AEDtrax

User manual v1.1

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1 Contents

2 About this manual

The issue date for this document is May 2025.

2.1 Terminology

- **AED** – Automated external defibrillator
- **ZOLL Medical –** vendor of resuscitation medical equipment
  - **ZOLL AED 3** – ZOLL's model of AED with a screen, speaker and internal storage
  - **AEDtrax** –low-power monitoring and tracking system
- **RF** – radiofrequency components for communication or position tracking
  - **receiver –** an RF component than only receives, does not transmit
  - **transceiver** – an RF component that both transmits and receives
  - **GPS** – global positioning system, a global navigation satellite system, receiver
  - **RFID** – short-distance card reader, uses **ISO 15693** standard cards, transceiver
  - **LTE** – 4G phone network communications using **CAT-M1** or **NB-IoT** standards, transceiver
  - **BLE** – Bluetooth Low Energy for initial configuration, transceiver
- **USB** – Universal Serial Bus industry standard for interfaces and protocols
  - **host** – bus controller regulating traffic and actions; in this scenario, the *AED 3*
  - **client** – bus peripheral responding to host commands; in this scenario, the *AEDtrax*
  - **MSC –** mass storage class protocol, presents the *client* as a file storage device
- **operational modes –** modes of device functionality regulated by hardware and software switches
    - **tracking –** detects and tracks motion, sends scheduled telemetry and files
      - intended for common use
    - **no-tracking –** ignores motion, sends scheduled telemetry and files
      - intended for public service vehicles whose position should not be tracked
    - **airplane** – ignores motion, suspends all *RF* components
      - activated automatically if *AEDtrax* detects *ZOLL AED 3* is active to minimize interference
    - **transport** – activated on-demand, status change is reported to backend, also enters *airplane*
      - intended for shipping the *AEDtrax* to the point-of-use in very-low-power mode

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3 System components

3.1 Device

3.1.1 Technical specifications

Enclosure: 210 mm × 110 mm × 25 mm
Operating temperature: -15°C to +50°C
Power supply: battery-powered

- 8× ER14505M 3.6V, Li-$SOCl_2$ chemistry
- total capacity 16.8 Ah, lifetime exceeding 5 years
- user-replaceable, non-rechargeable
- Reorder PN (4packs of 2 cells): AEDTRAX-008

Microcontrollers:

- STMicroelectronics STM32L4-series general-purpose microcontroller
- BLE 5.1 microcontroller (Nordic nRF52840)

RF Components, onboard:

- Quectel BG95 LTE/CAT-M1/NB-IoT modem
  Frequency Bands:
  - Cat M1: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B27/B28/B66/B85
  - Cat NB2: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28/B66/B71/B85
  - GSM/EDGE: 850/900/1800/1900 MHz
- GPS/Galileo/GLONASS GNSS receiver

RF Components, addon:

- ISO15693 vicinity card reader, daughterboard

Sensors

- 3-axis accelerometer
- Atmospheric sensor

Connectors

- USB-C running in USB 2.0 configuration

Certifications

- EMC: EN 301 489-1 V2.1.1 & EN 301 489-52 V1.1.1
- FCC ID: XMR201910BG95M3
- IC ID: 10224A-2019BG95M3
- CE
- RoHS Compliant
- REACH Compliant
- This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
  (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

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Other

- multiple LEDs for visual status signaling
- buzzer for acoustic status signaling
- three-position switch for operational mode selection

3.1.2 External overview

Figure 1 Illustrative Image of AEDtrax Housing

3.1.3 AEDtrax, ZOLL AED 3 and storage integration

The *AEDtrax* is placed on the rear side of the *ZOLL AED 3 device*, in the components compartment, and the two connect using a USB A/m-to-C/m cable. No mechanical attachment is required between the two devices.

Additionally, each transport bag or storage cabinet intended for use should have its own RFID tag (ISO15693 Vicinity Card). When mounting the tag on the transport bag or storage cabinet, ensure:

- the RFID card has at least a 2.5 cm (1″) gap from the metal backing

- the RFID card is aligned with the RFID antenna active area as indicated on the casing

Figure 2 AEDtrax mounted on ZOLL AED 3 device

4 Device operational behavior

The following sub-chapters assume a fully assembled and registered device.

4.1 Bluetooth Low Energy

The *BLE* module is turned on automatically on device boot and reboot. The module will remain on for a total of **three minutes**, to perform device configuration.

While the device is in *tracking* or *non-tracking* mode, BLE can be turned on by pushing the *mode switch* to the *transport* position and back to its original position.

BLE is automatically turned off during *airplane* mode to comply with low-interference requirements, and *transport mode* to consume minimal power.

4.2 Heartbeat telemetry

The device takes the following measures **every hour**:

- atmospheric pressure
- atmospheric humidity
- atmospheric temperature
- battery voltage
  - only if this was also the lowest temperature of the day
  - only one value stored per measurement cycle

Telemetry measurement is skipped if:

- the modem is active at the scheduled measurement time (impact voltage measurement accuracy)
- the device is in *airplane mode* (to comply with low-interference requirements)

The firmware sends the telemetry file to the backend once a day.
After a successful upload, the firmware deletes the file and creates it from scratch for next day's telemetry.

