



# CES Device Simulator Project

**Final Project Report Submission**

COMP 3004: Object Oriented Software Engineering  
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*Team 9 | Fazlay*

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## A. USE CASE MODEL

Use Case Models & Diagram based on the given information of CES Device

## *Use Case 0: Typical Operation of the CES Device*

Primary Actor: User

Scope: Microcurrent Electro Therapy (MET) provided by a Cranio-Electro Stimulation (CES) device

Level: User goal

Stakeholders and Interests:

*Device manufacturers/ company* - wants to deliver a proven product that upholds its promises, leading to increased sales

*Users* - wants a product that can improve/ treat their condition (ie. insomnia, anxiety, depression, alleviation of pain, improvement in cognition)

Precondition: The device is in good working condition with required setups including a 9-Volt Alkaline Battery and stimulus cable with ear clips. The user is also familiar with the operator's manual and general, safe operation of the machine.

Trigger: The device is turned on to begin a session

Minimal Guarantee: User completes a session with the desired mode/ intensity/ duration

Success Guarantee: User completes a session with the desired mode/ intensity/ duration, and is able to save their records for repeats

Main Success Scenario:

1. Turn on the device by pressing and holding the power button as outlined in Use Case 1.
2. Upon startup, and periodically, the battery level is displayed on the graph as per Use Case 2, 3, 4 depending on the charge.
3. Begin a session by selecting a session duration (length) and session frequency range as outlined in Use Case 5.
4. Upon selection of a session, the device performs a connection test as outlined in Use Case 6.
5. The intensity can be adjusted by the user as outlined in Use Case 7.
6. The preferences can be saved by the user as outlined in Use Case 8.
7. A session can be added to the user's history as outlined in Use Case 9.
8. The session ends as outlined in Use Case 10.
9. Upon completion of a session, the device is either manually or automatically powered off as outlined in Use Case 11.

Extensions:

1-10a. Refer to corresponding use case extensions for further elaboration.

## *Use Case 1: Power CES Device On*

Primary Actor: User

Precondition: The device is in the "off" state with battery power inserted

Minimal Guarantee: Device powers on with an LED indicator.

Success Guarantee: Device powers on as outlined in minimal guarantee but also turns off when inactive.

Main Success Scenario:

1. The power button is pressed and held until the power LED indicator turns on.
2. Within two minutes of turning to its "on" state, the user interacts with the interface as desired (ie. viewing history, starting a session).
3. The power button is pressed and held again turning the unit to its "off" state.

Postcondition: Device is turned on and ready for user input.

Extensions:

- 2a. The user does not interact with the device within two minutes of turning on.
  - 2a1. The device automatically shuts off due to inactivity.
- 3a. User attempts to turn the device off during a session.
  - 3a1. The device takes up to one second to power off.

### *Use Case 2: Display Normal Battery Level*

Primary Actor: Battery level graph

Precondition: The device has sufficient battery for *normal level*

Minimal Guarantee: Level of battery charge is communicated to the user through the graph upon device turning on.

Success Guarantee: Level of charge is communicated as outlined in minimal guarantee but also throughout use.

Main Success Scenario:

1. The battery level is displayed on the graph for a few seconds after the device has been turned on.
2. During use, the level is monitored and displayed periodically during sessions.

Postcondition: User is aware of the battery level and is able to make decisions accordingly.

Extensions:

- 2a. The graph is used during a session to indicate intensity level causing confusion to the user
  - 2a1. Battery level mode is indicated through the blinking of the LEDs.

### *Use Case 3: Display Low Battery Level Warning*

Primary Actor: Battery level graph

Precondition: The device has sufficient battery for *low level*

Minimal Guarantee: Level of battery charge is communicated to the user through the graph upon device turning on.

Success Guarantee: Level of charge is communicated as outlined in minimal guarantee but also throughout use.

Main Success Scenario:

1. Either upon turning on and during use, when the battery level approaches its low level the graph displays two bars and blinks.

2. This indicates to the user that the battery should be replaced before running a session.

Postcondition: User is aware of the battery level and is able to make decisions accordingly.

Extensions: None

### *Use Case 4: Display Critically Low Battery Level Warning*

Primary Actor: Battery level graph

Precondition: The device has sufficient battery for *critically low level*

Minimal Guarantee: Level of battery charge is communicated to the user through the graph upon device turning on.

Success Guarantee: Level of charge is communicated as outlined in minimal guarantee but also throughout use.

Main Success Scenario:

1. Upon turning on the device, the graph displays one bar and blinks.
2. During a session, the graph displays one bar and blinks.

Postcondition: User is aware of the battery level and is able to make decisions accordingly.

Extensions:

- 1a. The device does not have sufficient power to run.
  - 1a1. Battery is immediately replaced by the user.
- 2a. The device runs out of power during use.
  - 2a1. The session ends early and the battery indicator continues to blink for a short period of time.
  - 2a2. The battery is replaced by the user in order to continue use.

### *Use Case 5: Begin a Session*

Primary Actor: User

Precondition: The device is turned on and ready for use with default settings illuminated

Minimal Guarantee: The duration and frequency range of a session is available for selection by the user.

Success Guarantee: The duration and frequency range of a session is available as outlined in minimal guarantee but the user can also save their settings in their history.

Main Success Scenario:

1. Using the touch screen buttons, a session duration is selected by the user (20 min, 45 min, 3 hrs, User Designed).
2. Using the touch screen buttons, a session frequency range is selected by the user (MET, Sub-Delta, Delta, Theta, Alpha, Beta1, Beta2, 100Hz).
3. The selected settings illuminate on the graphical user interface.
4. The select button is pressed to start the session with chosen settings.
5. The session number flashes and begins after a five second delay.

Postcondition: A session successfully completes with the chosen duration and frequency range.

Extensions:

- 2a. No sessions are available in a group.
- 2a1. Icons do not illuminate.

### *Use Case 6: Connection Test*

Primary Actor: Device

Precondition: Session has been started with selected settings

Minimal Guarantee: Electrical connection is confirmed by entering a test mode.

