Model S3534EC

Full Outage Drive Ride-Thru System for Variable Frequency AC Drives

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.

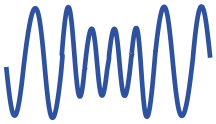
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience.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

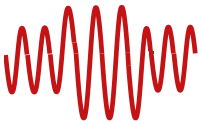
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable 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

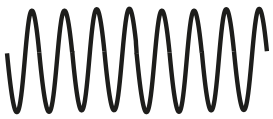
Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives

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 S3534EC Full Outage Ride-Thru System. It will provide the user with the necessary information to successfully install, integrate, and use the S3534EC system in a variable frequency AC drive system.

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

1.3. MANUAL VERSION AND CHANGE RECORD

Rev 01 incorporates the new part number format and additional data.

Rev 01a updates include connection clarifications.

The product name and ratings are updated in Rev 01b.

An internal wiring drawing is updated in Rev 01c.

Updates to the ratings and manual template were made in Rev 02a.

Updates for product redesign made in Rev 03a.

Figure 1-1: Typical S3534EC Ride-Thru System

1.4. SYMBOL CONVENTIONS USED IN THIS MANUAL AND ON EQUIPMENT

	Earth Ground or Protective Earth
	AC Voltage
	DC Voltage
 DANGER!	DANGER: Electrical hazard - Identifies a statement that indicates a shock or electrocution hazard that must be avoided.
 DANGER!	DANGER: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.
 CAUTION!	CAUTION: Identifies information about practices or circumstances that can lead to property damage, or economic loss. Attentions help you identify a potential hazard, avoid a hazard, and recognize the consequences.
 CAUTION!	CAUTION: Heat or burn hazard - Identifies a statement regarding heat production or a burn hazard that should be avoided.

2. PRODUCT DESCRIPTION / FEATURES

Variable Frequency Drives (VFDs) are commonly used in industry to improve control over continuous process applications, such as in the textile and semiconductor industries, where very accurate motor speed control is required. Unfortunately, these systems are quite susceptible to problems caused by fluctuations of incoming power, such as AC line voltage sags or outages. Long downtimes as well as large and costly production losses have been experienced due to VFD shutdowns caused by these occurrences.

Bonitron's model S3534EC series of ride-thru provide protection from AC line voltage sags and outages for AC drive systems that use a fixed DC bus. The S3534 series provides protection from line voltage sags or the momentary loss of one phase by temporarily storing energy internally and releasing it back into the DC bus when needed. This allows the drive to "ride through" these events, maintaining motor speed and torque, without experiencing drive shutdown.

The majority of AC line voltage fluctuations that occur in three-phase distribution systems have a magnitude (decrease from nominal voltage) of less than 50% and duration of less than 2 seconds. The S3534EC incorporates additional capacitive energy reservoirs known as storage capacitors. This allows the ride-thru to supply DC bus power to the inverter during full outages of a predetermined duration in addition to its normal sag protection to allow sufficient time for auxiliary power systems to engage before shutdown occurs. Or, it may allow the drive system to ride through the outage completely, thus avoiding the problems associated with other power supply backup methods.

2.1. RELATED PRODUCTS

S3460UR SERIES RIDE-THRU SYSTEMS

Complete systems that use ultracapacitor storage for short term power outages.

S3460BR SERIES RIDE-THRU SYSTEMS

Complete systems that use batteries for longer term power outages.

M3534 SERIES RIDE-THRU MODULES

Voltage regulators used for sag or outage protection of lower power systems.

M5628 BATTERY AND ULTRACAPACITOR CHARGERS

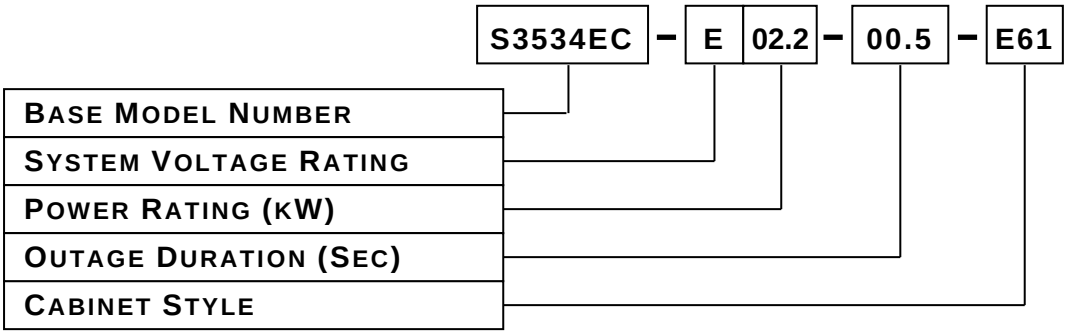
Chargers for high voltage storage strings.

M3628 ULTRACAPACITOR SAFETY DISCHARGERS

Automatic discharge for large capacitor storage banks for safety and quick maintenance entry.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number for a full outage AC Input Drive Ride-Thru System without a M3534R Module is **S3534EC.**

SYSTEM VOLTAGE RATING

The System Voltage rating indicates the nominal AC / DC voltage levels of the AC drive system the S3534EC is intended to support. A letter indicates the system voltage.

Table 2-1: System Voltage Rating Codes

RATING CODE	VOLTAGES (NOMINAL AC LINE / DC BUS)
L	230VAC / 320VDC
E	380 - 415VAC / 540 - 585VDC
H	460VAC / 640VDC

POWER RATING (KW)

The Power rating indicates the maximum power in kilowatts that can safely be handled by the S3534EC. This rating is directly represented by a 3-digit value. For instance, the rating for a 2.2kW S3534EC is **02.2**.

OUTAGE DURATION (SEC)

The Outage Duration indicates the maximum time the S3534EC will support the DC bus at the minimum bus voltage setpoint for the specified system voltage. The time is directly represented in seconds by a 3-digit value. For example, **00.5** in this position represents 0.5 seconds of outage duration.

CABINET STYLE

Enclosure type and size is dependent on the Ride-Thru System specifications. See section 6-4 for dimension information.

Table 2-2: Cabinet Styles and Codes

CHASSIS CODE	CHASSIS DESCRIPTION
E61	24"(H) x 20"(W) x 12(D) Type-12 wall mount enclosure
E63	30"(H) x 24"(W) x 12(D) Type-12 wall mount enclosure
E66	36"(H) x 30"(W) x 12(D) Type-12 wall mount enclosure

2.3. GENERAL SPECIFICATIONS

Table 2-3: General Specifications

PARAMETER	SPECIFICATION
AC Input Voltage	3-Phase, 230 – 480VAC
DC Output Voltage	320 - 650VDC
DC Output Current	Up to 5.0A
Power Rating	Up to 3.0kW
Maximum Outage Duration	2.0 seconds
Pre-charge Time	Approximately 8 seconds
Pre-charge Current	Approximately 8A peak per capacitor assembly
Discharge Resistance	780 Ohms
Discharge Times with Discharge Resistor	≈ 60 seconds
Discharge Times without Discharge Resistor	≈ 90 minutes
Inactive Power Usage	Less than 4 watts
Field Connections	AC Line Input DC Bus Output Ground
Metering	Grace voltage Indicator
Operating Temperature	40°C
Storage Temperature	-20ºC to +65ºC
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and conductive dust
Enclosure	Type-12

2.4. General Precautions and Safety Warnings

DANGER!

