MX SERIES OPERATION AND INSTALLATION MANUAL

EXELTECH
7317 Jack Newell Blvd North
Fort Worth, Texas 76118-7100
817.595.4969 voice, 817.595.1290 fax
800.886.4683 toll free
e-mail address info@exeltech.com
e-mail address sales@exeltech.com
website www.exeltech.com

Manufacturer of UL Listed Products

TÜV MANAGEMENT SERVICE ISO 9001 TL 9000

TL 9000™
The Telecom Quality Measurement System

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Acknowledgments
Project Management: Ben Baker and John Goetz
Writing: Gary Chemelewski
Copy Editing: Ben Baker
Art, Photography and Layout: John Goetz
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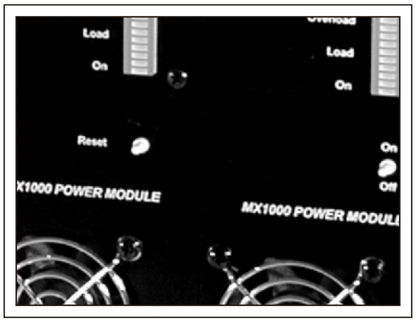
Exeltech
7317 Jack Newell Blvd North
Fort Worth, Texas 76118-7100



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 with American parts, 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 it's 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. 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 (W), which is power the inverter can actually deliver. If Exeltech inverters were specified in VA, Our 1100 Watt inverter could be rated at 1375 VA at .8 power factor, 1570 VA @ .7 pf, or an incredible 2200 VA @ .5 pf. It is confusing to specify a product in VA, because the power factor must also be specified. Exeltech's XP-Series inverters can output their full rated power continuously at 30° C (86° F).

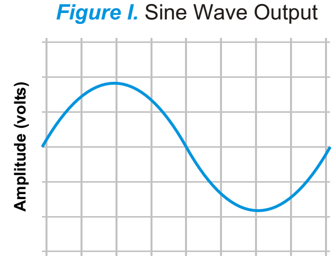
The inverter can maintain a spectrally pure output with any load, due to a specially designed non-linear control loop in the primary DC to DC converter. This circuitry is one of three circuits which protect the inverter from any overload condition.

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

Waveform

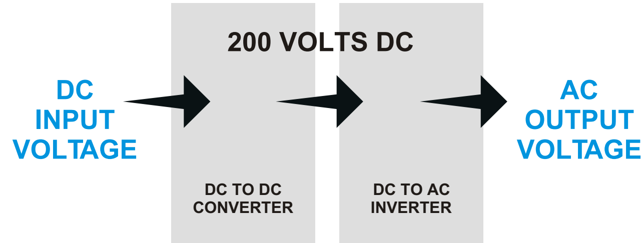
The inverter is designed to convert DC power from a Battery system into AC power. Exeltech inverters are unique in that they provide a pure clean AC Voltage independent of input battery voltage or changes in output loads. The AC output is a true sine wave, meaning that output voltage changes smoothly 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.

Figure I. Sine Wave Output



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 a more detailed explanation of operation, refer to appendix A.

Figure II. Block Diagram



The building blocks of the system are as follows:

1. Power Module - A 1000 Watt slave power inverter. It requires drive signals from a Master Module or Control Card as described below. This module is the backbone of the inverter system and will be the majority of modules in most systems. Supplies up to 1000 Watts of continuous 120 Vac power. In a redundant configuration, Power Modules can be added or removed at any time without disruption of power. Each Power Module has built-in self monitoring circuits to detect problems and "shutdown" if a problem is detected. Each Power Module has LED indicators that allow the operator to monitor relative load and overload conditions. A "RESET" is provided to "reset" the module if tripped accidentally. The bottom LED of the LED bar graph must be "ON".

DC POWER ON LED, (green, bottom segment of bar graph),*will be "ON" when DC power is available and the Power Module is functioning normally.

OUTPUT CURRENT LED, (green, segments 2,3,4,5; yellow segments 6,7,8),* indicates relative output current. The LED is peak sensitive RMS calibrated. This will tend to display a higher current than the Power Module is actually producing, especially on high crest factor electronic loads.

OUTPUT CURRENT OVERLOAD LED, (red, segments 9 and 10),* indicates output current may be in excess of rated power.

RESET SWITCH,* resets the Power Module if "tripped" accidentally.

* located in the front panel

Operation of the Power Module

There is one LED bar graph and one reset button on each module. The bar graph is a peak responding, RMS calibrated representation of output current. This meter will read properly when loads are resistive. As all meters 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 quite high. In fact 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 however, for the inverter to be operating totally within it's capabilities when the bar graph indicates full scale.

2. Master Module - A 1000 Watt power inverter which contains all the electronics necessary to operate. It requires an enclosure to provide connections to the battery and AC output. This module can also operate from 1 to 19 slave Power Modules. If this module is used to operate slave modules, the system cannot be fully redundant. Supplies up to 1000 Watts of continuous 120 Vac power.

Each Master Module has LED indicators that allow the operator to monitor relative load and overload conditions. An "ON/OFF" switch is provided to power the module. The bottom LED of the LED bar graph must be "ON".

DC POWER ON LED, (green, bottom segment of bar graph),* will be "ON" when DC power is available and the Master Module is functioning normally.

OUTPUT CURRENT LED, (green, segments 2,3,4,5; yellow segments 6,7,8),* indicates relative output current. The LED is peak sensitive RMS calibrated. This will tend to display a higher current than the Master Module can supply, especially on high crest factor electronic loads.

OUTPUT CURRENT OVERLOAD LED, (red, segments 9 and 10),* indicates output current may be in excess of rated power.

ON / OFF SWITCH,* turns "on" or "off" the Master Power Module.

*located in the front panel

3. **Control Card Module -** Provides all control functions for power modules. Adding a second module provides redundant operation as only one Control Card is required to operate the system. In case the primary Control Card fails, transfer to the secondary Control Card is automatic. Control Cards can be "removed" or "inserted" without disruption of the unit, providing one module is installed at all times.

This card will generate all signals necessary to operate up to 20 Power Modules. The card itself will not generate any power flow through it. This card can be paralleled with another Control Card to generate a redundant set of control signals to form the basis of a completely redundant inverter system.

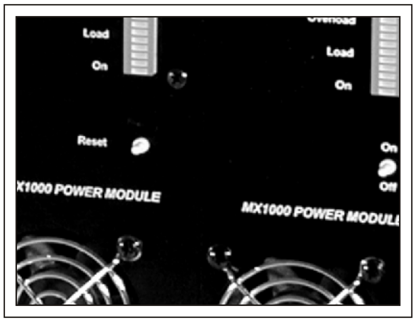
The control card or a master module produce a reference to the DC to AC converter from a crystal oscillator running at 512 times output frequency. The resulting square wave at the reference frequency is filtered to its fundamental frequency component only. This output is then used as a reference for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

DC POWER ON LED (green),* will be "ON" when the Control Module is providing all control signals for the Inverter.

RESET SWITCH,* resets the Control Module if "tripped" accidentally. This switch acts as a transfer switch when redundant Control Modules are used. Control Card #1 (left) must be active for the system to be redundant.

* located in the front panel

Exeltech manufactures a complete line of power inverters. This manual covers all possible configurations of an Exeltech MX series inverter with 19 inch cage or 23 inch cage, available from 1000 Watts to 20,000 Watts.



Standard Features
2.0

DC INPUTS: 12 VDC ; 24 VDC ; 32 VDC ; 48 VDC ; 66 VDC ; or 108 VDC. Hard-wired. Recommend a maximum ripple voltage of less than 5% of nominal Vdc with no part of the ripple voltage going below Vmin or above Vmax.

REMOTE ON/OFF: Provides the User with a remote method to turn the inverter on and off. "REMOTE" connection is on a terminal block connector located ON THE BACKPLANE. (Connect battery NEGATIVE to this terminal 'RMT' to turn inverter "ON". There is no current flow in this lead. The remote switch and front panel switch are wire "ORed" together, If either switch is "ON", the inverter will turn on, and both must be "OFF" to shut off the inverter. Make sure front panel switch is in the "OFF" position to control with the remote switch).

ALARM SWITCH MODULE
Provides various alarm output signals to the user via LED's and alarm contact closures. It must be included in redundant systems to detect failure of control card. See APPENDIX D - OPTIONS for more details.

TRANSFER SWITCH MODULE
Provides various alarm output signals to the user via LED's and alarm contact closures. It must be included in redundant systems to detect failure of control card. The Transfer Switch Module will provide a relay to transfer AC power to the load from either the inverter or utility input. Use only with systems 7KW or less. See APPENDIX D - OPTIONS for more details.

REMOTE FOR PRIMARY SOURCE (WITH TRANSFER SWITCH MODULE ONLY)
Provides the User with a remote method to operate inverter on alternative source. (ie. Front panel switch is in Inverter Primary and if remote switch condition is changed, Inverter will switch to Utility Primary; overrides front panel selection and Reverse Primary LED will turn to "ORANGE"). "PRIMARY SOURCE REMOTE SELECTION" connection is on the terminal block located ON THE BACKPLANE. (Connect battery NEGATIVE to this terminal 'BREAKER OPEN or BRKR / RVRS' to select source. There is no current flow in this lead).

AC OUTPUTS: 100 VAC ; 117 VAC ; or 230 VAC (+ / - 6%). Hard-wired. 60Hz ; *50Hz ; and *400Hz (+/- 0.1%). * = optional

POWER MODULES
COOLING is provided by thermostatically controlled fans located on the Front Panel of MX Master Module and MX Power Modules. These fans only run as required, it will take 5 to 7 minutes for them to turn on at full power.

POWER ON LED located on the front panel and will be "ON" when power is available and the inverter is functioning normally. (The bottom LED of the bar graph is an ON indicator and should be illuminated any time the inverter is powered up. This LED should be ON in all installed Power Modules and Master Modules).

LED BAR GRAPH: there is one LED bar graph on each module. The bar graph is a peak responding, RMS calibrated representation of the output current. This meter will read properly when loads are resistive. As all meters however, when output current is non-linear, the meter will tend to show higher output than is actually being provided.

LOW BATT / THERM BUZZER: produces an audible alarm if DC input voltage falls to a level within 2% to 4% of the low limit of the inverter, or, if there is an over temperature condition. Master Module based systems only.

