

TESLA

# TESLA MODEL 3

TF 5036 Electric Vehicle Energy System

Bernardus Rendy - 13317041





# GENERAL OVERVIEW AND SPECIFICATION

Tesla  
**Model 3**



3.2s  
From 0-60 mph

310mi  
Range

AWD  
Dual Motor

ORDER NOW

You can return your car for a full refund within 7 days or 1,000 miles, whichever comes first.

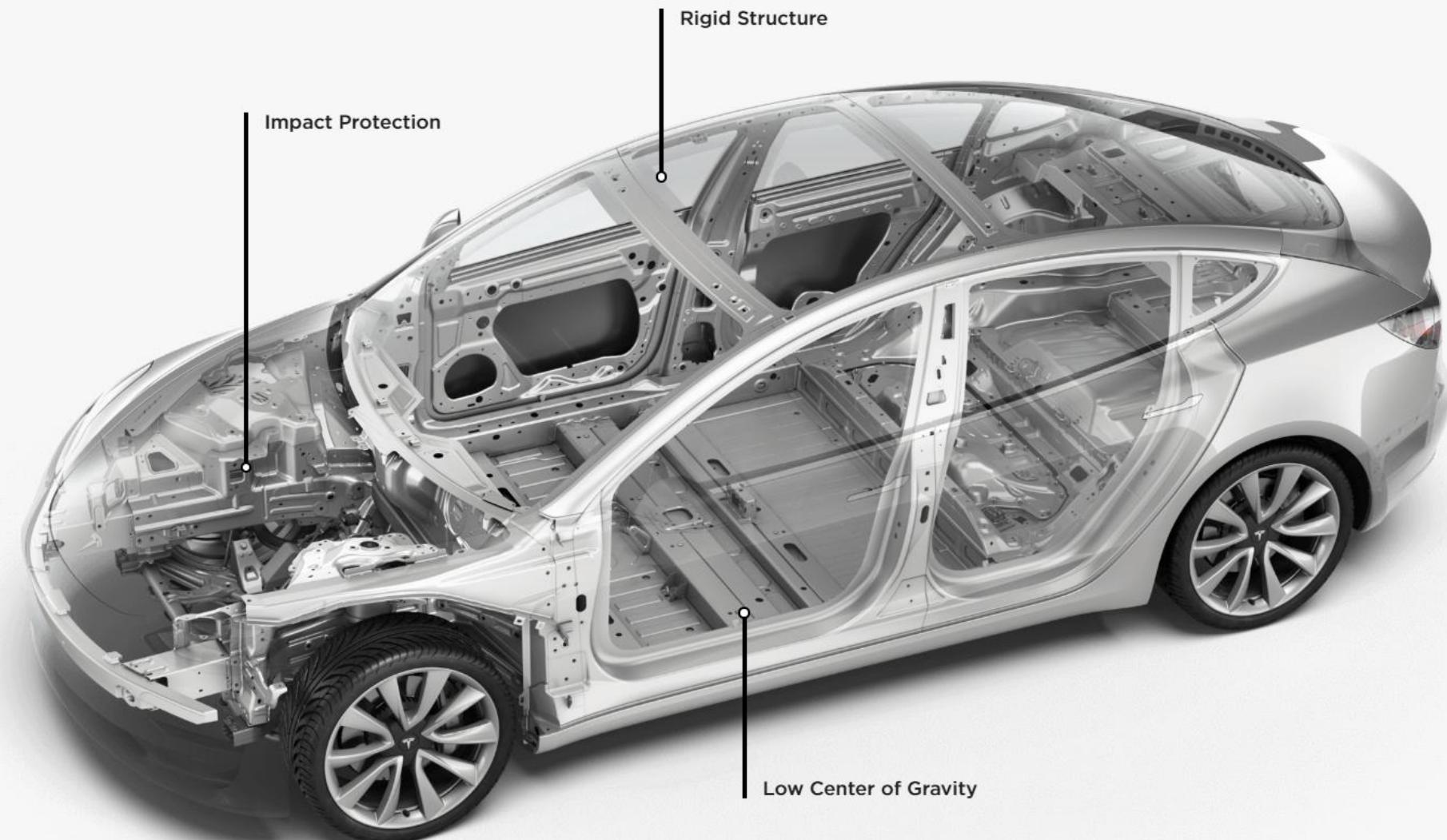
Safety

## Built for Safety

Safety is the most important part of the overall Model 3 design. The metal structure is a combination of aluminum and steel, for maximum strength in every area. In a roof-crush test, Model 3 resisted four times its own mass, even with an all-glass roof: that's the same weight as two full-grown African elephants.

### 5-Star Overall NHTSA Rating

Driver Frontal	★★★★★
Passenger Frontal	★★★★★
Front Seat Side	★★★★★
Rear Seat Side	★★★★★
Rollover	★★★★★



LEARN MORE

ORDER NOW

# Model 3 earns 5-Star Safety Rating from Euro NCAP

The Tesla Team • July 3, 2019

At Tesla, we're deeply committed to safety, which is why we engineered Model 3 to be the safest car ever built. In the U.S., Model 3 has already earned an overall 5-star rating from NHTSA (National Highway Traffic Safety Administration), including earning 5-stars in every category and sub-category, and scoring the **lowest probability of injury** of any car ever evaluated by the U.S. New Car Assessment Program.

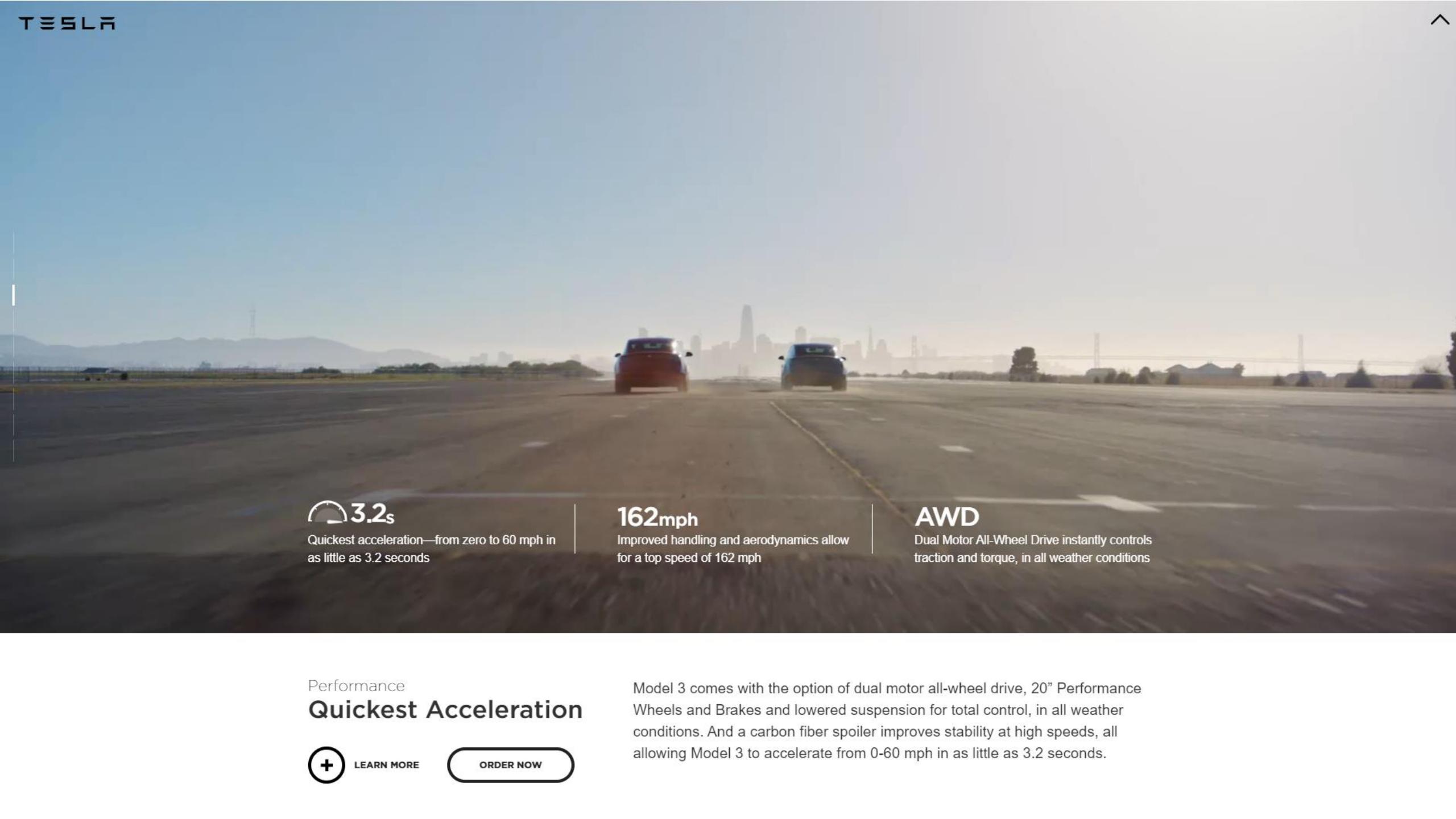
Today, Model 3's safety record continues in Europe, where it has just been awarded a 5-star rating from the European New Car Assessment Programme (Euro NCAP). The Programme's four categories – each of which Model 3 earned 5-stars in – evaluate a car's ability to protect adults, children, vulnerable road users like cyclists and pedestrians, as well as its safety assistance features. In this latter "Safety Assist" category, which evaluates a car's active safety features including its ability to avoid accidents, mitigate injuries and prevent drivers from unintentionally drifting out of their lane, Model 3 earned the highest score that Euro NCAP has awarded to date under their 2018/2019 testing protocols.

Euro NCAP's results demonstrate the impact of recent improvements made to our Automatic Emergency Braking (AEB) system that were extended to all Model S, Model X and Model 3 cars built since October 2016 via an over-the-air software update earlier this year. They also reflect important safety improvements made with new features like **Lane Departure Avoidance, Emergency Lane Departure Avoidance**, and conditional speed limits based on time of day and weather conditions.

Tesla's engineers developed each active safety feature evaluated by Euro NCAP by leveraging the real-world data collected from the sensor suite of every Tesla vehicle made since October 2016, coupled with data from billions of inputs from actual drivers to help us understand how drivers

Be the first to receive the latest Tesla news, events and product updates.

SUBMIT

**3.2s**

Quickest acceleration—from zero to 60 mph in  
as little as 3.2 seconds

**162mph**

Improved handling and aerodynamics allow  
for a top speed of 162 mph

**AWD**

Dual Motor All-Wheel Drive instantly controls  
traction and torque, in all weather conditions

Performance

## Quickest Acceleration

[LEARN MORE](#)[ORDER NOW](#)

Model 3 comes with the option of dual motor all-wheel drive, 20" Performance Wheels and Brakes and lowered suspension for total control, in all weather conditions. And a carbon fiber spoiler improves stability at high speeds, all allowing Model 3 to accelerate from 0-60 mph in as little as 3.2 seconds.

**310 mi**

Go anywhere with up to 310 mi of range on a single charge

**15 min**

Recharge 180 mi in 15 minutes at Supercharger location

**14,000+**

Superchargers placed along well-traveled routes around the world

Range

## Go Anywhere

Model 3 is fully electric, so you never need to visit a gas station again. If you charge overnight at home, you can wake up to a full battery every morning. And when you're on the road, it's easy to plug in along the way—at any public station or with the Tesla charging network. We currently have over 14,000 Superchargers worldwide, with six new locations opening every week.

[LEARN MORE](#)[ORDER NOW](#)

**360°**

Rear, side and forward-facing cameras provide maximum visibility

**160m**

Forward-facing radar provides a long-range view of distant objects

**12****Ultrasonic Sensors**

Detects nearby cars, prevents potential collisions and assists with parking

Autopilot  
**Future of Driving**

[LEARN MORE](#)[ORDER NOW](#)

Autopilot advanced safety and convenience features are designed to assist you with the most burdensome parts of driving.

## Autopilot

Autopilot advanced safety and convenience features are designed to assist you with the most burdensome parts of driving. All new Tesla cars come standard with driver assistance features such as emergency braking, collision warning and blind-spot monitoring.



### Full Self-Driving Capability

- Navigate on Autopilot: automatic driving from highway on-ramp to off-ramp including interchanges and overtaking slower cars.
- Auto Lane Change: automatic lane changes while driving on the highway.
- Autopark: both parallel and perpendicular spaces.
- Summon: your parked car will come find you anywhere in a parking lot. Really.

Coming later this year:

- Recognize and respond to traffic lights and stop signs.
- Automatic driving on city streets.

Select Option \$6,000

#### Includes the Full Self Driving Computer

Full Self-Driving Capability is available for purchase post-delivery, prices are likely to increase over time with new feature releases

The currently enabled features require active driver supervision and do not make the vehicle autonomous. The activation and use of these features are dependent on achieving reliability far in excess of

CASH ▾

\$40,065  
After potential  
savings

\$48,740  
Purchase price

[Estimate payment](#)

[Estimated delivery: Within 2-3 weeks](#)

NEXT



Interior

## Built Around the Driver

[LEARN MORE](#)[ORDER NOW](#)**15 inch**

A touchscreen display designed to improve over time



Over-the-air software updates introduce new features, functionality and performance



An expansive Glass Roof provides more headroom and UV protection

The inside of Model 3 is unlike any other car. You can use your smartphone as a key, and access all driver controls in the central 15-inch touchscreen. The all-glass roof extends from front to back, creating a sense of openness from every seat.



SPECs

## Model 3 Specs

[PERFORMANCE](#)[LONG RANGE AWD](#)[STANDARD PLUS](#)[COMPARE](#)**Battery**

Long Range

**Weight**

4,072 lbs

**Acceleration**

3.2 seconds 0-60 mph

**Cargo**

15 cu ft

**Range**

310 miles

**Displays**

15" Center Touchscreen

**Drive**

Dual Motor All-Wheel Drive

**Supercharging**

Pay Per Use

**Seating**

5 Adults

**Warranty**Vehicle  
4 year 50,000 miles**Wheels**

20" Performance Wheels

Battery & Drive Unit  
8 year 120,000 miles

EXPAND LIST

Battery	Standard Range	Standard Range Plus	Mid Range	Long Range		
Powertrain	RWD	RWD	RWD	AWD		
Production	March 2019 – present	October 2018 – March 2019[166]	Previously July 2017 – October 2018)	July 2018 – present		
Base price (US market)	US\$34,990 <sup>[4]</sup> (call or in store order only)	US\$38,990 <sup>[4]</sup>	(was US\$40,000 <sup>[4]</sup> )	US\$47,990 <sup>[4]</sup>		
Range	EPA: 220 miles (354 km) <sup>[4]</sup>  WLTP: 381 km 237 mi  NEDC: 429 km 267 mi	EPA: 240 miles (386 km) <sup>[4]</sup>  WLTP: 409 km 254 mi  NEDC: 460 km 286 mi	EPA: 264 miles (425 km) combined 270 miles (430 km) city 248 miles (399 km) highway  WLTP: 457 km 284 mi 514 km 319 mi	EPA: 25 miles (523 km) combined 32 miles (534 km) city 18 miles (51 km) highway  WLTP: 100 km 73 mi 75 km 19 m	EPA: 310 miles (500 km) combined 319 miles (513 km) city 296 miles (476 km) highway  WLTP: 560 km 348 mi 620 km 385 mi	EPA: 310 miles (500 km) combined 319 miles (513 km) city 296 miles (476 km) highway  WLTP: 530 km 329 mi 560 km 348 mi
Efficiency	26 kWh/100 miles (16 kWh/100 km)  MPGe: 131 miles 111 km) combined 88 miles (222 km) city 144 miles (200 km) highway	25 kWh/100 miles (16 kWh/100 km)  MPGe: 133 miles (214 km) combined 140 miles (225 km) city 140 miles (225 km) highway	27 kWh/100 miles (17 kWh/100 km)  MPGe: 127 miles 118 km) combined 128 miles (206 km) city 127 miles (183 km) highway	26 kWh/100 miles (16 kWh/100 km)  MPGe: 130 miles 109 km) combined 126 miles (219 km) city 123 miles (193 km) highway	29 kWh/100 miles (18 kWh/100 km)  MPGe: 116 miles (187 km) combined 120 miles (193 km) city 112 miles (180 km) highway	
Battery capacity	50 kWh (180 MJ) <sup>[165]</sup>	62 kWh (220 MJ) <sup>[169]</sup>	62 kWh (220 MJ)	75 kWh (270 MJ) <sup>[170][175][176][171]</sup>		

Specifications								
Battery	Standard Range	Standard Range Plus	Mid Range	Long Range				
DC charging	130 miles (209 km) range available after 30 minutes. <sup>[172]</sup>	TBA	TBA	up to 75 mi (121 km) in 5 minutes. <sup>[173]</sup> and 180 mi (290 km) in 15 minutes. <sup>[174]</sup> (250 kW V3 Supercharger)				
AC charging	30 miles (48 km) range per hour (240 V 32 A) <sup>[168]</sup>			44 miles (71 km) range per hour (240 V 48 A) <sup>[168][175]</sup>				
Powertrain	Single-Motor Rear-Wheel Drive <sup>[4][176][177]</sup>			Dual-Motor All-Wheel Drive <sup>[4]</sup>				
Motor	permanent magnet switched reluctance <sup>[178][179][180][181]</sup> rear			permanent magnet switched reluctance rear & induction front <sup>[178][179][180][181]</sup>				
Curb Weight	3,552 lb (1,611 kg) <sup>[4]</sup>	3,627 lb (1,645 kg) <sup>[4]</sup>	3,680 lb (1,672 kg) <sup>[4]</sup>	3,855 lb (1,726 kg) <sup>[4]</sup>	4,072 lb (1,847 kg) <sup>[4]</sup>			
Power	283 hp (211 kW) <sup>[182]</sup>	283 hp (211 kW) <sup>[182]</sup>	283 hp (211 kW) <sup>[182]</sup>	283 hp (211 kW) <sup>[182]</sup>	412 hp (307 kW) combined <sup>[184]</sup>	473 hp (353 kW) combined <sup>[185]</sup>		
Power-to-weight	12.6 lb/hp (166 W/kg)	12.8 lb/hp (128 W/kg)	13.0 lb/hp (164 W/kg)	13.1 lb/hp (127 W/kg)	252 hp (188 kW) rear & 197 hp (147 kW) front <sup>[183]</sup>	283 hp (211 kW) rear & 197 hp (147 kW) front <sup>[183]</sup>		
Torque	TBA	TBA	TBA	TBA	9.9 lb·ft (166 N·m) combined <sup>[186]</sup>	471 lb·ft (639 N·m) combined <sup>[185]</sup>		
Acceleration	0–60 mph (0–97 km/h) 5.6 seconds advertised <sup>[4]</sup>	0–60 mph (0–97 km/h) 5.3 seconds advertised <sup>[4]</sup>	0–60 mph (0–97 km/h) 5.2 seconds advertised <sup>[4]</sup>	0–60 mph (0–97 km/h) 5.0 seconds advertised <sup>[4]</sup> (4.6 seconds tested <sup>[187]</sup> )	0–60 mph (0–97 km/h) 4.4 seconds advertised <sup>[4]</sup> (4.0 seconds tested <sup>[186]</sup> )	0–60 mph (0–97 km/h) 3.2 seconds advertised <sup>[4]</sup> 0–100 km/h (0–62 mph) 3.4 seconds advertised		
Top speed	130 mph (209 km/h) <sup>[4]</sup>	140 mph (225 km/h) <sup>[4]</sup>	140 mph (225 km/h) <sup>[4]</sup>	140 mph (225 km/h) <sup>[188]</sup>	145 mph (233 km/h) <sup>[189]</sup>	162 mph (261 km/h) <sup>[189]</sup>		
Wheels	18-inch (457 mm) diameter 8.5-inch (216 mm) width 21.3 lb (9.7 kg), Aero wheel covers 2 lb (0.91 kg), 235/45R18 tires				20-inch (508 mm) 8.5-inch (220 mm) 235/35R20			
Roof	Tinted glass roof with ultraviolet and infrared protection, with mounting points for a roof rack (sold separately). <sup>[190][191]</sup> A single pane of glass extends from the center of the roof to the trunk. <sup>[176]</sup>							
Autonomous capability	Autopilot including TACC, autosteer, lane-keeping, lane-changing, active-safety autonomy. <sup>[176][192]</sup> (All vehicles include all hardware needed for "Full Self-Driving", including 1 radar, 8 cameras, 12 sonar, and AI computer.)							
Luggage	Rear 12 cu ft (340 L) and front 3 cu ft (85 L) trunks with 15 cu ft (425 L) total volume <sup>[176][4][193][194]</sup>							



