UltraCell®

XX25-A1

Operating Manual

XX25-A1 unit not for commercial distribution
This product has been released for test purposes only
Startup and operation limited to trained personnel only
Patents Pending

December, 2007

UltraCell®

Table of Contents

Safety

- Read this Operator Manual before using the XX25. Operating the UltraCell XX25 outside of system specifications (page 6) may cause damage to the system. Follow all safety instructions and be sure to comply with all warnings in this Operator Manual to minimize risk or injury to yourself and others.

Toxic Fuel

- **Handle fuel cartridges with care. If a fuel spill occurs, do not inhale, swallow or allow fuel to come into contact with skin. In case of accident or nausea, immediately seek medical assistance and present the methanol safety data sheet (included with cartridge shipments).**

- Keep children away from the XX25 and fuel cartridges.

- Operate the UltraCell XX25 only in well ventilated areas.

Flammable

- **There is a risk of fire if any fuel leaks out of the system or cartridge. Keep ignition sources at a safe distance and thoroughly ventilate the area. Spilled fuel will evaporate without leaving any residue.**

- Keep sources of heat and ignition at a safe distance from the XX25 and its fuel cartridges.

- Do not smoke when handling the XX25 or fuel cartridges.

- Do not operate or store the XX25 or fuel cartridges above 49ºC (120ºF)

- Do not disassemble or tamper. Any changes made to the XX25 or cartridges may compromise safety.

- For Repair or Disposal, return system to UltraCell Corporation. UltraCell headquarters telephone number: (925) 455-9400

The XX25 has not been specifically developed for use in the planning, construction, maintenance, operation or other use of any nuclear facility, for flight, navigation or communication of any aircraft or ground support equipment involving flight aircraft, medical instruments or medical equipment, or in any other device which involves life threatening of or inherently dangerous activity. The purchaser of the XX25 system agrees that UltraCell and, if applicable, the distributor shall have no liability for any claims, losses, costs, or damages arising from such use. Without limiting the immediately foregoing two sentences in any respect, The purchaser agrees to indemnify and hold UltraCell and, if applicable, the distributor harmless from and against all claims, losses, costs, or damages arising out of or in connection with the use of the XX25 in any such applications.

Introducing the *UltraCell*® XX25

      The UltraCell XX25 is a complete reformed methanol fuel cell system. Unlike traditional hydrogen fuel cells, the UltraCell system does not rely on low energy density hydrogen storage methods such as compressed hydrogen or chemical hydrides. Instead, this system reforms a highly concentrated methanol fuel into hydrogen, which is then fed into a fuel cell stack. UltraCell's fuel cell system is high powered and efficient - able to directly power devices up to 25 Watts. The XX25 comes with easy to use tethers to power your application.
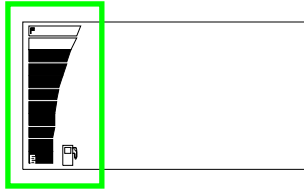
      UltraCell's innovative fuel cartridge is safe, easy to install, and reliable. An integrated chip keeps track of the amount of fuel in the cartridge.

      Exhaust from the fuel cell is similar to human breath, a mixture of carbon dioxide and water vapor. Steam in the exhaust is normal.

1. LCD display
2. Air Exhaust
3. Cartridge eject button
4. Fuel cartridge
5. LCD backlight and contrast adjust button
6. Power Output connector
7. Air Intake
8. Power button

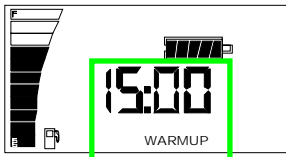**Figure 1. XX25 Overview**

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LCD display:

Fuel Gauge
The fuel gauge is located on the left side of the LCD display. This is displayed as a bar indicating the remaining fuel level.
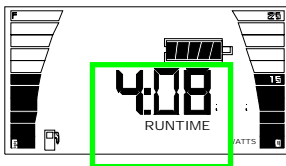
Power Meter
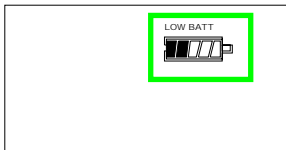The output power of the XX25 is displayed in Watts on the right side of the display

