BONITRON

Bonitron Power Source

Model M3534CR

400VAC, 10-20kW, 1-10kJ

Full Outage DC Bus Ride-Thru System

For Variable Speed AC Drives

Customer Reference Manual

Bonitron, Inc.

An Industry Leader in AC Drive Systems and Industrial Electronics

OUR COMPANY

Bonitron Inc. is an industrial electronics and electrical systems design, engineering, and manufacturing company founded in 1962 and located in Nashville, Tennessee. Bonitron designs and manufactures custom and standard product modules and systems for industry with the highest possible degree of quality and reliability.

Bonitron has all the necessary resources in-house for complete electronic product development and manufacturing. Engineering facilities include a CAD lab for circuit board design and engineering labs for prototype testing and evaluation. Production facilities include production areas for circuit board assembly, a machine tool and sheet metal shop for chassis fabrication, and a systems assembly and checkout area. With these assets, Bonitron is positioned to be a leader into the future while maintaining first class support for their current customer base.

Worldwide sales of equipment are generated mainly by reputation and referrals. Our customer base includes all of the major drive manufacturers, their distributors, OEMs, end users, and many other satisfied companies. Equipment is installed throughout the United States as well as in Canada, Mexico, Costa Rica, Argentina, Brazil, Chile, Venezuela, Northern Ireland, the Netherlands, Spain, Hungary, Israel, Turkey, China, India, Indonesia, Singapore, Taiwan, and the Philippines.

TALENTED PEOPLE MAKING GREAT PRODUCTS

The engineering team at Bonitron has the background and expertise needed to design, develop, and manufacture the quality industrial systems demanded by today's client. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. Expertise encompasses a broad range of applications and engineering solutions such as modern power conversion design techniques and microprocessor-based controls. This insures a solution tailored to the specific needs of the client.

A clear advantage that Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities. This allows the engineering team to have immediate access to and response from testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the best quality products.

AC DRIVE OPTIONS

In 1975, Bonitron began working with the AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced to their plant process computers. Since that time, Bonitron has developed AC drive option modules that help overcome many of the problems encountered in applications of modern AC variable frequency drives. Bonitron's Ride-Thru module provides protection from AC line voltage sags while the Line Regen and Resistive Braking modules provide DC Bus regulation for over-voltage due to regenerated voltage. Today, many drive system integrators use Bonitron AC drive option modules with their variable frequency drives.

WORLD CLASS PRODUCTS

Bonitron has developed over 3000 different modules and systems. Bonitron is willing and able to meet the unique specifications the client may request.

Some Bonitron products include:

- Power Sag Ride-Thru Modules
- Power Outage Ride-Thru Modules
- Line Regen Modules
- Resistive Braking Modules
- Modular High Speed Precision AC Inverter Systems
- Inverter Upgrade Modules
- Multi-motor, Multi-phase Current Sensors
- Battery Production Charging Systems
- Data Acquisition Systems
- Process Controllers
- Temperature Control Systems
- RMS True Reading Digital Voltmeters, Ammeters, and Frequency Meters

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 M3534CR Full Outage DC Bus Ride-Thru system. It will provide the user with the necessary information to successfully install, integrate, and use the M3534CR Module in a variable speed 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

Minor formatting changes make this rev00a.

Rev (00) is the initial printing of this manual, which covers the M3534CR in the E61, E63, E65, and E69 cabinets.

Figure 1-1: M3534CR in E61 Chassis

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. Including a Model M3534 RTM as part of a fixed bus inverter system will enable the system to surpass SEMI-47 compliancy specifications.

Bonitron's Model M3534 series of DC Bus Ride-Thru Modules (RTM) provide protection from AC line voltage sags and outages for AC drive systems that use a fixed DC bus as with AC PWM variable frequency drives. The Model M3534 series of DC Bus Ride-Thru Modules 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 Model M3534RT DC Bus Ride-Thru Control module provides sufficient ride through capability to handle these types of voltage sags. However, 100% power outages can still occur, and even one such instance can be costly. For this reason, the M3534CR Full Outage DC Bus Ride-Thru Module incorporates additional capacitive energy reservoirs known as Bus Support Modules (BSMs) with the base M3534RT Controller module. This allows the RTM to supply DC bus power to the inverter during total 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

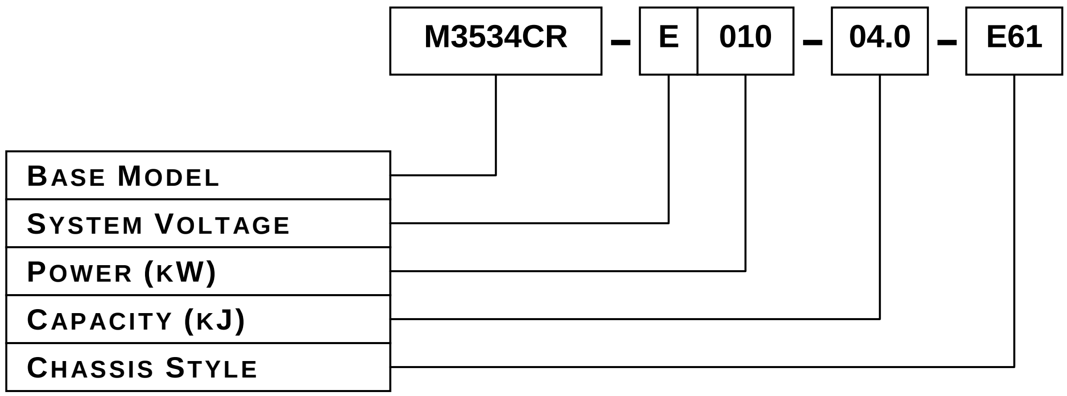
M3534EC

M3534UR

M3460UR

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The basic model number for these 100% sag AC Input DC Bus Ride-Thru Modules (RTM) is **M3534CR.**

SYSTEM VOLTAGE RATING

The System Voltage rating indicates the nominal AC / DC voltage levels of the AC Drive system the RTM is intended to support.

BPS Model M3534CR is available for either of several standard AC / DC voltages.

A code letter indicates the system voltage.

Table 2-1: Voltage Codes

RATING CODE	VOLTAGES (NOMINAL AC LINE / NOMINAL DC BUS)
U	115VAC Line / 160VDC
L	230VAC Line / 320VDC
E	400VAC Line / 560VDC
H	460VAC Line / 640VDC
C	575VAC Line / 800VDC

POWER (KW)

The Power rating indicates the maximum power in kilowatts that can safely be handled by the M3534CR. This rating is directly represented by a 3-digit value. For instance, the rating for a 10kW BPS is **010**.

CAPACITY (KJ)

The Capacity Rating indicates the maximum usable stored energy that the M3534CR BPS will have available to support the DC bus at the minimum bus voltage setpoint for the specified system voltage. The capacity is directly represented in kilojoules by a 3-digit value. Fractional values are indicated as single-place decimals. For example, an 8.0 kilojoule maximum capacity is indicated as **08.0**.

CHASSIS STYLE

Enclosure type and size is dependent on the Ride-Thru system specifications.

Table 2-2: Chassis 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)
E66	36"(H) x 30"(W) x 12"(D) Type-12 wall mount enclosure
E69	42"(H) x 36"(W) x12"(D) Type-12 wall mount enclosure

OPTIONS

No options are currently available for the Model M3534CR.

2.3. GENERAL SPECIFICATIONS

Table 2-3: General Specifications Table

PARAMETER	SPECIFICATION
RTM Control Module	(1) M3534RT-E010-002-A5 or (1) M3534RT-E020-K6
DC Bus Support Modules	ASM-3534EC-E100
AC Input Voltage	3-Phase, 400VAC ±10% (380 – 415VAC)
DC Output Voltage	485VDC minimum 535 – 585VDC nominal
DC Output Current	Factory limited to 150% of required application current up to 20A max. @ 50% input. 20A default output max. if application requirements are not known at time of calibration. Consult Bonitron for details.
Power Rating	20kW peak 1kW continuous
Maximum Sag Duration	2 seconds at 50% sag across all 3 phases of AC line or total loss of a single phase of AC line with remaining 2 phases at rated voltage
Maximum Outage Duration	Divide Capacity (kJ) by Motor Power (in kW) See "Capacity" in Figure 2-1 or Usable kJ Charts in Section 6
Pre-charge Charge Time	Less than 8 seconds
Pre-charge Current	Approximately 5A peak per cap assy
Discharge Resistance	780 or 390 Ohms
Discharge Times	< 80 sec. from 540VDC to 50VDC through discharge resistor (with disconnect in OFF position) ≈ 90 min. from 540VDC to 50VDC without discharge resistor or booster (with power removed but disconnect in ON position)
Inactive Power Usage	Less than 35 watts
Field Connections	AC Line Input DC Bus Output Ground
Disconnect	6-pole for AC in / DC out with Aux. contact & door mounted actuator
Metering	Analog 0 – 750V Voltmeter
BPS Status Indicators	LED located on the M3534RT RTM Control Module front panel for each of the following: Power (PWR), Overtemp (OT), Ride-Thru Active (RTA)
BPS Status Contacts	3 outputs, each jumper selectable for N.O. or N.C. contact state Each Form C dry contact output is rated for 1A @ 24VDC, resistive or 0.5A @ 120VAC, resistive. 1 output available for each of the following via TB4 on the 3534R2 control board located within the M3534RT RTM Control Module: Power (PWR), Overtemp (OT), Ride-Thru Active (RTA)
Cap bank fusing	Dependent on RTM control module and reservoir specifications
Enclosure	See Table 2-2
Operating Temperature	40°C
Storage Temp	-20ºC to +65ºC
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and dust

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 REMOVING 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 AMPLE 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

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 BPS Model M3534CR Ride-Thru Module 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 start up of this product to the equipment supplier or system integrator.

3.1. ENVIRONMENT

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

- The unit has a NEMA-12 rating and will therefore require some protection from the elements.
- Conduit access for field wiring is provided on the top-right surface of the enclosure.
- The unit will require a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source.
- 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 RTM enclosure is provided with (4) 7/16" diameter 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 6.5 of this manual to determine the correct mounting dimensions and provisions for the unit.

WARNING!

THE RTM ENCLOSURE IS HEAVY! *A minimum of two people should be used to position the unit!*

3.4. WIRING AND CUSTOMER CONNECTIONS

This section provides information pertaining to the field wiring connections of the M3534CR Ride-Thru Module. Actual connection points and terminal numbers of the AC Drive system will be found in the documentation provided with that system.

Be sure to review **all** pertinent AC Drive System documentation as well as the Power Wiring details in Section 3.4.1 before proceeding.

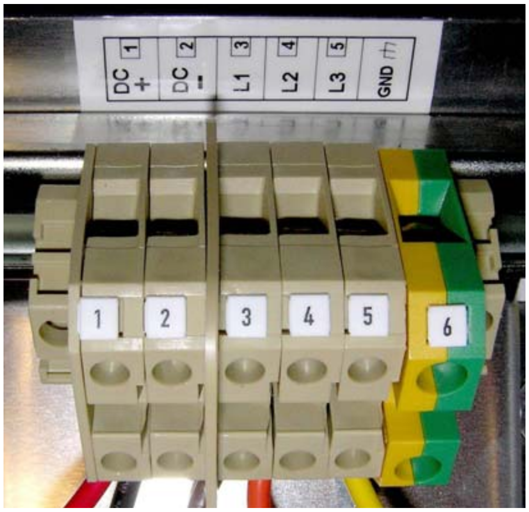
WARNING!

Interconnect wiring of this product should only be done by a qualified electrician in accordance with National Electrical Code or equivalent regulations.

Table 3-1: Field Wiring Connections

TERMINAL	ELECTRICAL SPECIFICATIONS	MAX WIRE AWG	TORQUE RANGE	
			LB-IN	N M
1, 2 (DC bus) 3, 4, 5 (AC line)	600VAC / 47Amps	8	7 - 14	0.8 - 1.6
6 (ground)		10	5.2	0.6

Figure 3-1: M3534CR Field Connection Terminal Layout – TS1



3.4.1. POWER WIRING

Several illustrations are provided to assist with the field connection of the M3534CR Ride-Thru module to an existing AC drive system. Also, be sure to refer to the documentation supplied with the drive system for field connection points within that system.

Figure 3-1 shows the typical Field Connection Terminal layout for the M3534CR RTM. Figure 3-3 shows a typical power interconnection of the M3534CR Ride-Thru Module with an existing AC Drive System.

Field connection terminals for the DC Bus output, AC Line input, and Ground are located on field connection terminal strip TS1 at the top right of the RTM enclosure backplate. All field interconnections to the drive system can be made using 10 AWG wire. See Figures 3-4 thru 3-7 for location of TS1.