ON/OFF SWITCH: located on front panel and turns the inverter on and off. Found on Master Module, Transfer Switch Module or Alarm Card Module.

OVER VOLTAGE PROTECTION: 'Shutoff at maximum input voltage, per input conditions.' If input voltage to the inverter exceeds set limits, the inverter will immediately and without warning shut off. When voltage returns to normal range, the inverter will immediately restart. This urgency exists because input over voltages tend to happen very rapidly and can cause damage to the inverter if it stays running. There is a small amount of hysteresis built into the Over voltage turn off and turn on set points to avoid the possibility of the inverter turning off then rapidly turning on. No damage to the inverter occurs unless the amount of power in the surge is very high. Normally capacitors on the input of the inverter will absorb surge without damage. This kind of fault usually occurs if the battery is suddenly disconnected from the system and the battery charger continues to supply current.

UNDER VOLTAGE PROTECTION: 'Shutoff at minimum input voltage, per input conditions.' When battery voltage falls to a level within 2% to 4% of the low limit of the inverter, the LOW BATT / THERM buzzer will sound and/or contact closure. If the condition continues without reducing load to the inverter or adding charge to the battery, the inverter will shut off. This voltage level is called out on the specification sheet. When voltage rises to approximately 95% of nominal battery voltage, the inverter will turn back on and the alarm condition will clear.

OVER TEMPERATURE PROTECTION: '105 C internal temperature. Warning buzz 5 C before shutoff.' The inverter is also protected against overheating. 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. If the inverter LOW BATT/THERM buzzer sounds and/or contact closure, immediate action is required or the inverter will shut down. Either reduce load on the inverter or provide more cooling air circulating in the inverters immediate environment. If no action is taken the inverter will likely shut down within 2 minutes. When the inverter shuts down, the alarm condition will persist and the cooling fans will continue to run. Since the inverter has eliminated its load it will cool itself fairly quickly. The inverter will automatically restart when it has cooled sufficiently and the LOW BATT/THERM alarm will clear and/or contact closure.

OVERPOWER, SHORT CIRCUIT PROTECTION: 'Unit shuts off: Circuit breaker protected.' The inverter has two levels of overpower protection. The first, limits peak instantaneous current to 25 Amps per 1000 Watt Module. This acts to limit current with highly reactive loads. The second system limits absolute power coming from the module to just above 1000 Watts per module. Both of these circuits act to reduce output voltage as required to limit current to a safe level. The power limit circuit has two stages to allow the inverter to output 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 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 requires the user to clear the short circuit safely and guarantee that hazardous voltage will not come back on line until desired. To reset the inverter from this condition, cycle power switch “OFF” then “ON” again.

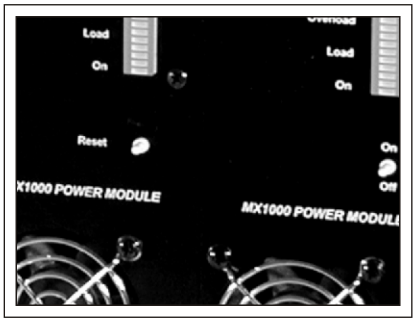
If output power is exceeded, output voltage is reduced to a level which will provide the inverter’s rated power to the load by clipping tops of the waveform. The inverter can operate safely in this mode indefinitely. The overpower protection circuit will recover instantly when the overpower condition clears.

ENVIRONMENTAL AND MECHANICAL SPECIFICATIONS:

Temperature: -25°C [-13°F] to 40°C [104°F] full power, derated above 40°C.
Humidity: 5% to 95% non-condensing.
Altitude: -200 feet to 10,000 feet full power, derated above 10,000 feet.
Audible Noise: less than 45dbA.
Cooling: 1,000Watts - Thermostatically controlled forced air.
Finish: Polyurethane base paint.
Warranty: Full year parts and labor.

Four case sizes are available; all are: 7 inches High x 15 inches Deep.

7 inch Wide: (For 1 or 2KW applications; shelf mounting only)
9.97 inch Wide: (For 1 to 3KW applications; shelf mounting only)
19 inch Wide: (Includes hardware for rack or shelf mounting)
23 inch Wide: (Includes hardware for rack or shelf mounting)
24 inch Wide: (Includes hardware for rack or shelf mounting)



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 APPENDIX C – Theory of Operation (Input Power)

WARNING: Inverter Chassis, and Neutral AC output lead must be connected together with either one of the Battery connections and bonded to Earth Ground to comply with most code requirements. See APPENDIX C - 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 48Vdc systems and Positive (+) for other DC Voltage systems.

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

CAUTION: Observe all National and Local Electric Codes when connecting AC Power Connections.

INSTALLATION (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. Gasses 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 weather. Keep it away from condensing water. The inverter will provide its full capability in ambient temperatures from -20°C (-4° F) to 40°C (104° F). As with all electronics, higher ambient temperatures will lead to a shorter life. There is little that can be done about ambient air temperature but 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. Therefore, when choosing a mounting location, consider the following requirements listed in order of importance:

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. This will allow warm air to rise through vent holes on top, drawing cool air through vent holes on the bottom.

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 wiring chart - APPENDIX A.

INSTALLATION (Wiring)

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 positive (+) terminal. To select the appropriate size fuse, consult “Rated and Peak Current”. See APPENDIX A**.**

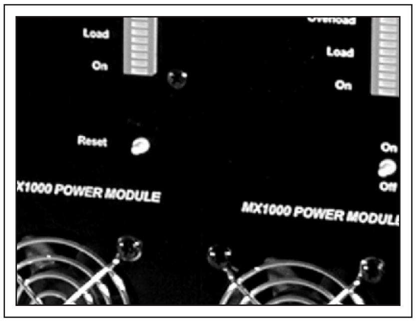
DC INPUT CONNECTIONS: Positive (+) and Negative (-) input terminals are 5/16" studs with brass hardware. They are provided under the Rear Cover. Choose appropriate gauge wire for your specific model and distance from the battery.

1. Disconnect **positive (+)** terminal of the battery and make sure the charger and inverter are <u>off</u>.
2. Make DC input connections to the inverter as illustrated.
3. (Optional) Using 18-22 AWG wire, make Remote On/Off connection from terminal on the Rear Panel labeled “RSW1” to one pole of a small toggle switch. Then from the other pole of toggle switch make a connection to battery negative (-).

4. Make sure the toggle switch is off.

Note; in order for Remote On/Off switch to operate the inverter, On/Off switch on the Front Panel <u>must be off.</u>

5. Load AC voltage connection will be hard wired from the Backplane of the inverter.



Operation

4.0

TURN ON Inverter:

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
- 100 watt heavy duty light bulb (to be used as initial dc bus discharge resistance, before connecting DC wires)

Start up procedure: (single phase system)

NOTE: Refer to APPENDIX B for System connections.

STEP 1: Make sure unit is safe and secure.
STEP 2: Remove rear cover of unit.
STEP 3: Do not connect AC load or commercial utility, until all checks are complete.
STEP 4: Verify that all front panel switches are in the "off" position and that primary selection switch is in the "utility" position (this last one, if using Transfer Switch Module).
STEP 5: Verify battery cables polarity. (Negative voltage and positive voltage - label wires if necessary).
STEP 6: Connect negative cable from battery bank to negative terminal of the unit backplane.
STEP 7: Connect positive cable from battery bank to positive terminal of the unit backplane. (Measure DC voltage - nominal +/- 6%)
STEP 8: Turn inverter "on" - switch is located on the Alarm Card Module, Transfer Switch Module or Master Module. Turn the inverter on using toggle switch on the front panel, or the "remote" switch if installed.
STEP 9: Measure output voltage from inverter: line ("hot"- black wire) - (located on the backplane) to neutral (white wire) - (located on the backplane). Reading should be nominal Vac +/- 6%.

NOTE: MAKE SURE THE SYSTEM IS WORKING ON THE (LEFT) PRIMARY CONTROL CARD MODULE. TO DO THIS, PRESS "RESET" AT BOTTOM OF PRIMARY CONTROL CARD.

Turn on load:

Check input power requirement of the load. Make sure that it is less than rated output power of the inverter. If more than one load will be run simultaneously from the same inverter, the sum of their input power requirements must be less than rated output power of the inverter.

If rated input power of the load is less than or equal to rated output power of the inverter, then follow next steps.

Steps 10 through 15 are for Transfer Switch OPTION only. If you have a basic system go to step 16.

STEP 10: Before connecting commercial utility to the inverter, make sure that commercial utility

breakers are “off.”
STEP 11: Turn inverter “off”.
STEP 12: Connect commercial utility line (“hot” - black wire) - (located on the backplane). Connect commercial neutral (white wire) to utility neutral (located on the backplane) and connect ground (green wire) to chassis ground connector.
STEP 13: Turn inverter “on”. Turn the inverter on using toggle switch on the front panel, or “remote” switch if installed.
STEP 14: Turn commercial utility breakers “on.”
STEP 15: Measure from commercial utility line (“hot” - black wire) to commercial utility neutral (white wire) - reading should be nominal Vac +/- 6%.
STEP 16: Before connecting load to the inverter, make sure that load breakers are “off.” (For a basic system you can turn inverter “on”). Turn the inverter on using toggle switch on the front panel, or “remote” switch if installed.
STEP 17: Measure line (“hot” - black wire) load (load connector) to neutral (white wire - load connector). Reading should be nominal Vac +/- 6%.
STEP 18: Test unit with a low load first to verify system operation, then increase load to desired level being careful not to exceed design specifications. Lower LED of the LED bar graph will illuminate, indicating the inverter is operational.
NOTE: If using “REMOTE” switch, the Front Panel Switch must be off.

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, Power should be disconnected from the inverter system.

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

STEP 1: Shut off power to inverter.
STEP 2: Loosen 2 Thumb screws on front Panel of the inverter. They should become completely loose from the rack, yet remain captive in the Power Module front panel.
STEP 3: Remove rear cover of the inverter rack.
STEP 4: Remove 2 brass screws that connect backplane to the Power Module.
STEP 5: Remove Power Module by pulling on the front handle; some force will be required.
STEP 6: Install new module insuring that ribs on the edge of heatsink are in grooves of the plastic slides.
STEP 7: Seat module firmly into connector and tighten two front panel thumb screws. Need to loosen and tighten top and bottom 2 turns at a time. Inverter will not seat in connector until thumb screws are completely in.
STEP 8: Install two brass screws through the backplane battery bus bar connections.
STEP 9: Re-install back cover (4 screws).