- High voltages may be present!
- Never attempt to operate this product with the enclosure door open!
- Never attempt to service this product without first disconnecting power to and from the unit!
- Always allow adequate time for residual voltages to drain before opening the enclosure door.
- **Failure to heed these warnings may result in serious bodily injury or death!**

CAUTION!

- This product will generate high ambient temperatures during operation.
- This product should be installed accordingly on non-flammable surfaces with clearances of at least two inches in all directions.
- Always allow adequate time for the unit to cool before attempting service on this product.
- Before attempting installation or removal of this product, always review all AC drive documentation for pertinent safety precautions.
- 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.

3. INSTALLATION INSTRUCTIONS

DANGER!

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 S3534EC ride-thru should be accomplished by 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. See Section 7.2 for additional installation considerations.

3.1. ENVIRONMENT

The installation site for the S3534EC should be chosen with several considerations in mind:

1. The unit has a Type-12 rating and will therefore require some protection from the elements.
2. Conduit access for field wiring may be provided on the top-right surface of the enclosure if desired.
3. The unit will require a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source.
4. The mounting surface should be clean and dry.

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

Once the installation site has been selected as outlined above, the unit should be mounted in place. The enclosure is provided with (4) mounting holes.

Mounting holes should be drilled and mounting studs or anchors installed before positioning the enclosure. Mounting hardware is not supplied.

Refer to Section 6 of this manual for the mounting dimensions for the unit.

3.4. WIRING AND CUSTOMER CONNECTIONS

This section provides information pertaining to the field wiring connections of the S3534EC. Actual connection points and terminal numbers of the AC drive system will be found in the documentation provided with that system.

Review all pertinent AC drive system documentation before proceeding.

DANGER!

THE S3534EC CAN HAVE MULTIPLE POWER SOURCES, INCLUDING THE MAIN AC INPUT, ENERGY STORAGE SYSTEMS AND THE DC CONNECTION TO THE VFD.

ENSURE THAT ALL SOURCES ARE DISCONNECTED AND LOCKED OUT BEFORE ATTEMPTING SERVICE OR INSTALLATION.

FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!

3.4.1. POWER WIRING

Field connection terminals for the DC Bus output, AC Line input, and Ground are located at the top right of the ride-thru enclosure backplate. See Figure 3-3 for power connection location in the enclosure.

DC BUS OUTPUT (DSC1-1, 2)

DC Power Output connections.

3-PHASE AC LINE INPUT (DSC1-3, 4, 5)

AC Line input connections The AC source needs to be able to supply 8 Amps peak per capacitor module.

GROUND

Cabinet should be earth grounded to the stud in the upper right corner of the backplate.

Table 3-1: Field Wiring Connections

TERMINAL	FUNCTION	ELECTRICAL SPECS		MIN WIRE AWG	MAX WIRE AWG	TORQUE
DSC1-1	DC Power Output +	3.0KW	650VDC, 5A	14 AWG	8 AWG	7 - 14 lb-in
DSC1-2	DC Power Output -		650VDC, 5A			7 - 14 lb-in
DSC1-3,4,5	AC Power Input		460VAC, 6.25A			7 - 14 lb-in
GND	System Ground		Limited by Ring Lug 3/8"			40 - 50 lb-in