DC BUS OUTPUT (TS1-1,2)

Make the DC bus output interconnections to terminals TS1-1 (DC Pos.) and TS1-2 (DC Neg.). Connections can be made using 10 AWG wire. Terminals will accept 8 AWG wire max. Torque all terminal screws to 7-14 lb-in.

3-PHASE AC LINE INPUT (TS1-3,4,5)

The 3-phase AC Line input interconnections are made at terminals TS1-3, TS1-4, and TS1-5 on field connection terminal strip TS1. Connections can be made using 10 AWG wire. Terminals will accept 8 AWG wire max. Torque all terminal screws to 7-14 lb-in.

GROUND (TS1-6)

Make the Ground interconnection to terminal TS1-6. Connection can be made using 10 AWG wire. Terminals will accept 10 AWG wire max. Torque terminal screw to 5.2 lb-in.

Figure 3-2: Typical M3534CR Interconnection with Existing Drive System

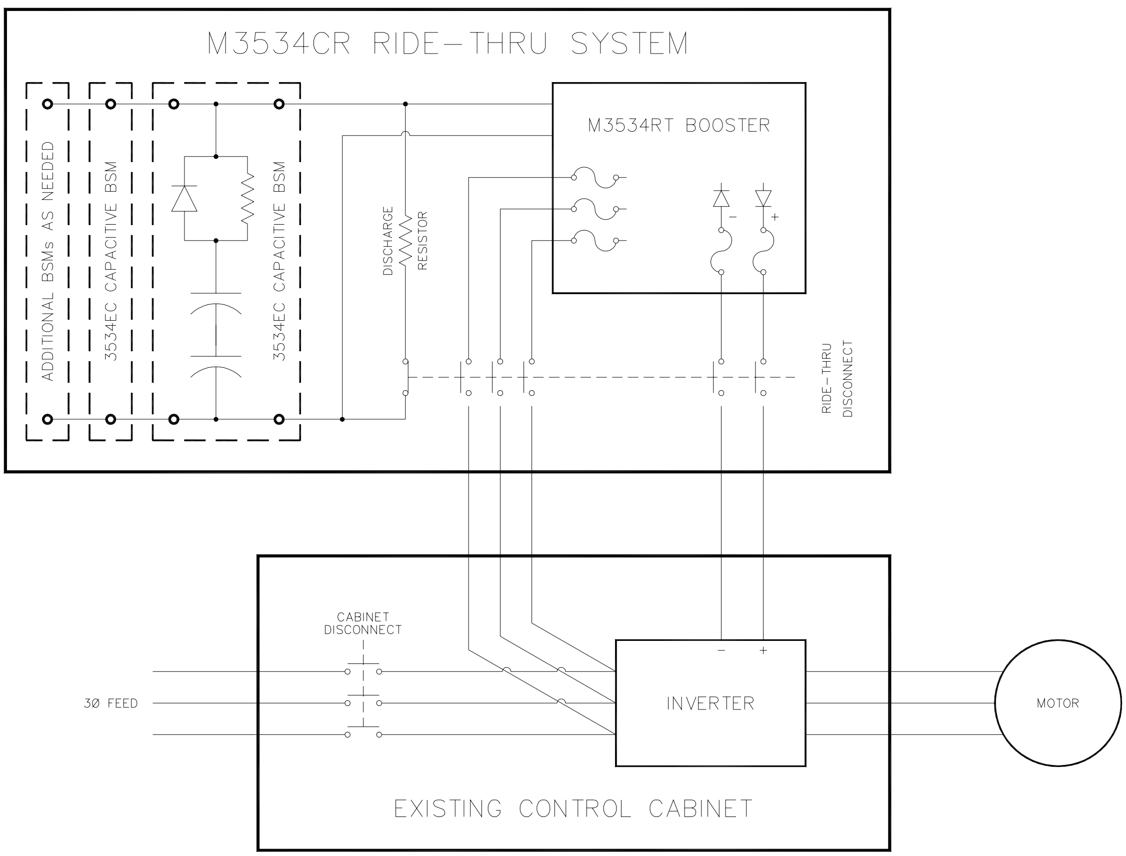
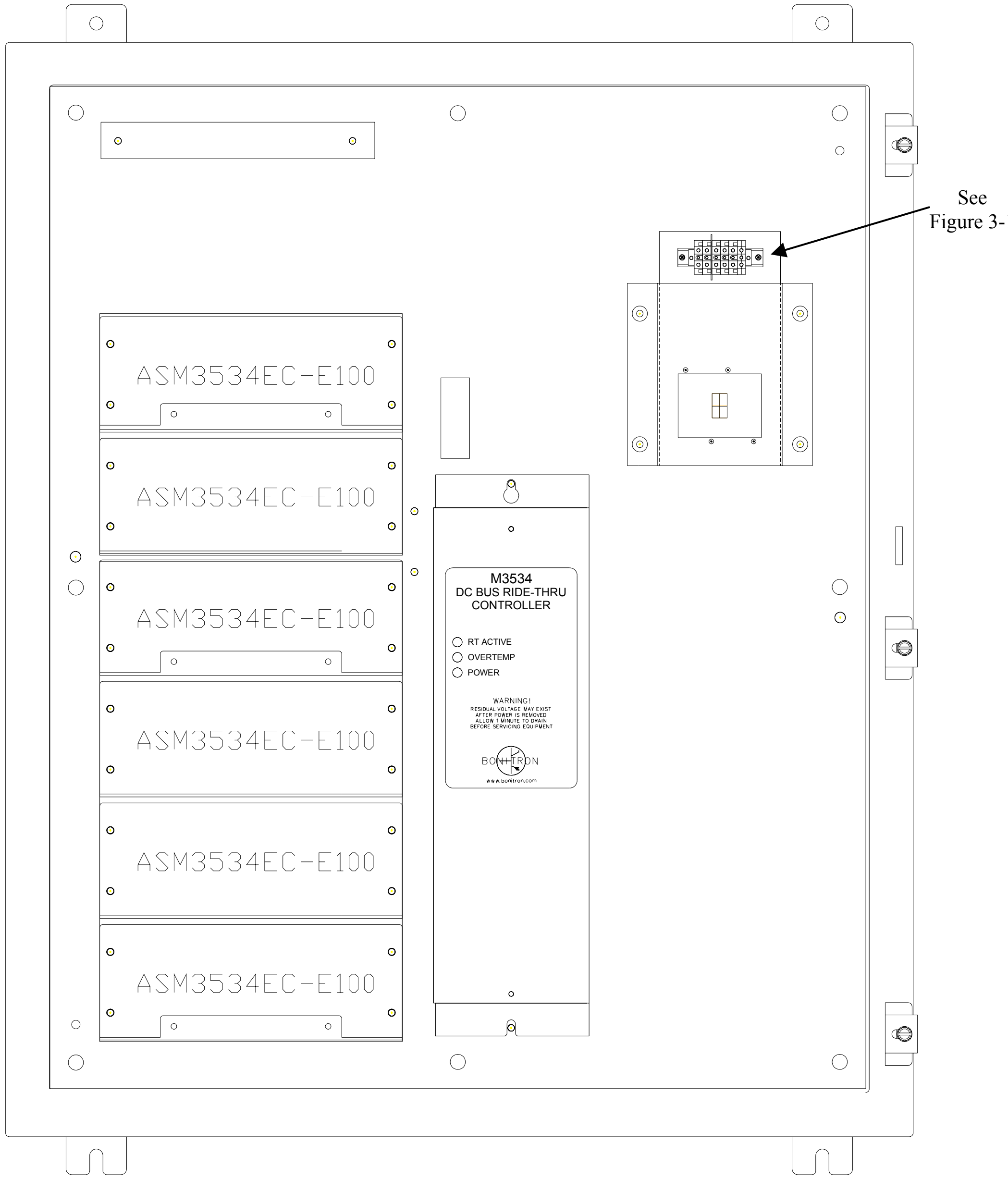


Figure 3-3: Typical M3534CR Ride-Thru System Internal Layout and Connections



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4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3534 Series RTM employs IGBT switching technology to regulate the inverter DC bus to a preset minimum voltage level. During a voltage sag or outage, the inverter DC bus level will decrease, pulling the RTM bus down with it. Once the DC bus drops below a preset low limit threshold the RTM will become active. When this occurs, the **RTA** front panel LED will illuminate, the internal **RTA** relay contact will change states, the cooling fan will begin running in order to cool the internal IGBT heatsink, and the DC bus level will be supported from the BSM reservoirs. The **RTA** LED and internal relay will be **ON** only while the RTM is active (real time). The cooling fan will continue running for 2 minutes after activity stops.

As the energy in the BSM reservoir drains, the Voltage Booster runs faster to compensate for the dropping voltage level. If the reservoir drops below 50% and RTM is fully loaded, the output DC bus level will begin to drop along with the reservoir level. If the inverter's **LOW BUS** trip level is reached, the inverter will shut down. The lightly loaded BSM reservoir will then continue to drop very slowly. When the DC bus drops to 100V, the RTM's internal logic supply will shut down.

If the RTM begins supplying power continuously, possibly due to a low line level, incorrect threshold adjustment, or inverter failure, an over temperature condition may occur. If this happens, the **OVERTEMP** front panel LED will turn **ON** and the internal **OT** relay will energize, shutting down the switching circuits and allowing the DC bus to drop to the nominal level. At this point, the RTM will continue supplying power, via an internal bridge rectifier, at the nominal line level.

4.2. FEATURES

4.2.1. TERMINAL STRIP I/O

4.2.1.1. RTM FAULT LOGIC DETAILS

All M3534CR BPS models use an M3534RT booster module. The booster modules are equipped with basic fault and status outputs. See Figures 3-3 thru 3-6 for location of the booster module inside each CR cabinet. See Figures 6-14 & 6-15 for location of internal booster connectors. For connection details see Section 4.2.1 of the M3534RT booster manual used in your BPS system.

4.2.2. LOCAL INDICATORS

There are no local indicators on M3534CR modules.

4.2.3. LOCAL METERS (BUS VOLTAGE)

A 1mA input DC voltmeter displays the storage capacitor bank voltage. Each set of capacitors adds some current to the meter via high value resistors. If one set of caps drops in voltage, the meter will drop accordingly. Each meter is trimmed to read accurately using shunt resistance at time of production.

4.3. STARTUP

4.3.1. PRE-POWER CHECKS

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

4.3.2. STARTUP PROCEDURE AND CHECKS

The associated drive should be powered up and proven operational before adding the BPS unit on-line

1. With power already applied to the associated drive, turn on disconnect switch.
   - Cap voltage meter should read cap bank as it charges
     a. Precharge of cap bank should last approximately 8 seconds.
     b. Cap bank DC voltage should read 1.4 times the AC line RMS voltage
   - Booster should power up
     a. Power LED should turn ON
     b. Overtemp LED should remain OFF
     c. Ride-Thru Active LED may momentarily flash ON, then should turn OFF and remain OFF

M3534CR is now ready for operation. Full power operational testing is recommended during commissioning. Often this is not possible because the complete system is not online, or motor is not fully loaded, and once on-line, the pressure to get production going usually outweighs any desire to test. For testing methods see Section 5.1.

4.4. OPERATIONAL ADJUSTMENTS

4.4.1. THRESHOLD VOLTAGE ADJUSTMENT PROCEDURE FOR MODEL M3534 RIDE-THRU MODULES

The "Threshold" voltage level is the voltage at which the Bonitron Model M3534 Ride-Thru module maintains the DC bus during a power dip. Whenever the DC bus level drops to the "Threshold" setpoint, the Ride-Thru module becomes active to regulate the DC bus voltage to the "Threshold" setpoint voltage.

Generally, the “Threshold” level should be set at 10-15% below the nominal DC bus level. If running on single phase system, threshold and battery levels may need to be lowered to prevent excessive activity. An actual on-site level setting must be determined by the loaded DC bus level as well as the amount of ripple present on the DC bus. The Ride-Thru module should not become active during normal everyday operation.

During a test cycle the "Test Boost" level is typically elevated 17% above threshold on all Bonitron Model M3534 Ride-Thru modules. These approximate levels are specified in the General Specifications section of the Customer Reference manual for each Ride-Thru module and are based on the original factory setting of the threshold level. Some field adjustment of this level may be required to achieve the optimum setpoint level for any given system.

Table 4-1 lists the typical factory setpoints for the "Threshold", "Over-Voltage", and "Test Boost" levels for the Model M3534 Ride-Thru modules based on the system AC or DC input voltage requirements. Be sure to check the Customer Reference manual for each Ride-Thru module for specific setpoint levels.

