

EPD-T100Y

PD100 TELEDOSIMETER

LORA ENABLED

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Chapter 1

Overview



Figure 1.1: EPD-T100Y

EPD-T100Y is a series of pocket dosimeters capable of telemetry with LoRa-based Chirp Spread Spectrum Modulation. EPD-T100Y makes use of BG51, a sensor comprising an array of PIN Diodes that are designed to be sensitive toward Gamma Radiations. The device also supports a re-configurable telemetry cycle. The devices can be paired with any LoRaWAN gateway. These specialized devices are a perfect fit for remotely monitoring human dose.

- Compact Size & Lightweight

- Large 1.3", 128 * 64px OLED Display
- Detector Sensitivity of 5 cpm/ μ Sv/h
- 1 μ Sv/h to 100 mSv/h Dose Rate
- Energy Response of 70 keV to 2 MeV
- High Immunity to RF and Electrostatic Fields
- Uses LoRa Modulation for Telemetry with over 1km Range (Line of Sight)
- Full Charge in 3 Hour
- Re-configurable Telemetry Cycle from 10 to 3600 Seconds
- 6 Layer High Precision PCB with Gold Plated Pads
- Built in Automotive Grade Temperature and Humidity Sensor (SHTC3)



Figure 1.2: EPD-T100Y Back

1.1 Technical Specifications

Parameter	Min	Max	Unit	Remarks
Operating Voltage		3.3	V	
Current Consumption	89	90	mA	30-Second Telemetry Cycle
Battery Capacity		1500	mAh	0.5C LiPo
Battery Life	13	14	h	20-Second Telemetry Cycle
Operating Range	-40	85	°C	
Dose Rate Range	1	100000	uSv/h	
Energy Response	70	2000	KeV	
Detector Sensitivity		5cpm	cpm/μSv/h	±15%
LoRa Frequency	865	867	MHz	8 Channel
LoRa Spread Factor	7	12		Default - SF12
LoRa Bandwidth	125	250	KHz	Default - 125KHz
Enclosure Type		ABS		
Dimensions	95*60*26	96*61*27	mm	
Total Weight	98	105	g	
Charging Current		545	mA	

Chapter 2

Hardware

The chapter describes the general hardware overview of the EPD-T100Y.

2.1 Sensor

EPD-T100Y uses the BG51 sensor made by Teviso. Custom Aluminum Shielding and Power Filtering was done in order to improve immunity from RF and Power Fluctuations. The sensor specifications are listed below,

- Detector sensitivity: 5 cpm/ μ Sv/h
- Energy response: 50 KeV to above 2 MeV
- 5 cpm \pm 15% Detector Sensitivity
- High immunity to RF and electrostatic fields

2.2 LED Indicators



Figure 2.1: LED Indicators

EPD-T100Y dosimeter makes use of 4 LED indicators.

- The LED marked **1** in the image 2.1 is the **Charging Indicator**. This Orange LED only work when the device is powered by a USB Type-C Cable.
 - If ON: Device is Charging
 - If OFF: Device is Not Charging
- LED marked **2** in the image 2.1 is the **Full Charge Indicator**. This Orange LED only work when the device is powered by a USB Type-C Cable.
 - If ON: Device Completely Charged
 - If OFF: Device Not Completely Charged

- The LED marked **3** in the image 2.1 is the **Power Status Indicator**. This Red LED only work if the device is turned on.
- The LED marked **4** in the image 2.1 is the **Transmission Indicator**. This Green LED only work while Transmitting Data.

2.3 Display Layout & Navigation



Figure 2.2: EPD-T100Y Display Layout Example

EPD-T100Y comes with a 1.3" OLED Display with 128*64 Pixel resolution. By default, the device consists of 4 pages, cycled through by pressing the button.



Figure 2.3: Display Pages 1 & 2



Figure 2.4: Display Pages 3 & 4

This is a display with a dynamic layout as shown in the image 2.3 & 2.4. All pages have a Static Header and Footer Layout.

