YORK BY JOHNSON CONTROLS	OPTISPEED™ VARIABLE SPEED DRIVE	
SERVICE	Supersedes: 160.78-M3 (113)	Form 160.78-M3 (214)

MODELS
HYP490
HYP744

LD14681

490 AMPS – 50/60 HZ, 380-460 VAC (P/N 371-05614-XXX)
744 AMPS – 50/60 HZ, 380-460 VAC (P/N 371-05571-XXX)

Issue Date:
February 28, 2014

IMPORTANT!

READ BEFORE PROCEEDING!

GENERAL SAFETY GUIDELINES

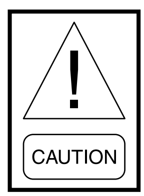
This equipment is a relatively complicated apparatus. During installation, operation maintenance or service, individuals may be exposed to certain components or conditions including, but not limited to: refrigerants, materials under pressure, rotating components, and both high and low voltage. Each of these items has the potential, if misused or handled improperly, to cause bodily injury or death. It is the obligation and responsibility of operating/service personnel to identify and recognize these inherent hazards, protect themselves, and proceed safely in completing their tasks. Failure to comply with any of these requirements could result in serious damage to the equipment and the property in which it is situated, as well as severe personal injury or death to themselves and people at the site.

This document is intended for use by owner-authorized operating/service personnel. It is expected that these individuals possess independent training that will enable them to perform their assigned tasks properly and safely. It is essential that, prior to performing any task on this equipment, this individual shall have read and understood this document and any referenced materials. This individual shall also be familiar with and comply with all applicable governmental standards and regulations pertaining to the task in question.

SAFETY SYMBOLS

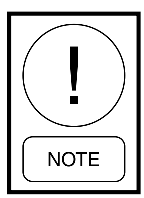
The following symbols are used in this document to alert the reader to specific situations:

Indicates a possible hazardous situation which will result in death or serious injury if proper care is not taken.



Identifies a hazard which could lead to damage to the machine, damage to other equipment and/or environmental pollution if proper care is not taken or instructions and are not followed.

Indicates a potentially hazardous situation which will result in possible injuries or damage to equipment if proper care is not taken.



Highlights additional information useful to the technician in completing the work being performed properly.

External wiring, unless specified as an optional connection in the manufacturer's product line, is not to be connected inside the control cabinet. Devices such as relays, switches, transducers and controls and any external wiring must not be installed inside the micro panel. All wiring must be in accordance with Johnson Controls' published specifications and must be performed only by a qualified electrician. Johnson Controls will NOT be responsible for damage/problems resulting from improper connections to the controls or application of improper control signals. Failure to follow this warning will void the manufacturer's warranty and cause serious damage to property or personal injury.

CHANGEABILITY OF THIS DOCUMENT

In complying with Johnson Controls' policy for continuous product improvement, the information contained in this document is subject to change without notice. Johnson Controls makes no commitment to update or provide current information automatically to the manual owner. Updated manuals, if applicable, can be obtained by contacting the nearest Johnson Controls Service office.

Operating/service personnel maintain responsibility for the applicability of these documents to the equipment. If there is any question regarding the applicability of these documents, the technician should verify whether the equipment has been modified and if current literature is available from the owner of the equipment prior to performing any work on the chiller.

CHANGE BARS

Revisions made to this document are indicated with a line along the left or right hand column in the area the revision was made. These revisions are to technical information and any other changes in spelling, grammar or formatting are not included.

ASSOCIATED LITERATURE

This instruction is to be used in conjunction with the Operation Instructions for YORK Model YMC^2 chiller.

MANUAL DESCRIPTION	FORM NUMBER
Operation (Unit) Model YMC^2	160.78-O1
Operation (Control Panel) Model YMC^2	160.78-O2
Service (Control Panel) Model YMC^2	160.78-M2
Wiring Diagram (Control Panel) Model YMC^2	160.78-PW2
Wiring Field Connections (OptiSpeed Compressor Drive) Model YMC^2	160.78-PW4
Replacement Parts List (OptiSpeed Compressor Drive) Model YMC^2	160.78-RP3

WARNING

This product contains voltages that could cause injury or death. Follow all NFPA-70E safety rules. Before performing any troubleshooting procedures. Place the compressor switch in the stop position. Wait 5 minutes. Ensure that the DC BUS voltage is 50 VDC or less on the display of the chiller control panel. Ensure that all sources of power to the chiller are removed. Remove all AC power sources upstream of the VSD and perform lockout / tagout procedures. Use a non-contact voltage sensor to ensure no AC power is present in the enclosure. Use a DVM to measure AC and DC voltage at locations shown below. Measure the three phase connections phase to phase and phase to ground. All values should be zero. Measure voltage from point A to ground.

Measure the BUS voltage at J1 pins 1-2 on the VSD logic board using a DVM to ensure that BUS voltage is less than 50 VDC.

WARNING

YMC^2 with high speed direct drive permanent magnet rotor hermetic motor

Motor auto-rotation electrical hazard

While the chiller is off, thermal energy provided to the chiller shells through the plant systems can result in auto rotation of the hermetic motor by refrigerant vapor driven across the compressor impeller. This results in the permanent magnet motor rotor acting as an electrical generator. The output at the motor terminals will vary directly with speed of rotation and may provide a safety hazard to a service person if unaware.

The force to drive the rotation depends on maintenance of differential pressure across the chiller shells by cooled or warmed liquid flow through the tubes of one shell and existence of refrigerant to vaporize and flow across the impeller. Rotation is impeded when the motor leads are connected to the VSD output and is also impeded when the leads are removed and electrically connected together. Conditions that do not initiate rotation when the motor leads are connected could incite rotation and electrical potential across phases if the leads are disconnected.

The following are recommendations to safely service the machine:

- ***Shut down the machine, extend the Variable Geometry Diffuser and close discharge isolation valve (if so equipped). Isolation prevents a path for refrigerant movement. Isolation that is relied upon should be locked in position to prevent inadvertent restoration to a dangerous condition.***
- ***Remove and secure input power to the VSD and wait 15 minutes for DC bus to dissipate.***
- ***Open the VSD panel with proper electrical PPE for the drive rating and measure voltage at the motor connection points.***
- ***If measured voltage is zero, install shorting/grounding wires to short together and ground the three motor phases. Wire should be a minimum of AWG 0.*** **NOTE:** ***A shorting harness is also available as P/N 325-44935-000.***
- ***If the voltage is not zero, this indicates that the motor is auto rotating. The service technician must take the necessary measures to stop refrigerant and/or liquid flow through the machine such as closing discharge or liquid line isolation, stopping customer water pumps, etc. to cease generation of electrical potential before shorting or grounding motor leads.***
- ***If the motor is to be disconnected from the output of the VSD, a set of shorting/grounding wires would need to be installed directly to the motor structure.***

DANGER

When the machine is ready for return to service or standby, remove shorting/grounding wiring with care that auto-rotation remains prohibited so the free motor wires are safe to handle.

CAUTION

Because of the use of shorting and grounding devices during the process, be very certain they have been removed before applying line power to the VSD for return to service.

HYP MODEL NOMENCLATURE

HYP 744 X H 30 D - 46

Voltage Rating
40 = 380VAC 60Hz
46 = 460VAC 60Hz
50 = 400VAC 50Hz
68 = 415VAC 50Hz

Input Type
D = Disconnect Switch
B = Circuit Breaker

Condenser Liquid Pressure PSIG
15 = 150
30 = 300

Chiller Application
H = YMC^2

X = Factory Package
R = Retrofit Package

Drive Current Rating (744 or 490)

Type of Drive

MODEL NUMBERS AND PART NUMBERS

490 AMP MODEL 400 VAC 50HZ	
HYP490XH30D-50	371-05614-121
HYP490XH30B-50	371-05614-122
490 AMP MODEL 415 VAC 50 HZ	
HYP490XH30D-68	371-05614-123
HYP490XH30B-68	371-05614-124
490 AMP MODEL 400 VAC 60 HZ	
HYP490XH30D-40	371-05614-103
HYP490XH30B-40	371-05614-104
490 AMP MODEL 460 VAC 60 HZ	
HYP490XH30D-40	371-05614-101
HYP490XH30B-40	371-05614-102
744 AMP MODEL 400 VAC 50HZ	
HYP744XH30D-50	371-05571-121
HYP744XH30B-50	371-05571-122
HYP744XH30D-50	371-05571-161
HYP744XH30B-50	371-05571-162

744 AMP MODEL 415 VAC 50 HZ	
HYP744XH30D-68	371-05571-123
HYP744XH30B-68	371-05571-124
HYP744XH30D-68	371-05571-163
HYP744XH30B-68	371-05571-164
744 AMP MODEL 400 VAC 60 HZ	
HYP744XH30D-40	371-05571-103
HYP744XH30B-40	371-05571-104
HYP744XH30D-40	371-05571-143
HYP744XH30B-40	371-05571-144
744 AMP MODEL 460 VAC 60 HZ	
HYP744XH30D-46	371-05571-101
HYP744XH30B-46	371-05571-102
HYP744XH30D-46	371-05571-141
HYP744XH30B-46	371-05571-142

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

LIST OF FIGURES

LIST OF TABLES

SECTION 1 - GENERAL OPERATON

This new drive design brings to market a product that uses new light weight materials, new power semi-conductors, new bus capacitor, compact power assembly design, liquid cooled inductors, and includes harmonic filter in all models. The model number now describes the maximum input current of the 460 VAC model.

The copper chill plates used to cool the power semi-conductors are replaced with direct liquid cooled plastic cooling assemblies. The design is very similar to the design used on the VSD model drive. The liquid is sealed between the baseplate of the power semi-conductor and the plastic cooling assembly. The cooling is provided to the power semi-conductor by liquid flowing across the baseplate.

WHAT IS NEW?

This drive uses Insulated Gate Bipolar Transistors (IGBT). The IGBT has been used for many years in the design of the drive output and the harmonic filter. Typically, the IGBT modules used at this current rating contain 2 IGBT's. JCI worked closely with the IGBT manufacturer and had a third IGBT installed in the same module. This new module is used in the rectifier of the drive and allows the drive to pre-charge without the use of an input contactor, or pre-charge resistors.

At the heart of the compact power unit is the new bus capacitor. The new bus capacitor contains all of the mounting hardware for the rectifier assembly, bus structure, and the inverter assembly. A separate heavy metal structure is not required in this assembly.

The bus capacitor is no longer an electrolytic design that required voltage balancing or the need of many capacitors in parallel due to low current ratings. The new bus capacitor uses a higher voltage rated material so that voltage balancing is not required. The current rating of this new capacitor is much higher, requiring only one bus capacitor to be used on smaller designs, and only one capacitor per phase on many other models.

Inductors at these power levels get very hot, which could cause concern. Not any more. The output inductor in this drive is liquid cooled. The inductor is now no hotter than the inside of the drive. Most of the heat is rejected directly into the liquid cooling system. Some designs will have input and output liquid cooling inductors resulting in much more efficient drive cooling

HARMONIC FILTERING

Harmonic filtering is no longer a question with this new design. The controls for the rectifier IGBT's now provide harmonic filtering standard. A separate heavy power assembly, contactors, fuses, and harmonic filter logic board are no longer required for harmonic filtering. Today all of the controls for the drive and the harmonic filter are contained in the drive logic board. This new board is about the same size as the VSD model drive logic board.

COMPONENT OVERVIEW

HYP Compressor Drive 744 Amp

The new HYP compressor drive is a liquid cooled, transistorized, PWM inverter in a highly integrated package. The harmonic filter is now integrated into the standard HYP model drive. This package is small enough to mount directly onto the chiller motor. The power section of the drive is composed of four major blocks:

- a three phase AC to DC rectifier section with an integrated pre-charge circuit,
- a DC bus filter section,
- a three phase DC to AC inverter section and
- an input and output harmonic filters.

The following component overview is general to all models of HYP unless otherwise noted.

Disconnect Switch

An electronic circuit breaker or disconnect switch connects the three phase power to input fuses and then onto the AC line inductor, input filter and then to the DC rectifier section. After the rectifier, power is stored in the bus capacitor until needed by the inverter. The inverter changes the DC into the proper AC voltage and frequency. The output harmonic filter will smooth out the AC voltage waveform to improve the operation of the motor.

Harmonic Filter

The input harmonic filter in the HYP model is much like the harmonic filter used in earlier designs, except the IGBT's used in the harmonic filter are now part of the rectifier. The upper and lower IGBT's in the rectifier are used to command the wave shape of the input current. The input current waveform is commanded to be a sine wave that provides a very low total demand distortion value as well as a power factor value of nearly unity.

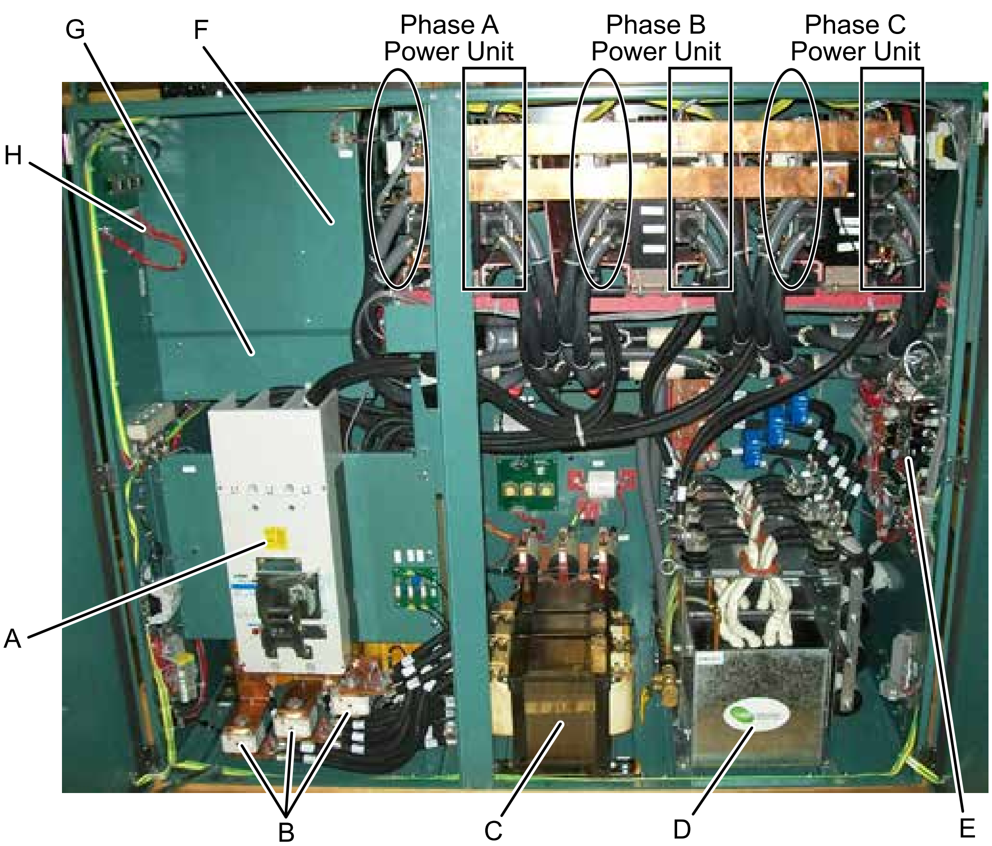
The AC to DC rectifier uses several IGBT's in parallel. Each phase has one or more modules arranged in a parallel connection depending on the amount of input current required for that model. Each rectifier module contains 3 IGBT's that are called the Upper, Lower, and Auxilliary IGBT. All three IGBT's are required to rectify the 3 phase input AC voltage into DC voltage in a new three-phase bridge configuration (*Figure 1*). The use of the Auxilliary IGBT in the new three-phase bridge configuration in the rectifier permits pre-charge of the DC bus filter capacitors without the use of an additional component, and they also provide a fast disconnect from the AC line when the chiller enters the stopped mode.

DC Bus

The DC Bus section of the drive consists of one basic component, a large capacitor or capacitors depending on the current requirement of the HYP model. These capacitors provide a large energy reservoir for use by the DC to AC inverter section of the HYP. These capacitors provide the physical foundation for the HYP power unit. All of the other components in the power unit are connected to the foundation of the bus capacitor.

The output of the drive also uses IGBT's to control the voltage and frequency to the motor. The controls within the drive logic board are different in how the output IGBT's are turned on and off, but the configuration of the IGBTs' is the same.

The output harmonic filter is new to the JCI design. The reason for the output harmonic filter is that the permanent magnet motor used on this chiller design has very little inductance, and does not provide much filtering of the output current from the drive. Without the output harmonic filter the compressor motor would overheat, and reduce the power available to the chiller.



A	Circuit Breaker (Disconnect)
B	Input Power Fuses
C	Input Line Inductor
D	Output Harmonic Filter
E	Drive Logic Board
F	Cooling Fans (Behind Panel)
G	Cooling Coil (Behind Panel)
H	Line Voltage Isolation Board
◯	Rectifiers
□	Inverter

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FIGURE 1 - DRIVE CABINET

SECTION 2 - DRIVE WIRING DIAGRAMS

Elementary Wiring Diagram 490 AMP Notes

1. Field wiring to be in accordance with the National Electrical Code as well as all other applicable codes and specifications.
2. Terminal block connection points are indicated by numbers within a square, i.e. [1] 1TB. Main power connection points are indicated by numbers within a hexagon, i.e.⟨L1⟩. Component terminal markings are indicated by numbers within a circle. i.e.(2). Numbers adjacent to circuit lines are the circuit identification numbers.
3. Terminals L1. L2, L3 and ground are the main power input terminals and are field connected. (See note 6). Terminals T1, T2 and T3 are the compressor motor lead power terminals and are factory connected on factory packaged units.
4. The three phase solid state motor overload protection system provide motor overcurrent protection at 105% full load amps.
5. See YORK Control Center wiring diagram product drawing Form 160.78-PW2.
6. Field Wiring Connections per Product Drawing Form 160.78-PW1.

