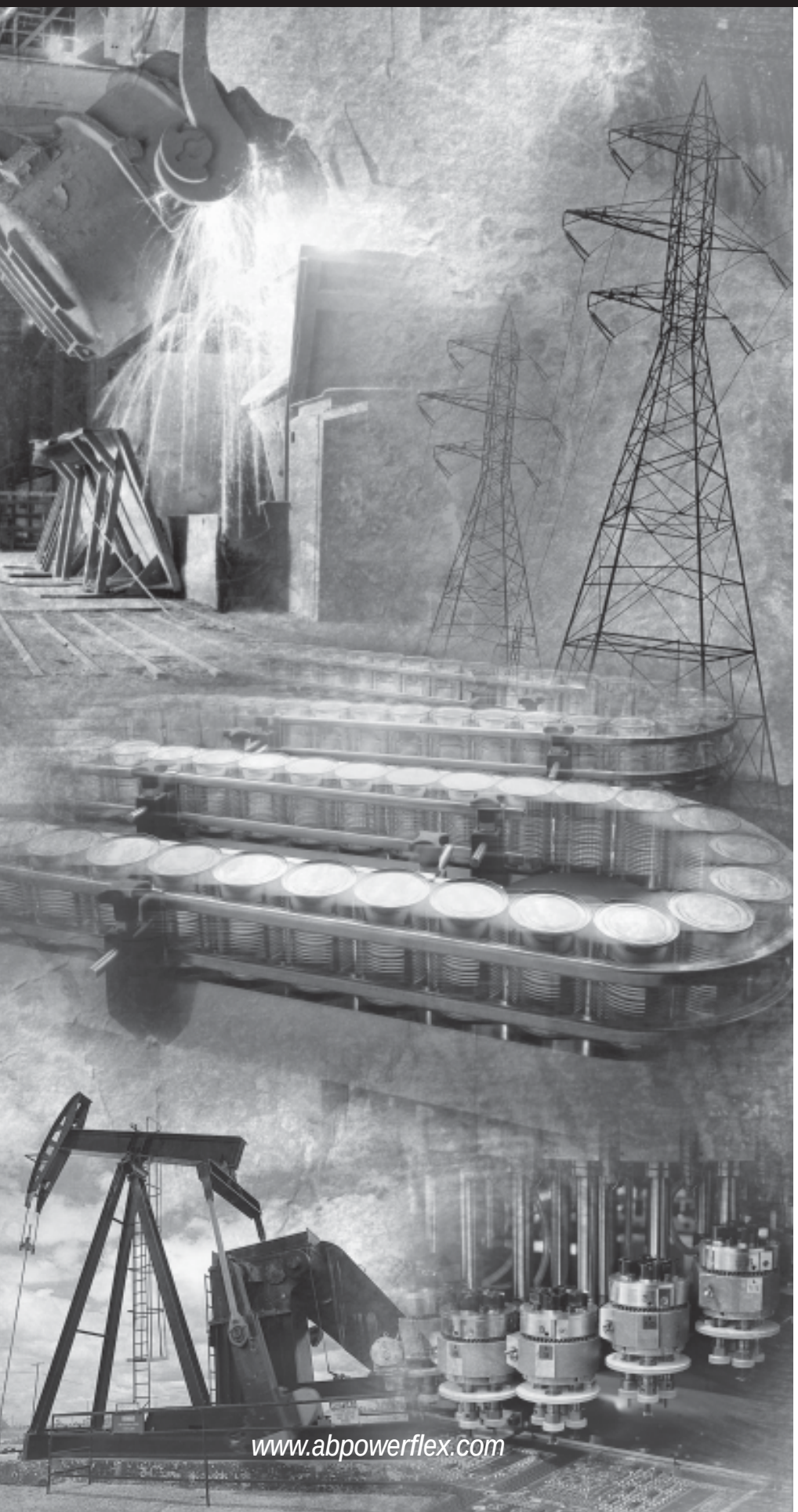

Allen-Bradley

PowerFlex™ 7000

Medium Voltage AC Drive "A" Frame (Air-Cooled)

Technical Data Guide

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at **http://www.ab.com/manuals/gi**) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of these differences, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

WARNING 	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION 	Identifies information about practices or circumstances that that can lead to personal injury or death, property damage, or economic loss. Attentions help you: • identify a hazard • avoid a hazard • recognize the consequence
SHOCK HAZARD 	Labels may be located on or inside the equipment to alert people that dangerous voltage may be present.
BURN HAZARD 	Labels may be located on or inside the equipment to alert people that surfaces may be at a dangerous temperature.

Table of Contents

1. Drive Overview

1.1 Introduction

The PowerFlex™ 7000 "A" Frame medium voltage AC drive is part of the PowerFlex 7000 family of MV drive products. The PowerFlex 7000 "A" Frame Medium Voltage AC drive complements the PowerFlex 7000 MV AC drive product line by offering many of same features and benefits in a much smaller footprint. Designed for end-users, solution providers and OEMs, PowerFlex 7000 "A" Frame drives are suitable for applications ranging from 200 to 1250 horsepower (150 to 933kW).

The PowerFlex 7000 "A" Frame is a general purpose, stand alone medium voltage drive that controls speed, torque, direction, starting, and stopping of standard induction or synchronous AC motors. It is intended for use on a host of standard applications such as fans, pumps, compressors, mixers, conveyors, kilns, fan-pumps and test stands. Primary industries for these applications include petrochemical, cement, mining and metals, forest products, power generation, and water / wastewater.

The PowerFlex 7000 "A" Frame is a global product that adheres to the most common standards from NEC, IEC, NEMA, UL, and CSA. It is available with the world's most common supply voltages at medium voltage, from 2400-6900 volts.

The design focus is on high reliability, ease of use, and lower total cost of ownership.

1.2 Benefits of MV Drives

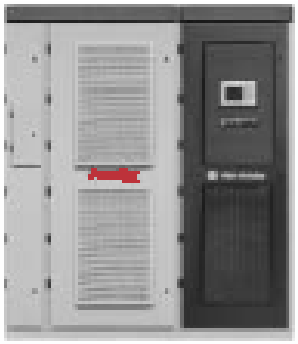
1. Reduced costs
   - energy savings on fans, pumps, compressors, etc.
   - reduced maintenance costs on mechanical equipment
   - increased life of mechanical equipment

2. Improved process control
   - increase productivity
   - greater flexibility
   - environmental compliance

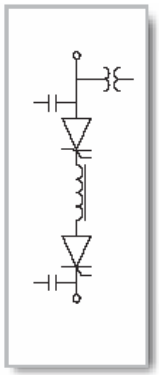
3. Starting large motors on weak power systems
   - eliminate voltage flicker
   - reduce inrush current
   - higher starting torque than reduced voltage starter

1.3 PowerFlex™ 7000 "A" Frame Drive Configurations

Configuration #1
Base Drive



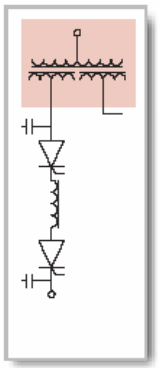
- Optimum installation flexibility with connection to indoor or outdoor isolation transformers.
- Compact packaging for smallest footprint requirements.
- New or existing motors.
- 3 cables in / 3 cables out, for easy installation.
- Integral cooling fan for VFD.
- Low line harmonics & high power factor (with PWM rectifier).
- Fan control power supplied internally (1-Phase control circuit power supplied by customer, 120V / 60 Hz, 110V / 50 Hz, 20 amp).



Base Drive

Configuration #2
Drive with Integral Isolation Transformer

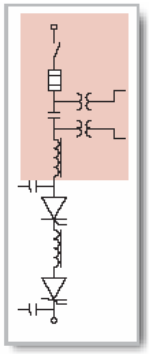
- An integrated system solution for fewer connections and reduced installation costs.
- Small system footprint.
- New or existing motors.
- 3 cables in / 3 cables out for easy installation.
- Integral cooling fan for VFD.
- Low line harmonics & high power factor (with PWM rectifier).
- Fan control power supplied internally.
- Single-phase control circuit power supplied by customer, 120V/60 Hz, 110V / 50 Hz, 20 amp).



Integral Isolation Transformer

Configuration #3
Drive with Integral Line Reactor & Input Starter

- Elimination of isolation transformer results in lower losses and saved space.
- An integrated system solution for fewer connections and reduced installation costs.
- Compatible with new or existing motors.
- Small system footprint.
- 3 cables in / 3 cables out, on entire system for easy installation.
- Integral cooling fan for VFD.
- Low line harmonics & high power factor (with PWM rectifier).
- Internally supplied fan / control power.



Integral Line Reactor **& Input Starter**

1.4 Applications

The PowerFlex 7000™ "A" Frame is intended for use on a host of standard and specialty applications in many different industries:

Petrochemical
- Pipeline pumps
- Gas compressors
- Brine pumps
- Mixers/extruders
- Electric submersible pumps
- Induced draft fans
- Boiler feed water pumps

Mining & Metals
- Slurry pumps
- Ventilation fans
- Descaling pumps
- Conveyors
- Baghouse fans
- Cyclone feed pumps
- Ball mills
- Sag mills

Water/Waste Water
- Raw sewage pumps
- Bio-roughing tower pumps
- Treatment pumps
- Freshwater pumps

Miscellaneous
- Test stands
- Wind tunnels
- Agitators
- Rubber mixers

Forest Products
- Fan pumps
- Induced draft fans
- Boiler feedwater pumps
- Pulpers
- Refiners
- Kiln drives
- Line shafts

Cement
- Kiln induced draft fans
- Forced draft fans
- Cooler baghouse fans
- Preheat tower fans
- Raw mill induced draft fans
- Kiln gas fans
- Cooler exhaust fans
- Separator fans
- Baghouse fans
- Ball mills
- Vertical roller mills
- Kilns

Electric Power
- Feedwater pumps
- Induced draft fans
- Forced draft fans
- Baghouse fans
- Effluent pumps
- Compressors

1.5 Topology

The PowerFlex™ 7000 “A” Frame utilizes a Pulse Width Modulated (PWM) – Current Source Inverter (CSI) for the machine side converter as shown in Figure 1.1. This topology offers a simple, reliable, cost effective power structure that is easy to apply to a wide voltage and power range. Power semiconductor switches are easy to series for any medium voltage level. Semiconductor fuses are not required for the power structure due to the current limiting DC link inductor.

With 6500 volt PIV rated power semiconductor devices, the number of inverter components is kept to a minimum. For example, only six inverter switching devices are required at 2400V, 12 at 3300-4160V, and 18 at 6600V.

The PowerFlex 7000 “A” Frame has the additional benefit of inherent regenerative braking for applications where the load is overhauling the motor, or where high inertia loads need to be slowed down quickly. Symmetrical Gate Commutated Thyristors (SGCTs) are used for machine converter switches. Silicon-controlled rectifiers (SCRs) (for 6 pulse) or SGCTs (for PWM rectifier) are used for the line converter switches.

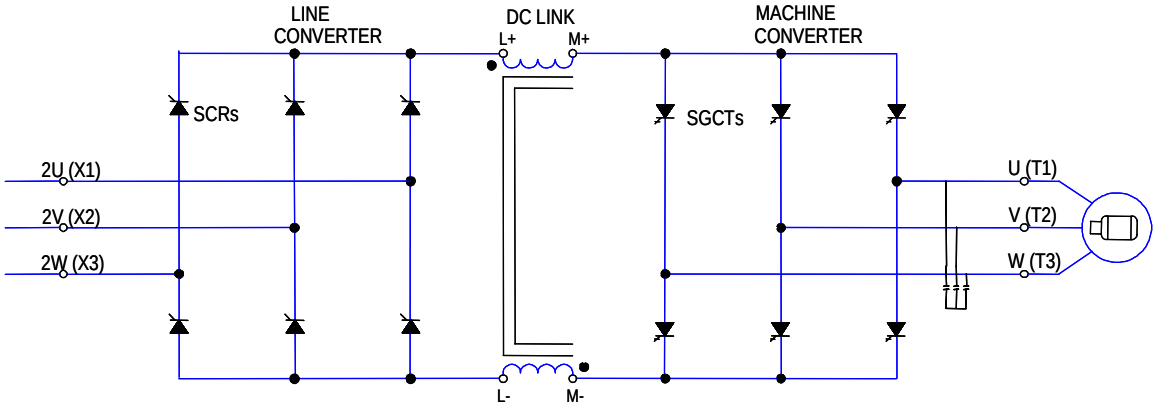


Figure 1.1 – PWM-CSI AC Drive

1.6 Rectifier Designs

There are two standard designs for the rectifier of the PowerFlex 7000 “A” Frame drive – the 6-pulse rectifier and the PWM rectifier.

6-Pulse Rectifier

A 6-pulse thyristor phase controlled rectifier with passive tuned filter is shown in Figure 1.2. The line current before and after the filter is shown. It can be seen that the current before the filter contains the 5^{th}, 7^{th} and 11^{th} harmonics, however, the current after the filter is more sinusoidal since these harmonics are redirected through the tuned filters. The tuned filters also serve to improve input power factor to near unity. The total harmonic distortion (THD) of line current with the 6-pulse rectifier and tuned filters is approximately 5.2%. The THD of line voltage (line-to-line) is approximately 2.6%. (THD of line voltage is a function of system impedance).

The 6-pulse rectifier can be used in conjunction with a rectifier duty isolation transformer, as shown, or with an AC line reactor. A rectifier duty isolation transformer is required when the drive is being applied to existing or retrofit motors or when the supply voltage is higher than the drive rated voltage. (Refer to Specification 80001-005, Rectifier Duty Transformers for more details on transformer requirements and features.)

An AC line reactor can be used in front of the 6-pulse rectifier when the drive is being applied to new motors. (Refer to Specification 80001-004, Stator Insulation Requirements for MV Motors Applied to MV Drives without isolation transformers.) Elimination of the isolation transformer reduces capital and installation costs, saves on valuable floor space, and increases overall system efficiency.

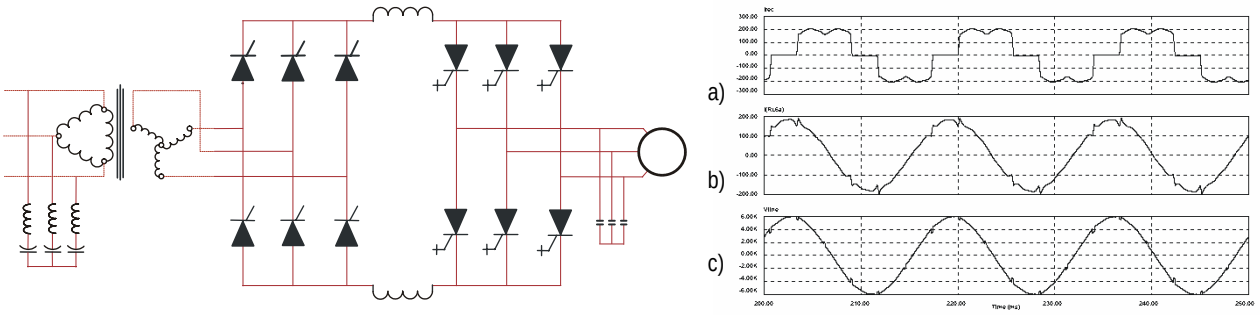


Figure 1.2 – 6-pulse Rectifier with input waveforms
- a) Line current before the filter
- b) Line current after the filter
- c) Line-to-line voltage at point of common coupling (PCC)

PWM Rectifier (Active Front-End)

An active front-end suitable for the PowerFlex™ 7000 "A" Frame topology is called a PWM rectifier. This is particularly attractive for applications since it does not require an isolation transformer to meet IEEE-519. (See Specification 80001-012, Stator Insulation Requirements for Medium Voltage Motors with Common Mode Voltage Elimination). Many competing technologies in today's MV market require a multi-winding transformer to mitigate the unwanted harmonics by phase shifting the transformer secondary windings. Depending on the topology, the transformer can have up to 15 sets of secondary windings.

Elimination of the isolation transformer reduces capital and installation costs, saves on valuable floor space, reduces operating costs, and increases overall system efficiency.

The PWM rectifier requires a switching pattern that complies with similar rules as the inverter. The pattern used for the example shown in Figure 1.4 is a selective harmonic elimination (SHE) pattern, which eliminates the 5^{th}, 7th and 11^{th} harmonics. The input capacitors are designed to reduce the current harmonics of the higher order. The filter resonant frequency is placed below 300 Hz where no residual harmonics exist. This prevents the excitation of system harmonic frequencies. Other factors that are considered when designing the filter are the input power factor and the Total Harmonic Distortion (THD) requirement of input current and voltage waveforms.

The small AC line reactor (see Fig. 1.4) provides additional filtering and current limiting features for a line side short circuit fault. The line current and voltage waveforms are shown in Figure 1.4. The line current THD is approximately 4.5%, while line-to-line voltage THD is approximately 1.5%. (THD of line voltage is a function of system impedance.) Input power factor with the PWM rectifier is near unity from 30-100% speed when applied to variable torque loads.

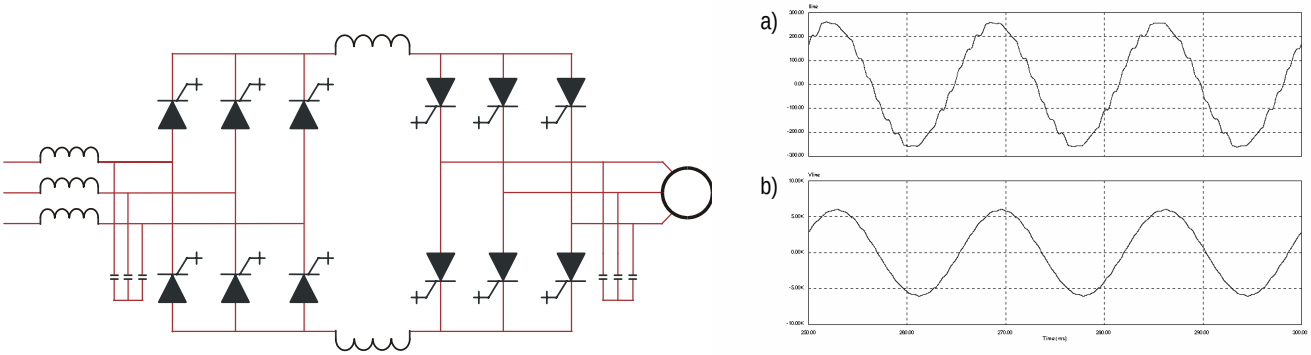


Figure 1.3 – PWM rectifier (active front-end) and its input current/voltage waveforms
a) Line current
b) Line-to-line voltage at PCC

The PWM rectifier can be used in conjunction with a rectifier duty isolation transformer or with an AC line reactor (as shown in Figure 1.3).

Isolation transformers are available:
1. Integral to the drive
2. Remote, indoor dry type
3. Remote outdoor oil filled

This allows for maximum flexibility in dealing with the floor space, installation costs and control room air conditioner loading.

1.7 Motor Compatibility

The PowerFlex™ 7000 “A” Frame achieves near sinusoidal current and voltage waveforms to the motor, resulting in no significant additional heating or insulation stress. Temperature rise in the motor connected to the VFD is typically 3 °C higher compared to across-the-line operation. Dv/dt in the voltage waveform is less than 10 volts / microsecond. The peak voltage that the motor insulation will see is the rated motor RMS voltage divided by 0.707. Reflected wave and dv/dt issues often associated with VSI (voltage source inverter) drives do not exist with the PowerFlex™ 7000. Typical motor waveforms are shown in Figure 1.5. These motor friendly waveforms are achieved by utilizing a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, in conjunction with a small output capacitor (integral to the drive) to eliminate higher order harmonics.

Standard motors are compatible without de-rating, even on retrofit applications.

Motor cable distance is virtually unlimited. This technology is capable of controlling motors up to 15 km (9.32 miles) away from the drive.

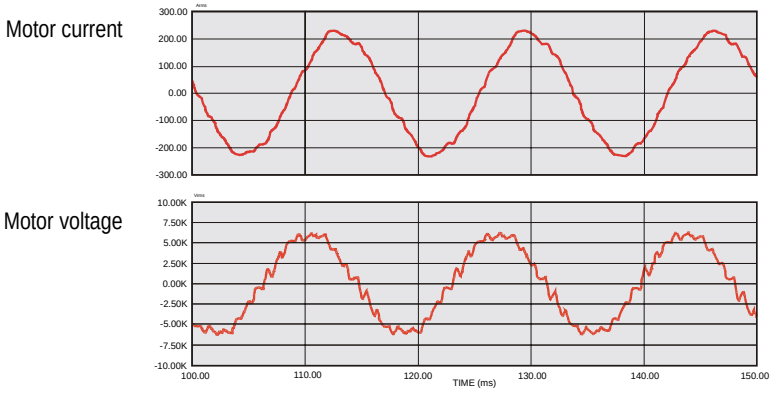


Figure 1.5 – Motor waveforms @ full load, full speed

1.8 SGCT (Symmetrical Gate Commutated Thyristor) Features and Benefits

An SGCT is a thyristor with an integrated gate drive. Positioning the gate drive close to the SGCT as shown in Figure 1.6, creates a low inductance path that provides more efficient and uniform gating of the device. As a result, the device is better suited to handle the fluctuating levels of voltage and current while it is switching on and off during gating.

An SGCT has low conduction and switching losses, low failure rate, and double sided cooling for low thermal stress. The SGCT achieves voltage blocking capability in both forward and reverse directions up to 6500 volts by a NPT (Non-Punch-Through) structure and nearly symmetrical pnp transistor in the wafer, while the current is unidirectional.

Implementing SGCTs in the PowerFlex™ 7000 “A” Frame results in significant advantages including:

1. Simplification of the snubber design and a reduction in the size of the snubber capacitor by a factor of 10.
2. Operation at a higher switching frequency (420-540 Hz), hence reducing the size of passive components (DC link inductor and motor filter cap) by 50%.
3. Improved performance of the drive.
4. Reduction of component count, hence improving reliability, cost, and size of the drive.
5. Ease of service.
6. Non-rupture power device to contain any device failure within the device, eliminating a cascade failure mode.

