# Low Energy Bluetooth Service Broadcasting using ESP32 Devkit V1

**By Nirvan Tamhane**

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**Task Details**

**Services to be Broadcasted:**

- Temperature Measurement
- Humidity

**Details about the Service to Broadcast Over Bluetooth:**

- **Service UUID:** 00000002-0000-0000-FDFD-FDFDFDFDFDFD
- **Characteristics:**
    - Temperature Measurement: Standard BLE characteristic - GATT Char UUID: 0x2A1C
    - Humidity: Standard BLE characteristic - GATT Char UUID: 0x2A6F
- **Supported Operations:** Both characteristics support read and notify.

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**Hardware Components Used**

1. Espressif System's ESP32 Devkit V1 Development Board
2. DHT11 Temperature and Humidity Sensor
3. 10K Ohm Resistor (Pull-up)
4. USB to MicroUSB Cable
5. Breadboard
6. Jumpers

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**Tools Used**

**Arduino IDE**

Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

- For more details, refer to: Arduino IDE

**Fritzing**

Fritzing is an open-source hardware initiative that makes electronics accessible as creative material for anyone. We offer a software tool, a community website, and services in the spirit of Processing and Arduino, fostering a creative ecosystem that allows users to document their prototypes, share them with others, teach electronics in a classroom, and layout and manufacture professional PCBs.

- For more details, refer to: Fritzing

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**Microcontroller Interfacing**

- Used OneWire protocol to interface the microcontroller to the DHT11 sensor.
- Used BLE protocol for Connectivity with the nRF Connect Mobile Application.

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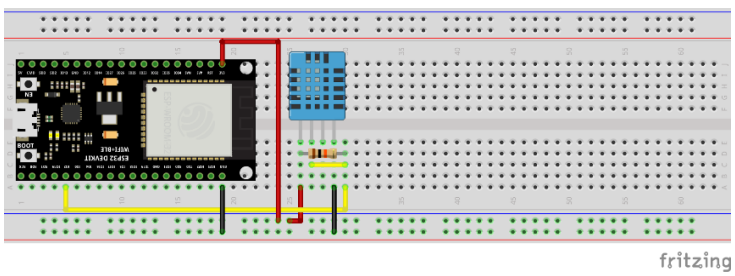
**Schematic**