Table 4-1: Factory Setpoints for Threshold and Test Boost Voltages

INPUT VOLTAGE	THRESHOLD	TEST BOOST	OVER-VOLTAGE
208VAC	265VDC	+45VDC	360VDC
230VAC	285VDC	+48VDC	360VDC
380VAC	485VDC	+82VDC	630VDC
400VAC	500VDC	+85VDC	630VDC
415VAC	515VDC	+87VDC	630VDC
460VAC	585VDC	+100VDC	710VDC

4.4.2. DETERMINING THRESHOLD VOLTAGE SETPOINT

Testing and adjustment of the "Threshold" voltage setpoint can be performed on systems in either an "On-line and loaded" or an "Off-line and unloaded" condition as described in Methods 1 and 2 below. Each of the two methods described require that you monitor the DC bus voltage during the testing and adjustment procedures.

Be sure to read through both adjustment methods completely before attempting any adjustment of the "Threshold" voltage setpoint.

METHOD 1: DETERMINING THE THRESHOLD VOLTAGE SETPOINT FOR AN ON-LINE AND LOADED SYSTEM

- Verify proper installation.
  - Ensure that the Bonitron Model M3534 Ride-Thru module has been properly installed and wired according to all applicable system and module wiring diagrams.
- Push the TEST button.
  - Push the "Test" button while monitoring the DC bus voltage.
  - On modules so equipped, the "Test" button is located on the module's control/display front panel. For modules without a control/display front panel, a normally-open momentary switch should be installed to serve as a test switch for this procedure. Refer to applicable field wiring diagrams for switch connection points.
- Read the DC bus meter and subtract the BOOST voltage.
  - When the TEST button is pushed, the Threshold voltage level is "Boosted" above the threshold setpoint. The Boost will be maintained in real-time by the TEST button for as long as the button is pressed.
  - During this "Boost" period, you should see the DC bus level increase. The amount that the DC Bus actually increases will

depend on the Threshold level adjustment as well as the input voltage and DC bus output current.

- For example, for a Ride-Thru system with an input voltage of 460VAC, the Threshold voltage level is preset to be 585VDC and the Boost voltage level is factory preset for an increase of 17% (100VDC).

Assuming that these preset levels have not been altered, initiating the test described above on a lightly loaded system of this nature would cause the DC bus level to rise to 685VDC (585VDC + 100VDC). Subtracting the Boost voltage (100VDC) from this reading shows that the actual Threshold voltage level is 585VDC.

Initiating this test on a heavily loaded system of this nature would also cause the DC bus level to rise. However, the DC bus would stop rising once current limit is reached.

- NOTE: The Boost voltage level is factory preset and is not adjustable in the field.

METHOD 2: DETERMINING THE THRESHOLD VOLTAGE SETPOINT FOR AN OFF-LINE AND UNLOADED SYSTEM

1) REMOVE INPUT VOLTAGE SUPPLY FROM SYSTEM.

Disconnect the input voltage to the Ride-Thru while monitoring the DC bus voltage. As the DC bus drops to the Threshold setpoint voltage, the Ride-Thru module will become active. The Ride-Thru will then maintain the DC bus voltage at the Threshold setpoint level for approximately 1 second while the primary capacitor discharges, at which point, the DC bus will continue to drop. Read the DC bus voltage as it is being maintained. This is the Threshold setpoint voltage.

4.5. CALIBRATION

The front panel voltmeter is trimmed at the factory to be within 2% and should not require calibration. If the voltmeter reads low, voltage across each cap bank should be checked.

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

Yearly testing of BPS Ride-Thru capability is recommended for critical applications. Testing can be done by removing power to the drive system, or by verifying the BPS capacity using discharge curves.

1. Remove power to the drive system for the specified outage time.
    - Monitor motor speed or watch system parameters.
    - Turn off the disconnect to the BPS unit for the specified time.
    - Booster RTA LED should come on indicating it has become active.
    - DC bus should be held to threshold level during specified time.
2. Check internal capacitance - Each "CR" model is equipped with an internal discharge resistor that is used to drain the capacitor bank for maintenance purposes. The resistance and discharge curve can be used to calculate the capacitance. See Section 6.1.1 for theoretical discharge curves.
    - With cap bank fully charged, remove cap bank fuse between cap bank and booster module.
        - This step is not absolutely necessary, but removes the booster from the load on cap bank and will provide more accurate results.
    - Monitor cap bank voltage with oscilloscope and turn off disconnect switch.
        - Discharge curve should be relatively close to curves in Section 6.1.1 for your model.

5.2. MAINTENANCE ITEMS

5.2.1. CAPACITOR REPLACEMENT CRITERIA

Bonitron Model 3534CR 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 M3534CR 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 11 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 20 years.

The recommended test is to measure the voltage across each series set of capacitors. Any voltage difference greater than 15% between each set of series caps would indicate a change in value in one cap, or an extreme increase of leakage, and would constitute a more detailed out of circuit capacitance check. (A difference of 5% is allowed at time of production.)

5.2.1.1. CAPACITOR TESTING PROCEDURE:

1. Remove Lexan covers to gain access to capacitor terminals.
2. Measure voltage across each cap and make note for future reference.
   - Any voltage difference more than 15% indicates a substantial change in capacitance or leakage.
     a. Example: DC bus = 540V, each series cap = 270V
        15% of 270 = 40.5V cap 1 = 290V, cap 2 = 250V
3. If any set of caps is out of tolerance, remove power and replace both capacitors.

5.3. TROUBLESHOOTING

SYMPTOM	ACTION
No Ride-Thru capability	• Check for Power LED on booster module • Check for voltage reading on cap bank o If OK, check DC output fuses in booster module o If OK, do capacity test, checking for activity on booster module
No voltage on meter	• Check for 3-phase AC voltage at input to box • Check for 3-phase AC downstream of disconnect • Check AC line fuses inside booster module • Check cap bank fuse on backplate • Check voltmeter and wires to meter
Low voltage on meter	• Check each individual cap pack, measuring on cap terminals o Each cap pack supplies some voltage to meter. If one out of two cap packs is at zero volts, the meter will read half voltage. o Bonitron's design will allow a cap pack to fail short and not affect the remaining cap packs, with the Cap Voltage Meter reading proportionally low.
No POWER LED on booster module	• Check for 3-phase AC downstream of disconnect • Check AC line fuses inside booster module o If OK, replace booster module
No RTA LED on booster module	• Ensure booster threshold is set properly • If DC bus drops below threshold setting, and no activity occurs, replace booster module.
OT LED is ON	• Check temperature of booster module o Warmth indicates excessive activity or current flow. o Check threshold setting and lower if nominal DC bus level is within 10V of threshold. o Measure static current flow. Presence of line chokes in series with inverter may allow excessive current flow through booster's parallel rectifier bridge.

6. ENGINEERING DATA

6.1. RATINGS CHARTS

Table 6-1: Model M3534CR Ride-Thru Module Ratings

MODEL NUMBER	AC INPUT	MAX. OUTPUT POWER	RECOMMENDED FUSE RATINGS (AC INPUT / DC OUTPUT)	MAX. DC OUTPUT CURRENT	CHX SIZE
M3534CR-E010-01.0-E61	380 - 415VAC	13hp/10kW	A60Q30 / A60Q25	20A	E61
M3534CR-E010-04.0-E66	380 - 415VAC	13hp/10kW	A60Q30 / A60Q25	20A	E66
M3534CR-E010-06.0-E66	380 - 415VAC	13hp/10kW	A60Q30 / A60Q25	20A	E66
M3534CR-E020-08.0-E69	380 - 415VAC	26hp/20kW	A60Q40 / A60Q40	40A	E69

Table 6-2: Model M3534RT Ride-Thru Module Voltage Levels

AC INPUT VOLTAGE	DC BUS VOLTAGE LEVELS		
	THRESHOLD	MIN @ FULL LOAD	NOMINAL
380 / 400 / 415VAC	485VDC	475VDC	565VDC

Table 6-3: kJoule Ratings for 400VAC M3534CR 100% Ride-Thru Systems

kJ① Rating	BSM QTY	Total Capacitance (microfarads)	Usable Energy @ Nom. Line (kilojoules)	Usable Energy @ 4% Below Nom. Line (kilojoules)	Usable Energy @ 7% Below Nom. Line (kilojoules)	Usable Energy @ 10% Below Nom. Line (kilojoules)
01.0	1	10,000	1.19	1.07	0.98	0.89
02.0	2	20,000	2.39	2.14	1.96	1.78
03.0	3	30,000	3.58	3.20	2.93	2.67
04.0	4	40,000	4.77	4.27	3.91	3.56
05.0	5	50,000	5.96	5.34	4.89	4.45
06.0	6	60,000	7.16	6.41	5.87	5.34
07.0	7	70,000	8.35	7.48	6.85	6.23
08.0	8	80,000	9.54	8.55	7.82	7.13
09.0	9	90,000	10.74	9.61	8.80	8.02
10.0	10	100,000	11.93	10.68	9.78	8.91
11.0	11	110,000	13.12	11.75	10.76	9.80
12.0	12	120,000	14.31	12.82	11.74	10.69
13.0	13	130,000	15.51	13.89	12.71	11.58
14.0	14	140,000	16.70	14.95	13.69	12.47
15.0	15	150,000	17.89	16.02	14.67	13.36
16.0	16	160,000	19.09	17.09	15.65	14.25
17.0	17	170,000	20.28	18.16	16.63	15.14
18.0	18	180,000	21.47	19.23	17.60	16.03
19.0	19	190,000	22.66	20.30	18.58	16.92
20.0	20	200,000	23.86	21.36	19.56	17.81

① The kJ rating of the Model M3534CR 100% Ride-Thru Module is based on the "Usable" energy of electrolytic storage reservoir assemblies at 7% below nominal line voltage. The actual usable energy of the reservoir will vary according to drive under-voltage trip point and line or bus voltage levels. Refer to Figure 6-1 thru 6-4 for "Usable Energy" curves representing 1-20 reservoir assemblies.