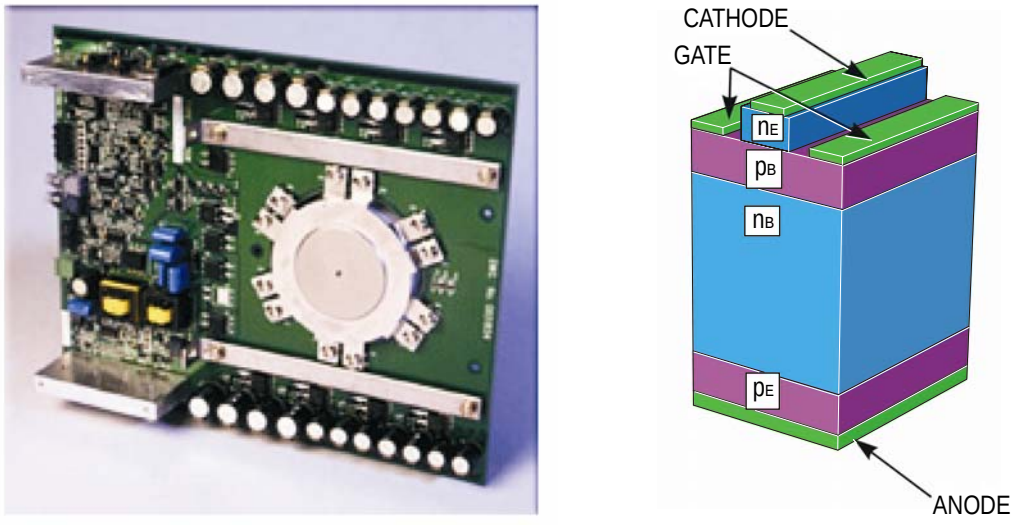


Figure 1.6 – SGCT with integrated gate drive (left) and unit cell structure (right)

2. Control Overview

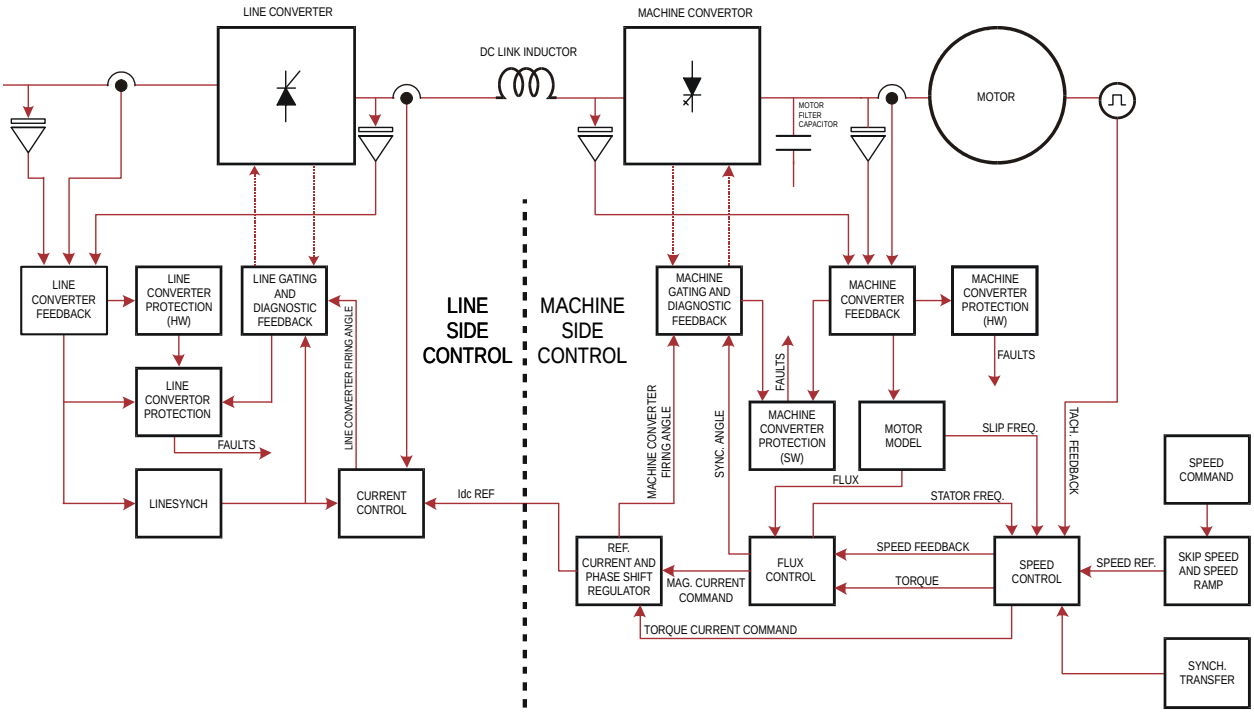


Figure 2.1 – PowerFlex™ 7000 Function Block Diagram

2.1 Direct Vector Control

The method of control in the PowerFlex™ 7000 medium voltage AC drive is called sensorless direct vector control, meaning that the stator current is divided into torque producing and flux producing components, allowing the motor torque to be changed quickly without affecting motor flux. This method of control is used without tachometer feedback for applications requiring continuous operation above 6 Hertz and less than 100% starting torque.

Full vector control can also be achieved with tachometer feedback for applications requiring continuous operation down to 0.2 Hertz with up to 150% starting torque. Either vector control method offers superior performance over volts/hertz type drives. The speed bandwidth range is 5-25 radians per second, while the torque bandwidth range is 15-50 radians per second.

2.2 Control Hardware

The control hardware includes identical drive control boards for machine and line side, complete with up to three fibre optic interface boards (depending on the voltage and number of switching devices), signal conditioning boards for machine and line side, customer interface board and external I/O board. The common drive control boards are used for the rectifier and inverter, induction or synchronous drive control, and the two rectifier types (6 Pulse or PWM Rectifier).

The drive control boards feature a floating point digital signal processor and field programmable gate arrays for advanced functions such as gating and diagnostics, fault handling, and drive synchronization control.

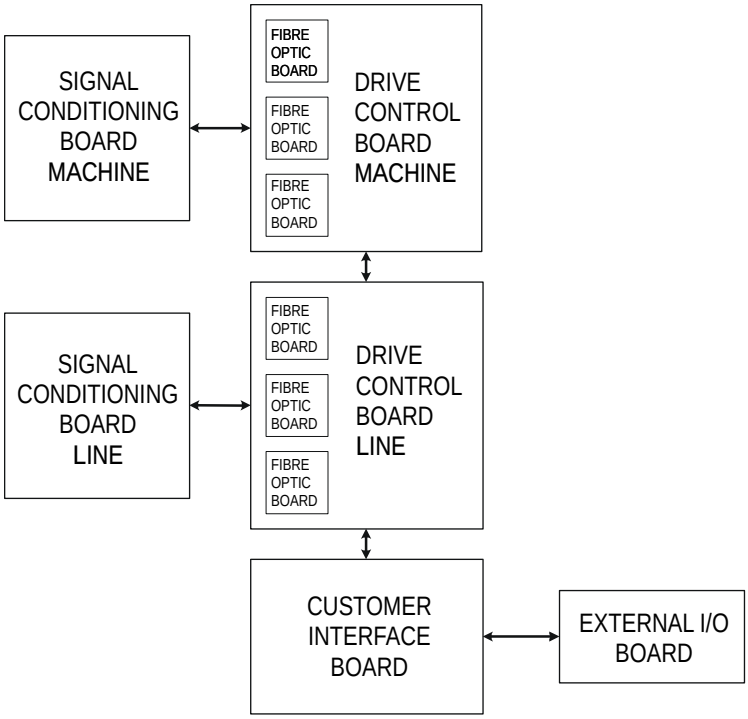


Figure 2.2 – Control Hardware Layout for PowerFlex™ 7000

2.3 Operator Interface

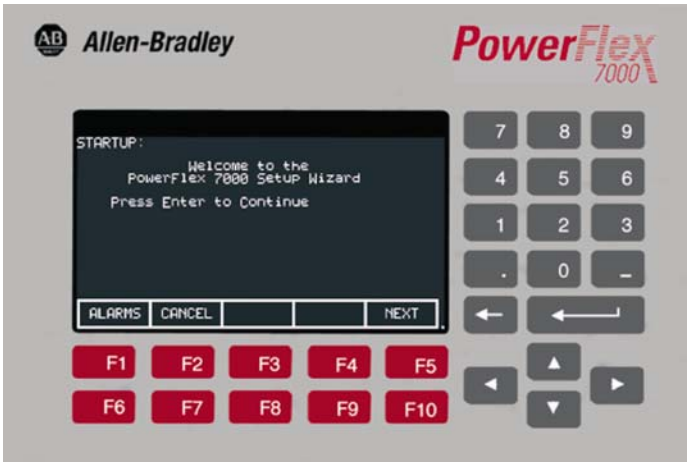


Figure 2.3 – PowerFlex™ 7000 Operator interface terminal

The operator interface terminal features a 16-line, 40-character, pixel based LCD display that makes text and graphics easy to read. Bar chart meters are configurable for common process variables including speed, voltage and load. Elapsed time in hours is also displayed on the main screen.

Everything is user-friendly about the PowerFlex 7000 operator interface terminal including the greeting on the opening screen. The terminal is designed for the greatest ease of use for start-up, monitoring and troubleshooting. The setup wizard helps the user to set the required parameter menus by asking questions or prompting selections for desired operation. Warnings and comments appear, complete with help text, to keep the user on the right track. The setup wizard, combined with the auto-tuning feature, allows the drive to be tuned to the motor and load as quickly and accurately as possible, resulting in fast start-ups, smooth operation, and less down time.

Up to four test modes are available including low voltage gate check, and running at full current without motor connected.

Enhanced diagnostic functions are available on the operator interface terminal including separate fault and warning queues in non-volatile RAM (NVRAM), extended fault text strings and on line help, and trend buffers for 8 variables.

The following operator devices are included as standard on the low voltage door:

- Start Pushbutton
- Stop Pushbutton
- E-Stop Pushbutton
- Speed Potentiometer
- Local/Remote Selector Switch

2.4 Software Interface – DriveTools

DriveTools™ SP Software, is a drive monitoring software that enables users to view and edit their PowerFlex 7000 medium voltage drive parameters either online or offline.

DriveTools SP Software Overview (includes DriveExecutive and DriveObserver software):

- Program, maintain and troubleshoot drives
- Configure drives, adapters and PowerFlex LCD HIMs
- Uses RSLinx for communications
- Communicates with multiple drives via different communication methods simultaneously

DriveExecutive Benefits:

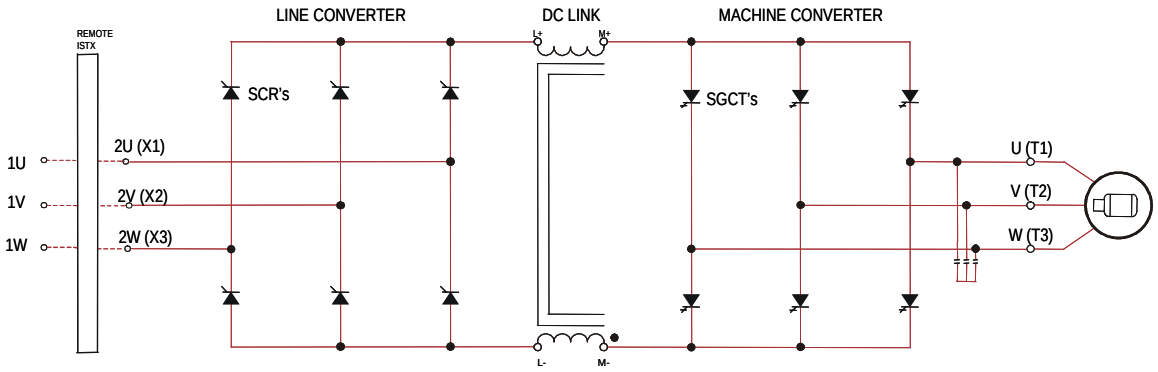
- Immediate visual indication of drive status while you view and edit drive parameters
- Easy access to drive fault and alarm information

DriveObserver Benefits:

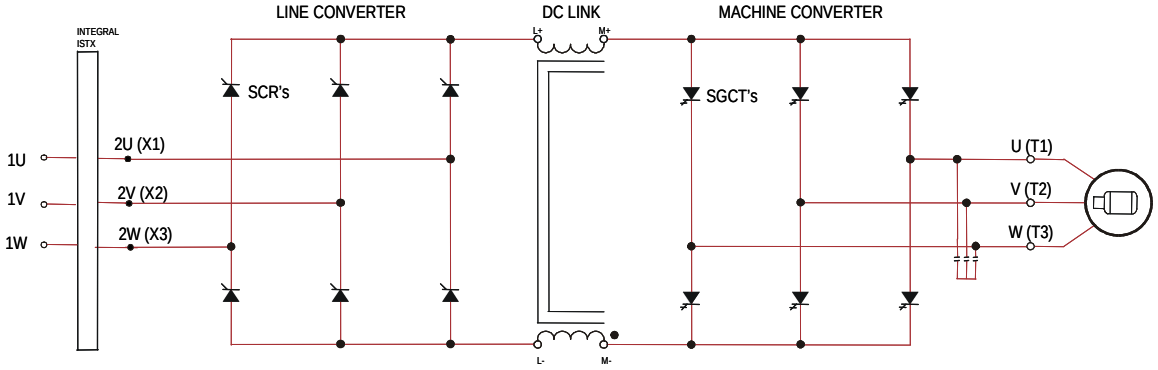
- Provides easy to use interface for creating and using charts
- DriveObserver know the drives the DriveExecutive is already using and shares the behind the scenes database.
- Add non-recorded parameters such as gain parameters, for easy editing access

3. Simplified Electrical Drawings

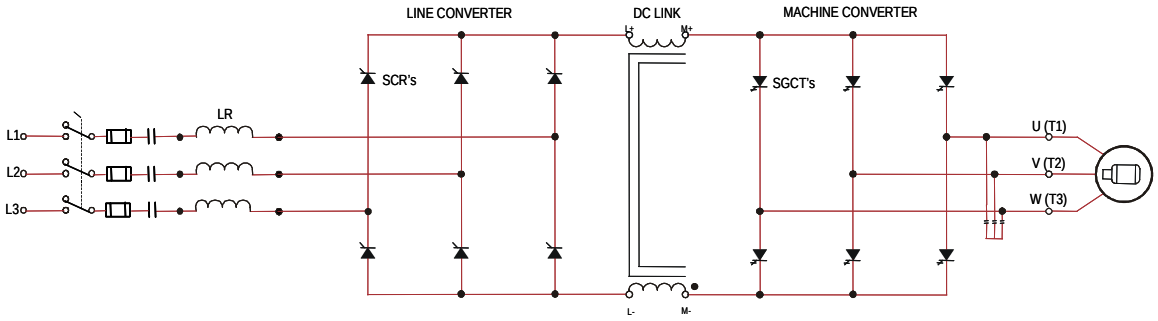
3.1 2400V with 6-Pulse Rectifier



2400 Volt – 6-Pulse Rectifier, Base Drive with Connection for Remote Isolation Transformer

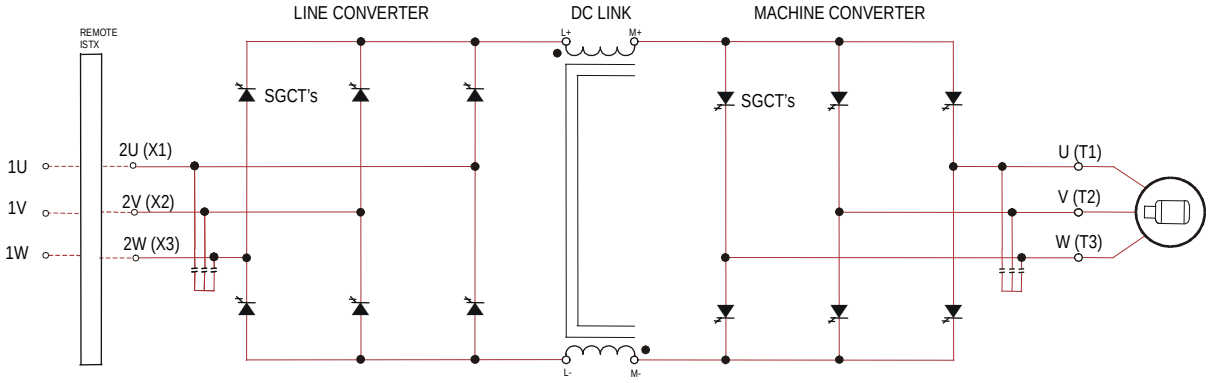


2400 Volt – 6-Pulse Rectifier, Base Drive with Integral Isolation Transformer

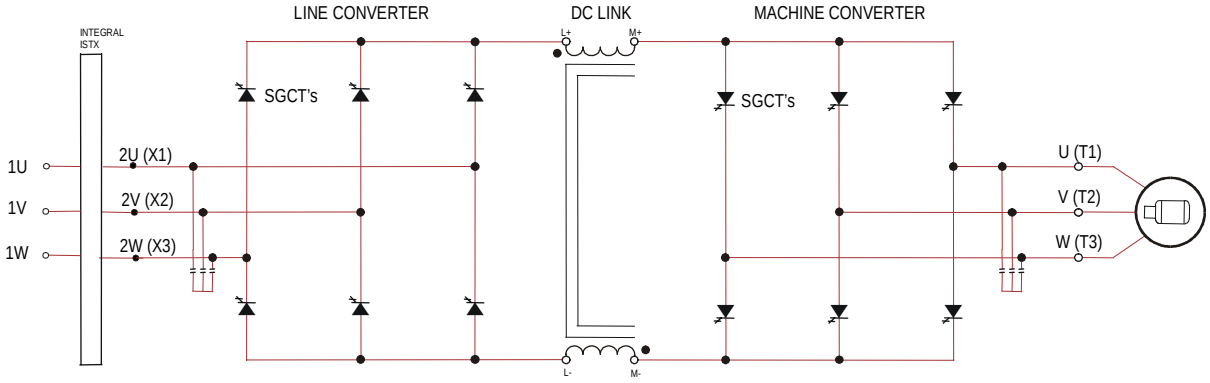


2400 Volt – 6-Pulse Rectifier, Base Drive with Integral Line Reactor and Input Starter
(Configurations without integral sarter are available)

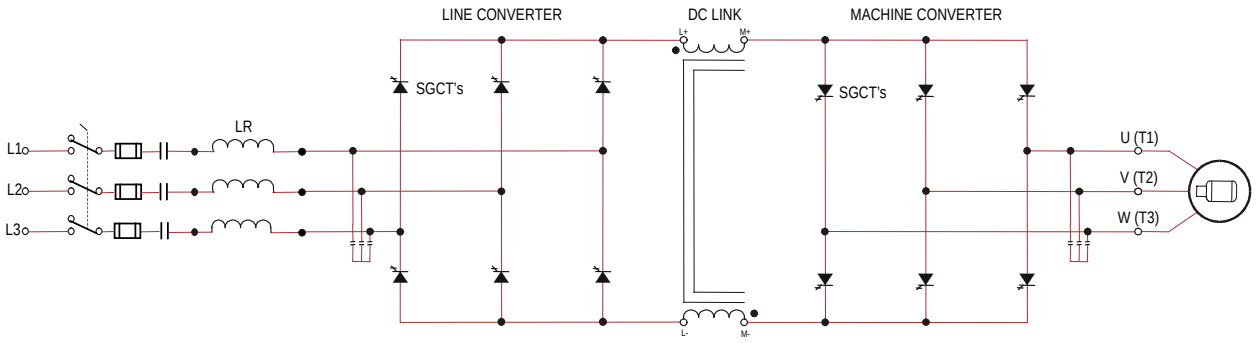
3.2 2400V with PWM Rectifier



2400 Volt – PWM Rectifier, Base Drive with Connection to Remote Isolation Transformer

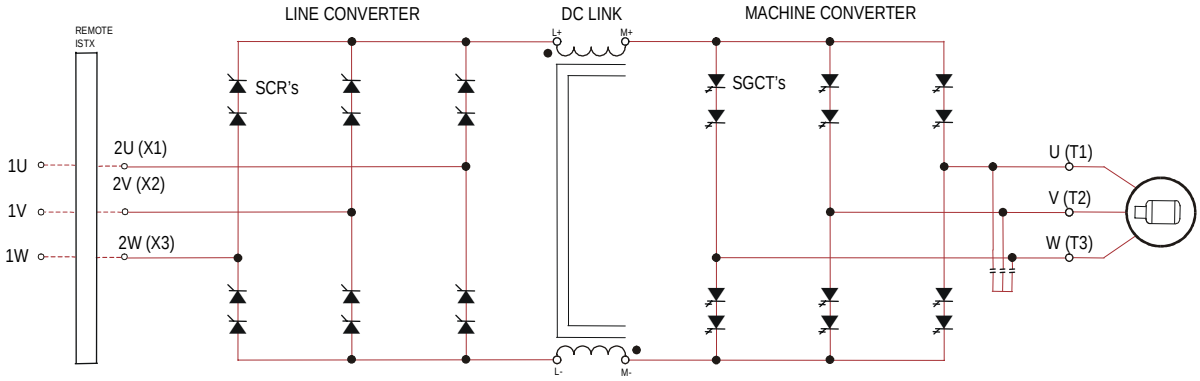


2400 Volt – PWM Rectifier, Base Drive with Integral Isolation Transformer

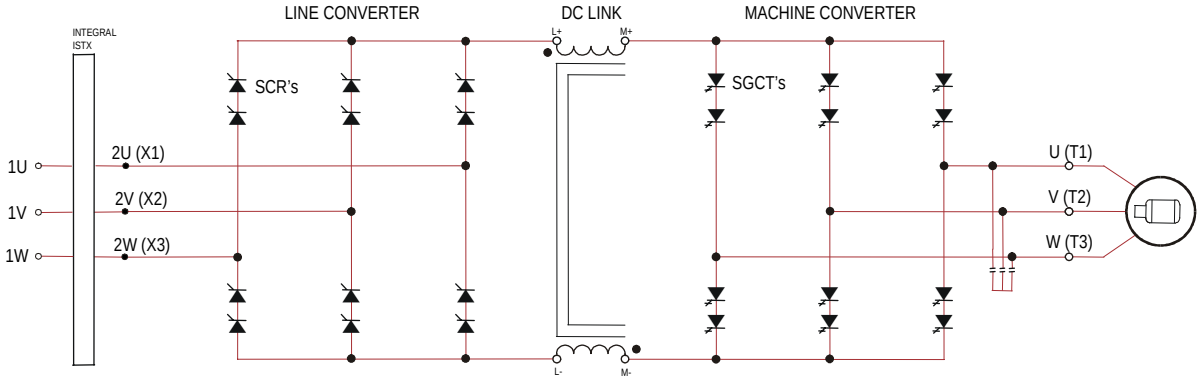


2400 Volt – PWM Rectifier, Base Drive with Integral Line Reactor and Input Starter
(Configurations without integral starter are available)

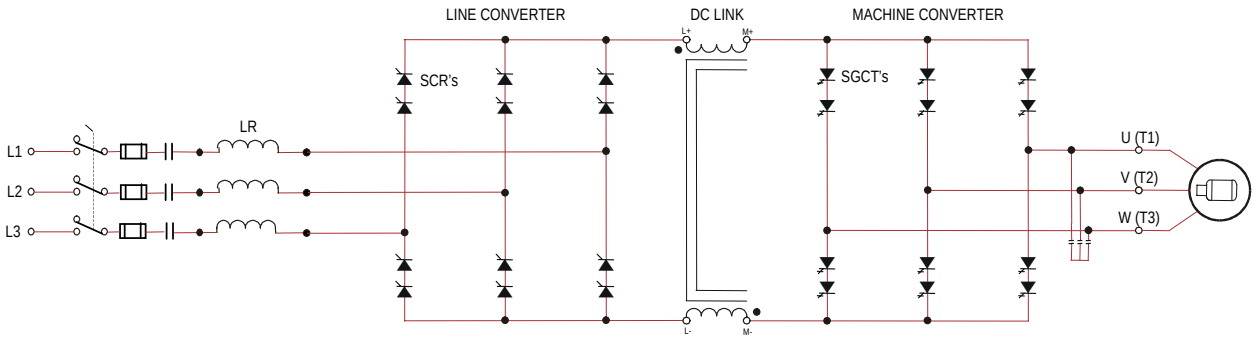
3.3 3300/4160V with 6-Pulse Rectifier



3300/4160 Volt – 6-Pulse Rectifier, Base Drive with Connection for Remote Isolation Transformer

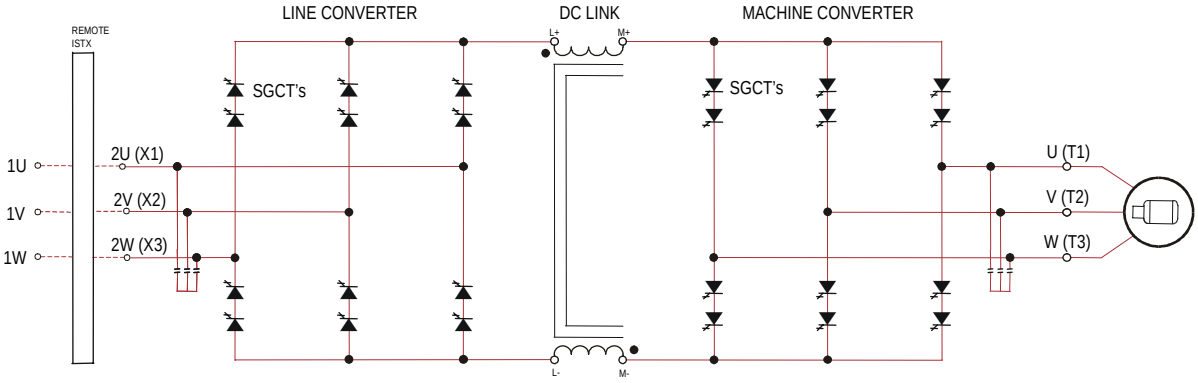


3300/4160 Volt – 6-Pulse Rectifier, Base Drive with Integral Isolation Transformer