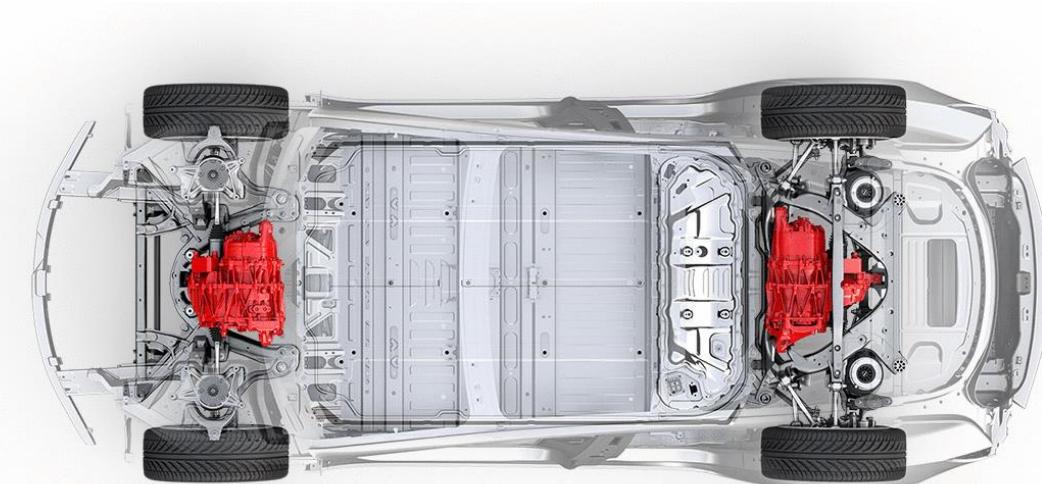
# M E C H A N I C A L A R C H I T E C T U R E

# BODY DESIGN

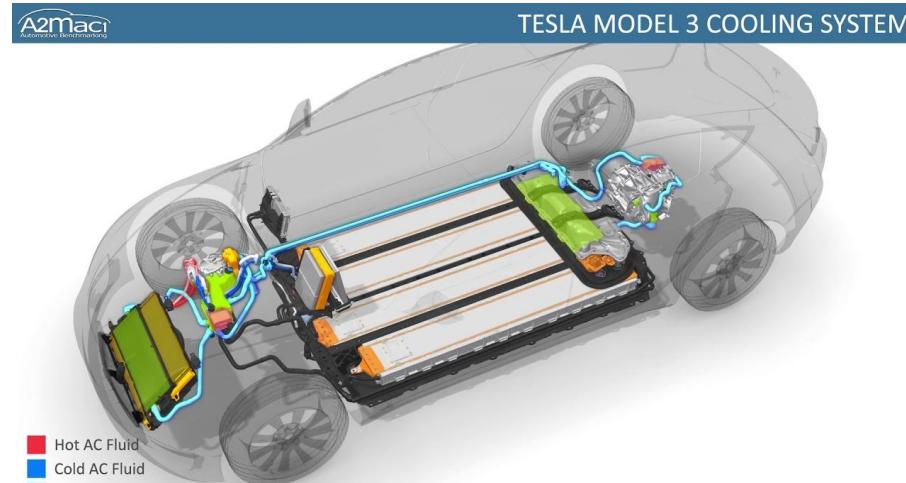


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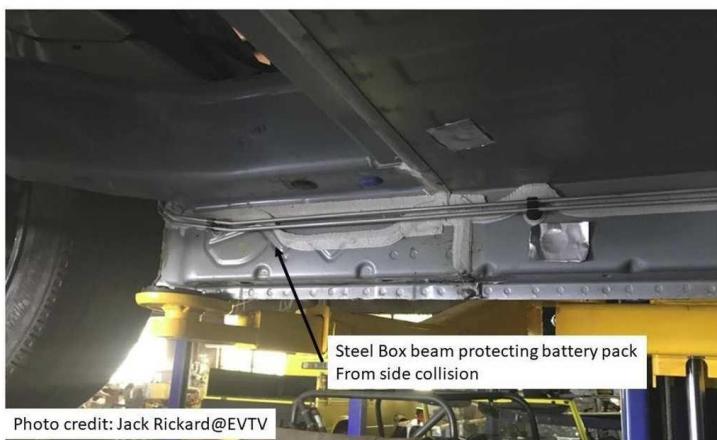
# CHASSIS AND SYSTEMS COMPONENT PLACEMENT



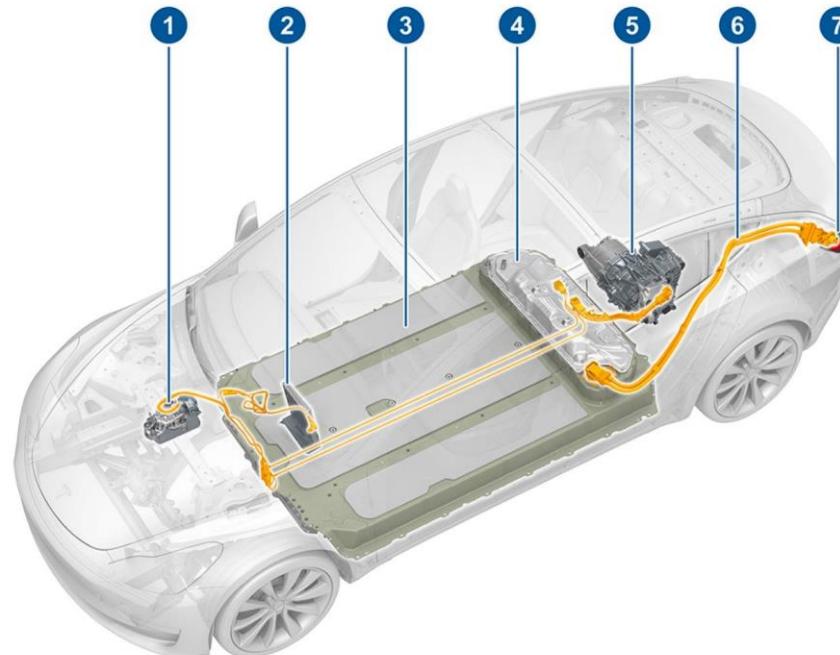
# CHASSIS AND SYSTEMS COMPONENT PLACEMENT



f3 Steel Box Beam Protects Model 3 battery from side collision

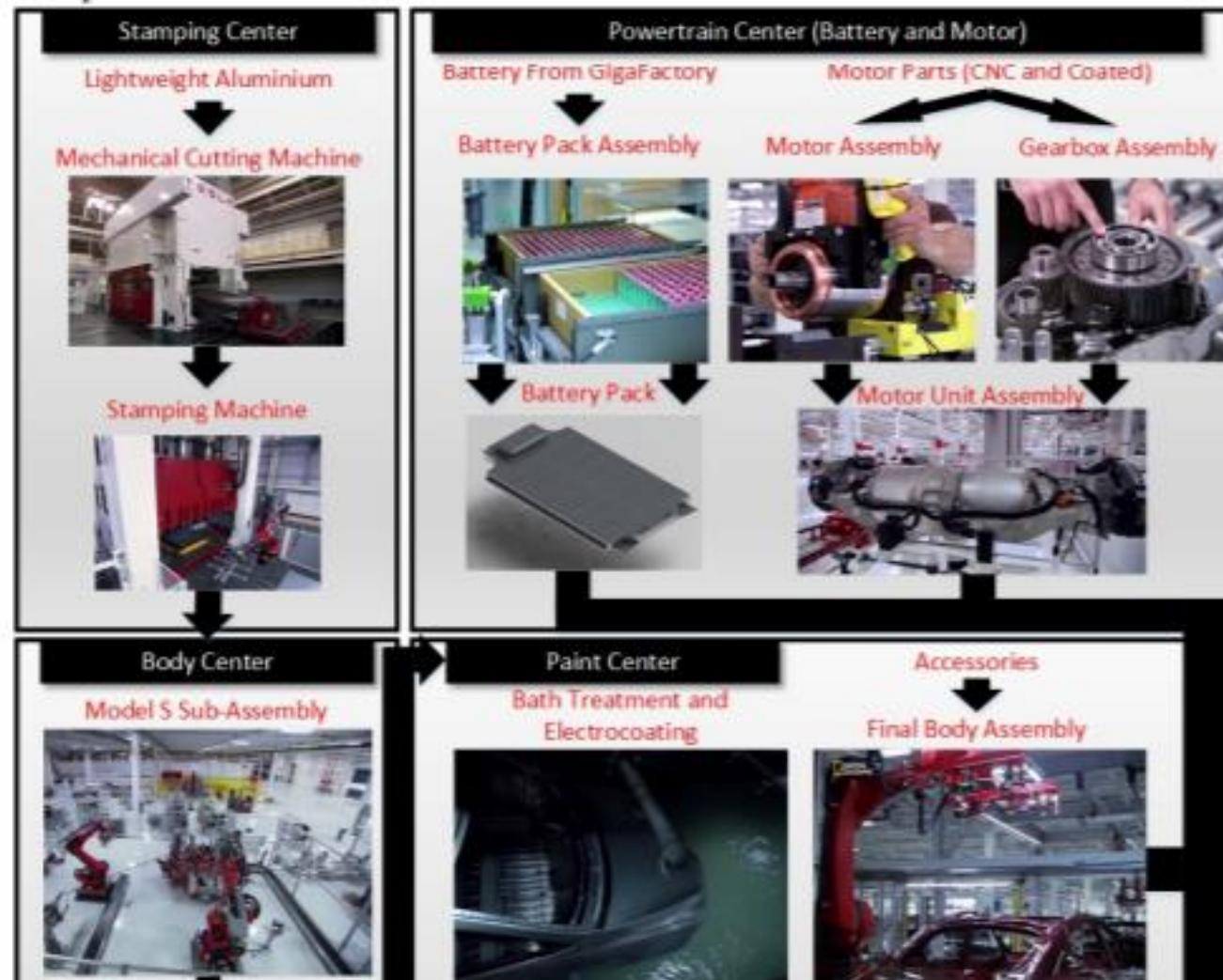


## HIGH VOLTAGE COMPONENTS



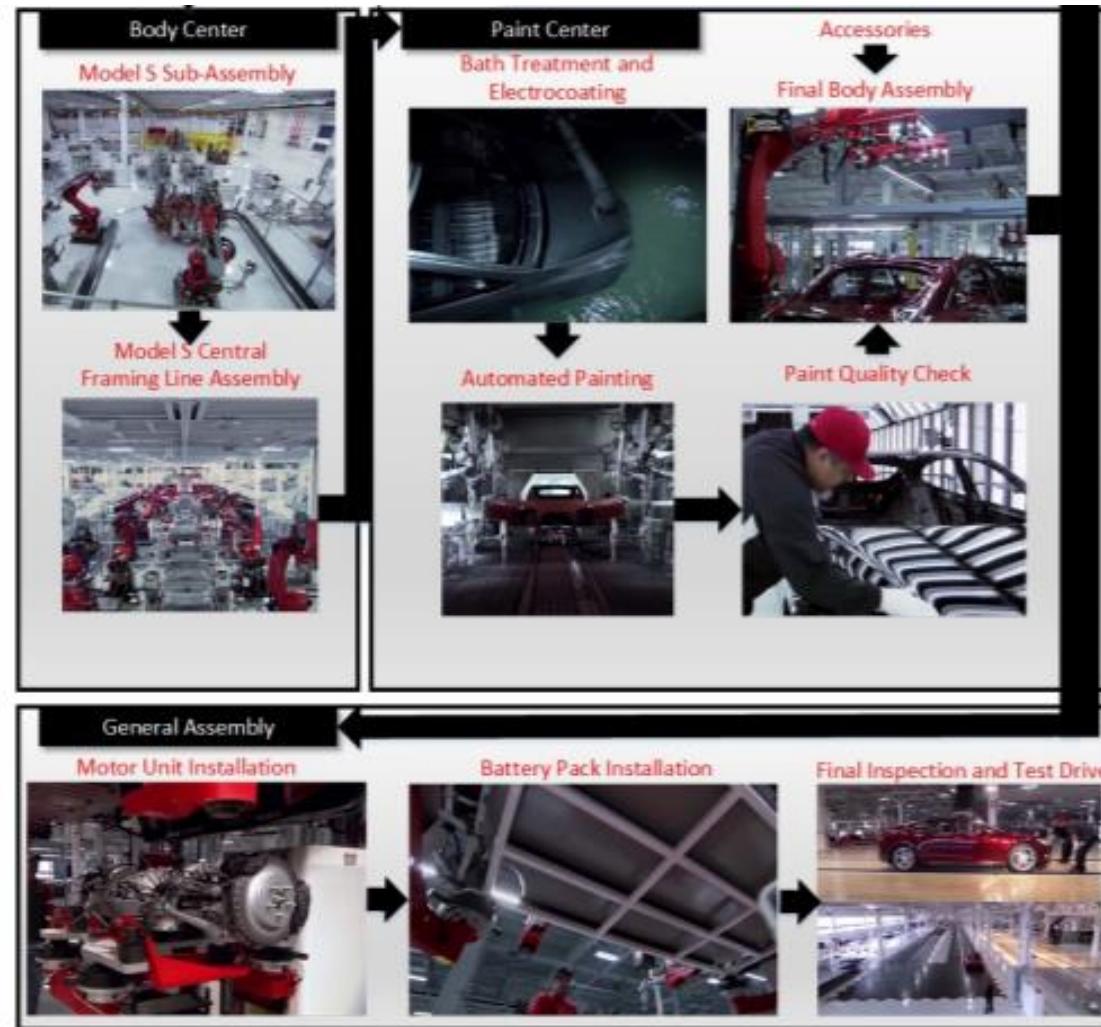
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# LITTLE DETOUR: MANUFACTURING PROCESS



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# LITTLE DETOUR: MANUFACTURING PROCESS

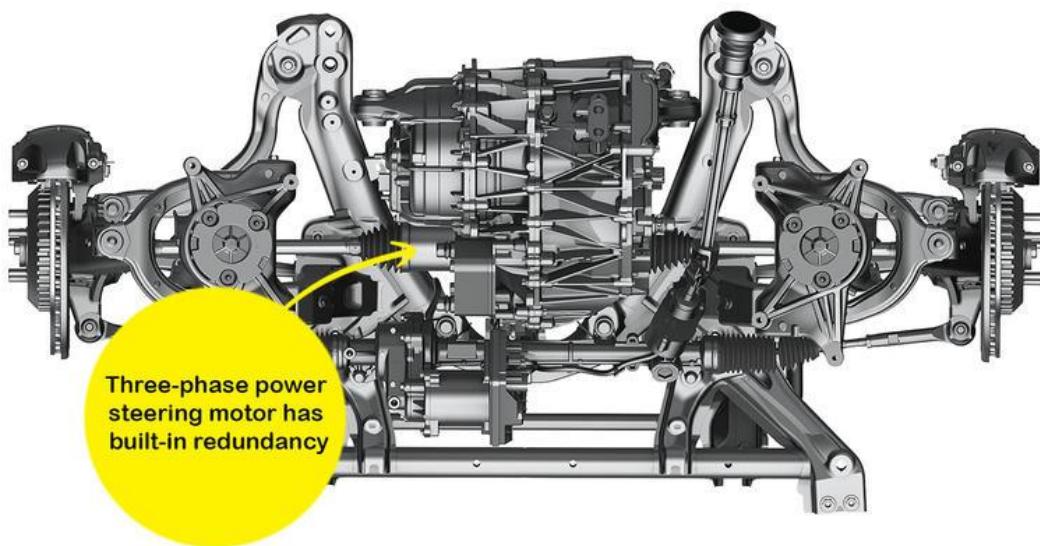


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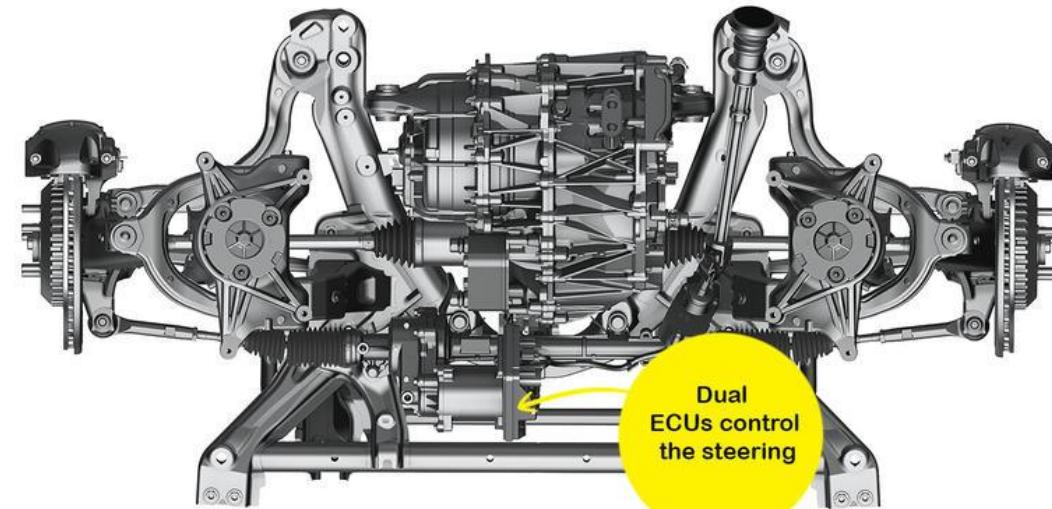


