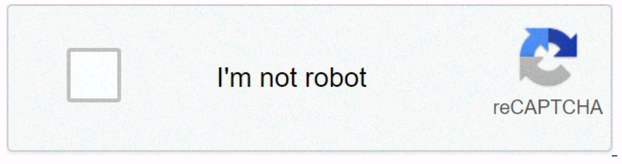

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compressors without chargers or a compressor with a charger (two steps). 18 Figure 14 Two compressors with downloaders (four steps). . 19 Figure 15 Modulation of digital displacement capacity, 10-100% variable. . 20 Figure 16 Activation points of the single and dual digital displacement compressor. . 20 Figure 17 Three-point actuator control (example: cooling). 21 Figure 18 Second source of refrigeration and compressed cooling. . 22 Figure 19 Heating in three stages. 24 Figure 20 Two one-step compressors with reheat SCR set to tight mode. 25 Figure 21 Two one-step compressors with reheat SCR set to standard mode. . . . . 26 Figure 22 Proportional band humidity. . 27 Figure 23 Teamwork mode 1 with two cooling units. . 40 Figure 24 Connection of two cooling units, each with a small screen using an Ethernet crossover cable . . . 44 Figure 25 Wiring a small screen for standalone operation. 45 Figure 26 Wiring a small screen for U2U network operation. 45 Figure 27 Wiring a large screen for 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data. 52 Table 17 Sets alarm parameters. . 52 Table 18 Active Alarm Settings . 53 Table 19 Show configuration settings. . 53 Table 20 Timer Settings:Sleep Mode. . 54 Table 21 Total parameters of hours of execution . 54 Table 22 Service Contact Settings. . 55 Table 23 Fixed Point Parameters. 56 Table 24 Unit Journal Settings. 57 Table 25 Maintenance settings / welfare configuration. 58 Table 26 Standby Settings / Lead Delay Parameters. 58 Table 27 Diagnostic mode / service settings. 61 Table 28 Sets alarm parameters. . 63 Table 29 Calibration Parameters / Sensor Configuration. 69 Table 30 System Settings / Network Configuration: Big Screen Only. 70 Table 31 Network Configuration Settings. . . . . 71 Table 32 Configuration Settings Options. 73 Table 33 Service Contact Information Settings . 74 1.0INTRODUCTION Liebert iCOM's control™ offers the highest capabilities in unit control, communication and monitoring of Liebert mission critical cooling units. Liebert iCOM can be used to combine multiple cooling units into a computer that operates as a single entity, improving the performance and already high efficiency of Liebert's units. Liebert iCOM is available as a factory-installed assembly or can be reappropriated in existing products with SM, AM or AG controls. Large wall mounting graphics versions of the control are available for remote operation and monitoring of cooling units. 1.1 Features Large and small screens Liebert's iCOM control is available with a large or small liquid crystal display. •The liebert iCOM with small screen has a 128 x 64 dot array screen that simultaneously displays two menu icons, along with descriptive text. This screen can only control the drive to which it is directly connected. •The large-screen Liebert iCOM has a 320 x 240 dot array screen that displays up to 16 menu icons at a time, as well as descriptive text. This display can be used to control a single cooling unit or any cooling unit in a network, regardless of how connected it is, either built into a cooling unit or simply connected to the network and mounted remotely. Liebert iCOM's menu-based display is used for all programming features of each connected cooling unit. The Status menu shows the state of the conditioned space, such as room temperature and humidity, temperature and humidity points, alarm status and settings, event histories and current time. Figure 1 Components Liebert iCOM Wall MountIng Large Screen Panel Large Screen Mount and Bezel Direct Panel Mount Liebert iCOM Input / Output Panel Small Screen and Bezel 2.0LIEBERT ICOM SCREEN COMPONENTS AND FUNCTIONS The small and large screen have a common key design, as shown in Figure 2. Figure 2 Display components of Liebert iCOM Liquid Crystal Status Indicators (upper LED is red or flashing red; Bottom LED is green or amber) Gran Liebert iCOM Shown – Keypad and LEDs are identical on all screens. Alarm key up arrow key ? Help key on/off left arrow key Enter right arrow key esc key escape down arrow key Note the help key can be pressed on either for a brief explanation of what is being seen. Liebert iCOM Screen Components and Functions Table 1 Keyboard Icons and Functions Key Icon Function On/Off Key operational status of the cooling unit. The alarm key silences an alarm. ? Key access to built-in help menus. Esc EsCape Key Returns to the previous view view. Enter key Confirm all selections and select icons or text. Increases key movements up in a menu or increases the value of a selected parameter. (Up