



KULR ONE Space (K1S) Product Overview

Safe. Reliable. High Performance. Flight Ready.

September 2024 Update

Key Market Drivers

- **The space economy is growing to >\$1T by the 2030s; this is driven by the commoditization of commercialized space industry. Key players in the growth here are:**
 - Continued dominance of existing Tier 1 private firms such as SpaceX and Blue Origin.
 - Sustained participation from traditional government contract entities like Boeing, NGC, and LMCo.
 - Introduction of new critical players such as Intuitive Machines with their lunar rover contract with NASA.
 - New up and coming companies like Starlink, Firefly Space (launch provider), Axiom (space station provider), and Vast (space station provider)
- **The space economy trends drive the needs for cost effective energy storage solutions (est. \$25B market by 2032) that are suitable for a commoditization model which seeks to reduce the overall cost of space exploration by drastically decreasing the overall price entry barrier**
- **Commercialization of crewed spaceflight drastically increases the need for JSC 20793-Revision D compliant batteries with reduced cost and short delivery timeframe:**
 - i.e., there is an increasing need for a virtually non-existent market offering of a 20793 rated battery that is off-the-shelf (OTS) delivery and commoditized price tag.
 - Balancing the push for reduced cost with mission risk and safety is very difficult for energy storage systems; if the battery fails, so does the mission.
- **The scalable KULR ONE Space (K1-S) architecture seeks to provide a solution for this rapidly growing market vertical and to be the first OTS 20793 rated battery to market. Without this capability, space design teams requiring batteries must:**
 - Contract battery design efforts to expensive 3rd party firms or,
 - Build their own battery team from the ground up.

Our History

2015
KULR Technology Corporation founded in San Diego, CA.

2017
Licensing agreement with NASA – carbon fiber thermal management technology.

2019
Announcement of safe battery design leveraging NASA FTRC data.

2021
Listed on the NYSE American Exchange.

2023
Battery Design and Testing Center of Excellence opened in Webster, TX. Exclusive NASA L-FTRC license.

2025
Launch of the commercialized KULR ONE Space (K1S) platform

2015

2016

2017

2018

2019

2020

2021

2022

2023

2024

2025

2026

2016
Development of thermal runaway shield (TRS) for batteries.

2018
Exclusive licensing agreement with NREL and NASA for ISC-D.

2019
SafeX product line flow to ISS for use in crewed space applications.

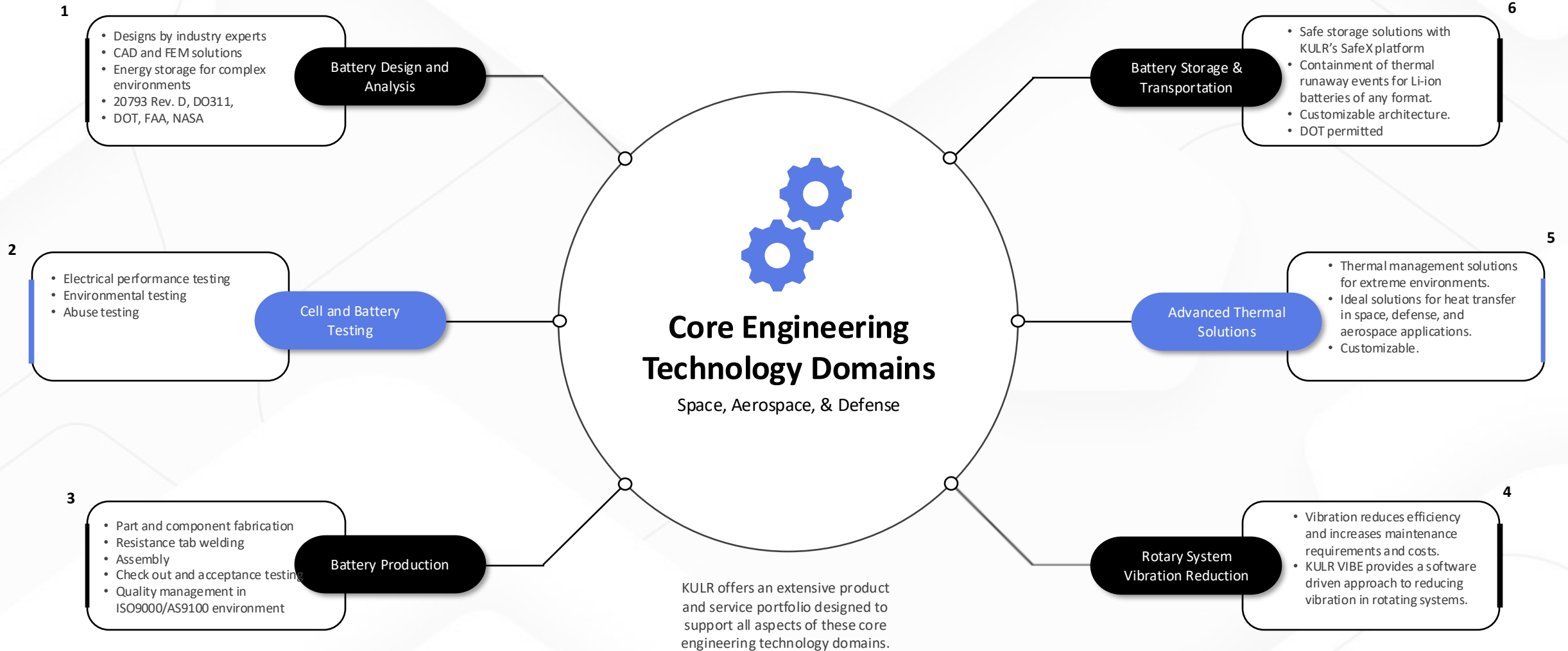
2021
KULR PCM heat sink lands on Mars with Mars Rover Perseverance.

