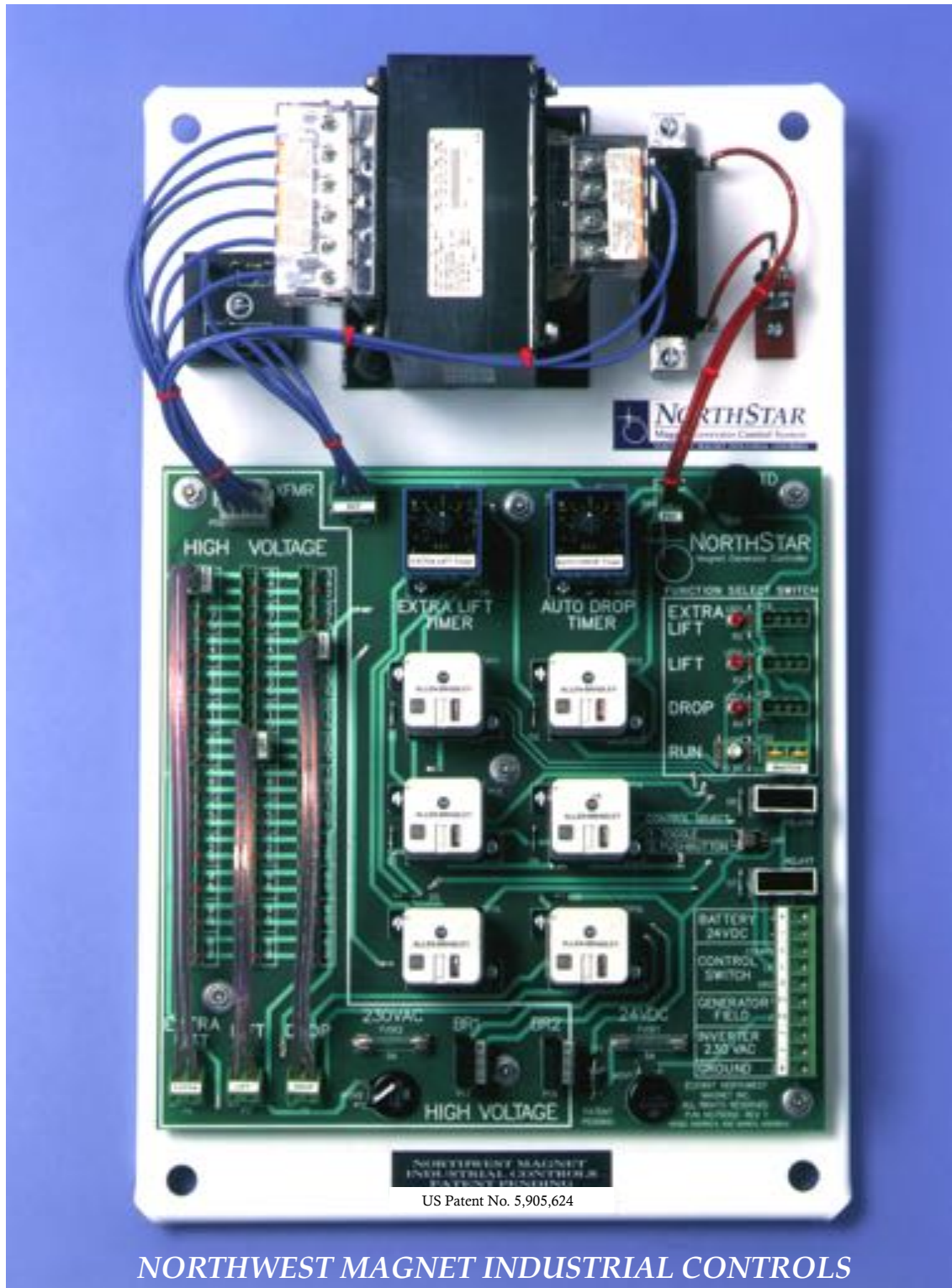


NORTHSTAR

Magnet Generator Control System



US Patent No. 5,905,624

NORTHWEST MAGNET INDUSTRIAL CONTROLS

Forward

Congratulations on your purchase!

The NorthStar Magnet Generator Control System is at the leading edge of magnet generator control technology and a significant improvement over conventional magnet controllers. It is designed to be versatile, rugged, easy to use and maintain while providing a lifetime of trouble-free operation. Our goal in creating this system was to increase your magnet's lifting capacity and productivity while reducing maintenance costs and downtime.

Please take the time to read and this manual. You'll find the time well spent as this significantly reduces your installation, set-up and maintenance time. We recommend that you try out your new control system right away to familiarize yourself with the NorthStar's features and benefits. Make sure that it does the job you want it to do. It is important that you are completely satisfied.

Please call us with any questions or comments that you may have. We look forward to answering any questions that you may have regarding installation, setup and operation. Thank you again for your business and look forward to a long, prosperous and mutually beneficial business relationship.

Sincerely,



Marius Andreica
President, CEO
Northwest Magnet, Inc.

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Disclaimer of Liability

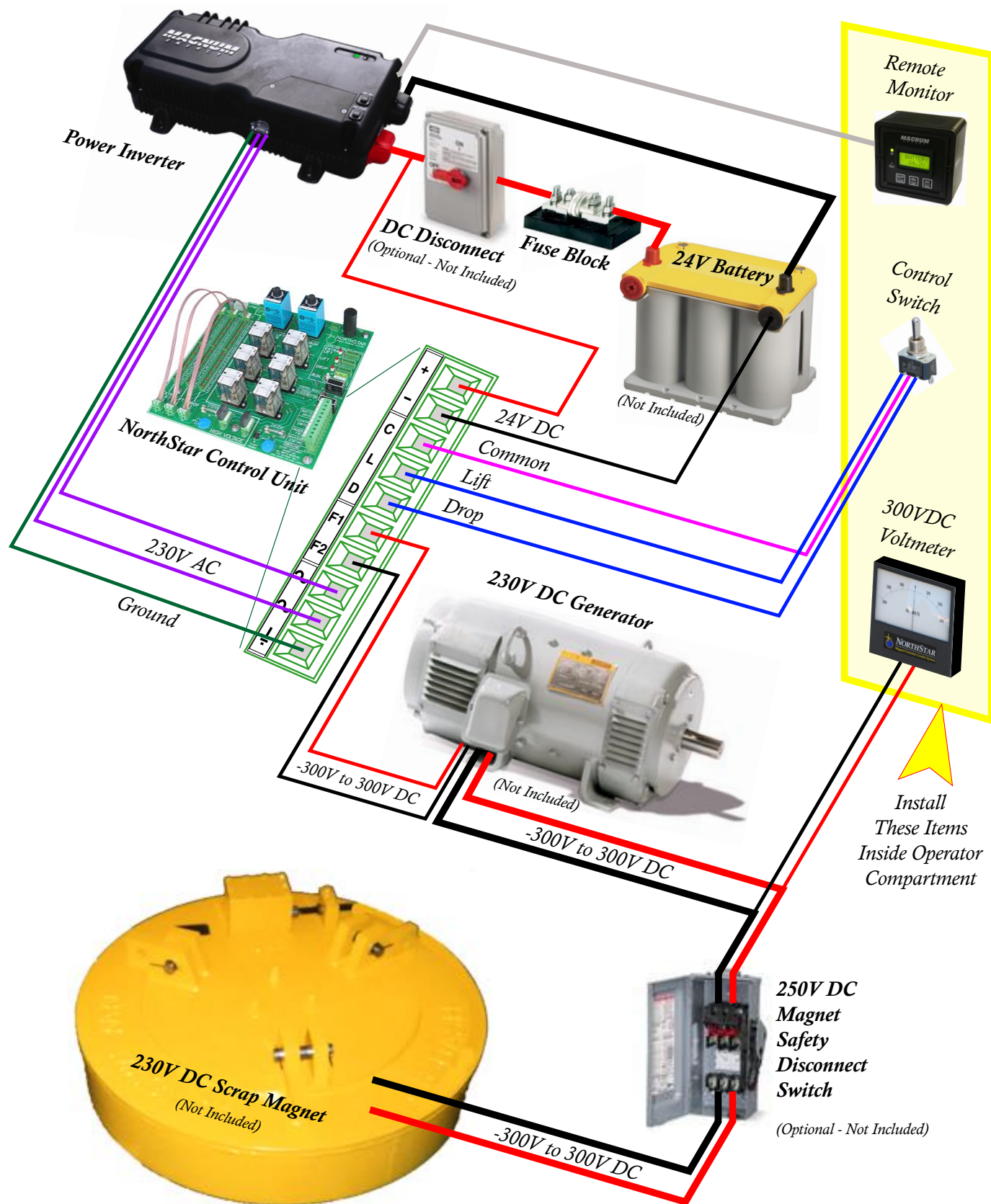
Since the use of this manual and the conditions or methods of installation, operation, use and maintenance of the NorthStar Control System are beyond the control of the manufacturer, Northwest Magnet Inc., does not assume responsibility and expressly disclaims liability for loss, damage or expense, whether direct, indirect, consequential or incidental, arising out of or anyway connected with such installation, operation, use, or maintenance. Due to continuous improvements and product updates, the images shown in this manual may not exactly match the unit purchased.

Important Product Safety Instructions

This manual contains important safety instructions that must be followed during the installation and operation of this product. Read this manual carefully before installing or using this product.