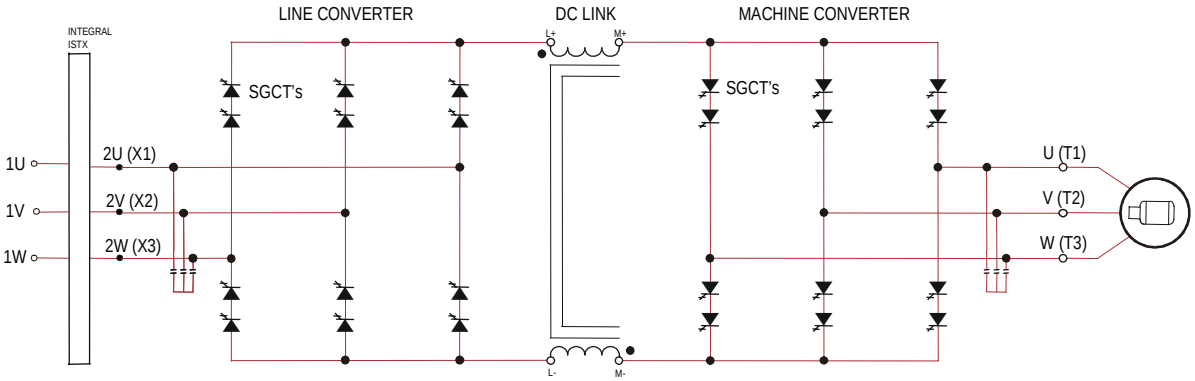


3300/4160 Volt – 6-Pulse Rectifier, Base Drive with Integral Line Reactor and Input Starter
(Configurations without integral starter are available)

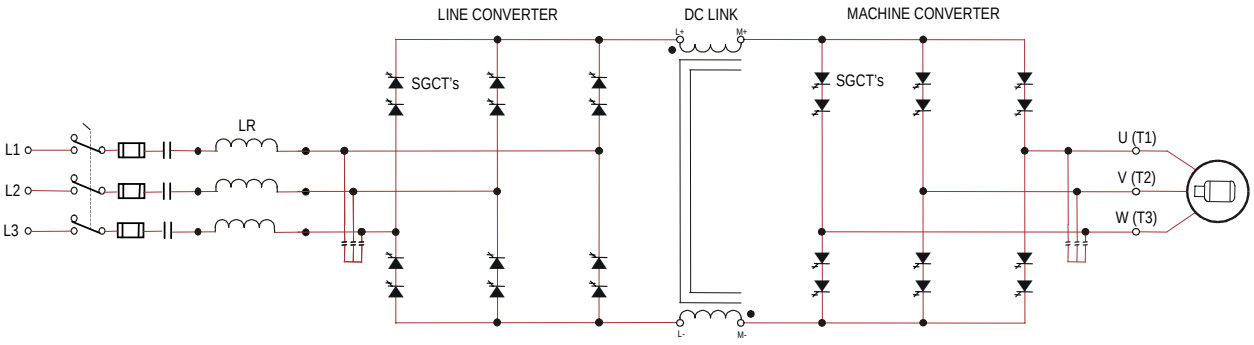
3.4 3300/4160V with PWM Rectifier



3300/4160 Volt – PWM Rectifier, Base Drive with Connection for Remote Isolation Transformer

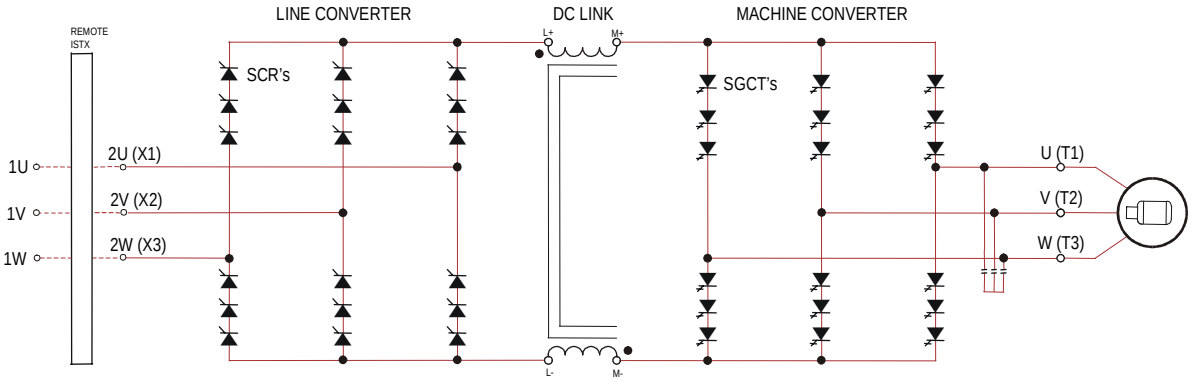


3300/4160 Volt – PWM Rectifier, Base Drive with Integral Isolation Transformer

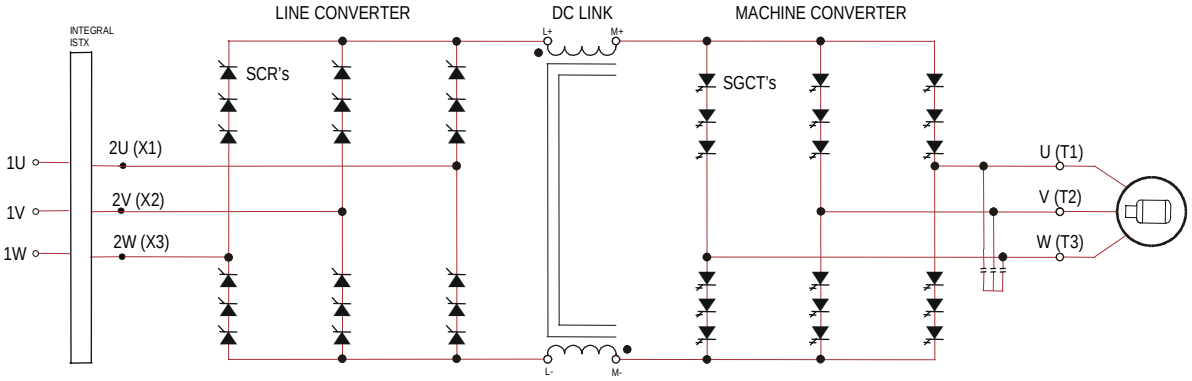


3300/4160 Volt – PWM Rectifier, Base Drive with Integral Line Reactor and Input Starter
(Configurations without integral starter are available)

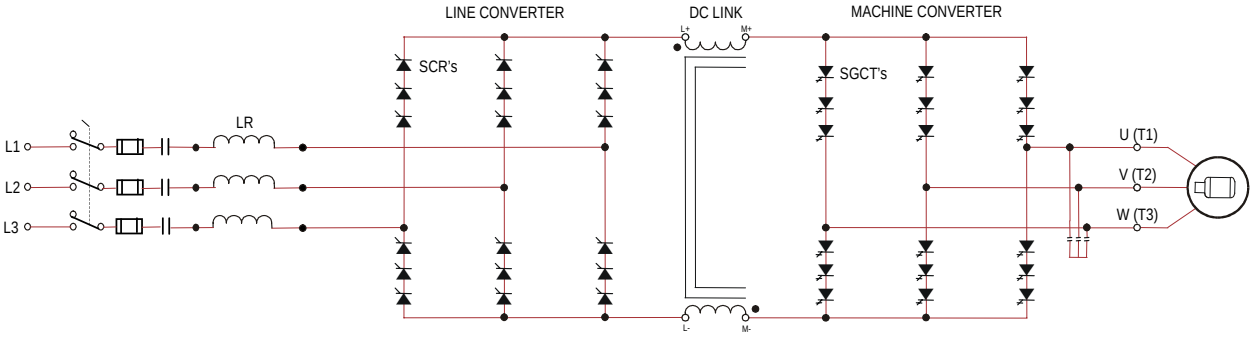
3.5 6600V with 6-Pulse Rectifier



6600 Volt – 6-Pulse Rectifier, Base Drive with Connection for Remote Isolation Transformer

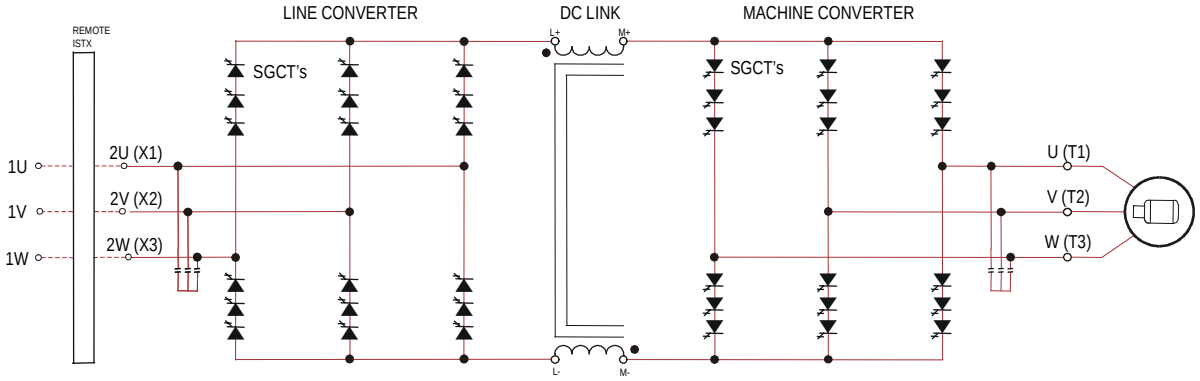


6600 Volt – 6-Pulse Rectifier, Base Drive with Integral Isolation Transformer

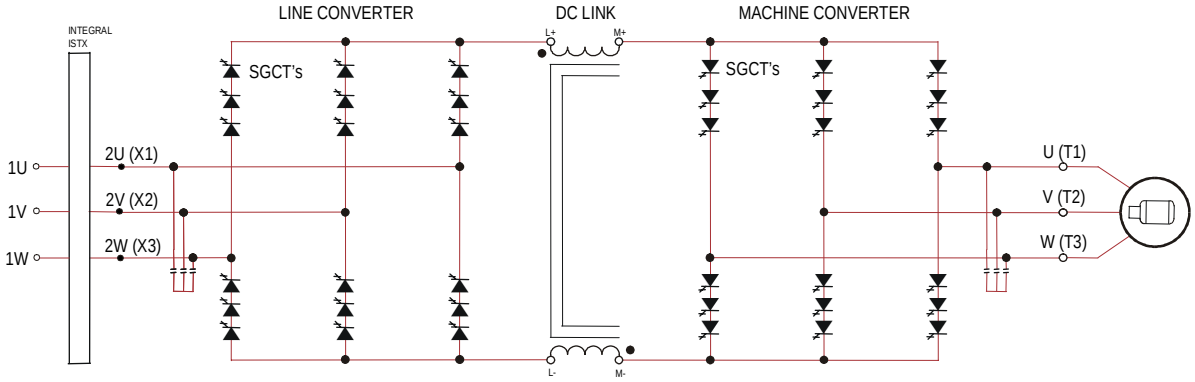


6600 Volt – 6-Pulse Rectifier, Base Drive with Integral Line Reactor and Input Starter
(Configurations without integral starter are available)

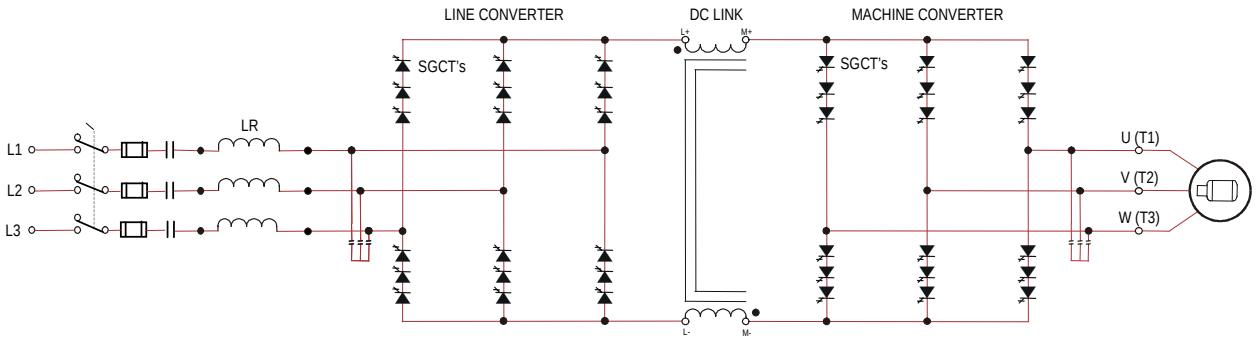
3.6 6600V with PWM Rectifier



6600 Volt – PWM Rectifier, Base Drive with Connection for Remote Isolation Transformer



6600 Volt – PWM Rectifier, Base Drive with Integral Isolation Transformer



6600 Volt – PWM Rectifier, Base Drive with Integral Line Reactor and Input Starter
(Configurations without integral starter are available)

4. MV Drive Selection Explanation

The Bulletin 7000 "A" frame drive selection and pricing tables are based on two (2) types of drive service duty ratings:

1. Normal Duty (110% overload for one (1) Minute, once every 10 minutes) - used for Variable Torque (VT) applications only. Drives with this rating are designed for 100% continuous operation, with 110% overload for one (1) minute, once every 10 minutes.

2. Heavy Duty (150% for one (1) Minute, once every 10 minutes) – used for Constant Torque (CT) or Variable Torque (VT) applications. Drives with this rating are designed for 100% continuous operation, with 150% overload for one (1) minute, once every 10 minutes.

Service Duty Rating, Continuous Current Rating, & Altitude Rating Code

There are seven different codes that define service duty and altitude in the drive catalog number.
For example,

- Catalog number 7000A-A105DEHD-R6TX, has a continuous current rating of 105 amps, with a "normal duty" service rating up to 1000 meters altitude.
- Catalog number 7000A-B105DEHD-R6TX has a continuous rating of 105 amps with a "normal duty" service rating up to 5000 meters altitude at a reduced ambient temperature.
- Catalog number 7000A-C105DEHD-R6TX, has a continuous current rating of 105 amps, with a "heavy duty" service rating up to 1000 meters altitude.

Service Duty Rating and Altitude Rating Code	Continuous Current Capability		Type
	Code	Rating	
A = Normal Duty, 0-1000 m Altitude (Maximum 40°C Ambient)	**40**	40 Amp	Air-Cooled
	46	46 Amp	
	53	53 Amp	
B = Normal Duty, 1001-5000 m Altitude (Reduced Ambient) 1001 – 2000 m = 37.5°C 2001 – 3000 m = 35°C 3001 – 4000 m = 32.5°C 4004 – 5000 m = 30°C	**61**	61 Amp	
	70	70 Amp	
	81	81 Amp	
	93	93 Amp	
	105	105 Amp	
	120	120 Amp	
C= Heavy Duty, 0-1000 m Altitude (Maximum 40°C Ambient)	**140**	140 Amp	
D= Heavy Duty, 1001-5000 m Altitude (Reduced Ambient – Same as '**B'** above)	**160**	160 Amp	
Z = Custom Configuration (Contact Factory)			

Note: Contact factory for assistance sizing air-cooled drives that require greater than 150% overload. To detmine which drive overload rating is best suited for your applications, refer to Table 4.1 on page 23 for typical application load torque profiles.

4.1 Typical Application Load Torque Profiles

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Tachometer Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
Agitators						
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	100	100	Heavy	Yes
Blowers (Centrifugal)						
Damper Closed	VT	30	50	40	Normal	No
Damper Open	VT	40	110	100	Normal	No
Chipper (Wood) Starting Empty	CT	50	40	200	Contact Factory	No
Compressors						
Axial-vane, Centrifugal (Loaded)	VT	40	100	100	Normal	No
Reciprocating, start unloaded	CT	100	100	100	Contact Factory	Yes
Conveyors						
Belt type, loaded	CT	150	130	100	Heavy	Yes
Drag type	CT	175	150	100	Contact Factory	Yes
Screw type, loaded	CT	200	100	100	Contact Factory	Yes
Extruders (Rubber or Plastic)	CT	150	150	100	Contact Factory	Yes
Fans (Centrifugal, ambient)						
Damper closed	VT	25	60	50	Normal	No
Damper open	VT	25	110	100	Normal	No
Fans (Centrifugal, hot gases)						
Damper closed	VT	25	60	100	Normal	No
Damper open	VT	25	200	175	Contact Factory	No
Fans (Propeller, axial flow)	VT	40	110	100	Normal	No
Kilns (Rotary, loaded)	CT	250	125	125	Contact Factory	Yes
Mixers						
Chemical	CT	175	75	100	Contact Factory	Yes
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	125	100	Heavy	Yes
Solids	CT	175	125	175	Contact Factory	Yes
Pulper	VT	40	100	150	Contact Factory	No
Pumps						
Centrifugal, Discharge open	VT	40	100	100	Normal	No
Oil field Flywheel	CT	150	200	200	Contact Factory	Yes
Propeller	VT	40	100	100	Normal	No
Fan Pump	VT	40	100	100	Normal	No
Reciprocating / Positive Displacement	CT	175	30	175	Contact Factory	Yes
Screw type, started dry	VT	75	30	100	Normal	No
Screw type, primed, discharge open	CT	150	100	100	Heavy	Yes
Slurry handling, discharge open	CT	150	100	100	Heavy	Yes
Turbine, Centrifugal, deep-well	VT	50	100	100	Normal	No
Vane-type, positive displacement	CT	150	150	175	Contact Factory	Yes
Separators, air (fan type)	VT	40	100	100	Normal	No

5. Drive Power Ratings

5.1 *Product Selection – For 6-Pulse and PWM Rectifiers (With Integral Line Reactor & Input Starter)*

Nominal Line Voltage	VFD Continuous Current (Amps)	Nominal Motor Kilowatts (Reference only)❶	Nominal Motor Horsepower (Reference only) ❶	Structure Code	CATALOG NUMBER Enclosure Type **D = NEMA Type 1 w/gaskets & vents (IEC IP 21)**
2400 (60Hz)	46	150	200	71.4	7000A – A46DA – R_LR
	53	168	225		7000A – A53DA – R_LR
	61	187	250		7000A – A61DA – R_LR
	70	225	300		7000A – A70DA – R_LR
	81	261	350		7000A – A81DA – R_LR
	93	300	400		7000A – A93DA – R_LR
	105	335	450		7000A – A105DA – R_LR
	120	373	500		7000A – A120DA – R_LR
	140	450	600		7000A – A140DA – R_LR
	160	522	700		7000A – A160DA – R_LR
3300 (50Hz)	46	187	250	71.4	7000A – A46DCY – R_LR
	53	225	300		7000A – A53DCY – R_LR
	61	261	350		7000A – A61DCY – R_LR
	70	300	400		7000A – A70DCY – R_LR
	81	373	500		7000A – A81DCY – R_LR
	93	410	550		7000A – A93DCY – R_LR
	105	450	600		7000A – A105DCY – R_LR
	120	560	750		7000A – A120DCY – R_LR
	140	600	800		7000A – A140DCY – R_LR
	160	750	1000		7000A – A160DCY – R_LR
4160 (50/60Hz)	46	261	350	71.4	7000A – A46DE_ – R_LR
	53	300	400		7000A – A53DE_ – R_LR
	61	335	450		7000A – A61DE_ – R_LR
	70	373	500		7000A – A70DE_ – R_LR
	81	450	600		7000A – A81DE_ – R_LR
	93	522	700		7000A – A93DE_ – R_LR
	105	600	800		7000A – A105DE_ – R_LR
	120	671	900		7000A – A120DE_ – R_LR
	140	750	1000		7000A – A140DE_ – R_LR
	160❷	933	1250		7000A – A160DE_ – R_LR
6600 (50Hz)	40	400	500	71.5	7000A – A40DJY –R_LR
	46	410	550		7000A – A46DJY –R_LR
	53	450	600		7000A – A53DJY –R_LR
	61	560	750		7000A – A61DJY –R_LR
	70	671	900		7000A – A70DJY –R_LR
	81	750	1000		7000A – A81DJY –R_LR
	93	895	1200		7000A – A93DJY –R_LR
	105	933	1250		7000A – A105DJY –R_LR

❶ The drive is sized based on assumed motor full load current using “average values” for “4” pole horsepower rated motors. The rated full load current, shown on the motor nameplate, may vary considerably from the list value depending on the specific motor design. If the actual motor full load current exceeds the drive current rating, a higher rated drive will be required at the associated cost.

❷ Not available for 50 Hz applications

5.2 *Product Selection – For 6-Pulse and PWM Rectifiers (With Integral Transformer)*

Nominal Line Voltage	VFD Continuous Current (Amps)	Nominal Motor Kilowatts (Reference only) ❶	Nominal Motor Horsepower (Reference only) ❶	Structure Code	CATALOG NUMBER Enclosure Type **D = NEMA Type 1 w/gaskets & vents (IEC IP 21)**
2400 (60Hz)	46	150	200	71.3	7000A – A46DAD – R_TXI
	53	168	225		7000A – A53DAD – R_TXI
	61	187	250		7000A – A61DAD – R_TXI
	70	225	300		7000A – A70DAD – R_TXI
	81	261	350		7000A - A81DAD - R_TXI
	93	300	400		7000A – A93DAD – R_TXI
	105	335	450		7000A – A105DAD – R_TXI
	120	373	500		7000A – A120DAD – R_TXI
	140	450	600		7000A – A140AD – R_TXI
	160	522	700		7000A – A160AD – R_TXI
3300 (50Hz)	46	187	250	71.3	7000A – A46DCDY – R_TXI
	53	225	300		7000A – A53DCDY – R_TXI
	61	261	350		7000A – A61DCDY – R_TXI
	70	300	400		7000A – A70DCDY – R_TXI
	81	373	500		7000A – A81DCDY – R_TXI
	93	410	550		7000A – A93DCDY – R_TXI
	105	450	600		7000A – A105DCDY – R_TXI
	120	560	750		7000A – A120DCDY – R_TXI
	140	600	800		7000A - A140DCDY – R_TXI
	160	750	1000		7000A - A160DCDY – R_TXI
4160 (50/60Hz)	46	261	350	71.3	7000A – A46DED_ – R_TXI
	53	300	400		7000A – A53DED_ – R_TXI
	61	335	450		7000A – A61DED_ – R_TXI
	70	373	500		7000A – A70DED_ – R_TXI
	81	450	600		7000A – A81DED_ – R_TXI
	93	522	700		7000A – A93DED_ – R_TXI
	105	600	800		7000A – A105DED_ – R_TXI
	120	671	900		7000A – A120DED_ – R_TXI
	140	750	1000		7000A – A140DED_ – R_TXI
	160❷	933	1250		7000A – A160DED_ – R_TXI
6600 (50Hz)	40	400	500	71.6	7000A – A40DJDY –R_TXI
	46	410	550		7000A – A46DJDY –R_TXI
	53	450	600		7000A – A53DJDY –R_TXI
	61	560	750		7000A – A61DJDY –R_TXI
	70	671	900		7000A – A70DJDY –R_TXI
	81	750	1000		7000A – A81DJDY –R_TXI
	93	895	1200		7000A – A93DJDY –R_TXI
	105	933	1250		7000A – A105DJDY –R_TXI

❶ The drive is sized based on assumed motor full load current using “average values” for “4” pole horsepower rated motors. The rated full load current, shown on the motor nameplate, may vary considerably from the list value depending on the specific motor design. If the actual motor full load current exceeds the drive current rating, a higher rated drive will be required at the associated cost.

