

**KELLER**

# OPERATING MANUAL

# ADT1

Version 11/2024  
Subject to alterations  
Company certified according to ISO9001  
[www.keller-pressure.com](http://www.keller-pressure.com)



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## 1 ADT1

The ADT1 is a maintenance-free, battery-operated (three conventional, high-quality lithium AA batteries), autonomous remote transmission unit with a battery life of up to 5 years. The robust, waterproof housing allows outdoor use in all places where pressure or a level must be monitored. Typical applications: Pressure monitoring (water and gas pipes), level measurement of surface water and groundwater tanks, and liquid containers.

This device can be linked with digital level sensors and pressure transmitters with the KELLER "D" and "X" low voltage product lines. With its wide range of water level sensors and pressure transmitters, KELLER can offer the right solution for any measuring situation. The device records the pressure and temperature (and optionally conductivity as well) of the connected sensor as well as the internal measured values like barometer and temperature.

The ADT1 offers the choice between a LoRa or a NB-IoT/LTE-M module, depending on the application requirements.

KELLER provides a range of licence-free software solutions for configuration and data processing. The easiest and most convenient way to access the collected data is via PressureSuite Cloud.

### 1.1 Overview

The remote data transmission unit is offered in two different housings (Box and Tube) that accommodate different installation requirements in the locations where it is to be used.

#### 1.1.1 ADT1-Box:



The remote data transmission unit ADT1-Box is encased in a robust, water-tight polycarbonate housing.

#### 1.1.2 ADT1-Tube:

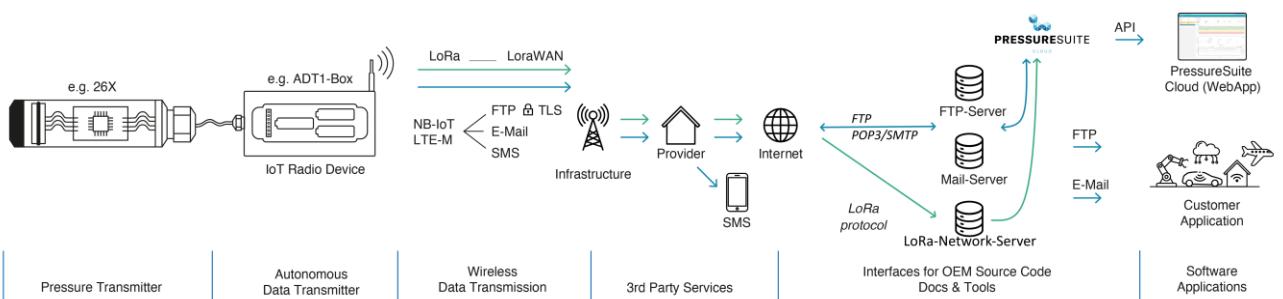


The remote data transmission unit ADT1-Tube is encased in a robust, stainless-steel housing, which is ideally suited to installation in 2" monitoring pipes.

## 2 General Description

KELLER's solution offers a robust and flexible approach to data handling, spanning from pressure measurement to end-device access, thanks to its modular data chain structure. The ADT1 remote transmitter plays a central role as an intermediary between the pressure transmitter and receiver station, facilitating efficient data transfer. This setup enables seamless integration with existing transmitters and supports highly accurate KELLER level sensors, OEM transmitters, or transducers for specialized needs.

For software integration, KELLER provides well-documented protocols, including LoRaWAN, FTP, Email, and API, enabling smooth connectivity with custom systems. In addition, DLLs and example source codes offer valuable support for developers. While these options increase integration flexibility, KELLER's PressureSuite Cloud remains the simplest way to access collected data, making it an optimal choice for users who prefer ease of use without extensive integration effort.



### NOTE:

A detailed description of the ADT1 communication protocol can be found under [Communication Protocol ADT1](#). The protocol documentation is also available on [docs.pressuresuite.com](#), which includes a [Live-Editor](#) for real-time configuration and testing. This tool enables users to interactively explore and customize the protocol parameters, enhancing ease of integration and setup for various applications.

### 2.1 Wireless Data Transmission / Technology

Each technology has its strengths, depending on the use case and available infrastructure.