Arrow) Decreases key movements down in a menu or reduces the value of a selected parameter. (Down Arrow) Left and right Navigate through text and sections of the screen. The red-flashing arrow keys —Active, unreco recognized alarm top solid LED network exists —Activate, recognized alarm exists Amber—Power is available for drive, drive NOT operating Lower LED Green— Power is available for drive, unit is operating iCOM Liebert iCOM Figure 3 Status Menu display components, Large screen, Graphic view Temperature Humidity system or Setpoint Setpoint Sensor Reading unit # view Temperature Sensor Supply Temperature Air Temperature Reading Percentage Hot Water Evaporator Heating Fan Speed percent electric heating Percent dehumidification of free cooling percentage percentage system humidifying (or unit) On/Off Next maintenance date and time Most recent alarms (Date, time Unit, Description) Figure 4 Liebert iCOM fan default screen symbols cooling the maintenance of electric heat humidification hot water dehumidification Liebert iCOM Components and functions 2.1Navigating through the Liebert iCOM Liebert iCOM menus displays icons and text for tracking and controlling your Liebert cool sales units or network of cooling units. The number of icons and the amount of text displayed depends on the screen size. Control interface 2.1.1 When Liebert's iCOM control buttons have not been pressed for a short period, the screen light turns off. Pressing any key will activate the rear light (wake up the screen) and display the Status menu of the last cooling unit seen. The Status menu will display the operating modes of the cooling unit, return air temperature and humidity readings, temperature and humidity points and active alarm conditions. If the cooling unit has a large screen and is not on a network, or if the drive has a small screen, either in network or standalone, the Status menu will display only the information for that cooling unit. Any large screen that is connected to a network can be used to view any cooling unit on the grid or display an average view of the entire cooling units system. Liebert's iCOM control has three main menus; User, Service Advanced. The User menu contains the most commonly used features, settings, and status information. The Service menu contains the settings and features used to configure unit communications and for the maintenance of units. The Advanced menu contains the settings used to configure the drive to the factory. Note the menu settings can be viewed without password, but changing requires a password. If a password is required, Liebert iCOM displays a request to enter the password. The password for the User menu is 1490. The password for the service menu is 5010. For more information about entering a password, see Entering a password on page 6 2.1.2Accessing Submenus to access the user, service, or advanced menu, press the Enter key or down arrow while viewing the Status menu of the drive you want to access. The User menu will be displayed first. To view the Service or Advanced menus, press the right arrow key. By accessing the Submenus on small screens While viewing the menu you want to access (User, Service, or Advanced), use the up and down arrow keys to scroll through the icons page by page. To scroll through the icons one by one, press the input key, and then use the up and down arrow keys. With the desired icon highlighted, press the input key to enter this submenu. Once in a Submenu, a list of parameters is displayed. Press the input key and use the up and down arrow keys to scroll through the settings one by one. Pressing the Esc key will return a level. Figure 5 displays Liebert iCOM's control menus for a small screen. By accessing Submenus on Large Screens While viewing the menu you want to access (User, Service, or Advanced), press the input key to highlight the first icon. Use the arrow keys to navigate through the icons. With the desired icon highlighted, press the input key to enter this submenu. Once in a Submenu, a list of parameters will be displayed. Up and down arrow keys can be used to scroll through the page-by-page settings if the submenu has multiple pages. To move item by item, press the Enter key, and then use the up and down arrow keys. Using the right or left arrow keys on large screens attached to a network will change the unit being displayed. Pressing the Esc key will return a level. Figures 6 and 7 show Liebert iCOM's control menus for a separate large screen and for a large networked screen, respectively. Note The settings can be read without a password, but changing settings requires a password. Liebert iCOM Display Components and Functions 2.1.3Entering in Password To change the value of a parameter in a menu, you must first enter the password for this menu. The User, Service and Advanced menus have a unique password to prevent unauthorized changes. The user menu password is 1490; the service menu password is 5010. NOTE The introduction of the password of the service menu allows access to both the menus and the Service. To enter a password: 1.Navigate to the menu containing the parameter to change. 