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Electric Scooter Requirements Specification

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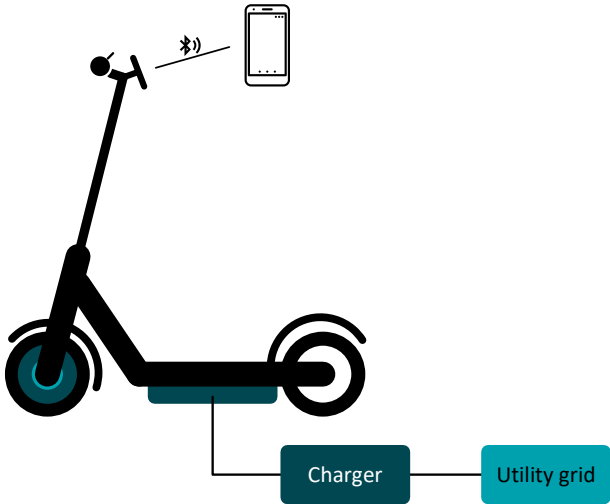

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ID	Object Type		Parent Requirement	Rationale
Req_1	Title	1 Introduction		N.A
Req_2	Title	2 Purpose		N.A
Req_3	Info	The purpose of this specification is to describe the functionality for the system Electric Scooter The system will be developed within the scope of Validation and Testing Platforms.		N.A
Req_248	Title	2.1 Background and Context		N.A
Req_250	Info	<p>This document describes the requirements specification of an electric scooter manufactured and sold by MU Scooters Inc. The following figure shows the general structure of the scooter.</p>  <p>The scooter is sold with the charger and it will be prepared to charge from the common 230 V utility grid.</p>		N.A

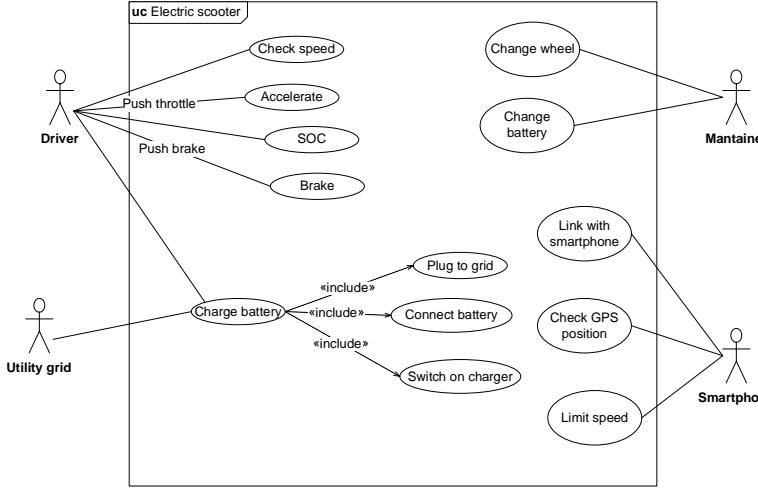
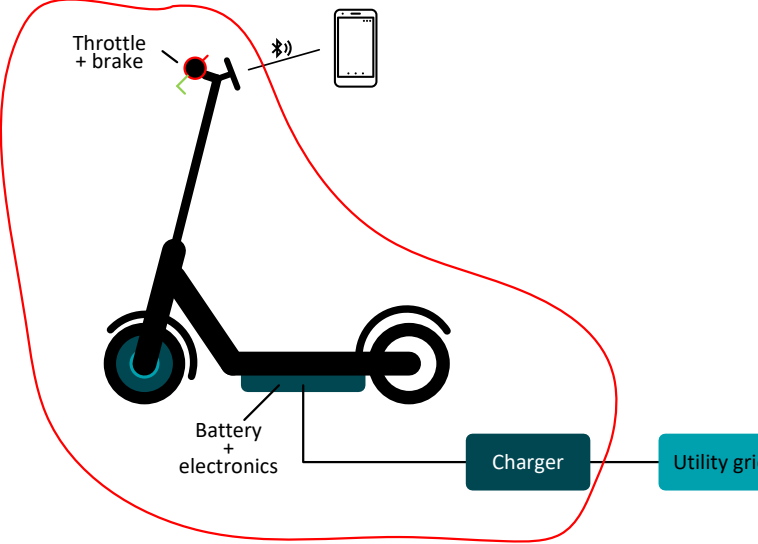
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ID	Object Type		Parent Requirement	Rationale
		<p>The scooter will be connected to an app in a smartphone via Bluetooth. The app will record information about rides and will have access to GPS coordinates.</p> <p>Using GPS coordinates, the app will send a speed limitation command to the scooter in certain areas.</p>		
Req_246	Title	2.2 Traceability and Notation		N.A
Req_247	Info	<p><i>Parent Requirement</i> attribute may be used to identify the requirement(s) of the higher level of abstraction that justify the existence of a requirement. Requirements from which a requirement derives.</p> <p>To say it differently, a requirement must justify the compliance with the requirement(s) of the superior level listed in its <i>Parent Requirement</i> attribute.</p>		N.A
Req_211	Info	<p>The <i>Rationale</i> attribute may be used to write down the reasons that justify the existence of a requirement without <i>Parent Requirements</i>.</p> <p>That is, there may be requirements that do not derive from requirements of a superior level; they may respond to arbitrary design decisions, design restrictions of different types etc. These cases may be explained in the <i>Rationale</i> attribute.</p> <p>Rationale shall be N.A (not applicable) if not used.</p>		N.A
Req_64	Info	Describe here any special notation that will be used in this specification		N.A
Req_5	Title	3 Definitions		N.A
Req_7	Title	3.1 Acronyms		N.A
Req_8	Info	<p>SOC: State-of-Charge</p> <p>GAP: Generic Access Profile</p> <p>GATT: Generic Attribute Profile</p> <p>SPP: Serial Port Profile</p>		N.A