Figure 6-1: Usable kJoules @ -7% Line Using Booster

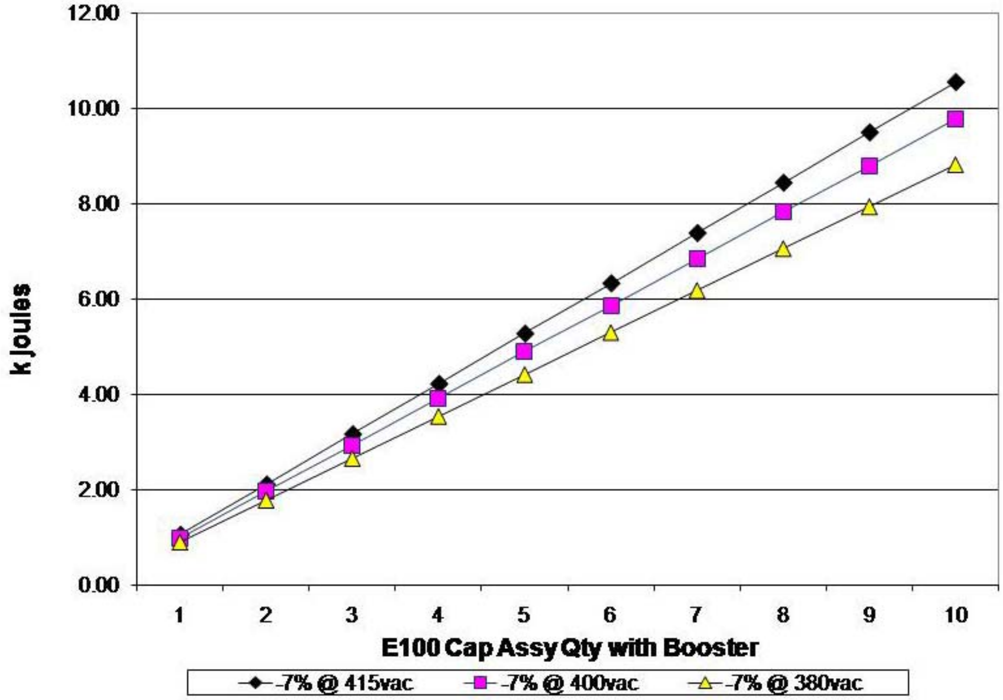


Figure 6-2: Usable K Joules with 380VAC Feed Using Booster

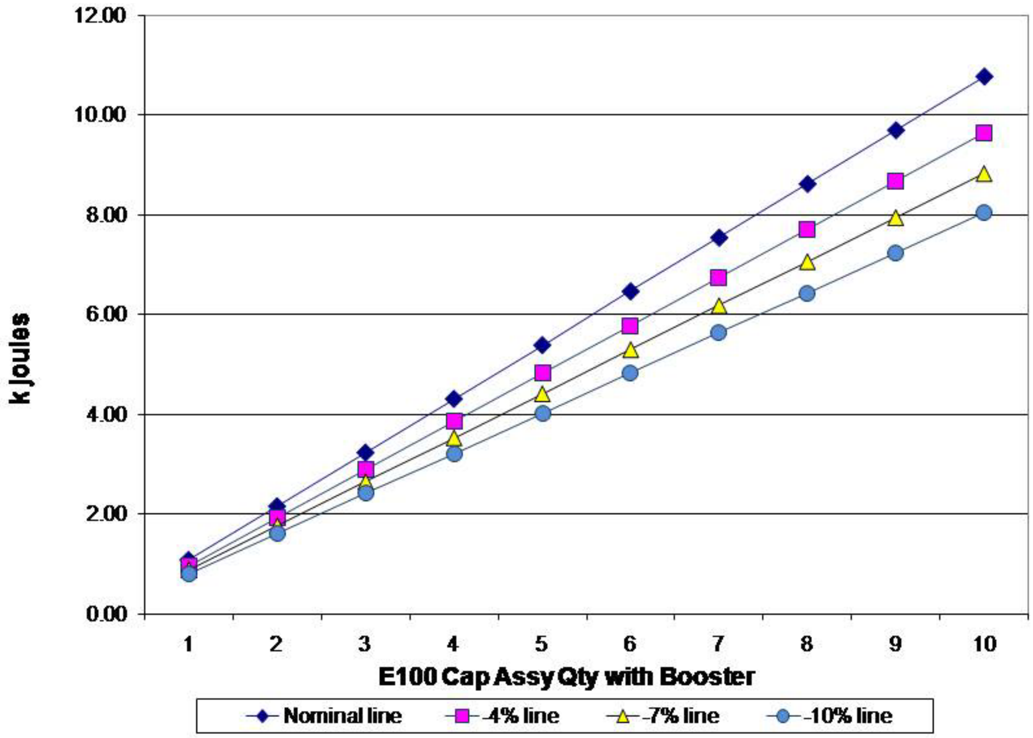


Figure 6-3: Usable K Joules with 400VAC Feed Using Booster

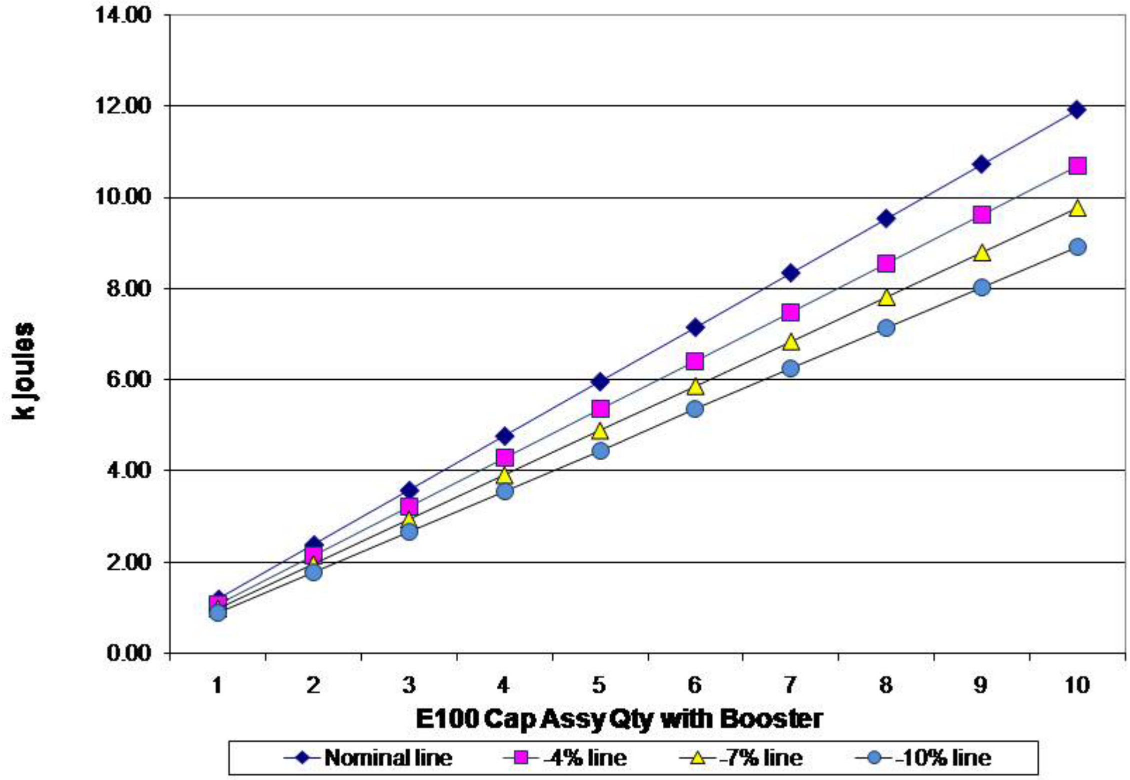
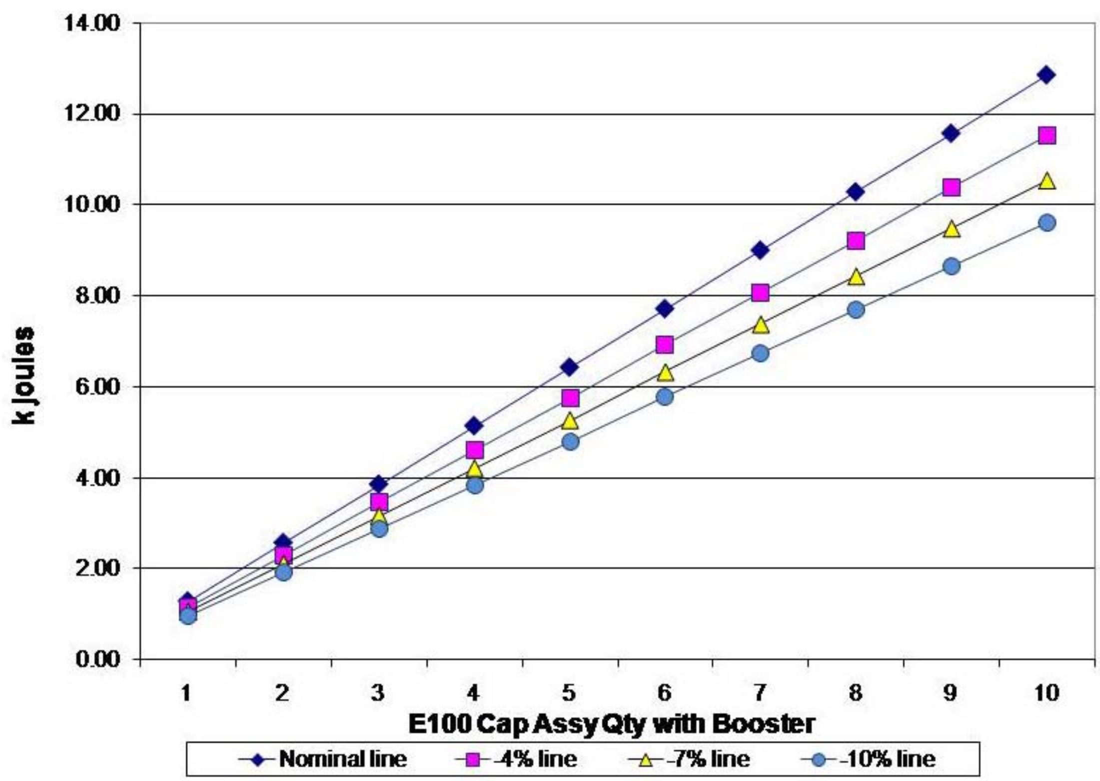


Figure 6-4: Usable K Joules with 415VAC Feed Using Booster



6.1.1. DISCHARGE CURVES

Figure 6-5: Discharge Curve for 10,000uF (1kJ) Bank Using Internal 780ohm Resistor

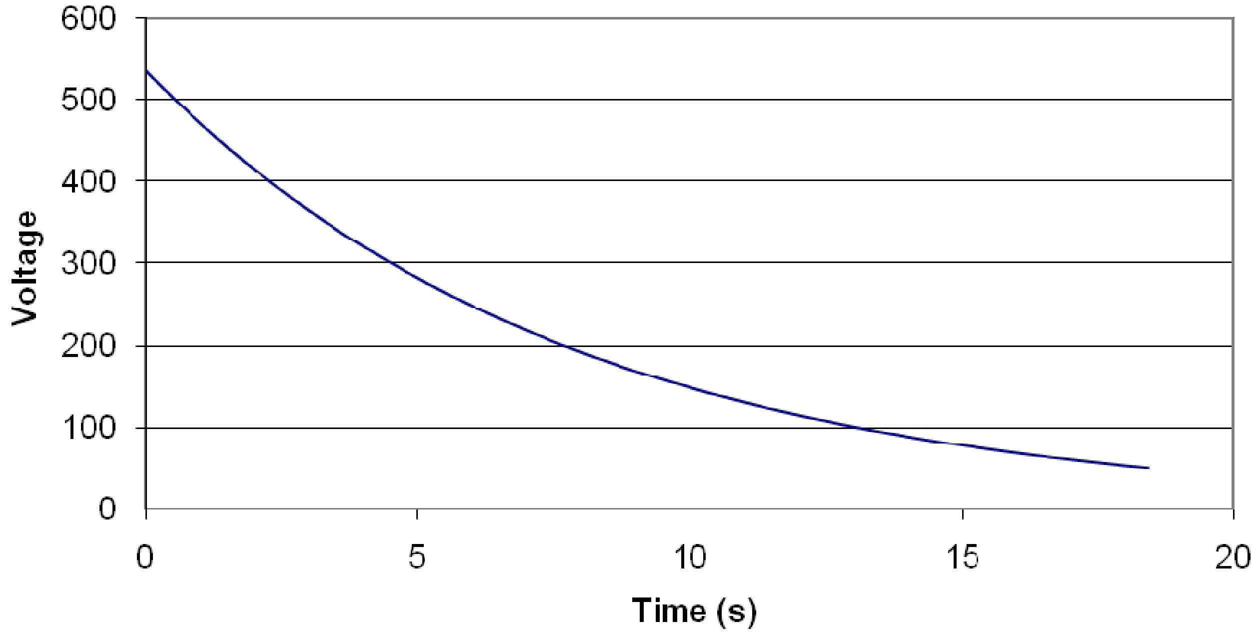


Figure 6-6: Discharge Curve for 40,000uF (4kJ) Bank Using Two Internal, Parallel 780ohm Resistors

