EVAL-HCRWATCH4Z I EDA

Healthcare Support

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1 EVAL-HCRWATCH4Z I EDA: INTRODUCTION

Electrodermal activity (EDA) is defined as the variations in the electrical properties of the skin due to the sympathetic neuronal activity. This phenomenon occurs as a result of the sweat gland activity which causes changes in the electrical conductance of the skin. EDA is widely accepted as a useful measure of sympathetic arousal due to emotional and cognitive states. The EDA complex comprises two components: background tonic component (Skin Conductance Level) and rapid phasic components (Skin conductance Responses).

EDA provides useful information for both psychophysiological applications (including emotional or cognitive stress) and pathophysiological applications (including fatigue, pain, sleepiness, exercise recovery). The EDA application on the watch performs a '2-wire bioimpedance measurement' which is a voltammetry measurement to calculate skin conductance.

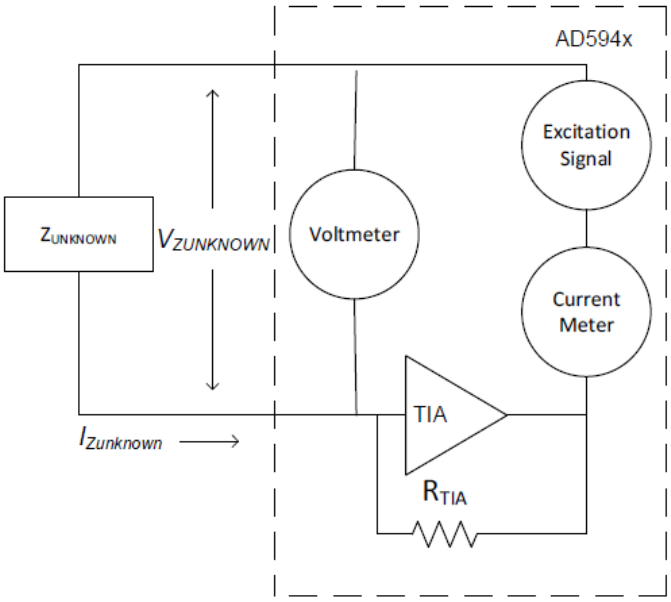
2 EVAL-HCRWATCH4Z I EDA: HOW EDA IS MEASURED

The EDA measurement is performed using AD5940 and the two bottom electrodes on the watch. The AD5940 includes two high precision excitation loops, a low bandwidth loop and a high bandwidth loop. The low bandwidth loop consists of an ultra-low power, dual-output string, digital-to-analog converter (DAC) capable of generating signals from dc to 200 Hz. The low bandwidth loop also consists of a low power transimpedance amplifier (TIA) used to convert input currents to voltage. This loop is used for EDA measurements.

The low power DAC generates a low frequency sine wave (≈100 Hz) which is applied to the sensor via the potentiostat amplifier (PA). The unknown impedance is measured by calculating the current ($I_{ZUNKNOWN}$) flowing from the unknown impedance and the voltage ($V_{ZUNKNOWN}$)across the unknown impedance using the following formula:

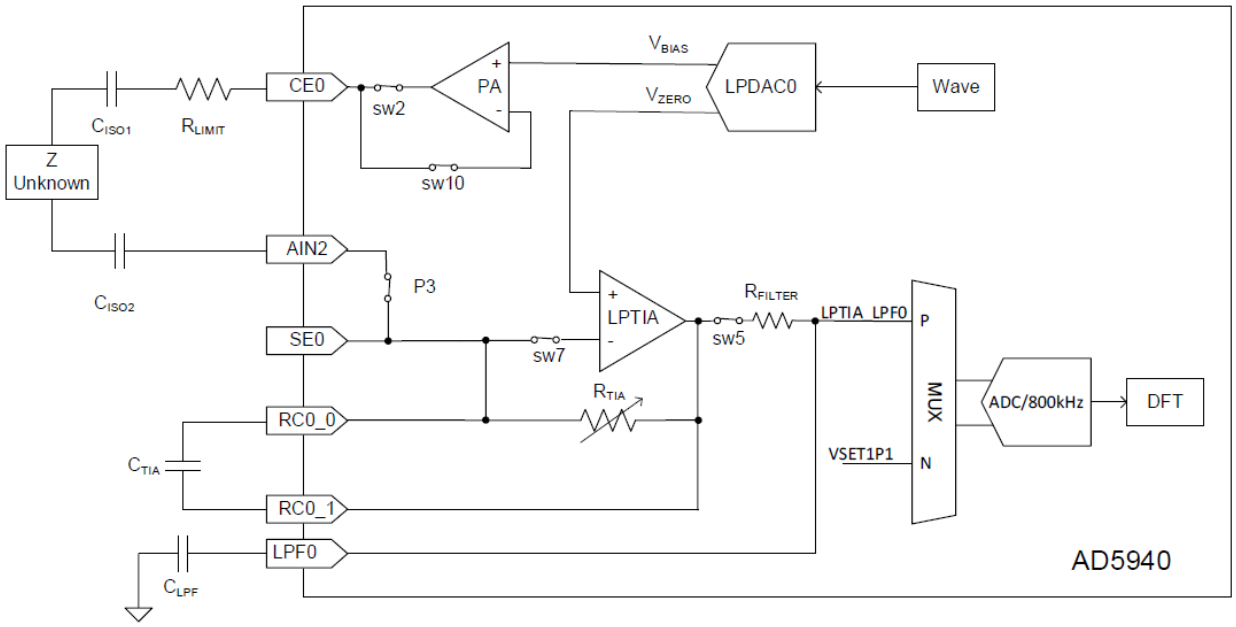
$$|Z_{UNKNOWN}| = |V_{UNKNOWN}|/|I_{UNKNOWN}| * R_{TIA}$$

Here, R_{TIA} is the feedback resistance of the TIA of the low power TIA loop.



