MX SERIES OPERATION AND INSTALLATION MANUAL

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TÜV MANAGEMENT SERVICE ISO 9001 TL 9000

TL9000

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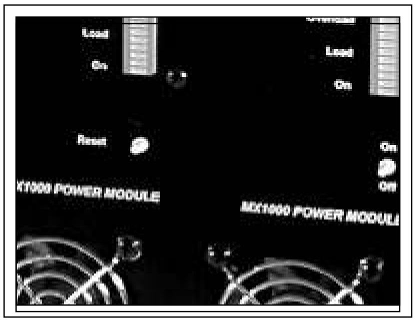


Introduction 1.0

Thank you for purchasing the finest sine-wave inverter in the power conversion industry. Exeltech's journey to excellence includes the first affordable sine wave inverter, first modular inverter system, first N+1 redundant inverter system, and the cleanest sine wave output in the industry. Exeltech strives to manufacture products of the highest possible quality and is dedicated to 100% customer satisfaction. Proudly built in the USA, Exeltech is committed to TL 9000 standards and beyond, adding people and procedures continually to further improve quality and customer service. We welcome you as a customer to the Exeltech family. Congratulations!

MX series inverters provide the cleanest, best regulated sine wave output over the widest DC input of any inverter on the market today. They are extremely low in Total Distortion; specified to 2%, and typically better than 1.5%. Total Harmonic Distortion is typically 0.8 to 0.9%. Remaining distortion is a result of residual switching noise, which amounts to a very clean 25 kHz sine wave superimposed on the fundamental output. No significant harmonics of 25 kHz exist. This spectral purity will exist over the inverter's entire operating envelope, including non-linear and reactive loads. As long as peak output current remains less than 300% of rated current, total harmonic distortion will remain within the 2% spec. Peak current capability of the inverter is key to understanding its operational envelope. As long as the inverter is supplying less than this amount, it will function properly and operate virtually any load.

Many inverters are rated in Volt-Amps (VA), as opposed to Watts (W). This is an attempt to make an inverter or UPS (Uninterruptible Power Supply) appear larger than it really is. The only fair way to specify these products is in Watts, which is power the inverter can actually deliver. If Exeltech inverters were specified in VA, our 1000 Watt inverter could be rated at 1250 VA at .8 power factor, 1410 VA @ .7 pf, or an incredible 2000 VA @ .5 pf. It is confusing to specify a product in VA, because the power factor must also be specified.

The inverter can maintain a spectrally pure output with any load due to a specially designed non-linear control loop in the primary DC to DC converter. This circuitry is one of three circuits which protect the inverter from any overload condition.

Adhere to this manual, and your inverter will provide years of trouble-free service.

1.1 Output Waveform

The inverter is designed to convert DC power from a battery system into AC power. Exeltech Inverters are unique in that they provide a pure clean AC Voltage independent of input battery voltage or changes in output loads. The AC output is a true sine wave, meaning that output voltage changes smoothly and continuously over the period of each cycle. Figure I shows the waveform of a true sine wave. This is the waveform of Exeltech Inverters.

This extraordinary output is achieved through a process of double regulation. The Block Diagram in Figure II shows this. Input voltage is stepped up by a high power DC to DC converter. This supply is regulated, which helps keep output voltage immune to battery voltage changes. The output of this DC to DC converter feeds the input of a proprietary DC to AC converter. This converter compares the output voltage of the inverter to a perfect sine wave and makes 25,000 adjustments per second. These adjustments are then filtered so all that remains is a pure sine wave output. For more detailed explanation of operation refer to section 6.0 Theory of Operation.

Figure I Sine Wave Output

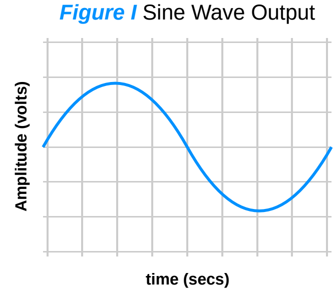
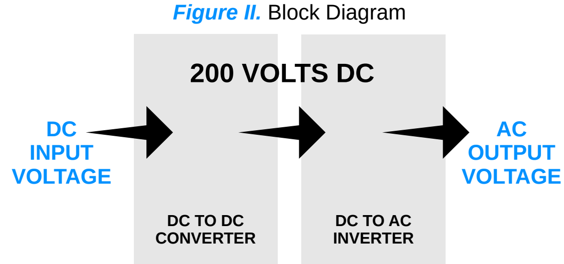


Figure II. Block Diagram



1.2 Modules Overview

The MX Series Inverters are a modular design and allows each system to be tailored for specific needs. Systems can range in output power, input voltage, redundancy, and a variety of other options. This is done by selecting different combinations of modules to create a MX inverter system.

1.2.1 Power Modules

The power module is the backbone of the MX Inverter System and is the majority of the modules in most systems. Each module is capable of producing 1000 Watts of continuous output power. In a redundant system, the slave power modules can be added and removed at any time without any disruption of power.

Each power module is equipped with a LED bar graph to display output current and a reset button on the face plate. Each power module has its own self monitoring circuits for extra protection. If a problem is detected the module will shutdown individually and, if the system is redundant, the output will not be effected. The reset button can be pressed to reset the module if a problem occurs.

1.2.1.1 Master Module

The master power module contains all the required circuits to operate. A master module could be placed in a system by itself and produce power if connected to a DC source. It can also operate with 1 to 19 slave modules in the same system. When operating with a master module the system cannot be redundant and the master module is not hot swappable.

1.2.1.2 Slave Module

The slave power module is similar to the master module but cannot operate independently. It requires a control card or a master module in the system. If the system is redundant, the modules can be added and removed at anytime.

1.2.2 Control Card

The control card will provide all the signals for slave modules to operate properly. Only one control card is required in system without a master module and can operate up to 20 power modules. A second control card can be added for redundancy. If a second control card is present and the first control card fails, the second control card will switch on automatically. The control cards are hot swappable but require that one control card be present at all times of operation.

The control card has a green LED and reset switch on its front plate. The LED turns on when the control card is working properly and creating a signal for power modules. The reset switch can be used to select the control card that is to be used Pressing the reset switch will switch operation to that card.

1.2.3 Monitoring Modules

There are a few different ways to monitor the MX Systems. Each monitoring module has an on/off switch for the system. If a monitoring module is not used the remote switch must be used to turn the system on and off. A monitoring module is required to detect a control card failure and switch to the secondary control card if it is available.

1.2.3.1 Alarm Card

The Alarm Card provides a visual representation of different alarms created by the system. These are all shown on the front panel through LED’s. It also has an option of a breaker on the front panel.

1.2.3.2 Transfer Switch

A transfer switch can be used in place of an alarm card if another AC source is to be used along side the inverter. A simple AC relay is used to switch between the two sources. Transfer time is typically 4ms. The front panel also has LED’s to display certain alarms. The transfer switch can be used on systems of 4.7KW or less.

1.2.3.3 System Monitor Card

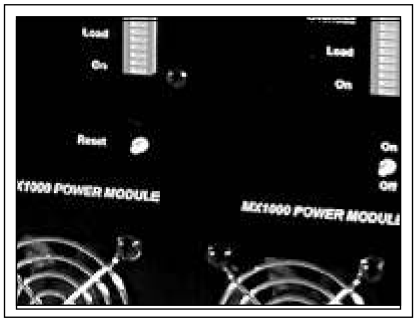
The system monitor card is a more advance version of the alarm card. It has an LCD display on its front panel to view all the system’s information, like AC and DC voltage and current. There is also an Ethernet port located on the front panel. These are both used for remote monitoring of all vital information on a PC. It is only recommend to use this card in single phase applications. For multi-phase applications the System Monitor 2 is to be used.

1.2.3.4 System Monitor 2 Card

The system monitor 2 card is more advanced than the original system monitor card. It monitors all of the same system information and alarms but can be used in multiphase applications. Each phase's information can be reported via an Ethernet connection. The data can be sent to a PC to be viewed and logged or reported via SNMP v1. **Only Major and Minor Alarms are provided via dry form C relay contacts. Use of the other alarm ports on the back plane may result in damage to the module or system.**

1.2.4 Solid-State Transfer Switch

The solid-state transfer switch (STS) is a transfer switch without any moving parts, reducing mechanical failures. It can be used in systems where another source besides the inverter is present. Detecting a failure and transferring to the secondary source is typically 4ms. Most loads will not be disturbed with a single source failure. It can also be paired with a system monitor 2 card for monitoring of all its data. An LCD screen is also provided to view the card’s state. **Only Major and Minor Alarms are provided via dry form C relay contacts. Use of the other alarm ports on the back plane may result in damage to the module or system.**



Standard Features 2.0

2.1 Power Modules

DC Voltage Inputs: 12V, 24V, 32V, 48V, 66V, and 108 VDC inputs are available. It is recommended to have a maximum ripple voltage of less than 5% with the peaks not going above Vmax and below Vmin.

AC Voltage Outputs: 100V, 117V, and 230 VAC outputs are available (+/- 6%) at 60Hz, 50Hz, and 400Hz (+/- 0.1%).

LED Bar Graph: Power modules all have a bar graph to display the output current being produced. It is a peak responding, RMS calibrated representation of output current. This meter will read properly when loads are resistive. However, when output current is non-linear, the meter will tend to show a higher output than is actually occurring. This is particularly noticeable when running electronic loads. With this type of load, peak current can be very high while RMS current may be quite low. Since the meter will display output relative to peak current, it will read on the high side. In some electronic loads, the meter may read two to three times higher than actual RMS current. This conservative approach guarantees the user will be warned of any possible type of overload. It is possible for the inverter to be operating totally within it's capabilities when the bar graph indicates full scale.

Remote On/Off Switch: A set of terminals are provided to allow the user with a remote method to turn the inverter on and off. The connection for the remote switch is on a terminal block connector located on the backplane. Connect battery negative (A-) to the 'RMT' terminal to turn the inverter on. There is little current flow in this lead, so wire size is not a concern and any size DC switch can be used. The remote switch and front panel switch are wire "OR'd" together so if either switch is on, the inverter will turn on, and both must be off to shut down the inverter. When using the remote switch, insure the front panel switch is in the off position to control the inverter with the remote switch.

On/Off Switch: The on/off switch is located on master modules and monitoring modules. It is used to turn the inverter system on and off.

Cooling: A temperature controlled fan is located on the front panel of MX Master and Slave modules. They will also turn on at full power within 5-7 minutes.

Over Temperature Protection: Each inverter will go into thermal shutdown at 105C internal temperature. The warning buzzer will go off 5C before thermal shutdown is reached. The inverter will provide its full rated output up to the temperature listed in the specification sheet. If the inverter is subjected to higher ambient temperatures or air circulation is blocked, the inverter may overheat. When the inverter buzzer sounds, immediate action is required or the inverter may shut down. Either reduce the load on the inverter or provide more air circulation in the inverter's immediate environment. When the inverter shuts down, the alarm condition will persist and the cooling fans will continue to run. Since the inverter has stopped producing output power, it will cool down quickly. The inverter will automatically restart when it has cooled sufficiently. When the inverter restarts the buzzer will stop.

Buzzer: The buzzer is used in master module systems only. It is used to alert the user of low DC voltage or over temperature. If the DC voltage gets to within 2-4% of the lower DC voltage limit the alarm will sound. If the temperature gets to within 5C of the temperature shutoff limit the alarm will sound.

Over Voltage Protection: The inverter will shutdown immediately if the DC voltage exceeds the set limits. When the voltage returns to the normal range, the inverter will immediately restart. Input over voltages tend to happen very rapidly and can cause damage to the inverter, therefore shutdown is immediate and without warning. There is a small amount of hysteresis built into the over voltage turn off set point to avoid the possibility of the inverter turning off and on rapidly. No damage to the inverter occurs unless the amount of power in the surge is very high. Normally the capacitors on the input of the inverter will absorb the surge without damage. This fault usually occurs if the battery is suddenly disconnected from the system and the battery charger continues to supply current.

Under Voltage Protection: The inverter will shutdown when the DC voltage goes below the set limits. The buzzer will sound when the battery voltage falls within 2% to 4% of the lower DC voltage limit. If the condition continues without reducing load to the inverter or adding charge to the battery, the inverter will shut off. When the voltage rises to approximately 95% of the nominal battery voltage, the inverter will turn back on and the alarm condition will clear.

Overload/Short Circuit Protection: The inverter has two levels of overpower protection. The first limits peak instantaneous current to 22 Amps per 1000 Watt module. This acts to limit the current with highly reactive loads. The second limits absolute power coming from the module to just above 1000 Watts per module. Both of these circuits act to reduce the output voltage as required to limit the current to a safe level. The power limit circuit has two stages to allow the inverter to produce its rated surge power for 3 seconds. This surge power is designed to give motors and electronics the extra current they need to get started. The overpower protection circuit will recover instantly when the overpower condition clears. If the over current condition is so severe that it causes the output voltage to collapse to under 10% of its normal value for more than 1 second, the inverter will shut down and not automatically restart. This short circuit protection requires the user to clear the short circuit safely and then reset the inverter by cycling the power switch off and then on again.

If the inverter is overloaded the output voltage is reduced. In this mode it will produce its rated power. It does this by clipping the tops of the waveform. The inverter can operate safely in this mode indefinitely. The overpower protection circuit will recover instantly when the overpower condition clears.