#### 2.1.1 Cellular communication

NB-IoT (Narrow Band Internet of Things) and LTE-M (Long Term Evolution for Machines) are low-power wide-area networks (LPWAN) radio technologies standards developed by 3GPP for cellular devices and works on the licensed spectrum.

These technologies focus specifically on indoor coverage, long battery life, and high connection density. They use a subset of the LTE standard. Ensure in advance that the NB-IoT or CAT M1 radio technology is available in the intended area of use.

#### 2.1.2 LoRa communication (non-cellular)

LoRaWAN®: Long Range Wide Area Network, is a protocol developed by the LoRa Alliance and is part of Low Power Wide Area Networks (LPWAN). The peculiarity of this protocol is its efficiency, because LoRaWAN® has minimal power consumption, a long range of communication (up to 15km in rural areas and 2km in a dense urban areas), and secure data transmission (with AES-128 encryption).

LoRaWAN® operates in the unlicensed spectrum, which means there are no license fees. This enables a flexible network infrastructure as everyone can set up their own networks. Operating costs are also lower as no spectrum or SIM card fees are required. The absence of mobile network providers increases cost efficiency and offers more independence but can also result in interference with other users in the same frequency range.

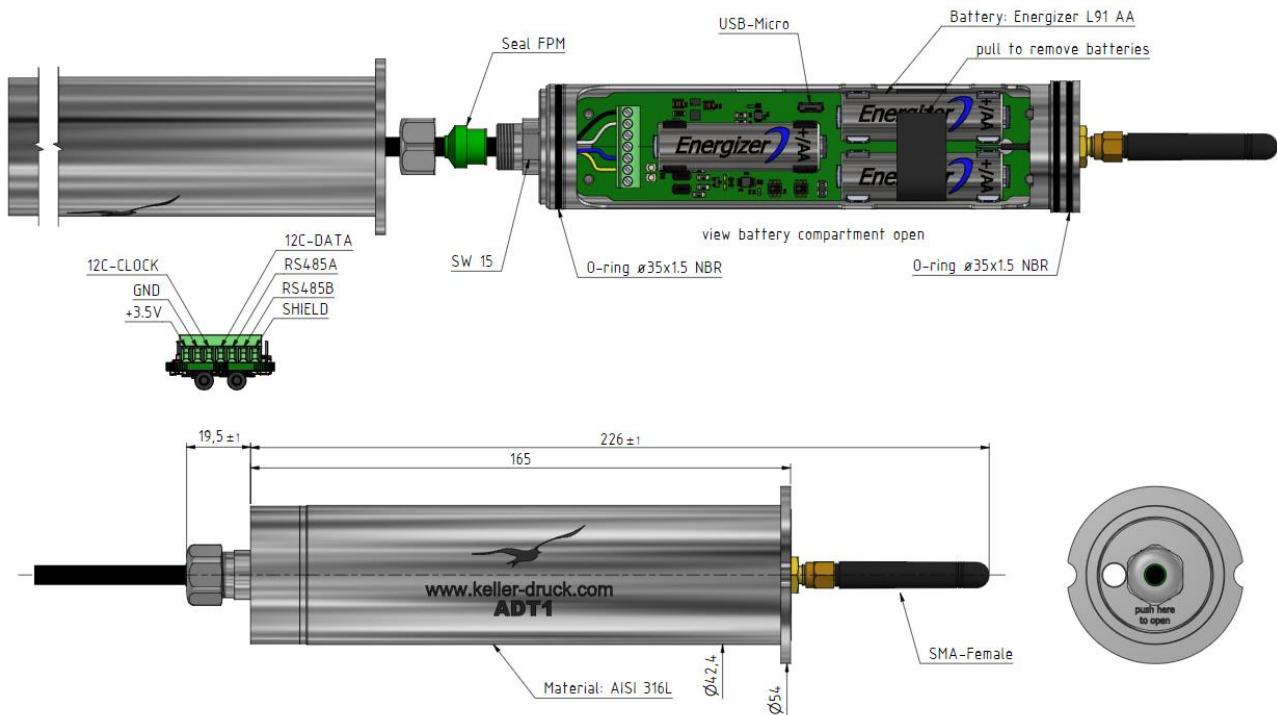
## 2.2 [PressureSuite Cloud](#)

The PressureSuite Cloud from KELLER offers simple and convenient access to your measurement data with your own personal login and SSL encryption. You can enjoy readily available data without the need to set up and maintain a database. The measurements can be displayed as graphs in no time at all and the export function allows you to download your data as Excel or CSV files. Measuring points are effortlessly and efficiently monitored with the integrated alarm system. For instance, a warning can be triggered via e-mail if there is an increase in water level or a battery is running low. The PressureSuite Cloud API allows customer-specific software to call up measurements in a standardised JSON format via HTTPS.