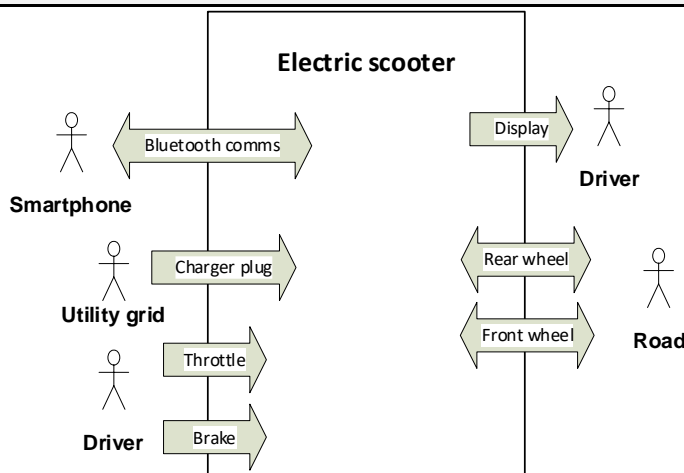
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ID	Object Type		Parent Requirement	Rationale
Req_9	Title	3.2 Definitions		N.A
Req_10	Info	List and describe here the terms that may not be common knowledge		N.A
Req_11	Title	4 References		N.A
Req_68	Title	4.1 Documents		N.A
Req_96	Info	List here any external document that may be cited in the specification. Make sure the document referenced is available for the reader (via hyperlink or similar).		N.A
Req_14	Title	5 General Description		N.A
Req_15	Title	5.1 Users and Use cases		N.A
Req_237	Info	The following system users are identified: <ul style="list-style-type: none"> - Driver. - Maintainer. - Utility grid. - Smartphone. 		N.A
Req_236	Info	Use case diagram.		N.A

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ID	Object Type		Parent Requirement	Rationale
		 <p>The diagram shows a system boundary 'uc Electric scooter'. Actors include Driver, Utility grid, Maintainer, and Smartphone. Use cases include: Check speed, Accelerate, SOC, Brake, Change wheel, Change battery, Charge battery, Plug to grid, Connect battery, Switch on charger, Link with smartphone, Check GPS position, and Limit speed. Relationships show Driver interacting with Check speed, Accelerate, SOC, Brake, and Charge battery. Utility grid interacting with Charge battery. Maintainer interacting with Change wheel, Change battery, and Link with smartphone. Smartphone interacting with Check GPS position and Limit speed. Charge battery includes Plug to grid, Connect battery, and Switch on charger.</p>		
Req_16	Title	5.2 System Boundary and Interfaces		N.A
Req_200	Info	<p>Electric scooter Boundary</p>  <p>The diagram shows a physical representation of an electric scooter. A red line outlines the scooter's frame. Labels include: Throttle + brake (pointing to the handlebar controls), Battery + electronics (pointing to the deck), Charger (a separate box), and Utility grid (a separate box). A smartphone icon is shown near the handlebar.</p>		
Req_238	Info	System interfaces diagram		N.A

