



S A F T

LI ION BESS

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SAFT

Presentation for:

DOE Energy Storage Systems

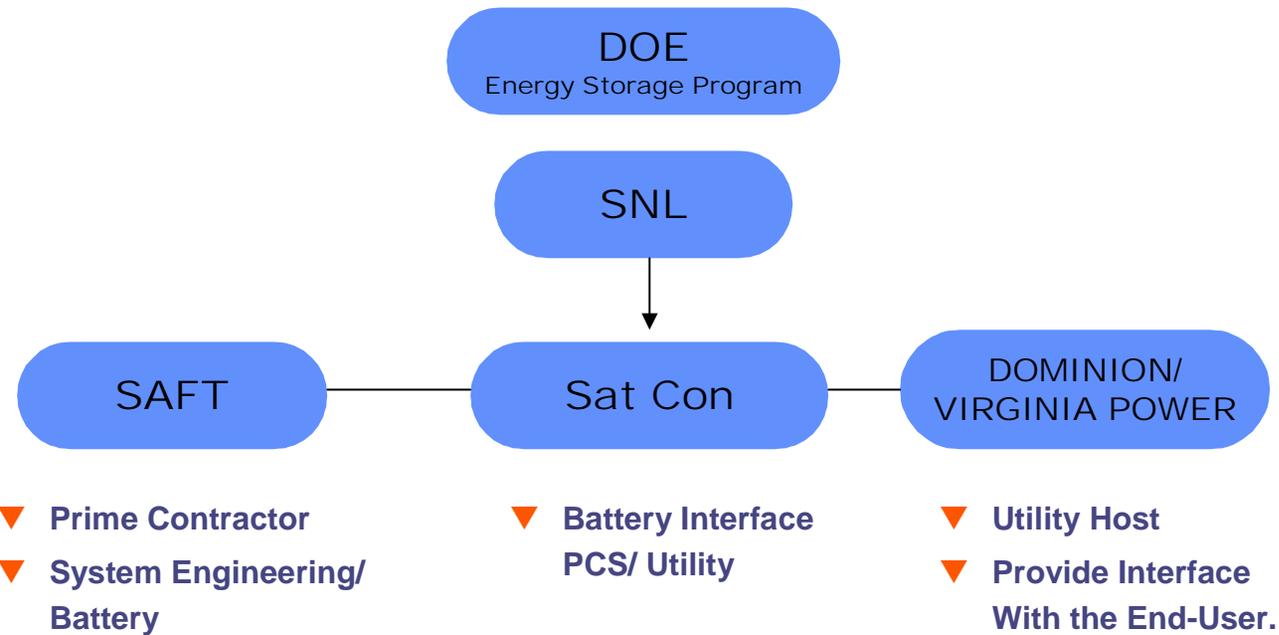
Peer Review Meeting

Washington D.C., November 14-15, 2001



100 kW LiON Battery System For Power Quality Application

THE PROGRAM





100 kW LiON Battery System For Power Quality Application

SYSTEM DESCRIPTION

- ▼ A battery system: 100 kW LiON battery system with battery management system (BMS)
Responsibility: Saft
- ▼ Battery/system: Connects the battery system to the utility “grid”...
Responsibility: SatCon



100 kW LiON Battery System For Power Quality Application

Basic ESS Battery Characteristics

- ▼ Power: 100kW/ 1 minute, 150kW/ 10 sec
- ▼ Energy; ~ 15 kWh.
- ▼ Voltage window: 515/405 V no load/ full load.
- ▼ Operating temperature: Room temperature (estimated between 15 and 35°C).
- ▼ Typical operating mode: Floating with occasional power pulse.
- ▼ Life: > 10years (based on accelerated aging).



100 kW LiON Battery System For Power Quality Application

ESS BATTERY

- ▼ 132- HP30 LiON cells in series.
- ▼ 11 modules: 12- HP 30 cells per module.
- ▼ BMS: 2 Electronic levels:
 - ▼ *Module level:*
 - ▼ Active cell balancing to optimize battery performance.
 - ▼ Sensing of overcharge & over-discharge conditions
 - ▼ Powered by the module itself.
 - ▼ *Battery level:*
 - ▼ Interrupts battery “charge” or “discharge” in response to signal(s) from one or more modules.
 - ▼ Automatically resumes charge/ discharge when alarm signal is cleared.

