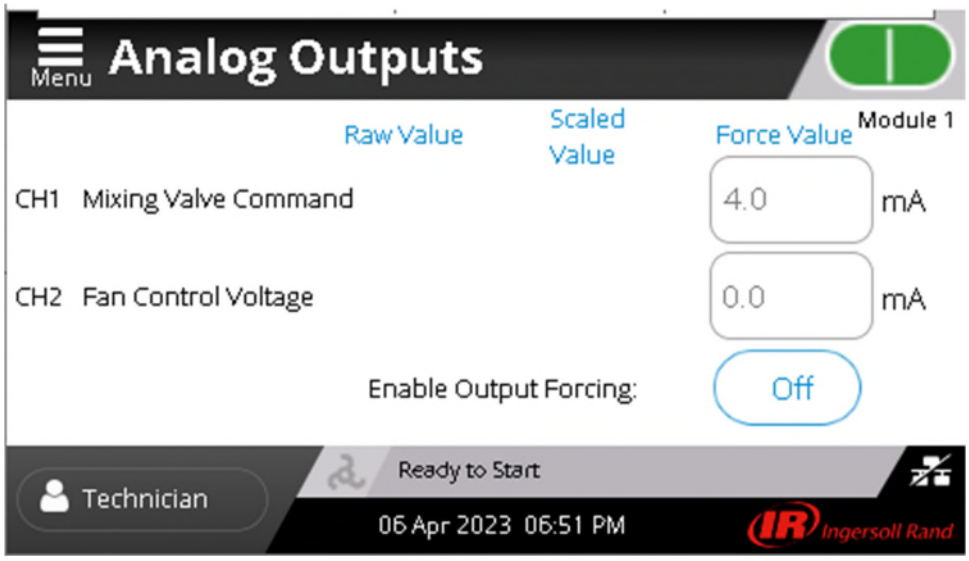

Figure 6.1-E: Local Diagnostic Screens

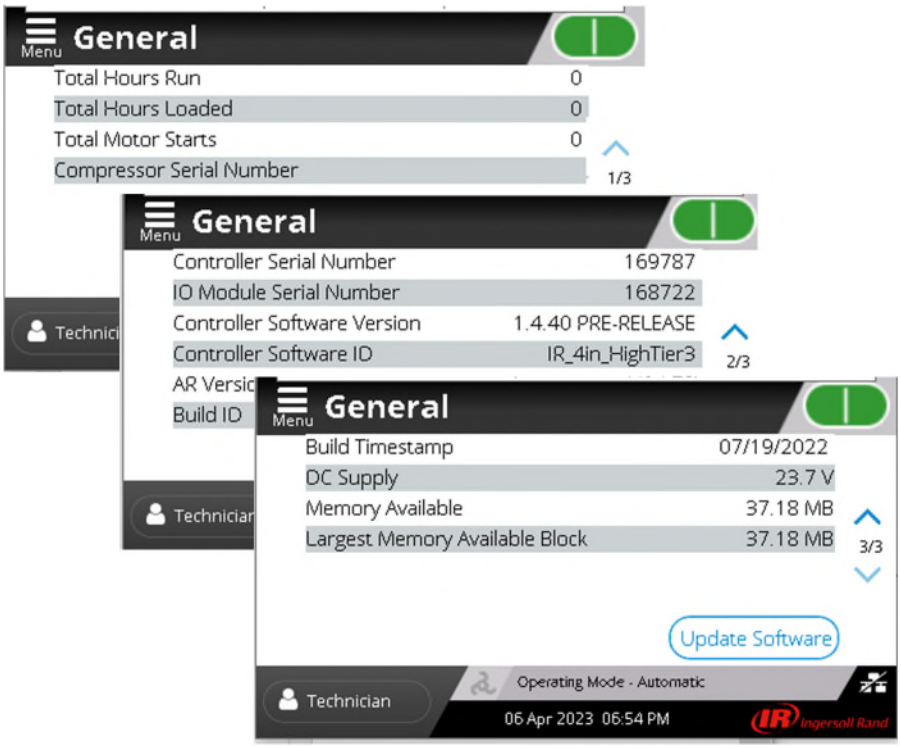

Figure 6.1-F: General Diagnostic Screens

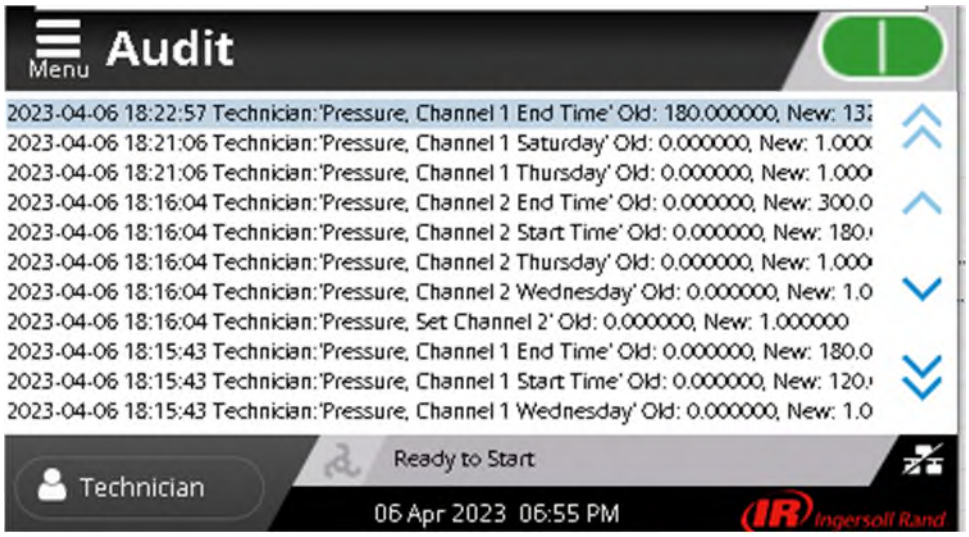

Figure 6.1-G: Audit Diagnostic Screens

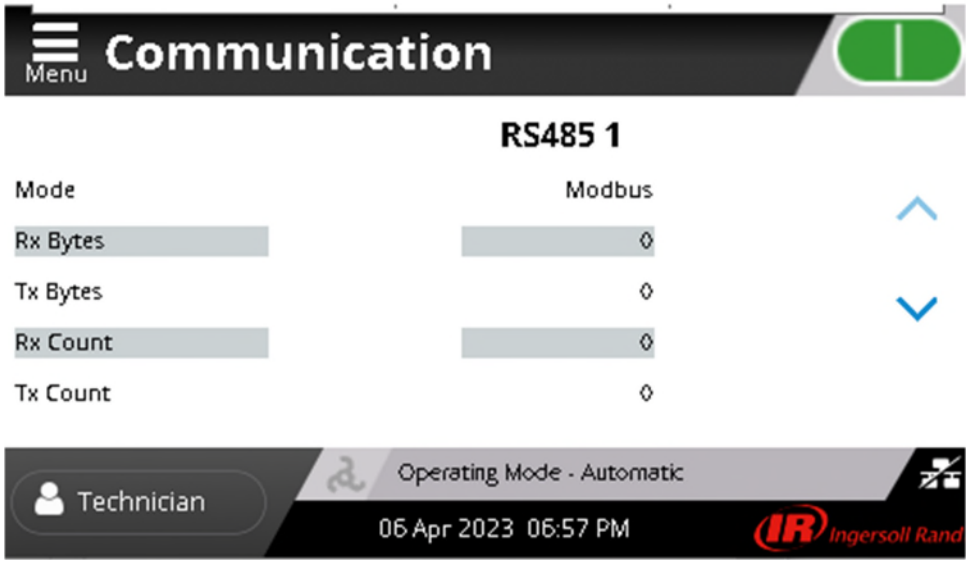

Figure 6.1-H: Communication Diagnostic Screens

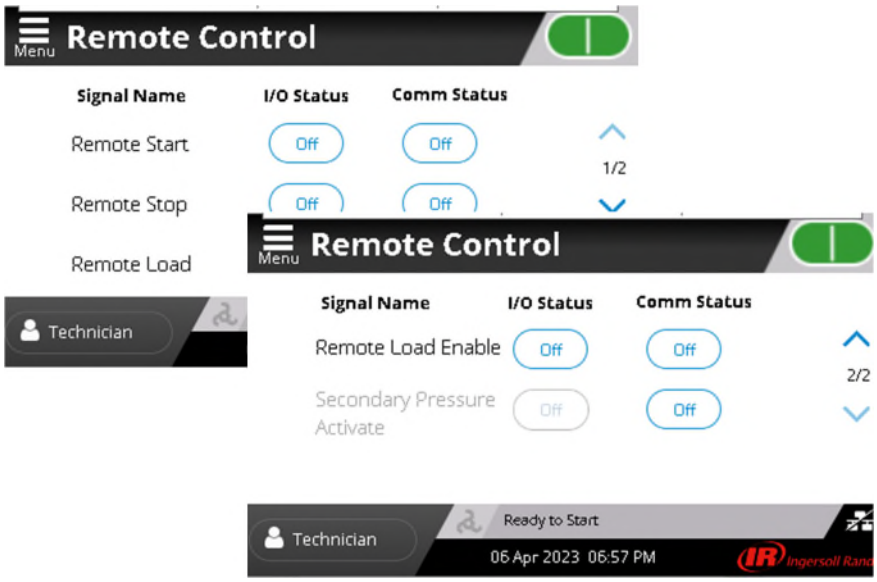

Figure 6.1-I: Remote Commands Diagnostic Screens

7. Integrated System Control

"Integrated System Control" is incorporated in every controller. It has the ability to connect and integrate multiple compressors as one system, providing shared load, sequencing and capacitance to help ensure consistent air production for processes and production in the plant. The following provides an overview of the integrated system controls currently implemented within each controller.

3.1. AirSmart Sequence Control

AirSmart sequence control was first introduced in Gardner Denver compressor and blower applications. It has been adopted into the Ingersoll Rand Sequence control feature to establish the compatibility between product brands for the common feature called "Integrated System Control". The features include:

- Setup, Port Configuration,
- Setup, Pressure sensor for leading machines,
- Setup, Sequencing Configuration:
  - Unit Number,
  - Fault Action,
  - Capacity,
  - Transfer Interval,
  - Transfer Load Decrement,
  - Transfer Load Increment,
  - Hour Offset.
- Operation:
  - Startup,
  - Lead Transfer,
  - Pressure Control.

7.1.1. Setup, Port Configuration

Prior to any AirSmart configuration, it is necessary to set up a serial port as an "AirSmart Port".

Figure 7.1.1 Configuration > Communication

7.1.2. Setup, Pressure sensor for leading machines

For a compressor intended to act as a lead machine, it will be necessary to install and configure the “Sequence System Pressure” sensor. This sensor takes the place of the Remote sensor input.