## 4 Hardware

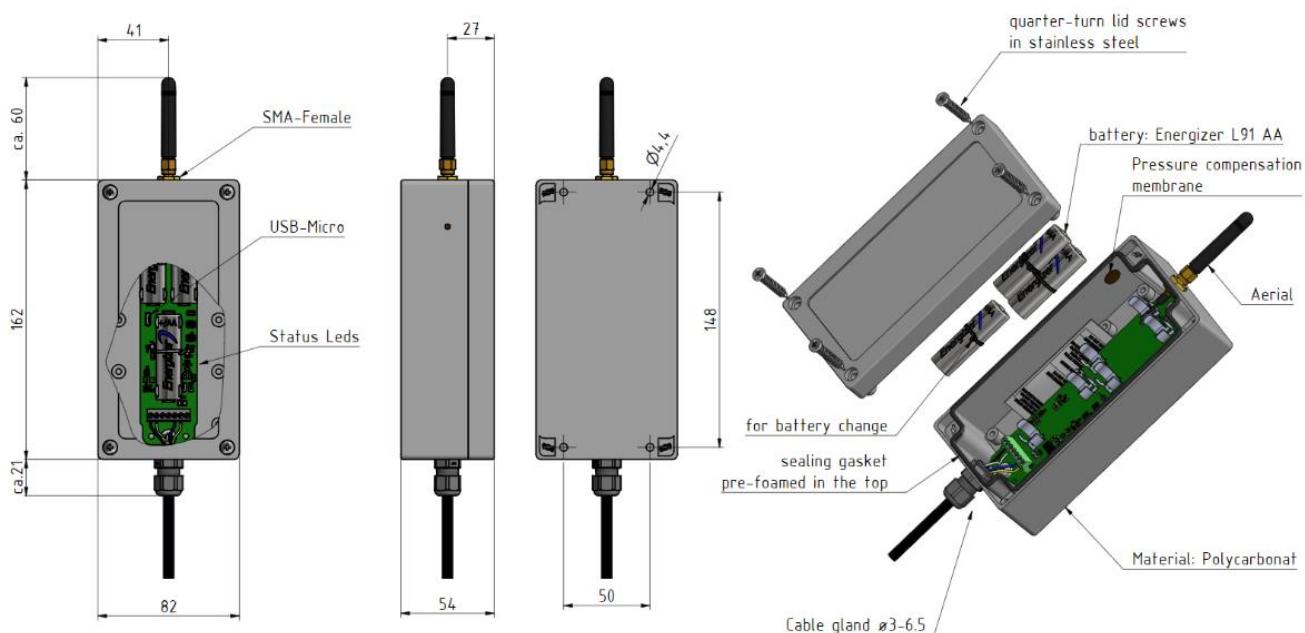
### 4.1 ADT1-Tube

At just 43 mm in diameter, the cylindrical design of the ADT1-Tube can simply be placed into the top of a two-inch-wide sounding tube standard in the groundwater measuring industry. It can be installed in a matter of seconds. The housing is designed to withstand condensation and temporary flooding. The sealed antenna can be covered by a lockable protective cap.



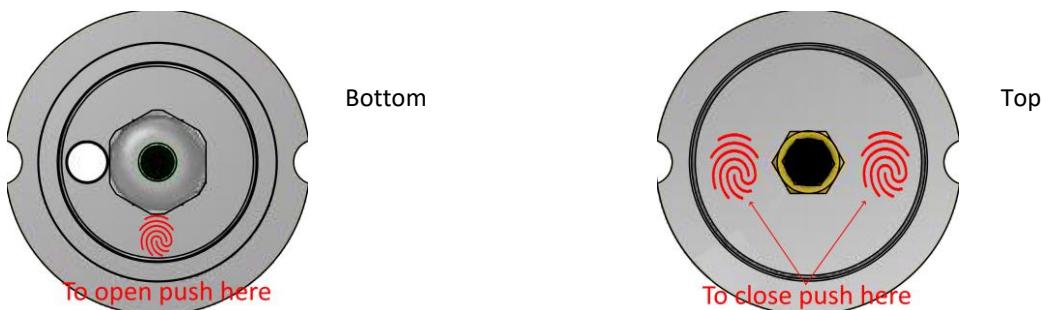
### 4.2 ADT1-Box

The remote data transmission unit ADT1-Box is encased in a robust, water-tight, impact- and UV-resistant polycarbonate enclosure.