# DRIVE TRAIN AND MECHANICAL SAFETY SYSTEMS

# STEERING

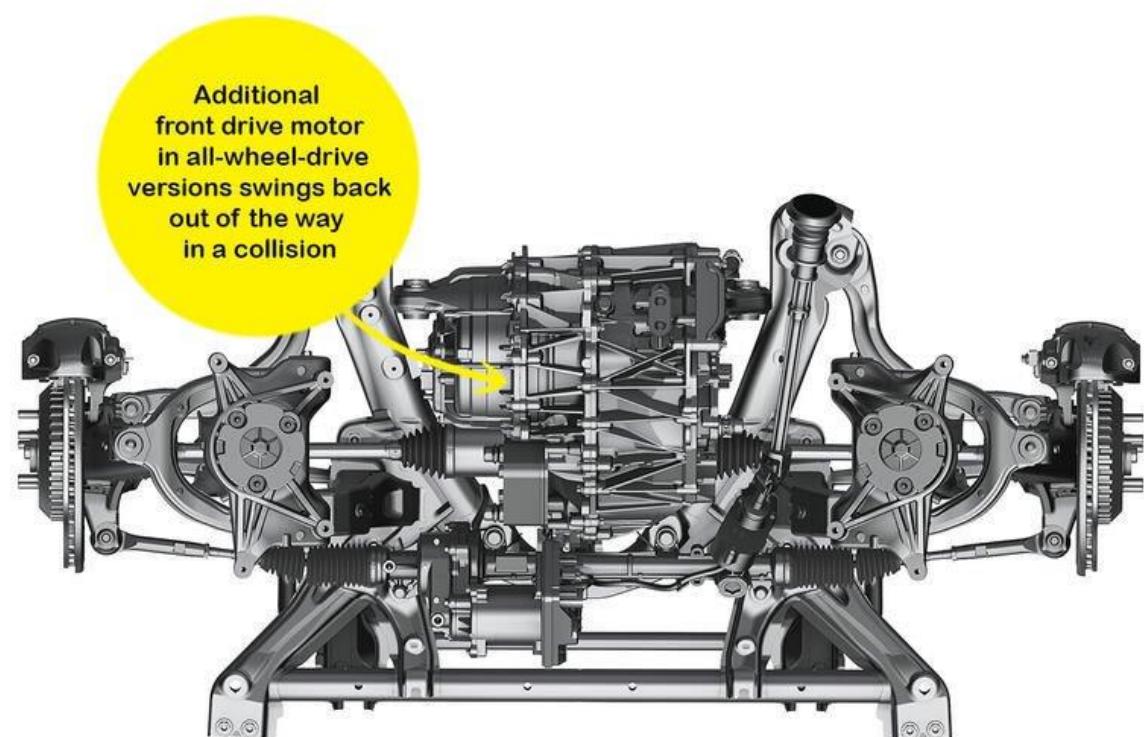
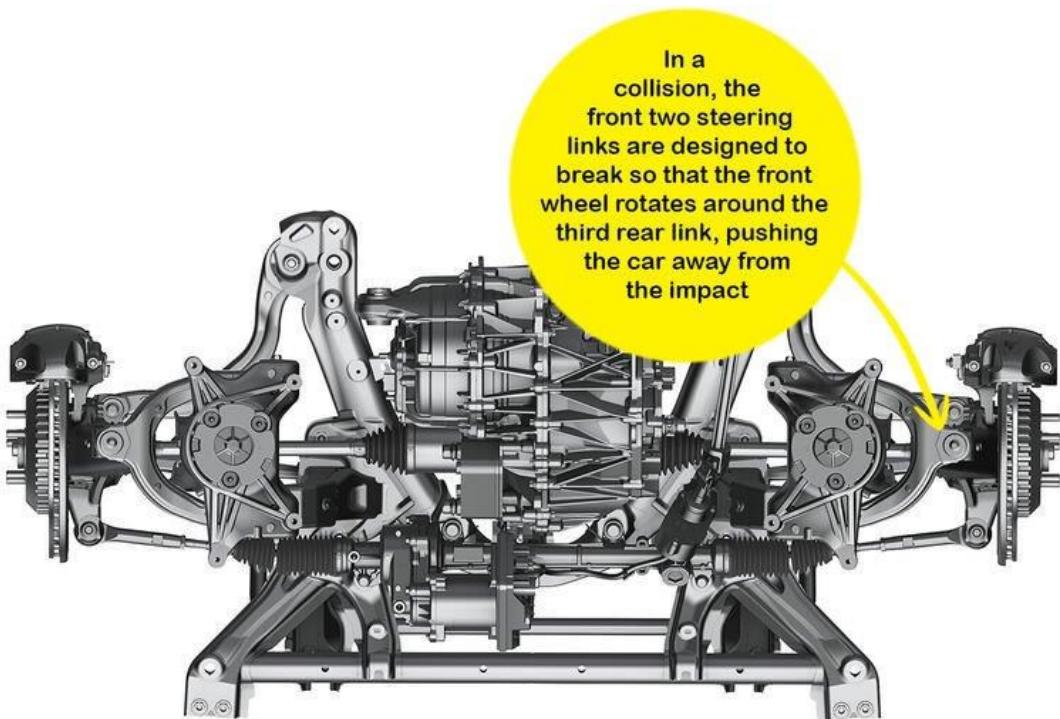


Three-phase power steering motor has built-in redundancy

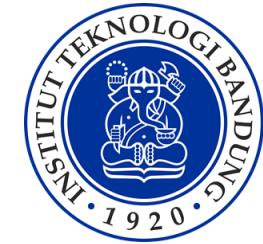


Dual ECUs control the steering

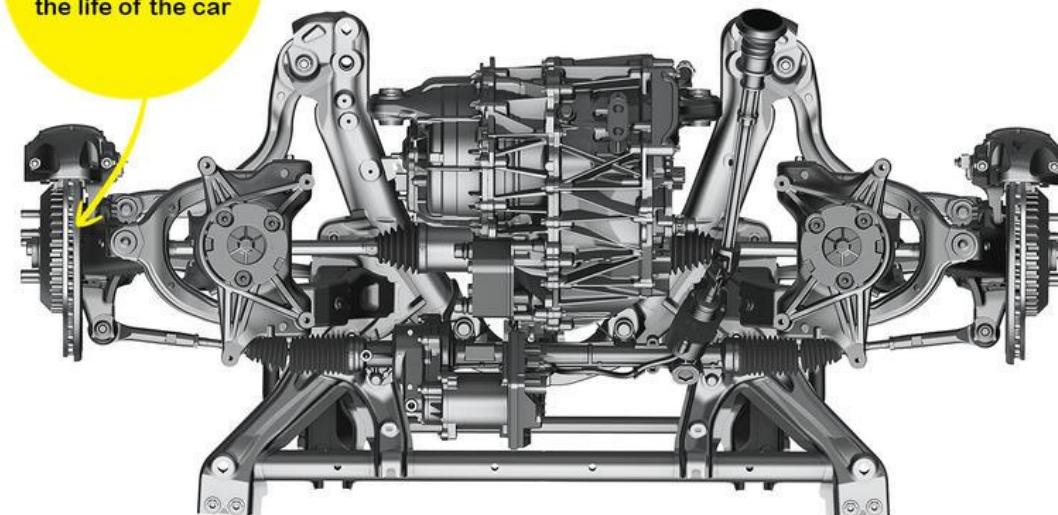
# COLLISION PROTECTION



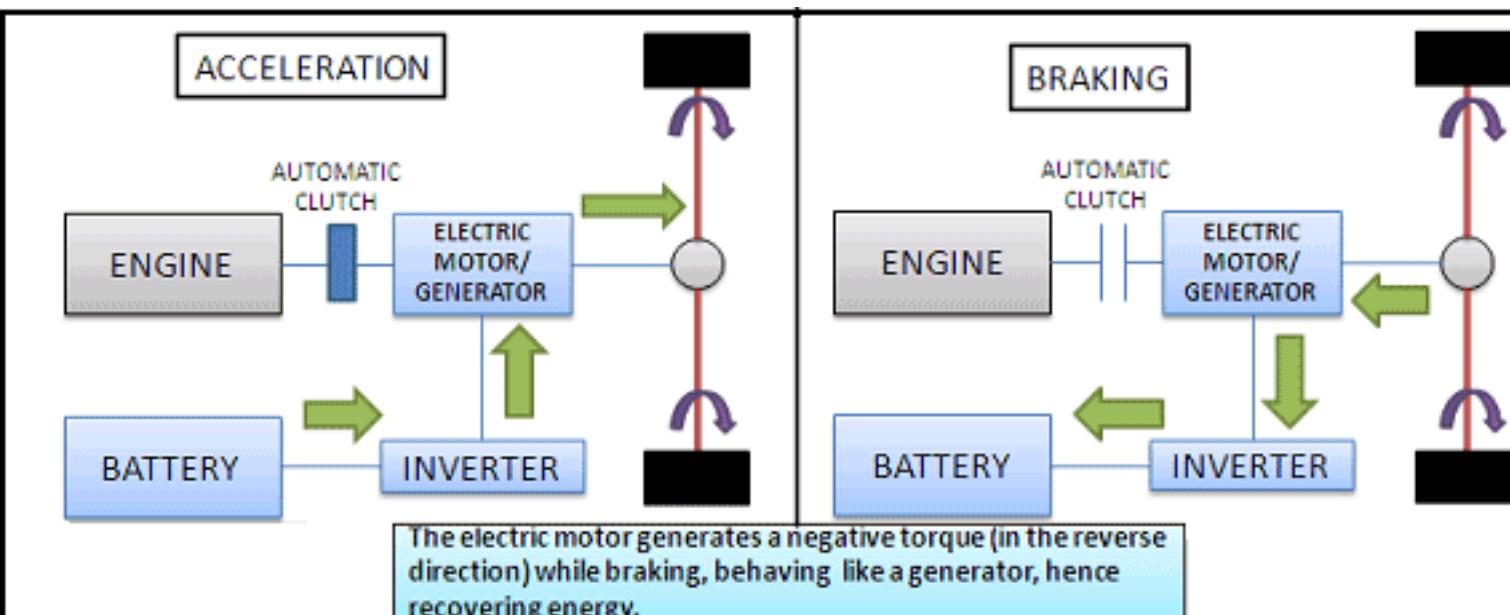
# REGENERATIVE BRAKING SYSTEM



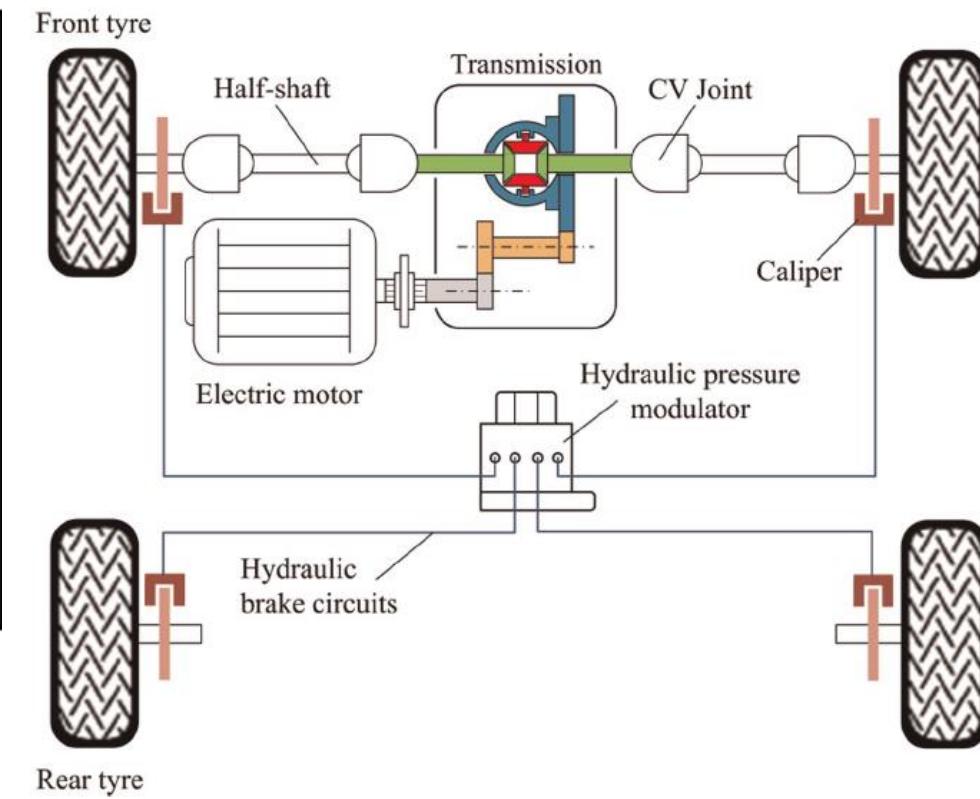
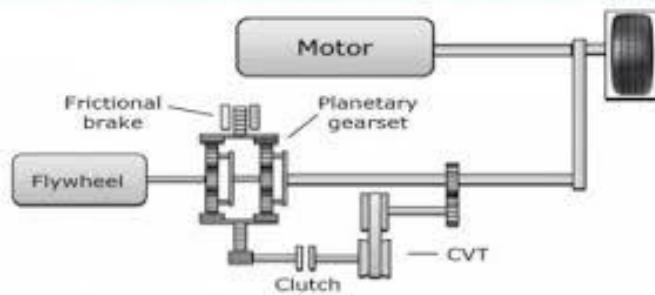
The brake discs and pads are designed to last the life of the car



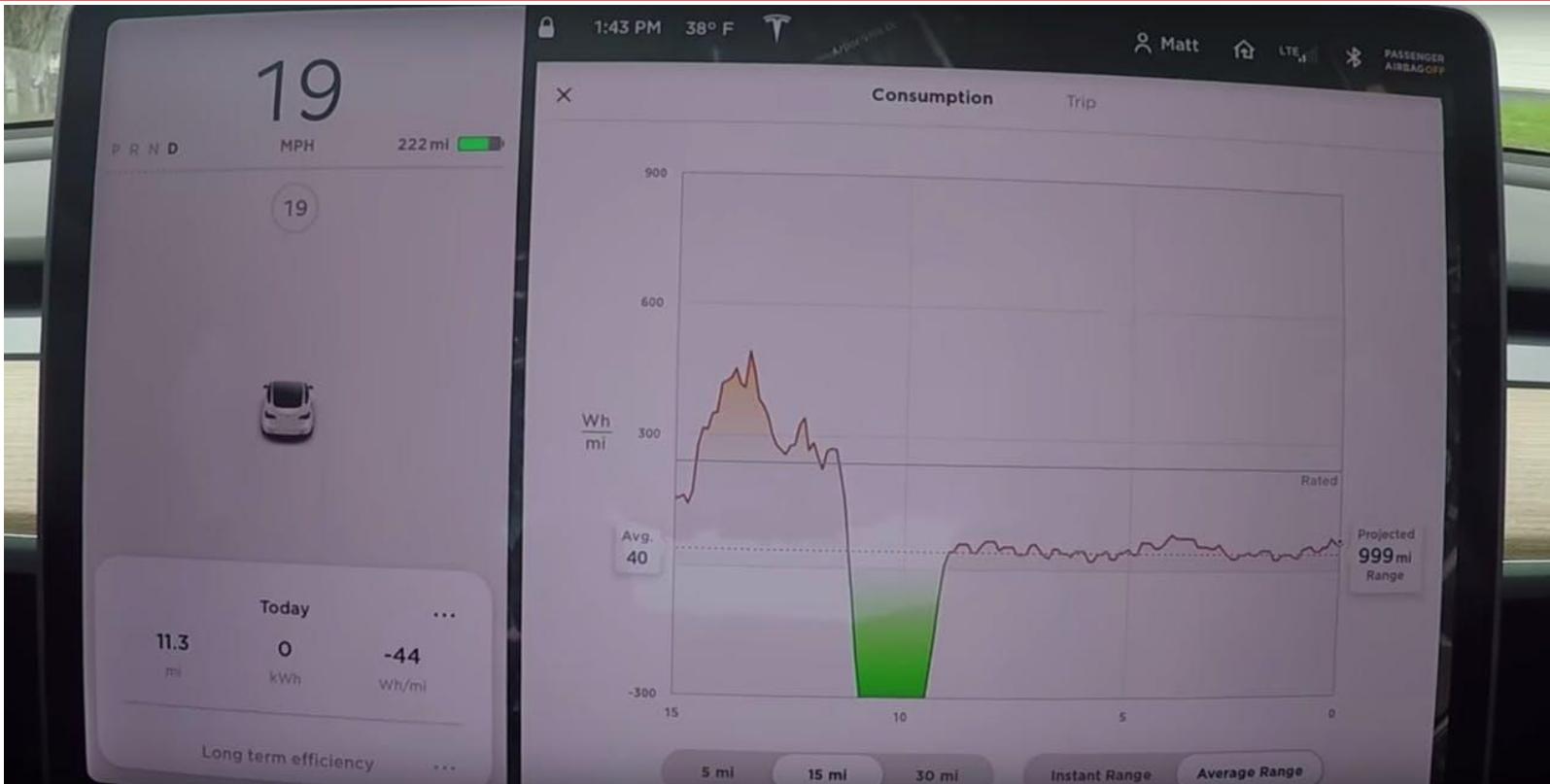
# REGENERATIVE BRAKING SYSTEM



### Flywheel Regenerative Braking



# REGENERATIVE BRAKING SYSTEM



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# WHEELS AND TIRES



18" Tesla Model 3 Aero Wheel



19" Tesla Model 3 Sport Wheel

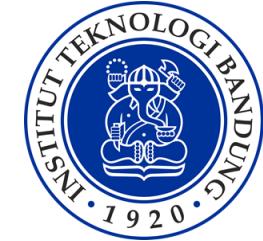


- **Size:** 18X8.5"
- **Offset:** +40
- **PCD:** 5X114.3
- **Center Bore:** 64.1mm
- **Weight:** 21.6 lbs (Without Aero Cover), 23 lbs (With Aero Cover)
- **Lug Nut Spec:** 21mm Hex, 14X1.50 Thread
- **Lug Nut Torque Spec:** 129 lb-ft
- **Price:** **No Charge**
- **Tire Spec:** Michelin Primacy MXM4, 235/45-18, 98W
- **Details:** This is the original base model wheel that comes with every Tesla Model 3 free of charge.

- **Size:** 19X8.5"
- **Offset:** +40
- **PCD:** 5X114.3
- **Center Bore:** 64.1mm
- **Weight:** 25.0 lbs
- **Lug Nut Spec:** 21mm Hex, 14X1.50 Thread
- **Lug Nut Torque Spec:** 129 lb-ft
- **Price:** **\$1,500**
- **Tire Spec:** Continental ProContact RX, 235/40-19, 96W
- **Details:** This is the optional +1 size up sport wheel that costs an additional \$1,500 when ordering a Tesla Model 3.



# WHEELS AND TIRES



20" Tesla Model 3 Sport Wheel



- Size: 20X8.5" Front / Rear
- Offset: +35
- PCD: 5X114.3
- Center Bore: 64.1mm
- Weight: 28.75 lbs
- Lug Nut Spec: 21mm Hex, 14X1.50 Thread
- Lug Nut Torque Spec: 129 lb-ft
- Price: **\$4000 direct from Tesla or \$5000 as a part of the P Model 3 Performance Package**
- Tire Spec: Michelin Pilot Sport 4S, 235/35-20 92Y Front / Rear
- Details: This Sport Wheel is available for purchase effective March 20, 2018 from the Tesla Store as a Wheel & Tire Package . It is also included in the \$5,000 Performance Package Option on the P Model 3.

