

Battery Systems Overview



Ocean Bottom Seismology Laboratory
Institute for Geophysics and Planetary Physics

Sean McPeak

Sr. Development Engineer
Scripps Institution of Oceanography
University of California San Diego



SIO OBS - Battery Systems Presentation Overview

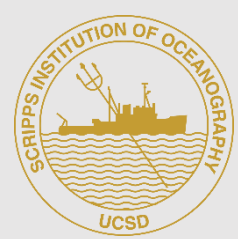


- Description of OBS system loads
- Breakdown of Electrochem battery packs used and cell specifications / related applications.
- Alkaline Packs used (Internal as well as external sourcing)
 - 'D' Cell pack used for active cruise short duration deployments
 - Acoustic Release Pack
 - Clock pack
- Flex cable design for series and parallel connections of packs
- Electrochem pack with integrated fuel gage monitor



OBS System Electrical Loads

Description	Voltage Supply Range	Current Draw	Nominal Power Consumption
Logger (@ 200 SPS)	7 – 16VDC	85mA - 37mA	592mW – 607mW
Sensor (Trillium 240)	~15VDC	~53mA	800mW (original) 650mW (new version)
HTI-90-U Hydrophone	10VDC	4mA	40mW
DPG sensor	5VDC	1.25mA	6.25mW



CSC93 DD and BCX85 DD Cell Information



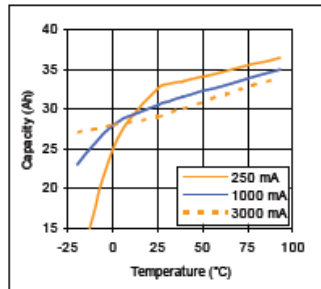
HIGH RATE LITHIUM CELL CSC93 SERIES: 3B0036 SIZE DD

LITHIUM SULFURYL CHLORIDE CELL

Technical Overview

Open Circuit Voltage (25°C)	3.9 V
Rated Discharge Current	1.0 A
Rated Capacity	30 Ah
Maximum Continuous Current	4.0 A
Cell Diameter	33.5 mm (1.32 in.)
Cell Length	111.4 mm (4.39 in.)
Cell Weight	213 g
Lithium Weight	10.2 g
Safety Fuse	7.0 A
Self Discharge	3% per year at 25°C
Operating Temperature	-20°C to +93°C -4°F to +200°F

Capacity as a function of current and temperature



CSC93 has higher discharge and max continuous current capability

BCX85 has improved cold temp performance over CSC at or below -20°C.

If the battery is discharged at 0°C or warmer and load per cell is low, both BCX or CSC could be used.

If load per cell is high then CSC will have better performance.



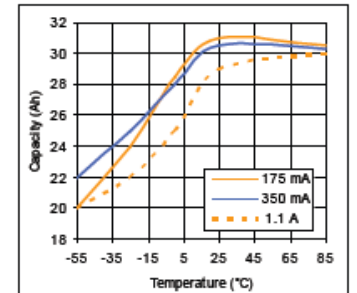
HIGH RATE LITHIUM CELL BCX85 SERIES: 3B0076 SIZE DD

LITHIUM BROMINE CHLORIDE CELL

Technical Overview

Open Circuit Voltage (25°C)	3.9 V
Rated Discharge Current	350 mA
Rated Capacity	30 Ah
Maximum Continuous Current	3.0 A
Cell Diameter	33.5 mm (1.32 in.)
Cell Length	111.5 mm (4.39 in.)
Cell Weight	216 g
Lithium Weight	10.2 g
Safety Fuse	4.0 A
Self Discharge	3% per year at 25°C
Operating Temperature	-55°C to +85°C -67°F to +185°F

Capacity as a function of current and temperature



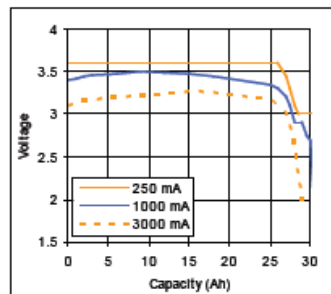
Key Features:

- Primary chemistry (non-rechargeable)
- High rate capability
- Advanced spiral-wound technology
- Stainless steel container
- Hermetic glass-to-metal sealing
- Wide operating temperature range as low as -20°C and up to +93°C
- Low self discharge rate (3% per year at 25°C)
- Restricted for transportation (Class 9)
- Custom terminations available

Main Applications:

- Military communications
- Oceanographic buoys and gliders
- Tracking systems
- Sensor systems
- Pipeline inspection gauges
- Beacons, transponders and receivers
- Seismic surveying birds

25°C discharge



NOTICE: The information on this datasheet is for single cells only. Please consult with Electrochem if you are interested in additional information. The information in this document is subject to change without notice and does not constitute a warranty of performance.

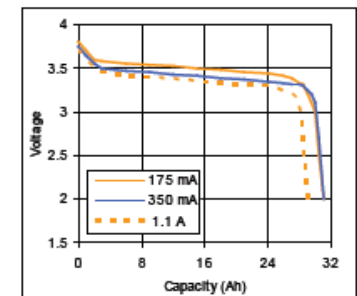
Key Features:

- Primary chemistry (non-rechargeable)
- High rate capability
- Advanced spiral-wound technology
- Stainless steel container
- Hermetic glass-to-metal sealing
- Wide operating temperature range as low as -55°C and up to +85°C
- Low self discharge rate (3% per year at 25°C)
- Restricted for transportation (Class 9)
- Custom terminations available

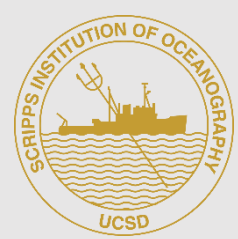
Main Applications:

- Military communications
- Oceanographic buoys and gliders
- Tracking systems
- Sensor systems
- Pipeline inspection gauges
- Beacons, transponders and receivers
- Seismic surveying birds

25°C discharge



NOTICE: The information on this datasheet is for single cells only. Please consult with Electrochem if you are interested in additional information. The information in this document is subject to change without notice and does not constitute a warranty of performance.