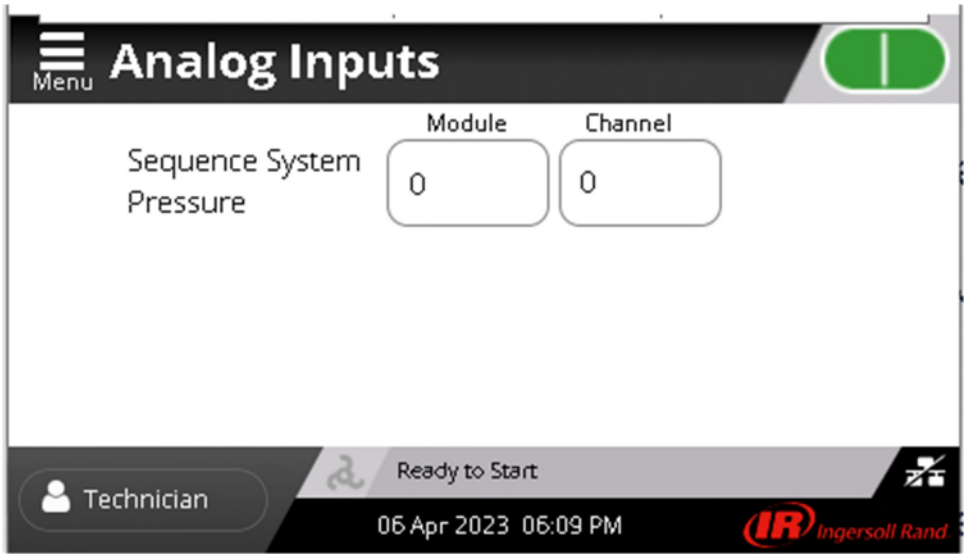

Figure 7.1.2 Settings > Programmable IO

7.1.3. Setup, Sequencing Configuration

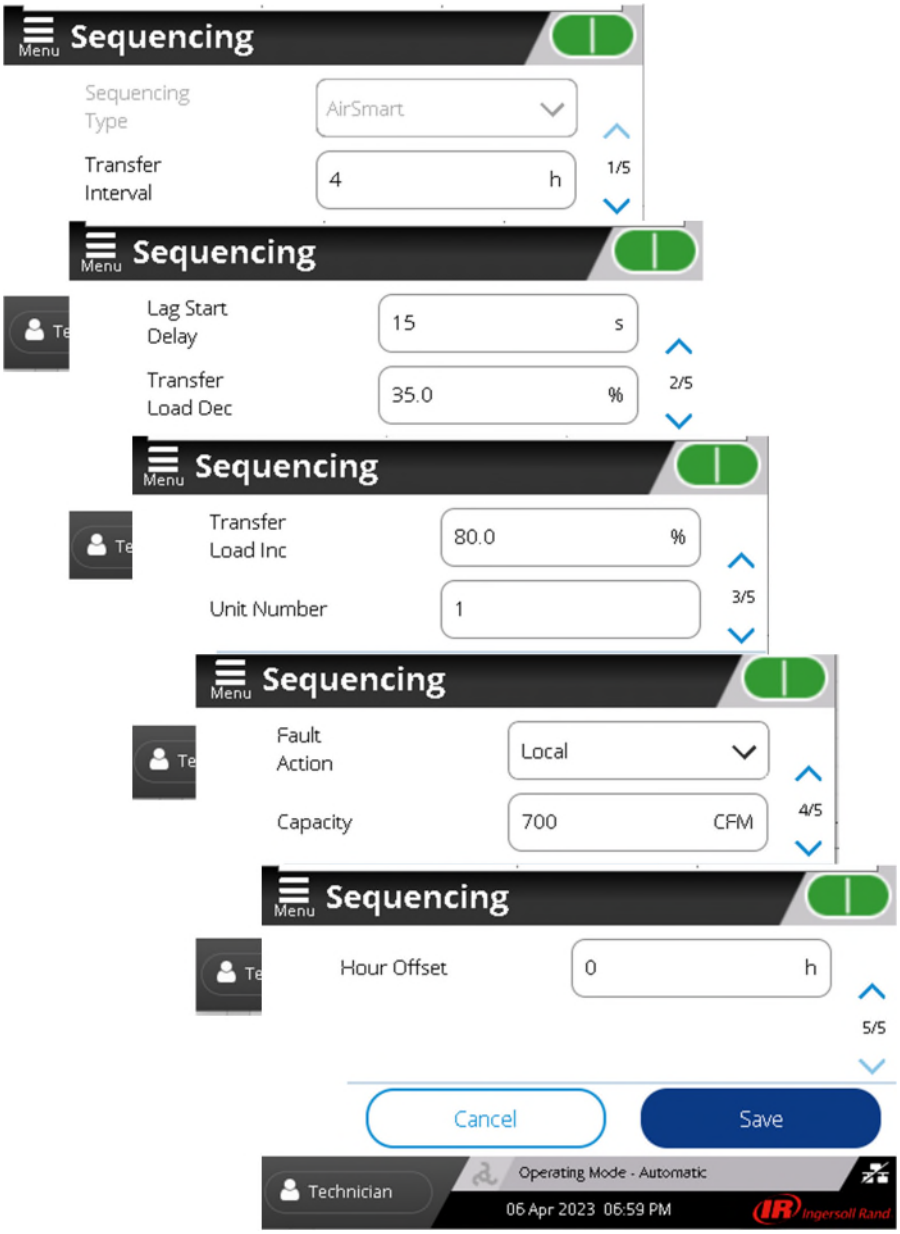

Figure 7.1.3: Settings > Sequencing

7.1.3.1. Unit Number

The “Unit Number” defines the address on the AirSmart network, which this compressor might be using. Each machine needs a unique address and if more than one machine is assigned the same Unit number, operation of sequence control will not operate as described. However, each node will follow all of its local safety overrides for any type of system control. For multiple lead systems, the highest priority lead will be the machine with the lowest address when the system is started.

