DSPM INC.
DIGITAL SIGNAL POWER MANUFACTURER
WWW.DSPManufacturing.com

D S P M PowerClone

User's Manual

Defender 1 Harsh Environment
Emergency Lighting Inverter

Technical Manual **#018-0056-02 Revision D**

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Congratulations on selecting one of the fine products from DSPM PowerClone, the leader in power protection technology. Our wide product offering includes Emergency Lighting Inverters (DE1), Power Conditioners, Frequency Converters and Specialty Transformers. Since our beginnings DSPM PowerClone has shipped many of these fine products to discerning customers for use on sensitive equipment and critical loads.

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SAFETY

Important Safety Instructions
Save These Instructions

This manual contains important instructions for the Defender 1 DE1 System and should be followed during the installation, operation and maintenance of the DE1 system.

IMPORTANT SAFETY

When using Electrical Equipment, basic safety precautions should always be followed, including the following:

IMPORTANT SAFEGUARDS
READ AND FOLLOW ALL SAFETY INSTRUCTIONS

1. Do not mount near gas or electric heaters.
2. Check that all electrical connections are tightened properly.
3. Equipment should be mounted in a location to prevent tampering by unauthorized personnel.
4. Equipment should be locked at all times.
5. Only DSPM trained personnel should be permitted to service or maintain equipment.
6. Only accessories recognized by DSPM shall be used with this equipment.

Contact DSPM PowerClone if options are desired.

BATTERY SHELF LIFE-STORAGE

The batteries must be recharged every 4 months for at least eight hours or the batteries can be damaged. If the DE1 is placed in storage, failure to re-change batteries will invalidate your warranty.

BATTERY SAFETY

1. Person knowledgeable of batteries and the required precautions should perform servicing of batteries.
2. Do not dispose of batteries in a fire. The battery may explode.
3. Do not open and manipulate the battery. Released electrolyte is harmful to the skin and eyes.
4. A battery can present a risk of electrical shock and high short circuit current. Remove watches, rings or any other metal objects. Use only insulated tools.
5. Install in a protected environment.
6. Always turn off the battery circuit breaker before testing or performing maintenance on the battery system.

WARNING

It is strongly advised not to open the DE1 cabinet as the components have very high voltages and touching them may be fatal. Only a technician from DSPM or a DSPM trained technician may service the unit.

SECTION 1- OPERATION

1-1INTRODUCTION

The DEFENDER HARSH ENVIRONMENT (HE) DE1 (Emergency Lighting Inverter) from DSPM provides an exceptional level of load protection and monitoring capabilities. The critical load is provided with conditioned, regulated, computer- grade power at all times. Both the voltage level and frequency are controlled at all times to the load.

When the input power is lost to the DE1, such as during a power outage, the DE1 automatically draws power from its internal battery supply. The critical load receives only clean sine wave power at all times. There are no disturbances or power interruptions on the output when the DE1 transfers to battery operation. Transfers to and from battery operations are “No Break” transfers. The internal maintenance-free batteries provide a few minutes to hours (depending upon model) of backup power. Upon restoration of input power, the DE1 automatically resumes normal operation. Also the DE1 immediately begins to recharge the batteries.

The DEFENDER HE is a dual conversion single and three phase DE1 available in output ratings of 2 to 150 kVA. The DE1 is designed and built to UL1778 and/or UL924 standards. The DE1 is available with input voltages of 120, 208, 240, 277 and 480 VAC; and output voltages of 480, 277, 240, 208, and 120 VAC. This information is provided on the nameplate located on the inside of the front door.

1-2 BENEFITS

The DEFENDER HE DE1 is designed to fit the needs for virtually all power conditioning and DE1 applications. It has been specifically designed to power all forms of lighting and emergency lighting equipment. The DE1 does not require any derating as other DE1 products may when powering 100% electronic loads including switch-mode power supplies.