Figure 3-1: S3534EC Field Connection Terminal Layout

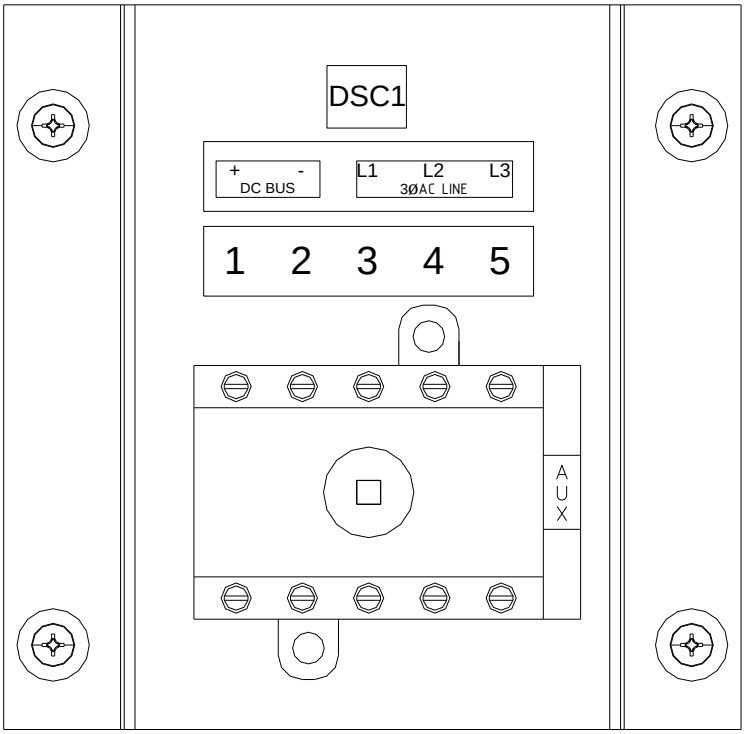


Figure 3-2: Typical S3534EC Interconnection with Existing Drive System