The logo for SAFT, featuring the letters 'S A F T' in white on a dark grey rectangular background. Above the letters is a small orange downward-pointing triangle.

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100 KW /100 KVS Battery / Microturbine Power Conditioning System (PCS)

The SatCon AE-100-60-B-A is designed to interface with the dc power from the SAFT America Battery output to the utility power line, in Line Linkage Mode, or to critical load, in Stand-alone Mode and also interface with Capstone Microturbine on ac side.

The PCS is designed for three-phase output connection of 480Vac 60 Hz operation

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DESIGN FEATURES :



- ▼ The PCS is designed according to the SAFT Specification of 100kW/100kVA Inverter for Battery / Microturbine.
- ▼ The unit has two modes of operation, namely Line Linkage Mode (GRID EXPORT MODE) and Stand Alone Mode (V-MODE). The transition between the two modes of operation is automatic.
- ▼ The control for line linkage operation (GRID EXPORT MODE) is Current Control and for stand-alone operation (V-MODE) is AC PWM voltage control.
- ▼ The three phases output voltages and currents are sinusoidal with low total harmonic distortion.
- ▼ The inverter design uses IGBT for fast switching, high switching frequency and high efficiency.

▼
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DESIGN FEATURES :
(cont.)



- ▼ The control circuit uses Digital Power Control Board using TI-DSP (Texas Instrument-Digital Signal Processing) for control, system monitoring and protection.
- ▼ Use of DSP based control allows for advanced control strategies such as field oriented control, D/Q Frame control, predictive control resulting in improved system dynamic response, stability and accuracy. Use of two DSP with a dual port SRAM architecture provides parallel processing capability
- ▼ All areas sensitive to over-temperature conditions are monitored with thermal detectors.
- ▼ Extensive electronic fault detection schemes, with fuses to ensure safety.



POWER CONDITIONING SYSTEM PCS SPECIFICATIONS:

Electrical:

DC Parameters

Battery Voltage Range	:	350 to 546V DC
Battery Current	:	0 to 285A DC max. 110% Over-Load Continuous
Maximum current ripple from PCS	:	< 5%



AC Parameters – Line Operation (Grid connected):

Rated Output Power	:	100kW/100kVA
Frequency	:	60 Hz
Rated AC output voltage	:	480 V AC
Operational range of line linkage voltage	:	Rated voltage +10%/- 12%
Operational range of line linkage frequency	:	Rated frequency \pm 1%
Efficiency of power conversion	:	> 95% Without Transformer
Power factor at reduced load	:	Full lead to full lag
		Programmed ramp
Power Real and Reactive Accuracy	:	\pm 1%
Output current harmonics	:	THD \leq 5%, Each \leq 3%



Output Parameters – Stand Alone Operations (V-MODE)

Rated AC output voltage	:	480V AC, 3 phase
Rated output frequency	:	60 Hz
Accuracy of output voltage	:	$\pm 2\%$ of rated voltage
Accuracy of output frequency	:	$\pm 0.1\%$ of rated frequency
Distortion of voltage waveform	:	$\leq 3\%$ for linear load
Current / VA Limit	:	110% Over-Load (Continuos)

