Baker Hughes

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FusionPro Operations and Installation Manual

Legal Information

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Mark	Company
MOXA®	Registered trademark of Moxa Inc.

Revision History

Rev.	PR	Amendment Detail	Author	Reviewer/Approver	Effective Date
Current Revision					
A	105852	Initial Release	Gerald Otoide	Rod Smith, Jeremy Hillshafer	5 Feb 2025
Three Previous Revisions					
-	--				
-	--				
-	--				

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Introduction

The Baker Hughes FusionPro™ variable speed drive (VSD) is a voltage source inverter (VSI) low voltage VSD that gets its power from the utility supply or generator and uses a six-pulse silicon-controlled rectifier (SCR) front end to convert the incoming AC power into an intermediate DC power. The DC link comprises inductors and capacitors connected in series and/or parallel (as required per power rating). It filters (smooths out) the DC power and provides a stable voltage for the inverter section. The inverter section uses insulated gate bipolar transistors (IGBT) to convert the DC power into variable voltage variable frequency AC power which is used to drive an electrical submersible pump (ESP), or a surface motor. The VSD's inverter output could be selected to be either an ESP mode or pulse width modulation (PWM) mode depending on the application. For applications where harmonic reduction is required, the Baker Hughes FusionPro VSDs 12- or 24-pulse drives can be configured to meet such needs. The VSD is designed to meet all applications that require a variable frequency source, and it operates directly from 380 to 480 VAC 3-phase 50/60 Hertz power. The drive is compatible with both 3-phase and single-phase input operations[1].

The VSD is packaged in a weatherproof (NEMA 4, IP56) enclosure. The waterproof cabinets use a cooling system that eliminates the inefficiencies and reliability problems associated with heat pumps. Two NEMA 4 enclosure sizes – VSD 0130-260kVA and VSD 0325-520kVA – are currently manufactured.

The FusionPro™ VSD uses field programmable gate array (FPGA) technology and a FusionPro motor control (FPMC) firmware to control the speed and torque of induction motors and permanent magnet motors effectively and efficiently in real time. The VSD is equipped with the FusionPro Control System which has several features that provide advanced communication capability, extensibility, and functionality. It has powerful processing capabilities and provides effective system control, monitoring, logging, interfacing, secure remote serviceability, and communications to meet and exceed the requirements of modern applications. It includes WI-FI and TCP/IP ports that classify it as an Industrial Internet of Things (IIOT) endpoint. More information about the functionality and capabilities of the FusionPro control system can be found in the FusionPro System Controller manual (PN 500031487).

[1]Single phase operation is also possible (consult an applications specialist for assistance concerning this non-typical, specialized application).

Features/Functions and Benefits

Features/Functions	Benefits
Connectivity, telemetry ready	Allows network connection or remote operation
Downloadable configuration files	Ease of multiple drive setup
Control system expandability via MOXA modules	Flexibility in system design and configuration
Field upgradeable software	Drive does not have to be removed from the location to modify or upgrade software
Automatic and continuous data log function	About six months of recorded data without user configuration or intervention
Surface mount electronics technology	Smaller circuit boards with fewer connections lead to higher reliability
Redundant backup of data and operating due to failure	Reduces the chance of data and protection loss parameters
Date/time stamp of event, shutdown history, and log data	Helps identify problems or trends
Diagnostic/alarm windows automatically pop up	Automatic display of problems without operator security clearance
Enclosures comply with industrial standards NEMA 4 (IP56)	Reliable operation in any environment
ESP or sine-wave filter (SWF) PWM	Two drive options (ESP and SWF PWM) are available depending on the output waveforms required for an application
Power ride through, backspin detection and startup, MaxStart, MaxRate Gas Prime, and IIoT	Increase uptime
Smart motor load protection, pump curve protection, output transformer saturation protection, and auto cable voltage compensation	Increased operation reliability
Flexible control, MaxRate Gas Control, MaxPoint plus, Hz to PID on the fly	Optimized production
This drive family implements the foundation FusionPro human-machine interface (HMI) that integrates and expands upon the functionality of legacy BH drive HMIs.	Maintenance and operations personnel need to learn the interface only once

Safety

Safety Recommendation

- It is required that all qualified electrical maintenance personnel read and understand this manual in its entirety before installing, operating, or servicing this drive.
- The drive must only be installed and serviced by qualified and authorized personnel following the guidelines in this manual, relevant installation guides, and all applicable local and national electrical codes.
- Thorough checks must be made to ensure all power sources are disconnected before installation, maintenance, and repair jobs.

⚠ WARNING

FusionPro VSDs require and produce potentially lethal voltage levels. Failure to comply with the safety recommendations may lead to death, serious personal injury, and/or equipment damage.

⚠ WARNING

When the FusionPro VSD is connected to customer systems through communication protocols such as RS232, RS485, and Ethernet, it may be started/stopped remotely without warning.

Injury or death may occur if the communication protocol is not disengaged and locked out during all maintenance activities.

- Coordinate with all applicable parties involved with the control and monitoring of the VSD.
- Disengage and lock out the start/stop capability of the communication protocol for the duration of the maintenance activity.

- All warnings, cautions, notes, and instructions must be followed.
- Appropriate PPE shall be used as required for each related task. More information can be found in the document 2013_ESA_Complete_Handout (NFPA 70E section H).
- This drive may contain SCADA or telemetry connections causing automatic starting. To prevent unexpected starts, the service person must disconnect any communication devices attached to the drive. When performing maintenance or troubleshooting, always assume communication protocols are being utilized and take appropriate action.
- Ensure Earth ground is properly bonded before making any contact with the drive or attached equipment. See Figure 25.

- Serious or fatal electrical shock or burns may result from failure to isolate the incoming electrical power source(s) before servicing (follow NFPA 70E Article 120). Be aware that multiple power sources may be present.
- Do not connect or disconnect wiring while power is applied to the drive.
- Do not remove covers or touch any components while the power is on.
- Do not bypass the internal power switches or circuit breakers of the drive for any reason.
- Verify that the rated voltage of the drive matches the voltage of the incoming power supply before applying power.
- Replace any protective covers or shields that may have been removed during servicing before applying power to the drive.
- Do not connect or operate this unit with visible damage or missing/removed parts.
- This unit may start unexpectedly upon application of power. Clear all personnel from the drive and other connected equipment and/or remove any mechanical hazards that may be present before power is applied to this drive.
- This drive contains Electrostatic Discharge (ESD) sensitive parts and assemblies. Static control precautions are required when installing, testing, or servicing this unit.
- Connected downhole motor may generate back-fed voltage. Once all drive incoming power is removed, isolate downhole motor power potential at the vented junction box before servicing.
- Any unauthorized modifications not provided, installed, or approved by Baker Hughes may result in the following:
  - injury or death
  - serious property or environmental impact
  - damage or failure of the equipment
  - voiding the unit certification
  - voiding the product warranty
- Baker Hughes is not responsible for any unauthorized use of the equipment; such use may impede physical and software protections provided by the equipment.
- This equipment contains a Wi-Fi module (FCC ID: N6C-PMACS and ISED ID: 4908A-PMACS) which operates at 2.4GHz and 5GHz (802.11 a/b/g/n/ac). The integration of this module has been tested and found to be within the limits of FCC Part 15 and should not cause harmful interference. The antenna supplied with the system must not be modified in any way. Only a replacement of the same antenna type and gain is permitted.
- This equipment meets the electromagnetic compatibility requirements of IEC/EN 61800-3 category 3 environments for the EMC Directive 2014/34/EU and FCC Part 15. Electromagnetic compatibility impact must be considered for any alternate component changes, add-ons, or enclosure alterations of this equipment.
- In areas with high humidity or significant temperature fluctuations, it is advisable to use continuous heating with heaters to minimize the risk of condensation. For more details or to purchase a heater kit, please contact your sales representative.

- **Warning!** Motor overload must be properly set for motor protection. Details on this can be found in Appendix F: Motor Overload ProtectionAlso, see safety topics in Figure 9.
- Ensure equipment is powered down at least 300 seconds and that the capacitors are discharged to a safe level below 50VDC before servicing to avoid the risk of potentially lethal electrical shock from energy stored in drive (capacitors).
- **Warning!** DC bus capacitors can store lethal energy. Before servicing, verify their voltage is safely discharged by measuring at points shown in Figure 1 below for 2N4 and 4N4. Voltage must be below 50VDC. See the safety topic in Figure 13.

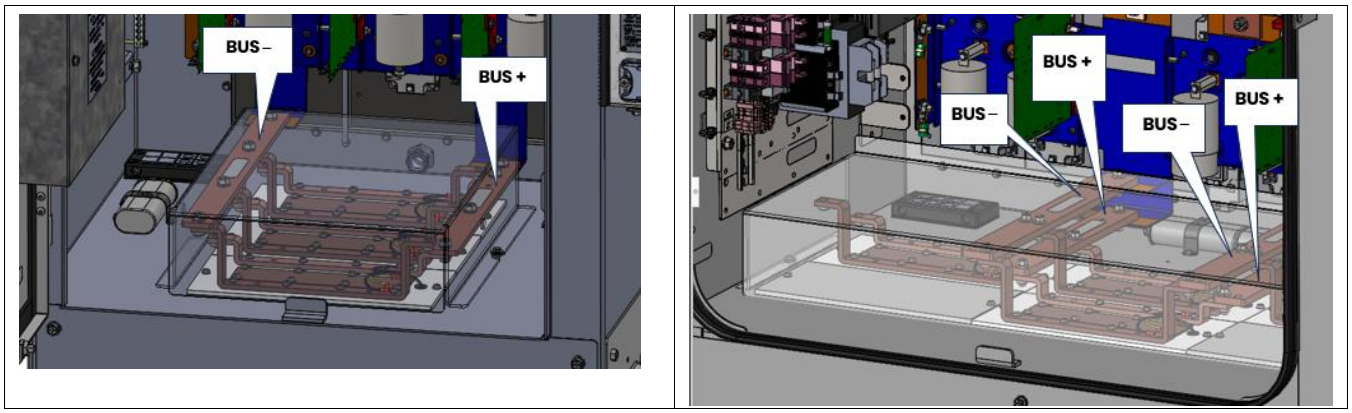


Figure 1: DC Bus voltage measurement locations.

Common Safety Conventions

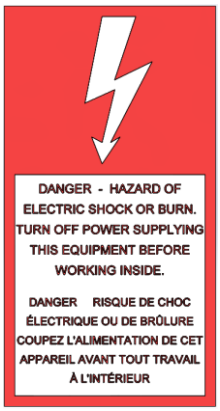
DANGER indicates a hazardous situation which if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation which if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation which if not avoided, could result in minor or moderate injury.

NOTICE indicates instructional information for proper equipment management.

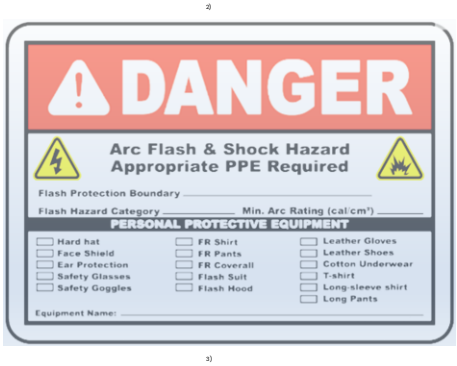
FusionPro VSD Safety Labels and Descriptions



This is a danger label. Drives are powered by sources with high potential energy that operate on lethal voltages. All prospective energy sources should be removed per LOTO procedures before entering the enclosure to do work or make observations.

Figure 2: Danger Label: Shock Hazard

This is an arc-flash danger label. There is an inherent potential for an arc flash explosion with this equipment. The upper label is included on all drives to warn of the potential hazard. Before working on or around any of this equipment, perform a Hazardous Risk Assessment to determine the appropriate PPE necessary for the task to be performed.



In North America, installation sites must be assessed per NFPA 70E or CSA Z462. After installation, another label should be attached by a qualified evaluator indicating the calculated arc-flash risk for the system.

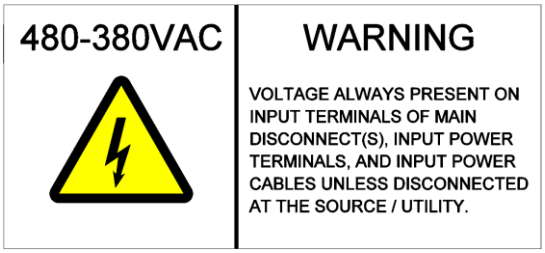
Figure 3: Danger Label Arc-Flash

Although the drive's molded case circuit breaker(s) cuts offline voltage from the main cabinet, it remains present in the junction box at the line side of the MCCB(s). Upstream power should be removed before entering this compartment. Otherwise, appropriate PPE is required to access the junction box.

Figure 4: Danger Label: "Disconnect Source."

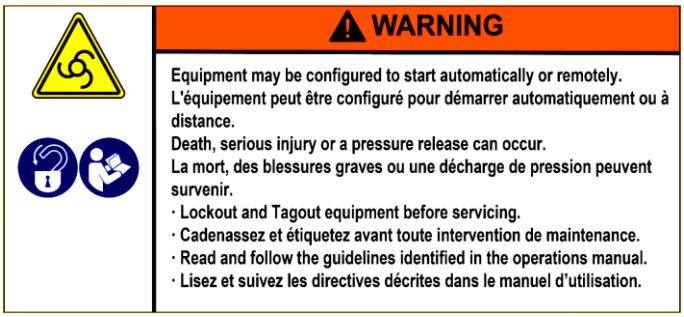
The electrical warning symbol is a lightning bolt mark enclosed in a triangle. The electrical warning symbol is used to indicate locations where hazardous voltage levels are present and conditions may cause serious injury if proper precautions are not followed.

Figure 5: Electrical Warning Symbol



This label is present to notify of the allowable operating voltage range. Note that it is necessary to modify tap settings on all control power transformers if a lower voltage is used than 480V input that is typically pre-configured. It also reminds one that the line side of molded case switches or circuit breakers is energized until isolated from source power.

Figure 6: Warning Label: "380~480V Input."



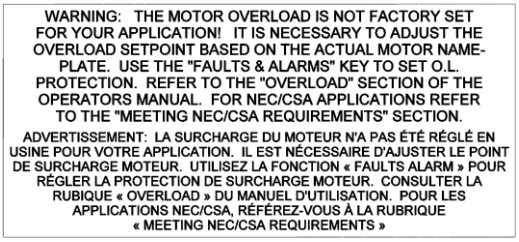
FusionPro drives are capable of being started remotely via SCADA or other telemetry control devices. Perform LOTO, then disable all added remote-control interfaces when servicing and troubleshooting. Do not restore remote operability until related tasks are completed. It is best practice to always communicate the service activities with the control room before starting work.

Figure 7: Warning Label: "Automatic Start"

This is a Back-spin regeneration warning label. Back-spinning motors can generate lethal voltages, especially those having permanent magnets. Pressure kicks in an ESP well system can also cause rotation, thus impressing voltage across the motor leads. After ensuring voltage is no longer present on the system output, motor lead wires should be isolated at the vent box as part of the related LOTO process. Appropriate PPE and test equipment must also be implemented to ensure safety, and this work must only be performed by qualified personnel.

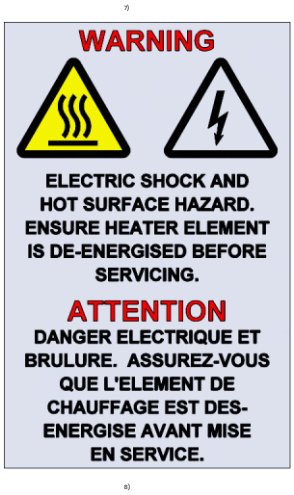
DANGER: Medium Voltage (up to 5kV) may be present at the vented junction box. Ensure a properly rated voltage indicator is used to prove the circuit is dead.

Figure 8: Warning Label: "Back-spin Regeneration"



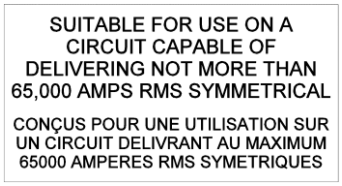
This is a warning label concerning the drive's motor overload setting. By default, a new drive is configured to shut down based on the drive's maximum current capacity. For typical applications, the drive's power rating exceeds the motor's power rating by a nominal amount. To ensure proper setup of the drive's motor protection algorithm, navigate to the Motor Overload screen by selecting the Faults & Alarms menu from the Main menu and setting the motor overload based on the nameplate current rating of the motor. Refer to Section 3.10 of the FusionPro System Controller Manual for more information on motor overload setup. For further details see Appendix F: Motor Overload Protection.

Figure 9: Warning Label: "Motor Overload Setting"



This label warns that the drive's internal heater may cause local surface temperatures to exceed normal conditions (> 55°C). Furthermore, the heater may potentially be energized with line voltage (380~480V). This label is typically located on the heater chassis.

Figure 10: "Warning Label:" High Heater Voltage and Temperature""



FusionPro VSDs must not be connected to a source (input transformer) having a short circuit capacity greater than 65000 Amps. Else, the drive's circuit protection system may fail to operate as intended.

Figure 11: Warning Label: "Short Circuit Current"

The Zenith surface board supplies roughly 120 VDC to the down-hole sensor to energize its circuits. DC voltages in this range can cause involuntary muscle reactions, discomfort, and other unexpected reactions. Avoid making contact with the sensor's circuit when energized.

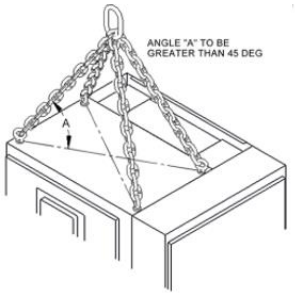
Figure 12: Warning Label: "ZIU Voltage"

Drives implement capacitors that manipulate electrical energy in a high-voltage state. Bleeder resistors are included in the circuit to attenuate this voltage, but it takes time to reach a safer, low-voltage state. Allow at least 300 seconds after removing power and performing LOTO procedures before accessing internal power circuits, and always prove circuits dead while wearing appropriate PPE. To measure see Figure 1.

Figure 13: Caution Label: "Capacitor Discharge"

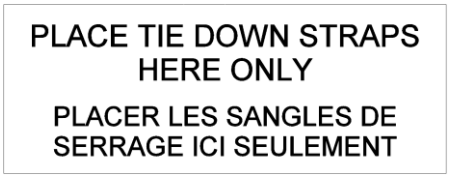
Correct system grounding and equipment bonding are required to ensure the proper functioning of the equipment's protective circuits. Grounding and bonding conductors provide a path to ground for lethal fault currents and voltages. Failure to correctly ground and bond equipment can lead to equipment damage, personnel injury, or death. This label is located at the ground bar inside the drive's J-box. Reference the installation procedures in this manual for more details.

Figure 14: Notice Label: "Ground"



Drives are equipped with dedicated lifting points that should be used for top lifting. For further details, see information in the Shipping and Handling section of this manual.

Figure 15: Notice Label: "Lifting Points"



When transporting a drive, straps should be used to strengthen anchoring by adding securing forces above its center of mass. However, certain surfaces may lack structural integrity for this purpose. This label indicates acceptable strapping locations. For further details, see information in the Shipping and Handling section of this manual.

Figure 16: Notice Label: "Strapping"

If equipped, this label indicates that the drive has been evaluated and certified by TUV Rheinland to meet safety requirements per US and Canadian standards for Adjustable speed electrical power drive systems.

Figure 17: Notice Label: "TUV C-US"

If equipped, this label indicates the drive has been evaluated and certified by TUV Rheinland of NA to meet the listed European Normative (EN) safety requirements.

Figure 18: "Notice Label: "TUV T-Mark"

If equipped, this label indicates the drive has been evaluated by the manufacturer and found to be compliant with all the applicable European Union Directives.

Figure 19: "Notice Label: "CE Mark"

FusionPro drives have QR codes on the front door to scan to gain access to related support documentation using a smartphone or other capable devices. Use these ongoing links to access and download the latest documentation.

Figure 20: "Notice Label: "QR Codes"

This equipment can produce noise levels greater than 70dB. Ear protection should be considered when working near this equipment for an extended period. Review local regulations to determine if ear protection is required.