LEGEND for 035-23185-001 and 002

IC-6C	Capacitor, Film, Input Power Filter
7C	Capacitor, Film
9C-20C	Capacitor, Film, Snubber
21C	Capacitor, Film, DC Link
22C-33C	Capacitor, Film
34C-35C	Capacitor, Electrolytic
IDSW	Switch Disconnect
ISW	Circuit Breaker
IDCCT -6DCCT	DC Current Transformer
IFU-3FU	Fuse, Input Power
4FU-6FU	Fuse, Input Voltage Sense
7FU-8FU	Fuse, Control Transformer Primary
14FU	Fuse, To Ups
15FU	Fuse, To Panel Non Critical
16FU-18FU	Fuse, Transient Suppressor PCB
19FU	Fuse, To VSD Circuits Non Critical
21FU	Fuse, Input Voltage Common Mode
22FU-24FU	Fuse, Output Voltage Sense
25FU-26FU	Fuse, To BMI MBC, IDA
IL	Inductor, Line
2L	Inductor, Drive
3L	Inductor, Output
4L	Inductor
1MOD-6MOD	Module, Power Dual, Active Converter
7MOD-12MOD	Module, Power Dual, Inverter
1R	Relay, Cooling Fans And Pump
1RES-4RES	Resistor, Bleeder
5RES-I0RES	Power Resistor
17RES	Resistor
18RES-19RES	Resistor, Bleeder
1RT -2RT	Thermistor, Ambient
1T	Transformer, Control
2T-3T	Transformer, Class 2
1TB	Terminal Block
2TB	Terminal Block
3TB	Terminal Block
5TB	Terminal Block, Fan
1D	Diode Module

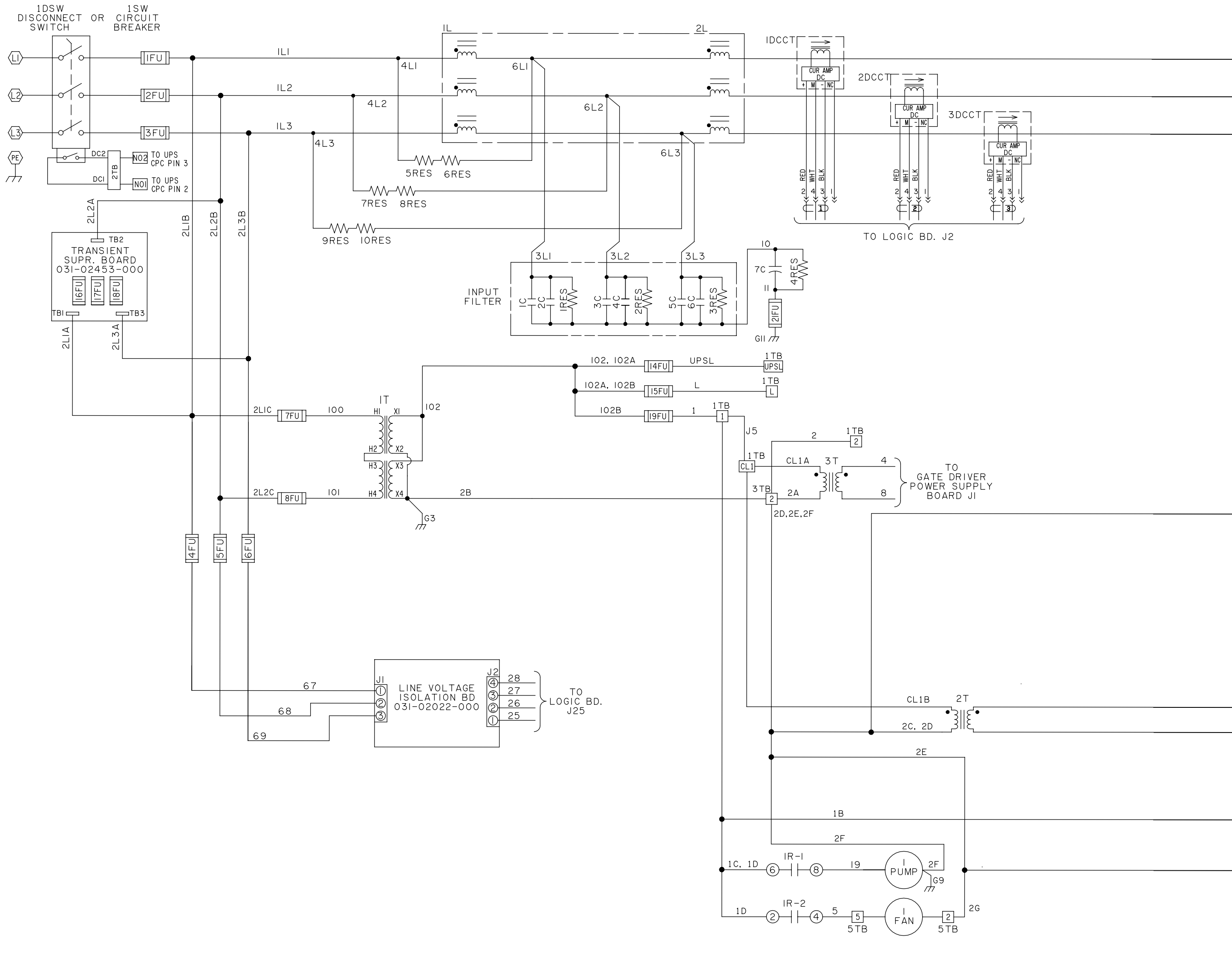

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FIGURE 2 - ELEMENTARY WIRING DIAGRAM 490 AMP

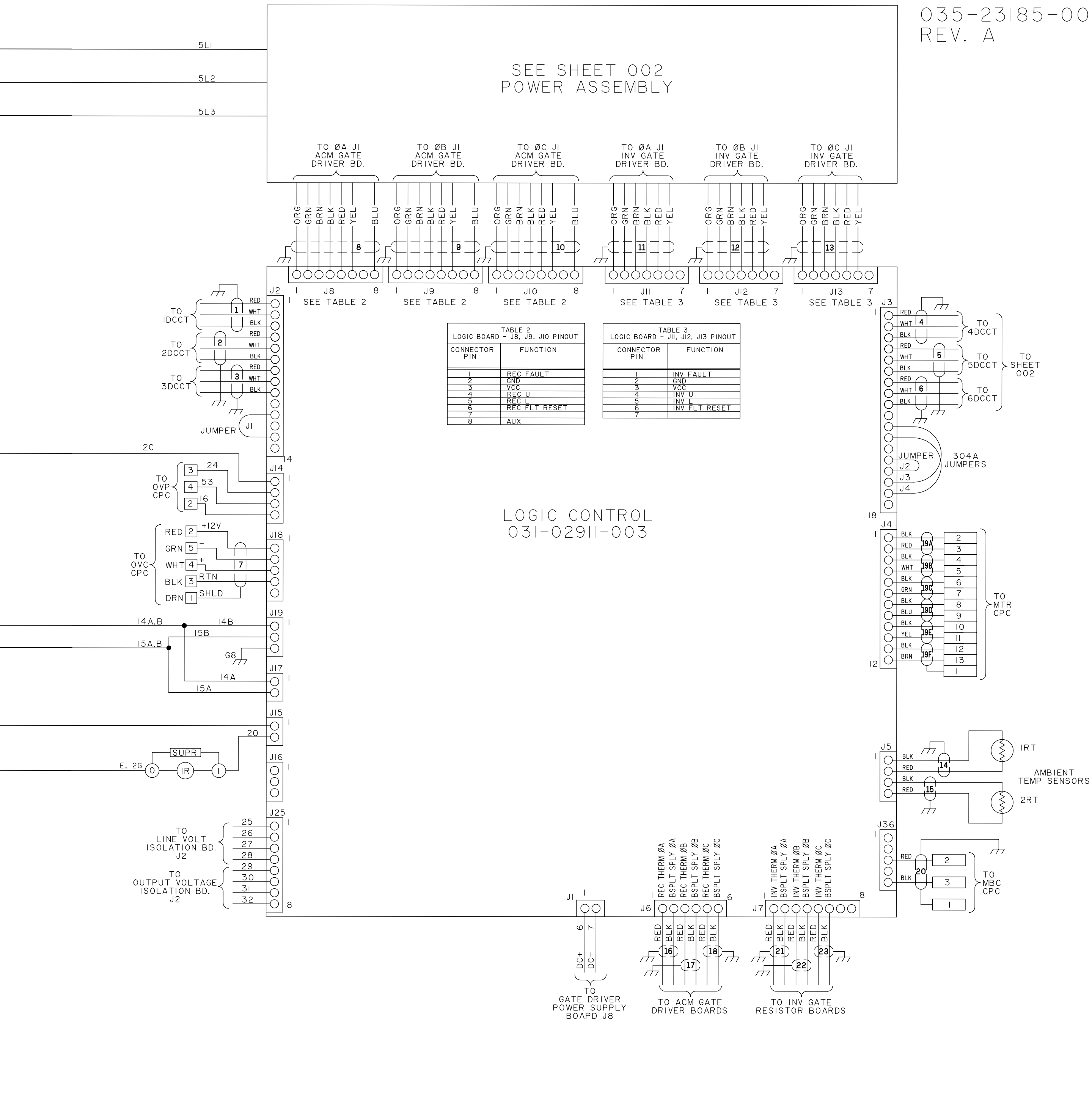

TABLE 2
LOGIC BOARD - J8, J9, J10 PINOUT

CONNECTOR PIN	FUNCTION
1	REC FAULT
2	GND
3	VCC
4	REC U
5	REC L
6	REC FLT RESET
7	
8	AUX

TABLE 3
LOGIC BOARD - J11, J12, J13 PINOUT

CONNECTOR PIN	FUNCTION
1	INV FAULT
2	GND
3	VCC
4	INV U
5	INV L
6	INV FLT RESET
7	

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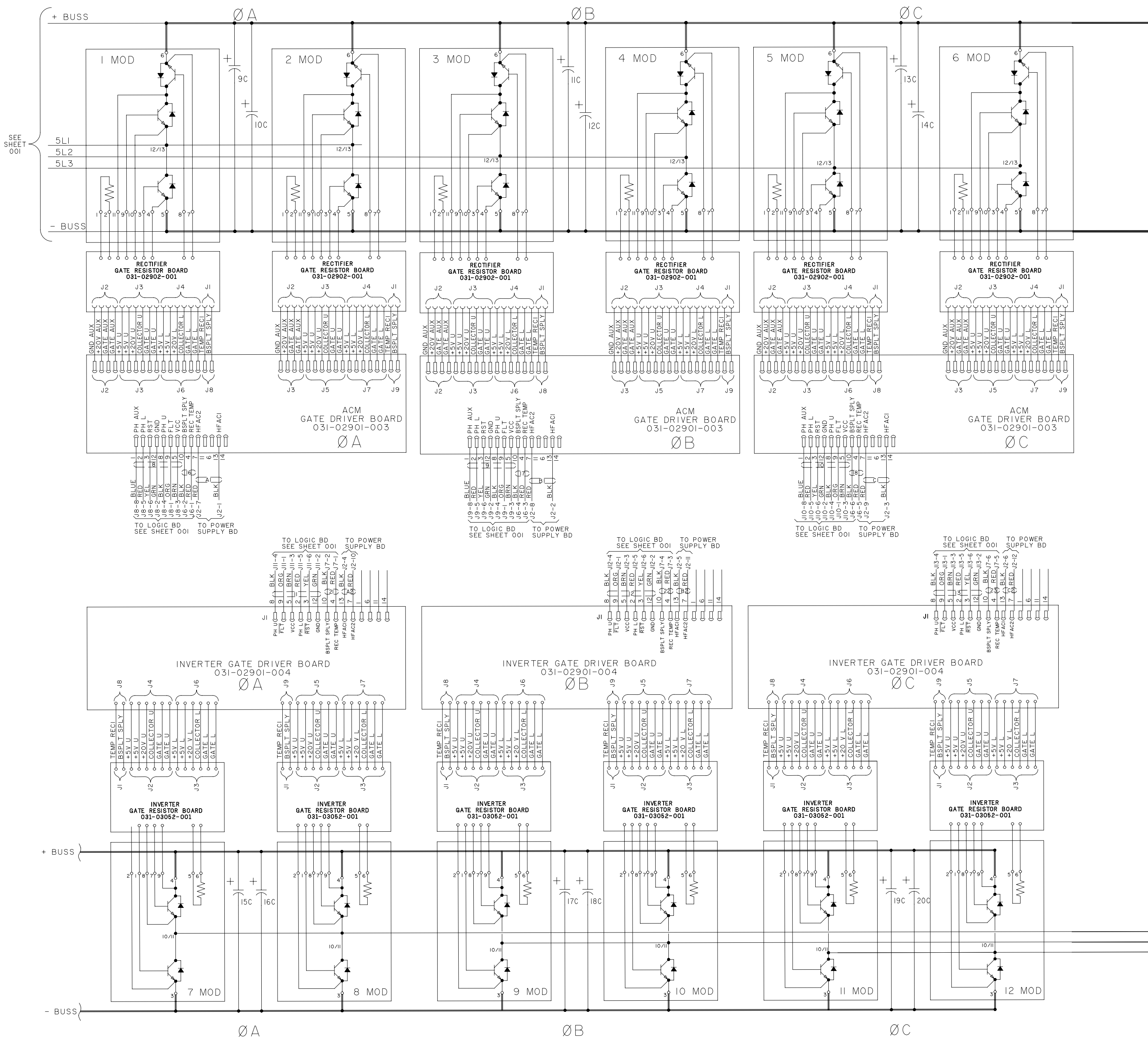
FIGURE 7 - ELEMENTARY WIRING DIAGRAM 490 AMP (CONT'D)



* The 490AMP unit consists of all 3 phases in one power unit.

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FIGURE 3 - POWER UNIT - ELEMENTARY WIRING DIAGRAM 490 AMP

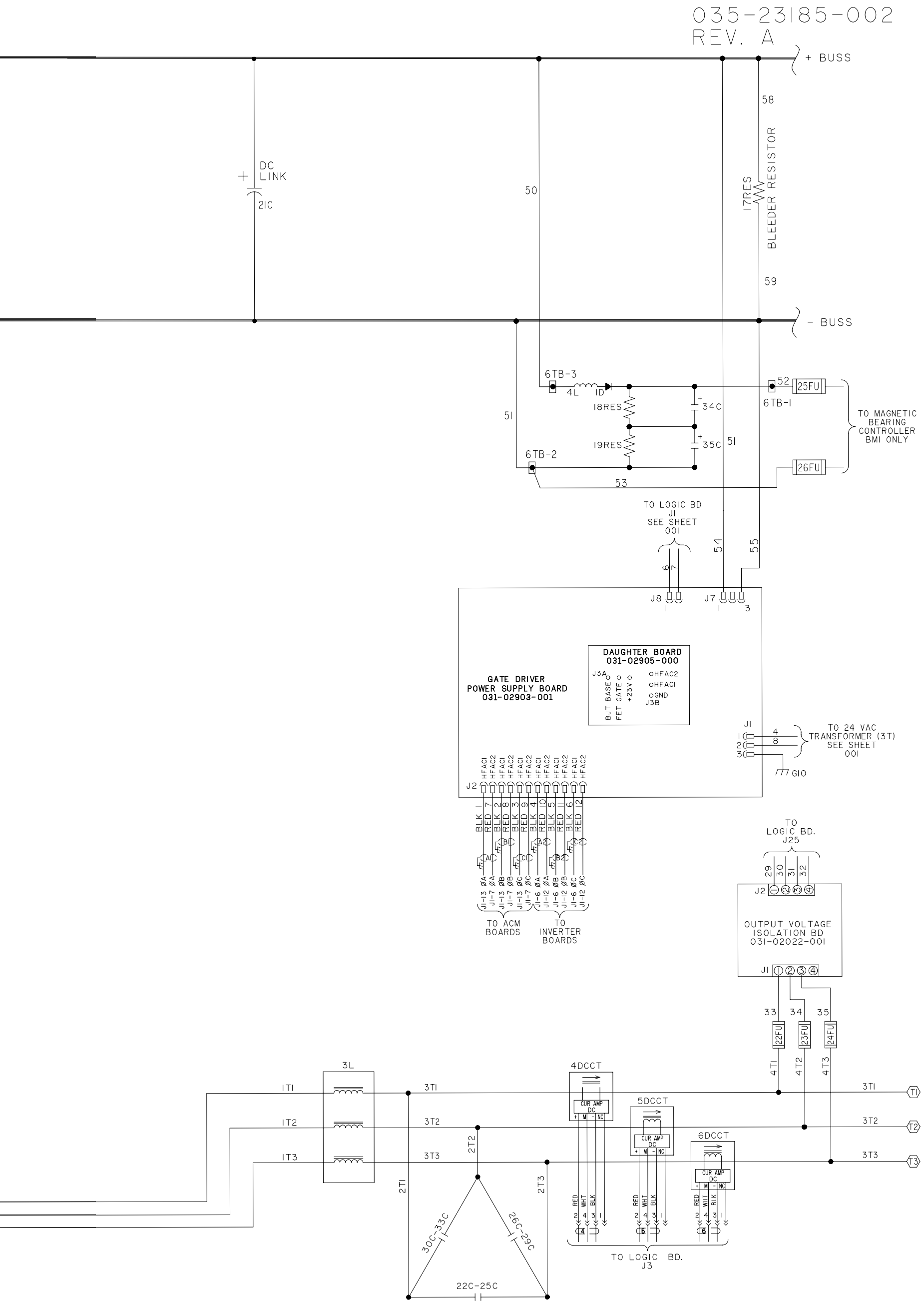

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FIGURE 4 - DRIVE OUTPUT - ELEMENTARY WIRING DIAGRAM 490 AMP

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Elementary Wiring Diagram 744 AMP Notes

7. Field wiring to be in accordance with the National Electrical Code as well as all other applicable codes and specifications.
8. Terminal block connection points are indicated by numbers within a source, i.e. [1] 2TB. Main power connection points are indicated by numbers within a hexagon, i.e.⟨L1⟩. Component terminal markings are indicated by numbers within a circle, i.e. (2). Numbers adjacent to circuit lines are the circuit identification numbers.
9. Terminals L1, L2, L3 and ground are the main power input terminals and are field connected (see note 6). Terminals T1, T2 and T3 are the compressor motor lead power terminals and are factory connected on factory packaged units.
10. The three phase solid state motor overload protection system provides motor overcurrent protection at 105% full load amps.
11. See YORK Control Center wiring diagram product drawing Form 160.78-PW2.
12. Field Wiring Connections per Product Drawing Form 160.78-PW1.

