Model M3612EC

Common DC Bus High Ripple Capacitor with Cooling

Customer Reference Manual

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Bonitron, Inc.
Nashville, TN

An industry leader in providing solutions for AC drives.

ABOUT BONITRON

Bonitron designs and manufactures quality industrial electronics that improve the reliability of processes and variable frequency drives worldwide. With products in numerous industries, and an educated and experienced team of engineers, Bonitron has seen thousands of products engineered since 1962 and welcomes custom applications.

With engineering, production, and testing all in the same facility, Bonitron is able to ensure its products are of the utmost quality and ready to be applied to your application.

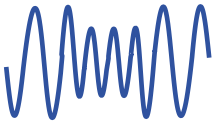
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. A clear advantage Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities, which allows the engineering team to have immediate access to testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the highest quality products.

The sales and marketing teams work closely with engineering to provide up-to-date information and provide remarkable customer support to make sure you receive the best solution for your application. Thanks to this combination of quality products and superior customer support, Bonitron has products installed in critical applications worldwide.

AC Drive Options

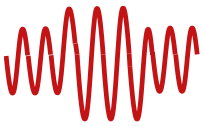
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable frequency drives and aid in reducing drive faults. Below is a sampling of Bonitron's current product offering.

World Class Products



Undervoltage Solutions

Uninterruptible Power for Drives
(DC Bus Ride-Thru)
Voltage Regulators
Chargers and Dischargers
Energy Storage



Overvoltage Solutions

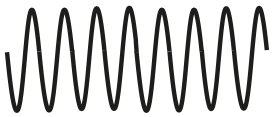
Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives

Common Bus Solutions

Single Phase Power Supplies
3-Phase Power Supplies
Common Bus Diodes

Portable Maintenance Solutions

Capacitor Formers
Capacitor Testers



Power Quality Solutions

12 and 18 Pulse Kits

Green Solutions

Line Regeneration

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1. INTRODUCTION

1.1. WHO SHOULD USE

This manual is intended for use by anyone who is responsible for integrating, installing, maintaining, troubleshooting, or using this equipment with any AC Drive System.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the Model M3612EC Capacitor Bank. It will provide you with the necessary information to successfully install and use the M3612EC module in your application.

In the event of any conflict between this document and any publication and/or documentation related to the application, the latter shall have precedence.

1.3. MANUAL VERSION AND CHANGE RECORD

Rev01 of this manual contains clarified specs and updated drawings.

Rev02 of this manual contains updated drawings, part numbers, and rating information.

The placement of the field connections was modified in Rev 03.

The manual template was updated in Rev 03a.

Updates to Section 2-1 Related Products in Rev 03b.

Updates to Section 4.2.2 Startup procedure in Rev 03c.

Figure 1-1: Typical M3612EC Capacitor Bank

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2. PRODUCT DESCRIPTION

The M3612EC is a filter capacitor bank for a common DC bus drive systems. The drives can be either servo or variable frequency drives intended for use with common bus capacitors.

2.1. RELATED PRODUCTS

2.1.1. COMMON BUS DIODES

- M3345CBM Common Bus Sharing Diodes
  - Allows power sharing between drives, while isolating input bridges
- M3345D Common Bus Isolation Diodes
  - Provides blocking diodes that isolate drives from each other, while still establishing a shared, common DC bus

2.1.2. COMMON BUS FILTERING

- M3612RC Common Bus Snubber
  - High frequency filter that limits spikes and ringing in DC bus systems caused by inverter switching, supply noise, bus reactance, and other such sources

2.1.3. COMMON BUS POWER SUPPLIES

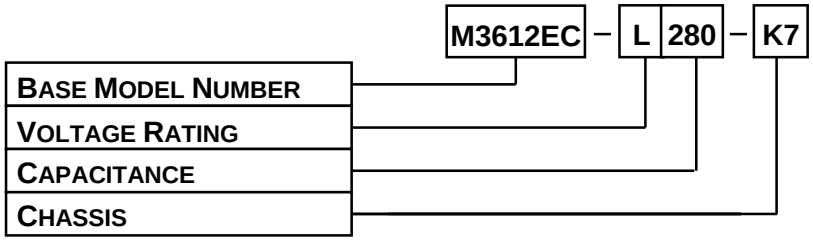
- M3712 Single Phase Power Supply
  - Power 3-Phase drives via the DC bus from a single-phase source without de-rating the drive
- M3713SC 3-Phase Power Supply with Pre-charge
  - Six pulse diode bridge with pre-charge that can serve as the main power supply for common DC bus systems.
  - Multiples can be used to serve as 12 or 18 pulse building blocks.