- Min Value: 1
- Max Value: 8
- Default Value: 1.

7.1.3.2. Fault Action

The “Fault Action” defines the action, which a server unit should take when sequence communication is lost (either there is no client unit available or there is a fault in the network communications). If set to LOCAL, then revert the unit to local control as if operating in AUTOMATIC mode. If set to WAIT, then do not allow the unit to run until a client becomes available, and report an event when there is no client in control after a client has taken control of the machine.

- Range: Local, Wait
- Default Value: Local.

7.1.3.3. Capacity

The “Capacity” is the maximum air flow that a unit can produce, expressed in CFM. This value is compared with other units in the sequencing group. The machine with the largest capacity in the sequencing group will be the client.

- Min Value: 0 CFM
- Max Value: 10000 CFM
- Default Value: 700 CFM.

7.1.3.4. Transfer Interval

“Transfer Interval” controls how often the group Lead is transferred to a dormant machine during periods of low demand. This parameter is referenced to the total hours’ value. It is critical for all lead candidates in a network to have the same value if the goal is to balance usage among machines.

- Min Value: 1 Hours
- Max Value: 1000 Hours
- Default Value: 4 Hours.

7.1.3.5. Transfer Load Decrement

The Transfer Load Decrement value controls the load level the group must reach before unloading a compressor or blower during periods of decreasing demand.

- Min Value: 0%
- Max Value: 80%
- Default Value: 35% (variable speed compressor), 40% (variable speed blower), 100% (fixed speed compressor or blower).

7.1.3.6. Transfer Load Increment

The next Transfer Load Increment value controls the load level the group must reach before loading a compressor or blower during periods of increasing demand.

- Min Value: 0%
- Max Value: 100%
- Default Value: 80% (variable speed compressor or blower),100% (fixed speed compressor or blower).

7.1.3.7. Hour Offset

The Hour Offset is added to the “Total Hours” and allows two machines with large differences in “Total Hour” values to transfer the sequence lead using the “Transfer Interval Timer”.

- Min Value: 0 Hours
- Max Value: 1000000 Hours
- Default Value: 0 Hours.

7.1.4. Operation

To use sequencing once it has been configured, the user should set the operating mode (under the Settings/Control display) to “Sequencing” to work with any sequence control operation. Under Sequence control, the following features are disabled to prevent conflicts with Sequence control:

- Modbus host-control commands (start, stop, load and unload),
- Remote load/unload inputs,
- Inlet valve modulation,
- Remote pressure control.

Machines in a Trip state shall drop out of Sequence control until the trip condition(s) are cleared and the machine is restarted.

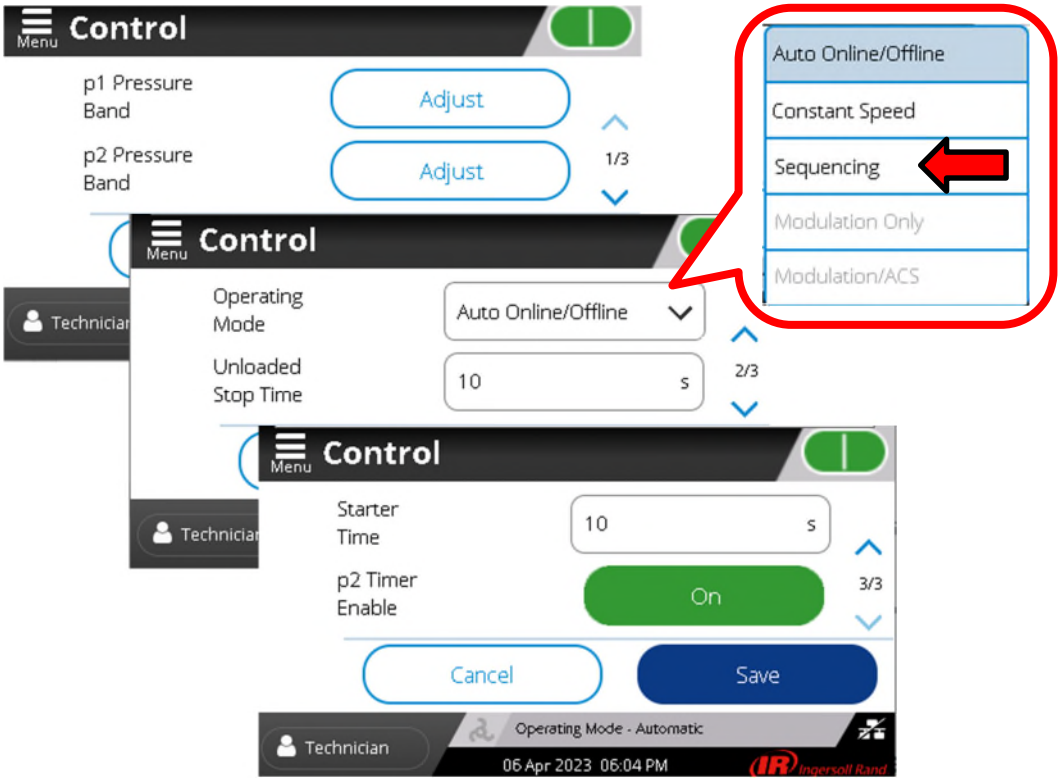

Figure 7.1.4: Settings > Control

7.1.4.1. Startup

Upon network startup, the AirSmart lead with the following parameters shall start as the lead unit:

- The largest capacity unit shall be lead.
- If the units are of equal capacity, the unit with the lowest value of “Total Hours + hour offset” shall be the lead.
- If units have the same capacity and the same amount of run time, then the unit with the lowest unit number shall be lead.