2.2 Alarm Card/Relay Transfer Switch

Alarm LEDs: The Alarm Card relay Transfer Switch will monitor and display different alarms from the system through the LED’s on the front panel.

Relay Contacts for Alarms: Dry relay contacts are available on the backplane to be used with several different alarms.

2.3 System Monitor Card

LCD Display: All system information is gathered and displayed via the LCD.

Relay Contacts for Alarms: Dry relay contacts are available on the backplane to be used with several different alarms.

Ethernet Monitoring: An Ethernet port is available to connect to a network for remote monitoring of the system.

RS-232 Monitoring: An RS-232 port is available to connect a PC for remote monitoring of the system.

2.4 System Monitor 2 Card

LCD Display: All system information is gathered and displayed via the LCD.

Relay Contacts for Alarms: Dry relay contacts are available on the backplane to be used with Major and Minor alarms **ONLY**.

Ethernet Monitoring: An Ethernet port is available to connect to a network for remote monitoring of the system.

SNMP v1 Monitoring: SNMP over Ethernet can be used to monitor all the system information.

2.5 Solid State Transfer Switch

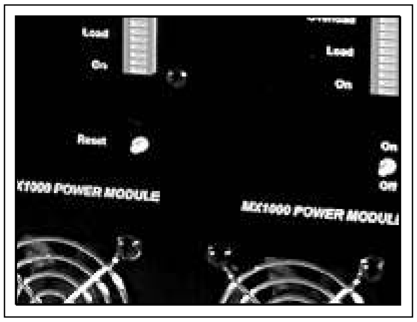
LCD Display: All system information is gathered and displayed via the LCD.

Relay Contacts for Alarms: Dry relay contacts are available on the backplane to be used with Major and Minor alarms **ONLY**.

Primary Select: The primary source can be selected from a switch on the front plate.

Detect Time: Detection and transfer typically less than 4ms. Most loads will not notice any failure at all.

System Monitor 2: In systems of 5KW or less, the Transfer Switch and System Monitor 2 can be consolidated into one card. The System Monitor 2 will report all of the transfer switch's information.



Installation 3.0

CAUTION: It is essential to read and understand all Warnings, Cautions, and Notes before any connections are made to the unit or system. If further assistance is needed call (817) 595-4969 and ask for Customer Service.

WARNING: The inverter is designed to operate from a battery. Performance cannot be guaranteed when a charger or power supply is used without a battery in the circuit. See Section 6.0 Theory of Operation (Input Power).

WARNING: Inverter chassis and neutral AC must be connected together with either of the battery connections and bonded to earth ground to comply with most code requirements. See Section 6.0 Theory of Operation(Grounding).

CAUTION: Before any connections are made to the unit or system, be sure to disconnect the ungrounded battery terminal, usually negative (-) in 48 Vdc systems and positive (+) for other DC voltage systems.

CAUTION: Check batteries and battery cables for correct polarity and voltage. The polarity of the leads is critical to avoid damage to the unit or the system.

CAUTION: Observe all national and local electric codes during installation.

3.1 Location

The inverter is a highly sophisticated piece of electronic equipment. As such, its location warrants some special consideration. The inverter should be mounted indoors, preferably in some type of equipment room as close to the battery bank as possible. Gases emanating from the battery can be corrosive and highly flammable. Therefore, the inverter should be isolated from the battery bank as much as possible. The inverter can be wall or shelf mounted.

The inverter must be sheltered from the weather. Keep it away from condensing water. The inverter will provide its full capability in temperatures from -20C (-4 F) to 40C (104 F). As with all electronics, higher temperatures will lead to a shorter life. Make sure that adequate ventilation is provided.

Choosing a mounting location is critical to the performance and life span of the inverter. Heat and moisture are the two worst enemies of any electronic device. When choosing a mounting location, consider the following requirements:

1. The inverter must be sheltered from the elements. Select a clean, dry location.
2. The inverter requires adequate ventilation for cooling. With proper cooling the inverter will operate efficiently and meet its published ratings. Do not obstruct air circulation. Air is drawn into the inverter through the front panel mounted fans, and exits through vent holes in the top and rear of the inverter.
3. The inverter should be mounted as close to the battery as possible. Shorter lengths of wire have less resistance, which translates to increased efficiencies. See Section 5.3 Wiring Charts.

3.2 Wiring

NOTE: An in line fuse may be desired to protect the battery and wiring to the inverter. This fuse should be located very close to the battery terminal. To select the appropriate size fuse, consult "Rated and Peak Current". See Section 5.3 Wiring Charts.

DC INPUT CONNECTIONS: Positive (+) and Negative (-) input terminals are 5/16" studs with brass hardware. They are provided under the Rear Cover. Choose appropriate gauge wire for your specific model and distance from the battery. (Recommended Torque = 70 in-lbs.)

Installation clearance:
- from top of the unit 1 ft. Min.
- from sides of the unit 1 ft. Min.
- from front of the unit 1½ ft. Min.
- from back of the unit 2 ft. Min.

recommended tools:
- 6 in 1 screwdriver
- ½ inch nut driver
- multi-meter

Start up procedure: (single phase system)

NOTE: Refer to Section 5.3 Wiring Chart for system connections.

STEP 1: Make sure unit is mounted securely.
STEP 2: Remove rear cover of unit.
STEP 3: Do not connect the AC load until all steps are complete.
STEP 4: Verify that all front panel switches are in the "off" position
STEP 5: Verify the battery cable polarity. Label the wires if necessary. Verify the battery voltage is within the specifications for the inverter.
STEP 6: Verify DC breaker or fuse is open and leads are not energized.
STEP 7: Connect negative cable from battery bank to negative terminal of the inverter's backplane.
STEP 8: Connect the positive cable from the battery bank to the positive terminal of the inverter's backplane.

NOTE: If the battery system is being utilized by other equipment it may be necessary to precharge the inverter's DC buss. Precharge the input capacitors of the inverter by connecting one lead of a large resistor (a small wattage light bulb will suffice) to the positive terminal of the battery bank and the other lead to the positive terminal of the inverter. On a positive ground system (most 48 volt systems) connect the resistor or light bulb between the negative battery terminal and the negative terminal of the inverter.

STEP 9: Close the DC breaker or insert the fuse to energize cables and the inverter's DC buss.
STEP 10: Turn the inverter "on". The switch is located on the alarm card module or the master module. Ensure the system is operating on the (left) primary control card module. To do this, press the "reset" button of the primary control card.

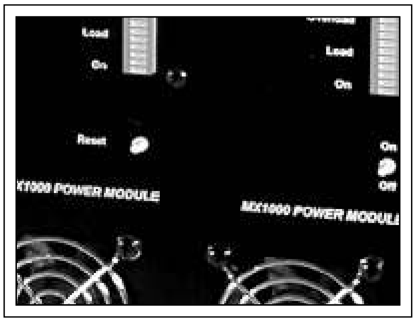
NOTE: If using the remote switch, the switch on the inverter must be in the off position.

STEP 11: Measure the output voltage at the LOAD terminals on the backplane. The reading should be the nominal AC voltage +/- 6%.

Steps 12 through 20 are only for inverters equipped with a transfer switch.

STEP 12: Before connecting the commercial utility to the inverter, make sure that the commercial utility breakers are "off".
STEP 13: Turn the inverter "off".
STEP 14: Verify that the load breakers are "off"
STEP 15: Connect the commercial utility line wire (black) to the utility line connection on the backplane. Connect the commercial utility neutral wire (white) to the utility neutral connection on the backplane. Connect the ground wire (green) to the chassis ground connector.
STEP 16: Turn the inverter "on" by using the toggle switch in the front panel or the remote switch. Ensure that the system is operating on the (left) primary control card.
STEP 17: Turn the commercial utility breakers "on".
STEP 18: Measure from the commercial utility line (black) to the commercial utility neutral (white). The reading should be the nominal voltage +/- 6%.
STEP 19: Move the primary select switch located on the transfer switch to the desired position. The source LED in the transfer switch will display switch position.

STEP 20: Measure the output voltage at the LOAD terminals on the backplane. The reading should be the nominal AC voltage +/- 6%.
STEP 21: Check the input power requirements of the load. Make sure that it is less than the rated output power if the inverter. If more than one load will be run simultaneously the sum of the input power requirements must be less than the rated power of the inverter.
STEP 22: Close the LOAD breakers to energies the equipment.



Operation 4.0

4.1 Module Replacement

Power Modules and Control Cards are “HOT INSERTABLE” or in other words, the modules can be replaced while the system is powered and running. Alarm cards, master modules, and 12Vdc power modules ARE NOT hot insertable. To replace these units, the power should be disconnected from the inverter system.

4.1.1 Power Module & Master Module 12Vdc System Remove and Replace Procedure

STEP 1: Shut off power to the inverter.
STEP 2: Remove rear cover of the inverter rack.
STEP 3: Remove 2 brass screws that connect backplane to the power module.
STEP 4: Alternatly loosen the thumb screws on front panel of the inverter two turns at a time. They should become completely loose from the rack, yet remain captive in the power module front panel.
STEP 5: Remove the power module by pulling on the front handle.
STEP 6: Install the new module insuring that the ribs on the edge of heatsink are in the grooves of the plastic slides.
STEP 7: Tighten the top and bottom thumb screws using the procedure below. The inverter will not seat in the connector until the thumb screws are completely screwed into the rack .
STEP 8: Install the two brass screws through the backplane battery buss bar connections.
STEP 9: Re-install back cover (4 screws).
STEP 10: Turn the inverter “on”.

4.1.2 Power Module 24Vdc - 108Vdc System Remove and Replace Procedure

STEP 1: Shut off power to the inverter. (Step 1 only for non-redundant system. In redundant systems, modules are “hot-insertable”).
STEP 2: Alternately loosen the two thumb screws on front panel of the inverter two turns at a time. They should become completely loose from the rack, yet remain captive in the power module front panel.
STEP 3: Remove the power module by pulling on the front handle.
STEP 4: Install the new module insuring that the ribs on the edge of heatsink are in the grooves of the plastic slides.
STEP 5: Slide the module in until it just touches the rear connector.
STEP 6: Tighten the top and bottom thumb screws using the procedure below. The inverter will not seat in the connector until the thumb screws are completely screwed into the rack.
STEP 7: The module should power up and level with other module(s).
STEP 8: Turn the inverter “on”.

4.1.3 Master Module 24 - 108Vdc System Remove and Replace Procedure

STEP 1: Shut off power to the inverter.
STEP 2: Alternately loosen the two thumb screws on the front panel of the inverter two turns at a time. They should become completely loose from the rack, yet remain captive in the power module front panel.
STEP 3: Remove the power module by pulling on the front handle.
STEP 4: Install the new module insuring that the ribs on the edge of the heatsink are in grooves of the plastic slides.
STEP 5: Tighten the top and bottom thumb screws using the procedure below. The inverter will not seat in the connector until the thumb screws are completely screwed into the rack.

The module cannot be quickly inserted into the cage. There is a 3 step procedure that occurs during installation of the module

a) The input capacitors are precharged.
b) All electrical connections to the inverter occur.
c) The module is powered up and brought on line with the rest of the modules.

In order for these things to occur in the correct sequence and timing, the screws are designed to stop the installation of the inverter before any electrical contact takes place in the card edge connector. As the thumb screws are tightened, the above events are forced to happen in sequence and fairly slowly.

In our experience, most of the problems occur because people try to install it just as they would a rectifier module, which has no input capacitance. Use the below procedure.

1) The module should be placed in the cage just to the point of starting the thumb screws.
2) Turn the bottom screw in 2 turns.
DO NOT ATTEMPT TO SCREW ALL THE WAY AT ONCE, SCREW STRIPPING MAY RESULT.
3) Turn the top screw in 2 turns.
DO NOT ATTEMPT TO SCREW ALL THE WAY AT ONCE, SCREW STRIPPING MAY RESULT.
4) Repeat 2 and 3 until the module is completely seated.

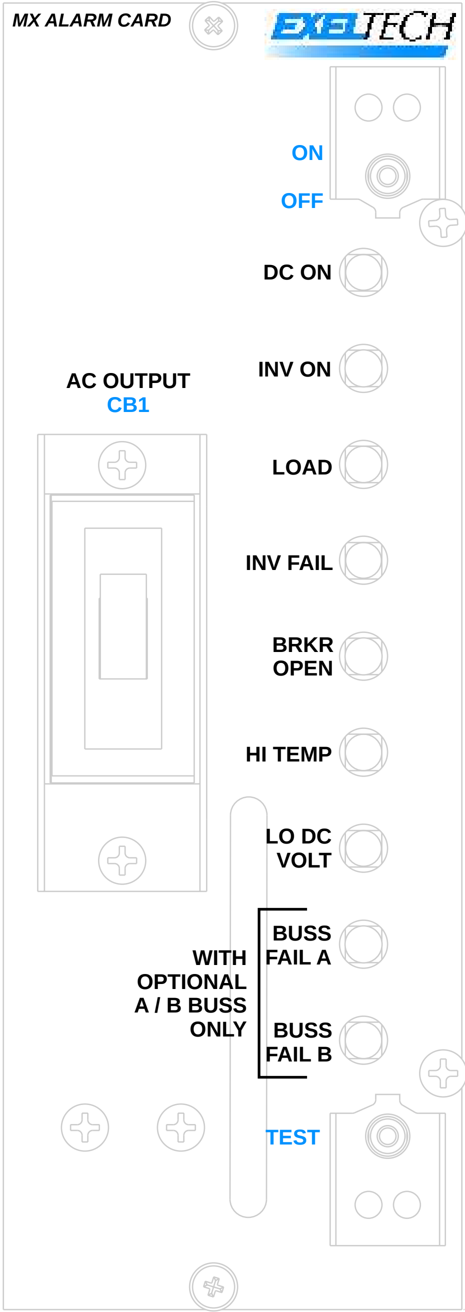
You may see the inverter fail LED illuminate during the seating process. This is normal. When fully seated the bottom LED of the module will illuminate, and depending on the load, many bars of the LED bar graph will illuminate as the power module levels current with the rest of the system.