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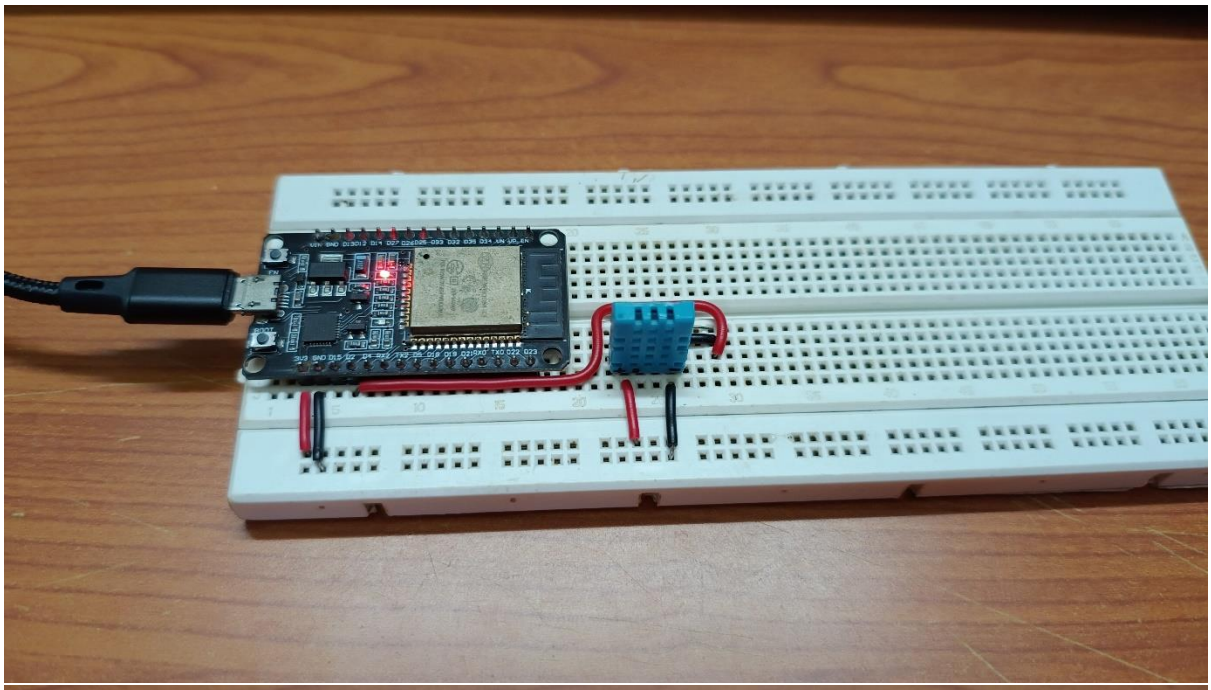
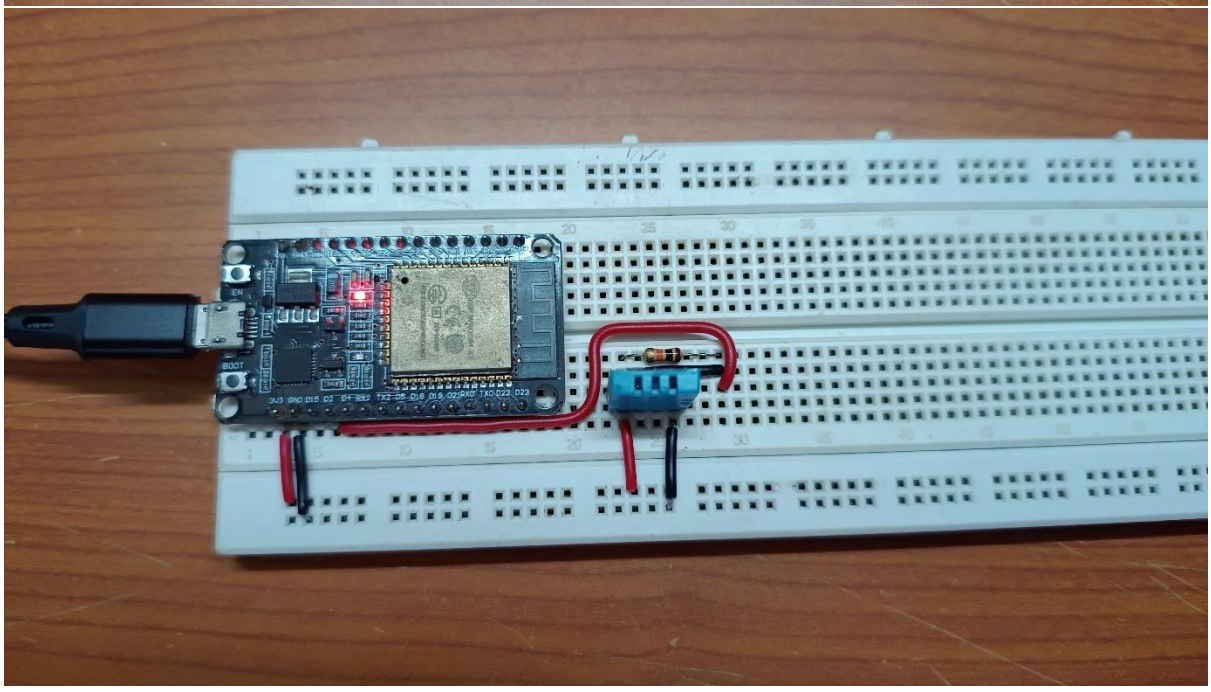
**Complete Hardware Assembly**





