Designing Modular, Scalable, N+1 Redundant Uninterruptible Power Systems

Timothy Lowe, PhD
Energy Technologies, Inc.
Development and Application Drivers

Reduced Rack Mounting Space with additional power Capacity

Light weight but Rugged to Meet Shock and Vibration Specifications

High Reliability, High MTBF and Low MTBR Cost Effective in all applications

Modularity With Redundancy

Longer Battery Back up Time

Intelligent Monitoring and Performance History

Ease of Future Application expansion

Flexible Out Put Connector Selection
Designing Modular, Scalable, 
N+1 Redundant UPS

Product Goals and Desires

• 2000 Watts in “1U” of Rack Space (1.75 inches)
• Hot Swappable Power and Battery Modules
• N+1 Redundant Capable
• Paralleled Configurations
• Elimination of Output Power Cable Arm Retractors
• Single Phase or Three Phase Configuration
• Ease of Use Display (Single Button Management)
• Input Power Isolation
• 13 Minute Full Load Battery Backup @ 2000 Watts
• High Efficiency and Overload Capable
• Wide Range Voltage Input and Output
• Full Power Capacity at Low and High Temp (-40C to +70C)
• Less Than 40 Pounds
• Flexible Remote Communication (SNMP, WAN, RS232, RS485)
Delivered Features

- 2000 Watts, 2500 VA output power per module
- 13 minute run-time per battery module at 2000 W
- Field replaceable, hot swap battery modules
- High reliability & capacity lithium iron phosphate
- Full power operation from -20°C to +60°C
- Power factor correction at AC input
- True on-line double conversion
- Cold start with no AC or DC input connections
- Pure sinusoidal AC output voltage
- Handles both linear and non-linear loads
Delivered Features

- **N+1 redundancy**: Increased reliability
- 1-phase or 3-phase AC output configurations
- Up to 32 units can be combined for increased power rating
- 1U high rack mount unit (1.73” x 19” x 23.0”)
- Light weight: <40 lbs. including battery
- Meets Mil Spec mechanical shock and vibration standards
- Multiple output connector configurations
- User I/O and Configuration signal ports
Designing Modular, Scalable, N+1 Redundant UPS

Block Diagram of Power Chain
Designing Modular, Scalable, N+1 Redundant UPS

Lithium Battery Specifications

**SPECIFICATIONS**
- Nominal Capacity @ C/5 (Ah): 2.6
- Average Operating Voltage @ C/5 (V): 3.2
- Internal Impedance @ 1kHz, AC(mΩ): 9
- Weight (g/oz): 80.5 ± 2 / 2.84

**RECOMMENDED OPERATING CONDITIONS**
- Continuous Discharge (A): ≤ 10
- Pulse Discharge (A) 30 Seconds: 26
- Charge Current (A): ≤ 2.6
- Charge Voltage Cutoff (V): 3.65
- Discharge Voltage Cutoff (V): 2.50
- High Operating Temp (°C): 60
- Low Operating Temp (°C): -20

**MAXIMUM OPERATING CONDITIONS**
- Continuous Discharge (A): 42
- Pulse Discharge (A) 30 Seconds: 50
- Short Pulse Discharge Current (A): 150
- Charge Current (A): 5
- Charge Voltage Cutoff (V): 4.1
- Discharge Voltage Cutoff (V): 2.0
- High Operating Temp (°C): 85*
- Low Operating Temp (°C): -40*

---

*Performance may vary depending on application. All specifications and operation conditions are subject to change without notice. This data is for evaluation purposes only. No guarantee is intended or implied by this data. *May reduce cycle life ** Tested and certified - MDS. C0005 REV- D
Designing Modular, Scalable, N+1 Redundant UPS

UPS Single Button Flowchart

PUSH to select MAJOR menu items.
TURN to select MINOR menu items.
Designing Modular, Scalable, N+1 Redundant UPS

Ultimate Power Source™
Rugged, Compact, Light Weight with N+1 Parallel Redundancy

Output Power
2000 Watts, 2500 VA

AC Input Voltage Options
80-140 Vrms or 150-265 Vrms @ 47-65 Hz

AC Output Voltage Options
115 Vrms or 230 Vrms
50Hz or 60Hz

DC Input Voltage Options
28 V nominal or 48 V nominal

DC Output Options
up to 1250 Watts of DC total

Stand Alone Battery Run Time
13 Min. @2000 W
26 Min. @1000 W
Lithium Iron Phosphate

Front View of Single 1U Module
Designing Modular, Scalable, N+1 Redundant UPS

Combine up to 32 Units for increased power! 1-phase or 3-phase AC output!