1 EDA Measurement Diagram

The unknown impedance is connected between the CE0 pin and the SE0 pin (refer to EDA Signal Path figure). The SE0 is connected to the inverting input of the low power TIA. The voltage ($V_{ZUNKNOWN}$) across the unknown impedance is retrieved by calculating the voltage on CE0. The V_{CE0} is provided as an input to the ADC. The current ($I_{ZUNKNOWN}$) flowing from the unknown impedance is measured by the low power TIA. The low pass filter output (LPTIA_LPF0) is connected as an input to the ADC. A discrete Fourier transform (DFT) is performed on the current and voltage measurements to calculate the respective real and imaginary parts. The real and imaginary parts are stored in the FIFO register which is read by the microcontroller when an interrupt is generated. The AD5940 uses a sequencer to run commands automatically independent of the microcontroller. The sequencer runs the commands and fills the data FIFO with the DFT real and imaginary results for both the voltage and current measurements. The host microcontroller reads the data FIFO and uses the real and imaginary DFT results to calculate unknown Z.



2 EDA Signal Path

3 EVAL-HCRWATCH4Z I EDA: USE CASES

The EDA application addresses the following use cases:

- **Spot Measurement of EDA:** The application provides a spot measurement of the skin conductance which can be utilized for various psychological applications.
- **Continuous tracking of EDA**: The application provides a long-term reliable measurement of the skin conductance provided a proper electrical contact between the two bottom electrodes and the skin is maintained.

> ⚠ **Note**
>
> The EDA application is not intended for use in a clinical setting for medical diagnosis.

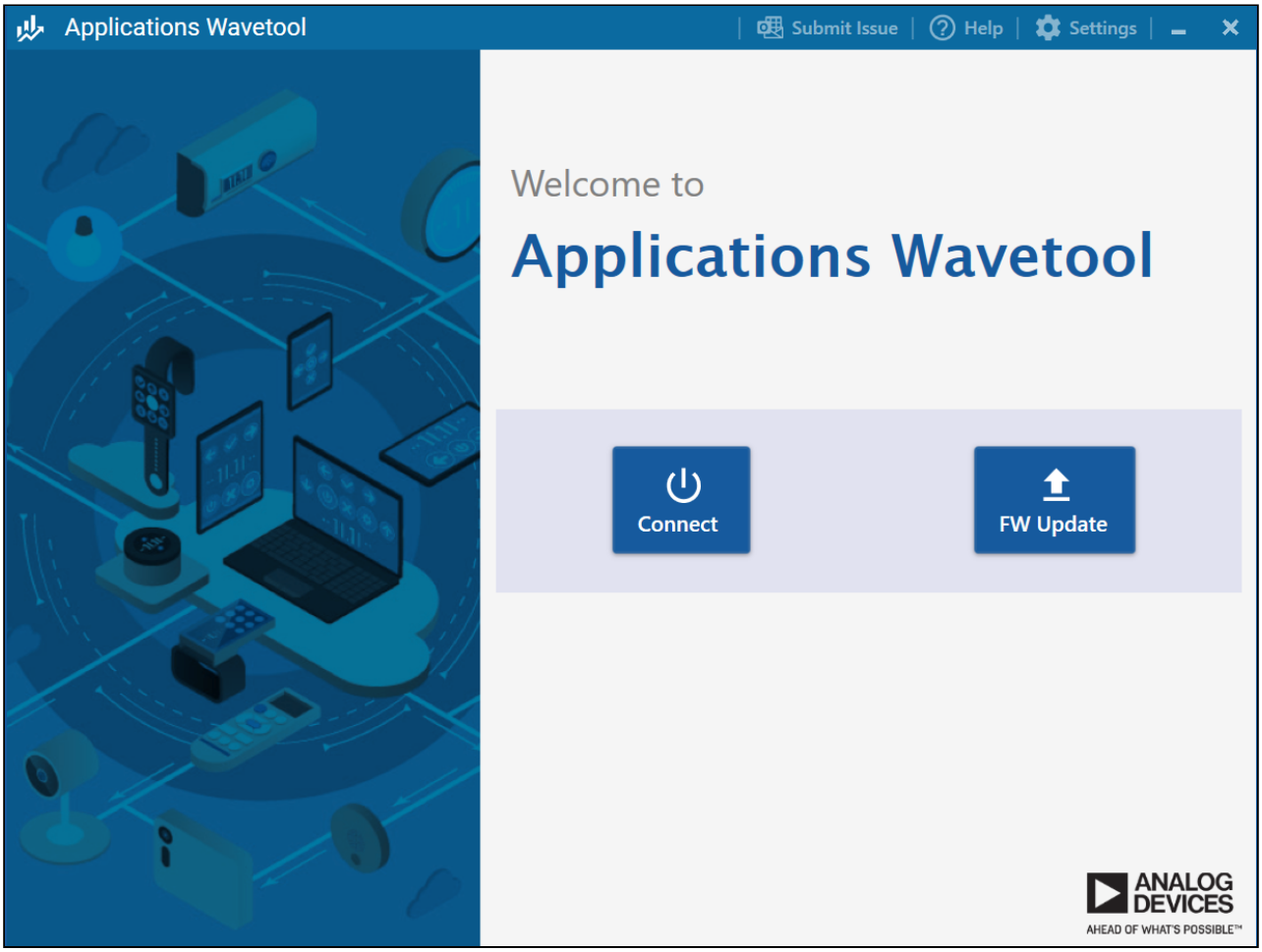
4 EVAL-HCRWATCH4Z I EDA: HOW TO VIEW, CONFIGURE, AND LOG

4.1 Applications Wavetool Interface

Applications Wavetool is an ADI-developed evaluation software for the watch platform. The software allows seamless connectivity to the watch for running a multitude of supported applications. The software enables controlling the application behavior through configurable user inputs and allows live data streaming, visualization, and logging of the application output.

