

Traceability Matrix

ID	Requirement	Related Use Case	Fulfilled By	Test	Description
1	The application interface contains buttons, display, and electrodes.	N/A	MainWindow.ui	Run the simulator in Qt to observe the ui.	Using QT's built in user interface framework, the physical CES system was replicated. Also, all buttons are clickable with the mouse. The CES is displayed alongside an admin panel, which allows for more precise control of specific elements of the simulator system.
2	The application battery level is dependent on time and power level of therapy.	N/A	MainWindow, Therapy,	Start a treatment, and observe the battery icon: battery level will lower as the treatment progresses.	As a therapy is run, the battery level will consistently decrease (rate of decrease is affected by the power level). The <i>MainWindow</i> will update its information. The battery power is equally divided into five equal parts, which are reflected in the number of cells on the power icon

3	Treatment displays the time of treatment.	N/A	MainWindow, Therapy	Select a treatment to observe its allotted time.	<i>Therapy</i> classes contain a <i>QTimer</i> attribute, which will maintain an internal time of how long the therapy has been running. The <i>MainWindow</i> will display this information when a therapy is running
4	Treatment time advanced only when on skin (References Requirement 2).	Skin Connect Use Case (UC7)	MainWindow, Therapy	Start a treatment, and observe the timer when toggling the <i>apply to skin</i> button.	The <i>MainWindow</i> class keeps track of whether or not the device is pressed to the skin (on skin status can be changed in the admin panel). The therapy timer will only advance if the device is considered to be on skin.

5	Treatment time pauses when not applied to skin (References Requirement 2).	Skin Connect Use Case (UC7)	MainWindow, Therapy	Start a treatment, and observe the timer when toggling the <i>apply to skin</i> button.	Implementation here is the opposite of the previous case. The timer will not advance if the device is considered to be off skin.
6	During treatment, the treatment stops 5s after the skin connection is disconnected (References Requirement 2).	Skin Connect Use Case (UC7)	MainWindow, Therapy	When the treatment is in progress, disconnect the skin. Wait for more than 5s to observe.	When disconnected for 5s, the treatment will be reset. Without any settings, connecting the skin again will not restart the treatment

7	During the treatment, disconnect the skin within 5s, reconnect to the skin, and the treatment will continue (References Requirement 2).	Skin Connect Use Case (UC7)	MainWindow, Therapy	When the treatment is in progress, disconnect the skin. Wait for less than 5s to observe.	The treatment will be resume. Screen treatment time continues.
8	Device supports output current of a therapy in the range [0, 500]. (References Requirement 7).	Set Current Use Case (UC6)	MainWindow, Therapy	Start a treatment, and change output current by clicking either the <i>up</i> or <i>down</i> button or modify the output current. Observe increasing and decreasing current values	Output current can be changed via the up and down buttons on the CES simulator when a therapy is running. When any change in the output current is detected, the progress bar of Screen will update. Each increase is 100, and the decrease is 50.

9	Device supports 3 frequencies. (0.5Hz, 77Hz, 100Hz) (References Requirement 3).	Set Frequency Use Case (UC5)	MainWindow, Therapy	Select the <i>Frequencies</i> ComboBox to view device's supported frequencies.	The Frequencies are represented as <i>Therapy</i> objects. And can be kept as a record normally.
9	Device supports 3 Waveforms. (Alpha, Beta and Gamma) (References Requirement 4).	Set Waveform Use Case (UC4)	MainWindow, Therapy	Select the Waveforms ComboBox to view device's supported Waveforms.	The Waveforms are represented as <i>Therapy</i> objects. And can be kept as a record normally.

10	The user can choose to record a therapy and add to history of treatment for a single user. (References Requirement 10).	Save a Therapy Use Case (UC9)	MainWindow, HistoryDBManager	Start a treatment, and press lock button to save to the history of treatments.	Selected therapies will be record. Their information (start time, duration, etc) is stored in a corresponding record object and then saved to an external database via the HistoryDBManager object in <i>MainWindow</i> .
11	The user can view a history of treatment.	View Saved Therapies Use Case (UC8)	MainWindow, HistoryDBManager	From the control panel, select <i>History</i> table to view all treatments currently saved to the device.	The user can see a scrollable list of all the therapies the device has run since they were last cleared. These records are loaded from the database via <i>DBManager</i> into <i>MainWindow</i> .