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**Firmware**

**Link:** Firmware .ino File

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**Project Overview Video**

**Link:** Project Overview Video

## Issues Faced and Resolution

### ESP32 Not Advertising After Disconnection

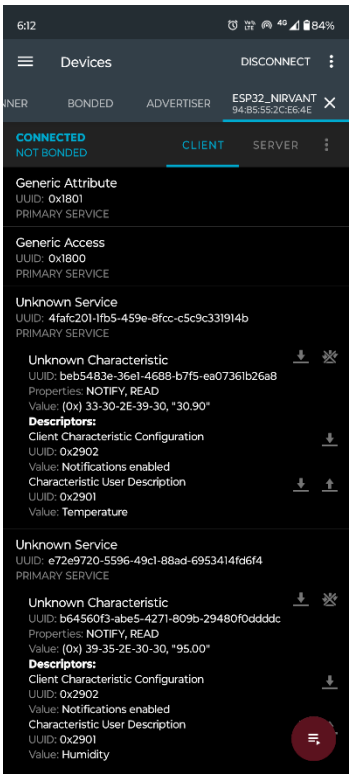
**Approach 1:**

- **Used the callback function to restart advertising within the loop itself.**
  - **Result: Successfully connected and reconnected multiple times with no issues (Check at the end of the Project Overview Video).**

### BLE Data Transmission Problem

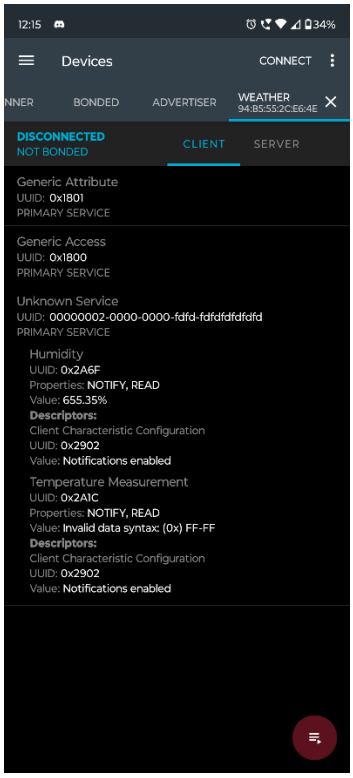
**Approach 1:**

- **Started with using custom characteristic UUIDs and tried to send the data as String values (I had worked on this before).**
- **Result: Successfully received both values Temperature Measurement & Humidity in Strings.**
- **Comment: This was not asked in the task. It was mandatory to use the default GATT UUIDs.**



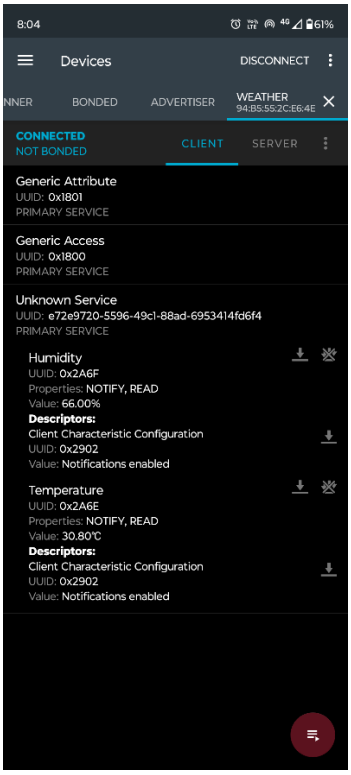
**Approach 2:**

- **Set the UUIDs to the required UUIDs (Temperature Measurement = 0x2A1C; Humidity = 0x2A6F) and tried to send the data as String values.**
- **Result: Error: Invalid Data Syntax @ nRF Application for Temperature Measurement value & Garbage value for Humidity value.**
- **Comment: This was not asked in the task. Getting the Humidity in % and Temperature Measurement in Celsius was mandatory.**



