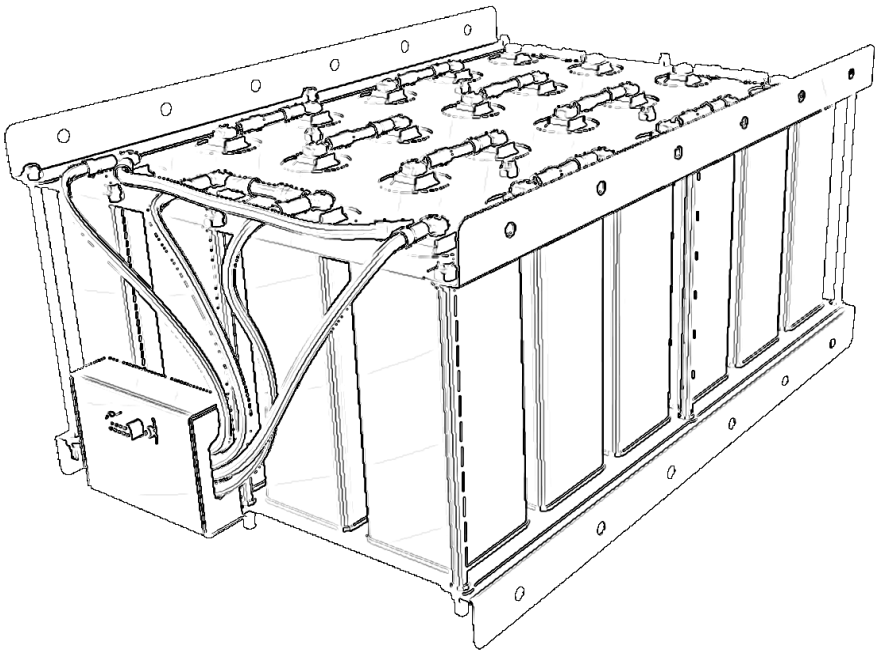
TECK

Thermal Energy Complex Knot
Designed and presented By Next Space Lab



This document presents all characteristics for TECK batteries and parts from which it is constructed. In addition it includes some manufacturing processes for parts to be made.

