TOSHIBA

T300BMV2

MEDIUM VOLTAGE

ADJUSTABLE SPEED MOTOR DRIVE

INSTRUCTION MANUAL

TOSHIBA INTERNATIONAL CORPORATION

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TOSHIBA INTERNATIONAL CORPORATION
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Printed in U.S.A.

Important Notice

The instructions contained in this manual are not intended to cover all details or variations in equipment types, nor may it provide for every possible contingency concerning the installation, operation, or maintenance of this equipment. Should additional information be required contact your Toshiba representative.

The contents of this manual shall not become a part of or modify any prior or existing agreement, commitment, or relationship. The sales contract contains the entire obligation of Toshiba International Corporation. The warranty contained in the contract between the parties is the sole warranty of Toshiba International Corporation and any statements contained herein do not create new warranties or modify the existing warranty.

Any electrical or mechanical modifications to this equipment without prior written consent of Toshiba International Corporation will void all warranties and may void the UL/CUL listing or other safety certifications. Unauthorized modifications may also result in a safety hazard or equipment damage.

Misuse of this equipment could result in injury and equipment damage. In no event will Toshiba Corporation be responsible or liable for either indirect or consequential damage or injury that may result from the misuse of this equipment.

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Adjustable Speed Drive

Please complete the Warranty Card supplied with the ASD and return it to Toshiba by prepaid mail. This will activate the 12 month warranty from the date of installation; but, shall not exceed 18 months from the date of purchase.

Complete the following information about the drive and retain it for your records.

Model Number: _____

Serial Number: _____

Project Number (if applicable): _____

Date of Installation: _____

Inspected By: _____

Name of Application: _____

Manual's Purpose and Scope

This manual provides information on how to safely install, operate, and maintain your TIC power electronics product. This manual includes a section of general safety instructions that describes the warning labels and symbols that are used throughout the manual. Read the manual completely before installing, operating, or performing maintenance on this equipment.

This manual and the accompanying drawings should be considered a permanent part of the equipment and should be readily available for reference and review. Dimensions shown in the manual are in metric and/or the English equivalent.

Toshiba International Corporation reserves the right, without prior notice, to update information, make product changes, or to discontinue any product or service identified in this publication.

TOSHIBA is a registered trademark of the Toshiba Corporation. All other product or trade references appearing in this manual are registered trademarks of their respective owners.

Toshiba International Corporation (TIC) shall not be liable for direct, indirect, special, or consequential damages resulting from the use of the information contained within this manual.

Printed in the U.S.A.

Contacting Toshiba's Customer Support Center

Toshiba's Customer Support Center can be contacted to obtain help in resolving any **Adjustable Speed Drive** system problem that you may experience or to provide application information.

The center is open from 8 a.m. to 5 p.m. (CST), Monday through Friday. The Support Center's toll free number is US (800) 231-1412/Fax (713) 466-8773 — Canada (800) 527-1204.

You may also contact Toshiba by writing to:

Toshiba International Corporation
13131 West Little York Road
Houston, Texas 77041-9990
Attn: CASD Product Manager.

For further information on Toshiba's products and services, please visit our website at www.toshiba.com/tic.

General Safety Instructions

DO NOT attempt to install, operate, maintain or dispose of this equipment until you have read and understood all of the product safety information and directions that are contained in this manual.

Safety Alert Symbol

The **Safety Alert Symbol** indicates that a potential personal injury hazard exists. The symbol is comprised of an equilateral triangle enclosing an exclamation mark.

Signal Words

Listed below are the signal words that are used throughout this manual followed by their descriptions and associated symbols. When the words **DANGER**, **WARNING** and **CAUTION** are used in this manual they will be followed by important safety information that must be adhered to.

The word **DANGER** preceded by the safety alert symbol indicates that an imminently hazardous situation exists that, if not avoided, will result in death or serious injury to personnel.

DANGER

The word **WARNING** preceded by the safety alert symbol indicates that a potentially hazardous situation exists that, if not avoided, could result in death or serious injury to personnel.

WARNING

The word **CAUTION** preceded by the safety alert symbol indicates that a potentially hazardous situation exists which, if not avoided, may result in minor or moderate injury.

CAUTION

The word **CAUTION** without the safety alert symbol indicates a potentially hazardous situation exists which, if not avoided, may result in equipment and property damage.

CAUTION

Special Symbols

To identify special hazards, other symbols may appear in conjunction with the **DANGER**, **WARNING** and **CAUTION** signal words. These symbols indicate areas that require special and/or strict adherence to the procedures to prevent serious injury to personnel or death.

Electrical Hazard Symbol

A symbol which indicates a hazard of injury from electrical shock or burn. It is comprised of an equilateral triangle enclosing a lightning bolt.

Explosion Hazard Symbol

A symbol which indicates a hazard of injury from exploding parts. It is comprised of an equilateral triangle enclosing an explosion image.

Arc Flash Hazard Symbol

A symbol which indicates a hazard of injury from arc flash. It is comprised of an equilateral triangle enclosing an arc flash image.

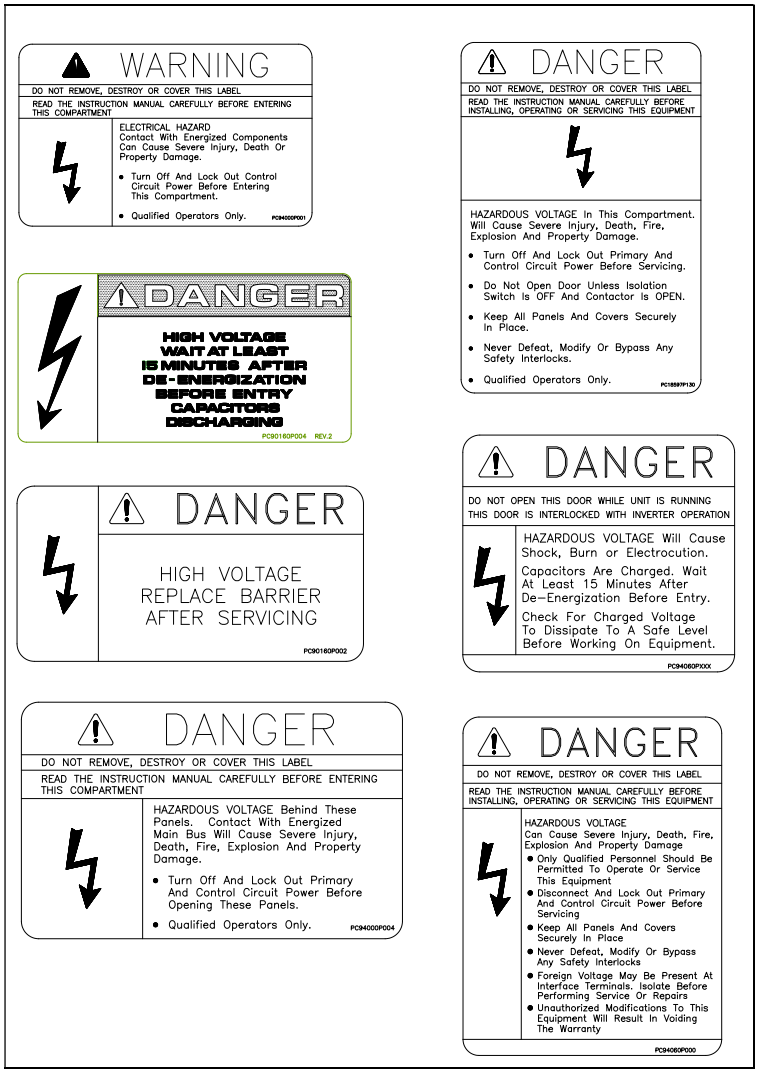
Equipment Labels (Safety, Rating, Information)

DO NOT attempt to install, operate, perform maintenance, or dispose of this equipment until you have read and understood all of the product labels and user directions that are contained in this manual.

Shown below are examples of safety labels that may be found attached to the equipment. **DO NOT** remove or cover any of the labels. If the labels are damaged or if additional labels are required, contact your Toshiba representative for additional labels.

Labels attached to the equipment are there to provide useful information or to indicate an imminently hazardous situation that may result in serious injury, severe property and equipment damage, or death if the instructions are not followed.

SAFETY labels that will be found on the equipment are shown below:



Additional SAFETY labels that will be found on the equipment or in the manual that has the CE mark applied are shown below:

Electrical hazard.

Electrical hazard with a minimum discharge time listed below.

xxx MIN

Electrical hazard with the system rated voltage listed below.

xxxxx V

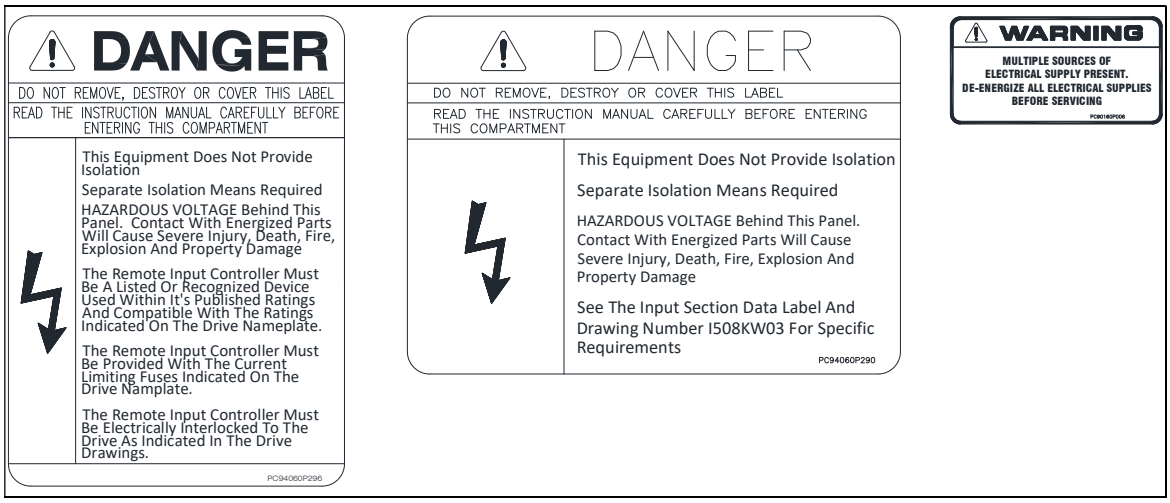
Do not remove covers or panels when energized.

Burn hazard from high surface temperatures.

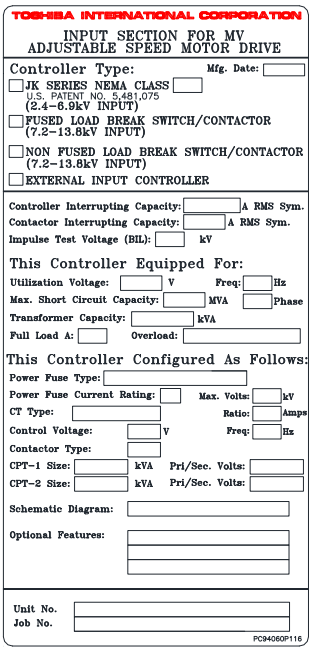
Use and follow lock out tag out proceedures

Read the manual.

Some additional SAFETY labels that may be found on the equipment are shown below:



RATING labels that will be found on the equipment are shown below: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INPUT SECTION FOR MV
ADJUSTABLE SPEED MOTOR DRIVE

Controller Type: Mfg. Date:

☐ JK SERIES NEMA CLASS ☐
U.S. PATENT NO. 5,481,075
(2.4–6.9kV INPUT)

☐ FUSED LOAD BREAK SWITCH/CONTACTOR
(7.2–13.8kV INPUT)

☐ NON FUSED LOAD BREAK SWITCH/CONTACTOR
(7.2–13.8kV INPUT)

☐ EXTERNAL INPUT CONTROLLER

Controller Interrupting Capacity: A RMS Sym.
Contactor Interrupting Capacity: A RMS Sym.
Impulse Test Voltage (BIL): kV

This Controller Equipped For:
Utilization Voltage: V Freq: Hz
Max. Short Circuit Capacity: MVA Phase
Transformer Capacity: kVA
Full Load A: Overload:

This Controller Configured As Follows:
Power Fuse Type:
Power Fuse Current Rating: Max. Volts: kV
CT Type: Ratio: Amps
Control Voltage: V Freq: Hz
Contactor Type:
CPT–1 Size: kVA Pri/Sec. Volts:
CPT–2 Size: kVA Pri/Sec. Volts:

Schematic Diagram:

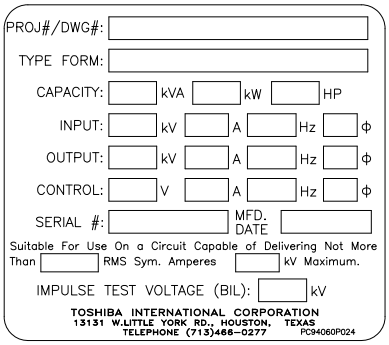
Optional Features:

Unit No.
Job No.

PC94060P116

Input Controller Rating Label

Note: If no input controller is supplied, this label will indicate the *required fuses and the minimum acceptable ratings for the external controller.*


PROJ#/DWG#:

TYPE FORM:

CAPACITY: kVA kW HP

INPUT: kV A Hz ϕ

OUTPUT: kV A Hz ϕ

CONTROL: V A Hz ϕ

SERIAL #: MFD. DATE

Suitable For Use On a Circuit Capable of Delivering Not More Than RMS Sym. Amperes kV Maximum.

IMPULSE TEST VOLTAGE (BIL): kV

TOSHIBA INTERNATIONAL CORPORATION
13131 W.LITTLE YORK RD., HOUSTON, TEXAS
TELEPHONE (713)466–0277 PC94060P024

Adjustable Speed Drive Rating Label


TYPE–FORM :

RATING :

MFG. DATE :

SERIAL NO. :

TOSHIBA INTERNATIONAL CORPORATION

Inverter Power Module Rating Label

Note:

The above labels are shown blank. The labels affixed to the equipment will be filled in with rating data specific to the actual unit(s) furnished. Complete rating data is also provided on the rating sheet included in the supplementary drawing packet. Ensure that all rating data matches the power system and the driven load connected to the equipment.

INFORMATION labels that will be found on the equipment are shown below:

TORQUE VALUES VALEURS DE COUPLES		
HARDWARE SIZE TAILLE DE L'ÉQUIPEMENT	TORQUE COUPLE (ft-lb)	TORQUE COUPLE (kgf-cm)
1/4-20	4~6	55~83
5/16-18	10~15	138~207
3/8-16	20~30	276~415
1/2-13	40~50	553~691
USE ONLY 75°C COPPER CONDUCTORS N'UTILISER QUE DES CONDUCTEURS EN CUIVRE 75°C		

Torque Label

TO OBTAIN PARTS
OR SERVICE FOR YOUR
TOSHIBA PRODUCT
CALL 800–231–1412
OR 713–466–0277

ASK FOR FIELD SERVICE

HAVE THE FOLLOWING READY:

TYPE OF EQUIPMENT
INSTALLATION DATE
JOB NUMBER
MODEL NUMBER
SERIAL NUMBER
APPLICATION
QUESTION OR PROBLEM
TEST OR OPERATION DATA

Service Label

C UL US
LISTED
MEDIUM VOLTAGE
POWER CONVERSION
EQUIPMENT
4ZA1

UL Label
(for UL Listed drives)

CE

CE Label
(for drives designed for use in the European Union)

Qualified Personnel

Installation, operation, and maintenance shall be performed by **Qualified Personnel Only**. A **Qualified Person** is one that has the skills and knowledge relating to the construction, installation, operation, and maintenance of the electrical equipment and has received safety training on the hazards involved. In the U.S., refer to the latest edition of NFPA 70E for additional safety requirements. Outside the U.S., follow all applicable national and local safety practices.

Qualified Personnel shall:

- Have read the entire operation manual.
- Be familiar with the construction and function of the ASD, the equipment being driven, and the hazards involved.
- Able to recognize and properly address hazards associated with the application of motor-driven equipment.
- Be trained and authorized to safely energize, de-energize, ground, lockout/tagout circuits and equipment, and clear faults in accordance with established safety practices.
- Be trained in the proper care and use of protective equipment such as safety shoes, rubber gloves, hard hats, safety glasses, face shields, flash clothing, etc., in accordance with established safety practices.
- Be trained in rendering first aid.

For further information on workplace safety in the U.S. visit www.osha.gov. Outside the U.S., refer to your existing plant safety regulations.

Equipment Inspection

- Upon receipt of the equipment inspect the packaging and equipment for shipping damage.
- Carefully unpack the equipment and check for parts that were damaged from shipping, missing parts, or concealed damage. If any discrepancies are discovered, it should be noted with the carrier prior to accepting the shipment, if possible. File a claim with the carrier if necessary and immediately notify your Toshiba representative.
- **DO NOT** install or energize equipment that has been damaged. Damaged equipment may fail during operation resulting in further equipment damage or personal injury.
- Check to see that the rated capacity and the model number specified on the nameplate conform to the order specifications.
- Modification of this equipment is dangerous and must not be performed except by factory trained representatives. When modifications are required contact your Toshiba representative.
- Inspections may be required before and after moving installed equipment.
- Keep the equipment in an upright position as indicated on the shipping carton.
- Contact your Toshiba representative for assistance if required.

Handling and Storage

- Use proper lifting techniques when moving the ASD; including properly sizing up the load, getting assistance, and using a forklift if required.
- Store in a well-ventilated covered location and preferably in the original carton if the equipment will not be used upon receipt.
- Store in a cool, clean, and dry location. Avoid storage locations with extreme temperatures, rapid temperature changes, high humidity, moisture, dust, corrosive gases, or metal particles.
- Do not store the unit in places that are exposed to outside weather conditions (i.e., wind, rain, snow, etc.).
- Store in an upright position as indicated on the shipping carton.
- Include any other product-specific requirements.

Disposal

Never dispose of electrical components via incineration. Contact your state environmental agency for details on disposal of electrical components and packaging in your area.

Installation Precautions

Location and Ambient Requirements

- Adequate personnel working space and adequate illumination must be provided for adjustment, inspection, and maintenance of the equipment. In the U.S., refer to NEC Article 110-34 for requirements. Outside the U.S., follow applicable local electrical code requirements.
- Avoid installation in areas where vibration, heat, humidity, dust, fibers, steel particles, explosive/ corrosive mists or gases, or sources of electrical noise are present.
- Do not install the ASD where it may be exposed to flammable chemicals or gasses, water, solvents, or other fluids.
- The installation location shall not be exposed to direct sun light .
- MTX drives are designed for outdoor use with exposure to rain and direct sunlight.
- Allow proper clearance spaces for installation. Do not obstruct the ventilation openings. Refer to the recommended minimum installation dimensions as shown on the enclosure outline drawings.
- The ambient operating temperature shall be between 0 and 40 °C (32 and 105 °F), unless stated otherwise.

Mounting Requirements

- Only **Qualified Personnel** should install this equipment.
- Install the unit in a secure upright position in a well-ventilated area.
- A noncombustible insulating floor or mat should be provided in the area immediately surrounding the electrical system at the place where maintenance operations are to be performed.
- Equipment should be installed according to all applicable national, regional, and industry codes and standards. In the U.S., installation of the equipment should conform to NEC Article 110 Requirements For Electrical Installations and to OSHA requirements.
- In the U.S., installation practices should conform to the latest revision of NFPA 70E Electrical Safety Requirements for Employee Workplaces. Outside the U.S., applicable national and local installation safety practices should be followed. In the EU refer to section 6.5 of HD 637 and its sub clauses.

Conductor Routing and Grounding

- Use separate metal conduits for routing the input power, output power, and control circuits.
- A separate ground cable should be run inside the conduit with the input power, output power, and control circuits.
- **DO NOT** connect control terminal strip return marked LG to earth ground.
- Always ground the unit to prevent electrical shock and to help reduce electrical noise.
- It is the responsibility of the person installing the ASD or the electrical maintenance personnel to provide proper grounding and branch circuit protection in accordance with all applicable national and local electrical codes (in the U.S. refer to the current version of NEC).

WARNING

The Metal Of Conduit Is Not An Acceptable Ground.

Connections

WARNING

Contact With Energized Wiring Will Cause Severe Injury Or Death.

- Turn off, lockout, and tagout all power sources before proceeding to connect the power wiring to the equipment.
- After ensuring that all power sources are turned off and isolated in accordance with established lockout/tagout procedures, connect three-phase power source wiring of the correct voltage to the correct input terminals and connect the output terminals to a motor of the correct voltage and type for the application. In the U.S., refer to NEC Article 300 – Wiring Methods and Article 310 – Conductors For General Wiring and size the branch circuit conductors in accordance with NEC Table 310.16. Outside the U.S., follow your national and local electrical codes.
- If multiple conductors that are smaller than the recommended sizes are used in parallel for the input or output power, each branch of the parallel set shall have its own conduit and not share its conduit with other parallel sets (i.e., place U1, V1, and W1 in one conduit and U2, V2, and W2 in another) (refer to NEC Article 300.20 and Article 310.4 for U.S. requirements). National and local electrical codes should be referenced if three or more power conductors are run in the same conduit (in the U.S. refer to 2002 NEC Article 310 adjustment factors on page 70-142). Outside the U.S., consult your national and local electrical codes for additional requirements for running multiple conductors.
- Ensure that the 3 phase input power is **Not** connected to the output of the ASD. This will damage the ASD and may cause injury to personnel.
- Do not install the ASD if it is damaged or if it is missing any component(s).
- Turn the power on only after attaching and/or securing the front cover.
- Ensure the correct phase sequence and the desired direction of motor rotation in the **Bypass** mode (if applicable).

Protection

- Ensure that primary protection exists for the input wiring to the equipment. This protection must be able to interrupt the available fault current from the power line. The equipment may or may not be equipped with an input disconnect (option).

When sizing and installing the upstream cabling and protection equipment:

- Consult the Manufacturer's Nameplate for Equipment Voltage and Current Requirements.
- The equipment must be installed to meet the National Electrical Code rules of the country where installed as a branch circuit protector.
- The equipment must bear a safety mark accepted by the country where installed.
- The equipment must be installed by a qualified electrician.

- All cable entry openings must be sealed to reduce the risk of entry, by vermin, and to allow for maximum cooling efficiency.
- Follow all warnings and precautions, and do not exceed equipment ratings.
- If using multiple motors, provide separate overload protection, for each motor, and use V/f control.
- External dynamic braking resistors, if supplied, must be thermally protected.
- It is the responsibility of the person installing the ASD or the electrical maintenance personnel to setup the **Emergency Off** braking system of the ASD. The function of the **Emergency Off** braking function is to remove output power, from the drive, in the event of an emergency. A supplemental braking system may also be engaged in the event of an emergency.
***Note**: A supplemental emergency stopping system should be used with the ASD. Emergency stopping should not be a task of the ASD alone.*

System Integration Precautions

The following precautions are provided as general guidelines for the setup of the ASD within the system.

- The Toshiba ASD is a general-purpose product. It is a system component only and the system design should take this into consideration. Please contact Toshiba for application-specific information and for training support.
- The Toshiba ASD is part of a larger system and the safe operation of the device will depend on observing certain precautions and performing proper system integration.
- A detailed system analysis and job safety analysis should be performed by the systems designer and/or systems integrator, before the installation of the ASD component. Contact Toshiba for options availability and for application-specific system integration information, if required.

