Installation, Operation, and Maintenance

Liquid-Cooled Adaptive Frequency™ Drive with Tracer® AdaptiView™ Control

Models AFDE

X39641074060

⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

June 2020 **AFDE-SVU02F-EN**

Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

⚠WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only accidents.

Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants-including industry replacements for CFCs and HCFCs such as saturated or unsaturated HFCs and HCFCs.

Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.
- All electrical enclosures—unit or remote—are IP2X.
- Customers are responsible for all field wiring in compliance with local, national, and/or international codes.

⚠WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labeling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

⚠WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Trane personnel should always follow local regulations.**

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Revision History

- Updated Model Number Descriptions chapter.
- Added Installing External 120 Vac Control Power section to Input Power and Control Wiring chapter.
- Running edits.

Table of Contents

General Information

About This Manual

This manual is intended for use by experienced service personnel, qualified electrical personnel, Trane service personnel, and Rockwell automation global technical service personnel who are familiar with the custom liquid-cooling features described.

The instructions in this manual outline the procedures for operating the UNIT-MOUNTED Trane Adaptive Frequency Drive. Operation and maintenance of the controls are also explained in this manual.

Other Required Manuals

The following publication ships with the Trane Adaptive Frequency Drive from the factory: D2-3496-1, Liqui-Flo 2.0 AC Drive User Manual.

Cabinet Servicing

For information regarding the servicing of drive components please refer to the appropriate Rockwell literature.

Service Information

This equipment should be installed, adjusted and serviced by qualified electrical maintenance personnel who are familiar with the construction and operation of the equipment and the hazards involved, as defined in the National Electrical Code. Trane assumes no liability for installation or service procedures performed by unqualified personnel.

Parts Ordering Information

Refer to the model number printed on the Trane Adaptive Frequency Drive nameplate when ordering replacement parts or service for the drive. When ordering parts, contact the local Trane Parts Office in your area. For service, contact a qualified service organization.

NOTICE

Do Not Megohm Test!

Failure to follow instructions below could cause damage to the controller circuitry. Do NOT use a megger to perform continuity checks in the drive equipment.

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. If this equipment is interlocked with other equipment, 115 volts AC may be present in the cabinet even though the main power is disconnected. If this is the case, these interlock signals should be deactivated before any work is performed on this equipment. Suitable warning tags or disconnects should be added to these circuits and all circuits should be tested before attempting to energize or service the controller.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN.*

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures—unit or remote—are IP2X.*

⚠WARNING

Capacitors Must Be Allowed To Discharge!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Each time power is removed, allow at least 10 minutes for DC units to discharge after power is disconnected before servicing. Use extreme caution when applying power. Equipment terminals and other internal parts of the controller are at line voltage when AC power is connected to the controller. All ungrounded conductors of the AC power line must be disconnected from the controller before it is safe to touch any internal parts of this equipment.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures—unit or remote—are IP2X.*

Motor Checks

1. Check the motor for proper horsepower and voltage ratings. Verify that the motor full load amps do not exceed the nameplate rating of the controller.
2. Check that the motor terminals are correctly connected to the controller's power terminals for the proper voltage and motor rotation.

NOTICE

Disconnect Motor Leads!

Failure to disconnect all motor leads prior to megging the motor could cause equipment damage.

3. Use an ohmmeter to check for any short circuits between the motor frame and the motor power leads. If a short circuit exists, it must be corrected before proceeding.

Controller Checks

4. Check that local, state and national electric codes have been observed for the installation and wiring of this equipment.
5. Check that all external power wiring has been properly routed through the cabinet.
6. Check all input power and output power connections for tightness.
7. Check the chassis ground and other connections for tightness.
8. Check all external control connections (this includes the operator station connections) for tightness.
9. Check to assure incoming power to the drive is phased A, B, C.

AFDE Checks

NOTICE

Perform Visual Inspection!

Before powering up this drive for the first time conduct a visual inspection for the following:

- **Shipping damage.**
- **Signs of moisture.**
- **Signs of debris or dust from storage.**
- **Signs of corrosion on components and/or enclosure.**

These conditions could cause equipment damage. Do not power up equipment if you have concerns regarding equipment condition. Upon initial power up, remain in the area for the first two hours of operation and observe the chiller and drive for any abnormalities. Contact CenTraVac™ Technical Support for assistance if needed.

⚠WARNING

Hazardous Voltage!

Failure to ensure that all enclosure doors are closed and properly secured with fasteners when operating equipment could result in death or serious injury.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures—unit or remote—are IP2X.*

Safety Precautions

1. This equipment should be adjusted and serviced by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and the hazards involved.
2. Be sure the input disconnect is in the correct position, either "on" or "off" depending on the work to be performed.
3. Check the status of the drive shutdown interlocks, if used. These interlocks can be limit switches, guards or safety switches installed around the driven machine or the system interface controller.

⚠WARNING

Bypassed Electrical Interlocks!

Failure to return all interlocks to operation when the startup is completed could result in death, serious injury or equipment damage. The electrical interlocks provide machine and personal protection. If deactivated or bypassed for servicing, use extreme caution when performing the startup.

4. Check to see that the AFDE is properly ground to earth. See "Grounding the Cabinet," p. 33 in "Input Power and Control Wiring," p. 31.

⚠WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes.

⚠WARNING

Hazardous Voltage!

Failure to follow instructions below could result in death, serious injury or equipment damage. Do NOT remove or insert control boards or fuses while input power is connected to the controller.

⚠WARNING

Hazardous Service Procedures!

Failure to follow all precautions in this manual and on the tags, stickers, and labels could result in death or serious injury.
Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the following instructions: Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks.

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged.

- **Before working on the controller, check to be sure capacitors are discharged with a DC voltmeter on the 1000V scale. Charged capacitors require at least 10 minutes to discharge to less than 50Vdc after line power is removed.**
- **Before proceeding with the startup procedure, disconnect and lockout all incoming power to the drive controller!**

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN.*

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures—unit or remote—are IP2X.*

Overview

⚠WARNING

Hazardous Service Procedures!

Failure to follow all precautions in this manual and on the tags, stickers, and labels could result in death or serious injury.
Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the following instructions: Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks.

⚠WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

All electrical circuits shall be treated as energized until all lockout/tagout procedures are in place and the circuit has been tested to verify that it is de-energized. The medium voltage motor terminal box cover must not be removed if power is present, or if there is a possibility that power may be present. Working on energized medium voltage circuits is not an approved practice for normal HVAC maintenance or service.

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. If this equipment is interlocked with other equipment, 115 volts AC may be present in the cabinet even though the main power is disconnected. If this is the case, these interlock signals should be deactivated before any work is performed on this equipment. Suitable warning tags or disconnects should be added to these circuits and all circuits should be tested before attempting to energize or service the controller.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN.*

⚠WARNING

Capacitors Must Be Allowed To Discharge!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Each time power is removed, allow at least 10 minutes for DC units to discharge after power is disconnected before servicing. Use extreme caution when applying power. Equipment terminals and other internal parts of the controller are at line voltage when AC power is connected to the controller. All ungrounded conductors of the AC power line must be disconnected from the controller before it is safe to touch any internal parts of this equipment.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

CE for AFDE Drives

⚠WARNING

Lockout/Tagout Before Removing Touch-Safe Covers!

Failure to follow instructions regarding touch-safe covers could result in death or serious injury. Touch-safe covers inside panels are there for protection and may be removed if necessary for service only and only after disconnection of main power supply. Before removing any touch-safe cover, ensure that there is no line power. Removal of touch-safe covers would be at the customer/service personnel's own risk. After any service is completed, if the touch-safe covers have been removed, the touch-safe covers must be replaced to ensure safety and protection.

Important:

- *All Trane-supplied drives must be used with CVHH or CDHH Trane chillers to ensure CE compliance.*
- *Basic drive details are provided on drive nameplate. Please refer to the chiller unit nameplate located on the chiller-mounted control panel for details on wire sizing (minimum current ampacity) and overcurrent protection sizing upstream of unit (maximum overcurrent protection).*
- *Always refer to as-built schematic wiring diagram and the chiller* Installation, Operation, and Maintenance *manual located inside the chiller-mounted control panel for details on wiring, safety, installation, and warnings.*

- *Customers are responsible for all field wiring with respect to EMC and EMI interference. Customers are responsible for mitigating the risks associated with EMC and EMI interference that can occur as a result of customer-provided field wiring as dictated by international, national, and local codes. This also implies that customers are responsible for incoming power wiring to the drive with respect to EMC and EMI interference.*

All customer wiring, including power wiring to drives, must be separated: 24–27 Vdc, 110–120 Vac, and 380–600 Vac each must be in separate conduit runs.

The customer is required to provide an overcurrent protective device upstream of all drives in accordance with IEC standards and/or any applicable national and local and codes.

Service personnel must use proper PPE for servicing and must also use proper lockout/tagout procedures during servicing: lock the drive disconnect handle before servicing to prevent accidental pulling of disconnect handle at the drive panel.

In addition, service personnel should disconnect the main supply disconnecting device upstream of the drive *before* performing any service on any part of the chiller.

AFDE Information

The AFDE refrigerant-cooled Adaptive Frequency Drive is a pulse width modulated (PWM) design incorporating both an IGBT (Insulated Gate Bipolar Transistor) active rectifier and inverter. It is designed for 380–480 volt application. This drive converts AC power to DC power and back to AC power. The incoming 380–480 volts are converted to a constant 700 Vdc by the active rectifier, and into a section of capacitors that are used to store the DC voltage. The DC output feeds the inverter IGBTs that switch at predetermined time to change the DC input voltage to a symmetrical AC output voltage of desired magnitude and frequency. The output frequency range is 38 to 60 hertz.

The DC voltage is fixed at 700 Vdc. A variable output is accomplished by PWM control within the inverter by the IGBTs which are basically transistors that turn on and off in response to the gate driver.

A combination of two distinct operating modes make up the AFDE control within the chiller's UC800 control. First by controlling the inlet vanes, and second by modulating impeller speed from 38 to 60 hertz. The IGBTs control the speed in response to the UC800 compressor control signal. Circuit breakers, surge capacitors and ground faults are standard on all AFDE units.

Some of the basic principles of the drive are:

- Less than or equal to 5 percent current harmonic distortion (TDD).
- Minimum efficiency of 97 percent at rated load and 60 Hz.
- Unit displacement power factor of 0.98 or better at full load and a value of 0.96 at part load.
- Low in rush current.
- The current never exceeds the full load amps.
- The AFDE varies the motor speed in response to the speed command from the UC800 control.

The CenTraVac™ Control Panel has full control of the unit operation, including the start/stop functions. If you encounter a fault condition or an alarm on the drive, the Tracer® AdaptiView™ display will indicate "alarm" and an "alarm message."

This manual covers the features and specifications that are unique to the Trane Adaptive Frequency Drives being produced for Trane. Only product information is covered here that supplements that presented in the standard LiquiFlo instruction manuals that ship with the unit.

Model Number Descriptions

Model Number Digit Identification

Model number digits are selected and assigned in accordance with the following definitions using the above model number example:

Digit 1, 2, 3 — Unit Function

AFD= Adaptive Frequency Drive

Digit 4— Development Sequence

E = Refrigerant-Cooled with Tracer AdaptiView™ Controls

Digit 5, 6, 7, 8 — Adaptive Frequency Drive Size

Use Motor Rated Load Amps (NRLA) Value

Digit 9 — Unit Motor Voltage

F = 460V-60Hz-3Ph
G = 480V-60Hz-3Ph
S = Special

Digit 10, 11 — Design Sequence

A0 = First Design
B0 = Addition of 405 Amp Drive
C0 = Vendor Component Change
D0 = Addition of 900 Amp Drive
E0 = Revise RECOMM-TRANE Software
F0 = Tyco Connector/Harness
G0 = Precharge Resistor
H0 = I/F PCBA Connector Change
J0 = Chill Plate Redesign
K0 = Addition of Common Mode Magnetic Core Choke Mounting Brackets
L0 = Updated Circuit Breaker and Control Power Transformer
M0 = Added Line Voltage Digit
N0 = Touch Safe Control Circuit Fuse Blocks
P0 = Pre-Charge Contactor Reduction and Back Plate Modification
R0 = New Precharge Contactor
T0 = External 120 Vac hookup, binding from keypad

Digit 12 — AFD Mounting Location

A = Unit-Mounted

Digit 13 — Agency Listing

1 = UL and CUL
2 = CE

Digit 14 — Special Options

0 = None
9 = Special

Digit 15 — AFD Frame Size (SSRL)

A = 405
B = 608
C = 900
D = 1210

Digit 16 — Unit Line Voltage and Frequency (IVLT and IHRZ)

A = 380/50
B = 380/60
C = 400/50
D = 415/50
E = 440/60
F = 460/60
G = 480/60
S = Special Voltage

Digit 17 — Seismic

0 = None
B = With Seismic Cabinet and Brackets

Digit 18 — Three-Phase Oil Pump Contactor/Relay

1 = Pilot Relay Only
2 = Pilot Relay to Three-Phase Oil Pump Starter

Digit 19 — Common Mode Cores

0 = No Common Mode Cores
C = Common Mode Cores

Drive and Cabinet

Enclosure Rating

The Trane® cabinet has a NEMA 1 enclosure rating:

NEMA 1: Vented. Intended for general-purpose indoor applications.

Environmental Conditions

Important: *Location of the AFDE is important if proper performance and normal operating life is to be expected. Therefore, unless designed for special environments, the controller should be installed in an area where the following conditions exist*

- Verify that NEMA 1 enclosure drives can be kept clean and dry.
- The area chosen should allow the space required for proper air flow. Adequate clearance for air circulation around the enclosure is a 6 inch (15.25 cm) minimum clearance required wherever vents are located in the cabinet.
- Be sure that the NEMA 1 enclosure is installed away from oil, coolants, or other airborne contaminants.
- Do not install the drive above 3300 feet (1000 meters) without derating output power. For every 300 feet (91.4 meters) above 3300 feet (1000 meters), derate the output current 1%.
- Line frequency is 50 or 60 Hz.
- Line Voltage is 380–480 volts; variation are within ±10%.
- Non-corrosive location.
- Verify that the drive location will meet the environmental conditions specified in Table 1.

Table 1. Environmental conditions

Condition	Specification
Operating Temperature (inside NEMA 1 enclosure)	32° to 131°F (0°C to + 55°C)
Ambient Temperature (outside NEMA 1 enclosure)	32°F to 104°F (0°C to + 40°C)
Storage Temperature (Ambient)	-40°F to 149°F (-40°C to 65°C)
Humidity	5% to 95% (non-condensing)

Identifying Trane AFDE Cabinet Components

Trane AFDE cabinets have the following main components. For convenience, the drive is discussed in two sections, a rectifier (input) and inverter (output) sections. See Figure 1, p. 15 and Figure 3, p. 18 for Frame 3, and Figure 4, p. 19, Figure 5, p. 21 and Figure 7, p. 24 for Frame 4.

Drive Cabinet Component Locations

Frame 3 Units 179910-903 and 179910-905

The main drive components for a Frame 3 unit are listed below. Each numbered item corresponds to a number in Figure 1.