Startup Timer
During startup, the LCD will show the remaining time till the XX25 is ready to produce power. Startup time is 12 to 20 minutes, depending on the internal temperature of the system and internal battery charge level.
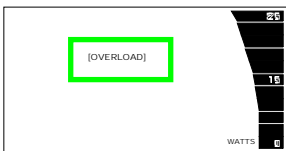
Runtime Timer
When the system is up to temperature and providing power out, the fuel and battery gauges are on and updated. The estimated runtime in hours and minutes until fuel runs out is also displayed. "Warmup" may additionally be displayed if power out is available but stack is still warming up.
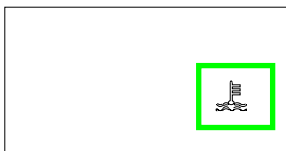
Internal Battery
The charge level of the XX25 internal battery is displayed with a battery indicator. "LOW BATT" indicates that the internal battery needs to be charged.

Overload Condition
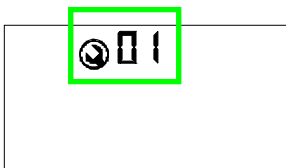If the connected load exceeds 25 Watts, the XX25 will limit the output power and the overload warning will turn on.
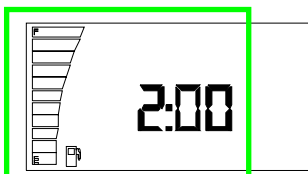
Over Temperature Condition
If the XX25 should overheat, the over temperature warning indicator will turn on.

Operational Status Codes
See Pages 14 to 15

Cartridge Replacement
When the XX25 is operating and the cartridge is removed, a 30 second timer will be displayed.

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Package Contents:

- ✓ XX25 unit
- ✓ Power cable to connect to Application
- ✓ Operator Manual
- ✓ CD with UltraCell Dashboard software

XX25 System Specifications

System Performance

Power:	0 to 25 Watts (up to 600 Wh/day)
Maximum Power:	25 Watts (2.1A at 12V)
Voltage:	Factory set: 12V to 24V
Startup:	12 to 20 minutes

Physical

Dimensions (Including fuel cartridge):	5.9" X 9.1" X 1.7" (15cm X 23cm X 4.3cm)
Weight:	2.7 lbs (1.24 kg)
Color:	Sand

Environmental

Operating temperature:	-4ºF to +104ºF (-20ºC to +40ºC)
Humidity:	0% to 95%

User Interface

On/Off control:	Power button
LCD display:	NVG compatible

250cc Fuel Cartridge*

Fuel:	240cc ± 10cc Methanol (67%) and Water (33%)
Energy Capacity:	≈ 160 Watt-hours ≈13.3 Ah (at 12V) (8 hrs @ 20 W average power output)
Weight (full):	12.4 oz. ± 0.4 oz. (351 g ± 11 g)
Weight (empty):	4.6 oz. (131 g)
Storage Temperature Range:	-20ºC to +60ºC (-4ºF to +140ºF)

Tether/Connector

Output connector type:	Land Warrior connector **&** 4mm Red & Black (banana plugs)

* Larger cartridges available

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Fuel Cartridges

Use only UltraCell fuel cartridges with this system. Fuel cartridges are not pressurized. Each cartridge contains no more than 250cc of fuel, a solution of methanol and water.

Do not press down on cartridge nozzle. If a cartridge leak is detected, call (925) 455-9400, and return the cartridge to UltraCell. Consult the Methanol MSDS (page 16).

To install a cartridge:

1. Remove old cartridge **per Figure 3**.
2. Insert new cartridge **per Figure 2**.

To insert a new cartridge, slide it onto the rail, until the eject buttons click into place. Insert a new cartridge within two minutes of removing an old cartridge, otherwise the system will begin shutting down.