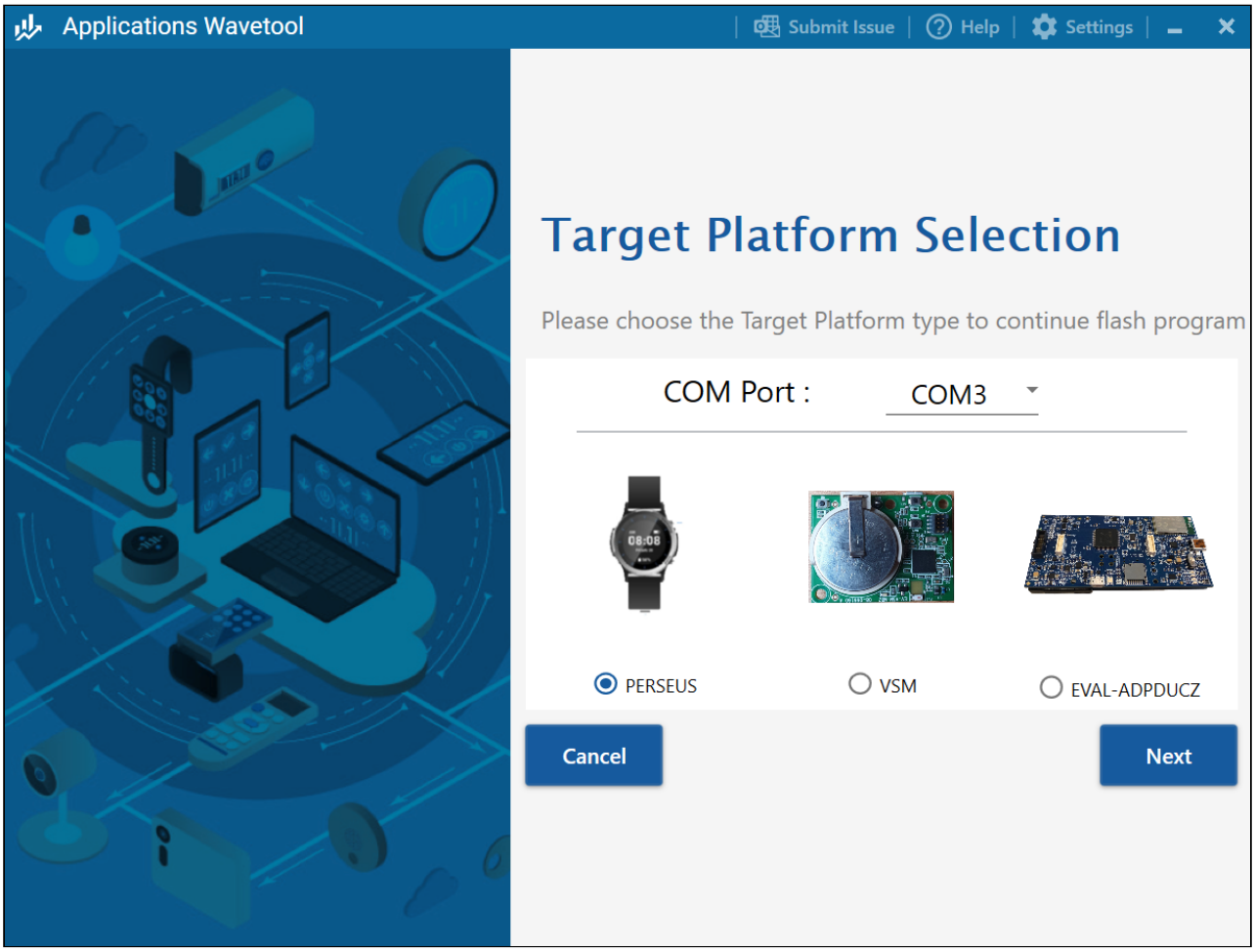
4.1.1 Updating Firmware for Watch

- Attach the watch to the charging cradle.
- Connect the watch to your PC or laptop through a USB cable.
- Launch Applications Wavetool.



3 Applications Wavetool Home Screen

- Click **FW Update** to update the firmware for the watch.
- On the Target Platform Selection screen, select the watch.