2.Select Password in the submenu by pressing the Enter key 3.Press the Enter key to move the cursor to the right side of the screen to select the question marks. 4.Use the arrow keys to enter the number for the first digit of the password (the up arrow key moves from 1 to 1 digit next). 5.Use the right arrow key to move the following question mark and repeat step 4 to enter all digits into the password. 6.After entering the password, press Enter. If the password is correct, the actual level shown to the right of the password will change from 0 to 1 or 2. The menu will remain locked if the password was incorrect. NOTE Returning to the Status menu will require re-entering a password to make changes. Figure 5 Menu Tree-Small Screen, Stand-Alone or Network State Menu Unit 1 View Menu User Menu Password Security Points Settings Factory Log Events Standby Passwords Wellness Set Alarms Diagnostic Sensor Data Set Alarms Settings Calibration Total Run Hours Network Configuration Schedules Service Settings Info Service Info Active Alarms Liebert iCOM Displays Components and Functions Figure 6 Menu Tree - Great Display, Standalone Drive 1 will display Status Menu - System View in the upper left corner of the screen. State Menu Drive 1 View Advanced User Menu Menu Drive 1 Unit 1 Password Set Points Factory Settings Spare Parts List Daily Compressor Information Event Log Waiting Settings /Lead-Lag Access Passwords Graphics Maintenance/Wellness Settings View Network Diagnostics / Service Mode Set Alarms Data Sensor Calibration/Configuration Active Alarms System /Network Settings Screen Installation Options Total Hours Settings Contact Service Sleep Mode Information Liebert iCOM Display Components and Features 2.1.4View multiple drives with a large network screen When you wake up control for the first time, press the Esc key to return to the System Display Status menu. This view displays an average of all network drives and alarms present. To see a network-specific drive, press the Enter key or the Down arrow key. When you do this, you'll see the word System at the top left of the screen change to a unit number. Using the left and right arrow keys you can switch across the various units of the network. To return to the System view, or back a level from any control menu, press the Esc key. Figure 7 Menu Tree – Large Display, Network drive # or System will be Status Menu – System View shown at the top left (Large Network Display Only) corner of the screen. Status Menu Unit 2, 3, 4... User Menu Menu Advanced Menu Unit # Unit # Password Set Points Factory Settings Factory Spare Parts List Daily Compressor Event Registration Event Registration Waiting Settings / Lead-Lag Access Passwords Maintenance /Welfare Settings View Diagnostic Network / Service Mode Set Alarms Alarms Data Sense Calibration Data Sense /Settings Active Alarms System/Network Settings Screen Installation Options Total Service Hours Service Information Mode Contact Info Liebert iCOM Display Components and Functions Figure 8 User Menu User Menu Password: 1490 Table 2 User Menu Icons Description of icon name Available on screen °C/°F % RH Setpoints View and change temperature and humidity Small and large playpoints SET Spare Parts List Shows the various numbers of part of the large components/parts in the EVENT cooling unit Event Log Contains the latest 400 small and large graphics events LOG Shows temperature and humidity graphics Small and large view network Show the status of all connected units Large set of alarms enables to disable and settings for alarms Small and Large ALARM Sensor Data Shows small and large standard and optional sensor readings! Active Alarms Allow the user to view all active active alarms and active alarms 1 2 Change settings for the screen: language, time, 9 3 Small and Large Screen Configuration Plain or Graphical View SET 6 1234h Total Run Hours Records the runtime of all components and Small and Large enables to set limits on Liebert iCOM Runtime Screen Components and Functions Table 2 User Menu Icons (Continuous) Description of the icon name available on screen 1 2 Allow mishaps settings for non-peak sleep mode 9 3 Small & Large operation 6 Service Contact Info Contains contact key information for the local Small &service Large, including names and phone numbers Liebert iCOM Display Components and Functions Figure 9 Service Menu Icons Service Menu Password: 5010 Table 3 Service Menu Icons Available in Name Description Show°C/°F % RH Fixed Points To view and change the temperature and humidity fixed points Small and large Set Unit Daily Shows all program changes introduced and large maintenance made in the Standby Settings unit / Allows lead/delay settings when connecting multiple small units and large lead maintenance / Allows you to set maintenance interval reminder, maintenance message, number of starts and stops of unit, Small and large wellness arrangements WELLNESS and time since the last maintenance Diagnostics / Allows the solution of problems , manual mode, analog reading and small and large mode of digital input service SERVICE SET Alarms Allows you to enable, disable and settings for small and large alarms ALARMS + / - Sensor Allows sensor calibration Small and large Calibration/Network Network System Allows organization and communication U2U for multiple units Options Organization Large Setup Allows component operation setup Small and large Service Contact Information Contains key contact information for local, Small and large service including phone names and numbers 3.0OPERATION The iCOM Liebert display by in the Liebert cooling unit features easy use, menu-based liquid crystal display (LCD). All drive settings and settings can be viewed and adjusted through three menus: User, Service, and Advanced. All active alarms are displayed on the LCD and advertised. The control is sent from the factory with default selections for all required parameters. Adjustments can be made if the defaults meet their requirements. References to the menu items in this manual are followed by the main menu and the submenu where they can be found. For example: •Temperature settings point (user menu, Settings points) - The Temperature Settings Point parameter is in the User menu under the Depunts submenu. •High profitability humidity (service menu, Set alarms) - The high return humidity alarm is in the Service menu under the Define Alarms submenu. 3.1 Functions of unshackled drive 3.1.1 Fan Control - Stops the drive in the media where the fan output is activated. The drive can be activated and deactivated from two entries: 1.Remote on/off input 2.Display button Pressing the On/Off key on a small screen will control only the cooling unit to which it is independently connected, whether the cooling unit is a separate unit or part of a network. Pressing the On/Off key on a large screen of a separate cooling unit will only control that unit. The effect of pressing the On/Off key on a large screen connected to a network depends on the view: System or Drive. •In system view, pressing the On/Off key displays a warning asking for confirmation to shut down the entire system. •In Unit view, pressing the On/Off key only affects the drive being displayed, without a confirmation request. Each time a unit turns on or taps, an event is added to the event log in the User menu. NOTE Client switches: Remote on/off switches (if used) and on/off switches on the screen are serial. A cooling unit will start only if both switches are on; if one of these switches is turned off, the drive will stop. Security devices inside the drive are also serial and will close the drive if necessary. Figure 10 Remote Start Stop Priority Switches On/Off Display On/Off NOTE If remote power/shutdown is not used, a bridge is inserted to avoid the switch. Operation Self-Author when there is a loss of power in the cooling unit and the power returns, the unit will return to its previous operating state - in case it was off, off if it was off. When power returns, the time of the author-authorship —time-selectable: Automatic restart of a single unit (service menu, option settings)— controls the start of the drive. The author timeestart runs on a loop, starting the next drive each time it passes, starting with Unit #1. Loss of the power alarm A power alarm loss is triggered when power is restored after an interruption. If recognized, the alarm restarts automatically after 30 minutes. This alarm can be in different types of events (Message, Alarm or Warning) and can be disabled under the Power Loss menu item (Service Menu, Set Alarms). NOTE The loss of power alarm will be activated only in the units that had the fan activated before losing power. Fan Alarm / Fan Protection Settings The fan operation is protected by two digital devices: engine protection (optional) and differential pressure switch. Engine protection monitors for main fan overload and differential differential ensures that the blowers are moving air. If any of the protection devices are activated, a bell, an alarm relay and an event to control after an adjustable time delay (main fan overload and airflow loss in the service menu, Set Alarms). The time delay at the start of the drive is always five seconds shorter than the control delay (to avoid short component starting when the fan is not working). During the operation, the fan delay is set to 15 seconds. There are two selection possibilities for both Loss Of Airflow and Main Fan Overload: •Shutdown— stops the unit (intended for DX models). •Deactivate— stops the humidifier, electric heaters and dehumidification; allows free cooling and cooling only (intended for cold water models / external cooling). NOTE When the main fan overload alarm is active, the airflow alarm loss is masked. 3.1.2Chilled Water Units with Variable Speed Motor VSD Fan Speed (Auto or Manual VSD Fan Speed Control) The VSD Fan Speed (Service Menu, Setpoints) allows you to set the fan engine speed of the cooling unit to: •Automatic operation: when set to Auto, the speed of the VSD engine (variable speed unit) follows the position of the default logic-based cooled water valve for cooling and dehumidification. •Manual operation: When set to Manual, the vsd engine speed follows the user's input as set locally on the Cooling Unit's iCOM screen (under the VSD installation point in the service menu, fixed points) or remotely using the Modbus BMS signal with an Optional Liebert IntelliSlot® 485 card. VSD Setpoint (VSD Fan Speed Setting) If the VSD Fan Speed Control (Service Menu, Setpoints) is configured by manual, the VSD fan speed viewpoint (service menu, configuration points) can be set for the desired speed of the variable speed engine. Depending on the product control design, there may be a minimum internal speed, as defined in this product-specific operation, while customer input can be set for 0-100%: •The fan speed can be set locally on the drive using the Liebert iCOM display. • The fan speed can be set remotely via a BMS signal (sent via Modbus using an Optional Liebert IntelliSlot 485 card), which it then transmits to the local control of the unit. Operation 3.1.3 General Compressor Requirements Low Pressure Time Delay When compressor starts, low pressure input is ignored for a selected period of time based on alarm delay settings pressure (service menu, Options settings). This time it is usually set to 3 minutes in air-cooled units, and at 0 or 1 minute in water-cooled units. When this time has expired, a second timer starts working if the low pressure input is active. This second timer is active during normal compressor operation to avoid compressor trips due to bubbles in the coolant or other influences creating short trips from the low pressure switch. The entry of the low pressure switch is only if the compressor is working. Exception: Pump Down (see bomb down). NOTE The low pressure condition can be read through contacts or by pressure transducers with threshold configuration. Pump Down The Pump Down operation is performed to protect the oil from the compressor from being diluted with liquid coolant to ensure that the compressor is lumbered properly for the next startup. The Pump Down operation works as follows: Every time a compressor is turned off and the low pressure switch closes (OK pressure), the compressor will be operated with the LLSV (liquid line solenoid valve) closed (devengibleized) until the low pressure switch (low pressure condition, without giving alarm) opens. When there is a call to turn off a compressor, the LLSV is closed. If the low suction pressure switch (LPS) does not open in a specified time, the LLSV is activated and then exits again (to try to unhing the LLSV). Then the control will wait a certain period of time for the LPS to open. This will happen three times. If, after three times, the low suction switch does not open, the compressor and LLSV are locked and a not completed Pump Down alarm will appear. There is a re-pump down if the LPS opens again after the compressor has already stopped - a maximum of six re-pumping cycles per hour are allowed. On the seventh request to re-pump the Comp 1 Pumpdown Fail or Comp 2 Pumpdown Fail alarm will appear and the compressor will be locked. Pump down is always loaded (for compressors with downloaders: off downloaders, digital displacement: solenoid control valve disabled). Only for digital scrolling: When the pump down is successfully finished (open LPS), the