#### 4.3 How to open and to close the housing

To open the ADT1-Tube housing, push at the marked positions against the bottom of the housing/piston (see illustration below). The ADT1-Box can be easily opened with a Screwdriver PZ1, unscrew the four screws and carefully open the lid.



To close the unit, push with two fingers against the top of the housing/piston until it stops. Be sure that the piston is completely inserted. Keep dry before opening and closing. To close the ADT1 Box you just squeeze the screws together and make a quarter turn. A bag containing silicate desiccant is used to protect the sensitive electronics from humidity. Put this bag into the box or tube.

**CAUTION:**

**Do not touch the electronic components (ESDS / Electrostatic sensitive discharge components).**



**CAUTION:**

**Do not touch or remove the protective vent.** Keep all sharp or jagged items away from the ePTFE membrane.

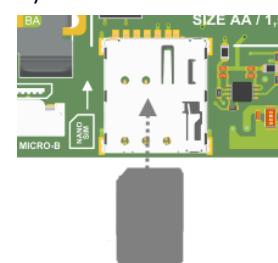
**CAUTION:**

**Keep dry** before opening and closing. To maintain the watertight seal, all O-Rings must be **kept free of dirt and debris**. We recommend the use of silica-gel moisture absorbing packets which are reusable after drying out in an oven.

#### 4.4 SIM card (only for cellular version)

For communication via the mobile network, you need a SIM card (4FF / Nano SIM).

4FF / Nano SIM



**NOTE:**

We recommend the use of a prepaid card. Thus, in case of an incorrect configuration, only the current credit on the card is used up. Make sure that there is always sufficient credit on the card. Contact your phone provider for information on recharging options and configuration settings (APN, username, password).

##### 4.4.1 Inserting and removing the SIM card

The SIM card holder has a push-to-insert, push-to-eject mechanism. To insert, gently push the SIM card as shown in the illustration (bevelled corner facing left) into the silver SIM card compartment until you will hear a "click" noise. To remove it you must push against the SIM card until you will hear a "click" noise and the SIM card will be ejected by the connector itself, allowing it to be easily pulled out.

**CAUTION:**

The 4FF SIM slot allows SIMs to be inserted either way round, but the breakout board expects SIMs to be inserted notched/narrow end first. Please ensure that you insert your SIM correctly. Do not touch the gold-coloured contacts of the SIM card when inserting!

#### 4.5 Batterie

The ADT1 is equipped with 3 high-quality lithium AA batteries (Energizer Ultimate Lithium / L91 (1.5 V / 3.3 Ah)). As soon as the insulating tab is removed, the ADT1 powers on automatically as it lacks an on/off switch. If the battery voltage drops below 4.0 V, LED1 will flash red (see section 5 Operating Modes).

**CAUTION:**

Risk of fire and explosion if batteries are handled improperly

- **Do not** charge the battery
- Avoid electrical short circuits
- Avoid mechanical damage
- **Do not** open the battery
- **Do not** throw the battery into a fire and do not expose it to temperatures above +60 °C
- **Do not** carry out any soldering work on the battery
- Protect the battery from moisture

