HUSSMANN®

CoreLink™

**Electronic Controller for
HE H-Series Condensing Units**

Installation &
Operation Manual

P/N 3182246_A
**June 2023**

MANUAL- CORELINK HE H-SERIES CONDENSING UNITS

BEFORE YOU BEGIN
Read these instructions completely and carefully.

PERSONAL PROTECTION EQUIPMENT (PPE)

Personal Protection Equipment (PPE) is required whenever servicing refrigeration equipment. Always wear safety glasses, gloves, protective boots or shoes, long pants, and a long-sleeve shirt when working with this equipment.
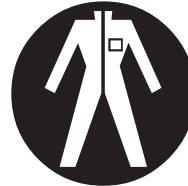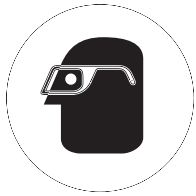
Electrostatic discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown.

ATTENTION
OBSERVE PRECAUTIONS FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICES

Hussmann recommends industry workers use antistatic wrist straps, ESD wrist strap, or ground bracelet when working on electronic devices which can be damaged by ESD. Please consult chosen strap literature for best practices for usage.

FOR CALIFORNIA INSTALLATIONS ONLY:

⚠ **WARNING:**

Cancer and Reproductive Harm
www.P65Warnings.ca.gov

August 31, 2018   3069575

This warning does not mean that Hussmann products will cause cancer or reproductive harm, or is in violation of any product-safety standards or requirements. As clarified by the California State government, Proposition 65 can be considered more of a 'right to know' law than a pure product safety law. When used as designed, Hussmann believes that our products are not harmful. We provide the Proposition 65 warning to stay in compliance with California State law. It is your responsibility to provide accurate Proposition 65 warning labels to your customers when necessary. For more information on Proposition 65, please visit the California State government website.

REVISION HISTORY
ORIGINAL ISSUE — June 2023

Hussmann reserves the right to change or revise specifications and product design in connection with any feature of our products. Such changes do not entitle the buyer to corresponding changes, improvements, additions or replacements for equipment previously sold or shipped.

ANSI Z535.5 DEFINITIONS

⚠ DANGER	**DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠WARNING	**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	**CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	**NOTICE** is used to address practices not related to personal injury.
SAFETY INSTRUCTIONS	**SAFETY INSTRUCTIONS** (or equivalent) signs indicate specific safety-related instructions or procedures.

TABLE OF CONTENTS

CONTROLLER OVERVIEW

CoreLink is a control system for complete management of HE H-Series condensing units with options of controlling various compressor types and different types of condensers. One of the main features of this solution is continuous modulation control of the main equipment such as a compressor and condenser contributing to the energy efficiency and reliability of the entire system. When the controller is turned ON, it will perform a quick check-up on all inputs/outs configurations to ensure all sensors are performing optimally.

Any alarm generated during the quick check-up will be displayed on the seven-segment display as "err". The control board is designed for DIN rail assembly. CoreLink can manage both medium and low temperature applications. This system has a with Web UI built interface and seven-segment display modules for the user interface.

➢ **Main Features:**
  • Management of different type of compressors
    • Digital scroll compressor with IDCM control module
    • Digital scroll compressor with direct control (without IDCM Module)
    • Bitzer reciprocating CMRC-01
    • Standard compressor control (ON / OFF with digital output)
    • Compressor with VFD control (0V-10V)
  • Management of different types of condensers
    • Air-cooled condenser (ECM Motors [10V – 0V], ON / OFF control, VFD control, KB drive[10V - 0V])
    • Water-cooled condenser

➢ Management of condenser fans for different ambient conditions
➢ Self-test of the system for ensuring the system reliability available with Web UI
➢ Data log of system parameters
➢ Fault Log of system performance
➢ Variable change log for the user parameter changes
➢ Different levels of users (Admin / Commission / Service / User)
➢ Override commands are provided for the system control if needed
➢ System is equipped with modbus and BACnet communication protocols
➢ Conf. file mechanism for saving and restoring the parameters. This allow the parameters to be downloaded and a copy saved to be used in another controller.

CONTROLLER FEATURES

CoreLink is a customizable, programmable controller that can interface with I/O expansions, drivers for electronic valves to specifically work with refrigeration and cooling equipment.

All the inputs and outputs are factory configured for display case refrigeration systems.

The program and parameters are stored in a permanent flash memory. No data is lost in case of power failure.

Internal web server graphical interface with the CoreLink website with no special software or application required to access CoreLink.

HARDWARE:

- USB Port
- Hussmann LCD Remote Display
- Serial Port (LAN) Communication
- RS485

CONFIGURABLE I/O:

- (x11) Digital Inputs
- (x8) Relay Outputs [Digital Out]
- (x6) Analog Input
- (x4) Analog Output
- Additional Power (accessories)
- 12 VDC 200mA MAX
- 5 VDC 100mA MAX

NETWORK

USB port provide maximum flexibility of integration with the outside world.

MODBUS RTU protocol used with refrigeration and all other building automation systems Application and firmware upgrades as well as configuration changes can be made via USB flash drive.

BACnet communication protocol integration

USB to Ethernet Adapters (Hussmann approved)can be used to connect CoreLink onto a local area network. Through the addition of the Hussmann Wireless Connection Kit (PN 3053757), users have wireless connectivity to a phone, tablet or laptop. No special software or application required to access CoreLink.

Technicians can bypass and view inputs/outputs from their personal smart devices.

Wireless connectivity provides flexibility when troubleshooting in the field. Technicians are not linked to long cables while working in large areas.

NOTE:
Refer to "How to Connect to CoreLink" for first time connection.

Serial Port (LAN Connection) - CoreLink can connect to external peripherals through the LAN serial port and easily allow expansion to additional control devices.

CoreLink can connect to external peripherals through the LAN serial port and easily allow expansion to additional control devices.

OPTIONAL HUSSMANN REMOTE DISPLAY:

A small surface mount display is available for customers that want direct control.

INTERNAL WEB SERVER:

The CoreLink Case Controller has a web browser interface. The browser UI can be accessed by in-store networks or using a Hussmann Wireless Connection Kit (PN 3053757) for viewing via a smart phone. No special software or application required to access CoreLink.

DATA LOGGING:

CoreLink logs operation data that can be downloaded.
- 1-minute intervals
- 7-day capacity
- Advanced analytics Browser User Interface
- Exportable CSV format

On-board data logging allows users to review performance data from the past week. User can see Min/Max/Average data along with saving data sets and importing data sets for viewing.

FACTORY RESTORE:

The CoreLink application has a configuration file with the complete and optimized default case settings. Anytime a user wants to default to factory settings they can simply access the user interface and force a factory reset.

SAVE/LOAD FEATURE:

The CoreLink Case Controller is setup from the factory with a specific product configuration when a customer purchases a display case.

This specific configuration is hard-coded into the controller and is the factory default file. There are three user save/restore presets that allow custom configuration settings to be used.

SPECIFICATIONS

DEVICE WARNINGS   ⚠WARNING

Make sure the condensing unit is switched off before working on electrical connections. All operations must be carried out by qualified personnel. To ensure proper connections, comply with the following:

DO NOT work around live electrical equipment. All operations and installations should be carried out by qualified personnel only. For safety purposes, always make sure the device is switched OFF before touching connections.

All system components should be obtained from Hussmann to ensure system compatibility and reliability.

Under no circumstances is the device to be opened – Opening the case on the device will void the warranty.

Prevent the device from being dropped, knocked or shaken as this can cause irreparable damage.

The device must always be inserted inside an electrical panel that can be accessed by authorized personnel only.

Comply with the temperature and humidity limits specified in the manual. Prevent frequent and sudden changes in temperature and/or humidity.

Do not mount devices in extremely damp and/or dirt-laden areas; Electronics should never come in contact with water or any other type of liquid.

Separate the cables of the analog inputs from those of the digital inputs and the serial line cables from the power cables (resistive as well as inductive) in order to prevent malfunction due to electromagnetic interference.

Make connections as short as possible, and do not wind them around electrically connected parts.

Do not install device in area of high mechanical stress vibrations. Harsh vibrations can cause component level failure or unintended disconnection of controller cables.

Do not clean the device with corrosive chemical products, solvents or aggressive detergents. The device must not be used in applications that differ from that specified in the following material.

Do not install the device in the presence of flammable or explosive gas. Device is not ignition protected for application in flammable environments.

Do not expose device to sulfur and ammonia gas, smoke and salt spray that can cause corrosion and/or oxidation.

Do not install device near items that generate large amounts of magnetic interference, or abnormal operation can result.

Always make sure the area near the cooling slot is ventilated and that the controllers always receive sufficient passage for cooling air.

Always comply with the laws and regulations applicable in the country where the device is installed. Always protect and stow the device securely so it can only be accessed by authorized personnel. If controller malfunctions, always contact the relative distributor for the device to be repaired.

⚠WARNING

Be aware of the current limits for the power output devices. Additional power outputs are available on the CoreLink case controller and valve drivers.

Please pay extra attention to the current limits when applying power accessories. Avoid overloading the devices.

Hussmann is not responsible for misuse of device. Hussmann is not held responsible for deviation from this manual and its intended use. If you have any questions, please contact your local Hussmann branch.

When utilizing the digital inputs of the CoreLink Case Controller, use another transformer in order to prevent the digital inputs from malfunctioning or being damaged.

WARNING!
DO NOT use the same secondary of the controller's power. Doing so can result in damage to case controller.

Any inputs that are powered with a voltage that differs from that supplied by the device (+12V or +5V) must be powered separately with another transformer.

DO NOT exceed the maximum current capacity of the onboard controller relays.

Always verify the capacity of the output used.

DO NOT use different voltages for the various groups of relays nor within each group.

Digital Output (RELAYS) have two separate groups with separate commons. Please refer to the wiring diagrams on the Web UI or within this manual for more details.

Electrical devices that are controlled by the analog outputs must be powered separately with another transformer (Do not use the same secondary of the controller's power).

DO NOT plug in accessory devices that are not approved by Hussmann.

USB WARNINGS!

USB port can support maximum 200mA.

DO NOT plug your smart device or tablet into the USB port of the controller. You cannot charge your personal devices from this port.

The CoreLink Case Controller can be connected to a computer via an external USB to Ethernet adapter. This adapter is not set up for fixed or continuous connection. If the adapter should be kept connected continuously, the room temperature must not exceed 50°C or 122°F.

CORELINK CONTROLLER

Electrical Specifications	
Power Supply	24Vac (+10/-15%) 50/60Hz 20 - 36Vdc
Consumption	30VA (Vac) - 25W (Vdc)
Connectors	Molex connectors with low voltage wiring (for IPS100D and IPS400D) Phoenix quick coupling connectors for low voltage (for IPS200D) STELVIO 90° screw connectors for digital outputs (250Vac, 6A max)

Mechanical Specifications	
Mounting	On a DIN rail (EN 50022, DIN 43880) Fastened with screws via the removable plastic flaps.
Operating temperature	-10 to 60°C; Storage: -30 to 85°C
Relative humidity	20 to 85% (no condensing)

DIGITAL INPUT / OUTPUT

Digital Input	
Type	Opto-insulated live contact (24Vac/dc) External power 24 Vac/dc ±20%
Number of Inputs	11

Digital Output	
Number of Outputs	8
Type of output . . . . (Configurable via software parameter)	Relays with normally open contact
Maximum load.	5A(250Vac) SPST 5(2)A
NOTICE	Verify the capacity of the output used. There is double insulation between the digital outputs and the low voltage of the rest of the circuit.
See Specifications Warnings.	Do not use different voltages for the various groups of relays nor within each group.

ANALOG INPUT / OUTPUT

Analog Input

Number of Inputs 6

Type of Analog Input . . . . NTC Dixell (-50T110°C; 10KΩ±1% at 25°C)
PTC Dixell (-55T115°C; 990Ω±1% at 25°C)
Digital input (potential free contact)
Voltage: 0 - V, 0 - 5V, 0 - 10V
(input resistance 3.7KΩ)
Current: 0 - 20mA, 4 - 20mA
(input resistance 100Ω)

Additional Power. . . . . +12V: 200mA in total
(between +12V and analogue outputs)
+5v: 100mA

NOTICE . . . . Any inputs that are powered with a voltage
that differs from that supplied by the device
(+12V or +5V) must be powered separately
with another transformer (do not use the
See Specifications Warnings   same secondary of the controller's power)
in order to prevent the inputs from
malfunctioning or being damaged.

Analog Output

Type . . . . Non opto-insulated internal power

Number of Inputs 4

Type of Analog Input . . . . 4 configurable outputs 0-10Vdc 4-20mA
(Out1 - Out4)

Maximum Load . . . . 40mA (Out1 - Out4) max with configured out
puts 0-10Vdc
400Ω max with configured outputs 4-20mA
22Ω per live analogue output

NOTICE . . . . The electrical devices controlled by these
analogue outputs must be powered separately
with another transformer (do not use the
same secondary of the controller's power) in
order to prevent the outputs from
malfunctioning or being damaged.

HOW TO CONNECT TO CORELINK CONTROLLER

Wireless Connection

The following items are required for first time connection:

Wireless Connection Kit

➢ Wireless Access Point
➢ One Wireless Connection Kit - PN 3053767
➢ One Computing Device
   • Smartphone / Mobile
   • Tablet
   • Laptop
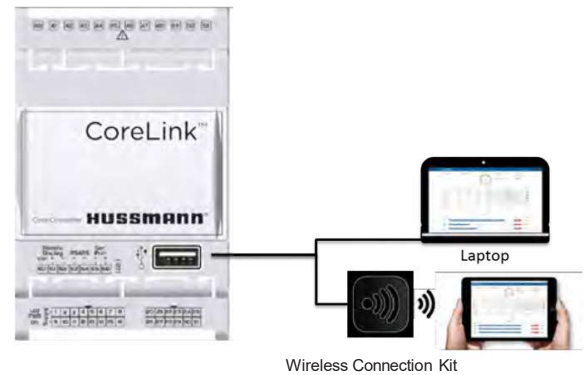
Connect the CoreLink with Wireless Access Point:

1. Connect your wireless access point box to the CoreLink USB port.

2. Allow the router boots up (about 30 seconds). Next, open your laptop/tablet/phone wireless network connection panel and use the default Wi-Fi network/SSID name and network key/ password noted below. These are also printed on the wireless connection kit.

Wireless Network Name/SSID:
HSM_CORELINK_AP

Network Key / Password:
HussmannCL1234

NOTICE

This device must not leave the store.
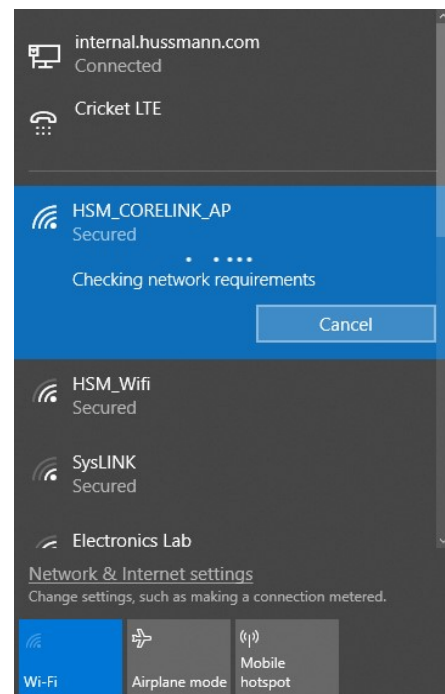
3. Launch a web browser.