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

STEP 1: Shut off power to inverter. (Step 1 only for Non-redundant System. In Redundant systems, modules are “Hot-insertable”).
STEP 2: Loosen 2 Thumb screws on front Panel of the inverter. They should become completely loose from the rack, yet remain captive in the Power Module front panel.
STEP 3: Remove Power Module by pulling on the front handle; some force will be required.
STEP 4: Install new module insuring that ribs on the edge of heatsink are in grooves of the plastic slides.

STEP 5: Slide module in until it just touches the rear connector (first sign of resistance). Exert pressure slowly on front of module (over a 10 sec period) until module enters connector.
STEP 6: Seat module firmly into connector and tighten two front panel thumb screws. Need to loosen and tighten top and bottom 2 turns at a time. Inverter will not seat in connector until thumb screws are completely in.
STEP 7: Module should power up and level with other module(s).

Master Power Module 24 - 108Vdc range System
Remove and Replace Procedure

STEP 1: Shut off power to inverter.
STEP 2: Loosen 2 Thumb screws on front panel of the inverter. They should become completely loose from the rack yet remain captive in the Power Module front panel.
STEP 3: Remove Power Module by pulling on the front handle, some force will be required.
STEP 4: Install new module insuring that ribs on the edge of heatsink are in grooves of the plastic slides.
STEP 5: Seat module firmly into connector and tighten two front panel thumb screws. Need to loosen and tighten top and bottom 2 turns at a time. Inverter will not seat in connector until thumb screws are completely in.

The module does not and 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 slow.

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.
Insure they are using 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 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.

APPENDIX A

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):

CONTINUOS 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):

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

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

Po / .85 = Pin / VBat = DC Amps

Knowing DC Amps, distance from the inverter, and voltage drop between the inverter and battery to be less than 2% at Low-Line Input Voltage, we can verify cable size in the National Electrical Code Book.

Wiring between inverter and battery bank should be as short as possible and of a gauge at least as great as 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, then read the size wire cable 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:

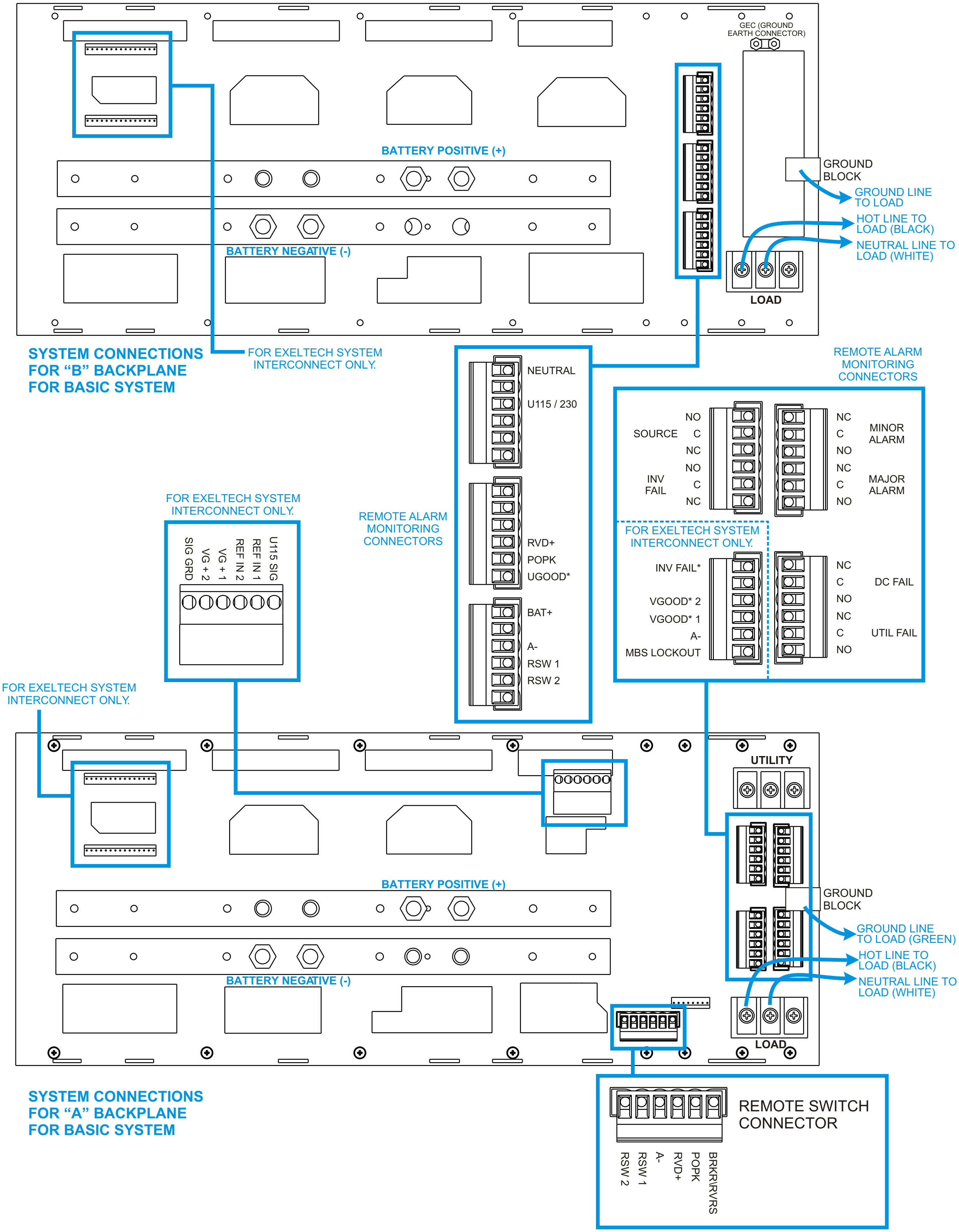
MODEL	LESS THAN 5’	LESS THAN 10’	LESS THAN 15’	LESS THAN 20’
12 VDC	-	-	-	-
24 VDC	-	-	-	-
32 VDC	000 AWG	-	-	-
48 VDC	0 AWG	000 AWG	0000 AWG	SEE NOTE
66 VDC	2 AWG	0 AWG	00 AWG	000 AWG
108 VDC	6 AWG	4 AWG	2 AWG	0 AWG

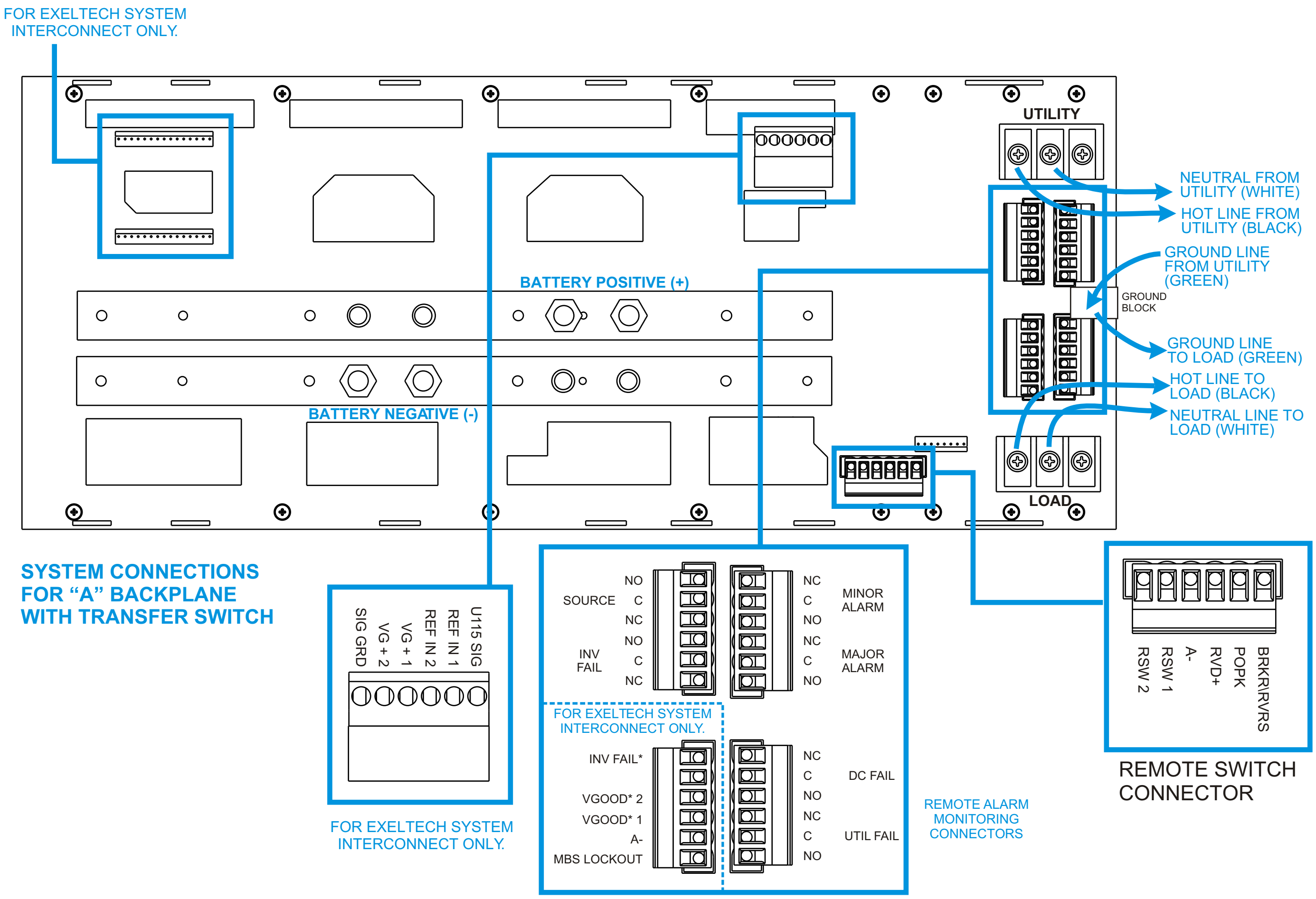
NOTE: a 20ft run , 20KW system, 48Vdc input, and 1.7% voltage drop will require a 600kcmil wire gauge.