❷ Not available for 50 Hz applications

Drive Ratings (continued)

5.3 *Product Selection – For 6-Pulse and PWM Rectifiers (For Connection to Remote Transformer)*

Nominal Line Voltage	VFD Continuous Current (Amps)	Nominal Motor Kilowatts (Reference only) ❶	Nominal Motor Horsepower (Reference only) ❶	Structure Code	CATALOG NUMBER Enclosure Type **D = NEMA Type 1 w/gaskets & vents (IEC IP 21)**
2400 (60Hz)	46	150	200	71.7	7000A – A46DAD – R_TX
	53	168	225		7000A – A53DAD – R_TX
	61	187	250		7000A – A61DAD – R_TX
	70	225	300		7000A – A70DAD – R_TX
	81	261	350		7000A – A81DAD – R_TX
	93	300	400		7000A – A93DAD – R_TX
	105	335	450		7000A – A105DAD – R_TX
	120	373	500		7000A – A120DAD – R_TX
	140	450	600		7000A – A140DAD – R_TX
	160	522	700		7000A – A160DAD – R_TX
3300 (50Hz)	46	187	250	71.7	7000A – A46DCDY – R_TX
	53	225	300		7000A – A53DCDY – R_TX
	61	261	350		7000A – A61DCDY – R_TX
	70	300	400		7000A – A70DCDY – R_TX
	81	373	500		7000A – A81DCDY – R_TX
	93	410	550		7000A – A93DCDY – R_TX
	105	450	600		7000A – A105DCDY – R_TX
	120	560	750		7000A – A120DCDY – R_TX
	140	600	800		7000A – A140DCDY – R_TX
	160	750	1000		7000A – A160DCDY – R_TX
4160 (50/60Hz)	46	261	350	71.7	7000A – A46DED - R_TX
	53	300	400		7000A – A53DED - R_TX
	61	335	450		7000A – A61DED - R_TX
	70	373	500		7000A – A70DED - R_TX
	81	450	600		7000A – A81DED - R_TX
	93	522	700		7000A – A93DED - R_TX
	105	600	800		7000A – A105DED - R_TX
	120	671	900		7000A – A120DED - R_TX
	140	750	1000		7000A – A140DED – R_TX
	160❷	933	1250		7000A – A160DED – R_TX
6600 (50Hz)	40	400	500	71.8	7000A – A40DJDY – R_TX
	46	410	550		7000A – A46DJDY – R_TX
	53	450	600		7000A – A53DJDY – R_TX
	61	560	750		7000A – A61DJDY – R_TX
	70	671	900		7000A – A70DJDY – R_TX
	81	750	1000		7000A – A81DJDY – R_TX
	93	895	1200		7000A – A93DJDY – R_TX
	105	933	1250		7000A – A105DJDY – R_TX

❶ The drive is sized based on assumed motor full load current using “average values” for “4” pole horsepower rated motors. The rated full load current, shown on the motor nameplate, may vary considerably from the list value depending on the specific motor design. If the actual motor full load current exceeds the drive current rating, a higher rated drive will be required at the associated cost.

❷ Not available for 50 Hz applications

5.4 *Product Selection – For 6-Pulse and PWM Rectifiers (With Integral Line Reactor / Without Starter)*

Nominal Line Voltage	VFD Continuous Current (Amps)	Nominal Motor Kilowatts (Reference only) ❶	Nominal Motor Horsepower (Reference only) ❶	Structure Code	CATALOG NUMBER Enclosure Type **D = NEMA Type 1 w/gaskets & vents (IEC IP 21)**
2400 (60Hz)	46	150	200	71.7	7000A – A46DAD – R_LR–14NS
	53	168	225		7000A – A53DAD – R_LR–14NS
	61	187	250		7000A – A61DAD – R_LR–14NS
	70	225	300		7000A – A70DAD – R_LR–14NS
	81	261	350		7000A – A81DAD – R_LR–14NS
	93	300	400		7000A – A93DAD – R_LR–14NS
	105	335	450		7000A – A105DAD – R_LR–14NS
	120	373	500		7000A – A120DAD – R_LR–14NS
	140	450	600		7000A – A140DAD – R_LR–14NS
	160	522	700		7000A – A160DAD – R_LR–14NS
3300 (50Hz)	46	187	250	71.7	7000A – A46DCDY – R_ LR–14NS
	53	225	300		7000A – A53DCDY – R_ LR–14NS
	61	261	350		7000A – A61DCDY – R_ LR–14NS
	70	300	400		7000A – A70DCDY – R_ LR–14NS
	81	373	500		7000A – A81DCDY – R_ LR–14NS
	93	410	550		7000A – A93DCDY – R_ LR–14NS
	105	450	600		7000A – A105DCDY – R_ LR–14NS
	120	560	750		7000A – A120DCDY – R_ LR–14NS
	140	600	800		7000A – A140DCDY – R_ LR–14NS
	160	750	1000		7000A – A160DCDY – R_ LR–14NS
4160 (50/60Hz)	46	261	350	71.7	7000A – A46DED - R_ LR–14NS
	53	300	400		7000A – A53DED - R_ LR–14NS
	61	335	450		7000A – A61DED - R_ LR–14NS
	70	373	500		7000A – A70DED - R_ LR–14NS
	81	450	600		7000A – A81DED - R_ LR–14NS
	93	522	700		7000A – A93DED - R_ LR–14NS
	105	600	800		7000A – A105DED - R_ LR–14NS
	120	671	900		7000A – A120DED - R_ LR–14NS
	140	750	1000		7000A – A140DED – R_ LR–14NS
	160❷	733	1250		7000A – A160DED – R_ LR–14NS
6600 (50Hz)	40	400	500	71.8	7000A – A40DJDY – R_ LR–14NS
	46	410	550		7000A – A46DJDY – R_ LR–14NS
	53	450	600		7000A – A53DJDY – R_ LR–14NS
	61	560	750		7000A – A61DJDY – R_ LR–14NS
	70	671	900		7000A – A70DJDY – R_ LR–14NS
	81	750	1000		7000A – A81DJDY – R_ LR–14NS
	93	895	1200		7000A – A93DJDY – R_ LR–14NS
	105	933	1250		7000A – A105DJDY – R_ LR–14NS

❶ The drive is sized based on assumed motor full load current using “average values” for “4” pole horsepower rated motors. The rated full load current, shown on the motor nameplate, may vary considerably from the list value depending on the specific motor design. If the actual motor full load current exceeds the drive current rating, a higher rated drive will be required at the associated cost.

❷ Not available for 50 Hz applications

5.5 Drive Options, Modifications and Accessories

Device	Option Number	Description
Door Mounted Push Buttons	**1** ❶ ❷	START, STOP
	1DD ❶	EMERGENCY STOP (Push-Pull)
	1M	JOG
Door Mounted Selector Switches	**3FF**	FORWARD-REVERSE
	3LL ❶	LOCAL-REMOTE
Pilot Lights (Transformer Type) ❸	**4FF**__	FORWARD-REVERSE
	4J-- ❷	ON, OFF (Only available with integral starter)
	4M__ ❷	SYSTEM READY
	4N__ ❷	RUN,READY,FAULT,WARNING
Communication Modules	**13COMMC**	PowerFlex DPI ControlNet Adapter connected to Customer Interface Board
	13COMMD	PowerFlex DPI DeviceNet Adapter connected to Customer Interface Board
	13COMME	PowerFlex DPI Ethernet Adapter connected to Customer Interface Board
	13COMMH	PowerFlex DPI RS-485 HVAC (Modbus RTU / Metasys N2 / Siemens P1) Adapter connected to Customer Interface Board
	13COMMP	PowerFlex DPI Profibus Adapter connected to Customer Interface Board
	13COMMR	PowerFlex DPI RI/O Adapter connected to Customer Interface Board
	13COMMS	PowerFlex DPI RS-485 DF1 Adapter connected to Customer Interface Board
	13MOD	Modem, DIN rail mounted, complete with 1203-GD2, RS-232 to SCANPORT adapter and cables
Door Printer	**14DP**	Door mounted diagnostic printer.
Chinese WinCE Terminal	**14CET**	English/Chinese, WinCE Operator Interface Terminal complete with cables and 24 V DC power supply. Note: This terminal only supports simplified Chinese (used in Mainland China), not traditional Chinese (used in Hong Kong and Taiwan).
Provision for Ducting Exhaust Air	**14RD**	Provision for ducting VFD exhaust air outside control room. Customer is responsible for duct, installation, and required make-up air. Contact factory for specific VFD fan CFM and static pressure drop requirements.
Customer Supplied UPS	**14RT3**	Provision for remote customer supplied UPS for extended ride through.
Tachometer Interface Feedback	**14TF**	Tachometer Interface feedback. Note: This option does not include the tachometer. Customer is responsible for sourcing and mounting the tachometer.
Isolated Analog Signal Interfaces ❹	**14TS1** ❶	Speed reference input (4-20 mA input signal).
	14TS2	Speed output (4-20 mA output signal).
	14TS3	Voltage output (4-20 mA output signal).
	14TS4	Current output (4-20 mA output signal).
	14TS5	Load (kW) output (4-20 mA output signal).
	14TS6	Torque output (4-20 mA output signal).
L.V. Surge Suppressor(s)	**17**	(1) - Low voltage surge suppressor across each coil in the control circuit, where possible.

❶ These options are defaulted ON automatically as part of standard cluster.

❷ Mutually exclusive with 24*ST options.

❸ To specify pilot light lens color, add letter(s) to the option number: A = Amber, B = Blue, C = Clear, G = Green, R = Red.

❹ Maximum of 4 isolated outputs allowed. The first one is no charge and can be configured for speed, voltage, current, load or torque.

Device	Option Number	Description	
Drive System Control Circuits ❶	**24AST**	Single motor synchronous transfer control circuit.	See Table below for operator interfaces featured with options
	24BST	Two motor synchronous transfer control circuit.	
	24CST	Three motor synchronous transfer control circuit.	
	24DST	Four motor synchronous transfer control circuit.	
	24AMB	Isolated bypass control circuit (no synchronization) c/w DRIVE-OFF-BYPASS keylock selector switch	
	24AOP	Output contactor control circuit.	

❶ These options do not include appropriate contactors. Refer to Bulletins 1512M or 1512DO for unit pricing.

5.6 Drive Control Circuit Features

OPERATOR INTERFACE DESCRIPTION	24AST	24BST	24CST	24DST	24AMB
DRIVE-OFF-BYPASS keylock selector switch					1
DRIVE START illuminated pushbutton (red incandescent)	1	2	3	4	
BYPASS START illuminated pushbutton (red incandescent)	1	2	3	4	
STOP illuminated pushbutton (green incandescent)	1	2	3	4	
BYPASS ENABLE-BYPASS DISABLE Keylock selector switch (mounted in LV panel)	1	1	1	1	
TEST START pushbutton (mounted in LV panel)	1	1	1	1	
TEST STOP pushbutton (mounted in LV panel)	1	1	1	1	
PILOT LIGHT TEST pushbutton (mounted in LV panel)	1	1	1	1	
VFD READY pilot light (blue incandescent)	1	1	1	1	
VFD RUN pilot light (red incandescent)	1	1	1	1	
FAULT pilot light (red incandescent)	1	1	1	1	
WARNING pilot light (amber incandescent)	1	1	1	1	
SYSTEM READY pilot light (blue incandescent)	1	1	1	1	

Device	Option Number	Description
Thermistor Relay	**84A1** ❸	Bulletin 817M manual reset thermistor protection relay.
Tec System Temp. Relay ❶	**84L__** ❸	TecSystem T-538 temperature monitor/controller for use with up to eight (8), three-wire RTD inputs. **Note:** A separate channel scanner is not required.

❶ The catalog string number is not complete. Select the appropriate suffix from **Table 2** below to identify the RTD type.

❷ When the relay includes platinum RTD option, the delivery program is PE2. When the relay includes either of the nickel or copper options, the delivery program for the option changes to ENG.

❸ Mutually exclusive with 24*ST options. Motor protection options must be added to each 1512M if required.

Table 2 – RTD Type

RTD Type	Option Number Suffix (Add to Option Number from above Table above, e.g. 84L**P**.)
100 Ohm Platinum	**P**
10 Ohm Copper	**C**
100 Ohm Nickel	**N**
120 Ohm Nickel	**M**

Device	Option Number	Description
Panel Type (3-1/2") Metering ❶	**85MV10**	Panel mounted analog meters (cluster of 4) including output voltage, output amps (load current), **output % speed**, and output kilowatt
	85MV11	Panel mounted analog meters (cluster of 4) including output voltage, output amps (load current), **output (motor) RPM**, and output kilowatt
Auxiliary Contacts	**89D5**	(2) Form 'C' auxiliary contacts for remote indication for each of Ready, Run, Fault, and Warning
Door Mounted Speed Potentiometer	**760A** ❷	10k ohm, single turn potentiometer for 'SPEED' control
Terminal Blocks	**804**	Twenty (20) additional unwired terminal blocks

❶ **Note:** The main menu on the operator interface terminal includes a bar type digital display of the motor RPM, amps, volts and kW. Only one option selection allowed (85MV10 **or** 85MV11).

❷ This option is defaulted ON automatically as part of standard cluster.

Device	Option Number	Description			7000	1508T
Cabinet Space Heaters	**5010E**	Cabinet space heater and thermostat supplied in each section of the unit. Power supplied from an external power source. (150W @ 120/240V)				7000
Motor Space Heater Circuits	**Option Number**	**Heater Circuit Voltage**	**Power Source**	**Heater Size**	**7000**	**1508T**
	5025D	110/120 V	External Power	= 2700 watts	✓	✓
	5035D	220/240 V		= 2500 watts	✓	✓

5.7 Structure Modification and Accessories

Description		Prices 7000A	Delivery Program
Enclosure Paint Finish	Sandtex gray ❶	Standard	PE2
	ANSI 49, medium light gray ❶	15,000	ENG
	ANSI 61, light gray ❶	15,000	
	Special - Customer Specified Color ❶❷	15,000	

❶ The low voltage control door and horizontal wireway covers are always painted Sandtex Black.
❷ When special paint is specified, all external surfaces shall be painted. Consult Cambridge to ensure the specified color is available. The pricing may vary depending upon availability

Description		7000A Air-Cooled Drive
Enclosure Type	NEMA Type 1 with gasketing (IEC IP21)	✓

5.8 Tachometer Requirements

When is a tachometer required?

A tachometer is required under the following conditions:

1. When speed regulation accuracy must be between 0.01 – 0.02% of nominal speed.
2. When the zero speed breakaway torque needed is greater than 90% of continuous running torque.
3. When continuous running speed is greater than or equal to 0.1 Hz, but less than 6 Hz.
4. For minimizing restart times using the flying start capability in forward or reverse direction.
5. Required when attempting to start a motor rotating in reverse direction.

PowerFlex Speed Regulation

	Frequency Output		
	< 6 Hertz	6 – 15 Hertz	Above 15 Hertz
Without Tachometer	Not applicable	0.1 %	0.1 %
With Tachometer	0.02 %	0.01%	0.01%

Notes:

1. Speed Regulation is based on % of motor synchronous speed.
2. Tachometer to be mounted on the AC machine.
3. Operational 15 V Dc Power Supply mounted in drive to power the tachometer as a standard option with the tachometer feedback card.
4. Customer is responsible for providing and mounting of tachometer.
5. Sleeve bearing motors require the tachometer to have an axial movement tolerance.
6. Recommended tachometers are the shaft mounting type, examples are the Avtron 585 and 685 models or the Northstar (Lakeshore) RIM Tach HS85, 12 to 15V models or equivalent. Magneto resistive models are more adaptable to harsh environments.
7. When installing, the tachometer body and electronics must be isolated from ground (options available from the tachometer manufacturer to accomplish this).
8. When cable lengths exceed 1000 ft. for the Northstar or 2000 ft. for the Avtron, consult the factory.

Tachometer Selection:

Recommended Tach PPR	
Motor RPM	Tach ppr
3600	600
3000	600
1800	1024
1500	1024
1200	2048
1000	2048
900	2048
720	2048
600	2048

5.9 Tachometer Specifications

Avtron : 685 Magneto Resistive

ELECTRICAL	
Input Operating Power	
Volts(V+):	11.5 VDC to 15.5 VDC
Current	120mA no load, per output. As loads are added, required current increases. See following examples for added loads:
Cable impedance switching examples	• 320 mA @ 0.05 uF, 15 VDC, 72 kHz Differential • 15mA @ 0.05 uF, 12VDC, 12 kHz,Single ended
Output example	28 mA for Quadrature output into 1KΩ, 15 VDC
Alarm example	+V (OUT) for Alarm 50 mA max.
Outputs:	Square wave from 4428 differential line driver with transient protection
Volts, High	• (+V) – 1.8, min. (0.05 uF, 15VDC, 72 kHz, differential, +V (OUT) @50mA
	• (+V) – 0.6, max. (0.0 uF, no load) Note: Does not include cable IR drop
Volts, Low	0.12 typical, 0.5 max.
Current	1.5 amps peak, 30 mA average typical
Incremental channel	Quadrature square wave, phase A leads phase B for CW rotation as viewed from anti-drive end of the motor (tach mounting end).
Duty cycle	50% +/- 5% (Average)
Transition separation	25% +/- 5% (Average)
Resolution	up to 1200 PPR (see resolution table in the description section).
Marker channel	Once per revolution. Pulse width approximately 1/3 of base PPR period
Alarm Output	Refer to Engineering Note 30.
+V (OUT)	This is a convenience output, internally jumpered to +V operating voltage. It is intended for alarm circuits like solid state relays that can be referenced to +V.
Alarm	Open collector, sink 100 mA max., withstand 50 V max referenced to common. Output goes low on alarm.
MECHANICAL	
Speed range	0-4500 RPM for base PPR of 480
	0-4200 RPM for base PPR of 512
	0-3600 RPM for base PPR of 600
Weight	14 lbs.
ENVIRONMENTAL	
Operating temperature	-20°C to 71°C
Dust and Water	A standard M685 pulse generator is shipped with a universal breather/drain to equalize pressure if the M685 is exposed to temperature cycles and provides a drain for condensate. The labyrinth design limits the entry of dust to normally satisfactory levels, and water spray in any direction has no harmful effect. In environments with stable temperatures, the breather may be replaced with a ¼" pipe plug – making the pulse generator water-tight and dust-tight

Features and Specifications subject to change without notice.

Lakeshore/ Northstar 8500

ELECTRICAL	
Resolution	60, 64, 75, 120, 128, 150, 240, 256, 300, 480, 480Z, 512, 512Z, 600, 600Z, 960, 960Z, 1024, 1024Z, 1200, 1200Z 2048, 2048Z
Frequency Response	0 – 120 kHz
Pulse Code	A, B, Z (Index) and complements (A, B, Z)
Output Pulses	A phase, B phase, @ quadrature 90°
Pulse Duty Cycle	50 +/- 15% (within defined mechanical specifications)
QuadratureAccuracy	90 +/- 22° (within defined mechanical specifications)
Output Type	High speed, differential line driver
Rise and fall time	Less than 1μs @ 10,000 pf typical load
Current consumption	45mA typical plus line driver load
Output current capability	150 mA maximum continuous
ESD Protection	2kV
ENVIRONMENTAL	
Operating Temperature	-40° to 70°C
Operating Humidity	Maximum 90%
Vibration	Minimum 18 g's RMS, 5 – 2000Hz shock spectrum
Shock	1 meter drop tested, min. 30 g's
Chemical Resistance	Salt spray, most solvents, mild acids and bases
Box dimensions/Weight	33.5" (851 mm) x 23" (585mm) x 7.25" (185mm)/5.10 lbs. 2.40 kg.
MECHANICAL	
Maximum operational speed	3,600 RPM
Enclosure material	Ductile iron casting, steel flanges
Radial Runout	.010" (.260 mm) Total Indicated Runout
Allowable axial movement	0.25" (6.4 mm) max.
Unit Weight	25 lbs. Typical (11.4 kg)
Box dimensions / Weight	33.5" (851 mm) x 23" (585mm) x 7.25" (185mm) / 5.10 lbs. 2.40 kg.
INTERFACE	
Power	+5.0 to +15.0 VDC
Output	Differential Output swinging between Vcc – 0.6V and ground
Connector	10 pin industrial latching connector with ½ inch NPT fitting. IP-65 NEMA 4, 12 rated
Suggested Cable	22 – 14 AWG, 6 conductor, shielded, twisted pair

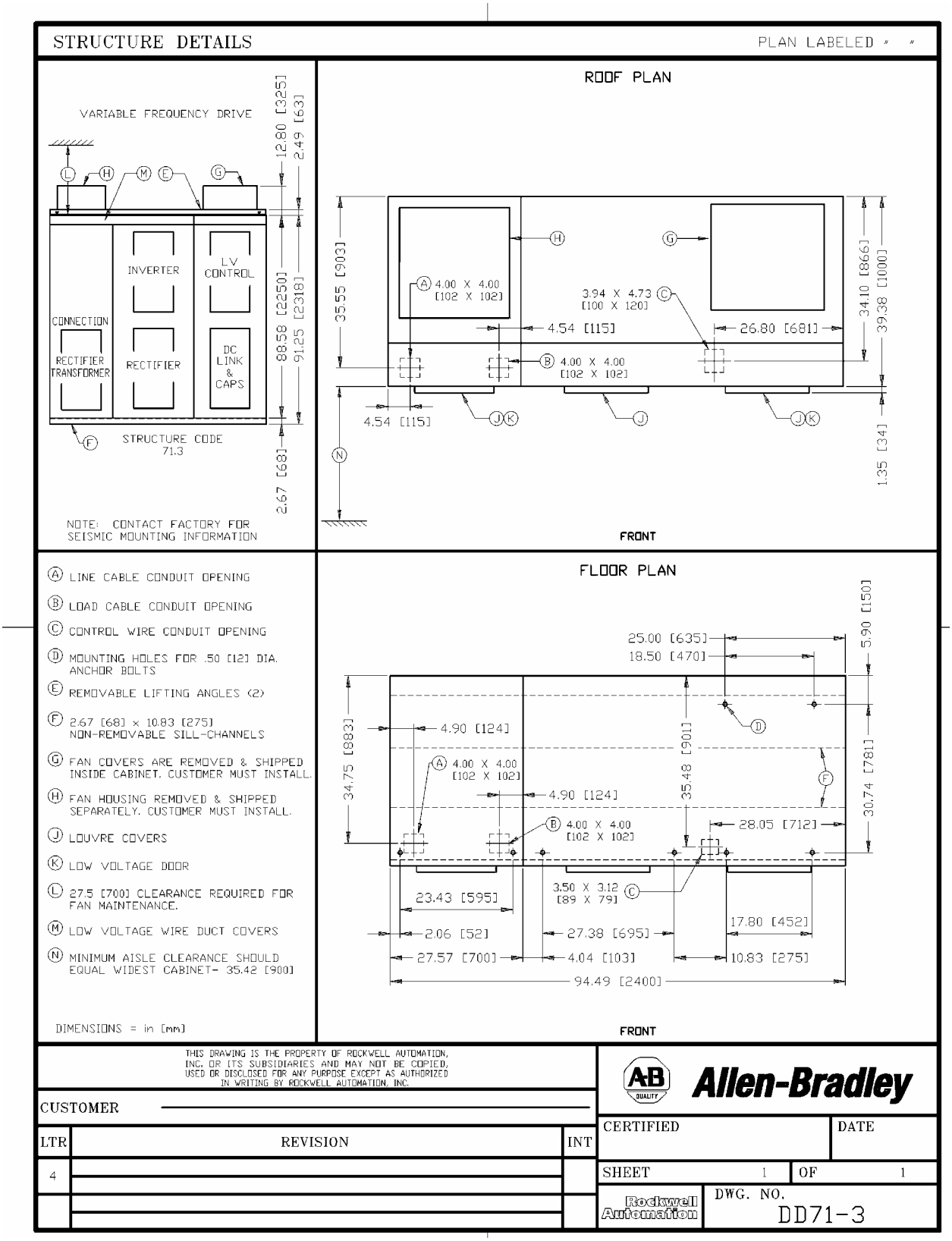
Features and Specifications subject to change without notice.