Success Guarantee: As outlined in minimal guarantee.

Main Success Scenario:

1. At the start of a session, the device indicates that it is entering the connection test mode by blinking the CES Mode lights.
2. The status of the connection is displayed on the graph, indicating one of the following: “no connection (blinking)”, “okay connection (solid)”, “excellent connection (solid)”.
  - a. Note: Since there is no way for the user to actually change the connection of the ear clips, each connection test will simply consist of gradual transitions from no connection to okay connection to excellent connection
3. Once the connection has been established as either “okay” or “excellent”, the display goes blank.

Postcondition: The user is able to adjust the intensity upon completion of the test.

Extensions:

- 2a. Ear clips are disconnected during the connection test.
  - 2a1. The session is paused and the “no connection” indicator is displayed.
- 3a. The user resumes or restores a saved preference.
  - 3a1. A Soft On animation is displayed.

### *Use Case 7: Adjust Intensity*

Primary Actor: User

Precondition: Device has completed the connection test and a session is in progress

Minimal Guarantee: User is able to adjust the intensity of the session.

Success Guarantee: User is able to adjust the intensity as outlined in minimal guarantee, but also see graph lights illuminate to view settings.

Main Success Scenario:

1. The user presses on the up/ down button to increase/ decrease intensity.
2. When adjusting intensity, the topmost graph level light blinks.

Postcondition: The intensity is set just below the user's ability to feel the stimulus. The user is able to complete a session with the desired intensity settings

Extensions:

- 1a. By default, all sessions are set to an intensity of zero.
- 1a1. The user must turn up the intensity every time.

### *Use Case 8: Save Preferences*

Primary Actor: User

Precondition: The desired intensity setting has been selected on the device

Minimal Guarantee: User is able to save the intensity for a session.

Success Guarantee: As outlined in minimal guarantee.

Main Success Scenario:

- 1. The select button is pressed and held for one second.
- 2. The graph displays a short animation.
- 3. The session is either cut short or completed.
- 4. The intensity preference is saved in the database for the next time an identical session is requested.

Postcondition: The user has a list of their saved intensity preferences.

Extensions:

- 4a. The saved intensity is too high or too low the next time the user or another user uses the unit.
- 4a1. The Soft On process is interrupted at any time using the up/ down buttons.

### *Use Case 9: Record Session and Add to History*

Primary Actor: User, Device - Session History List, Device - Record Button

Precondition: A session has been started

Minimal Guarantee: User is able to save their session to the history list

Success Guarantee: User is able to save their session as outlined in minimal guarantee, recording their session type, duration and intensity level.

Main Success Scenario:

- 1. User presses the "record" button while the session is in progress.
- 2. Upon completion of the session, the data (type, duration, intensity) is appended to the history list.

Postcondition: The user has the ability to view a list of their therapy history..

Extensions: None



### *Use Case 10: Ending a Session*

Primary Actor: Device

Precondition: A session has been completed

Minimal Guarantee: All sessions end with *Soft Off*: a gradual reduction of the CES stimulus.

Success Guarantee: As outlined in minimal guarantee.

Main Success Scenario:

1. The session duration is reached and the device enters Soft Off mode.
2. The graph scrolls from 8 to 1 to indicate that Soft Off is in progress.
3. Upon completion of Soft Off, the unit powers off.

Postcondition: A session successfully completes and the device is turned off.

Extensions:

- 1a. The session is ended early by the user.
  - 1a1. The power button is pressed and released, turning the device off as per User Case 11.

### *Use Case 11: Power CES Device Off*

Primary Actor: Device

Precondition: The device is in the "on" state with battery power inserted

Minimal Guarantee: The device enters its "off" state.

Success Guarantee: As outlined in minimal guarantee.

Main Success Scenario:

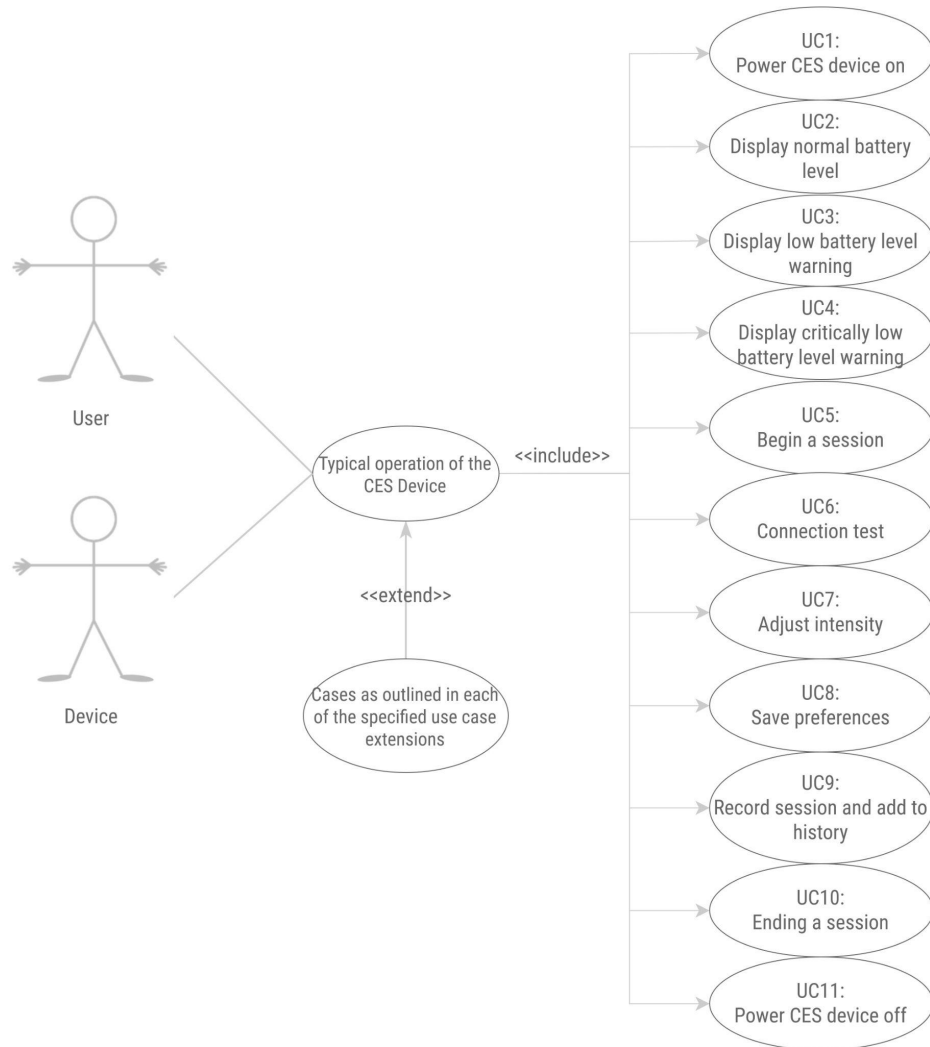
1. While the machine is on, the power button is pressed and held.
2. The unit is shut off.