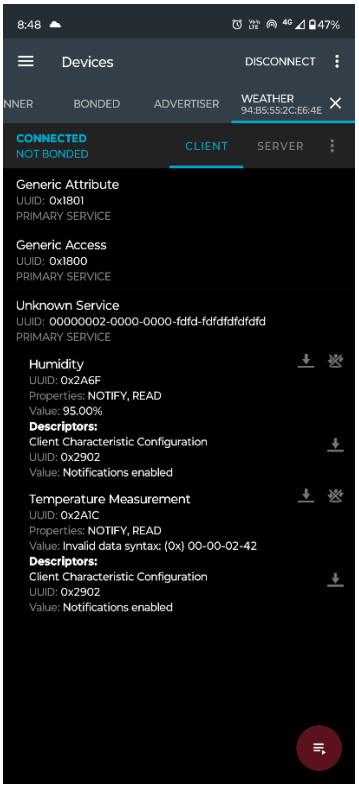

**Approach 3:**

- **Changed the Temperature characteristic UUID to default temperature (Temperature = 0x2AE6) and tried to send the data as unsigned 16-bit int.**
- **Result: Successfully received both values Temperature Measurement & Humidity in unsigned 16-bit int values.**
- **Comment: Checked the BLE documentation for the UUIDs (Temperature = 0x2AE6; Humidity = 0x2A6F) and their required data syntax type required.**



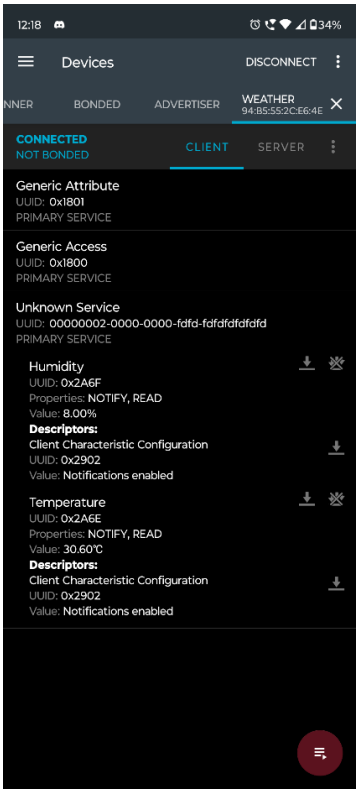
**Approach 4:**

- **Reset the Temperature characteristic UUID (Temperature Measurement = 0x2A1C) and tried to send the data as unsigned 16-bit int.**
- **Result: Error: Invalid Data Syntax @ nRF Application for Temperature Measurement value, but successfully received values for Humidity in unsigned 16-bit int values.**
- **Comment: Checked the BLE documentation for the Temperature Measurement UUID (Temperature Measurement = 0x2A1C) and their required data syntax type required.**



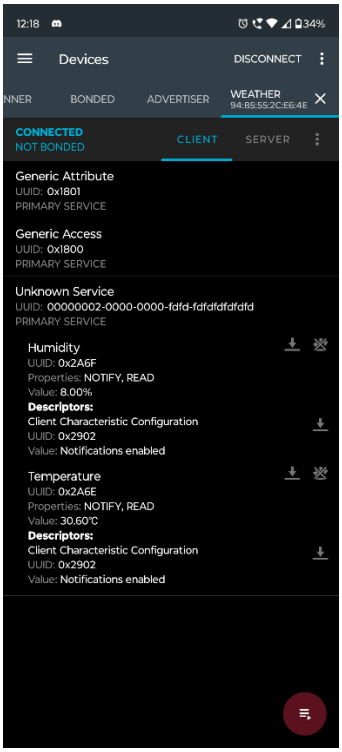

**Approach 5:**

- **Tried to convert the temperature data to 32-bit float and send the data along with the humidity data as unsigned 16-bit int.**
- **Result: Successfully received both values Temperature Measurement & Humidity in unsigned 16-bit int values, but Temperature Measurement unit was in Fahrenheit scale.**
- **Comment: Checked the BLE documentation for the Temperature Measurement UUID (Temperature Measurement = 0x2A1C) and their required data syntax type required and flags.**
- **Comment: Checked the conversion requires an IEEE11073 32-bit float data stream with 5 bytes (1 byte for C/F and 4 bytes for the actual value).**