LEGEND for 035-23042-001, 002, and 003

1C-9C	Capacitor. Film, Input Power Filter
10C-12C	Capacitor, Film, DC Link
13C-30C	Capacitor, Film, Snubber
31C	Capacitor, Film
32C-43C	Capacitor, Film
1DSW	Switch Disconnect
1SW	Circuit Breaker
1DCCT-3DCCT	DC Current Transformer, Input
4DCCT-6DCCT	DC Current Transformer, Output
1FU-3FU	Fuse, Input Power
4FU-6FU	Fuse, Input Voltage Sense
7FU-I0FU	Fuse, Control Supply XFMR Primary
11FU	Fuse, External Control Supply XFMR Secondary
12FU	Fuse, Internal Control Supply XFMR Secondary
13FU	Fuse, Internal Control Supply XFMR Secondary
14FU	Fuse, Gate Driver Control Supply XFMR Primary
1SFU	Fuse, Gate Driver Control Supply XFMR Secondary
16FU-18FU	Fuse, Transient Suppressor PCB
19FU-21FU	Fuse, Output Voltage Sense
2SFU, 26FU	Fuse, DC
27FU	Fuse, Input Voltage Common Mode
1L	Inductor, Line
2L	Inductor, Drive
3L	Inductor, Output
1MOD-12MOD	Module, Power Dual, Active Converter
13MOD-18MOD	Module, Power Dual, Inverter
1R	Relay, Cooling Fans And Pump
1RES-3RES	Resistor, Input Power Filter, Bleeder
4RES-10RES	Resistor, DC Link
11RES-16RES	Resistor, Input Filter
1RT -2RT	Thermistor, Ambient
1T-2T	Transformer, Control
3T-4T	Transformer, Class 2
5T	Transformer, Control
2TB	Terminal Block, Communications
3TB	Terminal Block
4TB	Terminal Block, MTR Thermistors
STB	Terminal Block, Fans
MBC	Magnetic Bearing Controller

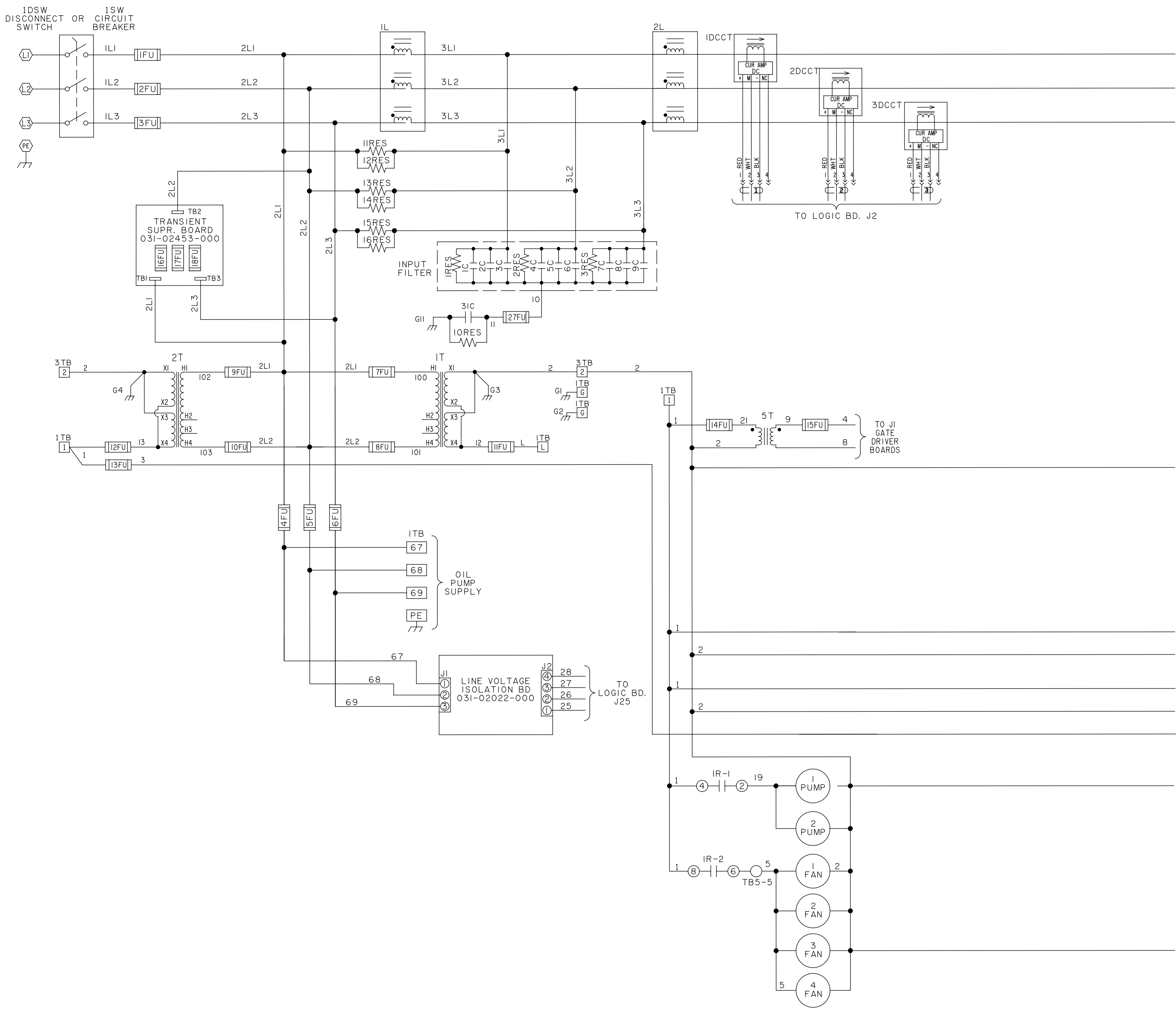

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FIGURE 5 - ELEMENTARY WIRING DIAGRAM 744 AMP

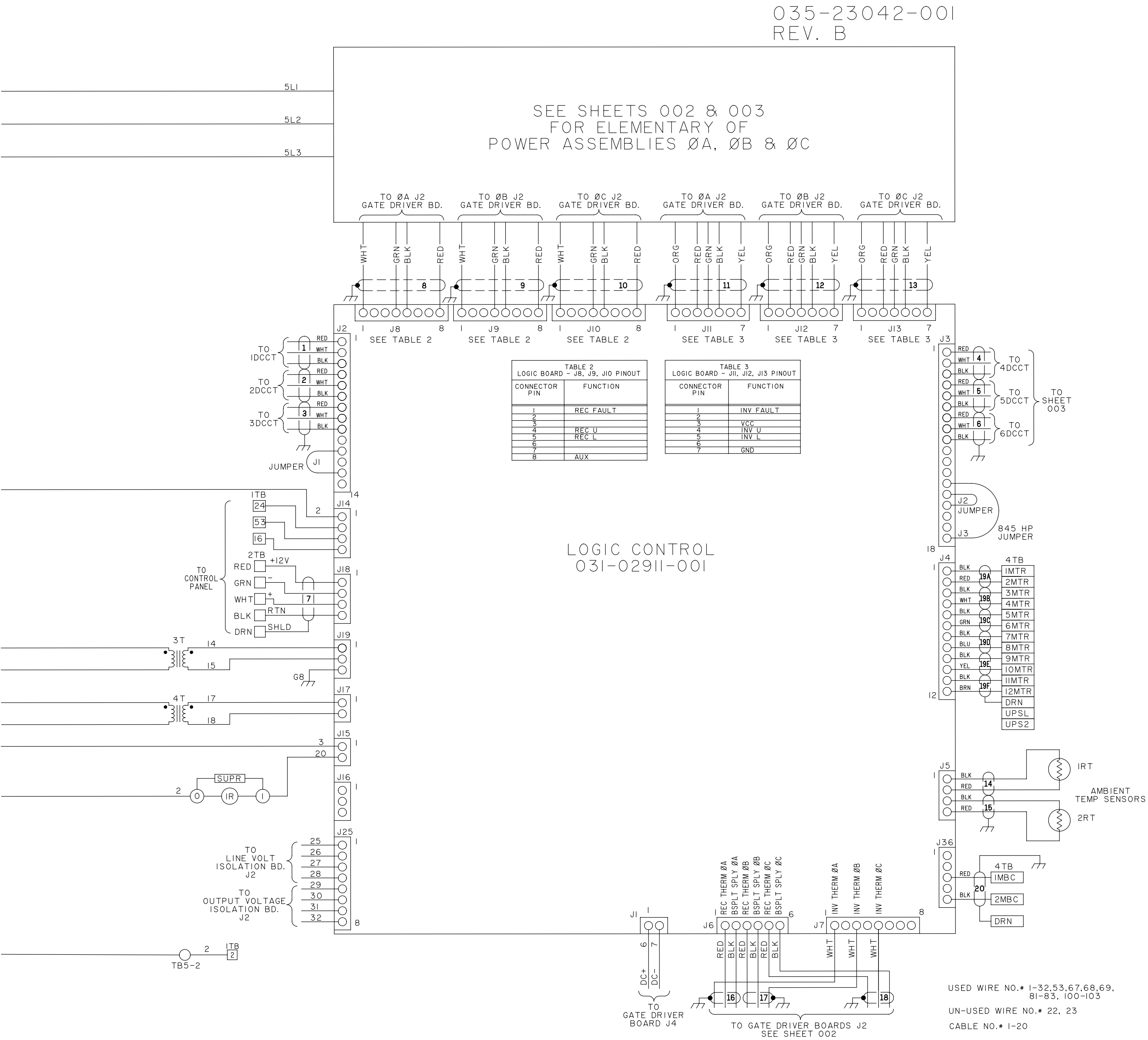

TABLE 2
LOGIC BOARD - J8, J9, J10 PINOUT

CONNECTOR PIN	FUNCTION
1	REC FAULT
2	
3	
4	REC U
5	REC L
6	
7	
8	AUX

TABLE 3
LOGIC BOARD - J11, J12, J13 PINOUT

CONNECTOR PIN	FUNCTION
1	INV FAULT
2	
3	VCC
4	INV U
5	INV L
6	
7	GND

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FIGURE 2 - ELEMENTARY WIRING DIAGRAM 744 AMP