Electrical disturbances can come from practically anywhere: from the incoming power lines and from within a building. Outside electrical disturbances include lightning strikes, utility switching, brownouts, and accidents. Electrical disturbances from within the building can be caused by load cycling (elevators, HVAC systems) fault conditions, welders, and other electrically noisy equipment. Whether the electrical disturbances are generated outside or from within the facility, the following power problems will occur:

- Complete power outages
- Brown-outs including momentary sags
- Voltage surges
- Transients including common-mode and transverse-mode noise
- Frequency shifts and fluctuations

Typical HE-DE1 Front View

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PRODUCT FEATURES

The following describes the major sub-systems within the DEFENDER HE DE1.

INPUT POWER FACTOR CORRECTION - The DEFENDER HE DE1 system includes state - of – the – art input power factor correction. This greatly reduces the amount of current demanded from your building wiring system, yielding a highly efficient “Building Friendly” DE1 System.

RECTIFIER/INVERTER

The Rectifier-Inverter system provides controlled sine wave power to the output. The output voltage and frequency are monitored by the microprocessor and controlled to provide precision power with changing inputs and outputs to the DE1 system.

MICROPROCESSOR, Display

The microprocessor monitors the input and the output to the DE1 system and corrects for any abnormal condition that may occur. This is displayed on the LCD for operator information.

DIAGNOSTIC TESTS

When you start the DE1, a diagnostic test is automatically executed that checks the electronics, batteries, and reports and problems on the display.

SECTION 2 – PREINSTALLATION

2-1 SITE PLANNING AND PREPARATION

The DEFENDER HE is designed for installation outdoors where it is exposed to the elements. The DE1 can be installed in a variety of different environments including computer rooms, offices, and industrial/process control locations.

Listed below are the environmental specifications for the DEFENDER HE DE1 SYSTEM.

Adequate clearance around the equipment should be provided for service access and proper equipment cooling. The DE1 must be protected from flood conditions or gale force wind driven rain. If the DE1 is installed in a small, enclosed area, provisions for additional cooling may be necessary.

OPERATING ENVIRONMENT. Provide an operating environment that meets the following conditions:

o AMBIENT TEMPERATURE	-30° to 122°F
	-34 ° to 50°C
o OPERATING ALTITUDE	2,286 M (7500 FT)
o NON-OPERATING ALTITUDE	up to 3,048 M (10,000 FT)
o RELATIVE HUMIDITY	0% to 98% (non-condensing)

Operating the DE1 and batteries at either extreme of the temperature range may affect the long-term rDE1ability of the system. This is especially true of the sealed, maintenance-free batteries. Sealed, maintenance-free batteries are designed to operate at normal room temperatures (72 to 77° F)

! WARNING ! BATTERY SHELF LIFE !

- **BATTERY SHELF LIFE, WHEN STORED UNDER TEMERATURE CONDITIONS of 66° F ~ 77° F, is FOUR (4) MONTHS MAXIMUM AFTER THE SHIP DATE.**
- **BATTERY MUST BE RECHARGED FOR EIGHT HOURS AFTER THIS DATE OTHERWISE THEY MAY BE DAMAGED.**

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DE1 Emergency Lighting Inverter

Watts	Input Voltage	Output Voltage	Utility Feed Amps	Max Output Amps	Watts	Input Voltage	Output Voltage	Utility Feed Amps	Max Output Amps
5.25	120	120	88	43.7	10.5	120	120	175	87.5
		240		21.8			240		43.7
		277		18.9			277		37.9
	208	120	51	43.7		208	120	101	87.5
		240		21.8			240		43.7
		277		18.9			277		37.9
	240	120	44	43.7		240	120	88	87.5
		240		21.8			240		43.7
		277		18.9			277		37.9
	277	120	38	43.7		277	120	76	87.5
		240		21.8			240		43.7
		277		18.9			277		37.9
	480	120	22	43.7		480	120	44	87.5
		240		21.8			240		43.7
		277		18.9			277		37.9
		480		10.9			480		21.8
7	120	120	117	58.3	12.5	120	120	209	104.1
		240		29.1			240		52.0
		277		25.2			277		45.1
	208	120	68	58.3		208	120	121	104.1
		240		29.1			240		52.0
		277		25.2			277		45.1
	240	120	59	58.3		240	120	105	104.1
		240		29.1			240		52.0
		277		25.2			277		45.1
	277	120	51	58.3		277	120	91	104.1
		240		29.1			240		52.0
		277		25.2			277		45.1
	480	120	30	58.3		480	120	53	104.1
		240		29.1			240		52.0
		277		25.2			277		45.1
		480		14.5			480		26.0
9	120	120	150	75.0	15	120	120	250	125.0
		240		37.5			240		62.5
		277		32.4			277		54.1
	208	120	87	75.0		208	120	145	125.0
		240		37.5			240		62.5
		277		32.4			277		54.1
	240	120	75	75.0		240	120	125	125.0
		240		37.5			240		62.5
		277		32.4			277		54.1
	277	120	65	75.0		277	120	109	125.0
		240		37.5			240		62.5
		277		32.4			277		54.1
	480	120	38	75.0		480	120	63	125.0
		240		37.5			240		62.5
		277		32.4			277		54.1
		480		18.7			480		31.2

