

# EPD-T100Y PD100 TELEDOSIMETER LORA ENABLED



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## 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/µSv/h
- $1 \mu$ 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

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	

## **1.1 Technical Specifications**

## 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/µSv/h
- Energy response: 50 KeV to above 2 MeV
- 5 cpm ± 15% Detector Sensitivity
- High immunity to RF and electrostatic fields

### 2.2 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 2.4: 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

## 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.

* Starred       Image: Starred         in Home       Image: Starred         in Downloads       Image: Starred         in Music       Image: Starred         in Videos       Image: Starred         in Trash       Access         in Media       Others         in Security context       Image: Starred         in Media       Others         in Media       Starred         in Media       Others         in Media       Starred         in Media       Stared         in Media	🕯 Starred					
Home   Documents   Downloads   Music   Dictures   Videos   Trash   Access   Read-only   Media   Other Locations   Execute   Execute   Execute   Execute   Chlow executing file as program   Security context		O.				
Bocuments Configurat   Ownloads Owner Me   Music Access   Pictures Access   Videos Group   Videos Group   Abish ~   Media Others   Access Read-only   Other Locations Execute   Security context unknown	) Home	Teledosime	Teledosimeter	rator_V2_0_RC04 Prop	oerties ×	
Downloads     Owner Me     Access Read and write     Access Read and write     videos     Group abish ~     Access Read-only ~     Media     Other Locations     Execute Allow executing file as program     Security context unknown	) Documents	Configurat	Basic	Permiss	tions	
Music     Owner     Me       Pictures     Access     Read and write       Videos     Group     abish       Trash     Access     Read-only       Media     Others       Access     Read-only       Other Locations     Execute       Security context     unknown	Downloads	RC04				
Pictures     Access     Read and write       3 Videos     Group     abish       2 Trash     Access     Read-only       2 Media     Others       Access     Read-only       • Other Locations     Execute       Execute     Callow executing file as program       Security context     unknown	Music		Owner M	Me		
3 videos     Group abish ~       2 Trash     Access Read-only ~       0 Media     Others       0 Other Locations     Access Read-only ~       Execute     Allow executing file as program       Security context     unknown	] Pictures			Read and write		
Access     Read-only       Media     Others       Other Locations     Access       Execute     Allow executing file as program       Security context     unknown	3 Videos			abish ~		
Media     Others       Other Locations     Access       Execute     Allow executing file as program       Security context     unknown	] Trash			Read-only		
Other Locations  Access Read-only  Cher Locations  Execute Cher Locations  Execute Cher Locations  Cher Locati	🗇 Medla					
Execute Allow executing file as program				Read-only		
i¢ Security context: unknown	Other Locations			🛛 Allow executing file	as program	
			Security context	unknown		

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.

ER	AD Configurator V2.2		ERAD Confi	gurator V2.2	9
Connection			Connection		
Board Type	TD	•	Board Type	TD	
JSB Port	No connec	ted ports -	USB Port	/dev/ttyUSE	80
Disconnect	Refresh		Disconnect	resh	Conn
Get Config	Reset/Reboot	Power Off	Get Config Reset/		
Serial Logs		Serial Logs			
() Calibration Mode			O Calibration Mode		
Device Configuration	M1)		Device Configuration Calibration Constant (M1)		
Calibration Constant (M		Configure			
Calibration Constant ()			Maximum Dose Rate (uSv/h)		
Calibration Constant () Maximum Dose Rate (u	JSv/h)				
alibration Constant () Iaximum Dose Rate (u	JSv/h)	Configure	Dutu Curla (Talamatra)		
alibration Constant () Iaximum Dose Rate (u uty Cycle (Telemetry)	uSv/h)	Configure	Duty Cycle (Telemetry)		
alibration Constant () aximum Dose Rate (u uty Cycle (Telemetry) ansmit Power	uSv/h)	Configure	Duty Cycle (Telemetry) Transmit Power		
alibration Constant () laximum Dose Rate (u uty Cycle (Telemetry) ransmit Power	uSv/h)	Configure Configure	Duty Cycle (Telemetry) Transmit Power		
alibration Constant () laximum Dose Rate (u uty Cycle (Telemetry) ransmit Power elemetry Channel	uSv/h) )	Configure Configure	Duty Cycle (Telemetry) Transmit Power Telemetry Channel		
elibration Constant () laximum Dose Rate (; uty Cycle (Telemetry) ansmit Power ilemetry Channel	usv/h)	Configure Config	Duty Cycle (Telemetry) Transmit Power Telemetry Channel		
Calibration Constant () Maximum Dose Rate (; Juty Cycle (Telemetry) Iransmit Power 'elemetry Channel Jevice EUI	usv/h)	Configure Configure Configure Configure	Duty Cycle (Telemetry) Transmit Power Telemetry Channel Device EUI		

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.

