



Model ASM 3534EC

Ridethrough Cap Assembly with Precharge Option

Customer Reference Manual

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.

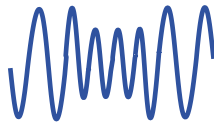
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. 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

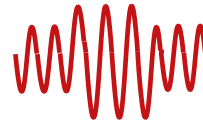
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable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

WORLD CLASS PRODUCTS



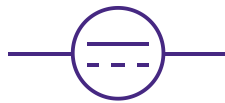
Undervoltage Solutions

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 ASM 3534EC Capacitor Assembly. It will provide you with the necessary information to successfully install and use the ASM 3534EC 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.

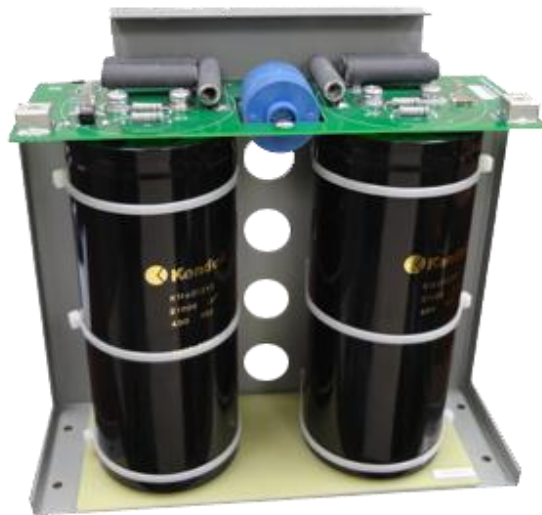
1.3. MANUAL VERSION AND CHANGE RECORD

Formatting and drawings updated in Rev 00a.

Clarification of Functional Description and Startup in Section 4 updated in Rev 00b.

Update to the manual template in Rev 00c.

Figure 1-1: Typical ASM 3534EC Capacitor Assembly



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2. PRODUCT DESCRIPTION

The ASM 3534EC is a filter capacitor assembly for a common DC bus drive systems. The drives can be either servo or variable frequency drives intended for use with common bus capacitors.

These units can be used to add capacitance to the DC bus for tolerance to short term outages or sags on the incoming AC line of a drive. The ASM 3534EC is configured so that the added capacitance has a minimal impact on the RMS peak currents through the drive input bridge.

2.1. RELATED PRODUCTS

M3528 ULTRA CAP / BATTERY CHARGER

M3528 is a voltage and current limited power supply used to charge electrical energy storage devices such as battery banks or ultra capacitor reservoirs for industrial voltage levels of 240, 480, and 600V. User inputs allow for remote enable and second setpoint charging for battery equalization.

M3534R RIDE-THRU VOLTAGE REGULATOR

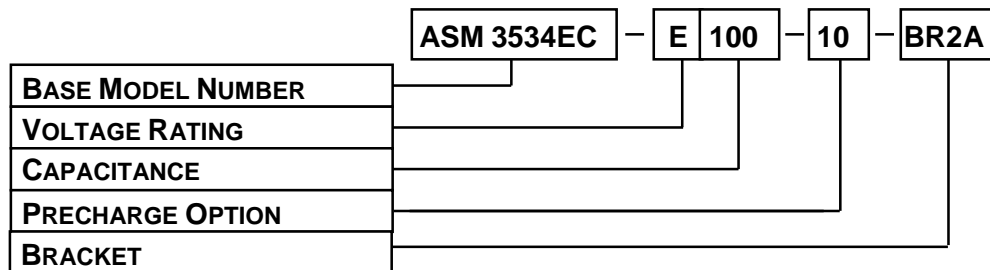
The M3534R Ride-Thru Voltage Regulator regulates the DC bus during a voltage sag or outage event. If the incoming voltage level drops, the M3534R boosts the DC bus up to the minimum level needed by the drive. The M3534R provides full-load power for up to 2 seconds for 50%, 3-phase sags or for 1-phase sags to 0V with no energy storage. Capacitors can be added for outage protection up to 2 seconds.

ASM 3612EC CAP ASSEMBLY W/TALL BRACKET, NO PRECHARGE

The ASM 3612EC is a filter capacitor assembly for a common bus DC drive that does not require precharge.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number for the Capacitor Assembly is **ASM 3534EC**.

VOLTAGE RATING

A 1-letter code represents the AC system voltage to the ASM 3534EC Capacitor Assembly. Select the Voltage Rating for the system voltage that will be applied.

Table 2-1: Voltage Rating

RATING CODE	SYSTEM VOLTAGE
E	380VAC
H	480VAC

CAPACITANCE

A 3-digit code represents the nominal capacitance of the unit. The capacitance is found by multiplying the code by 100uF. (Example: **100** = 10,000μF).

Table 2-2: Capacitance Ratings

RATING CODE	NOMINAL CAPACITANCE (μF)
100	10,000
400	40,000

PRECHARGE OPTION

A 2-digit code represents the selected Precharge Source Option as described in Section 4.1.

Table 2-3: Precharge Option Selections

CODE	DESCRIPTION
10	One cap rack with jumper removed to allow separate charge input from discharge input
11	One cap rack with jumper installed to allow caps to precharge from the drive bus

BRACKET

A 3 or 4-digit code represents the bracket type for the ASM 3534EC.