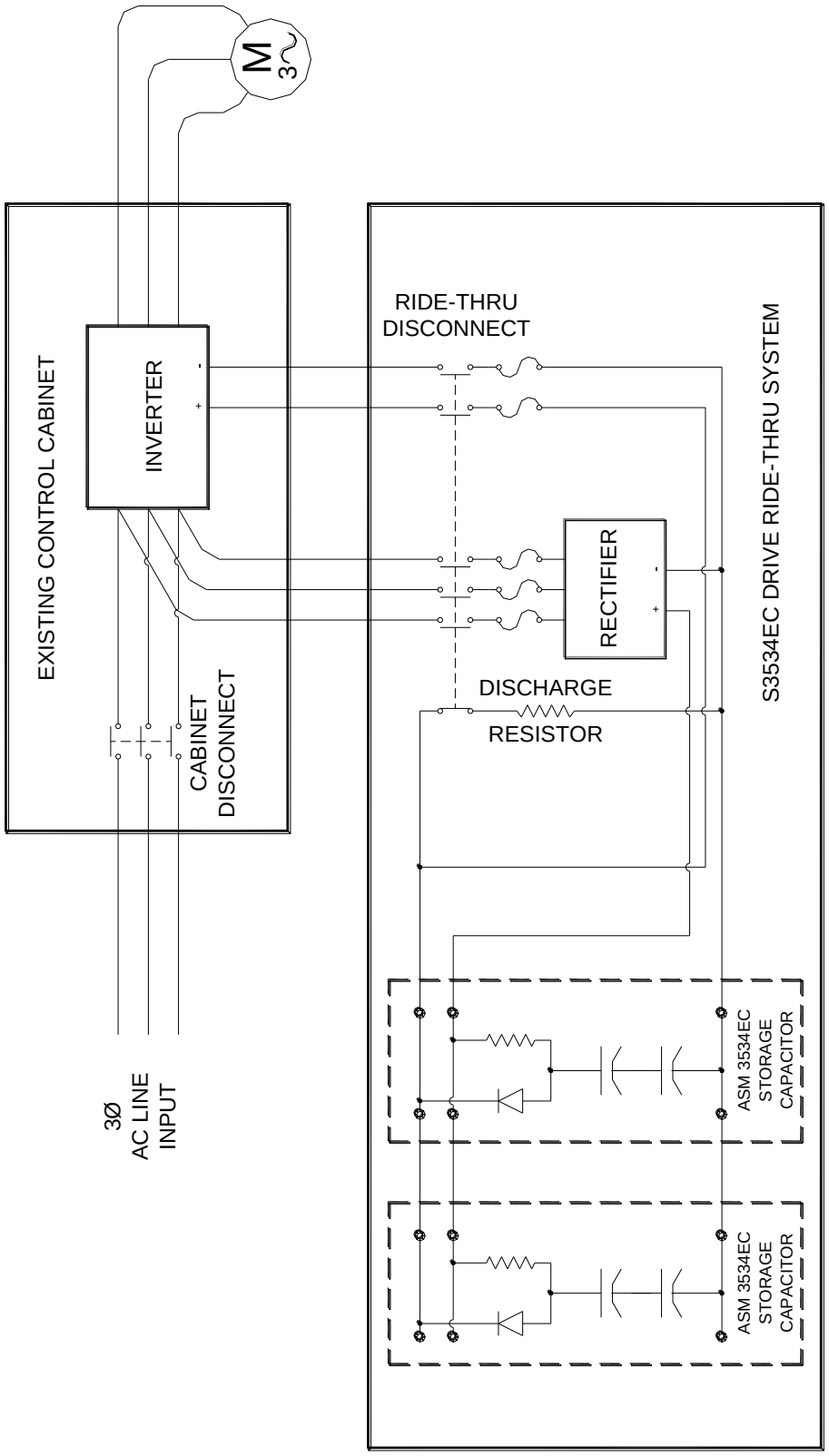


Figure 3-3: S3534EC Drive Ride-Thru System in E61 Cabinet Internal Layout

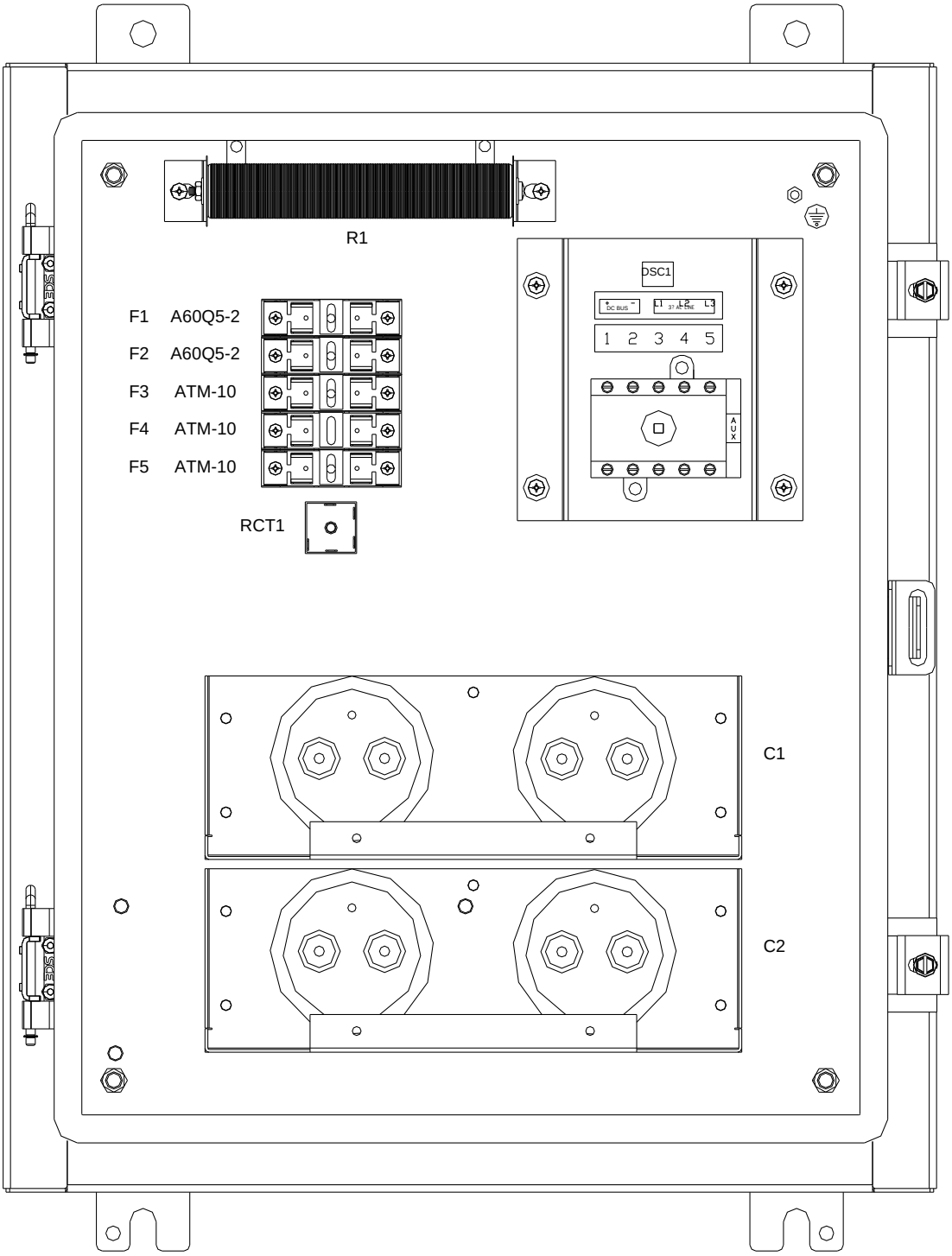
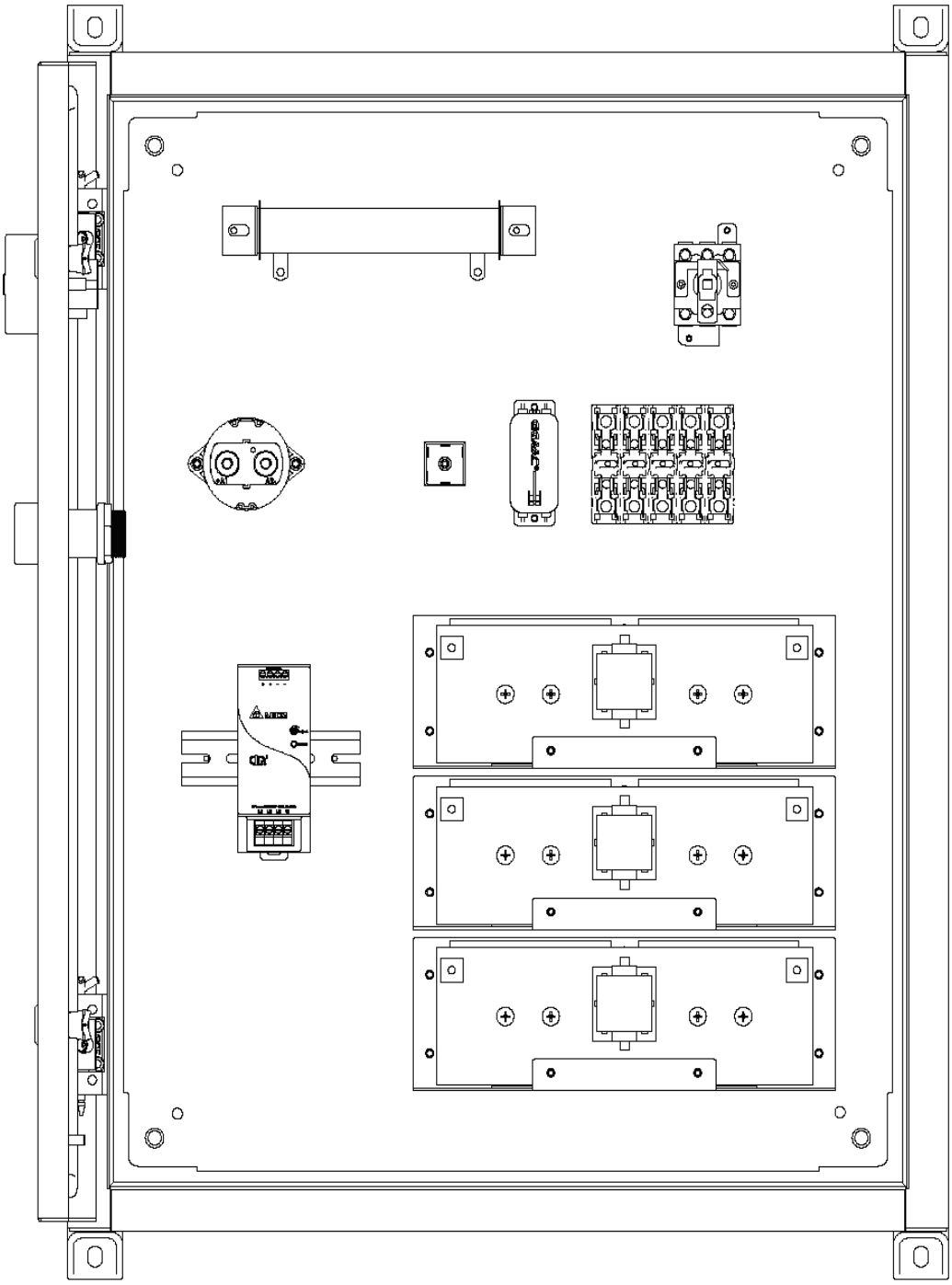


