

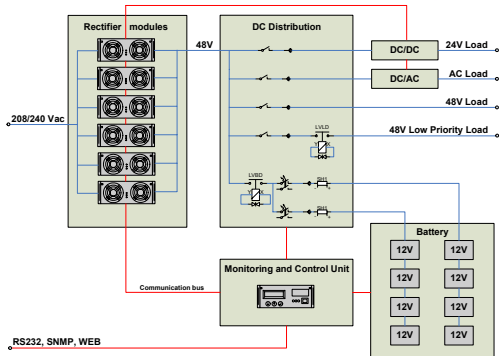
Telecom Power Solutions – More for Less Presentation at InfoBatt 2005 Canada

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What is a Telecom Power System

System Voltage: 24V or 48V
Building blocks:

- Rectifier modules
 - ↳ Paralleled to deliver required power and redundancy
 - ↳ Load sharing
- Control unit
 - ↳ Controls rectifiers and battery charging
 - ↳ Monitors site parameters
 - ↳ Communicates alarms and site information
- Distribution panel (customer connections)
 - ↳ DC fuse or MCB panels
 - ↳ Battery and load contactors
- Batteries
- Inverters, DC/DC Converters
- Backup Generator



- ### Reliability Requirements
- ✓ The system shall maintain redundancy requirements for all vital functions.
 - ✓ The system shall have a controlled performance with any single failure in the system components:
 - ↳ Output voltage within specified range
 - ↳ Sufficient power available to the load
 - ↳ Battery backup available
 - ↳ Fallback to factory set charge voltage if control unit fails
 - ✓ Rectifier field MTBF > 1.000.000 hours

Market Requirements and Challenges

- Requirements in a global market:
 - ↳ Shorter time to market
 - ↳ High reliability
 - ↳ Lower cost
 - ↳ Higher power density
 - ↳ More functionality
 - ↳ Global approvals
- How to meet these challenges?
 - ↳ Make designs suitable for high volume production
 - ↳ Standardize on few building blocks (modules)
 - ↳ Increase flexibility on systems and building blocks
 - ↳ Increase flexibility on functionality and protocols
 - ↳ Remote management
 - ↳ Easy adaption to local requirements

Rectifiers

- Typical specification:
 - ↳ Output voltage adjustable from 40 to 60V
 - ↳ Wide input voltage range, 176 – 264Vac minimum
 - ↳ Active power factor correction, >0.99
 - ↳ Efficiency >90%
 - ↳ Operational temperature -40 to +65 °C
 - ↳ Active load sharing
 - ↳ Protection against mains voltage and temperature variation
 - ↳ IEC/UL60950 Safety compliance
 - ↳ EN/FCC/NEBS EMC compliance

Rectifiers

Main research areas

- Power electronics topologies
 - Soft switching, high efficiency
 - Simple, reliable
 - High frequency switching
- Magnetic components
 - Higher frequency, lower losses
 - Low cost designs
- Thermal management
 - Optimized fan cooled designs
- Digital control
 - Easier to implement advanced functionality
 - Increased flexibility
 - Reduced component count

Power Density Development (Fan cooled rectifiers)

Year	Power density (W/in³)
1990	4
1995	5
2000	7
2005	10
2010	18

- High efficiency, soft switching topologies, efficiency => 93%
- Better components, including fans
- Improved thermal designs
- Improved packaging of components and boards
- Reduced number of components by using digital control

Rectifier Cost Development

Year	Relative Cost/Watt
1990	1.0
1995	0.5
2000	0.4
2005	0.3
2010	0.25

- Technology: New soft switching topologies with higher efficiency.
- Manufacturing/logistics: Transfer to low cost countries, high production volume on (few) standard modules
- Components: Improved price/performance

Rectifier Technology - Digital Control

- Enables a significant reduction of component count
 - Typically reduced by 40%
- Easy to implement advanced functionality
 - Fan speed control
 - Temperature derating
 - Power derating at low mains
 - Constant power limit
- Detailed rectifier information available
 - Mains voltage, output current, temperature, alarms
 - Rectifier type, serial number, sw version
 - All control via serial bus (CAN), including load sharing between rectifier modules
- Individual rectifier control possible

Rectifier Technology - Digital Control

Primary side

- Monitoring:
 - Mains voltage
 - $48VDC$ line voltage
 - Temperature
- Control:
 - Start-up sequence
 - Shutdown
 - Hold-up time
 - Over-voltage protection
 - Temperature derating
 - Low mains derating
 - High mains shutdown

Secondary side

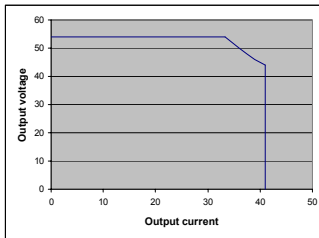
- Monitoring:
 - Output voltage
 - Output current
 - Temperature
 - Fans
- Control:
 - Output voltage
 - High voltage shutdown
 - Temperature shutdown
 - Start ramp
 - Fan speed
 - Power limit
 - Current limit

Output power vs mains voltage

Mains voltage (V)	Output power (W)
0	0
100	0
200	1800
300	1800
350	0

- Wide nominal voltage range required, 176 – 300Vac
- Derated output power down to 90 Vac
- Protective shutdown at high mains
- Needs to survive loss of neutral conductor in a 400V system

Output characteristics



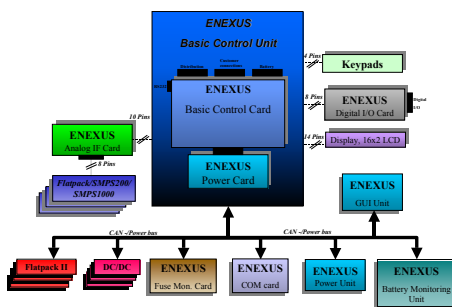
- Constant power limit, not constant current
- Optimized to feed electronic loads, which draw more current at low voltage
- With defined charging capacity and redundancy requirements, less rectifiers are needed

Control system technology



- Modular hardware and software
 - Basic hw and sw platform common for all system sizes and families
 - Expandable
 - Distributed intelligence
- Digital internal communication bus
 - Less wiring, more control
- Software design using UML
 - Modular software
 - Reusable
- Gateway solutions
 - Remote monitoring via internet
 - SNMP

Control system structure



Battery monitoring



- Temperature compensated charge voltage
- Battery charge current limitation
- Block voltage or midpoint monitoring on several battery strings
- Battery string current measurement
- Battery string current share during discharge
- Battery discharge tests at defined time intervals
- Stored discharge test data
- Monitoring number of deep discharges to predict battery lifetime

It's just a battery charger...



Yes, but:

- for almost any size and type of stand by batteries
- it is also a complete uninterruptible power supply system for DC applications
- with highly efficient power conversion
- with a modular design to achieve high availability through redundancy
- due to the modularity, the customer can buy exactly the system size he needs
- with remote connectivity allowing centralized monitoring for regional or national operators