4.2 Alarm Card

Alarm Card - Exeltech's modular Alarm Card can be added to 23" and 19" cages.

NOTE: With an alarm card system there must be a control card in the left slot.

LED ALARMS: The alarm module contains LED indicators that monitor DC voltage, module fail, temperature, load, and inverter.



LED's and Switch Settings

ON / OFF	ON
DC ON	GREEN
INV ON	GREEN
LOAD	GREEN
INV FAIL	-
BRKR OPEN	-
HIGH TEMP	-
LO DC VOLTS	-
BUSS FAIL A	-
BUSS FAIL B	-
TEST	-

INV SWITCH: Up is "On" and down is "Off".

DC ON LED: Will be green (indicating inverter on) when the DC power is in specs. Will be orange when the DC power is in the warning range of low voltage. Will be red when the inverter is off or the DC power is out of range.

INV ON LED: Green indicates that the inverter is operating within specified limits. Orange indicates an overload and red indicates fail.

LOAD LED: Green indicates that output power is being supplied to the "load" and red indicates that the load is off.

INV FAIL LED: Red indicates a power failure, an inverter module failure, a control card failure or a system overload.

BRKR OPEN: Red indicates that output power is NOT being supplied to the load, and the breaker is open. Green indicates that the breaker is closed and power is being supplied to the load.

HIGH TEMP LED: Indicates an over temperature condition exists. In conjunction with an Inverter Fail indicator, this likely indicates a Power Module failure.

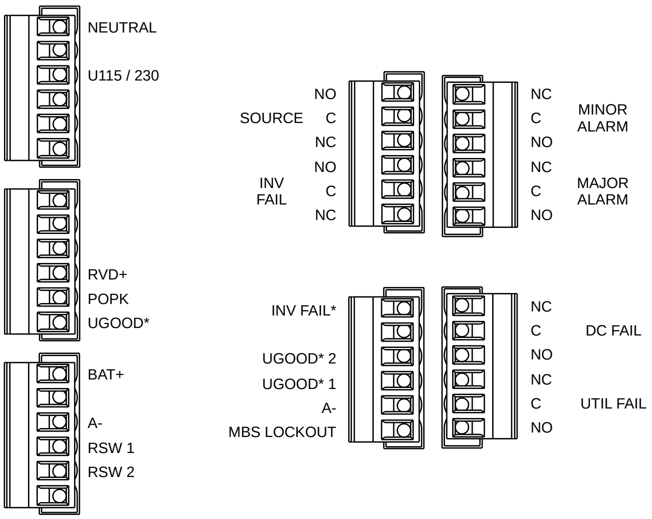
LOW VOLT DC LED: Green indicates that the Inverter is operating within specified limits. Fail is "red".

BUSS FAIL A LED: Only on systems with optional A/B BUSS.

BUSS FAIL B LED: Only on systems with optional A/B BUSS.

CONTACT CLOSURES (REMOTE ALARMS): The alarm module contains "form-C" contact closures to monitor inverter status remotely. These remote alarms include: Minor Failure, Major Failure, Inverter Fail, and DC Fail.

Remote alarm monitoring (available in the Backplane):



NOTES: P104 - *INV FAIL, UGOOD #1, and UGOOD #2 are for Exeltech use only.

MINOR ALARM: Relay is energized in case of any “soft” failure: Module failure, Inverter failure.

MAJOR ALARM: Relay is energized in case there is no AC to the load: Breaker open, inverter failed, or inverter voltage out of limits.

SOURCE: Energized when primary source selection switch goes to secondary source.

INV FAIL: Relay is energized when there is no AC out of the inverter.

DC FAIL: Relay is energized when the DC is out of limits.

4.3 Transfer Switch

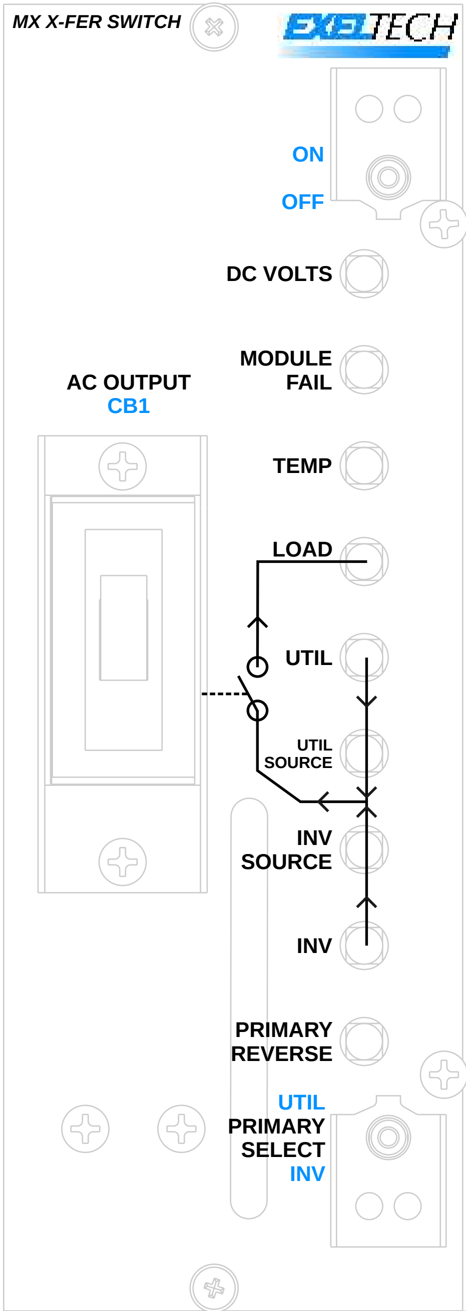
Transfer Switch- A simple AC relay can also be used for inverter / shore power applications.

Note: With a transfer switch system there must be a control card in the left slot.

Transfer Time
- Inverter to Commercial Power: 4 msec.
- Commercial Power to Inverter: 4 msec.

Note: All transfers are Phase Synchronous

Voltage Transfer Set Points
- Low Voltage Setting: 105Vac
- High Voltage Setting: 135Vac



LED's and Switch Settings

	UTILITY ON					UTILITY OFF	
INV ON / OFF	ON	ON	OFF	OFF	ON	ON	ON
DC VOLTS	GREEN	GREEN	RED	RED	GREEN	GREEN	GREEN
MODULE FAIL	-	-	-	-	-	-	-
TEMP	GREEN	GREEN	RED	RED	GREEN	GREEN	GREEN
LOAD	RED	GREEN	GREEN	RED	GREEN	RED	GREEN
UTIL	GREEN	GREEN	GREEN	GREEN	GREEN	RED	RED
UTIL SOURCE	-	-	GREEN	GREEN	GREEN	-	-
INV SOURCE	GREEN	GREEN	-	-	-	GREEN	GREEN
INV	GREEN	GREEN	RED	RED	GREEN	GREEN	GREEN
PRIMARY REVERSE	-	-	-	-	-	-	-
PRIMARY SELECT UTIL / INV	INV	INV	UTIL	UTIL	UTIL	INV	INV
MAIN AC BREAKER	OFF	ON	ON	OFF	ON	OFF	ON

INVERTER SWITCH: When the switch is up the inverter is “on” and when down it is “off”.

DC VOLTAGE LED: When this LED is green the inverter will be “on” and the DC power is within specs. This LED will be orange when the DC power is in the warning range of low voltage. This LED will be red when the inverter is off or the DC power is out of range.

MODULE FAIL LED: This LED indicates a module “failure” for any Module or Control Card. It also indicates a system overload.

TEMP LED: This LED indicates an over temperature condition exists. In conjunction with a module fail indicator, this indicates a Power Module failure.

LOAD LED: This LED is green when output power is being supplied to the “load”. When the Main AC Breaker is open the LED is red.

UTIL LED: This LED is green when the utility voltage is within specified limits. When Orange the utility voltage is reduced (overloaded). When red, the utility has failed.

UTIL SOURCE LED: When this LED is green it indicates that the utility is supplying power to the “load”. When red the utility power is not present.

INVERTER SOURCE LED: When this LED is green it indicates that the Inverter is supplying power to the “load”. When red the inverter power is not present.

INV LED: When this LED is green it indicates that the Inverter is operating within specified limits. When this LED is orange an overload exists, and when red the inverter has failed.

PRIMARY REVERSE: When orange this indicates the Primary Select Switch's function is reversed. Normal is off.

PRIMARY SELECT SWITCH: When up the Utility is selected as primary. When down the Inverter is selected as primary.

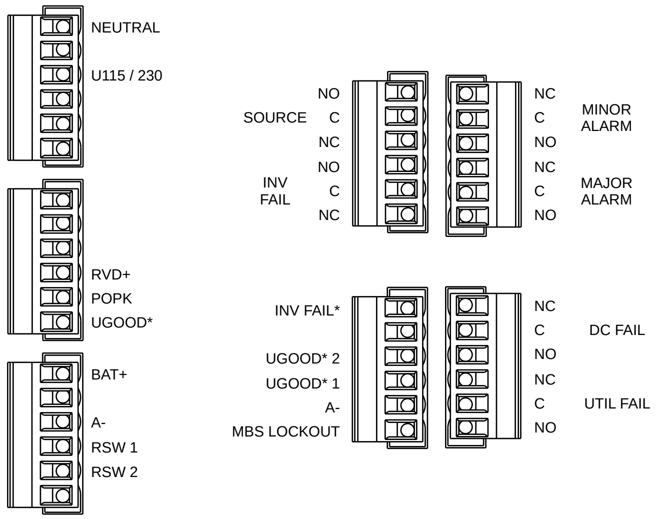
Exeltech's modular transfer switch can be added to 23", 19", 9", and 7" cages. The transfer switch allows the inverter to automatically switch between inverter power and a secondary source of AC power. The transfer switch has a maximum capacity of 40Amps and a typical transfer time of 4ms. Primary power is selectable via a front toggle switch. This means that you can run the load off of the inverter and switch to the utility when there is a problem, or run the load off of the utility and switch to the inverter if there is a problem.

TRANSFER CONDITIONS: The transfer module will switch the load from its primary source when voltage of that source drops below 105Vac or above 135Vac. The transfer module will transfer the load back to the primary source when the voltage of that source returns to between 110Vac and 130Vac. The transfer switch can be programmed to re-try the primary source upon the primary source returning to normal voltage, or the transfer switch can be programmed to stay connected to the secondary source until the transfer switch is manually reset.

LED ALARMS: The transfer module contains LED indicators that monitor DC Voltage, Module Fail, Temperature, Load, Utility, Utility Source, Inverter Source, Inverter, and Primary Select Reverse.

CONTACT CLOSURES (REMOTE ALARMS): The transfer switch module contains "form-C" relay contact closures to monitor the inverter status remotely. These remote alarms include: Minor Failure, Major Failure, Inverter Failure, and DC Failure.

Remote alarm monitoring (available in the Backplane):



NOTES: P104 - *INV FAIL, UGOOD #1, and UGOOD #2 are for Exeltech use only.

Make sure that the JUMPER on the Backplane is present from [MBS] to [A-] in order for the Transfer Switch to operate. This jumper is normally installed at the factory. Removing this jumper forces the switch to utility mode.

MINOR ALARM: Relay is energized in case of any “soft” failure: Unit is in bypass, Module failure, inverter failure (if utility is OK).

MAJOR ALARM: Relay is energized in the case of no AC to the load, breaker open, utility and inverter failed or out of limits.

SOURCE: Relay is energized when the primary source selection switch goes to the secondary source.

INV FAIL: Relay is energized when there is no AC out of the inverter.

DC FAIL: Relay is energized when the DC is out of limits.

UTIL FAIL: Relay is energized when the utility is out of limits.

JUMPER SELECTS

	JUMPER	CONDITION	FUNCTION
1	J 1	CLOSED	LATCHES INVERTER OVERLOAD
0		OPEN	RE-TRIES INVERTER OVERLOAD
1	J 2	CLOSED	AUTO RESETS INVERTER OVERLOAD ON FAIL
0		OPEN	MANUAL RESETS INVERTER OVERLOAD (SELECT OR REMOTE)
1	J 3	CLOSED	LATCHES UTILITY OVERLOAD
0		OPEN	RE-TRIES UTILITY OVERLOAD
1	J 4	CLOSED	AUTO RESETS UTILITY OVERLOAD ON FAIL (SELECT OR REMOTE)
0		OPEN	MANUAL RESET UTILITY OVERLOAD

Default Condition is ALL JUMPERS OPEN.