Specs:	Value:
Sidewall	BSW
Load Index	92
Speed Rating	Y
Ply Rating	Not Available
UTQG	300AAA
Max Single Load(lbs)	1389
Max Single Air Pressure(PSI)	50
Tread Depth	9.5
Tread Design	Not Available
Rim Width Range	8.0-9.5
Measured Rim Width	8.5
Section Width	9.5
Tread Width	8.5
Overall Diameter	26.5
Manufacturer Part Number	33211

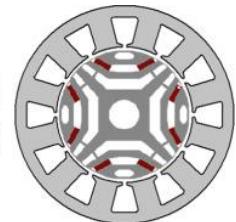
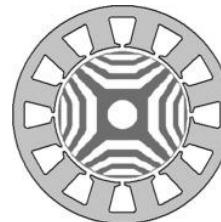
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DRIVE UNIT

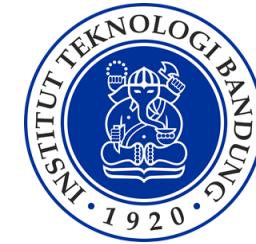
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# PERMANENT MAGNET SWITCHED RELUCTANCE MOTOR



TESLA

# PERMANENT MAGNET SWITCHED RELUCTANCE MOTOR



Powertrain	RWD	AWD Performance	Torque	376 lb·ft (510 N·m)	471 lb·ft (639 N·m)
Motor	permanent magnet switched reluctance rear	permanent magnet switched reluctance rear & induction front	Torque	376 lb·ft (510 N·m)	471 lb·ft (639 N·m)
Curb Weight	3,552 lb (1,611 kg)	4,072 lb (1,847 kg)			
Power	283 hp (211 kW)	473 hp (353 kW) combined 283 hp (211 kW) rear & 197 hp (147 kW) front			

TESLA



**ENERGY STORAGE  
SYSTEM, BATTERY  
MANAGEMENT  
SYSTEM,  
ELECTRICAL SYSTEM,  
AND UTILITIES**

# ENERGY STORAGE SYSTEM



STAGE 1  
2009 - 2012

STAGE 2  
2016 - 2018

STAGE 3  
2018 -

Model 3 2170 Cell:

- Weight: 70 grams
- Volume: 970 mm<sup>3</sup>
- Capacity: 4.8Ah / 17.3 Wh
- Density: 247 Wh/kg

Model S/X 18650 Cell:

- Weight: 45 grams
- Volume: 660 mm<sup>3</sup>
- Capacity: 3.0 Ah / 10.8 Wh
- Density: 240 Wh/kg

STAGE 1

2009 - 2012

COBALT: 11 KG  
GRAPHITE  
ANODE

STAGE 2

2016 - 2018

7 KG  
GRAHITE + SILICON  
5-15% SILICON OXIDE

STAGE 3

2018 -

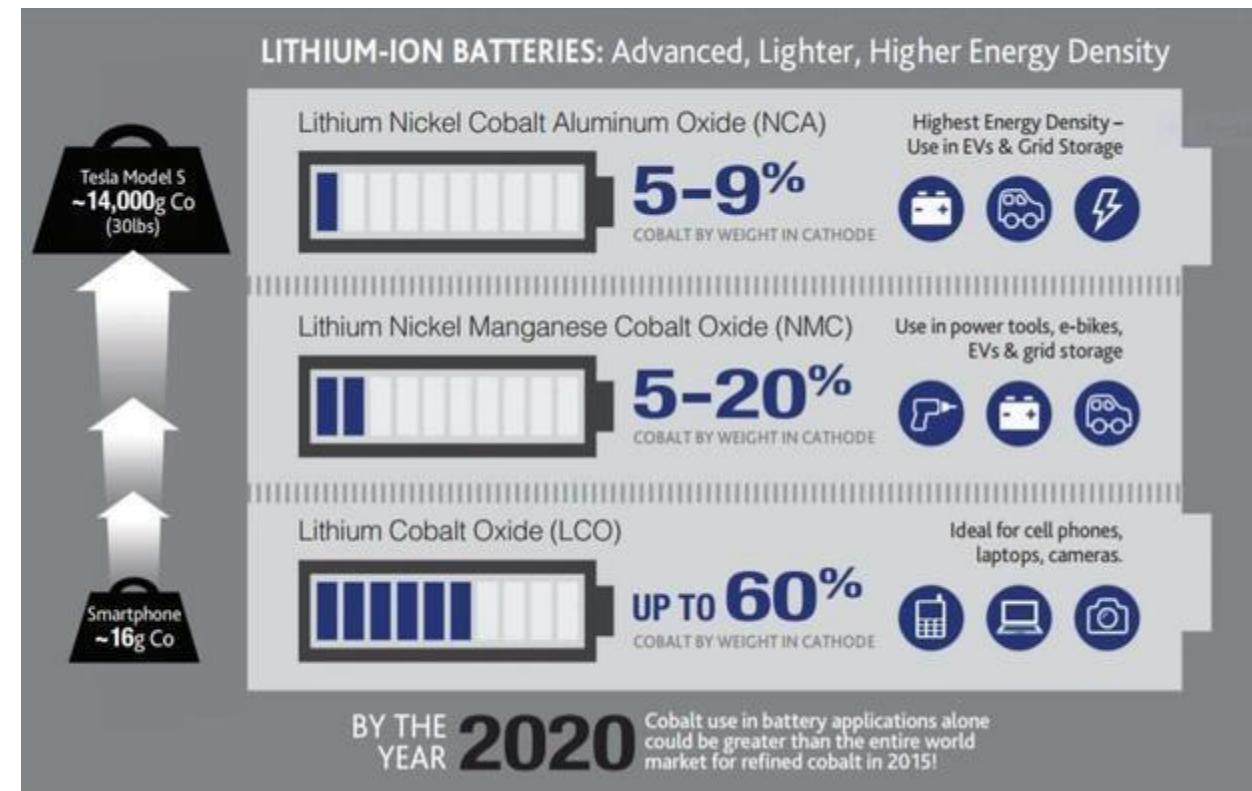
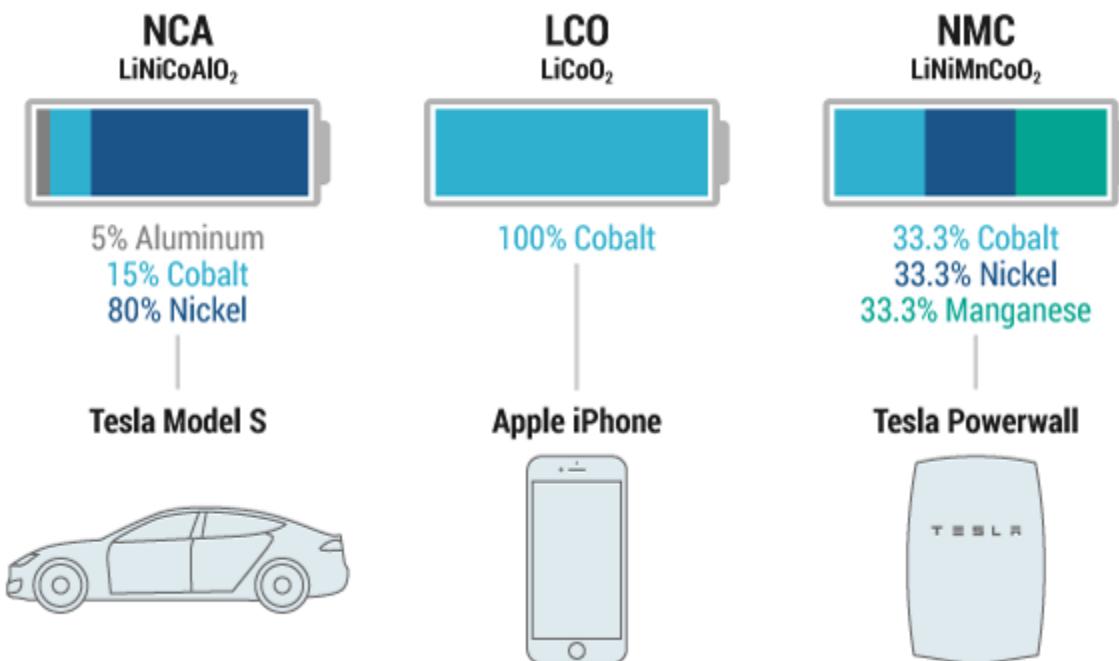
- 21700 BATTERY  
STAGE 3

- 18650 BATTERY  
higher silicon content than their stage 2  
batteries. STAGE 1 + 2



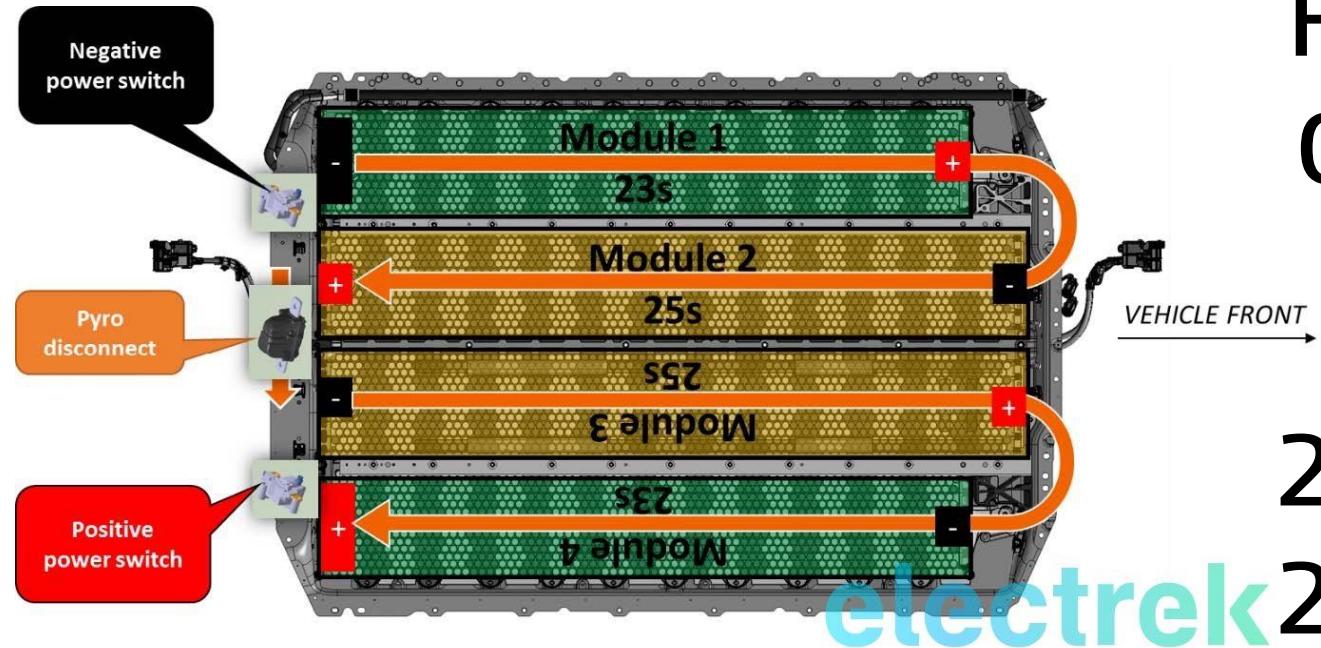
The 2170 cell is around 50% larger by volume than the 18650, but it can deliver almost double the current (the 18650 delivers 3,000 mA, and the 2170 has been tested at 5,750-6,000 mA).

# ENERGY STORAGE SYSTEM



The new patent focuses on a new battery cell using two additives in the electrolyte, vinylene carbonate (VC) combined with 1,2,6-oxodithiane-2,2,6,6-tetraoxide, in order to boost the performance of the cell.

# ENERGY STORAGE SYSTEM



## High-voltage Electrical Controller and Cooling System

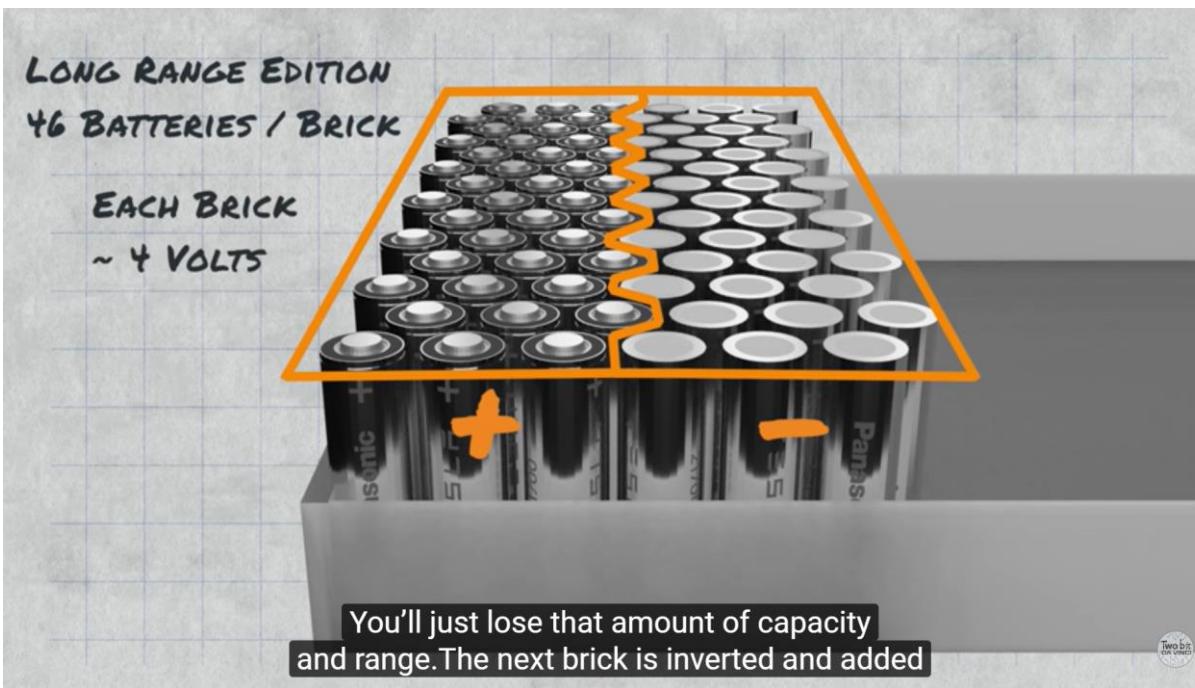
2 Modules of 23 Bricks  
2 Modules of 25 Bricks

18650->2170 →

2,976 to 4416 Cells in groups of  
31 to 46 Cells per "brick"

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# ENERGY STORAGE SYSTEM



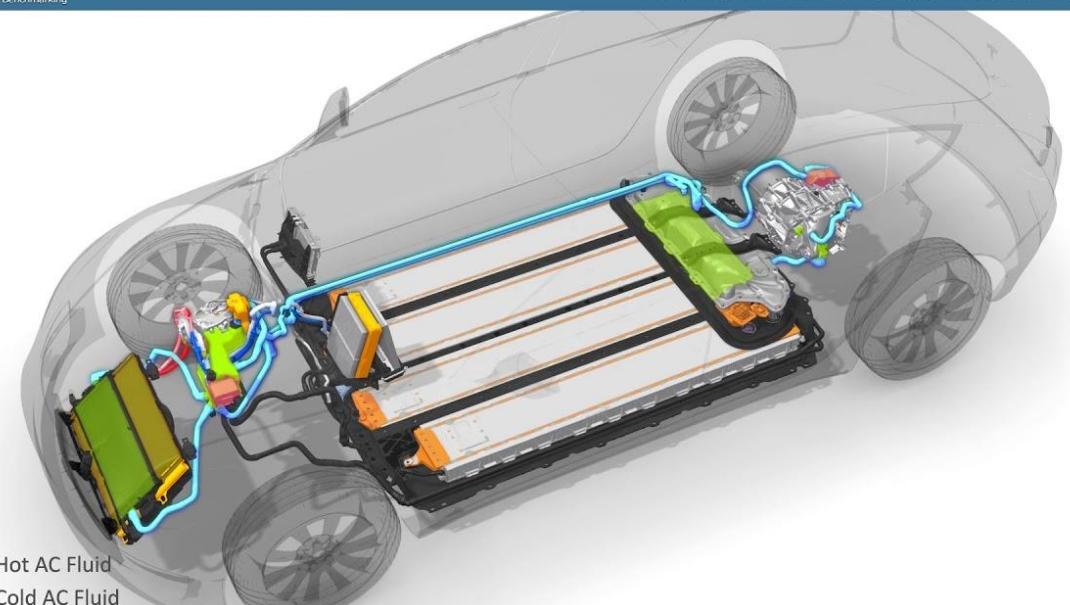
# ENERGY STORAGE SYSTEM



"This battery is glued together like no one would believe"- Munroe and Associates