CAUTION: If the cartridge fails to click into place during insertion, or if methanol leaks during cartridge insertion, check to see that the cartridge nozzle is not misaligned or damaged.
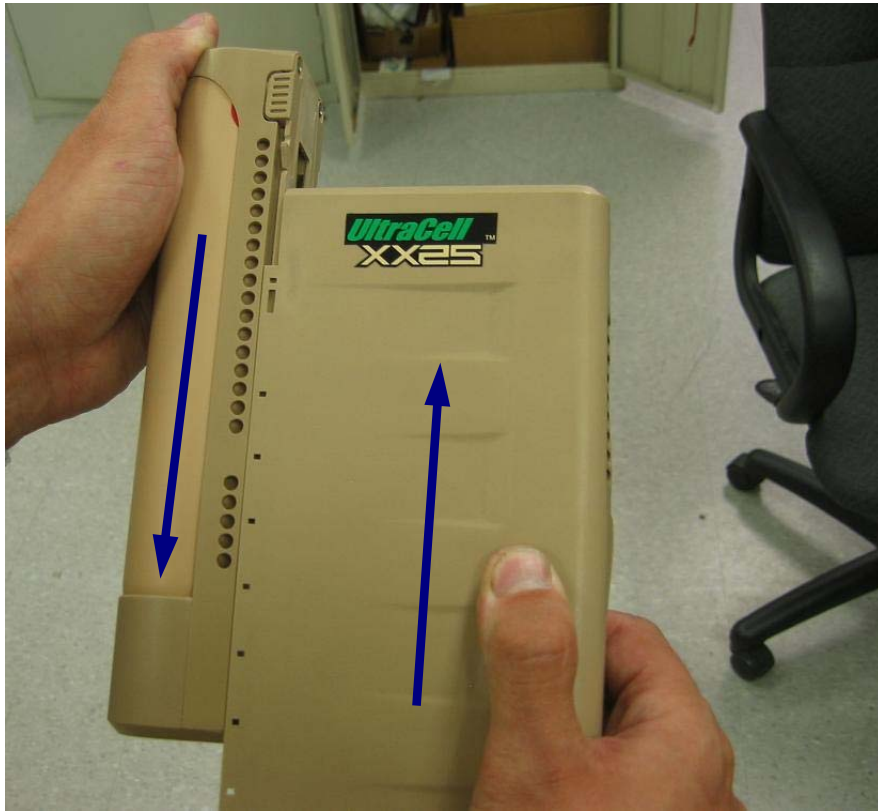
Figure 2: Cartridge installation: Slide cartridge into system until eject buttons click into place

Figure 2: Cartridge installation (continued): The cartridge nozzle will mate with the nozzle acceptor shown in the above picture.

To remove a cartridge:

1. Remove old cartridge **per Figure 3**.

Empty cartridges can be returned to UltraCell for recycling. Cartridges that are less than 10% full are not considered hazardous and can be disposed of anywhere. Do not discard cartridges that are more than 10% full. For information about cartridge disposal and recycling, contact UltraCell Corporation at **(925) 455-9400**.

Figure 3: Cartridge removal: Push cartridge eject tabs in to unlock cartridge and pull cartridge out of system

Q: Can end users refill cartridges?
A: **No**. The mixture and purity of the fuel is important in ensuring the life of UltraCell fuel cells. UltraCell cartridges include a chip that is programmed in factory to verify cartridge authenticity. The cartridge chip also keeps track of fill level, and once the cartridge is empty it will no longer be accepted by UltraCell fuel cell systems. **For new cartridges, or refills, contact UltraCell at: (925) 455-9400 or at sales@ultracellpower.com**

XX25 Use and Operation

Run the UltraCell XX25 only in well ventilated areas with ambient temperature between -20ºC and 40ºC (-4ºF to 104ºF).