BCX-C Cell Information



ELECTROCHEM
CREATING TOMORROW

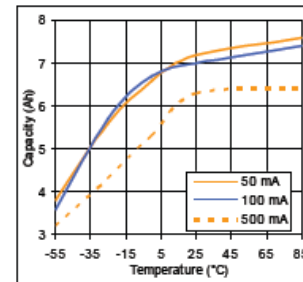
HIGH RATE LITHIUM CELL
BCX85 SERIES: 3B0070
SIZE C

LITHIUM BROMINE CHLORIDE CELL

Technical Overview

Open Circuit Voltage (25°C)	3.9 V
Rated Discharge Current	50 mA
Rated Capacity	7 Ah
Maximum Continuous Current	500 mA
Cell Diameter	25.6 mm (1.01 in.)
Cell Length	48.4 mm (1.90 in.)
Cell Weight	55 g
Lithium Weight	2.2 g
Safety Fuse	4.0 A
Self Discharge	3% per year at 25°C
Operating Temperature	-55°C to +85°C
	-67°F to +185°F

Capacity as a function of current and temperature



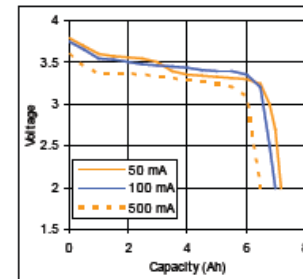
Key Features:

- Primary chemistry (non-rechargeable)
- High rate capability
- Advanced spiral-wound technology
- Stainless steel container
- Hermetic glass-to-metal sealing
- Wide operating temperature range as low as -55°C and up to +85°C
- Low self discharge rate (3% per year at 25°C)
- Restricted for transportation (Class 9)
- Custom terminations available

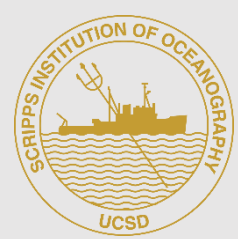
Main Applications:

- Military communications
- Oceanographic buoys and gliders
- Tracking systems
- Sensor systems
- Pipeline inspection gauges
- Beacons, transponders and receivers
- Seismic surveying birds

25°C discharge



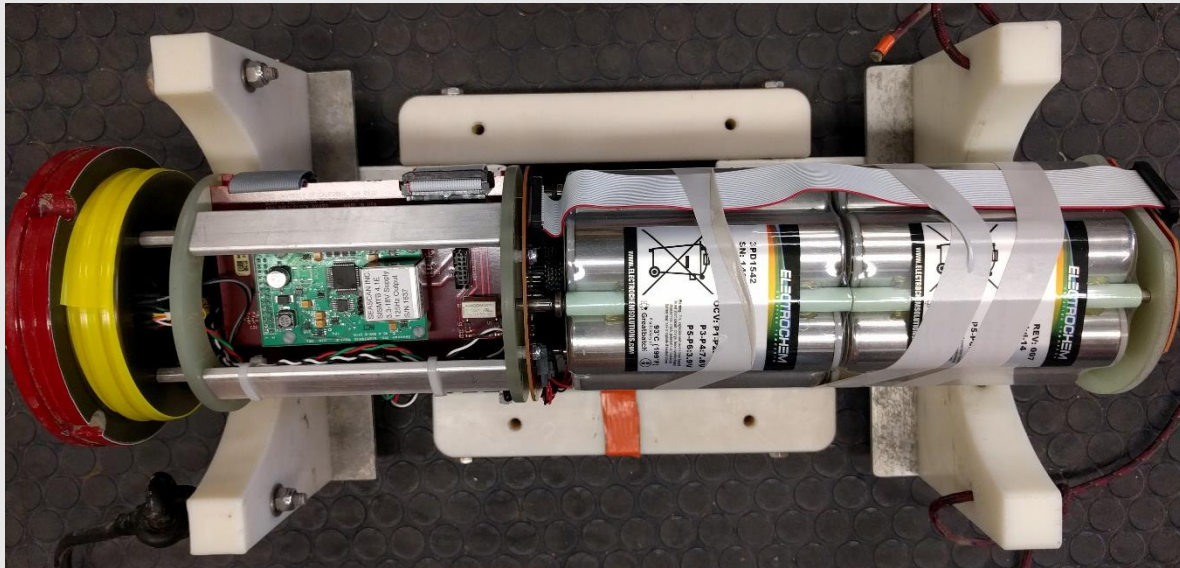
NOTICE: The information on this datasheet is for single cells only. Please consult with Electrochem if you are interested in additional information. The information in this document is subject to change without notice and does not constitute a warranty of performance.



Electrochem Lithium Primary Battery Pack Examples



New Electronics Abalones Small Pressure Case



Clock Pack

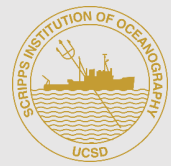


4x4 LP or SP



Abalones Instrument Battery Bottle





Electrochem Lithium Primary Battery Packs



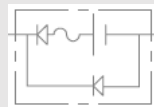
Application	Diagram	Cell Type	Nominal Cell Capacity (Ah)	Pack Cell Config	Nominal Pack Capacity per output (Ah)	Cell / Supply Count	Available Voltages Open Circuit	Protection Circuitry
Clock Pack		BCX-C	7	1S-2P	14	2 / 1	3.7	
Abalones LP w/new logger small housing		CSC-DD	30	1S,2S,4S	30	7 / 3	3.9, 7.8, 15.6	
WHOI Modem		BCX-DD	30	6S-2P	60	12 / 1	23.28-23.64	
Larger pressure case w/new logger or 4x4 OR 4x4 batt bottle		BCX-DD	30	4S-3P	90	12 / 1	15.0-15.7	
Fuel Gauge FLIP (low profile SP) OR Abalones LP		CSC-DD	30	4S-7P	210	28 / 1	15.6	
L-Cheap Logger Legacy		BCX-DD	30	2S,2S 4S-2P	90	12 / 3	+/-7.4-7.9 14.8-15.8	
4x4 Logger Larger Pressure Case		BCX-DD	30	2S, 6P	180	12 / 1	7.4-7.9	
Abalones Instrument Battery Bottle		CSC-DD	30	4S, 7P	210	28 / 1	15.6	



Each cell has 4A series fuse w/ parallel diode



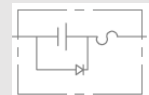
Each cell has 4A series fuse w/ parallel diode, plus diode in series



Each cell has parallel diode and series 4A fuse



Blocking diode at the top of each series string of cells





Protection Diode Spec

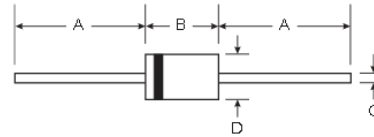


1N5817 - 1N5819

1.0A SCHOTTKY BARRIER RECTIFIER

Features

- Guard Ring Die Construction for Transient Protection
- Low Power Loss, High Efficiency
- High Surge Capability
- High Current Capability and Low Forward Voltage Drop
- For Use in Low Voltage, High Frequency Inverters, Free Wheeling, and Polarity Protection Application
- **Lead Free Finish, RoHS Compliant (Note 5)**



Mechanical Data

- Case: DO-41
- Case Material: Molded Plastic. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020C
- Terminals: Finish — Tin. Plated Leads Solderable per MIL-STD-202, Method 208
- Polarity: Cathode Band
- Ordering Information: See Page 2
- Marking: Type Number and Date Code
- Weight: 0.3 grams (approximate)

DO-41 Plastic		
Dim	Min	Max
A	25.40	—
B	4.06	5.21
C	0.71	0.864
D	2.00	2.72
All Dimensions in mm		

Maximum Ratings and Electrical Characteristics @ T_A = 25°C unless otherwise specified

Single phase, half wave, 60Hz, resistive or inductive load.
For capacitive load, derate current by 20%.