Personnel Protection

- Installation, operation, and maintenance shall be performed by **Qualified Personnel <u>Only</u>**.
- A thorough understanding of the ASD will be required before the installation, operation, or maintenance of the ASD.

WARNING

- Rotating machinery and live conductors can be hazardous and shall not come into contact with humans. Personnel should be protected from all rotating machinery and electrical hazards at all times.
- Insulators, machine guards, and electrical safeguards may fail or be defeated by the purposeful or inadvertent actions of workers. Insulators, machine guards, and electrical safeguards are to be inspected (and tested where possible) at installation and periodically after installation for potential hazardous conditions.
- Do not allow personnel near rotating machinery. Warning signs to this effect shall be posted at or near the machinery.
- Do not allow personnel near electrical conductors. Human contact with electrical conductors can be fatal. Warning signs to this effect shall be posted at or near the hazard.
- Personal protection equipment shall be provided and used to protect employees from any hazards inherent to system operation.

System Setup Requirements

- When using the ASD as an integral part of a larger system, it is the responsibility of the ASD installer or maintenance personnel to ensure that there is a fail-safe in place, i.e., an arrangement designed to switch the system to a safe condition if there is a fault or failure.
- System safety features should be employed and designed into the integrated system in a manner such that system operation, even in the event of system failure, will not cause harm or result in personnel injury or system damage (i.e., E-Off, Auto-Restart settings, System Interlocks, etc.).
- The programming setup and system configuration of the ASD may allow it to start the motor unexpectedly. A familiarity with the Auto-restart settings is a requirement to use this product.
- Improperly designed or improperly installed system interlocks may render the motor unable to start or stop on command.
- The failure of external or ancillary components may cause intermittent system operation, i.e.; the system may start the motor without warning.
- There may be thermal or physical properties, or ancillary devices integrated into the overall system that may allow for the ASD to start the motor without warning. Signs at the equipment installation must be posted to this effect.
- If a secondary magnetic contactor (MC) is used between the ASD and the load, it should be interlocked to halt the ASD before the secondary contact opens. If the output contactor is used for bypass operation, it must be interlocked such that commercial power is never applied to the ASD output terminals (U, V, and W).
- Power factor improvement capacitors or surge absorbers must not be installed on the output of the ASD.
- Use of the built-in system protective features is highly recommended (i.e., E-Off, Overload Protection, etc.).
- The operating controls and system status indicators should be clearly readable and positioned where the operator can see them without obstruction.
- Additional warnings and notifications shall be posted at the equipment installation location as deemed required by **Qualified Personnel**.

Operational and Maintenance Precautions

WARNING

- Turn off, lockout, and tagout the main power, the control power, and instrumentation connections before inspecting or servicing the drive, or opening the door of the enclosure.
- Turn off, lockout, and tagout the main power, the control power, and instrumentation connections before proceeding to disconnect or connect the power wiring to the equipment.
- The capacitors of the ASD maintain a residual charge for a period of time after turning the ASD off. The required time for each ASD typeform is indicated with a cabinet label and a **Charge LED**. Wait for at least the minimum time indicated on the label and ensure that the **Charge LED** has gone out before opening the door of the ASD once the ASD power has been turned off.
- **Do Not** attempt to disassemble, modify, or repair the ASD. Call your Toshiba sales representative for repair information.
- Do not place any objects inside of the ASD.
- Turn the power on only after attaching (or closing) the front cover and **Do Not** remove the front cover of the ASD when the power is on.
- If the ASD should emit smoke or an unusual odor or sound, turn the power off immediately.
- The heat sinks, magnetics, and other components may become extremely hot to the touch. Allow the unit to cool before coming in contact with these items.
- Remove power from the ASD during extended periods of non-use.
- The system should be inspected periodically for damaged or improperly functioning parts, cleanliness, and to ensure that the connectors are tightened securely.
- Ensure that the **Run** functions (**F**, **R**, **Preset Speed**, etc.) of the ASD are off before performing a **Reset**. The post-reset settings may allow the ASD to start unexpectedly.
- In the event of a power failure, the motor may restart after power is restored.
- **Retry** or **Reset** settings may allow the motor to start unexpectedly. Warnings to this effect should be clearly posted near the ASD and motor.

DO NOT install, operate, perform maintenance, or dispose of this equipment until you have read and understood all of the product warnings and user directions. Failure to do so may result in equipment damage, operator injury, or loss of life.

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INTRODUCTION

Thank you for purchasing the T300BMV2 Medium Voltage ASD. This adjustable frequency, solid-state AC drive features a 3ϕ input isolation transformer with a 24-pulse converter design, a 32-bit CPU, and a three-unit power module inverter section providing a 5 level output for 4160V drives. These drives also feature as standard, an 8 key Control Panel with a LCD screen and 2 discrete LED lamps to indicate Ready, Run, Local, Remote and Alarm/Fault.

On most power systems, this drive will meet IEEE-519-1992 harmonic regulation guidelines without installing additional harmonic filters. The input power factor is typically 0.95. The multi-level output produces a more sinusoidal voltage and reduces stress on the motor winding insulation. This drive uses high capacity 3300V IGBTs to improve reliability, reduce switching losses, and improve control performance. The PP7 control processor and 6-layer control board achieves high integration and reliability.

INITIAL COMMISSIONING

CAUTION

The drive should be commissioned by qualified personnel only. Below are some general steps required for commissioning.

Confirmation of Wiring

CAUTION

Make the following final checks before applying power to the unit:

1) Confirm that source power is connected to terminals L1, L2, L3 (R, S, T). **Connection of incoming source power to any other terminals will damage the drive. Other control voltages may be required. Consult your custom equipment diagrams shipped with the drive for any other requirements.**

2) Verify that the power modules are properly installed and that there was no damage during shipping or handling.

3) Verify that there are no loose connections or wires and that all of the required shipping split connections have been made.

4) Verify all external control circuit wiring is complete and properly connected.

5) The 3-phase source power should be within the correct voltage and frequency tolerances.

6) The motor leads must be connected to terminals T1, T2, T3 (U, V, W).

7) Make sure there are no short circuits or inadvertent grounds and tighten any loose connector terminal screws.

Start-Up and Test

CAUTION

Prior to releasing the drive system for regular operation after installation, the system must be adjusted and tested by qualified personnel. This assures correct operation, of the equipment, for reasons with reliability and safety performance. It is important to make arrangements for such a check and that sufficient time is allowed for it.

Cautions on Changing Setting Parameters

CAUTION

The setting data of the drive is saved in an EEPROM, non-volatile memory. When the micro controller initializes at power-up, it reads the EEPROM data and copies it to the RAM (Random Access Memory). From then on, the micro controller controls the drive using the values in the RAM.

When the setting parameters are changed, by the display-keypad or personal computer ("support tool"), only the execution parameters in RAM are changed. If they need to be stored, they must be manually written to the EEPROM. Without this operation, the next initialization or power up will cause them to be replaced by the old data.

When a write to the EEPROM is performed, write processing may take 30 seconds. Turning off the control power supply during write processing will make both the RAM and EEPROM data abnormal. When the power is turned on again, this abnormal data will result in an error ("CHECK ERROR") preventing the drive from running. If such an error occurs, the settings must be reloaded from a saved file. If no setting file exists, the drive must be re-commissioned.

Do not turn off the control power supply, under any circumstances, while writing data to the EEPROM.

INSPECTIONS AND MAINTENANCE

Maintenance and inspection is a particularly effective means to help prevent failures and reduce down time. Creating equipment specific inspection and maintenance check sheets can help in performing maintenance and inspection effectively. Detailed inspections and regular maintenance should be carried out, in short cycles initially, until a schedule, reflecting the site-specific conditions, can be determined.

For items that are too high to reach, use a step ladder to gain access. Do not attempt to climb on the equipment.

Daily Inspections

Daily inspections consist mainly of **visual** inspections on the following items. These observations should be made with all cubicle doors closed and safety covers installed. Any abnormalities discovered should immediately be repaired.

1) Check the temperature, the humidity, the presence of corrosive or explosive gases, and the presence of dust in the area.

2) Check for any abnormal sound or vibration originating from the reactor, transformer, or cooling fans.

3) Check for abnormal odors such as the smell of burning insulating materials.

Regular Inspections

Carry out regular inspections **with the power off, locked out, and with confirmation that the bus voltage is completely discharged.** Use proper power **lockout/tagout procedure** on the disconnecting means in accordance with applicable local electrical codes (in the U.S., see 2002 NEC Article 430-101) before performing any drive maintenance.

The first thing to do in maintenance and inspection is cleaning. Cleaning should be carried out according to the conditions of the equipment. Before starting cleaning, turn off the power supply and check that the main circuit voltage is reduced to 0. Clean dust with a vacuum, dry compressed air, and clean dry cloths. Note that excessive air pressure when blowing out equipment may damage parts and wiring. **Do not use solvents to clean the drive.** Substances stuck to the circuits, which cannot be removed by blowing, should be wiped away using a cloth. As a basic rule, cleaning should start from the upper parts and end at the lower parts. Cleaning of the lower parts last will allow proper removal of substances that could drop from the upper parts.

INSPECTIONS AND MAINTENANCE (cont'd)

CAUTION

Main Components

1) Cooling fan - Check to see if there is any abnormality with airflow, increased fan noise, etc.

2) Air filter - Visually check if the air filter is clogged. Gently tap it outside the room to remove loose dust. To remove caked on dirt use water and a gentle detergent, rinse it with clean water and dry it. Otherwise replace it with a new one. **Cleaning with solvents is not recommended.**

3) Main circuit parts and entire cubicle - Check to see if dust is stuck to the cubicle interior or if there is any discoloration, heat generation, abnormal sound, leakage, odor or damage with the reactor, transformer, contactors, cables and connections, fuses, capacitors, lightening arrestors, and resistors. Check to see that no wires or mounted parts are broken, disconnected, loose or damaged. High voltage standoffs, insulators, and cable can be cleaned with isopropyl alcohol.

4) Printed Wiring Boards - The boards, which are made up of ICs and electronic components, must be protected from dust, corrosive gases and extreme temperatures. Pay attention to the installation environment of the equipment. Regular inspections, the proper cleaning, and maintenance in an optimal environment is essential for circuit boards. Since most of the components and parts are small and vulnerable to external forces, when cleaning them, use a brush to carefully wipe off dust. Inspect the boards for signs of component damage, heating, and corrosion.

Cautions on Handling Printed Wiring Boards

a) All maintenance work on the board should be carried out at least 15 minutes after all power supplies are turned off to allow the capacitors on the boards to discharge.

b) When removing the board, disconnect all the connectors and wires and remove the mounting screws from the upper part of the board first. At this time, be careful not to drop the boards or screws. When setting the board down, place it on a static free surface. Be careful not to damage any components.

c) When attaching the board, do so in the order opposite to the removing procedure. Be sure that all of the connectors and wires are connected correctly.

d) New boards are shipped in an anti-static bag. Use this bag to store them.

Note that the anti-static coating is only on the inner side of the bag.

5) Check the protection functions for proper operation (Door switches, OH, E-stop...)

6) Check the insulation resistance of the medium voltage circuits.

INSPECTIONS AND MAINTENANCE (cont'd)

CAUTION

Recommended Parts to be Regularly Renewed

To use the drive for a maximum period of time, it is necessary to regularly renew (replace) components whose characteristics have deteriorated. The table below shows the parts used for the inverter equipment whose regular renewal is recommended for critical applications and their recommended renewal period. We always recommend that spares be on hand to reduce down time.

Product name		Recommended renewal period	Remarks
Cooling fan		7 years	Sooner if dust or dirt damages bearings
Air filter		6 months	Can also be cleaned.
Aluminum Electrolytic Capacitors On Circuit Boards		7 years	Contact Toshiba for replacement of these devices
Oil-filled capacitor Main circuit		20 years	
Control power supply		7 years	
Fuse	Main circuit	7 years	
	Control circuit	7 years	

Recommended Spare Parts

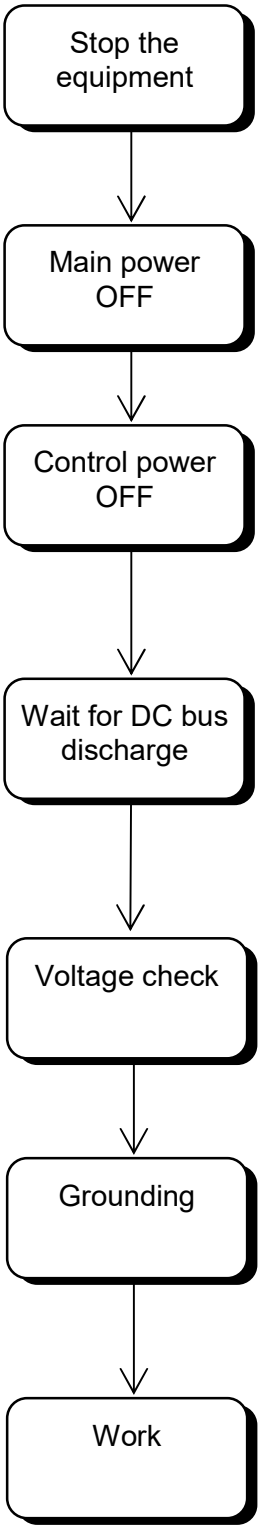
Spare parts are an important part of downtime reduction. When parts in the drive have failed, on-hand spare parts are necessary to shorten the mean time to repair (MTTR). Since replacement of discrete components is time consuming, it is recommended that entire assemblies be replaced. Recommended spare parts common to all drives are shown in the following tables. The recommended spare rate and minimum amount can serve as references for the minimum number of spare parts relative to the total number of drives on site. It is recommended that the quantity be determined in accordance with the number drives on site. Many other parts are job specific. It is up to the end user to determine what other parts may be needed.

Recommended Common Spare Parts **

Product name	Model/Rating		Number of parts per drive	Recommended spare parts	
			4160V/2300V	Spare rate	Recommended Min Q'ty
CTR	Control board	ARND-4044(*)	1 each	10%	1
GSD	Gate signal distribution board	PC61910P203A	1 each	10%	1
XIO	External input/output board	ARND-4045(*)	1 each	10%	1
EXIO	External input/output board	PC61910P205C	1 each	10%	1
IFBK	Current feedback board	PC61910P207*	1 each	10%	1
IPAD	Keypad interface board	PC61910P204A	1 each	10%	1
DISP	Display/keypad	PC61910P216	1 each	10%	1
PS1	Control power supply	GCI6722G282	1 each	10%	1
GDI	Earth fault detection	PC61910P135A	1 each	10%	1
PDM	Phase detection module	PC61910P107A	1 each	10%	1
Control Fuses	*	*	2 each	10%	2
Main Fuses	*	*	3 each	10%	3
Pt fuses	*	*	4 each	10%	4
Rectifier fuses	*	*	36/12	10%	3
Power modules***	*	*	3	10%	1
Cooling Fans	*	*	*	10%	1

* This data is job/inverter specific. Check the drawings for the specific inverter for this information.
** This is a general list of spares. Check the specific job drawings for other components that may need to be spared.
*** It is recommended that failed power modules be replaced as a unit and that the failed modules be returned to Toshiba for repair and testing.

Preparations for Inspection and Maintenance of Equipment (Powering-Off)



1) Stop the equipment and check that the motor has completely stopped.

2) Press the interlock switch on the operation panel (See Fig. 1 in the next section). The light on the switch should turn on.

3) **Turn off the external main power supply. Disconnect and lockout the main power.**

4) **Turn off and lock out** the control power supply.

5) **Turn off and lock out** any other job specific power feeding the drive.

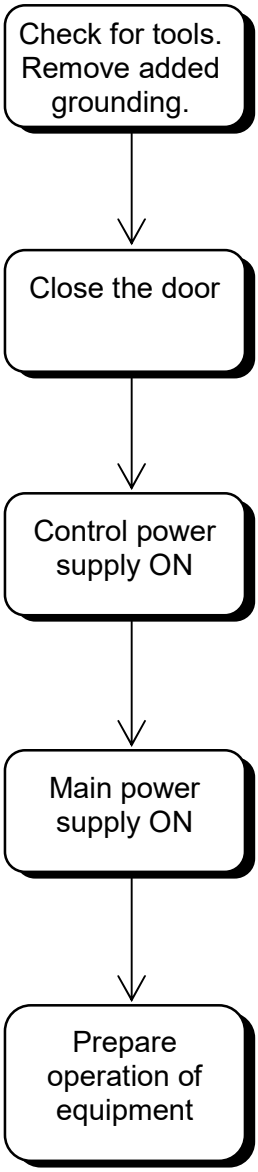
6) Wait for 15 minutes or more for the bus to discharge.

7) Verify that all power is removed by measuring the main, the DC bus, the control, and any other external source voltage levels with properly rated measuring equipment.
Note! A meter rated for the main circuit voltage is required to safely check the main circuit voltages.

8) Ground the 3-phase input power supply terminal at the main circuit input terminals.

9) Perform the necessary maintenance.

Recovery after Inspection and Maintenance of Equipment (Powering-On)



1) Check the drive to make sure no tools or other foreign objects were left in the drive.
2) **Remove any grounding devices** that may have been attached to the main circuit input terminal.

3) Replace any safety barriers or covers that were removed for maintenance. **Close and latch all doors.** Operation of the equipment cannot start when the door of the main circuit related cubicles is open.

4) Turn on the control power supply.
5) Turn on any other external power suppy sources.

6)Turn on the external main power supply.

7) After safety checks, prepare for the operation.
Press the interlock switch on the operation panel (See Fig. 1 in the next section).
(When the LED is turned off, the interlock is off. If the drive is ready, it will start if commanded).)

OVERVIEW

Display/Keypad (EOI)

The following figure shows the display/keypad of the equipment. Refer to the keypad operation manual for more details on its use.

EOI Diagram

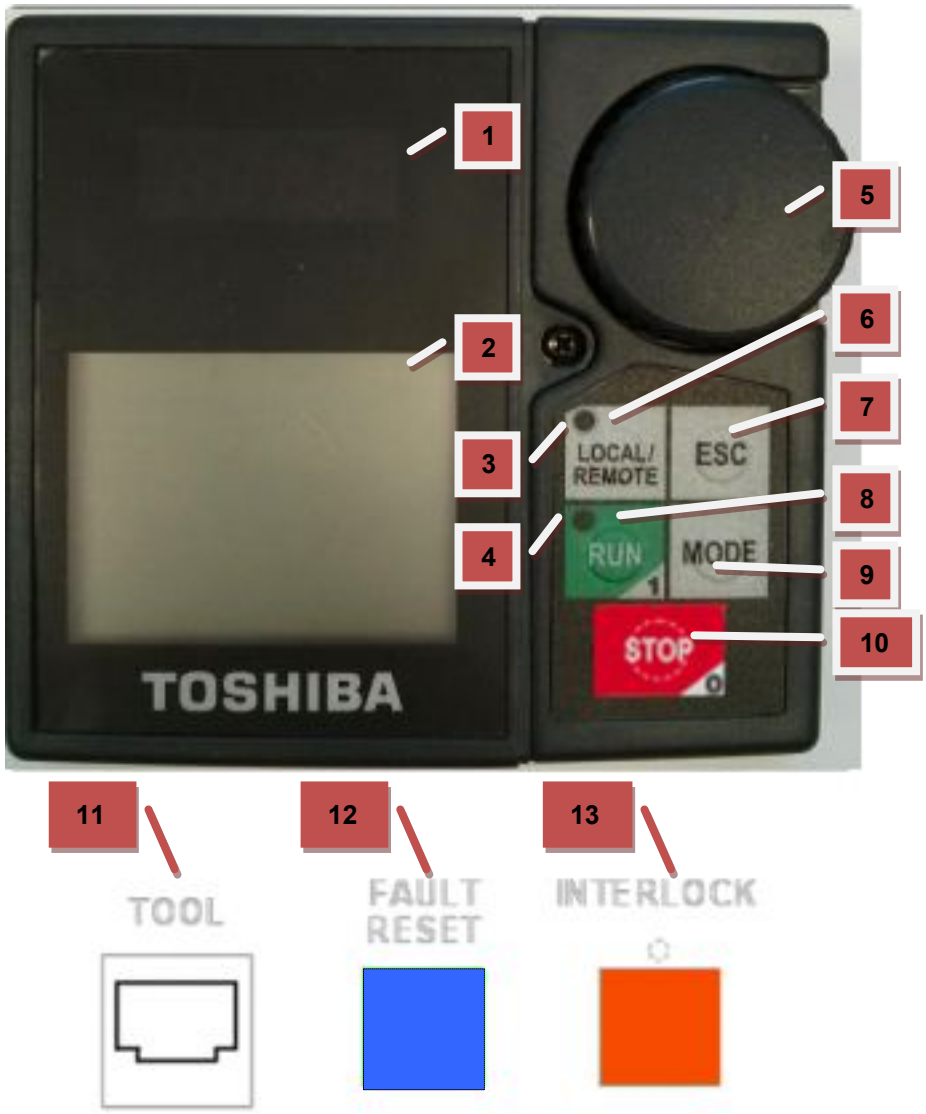


Figure 1.

1. 4 Digit 7 Segment Display – Brightly displays the frequency when connected to V/Hz, Vector and SM drive types. Displays feedback (%) when connected to a Static Var. Controller.
2. Graphical LCD – Displays user information in text and numerical form.
3. Green Local/Remote LED – The green LED is lit when in local mode and off during remote mode.
4. Green and Red Status LED's:
   - Not ready and not running – Both Red and Green off.
   - Ready and not running – Green LED only
   - Ready and running – Red LED only.
   - Fault – Fast blinking Red LED. (0.5Hz).
   - Alarm – Slow blinking red if running or green if not running. (1.5Hz).
   - Test mode – Alternating red and green regardless of condition. (0.5Hz).
5. Encoder – This is a multi-function device. If pushed, it will function as an Enter/select button*. If turned clockwise, it will scroll down a menu listing and increments a selected field's parameter data. If turned counter clockwise, it will scroll up a menu listing and decrement a selected field's parameter data. (*Enter action – Selects a menu item to be changed or accepts and writes the changed data of a selected field. This key, when in the Main tab and held for more than 2 seconds will toggle the direction of the motor. This function only works if the drive is not running.)
6. Local/Remote key – Toggles between Local and Remote mode's while in the Main screen and the drive is not running. To toggle modes the key must be held for at least 2 seconds.
7. Escape key – Multi function key. It returns to the previous level of the menu tree. It cycles through the tabs (see figure 2).
8. Run key – Will run the drive when in local mode. (Note: If the drive does not have a reference speed it will display forward direction even though it may be in reverse direction. When a reference speed is given it will display the correct direction.)
9. Mode key – This key will cycle through the tabs (see figure 2). This key will also initialize the selection of individual digits by position in conjunction with the encoder when changing the values of parameters.
10. Stop key – This key will stop the drive from running when in local mode and works from all screens. (Please refer to Section 4.1 to change the effect of the STOP key when in Local or Remote Mode.)
11. Commissioning Tool Port – Ethernet port used for communication to the commissioning and support tool. A cross over cable may be required to establish a direct connection to a PC.
12. RESET Pushbutton – This pushbutton is used to clear inverter faults and alarms displayed on the LCD.
13. INTERLOCK Pushbutton – This pushbutton is used to disable the inverter via a hard-wired circuit. The pushbutton is illuminated while the inverter is interlocked, and extinguished for normal operation. Operating the INTERLOCK pushbutton will result in an inverter gate block and free-run deceleration of the load.