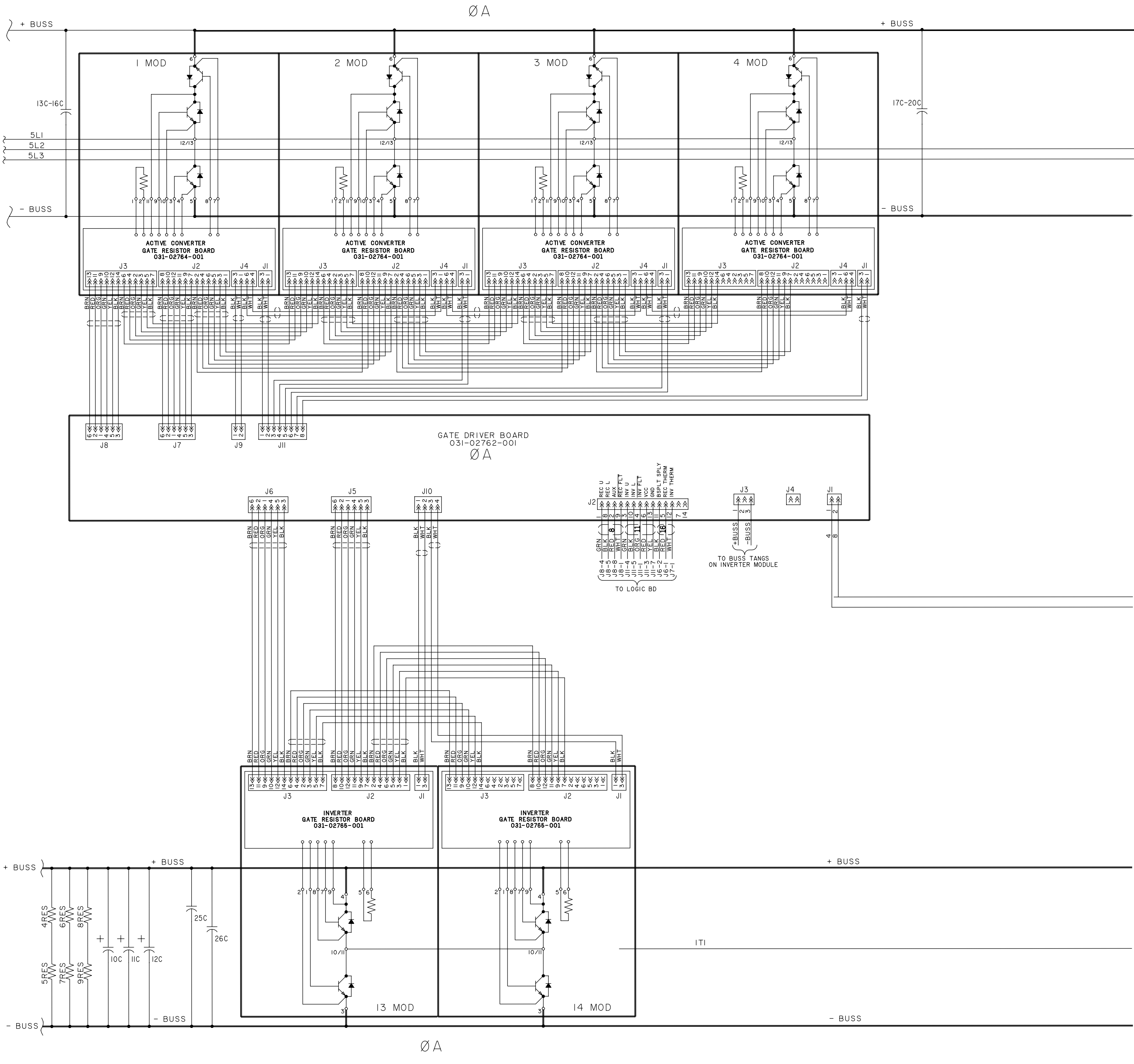

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FIGURE 6 - POWER UNIT A - ELEMENTARY WIRING DIAGRAM 744 AMP

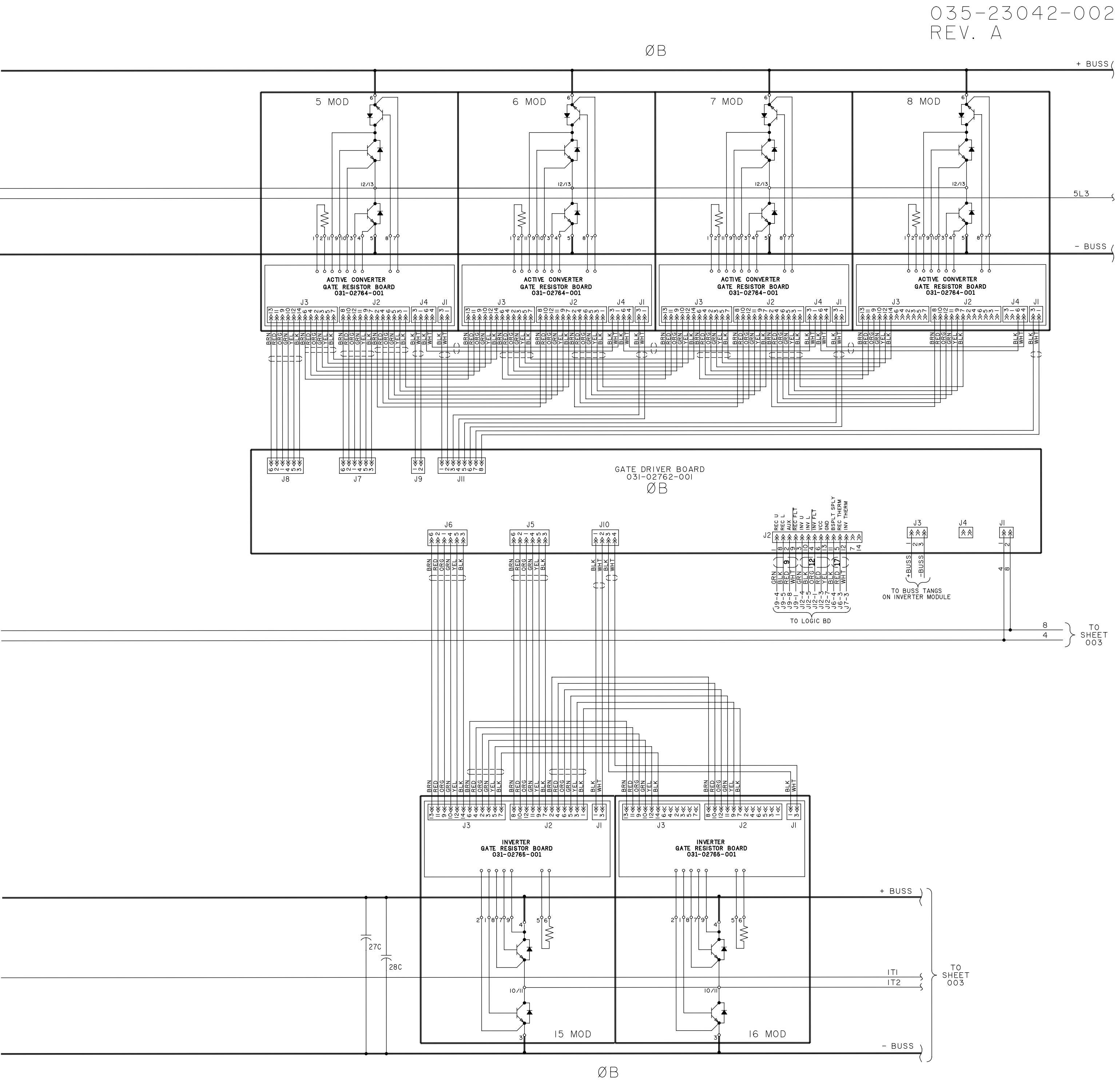

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FIGURE 7 - POWER UNT B - ELEMENTARY WIRING DIAGRAM 744 AMP

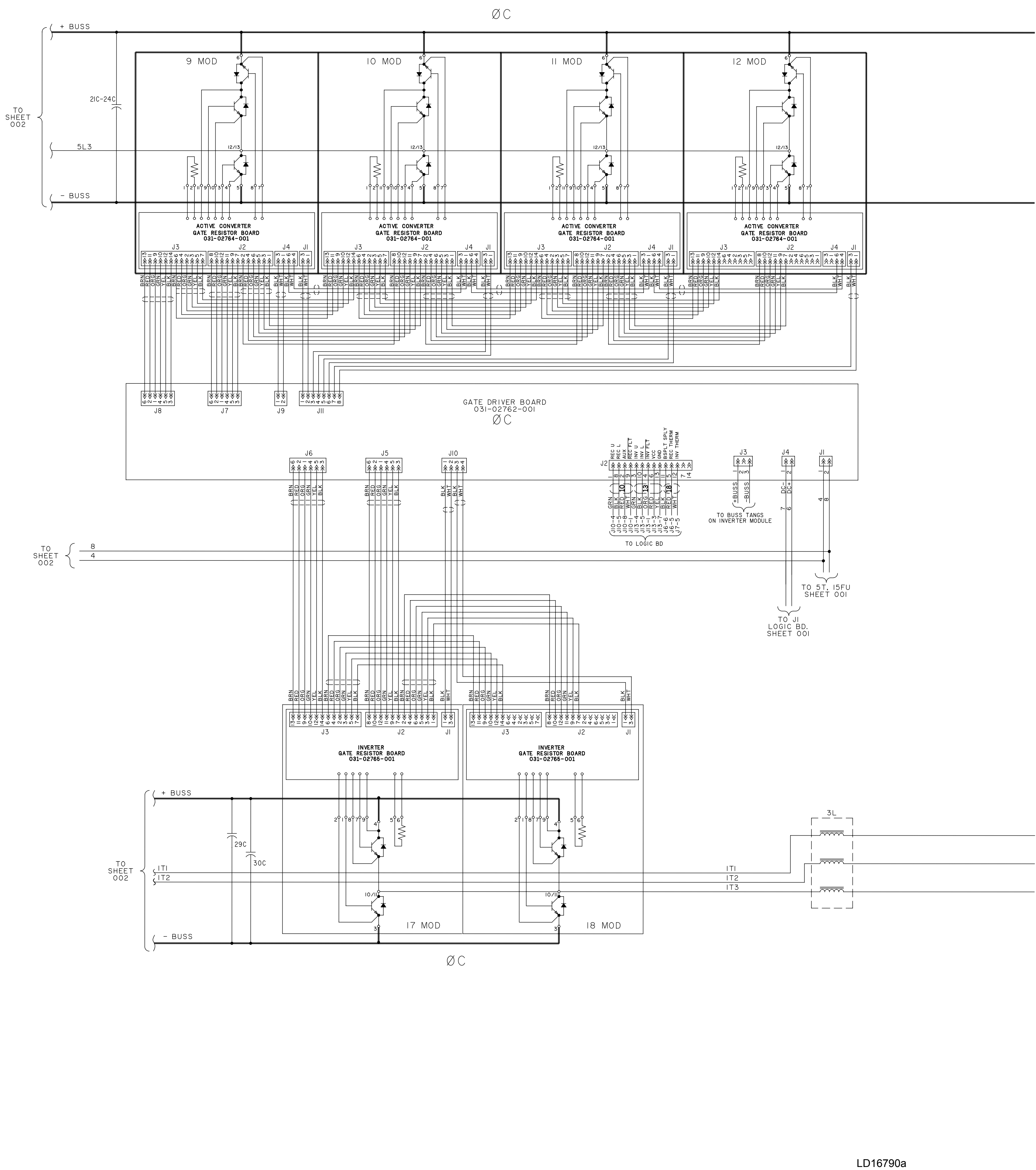

FIGURE 8 - POWER UNIT C - ELEMENTARY WIRING DIAGRAM 744 AMP

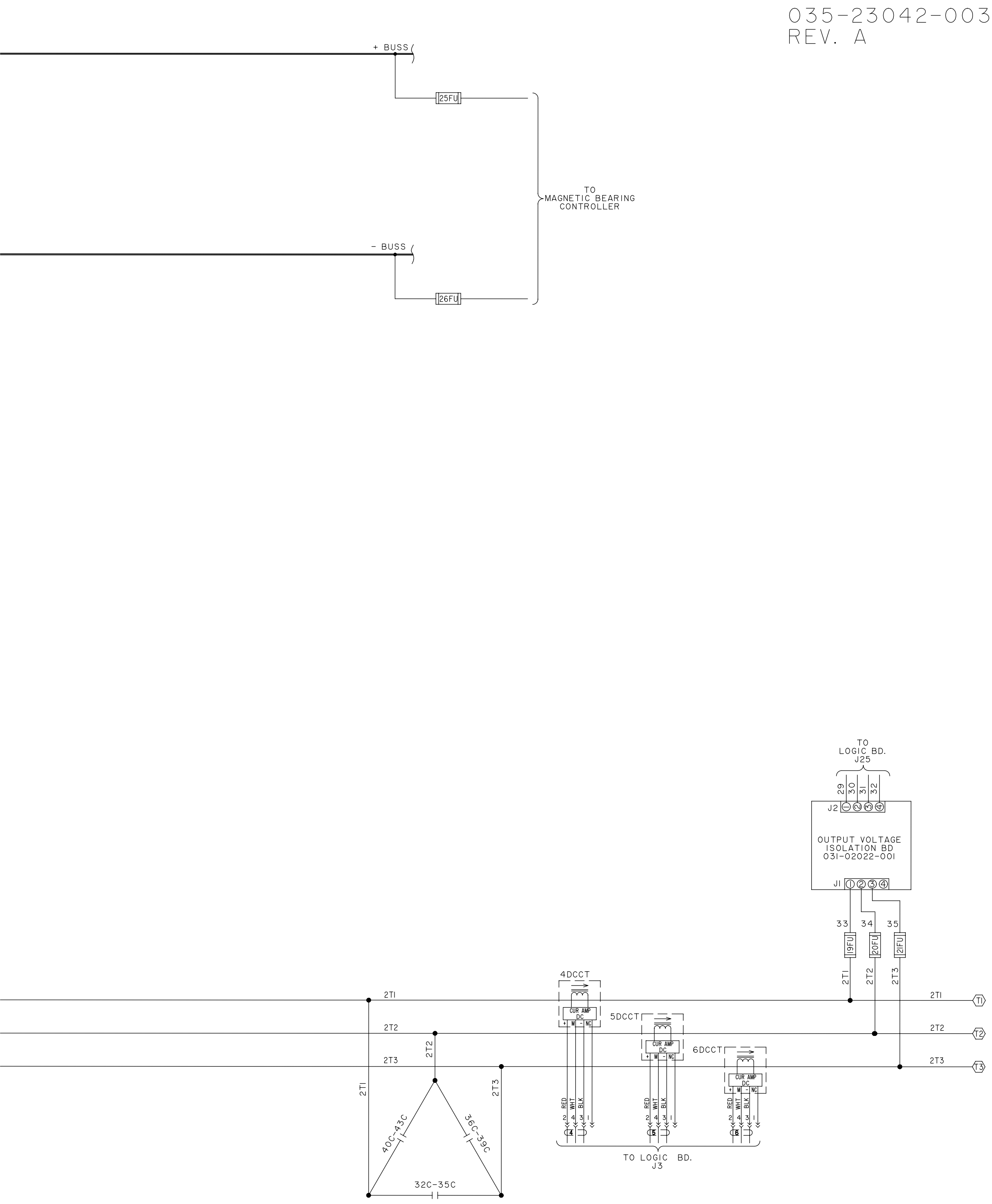

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FIGURE 9 - DRIVE OUTPUT - ELEMENTARY WIRING DIAGRAM 744 AMP

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SECTION 3 - COMPRESSOR DRIVE OPERATION DETAILS

NOTE

The following description of operation is general of all models of HYP drives unless otherwise noted.

The description of operation will be divided into sections, power, control, and protection. Some components will be discussed in one or all of the sections since they may provide a function in each section.

POWER SECTION DETAILS

When power is applied to the drive, the control circuitry receives power, but the power section is maintained in an off state. The drive will only activate the power section when commanded by the control panel to enter the start mode. When start mode is requested, the drive will enter the pre-charge state. This design does not have a dedicated pre-charge circuit. This function is integrated into the rectifier module.

When the chiller enters the start mode, the drive is commanded to pre-charge by the OptiView panel. The drive is pre-charged by gradually turned on the Auxilliary IGBT's so the current required to charge the DC bus capacitors is limited. When the pre-charge is complete the Auxilliary IGBT's remain turned on until the drive enters the stop mode, or a drive fault is generated.

The diagram in *Figure 10 on page 25* shows the three phase input rectifier for the drive. All HYP model drives have the same rectifier configuration. Depending on the input current rating of the drive, more or less modules will be connected in parallel to provide the required current.

During pre-charge, if the A phase voltage is positive relative to the C phase voltage and the Auxilliary 1 IGBT is turned on, then current will flow through the Upper 1 diode, through the Auxilliary 1 IGBT, charge up the bus capacitor, and return to the C phase through the Lower 3 diode. All three of the Auxilliary IGBT's are used during the pre-charge event. The voltage on the Bus capacitor at the end of the pre-charge event will be approximately 1.414 times the RMS value of the line voltage. For example, if the line voltage is 460 VAC, then 1.414 x 460 will provide a bus voltage of 650 VDC.

After pre-charge is complete the drive will enter the pre-regulation state. The pre-regulation state is a time where the upper and lower rectifier IGBT's are turn on and off in a specific pattern to boost the bus voltage up to 750 VDC. The boost voltage occurs when current is pulsed through the L2 inductor. When current is pulled through the L2 inductor a magnetic field is developed. When the current is stopped, the magnetic field

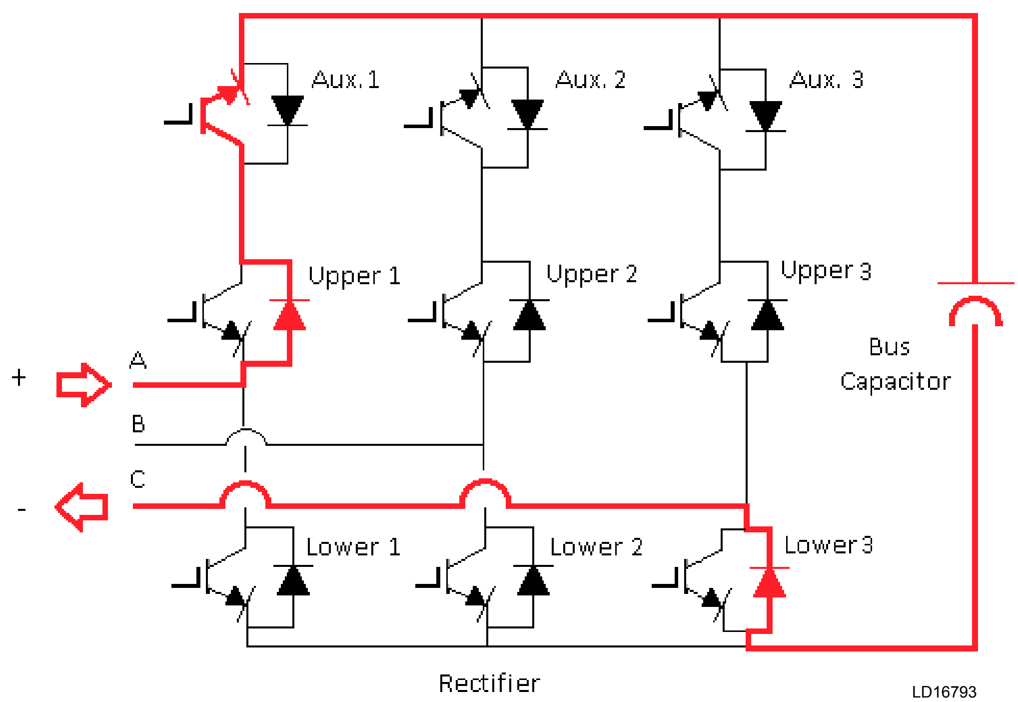
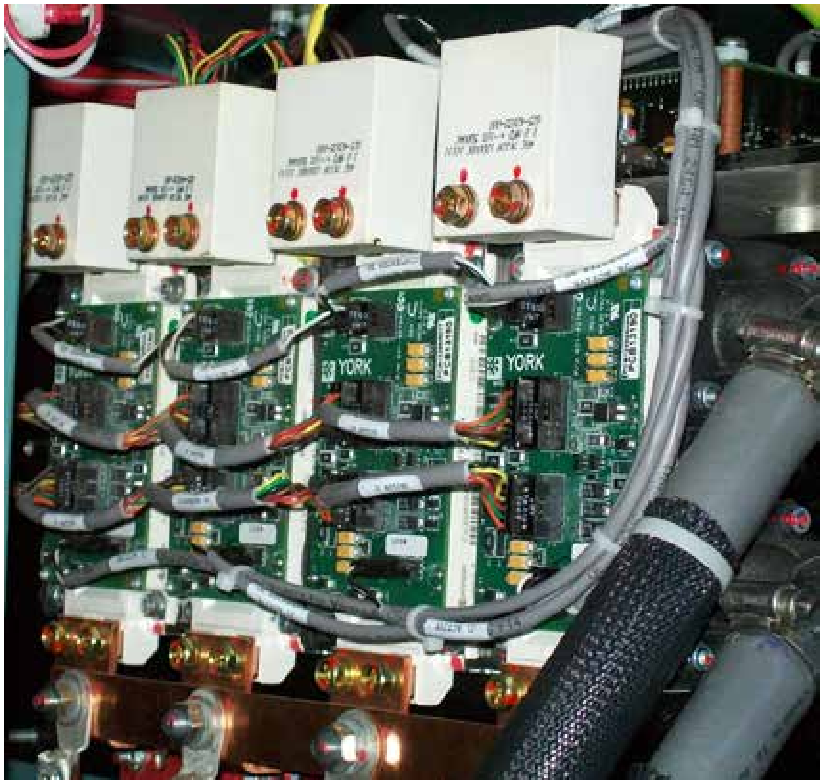


FIGURE 10 - INPUT RECTIFIER ELECTRICAL DIAGRAM



LD16292

FIGURE 11 - RECTIFIER SIDE OF THE POWER UNIT (MODEL 744 SHOWN).

collapses and provides a voltage that is added to the peak line voltage. The higher bus voltage allows the drive to provide the input current correction required to meet certain IEEE standards for input current harmonics.

The bus capacitor is needed because the rectifier does not provided current into the bus capacitor at the same time the current is needed by the inverter. In other words, the bus capacitor is like a big barrel. The rectifier dumps a bucket of power into the barrel every so often. The inverter dips out tablespoons of power to the motor at a much higher frequency.

The DC to AC inverter section serves to convert the DC voltage back to AC voltage at the proper magnitude and frequency as commanded by the Drive Logic board. The inverter section is actually composed of one or three power units, depending on the current requirements of the HYP model. Three power units are used in the 744 amp model. This power unit is composed of rectifier and inverter power assemblies the DC bus capacitor, and a gate driver board. Both the rectifier and inverter power modules are direct liquid cooled. The heat sinks for the power modules are mounted to the sides of the DC Bus capacitor. A bus structure connects the rectifier modules, DC Bus capacitor, and the inverter modules together. The bus structure is mounted on top of the DC Bus capacitor. A gate driver board is mounted on top of the bus structure, and held in place with mounting screws into the bus structure. This method provides a highly integrated and lighter weight power unit.

In *Figure 14 on page 28,* is the three phase output inverter for the drive. All of the HYP model drives have the same inverter configuration. Depending on the output current rating of the drive, more or less modules will be connected in parallel to provide the required current.

For the following description refer to *Figure 14 on page 28*. Typically, three power devices are turned on at the same time. In *Figure 14 on page 28*, current is flowing in the 'B' and 'C' phase motor windings. Most of the current required for the inverter is provided by the bus capacitor as explained earlier. Current will flow from the bus capacitor through the turned on Upper 2 and 3 IGBT's. Energizing the 'B' and 'C' phase motor windings. The current will then return to the drive through the turned on Lower 1 IGBT and back to the bus capacitor. This sequence continues with all of the switches being used. At no time will an Upper and Lower of the same number IGBT ever be turned on at the same time. If this were to happen, a drive failure would occur.