Characteristic	Symbol	1N5817	1N5818	1N5819	Unit
Peak Repetitive Reverse Voltage	V _{RRM}	20	30	40	V
Working Peak Reverse Voltage	V _{RWM}				
DC Blocking Voltage	V _R				
RMS Reverse Voltage	V _{R(RMS)}	14	21	28	V
Average Rectified Output Current (Note 1)	I _O		1.0		A
	@ T _L = 90°C				
Non-Repetitive Peak Forward Surge Current 8.3ms single half sine-wave superimposed on rated load	I _{FSM}		25		A
Forward Voltage (Note 2)	V _{FM}	0.450 0.750	0.550 0.875	0.60 0.90	V
	@ I _F = 1.0A				
	@ I _F = 3.0A				
Peak Reverse Leakage Current at Rated DC Blocking Voltage (Note 2)	I _{RM}		1.0 10		mA
	@ T _A = 25°C				
	@ T _A = 100°C				
Typical Total Capacitance (Note 3)	C _T		110		pF
Typical Thermal Resistance Junction to Lead (Note 4)	R _{θJL}		15		°C/W
Typical Thermal Resistance Junction to Ambient	R _{θJA}		50		°C/W
Operating and Storage Temperature Range	T _J , T _{STG}		-65 to +125		°C

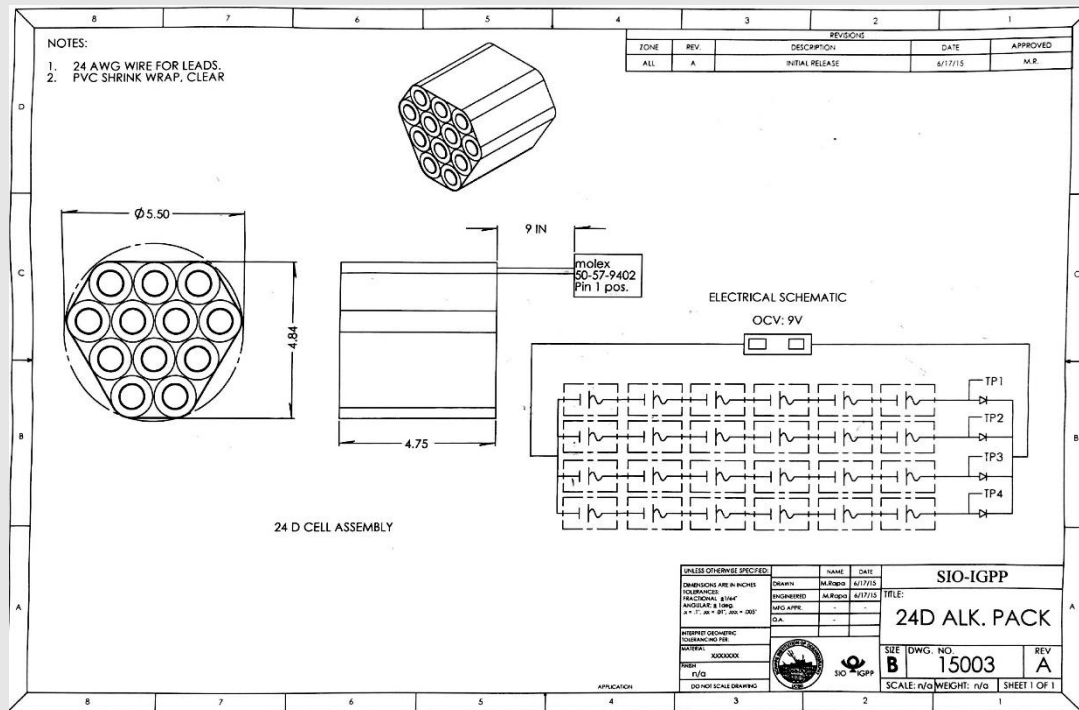


Alkaline Pack for Logger



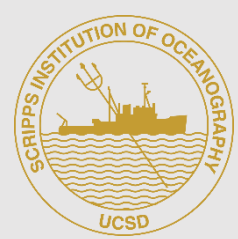
- Industrial Energizer D Cell x 24
- 9V open circuit
- Each cell is fused
- Each series string is diode protected

In house battery pack fabrication



Pro Battery Specialist - pack fabrication



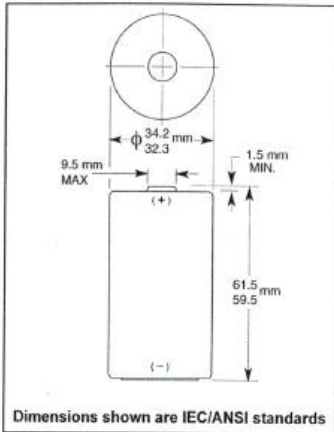


Pro Battery Specialist - Alkaline D Cell Spec

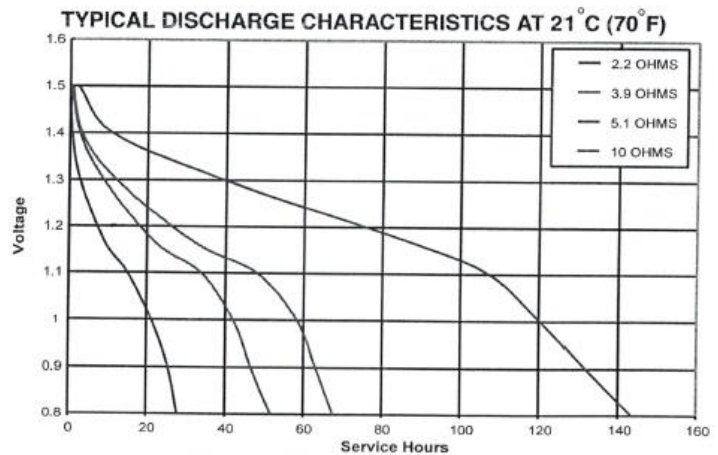


DURACELL[®] COPPERTOP[™] MN1300
Alkaline-Manganese Dioxide Battery Size: D (LR20)