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Introduction

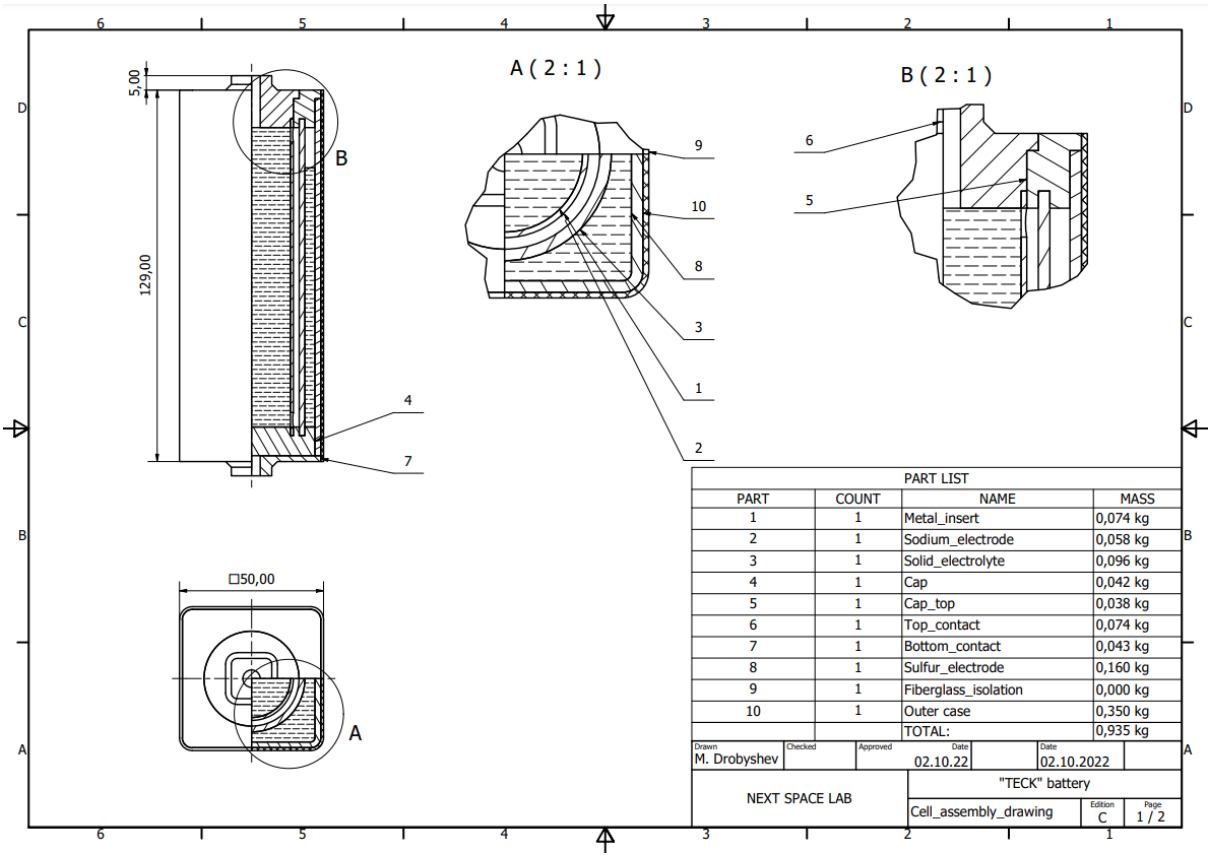
Our team competes in the Exploring Venus Together category. Main objective of this challenge is to design a power storage system which can provide a rover or lander with power for at least 60 days.

Sodium-sulphur battery technology works perfectly in Venus conditions. So we decided to use it as the foundation on which improvements were made. Modified geometry allows to reduce size and weight. Modern materials and production technologies make it durable, easy to manufacture and reasonably priced. Its intended usage is to provide a temporary energy source for time when small amounts of power are generated. Best fighting power unit is solar panels, but others also will work. Power units have on board voltage transformators. To ensure redundancy they are made from three separate circuits which can work independently. In normal scenarios they use less than 60% of their abilities. Frame made using metal 3d printing technology. This way frame can be manufactured creating zero waste while created.

Batteries

Sodium-sulphur technology was chosen because of high efficiency in extremely high temperatures. Optimal for work temperatures are 300-600 °C . Due to its not bad power density, which is around 300 Watt-hours per kilogram, it can provide a significant amount of storage in relatively small mass. Sistem could be recharged 230 times with no characteristics lost. Cells have square casing which is made from AISI 202 Stainless Steel, coated with pure copper for adhesion and pure molybdenum layer for protection using electroplating method. Around cells also a fibreglass insulation main purpose of which is to protect cells from short circuit. The upper and lower contacts have an M6 internal thread for connecting cells to each other.
You can look at assembly drawing (img. 1) to see the design of the cell.

Cell characteristics:
Full cell mass is 0.935 Kg;
Dimensions: 50*50*139 mm;
EMF: 2 V
Capacity: 25 Ah
Sodium electrode mass: 58 g
Sulphur electrode mass: 160 g



PART LIST

PART	COUNT	NAME	MASS
1	1	Metal_insert	0,074 kg
2	1	Sodium_electrode	0,058 kg
3	1	Solid_electrolyte	0,096 kg
4	1	Cap	0,042 kg
5	1	Cap_top	0,038 kg
6	1	Top_contact	0,074 kg
7	1	Bottom_contact	0,043 kg
8	1	Sulfur_electrode	0,160 kg
9	1	Fiberglass_isolation	0,000 kg
10	1	Outer case	0,350 kg
		TOTAL:	0,935 kg