XX25 Startup Instructions:

1. Install a fuel cartridge. The XX25 will not run unless a fuel cartridge is installed. (**See Page 6**)

2. Press and hold the Power button. The LCD will display the status of the fuel cartridge and the battery.

3. Continue to press and hold the Power button until all segments of the display light up (approximately 5 seconds), then release the button, and the UltraCell XX25 will begin the startup sequence. **Figure 6**

4. To adjust the LCD contrast, press the LCD backlight button quickly.

5. Use an UltraCell tether to connect the XX25 to your Application. **Figure 4**

   Caution: The output voltage of the XX25 is set in factory. Check the quick start guide that was included with your XX25 for the voltage of your system. Do not connect the XX25 to any application that has not been approved by UltraCell for use with your XX25. See warning label on XX25 for approved applications

The system will automatically power up and will be ready to supply up to 25 Watts of power in 12 to 20 minutes.

The XX25 should be operated a minimum of one hour each time it is turned on to ensure that the internal batteries are fully charged. Startup time depends on ambient temperature, internal battery charge level, and upon how recently the XX25 was last operated. To ensure 12 minute startup, make sure internal battery is fully charged before shutting system down (run system for half an hour after removing load but before shutting down).

The LCD will display a Startup Timer until the XX25 is ready to produce power. It is normal to see steam during system startup. Any visible condensation is the result of water being exhausted from the fuel cell.

Figure 4: Connect XX25 to your Application using supplied tether. Red banana plug is Power, Black is Ground.
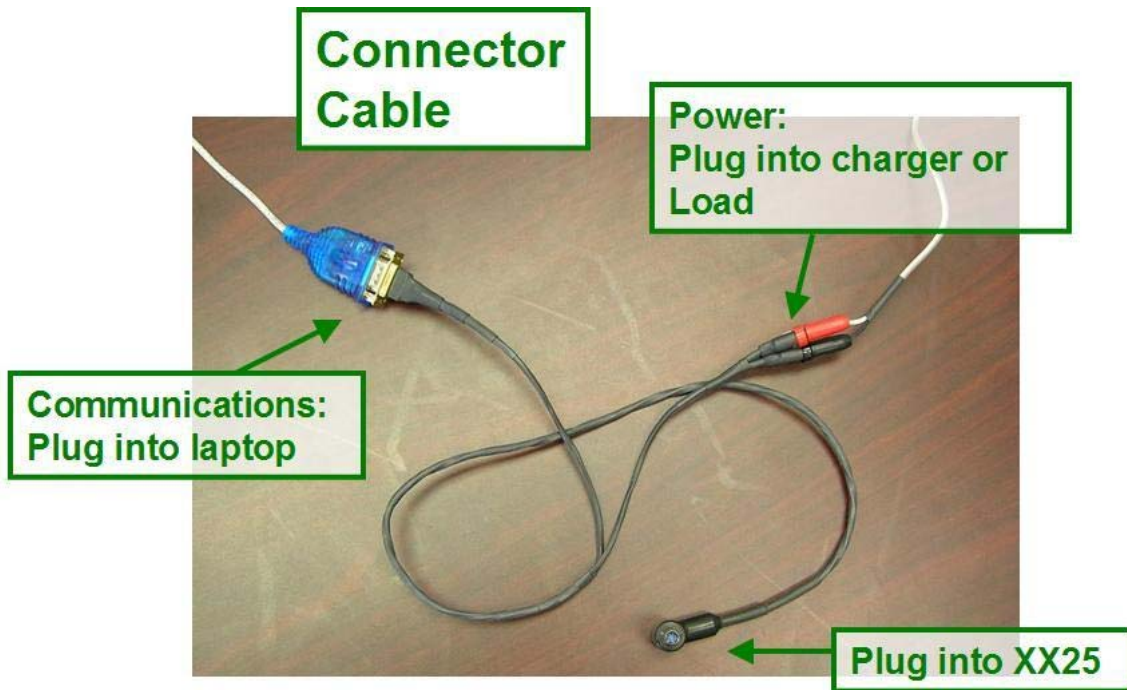
Figure 5: LCD display during system startup. Press the LCD backlight button quickly and repeatedly to adjust LCD contrast.
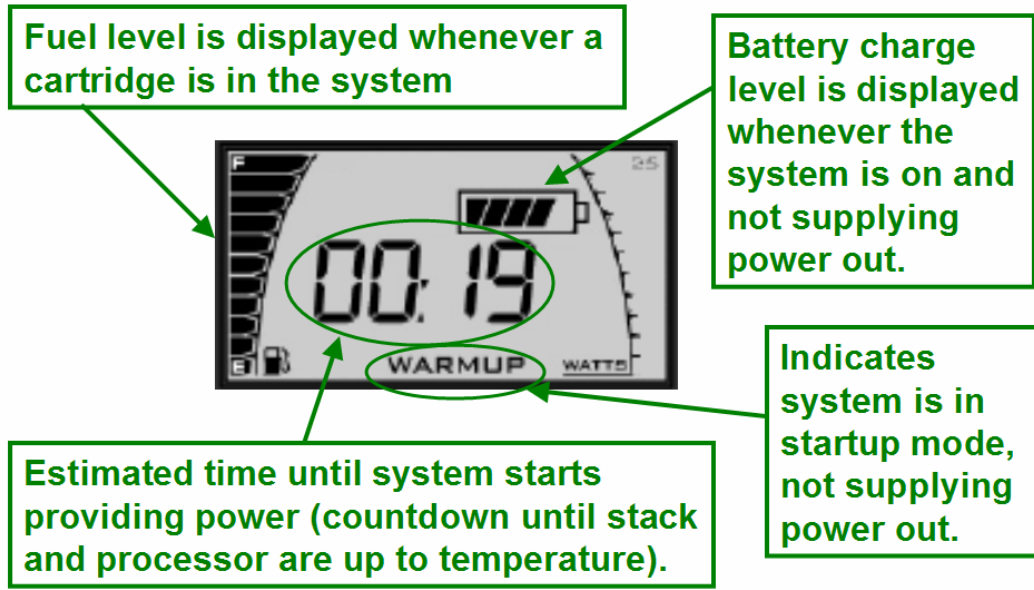
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Fuel level is displayed whenever a cartridge is in the system