Table 2-4: Bracket Codes

BRACKET CODE	DIMENSIONS (H x W x D)
BR2A	10.20 x 10.00 x 3.80
BR3	10.75 x 11.50 x 3.90

2.3. GENERAL SPECIFICATIONS

Table 2-5: General Specifications Table

PARAMETER	SPECIFICATION			
Input system Voltage	230VAC, 380VAC, 480VAC 3Ø, 60Hz			
Capacitance tolerance	± 20% (M)			
Rated ripple current multiplier	+45°C	+65°C	+85°C	+105°C
	2.45	2.25	1.75	1.00
Operating Temp	-25°C to +105°C			
Humidity	Below 90% non-condensing			
Atmosphere	Free of corrosive gas and conductive dust			

2.4. GENERAL PRECAUTIONS AND SAFETY WARNINGS



- HIGH VOLTAGES MAY BE PRESENT!
- THIS ASSEMBLY IS CONSTRUCTED WITHOUT PROTECTION AGAINST ACCIDENTAL CONTACT!
- ASSEMBLY MUST BE INSTALLED IN AN ENCLOSURE THAT PREVENTS ACCIDENTAL CONTACT BY PERSONNEL OR EQUIPMENT!
- FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!



- 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 ASSEMBLY TO DISCHARGE, AND ENSURE THERE ARE LESS THAN 40VDC ON THE DC BUS BEFORE ATTEMPTING SERVICE.
- 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



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 Capacitor Assemblies should be done following the steps outlined below. Be sure to refer to the AC Drive instruction manual for information on proper integration.

3.1. ENVIRONMENT



*High voltages may be present!
This assembly is constructed without protection against accidental contact!
Assembly must be installed in an enclosure that prevents accidental contact by personnel or equipment!
FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!*

The module should be installed in an enclosure protected from moisture falling debris and accidental contact.

Buildup of dust or debris may cause poor performance, arcing, and 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.

Do not use/expose capacitors to the following conditions.

- Oil, water, salty water storage in damp locations.
- Direct sunlight
- Toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium
- Ozone, ultraviolet rays or radiation
- Severe vibration or mechanical shock conditions beyond the limits prescribed in the product specification

3.2. LONG TERM STORAGE

If these capacitors are stored for more than 10 months without applying voltage, they will need to be reformed.

Long term storage allows the capacitors to change chemically, and the ESR will rise greatly. If the capacitors are put into service without reforming, they will quickly overheat and can fail catastrophically.

To reform the capacitor bank, voltage must be applied to the bank in slow increments over a period of 30 to 60 minutes.

Please consult Bonitron for this procedure, or consult the M3628PCF Portable Capacitor Former manual for more guidance.

3.3. 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.

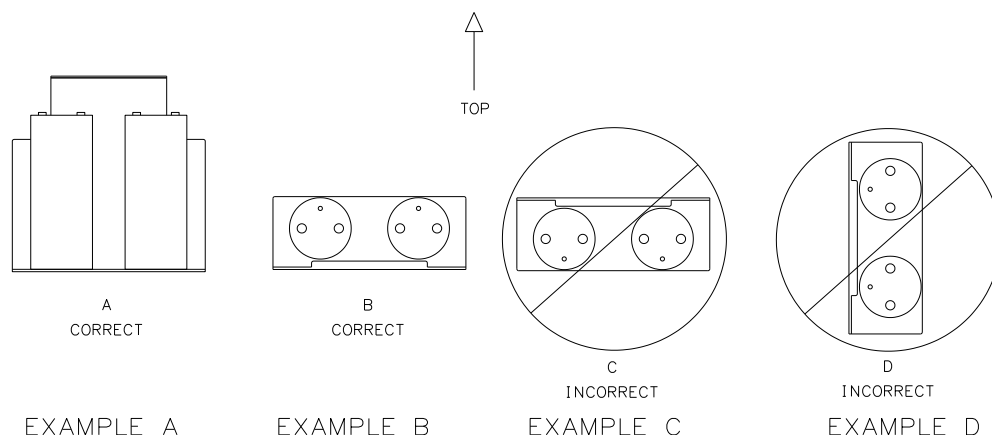
3.4. MOUNTING

3.4.1. MOUNTING THE ASM 3534EC CAPACITOR ASSEMBLY

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.
 - **Unit should be mounted** as shown in Example A & B of Figure 3-1.
 - **Do Not** mount the assembly as shown in Example C or D of Fig 3-1.

Figure 3-1: ASM 3534EC Mounting Orientation



3.5. 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.

3.5.1. 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.



WARNING!

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!

3.5.1.1. POWER CONNECTION SPECIFICATIONS

The terminal connectors on the ASM 3534EC must be torqued according to Table 3-1.

Table 3-1: Power Connection Specifications

MODEL	TORQUE
ASM 3534EC (any)	35.4 in-lbs (4Nm)

3.5.1.2. BUS CONNECTIONS

The outside "+" (plus) and "-" (minus) terminals should be connected in parallel to the DC bus of the common bus system. Ensure the polarity of the connection is correct, as this can cause severe damage to the capacitor assembly. Refer to your drive and power supply manuals for the exact location of this connection.