### Rear View of Single 1U Module

<table>
<thead>
<tr>
<th>Battery Modules</th>
<th>Configuration</th>
<th>Overload Capabilities</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Swappable Battery Modules</td>
<td>Parallelable (up to 32 Units) 1 or 3 Phase AC output</td>
<td>150% Power for 5 sec. 110% w/o degradation</td>
<td>95% Enhanced Power Conversion 90% Online</td>
</tr>
<tr>
<td>Light Weight Lithium</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Designing Modular, Scalable, N+1 Redundant UPS

1U UPS with Several Output Connector Configurations

- AC Input
- Temp Controlled Fans
- Sync/Config Ports
- I/O (RS232/TCPIP)
- Aux Battery
- (2) NEMA 5-15
- (2) MS
- NEMA 5-15 & MS

(2) MS
Designing Modular, Scalable, N+1 Redundant UPS

1U Battery Expansion Module (BEM)

- Hot swappable Battery Modules
- Same Battery Modules used in the 1U UPS

2 Lithium Iron Phosphate Modules
Designing Modular, Scalable, N+1 Redundant UPS

Connector Options for 1U BEM

(2) MS connectors. Dual connectors allow BEMs to be daisy chained for increased backup time

Temp Controlled Fans

Aux Battery Charger AC Input

(2) Anderson Connectors
Designing Modular, Scalable, N+1 Redundant UPS

2U Hot Swappable Paralleling Interface
Backplane Cage Rear View

TCPIP/ HTML Interface

With MS Connectors,
Other Style Connectors Available
Designing Modular, Scalable, N+1 Redundant UPS

2U Hot Swappable Paralleling Interface
Fully Assembled in Rack
Rear View
Hot Swappable Parallelizing Interface
Rear View (Backplane Cage not shown)
Designing Modular, Scalable, N+1 Redundant UPS

- Hot Swappable Paralleling Interface
- Backplane Cage
- Floating Self Aligning Protected Guide Pins
Designing Modular, Scalable, N+1 Redundant UPS

2U Hot Swappable Parallelizing Interface Backplane Cage Inside View

Floating Self Aligning Protected Guide Pins
3U Backplane Cage with MS Connectors
3U Hot Swappable Backplane Cage Fully Assembled with MS Connectors
Designing Modular, Scalable, N+1 Redundant UPS

Multiple Output connector configurations available to fit your application (2U Configurations)
Designing Modular, Scalable, N+1 Redundant UPS

Multiple Output connector configurations available to fit your application (3U Configurations)
Ultimate Power Source Mil Spec® Version
1U 2000 Watt Ultra Compact UPS with
1U Battery Extension Module (BEM)
39 Minutes @ 2000 W, 78 Minutes @ 1000 W
Designing Modular, Scalable, N+1 Redundant UPS

1U 2000 Watt Ultra Compact UPS with (2) 1U Battery Extension Modules (BEM)
65 Minutes @ 2000 W, 130 Minutes @ 1000 W
Designing Modular, Scalable, N+1 Redundant UPS

(2) 1U 2000 Watt Ultra Compact UPS with 1U Battery Extension Module (BEM)
26 Minutes @ 4000 W, 52 Minutes @ 2000 W
(2) 1U 2 kW UPS in parallel in hot swap configuration
Designing Modular, Scalable, N+1 Redundant UPS

Front Controlled 6 Load PDU with Status & Alarm Indicators

- UPS 1 or 2 AC Input Breakers
- Emergency Power Off (Press Both)
- Battle Short
- Load Control Switches
- Load Status LEDs
- Alarm Status LEDs
- Alarm Reset

Rear View with NEMA 5-15 Option

- UPS 1 or 2 AC Inputs
- Optional Status, Safety Interlock and Remote Control Ports
- Choice of NEMA, IEC or MS Connectors
Designing Modular, Scalable, N+1 Redundant UPS

PDU, UPS & BEM in Rack

PDU can be mounted Remotely from UPS and BEM
Designing Modular, Scalable, N+1 Redundant UPS

1U Power Distribution Unit (PDU) with 1U 2000 Watt Ultra Compact UPS and 1U Battery Extension Module (BEM)
Designing Modular, Scalable, N+1 Redundant UPS

12 kW, 3 Phase UPS or 6 kW, 3 Phase N+1 UPS
Field Replaceable Modules and Individual Phase Monitoring

Power Distribution Management (PDM)

(6) 2 kW UPS Paralleled together
(13 min backup @ 12 kW)

Allows Easy Field Replacement
Designing Modular, Scalable, N+1 Redundant UPS

Tactical Case with 4 kW total UPS power
26 Minutes of Battery Backup @ 4 kW
52 Minutes of Battery Backup @ 2 kW
In a 3U high configuration
Designing Modular, Scalable, N+1 Redundant UPS

Tactical, Shock Isolated Rack Case with:
1U UPS, 2 kW, 13-30 Min Backup
1U Workstation or Server and
1U Keyboard, Touchpad and Display
Designing Modular, Scalable, N+1 Redundant UPS

For more information go to
www.UltimatePowerSource.com

Tim Lowe PhD
tdlowe@ruggedsystems.com

Voice: 419.522.4444
Fax: 419.522.4466