- All electrical work must be performed in accordance with local, state and federal electrical codes.
- This product is designed for indoor/compartment installation. It must not be exposed to rain, snow, moisture or liquids of any type.
- Use insulated tools to reduce the chance of electrical shock or accidental short circuits.
- Remove all jewelry such as rings, watches, bracelets, etc., when installing or performing maintenance.
- Always disconnect the batteries or energy source prior to installing or performing maintenance. Live power may be present at more than one point since an inverter utilizes both batteries and AC. Turning off the inverter may not reduce this risk. As long as AC power is connected, it will pass thru the inverter regardless of the ON/OFF power switch.
- Always verify proper wiring prior to starting the inverter.
- Do not operate the NS control or inverter if it has been damaged.
- Do not dismantle the inverter; there are no user serviceable parts contained in this product. Attempting to service the unit yourself could cause electrical shock. Internal capacitors remain charged after all power is disconnected.
- No AC or DC disconnects are provided as an integral part of this inverter. Both AC and DC disconnects must be provided as part of the system installation.
- No overcurrent protection for the battery supply is provided as an integral part of this inverter. Overcurrent protection of the battery cables must be provided as part of the system installation..
- No overcurrent protection for the AC output wiring is provided as an integral part of this inverter. Overcurrent protection of the AC output wiring must be provided as part of the system installation.

System Installation Diagram



System Installation Overview

Carefully remove the NorthStar Controller and its components from their shipping containers and inspect all contents. Verify the following items are included:

Your NorthStar Control System consists of the following items:

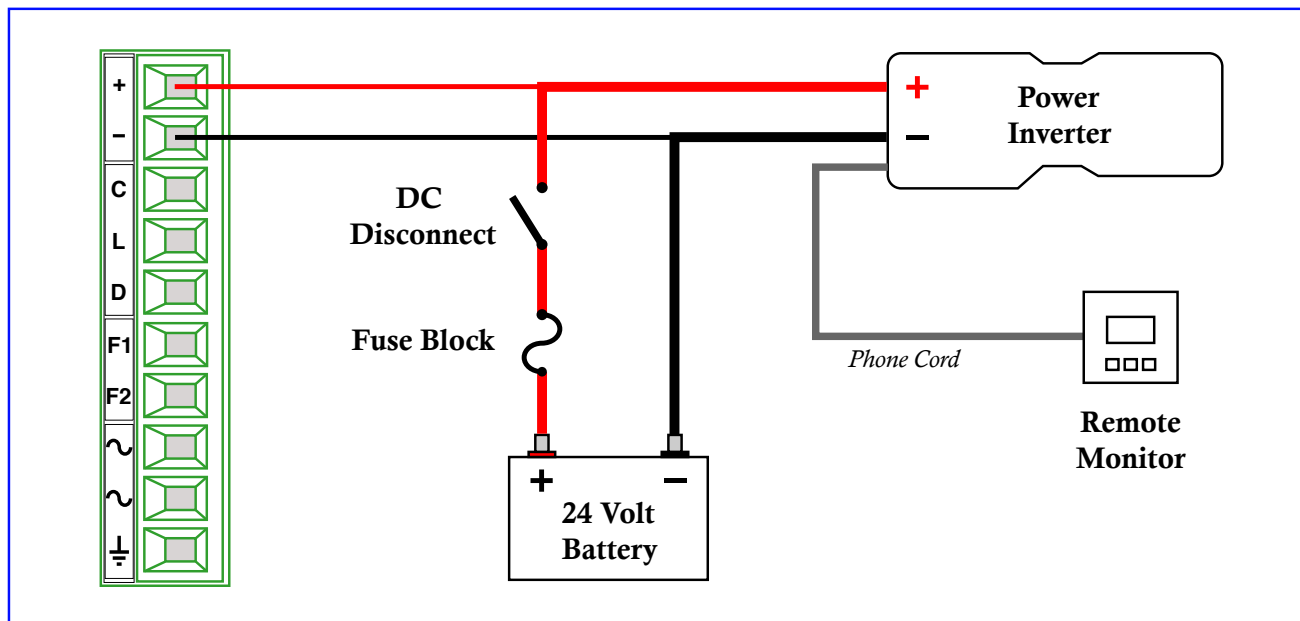
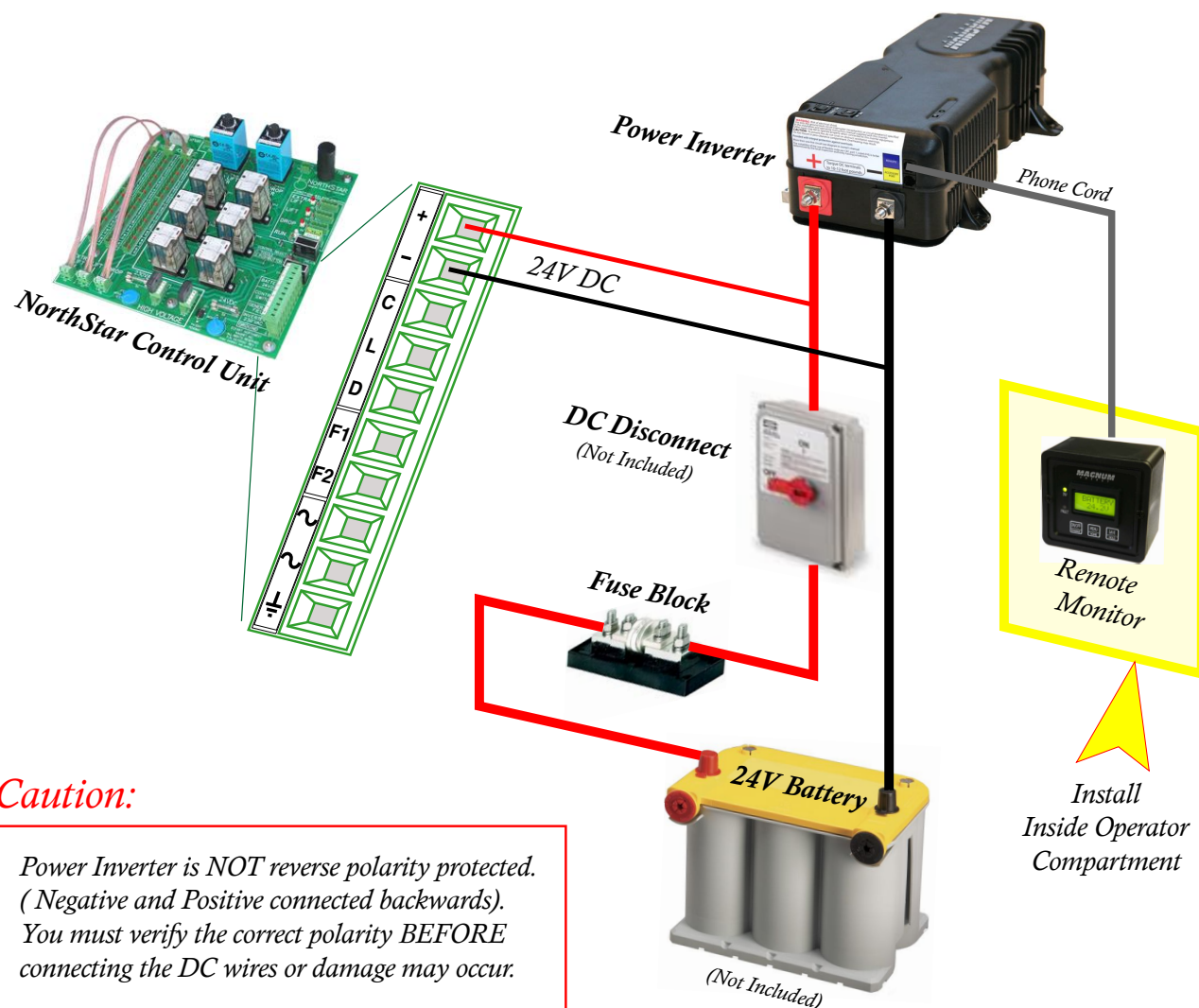
- NorthStar Control Unit (Nema 412 Enclosure)
- NorthStar Power Inverter Unit
- NorthStar Remote Monitor Unit
- NorthStar 300V DC Panel Meter
- NorthStar Inverter Fuse Block
- NorthStar Operator Control Switch

Items that are required for the installation but not included:

- 24V DC Battery (Existing Crane Battery)
- 230V DC Generator & Drive (Pulley & V-Belts, Hydraulic Motor or Engine)
- 230V DC Electromagnet
- DC Disconnect Switch (Optional)
- 250V DC Magnet Safety Disconnect Switch (Optional)
- Hardware required to mount components
- Electrical wiring required to connect components

This manual is intended to make the installation and setup as simple and straight forward as possible. The System Installation Diagram shows all of the components and their relationship to one another. We have chosen to use the NorthStar Printed Circuit Board and an enlarged Terminal Block Plug to represent the Control Unit so you can see where each component is connected. The Installation is broken down into sections to address a specific part of the installation with a diagram and step by step instructions. Please note that the Power Inverter and Remote Monitor panel come with a detailed set of instructions from the manufacturer. Please read and follow them for the installation of the inverter and remote monitor.

Battery Wiring Diagram



Battery Wiring Instructions

The NorthStar Control System and the Power Inverter are powered by the 24 volt battery of the mobile crane. The positive battery lead passes through a Fuse and a Safety Disconnect Circuit Breaker or “Dead Man Switch”. This switch shuts the entire system down so as to prevent the battery from being discharged when the system is not in use. It is extremely important to observe the battery polarity. The Power Inverter **is not reverse polarity protected** and will be damaged if it is connected incorrectly! The Remote Monitor is connected to the Power Inverter by a standard 4 conductor telephone cord (included).

Primary Function:

The NorthStar Power Inverter converts the 24 Volts Direct Current (VDC) from the battery to 230 Volts Alternating Current (VAC) to power the NorthStar Control Unit. This Power Inverter has 3 modes of operation. (Inverter, Transfer and Charger) We will only be using the Inverter Mode for our application.