Figure 3-2: ASB 3534EC Customer Connections

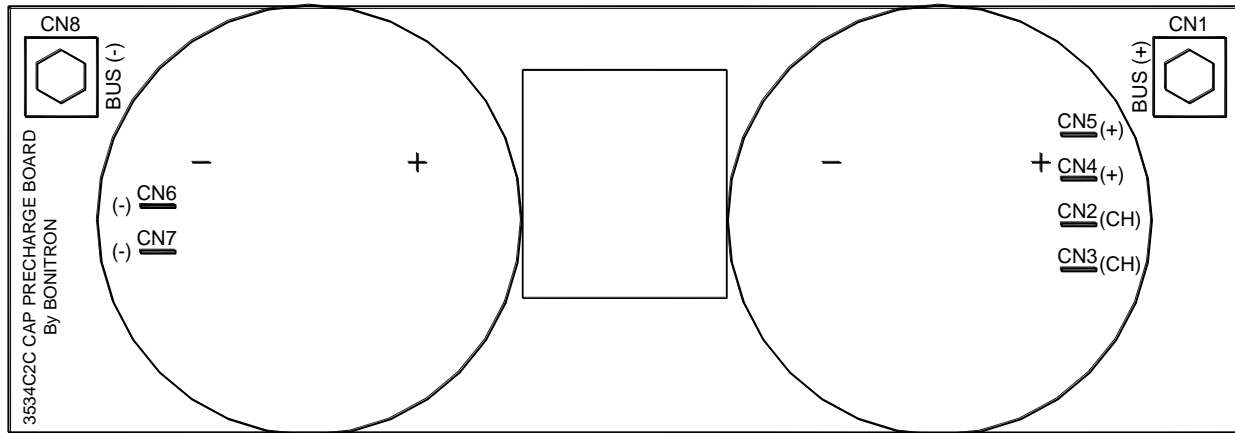


Table 3-2: Customer Connections with Precharge Boards

Terminal	Function	Electrical Specs	Connection Type
CN1	DC Bus +	600VDC-100A	M6 Terminal
CN8	DC Bus -		
CN2-3	Precharge Input	600VDC-5A	3/16" Spade Lug
CN4-5	Test +	600VDC-100mA	
CN6-7	Test -		

3.5.1.3. GROUNDING CONSIDERATIONS

The bracket of the assembly should be grounded either by contact with a grounded surface or with a separate wire to a mounting screw. If the mounting surface is painted, remove the paint to allow for conduction through the mounting screw.

Refer to your local codes and standards for installation guidelines.