2.3.1 Header and Footer

The Header from right to left consists of **Session ID**, **Counts Per Second**, **Transmission Active**, and **Battery Bar**.

- **Session ID:** Each Device Generates a New ID of 0-255 during device reset. Session ID helps the server to identify if a reset occurred.

- Counts Per Second (CPS)
- Transmission Active: **TX** tag represents whether the Transmission is Active. On Low Battery, Transmission is disabled, resulting in an empty tag. Device will continue to work without Telemetry. Once the device connects to a Type C Cable for charging, it will restart the Transmit Cycle.
- Battery Bar: A slider which shows the current state of charge (SOC).

The Footer represent the page number and the corresponding page heading. The type of pages which the device can show are listed below.

2.3.2 Total Dose Page

This page shows the Cumulative Dose on the left side of the screen. This value will have two decimal place and will automatically scale to **mSv** and **Sv** unit.

2.3.3 Dose Rate Page

This page shows the Dose Rate on the left side of the screen. This value will automatically scale to **mSv** unit on the display.

2.3.4 Settings Page

This page shows the basic settings and identifier of the device. The page showcases Serial Number and Device EUI on the first two lines. The third line consists of the currently saved calibration factor and duty cycle for telemetry.

2.3.5 Statistics Page

This page shows the basic device stats. The first line shows **Temperature**, followed by **Relative Humidity**. The next line shows the **Battery Voltage** in Millivolts and the battery **State of Health (SOH)**.

2.4 USB Type-C Connector & Reset Switch

The device has a USB Type C Connector on the bottom to charge and to access the configuration. Additionally, a reset button is placed on the right side of Type C connector, as shown in Image 2.5. The button is to reset the device under any malfunction, but the saved configuration will not be lost.



Figure 2.5: USB Port

2.5 Antenna

The device uses a Flexible Antenna connected to the onboard UFL Connector. Listed below are the antenna specifications.

- Frequency: 865-867 MHz
- VSWR: 1.5
- Gain: 5dBi
- Connector: UFL
- Weight: 3g +- 0.5g

2.6 Frequency Plans

The device supports up to 8 Channels for Telemetry. Five channels can be allocated to Teledosimeter, as shown in the table below.

Channel	Frequency (Hz)	Devices
0	865062500	Area Gamma Monitor
1	865402500	Area Gamma Monitor
2	865985000	Area Gamma Monitor
3	865742500	Teledosimeter
4	866185000	Teledosimeter
5	866385000	Teledosimeter
6	866585000	Teledosimeter
7	866785000	Teledosimeter

Chapter 3

Usage

ERAD Configurator V2.X is used to control the configuration parameters, which includes both Telemetry Cycle and Calibration Constants. The same utility is used to turn OFF and reset the reading. To ensure the proper functioning of the configurator, the following prerequisites should be done before running the configurator.

3.1 Prerequisites for Using Configurator

The following steps need to be done before using the Teledosimeter Configurator. These steps have to be repeated for every PC that will run the Configurator.

3.1.1 Ubuntu 20.04 or Above

- Open terminal and run the following command. This command is to give the user additional permission.

```
sudo usermod -aG dialout $USER
```