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- Safari

NOTE:
Clear cache to see latest Web UI Version. If your browser is still not working, please try the other browsers before reporting an issue.

4. Enter controllers IP into the Address/Search Bar of your browser.

Default – 192.168.0.250 Other – Review Store Network Chart
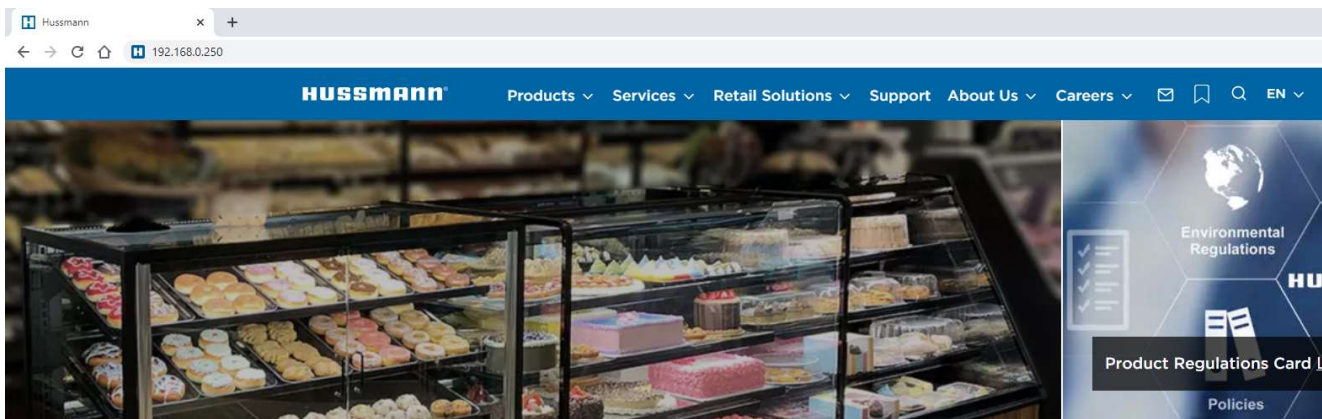
5. The controller login page will appear.
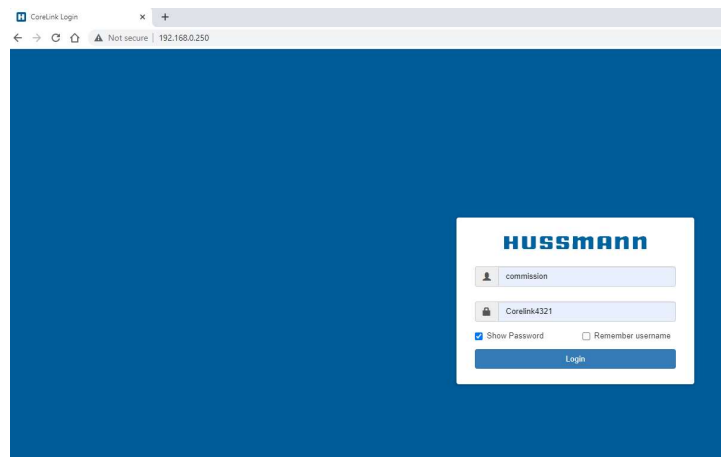
Direct Wired Connection

1. Connect laptop with RJ-45 ethernet cable/USB adaptor to CoreLink Case Controller

2. Change laptop network settings – open laptop network settings, right click Ethernet, select Properties.
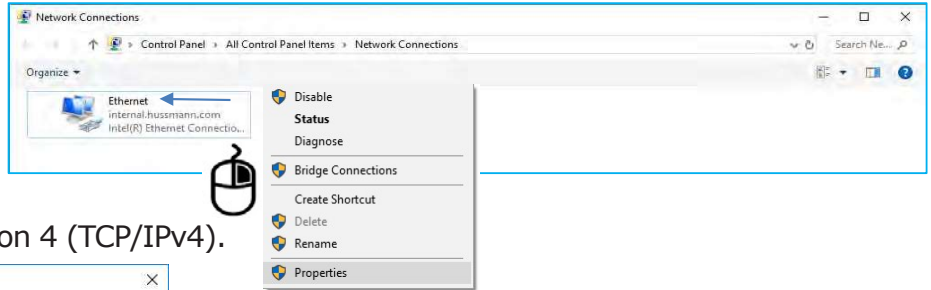
3. Select Internet Protocol Version 4 (TCP/IPv4).

Click > Properties
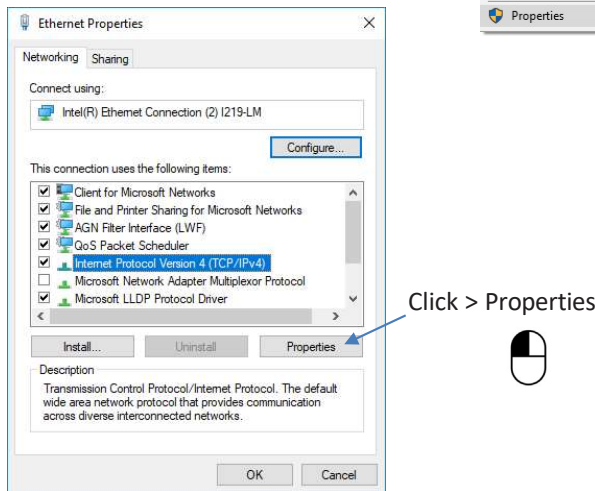
4. Enter IP address and subnet mask Internet Protocol Version 4 (TCP/IPv4) Properties

   Select Radial Button "Use the following IP address:" IP address: 192.168.0.1
   Subnet mask: 255.255.255.0
   Select "OK"

NOTE:
Changes to your Ethernet port settings might affect normal connection to the Internet with your personal laptop.

To revert Ethernet settings, repeat Steps 1-4.

Select > Obtain IP address automatically button on the general tab of the dialog box shown in the illustration at right. Click > OK
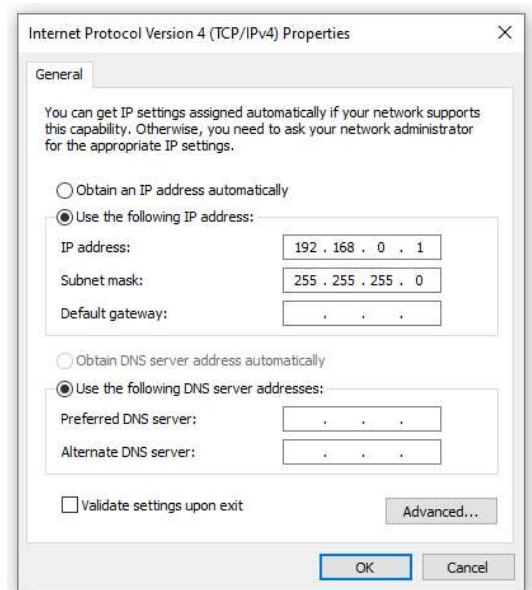
Direct Wired Connection

➢ One RJ-45 Ethernet to USB adaptor (details below)
➢ One RJ-45 Ethernet cable
➢ A laptop with an RJ-45 Ethernet port

- **USB 2.0 to Ethernet Adaptors**
- **(Approved RJ-45 Ethernet to USB adaptor)**

Amazon Basic AE2233X2
https://www.amazon.com/gp/product/B00M77HLII/
ref=ppx_yo_dt_b_ search_asin_title?ie=UTF8&psc=1

Manhattan 506731
https://manhattanproducts.us/products/manhattan-
en-usb-20-fast-ethernet-adapter-506731

Insignia NS-PU98505
https://www.bestbuy.com/site/insignia-usb-2-0-to-
ethernet-adapter-white/6233049.p?skuId=6233049

SUCCESSFUL CONNECTION TO CORELINK

Once you have established a connection to the CoreLink Controller, a Hussmann launch screen (pictured to the right) will appear.

NOTE:
Username and password are case sensitive.

After logging in, the CoreLink condensing unit summary page is displayed.
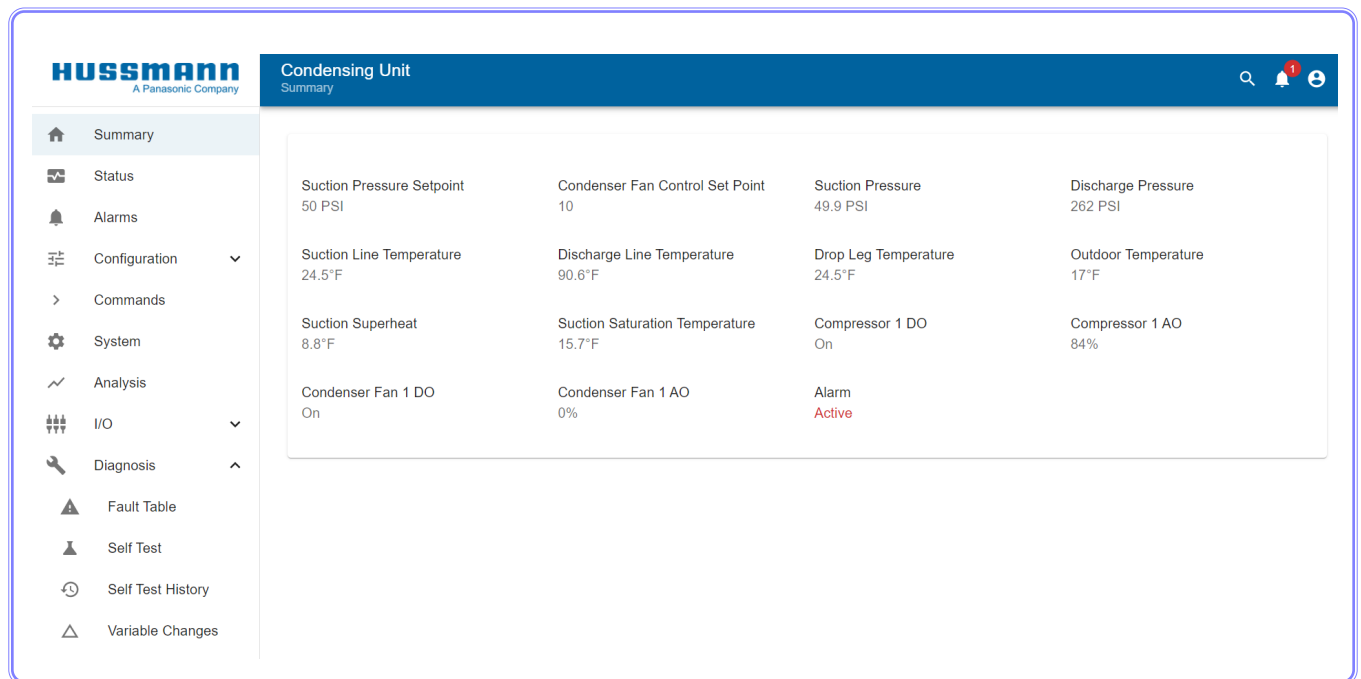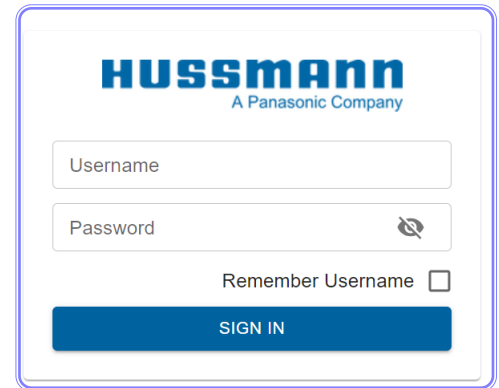
CORELINK LOGIN CREDENTIALS

SW version >= 2.6.0	All Previous Versions
Level 1 User Name: user Password: Hussmann	Level 1 User Name: Hussmann1 Password: Hussmann
Level 2 User Name: service Password: Hussmann1234	Level 2 User Name: Hussmann2 Password: Corelink1234
Level 3 User Name: commission Password: Corelink4321	Level 3 User Name: Hussmann3 Password: Corelink4321
Admin Not Available	Admin User Name: admin Password: Hussmann

APPLICATION

WEB UI STATUS HOME PAGE

Status Table

This status table displays alarms quick search for parameter set points in the controller and login page. The status page automatically updates at every 10-second interval to report any alarm (if available).

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The table below provides information about the inputs and outputs used for the HE H-Series condensing unit.

Digital I/O		Analog I/O	
Input	Output	Input	Output
Phase Loss	Compressor 1	Suction Pressure	Compressor 1
Compressor Run Proof	Condenser Fan 1	Discharge Pressure	Condenser Fan 1
Compressor IDCM Alarm	Vapor Injection Valve 1	Discharge Temperature	Hold Back Valve 1
Low Pressure Switch	Blocked Solenoid Valve 1	Outdoor Temperature	Compressor 1 Loader
High Pressure Switch	Alarm	Suction Temperature	
Oil Failure		Drop Leg Temperature	

ALARMS MENU

Superheat
If suction line temperature is only a few degrees above saturation on the suction line temperature outlet, superheat is too low and could be dangerous for compressor operation. If suction line temperature rises drastically above the saturation temperature on the suction line, superheat is too high for normal refrigeration performance.
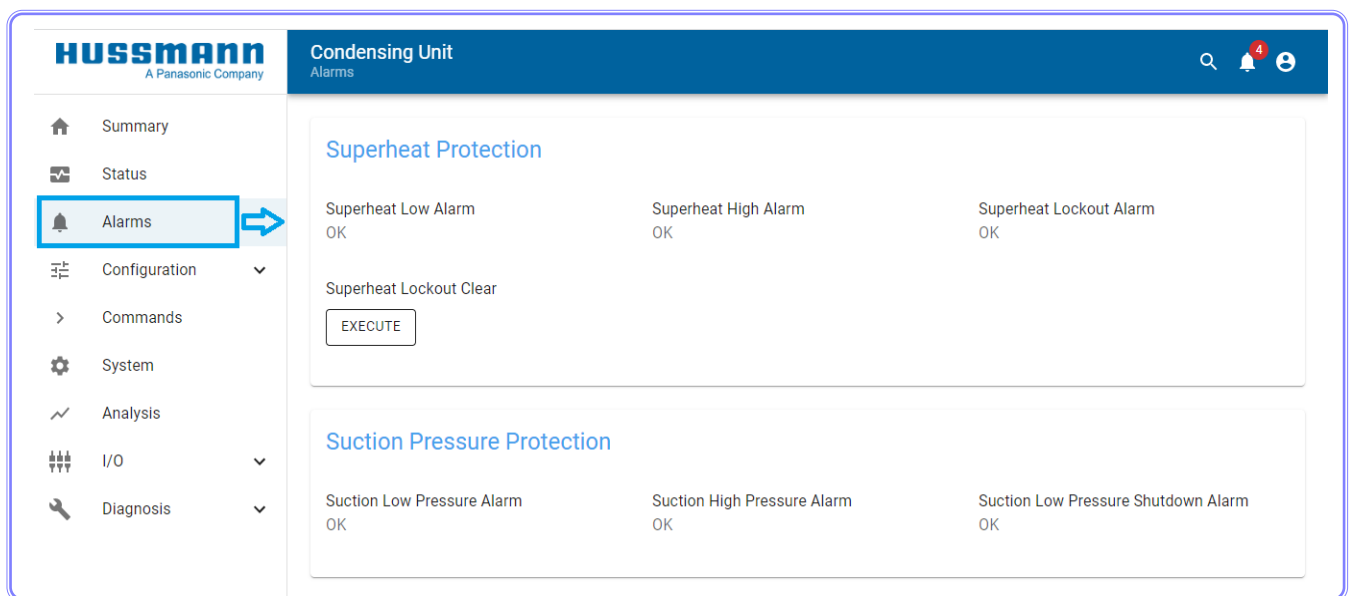
Suction Pressure Protection

The controller is equipped with the ability to generate an alarm or shut down the compressor in the event of low suction pressure.