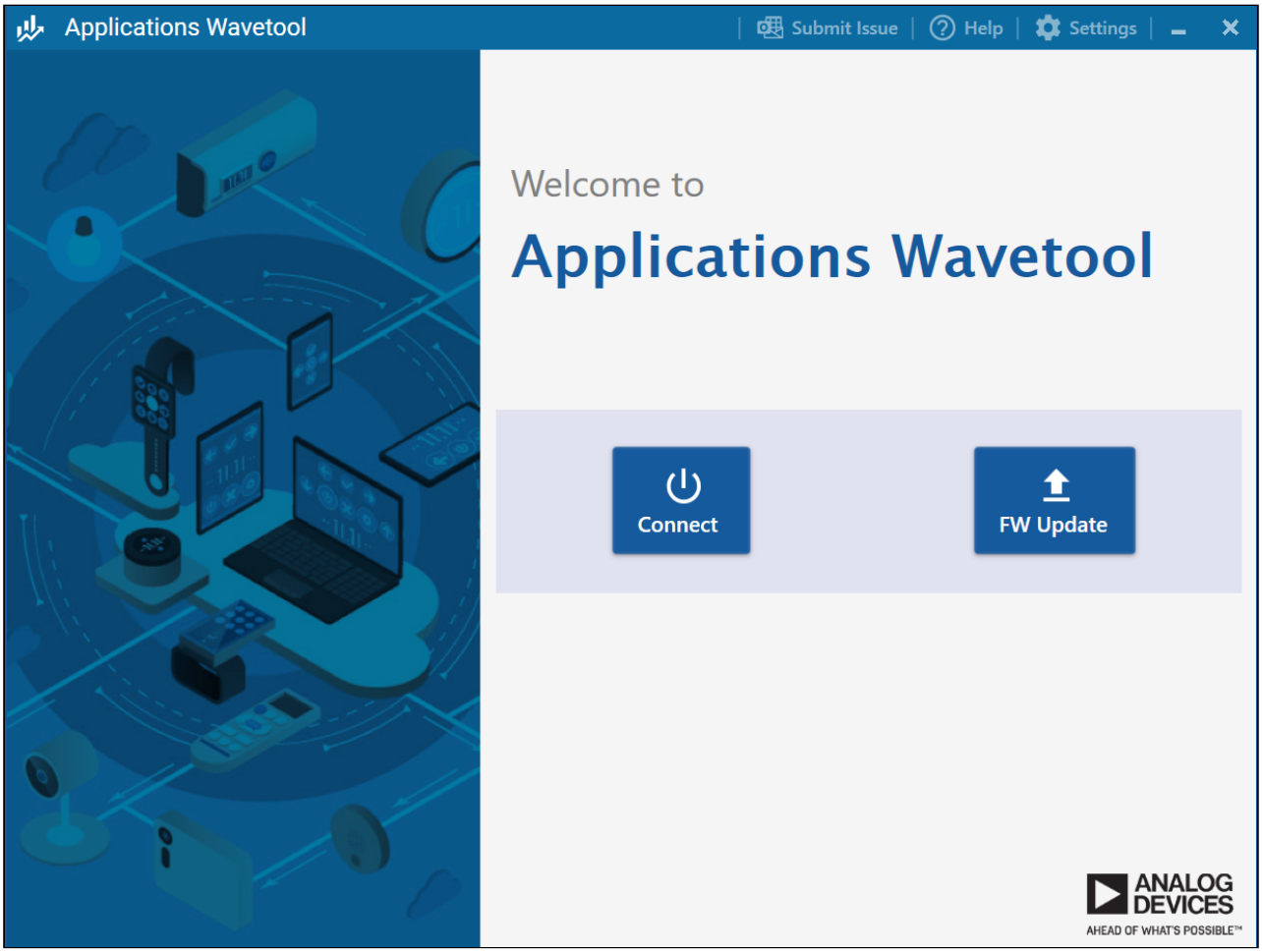


4 Target Platform Selection

- Press the 'Navigation' and 'Action' buttons for 5 seconds simultaneously.
- Click **Next** to finish the firmware update.

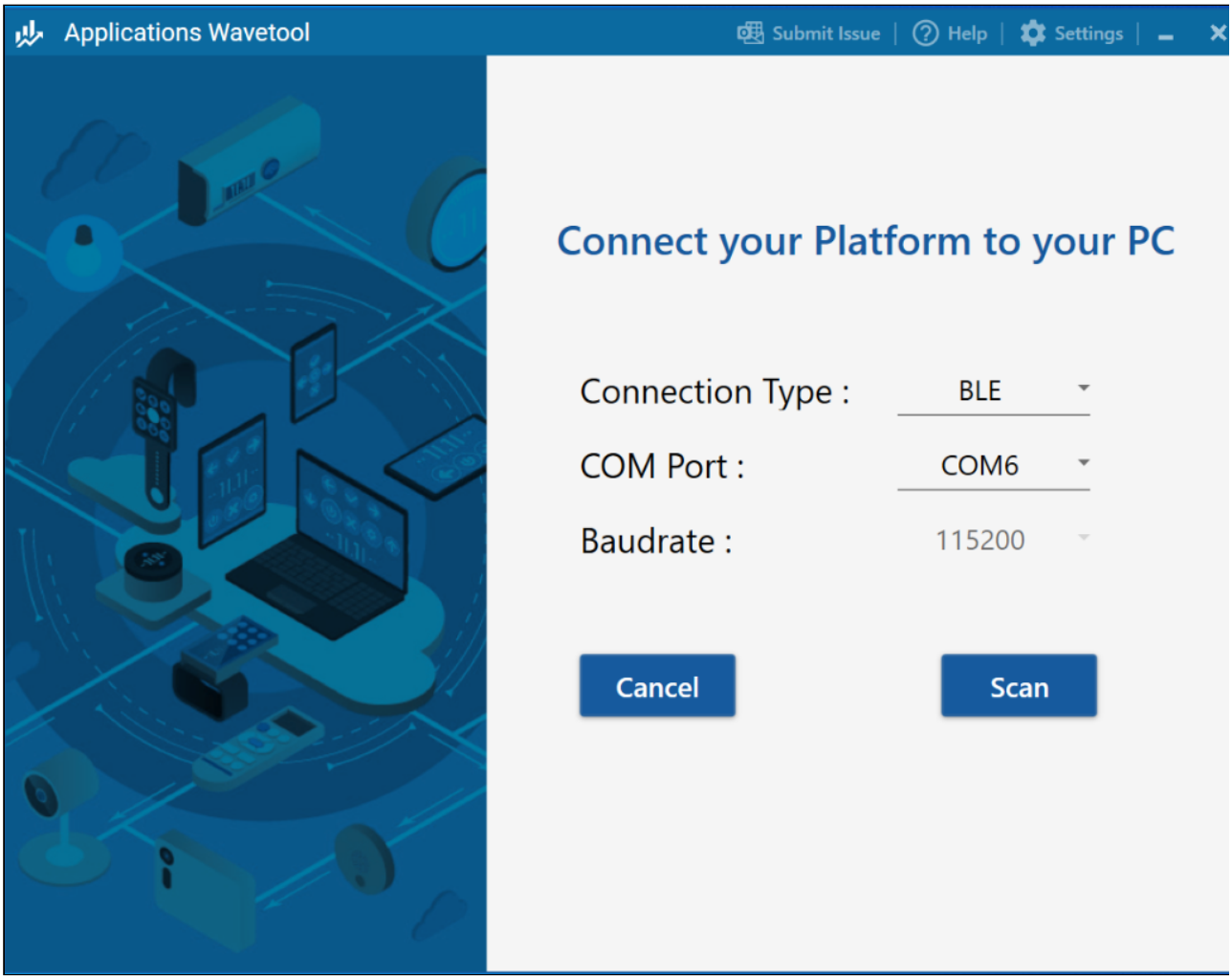
4.1.2 Running EDA application

- Connect the watch to your PC or laptop through a BLE dongle.
- Update the BLE firmware.
- Launch Applications Wavetool.
- On the Applications Wavetool Home screen, click **Connect**.