2.1.4. BRAKING AND OVERVOLTAGE PROTECTION

- M3452 and M3575T Modules add resistive dynamic braking to DC bus systems and VFDs.
- M3645 Modules are standalone line regeneration modules to add dynamic braking to DC bus systems and VFDs.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER
The Base Model Number for these Capacitor Banks is **M3612EC**.

VOLTAGE RATING
A 1-digit code represents the AC system voltage to the M3612EC module. The voltage rating must be selected for the system voltage that will be applied.

Table 2-1: Voltage Rating

RATING CODE	SYSTEM VOLTAGE
L	230 - 240VAC
H	460 - 480VAC

CAPACITANCE
A 3-digit code represents the nominal capacitance in.

Table 2-2: Capacitance Ratings

RATING CODE	NOMINAL CAPACITANCE (UF)
070	7,000
280	28,000

CHASSIS
The Chassis for the M3612EC is determined by the capacitance.

Table 2-3: Chassis Codes

CAPACITANCE (UF)	CHASSIS CODE	DIMENSIONS (H X W X D)
28,000	K7	20.00 x 7.12 x 10.30

2.3. GENERAL SPECIFICATIONS

Table 2-4: General Specifications Chart

PARAMETER	SPECIFICATION			
Input voltage	230VAC & 480VAC 3Ø, 60 Hz			
Capacitance tolerance	± 20% (M) at +25°C			
Leakage current	I=0.12CV (uA) or 30ma whichever is smaller			
Rated ripple current multiplier	+45°C	+65°C	+85°C	+105°C
	2.45	2.12	1.73	1.00
Operating temperature	-10°C to +50°C			
Humidity	Below 90% non-condensing			
Atmosphere	Free of corrosive gas and conductive dust			

2.4. General Precautions and Safety Warnings

DANGER!

- HIGH VOLTAGES MAY BE PRESENT!
- NEVER ATTEMPT TO OPERATE OR SERVICE THIS EQUIPMENT WITH ACCESS DOORS OR COVERS OPENED!
- FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!

DANGER!

- HIGH TEMPERATURES MAY BE GENERATED BY THIS EQUIPMENT DURING NORMAL OPERATION!
- THIS EQUIPMENT SHOULD BE INSTALLED ON A NON-FLAMMABLE SURFACE IN A WELL VENTILATED AREA WITH A MINIMUM OF 2 INCHES OF CLEARANCE ALL AROUND.
- LETHAL VOLTAGES CAN EXIST IN UNIT AFTER POWER HAS BEEN REMOVED. ALLOW 5 MINUTES FOR CAPACITOR BANKS TO DISCHARGE, AND ENSURE THERE ARE LESS THAN 40VDC ON THE DC BUS BEFORE ATTEMPTING SERVICE.
- ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT!
- INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE ACCOMPLISHED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.

ANY QUESTIONS AS TO APPLICATION, INSTALLATION, OR SERVICE SAFETY SHOULD BE DIRECTED TO THE EQUIPMENT SUPPLIER.

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3. INSTALLATION INSTRUCTIONS

WARNING! *Installation and/or removal of this product should only be performed by a qualified electrician in accordance with National Electrical Code or local codes and regulations.*

Proper installation of the Power Supply Modules should be accomplished following the steps outlined below. Be sure to refer to the AC Drive instruction manual as these steps are performed. Please direct all installation inquiries that may arise during the installation and startup of this product to the equipment supplier or system integrator.

3.1. ENVIRONMENT

The module should be installed in an area protected from moisture and falling debris. Buildup of dust or debris may cause poor performance and possibly a failure. Operating in a wet environment can pose a shock hazard. The recommended temperature range for operating or storing this module is 0°C to +40°C.

3.2. UNPACKING

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from which the product was purchased.