2022
Licensing of small and large FTRC technology from NASA.

2024
Expansion of TX operations and relocation of HQ to TX based offices.

2025
Battery testing services expanded to include environment testing.

Technology Domains



KULR ONE Space (K1S) Product Description

- **The KULR ONE Space (K1-S) is a flight ready and scalable lithium-ion (Li-ion) battery architecture incorporating the latest generation of high energy density cells in a passively propagation resistant (PPR) and flame arresting package.**
- **Although the K1S battery architecture is customization ready, the following off-the-shelf variations are also available:**
 - 100 Series (86 Wh to 115 Wh),
 - 200 Series (172 Wh to 230 Wh),
 - 400 Series (345 Wh to 460 Wh),
 - Capacity is dependent on customer chosen cell option.
- **The flame arresting and PPR design is designed with intent to satisfy:**
 - The most stringent of flight safety requirements, including, but not limited to, JSC 20793 Crewed Vehicle Battery Safety Requirements.
 - The 400 Series is currently undergoing final 20793 qualification testing with a target certification timeline of Q4 2024.
- **The K1-S architecture is designed with intent to be customized prior to delivery, including series/parallel scaling, cell selection, mounting interface, and electrical/communications interface:**
 - This means rapid, cost effective, customization for a fraction of the cost of traditional design cycles for users requiring deviation from the OTS versions of the K1S.
 - The design and fabrication of all modified components are handled internally at KULR's HQ in Texas to ensure the rapid delivery of high quality and customized space rated energy storage systems.
- **Product differentiation with safety and performance:**
 - K1-S architecture is PPR and flame arresting out the gate. This means confidence from Day 1 that there will be no safety related roadblocks.
 - KULR customers gain the benefit of combining safety testing specific to their use-case, with all previous safety testing conducted by KULR on the K1S architecture.
 - Construction with latest generation 3.5 Ah to 4.0 Ah 18650 format lithium-ion cells.
 - Construction with NASA best practice recommendations for safe battery design (i.e. built with intent to satisfy JSC 20793 Rev D).



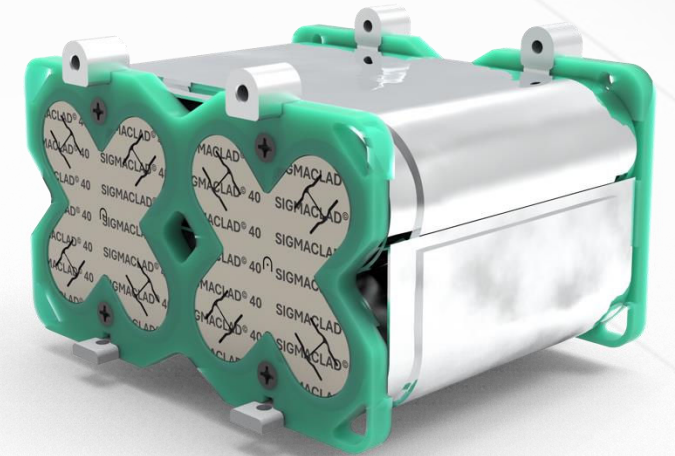
KULR ONE Space, 200 Wh (Top View)



KULR ONE Space, 200 Wh (Side View)

KULR ONE Space (K1S) Technical Features

- The KULR ONE Space (K1-S) architecture is a scalable passively propagation resistant (PPR) with flame arrestor designed to satisfy the intent of JSC 20793 Rev. D. Objective is to be the first true off the shelf 20793 option.
- KULR's current focus is on the 100 Wh, 200 Wh, and 400 Wh series.
- All designs will maintain the following features:
 - Passive propagation resistant design (multiple techniques employed),
 - Side wall rupture protective tubing,
 - Flame arresting ventilation,
 - WI-37A screened and matched lithium-ion cells,
 - Centrally installed thermistor,
 - Vibration / shock to GEVS, SLS, and Vulcan Centaur,
 - TVAC thresholds 0 to 40°C (intent to increase in 2025),
Note that Generation 1 battery does not have heaters integrated.
- Cell specific features:
 - Amprius SA10: medium power cell with high capacity, 2C charge capability, 300 cycles
 - MOLICEL M35A: cells from NASA lot with ILA
 - Samsung 30Q: power cell, 500 cycles, identified by NASA for strategic reserve
- Options
 - Non-rad tolerant BMS (\$)
 - Rad-tolerant BMS (\$\$\$)
- K1S purchase, without modification, would include:
 - Battery
 - Operations manual and connector pin-out diagram
 - Test plan and reports (thermal runaway, electrical performance, TVAC, vibe, shock)
 - Cell pedigree documentation when using ILA / LAT associated M35A
 - WI-37A cell screening report