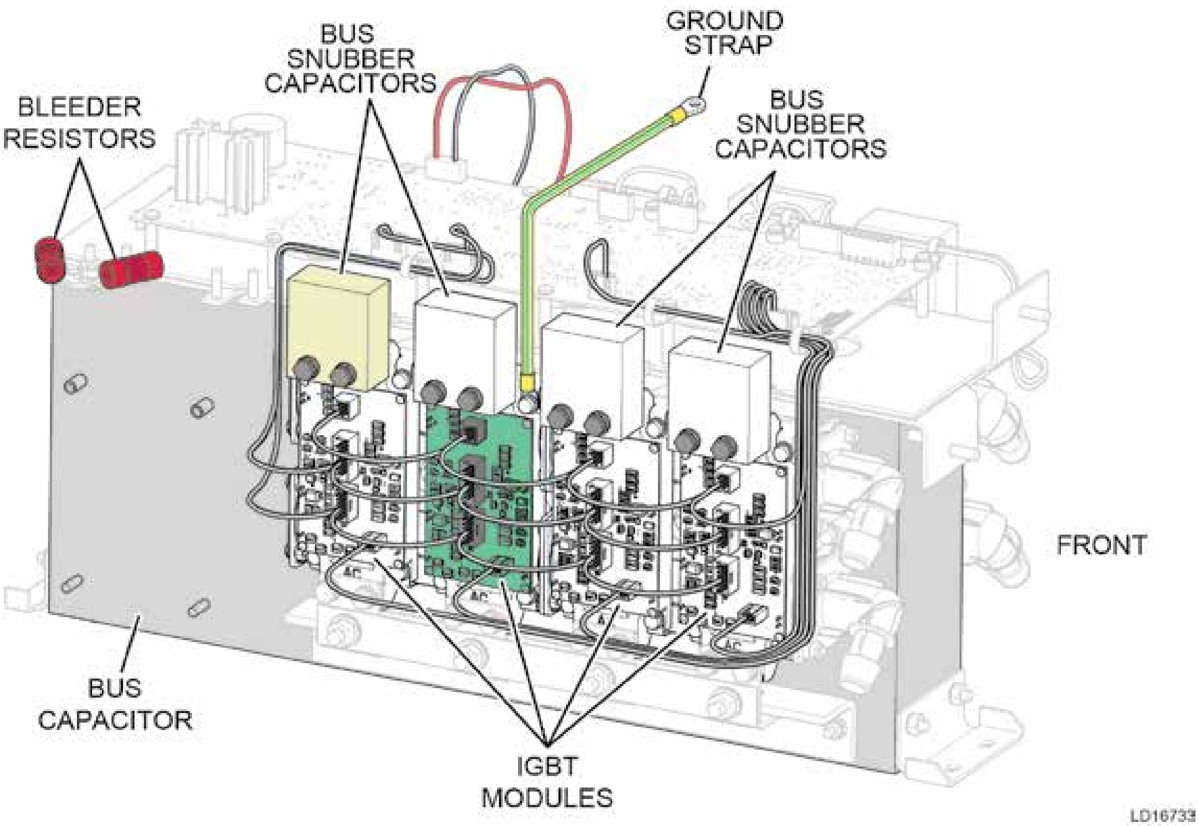


FIGURE 12 - POWER UNIT (RECTIFIER SIDE)

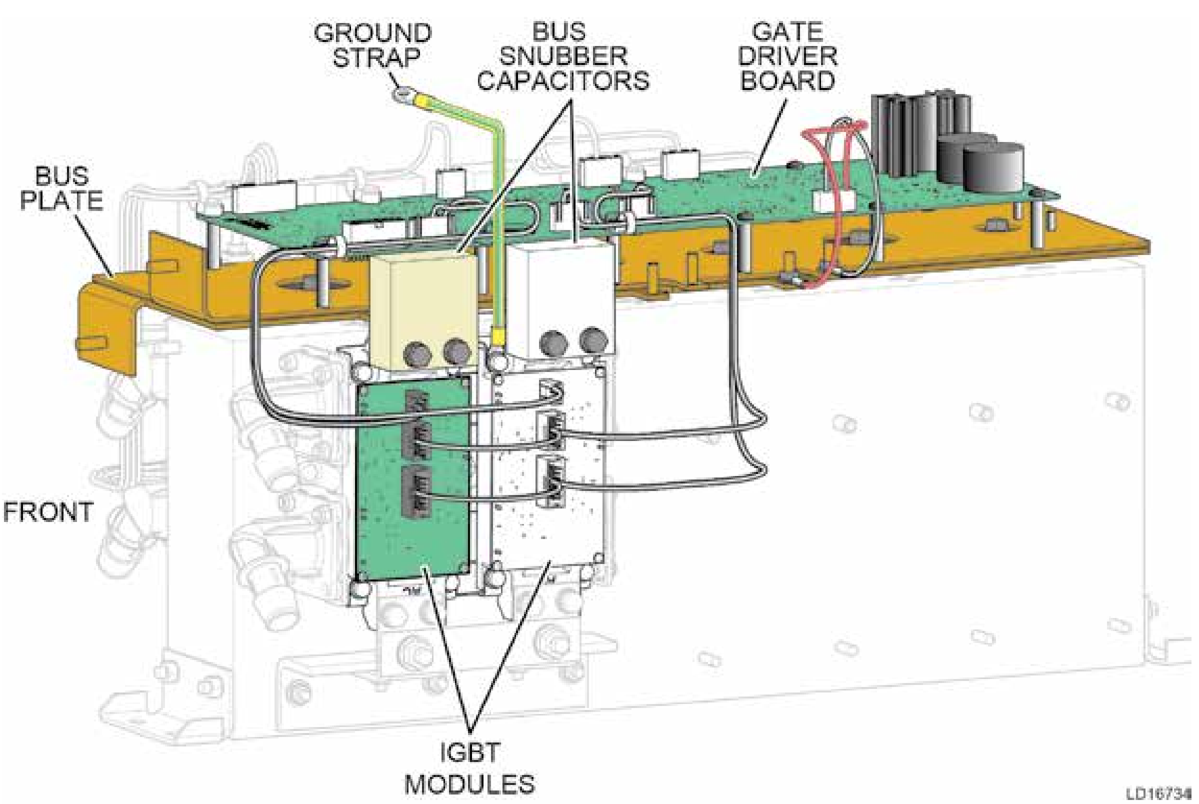


FIGURE 13 - POWER UNIT (INVERTER SIDE)

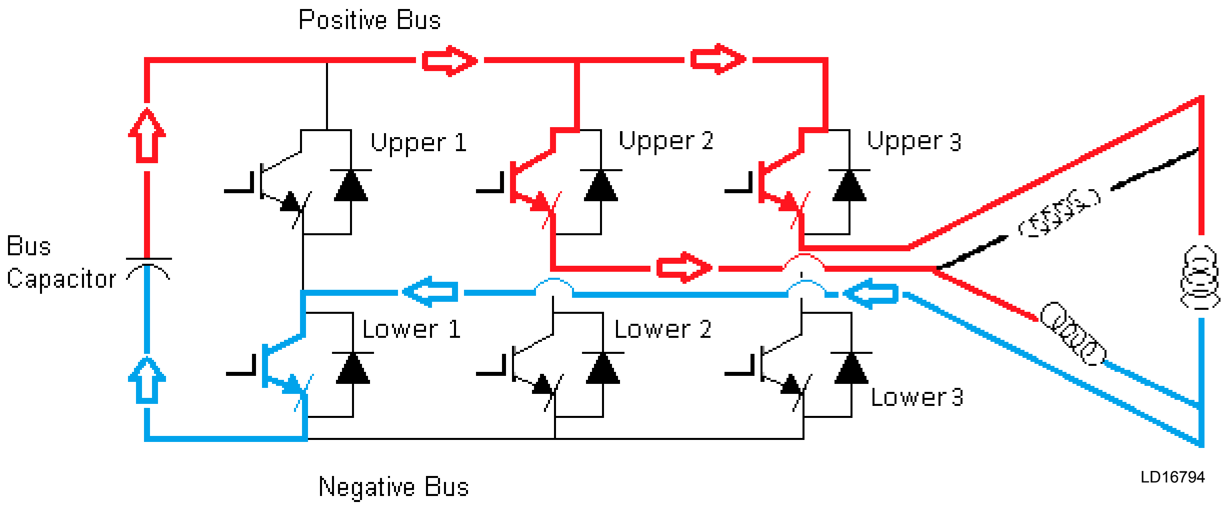


FIGURE 14 - OUTPUT INVERTER ELECTRICAL DIAGRAM

CONTROLS SECTION DETAILS

The Control Center

The Control Center used with today's HYP model drive provides all of the commands to the drive from the Microboard within the Control Center. A shielded cable is used to provide the communication link between the Control Center and the drive. This drive can only be connected to an OptiView Control Center that has MODBUS communications. The new features are not supported through the YORK Protocol style of communications. The HYP model drive is built to only function within a chiller system. The drive cannot pre-charge, start, or run without communications from the Chiller Control Center.

Various sensors located on the chiller provide data to the Control Center. The software within the Control Center determines the optimum operating speed for maximum chiller system efficiency.

The OptiView Control Center utilizes a different approach to speed reduction compared to earlier variable speed products. The capacity control is completely different from anything used in the past. Capacity control is now determined by a combination of compressor speed, hot gas bypass, and variable geometry diffuser. Refer to the specific OptiView Control Panel operation and service book for detailed information. A list of this information can be found in the front of this book.

The Drive Operation

As described earlier, when the chiller enters the start mode, the drive is commanded by the OptiView panel to pre-charge. The drive is pre-charged by turning on the Auxilliary IGBT's for a longer period of time in each line cycle so that the DC bus capacitors are slowly charged. This is called the pre-charge period, which last for 12-seconds. The Auxilliary IGBT's will remain turned on until the drive enters the stop mode (or a drive fault is generated).

After the 12-second time period has expired, the drive will enter the pre-regulation mode. In this mode, the rectifier IGBT's will start turning on and off and cause the bus voltage to regulate to a value of 750 VDC. The rectifier will continue to function until the chiller control enters the stop mode or a drive fault is generated.

During the run state the drive is constantly monitoring the input voltage, input current, bus voltage, output voltage and output current. There are many devices and boards that are used to provide this function, and they are described below.

Control Boards

The input line voltage isolator board is used to step down the input line voltage to the proper level to enable the drive logic board can read the input voltage. The input line voltage information is compared to the bus voltage value to determine when and for how long the input IGBT's should be turn on or off to maintain the correct bus voltage. This board is also the source for the input line voltage peak, RMS, voltage total harmonic distortion, total power factor, total supply KVA, input power, and input KW hours calculations data displayed on the OptiView panel.

Input current value and wave shape is determined by a device called a direct current current transducer (DCCT). This device is much faster at detecting changes in current than a current transformer. Most current transformers are designed to measure 50/60 Hz currents. The DCCT must be able to measure pulses of current very accurately. Since accuracy of the input current wave form is very important, one DCCT is needed for each phase. Power for this device is supplied from the drive logic board. The input current information is used by the drive logic board to determine when to draw current from the utility so that the input current waveform meets the IEEE 519-1992 standard for input current harmonics. These sensors are the source for the input current RMS, supply current total demand distortion, input % full load amps, input power, total power factor, total supply KVA, and the input KW hours calculations data displayed on the OptiView panel.

Bus voltage information is collected by the IGBT gate driver board. This information is used by the drive logic board to ensure that the bus voltage is properly regulated during pre-regulation and running states. This board is also the source for the DC bus voltage data displayed on the OptiView panel.

The output voltage of the drive is measured by the output voltage isolation board. The design of this board is very similar to the input voltage isolation board. It has 3 transformers on the board to step down the output voltage of the drive to the proper level so that the drive logic board can read the output voltage. The input and output voltage isolation boards are NOT inter-changeable. The output voltage isolation board contains an additional connector location so that it cannot be used on the input of the drive. The drive logic board will use this information to determine the rotational speed of the motor rotor, and then determine how and when to turn on and off the inverter section of the drive. The data from the output voltage isolation board is also used to provide the OptiView panel with the output motor voltage values.

The output current of the drive is measured by the same type of device used to measure the input current, but with a different current range. The drive logic board uses this information in combination with the output voltage to determine the rotational speed of the motor rotor, and then determine how and when to turn on and off the inverter section of the drive. The data from the motor current transducer is also used to provide the OptiView panel with the motor current values.

The gate driver board conditions the turn on and turn off commands from the drive logic board to the rectifier and inverter IGBT's. It also isolated the drive logic board from the bus voltage.

This drive contains just one logic board. The functions of controlling the motor and the harmonic filter are combined into this board. The logic board also performs other numerous functions such as control the cooling fans and pumps, when and how to pre-charge the bus capacitor or bus capacitors, maintain the correct bus voltage amplitude, generate the on and off commands for the rectifier and the inverter, and provide communications to the OptiView panel.

When the chiller enters a normal stop command the drive will continue to follow the speed command from the OptiView panel. The OptiView panel will begin to unload the chiller. As the load and pressure across the compressor starts to go down, the output speed of the drive will go down. When the capacity control devices (PRV or VGD and sometimes hot gas bypass valve) reach minimum load position, the drive will start to decelerate the motor to 50 Hz. When 50 Hz is reached all input and output power devices will be turned off except for the Auxilliary IGBT's. The OSCD will remain in a pre-charged state for 60 seconds, and then the Auxilliary IGBT's are turned off. The Auxilliary IGBT's remain turn on for 60 seconds to provide power to the magnetic bearing controller, so the motor rotor will remain levitated during this time. After the Auxilliary IGBT's are turn off the DC bus capacitors will start to discharge through the bleeder resistors.

The output harmonic filter is composed of a network of capacitors and a 3 phase inductor. The function of the output harmonic filter is to improve the output voltage and current waveforms to a wave shape that is very close to a sine wave. This reduces the temperature in the motor stator and rotor.

The Harmonic Filter Operation

The HYP model drive can now control the input current waveform to a near sine wave shape by controlling how the rectifier is turned on and off. The Harmonic Filter of the past injected harmonic current into the input of the drive so that the utility did not need to supply the harmonics.

Since the Harmonic Filter is now basically the input to the drive there is no need for the additional, pre-charge, power unit, Harmonic Filter logic board, and contactors for the harmonic filter of yesterday. The Harmonic Filter does not require its own pre-charge time, thus allowing the chiller to start or restart sooner. This is an important benefit to many customers. The reductions in parts counts will improve the reliability of the drive. The reduced parts count will also improve the ease of repair if a failure were to occur.

A line inductor is still needed to limit the rate of change in the input current. Without the line inductor the input current cannot be properly controlled and harmonic currents would be generated.

The rectifier now will provide two functions, allow current to flow into the DC bus capacitor during pre-charge, and control the input current waveform. A separate gate driver board is not needed for each function. One gate driver board is used to control the rectifier and inverter power devices for each phase.

The control for the harmonic filter works in such a manner that when current first flows into the drive a magnet field builds around the boost inductor. Since the current is flowing into the drive, the amplitude of the current is rising at the same time that the input voltage is rising. When the amplitude of current exceeds the desired value, the rectifier IGBT's switch state will chance. The change in switch state will cause the magnet field in the boost inductor to fall, and it will supply current into the drive. Although, current will continue to flow into the drive the current needed from the input of the drive will go down, since the boost inductor is providing some of the current. Depending on how much of the magnet field of the boost inductor is used, determines if the current is rising or if the current is falling. In the case of the rising current, the switch state will require the current to flow so that the magnet field is building for a longer period of time then it is falling. In the case of the falling current, the switch state will require the current to flow so that the magnet field is falling for a longer period of time then it is building.

The "trap" filter is integrated into all OSCD of this type. The "trap" filter is composed of a series of capacitors, inductors and resistors. The "trap" filter is used to reduce the effects of the PWM switching frequency from affecting other devices on the same power system.

Other Controls

Running the coolant pump no longer requires removing a plug from the drive logic board. The cooling system fans and pumps are now turned on by the press of a button on the OptiView panel. Refer to the OptiView panel operations form in the front of this form.

PROTECTION SECTION DETAILS

Many of the boards and sensors in the drive provide protection to the drive or the compressor motor.

The drive logic board is at the heart of the drive protection system. In all cases, the drive logic board makes the determination if there is a condition for a fault to occur. Other boards and sensors provide the information to the drive logic board to make the determination. It is important to understand that the device providing the information about the fault could be causing the fault, or the connection between the device and the logic board could cause the problem as well. Many times the problem can be a bad, loose, or dirty connector. Remove the connector and reinstall the connector to clean the connection.

The line voltage isolator board is used to step down the input line voltage to the proper level so that the drive logic board can read the input voltage. The input line voltage information is compared to the bus voltage value to determine when and for how long the input IGBT's should be turn on or off to maintain the correct bus voltage. Input phase rotation and phase loss information is also collected with this board.

Input current value and wave shape is determined by a device called a direct current current transducer (DCCT). This device is needed to provide input current limit, and protect the rectifier from instantaneous over current events.

The gate driver board provides the bus voltage data to the drive logic board. This information is used to protect the drive from high and low bus voltages.

The output voltage of the drive is measured by the output voltage isolation board. This data is used to protect the motor from high level of voltage harmonics also known as THD.

The output current of the drive is measured by 3 DCCT's. The data from these devices are used to protect the motor and the output of the drive from overload conditions and from instantaneous over current events.

The gate driver board provides protection to the Auxilliary, the rectifier, and the inverter IGBT's. When one of the IGBT's are not working properly, such as not turning on when the drive logic board is expecting a device to be in the "on" state. The gate driver board will indicate a fault. This board also provides over temperature protection for the IGBT's. The gate driver board also protects itself. If one of the low voltage isolated power supplies on the gate driver board were not working properly, then this board would generate a fault.

The OSCD Logic board also determines shutdown conditions by monitoring the three phases of input and output current, baseplate temperatures, internal ambient temperatures, input and output voltage as well as the DC Bus voltage.

SECTION 4 - SAFETY SHUTDOWNS

GENERAL INFORMATION

Safety shutdown messages are organized in alphabetical order based on the OptiView Control Center messages.

Whenever a safety shutdown is generated by the Drive Logic Board, a series of events will occur. These events are:

- If the chiller is not running at the time of the shutdown, the Drive Logic Board will not turn on the power device gate drivers for the Auxilliary, rectifier or inverter.
- The K1 relay on the drive logic board will de-energize to indicate to the Control Center that the drive has shutdown. The K1 relay will remain de-energized until the cause of the shutdown has been corrected.
- If the chiller is running at the time of a drive generated shutdown the gate driver for the power devices used in the Auxilliary, rectifier, and inverter will be turned off.
- The message “VSD Shutdown - Requesting Fault Data” will be displayed when the Control Center is requesting the fault data from the drive.
- The drive logic board will send a shutdown code via the serial communications link to the Control Center. The micro board will interpret the shutdown code, and display a shutdown message on the display of the Control Center.

After the coastdown period has timed out, the chiller may be restarted, if the shutdown is no longer active.

TABLE 1 - SAFETY SHUTDOWNS

MESSAGE	DESCRIPTION
VSD - 105 % Motor Current Overload	This shutdown is generated when the VSD logic board has detected that the highest of the three output phase currents has exceeded 105% of the programmed full load current for 40 continuous seconds.
VSD – DC Bus Pre-Regulation Lockout	If the drive were to fail under the conditions of VSD – DC Bus Pre-Regulation 3 times in a row then this message will appear. Refer to VSD – DC Bus Pre-Regulation for detailed information.
VSD – DC Bus Lockout – Do Not Cycle Power	This shutdown is generated anytime when the bus voltage should be zero, but it is greater than 50 VDC. This shutdown is an indication that an Auxilliary IGBT is shorted. The bus cannot discharge when an Auxilliary IGBT is shorted. **If power is removed, and then reapplied without correcting this problem more damage will occur to the drive, and the repair will be more costly.**
VSD – Ground Fault	The 3 phases of input current to the drive are continuously monitored. This shutdown is generated if the sum of the instantaneous current values exceeds the value listed below for 1 second. These values are based on the drive model. **DRIVE AMP RATING** / **GROUND FAULT CURRENT** 490 / 40 744 / 120
VSD – High Phase A Input Baseplate Temperature	The input/rectifier modules temperature is continuously monitored. This shutdown is generated, when the temperature of any module exceeds 170°F (76.6°C). This shutdown cannot be reset until the temperature of all modules drops below 165°F (73.8°C). The fans and pumps for the VSD will continue to run until the temperature drops below the reset level.
VSD – High Phase B Input Baseplate Temperature	For details see “VSD – High Phase A Input Baseplate Temperature” message preceding
VSD – High Phase C Input Baseplate Temperature	For details see “VSD – High Phase A Input Baseplate Temperature” message preceding
VSD – High Phase A Motor Baseplate Temperature	The motor / inverter modules temperature is continuously monitored. This shutdown is generated, when the temperature of any module exceeds 190°F (87.7°C). This shutdown cannot be reset until the temperature of all modules drops below 165°F (73.8°C). The fans and pumps for the VSD will continue to run until the temperature drops below the reset level.