Battery charge level is displayed whenever the system is on and not supplying power out.

Estimated time until system starts providing power (countdown until stack and processor are up to temperature).

Indicates system is in startup mode, not supplying power out.

Figure 6: LCD display during startup

Load On:

The system will automatically power up and will be ready to supply up to 25 Watts of power in 12 to 20 minutes

When the system is ready to produce power (when the Startup Timer has reached 0.00), "Load On" and "runtime" will appear on the LCD.

The "warmup" indicator will remain on if the fuel cell stack is still warming up. The internal battery will provide power out until the fuel cell stack is up to temperature. The "warmup" indicator will turn off when the fuel cell stack is up to temperature and providing power.

XX25 Normal Operation (Ready to Produce Power):

At one minute intervals, "Load On" is displayed for 8 seconds while the XX25 is providing output power.

The XX25 can run unattended.

XX25 power output is limited to 25 Watts depending on internal system characteristics. This is a safety feature – it is not possible to pull more power from the XX25 than what the fuel cell can provide. Voltage output will begin smoothly decreasing if your application load rises above 25 Watts. Connecting the XX25 to an application that requires high power will not damage the XX25. As a safety measure, the XX25's power output is automatically shut off if the XX25 overheats or malfunctions. Restarting the system usually fixes this problem, otherwise see **Troubleshooting** section.

In Sand or Rain storms, operate the XX25 in the upright orientation. If possible, keep air vents out of rain or sand.