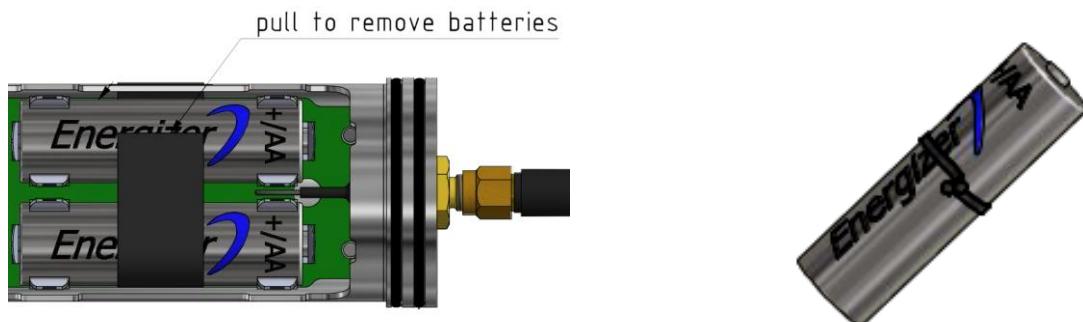
##### 4.5.1 Battery replacement

The ADT1 will operate until the battery voltage drops to 3.6 V, at which point it is still functional. However, we recommend replacing the battery at 4.0 V to ensure optimal performance. Both the PressureSuite Desktop and PressureSuite Cloud display the battery capacity as a percentage of the remaining charge, calculated by the ADT1. The actual battery voltage is also displayed.

**CAUTION:**

**Only** the recommended high-quality lithium AA batteries (L91) should be used. Always replace all three batteries simultaneously with identical and new ones. Make sure you insert the batteries the right way as shown in the picture.

The cable twist or tape allows for easy removal of the batteries from the holder without tools. Simply turn the cable twist upwards and pull on the two balls to remove the batteries (see illustration below). The cable twist can then be clipped onto the new batteries.



**NOTE:**

Dispose of used batteries according to local regulations; do not discard with household waste

**NOTE:**

When the battery is changed, the time keeping function is working for about 4 min, which has the advantage that the time does not need to be readjusted.

#### 4.5.2 Battery lifetime estimation

The calculated lifetime in the table below indicates how long the battery can last under different conditions. The calculated lifetime values in the table are merely calculations. External factors, such as temperature and storage time, can significantly impact the battery's capacity and overall service life.

**NOTE:**

Firmware Version < 23.38

Please note that a battery voltage change or disconnection of the battery always results in resetting the capacity indication to 99%! For this reason, the battery should be disconnected for battery replacement only.

Firmware Version >= 23.38

Please note that's only battery voltage change of > 0.3V leads to a resetting of the capacity indication to 99%! For this reason, the battery can also be disconnected when the ADT1 is taken out of operation without losing the remaining capacity.

#### 4.5.3 ADT1-M1&NB

Device	measure-interval	sending-interval	lifetime estimation
ADT1-M1&NB	1 min	1 h	~ 4 months
ADT1-M1&NB	10 min	1 h	~ 5 months
ADT1-M1&NB	1 min	6 h	~ 1 years
ADT1-M1&NB	10 min	6 h	~ 2 years
ADT1-M1&NB	10 min	1 d	~ 5 years
ADT1-M1&NB	60 min	1 d	~ 6 years*
ADT1-M1&NB	60 min	2 d	~ 9 years*

#### 4.5.4 ADT1-LR

Device	measure- and sending interval	Spreading Factor	lifetime estimation
ADT1-LR	10 min	SF12	> 1.7 year
ADT1-LR	10 min	SF7	> 5 year
ADT1-LR	60 min	SF12	> 7 year*
ADT1-LR	60 min	SF7	> 14 year*

**NOTE:**

\*The batterie is subject to self-discharge over time. To ensure reliable performance, KELLER recommends replacing the battery at least every 5 years, even if it has not yet reached its minimum voltage threshold. This preventative replacement helps maintain optimal operation and prevents unexpected downtime due to gradual battery depletion.

#### 4.6 Connecting the antenna

Screw the stub antenna into the corresponding SMA plug located at the top of the ADT1 and **tighten by hand only**. Make sure it is tight enough.

**CAUTION:**

Please only use the original accessories to prevent injuries and health risks. Only monopole antennas with the specified maximum permissible gain according to 10.5 Antenna, in the respective frequency range may be used. The antenna must be installed at least 0.20 meters away from people and other electrical equipment and antennas.

**NOTE:**

To ensure reliable data transmission, install the antenna in a location with strong signal coverage for the technology required by your wireless module. The Antenna must not be installed inside metal cases.