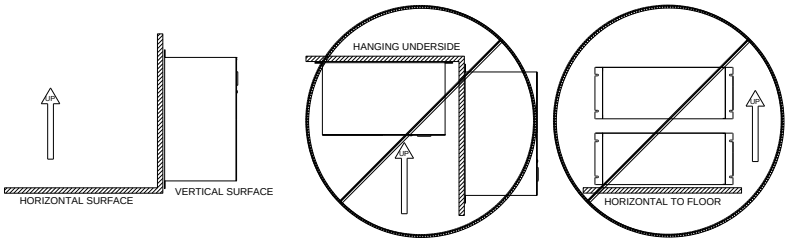
3.3. MOUNTING

3.3.1. MOUNTING THE M3612EC CAPACITOR BANK

The installation site for the module should be chosen with several considerations in mind:

- The unit requires a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source.
- Unit should not be exposed to falling debris or condensation.
- Once the installation site has been selected as outlined above, the unit should be mounted in place. The M3612EC must be properly oriented for proper heat flow through the units. The M3612EC must be mounted with the rear surface of the unit to the mounting surface. **Unit should be mounted vertically** as shown in Example A of Figure 3-1.
  - **Do Not** mount the unit upside-down or on the underside of a mounting surface as shown in Example B of Figure 3-1.
  - **Do Not** mount unit in a horizontal position with its side parallel to the mounting surface or floor as shown in Example C of Figure 3-1.

Figure 3-1: M3612EC Mounting Orientation



Example A Example B Example C

3.4. WIRING AND CUSTOMER CONNECTIONS

Be sure to review all AC Drive and system documentation for attached equipment as well as the information listed below before proceeding. Connection points and terminal numbers of the AC Drive will be found in the documentation provided with those units. See Table 3-1 and Figure 3-2 for connection details.

3.4.1. POWER WIRING

WARNING!

Only qualified electricians should perform and maintain the interconnection wiring of this product. All wiring should be done in accordance with local codes.

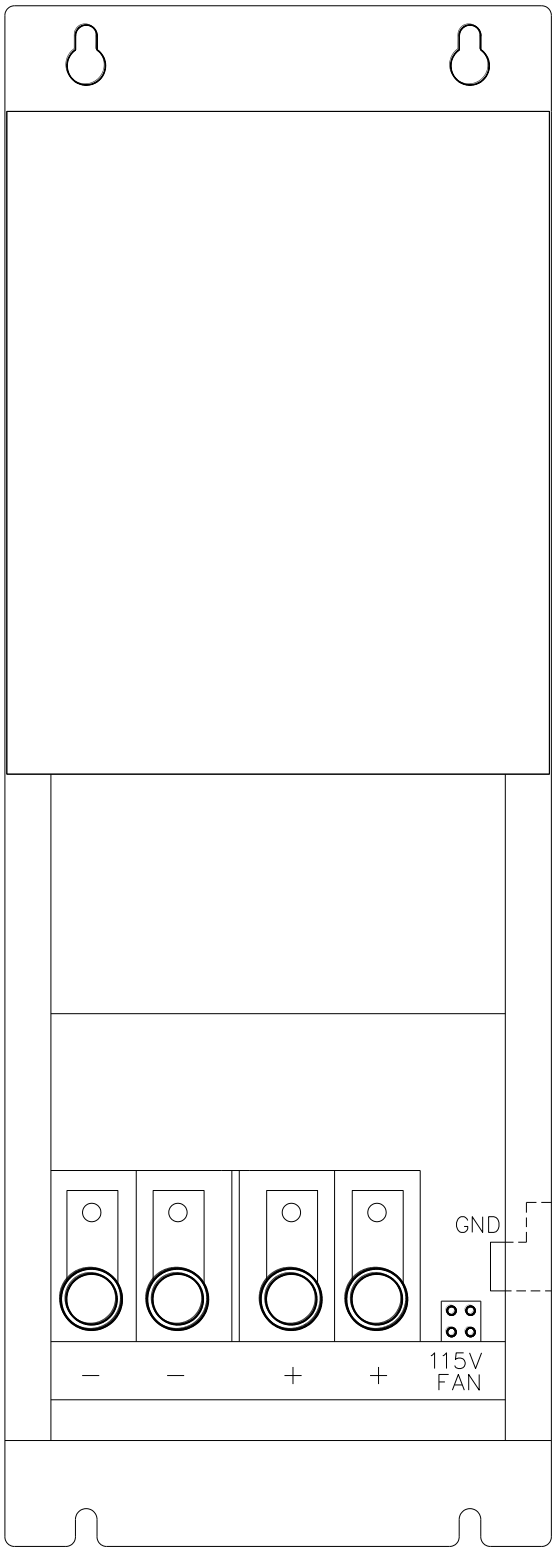
DANGER!

This unit contains substantial capacitance and can maintain lethal voltages for a long time after power is removed! Ensure that the DC bus level has dropped below 40VDC before attempting to work on or with this unit!