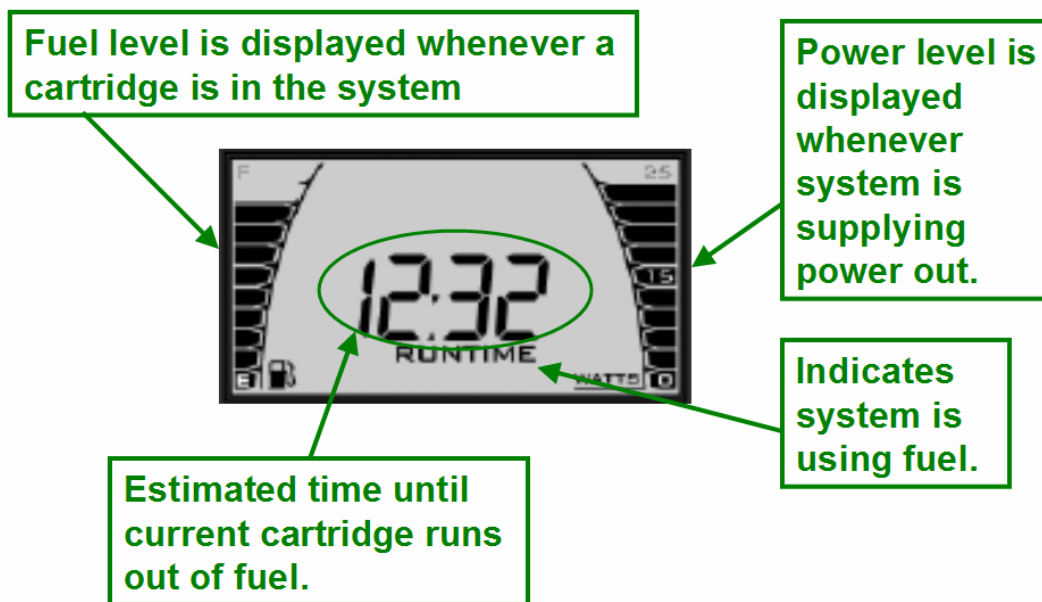**Note:** System operates best in normal, upright, orientation.

Figure 7: LCD display during normal run mode.

LCD Display – Status Codes:

Status codes (also known as error codes) can be used to troubleshoot minor system issues. If multiple status codes occur, the codes will display sequentially. Status codes are alternated with regular display information (i.e. shutdown, runtime remaining). If LCD is difficult to read, press the LCD backlight quickly and repeatedly to adjust LCD contrast.

Err1: Occurs if a new cartridge needs to be inserted.

Corrective Action: Replace cartridge

⊛ **10:** No cartridge installed. The XX25 won't startup; or, if on, remains on and providing power out for 30 seconds and then shuts down.

⊛ **11:** Cartridge not recognized. The XX25 won't startup; or, if on, shuts down.

⊛ **12:** Cartridge empty. The XX25 won't startup; or, if on, remains on and providing power out for 30 seconds and then shuts down.

Err2: Occurs if the system needs to be restarted with a new cartridge.

Corrective Action: Replace cartridge

⊛ **20:** Cartridge fuel low. The XX25 continues to run until the cartridge runs out of fuel.

⊛ **21:** Cartridge out of fuel. The XX25 won't startup; or, if on, remains on and providing power out for 30 seconds and then shuts down.

⊛ **22:** Operator took more than 30 seconds to replace empty cartridge. The XX25 shuts down. Restart system

Err3: Occurs if the load is incorrectly connected to the XX25, if the load is drawing too much power, or if the system overheats.

Corrective Action: Check to make sure that the XX25 is connected properly to an approved application. Reduce or disconnect load if problem persists.

🔄 **30:** External load greater than 25 Watts. The XX25 output voltage may drop due to current limiting.

🔄 **31:** Fuel Cell stack temperature too high. The XX25 shuts down. Make sure nothing is blocking system air intakes or exhaust. Verify that ambient temperature is less than 40ºC.