4.4 MX SYSTEMS MONITOR CARD

It is now possible to monitor all of your remote power stations from a single location. You can have up to the minute verification that all of your remote power systems are 100% operational. For example your remote power system can tell you that it is currently running at 90% of its rated capacity.

You can monitor all system alarm functions including: Power Module Fail, Control Card Fail, Over Temperature, Under DC Voltage, A-B Bus failure, System Breaker Open, and System Failure. Additionally, you can monitor battery voltage, battery current, system output voltage and system output current. All alarm functions are viewable from an LCD located on the System Monitor Card.

Main Menu Items

The main menu consists of 9 different screens. To switch between each menu item press the MENU button. Alarm Details and System Settings have several addition screens available for viewing or changing system parameters. Press the SELECT button to choose a parameter for viewing, or modification of settings. Hold the MENU button down to return to the main menu screens.

Operation

Normal operation of the monitor card is exactly the same as the alarm card previously described in this document. One notable exception is the remote monitoring of the system status. An LED will blink for a new alarm state. Pressing either button stops the blinking, and alarm details will give a listing of any alarms that have been activated.

Remote Monitoring

Remote monitoring can be performed via a DHCP enabled network. Monitoring software is available from Exeltech on-line to allow remote sensing of alarm states. However, it is also possible to implement custom software to meet any monitoring needs.

4.5 MX Solid State Transfer Switch

The MX Solid State Transfer Switch is designed for flexibility. Several configurations are available. The transfer switch is compatible with the existing Exeltech inverter systems, but is also capable of stand alone operation.

Features

The switch is available in 3 power levels: 5KW, 10KW, and 20KW. It is available for single, split, or 3 phase systems. It is capable of reporting AC voltage, current, and frequency for both the primary source as well as the secondary source. Major and minor alarm contacts are available for local monitoring of any potential fail state.

When used as a 5KW single 23" cage system, the transfer switch also works as a system monitor card, providing DC information as well. Network remote monitoring is available via SNMP.

. It can measure the A and B Buss voltage in an A/B Buss system.
. It can monitor the status of power modules and control cards, and report as a minor alarm
. It can switch to the secondary control card if the primary card fails.

Remote Monitoring

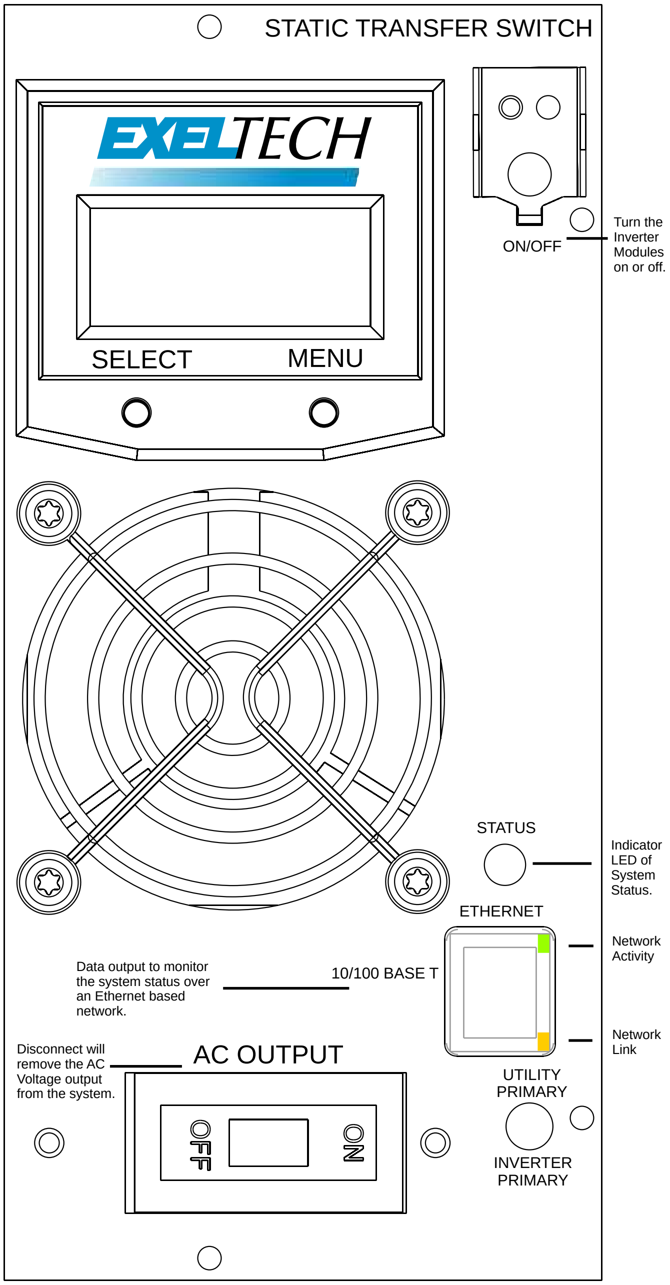
The transfer switch's status can be monitored over Ethernet in two ways. The first way to monitor the system is with SNMP. An “mib” file is provided and can be loaded into any SNMP monitoring software. Another program is provided to monitor the system and needs to be loaded onto a PC connected to the transfer switch's network. This program displays the status of the system and also logs the data to be viewed at another time. A DHCP server is required for the system to acquire an IP address.

LCD Display Details

The LCD is an easy way to visually collect information of the power inverter system. The system’s voltage and current along with all the alarms are shown with other items of interest. There are two buttons that are used to navigate through the different menus. The LCD menu structure is designed for transfer switches, alarm cards, and systems with both. This causes some menus to not be used in all systems. The menu will still be there, but without any relevant data.

LCD BUTTONS

The two buttons below the LCD are the menu and select keys. The right key is the menu key and the left is the select key. The menu button is used to scroll through the different menus when pressed and released. It is also used to return to the top of the menu tree when pressed and held. The select button is used only as the select key. It should be pressed when wanting to select the menu item being displayed or enter into a sub-menu of the menu being displayed. The select button has no effect on some menus when there is nothing to select or no sub-menu to enter. An example would be the menu that displays the DC voltage. That menu is used for display and the select button can be pressed but will have no effect.



Detect and Transfer Time
- Inverter to Commercial Power: < 4 msec.
- Commercial Power to Inverter: < 4 msec.
- Transfer time when changing primary: 0 msec.

Note: All transfers are Phase Synchronous in Multi-phase systems.

Voltage Transfer Set Points
- Low Voltage Setting: 100Vac
- High Voltage Setting: 130Vac

4.6 MX System Monitor 2 Card

The System Monitor 2 card is the newest of the monitoring card family and has more features than the original system monitor card. It will monitor all the alarms, AC and DC voltage and current, and AC frequency. Multi-phase systems can also be monitored with all the information available from the front panel LCD or via an Ethernet connection. The card can handle all of the system monitoring and alarm reporting that is required for a MX system.

Features

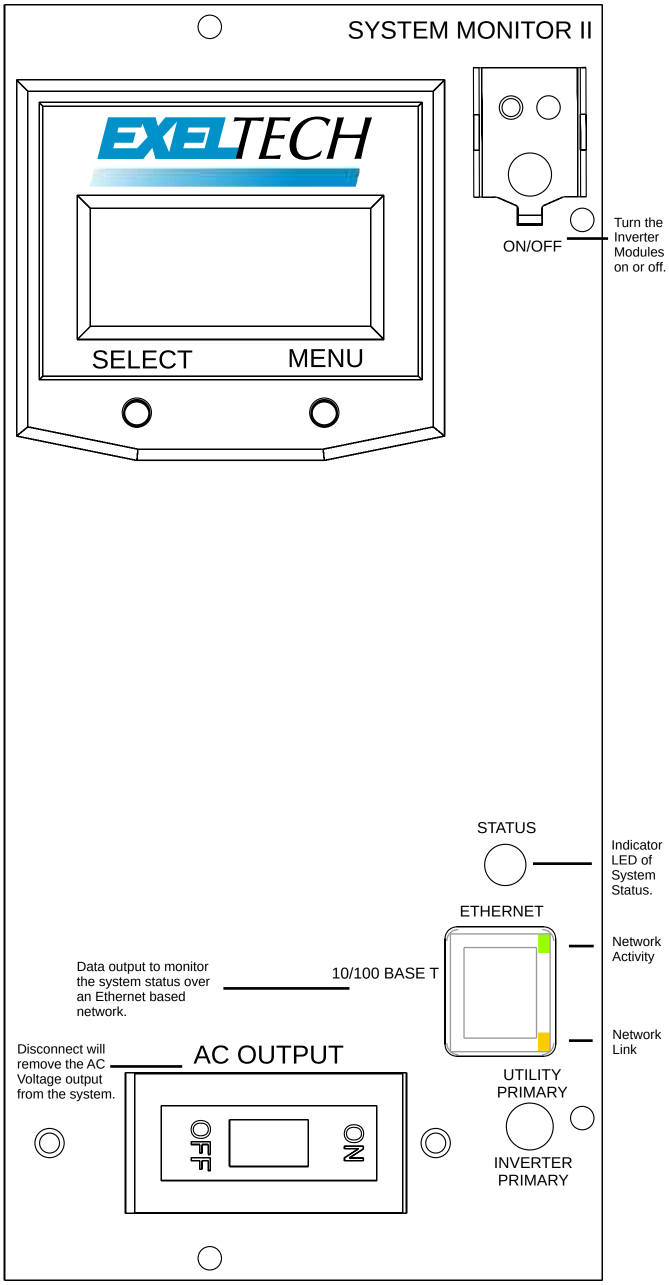
The System Monitor 2 card is available in three power levels, 5KW, 10KW, and 20KW. It is available for single, split, and 3 phase systems. It will report AC voltage, current, and frequency, along with DC voltage, and current. All the standard alarms are also monitored and reported via the front panel LCD or the Ethernet connection. It can switch to the secondary control card (when present) if the primary card fails.

Remote Monitoring

The System Monitor 2 status can be monitored over Ethernet in two ways. The first way to monitor the system is with SNMP. An “mib” file is provided and can be loaded into any SNMP monitoring software. Another program is provided to monitor the system and needs to be loaded onto a PC connected to the System Monitor 2’s network. This program displays the status of the system and also logs the data to be viewed at another time. A DHCP server is required for the system to acquire an IP address.

LCD Display Details

See section 4.5



LCD MENUS

The LCD menus are broken down as a menu tree for the ease of navigation. Figure 1, figure 2, and Figure 3 show the menu tree broken down. Figure 1 is the top menu level. Upon startup the menu will display the 'System Status' menu. This menu rotates through three menus without any interaction required. The first menu is the system output voltage. The next menu is displays that it is an alarm card. The third is the alarm status. The alarm status menu is there to alert of any possible problems, but not to display the actual alarm.

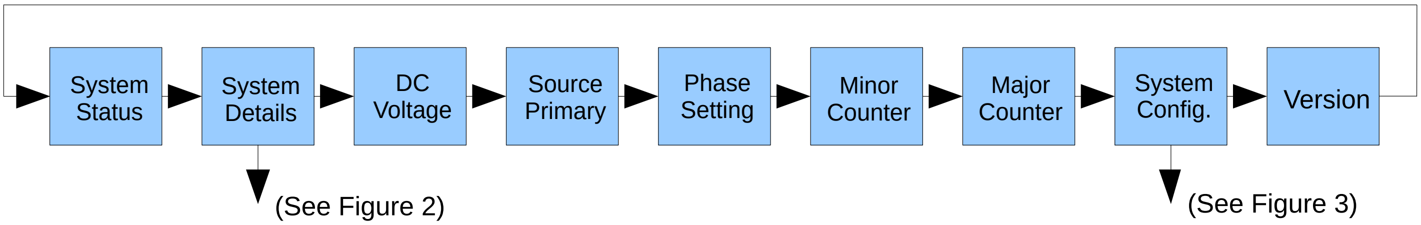


Figure 1 NOTE: In this menu M goes through the menu, S enters sub menu at SYSTEM DETAILS and at SYSTEM CONFIGURATION.

The menu button is used to scroll to the next menu, which is the 'System Details' menu. Here the select button can be used to enter into that sub-menu section. That section is covered below. The next menu is the 'DC Voltage' menu. Here the DC voltage is displayed. The next menu is used to display the present output source and its current primary source. The next menu displays the 'Phase Setting' of the system. There are three different options: single, split, and three phase. The next two menus will be minor and major failure counters. Pressing the select key while on the individual counter will reset that counter to zero. If both major and minor counters need to be reset, both menus need to be reset individually. The last menu screen for the top of the menu tree is the version number. Scrolling over again will start the menu back at the 'System Status' menu.

SYSTEM DETAILS

The first of the two sub-menus is the 'System Details' menu and can be seen in Figure 2. In this version, this sub-menu is for displaying values of the systems. The select button will be used to scroll backwards since there is nothing to select. To get back to the top menu level press and hold the menu button.

