بسم الله الرحمن الرحيم

North Lebanon Automotive Systems (NLAS)

Products

- Agricultural 4-wheels Electrical Tuk-Tuk
- Transportation 4-wheels Electrical Tuk-Tuk
- Lithium-Ion Batteries and Battery Mangement Systems (BMS)
- Electrical Vehicles for Deep-Sea Research

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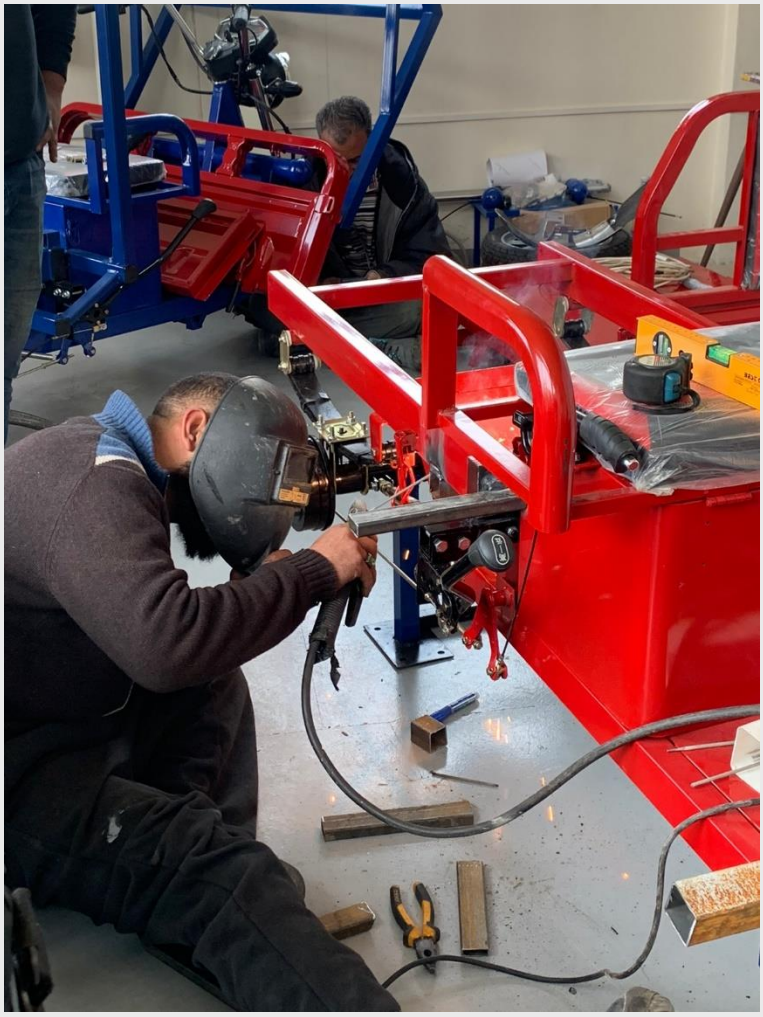
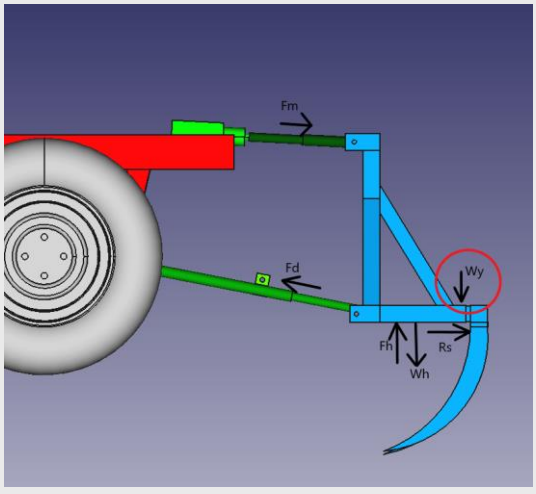
Laboratory Test vehicle