All Circuit Breakers provided by end user, that are connected to the inputs and outputs need to have a Trip Curve which is at least 10 times the rated current for .3 seconds, this is to prevent the breakers from tripping during startup of the unit or the loads, attached to the units. Some Manufactureres refer to these breakers as "High Inrush" breakers.

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SECTION 3 – INSTALLATION

The DEFENDER HE DE1 system is shipped on a pallet with the batteries outside the DE1. This Manual, battery jumper wires and accessories may be included within the packaging, ensure that these are not discarded with the packaging. Unwrap the DE1 and carefully inspect the external surfaces for abrasions, indentations, or other obvious damage.
File a claim with the shipping agency for any damage caused by shipping. Forward a copy of the damage claim to DSPM.

Mount the DE1 system so the back of the unit has six inches of clearance for airflow. Leave appropriate space in the front so the front door can be opened fully for operation and installation.

3-1 INSTALLATION EQUIPMENT

The following instructions cover general requirements for standard installation of the input and output power circuits, battery connections and control interface connections. Install the DE1 using the procedures in this section. Care must be taken to insure the unit is properly connected. Connections should be torqued as shown in Table 2-1

TABLE 2-1
WIRING TERMINAL TORQUE

Wire Gauge (AWG)	Terminal Torque pound-inches (neutons)
1 - 4	35 (6)
6 - 10	25 (4.4)

DANGER!!

THE DE1 CONTAINS POTENTIALLY LETHAL VOLTAGES INSIDE, EVEN IF THE UNIT IS NOT CONNECTED TO AN EXTERNAL SOURCE OF POWER. ALL INSTALLATION AND SERVICE PROCEDURES SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

The input power circuit is supplied by the customer. This provides power from the building source to the DE1 system. This circuit should be a dedicated branch circuit that is hard wired in conduit. Size the branch circuit feeder conductors according to the specific power rating of the unit. Refer to the latest edition of National Electric Code (NEC) for the proper wire size required.

An insulated grounding conductor must be installed as part of the input circuit. Size the grounding conductor in accordance with NEC and local codes. The manufacturer recommends a parity-sized ground, with respect to the input power wires.

3-1 INSTALLATION OF EQUIPMENT (continued)

The DE1 is designed to provide superior isolation and protection for sensitive loads. The DE1 can be wired as a separately derived source that allows the re-establishing of the ground reference at the output of the DE1. This method of installation will provide additional load isolation from noise and other disturbances.

DANGER!!

INSURE THAT ALL CODE REQUIREMENTS ARE FOLLOWED IN GROUNDING THE DE1 AND ITS LOADS. BODILY INJURY OR DAMAGE TO EQUIPMENT MAY OCCUR IF UNIT IS NOT PROPERLY GROUNDED.

NOTE

The equipment to be connected to the DE1 may require special grounding procedures. Refer to technical documentation which accompanies that equipment.