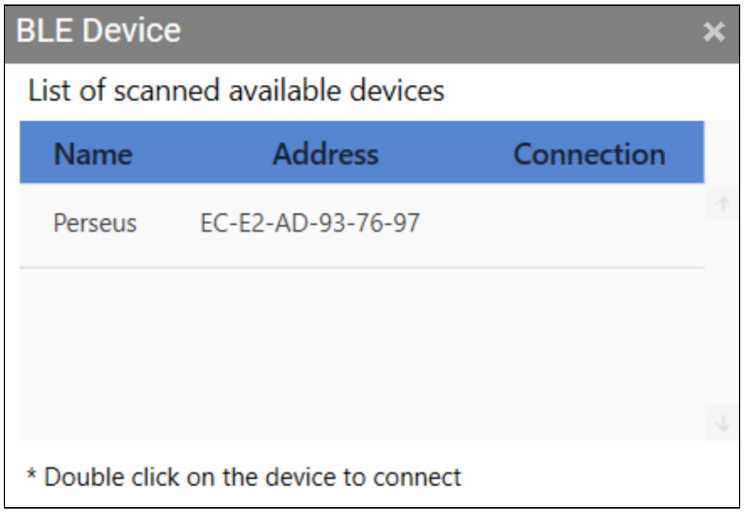
5 Applications Wavetool Home Screen

- Specify the required connection parameters as shown in the following figure and click **Scan**.



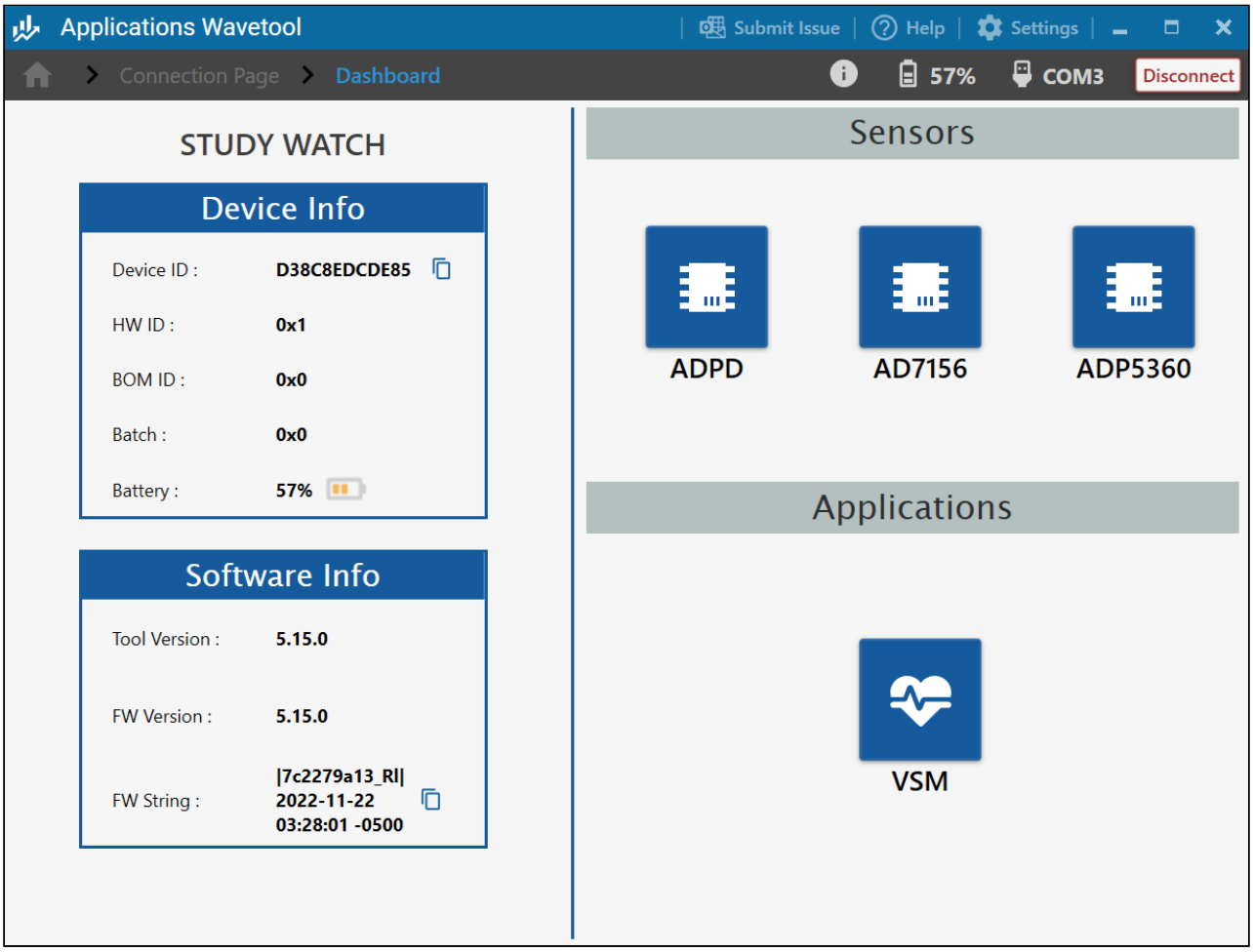
6 Connection Parameters

- Select the BLE device from the list shown and double-click to connect.