Postcondition: The device is turned off.

Extensions:

- 1a. The power button is triggered during a session.
  - 1a1. The device takes up to one second to turn off.

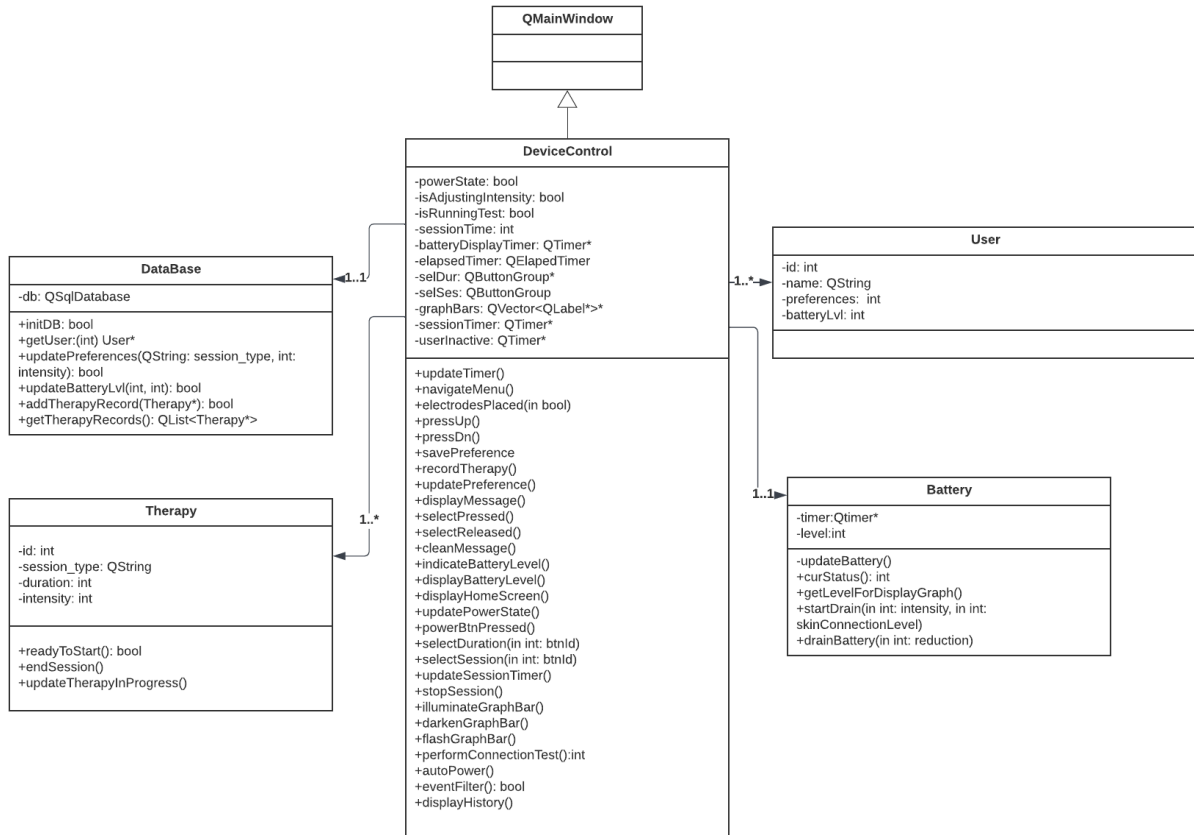
## Use Case Diagram



## B. OBJECT ORIENTED DESIGN MODEL

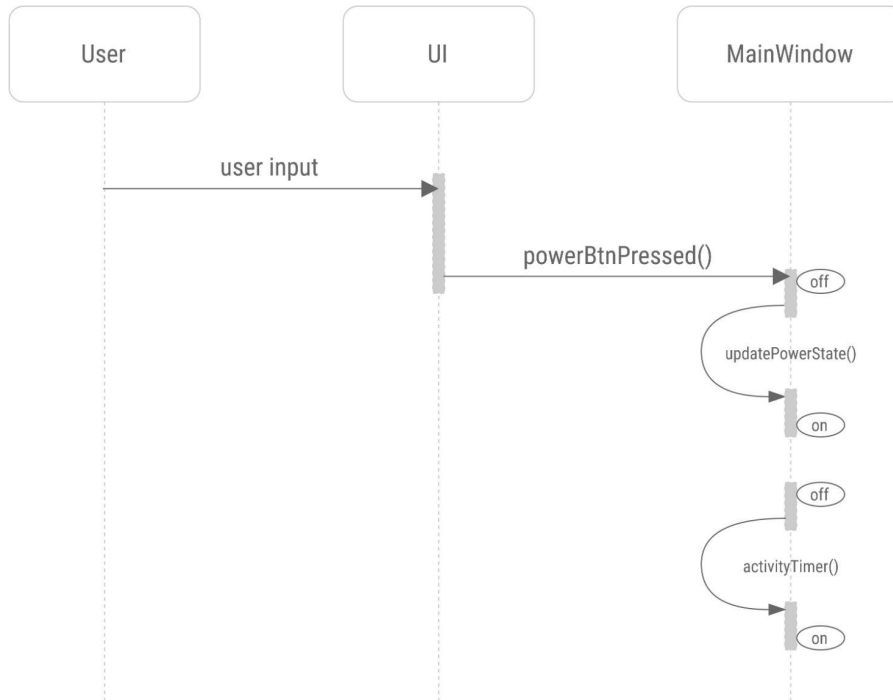
UML Class & Sequence Diagrams based upon mentioned Use Cases