1. Circuit Breaker, 600V
2. Circuit Breaker Operating Mechanism
3. Inductor
4. AC Contactor
5. Power Module Assembly (refer to Figure 3, p. 18 and Figure 4, p. 19 for details)
6. Input Filter Capacitor Assembly
7. Input Filter Capacitor Guard Panel
8. Fans, 115Vac, Inductor (2)
9. Transformer, 3kVA
10. Fan, 115Vac, Contactor
11. Resistors, 100k Ohms, 50W
12. Precharge Resistors
13. Relay, Oil Pump and Control Power Terminals
14. Fuse, Class RK-5, 600V, 15A (2)
15. Fuse, Class CC, 600V, 25A (1)
16. Fuse, Class CC, 600V, 5A (1)
17. Fuse, Class T, 500V, 150A (3)
18. Fuse, Class CC, 600V, 20A (3)
19. Fuse, Class CC, 600V, 1A (3)
20. Ground Lug, 2–600 MCM (for AWG/MCM equivalents in mm2, refer to Table 2, p. 31)
21. Nameplate, Power Module
22. Door Inter-lock

23. Line Sync, PCB Assembly
24. Line Sync, PCB Cover
25. Terminal Block, Fans, 6-Position
26. Surge Suppressor
27. OIM

Note: *OIM is mounted inside panel for design sequence P0 and earlier. OIM is mounted outside panel for design sequence R0 and later.*

Figure 1. Drive components locations: Frame 3 units

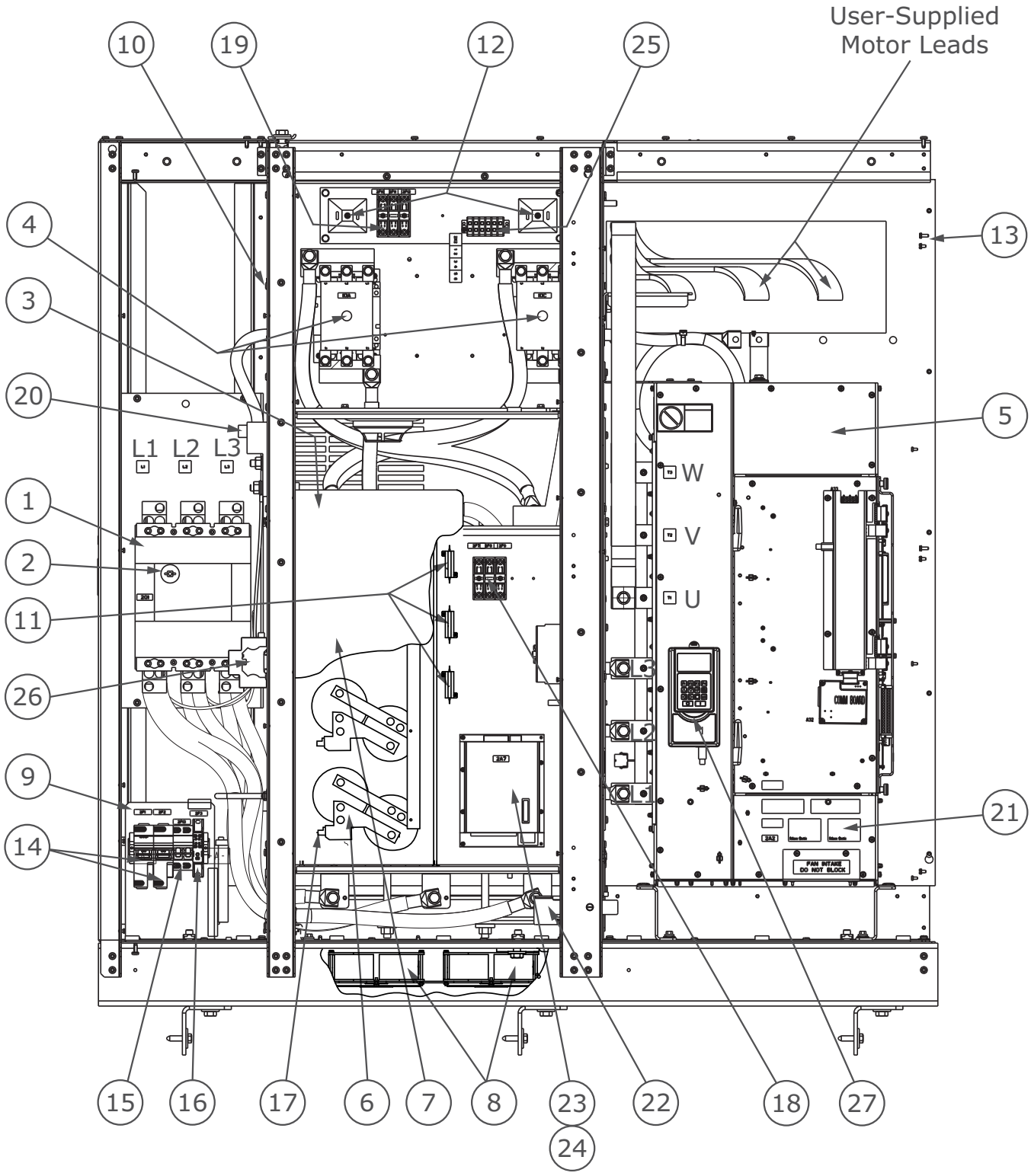
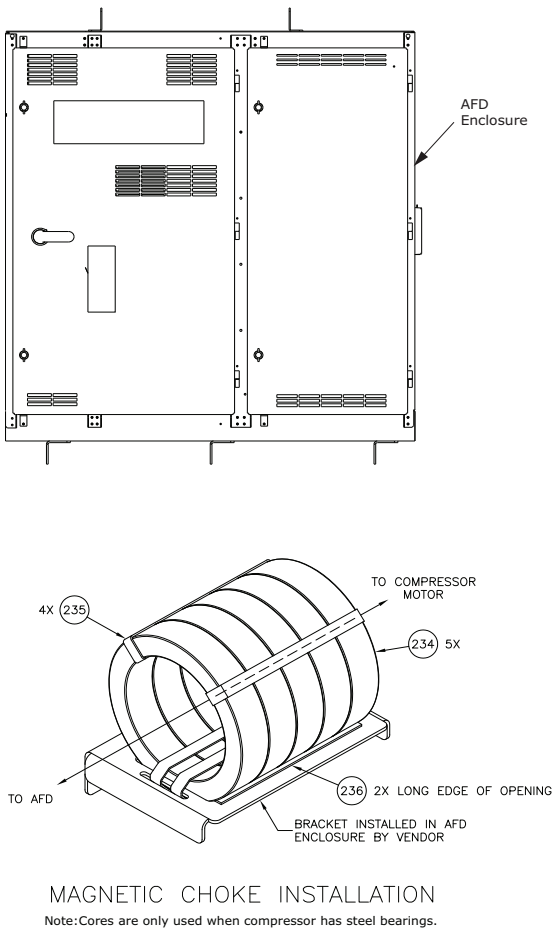


Figure 2. Magnetic choke



Power Module Component Locations

Frame 3 Units LF200405AAP and LF200608CCP

The main power module components for a Frame 3 unit are listed below. Each numbered item corresponds to a number in Figure 3, p. 18 or Figure 4, p. 19.

1. Wire Harness Assembly, Power Supply, Logic
2. Current Feedback Device, 1000 A
3. Terminal Block, 2-position
4. 80W Power Supply Assembly
5. Cable Assembly, 40-pin, 0.050 in (1.27 mm) Pitch, Flex Film
6. Cable Assembly, 30-pin, 0.050 in (1.27 mm) Pitch, Flex Film
7. Wire Harness Assembly, Power Supply, Upper Gate
8. Inverter Power Interface Assembly
9. Wire Harness Assembly, Power Supply, Lower Gate
10. Insulation Sheet
11. DPI Communications Interface
12. Rectifier Power Interface Assembly
13. Wire Harness Assembly, Gate Driver
14. Wire Harness Assembly, Current Feedback Device
15. Wire Harness Assembly, Line Sync.
16. Wire Harness Assembly, DC Bus Bleeder Resistors
17. Cable Assembly, 20-pin, 0.050 in (1.27 mm) Pitch, Flex Film
18. RS-485 Communications Assembly (RECOMM)
19. Internal Fan
20. Connector, Terminal Block, 32-pin
21. AC Line I/O Assembly
22. Rectifier Control Assembly
23. Inverter Control Assembly
24. Standard I/O Board (optional)
25. Synchronization Cable

Figure 3. Power module component locations door open: Frame 3 units

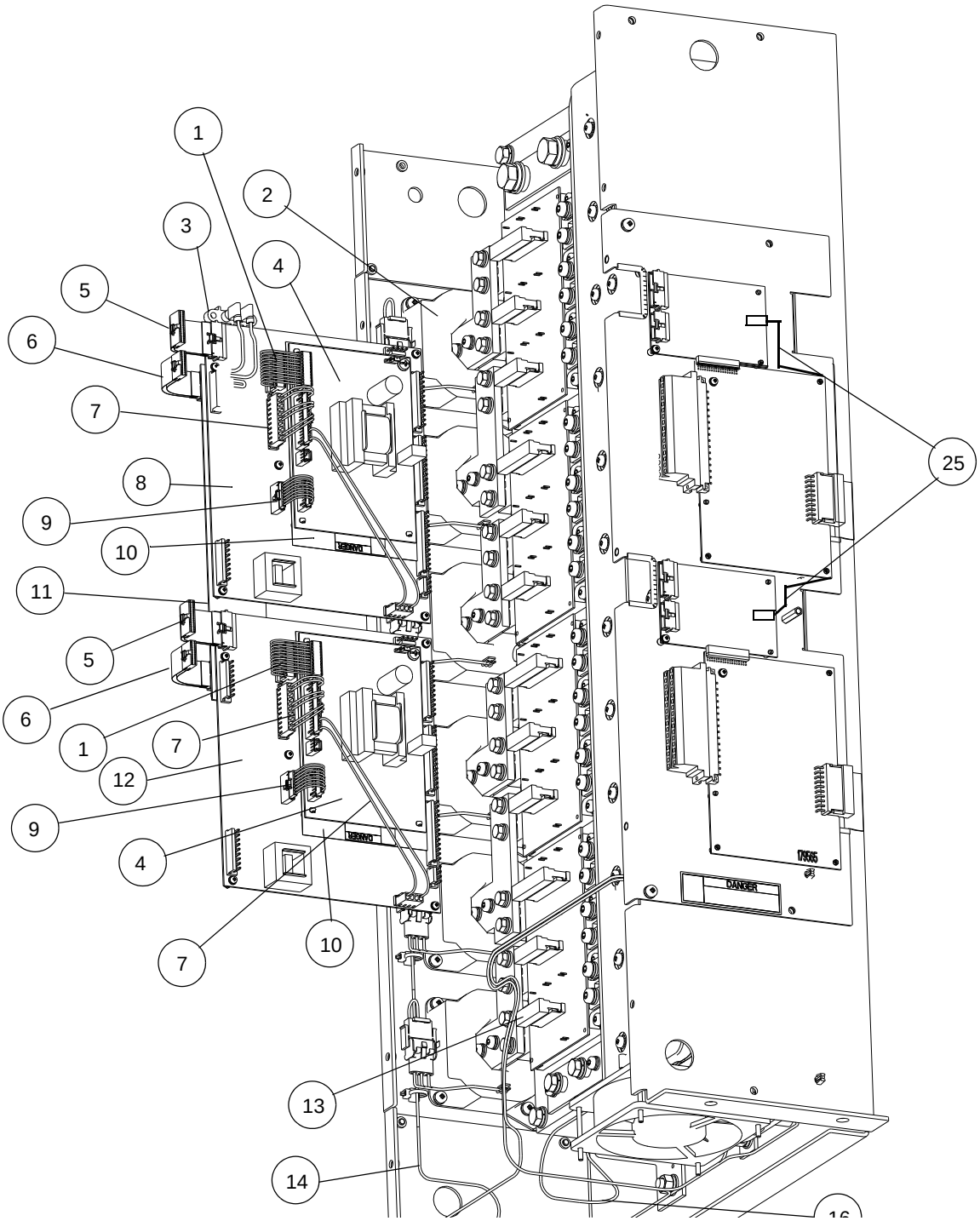
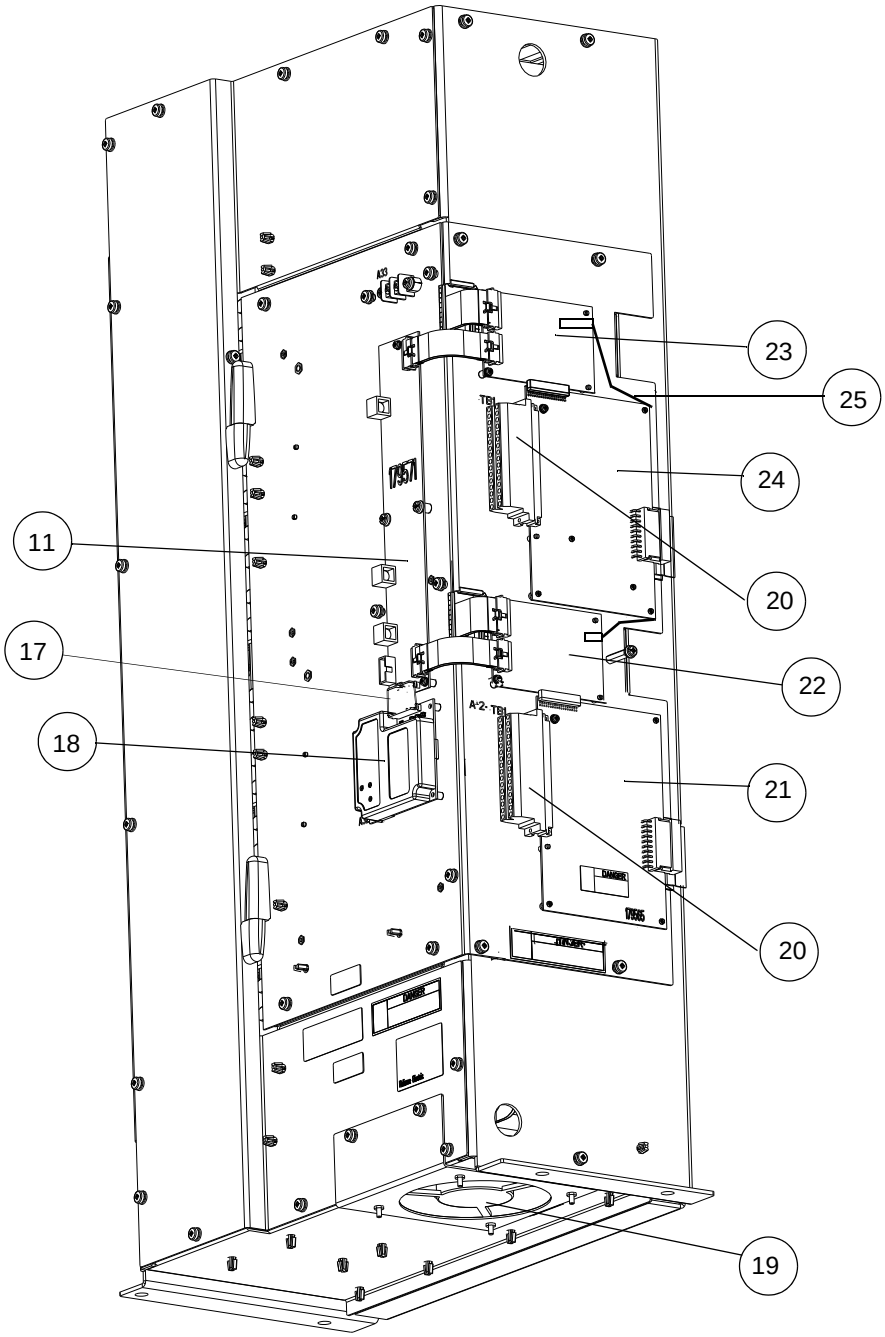


Figure 4. Power module component locations door closed: Frame 3 units



Drive Cabinet Component Locations

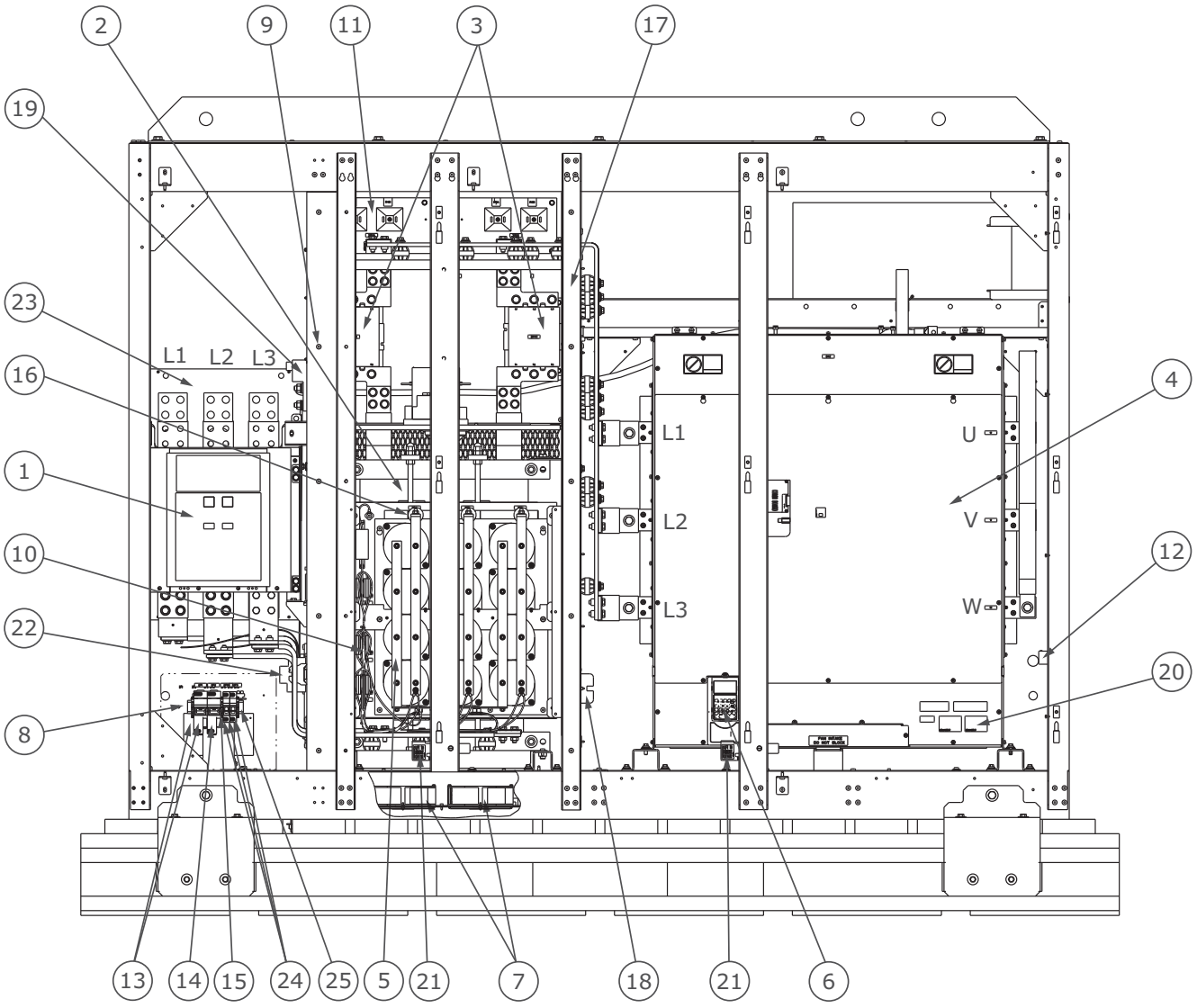
Frame 4 Units 180180-A07 and 180180-A09

The main drive components for a Frame 4 unit are listed below. Each numbered item corresponds to a number in Figure 5, p. 21.