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%

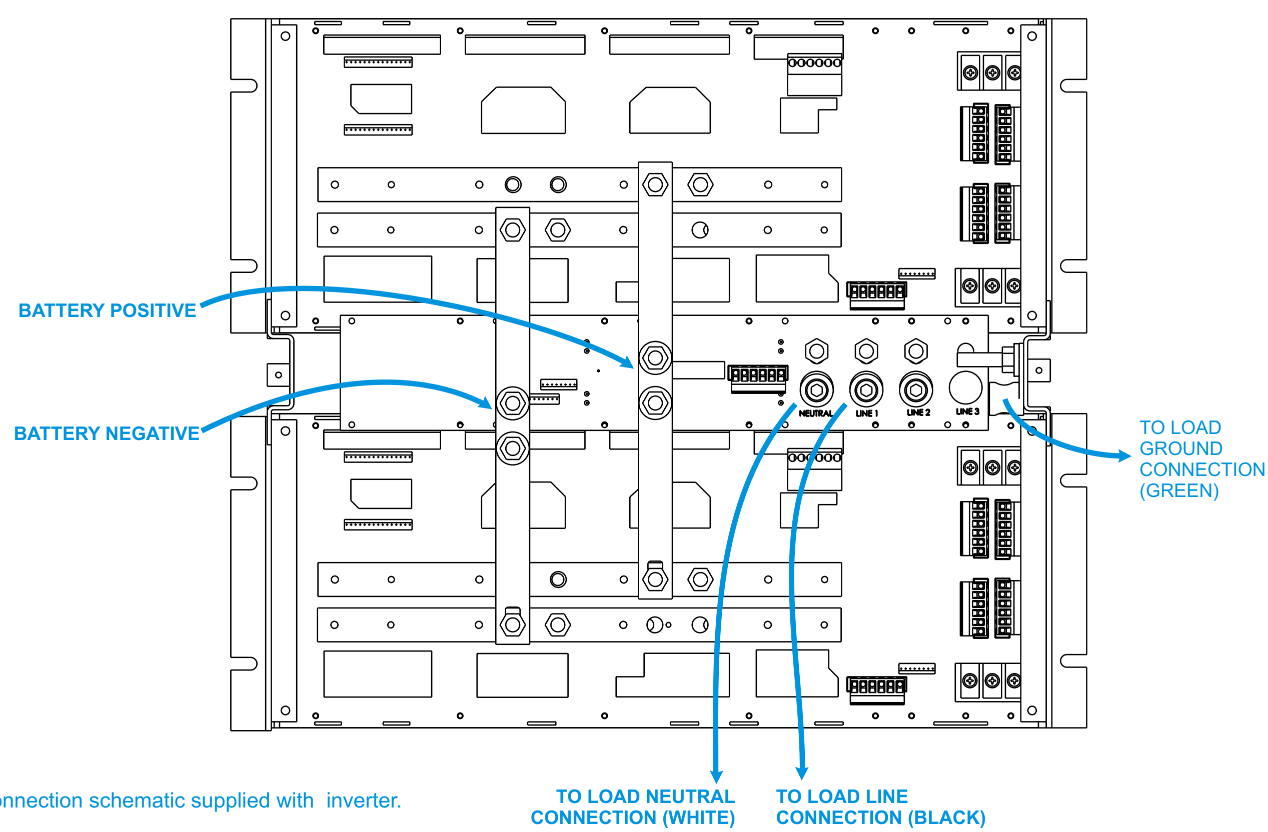
APPENDIX B


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
BRKRIRVRS



SYSTEM CONNECTIONS FOR "A" BACKPLANE WITH TRANSFER SWITCH

SYSTEM CONNECTIONS FOR BASIC STACKED CAGE



See connection schematic supplied with inverter.

APPENDIX C

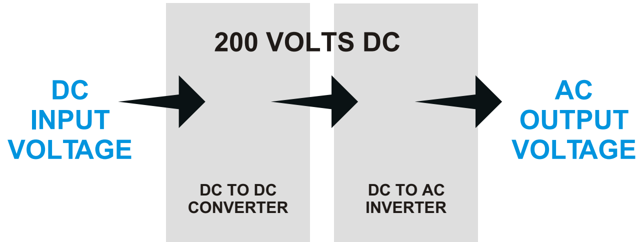
Theory of Operation

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 inverters 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 run.

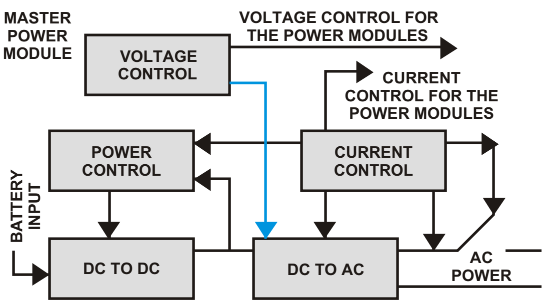
Many inverters are rated in Volt-Amps (VA) as opposed to Watts. This is in an attempt to make an inverter or UPS (Uninterruptable Power Supply) appear larger than it really is. The only fair way to spec a product is in Watts (W) which is the real power the inverter can deliver. If Exeltech inverters were to be specified in VA, the 1000 Watt inverter could be rated at 1250 VA, at .8 power factor, 1430 VA @ .7 pf, or an incredible 2000 VA @ .5 pf. It is confusing to spec a product in VA because the power factor, must be specified. However a power factor is only valid for linear loads such as motors which have an inductive component at light loads. The majority of loads are electronic or non-linear, for which a power factor can not be easily specified. 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 totally a function of the load as to how current will flow in the circuit. It may be incredibly non -inear 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, owing 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, 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 maximum peak current does not exceed 22 Amps. Should this number be exceeded, it will again reduce output voltage as required to maintain the limit. Again, the inverter can operate in this mode indefinitely, so that when the overload clears, output voltage is automatically restored. If the inverter stays at it’s maximum 22 Amp 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 .5ohms per 1000 Watts. This guarantees the inverter is disabled in the event a technician works to clear the short without first shutting off the inverter. The inverter in fact acts as an extremely high performance circuit breaker. The short circuit and overload circuitry responds much faster than any normal fuse or breaker, so 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 may be smaller than the inverters 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, even at low DC input extremes.



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 made; 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 control card which tell it exactly which voltage to output. The power module contains circuitry to regulate its output current to the same as all other modules, and take itself off line if it cannot match that current. The alarm card monitors the output of the inverter system and if output voltage cannot be maintained, it tries the other control card. It also sets various alarms if inverter performance is impaired.



The power module consists of two pulse width modulation (PWM) circuits in series. A DC to DC converter, which takes input voltage from the battery up to an intermediate high voltage. This converter regulates high voltage output, and acts as 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. Since DC voltage is known and regulated, power is strictly a function of current at this point. Current limit, therefore power limit, is regulated to maintain the inverters output power to 1000 Watts. It allows this current to exceed its rated current for 3 seconds, at which time it will limit current back to the rated power current limit. The bandwidth of this regulator is very slow (ie. < 30 HZ). This is done intentionally so that current draw from the battery system is an average of current demand over a period of 1 cycle. Enough energy is stored at this low current high voltage point to supply instantaneous demands of the load and to provide storage of reactive currents caused by the load. This current limit is also non-linear, such that if it detects a sudden change in output current demand, it opens bandwidth to respond in less than 1 millisecond to load demand.

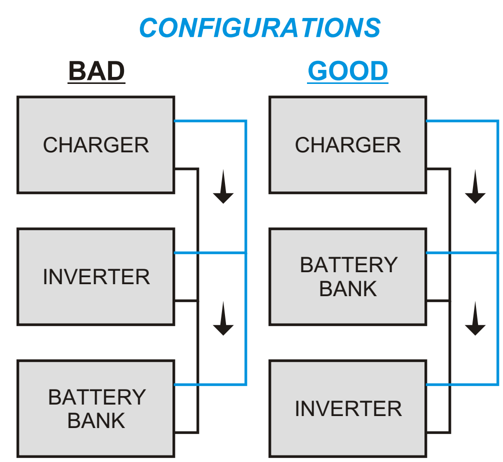
The DC to DC section is followed by a patented DC to AC converter. It is unique in that it can provide instantaneous currents to 3 times its rated capacity, it can supply voltages both positive and negative of true ground, source or sink reactive currents without regard to voltage phase and can be paralleled for higher power. This section alternately provides a positive, negative or 0 volt 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 to this is very quick (25 Khz), to protect 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 voltage to collapse. When this condition is detected, it will shut off the inverter completely. The operator will have to recycle 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 it's output current. In this way all modules tend to level themselves to the highest module. If a module cannot level itself to within about 2 bars of the others it will take itself off line. The circuitry that determines this is fail safe in that any failure in the circuitry will cause the module to go off line.

The control card or master module produces a reference to the DC to AC converter from a crystal oscillator running at 512 times output frequency. The resulting square wave at the reference frequency 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 allows the engineers feedback to improve the design even further. Calculations of the most recent revisions of the board indicate MTBF numbers greater than 40 years may be attained.

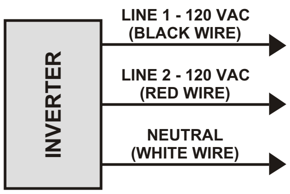
Input Power



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 power supply voltage to collapse again and the cycle will continue. Depending on the dynamics of the interaction between the inverter, supply and the load, 3 situations may occur. The load may eventually turn on. The system may continue to “motorboat” indefinitely. The inverter, load or power supply may be damaged.