Recommended Mounting Location:

The Power Inverter should be located as close to the battery as possible. Mount the unit in an accessible, cool, clean, dry, well ventilated location away from corrosive or flammable materials.

Wiring Instructions:

as shown in the illustration. DO NOT connect the Inverter negative (-) terminal to the vehicle chassis (ground). Use two properly sized wires to connect the Inverter DC input terminals to the battery. Please refer to the Installation and Operation Guide for detailed instructions.

Fuse Block & DC Disconnect Switch

Distance from Inverter to Battery:	1 to 3 ft	3 to 5 ft	5 to 10 ft
Recommended DC Wire Size:	AWG 1	AWG 1/0	AWG 2/0

Use a three conductor S.O. cord (AWG 12) to connect the Inverter AC Output Leads to the Terminal Block on the NorthStar Control Unit.

Built in Safety Protection:

The Inverter is protected against five fault conditions. In the event that a condition occurs the inverter will shut down in an attempt to protect itself.

Low Battery – If the battery voltage below 20VDC for more than a minute.

High Battery – If the battery voltage exceeds a high voltage level of 30VDC.

Overload – If a short-circuit or overload condition occurs on either the AC or DC side.

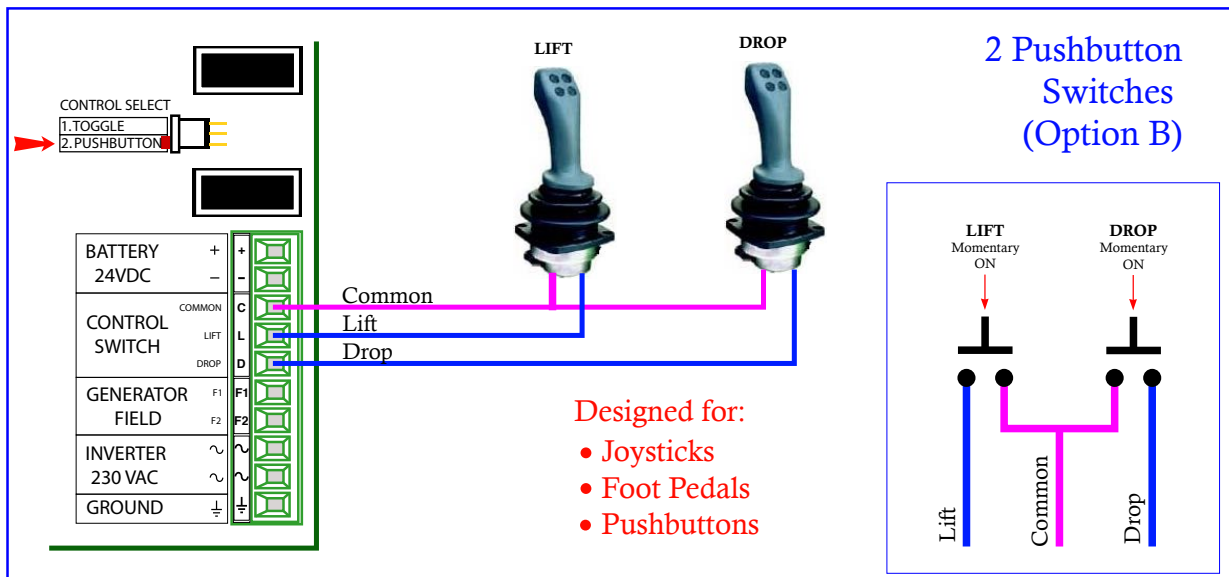
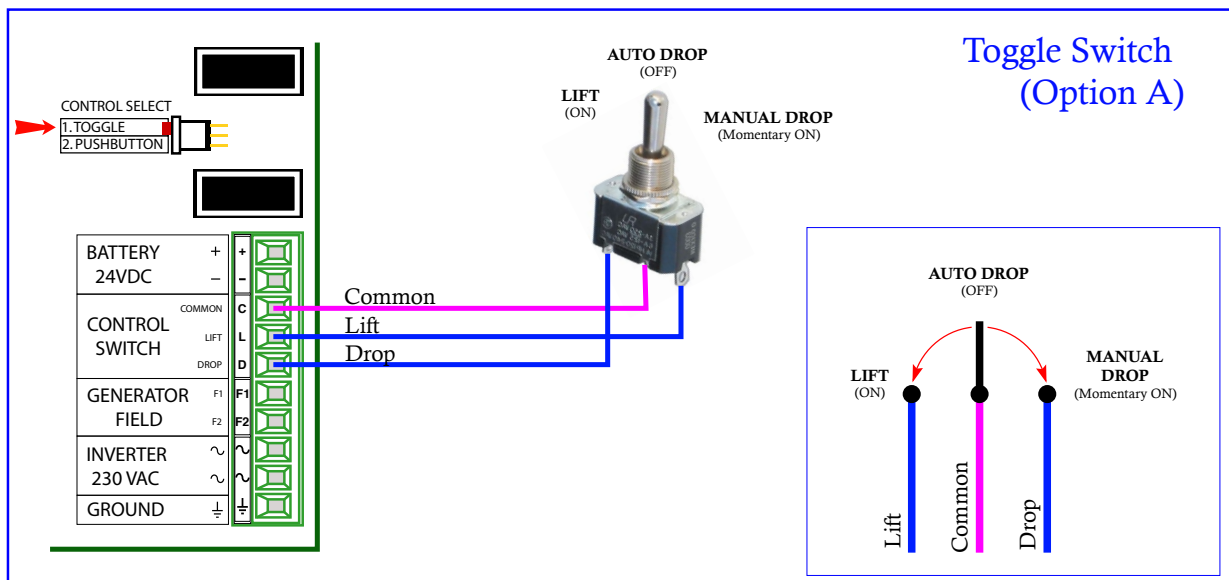
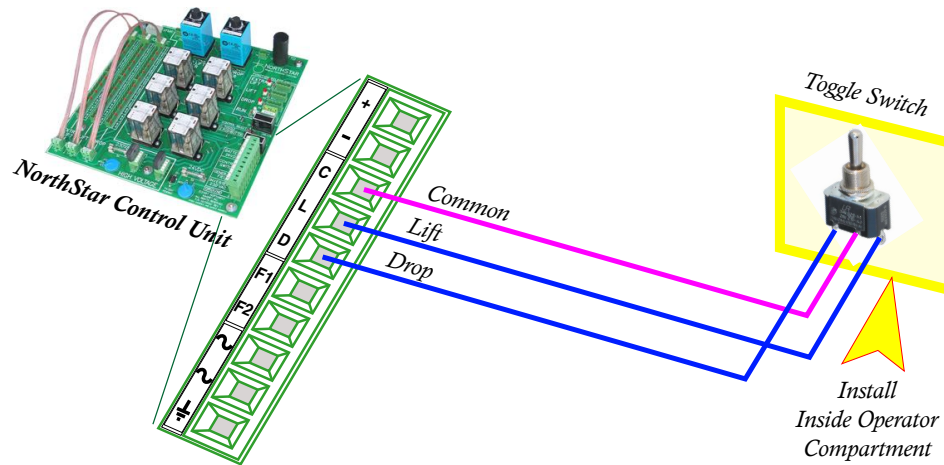
Over-Temperature – If internal power components begin to exceed their safe operating temperature levels.

Under-Temperature - If the surrounding temperature drops below safe operating temperature levels.

Internal Fault – If a condition occurs that prevents proper internal operation.

Please refer to the Inverter Manual for additional mounting, operating and troubleshooting information.

Operator Control Switch Wiring Diagram



Operator Control Switch Wiring Instructions

The NorthStar Control System is a very versital user friendly piece of equipment. It has been designed to work with a variety of operator control switches to engage the Lift and Drop operations. A toggle switch is included with your NorthStar Control System. You may choose to use this toggle switch or any other type of non-powered switches (trigger, foot pedal, push button, etc...) capable of creating a momentary contact signal to initiate the Lift and Drop operations

Toggle Switch (Option A)

This installation requires a 3 Position Toggle Switch with an ON, OFF and Momentary ON position.

Using a three conductor AWG 14 S.O. Cord connect the wires from the CONTROL SWITCH portion of the Terminal Block Plug to the toggle switch (as shown). Use a multimeter to identify the ON and Momentary ON terminals on the Toggle Switch in reference to the COMMON center terminal

1. Connect the COMMON wire from the Terminal Block Plug to center post of the toggle switch.
2. Connect the LIFT wire from the Terminal Block Plug to the ON post of the toggle switch.
3. Connect the DROP wire from the Terminal Block Plug to the Momentary ON post of the toggle switch.
4. Set the Function Select Micro Toggle Switch on the PCBoard to TOGGLE
5. Use a multimeter to check your installation and to confirm that the switch is functioning properly.