## UML Class Diagram

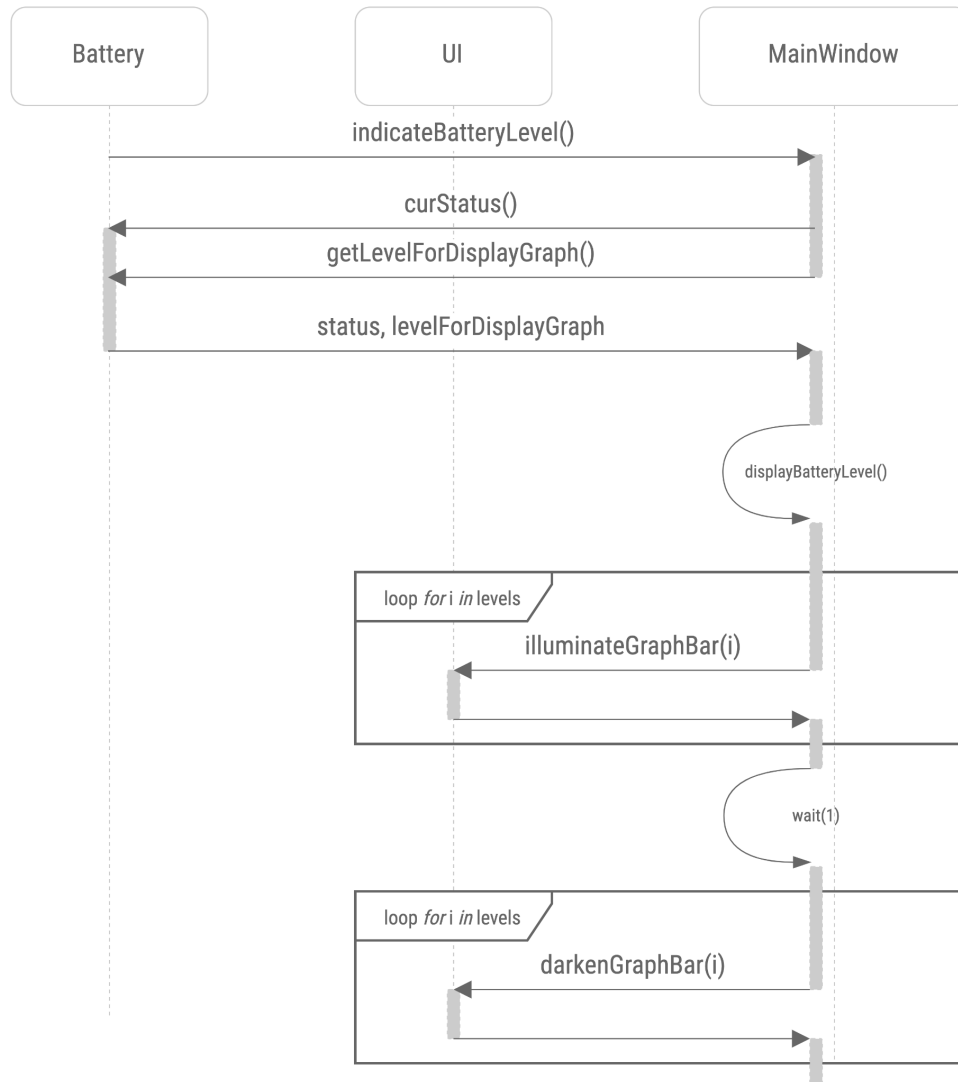


### Sequence Diagram: Power CES Device On (Use Case 1)

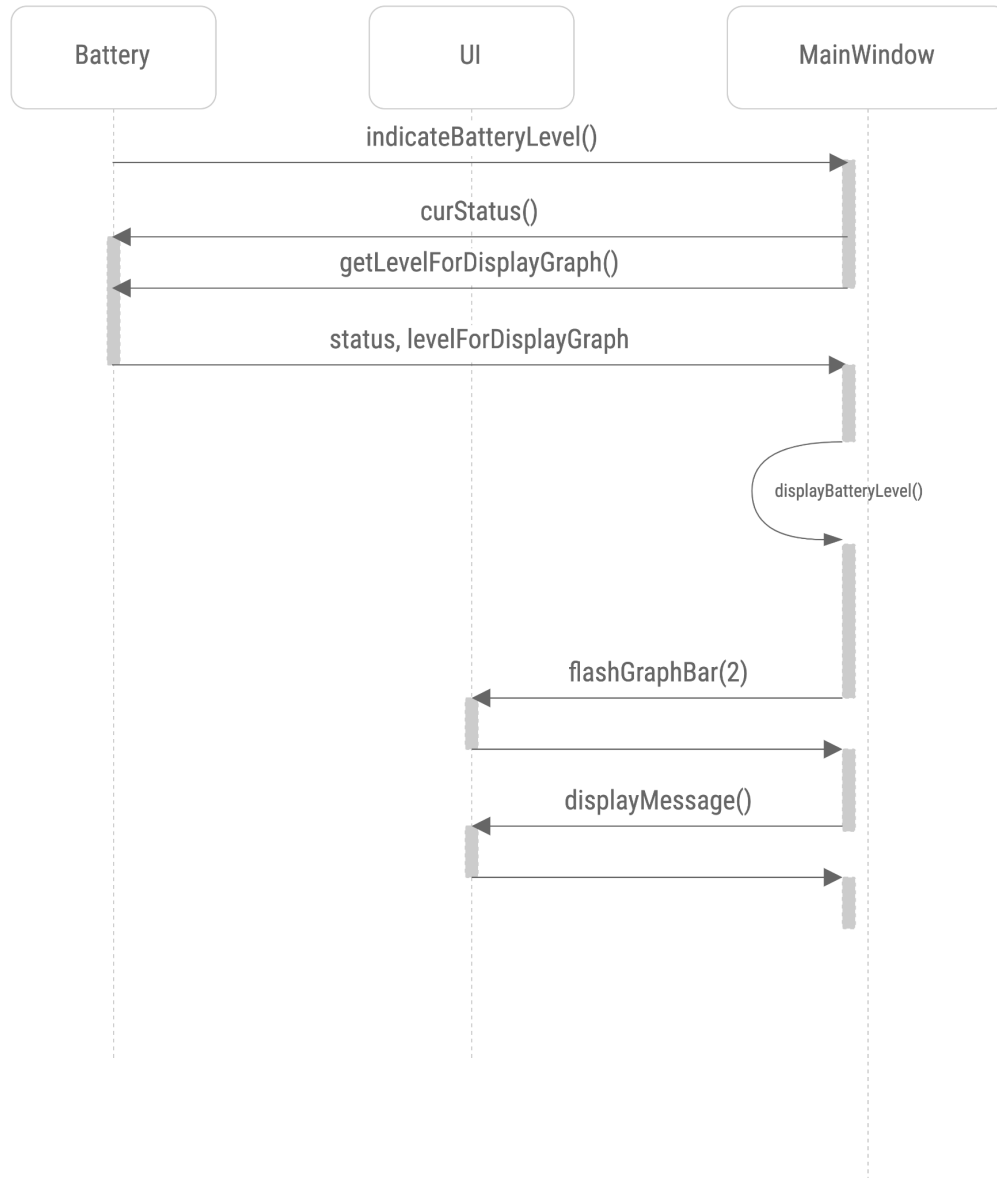
As outlined in Use Case 1 of Section A, the