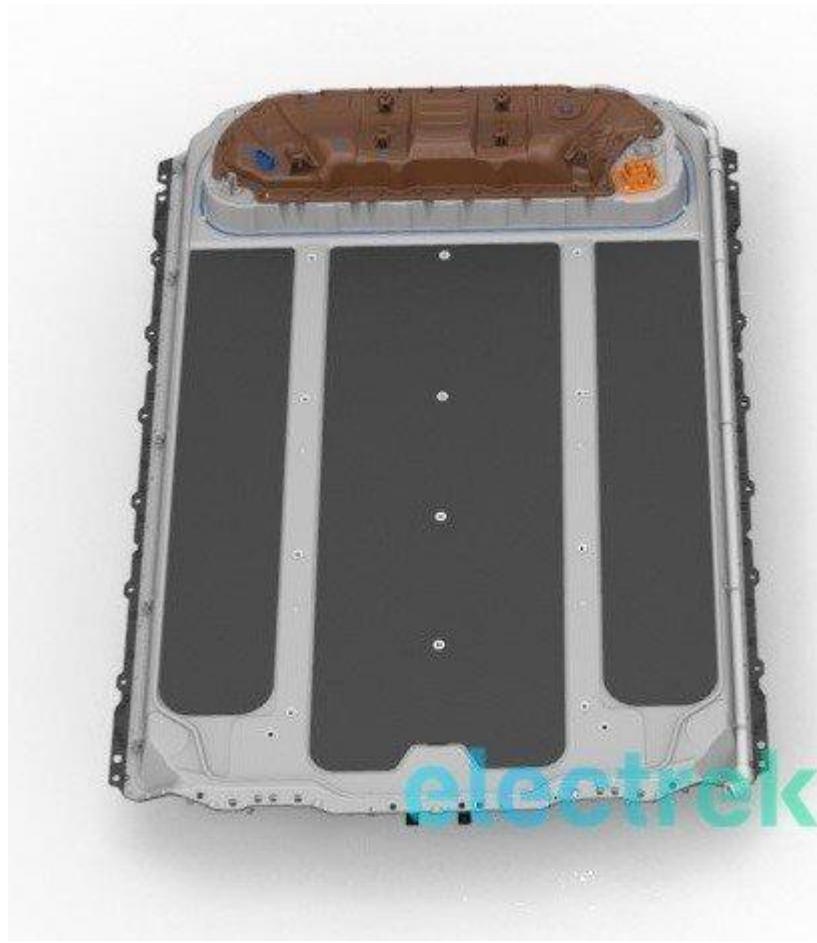
A2maci  
Automotive Benchmarking

TESLA MODEL 3 COOLING SYSTEM



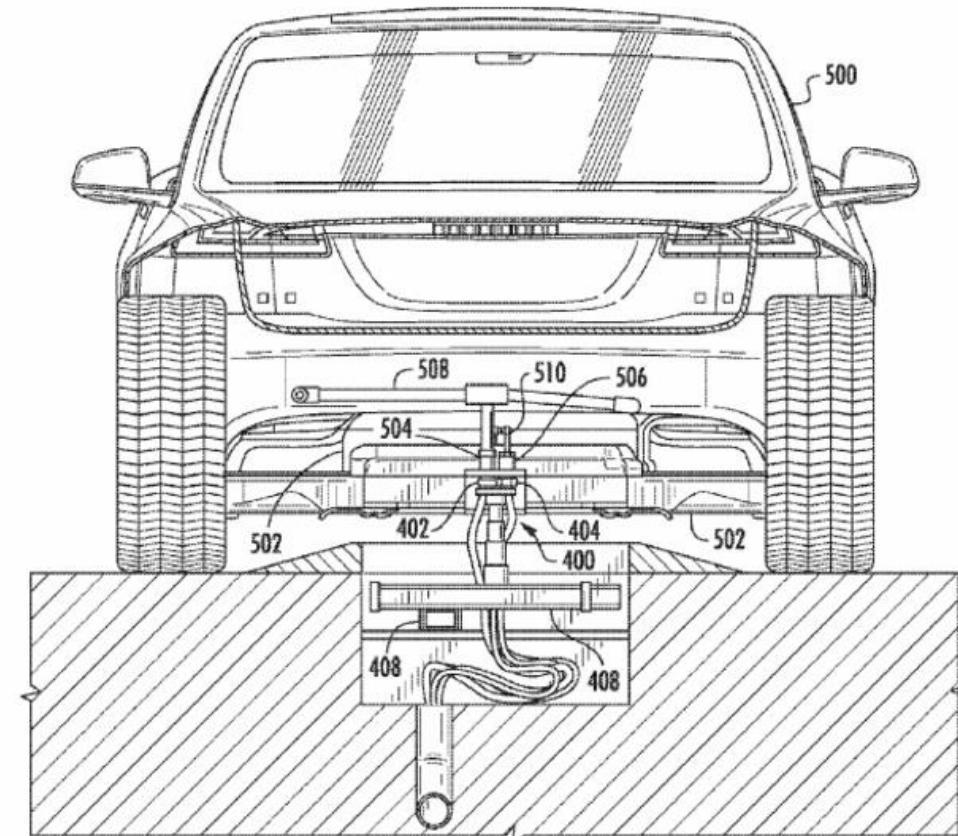
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# ENERGY STORAGE SYSTEM



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# AUTOMATED CHARGING WITH EXTERNAL COOLING



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# AUTOMATED CHARGING WITH EXTERNAL COOLING

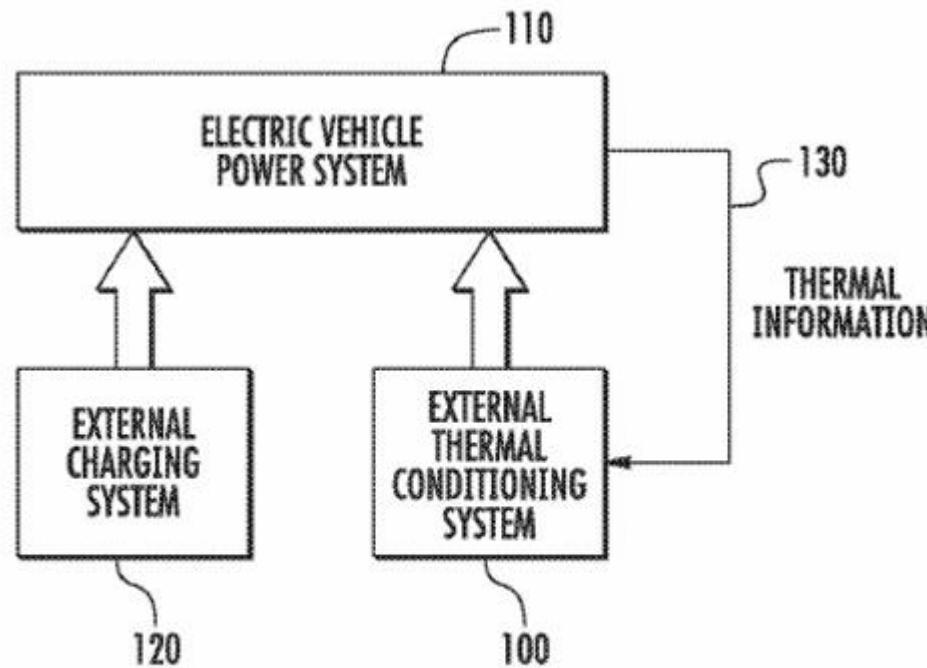


FIG. 1

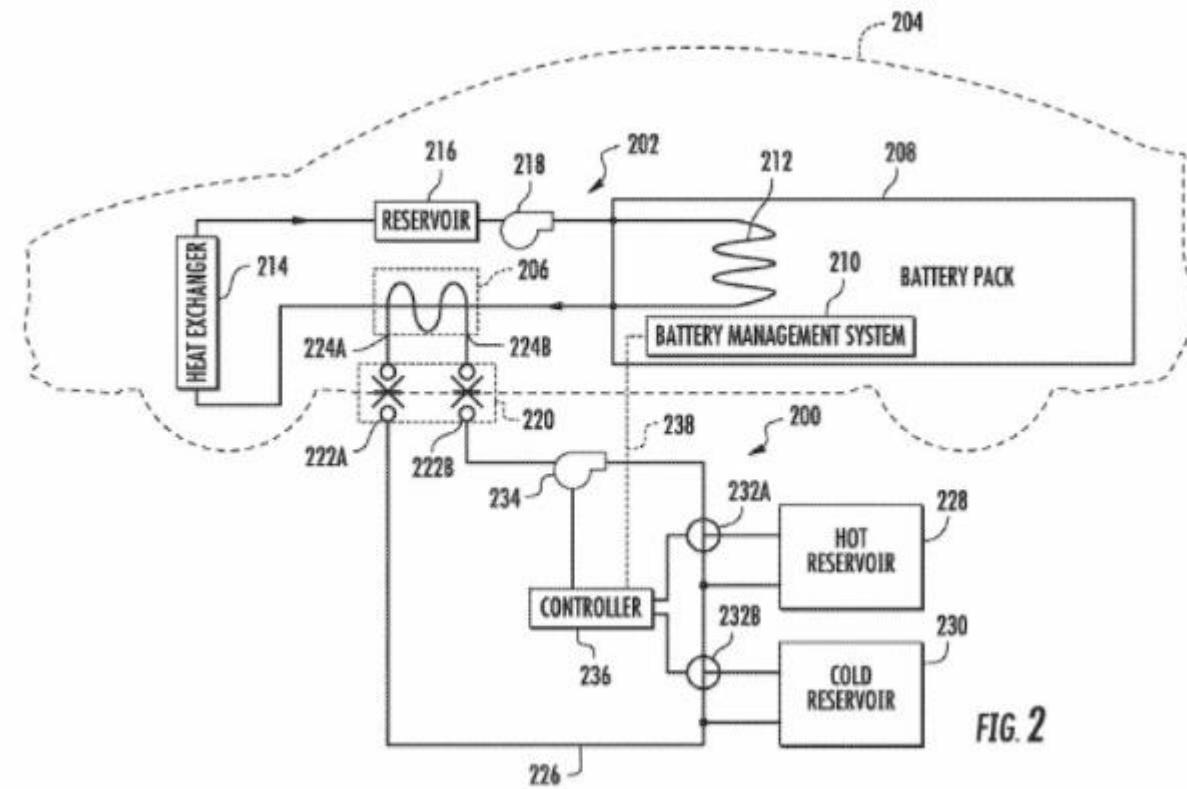


FIG. 2

# AUTOMATED CHARGING WITH EXTERNAL COOLING

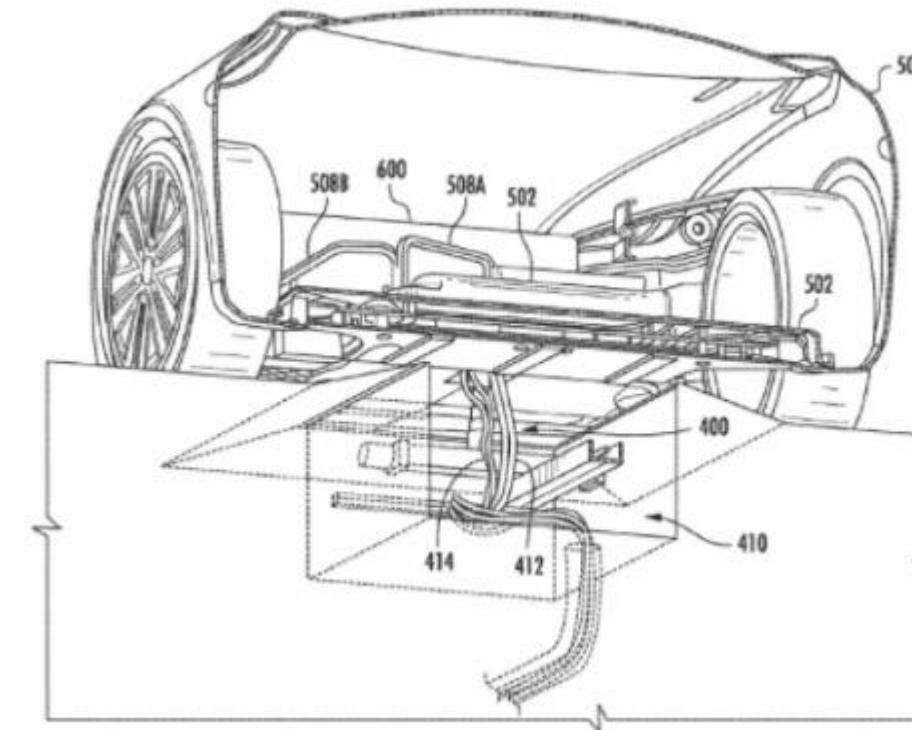


FIG. 6

TESLA

# ENERGY STORAGE SYSTEM COOLING SYSTEM

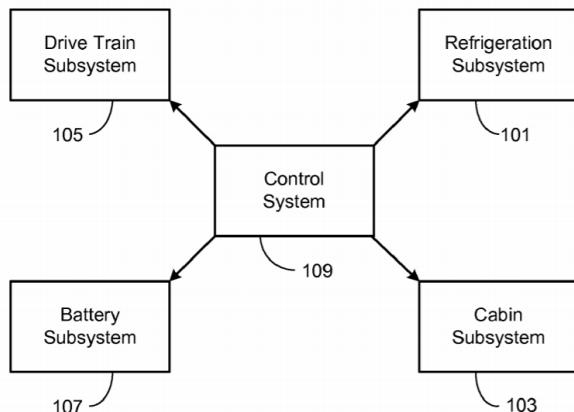


FIG. 1

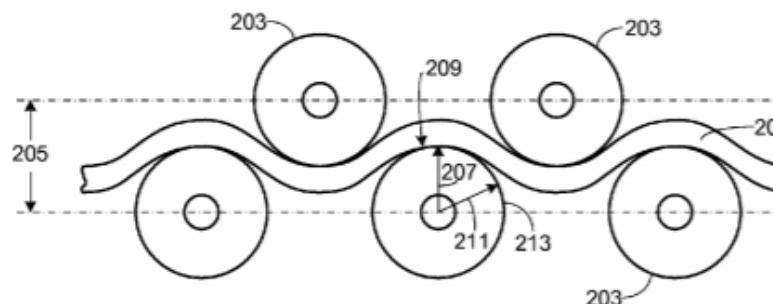
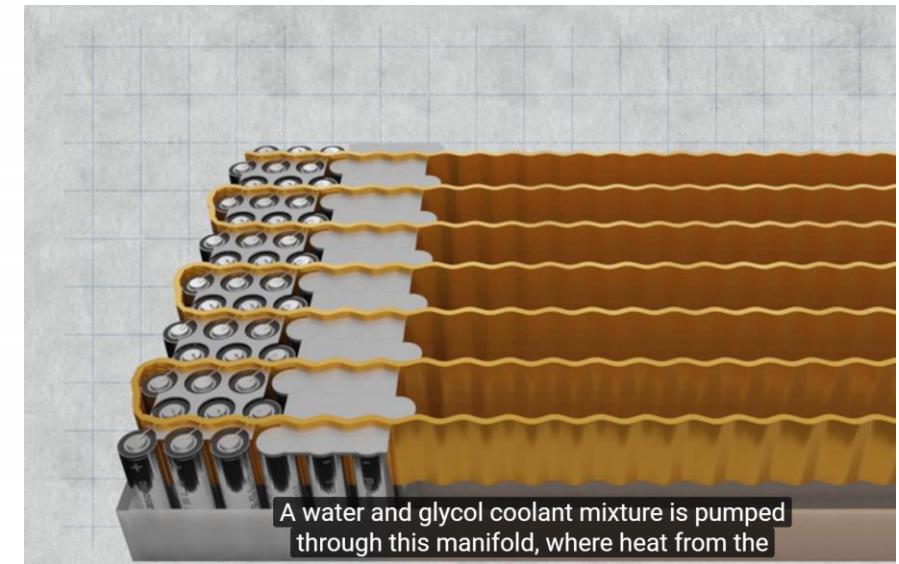


FIG. 2



# ENERGY STORAGE SYSTEM COOLING SYSTEM

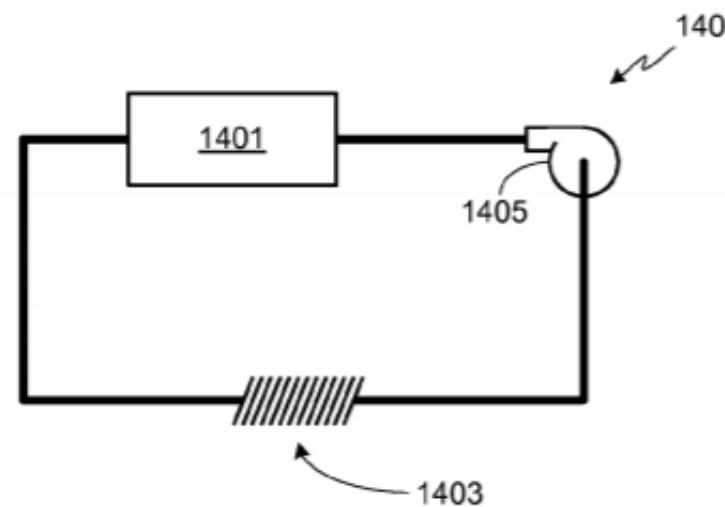
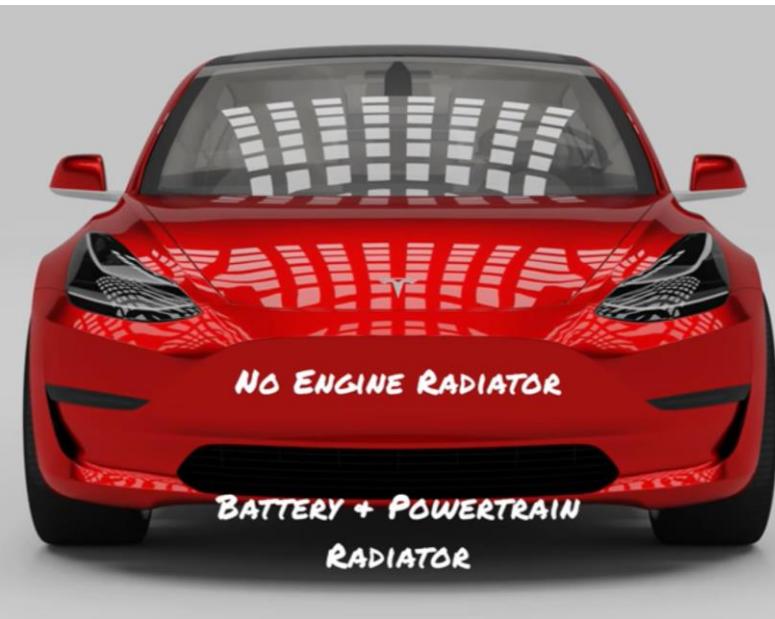
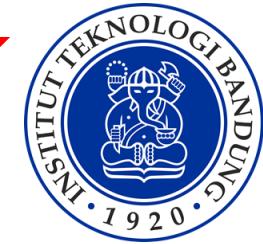