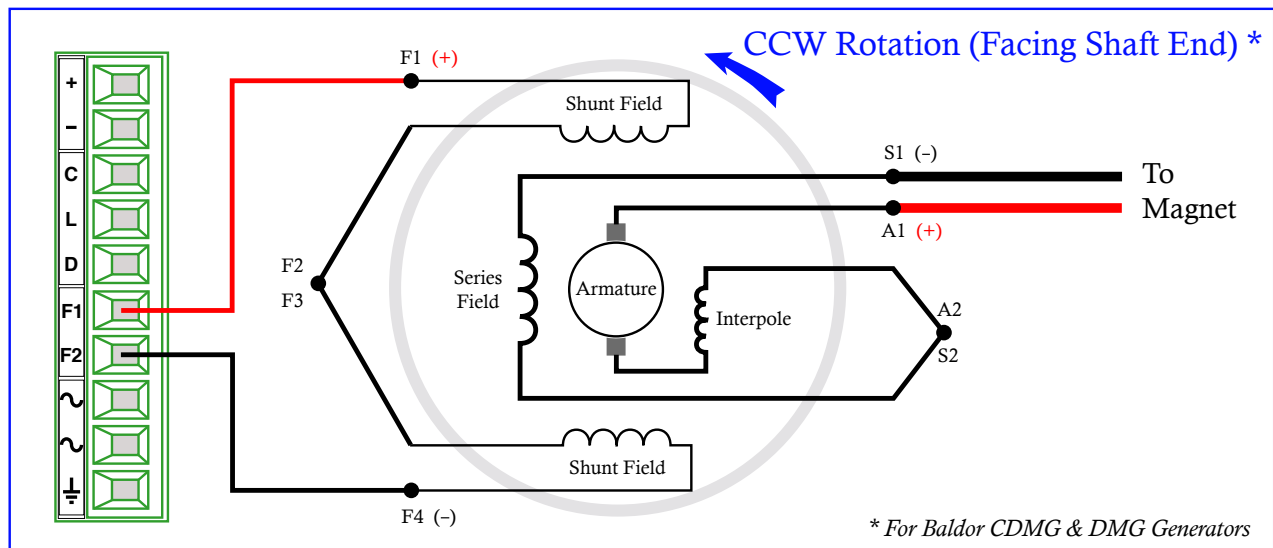
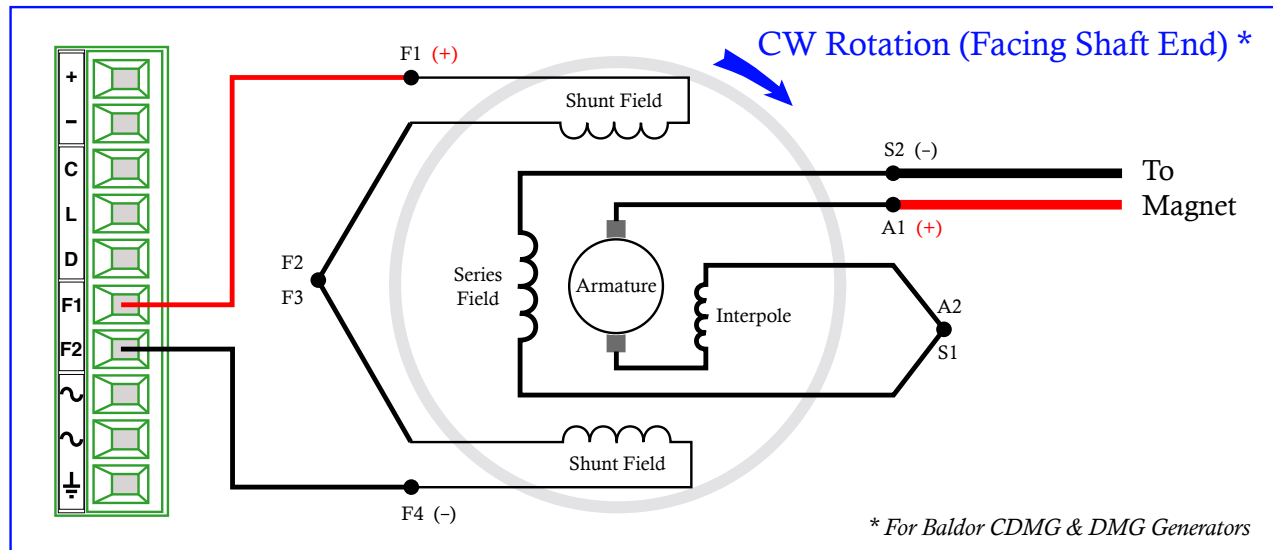
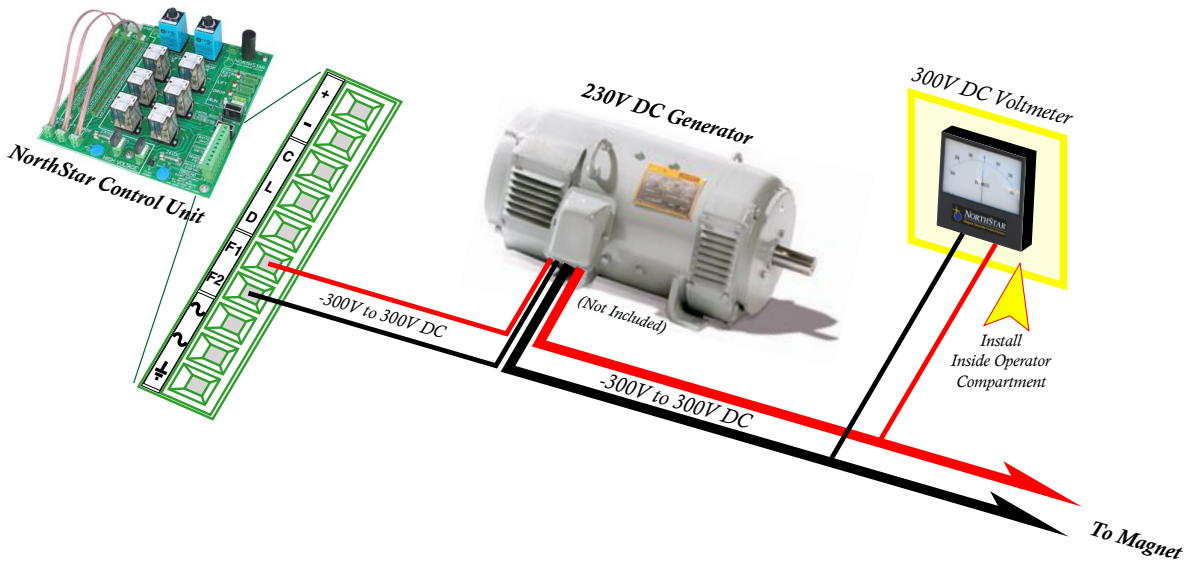
2 Pushbutton Switches (Option B)

This installation requires of two Normally Open Pushbutton Switches. They should **not** be connected to any external power source.

Using a three conductor AWG 14 S.O. Cord connect the wires from the CONTROL SWITCH portion of the Terminal Block to the switches (as shown).

1. Connect the COMMON wire from the Terminal Block Plug to both the LIFT and DROP switches.
2. Connect the LIFT wire from the Terminal Block Plug to the LIFT switch.
3. Connect the DROP wire from the Terminal Block Plug to the DROP switch
4. Set the Function Select Micro Toggle Switch on the PCBoard to PUSHBUTTON
5. Use a multimeter to check your installation and to confirm that the switch is functioning properly.

Generator Wiring Diagram



Generator Wiring Instructions

Extremely Important!!! Please Read Before You Begin.

Please note that there are two different wire sizes found in the generator terminal box. The larger guage wires are for the high current power output from the generator. The smaller wires carry a relatively small current from the NorthStar Control used to excite the Generator Shunt Field Winding. Disregard the connection diagram found in the generator terminal box cover or in connection instruction found in the generator operator's manual. **DO NOT CONNECT THE SMALL GUAGE WIRES TO ANY OF THE LARGE OUTPUT POWER WIRES!!!** This generator is no longer self-exciting and will be excited by the NorthStar Contol Unit. Powering up a self-exciting generator that is connected to the NorthStar will send power back through the control and may cause extensive damage to the printed circuit board and its components.