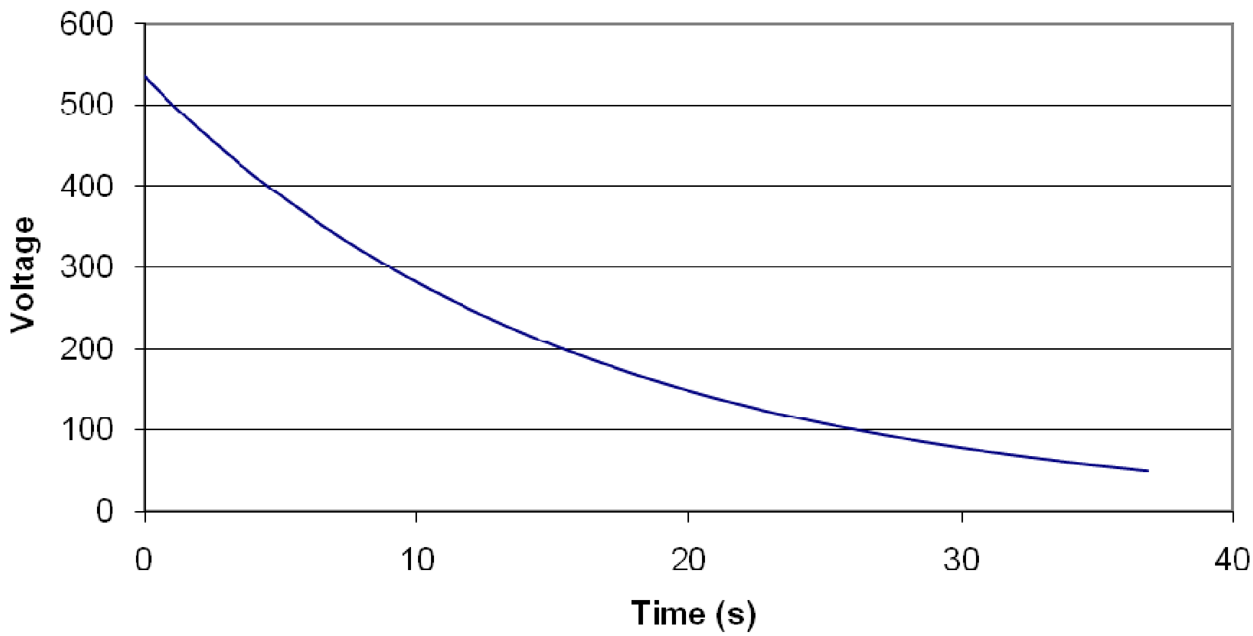


Figure 6-7: Discharge Curve for 60,000uF (6kJ) Bank

Using Two Internal, Parallel 780ohm Resistors

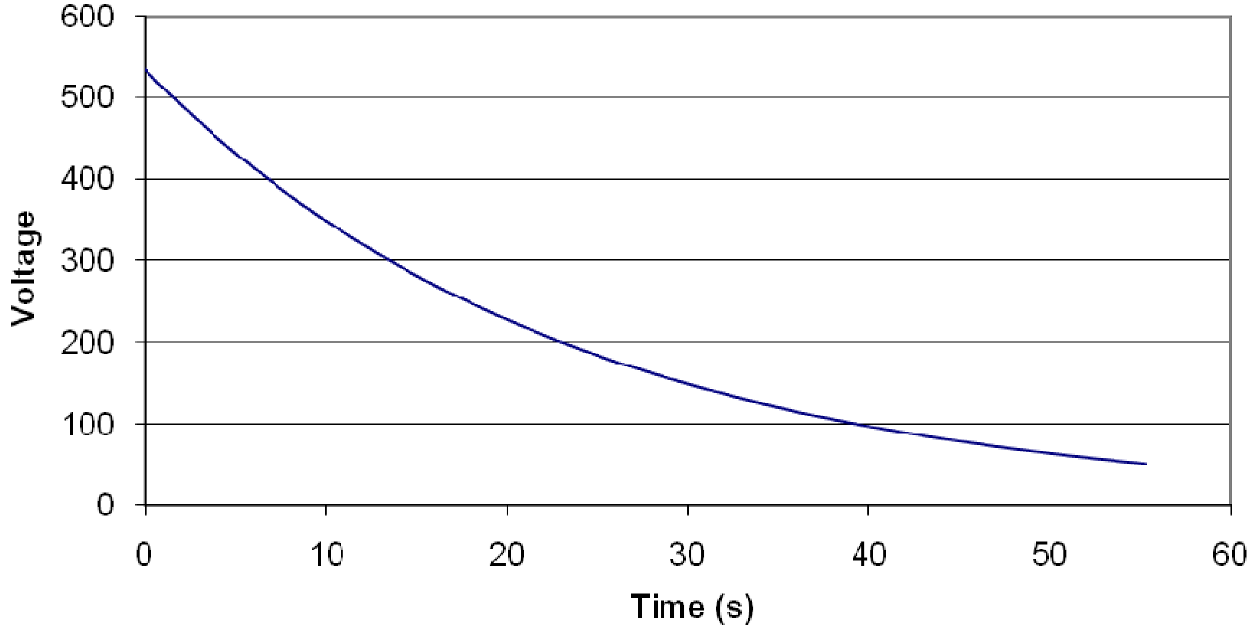
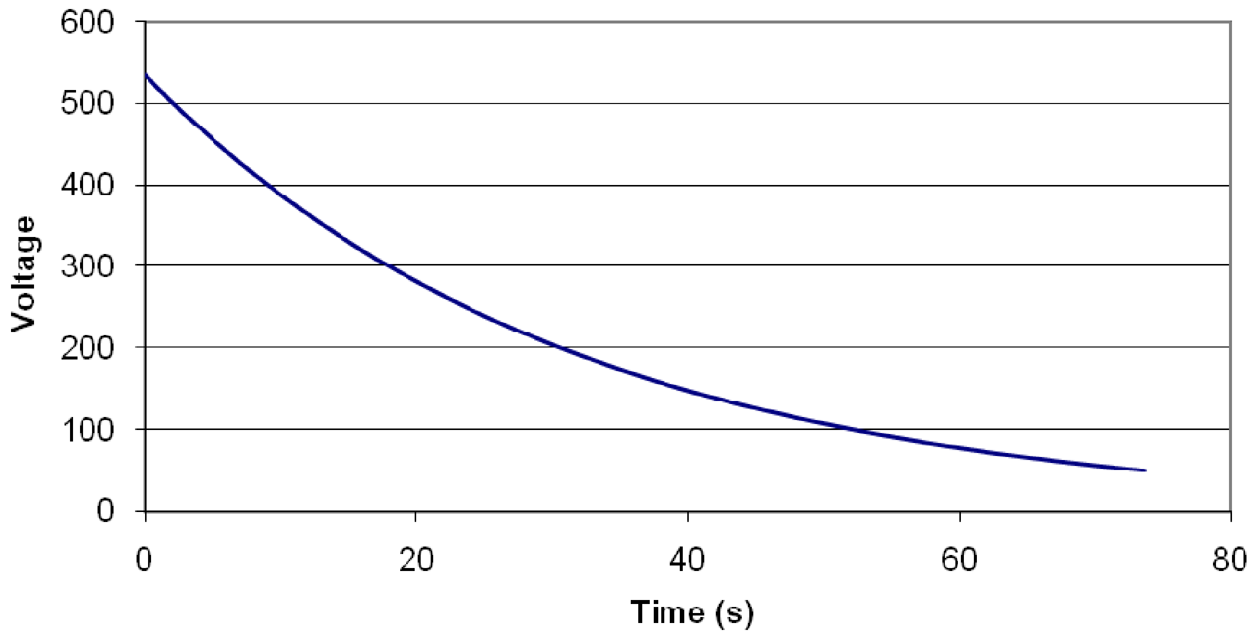


Figure 6-8: Discharge Curve for 80,000uF (8kJ) Bank

Using Two Internal, Parallel 780ohm Resistors



6.2. Watt Loss

M3534CR Models use less than 35W in stand-by mode, and are 93% (or better) efficient at full load.

6.3. Certifications

M354RT Boosters are certified to meet SEMI-47 specifications.

6.4. Fuse Sizing And Rating

Fuses are located inside the M3534RT Booster enclosures.

Table 6-4: Fuse Sizing and Rating

Model	AC Input	Power	Fuse		Output Current	Chassis
			AC	DC		
M3534RT-E010-A5	380-415V	13hp / 10kW	A60Q30	A60Q25	20A	A5
M3534RT-E020-K6	380-415V	26hp / 20kW	A60Q40	A60Q40	40A	K6

6.5. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-9: M3534CR 'E61' 1.0 kJ Enclosure Dimensional Outline

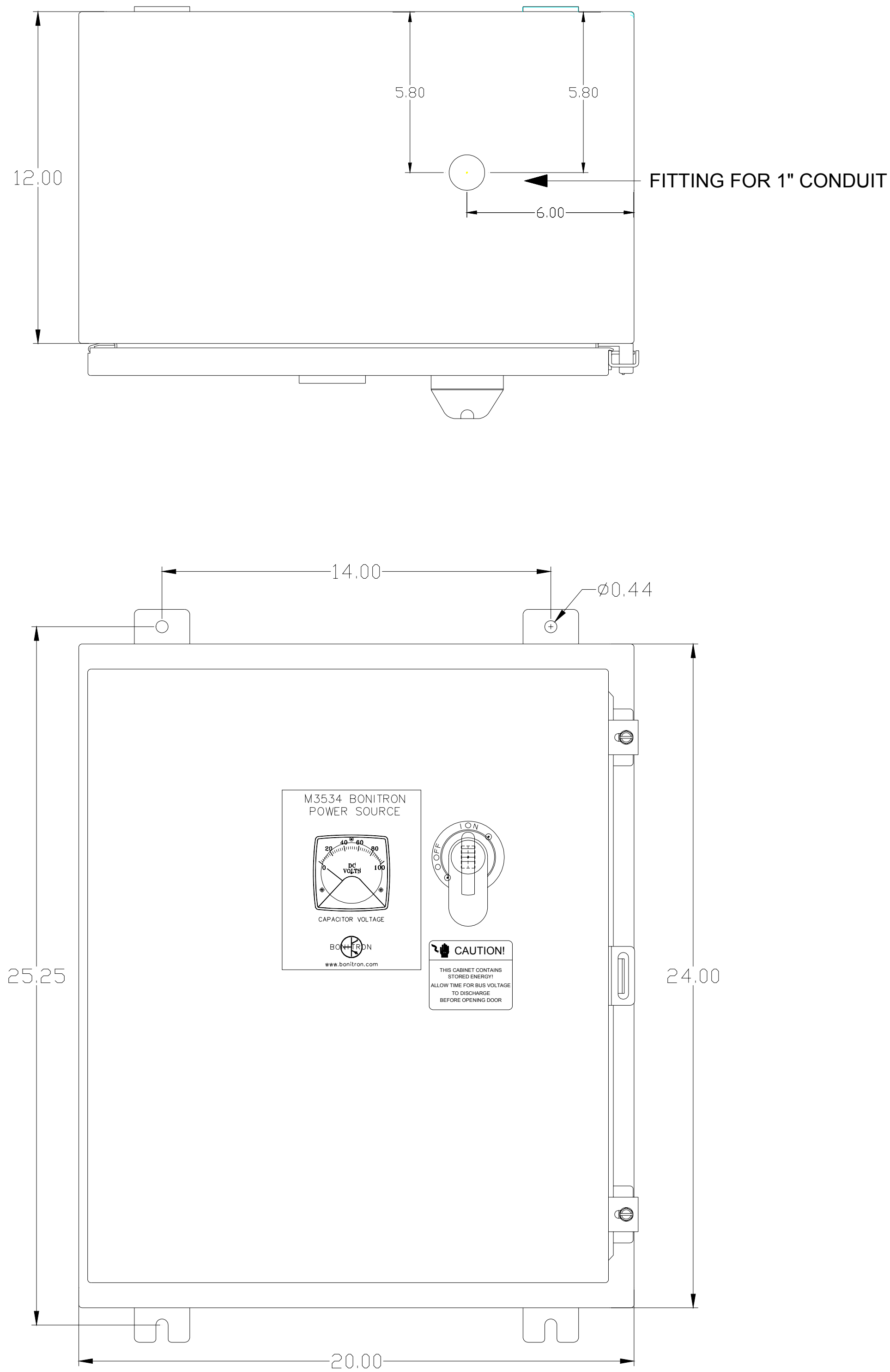
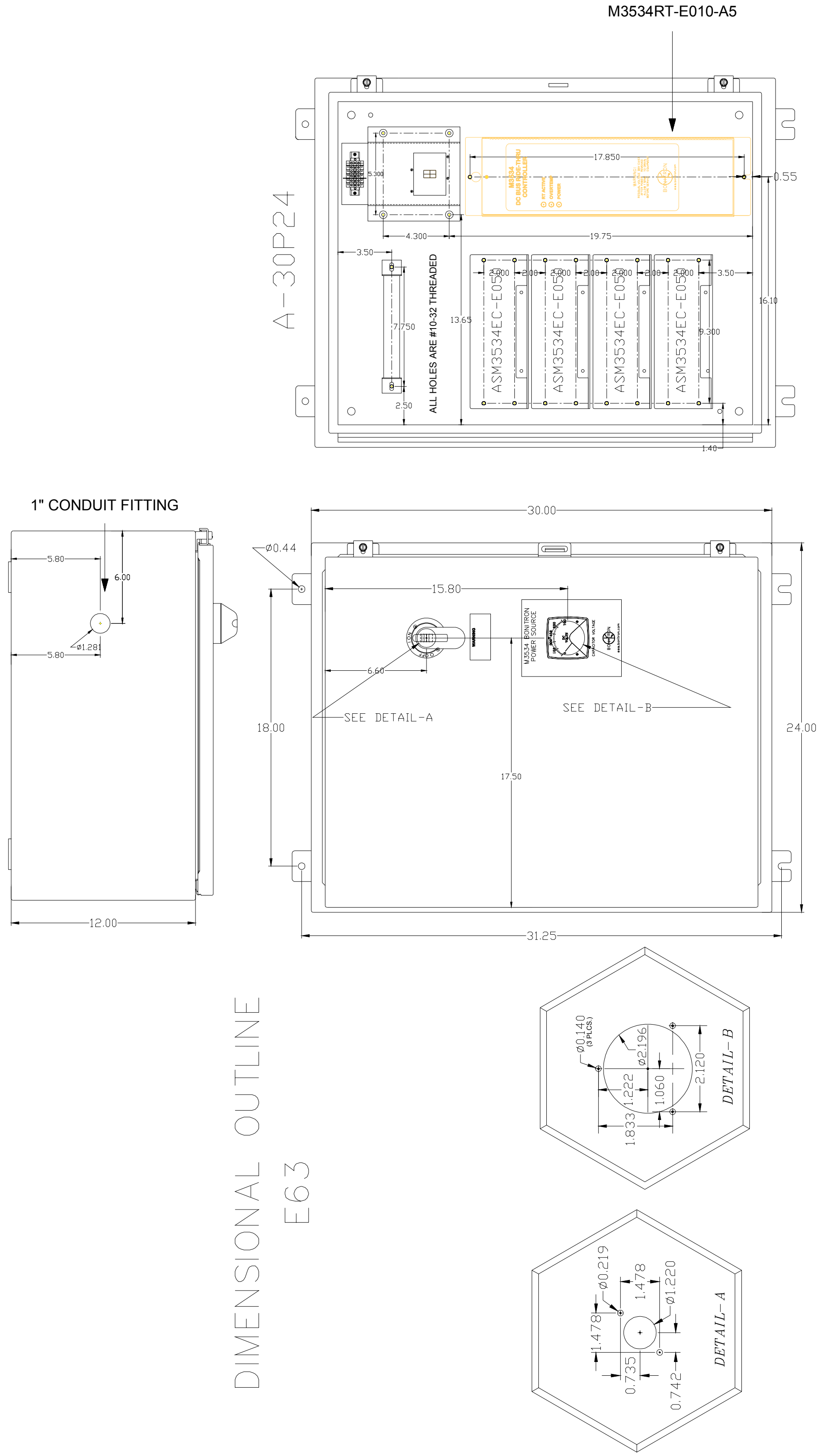
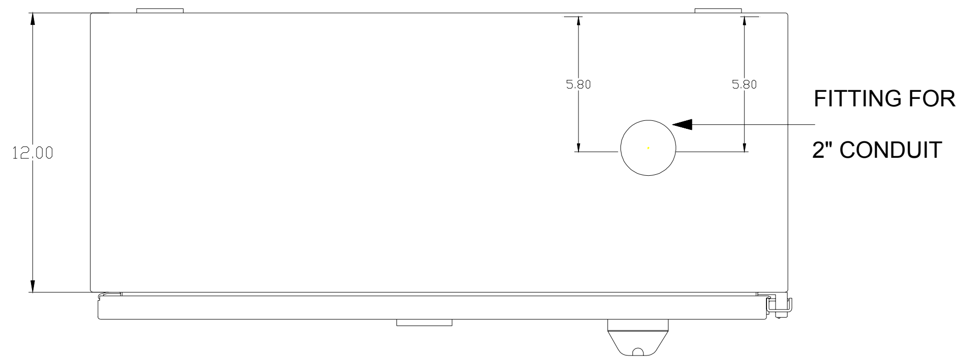