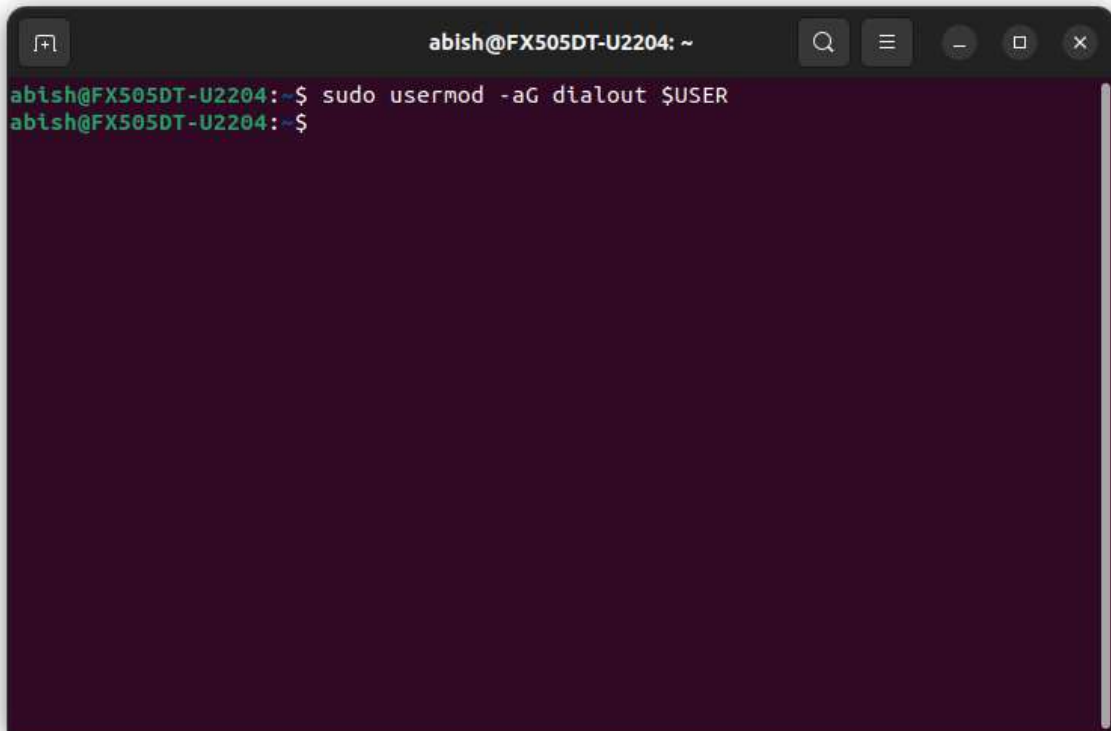


Figure 3.1: Prerequisite: Adding Path to Group

- Restart the computer
- Right Click on Configurator, Select **Properties** and Check **Allow executing file as program** in the **Permission** Tab.