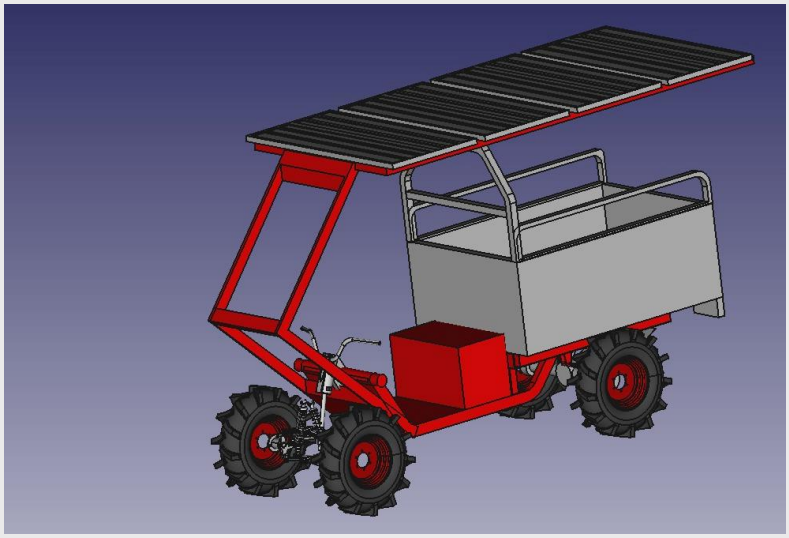


Agricultural 4-wheels Electrical Tuk-Tuk



Transportation 4-wheels Electrical Tuk-Tuk

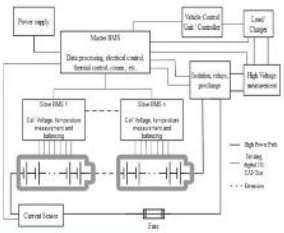
Part	quantity	discription
tuk tuk parts		
Front sides flashers	1	the two are connected to each other
Rear flashers	2	
differartial regulation axe	2	
rear brake axe	3	
flasher coil 60v	1	
pins for rear dampers	12	
digital 60v dashboard	1	
T shape front suspension axe	1	
12 inch rear rims	2	without standard tires
start switch	1	
rear differatial axe	1	with gear and fising pins
front steering wheel bearing	1	
control circuit for all electric parts	1	
Gear shifter rod	1	
brake sensor	1	
6 pins connector box	1	for power distribution
steering wheel switches and buttons	1 set	
supports for rear damper	2	
controller 1500w 72v BRSH-60	1	
steering wheel	1	
Gear shifter handle	1	
hand brake handle	1	
speed controller FR-3S	1	
rear dampers	2	
electric motor 1500w 72v	1	
Solar panels parts		
MPPT	1	
solar panels 100w	5	
solar system connectror and wires	1 set	
front suspension parts		
Front shock absorber	2	350mm for 200cc ATV
Upper swing arm	2	
Lower swing arm	2	
steering strut knuckle spindle and wheel hub	2	
Bolts	4	
chassis and body		
long chassis with front suspesion chassis	1	
battery container and driver seat	1	
cabin	1	
solar panels stand	1	



Battery Mangement System (BMS)

Lithium-Ion Battery Charger (18650)

Battery Management System(BMS)



1 Theory of Operation — Theoretical and mathematical aspects of Li-Ion battery charging

2 Hardware — Hardware design aspects of Li-Ion chargers

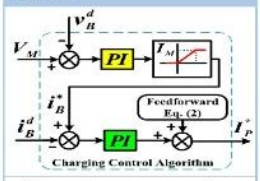
3 Circuit Diagram — Li-Ion charger circuit diagram

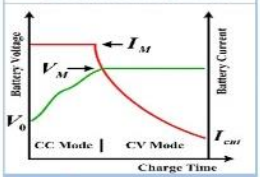
4 PCB Layout — PCB Layout for Li-Ion Charger

5 User Interface — Lithium-ion charger user interface

1.1 CC-CV Charging

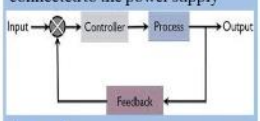
Li-Ion batteries are charged using the constant current charging (CC-CV) method at a constant current to reach a certain voltage Vmax = 4.2Vcell.





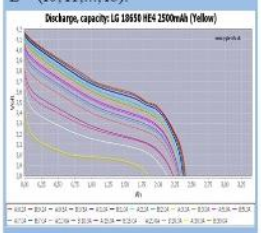
1.2 Control Loop

The "–" battery connected to the positive power supply (by MOSFET) The "-" battery connected to the power supply



1.3 State-of-Charge Estimation

The state of charge of the SOC is read through the battery voltage V and compared with the values stored in the lookup table L = (10, 11,…, 18).



1.4 Safety

The charger implements many safety features, such as under-voltage, over-voltage, short circuit, and open circuit detection.

1.5 Trickle Charging

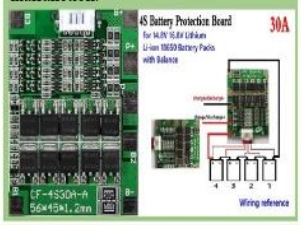
Once the end-of-charge (EOC) criteria are met, the charger cuts off the charging current, switches to idle mode, and continuously monitors the battery voltage.