1. Circuit Breaker, 600V
2. Inductor
3. AC Contactor
4. Power Module Assembly (refer to Figure 7, p. 24 and Figure 8, p. 25 for details)
5. Input Filter Capacitor Assembly
6. OIM

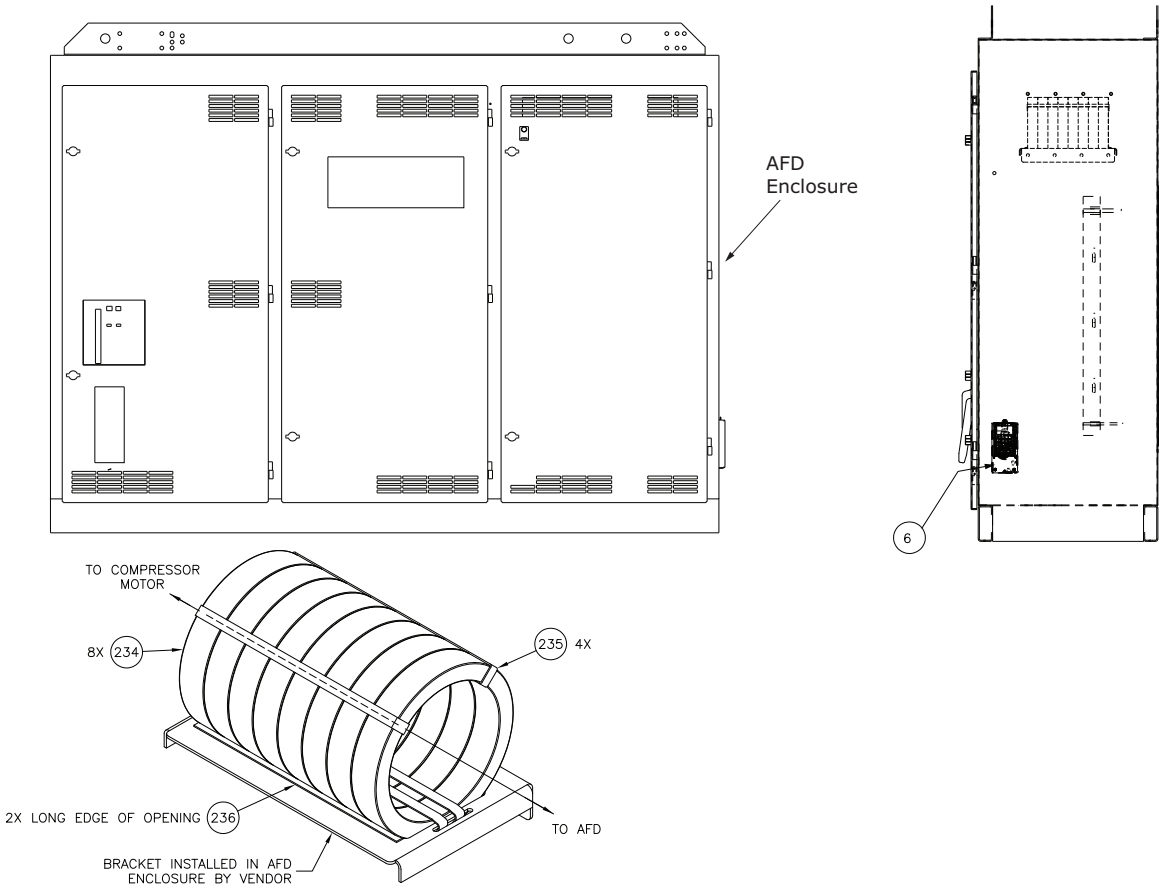
   Note: *OIM is mounted inside panel for design sequence P0 and earlier. OIM is mounted outside panel for design sequence R0 and later.*
7. Fans, 115Vac, Inductor (4)
8. Transformer, 115Vac, Control Power
9. Fan, 115Vac, Contactor
10. Resistors, 100k Ohms, 50W
11. Precharge Resistors
12. Relay, Oil Pump and Control Power Terminals
13. Fuse, Class J, 600V, 10A (2)
14. Fuse, Class J, 600V, 25A (1)
15. Fuse, Class CC, 600V, 10A (1)
16. Fuse, Class T, 600V, 300A (3)
17. Fuse, Class CC, 600V, 20A (3)
18. Fuse, Class CC, 600V, 1A (3)
19. Ground Lug, 2–600 MCM (for AWG/MCM equivalents in mm2, refer to Table 2, p. 31)
20. Nameplate, Power Module
21. Door Inter-lock (2)
22. Surge Suppressor
23. EMC Line Filter (Optional)
24. Fuse, Class CC, 600V, 6A (3) (Optional)
25. Oil Pump Motor Starter Assembly (Optional)

Figure 5. Drive component locations: Frame 4 units



Note: *Units with CE certification include touch-safe barriers (not shown).*

Figure 6. Magnetic choke



MAGNETIC CHOKE INSTALLATION

Note: Cores are only used when compressor has steel bearings.

Power Module Component Locations

Frame 4 Units LF200900CCP and LF201215CCP

The main power module components for a Frame 4 unit are listed below. Each numbered item corresponds to a number in Figure 7, p. 24 or Figure 8, p. 25.

1. Combined Power PCB Assembly, 900 Amps

   Combined Power PCB Assembly, 1215 Amps
2. Wire Harness Assembly, Gate Driver
3. Internal Fan, 24Vdc
4. Internal Fan, 24Vdc
5. Wire Harness Assembly, Internal Fan
6. Wire Harness Assembly, DC Power
7. Wire Harness Assembly, DC Bus Resistors (under top cover)
8. Current Feedback Device, 2000 A
9. Wire Harness Assembly, Current Feedback Device, Rectifier Side
10. Wire Harness Assembly, Current Feedback Device, Inverter Side
11. Wire Harness Assembly, RTD, Recitifier Side
12. Wire Harness Assembly, RTD, Inverter Side
13. Cable Assembly, 40-Pin
14. Combined Control PCB Assembly
15. Combined I/O PCB Assembly
16. RS-485 Communications Assembly (RECOMM)
17. Cable Assembly, 20-Pin
18. Cable, Mini DIN, 8 Pos., Male/Male, 3.28 ft (1 meter) Long

Figure 7. Power module component locations IO and control panel removed: Frame 4 units

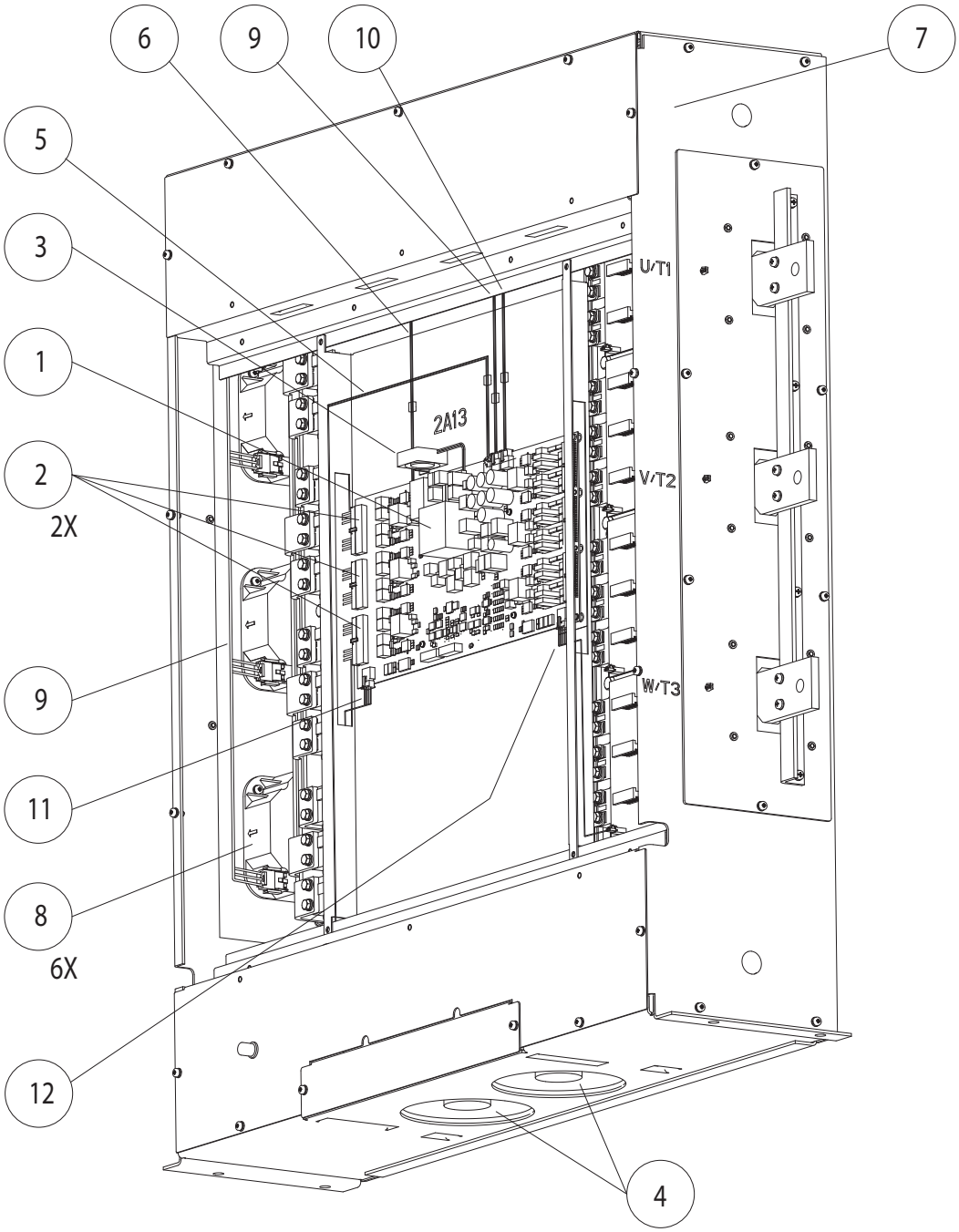
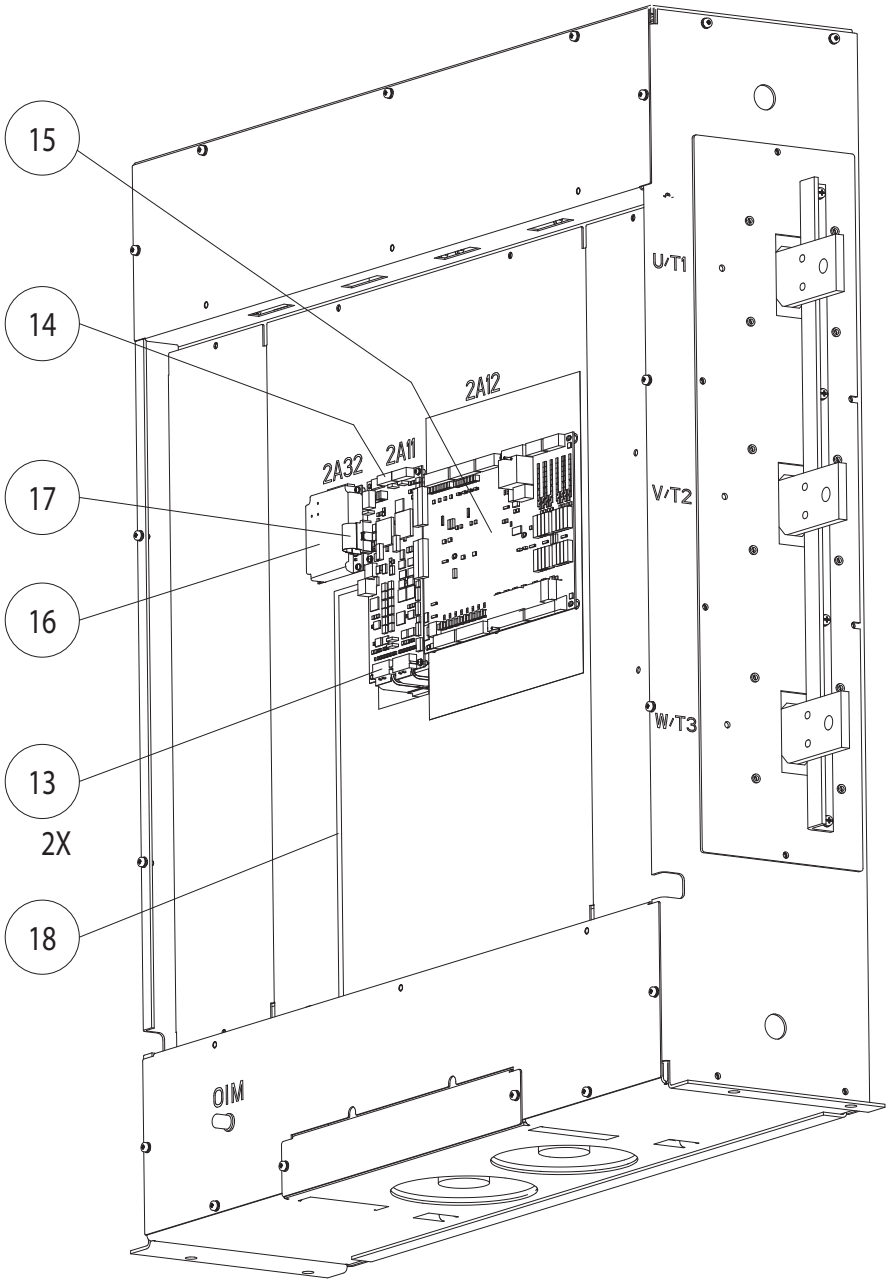


Figure 8. Power module component locations front panel removed: Frame 4 units



About the Cabinet

This section provides cabinet dimension information and shows where the wire entry areas and liquid-cooling connection points are located.

Figure 9, p. 26 shows overall dimensions for Frame 3 units and Figure 10, p. 27 shows overall dimensions for Frame 4 units.

Figure 9. Drive cabinet dimensions: Frame 3, in. (mm)