TABLE 1 - SAFETY SHUTDOWNS

MESSAGE	DESCRIPTION
VSD – High Phase B Motor Baseplate Temperature	For details see “VSD – High Phase A Motor Baseplate Temperature” message preceding
VSD – High Phase C Motor Baseplate Temperature	For details see “VSD – High Phase A Motor Baseplate Temperature” message preceding
VSD – Input Current Overload	This shutdown is generated when the VSD logic board has detected that the highest of the three input phase currents has exceeded 105% of the programmed input full load current for 10 continuous seconds.
VSD – Input DCCT Offset Lockout	The drive contains 3 DCCT’s to measure the input current. If the Input DCCT Offset cycling shutdown occurs 3 times in a row on the same phase, then this shutdown will occur.
VSD – Inverter Program Fault	This shutdown is generated when the programmed motor selection in the Control Panel does not match the motor selection jumper located on the VSD logic board. This application should not have a wire installed on J2 pin 14 of the VSD logic board.
VSD – Line Voltage Phase Lock Loop	This shutdown is generated when the drive cannot properly determine the input frequency.
VSD – Line Voltage Phase Rotation	This shutdown is generated when the drive cannot properly determine the input phase rotation.
VSD – Logic Board Plug	The wiring harness in the VSD contains 2 jumpers that prove the connectors for the input and motor DCCT’s are connected at the VSD logic board. This shutdown is generated when either of these two jumpers is not connected. J2 pin 11 to pin 13 are J3 pin 13 to 18
VSD – Logic Board Hardware	This shutdown is generated when the state of any gate driver is not correct after power is applied to the drive. The drive logic board will determine that the logic states of the gate drivers are correct before the drive is started. *Possible Solution:* Replace the drive logic board.
VSD – Motor Current THD Fault	This shutdown is generated when the motor current waveform is compared to a sine wave and there is a deviation greater than a threshold determined by the VSD logic board.
VSD – Motor Current Imbalance	This shutdown is generated if the motor current imbalance exceeds the value listed below for 45 continuous seconds. These values are based on the compressor motor. Refer to the sales order screen on the control center for the compressor motor model number. **MOTOR MODEL NUMBER** / **AMP VALUE**: M1B – 25 M1 – 25 M2 – 37
VSD – Phase A Input DCCT	This shutdown determines if the cable at the input DCCT is connected. During the pre-charge state the drive logic board must detect a minimum value of current. These values are based on the drive amp rating. **DRIVE AMP RATING** / **MINIMUM CURRENT**: 490 – 5 744 – 15
VSD – Phase B Input DCCT	For details see “VSD – Phase A Input DCCT” message preceding
VSD – Phase C Input DCCT	For details see “VSD – Phase A Input DCCT” message preceding
VSD – Phase A Motor DCCT	This shutdown determines if the cable at the motor DCCT is connected. This shutdown is generated 1.5 seconds after the motor run command if the motor current does not exceed 25 amps.
VSD – Phase B Motor DCCT	For details see “VSD – Phase A Motor DCCT” message preceding
VSD – Phase C Motor DCCT	For details see “VSD – Phase A Motor DCCT” message preceding
VSD – Precharge Lockout	This shutdown is generated when the Precharge cycling fault occurs 3 consecutive times. See the Precharge cycling shutdown message for details.
VSD – Rectifier Program Fault	This shutdown is generated when the programmed input line frequency in the Control Panel does not match the input line frequency as measured by the VSD logic board.

SECTION 5 - CYCLING SHUTDOWNS

General Information

Cycling shutdown messages are organized in alphabetical order based on the OptiView Control Center messages.

Whenever a cycling shutdown is generated by the Drive Logic Board, a series of events will occur. These events are:

- If the chiller is not running at the time of the shutdown, the drive logic board will not turn on the power device gate drivers for the Auxilliary, rectifier or inverter.
- The K1 relay on the drive logic board will de-energize to indicate to the Control Center that the drive has shutdown. The K1 relay will remain de-energized until the cause of the shutdown has been corrected.
- If the chiller is running at the time of a drive generated shutdown the gate driver for the power devices used in the Auxilliary, rectifier, and inverter will be turned off.
- The message "VSD Shutdown - Requesting Fault Data" will be displayed when the Control Center is requesting the fault data from the drive.
- The drive logic board will send a shutdown code via the serial communications link to the Control Center. The micro board will interpret the shutdown code, and display a shutdown message on the display of the Control Center.

After the coastdown period has timed out, the chiller will automatically restart if the shutdown is no longer active.

TABLE 2 - CYCLING SHUTDOWNS

<table>
<tr><th>MESSAGE</th><th>DESCRIPTION</th></tr>
<tr><td>VSD - DC Bus Pre-Regulation</td><td>This shutdown is generated 2 seconds after the VSD enters the pre-regulation state if the bus voltage is not within +/- 20 VDC of the DC Link voltage setpoint. The DC Link voltage setpoint is determined by the compressor motor. Refer to the sales order screen on the control center for the compressor motor model number.
<table>
<tr><th>MOTOR MODEL NUMBER</th><th>DC LINK VOLTAGE SETPOINT</th></tr>
<tr><td>M1B</td><td>750</td></tr>
<tr><td>M1</td><td>750</td></tr>
<tr><td>M2</td><td>785</td></tr>
</table></td></tr>
<tr><td>VSD - High DC Bus Voltage</td><td>This shutdown is generated when the bus voltage exceeds a value of 878 +/- 28 VDC.</td></tr>
<tr><td>VSD - High Internal Ambient Temperature</td><td>This shutdown is generated when one of the two ambient temperature sensors exceeds a temperature of 158°F (70°C). This shutdown cannot be reset until the temperature of all modules drops below 148°F (64.4°C). The fans and pumps for the VSD will continue to run until the temperature drops below the reset level.</td></tr>
<tr><td>VSD - High Phase A Input Current</td><td>This shutdown is generated when the input instantaneous current exceeds a limit determined by the VSD logic board. This limit is based on the drive amp rating.
<table>
<tr><th>DRIVE AMP RATING</th><th>INSTANTANEOUS CURRENT VALUE</th></tr>
<tr><td>490</td><td>886</td></tr>
<tr><td>744</td><td>1446</td></tr>
</table></td></tr>
<tr><td>VSD - High Phase B Input Current</td><td>For details see "VSD – High Phase A Input Current" message preceding</td></tr>
<tr><td>VSD - High Phase C Input Current</td><td>For details see "VSD – High Phase A Input Current" message preceding</td></tr>
<tr><td>VSD - High Phase A Motor Current</td><td>This shutdown is generated when the motor instantaneous current exceeds a limit determined by the VSD logic board. This limit is based on the drive amp rating.
<table>
<tr><th>DRIVE AMP RATING</th><th>INSTANTANEOUS CURRENT VALUE</th></tr>
<tr><td>490</td><td>776</td></tr>
<tr><td>744</td><td>1086</td></tr>
</table></td></tr>
</table>

TABLE 2 - CYCLING SHUTDOWNS

<table>
<tr><th>MESSAGE</th><th>DESCRIPTION</th></tr>
<tr><td>VSD - High Phase B Motor Current</td><td>For details see “VSD – High Phase A Motor Current” message preceding</td></tr>
<tr><td>VSD - High Phase C Motor Current</td><td>For details see “VSD – High Phase A Motor Current” message preceding</td></tr>
<tr><td>VSD - Initialization Failed</td><td>Upon the application of power, the Drive logic board will go through a process called initialization. At this time, memory locations are cleared, jumper positions are checked, and serial communications links are established between the Drive logic board, and the Control Center. If any one of these items are not completed this shutdown is generated.</td></tr>
<tr><td>VSD – Invalid Setpoint</td><td>This shutdown is generated when setpoint data is compared between the control panel and the VSD. This data is verified after initialization of the drive and the control panel.</td></tr>
<tr><td>VSD - Logic Board Processor</td><td>The drive logic board contains several microprocessors. This shutdown is generated when the communications between these microprocessors stop communicating for a period of 1.5 seconds.</td></tr>
<tr><td>VSD - Logic Board Power Supply</td><td>This shutdown is generated when one of the low voltage power supplies on the VSD logic board are out of tolerance.</td></tr>
<tr><td>VSD - Low DC Bus Voltage</td><td>This shutdown is generated anytime after the pre-regulation state has generated the correct DC link voltage setpoint, and then the DC link voltage drops to a minimum value. This value is based on the motor model number.
<table>
<tr><th>MOTOR MODEL NUMBER</th><th>DC LINK VOLTAGE SETPOINT</th></tr>
<tr><td>M1B</td><td>720</td></tr>
<tr><td>M1</td><td>720</td></tr>
<tr><td>M2</td><td>755</td></tr>
</table></td></tr>
<tr><td>VSD - Low Phase A Input Baseplate Temperature</td><td>This shutdown is generated anytime input/rectifier modules temperature drops below 37°F (2.7°C). This shutdown cannot be reset until the temperature of all modules exceeds 42°F (5.5°C). The fans and pumps for the VSD will continue to run until the temperature exceeds the reset level.</td></tr>
<tr><td>VSD - Low Phase B Input Baseplate Temperature</td><td>For details see “VSD – Low Phase A Input Baseplate Temperature” message preceding</td></tr>
<tr><td>VSD - Low Phase C Input Baseplate Temperature</td><td>For details see “VSD – Low Phase A Input Baseplate Temperature” message preceding</td></tr>
<tr><td>VSD - Low Phase A Motor Baseplate Temperature</td><td>This shutdown is generated anytime motor / inverter modules temperature drops below 37°F (2.7°C). This shutdown cannot be reset until the temperature of all modules exceeds 42°F (5.5°C). The fans and pumps for the VSD will continue to run until the temperature exceeds the reset level.</td></tr>
<tr><td>VSD - Low Phase B Motor Baseplate Temperature</td><td>For details see “VSD – Low Phase A Motor Baseplate Temperature” message preceding</td></tr>
<tr><td>VSD - Low Phase C Motor Baseplate Temperature</td><td>For details see “VSD – Low Phase A Motor Baseplate Temperature” message preceding</td></tr>
<tr><td>VSD – Not Running</td><td>This shutdown is generated by the Control Panel when the VSD logic board does not report its run state for 10 continuous seconds.</td></tr>
<tr><td>VSD - Phase A Input DCCT Offset</td><td>This shutdown is generated when the DCCT’s output exceeds a threshold when no current is flowing through it.</td></tr>
<tr><td>VSD - Phase B Input DCCT Offset</td><td>For details see “VSD – Phase A Input DCCT Offset” message preceding</td></tr>
<tr><td>VSD - Phase C Input DCCT Offset</td><td>For details see “VSD – Phase A Input DCCT Offset” message preceding</td></tr>
</table>

TABLE 2 - CYCLING SHUTDOWNS

<table>
<tr><th>MESSAGE</th><th>DESCRIPTION</th></tr>
<tr><td>VSD - Phase A Input Gate Driver</td><td>This shutdown is generated when one of the input gate driver power supplies is operating outside of tolerance, or the voltage across the input / rectifier IGBT is too high. The gate driver board determines this shutdown, and provides feedback to the VSD logic board that this shutdown occurred.</td></tr>
<tr><td>VSD - Phase B Input Gate Driver</td><td>For details see “VSD – Phase A Input Gate Driver” message preceding</td></tr>
<tr><td>VSD - Phase C Input Gate Driver</td><td>For details see “VSD – Phase A Input Gate Driver” message preceding</td></tr>
<tr><td>VSD - Phase A Motor Gate Driver</td><td>This shutdown is generated when one of the motor / inverter gate driver power supplies is operating outside of tolerance, or the voltage across the motor / inverter IGBT is too high. The gate driver board determines this shutdown, and provides feedback to the VSD logic board that this shutdown occurred.</td></tr>
<tr><td>VSD - Phase B Motor Gate Driver</td><td>For details see “VSD – Phase A Motor Gate Driver” message preceding</td></tr>
<tr><td>VSD - Phase C Motor Gate Driver</td><td>For details see “VSD – Phase A Motor Gate Driver” message preceding</td></tr>
<tr><td>VSD - Precharge -
High DC Bus Voltage</td><td>This shutdown is generated when the bus voltage does not reach a minimum value 12 seconds after precharge was started. The minimum value is determined by the input voltage setpoint. If this shutdown repeats 3 times in a row a VSD – Precharge Lockout will occur.
<table>
<tr><th>INPUT VOLTAGE SETPOINT</th><th>MINIMUM VALUE</th></tr>
<tr><td>230</td><td>250</td></tr>
<tr><td>380 / 415</td><td>414</td></tr>
<tr><td>460</td><td>500</td></tr>
</table></td></tr>
<tr><td>VSD - Precharge -
Low DC Bus Voltage</td><td>This shutdown is generated when the bus voltage does not reach a minimum value 4 seconds after precharge was started. The minimum value is determined by the input voltage setpoint. If this shutdown repeats 3 times in a row a VSD – Precharge Lockout will occur.
<table>
<tr><th>INPUT VOLTAGE SETPOINT</th><th>MINIMUM VALUE</th></tr>
<tr><td>230</td><td>25</td></tr>
<tr><td>380 / 415</td><td>41</td></tr>
<tr><td>460</td><td>50</td></tr>
</table></td></tr>
<tr><td>VSD - Run Signal</td><td>This shutdown is generated when more than 5 seconds has passed between the receipt of the 2 run commands from the control center.</td></tr>
<tr><td>VSD - Serial Communications</td><td>This shutdown is generated when serial communications is missing or corrupt for 10 continuous seconds between the control center and the drive logic board.</td></tr>
<tr><td>VSD - Single Phase Input Power</td><td>This shutdown is generated when the RMS phase to phase voltage drops to a low limit based on the input line voltage for a period of one line cycle.
<table>
<tr><th>INPUT LINE VOLTAGE</th><th>LOW LIMIT VALUE</th></tr>
<tr><td>230</td><td>147</td></tr>
<tr><td>380 / 415</td><td>263</td></tr>
<tr><td>460</td><td>294</td></tr>
</table></td></tr>
<tr><td>VSD – Stop (Fault) Contacts Open</td><td>This shutdown is generated when the drive’s fault relay opens, but does not provide a reason via the communication link as to why the relay is open.</td></tr>
</table>

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SECTION 6 - WARNING MESSAGES

GENERAL INFORMATION

A WARNING message will indicate that the operation of the Drive is affected in some manner, but the Drive is still functioning.

TABLE 3 - WARNING MESSAGES

MESSAGE	DESCRIPTION
WARNING - VSD – DC Bus Active	This warning is displayed anytime the DC bus voltage is greater than 50 volts and the drive is not in the run state.

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SECTION 7 - START-UP PREPARATIONS

CIRCUIT BREAKER SETUP

The circuit breaker used on the HYP model drive has many settings for overload, short circuit, and ground fault protection. Generally, these setting are adjusted by the manufacture, but these setting should be verified before starting the chiller. The breaker settings for each drive are a little different. Details for the circuit breaker settings are listed below.

TABLE 4 - SETTINGS FOR CIRCUIT BREAKER

SETTINGS FOR THE 490 AMP CIRCUIT BREAKER (P/N 224-37879-000)		
NAME OF ADJUSTMENT	**ABBREVIATION OF ADJUSTMENT**	**SETTING VALUE**
Long Time Pickup	“IR”	“F”
Long Time Delay	“TR”	“2”
Short Time Pickup	“ISD”	“2”
Short Time Delay	“TSD”	“inst”
Ground Fault Pickup	“IG”	“2”
SETTINGS FOR THE 744 AMP CIRCUIT BREAKER (P/N 224-37419-000)		
Long Time Delay	“TR”	“2”
Short Time Pickup	“ISD”	“2”
Ground Fault Pickup	“IG”	“2”
Ground Fault Delay	“TSD”	“J”

OPTIVIEW CONTROL CENTER

Make certain the correct EPROMs are all installed in the proper locations by referring to the EPROM Reference List in this form. The list at the end of this form contains the earliest versions in which the product is supported. Be sure the dimple in the end of the chip is oriented in the correct direction.

Perform a visual inspection of the drive. Ensure that all wiring and wiring connectors are tight and properly seated. Verify that no coolant leaks are present in the drive. Inspect the power assemblies, coolant headers, and liquid cooled inductors for any signs of a coolant leak.

Apply power to the chiller, and check the System Status Line on the Control Center. After a few seconds you should get the message, “System Ready to Start”. If you do not, turn off power, wait five minutes for the voltage to discharge, verify voltage is no longer present, and then double check all wiring and connections.

1. If initial power-up is successful, verify that the programmed input current is the same as listed on the contract screen. The input current is now programmed from the control center. The drive logic board does not have a trimpot for this adjustment any more.
2. Next, drain the coolant from the drive. Follow the drain procedure found below. The drive is shipped with a 50/50 mix of Propylene Glycol and YORK Corrosion Inhibitor. This type of coolant is being used to protect the cooling loop from damage due to freezing conditions during the shipping process. This coolant mixture does not have the thermodynamic properties required by the drive, and may cause it to overheat. Thus, this 50/50 mixture must be drained and replaced with YORK Corrosion Inhibitor as currently used in the drive. **Propylene Glycol is the same material used to winterize recreational vehicles. Although, it is non-toxic we suggest permission should be obtained before discarding it into a sewer.**
3. Next, fill the coolant loop using YORK’s Corrosion Inhibitor, part number 013-02987-000. Follow the fill procedure found in this form. The coolant pump/pumps can be turn on and off from a selection on the control panel.