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ID	Object Type		Parent Requirement	Rationale
				
Req_239	Info	<p>The following are the system interfaces.</p> <p>Bluetooth comms: Bluetooth communications will be used to exchange information between the scooter and a smartphone. They mainly will exchange information about location coordinates. On the one hand, an application will store the location of the scooter every 5 seconds. For that, the application will be linked to the scooter using a QR code present in the handle. On the other hand, depending on the coordinates of the scooter, the application may send a speed limitation command to the scooter.</p> <p>Charger plug: The battery will be charged from the conventional low voltage grid (230 V_{rms}) using a Type F electrical plug.</p> <p>Throttle: The user will establish an acceleration command using a mechanical throttle installed in the handle. Depending on the angle of the throttle, it will send an electrical signal readable by the control board.</p> <p>Brake: A mechanical friction brake will be used to stop the scooter. It will be installed in the rear wheel and the user will control it with a lever in the handle of the scooter.</p> <p>Display: A display will be used to show the status of the scooter to the driver and maintainer. It may be used to show speed and battery SOC information.</p> <p>Rear wheel: Wheel with embedded mechanical brake.</p> <p>Front wheel: Wheel with embedded electric motor.</p>		N.A
Req_240	Title	<h3>5.3 Assumptions and non-goals</h3>		N.A
Req_241	Info	Write here the non-obvious assumptions that have been made when doing this specification, if there are any.		N.A

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ID	Object Type		Parent Requirement	Rationale
Req_242	Info	Write here the non-obvious non-goals that have been set in relation to the <SYSTEM>, if there are any.		N.A
Req_74	Title	<h2>6 System Functions</h2>		N.A
Req_75	Info	<p>Major system functions are:</p> <ol style="list-style-type: none"> 1. Turn on: turns on the electric scooter. 2. Turn off: turns off the electric scooter. 3. Accelerate: driver pushes throttle and scooter accelerates. Increase scooter speed by certain amount. 4. Brake: driver pushes brake and scooter decelerates. Decrease scooter speed by certain amount. 5. Ride: Move forward with the current speed. 6. Display speed: show actual speed in display. 7. Display SOC: show actual SOC in display. 8. Charge battery: charge battery to 100 % of SOC. 9. Limit propulsion torque: limit propulsion torque depending on the location. 10. Fold/Unfold scooter. 11. Install/Remove battery. 12. Install/Remove wheels. 		N.A
Req_18	Title	<h2>7 System Requirements</h2>		N.A
Req_19	Title	<h3>7.1 Function: Turn on</h3>		N.A
Req_535	Requirement	Users shall be able to turn on/off the scooter.		N.A
Req_536	Requirement	The scooter shall have only one mechanical turn on/off switch.		N.A
Req_537	Requirement	The scooter shall connect the battery to the electronics when the turn on/off button is in ON position while SOC is more than 10 %.		N.A
Req_539	Requirement	The scooter shall display initial SOC when the turn on/off button is in ON position while SOC is more than 10 %.		N.A

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ID	Object Type		Parent Requirement	Rationale
Req_540	Requirement	The scooter shall display a no battery sign in the display when the SOC is less than 10 %.		Operation with low SOC is not recommended
Req_100	Title	7.2 Function: Turn off		N.A
Req_101	Requirement	The scooter shall disconnect the battery from the electric drive when the turn on/off button is in OFF position.		N.A
Req_102	Title	7.3 Function: Accelerate		N.A
Req_103	Requirement	The scooter shall have a mechanical throttle actionable by hand.		N.A
Req_104	Requirement	The scooter shall control motor torque proportionally to the angle of the mechanical throttle.		N.A
Req_105	Requirement	The scooter shall accelerate from 0 to maximum speed in 6 seconds at the following conditions: maximum rider weight, 100 % SOC, tires inflated to the manufacture specifications, flat ground, maximum performance configuration.		N.A
Req_106	Title	7.4 Function: Brake		N.A
Req_107	Requirement	The scooter shall have a mechanical brake installed in the rear wheel.		N.A
Req_108	Requirement	The scooter shall decelerate from maximum speed to zero in 6 seconds at the following conditions: maximum rider weight, 100 % SOC, tires inflated to the manufacture specifications, flat ground, maximum performance configuration.		N.A
Req_109	Requirement	The scooter shall be able to stop from 25 km/h within a maximum distance of 2 m when the mechanical brake is applied.		N.A
Req_110	Title	7.5 Function: Ride		N.A