7.1.4.2. Lead Transfer

When a lead-capable unit’s transfer interval expires, it shall attempt a coup, where it tries to become the new lead. Once a new lead is established, no other lead candidate shall attempt a coup until its transfer interval has expired.

7.1.4.3. Pressure Control

The system control pressure band is determined by the current lead machine’s local pressure band configuration.

When the current lead’s system control pressure is less than the load point of the current pressure band, the lead shall attempt to load one unit every lag start delay time until system pressure is inside the current pressure control band. Units will be loaded in order 1 to 8, skipping IDs that are not under sequence control (not preset, faulted, or simply not configured under system control).

When the current lead’s system control pressure is greater than the lead’s unload point of the current pressure band, the client shall attempt to unload one unit every Lag Start Delay Time until system pressure is inside the current pressure control band. Units will be unloaded in order 8 to 1, skipping IDs that are not under sequence control (not preset, faulted, or simply not configured under system control).

A unit will respond to a forced unload condition. For an IR branded compressor other than the Frame 2 L-Series models, the forced unload condition coincides with that for the high discharge pressure warning. When a forced unload happens, the following will occur:

- A warning shall be reported. For an IR branded compressor other than the Frame 2 L-Series models, this will be the high discharge pressure warning.
- A unit that has experienced a forced unload shall not be allowed to re-load until its local pressure falls below its reset pressure. For an IR branded compressor other than the Frame 2 L-Series models, the reset pressure is equal to the rated (design) pressure.
- Lead control is turned off (if the unit is lead capable). This means if the unit is the AirSmart lead at the time, it shall drop out of client control and another unit may take over as client.

A lead unit running alone on the network (no other lag compressors communicating) will load and unload itself according to its pressure settings, so it may not experience a situation where its delivery pressure can exceed the adjusted design pressure. As such, the above conditions may not apply to a machine running in this way.

Any unit under sequence control that is not lead capable shall operate as defined by the setting in Fault Action setting after 16 seconds of

communication loss.

3.2. Delcos Sequencing

Delcos must be set up as either a lead using “client enable”, or the “Unit Number” must be configured with a value between 1 and 12. Note that a compressor controller client is limited to controlling only units 1 to 4, while an external sequencer called “Connect 12” may control up to 12 units. Only one Delcos lead should be configured on a network.

- Setup>Port Configuration
- Setup>Pressure Sensor for Lead Machine
- Setup>Sequencing Configuration
- Operation
- Diagnostics

7.2.1. Setup, Port Configuration

Prior to any Delcos configuration, it shall be necessary to set up a serial port as a “Sequence-Delcos Port” by selecting “Delcos” in the Mode drop-down list. Note that the “Baud Rate” should be set to 9600 for use with Delcos.

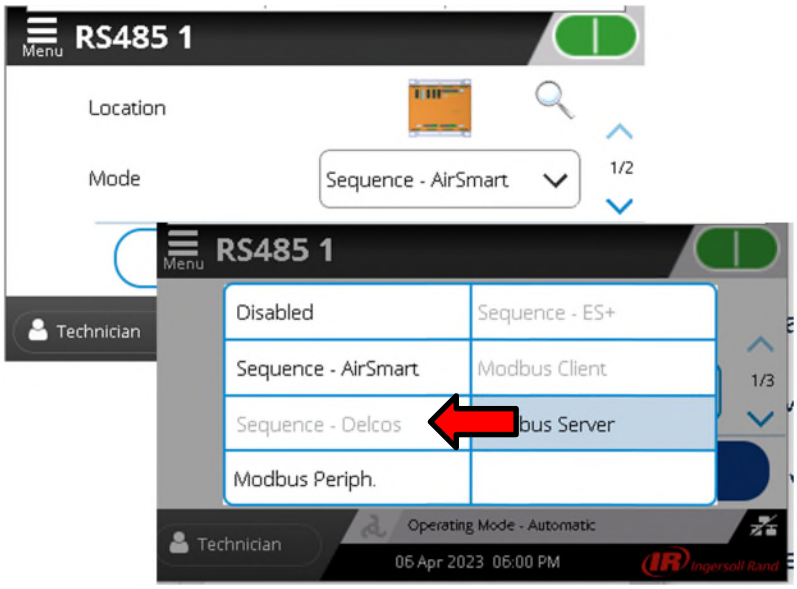

Figure 7.2.1: Configuration > Communication

7.2.2. Setup, Pressure sensor for lead machine

For a compressor intended to act as a lead machine, it will be necessary to install and configure the sequence system pressure sensor. This sensor takes the place of the remote sensor input.