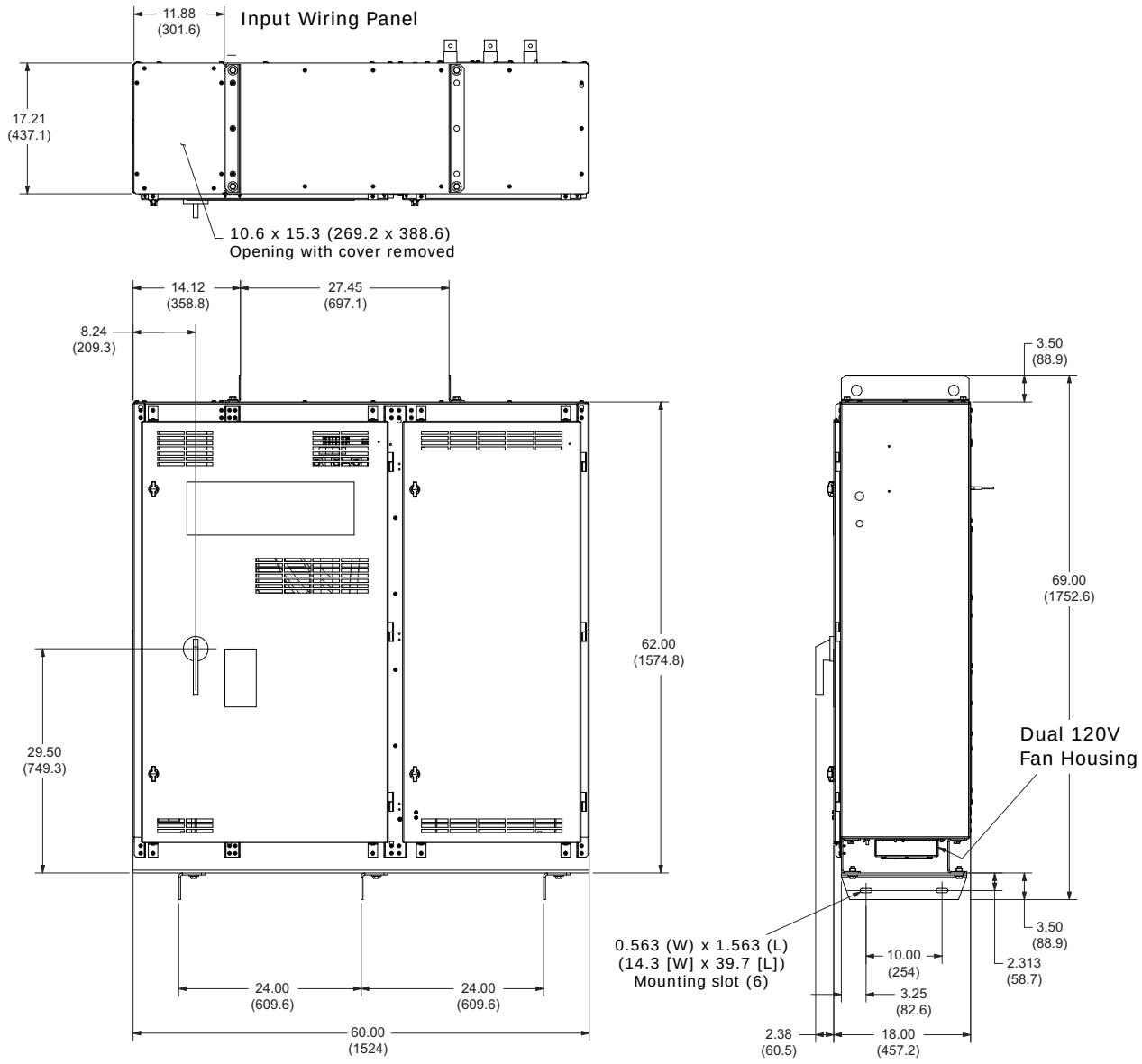
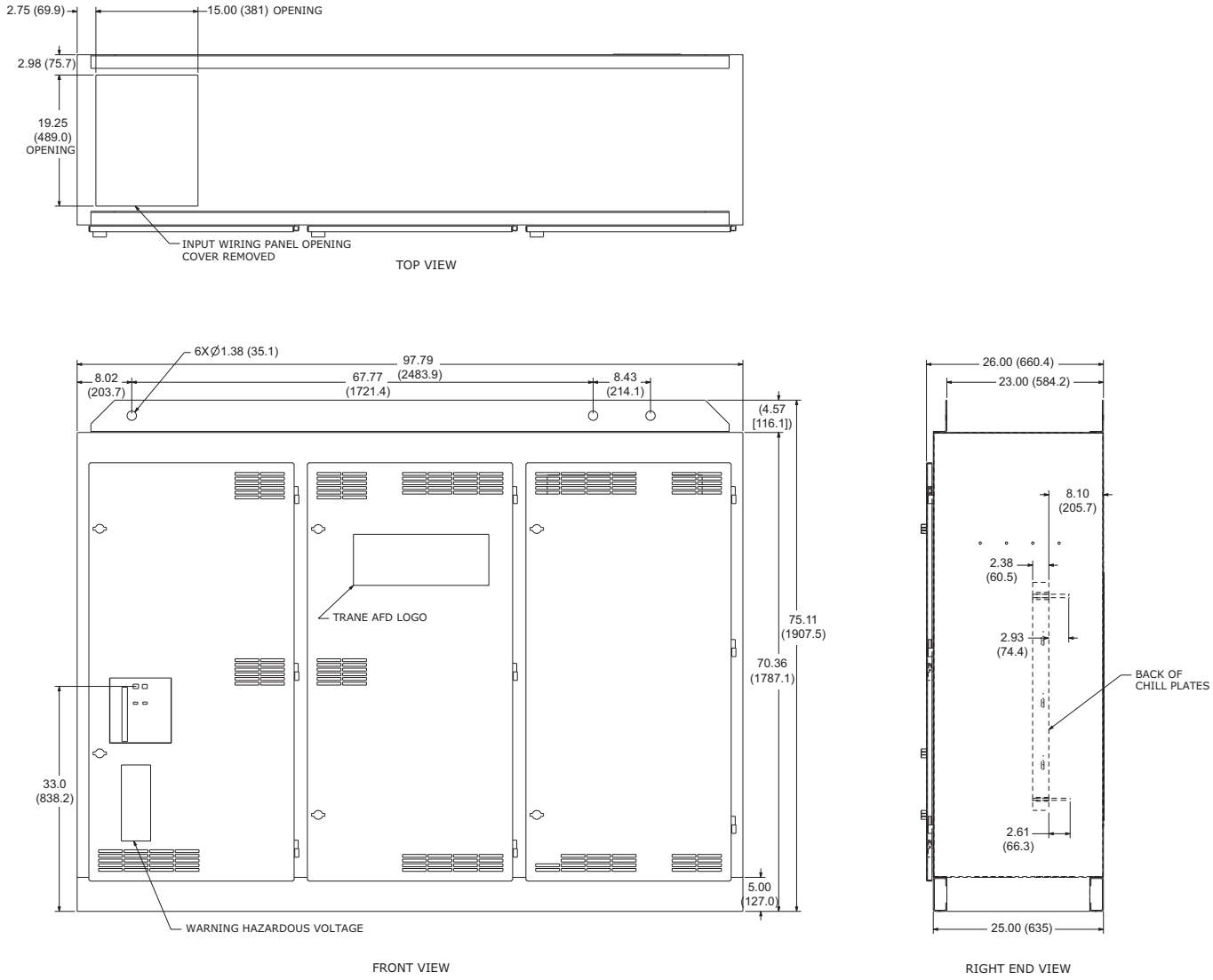


Figure 10. Drive cabinet dimensions: Frame 4, in. (mm)



Drive Removal

If you need to temporarily remove the entire drive and enclosure from the chiller to allow unit installation through restricted spaces, use the following general information and instructions.

The maximum weight of the drive and the enclosure is 1520 lb (689 kg) for Frame 3 and 2800 lb (1270 kg) for Frame 4.

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. If this equipment is interlocked with other equipment, 115 volts AC may be present in the cabinet even though the main power is disconnected. If this is the case, these interlock signals should be deactivated before any work is performed on this equipment. Suitable warning tags or disconnects should be added to these circuits and all circuits should be tested before attempting to energize or service the controller.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN.*

1. Power down the chiller and lockout/tagout the unit.
2. Disconnect the FLEXIBAR (flexible insulated busbar) conductors at the motor terminals.
3. At the drive, disconnect the control wiring between the drive and the unit controls. Set the control conduit aside.

⚠WARNING

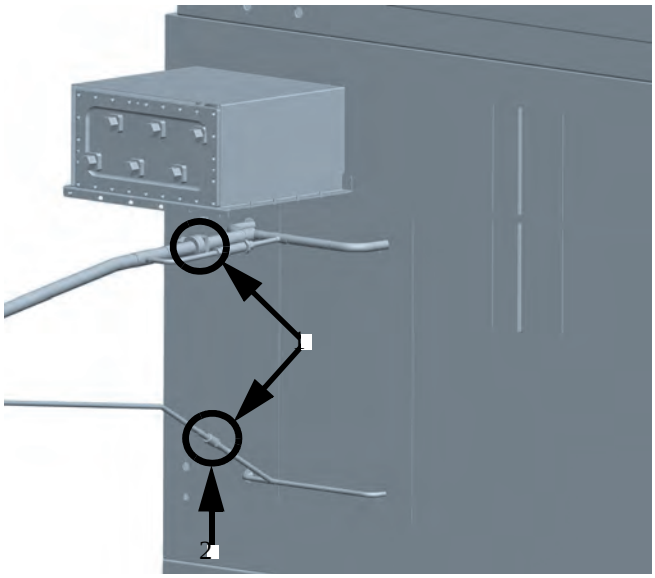
Refrigerant Vapor Hazard!

Failure to follow instructions could result in death or serious injury. Recover refrigerant before opening and servicing the component or entire unit as necessary. Lockout/tagout to ensure a refrigerant valve cannot be accidentally opened.

4. Close the isolation valves for the AFD cooling lines if present, both supply and return. Recover refrigerant present in AFD cooling circuit using Schrader fitting located on supply isolation valve (see Figure 11).

Important: *Lockout/tagout isolation valves AFTER recovery of refrigerant.*

Figure 11. Isolation valves



1. Service isolation valves
2. This valve includes a Schrader fitting to connect nitrogen.

5. Remove the screws on the back side of the drive that secure the panels over the refrigerant connections.

⚠WARNING

Hazard of Explosion and Deadly Gases!

Failure to follow all proper safe refrigerant handling practices could result in death or serious injury. Never solder, braze or weld on refrigerant lines or any unit components that are above atmospheric pressure or where refrigerant may be present. Always remove refrigerant by following the guidelines established by the EPA Federal Clean Air Act or other state or local codes as appropriate. After refrigerant removal, use dry nitrogen to bring system back to atmospheric pressure before opening system for repairs. Mixtures of refrigerants and air under pressure may become combustible in the presence of an ignition source leading to an explosion. Excessive heat from soldering, brazing or welding with refrigerant vapors present can form highly toxic gases and extremely corrosive acids.

⚠WARNING

Refrigerant May Be Under Positive Pressure!

Failure to recover refrigerant to relieve pressure or the use of non-approved refrigerants, refrigerant substitutes, or refrigerant additives could result in an explosion which could result in death or serious injury or equipment damage. System contains oil and refrigerant and may be under positive pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives.

6. Loosen and remove the bolts that secure the refrigerant line flanges to the drive flanges. Take care not to misplace any orifice plates that may be installed on the refrigerant inlet.

Important: *Any unit pressure must be relieved before disconnecting refrigerant lines. The units ship from the factory with a 5 psi (34.5 kPa) dry nitrogen holding charge.*

Lifting the Drive

⚠WARNING

Heavy Objects!

Failure to properly lift unit could result in death or serious injury. Do not use cables (chains or slings) except as shown. Each of the cables (chains or slings) used to lift the unit must be capable of supporting the entire weight of the unit. Lifting cables (chains or slings) may not be of the same length. Adjust as necessary for even unit lift. Other lifting arrangements may cause equipment or property-only damage.

⚠WARNING

Improper Unit Lift!

Failure to properly lift unit could result in death or serious injury or possible equipment or property-only damage. Test lift unit approximately 24 inches (61 cm) to verify proper center of gravity lift point. To avoid dropping of unit, reposition lifting point if unit is not level.

7. Use an overhead or portable hoist (minimum 2-ton [907 kg] rated capacity) and connect it to the enclosure using slings or chains. Rig in a manner that will equalize the load at the pickup points. Use a spreader bar if the angle of the sling or chains is less than 45° relative to the horizontal. Take up the vertical slack. A fork lift truck or similar means of lifting or transporting the drive may also be used if care is taken. See Figure 12.
8. Loosen and remove the bolts that secure the drive enclosure to the motor terminal transition piece or terminal board.
9. Loosen and remove the bolts that secure the drive enclosure to the lower mounting brackets.
10. Carefully lift the drive away. Do not bump or jolt the drive while lifting.
11. Store the drive in a clean and dry location with ample air circulation and heat to prevent condensation from occurring. Always protect the drive from dirt and moisture. If it is necessary to cut and remove the mounting brackets below the drive, it is recommended that alignment or "fish" plates be field constructed to assure the brackets are properly re-aligned when they are reinstalled.

Re-assembly of the drive is essentially the reverse of the above procedure. The drive enclosure to mounting bracket bolts should be torqued to 90 ft·lb (122 N·m). The drive enclosure to motor terminal transition piece or terminal board should be torqued to 21 ft·lb (28.5 N·m).

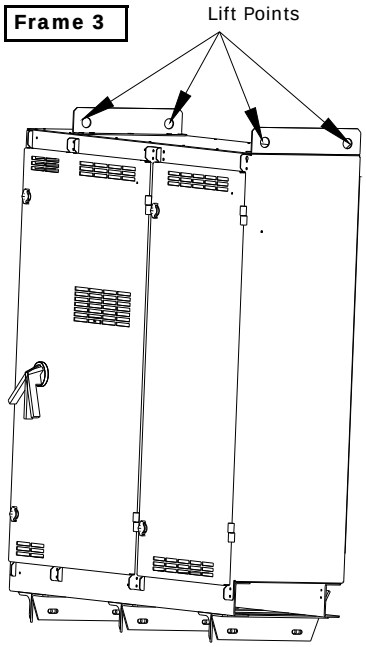
⚠WARNING

Improper Unit Lift!

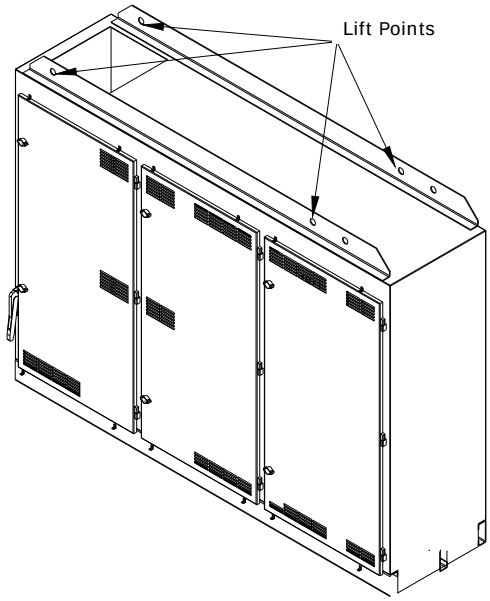
Failure to properly lift unit could result in death or serious injury or possible equipment or property-only damage. Test lift unit approximately 24 in. (61 cm) to verify proper center of gravity lift point. To avoid dropping of unit, reposition lifting point if unit is not level.

Figure 12. Lift point locations for LiquiFlo 2.0 drives

Frame 3



Frame 4



Use new gaskets when reconnecting the refrigerant lines to the drive (see Figure 14, p. 36).

Note: *Refer to "Liquid-Cooling Connections," p. 36 for detailed instructions. Ensure any orifice is also correctly re-installed. Refrigerant line flanges with 1/2-in. (1.3 cm) bolts must be torqued to 70 ft·lb (94.9 N·m). Refrigerant line flanges with 5/16-in. (0.8 cm) bolts must be torqued to 17 ft·lb (23.0 N·m). The FLEXIBAR (flexible insulated busbar) connections to the motor terminals should be torqued to 27 ft·lb (36.6 N·m).*

Frame 3 drives (608 Amp and 405 Amp) have an orifice plate located between the inlet flange and the heat sink. The orifice plate sits between two gaskets.

Frame 4 drives have no orifice plate.

Input Power and Control Wiring

Installing Input Power Wiring Standard Cabinet

For AWG/MCM equivalents in mm^2, refer to Table 2:

Table 2. Wire sizing reference

AWG / MCM	mm^2 equivalent
22	0.32
21	0.35
20	0.5
18	0.75
17	1.0
16	1.5
14	2.5
12	4
10	6
8	10
6	16
4	25
2 or 1	35
1/0	50
2/0	70
2/0 or 3/0	95
4/0 or 250	120
300	150
350 or 400	185
450 or 500	240
Note: AWG = American Wire Gauge	

Important: *Customers are responsible for all field wiring in compliance with local, national, and/or international codes.*

Use the following steps to connect AC input power to the cabinet:

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN.*

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

NOTICE

Load Side Wiring!

Failure to route the wires through the cores could result in bearing damage. The electrical wiring from the drive output to the motor must be routed through the magnetic cores. The cores are used to protect the motor bearings.

1. Turn off, lock out, and tag the input power to the drive.
2. Remove the 12 x 17 in. (30.5 x 4 cm) panel from the top left of the drive enclosure.

NOTICE

Equipment Failure!

Failure to follow instructions below could result in damaged equipment. Do not cut holes in adaptive frequency drive enclosure. Debris falling inside of adaptive frequency drive could cause failure of electronic components.

3. Once removed, drill the wire routing holes in the panel. These wire routing holes are the only entry points for input power wiring into the cabinet.
4. Install the appropriate conduit hubs.
5. Reinstall the cabinet's top panel.
6. Connect the three-phase 380–480Vac input power leads:
   a. *For non-CE units*, connect the input power leads to circuit breaker terminals L1, L2, and L3.

b. *For CE units*, connect the input power leads to the L1, L2, and L3 terminals located *before the EMC line filter*.

7. Tighten connections to 30 ft·lb (40.7 N·m). Use only copper conductors for the input power leads.

   Input power wiring should be copper and should be sized according to applicable codes to handle the drive's continuous rated input current.

Refer to submittals for power lug sizes and location along with control wiring specifics for the controller.

Important: *Power connections should be re-torqued after the first three to six months of operation and on an annual basis thereafter.*

Installing External 120 Vac Control Power

The 120 Vac control power for the unit is typically generated by the Control Power Transformer (CPT) that is installed in the AFDE panel. Some customers may wish to use external 120 Vac control power, such as from an Uninterruptable Power Supply (UPS). Design sequence T0 and later includes standard terminal blocks to hookup external 120 Vac control power. Follow the instructions on the schematic to install.

Torquing Electrical Power Connections

Use a torque wrench to tighten power connections. A torque wrench eliminates the human element and provides proper hardware tightening.

Proper torque for connections depends on both the bolting materials and the metals being connected. Strand migration will occur when the copper is under prolonged pressure.

Electrical power terminations should be rechecked for tightness when the apparatus is first installed and periodically afterwards. The conductor could flow under prolonged pressure. Thermal cycling will be greater during the first few months in operation.

Most hardware used for making a bolted electrical joint will be low carbon steel. The hardware does not carry electrical current but holds the two conducting surfaces together under pressure. When properly torqued, the slight elongation of the bolt or screw acts to maintain pressure on the electrical joint. The thermal expansion of steel is less than that of the conducting metals, which is usually copper.

The pressure at the electrical joint will vary slightly during thermal cycling and reduces somewhat when there is cold flow in the conducting metals. Re-torquing will re-establish the surface pressure, which is essential to keeping a low resistance drop between the two conducting surfaces and avoiding eventual failure.

Note: *Connection from the AFDE output to the motor is made with FLEXIBAR. PROPER TORQUE IS "CRITICAL." See Table 3.*

Table 3. Torque value for AFDE output to motor FLEXIBAR (flexible insulated busbar)

Bolt Size	Torque Value
3/8 in.	30 ft·lb (40.7 N·m)
M10	44 ft·lb (60.0 N·m)
1/2 in.	75 ft·lb (101.7 N·m)

NOTICE

Equipment Damage!

When tightening FLEXIBAR® (flexible insulated busbar) connections at the drive terminals, take care not stress the IGBTs. The IGBTs are connected to the other end of the terminal bar, and stressing them could cause equipment damage.

Cabinet Wire Routing

All wiring should be installed in conformance with the applicable local, national, and international codes (for example, NEC/CEC). Control wiring enters the cabinet through the right side and terminates at the control panel's terminal block. Tighten the control wire connections to 7.1 to 8.9 in·lb (0.8 to 1.0 N·m).