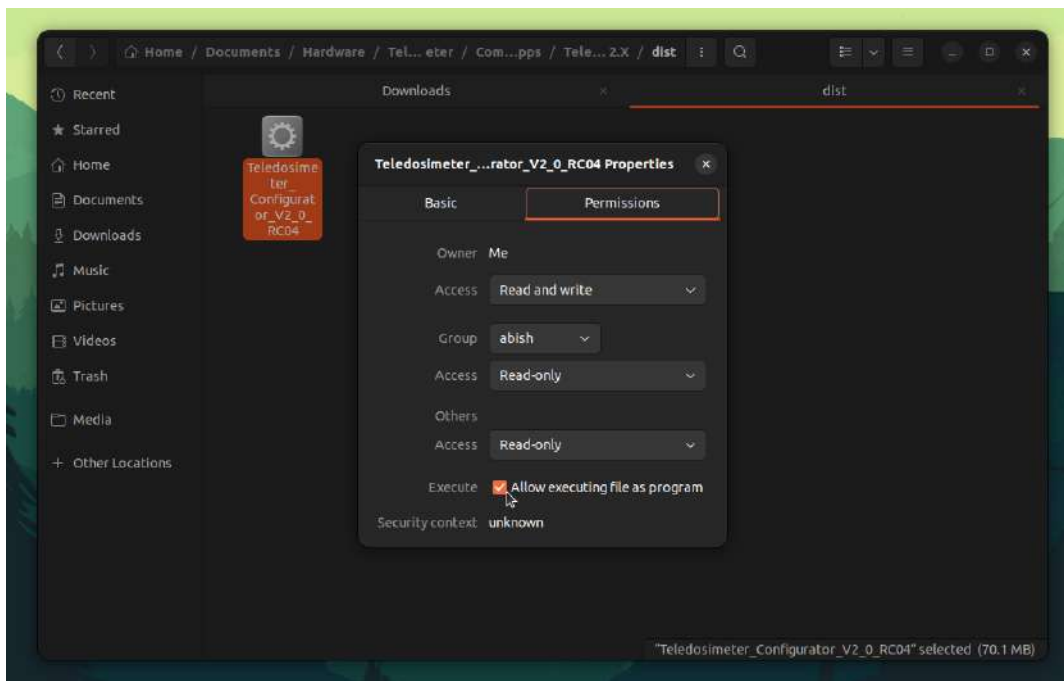


Figure 3.2: Adding File Run as Executable

3.1.2 Windows 10 or Above

- Check Whether PC is 64bit or 32bit.
- Install CP210X Driver from Silicon Labs (**Source**). Make sure to choose either 32bit or 64bit, depending upon the PC.
- Restart the computer

3.2 Turning On Dosimeter

A turned off Dosimeter will have the **Power LED** Turned off (Refer 2.2). To turn on the device, press on the **Button** of Teledosimeter. The **Display** and **Power LED** will turn on after pressing the button.

Note: If the device does not turn on, the device may have a fully drained battery. Connect a Type C Cable to the supplied Wall Adapter.

3.3 Waking Up Display

A normally functioning device will turn off the display after every 60 seconds in order to reduce power consumption. Make sure that the device is turned on by checking the **Power LED** (Refer 2.2).

To wake the display, press the **Button** once to turn on the display.

3.4 Connecting Dosimeter with Configurator

Following is the procedure to connect Teledosimeter with the Configurator.

- Open the ERAD Configurator V2.X Software.
- Connect the Teledosimeter to computer with the supplied USB Type C Cable.
- Click on **Refresh** Button and Check for Open Ports.

Note: Ports will be in format, **/dev/ttyUSBX** in Linux and **COMX** on Windows. If showing **"No Connected Ports"**, it would probably be a malfunctioning cable or Prerequisites has not been as mentioned in 3.1.

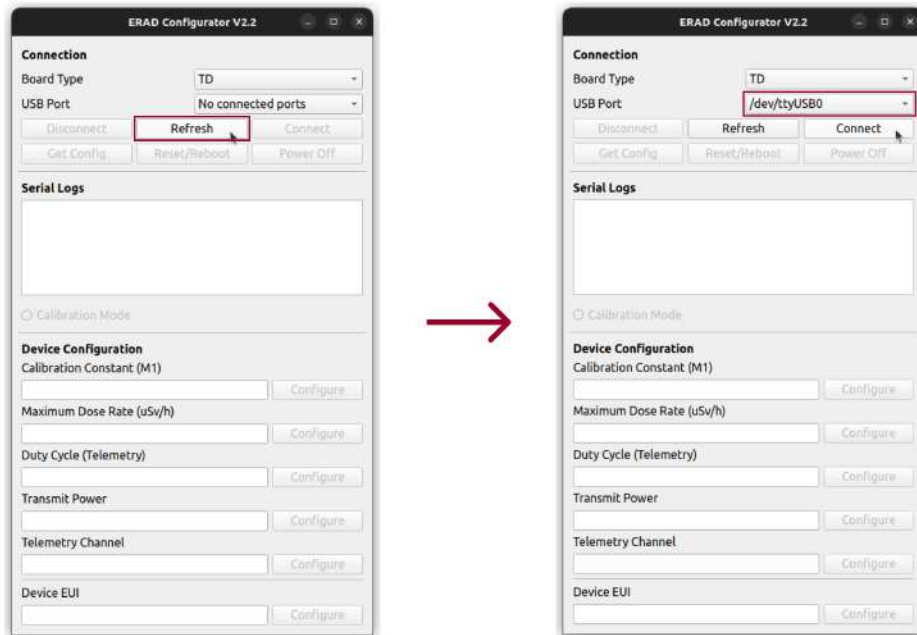


Figure 3.3: Connecting Dosimeter with Configurator

- Select the Port from the **USB Port** Drop down, and Click on **Connect** Button.
- Once the device is connected, the **Connect** button will be disabled.
- ERAD Configurator V2.2 or above automatically tries to retrieve configuration upon connecting to a device. If Configuration is not received, Click on **Get Config** Button to retrieve all the Parameters currently saved within the device.

