

Vyper

Variable Speed Drive

700 (60 Hz) / 572 (50 Hz) Horsepower
912 (60 Hz) / 752 (50 Hz) Horsepower



THIS MANUAL CONTAINS RIGGING, ASSEMBLY, START-UP, AND MAINTENANCE INSTRUCTIONS. READ THOROUGHLY BEFORE BEGINNING INSTALLATION. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN PERSONAL INJURY OR DEATH, DAMAGE TO THE UNIT, OR IMPROPER OPERATION.

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IMPORTANT!

READ BEFORE PROCEEDING!

SAFETY PRECAUTION DEFINITIONS

The symbols below are used in this document to alert the operating/service personnel to an area of potential hazard or to note something of importance. The danger, warning, and caution text identifies the hazard type, location, and avoidance.



Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a potentially hazardous situation or practice which, if not avoided, will result in death or serious injury.



Indicates a potentially hazardous situation or practice which, if not avoided, will result in damage to equipment and/or minor injury.

NOTE:

Indicates an operating procedure, practice, etc., or portion thereof which is essential to highlight.

PREFACE

INTRODUCTION

This manual has been prepared to acquaint the owner and service personnel with the **INSTALLATION, OPERATION, and MAINTENANCE** procedures as recommended by Johnson Controls-Frick for the Frick Vyper™ Variable Speed Drive unit.

For information about the functions of the Quantum™LX Control panel, communications, specifications, and wiring diagrams, please see the applicable and most current Frick documentation.

It is most important that these units be properly applied to an adequately controlled refrigeration system. Consult an authorized Johnson Controls-Frick representative for expert guidance in this determination.

Proper performance and continued satisfaction with the Frick Vyper™ is dependent upon the following:

- Correct unit installation
- Correct utilization and operation of the unit in accordance with the procedures detailed in Frick manuals.
- Regular and proper unit maintenance.

To ensure correct installation and application, the equipment must be properly selected and connected to a properly designed and installed system. The engineering plans, piping layouts, etc. must be detailed in accordance with the best practices and local codes, such as those outlined in ASHRAE literature.

The Frick Vyper™ is a sophisticated piece of electronic control equipment. All safety precautions consistent with operation of high current and voltage electrical equipment should be strictly enforced.

JOB INSPECTION

Immediately upon arrival of the unit, examine all crates, boxes, and exposed compressor and component surfaces for damage. Unpack all items and check against shipping lists for any possible shortage. Examine all items for damage from unit transit.

TRANSIT DAMAGE CLAIMS

All claims must be made by consignee. This is an ICC requirement. Request immediate inspection by the agent of the carrier and be sure the proper claim forms are executed.

Contact the Sales Administration Department in Waynesboro, PA to report damage or shortage claims. **NOTE: Damage must be photographically documented.**

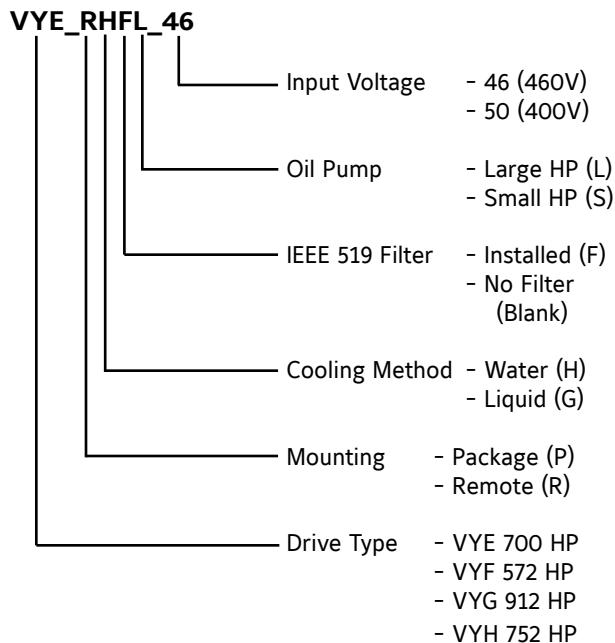
UNIT IDENTIFICATION

⚠ DANGER Shock Hazard! Wait five (5) minutes after switching power to the Vyper™ OFF to allow capacitors in the cabinet to discharge before opening the cabinet door. Failure to do so will result in death or serious injury.

Each Vyper™ has a unit identification label located on the right side of the cabinet. The data plate contains the Frick Part Number, the unique Serial Number, and the basic Model Number for the unit. In addition, the data label also has electrical information pertinent to the individual unit.

NOTE: When inquiring about the Vyper™ or ordering spare parts, please provide the **MODEL** Number and **SERIAL** Number from the data plate.

FRICK VYPER™ MODEL NUMBER DEFINITIONS/NOMENCLATURE



Frick		Vyper™	
PART NO.	"A"	MODEL NO.	"B"
SERIAL NO.			
ELECTRICAL RATINGS			
INPUT		OUTPUT	
VOLTAGE	"C"	VOLTAGE	"G"
VOLTAGE RANGE	"D"	PHASE	3
PHASE	3	HZ	"H"
HZ	"E"	MAX LOAD HP	E
CURRENT	"F"	MAX LOAD FLA	380
		MAX LOAD LRA	"J"
		MIN LOAD FLA	129
SUITABLE FOR USE ON A CIRCUIT CAPABLE OF DELIVERING NOT MORE			
THAN	65.000	RMS SYMMETRICAL AMPERES	"K"
		VOLTS MAXIMUM	
ENCLOSURE TYPE RATING		4	
LIQUID DWP, PSIG		"P"	
2KVA CONTROL SUPPLY		OIL PUMP SUPPLY	
VOLTS-PHASE-HZ	"L"	VOLTS-PHASE-HZ	"M"
RATED OUTPUT AMPS	16	MAX LOAD FLA	"N"
JOHNSON CONTROLS, INC. WAYNESBORO, PA 17268 BUILT UNDER THE FOLLOWING PATENTS: 4,499,534 4,554,463 4,864,487 4,895,005 5,850,160 5,898,554 991C0002 REV			

Figure 1 – Vyper™ Data Plate

MODEL DESCRIPTIONS

These tables provide the model number, Frick part number and basic description of each Vyper™ Drive covered in this manual.

Model No.	Frick P/N	Description
VYE_PH_S-46	720C0168G01	700 HP, Water Cooled, 460 Volts, Package Mount, 3 HP Oil Pump
VYE_PH_M-46	720C0168G02	700 HP, Water Cooled, 460 Volts, Package Mount, 5 HP Oil Pump
VYE_PH_L-46	720C0168G03	700 HP, Water Cooled, 460 Volts, Package Mount, 7.5 HP Oil Pump
VYE_PHFS-46	720C0168G04	700 HP, Water Cooled, w/ Filter, 460 Volts, Package Mount, 3 HP Oil Pump
VYE_PHFM-46	720C0168G05	700 HP, Water Cooled, w/ Filter, 460 Volts, Package Mount, 5 HP Oil Pump
VYE_PHFL-46	720C0168G06	700 HP, Water Cooled, w/ Filter, 460 Volts, Package Mount, 7.5 HP Oil Pump
VYE_RH_S-46	720C0168G07	700 HP, Water Cooled, 460 Volts, Remote Mount, 3 HP Oil Pump
VYE_RH_M-46	720C0168G08	700 HP, Water Cooled, 460 Volts, Remote Mount, 5 HP Oil Pump
VYE_RH_L-46	720C0168G09	700 HP, Water Cooled, 460 Volts, Remote Mount, 7.5 HP Oil Pump
VYE_RHFS-46	720C0168G10	700 HP, Water Cooled, w/ Filter, 460 Volts, Remote Mount, 3 HP Oil Pump
VYE_RHFM-46	720C0168G11	700 HP, Water Cooled, w/ Filter, 460 Volts, Remote Mount, 5 HP Oil Pump
VYE_RHFL-46	720C0168G12	700 HP, Water Cooled, w/ Filter, 460 Volts, Remote Mount, 7.5 HP Oil Pump
VYF_PH_S-50	720C0168G13	572 HP, Water Cooled, 400 Volts, Package Mount, 3 HP Oil Pump
VYF_PH_M-50	720C0168G14	572 HP, Water Cooled, 400 Volts, Package Mount, 5 HP Oil Pump
VYF_PH_L-50	720C0168G15	572 HP, Water Cooled, 400 Volts, Package Mount, 7.5 HP Oil Pump
VYF_PHFS-50	720C0168G16	572 HP, Water Cooled, w/ Filter, 400 Volts, Package Mount, 3 HP Oil Pump
VYF_PHFM-50	720C0168G17	572 HP, Water Cooled, w/ Filter, 400 Volts, Package Mount, 5 HP Oil Pump
VYF_PHFL-50	720C0168G18	572 HP, Water Cooled, w/ Filter, 400 Volts, Package Mount, 7.5 HP Oil Pump
VYF_RH_S-50	720C0168G19	572 HP, Water Cooled, 400 Volts, Remote Mount, 3 HP Oil Pump
VYF_RH_M-50	720C0168G20	572 HP, Water Cooled, 400 Volts, Remote Mount, 5 HP Oil Pump
VYF_RH_L-50	720C0168G21	572 HP, Water Cooled, 400 Volts, Remote Mount, 7.5 HP Oil Pump
VYF_RHFS-50	720C0168G22	572 HP, Water Cooled, w/ Filter, 400 Volts, Remote Mount, 3 HP Oil Pump
VYF_RHFM-50	720C0168G23	572 HP, Water Cooled, w/ Filter, 400 Volts, Remote Mount, 5 HP Oil Pump
VYF_RHFL-50	720C0168G24	572 HP, Water Cooled, w/ Filter, 400 Volts, Remote Mount, 7.5 HP Oil Pump

Model No.	Frick P/N	Description
VYG_PH_M-46	720C0169G01	912 HP, Water Cooled, 460 Volts, Package Mount, 5 HP Oil Pump
VYG_PH_L-46	720C0169G02	912 HP, Water Cooled, 460 Volts, Package Mount, 7.5 HP Oil Pump
VYG_PHFM-46	720C0169G03	912 HP, Water Cooled, w/ Filter, 460 Volts, Package Mount, 5 HP Oil Pump
VYG_PHFL-46	720C0169G04	912 HP, Water Cooled, w/ Filter, 460 Volts, Package Mount, 7.5 HP Oil Pump
VYG_RH_M-46	720C0169G05	912 HP, Water Cooled, 460 Volts, Remote Mount, 5 HP Oil Pump
VYG_RH_L-46	720C0169G06	912 HP, Water Cooled, 460 Volts, Remote Mount, 7.5 HP Oil Pump
VYG_RHFM-46	720C0169G07	912 HP, Water Cooled, w/ Filter, 460 Volts, Remote Mount, 5 HP Oil Pump
VYG_RHFL-46	720C0169G08	912 HP, Water Cooled, w/ Filter, 460 Volts, Remote Mount, 7.5 HP Oil Pump
VYH_PH_M-50	720C0169G09	752 HP, Water Cooled, 400 Volts, Package Mount, 5 HP Oil Pump
VYH_PH_L-50	720C0169G10	752 HP, Water Cooled, 400 Volts, Package Mount, 7.5 HP Oil Pump
VYH_PHFM-50	720C0169G11	752 HP, Water Cooled, w/ Filter, 400 Volts, Package Mount, 5 HP Oil Pump
VYH_PHFL-50	720C0169G12	752 HP, Water Cooled, w/ Filter, 400 Volts, Package Mount, 7.5 HP Oil Pump
VYH_RH_M-50	720C0169G13	752 HP, Water Cooled, 400 Volts, Remote Mount, 5 HP Oil Pump
VYH_RH_L-50	720C0169G14	752 HP, Water Cooled, 400 Volts, Remote Mount, 7.5 HP Oil Pump
VYH_RHFM-50	720C0169G15	752 HP, Water Cooled, w/ Filter, 400 Volts, Remote Mount, 5 HP Oil Pump
VYH_RHFL-50	720C0169G16	752 HP, Water Cooled, w/ Filter, 400 Volts, Remote Mount, 7.5 HP Oil Pump

Read This First

Vyper Pre-Installation and Pre-Operation Checklist

The following items **MUST** be checked and completed by the installer prior to the arrival of the Frick Field Service Supervisor. Details on the checklist can be found in this manual. Certain items on this checklist will be re-verified by the Frick Field Service Supervisor prior to the actual start-up.

Vyper Pre-Installation Site Check List

Before attempting to install a Vyper Drive system, please perform a site inspection to assure that the following requirements are met. (Where Applicable)

- ☐ -- Verify that the coolant (water or glycol) is available for the Vyper heat exchanger connections. Hard-pipe the coolant supply in accordance to all local and national piping codes. Sufficient coolant flow and temperature levels must be available to the Vyper VSD at installation. When hard-piping the coolant supply, take into consideration that room is required in order to add coolant to the system.
- ☐ -- Verify that the compressor package temperature sensors are RFI suppression type (639A0151G01).
- ☐ -- Incoming power cables must enter through the access plate supplied on the top left side of the unit. This access plate **MUST BE** removed, entry holes made in the plate, and then reinstalled. Power cables **MUST BE** in accordance with local and national electrical codes and current safety standards. See "External Power And Control Wiring" in the INSTALLATION section of this manual.
- ☐ -- Verify that the power cable lengths from the Vyper to the compressor motor do not exceed 50 feet (15 meters) and the location of the Vyper is suitable for mounting.
- ☐ -- Verify that the motor is suitable for Inverter duty service: 20-100% Speed (12-60 hZ) or 50-100% (30-60 hZ) The motor must have thermal protection per NEC 2005. (RTD, Thermostat, Thermistor).
- ☐ -- Verify that the ambient temperature remains within the recommended operating range of 40-135°F (4-57°C). If the drive is to operate below 40°F (4°C), provide enclosure ambient space heating.
- ☐ -- Verify that all wiring is contained in metallic conduit. Use of PVC or other materials is not acceptable **UNLESS** shielded UL rated power cable is used. Follow recommendations of "Proper Installation Of Electronic Equipment In An Industrial Environment" in the INSTALLATION section of this manual.
- ☐ -- Verify that all control power (120 VAC), communications / analog wiring, and 460 VAC power are in separate metallic conduits. Properly shielded and grounded analog cables are not required to be in EMT.

Vyper Pre-Operation Site Check List

Prior to Quantum™LX setup and starting operation of the Vyper Drive system, review the following checklist to ensure all installation requirements are met. (Where Applicable)

- ☐ -- Environmental:
 - A: Cleanliness – Keep panel doors closed and ensure that construction debris is kept out of the cabinet.
 - B: Use the conduit knockouts provided. Avoid metal shavings in the drive enclosure.
 - C: Clean out all debris with a low power magnet or a vacuum cleaner.
- ☐ -- Mounting: Verify that the Vyper Drive is properly mounted: to the floor or wall for remote mounts or to the package for package mounted units.
- ☐ -- Verify that the primary water or glycol coolant supply is connected to the heat exchanger at the recommended flow and temperature recommendations.
- ☐ -- Wiring (use "Proper Installation Of Electronic Equipment In An Industrial Environment" in the INSTALLATION section of this manual as a guideline):
 - A: Wiring from the drive to the motor must be enclosed in a grounded metal conduit even if poured in a concrete floor. Use of PVC or other materials is not acceptable **UNLESS** shielded UL rated power cable is used.
 - B: Separate grounded metal conduits must be provided for input power, output power, and control wiring. Failure to provide separate conduits could result in disruption of other electrical devices due to harmonics and RFI / EMI generated in the drive.
 - C: Bond all conduit to the cabinet.
 - D: Protect control wires (analog and digital) from noise. Use properly shielded and grounded analog control wires. Digital and analog control wiring must be separate from each other as well as separate from 3 phase control and power wiring. Noisy input signals will cause erratic drive operation.
 - E: Verify control wiring has been connected from the Quantum™LX panel to the Vyper in accordance with the engineering drawings for the specific installation.
 - F: Verify power wiring has been connected at the correct connection points and properly seated in accordance with the provided engineering drawings for the specific installation.
- ☐ -- Drain the shipping coolant from the Vyper and properly dispose. Replace with running coolant (pink) and purge air from the cooling system. Refer to "Replacing Coolant" in the OPERATION section of this manual.

☐-- Apply power to the Vyper Drive system.

- A: Confirm dipswitches on the Vyper Logic Board are properly set. Refer to "VSD Logic Board Setup" in the OPERATION section of this manual.
- B: Verify no problems exist with the unit power supply connections.
- C: Verify no problems exist with the boot-up of the Quantum™LX panel and control system.
- D: Set the FLA ratings on the Vyper Logic Board as per job site requirements.
- E: Set up the Quantum™LX panel in accordance with job site requirements. Refer to "Quantum™LX Panel Setup" in the OPERATION section of this manual.
- F: Confirm operation of internal cooling fans.
- G: Confirm operation of the coolant pump.
- H: Confirm operation of the Vyper motorized coolant temperature control mixing valve.
- I: Confirm wiring, operation, and correct rotation of motor blower fans if present.

Pre-Startup Inspection

After installation is complete, use the following as guide to checks items D – I, under in the Applying power to the Vyper™ Drive system section, in the preceding Vyper™ Pre-Operation Site Checklist. Any changes to factory setpoints, needs to be approved by Frick®. Failure to obtain approval may void warranty. Read all steps thoroughly and contact the factory with any questions before proceeding.

1. With power off - In the drive, remove wire 624 (compressor run) on the drive side of control wiring terminal strip.
2. Remove wire 675 (oil pump run) if the unit is equipped with an oil pump.
3. Close the drive, turn on the disconnect using the operating handle on the door.
4. Once the Quantum™LX panel has booted go to the level 2 operating session.
5. Confirm communications between the Vyper™ drive and the Quantum™LX by going to the Vyper™ screen. If there are base-plate temperature readings that are approximate to ambient and a value is displayed for the JOB FLA communications is confirmed. Compare the Job FLA value to the panel test report Special Instructions section to ensure they match. If the JOB FLA is not listed on the panel test report, use the JOB FLA tables in this manual to calculate.
6. Go to the motor setpoints screen to check the motor amps safeties, relative to the motor and drive combination. If these values are not correct use the tables in this manual to calculate what they should be.
7. Verify proper operation of the motorized coolant mixing valve on the back of the drive.
 - Locate the Coolant mixing valve on the back of the drive, remove the cover from the motor and check that the dip-switches are set as 1 ON, 2 OFF, 3 ON & 4 OFF. If a change needs to be made, the power must be cycled at the panel for the change to be in effect.
 - Go to Page 2 of PID setpoints, for the Vyper Coolant PID. Ensure the setup is per the setup in this manual. If it is, set the Control as Always and the Direction as Reverse. Check the indicator disc or arrow on the shaft between the valve and the actuator motor that it is operating. Once it has moved to one end of the stroke, change the Direction back to Forward. This should move the Indicator Disc or Arrow back to the other end of the stroke.
8. Using a screw driver at the operating handle on the door, open the drive leaving the power on, so that the ride side panel can be opened providing access to the logic board.
9. Re-secure the left side panel.
10. If the Job FLA setting is not correct this can now be set using the Job FLA pot on the control logic board. Monitor the value on the Vyper screen of the Quantum™LX to determine when the value is properly set.
11. Test the internal fan and coolant circulation pump operation by removing the P2 plug from the J2 connector on the control logic board. Removing this plug will start these devices. You will hear the fans run. The circulation in the coolant loop should be seen through the clear hose, proving the circulation pumps operation. Reconnect the P2 plug to the J2 connector to turn off these devices. Doing this test will create a Low Inverter Base-Plate Temperature shutdown on the Quantum™LX that will need to be cleared.
12. Close the drive completely and with power still on, do a simulated run of the compressor by pressing the manual start button on the Quantum™LX. This should engage the blower motors on the compressor drive motor to verify proper rotation and operation of the blower motors. Rotational arrows on the fan housing shows proper rotation, correct if necessary by changing any two wires at the blower motor connection box with power locked out.
13. Turn power off with the operating handle on the door of the drive. Open the drive and check to ensure the panel is de-energized. Carefully replace wires 624 and 675. Tighten to 12 lb. In.

VYPER™ SYSTEM OVERVIEW

VYPER™ COMPONENT DESCRIPTION

The Frick Vyper™ Variable Speed Drive is a liquid-cooled, transistorized, PWM inverter in a highly integrated package. This unit is factory designed to mount either remotely on a stand or integrally to the compressor package. The power section of the drive is composed of four major blocks:

- AC to DC rectifier section with integrated precharge circuit
- DC link filter section
- Three-phase DC to AC inverter section
- Output suppression network

An electronic circuit breaker with ground fault sensing connects the AC line to an AC line choke and then to the DC converter. The line choke will limit the amount of fault current so that the electronic circuit breaker is sufficient for protecting the Vyper™ input fuses. See the elementary wiring diagram in Figures 2A and 2B for wiring and component references.

The AC to DC Rectifier utilizes a semi-converter formed by the connection of three SCR/diode modules (1SCR-3SCR) in a three phase bridge configuration (See Figure 2). The modules are mounted on a liquid cooled heatsink. Use of the semiconverter configuration permits implementation of a separate precharge circuit to limit the flow of current into the DC link filter capacitors when the drive is switched on and it also provides a fast disconnect from the power mains when the drive is switched off. When the drive is turned off, the SCRs in the semiconverter remain in a nonconducting mode and the DC link filter capacitors remain uncharged.

When the drive is commanded to run, a set of precharge resistors (1RES, 2RES) are switched into the circuit by contactor 1M. The DC link filter capacitors are slowly charged via the precharge resistors and the diodes of the semiconverter for a fixed time period of fifteen (15) seconds. After the fifteen-second time period has expired, the SCR's are gated fully on and the contactor 1M is dropped out.

A "free-wheeling" diode (1CR) is included to reduce the surge current which must be conducted through the semiconverter if a serious fault occurs across the DC link. Three (3) power fuses (1FU - 3FU) and an electronic circuit breaker (1SW) with ground fault sensing connects the AC to DC converter to the power mains. The drive utilizes very fast semiconductor power fuses to ensure that the SCR/diode module packages do not rupture if a catastrophic failure occurs on the DC link. The SCR Trigger board (031-01472) provides the gating pulses for the SCR's as commanded by the VSD Logic board (031-02506).

The DC Link Filter section of the drive consists of two basic components, a DC Link "smoothing" inductor or pair of inductors (1L, 2L) and a series of electrolytic filter capacitors (C1-C36). This inductor / capacitor combination forms a low-pass L-C filter which effectively smooths the ripple voltage from the AC to DC rectifier while simultaneously providing a large energy reservoir for use by the DC to AC inverter section of the drive. In order to achieve a suitable voltage capability for the capacitor portion of the filter; filter capacitor "banks" are formed by connecting two capacitors in series to form a "pair", and then paralleling a suitable number of "pairs" to form a capacitor "bank". In order to assure an equal sharing of the voltage between the series connected capacitors and to provide a discharge means for the capacitor bank when

the VSD is powered off, "bleeder" resistors (3RES and 4RES) are connected across the capacitor banks.

The DC to AC Inverter section of the VSD (See Fig. 2), serves to convert the rectified and filtered DC back to AC at the magnitude and frequency commanded by the VSD Logic board. The inverter section is actually composed of three identical inverter output phase assemblies. These assemblies are in turn composed of a series of Insulated Gate Bipolar Transistor (IGBT) modules (Q1-Q4) mounted to a liquid cooled heatsink, a filter capacitor "bank" (C13-C20) and a VSD Gate Driver board (031-01681) which provides the On and Off gating pulses to the IGBT's as determined by the VSD Logic board.

In order to minimize the parasitic inductance between the IGBT's and the capacitor banks, copper plates which electrically connect the capacitors to one another and to the IGBT's are connected together using a "laminated bus" structure. This "laminated bus" structure is a actually composed of a pair of copper bus plates with a thin sheet of insulating material acting as the separator/insulator. The "laminated bus" structure forms a parasitic capacitor which acts as a small valued capacitor, effectively canceling the parasitic inductance of the busbars themselves. To further cancel the parasitic inductances, a series of small film capacitors (C43-C51) are connected between the positive and negative plates of the DC link. An IGBT driver "shield board" (031-01627), mounted just beneath the VSD Gate Driver board, provides electrical shielding for the Gate Driver board.

The VSD Output Suppression Network is composed of a series of capacitors (C61-C66) and resistors (5RES-10RES) connected in a three phase delta configuration. The parameters of the suppression network components are chosen to work in unison with the parasitic inductance of the DC to AC inverter sections in order to simultaneously limit both the rate of change of voltage and the peak voltage applied to the motor windings. Limiting the peak voltage to the motor windings, as well as the rate-of-change of motor voltage avoid problems commonly associated with PWM motor drives, such as stator-winding end-turn failures and electrical fluting of motor bearings.

Various ancillary sensors and boards are used to convey information back to the VSD Logic board. The following list describes some of these components.

- Each liquid-cooled heatsink within the DC to AC inverter section contains a thermistor heatsink temperature sensor (RT1 - RT3) to provide temperature information to the VSD logic board.
- The AC to DC semiconverter heatsink temperature monitored using a thermistor temperature sensor (RT4).
- The bus isolator board (031-01624) utilizes three resistors on the board to provide a "safe" impedance between the DC link filter capacitors located on the output phase bank assemblies and the VSD logic board. The bus isolator board provides the means to sense the positive, midpoint, and negative connection points of the VSD's DC link.
- A Current Transformer (3T - 5T) is included on each output phase assembly to provide motor current information to the VSD logic board.

VYPER™ VARIABLE SPEED DRIVE INSTALLATION - OPERATION - MAINTENANCE

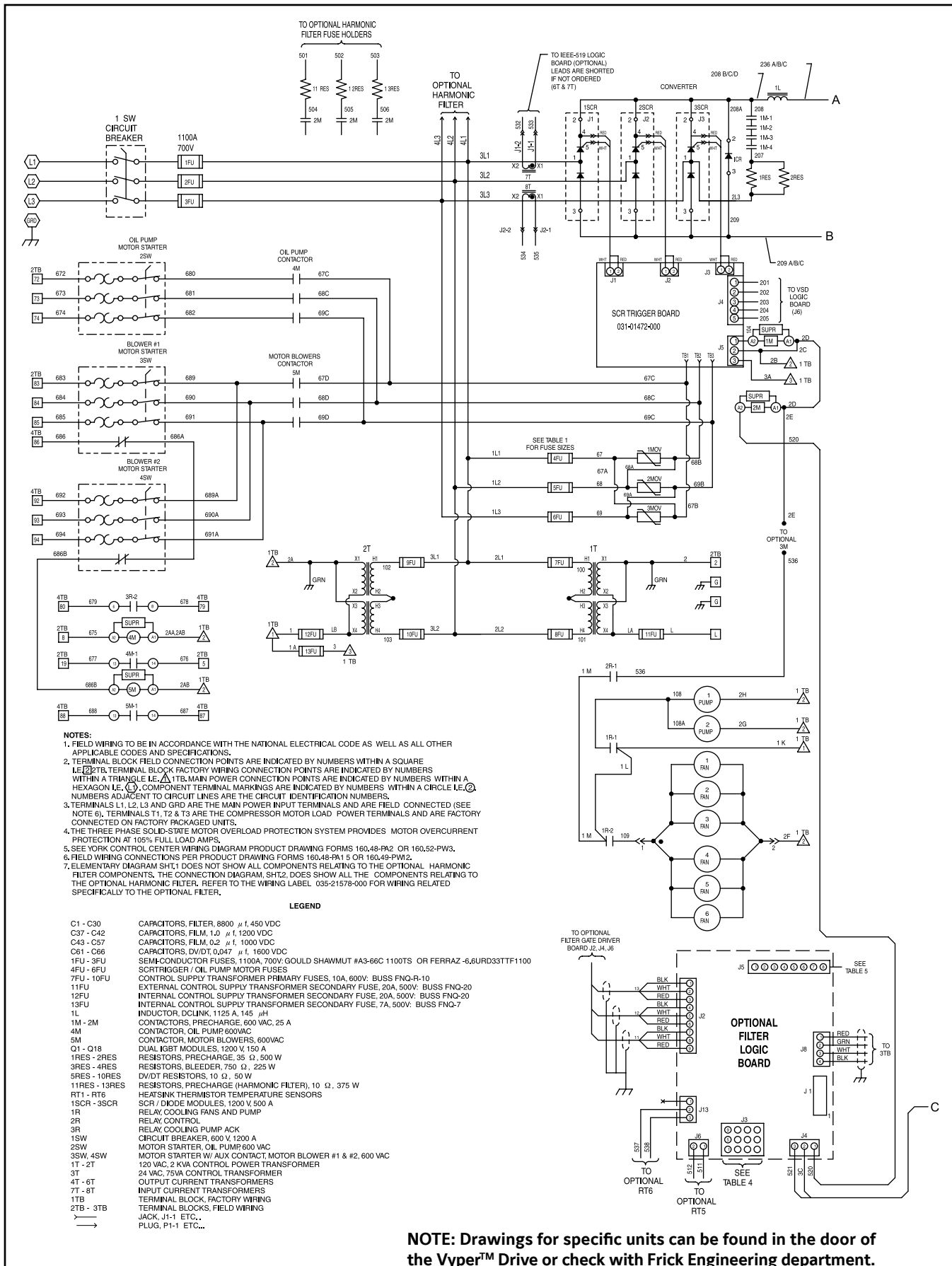


Figure 2A - Vyper™ Elementary Wiring Diagram

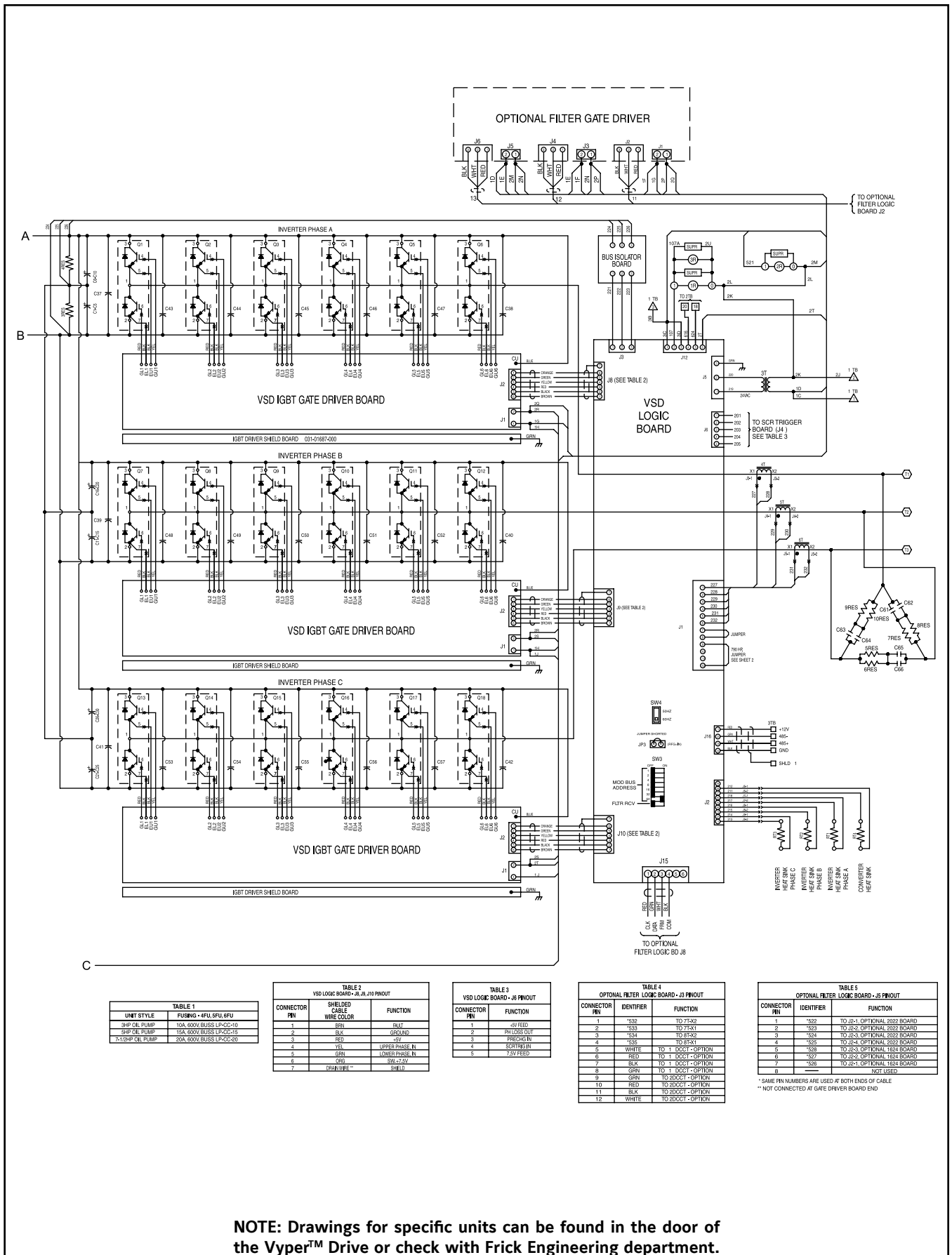


Figure 2B - Vyper™ Elementary Wiring Diagram

HARMONIC FILTER

The VSD system may include an harmonic filter designed to meet the IEEE Std 519 -1992, "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems". The filter is offered as a means to "clean up" the input current waveform drawn by the VSD from the power mains, thus reducing the possibility of causing electrical interference with other sensitive electronic equipment connected to the same power source.

Figure 3 is a plot of the typical input current waveform for the VSD system without the harmonic filter when the system is operating at 50% load. Figure 4 is a plot of the typical input current waveform for the VSD system with the harmonic filter installed when operating at the same load conditions. The plots show that the input current waveform is converted from a square wave to a fairly clean sinusoidal waveform when the filter is installed. In addition, the power factor of the system with the harmonic filter installed corrects the system power factor to nearly unity.

The power section of the Harmonic Filter is composed of four major blocks: a precharge section, a "trap" filter network, a three phase inductor and an IGBT Phase Bank Assembly. See the elementary wiring diagram in Figures 5A and 5B for wiring and component reference

The Precharge Section is formed by three resistors (11RES - 13RES) and two contactors, the precharge contactor (2M), and the supply contactor (3M). The precharge network serves two purposes, to slowly charge the DC link filter capacitors associated with the filter Phase Bank Assembly (via the diodes within the IGBT modules Q13-Q18) and to provide a means of disconnecting the filter power components from the power mains. When the drive is turned off, both contactors are dropped out and the filter phase bank assembly is disconnected from the mains.

When the drive is commanded to run, the precharge resistors are switched into the circuit via contactor 2M for a fixed time period of five (5) seconds. This permits the filter capacitors in the phase bank assembly to slowly charge. After the five-second time period, the supply contactor is pulled in and the precharge contactor is dropped out, permitting the filter phase bank assembly to completely charge to the peak of the input power mains. Three power fuses (11FU -13FU) connect the filter power components to the power mains. Very fast semiconductor power fuses are utilized to ensure that the IGBT modules do not rupture if a catastrophic failure occurs on the DC link of the filter phase bank assembly.

The "Trap" Filter is composed of a series of capacitors (C84-C92), inductors (4L-6L) and resistors (16RES-18RES). The "trap" filter acts as a low impedance for a range of frequencies centered at the PWM switching frequency of the filter (20 kHz). The purpose of the trap is to block currents at the switching frequency of the filter from getting onto the power mains.

The Three-Phase Inductor provides some impedance for the filter to "work against". The inductor effectively limits the rate of change of current at the input to the filter to a reasonable level.

The IGBT Phase Bank Assembly is the most complicated power component in the harmonic filter. The purpose of the assembly is to generate harmonic currents required by the drive's AC to DC converter so that these harmonic currents are not drawn from the power mains. The phase bank is composed of a series of IGBT modules (Q13-Q18) mounted to a liquid-cooled heatsink, a filter capacitor "bank" (C67-C76) and an IEEE 519 Filter Gate Driver board (031-01786) which provides the On and Off gating pulses to the IGBT's as determined by the 519 Filter Logic board. In order to assure an equal sharing of the voltage between the series connected capacitors on the filter bank, "bleeder" resistors 14RES and 15RES are connected across the banks. In order to counteract the parasitic inductances in the mechanical structure of the phase bank, the filter incorporates "laminated bus" technology and a series of small film capacitors (C77-C83). The technology used is identical to that used in the VSD's DC to AC inverter section of the drive.

Various ancillary sensors and circuit boards are used to convey information back to the harmonic filter logic board. The following list describes some of these components.

- A thermistor temperature sensor, RT5, is mounted onto the liquid-cooled heatsink to provide temperature information.
- Current Transformers 6T and 7T sense the input current drawn by the VSD's AC to DC converter.
- DC Current Transformers (DCCT1 and DCCT2) sense the current generated by the harmonic filter.
- The Line Voltage Isolation Board (031-02022) senses the input voltage to the system, steps the voltage down to a safe level and provides isolation between the Filter Logic board and the power mains.
- The Bus Isolation Board (031-01624) incorporates three resistors to provide a "safe" impedance between the DC filter capacitors located on the phase bank assembly and the filter logic board. The bus isolation board provides the means to sense the positive, midpoint, and negative connection points of the filter's DC link.