SERVICE PROCEDURES

General

The following are detailed steps required to drain, fill and vent the cooling loop for the Raptyr 744 and 490 VSD. All of these steps are to be followed completely to prevent the introduction of air into this system. There are individual components of this system that by their design may contribute to air entrainment and can cause the VSD to overheat some specific piping components that are not thermally protected.

7

VSD Cooling System Components

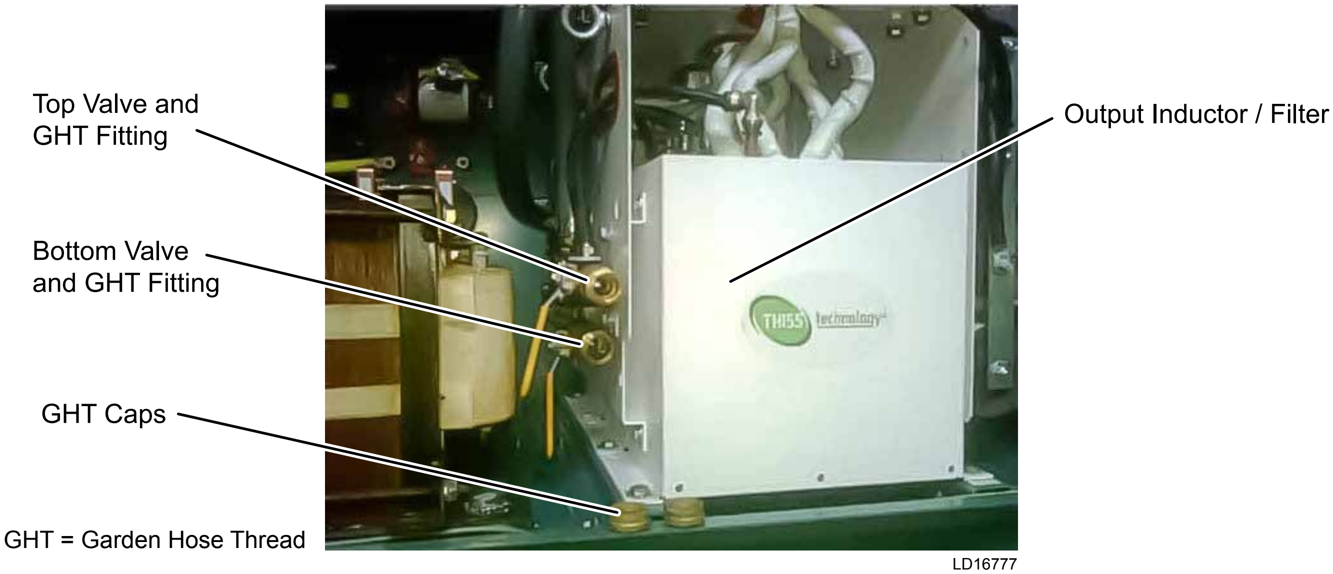


FIGURE 15 - INSIDE OF VSD CABINET

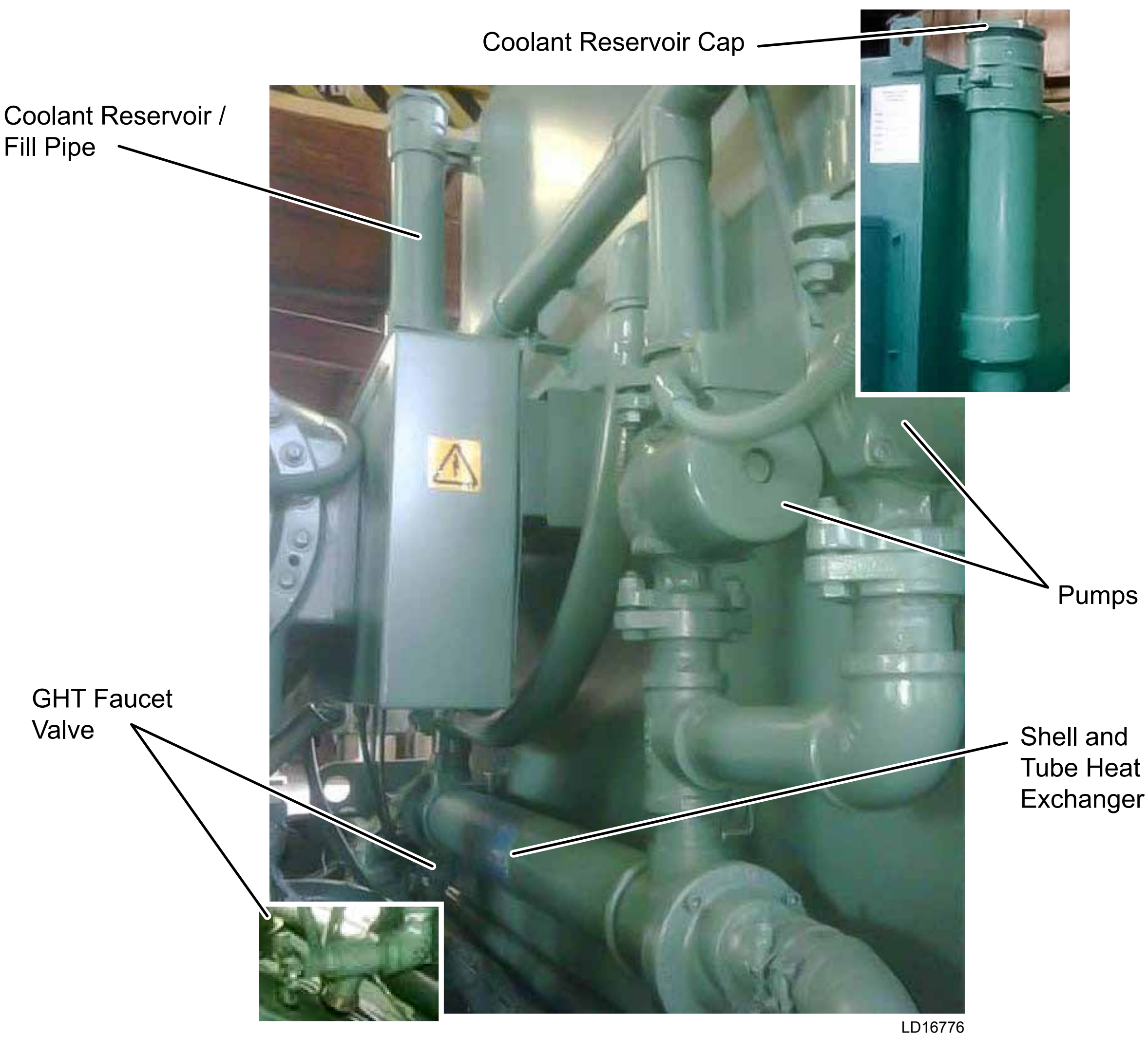


FIGURE 16 - BACK OF VSD

DRAINING THE SYSTEM

NOTE

All fluids drained containing Propylene Glycol or Inhibited Water should be collected and disposed of properly according to facility procedures.

If two hoses are available, the heat exchanger and the output filter can be drained at the same time.

1. Remove coolant reservoir cap.
2. Attach drain hose to GHT faucet valve on the bottom of the shell and tube heat exchanger.
3. Ensure supply manifold valve(s) are open.
4. Open the heat exchanger drain valve to allow coolant to drain. Once coolant stops flowing close the valve, and remove drain hose.
5. Attach drain hose to the top fitting of the output inductor inside the VSD cabinet.
6. Open top valve of the output inductor to allow coolant to drain. Once coolant stops flowing close the valve, and remove drain hose.
7. Attach drain hose to the bottom fitting of the output inductor.
8. Open bottom valve of the output inductor to allow coolant to drain.
9. Install coolant reservoir cap to prevent too much air leaking out.
10. Apply 5 PSI compressed air in the top fitting on the output inductor to blow residual liquid out of the output inductor.

    Warning – Do NOT exceed the 5 PSI rating. Damage to the cooling system my result.

    Once coolant stops flowing turn off the air supply, close the valve, and remove drain hose.
11. Attach drain hose to the valve on the bottom of the shell and tube heat exchanger.
12. Open heat exchanger drain valve, repeat step #10 to allow remaining coolant to drain from the shell and tube heat exchanger.
13. Close all valves and replace all caps. System is now drained.

COOLANT FILL PROCEDURE

Part Numbers

Inhibited Water (Pink)

1 gal = 013-02987-000
55 gal = 013-03346-000

Propylene Glycol (Yellow)

5 gal = 013-03344-000
55 gal = 013-03345-000

WARNING

Coolants may foam up when cycled through the system or when the pumps are shut off and the coolants tend to rise. Do not fill reservoir to top while unit is running or it may overflow when pumps are shut off.

1. Confirm that the heat exchanger drain valve and both of the output inductor drain valves are closed.
2. Open supply manifold valve(s).
3. Remove the cap from the coolant reservoir.
4. Connect a low volume pump to the bottom fitting on the output inductor.
5. Use the low volume pump to fill the coolant loop. Open the valve for the bottom fitting on the output inductor. Slowly, fill the cooling system until coolant is within 1 inch from the top of the coolant reservoir.
6. Close the valve for the bottom fitting on the output inductor, and remove the low volume pump. Wipe up any inhibitor that may have dripped.
7. Apply power to the chiller.
8. Start pumps using the OptiView panel.

    Press: Home > VSD > VSD Details > Manual Cooling > Enable.
9. Allow pumps to run for 15 seconds.
10. Disable the pumps.

    Press: Home > VSD > VSD Details > Manual Cooling > Disable.
11. Check the fill pipe and add more inhibitor if needed to bring the level back to the within 1 inch from the top.

12. Start the pumps and run for 5 minutes.
13. Disable the pumps and check the fill pipe. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
14. Close the supply manifold valve(s).
15. Start the pumps and run for 5 minutes.
16. Disable the pumps and check the fill pipe. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
17. Open the supply manifold valve(s).
18. Start the pumps and run for 10 minutes.
19. Disable the pumps and check the fill pipe. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
20. Close the supply manifold valve(s).
21. Start the pumps and run for 10 minutes.
22. Disable the pumps and check the fill pipe. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
23. Open the supply manifold valve(s).
24. Start the pumps and run for 15 minutes.
25. Disable the pumps and check the fill pipe. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
26. Close the supply manifold valve(s).
27. Start the pumps and run for 15 minutes.
28. Disable the pumps and check the fill pipe. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
29. Open the supply manifold valve(s).
30. Start the pumps and run for 20 minutes.
31. Disable the pumps.
32. Check the fill pipe for inhibited water level. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.
33. Check the fill pipe again for inhibitor level at 1 hour and 24 hours of operation. Add more inhibitor if needed to bring the level back to the within 1 inch from the top.

SECTION 8 - TROUBLESHOOTING AND COMPONENT REPLACEMENT PROCEDURES

GENERAL INFORMATION

The following procedures are designed to guide the service technician along the path that leads to the identification of the cause for the problem. The service technician should understand the operation of the HYP model drive and function of each major component. It is recommended that the service technician read and understand the information contained in this instruction prior to troubleshooting this product. Also, the service technician must understand the system interface and be able to utilize system wiring diagrams to follow signal flow throughout the system. Due to the integration of the HYP model drive with the Graphic Control Center, a good working knowledge of the Control Center is also necessary (Refer to the Associated Literature listed at the beginning of this document).

Several levels of documentation are required for the troubleshooting process. The HYP model drive wiring diagram, (Form 160.78-PW4) supplied with every drive is the top level document. It provides the overall wiring and configuration. Sections of this instruction provide the required lower level understanding. Specifically, block diagrams provide signal flow and simplified representations of all board circuitry.

Begin the troubleshooting process by selecting the appropriate procedure. It is not necessary to sequentially perform all of them. Perform a procedure only if there is a problem with that function.

NOTE

Some of the protection circuitry for the drive is protected by fuses. If these fuses are open, then the protection circuit will not protect the drive. A failure of these fuses will not cause the drive to perform differently, and no faults will occur. It is best practice to verify that all fuses are still in working order every time the drive is entered.

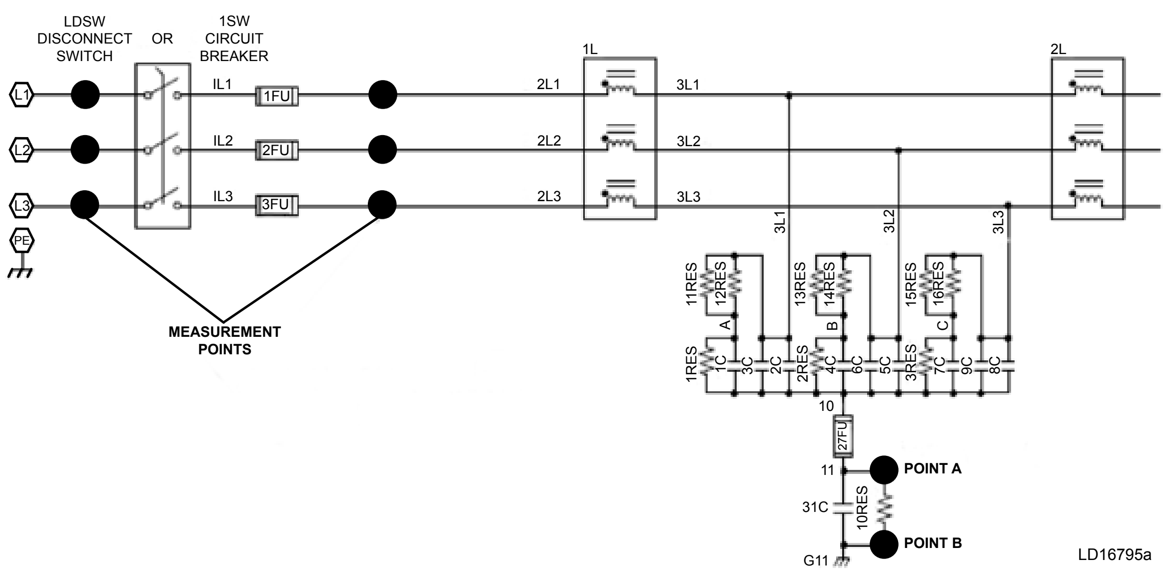
NOTE

Due to the way the input fuses are manufactured, if any of the fuses are open, then all three fuses must be replaced.

WARNING

This product contains voltages that could cause injury or death. Follow all NFPA-70E safety rules. Before performing any troubleshooting procedures. Place the compressor switch in the stop position. Wait 5 minutes. Ensure that the DC BUS voltage is 50 VDC or less on the display of the chiller control panel. Ensure that all sources of power to the chiller are removed. Remove all AC power sources upstream of the VSD and perform lockout / tagout procedures. Use a non-contact voltage sensor to ensure no AC power is present in the enclosure. Use a DVM to measure AC and DC voltage at locations shown below. Measure the three phase connections phase to phase and phase to ground. All values should be zero. Measure voltage from POINT A to POINT B.

Measure the BUS voltage at J1 pins 1-2 on the VSD logic board using a DVM to ensure that BUS voltage is less than 50 VDC.

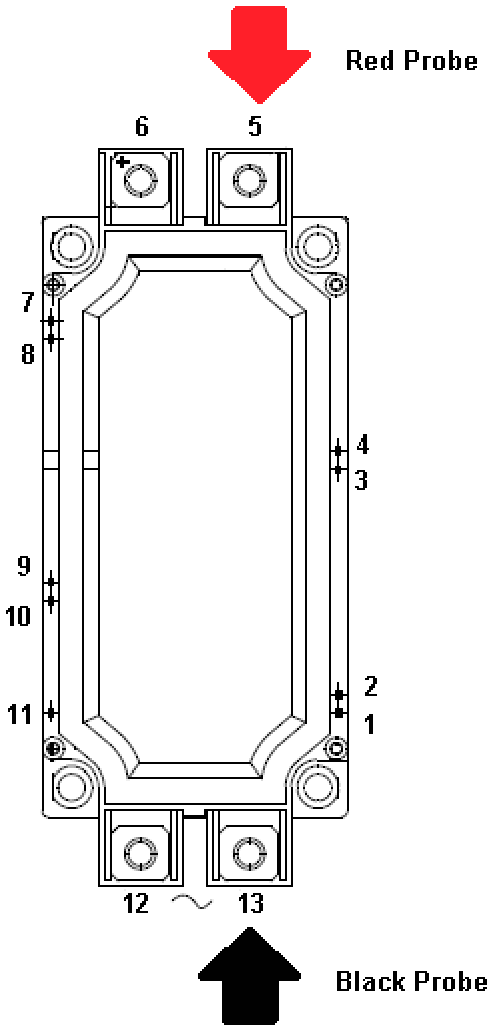


Verify a Rectifier Failure

General Information

The procedure below should only be used after all Lockout and Tag out procedures are performed, and the proper verification performed to determine that the drive is safe to enter. The steps below provide information on where to connect a digital ohm meter or an analog ohm meter. The digital ohm meter will need to be set to the diode reading. The analog ohm meter will need to be set to read resistance on the Rx1 scale. The resistance readings for these tests will indicate that the diode in the device is turned on or turned off. The absolute resistance values are not that important. The digital meter will indicate a low voltage reading when the diode is turned on such as 0.3-0.4 volts. With the digital meter the voltage will be higher when the diode is turned off such as a reading of 2.0 to 3.0 volts or overload. The analog meter will read resistance of 5 – 15 ohms when the diode is on. The analog meter will read greater than 70 ohms when the diode is turned off. For reading the meter when the diode is off, it may take a few seconds for the meter to respond correctly because of the bus capacitors in the circuit.