Table 3-1: Power Connection Specifications

MODEL	CONNECTOR	TORQUE
M3612EC-L280	#4AWG - 500Kcmil (AL/CU)	375 in-lbs
M3612EC-H070	#4AWG - 500Kcmil (AL/CU)	375 in-lbs

Figure 3-2: Power Connections



3.4.1.1. MAIN DC INPUT

"DC–" and "DC+" should be connected to the DC bus terminals of the power supply. Ensure the polarity of the connection is correct, as this can cause severe damage to the capacitor bank. Refer to your drive and power supply manuals for the exact location of this connection.

3.4.1.2. OUTPUT TO VFD

"DC–" and "DC+" should be connected to the DC bus terminals of the VFD. Ensure the polarity of the connection is correct, as this can cause severe damage to the drive. Refer to your drive manual for the exact location of this connection.

This link should be fused in accordance with the drive manufacturer's recommendations. **If the M3612EC is installed in the same cabinet as the VFD, DC link fusing may not be necessary.** Semiconductor fuses such as the A70Q or FWP are recommended for this purpose.

Do not connect the output of the M3612EC to the braking terminals of the drive. This can also cause severe damage to the drive.

3.4.1.3. GROUNDING CONSIDERATIONS

Using the ground stud provided, ground the chassis in accordance with local codes. Typically, the wire gauge will be the same as is used to ground the attached drive.

Refer to your local codes and standards for installation guidelines.

3.4.1.4. FAN POWER

The fan has a current draw of ½A and will need an 115VAC, 15W power supply. See Figure 3-2 for location of fan hook-up.