user turns on the device by pressing and holding the power button and the power LED illuminates.



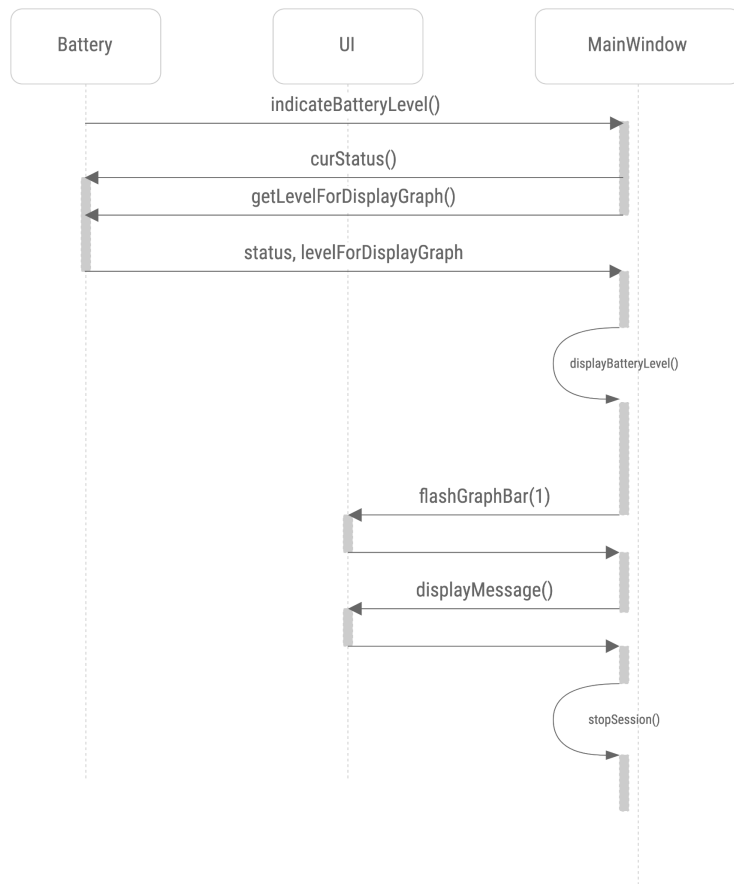
*Sequence Diagram: Display Normal Battery Level (Use Case 2)*