5.10 Selection for MV Drive Structures ❶

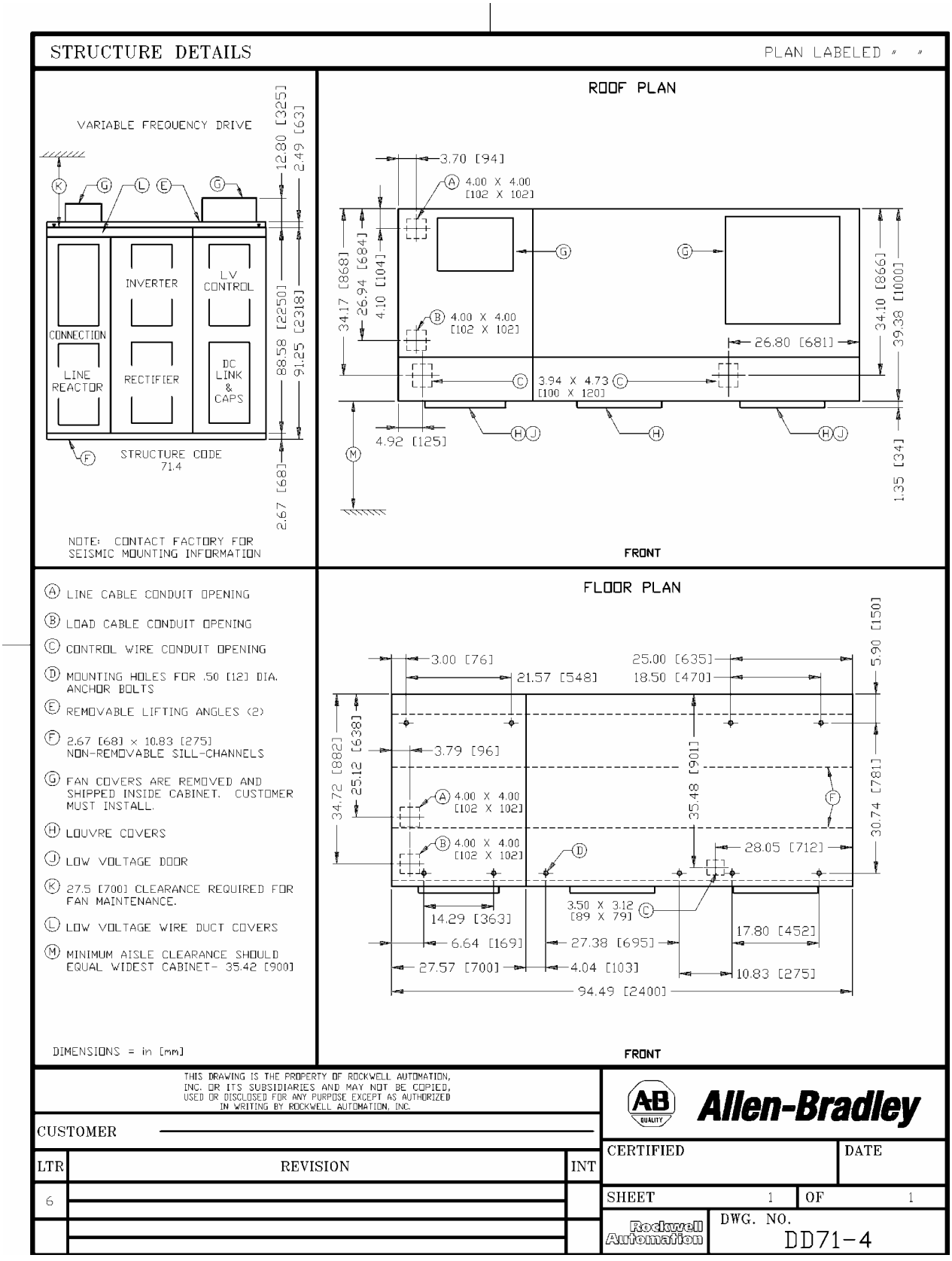
Structure Code	Dimensions in Inches (mm) W x H x D	Approx. Weight lb (kg)	Notes
71.7	82.67 x 104.05 x 39.37 (2100 x 2643 x 1000)	4300 (1955)	
71.8	94.49 x 104.05 x 39.37 (2400 x 2643 x 1000)	4750 (2160)	
71.3	94.49 x 104.05 x 39.37 (2400 x 2643 x 1000)	9800 (4455)	
71.4	94.49 x 104.05 x 39.37 (2400 x 2643 x 1000)	6500 (2955)	
71.5	110.24 x 104.05 x 39.37 (2800 x 2643 x 1000)	7500 (3410)	
71.6	110.24 x 104.05 x 39.37 (2800 x 2643 x 1000)	10000 (4545)	
71.11	94.49 x 104.05 x 39.37 (2400 x 2643 x 1000)	4600 (2100)	
71.12	110.24 x 104.05 x 39.37 (2400 x 2643 x 1000)	6350 (2880)	

❶ The structures are available in a NEMA Type 1 with gasket (IP 21) enclosure only. The power cell doors are vented and an exhaust fan is included inside the structure. (VFD height includes fan housing.)

6. Drive Dimensional Drawings

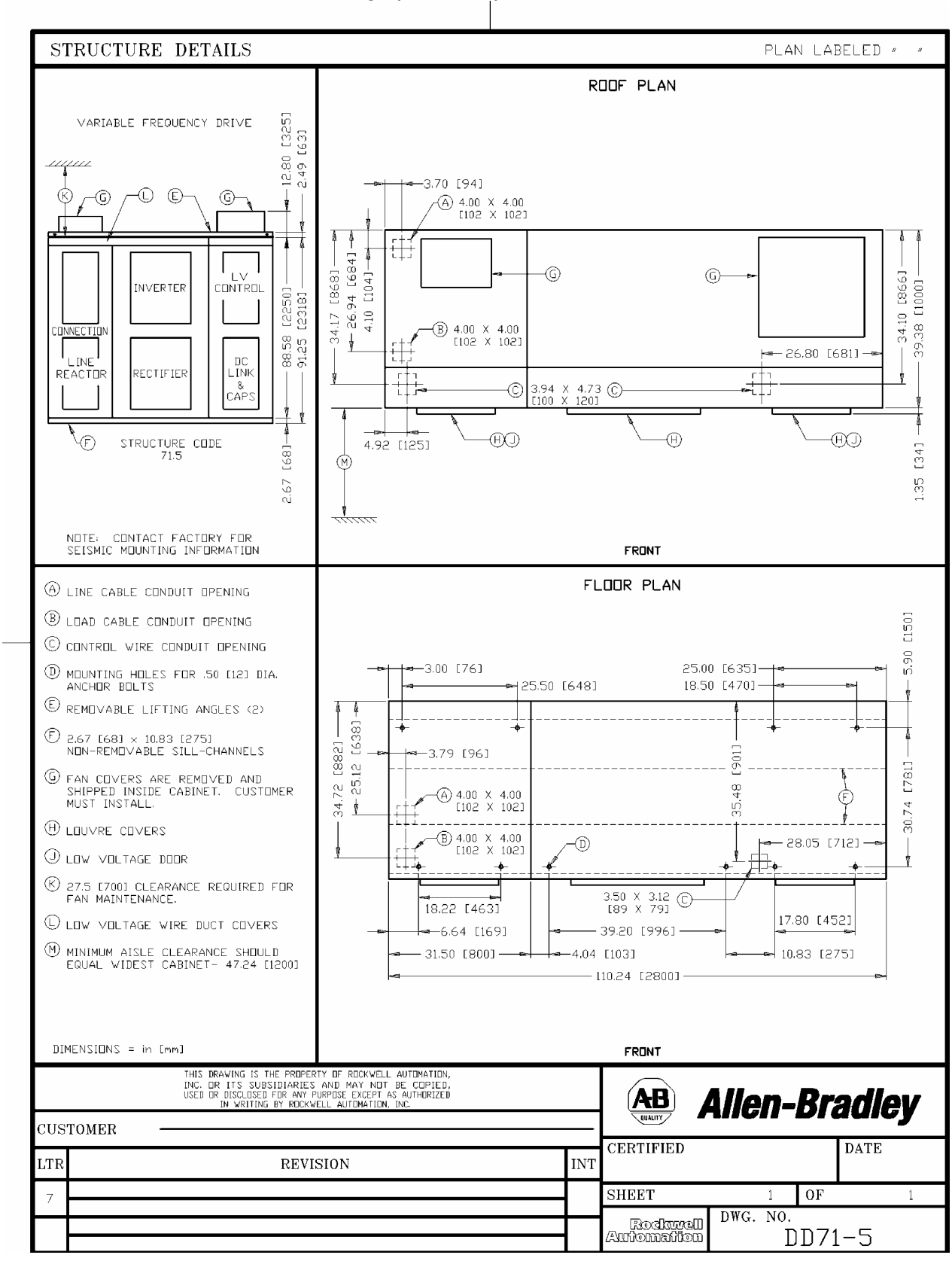


Note: Contact Factory for Seismic Mounting Information.

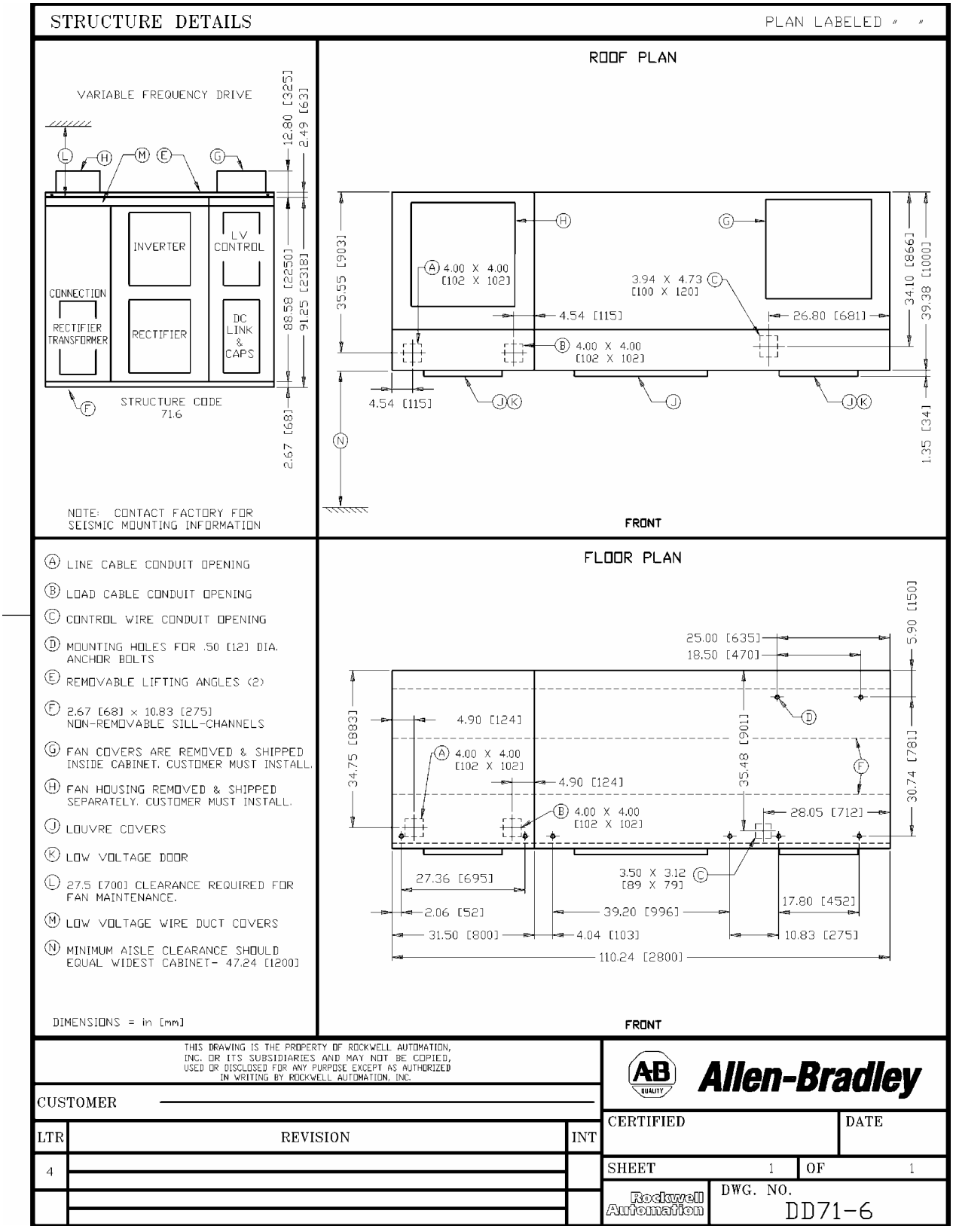


Note: Contact Factory for Seismic Mounting Information.

PowerFlex 7000™ Dimensional Drawings (continued)

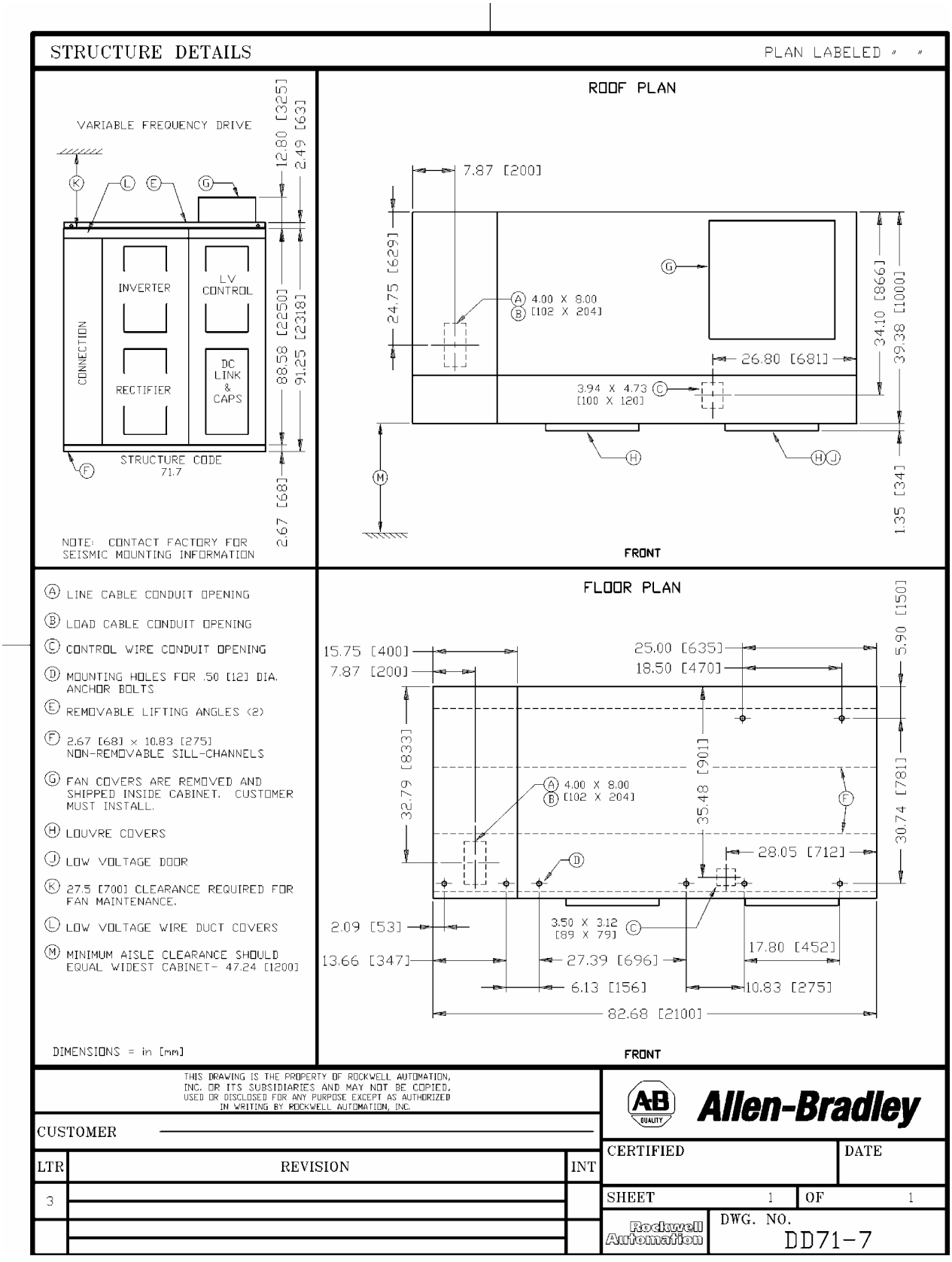


Note: Contact Factory for Seismic Mounting Information.

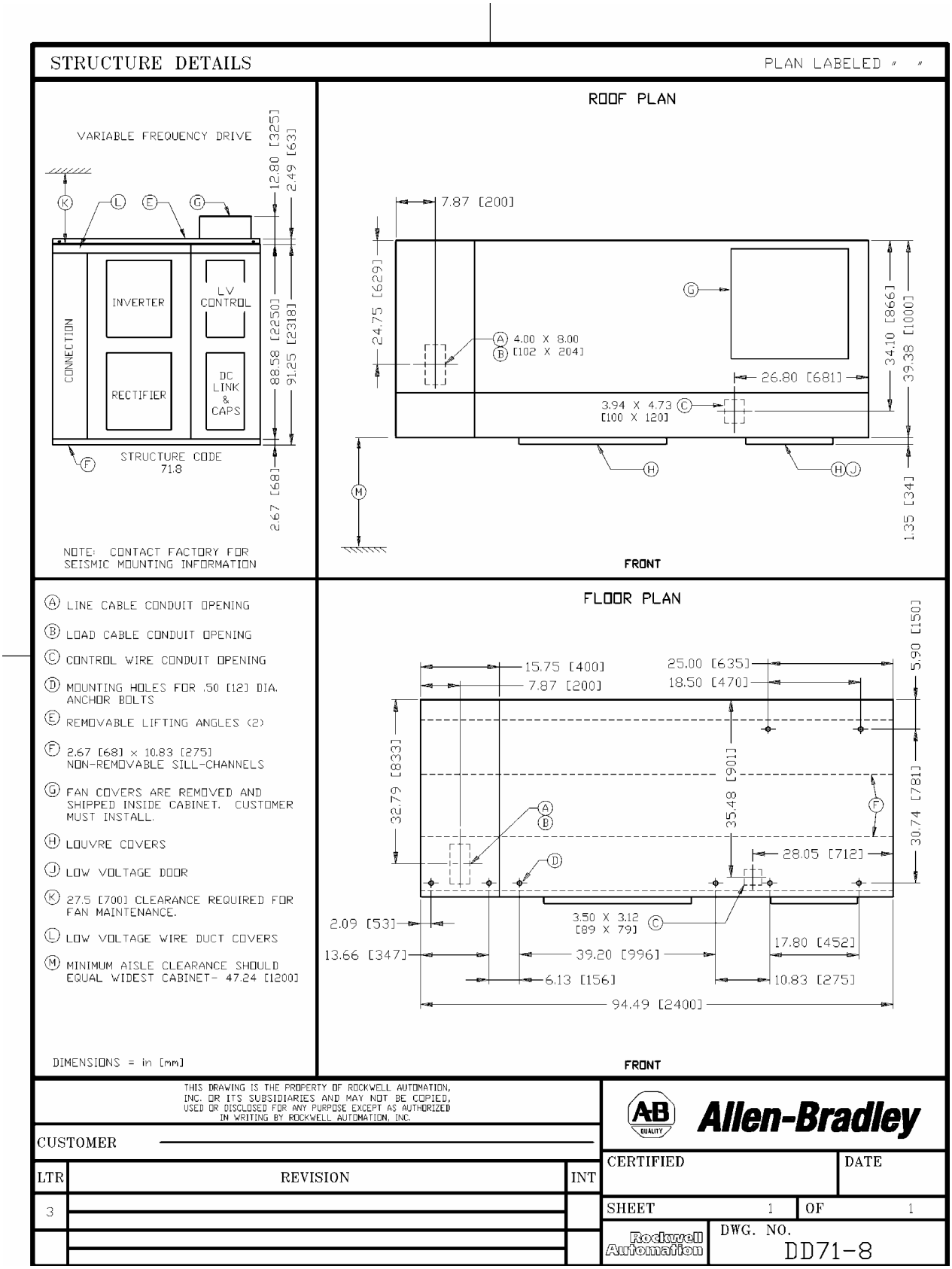


Note: Contact Factory for Seismic Mounting Information.

PowerFlex 7000™ Dimensional Drawings (continued)

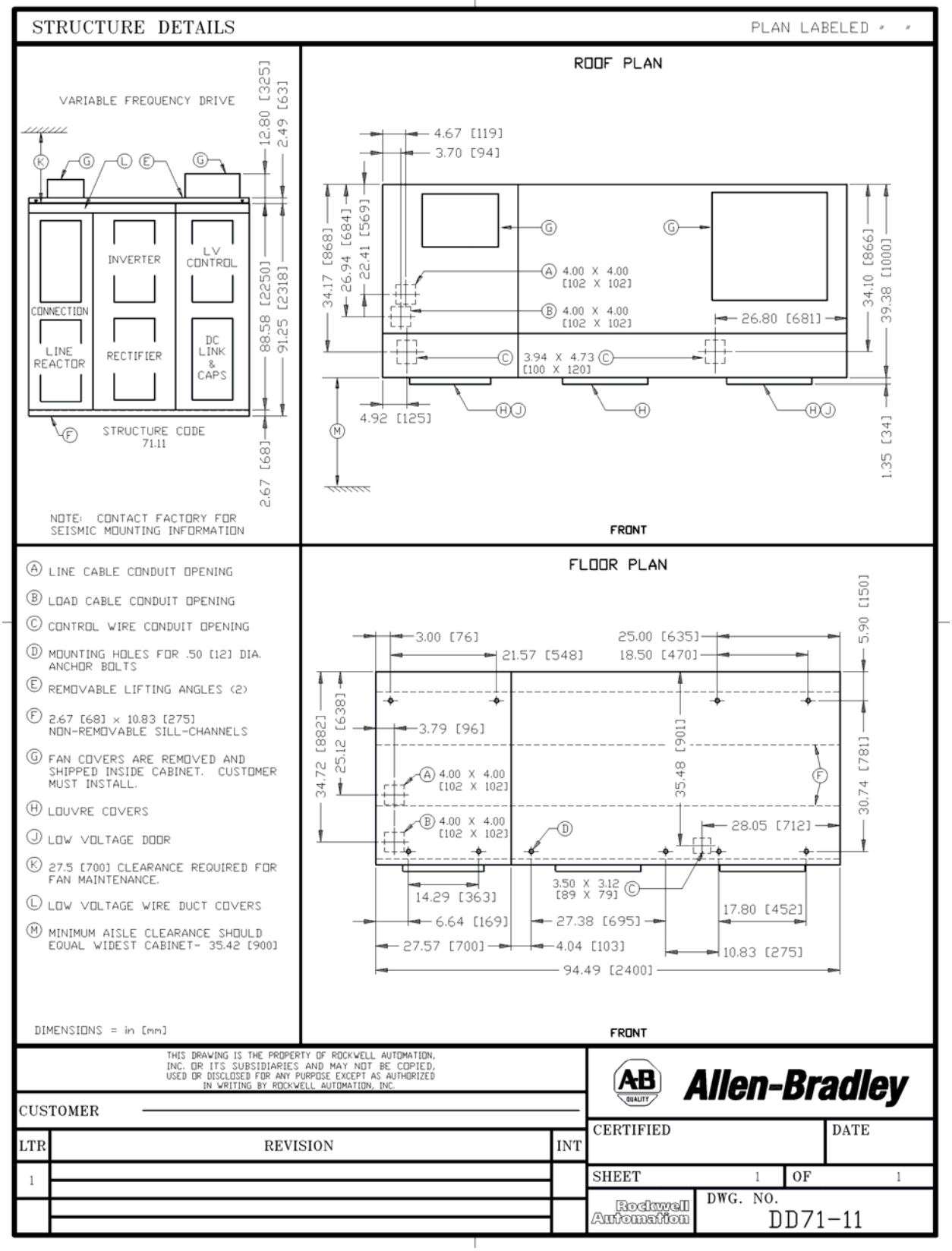


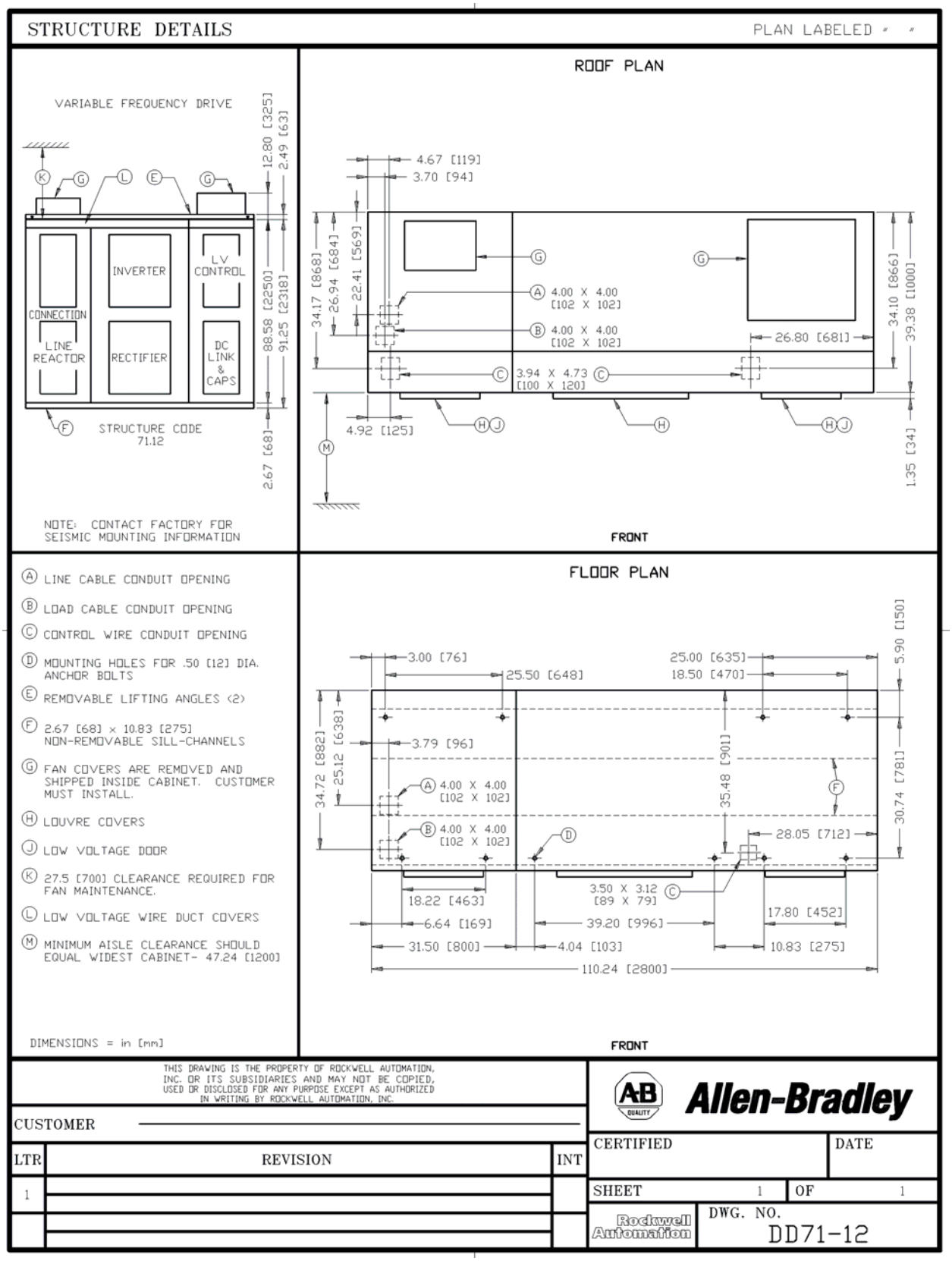
Note: Contact Factory for Seismic Mounting Information.