- **Suction Low Pressure Alarm:** Alarm is generated when actual suction pressure value is less than the suction pressure low limit for the duration set in *SPP pressure alarm delay*.
- **Suction High Pressure Alarm:** Alarm is generated when actual suction pressure value is greater than the *SPP High pressure limit* for the duration set in the *SPP pressure alarm delay*.
- **Suction Low Pressure Shutdown Alarm:** Compressor will shutdown and generate alarm when suction pressure reaches to *SPP compressor shutdown limit* after *SPP pressure alarm delay*. Alarm is clear when suction pressure is greater than *suction shutdown limit + SPP Low Pressure Diff* after *SPP pressure alarm delay*.

Suction Pressure Protection (SPP)

SPP Enable	SPP Low Pressure Limit	SPP Low Pressure Diff	SPP High Pressure Limit
	Range: 0 to 200	Range: 0 to 30	Range: 0 to 200
Enable	45 PSI	5 PSI	80 PSI

SPP High Pressure Diff	SPP Shutdown Enable	SPP Compressor Shutdown Limit	SPP Pressure Alarm Delay
Range: 0 to 30		Range: 0 to 200	Range: 0 to 360
5 PSI	Enable	5 PSI	60 sec

Discharge Pressure Protection

- **Discharge Pressure Low Alarm:** Alarm is active when actual discharge pressure value is lower than the *DPP low pressure limit* for a duration set in *DPP pressure alarm delay*.
- **Discharge Pressure High Alarm:** Alarm is active when actual discharge pressure value is greater than the *DPP high pressure limit* for a duration set in *DPP Pressure Alarm Delay*.
- **Compressor Shutdown Limit:** Compressor will shutdown and generate alarm when actual discharge pressure reaches to Compressor Shutdown limit for a duration set in DPP pressure alarm delay. Alarm is clear when discharge pressure is less than *DPP High Pressure Limit - DPP high pressure diff* after *DPP pressure alarm delay*.

Discharge Pressure Protection (DPP)

DPP Enable	DPP Low Pressure Limit	DPP Low Pressure Diff	DPP High Pressure Limit
	Range: 0 to 500	Range: 0 to 50	Range: 0 to 500
Enable	70 PSI	10 PSI	350 PSI

DPP High Pressure Diff	DPP Shutdown Enable	Compressor Shutdown Limit	DPP Pressure Alarm Delay
Range: 0 to 50		Range: 0 to 500	Range: 0 to 360
25 PSI	Enable	375 PSI	30 sec

Compressor IDCM Alarm: This alarm is active when IDCM (DI) generates an alarm.

Discharge Line Temperature Alarms

- **Discharge Line Temperature High Alarm:** When enabled, the discharge line temperature high alarm will be active if the compressor discharge line temperature value is greater than the Discharge Line Temperature Protection (DLTP) cut-off temp set. Compressor will turn back on when the discharge line temperature reaches the DLTP Cut-in Temp.
- **Discharge Line Temperature Lockout Alarm:** Compressor will be locked out when the actual number of high discharge temperature alarm count within the lockout duration time.
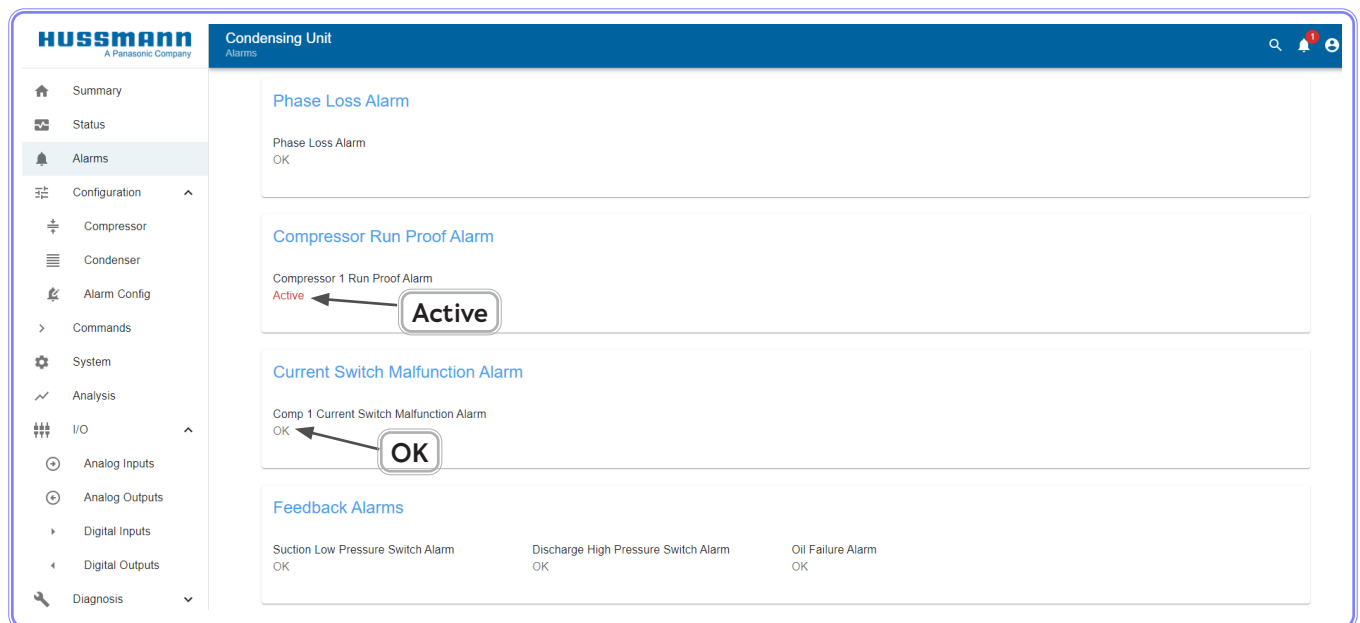
The following will be the status display when controller is "OK" or in "alarm" mode:

Where "OK" in green color **OK** means no alarm. Active alarm will be displayed in red color as shown. **Active**

- **Phase Loss Alarm:** Alarm is active when a phase loss is detected on any of the power lines. Phase loss alarm will shut compressor and condenser off. This alarm needs to be investigated.
- **Compressor Run Proof Alarm:** If this is configured, the alarm will be generated when no signal is received from the compressor run proof.
- **Current Switch Malfunction Alarm:** When enabled in the controller, this will monitor the status of the compressor run proof for open or close position depending on the CSR configuration to generate an alarm for defective CSM or CSR.

- **Feedback Alarms:**
    1. **Suction Low Pressure Switch Alarm:** When enabled in the controller and wired, compressor will shutdown and generate alarm when LPC switch opens. Alarm is clear when LPC switch returns to normal.

    2. **Discharge High Pressure Switch Alarm:** When enabled in the controller and wired, compressor will shutdown and generate alarm when HPC switch opens on high pressure. Alarm is cleared when high pressure switch returns to normal.

    3. **Oil Failure Alarm:** Alarm is active when low oil level signal is received from the oil level control device.

CONDENSING UNIT - ANALOG INPUT

The controller will generate an alarm for all input/outputs points that is configured and not wired or missing on the controller.

Available digital inputs alarms that can be configured in the controller:

- **Alarms tied with the digital inputs:**
    1. Suction pressure switch alarm

    2. Discharge pressure switch alarm

    3. Oil failure alarm

    4. IDCM alarm

    5. *Current switch alarm* -With current switch feedback, controller can decide the run proof alarm / malfunction alarm

    6. Phase loss alarm

- **Alarms tied with the analog inputs:**
    1. Suction temperature

    2. Discharge temperature

    3. Outdoor temperature

    4. Suction pressure

    5. Discharge temperature

    6. Drop-leg pressure

Analog Input Alarms		
Probe Alarm 1 (Suction Pressure) OK	Probe Alarm 2 (Discharge Pressure) OK	Probe Alarm 3 (Discharge Line Temper… OK
Probe Alarm 4 (Outdoor Temperature) OK	Probe Alarm 5 (Suction Line Temperat… OK	Probe Alarm 6 (Drop Leg Temperature) OK

CONFIGURATION

The CoreLink Controller parameter menus are organized under the Configuration drop down.

Compressor configuration includes:
Type of compressor being used on the unit, suction pressure set point, sensor filter settings, compressor timings, compressor capacity settings, analog output settings, and PID setup.

Condenser configuration includes:
Types of condenser control, condenser pressure setpoint, condenser capacity settings, and condenser PID settings.

Alarm configuration includes:
Superheat alarm protections: Suction Pressure Protection (SPP), Discharge Pressure Protection (DPP), Compressor IDCM Alarm, Discharge Line Temperature Protection(DLTP), Phase Loss Alarm (PL), Compressor Run Proof alarm (CRP), Current Switch Malfunction Alarm (CSM), and Feedback alarm delay.
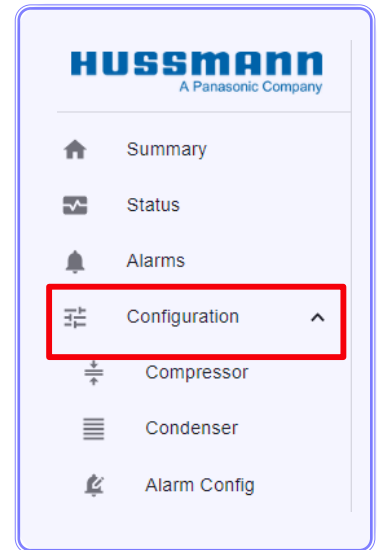
COMPRESSOR

Compressor Controls:
Compressor will run continuously if the minimum suction pressure and all condition for the compressor is satisfied and there is no alarm generated or active in the controller.
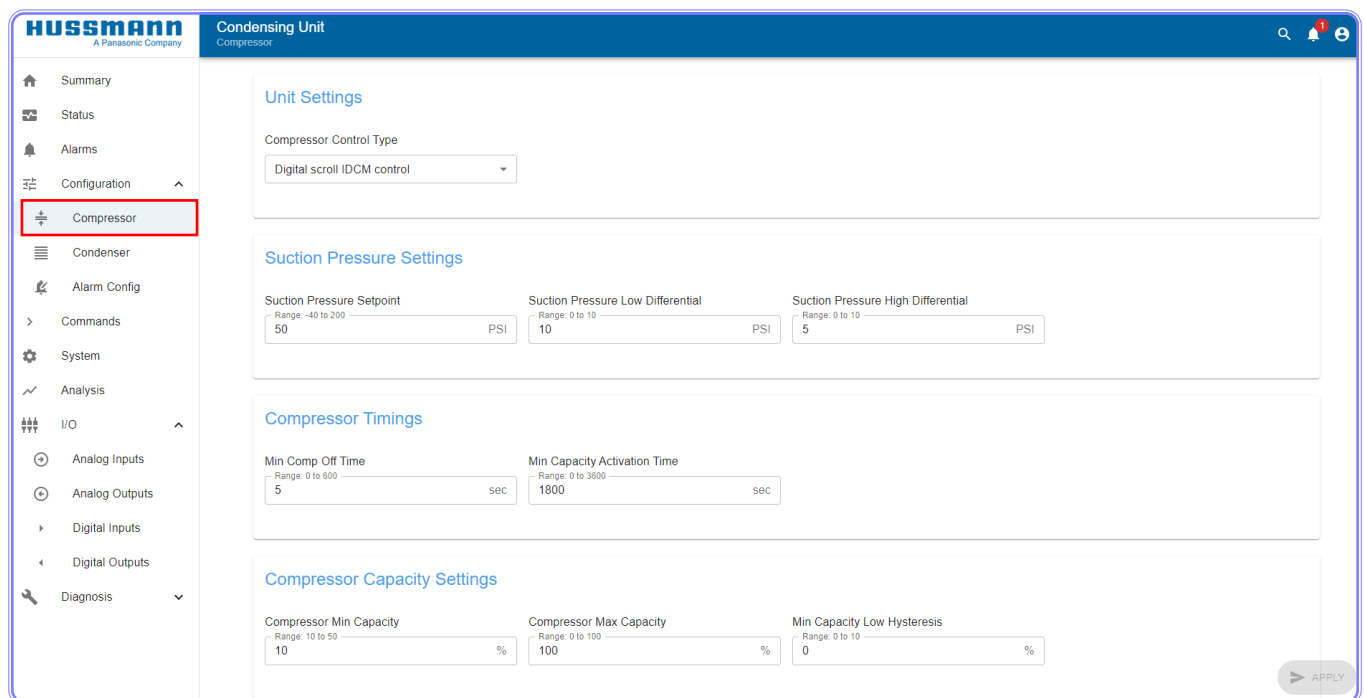
3-7

Unit Settings

Compressor Control Types

There are 4 different compressor operations in
this version of the application.
- Digital scroll IDCM control
- Digital scroll directly control
- Bitzer recip CMR01
- Standard compressor control (ON / OFF with digital output)

NOTE:
Compressor operation will vary as per the different operations.

Unit Settings

Compressor Control Type

Digital scroll IDCM control ▲

Digital scroll IDCM control

Digital scroll direct control

Bitzer recip VUII

Bitzer recip CMRC01
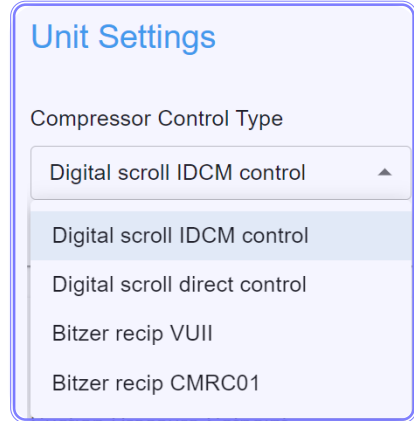
Suction Pressure Settings
The controller comes with a default settings based on refrigerant type being used and other
factors such as temperature, LT or MT unit.

Suction Pressure Set Point: PID will modulate the digital compressor capacity based on suction
pressure deviation from suction pressure set point.

- **Suction Pressure High Differential:** This is the higher band from the set point.
- **Suction Pressure Low Differential:** This is the lower band from the set point.

Example: If the set point is 40 and the low and high differential is 10 each, the lower band will
be 40-10=30, and the upper band will be 40+10=50. The final band is 30-50, and the PID will
modulate between these values.