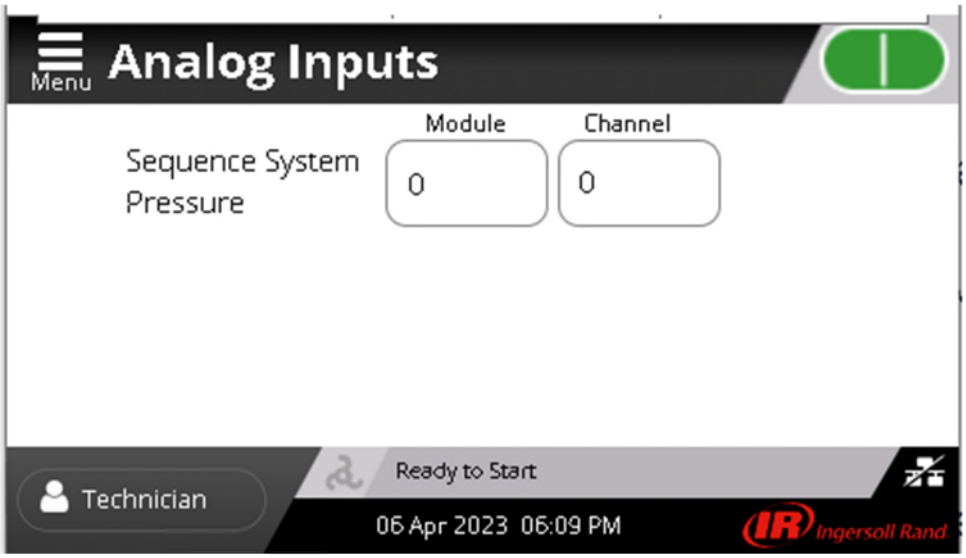

Figure 7.2.2: Settings > Programmable IO

7.2.3. Setup, Sequencing Configuration

Setting	Minimum Value	Maximum Value	Default Value	Description
Client Enable	Off	On	Off	Designates which machine in the sequenced network is the client. Only a single machine in the network can have client enable turned 'ON'. Client enable must also set to 'OFF' for sequencing with a connect 12.
Unit Number	1	12	1	Number between one and four assigned to each machine in sequence. Two machines cannot share the same unit number.
Number of Servers	0	3	0	Number of machines in the sequenced group behind the client.
Lag Start Delay	5 seconds	60 seconds	15 seconds	The lag start delay sets the amount of time client will wait before asking another machine to come online.
Load Net In	1 minute	60 minutes	15 minutes	This value sets the amount of time required to increase network pressure to target pressure from when sequencing is activated. Shorter values will switch on more compressors at startup. When sequencing is activated, the compressed air network is filled in the time set and only the number of compressors required to fill the compressed air network in this time are switched 'ON'.
Network Size	2%	100%	5%	Network size is used to calculate how many compressors to switch 'ON' or 'OFF' to meet the changes in demand. This value should only be changed if there are significant fluctuations in the compressed air requirements. Formula to calculate: a = (100 x b) / c where a = network size (%), b = network volume size (size of closest receivingtank, ignore size of pipework and other air tanks), c = total delivery volume of network.
Transfer Interval	0 h	1000 h	24 hours	The transfer interval controls how frequently the sequence is redefined based on the hours run (BLS) setting of the compressor.

7.2.4. Operation

Delcos sequencing systems use as a dedicated client running in the sequencing operating mode. Up to three servers can be connected to the client via a serial connection and should be of the same type of machine (either all fixed speed or all variable speed) and relatively the same capacity.

Delcos sequencing has the following two functions:

1) A central high-level controller is used to control a group of compressors in order to maintain the system pressure within a narrow pressure band.

2) The client controller regularly changes the priority of the compressors in the group so that the load is distributed among the compressors.

As long as the machine's operating mode is not set to sequencing, the servers run independently of the client and use their local set points. When the sequencing mode is activated, the network is pressurized within a defined period of time according to the load net in setting. To do so, only the required number of compressors are switched 'ON' in order to pressurize the network within this time period. After a power loss, this function is not activated, because in this case it is important to pressurize the network as fast as possible.

In case of a pressure sensor fault on the client controller, the client can no longer control the group and therefore switches sequencing 'OFF' until the fault is cleared and reset. If the client compressor switches itself 'OFF' because of a different fault than the pressure sensor fault has occurred, or if it is manually stopped, the client continues to control the sequencing network using the remaining servers.

As soon as the pressure is above the unload pressure setting, the compressor to the far right in the sequence is switched 'OFF'. When the unload pressure is exceeded, additional compressors are switched 'OFF' in sequence at short time intervals. If the system pressure drops below the load pressure, the next available compressor is started immediately, followed by additional compressors in a defined sequence if the system pressure remains low.

Variable Speed Client – Fixed Speed Servers: The line pressure is controlled precisely between the minimum and maximum line pressure by the speed-controlled compressor, within the available speed range. If the limits of the pressure band have been reached, then compressors are switched 'ON' or 'OFF' as described above.

Variable Speed Client – Variable Speed Servers: The speed-controlled compressors run at approximately the same speed and load if they are approximately the same size. After a compressor is restarted manually (e.g., after 'Service'), the speed may not synchronous for a brief period, until the compressor reaches its minimum or maximum speed limit for the first time.

Defining a new sequence based on Hours Run (BLS): When the transfer interval has expired, the client defines a new sequence based on the hours run (BLS) of the compressors. The compressor with the least hours run (BLS) is placed first in the sequence, etc. "Sequencing diagnostics" section shows how to change the BLS Run Hours. On variable speed compressors with fixed speed servers, the variable speed compressor will always remain in the first place of the sequence, while the position of the servers is changed periodically.

To use the Governor™ controller with a Connect 12 system, the sequencing mode will need to be configured as a server machine with the client enable turned 'OFF'. All machines are configured this way and the Connect 12 acts as the client Control. To use the Governor with a Connect 4 system, an iPCB module is required.

7.2.5. Diagnostics

The sequencing diagnostics page can be found by going to the menu, then selecting diagnostics, then sequencing.

This page gives an overview of the sequencing settings for the machine. The compressor name, run hours, BLS run hours, operating pressure, and the pressure bands are shown on this page for machines that are configured as a client.