Zn/MnO₂



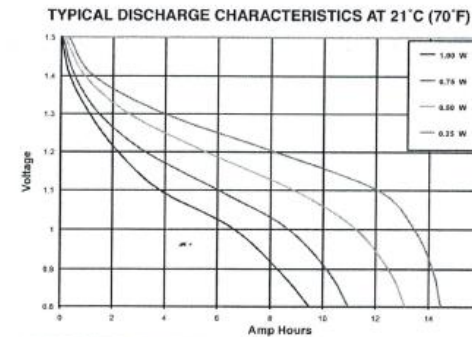
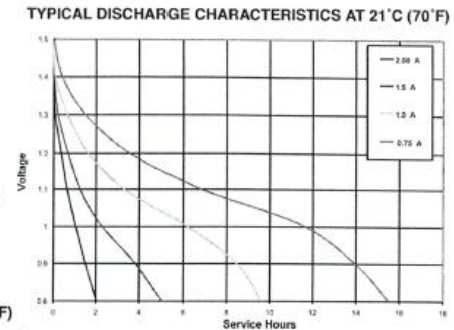
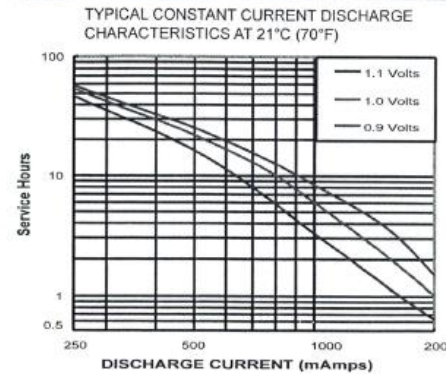
Nominal Voltage:	1.5 V
Nominal Internal Impedance:	136 m-ohm @ 1kHz
Average Weight:	139 gm (4.9 oz.)
Volume:	56.4 cm ³ (3.44 in. ³)
Terminals:	Flat
Operating Temperature Range:	-20°C to 54°C (-4°F to 130°F)
NEDA/ANSI:	13A
IEC:	LR20



* Delivered capacity is dependent on the applied load, operating temperature and cut-off voltage. Please refer to the charts and discharge data shown for examples of the energy / service life that the battery will provide for various load conditions.

DURACELL[®] COPPERTOP[™] MN1300
Alkaline-Manganese Dioxide Battery Size: D (LR20)

Zn/MnO₂



DURACELL[®]
BATTERIES
Berkshire Corporate Park
Bethel, CT 06801 U.S.A.
Telephone: Toll-free 1-800-544-5454
Internet: www.duracell.com

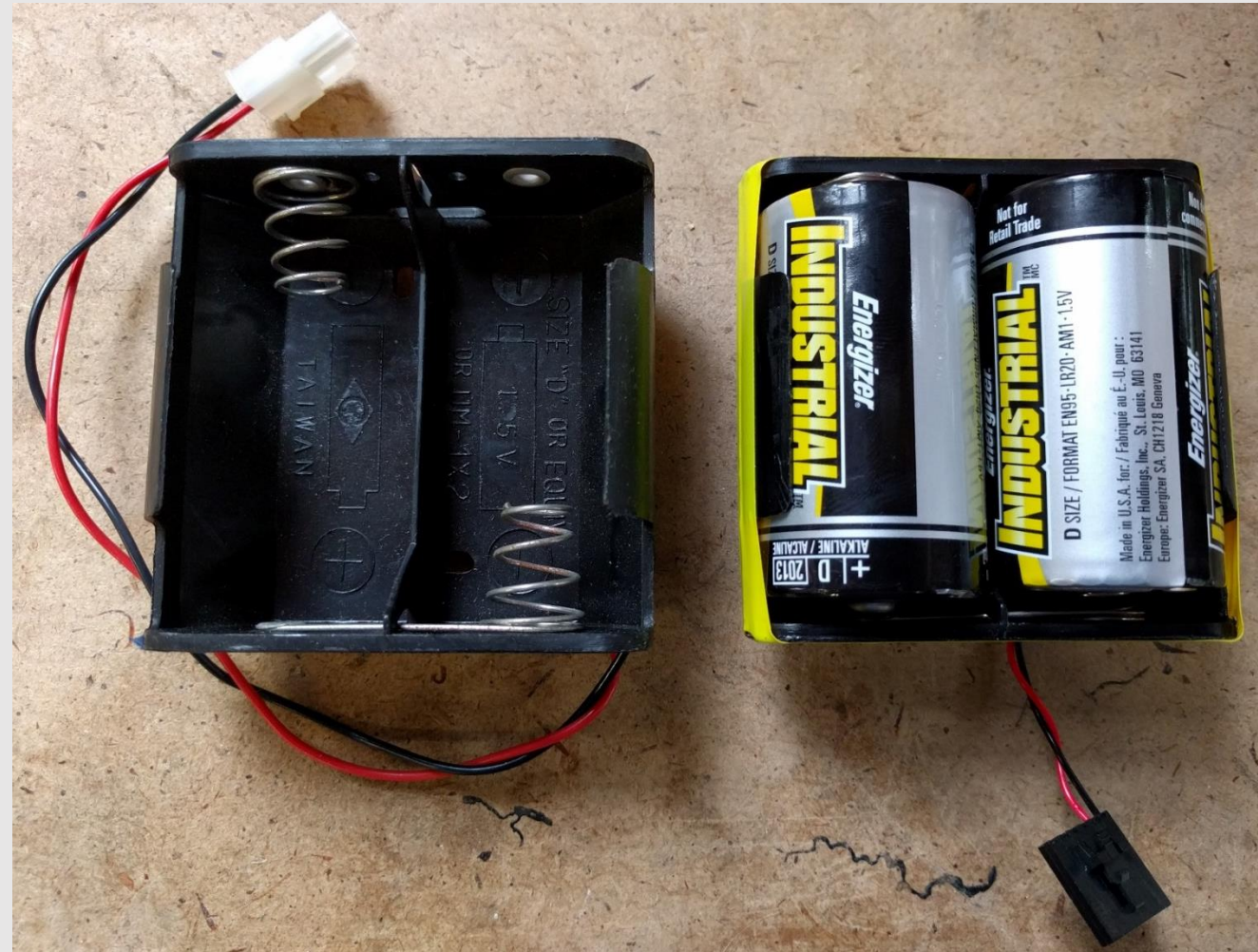
* Delivered capacity is dependent on the applied load, operating temperature and cut-off voltage. Please refer to the charts and discharge data shown for examples of the energy / service life that the battery will provide for various load conditions.

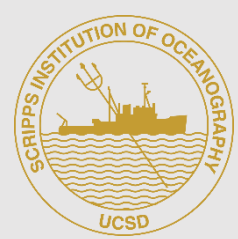
Alkaline Clock Pack



Purpose: provide power to
Keep the system clock running
In the event that the main battery
output voltage drops below cutoff.
If the clock can be kept running in
A lower power mode (PLL off) the
system's total drift can still be
Determined upon recovery.