3.6. TYPICAL CONFIGURATIONS

Figure 3-3: Basic Schematic Options

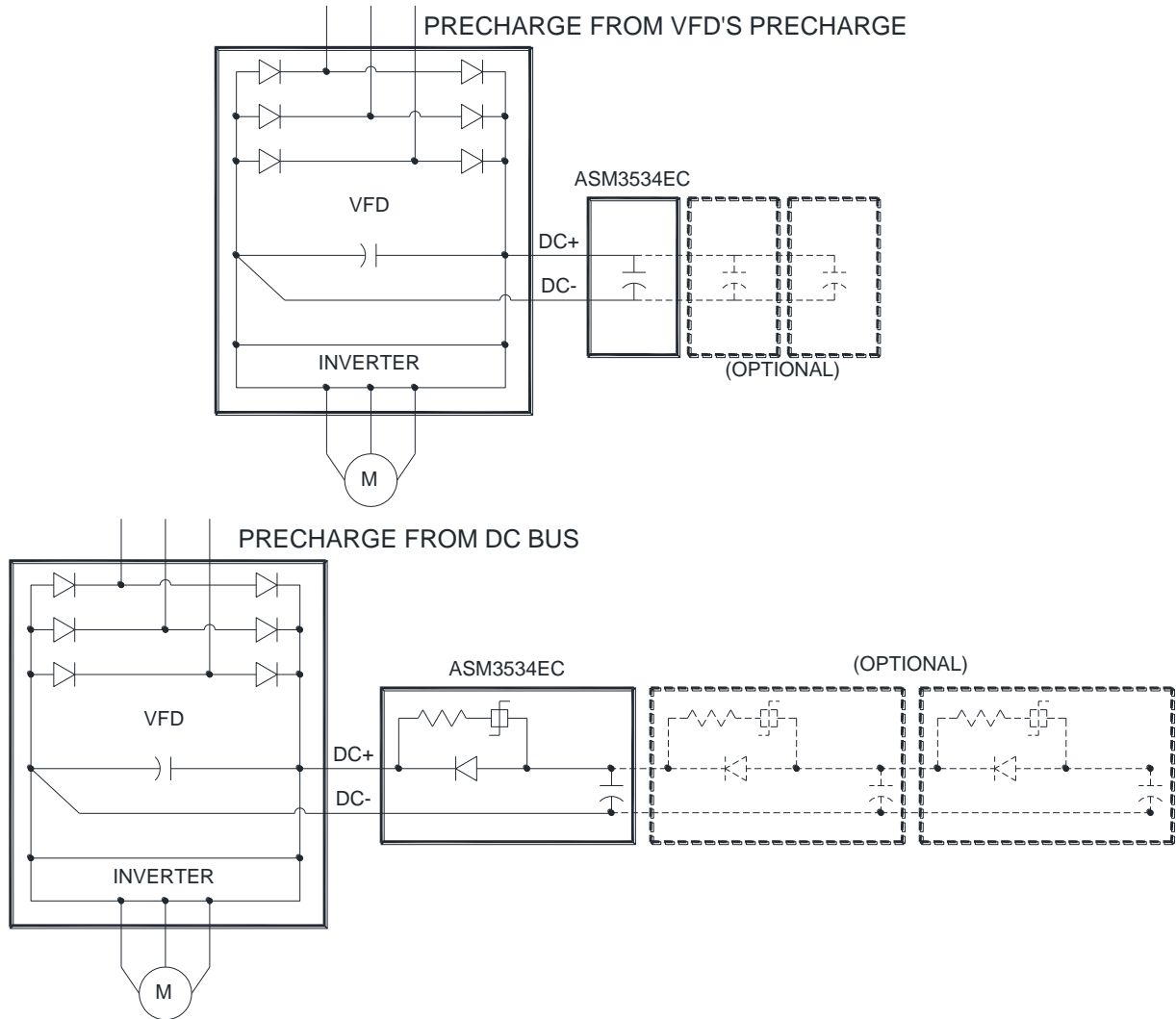


Figure 3-4: ASM 3534EC Field Wiring with Precharge from DC Bus or No Precharge

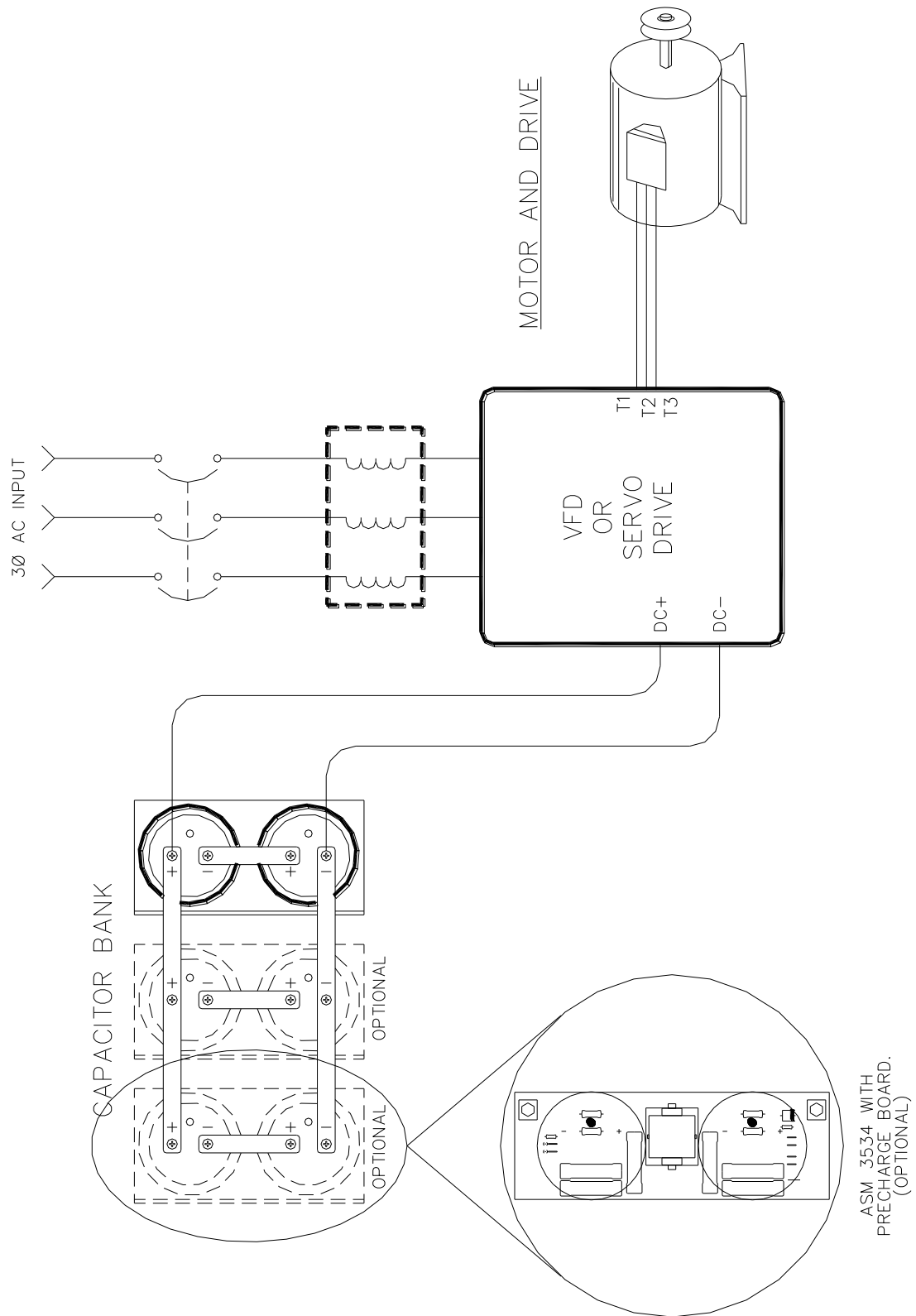
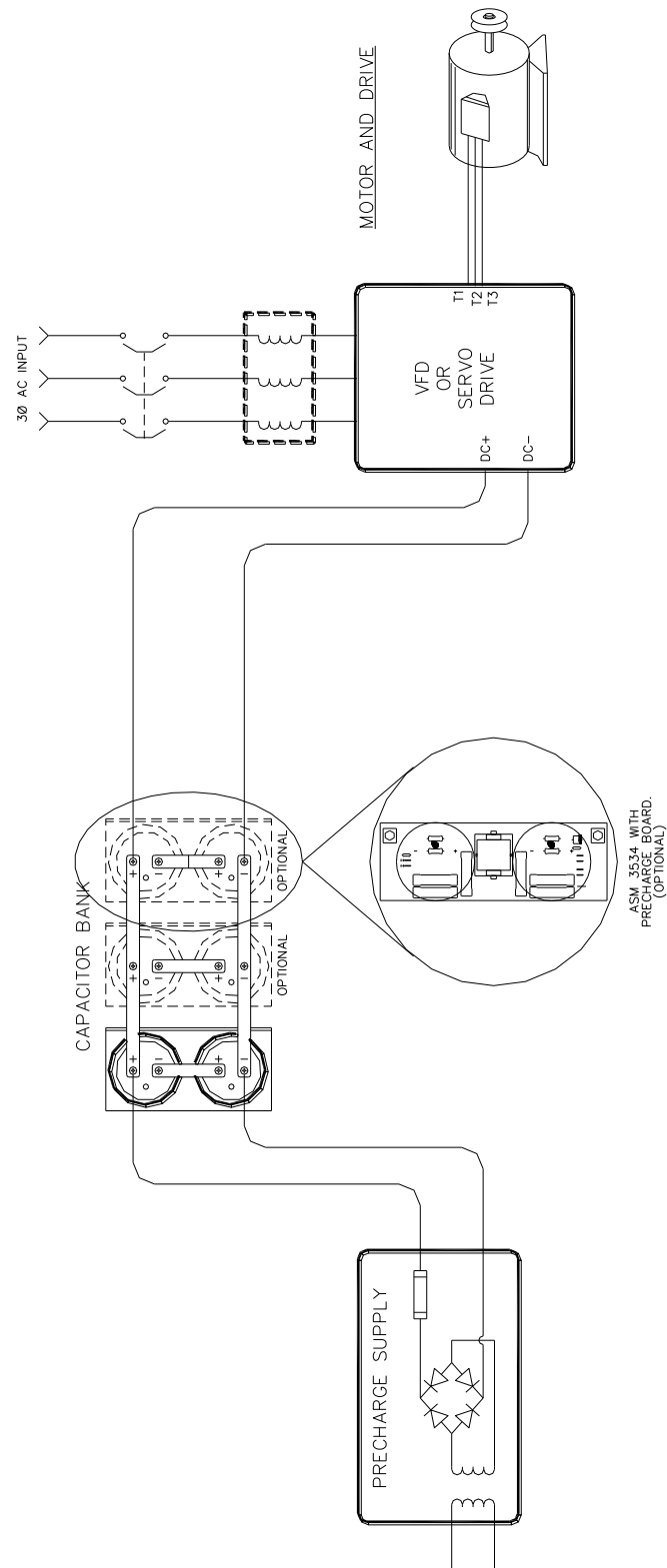