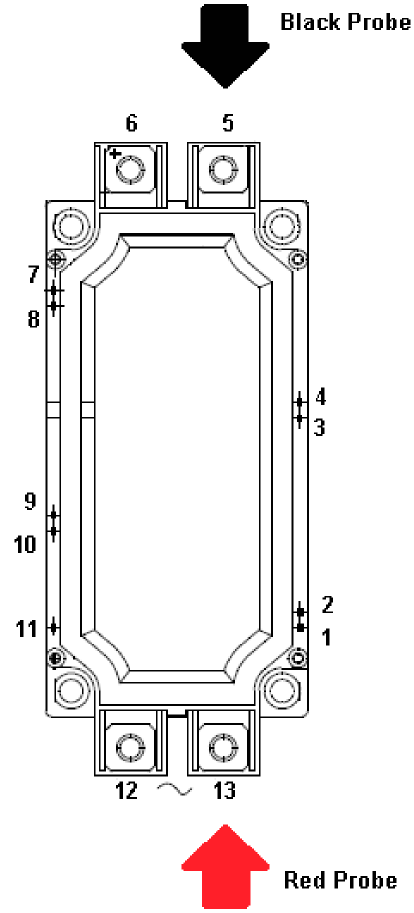
Step 1



LD16796

1. Place the Red or Positive probe of the meter on Pin 5 of the IGBT assembly.
2. Place the Black or Negative probe of the meter on Pin 13 of the IGBT assembly.
3. A normal reading will indicate that the switch is “ON”.

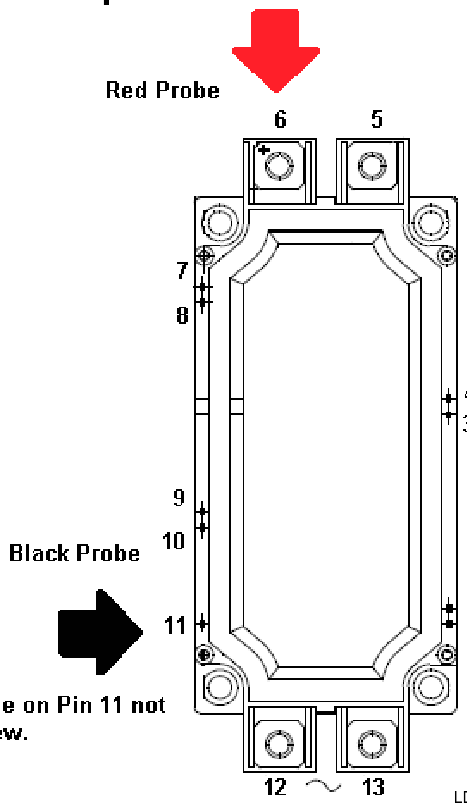
Step 2



LD16797

1. Place the Black or Negative probe of the meter on Pin 5 of the IGBT assembly.
2. Place the Red or Positive probe of the meter on Pin 13 of the IGBT assembly.
3. A normal reading will indicate that the switch is “OFF”.

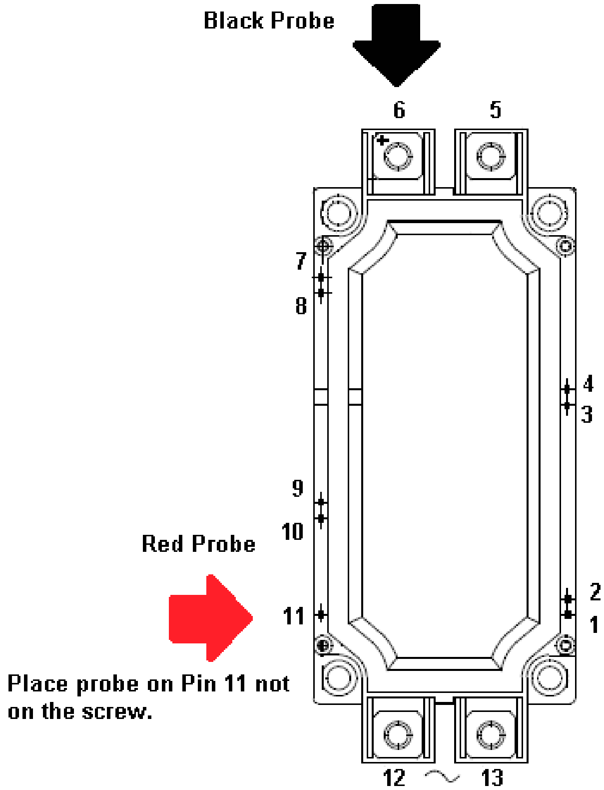
Step 3



LD16798

1. Place the Red or Positive probe of the meter on Pin 6 of the IGBT assembly.
2. Place the Black or Negative probe of the meter on Pin 11 of the IGBT assembly.
3. A normal reading will indicate that the switch is “ON”.

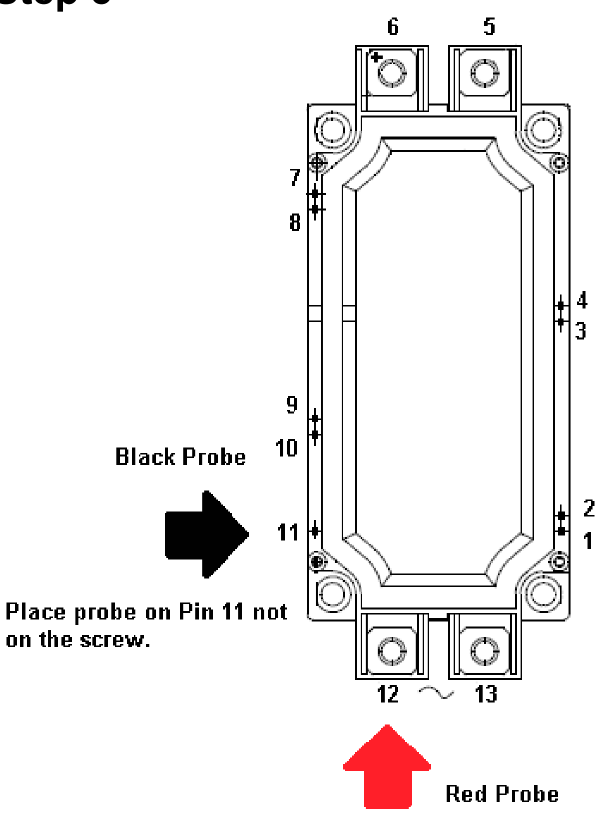
Step 4



LD16799

1. Place the Black or Negative probe of the meter on Pin 6 of the IGBT assembly.
2. Place the Red or Positive probe of the meter on Pin 11 of the IGBT assembly.
3. A normal reading will indicate that the switch is "OFF".

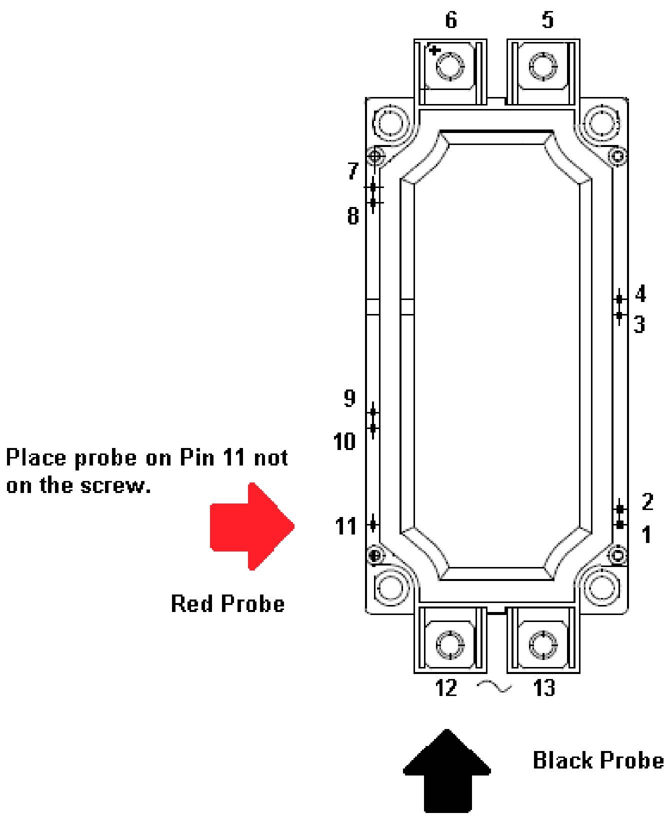
Step 5



LD16800

1. Place the Black or Negative probe of the meter on Pin 11 of the IGBT assembly.
2. Place the Red or Positive probe of the meter on Pin 12 of the IGBT assembly.
3. A normal reading will indicate that the switch is "ON".

Step 6



LD16801

1. Place the Red or Positive probe of the meter on Pin 11 of the IGBT assembly.
2. Place the Black or Negative probe of the meter on Pin 12 of the IGBT assembly.
3. A normal reading will indicate that the switch is “OFF”.

8

Repeat this test for each rectifier module in the suspected phase. If any of the modules failed this test then the complete rectifier assembly for that phase must be replaced.

NOTE

If any of the input power fuses failed, then all 3 of the input power fuses must be replaced.

NOTE

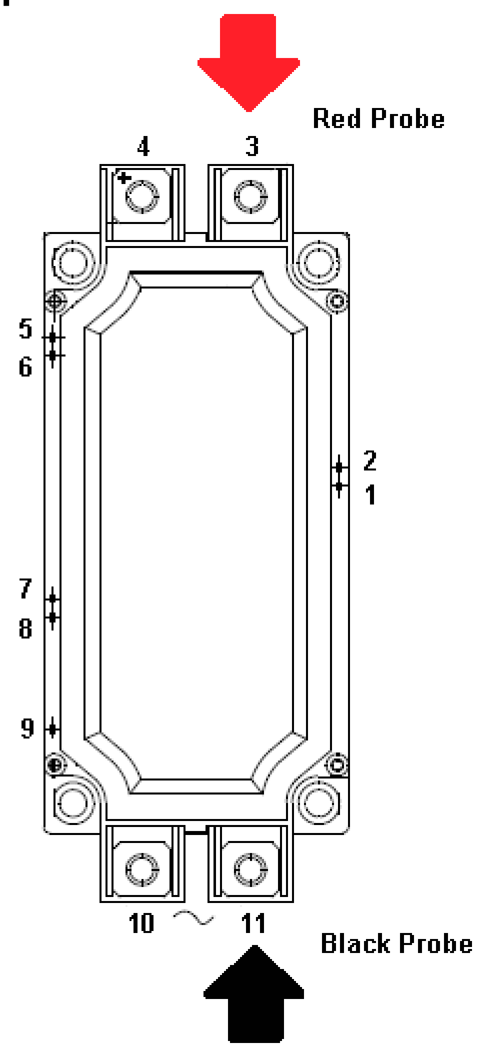
The rectifier assembly associated with an input power fuse failure must be replaced regardless of test results. For example, if the A and C phase input power fuses failed, and the C phase rectifier assembly failed the above test, but the A phase assembly passed the above test, then the A phase rectifier assembly must also be replaced.

Verify an Inverter Failure

General Information

The procedure below should only be used after all Lockout and Tag out procedures are performed, and the proper verification performed to determine that the drive is safe to enter. The steps below provide information on where to connect a digital ohm meter or an analog ohm meter. The digital ohm meter will need to be set to the diode reading. The analog ohm meter will need to be set to read resistance on the Rx1 scale. The resistance readings for these tests will indicate that the diode in the device is turned on or turned off. The absolute resistance values are not that important. The digital meter will indicate a low voltage reading when the diode is turned on such as 0.3-0.4 volts. With the digital meter the voltage will be higher when the diode is turned off such as a reading of 2.0 to 3.0 volts or overload. The analog meter will read resistance of 5 – 15 ohms when the diode is on. The analog meter will read greater than 70 ohms when the diode is turned off. For reading the meter when the diode is off, it may take a few seconds for the meter to respond correctly because of the bus capacitors in the circuit.

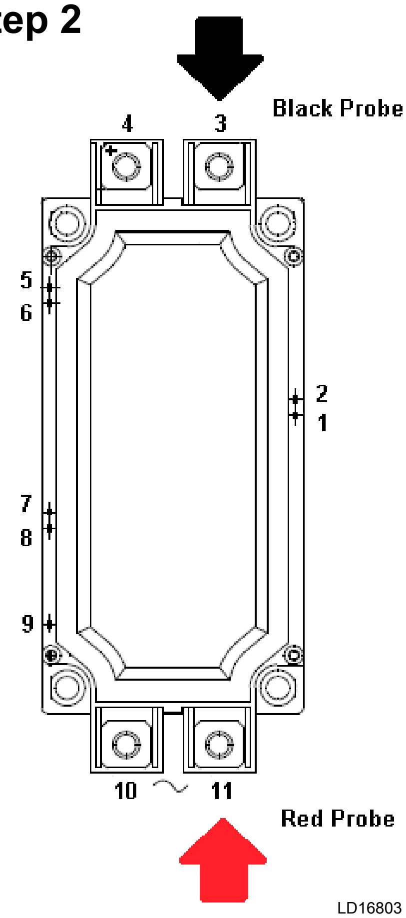
Step 1



LD16802

1. Place the Red or Positive probe of the meter on Pin 3 of the IGBT assembly.
2. Place the Black or Negative probe of the meter on Pin 11 of the IGBT assembly.
3. A normal reading will indicate that the switch is “ON”.

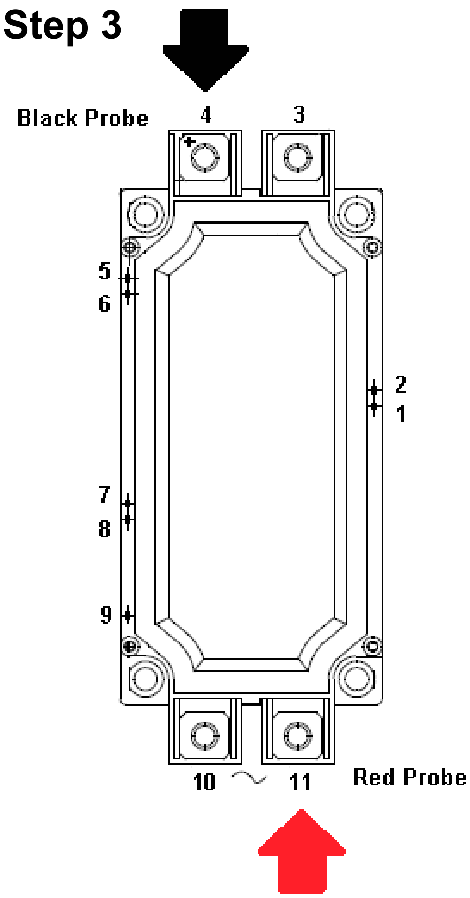
Step 2



LD16803

1. Place the Black or Negative probe of the meter on Pin 3 of the IGBT assembly.
2. Place the Red or Positive probe of the meter on Pin 11 of the IGBT assembly.
3. A normal reading will indicate that the switch is “OFF”.

Step 3

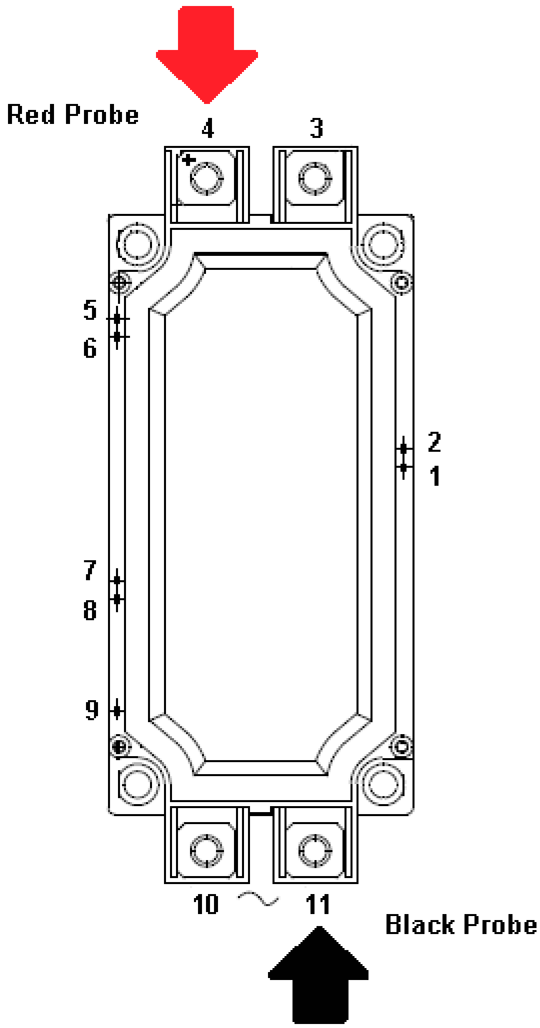


LD16804

1. Place the Black or Negative probe of the meter on Pin 4 of the IGBT assembly.
2. Place the Red or Positive probe of the meter on Pin 11 of the IGBT assembly.
3. A normal reading will indicate that the switch is “ON”.

8

Step 4



LD16805

1. Place the Black or Negative probe of the meter on Pin 4 of the IGBT assembly.
2. Place the Red or Positive probe of the meter on Pin 11 of the IGBT assembly.
3. A normal reading will indicate that the switch is "OFF".

Repeat this test for each inverter module in the suspected phase. If any of the modules failed this test then the complete inverter assembly for that phase must be replaced.

The following factors can be used to convert from English to the most common SI Metric values.

TABLE 5 - SI METRIC CONVERSION

MEASUREMENT	MULTIPLY ENGLISH UNIT	BY FACTOR	TO OBTAIN METRIC UNIT
Capacity	Tons Refrigerant Effect (ton)	3.516	Kilowatts (kW)
Power	Horsepower	0.7457	Kilowatts (kW)
Flow Rate	Gallons / Minute (gpm)	0.0631	Liters / Second (l/s)
Length	Feet (ft)	0.3048	Meters (m)
	Inches (in)	25.4	Millimeters (mm)
Weight	Pounds (lbs)	0.4538	Kilograms (kg)
Velocity	Feet / Second (fps)	0.3048	Meters / Second (m/s)
Pressure Drop	Feet of Water (ft)	2.989	Kilopascals (kPa)
	Pounds / Square Inch (psi)	6.895	Kilopascals (kPa)

TEMPERATURE

To convert degrees Fahrenheit (°F) to degrees Celsius (°C), subtract 32° and multiply by 5/9 or 0.5556.

Example: (45.0°F - 32°) x 0.5556 = 27.2°C

To convert a temperature range (i.e., a range of 10°F) from Fahrenheit to Celsius, multiply by 5/9 or 0.5556.

Example: 10.0°F range x 0.5556 = 5.6 °C range

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Form 160.78-M3 (214)
Issue Date: February 28, 2014
Supersedes: 160.78-M3 (113)