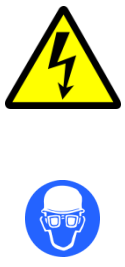
Figure 21: "Warning Label: "Ear Protection"

Personal Protective Equipment (PPE)

The basic personal protection equipment (PPE) required for field service includes but is not limited to, steel-toe shoes, safety glasses, and a hard hat. If electrical configuration or maintenance is performed on potentially energized circuits, personal protective equipment is required to minimize the danger of electrical shock, arc flash, and/or arc blast. The level of PPE required can vary based on the available electrical energy available at the installation site. To verify the absence of voltage, the minimum **hazard risk category 2 garments** and high-voltage safety gloves are recommended. If any doubt exists, consult, and employ the recommendations published in the National Fire Protection Code, NFPA-70E.

Electrical Disconnect Handle with Interlock and Override

The electrical disconnect on the FusionPro VSDs has an interlock feature which will not allow it to be turned on unless the cabinet door is closed. The technician can temporarily override this safety feature by turning the interlock with a slot screwdriver. This allows the cabinet door to be opened while the drive continues to operate, and power is still applied. Note that hot work is strongly discouraged, and appropriate arc flash PPE must be worn when opening cabinet doors while the drive is energized.



⚠ DANGER

High Voltage Shock

Death or serious bodily injury

- Operate per manufacturer's specification.
- Ensure all required PPE is used.

Shipping and Handling

The center of gravity of the FusionPro VSD is high and as such much care needs to be taken when moving the drive to avoid tilting over and damaging the equipment. The FusionPro drive cabinet is specially designed so it can be moved either from below on a pallet with a forklift or from above using the designated lifting points. It is important to be mindful of the high center of gravity of the drive when lifting it from below to avoid tipping. Following ASME B30.26 – Ringing Hardware, the four lifting points indicated on the drive shall be used when the drive is to be lifted from the top as shown in Figure 222 below. Please refer to Appendix A: Drive Specifications and Ratings for the size and weight of specific drive models.

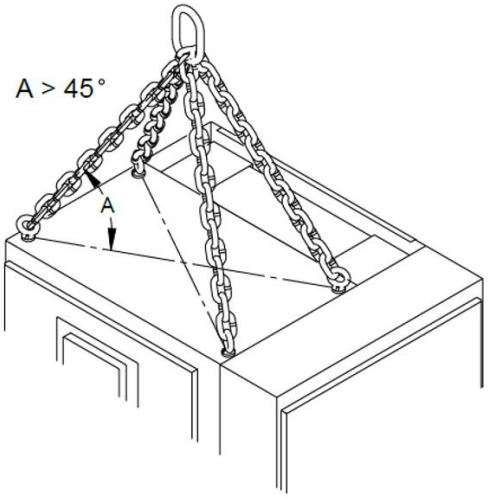


Figure 22: Standard Overhead lifting method for safe movement of FusionPro VSDs

The FusionPro VSD enclosure should be securely fastened to any vehicle used to transport the unit. Use tie-down ropes or straps to immobilize the unit during shipping and prevent shipping damage. To prevent damage during transportation, the unit must not be shipped in corrosive atmospheres.

NOTICE	Route straps over left and right enclosure walls or through the provided tie down points to prevent the possibility of strap working its way loose during transit. Each strap should have a twist between eyelets to prevent paint damage during transit.

Figure 23: Strapping details.

Safety/Commissioning Checklist

Safety Checklist

The following are the general safety guidelines.

- Visual inspection for obvious shipping damage. Do not proceed if damages jeopardize the electrical or mechanical integrity of the equipment.
- Ensure correct application. The drive nameplate data, transformers, and load must be compatible.
- Remove all packing materials such as tape, foam, shipping restraints, and padding.
- Safety information and instructions must always be available for the personnel or operator at the user site at any time.
- Before starting any tasks, personnel must have carefully read and understood the safety instructions.
- If any part of this manual is lost or misplaced, the operator is obligated to find the replacement or download the latest version from the BH website.
- Keep all safety precaution signage on the equipment in legible condition, the operator (equipment owner) is responsible for replacing safety labeling which is no longer legible.
- In addition to this manual, follow all local accident and hazard-prevention regulations or general safety regulations that may apply to the equipment.
- This equipment must only be commissioned, decommissioned, and maintained by authorized, certified trained personnel.
- The intended use of the equipment should only be for the purposes described in this manual and any misuse may result in damage to the equipment or unintentional safety hazards.
- This equipment must not be installed or operated in potentially explosive atmospheres (outside of Class 1 Div 2 zone).
- Ensure adequate clearance from obstructions (see Equipment Placement and Mechanical Installation).

- Ensure the Foundation is secure and adequate (see Equipment Placement and Mechanical Installation).
- All electrical panel doors are equipped with a lockable means and should be secured to prevent unauthorized access.
- If this product carries the certified mark by TUV Rheinland, any unauthorized part substitutions or modifications will void this certification.

Commissioning Checklist




⚠ DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

- Ensure Earth ground is properly bonded prior to any contact with this equipment.
- Only qualified personnel are allowed to install and commission this equipment.
- Arc-Flash Hazard: Never take internal electrical measurements without proper PPE, including goggles, gloves, helmet, and arc-flash suit. When situations allow, avoid working with doors open and/or covers removed.
- Serious or fatal electrical shock may result from failure to isolate the incoming power from the drive electrical power source.
- Always Lock-Out/Tag-Out (LOTO) all incoming power at the source/utility before opening the enclosure to create a safe work condition (per NFPA 70E Article 120). Be aware there may be multiple power sources present. Verify the absence of voltage by wearing the proper safety equipment equivalent to Hazard Risk Category 2 garments and high-voltage safety gloves.
- Allow at least 5 minutes for bus capacitors to discharge or until the voltage is less than 50V prior to opening the enclosure.
- This equipment may contain SCADA or telemetry connections causing automatic starting. To prevent unexpected starts, always Lock-Out/Tag-Out (LOTO) equipment before servicing.
- Connected downhole motor may generate back-fed voltage. Once all drive incoming power is removed, isolate downhole motor power potential at the vented junction box prior to servicing.

A detailed lock out tag out (LOTO) procedure can be found in the Energy Isolation (LOTO) Document under Wellsite Safety.

The sequence of steps below should be followed when first commissioning a drive.

- Steps involving VSD in LOTO state (lock out tag out)
  - Input wire size, quantity, routing, and securement (see Power Wiring Requirements & Table 4)

- Output wire size, quantity, routing, and securement (see Power Wiring Requirements & Table 4)
- Ground wire size, routing, and securement (see Power Wiring Requirements & Table 4)
- Control wires per site requirements.
- Check the torque on all power cable connections, any phase shift transformers, incoming power connections, output power connections, and step-up transformer connections.
- Check that CPTs are tapped for the expected input voltage range (380/427/480 V).
- Check the step-up transformer ratio is correct (dictates correct output voltage).
- Confirm the phase sequence wiring of any phase shift transformers for multi-pulse converter configurations is correctly sequenced.
- Initially leave drive's power output disconnected in preparation for ensuing verification tests.
- Check the torque on all power cable connections, (see Table 8), any phase shift transformers, incoming power connections, output power connections, and step-up transformer connections.

- Steps with drive powered up (ESP applications)
  - Confirm the drive input voltage level is correct (requires proper PPE).

DANGER

High Voltage Shock

Death or serious bodily injury

- Operate per manufacturer's specification.
- Ensure all required PPE is used.

  - Confirm the phase sequence wiring of any phase shift transformers for multi-pulse converter configurations is correctly sequenced.
  - Check the drive model on the nameplate and confirm it matches the model indicated on the HMI.
  - Using nameplate ratings and the motor parameters, navigate to the Setup menu and program the parameters on the Drive Setup and Load Setup screens on the HMI.
  - Navigate to the Faults & Alarms menu and program the overcurrent values, undercurrent values, overvoltage threshold, undervoltage threshold, input voltage unbalance threshold, and overload set point.
  - With the drive's power output disconnected, perform a No-load test by starting and running the drive to ensure it reaches the set frequency (tests the converter section).

Note: Please ensure to enable the Volts per Hertz (V/Hz) feature before performing the No-Load test

- Shut down drive then perform LOTO in preparation for the following step.
- Connect the drive output to the step-up transformer and down-hole motor. Reference the FusionPro Troubleshooting manual (PN 500032468) for the detailed shorted-output test procedure.
- Ensure site is safe then remove LOTO.
- Power up the drive and start the downhole equipment. Note: FusionPro drive can generate output up to 140 Hz (6 Step option) or 200 Hz (SWF option). Before adjusting the output frequency, ensure downhole equipment is rated to operate at the specified frequency.
- While loaded monitor the drive output power currents and/or the output step-up transformer currents and discharge pressures to confirm correct motor rotation.
- Measure the drive's incoming power currents with a clamp on the meter to evaluate the percentage of drive load to the predicted values and assess the accuracy of the current sharing algorithms if any phase shift transformers are used.
- Measure the drive output power currents with a clamp on the meter and compare them to the displayed current data on the HMI (instrument measurement = HMI measurement +/- 5%).
- The next two steps must be performed by certified trained personnel.
- Measure the step-up transformer output power currents with a clamp on the meter and use the drive output power currents (these should be equal to the step-up transformer input power currents); evaluate the actual step-up transformer ratio to the calculated/desired value.
- Measure the phase shift transformer input voltages, phase shift transformer output voltages, drive input voltages, drive output voltages, and step-up transformer input voltages to confirm minimal voltage drop under loaded conditions.
- Do not measure the step-up transformer's output voltages unless the proper equipment is available and medium voltage electrical system training has been completed.
- Evaluate the measured motor load to predicted values at the particular operating frequency.

⚠ WARNING

Do not measure the step-up transformer's output voltages and currents unless the proper equipment and PPE are available and medium voltage electrical system training has been completed.

- Monitor the drive output currents and/or the output step-up transformer currents and discharge pressures to confirm correct motor rotation.
- Measure the step-up transformer's input and output currents with a clamp-on meter to evaluate the actual step-up transformer ratio to the calculated/desired value.
- Measure the step-up transformer output currents with a clamp-on meter and read the HMI's output currents to verify proper configuration and agreement of values.
- Measure all the phase-shift transformer output voltages, drive input voltages, drive output voltages, and step-up transformer input voltages to confirm minimal voltage drop under loaded conditions.
- Evaluate the measured motor load to predicted values at a particular operating frequency.

**** Note that measuring equipment may be inaccurate at frequencies outside of 50/60 Hz ****

Installation

Initial checks

Before installing the FusionPro drive, check the unit for:

- Physical damage to drive and visual damage to the shipping container or cabinet.
- Remove all packing materials such as tape, foam, shipping restraints, and padding.
- Correct application. The drive nameplate data, transformers, and load must be compatible.
- Internal connections. Ensure all circuit boards, cables, components, and connectors are secure.

Equipment Placement and Mechanical Installation

Surface equipment used in conjunction with Electric Submersible Pumps should be placed in accordance with American Petroleum Institute Recommended Procedure 11S3 (API RP11S3). To prevent exposure to explosive gasses and provide adequate access to equipment, the drive system (transformers, VSD, filters, etc.) should be placed at least 50 ft (15 m) from the wellhead. The main power service should be located no closer than 100 ft (30 m) from the wellhead and the drive should be placed at least 50 ft (15 m) from the wellhead. See Figure 244 for details.

Secure the drive to a surface that is structurally sound, flat, level, and non-flammable, (such as a concrete pad) through the mounting holes in the enclosure base using only mounting hardware designed for use with the pad material. See “Outline & Anchor Dimensional Diagrams” in the Appendix (Figure TBD) for recommended pad dimensions, critical drive dimensions, drive weights, wiring interfaces, etc. A minimum of 6 inches of space should be maintained on all four sides of the drive to allow sufficient cooling airflow across heat sinks and fan intakes as well as providing easy access for servicing and cable entry. Service access points for low-voltage electrical equipment require 1 meter (3 ft) minimum opening clearance, or as required per local ordinances.

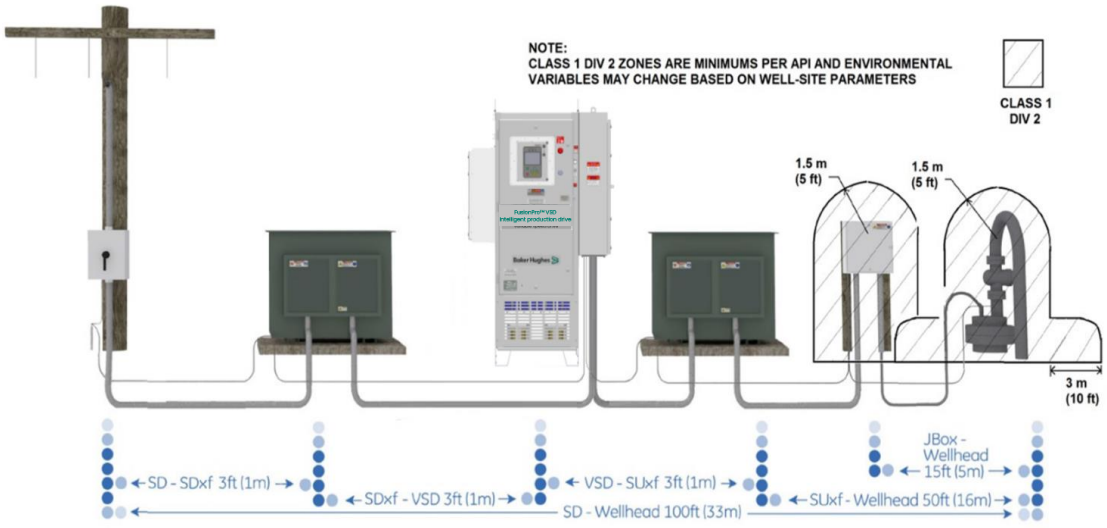


Figure 24: Typical Site Equipment Placement

Electrical Power Installation

Service Requirement

FusionPro Drives are assessed as protective ground class 1 per IEC 61140 and overvoltage category 3 per IEC 60364-4-44 and IEC 60664-1. They are designed to be used in T-N networks (solidly grounded wye source, grounded neutral point). However, using phase-shift (multi-pulse) transformers typically makes it impractical to obtain a neutral point from the transformer secondary for service grounding purposes. Per NEC 250.21 and CEC 10-106(2), grounding is not required, but the transformer must be dedicated solely to powering the drive. Furthermore, ground detectors are required, and the system must be marked “Caution: Ungrounded System Operating — 480 Volts Between Conductors”. If installing the drive on other grounded systems, contact your Baker Hughes representative for assistance.

Main service amperage requirements are based on drive kVA and motor load calculations. An appropriately sized service disconnect is required between the service source and the drive. Powering drives from pole-mounted 380/480V transformers is discouraged and requires appropriate transient suppression upstream from the drive’s service entrance to ensure category-3 service compliance. If the equipment is installed in North America, it is necessary to perform an arc-flash study per NFPA 70E or CSA Z462 and label the equipment accordingly. To minimize arc-flash protection requirements calculated from the study, avoid oversizing the power rating of the system’s service transformer. Furthermore, the short-circuit current rating for both the VSD 130-260kVA and VSD 325-520kVA FusionPro drives is 65 kA.

Grounding and Bonding Requirements

Correct system grounding and equipment bonding are required to ensure the proper functioning of the equipment’s protective circuits. Grounding and bonding conductors provide a path to ground for lethal fault currents and voltages. Failure to correctly ground and bond equipment can lead to equipment damage, personnel injury, or death.

Service wye point (when available) and enclosures, including the service disconnect switch, must be connected to a common ground conductor and grounding electrodes. Refer to the local electrical authority for approved grounding electrodes and methods for the installation site. System ground resistance ideally should be less than 5 Ohms to the ground and should not exceed 25 Ohms to the ground. Ground resistance checks should only be made by qualified electrical inspection agencies. A bonding conductor must be connected from the main grounding electrodes to all enclosures, junction boxes, buildings, electrical pipes, and the wellhead (see Figure 244). When powering loads, the “touch current” through the drive’s protective earthing conductor will exceed 3.5 mA a.c.

FusionPro drives are equipped with a ground point inside the junction box for connecting bonding conductors (see Figure 255). It attaches to the internal ground bus of the enclosure. The bar includes a mechanical lug for wire ranging from 6 AWG to 250 MCM (16 to 185 mm2) along with 8 holes for other user connections. The recommended size for a single-wire bonding connection (per system kVA as deciphered from NEC 250.66) is listed in Table 4, along with the bonding wire size that is included with the recommended armor cable (that can also be used for system bonding).

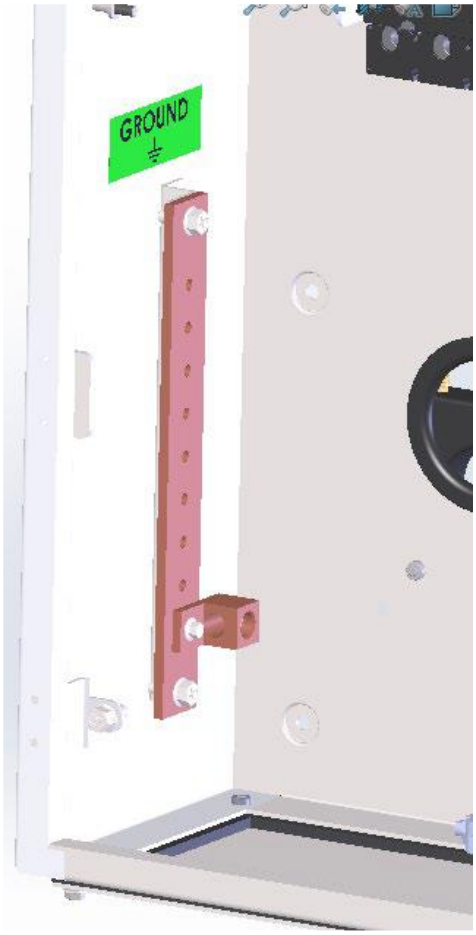


Figure 25: Grounding the FusionPro Drive and Enclosure

Power Wiring Requirements

Correct power wire selection, including ampacity, insulation dielectric strength, and insulation temperature are critical to the safe operation of the system. Furthermore, power wires must be protected from damage and unintended access using methods that meet NFPA 70 (NEC or equivalent) standards. Failure to follow installation guidelines can lead to equipment damage, personnel injury, or death.

FusionPro drives are powered with 3-phase voltage (typical, or up to 12-phase) ranging from 480V down to 380V. The rated output currents of the VSD 130-260kVA and the VSD 325-520kVA drives (see Table 7) indicate that significant wiring ampacity is required for installation. Details on this are indicated in Table 8 (Appendix). Furthermore, in extremely hot environments the air temperature inside the junction box can reach 70°C. Therefore, it is crucial to adhere to wiring requirements and follow component recommendations indicated in Table 8 (Appendix.). To maintain the ingress integrity of the enclosure, penetrations must be made with glands or techniques implementing NEMA-4 components. The bottom of the junction box is equipped with a removable ferrous gland plate for installing input and output wires/cables. To avoid unwanted eddy currents, a tri-symmetric 3-phase set (-120°, 0°, +120°) or comparable phase-shifted group variants should pass through each penetration (see Figure 266). Approximate gland plate dimensions and power-connection dimensions are indicated in the Outline and Anchor drawings for 2N4 (PN 500031777) and 4N4 (PN 500031977) in the Appendix.

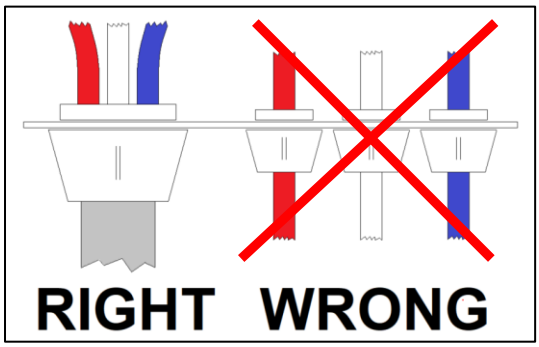


Figure 26: Ferrous Gland Plate Wiring Technique

Input and output connection points in the j-box are indicated in **Error! Reference source not found.**. Input wires should be routed to the mechanical lugs on the bottom side of the molded case circuit breaker. Use extreme care to ensure that phases are not crossed (using color tape to mark phases is recommended). Route incoming wires such that they do not interfere with operating mechanisms. For VSD 130-260kVA and VSD 325-520kVA, the output wires are routed from mechanical lugs on the power distribution blocks on the right side of the J-box. Wire range for related lugs and recommended fastening torques are listed in Table 8 (Appendix).