How to Handle Faults

In the event of a fault, the following measures should be taken:

(1) Record the fault message shown on the display on the operation panel.
(2) Collect the trace back data, if the commissioning software package was purchased.
(3) See the Fault and Recovery section.

Description of Terminology

This section describes the special terms used in this manual.

Description of Terminology

Term	Meaning
Power module	A single-phase DC-fed inverter module using IGBTs.
IGD board	IGBT Gate Driver Board. Converts gate signals sent in optical signal form to electric signals.
OLB board	Optical Link Board. Converts gate signals from electric to optical signals for isolation.
VDET board	Voltage Detection Board. Board that measures analog voltage signals and converts them to optical signals.
GSD board	Gate Signal Distributor. Board that distributes gate signals to each output phase.
CTR board	Inverter main control board
TEX board	Twin Expansion Board. Distributes the gate signals to the power modules for twin drives.
EEPROM	Electrical Erasable Programmable Read Only Memory
IGBT	Insulated Gate Bipolar Transistor
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCCB	Molded Case Circuit Breaker
PP7	Power electronics Processor for Various Inverter control Integration (VII=7). Toshiba dedicated power electronics control 32-bit micro-controller.
PSM	Switching power supply that providing ±15 VDC and +5 VDC for boards.
RAM	Random Access Memory
Initialize	Act of initialization. When the control power switch is turned from OFF to ON the inverter equipment initializes data and circuits.
Interface	Means by which this equipment transfers signals to/from external devices.
Inverter	Inverse converter that converts DC power to AC power. (DC → AC conversion)
Overload	Operation at a current output that exceeds the continuos rating of the equipment.
Display-keypad	Operational panel installed on the cubicle surface that is used for data display and basic operations.
Load	Refers to a motor that receives power from this equipment.

General Specifications (Structure)

The general specifications (structure) of the equipment are shown in the following table.

General Specifications (Structure)

Item		Standard specification	Additional optional specification	Remarks
Applicable standard		UL, NEMA		
Ambient conditions	Temperature	0 to +40°C (Operation) -20 to +60°C (Storage)	+50°C operation with a derate.	
	Humidity	Max 95%, no condensation		At no time should the drive be subjected to conditions that would allow condensation to form on the components.
	Altitude	1000 m Max. above sea level	5000' (1524m) with a derate.	
	Installation location	Indoors		
	Vibration	10 to 60 Hz, 0.5 G or less		
	Corrosive factors	Hydrogen Sulfide (H_2S) ≦ 0.001 PPM		This is a list of corrosive agents know to attack the drive components. Other agents may also have adverse effects on the drive.
		Sulfur Dioxide (SO_2) ≦ 0.05 PPM		
		Chlorine gas (Cl_2) ≦ 0.1 PPM		
		Ammonia gas (NH_3) ≦ 0.1 PPM		
		Nitrogen Dioxide (NO_2) ≦ 0.02 PPM		
		Nitrogen Oxide (NOx) ≦ 0.02 PPM		
		Ozone (O_3) ≦ 0.002 PPM		
		Hydrochloric acid mist (HCl_1) ≦ 0.1 mg/m^3		
Paint color	Cubicle surface	ANSI 61 Gray	Consult factory for optional colors	
Cubicle structure		Front maintenance		
Cubicle protective structure		Type 1, Forced ventilated		
		With channel base		
Air filter		Front mounted		

Altitude and Temperature De-rating

Altitude Derate Chart

Altitude	% Amp Output Derate
3,300’	0.0%
4,000’	2.0%
4,500’	3.3%
5,000’	4.7%

Temperature Derate Chart

Ambient Temperature	% Amp Output Derate
40 °C	0.0%
45 °C	7.5%
50 °C	15.0%

Motor Cable Length

Below are cable length guidelines for use with most standard industrial motors.

Suggested Maximum Output Cable Distances

AC Motor Voltage	Drive Output Voltage	Max lead length without filter
2300	2400	0-1000 ft
2300/4000	2400	0-1000 ft
4000 or 2300/4000	4160	0-1000 ft
6600	6600	0-1000 ft

CAUTION

(1) Older motors, or motors with marginal insulation systems, may require filters to help reduce the stress on the insulation system. Consult Toshiba application engineering.

(2) Exceeding the peak voltage and allowable voltage rise time of the motor insulation system will reduce motor life expectancy. To insure good insulation life, consult with the motor supplier to determine motor insulation ratings and allowable maximum output lead distance. Long lead lengths between the motor and drive may require that filters be added to the drive output.

General Specifications (Electrical)

The general (electrical) specifications of the equipment are shown in the following table.

General (Electrical) Specifications

Item		Standard specification	Standard Optional Specification	Additional Optional Specification	Remarks
Frame Sizes		A4µ, A4, AS4, B4, BS4, & C4			See ratings table for specific kVA ratings available
Motor driven by this equipment		Squirrel-cage induction motor	Synchronous motor		
Main power supply	Input supply voltage and range of fluctuation	Rated Voltage ±10% Rated Frequency ±5%			
	Output voltage	0 ~ Rated Voltage			
Control power supply	Supply voltage frequency	Internally supplied 480 V, 60 Hz	Externally supplied 480V, 60 Hz		
Main circuit	PWM frequency	2048Hz			
	Regeneration system	None			
Input controller/disconnect	A4u, A4, & B4	External	Internal		
	AS4	External			
Others	Overload capacity	100% - continuous 110-115% - 60 sec (Depends upon frame size and drive rating)		125%,150%, 175%,200% 225%,250%	The higher OL ratings require a reduction in continuous capacity
	dV/dt filter	No	A4u, A4, & B4 only		
	Ground protection	Yes			
	Receptacle	No		Yes	
	Motor cooling fan control	No		Yes	
	Cabinet space heater	No		Yes	Space heaters must be externally powered.
	Cabinet internal light	No			
	Typical operating sound levels measured at a distance of 1m x 1.5m high	<80 dBA			

General Specifications (Control)

The general (control) specifications are shown in the following table.

General Control Specifications

Item		Standard specification	Option	Remarks
Maximum output frequency		75 Hz	120 Hz	
Speed sensor (PG pulse output)		No	Yes	
Basic control performance	Basic control system	Induction Motor Volts/Hertz	Induction Motor Sensor Type Vector Induction Motor Sensorless Vector	Sensor type vector control uses a 1x resolver or a PG. The maximum PG freq. is 100kHz.
	Operation control range	3%-100%	1%-100%	Limited by motor heating
	Field weakening control	1:1.5	1:5	Vector Control
	Speed accuracy	±0.5%	±0.01%	
	Speed resolution	1/25000 (Digital setting)	Analog setting 1/1000. Isolation transducer recommended.	
	Acceleration/deceleration time	0.1 – 3276.7 sec, acceleration/deceleration independent setting		Cannot regenerate.
Operation specification	Restart after instantaneous interruption	Possible (more than 5 cycles interruption causes shut down)	Under-voltage trip at 75% level	
Communications	Serial interface	None	MODBUS DEVICE_NET PROFIBUS TL-S20	Requires optional board.
	Commissioning/Maintenance Tool	Ethernet (with modular jack attached to keypad)		
Cubicle display/ operation	LED 1 lamp	READY: Operation preparation completed(Green) RUN: Inverter in operation(Red) ALARM/FAULT: Alarm slow flashing/Fault fast flashing	READY and RUN light colors can be reversed by changing an EOI parameter	
	LED 2 lamp	ON - Keypad control OFF - Other than keypad control		
	LCD display	128x64 Pixel Graphical LCD display		
	Operation apparatus	Backlit type interlock switch: 1 Unlit reset switch: 1 Operation via 8 key keypad and a 15pulse/30detent incremental encoder		
	Connector	Personal computer connection Ethernet modular jack		

General Control Specifications Continued:

General Control Specifications

Item	Standard specification	Option	Remarks
Analog signal output	±10VDC x 1 Channel on XIO brd.		Connected measuring equipment must be isolated from ground
Analog signal input	T300BMV2: ±10VDC x 1 channel on XIO brd.		Connected source equipment must be isolated from ground
Digital input	T300BMV2: 4 Programmable on XIO brd. Photo coupler 50mA 5-24Vdc 2 Fixed(UVS1 & UVS2) on XIO brd. Photo coupler 50mA 5-24Vdc		Fixed contact is always used for interlocking control function
Digital output	T300BMV2: 4 Programmable on XIO brd. Photo coupler 50mA 5-24Vdc		24V contact always used for internal control functions
Commissioning and Maintenance Tool	TIC MVD Tool	Parameter setting, fault data display, etc.	Optional Software Package

Rating Specifications

NEMA Type 1 Standard Ratings Table (T300BMV2)

Standard Model	Input Voltage	Motor Hp	Output kW	Output KVA	Output Current 100%	Overload Current 110~115%-60 s.	Frame	Output Voltage & Frequency
MB4AAN44030 AAA0	4160V	300	233	268	37	43	A4µ	0~4160 V
MB4AAN44035 AAA0		350	272	313	43	50	A4µ	0~75 Hz
MB4AAN44040 AAA0		400	311	357	50	57	A4µ	
MB4AAN44045 AAA0		450	350	402	56	64	A4µ	
MB4AAN44050 AAA0		500	389	447	62	71	A4µ	
MB4AAN44060 AAA0		600	466	536	74	86	A4µ	
MB4AAN44070 AAA0	4160V	700	544	625	87	100	A4	
MB4AAN44080 AAA0		800	622	715	99	114	A4	
MB4AAN44090 AAA0		900	699	804	112	128	A4	
MB4AAN44100 AAA0		1000	777	893	124	136	A4	
MB4ASAN44070 AAA0	4160V	700	544	625	87	100	AS4	
MB4ASAN44080 AAA0		800	622	715	99	114	AS4	
MB4ASAN44090 AAA0		900	699	804	112	128	AS4	
MB4ASAN44100 AAA0		1000	777	893	124	136	AS4	
MB4BAN44100 AAA0	4160V	1000	777	893	124	143	B4	
MB4BAN44125 AAA0		1250	971	1116	155	178	B4	
MB4BAN44150 AAA0		1500	1166	1340	186	214	B4	
MB4BAN44175 AAA0		1750	1360	1563	217	249	B4	
MB4BAN44200 AAA0		2000	1554	1786	248	273	B4	
MB4BSAN44100 AAA0	4160V	1000	777	893	124	143	BS4	
MB4BSAN44125 AAA0		1250	971	1116	155	178	BS4	
MB4BSAN44150 AAA0		1500	1166	1340	186	214	BS4	
MB4BSAN44175 AAA0		1750	1360	1563	217	249	BS4	
MB4BSAN44200 AAA0		2000	1554	1786	248	273	BS4	
MB4CAN44225 AAA0	4160V	2250	1748	2010	279	321	C4	
MB4CAN44250 AAA0		2500	1943	2233	310	356	C4	
MB4CAN44300 AAA0		3000	2331	2680	372	409	C4	

Specifications subject to change without notice. Inverter performance data is based on a typical 4 pole motor operating at 0.87 pf and 0.96 efficiency.

Protective Functions

The main protective functions are shown in the following table. For other faults or more details, refer to the troubleshooting and EOI manuals.

Protective Function Table

Item	Abbreviation	Hardware Detection	Software Detection	Heavy Fault		Medium Fault	Light Fault	Start Interlock
				Coast to stop	Decel stop	Stop request	Alarm	
Input main switch open	AC_MCCB		O	O				
No load connected	NO_LOAD		O	O				
Output main switch open timer	ACSW_T		O					O
Brake healthy	B_HLTY		O	O				
External trip from input breaker	BLA		O	O				
Electromagnetic brake energizing circuit fault	BR_F		O		O			
Equipment ventilation fan stop	C_FN		O			O	O	
Equipment ventilation fan stop timer	C_FN_T		O	O				
Current limit timer	CL_T		O	O				
Current limit alarm	CL_TA		O			O		
Control power supply loss	CPSF		O	O*				
P15 or N15 volts Power Supply Fault	PN15_F		O	O*				
Control Power from UPS Loss	UPS_ERR		O	O*				
CPU error	CPU_A or M	O		O*				
GSD brd. clock fault	GSD_CLK_DWN	O		O*				
GSD brd. voltage supply/programmable device error	GSD_ERR	O		O*				
U or V or W phase feedback error	CURU or V or W		O	O*				
Current Unbalance Between A and B Bank	CUR_DIFF						O	
Undercurrent Alarm	UL_A		O				O	
Undercurrent Time Delayed Fault	UL_T		O	O*				
Door open	DS_T		O	O*				
Rectifier fuse fault	FUSE_xP FUSE_xN		O	O*				
Ground fault alarm	GR_A_		O			O	O	
Ground fault trip	GR_T_		O	O				
External interlock	IL		O	O				
Motor cooling fan stop timer	M_FN_T		O		O			
Motor cooling fan stop	M_FN		O			O	O	O
Motor overheat	M_OH		O	O		O	O	
Motor overheat alarm	M_OH_A		O			O	O	
Main power supply loss	MPSF		O	O*				
Motor temperature sensor error	MTMP_S		O			O	O	
AC over-current	OCA, OCA_B, OCA_CNV		O	O*				
Power Module IGBT over-current	OCD_xA1 OCD_xA4 OCD_xB1 OCD_xB4	O		O*				
Power Module overheat	OH_T_x		O	O*				
Input Rectifier Overheat	OH_REC		O	O*				
Transformer over heat	OH_TR		O	O*				
AC Link Reactor Overheat	OH_ACL_T		O	O*				

Item	Abbreviation	Hardware Detection	Software Detection	Heavy Fault		Medium Fault	Light Fault	Start Interlock
				Coast to stop	Decel stop	Stop request	Alarm	
Overload alarm	OL_A,OL_A_B					O	O	
Overload (5 minutes)	OL5, OL5_B		O	O				
Overload (20 minutes)	OL20, OL20_B		O	O				
Over speed	OSS		O	O*				
Output frequency high	OSS_F0		O	O*				
DC bus over-voltage positive/negative	OV_xP OV_xN		O	O*				
Panel safety switch	P_SW	O		O				
Emergency Stop by Keypad	DSP_ESTP	O		O				
Parameter setting error	PARA_ERR		O	O				
PLL phase error	PHASE_ERR		O	O				
PLD error	PLD_ERR		O	O*				
Pre-charge CTT trip	PRE_CTT		O	O				
Pre-charge CTT alarm	PRE_CTT_F					O	O	O
DC Bus Charging Failure	REC_F		O	O				
Rectifier failure	FUSE		O	O*				
Reverse rotation failure	REV_ROT_F		O	O*				
Rotation/start failure	ROT_F		O	O*				
Soft stall	SOFT_STL						O	
Analog Input Fault	AIN_FAULT		O	O*			O	
Speed feedback error	SP_ERR		O	O*				
Speed feedback error2	SP_ERR2		O	O*				
Speed reference lost	SP_LOST		O	O	O			
Speed reference lost alarm	SP_LST_A					O	O	O
Motor turning start interlock	SP_SIL							O
Spare input 1-4	SPA1-4		O	O*	O	O		
Spare input 1-4 timer	SPA1-4_T		O	O*	O	O		
System configuration error	SYS_ERR		O		O			
Communication error 1-4	TL_F1-4		O	O	O			
Main under-voltage	UV_MPSF		O	O				
AC main voltage drop	UVA_SIL							
DC under-voltage start interlock	UV_SIL		O	O				O
DC under-voltage trip	UVD, UVD_B		O	O				
External equipment electrical ready condition	UVA_EX		O	O				
External safety switch	UVS	O		O				
Input voltage phase loss	VAC_PH_LOSS		O	O				
Input Voltage Phase Rotation Error	VAC_ROT_F		O	O				
Converter Input Phase Lost	VCNV_PH_LOSS_		O	O				
Output current phase loss	VINV_PH_LOSS		O	O				
Inverter output voltage PLL error	VPLL_ERR_		O	O				
Stator Over Voltage	OV_S		O	O*				
Field Current Limit Timer	FCL_T		O	O*				
Field Current Limit Timer Alarm	FCL_TA_		O			O		
Exciter Failure (Exciter Detection)	FL_FAULT_		O	O*				
Instantaneous Field Overcurrent (Exciter Detection)	FOC		O	O*				
Instantaneous Field Overcurrent	FOC_S		O	O*				
Exciter Stopped while Running	FSTOP		O	O*				
Field Current Lost	LF		O	O*				
Limit Fault Reset	LMT_FRST		O	O*				

(Note 1) Hardware Detection: Items for which all IGBTs are directly turned off by hardware. Software Detection: Items for which the protective interlock operation is performed by detecting errors, via software.

(Note 2) "O" marks in the interlock operation fields can be selected by parameter setting.
"*" indicates that the equipment outputs the trip signal to the input main circuit breaker.
“x” indicates the phase (U,V,W).

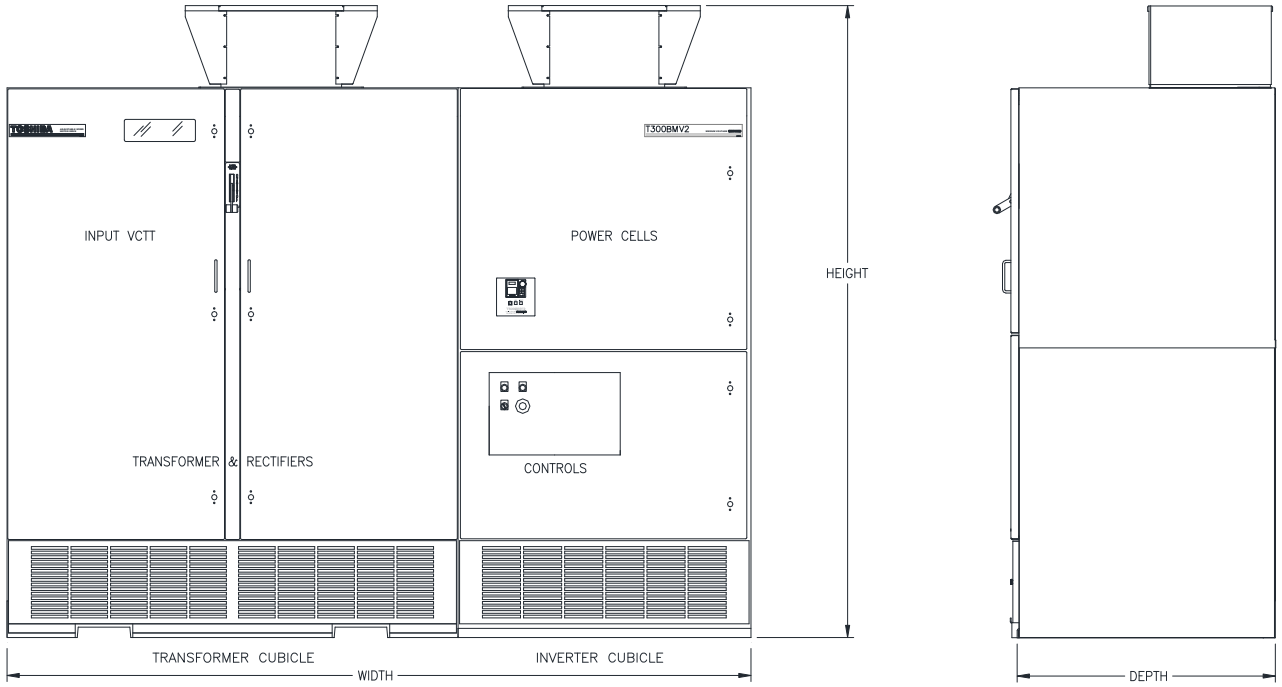
General Cubicle Structure

The configuration and dimensions of the equipment are described below.

Cubicle Structure and Dimensions

The equipment is made up of one or more cabinets containing the transformer, incoming terminals, converter section, and the inverter section. All components can all be accessed from the front.

This outline is for the standard Frame 1 model. For details of this and other ratings, see the outline drawing of each product.



Dimensional Outline of 4160V- (See the following page for dimensions)

General structure

1) All cubicles have a structure that allows maintenance from the front. Rear maintenance access is not required. The cubicles may be placed within 1" of the rear wall.

2) Provide a maintenance space of at least 72 inches (1829 mm) in front of the cubicles.

3) Provide a clearance of at least 24 inches (610 mm) above the exhaust fans.

4) The following are not included in the dimensions on the next page:
   a) Handle projections
   b) Door mounted device projections
   c) Fastener projections

Dimensions and Weights of Equipment

Dimensions of the complete drive, including the power modules

Standard Model Number	Dimensions – inches (mm)				
	H	W Conv Sect	W Inv Sect	W total	D
MB4AAN44030-60AAA0	103.7 (2634)	48 (1219)	*	48 (1219)	48 (1219)
MB4AAN44070-100AAA0	103.7 (2634)	60 (1524)	*	60 (1524)	48 (1219)
MB4ASAN44070-100AAA0	103.7 (2634)	55 (1397)	*	55 (1397)	48 (1219)
MB4BAN44100-200AAA0	103.7 (2634)	90 (2286)	*	90 (2286)	48 (1219)
MB4BSAN44100-200AAA0	103.7 (2634)	84 (2134)	*	84 (2134)	48 (1219)
MB4CAN44225-300AAA0	103.7 (2634)	80 (2032)	74 (1880)	154 (3912)	49.5 (1257)

Weights of the complete drive, including the power modules

Standard Model Number	Weight Conv** lbs (kg)	Weight Inv** lbs (kg)	Weight Output lbs (kg)
MB4AAN44030-60AAA0	5500 (2500)	*	N/A
MB4AAN44070-100AAA0	7300 (3318)	*	N/A
MB4ASAN44070-100AAA0	6700 (3318)	*	N/A
MB4BAN44100-200AAA0	11200 (5091)	*	N/A
MB4BSAN44100-200AAA0	11200 (5091)	*	N/A
MB4CAN44225-300AAA0	12800 (5818)	4500 (2041)	N/A

"*" Inverter and converter sections combined into one cubicle.
"**" Maximum weight for the frame size with the standard transformer and no options. Consult the factory for weights for non-standard inverters, as they are job specific.

Dimensions and weights of the inverter power modules

Drive Model Number	Module Voltage Class	Module Dimensions – inches (mm)			Weight lbs (kg)
		Width	Depth	Height	
MB4AAN44030-60AAA0	4160	7.1 (181)	31.8 (808)	24.1 (613)	120 (55)
MB4AAN44070-100AAA0	4160	9.6 (244)	27.0 (686)	24.2 (615)	140 (64)
MB4ASAN44070-100AAA0	4160	9.6 (244)	27.0 (686)	24.2 (615)	140 (64)
MB4BAN44100-200AAA0	4160	11.6 (295)	30.2 (767)	31.6 (803)	260 (118)
MB4BSAN44100-200AAA0	4160	11.6 (295)	30.2 (767)	31.6 (803)	260 (118)
MB4CAN44225-300AAA0	4160	16.7 (424)	35.4 (899)	38.6 (980)	400 (181)

INTERFACE

The interface between the drive system and external devices is divided into two categories: power supply system and control system.