2.1 Mechanical Design

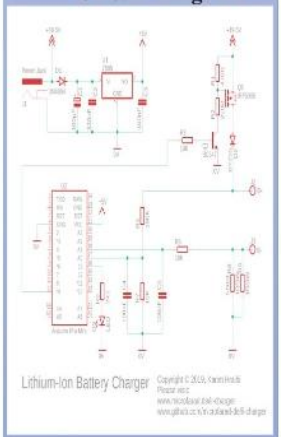
We used four LG 18650 HE4 Li-Ion cells and a battery protection board (or battery management system also known as BMS). Modern lithium-ion cells use much less space.

2.2 Battery Protection Board

It is necessary to use a dedicated battery protection board for each battery pack. This provides additional protection to prevent over-charging or over-discharging due to software or hardware malfunction.



3.1 Li-Ion Charger Circuit Diagram

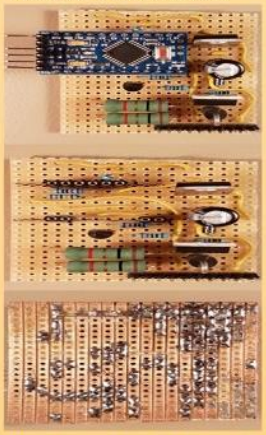


3.2 Different Number of Cells

The following values for R2, R4 and the power supply voltage need to be chosen in order to charge different numbers of Cells:

N_{cells}	Power Supply	R_2	R_4
1	5V-6V	220Ω	39KΩ
2	10V-15V	100Ω	82KΩ
3	14V-20V	220Ω	120KΩ
4	18.5V-20V	220Ω	180KΩ

All components are of the punch-hole type and are mounted on a PCB board. The Figure below shows the PCB layout of a Li-Ion charger.



The pin header located at the top right corner is used for connecting all the external wires. Following is the pinout assuming that pin 1 is at the top right corner and pin 10 is towards the middle of the board.

Pin	Purpose
1 *	LED +
2 *	LED -
3,4 ⏚	Power supply +
5,6 ⏚	Battery +
7,8 ⏚	Power supply -
9,10 ⏚	Battery -

5.1 LED Indicator

The charger status is displayed by turning on or flashing a single LED

Blinking Pattern	Meaning
On for half a second every 2 seconds	Ready, waiting for the battery to be connected
Solid on	Battery charging
On For 0.1 second every 2 seconds	Battery fully charged
Blinking fast (0.4 s period)	Error
Blinking very fast (0.2 s period)	Calibration mode

5.2 Command-Line Interface

This simple lithium-ion battery charger features a CLI that can be accessed via the Arduino's RS232.

Once turned on, the charger will display the current firmware version and present with a list of commands.

Some of these CLI commands must be supplied with arguments.

5.3 Calibration Procedure

This section provides an example on how to perform the first-time calibration of the Lithium-Ion battery charger using the CLI over the serial monitor.

5.3.1 Initial ranking

Initial configuration parameters must be loaded into the EEPROM by executing a command sequence.

ncells 4	lut 0 3200	lut 5 3710
cfull 2500	lut 1 3450	lut 6 3825
ichrg 1500	lut 2 3530	lut 7 3920
ifull 150	lut 3 3610	lut 8 4020
rshunt 500	lut 4 3650	

5.3.2 Voltage calibration

After performing the initial step please proceed to calibrate the ADC readings for voltages V1, V2:

1. Enter the Cal start command in the serial monitor.
2. Connect a constant voltage source between terminal B and ground.
3. Enter the command cal-v2 into the serial monitor
4. Connect a constant voltage source between terminal B+ and the ground of the power supply.
5. Enter the command cal v1 <value> into the serial monitor
6. Check the voltage calibration by applying a known voltage to both B+ and B-.
7. Repeat steps 2, 3,... and 6 until the voltage V readings are correct.
8. Enter the command cal stop in order to exit the voltage calibration mode.

5.3.3 Current calibration

Please proceed with calibrating the reading of the current I by following the steps below:

1. Connect a discharged lithium-ion battery in series using a digital ampere meter (set to the 10 A range) to terminals B+ and B-.
2. 2. The Charging message should appear and the current value should begin to increase gradually to approximately 1.5 A.
3. 3. Enter the command [.] and check the displayed value of I.
4. If output of the[.] command is higher than amper meter reading: Increase the Rshunt by 10 mΩ.
5. If output of the[.] command is lower than amper meter reading: decrease the Rshunt by 10 mΩ.
6. Repeat steps 3,4,5 until the current I readings are correct.