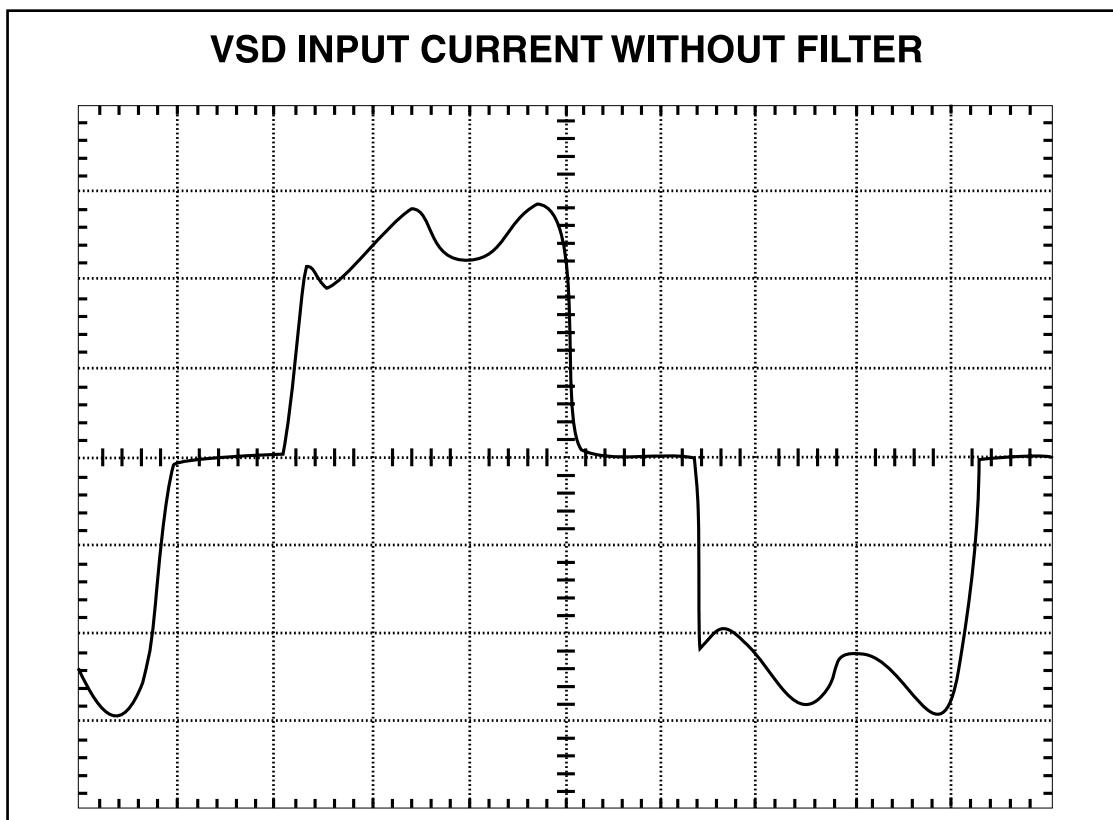


Figure 3 - VSD Input Current Without Harmonic Filter

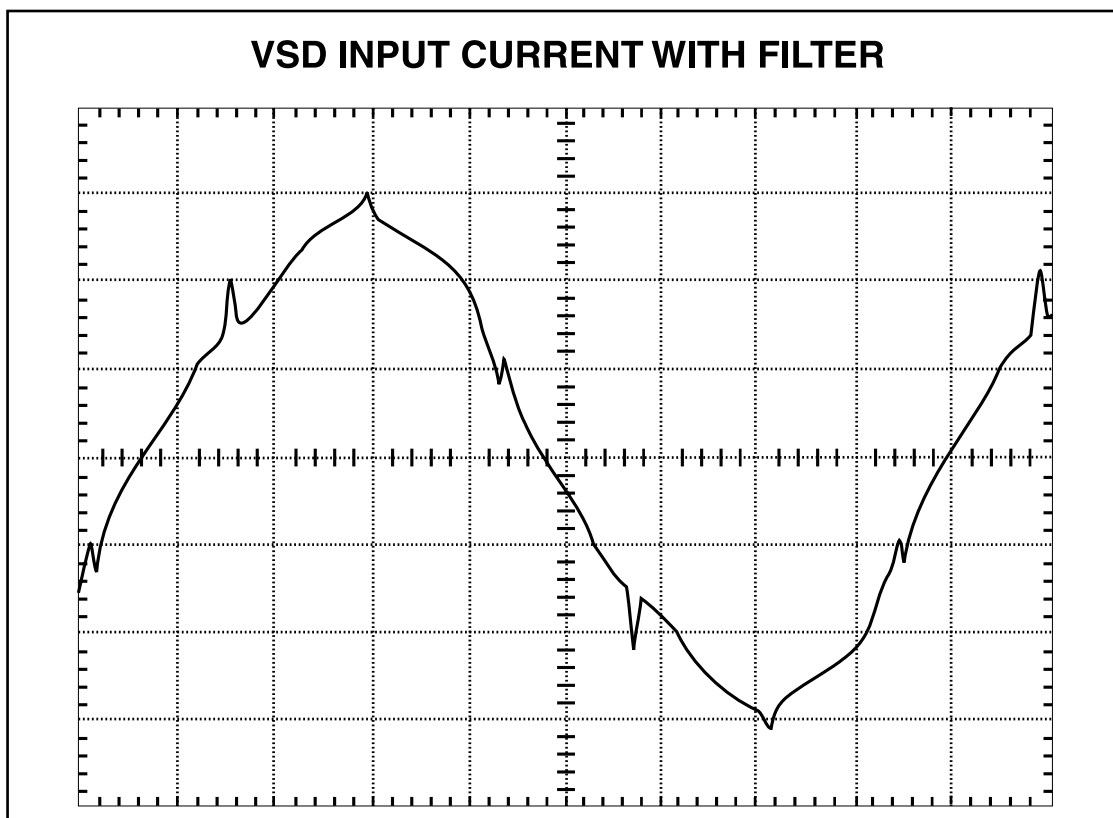
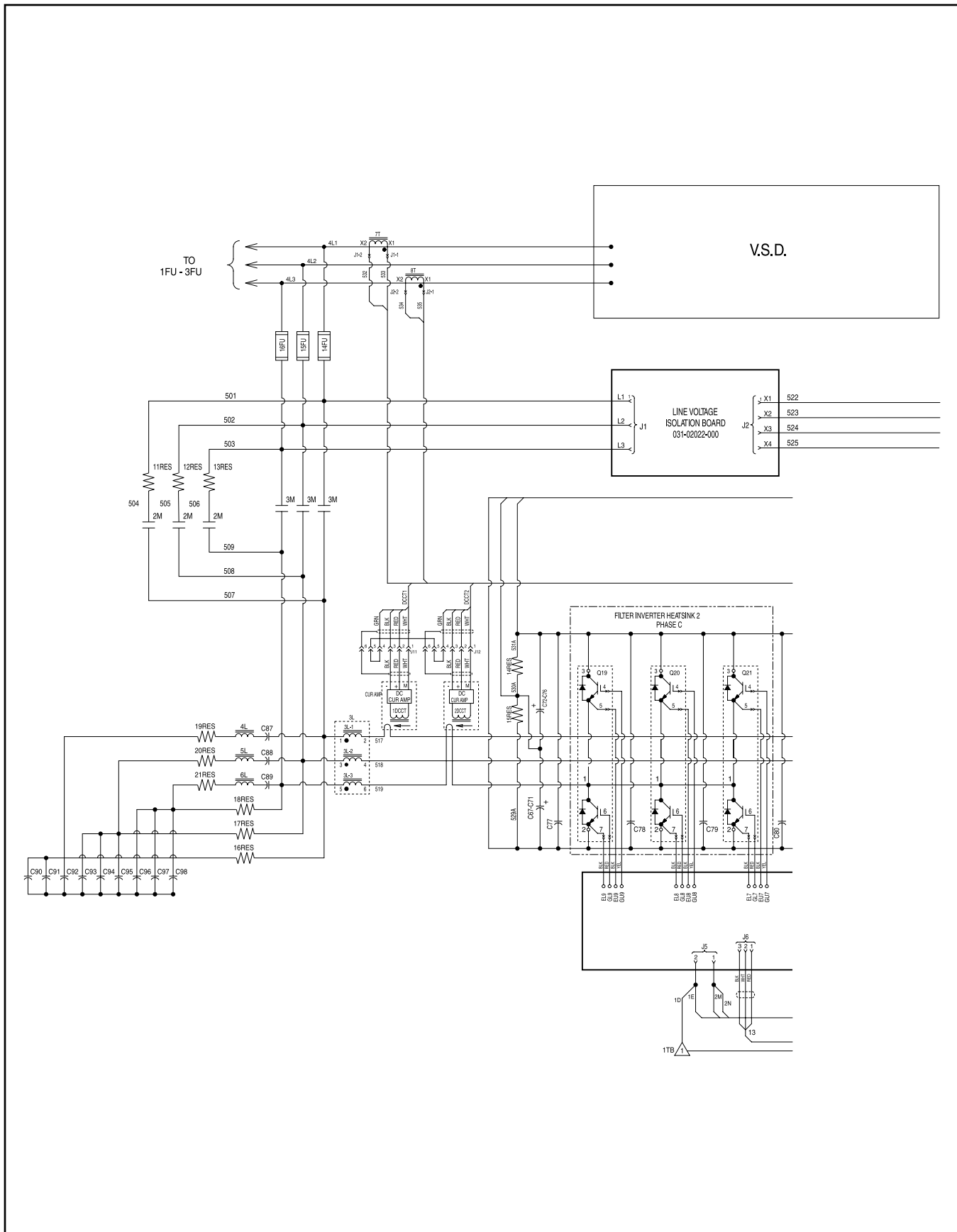
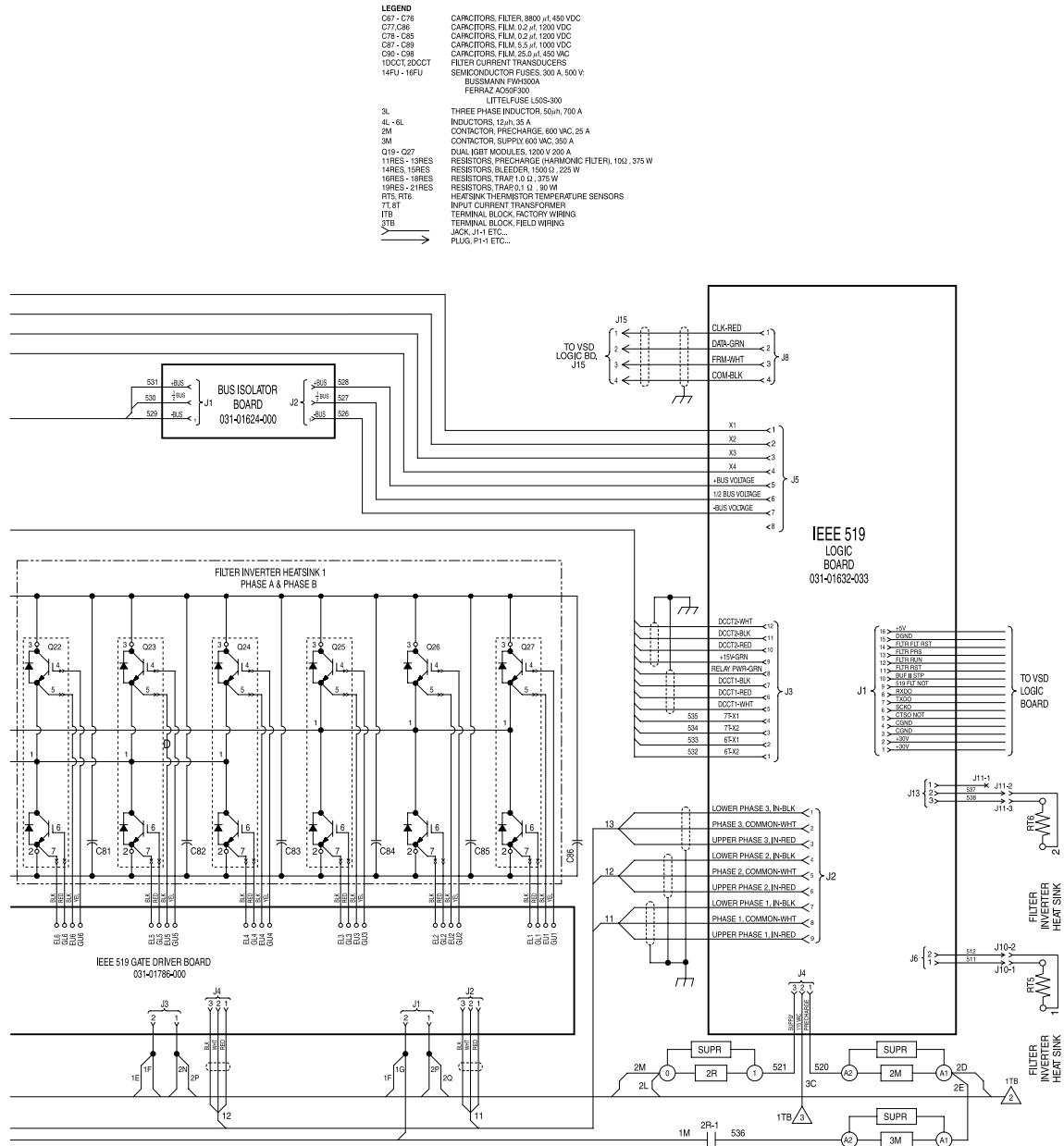


Figure 4 - VSD Input Current With Harmonic Filter



NOTE: Drawings for specific units can be found in the door of the Vyper™ Drive or check with Frick Engineering department.

Figure 5A - Harmonic Filter Elementary Wiring Diagram



NOTE: Drawings for specific units can be found in the door of the Vyper™ Drive or check with Frick Engineering department.

Figure 5B - Harmonic Filter Elementary Wiring Diagram

GENERAL OPERATION DESCRIPTION

The Vyper™ serves as the motor starter and capacity control for a Frick screw compressor. The Vyper™ controls capacity by reducing compressor speed and optimizing the compressor efficiency at all loads.

The Vyper™ varies the screw compressor speed by controlling the frequency and voltage of electrical power supplied to the compressor motor. Unlike general purpose variable speed drive units, the Vyper™ is factory calibrated for maximum performance with Frick screw compressors. Because of the specific application to commercial building systems, the Vyper™ has been designed to be electronically compatible with other electronic equipment that typically operates in the same facility.

The Vyper™ can be cooled by two coolants: water or glycol. Both coolants can be used with either package mounted or remotely mounted Vyper™ units. Power wiring and some piping between the facility and Vyper™ must be field supplied.

ELECTRICAL LIMITS

Supply voltage to the Vyper™ must be 440/460/480V @ 60 Hz or 380V @ 50 Hz. If a building has higher or lower supply voltage, consider a step-up or step-down transformer. Refer to Table 1.

TABLE 1 – SUPPLY VOLTAGE REQUIREMENTS

Frequency	Supply Voltages VAC
60 Hz	440/460/480
50 Hz	380

Extreme operating voltage ranges from a minimum of 414 VAC to a maximum of 508 VAC, 3-phase, 60 Hz, or 342 to 423 VAC, 50 Hz. The maximum allowable voltage imbalance is 3%. Size the main transformer so voltage does not sag more than 5% when subjected to load excursions. The steady-state operating voltage should be within the range of 414 to 508 VAC, 3 phase, 60 Hz, or 342 to 423 VAC, 3 phase, 50 Hz. Refer to Table 2.

TABLE 2 – OPERATING VOLTAGE LIMITS

Frequency	Operating Voltage Limits		Phase
	Min	Max	
60 Hz	414	508	3
50 Hz	342	423	3

Unit controls may shut down with power interruptions up to one cycle. Interruptions greater than one cycle will result in a shutdown. A voltage dip below 391V, 60 Hz or 340V, 50 Hz constitutes a power interruption. Refer to Table 3.

TABLE 3 – POWER INTERRUPTION MINIMUM VOLTAGE LIMITS

Frequency	Minimum Voltage Limits VAC
60 Hz	391
50 Hz	340

CURRENT LIMITS

The drive is capable of outputting the rated full load current over the operating frequency range of the drive. The unit is started with the compressor fully unloaded until the frequency reaches the minimum operating frequency range. In addition, the drive is capable of operating without a load for ease of service. Refer to Table 4 for current limits.

TABLE 4 – UNIT CURRENT LIMITS

HP	Freq	Voltage	RMS current	LRA max
912 HP	60 Hz	460V	1180A	7014A
752 HP	50 Hz	400V	1180A	8205A
700 HP	60 Hz	460V	880A	5777A
572 HP	50 Hz	400V	880A	5780A

The following information is also helpful in the operation of the unit:

- Overload: 105% of full load rating for seven (7) seconds.
- Efficiency: 98% Typical at rated load and frequency.

INPUT SHORT CIRCUIT LIMITS

Vyper™ drives are suitable for use on circuits capable of delivering up to 100,000 RMS symmetrical amperes and a maximum of 480 VAC.

The Vyper™ can be affected by specific events that can decrease product life and cause component damage related to the input power conditioning. These events include:

- The power source experiences interruptions.
- The power system has power factor correction capacitors switched in and out of the system by either the power supplier or the end user.
- The power source contains voltage spikes which could be caused by equipment on the same line or natural phenomena such as electrical storms.

If one or more of these conditions exist, Frick recommends that the end user install minimum impedance between the Vyper™ and the power source. A transformer or other similar device can supply the impedance.

A 100% rated input power circuit breaker with ground fault protection and external lockable operator is supplied as standard. The circuit breaker is sized in accordance with the National Electrical Code or UL requirements. Refer to Table 5 for circuit breaker ratings and lug sizes.

TABLE 5 – CIRCUIT BREAKER RATINGS AND LUG SIZES

Horsepower	Circuit Breaker Rating (Amps)	Circuit Breaker Lug Sizes
700/572	1000	3/0 to 500 KCMIL
912/752	1200	3/0 to 500 KCMIL

The maximum per phase Total Harmonic Distortion (THD) of the input current shall not exceed 30% at 100% rated power. The Frick® Vyper™ drive typically produces between 20-30% THD.

An IEEE 519 Harmonic Filter is required if the THD of the input current at the installation cannot exceed 8%. The IEEE 519 Harmonic Filter is highly recommended for crucial applications such as hospitals, computer networks, airports, etc.

Installation

RIGGING AND HANDLING

Each Vyper™ Variable Speed Drive unit is shipped mounted on a wooden skid or mounted to the refrigeration package. All shipping materials must be removed prior to unit installation.

The Vyper™ cabinet unit is best moved via lifting lugs on the top sides of the cabinet. Caution must be used to not damage the pump or peripheral equipment on the rear of the cabinet. Never move the unit by pushing against the Vyper™ cabinet with a forklift or other machinery.

UNIT (WITH FILTER) WEIGHTS (lb)

MODEL	UNIT	UNIT AS SHIPPED
700/572	1,890	2,319
912/752	2,026	2,455

VYPER™ MOUNTING CONFIGURATIONS

NOTE: When mounting the Vyper™ unit, allow space for servicing both sides of the unit cabinet.

The Frick Vyper™ is offered in two mounting configurations, package mounted and remote mounted.

PACKAGE MOUNTED UNITS

One advantage of the package mounted version is that all electrical connections have been prewired and tested at the factory which ensures proper installation of control and power lines. Package mounting is available for all horsepower ratings of the Vyper™. Both water or glycol cooling connections are also available as well as the optional IEEE 519 harmonic filter. In addition, the package-mounted Vyper™ does not require an additional dV/dt filter between the VFD cabinet and the motor.

Figure 6 shows Vyper™ cabinet mounted on a Frick RWF II refrigeration package. Individual systems configurations will vary according to model and horsepower sizes selected.

On package mounted units, the Vyper™ cabinet is mounted on a rectangular welded steel channel, which provides both an attachment point for the cabinet's side brackets and also helps to maintain the rigidity of the cabinet during service. The channel assembly / VSD cabinet is mounted on two extension brackets welded to pads on the system's oil separator. All package-mounted units are assembled with vibration isolators located between the Vyper™ channel frame and the extension mounting brackets. The isolators help to minimize the exposure of internal components and connections to cyclic vibrations during unit shipping and operation.

Power supply to the Vyper™ is from the top. Power supply to the motor is made via a conduit exit from a rear panel in the Vyper™ Cabinet. Control wiring in/out is located at the lower left side of the cabinet.

Please consult standard compressor package installation procedures for this mounting method.

Drive Disconnect Height – covered under Exception 2, section 8 of article 404 of the NEC, which states, Switches and Circuit Breakers installed adjacent to motors, appliances, or other equipment that they supply shall be permitted to be located higher than 2.0 M (6 ft 7in) and to be accessible by portable means.

REMOTE MOUNTED UNITS

For the remote mounting method, the Vyper™ cabinet is mounted on a steel base specifically designed for the VSD. The primary requirement for mounting the Vyper™ is that the foundation must be able to support the weight of the cabinet and base. In addition, the Vyper™ cabinet must be



Figure 6 - Vyper™ Package Mounted on Frick RWF II. Diagram is for orientation purposes only and is not to scale.

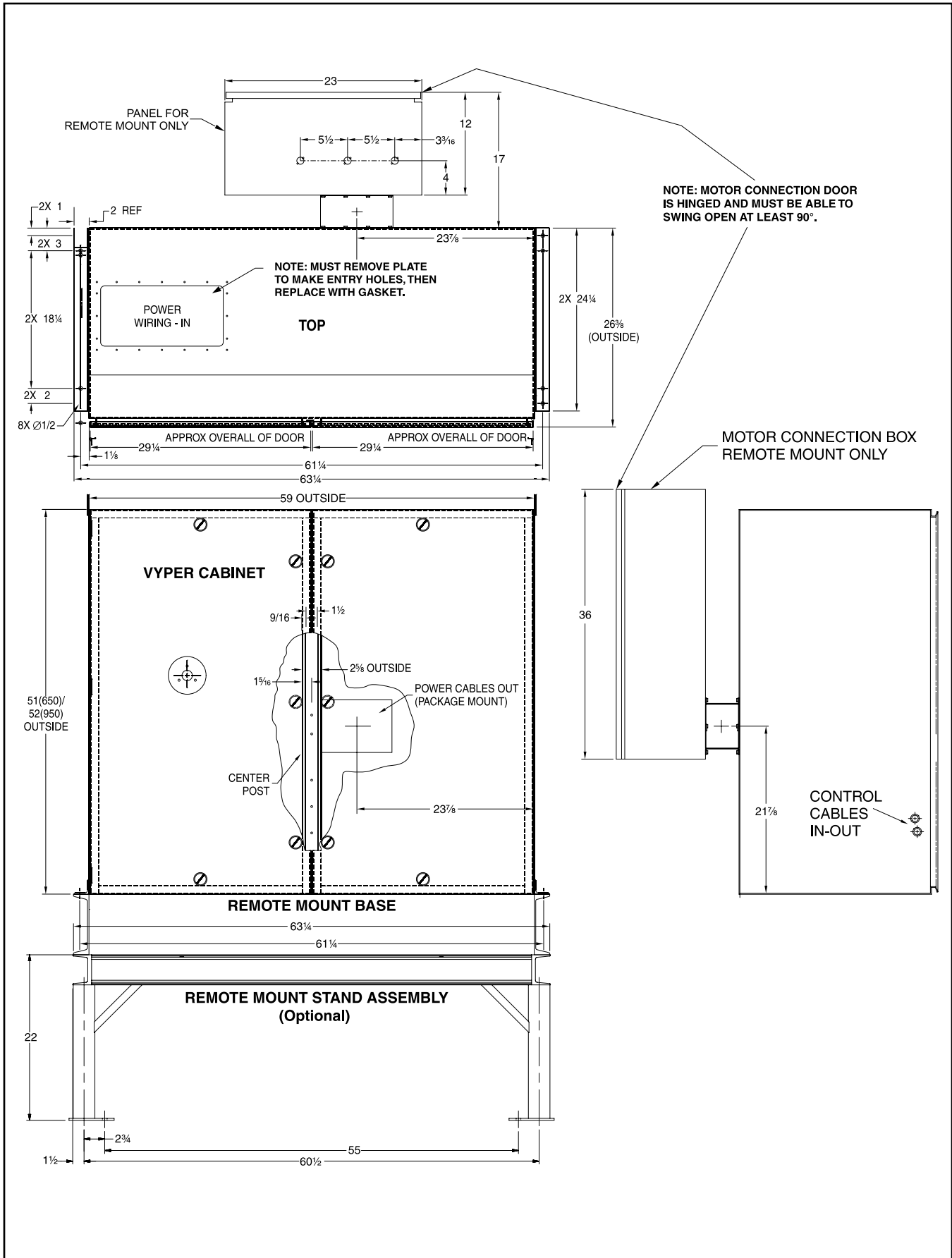


Figure 7 - Vyper™ Cabinet and Stand

located so that no more than fifty (50) feet (15 meters) of motor wiring length is needed between the VSD cabinet and the package motor.

The remote-mounted units have fastener holes located on the bottom of the base for floor anchors. If optional stand is used, fastener holes are located on the rear stand legs for wall anchoring.

Anchor bolts are recommended to firmly mount the unit to the foundation. Anchoring the cabinet to a firm foundation by proper leveling and employment of fastening bolts is the best assurance for trouble-free installation.

Foundations must be in compliance with local building codes and materials must be of industrial quality. All electrical conduits must be metallic, no PVC or other materials are permitted. The remote-mounted Vyper™ configuration is shown in Figure 7. Table 6 provides the dimensions of the unit and stand. The mounting location of remote-mount units must be able to support the weight of the Vyper™. Dimensions of the package-mount cabinets are identical except for the elimination of the optional stand. Coolant connections to the heat exchanger are 1 in. NPT.

ENVIRONMENT

The Vyper™ is housed in a NEMA 4 indoor class enclosure. The electronics are sealed against ambient conditions, however it is recommended that the end user employ good standard practices in regard to moisture exposure and extreme temperature conditions. It is recommended that the Vyper™ be operated within the ambient temperature range of 41°F (5°C) and 135°F (57°C) with the dew point no higher than 90°F (32°C). Refer to Table 6 for temperature limits.

TABLE 6 – AMBIENT TEMPERATURE OPERATING LIMITS

Recommended Ambient Temperature Limits		
Unit Status	Min	Max
Storage	-4°F (-20°C)	158°F (70°C)
Operating	41°F (5°C)	135°F (57°C)

The Vyper™ can be used at altitudes up to 10,000 feet (3048 meters) without derating for units without the IEEE 519 Harmonic Filter. A Vyper™ with the Harmonic Filter option included can be operated up to 5,000 feet (1524 meters) without derating. Remotely mounted units must have the distance limited between the Vyper™ and the compressor motor to fifty (50) feet (15 meters) of wire or less. Problems that may be encountered with wire lengths greater than fifty feet are as follows:

- VSD picks up interference in the control wiring, causing the VSD to intermittently trip.
- Voltage drop becomes excessive, rising above the 5% voltage drop limit.
- Peak voltage applied to the motor windings becomes excessive and may cause premature motor failure.
- A dV/dt filter must be installed on remote-mounted units with motor power lead lengths between 3 to 50 feet (1 to 15 meters).

Adequate service clearances, including door swing, must be maintained around the Vyper™. During installation, care should be taken to ensure that the Vyper™ and the associated piping and wiring do not obstruct access to service areas.

VYPER™ COOLING CONFIGURATION

The Frick Vyper™ is internally cooled with a factory calibrated liquid cooling circuit that offers many advantages over traditional air-cooled systems. The liquid circuit provides precisely controlled coolant temperatures to the heat generating components and delivers coolant into locations that air-over fan systems could not penetrate. The Vyper™ liquid-cooling arrangement performs independently of fluctuating ambient conditions. The NEMA 4 indoor-rated cabinet seals the internal electronics and piping from corrosive refrigerant vapors while providing superior cooling for the internal electronic components. Efficient liquid cooling also allows for smaller cabinet size and longer component life than traditional air-cooled units. Plant condenser water or a facility-supplied glycol loop subsequently removes the heat in the coolant via the heat exchanger located at the back of the Vyper™ cabinet.

VYPER™ COOLING LOOP

While the compressor is running, the Quantum™LX control panel monitors the temperature of Vyper™ drive coolant. With this information, the Quantum™LX delivers a 4-20 mA signal to the 3-way mixing valve, based on the setpoints of a PID loop output from the Quantum™LX. This signal will maintain the Vyper™ coolant temperature at the control setpoint for the PID loop. This setpoint will be set at 110°F at the factory. There are also low and high temp alarms and shutdowns associated with the Vyper™ coolant temperature reading. These will also be factory set for a Low Temp. alarm and shutdown at 85°F and 80°F with a 90 second delay, when running. The High Temp. Alarm and shutdown will be factory set at 125°F and 130°F with a 30 second delay when running. If the Vyper™ coolant temperature drops too low, condensation may occur, damaging vital electronic components.

In addition to controlling the Vyper™ cabinet cooling system, the Quantum™LX panel also monitors the temperature of four components in the Vyper™ cabinet. If any of these temperatures reaches a critical threshold, the Quantum™LX panel will enter a Stop Load condition, preventing either the slide valve position or motor speed from increasing. If the temperature continues to rise, the Quantum™LX panel will next go to a Force Unload condition. In this situation, the slide valve will unload to lower the motor torque required, in an effort to drop the temperature in the panel. Table 7 shows the Stop Load and Force Unload temperatures as well as the temperatures where the Vyper™ cabinet will automatically shut down.

TABLE 7 – VYPER™ CABINET COMPONENT TEMPERATURE THRESHOLDS

Location	Stop Load	Force Unload	Shutdown
Baseplate Temp Inverter	160°F (71°C)	165°F (74°C)	170°F (77°C)
Heat Sink Temp	155°F (68°C)	160°F (71°C)	158°F (70°C)
Harmonic Filter	130°F (54°C)	135°F (57°C)	145°F (63°C)
Baseplate Temp	160°F (71°C)	165°F (74°C)	175°F (79°C)

COOLANT TEMPERATURE LIMITS

Liquid supply cooling temperature limits vary between Water and Glycol cooled units. The required coolant flow rate is based on the maximum temperature of the coolant type to be used.

TABLE 8 – ENTERING COOLANT TEMPERATURE LIMITS

Entering Coolant Temperature Limits			
Drive Size	Coolant Type	Min	Max
912 hp	Water	40°F (4°C)	100°F (38°C)
912 hp	Glycol (30% mix)	35°F (2°C)	95°F (35°C)
752 hp (50Hz)	Water	40°F (4°C)	100°F (38°C)
752 hp (50Hz)	Glycol (30% mix)	35°F (2°C)	100°F (38°C)
700 hp	Water	40°F (4°C)	105°F (41°C)
700 hp	Glycol (30% mix)	35°F (2°C)	100°F (38°C)
572 hp (50Hz)	Water	40°F (4°C)	105°F (41°C)
572 hp (50Hz)	Glycol (30% mix)	35°F (2°C)	105°F (41°C)

GENERAL COOLING SYSTEM REQUIREMENTS

- Vyper™ Liquid-cooled 700/912 HP models provide one in. NPT threaded male connections IN and OUT of the heat exchanger for customer connections.
- Sufficient clearance to perform normal service and maintenance work should be provided around the entire unit.

- An upstream strainer is recommended to stop particulate matter from entering the heat exchanger. The strainer should be cleaned several times during the first twenty-four hours of operation.
- Refer to the charts in Figures 8 and 9 for minimum flow rates.

WATER RECOMMENDATIONS

- Johnson Controls-Frick recommends a closed-loop system for the customer-supplied water side of the heat exchanger.
- Johnson Controls-Frick recommends a water pH level between 6.0 and 7.4 for proper heat exchanger life.

NOTE: To reduce the potential of fouling the heat exchanger, recommended minimum flow rate is 5 GPM.

- When adding a booster pump to supply condenser water to the heat exchanger of the water-cooled Vyper™, choose a pump which will supply the proper GPM based on the drive size and temperature of coolant where a 700 HP drive would require 10 gallons @ 103°F. See Figure 8.

GLYCOL RECOMMENDATIONS

- Propylene Glycol is to be used exclusively. Glycol concentration must be 50% or less by volume. See Figure 9.

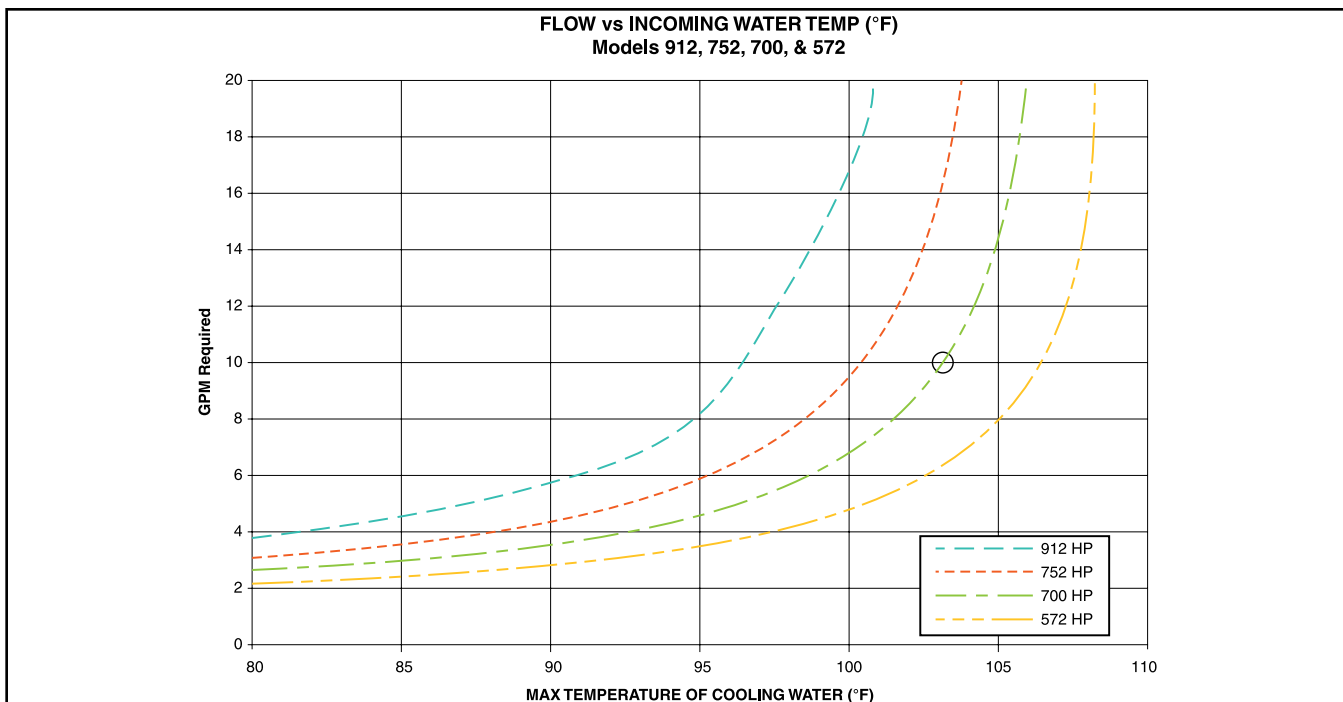


Figure 8 – Minimum Flow Rates - WATER

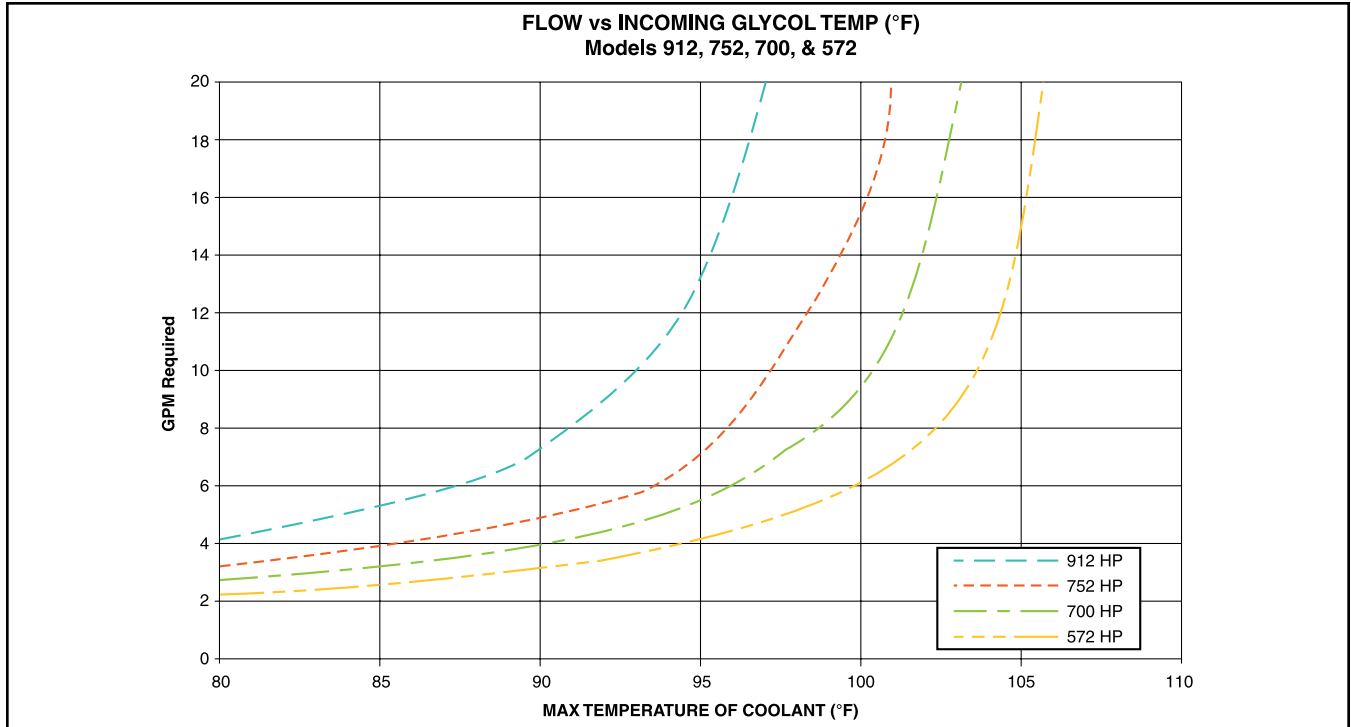


Figure 9 - Minimum Flow Rates - GLYCOL

HEAT EXCHANGER PRESSURE DROP 912, 752, 700, 572 Models

In order to adequately size piping and booster pump requirements, the pressure drop of the coolant across the heat exchanger must be known. Figure 10 provides installation

designers with pressure drop reference for different mixtures of propylene glycol and water.