Grounding

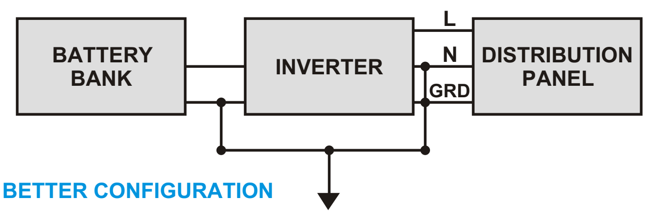
The input and output of the inverter are isolated with a minimum of 1500 Vac. This isolation guarantees hazardous voltage from the input will not reach the output, and conversely the inverter is designed to have both the input and output grounded. The inverter is compatible with negative or positive 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. That is, a wire should be connected from those 3 points to the same grounding rod. The following set of illustrations show possible combinations. All schemes except the last one attempt to eliminate the possibility of high currents flowing through the chassis of the inverter. The last scheme shows two separate grounding rods at different locations as may occur if the inverter is installed in a remote equipment shed. If a nearby lightning strike occurs in this situation, there could be a great potential difference between the ground rods. This would cause a high current to flow through the ground wires, then the inverter chassis, and finally to ground via the battery ground. This high current may cause a voltage to appear across the case of the inverter which would then cause parts of the inverter electronics to see two different ground potentials. If the ground potential difference is great enough it can damage integrated circuits within the inverter.

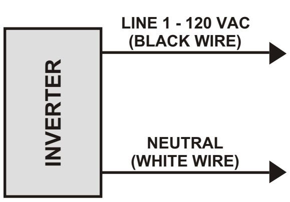


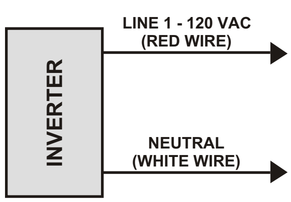
BETTER CONFIGURATION

235 Vac Grounding

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.



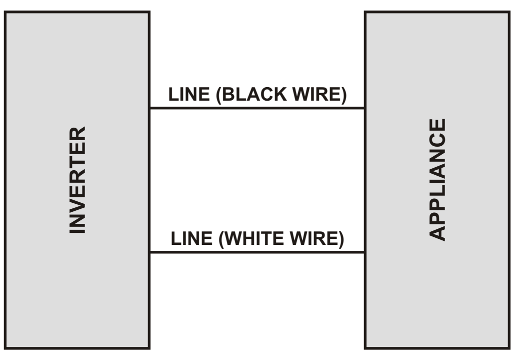


It is important to note that the neutral wire must be grounded in this situation for the same reasons stated above.

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. All electronics are designed such that a single fault will not subject the user to a hazardous voltage. This will remain true even if the inverter is used to power with the neutral connected to ground rather than one of the line conductors. Two situations are possible:

3 Wire systems
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
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. It is typically tested to 1500 Vdc from either phase to ground. 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 230 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 cause the inverter to fail.

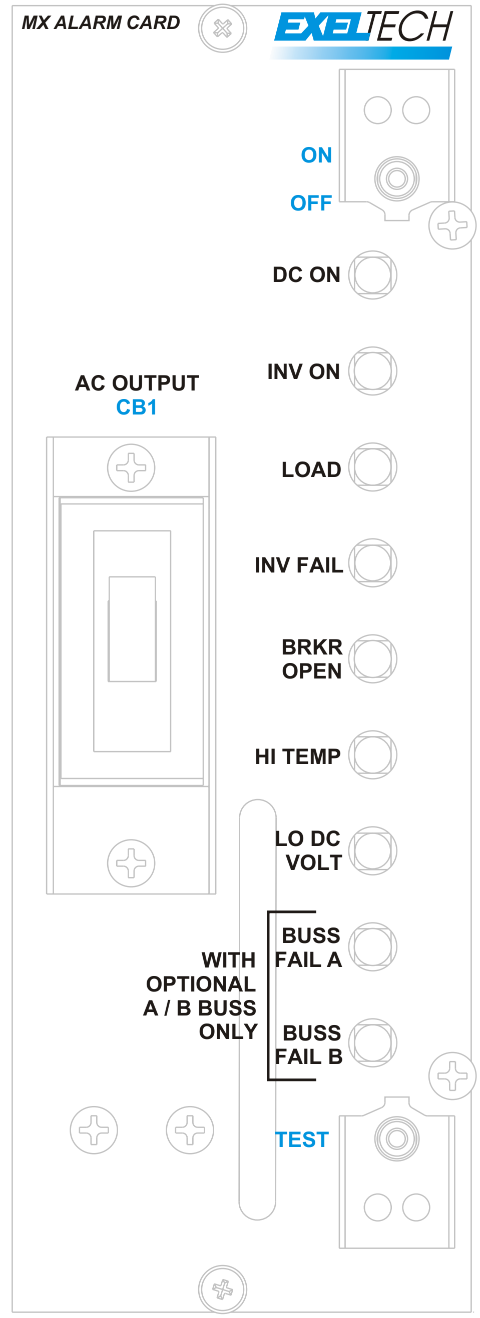


APPENDIX D

Alarm Card - A2 (Without AC Breaker) A5 (With AC Breaker)

Note: With an Alarm Card system there must be a Control Card in the Left Slot.

NOTE: MAKE SURE SYSTEM IS WORKING ON THE (LEFT) PRIMARY CONTROL CARD MODULE. TO DO THIS, PRESS "RESET" AT BOTTOM OF PRIMARY CONTROL CARD.



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 "ON" (green) when DC power in specs.; Orange - DC power in warning range or low voltage; Red - Inverter OFF or DC power out of range.

INV ON LED:* Indicates that the Inverter is operating within specified limits. Overload (orange) and fail (red).

LOAD LED:* Indicates that output power is being supplied to the "Load" (green) or "OFF" (red).

INV FAIL LED:* Indicates a power "failure" (red), indicates an Inverter Module failure, Control Card or system overload.

BRKR OPEN:* Indicates that output power is NOT being supplied to the "Load" (green) is "ON" or "OFF" (red).

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

LOW VOLT DC LED:* Indicates that the Inverter is operating under specified limits. Fail is "Red".

BUSS FAIL A LED:* With optional A / B BUSS only.

BUSS FAIL B LED:* With optional A / B BUSS only.

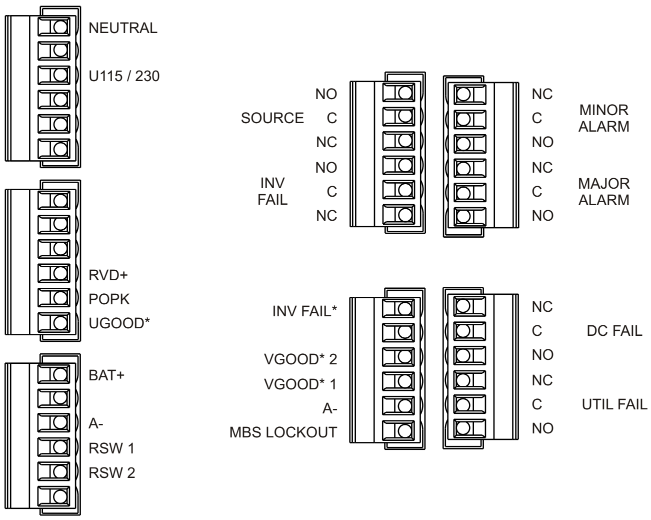
EXELTECH'S modular Alarm Card can be added to 23" and 19" cages.

LED ALARMS: The Alarm module contains LED indicators that monitor DC Voltage, Module Fail, Temperature, Load, and Inverter.

* located in the front panel

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.

Make sure that JUMPER on the Backplane is present from [MBS] to [A-] in order for Transfer Switch to operate. Normally installed. (Removing forces switch to utility).

MINOR ALARM: energize in case of any “soft” failure; unit in bypass, module fail, inverter fail (if utility is OK).

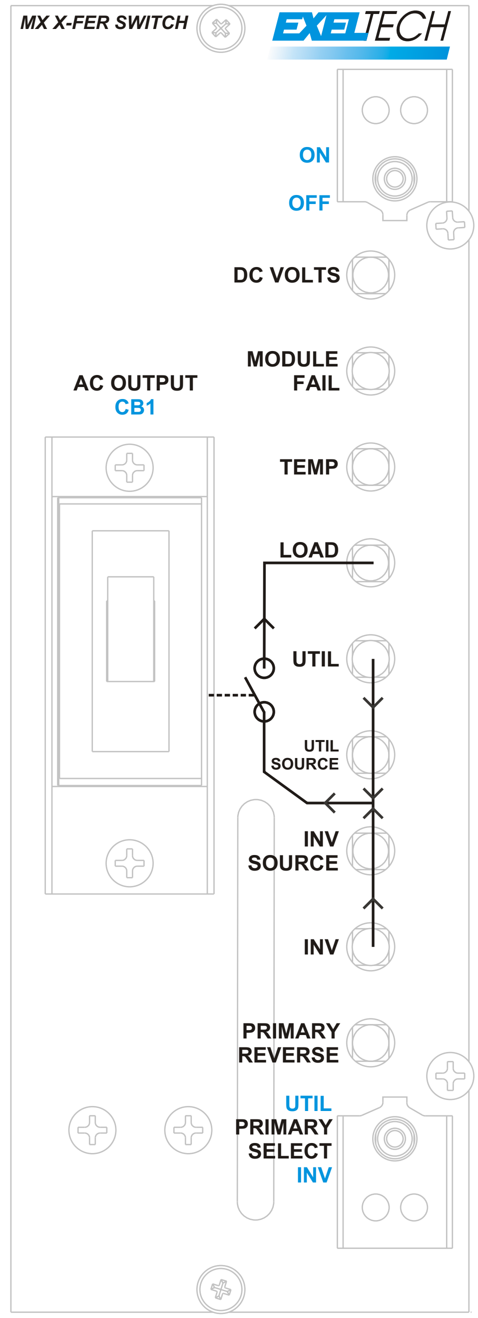
MAJOR ALARM: energize in case of no AC to load, breaker open, utility and inverter failed or out of limits.

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

INV FAIL: energize when no AC out of inverter.

DC FAIL: energize when DC is out of limits.

UTIL FAIL: energize when utility is out of limits.



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 Settings: 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:* UP is "ON" and DOWN is "OFF".

DC VOLTAGE LED:* Will be "ON" (green) when DC power in specs.; Orange - DC power in warning range or low voltage; Red - Inverter OFF or DC power out of range.

MODULE FAIL LED:* Indicates a module "failure", indicates an Inverter Module failure, Control Card failure or system overload.

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

LOAD LED:* Indicates that output power is being supplied to the "Load". Main AC Breaker "ON" (green) or "OFF" (red).

UTIL LED:* Indicates that Commercial Power is operating within specified limits (green); overload (orange) and fail (red).

UTIL SOURCE LED:* Indicates that Commercial Power is supplying power to the "Load". Present (green) and not present (red).