E	RAD Configurator V2.	2 😑 🗆 X	E	RAD Configurator V2.2 🔤 🗉
Connection			Connection	TD0C8B95A860E
Board Type	TD	*	Board Type	TD
USB Port	/dev/ttyU	5B0 -	USB Port	/dev/ttyUSB0
Disconnect	Refresh		Disconnect	
Get Config 🖡	Reset/Reboot	Power Off	Get Config	Reset/Reboot Power Off
Serial Logs			Serial Logs	v
Calibration Mode			(CPS)0 (COUNTS)0 (DOSERATE)0.00 (AV (DS] Rendering Calibration Mode	/G]0.00
evice Configuratio	n Maran		Device Configuratio	n
Calibration Constant	(M1)	CooFiguro	Calibration Constant	(M1) 18:16:
Aavimum Dose Pate	(uSv/h)	Coningure	Maximum Dose Rate	(uSu/h) 18:16:
Auxiliani bose nece	(034/14	Configure	100000.00	Configure
Outy Cycle (Telemetr	ry)	1	Duty Cycle (Telemetr	y) 18:16:
		Configure	20	Configure
ransmit Power			Transmit Power	18:16
		Configure	5	Configure
elemetry Channel			Telemetry Channel	18:16
		Configure	3	Configure
evice EUI			Device EUI	18:16:
		l e e l	708305750006068	CasEeura

Figure 3.4: Settings Saved Parameters from Device

## 3.5 Turning Off Dosimeter

i.	ERAD Configurator V2.	2 😔 🖻 😣
Connection		TD0C8B95A860E4
Board Type	TD	*
USB Port	/dev/ttyU	580 -
Disconnect	Refresh	
Get Config	Reset/Reboot	Power Off
Serial Logs		V1.0
[FC][POLL] 4199mV 21.00mA 100% 54%         -           [CPS]0         [CPS]0           [COUNTS]0         [D0SER.00           [D0SERATE]0.00 [AVC]0.00         [D5] Rendering		
Calibration Mode		
Device Configurati Calibration Constan	ion it (M1)	18:17:04
2.00		Configure
Maximum Dose Rab	e (uSv/h)	18:17:04
100000.00		Configure
Duty Cycle (Teleme	try)	18:17:04
20		Configure
Transmit Power		18:17:04
5		Configure
Telemetry Channel		18:17:04
3		Configure
Device EUI		18:17:04
70B3D57ED00606E	34	Configure

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

	ERAD Configurator V2.2	
Connection		TD0C8B95A860E4
Board Type	TD	
USB Port /dev/		5B0 -
Disconnect	Rofresh	
Get Config Reset/Reboot		Power Off
Serial Logs		V1.0
[COUNTS]0 [DOSE]0.00 [DOSERATE]0.00 [A [DS] Rendering Calibration Mode	VG]0.00	-
Device Configuration	on	
Calibration Constant	18:17:4	
2.00	Configure	
Maximum Dose Rate	e (uSv/h)	18:17:49
100000.00	Configure	
Duty Cycle (Telemet	18:17:45	
20 Taxas mit Denues	Conrigure	
rransmic Power	18:17:45 CooFeuro	
J Talematov Channel		19-17-40
3		Configure
2		configure
Device EUI		18:17:49
70B3D57ED00606B	4	Configure

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

	ERAD Configurator V2.	1. I I I I
Connection		TD0C8B95A860E4
Board Type	TD	
USB Port	5B0 -	
Disconnect	Refresh	
Get Config	Reset/Reboot	Power Off
Serial Logs		V1.0
[DOSE]0.00 [DOSERATE]0.00 [A' [DS] Rendering	VG]0.00	
Device Configuration	on t (M1)	18:29:44
Device Configuration Calibration Constant 2.00	on t (M1)	18:29:44 Configure
Device Configuration Calibration Constant 2.00 Maximum Dose Rate	on t (M1) t (uSv/h)	18:29:44 Configure 18:29:44
Device Configuration Calibration Constant 2.00 Maximum Dose Rate 100000.00	on t (M1) e (uSv/h)	18:29:44 Configure 18:29:44 Configure
Device Configuration Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet	э <b>л</b> t (M1) e (uSv/h) гу)	18:29:44 Configure 18:29:44 Configure 18:29:44
Device Configuration Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet 20	on t (M1) e (uSv/h) ry)	18:29:44 Configure 18:29:44 Configure 18:29:44 Configure
Device Configurati Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet 20 Transmit Power	on L (M1) e (uSv/h) ry)	18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44
Device ConFigurati Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet 20 Transmit Power 5	on (M1) e (uSv/h) ry)	18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44 Configure
Device Configuratio Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet 20 Transmit Power 5 Telemetry Channel	ол ; (М1) ; (uSv/h) ту)	18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44
Device Configuratio Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet 20 Transmit Power 5 5 Telemetry Channel 3	оп t (M1) r (uSv/h) ry)	18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44 Configure
Device Configuratio Calibration Constant 2.00 Maximum Dose Rate 100000.00 Duty Cycle (Telemet 20 Transmit Power 5 5 Telemetry Channel 3 Device EUI	9 <b>n</b> t (M1) r (uSv/h) ry)	18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44 Configure 18:29:44

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.

## **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 Aventec,

- 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 (60Co)
- 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
СРМ	Counts Per Minute
mSv	milli Sievert
uSv	micro Sievert
VCC	Voltage Common Collector
Тх	Transmitter
Rx	Receiver
MHz	Mega Hertz
UART	Universal Asynchronous Receiver-Transmitter
SOH	State of Health
SOC	State of Charge