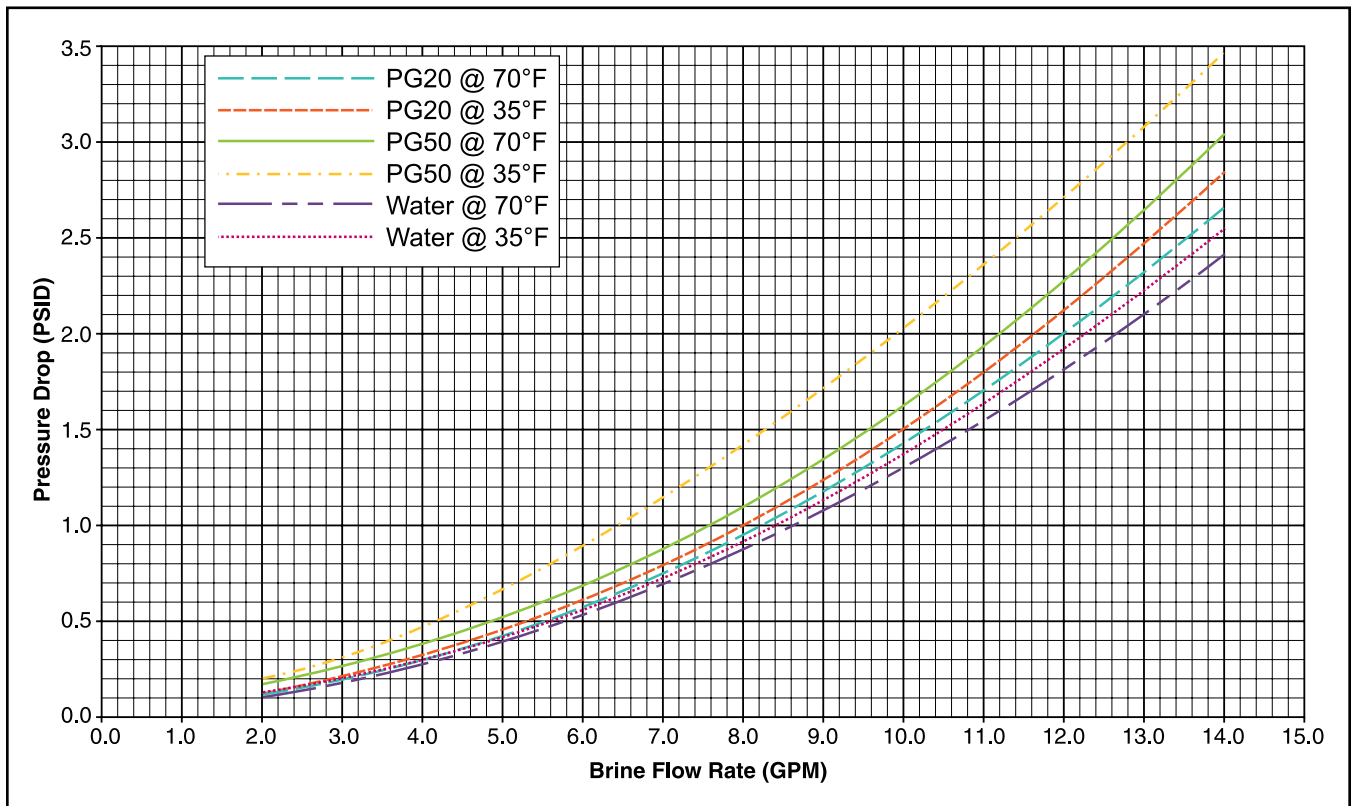


Figure 10 - Pressure Drop vs. Flow Rate

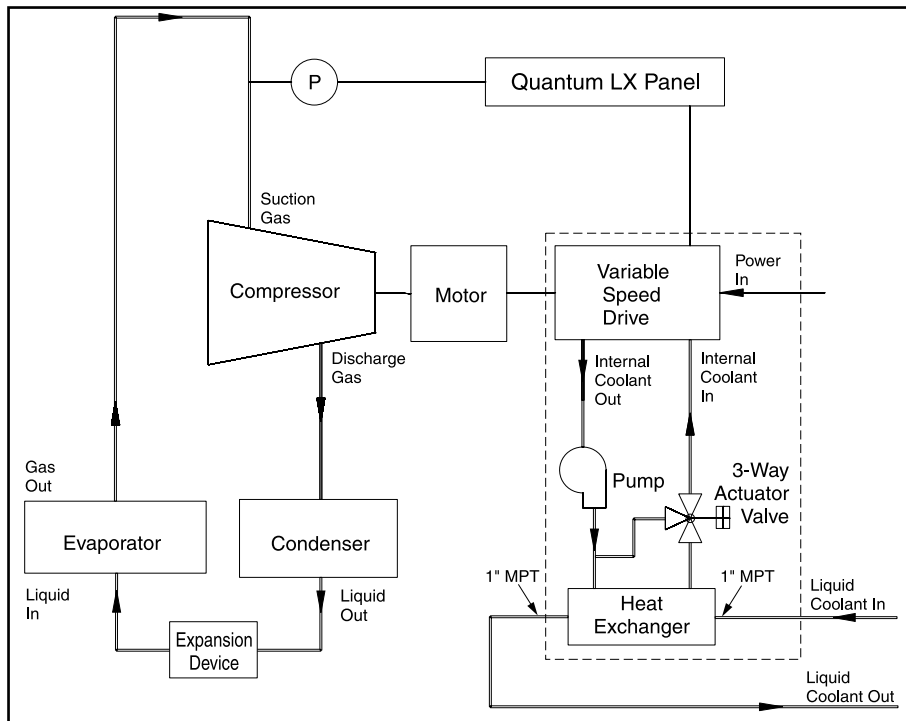


Figure 11 - Liquid Cooled Vyper™ P&I Diagram - Noneconomized

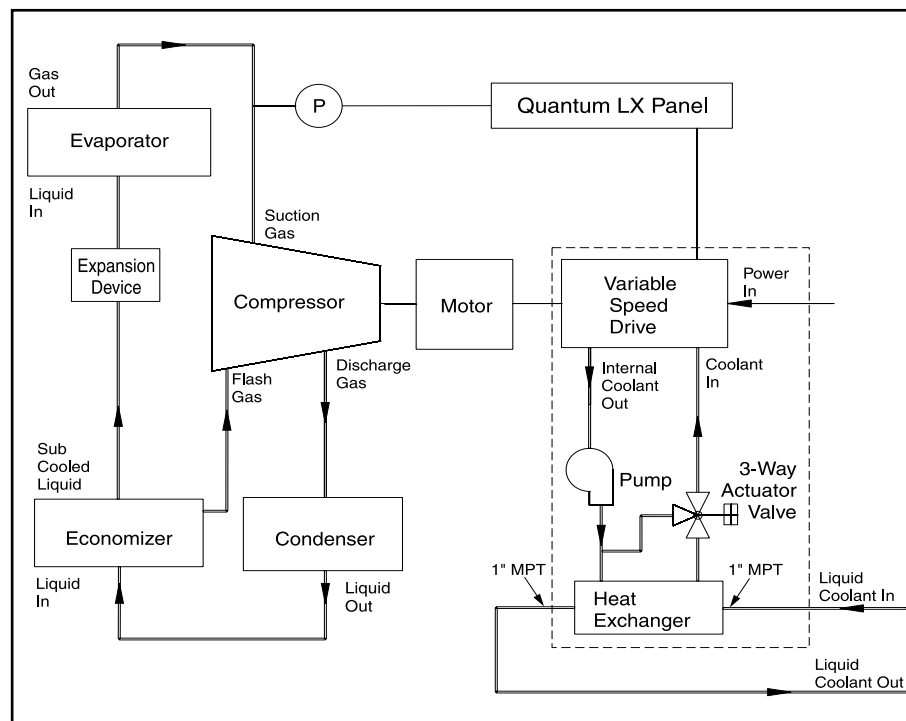


Figure 12 - Liquid Cooled Vyper™ P&I Diagram - Economized

PROPER INSTALLATION OF ELECTRONIC EQUIPMENT IN AN INDUSTRIAL ENVIRONMENT

In today's refrigeration plants, electronic controls have found their way into almost every aspect of refrigeration control. Electronic controls have brought to the industry more precise control, improved energy savings, and operator conveniences. Electronic control devices have revolutionized the way refrigeration plants operate today.

The earlier relay systems were virtually immune to radio frequency interference (RFI), electromagnetic interference (EMI), and ground loop currents. Therefore installation and wiring were of little consequence and the wiring job consisted of hooking up the point-to-point wiring and sizing the wire properly. In an electronic system, improper installation will cause problems that may outweigh the benefits of electronic control. Electronic equipment is susceptible to RFI, EMI, and ground loop currents which can cause equipment shutdowns, processor memory and program loss, as well as erratic behavior and false readings. Manufacturers of industrial electronic equipment take into consideration the effects of RFI, EMI, and ground loop currents and incorporate protection of the electronics in their designs. However, these design considerations do not make the equipment immune, so manufacturers require that certain installation precautions be taken to protect the electronics from these effects. All electronic equipment must be viewed as sensitive instrumentation and therefore requires careful attention to installation procedures. These procedures are well known to instrumentation, networking, and other professions but may not be followed by general electricians.

There are a few basic practices that if followed, will minimize the potential for problems resulting from RFI, EMI and/or ground loop currents. The National Electric Code (NEC) is a guideline for safe wiring practices, but it does not necessarily deal with procedures used for electronic control installation. Use the following procedures for electronic equipment installation. These procedures do not override any rules by the NEC, but are to be used in conjunction with the NEC code and any other applicable codes.

With exclusion of the three phase wire sizing, Frick drawing 649D4743 should be used as a reference for properly sizing control wires and other wiring specifications.

Throughout this document the term Electronic Control Panel is used to refer to the microprocessor mounted on the compressor package or a Central Control System panel.

It is very important to read the installation instructions thoroughly before beginning the project. Make sure you have drawings and instructions with your equipment. If not, call the manufacturer and request the proper instructions and drawings. Every manufacturer of electronic equipment should have a knowledgeable staff, willing to answer your questions or provide additional information. Following correct wiring procedures will ensure proper installation and consequently, proper operation of your electronic equipment.

WIRE SIZING

Control power supply wires should be sized one size larger than required for amperage draw to reduce instantaneous voltage dips caused by large loads such as heaters, contactors, and solenoids. These sudden dips in voltage can cause the electronic control panel, whether it is a microprocessor, a computer, or a PLC, to malfunction momentarily or cause a complete reset of the control system. If the wire is loaded to its maximum capacity, the voltage dips are much larger, and the potential of a malfunction is very high. If the wire is sized one size larger than required, the voltage dips are smaller than in a fully loaded supply wire and the potential for malfunction is much lower. The NEC code book calls for specific wire sizes to be used based on current draw. An example of this would be to use #14 gauge wire for circuits up to 15 amps or #12 gauge wire for circuits of up to 20 amps. Therefore, when connecting the power feed circuit to an electronic control panel, use #12 gauge wire for a maximum current draw of 15 amp and #10 wire for a maximum current draw of 20 amp. Use this rule of thumb to minimize voltage dips at the electronic control panel.

VOLTAGE SOURCE

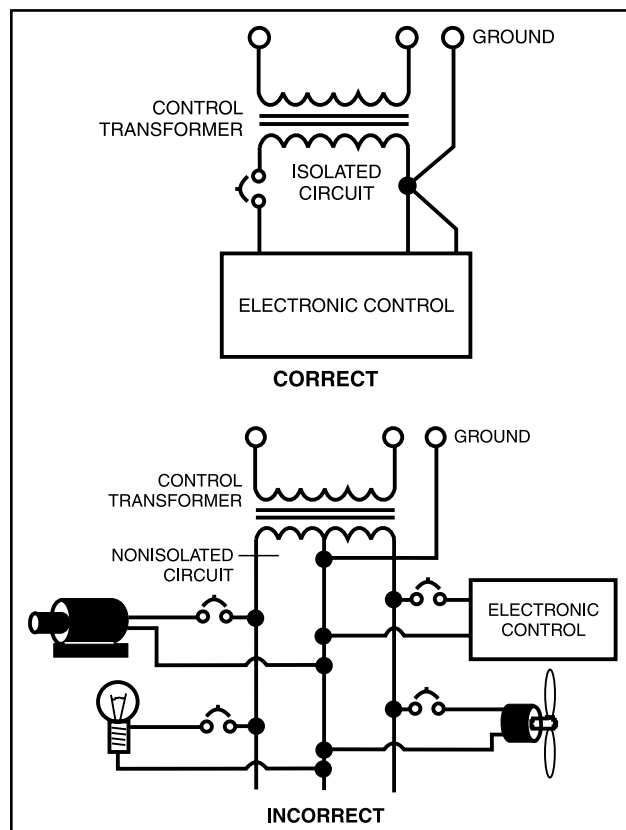


Figure 13 - Control Power Transformer

Selecting the voltage source is extremely important for proper operation of electronic equipment in an industrial environment. Standard procedure for electronic instrumentation is to provide a clean, isolated, separate-source voltage in order to prevent EMI (from other equipment in the plant) from interfering with the operation of the electronic equipment. Connecting electronic equipment to a breaker panel (also known as lighting panels or utility panels) subjects the electronic equipment to noise generated by other devices connected to the breaker panel. This noise is known as electromagnetic interference (EMI). EMI flows on the wires that are common to a circuit. EMI cannot travel easily through transformers and therefore can be isolated from selected circuits. Use a control power transformer of the proper VA rating, usually provided in the compressor drive motor starter, to isolate the electronic control panel from other equipment in the plant that generate EMI. See Figure 13.

GROUNDING

Grounding is the most important factor for successful operation and is typically the most overlooked. The NEC states that control equipment may be grounded by using the rigid conduit as a conductor. This worked for the earlier relay systems, but it is in no way acceptable for electronic control equipment. Conduit is made of steel and is a poor conductor relative to an insulated stranded copper wire. Electronic equipment reacts to very small currents and must have a proper ground in order to operate properly; therefore, stranded copper grounds are required for proper operation.

For proper operation, the control power ground circuit must be a single continuous circuit of the proper sized insulated stranded conductor, from the electronic control panel to the plant supply transformer (Figure 14). Driving a ground stake at the electronic control may also cause additional problems since other equipment in the plant on the same circuits may ground themselves to the ground stake causing large ground flow at the electronic control panel. Also, running multiple ground conductors into the electronic control panel from various locations can create multiple potentials resulting in ground loop currents. A single ground wire (10 AWG or 8 AWG) from the electronic control panel, that is bonded to the control power neutral at the secondary side of the control power transformer in the starter and then to the 3-phase ground point, will yield the best results.

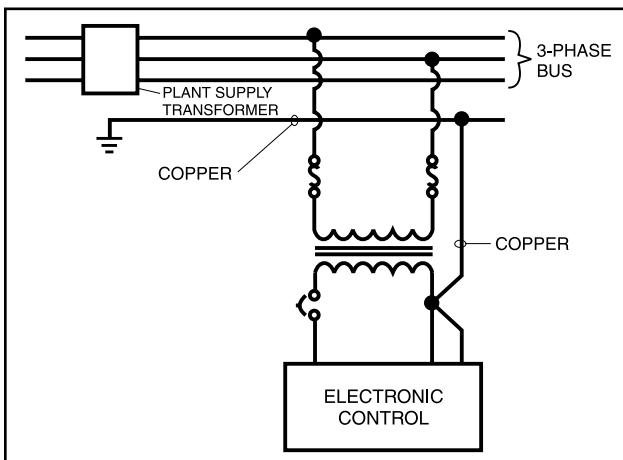


Figure 14 - Control Power Ground Circuit

NOTE: Structural grounding can also result in multiple ground potentials and is also a relatively poor conductor. Therefore, this is not an acceptable method for proper operation of electronic equipment.

There must be a ground for the three-phase power wiring. This must be sized in accordance to the NEC and any local codes relative to the highest rated circuit overload protection provided in the circuit. The manufacturer may require a larger ground conductor than what is required by the NEC for proper steering of EMI from sensitive circuits. This conductor must also be insulated to avoid inadvertent contact at multiple points to ground, which could create Ground Loops. In many installations that are having electronic control problems, this essential wire is usually missing, is not insulated, or improperly sized.

NEC size ratings are for safety purposes and not necessarily for adequate relaying of noise (EMI) to earth ground to avoid possible interference with sensitive equipment. Therefore sizing this conductor 1 – 2 sizes larger than required by code will provide better transfer of this noise.

Johnson Controls-Frick requires that the ground conductor meet the following:

- Stranded Copper
- Insulated
- One size larger than NEC requirements for conventional starters
- Two sizes larger than NEC requirements for VFD starters
- Conduit must be grounded at each end
- This circuit must be complete from the motor to the starter continuing in a seamless manner back to the plant supply transformer (power source).

For Direct Coupled, Package Mounted Starters, the ground between the motor and the starter may need to be made externally (Figure 15). The connection on the starter end must be on the starter side of the vibration isolators. Be certain the connection is metal to metal. Paint may need to be removed to ensure a proper conductive circuit. The use of counter-sunk star washers at the point of connection at each end will maximize metal to metal contact.

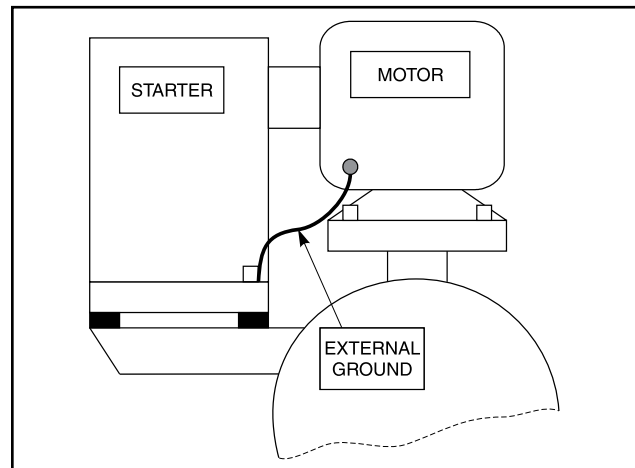


Figure 15 - Package Mounted Starter Ground

VFD Applications

The primary ground conductor that accompanies the three-phase supply must be stranded copper, insulated and two sizes larger than the minimum required by the NEC or any other applicable codes. This is necessary due to the increased generation of EMI which is a characteristic of a VFD output to the motor when compared to a conventional starter.

For VFD applications, isolation of the control power, analog devices, and communications ground from the 3-phase ground within the starter and the electronic control panel may be necessary. This is due to the higher noise (RFI/EMI) levels generated between the VFD output and the motor, relative to a conventional starter. If these grounds are left coupled by a common back-plate in the starter/drive, this noise can be direct coupled to the control power, analog device, and communications grounding and may cause unexplained behavior and possible damage to components.

To install correctly, run a separate, properly sized (10 or 8 AWG typically) insulated ground along with and taken to ground with, the 3-phase ground at the 3-phase supply transformer (plant). This will require that the 3-phase ground and the control power ground be electrically isolated except for the connection at the plant supply transformer.

This style of grounding should steer the noise (EMI/RFI) to earth ground, reducing the potential for it to affect the sensitive equipment, which could occur if the grounds were left coupled. NOTE: If all other recommendations for grounding are followed, this process should not be necessary.

CONDUIT

All national and local codes must be followed for conduit with regard to materials, spacing and grounding. In addition, **Johnson Controls-Frick requirements must be followed where they exceed or match national or local codes. Conversely, there is no allowance for any practices that are substandard to what is required by national or local codes.**

Johnson Controls-Frick conduit requirements:

- For variable frequency drives (VFDs) of any type, threaded metallic or threaded PVC-coated metallic is required for both the power feed (line side) from the source and between the VFD output and the motor (load side).
- PVC conduit is acceptable only when VFD rated cable of the proper conductor size and ground is used. This applies to both the line side and load side of the drive. When VFD rated cable is not used, threaded metallic or threaded PVC-coated metallic must be used.
- When threaded metallic or threaded PVC-coated metallic is used, it must be grounded at both ends.
- When not required to be in metal or other material by national or local codes, conduits for the power feed (3-phase) of constant speed starters may be PVC.
- When not required to be in metal or other material by national or local codes, conduits between a constant speed starter and the motor (3-phase) may be PVC.
- Any unshielded control voltage, signal, analog, or communication wiring that does not maintain 12 inches of separation from any 3-phase conductors for every 33 feet (10 meters) of parallel run must be in metal conduit which will be grounded.

Separation: (0-33 feet, 0-10 meters – 12 inches, .3 meters), (33-66 feet, 10-20 meters – 24 inches, .6 meters)

- Since PVC conduit does absolutely nothing to protect lower voltage lines from the magnetic field effects of higher voltage conductors, running either the lower or the higher voltage lines in PVC, does not reduce these requirements on separation. Only running in metal conduit can relieve these requirements.
- Due to the level of EMI that can be induced onto lower voltage lines when running multiple feeders in a trench, control power, communications, analog, or signal wiring cannot be run in trenches that house multiple conduits/electrical ducts carrying 3-phase power to starters/vfd or motors.
- Control power, communications, analog, or signal wiring should be run overhead (preferred) or in a separate trench. If these lines are not in threaded metallic or threaded PVC-coated metallic, abiding by the separation requirements noted above is necessary.
- Though not recommended, if cable trays are used, metallic dividers must be used for separation of conductors of unlike voltages and types (AC or DC).

NOTE: When in doubt contact the factory or use threaded metallic or threaded PVC coated metallic conduit.

WIRING PRACTICES

Do not mix wires of different voltages in the same conduit. An example of this would be the installation of a screw compressor package where the motor voltage is 480 volts and the electronic control panel power is 120 volts. The 480 volt circuit must be run from the motor starter to the motor in its own conduit. The 120 volt circuit must be run from the motor starter control transformer to the electronic control panel in its own separate conduit. If the two circuits are run in the same conduit, transients on the 480 volt circuit will be induced onto the 120 volt circuit causing functional problems with the electronic control panel. Metallic dividers must be used in wire way systems (conduit trays) to separate unlike voltages. The same rule applies for 120 volt wires and 220 volt wires. Also, never run low voltage wires for DC analog devices or serial communications in the same conduit with any AC wiring including 120 volt wires. See Figure 16.

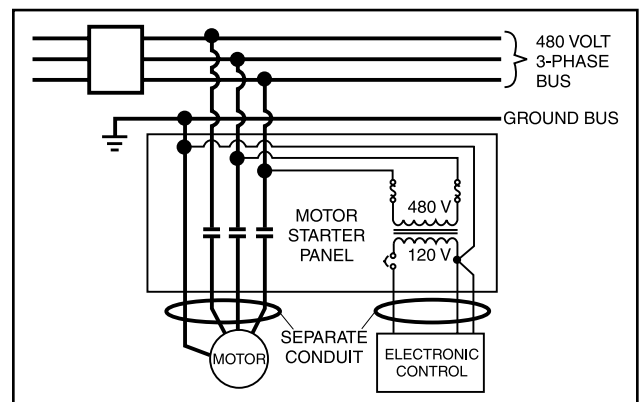


Figure 16 - Run Wiring Correctly

Never run any wires through an electronic control panel that do not relate to the function of the panel. Electronic control panels should never be used as a junction box. These wires may be carrying large transients that will interfere with the operation of the control panel. An extreme example of this would be to run 480 volts from the starter through the electronic control panel to an oil pump motor.

When running conduit to the electronic control panel, use the access holes (knockouts) provided by the manufacturer. These holes are strategically placed so that the field wiring does not interfere with the electronics in the panel. Never allow field wiring to come in close proximity with the controller boards since this will almost always cause problems.

Do not drill into an electronic control panel to locate conduit connections. You are probably not entering the panel where the manufacturer would like you to since most manufacturers recommend or provide prepunched conduit connections. You may also be negating the NEMA rating of the enclosure. Drilling can cause metal filings to land on the electronics and create a short circuit when powered is applied. If you must drill the panel, take the following precautions:

- First, call the panel manufacturer before drilling into the panel to be sure you are entering the panel at the right place.
- Take measures to avoid ESD (electrostatic discharge) to the electronics as you prep the inside of the Electronic control panel. This can be done by employing an anti-static wrist band and mat connected to ground.
- Cover the electronics with plastic and secure it with masking or electrical tape.
- Place masking tape or duct tape on the inside of the panel where you are going to drill. The tape will catch most of the filings.
- Clean all of the remaining filings from the panel before removing the protective plastic.

When routing conduit to the top of an electronic control panel, condensation must be taken into consideration. Water can condense in the conduit and run into the panel causing catastrophic failure. Route the conduit to the sides or bottom of the panel and use a conduit drain. If the conduit must be routed to the top of the panel, use a sealable conduit fitting which is poured with a sealer after the wires have been pulled, terminated, and the control functions have been checked. A conduit entering the top of the enclosure must have a NEMA-4 hub type fitting between the conduit and the enclosure so that if water gets on top of the enclosure it cannot run in between the conduit and the enclosure. This is extremely important in outdoor applications.

NOTE: It is simply NEVER a good practice to enter through the top of an electronic control panel or starter panel that does not already have knockouts provided. If knockouts are not provided for this purpose it is obvious this is not recommended and could VOID WARRANTY.

Never add relays, starters, timers, transformers, etc. inside an electronic control panel without first contacting the manufacturer. Contact arcing and EMI emitted from these devices can interfere with the electronics. Relays and timers are routinely added to electronic control panels by the manufacturer, but the manufacturer knows the acceptable device types and proper placement in the panel that will keep interference to a minimum. If you need to add these devices, contact the manufacturer for the proper device types and placement.

Never run refrigerant tubing inside an electronic control panel. If the refrigerant is ammonia, a leak will totally destroy the electronics.

If the electronic control panel has a starter built into the same panel, be sure to run the higher voltage wires where indicated by the manufacturer. EMI from the wires can interfere with the electronics if run too close to the circuitry.

Never daisy-chain or parallel-connect power or ground wires to electronic control panels. Each electronic control panel must have its own control power supply and ground wires back to the power source (Plant Transformer). Multiple electronic control panels on the same power wires create current surges in the supply wires, which may cause controller malfunctions. Daisy-chaining ground wires, taking them to ground at each device, allows ground loop currents to flow between electronic control panels which also causes malfunctions. See Figure 17.

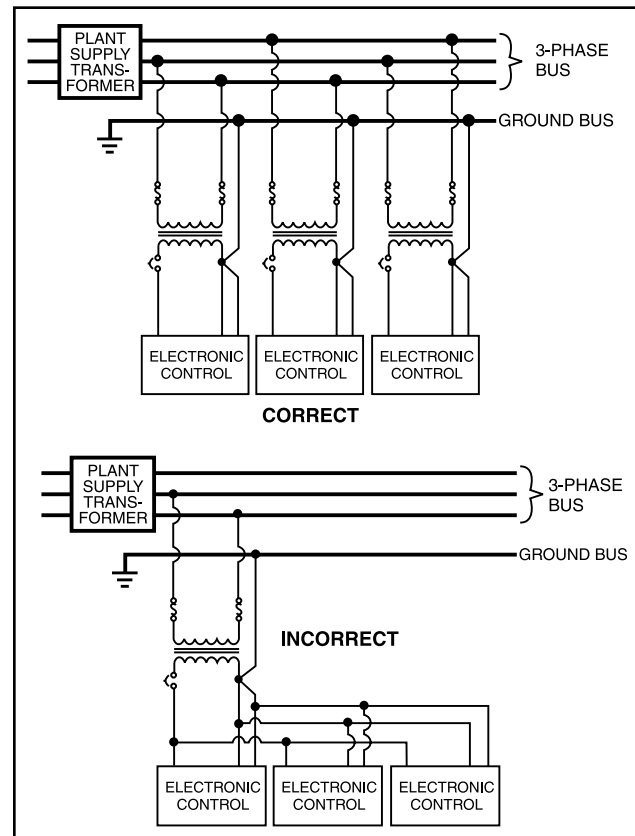


Figure 17 - Daisy-Chaining Ground Wires

COMMUNICATIONS

The use of communications such as serial and ethernet in industrial environments are commonplace. The proper installation of these networks is as important to the proper operation of the communications as all of the preceding practices are to the equipment.

Serial communications cable needs to be of the proper gauge based on the total cable distance of the run. Daisy-chaining is the only acceptable style of running the communications cable. While Star Networks may use less cable, they more often than not cause problems and interruptions in communications, due to varying impedances over the varying lengths of cable. Ground or drain wires of the communications cable are to be tied together at each daisy-chain connection and only taken to ground in the central control system panel.

It is important to carefully consider the type of cable to be used. Just because a cable has the proper number of conductors and is shielded does not mean it is an acceptable cable. Johnson Controls, Inc. recommends the use of Belden #9829 for RS-422 communications and Belden # 9841 for RS-485 up to 2000 feet (600 Meters) total cable length. Refer to Johnson Controls-Frick drawing 649D4743 for more detail

Comm Port Protection: Surge suppression for the comm ports may not be the best method, since suppression is required to divert excess voltage/current to ground. Therefore, the success of these devices is dependent on a good ground (covered earlier in this section). This excess energy can be quite high and without a proper ground, it will access the port and damage it.

Isolation or Optical Isolation is the preferred comm port protection method. With optical isolation, there is no continuity between the communications cable and the comm port. There is no dependence on the quality of the ground. Be sure to know what the voltage isolation value of the optical isolator is before selecting it. These may range from 500 to 4000 Volts.

Frick Optical Isolation Kits are offered under part number 639C0133G01. One kit is required per comm port.

UPS POWER AND QUANTUM™LX PANELS

Johnson Controls, Inc. does not advise nor support the use of uninterrupted power supply systems for use with the Quantum™LX panel. With a UPS system providing shutdown protection for a Quantum panel, the panel may not see the loss of the 3-phase voltage on the motor because the UPS may prevent the motor starter contactor from dropping out. With the starter contactor still energized, the compressor auxiliary will continue to feed an "okay" signal to the Quantum™LX panel. This may allow the motor to be subjected to the fault condition on the 3-phase bus.

A couple of fault scenarios are: 1. The 3-phase bus has power "on" and "off" in a continuous cycle manner which may cause the motor to overheat due to repeated excessive in-rush current experiences. 2. The motor cycling may damage the coupling or cause other mechanical damage due to the repeated high torque from rapid sequential motor "bumps." 3. Prolonged low voltage may cause the motor to stall and possibly overheat before the motor contactor is manually turned off.

Under normal conditions, the loss of 3-phase power will shut down the Quantum™LX panel and it will reboot upon proper power return. If the panel was in "Auto," it will come back and return to running as programmed. If the unit was in "Remote," the external controller will re-initialize the panel and proceed to run as required. If the panel was in "Manual" mode, the compressor will have to be restarted manually after the 3-phase bus fault/interruption has been cleared / restored.

If the local power distribution system is unstable or prone to problems there are other recommendations to satisfy these problems. If power spikes or low or high line voltages are the problem, then a constant voltage (CV) transformer with a noise suppression feature is recommended. Johnson Controls, Inc. can provide these types of transformers for this purpose. Contact Johnson Controls for proper sizing (VA Rating) based on the requirement of the job. If a phase loss occurs, then you will typically get a high motor amp shutdown. If the problem continues, an analysis of the facility's power supply quality may be necessary.

NOTE: It is very important to read the installation instructions thoroughly before beginning the project. Make sure you have drawings and instructions for the equipment being installed. If not, call the manufacturer to receive the proper instructions and drawings. Every manufacturer of electronic equipment should have a knowledgeable staff, willing to answer your questions or provide additional information. Following correct wiring procedures will ensure proper installation and consequently, proper operation of your electronic equipment.

TABLE 9 – DIGITAL CONTROL SIGNAL WIRE RECOMMENDATIONS

Recommended Digital Signal Wire	
Unshielded	Per US NEC or applicable electrical code.
Shielded	18AWG (0.750 mm ²), 3 conductor, shielded.

ELECTRICAL WIRING CONDUIT

All Vyper™ power and control wiring must be contained in suitable metallic conduit and separated by system/component as follows:

- Compressor motor wiring
- Oil pump motor wiring
- Compressor motor cooling fan power wiring
- Control wiring between the Quantum™LX panel and the Vyper™
- System Analog and Communications wiring

TRANSFORMERS

NOTE: Use only K-4 Standard rated transformers.

In most installations, the transformer that supplies the refrigeration equipment is the same transformer that powers most of the other loads in the same building. These transformers are generally very large relative to the refrigeration load.

In some cases there will be an individual transformer, sized and dedicated to the refrigeration system alone. For example, when a 460 VAC VSD is used and the existing power is 208V, a 208 V to 460V step-up transformer should be installed.

Dedicated transformers must be specially sized for Vyper™ applications. Failure to properly size the transformer may result in unreliable operation. **NOTE: Contact the factory or power provider for transformer sizing.**

When installing a Vyper™ on an existing transformer, the total Kilovolt-amperes (kVA) requirement of the VSD controlled system and all branch circuits must be considered. Size the transformer supplying the Vyper™ so that the transformer voltage does not sag more than 5% when subjected to load excursions. The steady-state operating voltage should be within the range of 414 to 508 VAC, 3 phase 60 Hz, or 342-423 VAC, 3 phase, 50 Hz. Refer to Table 10 for transformer ratings/sizes.

Johnson Controls offers a line of recommended Vyper VSD Transformers. These transformers have the following features:

- Steel core for low flux density operation.
- Standard K-4 rating. K-13, K-20, K-30 is available as an option.
- UL / CSA certified.
- 600 Volt class
- Primary Voltage: 208V, 230V, 460V, 575V
- Conductors, 40°C ambient
- Sinusoidal loading not to exceed K-4
- Secondary Voltage: 460
- NEMA 2 housing
- 60 Hz, 150°C temperature rise, 220°C insulation
- Taps: 1 plus, 1 minus@5%

TABLE 10 – RECOMMENDED TRANSFORMER SIZES

kVA	Impedance	Weight (lb)
175	5%-6%	1100
220	5%-6%	1470
275	5%-6%	1750
330	5%-6%	1990
440	5.5% - 6.5%	2700
550	5.5% - 6.5%	3100
660	5.5% - 6.5%	3600
750	6% - 7%	4600
880	6% - 7%	5300
990	6% - 7%	5800
1250	6.5% - 7.5%	6200
1500	6.5% - 7.5%	6800
1750	6.5% - 7.5%	7500
2000	6.5% - 7.5%	8200

POWER FACTOR CAPACITORS

Power factor correction capacitors are not required since the Vyper™ has a 0.95 minimum power factor at all operational loads and conditions. Capacitors can be located at one or several places on a distribution system and solid-state motor controllers may not run or have difficulty starting units with this scenario. The severity of the malfunction depends on the size of the capacitors, the distance away for the solid-state controls, and the size of the building supply transformer.

In Variable Speed Drive (VSD) applications, there is no way to know in advance whether the capacitors will cause interference. When a VSD is started and there are problems caused by power factor capacitors; the capacitors require removal. Note that in some installations, capacitors are switched on-line as the power factor drops.

The switching transients created by connecting and disconnecting power factor capacitors may cause the Vyper™ to drop off-line. High voltage power factor capacitors may be located on the primary side of the transformer supplying power to the Vyper™ without causing any malfunction to equipment located on the secondary side.

SOFT-START SEQUENCE

NOTE: There is a thirty (30) second delay at initial start-up to charge the capacitors of the Vyper™. This delay does not occur in "Standby Mode", only on initial start-up.