Figure 3-5: ASM 3534EC Field Wiring with Separate Precharge Supply



4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The ASM 3534EC is a Capacitor Assembly with or without integrated precharge and an integral bleeder for DC bus backup. . The module is configured to greatly reduce ripple currents in the capacitor banks during normal operation. This will reduce the RMS input currents in the AC bridge that would increase if only bulk capacitance were added.

The ASM 3534EC has two different precharge options available:

1. **Precharge via an external power supply** – using either terminal CN2 or CN3, an external power supply can be used to precharge the ASM 3534EC to a voltage independent of the DC bus. This option (Option 10) is useful for applications in which the outage specification will allow the ASM 3534EC to operate at a voltage lower than the DC bus. Jumper J1 must open in order to use an external power supply for precharge.
2. **Precharge via the DC bus** – the DC bus of the drive can be used as the power source for the precharge of the ASM 3534EC if jumper J1 is in the closed position. With J1 closed and the DC bus connected to terminals CN1 and CN8 the ASM 3534EC will precharge with no additional power supply. In this configuration the ASM 3534EC will follow the DC bus voltage. (Option 11)

4.2. STARTUP

This section covers basic checks and procedures that may be used when performing a startup with an ASM 3534EC.

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.

4.2.2. COMMISSIONING AFTER LONG TERM STORAGE

If these capacitors are stored for more than 10 months without applying voltage, they will need to be reformed.

Long term storage allows the capacitors to change chemically, and the ESR will rise greatly. If the capacitors are put into service without reforming, they will quickly overheat and can fail catastrophically.

To reform the capacitor bank, voltage must be applied to the bank in slow increments over a period of 30 to 60 minutes.

Please consult Bonitron for this procedure, or consult the M3628PCF Portable Capacitor Former manual for more guidance.

4.2.3. STARTUP PROCEDURE AND CHECKS

- After completing pre-checks and recommended checks for connected equipment, you may apply power to the system.
- Check bus voltage to make sure it is within the capacitance assembly specification.
- The attached drive should then be started up according to its instructions.

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.

5.2. MAINTENANCE ITEMS

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

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

5.3. TROUBLESHOOTING



Capacitor assembly 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!



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!

5.3.1. ATTACHED DRIVE DOES NOT COME ON

- Ensure that power is applied to the input of the ASM 3534EC. 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



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

High capacitance DC filter banks increase the input RMS currents on the AC line. High RMS currents can blow fuses or circuit breakers over time. If the AC input currents are too high for your system design, consider using input chokes to reduce them. Contact Bonitron Technical Support before attempting to restart the system.

5.4. TECHNICAL HELP – BEFORE YOU CALL

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

- Model number of unit
- 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

Table 6-1: Ratings Table

MODEL NUMBER	SYSTEM VOLTAGE	MAX DC VOLTAGE	TOTAL CAPACITANCE	MAX RIPPLE CURRENT @300Hz 45°C	MAX RIPPLE CURRENT @300Hz 105°C	DC LINK FUSES (SEMI-CONDUCTOR TYPE)
ASM 3534EC-E100	400VAC	800VDC	10,000uF	21.5	15A	25A
ASM 3534EC-H105	480VAC	800VDC	10,500 uF	21.5	15A	25A

6.2. WATT LOSS

Table 6-2 lists the maximum Watt Loss generated by the listed units. When installing M3534EC 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 6-2: Full Load Watt Loss