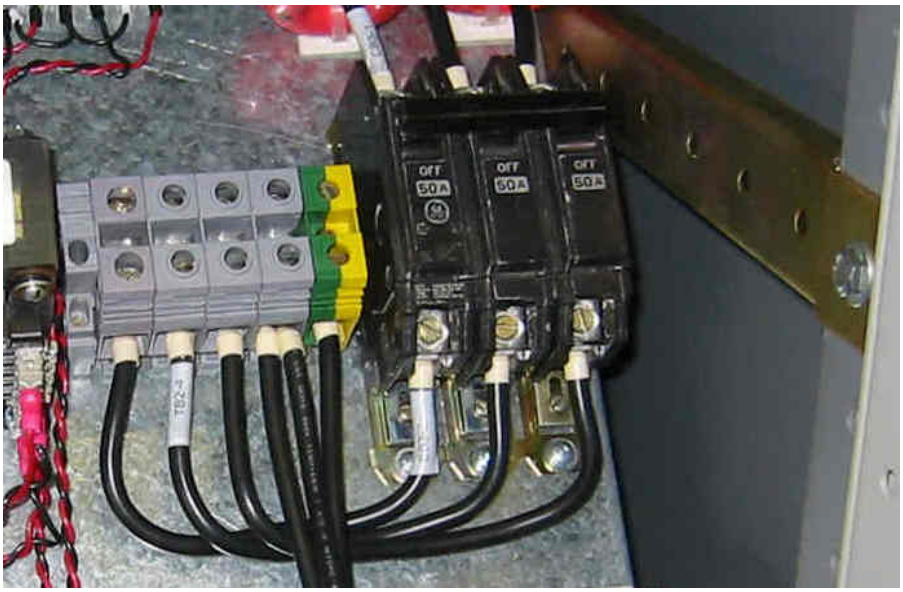
3-2 INPUT CONNECTIONS

1. Verify that power source to the unit is OFF, locked and tagged according to OSHA requirements.

CAUTION

Verify that the input voltage as stated on the DE1 nameplate, matches the customer-supplied voltage. If the voltage does not match, STOP installation of the DE1 and contact Customer Service at DSPM.

2. Verify that Input cable and conduit are routed correctly and are in position to connect the unit.
3. Open the Unit and verify the optimum location for Conduit Access.
4. Punch the appropriate sized conduit hole in the chosen location.
5. Pass wires through the mounting hole.
6. Secure conduit fitting to the panel of unit.
7. Connect power wires to the input, neutral and ground terminal blocks. These are pre-wired to the DE1 System. See picture below.



(Pre-Wired Input /Output terminals block(s)

3-3 OUPUT CONNECTIONS

1. Verify that power source to the unit is OFF, locked and tagged according to OSHA requirements.

CAUTION

Verify that the output voltage as stated on the DE1 nameplate matches the actual output voltage of the unit. Ensure that the intended connected load does not exceed unit capacity. If the voltage does not match, or the intended applied load exceeds unit capacity, STOP installation of the DE1 and contact Customer Service at DSPM.