pump down will continue for another half a second with the energized control solenoid valve. High pressure alarm When the compressor is initially activated, the system will be monitored for a high pressure situation. When a high pressure situation is detected during the first 10 minutes of operation, the unit will try to correct the problem several times without notification. If the drive is unsuccessful in correcting the problem, an alarm will occur and the affected compressor will be blocked. If the head's high pressure alarm travels three times in a rolling 12-hour period, the affected compressor will be blocked. After the compressor has been running for 10 minutes, if a high head pressure situation is detected, an alarm will occur and the affected compressor will be blocked immediately without the unit attempting to correct the problem. Once the compressor is closed, it will not go back forward until the main power is restored, or until the HP Alarm Counters (Menu Diagnosis) are reset to 0. Setting the counter to 0 will automatically reset the alarm without pressing the reset button on the screen. Even if the pressure in the system falls below the point, the compressor will remain off until the system is restored. NOTE If the drive is equipped with high pressure switches from the manual reset head, or if the high head pressure switches are not restarted, the compressor will not turn on again, but there will be a delay of 30 seconds from when the high head pressure situation occurs and when the alarm is re-ignited. Operation High temperature digital displacement A maximum temperature limit of the protective operational compressor is imposed on units with digital displacement compressors with thermistor. Once the digital scroll temperature reaches the maximum temperature threshold, the compressor will be locked for at least 30 minutes and an alarm will be made. If after 30 minutes the temperature has cooled to a safe operating temperature, the compressor will resume operation. Each time a high temperature alarm occurs, the HT 1 alarm counter (service menu, diagnostics) or HT 2 alarm counter (service menu, diagnostics) is increased by one. Once these meters reach five occurrences in a rolling period of four hours, the compressor will be blocked. The alarm can be reset once the temperature returns to a safe level by: 1.Setting the meter back to 0 from the screen and pressing the alarm reset button. 2.S by shutting down power on the control panel by turning off the cooling unit shutdown and shutdown. 3.1.4 Timingcompressor— Units with two compressors To help maximize compressor life(s), there is a next start delay for each single compressor. In the Advanced menu you can select a minimum time of ed hour and a minimum of rest (minimum of three minutes for compressors of a single phase). See the factory on how to modify the minimum time settings of Àneu and OFF. 3.1.5Compressor Sequencing the compressor sequencing parameter (Service Menu, Options Settings) aims to keep execution times the same between compressors. This selection option has three selection possibilities: •Always use Compressor 1 as a lead compressor •Always use Lead Compressor 2 as a lead compressor •Auto: •Priority: If security times are acceptable for a single compressor, then this is the next thing to start or stop. •If both compressors are off: the one with the least working hours is the next to start. •If both compressors are up and running: the one that has been running longer since the last start is the next to stop. Operation 3.2 Motorized ball valve in digital displacement units In units discharge pressure is controlled by a motorized ball valve. During the discharged operation, pressure changes during each digital cycle could cause a pressure-controlled water regulation valve to open and close an excessive number of times. The motorized ball valve is designed to maintain a consistent peak discharge pressure on digital water/cooled glycol Systems. The motorized ball valve control algorithm uses intelligent sampling speed and adjustable pressure thresholds to reduce the number of times the valve opens and closes. The valve assembly consists of the brass valve, link and actuator. Each compressor has a motorized ball valve that is driven by the analog output of the pressure-based iCOM Liebert control panel. If there is a call for cooling, the start of the compressor is delayed by a 30-second timer. During this delay, the motorized ball valve is set at 50% open. The compressor will begin after the 30-second timers elapse. Manual motorized ball valve mode: (Service /Service) Manual operation can be selected