Figure 6-10: M3534CR 'E63' 4.0 kJ Enclosure Dimensional Outline



Dwg#: 080432 Rev: 20081008

Figure 6-11: M3534CR ‘E66’ 3.0 - 6.0 kJ Enclosure Dimensional Outline



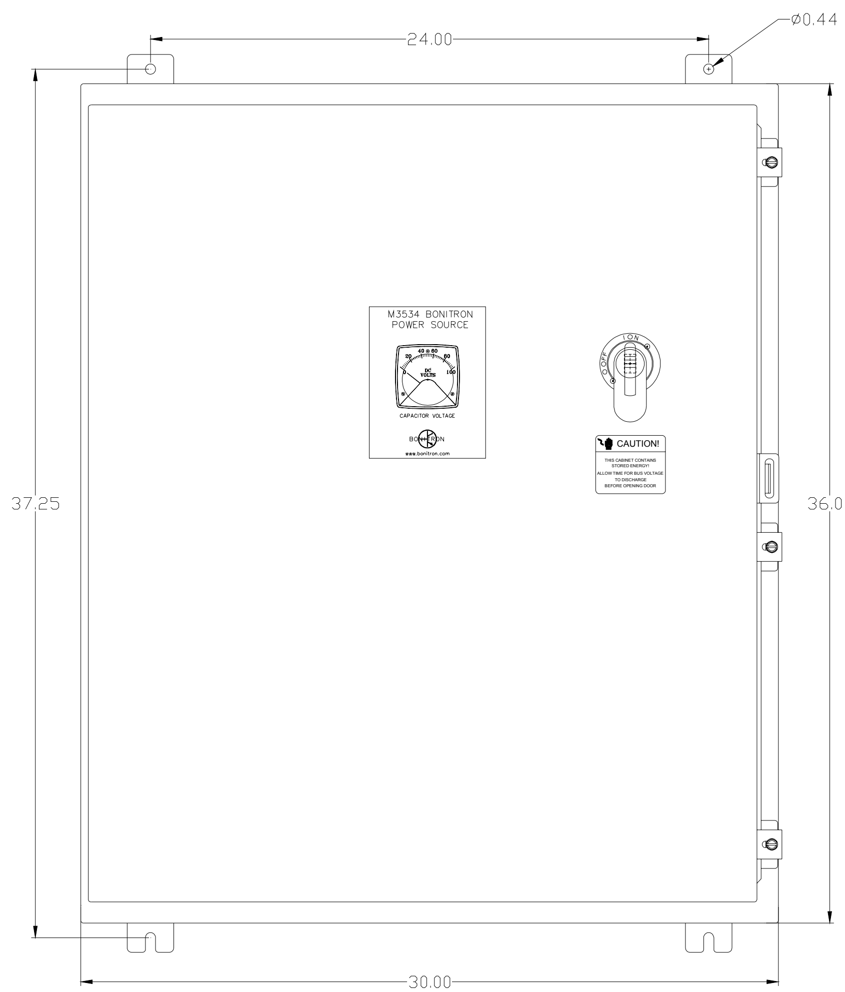
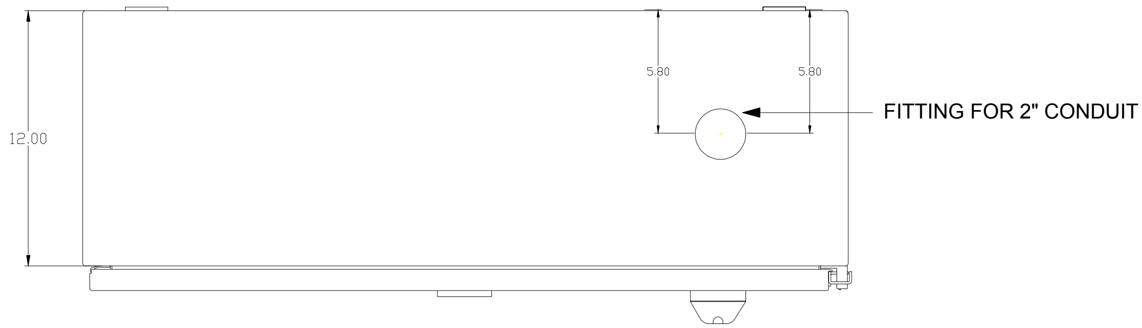