Suction Pressure Settings

Suction Pressure Setpoint	Suction Pressure Low Differential	Suction Pressure High Differential
Range: -40 to 200	Range: 0 to 10	Range: 0 to 10
50 PSI	10 PSI	5 PSI
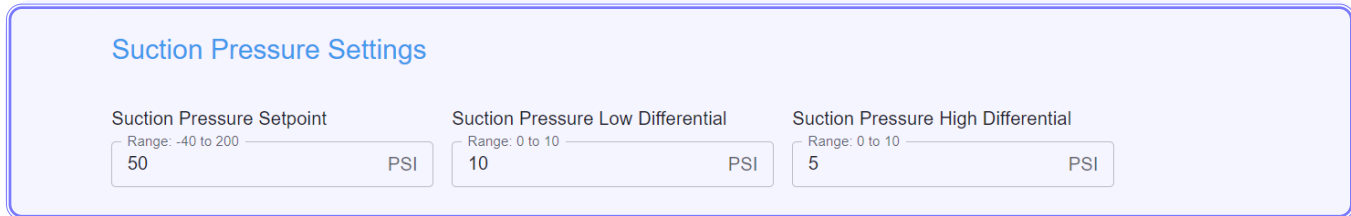
Compressor Timings
Compressor timings are set for compressor to respond to changes such as when to turn OFF/ON,
delay an alarm or to run at low speeds.

Min Comp Off Time: This is the duration of time in which the compressor must remain OFF after
being turned off for any reason before turning back ON .

Min Capacity Activation Time: This is the duration of time that the compressor will be allowed
to run at its minimum capacity before turning OFF. Compressor will be turn off to avoid oil
circulation issues if the pressure does not rise to allow full speed of the compressor.

Compressor Timings

Min Comp Off Time	Min Capacity Activation Time
Range: 0 to 600	Range: 0 to 3600
5 sec	1800 sec

Compressor Capacity Settings

The following set points in the controller can be adjusted to improve the compressor performance and to save energy:

- **Compressor Minimum Capacity:** This editable tab can be set between a range from 10 to 50%. The recommended minimum capacity speed is 20 percent.
- **Compressor Maximum Capacity:** Vary maximum capacity range from 0 to 100 percent.
- **Compressor Capacity Change Rate:** The rate of change of the input once it exceeds the minimum capacity. Maximum change of the input value will not exceed the change rate limit in one cycle.
- **Compressor Load / Unload Delay:** Delay for the load / unload.
- **Min Capacity Low Hysteresis:** Is the minimum capacity set point required for the compressor to work.

Compressor Capacity Settings

Compressor Min Capacity	Compressor Max Capacity	Min Capacity Low Hysteresis
Range: 10 to 50	Range: 0 to 100	Range: 0 to 10
10 %	100 %	0 %

Compressor PID Settings

A Proportional–Integral–Derivative (PID) controller is a control loop mechanism widely used in industrial control systems when continuously modulated control is needed. A PID controller calculates an error value $e(t)$ as the difference between a desired set point (SP) and a measured process variable (PV) and applies a correction based on proportional, integral, and derivative, terms (P, I, and D respectively).

PID will be working as per the input suction pressure deviation from its set point. Compressor will modulate its speed as per the PID values.

Once the suction pressure deviates from the suction pressure set point the compressor capacity will modulate with respect to the PID output.

Compressor PID Settings

Compressor P Factor	Compressor I Factor	Compressor D Factor	Compressor Sample Time
Range: 0 to 100	Range: 0 to 25.5	Range: 0 to 25.5	Range: 0 to 1000
1 PSI	0.5	0	1 sec

Compressor Controls

The type of compressor to be used can be selected from the drop-down box at right:

Digital Scroll IDCM Control:

IDCM – Is an electronics interface between the Discus digital scroll compressor and the system controller. It provide power to properly energize and de-energize the solenoid to control the compressor loading and unloading.
If the voltage drops below 1.0V, IDCM will enable the alarm after the **Alarm delay**.
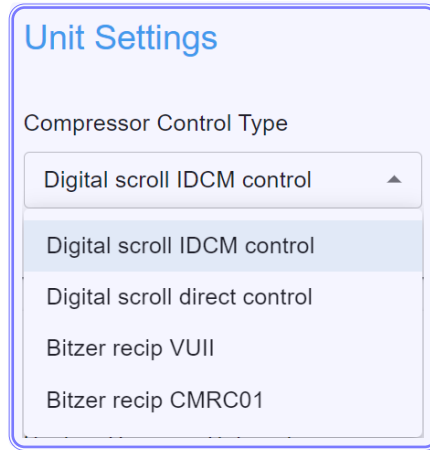
Unit Settings

Compressor Control Type

Digital scroll IDCM control ▲

Digital scroll IDCM control

Digital scroll direct control

Bitzer recip VUII

Bitzer recip CMRC01

Compressor Controls

The type of compressor to be used can be selected from the drop-down box below:

Digital Scroll IDCM Control:

IDCM:Is an electronics interface between the Discus digital scroll compressor and the system controller. It provide power to properly energize and de-energize the solenoid to control the compressor loading and unloading.

If the voltage drops below 1V, IDCM will enable the alarm after the **Alarm delay**.

When interfacing with the digital scroll compressor through IDCM, the capacity modulation shall be achieved by supplying 1 – 5Vdc where:

1.0Vdc is 0% capacity (if the signal falls below 10% capacity (1.25Vdc on decreasing demand) the compressor would shut down).

5.0Vdc is 100% capacity (if the signal rises above 10% capacity (1.44Vdc on increasing demand) the compressor would start).

Based on the demand when the compressor needs to be turned off, the application will limit the AO to 1.0Vdc to avoid any alarm to be reported by the IDCM.

Analog Output Configuration

AO 1 (Pin 7)

Compressor 1 ▼

Analog Output Type

AO 1 Type (Pin 7)

1-5V ▼
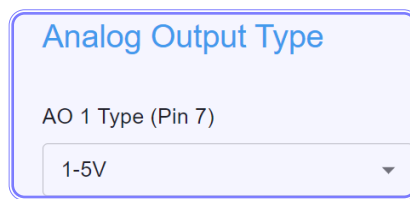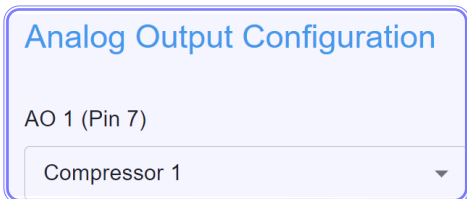
This configuration can be done by selecting the analog output control signal 1-5V to control the digital compressor.

Set the analog output range for the (1 - 5V): (1.0VDC is 0% capacity, 5.0VDC is 100% capacity)

When the signal falls below 10% capacity (1.25VDC on decreasing demand), the compressor would shut down.

When the signal rises above 10% capacity (1.44VDC on increasing demand), the compressor would start.

Digital Scroll Direct Control

When interfacing with the digital scroll compressor directly, the capacity modulation shall be achieved by energizing and de-energizing the solenoid valve through Pulse Width Modulation (PWM) signal.

- When the solenoid valve is de-energized, the compressor capacity is 100%.
- When the solenoid valve is energized, the compressor capacity is 0%.

The PWM cycle time (energized + de-energized time) is 20 seconds based on Copeland's recommendation.

The CoreLink controller will monitor suction pressure and generate the PWM signal to control the digital compressor by starting to de-energized (loaded) state and ending in an energized (unloaded) state. When the digital compressor is turned on, it will be at digital compressor minimum capacity.

The rate at which the digital is ramped up or down every 20 seconds of the PWM cycle shall be limited to the digital compressor change rate limit set point.

Digital Scroll Direct Control – (100% – 0%)
- Set the analog output range for minimum 20% to maximum 100%.
- When the solenoid valve is de-energized, the compressor capacity is 100%.
- When the solenoid valve is energized, the compressor capacity is 0%.

Unit Settings

Compressor Control Type

Digital scroll direct control ▲
Digital scroll IDCM control
Digital scroll direct control
Bitzer recip VUII
Bitzer recip CMRC01
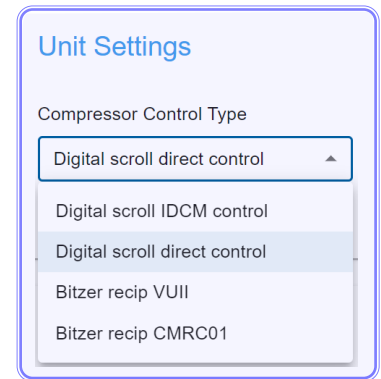
Controlling Bitzer reciprocating through VUII or CMRC01

Example: If the compressor to be used is a Bitzer CMRC, select the compressor control from the below selection menu.

Unit Settings

Compressor Control Type

Bitzer recip VUII ▲
Digital scroll IDCM control
Digital scroll direct control
Bitzer recip VUII
Bitzer recip CMRC01

Unit Settings

Compressor Control Type

Bitzer recip CMRC01 ▲
Digital scroll IDCM control
Digital scroll direct control
Bitzer recip VUII
Bitzer recip CMRC01
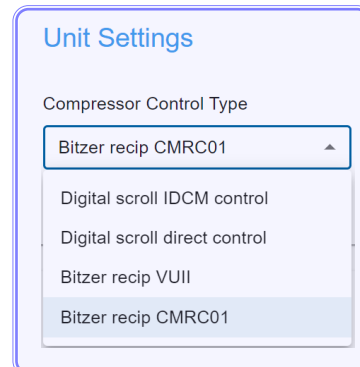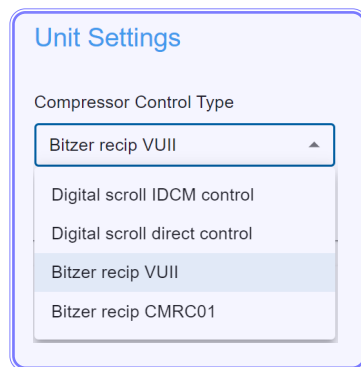
Then select the analog output configuration as compressor 1 and set the analog output voltage type to 0-10V to control the CMRC module.

Analog Output Configuration

AO 1 (Pin 7)

Compressor 1 ▼

Analog Output Type

AO 1 Type (Pin 7)

0-10V ▼
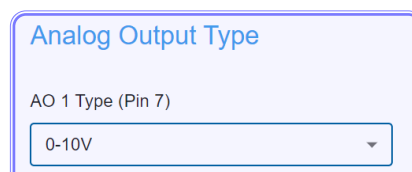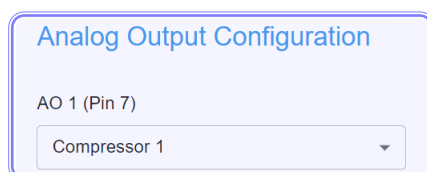
CONDENSER

A condenser is a heat exchanger that condenses a gaseous substance into a liquid state through cooling. The latent heat in this process is released by the substance and transferred to the surrounding environment.

The condenser fan speed variation depends on the input discharge pressure deviation from the discharge pressure set point, or outdoor temperature from the drop-leg temperature. When using electronically commutated motors (ECM), a voltage selection of 10-0V is required to run the motor. A 10V signal will stop the fan and a 0V signal will run the fan at full speed. PID will vary the condenser fan speed between the band offset with analog output from 10 to 0V.

Condenser Fan Controls

The following condenser fan control strategies are available for condenser fan controls:

- Discharge Pressure TD Control
- Fixed Discharge Pressure Control
- Drop Leg Pressure TD Control
- Fixed Drop Leg Pressure Control

Discharge Pressure TD Control
Select the Discharge Pressure TD Control from
the Condenser Fan Control Tab:
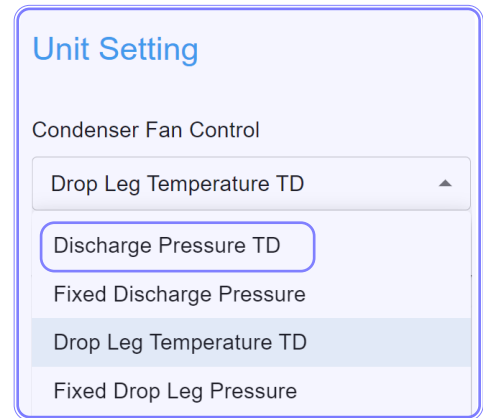
Unit Setting

Condenser Fan Control

| Drop Leg Temperature TD | ▲ |

Discharge Pressure TD

Fixed Discharge Pressure

Drop Leg Temperature TD

Fixed Drop Leg Pressure

When the Discharge Pressure TD Control is selected, it
will modulate the condenser fan speed to maintain the
temperature difference. This is defined in the **Condenser
TD Set Point Parameter** between the outside air
temperature and saturation temperature (discharge
pressure converted to temperature based on the
refrigeration type).

To find out the saturation temperature, select the
refrigerant type:

Refrigerant Type

| R-404A | ▲ |

R-404A

R-407A

R-407F

R-448A

R-449A

R-507A

R-513A
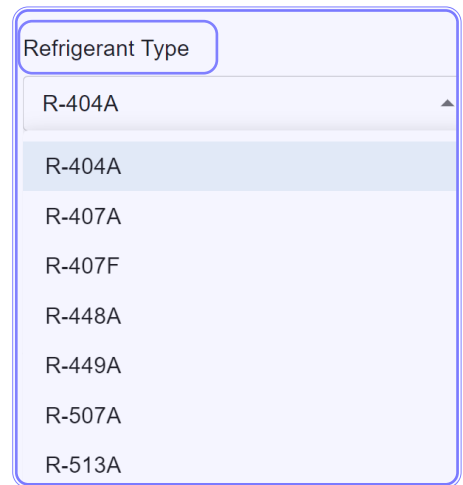
Fixed Discharge Pressure Control
When selected, the Fixed Discharge Pressure Control will
modulate the condenser fan speed to maintain the discharge
pressure around the set point (configured in the Condenser
Pressure Set Point Parameter.)