Wire Routing

Wire Sizing

Care should be taken to see that all interconnection wiring and ground wiring is sized and installed in conformance with the National Electrical Code (NEC), the National Fire Protection Association (NFPA), or the Canadian Electrical Code (CEC) as applicable, and other appropriate local codes. Refer to controller and motor nameplates for electrical data.

⚠WARNING

Hazardous Voltage/Improper Grounding!

Hazardous voltage due to improperly grounded electrical components could result in death or serious injury. The motor controller has a chassis ground that must be connected to an earth ground.

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

Note: *Graphic labels (shown above) are used for CE application only.*

Table 4. Standard wiring requirements AFD control wiring (between the chiller and the starter)

AFD Starter to Control Panel Control Wiring	Starter Panel Terminations	Control Panel Terminations		Comment
		CVHE, CVHF, CVHG	CVHH	
AFD 120Vac Power Supply (hot)	2X1-1	1X1-1	1X1-1	
AFD 120Vac Power Supply (neutral)	2X1-15	1X1-12		
Ground	2X1-11	1X1-G	1X1-G	Panel ground.
Ref/Oil Pump Interlock (2K11)	2X1-7, 2X1-8	LLID 1A7 J2-4, J2-2	LLID 1K17 J2-3, J2-1	Normally open.
Condenser High Pressure Cutout (3S1)	2X1-3, 2X1-4 (shield to 2X1-5)	N/A	N/A	Normally closed. Operates the gate kill input on 2A2-TB33.
Recomm Bus +24V	2A32-1	WB2 to 1A1, J4-1	WB2 to 1T2, J4-1	4-wire bus WB2 connects to power supply module, terminals J4-1, 2, 3, and 4
Recomm Bus Ground	2A32-2	WB2 to 1A1, J4-2	WB2 to 1T2, J4-2	
Recomm Bus Com +	2A32-3	WB2 to 1A1, J4-3	WB2 to 1T2, J4-3	
Recomm Bus -	2A32-4	WB2 to 1A1, J4-4	WB2 to 1T2, J4-4	

Grounding the Cabinet

Note: *Follow Applicable Codes! The user is responsible for conforming to all applicable, local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.*

Use the following steps to ground the cabinet:

1. Open the left-hand enclosure door of the drive. The grounding stud is located just above and to the right of the breaker.
2. Run a suitable earth ground (completed by field) to the cabinet's ground connection point. The grounding lug is capable of accepting up to 2–600 MCM wire. For AWG/MCM equivalents in mm2, refer to Table 2, p. 31. Tighten the ground connections to 375 in·lb (42.4 N·m).

⚠WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

NOTICE

Equipment Damage!

Failure to follow instructions below could result in damage to equipment. Do not route signal and control wiring with power wiring in the same conduit. This can interfere with drive operation.

An input disconnect circuit breaker is factory-installed in the cabinet. Verify that the available fault current is less than the interrupting rating on the circuit breaker nameplate, which is 65,000 amps at 480 Vac.

AFDE Cooling Circuit

The AFDE Adaptive Frequency Drive is cooled with liquid refrigerant from the chiller. The refrigerant pump on the chiller takes refrigerant from the condenser sump and pushes it upwards to the motor to provide motor cooling. The AFDE taps into this refrigerant flow and diverts a portion of the refrigerant to the drive.

The refrigerant coolant enters the drive through the lower flange fitting(s) on the back of the drive enclosure. The refrigerant flows upwards through the drive and removes heat from the assembly. The refrigerant exits the drive at the top flange fitting(s) and flows to join the refrigerant return from the motor, which then flows to the condenser. Frame 3 (405A, 608A) utilizes a single chill plate.

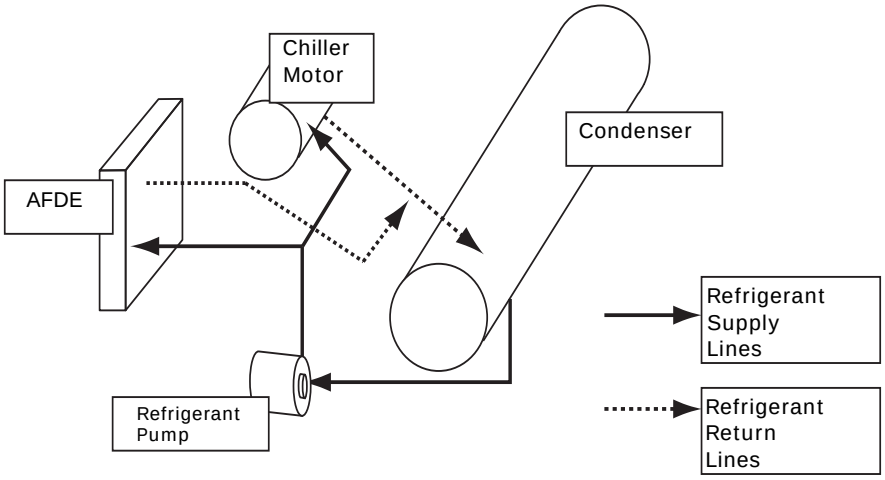
A small orifice is installed in the lower flange inlet at the drive. The purpose of the orifice is to regulate the amount of refrigerant that enters the drive. Frame 4 (900A, 1210A) utilizes dual chill plates. No orifices are used on the lower flange inlets.

The differential pressure across the refrigerant pump is normally 10 to 15 psid (68.9 to 103.4 kPad).

The temperature within the drive is monitored by the drive controls and is displayed on the chiller's Tracer AdaptiView display. The UC800 shuts the chiller down if the displayed drive temperature exceeds 185°F (85°C).

The AFDE is not water-cooled, so water-cooling loop maintenance is NOT needed for the drive.

Figure 13. Schematic of the cooling circuit



Liquid-Cooling Connections

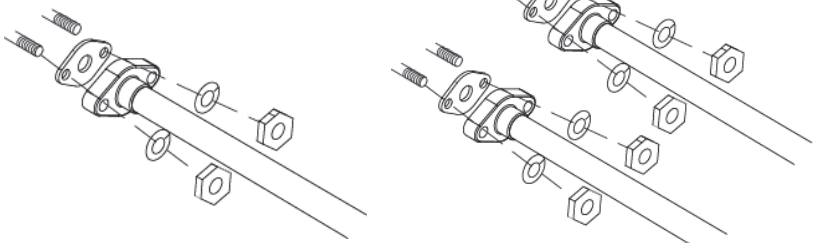
Factory Connected on Unit Mounted Drives

⚠WARNING

Contains Refrigerant!

System contains oil and refrigerant and may be under positive pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives. Failure to follow proper procedures or the use of non-approved refrigerants, refrigerant substitutes, or refrigerant additives could result in death or serious injury or equipment damage.

Figure 14. Coolant lines



Outlet

Torque to 70 ft·lb (94.9 N·m)
1-1/8 in. (2.9 cm) OD

Outlet

Torque to 70 ft·lb (94.9 N·m)
1-1/8 in. (2.9 cm) OD

Inlet

Torque to 17 ft·lb (23.0 N·m)
5/8 in. (1.6 cm) OD

Frame 3
(405 and 608 Amp)

Inlet

Torque to 17 ft·lb (23.0 N·m)
5/8 in. (1.6 cm) OD

Frame 4
(900 and 1210 Amp)

Refrigerant coolant lines connect to the cabinet through flange fittings located on the rear of the cabinet. A panel must be removed to provide access to the flange connections. If you have removed the refrigerant cooling lines for field disassembly or repairs use the following steps to re-connect the coolant lines to the cabinet (see Figure 14).

1. Be sure the flange fittings on the cabinet and the CenTraVac chiller's tubing are free of dirt, burrs, and excessive nicks.
2. On both the inlet and outlet connections place a new flange gasket over the studs on the back side of the drive.
3. Align the chiller tubing and flanges over the studs on the drive so that the flanges are straight and parallel. Place the proper washers and nuts over the studs and snug them up by hand. Be careful to maintain the parallel alignment of the flanges.
4. Use a socket and torque wrench to further tighten the flange bolts to their proper torques. Tighten the flange bolts in small equal steps to ensure an equal draw-down of the flange onto the gasket.

   Flange Bolt Torques:
   1/2-in. bolts = 70 ft·lb (94.9 N·m)
   5/16-in. bolts = 17 ft·lb (23.0 N·m)
5. Inspect the connections for leaks.

UC800 AFD Operation

Adaptive Frequency Drive Control

Introduction

Achieving Efficiency

Adjustable speed impeller control is used to improve CenTraVac™ efficiency at part-load while tower relief is available. This occurs because the addition of the variable frequency drive gives the chiller control an extra degree of control freedom. The combination of inlet guide vane position and variable speed creates the possibility to control both chiller capacity and compressor efficiency. By manipulating speed and inlet guide vane position it is possible to adjust the aerodynamic loading on the compressor to operate in a region of higher efficiency.

Challenges

There are challenges associated with achieving high efficiency. The region of higher efficiency is near the compressor surge boundary. Surge occurs when the compressor can no longer support the differential pressure required between the evaporator and condenser. Reducing compressor speed can improve efficiency; however, at some point the reduced impeller speed does not add enough dynamic pressure to the discharged refrigerant. When the total pressure (static + dynamic) leaving the compressor is less than the condenser pressure, refrigerant will start to flow backwards from the condenser. The flow reversal from the condenser to the compressor discharge creates a sudden loss of the dynamic pressure contribution from the compressor. Refrigerant flows backwards through the compressor creating an unpleasant audible noise. Surge is avoided when possible because it causes a loss of efficiency and cooling capacity if the compressor is allowed to cycle in and out of surge for an extended period.

Solutions

The adjustable speed control algorithm of the Tracer® UC800 control was developed to operate near the surge boundary by periodically testing to find the surge boundary and then holding conditions at an optimal distance from surge. Once the optimal operating condition is found the algorithm can avoid the surge in the future. When surge is detected, a surge recovery routine makes adjustments to move out of surge, reestablish stabile operating conditions, and adjust the control boundary to avoid surge in the future.

Chiller and AFD Sequence of Operation

In the UC800, the chiller/AFD sequence of operation is identical to a standard fixed speed chiller. Chiller capacity control, safeties, and limits work in the same manner regardless of whether an AFD is present.

The UC800's AFD speed control algorithm will simultaneously set Inlet Guide Vane (IGV) position and compressor speed to achieve a desired compressor loading command while holding a fixed margin of safety between the compressor operating point and compressor surge. In order to quantify nearness to surge, a non-dimensional parameter called "compressor pressure coefficient" is used as a measure of surge potential. Decreasing motor speed increases the compressor pressure coefficient. The goal of the AFD control algorithm is to reduce speed enough to increase the pressure coefficient to the surge boundary.

Compressor Pressure Coefficient

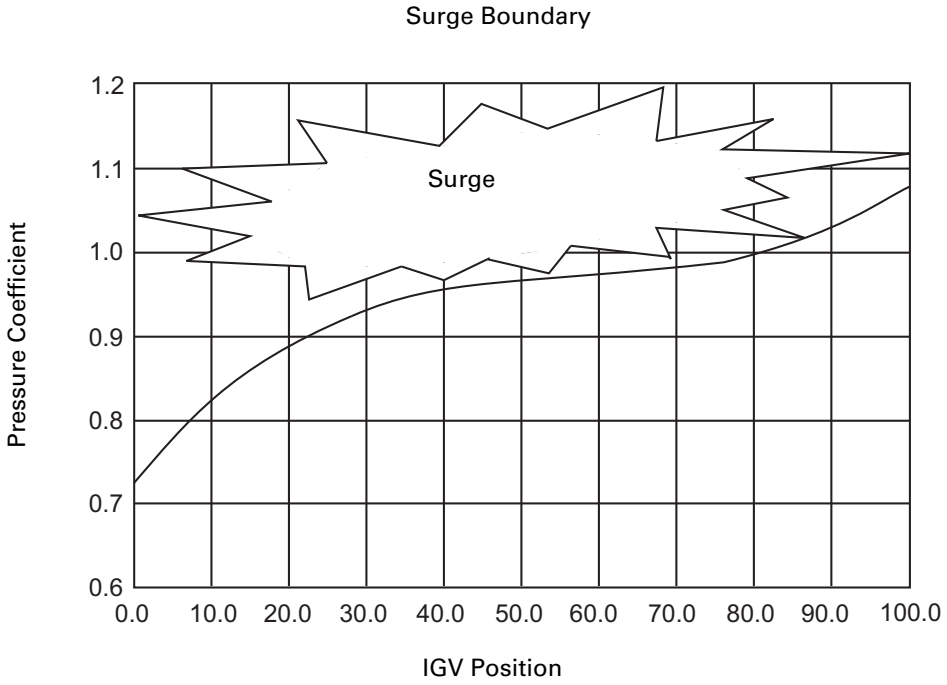
The non-dimensional pressure coefficient is derived based on turbo machinery principles. Fundamentally, the pressure coefficient is the ratio between the potential energy based on the pressure rise across the compressor and the kinetic energy of the refrigerant at the compressor discharge. This normalized equation uses enthalpy change across the compressor as a measure of potential energy and compressor parameters such as average impeller diameter, speed, and number of stages, to determine kinetic energy.

The kinetic energy can be reduced by reducing the condenser pressure. To achieve condenser pressure reduction, reduce the temperature of the entering tower water. To obtain the best efficiency, follow a tower relief schedule at part loads.

Surge Boundary

Surge boundary is a non-linear, empirically derived function of the compressor load. For the UC800, the compressor pressure coefficient boundary is defined as a function of IGV position as shown on Figure 15.

Figure 15. Pressure coefficient surge boundary



AFD Speed Control

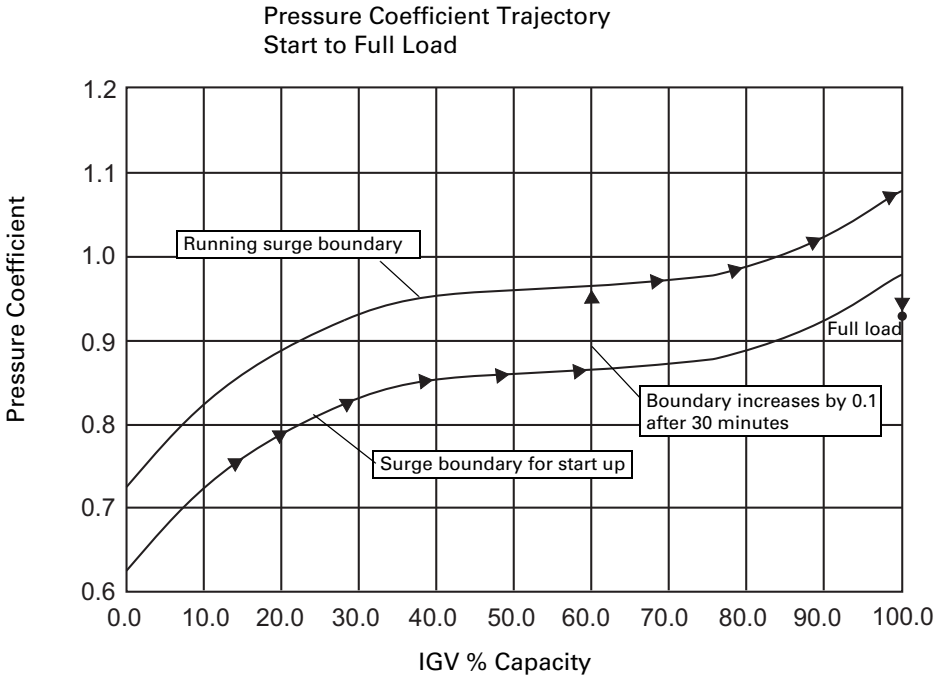
UC800 control utilizes an enhanced control method capable of simultaneously adjusting compressor speed and inlet guide vane position to achieve the desired chiller capacity and pressure coefficient. At the heart of the control is a match model that describes the relationship between control parameters and actuators. This model has converted a complicated multi variable control problem to a system of algebraic equations. The equations cannot be solved directly, so a binomial search algorithm is used iteratively to find a solution. A new solution is found every 5 seconds. This is possible because of the increased performance of the microprocessor available with the UC800.

Startup

The starting speed for AFD under UC800 control will vary depending upon the pressure ratio across the compressor. For most starts, the pressure ratio will be small and the AFD will start at its minimum speed. The speed will be adjusted every 5 seconds in response to changing pressure ratio and load requirements.

On startup, shell pressures and temperatures may not correspond to saturated conditions. To avoid potential surge on start, the boundary pressure coefficient will be reduced by 0.2 below the last running condition, and over 40 minutes adjusts itself towards the last running condition. This allows for the stabilization of pressures and water loop conditions. After reaching this condition the control will do a re-optimization.