- 2 x Energizer D cells
- 3VDC nominal output
- ~17Ah @ 25mA, 21C
- Configuration: 2S





Energizer D Cell Specification



PRODUCT DATASHEET

Energizer

1-800-383-7323 USA/CAN
www.energizer.com

ENERGIZER E95

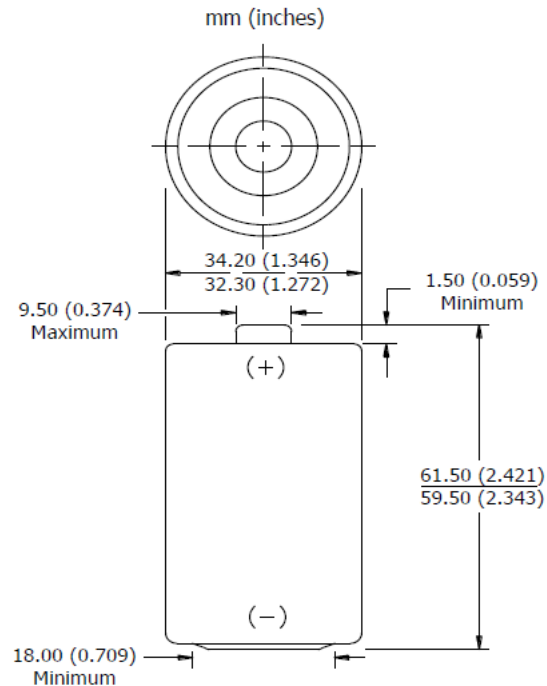


D

Specifications

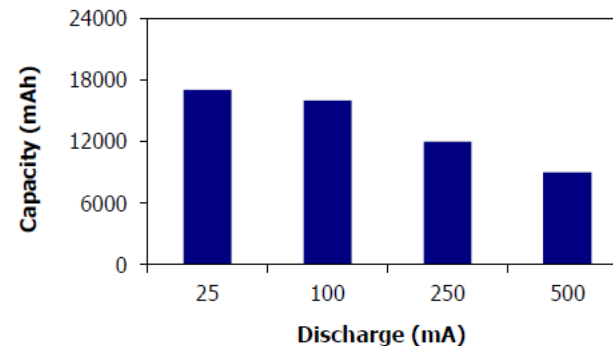
Classification:	Alkaline
Chemical System:	Zinc-Manganese Dioxide (Zn/MnO ₂) No added mercury or cadmium
Designation:	ANSI-13A, IEC-LR20
Nominal Voltage:	1.5 volts
Nominal IR:	150 to 300 milliohms (fresh)
Operating Temp:	-18°C to 55°C (0°F to 130°F)
Typical Weight:	144.0 grams (5.1 oz.)
Typical Volume:	56.0 cubic centimeters (3.4 cubic inch)
Jacket:	Plastic Label
Shelf Life:	10 years at 21°C
Terminal:	Flat Contact
Manufactured:	Made in the USA

Industry Standard Dimensions



Milliamp-Hours Capacity

Continuous discharge to 0.8 volts at 21°C





Acoustic Release Battery Pack



9V Battery Side



AA Battery Side



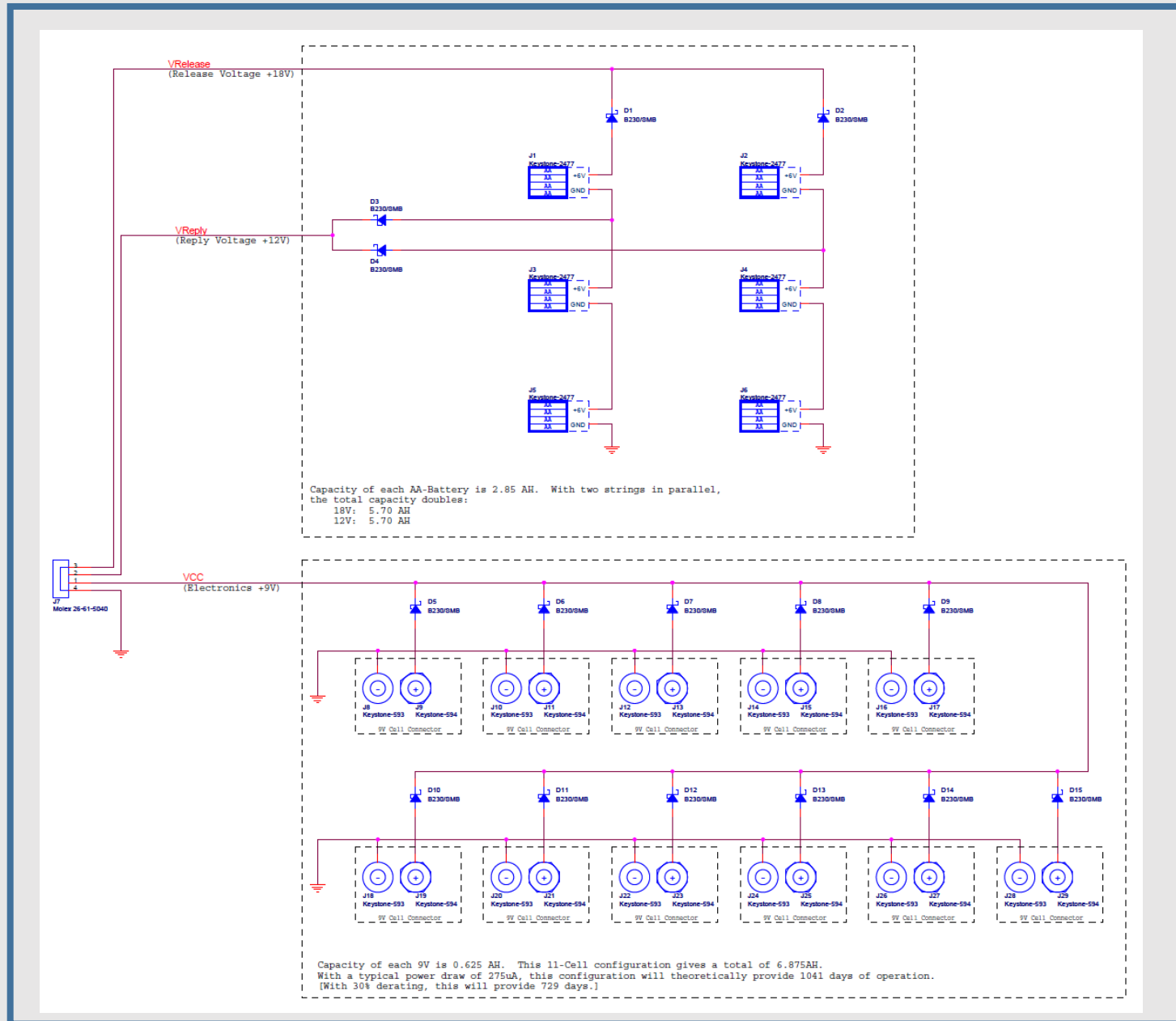
Output Voltages: +18V Release, +12V Reply, +9V Electronics

- 11x 9V Energizer Batteries
- 24x AA Energizer Batteries

Supply Voltage	Configuration	Capacity (Ah)	Nominal Load
+18V (Release)	24 x AA batteries 2 x series banks of 12 cells in parallel 16 of the cells are part of the +12V supply	6 Ah @ 25mA, 21C 3 Ah @ 0.5A, 21C	<1uA Que., 2A typ. active
+12V (Reply)	16 x AA batteries 2 x series banks of 8 cell in parallel	6 Ah @ 25mA, 21C 3 Ah @ 500mA, 21C	< 1uA Que., 500mA max
+9V (Electronics)	11 x 9V batteries in parallel	1.44 Ah @ 25mA, 21C	275uA typ.