Note: Contact Factory for Seismic Mounting Information.

PowerFlex 7000™ Dimensional Drawings (continued)




STRUCTURE DETAILS
PLAN LABELED " "
VARIABLE FREQUENCY DRIVE
INVERTER
LV CONTROL
CONNECTION
LINE REACTOR
RECTIFIER
DC LINK & CAPS
STRUCTURE CODE 71.12
12.80 [325]
2.49 [63]
88.58 [2250]
91.25 [2318]
2.67 [68]
NOTE: CONTACT FACTORY FOR SEISMIC MOUNTING INFORMATION
ROOF PLAN
4.67 [119]
3.70 [94]
34.17 [868]
26.94 [684]
22.41 [569]
4.00 X 4.00 [102 X 102]
4.00 X 4.00 [102 X 102]
3.94 X 4.73 [100 X 120]
26.80 [681]
34.10 [866]
39.38 [1000]
4.92 [125]
1.35 [34]
FRONT
A LINE CABLE CONDUIT OPENING
B LOAD CABLE CONDUIT OPENING
C CONTROL WIRE CONDUIT OPENING
D MOUNTING HOLES FOR .50 [12] DIA. ANCHOR BOLTS
E REMOVABLE LIFTING ANGLES (2)
F 2.67 [68] x 10.83 [275] NON-REMOVABLE SILL-CHANNELS
G FAN COVERS ARE REMOVED AND SHIPPED INSIDE CABINET. CUSTOMER MUST INSTALL.
H LOUVRE COVERS
J LOW VOLTAGE DOOR
K 27.5 [700] CLEARANCE REQUIRED FOR FAN MAINTENANCE.
L LOW VOLTAGE WIRE DUCT COVERS
M MINIMUM AISLE CLEARANCE SHOULD EQUAL WIDEST CABINET- 47.24 [1200]
DIMENSIONS = in [mm]
FLOOR PLAN
3.00 [76]
25.50 [648]
25.00 [635]
18.50 [470]
5.90 [150]
34.72 [882]
25.12 [638]
3.79 [96]
4.00 X 4.00 [102 X 102]
4.00 X 4.00 [102 X 102]
35.48 [901]
30.74 [781]
28.05 [712]
3.50 X 3.12 [89 X 79]
18.22 [463]
6.64 [169]
39.20 [996]
17.80 [452]
31.50 [800]
4.04 [103]
10.83 [275]
110.24 [2800]
FRONT
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DATE
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Rockwell Automation
DWG. NO. DD71-12

7. Hardware Overview

7.1 Typical PowerFlex™ 7000 Drive Structure Layout (Configuration # 1)

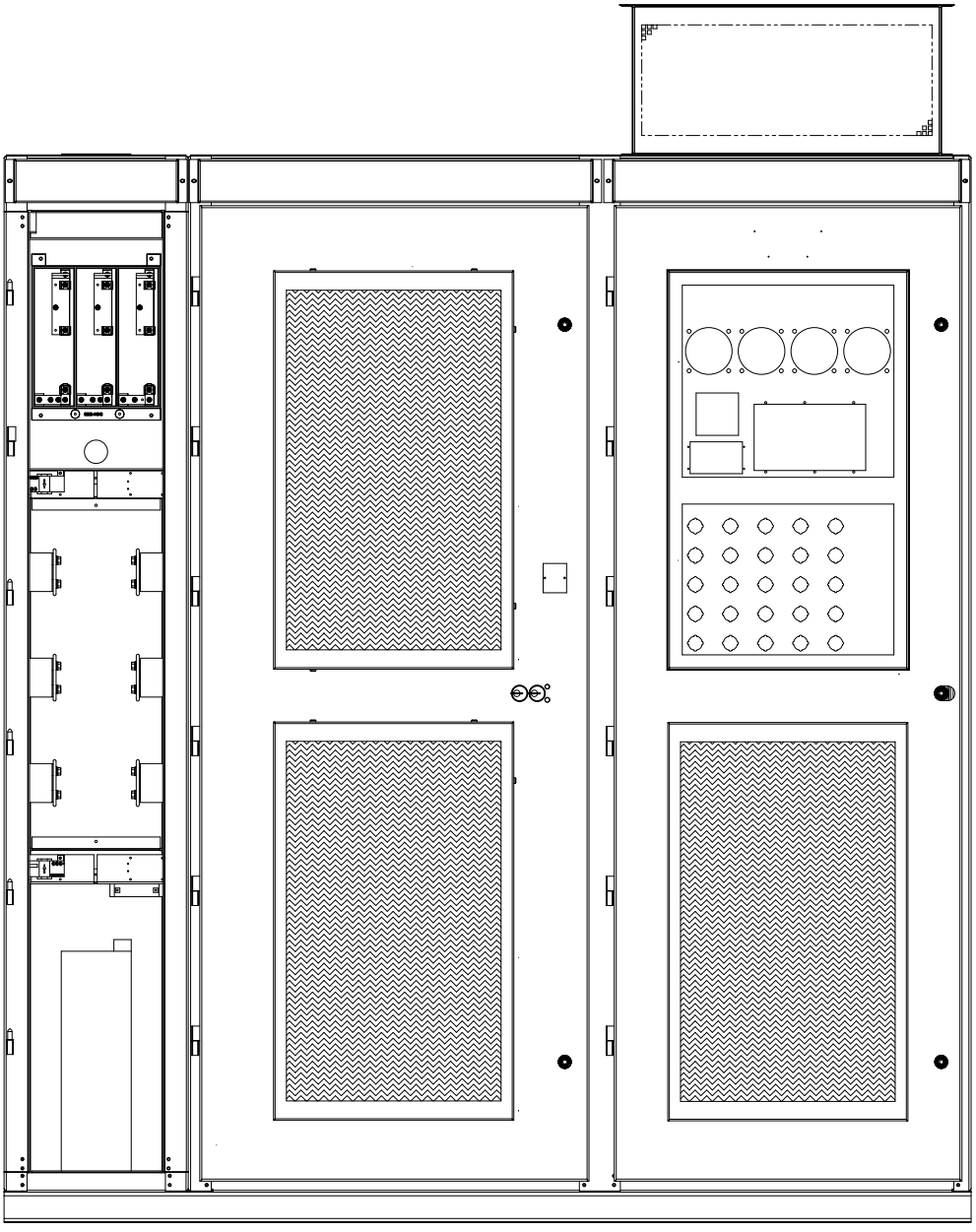


Figure 7.1 – Structure for Base Drive

Drive with Integral Isolation Transformer (Configuration # 2)

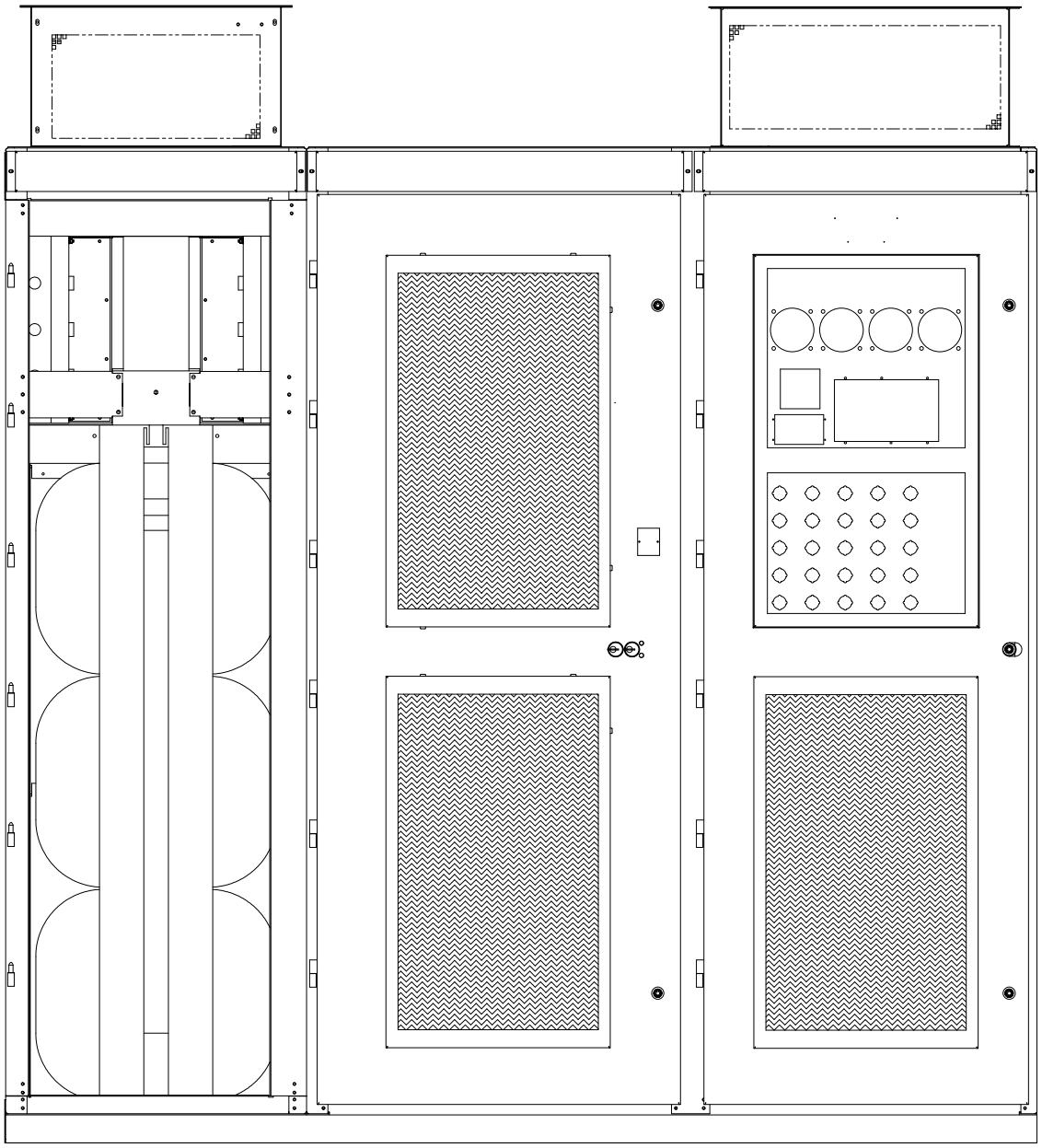


Figure 7.2 – Structure for Drive with Integral Isolation Transformer

Hardware Overview (continued)

Drive with Integral Line Reactor & Input Starter (Configuration # 3)

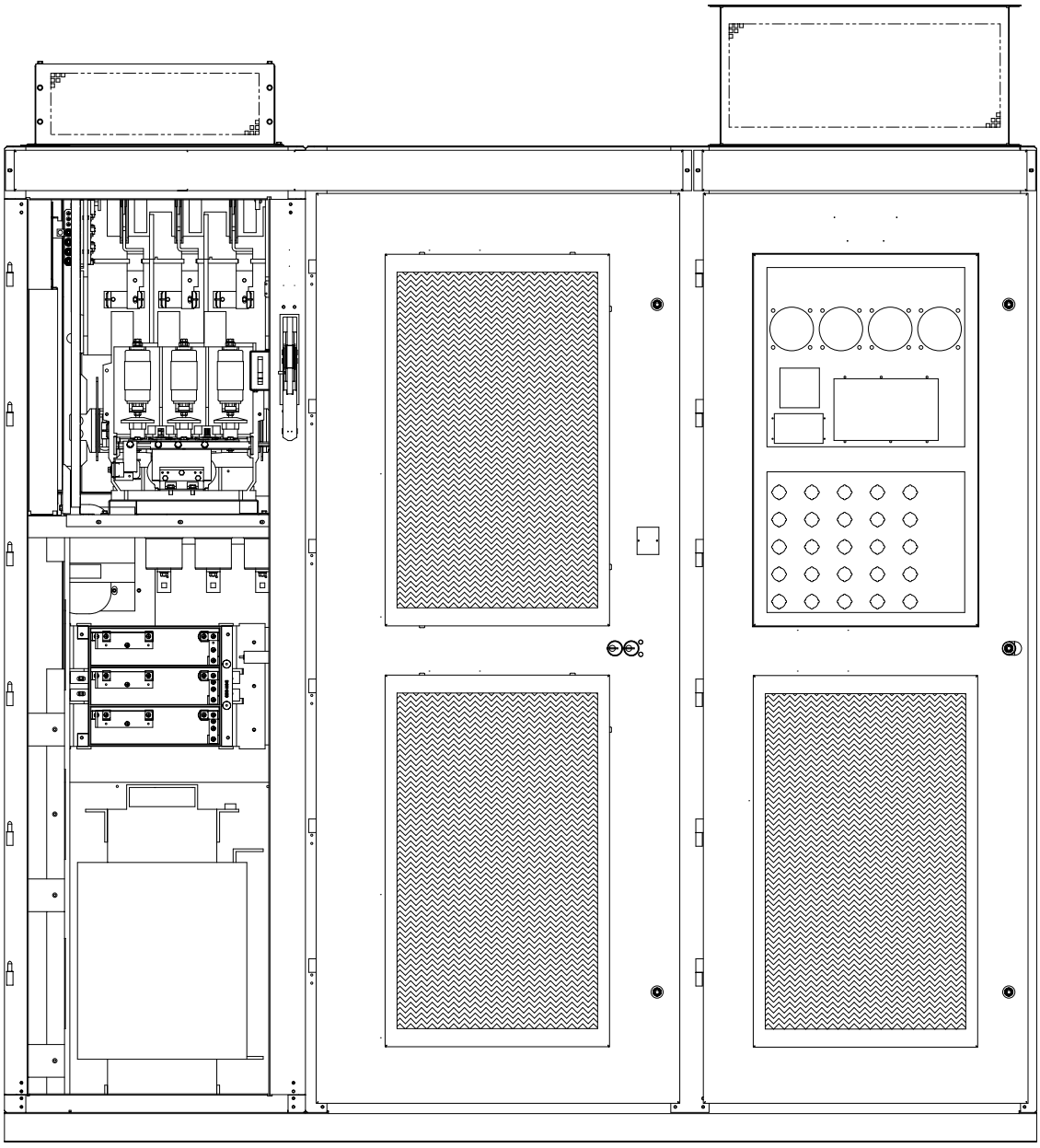


Figure 7.3 – Structure for Drive with Integral Line Reactor & Input Starter

Cabling Cabinet (Base Drive)

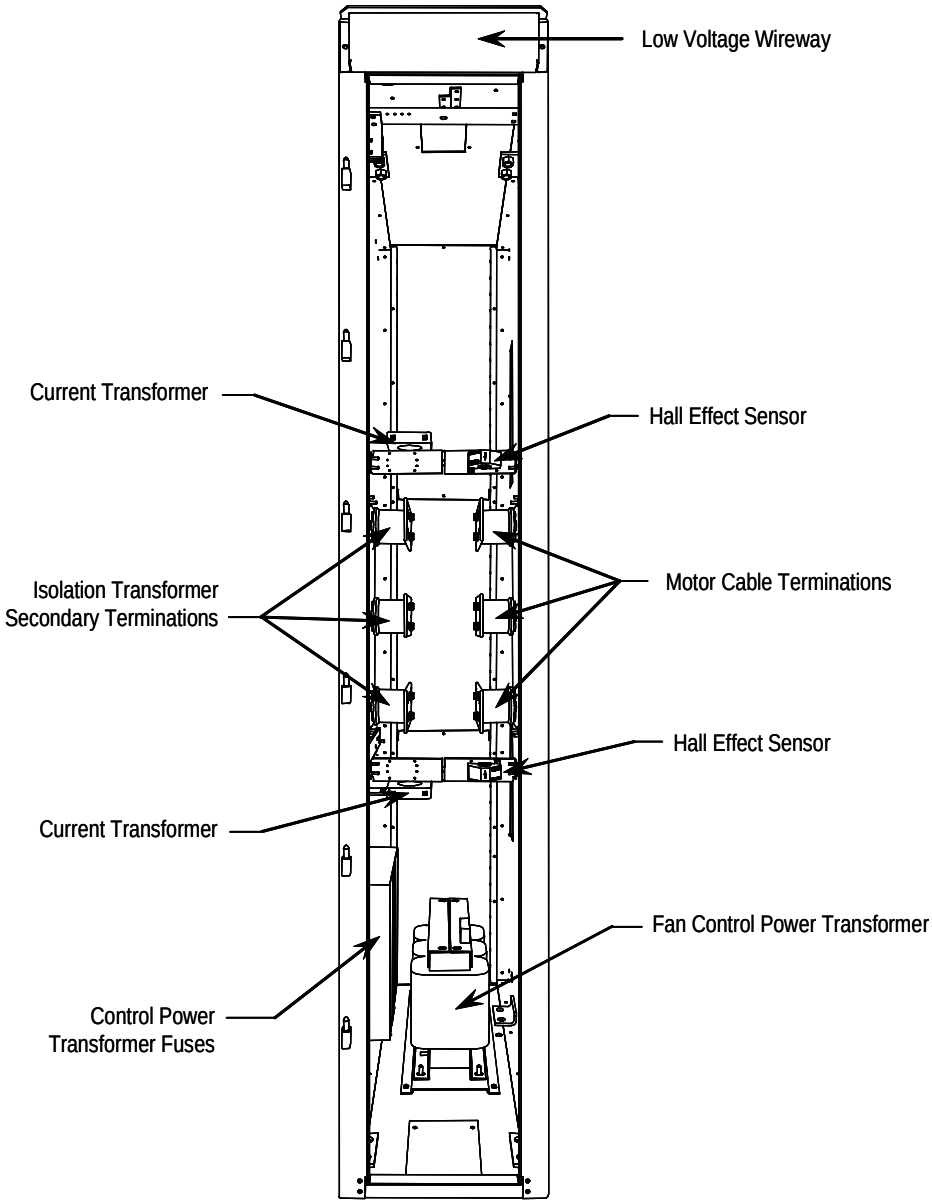


Figure 7.4 – Cabling Cabinet for Base Drive

Cabling Cabinet (Integral Isolation Transformer)

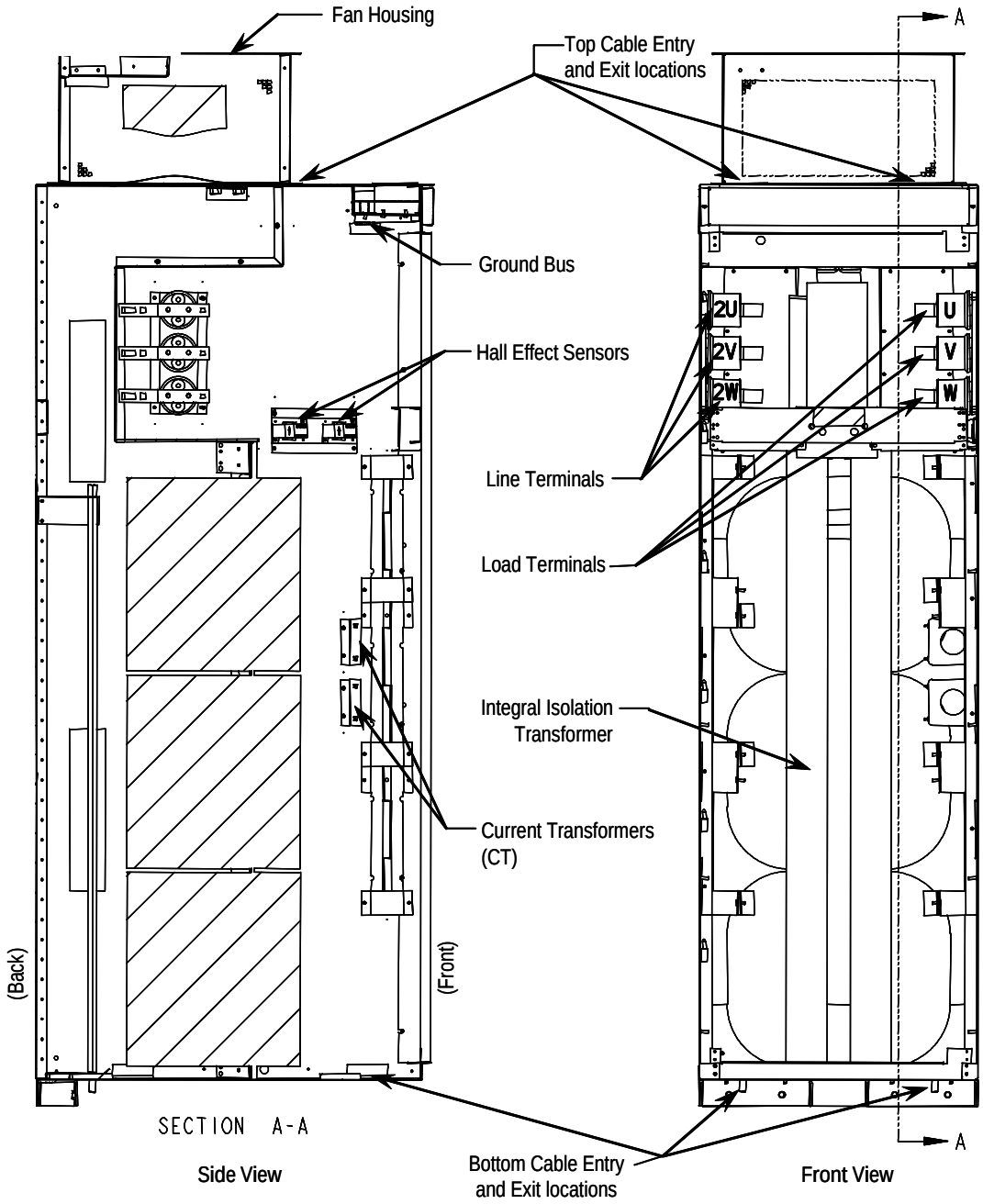


Figure 7.5 – Cabling Cabinet with Integral Isolation Transformer

Cabling Cabinet (Integral Line Reactor & Input Starter)