*Sequence Diagram: Display Low Battery Level Warning (Use Case 3)*



*Sequence Diagram: Display Critically Low Battery Level Warning (Use Case 4)*

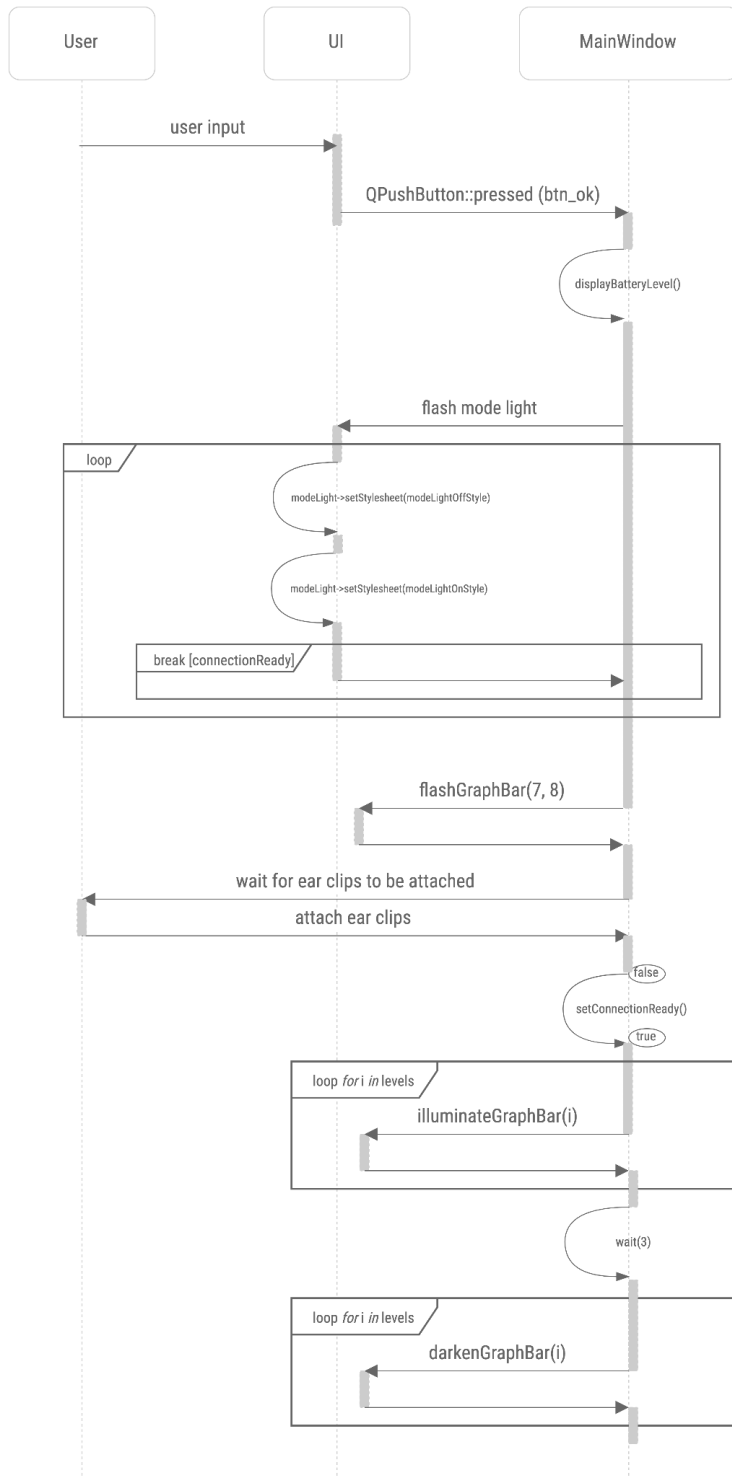




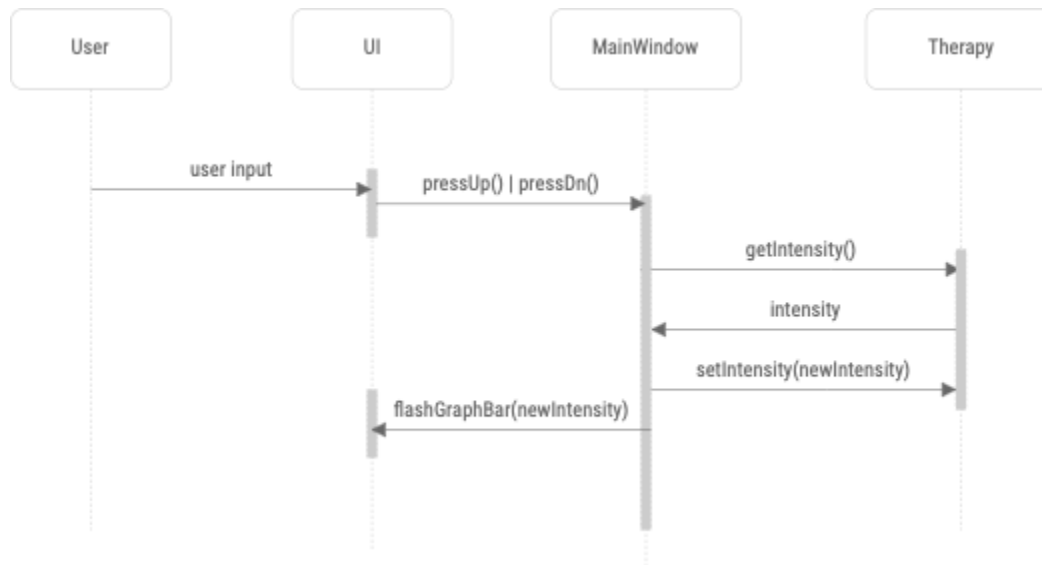
### Sequence Diagram: Begin a Session (Use Case 5)



### Sequence Diagram: Connection Test (Use Case 6)



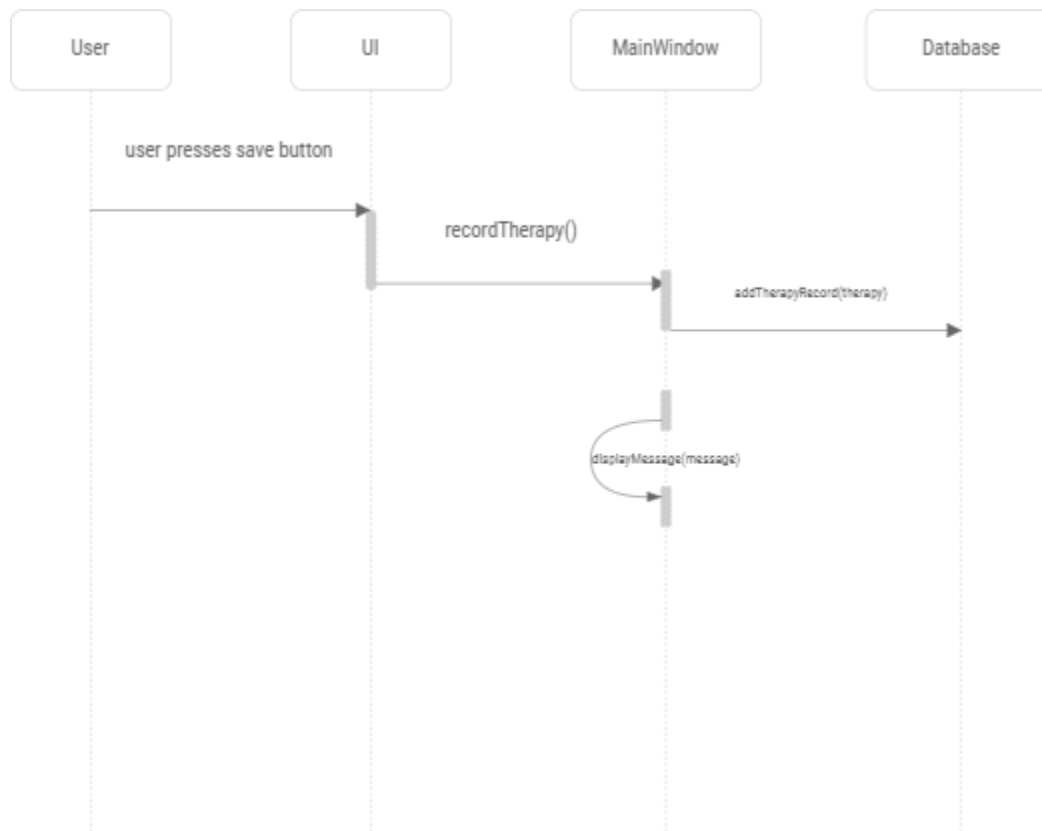
*Sequence Diagram: Adjust Intensity (Use Case 7)*