4.3 USB file storage

The AEDtrax firmware constantly monitors the USB connector's power line for a signal that the AED is active, which happens in the following situations:

- the AED is in use for life-saving or training operations
- the AED has been turned on in maintenance mode
- the AED has just generated a *self test* file (***DSF*** or ***DHF***) or a clinical event file (***CRD***)

On detecting positive voltage, the AEDtrax switches over to *airplane mode* so as not to interfere with the AED's operations.
At the same time, the AEDtrax initializes its internal USB peripheral stack, present itself to the AED host device as an *MSD* and allow the AED to store data on the AEDtrax SD card.
After the AEDtrax firmware detects no more voltage on the USB connector's power line, it scans the SD card for new files, adds them to the upload queue, and after a successful upload of each file, deletes it.

4.4 Motion detection and tracking

The AEDtrax in standard operation tracks the motion of the device using an *accelerometer* and a GPS *module.* The following prerequisites are mandatory for tracking:

- the physical mode switch is in the *tracking* (*normal*) mode
- the firmware settings for GPS and RFID are enabled
- the device is currently not in *airplane mode* (due to *transport mode* or an active USB host).

Once the firmware senses motion through the accelerometer, it waits several seconds before determining its position to prevent false inputs. If RFID is enabled, the firmware will scan for nearby RFIDs and transmit the result.

After this, the firmware starts the GPS flow by powering on the GPS module. During every 30-second cycle, the firmware retains and transmits the most accurate GPS coordinates it found. If the accelerometer sensed more motion while GPS was working, the firmware will keep the GPS scanning for an additional 30 seconds. Once the device has remained at rest for 60 seconds, the GPS flow will end. If RFID is enabled, the firmware will scan for nearby RFIDs once more.

4.5 Transport mode

The AEDtrax can be put into a low-power, no-transmissions mode for shipping to customers by moving the *mode switch* to *transport mode* and leaving it there. After the switch is in that position for a minimum of **5 seconds**, the firmware transmits its intent to enter transport mode to the backend, turns off all RF components by entering *airplane mode*, disables its own accelerometer logic and remains inert and unresponsive. While in *transport mode*, the device will continue to receive files over USB if the attached AED generates any.

The AEDtrax can be taken out of *transport mode* by moving the *mode switch* away from *transport mode*. The device immediately exits *airplane mode,* connects online, transmits its exit from transport mode to the backend, enables its accelerometer logic and, if the option is enabled, attempt to detect the nearest RFID. From this point on, the device will continue working in either *tracking* or *non-tracking* mode depending on the position of the *mode switch*.

4.6 Firmware update

Once a day, the firmware contacts the backend to check for a firmware update, sending its current firmware version for comparison.

On the *proxy backend*, each instance is shipped with a singular firmware version. If the device firmware and the proxy backend firmware version do not match, the firmware will start downloading the update.

5 Operational compliance and standards

The solution is expected to fulfill the following requirements:

- behave strictly as a USB peripheral device, without USB host capability
- when connected to a USB host, draw the minimum amount of current necessary for successful USB insertion detection
- on connecting to a USB host, power down all RF components within a reasonable time to minimize RF interference with the USB host

5.1 USB

5.1.1 Power consumption

The AEDtrax board is self-powered using its own battery packs and does not draw significant power through its USB connection.

The USB interface is limited to only signaling the AEDtrax board that a cable connects it to a host, as well as actual USB data signaling with the following limits:

Parameter	*Symbol*	*Minimum*	*Typical*	*Maximum*	*Unit*
Supply voltage	V_{cc}	-	5.00	-	V
USB connected current	I_{Vcc}	0.10	0.60	1.00	µA
USB data lines current	I_{DP}, I_{DM}	25	-	500	µA

The feature has been validated through test report number: 21583SIG23048-2 (AEDtrax - USB consumption test - 21583SIG23048-2.pdf)

5.2 Radio-frequency components

The device contains the following active RF components:

- BLE – u-blox NINA B301 BLE 5.1 transceiver
- LTE – Quectel BG95-M3 NB-IoT/CAT-M1 transceiver
- RFID – NXP PN5180 ISO 15693 transceiver
- GPS – u-blox SAM-M8Q GPS receiver

BLE, LTE and GPS components are all embedded onto the main board and have vendor-provided RED certificates, test report number: 21583SIG23048-1 (AEDTrax - 21583SIG23048-1.pdf)

The RFID component is in full compliance with NFC forum

5.2.1 Overall RF component activity

The RF components are only active when required by external inputs (e.g. accelerometer detects device motion), internal logic (scheduler, timer).

Additionally, the firmware will enter *airplane mode* whenever there is an active USB connection, powering off all RF components and their software task. This prioritizes the well-being of the defibrillator.