Figure 16. Startup surge boundary



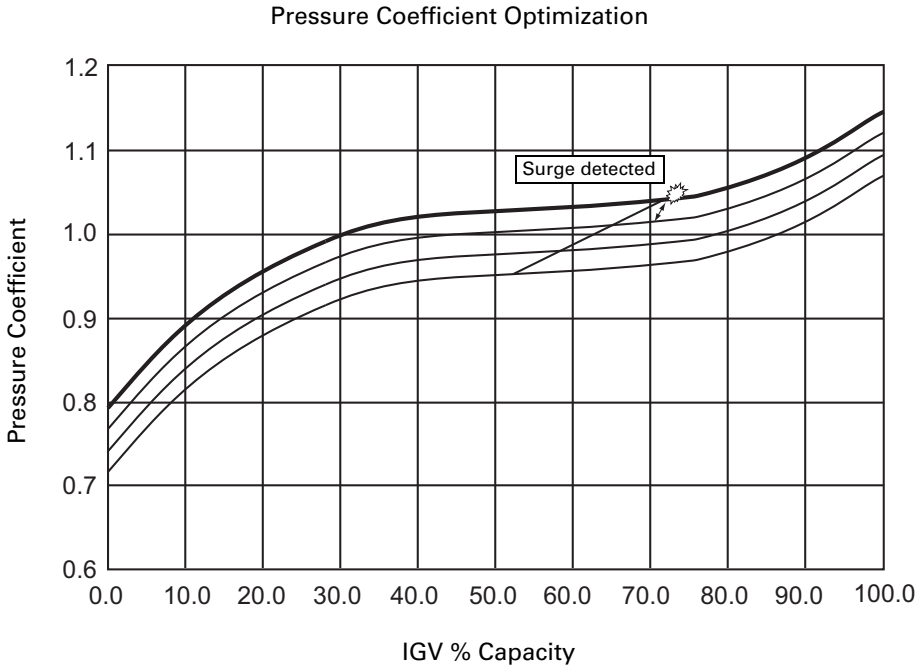
Re-optimization

The AF Surge Boundary Offset Coefficient is a user settable parameter to be used for adjusting the surge boundary either higher or lower. In addition to being user settable, the surge control algorithm will periodically readjust this boundary. This re-optimization will occur when any of three different criteria are met.

1. After startup stabilization the control will re-optimize unless the surge is detected in that time period.
2. Every 30 minutes, the control will compare the current IGV position with the IGV position at the end of the last re-optimization time and, if greater than the user adjustable sensitivity, will re-optimize.
3. When the re-optimization timer expires.

The control is re-optimized by increasing the AF Surge Boundary Offset Coefficient every minute until surge occurs. When surge occurs, the control will go into surge recovery until the surge flag is removed and all of the re-optimization timers will reset.

Figure 17. Boundary re-optimization



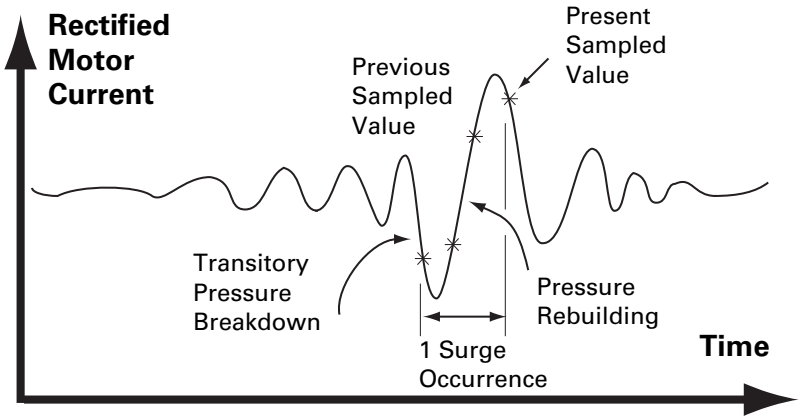
Surge Recovery

When surge occurs, the pressures in the evaporator and condenser shells can become erratic. Surge recovery is needed to force conditions out of this unstable operating point. This is accomplished by reducing the pressure coefficient every 90 seconds of continuous surge. In addition, when the surge flag is set, the compressor speed command is increased by 1 Hz every 5 seconds until the surge condition clears. When the surge flag is removed, the speed command will relax back to the speed needed to raise the pressure coefficient to the new surge boundary.

Surge Detection

Surge detection control logic monitors changes in compressor motor current. A surge occurrence leaves a characteristic motor current signature as shown in Figure 18 This signature is formed because the transitory pressure breakdown between the condenser and evaporator causes a sudden reduction in compressor motor load. As the pressures equalize, the compressor begins to quickly load, increasing the motor current.

Figure 18. Motor current signature representing surge



UC800 Interface to Adaptive Frequency Drive

Communications between the UC800 and the AFD are handled via the Machine Bus ("M-bus") connected to the RS-485 AFD Comm Interface module. Signals digitally sent over the M-bus include start, stop, speed change, and drive faults.

At start of the compressor motor a signal corresponding to the starting frequency (38 Hz) is sent to the drive.

The digital speed signal is set-up such that the AFD operates over a 38–60 Hz frequency range.

AFD faults are sent over the M-bus to the UC800 controls for communication on the Tracer AdaptiView display.

High Pressure Cutout – The inverter accepts a NC HPC switch (at terminals 2X1-3 and 2X1-4. In the event of a chiller high pressure condition, the HPC switch opens, the drive shall shut down and de-energize the motor.

Output contacts are required to control the load of the refrigerant/oil pump motor and the cooling circulating pump. The contacts are Normally Open, and closed when the AFD energizes the motor.

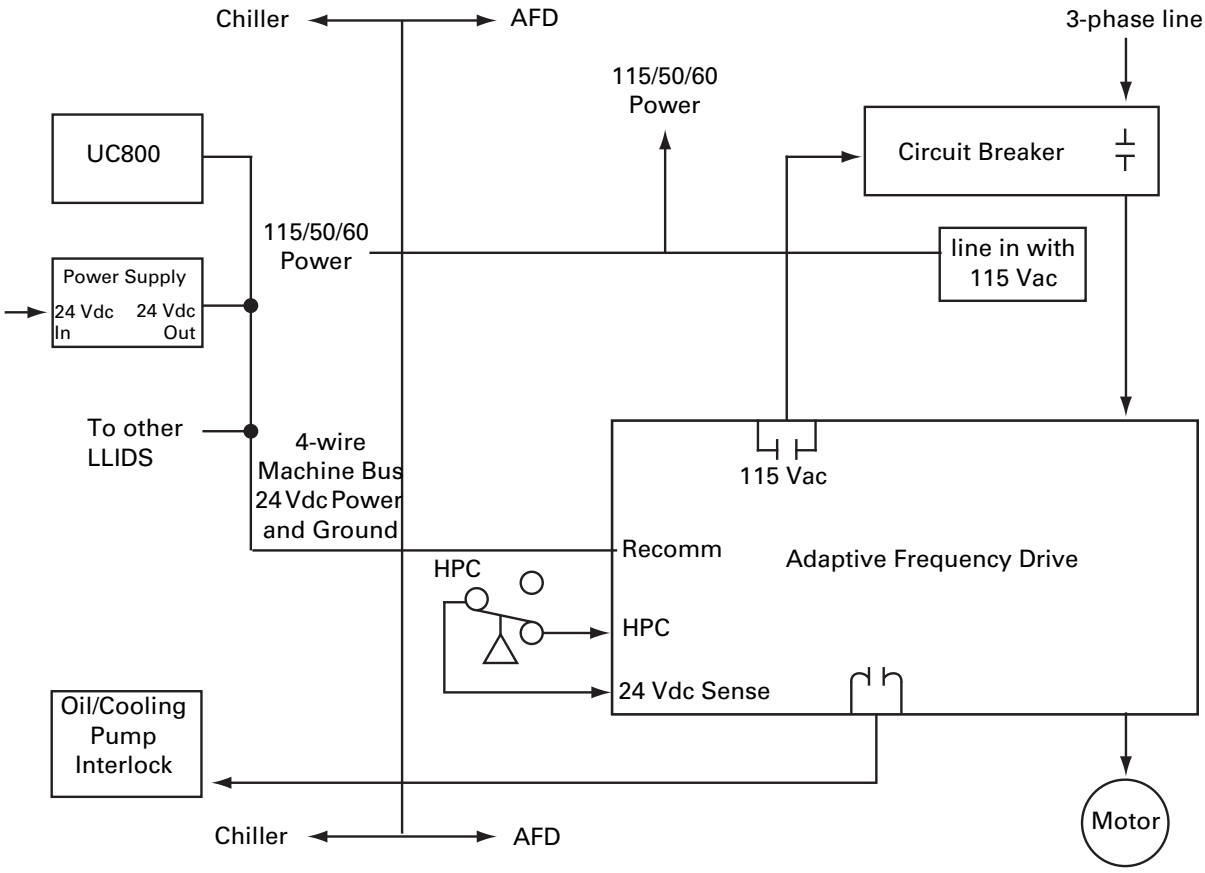
Note: *Unlike locked rotor amps associated with electromechanical starters, the phase currents are not expected to rise above 85 percent RLA prior to 1.6 seconds following the sending of the speed signal, after which they then remain above 85 percent RLA until the compressor motor has come up to speed.*

An "Up-to-Speed" signal must occur before the Maximum Acceleration Timer times out (plus 15 seconds) or a MANUAL RESET (MMR) alarm will occur.

The block diagram (see Figure 19) shows the communication of the starter module to Unit Mounted Inverter Interface controls interconnecting circuits.

The Oil Pump Interlock load is 115 Vac, 3/4 hp reset.

Figure 19. UC800 to unit mounted inverter interface block diagram



Service Interface

AFD Operator Interface

Chiller information is tailored to operators, service technicians, and owners. When operating a chiller, there is specific information you need on a day-to-day basis—setpoints, limits, alarm information, and reports.

When servicing a chiller, you need different information and usually more of it—historic and active alarms, configuration settings, and customizable control algorithms, as well as operation settings.

By providing two different tools—one for daily operation and one for periodic service—everyone has easy access to pertinent and appropriate information.

Tracer AdaptiView Operator Interface

The Chiller's Tracer AdaptiView display is the Operator interface for the Adjustable Frequency Drive (AFD). For the operator's day-to-day operational information, Tracer® AdaptiView™ displays data (English or SI units) simultaneously on the 12-inch, color touch-sensitive screen. Logically organized groups of information—chiller modes of operation, active alarms, settings and reports put information conveniently at your fingertips. The AFD status can be viewed from the Tracer® AdaptiView™ MOTOR target area on the home page. Refer to the *Tracer AdaptiView Display for CenTraVac Chillers, Daily Operations* manual (CTV-SVU01*-EN) for more information on the Tracer® AdaptiView™ display.

Tracer TU Service Tool (Laptop Computer)

Tracer® TU is software installed on a portable laptop computer and used, by the service technician or advanced operator, to interface with the UC800 controller on the CenTraVac™ chiller. When you need more detailed information about a Trane® chiller, connect your laptop computer (with the Tracer® TU software installed) to the UC800's "Service Tool" USB plug-in port (this port is extended to exterior of the control panel cabinet for easy access).

The Tracer® TU software provides access to that particular machine's configuration settings, customizable limits, status, and up to 60 active or historic alarms. A technician can interact with an individual device or a group of devices for advanced troubleshooting. For more information on Tracer® TU, visit your local Trane Service company, or Trane's website at www.Trane.com.

Use Tracer® TU when a factory or startup setting requires field alterations. All adjustable AFD settings (see Table 6 to Table 11, p. 45) are available via Tracer TU. All others are set to defaults predetermined for this application as based on laboratory testing.

Table 5. The following Adaptive Frequency Drive (AFD) information is available from the Tracer AdaptiView display:

Tracer® AdaptiView™ Display	MENU items	Units	Comments
Reports - Motor (AFD items)	AFD Frequency	Hz	
	AFD Speed	RPM	
	AFD Transistor Temp	F/C	* See section 10 on Control Algorithm. [Drive has a limit mode that utilizes this temperature]
Settings - Mode Overrides	Oil Pump Manual Control	Auto/On	Oil/refrigerant/(AFD water pump) manual control
	Compressor Control Signal	Auto/Manual	Manual control allows the user to override the automatic signal and manually drive the Compressor Control Signal from 0–100%. The limits and safeties remain active. The compressor control signal controls a calculated combination vanes position and drive speed for leaving water control signal.

Note: Both motor report and mode overrides contain chiller content along with the AFD related items identified above.

Table 6. Tracer TU: Unit Status view: Motor Expanding section

Motor Winding Temp #1	F/C
Motor Winding Temp #2	F/C
Motor Winding Temp #3	F/C

Table 7. Tracer TU: Unit Status view: AF Expanding section

AFD DC Bus Voltage	Vdc
AFD Last Diagnostic Code (decimal)	Number
AFD Output Power	kW
AFD Transistor Temp	F/C
Boundary Pressure Coefficient	None
Frequency	Hz
Frequency Command	Hz
IGV and AF Control	
Re-optimization Time Remaining	Hrs/Mins
Speed	RPM

Table 8. Tracer TU: Service Setpoints view: Adjustable Frequency Drive Setpoints section

Description	Min	Max	Factory Default	Units
AF Control	N/A	N/A	(Auto, Fixed) **Auto**	N/A
Re-Optimization Sensitivity	0	100	20%	Percent

Notes:
1. Use only Factory Defaults. Defaults other than above may effect chiller reliability
2. **AF Re-optimization Sensitivity** - Every 30 minutes the optimizing algorithm compares the current value of the inlet guide vane position to the value that was stored after the last re-optimization. If the difference is greater than the AF Re optimization Sensitivity setting, re-optimization occurs. This value is adjustable from 0 to 100%, where 0 would guarantee re-optimization every 30 minutes and 100% would guarantee no re-optimization.

Table 9. Tracer TU: Field Startup view: Adjustable Frequency Drive section

Description	Min	Max	Factory Default	Units
Maximum Frequency	38	60	60	Hertz (Hz)
Minimum Frequency	38	60	38	Hertz (Hz)
AFD Surge Capacity Increase	0	5	1	Hertz (Hz)

Table 10. Tracer TU: Unit Status overrides

There is no specific view for overrides. If an item is available for override, the Override icon displays.		
Frequency Command	AFD Frequency:	When Manual is selected, the user can enter AFD Frequency commands

Table 11. Tracer TU: Configuration view: Starter Expanding section

Configuration of Drive **Note:** These items are factory set, and checked at unit commissioning. Do not change without authorization				
Description	**Range**	**Default**	**Units**	**Notes**
Surge Protection	0 = disable 1 = enable	1		
Surge Sensitivity	0–100	20	%	
Power Loss Reset Time	0–255	60	Seconds	Use the default
Unit Line Voltage	180–8,000	(a)	Vac	Nameplate Data
Unit Motor Voltage	180–15,000	(a)	Vac	Nameplate Data
Motor NP FLA (TVA)	0–2,000	(a)	Amps	Nameplate Data
Motor NP RLA	1–2,000	(a)	Amps	Nameplate Data
Motor NP Power	0–4,000	(a)	kW	Nameplate Data
Motor NP Hertz	5–250	(a)	Hz	Nameplate Data
Motor NP RPM	60–24,000	(a)	RPM	Nameplate Data
Stator Resistance	0–10,000,000	(a)	micro-ohms	Nameplate Data
Flux Current Ref.	0–1,200	(a)	Amps	Nameplate Data
Acceleration Time	1–99	10	Seconds	
Deceleration Time	1–99	30	Seconds	
Starter Current Limit	1–3,200	1 (1.2XNMRA)(a)	Amps	Nameplate Data
Current Limit Gain	0–5,000	10		
Power Loss Mode	decel, coast	decel		
Power Loss Time	0–25	0	Seconds	Default is 0; if you encounter AFD power loss try 5 sec.
Flying Start	0 = disable 1 = enable	0		Enabled is not recommended.
Flying Start Gain	0-32,767	2,000		
Use Trane Defaults	No Yes	Yes		Yes = required for most applications. No = allows “non-Trane” application defaults to be used for all other drive parameters not accessible via the Tracer TU service tool.
RTD Type	75 ohm at 75°F 100 ohm at 0°C	75 ohm		
Line Side Items	0 = Not Installed 1 = Installed	0		

(a) Use only the factory settings for this application as they are specific to the sales order. Instability and faults may occur by using other settings and is not recommended. Contact your local Trane Representative for service when necessary.

Troubleshooting

Alarms

When an active alarm is present, it is identified in the **Active Alarms** area in the upper left corner of the Tracer AdaptiView display. This serves two purposes. First to alert the operator that a alarm exists, and second to provide navigation to the Alarms list.

Clicking on the active alarms causes the Alarms list to display. All active alarms are listed first and ordered by the alarm's severity. The severity hierarchy is:

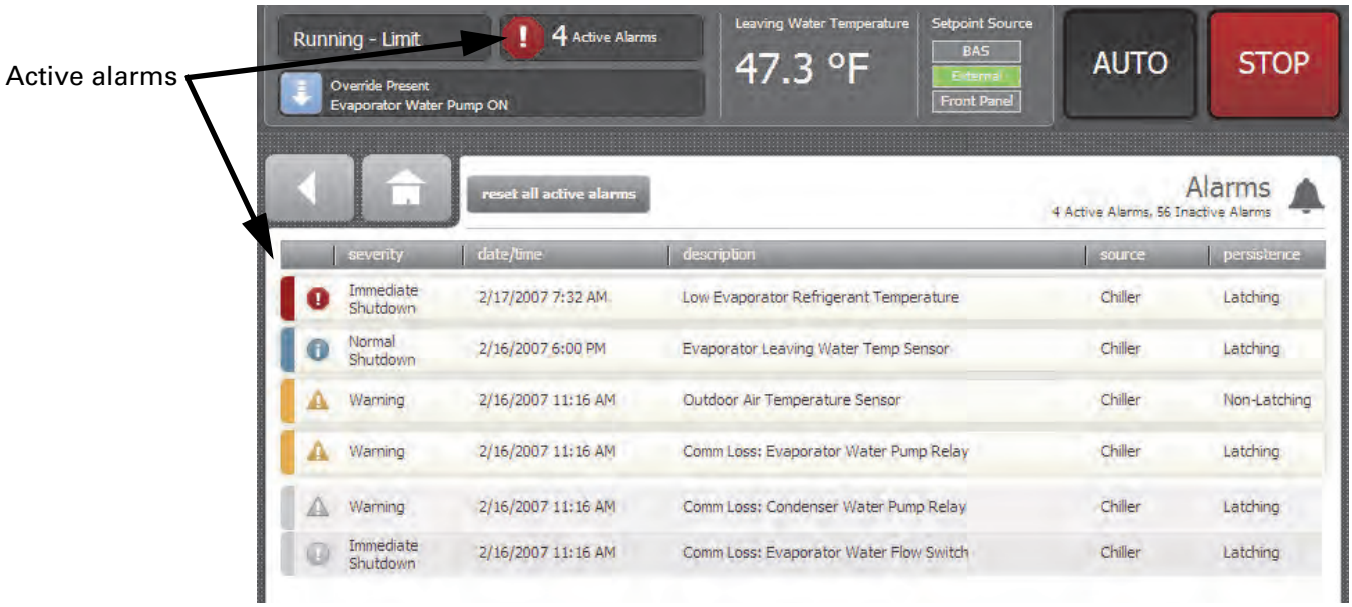
- Immediate shutdown (highest priority and displays first)
- Normal shutdown
- Warning
- Unknown (lowest priority and displays last)

Active alarms are followed by any historical alarms. These appear gray on the screen. The alarms button at the bottom of the screen flashes between two colors depending on the severity of the highest priority alarm (i.e., Immediate shutdown alarms cause the button to flash between red and black, and Normal shutdown alarms cause the button to flash between yellow and black).