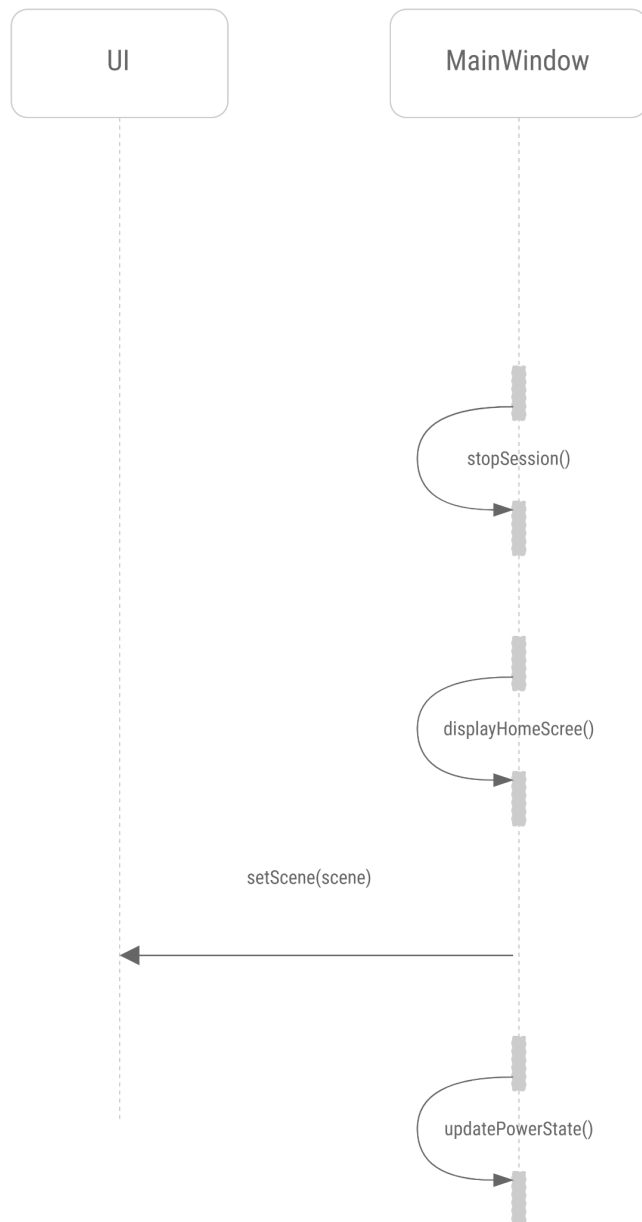
*Sequence Diagram: Save Preferences (Use case 8)*