KULR ONE Space, 100 Wh (Internal View)



K1S Cell Options

K1S 100 Series Specification



K1S 100, ISO View



K1S 100, Side View

K1S 100, Samsung 18650-30Q

Description	
Cell Voltage (Max)	4.2 V
Cell Voltage (Nominal)	3.6 V
Cell Capacity	3.0 Ah
Cell Stored Energy	10.8 Wh
Series	4 #
Parallel	2 #
Pack Max Voltage	16.8 V
Pack Nominal Voltage	14.4 V
Pack Capacity	6.0 Ah
Pack Energy	86.4 Wh
2C Current	12.0 A
2C Power	172.8 W

K1S 100, MOLICEL 18650-M35A

Description	
Cell Voltage (Max)	4.2 V
Cell Voltage (Nominal)	3.6 V
Cell Capacity	3.5 Ah
Cell Stored Energy	12.6 Wh
Series	4 #
Parallel	2 #
Pack Max Voltage	16.8 V
Pack Nominal Voltage	14.4 V
Pack Capacity	7.0 Ah
Pack Energy	100.8 Wh
2C Current	14.0 A
2C Power	201.6 W

K1S 100, Amprius 18650-SA10

Description	
Cell Voltage (Max)	4.2 V
Cell Voltage (Nominal)	3.6 V
Cell Capacity	4.0 Ah
Cell Stored Energy	14.4 Wh
Series	4 #
Parallel	2 #
Pack Max Voltage	16.8 V
Pack Nominal Voltage	14.4 V
Pack Capacity	8.0 Ah
Pack Energy	115.2 Wh
2C Current	16.0 A
2C Power	230.4 W

- **The K1S 100 series comes in a 10 cm x 10 cm x 10 cm form factor** and is suitable for use in 2U and up CubeSat / SmallSat or larger.
- **Electrical Configurability:** 4S-2P (specification above) and (2S-4P, not shown above)
- **Power and Communications:** Space-rated Glenair Connector
- **Thermal:** 0 to 40 °C (expanding in 2025 with heater integration)
- **Vibration / Shock:** NASA SLS Environment / GEVS
- **Safety:** In-line with JSC 20793 Revision D. Off-the-shelf 20793 coming Spring 2025 (requires flight acceptance testing prior to delivery).
- **Quality:** All packs constructed with NASA JSC WI-37A screened cells, regardless of cell selection. Packs constructed with MOLICEL 18650-M35A are constructed with cells that have an associated NASA Initial Lot Assessment (ILA) and Lot Acceptance Testing (LAT).

K1S 200 Series



K1S 200, Front View



K1S 200, Side View

K1S 200, Samsung 18650-30Q

Description	
Cell Voltage (Max)	4.2 V
Cell Voltage (Nominal)	3.6 V
Cell Capacity	3.0 Ah
Cell Stored Energy	10.8 Wh
Series	4 #
Parallel	4 #
Pack Max Voltage	16.8 V
Pack Nominal Voltage	14.4 V
Pack Capacity	12.0 Ah
Pack Energy	172.8 Wh
2C Current	24.0 A
2C Power	345.6 W

K1S 200, MOLICEL 18650-M35A

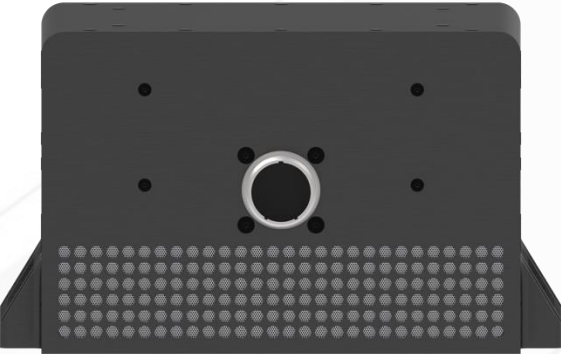
Description	
Cell Voltage (Max)	4.2 V
Cell Voltage (Nominal)	3.6 V
Cell Capacity	3.5 Ah
Cell Stored Energy	12.6 Wh
Series	4 #
Parallel	4 #
Pack Max Voltage	16.8 V
Pack Nominal Voltage	14.4 V
Pack Capacity	14.0 Ah
Pack Energy	201.6 Wh
2C Current	28.0 A
2C Power	403.2 W

K1S 200, Amprius 18650-SA10

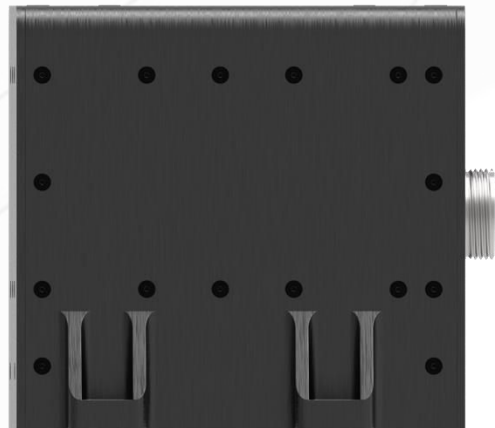
Description	
Cell Voltage (Max)	4.2 V
Cell Voltage (Nominal)	3.6 V
Cell Capacity	4.0 Ah
Cell Stored Energy	14.4 Wh
Series	4 #
Parallel	4 #
Pack Max Voltage	16.8 V
Pack Nominal Voltage	14.4 V
Pack Capacity	16.0 Ah
Pack Energy	230.4 Wh
2C Current	32.0 A
2C Power	460.8 W