Clicking directly on any of the active alarms links to a screen that explains the alarm and provides possible solutions.

You can also connect the laptop computer loaded with the Tracer TU service tool software directly to the UC800 controller to view the AFD last diagnostic code.

Figure 20. AdaptiView alarms screen



Troubleshooting

This section can assist in field troubleshooting LiquiFlo 2.0 drives, and can provide information, which others can use to help you troubleshoot the drive.

⚠ WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN*

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

1. Collect alarm and parameter information.
   a. DO NOT cycle unit power or reset the controls. Leave AFD and UC800 in their present states.
   b. Record the "AFD Last Diagnostic Code" using Tracer TU. This value is available under the Unit Status tab, in the Motor expanding box.
   c. Record all UC800 active and historic alarms. Make a full chiller service report.
   d. Document and check all applicable parameter settings. This information can be verified from the chiller nameplate, and by referring to this manual.
   e. In the Binding view of the Tracer® TU service tool, verify there is a green circle indicating that the AFD Recomm Starter LLID is bound.
   f. If an OIM is available, record any drive diagnostics found.
2. Collect Chiller Information.
   a. Note the following chiller information:
      - Operating mode and any sub-mode (i.e., 100 percent or 75 percent load etc.)
      - Number of chiller starts, and hours of operation.
      - Time since last diagnostic shutdown (<1 minute, <1 hour, >1 hour, etc.)
   b. What was the chiller state at the time of the failure? (Chiller starting? Running low load? Running full load? etc.)
   c. Record the chiller's sales order and serial numbers, & the drive's serial and model numbers.
3. Troubleshooting
   a. Measure and record the DC bus (via the Operator Interface Module [OIM]).
   b. Check ALL wiring (tightness, ribbon cables fully seated, proper phasing, etc.)
   c. Refer to the Rockwell manuals for further troubleshooting information (manual D2-3496-1).
   d. If possible, Use the Rockwell OIM and provide the following drive parameter information:
      - LiquiFlo 2.0 (inverter) Parameters 49, 50, 209, 210, 224, 225, 226, 227, 228, 229, 230, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 262, 263, 264, 265, 266, 267, 268, and 269.
4. Drive Over Temperature
   a. Measure refrigerant pump discharge pressure and compare to the condenser pressure. It should be 10-15 psid.
   b. Measure drive coolant line delta-T.
   c. Record parameters 120, 121, and 122 from the active rectifier.
   d. Operate the condenser at or below design temperature. Elevated tower water temperatures will raise drive temperatures.
   e. The ambient temperature must remain below specification (refer to Table 1, p. 13). Make sure the fan grills are clean and operational.
   f. Do not place manuals or prints below the power module as this can block air flow.

Alarm Messages and Fault Codes

The “AFD Last Diagnostic Code” value is available using Tracer TU. This value is located under the Unit Status tab, in the Motor expanding box.

Table 12. Alarm messages and fault codes

Tracer AdaptiView Alarm	TU Last Diag Code	Drive Fault	Tracer AdaptiView Alarm	TU Last Diag Code	Drive Fault
General	2	Auxiliary Input	I/O Board Fail	121	I/O Comm Loss
Power Loss	3	Power Loss	I/O Board Fail	122	I/O Board Fail (3)
Power Loss	4	Under Voltage	I/O Board Fail	123	Invtr Unk IO Brd (2)
High Bus	5	Over Voltage	Drive Overcurrent	197-199	Invtr Dsat U-, V-. W- (2)
Motor Overload	7	Motor Overload	Drive Overcurrent	200-202	Invtr Dsat U, V, W (3)
Drive Overtemp	8	Invtr Base Temp	Drive Overcurrent	200-202	Invtr Dsat U+, V+, W+ (2)
Drive Overtemp	9	Invtr IGBT Temp	Drive Overcurrent	203-205	Invtr Over Cur U, V, W
Drive Overcurrent	12	HW OverCurrent	Power Board Fail	206	Invtr HW Unused (3)
Ground Fault	13	Ground Fault	Estop	207	Invtr Gate Kill
General	24	Decel Inhibit	Drive Overcurrent	208-210	Rctfr Dsat R, S, T (3)
General	25	OverSpeed Limit	Drive Overcurrent	208-210	Rctfr Dsat R+. S+. T+ (2)
General	29	Analog in Loss	Drive Overcurrent	211-213	Rctfr Over Cur R, S, T
Power Board Fail	30	NTC Demux Fail (2)	Drive Overcurrent	214	Reactor Temp
General	31	Inv Temp Switch (2)	Power Board Fail	215	Rctfr HW Unused (3)
General	33	Auto Rstrt Tries	Ground Fault	216	Rctfr Gnd Fault
Phase Loss	35	Current Fbk Lost	Drive Overtemp	217	Rctfr Base Temp
Drive Overcurrent	36	SW OverCurrent	Drive Overtemp	218	Rctfr IGBT Temp
Phase Loss	37	Motor I Imbalance	Drive Overcurrent	219	Rctfr IT Overld
Motor Short	38	Phase U to Grnd	Drive Overcurrent	220	Rctfr 12T Overld
Motor Short	39	Phase V to Grnd	Power Loss	221	Ride Thru Abort
Motor Short	40	Phase W to Grnd	High Bus	222	High AC Line
Motor Short	41	Phase UV Short	Power Loss	223	Low DC Bus
Motor Short	42	Phase VW Short	High Bus	224	Rctfr Over Volt
Motor Short	43	Phase WU Short	Power Loss	225	Input I Imbalance
General	48	Params Defaulted	Power Loss	226	Input V Imbalance
Drive Overcurrent	63	Shear Pin	Power Loss	227	AC Line Lost
Drive Overcurrent	64	Drive Overload	General	228	Line Feq Lost
Power Structure Fail	70	HW Fault	Control Board NVS	229	Rctfr Checksum
Ignore	71-75	Port 1-5 Adapter	Power Structure Fail	230	Invtr HW Unk
General	77	Volts Range	Power Structure Fail	231	Rctfr HW Unk
General	78	FluxAmps Rang	General	232	Rctfr Not OK
General	79	Excessive Load	General	233	Precharge Closed
General	80	AutoTune Aborted	General	234	Precharge Opened
General	81-85	Port 1-5 DPI Loss	Power Board Fail + Control Board NVS	235	Rctfr Pwr Board
General	87	IXo Voltage Range	I/O Board Fail	236	Rctfr IO Board
Control Board NVS	100	Parameter Chksum	General	237	Not at Voltage
Control Board NVS	101	UnserSet1 Chksum	DPI Communication	238	Rctfr Not Login
Control Board NVS	102	UserSet2 Chksum	General	239	Power Phased ACB
Control Board NVS	103	UserSet3 Chksum	Estop	240	Rctfr Gate Kill (2)
Power Board Fail	104	Pwr Brd Chksum1	Drive Overcurrent	241-243	Rctfr Dsat R-, S-, T- (2)
Power Board Fail	105	Pwr Brd Chksum2	Power Board Fail	244	Rctfr NTC Demux (2)
Power Unit HW+ Control Board NVS	106	Incompat MCB-PB	I/O Board Fail	245	Rctfr Unk IO Brd (2)
Control Board NVS	107	Replaced MCB-PB	DPI Communication	246	Rctfr DPI Comm (2)
General	120	I/O Mismatch (3)	General	247	CarrSync Lost

Note: (1) = Fault Numbers not listed are reserved for future use. (2) = Fault available on Frame 4 drive only (3) = Fault available on Frame 3 drives only

For additional information regarding descriptions and corrective actions, refer to the Rockwell Instruction Manual D2-3496-1.

AFDE Startup Procedure

NOTICE

Perform Visual Inspection!

Before powering up this drive for the first time conduct a visual inspection for the following:

- **Shipping damage.**
- **Signs of moisture.**
- **Signs of debris or dust from storage.**
- **Signs of corrosion on components and/or enclosure.**

These conditions could cause equipment damage. Do not power up equipment if you have concerns regarding equipment condition. Upon initial power up, remain in the area for the first two hours of operation and observe the chiller and drive for any abnormalities. Contact CenTraVac™ Chiller Technical Support for assistance if needed.

⚠WARNING

Hazardous Voltage!

Failure to follow the instructions below could result in death or serious injury. Be sure all enclosure doors are closed and properly secured with fasteners when operating equipment.

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

The refrigerant-cooled adaptive frequency drive is unit-mounted on CenTraVac™ chillers. It is installed and programmed completely in the factory. Follow the procedure below when starting the water chiller and drive.

1. The UC800 is the primary controller for the CenTraVac™ chiller and is located in the control panel. The UC800 starts, stops, and monitors all unit and AFDE run functions.

   Complete all items on the commissioning checklist and in the startup procedures for the chiller as defined in the chiller *Installation, Operation, and Maintenance* manual, or other applicable manual.

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged.

Failure to follow the instructions below could result in death or serious injury. DC bus capacitors retain hazardous voltages after input power has been disconnected. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. after disconnecting input power, wait ten (10) minutes for the DC capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN*

2. Check the following on the drive:
   a. 380–480 volt input wiring to the drive is sized correctly and connected as noted in this manual.
   b. Check the drive ground connection as detailed in "Input Power and Control Wiring," p. 31, check cabinet wire routing and grounding.
   c. *For CVHH and CDHH chillers*, verify the overload setting on the oil pump motor starter assembly (refer to Table 13 for settings; see item 26 in Figure 5, p. 21 for location of the oil pump motor starter assembly).

Table 13. Oil pump motor starter assembly overload setting

Line Voltage (V)	Line Frequency (Hz)	Overload Relay Setting (A)[a]
380	60	3.1
440	60	2.7
460		
480		
380	50	2.6
400		
415		

(a) Value is equal to motor FLA and assumes relay has built-in 125% factor.

3. Check all drive wiring and connections in the drive to make sure they are tight and free of any shipping damage.
4. AFDE control checkout: Use the Tracer® TU service tool.
   a. Confirm the drive LLID has been properly bound and is recognized by the unit controls.
   b. CHILLER Setpoints: As with any new chiller, first check out all UC800 setpoints for the Chiller.
   c. AFD Setpoints: Check out all AFD setpoints.
   d. AFD Configuration: Verify the correctness of the "Sales Order" specific setpoints in the "Starter Configurations for AFD Starters." These settings are specific to unit/motor combination in the drive. All of the remaining settings are factory-determined default setpoints that are the same on all AFDE refrigerant-cooled drives.

      Note: *If the set values do not match, contact the local Trane Service agency first, or, the La Crosse Business Unit Technical Service Department. The correct values are listed on the unit nameplate shipped with each unit.*
5. In order to view the AFDE configurable settings, go to the Chiller Configuration tab in the Tracer® TU service tool and select the AFD expanding section.
6. If the drive LLID is not found or if it is necessary to re-bind the drive LLID, follow the procedure below.
   a. The drive's main DC bus must be charged in order for the drive LLID to be recognized or bound. Close the drive disconnect and apply line power to the drive.
   b. With a laptop connected to the chiller and with Tracer® TU running, enter the binding view menu of Tracer® TU and locate the "AFD Starter" LLID in the menu. Select the "Bind" button for the AFD Starter LLID.
   c. The screen "Is the device alone selected?" displays. In the AFD, depress the "service" button on the LLID, or from outside the AFD panel use the OIM to set RECOMM parameter 21 "Bind Ctrl" from 0 to 1.
   d. You do not use a magnet to bind the AFD Starter LLID.
   e. On the Tracer® TU screen, select the "yes" button to indicate the LLID has been selected.
   f. When properly bound, exit the binding view.
   g. Perform any remaining startup items.
7. When ready, start the drive from the Tracer® AdaptiView™ display.
8. Check the AFDE chiller drive response to the UC800. Initially, the drive will go to 38 hertz and stay there until the CenTraVac™ chiller vanes open based on load. The drive will change the speed from there based on load demand.
9. Document all information on the Startup log.

Startup Test Log

Water-Cooled CenTraVac Chiller with Tracer AdaptiView Control and Adjustable Frequency Drive (AFD) Starter

Job Name	
Job Location	
Sales Order Number	
Chiller Serial Number	
Chiller Model Number	

AFD Serial Number	
AFD Model Number	
Ship Date	
Start Date	

Starter Date:	
Manufacture	
Type	
Vender ID	
Model Number	
Volts & Hz	
Amps	
Motor Data:	
Manufacturer	
Type & Frame	
Drawing #	
Serial Number	
Nameplate Data:	
RLA	
KW	
Volts & Hz	

Prestart Checks	Date Checked
Drive Grounded	
Motor Rotation	
Drive Chassis Grounded	
Control Wiring Tight	
Drive Connections are Tight	
Verified Settings	

Comments:

Tracer TU: Service Setpoints View: AFD	Default	Setting
AFD Control	Auto	
Re-Optimization Sensitivity	20%	

UC800 Starter Type: Unit Mount AFD Tracer TU: Configuration View: Starter	Trane Default	Setting
Restart Inhibit Stop to Start Time	30	
Surge Protection	enable	
Surge Sensitivity	20	
Power Loss Reset Time	60	
Unit Line Voltage	*	
Motor NP FLA (TVA)	*	
Motor NP RLA	*	
Motor NP Power	*	
Motor NP Hertz	*	
Motor NP PRM	*	
Stator Resistance	*	
Flux Current Ref.	*	
Acceleration Time	30	
Deceleration Time	30	
Starter Current Limit	*	
Current Limit Gain	10	
Power Loss Mode	Decel	
Power Loss Time	0	
Flying Start	Disable	
Flying Start Gain	2000	
Use Trane Defaults (for all other AFD parameters not accessible via Tracer TU)	Yes	
RTD Type	75	

*Must be set per sales order variable.

Test Log Date:	Log 1	Log 2
Tracer TU Unit Status View: AF		
AFD Output Power (KW)		
Speed		
Frequency		
AFD Transistor temp		
Tracer TU Field Startup View: AFD		
Maximum Frequency	60	
Minimum Frequency	38	
AFD Surge Capacity Increase	1	
Tracer TU Status View: Motor		
Average Line Current		
Starter Average Phase Voltage		
Starter Load Power Factor		
Motor Winding #1 temp		
Motor Winding #2 temp		
Motor Winding #3 temp		

Recommended Periodic Maintenance and Inspection

Visual Inspection—Power Removed

⚠WARNING

Hazardous Voltage w/Capacitors!

Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury. Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged.

For additional information regarding the safe discharge of capacitors, see PROD-SVB06-EN.*

Note: *Graphic labels (shown above) are used for CE application only.*

Important:

- *Before servicing, disconnect all power sources and allow at least 10 minutes for capacitors to discharge.*
- *All electrical enclosures-unit or remote-are IP2X.*

1. Check the refrigerant coolant lines and 2-bolt flange drive connections to ensure they are tight and do not leak.
2. Ensure the door interlocks are present and working.
3. Verify the safety ground connections to the door panels are securely connected.
4. Inspect power wire cables and devices to assure no abrasion is occurring from vibrations against chassis of cabinets, or other edges.
5. Ensure the drive interior and exterior is clear of any dust or debris. Fans, circuit boards, vents etc. must be clean. Only use a vacuum for cleaning. DO NOT use compressed air. If aftermarket intake filter kits (KIT19035=frame 3, KIT19036=frame 4) have been installed, remove the washable filter media, clean and dry the filter media and re-install.
6. Inspect the interior of the drive for any signs of moisture entry or leakage.
7. Visually inspect all drive components and wiring. Look for signs of heat or failure (look for swelled or leaking capacitors, discolored reactors or inductors, broken pre-charge resistors, smoke or arc trails on MOVs and capacitors, etc.).
8. Closely inspect the motor terminal board for any signs of leakage, arcing, etc.
9. Check ALL cable/lug/terminal connections inside the drive enclosure. Ensure all are clean and tight, and not rubbing against each other anywhere.
10. Check any bypass or pre-charge contactors. Confirm the contacts are in serviceable condition and that the contactor operates smoothly.
11. Re-seat all ribbon cable or control wire plugs to ensure all are snug and tight.
12. Verify 2A6 filter cap assembly fuses 2F6, 2F5, and 2F4 are OK.
13. Check the precharge resistors.