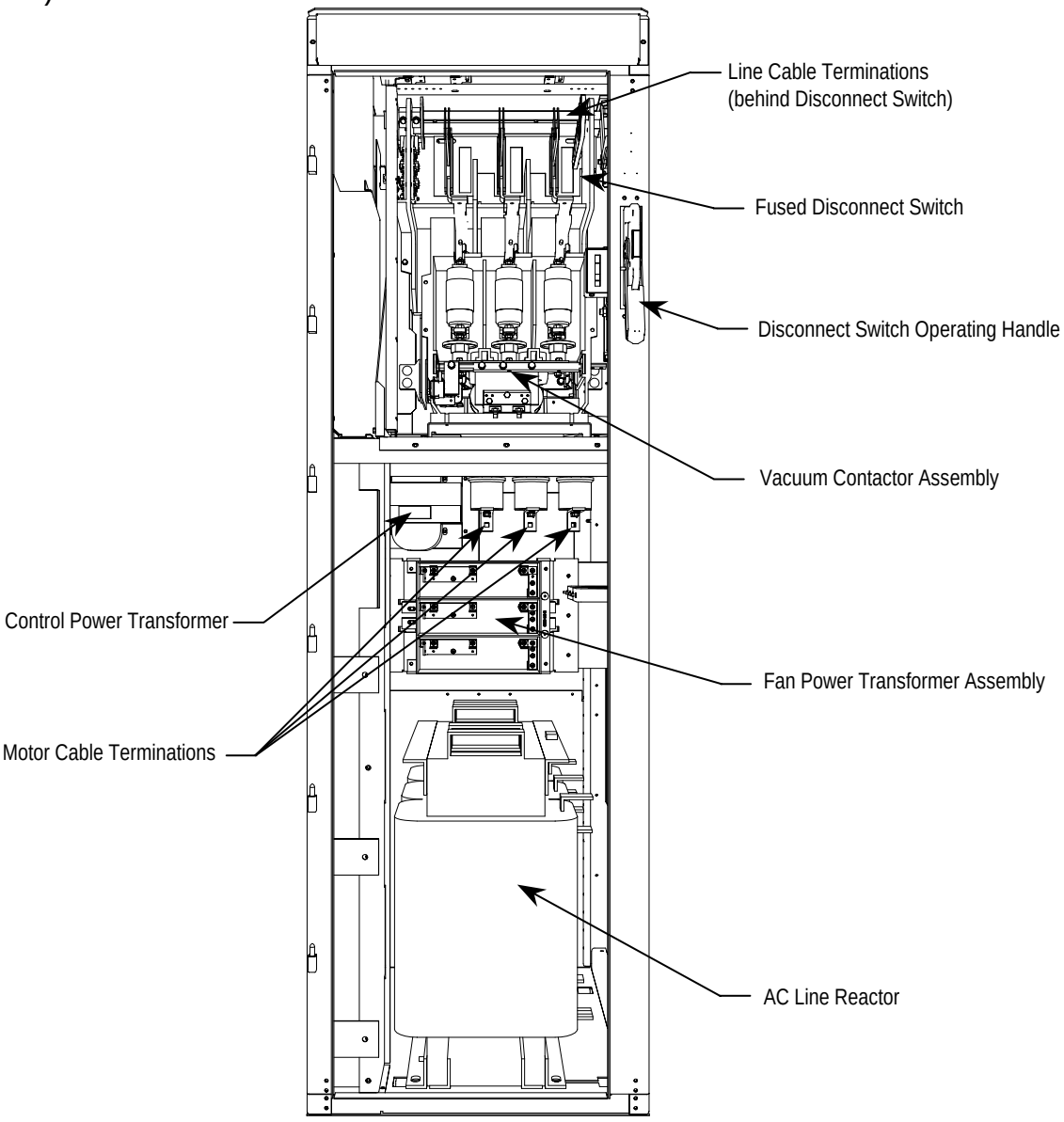


Figure 7.6 – Cabling Cabinet with Integral Line Reactor & Input Starter

Cabling Cabinet (Integral Line Reactor without Input Starter)

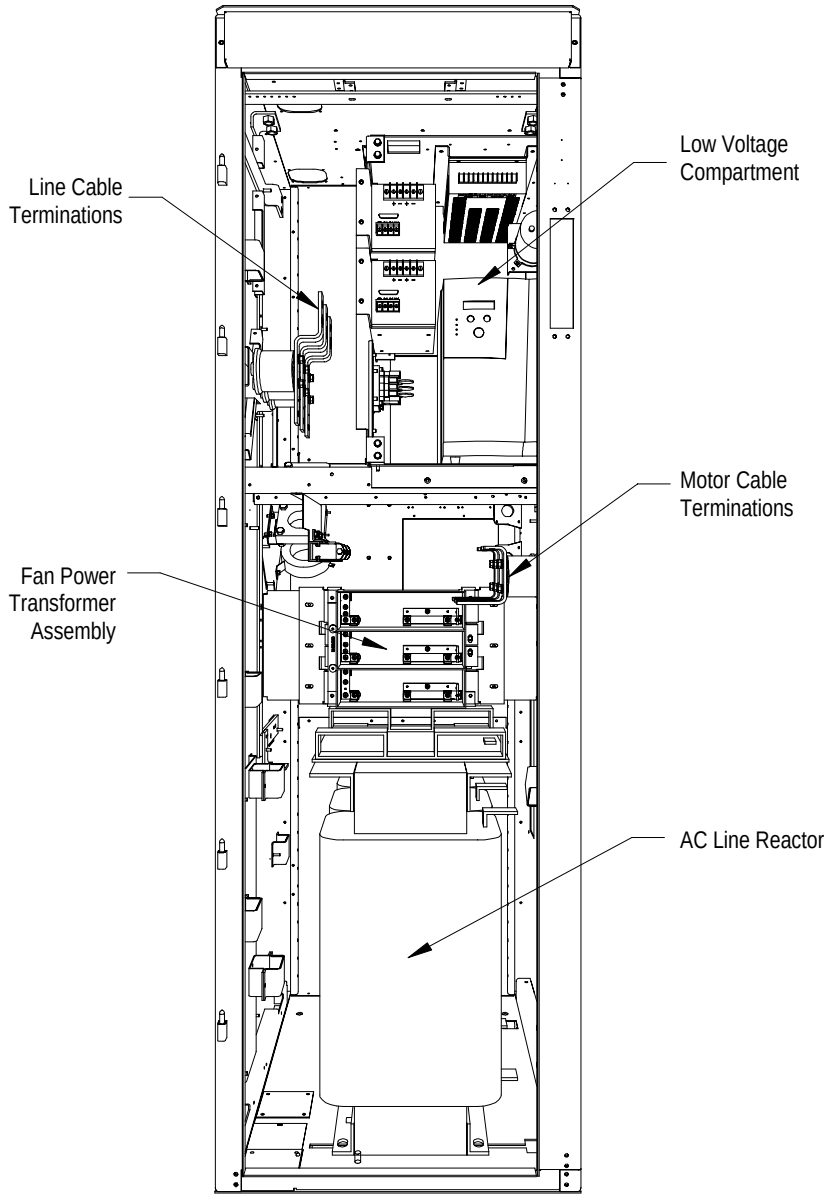


Figure 7.7 – Cabling Cabinet with Integral Line Reactor without Input Starter

Converter Cabinet

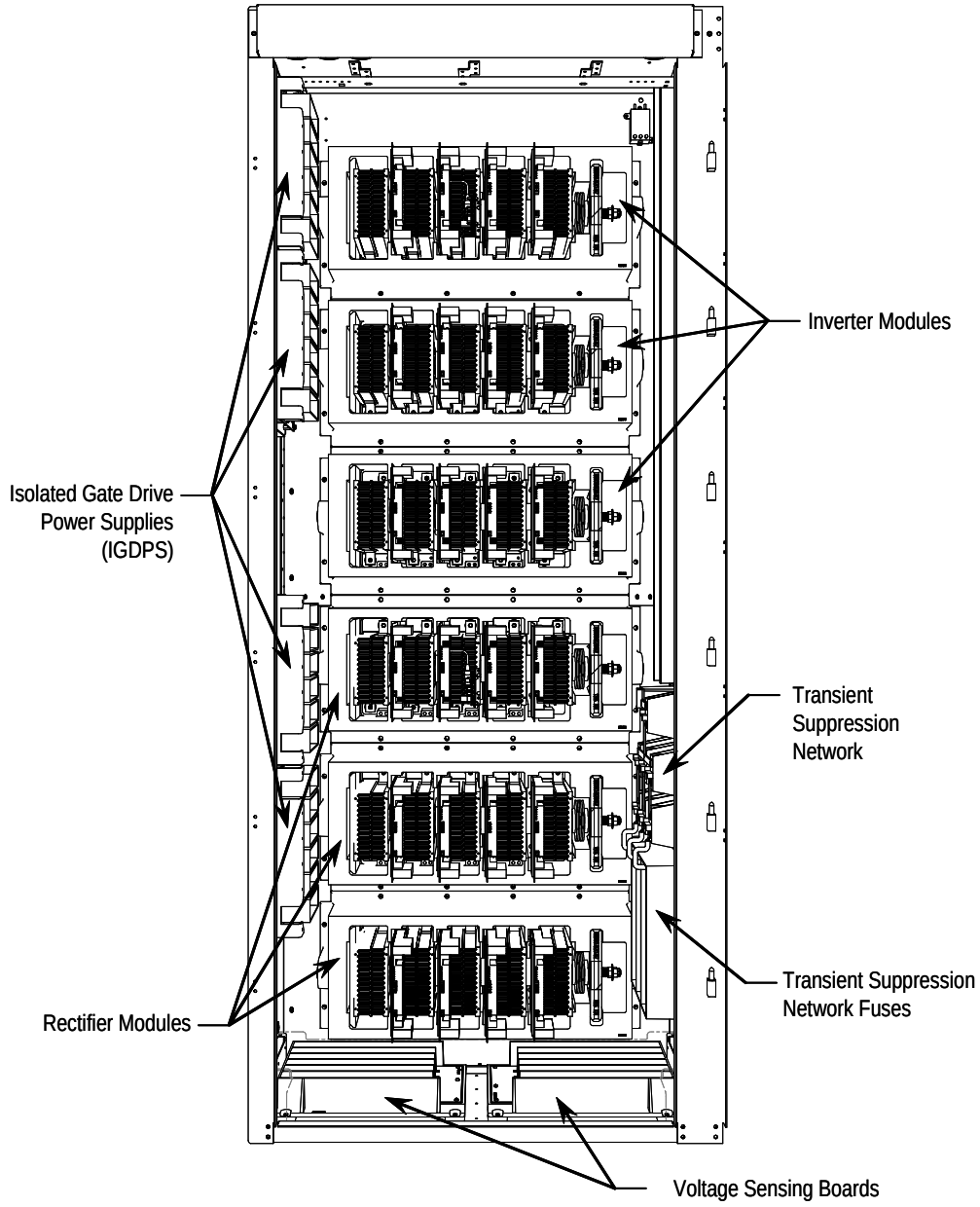


Figure 7.8 – Major Components of the Converter Cabinet
(3300/4160V version shown)

Control / DC Link / Fan Cabinet

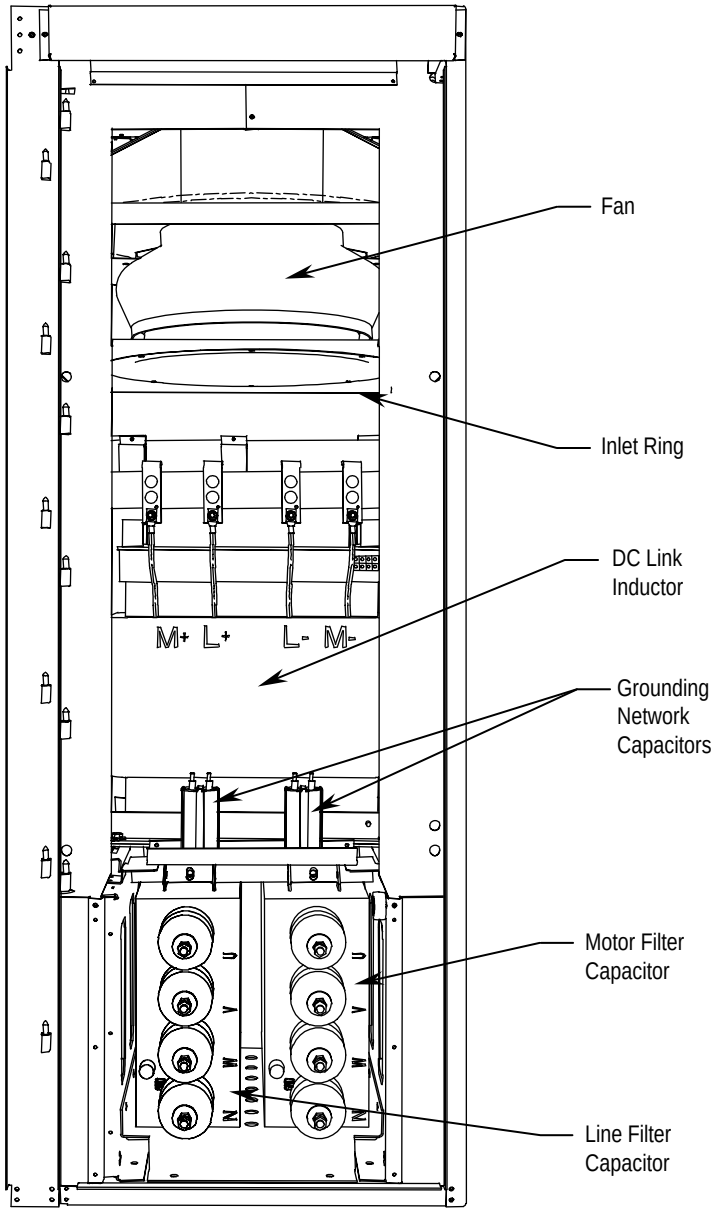


Figure 7.9 – Major Components of Control / DC Link / Fan Cabinet
(with low voltage control tub removed)

Hardware Overview

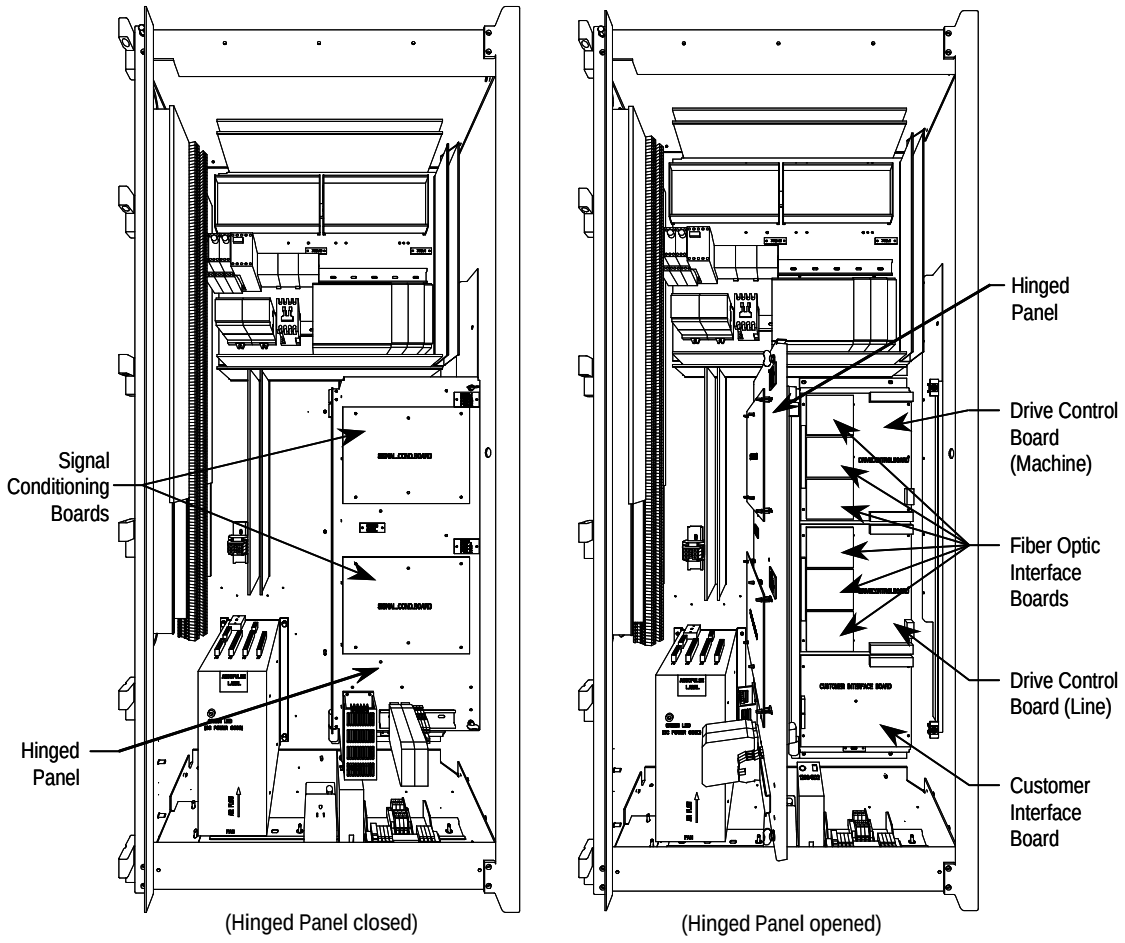


Figure 7.10 – Location of Low Voltage Control Tub

7.2 Air Flow Pattern from Converter to DC Link / Fan Cabinet

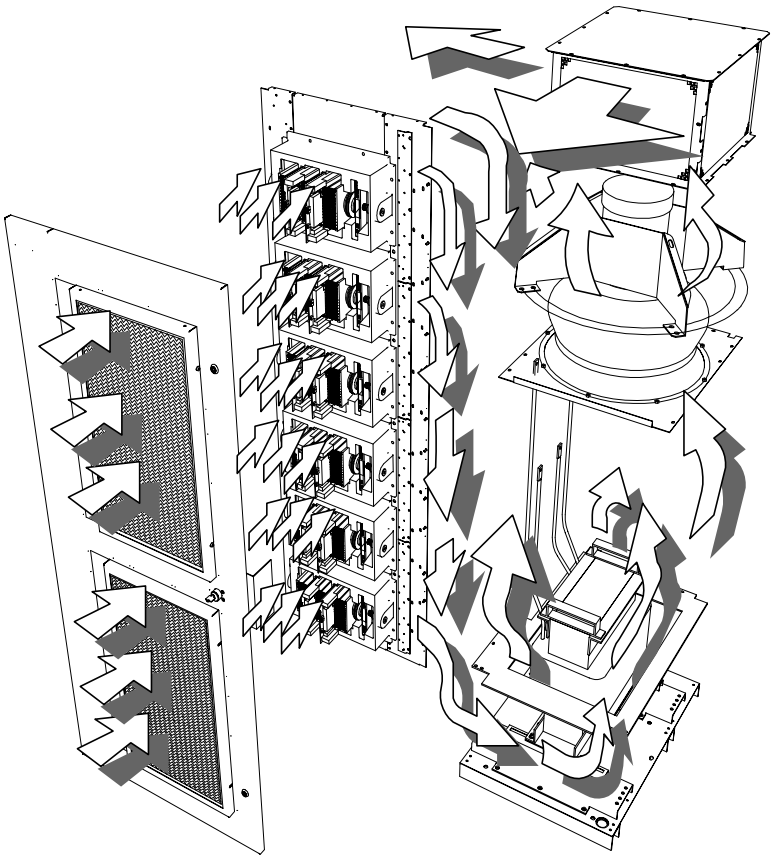


Figure 7.11 – Air Flow Pattern for Drive Cooling

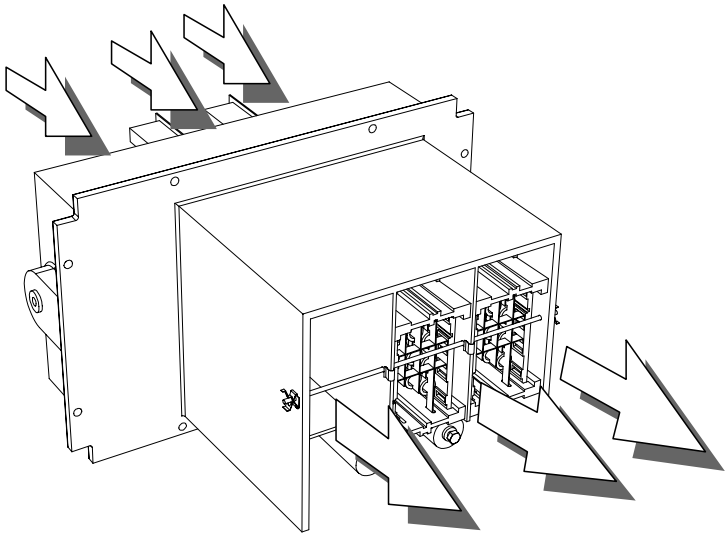


Figure 7.12 – Air flow through PowerCage

7.3 Air Flow Requirements

Drive Main Cooling Fan

Line Voltage (V)	Frequency (Hz)	Rectifier Type	Flow (m^3/h)	Flow (CFM)	Pressure (Pa)	Pressure (inch H_2O)
2300	60	6P or PWMR	3177	1870	548	2.20
3300	50	6P or PWMR	5296	3117	658	2.64
4160	50	6P or PWMR	5296	3117	658	2.64
4160	60	6P or PWMR	5296	3117	658	2.64
6600	50	6P or PWMR	5792	3409	519	2.08

Integral Transformer Fan

Line Voltage (V)	Frequency (Hz)	Rectifier Type	Flow (m^3/h)	Flow (CFM)	Pressure (Pa)	Pressure (inch H_2O)
2400	60	6P or PWMR	4757	2800	100	0.40
3300	50	6P or PWMR	4757	2800	100	0.40
4160	50	6P or PWMR	4757	2800	100	0.40
4160	60	6P or PWMR	4757	2800	100	0.40
6600	50	6P or PWMR	4757	2800	100	0.40

Air cleanliness for PF7000 drives is important for two main reasons:

1. Airborne particulate that has settled on heat sinks and heat producing components increases the thermal resistance of the components resulting in an increase in the temperature of the part. In particular, the internal fins of the thyristor heat sinks must be kept clean; the dust on the surfaces of heat sinks interferes with the boundary layer air flow and hence the cooling of the part.

2. Particulate may decrease the tracking insulation of electrical insulation materials within the drive. Electrically conductive dusts such as coal dust and metallic dusts can be severe, however other particulates such as cement dust, moist from high ambient relative humidity, may prove destructive as well. Dusts coating low voltage circuit boards can cause failures too.

Air presented to the PowerFlex 7000 must be of a cleanliness expected in a typical industrial control room environment. The drive is intended to operate in conditions with no special precautions to minimize the presence of sand or dust, but not in close proximity to sand or dust sources. This is defined by IEC 7211 as being less than 0.2 mg/m^3 of dust.

This environment can most effectively be accomplished by providing a pressurized room with adequate air conditioning to maintain the ambient temperature within the room. The drive exhaust air is circulated within the control room. Five to ten percent cooled/heated and filtered make-up air is usually provided to keep the room pressurized.