INVERTER SOURCE LED:* Indicates that the Inverter is supplying power to the "Load". Present (green) and not present (red).

INV LED:* Indicates that the Inverter is operating within specified limits. Overload (orange) and fail (red).

PRIMARY REVERSE:* Indicates Service is reverse (orange). Normal is off.

SELECT SWITCH:* UP is "UTIL" and DOWN is "INV" PRIMARY SOURCE selection switch, located on the front panel, indicates which source has been selected as the primary source.

*** located in the front panel**

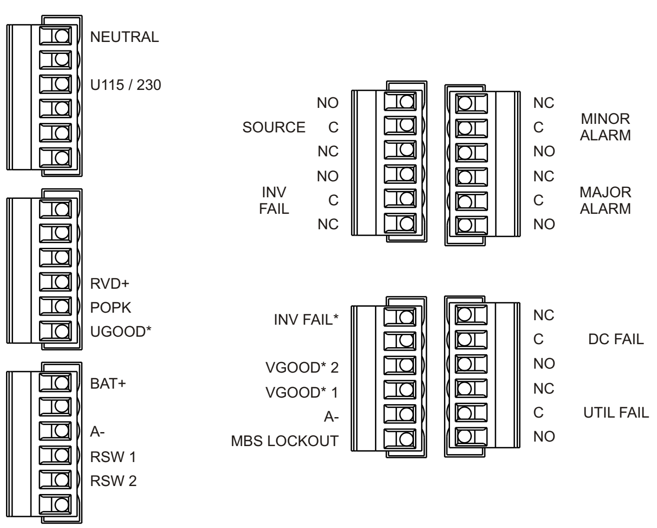
EXELTECH'S modular transfer switch can be added to 23", 19", 9", and 7" cages. The transfer\ switch allows the inverter to automatically switch between inverter power and a secondary source of AC power. The transfer switch has a maximum capacity of 50Amps and a typical transfer time of 4ms. When used in an assembly rack, can optimally do 75Amps. Primary power is selectable via a front toggle switch. (i.e. you can run off the inverter and switch to utility when there is a problem, or run off utility and switch to inverter if there is a problem).

TRANSFER CONDITIONS: The transfer module will switch from its primary source when voltage of that source drops below 105Vac or above 135Vac. The transfer module will transfer back to primary source when the voltage of that source goes above 110Vac or below 130Vac. The transfer switch can be programmed to re-try primary source upon return to normal voltage, or it can be programmed to stay in secondary source until 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 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.

Make sure that JUMPER on the Backplane is present from [MBS] to [A-] in order for Transfer Switch to operate. Normally installed. (Removing forces switch to utility).

MINOR ALARM: energize in case of any "soft" failure, unit in bypass, module fail, inverter fail (if utility is OK).

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

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

INV FAIL: energize when no AC out of inverter.

DC FAIL: energize when DC is out of limits

UTIL FAIL: energize when 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

J 2 open is don’t care with J 1 open. J 4 open is don’t care with J 3 open.
J 1 and J 3 open default - Transfer will re-try on restoration of valid system.
J 1 and J 3 closed - will latch on Overload.
J 2 closed - a complete failure will Reset latch of J 1 or J 3.

Default Condition is ALL JUMPERS OPEN.

APPENDIX E

Battery Type

The following section will help you make the correct choice.
Use only Deep cycle batteries for extended use. These batteries are designed to be repeatedly discharged to 50% of their capacity then fully recharged. If used in this manner they will last through hundreds of charge, discharge cycles.

Most people are familiar with lead acid batteries in their vehicles. These batteries are designed to output a large amount of current for a short period of time then be completely recharged. Deep discharging these batteries seriously degrades their life. They are not recommended for powering inverters for any length of time.

There are many types of Deep Cycle batteries available from distributors. A 105AH Deep cycle battery is used in sample calculations below.

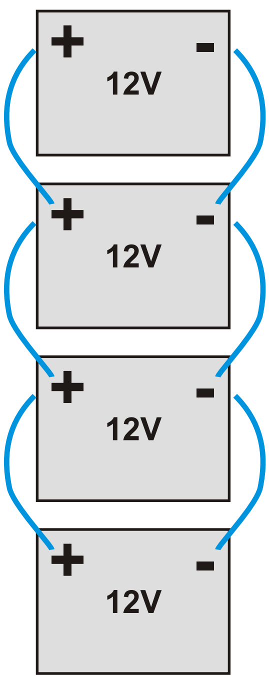


Figure 4a

Watt-Hour conversion

All calculations will be in Watts and Watt-Hours since this makes calculations independent of input voltage. Most batteries however are rated in amp-hours. It will be necessary to convert this to Watt-Hours.

From OHM's Law :
Voltage is equal to current times resistance V = I x R
and Power is equal to current times voltage P = I x V

Watt-Hours = Amp-Hours x Battery Voltage

for example: to find out how many Watt-Hours in a 100AH 12Vdc battery.

100AH x 12 Vdc = 1200 Watt-Hours

Therefore a 12Vdc 100AH battery has 1200 Watt-Hours of capacity.

Watt-Hour capacity of a battery bank is the sum of all batteries connected in the system. For example four 100AH batteries (1200 Watt-Hours each) result in a 4800 Watt-Hour battery Bank (4x 1200 = 4800). As shown in figure 4a. This is true despite terminal voltage of the battery bank, assuming the rules for connecting them described in the next section are followed. These four batteries for instance may be connected for a battery bank terminal voltage of 12 Vdc, 24Vdc or 48Vdc.

Battery Bank Configuration

A battery is typically a collection of cells connected in series to give the desired output voltage and Watt-Hour capacity. For purposes of this manual, a battery bank is defined as a series, parallel or series-parallel connection of batteries to give a desired battery bank terminal voltage and Watt-Hour capacity.

Again we will use 100AH batteries for our examples. These batteries have a terminal voltage of 12Vdc. They may be connected in series to give higher voltages. Connecting two batteries in series, positive terminal of one battery connected to the negative terminal of the other as shown in figure 4b, will make a battery bank with a 24Vdc terminal voltage. It is important that all batteries in this series connected branches be of exactly the same capacity. If not, the branch will only have the Watt-Hour capacity of the smallest battery. They may also be connected in parallel to give higher capacity. As shown in figure 5, connecting the positive terminal of one battery to the positive terminal of the other. Connect negative terminal of the first battery to negative terminal of the second battery. This results in a 12Vdc battery bank with a capacity of 2400 Watt-Hours. Batteries of dissimilar capacities may be connected in parallel without any detrimental effects. These batteries must however be of the same type. That is to say, they must all be lead acid deep cycle batteries or they must be nickel-cadmium batteries. DO NOT CONNECT DISSIMILAR BATTERIES IN PARALLEL, such as a lead-acid to a nickel-cadmium, damage to the batteries may result. Batteries may also be connected in combinations of series and parallel to get higher voltages and higher capacities. This combination is shown in figure 6. This is a combination of the above connections with a couple more rules of connection. As shown in figure 6, each series connection of batteries will be referred as a branch. Each of these branches must have the same terminal voltage (ie. 24Vdc, 36Vdc, etc.). The Watt-Hour capacity of each battery in a branch must be the same. Any two branches can be of different Watt-Hour capacity. These These branches can then be connected in parallel to create a battery bank of any size. The diagram in figure 6 shows two (2) branches of two (2) batteries each, connected in parallel to give a total of 4800 Watt-Hours of capacity.

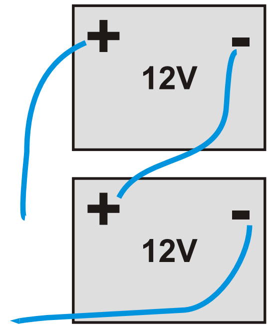


Figure 4b

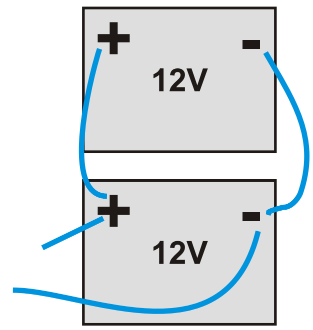


Figure 5

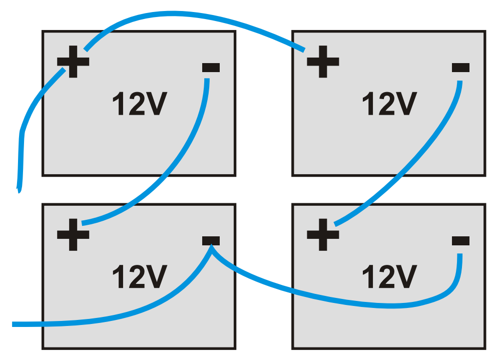


Figure 6

Sizing the battery bank and inverter

Now, determine the size battery bank required for your set of circumstances. Two things determine the size battery bank required; TOTAL NUMBER OF WATT-HOURS REQUIRED and MAXIMUM NUMBER OF WATTS THAT WILL RUN AT ONE TIME.

ITEM	RUNNING POWER (WATTS)	STARTING POWER (WATTS)	SIMULTANEOUS STARTING POWER (WATTS)	CONTINUOUS RUNNING (WATTS)	TIME	WATT-HOURS
CRT	40	N/A	40	40	3	120
A / D CONVERTER	30	N/A	40	30	3	90
COMPUTER	100	N/A	-	100	3	300
HEATER	900	N/A	900	-	0.3	270
OSC	70	N/A	-	-	2	140
DRILL	200	N/A	-	-	0.2	40
CIRCULATION PUMP	500	2000	2000	500	1.5	750
TOTAL	-	-	2980 - WORST CASE LOAD	670	-	1710

Make a list of all items that will run on the inverter and the length of time they must run between battery charges. Placing it in a grid similar to the example below may be helpful. The first column describes the accessory for identification. The second column is running watts of the item under steady state conditions. The third column is maximum starting power required. This is usually only needed on items that use motors, such as pumps, refrigerators, power tools, and the like. This data can be found on the product identification label of the item. Usually close to the power cord will be some kind of label or stamp that gives the model number, manufacturer and power requirements. Sometimes it will state the amps required.

You will then need to convert amps into watts per the following formula.