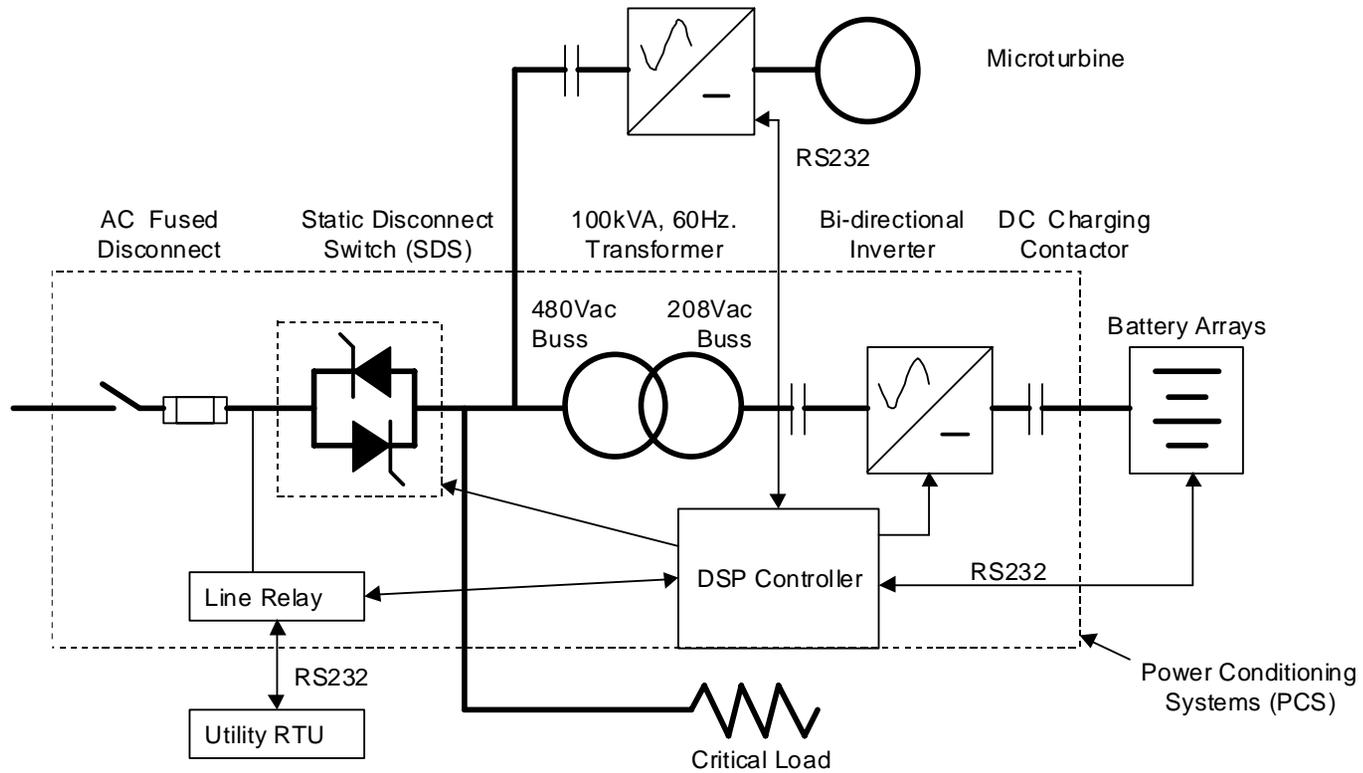


Environment

Operating Ambient Temperature	:	-30°C to +40°C
Relative Humidity	:	Non-condensing

Physical:

Location	:	Indoor
Enclosure	:	NEMA 1 (IP23) Power Circuit NEMA12 (IP55) Control Circuits
Dimension	:	72" H x 60" W x 30" D max.
Weight	:	TBD
Cooling	:	Forced Air with Central Blower



**SAFT
SANDIA 9.6kWh Battery Test Cycle**

Step	Direction	Current	Power (KW)	Duration (Seconds)	Energy (WHr)
1	Discharge	1C	8	1,350	-3000
2	Charge	0.25C to 106.4V + Float		9,000	4000
3	Discharge	1.5C	12	300	-1000
4	Charge	0.25C to 106.4V + Float		4,500	1000
5	Discharge	3C	24	5	-33.3
6	Charge	0.25C to 106.4V + Float		1,195	33.3
7	Discharge	1.5C	12	300	-1000
8	Charge	0.25C to 106.4V + Float		4,500	1000

September 20, 2001

Notes:

1. C_{rate} is 80 Amps.
2. Floating voltage is arbitrarily selected at 3.85V/Cell.
3. Do Steps 1 & 2 once per month
4. Repeat Steps 3 – 8 224 times, then do a cell characterization (once/month).
5. Repeat the previous sequence every month for 6 months.
6. Equipment safety limits:
 - $I_{MAX} = (3.5 * C_{rate})$
 - $I_{MIN} = -3.5 * C_{rate}$
 - $P_{MIN} = -27.0 \text{ KW}$
 - $P_{MAX} = 2.5 \text{ KW}$