3.5. TYPICAL CONFIGURATIONS

Figure 3-3: M3612EC Capacitor Bank Field Wiring Diagram Option 1

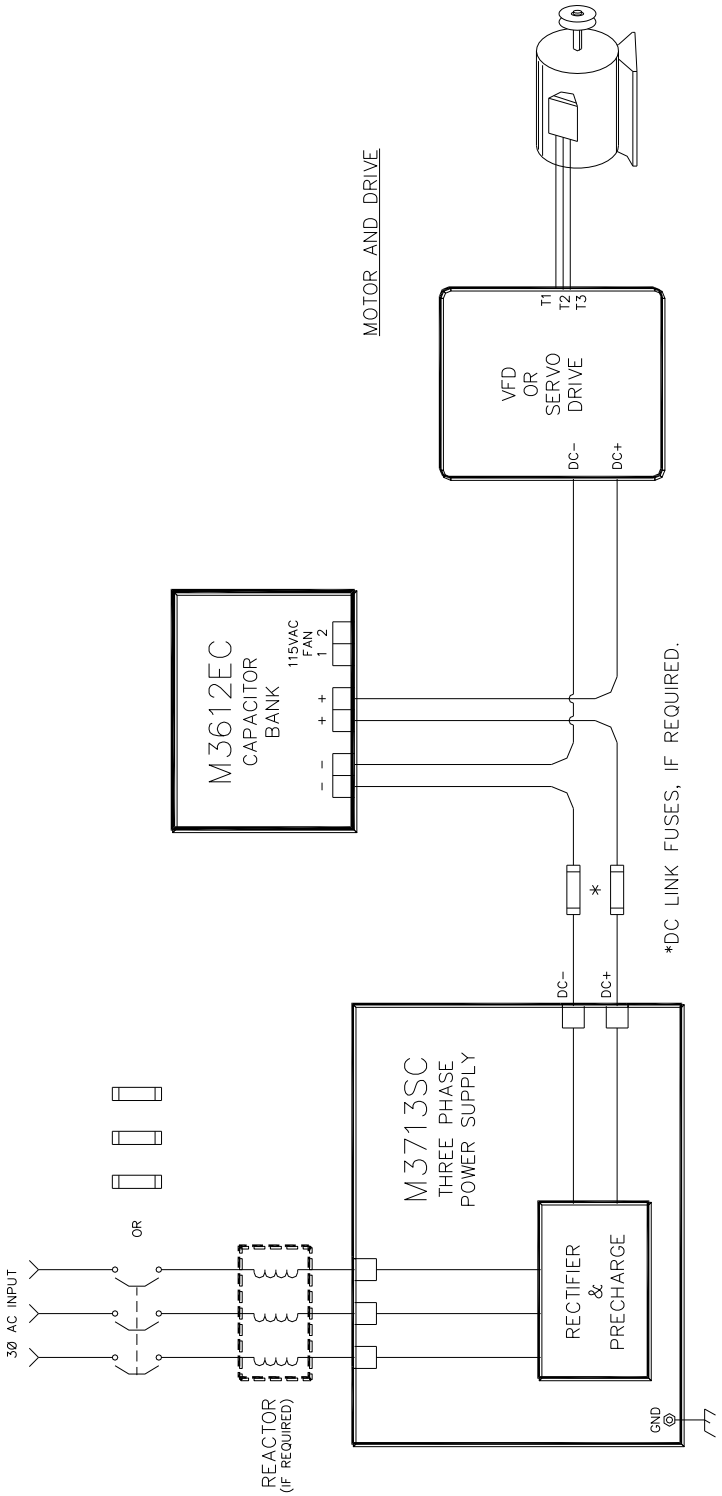
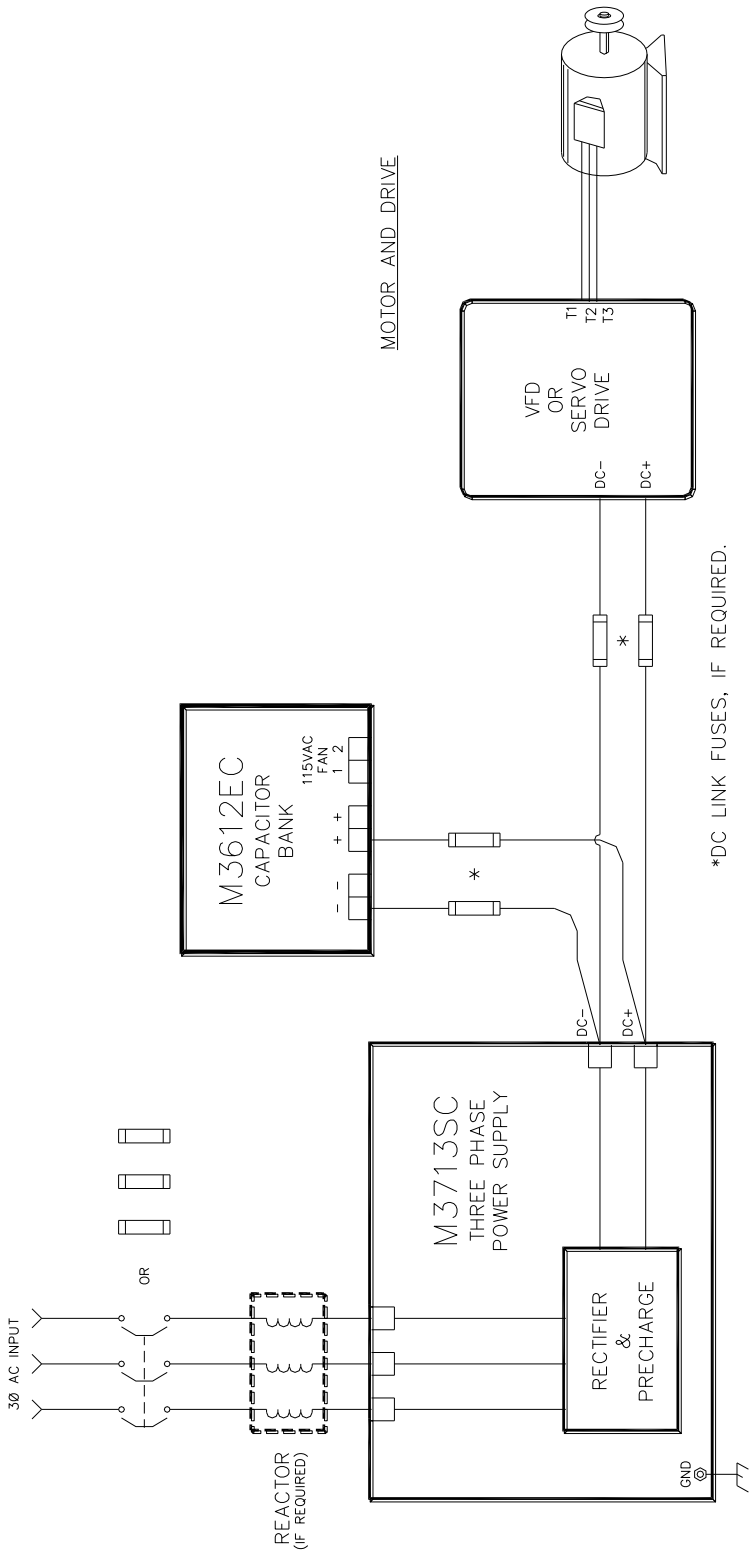


Figure 3-4: M3612EC Capacitor Bank Field Wiring Diagram Option 2



4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3612EC is a capacitor bank with an integral bleeder to build a DC bus if bus filter capacitance is required.