Unit Setting

Condenser Fan Control

| Fixed Discharge Pressure | ▲ |

Discharge Pressure TD

Fixed Discharge Pressure

Drop Leg Temperature TD

Fixed Drop Leg Pressure
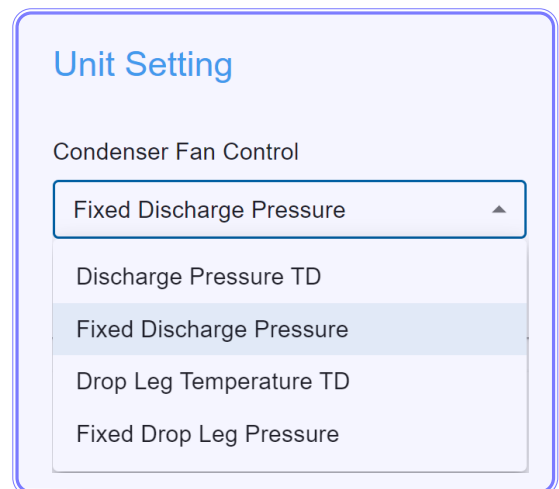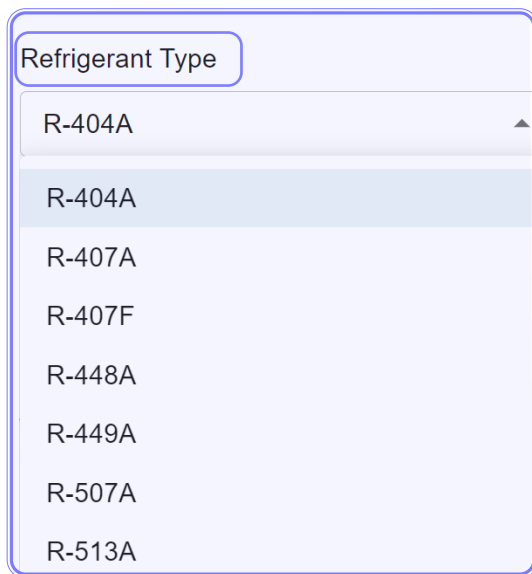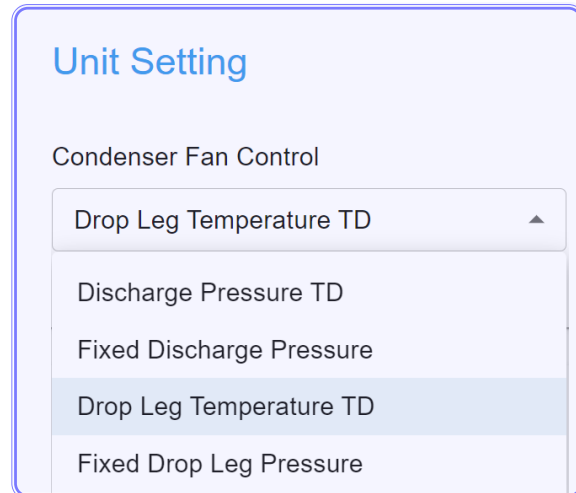
Drop Leg Temperature TD Control
Select the Drop Leg Pressure TD Control from the condenser control tab.

When drop leg temperature TD control is selected, it will modulate the condenser fan speed to maintain the temperature difference (defined in the Condenser TD set point parameter) between the outside air temperature and drop leg saturation temperature (drop leg pressure converted to temperature based on the refrigeration type).

Unit Setting

Condenser Fan Control

Drop Leg Temperature TD	▲

Discharge Pressure TD

Fixed Discharge Pressure

Drop Leg Temperature TD

Fixed Drop Leg Pressure

Refrigerant Type

R-404A	▲

R-404A

R-407A

R-407F

R-448A

R-449A

R-507A

R-513A
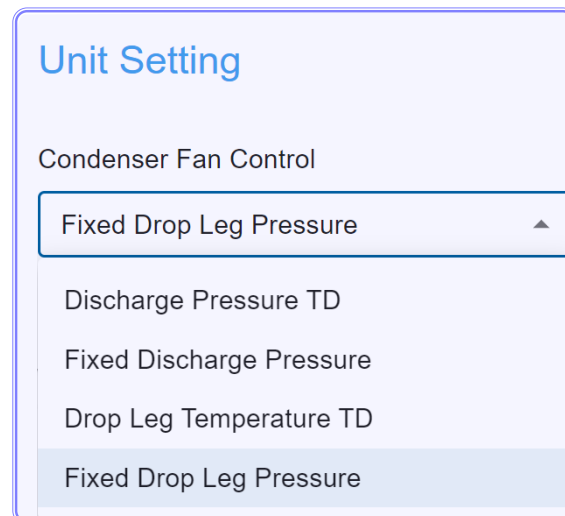
Fixed Drop Leg Pressure Control
To use any control strategy, click in the drop box to select the type of control to use.

When the fixed drop leg pressure control is selected, it will modulate the condenser fan speed to maintain the drop leg pressure around the set point (configured in the condenser pressure set point parameter).

Unit Setting

Condenser Fan Control

Fixed Drop Leg Pressure	▲

Discharge Pressure TD

Fixed Discharge Pressure

Drop Leg Temperature TD

Fixed Drop Leg Pressure

TD Control Set Point: When the Drop Leg Temp / Discharge Pressure TD control is selected, this parameter is used as a set point for the drop leg temp TD control (Outdoor temperature minus the drop leg saturation temperature compared to set point). In the Discharge Pressure TD control, the condenser TD set point equals the outside air temperature minus the saturation temperature).

Pressure Control Set Point: If the Fixed Discharge Pressure is selected, the output will modulate the condenser fan speed to maintain the discharge pressure around the condenser pressure set point parameter.

Pressure Low Differential: Condenser fans will be off if the Discharge Pressure or Drop Leg Temperature reaches the Pressure Control Set Point minus the Pressure Low Differential. Pressure High Differential: Condenser fans will be ON if the Discharge Pressure or Drop Leg Temperature reaches or is greater than the Pressure Control Set Point plus Pressure High Differential.

TD Control Low Limit Floating Set Point: If the Drop Leg Temperature TD control is configured, the fan will modulate if the outside air is above the TD control high limit floating set point. The condenser fans will always be OFF (if the outdoor temperature is less than the TD control low limit floating set point, and when the head pressure goes up above the Pressure Control set point the fan will modulate to maintain head pressure).

TD Control High Limit Floating Set Point: If the Drop Leg temperature TD control is configured, the condenser fans will be always ON (if the outdoor temperature is greater than the TD control low limit floating set point).

Condenser Pressure Setpoint

TD Control Setpoint	Pressure Control Setpoint	Pressure Low Differential	Pressure High Differential
Range: 0 to 500	Range: 0 to 500	Range: 0 to 50	Range: 0 to 50
10	140 PSI	10 PSI	10 PSI

TD Control Low Limit Floating Set P...	TD Control High Limit Floating Set P...
Range: 0 to 500	Range: 0 to 500
60	90

Condenser Min Capacity: Condenser runs at the minimum speed dependent upon the temperature and discharge pressure value set points.

Condenser Max Capacity: Condenser runs at the maximum speed dependent upon the temperature and discharge pressure value set points.

Condenser Capacity Settings

Condenser Min Capacity	Condenser Max Capacity
Range: 0 to 100	Range: 0 to 100
0 %	100 %

Setting the PID Parameters

A Proportional–Integral–Derivative (PID) controller is a control loop mechanism widely used in industrial control systems when continuously modulated control is needed. A PID controller calculates an error value e(t) as the difference between a desired set point (SP) and a measured process variable (PV) and applies a correction based on proportional, integral, and derivative, terms (P, I, and D respectively).

Once the condenser fan input (discharge pressure / drop leg pressure) deviates from the discharge pressure set point / TD set point, the condenser capacity will modulate with respect to the PID output.

The PID will vary the condenser fan speed between the band offset with analog output from 10 to 0V.

Condenser P Factor = Proportional Band
Condenser I Factor = Integral Sampling Interval
Condenser D Factor = Derivative Sampling Interval
Condenser Sample Time = Time Delay for PID Output Update

Condenser PID Settings

Condenser P Factor
Range: 0 to 100
2   PSI

Condenser I Factor
Range: 0 to 25.5
0.5

Condenser D Factor
Range: 0 to 25.5
0

Condenser Sample Time
Range: 0 to 1000
1   sec

ALARMS CONFIGURATION

Select the Alarm Config from the drop-down menu to set settings for the different alarms.

Configuration

Compressor

Condenser

Alarm Config
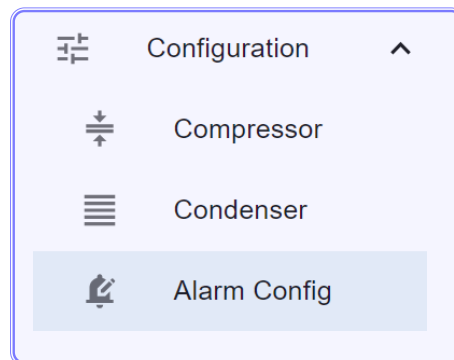
Suction Pressure Protection
Suction pressure is monitored to indicate abnormal or undesirable levels of suction pressure in the system.

SPP Enable:
When enabled in the controller, alarm will be active upon detection of both low or high suction pressure alarm.

SPP Disable:
The respective alarm will not be active even when a fault condition is available.

SPP Low Pressure Limit:
Is the minimum amount of pressure on the suction line minus the low-pressure diff to the compressor at which low pressure alarm will be active.

SPP Low Pressure Diff:
Is the pressure diff above or below the Suction Pressure Protection (SPP) Low Pressure limit.

Alarm Delay
Delay in seconds / minutes before the alarm becomes active.

High Pressure Limit:
Is the maximum amount of suction pressure plus high pressure diff allowed to the compressor at which an alarm will be active.

High Pressure Differential:
Is the maximum difference in suction pressure between the suction pressure set point and the high-pressure differential.

SPP Shutdown Enable:
When this is enabled in the controller the controller will shutdown on Low Suction Pressure alarm.

Suction Pressure Protection (SPP)

SPP Enable	SPP Low Pressure Limit	SPP Low Pressure Diff
Enable	Range: 0 to 200 45 PSI	Range: 0 to 30 5 PSI

SPP High Pressure Limit	SPP High Pressure Diff	SPP Shutdown Enable
Range: 0 to 200 80 PSI	Range: 0 to 30 5 PSI	Enable

SPP Compressor Shutdown Limit	SPP Pressure Alarm Delay
Range: 0 to 200 5 PSI	Range: 0 to 360 60 sec

Discharge Pressure Protection
Discharge pressure in the system is monitored to indicate abnormal or undesirable levels of discharge pressure.

DPP Low Pressure Limit:
Is the discharge pressure at which the discharge low alarm will be activated when discharge pressure is less than the Low Pressure Limit Set Point.

DPP Low Pressure Differential:
Is the discharge pressure difference at which the low pressure alarm will be deactivated when discharge pressure is greater than Low Pressure Limit Set Point + Low Pressure Differential.

DPP High Pressure Limit:
Is the discharge pressure at which the discharge high alarm will be activated when discharge pressure is greater than the High-Pressure Limit Set Point.

DPP High Pressure Differential:
Is the discharge pressure difference at which the high-pressure alarm will be deactivated when discharge Pressure is less than High Pressure Limit Set Point - High Pressure Differential.

DPP Shut Down Enable/Disable:
If the DPP shutdown is enabled, the compressor will be shut down by the controller when the discharge pressure is higher than the shutdown limit set points.

Disable – If DPP shutdown is disabled, the compressor will not be shut down by the controller when discharge pressure is greater than compressor shutdown limit.

Compressor Shut Down Limit:
Is the discharge pressure set point at which the compressor will shut down when the discharge Pressure rises above the shutdown set point.

Discharge Pressure Protection (DPP)

DPP Enable	DPP Low Pressure Limit	DPP Low Pressure Diff	DPP High Pressure Limit
	Range: 0 to 500	Range: 0 to 50	Range: 0 to 500
Enable	70 PSI	10 PSI	350 PSI

DPP High Pressure Diff	DPP Shutdown Enable	Compressor Shutdown Limit	DPP Pressure Alarm Delay
Range: 0 to 50		Range: 0 to 500	Range: 0 to 360
25 PSI	Enable	375 PSI	30 sec

Discharge Temperature Protection

When the Discharge Temperature Line Protection is enabled in the controller it monitors the discharge line temperature to report high discharge alarm and trip accordingly to protect the compressor from over heating and damaging of the compressor.

Discharge Line Temperature Protection (DLTP)

DLTP Enable	DLTP Cut-off Temp	DLTP Cut-in Temp
Enable ▾	Range: 0 to 500 300 °F	Range: 0 to 500 260 °F

DLTP Alarm Delay	High Discharge Temp Lockout Durat...
Range: 0 to 360 10 sec	Range: 0 to 600 60 mins

Discharge Cut-Out Temperature:
The Discharge Cut-Out Temp is the maximum discharge line temperature value at which the compressor will trip on high discharge line temperature alarm.

Discharge Cut-In Temperature:
The Discharge Cut-In Temperature is the temperature at which the compressor will turn back ON, once the temperature reaches or below the cut-in temperature.

NOTE:
For 3D Discus Digital and Scroll Digital compressors, the cutout temperature is 268F (131C) and the cut-in or reset temperature is 250F (121C).

For the 4D Discus Digital, the cutout temperature is 310F (154C) and the cut-in temperature is 267F (130C).

Superheat Protection

High Superheat Limit:
The High Superheat Limit Alarm is activated when the actual superheat value is greater than the high limit set in the controller.

High Superheat Differential:
Is the High Superheat Differential at which the superheat high alarm will be active or inactive when the actual superheat is less or greater than the High Superheat Limit.

High Superheat Alarm Delay:
The High Superheat Alarm is the time Delay before the high superheat alarm is activated or deactivated.

Low Superheat Limit:
The Low Superheat Limit alarm is activated when the actual superheat value is less than the low superheat set point in the controller.

Low Superheat Differential:
The Low Superheat Differential is when the actual superheat value is greater than the low superheat limit plus the low superheat differential.

Low Superheat Alarm Delay:
The Low Superheat Alarm Delay is the time delay before the alarm is activated and deactivated.

Low Superheat Alarm Count:
Is the number of low superheat allowed within 60 minutes before the controller is locked out on low superheat alarm. Low superheat alarm needs to be resolved/clear before controller will start again.

Superheat Protection (SP)

SP Enable	Low Superheat Limit	Low Superheat Diff
Enable ▾	Range: 0 to 100 10 °F	Range: 0 to 50 5 °F

Low Superheat Alarm Delay	High Superheat Limit	High Superheat Diff
Range: 0 to 360 120 Sec	Range: 0 to 100 55 °F	Range: 0 to 50 5 °F

High Superheat Alarm Delay	Low Superheat Alarm Count	Superheat Low Alarm Lockout Duration
Range: 0 to 360 120 Sec	Range: 0 to 20 3	Range: 0 to 600 60 mins

Phase Loss Alarm

PL Enable:
Enables Phase Loss alarm Detection
PL Alarm Delay: is the time delay before phase loss alarm becomes active.

Phase Loss Alarm (PL)

PL Enable

| Enable ▾ |

PL Alarm Delay
Range: 0 to 360

| 120 | sec |

Compressor Run Proof Alarm

CRP Enable:
Enables Compressor Run Proof Alarm Detection
CRP Alarm Delay: is the time delay before the alarm becomes active.

Compressor Run Proof Alarm (CRP)

CRP Enable

| Enable ▾ |

CRP Alarm Delay
Range: 0 to 360

| 120 | sec |

Current Switch Malfunction Alarm

CRP Enable:
Enables Compressor Malfunction Alarm Detection
CSM Alarm Delay: is the time delay before the alarm becomes active.

Current Switch Malfunction Alarm (CSM)

CSM Enable

| Disable ▾ |

CSM Alarm Delay
Range: 0 to 360

| 10 | sec |

Feedback Alarms

Suction Low Pressure Switch Enable:
If Low Pressure Switch/control (LPC) is mounted on the unit and Enables in the controller it allows Suction Low Pressure Switch Alarm Detection if wired.

Discharge High Pressure Switch Enable:
If High Pressure switch/control is mounted on the unit and Enables in the controller it allows the high-Pressure Switch Alarm Detection if wired.

Oil Failure Enable:
Enables oil failure alarm Detection if wired to the unit. This would allow the detection of oil failure alarm.

Pressure Switch Alarm Delay:
Time Delay before the Alarm becomes active.