Figure 3-4: S3534EC Drive Ride-Thru System in E63 Cabinet Internal Layout



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4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The S3534EC ride-thru system is a passive energy storage reservoir designed to maintain the DC bus of electronic equipment during power sag or loss conditions. During a voltage sag or outage, the inverter DC bus level will be supported by the energy stored within the internal storage capacitors.

Upon application of power to the S3534EC capacitive energy reservoir, its internal storage capacitor will begin to precharge. Storage capacitors used in the ride-thru system incorporate their own slow precharge controls. Complete precharge of the storage capacitor reservoir to nominal DC bus level takes approximately 8 seconds. Once the DC bus has fully precharged to its preset nominal value, the S3534EC is ready to protect from full outages for the duration specified for the system.

The S3534EC ride-thru employs a modular design that allows reservoirs of various capacities to be assembled by connecting fixed storage capacitors in parallel configurations. Each storage capacitor includes its own precharge circuitry, which is designed to open in the event that a capacitor fails within the storage bank. By opening, the precharge circuit limits the energy to the failed capacitor and prevents itself from burning out. In addition, this selective shutdown of a failed capacitor allows the remaining capacitive energy reservoir system to continue functioning at a reduced capacity.

4.2. FEATURES

4.2.1. LOCAL INDICATORS

A Grace voltage indicator is mounted on the door of S3534EC systems.

4.3. STARTUP

4.3.1. PRE-POWER CHECKS

1. Ensure power connections have proper torque.
2. Ensure DC bus connections between drive and the S3534EC are the proper polarity.

4.3.2. STARTUP PROCEDURE AND CHECKS

The associated drive should be powered up and proven operational before adding the S3534EC.

1. With power already applied to the associated drive, turn on disconnect switch.
   a. Pre-charge of capacitor bank should last approximately 8 seconds.
   b. Capacitor bank DC voltage should read 1.4 times the AC line RMS voltage.

The S3534EC is now ready for operation. Full power operational testing is recommended during commissioning.

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5. MAINTENANCE AND TROUBLESHOOTING

5.1. PERIODIC TESTING

Yearly testing of the S3534EC capability is recommended for critical applications. Testing can be done by removing power to the drive system, or by verifying the ride-thru capacity through calculation.

1. Remove power to the drive system for the specified outage time.
   - Monitor motor speed or watch system parameters.
2. Turn off the disconnect to the S3534EC.
   - Monitor capacitor bank voltage with oscilloscope and see typical the capacitor performs a normal discharge.

5.2. MAINTENANCE ITEMS

5.2.1. CAPACITOR REPLACEMENT CRITERIA

Bonitron Model 3534EC ride-thru uses high quality aluminum electrolytic capacitors and is designed for long life without maintenance. While a typical inverter may require capacitor replacement after a certain time due to the heavy ripple currents, the S3534EC typically is in a standby mode waiting for a power disturbance, and there is no ripple current, thus no heating.

The capacitor manufacturer has given a rating of 10 years MTBF if ambient temp is 50°C, capacitors are held at 100% rated voltage, and caps run full ripple current at 1% duty.

With typical operating conditions of 35°C, caps running at 75% rated voltage, and a duty cycle of one sag per month, Bonitron recommends the capacitors be checked every 5 years or replaced every 10 years.

5.2.1.1. CAPACITOR TESTING PROCEDURE

1. Remove Lexan covers to gain access to capacitor terminals.
2. Measure voltage across each capacitor and make note for future reference.
   - Any voltage difference more than 15% indicates a substantial change in capacitance or leakage.
     Example: DC bus = 540V, each series cap = 270V.
     15% of 270 = 40.5V cap 1 = 290V cap 2 = 250V.