4.2. STARTUP

This section covers basic checks and procedures that may be used when performing a startup with a M3612EC.

4.2.1. PRE-POWER CHECKS

- Ensure that all connections are tight and that all wiring is of the proper size and rating for operation.
- Verify continuity of all input fuses.
- Ensure that the polarity of the DC link to the attached drive is correct.
- Check for exposed conductors that may lead to inadvertent contact.
- Check for any debris, shavings, trimmings, etc that may cause shorts or obstruct ventilation on unit.
- Perform the pre-power checks required for the attached drive.

4.2.2. STARTUP PROCEDURE AND CHECKS

WARNING!

Make sure the M3612EC Capacitor Bank is fully charged before applying power to the drive

- After completing pre-checks and recommended checks for connected equipment, you may apply power to the power supply.
- Confirm a Pre-Charge complete indication on the power supply to make sure the attached capacitor bank is fully charged.
- Check bus voltage to make sure it is within the capacitance bank specification.
- The attached drive should then be started up according to its instructions.

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5. MAINTENANCE AND TROUBLESHOOTING

Repairs or modifications to this equipment are to be performed by Bonitron approved personnel only. Any repair or modification to this equipment by personnel not approved by Bonitron will void any warranty remaining on this unit.

5.1. PERIODIC TESTING

There are no requirements for periodic testing of these units. When performing routine maintenance it may be beneficial to repeat start-up procedures and checks.

5.2. MAINTENANCE ITEMS

Check periodically for debris, clear as necessary. Buildup can cause short circuits and dangerous conditions.

Reduced airflow can cause nuisance tripping and overheating.

Power should not be applied when blowing dust and debris out of unit.

5.3. TROUBLESHOOTING

DANGER!

Capacitor bank can maintain lethal voltages for a long time after power is removed! Ensure that the DC bus level has dropped below 40VDC before attempting to work on or with this unit!

DANGER!

Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply may result in personal injury, death, and/or equipment damage!

Feel free to call Bonitron at any time if the equipment appears to be having problems.

5.3.1. ATTACHED DRIVE DOES NOT COME ON

- Ensure that power is applied to the input of the M3612EC. Check all fuses, circuit breakers, disconnects, etc. that may interrupt power to the unit.
- Consult power supply manual for further assistance.

5.3.2. OVERHEATING

If the unit continually overheats during operation, you may need more capacitance. Check the output ripple current to ensure it is within tolerance of the unit. If the unit is sized properly to the application, you may need to install an input reactor or large input choke. See Section 7 for guidelines.

5.3.3. BLOWN INPUT FUSES OR CIRCUIT BREAKERS

WARNING!

Blown overcurrent devices can indicate damage to the unit. Do not replace the input fuses and repower the unit as severe damage can occur.

Contact Bonitron Technical Support before attempting to restart the system.

5.4. TECHNICAL HELP – BEFORE YOU CALL OR EMAIL

If technical help is required, please have the following information when contacting us:

- Serial number of unit
- Name of original equipment supplier (if available)
- Record the line voltage
- Record the DC Bus voltage immediately after the AC voltage
- Brief description of the application
- Drive and motor hp or kW
- kVA rating of power source
- Source configuration and grounding

6. ENGINEERING DATA

6.1. RATINGS CHARTS

Table 6-1: Ratings Table

MODEL NUMBER	SYSTEM VOLTAGE	MAX. CAPACITOR VOLTAGE	CAPACITANCE	ESR	END-OF-LIFE	
					CAPACITANCE CHANGE	ESR CHANGE
M3612EC-L280-K7	230-240VAC	450VDC	28,000µF	3.8mΩ	-20%	100%
M3612EC-H070-K7	460-480VAC	900VDC	7,000µF	15.3mΩ	-20%	100%

6.1.1. RIPPLE CURRENT

Table 6-2: Ripple Current and Fuse Table

MODEL NUMBER	MAX RIPPLE CURRENT		DC LINK FUSES (SEMICONDUCTOR TYPE)
	300HZ 45°C	300HZ 105°C	
M3612EC-L280-K7	385A	175A	400A
M3612EC-H070-K7	200A	90A	200A

6.2. WATT LOSS

Table 6-3 lists the maximum Watt Loss generated by the listed units. When installing M3612EC units in an additional enclosure, consideration should be given to internal temperature rise. The Watt Loss rating in following table is based upon the maximum capability of each unit.