*Sequence Diagram: Record Session and Add to History (Use case 9)*

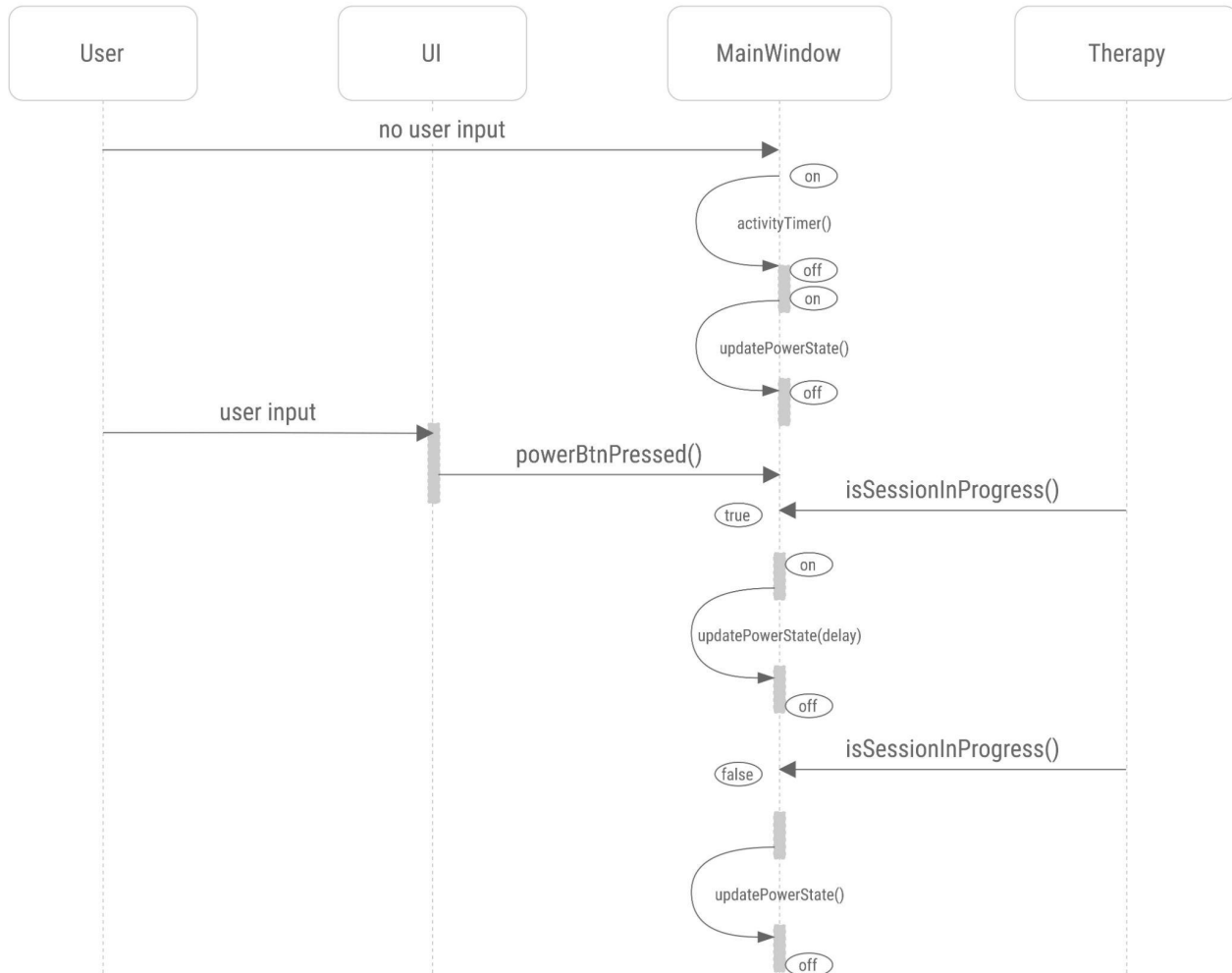


*Sequence Diagram: Ending a Session (Use Case 10)*



### Sequence Diagram: Power CES Device Off (Use Case 11)

As outlined in Use Case 11 of Section A, the user turns off the device by pressing and holding the power button at any point of the program. If the power button is triggered during a session, the device takes up to one second to turn off. Additionally, if there is no activity within two minutes of powering on, the device automatically turns off.



## C. IMPLEMENTATION

Refer to the 'CESDevSim' Directory for Source Files to Application Implementation



## D. TESTS AND TRACEABILITY MATRIX

Traceability Matrix from Use Cases, Tests, and Design

ID	Req	Use Case	Fulfilled by	Test	Description
1	User can turn on the device	Use Case 1: Power CES Device On	DeviceControl	Press and hold the power button.	Once device is turned on via the power button, the power LED turns on, the display turns on, and the battery is displayed.
2	Device turns off if no session is selected within 2 minutes	Use Case 2: Display Normal Battery Level	DeviceControl	Wait for 2 minutes without selecting anything for the session.	Device will turn off automatically upon inactivity for 2 minutes.
3	Battery is drained during running of session based on session length, intensity, and connection level	N/A	Battery	Run a session with differing intensities, times, and connection levels and view battery levels when indicated periodically.	Battery will be drained more quickly for higher intensities, longer times, and worse connection levels (OK connection will be worse than excellent).
4	Indicate battery level when normal	Use Case 2: Display Normal Battery Level	Battery, DeviceControl	Turn the CES device on to show the normal battery level, and wait for the battery level to be indicated periodically during session.	Graph will illuminate bars based on battery level for a few seconds, when the CES device is turned on, and periodically during a session.
5	Indicate battery level when low	Use Case 3: Display Low Battery Level Warning	Battery, DeviceControl	Wait for the battery level to be indicated periodically when it reaches 25% or less.	Graph will flash bars based on battery level for a few seconds and low battery message will be displayed on menu.
6	Indicate battery level when critically low	Use Case 4: Display Critically Low Battery Level Warning	Battery, DeviceControl	Wait for the battery level to be indicated periodically when it reaches 12% or less.	Graph will flash bars based on battery level for a few seconds, a critically low battery message will be displayed on menu, and if a session is running, it will be stopped prematurely.
7	Select a session frequency range(session type) and a duration	Use Case 5: Begin a Session	DeviceControl	Select a session frequency range and a duration by using the touch screen buttons	The selected button illuminates and it sets the session type and grabs thier preferred intensity level for the session type from the database and set therapy->intensity
8	Start a session	Use Case 5: Begin a Session	DeviceControl	Press the ok button and a seession will start after running a connection test	After succefully running a connection test, the sessionTimer starts
9	Perform a connection test before start of session	Use Case 6: Connection Test	DeviceControl	Start a session to see the connection test be performed	When the select button is pressed to start a session, a connection test is first performed which involves the mode light blinking, and the graph displaying the level of connection - once connection is okay/excellent, it proceeds to start the session.
10	Adjust the intensity level	Use Case 7: Adjust Intensity	DeviceControl	Before starting a session or after the connection test, press the up/down button to increase/decrease inetensity level	When the up/down button is pressed, it calls pressUp()/pressDn() and lets you adjust the intensity level as long as it's a number between 1 and 8
11	User can update preferences	Use Case 8: Save Preferences	DeviceControl, DataBase	Adjust intensity and press ok button for more than a second	Ok button has onPressed() and onRelease() listeners. We calculate the time difference between those two actions; if it's more than a second then updatePreferences() fuction is called which gathers information about the current intensity and passes the info to the database function to store the preferred intensity for the fiven session.
12	User can choose to record a therapy and add to the history of treatment.	Use Case 9: Record Session and Add to History	DeviceControl, DataBase	Start the session and press the save button to record the session. Press the display history button to check if the record is saved.	When the save button is pressed it calls the recordTherapy function, which gathers information about the current therapy and passes it to the database function to store a therapy record.
13	User can end the session	Use Case 10: Ending a Session	DeviceControl	Press btn_del when the session is in process	When the btn_del is pressed when the session is in progress, stopSession() function is called which resets the session timers and brings the user to the home screen.

14	User can turn off the device	Use Case 11: Power CES Device Off	DeviceControl	Press the power button and the display turns off.	When there is a session in progress, press and hold the button for 2 seconds.
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