2. Verify that Output cable(s) and conduit(s) are routed correctly and are in position to connect the unit.

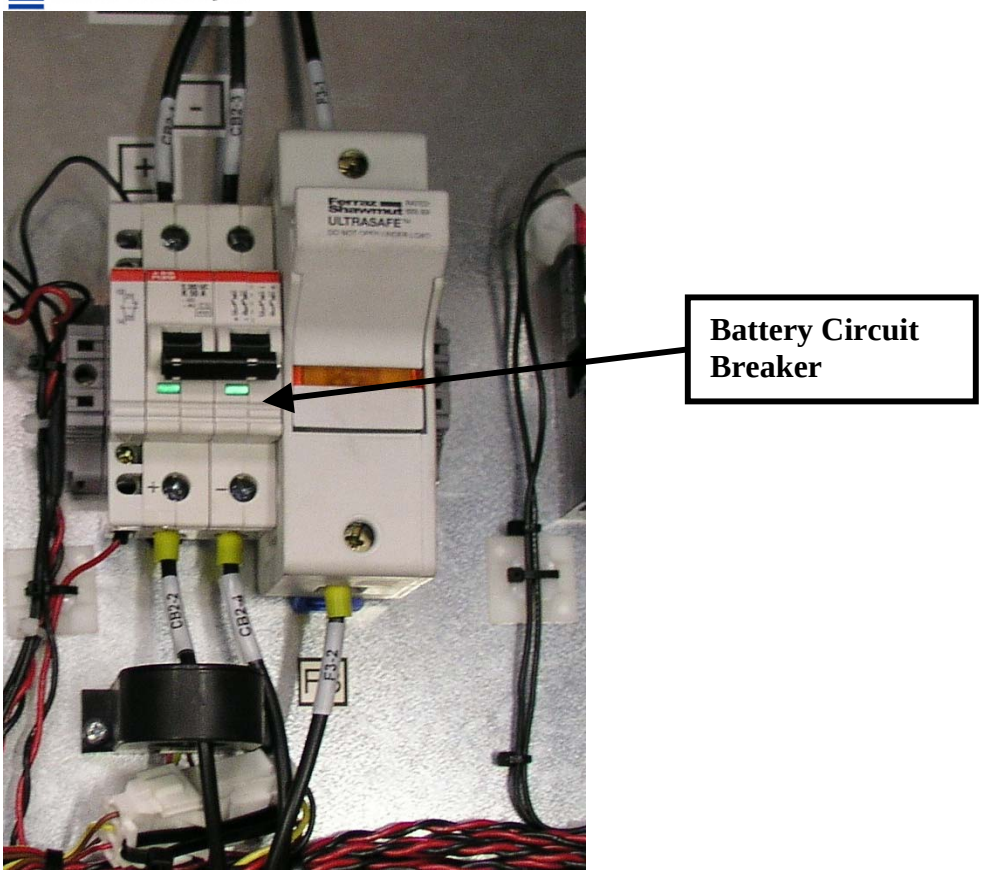
3. Punch the appropriate sized conduit hole in the unit.
4. Pass wires through the mounting hole.
5. Secure conduit fitting to the panel of unit.
6. Connect power wires to the output, neutral and ground terminal blocks. These are pre-wired to the DE1 System. See the picture above.

3-4 BATTERIES AND BATTERY CABLES

WARNING!!

FOLLOW THE BATTERY SAFETY PROCEDURE IN THE FRONT OF THIS MANUAL.

The DE1 system has fixed battery trays. All battery systems connect the batteries in series, i.e. plus terminal to minus terminal from one battery to another battery. The **battery circuit breaker must be off during the installation**. Install the batteries and connect the battery cables. The DE1 utilizes 10, 18 or 20 battery, bus voltage should be 12 to 13.2 VDC times the number of battery provided (See battery diagram). Connect the battery string to the DC Circuit Breaker. See picture below.



BATTERY SYSTEM TEST

1. Make sure A.C. input circuit breaker is OFF.
2. Make sure battery circuit breakers are OFF.
3. Use a meter and note the D.C. voltage at the battery circuit breaker. The voltage must be the correct polarity positive lead of the meter to the positive terminal of the circuit breaker.
4. The D.C. voltage should be 12 and 13.2 volts times the number of battery provided (See battery diagram). If the D.C voltage reads below these figures, the battery cables are not connected correctly.
5. If the battery polarity and voltage level are correct, proceed to section 3.0.

SECTION 4 - OPERATIONS

4-1 STARTING THE DE1

1. Check the input A.C. circuit breaker is OFF.
2. Check all output circuit breaker(s) (optional) are OFF.
3. Check the battery circuit breaker(s) are OFF.
4. Energize the Utility feeder to the unit.
5. Turn the Input circuit breaker ON.
6. Wait for the System display message instructing you to close the battery breaker.
7. Turn on the Battery Breaker.
8. Wait for the System Display message stating unit is operational.
9. Turn on the Output Breaker.

System Display Panel

History Log Key:

The *History Log* is used to record certain events that reflect the status and operating mode of the unit.

There are 64 lines (00 through 63).
It is read by holding down the *Alarm Scan* button. Each time the button is pressed, the log is read sequentially with the most recent event being displayed first. After 00 is displayed, the system will cycle around to 63.
After 64 events are logged, the system will start recording again at 00.