to allow service personnel to control the motorized ball valve from Liebert's iCOM control only when the system is in manual mode. When Auto BV Control is selected, the motorized ball valve works as it would be during normal system operation. Note compressor operation will be delayed by 30 seconds to allow the motorized ball valve to position itself for the initial start. When selecting manual BV control, the user must be careful when setting the analog output so that the ball valves will remain in the position set in the Service menu until the control is changed back to Auto or until a technician changes the valves to another manual position (the motorized ball valve in manual mode can be set in increments of 1% from fully closed to fully open). Low or high discharge pressure can occur during this mode, depending on the environmental conditions and position of the motorized ball valve. The motorized ball valve is driven by a proportional control signal 2-10VDC: the valve is closed at 2VDC, 50% open to 6VDC and fully open to 10 VDC. Operation 3.2.1MBV After turning off the compressor Once a compressor has stopped, the MBV control will continue to change the MBV position to maintain system pressures for a maximum time of 10 minutes following the automatic control algorithm. Once the 10-minute delay has expired or the discharge pressure is below the minimum threshold, the motorized ball valve will be closed until the next compressor activation. 3.2.2Service Offset-Changing System Pressure Settings The MBV control is set to maintain a specific system pressure for the particular type of cooling unit. A properly trained and qualified technician can increase or decrease the pressure by moving the starting point of the ball valve found in the Service Settings/Options menu. The range is from 0 to 50 PSI; the default value is 30 PSI. NOTE Adjust this setting or it will decrease the download pressure of the operating compressor by changing the target control range. Download pressure is the maximum pressure of the digital cycle. Operation 3.3 Operating control—Simple code cooling (no extra cooling coil) 3.3.1 Proportional temperature toralin Control uses proportional temperature band to determine determine operation (cooling/heating) and the intensity with which to perform it. The Proportional Band of Temperature is a user-defined range that is divided into two equal parts for cooling and heating. The temperature point is between these two equal parts. An optional Deadband temperature range can be defined, which is equally divided on either side of the starting point and separates the two halves from the proportional band. Figure 11 illustrates how the proportional band of temperature is evenly divided on either side of the temperature point of view, with and without a dead band. Figure 11 Proportional band temperature Without Deadband - Temp Heating Cooling + Temp 1/2 Proportional band 1/2 Proportional band + 100% - 100% 0% Heating Knit cooling with Deadband Dead- - Temp Heating cooling band + Temp - 100 %1/2 Proportional band 1/2 Proportional band + 100% 0% Heating Setpoint Cooling When the return air temperature is diverted from the starting point begins to penetrate one of the proportional band halves, cooling or heating. If the return air temperature increases, the control requires 0% (none) at a 100% cooling capacity (complete) depending on how far the temperature penetrates the cooling part of the proportional band. If the return air temperature decreases, the control requires 0% (none) to - 100% (complete) heating capacity based on how far the temperature penetrates the warming part of the proportional band. When the return air temperature reaches the end of the proportional band, either 100% or -100%, complete cooling or full heating capacity is provided. No operation is performed when calculating a 0% call. Control varies the call for cooling and warming by 1% increases as the return air temperature moves through the proportional halves of the band. The dead band range is used to expand the starting point. When the return air temperature drops within the dead band, the control works just like if the temperature exactly equals the starting point. This configuration helps maximize the life of components by avoiding excessive component cycling. The Deadband Temperature and Temperature Proportional Band parameters are found in the Service menu under the Setpoints submenu. The Temperature Setting Point setting is found in both the user menu and the service menu at Setting Points. There is an AutoSet Enable parameter (Service Menu, Fixed Points), which automatically sets the proportional bands for temperature and humidity, and both the integration time factors according to the unit type (Cold water, single or double compressor), with the influence of the mode team selected. See 4.1 – Teamwork Modes for more information about using this feature. Operation 3.3.2Compressor control Depending on the type of air conditioning unit Liebert has in your unit may contain one or two compressors with or without downloaders. Compressor Proportional Bands A one-step compressor without downloaders - One-step compressor, cool cool starts