- **The K1S 200 series comes in a 10 cm x 10 cm x 20 cm form factor** and is suitable for use in 2U and up CubeSat / SmallSat or larger.
- **Electrical Configurability:** 4S-2P (specification above) and (2S-4P, not shown above)
- **Power and Communications:** Space-rated Glenair Connector
- **Thermal:** 0 to 40 °C (expanding in 2025 with heater integration)
- **Vibration / Shock:** NASA SLS Environment / GEVS
- **Safety:** In-line with JSC 20793 Revision D. Off-the-shelf 20793 coming Spring 2025 (requires flight acceptance testing prior to delivery).
- **Quality:** All packs constructed with NASA JSC WI-37A screened cells, regardless of cell selection. Packs constructed with MOLICEL 18650-M35A are constructed with cells that have an associated NASA Initial Lot Assessment (ILA) and Lot Acceptance Testing (LAT).

K1S 400 Series



K1S 400, Front View



K1S 400, Side View

K1S 400, Samsung 18650-30Q

Description		
Cell Voltage (Max)	4.2	V
Cell Voltage (Nominal)	3.6	V
Cell Capacity	3.0	Ah
Cell Stored Energy	10.8	Wh
Series	8	#
Parallel	4	#
Pack Max Voltage	33.6	V
Pack Nominal Voltage	28.8	V
Pack Capacity	12.0	Ah
Pack Energy	345.6	Wh
2C Current	24.0	A
2C Power	691.2	W

K1S 400, MOLICEL 18650-M35A

Description		
Cell Voltage (Max)	4.2	V
Cell Voltage (Nominal)	3.6	V
Cell Capacity	3.5	Ah
Cell Stored Energy	12.6	Wh
Series	8	#
Parallel	4	#
Pack Max Voltage	33.6	V
Pack Nominal Voltage	28.8	V
Pack Capacity	14.0	Ah
Pack Energy	403.2	Wh
2C Current	28.0	A
2C Power	806.4	W

K1S 400, Amprius 18650-SA10

Description		
Cell Voltage (Max)	4.2	V
Cell Voltage (Nominal)	3.6	V
Cell Capacity	4.0	Ah
Cell Stored Energy	14.4	Wh
Series	8	#
Parallel	4	#
Pack Max Voltage	33.6	V
Pack Nominal Voltage	28.8	V
Pack Capacity	16.0	Ah
Pack Energy	460.8	Wh
2C Current	32.0	A
2C Power	921.6	W

- **The K1S 400 series comes in a 12.7 cm x 21.6 cm x 12.4 cm form factor** and is suitable for use in 2U and up CubeSat / SmallSat or larger.
- **Power and Communications:** Space-rated Glenair Connector
- **Thermal:** 0 to 40 °C (expanding in 2025 with heater integration)
- **Vibration / Shock:** NASA SLS Environment / GEVS
- **Safety:** First of the K1S family offered as OTS 20793 rated (flight acceptance testing required prior to delivery)
- **Quality:** All packs constructed with NASA JSC WI-37A screened cells, regardless of cell selection. Packs constructed with MOLICEL 18650-M35A are constructed with cells that have an associated NASA Initial Lot Assessment (ILA) and Lot Acceptance Testing (LAT).

Radiation Tolerant BMS

Operating batteries in space environments often requires utilization of a battery management system (BMS) constructed with radiation tolerant components which can be difficult to acquire with existing supply chain conditions. To overcome this challenge, KULR provides the TIDA-010931 for relevant applications.