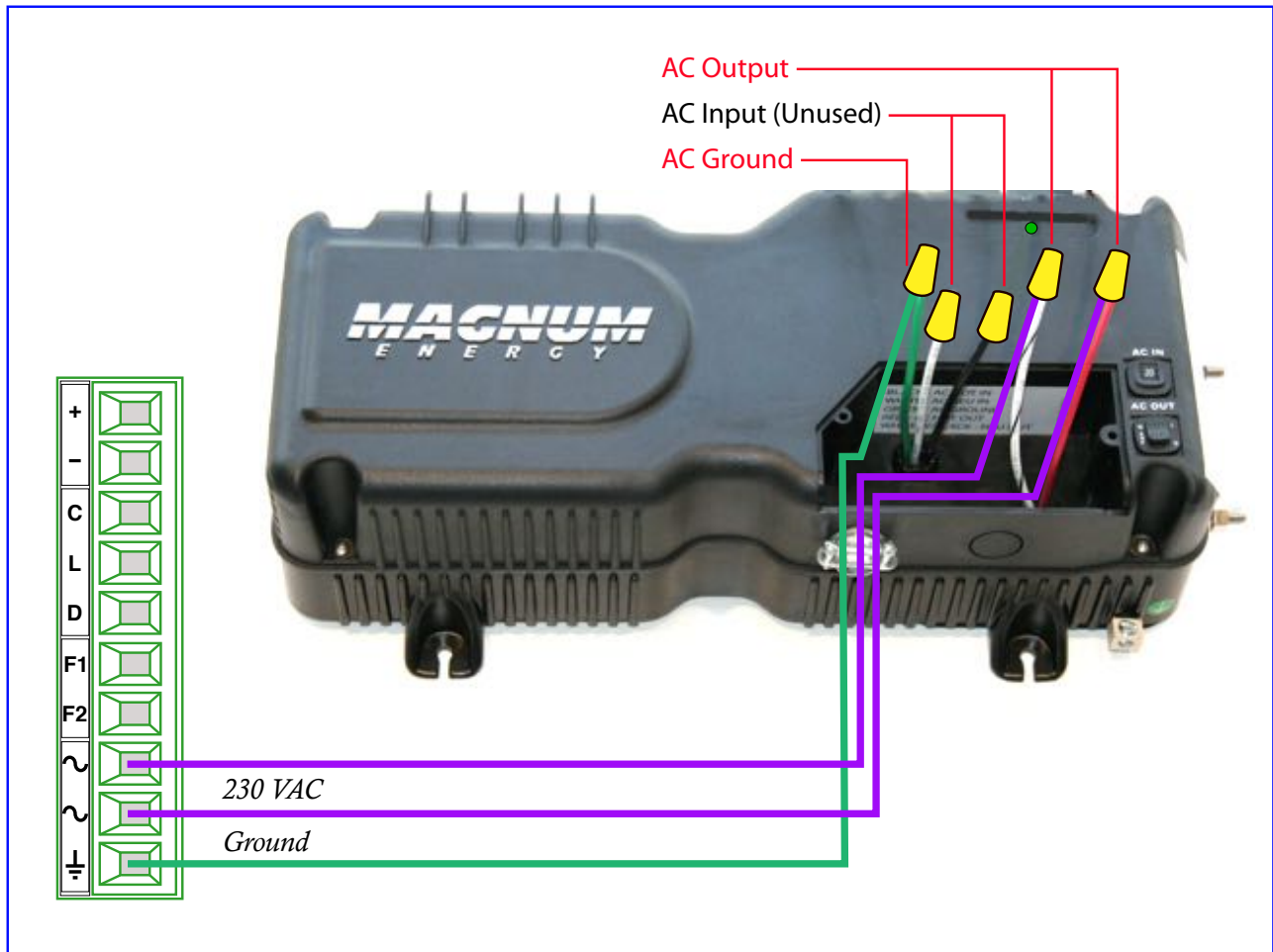
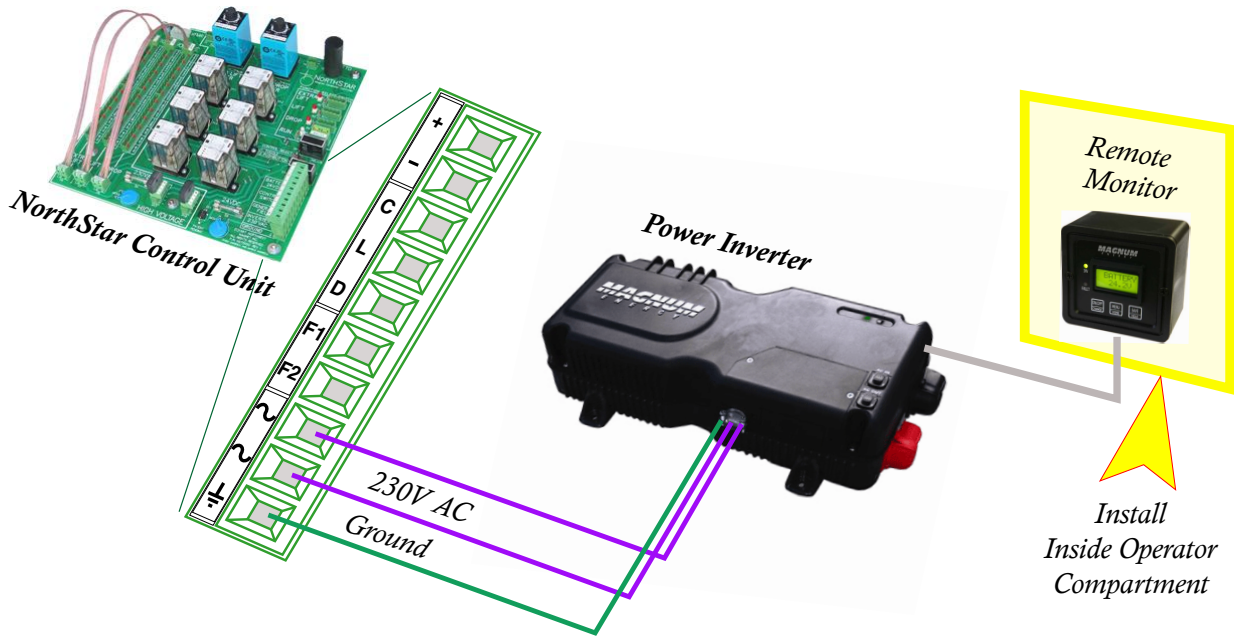
- 1 Determine the rotating direction of the generator as seen from the shaft end. Then follow the appropriate connection diagram.
- 2 Connect the Generator Shunt Field Wires F1 and F4 to the NorthStar Control Board Terminal Block F1 and F2. Note that Generator Shunt Field Wires F2 and F3 are connected together. (Use a 2 conductor AWG 14 SO Cord or equivalent)
- 3 Connect the A1, A2, S1 & S2 generator leads and the two magnet lead wires (as shown on the previous page). Use a proper sized two conductor magnet crane cable to connect to the magnet to the generator.

Magnet Crane Cable Reference Guide (Round/Two Conductor/Type W)

AWG 8	74 Amps
AWG 6	99 Amps
AWG 4	130 Amps
AWG 2	174 Amps

- 4 Mount the **NorthStar 300VDC Voltmeter** in a the operator cab within plain view of the operator. The meter is used to accurately set the generator output voltages for the Extra Lift, Lift and Drop functions. It is also very important when it comes to monitoring your magnet and generator system. Changes indicated by the meter usually signal problems with the magnet, leads, generator and/or the control. If this occurs, troubleshoot these items in that order. Starting with the magnet and ending with the controller. Refer to the Troubleshooting section for detailed instructions.
- 5 Connect the 300VDC Voltmeter to the generator output leads as shown. (Use a 2 conductor AWG 14 SO Cord or equivalent) The generator should read positive when in the LIFT cycle and negative during the DROP cycle. If this is reversed just swap the leads at either the generator or the meter so that the correct polarity is displayed.
- 6 Check and Re-check all connections then tighten and insulate to prevent shorting and grounding.
- 7 Replace generator terminal box cover.

Inverter AC Wiring Diagram



Inverter AC Wiring Instructions

Extremely Important!!! Please Read Before You Begin.

The NorthStar Power Inverter Unit that is manufactured by Magnum Energy and comes with a Installation and Operation Guide. Please read it and refer back to it as necessary. The following instruction cover the inverter wiring as it pertains to the NorthStar control unit.

Using a three conductor (AWG 12) S.O. Cord connect the wires from the INVERTER 230VAC portion of the Terminal Block Plug to the AC Output Leads of the Power Inverter (as shown).

1. Connect the top AC wire from the Terminal Block Plug to the Red AC Output Lead of the Inverter.
2. Connect the bottom AC wire from the Terminal Block Plug to the White & Black striped AC Output Lead of the Inverter.
2. Connect the Ground wire from the Terminal Block Plug to the Green AC Ground Lead of the Inverter.
3. The insulated White and Black AC Input Leads of the Power Inverter are not used.
4. Re-check all connections. Make sure that they are correct and that the insulated connector are secure.
5. Tighten cable strain relief fitting and replace AC terminal compartment cover.

Caution!!! The inverter's AC output must never be connected to an AC power source.
This will cause severe damage to the inverter and is not covered under warranty.

Remote Monitor

The Remote Monitor enables the operator to turn the Power Inverter ON or OFF and to monitor the battery voltage. This device displays the input DC battery voltage, INV status and FAULTS. The NorthStar Control System is completely disabled when the Inverter is turned OFF.

The Remote Monitor is connected to the Inverter via a 25 foot long 4 conductor telephone cable (included).

Mount the Remote Monitor in a **safe, dry location** within easy reach and sight of the operator.

Connect the Remote Monitor to the Inverter by plugging one end of the phone cord into the back of the Monitor and the other into the Inverter Port labeled REMOTE.

Setup & Tuning

You must have the NorthStar Control and Inverter turned ON with the Generator turning (max rpm) in order to properly Setup and Tune your control.

Setting the EXTRA LIFT Function:

1. Remove MASTER Plug from the RUN position.
2. Insert it into the EXTRA LIFT Socket.
3. Unplug the EXTRA LIFT Voltage Select Plug and insert it into sockets which make up the EXTRA LIFT Voltage Select Rail. Start near the bottom and work your way up until the desired voltage is obtained. (+250 to +280 VDC).

If as you increase the EXTRA LIFT voltage the generator output voltage does not increase proportionately then you have reached saturation. Decrease the voltage down one step so as to not overload the generator and the control.

Place the MASTER Plug back to the RUN position.