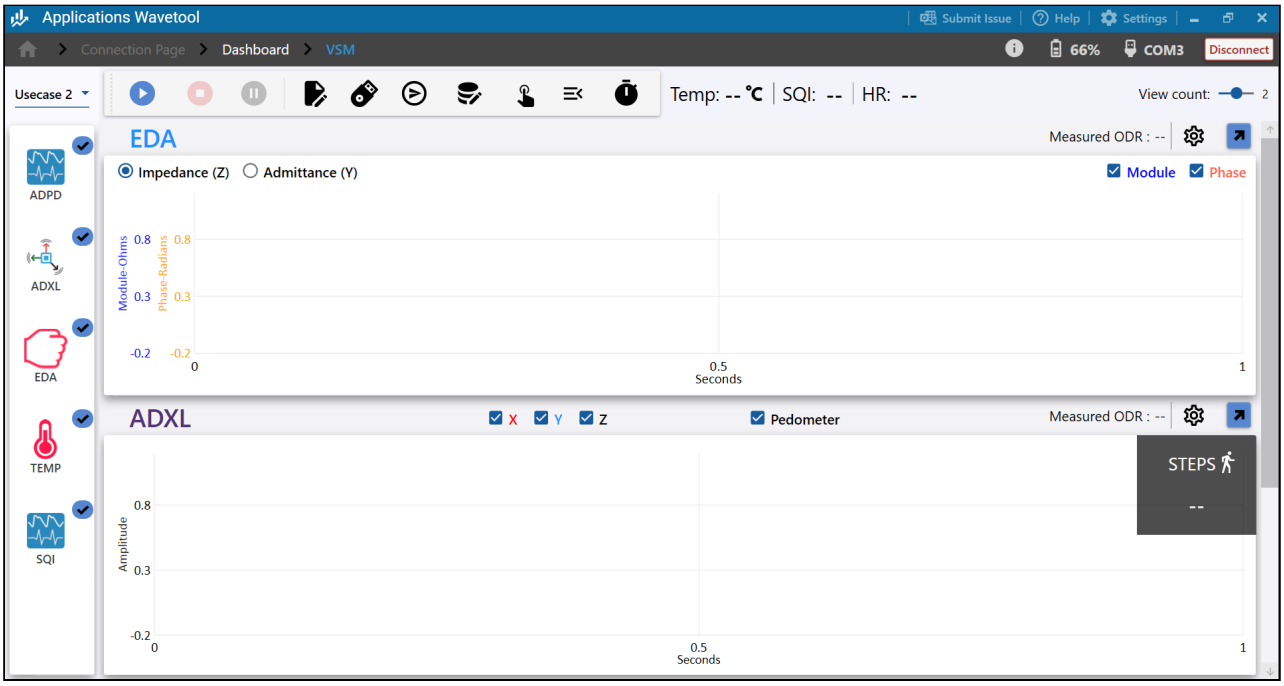
7 BLE Device

- Under **Applications**, click **VSM** to launch the application with default settings.



8 Applications Wavetool Dashboard

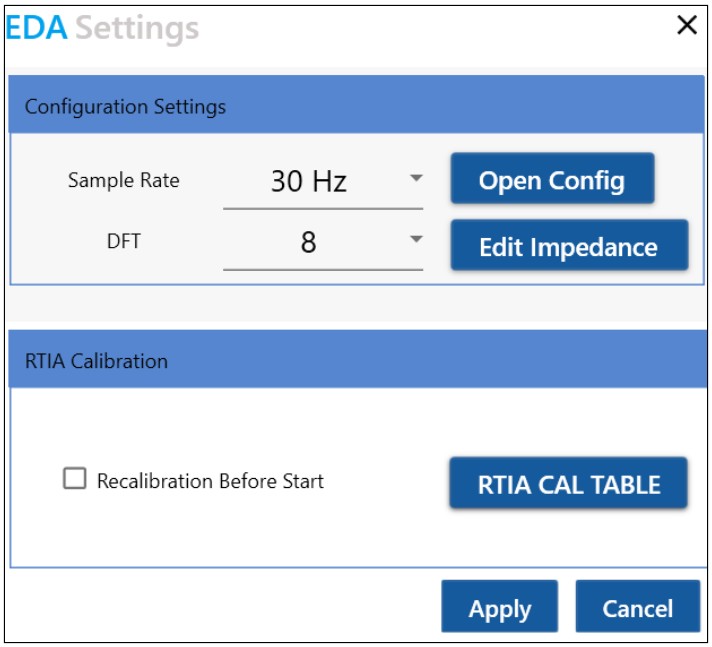
- Select the required use case and click the Play icon to start the application on the watch and analyze the output data stream on Applications Wavetool.



9 EDA Application View

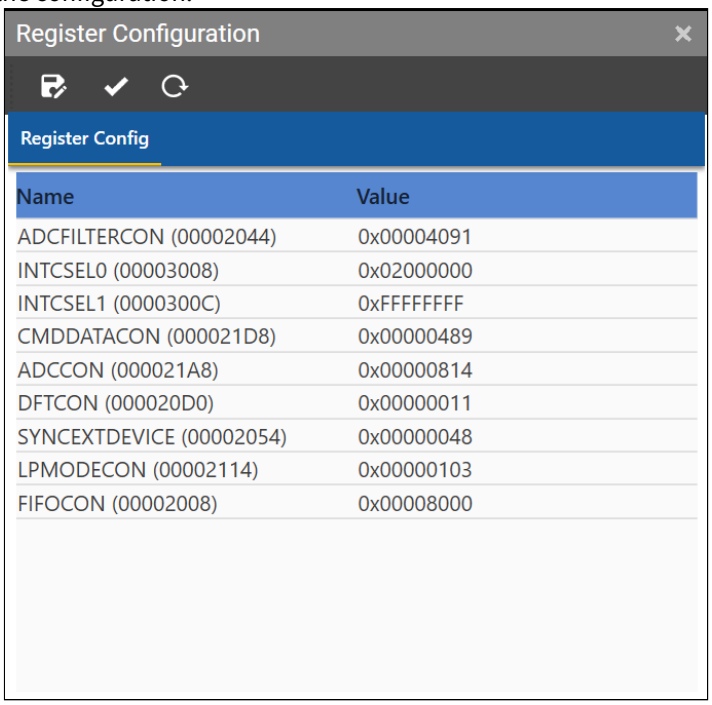
4.1.3 Configuring EDA Application

- On the application screen, click the Settings icon for EDA.
- In the EDA Settings dialog box, specify the following configuration parameters:



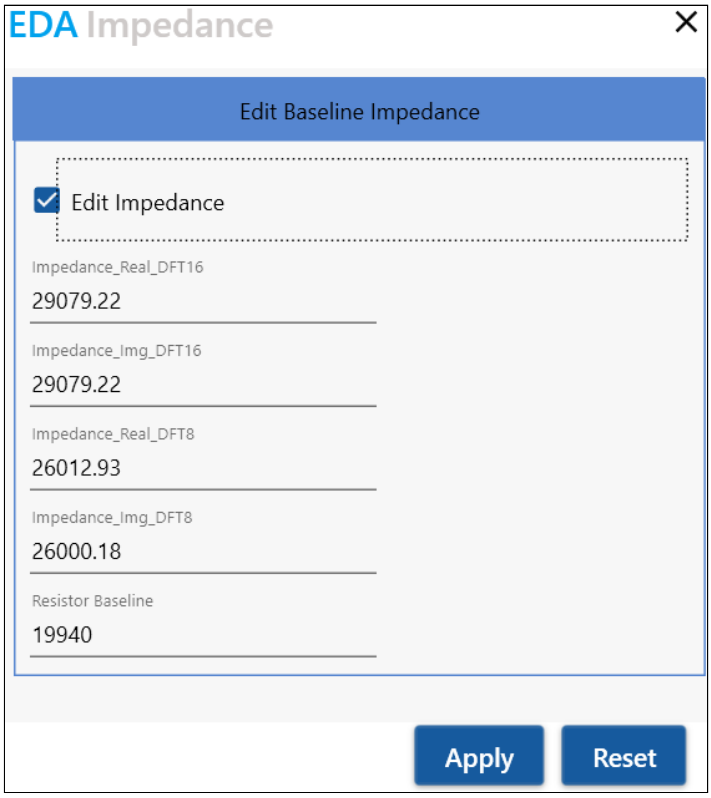
10 EDA Settings

- Configuration Settings:
  - Sample Rate: Specify the sampling rate for the EDA data.
  - DFT: Select the number of DFT points.
  - To set the register configuration for EDA measurement, click **Open Config**. In the Register Configuration dialog box, double-click a register value to edit and click the Apply Config icon  to apply the configuration.



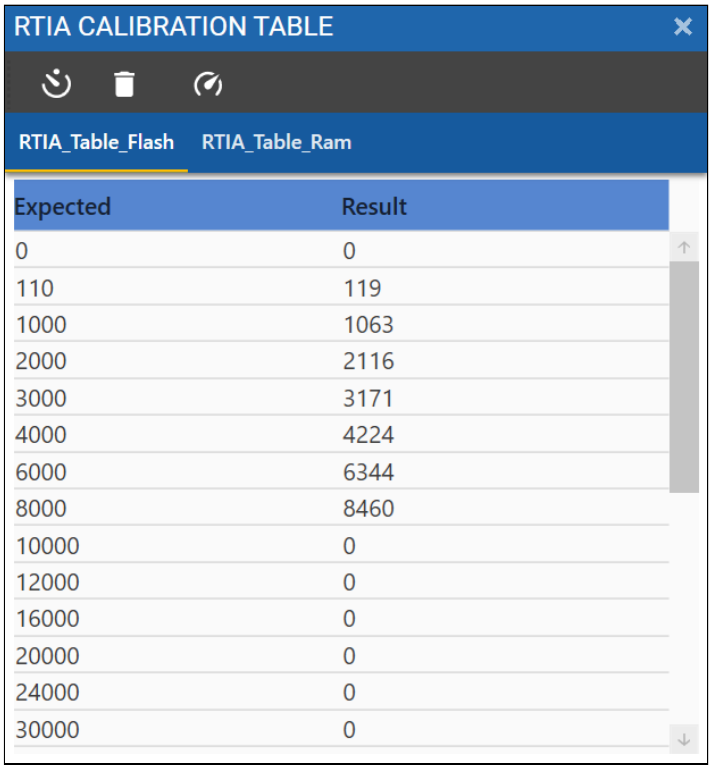
11 Register Configuration

- To edit baseline impedance values, click **Edit Impedance**. In the EDA Impedance dialog box, select the Edit Impedance checkbox, specify the real and imaginary parts of the baseline impedance for different DFTs and the resistor baseline value. Click **Apply**.



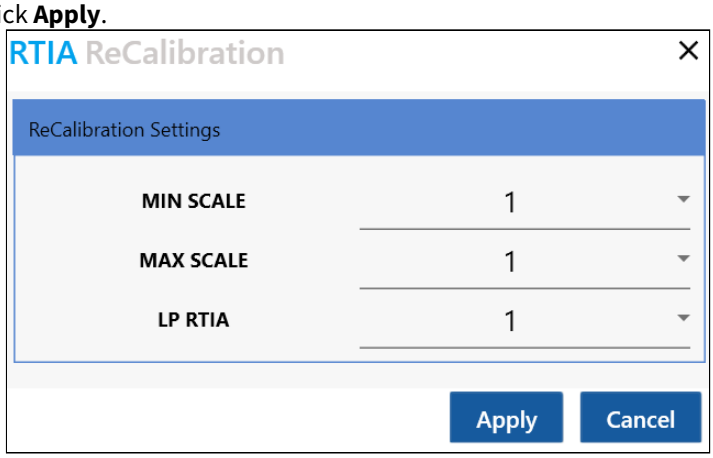
12 EDA Impedance

- RTIA Calibration:
  - Recalibration Before Start: Select the checkbox to perform RTIA recalibration before the measurement.
  - To view the RTIA calibration table, click **RTIA CAL TABLE**. In the RTIA CALIBRATION TABLE dialog box, click the Autoscaling icon  to enable dynamic scaling.



13 RTIA CALIBRATION TABLE

The RTIA ReCalibration dialog box is displayed. In the dialog box, specify the recalibration settings and click **Apply**.