Drawn: M. Drobyshev | Checked | Approved | Date: 02.10.22 | Date: 02.10.2022

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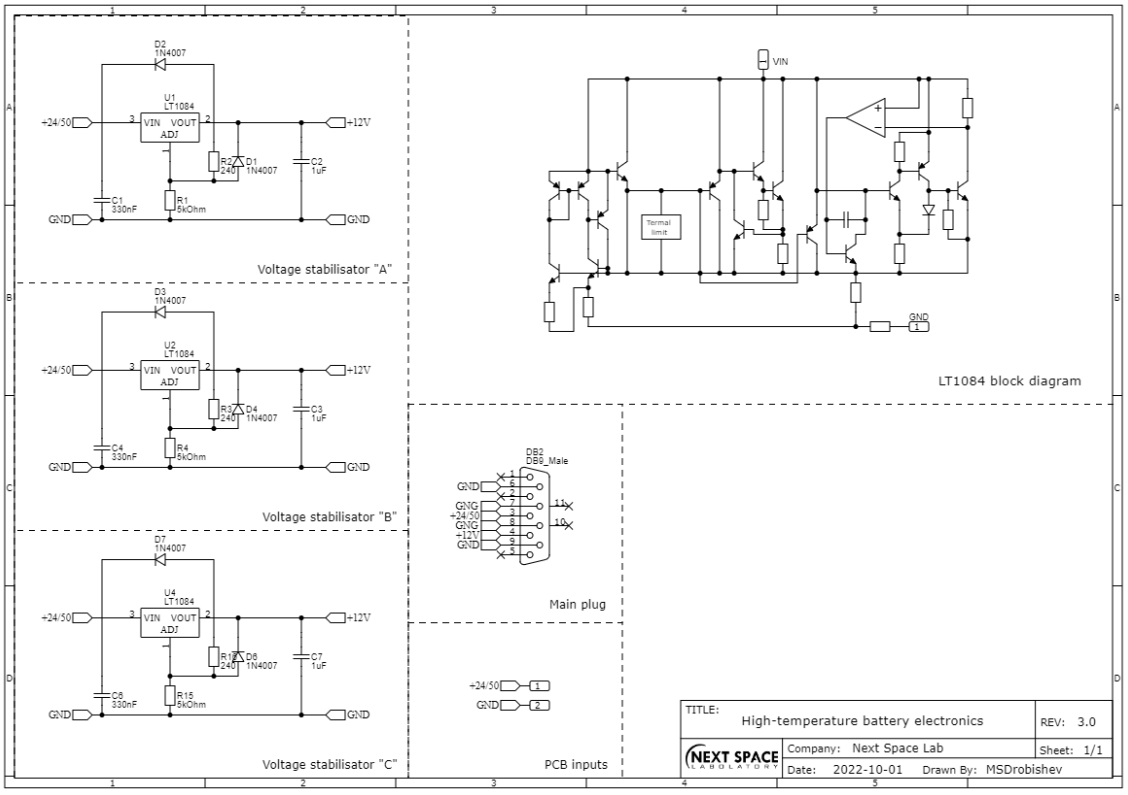
"TECK" battery

Cell_assembly_drawing | Edition: C | Page: 1 / 2

(img. 1; Cell assembly drawing)