FIG. 14

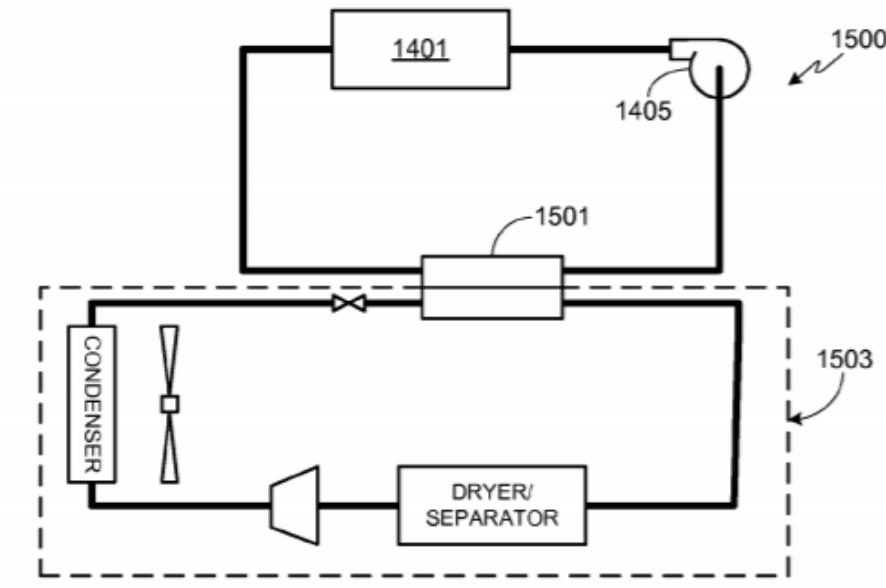
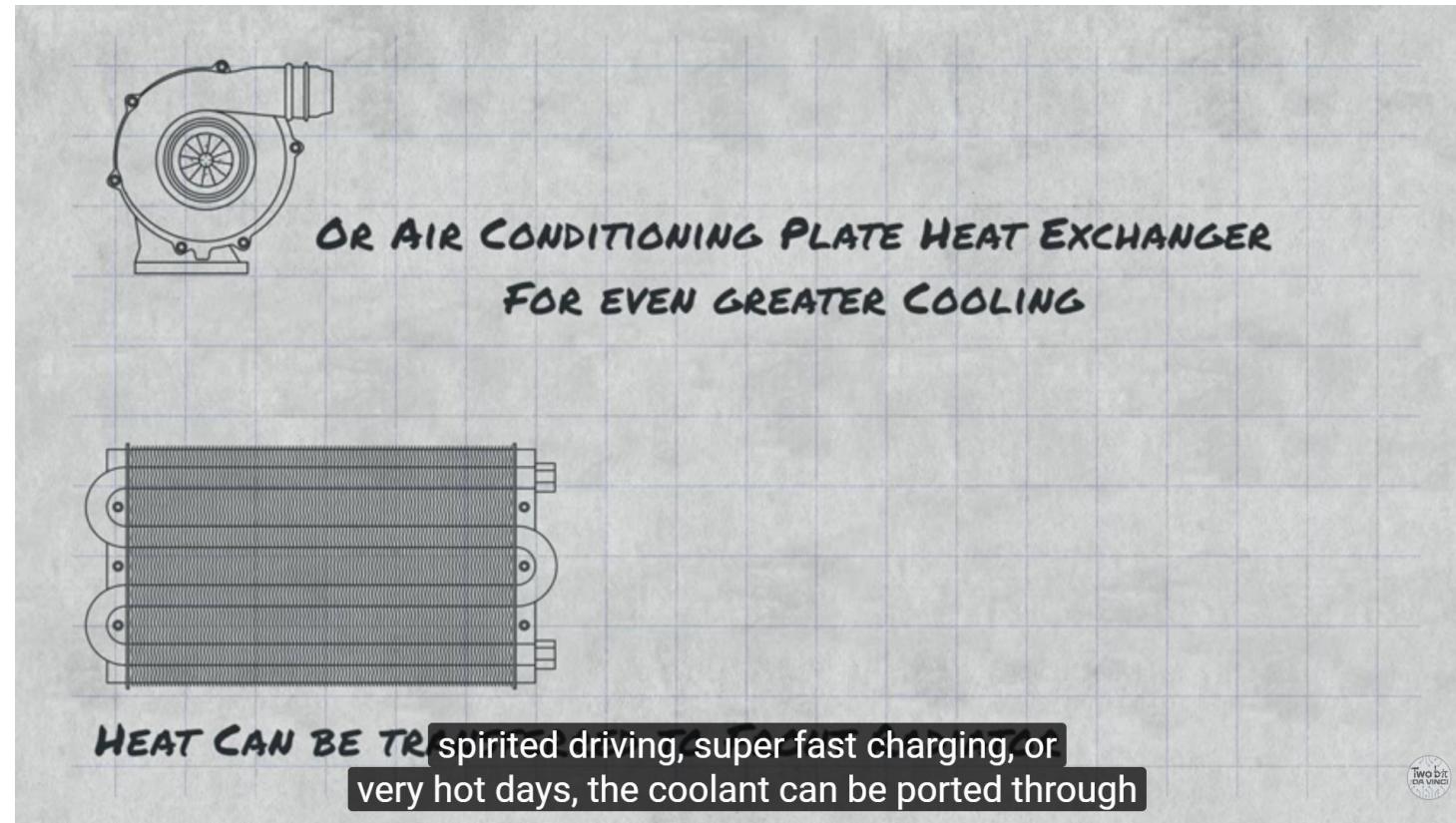
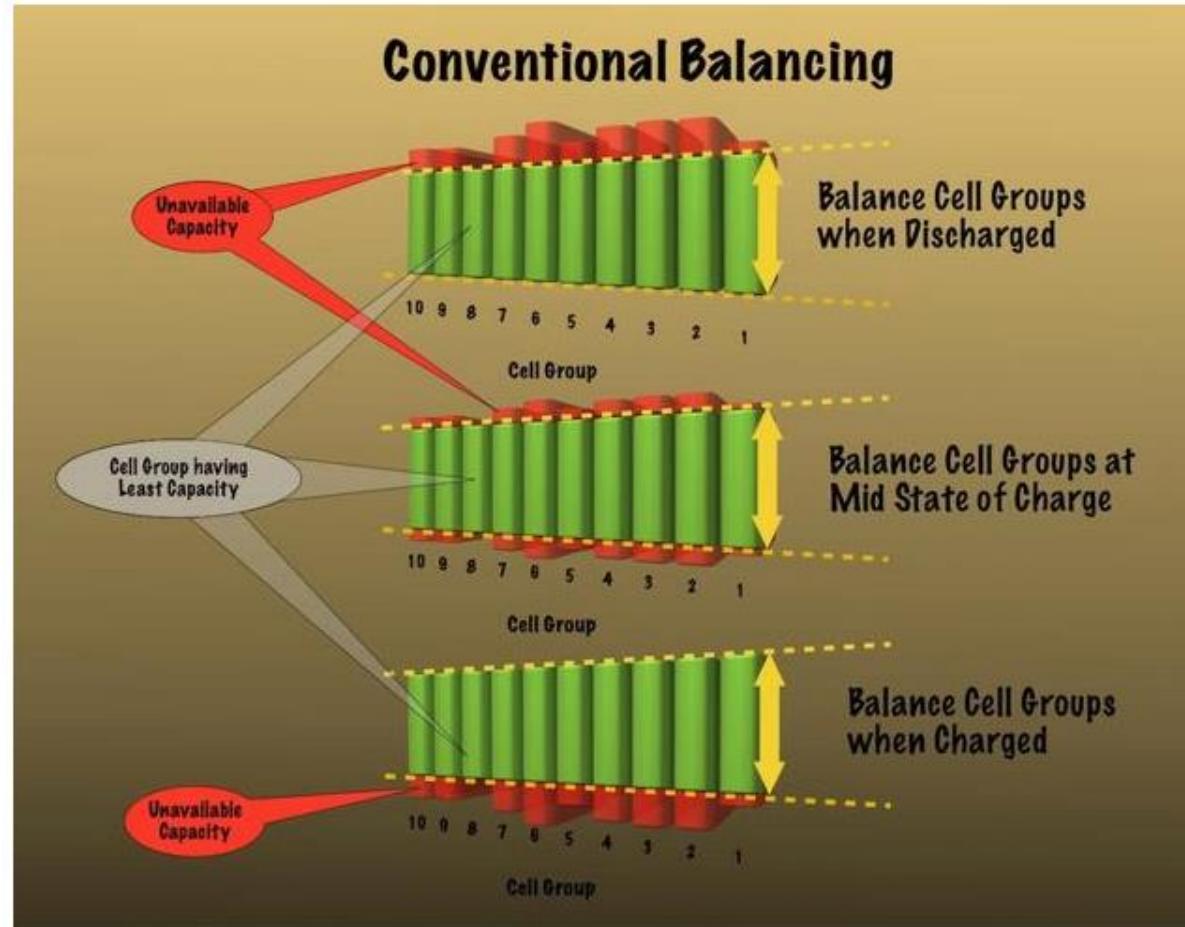
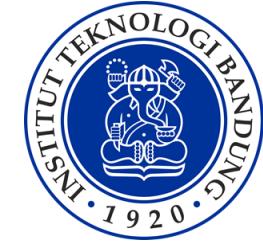


FIG. 15

# ENERGY STORAGE SYSTEM COOLING SYSTEM



# BATTERY MANAGEMENT SYSTEM - BALANCING

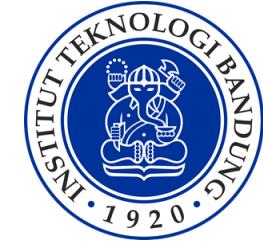


However we choose to balance the battery, the maximum amount of capacity available for discharging or charging is that of the cell group with the *least* capacity. Attempting to use the capacity of cell groups having greater capacity than the group with the least capacity will cause overcharging and/or over-discharging of the weakest cell group and ultimately failure of the battery.

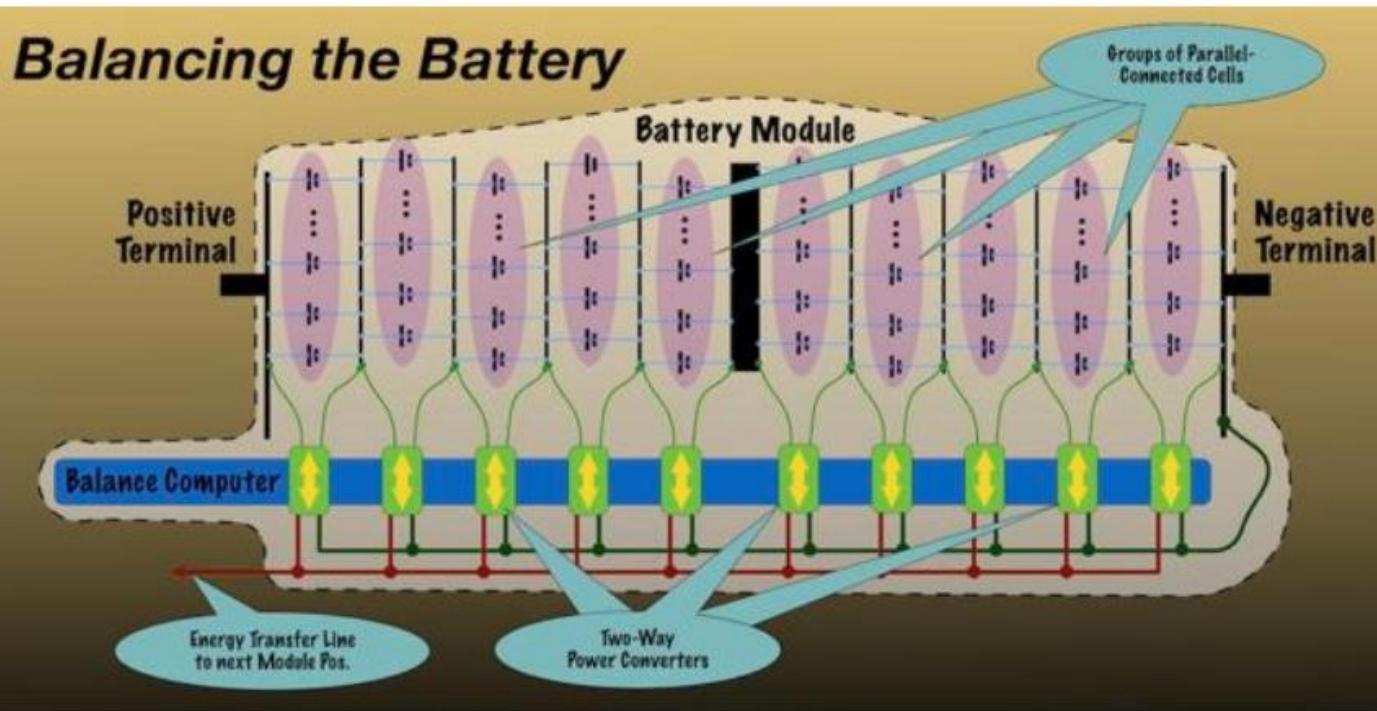
## Matching Cell Groups

If all cell groups have the same capacity, unavailable capacity is minimized - and one gets the most 'battery' for the weight and cost of the cells used. To match cell group capacity, each cell is measured by cycling it from fully discharged to fully charged on a testing machine. Then cells are sorted into groups of equal capacity. This capacity matching procedure allows the battery to store nearly as much energy as can possibly be stored in the combined cells it contains.

# BATTERY MANAGEMENT SYSTEM - BALANCING

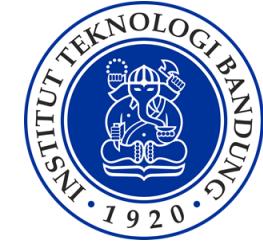


## Balancing the Battery

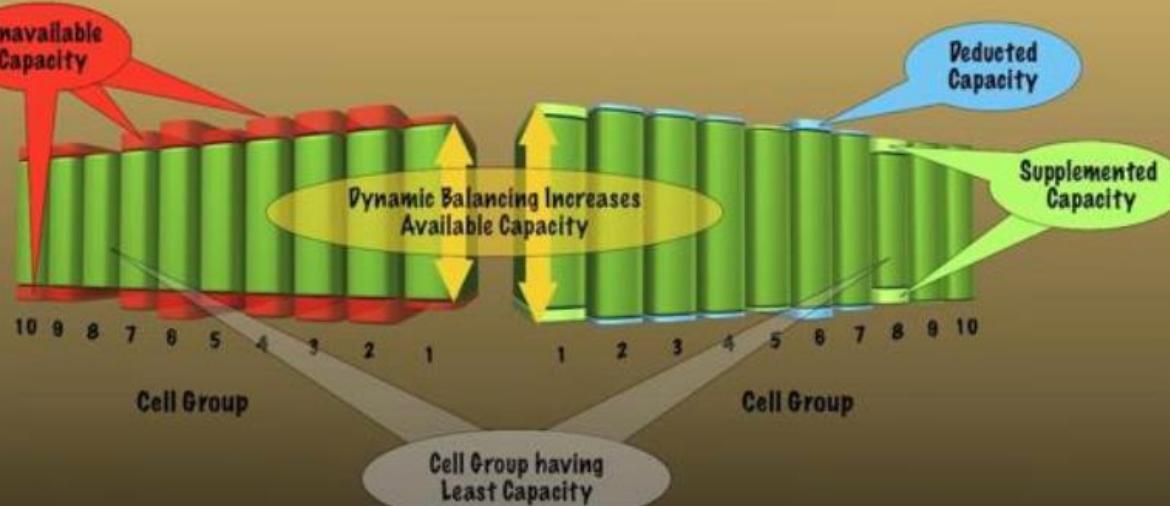


There is another way to balance cell groups within a lithium battery, that with advances in power electronics is now practical. If excess capacity in higher capacity cell groups is not simply bled away, but rather transferred to cell groups of lesser capacity, the SOC of cell groups can be maintained in balance continuously as the entire battery is charged and discharged. This works even if cell group capacity is not tightly matched because energy is shuttled between higher and lower capacity cell groups such that the capacity of each cell group - whatever it may be - is fully utilized. A battery module with this kind of balancing scheme might be arranged as in the following figure.

# BATTERY MANAGEMENT SYSTEM - BALANCING



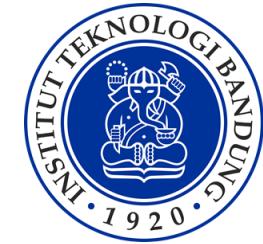
## Conventional Balancing vs. Dynamic Balancing



Conventional balancing only allows battery capacity of the cell group having the smallest capacity to be utilized. Cell groups with more capacity can never be fully charged and discharged without over charging/discharging the weakest cell group.

Dynamic balancing, on the other hand, shuttles energy between cell groups as the battery is charged and discharged so that all the capacity of all cell groups is effectively useable. If power converter efficiency is sufficiently high and the differences in capacity between cell groups is not too large, dynamic balancing can eliminate the need to match the capacity of cell groups, thus simplifying battery module manufacturing and reducing cost. But the really big cost savings require one final step.

# BATTERY MANAGEMENT SYSTEM - BALANCING



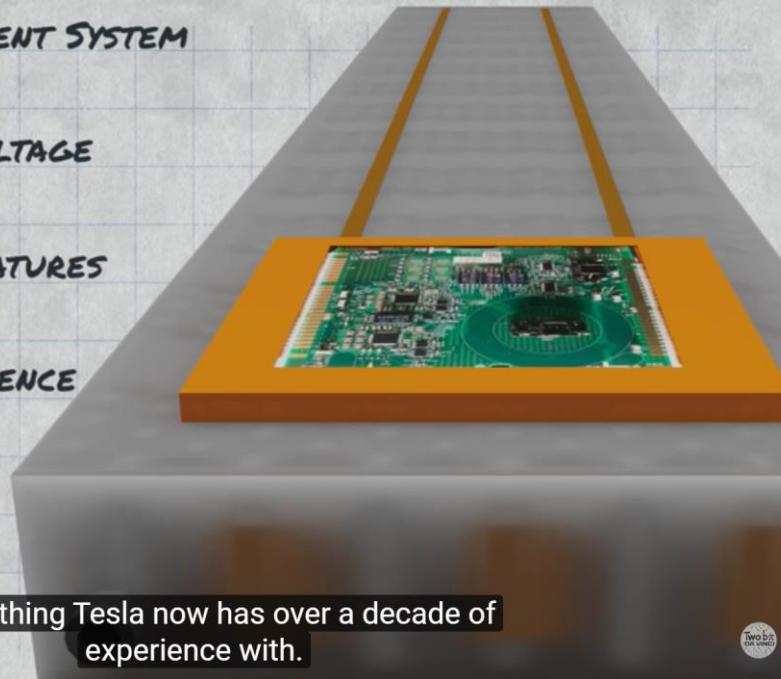
BATTERY MANAGEMENT SYSTEM  
(BMS)

MONITORS CELL VOLTAGE

MONITORS TEMPERATURES

10+ YEARS OF EXPERIENCE  
WITH BMS'S

is something Tesla now has over a decade of  
experience with.



There are individual BMSs for each of the  
four battery modules.