**Approach 6:**

- **Changed the IEEE11073 32-bit float data stream with 5 bytes (1 byte for C/F and 4 bytes for the actual value) and set it to 0x00 flag for Celsius unit scale.**
- **Result: Successfully received both values Temperature Measurement & Humidity values on the nRF Connect Application with correct unit scales.**
- **Comment: Checked the BLE documentation for the Temperature Measurement UUID (Temperature Measurement = 0x2A1C) and their required data syntax type required and flags.**

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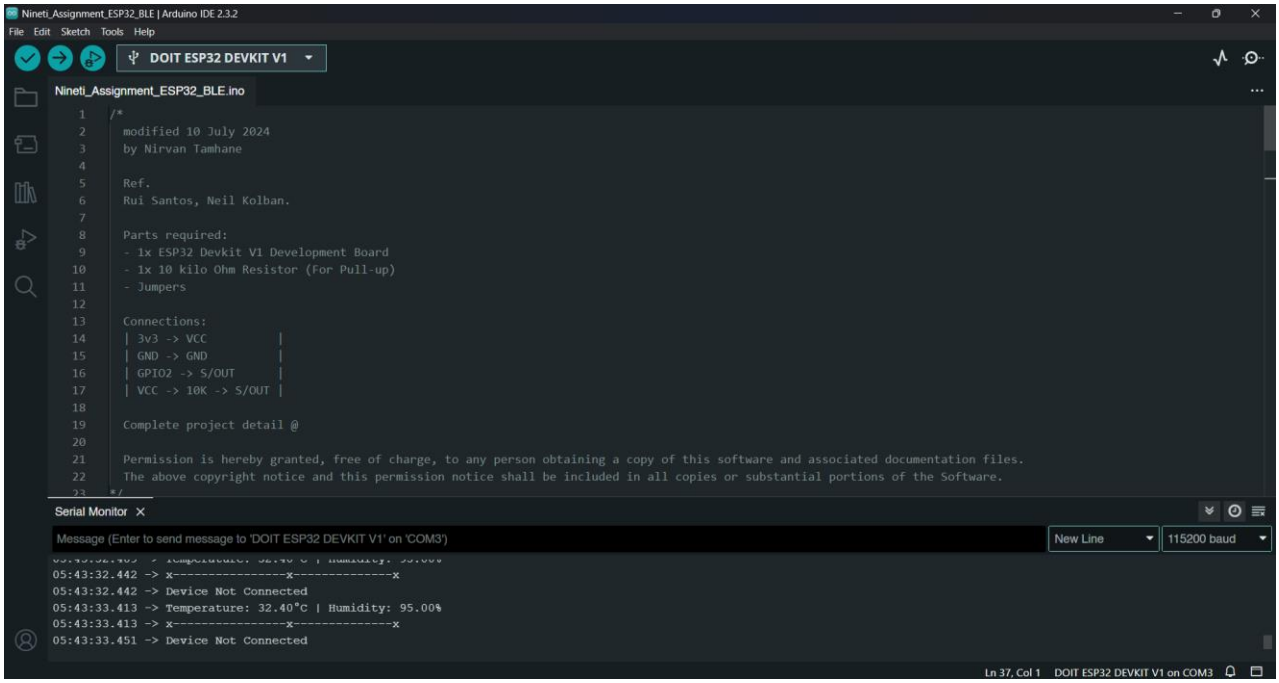
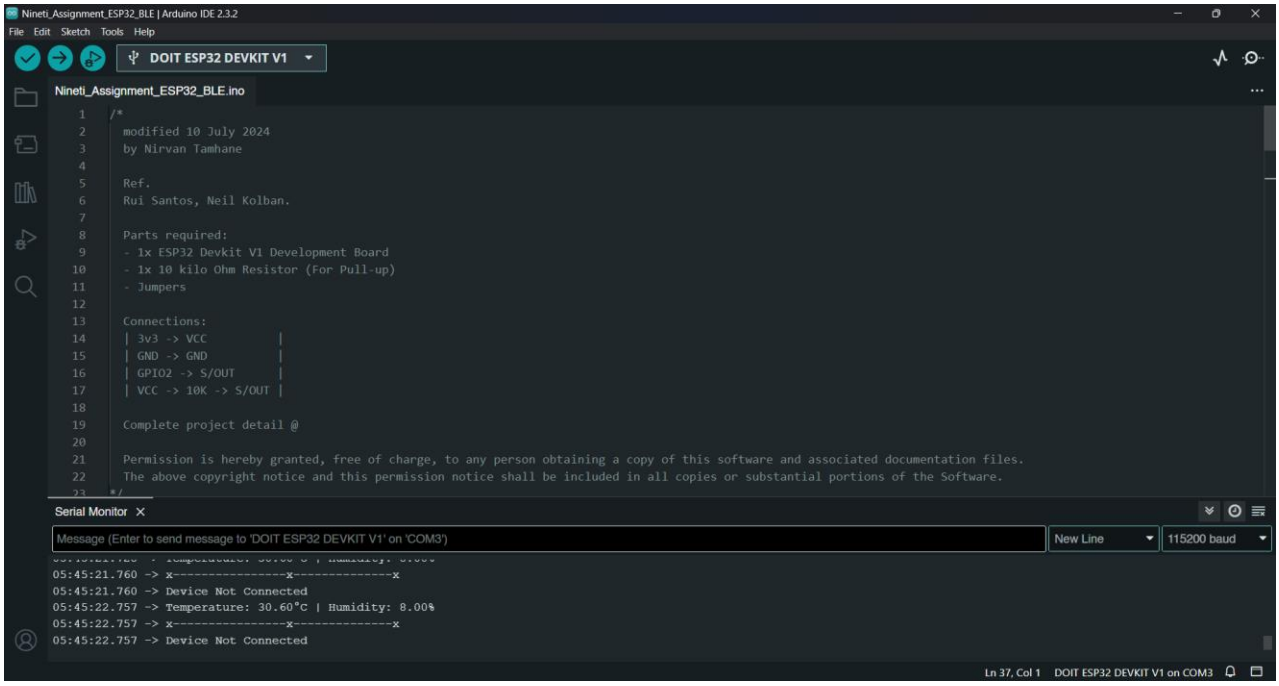
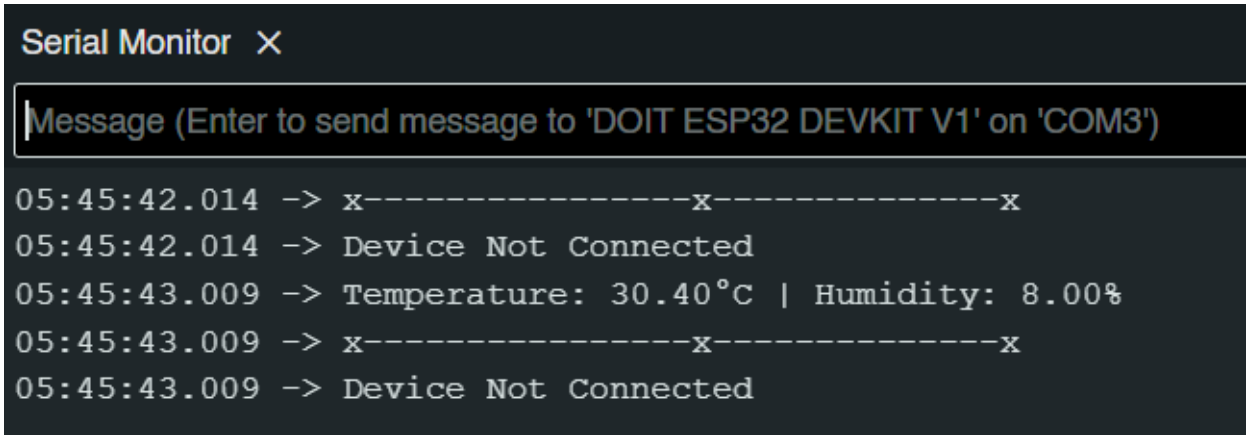
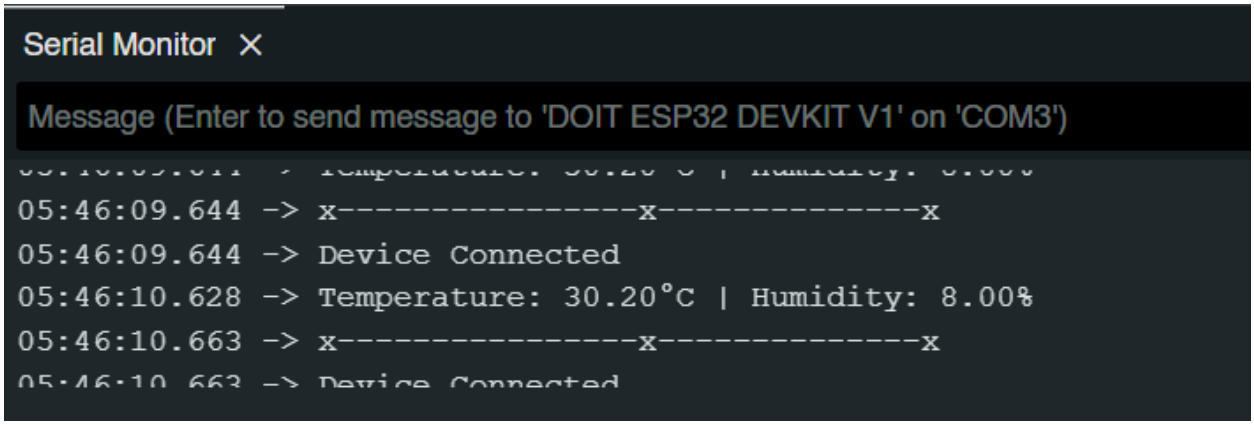
## Outputs