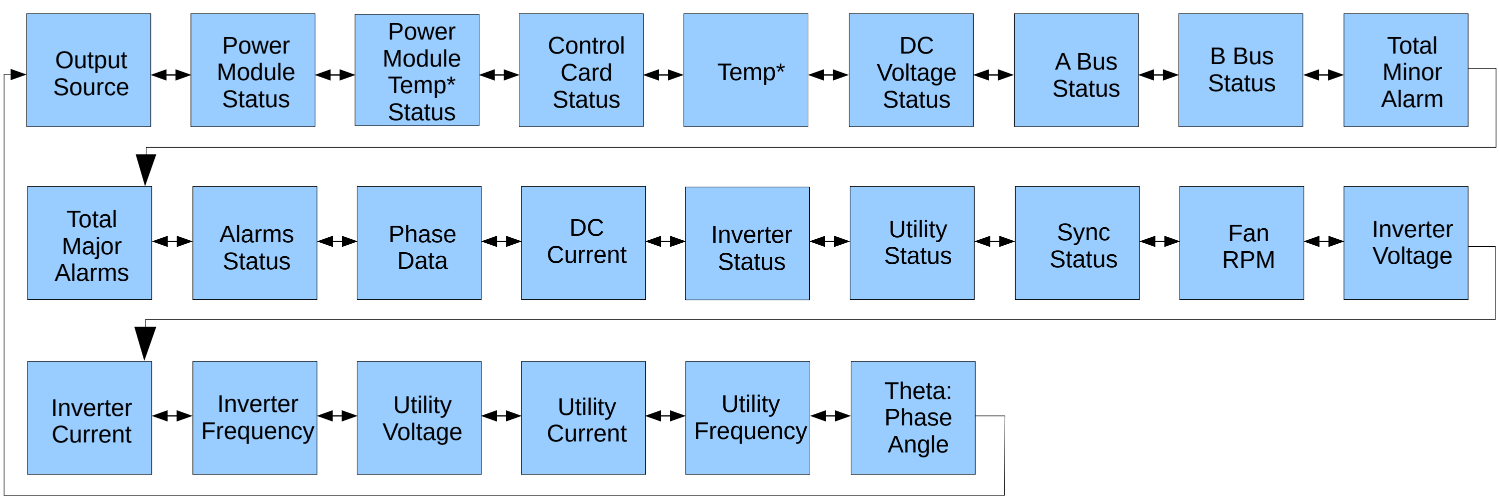


Figure 2 NOTE: In this menu M goes thru menu selections and S lets you go backwards thru the menu selections. Hold down M for 3 seconds to return to main menu.

* Temp = Temperature

Output Source: The source that the system is using. Transfer switches will display utility or inverter and alarm cards will have inverter as its source.

Power Module Status: This is the power module failure indicator. If a power module fails it will be present on this menu. Otherwise it will display everything is normal.

Power Module Temp. Status: This is the temperature status of the power modules. If one power module is over temperature, then this warning will display the failure, otherwise it will display everything is normal.

Control Card Status: This is the control card failure indicator. If a control card fails or if the system is on control card 'B' it will be present on this menu . Otherwise it will display everything is normal.

Temp: This displays the current temperature of the system.

DC Voltage Status: This is the DC low voltage warning screen. If the voltage is low it will indicate that it is low, otherwise it will display everything is normal.

A Bus Status / B Bus Status: These are the status of the A and B Bus, if installed.

Total Major/ Minor Alarms: This is the cumulative alarms of the system. This cannot be reset.

Alarm Status: This is the current alarm state of the card. The result will be major, minor, or none.

Phase Data: This displays phase number of the current card and number of phases of the system.

DC Current: The DC current is displayed in amps if it is available.

Inverter Status: This is the status of the inverter source for that phase. The result will be good or bad.

Utility Status: This is the status of the utility source for that phase. The result will be good or bad.

Fan RPM: This is the fan speed if a fan is connected.

Inverter Voltage: This is the inverter output voltage.

Inverter Current: This is the inverter output current.

Inverter Frequency: This is the inverter frequency.

Utility Voltage: This is the utility output voltage.

Utility Current: This is the utility output current.

Utility Frequency: This is the utility frequency.

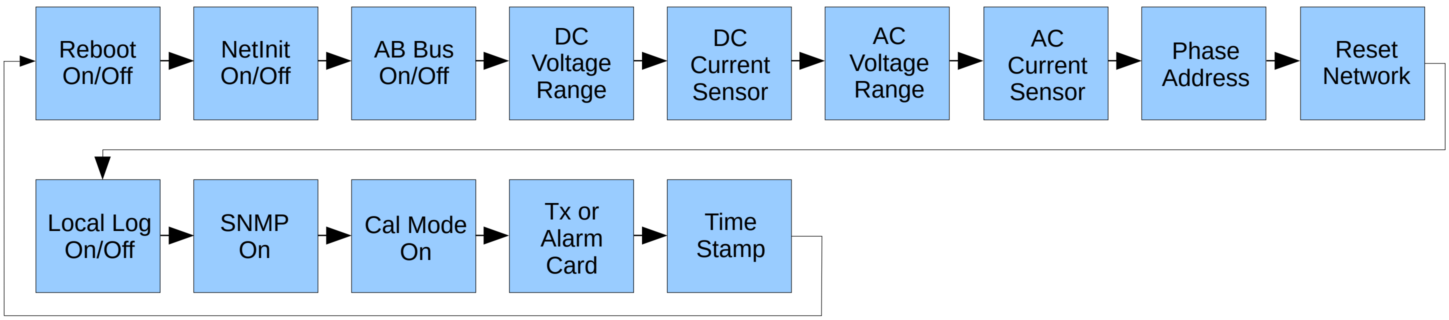


Figure 3 NOTE: In this menu M goes through the menu, S selects aternate settings if available. Hold down M for 3 seconds to return to main menu.

SYSTEM CONFIGURATION

Reboot: Not available at this time.

Net Init: Not available at this time.

AB Bus: Not available at this time.

DC Voltage Range: This is the range of the input DC Voltage.

DC Current Transformer: This is the setting of the DC current transformer installed in the system.

AC Voltage Range: This is the voltage range for the AC voltage of the card.

AC Current Transformer: This is the setting of the AC current transformer installed to the system.

Phase Address: This is the phase address of the current card. Can be phase 1, 2, or 3.

Reset Network: Pressing the select button will reset the network chip. It will try to get a new IP address. It will not effect the system in any way other than the network settings.

Local Log: The system has a local counter of all the major and minor alarms.

SNMP: Currently this is the default network communication for the card.

Cal Mode: This mode is set so that each card has been individually calibrated for greater accuracy.

TX or Alarm Card: Determines if the card is a transfer switch or alarm card.

Time Stamp: Time stamp for a reference of the code used.

ALARMS

LED:

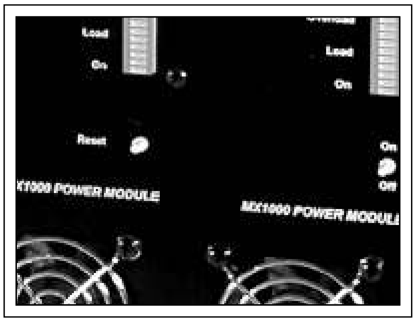
The LED on the front of the card is a quick way to determine if there is a problem with the inverter. There are three solid colors that the system can display: green, orange, and red. The green is for no alarms and everything is good. The orange is for minor alarms and the red is for major alarms. If there is a major and a minor alarm it will display the major alarm only.

Major:

If there is not a good source of AC power, a major alarm will be indicated. There are currently 2 ways to have a major alarm. If the system just has alarm cards then the inverter is the only source. If the inverter's output fails then a major alarm will be triggered. If it has a transfer switch it takes two bad sources to cause a major alarm. These alarms will be cleared with the alarm state goes away.

Minor:

There are 8 different minor alarms that can be triggered. These are: power module over temperature, power module fail, control card fail, one source fail or not phase locked, level alarm, control card over temperature, card over temperature, and low DC voltage. Some of these alarms are not used in certain variations of the transfer switch or alarm card, like the alarm card does not look for the other source to be locked if there is not a transfer switch.



Specs 5.0

5.1 MX Inverter Electrical Specs

Input Power Requirements (PER EACH POWER MODULE):

MODEL	NORMAL VDC	MINIMUM VDC CUT-OFF / ALARM	MAXIMUM VDC	RATED CURRENT	FUSE	PEAK CURRENT
12 VDC	13.8 VDC	10.4 / 10.6 VDC	16.5 VDC	98 A	140 A	111 A
24 VDC	27.6 VDC	19 / 21 VDC	33 VDC	49 A	80 A	56 A
32 VDC	36.8 VDC	26.5 / 28 VDC	45 VDC	36.8 A	60 A	42 A
48 VDC	55.2 VDC	41.5 / 42.5 VDC	62 VDC	24.5 A	-	27.7 A
66 VDC	75.9 VDC	57.5 / 58.5 VDC	91 VDC	17.8 A	40 A	20 A
108 VDC	124 VDC	94 / 95 VDC	149 VDC	10.9 A	20 A	12.4 A

Output Power (PER EACH POWER MODULE):

CONTINUOUS POWER	SURGE POWER (3 SECS)	NO LOAD POWER	OUTPUT VOLTAGE	OUTPUT CURRENT	WEIGHT LBS.
1000 W	2200 W	20 W	230 +/- 6%	4.3 A	7.5
1000 W	2200 W	20 W	120 +/- 6%	8.5 A	7.5
1000 W	2200 W	20 W	100 +/- 6%	10 A	7.5

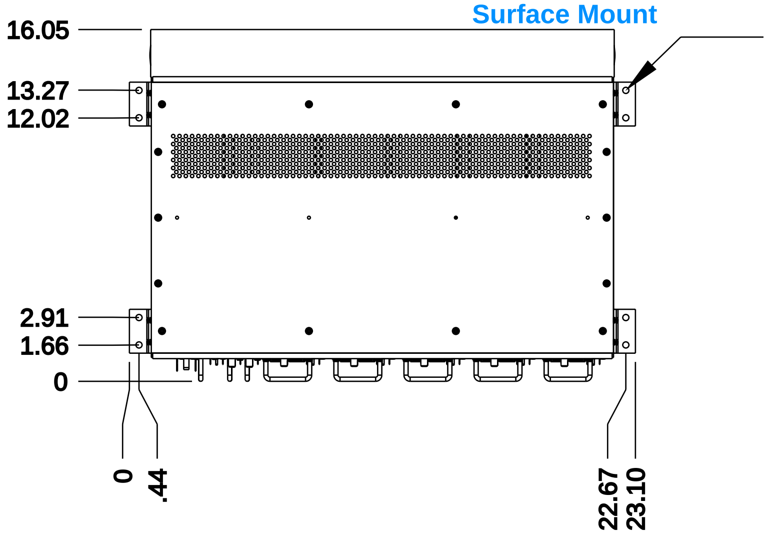
Recommended Input Wire Sizes (For Variable Distances from the Battery):

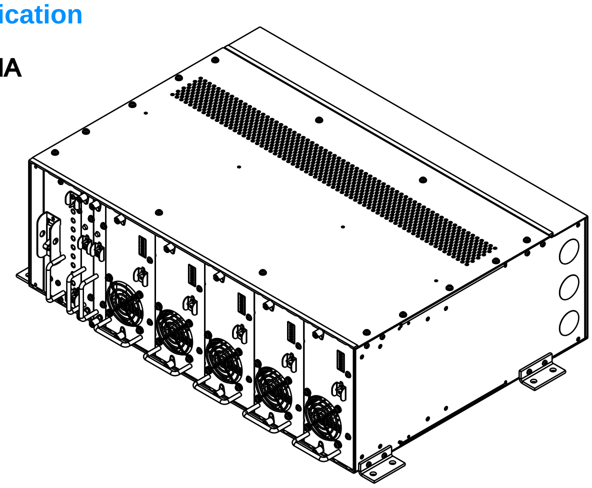
General information

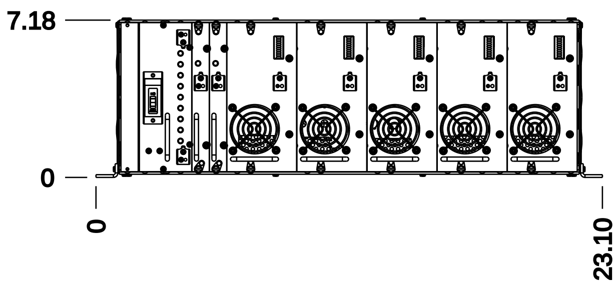
CONDITIONS	MINIMUM	TYPICAL	MAXIMUM
WAVEFORM	-	SINUSOIDAL	-
LINE REGULATION	-	0.1%	0.5%
LOAD REGULATION	-	0.3%	0.5%
DISTORTION	-	1.5%	2%
FREQUENCY	-0.1%	NOMINAL	+0.1%