5.4 Trace Buffer

A lithium-ion battery charger records events that occur during the charging process in a circular buffer within the available EEPROM space. The contents of the trace buffer are dumped using the t command.

0: * 16760	6: i 1495	106: i 241
0: % 0	8: v 14137	108: v 16759
0: v 7820	8: i 1503	108: i 231
0: T 135	10: v 14206	110: v 16764
0: C 3263	(skipped...)	110: i 221
0: S 150	100: v 16767	112: v 16761
0: I 1500	100: i 638	112: i 150
2: v 13222	102: v 16764	113: F 1
2: i 1495	102: i 529	113: t 113
4: v 13719	104: v 16761	113: c 2508
4: i 1499	104: i 381	113: v 16767
6: v 13982	106: v 16754	113: i 139

Event	Description	Event	Description
*	Beginning of the charging cycle, indicates the maximum battery voltage V_{max} in V	i	Instantaneous battery current I in mA
%	Initial charge state %	F	Battery full, indicates the end-of-charge condition (1 = I_{full} reached, 2 = C_{max} reached, 3 = T_{max} reached)
T	Maximum permissible charging time T_{max} in minutes	t	Actual charging time T in minutes
C	Maximum permissible charging capacity C_{max} in mAh	c	Actual charged capacity C in mA
S	Safety charging in progress, I_{safe} is indicated in mA	E	Error (1 = over-volt, 2 = under-volt, 3 = open-circuit, 99 = CRC fail)
I	Normal charge in progress, indicates I_{charge} in mA		
v	Instantaneous battery voltage V=V_2-V_1 in mV		

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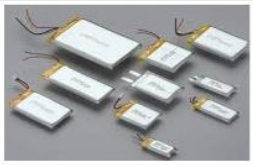
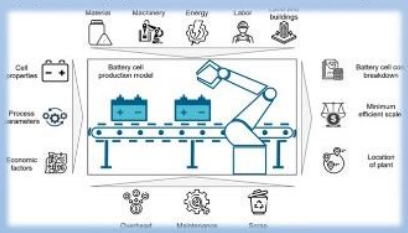
Lithium Battery Production

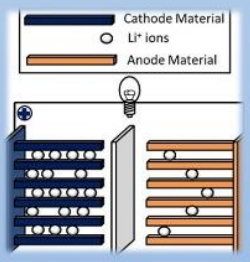


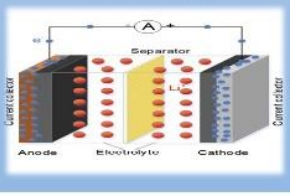
MANUFACTURING PROTOTYPE OF BATTERY LITHIUM ION

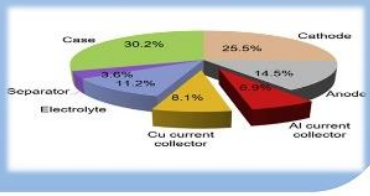
1 INTRODUCTION

The purpose of this project is manufacture a lithium-ion battery.





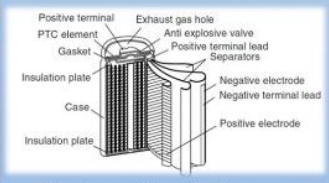




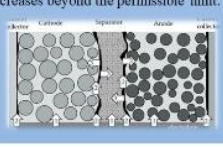
2 MATERIALS

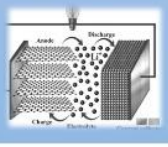
Lithium cell materials: One thousand lithium batteries consist of a metal shell containing three spirally wound foils, a carbon 6LiC anode and a lithium cobalt oxide 2LiCoO cathode. The universe consists of a thin sheet of plastic between the anode and cathode, this solution is mostly an electrolyte. This third layer is immersed in various electrolysis agents.

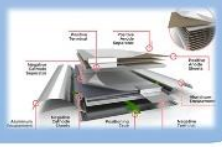
Type	Price/$	measuring unit
Lithium foil	0-400	/kilogram
Lithium ion foil	10-20	/kilogram
Separator	1-4	/square meter
Anode/ Cathode tab	0-10	/piece
LiFePO4 (electrolyte)	10-50	/ton
Aluminum laminate film	1-20	/square meter



Lithium-ion cells - The lithium-ion battery is surrounded by a metal casing, and this metal casing is necessary to protect battery contents. The cover contains special safety when the temperature rises. The battery pressure increases beyond the permissible limit.