⚠WARNING

Live Electrical Components!

Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks.

Operational Inspection—Power Applied

1. Verify the drive cabinet cooling fans are operating.

   This should be done from outside the enclosure, by looking into the cabinet at door and cabinet vents, to avoid electrical hazards.

   Note: *The power module fan comes on with power. Other fans cycle with drive operation.*

2. Check historic fault codes using OIM connected to the AFD.
3. Check configuration settings and confirm all proper settings are still present in the controls.
4. Review the diagnostic history.
5. Make Chiller Service report to document all setpoints.
6. Check the UC800 alarm histories for any indications of operational problems.

Do this every 1–12 months depending on operating environment

To properly diagnose service issues for Adaptive Frequency drives for centrifugal chillers equipped with LF 2.0 (AFDE) starters, and Operator Interface Module (OIM) and special cable are required. All UC800 chillers will be equipped with the OIM as standard on the drive power module. This is for service only and NEVER for machine operation. These items are available from Trane with the following part numbers:

OIM (Operator Interface Module): MOD01352

Cable for OIM: CAB01034

Do as needed

Replace the magnetic choke if there is physical damage (for example, cracks).

Chiller Operator Display Content

Refer to *Operations Guide: Tracer AdaptiView Display for Water-Cooled CenTraVac Chillers* (CTV-SVU01*-EN, or the most recent version) for Tracer® AdaptiView™ display information.

Important: *Please note that the Tracer® AdaptiView™ displayed voltage is **line side input voltage**, whereas current and power factor are **load side data**. Therefore, these are not used together to calculate kW; Tracer AdaptiView kW is communicated from the drive to the chiller panel, and represents input power to the drive.*

Wiring Schematics

For reference, an as-built schematic wiring diagram and a field wiring connection diagram are located inside the main control panel door of the chiller.

Figure 21. Field connection diagram: CVHE, CVHF, CVHG —Trane-supplied Adaptive Frequency Drive (1 of 2)

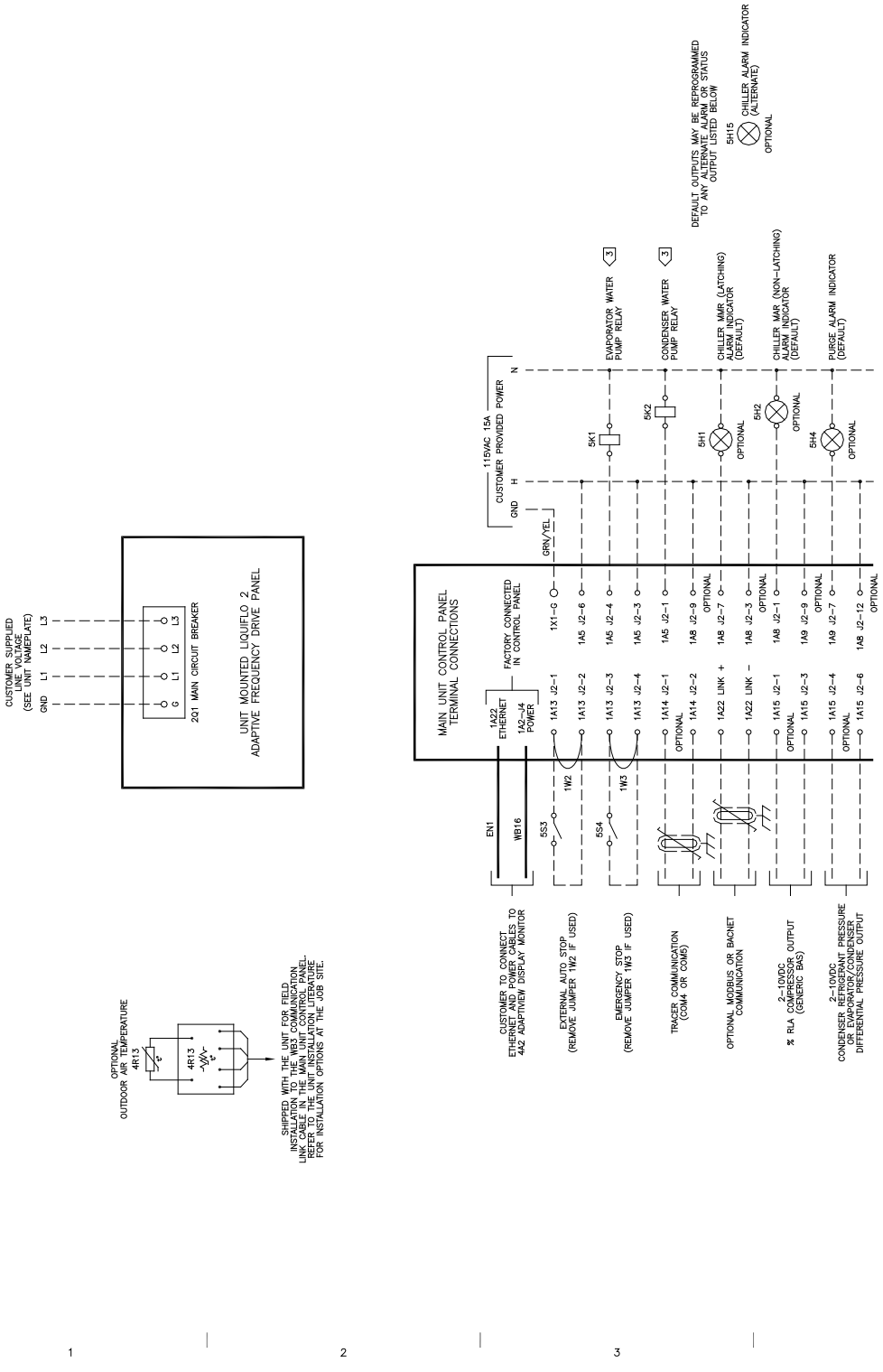


Figure 22. Field connection diagram: CVHE, CVHF, CVHG—Trane-supplied Adaptive Frequency Drive (2 of 2)

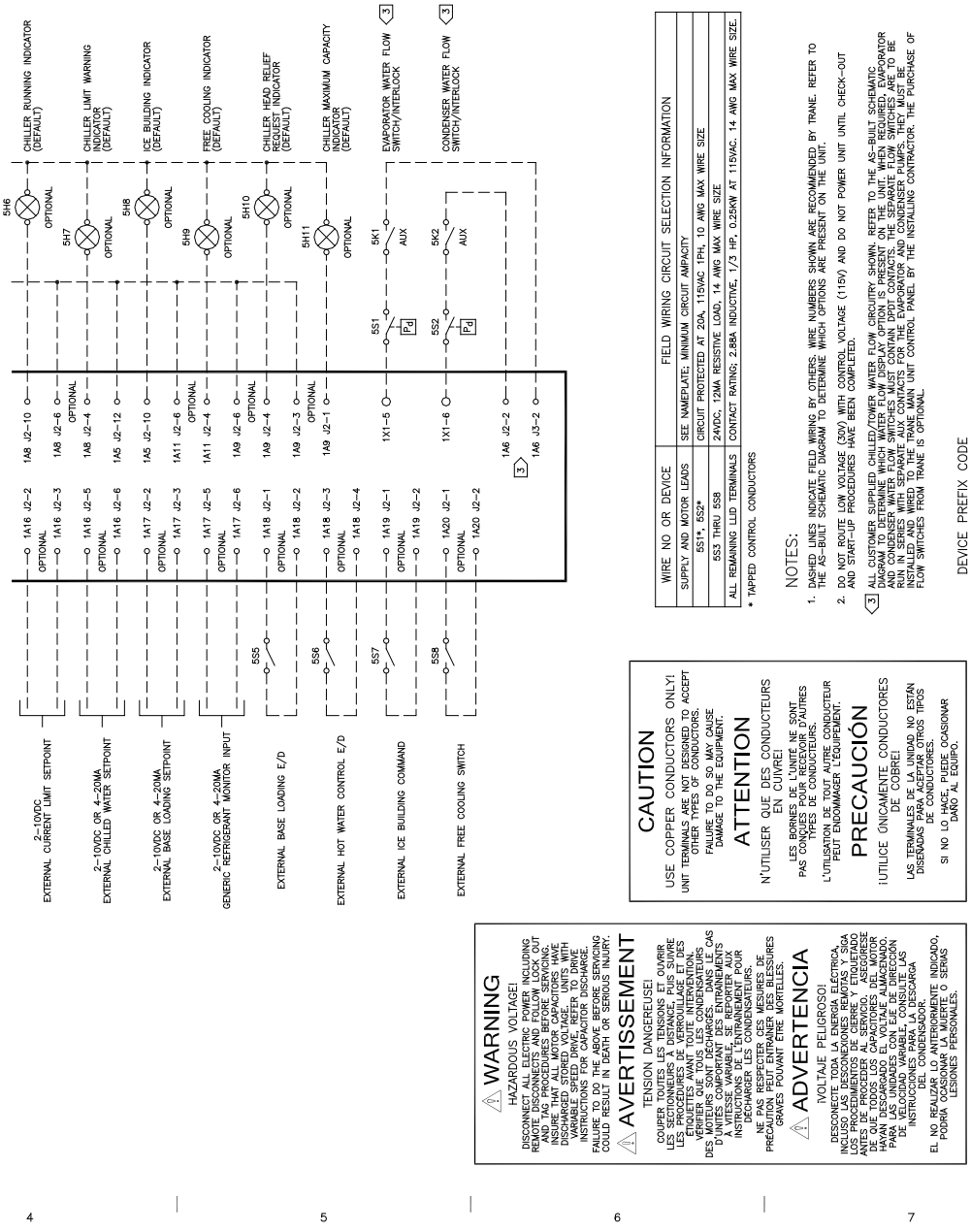


Figure 23. Field connection diagram: CVHH — Trane-supplied Adaptive Frequency Drive (1 of 2)

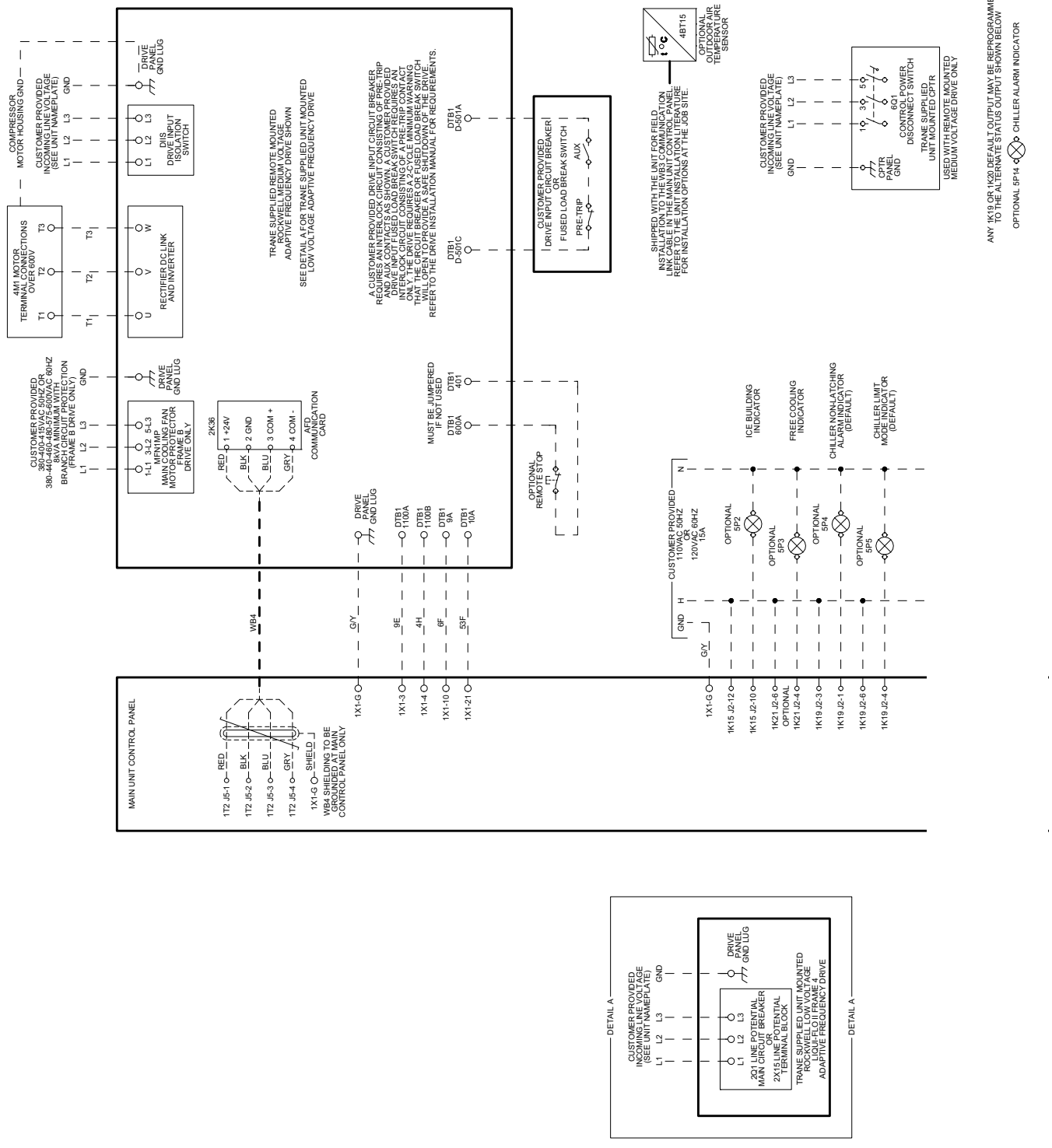
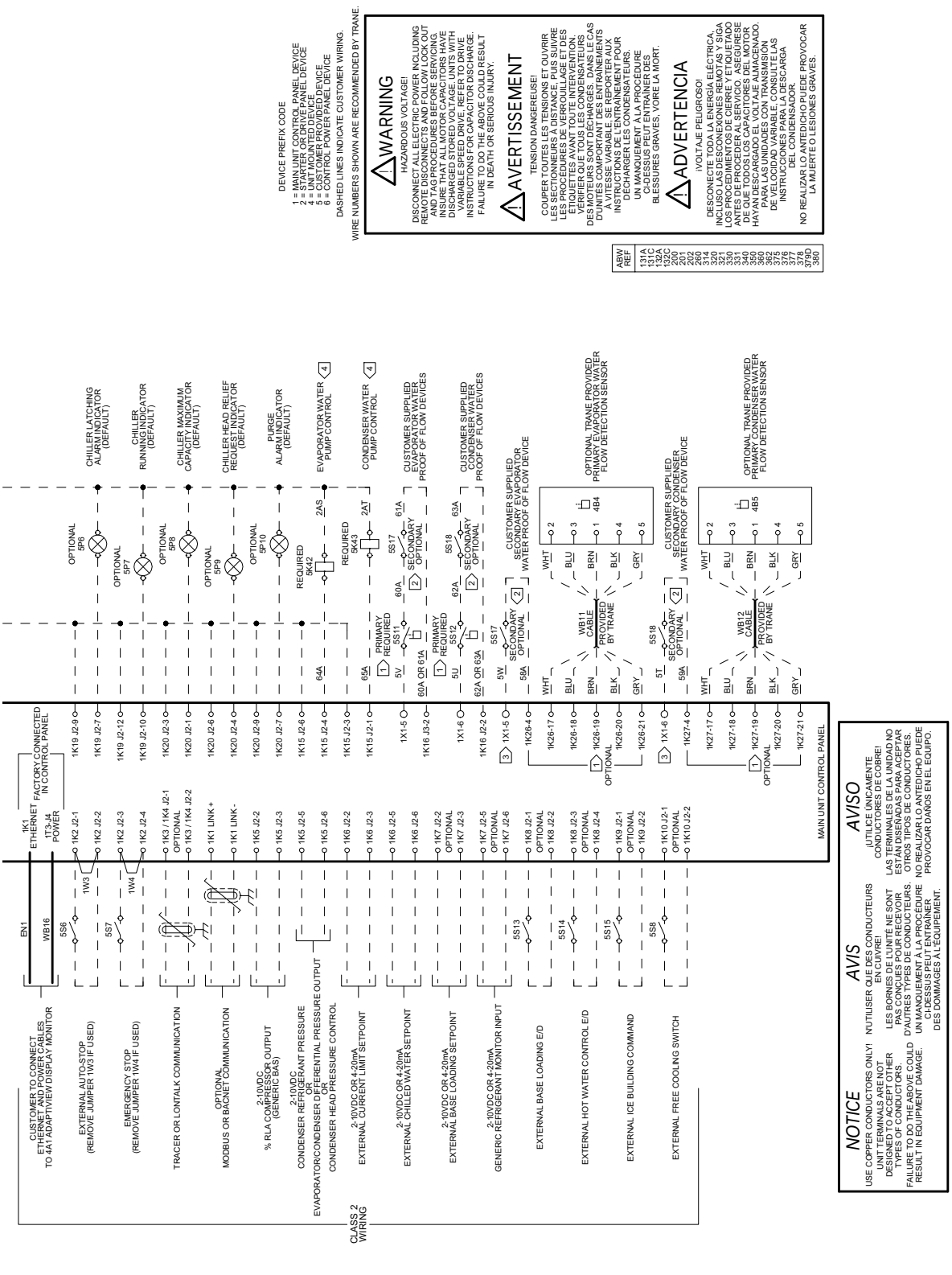


Figure 24. Field connection diagram: CVHH— Trane-supplied Adaptive Frequency Drive (2 of 2)



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