**NOTE:**

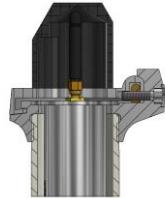
The antenna is provided with a seal. If you use other antennas or connectors, make sure that they are also equipped with a seal.

#### 4.7 Locking unit (Tube only)

The locking unit for the ADT1-Tube with antenna cover is available in sizes ranging from 2 up to 6 inches. The sealed antenna can be covered by a lockable protective cap made of robust plastic. This protects the data logger against theft and damage by people or wild animals when level measurements are being taken in the open countryside.



Option: Protection cap  
Ø2" ... Ø6"



#### 4.8 Humidity / Ventilation element

The units are equipped with a pressure compensation element which ensures that the housing is sufficiently ventilated inside the unit so that constant pressure compensation takes place and condensation is reduced to a minimum. At the same time, the penetration of liquids and dirt is prevented. In addition, the use of silica gel (moisture absorption bag) inside the housing is recommended (included in the device), which absorbs the residual moisture. These should be replaced regularly. The internal humidity sensor, which transmits the current humidity inside the device by radio, provides an additional indication of the current humidity status of the device.

#### 4.9 Mounting Instructions

Prefer a mounting location which is protected against rain and direct sun radiation. For best radio performance, install the device upwards with the cable towards ground. Ideally, in such a way that the antenna faces roughly in the direction of the next gateway/antenna. Also, the higher above ground, the better. Avoid metallic object close to the device.

**NOTE:**

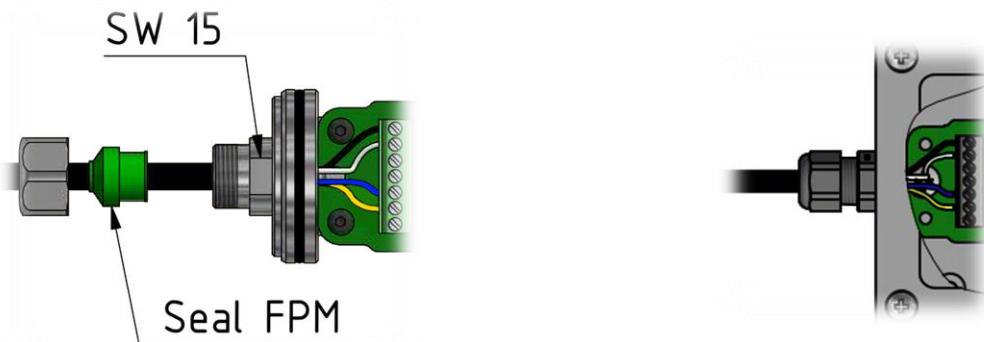
For outdoor installations, it is advisable to install the units so that they are protected from the weather. If this is not possible, consider a self-built weather protection. If you build a weather protection, use a material such as plastic that does not affect the wireless signal too much.

**CAUTION:**

The unit is not intended to be used underwater. The IP (for IPX7 / IPX8) protection is only to be understood as a short-term flood protection

#### 4.10 Cable gland / level sensor connection

The cable gland is required to connect a level sensor. Feed the sensor cable through the cable gland and connect the cable ends to the corresponding terminal strip. The ADT1-Tube has a nut with the wrench width 15 to provide a counter torque. The cable diameter must be in the range of 3.5 to 6.4 mm. If a level sensor with a reference tube is used, the reference tube is simply inserted into the housing.



**CAUTION:**

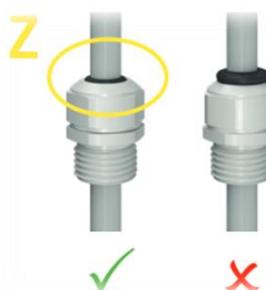
The cable shall be tightened only over the wrench width and the cable gland. Never use the housing or PCB as counterpart to tighten the cable gland.

**CAUTION:**

After opening the ADT1 case, always make sure that the ADT1 case is still tight.

**CAUTION:**

Make sure the cable is mounted securely, e.g. by using an additional retaining cable, for cable lengths > 50 m. Tighten the cable gland until the torque of 5 Nm for the metal cable gland resp. 1.7 Nm for the plastic cable gland is reached (depend on many different factors and influences) or the sealing insert forms a bulge that protrudes slightly over the compression nut (see picture).