5.2.1.1 BLE

BLE is activated through either:

- power-on (cold start or warm reboot)
- switching the *mode switch* from *normal* or *no-tracking* to *transport* and back within 5 seconds

BLE is deactivated through either:

- an internal 3-minute timer (extended if device is transceiving through LTE)
- an emergency shut-off through *airplane mode*

Parameter	*Symbol*	*Minimum*	*Typical*	*Maximum*	*Unit*
BLE power-off time	t_{BOFF}	80	160	240	ms

5.2.1.2 LTE

LTE is activated through either:

- detection of motion that started a GPS tracking flow
- device entering or exiting *transport mode*
- internal schedule when device sends daily telemetry
- USB power-off detected and a defibrillator file is ready for upload

LTE is deactivated through either:

- the transmission queue being empty for longer than 10 seconds
- an emergency shut-off through *airplane mode*

Parameter	*Symbol*	*Minimum*	*Typical*	*Maximum*	*Unit*
LTE power-off time	t_{LOFF}	1.25	1.50	1.85	s

5.2.1.3 RFID

RFID is activated in the following cases:

- motion is detected
- GPS tracking flow has ended
- exiting transport mode

RFID operation is atomic as it powers on, attempts up to three RFID reads, and powers off.

RFID does not power on if the device is in *airplane mode* or *transport mode*.

Parameter	*Symbol*	*Minimum*	*Typical*	*Maximum*	*Unit*
RFID activity time	t_{LOFF}	1.25	1.50	1.85	s

5.2.1.4 GPS

GPS is activated if the firmware first successfully detects motion, and then unsuccessfully detects an RFID card. GPS remains active in 60-second increments for as long as there is motion occurring. The GPS functions as a strict receiver, with no adverse effect on other electronics, either internal to the AEDtrax or to the attached AED.

5.2.2 RF component verification

The device's overall RF behavior in *airplane mode* is validated by monitoring it using an RF analyzer. The device can be tested through the following steps:

1. Check AEDtrax is registered, powered off with no batteries connected, with the USB plugged in on the AEDtrax side only, and the *mode switch* in the *no-tracking* positioning
2. Prepare the RF analyzer to scan from the moment AEDtrax is powered
3. Connect the batteries to the AEDtrax
4. Observe the BLE activity LED blinking, indicating BLE is working
5. Observe the modem activity LED blinking, indicating LTE is working
6. Check the RF analyzer for activity on BLE and LT frequency band
7. Connect the USB-A/m side of the USB cable to a computer or a defibrillator
8. The RF analyzer should show LTE and BLE frequency activity stopping within timing tolerance
9. Disconnect the USB-A/m side of the USB cable
10. The RF analyzer should show LTE and BLE frequency activity resuming

6 Maintenance procedures

6.1 USB cable

The AEDtrax connects to its ZOLL AED 3 host using a proprietary-form USB-A/m to USB-C/m cable which has integrated clips and gaskets. These clips and gaskets conform to the casing of the AED 3 to ensure dust- and air-tightness for all involved components. When replacing the USB cable, always use a genuine replacement part.

Figure 3 USB cable

6.2 Battery monitoring

All AEDtrax devices report their battery status to the backend once per day as part of the *heartbeat telemetry* process.

The *core backend* monitors all device telemetry including the *AEDtrax* battery voltage. If the voltage falls below a certain threshold, the *core backend* issues an alerting email.

The *proxy backend* only deserializes telemetry data and transmits it to the intended customer backend. It is up to the customer backend to generate alerting events.

The batteries should be replaced within 3-4 weeks of receiving the first alert.

6.3 Battery replacement

The battery replacement procedure is as follows:

1. If the device is in *normal mode*, place it in *no-tracking* mode by sliding the *mode switch* to the middle
2. Disconnect the USB cable from the AEDtrax and remove it from the AED 3 components compartment
3. Remove seven screws indicated in the photo and lift the cover
4. Remove all four battery cells by unplugging their corresponding cables
   - ⚠ Do not remove the black seal, which provides electrostatic discharge protection
   - The order of removal does not matter
5. Install all four battery cells by plugging in their cables
   1. ℹ Make sure the black and red wire are neatly tucked beside the batteries, not over or under
   2. The order of installation does not matter
6. Carefully replace the cover and refasten with seven screws
   1. If using a torque wrench, set to 5 N·m (3.7 lb·ft)
7. Return the AEDtrax to the AED 3 components and reconnect the USB cable
8. If the device was in *normal mode* prior to battery replacement, slide the *mode switch* towards the LEDs

Figure 4 Battery replacement

7 Contacting Technical Service

If an AEDtrax product requires service, contact your local Service or sales provider or Procamed Technical Service Department: Telephone: +41 52 368 60 00 / Email: aedtrax@procamed.ch. Have the following information available for the Technical Service representative: Serial number and description of the problem If you need to send the AEDtrax to Procamed.