At start-up, both the motor and slide valve begin to load to a preset value. The Frick slide valve will load to the "Minimum Slide Valve Position" setpoint and the Vyper™ will accelerate to the speed corresponding to the "Minimum Drive Output" setpoint. From this point, the slide valve position and motor speed are controlled by the Capacity Control setpoints.

During start-up, the VSD varies the voltage and frequency to maintain the same proportion that exists between the two at design conditions. The required inrush current to start the motor never exceeds the FLA rating of the given motor and is typically only 10-20% of FLA. Mechanical forces on the motor windings and motor heating are 20% to 50% lower than with a mechanical starter. This results in less mechanical shock to the system and longer motor life.

Refer to PROGRAMMING and VYPER™/QUANTUM™LX COMMUNICATIONS Sections and Manual **090.022-O, "Frick Quantum™LX Compressor Control Panel Operation"** for additional operation details.

INTERFERENCE WITH ELECTRONIC EQUIPMENT

RFI / EMI are acronyms for Radio Frequency Interference and Electro-Magnetic Interference. Any electronic device that switches currents at high speed is capable of generating RFI and EMI. Some typical sources are computers, light dimmers, and motor speed controls. RFI refers to electrical fields, which are transmitted through the air. EMI refers to electrical currents, which are conducted in wiring connected to the device.

The Vyper™ generates both RFI and EMI. Most RFI energy generated by Vyper™ is contained within the Vyper™ cabinet. The EMI energy is conducted back in to the power line and may be capable of causing interference to other electronic equipment that is powered by the same electrical distribution system.

VSDs are used successfully in many installations, which utilize sensitive electronic equipment. However, in some highly sensitive cases, there may be electronic equipment that is affected by Vyper™ originated EMI. For those cases, Johnson Controls-Frick recommends a Harmonic Filter to reduce conducted EMI levels by reducing current harmonics to limits defined by the IEEE 519-1992 standard. The filter is located within the Vyper™ cabinet and is factory installed and tested. The filter can also be retrofitted to an existing Vyper™.

All hospital applications require the IEEE 519 harmonic filter and is also strongly recommended for any installation with sensitive electronic equipment connected to the electrical distribution system. The filter is also required whenever a local utility places a limit on current distortion for an electronic device. Applications that need 8% or less total harmonic current distortion require the IEEE 519 harmonic filter.

INTERFACING ELECTRICAL EQUIPMENT

There are many low-voltage DC signals in the Vyper™ that may be picked up from other electrical devices or wiring in the vicinity of the Vyper™ electronic controls. Use the following guidelines to prevent the Vyper™ electronic controls from picking up low-voltage DC signals and possibly cause injury or damage to the electronic controls:

- **Never route non-VSD wiring through the Vyper™ cabinet or tie in external equipment to the Vyper™ control wiring in any way.**
- **Never wire a control system to the Vyper™ circuitry.**
- **Never use 120V supply to feed the VSD control wiring. The Vyper™ has it's own internal power supply. Using an external power supply may damage the Vyper™ and may also cause hazardous working conditions for service and operating personnel.**

SYSTEM OPERATING CONDITIONS

Refrigeration systems considered for Vyper™ application must be in good operating condition. A site survey should be completed with the help of a trained Frick service technician. The technician will review the condition of the equipment and recommend actions that must be taken to ensure that the equipment is in good operating condition. This survey must be taken and required repairs made prior to the application of the Vyper™.

PNEUMATIC CONTROLS

Pneumatic controls must be replaced with electronic controls to be compatible with the Vyper™ and the Quantum™LX control panel.

VYPER™ PREINSTALLATION SITE CHECKLIST

Before attempting to install a Vyper™ Drive system, please perform a site inspection to assure that the following requirements are met. (Where Applicable)

- ☐ Verify that the coolant (water or glycol) is available for the Vyper™ heat exchanger connections. Hard-pipe the coolant supply in accordance to all local and national piping codes. Sufficient coolant flow and temperature levels must be available to the Vyper™ VSD at installation. When hard-piping the coolant supply, take into consideration that room is required in order to add coolant to the system.
- ☐ Verify that the compressor package temperature sensors are RFI suppression type (639A0151G01)
- ☐ Incoming power cables must enter through the panel supplied on the top of the left side of the unit. Power cables must be in accordance with local and national electrical codes and current safety standards. See the Power Wiring section in this manual for more details.
- ☐ Verify that the power cable lengths from the Vyper™ to the compressor motor do not exceed 50 feet (15 meters) and the location of the Vyper™ is suitable for mounting.
- ☐ Verify that the motor is suitable for Inverter duty service: 20-100% speed. The motor must have thermal protection per NEC 2005. (RTD, Thermostat, Thermistor)
- ☐ Verify that the ambient temperature remains within the recommended operating range of 40° - 135°F (4° - 57°C). If the drive is to operate below 40°F (4°C), provide enclosure ambient space heating.
- ☐ All wiring must be contained in metallic conduit. **Use of PVC or other materials is not acceptable.**
- ☐ Verify that control power (120 VAC), communications/analog wiring, and 460 VAC power are in separate metallic conduits.

VYPER™ POWER AND CONTROL ENTRY LOCATIONS

Vyper drives provide a removable plate on the top left of the cabinet that designates the point of entry for the incoming power. This is the only acceptable point of entry for power into a Vyper drive. This plate must be removed for the proper sized holes to be punched and then reinstalled. For remote mounted cabinets, the power exits through the top of a separate motor connection box. The holes on this box can be punched in place since there is no chance for metal filings to fall into the electronics of the drive.

Under no circumstances is it acceptable to bring power into or take power out of a Vyper at any other point.

It is possible to come up through the floor, alongside of the Vyper, then turn in and down into the drive. All NEC codes relative to conductor size and bend radius must be followed.

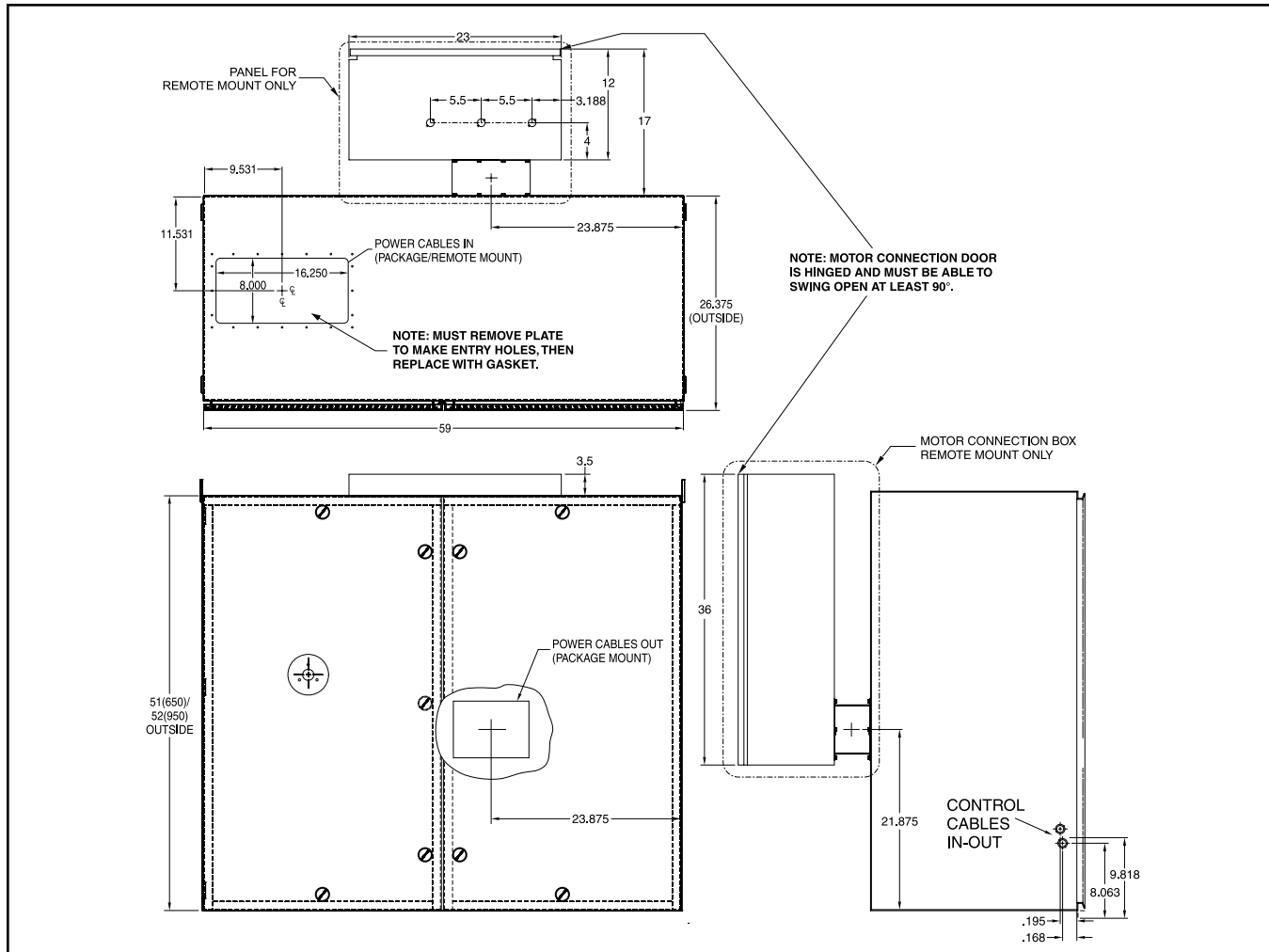


Figure 18 - Vyper™ Cabinet Power and Control Entry Locations

EXTERNAL POWER AND CONTROL WIRING

⚠ DANGER Shock Hazard! Before beginning service, use proper lock-out/tag-out procedures to disconnect all power supplies related to this equipment. Verify all power is removed from the supply leads. Death or severe personal injury will occur if proper care is not taken.

⚠ DANGER Shock Hazard! Wait five (5) minutes after switching power to the Vyper™ OFF to allow capacitors in the cabinet to discharge before opening the cabinet door. Failure to do so will result in death or serious injury.

NOTE: Perform all Vyper™ wiring in accordance with local and national electrical codes, applicable industrial safety regulations, and guidelines described in this manual.

External power and control signals must be fed in and out of the Vyper™ variable speed drive. The unit requires the wiring to be properly installed in order to supply power to the unit for processing. The Vyper™ also outputs processed power to the motor of a compressor package. The two connection points are at the following locations:

INPUT POWER CONNECTION

For remote-mounted units, the input power junction is located on the upper left side of the cabinet (See Figure 19). This location provides a junction for three power cables, L1, L2, and L3.



Figure 19 - Vyper™ Input Power Terminal Connection Lugs

Strip 0.5 to 1.0 inch (13 to 25 mm) of insulation from the ends of the input power leads (See Figure 20). This allows insertion of the copper into the junction area.



Figure 20 - Insulation Stripped from Power Leads

Insert the external power leads into the top of the circuit breaker and then fasten using a hex-style wrench (See Figure 21). Torque to 20 ft-lb (27.2 Nm)



Figure 21 - Fastening Power Leads

Fasten the grounding connection, adjacent to the external power connections located on the top of the left wall of the cabinet (See Figure 22).



Figure 22 - Ground Connection

OUTPUT POWER CONNECTION (REMOTE MOUNT)

Prepare the output power leads by stripping 0.5 to 1.0 inch (13 to 25 mm) of insulation from the ends of the power leads (See Figure 20).

The motor leads must be brought in from the top of the unit. Carefully remove the panel, which covers the motor lead entry point, by removing the screws. Wires may then be run into the interior of the cabinet. Be sure to leave enough relief in the leads so no undue stresses are transferred to the motor connection location in the interior of the unit. The attachment points are T1, T2, and T3. They are labeled in the body of the cabinet at the motor lead attachment points. Insert the stripped connectors and tighten with a small wrench. Connectors should not loosen when given a moderate tug by hand.

Remote mount units with power leads between 3-50 feet (1-15 meters) in length require installation of a dV/dt “snubber” filter between the Vyper™ and the motor to ensure a clean power signal into the motor.

OUTPUT POWER CONNECTION (PACKAGE MOUNT)

Package-mounted Vyper™ drives have a different output configuration than the remote-mount Vyper™. The Package-mounted Vyper™ uses 3/8 inch (0.375 in.) terminal lugs for the output power connection to the compressor motor. Appropriate motor lead hardware should be used to make the connections and torqued to specifications listed in Table 11.

TABLE 11 – VYPER™ OUTPUT POWER LEAD TORQUE SPECIFICATIONS

Output Power Lead Torque Requirement (Package-Mounted Vyper™)		
Connector Size	Termination	Torque
3/8" lug	Compression	216-240 in.-lb

The output power attachment lugs are labeled “T1”, “T2”, and “T3” are located on the inside right rear wall of the Vyper™ cabinet (See Figure 23).

The power wiring emerges from the rectangular cutout on the rear wall of the Vyper™ cabinet (See Figure 23). These connections are made in the factory and will be pretested before shipment. For proper installation, connect an appropriate conduit to the back cutout flange of the cabinet.



Figure 23 - Vyper™ Output Power Terminal Connection Lugs

VYPER™ WIRING AND WIRING DIAGRAMS

Figures 24 through 29 provide the wiring terminations for the Frick Vyper™ Drive. These drawings illustrate the necessary connections required to install the unit.

Always refer to the wiring diagrams included inside the Vyper™ cabinet to ensure the unit is wired following the most up-to-date version of the wiring diagram.

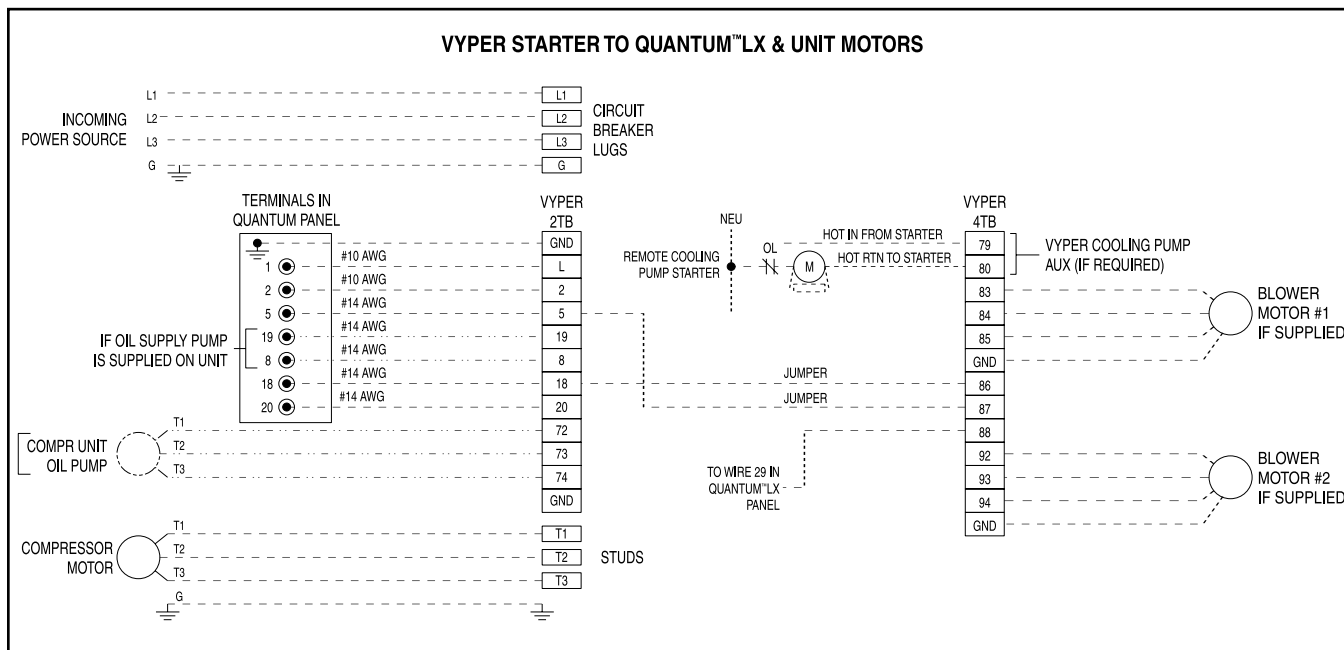


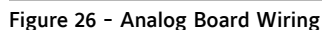
Figure 24 - Vyper™ Starter, Motor, Blower, and Quantum Wiring

QUANTUM™LX COMMUNICATIONS WIRING

Figure 25 shows the junction points for the Quantum™LX panel control wiring into the Vyper™ cabinet. This wiring location is in the lower left corner of the Vyper™ cabinet. The control wiring enters the Vyper™ cabinet from the left side cabinet wall through a connection port.



Figure 25 - Quantum™ LX Communications Terminal Block



MOTOR THERMAL PROTECTION OPTIONS

The National Electrical Code (NEC) requires thermal protection for motors operating with variable-speed drive systems.

Frick employs two types of thermal protection for motors. One method uses thermistors, and one method uses RTDs. Figures 27 and 28 show the wiring schematics for both options.

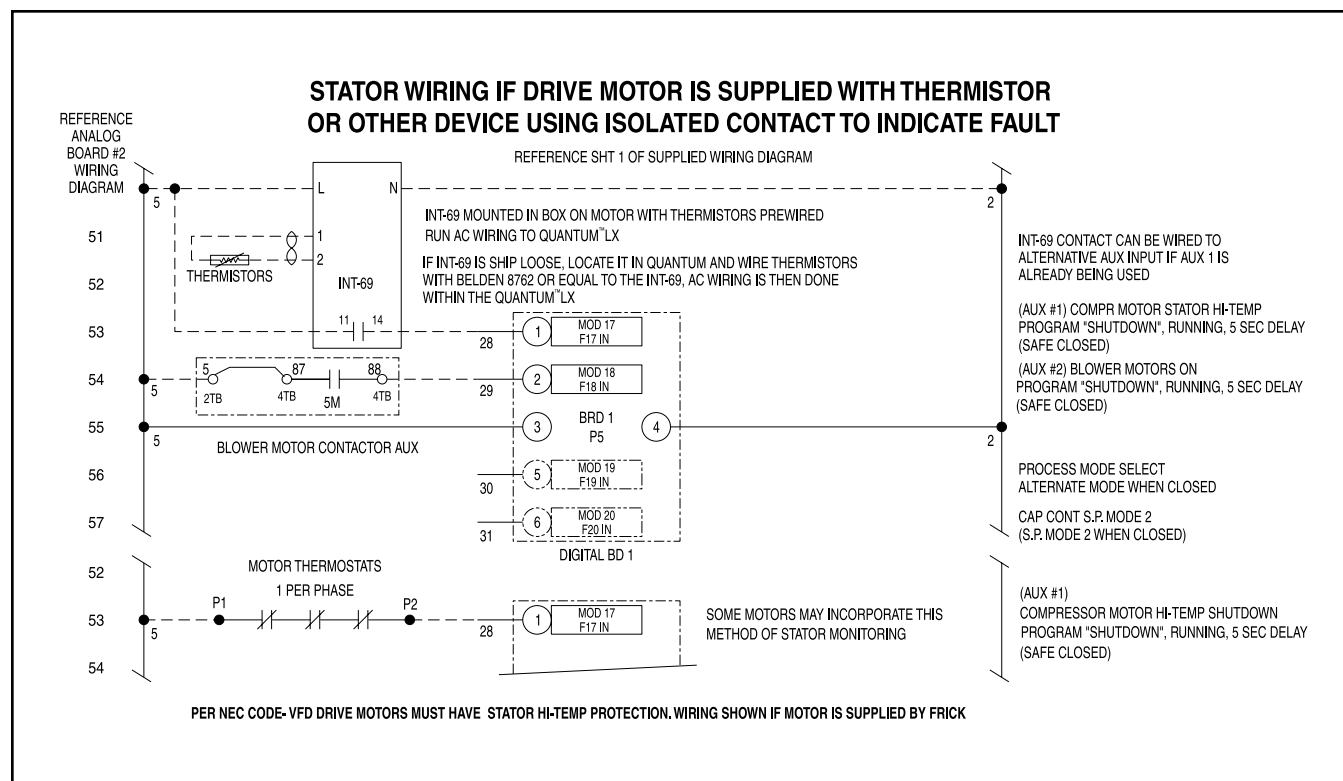


Figure 28 - Thermistor Motor Protection Wiring

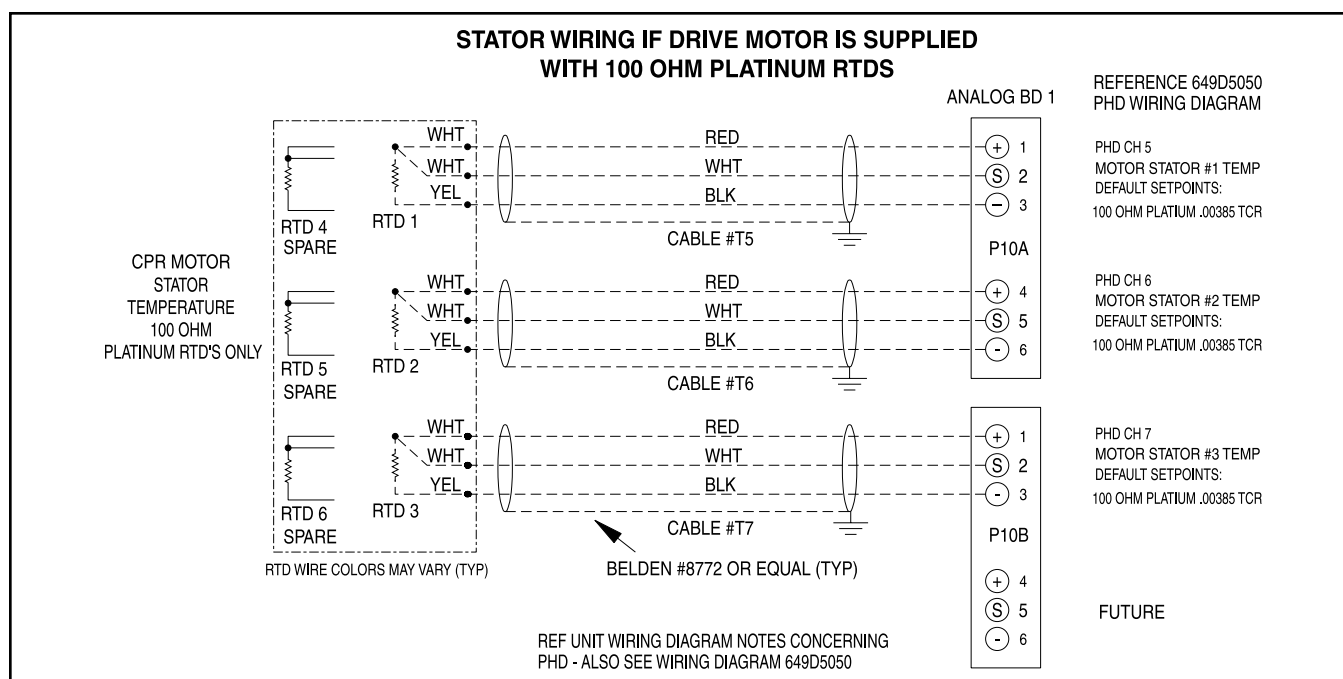


Figure 29 - RTD Motor Protection Wiring

VYPER™ PRE-OPERATION SITE CHECKLIST

Prior to Quantum™ LX setup and starting operation of the Vyper™ Drive system, review the following checklist to ensure all installation requirements are met. (Where Applicable)

- ☐ Verify that the primary water or glycol coolant supply is connected to the heat exchanger at the recommended flow and temperature recommendations.
- ☐ Drain the shipping coolant from Vyper™ and properly dispose. Replace with running coolant (pink) and purge air from the cooling system. Refer to the "Adding and Replacing Coolant" portion of this manual.
- ☐ Verify that the package temperature sensors are RFI suppression type (639A0151G01)
- ☐ Environment:
 - a. Cleanliness. Keep construction debris out of the cabinet
 - b. Confirm operation of internal cooling fans.
 - c. Confirm operation of coolant pump.
 - d. Confirm wiring and operation of the motor blower fans if present.
- ☐ Mounting:
 - a. Verify that the Vyper™ Drive is properly mounted: to the floor or wall for remote mounts or to the package for package-mounted units.
 - b. Verify that the Vyper™ power leads running to the motor do not exceed 50 ft (15 m) long.
- ☐ Wiring
 - a. Verify control wiring has been connected from the Quantum™ LX panel to the Vyper™ in accordance with the engineering drawings for the specific installation.
 - b. Verify power wiring has been connected at the correct connection points and properly seated in accordance with the provided engineering drawings for the specific installation.
 - c. Separate grounded metal conduits must be provided for input power, output power, and control wiring. Failure to provide separate conduits could result in disruption of other electrical devices due to harmonics and RFI/EMI generated in the drive.
 - d. Wiring from the drive to the motor be enclosed in a grounded metal conduit even if poured in a concrete floor. PVC conduit is NOT allowed.
 - e. Bond all conduit to the cabinet.
 - f. Use the conduit knockouts provided. Avoid metal shavings in the drive enclosure.
 - g. Clean out all debris with a low power magnet or a vacuum cleaner.
 - h. Protect signal wires from noise. Use shielded and properly grounded control wires. Noisy input signals will cause erratic drive operation.
- ☐ Apply power to the Vyper™ Drive system.
 - a. Verify no problems exist with the boot-up of the Quantum™ LX panel and control system.
 - b. Verify no problems exist with the unit power supply connections.
 - c. Set up the Quantum™ LX panel in accordance with job site requirements. Refer to "Quantum™ LX Panel Setup" in the "Operation" portion of this manual.
 - d. Set the FLA rating on the Vyper™ Logic board as per job site requirements.
 - e. Confirm dipswitches on the Vyper™ Logic Board are properly set. Refer to the "VSD Logic Board Setup" section found later in this manual.

BLOWER MOTOR ROTATION

The Blower Motor rotation is marked on the blower assembly and is to be such that the blower draws into the assembly through the screen and pushes down and through the motor. See Figures 30 and 30a.



Figure 30 - RTD Motor Protection Wiring



Figure 30a - RTD Motor Protection Wiring

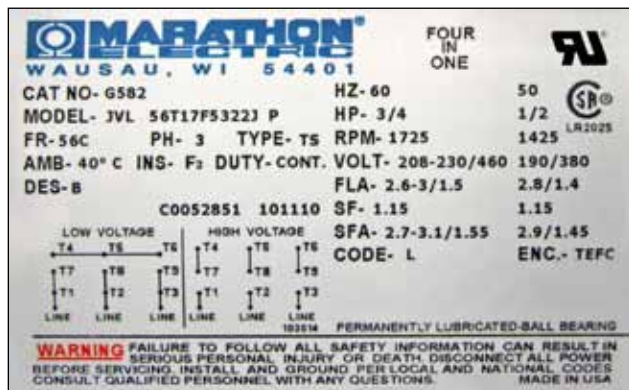


Figure 31 - Blower Motor Nameplate

COOLANT CONTAMINATION AND PROPERTIES

Drive coolant comes packaged in 1-gallon containers.

The coolant is premixed and should not be diluted.

The drive coolant is pink color but may become clear over time. Although the coolant may become clear, the nitrate inhibitor is still effective.

The coolant volume varies by the size of the drive. The 700 HP drive requires 3 gallons and the 912 HP requires 4 gallons.

Coolant part number is 639A0211H36.

The coolant consists of distilled water containing a nitrite inhibitor which has the same heat-transfer characteristics as water.

The nitrite inhibitor is designed to reduce the corrosion effect on the aluminum surfaces in the cooling circuit and helps to prevent galvanic action from taking place between dissimilar metals.

The coolant is not intended to be an antifreeze and will not prevent freezing at low temperatures.

The coolant should be inspected regularly and replaced annually.

Should it be necessary to remove the coolant from any reason, such as equipment repair, discard the old coolant and replace with new.

If the color of the coolant turns a brown or green, this indicates that a bacteria growth is taking place within the coolant. If the coolant turns milky white, or if the inside of the tubing has a white coating, the nitrate concentration has fallen below 990 ppm. This is an indication that the nitrate is corroding the inner surfaces of the cooling system and oxidizing the aluminum. If any of these conditions exist:

1. Drain the coolant and blow the system out with compressed air.
2. Flush the coolant system out thoroughly with water.
3. Fill the coolant loop with ethylene glycol (not Propylene glycol).
4. Circulate the ethylene glycol for approximately one hour.
5. Drain the ethylene glycol and refill the coolant loop with York coolant.

Pulling P2 and J2 on the control logic board will run the circulation pump which will help to remove air during the filling process.

6. Check the coolant system again in two weeks to ensure the biological growth or oxidization does not return.

ADDING AND REPLACING COOLANT

CAUTION

Irritant! Coolant is an irritant. Always wear eye protection when servicing the Vyper™ cooling system. Failure to do so may result in serious personal injury.

CAUTION

The shipping fluid must be drained from the Vyper™ cooling system at installation of drive and replaced with new system running coolant, shipped with unit. Failure to do so may result in damage to the Vyper™ cooling system.

NOTE: Follow all Environmental Protection Agency (EPA) and local guidelines for disposal of the Vyper™ shipping fluid and coolant.

NOTE: As part of preventative maintenance and for proper operation, replace the coolant in the cooling system once per year. Order Part# 639A0211H36, Qty 3 Required.

The Vyper™ is shipped from the factory with a premixed shipping fluid containing a rust inhibitor that prevents corrosion of the internal cooling passages. The shipping fluid also helps to keep the internal passages free from contaminants. The illustration in Figure 32 shows the cooling circuit of a remote-mounted water-cooled Vyper™. The cooling circuit for the glycol-cooled version is identical.



Figure 32 - Coolant Circulation System

Prior to starting the Vyper™ for the first time, drain and replace the shipping fluid from the Vyper™ cooling system with new running coolant appropriate for the type of system the Vyper™ is equipped with. Perform the steps in the following procedure to replace or add coolant to the system.

Step 1: (See Figure 33) Disconnect power from the VSD. Remove the pipe plug from the top of the exit manifold with an adjustable wrench. This allows air to enter the system and displace the fluid during draining.



Figure 33 - Removing the Cooling System Pipe Plug

Step 2: (See Figure 34) Connect a hose fitting to the drain of the heat exchanger. Be sure that the hose is connected tightly to the drain fitting so no fluid is spilled.



Figure 34 - Hose connected to the Heat Exchanger Drain

Step 3: (See Figure 35) Open the drain valve and allow the fluid to drain from the loop. Catch buckets should be able to hold approximately 4 gallons of liquid.



Figure 35 - Draining Coolant

Step 4: (Figure 36) Close the drain valve and refill the cooling system with the new coolant.



Figure 36 - Refilling the Cooling System

Step 5: (Figure 37) Apply power to the VSD unit and locate the Logic Board found on the inside of the cabinet. Unplug J2, which will manually power the cooling pump to run and circulate the coolant throughout the system. Allow the pump to run (at least 5 minutes) until all trapped air is purged from the coolant system.



Figure 37 - VSD Logic Board Connection J2

Step 6: (Figure 38) Top off the cooling system until the fluid level remains constant about one inch (25 mm) from the top of the manifold.



Figure 38 - Topping Off the Coolant Supply

Step 7: (Figure 39) Replace and tighten the plug on the top of the manifold using an adjustable wrench.



Figure 39 - Installing the Cooling System Pipe Plug

Step 8: (Figure 40) Insert plug J2 into the logic board to stop the coolant pump.



Figure 40 - VSD Logic Board Connection J2

OPERATION



Do not attempt to operate the Vyper™ Drive before performing proper setup the Frick Quantum™LX control panel.

Failure to do so may result in damage to the unit.

QUANTUM™LX CONTROL PANEL

This section is provided to briefly familiarize the operator with the user interface of the Frick Quantum™LX control panel. Frick document: **090-022 0, "OPERATION – SERVICE, FRICK® QUANTUM™LX COMPRESSOR CONTROL PANEL"** provides detailed information about operation and settings of the Quantum™LX Control Panel.

VYPER™ OPERATION

Relying on user input as well as system pressures and temperatures, the Quantum™LX directs the Vyper™ to start or stop the compressor as well as change the compressor's speed to regulate capacity. The setpoints that primarily control the operation of the Vyper are found on the Quantum™LX's Capacity Control Setpoints and Motor Setpoints Screens.

When the operator initiates a system start command (locally or remotely), the Quantum™LX sends a signal to the Vyper™ to operate the motor. When the Vyper™ receives this command, the Vyper™ begins a precharge process and prepares to start the motor. During the precharge process the cooling pump is switched on and the DC link voltage is slowly increased. After approximately thirty (30) seconds, the Vyper™ turns on the motor and ramps up to the speed set by the VFD "Minimum Drive Output" setpoint. Simultaneously, if the slide valve is below the Variable Speed Minimum Slide Valve Position, the Quantum™LX immediately loads the slide valve to the programmed "Variable Speed Minimum Slide Valve Position" setpoint.

As more capacity is required, the Quantum™LX loads the slide valve. The "Capacity Control" settings (on the Motor Setpoints Screen) can be configured to cause the motor speed to increase at the same time, but in most Vyper™ applications the capacity control "Drive Speed" setpoint is set to match the "Minimum Drive Output" setpoint. In this configuration, the motor speed will remain at its minimum speed until the slide valve loads above the capacity control "Slide Valve" setpoint. If the slide valve cannot load due to a slide valve load inhibit condition or because the compressor cannot build differential pressure, particularly between suction and oil pressure, the motor speed will increase to meet the capacity requirement.

When the slide valve reaches the capacity control "Slide Valve" setpoint, the motor speed can then increase. At this point the slide valve and motor speed continue to increase independently of one another until the capacity requirement is met or the maximum values are reached. If the compressor is in "AUTO" mode, the motor speed is controlled by the "VFD Proportional Band" and "VFD Integration Time" setpoints.

If less capacity is required, the Quantum™LX will first decrease the motor speed. The motor speed is allowed to drop as low as the capacity control "Drive Speed" setpoint. When the motor speed reaches this point, depending on the Quantum™LX's configuration, the slide valve may unload or the Quantum™LX may stop the compressor. If the slide valve is permitted to unload, the slide valve will not unload below the "Variable Speed Minimum Slide Valve Position" setpoint while the compressor is running.

When the Quantum™LX turns off the compressor, the control panel initially keeps the Vyper™ in "STANDBY" mode. In this mode, the drive's DC Link remains energized so that when the Quantum™LX sends a start command to the Vyper™, the compressor starts immediately. The Quantum™LX panel holds the Vyper™ in "STANDBY" mode for up to two (2) hours after the compressor shuts down. If this standby period passes without the compressor turning on, the Vyper™ then switches from Standby to "OFF".

When the Vyper™ enters "OFF" mode, the DC Link is de-energized and the Vyper™ will have to go through the thirty (30) second precharge prior to restarting the compressor. The current Vyper™ Operating Mode is displayed on the Vyper™ Status Screen. To allow the compressor to restart quickly, the control panel's Recycle Delay is disabled. When controlled by the Vyper™, the compressor can be started multiple times in a short period of time without causing damage to the motor.

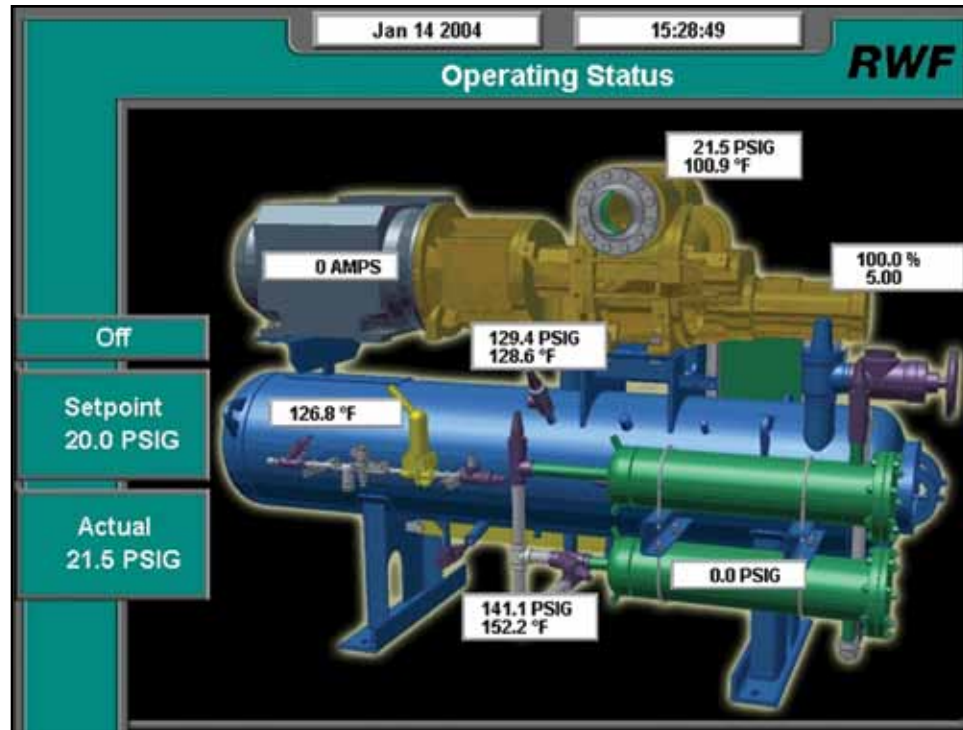


Figure 41 - Quantum™LX Operating Status Screen

QUANTUM™LX PANEL SETUP

The Quantum™LX software provides the necessary controls to operate Vyper™ Drive and optional Harmonic Filter on Frick screw compressors. This is accomplished through the reception of a Speed Command value (in rotations per minute), Run Command signal from the Quantum™LX control panel to the compressor motor.