MODEL NUMBER	TYPICAL WATT LOSS
ASM 3534EC-E100	30W
ASM 3534EC-H105	30W

6.3. DIMENSIONS AND OUTLINES

Table 6-3: Bracket Dimensions for ASM M3534EC

BRACKET	OVERALL (IN INCHES)			MOUNTING (IN INCHES)	
	A HEIGHT	B WIDTH	C DEPTH	D HEIGHT	E WIDTH
BR2A	3.80	10.00	10.20	9.30	2.00
BR3	10.75	11.50	3.90	10.60	2.00

Figure 6-1: BR2A Bracket Dimensional Outline

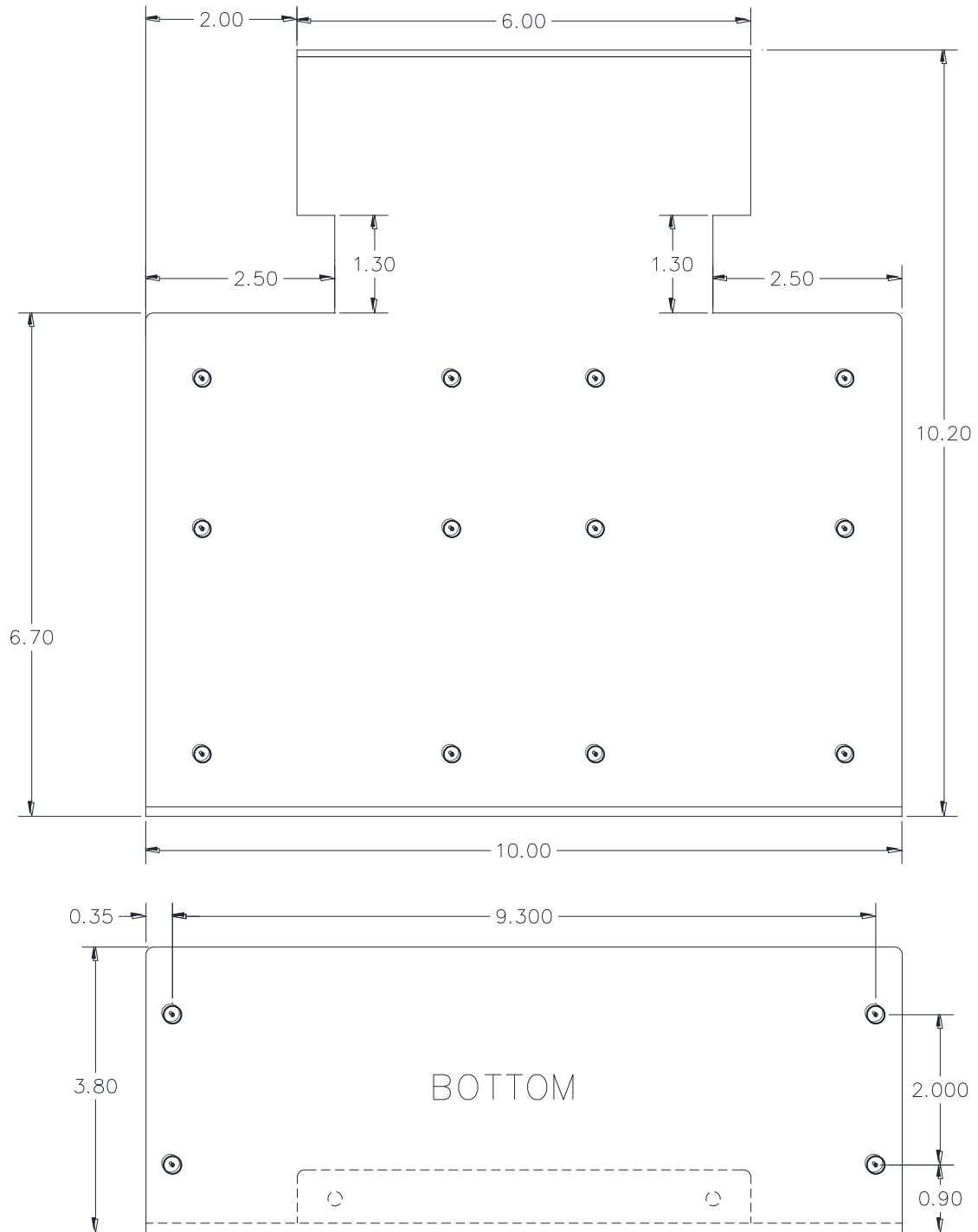
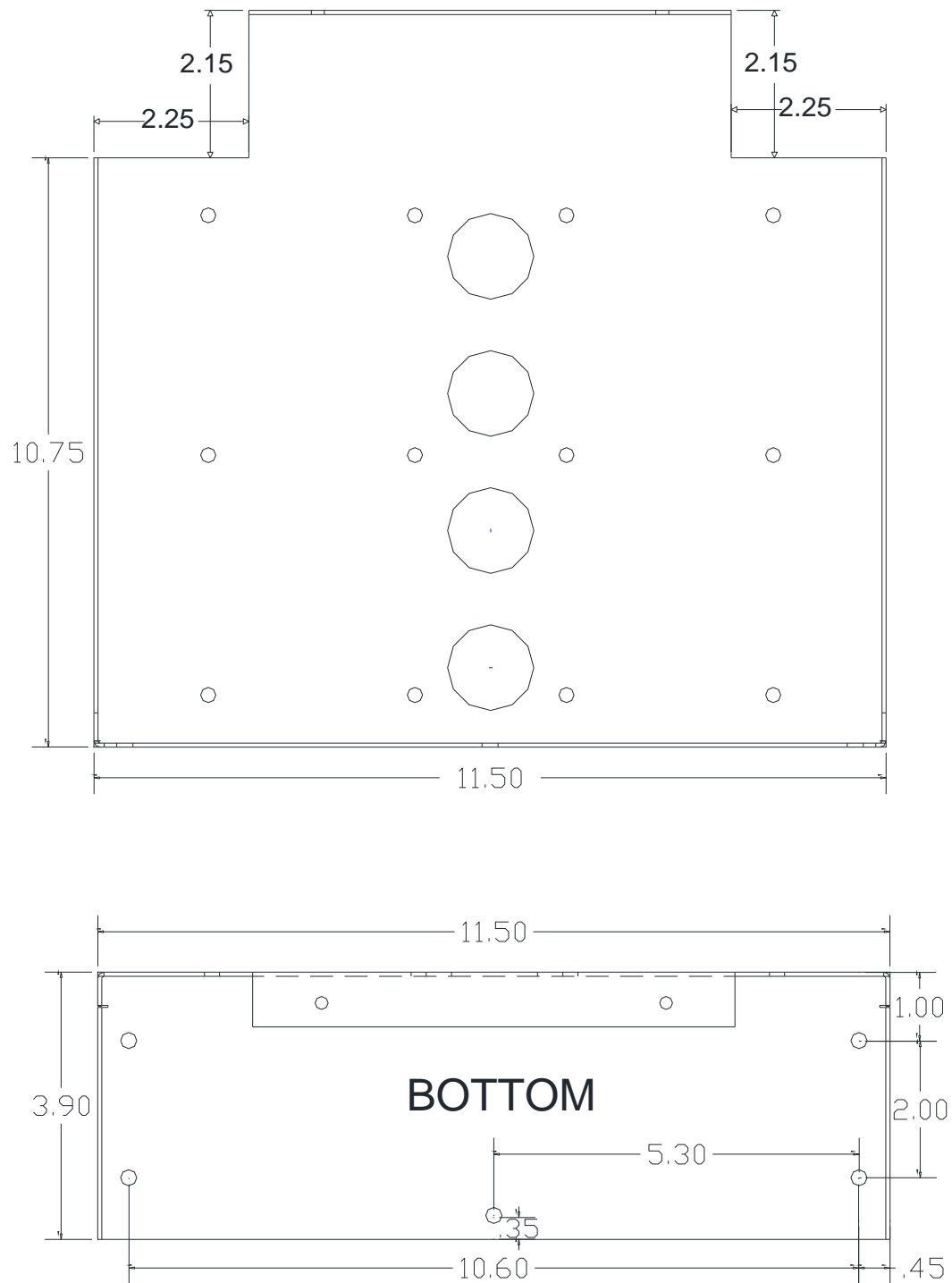