Benefits

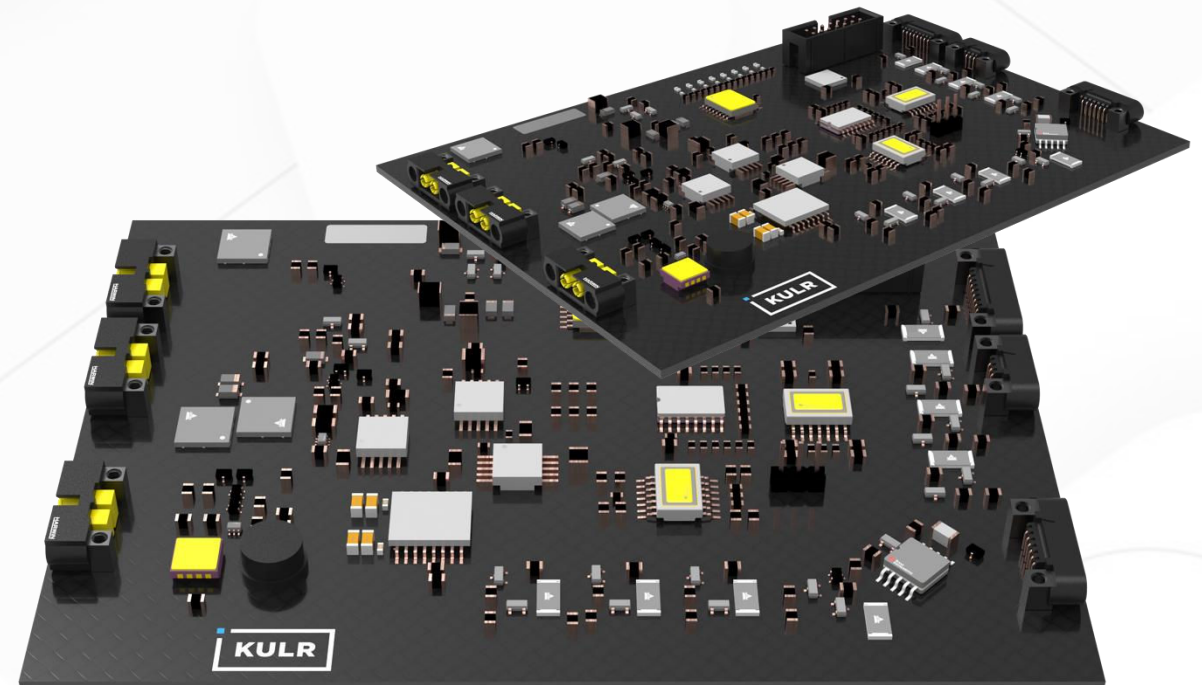
- Ready to fly design.
- Qual-tested to relevant thermal and vibration profiles for launch and space environment simulation.
- Reliable supply chain vendors for all component sourcing, PCB fabrication, and other related activities.
- Pursuing JSC-20793 Rev. D compatibility.

Key Features

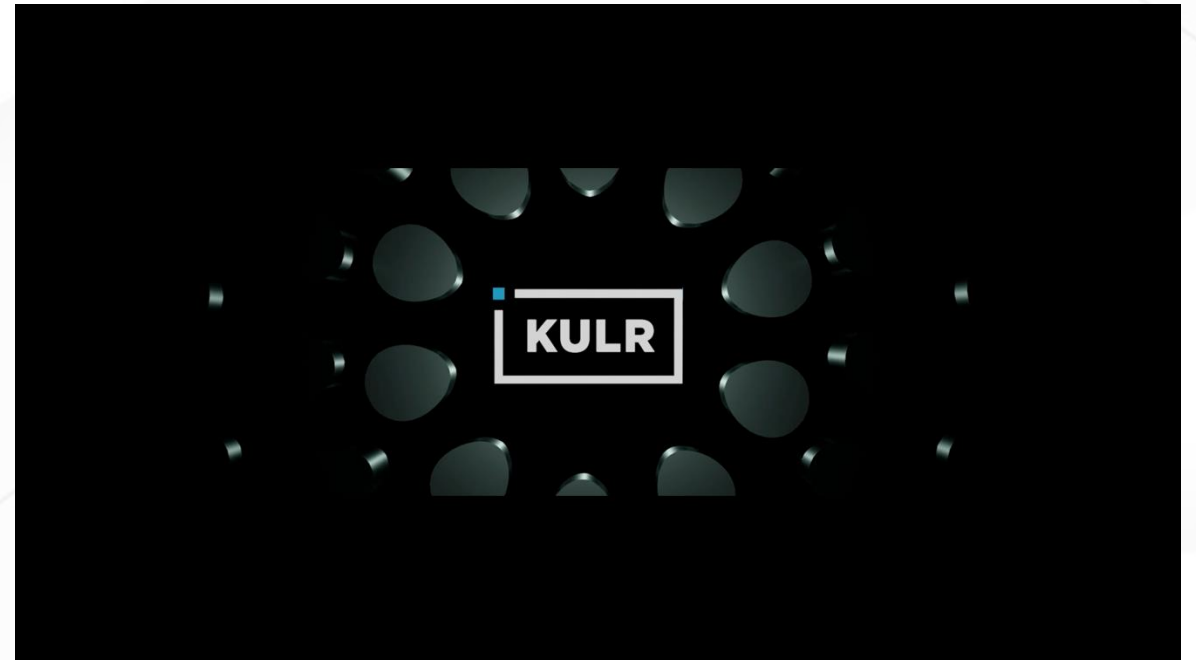
- Up to 8 series strings.
- GPIO controlled battery balancing circuit.
- SCP with 4.5 us delay.
- Isolated power supply.
- UART and I2C communication.
- Under and over voltage protection.
- External short protection.
- Long duration storage compatibility.