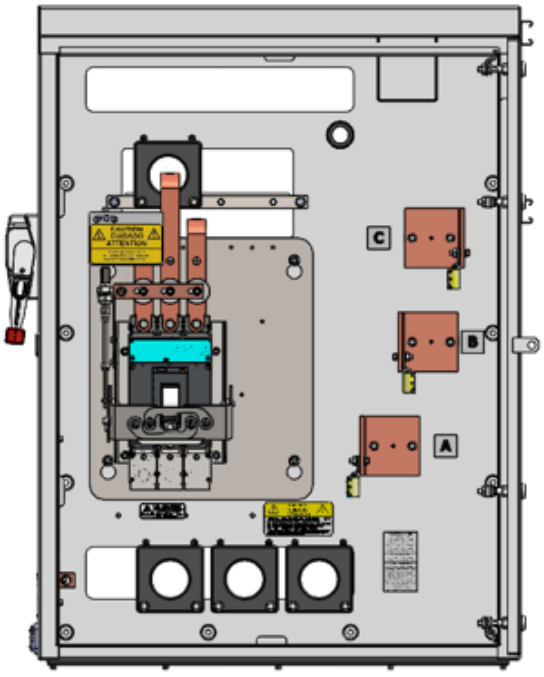


Figure 27: VSD 130-260kVA 6 Pulse J-Box

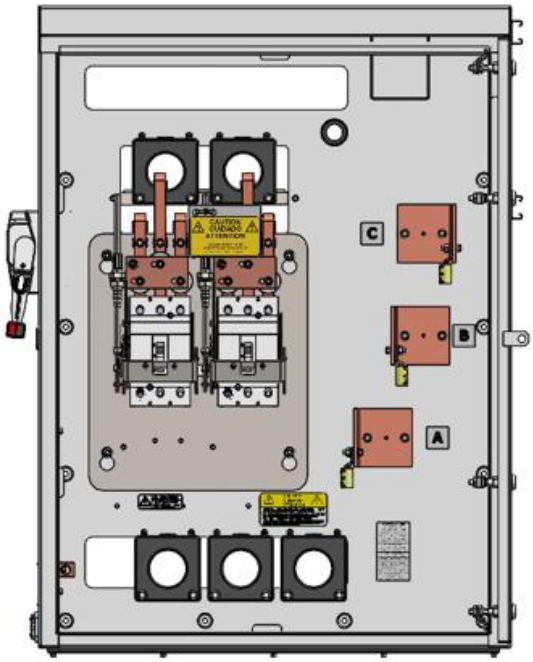


Figure 28: VSD 130-260kVA 12 Pulse J-Box

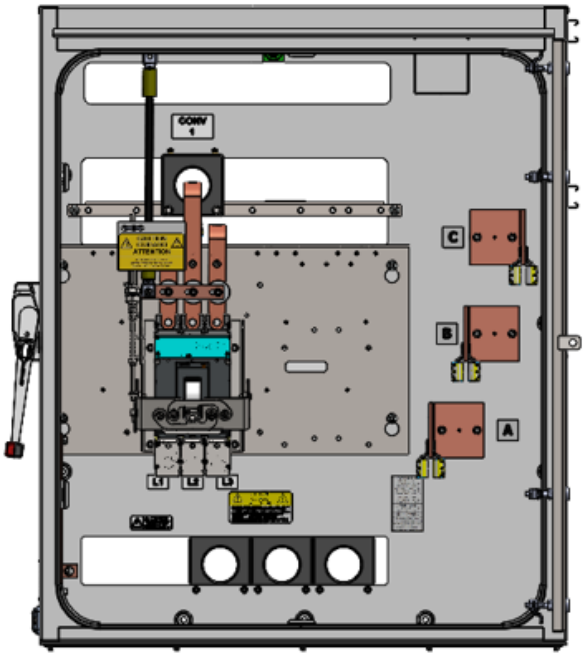


Figure 29: VSD 325/390kVA 6 Pulse J-Box

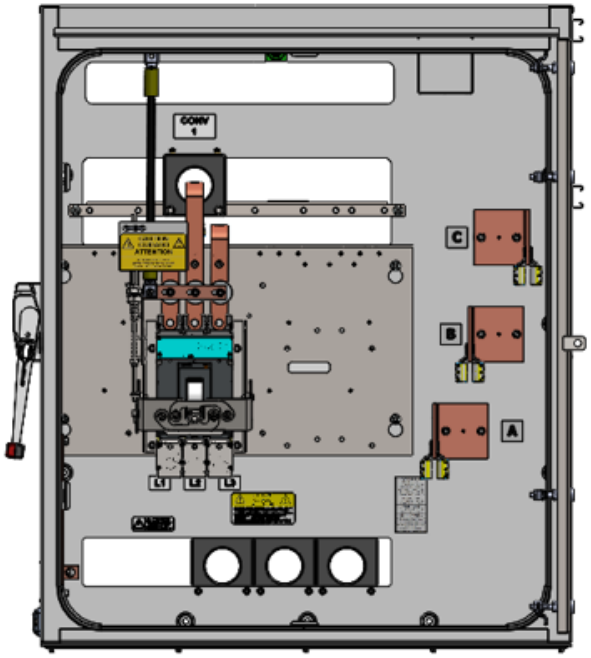


Figure 30: VSD 454/520kVA 6 Pulse J-Box

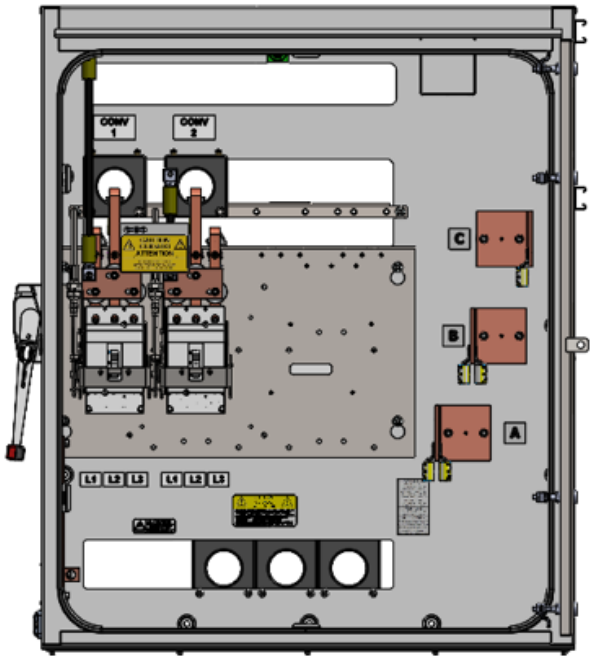


Figure 31: VSD 325 kVA 12 Pulse J-Box

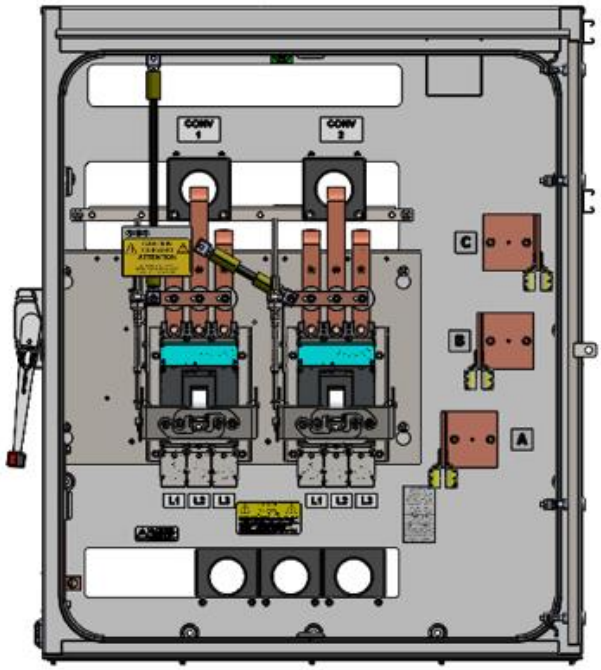


Figure 32: VSD 390kVA 12 Pulse J-Box

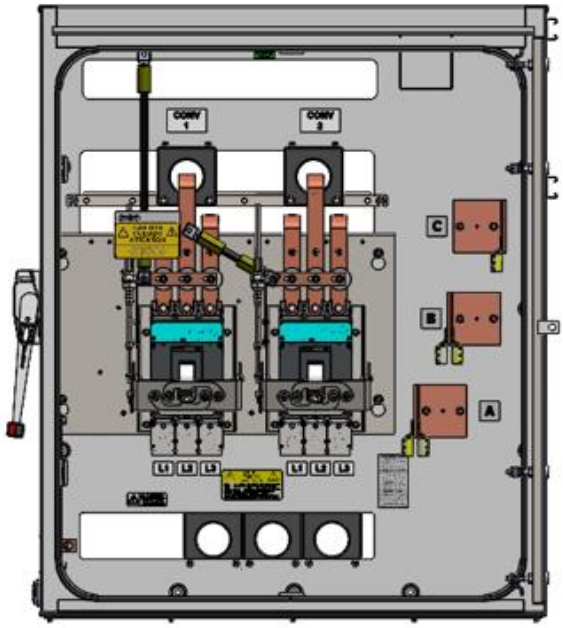


Figure 33: VSD 454/520kVA 12 Pulse J-Box

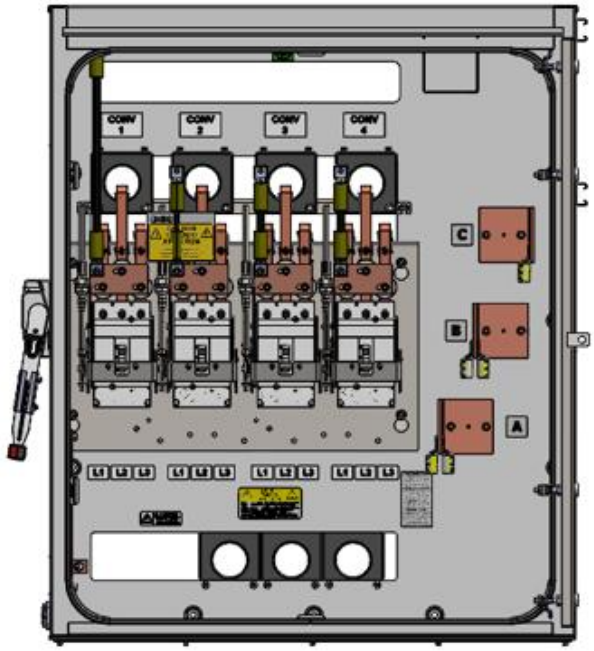


Figure 34: VSD 325/390kVA 24 Pulse J-Box

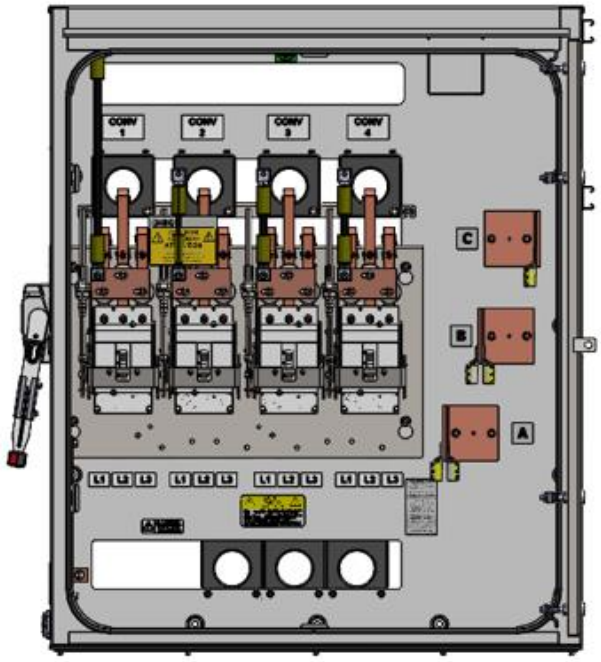


Figure 35: VSD 454/520kVA 24 Pulse J-Box

Figure 366 represents wiring items detailed in Table 8 (Appendix). These wiring components are recommended for safe and reliable FusionPro installations.

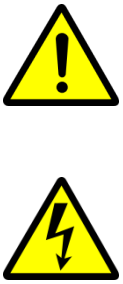
Cable (Foot) (Match Site Requirement)	Cable Gland (Each) (Match Cable Quantity)
	

Figure 36: Power Wiring Components

See Control Circuit Installation for the installation of control wiring as needed per site requirements. Once all wires and cables have been installed it is recommended to perform the following verifications prior to customary drive operation.

- Check that the step-up transformer ratio is set as intended.
- Ensure that all debris and tools used for installation have been removed.
- Ensure that CPTs are tapped to correlate with incoming voltage.
- Verify that the site is safe prior to removing any LOTO.
- Confirm the correct voltage levels are present on the incoming power lines to the drive.

Control Circuit Installation

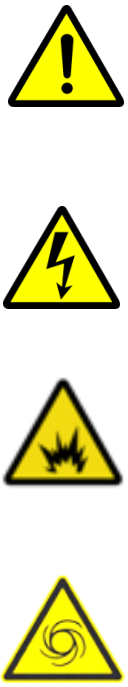


DANGER

FusionPro Drives require input and produce output voltages that are lethal.

Only authorized personnel shall perform electrical installation of this drive.

- All power sources must be isolated and wiring to and from the drive must be proven de-energized before installing this equipment. Always use LOTO.



DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

- Ensure Earth ground is properly bonded prior to any contact with this equipment.
- Only qualified personnel are allowed to open and service this equipment.
- Arc-Flash Hazard: Never take internal electrical measurements without proper PPE, including goggles, gloves, helmet, and arc-flash suit. When situations allow, avoid working with doors open and/or covers removed.
- Serious or fatal electrical shock may result from failure to isolate the incoming power from the drive electrical power source.
- Always Lock-Out/Tag-Out (LOTO) all incoming power at the source/utility before opening the enclosure to create a safe work condition (per NFPA 70E Article 120). Be aware there may be multiple power sources present. Verify the absence of voltage by wearing the proper safety equipment equivalent to Hazard Risk Category 2 garments and high-voltage safety gloves.
- Allow at least 5 minutes for bus capacitors to discharge or until the voltage is less than 50V prior to opening the enclosure.
- This equipment may contain SCADA or telemetry connections causing automatic starting. To prevent unexpected starts, always Lock-Out/Tag-Out (LOTO) equipment before servicing.
- Connected downhole motor may generate back-fed voltage. Once all drive incoming power is removed, isolate downhole motor power potential at the vented junction box prior to servicing.

FusionPro VSDs can be supplied with the following provisions:

- Optional CPT Power for auxiliary equipment requiring $115V_{ac}$ (275 VA)
- Optional Arctic heater to ensure operation at lower temperatures.
- Optional dehumidifier that warms enclosure air to avoid moisture wicking from heat cycling.
- Optional Surface unit to interface with Zenith down-hole sensors
- Control logic for auxiliary equipment.
  - $24V_{dc}$ power supply (external 2-amp load capacity)
  - Moxa E1242 I/O module

  - 4 analog input channels
  - 4 digital input channels
  - 4 digital output channels

    Connected to 4 dry-contact relays (250V/6A max)
- FusionPro System Controller
  - Enhanced setup and motor control
  - Data storage and diagnostics
  - Integrated system control via Moxa I/O modules
  - Communications interfaces for configuring, monitoring, and SCADA.
- Other standard options
  - Additional Moxa I/O modules. See the MOXA information section.
  - Emergency stop. The FusionPro drive may contain an optional red Emergency Stop (E-stop) mushroom switch on the front door of the drive. When pressed, the E-stop initiates a category 0 Safe Torque Off (STO) command immediately removing power from the converter and inverter control sections of the drive. The drive cannot be started until the E-stop button is disengaged (unlatched). The E-stop input complies with the requirements for IEC 61508 SIL2, IEC 62061 SILCL 2, and EN ISO 13849-1 CAT 3. For the SIL2 E-stop circuit, see Figure 61.
  - Enhanced power monitoring with additional line current transformers. For applications where additional input power information is desired, see Figure 61 in the Appendix section.
- Sine wave filter (SWF) option. See Appendix E: Sine-Wave Filter (SWF) PWM Operation.

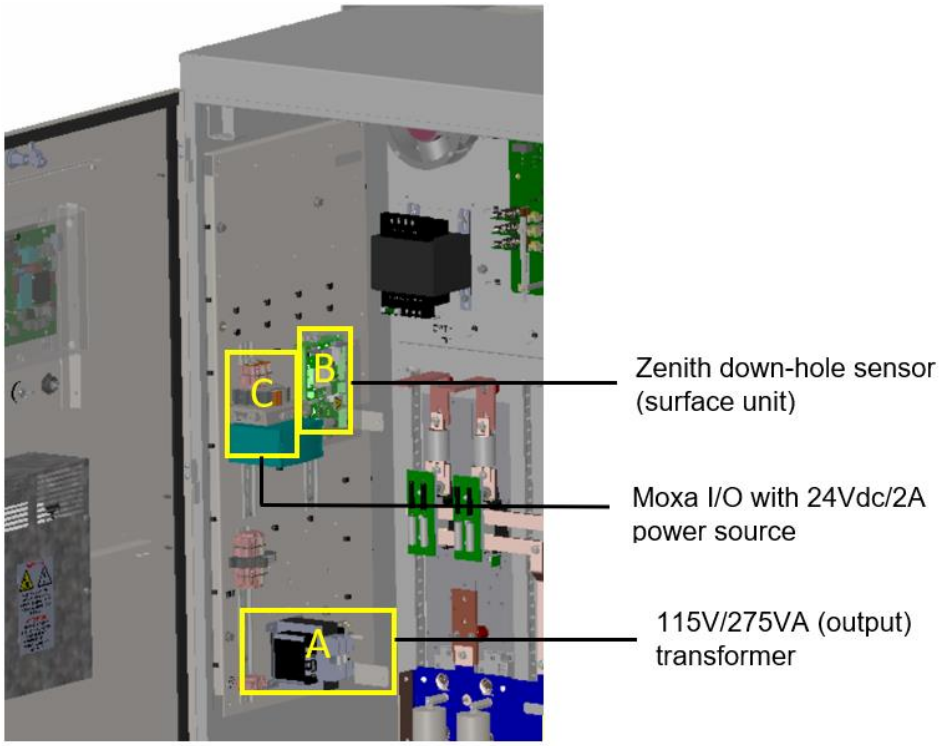
Control Panel Circuits Available for Customer Use

The FusionPro VSD has an internal panel on the left side with circuits for customer use as follows:

A. Optional: 115V/275VA (output) transformer

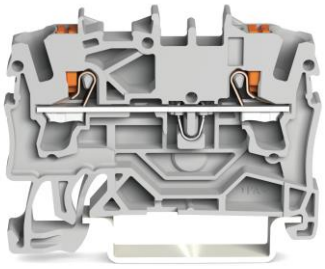
B. Optional: Zenith down-hole sensor (surface unit)

C. Moxa I/O with 24Vdc/2A power source



A general-purpose ground bar (14 ~ 4 AWG) is located at the lower back side of the panel. A "surface" PCBA is ready to interface with a Zenith down-hole sensor. The drive's system control interface allows its HMI to monitor and control external devices for enhanced motor-system control. See Internal Mounting of MOXA Modules for detailed information on this specialized I/O equipment.

Note that terminal blocks are Wago 2202 series with cage clamps for stranded wire from 18 to 14 AWG (1 ~ 2.5 mm^2). It is recommended to use ferrules such as Pan-Term® FSD77-10-D when terminating stranded wires.

	
Terminal Block Connector	18AWG Ferrule

115V/275VA (Output) Transformer (CPT2)

The FusionPro VSD is optionally equipped with a 275 VA transformer (CPT2) dedicated for customer use (see Detail "A" of Figure 377). If equipped with "CPT2", a 275VA load (2.4 A max) such as a work light, laptop PC, or small motor can be attached at TB9/TB10. Its input has two 2.8A fuses, time-delay, and Class CC (FU8~9, C901911, Bussmann FNQ-R-2 8/10). Its output is protected with a 4A, time-delay, AG-style fuse (FU10, C55535, Bussmann MDL-4). Connections are made at TB9 (hot) and TB10 (neutral). If a ground connection is needed, use the general-purpose ground bar.