TESLA

# MULTI-CHANNEL AND BI-DIRECTIONAL BATTERY MANAGEMENT SYSTEM

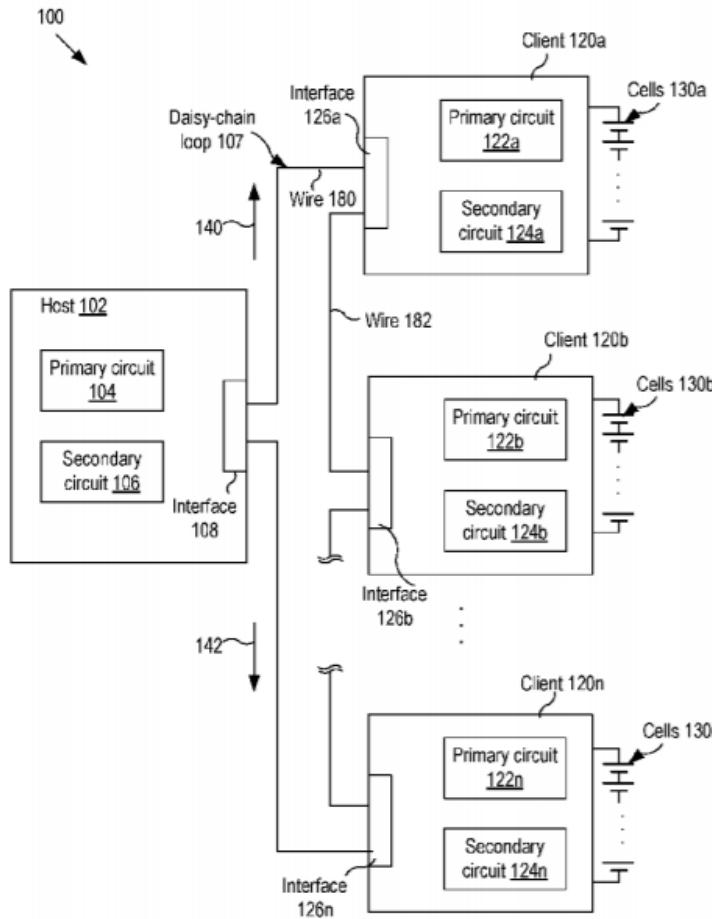
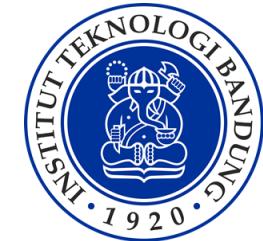
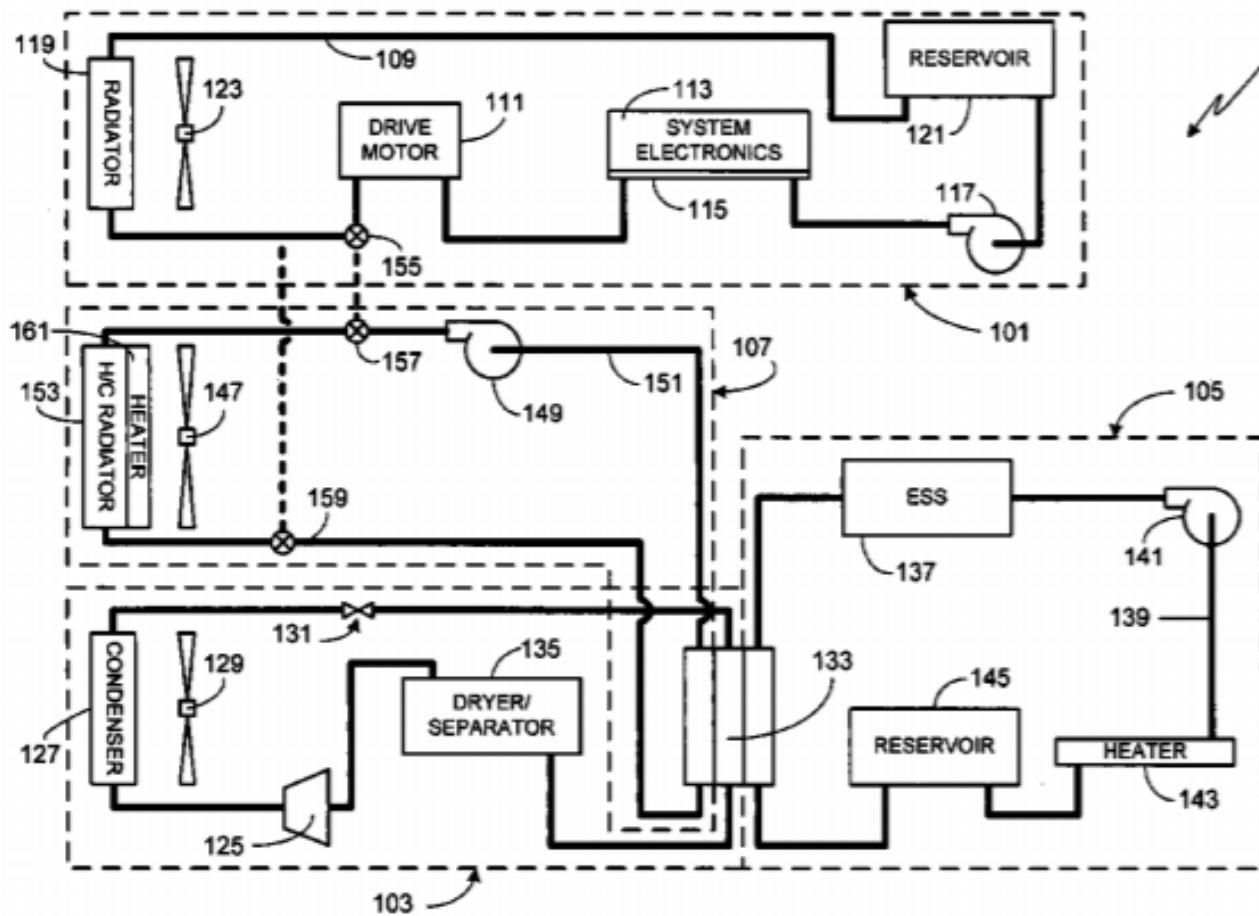
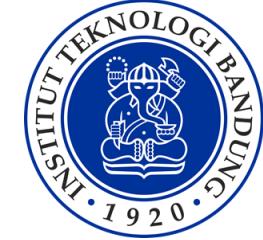


FIG. 1

**(57) Abstract:** Embodiments of the present invention include a battery management system that provide a plurality of channels that allow communication between host and clients. This communication may operate in bi-directional modes such that commands from the host and responses from the clients are transmitted clockwise or counter-clockwise around a daisy-chain loop. This architecture provides both a high level of redundancy across multiple channels as well as transmission directions around the loop. The use of multiple channels provides a separation in signal paths akin to the provision of completely separate physical wires, preventing malfunction of spurious operation of devices using one channel from interfering with the normal operation of devices using the other channel. In addition, the signaling architecture allows a host to dynamically transmit commands and receive responses between specific client(s) and host or broadcast communication across all clients.

# THERMAL MANAGEMENT SYSTEM

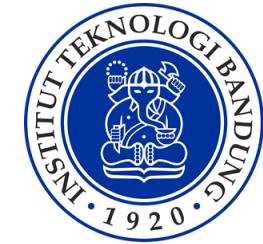


(57)

## ABSTRACT

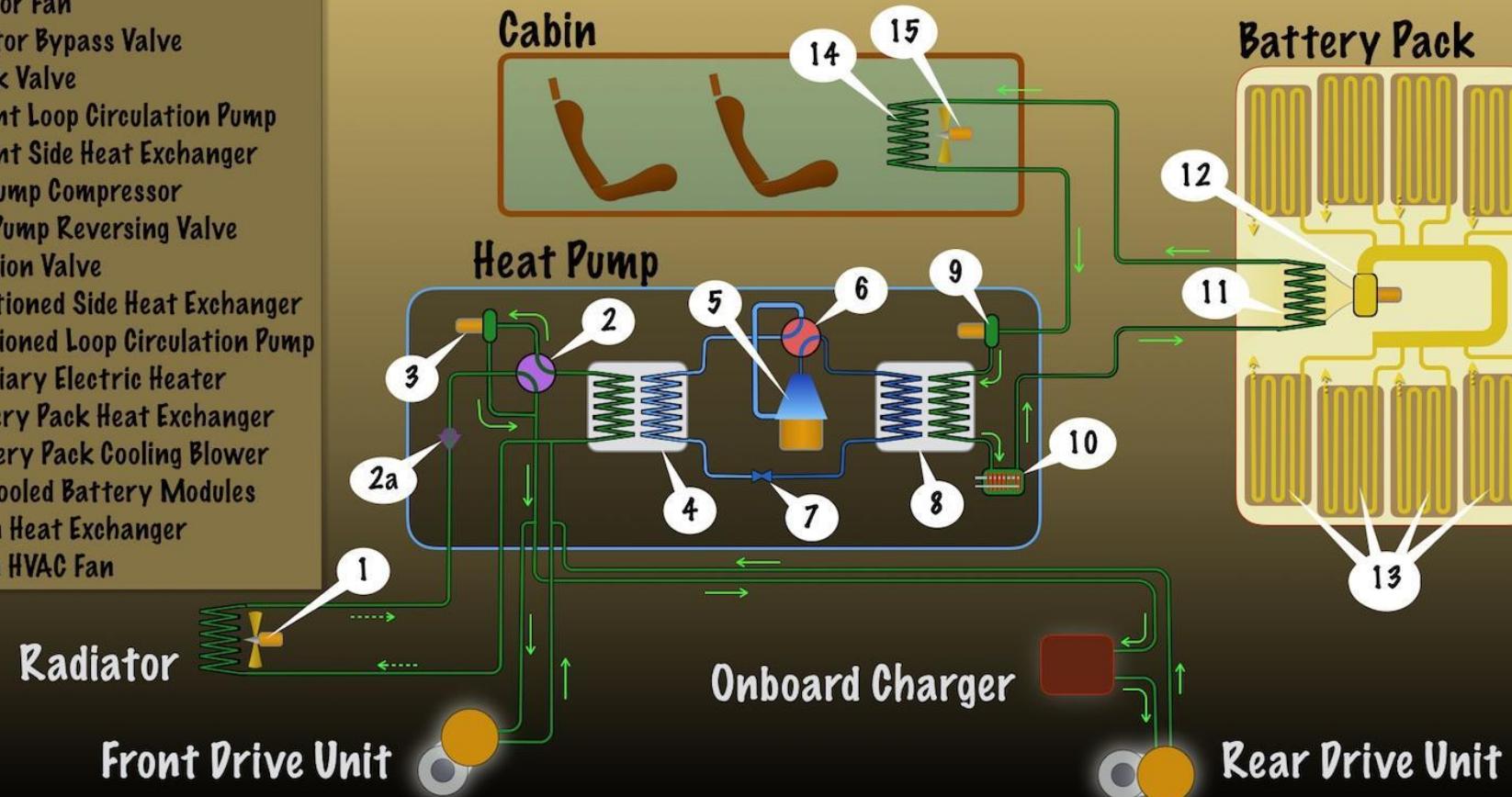
A method for managing thermal loads within an electric vehicle using an efficient thermal management system (100) that utilizes a single heat exchanger (133) is provided. A refrigeration subsystem (103) cools the heat exchanger (133). A first coolant loop (139) in thermal communication with the heat exchanger (133) is used to cool the energy storage system (137). A second coolant loop (151) corresponding to the HVAC subsystem (107) is also in thermal communication with the heat exchanger (133). Preferably a third coolant loop (109) corresponding to the drive motor cooling subsystem (101) is coupleable to the HVAC coolant loop (151), thus providing an efficient means of providing heat to the HVAC subsystem (107).

# THERMAL MANAGEMENT SYSTEM



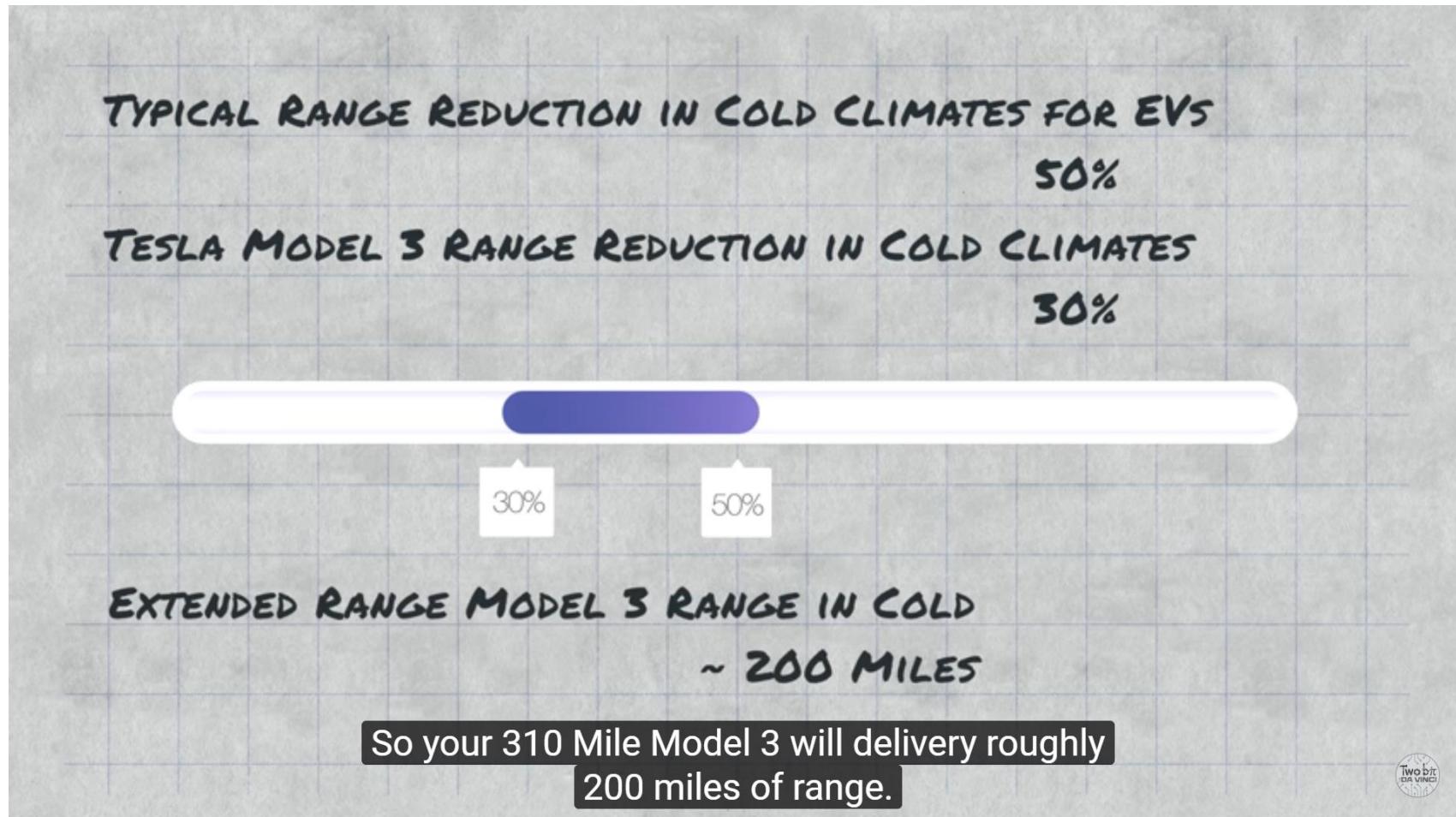
## Model ≡ Simplified Thermal Control

- 1. Radiator Fan
- 2. Radiator Bypass Valve
- 2a. Check Valve
- 3. Ambient Loop Circulation Pump
- 4. Ambient Side Heat Exchanger
- 5. Heat Pump Compressor
- 6. Heat Pump Reversing Valve
- 7. Expansion Valve
- 8. Coconditioned Side Heat Exchanger
- 9. Conditioned Loop Circulation Pump
- 10. Auxiliary Electric Heater
- 11. Battery Pack Heat Exchanger
- 12. Battery Pack Cooling Blower
- 13. Air Cooled Battery Modules
- 14. Cabin Heat Exchanger
- 15. Cabin HVAC Fan



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# THERMAL MANAGEMENT SYSTEM



TESLA

# ENERGY STORAGE SYSTEM



## Battery and Charging

Battery Capacity \*

75.0 kWh

Port Location

Left Side - Rear

Battery Useable\*

74.0 kWh

FC Port Location

Left Side - Rear

Europe

Charge Port

Type 2

Fastcharge Port

CCS

Charge Power

11 kW AC

Fastcharge Power (max)

250 kW DC

Charge Time (0->475 km)

8 hours

Fastcharge Time (48->380 km)

22 min

Charge Speed

60 km/h

Fastcharge Speed

900 km/h

\* = estimated value. Average energy consumption and range based on moderate drive style and climate. Real-life values may differ significantly. Pricing information might not be actual for some regions. No rights can be derived from the information on this site.

# ENERGY STORAGE SYSTEM



## Energy Consumption

### EVDB Real Range

Range	475 km
-------	--------

Vehicle Consumption	15.6 kWh/100km
---------------------	----------------

### WLTP Ratings

Range	560 km
-------	--------

Rated Consumption	No Data
-------------------	---------

Vehicle Consumption	13.2 kWh/100km
---------------------	----------------

CO2 Emissions	0 g/km
---------------	--------

Vehicle Fuel Equivalent	1.8 l/100km
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Rated = official figures as published by manufacturer. Rated consumption and fuel equivalency figures include charging losses.

Vehicle = calculated battery energy consumption used by the vehicle for propulsion and on-board systems.

# ENERGY STORAGE SYSTEM



## Home and Destination Charging (0 -> 100%)

Charging is possible by using a regular wall plug or a charging station. Public charging is always done through a charging station. How fast the EV can charge depends on the charging station (EVSE) used and the maximum charging capacity of the EV. The table below shows all possible options for charging the Tesla Model 3 Long Range Performance. Each option shows how fast the battery can be charged from empty to full.

### Europe

Charging an EV in Europe differs by country. Some European countries primarily use 1-phase connections to the grid, while other countries are almost exclusively using a 3-phase connection. The table below shows all possible ways the Tesla Model 3 Long Range Performance can be charged, but some modes of charging might not be widely available in certain countries.



Charging Point	Max. Power	Power	Time	Rate
Wall Plug (2.3 kW)	230V / 1x10A	2.3 kW	38 hours	12 km/h
1-phase 16A (3.7 kW)	230V / 1x16A	3.7 kW	23h45m	19 km/h
1-phase 32A (7.4 kW)	230V / 1x32A	7.4 kW	11h45m	38 km/h
3-phase 16A (11 kW)	400V / 3x16A	11 kW	8 hours	56 km/h
3-phase 32A (22 kW)	400V / 3x16A	11 kW †	8 hours	56 km/h

† = Limited by on-board charger, vehicle cannot charge faster.

## Fast Charging (10 -> 80%)

Rapid charging enables longer journeys by adding as much range as possible in the shortest amount of time. Charging power will decrease significantly after 80% state-of-charge has been reached. A typical rapid charge therefore rarely exceeds 80% SoC. The rapid charge rate of an EV depends on the charger used and the maximum charging power the EV can handle. The table below shows all details for rapid charging the Tesla Model 3 Long Range Performance.