TIDA-010931 BMS Characteristics

Radiation Performance	75 kRad / 75 MeV
Series Strings Capacity	8
Load Current (Maximum)	16 A @ 33.6 V
Battery Monitoring Accuracy	TBD
Battery Monitoring Accuracy	$\pm 1\text{mV}$ (Batt = 3 to 4.2 V)



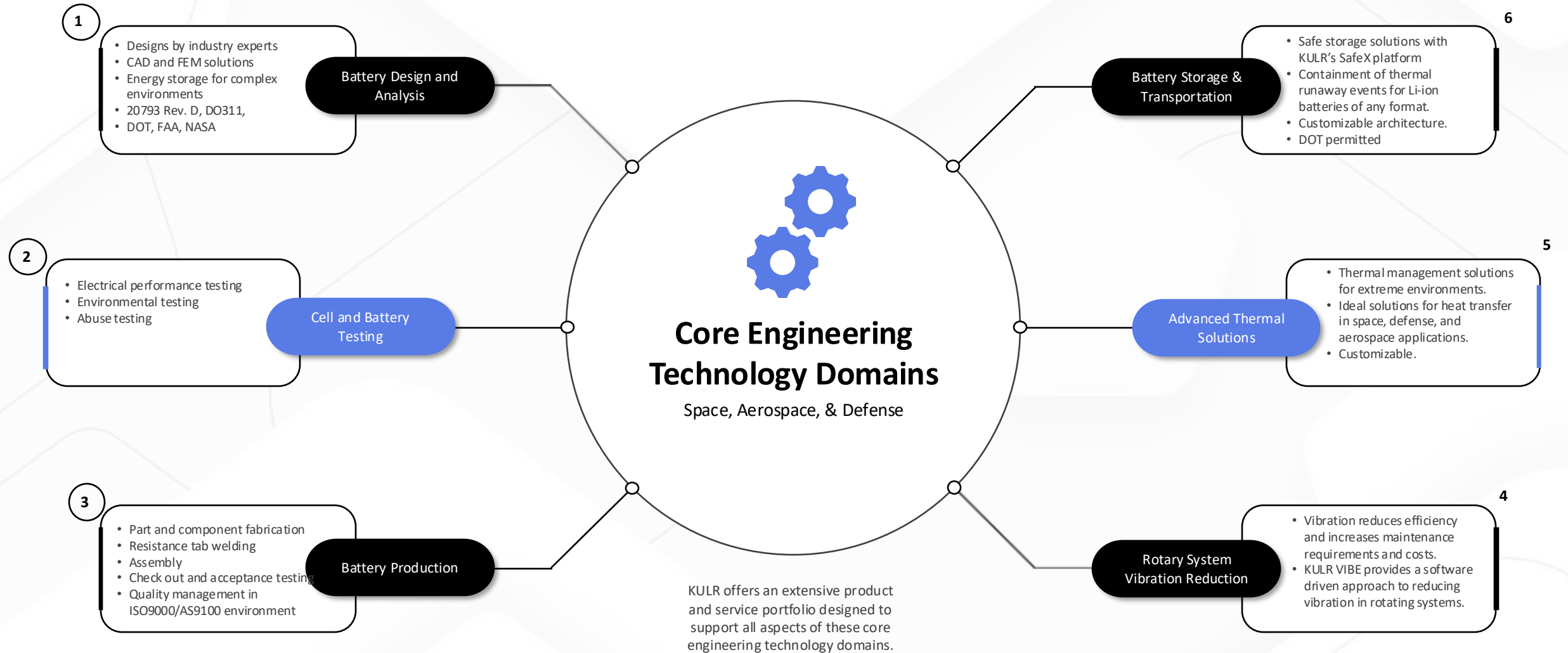
KULR ONE Space Safety Performance



K1S 200 Wh Abuse Test Example (M35A)

K1S 400 Wh Abuse Test Example (M35A)

Technology Domains

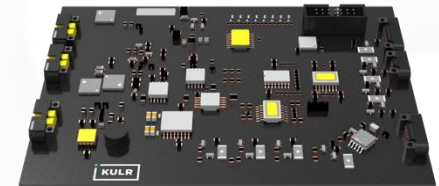


Battery Design and Analysis

Custom Batteries	KULR ONE	Products	
<p>Industry Experts</p> <ul style="list-style-type: none"> • Designs by engineering team with space flight hardware and BMS dev. experience. • Engineers with backgrounds from NASA, Axiom, commercial battery industry, small-sat industry 	<p>KULR ONE Space</p> <ul style="list-style-type: none"> • 18650/21700 architecture • Thermal runaway safety achieved via passive propagation resistant (PPR) design architecture. • Designed with intent for JSC 20793 Revision D satisfaction. 	<p>Radiation Tolerant Battery Management System (BMS)</p> <ul style="list-style-type: none"> • Designed for 20793 Rev. D battery systems • Off-the-shelf, vacuum tolerant & radiation tolerant, flight ready system. • Ground up safety first architecture. 	<p>Trigger Cells and ISC-Ds</p> <ul style="list-style-type: none"> • Internal short-circuiting device for implant. • Pre-built trigger cells with ISC-D already implanted. • Low temp trigger thermal runaway at 55 °C • High temp trigger thermal runaway at 70 °C
<p>Computer Aided Design (CAD)</p> <ul style="list-style-type: none"> • SolidWorks • Design management w/ SolidWorks PDM • Autodesk Fusion 360 • Design management with Autodesk Fusion Manage • ISO9000/AS9100 controlled design release processes 	<p>KULR ONE Guardian</p> <ul style="list-style-type: none"> • 18650/21700 architecture • PPR safety strategy. • Robust materials selection for extreme environments. • Designed for DoD applications. • MIL-STD-810H and MIL-PRF. 	<p>CellCheck™</p> <ul style="list-style-type: none"> • Real time monitoring and logistics of battery performance. • Safety and state-of-health monitoring. • Fleet management. 	<p>Thermal Runaway Cell Body Heating Protection</p> <ul style="list-style-type: none"> • Thermal Runaway Shield (TRS) for rapid cooling of conducted thermal runaway heating. • KULR core composite interstitial solution for operation heat management and thermal runaway heat management.
<p>Finite Element Modeling (FEM) and Analysis</p> <ul style="list-style-type: none"> • ANSYS SpaceClaim & TD Direct • Thermal Desktop • SINDA/FLUINT • GT-SUITEmp 	<p>KULR ONE Air</p> <ul style="list-style-type: none"> • Pouch silicon cell architecture • Low mass / low volume structures for aerospace (eVTOL) applications. • Module-to-module propagation resistance strategy. • Consideration given to DO311 requirements. 	<p>WI-37A Screened Cells</p> <ul style="list-style-type: none"> • 18650 format li-ion cells. • Pre-screened to NASA JSC EP-WI37A • Cells arrive to customers pre-matched, screened, and ready to be installed. 	<p>Thermal Runaway Ejecta Mitigation</p> <ul style="list-style-type: none"> • Side wall rupture tubing to protect from potential products expelled through an off-nominal failure. • Burst covers to protect from flowing ejecta. • Fibercore flame arrester to ensure only smoke exits the pack for single cell TR.