Zenith Down-Hole Sensor (Surface Unit)

Typical option: The Mark-2 Interface Card (ZPN 34460821000) is for interfacing with a Zenith down-hole sensor (see Detail "B" of Figure 377). It is powered by the drive's internal $24V_{dc}$ power and interfaces with the HMI's ethernet port in a daisy-chain connection with the Moxa I/O module. It is necessary to add a shielded cable (18 AWG) from the surface choke of the down-hole sensor. Avoid routing this cable near power wires and attach it at J11 (Pin-1 = +VE & Pin-2 = -VE).

Moxa I/O (with 24VDC/2A Power Source)

The FusionPro VSD is equipped with a 24 Vdc power supply (PS2) and Moxa E1242 module (IOM1, see Detail "C" of Figure 377). PS2 is protected with a 4A, time-delay, 5X20mm fuse (FU20, C48109, Bussmann GDC-4). Note that Moxa digital outputs (pins 16~19) have been buffered with dry-contact relays (RLY21~24, 250V/6A). This provides isolation and increases voltage and current capacity. All Moxa input and output functions are managed through the FusionPro System Controller. Reference this manual for related setup details.

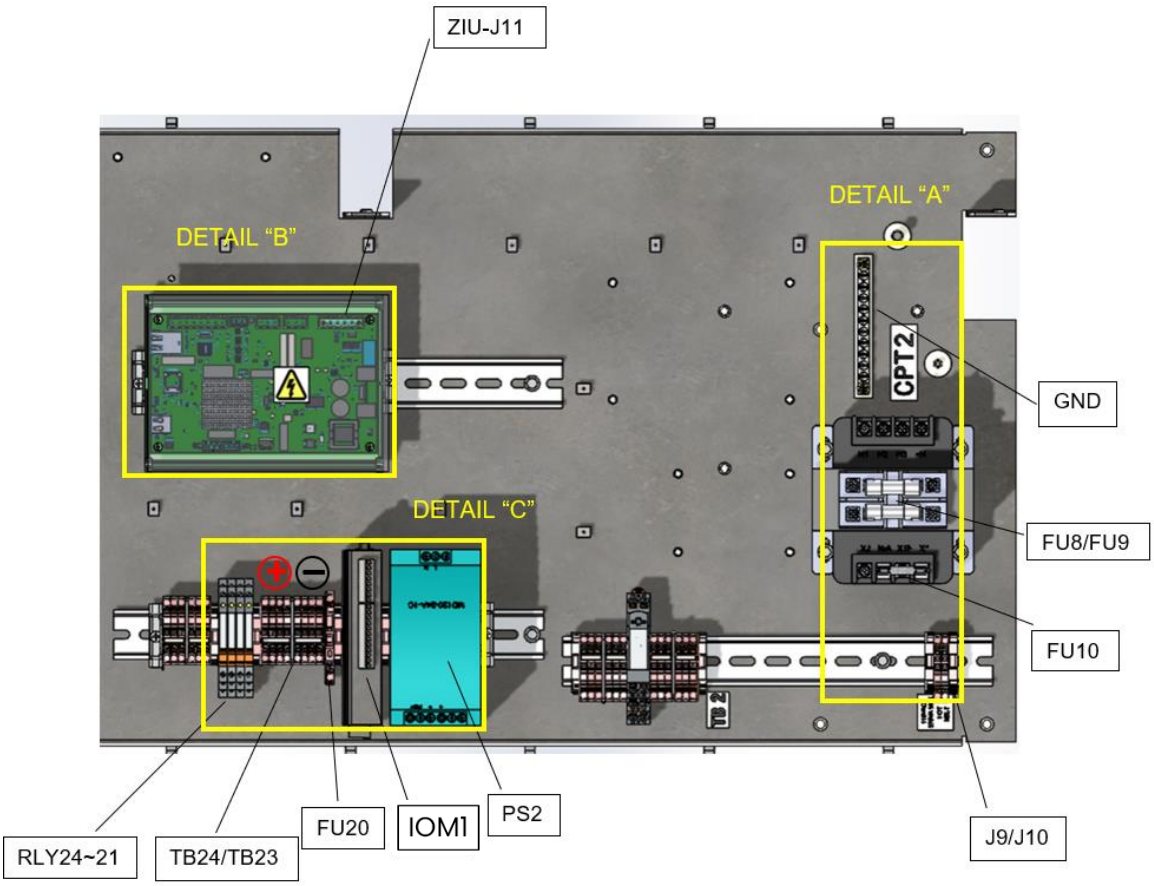


Figure 37: Control Panel (rotated 90° counterclockwise)

FusionPro System Controller

The FusionPro System Controller is the controller that integrates drive and system operation at the site. Its critical functions are as follows:

- Configure motor parameters.
  - Rated voltage, current, torque, RPM, motor control method, etc.
- Configure system parameters.
  - Step-up transformer ratio and impedance, motor cable size/type and length, skip-frequencies, define additional I/O and behavior, etc.
- Monitor and control motor performance.
  - Optimize running conditions, react to underload and overload conditions, etc.
- Monitor and control system behavior.
  - Compensate for impedances, transformer ratios, etc.
  - React accordingly to additional I/O conditions, etc.
- Communicate with local network devices.
  - Advantage power module, Moxa, ZIU, and other compatible Modbus devices.
- Communicate with external network devices.
  - RS-232 SCADA (Modbus Serial)

  - RS-485 SCADA (Modbus Serial)
  - Ethernet SCADA (Modbus TCP)

Figure 388 shows the carrier interface board and single-board computer (TS-7970) that make up the FusionPro drive's Human-Machine Interface (not shown: Liquid Crystal Display and membrane keypad). End-user connection points are as follows:

- J1a/b – USB "host" port internally accessed with an A-type connector on the SBC.
- J2a/b – USB "host" port accessed with an A-type connector on the cabinet door.
  - File transfer (data and configurations to and from the HMI using a thumb drive)
- T1 – Shielded RJ45 jack for connection with a Gigabit Ethernet port
  - Remote User Interface, SCADA, and file transfer
- P1a/b – Serial ports (see Figure 399)
  - RS-485 COM5 – P1a (pin2 = 485+, pin3 = 485-)
    - Modbus RTU (/dev/ttyMAX1 -> ttymxc1)
  - RS-232 COM4 – P1b (pin1 = com, pin7 = TX, pin8 = RX)
    - Modbus RTU (/dev/ttymxc4)
  - RS-232 COM3 (DB9, pin2 = RX, pin3 = TX, pin5 = GND

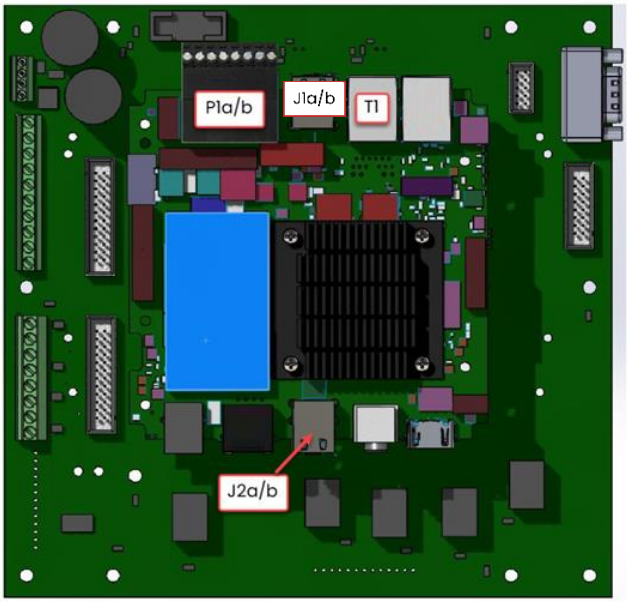


Figure 38: FusionPro Drive HMI PCB Assembly (Carrier Interface Board and Single-Board Computer)

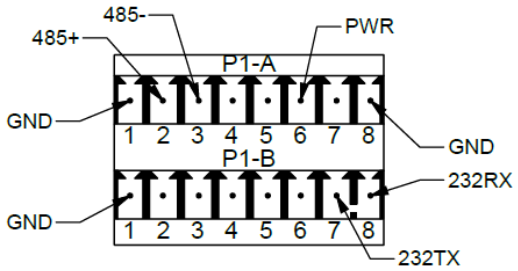


Figure 39: Dual Connector Pinout at P1-A and P1-B

Note that other communication connections are possible with adapters. Reference the FusionPro System Controller manual (PN 500031487) for expanded communication options. Installation of alternate down-hole sensors and other Modbus devices may be possible. Consult with your regional service center for assistance.

When installing communications cables within the cabinet avoid routing near power wires to prevent EMI exposure and ensure dielectric isolation. If communications wiring must cross circuits energized with more than 60V, tubing with 600V-class must be used to double-insulate the communications cable.

Note that any wiring penetrating the drive enclosure must maintain NEMA-4 integrity. Water-tight cable glands with sealing washers should be used to prevent water, dust, and vermin from entering the enclosure. Place holes on bottom-facing surfaces or as low as practical. Protection of wiring outside of the enclosure must also be responsibly managed.	

Control Power Transformer Tap Selection

FusionPro drives can be operated with input voltage from 480V down to 380V (plus tolerance), noting that power and output voltage capacity are directly affected by such variations. The drive's Control Power Transformers are tapped at 480V by default. When operating at lower voltages, the tap settings of CPT1 and CPT2 should be modified accordingly. Table 1 indicates tap settings for given line-voltage ranges, along with resultant CPT outputs. Figure **40**40 shows the basic layout of the CPTs and the screw terminals where the wire should be placed for a given input range. Note that the wire at H1 should not be moved.

Table 1: CPT Tap Selection

TAP	Line Input Range		CPT Output Range	
	Upper	Lower	Upper	Lower
H4 (480V)	504V	449V	121V	108V
H3 (427V)	448V	400V	121V	108V
H2 (380V)	399V	360V	121V	109V

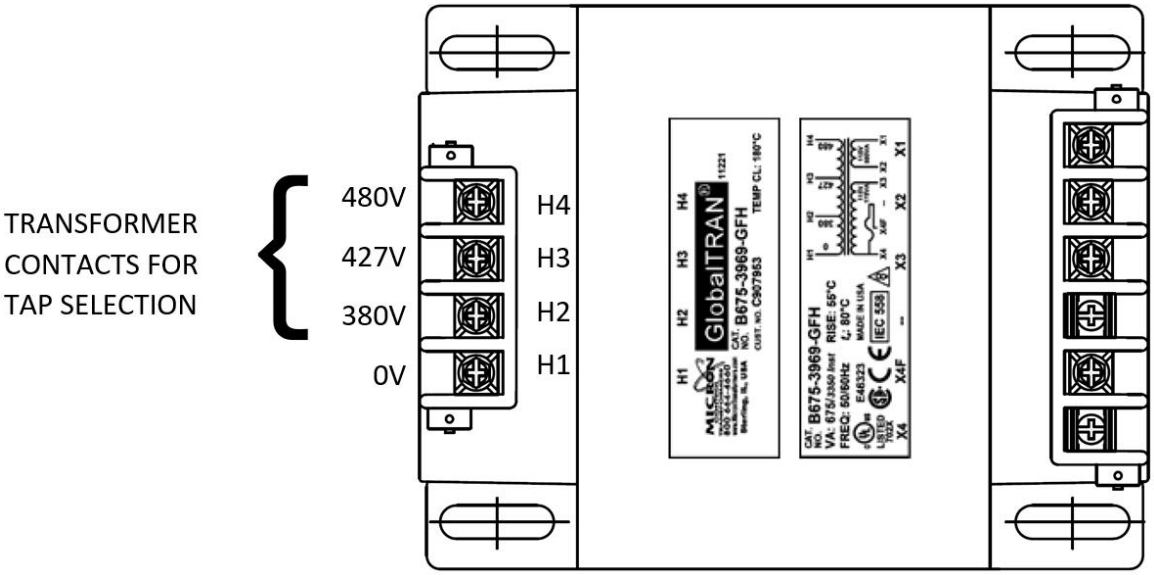


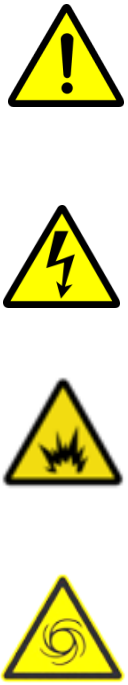
Figure 40: CPT Tap Terminals (CPT1 shown)

See Power Wiring Requirements for installation of power wiring as needed per site requirements. Once all wires and cables have been installed it is recommended to perform the following verifications prior to customary drive operation.

- Ensure field-installed low-voltage wiring is properly isolated from high-voltage wiring.
- Check that the step-up transformer ratio is set as intended.
- Ensure that all debris and tools used for installation have been removed.
- Ensure that CPTs are tapped to correlate with incoming voltage.
- Ensure any removed protective covers have been reinstalled.
- Verify site is safe prior to removing any LOTO.
- Confirm the correct voltage levels are present on the incoming power lines to the drive.

Moxa Installation

Internal Mounting of MOXA Modules



DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

- Ensure Earth ground is properly bonded prior to any contact with this equipment.
- Only qualified personnel are allowed to open and service this equipment.
- Arc-Flash Hazard: Never take internal electrical measurements without proper PPE, including goggles, gloves, helmet, and arc-flash suit. When situations allow, avoid working with doors open and/or covers removed.
- Serious or fatal electrical shock may result from failure to isolate the incoming power from the drive electrical power source.
- Always Lock-Out/Tag-Out (LOTO) all incoming power at the source/utility before opening the enclosure to create a safe work condition (per NFPA 70E Article 120). Be aware there may be multiple power sources present. Verify the absence of voltage by wearing the proper safety equipment equivalent to Hazard Risk Category 2 garments and high-voltage safety gloves.
- Allow at least 5 minutes for bus capacitors to discharge or until the voltage is less than 50V prior to opening the enclosure.
- This equipment may contain SCADA or telemetry connections causing automatic starting. To prevent unexpected starts, always Lock-Out/Tag-Out (LOTO) equipment before servicing.
- Connected downhole motor may generate back-fed voltage. Once all drive incoming power is removed, isolate downhole motor power potential at the vented junction box prior to servicing.

The FusionPro VSD is equipped with an internal panel for customer options. It is located on the left inside of the cabinet. The standard E1242-T module and customer 24Vdc terminal block are located on the upper forward DIN rail. Other I/O modules and/or terminal blocks can be added to the "ZIU" DIN rail as needed for specific applications. Ensure that supplemental wiring is routed in an orderly fashion and meets insulation requirements. For further details see the section discussing Control Circuit Installation. In addition to powering added MOXA modules, unused bus terminals on TB23-A~D (24V-) and TB24-A~D (24V+) can be used for powering accessories such as transducers and "wet contact" I/O modules. Room for additional components will vary depending on whether other options exist. Installation of MOXA modules outside the cabinet should also be possible but has not been thoroughly evaluated.

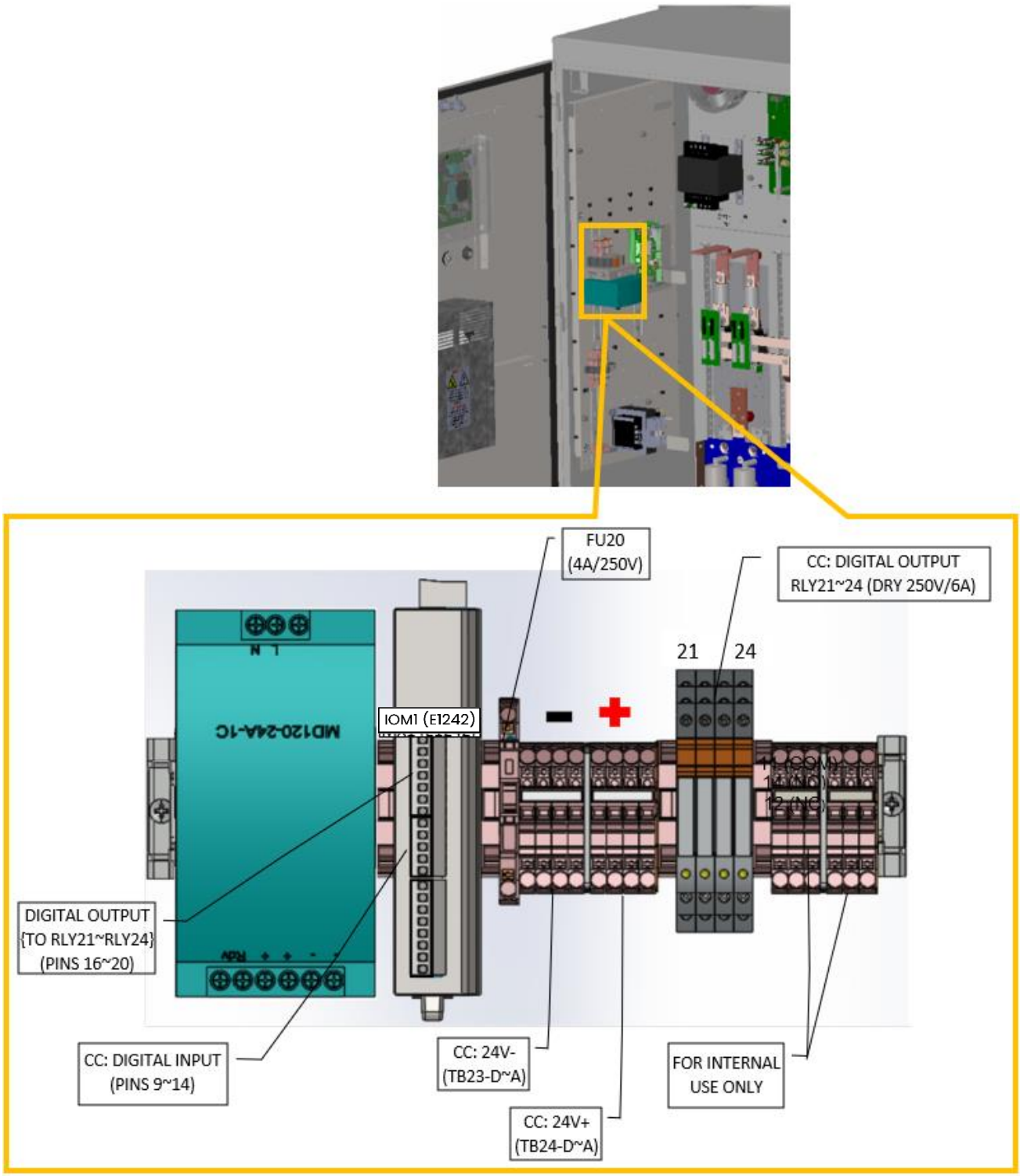


Figure 41: 24 VDC Controls (Including E1242-T MOXA) at VSD Customer Interface Panel (Rotated 90° Counterclockwise)

I/O Wiring

Moxa I/O terminal connections can accept 26 to 16 AWG wires (0.14 to 1.5 mm^2). However, 18 AWG (0.75 mm^2) is the recommended size. All wires should have at least 300V class, 90°C insulation. Note that wire routed with circuits greater than 300 Vac shall have 600V class insulation or 600V supplemental sleeving. Dielectric sleeving should be used with any wires or cables that have insufficient insulation with respect to voltage class. This particularly concerns installed wires that are routed adjacent to wiring for 600V class circuits (even if appropriately insulated). Many communication cables are considered as 30V class, so sleeving is typically necessary. Furthermore, insulation shall also be evaluated and certified for flammability (typically marked VW-1 or better). Pin 14 (GND) of the Moxa E1242 is the common return path for DI0, DI1, DI2, and DI3. Depending on the length of the cable and the total amount of impedance in the path, an external 10-30VDC external power supply may be required to help switch the DI state. In these cases, the power supply should be added to Pin 9 (+) and Pin 14 (-).