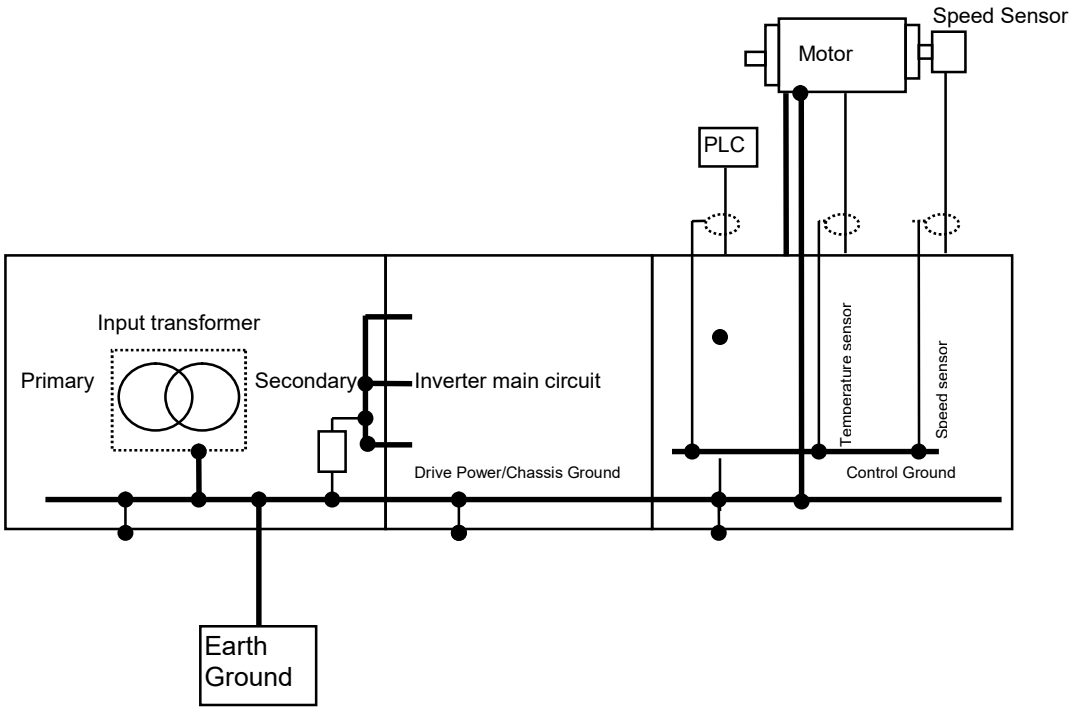
Power Supply Interface and Ground

The standard power supplies required are the main circuit input of 2400/4160V 3Φ and (optional) control power supplies of 120V 1Φ and AC480V 3Φ.

The following figure shows a recommended grounding circuit for the related equipment. Grounding is intended not only for safety but also to reduce noise problems. The control ground bus is mounted on insulated standoffs. It may be separated from the power ground and run separately to the earth ground with insulated cable if noise problems are encountered with auxiliary control devices.

Grounding must follow local and national codes by attaching a properly sized ground conductor to the drive equipment.

Recommended Ground Circuit



Grounding

INTERFACE (cont'd)

Motor Interface

If armored and shielded cables are to be used, be sure to connect the shield drain or armor to the ground bus provided in the drive equipment near the output terminals (U, V, W). It is not recommended that both ends be grounded. Ensure that the motor is connected properly at the junction box and properly insulated to protect against accidental shorting or grounding.

Speed Sensor Interface (Option)

In addition to open loop control, it is also possible to use a speed sensor to perform high precision speed control. Speed sensor selection explained below

Resolver

The drive is capable of accepting both 1x and 4x resolver feedback. The excitation can be either 1 or 4kHz. For resolver feedback, the following parameters need to be set:

CS_RES_TYPE=1or4 (Set to match the resolver)
CS_PG_OUT= Set to desired PG output count. (Minimum setting for resolver use is 64)
(See parameter manual for exact settings)
CS_PG_CNT=64
FLG_RES_EX4= 0 for 1kHz, 1 for 4kHz

PG (Pulse Generator)

This drive can read single ended or differential PG signals. The maximum frequency that the PG input can read is 10kHz for single ended and 100kHz for differential. The PG should be selected so that these limits are never exceeded. It is recommended that a 10% margin be allowed for overspeed. The following is an example of how to select your PG.

PG pulse count (PPR) = (maximum frequencyx0.9)/ (application top motor speed (min^{-1}) / 60)

<Example> When 100% speed is 1800 min^{-1}
Max PG pulse count = (10000x0.9)/(1800/60) = 300 PPR
Therefore, PG of 300 PPR or less is used.

The following settings should be used:
CS_RES_TYPE=1
CS_PG_OUT=0
CS_PGCNT = 256 (Set to the PPR of the PG.)

There are three PLG types, a differential type, a single-end totem pole type, and a single-end open collector type. The connections to the PLG, the jumper setting of XIO brd., and the parameter settings for each PLG are different.

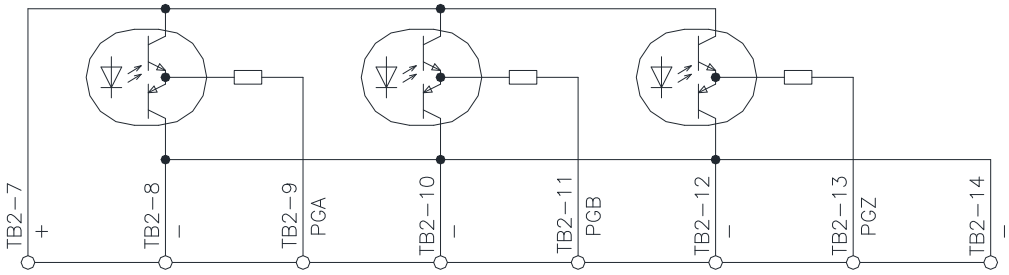
INTERFACE (cont'd)

Pulse Signal Output

If a speed sensor is used, speed feedback signals can be output as pulse signals. The PG pulse output circuit is shown in the following figure. The power supply for the pulses should be supplied from an outside source in a range of 12 V to 24 V. The max loading allowed is 25mA. The number of pulses per revolution output can be set using the parameter CS_PGOUT when a resolver is used. See the parameter setting manual for exact settings. Otherwise, set to zero when using a PG. With a PG, the number of pulses out equals the number of pulses in.

The PG pulse output consists of two phases of PGA and PGB at 90° separation and PGZ when a PG with a marker pulse is used. These pulse signals, at the level of the power supplied from an outside source, are isolated from the control power supply of the drive, through photo-couplers.

Pulse Output Circuit



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Digital Input

A total of 4 programmable digital inputs (DI1 to DI4) are provided. DI1-2 are capable of accepting an external voltage input (24VDC). DI3-4 are internally connected to the drive's internal 24VDC power supply and should only be connected to dry contacts. These input signals can be individually assigned to bits in the DI_EX1~7 and DIEX9~11 words. The available input assignments are shown below. For more detail refer to the parameter setting manual.

Digital Input Options

BIT	DI_EX1	DI_EX2	DI_EX3	DI_EX4	DI_EX5
F	IL_	N.U.	QSTOP	N.U.	JOG3
E	UVS	N.U.	UVS	SPA0	JOG2
D	EXT0	N.U.	EXT0	FLD	JOG1
C	SPA1	SPA4	CM_BUF1	B	JOG0
B	BRTST	SPA3	CM_BUF2	SC_PPI	EX_LMT_I1
A	ST	SPA2	ST	2S	EX_LMT_TR
9	F	BLA_	F	3S	SP_UP
8	R	M_FN_	R	R_TEN	SP_DN
7	3S	OH_ACL_EX_	3S	ST	SEL_DI
6	2S	E_DRIVE	2S	LB	DIR0
5	B	HOLD	N.U.	N.U.	DIR1
4	FLD	QSTOP	FLD	BC_	START0
3	BC_	F_LMT_	LATCH_PG_POS	N.U.	START1
2	SPA0	R_LMT_	SPA0	UVS	STOP0
1	EXRST	B_HLTY	EXRST	EXT0	STOP1
0	R_TEN	BA	R_TEN	EXRST	EXT1

BIT	DI_EX6	DI_EX7	DI_EX9	DI_EX10	DI_EX11
F	N.U.	N.U.	MP_BE_TM_H1_	MP_BR01_CL	MP_OL_TM_A_
E	N.U.	N.U.	MP_BE_TM_H2_	MP_BR02_CL	MP_OL_TM_TR_
D	PR_ST	N.U.	MP_BE_TM_H3_	MP_BR03_CL	MP_WD_TM_A_
C	RATE_CHG	F	MP_CF1_MR	MP_BR04_CL	MP_WD_TM_TR_
B	FL_FOC	R	MP_CF2_MR	MP_BR05_CL	MP_OL_LVL_A_
A	FL_READY	N.U.	MP_CF1_MCC_F_	MP_BR06_CL	MP_OL_LVL_TR_
9	FL_RNTD	R_TEN	MP_CF2_MCC_F_	MP_BR07_CL	MP_PRD_A_
8	FL_FAULT	N.U.	MP_CWF_L1_	MP_BR08_CL	MP_PRD_TR_
7	CHG_2S	EXRST	MP_CW_TM_H1_	MP_BR09_CL	MP_BH_RL_A_
6	SEL_MRH	3S	MP_OLU_LFD_	MP_BR10_CL	MP_BH_RL_TR_
5	ASD	2S	MP_OLU_HFD_	MP_WLK1_	MP_GP_RL_TR_
4	IM_NUM_B1	B	MP_OLU_HPL_N	MP_CF_IL_	N.U.
3	IM_NUM_B0	EXT0	MP_OLU_LPL_N	MP_SPH_IL_	N.U.
2	XFR_CHK	QSTOP	MP_SPH_ON	MP_OL_P_IL_	N.U.
1	CPT	IL	MP_SPH_MCC_F_	N.U.	N.U.
0	XFR	UVS	MP_SW_TM_H_	N.U.	N.U.

INTERFACE (cont'd)

Digital Input Descriptions **

Name	Description	
2S	2-speed reference command	1: 2-speed reference command
3S	3-speed reference command	1: 3-speed reference command
ASD	Variable speed drive operation command	
B	Brake command	1: Brake release command
BA	Brake answer	
BC_	Brake close command	0: Brake close
BLA_	AC Circuit breaker	
BRTST	Brake test	1: Brake release (open)
B_HLTY	Brake normal (healthy)	
CHG_2S	E2P bank selection	
CM_BUF1	Command buffer bit 1	
CM_BUF2	Command buffer bit 2	
CPT	Capture command	
DIR0	Motor rotation direction command (Local)	0: Forward; 1: Reverse
DIR1	Motor rotation direction command (Remote)	0: Forward; 1: Reverse
E_DRIVE	Emergency hard I/O operation	For external signal input
EXT	Startup command	1: Startup command
EXT1	Startup command (Remote)	1: Startup command (SEL=1)
EXRST	External reset	1: Reset request
EX_LMT_I1	Motor primary current limit selection	0: Internal; 1: External
EX_LMT_TR	Torque limit selection	0: Internal; 1: External
F	Forward jog run command	1: Forward inching command
F_LMT_	Forward limit	
FL_FAULT	Field critical fault	
FL_FOC	Field over current	
FL_READY	Field ready	
FL_RNTD	Filed running	1: Field exciter RUN I/F used
FLD	Field excitation command	1: Field excitation command
HOLD	Emergency speed hold	
IL	External interlock	0: Operation permitted
IL_	External interlock	1: Operation permitted
		Off while running; causes a deceleration stop.
IM_NUM_B0	Motor unit count switch bit 0	
IM_NUM_B1	Motor unit count switch bit 1	

INTERFACE (cont'd)

Digital Input Descriptions **

Name	Description	
JOG0	Jog speed reference selection bit 0	
JOG1	Jog speed reference selection bit 1	
JOG2	Jog speed reference selection bit 2	
JOG3	Jog speed reference selection bit 3	
LATCH_PG_POS	PG counter latch command	Latch at rising and falling edges of this signal.
LB	Load balance between stands	Load balance control when 1
M_FN_	Motor fan stopped	
MP_BE_TM_H1_	BearingTempHigh1	0:Tmperature High
MP_BE_TM_H2_	BearingTempHigh2	0:Temperature High
MP_BE_TM_H3_	BearingTempHigh3	0:Temperature High
MP_BH_RL_A_	BuchholzRelayAlarm	0:Alarm
MP_BH_RL_TR_	BuchholzRelayTrip	0:Trip
MP_BR01_CL	MotorBreaker01Closed	1:Closed
MP_BR02_CL	MotorBreaker02Closed	1:Closed
MP_BR03_CL	MotorBreaker03Closed	1:Closed
MP_BR04_CL	MotorBreaker04Closed	1:Closed
MP_BR05_CL	MotorBreaker05Closed	1:Closed
MP_BR06_CL	MotorBreaker06Closed	1:Closed
MP_BR07_CL	MotorBreaker07Closed	1:Closed
MP_BR08_CL	MotorBreaker08Closed	1:Closed
MP_BR09_CL	MotorBreaker09Closed	1:Closed
MP_BR10_CL	MotorBreaker10Closed	1:Closed
MP_CF_IL_	CoolingFan I/L SW	0:Interlocked
MP_CF1_MCC_F_	CoolingFan1MCC Fault	0:Fault
MP_CF1_MR	CoolingFan1MotorRun	1:Running
MP_CF2_MCC_F_	CoolingFan2MCC Fault	0:Fault
MP_CF2_MR	CoolingFan2MotorRun	1:Running
MP_CW_TM_H1_	CoolingWaterTempHi1	0:Temperature High
MP_CWF_L1_	CoolingWaterFlowLow1	0:Flow Low
MP_GP_RL_TR_	SuddenGasPressRyTrip	0:Trip
MP_OL_LVL_A_	OilLevelAlarm	0:Alarm
MP_OL_LVL_TR_	OilLevelTrip	0:Trip
MP_OL_P_IL_	OilLubPump I/L SW	0:Interlocked
MP_OL_TM_A_	OilTemperatureAlarm	0:Alarm
MP_OL_TM_TR_	OilTemperatureTrip	0:Trip
MP_OLU_HFD_	OilLubricationUniHFD	0:Fault
MP_OLU_HPL_N	OilLubUHiPressLineN	1:Normal
MP_OLU_LFD_	OilLubricationUniLFD	0:Alarm

INTERFACE (cont'd)

Digital Input Descriptions **

Name	Description	
MP_OLU_LPL_N	OilLubULowPressLineN	1:Normal
MP_PRD_A_	PressReliefDevAlarm	0:Alarm
MP_PRD_TR_	PressReliefDevTrip	0:Trip
MP_SPH_IL_	SpaceHeater I/L SW	0:Interlocked
MP_SPH_MCC_F_	SpaceHeaterMCC Fault	0:Fault
MP_SPH_ON	SpaceHeater On	1:On
MP_SW_TM_H_	StatorWindTempHigh	0:Temperature High
MP_WD_TM_A_	WindingTempAlarm	0:Alarm
MP_WD_TM_TR_	WindingTempTrip	0:Trip
MP_WLK1_	WaterLeakage1	0:Leakage
N.U.	Not used	
OH_ACL_	ACL overheating	
PLC	PLC Control	1:PLC Control (Always set to 1)
PR_ST	PID control start	
QSTOP	Emergency stop	1: Emergency stop command
R	Reverse jog run command	1: Reverse inching command
R_LMT_	Reverse limit	
R_TEN	Reverse rotation command	1: Reverse winding, 0: Forward winding (Torque direction when torque is controlled)
RATE_CHG	Optional rate selection	
SC_PPI	Speed control P/PI switching	P control when 1, PI control when 0
SEL_DI	Operation (Local/Remote) system selection	0: Local 1: Remote
SEL_MRH	MRH Enable	
SPA0	Spare 0	
SPA1	Spare 1	
SPA2	Spare 2	
SPA3	Spare 3	
SPA4	Spare 4	
SP_DN	Speed down	Slow down while on
SP_UP	Speed up	Speed up while on
ST	Torque control selection	1: Tension control, 0: speed control
START0	Start button (Local)	One shot to start (SEL=0)
START1	Start button (Remote)	One shot to start (SEL=1)
STOP0	Stop button (Local)	One shot to stop (SEL=0)
STOP1	Stop button (Remote)	One shot to stop (SEL=1)
UVS	External safety switch	Operation enabled when 1

"**" The function of many operation signals can be reversed via sign bit settings if needed.

INTERFACE (cont'd)

Digital Output

There are 4 programmable digital outputs (DO1-4). They are photo-coupler outputs and must be used with 24Vdc. DO1-3 may be connected to an external 24V supply if desired. DO4 is connected the drive internal 24V supply. These can be programmed to any bit in any word in the drive. The most commonly used bits can be found in the SSEQ_OUT1-4 words. The word assignment is made via DO1_AS – DO4_AS parameters.

Analog Input

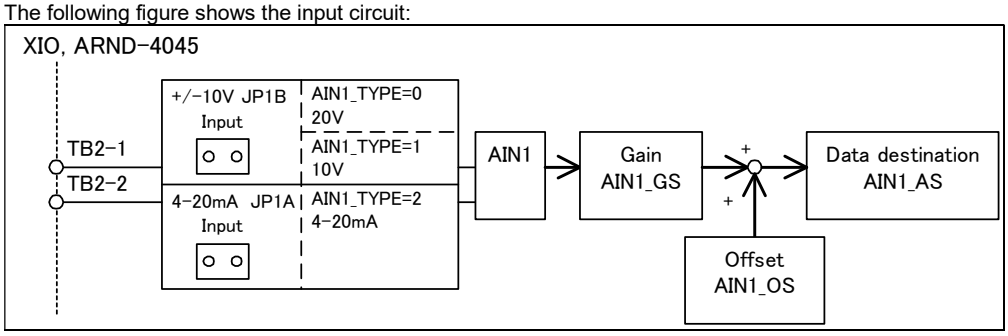
The drive has one general-purpose analog inputs (AIN1). They can be configured to any variable in the drive through assignment of AIN1_AS.

As a general-purpose analog input, the standard I/O circuit brd. (XIO) has one general-purpose analog input (AIN1). AIN1 has an option for current input thru an internal resistor.

The analog input signal is converted to the digital value through a 12-bit A/D converter. A ±10 Vdc input is converted to counts by software and is stored in the target data register. Since this signal is directly connected to the control circuit, it is recommended that an isolation transducer be used. The data register, the gain, and the offset are set with the following parameters:

AIN1_AS	Target register – set by symbol name
AIN1_GS	Gain setting – defines the number of counts for 10V input
AIN1_OS	Offset setting – offsets the input

The following figure shows the input circuit:



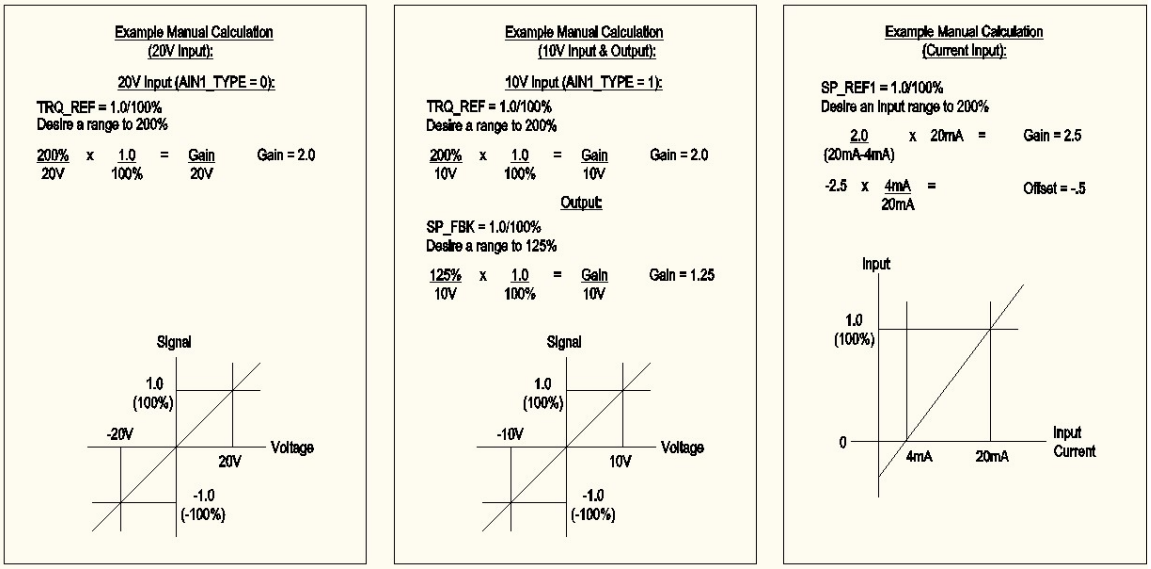
Analog Input Circuit

INTERFACE (cont'd)

[Setting examples]

Example 1: Analog speed reference is input to AIN1.