100 Wh KULR ONE Space (K1S)



Radiation Tolerant BMS

Cell and Battery Testing

Abuse Testing		Electrical Testing		Environment Testing	
<p>Small Fractional Thermal Runaway Calorimetry</p> <ul style="list-style-type: none"> Li-ion cells up to 10 Ah Total energy yield, Cell body vs. ejected energy yield Variability characterization vs. trigger method and SOC. Combination synchrotron. 	<p>Cell Level Abuse Testing</p> <ul style="list-style-type: none"> Temperature measurement Heater, ISC-D, and nail trigger methods 4K videography IR video feed Facilitate of online and in-person interaction with customer. 	<p>Gas Analysis</p> <ul style="list-style-type: none"> Equipped to take samples during testing (vacuum bottle) Submit for 3rd party analysis Evaluation of composition of expelled thermal runaway gases. 	<p>WI-37A Screening</p> <ul style="list-style-type: none"> Mass and dimensional consistencies Capacity retention. DCIR consistency. Visual defect inspection (scratches, dents, corrosion) Matched for pack installation. 	<p>Thermal Vacuum (2025 K1-TS Pipeline)</p> <ul style="list-style-type: none"> -60 C to +150 C thermal 10-6 Torr vacuum pull Can combine with Arbin systems for pack/module cycling. Electronics (BMS) check-out 	
<p>Large Fractional Thermal Runaway Calorimetry</p> <ul style="list-style-type: none"> Li-ion cells up to 200 Ah Total energy yield, Cell body vs. ejected energy yield Variability characterization vs. trigger method and SOC. 	<p>Pack/Module Abuse Testing</p> <ul style="list-style-type: none"> Temperature measurement Heater, ISC-D, and nail trigger methods 4K videography IR video feed Facilitate of online and in-person interaction with customer. 	<p>Particle Size Analysis</p> <ul style="list-style-type: none"> Ejecta materials vary in particle size depending on ejection characteristics and level of material decomposition. Microscopic characterization of particle size as a function of grouping. 	<p>Cell Cycling</p> <ul style="list-style-type: none"> 60 A / channel cycling capability w/ Arbin based systems. Cell capacity fade vs. cycle count vs. power profile. Accelerated aging (2025 pipeline). 	<p>Thermal & Humidity (2025 K1-TS Pipeline)</p> <ul style="list-style-type: none"> -40 to 120 C environment. Up to 100% humidity. Can combine with Arbin systems for pack/module cycling. Electronics (BMS) check-out 	
<p>Impingement Zone Mapping</p> <ul style="list-style-type: none"> Li-ion cells up to 30 Ah Ejecta impingement region intensity and heat flux characterization. High speed videography and frame by frame analysis of ejecta behavior. Variability characterization vs. trigger method and SOC. 	<p>Adiabatic Bomb Calorimetry</p> <ul style="list-style-type: none"> Adiabatic calorimetry modes Heat, wait, seek (standard ARC testing) Determination of material decomposition threshold Measurement of thermal runaway onset temperature Characterization of cell body heating rates 	<p>Specialized Instrumentation and Set-up (All Methods)</p> <ul style="list-style-type: none"> Equipped to provide custom specialized instrumentation and set-up for all testing methods. Ex: In-Situ HF sensors, gas collection systems, customizable NI based DAQ chassis. Controlled atmosphere composition experiments. 	<p>Module Cycling</p> <ul style="list-style-type: none"> 200 A / 200 V channel cycling capability with Arbin based system. Conductive set-up for pack/module electrical and thermal performance characterization. Can combine with abuse testing apparatus upon request. 	<p>Vibration (2026 K1-TS Pipeline)</p> <ul style="list-style-type: none"> Up to 300 lb. payload. SLS, Vulcan Centaur, and GEVS profile compatible. 	