MOXA Information

The FusionPro VSD comes equipped with a Moxa E1242-T industrial Ethernet remote I/O module. It can be connected to digital and/or analog devices as needed for enhanced system control. It has extended temperature range (-40 to 75°C) to ensure reliability and resilience in most any field application. The drive also implements a customer-dedicated 24 Vdc power supply capable of powering cumulative loads up to 3.7 A (with thermal de-rate) for items such as installed modules, transducers, and other related I/O circuits. It is recommended to limit additional loads to 2.0 A to avoid overloading the power supply especially if the typical external ambient temperature is above 45°C. Other supported modules can be added as listed in Table 2. For module "programming" information reference the FusionPro System Controller Manual. Further details can be found in schematic 5000xxxx (Figure TBD) and at Moxa's website (www.moxa.com/product).

Table 2: Supported Moxa Modules

BH #	MOXA #	FUNCTIONALITY	Function Ratings/Limits
5000006377	E1242-T	4 AIs; 4 DIs; 4 DOs	0 to 10 Vdc; 0/4~20 mA w/ 120 ohm resistor built in Wet-On: 10~30 Vdc, Wet-Off: 0~3 Vdc, Count: 250 Hz max;200 mA, Sink, Pulse: 500 Hz max
5000006378	E1241-T	4 AOs	I(short-circuit) > 10 mA, 400 ohm resistor built in
5000006379	E1240-T	8 AIs	0 to 10 Vdc; 0/4~20 mA w/ 120 ohm resistor built in
5000006381	E1260-T	6 RTDs	2- or 3- wire, 625 k-ohm input impedance, PT1000 (-200 to 350°C), PT50, PT100, PT200, PT500 (-200 to 850°C)

NOTICE	MOXA modules have been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

NOTICE	Moxa units are sensitive to Electrostatic Discharge which can cause internal damage and affect normal operation. Follow these guidelines when you handle unit(s): • Before handling the product, touch a grounded object to discharge static electricity from your body. • Wear an approved grounding wristband. • Do not touch connectors or pins on component boards. • Do not touch circuit components inside the equipment. • Use a static-safe workstation, if available. • Store the equipment in appropriate static-safe packaging when not in use.

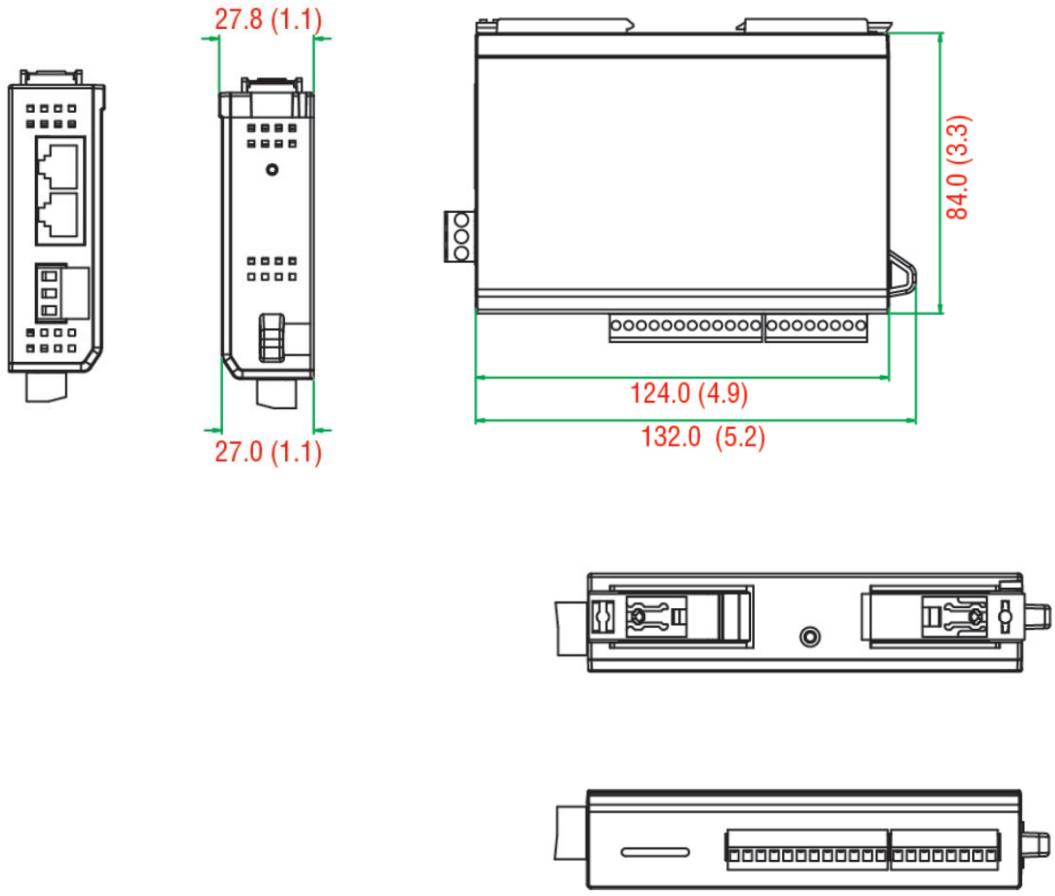
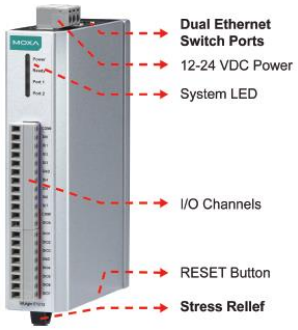


Figure 42: Moxa Profiles and Physical Dimensions (Characteristics of I/O channel connectors vary per module type)

Features	Ethernet Port



Pin	1	2	3	4
Signal	TXD+	TXD-	RXD+	---

Pin	5	6	7	8
Signal	---	RXD-	---	---

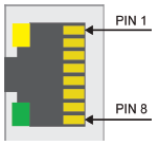


Figure 43: Other Moxa Module Details

Note: The RESET button restarts the server and resets all settings to factory defaults. Use a pointed object such as a straightened paper clip to hold down the RESET button for 5 seconds. The factory defaults will be loaded once the READY LED turns green again. You may then release the RESET button.

Table 3: Moxa System LED indicators

LED	State	Description
Power	Amber	System power is ON
	OFF	System power is OFF
Ready	Green	System is ready
	Flashing	Flashes every 1 second when the "Locate" function is triggered
	Flashing	Flashes every 0.5 seconds when the firmware is being upgraded
	Flashing	ON/OFF cycle period of 0.5 seconds represents "Safe Mode"
	OFF	System is not ready
Port 1	Green	Ethernet connection enabled
	Flashing	Transmitting or receiving data
Port 2	Green	Ethernet connection enabled
	Flashing	Transmitting or receiving data
EXT	Green	EXT field power input is connected
	Off	EXT field power input is disconnected

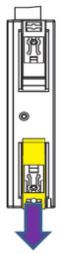
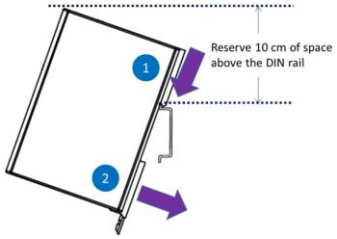
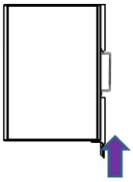
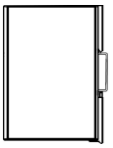
Step 1. Pull down the bottom of the two sliders on the back of the unit.	Step 2. Latch the top slider of the unit onto the DIN rail as shown in the diagram. Reserve at least 10 cm of space above the DIN rail to ensure that there is enough space to complete the installation.
	
Step 3. Rotate the unit down into a vertical position, and then push the bottom slider back up to its original position to lock the unit to the DIN rail.	Step 4. At this point, if the mounting was done correctly, the unit should be securely fixed to the DIN Rail.
	

Figure 44: Moxa DIN-Rail Module Mounting

NOTICE	Factory-installed modules are connected with a shielded ethernet cable that is grounded at the HMI so it is typically unnecessary (and undesirable) to use the module's ground connection. However, if additional modules are added and an unshielded ethernet cable is used, the module should be connected to a ground point in the VSD with 16 AWG (1.5 mm^2) wire.

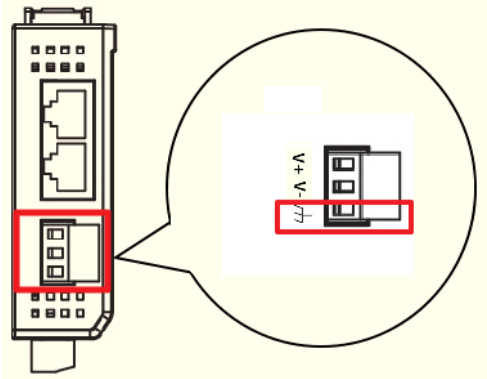


Figure 45: Moxa Chassis Grounding

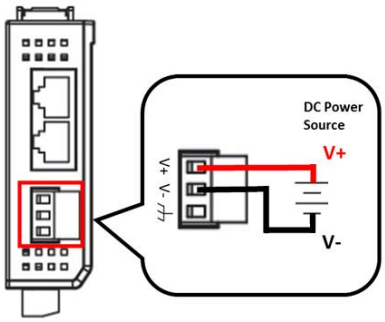
	Terminal connections can accept 24 to 12 AWG wire (0.25~4.0 mm^2). However, 16 AWG (1.5 mm^2) is the recommended size, ensuring minimal source power attenuation. See the section pertaining to I/O Wiring for matters related to insulation selection.

Figure 46: Power Wiring for Moxa Modules

I/O Channel Jumper Setting

For additional analog modules (E1240-T or E1242-T) it is necessary to configure whether voltage or current is being measured. The Analog Input (AI) jumpers on the E1240-T and E1242-T need to be changed from Voltage Mode to Current Mode. For additional digital modules (E1242-T) it is necessary to configure the direction such that the channel detects input status or controls output status. This is done by setting internal jumpers. Jumper configuration of the following modules is not necessary: E1240-T, E1241-T, nor E1260-T.

To access configuration jumpers, open the unit as follows.

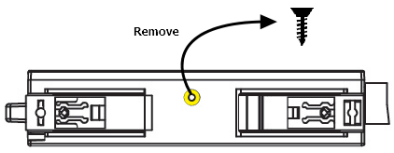
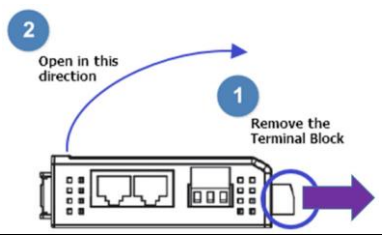
		
STEP 1. Remove the screw from the back panel. (Suggested Torque: 3.9 ± 0.4 kg-cm)	STEP 2. Remove the Terminal Block and open the top cover as shown in the diagram.	STEP 3. The jumpers are located near the IO channels. Position the jumper as described below.

Figure 47: Moxa Configuration Jumper Access

Position jumper for desired functionality as follows.

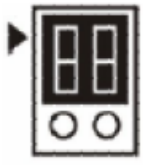
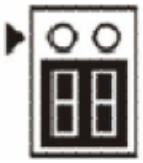
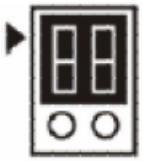
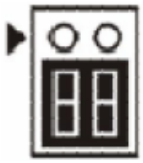
DIO Direction (DI, DO) *The default setting is DO Mode.*		AI Mode (Voltage, Current) *The default setting is Voltage Mode.*	
DI Mode	DO Mode	Voltage Mode	Current Mode
			

Figure 48: Moxa Configuration Jumper Positioning

Down-hole Sensor Installation

Downhole (DH) sensors are used with ESP systems to acquire related temperatures and pressures, along with cable integrity and motor vibration details.

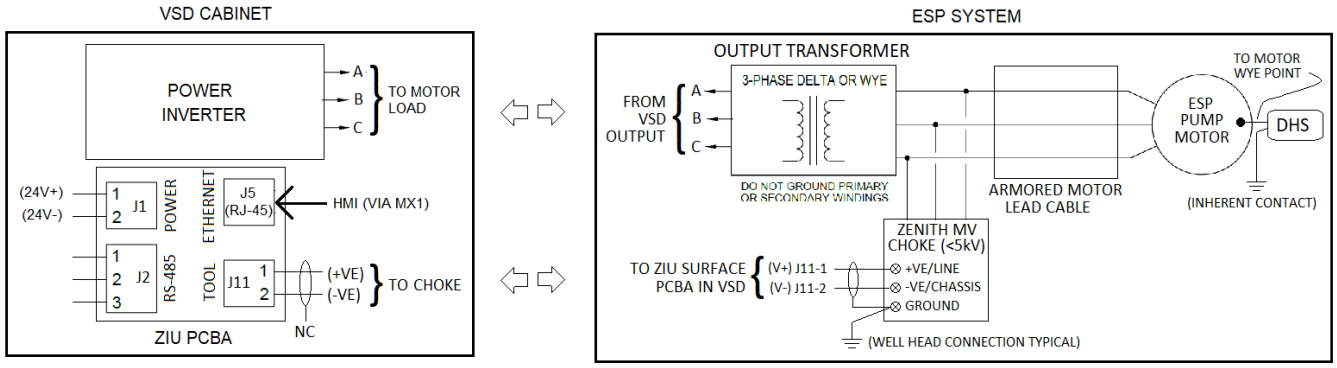


Figure **49** shows the black-box circuit for a typical ESP system with a FusionPro VSD. The drive comes equipped and preconfigured with a surface interface board (Figure 50 for use with Zenith down-hole sensors. Installation details for the down-hole sensor and surface choke can be found in Baker Hughes document number OPS-GLB-En-108688. A shielded 18 AWG cable is recommended to connect J11 of the surface interface board to the surface choke (see Figure 51). The internal wires of the cable must be rated 150 V minimum with a 600V jacket (preferred). If the jacket has a lower voltage class, then it is necessary to sleeve with a 600V tubing any cable sections that contact 600V-class wires or circuits. When penetrating the cabinet NEMA-4 rated glands shall be used to maintain enclosure integrity. It is also a good practice to avoid running the cable near power wires to avoid electrical noise caused by crosstalk. It is also recommended to place cabling outside of the cabinet in conduit or armored cable to avoid damage.

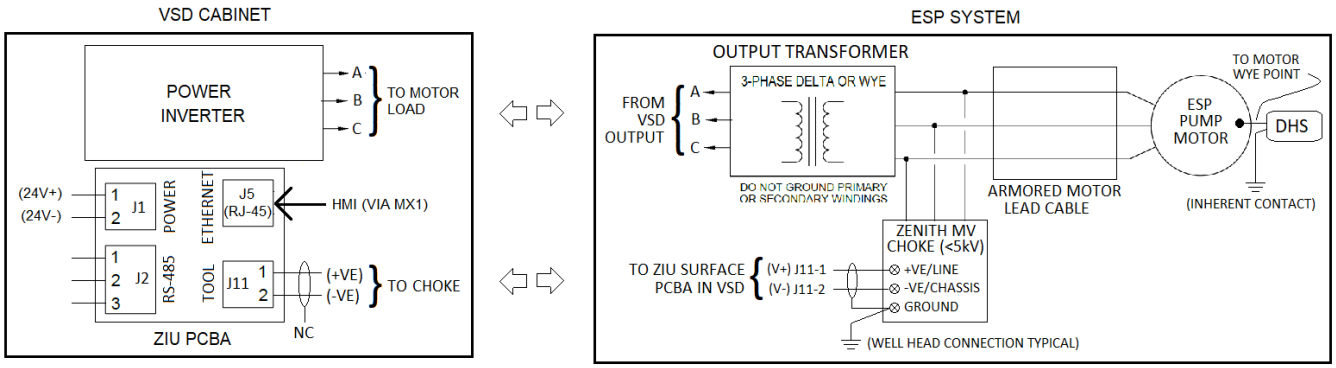


Figure 49: Typical ESP Down-hole Sensor Circuit

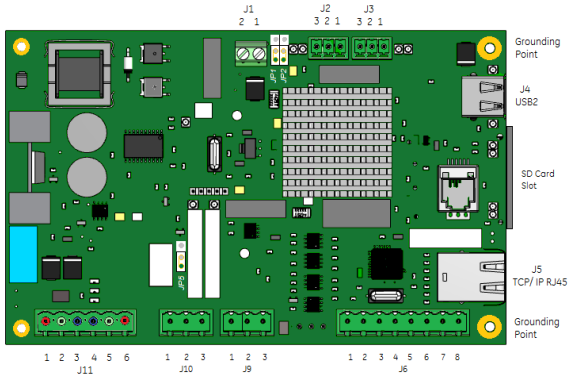


Figure 50: Zenith Surface PCBA

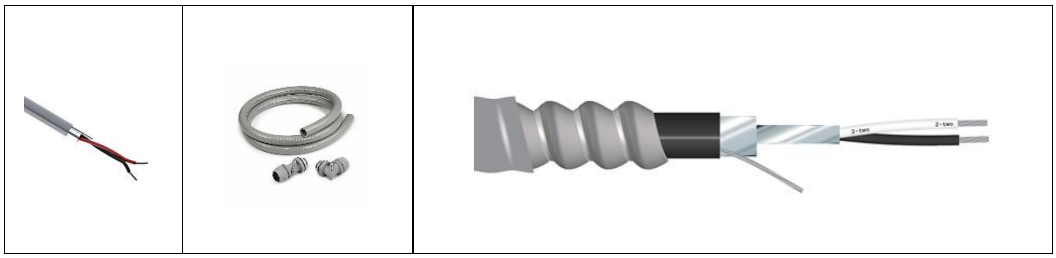


Figure 51: Recommended Cabling Options for Connection from PCBA to Choke

Appendix

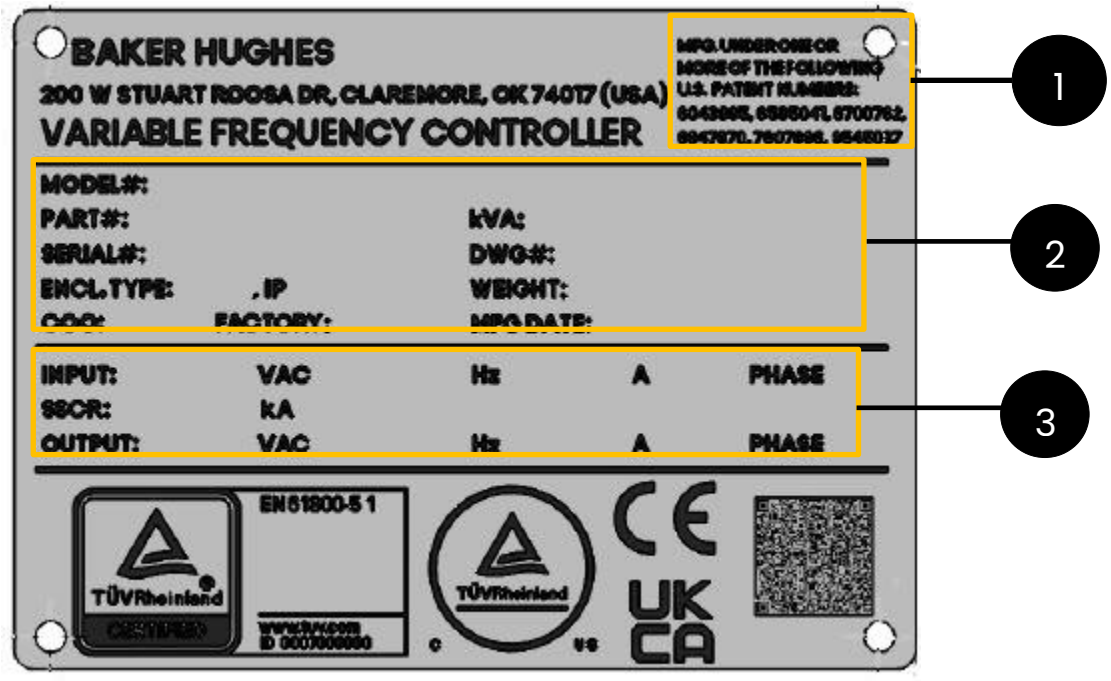
Appendix A: Drive Specifications and Ratings

Specifications

Ratings	
Input Voltage	
Magnitude (typical)	380 to 480 VAC (360 VRMS minimum & 504 VRMS maximum, see Table 5)
Phase (typical)	Need to account for all input configurations (6P, 12P, & 24P).
Frequency	50/60 Hz +/- 2 Hz (stable governing of speed is essential for generators)