The Quantum™LX control panel software will monitor motor current values, system operating parameters, and fault flags received from the Vyper™ Drive to determine whether the drive is operating safely. Any faults detected by the software will result in an immediate shutdown of the compressor. The specific fault information will then be displayed on the control panel.

Additionally, the Quantum™LX control panel will control the Vyper™ Drive and compressor to the user-defined parameters programmed at the control panel interface.

ACCESSING THE VYPER™ SETUP

Specific options and setpoints must be configured at the Quantum™LX control panel. These settings will provide the Quantum™LX with the necessary information to safely control the Vyper™ Drive, and to shut the drive down in the event the drive exceeds setpoint parameters.

The panel stores programmed setpoints into the panel memory, however when first applying power to the panel, all setpoints will be at default levels. The setpoints require programming in order to operate the system properly.

The following paragraphs provide a step by step procedure to properly set up the Quantum™LX control panel for operation. Figure 41 shows the Operating Status Screen, which is displayed when power is applied to the Quantum™LX panel.

SETTING USER LEVEL

Step 1: (See Figure 42) Set the User Level. Advance to the Session Screen by pressing the panel [Menu] key and then using the cursor arrow keys to select "Session" under the

pull-down menu. Use the keypad to enter Service Level 2 under the "User Level" Parameter on the Session Screen. Use the keypad to enter the password for User Level 2.



Figure 42 - Quantum™LX Session Screen

Step 2: (See Figure 43) Once the User Level is programmed, press the panel [Enter] and [Submit] keys to return to the Operating Status Screen. As shown in Figure 42, the Operating Status Screen now shows additional information.

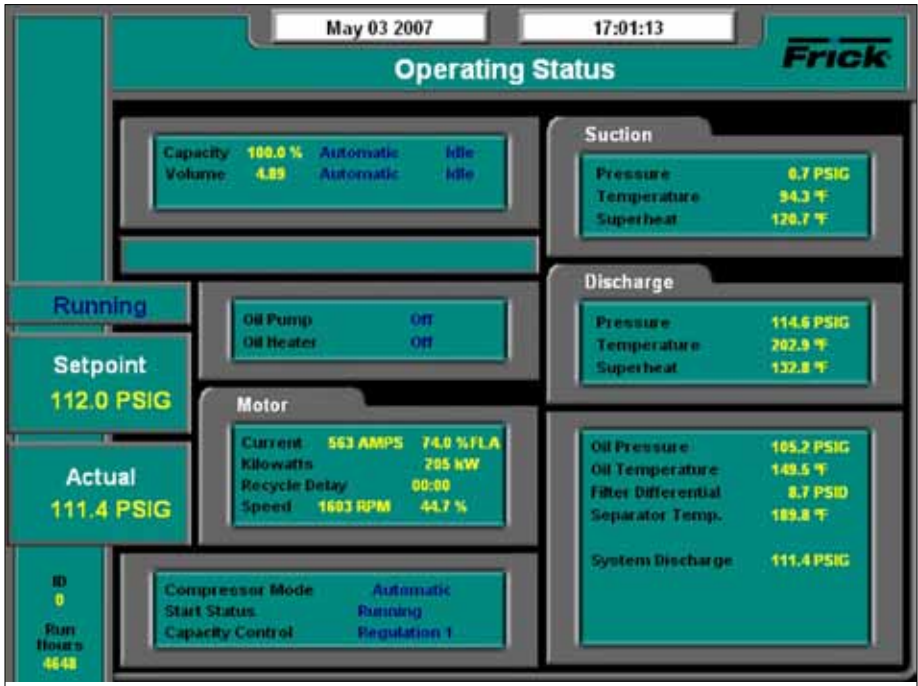


Figure 43 - Quantum™LX Operating Status Screen

CONFIGURING COMPRESSOR OPERATION

Step 1: (See Figure 44) Verify the Vyper™ Drive is set to be controlled by the Quantum™ LX panel. Press the [Menu] key and select “Configuration” at the pull-down. Select “Compressor” and then “Configuration” once again from the menu pull-down. This accesses the compressor Configuration Screen.

Step 2: (See Figure 44) Program the date, time, and select the capacity regulations and miscellaneous setpoints, as necessary using the cursor arrow and [Tab] keys to move around the screen to each setpoint. Press the [Enter] key to accept the new value for each setpoint.

Step 3: (See Figure 44) At the “Drive” field under the Package heading, verify the compressor with Vyper™ is programmed (See Callout 1). This allows control of the Vyper™ Drive as well as enables Vyper™-specific screens to be displayed on the control panel.

Step 4: Press the [Submit] key to accept changes and return to the Operating Status Screen.

The screenshot shows the Frick Quantum LX Compressor Configuration Screen. At the top, the date is May 04 2007 and the time is 09:15:30. The status is Running, with a Setpoint of 112.0 PSIG and Actual of 111.9 PSIG. The screen is divided into several sections: Date (Month: 5, Day: 4, Year: 2007), Time (Hour: 9, Minutes: 15), Capacity (Regulation 1: Enabled, Regulation 2: Enabled, Regulation 3: Disabled, Regulation 4: Disabled), Channel (System Disct, Discharge Pt), Direction (Reverse, Reverse), Miscellaneous (Sequencing: Disabled, Condenser: Disabled, Screen Saver: 15 MIN), Package (Compressor: RWF, Pump: Demand, Dual Pump: Disabled, Drive: Screw Compressor With Vyper (RAM), Refrigerant: R717, Filter: Filter Transducer, powerPAC: No), and K Factor (1.30). A callout '1' points to the 'Drive' field.

Figure 44 - Quantum™LX Compressor Configuration Screen

PROGRAMMING VYPER™ / QUANTUM™LX COMMUNICATIONS

Step 1: (See Figure 45) The communication rate between the Vyper™ and the Quantum™LX requires programming. Advance to the Communications Screen by pressing the [MENU] key and then selecting "Setpoints" and "Communications".

Step 2: (See Figure 45) Use the cursor arrow and [Tab] keys to navigate between setpoints. Use the keypad to program the parameters listed in Table 12 under "Comm1" (Callout 1) at the Communications Screen. Press the [Enter] key to accept each setpoint.

TABLE 12 – COMM1 SETPOINTS

Comm 1 Parameter	Setpoint
Baud Rate	19200
Data Bits	8
Stop Bits	1
Parity	None
RS-485 Connection	No
Protocol	Vyper
Map File	No

Step 3: Press the [Submit] key to accept the changes to Comm1 and return to the operating status screen.

PROGRAMMING PID SETUP



Figure 45 - Communications Screen

Step 1: (See Figure 46) The PID Setup Screen requires programming so that the Quantum™LX panel will control the cooling system for the Vyper™ Drive. Advance to the PID Setpoints Screen by pressing the [MENU] key and then selecting "Setpoints", "PID Setup", and "Page 2" .

Step 2: (See Figure 46) Use the cursor arrow and [Tab] keys to navigate between setpoints. With the keypad, program the parameters listed in Table 13 under "PID #5" on the PID Setup Screen. Press the [Enter] key to accept each setpoint.

TABLE 13 – PID CHANNEL #5 SETPOINTS

PID Parameter	Value
Name	Drive Cooling
Control	Running
Action	Forward
Control Point	Vyper™Coolant*
Device Source	Analog Board 2
Device Channel	1
Setpoint	100°F
Dead Band	0.0°F
Proportional Band	20°F
Integration Time	30
High Limit	100%
Low Limit	0%
When Running OFF Value	0%

Step 3: Press the [Submit] key to accept the changes to PID Channel 5 and return to the operating status screen.

RWFI		Feb 09 2009 14:16:09		Running	
PID Setup		Page 2		Setpoint	Actual
		108.0 PSIG		107.6 PSIG	
Name	Vyper Cooling	PID #6	PID #7	PID #8	
Control	Running	Disabled	Disabled	Disabled	
Action	Forward	Forward	Forward	Forward	
Control Point	Vyper Coolant	Capacity Slid	Capacity Slid	Capacity Slid	
IO Board	Analog Board	None	None	None	
Output Channel	1	0	0	0	
Output	15.4 %	0.0 %	0.0 %	0.0 %	
Actual	111.0 °F	100.0 %	100.0 %	100.0 %	
Setpoint	110.0 °F	0	0	0	
Proportional Band	30.0 °F	0	0	0	
Integration Time	30 SEC	30 SEC	30 SEC	30 SEC	
High Limit	100.0 %	100.0 %	100.0 %	100.0 %	
Low Limit	0.0 %	0.0 %	0.0 %	0.0 %	
When Running Off Value	0.0 %	0.0 %	0.0 %	0.0 %	

Figure 46 – PID Setup Screen (Page 2)

THE VYPER™ AND HARMONIC FILTER SCREENS

Step 1: (See Figure 47) Advance to the Vyper™ Screen by pressing the [MENU] key and then selecting "Setpoints" and "Operating Values" using the down cursor arrow key.

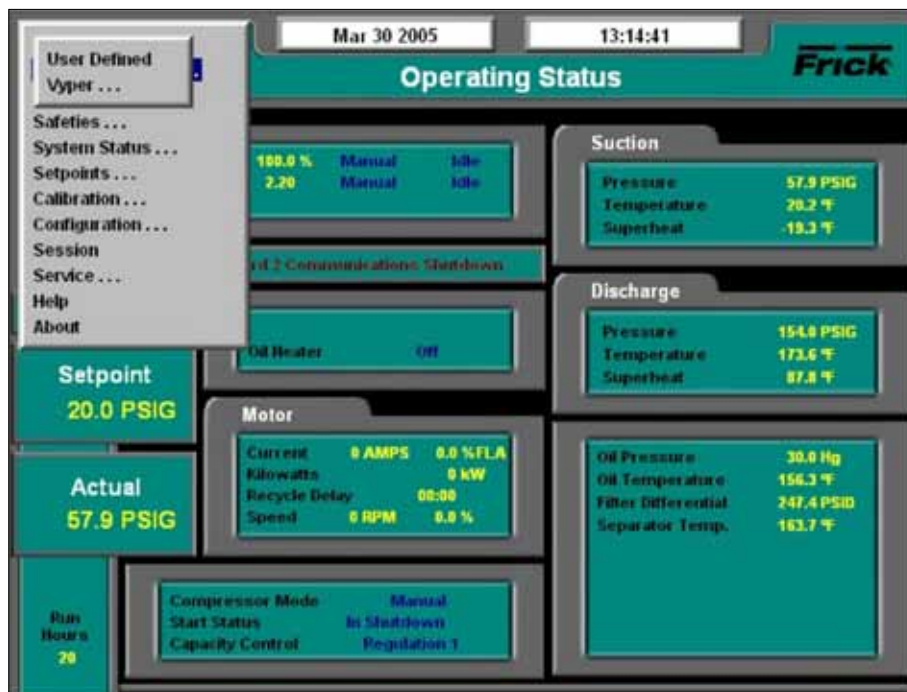


Figure 47 - Operating Values Menu

Step 2: (See Figure 48) The "Operating Values" menu allows the operator to select the "Vyper" or "Harmonic Filter" Screen. Select "Vyper" or "Harmonic Filter" and press the [Enter] key. The display will show values accessible under User Level 2.

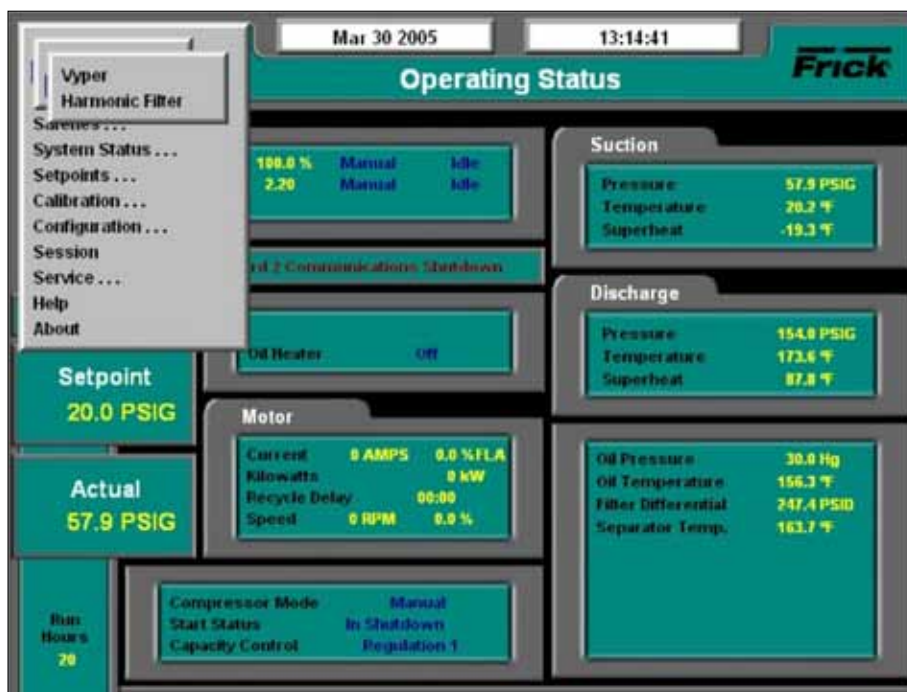


Figure 48 - Pulldown for Vyper Screen

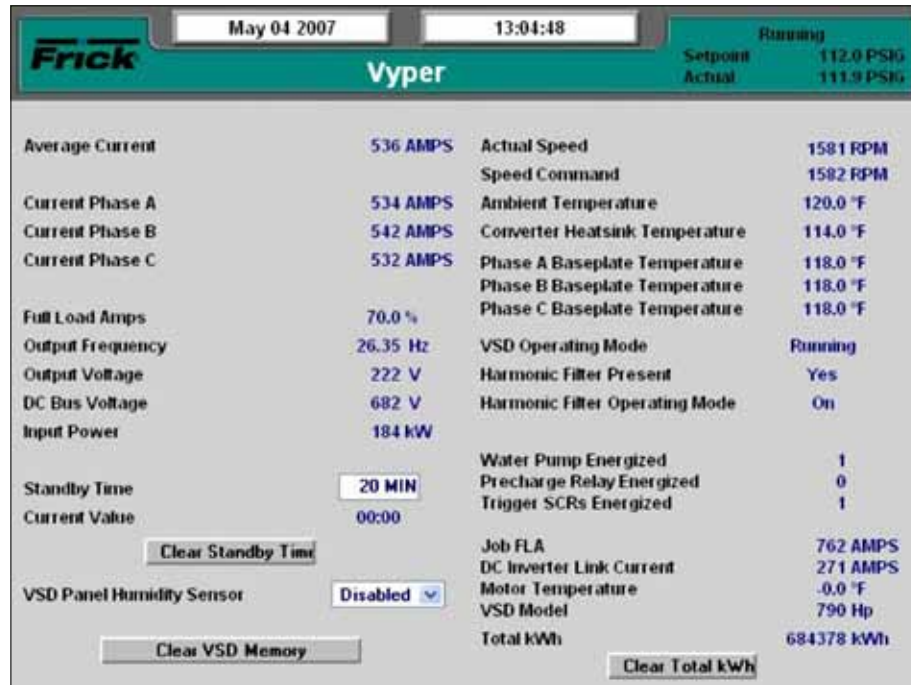


Figure 49 - Vyper™ Screen

VYPER SCREEN SETPOINTS

The Vyper™ Screen (See Figure 49) contains setpoints and information pertinent to the operation of the Vyper™ such as internal currents, voltages, and temperatures. This screen also gives detailed information on some external equipment such as the circulation pump and the motor temperature.

The Service Level 2 Vyper™ Screen is similar to Level 1, but adds the capability of adjusting several setpoints, as follows:

Standby Time: The VSD enters Standby mode when there is no load on the VSD. The VSD capacitor banks remain charged and the compressor output is 0 Hz. Standby mode permits fast acceleration when the load returns. If the time of zero load surpasses the Standby Time setting, the VSD will need to go through a restart sequence. The values for Standby mode can be set from 20 to 120 minutes.

Clear Standby Time: This option can be pressed to clear the Standby time value from the VSD if not desired.

Clear VSD Memory: Clear the existing trending values in the Vyper™ memory.

Clear Total kWh: This function clears the accumulated kWh totals from the counter since the last reset. The value returns to zero upon selecting this option.

The following Vyper™ screen parameters display measured values in accordance with the user defined unit selections.

- Average Current (Amps)
- Current Phase A (Amps)
- Current Phase B (Amps)
- Current Phase C (Amps)
- Full Load Amps (%)
- Output Frequency (Hz)
- Output Voltage (Volts)
- DC Bus Voltage (Volts)
- Input Power (kW)

- Current Value Timer (Min:Sec)
- Actual Speed (RPM)
- Speed Command (RPM)
- Ambient Temperature (°F or °C)
- Converter Heatsink Temp (°F or °C)
- Baseplate Temperature (°F or °C)
- Job FLA (Amps)
- DC Inverter Link Current (Amps)
- Motor Temperature (°F or °C)
- VSD Model (305 or 435)
- Total kWh (kWh)

The status of the following parameters are indicated using a binary number next to the field description. Table 14 describes the status of the parameter indicator.

TABLE 14 – BINARY PARAMETER INDICATOR STATUS

Indicator	Status
"0"	no /off
"1"	yes / on

- VSD Operating Mode
- Harmonic Filter Present
- Harmonic Filter Operating Mode
- Water Pump Energized
- Precharge Relay Energized
- Trigger SCRs Energized

NOTE: Repetitive/Unexplained Vyper Cutouts - For repetitive or unexplained cutouts, tab to the [Clear Standby Time] button and clear by pressing the enter button. Repeat that process to also clear the [Clear VSD Memory] and [Clear Total KWH] buttons.

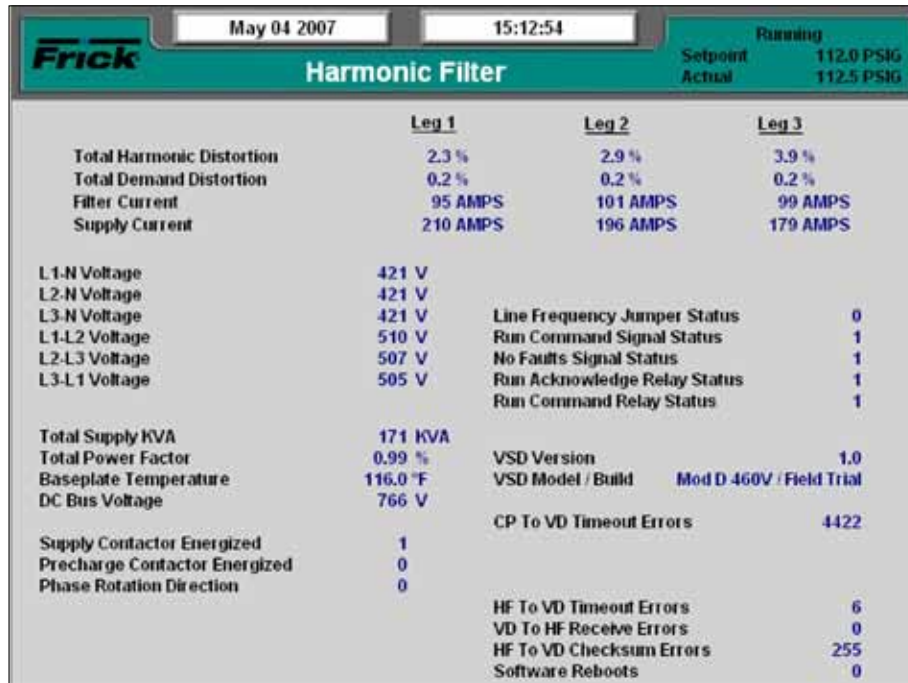


Figure 50 - Harmonic Filter Screen

HARMONIC FILTER SCREEN

The Harmonic Filter screen (See Figure 50) shows important aspects of the IEEE519 Harmonic Filter in action. In addition to current and voltage information the Harmonic Filter Screen also provides the important measure of current Total Harmonic Distortion (THD).

All IEEE 519 Harmonic filter parameters are displayed on this page. This information is useful to obtain the status, operating conditions and diagnostic information for the Harmonic Filter.

The following parameters display a real value based on the displayed units:

- Total Harmonic Distortion Leg,1,2,3 (%)
- Total Demand Distortion Leg 1,2,3 (%)
- Filter Current Leg 1,2,3 (Amps)
- Supply Current Leg 1,2,3 (Amps)
- Voltages L1-N, L2-N, L3-N,
- L1-L2, L2-L3, L3-L1 (Voltage)
- Total Supply kVA (kVA)
- Total Power Factor (%)
- Baseplate Temperature (°F or °C)
- DC Bus Voltage (Volts)
- Manual Speed Switch Status (RPM)

The status of the following parameters are indicated using a binary number next to the field description (See Table 16).

- Supply Contactor Energized
- Precharge Contactor Energized
- Phase Rotation Direction (0-ABC, 1-CBA)
- Automanual Switch Status

- Line Frequency Jumper Status
- Run Command Signal Status
- No Faults Signal Status
- Run Acknowledge Relay Status
- Run Command Relay Status

The following parameters display a count or version in whole numbers.

- Interface Board Version
- VSD Version
- Modbus Node ID
- IB Transmit Errors
- CP to IB Timeout Errors
- VD to IB Timeout Errors
- IB to VD Receive Errors
- VD to IB Checksum Errors
- HF to IB Timeout Errors
- VD to HF Receive Errors
- HF to IB Checksum Errors
- Software reboots

PROGRAMMING THE MOTOR SCREEN

The various portions of the Motor Screen require programming in order to control the compressor motor and Vyper™. Some fields require calculations to program the proper setpoints. Advance to the Motor Screen by pressing the [MENU] key and then selecting "Setpoints" and "Drive". Program each section as follows:

Nameplate (See Figure 52)

Refer to the motor nameplate for the information to enter in fields of the Motor Screen "Nameplate" section. These fields are for reference only and are not setpoints that control operation.

Use the cursor arrow and [Tab] keys to navigate between setpoints. Use the keypad to program the specifications listed on the motor nameplate. Press the [Enter] key to accept the value for each field.

Low Motor Amps (See Figures 51 and 52)

Program each of the values for the "Low Motor Amps" as shown in Figure 51. These values may be altered in accordance with job requirements.

Use the cursor arrow and [Tab] keys to navigate between setpoints. Use the keypad to program the specifications listed on the motor nameplate. Press the [Enter] key to accept the value for each field.

Low Motor Amps

Shutdown	230 AMPS	Delay	30 SEC
Confirmed Running Motor Amps	25 AMPS		
Starting Motor Amps Ignore Period	5 SEC		

Figure 51 - Low Motor Amps

High Motor Amps (See Figures 52 and 53)

The setpoints in "High Motor Amps" section of the Motor Screen are critical to protect the compressor motor and drive from damage due to excessive current.

The operator calculates the values for these setpoints using the formulas in Tables 15 through 18.

Step 1: (See Table 15) Determine the "Applied Motor Full Load Amps (FLA)" to be used for High Motor Amp setpoints. Use the Service Factor listed on the motor nameplate to determine the Applied Motor FLA. Use the calculated value in Table 16.

TABLE 15 – APPLIED MOTOR FLA CALCULATION

"Applied Motor FLA" Calculation	
IF	USE
Service Factor = 1.0	Mtr Nameplate FLA / 1.15
Service Factor = 1.15	Mtr Nameplate FLA

Step 2: (See Table 16) There are several safety scenarios regarding the compressor motor and Vyper™ Drive. Perform the calculations in Table 16 to determine which strategy is applicable to the motor and Vyper™ Drive at the job site.

TABLE 16 – HIGH MOTOR AMPS SAFETY CALCULATION

Line	Parameter	Value
1	Applied Motor FLA (Table 15)	
2	Applied Service Factor	1.15
3	Multiply (Line 1 x Line 2)	
4	HP rating of Vyper Drive	
5	Vyper Amp Limit If Line 4 is 700/572 HP, value is 880 A If Line 4 is 912/752 HP, value is 1180 A	
6	Multiply Line 5 x 1.05	

Motor

15:41:07
May 04 2007

Name Plate

Motor Amps	471 AMPS
Motor Amps	662 AMPS
Volts	460
Service Factor	1.15
Horse Power	600
CT Factor	100

Recycle Delay: 20 MIN
Current Value: 00:00
Clear Recycle Delay

High Motor Amps

Load Inhibit	662 AMPS
Force Unload	635 AMPS
Warning	728 AMPS
Shutdown	761 AMPS

Low Motor Amps

Shutdown	230 AMPS	Delay	30 SEC
Confirmed Running Motor Amps	25 AMPS		
Starting Motor Amps Ignore Period	5 SEC		

VFD

Maximum Drive Output	100.0 %
Minimum Drive Output	20.0 %

Remote Control

Rate Of Increase	0.5 %	Delay	2 SEC
Rate Of Decrease	3.0 %	Delay	2 SEC

Capacity Control

The Drive Speed will increase and decrease proportionally with the Slide Valve*. When the Slide Valve* loads to 95.0 % the Drive Speed will reach 20.0 %

Above these setpoints the Drive Speed will be controlled by the Proportional Band and Integration Time while the Slide Valve* will operate independently.

*Slide Valve or other mechanical unloader

Variable Speed Minimum Slide Valve Position: 40.0 %
Note: Slide Valve Range limited to protect compressor

Skip Frequency Bands

Bottom	Top
0.0 %	0.0 %
0.0 %	0.0 %
0.0 %	0.0 %
0.0 %	0.0 %
0.0 %	0.0 %

Figure 52 - Motor Screen

Step 3: (See Table 17 or 18) Use High Motor Amps Calculations Table A or B based on the following:

- If value of Line 3 is less than the value of Line 6, use Table A (Table 17) for amp calculations.
- If value of Line 3 is greater than value of Line 6, use Table B (Table 18) for amp calculations.

TABLE 17 – HIGH MOTOR AMP SETPOINT CALCULATIONS (TABLE A)

Table A - High Motor Amp Setpoint Calculations		
Parameter	Equation	Value
Load Inhibit	=Applied Motor FLA x 1.1	
Force Unload	=Applied Motor FLA x 1.12	
Warning	=Applied Motor FLA x 1.13	
Shutdown	=Applied Motor FLA x 1.15	

TABLE 18 – HIGH MOTOR AMP SETPOINT CALCULATIONS (TABLE B)

Table B - High Motor Amp Setpoint Calculations		
Parameter	Equation	Value
Load Inhibit	= Vyper Amp Limit x 0.97	
Force Unload	= Vyper Amp Limit	
Warning	= Vyper Amp Limit x 1.01	
Shutdown	= Vyper Amp Limit x 1.03	

Step 4: (See Figure 52) Program the calculated values for High Motor Amps. Set the delay for Warning and Shutdown setpoints for five (5) seconds. Refer to the examples provided as necessary.

Use the cursor arrow and [Tab] keys to navigate between setpoints. Use the keypad to program the setpoints as calculated. Press the [Enter] key to accept the value for each field.

Figure 53 - High Motor Amps

High Motor Amp Limit Examples

Example 1 (See Figures 56 and 57) What are the High Motor Amp setpoints if a 700 HP Vyper™ is to drive a motor with 1.15 SF and a 679 Amp FLA? Using these values, determine whether Table A or Table B should be used to calculate the setpoints.

Line	Parameter	Value
1	Applied Motor FLA	679 A
2	Applied Service Factor	1.15
3	Multiply (Line 1 x Line 2)	780 A
4	HP rating of Vyper Drive	700 HP
5	Vyper Amp Limit If Line 4 is 700/572 HP, value is 880 A If Line 4 is 912/752 HP, value is 1180 A	880 A
6	Multiply Line 5 x 1.05	924 A

Figure 54 - Ex.1 Motor Amps Safety Calculation Table

The value of Line 3 is 780 Amps; this is less than Line 6 Value of 924 Amps. Therefore, use Table A (Table 17) for High Motor Amp setpoint calculation. Refer to Figure 53 for the locations to enter calculated values.

Table A - High Motor Amp Setpoint Calculations		
Parameter	Equation	Value
Load Inhibit	=Applied Motor FLA x 1.1	858 A
Force Unload	=Applied Motor FLA x 1.12	873 A
Warning	=Applied Motor FLA x 1.13	881 A
Shutdown	=Applied Motor FLA x 1.15	897 A

Figure 55 - Ex. 1 Motor Amp Setpoint Calculations (Table A)

Example 2 (See Figures 56 and 57) What are the High Motor Amp setpoints if a 912 HP Vyper™ will drive a motor with 1.15 SF and a 1082 Amp FLA? Using these values, determine whether Table A or Table B should be used to calculate the setpoints.

Line	Parameter	Value
1	Applied Motor FLA	1082 A
2	Applied Service Factor	1.15
3	Multiply (Line 1 x Line 2)	1245 A
4	HP rating of Vyper Drive	912 HP
5	Vyper Amp Limit If Line 4 is 700/572 HP, value is 880 A If Line 4 is 912/752 HP, value is 1180 A	1180 A
6	Multiply Line 5 x 1.05	1239 A

Figure 56 - Ex. 2 Motor Amps Safety Calculation Table

The value of Line 3 is 1245 Amps; this is greater than Line 6 value of 1239 Amps. Therefore, use Table B (Table 18) for High Motor Amp setpoint calculation. Refer to Figure 53 for the locations to enter calculated values.

Table B - High Motor Amp Setpoint Calculations		
Parameter	Equation	Value
Load Inhibit	= Vyper Amp Limit x 0.97	1144 A
Force Unload	= Vyper Amp Limit	1180 A
Warning	= Vyper Amp Limit x 1.01	1191 A
Shutdown	= Vyper Amp Limit x 1.03	1215 A

Figure 57 - Ex.2 Motor Amp Setpoint Calculations (Table B)

Example 3 (See Figures 58 and 59) What are the High Motor Amp setpoints if a 700 HP Vyper is to drive a motor with 1.00 SF and a 679 Amp FLA? Using these values, determine whether Table A or Table B should be used to calculate the setpoints.

Motors with a 1.00 SF need to be derated by dividing the Nameplate FLA by 1.15 or an Applied motor FLA. This is calculated as shown:

$$\frac{679 \text{ Amps}}{1.15} = 590 \text{ Amps}$$

Line	Parameter	Value
1	Applied Motor FLA	590 A
2	Applied Service Factor	1.15
3	Multiply (Line 1 x Line 2)	679 A
4	HP rating of Vyper Drive	700 HP
5	Vyper Amp Limit If Line 4 is 700/572 HP, value is 880 A If Line 4 is 912/752 HP, value is 1180 A	880 A
6	Multiply Line 5 x 1.05	924 A

Figure 58 - Ex. 3 Motor Amps Safety Calculation Table

The value of Line 3 is 679 Amps; this is less than Line 6 Value of 924 Amps. Therefore, use Table A (Table 17) for High Motor Amp setpoint calculation. Refer to Figure 53 for the locations to enter calculated values.

Table A - High Motor Amp Setpoint Calculations		
Parameter	Equation	Value
Load Inhibit	=Applied Motor FLA x 1.1	747 A
Force Unload	=Applied Motor FLA x 1.12	760 A
Warning	=Applied Motor FLA x 1.13	767 A
Shutdown	=Applied Motor FLA x 1.15	780 A

Figure 59 - Ex. 3 Motor Amp Setpoint Calculations (Table A)

Example 4 (See Figures 60 and 61) What are the High Motor Amp setpoints if a 912 HP Vyper™ is to drive a motor with 1.00 SF and a 1245 A FLA? Using these values, determine whether Table A or Table B should be used to calculate the setpoints.

Motors with a 1.00 SF need to be derated by dividing the Nameplate FLA by 1.15 or an Applied motor FLA. This is calculated as shown:

$$\frac{1245 \text{ Amps}}{1.15} = 1082 \text{ Amps}$$

Line	Parameter	Value
1	Applied Motor FLA	1082 A
2	Applied Service Factor	1.15
3	Multiply (Line 1 x Line 2)	1245 A
4	HP rating of Vyper Drive	912 HP
5	Vyper Amp Limit If Line 4 is 700/572 HP, value is 880 A If Line 4 is 912/752 HP, value is 1180 A	1180 A
6	Multiply Line 5 x 1.05	1239 A

Figure 60 - Ex. 4 Motor Amps Safety Calculation Table

The value of Line 3 is 1245 Amps; this is greater than the Line 6 value of 1239 Amps. Therefore, use Table B (Table 18) for the calculation. Refer to Figure 53 for the locations to enter calculated values.

Table B - High Motor Amp Setpoint Calculations		
Parameter	Equation	Value
Load Inhibit	= Vyper Amp Limit x 0.97	1144 A
Force Unload	= Vyper Amp Limit	1180 A
Warning	= Vyper Amp Limit x 1.01	1191 A
Shutdown	= Vyper Amp Limit x 1.03	1215 A

Figure 61 - Ex. 4 Motor Amp Setpoint Calculations (Table B)

VFD Setpoints

(See Figures 52 and 62)

This section of the Motor Screen describes programmable parameters that regulate the loading and unloading response of the Vyper™ Variable Speed (Frequency) Drive (VFD). The speed limits of the motor control are set in this section of the page. There are various control strategies which are unique to specific industries. The following pages will show some suggestions that can be used as starting points. Specific applications may require additional adjustment.

VFD

Maximum Drive Output: 100.0 %

Minimum Drive Output: 20.0 %

Remote Control

Rate Of Increase: 0.5 %

Rate Of Decrease: 0.5 %

Delay: 2 SEC

Figure 62 - Motor Screen VFD Setpoints

Programming the Motor Screen VFD Setpoints - Setting the Motor Screen properly is critical to the optimal performance of the Vyper™.

The operator must understand how the Motor Screen VFD parameters affect the functionality of the Vyper™ unit. These setpoints affect the reaction speed of the VSD when accelerating and decelerating as well as affect the interaction between the codes and the slide valve.

Maximum Drive Output Speed - This parameter sets the limit for the highest allowable motor speed in terms of percentage. The maximum allowable setting is 100%, or full speed. Some applications may require the maximum motor speed to be limited. The Maximum Percentage parameter range can be set from 0 to 100%. However, Frick recommends that the Maximum percentage is always set to a higher value than the Minimum Percentage parameter setting.



Programming the Minimum Drive Output Speed to a setpoint lower than the minimum speed

recommended by the compressor motor may result in severe damage to the compressor motor.

Minimum Drive Output Speed - This parameter sets the lowest allowable percentage of motor speed at which the Vyper™ will permit the motor to run for an indeterminate period. The range on this function is 20 to 100%. The value of this parameter must always be set lower than the Maximum Percentage setting. The value of this setting is critical, as many electric motors are not designed for low speed operation due to temperature and lubrication requirements. Frick recommends that the manufacturer of the motor is contacted to determine if the design can be safely operated at the intended minimum speed.

Rate of Increase* - The Rate of Increase parameter setting determines the speed change step size at which the Vyper™ will accelerate the motor. The Rate of Change setting works in conjunction with the Cycle Time setting to provide variability in the desired speed change step rate. The Vyper™ has an internally set rate of acceleration of 6.08 Hz/sec. At setting values lower than 10%, a dwell time appears between acceleration steps due to an interaction between Vyper™ communications frequency, the Rate of Change and Cycle Time settings, and the maximum acceleration rate of 6.08 Hz/sec.

Rate of Decrease* - The Rate of Decrease setpoint determines the speed change step size at which the Vyper™ will decelerate the motor. The Rate of Decrease setting works in conjunction with the Cycle Time setting to provide variability in the desired speed change step rate. The Vyper™ has an internally set rate of deceleration of 6.08 Hz/sec. At setting values lower than 10%, a dwell time appears between deceleration steps due to an interaction between Vyper™ communications frequency, the Rate of Change, Cycle Time settings, and the maximum acceleration rate of 6.08 Hz/sec.

Rate of Increase Delay Time* - The Rate of Increase Delay Time setpoint is used in conjunction with the Rate of Increase setting to determine the acceleration response of the VSD acceleration rate step.

Rate of Decrease Delay Time* - The Rate of Decrease Delay Time setpoint is used in conjunction with the Rate of Decrease setting to determine the deceleration response of the VSD acceleration rate step.

* Utilized only when the motor speed is being controlled by a remote source such as a PLC.

Capacity Control Setpoints

(See Figures 52 and 63)

The Capacity Control setpoints work directly in conjunction with the VFD setpoints as the slide valve will be adjusted according to the speed of the Vyper™ Drive. The slide valve range of motion is limited by the Quantum™LX control panel.