External ducting of the PowerFlex 7000's exhaust air and bringing in make-up air from outside is also an option. In this case, consideration must be given to the conditions present in the atmosphere outside the control room. When externally ducting the exhaust air and bringing in cleansed outside air, the following requirements must be met:

[1] IEC 721-3-3 "Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weather protected locations"

- External ducting including an external filtering system must not add more than 50 Pa (0.2 inches of water) pressure drop to the PF 7000 drive air flow system.
- The control room must provide slightly more make-up air creating a pressurized room. This slight pressurization ensures no unfiltered air is drawn into the room.
- If outside air does not meet the conditions described above (0.2 mg/m^3), the air must be filtered to ASHRAE (American Association of Heating, Refrigeration and Air-Conditioning Engineers) Standard 52.2 MERV 11 (Minimum Efficiency Reporting Value). This filtration eliminates from 65% to 80% of the particulate in Range 2 (1.0 – 3.0 µm) and 85% of the particulate in Range 3 (3.0 – 10.0 µm). This filter system must be cleaned or changed regularly to ensure proper flow.
- The make-up air must be between 0 – 40 degrees C.
- Relative humidity must be less than 95% non-condensing.
- Five percent of drive losses will still be rejected into the control room and must be addressed to maintain the temperature in the control room within specification.
- Failure to maintain proper flow of cooling air into the control room can result in the drive stopping on low differential pressure across the heat sinks.

7.4 Air Filter Collection Efficiency

The PowerFlex 7000 has air filters installed in the doors. The efficiency of these filters is shown below:

Particle Size (Microns)	Collection Efficiency (%)
0.7 - 1.0	12.25
1.0 - 2.0	27
2.0 - 3.0	41
3.0- 5.0	43

These filters are intended to keep foreign objects from entering the drive with the cooling air drawn in by the drive's fan. The filters are not designed to allow the drive to operate in an excessively dirty environment. A separate ventilation fan supplying air to the location where the drive is located may be necessary if the air is heavily laden with dust. See Section 7.3, Air Flow Requirements.

ATTENTION

If the drive configuration has more than one exhaust outlet, ensure that each outlet is ducted separately to prevent back feeding of hot exhaust into the drive.

7.5 General Design Specifications

Description	Specifications	
Power Rating (Air Cooled)	200 to 1250 hp (150 to 933 kW)	
Motor Type	Induction or Synchronous	
Input Voltage Rating	2400V, 3300V, 4160V, 6600V	
Input Voltage Tolerance	± 10% of Nominal	
Voltage Sag ❶	-30%	
Power Loss Ride-Through	5 Cycles (Std)	
Input Protection	Metal Oxide Varistor (MOV)	
Input Frequency	50/60 Hz, +/- 5%	
Input Short-circuit Current Withstand	5 Cycle	
3300 V – 6000 V ❷	25 MVA RMS SYM	
Basic Impulse Level ❸	50 kV (0 – 1000 m)	
Power Bus Design	Copper – Tin plated	
Ground Bus	Copper – Tin plated 6 x 51 mm (¼ x 2 in.)	
Customer Control Wire Way	Separate and Isolated	
Input Power Circuit Protection	Vacuum Contactor with Fused Isolating Switch	
Input Impedance Device	Isolation Transformer or AC Line Reactor	
Output Voltage	0 – 2300 V 0 – 3300 V 0 – 4160 V 0 – 6600 V	
Inverter Design	PWM	
Inverter Switch	Symmetrical Gate Commutated Thyristor (SGCT)	
Inverter Switch Failure Mode	Non-rupture, Non-arc	
Inverter Switch Failure Rate (FIT)	100 per 1 Billion Hours Operation	
Inverter Switch Cooling	Double Sided, Low Thermal Stress	
Inverter Switching Frequency	420-540 Hz	
Number of Inverter SGCT's	Voltage	SGCTs (per phase)
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
SGCT PIV Rating (Peak Inverse Voltage)	Voltage	PIV
	2400 V	6500 V
	3300 V	6500 V
	4160 V	6500 V
	6600 V	6500 V
Rectifier Designs	6 Pulse PWM (Active Front End)	
Rectifier Switch	SCR (6 Pulse), SGCT (PWM Active Front End)	
Rectifier Switch Failure Mode	Non-rupture, Non-arc	
Rectifier Switch Failure Rate (FIT)	50 (SCR) 100 (SGCT) per 1 Billion Hours Operation	
Rectifier Switch Cooling	Double Sided, Low Thermal Stress	

❶ Voltage Sag tolerance is reduced to -25% when control power is supplied from medium voltage via CPT.
❷ Short-circuit fault rating based on input protection device (contactor or circuit breaker).
❸ BIL rating based on altitudes < 1000 m (3,300 ft.) Refer to factory for derating on altitudes >1000 m).

General Design Specifications (continued)

Description	Specifications		
Number of Rectifier Devices per phase	Voltage	6-Pulse	PWM
	2400 V	2	2
	3300 V	4	4
	4160 V	4	4
	6600 V	6	6
SCR PIV Rating (Peak Inverse Voltage)	Voltage	6-Pulse	PWM
	2400 V	6500 V	6500 V
	3300 V	6500 V	6500 V
	4160 V	6500 V	6500 V
	6600 V	6500 V	6500 V
Output Waveform to Motor	Sinusoidal Current / Voltage		
Medium Voltage Isolation	Fiber Optic		
Modulation Techniques	SHE (Selective Harmonic Elimination) PWM (Pulse Width Modulation)		
Control Method	Digital Sensorless Direct Vector Full Vector Control with Tach Feedback (Optional)		
Tuning Method	Auto Tuning via Setup Wizard		
Speed Regulator Bandwidth	5-25 Radians / Second		
Torque Regulator Bandwidth	15-50 Radians / Second		
Speed Regulation	0.1% without Tachometer Feedback 0.01-0.02% with Tachometer Feedback		
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 30 sec.		
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel		
S Ramp Rate	Independent Accel/Decel – 2 x 999 sec.		
Critical Speed Avoidance	3 x Independent with Adjustable Bandwidth		
Stall Protection	Delay / Speed		
Load Loss Detection	Adjustable level, delay, speed set points		
Control Mode	Speed or Torque		
Current Limit	Adjustable in Motoring and Regenerative		
Output Frequency Range	0.2-75 Hz		
Service Duty Rating Overload Rating	Normal Duty	Heavy Duty	
	110% Overload for 1 minute every 10 minutes (Variable Torque Load)	150% Overload for 1 minute every 10 minutes (Constant or Variable Torque Load)	
Typical VFD Efficiency	> 98% (6 Pulse) > 97.5% (PWM Active Front End) Contact Factory for Guaranteed Efficiency of Specific Drive Rating		
Input Power Factor	PWM Rectifier		
	0.98 minimum, 30 – 100% Load		
IEEE 519 Harmonic Guidelines ❹	IEEE 519 Compliant		
VFD Noise Level	< 85 dB(A) per OSHA standard 3074		
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required		
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction		
Operator Interface	40-character, 16-line formatted text		
Languages	English French Spanish	German Chinese	

❹ Harmonic filter required on 6-pulse drive to meet IEEE 519.
Under certain conditions, power system analysis will be required.

General Design Specifications (continued)

Description	Specifications
Control Power	220/240 V or 110/120 V, 1 phase – 50/60 Hz (20 Amp)
External I/O	16 Digital Inputs, 16 Digital Outputs
External Input Ratings	50/60 Hz AC or DC 120-240 V – 1 mA
External Output Ratings	50-60 Hz AC or DC 30-260 V – 1 amp
Analog Inputs	(1) Isolated, (1) Non-isolated, 4-20 mA or 0-10 V
Analog Resolution	• Analog input 12 Bit (4-20 mA) • Internal parameter 32 Bit resolution • Serial Communication 16 But resolution (.1 Hz) (Digital Speed Reference)
Analog Outputs	(1) Isolated, (7) Non-isolated, 4-20 mA or 0-10 V
Communication Interface	SCANPort /DPI
Scan Time	Internal ScanPort – 10 ms Internal DPI – 5 ms
Communications Protocols (Optional)	R I/O DeviceNet Ethernet Profibus Modbus Modbus + Interbus Lon Works Can Open RS485 HVAC RS485 DF1 RS232 DF1 RS232 C
Enclosure	NEMA 1, IP21
Lifting Device	Standard / Removable
Mounting Arrangement	Mounting Sill Channels
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)
Interlocking	Key provision for customer input Disconnecting Device
Corrosion Protection	Unpainted Parts (Zinc Plates / Bronze Chromate)
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning/Trip)
Door Filter	Painted Defuser with Matted Filter Media
Door Filter Blockage	Air Flow Restriction Trip/Warning
Ambient Temperature	0° to 40°C (32°F to 104°F)
Storage and Transportation Temperature Range	-40°C to 70°C (-40°F to 185°F)
Relative Humidity	95% Non-Condensing
Altitude (Standard)	0 to 3300 ft. (0 to 1000 m)
Altitude (Optional)	0 to 16400 ft. (1001 to 5000 m)
Seismic (UBC Rating)	1, 2, 3, 4
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE

7.6 Typical Auxiliary Equipment

Bulletin No.	Description
1508T	Isolation Transformer Unit
1512AD	1-High, VFD Input Contactor Unit
1512DM	VFD Input Contactor Unit with Output Isolator for Output or Bypass, Single or Multi-Motor Applications
1512DO	VFD Output Contactor Unit
1512M	Output-Bypass Starter Unit

Bulletin 1508T - Isolation Transformer Unit

The isolation transformer is defined by Bulletin number 1508T. It is purchased from a 3rd party and normally shipped from the supplier directly to the job site. It is available in a variety of enclosure types, sizes, winding materials and voltages.

For variable torque applications, transformers will be sized 1.0 kVA / Motor hp X Drive Service Factor. Applications at altitudes greater than 1000 meters, will be treated as custom designs.

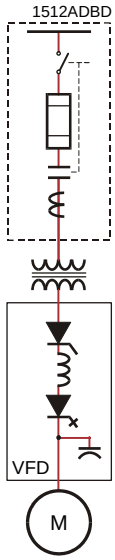
Bulletin 1512AD, 1512BD - VFD Input Contactor Unit

The input contactor is defined by Bulletin numbers 1512AD and 1512BD. The unit is FVNR available in 400 size. The unit is available in 1-High and 2-High configurations. The input contactor is controlled by the drive. There are several options available with this type of unit that effect the configuration of the structures and wiring of the system. When the load is the isolation transformer, the power fuses will be "E" rated, and "R" rated when "E" rated are NOT available.

Typical Bulletin 1512AD, MV Drive Input Starter Feeding Isolation Transformer

400 amp

Structure Code: 1.2
Catalog No: 1512AD-AA_-6-14TX-kVA
Dimensions: 26"W x 36"D x 91"H



Bulletin 1512DM - VFD Input Contactor Unit with Output Isolator for OUTPUT or BYPASS, Single or Multi-Motor Applications

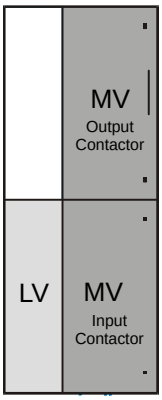
The input contactor unit is a FVNR starter with an output isolating switch on the output of the VFD that will feed a VFD power bus. The output isolator and FVNR starter isolating switches are mechanically interlocked for the 400 amp design. The OUTPUT or BYPASS configurations are available as standard. The same options used on the 1512AD (above) are available with this unit. This unit shall also include a 500 VA CPT as standard (like a starter application), to supply the control circuit power only for the starter. The catalog number will also included a hp (-14LR) or kVA (-14TX) rating. When the load is the isolation transformer, the power fuses will be "E" rated, and "R" rated when "E" rated are NOT available. When the load is a line reactor, the power fuses will be "R" rated.

NOTE: For any OUTPUT or BYPASS configuration, Allen-Bradley prefers to supply the Input Contactor. This is to ensure that there is proper isolation and protection (interlocking).

A double power bus configuration is utilized in the bus compartment (one is the main power bus, the other is the variable frequency bus). The variable frequency bus is located above the standard main horizontal power bus.

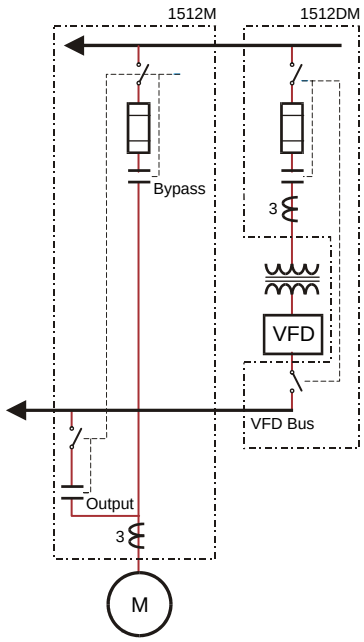
NOTE: When this unit is located on the left most side of the MCC, only bottom incoming cables can be terminated to the main horizontal power bus. For top incoming direction, an incoming line unit is required.

Typical Bulletin 1512DM, MV Drive Input Starter (For use with Output - Bypass Starter)



400 amp

Structure Code: 1.40
Catalog No: 1512DM-AA_-6-14TX-kVA
Dimensions: 36"W x 36"D x 91"H



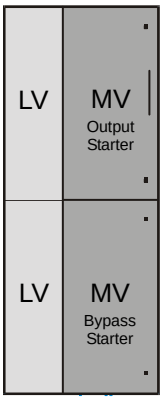
Bulletin 1512M - Output-Bypass Starter Unit

The output-bypass starters are allowed in the line-up when the 1512DM unit is used. The unit can be used for both single or multi-motor applications. The catalog number includes a horsepower rating and option numbers. When used in a drive system configuration, the 1512M units shall always be located on the left hand side of the input starter (1512DM). A double power bus configuration is utilized in the bus compartment (one is the main power bus, the other is the variable frequency bus). The variable frequency bus is located above the standard main horizontal power bus. This unit shall include a 500 VA CPT as standard (like a starter application), to supply the control circuit power only for the starter. The power fuses will be "R".

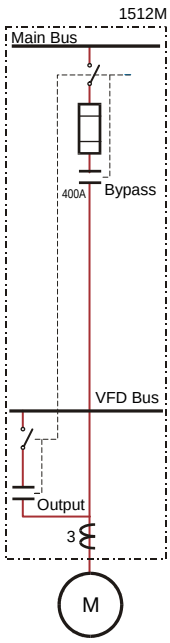
NOTE: When this unit is located on the left most side of the MCC, only bottom incoming cables can be terminated to the main horizontal power bus. For top incoming direction, an incoming line unit is required.

Typical Bulletin 1512M, Output-Bypass Starters

400 amp



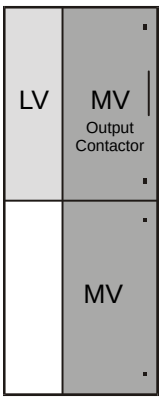
Structure Code: 1.15
Catalog No: 1512M-AA_-6-7F-hp
Dimensions: 36"W x 36"D x 91"H



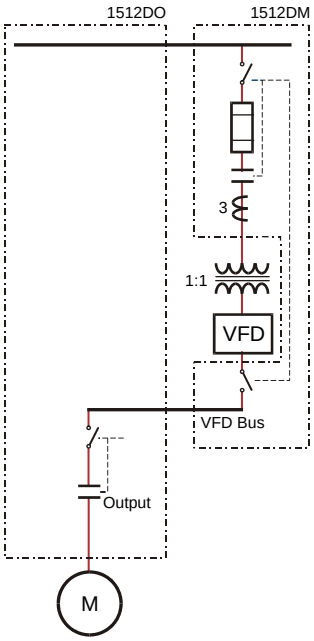
Bulletin 1512DO - Output Contactor Unit

The Bulletin 1512DO is an output contactor for the drive and is allowed in the line-up when a 1512DM unit is used. This unit includes an isolating switch and contactor only. The catalog number includes a horsepower rating and option numbers. When used in a drive system configuration, the 1512DO unit shall always be located on the left hand side of the input starter (1512DM). A double power bus configuration is utilized in the bus compartment (one is the main power bus, the other is the variable frequency bus). The variable frequency bus is located above the standard main horizontal power bus. This unit does not include CPT for the control circuit power. An external power source is required. This unit also does not include power fuses or CT's and is controlled by the drive control circuit. If additional relays, CT's, etc are required, they shall be included by using CMODs.

Typical Bulletin 1512DO, VFD Output Contactor



Structure Code: 1.17
Catalog No: 1512DO-AA_-6-7F-HP
Dimensions: 36"W x 36"D x 91"H



8. APPENDIX A

Full Load Currents of 3-phase, 50/60 Hz, Medium Voltage AC Induction Motors

This table is **FOR REFERENCE ONLY**. The full load currents listed below are "average values" for horsepower rated motors. These "average values," along with the similar values listed in NEC/CEC, should be used only as a guide for selecting appropriate components for the Motor Branch Circuit. The rated full load current, shown on the motor nameplate, may vary considerably from the list value depending on the specific motor design and RPM.

IMPORTANT: The motor nameplate full load current should always be used in determining the rating of the devices used for Motor Running Overcurrent Protection.

kW Rating	hp Rating	Full Load Current at 1800 RPM (Amperes)							
		2300V	3300V	4000V	4600V	6000V	6300V	6600V	6900V
75	100	23	16	13	11	9	8	8	8
95	125	29	20	16	14	11	10	10	10
110	150	34	24	20	17	13	13	12	11
130	175	40	28	23	20	15	15	14	13
150	200	46	32	26	23	18	17	16	15
170	225	52	36	30	26	20	19	18	17
187	250	57	40	33	29	22	21	20	19
225	300	68	48	39	34	26	25	24	23
260	350	80	56	46	40	31	29	28	27
300	400	91	64	52	46	35	33	32	30
335	450	103	72	59	51	39	38	36	34
373	500	113	79	65	57	43	41	39	38
450	600	134	94	77	67	52	49	47	45
522	700	158	110	91	79	60	58	55	53
560	750	169	118	97	85	65	62	59	56
600	800	177	124	102	89	68	65	62	59
670	900	202	141	116	101	77	74	70	67
750	1000	216	151	124	108	83	79	75	72
933	1250	273	190	157	137	105	100	95	91
1120	1500	326	227	188	163	125	119	114	109
1300	1750	376	262	216	188	144	137	131	125
1500	2000	434	303	250	217	166	159	151	145
1680	2250	485	338	279	242	186	177	169	162
1865	2500	537	375	309	269	206	196	187	179
2050	2750	591	412	340	296	227	216	206	197
2240	3000	647	451	372	324	248	236	226	216
2600	3500	750	523	431	375	288	274	261	250
3000	4000	857	597	493	429	329	313	299	286
3360	4500	964	672	554	482	370	352	336	321
3730	5000	1071	747	616	536	411	391	373	357
4100	5500	1179	821	678	589	452	430	411	393
4475	6000	1286	896	739	643	493	469	448	429
5225	7000	1500	1046	863	750	575	548	523	500
6000	8000	1714	1195	986	857	657	626	597	571
6720	9000	1929	1344	1109	964	739	704	672	643
7500	10000	2143	1494	1232	1071	821	782	747	714

9. APPENDIX B

Transformer Secondary Winding Insulation Levels Table

Rated Motor L-L Voltage (Vrms) ❶	Number of Secondary Windings ❶	Rated Secondary L-L Voltage (Vrms)	Minimum Secondary Winding Insulation Level (kVrms) ❷	Short Duration Power Frequency Withstand Voltage Test (kVrms)	Primary Winding Impulse Withstand Voltage (BIL) Test (for 1:1 ratio only) (kVpk)		Secondary Winding Impulse Withstand Voltage (BIL) Test (kVpk)	
					Air	Liquid	Air	Liquid
2300	1 (6 Pulse/PWM)	2400	5.0	12.0	30	60	30	60
3300	1 (6 Pulse/PWM)	3450	7.2	16.5	40	60	40	60
4000	1 (6 Pulse/PWM)	4200	7.2	16.5	45	75	45	75
6000	1 (6 Pulse/PWM)	6300	12.0	26.0	60	95	60	95
6300	1 (6 Pulse/PWM)	6600	12.0	26.0	60	95	60	95
6600	1 (6 Pulse/PWM)	6900 ❸	12.0	26.0	60	95	60	95

❶ Refer to rectifier duty transformer specification 80001-005.

❷ Minimum required insulation level from phase-to-ground, neutral-to-ground transformers.

❸ Contact factory for 6900V data.

10. APPENDIX C : Applicable Requirements of MV Controllers

10.1 Critical Standards

Code	Governing Association/Description
CEC-1998	Canadian Electrical Code- SAFETY STANDARD FOR ELECTRICAL INSTALLATIONS
NEC-1999	NATIONAL ELECTRICAL CODE (NFPA-70)
CSA C22.2	INDUSTRIAL CONTROL EQUIPMENT (MV)
No.14/73	
TIL NO D-21	CERTIFICATION REQUIREMENTS FOR CONTROL DEVICES RATED AT MORE THAN 1500V BUT NO MORE THAN 7200V FOR ELECTRIC MOTORS
UL347	HIGH VOLTAGE INDUSTRIAL CONTROL EQUIPMENT
IEEE –C37	CIRCUIT BREAKERS, SWITCHGEAR, SUBSTATIONS, AND FUSE STANDARDS COLLECTION
NEMA-ICS1	GENERAL STANDARD FOR INDUSTRIAL CONTROL SYSTEM
NEMA-ICS3	FACTORY BUILT ASSMBLIES
NEMA-ICS6	ENCLOSURES
IEC 60129	ALTERNATING CURRENT DISCONNECTORS (ISOLATORS) AND EARTHING SWITCHES
IEC 60298	AC METAL-ENCLOSED SWITCHGEAR AND CONTROLGEAR FOR RATED VOLTAGE ABOVE 1KV AND UP TO INCLUDING 52KV
IEC 60470	HIGH-VOLTAGE ALTERNATING CURRENT CONTACTORS
IEC 60694	COMMON SPECIFICATIONS FOR HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR STANDARDS
89/336/EEC, AND 92/31/EEC ASSOCIATED EN STANDARDS: EN 5081-2, EN 5082-2	EMC DIRECTIVE
92/59/EEC AND ASSOCIATED EN STANDARDS: EN 6010, EN60204-1.	GENERAL PRODUCT SAFETY DIRECTIVE (GPSD)

10.2 Components Standards

Code	Description
C22.2 NO14/95	INDUSTRIAL CONTROL EQUIPMENT (LV)
C22.2 No. 58	HIGH-VOLTAGE ISOLATING SWITCHES
C22.2 NO 201	METAL-ENCLOSED HIGH VOLTAGE BUSSWAYS
C22.2 NO 127	HIGH-VOLTAGE ISOLATING SWITCHES
C22.2 NO 190	CAPACITORS FOR POWER FACTOR CORRECTION
C22.2 NO 193	HIGH VOLTAGE FULL LOAD INTERRUPTER SWITCHES
UL508	INDUSTRIAL CONTROL EQUIPMENT (LV)
UL 1072	MEDIUM, VOLTAGE POWER CABLES
UL 1562	TRANSFORMERS, DISTRIBUTION, DRY TYPE OVER 600V
NEMA-MG1	MOTOR AND GENERATORS
IEC 60056	HIGH-VOLTAGE ALTERNATING-CURRENT CIRCUIT-BREAKERS
IEC 60076	POWER TRANSFORMERS
IEC 60265-1	HIGH-VOLTAGE SWITCHES - PART 1: HIGH-VOLTAGE SWITCHES FOR RATED VOLTAGES ABOVE 1 kV AND LESS THAN 52 kV
IEC 60420	HIGH-VOLTAGE ALTERNATING CURRENT SWITCH-FUSE COMBINATIONS
IEC 60282-1	HIGH-VOLTAGE FUSES
IEC 60871-1	SHUNT CAPACITORS FOR A.C. POWER SYSTEMS HAVING A RATED VOLTAGE ABOVE 1000 V

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Publication 7000A-TD200B-EN-P – November 2004
Supersedes 7000A-TD200A-EN-P July 2004