- Max. Power: maximum power provided by charge point
- Avg. Power: average power provided by charge point over a session from 10% to 80%
- Time: time needed to charge from 10% to 80%
- Rate: average charging speed over a session from 10% to 80%

### Europe

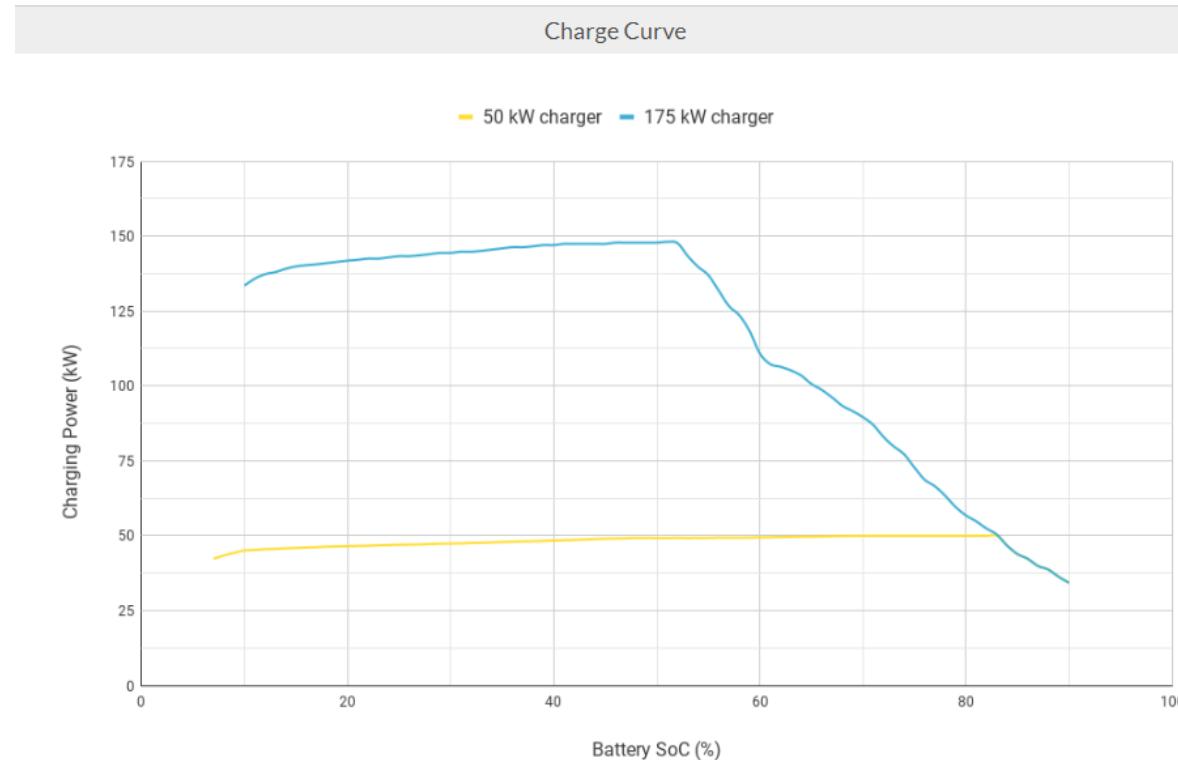
#### Combined Charging System (CCS Combo 2)



Charging Point	Max. Power	Avg. Power	Time	Rate
CCS (50 kW DC)	50 kW	48 kW †	76 min	240 km/h
CCS (175 kW DC)	148 kW †	124 kW †	29 min	650 km/h
CCS (350 kW DC)	190 kW †*	145 kW †*	25 min*	750 km/h*

TESLA

# ENERGY STORAGE SYSTEM



Data made available by Fastned



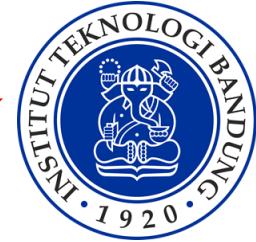
† = Limited by charging capabilities of vehicle

\* = Estimated or unconfirmed values

Actual charging rates may differ from data shown due to factors like outside temperature, state of the battery and driving style.

TESLA

# ENERGY STORAGE SYSTEM



Tesla Supercharger (CCS Combo 2)

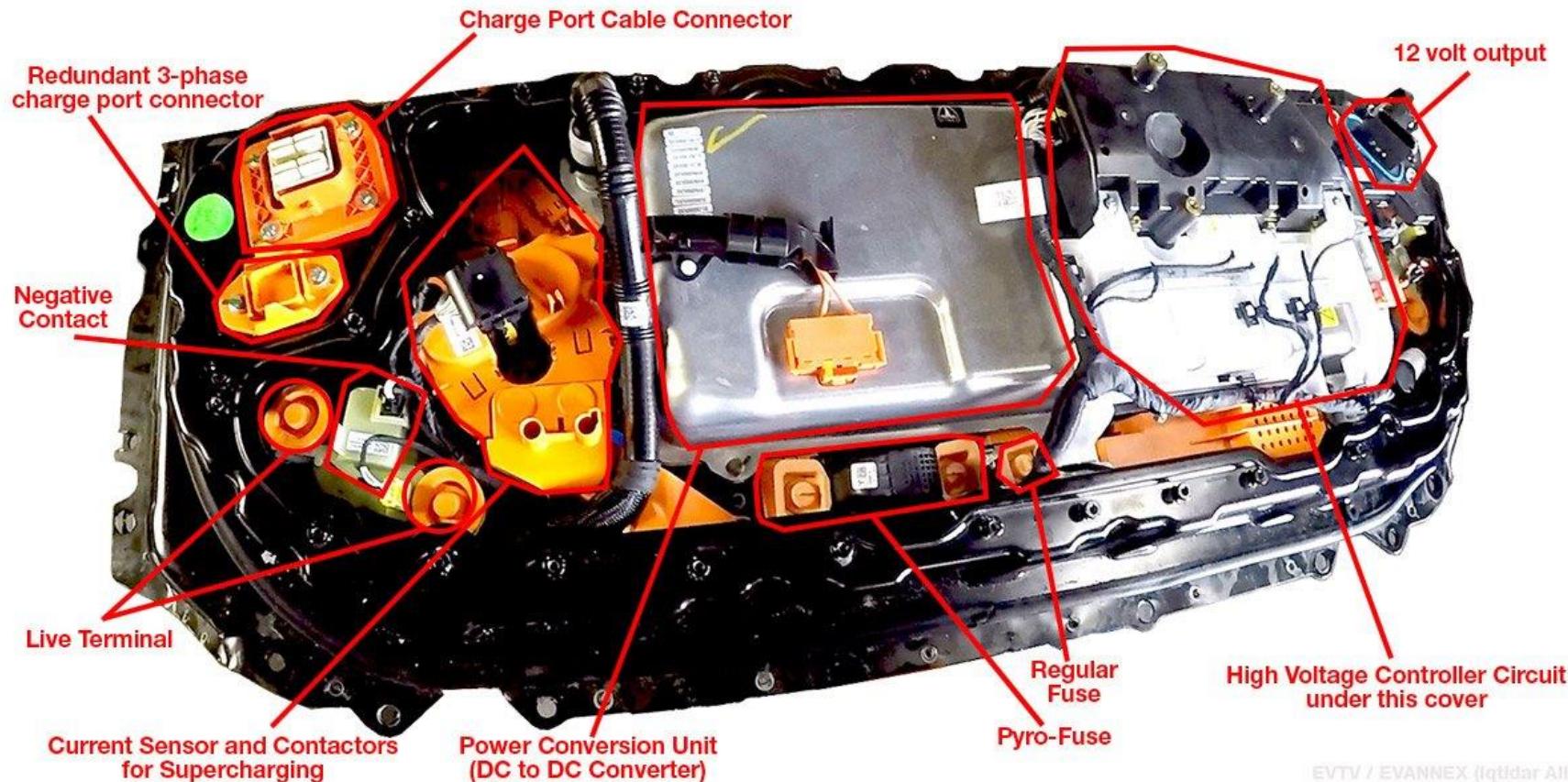


Charging Point	Max. Power	Avg. Power	Time	Rate
Supercharger v2 Shared (75 kW DC)	75 kW	66 kW †	55 min	360 km/h
Supercharger v2 (150 kW DC)	145 kW †	124 kW †	29 min	680 km/h
Supercharger v3 (250 kW DC)	250 kW	163 kW †	22 min	900 km/h

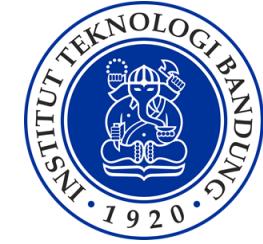
† = Limited by charging capabilities of vehicle

Actual charging rates may differ from data shown due to factors like outside temperature, state of the battery and driving style.

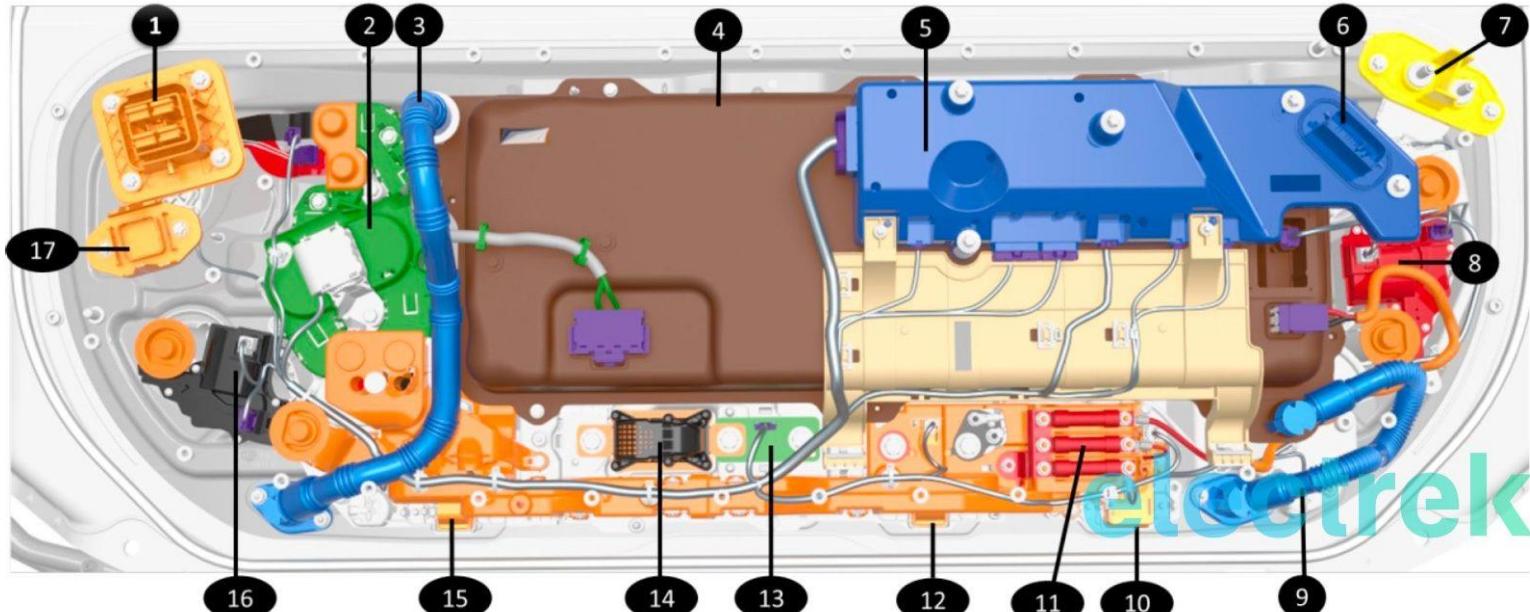
# CONTROLLER AND ELECTRICAL SAFETY



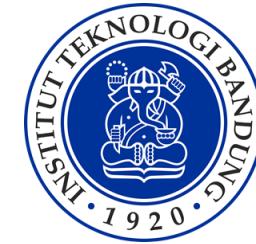
# CONTROLLER AND ELECTRICAL SAFETY



1. Charge port connector
2. Fast charge contactor assembly
3. Coolant line to PCS
4. PCS – Power Conversion System
5. HVC – High Voltage Controller
6. Low voltage connector to HVC from the vehicle
7. 12V output from PCS
8. Positive HV power switch
9. Coolant line to PCS
10. HV connector to cabin heater and compressor
11. Cabin heater, compressor and PCS DC output fuse
12. HV connector to rear drive unit
13. HV pyro fuse
14. Fuse
15. HV connector to front drive unit
16. Negative HV power switch
17. Connector for 3 phase AC charging



# CONTROLLER AND ELECTRICAL SAFETY



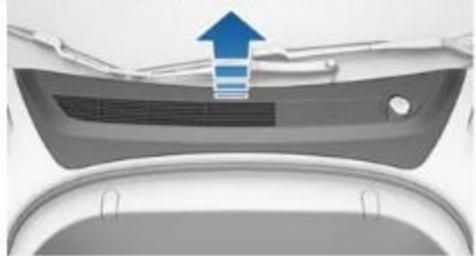
In order to disable the high-voltage components, Tesla is using the same concept as Model S and Model X with a cut loop located in the front trunk (frunk).

They explain how to access it here:

1. Open the hood. Refer to [Opening the Hood](#) on page 28 for instructions.



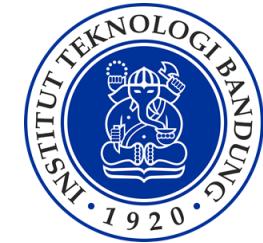
2. Remove the access panel by pulling it upwards to release the clips that hold it in place.



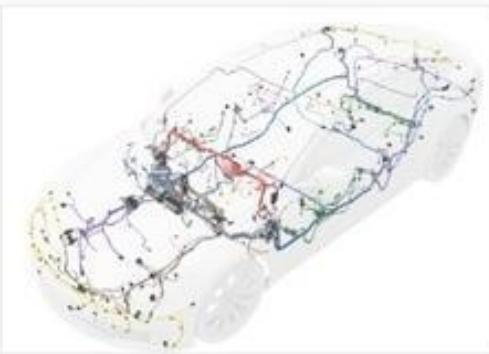
3. Double cut the first responder loop (shown in red).



# UTILITIES



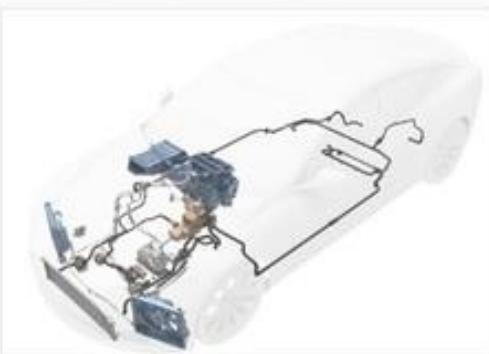
## 17 - ELECTRICAL



- 1701 - 12v Battery And Fuses
- 1710 - Harnesses
- 1715 - Electronic Control Modules
- 1720 - Radar Sensors
- 1723 - Front Camera
- 1725 - Rear Camera
- 1727 - Parking Sensors

- 1730 - Interior Switches And Aux Power Socket
- 1740 - Exterior Lights
- 1745 - Keyless Entry And Security
- 1750 - Wipers And Washers
- 1753 - Horn
- 1755 - Accelerator Pedal

## 18 - THERMAL MANAGEMENT

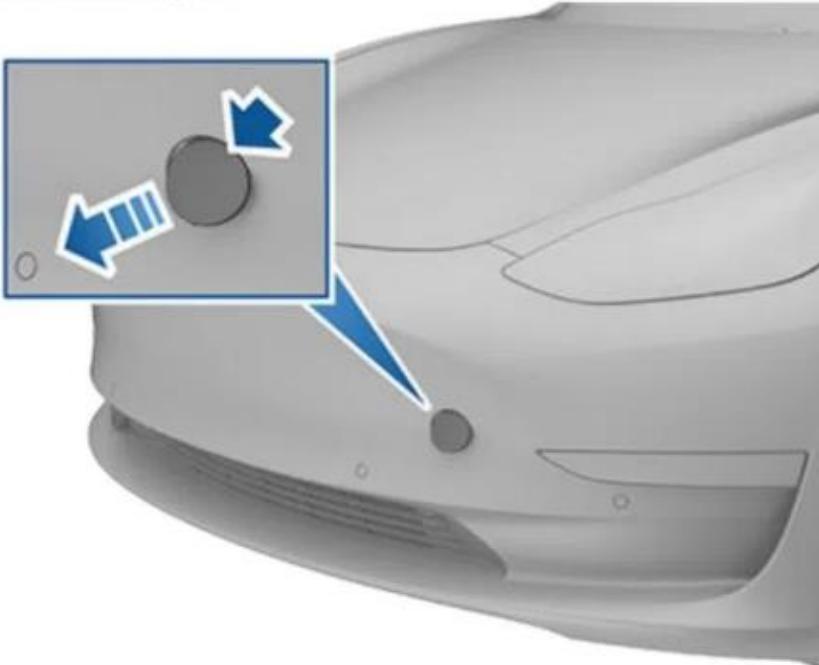


- 1810 - Cabin Hvac
- 1820 - Refrigerant System

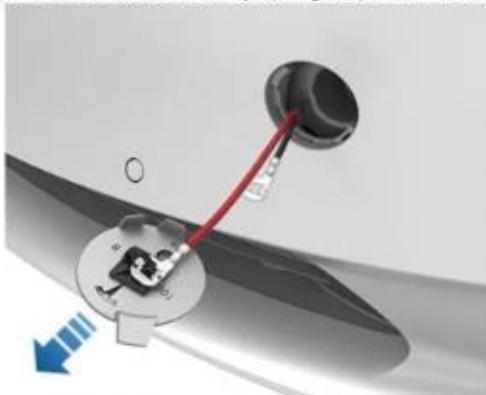
- 1830 - Cooling System
- 1850 - Air Distribution

Interestingly, unlike Model S and Model X, which only require to pull a loop hidden in the bumper in order to open the trunk, Model 3 has a more complicated system using the 12-volt battery connection:

1. Locate an external 12 volt power supply.
2. Release the tow eye cover by pressing firmly on the top right perimeter of the cover until it pivots inward, then pulling the raised section toward you.



3. Pull the two wires out of the tow eye opening to expose the vehicle-side terminals.



4. Connect the external 12 volt power supply's red positive (+) cable to the red positive (+) vehicle-side terminal.

5. Connect the external 12 volt power supply's black negative (-) cable to the black negative (-) vehicle-side terminal.



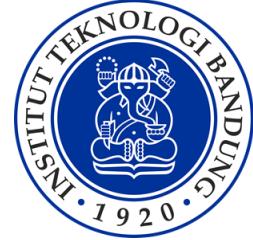
6. Turn on the external power supply (refer to the external power supply manufacturer's instructions). The hood latches are immediately released and you can now open the hood to access the front trunk area.  
7. Disconnect both external power supply cables, beginning with the black negative (-) cable.

# REFERENCES



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- **(US9527403B2) Charging station providing thermal conditioning of electric vehicle during charging session** <https://patents.google.com/patent/US9527403B2/en>
- **(WO2019006204) Multi-channel And Bi-directional Battery Management System**  
<https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2019006204>
- **(US20190280334) NOVEL BATTERY SYSTEMS BASED ON TWO-ADDITIVE ELECTROLYTE SYSTEMS INCLUDING 1,2,6-OXODITHIANE-2,2,6,6-TETRAOXIDE**  
<https://patentscope.wipo.int/search/en/detail.jsf?docId=US251449154&tab=NATIONALBIBLIO>
- **(US20110212356A1) Extruded and Ribbed Thermal Interface for use with a Battery Cooling System** <https://patents.google.com/patent/US20110212356A1/en>
- **(US7841431B2) Electric vehicle thermal management system**  
<https://patents.google.com/patent/US7841431>
- <https://www.tesla.com/model3>
- <https://www.teslarati.com/tesla-high-speed-wiring-full-self-driving-safety-patent/>

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- <https://www.researchgate.net/figure/Overall-structure-of-the-regenerative-and-hydraulic-blended-braking-system fig1 268389110>
- <https://ev-database.org/car/1138/Tesla-Model-3-Long-Range-Dual-Motor#charge-table>
- <https://www.youtube.com/watch?v=QW3PmRp7EK8>
- <https://www.teslarati.com/tesla-model-3-steering-drivetrain-suspension-secrets-revealed/>
- <https://www.carthrottle.com/post/electronic-power-assisted-steering-how-does-it-work/>
- <https://electrek.co/2019/04/13/tesla-model-3-longevity-claims-elon-musk/>
- <https://tsportline.com/blogs/owners-guide/the-tesla-model-3-wheel-guide>
- <https://electrek.co/2017/08/24/tesla-model-3-exclusive-battery-pack-architecture/>
- <https://seekingalpha.com/article/3983102-teslas-gigafactory-christmas-july>