Battery Production

Fabrication and Assembly Capabilities

<p>Precision Machining</p> <ul style="list-style-type: none"> • 4-Axis CNC capable of regular building materials • 3-Axis CNC capable of exotic material machining (Yttria, other ceramics, Syntactic foams) • Router CNC for organics and light materials 	<p>Laser Cutting</p> <ul style="list-style-type: none"> • CO2 Laser capable of cutting up to 0.5" thick organics and acrylics. Also capable of engraving • Fiber Laser capable of cutting nickel and other metals to make battery tabs and components 	<p>Clean Room Availability</p> <ul style="list-style-type: none"> • KULR maintains a clean room for assembly and testing of battery systems • 900sqft built for ISO 8 certification
<p>3D Printing</p> <ul style="list-style-type: none"> • Selective laser sintering (SLS) printing capable of nylon 11 and 12, and carbon fiber • Regular FDM multi-head printing ability in ABS, PLA, Nylon, and others 	<p>Pack/Module Assembly</p> <ul style="list-style-type: none"> • KULR maintains a prototype assembly lab in addition to the clean room. • All required tools including high voltage tooling, plastic manipulation tools and a full electrical bench. 	<p>Check-out & Acceptance</p> <ul style="list-style-type: none"> • Between the clean room and prototype room there are many high-power power supplies, load banks, battery testers and even Arbin Cyclers to perform testing at the cell and pack level.
<p>Standard Machine Shop</p> <ul style="list-style-type: none"> • Standard hand and power tools • Manual Mill • Saws, grinders, sanders and polishers 	<p>Resistance Tab Welding</p> <ul style="list-style-type: none"> • Resistance tab welding for battery pack assemblies in-house. • High current welding with waveform data monitoring 	<p>IS9000/AS9100 QMS and Standards</p> <ul style="list-style-type: none"> • KULR is certifying its Webster location as an AS9100 certified engineering and manufacturing facility to further serve the aerospace community



Haas® CNC Mill



Formlabs Fuse1 SLS 3D Printer

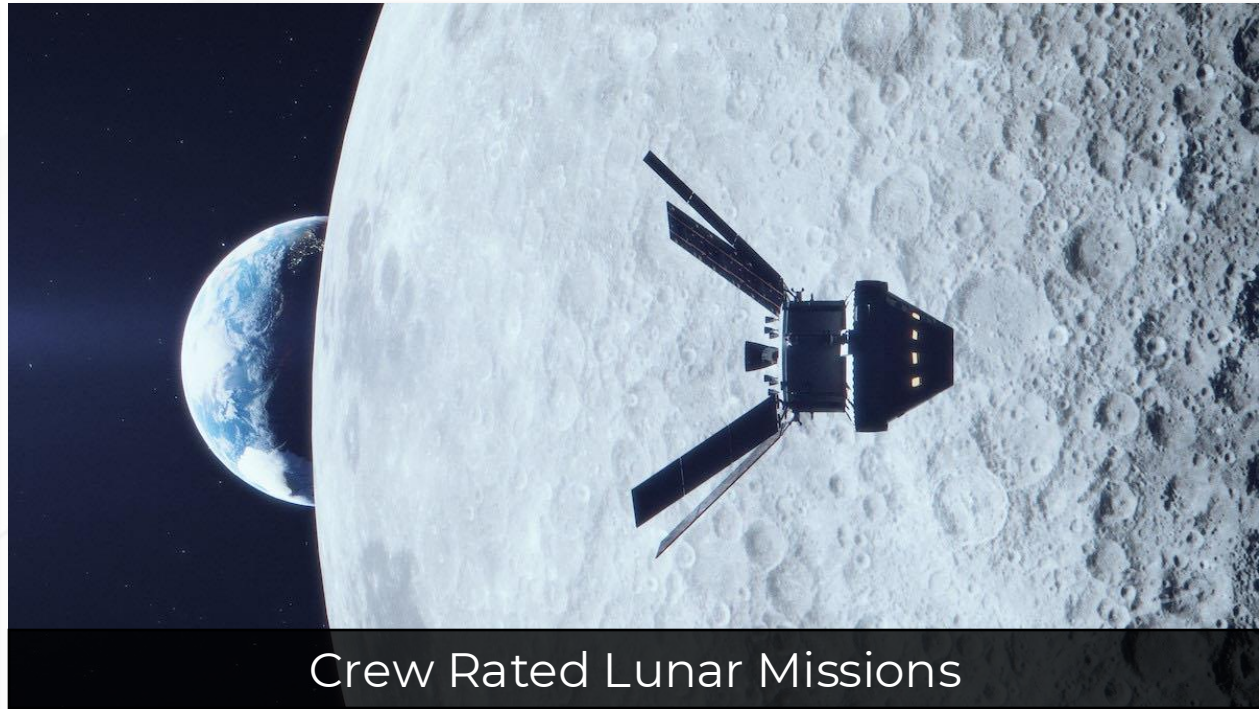


Amada Weld Tech Resistance Tab Welder



ISO 9001 Certification

KULR ONE Space, Ready for Flight





cooler · lighter · safer