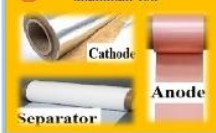




3 PROCESS TO MAKE THE POUCH CELL LITHIUM

The procedure of assembling the materials to obtain a lithium cell is as follows:

1 Cutting the copper and aluminum foil



3 Stacking:
1. Conductive copper foil coated with carbon for the anode
2. Break
3. Carbon coated conductive aluminum foil for cathode
4. Separator and so on until 5 anodes and 5 cathodes are separated by a separator

2 Tailoring

4 Welding

5 Sealing

6 Formation

4 DATA SHEET OF MATERIAL

1 Coated copper and aluminum foil:

Conductive carbon coating	Double side coating with 1 micron thickness each side for copper	Double side coating with 1 micron thickness each side for aluminum
Density	0.54 g/m^2	0.5 g/m^2
Surface resistivity	< 30 ohms per 25um^2	< 30 ohms per 25um2
Copper Purity	> 99.9%	> 99.9%
Copper Thickness	9 um	16 micron
Coating Width	~ 239 mm	~ 200 mm
Total Width	280 mm	260 mm

2 Separator:

Layer material	Thickness
Nylon	25 micron
DI.	3 micron
Aluminum	40 micron
EL	15 micron
PP	30 micron
Width	400 mm
Thickness	133 micron

3 Laminated aluminum film:

Nominal Voltage	4.5V
Nominal Capacity	800mAh
Type	Li-Ion

4 Electrolyte:

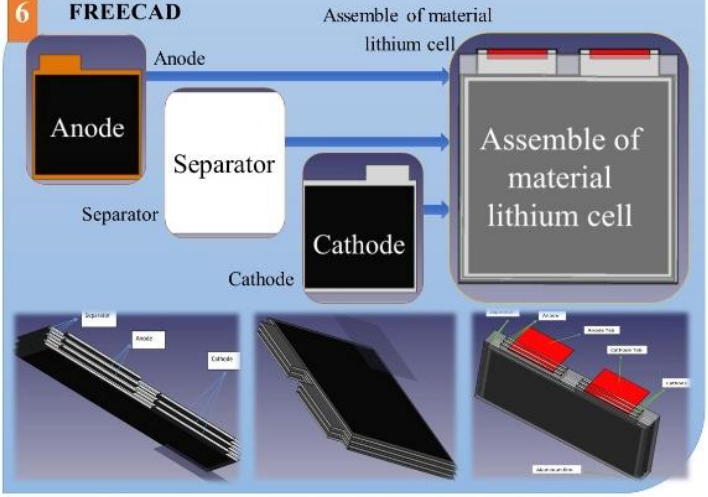
Electrolyte Salt	1 mol/L LiPF6
Organic Solvent	EC+DMC+DEC; 1:1:1 in volume
Net weight	4 Lbs
Max. Voltage	4.5V
Chromaticity	<50 Hazen
Moisture	≤ 20ppm
Free Acid (HF)	< 50ppm
Density	1.20±0.03g/ml @ 25o C
Electrical Conductivity	7.4±0.5mS/cm
Chlorine (Cl)	< 1ppm
Sulfate (SO4)	< 10ppm
Potassium (K)	< 10ppm
Sodium (Na)	< 10ppm
Calcium (Ca)	< 10ppm
Iron (Fe)	< 6ppm
Lead (Pb)	< 5ppm

5 COST OF MATERIAL

Material	Quantity	Dimension	Cost ($)	Total cost ($)
Coated copper foil	1.3 Kg/roll	width: 280 mm	230 $	620 $
Aluminum coated foil	1.5 kg/roll	30 m2 length : 120 m	210 $	
Separator	1 m2	w: 300 mm T: 120 mm	18 $	
Laminated aluminum film	1 m2	W : 400 mm T: 133 um	12 $	
Electrolyte	1 kg	---	140 $	
Nickel tab	10 pairs	w: 4 mm	10 $	

other supplier (top machine)	Quantity	Dimension	cost($)	total cost($)
Coated copper foil	1 piece (A4 210*297) --> 6$ 3 pieces --> 3*6 = 18 $	Width: 250mm Thickness: 0.01mm Length: 50m	18	44.5
Aluminum coated foil	1 piece (A4) --> 5$ 3 pieces --> 3*5 = 15 $	Width: 426mm Thickness: 0.015mm Length: 100 m	15	
Separator	1.5 $ / M2 we need 1 M2	Width: 215 mm Thickness: 25 um Length: 1000 m	1.5	
Laminated aluminum film	20 $ / M2 we need 1 M2	Width: 400 mm Thickness: 152 um Length: 250 m	10	
Nickel tab	10 pairs	Width : 50 mm		

6 FREECAD



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Electrical Vehicles for Underwater (Deep-Sea) Research

Planned