If any set of capacitors is out of tolerance, remove power and replace both capacitors.

5.3. TROUBLESHOOTING

Table 5-1: Troubleshooting Symptoms

SYMPTOM	ACTION
No Ride-Thru capability	• Check for voltage reading on capacitor bank • If OK, check DC output fuses
No indication on the Grace Voltage Indicator	• Verify disconnect is ON and associated wiring is correct.

CAUTION!

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.

5.4. TECHNICAL HELP – BEFORE YOU CALL

If possible, please have the following information when calling for technical help:

- Exact model number of affected units
- Serial number of unit
- Name and model number of attached drives
- Name of original equipment supplier
- Brief description of the application
- The AC line to line voltage on all 3 phases
- The DC bus voltage
- KVA rating of power source
- Source configuration Wye/Delta and grounding

This information will help us support you much more quickly. Please contact us at (615) 244-2825 or through www.bonitron.com

6. ENGINEERING DATA

6.1. RATINGS CHARTS

To provide full outage protection, 3534EC storage capacitors are required. Figures 6-1 through 6-3 provide data based on the number of storage capacitors used and the system AC line or DC bus voltage level.

Figure 6-1: Usable kJ with 460V Feed, Drive Undervoltage Trip Point of 550VDC

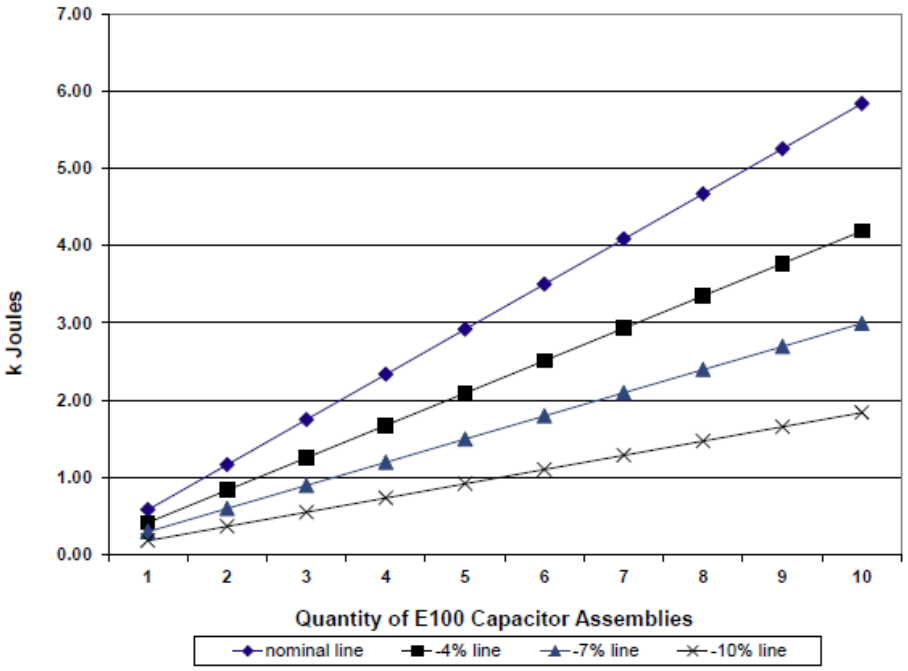


Figure 6-2: Usable kJ with 380V Feed, Drive Undervoltage Trip Point of 455VDC

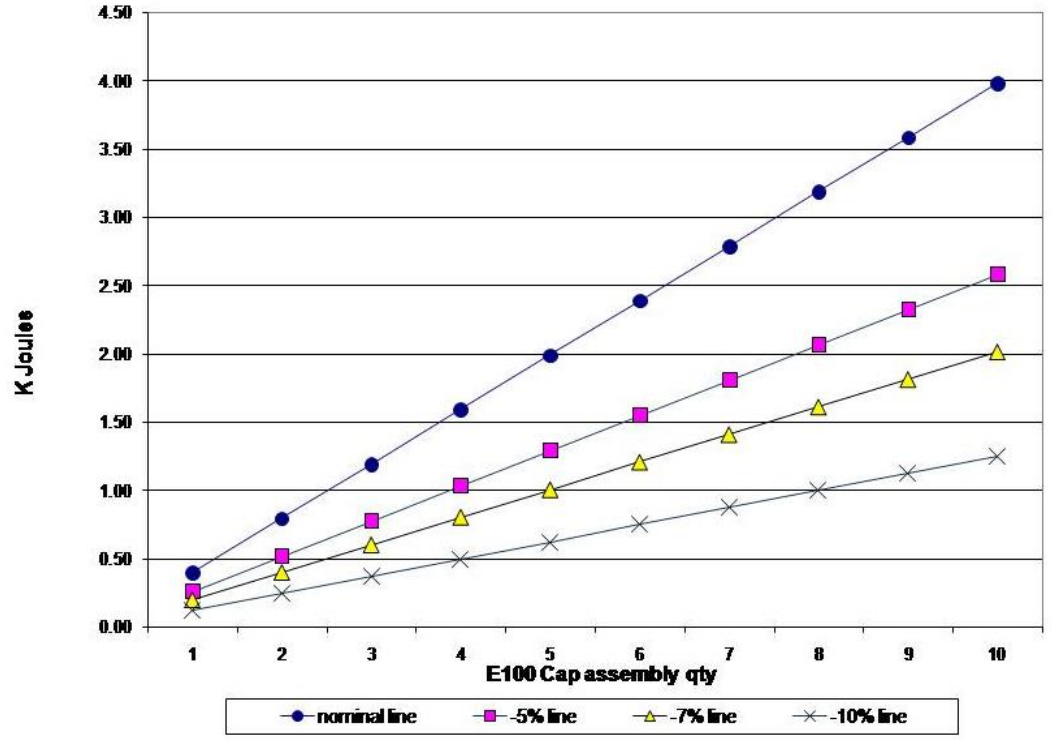
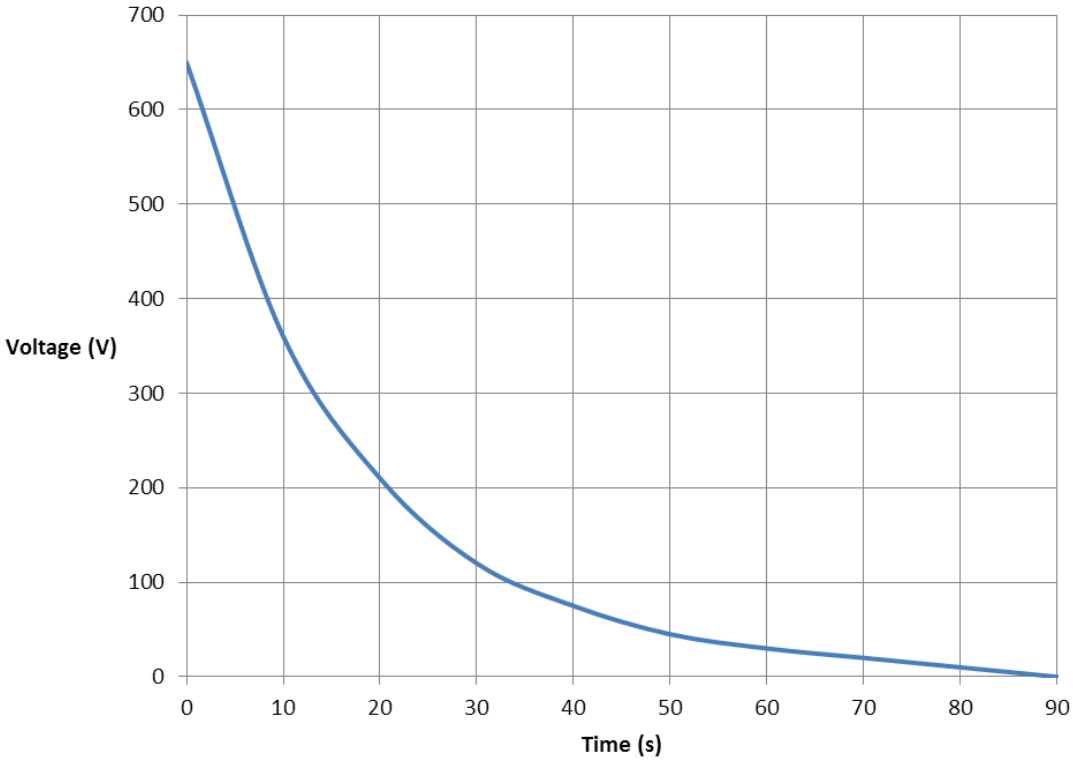