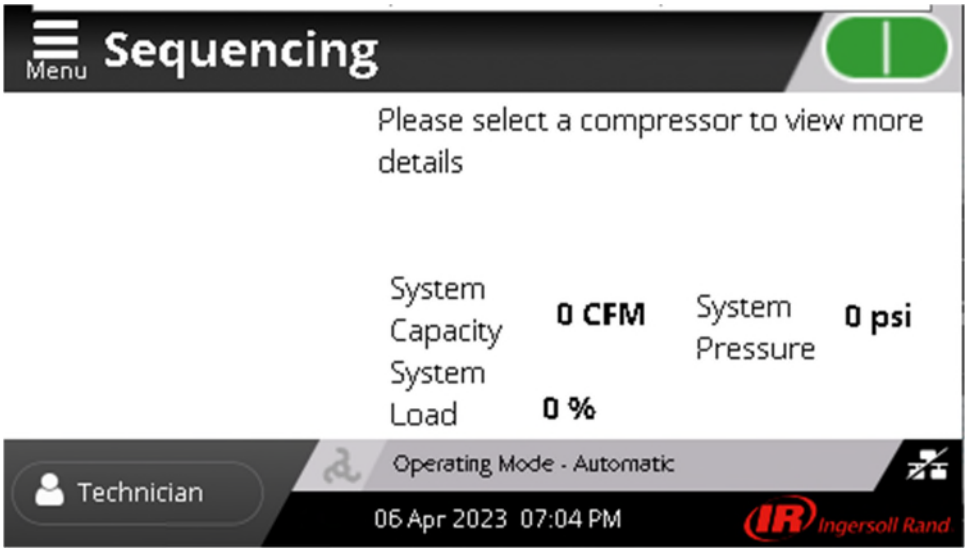

Figure 7.2.5-A: Diagnostics > Sequencing

Server machines will only have the name of the compressor, network pressure, and pressure band for the machine, as shown:

8. Reference Information

This section provides information and details available to support the user.

3.1. Modbus Register Table

Modbus Register	Data	Access	Type	Notes
976	Major Trip Code 0	R	ASCII Character Code	The most recent Trip code in the Active Alarms page on the controller. This value is the character at the beginning of the fault code. For , with code P.204 con the controller, this value will be 0x5000 (20480 decimal) – 'P'followed by a NULL byte, or ifthe fault code was XS.111, this value would be 0x5853 (22611 decimal) -- 'XS'
977	Minor Trip Code 0	R	Integer	The most recent Trip code in the Active Alarms page on the controller. This value is the character at the beginning of the fault code. For , with code P.204 con the controller, this value will be 204 (decimal), or if the fault code was XS.111, this value would be 111(decimal)
978	Major Trip Code 1	R	ASCII Character Code	Part of second trip code on the active alarms page
979	Minor Trip Code 1	R	Integer	Part of second trip code on the active alarms page
980	Major Trip Code 2	R	ASCII Character Code	Part of third trip code on the active alarms page
981	Minor Trip Code 2	R	Integer	Part of third trip code on the active alarms page
982	Major Trip Code 3	R	ASCII Character Code	Part of fourth trip code on the active alarms page
983	Minor Trip Code 3	R	Integer	Part of fourth trip code on the active alarms page
984	Major Trip Code 4	R	ASCII Character Code	Part of fifth trip code on the active alarms page
985	Minor Trip Code 4	R	Integer	Part of fifth trip code on the active alarms page
986	Major Warning Code 0	R	ASCII Character Code	The most recent Warning code in the Active Alarms page on the controller. This value is the character at the beginning of the fault code. For , with code P.204con the controller, this value will be 0x5000 (20480 decimal) – 'P' followed by a NULL byte, or if the fault codewas XS.111, this value wouldbe 0x5853 (22611 decimal) --'XS'

987	Minor Warning Code 0	R	Integer	The most recent Warning code in the Active Alarms page on the controller. This value is the character at the beginning of the fault code. For , with code P.204con the controller, this value will be 204 (decimal), or if thefault code was XS.111, this value would be 111(decimal)
988	Major Warning Code 1	R	ASCII Character Code	Part of second warning code on the active alarms page
989	Minor Warning Code 1	R	Integer	Part of second warning code on the active alarms page
990	Major Warning Code 2	R	ASCII Character Code	Part of third warning code on the active alarms page
991	Minor Warning Code 2	R	Integer	Part of third warning code on the active alarms page
992	Major Warning Code 3	R	ASCII Character Code	Part of fourth warning code on the active alarms page
993	Minor Warning Code 3	R	Integer	Part of fourth warning code on the active alarms page
994	Major Warning Code 4	R	ASCII Character Code	Part of fifth warning code on the active alarms page
995	Minor Warning Code 4	R	Integer	Part of fifth warning code on the active alarms page
996	Active Trip Count	R		Will indicate how many activetrip conditions are present. This does NOT indicate how many entries are present on the Active alarms.
997	Reset Events	R		Set to 1 to reset events, value resets to 0 automatically
998	Save Setpoints	W		Writing 1 causes the controller to save all data.
999	Number of Comm Table Entries	R		For engineering purposes only
2001	Controller Main Module ID	R	Integer	B&R ID is the display module
2002	Compressor ID value	R	Integer	GD/IR Compressor ID Value
2003 – 2004	Controller Serial Number	R	32-bit Integer	
2011 - 2019	Software ID String	R	20 byte String	Text for the Software ID as shown on UI Diagnostic /Controller/General page
2021 – 2030	Software Version String	R	20 byte String	Text for the Software version as shown on UI Diagnostic /Controller/General page
2031 – 2040	Software Serial number String	R	20 byte String	Text for the Controller serial number as shown on UI Diagnostic/Controller/General page
2041 – 2050	Machine Config file name	R	20 byte String	String containing the machine configuration file name
2051 – 2060	Machine Def File name	R	20 byte String	String containing the machine definition file name
2061	Current Controller time, Year	R	Integer	Current year
2062	Current Controller time, Month	R	Byte	Current month, range 1 to 12
2063	Current Controller time, Day	R	Byte	Current month, range 1 to 31