Feedback Alarms

Suction Low Pressure Switch Enable	Discharge High Pressure Switch En…	Oil Failure Enable	Pressure Switch Alarm Delay
Disable ▼	Disable ▼	Disable ▼	Range: 0 to 360 2 sec

Compressor IDCM Alarm

Enable IDCM (if mounted on the unit) to detect the IDCM alarm. Disable IDCM alarm if IDCM alarm is not wired.

Compressor IDCM Alarm

IDCM Enable	IDCM Alarm Delay
Disable ▼	Range: 0 to 360 1 sec

COMMANDS

Digital Output Points

The digital output points can override to aid troubleshooting or in the event that the operator wants to do a manual override of the system.

Override Delay:
Override time delay can be set between 0-20 minutes at which point the output override will return to auto.

SYSTEM MENU

The System Menu contains the following:
The type of unit selected, refrigerant selection, temperature unit, pressure unit, network configuration, upload/download configuration files for the application, factory restore system, E2 enabled, application version, Modbus TCP/IP address, etc.

Configuration

Unit Type – Type of Unit being used. This can be change to: HS, CS, CP, CD
Temperature Units – F° or C° Pressure Units – PSI or BAR
Refrigerant – R404A, R407A, R407F, R448A, R449A, R507A,
E2 Master – Recommend always set to Yes. Allows full communication to E2 BAS System

Version
This shows the current controller version used and the details of the BIOS, WebUI, Application, current date and time, and application date code.

Modbus / BACnet

First, select the protocol among Modbus and BACnet for the communication from the MSTP protocol selection bar.

To communicate between E2 or any device and the CoreLink Controller using Modbus, ensure the Modbus Address and baud rate match.

Default baud rate for BACnet: 19200
Default baud rate for Modbus: 9600
For BACnet update the address, device ID, baud rate.
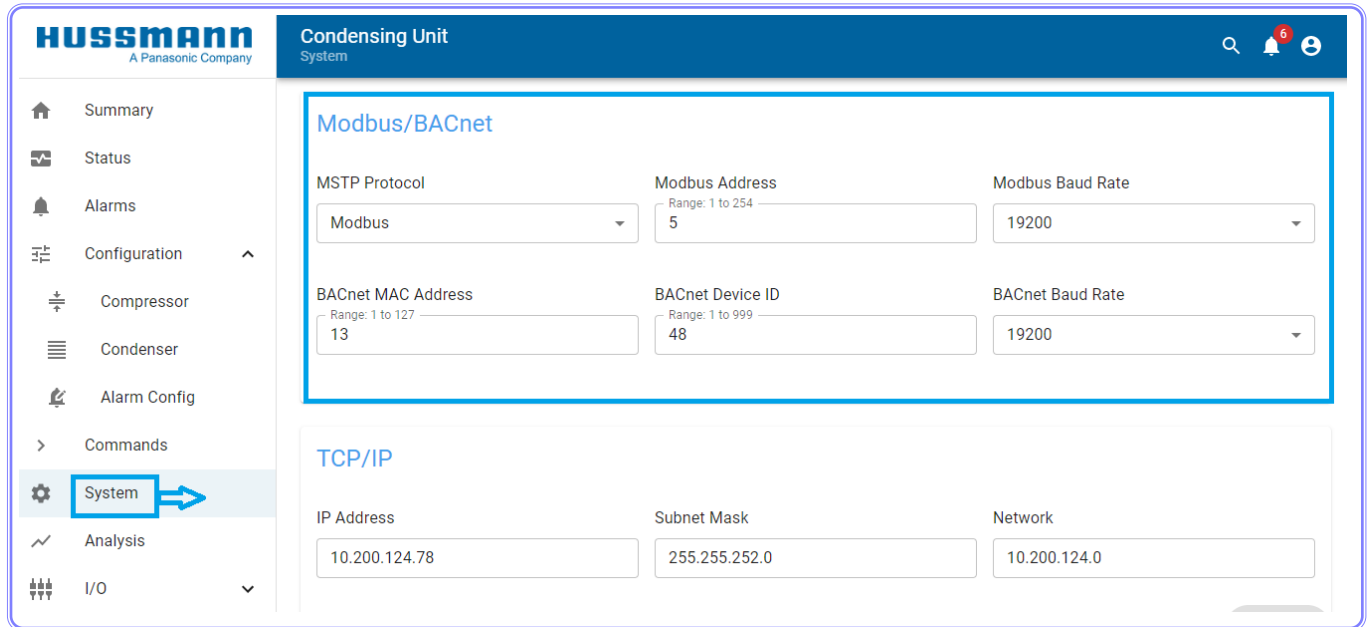
Controller reboot window will pop up if any configuration changes are made. A reboot must be done for the Modbus / BACnet changes to take effect.
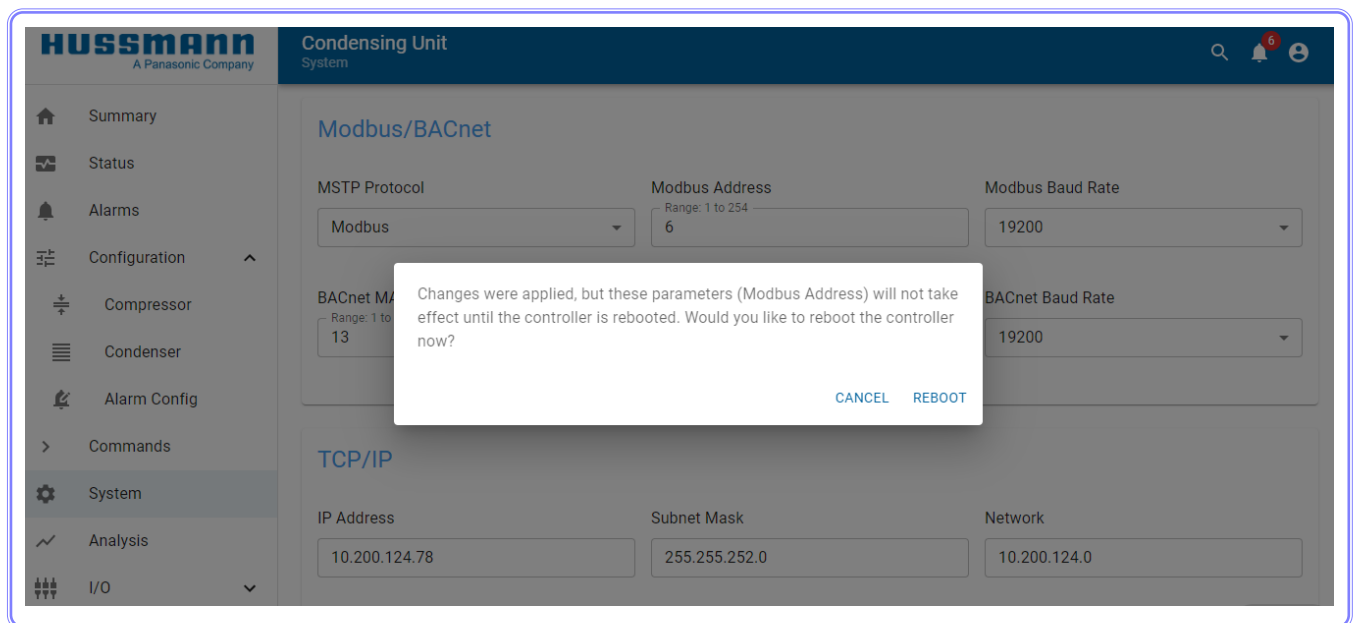
TCP / IP
Update the details for the TCP / IP communication protocols: IP address, subnet mask, network, gateway, DNS, and Secondary DNS.

Reboot is necessary for TCP / IP settings modification; otherwise, changes will not be reflected in the application.

System Commands
The system commands are as follows:

- **Factory Restore** will restore the controller back to factory configuration. Please note that changes to the controller set point should only be applied. Do not save changes as factory default.
- **Reboot Controller** is used for rebooting or restarting the controller.
- **Push Display Conf:** Use for updating the Conf file to the display system.
- **Upload/download .hsm file** can update/download the .hsm file \
- **Save settings as factory default.** Users can save the current settings as factory default.

Apply:
Use the apply ⮞ APPLY button to SAVE changes made to the set point after each editing. Using the APPLY button does not save changes as factory default.

ANALYSIS MENU

The Analysis Page consists of:

- Suction pressure
- Discharge pressure
- Discharge line temperature
- Outdoor temperature
- Suction line temperature
- Drop leg temperature
- Suction superheat

- Compressor 1 DO
- Condenser fan 1 DO
- Alarm
- Compressor 1 AO
- Condenser fan 1 AO
- Phase loss alarm

Only selected parameters will be displayed in the graph, and the parameter's name will be in black. Any parameters that are not selected will be displayed in gray and not be shown on the graph.

- Vertical (y-axis) indicates pressure and temperature data/units.
- Horizontal (x-axis) indicates time and date of data.
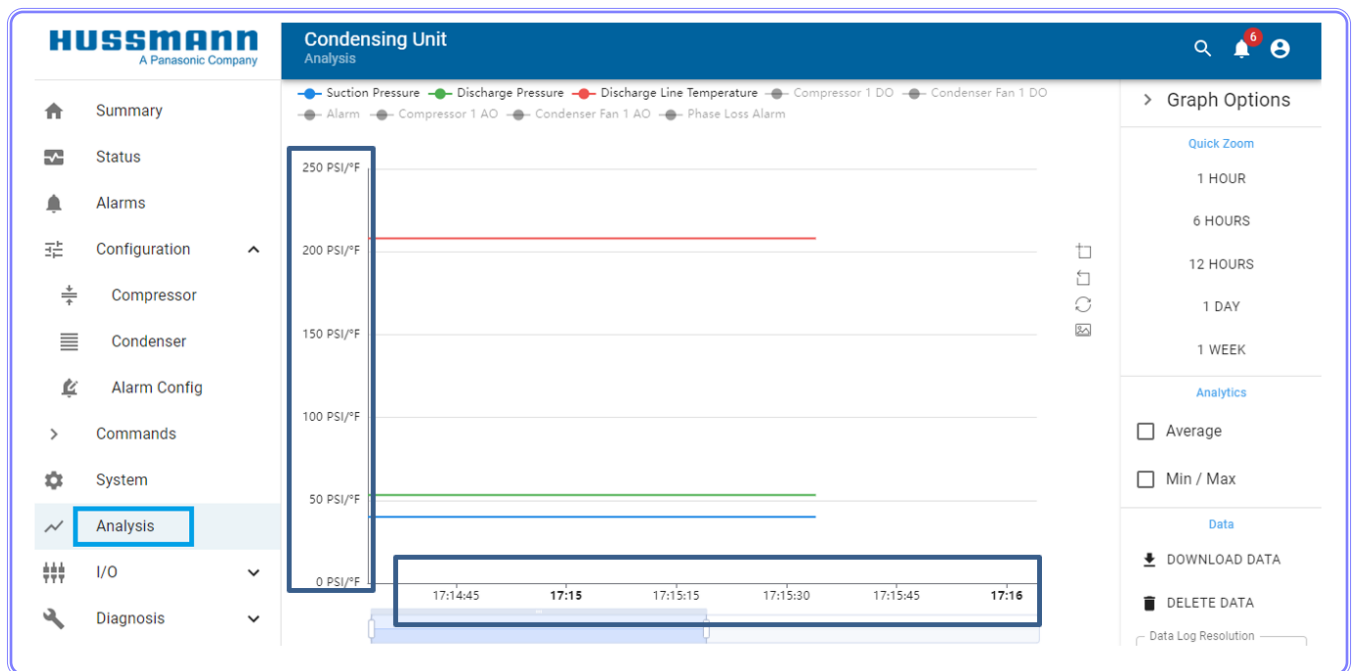
Graph Options:

Quick Zoom:
Select the options in the above graph for display in the graph and select Quick Zoom for a specified time (i.e., 1, 6, or 12 hours, one day or one week for a detailed understanding of that time period and use the slider (as shown in graph).

Analytics:
An option for average and min / max values selected.
- **Average:** Average value will be display for selected inputs.
- **Min / Max:** Minimum and maximum values will display for selected inputs.

Data:
Download and delete data by selecting side options for download data and delete data.

Data Log Resolution:
Graph can be set between 1 to 10 minutes (frequency of data logged). Default data log resolution is 1 minute.
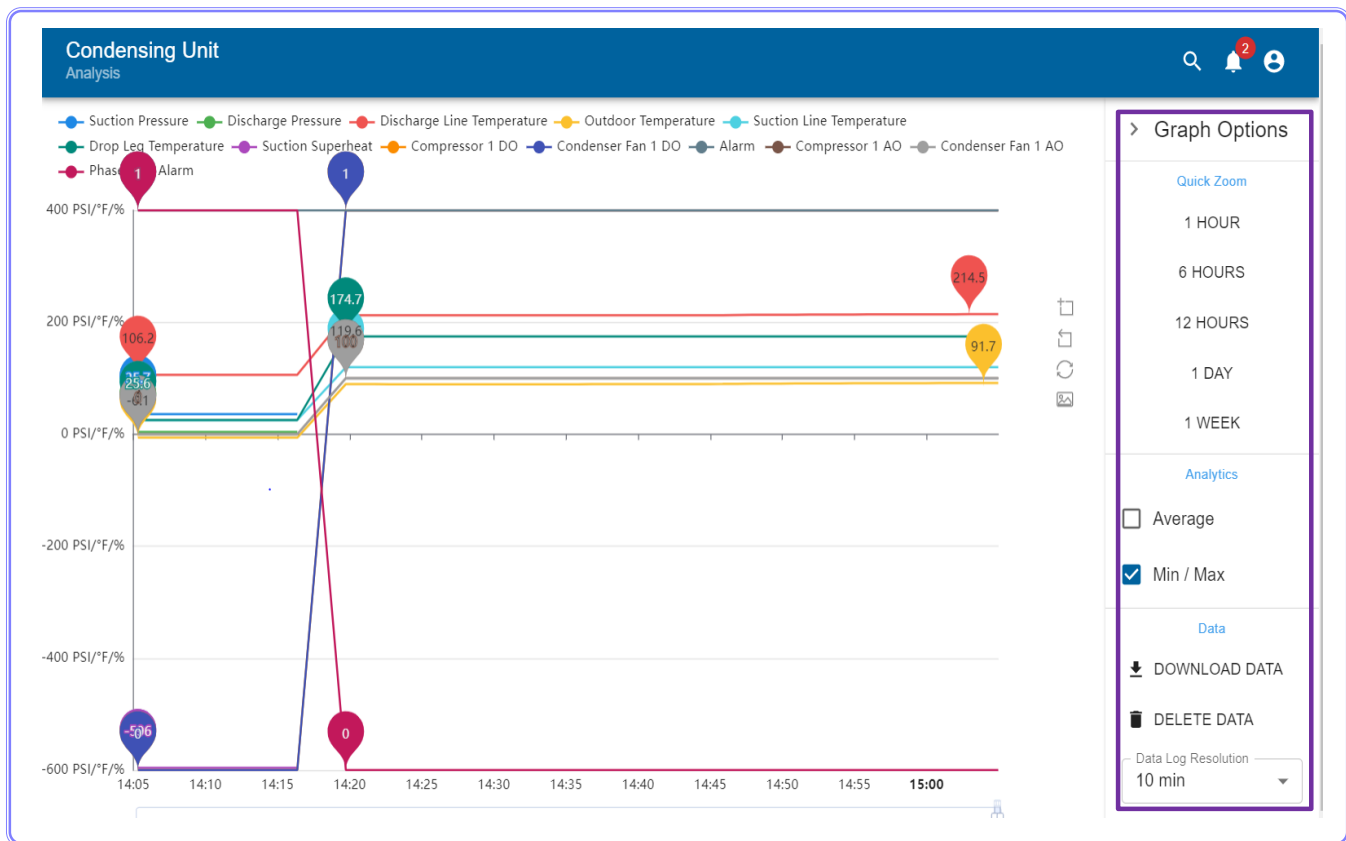
⬚ **Drag Zoom:** Use mouse pointer to drag and zoom the current data in graph.