Figure 6-3: S3534EC-H0.75-00.5-E61 Discharge Curve



6.2. WATT LOSS

Less than 2 watts per capacitor assembly.

6.3. FUSE SIZING AND RATING

AC Line input: (3) ATM-10 – 1 fuse per phase.
DC Bus output: (2) A60Q5-2 – 1 fuse per leg.

6.4. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-4: S3534EC E61 Enclosure Dimensional Outline

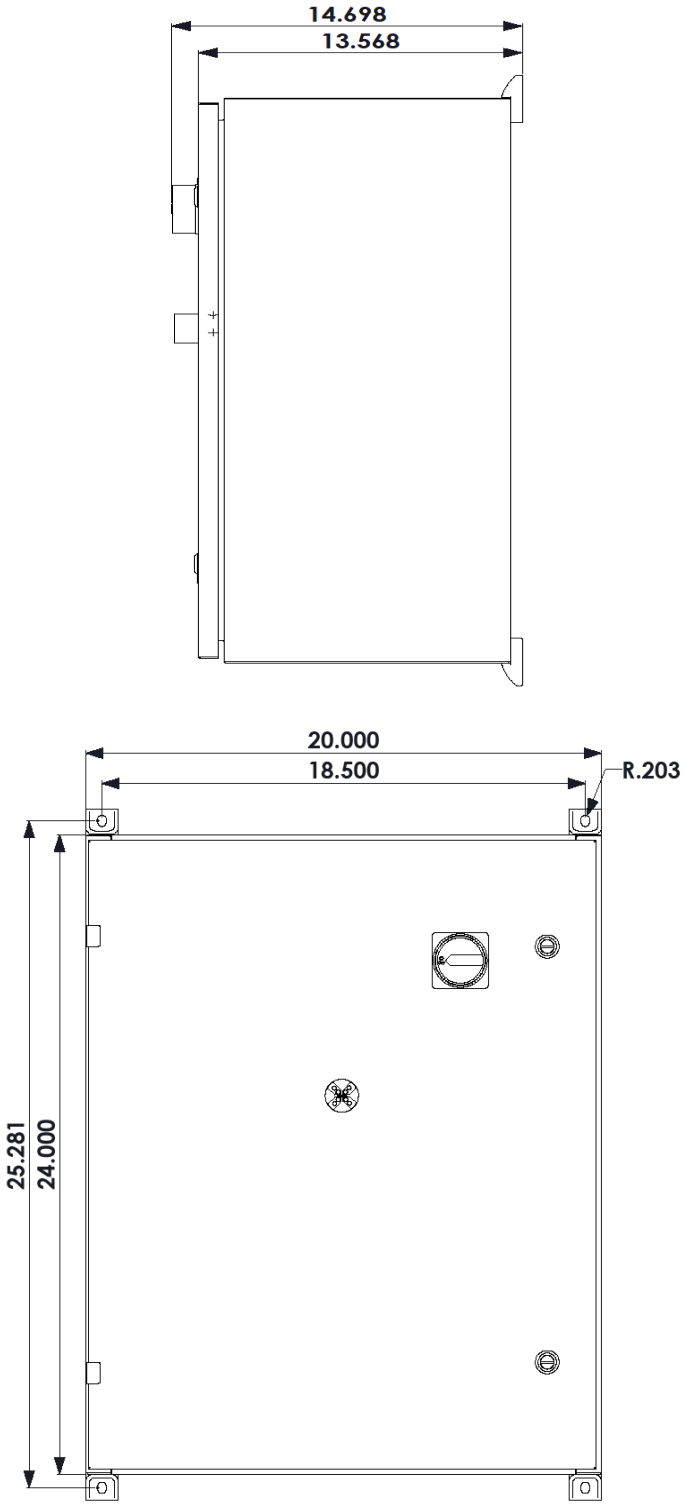


Figure 6-5: S3534EC E63 Enclosure Dimensional Outline

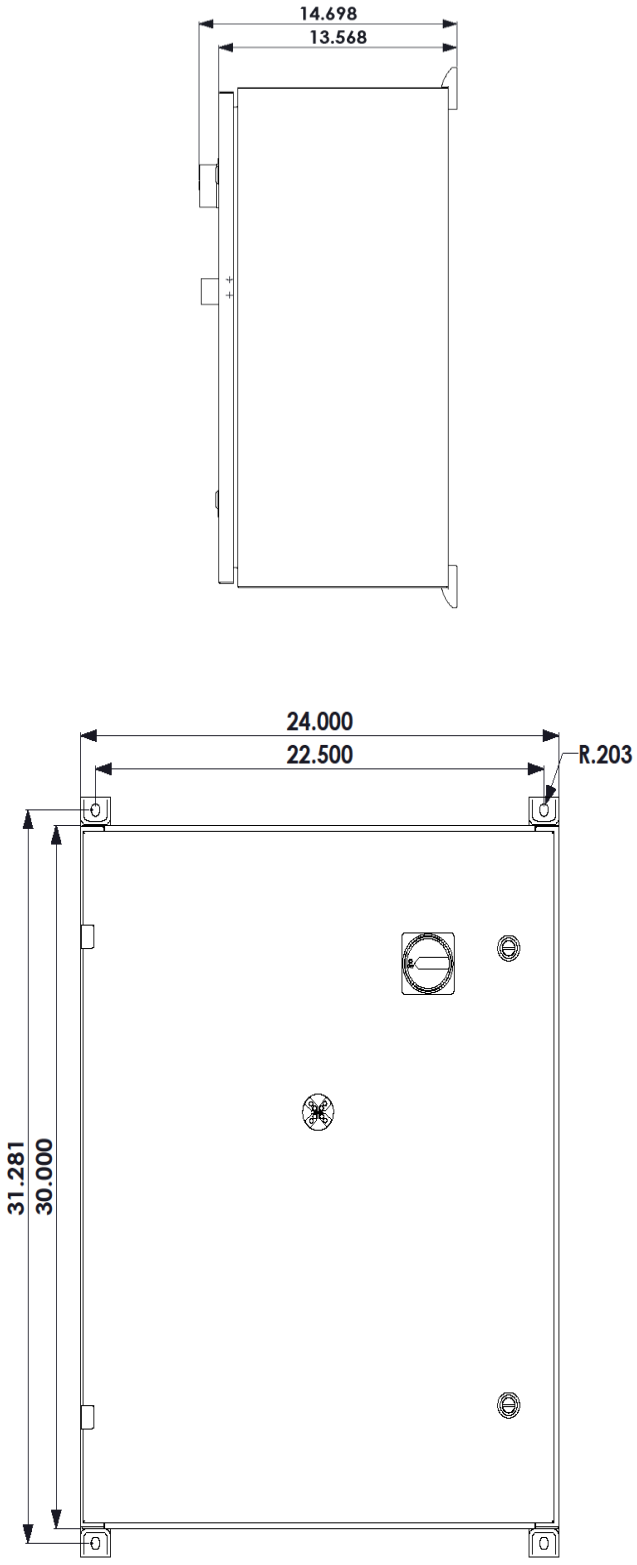
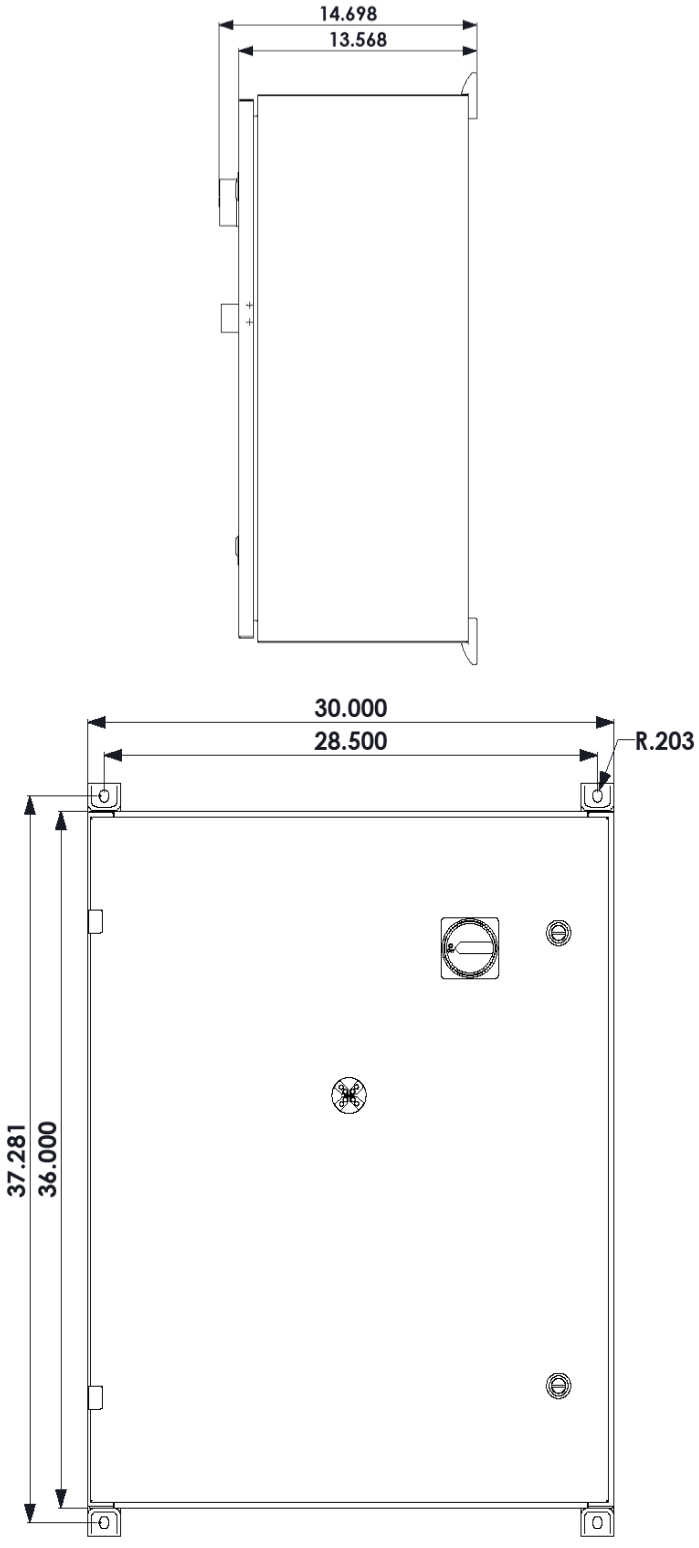
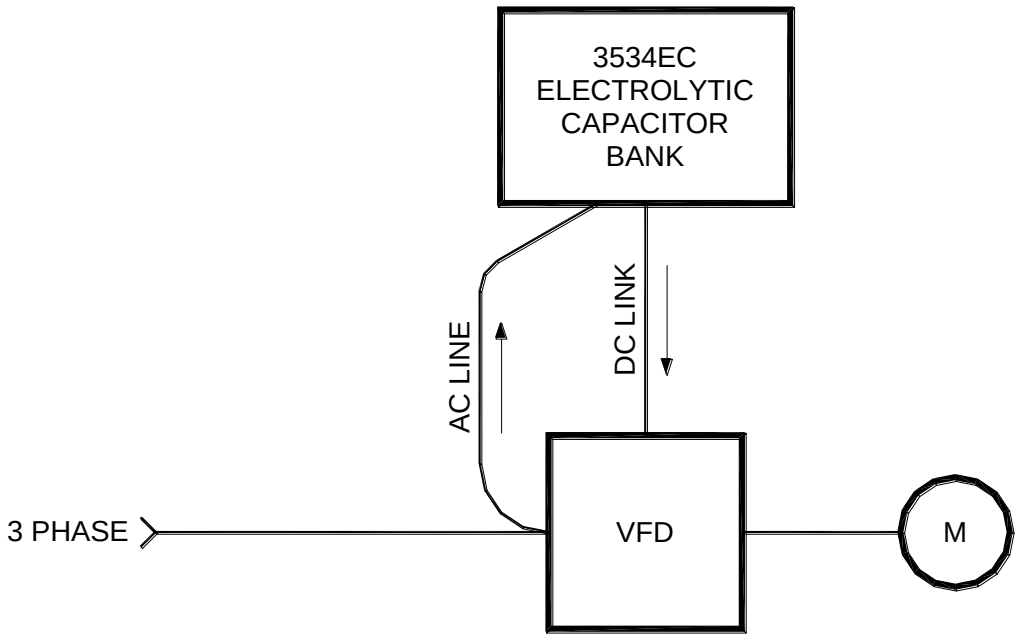