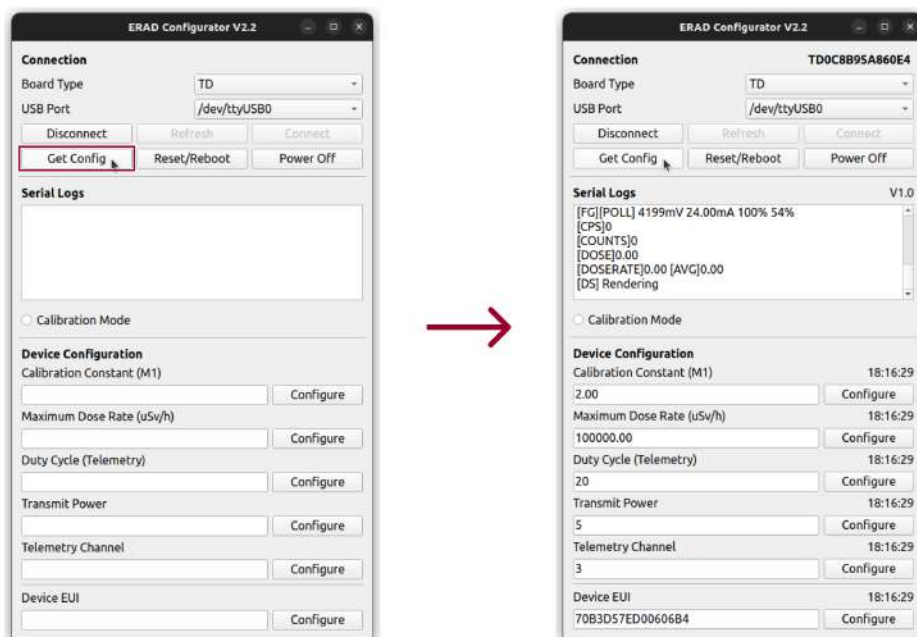


Figure 3.4: Settings Saved Parameters from Device

3.5 Turning Off Dosimeter

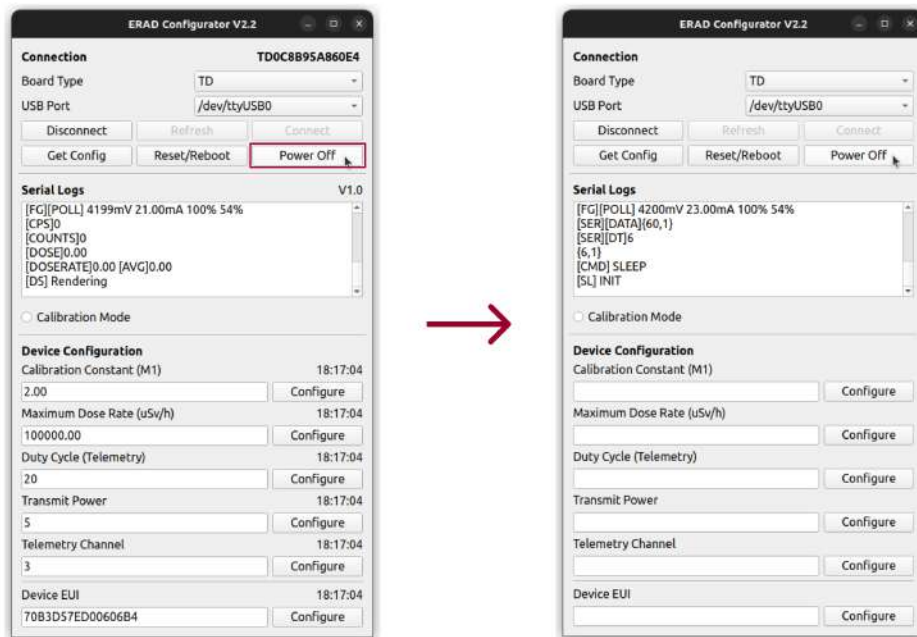


Figure 3.5: Powering Off Dosimeter

A turned on Dosimeter showcases a functioning **Power Status Indicator** LED (Refer 2.2).