Figure 6-12: M3534CR 'E69' 8.0kJ Enclosure Dimensional Outline



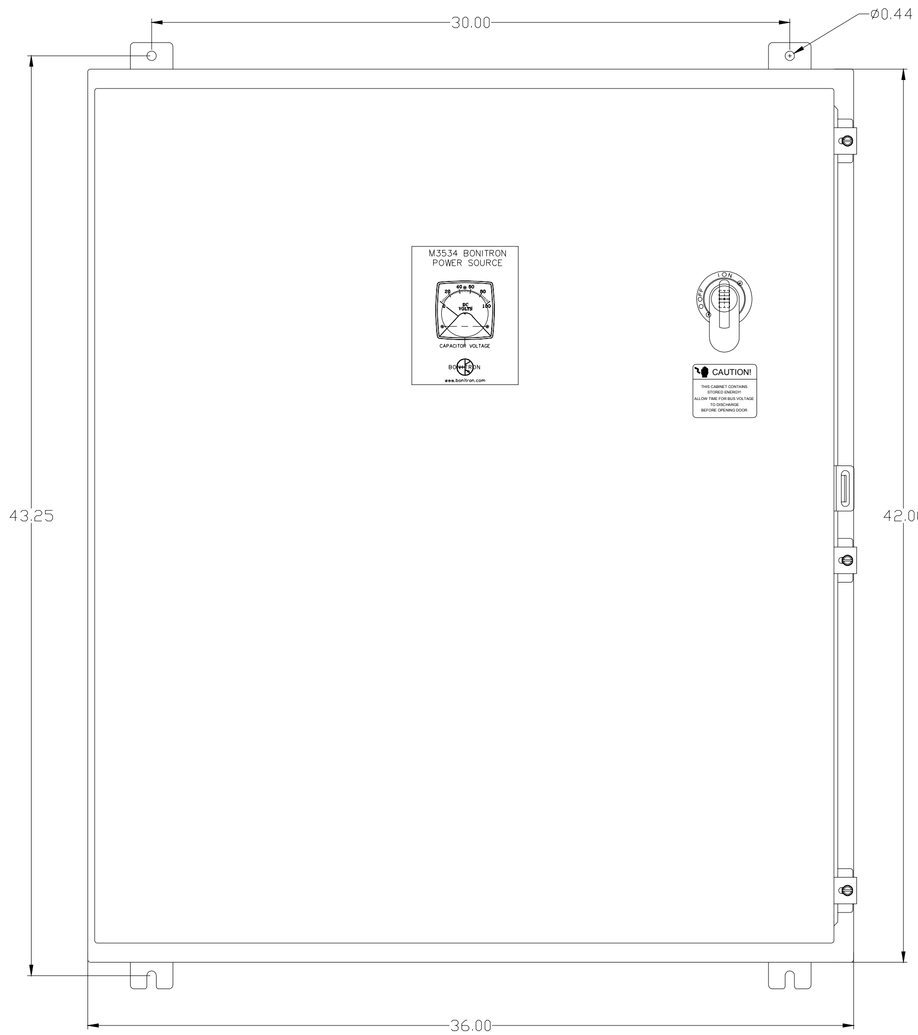


Figure 6-13: M3534RT Control Module 'A5' Chassis Dimensional Outline

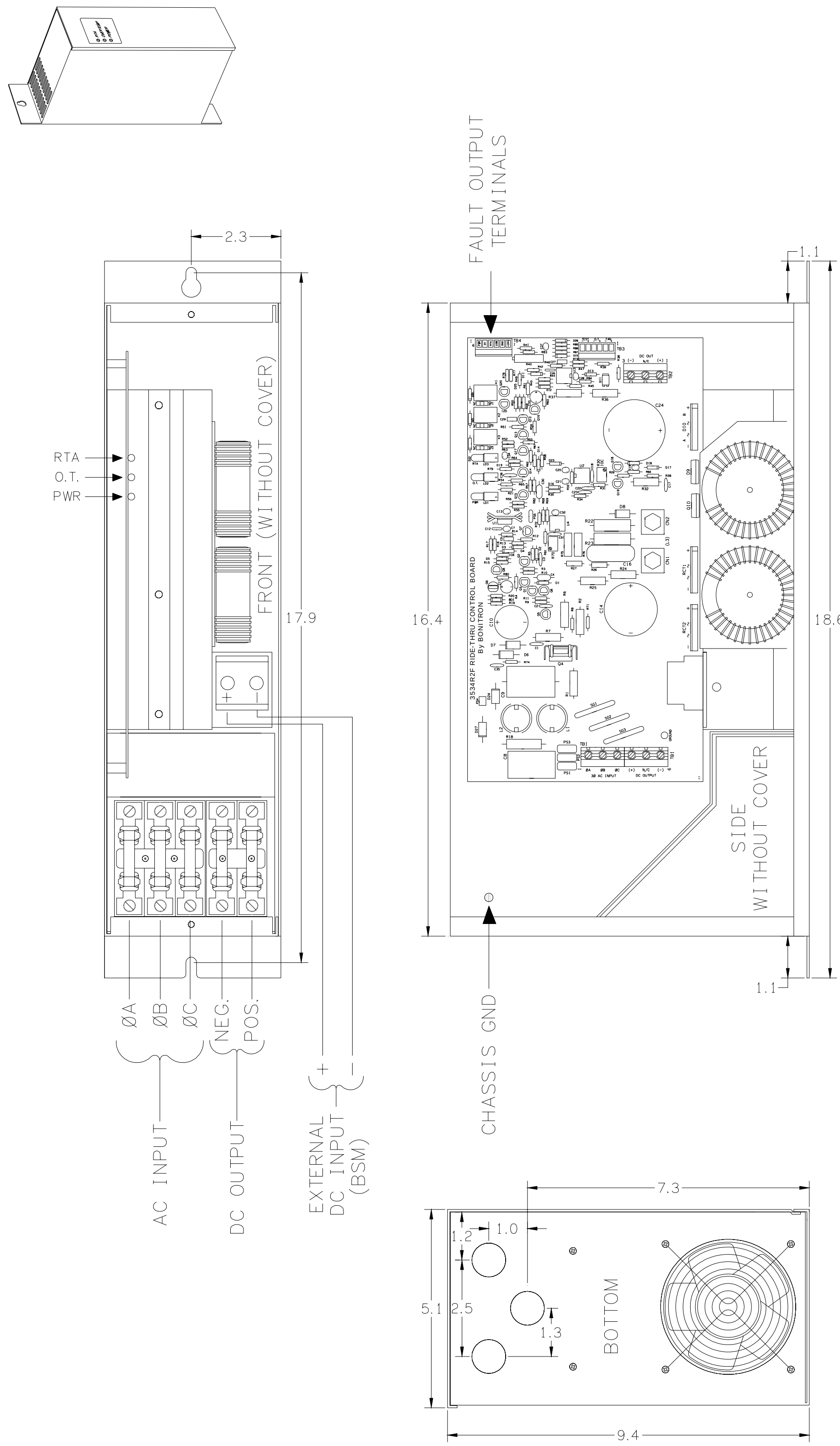
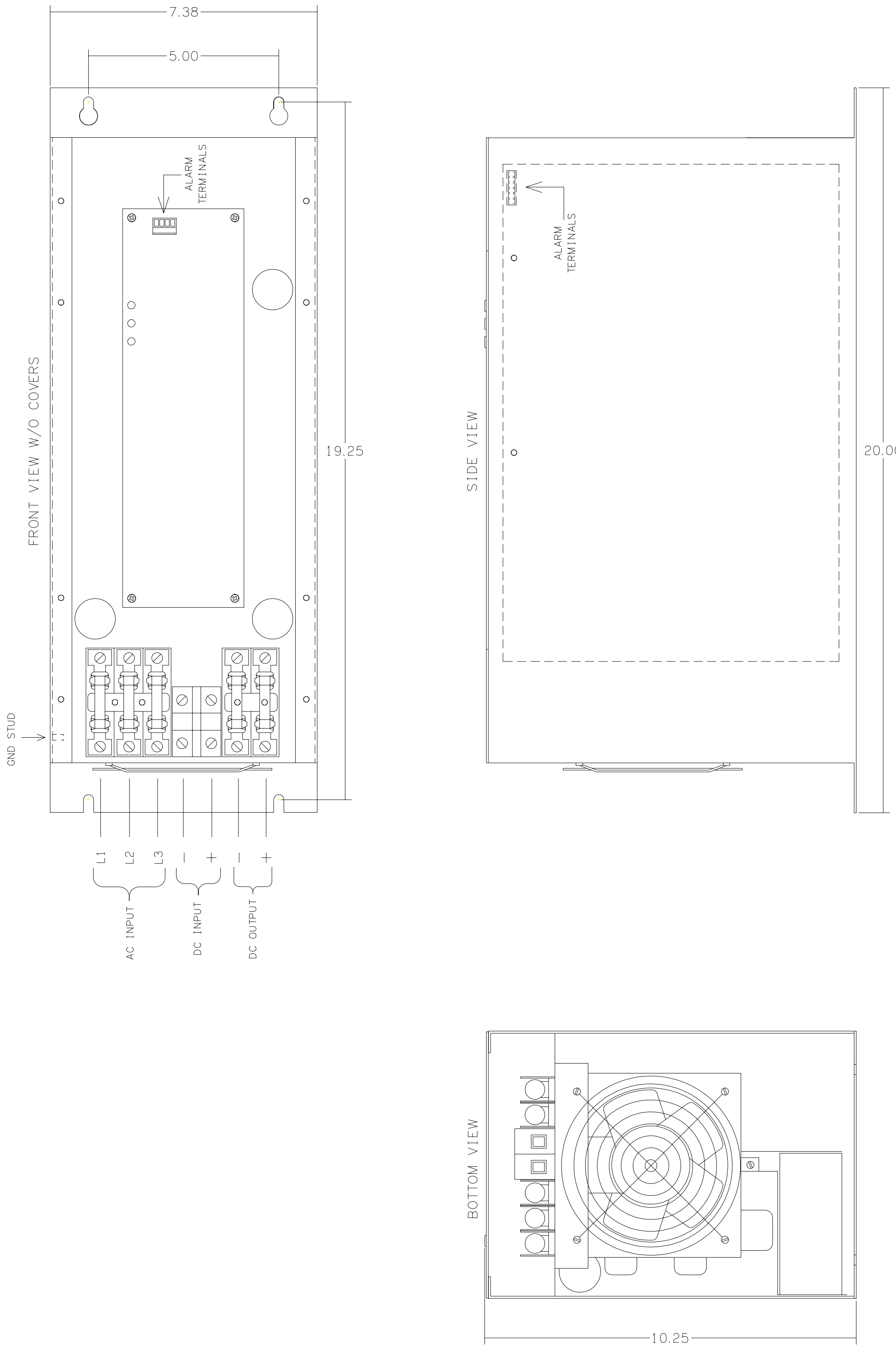


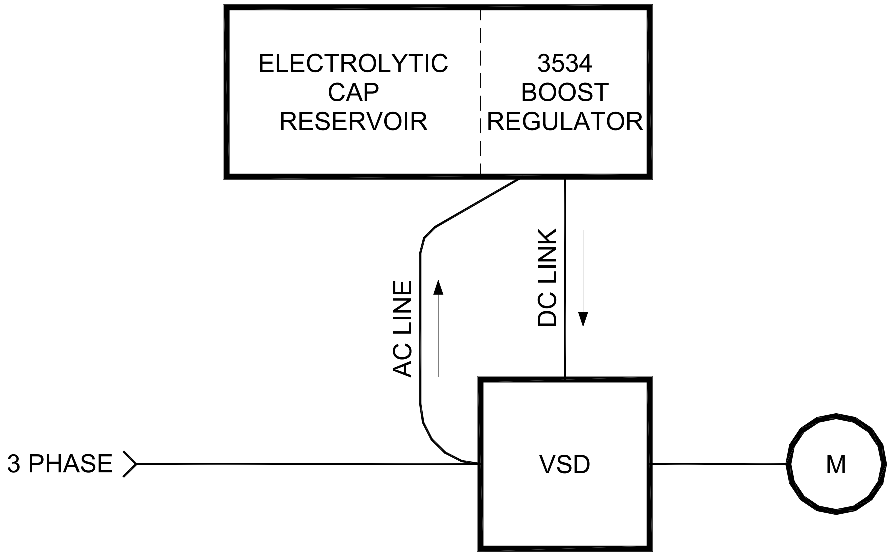
Figure 6-14: M3534RT 'K6' Chassis Dimensional Outline



Dwg#: 080033 Rev: 20080109

6.6. BLOCK DIAGRAMS

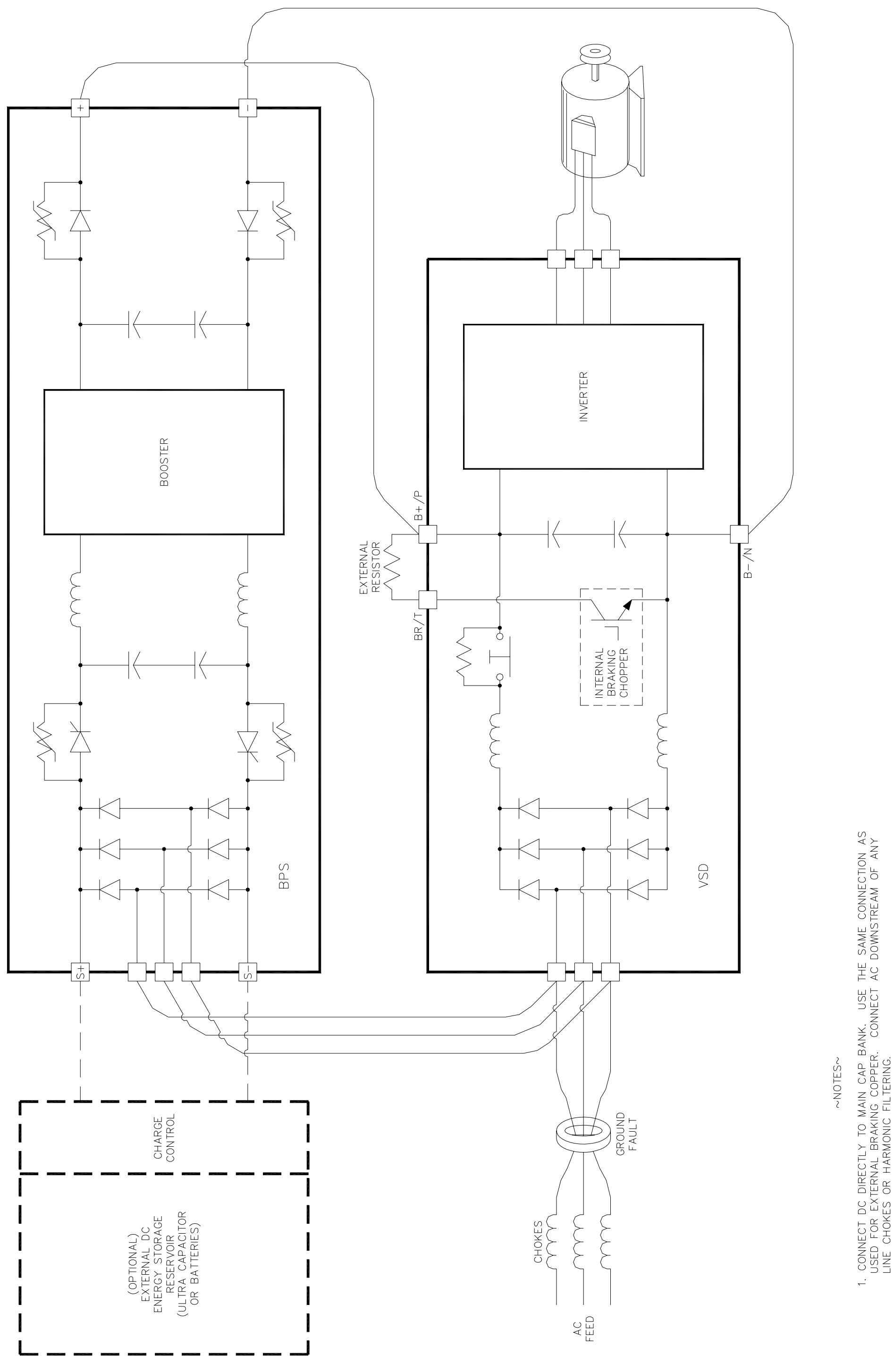
Figure 6-15: BPS Ride-Thru System Configuration 10



12KW & BELOW, 0.5 - 1 SECOND, 100% OUTAGE PROTECTION
USING DC BOOSTER WITH ELECTROLYTIC CAP RESERVOIR
SINGLE CABINET POWERED FROM AC LINE