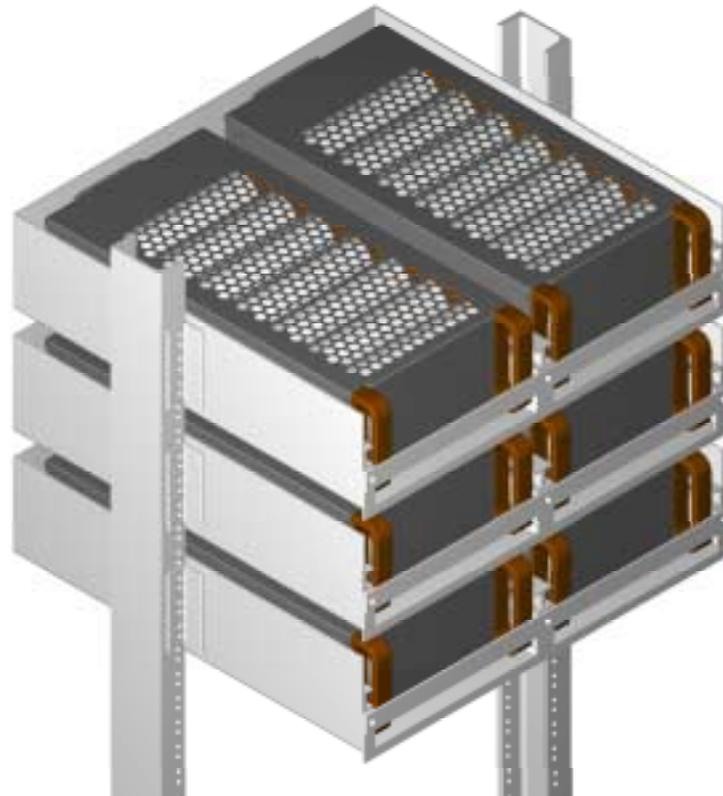
SNL BATTERY TEST COMPLETION SO FAR:

As of 11/14/01 @ 3:00PM: 177 Cycles of 224 completed



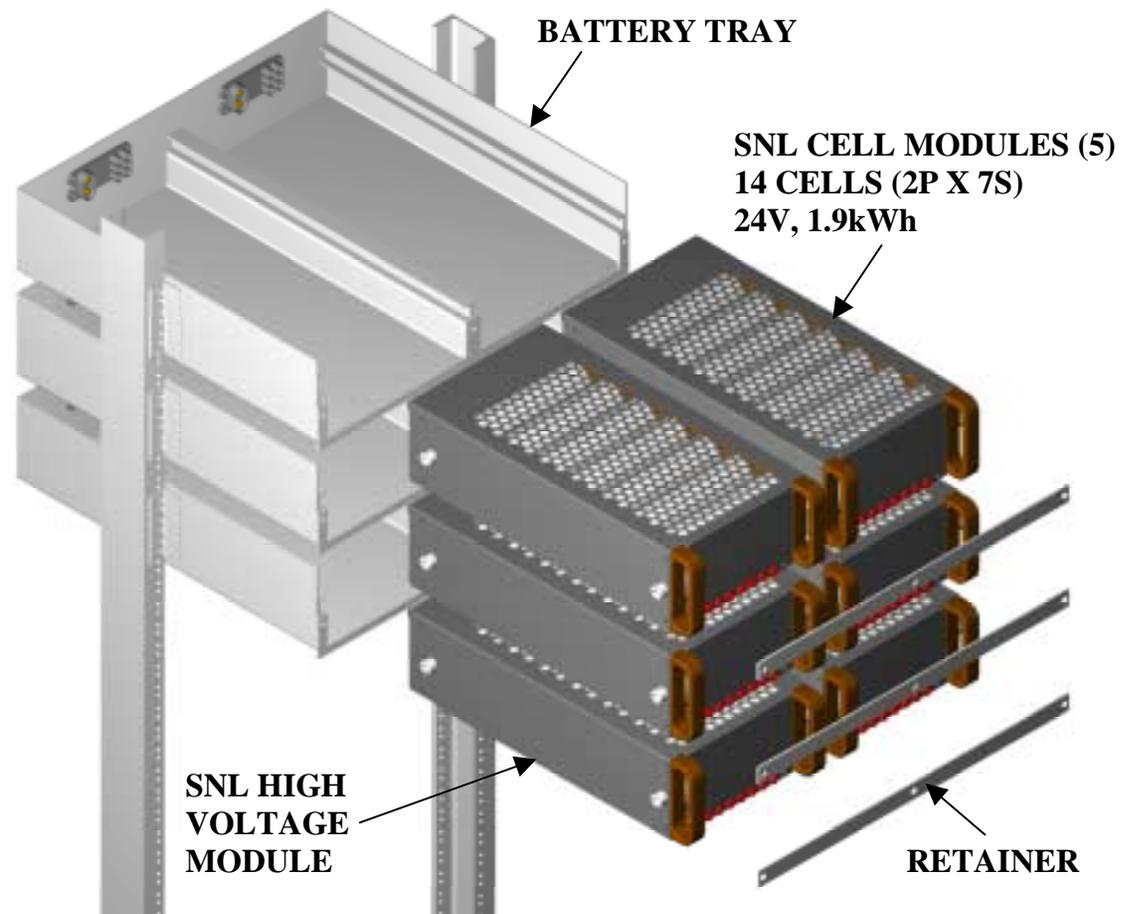
SNL Battery

Energy: 9.5 kWh
Voltage: 120 V





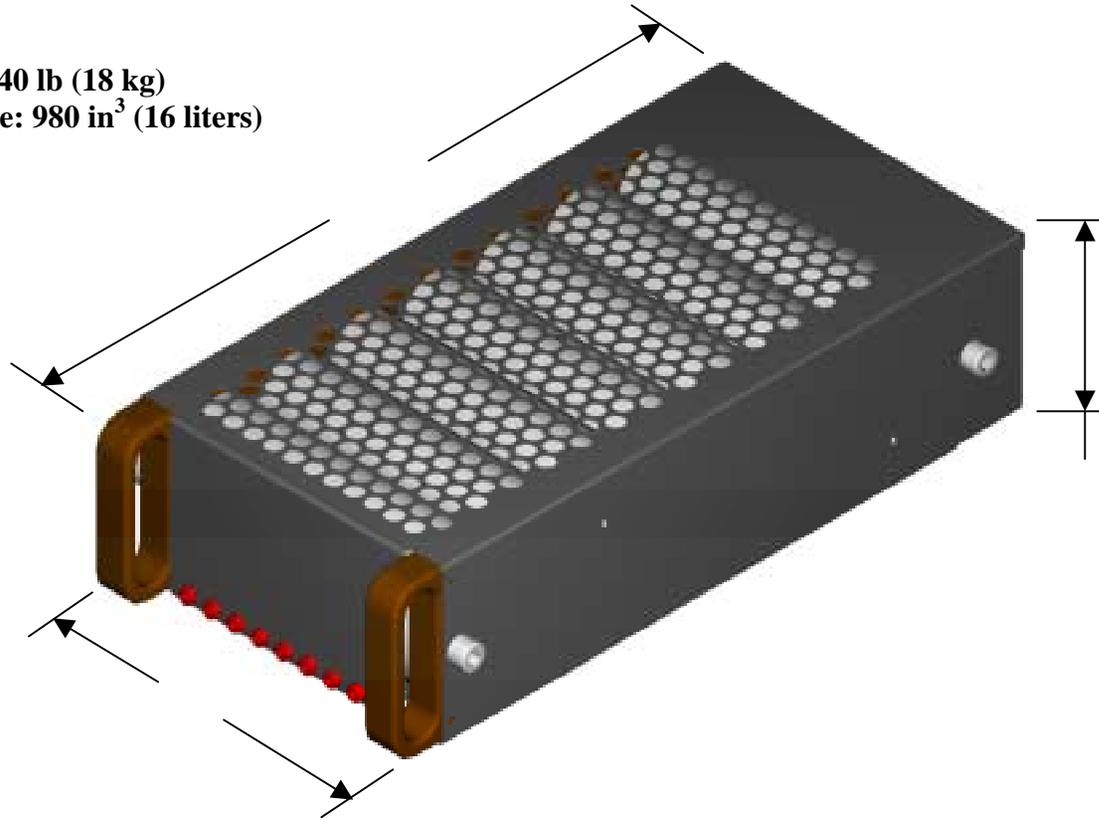
SNL Battery – Exploded View





SNL Cell Module

Mass: 40 lb (18 kg)
Volume: 980 in³ (16 liters)



- ▼ Subset of full trial battery
- ▼ 120V nominal
- ▼ 5 modules of 14 cells
 - ▼ 7 series / 2 parallel
 - ▼ Same configuration as likely telecom modules for 48V application
- ▼ 9.6kWh