Connect the device with the configurator as mentioned in 3.4. Following is the procedure to Turn Off Teledosimeter with the Configurator.

- Click on **Power Off** Button.
- Remove the Type C Cable from Teledosimeter.
- Click on **Disconnect** Button.

Follow the same procedure from 3.4 to do the same for multiple devices.

3.6 Reset Dose & Dose Rate

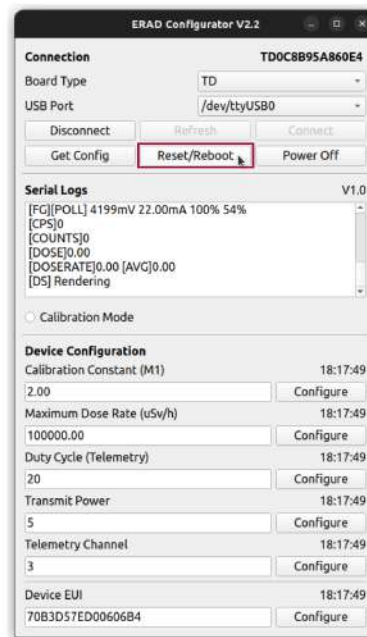


Figure 3.6: Reset Dose & Dose Rate

A turned on Dosimeter showcases a functioning **Power Status Indicator** LED (Refer 2.2).

Connect the device with the configurator as mentioned in 3.4. Following is the procedure to Reset the Teledosimeter within the Configurator.

- Click on **Reset** Button.
- Remove the Type C Cable from Teledosimeter.
- Click on **Disconnect** Button.

Follow the same procedure from 3.4 to do the same for multiple devices.

3.7 Modifying a Configuration Parameter

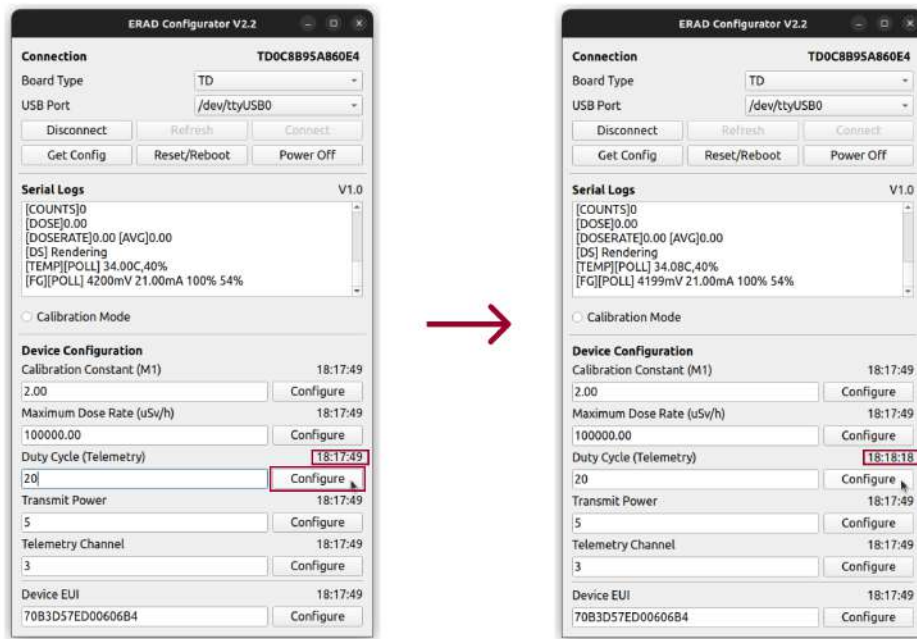


Figure 3.7: Modifying Telemetry Duty Cycle

A turned on Dosimeter showcases a functioning **Power Status Indicator** LED (Refer 2.2).