Ratings	
Input and Output Current	See Appendix A Table 8
Output Voltage	
Magnitude	40 to 480 VAC (at maximum speed, limited by input voltage magnitude)
Frequency	10 to 140 Hz for ESP operation and 10 to 200 Hz for SWF PWM operation (low and high-speed range, +/- 0.1 Hz resolution in V/f control)
Environment	
Storage Temperature	-40°C to 70°C (-58°F to 158°F)
Operating Temperature	-40°C to 55°C (-40°F to 131°F)
Construction	NEMA-4 (IP56)
Humidity	95% non-condensing; suitable for use outdoors
Elevation	Sea level to 5000 ft (1524 m) without derate
Classification Area	Non-hazardous
Weight and Dimensions	See Appendix D: Dimensions and Approximate Weights

Nameplate



1. VSD Nameplate with general product information
2. VSD physical properties
3. VSD electrical ratings

Table 4:Specifications (Particular to Application)

Output Voltage	
Magnitude Range	40 to 480 VAC (at maximum speed, limited by input voltage magnitude)
Voltage Magnitude Clamp	100 to 550 VAC (setting value)
Voltage Magnitude Boost	0 to 200 VAC
Voltage Boost Sync	0 to 200 VAC
Frequency Range	10 to 140 Hz (low-speed and high-speed range, +/- 0.1 Hz resolution)
Start Frequency	3 to 20 Hz
Sync Delay Time	0 to 60 seconds
Low Speed Clamp	10 to 140 Hz
High Speed Clamp	6 Step ESP (10 to 140 Hz) and SWF (10 to 200 Hz)
Output Current	
Instantaneous Over Current	170% of full load rating
Current Limit	0 to 150% of Variable Speed Control (VSC) rating
Current Limit Sync	0 to 150% of VSC rating
Maximum Overload Current	0 to 150% of VSC rating
Power Characteristics	
Efficiency	> 98% at rated load
Power Factor	0.96 at full load
Input Protection/Disconnect	Circuit breakers with electronic trip
Surge Protection	Metal oxide varistors (line-to-ground)
Rectifier Type	SCR frontend with DC link reactors (for harmonic mitigation)
Inverter Type	IGBT 3-Phase, 2 Level

Table 5: Control Features

Motor Control	
Application	Electric submersible pump or horizontal pump system
Motor Type	Induction or permanent magnet
Frequency Control	Manual setpoint Current control PID defined by user. PID + current control Analog follower Hz to PID on the fly
ESP Custom Software	MaxRate™ GasPrime

Motor Control	
	MaxStart™ Back-spin detection
Motor Protection	Overload I^2t protection (with auto frequency adjustment) Underload; Overtemperature protection available with Zenith sensor - option
Motor Speed Control	Scalar Volts/Hz Baker Hughes Vector Control
Down-hole Sensor	Zenith interface board option (sensor-driven alarms)
Acceleration Time	2 to 200 seconds
Deceleration Time	2 to 200 seconds
Emergency STOP	STO (Safe Torque Off) Cat 0 (J28 Pin 1 to 3 & J30 pin 1 to 3)
System Control	
Controller	FusionPro System Controller™ System Controller
Data Logging	Records for: events, shutdowns, and continuous operating data
Communications	Protocol: Modbus RTU, Modbus TCP/IP Ports: 1-RS232, 1-RS485, and 1-Ethernet Wi-Fi: Included
Standard External I/O (Included Moxa module, MX1 = E-1242, up to 4 others can be added)	Analog inputs: (4X) 0/4~20 mA (default, configurable to 0-10 VDC) Analog outputs: (0X) None (optional as additional module) Digital inputs: (4X) Wet-On, 10~30 VDC, Wet-Off: 0~3 VDC, Count: 250 Hz Digital outputs: (4X) Dry-contact relays, 6A @ 240V (derived from MX1)
Supported Moxa Modules	E1242-T, E1241-T, E1240-T, E1260-T
DC Control Power	PS2, 24 VDC @ 2 A, external access per TB23 (-) and TB24 (+)
AC Control Power	CPT2, 115 VAC @ 2.4 A, external access per TB9 (hot) and TB10 (neutral)

Appendix B: Model Designation and Variable Torque VSD Ratings

Model Designation:

VSD 0130-0260kVA ESP

VSD 0130K-04FP06ESP
VSD 0200K-04FP06ESP
VSD 0260K-04FP06ESP
VSD 0130K-04FP12ESP
VSD 0200K-04FP12ESP
VSD 0260K-04FP12ESP

VSD 0130-0260kVA SWF

VSD 0200K-04FP06SWF
VSD 0200K-04FP06SWF
VSD 0260K-04FP06SWF
VSD 0130K-04FP12SWF
VSD 0200K-04FP12SWF
VSD 0260K-04FP12SWF

VSD 0325-0520kVA SWF

VSD 0325K-04FP06SWF
VSD 0390K-04FP06SWF
VSD 0454K-04FP06SWF
VSD 0520K-04FP06SWF
VSD 0325K-04FP12SWF
VSD 0390K-04FP12SWF
VSD 0454K-04FP12SWF
VSD 0520K-04FP12SWF
VSD 0325K-04FP24SWF
VSD 0390K-04FP24SWF
VSD 0454K-04FP24SWF
VSD 0520K-04FP24SWF

VSD 0325-0520kVA ESP

VSD 0325K-04FP06ESP
VSD 0390K-04FP06ESP
VSD 0454K-04FP06ESP
VSD 0520K-04FP06ESP
VSD 0325K-04FP12ESP
VSD 0390K-04FP12ESP
VSD 0454K-04FP12ESP
VSD 0520K-04FP12ESP
VSD 0325K-04FP24ESP
VSD 0390K-04FP24ESP
VSD 0454K-04FP24ESP
VSD 0520K-04FP24ESP

Rated Voltage: 3phase AC 380/480V, 50-60Hz

Rated Input Current:

	VSD 0130-0260K			VSD 0325-0520K			
Model	0130K	0200K	0260K	0325K	0390K	0454K	0520K
Input Current (6P)	164	253	329	411	492	573	655
Input Current (12P)	82	127	165	206	246	287	328
Input Current (24P)	-	-	-	103	123	143	164

Output Ratings: 480Vmax, 10-140Hz.

Table 6: Output kVA at 380/480V at 50/60 Hz

Model (kVA)	380V	480V
0130	103	130
0200	159	200
0260	206	260
0325	257	325
0390	308	390
0454	359	454
0520	411	520

NOTE: When applying variable speed drives to constant torque loads, the continuous output current and output KVA are de-rated by 20%. The overload and start currents remain the same.

Table 7: Variable Torque Current and Power Ratings

Output Ratings at 380/480 VAC					Input Ratings (Amps)	
KVA 380/480	Model	Continuous Current	Overload	Start	-	-
		RMS Amps	Current	Current	Circuit Breaker	Input
			60 Sec	7 Sec	Frame Rating[2]	Current
103/130	VSD 0130K-04FP06ESP	156	187	234	250	164
	VSD 0130K-04FP06SWF	166	199	250	250	164
103/130	VSD 0130K-04FP12ESP	156	187	234	2x250	2x82
	VSD 0130K-04FP12SWF	166	199	250	2x250	2x82
159/200	VSD 0200K-04FP06ESP	241	289	362	400	253
	VSD 0200K-04FP06SWF	257	308	386	400	253

206/260	VSD 0260K-04FP06ESP	313	376	470	400	329
	VSD 0260K-04FP06SWF	334	401	501	400	329
159/200	VSD 0200K-04FP12ESP	241	289	362	2x250	2x127
	VSD 0200K-04FP12SWF	257	308	386	2x250	2x127
206/260	VSD 0260K-04FP12ESP	313	376	470	2x250	2x165
	VSD 0260K-04FP12SWF	334	401	501	2x250	2x165
257/325	VSD 0325K-04FP06ESP	391	469	587	600	411
	VSD 0325K-04FP06SWF	417	500	626	600	411
308/390	VSD 0390K-04FP06ESP	469	563	704	600	492
	VSD 0390K-04FP06SWF	500	601	751	600	492
359/454	VSD 0454K-04FP06ESP	546	655	819	800	573
	VSD 0454K-04FP06SWF	582	699	874	800	573
411/520	VSD 0520K-04FP06ESP	624	749	936	800	655
	VSD 0520K-04FP06SWF	666	799	998	800	655
257/325	VSD 0325K-04FP12ESP	391	469	587	2x250	2x206
	VSD 0325K-04FP12SWF	417	500	626	2x250	2x206
308/390	VSD 0390K-04FP12ESP	469	563	704	2x400	2x246
	VSD 0390K-04FP12SWF	500	601	751	2x400	2x246
359/454	VSD 0454K-04FP12ESP	546	655	819	2x400	2x287
	VSD 0454K-04FP12SWF	582	699	874	2x400	2x287
411/520	VSD 0520K-04FP12ESP	624	749	936	2x400	2x328
	VSD 0520K-04FP12SWF	666	799	998	2x400	2x328
257/325	VSD 0325K-04FP24ESP	391	469	587	4x250	4x103
	VSD 0325K-04FP24SWF	417	500	626	4x250	4x103
308/390	VSD 0390K-04FP24ESP	469	563	704	4x250	4x123
	VSD 0390K-04FP24SWF	500	601	751	4x250	4x123

359/454	VSD 0454K-04FP24ESP	546	655	819	4x250	4x143
	VSD 0454K-04FP24SWF	582	699	874	4x250	4x143
411/520	VSD 0520K-04FP24ESP	624	749	936	4x250	4x164
	VSD 0520K-04FP24SWF	666	799	998	4x250	4x164

[2]The MCCB trip value is factory set to correspond with VSD's input current rating and rectifier configuration – 6 pulse/12 pulse/24 pulse.

[3]:SWF Ratings are for 60 Hz output. Please see Figure 52 for the derating curve for frequencies higher than 60 Hz.

Appendix C: Circuit Breakers and Cable Sizing

Table 8: Recommended Circuit Breakers & Cable Sized for 131°F (55°C) Ambient

	Recommended Cable Sized for NEMA 4 / IP56 Drive, 131°F (55°C) Ambient							
	All power cabling must be 167°F (75°C) rated per UL 508C. The cable sizes below are based on 131°F (55°C) ambient temperature and will work under all circumstances. Cable sizes may be calculated based on your local maximum ambient. Higher temperature rating cables may be used but must be sized for 75°C rating.							
VSD Model	Circuit Breaker		Cable Size (AWG)	Ground Conductor Size	Cable P/N	Cable Gland P/N	Lug P/N	Torque Rating (in./lb)
	Rating	Input Current	(x) = Conductors per phase	(Included in Cable)				
				(x) = No. of Conductors	Input/Out	Input/Output	Output	Input/Out
VSD 0130K-04FP06ESP	250A	164	250MCM, (1) per input, (1) per output	#4 AWG (In:1/Out:1)	C902163	902174	902177	225/225
VSD 0200K-04FP06ESP	400A	253	3/0, (2) per input, (2) per output	#4 AWG (In:2/Out:2)	C902161	902172	88152	442/225
VSD 0260K-04FP06ESP	400A	329	250MCM, (2) per input, (2) per output	#4 AWG (In:2/Out:2)	C902163	902174	902177	442/225
VSD 0325K-04FP06ESP	400A	411	4/0, (3) per input, (3) per output	#4 AWG (In:3/Out:3)	C902162	902173	48455	442/225
VSD 0390K-04FP06ESP	600A	492	250MCM, (3) per input, (3) per output	#4 AWG (In:3/Out:3)	C902163	902174	902177	442/225
VSD 0454K-04FP06ESP	600A	573	350MCM, (3) per input, (3) per output	#3 AWG (In:3/Out:3)	C902164	902175	902178	442/225
VSD 0520K-04FP06ESP	800A	655	500MCM, (3) per input, (3) per output	#2 AWG (In:3/Out:3)	C902165	902176	86659	442/225
Note: for 0130-0260 6-Pulse Drives, the Cables are copper, 3 conductors with ground conductor and aluminum armor, XLP, 90°C (sized as 75°C)								
VSD 0130K-04FP12ESP	2-250A	2x82	1/0, (1) per input, (2) output	#6 AWG (In:2/Out:2)	C902159	902169	51145	225/225
VSD 0200K-04FP12ESP	2-250A	2x127	3/0, (1) per input, (2) output	#4 AWG (In:2/Out:2)	C902161	902172	88152	225/225

VSD 0260K-04FP12ESP	2-250A	2x165	250MCM, (1) per input, (2) output	#4 AWG (In:2/Out:2)	C902163	902174	902177	225/225
VSD 0325K-04FP12ESP	2-250A	2x206	350MCM, (1) per input, (2) output	#3 AWG (In:2/Out:2)	C902164	902175	902178	225/225

VSD Model	Circuit Breaker		Cable Size (AWG)	Ground Conductor Size	Cable P/N	Cable Gland P/N	Lug P/N	Torque Rating (in./lb)
	Rating	Input Current	(x) = Conductors per phase	(Included in Cable)			Output	Input/Out
VSD 0390K-04FP12ESP	2-400A	2x246	3/0, (2) per input, (4) output	#4 AWG (In:4/Out:4)	C902161	902172	88152	442/225
VSD 0454K-04FP12ESP	2-400A	2x287	4/0, (2) per input, (4) output	#4 AWG (In:4/Out:4)	C902162	902173	48455	442/225
VSD 0520K-04FP12ESP	2-400A	2x328	250MCM, (2) per input, 500MCM (3) output	In: #4 AWG (2) Out: #2 AWG (3)	In:C902163 Out:C902165	In:902174 Out:902176	In:902177 Out:86659	442/225
VSD 0325K-04FP24ESP	4-250A	4x103	2/0, (1) per input, (4) output	#6 AWG (In:4/Out:4)	C902160	902171	88160	225/225
VSD 0390K-04FP24ESP	4-250A	4x123	3/0, (1) per input, (4) output	#4 AWG (In:4/Out:4)	C902161	902172	88152	225/225
VSD 0454K-04FP24ESP	4-250A	4x143	4/0, (1) per input, (4) output	#4 AWG (In:4/Out:4)	C902162	902173	48455	225/225
VSD 0520K-04FP24ESP	4-250A	4x164	250MCM, (1) per input, 500MCM (3) output	#4 AWG (In:4/Out:3)	In:C902163 Out:C902165	In:902174 Out:902176	In:902177 Out:86659	225/225

Table 9: Cable Gland Plate Options

Model	Gland Plate PN	Description	Material
2N4	500031145	OPT PL GLAND DWG 2N4 AP	GRP
	500031146	OPT PL GLAND DWG 2N4 AP	CSW
	500031147	OPT PL GLAND DWG 2N4 AP	SSW
	500031148	OPT PL GLAND DWG 2N4 AP	SS NO PNT
	500031149	OPT PL GLAND DWG 2N4 AP	BRASS
4N4	500031150	PL GLAND DWG 4N4 AP	GRP
	500031151	PL GLAND DWG 4N4 AP	CSW
	500031152	PL GLAND DWG 4N4 AP	SSW
	500031153	PL GLAND DWG 4N4 AP	SS NO PNT
	500031154	PL GLAND DWG 4N4 AP	BRASS

Note:

CSW – Carbon steel white

SSW – Stainless steel white

SS NO PNT – Stainless steel no paint

GRP – Group

Table 10: Fuses for Basic Power Supply Board

Designator	Description	Baker Hughes P/N	Manufacturer	Mfr. P/N
F1, F2	Fuse, 4A 600 V time delay	10534928	BUSS	FNQ-R-4, ATQ-R-4
F3, F4	Fuse, 5A 600 V time delay	C54184	BUSS	FNQ-R-5
F5, F6	Fuse, 3.15A,250v,5x20MM, SLO-BLO	C901266	LITTELFUSE	02183.15
F7	Fuse, 6.3A,250v,5x20MM, FAST ACTING	C908171	LITTELFUSE	021706.3*P

Table 11: Fuses for Internal Control System

Designator	Description	Baker Hughes P/N	Manufacturer	Mfr. P/N
FU7	Fuse, 2 amp, 250 V, time delay	900967	BUSSMANN	#MDL-2
FU10	Fuse, 4 amp, 250V 5x20MM time delay	C55535	BUSSMAN	MDL-4
FU11 & 12	Fuse, 5 amp, 500V Midget time delay	C48106	BUSSMAN	FNQ-5
FU20	Fuse, 4 amp, 250V 5X20MM time delay	C48109	LITTELFUSE	218004

Appendix D: Dimensions and Approximate Weights

Table 12: General Structural Details Summary

	VSD Model	Height (in/mm)	Width (in/mm)	Depth (in/mm)	Approx Weight (lb/kg)
		H	W	D	
ESP	VSD 0130-0260K	81 5/8 / 2074	50.312 / 1278	43 3/4 / 1111	1020 / 462.7
	VSD 0325-0520K	81 5/8 / 2074	53.18 / 1351	49.49 / 1257	1890 / 857.3
Sine-Wave Filter	VSD 0130-0260K	81 5/8 / 2074	50.312 / 1278	52 3/8 / 1331	1780 / 807.4
	VSD 0325-0520K	81 5/8 / 2074	53.18 / 1351	58.1 / 1476	2610 / 1183.9

Note: The drive lifting eyes height (3 5/8 in) could be removed from the overall Height (H) indicated in the above table if tight spaces are needed.

Graphics showing the dimensions (D, W, and H) of each drive model can be found in the Outline and Anchor drawings for 2N4 (PN 500031777) and 4N4 (PN 500031977).

Appendix E: Sine-Wave Filter (SWF) PWM Operation

Setup of FusionPro variable speed drives with SWF capability applied on Electrical Submersible Pumps

This information applies to FusionPro variable speed drives configured to operate in sine wave filtered (SWF) pulse width modulation (PWM) mode. The following provides a brief overview of the system.

SWF PWM SYSTEM OVERVIEW

- In addition to the standard drive's power and control electronics, the SWF-configured drive incorporates series-connected filter Inductors and delta-connected capacitors.
- The carrier frequency of the FusionPro PWM waveform is 3.2 kHz. This frequency is fixed and will not need adjustments for different loads.
- Electrical Submersible Pump (ESP) systems can be damaged by an unfiltered PWM waveform. The FusionPro SWF design prevents this damage by creating a nearly sinusoidal waveform for the ESP system.

Figure 52 below shows the derate curve for FusionPro SWF PWM drives for frequencies higher than 60Hz. Table 13 shows the percentage load and voltage drop in SWF PWM mode from 10Hz to 200Hz.