Acoustic Release Battery Pack Schematic





Acoustic Release Battery Pack Cell Specs



PRODUCT DATASHEET

Energizer

1-800-383-7323 USA/CAN
www.energizer.com

ENERGIZER 522

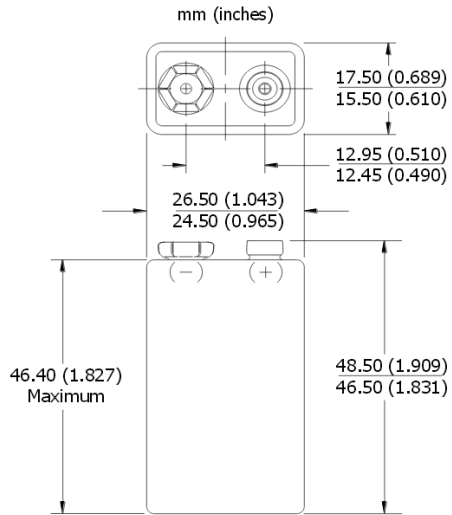
9V



Specifications

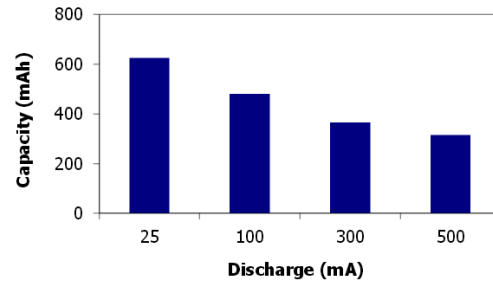
Classification: Alkaline
Chemical System: Zinc-Manganese Dioxide (Zn/MnO₂)
 No added mercury or cadmium
Designation: ANSI-1604A, IEC-6LR61
Nominal Voltage: 9.0 volts
Operating Temp: -18°C to 55°C (0°F to 130°F)
Typical Weight: 45.6 grams (1.6 oz.)
Typical Volume: 21.1 cubic centimeters (1.3 cubic inch)
Jacket: Metal
Shelf Life: 5 years at 21°C
Terminal: Miniature Snap

Industry Standard Dimensions



Milliamp-Hours Capacity

Continuous discharge to 4.8 volts at 21°C



PRODUCT DATASHEET

Energizer

1-800-383-7323 USA/CAN
www.energizer.com

ENERGIZER E91

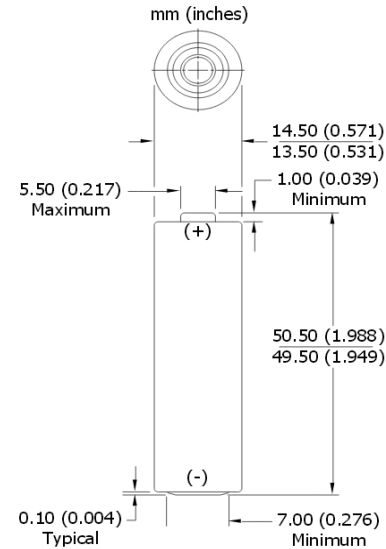
AA



Specifications

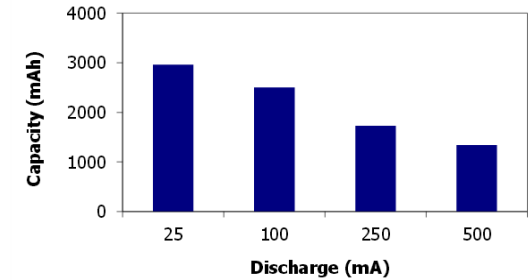
Classification: Alkaline
Chemical System: Zinc-Manganese Dioxide (Zn/MnO₂)
 No added mercury or cadmium
Designation: ANSI-15A, IEC-LR6
Nominal Voltage: 1.5 volts
Nominal IR: 150 to 300 milliohms (fresh)
Operating Temp: -18°C to 55°C (0°F to 130°F)
Typical Weight: 23.0 grams (0.8 oz.)
Typical Volume: 8.1 cubic centimeters (0.5 cubic inch)
Jacket: Plastic Label
Shelf Life: 10 years at 21°C
Terminal: Flat Contact