6.7. Supplemental Drawings

Figure 6-16: Inverter – Bonitron Power Source Connections



Dwg#: 060304 Rev: 20071205

Figure 6-17: Outage without Cap or Booster

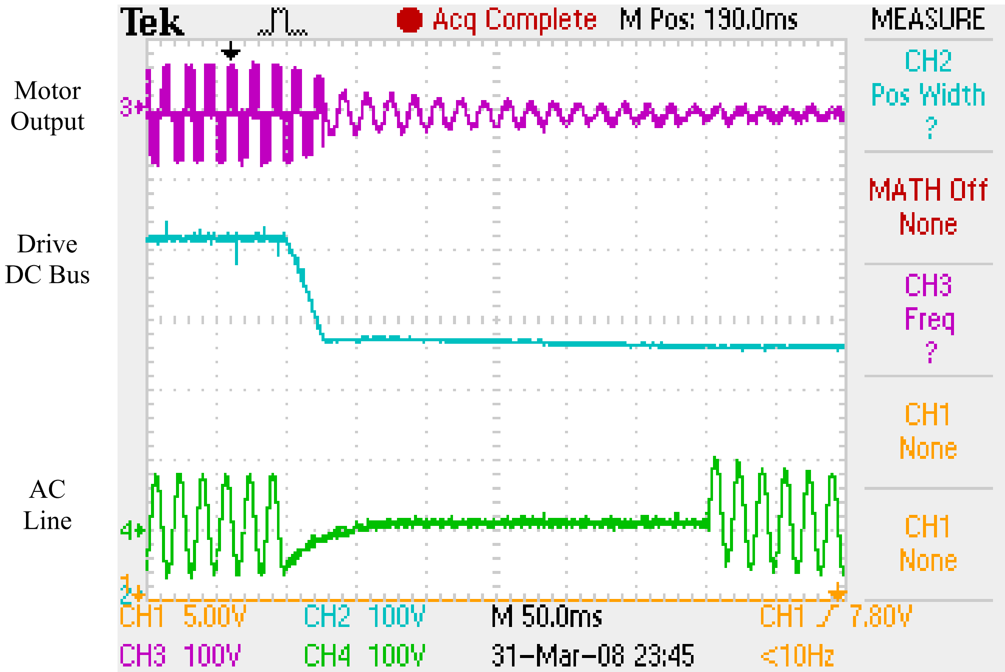
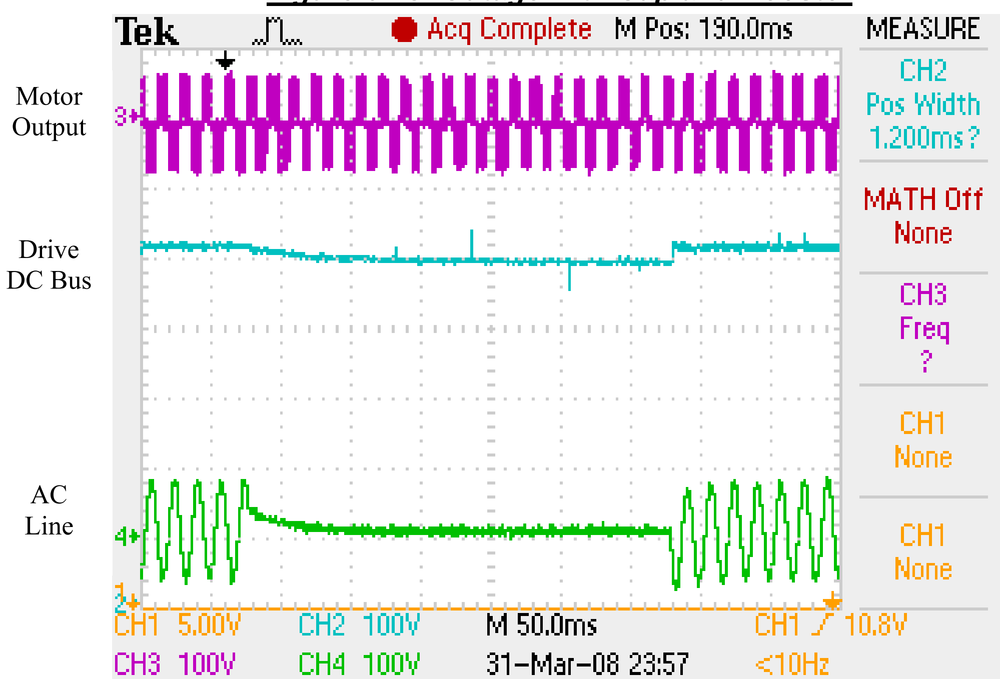


Figure 6-18: Outage with Cap and Booster



6.8. PARTS LIST

PART #	DESCRIPTION	QTY
ASM 3534EC-E100-81-BR1A	8 X E700V/10,000uF cap assy w/short bkt & booster	4
ASM 3534EC-E100-81-BR2A	8 X 700V/10,000uF cap assy w/tall bkt & booster	4
FS A60Q40-2	Ferraz A60Q40-2 ferrule fuse	1
FS HOLDR-04	BUSS BM6031SQ single pole fuseholder 600V	1
IST METR25-750V	YOKOGAWA 2.5" Meter: 0-750 VDC (0-1 mA input)	1
M3534RT-E010-A5	380-415 vac, 10 kW, 13 hp, 2 sec enclosed ride-thru	1
M3534RT-E020-K6	380-415 vac, 20 kW, 27 hp, 2 sec enclosed ride-thru	1
MTW 3534-BB-01	Flexible Bus Bar for ASM 3534EC cap bank modules	14
MTW 3534-DISC	050010: V3: bkt for ABB 6-pole disconnect	1
MTW 3534EC-TS	080124: g-rail for m3534EC/CR terminal strip	1
MTW 3534-ROD	050012: bracket to support disconnect rod	1
PLP 3534EC-04	040152: Lexan cover for (4) 'ASM 3534EC' cap assemblies	4
PLP 3534EC-08	040152: Lexan cover for (8) 'ASM 3534EC' cap assemblies	1
PVC 3534	050011: M3534CR backplate brace block	1
RS 130W7800J	Hei # fvt130-780: 780 ohm 130w w/ hdw	2
SW OA1G01	ABB #OA1G01: Aux contact	2
SW OHY65J5	Abb #OHY65J5: switch handle	1
SW OT25E6	ABB #OT25E6: 6 pole disconnect switch	1
SW OXP5X400	Abb #oxp5x400: 400mm shaft	1
TS RW-EK10	Weid #035466: ground terminal	1
TS RW-ENSAK6N	Weid. 11796- end piece for sak6n	1
TS RW-EWK1	(2061.6) end bracket	2
TS RW-SAK6N	Weidmuller 01932600000 : 47a terminal	5
TS RW-TS32	(111.001) steel rail (6'6")	6
TS RW-TW4-10	013016: partition for sak6n	1

6.9. RECOMMENDED SPARE PARTS

PART #	DESCRIPTION	QTY
ASM 3534EC-E100-81-BR2A	8 x 700V/10,000uF cap assy w/tall bkt & booster	4
FS A60Q40-2	Ferraz A60Q40-2 ferrule fuse	1
M3534RT-E010-A5	380-415VAC, 10 kW, 13 hp, 2 sec enclosed ride-thru	1
M3534RT-E020-K6	380-415VAC, 20 kW, 27 hp, 2 sec enclosed ride-thru	1
RS 130W7800J	Hei # fvt130-780: 780 ohm 130W w/ hdw	2
SW OA1G01	ABB #OA1G01: Aux contact	2
SW OT25E6	ABB #OT25E6: 6 pole disconnect switch	1

7. Appendices

7.1. Application Notes

Bonitron manufactures several different BPS models for specific applications. The following is a general guideline for applying the appropriate model for best cost effectiveness. Short term outage is defined as less than 2 seconds, and long term outage is defined as more than 2 seconds.

1. Fractional to 3hp, 50% sag or 100% short term outage should consider M3534EC
2. Fractional to 3hp, 100% long term outage should consider M3534BR
3. 3hp to 67hp 50% sag should consider M3534RT
4. 3hp to 15hp 100% short term outage should consider M3534CR
5. 15hp to 67hp 100% short term outage should consider M3534UR
6. 3hp to 67hp 100% long term outage should consider M3534BR
7. 75hp to 2000hp 50% sag should consider M3460R
8. 75hp to 2000hp 100% short term outage should consider M3460UR
9. 75hp to 2000hp 100% long term outage should consider M3460B4

7.2. Installation Considerations

The following items should be considered when installing a Bonitron Ride-Thru module.

1. Inverter logic voltage must be "backed up"
   - Most new Inverters derive logic supply from DC bus
   - Install small UPS on circuits with AC feed
2. Any control or Interlock relays must be "backed up"
   - Test Relays at half voltage for dropout
   - Use DC relays on logic supply
   - Install small UPS on circuits with AC feed
3. Determine the maximum motor voltage needed
   - To ensure "Threshold" level is sufficient to supply motor
   - Most inverters automatically compensate RMS to motor with 10% low DC bus level
4. Verify actual AC line voltage and DC bus level
   - To ensure "Threshold" level is set – 10% of actual DC bus level
   - To ensure valleys of ripple do not cause unwanted activity
5. Determine Inverter low bus trip point
   - To ensure "Threshold" level is above inverter dropout
6. Determine Inverter high bus trip point
   - To ensure "Test" level will not over voltage inverter
7. Inverter ground fault circuits
   - Ride-Thru currents on 20 amp model may use Inverter bridge negative diodes during operation
   - Circuits can be de-sensitized
   - External "upstream" ground fault circuits may be added

8. Electrical safety
   - Ride-Thru should not have AC power when inverter does not
   - RT and Inverter should feed from same point
   - Use shunt trip interlock between Inverter and Ride-Thru if RT power is not fed downstream of inverter power switch
   - Label Inverter as having two power sources
9. Monitoring of status signals
   - Fault contacts available for remote control room monitoring
10. Input feed should be capable of 2x rated current during the 2 sec 50% dip.
    - RT RMS rating is 1 percent of system KW
    - Most Inverter feeds have been sized for a 150-200% surge for motor starting
11. IR drop of wiring
    - This subtracts from the 50% dip spec
12. Maximum wire sizes allowed into Ride-Thru
    - Different models have standard max sizes
13. Local wiring codes
14. Ambient temperature
    - Under 50°C
15. Environment
    - Determines cabinet type

7.3. USABLE ENERGY DATA FOR BSMS

This section provides data pertaining to the amount of available Usable Energy for DC bus voltage support provided by M3534CR 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 Bus Support Modules (BSMs) used in the M3534CR DC Bus 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 capacitor bus drops to the low voltage input of the voltage booster. Accordingly, the actual USABLE ENERGY of the reservoir can be optimized through higher AC line levels and/or using a boost converter with a lower input voltage rating.

In order to ensure that the M3534CR DC Bus Ride-Thru module will adequately provide sufficient energy during anticipated outages under typical field conditions, the USABLE ENERGY ratings listed in Table 6-3 were conservatively calculated based on a low AC line level (approx. 7% below nom. AC line) combined with a 2x boost converter.

Figure 6-1 depicts the relationship of AC line levels to usable energy for the ASM-3534EC-E100 Electrolytic Capacitive Bus Support Module when used in the M3534CR DC Bus Support system for 380VAC, 400VAC, and 415VAC drive systems. Figures 6-2, 6-3, and 6-4 show usable kilojoules at '~4% Low', '~7% Low', and '~10% Low' levels for each nominal AC line input level. All charts assume a 275VDC booster low bus input level, and a threshold of 485V. While an inverter may continue to run at lower voltages, the output power is decreased to the motor.

Table 6-3 provides Usable Energy Ratings for M3534EC DC Bus Support systems utilizing up to 20 ASM-3534EC-E100 Bus Support Modules (BSMs). These ratings are based upon conservative estimates of drive system parameters.

7.4. CALCULATIONS

This section provides the calculations required to determine the optimum number of Bus Support Modules to be used when configuring a M3534CR DC Bus Support 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 BSM 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 BSMs to include in the system configuration. Each of these calculations is detailed below.

7.4.1. DETERMINING THE REQUIRED CAPACITY OF A M3534CR SYSTEM

The capacity or USABLE ENERGY rating (in kJ) of a M3534CR 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 M3534CR is rated for 20kW maximum. For load ratings greater than 20kW, the M3534UR 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 M3534CR System:

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

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

To be sure that the M3534CR will always be sufficiently sized for the drive system, use the horsepower 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 horsepower rating of the actual load may be used.

7.4.2. CALCULATING THE ACTUAL USABLE ENERGY OF ONE ASM-3534EC BSM

In order to provide a reliable general guideline for properly sizing a model M3534CR DC Bus Support system, the USABLE ENERGY ratings for ASM-3534EC-E100 BSMs, as listed in the Table 6-3, 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 M3534CR system will adequately perform under actual field conditions.

However, to more accurately determine the actual USABLE ENERGY of an ASM-3534EC Bus Support Module when used for support of a drive, 4 specific values must be known:

1. the capacitance of the BSM (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
4. the boost ratio

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

$$\mathbf{E_U = E_S - E_R}$$

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 at the boosters minimum input value.

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 = ½CV2

Where

E is energy (in joules)

C is the total capacitance (in farads) of the ASM-3534EC BSM

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 boosters 'Low Voltage' input. (268vdc for 380vac systems)

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

7.4.3. DETERMINING THE REQUIRED NUMBER OF BSMS FOR THE M3534CR

Now that a value for 'Usable Energy' has been determined for a single BSM, divide this number into the previously calculated 'Required Capacity' value to determine the required number of BSMs to be included in the M3534CR system.

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

7.5. DETERMINING ACTUAL CAPACITY FOR AN EXISTING SYSTEM

To quickly prove the remaining capacitance in any 3534CR BPS 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
     - Removing the fuse between the booster and cap bank will provide more accurate results. If the fuse cannot be removed under power, figure an additional 20 watts of load drain (booster power losses) on the cap bank during discharge test.

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 535 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.

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