Figure 6-6: S3534EC E66 Enclosure Dimensional Outline



6.5. BLOCK DIAGRAMS

Figure 6-7: Ride-Thru System Configuration



2.5KW & BELOW, 0 - 0.5 SECOND, 100% OUTAGE PROTECTION
USING ELECTROLYTIC CAP RESERVOIR
SINGLE CABINET POWERED FROM AC LINE

7. APPENDICES

7.1. USABLE ENERGY DATA FOR STORAGE CAPACITORS

This section provides data pertaining to the amount of available usable energy for DC bus voltage support provided by S3534EC Systems as well as the effect that drive system AC Line / Low Voltage trip levels have on these ratings.

The usable energy available from a capacitive energy reservoir, such as the ASM 3534EC-E100 Storage Capacitor used in the S3534EC Ride-Thru System, is the difference between the reservoir's total stored energy when charged to the normal DC bus level and its remaining energy when the DC bus drops to the low voltage trip setting of the drive system. Accordingly, the actual usable energy of the reservoir can be optimized through higher AC line levels and/or lower drive low voltage trip settings.

While an inverter may continue to run at lower voltages, the output power is decreased to the motor.

7.2. CALCULATIONS

This section provides the calculations required to determine the optimum number of storage capacitors to be used when configuring a S3534EC Drive Ride-Thru System.

There are three important calculations that must be made to properly size the system. First, the necessary capacity of the system to adequately support the drive system must be determined. Next, the actual usable energy level of the storage capacitor type to be used in the system must be calculated based on drive system parameters. Finally, the first two calculations are used to determine the optimum number of storage capacitors to include in the system configuration. Each of these calculations is detailed below.

7.2.1. DETERMINING THE REQUIRED CAPACITY OF A S3534EC SYSTEM

The capacity or **USABLE ENERGY** rating (in kJ) of a S3534EC DC bus support system required to support a given drive system can be determined by multiplying the drive or load rating (in kW) by the duration (in seconds) of the outage to be protected against. Keep in mind that the S3534EC is rated for 2.2kW maximum. For load ratings greater than 2.2kW or 3kJ, the M3534CR may be added for a more cost effective solution.

The following formula is used to determine the required capacity (in kJ or hps) of a S3534EC System:

Capacity (kJ) = Load (kW) x Duration (seconds)

Capacity (hps) = Load (hp) x Duration (seconds)

To be sure that the S3534EC will always be sufficiently sized for the drive system, use the power rating of the drive in the calculation. Since the load on the drive will not exceed the drive rating, the calculated capacity will always be sufficient. To determine capacity for a specific application where the drive may be oversized for the actual load, the power rating of the actual load may be used.

7.2.2. CALCULATING THE ACTUAL USABLE ENERGY OF ONE ASM-3534EC STORAGE CAPACITOR

In order to provide a reliable general guideline for properly sizing a model S3534EC DC Bus Support system, the **USABLE ENERGY** ratings for ASM-3534EC-E100 Storage Capacitors were calculated based on the combined conservative assumptions of a low AC line input level and relatively high drive Low Voltage trip setpoint. This helps to ensure that the S3534EC system will adequately perform under actual field conditions.

However, to more accurately determine the actual **USABLE ENERGY** of an ASM-3534EC Storage Capacitor when used for support of a drive, 3 specific values must be known:

1. the capacitance of the Storage Capacitor (10,000uF for the ASM-3534EC-E100)
2. the normal operating DC bus voltage for the drive system
3. the low voltage trip setpoint of the drive

The following equation is used to calculate Usable Energy (in *joules*) of a capacitive energy reservoir:

$$E_U = E_S - E_R$$

Where

E_U is the actual Usable energy (in *joules*) available from the capacitive reservoir to provide DC bus support during outage or dip situations.

E_S is the total Stored energy (in *joules*) in the capacitive reservoir during normal operating conditions.

E_R is the total unused Remaining energy (in *joules*) in the capacitive reservoir after the drive unit has tripped due to low voltage conditions.

Before the Usable Energy (**E_U**) can be calculated, it is necessary to first calculate the Stored Energy (**E_S**) and Remaining Energy (**E_R**) values.

The following equation is used to calculate both Stored and Remaining Energy (in *joules*) for the capacitive energy reservoir:

$$E = \tfrac{1}{2}CV^2$$

Where

E is energy (in *joules*)

C is the total capacitance (in *farads*) of the ASM-3534EC Storage Capacitor

V is DC voltage. For **E_S** calculations, this is the DC bus voltage during normal operating conditions. For **E_R** calculations, this is the drive's 'Low Voltage' trip setpoint.

Once the Stored and Remaining energy calculations have been completed, simply plug the values into the Usable energy equation and convert the results to horsepower-seconds, using the conversion factor below, to arrive at the Usable Energy rating.

If joules = watt-seconds

and watts x 0.001341 = horsepower

then joules x 0.001341 = horsepower-seconds

7.2.3. DETERMINING THE REQUIRED NUMBER OF STORAGE CAPACITORS FOR THE S3534EC

Now that a value for 'Usable Energy' has been determined for a single Storage Capacitor, divide this number into the previously calculated 'Required Capacity' value to determine the required number of Storage Capacitors to be included in the S3534EC system.

Req'd Capacity(hps) ÷ Storage Capacitor Usable Energy(hps) = Storage Capacitor Qty

7.2.4. DETERMINING ACTUAL CAPACITY FOR AN EXISTING SYSTEM

To quickly prove the remaining capacitance in any 3534EC Ride-Thru System, the following method can be used.

1. Determine discharge curve using oscilloscope or voltmeter and stopwatch
    - Note voltage at beginning of discharge
    - Calculate 36.8% of beginning voltage
    - Remove power and apply known resistive load, noting the time it takes to drop to 36.8% of original voltage
2. Calculate capacitance by dividing the time it took to get to 36.8% of beginning voltage, by the discharge resistance

Example: Beginning voltage is 535VDC. Discharge resistance is 780 ohms. 36.8% of 535 can be found by multiplying 535 x .368. This equals 196VDC. Note that it takes about 16 seconds to drop from 535V to 196V. Now divide 16 seconds by 780 ohms to get .02051. This answer is in Farads, so next multiply by 1 million to get nameplate rating in uF. .02051 x 1,000,000 = 20,510uF.

NOTES

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