4. Set the EXTRA LIFT TIMER to the desired time required for the magnet to magnetize and lift the metal from the pile. (4 to 6 seconds)

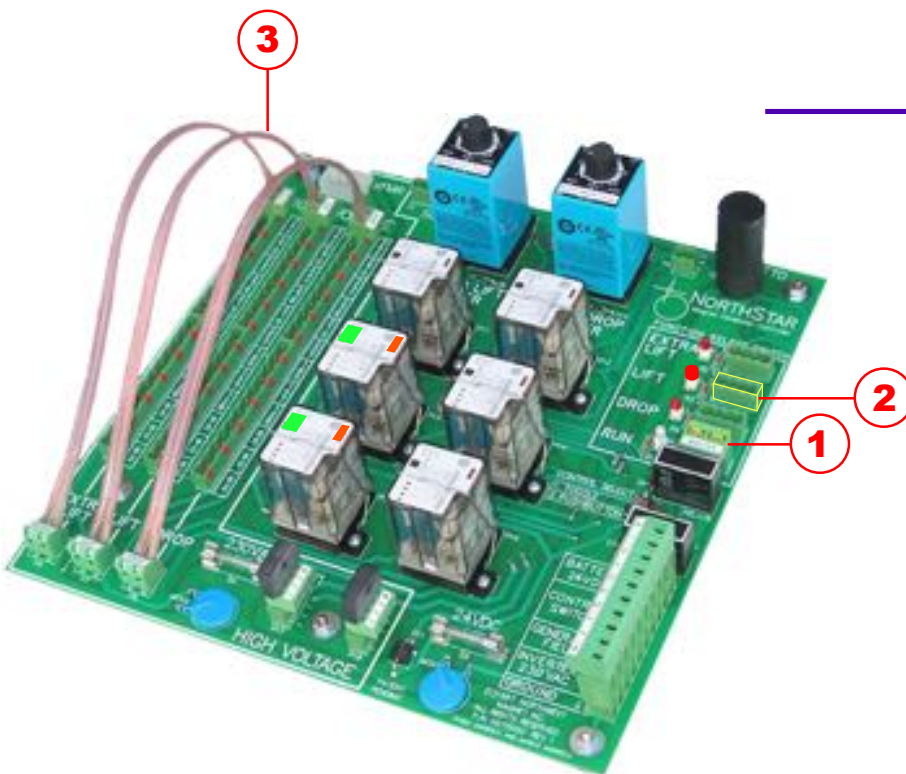
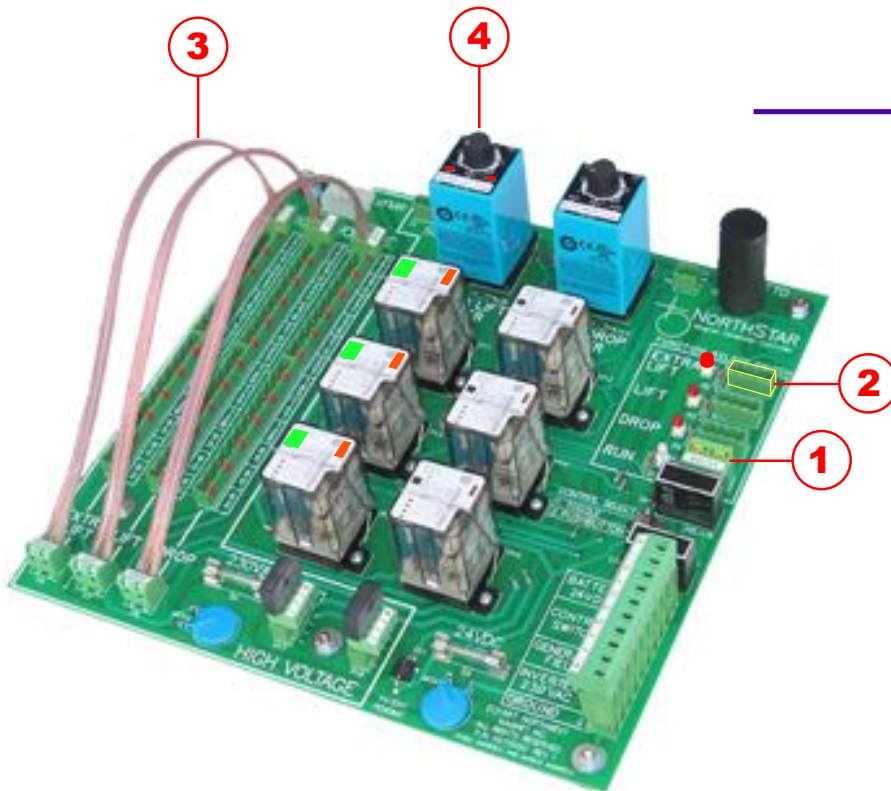
Do not engage your LIFT cycle before the magnet comes in contact with the scrap. This may reduce the lifting capacity of your magnet.

Setting the LIFT Function:

1. Remove MASTER Plug from the RUN position.
2. Insert it into the LIFT Socket.
3. Unplug the LIFT Voltage Select Plug and insert it into sockets which make up the LIFT Voltage Select Rail. Start near the bottom and work your way up until the desired voltage is obtained. (+180 to +210 VDC)

Place the MASTER Plug back to the RUN position.

Do not exceed +250VDC as this may overheat and damage the generator and magnet.



Setup & Tuning (Continued)

You must have the NorthStar Control and Inverter turned ON with the Generator turning (max rpm) in order to properly Setup and Tune your control.

Setting the DROP Function:

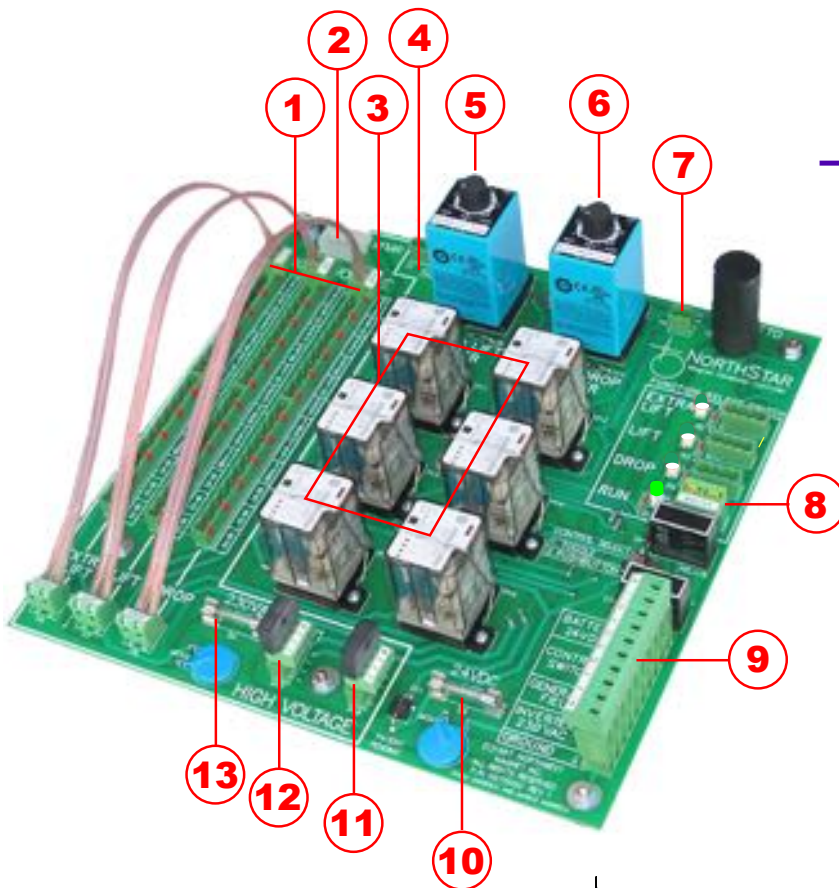
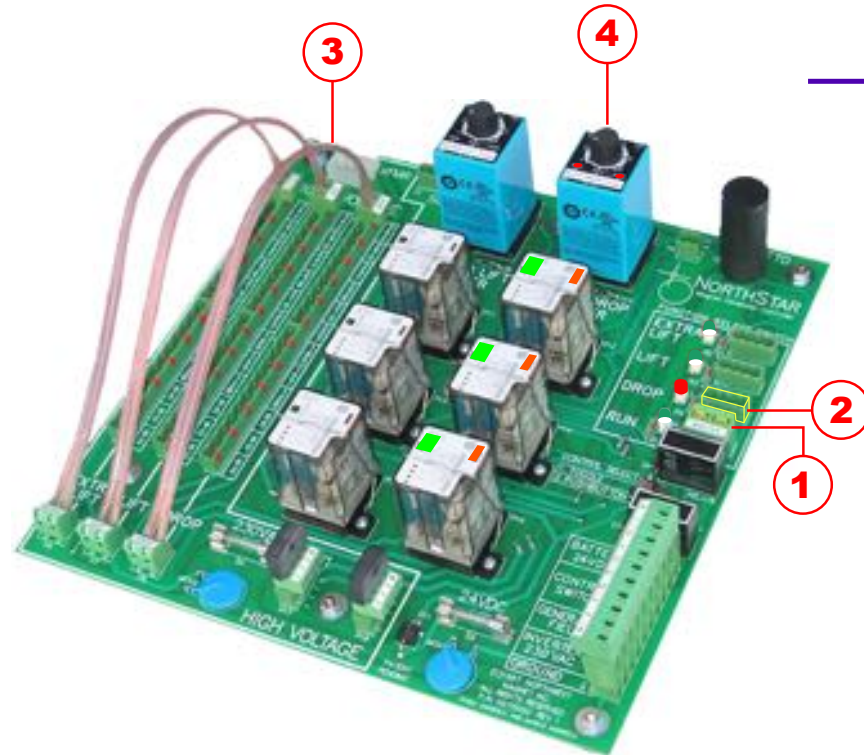
1. Remove MASTER Plug from the RUN position.
2. Insert it into the DROP Socket.
3. Unplug the DROP Voltage Select Plug and insert it into sockets which make up the DROP Voltage Select Rail. Start near the bottom and work your way up until the desired voltage is obtained. (+250 to +270 VDC).
- Place the MASTER Plug back to the RUN position.
4. Set the AUTO DROP TIMER so that the time interval provides consistent clean drops without operator intervention. (0.7 to 2.0 seconds)

When the operator is running the magnet another person can adjust the AUTO DROP TIMER. Starting at 0.5 seconds, slowly increasing the time interval after each lift/drop cycle. You will notice that as you increase the time interval that more and more metal falls off. If you go too far then the scrap drops then gets remagnetized back up to the magnet. Turn it back to where all of the metal falls off cleanly and you are done.