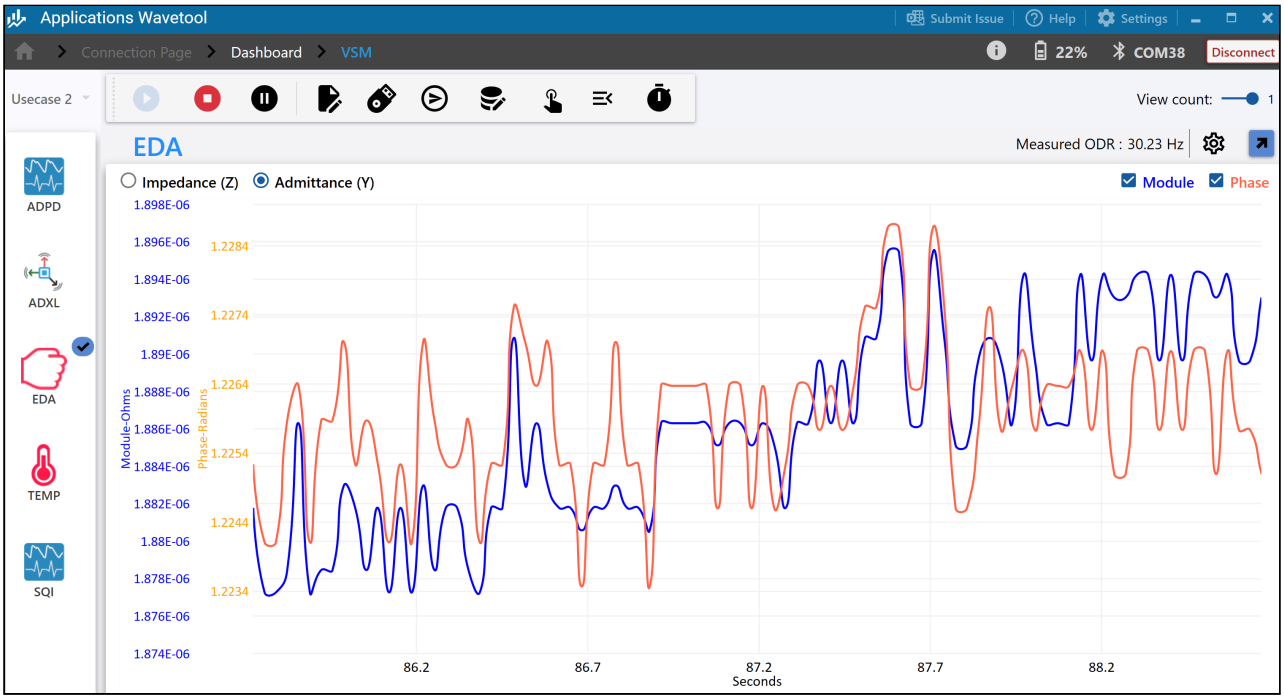
14 RTIA ReCalibration

- Click **Apply**.

4.1.4 Interpreting EDA Output

4.1.4.1 EDA: Admittance (Y)

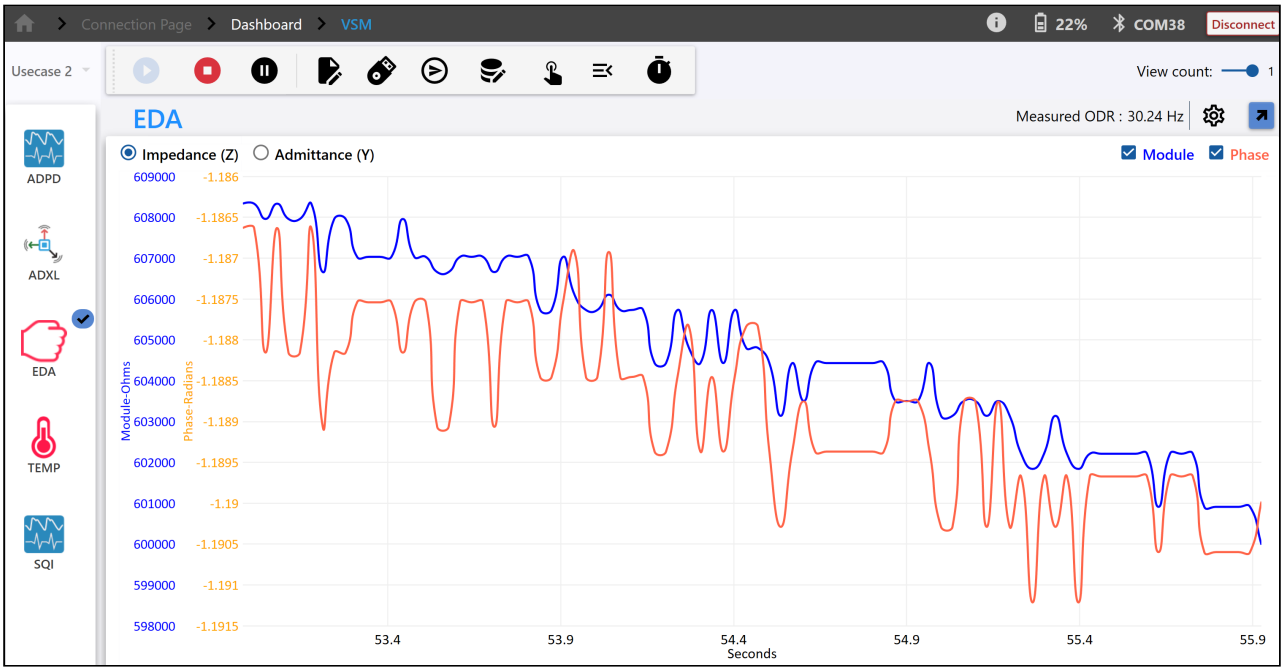
The blue graph shows a plot of skin admittance (ohms) with time (seconds). The red graph shows the plot of phase angle (radians) with time for determining the phase of admittance with respect to current.



15 EDA Application View

4.1.4.2 EDA: Impedance (Z)

The blue graph shows a plot of skin impedance (ohms) with time (seconds). The red graph shows the plot of phase angle (radians) with time for determining the phase of impedance with respect to current.



16 EDA Application View

4.1.5 Logging

The raw output data can be logged in local files (JSON or CSV) or in the NAND flash memory of the watch. To start logging raw data in the local files or NAND flash memory, click the Log icon or the Flash Log icon , respectively.

5 EVAL-HCRWATCH4Z I EDA: TROUBLESHOOTING

Error Scenario 1: BLE Dongle gets disconnected

Description: When the BLE dongle gets disconnected temporarily while running the EDA application on Applications Wavetool, the graphs display vague readings.

Solution: Reset the watch, connect the watch to your system again, and restart the EDA application on Applications Wavetool to display accurate data.

Error Scenario 2: Applications Wavetool displays erroneous data

Description: The placement of the watch on the wrist and the gap between the watch and the wrist are major factors affecting the measurement. Proper electrical contact between the two electrodes and the skin is critical for accurate and reliable long-term measurement.

Solution: Make sure that the device is worn one or two fingers away from the wrist bone (ulna). The device must be tight fit while being comfortable to the user. Additionally, ensure that there is almost no gap between the device and the wrist when the device is being pulled up.

6 EVAL-HCRWATCH4Z I EDA: LIMITATIONS