Table 6-3: Full Load Watt Loss

MODEL NUMBER	WATT LOSS
M3612EC-L280-K7	Maximum 563W
M3612EC-H070-K7	Maximum 612W

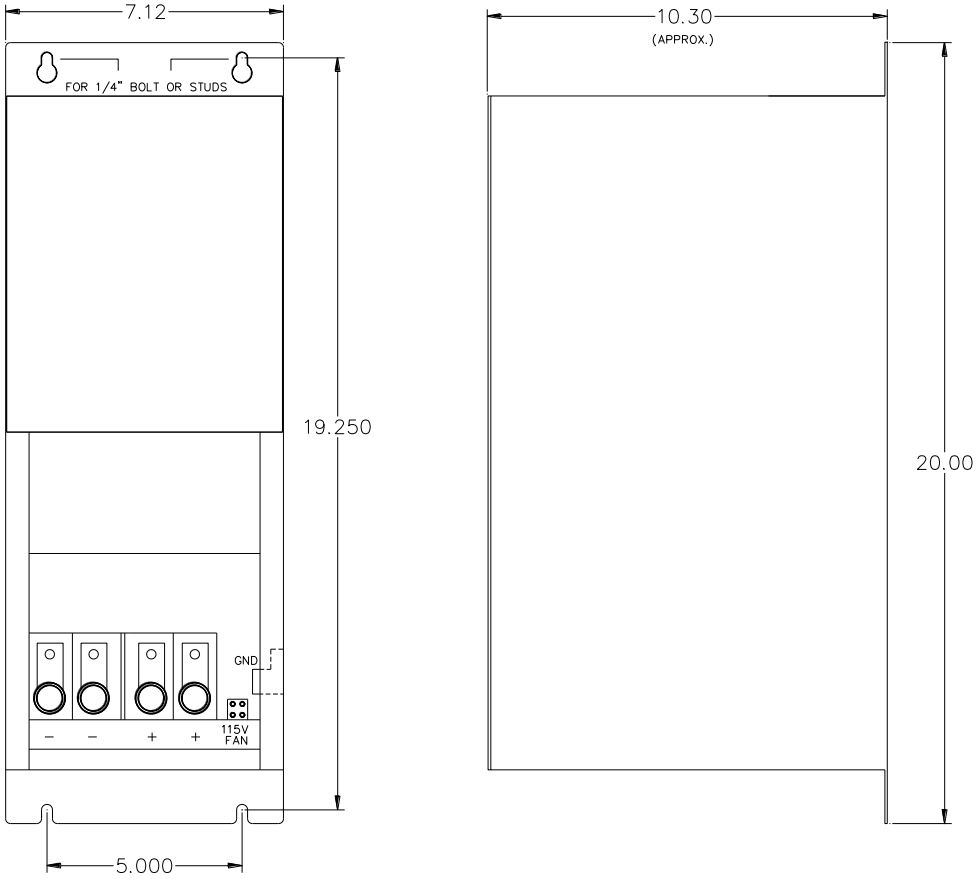
Note: Watt Loss = $(I_{ripple})^2$ * ESR