↰ **Undo Zoom:** Use Undo Zoom to reset previous graph.

↻ **Reset:** Use Reset button to view actual graph data

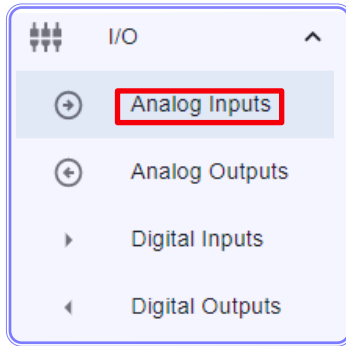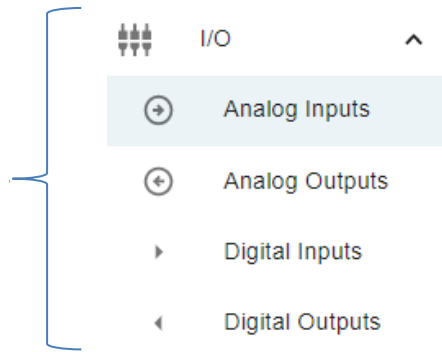🖾 **Download Image:** Use Download Image button to take screenshot of current graph readings.

I/O - INPUT / OUTPUT

The user can access details of digital/ analog input and output information from the I/O Tab.

Analog Inputs

Select Analog Inputs from the I/O Tab.

To configure six analog inputs, select the required AI configurations from the drop-down menu and click the apply button. The apply button **> APPLY** is on the bottom right side of the screen.

Analog inputs (Pb1 - Pb6, PbC)

Probe Configuration

AI 1 (Pin 2)
Suction Pressure ▲

Not Used
Suction Pressure
Discharge Pressure
Discharge Line Temperature
Outdoor Temperature
Suction Line Temperature
Drop Leg Temperature

AI 2 (Pin 3)
Discharge Pressure ▼

AI 3 (Pin 4)
Discharge Line Temperature ▼

AI 5 (Pin 11)
Suction Line Temperature ▼

AI 6 (Pin 12)
Drop Leg Temperature ▼

Probe Offset:

Set the probe offset values here:
- Every probe offset limit is -100.0 to 100.0.

Probe Offset

AI 1 Offset (Pin 2)	AI 2 Offset (Pin 3)	AI 3 Offset (Pin 4)
Range: -100 to 100	Range: -100 to 100	Range: -100 to 100
0	0	0

AI 4 Offset (Pin 10)	AI 5 Offset (Pin 11)	AI 6 Offset (Pin 12)
Range: -100 to 100	Range: -100 to 100	Range: -100 to 100
0	0	0

Probe / Sensor Type:

Select the correct analog voltage to be used:
- Example 0-5V transducer, or 4-20mA sensor, etc.

Probe Sensor Type

AI 1 Sensor Type (Pin 2)	AI 2 Sensor Type (Pin 3)	AI 3 Sensor Type (Pin 4)
0-5V	0-5V	CPC High Temp

	AI 5 Sensor Type (Pin 11)	AI 6 Sensor Type (Pin 12)
	CPC	CPC

NTC
PTC
0-20mA
4-20mA
0-10V
0-1V
0-5V
Digital Input
CPC
CPC High Temp

	AI 2 Filter (Pin 3)	AI 3 Filter (Pin 4)
	Range: 1 to 300	Range: 1 to 300
	1	1

Add the required analog filter values to the filter settings.

Filter Settings

AI 1 Filter (Pin 2)
Range: 1 to 300
1

AI 2 Filter (Pin 3)
Range: 1 to 300
1

AI 3 Filter (Pin 4)
Range: 1 to 300
1

AI 4 Filter (Pin 10)
Range: 1 to 300
1

AI 5 Filter (Pin 11)
Range: 1 to 300
1

AI 6 Filter (Pin 12)
Range: 1 to 300
1

The range of suction pressure scaling is between 0 to 200 PSI.

Suction Pressure Scaling

Suct Probe Value at 4mA or 0V
Range: 0 to 20
0   PSI

Suct Probe Value at 20mA or 5V
Range: 0 to 200
200   PSI

The range of discharge / dropleg pressure scaling is between 0 to 500 PSI.

Discharge/DropLeg Pressure Scaling

Probe Value at 4mA or 0V
Range: 0 to 50
0   PSI

Probe Value at 20mA or 5V
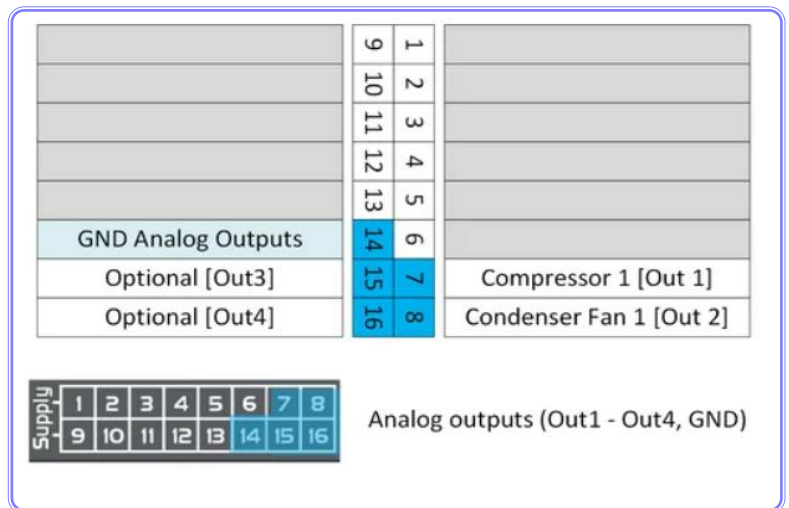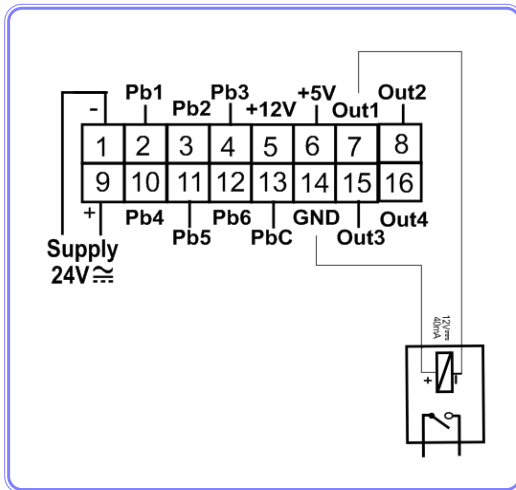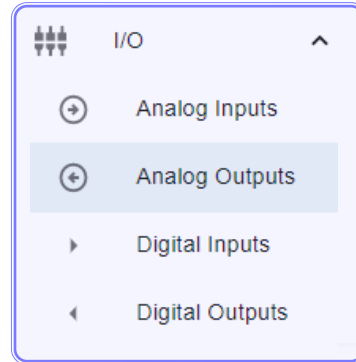Range: 0 to 500
500   PSI

ANALOG OUTPUT

Select the analog output option from the I/O Tab.

Available analog outputs are:
Compressor 1, Condenser Fan 1, Holdback Valve 1 (that uses 0-10V signal), Compressor 1 Loader.

Analog output for relays (coil power supply 3Vdc-10Vdc)

Connection to the analog outputs:
Depending on the model and configurations, it is possible to use analog outputs such as 0Vdc to 10Vdc, and 4 to 20mA for transducers.

NOTE:
Please separate the low voltage signal wires from the high voltage wires to avoid electric field interference.

Recommendations:
Please refer to the electrical diagram of the device for proper wiring.

Analog Output Configuration
Configure each analog output pin with the correct analog output control voltage depending on the type of device being used on the compressor of the fan—for example, IDCM, VFD, ECM, etc.

Analog Output Configuration

AO 1 (Pin 7)
Compressor 1 ▲

Not Used
Compressor 1
Condenser Fan 1
Hold Back Valve 1
Compressor 1 Loader

AO 2 (Pin 8)
Condenser Fan 1 ▼

AO 3 (Pin 15)
Not Used ▼

Select the analog output type from the given options:
0-10V, 1-5V, 10-0V, 5-0V, 4-20mA, Relay, PWM

Analog Output Type

0-10V
1-5V
0-5V
10-0V
5-0V
4-20mA
Relay
PWM

AO 2 Type (Pin 8)
10-0V ▼

AO 3 Type (Pin 15)
0-10V ▼

➤ APPLY

U.S. & Canada 1-800-922-1919 • Mexico 1-800-890-2900 • WWW.HUSSMANN.COM

DIGITAL INPUT

Select the digital input option from the I/O Tab.

Available digital inputs:
- Phase loss
- Compressor 1 Run Proof
- Compressor 1 IDCM Alarm
- Suction Low Pressure Switch 1
- Discharge High Pressure Switch 1
- Oil Failure

Once the digital input option is selected, it is possible to configure each pin in 11 digital inputs with 13 different configurations in the digital input configuration tables shown below:

- **Not Used** - digital input disabled
- **Enable DI** - Enables / disables controller. All outputs are deactivated. Control Status display DISABLE DI. Default: Enable-Open.
- **Phase Loss** - When a phase loss alarm is detected, the compressor and the condenser fan will be turned off. Please investigate the cause of phase loss alarm before attempting to turn power back on.
- **Compressor Run Proof** - Monitors corresponding current switch feedback (CSM) to ensure compressor is running. An open signal position from the current switch will generate an alarm.
- **Compressor IDCM Alarm -** Monitors the IDCM alarm feedback for closed position to detect and report IDCM Alarm in the compressor.
- **Low pressure Switch (LPC)**– Low pressure switch when wired to the controller will report an alarm in the event the low-pressure switch opens. An open low-pressure switch will shut the compressor down.
- **High Pressure Switch -** High pressure switch when wired to the controller will report an alarm in the event the HPC opens on high pressure. An open high-pressure alarm will shut down the compressor.
- **Oil Failure1** - Monitors oil failure feedback to detect and report Oil Failure Trip Alarm. Upon the detection of the oil failure alarm, the compressor will shut down.

Digital Input Configuration

DI 1 (Pin 20)	DI 2 (Pin 21)	DI 3 (Pin 22)
Phase Loss ▲	Compressor 1 Run Proof ▼	Not Used ▼

Not Used
Enable DI
Phase Loss
Compressor 1 Run Proof
Compressor 1 IDCM Alarm
Suction Low Pressure Switch 1
Discharge High Pressure Switch 1
Oil Failure

	DI 5 (Pin 24)	DI 6 (Pin 25)
	Not Used ▼	Not Used ▼

	DI 8 (Pin 27)	DI 9 (Pin 28)
	Not Used ▼	Not Used ▼

	DI 11 (Pin 30)	
Not Used ▼	Not Used ▼	

DIGITAL OUTPUT

Five digital outputs can be configured with their corresponding relay polarities for Normally Open (NO) or Normally Closed (NC) position, shown below.

Digital Input Polarity

All digital input wiring should be configured based on the status of the contact for either a closed or open position to correctly report alarms.

Digital Input Polarity

DI 1 Polarity (Pin 20)	DI 2 Polarity (Pin 21)	DI 3 Polarity (Pin 22)
Close ▼	Open ▼	Open ▼

DI 4 Polarity (Pin 23)	DI 5 Polarity (Pin 24)	DI 6 Polarity (Pin 25)
Open ▼	Open ▼	Open ▼

DI 7 Polarity (Pin 26)	DI 8 Polarity (Pin 27)	DI 9 Polarity (Pin 28)
Open ▼	Open ▼	Open ▼

DI 10 Polarity (Pin 29)	DI 11 Polarity (Pin 30)
Open ▼	Open ▼

Relay Configuration

Relay output selection:
- **Not Used** - When selected, the digital output is not used or disabled.
- **Compressor 1** - When selected, this means the relay point has been assigned to the compressor
- **Compressor 2** - when selected, the relay point has been assigned to another compressor.
- **Vapor Injection 1** - When selected, the relay point has been assigned to vapor injection. Energizes the compressor vapor injection solenoid valve whenever the compressor is running
- **Blocked Solenoid Valve 1** - when selected, the relay point has been assigned to a blocked solenoid valve. Energized to reduce the compressor capacity
- **Condenser Fan 1** - when selected, the relay point has been assigned to the condenser fan.

Digital Output Polarity

- **Open** - When the digital output is active the relay contact is Open
- **Close -** When the digital output is active the relay contact is Closed

Relay Delay:

Time delay can be set for the digital output relay to delay in turning ON or OFF.

Relay Polarity

DO 1 Polarity (Pin 42)	DO 2 Polarity (Pin 43)	DO 3 Polarity (Pin 44)
Open ▲	Open ▼	Close ▼

Open
Close

DO 5 Polarity (Pin 46)	DO 6 Polarity (Pin 49)
Close ▼	Close ▼

Close ▼

DO 7 Polarity (Pin 50)	DO 8 Polarity (Pin 51)
Close ▼	Close ▼

Connection of the Digital Outputs

Depending on the model, the digital outputs can have different connection specifications. The relays have been split into groups, each with a separate common. The same voltage should be used for the two groups of relays. For the electrical specifications, please refer to the manual that came with the CoreLink controller.

Relay Delay

DO 1 Delay (Pin 42)	DO 2 Delay (Pin 43)	DO 3 Delay (Pin 44)
Range: 0 to 255	Range: 0 to 255	Range: 0 to 255
0 sec	0 sec	0 sec

DO 4 Delay (Pin 45)	DO 5 Delay (Pin 46)	DO 6 Delay (Pin 49)
Range: 0 to 255	Range: 0 to 255	Range: 0 to 255
0 sec	0 sec	0 sec

DO 7 Delay (Pin 50)	DO 8 Delay (Pin 51)
Range: 0 to 255	Range: 0 to 255
0 sec	0 sec

DIAGNOSIS

Click on Diagnosis to see the following taps.

- Fault Table
- Self-Test
- Self-Testing History and Variable Changes

Fault Table:

The condensing unit controller records all fault occurrences with details including description of type of fault, time, date, and status of fault whether active or clear.