Set 0 to 100% (0 to 1.0) speed reference signal at 0 to +10 V so that it is stored in SP_REF1.
Use a personal computer with the maintenance tool installed for setting the parameters.
The input characteristic is shown in the following figure.
AIN1_TYPE = 1
AIN1_OS = 0
AIN1_AS = SP_REF_AIN1
AIN1_GS = (1.0 / 10 V) x 10 V
= 1.0



Input Characteristic Example

Example 2 When a 4~20 mA (0 to 100%) speed reference is input to AIN1, it is recommended that a 4-20 mA / 0-10 VDC transducer be used. If the source is isolated, an internal 510 Ohm burden resistor may also be used via a jumper on the brd.. This would give 2VDC at 4mA. In this case, an offset would need to be set in the drive as follows:

AIN1_GS = 2 / (20mA - 4mA) x 20mA = 2.5
AIN1_OS = -2.5 x 4mA / 20mA = -0.5
AIN1_AS = SP_REF_AIN1
AIN1_TYPE = 1

Analog Output

General-purpose Analog Output

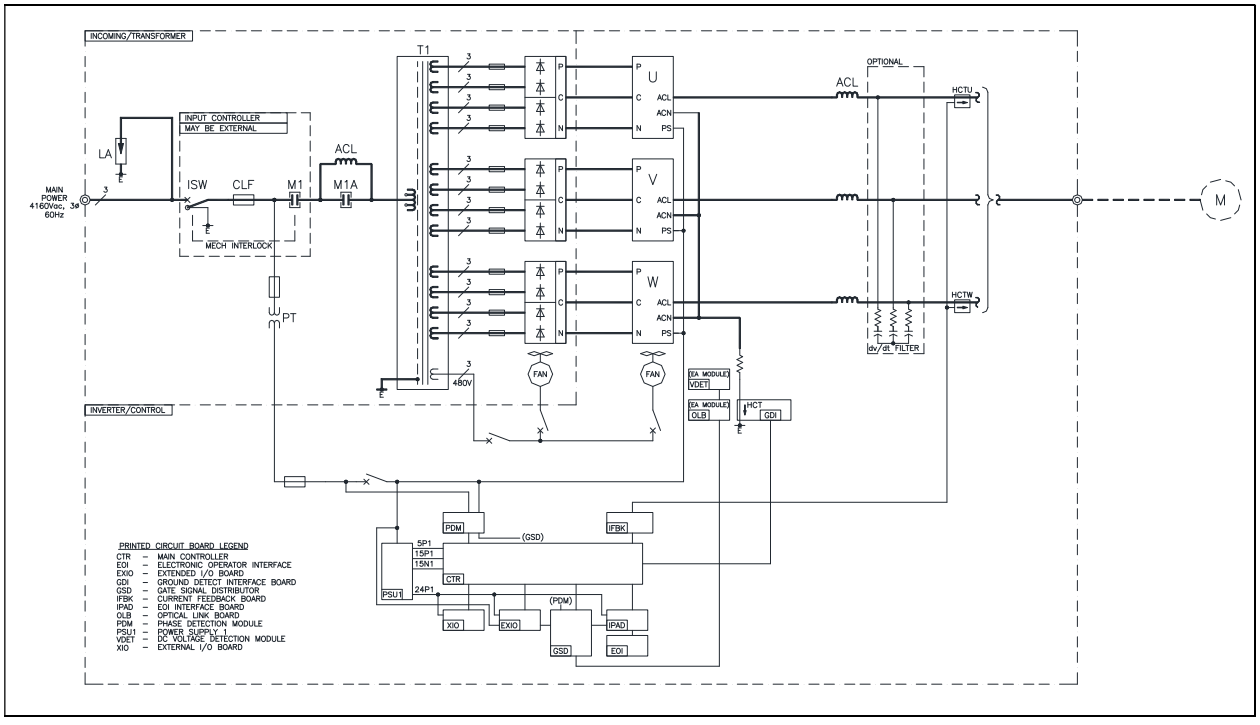
One channel (AOUT1) is provided as general-purpose, 10VDC analog output from the XIO brd.. This output is directly output from the control board. The device reading these signals must be isolated. To insure this, it is recommended that signal isolators be used. The output can be selected from a list shown in the parameter setting manual by using the parameter AOUT1_CODE. It may also be set to any function in the drive by the use of the parameters AOUT1_OP_AS, AOUT1_OP_GS, and AOUT1_OP_OS. When using the optional settings, care must be taken to set the output up so that the output signal does not exceed 10VDC. Exceeding this value will cause overflow problems.

CIRCUIT OPERATION

Main Circuit Configuration

The following circuit shows some typical configurations of the drives. Input AC is supplied through an input controller to transformer T1. This controller may be integrated into the drive or external. The transformer has multiple phase shifted secondaries connected to full wave diode rectifier bridges. The output of the rectifiers is connected to three inverter power modules that produce 3-phase AC power at the frequency and voltage required by the motor.

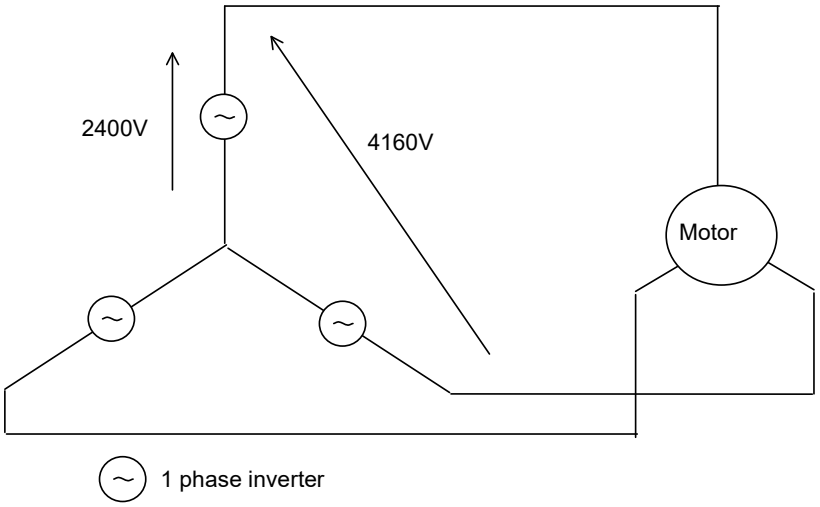
Configuration

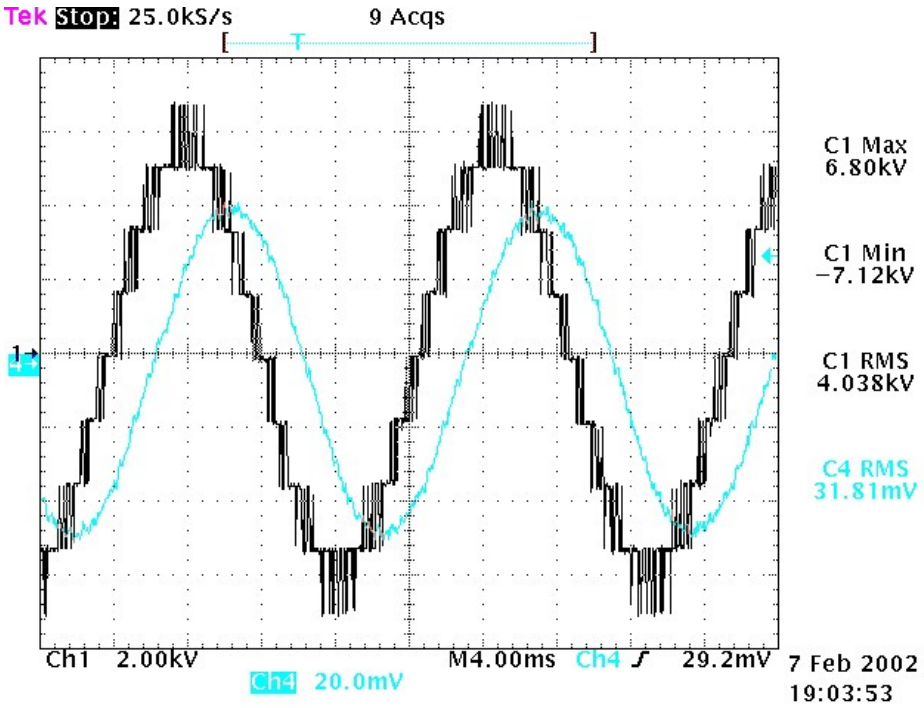


CIRCUIT OPERATION (cont'd)

The AC output voltage of the each inverter power module is 2400V line to neutral. With phase voltages shifted 120° from one other, an output voltage of 4160V between phases is generated. The output voltage closely approximates a sine wave. This is shown in the output waveform below. This produces a sine wave motor current with low distortion.

Generation of High Voltage by Wye Connection





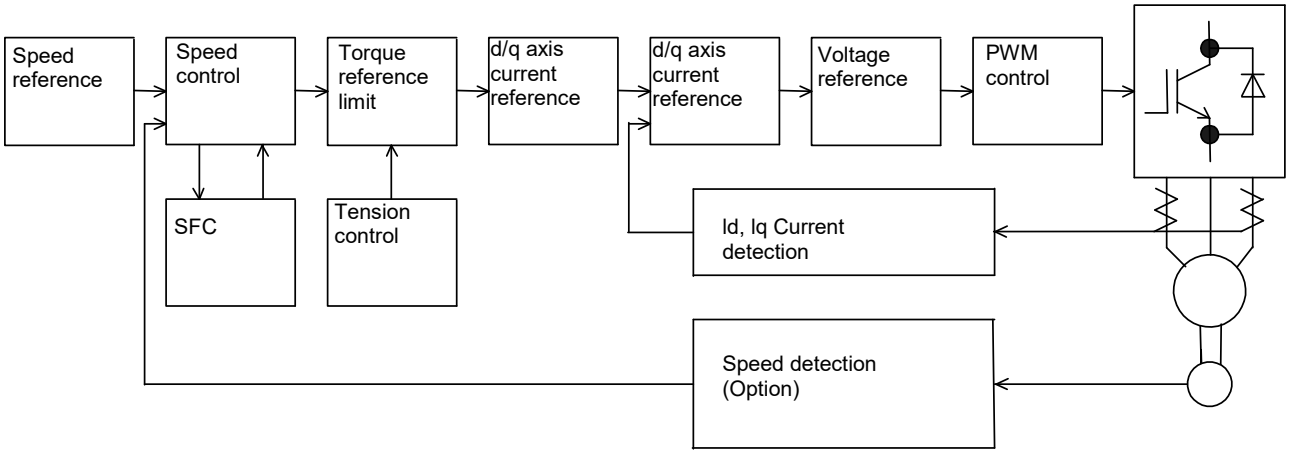
Output Voltage and Current Waveforms

CIRCUIT OPERATION (cont'd)

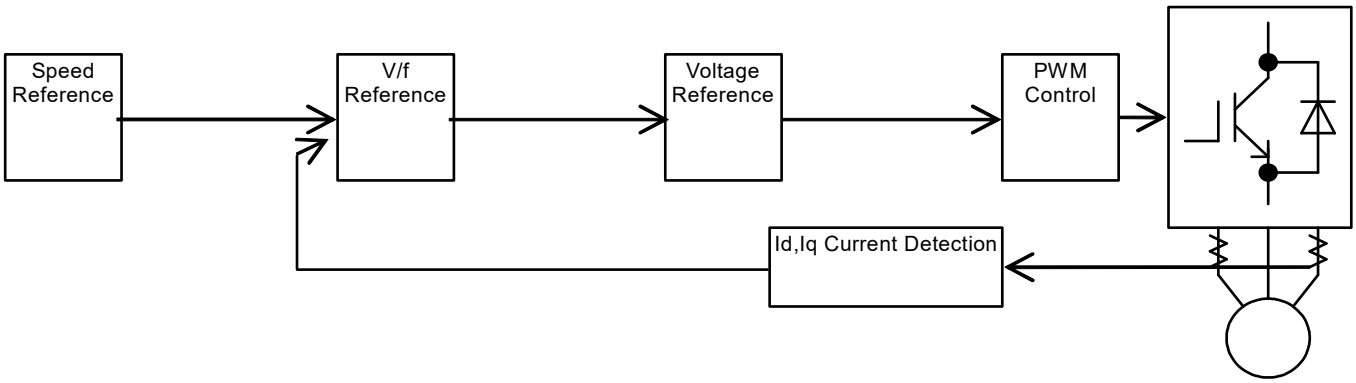
Control

The following figures show the overall Control block diagrams for IM (Induction Motor) control.

Vector Control Block Diagram



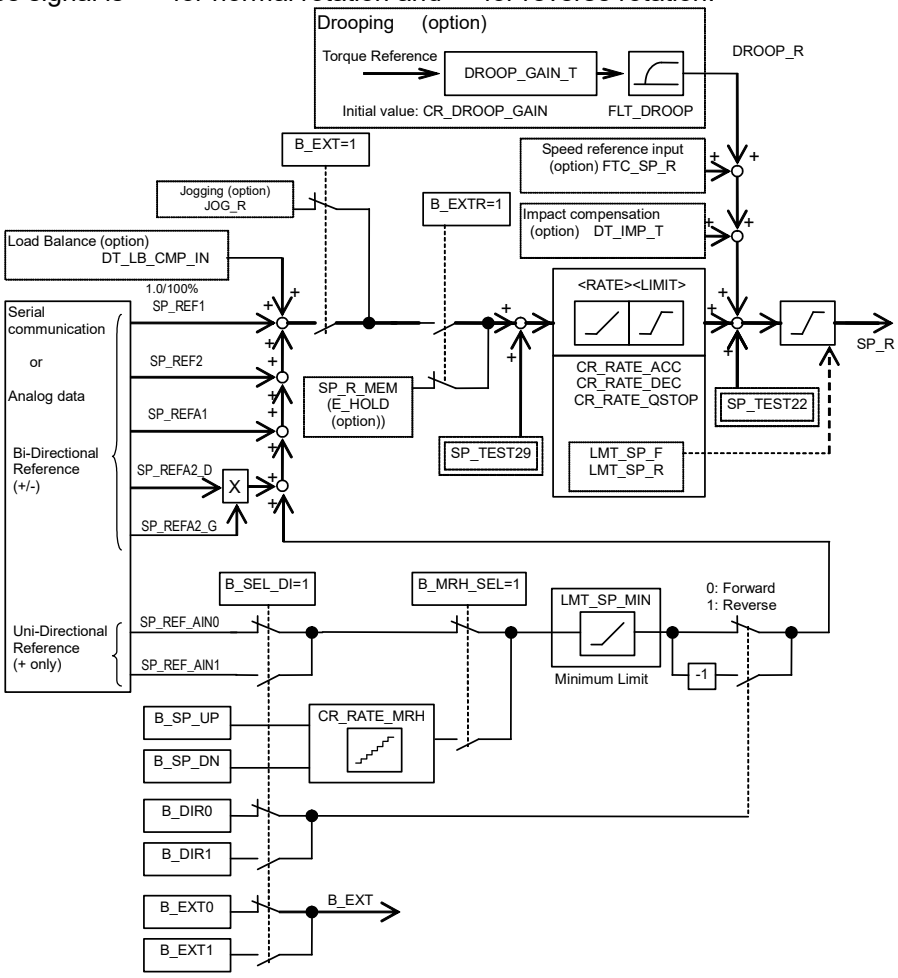
V/f Control Block Diagram



CIRCUIT OPERATION (cont'd)

Speed Reference

An external speed reference with count 1/100% weighting is input by serial transmission or analog input and subjected to rate processing and limit processing to output an SP_R signal. The sign of the speed reference signal is "+" for normal rotation and "-" for reverse rotation.



Speed Reference

(1) Speed references

SP_REF1 or SP_REF2 can be used when the drive speed is to be controlled from one location only. When using local and remote control or there is a need for selection between two separate inputs SP_REF_AIN1 and SP_REF_AIN2 should be used. To select between references, one of the digital inputs should be programmed as SEL_DI and an external selection switch to change SEL_DI should be connected.

SP_REF_AIN1 is used when the SEL_DI input is 0 (Open). SP_REF_AIN2 is used when SEL_DI is 1 (Closed). The start commands (EXT) are also different for this application. When SEL_DI is 0, EXT0 should be used and when SEL_DI is 1, EXT1 should be used.

(2) LMT_SP_MIN

LMT_SP_MIN is used as a minimum speed. The drive will run at this speed anytime the start command is on and the speed reference is less than LMT_SP_MIN.

CIRCUIT OPERATION (cont'd)

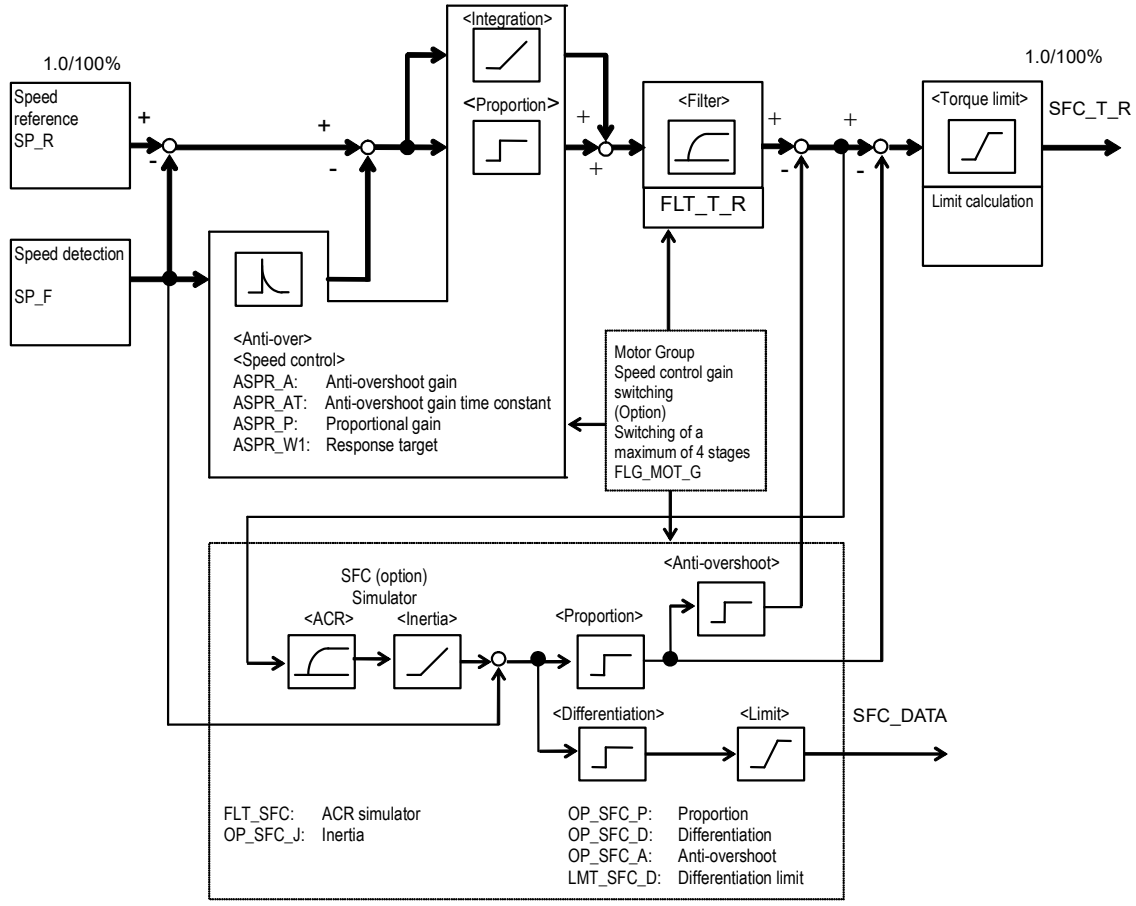
Vector Control Speed Control

The following figure shows the speed control block diagram.

The speed reference signal SP_R and the speed feedback signal SP_F are input with the count/weight of 1.0/100% and the deviation between these two is subjected to proportional/integral operations and then output. After the previously output signal is subjected to speed filtering, and the torque limit is processed, its torque reference SFC_T_R is output with count/weight of 1.0/100%. The control response is performed with the following parameter settings:

ASPR_A: Anti-overshoot gain
ASPR_AT: Anti-overshoot time constant
ASPR_P: Proportional gain
ASPR_W1: Response target

Note, that if GD2 of the machine is extremely large, compared to the GD2 of the motor, there is a long extension shaft, or if there is torsional resonance, the control response may need to be slow.



Speed Control

CIRCUIT OPERATION (cont'd)

Vector Control Simulator Follower Control (SFC, optional control used with a speed sensor)

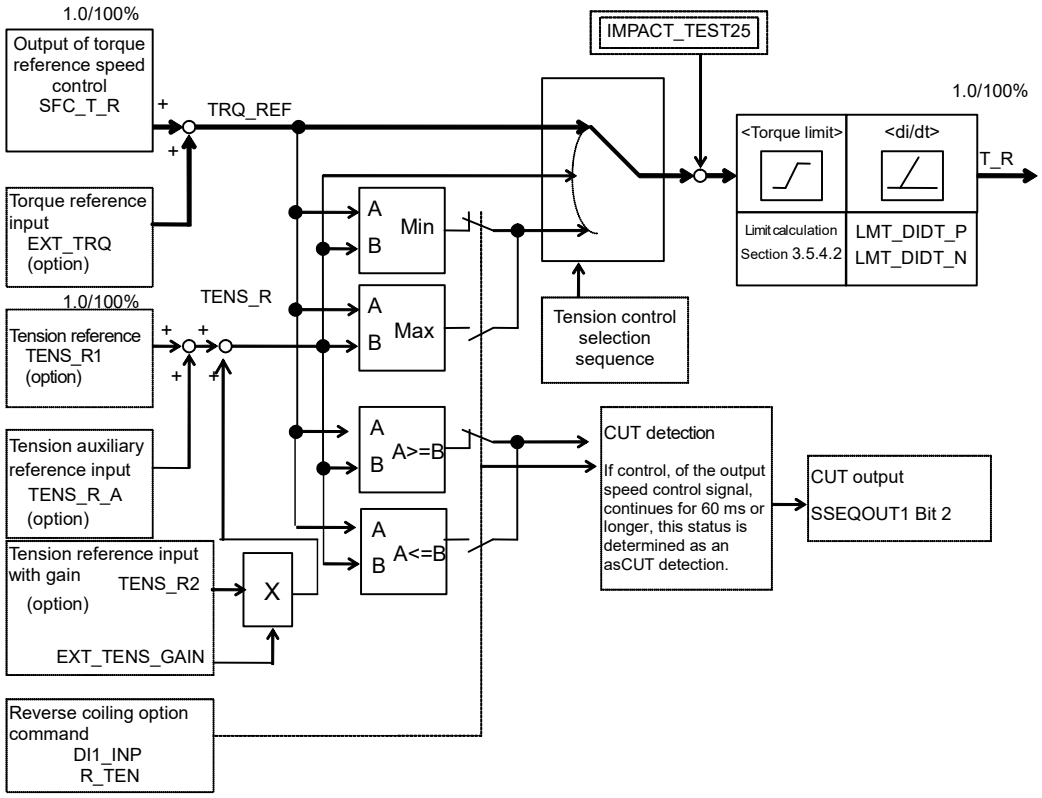
When the machine has torsional resonance, the (SFC) function may be used to try to reduce the torsional vibration and increase the speed response.

With SFC, the speed regulator output signal is input to an inertia compensation block. This block produces an estimated speed signal. The speed feedback is then subtracted from this value to create a speed deviation signal. This signal is then sent through a proportional block and added to the output of the speed regulator. The speed deviation signal is also sent through an anti-overshoot block and subtracted from the speed regulator output. The combination of these two functions can be used to help improve the recovery of the system during shock loading.

The speed deviation signal is also sent to a differential block and added to the torque reference (see below). This signal is effective for torsional vibration control. When the SFC function is not used, set all of the gains to 0.

Vector Control Torque Reference and Current Reference

The TRQ_REF signal, obtained from the calculation, results in the speed control compared with the external input tension reference TENS_R signal, to find the torque reference T_R. In this optional control, the operation is made based on TENS_R, used as a torque reference, during normal operation, and the speed control circuit functioning as a speed limit. (Operation is made based on the external torque reference in winding machines. However, if materials are broken, operation is changed to the speed control operation.)



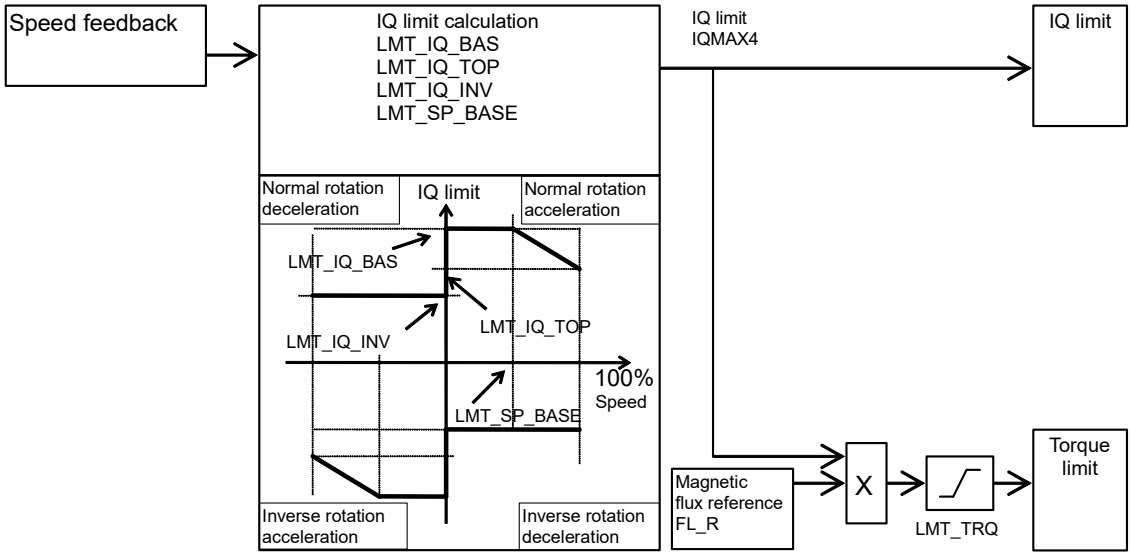
Torque Reference

CIRCUIT OPERATION (cont'd)

Vector Control IQ Limit (Torque current limit)

The IQ limit has a flat characteristic from 0 to base speed and tapers from base to top speed. The following settings are used to adjust the limits.