Industry Standard Dimensions



Milliamp-Hours Capacity

Continuous discharge to 0.8 volts at 21°C

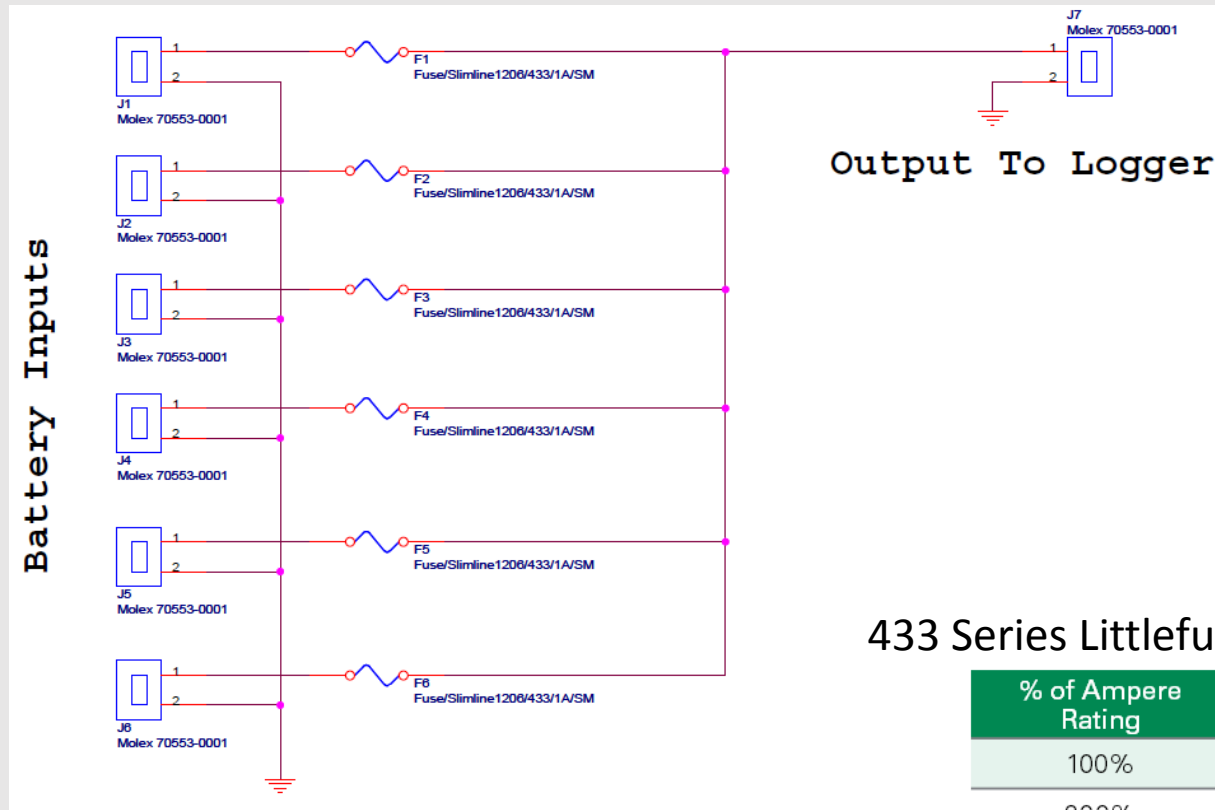




Battery Connection - Flex Cables



Parallel Connection of Batteries



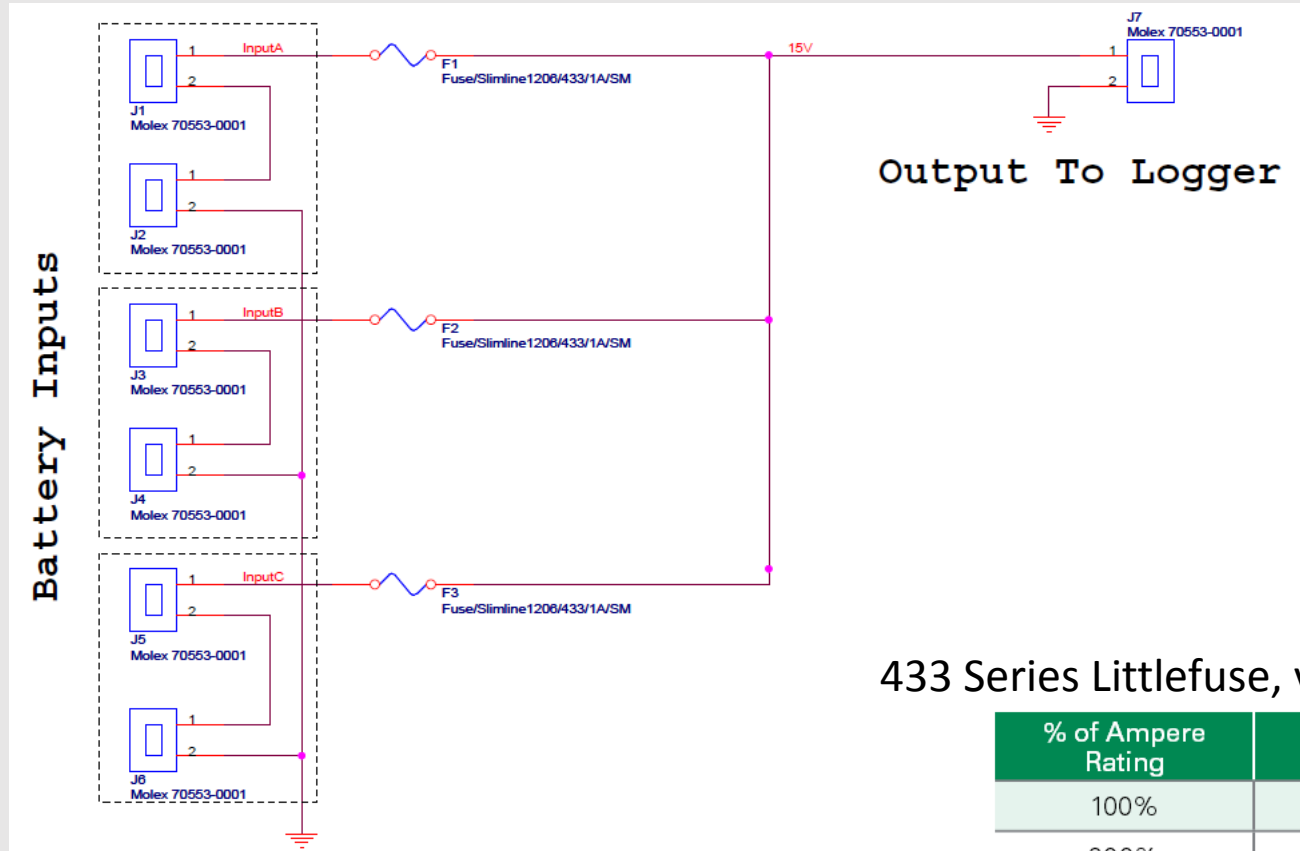
433 Series Littlefuse, very fast acting 1A - 1206 size

% of Ampere Rating	Opening Time at 25°C
100%	4 hours, Minimum
200%	5 sec., Maximum
300%	0.2 sec., Maximum