I (amps) x V (volts) = P (watts)

Example: A circulation pump running at 220 Vac has a running current of 2.2 Amps and a Starting Current (sometimes called LRA, locked rotor amps) of 9.0 Amps. Find the running and starting powers.

2.2A x 220V = 484 Watts running power

9.0A x 220V = 1980 Watts starting power

The rest of the columns will require some educated guessing. The fourth column tries to determine maximum load on the inverter and battery system. In this case we assume it is possible for the TV, VCR, and Microwave oven to be on when the well pump is started. This column is used to assure the inverter can meet the demand as well as the battery bank. The next column (5th) is an attempt to find the worst case continuous power draw from the battery bank. For purposes of this manual, continuous will mean the highest load that will be on the battery for more than 15 minutes at a time. Again here we assume the TV, VCR and water pump run a great deal of the time, or are at least representative of the average load on the battery. This column is used to determine if any derating of the battery bank will be required due to excessive power demand. The next column (6th) is used to calculate the amount of time each load will run between successive battery charges. The assumption is that the battery is completely charged at the beginning of this time. This may not be realistic in all situations but is useable for a first pass calculation.

To get total Watt-Hours, multiply Running Power Watts by Time columns to get Watt- Hours needed by each item. Now add the entries in each column to get total Simultaneous Starting Watts, total Continuous Running Watts and total Watt-Hours.

Examining totals generated in the table usually forces two difficult decisions.

First look at Simultaneous Starting Watts. Recall from above, this is a list of the worst case load on the inverter. This total must be less than or equal to the inverters surge power. If it is not, then you either need a larger inverter or must re-examine your choices. In the example above, simultaneous starting power came out to 3000 Watts, and surge power of the Exeltech 1000 inverter is 2200 Watts. This means the inverter may not start the circulation pump when the heater is running. After examining the chances of the heater and the pump running simultaneously, one may decide that it is not likely or take some action to assure that the two will not run at the same time. So modify the total to be 2100 Watts. The alternative is to add a module to the inverter system. This is within the inverters rating so we may proceed.

Second look at the ratio of total Watt-Hours to Continuous Running Watts.

WATT-HOURS ÷ CONTINUOUS-RUNNING-WATTS = LOAD-RATIO

1710/670 = 2.5

The result of this calculation is 2.5 for our example. Now take this load ratio to table. Find the Load Ratio in the left column then read directly to the right of that row to find the corresponding battery ratio.

LOAD RATIO	BATTERY RATIO
1 - 5	5
5 - 10	4
10 - 15	3
15 - 20	2.5
> THAN 20	2

Since in our example the load ratio is 2.5, we find this lies between 1 - 5 in the left column. The corresponding battery Ratio for this row is 5. To find the needed battery bank size, use the following equation.

Battery Ratio x Watt-Hours = Battery Bank Watt-Hours

5 x 1710 = 8550 Watt-Hours

Therefore, in our example, we need 8550 Watt-Hours of battery bank. Assuming we are going to use 100 Amp-Hour 12 Vdc batteries that are 1200 Watt-Hours each from our previous calculation, we need to find the number of batteries required.

Battery Bank Watt-Hours ÷ Battery Watt-Hours = # of required batteries

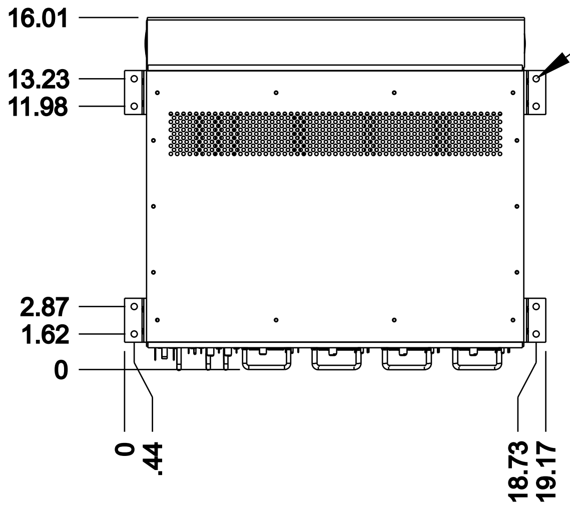
8550/1200 = 7 Batteries

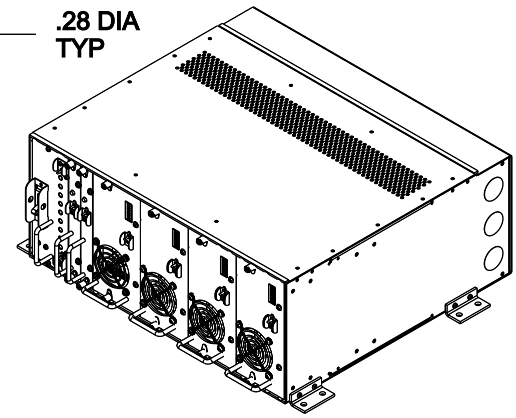
Our example requires seven 100 Amp-Hour batteries. Again this is independent of battery bank voltage. So with a 12 Vdc system we would need seven batteries in parallel.

Now, if we had a 24 Vdc system you would find you cannot build a battery bank per the rules stated above because each branch of the battery bank must have the same size batteries. The minimum number of batteries required then is the smallest number more than 7 that will build a proper battery bank. In this case it will take 8 batteries configured.

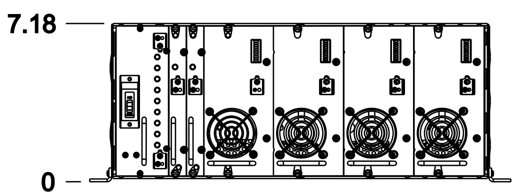
Notice in this example that the required battery bank size seems much larger than the total Watt-hours indicates. The reason for this is, the simultaneous running watts in our example places a very heavy current drain on the battery. Most batteries are designed to give their rated charge if discharged at a rate equal to 1/20th of their Amp-Hour capacity. For the case of our 100 Amp-Hour battery this means the battery will only give its full capacity if discharged at a rate of 5 Amps. In the example used, although we did not calculate it directly, it would discharge a single battery system at about 50 Amps. This is 10 times the discharge capacity of the battery. To compensate for this heavy loading, the load factor and corresponding battery factor was used to increase the battery bank size to account for this derating. If simultaneous running watts were reduced even slightly in this example, it would result in needing a much smaller battery bank.

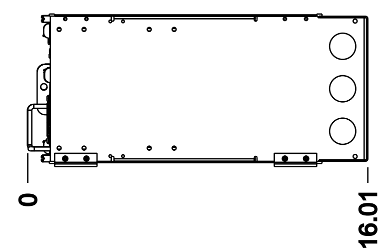
APPENDIX F

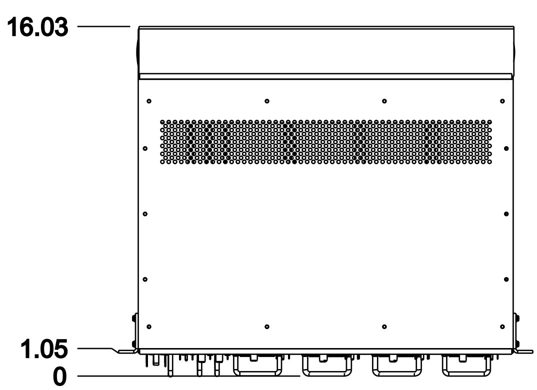


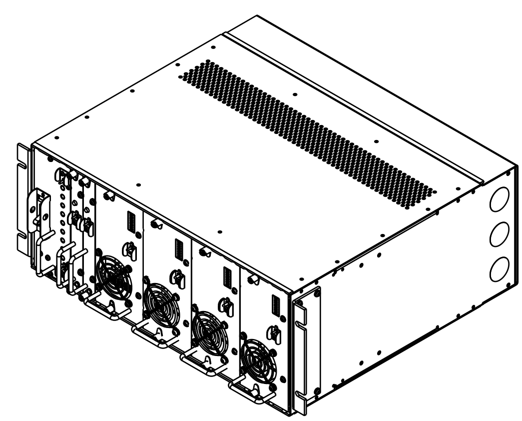


19” Cage - Mechanical Specification
Surface Mount

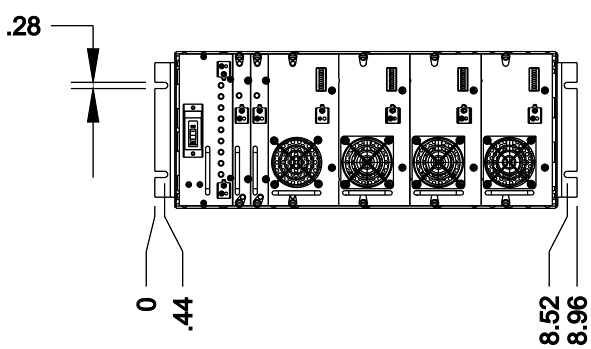


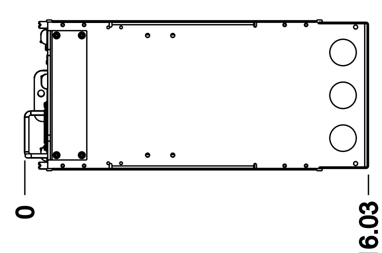




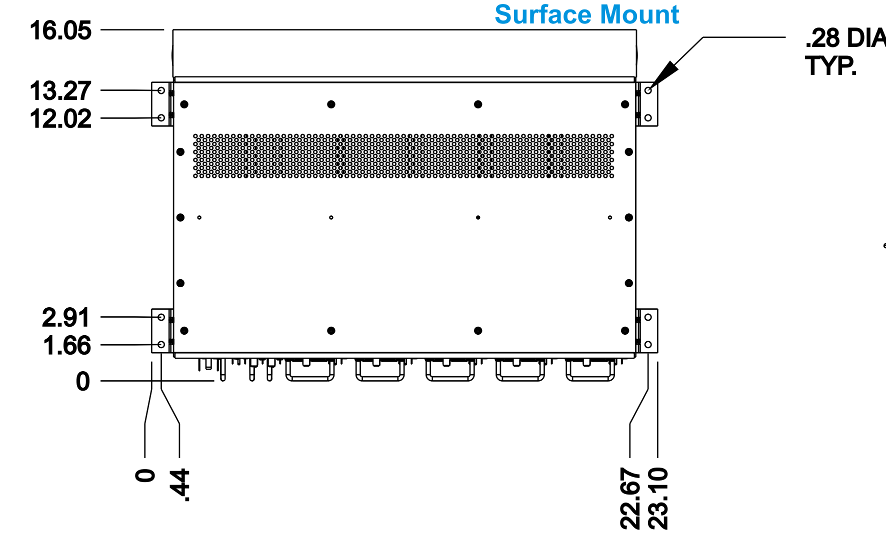


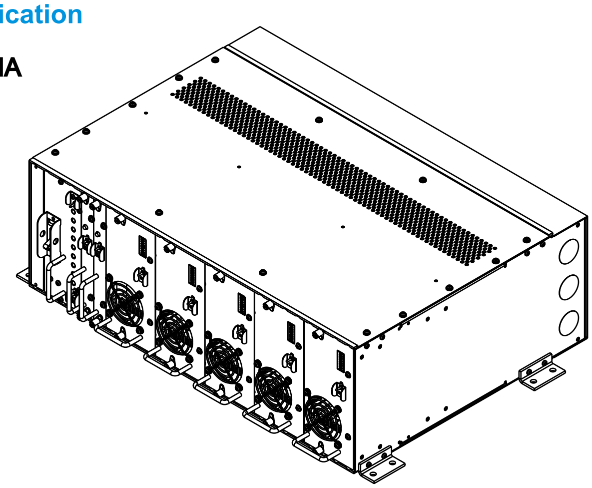
19” Cage - Mechanical Specification
Rack Mount