Final Safety Checks

Check that the all of the following items are properly inserted and secured.

1. EXTRA, LIFT, DROP Voltage Select Leads
2. XMFR Transformer Plug
3. Power Relays with Retainer Clips
4. SCT Surge Control Timer Plug
5. XLT Extra Lift Timer Relay
6. ADT Auto Drop Timer Relay
7. FDC Field Discharge Circuit Plug
8. MASTER Function Select Plug
9. Terminal Block Plug
10. 24VDC Battery Fuse
11. BR2 Bridge Rectifier Module (Drop Functions)
12. BR1 Bridge Rectifier Module (Lift Functions)
13. 230VAC Inverter Fuse



Turning the Control System ON

1. Turn the DC Disconnect Switch to the ON position.
2. Press the Remote Monitor ON/OFF button to turn the Inverter ON.
The LCD Display will indicate: STATUS: ON
The Battery voltage will then be displayed followed by the current.
3. Power up the DC Generator so that it is turning at the nominal RPM
4. The system is now ready to accept the Operators commands from the Operator Control Switch.

Turning the Control System OFF

1. Turn the Operator Control Switch to the OFF position.
2. Press the ON/OFF button on the Remote Monitor Switch to the OFF position.
The LCD Display will indicate: STATUS: OFF
3. Shut down the DC Generator.
4. Turn the DC Disconnect Switch to the OFF position.
The NorthStar Control and Power Inverter are now completely disconnected from the batteries.

How it works

It is important to understand how a conventional controller works in comparison to the NorthStar to truly appreciate the significant improvement that this system offers.

A conventional contactor type controller is connected in between the generator and the electromagnet. Its function is to connect and disconnect the high current DC power during LIFT and reverse polarity for DROP. The generator is continuously turning and producing 230V DC. During LIFT the power is sent from the generator to the magnet which causes the magnet to pickup and move ferrous metal. When the LIFT operation is complete, the contactors open and the energy from the generator and the magnet come together to create a destructive plasma arc. The controller has a bank of resistors and/or a varistor to reduce and limit the high voltage spike to 600VDC in an attempt to minimize arc damage. The DROP operation sends a reverse polarity reduced voltage to the magnet to clear the metal from the bottom of the magnet. There is an inherent problem with interrupting DC power. The plasma arc destroys contactor points, arc shields, varistors and breaks down electrical insulation while generating a great deal of heat within the enclosure. Arcing can be seen in the controller in the form of a flash but may also occur inside of the magnet. These self-destructive controllers require a lot of costly maintenance, expensive custom made parts and create a lot of unproductive down time. The process is costly and completely unnecessary.

That is why we designed the NorthStar. The concept of controlling the DC generator field is not new. In fact it has been around for over a hundred years.

The NorthStar Control System is used to control an electromagnet. The NorthStar energizes the field winding of the DC generator causing it to produce power to energize an electromagnet. There is no the switching device in between the DC generator and the electromagnet. Since this circuit is never opened there is no contactor arcing or high voltage surge and therefore no damage to the control or the magnet! Only a small excitation signal (less than 5 amps) is needed to control the power output and polarity of the generator. The following operations are available on the NorthStar Control.

Extra Lift: 300V powers the magnet for 3 - 6 seconds to magnetize & picking up 30% more scrap metal. (Increases lifting capacity and overall productivity with a reduced number of lift/drop cycles)

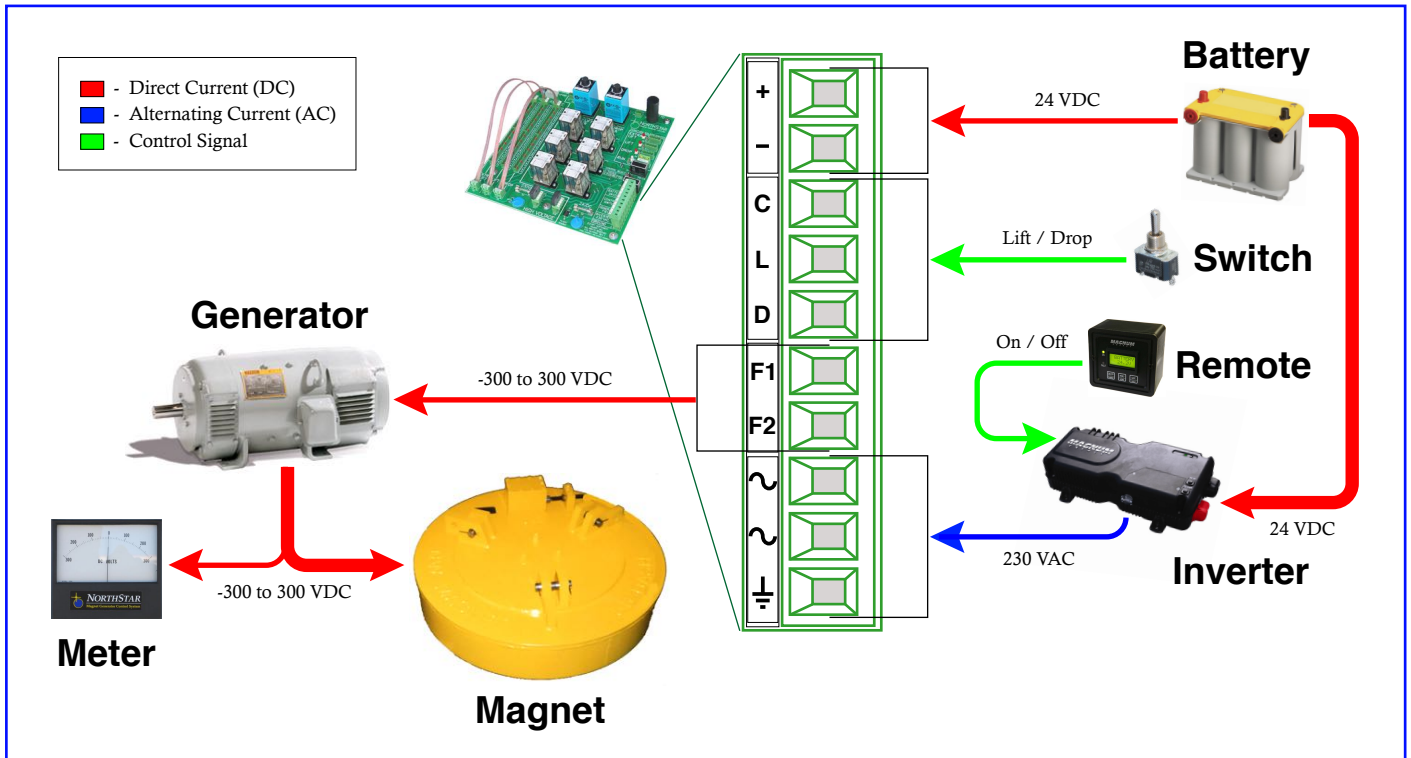
Lift: The magnet voltage is reduced to 190V during the moving/sorting process. (Decreases magnet overheating to maintains lifting capacity throughout the day, Increases magnet & generator life.)

Auto Drop: The magnet is quickly discharged then re-energized in the reverse polarity to quickly drop the scrap metal from the magnet. (Consistent clean drops)

Drop: The magnet is energized in the reverse polarity as required by the operator to clear off any remaining magnetized scrap metal. (This feature can be used for sorting ferrous material. Hold in Manual Drop mode to pick up metal and then release switch while traveling to sort metal into different grades.)

The NorthStar runs cool and efficiently for many years of trouble free productive operation!

Troubleshooting



Before troubleshooting the NorthStar Control please check the following items:

Magnet (230 VDC) *Disconnect the magnet from the generator before testing magnet*

Measure the coil resistance across the terminals or magnet leads with an ohmmeter.

No reading or high ohms = open or damaged coil (*repair/rewind magnet*)

Low reading or 0 ohms = shorted coil (*repair/rewind magnet*)

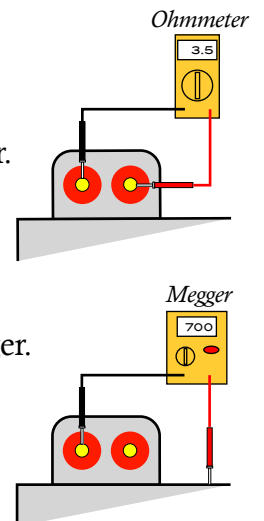
Coil resistance corresponds to the manufacturers specification (*good coil*)

Measure the insulation in between either terminal and the steel casing with a megger.

0 to 0.9 mega ohms = magnet is grounded. (*repair/rewind magnet*)

1 to 5 mega ohms = magnet is wet or going to ground. (*bake out magnet*)

5 to 4,000 mega ohms = coil insulation is in good shape. (*good insulation*)



Generator (230 VDC)

Check that the rpm remains constant under load and is set to maximum factory limit.

Inspect commutator surface. It should be smooth, clean and properly undercut.

Brushes and springs should move freely, have proper pressure and be long enough for good contact.

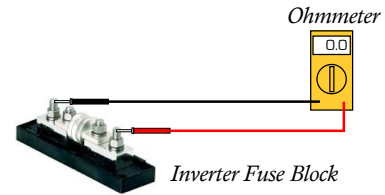
Check that all connections are correct, tight and properly insulated.

The generator output should be 230VDC when 230VDC is applied to the generator field (F1 & F2).

Troubleshooting (Continued)

Inverter Fuse (200 Amps)

Fuse should have continuity and read 0.0 to 0.1 Ohms.



Battery (24 VDC)

Battery voltage to the Inverter and NorthStar Control should be between 20 and 28 volts.