LMT_IQ_BAS: Base speed torque current limit. Set 110%, 115%, etc. according to OL specification of the drive.
LMT_IQ_TOP: Top speed torque current limit. Set as required by the application or set the same as the base limit when field weakening is not used.
LMT_IQ_INV: Regeneration torque current limit. Set to 1 or 2%. This Drive cannot regenerate.
LMT_SP_BASE: The upper speed of the drive at which LMT_IQ_BASE is used. Set 125% for applications that do not use field weakening. Otherwise set as required by the application.
LMT_TRQ: Torque reference motoring absolute limit. The maximum motoring torque reference allowed regardless of speed. Set to the base speed torque current limit.
LMT_TRQ_INV: Torque reference regeneration absolute limit. The maximum regeneration torque reference allowed regardless of speed. Set to 2%.



IQ Limit

CIRCUIT OPERATION (cont'd)

Vector Control D-Q Axis Current Control

The figure on the following page shows the block diagram of the D-Q axis current control.

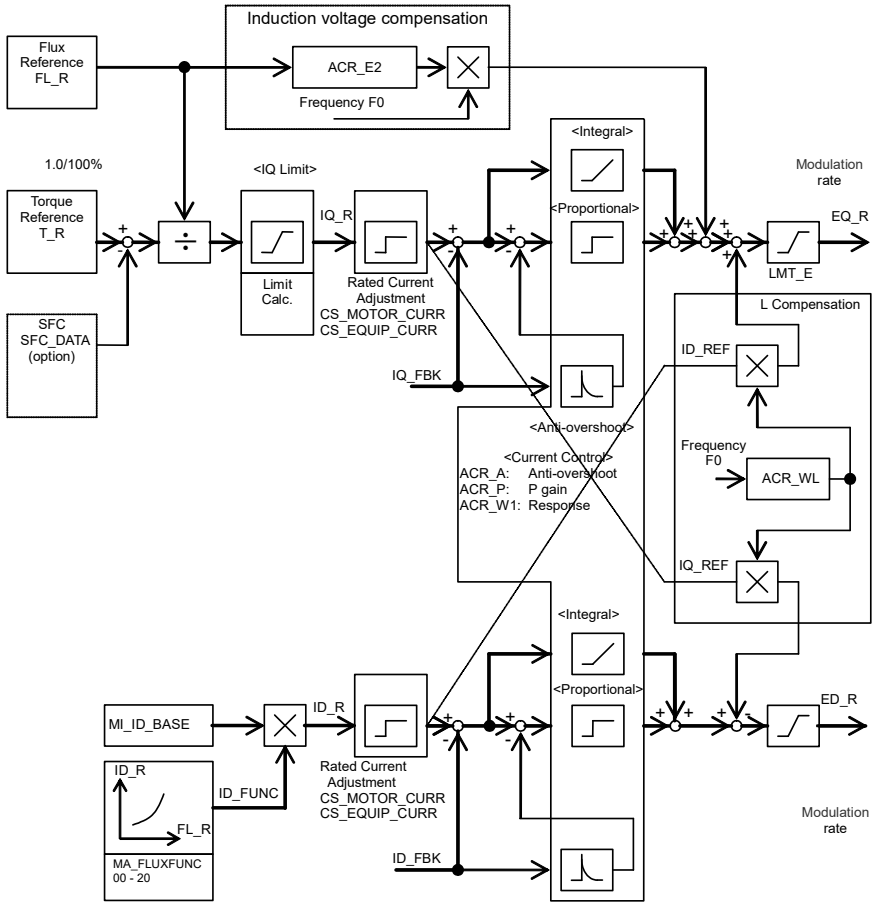
This system controls the current of an induction motor by separating it into a magnetic flux (Field) component and a torque component. This drive controls the current on the D-Q coordinates. It can control the current to an AC motor as a DC value, achieving high performance control irrespective of output frequencies.

(1) ID (Field current) control

A magnetic flux reference is generated based upon the speed reference. This and the field current setting (MI_ID_BASE) are used to generate an ID reference. This ID reference and the ID feedback signal are input into a PI controller. The output of this controller is the ED_R (Field voltage reference). Optional Inductance (L) compensation can also be used (ACR_WL). If used, these signals are combined with the PI controller output to create the ED_R.

(2) IQ (Torque current) control

The torque reference, which is the result of the previously mentioned speed control, is input and divided by magnetic flux to obtain an IQ reference. This IQ reference and IQ feedback signal are input into a PI controller. The output of this controller is the EQ_R (Torque voltage reference). An induction voltage compensation (ACR_E2) and L compensation (ACR_WL) may also be used. If used, these values are combined with the output of the PI controller to create the EQ_R.



D-Q Axis Current Control

CIRCUIT OPERATION (cont'd)

V/f Control

(1) Frequency reference (F_P)

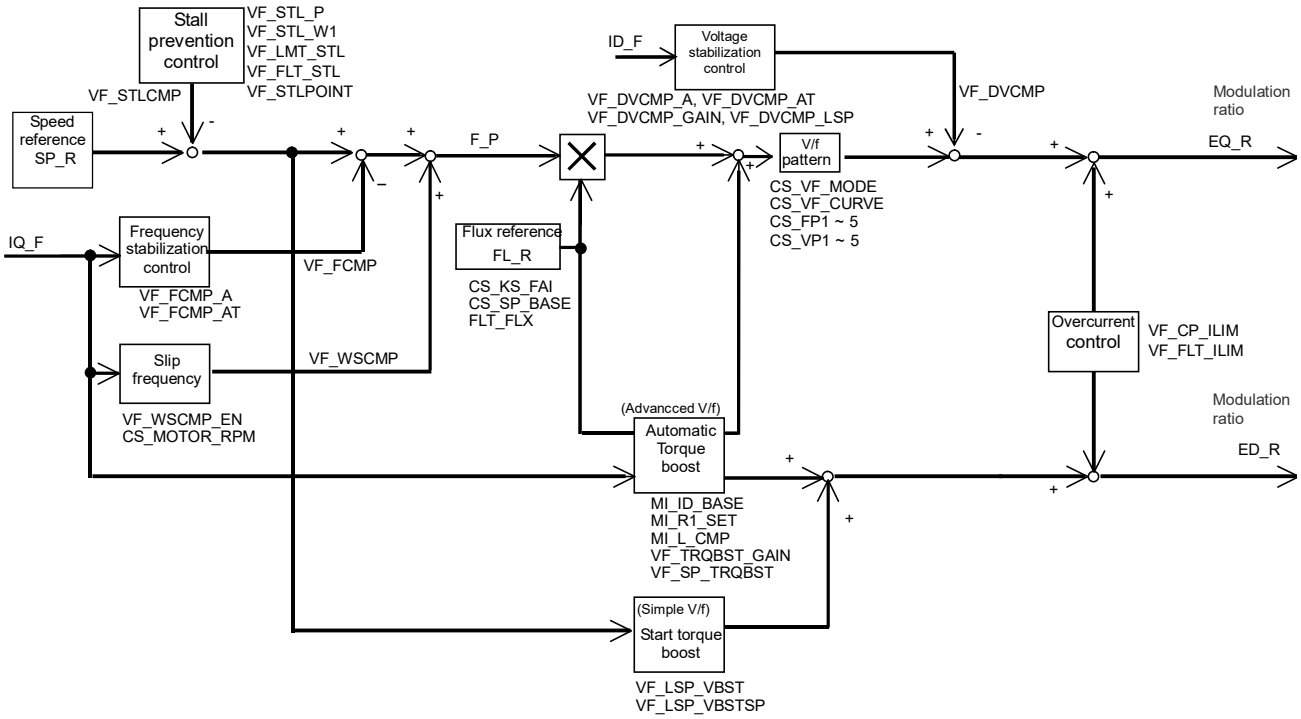
The frequency reference is determined by the speed reference signal (SP_R) and the slip frequency, when slip compensation is used.
The frequency is compensated by the change of the Q axis current for the control stability.

(2) Q axis voltage reference (EQ_R)

The Q axis voltage reference is proportional to the frequency reference and flux reference. This voltage may be compensated by the Q axis current for auto torque boost, when advanced V/f control is used. The V/f rate can be changed by the selected V/f pattern.
The Q axis voltage is compensated by the change of the D axis current for the control stability.

(3) D axis voltage reference (ED_R)

The D axis voltage reference is used for low speed torque boost normally. This voltage can also be compensated based upon Q axis current, when advance V/f control is used.

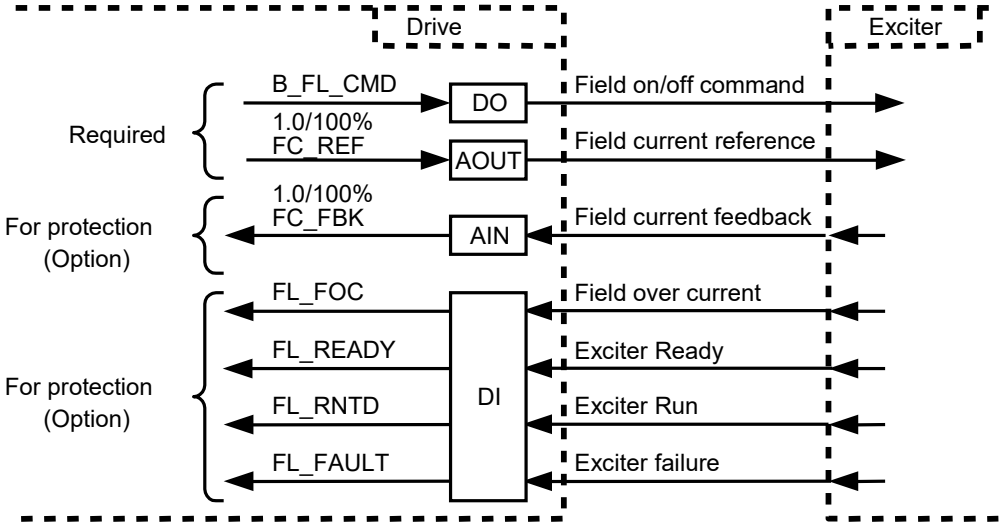


CIRCUIT OPERATION (cont'd)

Control Circuit for SM (Synchronous Motor) control

(1)Interface

SM control requires the use of an exciter. The exciter may be internal or external to the drive. The interface to the exciter is shown below.



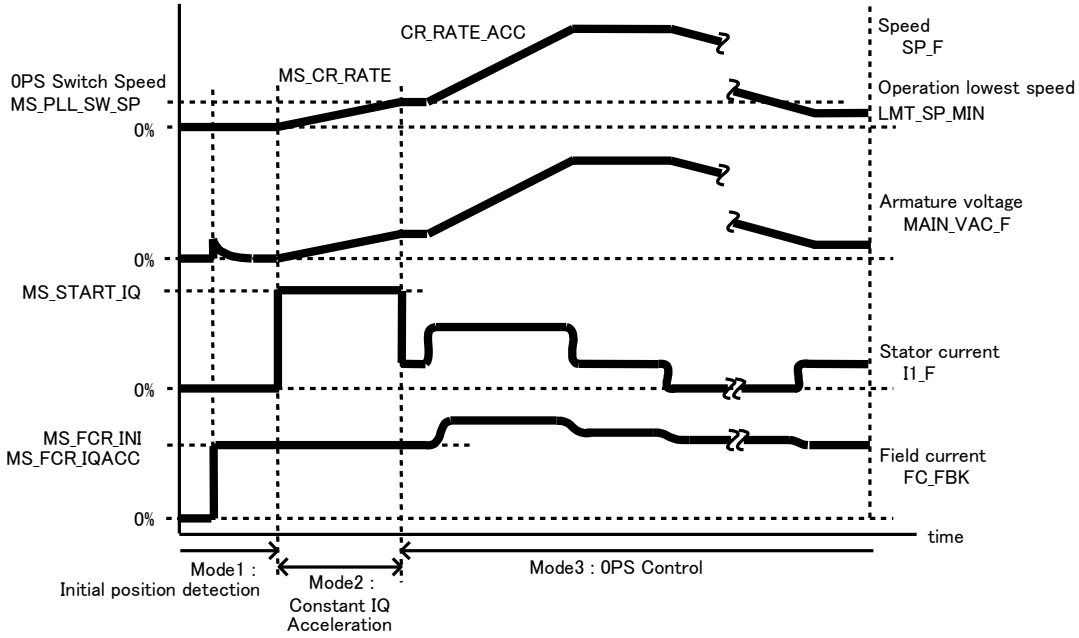
(2) Timing chart

There are 3 control modes.

Mode1 "Initial position detection" : Initial position is detected when the motor is stopped.

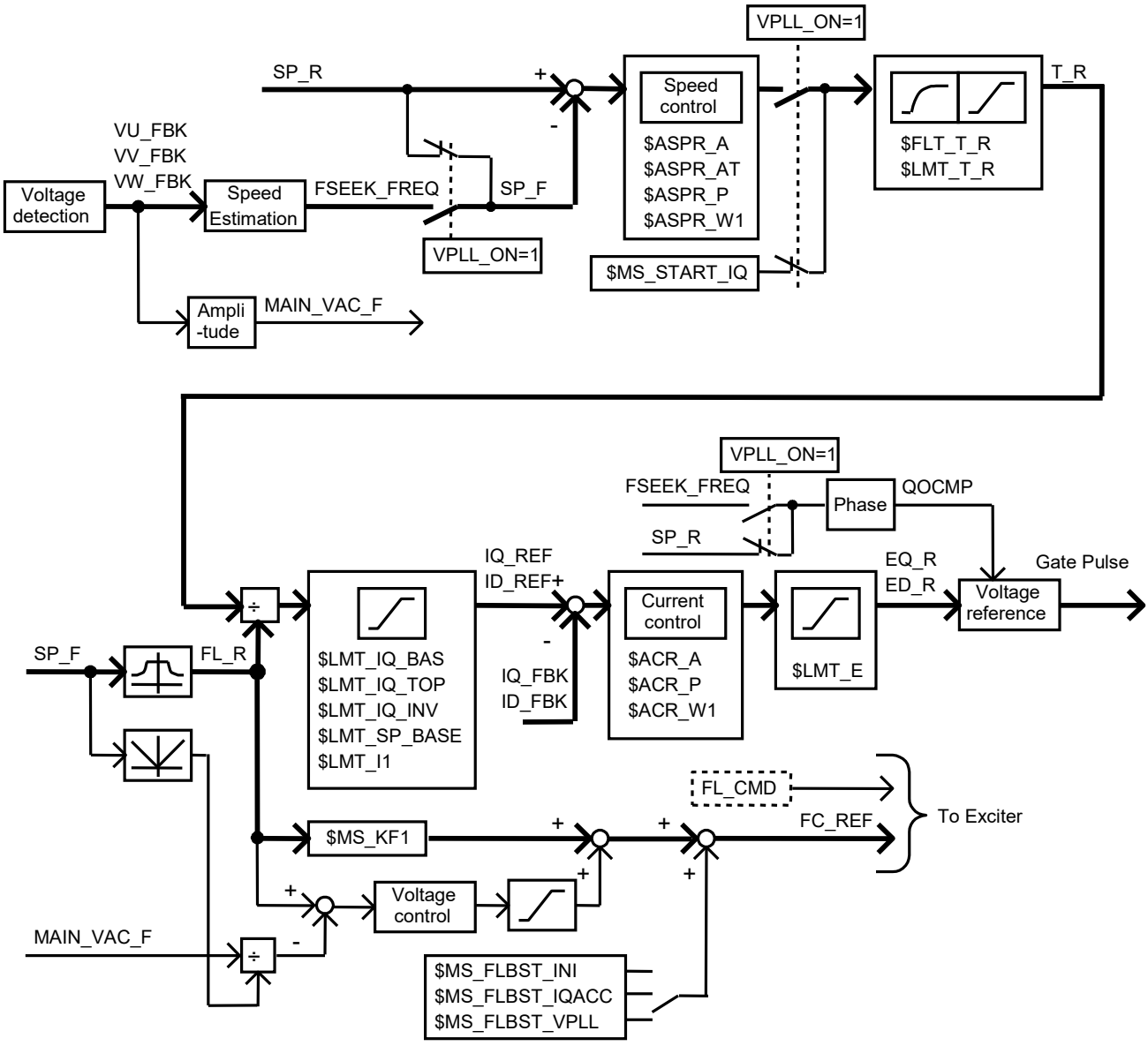
Mode2 "Constant IQ starting": This mode starts the motor without speed control. It uses the initial position and current control with pre-set speed reference rate and current.

Mode3 "ZPS control" (zero-PS): Speed and phase angle are estimated by the motor voltage PLL. Once the drive enters this mode it is in speed control and will follow the external speed reference.



CIRCUIT OPERATION (cont'd)

SM Control Block Diagram



CIRCUIT OPERATION (cont'd)

Speed Feedback (Option)

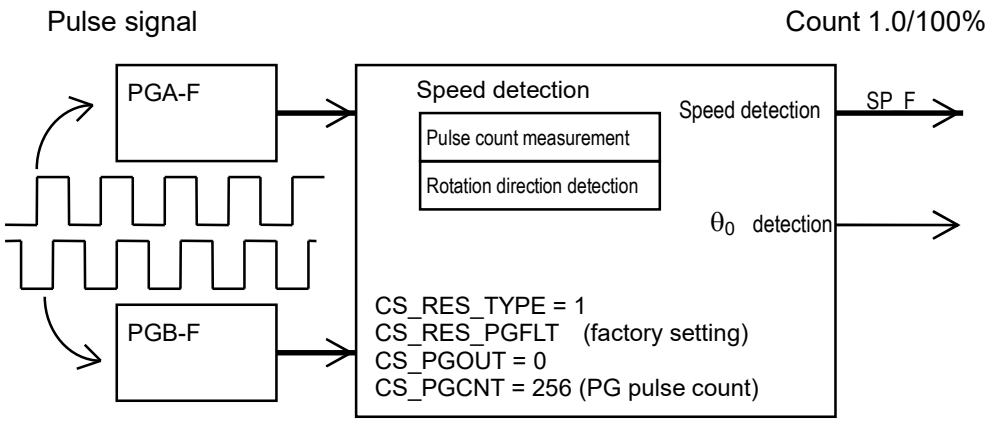
As an option, a Resolver or a Pulse Generator (PG) can be selected for speed feedback. Speed control with a Tach Generator is not available because Tach Generator performance is poor.

Resolver

A resolver is an analog feedback device that used for speed feedback. Two sine wave excitation signals (sine and cosine) are sent to the resolver and two signals (sine and cosine) are returned to the drive. The use of these two phase shifted signals allows the direction rotation to be determined. The position of the motor rotor is determined by the phase difference between the excitation and return signals. The speed is found from the change in this position over time.

PG

A signal is detected from a single ended PG attached to the motor and converted to a speed. Detection is performed according to the pulse interval measurement system. This system converts a signal to a speed based on the fact that the interval (time) between pulses input is inversely proportional to the speed. The maximum input frequency is 10kHz(Single-Ended type) or 100kHz(differential type).



PG Speed Detection

OPERATION

The powering-on operation must follow a certain sequence. Failing to observe the powering-on sequence described here may cause unnecessary stress on the equipment. **Be sure to observe the powering-on sequence**.

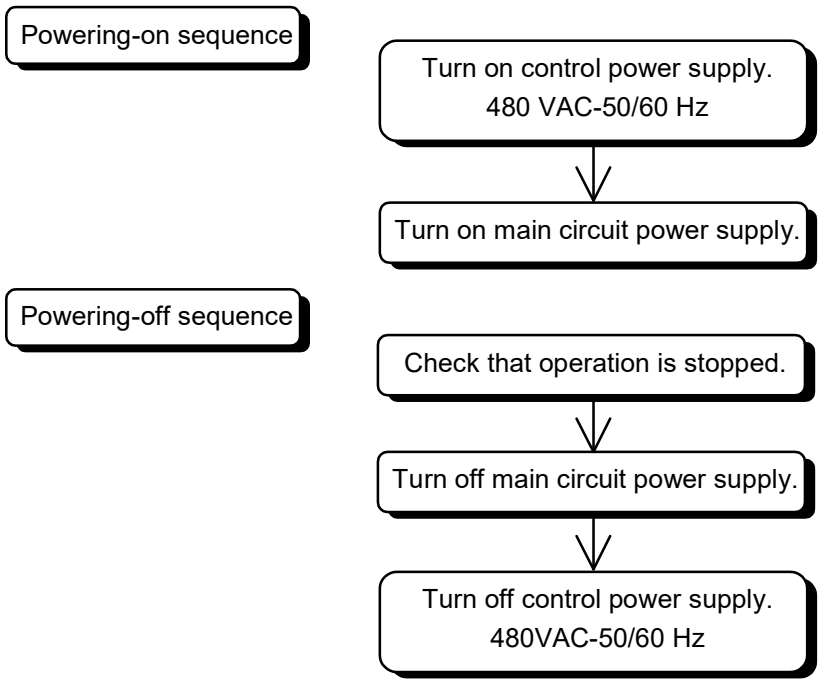
WARNING

While the equipment is in operation and the motor is running, do not turn off the main circuit power supply or control power supply under any circumstances. Do not open the cubicle doors or remove any covers.

When the operation of the equipment is completely stopped, use the following basic procedure to turn on/off the power.

NOTE: On some drives, the control power supply is internally derived from the main circuit power supply. In this case, disregard the steps below involving the 480 VAC control power supply.

General power-on and power-off sequence.



OPERATION (cont'd)

Pre-Operation Check Points

Check the following points before starting the operation.
1) Wiring is correct.
2) A voltage of 2400 V, or 4160 V, ±10% can be supplied as the input power supply voltage.
3) A voltage of 480 VAC ±10% can be supplied as the control power supply voltage.
4) The ground bus and any shielded wires are grounded.
5) The motor frame is also grounded.
6) The motor main circuit wire is not grounded.

Powering-On

The power should be turned on when the motor is completely stopped.
1) Turn on the control power supply MCCB "CONTROL."
2) Interlock the drive with the interlock switch on the keypad.
3) Turn on the main power supply.
4) Release the interlock switch on the keypad.

Operation

This section shows a typical operation procedure. You are also required to observe your own safety rules to prevent accidents.