12	The user can clear their history of treatment.	Clear Saved Therapies Use Case (UC9)	MainWindow, HistoryDBManager	From the control panel, select the <i>Clear History</i> button to clear all treatments currently saved to the device.	The <i>MainWindow</i> will instruct the <i>DBManager</i> to clear the database, and the history table will be clear.
13	The device simulation can be turned on and off, disabling normal device functionality when the device is turned off.	POWER ON Use Case(UC1), POWER OFF Use Case(UC2)	MainWindow	Turn the device on/off by toggling the <i>power</i> button. Select other buttons while the device is off, and observe that their functionality has been disabled.	The power button, when clicked, sends a signal to <i>MainWindow</i> to disable/enable the CES screen and all the buttons on the CES simulator(Except for the power button).

14	Output current of the device is only changeable during a treatment.	Set Current Use Case (UC6)	MainWindow	Start a treatment, and change output current by clicking either the <i>up</i> or <i>down</i> button. Next, try changing output current using the same method before start a treatment; power level will not change.	When outside of a treatment, <i>MainWindow</i> blocks all signals to the left and right buttons as they are not currently in use. When a treatment is running the signals are reenabled.
15	A saved record saves the waveform, frequency, start time of treatment, the last time output current, and the duration of the treatment.	Save a Therapy Use Case (UC10)	MainWindow, HistoryDBManager	N/A	The <i>TreatRecordType</i> struct has attributes for the date, time, type, highest power, and duration of treatments. The <i>MainWindow</i> class keeps a collection of <i>data</i> as they are created. The HistoryDBManager will store and retrieve older records from other runs of the simulator as is required.

16	The device issues a warning at 5% charge and shuts down at 2% after issuing another warning.	Battery undervoltage Use Case (UC11)	MainWindow	Drain the battery level by running a treatment. Once the battery level reaches 5, try to see if there are warnings. Once the battery level reaches 2, try to see if there are another warning. And the device turns off, try selecting any buttons on the device, and observe that their functionality has been disabled.	When the battery level reaches 2, the icon of 5% low battery will be display. When the battery level reaches 2, the icon of 2% will flash for a few seconds. And the function that handles battery reduction alerts the rest of the <i>_MainWindow</i> class to turn off the <i>_CES</i> simulator.
17	At the start of a program treatment, the timer starts at the time recommended for the particular program, and counts down to 0:00	Set Timer Use Case (UC3)	MainWindow, Therapy	Start a program treatment, and select countdown cycles. Observe the timer.	The <i>Therapy</i> classes maintain a <i>QTimer</i> attribute and a countdown cycles. For Programs, the visual timer will start at the max time and subtract time off of it until it reaches zero, at which point the treatment ends. And the device has been automatic shutdown.

18	Records are stored in persistent storage.	N/A	HistoryDBManager	Have record states observable in the <i>control panel</i> , and restart the application.	<p>The HistoryDBManager class is used to create tables, insert/delete, and query data in an external SQLite database.</p> <p>The HistoryDBManager will insert <i>TreatRecordType</i> struct created by <i>MainWindow</i> into the database. It will also retrieve the created records later for the <i>MainWindow</i> class to hold.</p>
19	The application does not contain any memory leaks.	N/A	N/A	Run valgrind to check for memory leaks.	All dynamically allocated memory that the program was designed to allocate is deleted in the appropriate class destructor.

20	Automatically and permanently disables itself should a single fault develop within the device causing the current to exceed 700 μ A.	Device Error Use Case (UC12)	MainWindow	Turn on the device and click the Error Trigger button. Observe whether the device is turned off. Try to operate the power button to see if the device can still be turned on.	When the Error trigger button is pressed, the device is permanently turned off and the error icon is displayed. The device cannot be turned on again until the application restarts.
21	30 minute (the unit of simulation is second) auto - off when not in use.	Not Use Timeout Use Case (UC13)	MainWindow	Turn on the device but do not start treatment. Record the time from when the last button is pressed to when the device automatically shuts down.	The device will automatically shut down 30s after the last button is pressed When the treatment hasn't started.