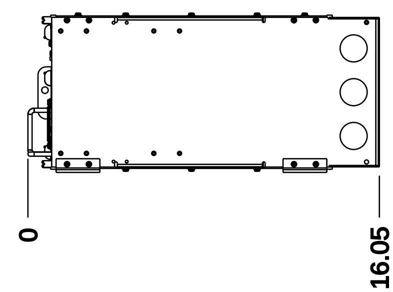
5.2 Mechanical Specs/Drawings

23” Cage - Mechanical Specification
Surface Mount

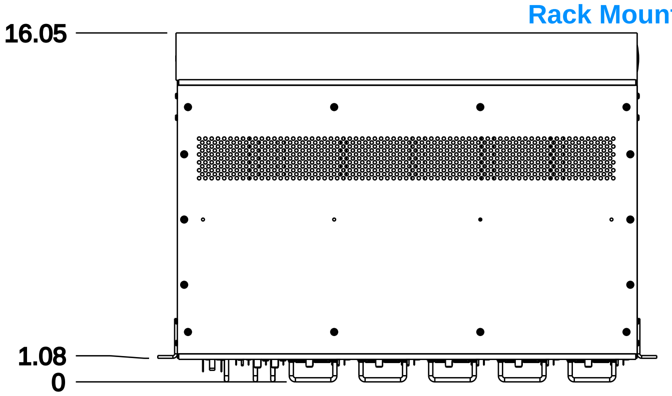


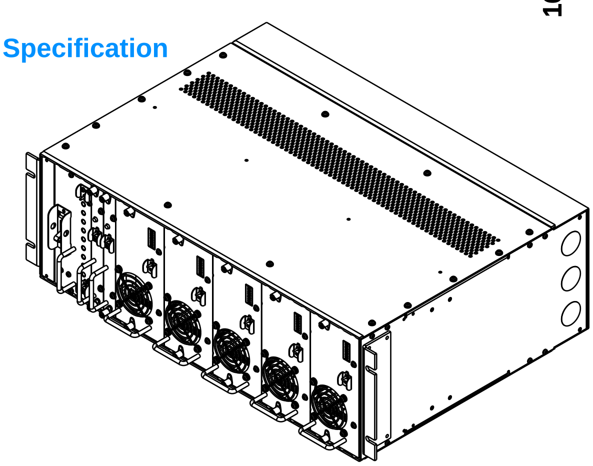


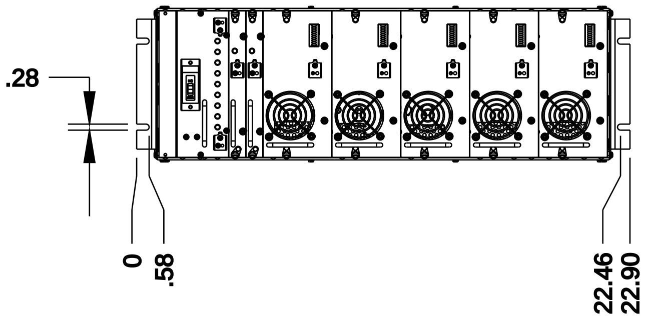


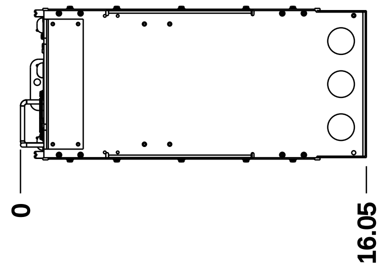


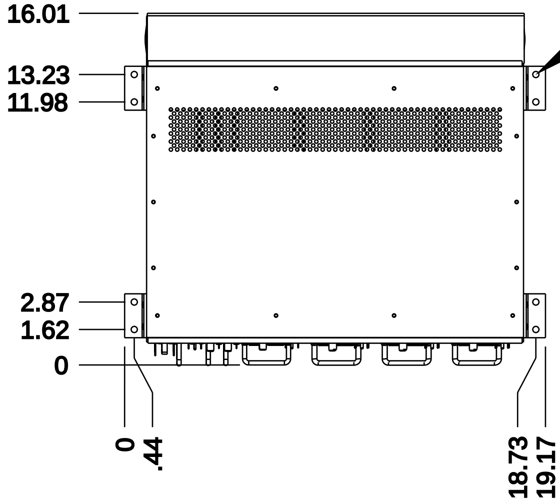
23” Cage - Mechanical Specification
Rack Mount

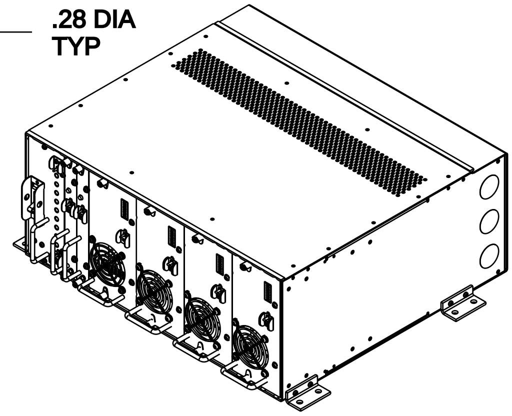




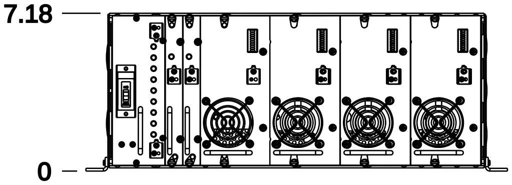


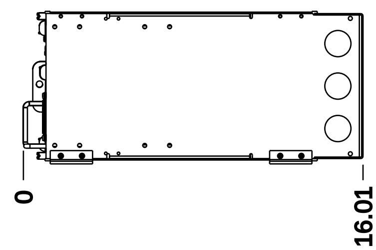


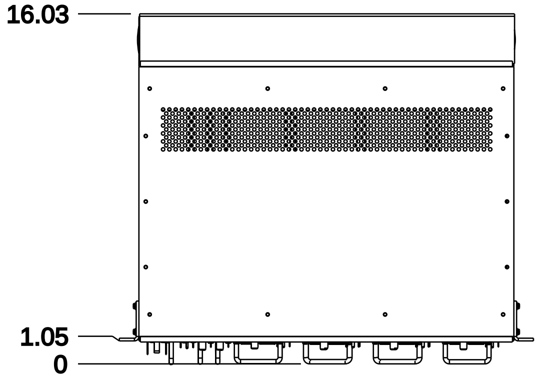


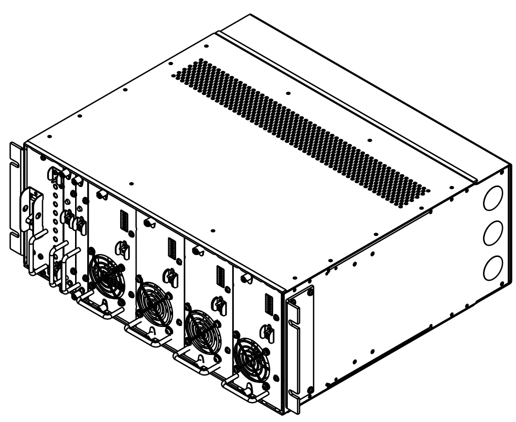


19” Cage - Mechanical Specification
Surface Mount

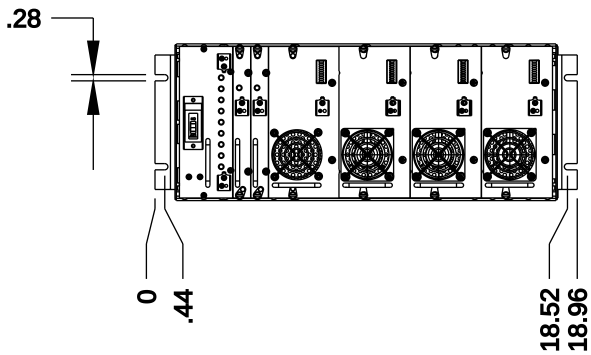


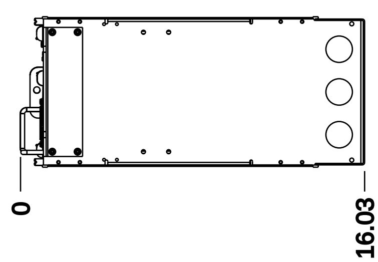






19” Cage - Mechanical Specification
Rack Mount





5.3 Wiring Charts

How much current does my EXELTECH inverter draw from my batteries?

Take the output power (Po) of the inverter and divide it by 0.85 (85% efficiency worst case). This gives you the input power (Pin) of the inverter. Now divide the input power by the voltage of the battery bank (Vbat). This is the current in amps (DC Amps) that the inverter draws from the battery.

Po / 0.85 = Pin; Pin / VBat = DC Amps

The voltage drop between the inverter and the battery should be less than 2% of the Low-Line DC battery voltage. The proper cable size can be verified in the National Electrical Code Book.

Wiring between inverter and battery bank should be as short as possible and of a gauge as larger or larger than that called for in the chart. This manual covers many different input voltages. Find the correct row for the inverter, read across to the column corresponding to the distance between the inverter and battery bank, and then read the size of the wire cable which is needed.

Wires for a 1KW load:

MODEL	LESS THAN 5’	LESS THAN 10’	LESS THAN 15’	LESS THAN 20’
12 VDC	2 AWG	00 AWG	0000 AWG	0000 AWG
24 VDC	6 AWG	4 AWG	2 AWG	0 AWG
32 VDC	12 AWG	8 AWG	6 AWG	4 AWG
48 VDC	14 AWG	10 AWG	8 AWG	8 AWG
66 VDC	16 AWG	14 AWG	12 AWG	10 AWG
108 VDC	18 AWG	18 AWG	16 AWG	14 AWG

Note: the table specifies standard wire sizes (not smaller than 18 AWG) that will provide less than a 2% voltage drop at Low-line Input voltage and Rated Output Power.

Wires for a 5KW load:

MODEL	LESS THAN 5’	LESS THAN 10’	LESS THAN 15’	LESS THAN 20’
12 VDC	0000 AWG	500 MCM	750 MCM	1000 MCM
24 VDC	2 AWG	00 AWG	000 AWG	500 MCM
32 VDC	4 AWG	2 AWG	0 AWG	00 AWG
48 VDC	8 AWG	4 AWG	4 AWG	2 AWG
66 VDC	10 AWG	8 AWG	6 AWG	4 AWG
108 VDC	12 AWG	12 AWG	10 AWG	8 AWG

Wires for a 10KW load:

MODEL	LESS THAN 5’	LESS THAN 10’	LESS THAN 15’	LESS THAN 20’
12 VDC	500 MCM	-	-	-
24 VDC	00 AWG	000 AWG	0000 AWG	500 MCM
32 VDC	2 AWG	00 AWG	0000 AWG	500 MCM
48 VDC	4 AWG	2 AWG	00 AWG	00 AWG
66 VDC	6 AWG	4 AWG	2 AWG	0 AWG
108 VDC	10 AWG	8 AWG	6 AWG	4 AWG

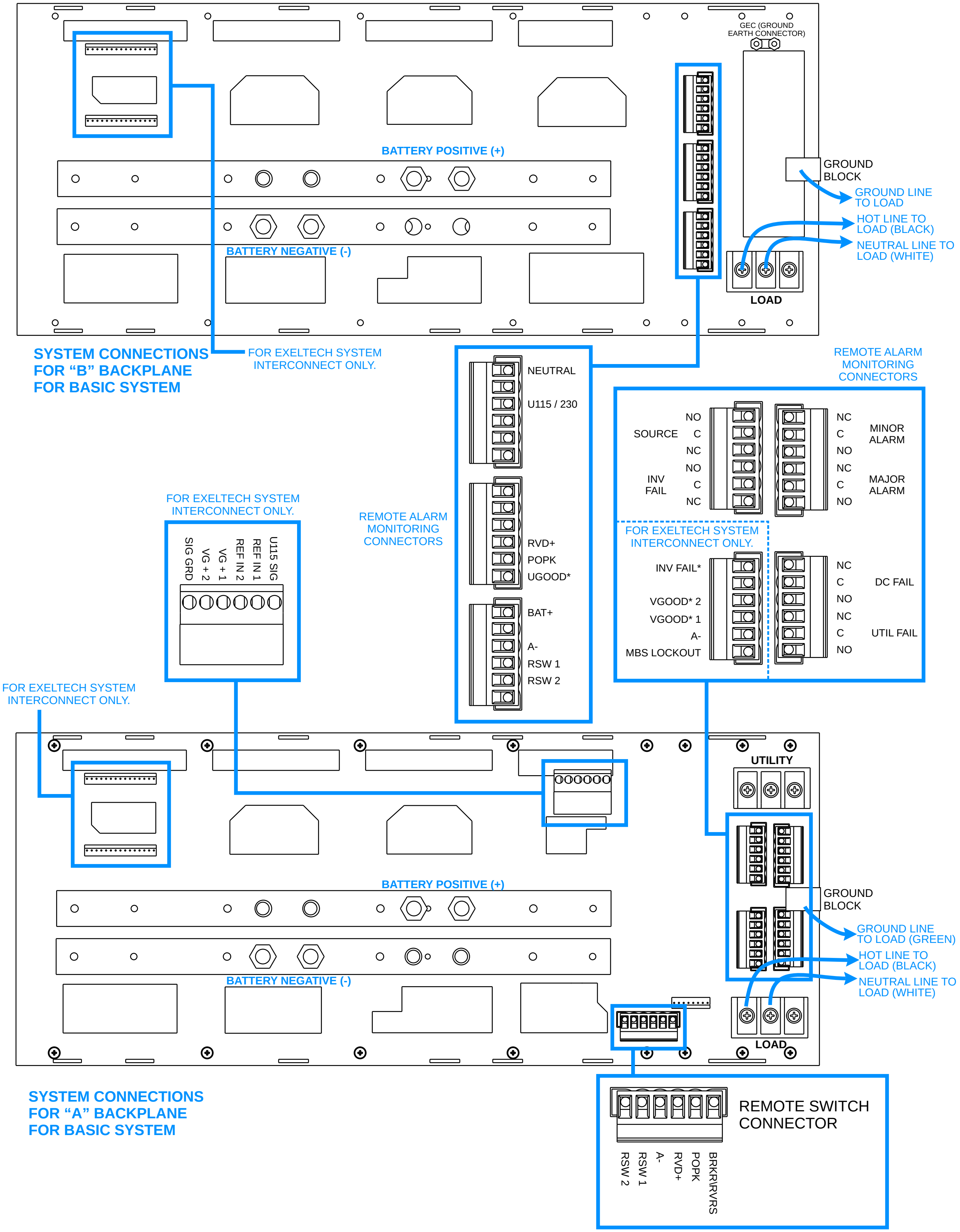
Wires for a 15KW load:

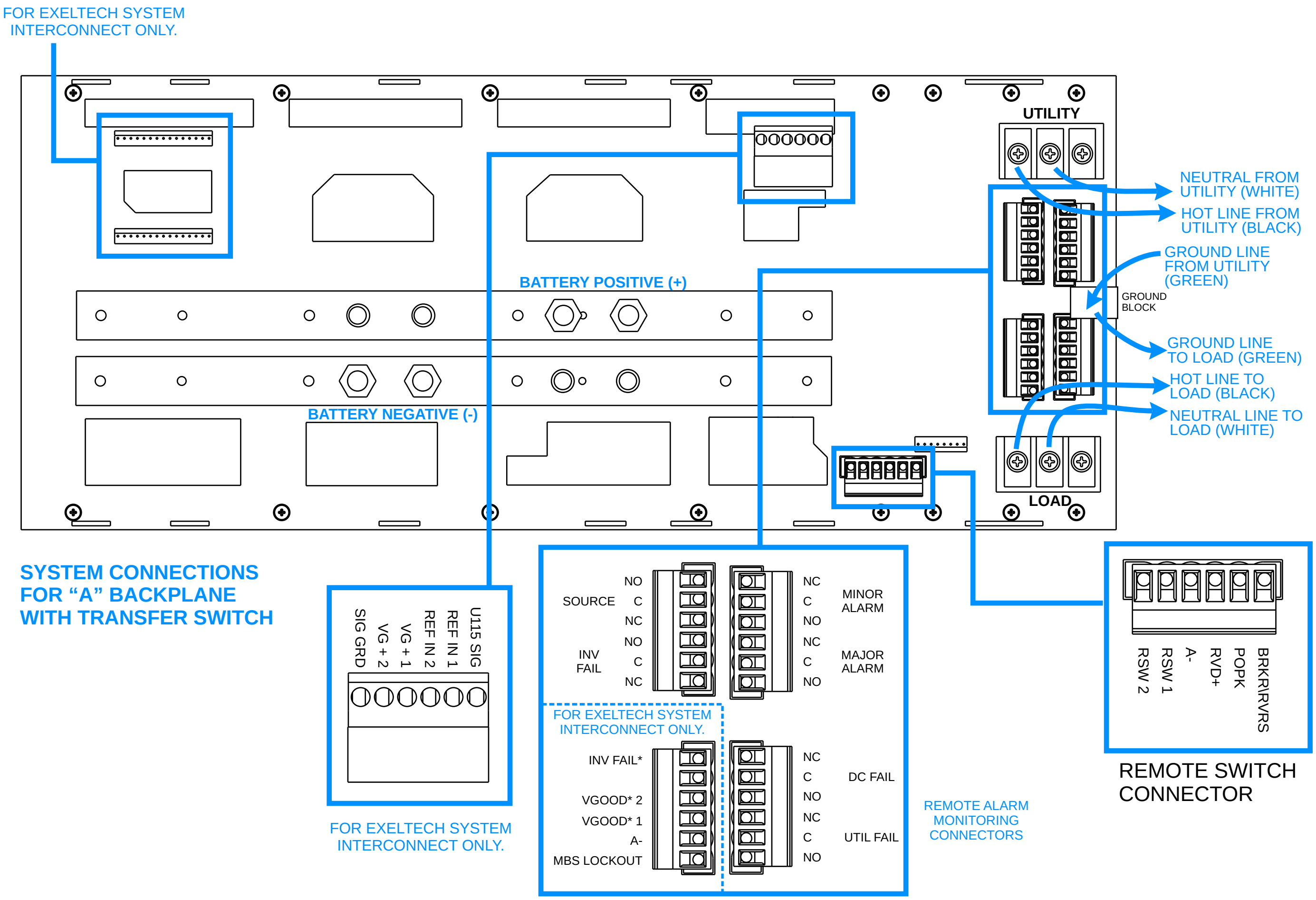
MODEL	LESS THAN 5'	LESS THAN 10'	LESS THAN 15'	LESS THAN 20'
12 VDC	-	-	-	-
24 VDC	0000 AWG	-	-	-
32 VDC	00 AWG	0000 AWG	-	-
48 VDC	2 AWG	00 AWG	000 AWG	0000 AWG
66 VDC	4 AWG	2 AWG	0 AWG	00 AWG
108 VDC	8 AWG	6 AWG	4 AWG	2 AWG

Wires for a 20KW load:

MODEL	LESS THAN 5'	LESS THAN 10'	LESS THAN 15'	LESS THAN 20'
12 VDC	-	-	-	-
24 VDC	-	-	-	-
32 VDC	000 AWG	-	-	-
48 VDC	0 AWG	000 AWG	0000 AWG	SEE NOTE
66 VDC	2 AWG	0 AWG	00 AWG	000 AWG
108 VDC	6 AWG	4 AWG	2 AWG	0 AWG

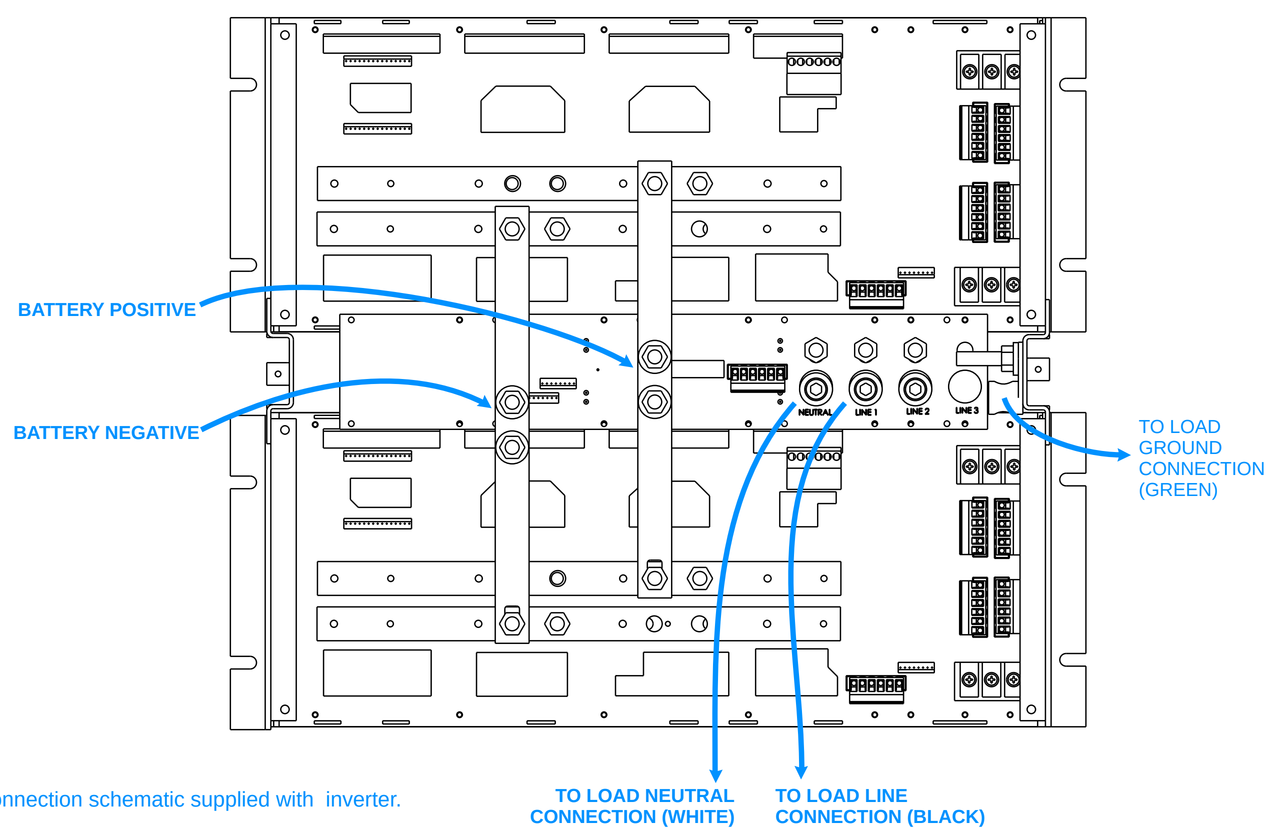
NOTE: a 20ft run , 20KW system, 48Vdc input, and 1.7% voltage drop will require a 600kcmil wire gauge.


GEC (GROUND EARTH CONNECTOR)
BATTERY POSITIVE (+)
BATTERY NEGATIVE (-)
GROUND BLOCK
GROUND LINE TO LOAD
HOT LINE TO LOAD (BLACK)
NEUTRAL LINE TO LOAD (WHITE)
LOAD
SYSTEM CONNECTIONS FOR “B” BACKPLANE FOR BASIC SYSTEM
FOR EXELTECH SYSTEM INTERCONNECT ONLY.
NEUTRAL
U115 / 230
RVD+
POPK
UGOOD*
BAT+
A-
RSW 1
RSW 2
REMOTE ALARM MONITORING CONNECTORS
NO
SOURCE C
NC
NO
INV FAIL C
NC
NC
C
NO
MINOR ALARM
NC
C
NO
MAJOR ALARM
FOR EXELTECH SYSTEM INTERCONNECT ONLY.
INV FAIL*
VGOOD* 2
VGOOD* 1
A-
MBS LOCKOUT
NC
C
NO
DC FAIL
NC
C
NO
UTIL FAIL
FOR EXELTECH SYSTEM INTERCONNECT ONLY.
U115 SIG
REF IN 1
REF IN 2
VG + 1
VG + 2
SIG GRD
REMOTE ALARM MONITORING CONNECTORS
FOR EXELTECH SYSTEM INTERCONNECT ONLY.
UTILITY
BATTERY POSITIVE (+)
BATTERY NEGATIVE (-)
GROUND BLOCK
GROUND LINE TO LOAD (GREEN)
HOT LINE TO LOAD (BLACK)
NEUTRAL LINE TO LOAD (WHITE)
LOAD
SYSTEM CONNECTIONS FOR “A” BACKPLANE FOR BASIC SYSTEM
REMOTE SWITCH CONNECTOR
RSW 2
RSW 1
A-
RVD+
POPK
BRKR/RVRS



SYSTEM CONNECTIONS FOR "A" BACKPLANE WITH TRANSFER SWITCH

SYSTEM CONNECTIONS FOR BASIC STACKED CAGE



See connection schematic supplied with inverter.

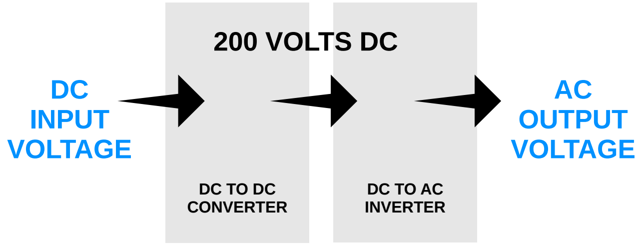
6.0
Theory of Operation

MX series inverters provide the cleanest, best regulated sine wave output over the widest DC input of any inverter on the market today. They are extremely low in total distortion, specified to 2% and typically better than 1.5%. Total harmonic distortion is typically 0.8 to 0.9%. Remaining distortion is a result of residual switching noise which amounts to a very clean 25 kHz sine wave superimposed on the fundamental output. No significant harmonics of 25 kHz exist. This spectral purity will exist over the inverter's entire operating envelope, including non-linear and reactive loads. As long as output current remains under 22 amps peak per 1000 watts, total harmonic distortion will remain within the 2% spec. The 22 amp peak capability is key to understanding the operational envelope of the inverter. As long as the inverter is supplying less than this amount, it will function properly and operate virtually any load. The inverter can run loads of any power factor. Any real world reactive or non-linear load can be operated.

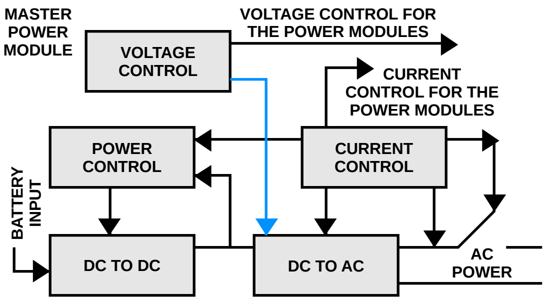
Our 1000 watt inverter can output an honest 1000 watts continuously at 40 degrees C (104 Degrees F). This is 8.5 amps RMS at 117.5 volts RMS, while not exceeding 22 amps peak. The job of the inverter is to provide a true sine wave voltage to the load. It is a function of the load as to how current will flow in the circuit. It may be non-linear so the inverter has to source this current to the best of its ability while maintaining a true sine wave voltage output. Exeltech products do this better than anything else on the market, due to it's precise voltage regulation, fast dynamic response, and high instantaneous current rating.