Power Inverter (Input: 24VDC / Output: 230 VAC)

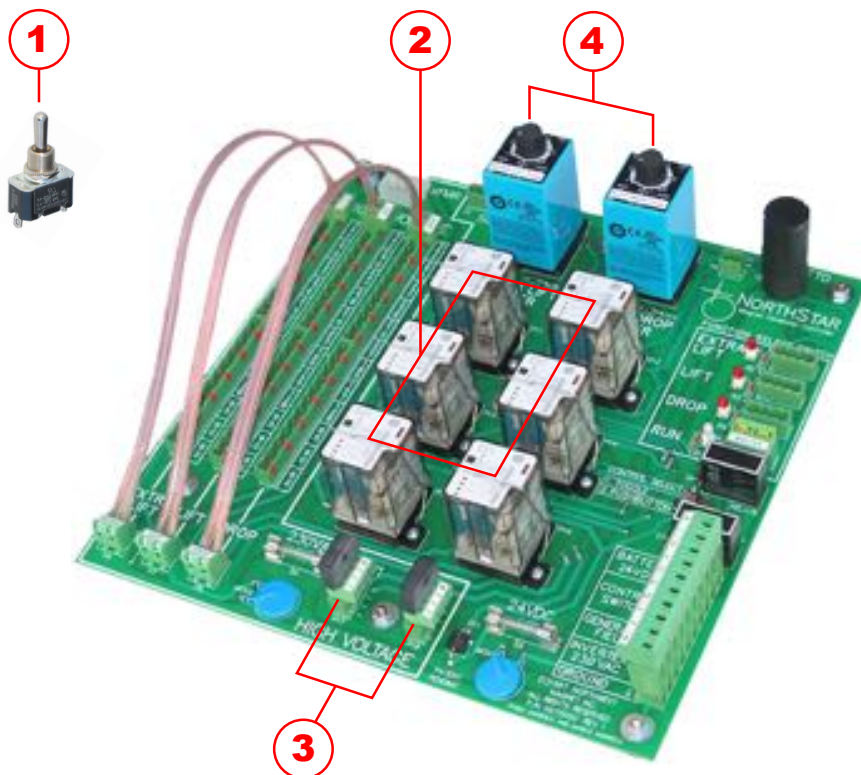
Remote Monitor should be connected and in the ON position.

Input voltage (from the 24V Battery to the Inverter) should be between 20 and 28 VDC.

Output voltage (from Inverter to NorthStar control) should be between 15 and 250 VAC.

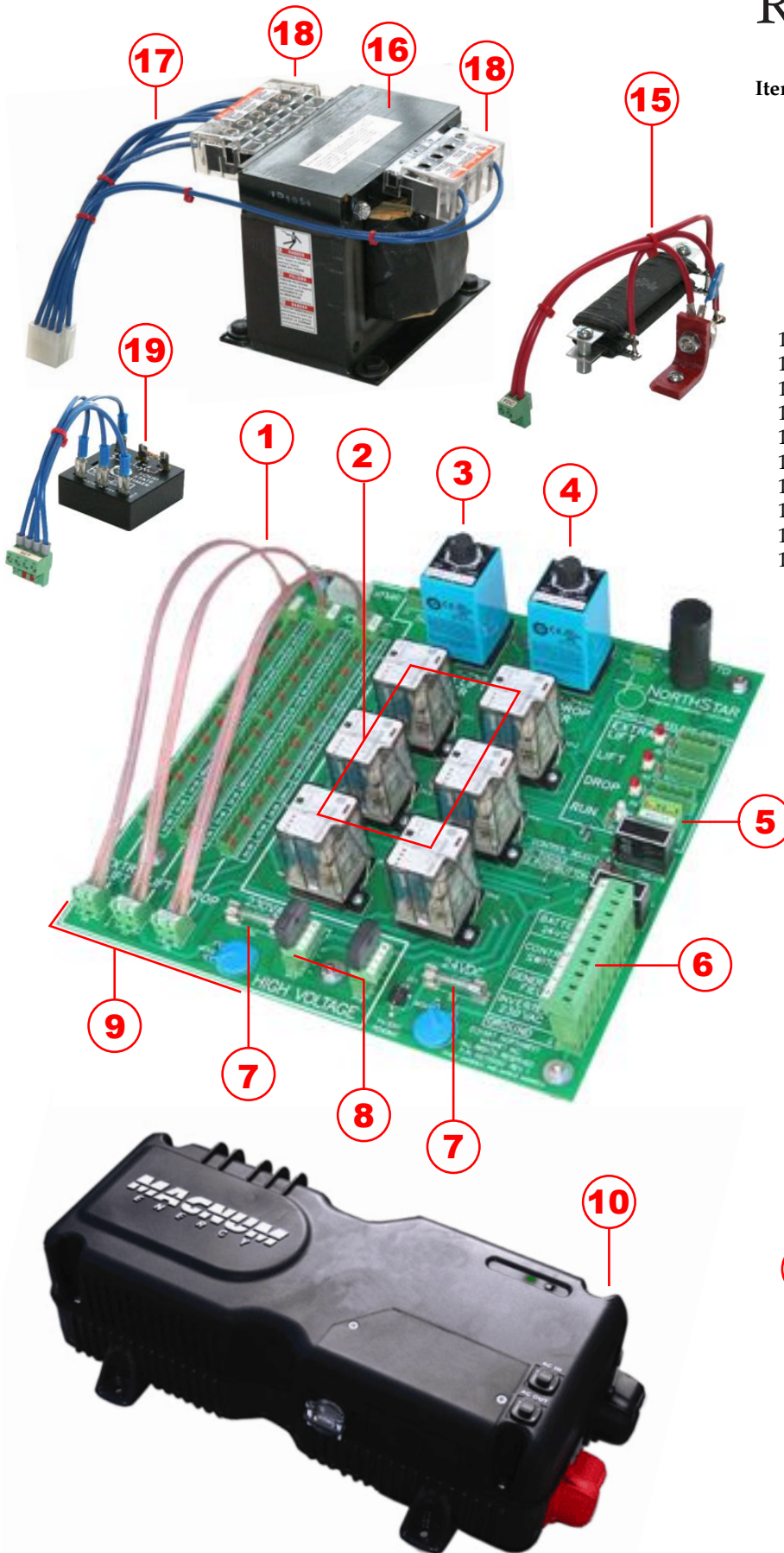
The following parts wear out under normal use and should be replaced prior to reaching their maximum number of cycles. It is recommended that a spare set of parts be purchased in the event that a failure does occur.

- 1 Operator Control Switch** (ON-OFF-Momentary ON) **50,000 Cycles**
- 2 Power Relays** (3PDT 24VDC) **500,000 Cycles**
- 3 Bridge Rectifier Modules** (1000V/250A) **500,000 Cycles**
- 4 XLT & ADT Timer Relays** (24VDC) **500,000 Cycles**



Replacement Parts

Item	Part Number	Description
1	NS1766990	Voltage Select Leads
2	NS700HB33Z24	Power Relays
3	NSELB1124V	Extra Lift Timer
4	NSADB1124V	Auto Drop Timer
5	NS1757035	Function Select Plug
6	NS1804988	Terminal Block Plug
7	NSBMAGC5	Fuse
8	NSNTE5331	Bridge Rectifier Module
9	NS75000PCB	NorthStar Control Board
10	NSMM1324E	Power Inverter
11	NSMMREM	Inverter Remote Monitor
12	NSTFB200	Inverter Fuse Block
13	NS300VDC	300V DC Voltmeter
14	NSOCS	Operator Control Switch
15	NSP55J150	Field Discharge Circuit
16	NSSDK500D19	Transformer
17	NSXFMRWH	Transformer Wiring Harness
18	NSXFMRSC	Transformer Safety Covers
19	NSTSD320N	Surge Control Timer



Customer Service

Please call our customer service department if you have any questions or experience a problem with your NorthStar Magnet Generator Control System. Please notify us as soon as a problem is detected. Operating damaged equipment or attempting to repair the problem unassisted may further damage the equipment and void your warranty.

In the event that the problem cannot be easily corrected on location, we recommend that the defective product or component be sent to our Service Department. We will promptly inspect it to determine whether the defect is under warranty. If it is, we will replace it or repair it free of charge. Please make sure that problem is found in the item that you send us and not elsewhere in the system. If the product is found to be in good working condition or is no longer under warranty, the customer will be billed for the inspection, repairs, replacement parts and return shipping charges.

Shipping Instructions:

Contact Customer Service to obtain a Return Material Authorization (RMA) Number.

Phone: (503) 282-1441 Fax: (503) 282-5858 Email: info@nwmagnet.com

Include the following items with the defective part:

Contact Information (Name, Company, Address, Phone, Fax and E-mail)

Copy of the original invoice or the Serial Number of the NorthStar Control System

Description of the symptoms and operating conditions at the time the problem occurred

Ship all repair items to: Northwest Magnet, Inc.
Attn: NorthStar Repair Department
508 N. Tillamook Street
Portland, OR 97227

Warranty

This product is warranted against defects in material and workmanship for a period of one year from the date of shipment to the initial user. During the warranty period, Northwest Magnet Incorporated will, at its option, either repair or replace products that prove to be defective. However if no defect is found in a returned item a service charge will be made.

This warranty shall not apply to defects resulting from improper use, physical damage or inadequate maintenance by the Buyer. No other warranty is expressed or implied. Northwest Magnet Incorporated specifically disclaims the implied warranty of fitness for a particular purpose.

The remedies provided herein are the Buyer's sole and exclusive remedies. Northwest Magnet Incorporated shall not be held liable for any direct, indirect, special, incidental or consequential damages, whether based on contract, tort or any other legal theory.