🔄 **32:** DC/DC converter failure. The XX25 load output will shutoff. The XX25 will remain on until manually restarted.

Err4: Occurs if the XX25 is connected to a short circuit.

Corrective Action: Disconnect load, check for short circuit, and restart system

🔄 **40:** Output shorted. The XX25 load output will shutoff. The XX25 will remain on until manually restarted.

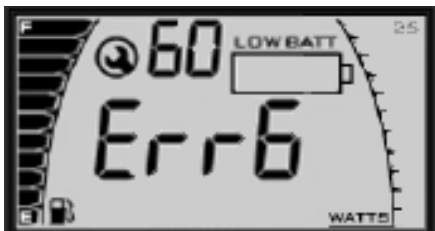**Err5:** Occurs when internal system components are outside of normal operating temperature range.

Corrective Action: Make sure nothing is blocking system air intakes or exhaust. Verify that ambient temperature is greater than -20ºC and less than +40ºC. Restart system.

🔄 **50:** Processor temperature too low. The XX25 shuts down.

🔄 **51:** Processor temperature too high. The XX25 shuts down.

🔄 **52:** Fuel Cell stack temperature too high. The XX25 shuts down.

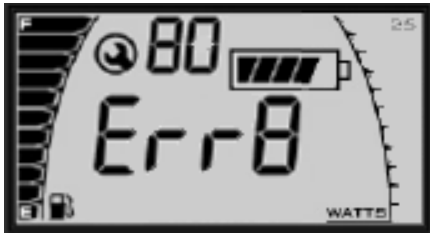🔄 **53:** Auto Shutdown. System met low-power shutdown condition setting.

Err6: Occurs when internal battery is discharged.

Corrective Action: Charge internal battery.

🔄 **60:** Internal battery charge is low. System won't startup. If system is on and up to temperature, it will continue to operate normally.

🔄 **61:** Recharge battery prior to shutdown or sleep. System will continue operating normally, but if the internal battery is not recharged, the system may not be able to restart.

🔄 **62:** Battery charger is not operational. Call UltraCell customer service at (925) 455-9400 or email support@ultracellpower.com

Err8: Signifies problem that requires UltraCell service support.

Corrective Action: Call UltraCell customer service at (925) 455-9400 or email support@ultracellpower.com

⊕ **80:** Fuel Processor failure. The XX25 shuts down.

⊕ **81:** Fuel Cell stack too cold. The XX25 shuts down.

⊕ **82:** Low Fuel Cell voltage. The XX25 shuts down.

If LCD is difficult to read, press the button next to the LCD (the LCD backlight button) rapidly to change contrast.

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Load Off:

"Load Off" appears during most errors and alternates with the error code. "Load Off" indicates that the XX25 is no longer providing power.

"Load Off" is almost always followed by shutdown, unless error 32 or error 40 occur (DC/DC converter failure or output shorted), in which case the system remains on and operational until the error is corrected or the system is shut down manually.

Shutdown:

Shutdown occurs:
- When the Power button is depressed for 5 seconds
- When a cartridge runs out of fuel (at which point the operator has two minutes to insert a new cartridge before shutdown)
- During most error conditions

"Load Off" appears first, and then, after a few seconds, "Shut down" will appear on the LCD indicating that the XX25 is shutting down.

Turning Off the XX25:

To turn off the XX25, press the Power button for 5 seconds, the XX25 will enter shutdown mode. The XX25 will remain in shutdown mode for 5 to 10 minutes while it cools down before turning off. While in shutdown mode, the fans will be running, but the XX25 will not supply power to your application. **To immediately turn off the XX25, depress the Power button a second time for 5 seconds.**

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Long Term Storage:

If the XX25 isn't going to be used for more than one week:

1. Make sure system is OFF.

2. Remove fuel cartridge from system.

3. Store system in zip-lock bag.

4. Store in a cool, dry, place.

UltraCell fuel cartridges should be kept in their original packaging until ready for use. Cartridges should be stored in a cool, dry, place.