FAULT TABLE

- Refresh: Fault data will get refreshed by using the Refresh button
- Upload: To verify old data upload old fault table data and
- Self-Testing History and Variable Changes

Fault Table Codes:

Codes	Alarm names
F0020	Suction Pressure Transducer Failure Alarm
F0030	Discharge Pressure Transducer Failure Alarm
F0040	Discharge Line Temperature Sensor Failure Alarm
F0050	Outdoor Temperature Sensor Failure Alarm
F0070	Drop Leg Temperature Sensor Failure Alarm
F0080	Suction Line Temperature Sensor Failure Alarm
F0310	Phase Loss
F0320	IDCM Feedback Alarm
F0330	Compressor 1 Run Proof Alarm
F0340	Compressor 1 Current Switch Malfunction Alarm
F0350	Compressor 1 Suction High Pressure Alarm
F0360	Compressor 1 Suction Low Pressure Alarm
F0370	Compressor 1 Suction Pressure Switch Alarm
F0380	Compressor 1 Suction Shutdown Alarm
F0390	Compressor 1 Discharge High Pressure Alarm
F0400	Compressor 1 Discharge Low Pressure Alarm
F0410	Compressor 1 Discharge Shutdown Alarm
F0420	Compressor 1 Discharge Pressure Switch Alarm
F0430	Compressor 1 Low Oil Level Alarm
F0440	Compressor 1 High Discharge Line Temperature Alarm
F0450	Compressor 1 Suction Low Superheat Alarm
F0460	Compressor 1 Suction High Superheat Alarm
F0490	Compressor 1 Suction Superheat Lockout alarm
F0500	Compressor 1 High Discharge Temperature Lockout Alarm
N0010	Reboot Notification

The above table consists of code and alarm names, respectively.

VARIABLE CHANGES

The condensing unit controller records all variable changes from different user level occurrences with details description of date, time, user details, parameter details, old value and new value data. See the Variable Changes Tab below.

WARRANTY INFORMATION

HUSSMANN®

To obtain warranty information or other support, contact your Hussmann representative or visit:
https://www.hussmann.com/services/warranty

Please include the model and serial number of the product.

For questions about your equipment please contact our Technical Support Team 866-785-8499

For General Support or Service Calls contact our Customer Support Call Center 800-922-1919

For ordering Aftermarket Warranty Parts 1-855-Huss-Prt (1-855-487-7778)
Hussmann_part_warranty@hussmann.com

APPENDIX A ─ CORELINK DISPLAY MANUAL

CoreLink™

Condensing Unit Display Manual

Operation Manual

IMPORTANT

Keep with controller for

future reference!

MANUAL- I/O CORELINK CONDENSING UNIT CONTROLLER DISPLAY

CoreLink Display

Key Display Features Include:

- Exit button
- Up/Down arrows for navigation
- Various helpful status indicators
    - Compressor
    - Condenser Fan
    - Alarm
- Dedicated Set/Enter button
- Built-in alarm for notifications

Power Up Sequence

First time power up displays: *noL*

> *noL* Indicates "no communication" between the display and CoreLink

> *noL* Displays until the CoreLink starts to communicate with the display a few seconds after power up.

Once communication is established between the display and CoreLink, the display will run a self test and then display the firmware version. The display will next show the default display after the reboot process completes.

Default Display

Shown below is the default display view. After boot up and successful connection to the CoreLink, the display will show suction pressure and system status on the lefthand side.

Menu Options and Navigation

1. Display Menu

The Display Menu is used to read sensor values.

▲ ▼	Menus are navigated with the UP/DOWN arrow buttons.

Use the ▲ arrow to scroll through the three main top-level menus: the **IO Menu** (10), **Override Menu** (CM) and **Configuration Menu** (CFG). D

Press the ▲ arrow to access the IO Menu when (10) is shown. Press SET again to enter the IO menu. Default menu option is Suction pressure display.

Exit Menu ⏻	Press Power button to exit any menu and return to previous menu.

	LP	Suction Pressure	Psi/bar
	HP	Discharge Pressure	Psi/bar
	dt	Discharge Line Temperature	°F/°C
	Ott	Outdoor temperature	°F/°C
I 0	SCt	Suction Line Temperature	°F/°C
	drt	Drop Leg Temperature	°F/°C
	SH	Suction Superheat	°F/°C
	CNO	Compressor Output	%
	CnO	Condenser Output	%

2. Configuration Menu

The Configuration Menu is used to modify setpoints and set the BACnet address.

Use the ▲ arrow buttons to navigate to the main top-level Configuration Menu. Select (CFG) menu by pressing SET when is displayed.
Use ▲ ▼ arrow to enter **passkey** and press SET to enter configuration. First config. menu displayed will be Compressor control (CNP). Use arrows to select other parameters.

- Press arrows to scroll through Configuration Menu options.
- Press SET to view configuration of selected option.
- Press and hold SET for 5 seconds to edit the new parameter value.
- Use arrows to enter a new parameter value. Press SET to accept value.
- A new value will flash once accepted.
- Press SET to exit Parameter Menu.

CNP	CtL	Compressor Control
	SSP	Suction Control Setpoint
	Std	Suction Low Differential
	SHd	Suction High Differential
Cnd	CrL	Condenser Control
	d5d	Discharge Pressure Control set point
	dLd	Pressure Low Differential
	dHd	Pressure High Differential
	td	TD Control Setpoint
ALr	LPn	Low Suction Pressure Alarm Enable
	LSn	Low Suction Pressure Shutdown Alarm Enable
	HPn	High Discharge pressure Alarm Enable
	HSn	High Discharge Pressure Shutdown Alarm Enable
	dtn	Discharge Temperature Alarm Enable
	SHn	Superheat Alarm Enable
	PSn	Phase Loss Alarm Enable
SyS	Add	Modbus Address
	bAC	BACnet MAC Address
	d id	BACnet Device ID
	rES	Factory Restore

3. Override Menu

The Override Menu is used to turn on/off digital outputs and regulate analog outputs with required value.

Exit Menu ⏻	Press Power button to exit any menu and return to previous menu.

Use the ⬆ arrow buttons to navigate to the main top-level Override Menu. SELECT Override Menu (CΠd) by pressing SET when is displayed. Use ⬆ arrow to enter **passkey** and press SET to enter configuration.

Use the ⬆ arrows to navigate the Override Menu Options. The first override menu is override. With a menu option selected, press SET to view override parameters. Press and hold SET for 5 seconds to enter a new override parameter value. Press SET again to accept the entered value. Press SET after value is accepted to exit options menu.

	CdO	Compressor Digital output	-
CΠd	CAO	Compressor Analog output	%
	FdO	Condenser Fan Digital output	-
	FAO	Condenser Fan Analog output	%

CoreLink Display Usage Examples

How to change a setpoint:

From the Hussmann display, compressor, condenser fans, alarms setpoints and Network settings can be set.
1. If not at the main top-level menu, press repeatedly until reaching the main top-level menu.
2. Press ⬆ arrow until Configuration (CFG) is displayed and press SET.
3. Use ⬆ arrow to enter **Passkey** then press SET to enter the Configuration Menu.
4. Press ⬆ arrows to scroll until desired parameter is shown.
5. Press SET to view the parameter setpoint.
6. Press and hold SET for 5 seconds (setpoint will flash on the screen when this step is complete).
7. Use the ⬆ arrows to select the new setpoint.
8. Press SET when the displayed setpoint is correct. The number will flash on the screen if this step was done correctly.

How to set a network address:

From the display, you can view and change the connected CoreLink's Modbus and BACnet addresses.

1.If not at the main menu, press ⏻ repeatedly until reaching the main top-level menu.

2. Press the ⬆ arrow to select the Configuration Menu (CFG)

3. Use ⬍ arrows to enter **passkey** and press SET to enter the Configuration Menu (CFG).

Modbus

4. Press ⬍ arrows until Add is shown, then press SET to view the current Modbus address setting.

5. To change the Modbus address, press and hold SET for 5 seconds to enter the network address edit mode.

6. Use the ⬍ arrows to enter a new address and press SET to save the new address (The new address will flash on the screen when this step is complete).

BACnet

7. To edit the CoreLink's BACnet address, repeat Steps 4, 5, and 6, but select bAc from the menu at Step 4.

How to reboot the controller

From the display, you can reboot the controller with a simultaneously two button push

1. If not at the default display, press ⏻ to navigate to default display

2. Press the light and exit button 🔆+⏻ simultaneously for 5 seconds

3. The display will immediately show 0

4. Controller will reboot, view controller yellow status LED to confirm reboot sequence

5. Display will show default display

6. Display will automatically reboot, then show default display again

7. Reboot complete

Menu	Sub-Menu	Display Code	Function	Range (Min Limit)	Range (Max Limit)	Units
Default Display		Suction Pressure	Suction Pressure Reading			Psi/bar
		Compressor Status	Compressor On/Off Indicator	0 (OFF)	1 (ON)	-
		Condenser Fan	Condenser Fan On/Off Indicator	0 (OFF)	1 (ON)	-
		Alarm	Alarm Indicator	0 (OFF)	1 (ON)	-
		Unit	Pressure Unit			Psi/bar
I O		LP	Suction Pressure			Psi/bar
		HP	Discharge Pressure			Psi/bar
		DT	Discharge Line Temperature			°F/°C
		OTT	Outdoor temperature			°F/°C
		SCT	Suction Line Temperature			°F/°C
		DRT	Drop Leg Temperature			°F/°C
		SH	Suction Superheat			°F/°C
		CMO	Compressor Output	0	100	%
		CNO	Condenser Output	0	100	%
Config Menu (Password 3) CFG	CMP	CTL	Compressor Control	1	4	-
		SSP	Suction Control Setpoint	-40.0	200.0	Psi/bar
		SLD	Suction Low Differential	0.0	10.0	Psi/bar
		SHD	Suction High Differential	0.0	10.0	Psi/bar
	CND	CRL	Condenser Control	1	4	-
		DSP	Discharge Pressure Control set point	0.0	500.0	Psi/bar
		DLD	Pressure Low Differential	0.0	50.0	Psi/bar
		DHD	Pressure High Differential	0.0	50.0	Psi/bar
		TD	TD Control Setpoint	0.0	500.0	-
	ALR	LPN	Low Suction Pressure Alarm Enable	0	1	-
		LSN	Low Suction Pressure Shutdown Alarm Enable	0	1	-
		HPN	High Discharge pressure Alarm Enable	0	1	-
		HSN	High Discharge Pressure Shutdown Alarm Enable	0	1	-
		DTN	Discharge Temperature Alarm Enable	0	1	-
		SHN	Superheat Alarm Enable	0	1	-
		PSN	Phase Loss Alarm Enable	0	1	-
	SYS	Add	Modbus Address	1	255	-
		bAC	BACnet MAC Address	1	127	-
		DID	BACnet Device ID	1	999	-
		rES	Factory Restore	0	1	-
Override Menu (Password 66)	CMd	CdO	Compressor Digital output	-1	1	-
		CAO	Compressor Analog output	-1	100	%
		FdO	Condenser Fan Digital output	-1	1	-
		FAO	Condenser Fan Analog output	-1	100	%

Alarm	Abbreviation	Full Description	Possible Cause	Action
Err	LP	Suction Pressure	Pressure below target setpoint, Sensor not reading any pressure, polarity cross, loose wire, break in cable.	Placed a pressure gauge on the unit to check the pressure in unit, check if transducer valve is close, check for loose wiring and check continuity in cable. Check if the correct sensor is installed.
Err	HP	Discharge Pressure	Pressure above target setpoint, Sensor not reading any pressure, loose wire, polarity cross, break in cable.	Placed a pressure gauge on the unit to check the pressure in unit, check if transducer valve is close, check for loose wiring and check continuity in cable. Check if the correct sensor is installed.
Err	dt	Discharge Temperature sensor	Break in cable, loose wire, bad sensor, Sensor reading out of range	Check resistance of sensor with a multimeter and if there is a short in the cable, replace sensor. Use an infrared ray thermometer or calibrated temperature device to check sensor reading to validate sensor reading.

Alarm	Abbreviation	Full Description	Possible Cause	Action
Err	Ott	Outdoor temperature sensor	Break in cable, loose wire, bad sensor, Sensor reading out of range	Check resistance of sensor with a multimeter and if there is a short in the cable, replace sensor. Use an infrared ray thermometer or calibrated temperature device to check sensor reading to validate sensor reading.
Err	SCt	Suction temperature Sensor	Break in cable, loose wire, bad sensor, Sensor reading out of range	Check resistance of sensor with a multimeter and if there is a short in the cable, replace sensor. Use an infrared ray thermometer or calibrated temperature device to check sensor reading to validate sensor reading.
Err	drt	Drop-leg Temperature Sensor	Break in cable, loose wire, bad sensor, Sensor reading out of range	Check resistance of sensor with a multimeter and if there is a short in the cable, replace sensor. Use an infrared ray thermometer or calibrated temperature device to check sensor reading to validate sensor reading.
Err	SH	Superheat	Alarm is active if actual superheat value is greater or less than superheat low & high limit setpoint and persistence time is greater than or equal to superheat low alarm delay.	Investigate the cause of the Alarm by checking all Sensor readings and ensure no changes has been made to the setting.

TROUBLESHOOTING

The Hussmann pressure transducer is constructed with a stainless-steel housing and a 1/8-inch male National Pipe Thread (NPT) fitting.

The rugged design makes it compatible with all HFC / HCFC refrigerants and ammonia. The sensor includes a 20-ft cable with a Packard connector for easy sensor replacement.

0-200 PSI   P/N: 0554218
0-650 PSI   P/N: 0529188
0-5V
Pressure Sensor

The temperature sensor has a 10K Ω thermistor.

The thermistor is enclosed in a nickel-plated brass shell with epoxy. The sensor has a green 20-ft pigtail. The wire is a 22 AWG CL3X cord with 2 conductors.

The cable is UL rated for 194°F (90°C). The sensor has been tested by Hussmann to maintain less than 0.72°F error between -40 and 248°F.

Green   P/N: 0529189
Blue   P/N: 0529190
Orange   P/N: 0529191
Purple   P/N: 0418813
White   P/N: 201-1191

NTC
10K Temperature Sensor

Volts	0-150 PSI	0-200 PSI	0-300 PSI	0-500 PSI	0-650 PSI
0	0	0	0	0	0
0.2	6	8	12	20	26
0.4	12	16	24	40	52
0.6	18	24	36	60	78
0.8	24	32	48	80	104
1	30	40	60	100	130
1.2	36	48	72	120	156
1.4	42	56	84	140	182
1.6	48	64	96	160	208
1.8	54	72	108	180	234
2	60	80	120	200	260
2.2	66	88	132	220	286
2.4	72	96	144	240	312
2.6	78	104	156	260	338
2.8	84	112	168	280	364
3	90	120	180	300	390
3.2	96	128	192	320	416
3.4	102	136	204	340	442
3.6	108	144	216	360	468
3.8	114	152	228	380	494
4	120	160	240	400	520
4.2	126	168	252	420	546
4.4	132	176	264	440	572
4.6	138	184	276	460	598
4.8	144	192	288	480	624
5	150	200	300	500	650

Temperature (°F)	Temperature (°C)	Resitance Ω
-40	-40	336,450
-30	-34	234,170
-20	-29	165,210
-10	-23	118,060
0	-18	85,399
10	-12	62,493
20	-7	46,235
30	-1	34,565
40	4	26,100
50	10	19,899
60	16	15,311
70	21	11,883
80	27	9,299
90	32	7,334
100	38	5,828
110	43	4,664
120	49	3,758
130	54	3,048
140	60	2,488
150	66	2,042
160	71	1,686
170	77	1,400
180	82	1,169
190	88	981
200	93	827