Code	Message	Description
00	00	blank – used in clearing Alarm History
01	alarm clr	Alarm History has been cleared
02	Phase SEQ	Input phase sequence has caused a fault and must be changed
04	Input OV	Input voltage has gone over fault limit
05	Input UV	Input voltage has gone below fault limit
07	Input CONT	System has failed to detect closure of the Input Contactor
08	Outpt HiV	Output voltage has gone over fault limit
09	Output LoV	Output voltage has gone below fault limit
10	Outpt OFrq	Output frequency has gone over fault limit
11	Outpt UFrq	Output frequency has gone below fault limit
12	Phase FLT	Input phase sequence fault has not been corrected and system has timed out
13	Invrtr FLT	a hardware fault has been detected by the inverter control board (IGBT PCBA); caused by IGBT failure, unexpected power on reset, or DC Bus over voltage
14	DC Bus OV	DC Bus has gone over fault limit
15	DC Bus UV	DC Bus has gone below fault limit
16	Input OFrq	Input frequency has gone over fault limit
17	Input UFrq	Input frequency has gone below fault limit
18	RECT off	Rectifier has shut off unexpectedly
20	Invrt Ofrq	Inverter frequency has gone over fault limit
21	Invrt UFrq	Inverter frequency has gone below fault limit
22	ISBS open	Inverter Static Bypass Switch has not engaged and system has timed out
23	USBS fault	Utility Static Bypass Switch has failed test
24	USBS short	Utility Static Bypass Switch failure, output voltage still detected after off command was issued
26	Output OVL	Output Current has gone over fault limit
28	Estop OPEN	Emergency Stop option enabled during system power-up
35	DE1 abort	System faults have caused system to switch to bypass
36	Normal run	Automated system test concluded
37	BATT test	Automated system test initiated (15 minute rectifier shutoff and battery run)
38	Inv start	Inverter has been started and matched with utility voltage
40	NMI trap	NMI button on processor board has been pressed, date and time marker
41	STKUF trap	Software Stack underflow detected

42	STKOF trap	Software Stack overflow detected
43	WDTMR trap	Software has detected a Watchdog timer overflow
45	ISBS xfer	Static Bypass Switch has transferred load to Inverter
46	Inv Stop	Inverter has unexpected shut off
47	Pwr on RST	CPU initialization complete
49	ESTOP trap	Emergency Stop option has caused an emergency transfer to utility
50	RunState0	Power has been applied to system
51	RunState1	Initial system checks complete, awaiting DC breaker closure
52	RunState2	Startup complete, system ready
53	RunState3	Utility power failure, system is on a battery run
54	Bypass on	System is in bypass
56	Battry Low	Battery Voltage is low, causes a system shutdown
57	KeyCode OK	Key Code Accepted
58	AirFlow DN	AirFlow fault detected, DC BUS set to minimum value

SECTION 5 - MAINTENANCE

DANGER!!

THE DE1 CONTAINS POTENTIALLY LETHAL VOLTAGES INSIDE, EVEN IF THE UNIT IS NOT CONNECTED TO AN EXTERNAL SOURCE OF POWER. ONLY QUALIFIED PERSONNEL SHOULD PERFORM ALL INSTALLATION AND SERVICE PROCEDURES.

CAUTION: DO NOT DISPOSE OF BATTERIES IN FIRE

CAUTION: DO NOT ATTEMPT TO OPEN THE BATTERIES

CAUTION: THE FOLLOWING PRECAUTIONS SHOULD BE TAKEN WHEN REPLACING ANY BATTERIES

- **REMOVE WATCHES, RINGS, ETC…**
- **USE TOOLS WITH INSULATED HANDLES.**

CAUTION: USE RUBBER PROTECTIVE GLOVES WHEN HANDLING DAMAGED BATTERIES.

5-1Semi-annual

4-1.1 Cabinet/Electronics

4-1.1.1 Inspect all fans and insure proper operation.

4-1.1.2 Inspect all air filters in the unit. Clean as necessary with hot soapy water. Allow to completely dry before replacing.

4-1.2 Batteries/Battery Cabinet

4-1.2.1 Inspect the battery cases for leakage.

4-1.2.2 Perform a battery load test of each individual battery.