at 100% of the call to cool the proportional temperature band and stopped at 0% (see Figure 12). Figure 12 A one-step compressor without Temp Setpoint downloaders: 70°F Proportional band : 8°F Cool 1 Deadband : 2°F When cooling 1 out 1/2 Dead- band 70 71 72 73 74 75 0% 1/ 2 Proportional band + 100% cooling cooling by increasing the temperature Two one-step compressors without downloaders - Two-step first-step compressor, Cool 1, starts at 50% of the production calculated from the proportional temperature band, and stopped at 0%. The second compressor, Cool 2, starts at 100% and stops at 50% (see Figure 13). A compressor with a downloader-Two Steps The two-step compressor starts downloads at 50%, Cool 1, calculated output of the proportional band of temperature and stops at 0%. 100% the compressor starts fully loaded, Cool 2, and reloads the operation at 50% (see Figure 13). Figure 13 Two one-step compressors without downloaders or a compressor with a charger (two steps) Time point of view: 70°F Proportional band: 8°F Deadband : 2°F 1/2 Dead- band 70 71 72 73 74 75 0% Cool 1 Cool 2 + 100% Cooling Cooling 1/2 Band Proportional Band Increasing Temperature Operation Two Compressors with Downloaders - Four Steps The first two-step compressor starts unloads at 33% calculated output of the proportional temperature band and stops at 17%. At 80% the compressor 1 will be charged, at 70% downloaded. The second compressor begins to be downloaded at 63% and stops at 47%. 100%, compressor 2 will be loaded, 90% downloaded (see Figure 14). The four stages of cooling are achieved as follows: •1 stage: A compressor, downloaded - Cool 1 •2 stages: Both compressors, downloaded - Cool 2 •3 stages: A compressor, loaded and a compressor, Downloaded - Cool 3 • 4 stages: Both compressors, loaded - Cool 4 Figure 14 Two compressors with downloaders (four steps) Temp Setpoint: 70° F Proportional band: 8°F Deadband : 2°F Cool 1 1/2 Band DeadOn 70 71 72 73 74 75 + 100% 0% Cool 1 Cool 3 Cool Cool cooling 2 Off Cool 4 Off 1/2 Proportional Band Increased Digital Scroll Compressor temperature operation A compressor with a suction cut-off downloader can only modulate its capacity between two different levels: fully loaded and half loaded. A digital displacement compressor can modulate its capacity by between 10-100%. This variable capacity modulation allows cooling units to control an environment more accurately. The modulation of the digital displacement capacity is achieved by energizing and energizing a solenoid valve in the compressor. When the solenoid valve is energized, the capacity of the is 100%. When the solenoid valve is energized, the compressor's capacity is zero. Therefore, the compressor's capacity depends on how long the solenoid is energized. If the solenoid is dynamized for 10 seconds, then energized for 5 5 during a cycle of 15 seconds, the resulting capacity will be 66% as shown in Figure 15. Figure 15 Modulation of digital displacement capacity, 10-100% Variable Call for Cooling: 66% Solenoid Solenoid Solenoid Charged Solenoid De-energized Energized Energized Energized 0% Loaded 0 5 10 15 25 30 15-Second Capacity 15-Second Capacity Cycle Modulation Cycle in single and dual digital displacement compressor systems the first compressor starts at a 25% output calculated from the proportional temperature band and stops at 10%. On dual digital displacement compressor systems, the second compressor starts at 35% and stops at 20%, see Figure 16. When a compressor starts, the solenoid is energized longer than they are energized to match the call for cooling. When the call to cooling increases to 100%, the solenoid is dynamized throughout the 15-second cycle. Figure 16 Single and Dual Temp Setpoint Digital Displacement Compressor Activation Points: 70°F Proportional Band: 8°F Comp 2 Partially Deadband : 2°F Loaded Comp 1 In Partially Loaded 1/2 Dead-Band 2Comp 1 && 2 In fully loaded 70 71 72 73 74 75 0% Comp 1 + 100% cooling Cooling Comp 2 Of 1 / 2 Proportional band increasing the temperature temperature

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