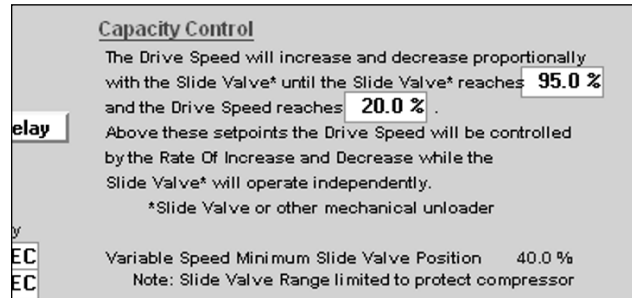


Figure 63 - Motor Screen Capacity Control Setpoints

Programming the Capacity Control Setpoints - Programming the Capacity Control Setpoints properly is critical to the optimal performance of the Vyper™.

The operator must understand how the Motor Screen Capacity Control parameters affect the functionality of the Vyper™ unit. These setpoints affect the capacity of the unit by changing the position of the slide valve as well as the interaction between the slide valve and motor speed.

Proportional Slide Valve Setpoint - This parameter sets the maximum slide valve percentage at which the Vyper™ operates under proportional capacity control in conjunction with speed change. Proportional control exists between this setpoint and the minimum slide valve position. This value must always be set less than 100%.

Proportional Speed Setpoint - This setpoint represents the maximum percentage of speed while under proportional control when used in conjunction with the slide valve. At speeds higher than this setpoint, the capacity is under total speed control. At values between this setpoint and the minimum speed setpoint, the compressor is under proportional control.

Minimum Slide Valve Position - This setting establishes the minimum Slide Valve position possible while the Frick screw compressor is running. At Minimum Drive Speed, this is the point at which no further mechanical unloading is allowed. This setpoint is programmed as a function of the chosen minimum drive speed. This setpoint is adjustable to higher minimum values but no lower than the default minimum. The default minimum is dependent of the minimum speed/output setpoint and is not user-programmable. The lower the minimum output setpoint is, the higher the minimum Slide Valve setpoint will be. When the minimum output is set to 20%, the minimum Slide Valve will be set to 40%.

VFD SKIP FREQUENCIES

Criteria for Identifying Elevated Energy on VFD Packages and Establishing "Skip" Frequencies

With the compressor package running loaded at full speed, the entire package must be physically checked for elevated energy, including any corresponding extremities such as valves, liquid injection piping, brackets, tubing, oil cooler and oil piping. The VFD speed is to be decreased by 100 rpm increments and the entire package physically checked for elevated energy at each stage until the minimum speed range is reached. As the high energy hot spots are identified, they are to be checked with a vibration meter and any readings that meet or exceed one inch per second must have that frequency range skipped in the microprocessor for the VFD, eliminating the ability of the package to operate within that frequency range. Each identified range needs to have the skip set to as narrow a frequency band as possible, only making it wider until full range is accommodated. Please also reference 070.902-1B for acceptable package vibration readings.

Skip frequencies should be reviewed and verified annually.

Suggested VFD and Capacity Control Settings

There are individual control strategies required for various industries. The Vyper™VFD and Capacity control settings provide versatility in meeting these individual needs. The following pages provide examples of some suggested control strategies and settings for individual industries. These are only suggestions. Specific applications may require further refinements of the control strategy.

NOTE: The operating range of the VSD is between 20% and 100% speed but the advantage of total speed control is only in effect between the Capacity Control Drive Speed setting and the Maximum Drive Output setting.

Capacity control can be achieved by adjustment of either the Slide Valve or the Motor Speed or a combination both. The full advantages of VSD control is obtained only by fixing the slide valve and modulating the capacity via Speed control.

The objective is to get the system into total speed control as quickly as possible and to maintain this strategy in the expected operating range. This is accomplished by the use of the proportional control ramp profile during the period that the slide valve is loading. This allows higher speeds and higher capacity during the period that slide valve is loading.

Figure 64 provides the VFD and Capacity Control setpoints typical for operation.

VFD		
Maximum Drive Output	100%	Delay
Minimum Drive Output	20 %	
Rate of Increase	%	
Rate of Decrease	%	
Capacity Control		
The Drive Speed will increase and decrease proportionally with the Slide Valve* until the Slide Valve* reaches 98 % and the Drive Speed reaches 75 %		
Above these setpoints, the Drive Speed will be controlled by the Rate Of Increase and Decrease while the Slide Valve* will operate independently.		
*Slide Valve or other mechanical unloader		
Variable Speed Minimum Slide Valve Position		40.0%

Figure 64 - Example 1 VFD and Capacity Control Setpoints

Example 1 - Suggested Control Strategy for 5 to 1 (5:1) Turndown

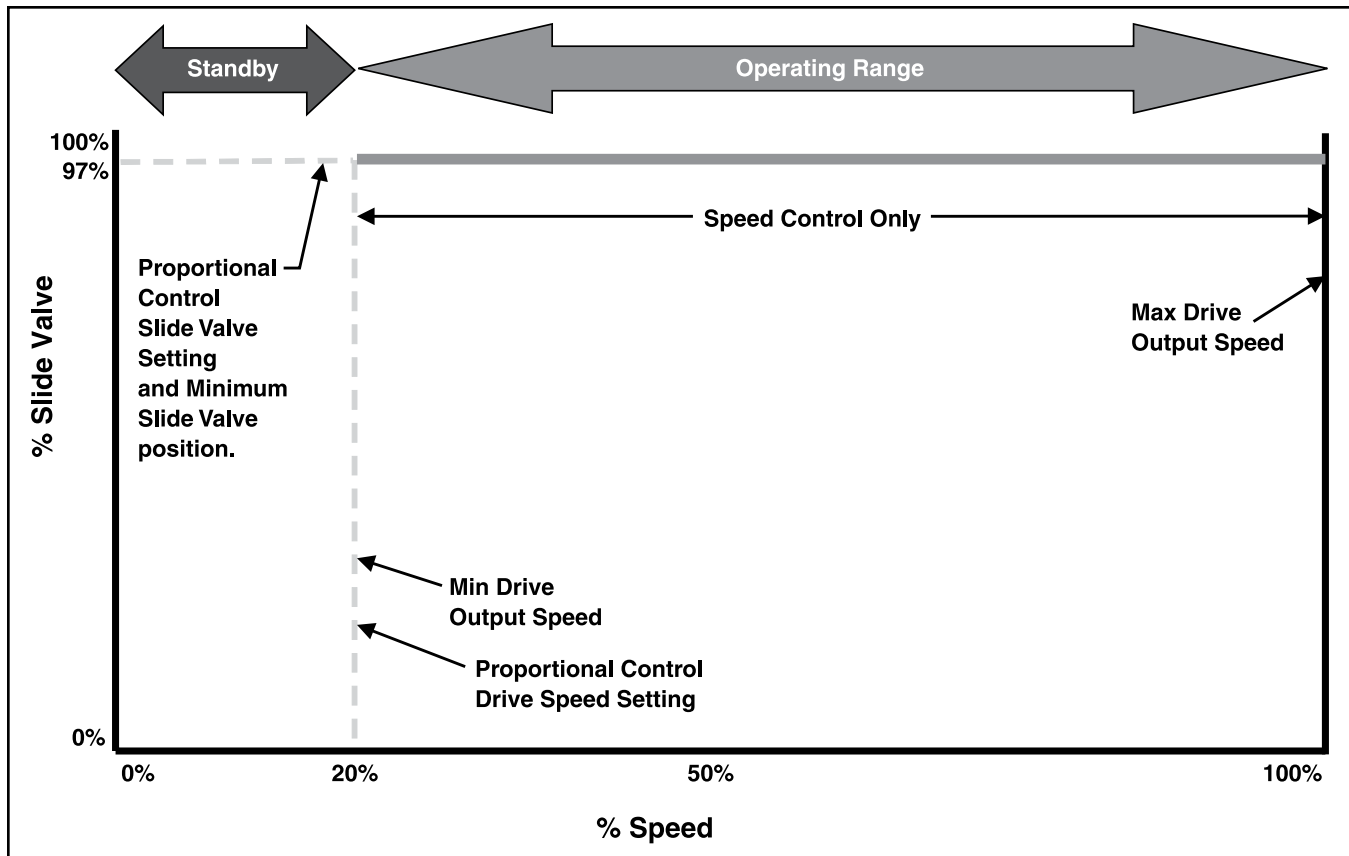


Figure 65 - 5:1 Turndown Suggested Control Strategy

Example 1 (Figure 65) depicts the 5 to 1 (5:1) control strategy, which is characterized by rapid response to highly dynamic load fluctuations. A quick start-up from zero load condition is also required. As shown in Figure 64, this is accomplished by programming total speed control over the entire operational speed range. There is little or no proportional control present for this setting. The slide valve remains loaded throughout the range of operation. Capacity is totally controlled by motor speed.

Often, the Vyper™ controlled screw compressor is used as a trim compressor, handling the fluctuating portion of the load while used in combination with other reciprocating compressors for the base load. This allows the required quick response and also prevents the rapid cycling on and off of the other compressors in the system.

Some additional Vyper™ features require programming in order create the rapid response envelope needed for 5 to 1 turndown applications. The Variable Speed Minimum Slide Valve Position is a factory default and is related to the Minimum Drive Output setting. However, an additional control feature is needed to override the Variable Speed Minimum Slide Valve Position setting in order to keep the Slide Valve loaded at a much higher level. Frick recommends that the slide valve position for 5:1 applications be set as high as 97%. The required setpoints are accessed from the Compressor Safeties Screen.

Figure 66 provides the VFD and Capacity Control setpoints typical for the operation shown in Figure 64.

VFD

Maximum Drive Output	100%	Delay
Minimum Drive Output	20 %	
Rate of Increase	12 %	
Rate of Decrease	12 %	

1 SEC
1 SEC

Capacity Control

The Drive Speed will increase and decrease proportionally with the Slide Valve* until the Slide Valve* reaches 97 % and the Drive Speed reaches 20 %

Above these setpoints, the Drive Speed will be controlled by the Rate Of Increase and Decrease while the Slide Valve* will operate independently.

*Slide Valve or other mechanical unloader

Variable Speed Minimum Slide Valve Position	40.0%
---	-------

NOTE: Slide Valve Range limited to protect compressor

Figure 66 - Example 2 VFD and Capacity Control Setpoints

Compressor Safeties Screen

To prevent the Slide Valve from unloading beyond a high setpoint level (97%) and permit rapid compressor response under load, make the following setting adjustments on the Compressor Safeties Screen:

Step 1: Press the [MENU] key and then selecting "Setpoints" and "Compressor". Press the [ENTER] key to advance to the Compressor Safeties Screen.

Step 2: (Refer to Figure 67) Use the cursor arrow and [Tab] keys to navigate to the "Highest Capacity To Permit Starting" (Callout 1) and "Compressor Automatic Mode Minimum Capacity" (Callout 2). Use the keypad to program the setpoints to "97%". Press the [Enter] key to accept the value for each field.

Step 3: Press the [Submit] key to accept the changes and return to the operating status screen.

The screenshot shows the 'Compressor Safeties' screen with the following parameters and values:

Parameter	Value	Unit	Delay
High Discharge Temperature - Load Inhibit	212.0	°F	
High Discharge Temperature - Force Unload	212.0	°F	Delay
High Discharge Temperature - Warning	205.0	°F	5 SEC
High Discharge Temperature - Shutdown	212.0	°F	5 SEC
High Discharge Pressure - Load Inhibit	190.0	PSIG	
High Discharge Pressure - Force Unload	200.0	PSIG	Delay
High Discharge Pressure - Warning	220.0	PSIG	2 SEC
High Discharge Pressure - Shutdown	270.0	PSIG	2 SEC
Start Differential Pressure Below	50.0	PSIG	
High Suction Pressure - Load Inhibit	105.3	PSIG	
High Suction Pressure - Force Unload	115.3	PSIG	Delay
High Suction Pressure - Warning	125.3	PSIG	2 SEC
High Suction Pressure - Shutdown	135.3	PSIG	2 SEC
Economizer	Enabled		
On When Above	75.0	Capacity	
Off When Below	50.0	Capacity	
Override: Discharge Pressure < (suction x 1.64k)	15.0		
Port Value	1.60		
Pressure Input	Disabled		
Blowdown Piston	Disabled		
Oil Log	Disabled		
Main Oil Injection	On When Discharge Temperature Is Above 150.0 °F For 5 SEC		
Highest Capacity To Permit Starting	97.0	%	
Starting Period Before Permitting Capacity Increase	0	SEC	
Stopping Period For Capacity Unload	30	SEC	
Compressor Automatic Mode Minimum Capacity	97.0	%	
Capacity Unload Assist	Disabled		

Callout 1 points to the 'Highest Capacity To Permit Starting' field (97.0 %).
Callout 2 points to the 'Compressor Automatic Mode Minimum Capacity' field (97.0 %).

Figure 67 - Compressor Safeties Screen

Example 2 - Suggested Control Strategy for Standard 2 to 1 (2:1) Turndown

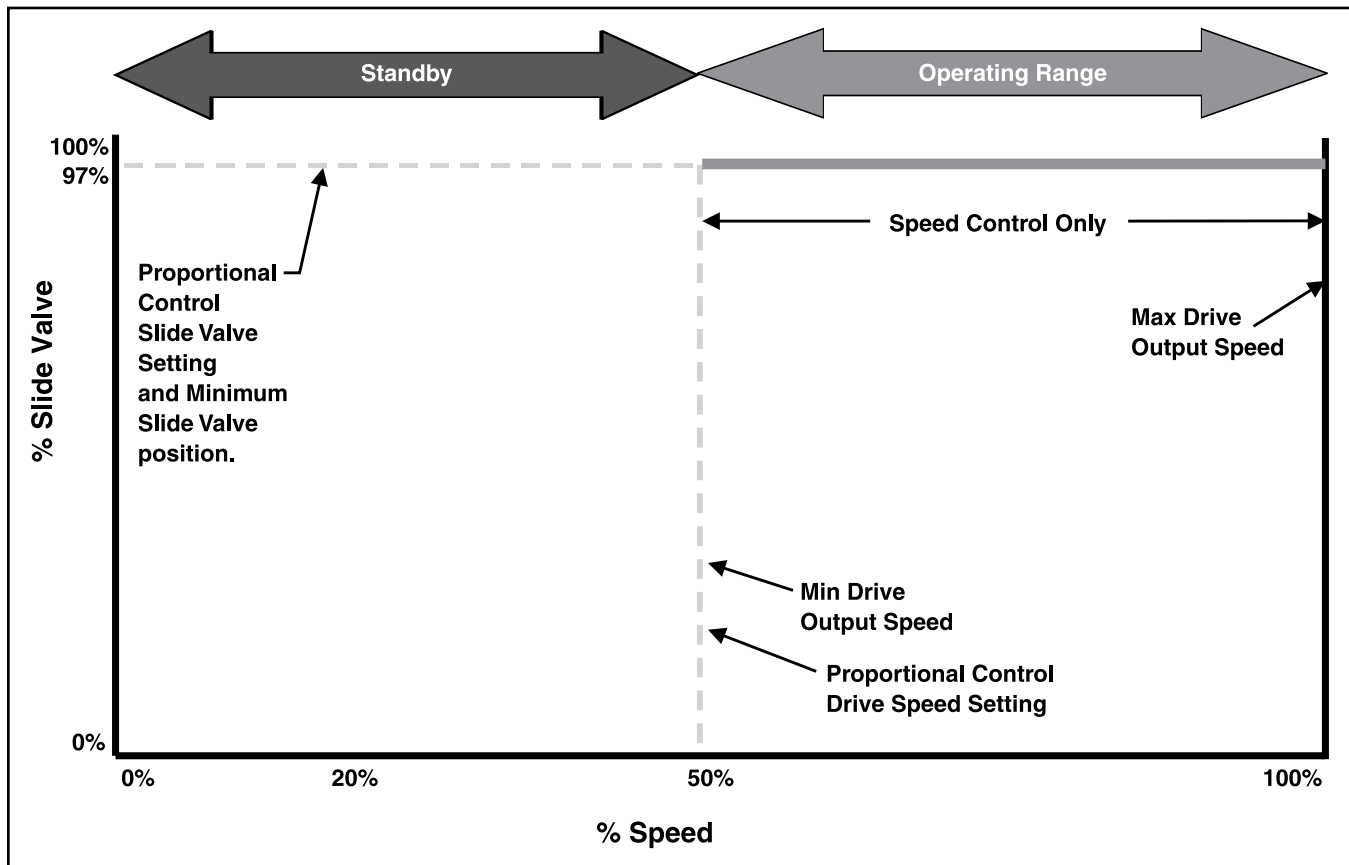


Figure 68 - 2:1 Turndown Suggested Control Strategy

NOTE: The Variable Speed Minimum Slide Valve Position of 25% is a factory default value based on the minimum slide valve position at 50% speed.

VFD

Maximum Drive Output	100%	Delay
Minimum Drive Output	50 %	
Rate of Increase	3 %	
Rate of Decrease	3 %	

5 SEC
5 SEC

Capacity Control

The Drive Speed will increase and decrease proportionally with the Slide Valve* until the Slide Valve* reaches 95 % and the Drive Speed reaches 50 %

Above these setpoints, the Drive Speed will be controlled by the Rate Of Increase and Decrease while the Slide Valve* will operate independently.

*Slide Valve or other mechanical unloader

Variable Speed Minimum Slide Valve Position	25.0%
---	-------

NOTE: Slide Valve Range limited to protect compressor

Figure 69 - Example 2 VFD and Capacity Control Setpoints

The standard 2:1 Turndown Control Strategy is depicted in Figure 68. This control strategy is a variation on the generic control strategy described previously. Not all applications require or are suitable for the very low speeds obtainable by the Vyper™ drive. Many times the motor is the limiting factor and is not suitable for 20% speed but is capable of 50% speed. For these applications, the settings within the Quantum™LX can assure that the motor never runs slower than the allowable minimum speed.

Figure 69 provides the VFD and Capacity Control setpoints typical for the operation shown in Figure 68.

VFD Proportional Band – This is the value above the Capacity Control setpoint for forward action at which the output to the drive will match the maximum output setpoint. Typically, proportional control alone will not permit running at the control setpoint. If the pressure is within the proportional band but not increasing the output will no increase with proportional control only.

VFD Integration Time – This is the value that sets the increase of the proportional component over time.

Example: with the following setpoints, Actual Value = 21psig
 Capacity Control [20psig]
 Maximum Output [100%]
 Minimum Output [20%]
 VFD Proportional Band [4psig]
 VFD Integration Time [30 sec]

With the actual pressure at 21psig the proportional component would be 20%. The Proportional Component is calculated as:

$[(\text{Actual Value} - \text{Setpoint}) / \text{PB}] \times (\text{Maximum output} - \text{Minimum Output})$

$[(21 - 20) / 4] \times (100 - 20) = 20\%$

When this proportional component is added to the minimum outpoint setpoint, the total output is 40% proportionally at

an actual value of 21 psig. It is the Integration Time setpoint which will increase the output over time without an increase in the actual value.

As long as the actual value (21 psig) does not change, the Integration Time setpoint, in this case [30 sec], will increase the output by the proportional component over every 30 seconds to drive the actual value back to the Capacity Control setpoint. If the actual value remains 21 psig, the Integration Time Setpoint would increase the drive output to 100% over 1.5 minutes. (See Figure 70)

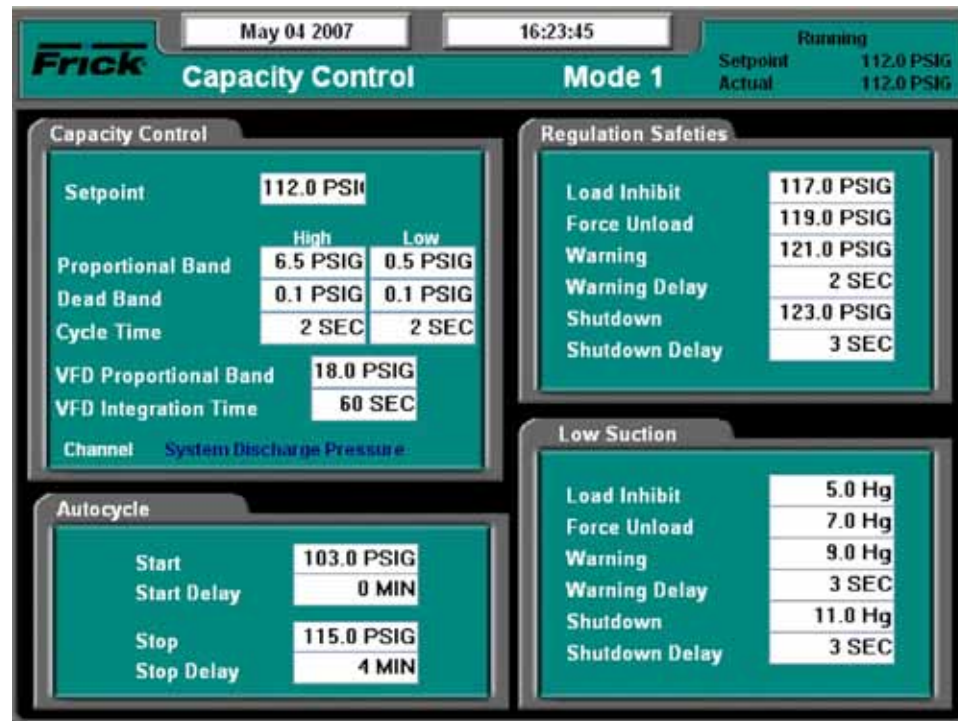


Figure 70 - Capacity Control Setpoints Screen

VSD LOGIC BOARD SETUP

The VSD logic board is equipped with a set of eight (8) DIP switches (SW3), 1, that configure the RS-485 communication between the logic board and Quantum™LX Panel as well as the optional harmonic filter board. The logic board is mounted inside the Vyper™ cabinet. Refer to Figure 71.

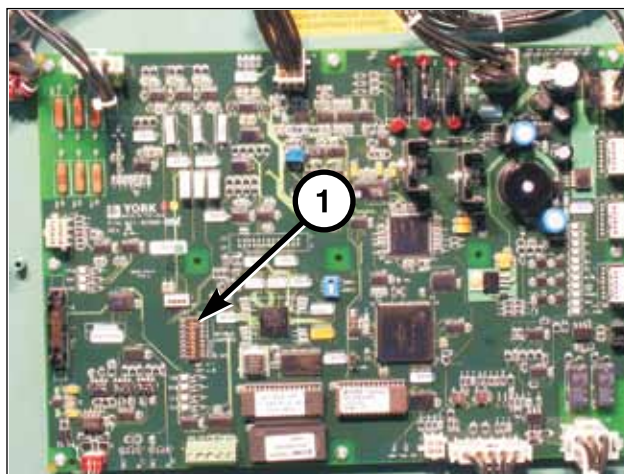


Figure 71 - Vyper Logic Board

The first seven switches in SW3 configure MODBUS communication address with the Quantum™LX Panel. To configure the switches for proper communication, set switches 1 through 6 to the "OFF" position. Place switch 7 in the "ON" position. The resulting MODBUS address is "0x40". Refer to Figure 71.

Switch 8 on SW3 allows harmonic filter communication. Verify switch 8 is in the "ON" position to allow proper communication. Refer to Figure 72.

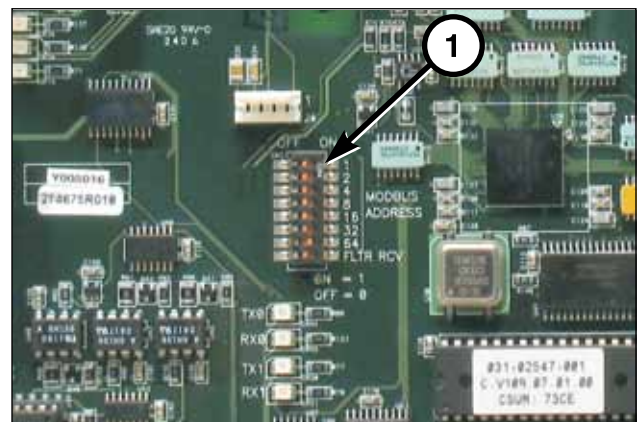


Figure 72 - Logic Board SW3

In addition to the eight DIP switches on SW3, jumper JP3 must be installed in order for Vyper™ control to be set at 'Refrigeration' mode. Refer to callout 1 on Figure 73 for the location of JP3 on the logic board.

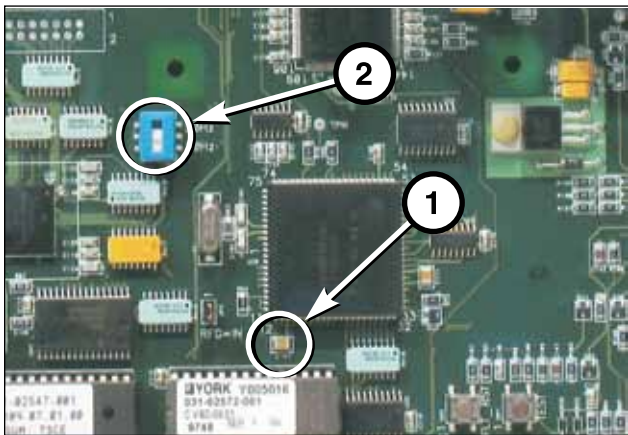


Figure 73 - Vyper Logic Board

There is also a dipswitch to select 60Hz or 50Hz, depending on the application. Ensure that it is properly set. See callout 2 on Figure 73.

SETTING THE JOB FLA

The final item for operational setup of the Vyper™ is adjusting the Job Full Load Amps (FLA) calibration via a trim pot on the Vyper™ Logic board.

The operator must perform a calculation to determine the Job FLA and then adjust the trim pot on the logic board in order to set the correct value for the Job FLA on the Quantum™LX Vyper Screen.

In order to perform the calculation, the "Applied Motor FLA" is required. The "Applied Motor FLA" was previously determined (Table 15) and is displayed on the Quantum™LX Motor Screen. Use the following steps to set the Job FLA:

Step 1: To complete the calculation, use Table 19, "Limit Calculations".

TABLE 19 - LIMIT CALCULATIONS

Limit Calculations		
Line	Parameter	Value
1	Applied Motor FLA (Table 15)	
2	Applied Service Factor	1.15
3	Multiply (Line 1 x Line 2)	
4	HP rating of Vyper Drive	
5	Vyper Amp Limit If Line 4 is 700/572 HP, value is 880 A If Line 4 is 912/752 HP, value is 1180 A	
6	Multiply Line 5 x 1.05	

Step 2: Referring to the calculations in Table 19, determine which of the following applies:

- If value of Line 3 is less than the value of Line 6, use the value of Line 3 for the Job FLA.
- If value of Line 3 is greater than value of Line 6, use the respective value in Line 5 as the Job Full Load Amps.

Step 3: Locate the trim pot on the Vyper™ Logic board. The trim pot is a rectangular blue component in the central area of the board. See Callout 1 in Figure 74.

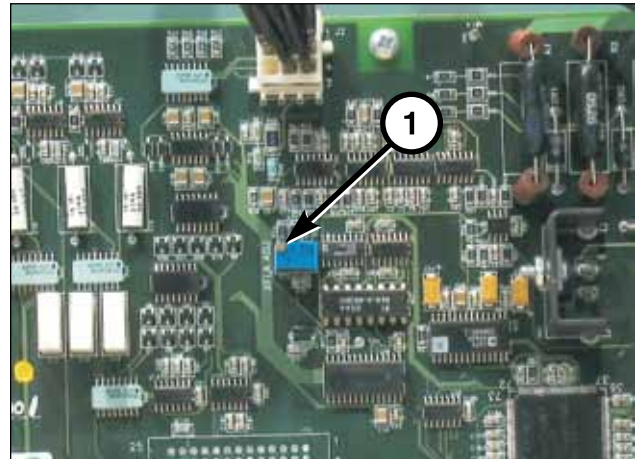


Figure 74 - FLA Trim Pot

Step 4: Advance to the Vyper™ Screen by pressing the [MENU] key and then selecting "Setpoints" and "Operating Values" using the down cursor arrow key. Select "Vyper" from the pull-down menu and press the [Enter] key. Locate "Job FLA" on the Vyper Screen. See Callout 1 in Figure 75.

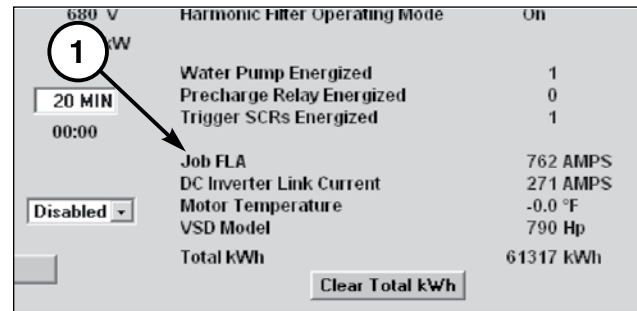


Figure 75 - Job FLA on the Vyper Screen

Step 5: Use a flat-blade screwdriver to adjust the trim pot until the "Job FLA" field on the Vyper™ Screen reads the Job FLA Value determined in Step 2. Turning the trim pot clockwise will increase the FLA reading; turning the trim pot counterclockwise will decrease the FLA reading.

Step 6: Close the door for the Vyper™ cabinet and secure using the latches on the side of the cabinet.

NOTE: If Logic Board is replaced, the Job FLA must be reset to the proper value using the Job FLA Trim Pot.

MOTOR ROTATION



Before operating the Vyper™ Drive, remove the coupling center and verify proper compressor motor rotation.

Damage to the motor will occur if the motor leads are not connected properly.

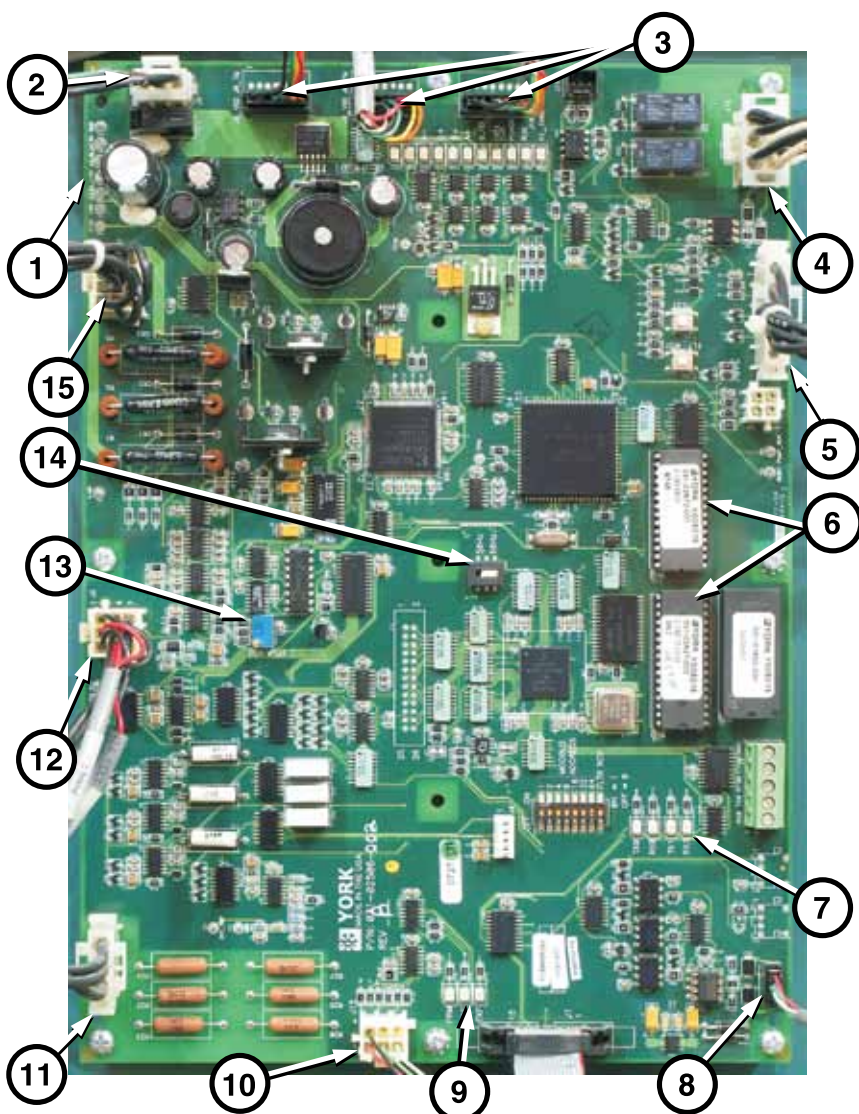
Verify the compressor motor rotates in the proper direction by removing the coupling center and initiating a system start. If the motor rotates in the wrong direction, the check motor leads for proper connections.

Installation and operational setup of the Vyper™ Drive is now complete and ready for operation.

The callouts on Figures 76 and 77 point out components, indicators and test points that can be used to aid in maintenance and troubleshooting of fault codes.

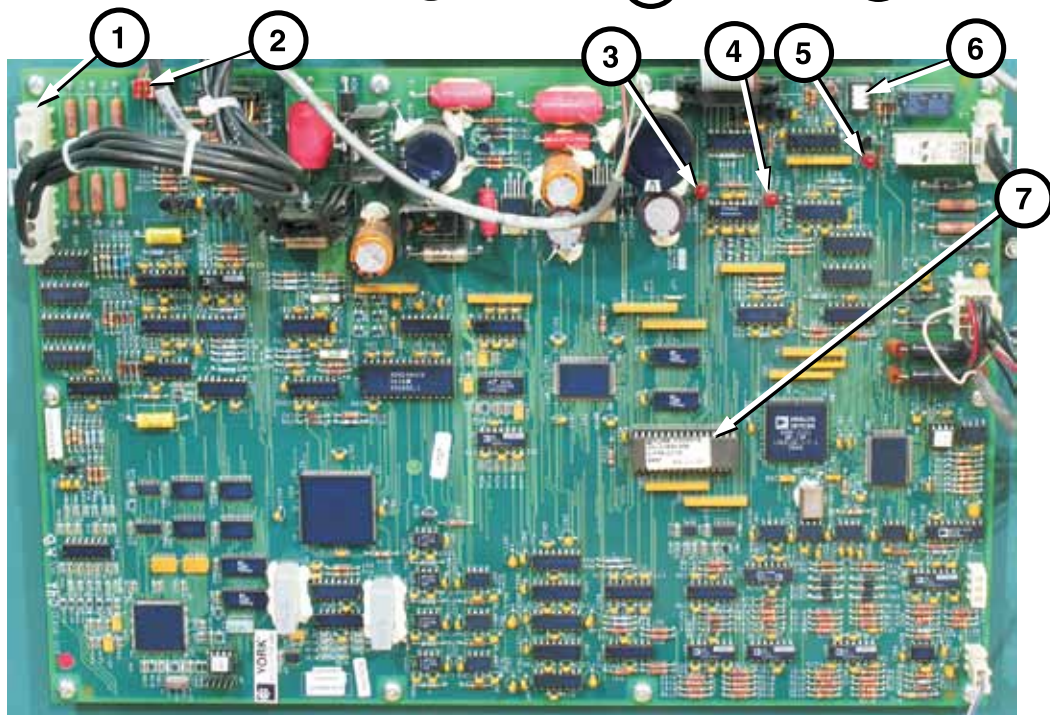
1. DC Voltage Test Points
2. 24VAC Input
3. Gate Drive Connections J8, J9 & J10
4. J12 Start Input / Run Output
5. J6 to J4 of the SCR Trigger Board
6. E-prom Chips
7. Communication Indicators RX/TX, Logic Board to Quantum LX
8. J16 Communications Cable, Logic Board to Quantum LX
9. Communications Indicators RX/TX, Logic Board to Filter Board
10. J15 Communications Cable, Logic Board to Filter Board.
11. DC Bus Voltage Input
12. J2 Remove to manually engage circulation pumps and internal fans
13. JOB FLA Potentiometer
14. Frequency Switch (60/50Hz)
15. Output Current input, Phase - A, B & C

Figure 76 - Control Logic Board



1. J5 Connector (voltage input / test points)
2. J8 Communications to the logic board (J15)
3. Power Supply "OK" LED
4. Filter "Over-Temp" LED
5. Run LED
6. Filter ON/OFF switch
7. E-prom

Figure 77 - Filter Logic Board



MAINTENANCE

DANGER

Shock Hazard! Before beginning service, use proper lock-out/tag-out procedures to disconnect all power supplies related to this equipment. Verify all power is removed from the supply leads. Death or severe personal injury will occur if proper care is not taken.

DANGER

This equipment is for power conversion purposes. It is energized with up to 600 volts AC and houses a DC bus that is charged up to 1.4 times the incoming voltage. It also encompasses multiple contactors that may open and close without notice. It is not intended to be operated with the doors open and appropriate ARC FLASH protection must be used when servicing.

DANGER

Shock Hazard! Wait five (5) minutes after switching power to the Vyper™ OFF to allow capacitors in the cabinet to discharge before opening the cabinet door. Failure to do so will result in death or serious injury. After opening the door, carefully verify that the incoming power has been removed and that the DC bus is completely discharged with a Cat. IV meter capable of reading up to 1000 volts AC & DC.