Normal Operation

When carrying out a normal operation using the digital interface (refer to the keypad manual for keypad operation), check that the necessary interface signals are correctly connected and then follow the procedure below.

1) Set the frequency command signal.
2) Turn on the IL (interlock) input signal if used.
3) Turn on the UVS input.
4) Turn on the EXT (start command) input signal.
5) Vary the frequency command as needed. Do not run the drive at zero speed unless you have a speed sensor.
6) Turning off the EXT signal during operation ramps the motor to a stop.
7) Removing the UVS signal or the IL signal during operation turns off the output of the drive and the motor coasts to a stop. If these signals are removed during operation, the EXT command must be removed and the UVS and/IL restored before the drive will restart.

Powering-Off

1) Stop the motor by removing the EXT, the IL, or the UVS command.
2) After the motor has stopped, interlock the drive with the interlock button on the keypad.
3) Turn off the external main power supply.
4) Turn off the control power supply MCCB "CONTROL."

DATA CONTROL

Setting Data

The parameter setfile is stored in the EEPROM on the main control brd.. This is non-volatile memory and will not generally be lost when the drive is powered down. However, this data could be lost if there is a brd. failure. If this data is lost, the drive will need to be re-commissioned. For this reason, it is recommended that the parameter setfile data be backed up in a file stored on a personal computer. This requires the use of the optional commissioning software. The software and training is available through Toshiba.

FAULT AND RECOVERY

Cautions when Handling Fault

CAUTION

When a fault occurs, before resetting, understand the fault code. It may be unsafe to restart if a component or motor has failed. Every effort should be made to determine the cause of the fault and to correct any problems before attempting to restart the drive.

To do this, it is necessary to record and evaluate the phenomena and conditions of the fault in detail from both electrical and mechanical standpoints. Collect as much data as possible on the following items to determine the operation situation when the fault occurred.

1) Record the fault message (fault display) shown on the display/keypad at the moment the fault occurred.
2) Collect Tracesave data with a PC. Visit our website at http://www.toshiba.com/tic/contact-us/find-support for information about Tracesave and where to send the file for analysis.
3) Operation different from ordinary operation
Check if there was anything that affected the input power supply of the equipment at the moment the fault occurred (for example, powering-on of large-capacity equipment which is connected to the common AC power supply or short-circuits, etc.).
4) Power failure
Check if the input power supply of the equipment was disconnected at the time of the fault (for example, if the line of the AC power supply was switched or if the breaker was turned on or off).
5) Load condition
Check if the load was drastically changed at the time of the fault.
6) Operation
Check to see if any changes in the process or load machinery were made by the operator at the time of the fault.
7) Installation environment
Check if there was any abnormal ambient conditions present in the electrical room at the time of the fault or before the fault. (Fault of air-conditioner or ventilation system, water leakage into the room, intrusion of dirt or chemicals, etc…)
8) Changes
Check if there were any recent changes to other equipment around the drive or load machinery. For example, if some electrical work was carried out on or around the equipment.
9) Lightning
Check if there were any lightning strikes in the area.
10) Abnormal sound, odor
Check if there was any odor or abnormal sound around the equipment at the time of the fault or after.

Understanding the conditions before and during the fault can help to determine whether the fault is attributable to factors inside or outside of the drive. Further, this information becomes an important clue to determine the cause of intermittent faults. It is important to keep a precise record.

Repair

CAUTION

Cautions on Repair

- **Be sure to use only the renewal parts specified by Toshiba. Parts other than those specified by Toshiba may not only not demonstrate the stipulated performance but also affect the safety. If spare parts are not available, contact Toshiba to order them or ask for replacement of parts.**

- **This equipment includes parts that need to be replaced periodically. It takes time to deliver parts, so order them as early as possible.**

1) The power modules have been designed for easy replacement as a unit. They are sold as units and should be replaced as units. Individual parts should not be removed from or installed on the power module assemblies. Modules that have failed or are believed to have failed should be returned to the factory for evaluation, repair, and testing. Refer to the information label on the inside of the power module compartment door for instructions on replacing a power module.
2) Prepare necessary tools and drawings, etc. before starting the work.
3) Be careful not to damage other parts when removing some parts.
4) Do not make wrong connections when changing parts. Put markings, etc., if necessary.
5) Before restarting after changing any part verify all connections are correct.
6) Use the right tools (torque wrench, etc.) when handling screws and bolts.
7) Special care is required when handling heavy articles.
8) When the work is completed, make sure that no tools or other foreign material is left in the drive.

DRIVE INSTALLATION DRAWINGS

Frame A4μ module lifting and installation

WARNINGS:

Disconnect power and wait 15 minutes to ensure capacitors are discharged before performing inspection or maintenance.

Improper handling of the fiber optic cables and connectors may cause drive failure due to problems transmitting signals. Take care when handling fiber optic cables.

REMOVING/REPLACING POWER MODULE

1. After 15 minute capacitor discharge time, remove front barrier, four "A" bolts. Figure 1.
2. Disconnect AC Neutral Cable. Disconnect and remove AC Neutral Bus. Figure 2.
3. Disconnect Power Cables P,C,N & ACL. Figure 2.
4. Disconnect Control Signal Cable and 120VAC Supply Cable from bottom of Cell. Access from below through LV Compartment. Figure 3.
5. Free slide tray by removing two "B" bolts. Figure 4.
6. Pull slide tray out until slides lock. Figure 4.
7. Remove four "C" bolts which secure module to tray.
8. Use a lifting device rated for 200 pounds or more to lift module from tray by module lifting hole.
9. Replace module by following the steps above in reverse order. Press buttons on inside slide surfaces to slide tray back. Torque power connections (10-32 nuts) to 30 inch-lbs.

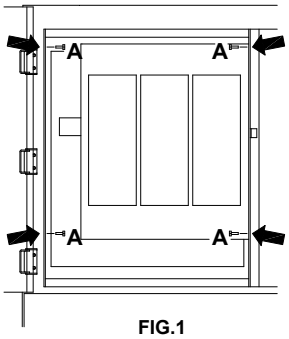


FIG.1

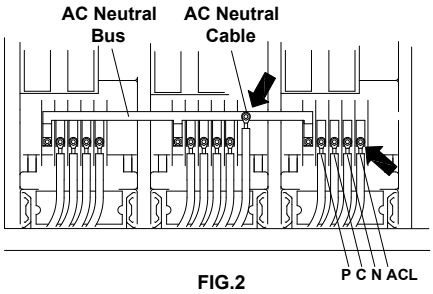


FIG.2

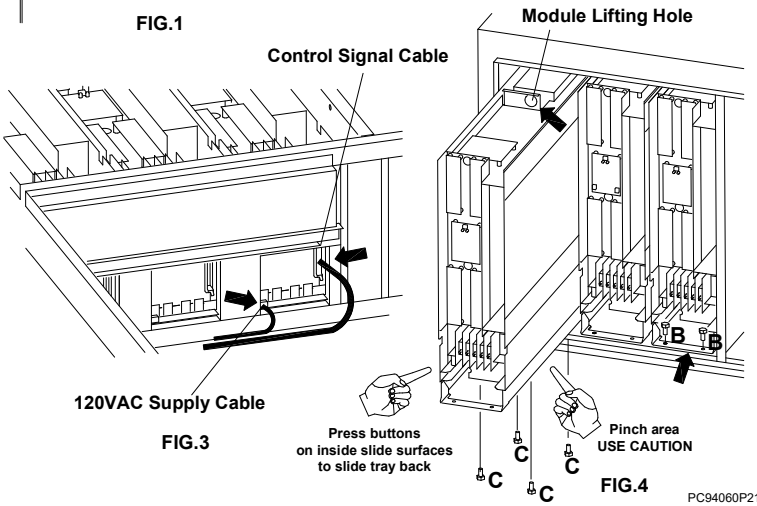
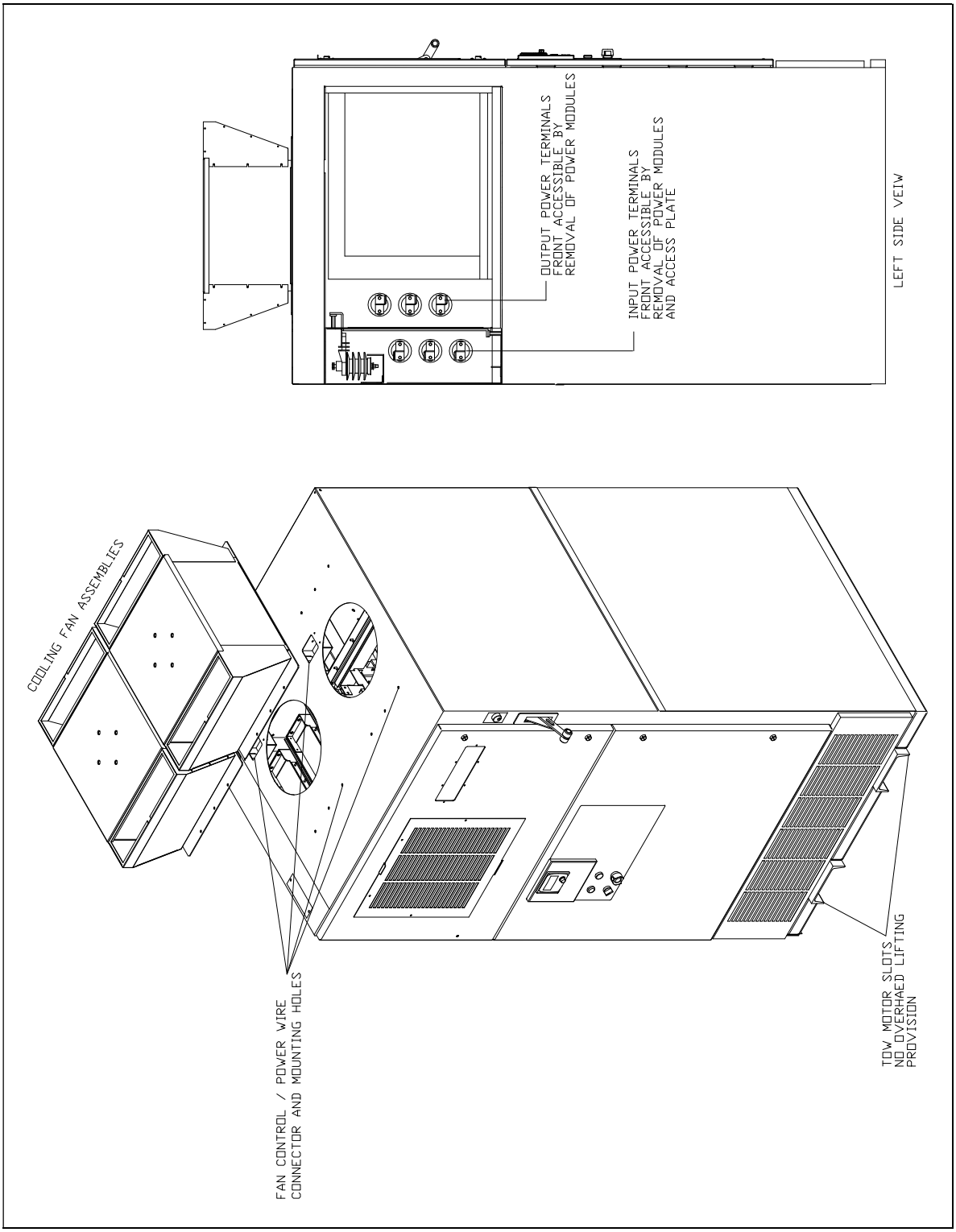


FIG.3 FIG.4

PC94060P214

DRIVE INSTALLATION DRAWINGS (cont'd)

Frame A4μ drive lifting and assembly



DRIVE INSTALLATION DRAWINGS (cont'd)

Frame A4 and AS4 module lifting and installation

WARNINGS

Disconnect power and wait 15 minutes to ensure capacitors are discharged before performing inspection or maintenance.

Improper handling of the fiber optic cables and connectors may cause drive failure due to problems transmitting signals. Take care not to disturb fiber optic cables when handling power module.

Use module lifting attachment GCI6720G055 and a lifting device rated 250 lbs minimum for removal and installation of modules.

Power Module Removal

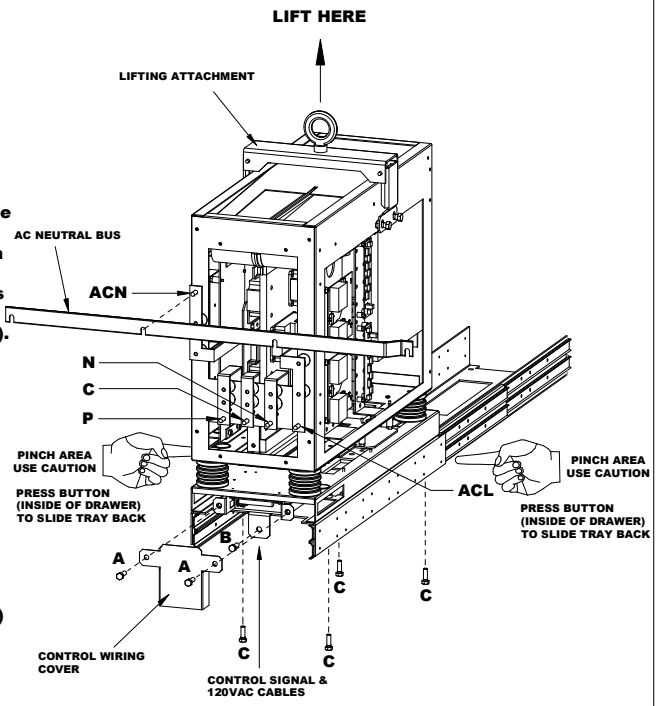
1. **Disconnect and remove AC neutral bus.**
2. **Disconnect power cables ACL, P, C & N.**
3. **Remove control wiring cover (two "A" bolts)**
4. **Disconnect control signal cable and 120VAC supply cable from module.**
5. **Free slide tray by removing bolt "B".**
6. **Pull slide tray out until slides lock.**
7. **Remove four "C" bolts which secure module to tray.**

Power Module Removal (cont'd)

8. **Using module lifting attachment and lifter, lift module from tray.**

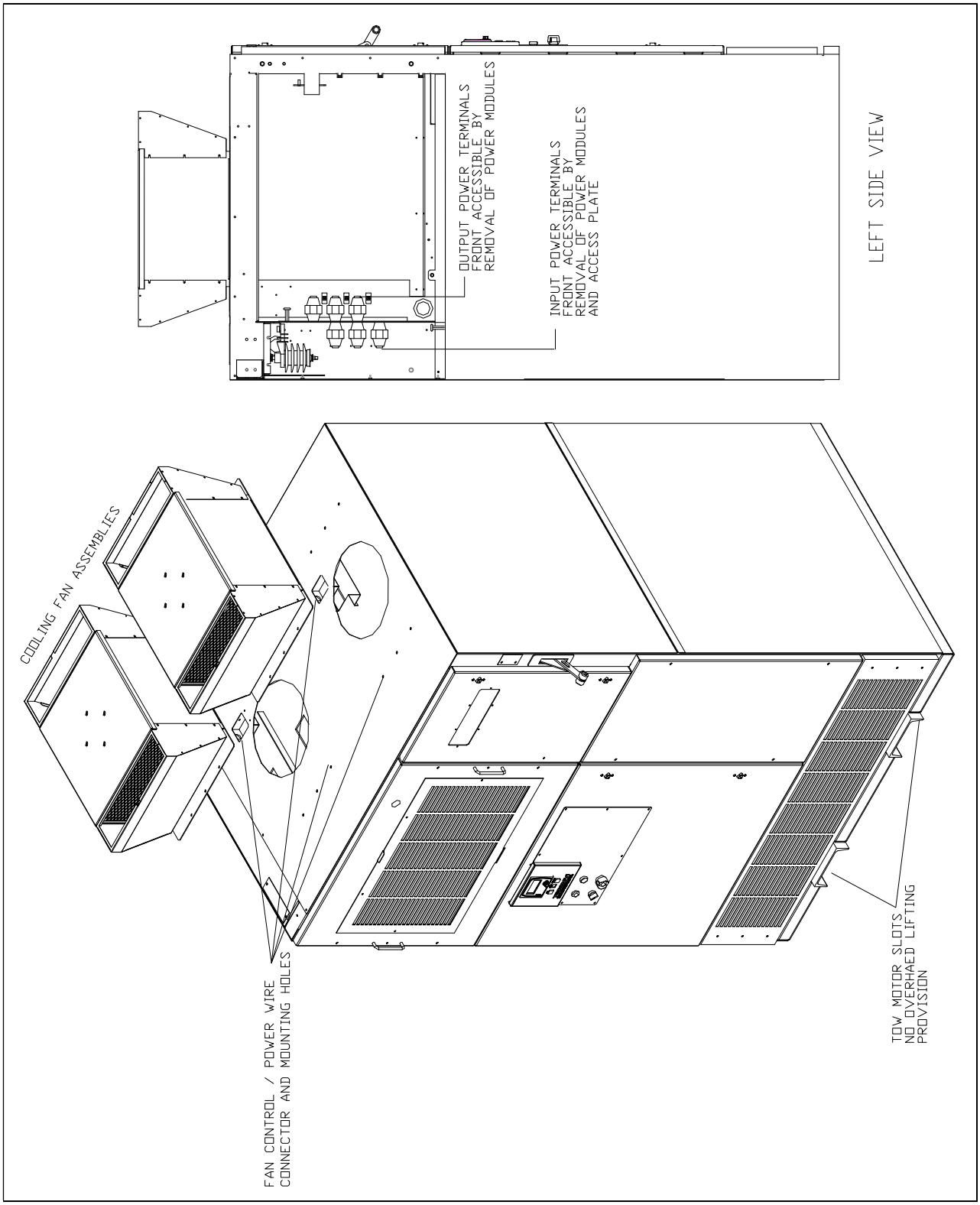
Power Module Installation

1. **Pull slide tray out until slides lock.**
2. **Using module lifting attachment and lifter, place module on tray.**
3. **Secure module to tray with four "C" bolts.**
4. **Press slide release buttons and slide module into compartment (use caution).**
5. **Reinstall bolt "B" to secure tray in position.**
6. **Reconnect control signal cable and 120VAC supply cable to module connectors.**
7. **Reinstall control wiring cover and secure with two "A" bolts.**
8. **Reconnect power cables ACL, P, C & N.**
9. **Reinstall AC neutral bus.**
10. **Torque all power connections (5/16-18 hdwr) to 10-15 ft-lbs.**



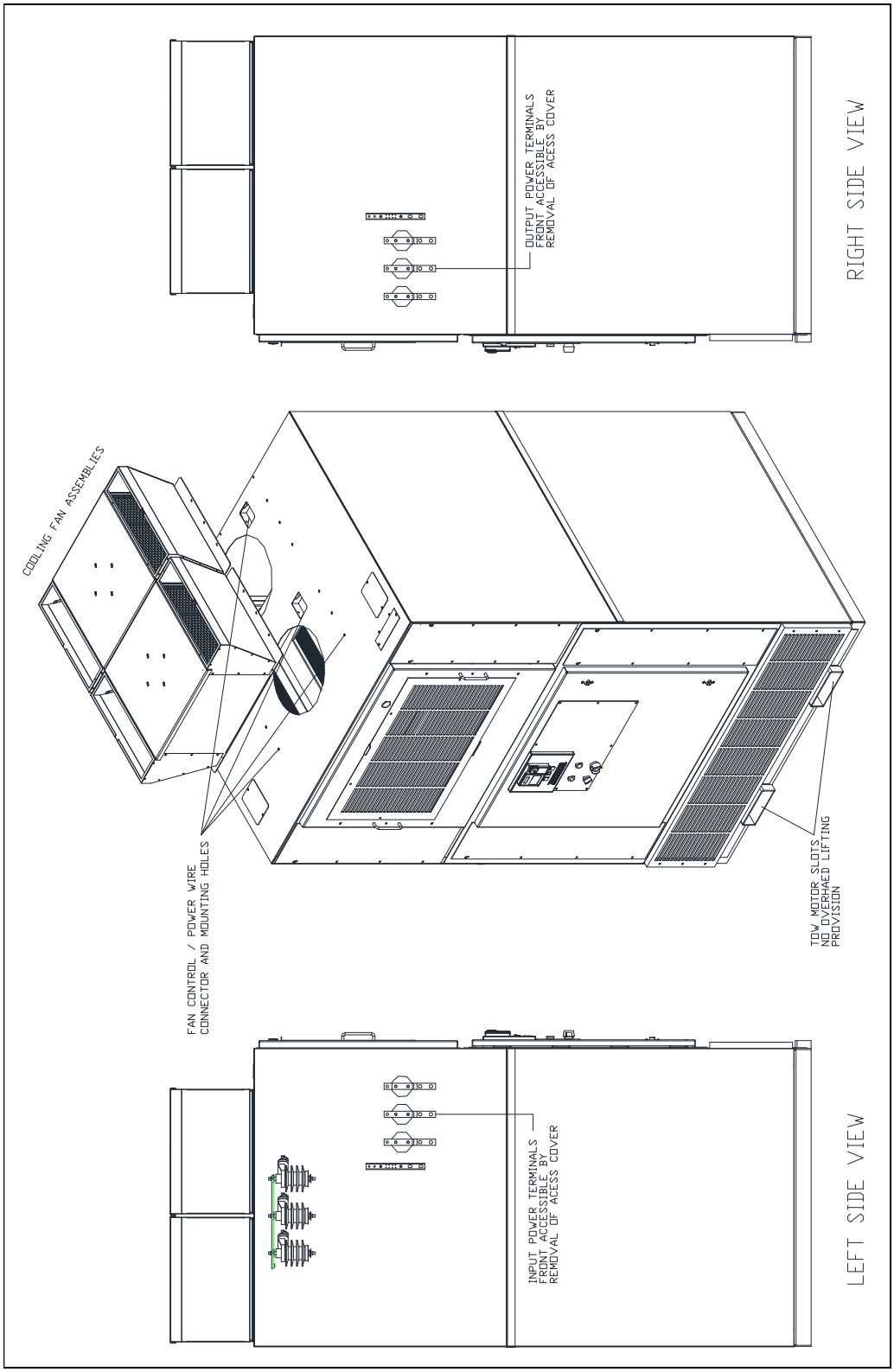
DRIVE INSTALLATION DRAWINGS (cont'd)

Frame A4 drive lifting and assembly



DRIVE INSTALLATION DRAWINGS (cont'd)

Frame AS4 drive lifting and assembly



DRIVE INSTALLATION DRAWINGS (cont'd)

Frame B4 & BS4 module lifting and installation

WARNINGS

Inverter cabinet is top heavy. Cabinet must be anchored to floor before withdrawing power modules to prevent tipping.

Disconnect power and wait 15 minutes to ensure capacitors are discharged before performing inspection or maintenance.

Improper handling of the fiber optic cables and connectors may cause drive failure due to problems transmitting signals. Take care not to disturb fiber optic cables when handling power module.

Use module lifting attachment GCI6721G055 and a lifting device rated 350 lbs minimum for removal and installation of modules.