Electronics

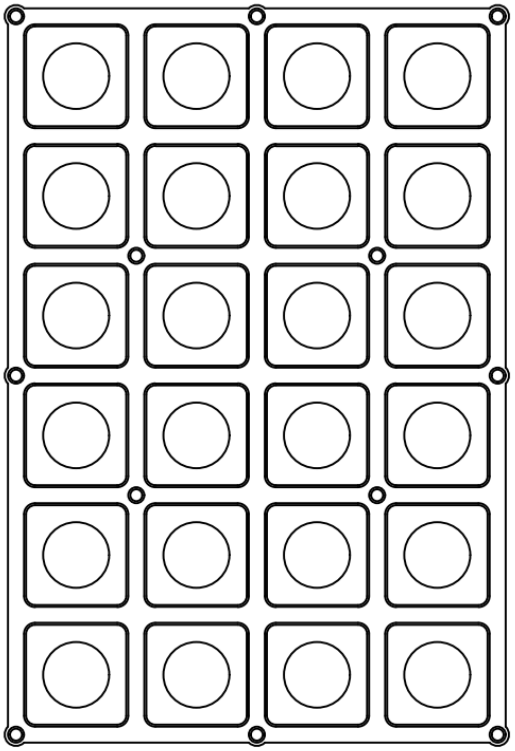
Electronic compartment contains small 3 circuits designed to withstand Venus' extreme temperatures. Purpose of these circuits is to lower Voltage from 24V to 12V. Each circuit can handle 60 Watts. All 3 of them can handle 180 Watts, in time when all battery assembly gives 100 Watts in optimal work mode. Changing the tuning resistor, R1; R4; R15, power output can be from 1V-23V to better suit the power system of the lander. Tracks made of gold to resist corrosion. All chips have their plastic covers removed and made from silicone carbide or gallium nitrate. This type of chip is able to work in extreme temperature and pressure.



(img. 2; High-temperature battery electronics)

Frame

Frame made from two plates made from AISI 302 Stainless Steel using SLM (Selective Laser Melting) 3D printing technology. Part coated with pure copper for adhesion and pure molybdenum layer for protection using electroplating method. Frame has slots for cells to fit in.

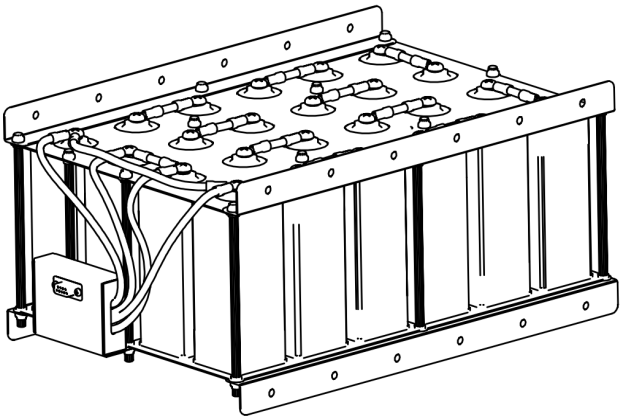


(img. 3; Frame)

Assembly

Each TECK unit is made of 24 separate cells. All cells connected into two groups, both of them make 24V and 4.1A. Each group has 2 ways to connect to output. Two parts of frames connected with threaded rods. Cells take place in slots and are properly fixed by compression of construction. External weirs are single core copper cowered in a molybdenum protective layer. They raped in fiberglass and have ceramic covers to prevent sort circuit.

Assembly characteristics:
Mass: 26 Kg
Dimensions: 370*270*181 mm
Volume: 0,01798 m^3
Voltage: 24V, 12V
Power in optimal mode: 100W
Max Power: 180W
Capacity: 50Ah



(img. 4; Assembled TECK)

Analog comparing

	Ni-Cd (Venera-9, USSR)	Li-Po (Popular solution)	TECK (The best solution)
t°C Preferable	-20…+65°C	-20…+60°C	300…+600°C
Energy density	45-80 Wh/kg	110-270 Wh/kg	250-300 Wh/kg
Voltage	1,2 V	3,8 V	2 V
Power	150-500 W/kg	245-430 W/kg	200W/kg
Life cycle	100-900	500-1000	4500
In use since	1950	1996	1980

(table.1; comperesing)

According to table.1 we can see that our solution in no parameter is significantly worse. And some much better than other analogs. For beginning, preferable temperature is perfectly suitable for this application. Also important is life cycle, because it directly affects mission lengths. High energy density is also important, it reduces overall costs of mission.

Team Members

Team lead, engineer	Makar Drobyshev
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