WARNING

All service on this equipment should be performed by Johnson Controls certified service personnel only. Death, severe personal injury, and/or equipment damage may occur if service is not performed by competent personnel.

NORMAL MAINTENANCE OPERATIONS

Before performing any routine maintenance or service on this equipment, read this section thoroughly first. This section provides instructions for normal maintenance, replacement of the power module, and replacement of the harmonic filter module.

An authorized Johnson Controls-Frick service representative should perform all service and maintenance activities other than the standard maintenance activities listed below.

STANDARD MAINTENANCE

The Vyper™ requires very little facility-operator-supplied maintenance. The only routine maintenance item involves the coolant system.

The Vyper™ is shipped to the customer with a premixed solution of 50/50 mixture of Propylene Glycol and a corrosion inhibitor. This shipping fluid needs to be replaced before starting the unit. Proper disposal of the Propylene Glycol is required.

The standard Frick running coolant is pink in color and contains a nitrite corrosion inhibitor to reduce corrosion effects on the aluminum surfaces of the cooling circuit. The pink color may become clear over time, but cooling performance is not affected. Do not dilute the premixed coolant.

Inspect the coolant and coolant level regularly and replace the coolant annually using the steps described previously in this manual. Any time the coolant is removed from system, always discard the old coolant and replace with new coolant.

Coolant that is any other color than pink (or clear) indicates bacterial growth or corrosion. Symptoms are as follows:

- Brown or green in color indicates that bacteria growth is occurring.
- Milky white coolant or the presence of a white milky coating inside of the tubing indicates corrosion exists on the inside of the cooling system and is oxidizing the aluminum components.

If any of these conditions occur, use proper health and disposal precautions when draining the coolant. Referring to the coolant changing procedure described previously in this manual, use the following steps to replace the coolant in the contaminated system:

1. Drain the coolant and blow the system out with compressed air.
2. Flush the coolant system out thoroughly with water.
3. Fill the coolant loop with **Ethylene Glycol** (Not Propylene Glycol, normal Frick running coolant).
4. Circulate the Ethylene Glycol for one hour.
5. Drain the Ethylene Glycol and refill the coolant loop with Frick running coolant.
6. Check the coolant system in two weeks for bacteria growth and/or corrosion.

REPLACEMENT OF THE VYPER™ POWER MODULE

WARNING

The Vyper™ Power Module is to be replaced by Johnson Controls certified service personnel only. Death, severe personal injury, and/or equipment damage may occur if service is not performed by competent personnel.

The following is a step-by-step procedure describing the replacement of the Vyper™ power module. Follow this procedure minimize the possibility of damage to other system components or to the Vyper™ drive.

Save all the packing material. This material must be reused when returning a defective power module for warranty claims.

Power module replacement procedure:

1. Be certain the Vyper™ has been de-energized for over five minutes, and then double-check for presence of voltage using a VOM. The DC bus must be fully discharged.
2. Drain the coolant from the heat exchanger into a suitable container and discard. Use proper handling and disposal procedures, as the coolant may contain bacteria.
3. Remove the connector to the IGBT Gate driver board.
4. Remove and discard the six (6) Phillips head screws from the power wire connector tangs and the remaining (6) Phillips head screws from the bus connections.
5. Remove and discard the eight (8) Allen screws from the IGBT module.

CAUTION

Use care when removing the Vyper™ power module. Do not place any stress on the bus structure and make sure coolant does not drip from the IGBT module to other components. Damage will occur to the components if this precaution is not followed.

6. Carefully remove the Vyper™ power module by sliding it away from the bus structure while lifting slightly. The bottom of the IGBT module will be wet. Ensure that the coolant does not drip onto any other components inside the Vyper enclosure. The coolant is conductive and contact with the harmonic filter gate driver can cause a failure.
7. Remove three (3) O-rings from the copper chill plate and discard.
8. Wipe the chill plate clean with a clean, soft, cloth. DO NOT clean using compressed air. DO NOT leave lint or any other materials on the chill plate.
9. Lightly lubricate the new O-rings with O-ring lubricant provided in the kit.
10. Install the new O-rings into the chill plate grooves.
11. Place the new Vyper™ power module on the chill plate so the connector is towards the front of the Vyper™ enclosure. Carefully slide the power module power connections under the bus structure. DO NOT tighten. The replacement assembly should still be loose.
12. Insert the eight (8) Allen head screws through the new IGBT module and engage a few threads in the chill plate, but DO NOT tighten. The new Vyper™ power module should still be loose.
13. Align the Vyper™ power module so that the (6) Phillips head screws can be installed through the bus structure and into the IGBT module. DO NOT tighten these screws.
14. Tighten the Allen head screws to 48 in-lb (5.5 Nm) $\pm 10\%$ in the numerical sequence shown in Figure 78.
15. Install the three (3) power wire connector tabs using (6) Phillip head screws and torque the screws to 48 in-lb (5.5 Nm) $\pm 10\%$.
16. Remove the six (6) Phillips head screws (not yet tightened) at the bus structure and install the three (3) square

capacitors to the bus structures with the these screws. Torque the screws to 48 in-lb (5.5 Nm) $\pm 10\%$.

17. Close the drain valve on the heat exchanger and refill the system with the coolant supplied and check for leaks.
18. Replace the running coolant using the procedure "Adding and Replacing Coolant" portion of this manual. If the system contained bacteria or corrosion, be sure to flush the system with ethylene glycol first.

REPLACEMENT OF THE VYPER™ HARMONIC FILTER POWER MODULE



WARNING The Vyper™ Harmonic Filter Module is to be replaced by Johnson Controls certified service personnel only. Death, severe personal injury, and/or equipment damage may occur if service is not performed by competent personnel.

Personnel not familiar with AC drive and proper electrical safety guidelines should not be working on this product. Power module replacement should be performed only by Johnson Controls-certified technicians.

The harmonic filter module replacement procedure is the same as the replacement for the Vyper™ power module except for the following:

- Drain the coolant as described in the "Power Module Replacement" section, then remove one of the coolant hoses feeding the Harmonic Filter Power Module.
- Failure to completely drain the coolant system will cause coolant to leak into the VSD cabinet and possibly cause damage to other components inside the cabinet.

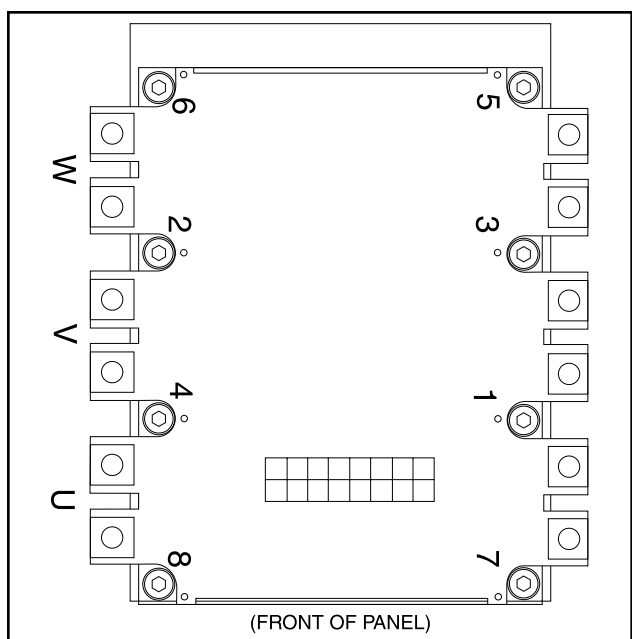


Figure 78 - Power Module Screw Tightening Sequence

FREQUENTLY ASKED QUESTIONS



All service on this equipment should be performed by Johnson Controls certified service personnel only.

Death, severe personal injury, and/or equipment damage may occur if service is not performed by competent personnel.

Why don't the measured input amps shown on the Quantum™LX control panel agree with the rated FLA?

The input current to the Vyper™ may be considerably lower compared to the output current. This is due to the power factor at the input to the Vyper™ being greater than 0.95 and nearly unity when the Harmonic filter option is included. Motor FLA must be measured at the motor terminals, where the power factor is the normal motor power factor. Use the true RMS reading meter to make the measurements.

On the Remote-mounted Vyper™ compressor drive, what is the dV/dt "snubber" filter for?

The combination of long runs of wire between the Frick Vyper™ and the compressor motor with the fast rise time of the output voltage of the Vyper™ can cause excessively high voltage potential at the motor terminals. Without the dV/dt filter, the insulation in the motor terminal can be overly stressed. The dV/dt network reduces the high voltage motor potential to below the motor's voltage specification. The design of the dV/dt network has a requirement to be added to the top of the motor terminal box. No additional wire may be added between the dV/dt network and the motor terminal connections. The addition of wire reduces the dV/dt network's effectiveness and potentially shortens the life of the motor.

What is the proper wire sizing for a Frick Vyper™ drive?

The input power wires are sized at 1.25 times the full load amps of the compressor motor, plus oil pump amperage and control transformer amps.

How is a 12-lead motor connected to the Vyper™?

Most of the 12 lead motors actually have two sets of parallel windings, and therefore have two ones, two twos, etc. The Vyper™ is connected to the motor in the delta configuration, which means that leads are paired 1 and 6, 2 and 4, and 3 and 5. The T1 lug in the Vyper™ will then have two 1s and two 6s attached to it.

Some motors, which were produced in the past, were labeled as 1 through 12. These motors had the first set of wires marked 1 to 6. Numbering then continued with the second 1 marked as 7, 2 numbered as 8, so on up to 12. Take the second set of numbers above six, subtract 6 from the number and relabel the result.

What is the peak input voltage value?

The displayed value is the phase to neutral voltage at the input to the drive in terms of peak voltage, as measured by an oscilloscope.

Phase to neutral is normally the phase-to-phase voltage divided by the square root of three, or 265 VAC phase to neutral, for a 460 VAC system. The peak value of the 265 VAC measurement is approximately that number times the square root of two.

When is a booster pump required on a Vyper™ compressor drive?

The Frick Vyper™ requires eight (8) foot of head for proper coolant flow (water or glycol) to the heat exchangers. If this amount of head is not available, then a booster pump providing at least 10 or 15 foot of head is required.

The pink color of the coolant has faded. Is there a problem?

The coolant normally has a pink or rosy color when new. After months of operation, this color may dissipate, and the coolant may appear almost colorless. The lack of color in the coolant does not necessarily indicate a problem. Most colorless samples test above 1000 PPM nitrite, which is normal. There is no need to flush the system unless the coolant becomes opaque or cloudy. If this is the case, please obtain a sample for analysis, then flush the system with coolant and install fresh coolant. Be aware that cloudy coolant may contain bacteria. Use adequate preventative procedures to avoid contamination. Change the coolant annually, regardless of color.

Why is the Vyper™ circuit breaker tripping?

Circuit breaker tripping is normal for a failed Vyper™ drive. The unit does not have input fuses. The AC choke now reduces the current flowing to the short and the circuit breaker is fast enough to provide proper protection. A tripped circuit breaker may be due to a shorted condition inside the drive, the presence of a ground fault condition, or due to the breaker itself being faulty. Check for shorts at the input and output of the drive. Check for leakage current to ground. If no leakage is found, try raising the adjustable thresholds on the breaker. The breaker is likely to be defective if tripping continues to occur.

What is the test button on the Vyper™ Logic board?

When the Vyper™ is not running, the test button (Callout 1, Figure 79) may be used to test operation of the logic outputs to the Vyper™ power module, as well as the operation of the gate driver board on the IGBT module. When the button is depressed, six output LEDs on the Logic Board alternately light the three plus (+) LEDs then the three (-) LEDs. At the same time, six LEDs on the gate driver board will alternate between dim and bright intensity. Several conditions can inhibit this test function:

- If any VSD fault exists.
- If the unit is in precharge.
- If the SCR trigger is enabled.
- If the VSD unit is running.
- A 4-minute timer is part of this function to ensure that the DC Link Voltage is discharged to a safe level. This timer must time-out before the Test Button will function.

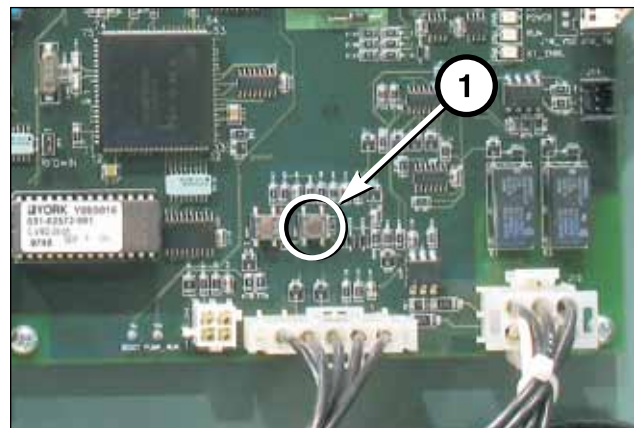


Figure 79 - Logic Board Test Button

VYPER™ ALARMS / SHUTDOWNS

OVERVIEW

In addition to the Alarms and Shutdowns that the Quantum™LX software generates for the basic compressor package, there are warnings and shutdowns that are associated with the Vyper™ drive operation. These can be initiated by the Quantum™LX panel or the Vyper™ drive. The following pages describe these warnings and shutdowns by title and description as well as the cause and items to check.

When a Shutdown occurs, the display backlight will flash on and off to alert an operator of the shutdown. This visual alarm will help get the attention of the operator in a noisy engine room environment where audible alarms may not be heard. Pressing any key on the keypad will clear the flashing backlight alarm. The FRICK VYPER™ FAULT CODES table shows the full listing of fault codes. A detailed description and troubleshooting recommendations follow.

The following warnings and or shutdowns are initiated by the Quantum™LX panel. These safeties are set for **When Running**:

High Motor Stator Temp. – If the motor stator temperature rises above a critical point, one or more embedded thermistors will open, removing the digital input to the Dig. Aux. #1 module, wire #28 (typical). There is one thermistor per winding.

If the motor is equipped with stator RTDs (one per winding) the same result will occur only that the signal is now an analog signal and is set up as one of the PHD monitoring channels. The warning and shutdown values can be seen on the PHD setpoints screen of the Quantum™LX panel and should be set based on the limits of the motor's insulation class.

Blower Motor Aux. – If the motor is equipped with auxiliary blowers mounted to the top of the main drive motor, then a confirmed run signal is required. This signal is in the form of a digital signal from the Aux. Contacts of the blower motor starter/s and is received by Dig. Aux. #2, wire #29 (typical).

High Vyper Coolant Temp. – The Vyper Coolant Temp. is monitored by the Quantum™LX Panel from a temperature probe mounted at the coolant reservoir on analog auxiliary #9 (Ch. 13 analog brd #2). If the Vyper™ Coolant exceeds the High Temp Warning or Shutdown values for the delays, this warning or shutdown will occur. These values can be seen on page 2 of the Analog Auxiliaries setpoints screens. Default settings are 130°F for the warning, 135°F for the shutdown.

Low Vyper Coolant Temp. – The Vyper Coolant Temp. is monitored by the Quantum™LX Panel from a temperature probe mounted at the coolant reservoir on analog auxiliary #9 (Ch. 13 analog brd #2). If the Vyper Coolant exceeds the Low Temp Warning or Shutdown values for the delays, this warning or shutdown will occur. These values can be seen on page 2 of the Analog Auxiliaries setpoints screens. Default settings are 85°F for the warning, 80°F for the shutdown.

NOTE: If the compressor has been down for an extended period and the ambient temperature is less than the Low Vyper Coolant Temp. warning or shutdown values, it may be necessary to lower these settings temporarily in order to get the drive running.



This setpoint can never be set lower than 5°F above ambient dry bulb temperature. If not sure of dry bulb temperature, DO NOT GUESS.

Once the drive is running with the coolant temperature back above the default setting for this safety, go back and change them to 85°F for the warning and 80°F for the shutdown.

The warnings and shutdowns on the following pages are initiated by the Vyper™ drive and communicated to the Quantum™LX panel for display and clearing purposes.

QUANTUM™LX LOAD INHIBIT, FORCE UNLOAD MESSAGES

Load Inhibit - VSD Ambient Temperature

Occurs when the Vyper cabinet temperature reaches 130°F and this will inhibit the Slide Valve from loading.

Force Unload - VSD Ambient Temperature

Occurs when the Vyper cabinet temperature reaches 135°F and this will unload the Slide Valve.

Load Inhibit - VSD Converter Heatsink Temp

Occurs when the converter heatsink temperature reaches 155°F and this will inhibit the Slide Valve from loading.

Force Unload - VSD Converter Heatsink Temp

Occurs when the converter heatsink temperature reaches 160°F and this will unload the Slide Valve.

Load Inhibit - Harmonic Filter Baseplate Temperature

Occurs when the harmonic filter baseplate temperature reaches 175°F and this will inhibit the Slide Valve from loading.
Occurs when the harmonic filter baseplate temperature reaches 160°F and this will inhibit the Slide Valve from loading.

Force Unload - Harmonic Filter Baseplate Temperature

Occurs when the harmonic filter baseplate temperature reaches 180°F and this will unload the Slide Valve.
Occurs when the harmonic filter baseplate temperature reaches 165°F and this will unload the Slide Valve.

Load Inhibit - VSD Baseplate Temperature

Occurs when the baseplate temperature reaches 160°F and this will inhibit the Slide Valve from loading.

Force Unload - VSD Baseplate Temperature

Occurs when the baseplate temperature reaches 165°F and this will unload the Slide Valve.

Load Inhibit - VSD Phase A Baseplate Temperature

Occurs when the Phase A baseplate temperature reaches 160°F and this will inhibit the Slide Valve from loading.

Force Unload - VSD Phase A Baseplate Temperature

Occurs when the Phase A baseplate temperature reaches 165°F and this will unload the Slide Valve.

Load Inhibit - VSD Phase B Baseplate Temperature

Occurs when the Phase B baseplate temperature reaches 160°F and this will inhibit the Slide Valve from loading.

Force Unload - VSD Phase B Baseplate Temperature

Occurs when the Phase B baseplate temperature reaches 165°F and this will unload the Slide Valve.

Load Inhibit - VSD Phase C Baseplate Temperature

Occurs when the Phase C baseplate temperature reaches 160°F and this will inhibit the Slide Valve from loading.

Force Unload - VSD Phase C Baseplate Temperature

Occurs when the Phase C baseplate temperature reaches 165°F and this will unload the Slide Valve.

FAULT CODE DESCRIPTIONS

Fault 1 : VSD Board Power Supply

Message

Quantum: "Fault 1"

Quantum LX: "VSD Board Power Supply Fault"

This fault is set on every power-up. The fault is immediately cleared and logged in the fault history to record the occurrence of the power loss.

Fault 3: VSD Interface Board Motor Current > 15%

Message

Quantum: "Fault 3"

Quantum LX: "VSD Interface Board Motor Current > 15%"

This fault occurs whenever the Vyper™ is not running and a motor current of greater than 15 % FLA is detected for at least ten seconds.

Fault 4: VSD Interface Board Run Signal

Message

Quantum: "Fault 4"

Quantum LX: "VSD Interface Board Run Signal Fault"

This fault occurs if the Run Signal from the Quantum Control Panel is high, but the speed command being sent over the RS-485 communications link is zero. This fault may also occur if the Run Signal is low, but the speed command is not zero. Both conditions must be present for five seconds before the fault is set, and are only applicable in automatic mode.

Fault 5: Interface Board Panel Communications Loss

Message

Quantum: "Fault 5"

Quantum LX: "VSD \ Board to Panel Comms Loss"

This fault occurs when the VSD board loses communications from the Quantum™LX Control Panel, meaning it has not received any data for a period of fifteen seconds. This fault is only applicable in automatic mode.

Fault 7: Vyper Initialization

Message

Quantum: "Fault 7"

Quantum LX: "VSD Initialization Fault"

At power-up, all the boards go through a process called initialization. At this time, memory locations are cleared, jumper positions are checked, and serial communications links are established. There are many causes for an unsuccessful initialization. The following check list should aid in determining why the initialization has not been completed:

- The Control Center and the Vyper™ must be energized at the same time. The practice of pulling the fuse in the control center to make wiring changes will create a problem. Power-up must be done by closing the main disconnect on the Vyper™ cabinet with all fuses in place. Be sure you do not have an open fuse, causing loss of power to the Vyper™ Logic board which can cause this fault.
- The EPROMs must be correct for each board, and they must be correctly installed. There are a total of seven (7)

FRICK VYPER™ FAULT CODE LIST

Quantum™LX Fault Code	Quantum™LX Fault Message
1	VSD Interface Board Power Supply Fault
3	VSD Interface Board Motor Current > 15%
4	VSD Interface Board Run Signal Fault
5	VSD Interface Board to Panel Comms Loss
7	VSD Initialization Fault
8	VSD Stop Contacts Fault
9	Harmonic Filter Logic Board Or Comms Fault
10	Harmonic Filter High Total Demand Distortion
11	VSD High Phase B Inverter Baseplate Temp
12	VSD High Phase C Inverter Baseplate Temp
13	VSD Low Phase B Inverter Baseplate Temp
14	VSD Low Phase C Inverter Baseplate Temp
17	VSD High Phase A Instantaneous Current
18	VSD High Phase B Instantaneous Current
19	VSD High Phase C Instantaneous Current
21	VSD Phase A Gate Driver Fault
22	VSD Phase B Gate Driver Fault
23	VSD Phase C Gate Driver Fault
24	VSD Single Phase Input Power Fault
27	VSD 105% Motor Current Overload Fault
28	VSD High DC Bus Voltage Fault
29	VSD Logic Board Power Supply Fault
33	VSD Low DC Bus Voltage Fault
34	VSD DC Bus Voltage Imbalance Fault
35	VSD High Internal Ambient Temp Fault
36	VSD High Phase A Inverter Baseplate Temp
37	VSD Logic Board Processor Fault
38	VSD Run Signal Fault
39	VSD High Converter Heatsink Temp Fault
40	VSD Invalid Current Scale Selection
41	VSD Low Phase A Inverter Baseplate Temp
42	VSD Serial Communication Fault
43	VSD Precharge Lockout Fault
44	VSD Low Converter Heatsink Temp Fault
45	VSD Current Imbalance Fault
46	VSD Precharge - DC Bus Voltage Imbalance
47	VSD Precharge - Low DC Bus Voltage 2
48	VSD Precharge - Low DC Bus Voltage 1
50	Harmonic Filter High DC Bus Voltage Fault
51	Harmonic Filter High Phase C Current Fault
52	Harmonic Filter High Phase B Current Fault
53	Harmonic Filter High Phase A Current Fault
54	Harmonic Filter Phase Locked Loop Fault
56	Harmonic Filter Logic Board Power Supply
65	Harmonic Filter Precharge - High DC Bus Voltage
66	Harmonic Filter Precharge - Low DC Bus Voltage
67	Harmonic Filter DC Current Transformer 1
68	Harmonic Filter DC Current Transformer 2
69	Harmonic Filter High Baseplate Temp Fault
71	Harmonic Filter Low DC Bus Voltage
75	Harmonic Filter DC Bus Voltage Imbalance
76	Harmonic Filter 110% Input Current Overload
77	Harmonic Filter Run Signal Fault
81	VSD Interface Board NovRAM Failure
83	Harmonic Filter Serial Communication
84	Harmonic Filter Input Frequency Out of Range

TABLE 20 - FAULT CODE LIST

EPROMs in each Vyper™ system. These EPROMs are created as a set, and cannot be intermixed. All pins must be properly inserted into the EPROM sockets.

- Serial data must be established. (See: Serial Communication Fault" error code). If communications between the Vyper™ Logic, Filter Logic, and Interface Boards and Quantum™ panel does not take place during initialization, Fault 5 message will appear before any other message can be generated. Check to see that the serial communications

have been established by selecting the Motor information screen verifying the drive horsepower. A zero displayed value for this parameter (and all other Vyper™ parameters) indicates a serial communications link or EPROM problem.

- If the Harmonic Filter option is included, make sure the Harmonic Filter Logic board is not in continuous reset. This will be evidenced by the LEDs on the filter logic board alternately blinking. To rule out the Harmonic Filter as the cause of initialization failure, disconnect the filter by switching the filter logic board's SW1 switch to the OFF position, and removing the 16 wire ribbon cable between the Harmonic Filter logic and Vyper™ Logic Board.

Fault 8: Vyper - Stop Contacts

Message

Quantum: "Fault 8 "

Quantum LX: "VSD Stop Contacts Fault "

This fault occurs if the No Fault signal from the Vyper™ is low. It indicates a fault is present at the Vyper™ or the Harmonic Filter, but the communications data contains no Vyper™ fault data for twenty seconds. The Frick Interface Board will send Initialize data requests while this fault is active.

Whenever the Vyper™ initiates a fault, the Vyper™ first opens the K1 relay on the Vyper™ Logic board. When the relay opens, the voltage between wire #53 and #16 will be 115 VAC. If wire #53 to #16 circuit ever opens without receiving an accompanying cause for the trip over the serial link (within 11 communication tries, approximately 22 seconds), this Fault Code will be displayed. A loose wire is often the cause of this problem. Check the #1 to #53 horseshoe jumper in the Control Center and all other wiring involving #53 and #16. This fault may be replaced with a Serial Communications fault if the serial link has failed.

Fault 9: Harmonic Filter - Logic Board Or Communications

Message

Quantum: "Fault 9 "

Quantum LX: "Harmonic Filter Logic Board or Comms Fault "

This fault occurs if the No Fault signal from the Vyper™ is low, indicating a fault is present at the Vyper™ or the Harmonic Filter, but the communications data contains no Harmonic Filter fault data for twenty seconds. The Frick Interface Board will send Initialize data requests while this fault is active.

This Fault Code can also occur as a background message when the chiller is running. When this message is displayed, all filter related values are unavailable. If communications is reestablished, normal values will again be displayed. If this problem is encountered, the ribbon cable connecting the Vyper™ Logic board to the Filter Logic board should be checked. The integrity of the shielded communications cable between the filter logic board and the interface board should also be checked. Finally, replacement of either the filter logic board or the Vyper™ Logic board should be tried.

Fault 10: Harmonic Filter - High Total Demand Distortion

Message

Quantum: "Fault 10"

Quantum LX: "Harmonic Filter High Total Demand Distortion"

This shutdown indicates that the filter is not operating correctly or the input current to the Vyper™/filter system is not sinusoidal. This fault occurs when any one of the three phases of Total Demand Distortion (TDD) is greater than 25.0 %, for forty-five continuous seconds while the Vyper™

is running. TDD is defined by the IEEE Std 519-1992 standard as "the total root - sum - square harmonic current distortion, in percent of the maximum demand load current (15 or 30 min demand)". In the filter option supplied by Frick, the displayed TDD is the total RMS value of the harmonic current supplied by the power mains to the Vyper™ system divided by the FLA of the Vyper™, in percent. The harmonic filter option was designed to provide an input current TDD level of 8% or less for the Vyper™ system. A standard Vyper™ less the optional filter typically has an input current TDD level on the order of 28 - 30%. Causes for this shutdown are numerous, but would most likely be caused by a faulty filter logic board. In order to initiate a chiller run again, the Quantum™LX panel's compressor switch must first be placed into the STOP/RESET position.

Fault 11: High Phase B Inverter Baseplate Temperature

Message

Quantum: "Fault 11"

Quantum LX: "High Phase B Inverter Baseplate Temperature"

The phase bank assembly shall contain one heat sink to cool the three inverter power modules and the converter SCR/Diode modules. The inverter power modules each contain an internal temperature sensor (5K ohm at 25°C) to monitor their baseplate temperatures. Each of the inverter power module baseplate temperatures are compared in software to a limit of 175°F (79°C). If this limit is exceeded, the unit initiates a safety shutdown. The fan(s) and water pump remain energized until the inverter power module baseplate temperature falls below 165°F (74°C). The fans and pumps are de-energized when all baseplate temperatures drop below the reset thresholds.

Fault 12: High Phase C Inverter Baseplate Temperature

Message

Quantum: "Fault 12"

Quantum LX: "High Phase C Inverter Baseplate Temperature"

Same comments as Fault 11 except applying to Phase C Inverter Baseplate Temperature

Fault 13: Low Phase B Inverter Baseplate Temperature

Message

Quantum: "Fault 13"

Quantum LX: "Low Phase B Inverter Baseplate Temperature"

The phase bank assembly shall contain one heat sink to cool both the inverter power module and the converter SCR/Diode modules. The three inverter power modules each contain internal temperature sensors (5K ohm at 25°C) to monitor baseplate temperature. The inverter power module baseplate temperatures are compared in software to a lower limit of 37°F (2.8°C). If this limit is exceeded, the unit initiates a cycling shutdown. In addition, if the three inverter baseplates and the converter heat sink temperature falls below the 37°F limit, the unit will trip and energize the fan(s) and coolant pump. This feature provides service personnel with a means to run the water pump while filling the cooling system (by pulling VSD logic board plug P2).

Fault 14: Low Phase C Inverter Baseplate Temperature

Message

Quantum: "Fault 14"

Quantum LX: "Low Phase C Inverter Baseplate Temperature"

Same comments as Fault 13 except applying to Phase C Inverter Baseplate Temperature

Fault 17: High Phase A Instantaneous Current

Message

Quantum: "Fault 17"

Quantum LX: "VSD High Phase A Instantaneous Current"

The three output lines to the motor are monitored via three current transformers within the drive. The unit's three phases of instantaneous output current are compared to a prescribed limit which is contained in hardware. If the peak current limit is exceeded, the unit will trip and the Quantum™ LX Panel will display a fault message.

The Vyper™ Logic board generates this shutdown. If any single phase of motor current, as measured by the output current transformers, exceeds 1890 Amps peak for 700 HP / 3093 Amps peak for 912 HP, a shutdown will occur. If an Instantaneous Current occurs, but the chiller restarts and runs without a problem, the cause may be attributed to a voltage sag on the utility power feeding the Vyper™ that is in excess of the specified dip voltage for this product. This is especially true if the chiller was running at or near full load. If there should be a sudden dip in line voltage, the current to the motor will increase, since the motor wants to draw constant horsepower. This is a common problem when a second chiller is started. Contact Frick factory service if this is confirmed to be a problem.

If the chiller will not restart, but keeps tripping on this same shutdown, then it is possible that the Vyper™ power unit is the problem. Check that all six red LEDs are illuminated on the Vyper™ gate driver board. Also, check for output short-circuits using an ohm-meter set to the minimum ohms scale. Measure from T1 to the Positive Bus and from T1 to the Negative Bus, checking with the ohm-meter in both polarities. Repeat this same check for T2 and T3.

If no short circuits are discovered in the Vyper™ power unit, the motor may be the problem. Meg the motor phase to phase and phase to ground. Also verify that the compressor is free to rotate. A seized compressor will also cause an overcurrent fault. If still no short circuits are discovered there is a Vyper™ Logic board problem. This is especially true if the trip occurs during start-up, before the motor begins to turn. If this is the case, it is possible to monitor the motor current during start-up on the Logic board. Using an oscilloscope, connect the ground clip to the GND test point on the board. Connect the probe tip to the top of one of the three CT terminating resistors R1, R2 or R3. If a trip occurs and no signal appears at the input, is definitely a Logic board problem. If the problem cannot be ascertained using an oscilloscope and the problem fits this description exactly, replace the Vyper™ Logic board to see if this corrects the problem.

Fault 18: High Phase B Instantaneous Current

Message

Quantum: "Fault 18"

Quantum LX: "VSD High Phase B Instantaneous Current"

Same comments as Fault 17 except applying to Phase B Instantaneous Current

Fault 19: High Phase C Instantaneous Current

Message

Quantum: "Fault 19"

Quantum LX: "VSD High Phase C Instantaneous Current"

Same comments as Fault 17 except applying to Phase C Instantaneous Current.

Fault 21: Vyper Phase A Gate Driver

Message

Quantum: "Fault 21"

Quantum LX: "VSD Phase A Gate Driver Fault"

The unit's phase bank assembly shall contain one IGBT gate driver control board. This board monitors the saturation voltage drop across each IGBT while gated on. If the IGBT's saturation voltage exceeds the prescribed limit, the gate driver will make the determination that a short circuit is present. This will cause the unit to trip and the Quantum™ LX Panel displays Fault 21. If the driver board's power supply voltage falls below the permissible limit, this same message is generated.

A second level of overcurrent protection exists on the Vyper™ gate driver board. The collector-to-emitter voltage of each IGBT is checked continuously while the device is being turned on. This is also called the collector-to-emitter saturation voltage. If the voltage across the IGBT is greater than a set threshold, the IGBT is turned off and a shutdown pulse is sent to the Vyper™ Logic board shutting down the entire system. To diagnose the problem, first check the LED's on the gate driver board of the Vyper™ power unit. Usually one of the six LED's will be out. This clearly points to a bad gate driver, and requires replacement of the Vyper™ power module. If all LED's are lit, and the problem repeatedly occurs in one phase, swap all three pole cables at the logic board J8, J9, and J10. Plug J8 into J9, J9 into J10, and J10 into J8. If the display now reports a trip in a different phase, the problem is either in the Vyper™ power module or gate driver board, or in the cable that feeds the gate driver board from the Vyper™ Logic board. The fault could also be caused by a problem in the drive line. Ensure that the compressor is free to rotate. If the display continues to report a gate driver FLT in the same phase, even with cables swapped, the problem is in the Vyper™ Logic board. Once troubleshooting is finished, be sure to put all of the cables back into the original mating connectors. Note that a gate driver fault can be initiated when the Vyper™ is not running because a power supply has failed on the gate driver board.

Verify that the LRA value of the motor does not exceed the LRA value rating of the drive.

Fault 22: Vyper Phase B Gate Driver

Message

Quantum: "Fault 22"

Quantum LX: "VSD Phase B Gate Driver Fault"

Same comments as Fault 21 except applying to Phase B Gate Driver.

Fault 23: Vyper Phase C Gate Driver

Message

Quantum: "Fault 23"

Quantum LX: "VSD Phase C Gate Driver Fault"

Same comments as Fault 21 except applying to Phase C Gate Driver.

Fault 24: Vyper Single Phase Input Power

Message

Quantum: "Fault 24"

Quantum LX: "VSD Single Phase Input Power Fault"

The Vyper's SCR Trigger Control board contains circuitry that checks the three-phase mains for the presence of all

three line voltages. If all line voltages are not present, the unit will trip and the Quantum™LX Panel will display the message Fault 24.

This shutdown is generated by the SCR Trigger board and relayed to the Vyper™ Logic board to initiate a system shutdown. The single-phase control uses circuitry to detect the loss of any one of the three input phases. The trigger board will detect the loss of a phase within one half line cycle of the phase loss. An LED on the SCR Trigger board will indicate that the board is detecting the fault, and not a wiring problem between the trigger board and the Vyper™ Logic board. This message is also displayed every time power to the Vyper™ is restored or if the input power dips to a very low level. Usually this indicates an open disconnect switch or one of the input fuses (F1-F3) to the trigger board has failed.

Fault 27: Vyper 105% Motor Current Overload

Message

Quantum: "Fault 27"

Quantum LX: "VSD 105% Motor Current Overload Fault"

The Vyper™ Logic Board generates this shutdown by reading the current from the 3 output current transformers. The shutdown is generated when the Vyper™ Logic board has detected that the highest of the three output phase currents has exceeded 105% of the programmed 100% full load amps (FLA) value for more than 7 seconds. If this is detected, the unit will trip and the Quantum™LX panel will display the fault message. The 100% FLA setpoint is determined by adjustment of the FLA trim pot on the logic board. This fault will require clearing using the manual reset button located on the Logic board. The overload timer resides in the Field Programmable Gate Array which is programmed by the serial E²PROM on unit power-up.

Fault 28: Vyper High DC Bus Voltage

Message

Quantum: "Fault 28"

Quantum LX: "Vyper High DC Bus Voltage"

The DC link overvoltage trip level is determined by hardware on the logic board and is designed to trip the unit at 745 +/- 17 VDC for both 60 and 50 Hz VSD's. If the DC bus current exceeds this level, the unit will trip and the Quantum™LX Panel will display the message Fault 28.

If this shutdown occurs, it will be necessary to look at the level of the 460 VAC applied to the Vyper™. The specified voltage range is 414 to 508. If the incoming voltage is in excess of 508, steps should be taken to reduce the voltage to within the specified limits.

This fault may also occur if there is little to no differential between suction and discharge pressure or if the package (separator and compressor) is in a vacuum. Low starting torque may allow the DC bus voltage to overshoot as it comes up to speed. Apply pressure to the package to create differential between suction and discharge pressure or break the vacuum on the package. Ensure suction and discharge check valves are operating properly.

Fault 29: Vyper Logic Board Power Supply

Message

Quantum: "Fault 29"

Quantum LX: "VSD Logic Board Power Supply Fault"

The various DC power supplies which power the Logic Board are monitored via hardware located on the Logic Board. If

any of these power supplies fall outside the allowable limits, the unit will trip and the Quantum™LX Panel will display the fault message.