In original packaging, the shelf life of cartridges is six months from the date of manufacture.

Maintenance and Service

The XX25 does not need any maintenance under normal operating conditions. Do not open the XX25 or tamper with internal components. Opening the XX25 will void any warranty and lead to cancellation of UltraCell service support.

For service and support contact UltraCell at**:**

UltraCell headquarters: (925) 455-9400
399 Lindbergh Avenue
Livermore, CA 94551

www.ultracellpower.com

support@ultracellpower.com

Cleaning:

Before cleaning, switch Off the XX25 and remove connector cables. The XX25 is not waterproof. Ensure that no moisture enters openings in the XX25 housing. Use only mild cleaning solutions and a damp, soft cloth to clean the unit.

Charging the XX25 internal battery:

To charge the XX25 internal battery, remove the fuel cartridge from the system and find the 9V battery connector. Connect a new 9V battery for 30 minutes to charge the XX25, then remove the battery, slide on a fuel cartridge, and start the system normally. Run the system for at least one hour to make sure that the internal battery is fully recharged.

NOTE: Make sure the XX25 system is turned OFF before charging the internal battery.
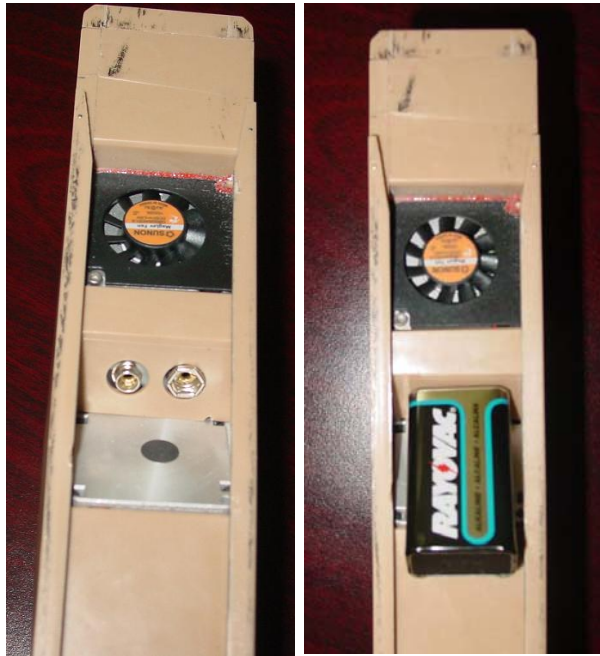

Figure 8: 9V battery charger connector.

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Troubleshooting

If system doesn't turn on:

Press and hold the Power button for four seconds

Make sure the cartridge is fully inserted.

Recharge system

If system takes long time to startup or doesn't produce power:

Allow up to 30 minutes for system startup

Insert a new cartridge if cartridge is empty.

Make sure the cartridge is fully inserted.

Make sure nothing is blocking the exhaust or air intakes.

Recharge system if "Low Batt" symbol appears on LCD

If system overheats:

Make sure nothing is blocking the exhaust, air intake, or cooling fans.

Improve airflow around system, move to colder ambient temperature

If power output turns off:

Make sure the cartridge is fully inserted.

Insert a new cartridge if cartridge is empty.

Make sure nothing is blocking the exhaust or air intake.

Check for proper connection to your application.

Verify power requirement for application is no more than 25 Watts.

Restart the system by pressing the "On" button for four seconds

If system produces odor:

Allow the XX25 to continue startup. If odor persists, check for cartridge leaks. Check for obstructions to the air intake. Odor should disappear within 30 minutes of system startup.

If LCD is difficult to read or doesn't turn on:

Press the button next to the LCD (the LCD backlight button) rapidly to change contrast. Press several times rapidly to cycle through the contrast modes.