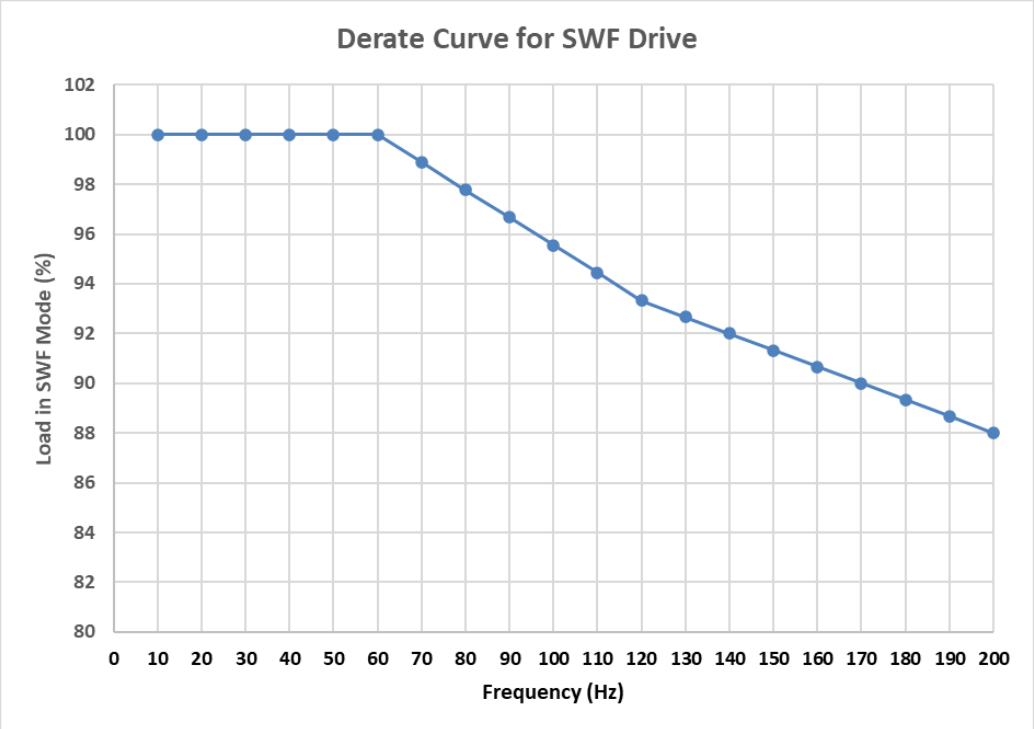


Figure 52: FusionPro SWF Drive Derate Curve

Table 13: Percentage Load and Voltage drop in SWF PWM mode for 60-200Hz Run

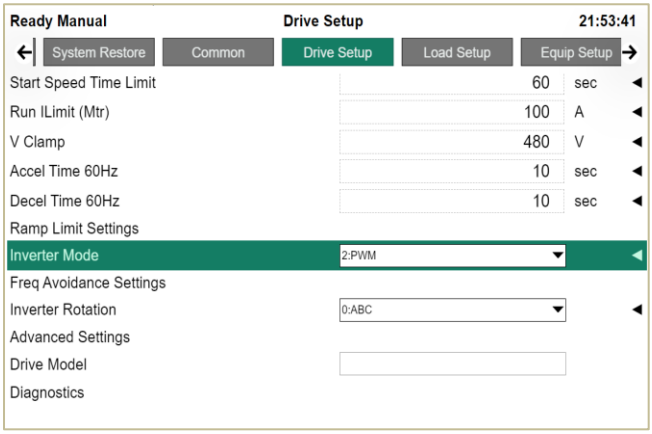
Frequency (Hz)	Load in SWF Mode (%)	Voltage Drop (%)
10	100.0	0.0
20	100.0	0.0
30	100.0	0.0
40	100.0	0.0
50	100.0	0.0
60	100.0	0.0
70	98.9	1.1
80	97.8	2.2
90	96.7	3.3
100	95.6	4.4
110	94.4	5.6
120	93.3	6.7
130	92.7	7.3
140	92.0	8.0
150	91.3	8.7
160	90.7	9.3
170	90.0	10.0
180	89.3	10.7
190	88.7	11.3
200	88.0	12.0

Note: To calculate the output kVA in SWF mode for higher than 60 Hz, please multiply the corresponding percentage load using nominal kVA in Table 7.

OPERATION

The FusionPro drives are designed to run in ESP and PWM Inverter modes. In PWM the drive will produce nearly sinusoidal waveforms when a FPWM output filter is included. When the drive model includes the suffix FPWM it is assumed that an output filter is an added option.

For a SWF-filtered drive with an FPWM drive model, the Inverter Mode parameter to select is **PWM**. With the PWM inverter mode, the drive will produce a PWM output.



Filter Faults

The FusionPro drive monitors the temperature of the filter inductors and the filter capacitors. Thermal switches are included with high-temperature thresholds. If an inductor or capacitor's internal temperature exceeds the threshold while the drive is running, the switch will open the circuit, and the power section will immediately shut down the drive. The Status screen of the FusionPro display will show either of the following as the last shutdown:

PM Flt Filter Inductor Fault
PM Flt Filter Capacitor Fault

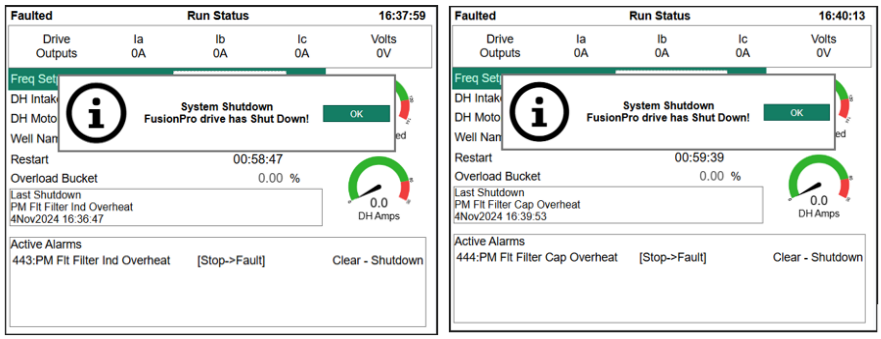


Figure 53: Filter Fault Display

Appendix F: Motor Overload Protection

Operating the motor above its rated amperage could cause significant or permanent damage to the equipment. To protect, and increase the lifespan and reliability of the motor, the Overload must be properly set.

During the setup, care must be taken to:

- Make sure the settings selected are within the recommended range and not too responsive to the point of creating nuisance trips.
- Make sure the motor is stopped within the recommended time, rather than never stopping.

NEC recommends the Motor Overload be set at 125% of its rated value. FusionPro provides the overload delay time at 25%, for simplification, the Motor Overload can be directly set to the nameplate value. During the operation, if the Motor Overload is greater than the nameplate, an internal timer starts counting the remaining time before the drive shuts down on Overload Fault. The percentage of time remaining before the shutdown is illustrated by the Overload Bucket parameter. The overload Delay time @25% sets how long it takes the motor to shut down if it continuously runs above 25% of the Motor Overload (see Figure 54). Note that:

- If the current supplied to the motor continues to be greater than 25% of the motor overload, it takes less than the time set in the overload Delay @25% time to shut down the drive.
- If the input current of the motor continues to be less than 25% of the motor overload value, it takes longer than the overload Delay @25% time to shut down the drive.
- If the motor is restarted after an Overload Fault and before the Overload Bucket reaches zero, the subsequent shutdown delay time is faster. This is referred to as the electronic motor thermal memory retention.

The motor thermal memory retention is maintained through a loss of power event, and active regardless of the operating speed of the motor. The duration of the thermal memory retention can be increased by adjusting the parameter Overvoltage Drain.

It is very important to always refer to the motor specification when adjusting the overload parameters.

The graph below represents the overload ratio values and the corresponding trip times.

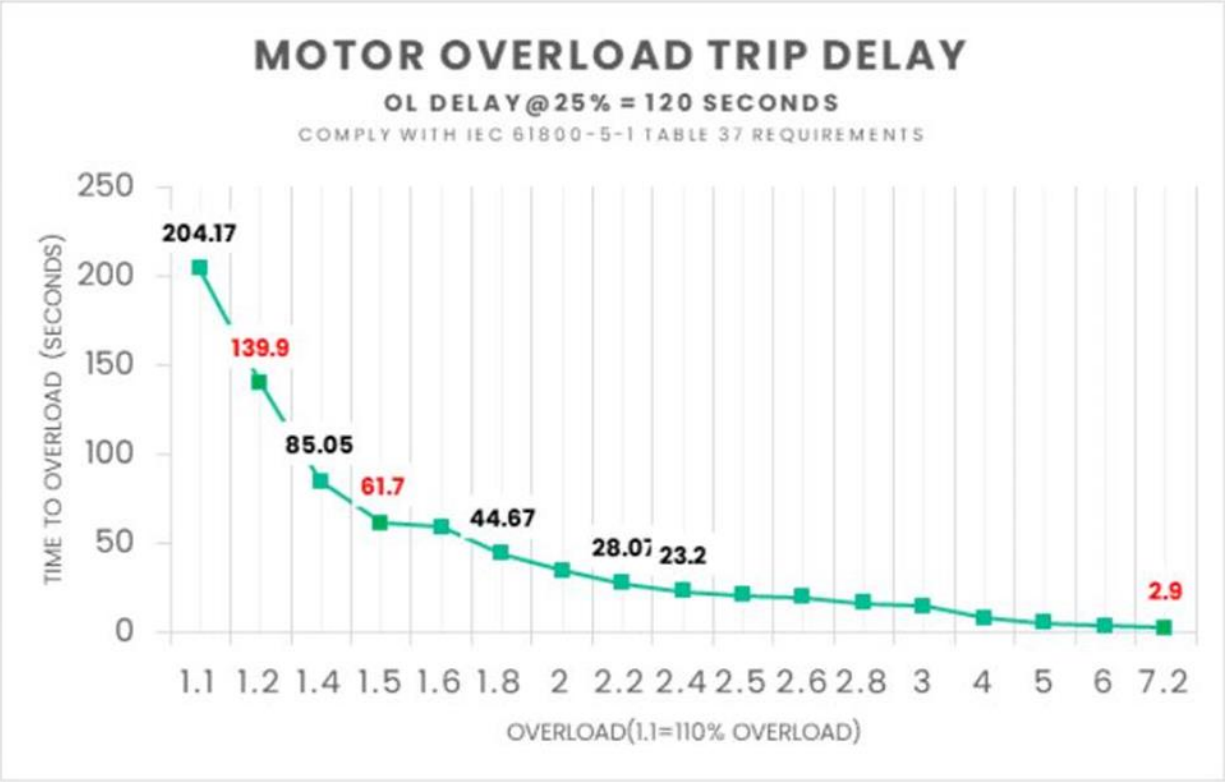


Figure 54: Motor Overload Trip Delay Curve

Appendix G: Schematics

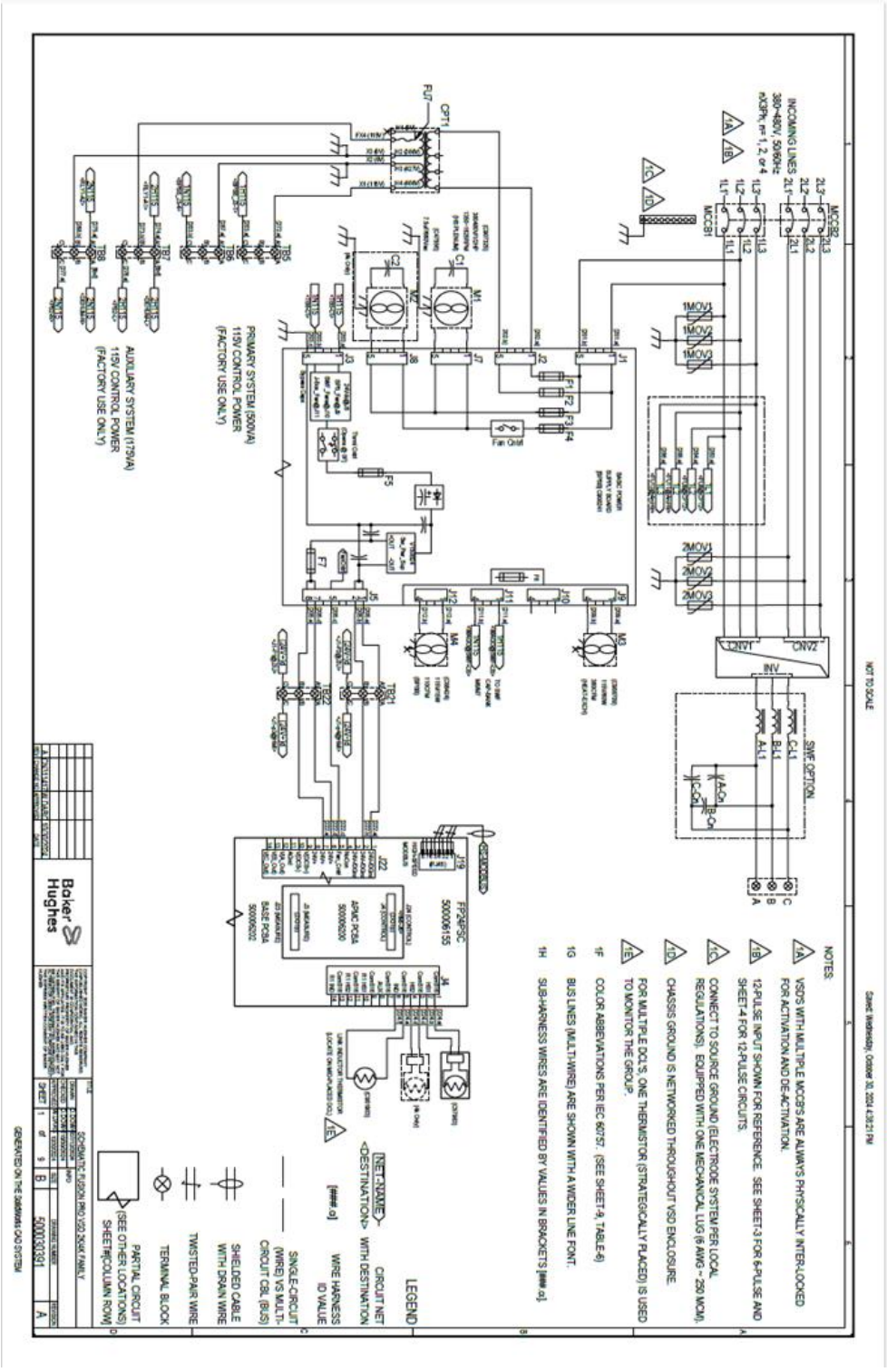


Figure 55: Schematic 500030391 Rev A, SHT-1; FusionPro 2N4/4N4 System Control and Power

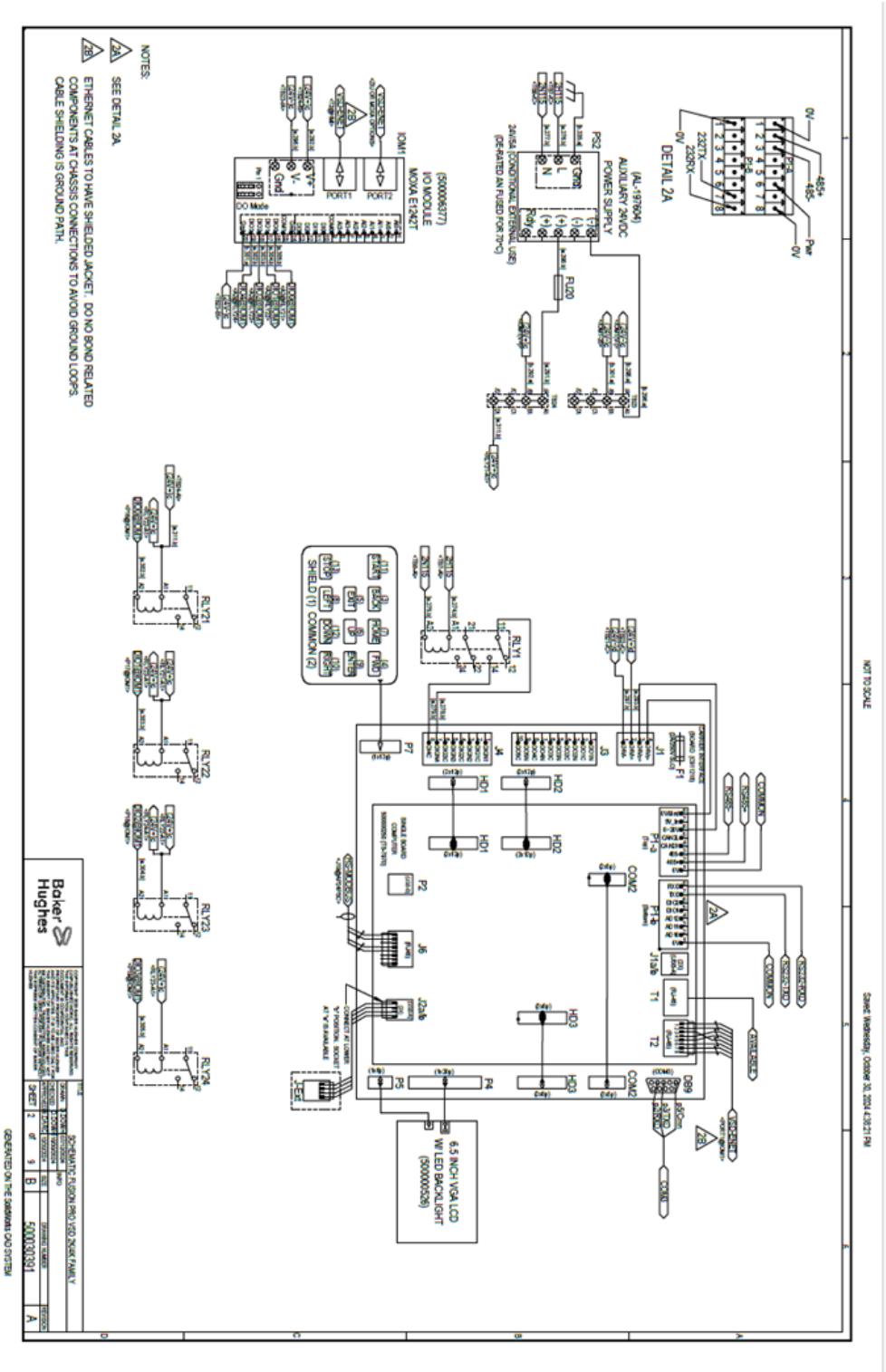


Figure 56: Schematic 500030391 Rev A, SHT-2; FusionPro 2N4/4N4 System Control and Power

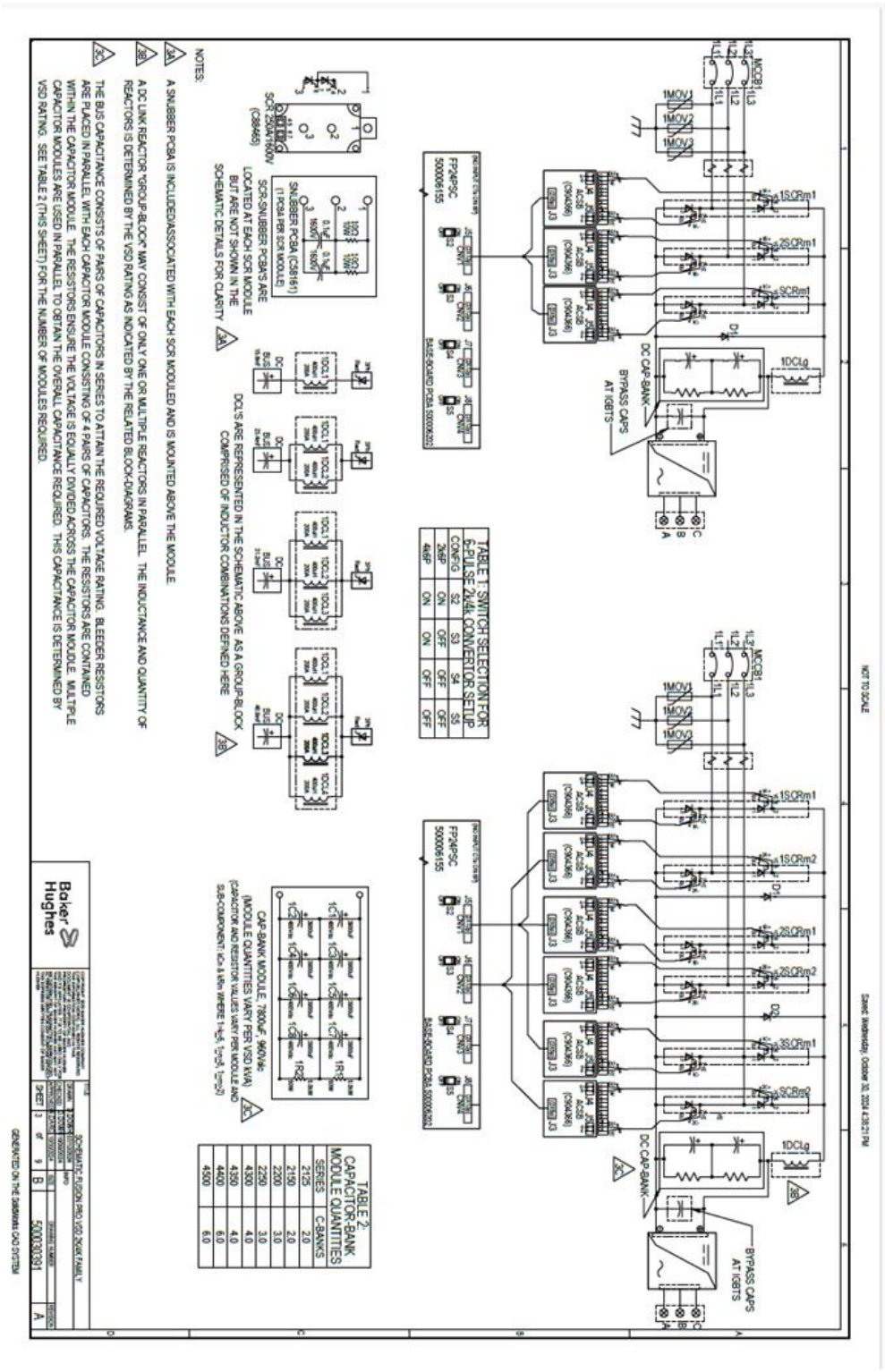


Figure 57: Schematic 500030391 Rev A, SHT-3; FusionPro 2N4/4N4 System Control and Power