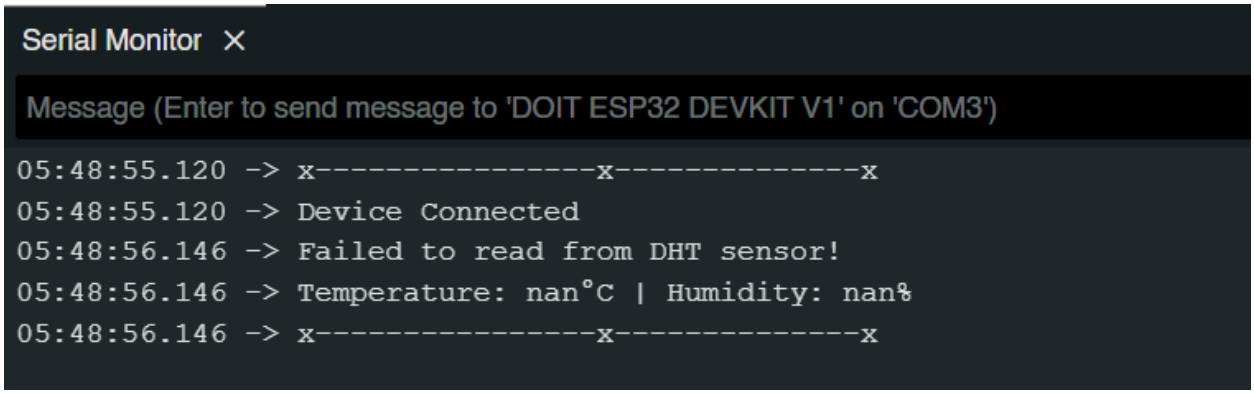
### Serial Monitor Messages




Nineti_Assignment_ESP32_BLE | Arduino IDE 2.3.2
File Edit Sketch Tools Help
DOIT ESP32 DEVKIT V1
Nineti_Assignment_ESP32_BLE.ino
/*
modified 10 July 2024
by Nirvan Tamhane
Ref.
Rui Santos, Neil Kolban.
Parts required:
- 1x ESP32 Devkit V1 Development Board
- 1x 10 kilo Ohm Resistor (For Pull-up)
- Jumpers
Connections:
| 3v3 -> VCC |
| GND -> GND |
| GPIO2 -> S/OUT |
| VCC -> 10K -> S/OUT |
Complete project detail @
Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files.
The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.
*/
Serial Monitor
Message (Enter to send message to 'DOIT ESP32 DEVKIT V1' on 'COM3')
New Line
115200 baud
05:45:21.760 -> x----------x----------x
05:45:21.760 -> Device Not Connected
05:45:22.757 -> Temperature: 30.60°C | Humidity: 8.00%
05:45:22.757 -> x----------x----------x
05:45:22.757 -> Device Not Connected
Ln 37, Col 1
DOIT ESP32 DEVKIT V1 on COM3


Serial Monitor
Message (Enter to send message to 'DOIT ESP32 DEVKIT V1' on 'COM3')
05:45:42.014 -> x----------x----------x
05:45:42.014 -> Device Not Connected
05:45:43.009 -> Temperature: 30.40°C | Humidity: 8.00%
05:45:43.009 -> x----------x----------x
05:45:43.009 -> Device Not Connected


Serial Monitor
Message (Enter to send message to 'DOIT ESP32 DEVKIT V1' on 'COM3')
05:46:09.644 -> x----------x----------x
05:46:09.644 -> Device Connected
05:46:10.628 -> Temperature: 30.20°C | Humidity: 8.00%
05:46:10.663 -> x----------x----------x

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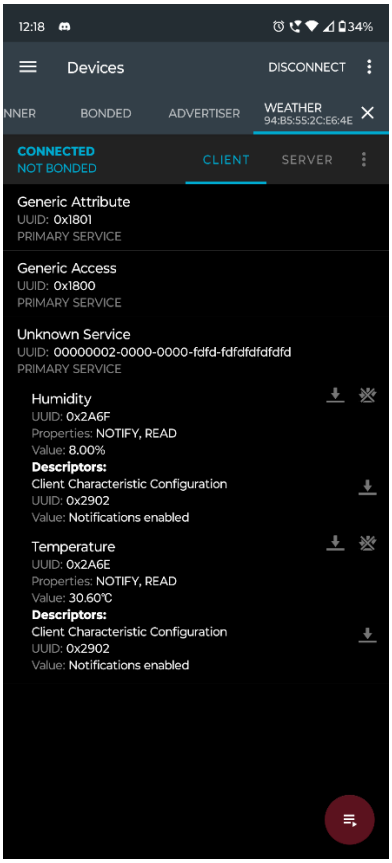
**nRF Connect Application interface**

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**References**


1. ESP32 BLE Arduino
2. RuiSantosdotme
3. Random Nerd Tutorials: ESP32 BLE Server Environmental Sensing Service
4. Makerhero: ESP32 BLE DHT11
5. ATC MiThermometer Issues
6. Converting Two Bytes to IEEE 11073 16-bit sfloat in C#
7. Dart: Convert IEEE 11073 32-bit Float to Simple Double
8. Bosch IoT Suite Bluetooth LE Driver API
9. GATT XML: Temperature Measurement


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