4-1.2.2.1 Turn off the Battery Breaker

4-1.2.2.2 Using a Battery load tester connected to only one battery test the battery and record the battery voltage after a 5 to 10 second load test. The picture to the left is an example of the type load tester that can be used.

4-1.2.2.3 Repeat step “b.” using the same timed load test, and record the data.

4-1.2.2.4 After the testing all the batteries, compare the test data. All recorded voltages should be approximately the same value. Any batteries that have a reading considerably different then the others needs to be investigated, or considered to be bad and replaced.

4-1.2.2.5 Check wiring for proper routing and damage, such as chaffing and/or cutting. Relocate and /or repair and found damaged wires.

4-1.2.2.6 Check the torque of each battery connection for 70in/lbs.

CAUTION: DO NOT OVER TORQUE THESE CONNECTION AS SOME BATTERIES HAVE LEAD POSTS AND THEY ARE VERY EASY TO COMPRESS AND WILL CAUSE FAILURES IN THE FUTURE.

Note: If Batteries are found to be leaking or fail the load test they should be replaced. (Consult DSPM as to the status of your Battery Warranty)

5-2 Annual

CAUTION: BEFORE PERFORMING ANY OF THE FOLLOWING STEPS BESURE THAT THE DE1/EMERGENCY LIGHTING INVERTER HAS BEEN TUNED OFF.

5-2.1 Perform all Semi-annual Maintenance.

5-2.2 Cabinet/Electronics

5-2.2.1 Inspect all power connections for loose connections. Tighten any that are found loose. See the Torque table below.

5-2.2.2 Check wiring for proper routing and damage, such as chaffing and/or cutting. Relocate and /or repair and found damaged wires.

5-2.2.3 Exercise all circuit breakers.

5-2.2.4 If there is a distribution internal to the cabinet and/or a panel attached to the side of the DE1/Emergency Lighting Inverter, check the power connections and exercise the breakers in the cabinet.

5-2.2.5 Inspect all air filters in the unit. Clean as necessary with hot soapy water. Allow to completely dry before replacing.

5-2.3 Batteries/Battery Cabinet.

5-2.3.1 Check wiring for proper routing and damage, such as chaffing and/or cutting. Relocate and /or repair and found damaged wires.

5-2.3.2 Check the torque of each battery connection for 70in/lbs.

CAUTION: DO NOT OVER TORQUE THESE CONNECTION AS SOME BATTERIES HAVE LEAD POSTS AND THEY ARE VERY EASY TO COMPRESS AND WILL CAUSE FAILURES IN THE FUTURE.

Note: If Batteries are found to be leaking or fail the load test they should be replaced. (Consult DSPM as to the status of your Battery Warranty)

SIZE OF WIRE THAT IS TO BE USED FOR CONNECTION OF THE UNIT		TIGHTENING TORQUE POUND–INCHES (N–m)			
		SLOTTED HEAD no.10 or LARGER		HEXAGONAL HEAD – EXTERNAL DRIVE SOCKET WRENCH	
AWG/kcmil	mm^2	SLOT WIDTH <0.47" & <1/4"	SLOT WIDTH >0.47" & >1/4"	Split–Bolt Connectors	Other Connections
18 – 10	0.82 – 5.3	20 (2.3)	35 (4.0)	80 (9.0)	75 (8.5)
8	8.4	25 (2.8)	40 (4.5)	80 (9.0)	75 (8.5)
6 – 4	13.3 – 21.2	35 (4.0)	45 (5.1)	165 (18.6)	110 (12.4)
3	26.7	35 (4.0)	50 (5.6)	275 (31.1)	150 (16.9)
2	33.6	40 (4.5)	50 (5.6)	275 (31.1)	150 (16.9)
1	42.2		50 (5.6)	275 (31.1)	150 (16.9)
1/0 – 2/0	53.5 – 67.4		50 (5.6)	385 (43.5)	180 (20.3)
3/0 – 4/0	85.0 – 107.2		50 (5.6)	500 (56.5)	250 (28.2)
250 350	127 – 177		50 (5.6)	650 (73.4)	325 (36.7)

SECTION 6 - TROUBLE SHOOTING

5-1If unable to resolve any problem please contact DSBM-PowerClone for assistance.

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