Figure 6-2: BR3 Bracket Dimensional Outline



6.4. CAPACITOR SPECIFICATIONS

Table 6-4: K11 Capacitor Specifications Table

ITEM	CHARACTERISTICS							
Temperature Range	Operating:	-40°C +85°C						
	Storage:	Preferably below +25°C, not exceeding +40°C						
Rated Voltage Range (V _r)	from 350V to 450V DC							
Surge Voltage (V _p)	V _p = 1.10 V _r							
Rated Capacitance Range	from 20,000 µF							
Capacitance Tolerance	±20% at 100 Hz, 20°C [M class IEC-62] on request: -10% +30% at 100 Hz, 20°C [Q class IEC-62]							
Leakage Current (I _L) (5 min, 20°C)	max I _L = 0.006 C _r V _r + 4 µA							
Ripple Current (I _r)	Refer to table at 85°C and 100Hz:							
	FREQUENCY	50Hz	100 Hz	500Hz	1000Hz	>10kHz		
	MULTIPLIER	0.8	1.0	1.2	1.3	1.5		
	AMBIENT TEMP	35°C	45°C	55°C	65°C	75°C	85°C	95°C
	MULTIPLIER	2.2	2.1	1.8	1.6	1.4	1.0	0.5
	Due to the current load capability of the contact elements, the following limits must not be exceeded:							
	CAPACITOR DIAMETER		76mm		90mm			
	Maximum Current		50A		70A			
Insulation Resistance	At 100V DC for 1 min is >100 MΩ across insulating sleeve and terminals.							
Vibration Resistance	Frequency range: 10 Hz to 55 Hz, amplitude 0.75 mm max acceleration 10G for 3x2 h							
Life Test	5000 hours. The following specifications shall be satisfied when the capacitors are restored to 20°C after subjecting them to the DC rated voltage for 5,000 hours at 105°C with the rated ripple current applied. The sum of DC voltage and peak AC voltage must not exceed the full rated voltage of the capacitors.							
	<ul style="list-style-type: none">Capacitance change: ≤20% of initial measured valueTan δ (DF) : ≤ 200% of initial specified value Leakage current : ≤ of initial specified value							
Shelf Life	2 years without reforming when stored at temperatures below 40°C The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them for 1,000 hours at 105°C without voltage applied. The rated voltage shall be applied to the capacitors for a minimum of 30 minutes, at least 24 hours and not more than 48 hours, before the measurements.							
	<ul style="list-style-type: none">Capacitance change: ≤20% of initial measured valueTan δ (DF): ≤ 200% of initial specified value Leakage current : ≤ initial specified value							
Useful Life	> 12000 h at 85°C							
Failure Percentage	≤ 1 % (during useful life)							
Failure Rate	≤ 70 fit							
Self-Inductance	Approx. 20 nH							
Reference Standards	CECC 30.300 IEC 60384-4 LONG LIFE GRADE							

7. APPLICATION NOTES

7.1. DRIVES

Most variable frequency AC drives are suitable for use with the ASM 3534EC. 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.