The inverter can maintain this spectrally pure output at any load, due to a specially designed non-linear control loop in the primary DC to DC converter. This circuitry is one of three circuits which protect the inverter from any overload condition: over current, over power, or short circuit. The inverter can also supply twice its rated output power for 3 seconds to start motors or supply inrush currents to electronic loads. If output power is exceeded for greater than 3 seconds, the output voltage is reduced to a level which will provide 1000 watts to the load, by clipping tops of the waveform. The inverter can operate safely in this mode indefinitely. Should the overload condition clear, the inverter will go back to providing 1000 watts at 117.5 Vrms. The over current circuitry insures that the maximum peak current does not exceed 22 amps. Should this number be exceeded, it will again reduce he output voltage, as required, to maintain the limit. The inverter can operate in this mode indefinitely, so that when the overload clears, the output voltage is automatically restored. If the inverter stays at it's maximum of 22 amps output for the majority of the cycle and for a prolonged period of 1 to 5 seconds, the inverter will completely shut off. A short is defined as less than 0.5 ohms per 1000 watts. This guarantees the inverter is disabled in the event a technician clears the short without first shutting off the inverter. The inverter acts as an extremely high performance circuit breaker. The short circuit and overload circuitry respond much faster than any normal fuse or breaker. No external current limiting devices are necessary (as certified by UL). If many loads are connected to a large inverter, you may desire to use normal circuit breakers to protect individual branch circuits, as the wiring in these branch circuits may be smaller than the inverter's surge capacity.

This inverter has a wide range of DC operation. Typical high line voltages are 1.6 times low line voltage. Over this entire range, the inverter performs to every specification. There is no measurable change in output voltage, little change in efficiency, and no degradation in output power or surge power



A brief explanation on the system block diagram may help to explain how everything interacts. The inverter is comprised of 1000 watt inverter modules with 117.5 Vac output. There are 5 types of modules: Master Module, Power Module, Control Card, Alarm Card and Transfer Switch. These modules are connected with their inputs in parallel and their outputs either in series or parallel to make an infinite variety of inverter systems. The control card generates reference signals that drive up to 20 power modules. The master module contains circuitry of both a control card and a power module. The power module cannot operate on its own. It must receive control signals from either a master module or a control card. The power module contains circuitry to regulate its output current to match all other modules. The alarm card monitors the output of the inverter system and if the output voltage cannot be maintained, it switches the system to the other control card. It also sets various alarms if the inverter performance is impaired.



The power module consists of two Pulse Width Modulation (PWM) circuits in series. A DC to DC converter takes the input voltage from the battery to an Intermediate high voltage. This converter regulates high voltage output, and acts as the input to the following DC to AC converter. The DC to DC converter has a very sophisticated non-linear feedback circuit which provides power protection, surge power time limit, and voltage regulation. The power limit regulation limits the inverter's output power to 1000 watts. It allows current to exceed its rated current for 3 seconds, after which time it will limit current back to its continuous rating. The bandwidth of this regulator is very slow (ie. < 30 Hz). This is done intentionally so that the current drawn from the battery system is an average of current demand over a period of 1 cycle. Enough energy is stored in the inverter to supply the instantaneous demands of the load and to provide storage of reactive currents caused by the load. This current limit is non-linear, such that if it detects a sudden change in output current, it opens the bandwidth to respond in less than 1 millisecond to the load demand.

The DC to DC section is followed by a patented DC to AC converter. It is unique in that it can provide instantaneous currents up to 3 times its rated capacity. It can supply voltages, both positive and negative of true ground, source or sink reactive currents without regard to voltage phase, and can be paralleled for higher power. This section alternately provides a positive, negative, or 0 voltage output to maintain a true sine wave output. Each mode allows for reactive current flow in either direction, should the load demand it. The output of this PWM is filtered to eliminate switching frequencies. This circuitry also measures and limits instantaneous output current to 22 amps per module as indicated above. The response time is very quick (25 kHz), to protect the output devices from overload. If a short circuit were to be applied to the output of the inverter, the result would be a very low voltage 22 amp square wave, since the short would cause the voltage to collapse. When this condition is detected, it will shut off the inverter completely. The operator will have to cycle the on/off switch to re-establish operation.

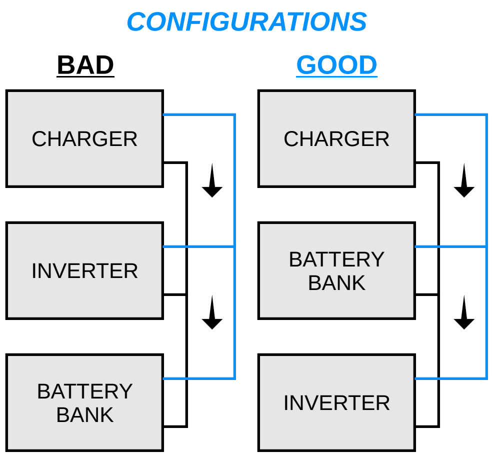
Power modules and master modules output a signal to the backplane, which represents the amount of current they are providing to the AC output. Power modules also monitor this backplane signal and compare it against their internally generated signal. If the internal signal is lower than the backplane signal, the module will increase its output current. In this way all modules tend to level themselves to the highest module.

The control card or master module produces a reference to the DC to AC converter from a crystal oscillator running at 512 times the output frequency. The resulting square wave is filtered to its fundamental frequency component only. This output is then used as a reference for the DC to AC converter. In this way, the reference is defined without the use of any potentiometers, which are a perennial source of quality problems both in the factory and the field.

This product and the factory were designed simultaneously. This affords a high quality cost effective product. Since all repairs are done at the factory, we can confidently quote a demonstrated MTBF in excess of 20 years. This also provides feedback to the engineers to further improve the design.

Input Power 6.1

The inverter must be installed with a battery on the DC side. If it is not, a destructive oscillation may occur between the inverter and DC power supply. The inverter employs an extremely fast non-linear control loop, allowing it to respond to fast changes in load requirements. No known power supplies have the dynamic response characteristics to keep up with the inverter. Typically the following scenario will occur: The power supply will supply power to the inverter, and the inverter will power some load. If a sudden change in the load occurs such as turning on some piece of electronics, the inverter will immediately demand its maximum surge current from the power supply. If the supply cannot provide the required current instantly, voltage of the supply will fall. If supply voltage falls below the low voltage cutoff of the inverter, the inverter will shut off. When this occurs, any energy stored in the output inductor of the power supply will immediately cause an output voltage spike. This voltage spike may rise so rapidly that the inverter will not turn on before the voltage increases to above the inverters over voltage cutoff. If this occurs there is nothing to limit the voltage spike. Should this spike exceed double the inverters input rating, damage to the inverter may occur. If the voltage from the power supply increases to a point that allows the inverter to turn on then the load will turn on. This will cause the power supply voltage to collapse again and the cycle will continue. Depending on the dynamics of the interaction between the inverter, the supply, and the load, 3 situations may occur. (1.) The load may eventually turn on. (2.) The system may continue to “motorboat” indefinitely. (3.)The inverter, the load, or the power supply may be damaged.

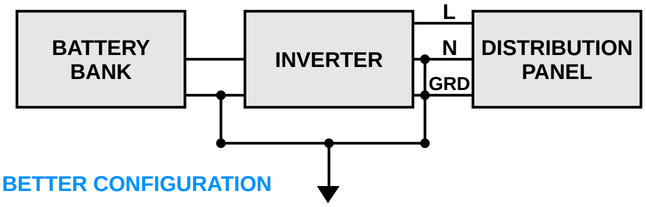


Grounding 6.2

The input and output of the inverter are isolated with a minimum of 1500 Vac. This isolation guarantees hazardous voltage from the output will not reach the input. The inverter is designed to have both the input and output grounded. The inverter is compatible with negative or positive ground battery systems. The battery bank may actually be grounded at any intermediate voltage. The AC output, again while floating, is designed to have the neutral (white) wire connected to chassis (green) wire somewhere in the system. While the inverter can actually function with the battery and output ungrounded, it is not warrantied in that configuration.

In order for the inverter to function, the AC output must be AC grounded to the DC input. This is accomplished internally by 2 capacitors. One goes from AC neutral (white) lead to inverter chassis (green) lead. The other capacitor goes from the battery negative lead to inverter chassis. In this way AC current can flow from AC neutral to battery negative via the inverter chassis. These are only small signal level currents and are not hazardous in any way but are necessary for proper operation of the inverter. If the neutral (white) wire is not grounded, nothing will limit the voltage between the AC output line and chassis ground. If this potential exceeds 1000 V, the capacitor between ground and neutral may fail and hence the inverter will not function. A similar situation exists with battery ground and chassis.

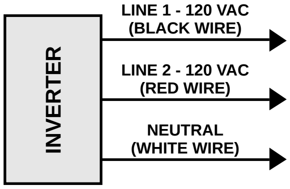
AC neutral, chassis, and battery should be grounded at the same point. A wire should be connected from those 3 points to the same grounding rod.



BETTER CONFIGURATION

235 Vac Grounding 6.3

235 Vac output is designed for the North American bi-phase standard. This is achieved with 2 inverter modules by setting one with a voltage output 180 degrees out of phase with the other. The result is 3 possible output combinations.



The inverter has 117.5 Vac phase 1 output from Line 1 (BLK) to neutral (WHT), 117.5 Vac phase 2 from Line 2 (RED) to neutral (WHT) and hence 235 Vac from Line 1 to Line 2. The advantage of this configuration is that power can be taken from the inverter in any combination of 117 / 235 so long as output current limit of either of the single phase inverters is not exceeded. Any degree of imbalance is allowed. For instance in a situation of a 2000 watt inverter with 1000 watts per phase, any of the following situations are acceptable: It may supply up to 1000 watts off phase 1 and up to 1000 watts off phase 2 simultaneously. It may supply 2000 watts to a single 235 Vac load or some combination that adds up to 2000 watts total, or 1000 watts per phase. A combination may be used like 1000 watts at 235 Vac, 500 watts 117 Vac on phase 1 plus 500 watts at 117 Vac off phase 2.

Outside of North America, most of the world uses a single phase 220 Vac to 240 Vac power system. The inverter while designed specifically for the North American standard can safely power any appliance made for these systems.

3 Wire Systems 6.3.1

This system is used on appliances with a metal case. The premise is if one of the line conductors shorts to the chassis, a circuit breaker in the AC supply system should open. This will occur exactly the same way in the inverter. The inverter will sense a short between one of the line outputs and neutral, or (chassis) ground. It will supply its short circuit current for approximately one second and then shut off both phases. This acts exactly like the required circuit breaker.

2 Wire System 6.3.2

This system is used when the appliance is double insulated or reinforced insulation is used. In this case the appliance is made such that either line can be “HOT” since the plug is generally made symmetrical. It does not make any difference to the electronics what the potential to ground may be. In this case there is no ground wire to short to and hence ground potential makes no difference. Some users have asked why they cannot connect one of the lines to ground and leave the neutral terminal floating. Unfortunately, the inverter may not survive this type of connection for reasons similar to those mentioned above in grounding. The inverter depends on the neutral terminal to be “ground”. If the neutral is left floating in the 235 Vac case it will ultimately be at 117.5 Vac relative to the inverter chassis. As mentioned before, the inverter cannot stand high currents flowing in the chassis. If 117 Vac is energizing the neutral and no voltage energizing the chassis it has the same effect as putting a current through the chassis because of the potential difference between neutral and chassis. This causes unexpected feedback currents between the battery negative terminal and neutral. These currents ultimately will cause the inverter to fail.

MX Stacked Rack Numbering System

S _ _ _ _ _ _ _ _ _ _ _ _ _ _

1. Indicates a Stacked Rack system
2. Number of phases 1, 2, 3
3 Cage code 1A, 2A, (for main rack from MX System Model Chart.)
4. Alarm Card or Transfer Switch A00, A02, B00, C00, X00, S01, etc. (**A** * will be for unpopulated system with configuration for alarm only)
5. Control Card, Master Modules, per phase (per MX brochure) C*, CC, M*
6. Number of Power Module, per phase 01 to 20 use (*'s) for no power modules
7. Voltage 1, 2, 4, E, I
8. Frequency 2, 4, 5, 6
9. M Option: Always has 2 characters, no option is 00

All stacked rack part numbers must be 15 characters long.

120V 1 PHASE w/ALM NO POWER MODULES	S12AA02****4600
120V 2 PHASE w/XFER 19IN RACK	S21AW00CC034600
208V 3 PHASE w/ALARM 23IN RACK	S32AA02CC064600
120V 1 PHASE w/MONT II w/COMM & SOLID STATE XFER SWITCH	S12AC0CCC064621

*Staked systems contain 2 cages unless otherwise specified by an M option.

Made in the USA

931-MM*M*-*0I

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