Power Module Removal

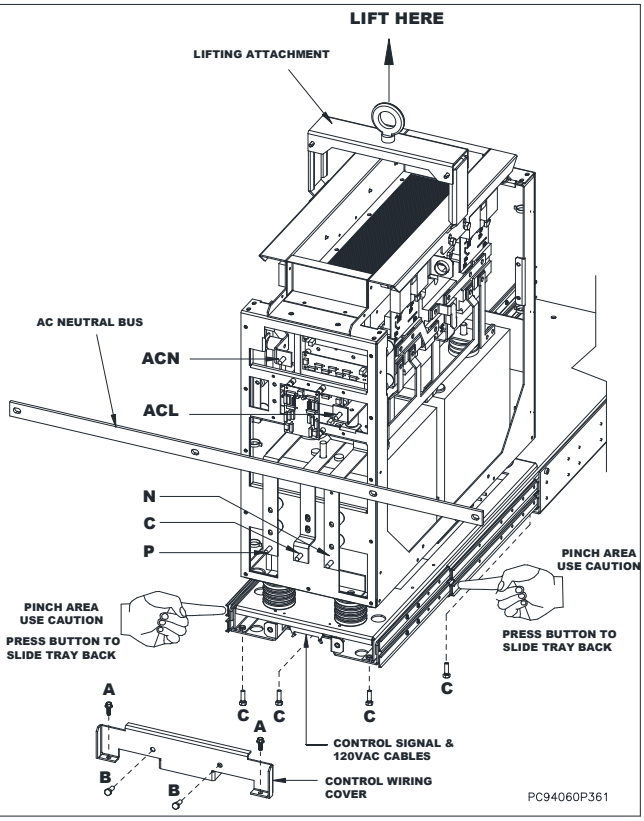
1. **Disconnect and remove AC neutral bus.**
2. **Disconnect power cables ACL, P, C & N.**
3. **Remove control wiring cover with two "A" & two "B" bolts**
4. **Disconnect control signal cable and 120VAC supply cable from module.**

Power Module Removal (cont'd)

5. **Pull slide tray out until slides lock.**
6. **Remove four "C" bolts which secure module to tray.**
7. **Using module lifting attachment and lifter, lift module from tray.**

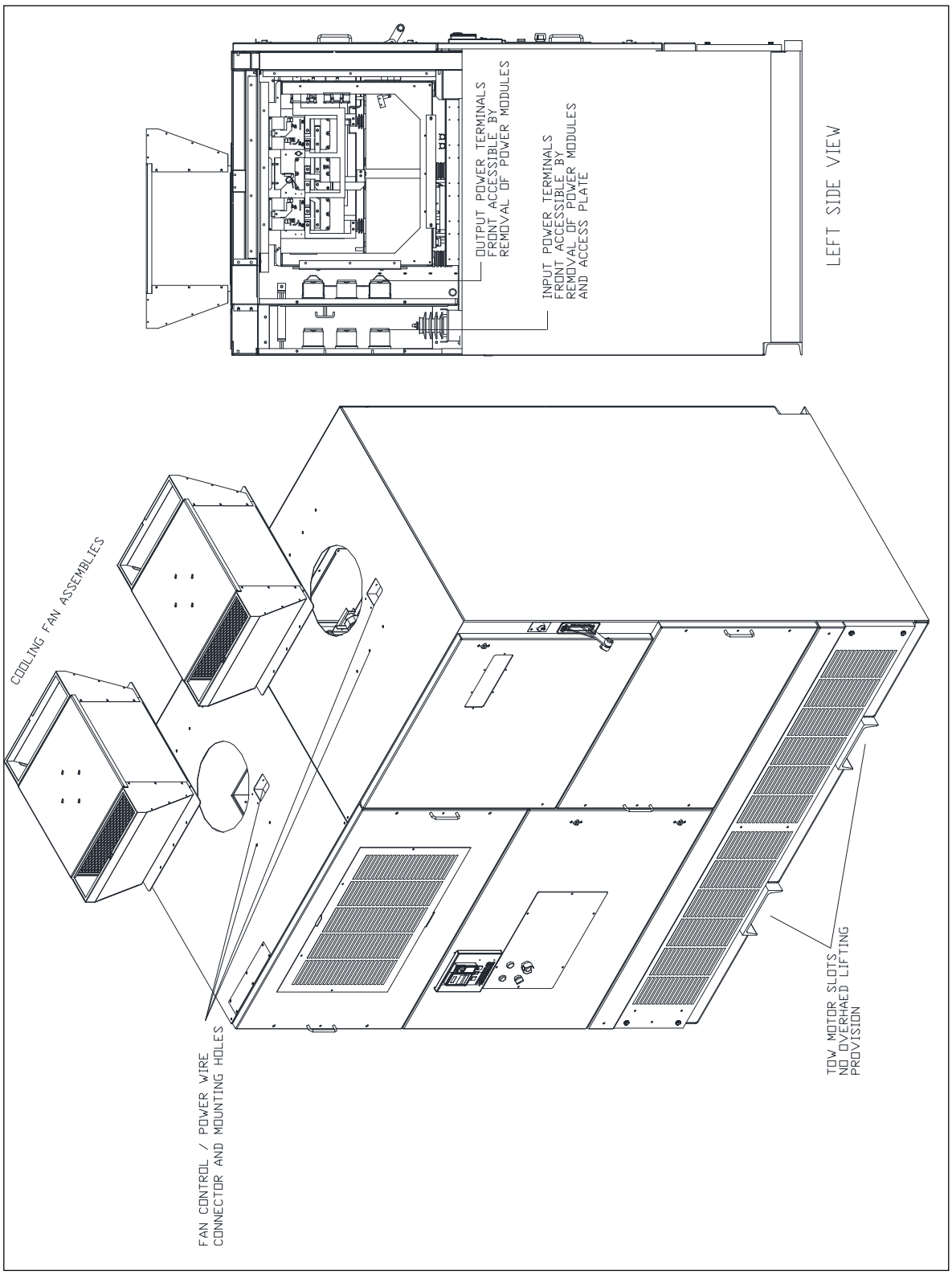
Power Module Installation

1. **Pull slide tray out until slides lock.**
2. **Using module lifting attachment and lifter, place module on tray.**
3. **Secure module to tray with four "C" bolts.**
4. **Press slide release buttons and slide module into compartment (use caution).**
5. **Reconnect control signal cable and 120VAC supply cable to module connectors.**
6. **Reinstall control wiring cover and secure with two "A" & two "B" bolts.**
7. **Reconnect power cables ACL, P, C & N.**
8. **Reinstall AC neutral bus.**
9. **Torque all power connections (5/16-18 hdwr) to 10-15 ft-lbs.**



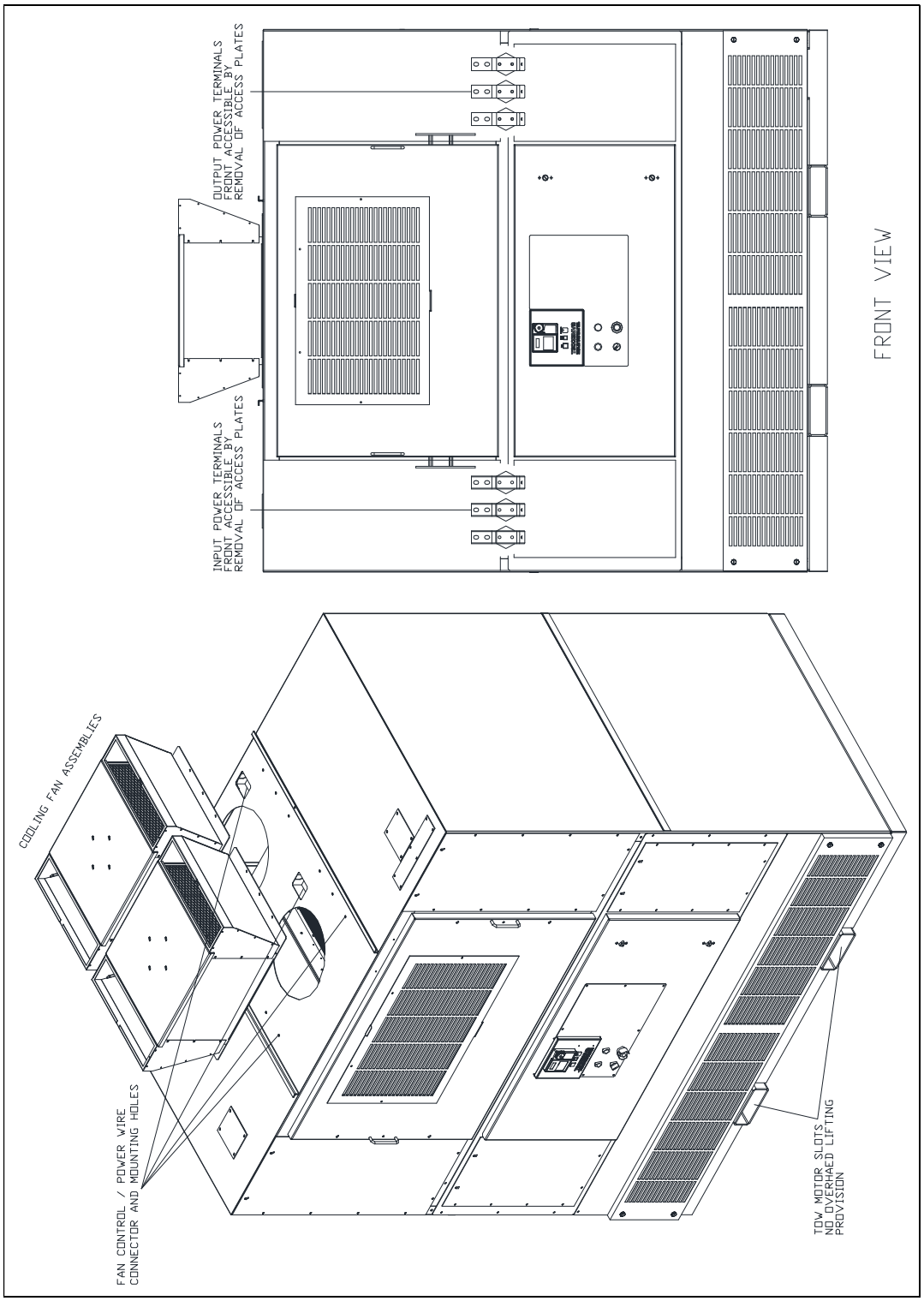
DRIVE INSTALLATION DRAWINGS (cont'd)

Frame B4 drive lifting and assembly



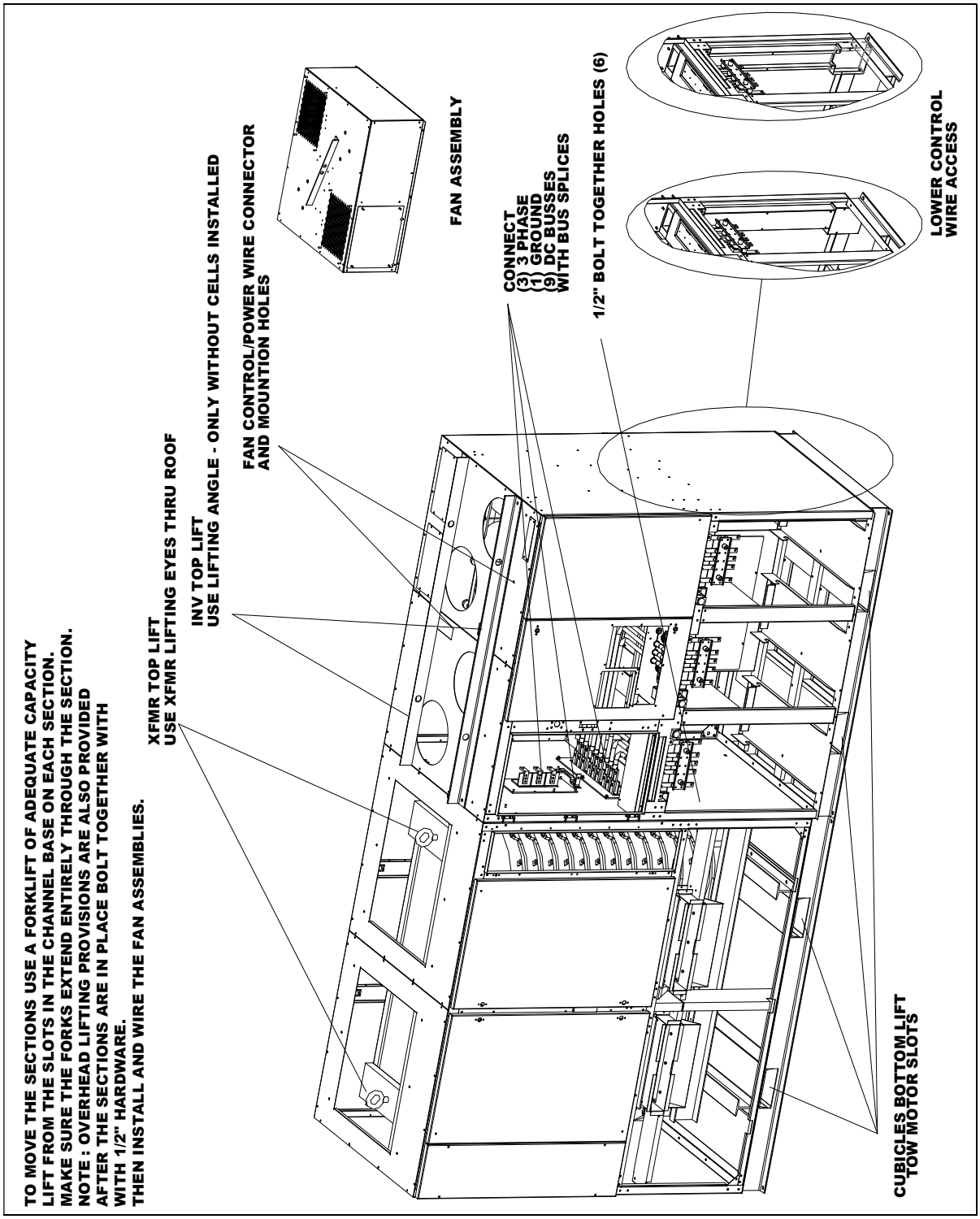
DRIVE INSTALLATION DRAWINGS (cont'd)

Frame BS4 drive lifting and assembly



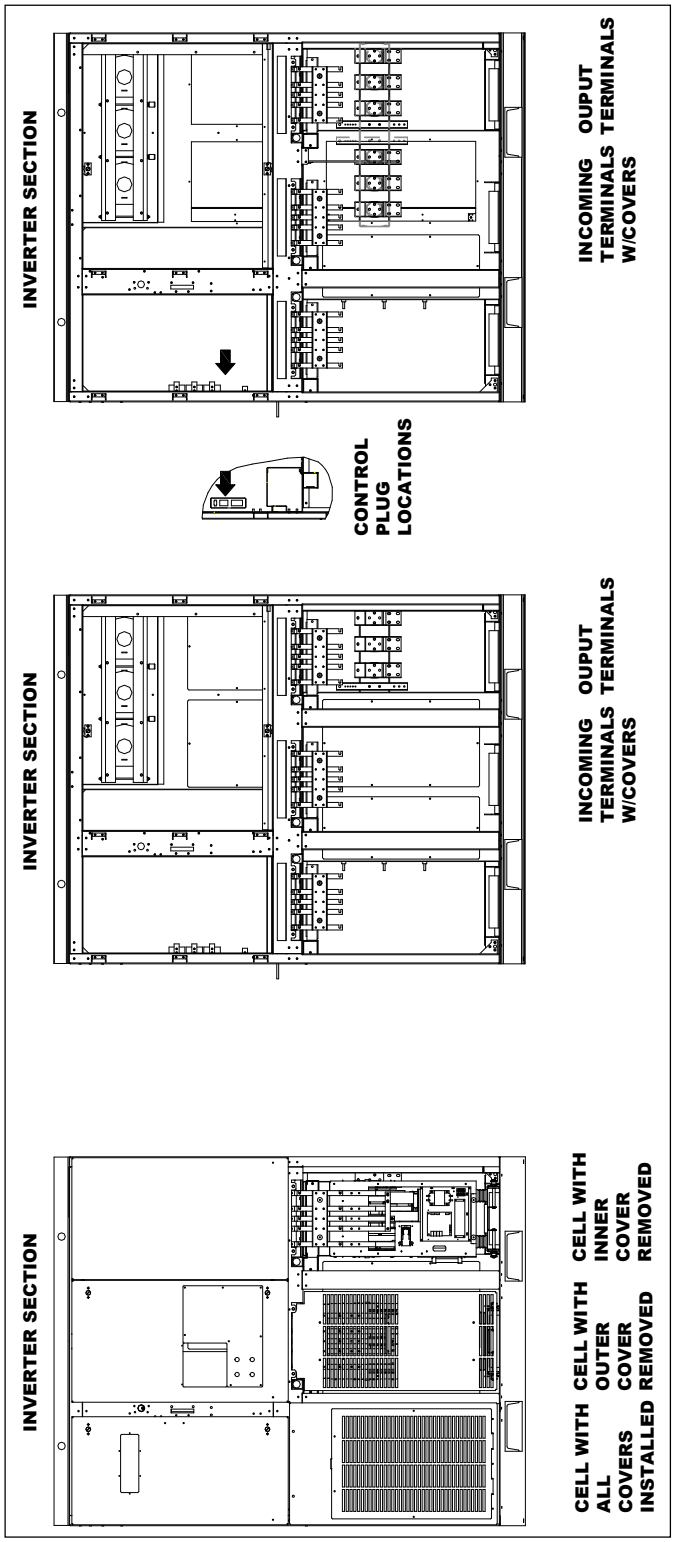
DRIVE INSTALLATION DRAWINGS (cont'd)

Frame C4 drive lifting and assembly



DRIVE INSTALLATION DRAWINGS (cont'd)

Frame C4 drive main cable installation

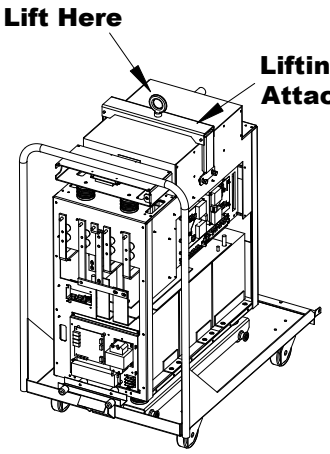


DRIVE INSTALLATION DRAWINGS (cont'd)

Frame C4 module lifting

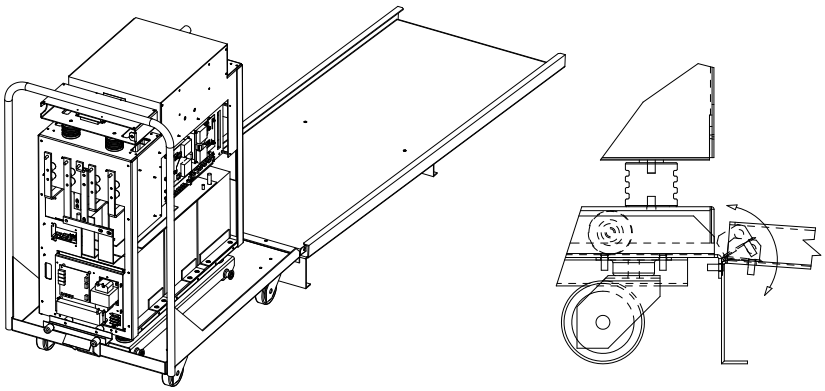
LIFTING PROVISIONS

2 LIFTING PROVISIONS ARE AVAILABLE



1. **Load or remove power module from truck GCI6723G055 using lifting attachment GCI6722G055 and a lifting device rated for 750 lbs or more.**

   Secure lifting attachment to power module using (4) 3/8-16 bolts provided.



2. **Load or remove power module from truck GCI6723G055 using ramp assembly GCI6723G053.**

   Lock truck to ramp by inserting truck pins into ramp holes.

   Set brakes on truck before carefully rolling power module up or down ramp.

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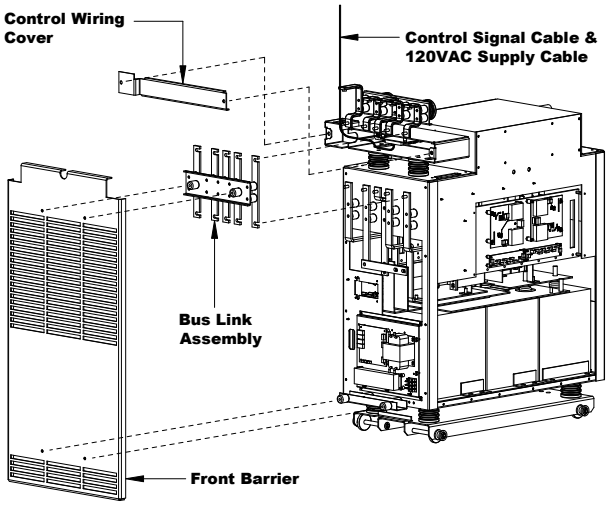
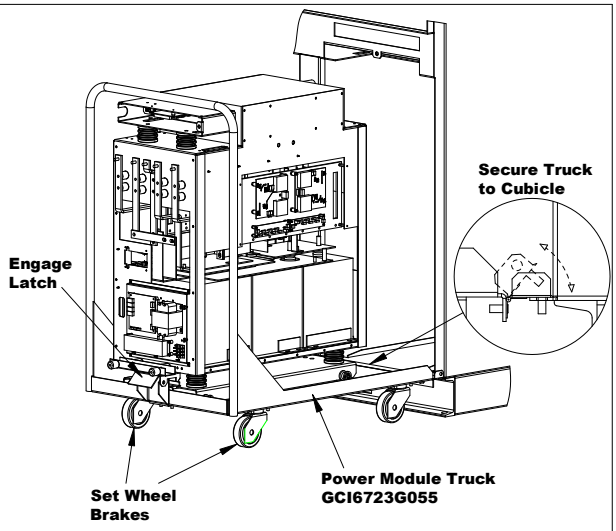
DRIVE INSTALLATION DRAWINGS (cont'd)

Frame C4 4160V module installation



POWER MODULE DISCONNECTION



POWER MODULE REMOVAL

WARNINGS

Disconnect power and wait 15 minutes to ensure capacitors are discharged before performing inspection or maintenance.

Improper handling of the fiber optic cables and connectors may cause drive failure due to problems transmitting signals. Take care not to disturb fiber optic cables when handling power module.

Power Module Disconnection

1. **Remove front barrier (four bolts).**
2. **Loosen ten nuts and remove bus link assembly by sliding sideways and off.**
3. **Remove control wiring cover (two bolts)**
4. **Disconnect control signal cable and 120VAC supply cable from module.**

Power Module Removal

1. **Align truck GCI6723G055 with front of cubicle.**
2. **Secure truck to cubicle by inserting two studs into holes in base.**
3. **Set wheel brakes on truck.**
4. **Roll power module onto truck until front latch engages.**
5. **Refer to additional instruction label for moving power module on and off of truck.**

Power Module Reinstallation

1. **Reverse the procedure followed during disconnection and removal of power module.**
2. **Ensure that control signal cable and 120VAC supply cable are properly reconnected.**
3. **Reinstall all hardware previously removed.**
4. **Torque bus link connections (5/16-18 hdwr) to 10-15 ft-lbs.**

PC94060P097

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