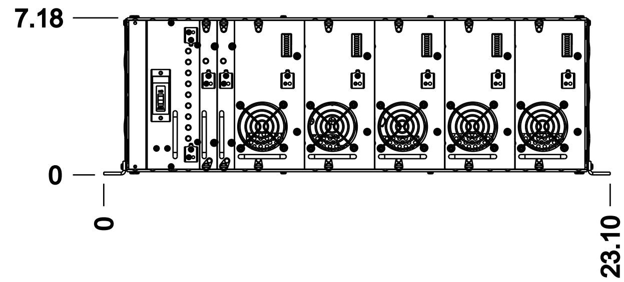


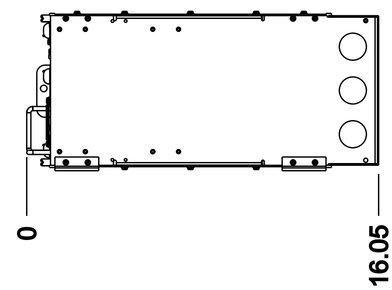


23” Cage - Mechanical Specification
Surface Mount

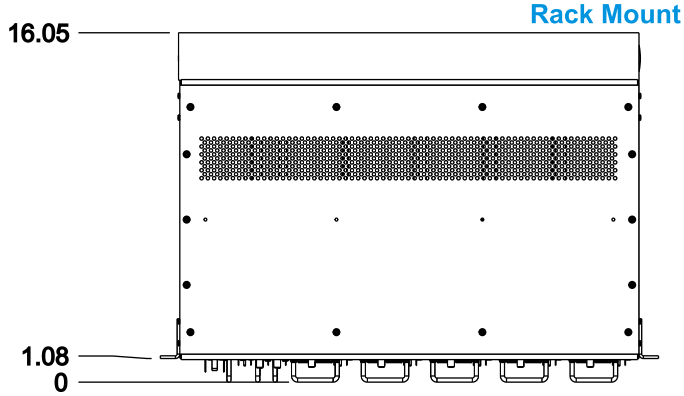


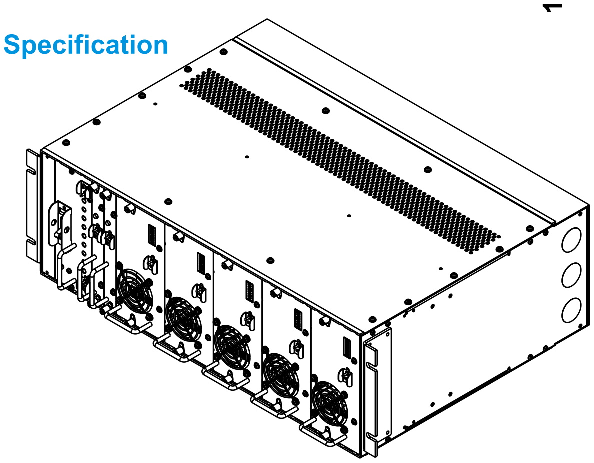


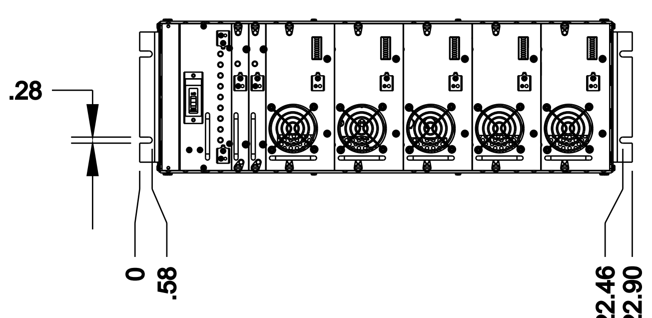


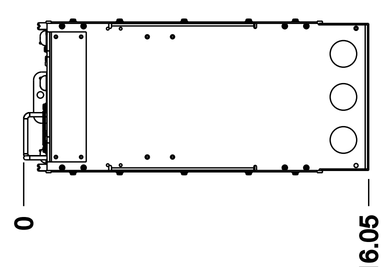


23” Cage - Mechanical Specification
Rack Mount









APPENDIX G

MX SYSTEMS MONITOR CARD

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

An Exeltech System Monitor card is an upgrade option for any Exeltech MX Series Redundant or Upgradeable System equipped with an Alarm Card or New MX Systems with a Transfer Switch. This new product allows customers to monitor all important aspects of their power system from any IP based Ethernet network.

Customers 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, customers can monitor battery voltage and current usage, and System output voltage and current. All alarm functions are viewable from an LCD display located on the System Monitor Card, and Ethernet connection, or a local Rs232 connection.

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.

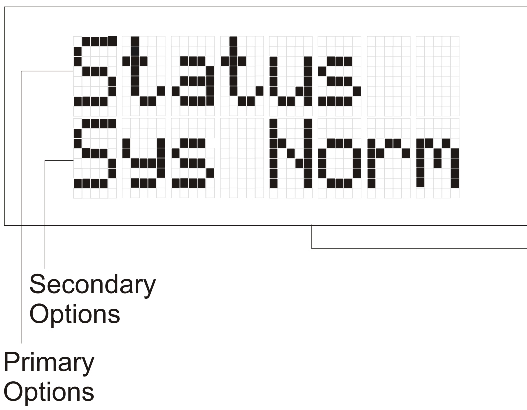
Operation

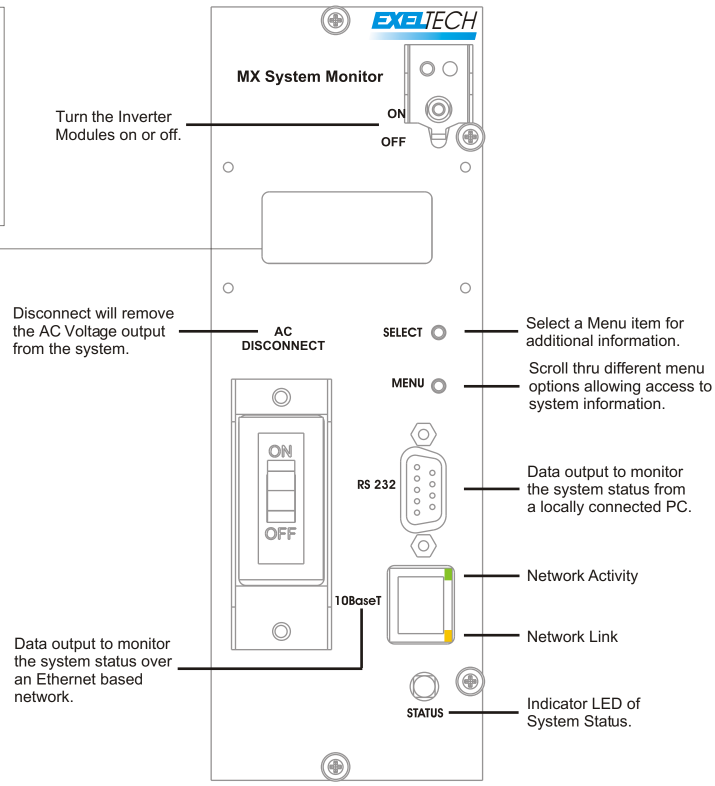
Normal operation of the Monitor Card is exactly the same as a standard Exeltech Alarm Card with the notable exception of remote monitoring of system status. A blinking LED for the new alarm state announces new alarm states; pressing ether button stops the blinking, and Alarm Details will give a listing of any alarms that have activated. For a complete description of the Exeltech Alarm Card, see the Exeltech System Installation/ Operation manual.

Remote Monitoring

Remote monitoring can be performed via DHCP enabled network, or RS 232 serial port. Monitoring software is included to allow remote sensing of alarm states, however, it is simple to implement custom software to meet any monitoring needs.

System Monitor Card





Press Menu to scroll:
System
MajAlm
MinorAlm
SysNorm
Alarm
Details → PRESS SELECT →
Vdc
0.0 V
Idc
0.0 A
Vac
0.0 V
Iac
0.0 A
Up H:M:S
HH:MM:SS
System
Settings → PRESS SELECT →
Version
Version Number

Press Menu to scroll:
SysPower
FAIL,OK
Breaker
ON/OFF
P Mod
OK/FAIL
OverTemp
OK/FAIL
CC Stat
OK/FAIL
Maint BP
ON/OFF
DCV Alarm
ON/OFF
A-Buss
0.0 V
B-Buss
0.0 V
SysVersion
Current Version

Press Menu to scroll:
RS232 Send
ON/OFF
Ethernet Send
ON/OFF
RS232 Baud
Several Selections
ReInit Ethernet
Software Reboot

Made in the USA

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Fort Worth, Texas 76118-7100
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800.886.4683 toll free
e-mail address info@exeltech.com
e-mail address sales@exeltech.com
website www.exeltech.com

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