The Vyper™ Logic Board generates this shutdown and indicates that one of the low voltage power supplies for the Vyper™ Logic Board has dropped below the allowable operating limits. The power supplies for the logic boards are derived from the secondary of the 120 to 24 VAC transformer which in turn is derived from the 480 to 120 VAC control transformer. This message usually means that power to the Vyper™ was removed. If this was not the case, check the DC voltage test points on the Vyper™ Logic Board at TPC (+15V), TPD (+10V), TPE (+5V), TPF (+7.5V) and TPG (-15V) with respect to TPH (Ground). If any of these voltages are incorrect, replace the Vyper™ Logic Board. This message normally appears when the power is removed and reapplied.

Fault 33: Vyper Low DC Bus Voltage

Message

Quantum: "Fault 33"

Quantum LX: "VSD Low DC Bus Voltage Fault"

The DC link under voltage trip level must be set at 500 VDC for 60 Hz and 414 VDC for 50 Hz VSD's. If the DC link drops below this level, the unit will trip.

If the DC link voltage drops below 500 VDC for 60 Hz, or 414 VDC for 50 Hz, the Vyper™ Logic Board will initiate a system shutdown. A common cause for this shutdown is a severe sag in the AC line to the drive. Monitor the incoming three-phase AC line for severe sags and also monitor the DC bus voltage with a digital meter. If the AC line or the DC bus voltage is not dropping, check the wiring and connections from the DC bus to the Bus Voltage Isolator Board (wires 224, 225 and 226), and from this board to the Vyper™ Logic Board (wires 221, 222 and 223). Also check the associated connectors. Measure the voltage at J3 on the Vyper™ Logic Board to verify the voltage is getting to the board. If no problem is found, try replacing the Bus Isolation board (031-01624) and the Vyper™ Logic board.

Fault 34: Vyper DC Bus Voltage Imbalance

Message

Quantum: "Fault 34"

Quantum LX: "DC Bus Voltage Imbalance Fault"

The one-half DC link voltage magnitude must remain within ± 88 VDC of the total DC link voltage divided by two for both 60 and 50 Hz VSD's. If the Half DC link magnitude exceeds the ± 88 volt window, the unit will trip and the Quantum™LX displays message Fault 34.

The DC link is filtered by many large electrolytic capacitors rated at 450 VDC. These capacitors are wired in series to achieve a 900 VDC capability for the DC link. The voltage must be shared equally from the junction of the center, or series capacitor connection, to the negative bus and to the positive bus. The center point is approximately half of the total DC link voltage. When voltage is greater than ±88 VDC from the half of the total DC link voltage, then this shutdown will occur.

Verify the operation of the DC bus voltage isolation board, and all associated wiring to the Vyper™ Logic Board. Many times the actual bus voltage imbalance conditions are caused by a shorted capacitor or a leaky or shorted IGBT transistor in the power unit. In order to check for these conditions, apply a 12 VDC source (such as a battery charger used to charge automobile batteries) between the positive bus and negative

bus plates on power unit while measuring the voltage from center to plus and center to minus. The bank causing the imbalance will indicate unequal voltage readings.

Fault 35: Vyper High Internal Ambient Temperature

Message

Quantum: "Fault 35"

Quantum LX: "VSD High Internal Ambient Temp Fault"

The logic board contains a temperature sensor which monitors the unit's internal ambient temperature. The magnitude of the unit's internal temperature is compared to a limit of 145°F (63°C). If this limit is exceeded, the unit will trip and the Quantum™LX panel will display Fault 35. The fan(s) and coolant pump remain energized until the internal temperature drops below 137°F (58°C). The fan(s) and water pump will be de-energized when the internal temperature drops below 137°F (58°C).

Some potential causes for this shutdown are: internal Vyper™ fan failure, Vyper™ water pump failure or an entering condenser water temperature which exceeds the allowable limit for the job. Additional causes for the shutdown include:

- Plugged Heat Exchanger – The heat exchanger should be cleaned once a year and back flushed.
- Low Condenser Flow – The Vyper™ system requires 8 feet of head across the heat exchanger to maintain adequate GPM. If the head is less than 8 feet, correct the flow problem or add a booster pump.

Fault 36: Vyper High Inverter Baseplate Temperature

Message

Quantum: "Fault 36"

Quantum LX: "VSD High Inverter Baseplate Temp Fault"

A thermistor is located inside the IGBT Module on the Vyper™ power unit. If this thermistor detects a temperature of 175°F (79°C) or higher, a shutdown will occur. The cooling fans and coolant pump on the Vyper™ will continue to run after the shutdown, until the thermistor temperature has dropped to below 165°F (74°C). This shutdown requires a manual reset button via the reset button on the Vyper™ Logic board.

Fault 37: Vyper Logic Board Processor

Message

Quantum: "Fault 37"

Quantum LX: "VSD Logic Board Processor Fault"

This shutdown is generated if a communications problem occurs between the two microprocessors on the Vyper™ Logic Board. If this shutdown occurs, replace the Vyper™ Logic board.

Fault 38: Vyper Run Signal

Message

Quantum: "Fault 38"

Quantum LX: "VSD Run signal Fault"

Upon receipt of either of the two run commands, a 5-second timer will start. If the missing run signal is not asserted within the 5-second window, the unit will trip and the Quantum™LX panel will display Fault 38.

Redundant run signals are generated, one via wire #24 and the second via the serial communications. Upon receipt of either of the two run commands by the Vyper™ Logic board, a 5-second timer will begin. If the missing run command is not

received within the 5-second window, the Vyper™ will shut down and the Quantum™LX Panel will display the shutdown message. This shutdown may occur if there is a problem with the wiring between the Quantum™LX panel and the Vyper™ Logic board. Check the #24 to #25 horseshoe jumper in the Quantum™LX panel, and all other wiring involved in energizing #24 in the Vyper™ cabinet. Also check to ensure that the serial communications wiring between the micro board and the Interface board, and Vyper™ Logic board and the Interface board are connected properly.

Fault 39: Vyper High Converter Heat Sink Temperature

Message

Quantum: "Fault 39"

Quantum LX: "VSD High Converter Heat Sink Temp Fault"

A thermistor sensor is located behind the last SCR/Diode module on the copper chill plate of the Vyper™ Power Unit. If at anytime this thermistor detects a temperature of 170°F (76°C) or higher, a shutdown will occur. The cooling fans and coolant pump on the Vyper™ will continue to run after the shutdown, until the thermistor temperature has dropped to below 160°F (71°C). This shutdown requires a manual reset via the reset button on the Vyper™ Logic board.

Fault 40: Vyper Invalid Current Scale Selection

Message

Quantum: "Fault 40"

Quantum LX: "VSD Invalid Current Scale Selection Fault"

The J1 connector on the Vyper™ Logic board contains jumpers along with wires from the output CTs. Since the part number of the logic board is the same on all horsepower sizes, the jumpers tell the logic board the size of the Vyper™ being employed in order to properly scale the output current. If the jumper configuration is found by the logic board to be invalid, the system will be shut down and the above message, Fault 40, will be generated. The proper jumper configuration is shown on the wiring label for the Vyper™.

Fault 41: Vyper Low Inverter Baseplate Temperature

Message

Quantum: "Fault 41"

Quantum™LX: "VSD Low Inverter Baseplate Temp Fault"

The phase bank assembly heatsink temperature and the inverter module baseplate temperature are compared to a lower limit of 37°F (3°C). If the inverter module baseplate temperature falls below this limit the unit will trip and the Quantum™LX Panel displays Fault 41. Also, if both the inverter and converter temperatures fall below the 37°F (3°C) limit, the unit will trip and the fan(s) and coolant pump are energized.

This feature provides the service personnel with a means to run the coolant pump while filling the cooling system (by pulling Vyper™ Logic board plug P2). In most cases, the problem will be broken wiring or an open thermistor. Check the circuit for continuity at Vyper™ Logic board plug J2. Also make certain that one side of the circuit is not shorted to the enclosure.

Fault 42: Vyperdrive - Serial Communication

Message

Quantum: "Fault 42"

Quantum LX: "VSD Serial Communications Fault"

When requesting Status data, the response data from the Vyper™ includes a bit that indicates whether communications

were lost from the Quantum™LX Panel to the Vyper™. If this bit is high for 22 consecutive seconds, this fault occurs. This fault also occurs whenever a receive, timeout, or checksum fault is detected on the Vyper™ communications, for twenty continuous seconds. While this fault is active, the Quantum™LX Panel will attempt to reestablish the communications link. All serial input data is also cleared.

This message is generated when communications between the Quantum™LX Panel and the Frick Interface board, or the Frick Interface board and Vyper™ Logic board is disrupted for a least 22 seconds. Check the shielded cable between J11 on the Vyper™ Logic board and J8 on the Frick Interface board. Check for continuity and also check to see that none of the conductors are shorted together or shorted to ground. The terminal block in the lower left corner of the Vyper™ cabinet serves as a junction point for this cable. There is the possibility for strands of wire to bridge across the terminals at this location. If all wiring is intact, this problem may also be caused by electrical noise. Ensure that the chiller and the Quantum™LX Panel are properly ground through the Vyper™. Make certain the shield for this cable is tied to chassis ground at the Quantum™LX panel end only via a green chassis ground screw. The shield should not go to ground through the Frick Interface board. If all of this has been done and communications cannot be established, even at power-up, you may have a bad communications driver on either the Vyper™ Logic or the Frick Interface boards. Change out both the Frick Interface and Vyper™ Logic boards. If the Serial Receive fault problem only occurs intermittently during times when the unit is running, the culprit could be electrical noise.

If the Harmonic Filter is installed then the fault can be generated when the communications between the Vyper™ Logic board and the Harmonic Filter Logic board, or the Harmonic Filter Logic board and the Frick Interface board is disrupted. Also check J8 on the filter logic board and J9 on the Frick Interface board. Repeat the above procedure for the Vyper™ serial cable on the Harmonic Filter serial cable.

Fault 43: Vyper™ Precharge Lockout

Message

Quantum: "Fault 43"

Quantum LX: "VSD Precharge Lockout"

If the Vyper™ fails to meet the precharge criteria (refer to precharge faults below), then the precharge circuit will wait for a period of ten (10) seconds. During this time, the unit's cooling fans and coolant pump remain energized in order to cool the input SCR's. Following this ten-second cool-down period, precharge will again be initiated. The unit will attempt to meet the precharge criteria three consecutive times. If the Vyper™ fails to meet the precharge criteria on three consecutive tries, the Vyper™ will shut down, lock out, and display this message. In order to initiate precharge again, the Quantum™LX panel's compressor switch must first be placed into the STOP/RESET position.

Fault 44: Vyper™ Low Converter Heat Sink Temperature

Message

Quantum: "Fault 44"

Quantum LX: "VSD Low Converter Heatsink Temp Fault"

The phase bank assembly heatsink temperature and the inverter module baseplate temperature are compared to a lower limit of 37°F (3°C). If the inverter baseplate temperature or the converter heat sink temperature falls below 37°F (3°C), the message displayed is Fault 44. In addition, if both

temperatures fall below the 37°F (3°C) limit, the unit will trip and the fan(s) and water pump will be energized. This feature provides service personnel with the ability to run the water pump while filling the cooling system (by pulling VSD logic board plug P2).

A thermistor sensor is located behind the last SCR/Diode block on the copper chill plate of the Vyper™ Power Unit. If at anytime this thermistor detects a temperature of 37°F (3°C) or lower a shutdown will occur. Sometimes a thermistor wire can be pinched against the enclosure.

In most cases, the problem will actually be an open thermistor or broken wiring to the thermistor. The normal thermistor resistance is 10K ohms at 77°F (25°C). Check the circuit for continuity at Vyper™ Logic board plug J2. Also make certain one side of the circuit is not shorted to the cabinet.

Fault 45: Vyper Low Current Imbalance

Message

Quantum: "Fault 45"

Quantum LX: "VSD Current Imbalance Fault"

When the average of the three output phase currents (see section 10.1) exceeds 80% of the 100% Job FLA (see section 13.1.6), the % Output Current Imbalance is calculated using the following equation:

$$\frac{(I_a - I_{ave}) + (I_b - I_{ave}) + (I_c - I_{ave})}{2(I_{ave})} \times 100 = \frac{(I_a + I_b + I_c)}{3}$$

If the % Imbalance exceeds 30% continuously for 45 seconds, the unit trips and the Quantum™LX panel displays Fault 45. The imbalance fault is released when the average of the three output phase currents drops below 80% FLA.

Fault 46: Vyper Precharge – DC Bus Voltage Imbalance

Message

Quantum: "Fault 46"

Quantum LX: "VSD Precharge DC Bus Voltage Imbalance"

The half DC link voltage magnitude will remain within ± 88VDC of the total DC link voltage divided by two during the precharge interval for both the 60 and 50 Hz VSD's. If not, the Quantum™LX panel displays Fault 46.

The definition for this fault is identical to "VSD – DC Bus Voltage Imbalance", except that the fault has occurred during the precharge period which begins during prelude.

Fault 47: Vyper Precharge – Low DC Bus Voltage 2

Message

Quantum: "Fault 47"

Quantum LX: "VSD Precharge Low DC Bus Voltage 2"

The DC link voltage will reach at least 500 VDC within 20 seconds after the precharge signal has been asserted on the 60 Hz VSD and at least 414 VDC within 20 seconds on the 50 Hz VSD. If not, the Quantum™LX panel will display Fault 47.

The unit is shut down and this message is generated if this condition is not met. If this shutdown occurs, measure the bus voltage at the laminated bus structure, check the wiring between the Vyper™ Logic board and Quantum™LX Vyper™ trigger board, and the input SCR's, and the DC bus isolator board and the Vyper™ Logic board.

Fault 48: Vyper Precharge – Low DC Bus Voltage 1

Message

Quantum: "Fault 48"

Quantum LX: "VSD Precharge Low DC Bus Voltage 1"

The DC Bus voltage must be equal to or greater than 50 VDC for 60 Hz (41 VDC for 50 HZ) four (4) seconds after precharge has begun. The unit is shut down and this message is generated if this condition is not met. If this shutdown occurs, measure the bus voltage at the laminated bus structure, check the wiring between the Vyper™ Logic board and Quantum™ LX Vyper™ trigger board, and the input SCR's, and the DC bus isolator board and the Vyper™ Logic board.

Fault 50: Harmonic Filter High DC Bus Voltage

Message

Quantum: "Fault 50"

Quantum LX: "Harmonic Filter High DC Bus Voltage Fault"

The harmonic filter's DC link voltage is continuously monitored and if the level exceeds a range of 822 to 900 VDC, a Filter Bus Over-Voltage shutdown is initiated. The harmonic filter has its own DC bus as part of the filter power module and this DC Link is not connected in any way with the drive's DC Link. If this shutdown occurs, check the level of the 460 VAC applied to the drive. The specified voltage range is 414 to 508. If the incoming voltage exceeds 508 VAC, reduce the voltage to within the specified limits. The cause of this message will typically be high line voltage or a surge on the utility supply.

This fault may also occur if there is little to no differential between suction and discharge pressure or if the package (separator and compressor) is in a vacuum. Low starting torque may allow the DC bus voltage to overshoot as it comes up to speed. Apply pressure to the package to create differential between suction and discharge pressure or break the vacuum on the package. Ensure suction and discharge check valves are operating properly.

Fault 51: Harmonic Filter High Phase C Current

Message

Quantum: "Fault 51"

Quantum LX: "Harmonic Filter High Phase C Current Fault"

The three output lines from the 519 filter to the three-phase output inductor are monitored via two Hall effect DC current transformers (DCCT1 and DCCT2) within the drive. The third phase is derived using the equation $I_{f2} = -I_{f1} + I_{f3}$.

The unit's three phases of instantaneous output current are compared to a prescribed limit contained in hardware. If any one of these three signals exceeds the prescribed limit, the filter is stopped by inhibiting the Current Regulator Run signal for five to six input line voltage. If any one of the three signals exceeds the prescribed limit three times in 60 line cycles, the unit will trip and the Quantum™ LX panel displays Fault 51. The preset limits are as follows:

- 700/572 HP = 782 Amps
- 912/752 HP = 1225 Amps

If this shutdown occurs and the Vyper™ auto-restarts, continuing to run properly with the filter operating, the like cause is the filter tripped on overcurrent due to a sag or surge in the voltage feeding the chiller. If this message reoccurs, preventing the unit from restarting, check the filter power module for shorted transistors. This is done by measuring resistance from wires 519, 518, and 517 to the filter's positive

bus, checking in both polarities – and from 519, 518, and 517 to the filter's negative bus in both polarities. None of the readings should be less than 5 ohms.

Fault 52: Harmonic Filter High Phase B Current

Message

Quantum: "Fault 52"

Quantum LX: "Harmonic Filter High Phase B Current Fault"

Same as Fault 51 except for applying to Phase B.

Fault 53: Harmonic Filter High Phase A Current

Message

Quantum: "Fault 53"

Quantum LX: "Harmonic Filter High Phase A Current Fault"

Same as Fault 51 except for applying to Phase A.

Fault 54: Harmonic Filter Phase Locked Loop

Message

Quantum: "Fault 54"

Quantum LX: "Harmonic Filter Phase Locked Loop Fault"

This shutdown indicates that a circuit called a "phase locked loop" on the Filter Logic board has lost synchronization with the incoming power line for a period of time. This is normally an indication that one of the Filter's incoming power fuses is blown. Check filter power fuses 14FU, 15FU and 16FU if this shutdown occurs. If the fuses are OK, then check the output of the line voltage isolation board at connector J5, pins 1, 2, and 3 on the Filter logic board. With 480 VAC present on the input to the line voltage isolation board, approximately 5.2 VAC should be present from pins 1 to 2, pins 2 to 3, and pins 3 to 1.

Fault 56: Harmonic Filter Logic Board Power Supply

Message

Quantum: "Fault 56"

Quantum LX: "Harmonic Filter Logic Board Power Supply"

This shutdown indicates that one of the low voltage power supplies on the Filter Logic board have dropped below permissible operating voltage range. The filter logic board receives power from the Vyper™ Logic board via the ribbon cable which connects the two. The power supplies for the logic boards are in turn derived from the secondary of the 120 to 24 VAC transformer which in turn is derived from the 480 to 120 VAC control transformer. If this shutdown occurs, check the CR10 LED, labeled "Power Supply OK". If CR10 is not illuminated, check the ribbon cable connecting the filter logic board to the Vyper™ Logic board. If the CR10 LED is illuminated, the logic board is faulty and requires replacement.

Fault 65: Harmonic Filter Precharge High DC Bus Voltage

Message

Quantum: "Fault 56"

Quantum LX: "Harmonic Filter Logic Board Power Supply"

The DC link voltage will reach at least 525 VDC within 5 seconds after the precharge relay is pulled in on the 60 Hz 519 filter and at least 425 VDC within 5 seconds on the 50 Hz 519 filter. If these voltages are not reached, the Quantum™ LX panel displays Fault 65.

Fault 66: Harmonic Filter Precharge Low DC Bus Voltage

Message

Quantum: "Fault 66"

Quantum LX: "Harmonic Filter Precharge Low DC Bus Voltage"

The DC link voltage will reach at least 50 VDC within 100 msec after the precharge relay has been pulled in on the 60 Hz 519 filter and at least 41 VDC within 100 msec on the 50 Hz 519 filter. If these voltages are not reached, the Quantum™LX panel displays Fault 66.

This shutdown requires that two minimum voltage thresholds must be exceeded in order to complete precharge. During precharge the filter's DC bus voltage must be equal to or greater than 50 VDC (41 VDC for 50 HZ) 1/10 second after the filter precharge relay is energized. Also, the filter's DC bus voltage must be equal to or greater than 525 VDC (425 VDC for 50 HZ) within 5 seconds after the filter precharge relay is energized. The unit is shut down and this message is generated if this condition is not met. If this shutdown occurs, check the filter precharge relay, filter precharge resistors, and the wiring between the filter logic board and the filter precharge relay.

Fault 67: Harmonic Filter DC Current Transformer 1

Message

Quantum: "Fault 67"

Quantum LX: "Harmonic Filter DC Current Transformer 1"

During initialization, the output voltage of the two DCCT's that sense the filter's input current will be monitored and compared against a level of ± 147 mv (± 6010 A to D counts). If the offset error falls outside this range, the unit will trip and the Quantum™LX panel displays Fault 67. If a DCCT error fault is not encountered, an average of eight readings on each DCCT output will be taken and used for DCCT offset compensation. The three phases of VSD input current are sensed by two current transformers. The three phases of filter input current are sensed by two D.C. current transformers. The third filter input current is derived from the equation $I_{f2} = -I_{f1} - I_{f3}$.

Fault 68: Harmonic Filter DC Current Transformer 2

Message

Quantum: "Fault 68"

Quantum LX: "Harmonic Filter DC Current Transformer 2"

Same as Fault 67 except applying to Harmonic Filter DC Current transformer 2.

Fault 69: Harmonic Filter High Baseplate Temperature

Message

Quantum: "Fault 69"

Quantum LX: "Harmonic Filter High Baseplate Temp Fault"

The Filter's power module baseplate temperature (see Appendix I for thermistor temperature vs. A to D count) will feed plug J6 on the Harmonic Filter Logic board. This temperature is compared in software to a limit of 175°F (79°C) and if the limit is exceeded, the unit trips and the Quantum™LX panel displays Fault 69.

A thermistor sensor is located inside the IGBT Module on the filter power module. If at anytime this thermistor detects a temperature of 175°F (79°C) or higher, a shutdown will occur. A manual reset is required by pressing the "Overtemp Reset" push button located on the Filter Logic board. The occurrence of this message typically indicates the level of coolant in the Vyper™ cooling system is low.

Fault 71: Harmonic Filter Low DC Bus Voltage

Message

Quantum: "Fault 71"

Quantum LX: "Harmonic Filter Low DC Bus Voltage"

The DC link voltage magnitude should remain within -80 VDC of the bus voltage setpoint determined from the peak input voltage. If the DC link voltage magnitude falls outside this range for 100 msec, the unit will trip and the Quantum™LX panel displays Fault 71.

The harmonic filter dynamically generates its own filter DC link voltage by the interaction of the filter choke and switching its IGBTs. This DC level is higher than what could be achieved by rectifying the input line voltage. Thus, the harmonic filter actually performs a voltage "boost" function. This is necessary in order to permit current to flow into the AC line from the filter when the AC line is at its peak level.

This particular shutdown and the accompanying message is generated if the filter's DC link voltage drops to a level less than 80 VDC below the filter DC link voltage setpoint. The filter DC link voltage setpoint is determined by the filter logic board via the sensing of the three phase input line-to-line voltage. This setpoint is set to the peak of the sensed input line-to-line voltage plus 59 volts, not to exceed 760 volts and varies with the input line-to-line voltage. If this shutdown occurs occasionally, the likely cause is a severe sag in the input line voltage. Install a power monitor to determine if a power problem exists. Also, verify the operation of the AC line voltage isolator board, by comparing the phase to phase voltage on J5 pins 1-3. The three voltage measurements should be almost the same voltage, approximately 5.2 VAC.

Fault 75: Harmonic Filter DC Bus Voltage Imbalance

Message

Quantum: "Fault 75"

Quantum LX: "Harmonic Filter DC Bus Voltage Imbalance"

The one-half DC link voltage magnitude will remain within ± 50 VDC of the total DC link voltage divided by two during the precharge interval for both 60 and 50 Hz 519 filters. If voltage is outside ± 50 VDC, the Quantum™LX panel displays Fault 75.

The one-half DC link voltage magnitude will remain within ± 50 VDC of the total DC link voltage divided by two for both 60 and 50 Hz 519 filters. If the one-half DC link magnitude exceeds this ± 50 VDC window, the unit will trip and the Quantum™LX panel display s Fault 75.

The Filter DC link is filtered by large, electrolytic capacitors which are rated for 450 VDC. These capacitors are wired in series to achieve a 900 VDC capability for the DC link. The voltage must be shared equally from the junction of the center or series capacitor connection, to the negative bus and to the positive bus. This center point should be approximately half of the total DC link voltage.

Verify the problem exists using a pair of digital meters, measuring from the series capacitor connection point (wire 525A) to the positive bus (wire 526A), and from the series capacitor connection point to the negative bus (wire 524A). When the filter precharge relay engages, both voltage readings should register simultaneously with values that is within ± 50 VSD of each other. If the voltages are equal, check the filter bus isolator board, the filter logic board, or the wiring/connectors between the boards. Check the voltages at the input to the filter logic board, J5 pin 4 to J5 pin 5 and J5 pin 5 to J5 pin 6. The voltages should be approximately equal. If voltage are not equal, the likely cause is a defective isolator board or a loose connection.

If the voltages are balanced, the filter logic board is defective. If the voltages are not equal, check the wiring between the bleeder resistors 12RES and 13RES and the filter power

module. Also check the value of these resistors. They should be 3000 ohms nominally. If a problem is not found by performing these steps, replace the filter power module.

Fault 76: Harmonic Filter 110% Input Current Overload

Message

Quantum: "Fault 76"

Quantum LX: "Harmonic Filter 110% Input Current Overload"

The overload threshold and timer functions reside in software on the Harmonic Filter's Logic board. The unit's three phases of RMS output current are compared to the overload threshold magnitude. If this threshold is exceeded for 7 seconds the unit will trip and the Quantum™LX panel displays Fault 76. The nominal RMS current trip levels are set at 110% of the maximum expected RMS input current when running at 100% FLA and are as follows:

- 700/572 – 277 Amps
- 912/752 – 385 Amps

Fault 77: Harmonic Filter Run Signal

Message

Quantum: "Fault 77"

Quantum LX: "Harmonic Filter Run Signal Fault"

When a digital run command is received at the filter logic board from the Vyper™ Logic board via the 16-pin ribbon cable, a 1/10 second timer is begun. A redundant run command must also occur on the serial data link from the Vyper™ Logic board via the ribbon cable before the timer expires. If both signals are not received, the Vyper™ will be shut down and this Fault message will be displayed. If this shutdown occurs, check the integrity of the 16-wire ribbon cable installed between the Vyper™ Logic board and the Filter Logic board. If the problem persists, replace the Vyper™ Logic board.

Fault 81: Interface Board NovRAM Failure (Warning Only)

Message

Quantum: "Fault 81"

Quantum LX: "VSD Interface Board NovRAM Failure (Warning Only)"

The integrity of the NovRAM is verified on every power-up. A known value is written to a specified location in NovRAM, read back from that location, and compared to the value originally written. If the two values do not match, the NovRAM Failure fault is set.

Fault 82: Interface Board Motor Current Limit Override (Warning Only)

Message

Quantum: "Fault 82"

Quantum LX: Interface Board Motor Current Limit Override (Warning Only)

This warning is triggered whenever the Frick Interface Board is operating under Current Limit Override. If the Run Command signal is disengaged, any current limit in effect will be cancelled. If the Run Command signal is engaged, the actual speed command is set to the initial speed command and the Motor Current is monitored every two seconds. If the Motor Current rises above 103%, the unit enters current limit and a warning condition will be set. Thereafter, as long as the Motor Current stays above 100%, the actual speed command will be reduced by 6 RPM every two seconds.

Once the Motor Current falls below 100%, the actual speed command is increased by 6 RPM every two seconds, until the actual speed command falls within ± 6 RPM of the initial speed command, when speed returns to the initial speed command, the warning is cleared. The actual speed command is used to set the Quantum™LX Vyper™ operating speed.

Fault 83: Harmonic Filter Serial Communication (Warning Only)

Message

Quantum: "Fault 83"

Quantum LX: "Harmonic Filter Serial Communication (Warning Only)"

When requesting Status data, the response data from the Harmonic Filter includes a bit that indicates whether communications were lost from the Vyper™ to the Harmonic Filter. If this bit is high for twenty consecutive seconds, this warning is triggered. This warning is also triggered whenever a twenty-second receive, timeout, or checksum fault is detected on the Harmonic Filter communications.

This message can also occur as a background message when the chiller is running. When this message is displayed, all filter related values are unavailable. If communication is reestablished, the message will disappear and normal values will again be displayed. If this problem is encountered, the ribbon cable connecting the Vyper™ Logic board to the Filter logic board should be checked.

Fault 84: Harmonic Filter Input Frequency Out of Range (Warning Only)

Message

Quantum: "Fault 84"

Quantum LX: "Harmonic Input Frequency Out of Range (Warning Only)"

The power line frequency detected by the Vyper harmonic filter is outside the range of 58 to 62 Hz (60 Hz), or 49 to 51 Hz (50 Hz) and the Quantum™LX panel displays Fault 84. This message automatically clears when the line frequency is within range.

HARMONIC FILTER SPARE PARTS LISTS¹

MODEL 700 PART DESCRIPTION	FRICK PART #
Filter Logic Board	639A0213H38
Filter Input Fuse, 300 Amp, 500 Volt	639A0213H39
Bus Isolator Board	639A0211H42*
Line Isolator Board	639A0211H44*
Filter Trap Assembly	639A0213H40
3-Phase Filter Inductor	639A0213H41
Filter Input Contactor	639A0213H42
Snubber Capacitor, .047 MFD	639A0213H43
Snubber Resistor, 10 Ohm	639A0213H44
Electronic Current Sensor 1000 amp	639A0213H45
Filter Pre-Charge Contactor	639A0213H46
519' Filter Pole Assembly	639A0213H47
Resistor, Filter, Pre-Charge	639A0213H48
Filter Upgrade (60Hz)	639A0213H49
Filter Upgrade (50Hz)	639A0213H50

1. Shaded rows are recommended spare parts.

* Also Used On the 305 & 437HP Drives

MODEL 912 PART DESCRIPTION	FRICK PART #
Filter Logic Board	639A0214H09
Filter Input Fuse, 500 Amp, 500 Volt	639A0214H10
Bus Isolator Board	639A0211H42**
Line Isolator Board	639A0211H44**
Filter Trap Assembly	639A0214H11
3-Phase Filter Inductor	639A0214H12
Filter Input Contactor	639A0214H13
Snubber Capacitor, .047 MFD	639A0213H43*
Snubber Resistor, 10 Ohm	639A0213H44*
Electronic Current Sensor (2000 Amp)	639A0214H14
Filter Pre-Charge Contactor	639A0213H46*
519' Filter Pole Assembly	639A0213H15
Resistor, Filter, Pre-Charge	639A0213H48*
Filter Upgrade/Retrofit Kit (60Hz)	639A0214H16
Filter Upgrade/Retrofit Kit (50Hz)	639A0214H17

1. Shaded rows are recommended spare parts.

* Also Used On the 700HP Drive

** Also Used On the 305 & 437HP Drives

700 HP SPARE PARTS LIST¹

PART DESCRIPTION	FRICK PART NUMBER
U33 Battery Backed RAM VSD Logic Brd.	639A0213H01
U34 VSD Logic Brd.EPROM	639A0213H02
U45 VSD Logic Brd. EPROM	639A0213H03
U26 IEEE-519 Filter Serial Eprom	639A0213H04
U42 IEEE-519 Filter EPROM	639A0213H05
U42 IEEE-519 Filter EPROM (50Hz)	639A0213H06
VSD Logic Board	639A0213H07
Circuit Breaker 1100 Amp	639A0213H08
Metal Oxide Varistors	639A0213H09
Input / Output Current Transformers	639A0213H10
Free Wheeling Diode (1CR)	639A0213H11
SCR Trigger Brd. (60Hz)	639A0213H12
SCR Trigger Brd. (50Hz)	639A0213H13
Internal Cabinet Fan	639A0211H37*
DC Link Inductor	639A0213H14
Resistor, Pre-Charge	639A0213H15
Resistor, DC Balancing	639A0213H16
Coolant Pump @ Coolant Header	639A0211H30*
Coolant Pump @ Heat Exchanger	639A0213H17
Plate Heat Exchanger	639A0213H18
Coolant (pre-mixed)	639A0211H36*
Control Transformer 3KVA (60Hz)	639A0211H40*
Control Transformer 3KVA (50Hz)	639A0211H41*
Control Transformer 2KVA (60Hz)	639A0213H19
Control Transformer 2KVA (50Hz)	639A0213H20
Transformer 24VAC	639A0211H39*
Relay, Control Fan/Pump	639A0211H34*
10 Amp Cartridge Fuse (3Hp Oil Pump/Blower Supply)	639A0213H21
15 Amp Cartridge Fuse (5Hp Oil Pump/Blower Supply)	639A0213H22
20 Amp Cartridge Fuse (7 1/2Hp Oil Pump/Blower Supply)	639A0213H23
7 Amp Cartridge Fuse	639A0213H24
10 Amp Cartridge Fuse	639A0213H25
20 Amp Cartridge Fuse	639A0211H17*
30 Amp Cartridge Fuse	639A0213H26
Input Fuses, 1100 Amp/700 Volt	639A0213H27
Input Rectifiers 1, 2, & 3SCR (each)	639A0213H28
VSD Output Pole Assembly	639A0213H29
Board, Gate Driver	639A0213H55
Snubber Resistor, 10 Ohm	639A0213H30
Positive Bus Plate	639A0213H31
Negative Bus Plate	639A0213H32
Insulator Sheet	639A0213H33
K-1 Contactor	639A0213H34
3-Way Electronic Valve (1" port) Valve Only	639A0213H35
Electronic Valve Actuator	639A0211H62*
Operator disconnect switch (door)	639A0213H36
Fuse Holder	639A0213H37
Contactor, 3-pole, 12amp (Oil Pump)	639A0213H51
Oil Pump Starter, Overload (3HP)	639A0213H52
Oil Pump Starter, Overload (5HP)	639A0213H53
Oil Pump Starter, Overload (7.5HP)	639A0213H54
Contactor 1M	639A0213H55
Cable, Comm J16 Logic Board	639A0213H56
Contactor, 3-pole 9amp (Blower Motor)	639A0211H68*
Blower Motor Starter, Overload	639A0211H70*
Blower Motor Aux. Contact	639A0211H71*

1. Shaded rows are recommended spare parts.

* Also Used On the 305 & 437HP Drives

912 HP SPARE PARTS LIST¹

PART DESCRIPTION	FRICK PART NUMBER
U33 Battery Backed RAM VSD Logic Brd.	639A0214H01
U34 VSD Logic Brd.EPROM	639A0213H02*
U45 VSD Logic Brd. EPROM	639A0213H03*
U26 IEEE-519 Filter Serial Eprom	639A0214H04*
U42 IEEE-519 Filter EPROM	639A0213H05*
U42 IEEE-519 Filter EPROM (50Hz)	639A0213H06*
VSD Logic Board	639A0213H07*
Circuit Breaker 1200 Amp	639A0214H02
Metal Oxide Varistors	639A0213H09*
Input / Output Current Transformers	639A0214H03
Free Wheeling Diode (1CR)	639A0213H11*
SCR Trigger Brd. (60Hz)	639A0213H12*
SCR Trigger Brd. (50Hz)	639A0213H13
Internal Cabinet Fan	639A0211H37**
DC Link Inductor	639A0214H04
Resistor, Pre-Charge	639A0213H14*
Resistor, DC Balancing	639A0213H16*
Coolant Pump @ Coolant Header	639A0211H30**
Coolant Pump @ Heat Exchanger	639A0213H17*
Plate Heat Exchanger	639A0213H18*
Coolant (pre-mixed) (1 US Gallon, qty. 3 required)	639A0211H36**
Control Transformer 3KVA (60Hz)	639A0211H40**
Control Transformer 3KVA (50Hz)	639A0211H41**
Control Transformer 2KVA (60Hz)	639A0213H19*
Control Transformer 2KVA (50Hz)	639A0213H20*
Transformer 24VAC	639A0211H39**
Relay, Control Fan/Pump	639A0211H34**
15 Amp Cartridge Fuse (5Hp Oil Pump/Blower Supply)	639A0213H22*
20 Amp Cartridge Fuse (7 1/2Hp Oil Pump/Blower Supply)	639A0213H23*
7 Amp Cartridge Fuse	639A0213H24*
10 Amp Cartridge Fuse	639A0213H25*
20 Amp Cartridge Fuse	639A0211H17**
30 Amp Cartridge Fuse	639A0213H27*
Input Fuses, 1600 Amp/700 Volt	639A0214H05
Input SCR Replacement Kit 1, 2, & 3SCR	639A0214H06
Input Diode Replacement Kit (1D, 2D & 3D)	639A0214H07
VSD Output Pole Assembly	639A0214H08
Board, Gate Driver	639A0213H55*
Snubber Resistor, 10 Ohm	639A0213H30*
Positive Bus Plate	639A0213H31*
Negative Bus Plate	639A0213H32*
Insulator Sheet	639A0213H33*
K-1 contactor	639A0213H34*
3-Way Electronic Valve (1" port) Valve Only	639A0213H35*
Electronic Valve Actuator	639A0211H62**
Operator Disconnect Handle (door)	639A0213H36
Fuse Holder	639A0213H37
Contactor, 3-pole, 12amp (Oil Pump)	639A0213H51*
Oil Pump Starter, Overload (5HP)	639A0213H53*
Oil Pump Starter, Overload (7.5HP)	639A0213H54*
Contactor 1M	639A0213H55*
Contactor, 3-pole 9amp (Blower Motor)	639A0211H68**
Blower Motor Starter, Overload	639A0211H70**
Blower Motor Aux. Contact	639A0211H71**

1. Shaded rows are recommended spare parts.

* Also Used On the 700HP Drive

** Also Used On the 305 & 437HP Drives

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