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ID	Object Type		Parent Requirement	Rationale
Req_111	Requirement	The scooter shall be able to ride at maximum top speed of 25 km/h \pm 2 km/h		City law
Req_112	Requirement	The scooter shall be able to climb an 80 m long 10 % average grade hill in a maximum of 10 s with an average speed of 10 km/h.		N.A
Req_113	Requirement	The scooter shall be able to accelerate until maximum speed, ride 10 seconds in maximum speed, and decelerate until stop at the following conditions: maximum rider weight, fully charged, tires inflated to the manufacture specifications, flat ground, maximum performance configuration.		N.A
Req_114	Requirement	The scooter shall have a range of at least 80 km under the following conditions: 5 % average slope hill, maximum rider weight, fully charged, tires inflated to the manufacture specifications, maximum performance configuration (no energy saving mode), maximum acceleration requested in all the accelerations. The scooter is ridden until battery dies completely.		N.A
Req_115	Title	7.6 Function: Display speed		N.A
Req_116	Requirement	The scooter shall display its actual speed in km/h.		N.A
Req_117	Requirement	The scooter shall display its actual speed in 2 km/h steps.		N.A
Req_118	Requirement	The scooter shall measure its actual speed with a maximum error of 2% with respect to the real speed.		N.A
Req_119	Title	7.7 Function: Display SOC		N.A
Req_120	Requirement	The scooter shall display its actual SOC in percentage respect to its full battery state.		N.A
Req_121	Requirement	The scooter shall display its actual SOC in 5 % steps.		N.A
Req_122	Requirement	The scooter shall estimate its actual SOC with a maximum error of 5 % with respect to the real SOC.		N.A
Req_123	Title	7.8 Function: Charge battery		N.A
Req_124	Requirement	The scooter shall charge the battery from the utility grid.		N.A

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ID	Object Type		Parent Requirement	Rationale
Req_125	Requirement	The scooter shall charge the battery from 30 % to 80 % of SOC in 2 hours.		N.A
Req_126	Title	7.9 Function: Limit propulsion torque		N.A
Req_127	Requirement	The system shall establish the torque limit as per data received via its bluetooth interface.		N.A
Req_128	Requirement	The system's Bluetooth interface shall have the following characteristics: <ul style="list-style-type: none"> - Bluetooth 5.0 or superior version. - Support for GATT and GAP protocols. 		N.A
Req_129	Requirement	The system shall use SPP protocol to receive the torque limit data, where the system is the server and the smartphone or sending device shall be the client.		N.A
Req_130	Requirement	The torque limit shall be interpreted as an Unsigned Integer of 8 bits, where the value represents the torque in Newton-meters.		N.A
Req_131	Requirement	The scooter shall limit its propulsion torque to 50 % of its maximum torque while the limit torque flag is activated.		N.A
Req_132	Title	7.10 Function: Fold/Unfold scooter		N.A
Req_133	Requirement	The scooter shall be foldable.		N.A
Req_134	Requirement	Folded size shall be length 45.5 x height 46.1 x width 19.8 inches		N.A
Req_135	Requirement	Unfolded size shall be length 45.5 x height 46.1 x width 21.3 inches		N.A
Req_136	Title	7.11 Function: Install/Remove battery.		N.A
Req_137	Requirement	The battery shall be removable.		N.A
Req_138	Requirement	The battery shall be replaced.		N.A
Req_139	Requirement	The battery shall include safety measures to avoid short-circuiting it while installing/removing.		N.A

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ID	Object Type		Parent Requirement	Rationale
Req_140	Title	7.12 Function: Install/Remove wheels		N.A
Req_141	Requirement	Front and rear wheels shall be removed		N.A
Req_142	Requirement	Front and rear wheel shall be replaced		N.A
Req_143		7.13 Miscellaneous		N.A
Req_144	Requirement	Maximum scooter weight shall be 20 kg \pm 2 kg		N.A
Req_145	Requirement	Maximum wheel diameter shall be 125 mm		N.A
Req_146	Requirement	Motor shall be embedded in the front wheel		N.A
Req_147	Requirement	The rider shall weight a maximum of 100 kg		N.A
Req_148	Requirement	The scooter shall be able to give rated power at an ambient temperature between -10 °C and 40 °C at the following conditions: maximum rider weight, fully charged, tires inflated to the manufacture specifications, flat ground, maximum performance configuration.		N.A