Battery Connection - Flex Cables



Series Connection of Batteries

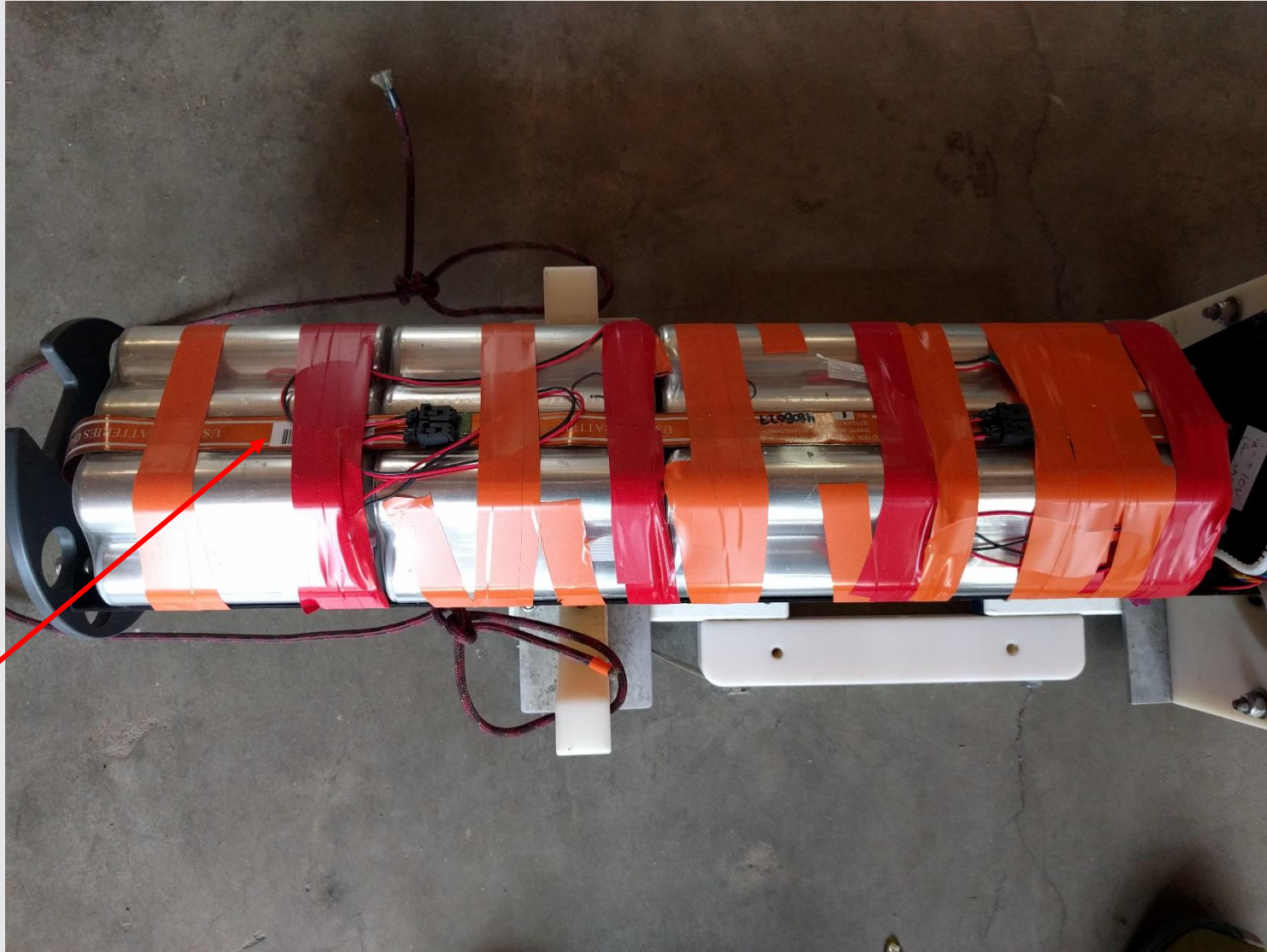


433 Series Littlefuse, very fast acting 1A - 1206 size

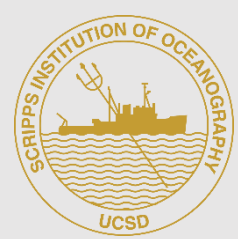
% of Ampere Rating	Opening Time at 25°C
100%	4 hours, Minimum
200%	5 sec., Maximum
300%	0.2 sec., Maximum



Battery Connection - Flex Cables



Flex Cable
taped along
top of battery
packs



Electrochem pack with fuel gauge monitor



Cell Type: CSC DD
Nominal Cell capacity: 30 Ah
Configuration: 4S, 7P
Pack nominal capacity: 210 Ah
Cell Count: 28
Voltage: 15.6

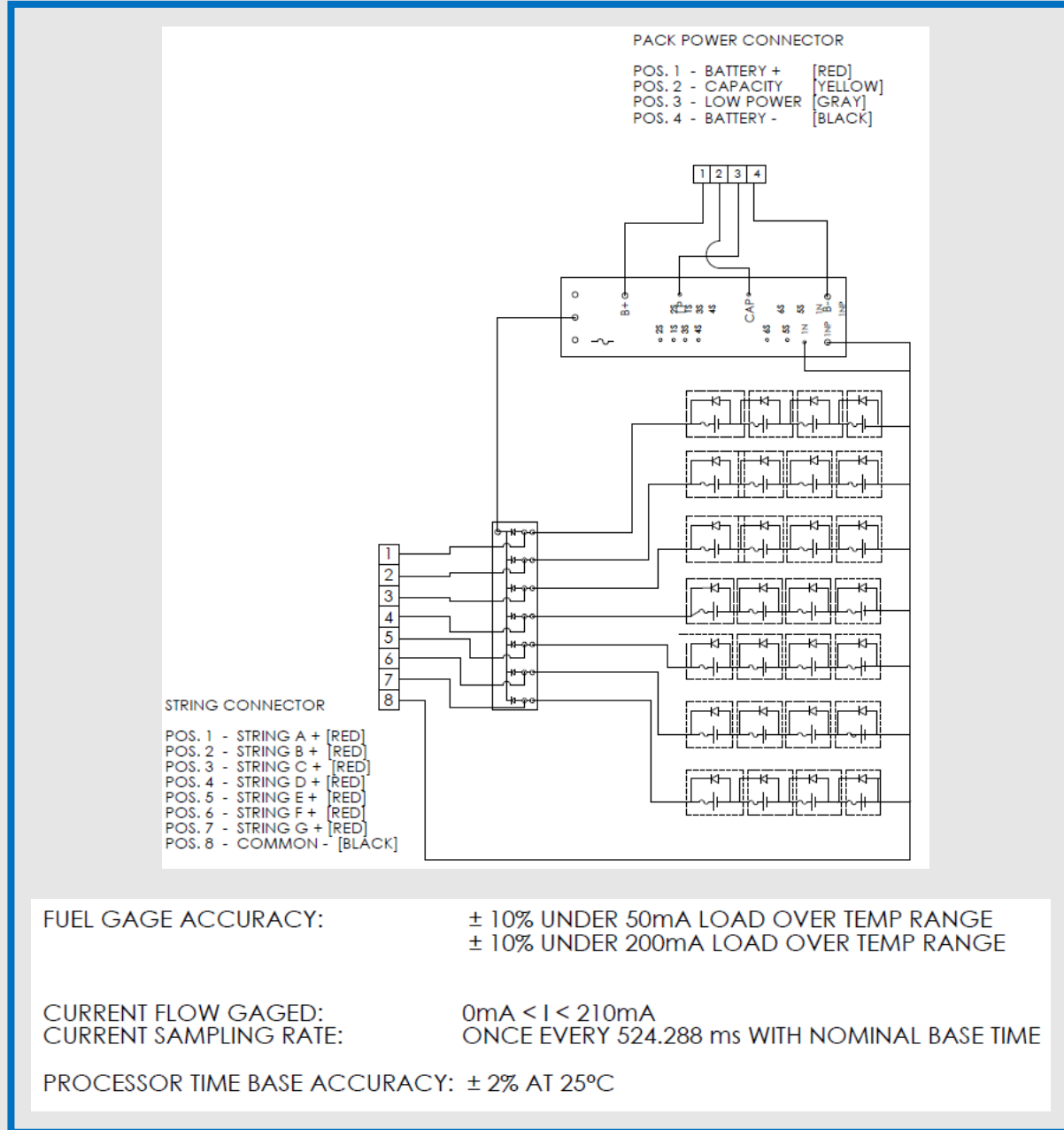
- Save shipping cost
- Reduce turn around time
- Ability to run multiple cruises from a single pack

Low Power Pin connection	Mode
No connection	Active Mode, 500uA draw on pack battery current monitored
PowerOut(-)	Low Power Mode, 46uA draw on pack Battery current NOT monitored

Capacity Pin Voltage	Battery Capacity Withdrawn
4V	capacity withdrawn < 25%
3V	25% < capacity withdrawn < 50%
2V	50% < capacity withdrawn < 75%
1V	capacity withdrawn > 75%
0V	No indication, battery in low power mode



Electrochem pack with fuel gauge monitor





Thank You!

Questions?