2064	Current Controller time, Hour	R	Byte	Current hour, range 0 to 23
2065	Current Controller time, Minute	R	Byte	Current minute, range 0 to 59
2066	Current Controller time, Second	R	Byte	Current second, range 0 to 59
2071	New Controller time, Year	R/W	Integer	New year
2072	New Controller time, Month	R/W	Byte	New month, range 1 to 12
2073	New Controller time, Day	R/W	Byte	New month, range 1 to 31
2074	New Controller time, Hour	R/W	Byte	New hour, range 0 to 23
2075	New Controller time, Minute	R/W	Byte	New minute, range 0 to 59
2076	New Controller time, Second	R/W	Byte	New second, range 0 to 59
2080	Time Command	R/W	Boolean	Writing a value of 1 will cause the controller to update its time with New Controller time
2101	P2 Timer Enabled	R/W	Boolean	Pressure Band 2 timer enabled
2102, 2112, 2122, 2132, 2142, 2152, 2162, 2172	P2 Timer Channel Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) is enabled
2103, 2113, 2123, 2133, 2143, 2153, 2163, 2173	P2 Day 0 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 0 (Monday) is enabled
2104, 2114, 2124, 2134, 2144, 2154, 2164, 2174	P2 Day 1 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 1 (Tuesday) is enabled
2105, 2115, 2125, 2135, 2145, 2155, 2165, 2175	P2 Day 2 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 2 (Wednesday) is enabled
2106, 2116, 2126, 2136, 2146, 2156, 2166, 2176	P2 Day 3 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 3 (Thursday) is enabled
2107, 2117, 2127, 2137, 2147, 2157, 2167, 2177	P2 Day 4 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 4 (Friday) is enabled
2103, 2113, 2123, 2133, 2143, 2153, 2163, 2173	P2 Day 0 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 0 (Monday) is enabled
2104, 2114, 2124, 2134, 2144, 2154, 2164, 2174	P2 Day 1 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 1 (Tuesday) is enabled
2105, 2115, 2125, 2135, 2145, 2155, 2165, 2175	P2 Day 2 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 2 (Wednesday) is enabled
2106, 2116, 2126, 2136, 2146, 2156, 2166, 2176	P2 Day 3 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 3 (Thursday) is enabled
2107, 2117, 2127, 2137, 2147, 2157, 2167, 2177	P2 Day 4 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 4 (Friday) is enabled
2108, 2118, 2128, 2138, 2148, 2158, 2168, 2178	P2 Day 5 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 5 (Saturday) is enabled
2109, 2119, 2129, 2139, 2149, 2159, 2169, 2179	P2 Day 6 Enabled	R/W	Boolean	Flag indicating P2 Pressure channel (1 – 8) Day 6 (Sunday) is enabled
2110, 2120, 2130, 2140, 2150, 2160, 2170, 2180	P2 Start Time	R/W	Integer	Value indicating P2 Pressure channel (1 – 8) Start time of day (minutes since midnight, 0 to 1440)

2111, 2121, 2131, 2141, 2151, 2161, 2171, 2181	P2 End Time	R/W	Integer	Value indicating P2 Pressure channel (1 – 8) End time of day (minutes since midnight, 0 to 1440)
2201	Scheduled Start/Stop Timer Enabled	R/W	Boolean	Scheduled Start/Stop timer enabled
2202, 2212, 2222, 2232, 2242, 2252, 2262, 2272	Scheduled Start/Stop Channel Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) is enabled
2203, 2213, 2223, 2233, 2243, 2253, 2263, 2273	Scheduled Start/Stop Day 0 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 0 (Monday) is enabled
2204, 2214, 2224, 2234, 2244, 2254, 2264, 2274	Scheduled Start/Stop Day 1 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 1 (Tuesday) is enabled
2205, 2215, 2225, 2235, 2245, 2255, 2265, 2275	Scheduled Start/Stop Day 2 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 2 (Wednesday) is enabled
2206, 2216, 2226, 2236, 2246, 2256, 2266, 2276	Scheduled Start/Stop Day 3 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 3 (Thursday) is enabled
2207, 2217, 2227, 2237, 2247, 2257, 2267, 2277	Scheduled Start/Stop Day 4 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 4 (Friday) is enabled
2208, 2218, 2228, 2238, 2248, 2258, 2268, 2278	Scheduled Start/Stop Day 5 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 5 (Saturday) is enabled
2209, 2219, 2229, 2239, 2249, 2259, 2269, 2279	Scheduled Start/Stop Day 6 Enabled	R/W	Boolean	Flag indicating Scheduled Start/Stop channel (1 – 8) Day 6 (Sunday) is enabled
2210, 2220, 2230, 2240, 2250, 2260, 2270, 2280	Scheduled Start/Stop Start Time	R/W	Integer	Value indicating Scheduled Start/Stop channel (1 – 8) Start time of day (minutes since midnight, 0 to 1440)
2211, 2221, 2231, 2241, 2251, 2261, 2271, 2281	Scheduled Start/Stop End Time	R/W	Integer	Value indicating Scheduled Start/Stop channel (1 – 8) End time of day (minutes since midnight, 0 to 1440)

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