Connect the device with the configurator as mentioned in 3.4. Following is the procedure to get or modify configuration of the Teledosimeter within the Configurator.

- Click on **Get Config** Button.
- Make the Required Changes in Configuration.
For example, Set the Duty Cycle to 60 so that the device transmits data every 60 seconds.
- On Clicking the **Configure** Button of the Changed Parameter, the time just above the **Configure** Button will be updated. This confirms the successful operation.
- Click on **Disconnect** Button.

Note: It is recommended not to use Channels 0 to 2 for Teledosimeter since those are Lo-RaWAN Join frequencies. 0 to 2 Channels are also reserved for Area Gamma Monitors and devices with Long Telemetry Cycle. Use 3 to 7 Channels for Teledosimeter.

Follow the same procedure from 3.4 to do the same for multiple devices.

3.8 Calibration Mode

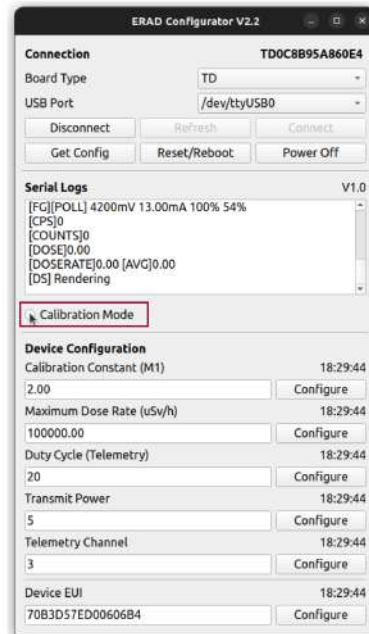


Figure 3.8: Calibration Mode

ERAD Configurator V2.2 or higher supports **Calibration Mode**, which can be turned on by clicking the radio button as shown in image 3.8. This will disable Telemetry if the calibration facility suggests avoiding any RF transmission during the calibration procedure.

Chapter 4

Calibration and LoRa Specification

4.1 LoRa Parameters

The subsequent list comprises the LoRa parameters that have been preconfigured on the EPD-T100Y. The device joins a LoRaWAN network with Authentication By Personalization (ABP). The devices were tested with a Wisgate Edge Lite 2 LoRaWAN Gateway manufactured by RAKWireless, which is an 8 Channel Gateway Supporting 49 Demodulators. Upon request, a preconfigured LoRaWAN Gateway with a High Gain Outdoor Antenna will be bundled along with the devices.

- Frequency: 865 - 867 MHz
- Bandwidth: 125 kHz
- Spreading Factor: 12
- Duty Cycle: 30 Second (0 - 15 Random Time Addition)

4.2 Calibration Information

Each and every EPD-T100Y dosimeter shipped will have a calibration certificate. The devices are calibrated at **Avantec**, an AERB recognized calibration facility.

The Following Reference Instrument was used for Calibration at **Avantec**,

- Instrument: 10cc Ion Chamber
- Model: IC10016
- Traceability No: BARC/RSSD/RSS/CAL/C-144/2022

Source with the Following Parameters were used for Calibration at **Avantec**,

- Radionuclide: Cobalt 60 (^{60}Co)
- Energy / Unit: 1.25 MeV
- Exposure Rate: 5.00 mSv/h

List of Abbreviations

LoRa	Long Range
RSSI	Received Signal Strength Indicator
VSWR	Voltage Standing Wave Ratio
CPS	Counts Per Second
CPM	Counts Per Minute
mSv	milli Sievert
uSv	micro Sievert
VCC	Voltage Common Collector
Tx	Transmitter
Rx	Receiver
MHz	Mega Hertz
UART	Universal Asynchronous Receiver-Transmitter
SOH	State of Health
SOC	State of Charge