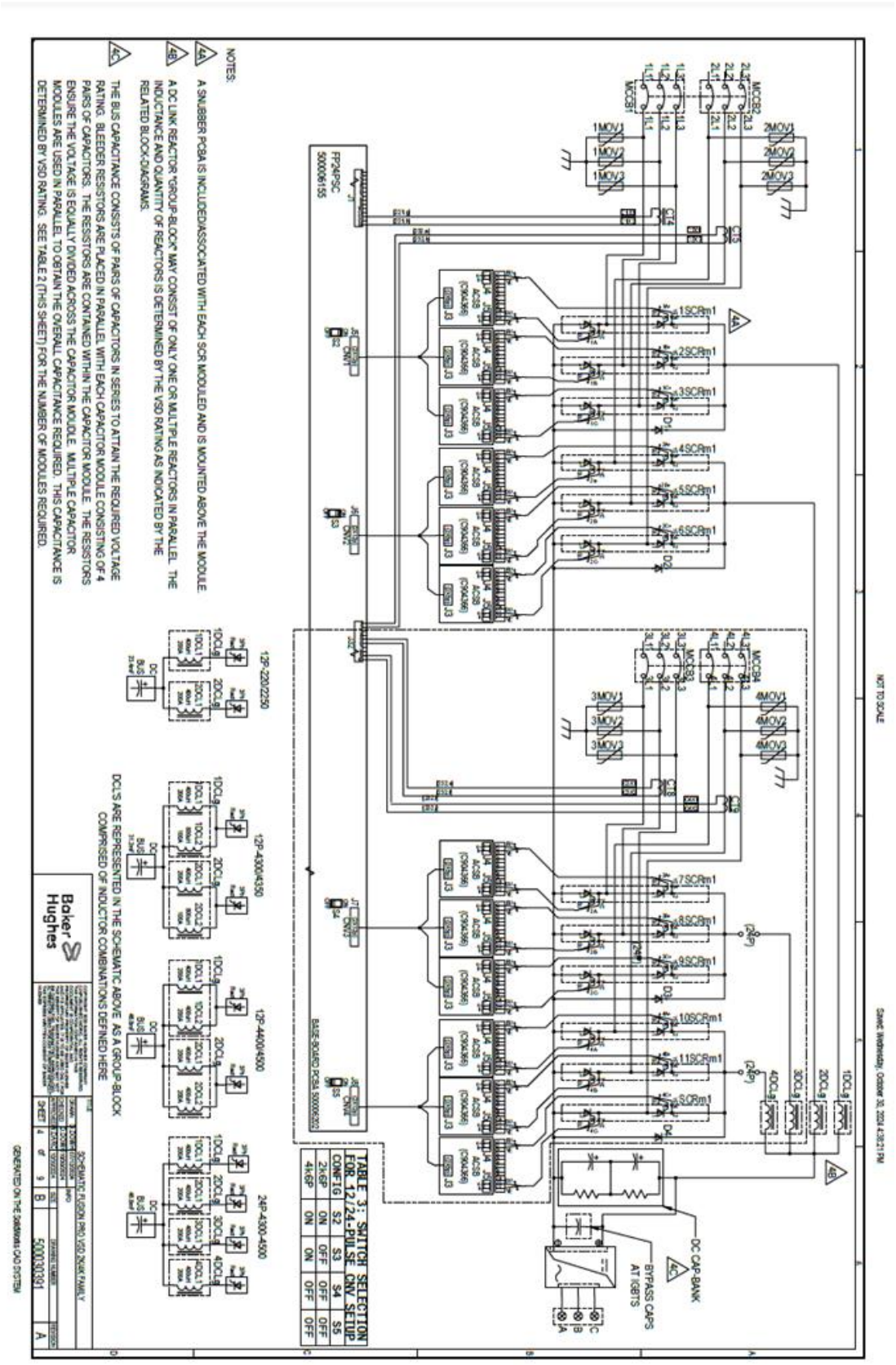


Figure 58: Schematic 500030391 Rev A, SHT-4; FusionPro 2N4/4N4 System Control and Power

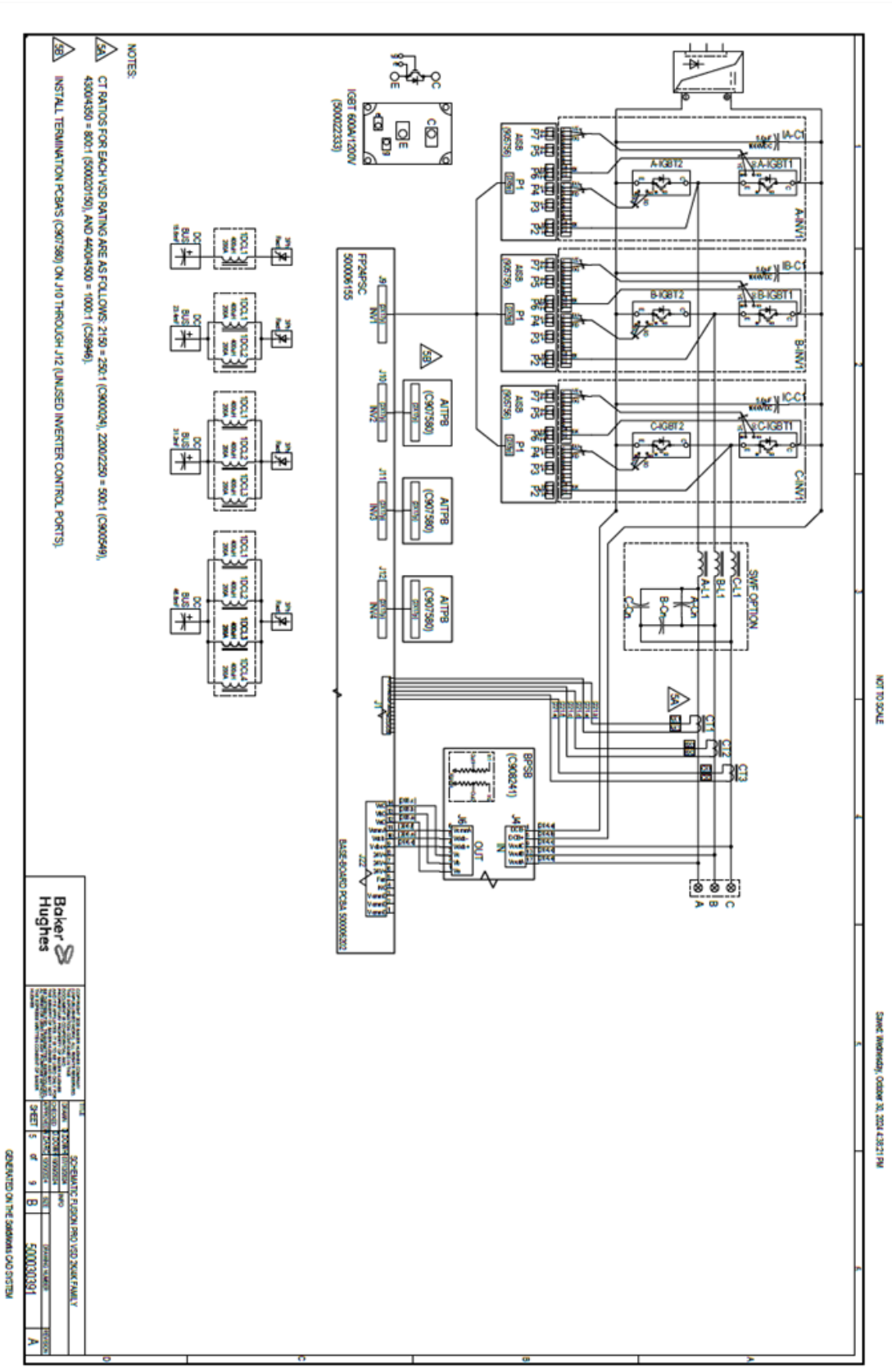


Figure 59: Schematic 500030391 Rev A, SHT-5; FusionPro 2N4/4N4 System Control and Power

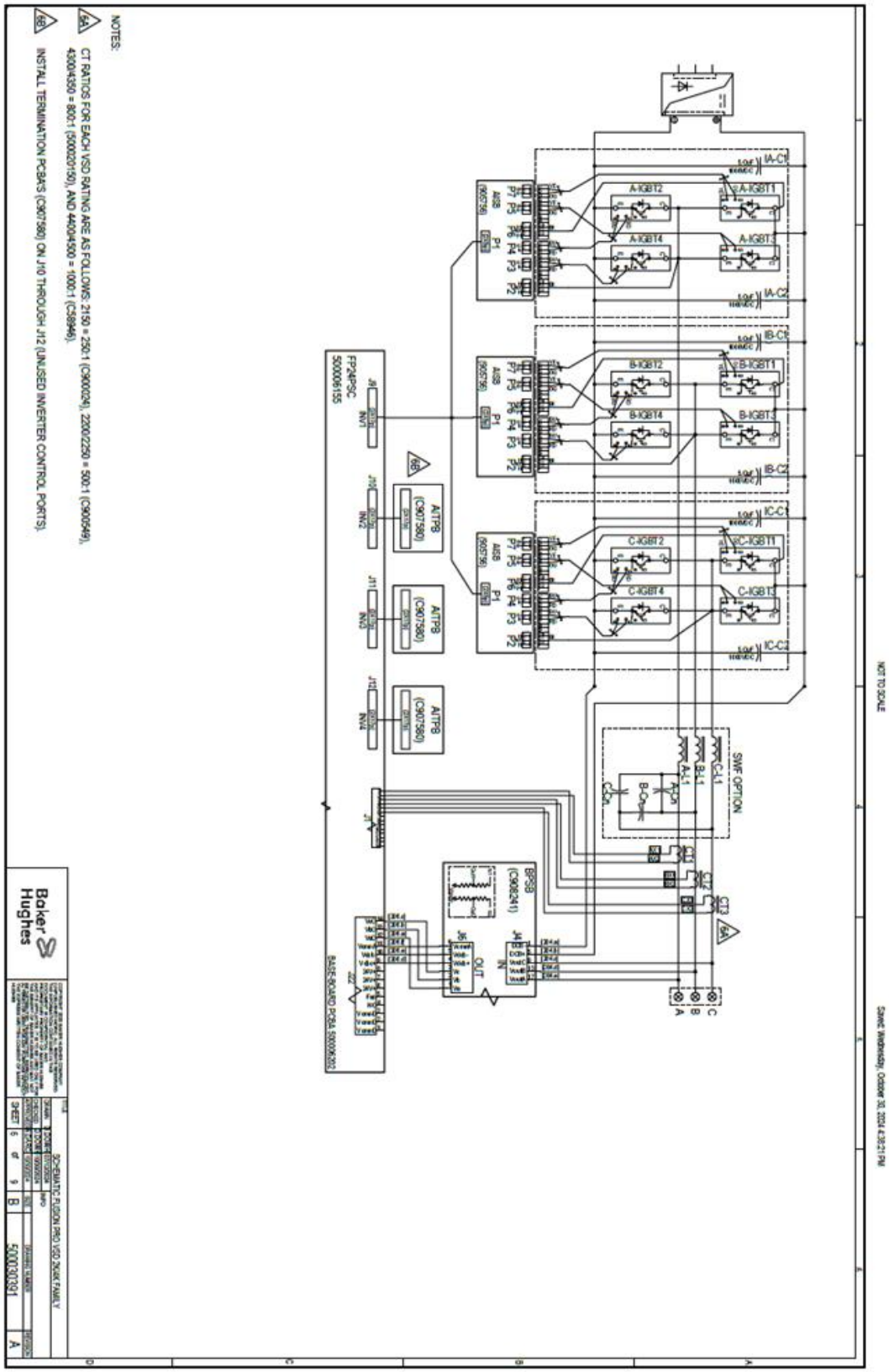


Figure 60: Schematic 500030391 Rev A, SHT-6; FusionPro 2N4/4N4 System Control and Power

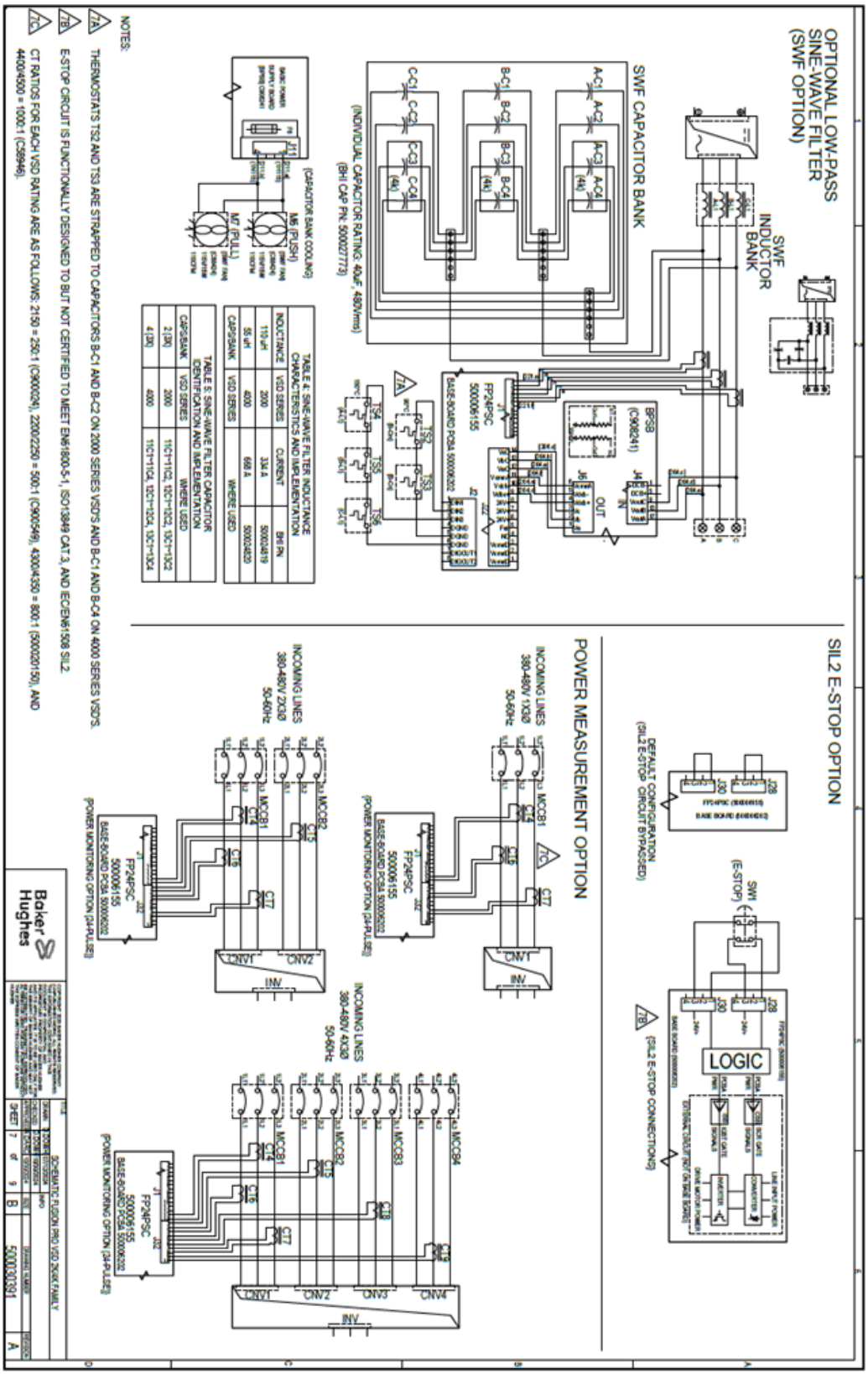


Figure 61: Schematic 500030391 Rev A, SHT-7; FusionPro 2N4/4N4 System Control and Power

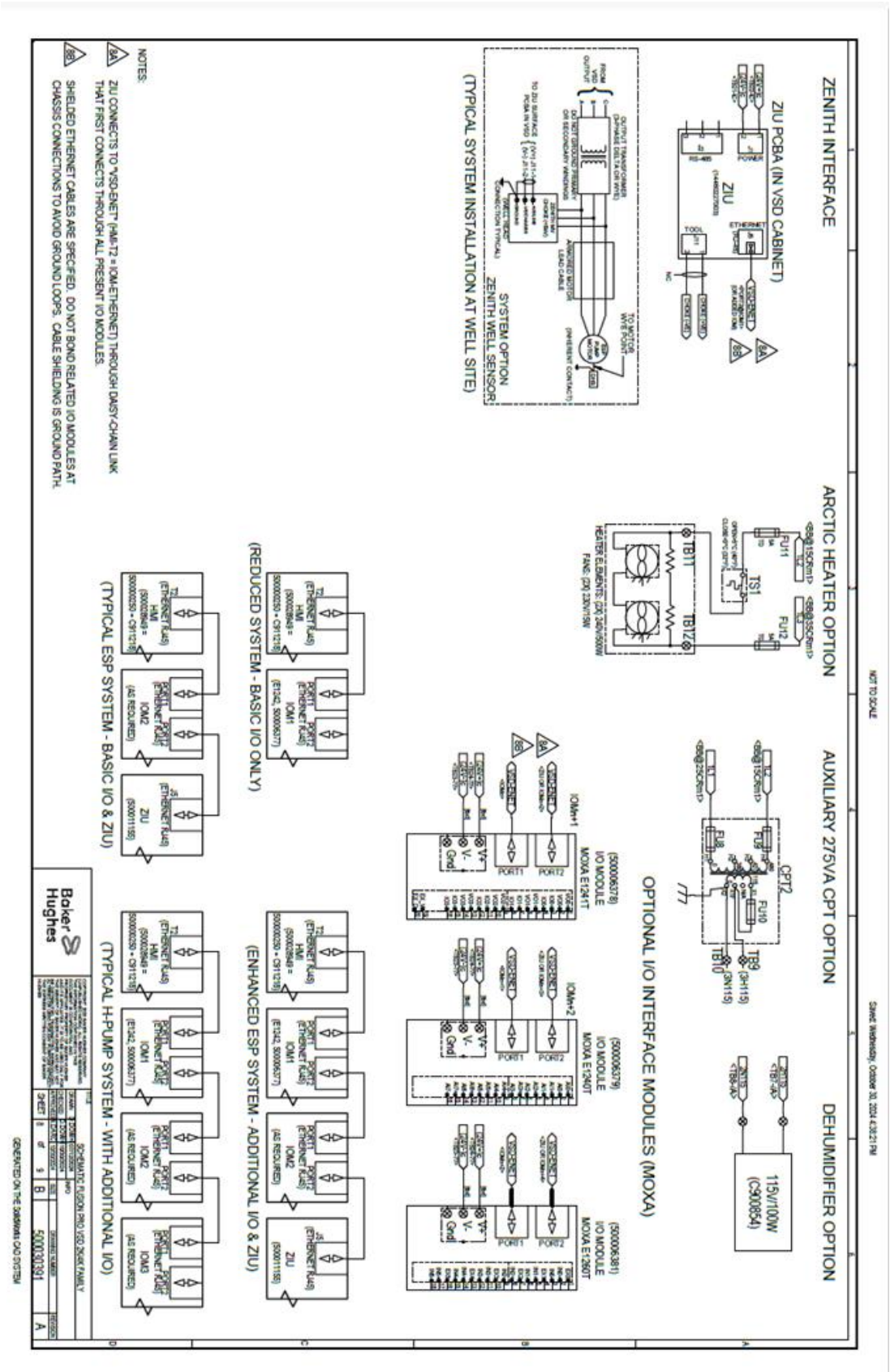


Figure 62: Schematic 500030391 Rev A, SHT-8; FusionPro 2N4/4N4 System Control and Power