7.2. CAPACITOR ASSEMBLY SIZES FOR BACKUP APPLICATIONS

The amount of capacitance required for backup of short term can be calculated with the following equations and procedure.

Throughout this section, consider the example of a 5hp application at 460Vac input voltage that requires 0.5 seconds of backup power.

7.2.1. SYSTEM POWER

First, determine the system power that is required. In this instance a 10hp drive would have the following system power:

$$P_{SYS} = 10hp * .746 kW / hp = 7.5kW$$

To determine the total energy required for an outage event multiply the System Power by the outage time.

$$J_{OUT} = P_{SYS} * T_{OUT} = 7.5kW * .5s = 3.8kJ$$

7.2.2. CHARGE ENERGY

The energy stored in a capacitor is given by:

$$J = \frac{1}{2} CV^2$$

Where C is the capacitance and V is the voltage.

We will use the worst-case scenario where the capacitor is nearing its end of life. Using the data sheet in Table 6-4, the end of life capacitance, C_{EOL} , is 80% of the initial measured value.

With a capacitor bank with two 20,000μF capacitors in parallel, the C_{EOL} for the capacitor bank is:

$$C_{EOL} = \frac{1}{\frac{1}{10,000\mu F} + \frac{1}{10,000\mu F}} * 80\% = 8,000\mu F$$

To find the energy in a capacitor bank for an outage event, we need to find the starting DC bus voltage and then subtract the voltage from where the drive will trip.

This is represented by the equation:

$$J_{charge} = \frac{1}{2} * C_{EOL} * (V_{start}^2 - V_{trip}^2)$$

The starting voltage is equal to the normal operating DC bus voltage.

V_{start} is determined by:

$$V_{start} = V_{input} * \sqrt{2} = 460Vac * \sqrt{2} = 640Vdc$$

The trip voltage is the voltage at which the drive will undergo an undervoltage fault. This will vary upon the drive; consult the manufacturer's drive manual for more details.

In this specific instance, assume that the fault occurs when $V_{trip} = 320VDC$.

$$J_{charge} = \frac{1}{2} * 8,000\mu F * (640Vdc^2 - 320Vdc^2) = 2.4kJ$$

This is less than is required to cover an outage for 0.5 seconds. Therefore, more capacitor banks are required.

7.2.3. AVAILABLE ENERGY

More capacitor banks are available to increase the capacitance by attaching the units in parallel. The equivalent capacitance for multiply capacitor banks of the same size is:

$$C_{eq} = n_{parallel} C_{EOL}$$

To accommodate the energy necessary to meet J_{OUT} , we need to parallel four ASM 3534EC's.

$$C_{eq} = 4 * 8,000\mu F = 32,000\mu F$$

Therefore the available energy is increased to:

$$J_{available} = \frac{1}{2} * 32,000F * (640Vdc^2 - 320Vdc^2) = 5kJ$$

7.2.4. ESR LOSSES

As capacitors deteriorate the ESR increases. In this worst-case scenario we assume that there will be 10% loss due to the ESR of the capacitor bank.

$$J_{Loss} = .1 * J_{available} = .5kJ$$

Verify that the value for $J_{available}$ is sufficient to accommodate the energy that is required for the outage event and the energy consumed by the ESR by evaluating the following inequality:

$$\begin{aligned} J_{OUT} + J_{Loss} &< J_{available} \\ 3.8kJ + .5kJ &< 5kJ \end{aligned}$$

Having four capacitor banks in parallel is adequate to meet the conditions set in this example.

7.3. CAPACITOR END OF LIFE

As the capacitor gradually deteriorates; the electrical parameters of the capacitor change. The criteria of judging the failures vary with application and design factors.

Capacitance decreases and Tan δ increases are caused by the loss of electrolyte in the wear-out failure period. This is primary due to loss of electrolyte by diffusion (as vapor) through the sealing material. Gas molecules can diffuse out through the material of the end seal. High temperature increase the electrolyte vapor pressure within the capacitor and the diffusion rate is therefore increased. This increases internal pressure may cause the seal to bulge caused by elevated temperatures. This bulging may accelerate diffusion and mechanically degrade the seal. Factors that can increase the capacitor temperature, such as ambient temperature and ripple current can decrease the life of a capacitor.

7.4. CAPACITOR FAILURE MODE

The typical failure mode for non-solid aluminum electrolytic capacitors is an open circuit. Overheating can cause the vent to open, and some material may be released. If a non-solid aluminum electrolytic capacitor expels gas when venting, it will discharge odors or smoke, or burn in the case of a short-circuit failure. Immediately turn off or unplug the main power supply of the device.

When venting, a non-solid aluminum electrolytic capacitor blows out gas with a temperature of over 100°C. (A solid aluminum electrolytic capacitor discharges decomposition gas or burning gas while the outer resin case is burning.)

Never expose the face close to a venting capacitor. If your eyes should inadvertently become exposed to the spouting gas or you inhale it, immediately flush the open eyes with large amounts of water and gargle with water. If electrolyte is on the skin, wash the electrolyte away from the skin with soap and plenty of water.

Do not ingest the electrolyte of non-solid aluminum electrolytic capacitors.

7.5. CAPACITOR LIFE

The nominal lifetime of a capacitor assembly under load is 5000 hours of use at 105°C. When operated at temperatures less than 105°C, the capacitor life is increased. If the capacitors are operated within 45°C, expected lifetime is 12,000 hours.

7.6. DISPOSAL

Please consult with a local industrial waste disposal specialist when disposing of aluminum electrolytic capacitors.

NOTES

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