6.3. DIMENSIONS AND OUTLINES

Table 6-4: Chassis Dimensions for M3612EC Module

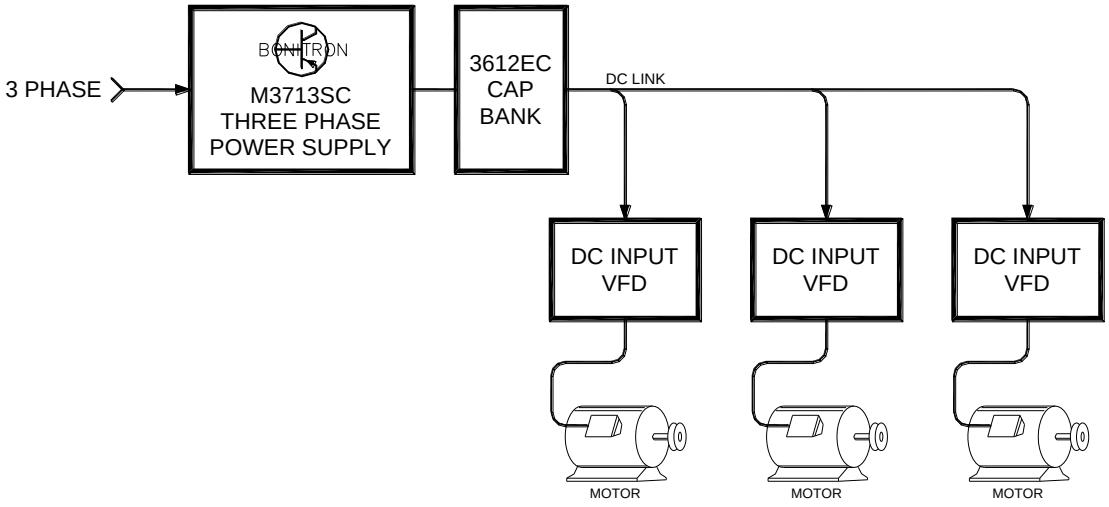
CHASSIS	OVERALL (IN INCHES)			MOUNTING (IN INCHES)		WEIGHT (LBS.)
	A HEIGHT	B WIDTH	C DEPTH	D HEIGHT	E WIDTH	
K7	20.00	7.12	10.30	19.25	5.00	30

Figure 6-1: M3612EC K7 Chassis Dimensional Outline



6.4. BLOCK DIAGRAMS

Figure 6-2: Functional Block Diagram



CONTINUOUS COMMON DC BUS POWER SUPPLY
WITH SHORT TERM 100% OUTAGE PROTECTION
USING DC BOOSTER WITH ULTRA CAP RESERVOIR

7. APPLICATION NOTES

7.1. APPLICATION CONSIDERATIONS

There are some issues that should be considered when designing the complete system.

7.1.1. DRIVES

Most variable frequency AC drives are suitable for use with the M3612EC. Some things to consider are listed below.

- Check the manual for the drive you are using, or call the technical support line for the drive manufacturer if you have questions on this hookup.
- The precharge circuit of the system must also be checked to make sure it will not be overloaded on startup. Consult your drive manual, or the specifications for the drive power supply for this specification.

7.2. SYSTEM VOLTAGE AND SOURCE IMPEDANCE

The M3612EC is intended to be used with an input reactor for the reduction of peak input currents and bus voltage ripple and ripple current. The reactor adds inductive impedance to the circuit to reduce these factors, and adds to the total input impedance of the system. Other sources of inductive impedance in your installation are the main incoming transformer and the conductors to that transformer. If the total input impedance is too high, it can cause low voltage at the input of the power source, and therefore the DC bus of the drive. This is referred to as a "soft" source, and will have a transformer closely matched to the load and high impedance.

If your system is running hot, or blows input fuses under normal loads, an input reactor can reduce the RMS input currents and the capacitor bank ripple current to allow the system to operate within tolerances.

Transformers are rated in kVA and percent impedance. In order to see what kVA your system needs, you can roughly multiply the horsepower by 1000. Your transformer should be rated higher than this. In other words, a 50 horsepower system would require at least a 50kVA transformer, if not larger. If the transformer has 5% impedance, the voltage drop to the output of the transformer at full load will be 5%. For instance, a 480V transformer with 5% impedance can only have 456VAC at the terminals at full load. If the transformer is much larger than the required kVA, or has a low percent impedance, the source is considered to be "stiff" and may not require further consideration.

If the input impedance is too high to the system, the input to the power source can drop to the point where the DC bus of the drive will be out of specifications. When the DC bus falls too low, the motor can lose power or run hotter than usual. If the DC bus falls low enough, the drive will trip and not operate the motor. This typically is shown as an "Undervoltage" fault on the drive.

There are situations where the existing system impedance may be high enough that the input reactor may be bypassed. The following steps will help determine if you should bypass the reactor.

- Measure the AC voltage at the input to the reactor (transformer side) with the unit disabled or turned off. If the AC voltage is lower than 95% of the nominal value, the transformer taps should be adjusted to raise the incoming voltage. If the AC voltage is between nominal and 110% continue to the next step.

- Enable the power supply and check the voltage at the output of the reactor (System side) while the system is running at full power. If the voltage drops to below 90% of the nominal value, check the DC bus voltage of the drive, and make sure it is well within the operating range of the drive's specifications.
- Check the voltage at the input of the reactor (transformer side). If the voltage stays above 90% of the nominal voltage, you can operate your system without the reactor. If the voltage drops below 90% of the nominal voltage, you may need to upsize your input transformer or get a transformer with lower impedance for proper operation.

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