**CAUTION:**

For cable diameters in the range of 3.5 to 6.4 mm only

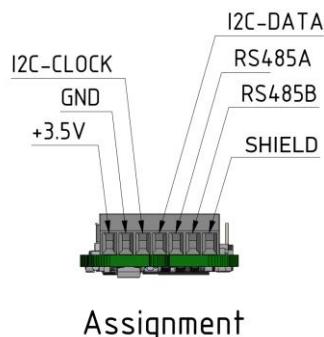
**CAUTION:**

The maximum cable length for the I<sup>2</sup>C interface is limited due to the datasheet of the respective sensor and is usually only a few meters (typically up to 3m).

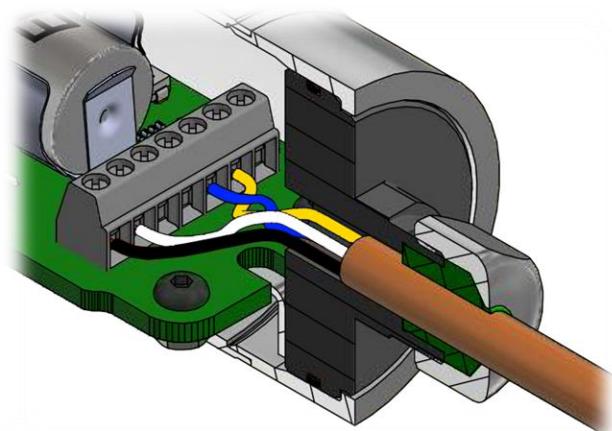
The maximum cable length (typically max. 100 m) for the RS485 interface is limited by the voltage drop of the power supply. This must be determined from the data sheet of the corresponding sensor (current consumption, line impedance and min. supply voltage).

#### 4.11 Connection Terminal for the Sensors

The ADT1 offers the possibility to connect a low cost I<sup>2</sup>C, or a more precise RS485 Sensor of KELLER. The pin assignment of the ADT1 is shown as follow:



##### 4.11.1 Connection for X-Line (RS485-Interface) "low voltage" type only



Connect the black wire to the +3.5V supply voltage and the white wire to the GND pin.

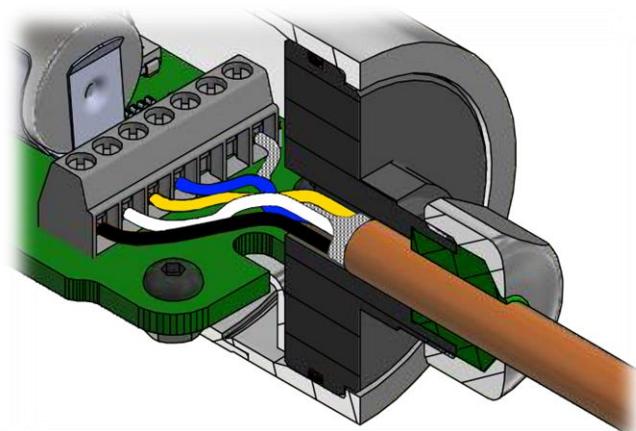
The blue wire is the RS485A (Pin 5) and the yellow the RS485B (Pin 6) with is the communication interface to the sensor.

The RS485 Interface is with an a 10kΩ resistor terminated.

**NOTE:**

The communication address is 250

##### 4.11.2 Connection for D-Line (I<sup>2</sup>C-Interface)



Connect the black wire to the +3.5V supply voltage and the white wire to the GND pin.

The yellow wire must be connected to the clock pin (Pin 3) and the blue wire to the data pin (Pin 4). The red wire (EOC) is not required.

**CAUTION:**

The I<sup>2</sup>C interface is very sensitive to external interferences. Therefore, we recommend connecting the CASE of the Sensor to the SHIELD pin of the ADT1.

**NOTE:**

The communication address is 0x40. However, the communication address must be assigned in advance

## 5 Operating Modes

The device has three operating modes:

Operating modes	LED2	LED1
Reset:	System (re-)start	
Sleep Mode:	no measurements and no data transmissions; no communication	 5 sec
Active Mode:	no measurements and no data transmissions; communication activ	 1 sec
	During periodic measurements (read sensor)	
	and while registration process	 1 sec
Active Mode:	and while data transmission	 1 sec
	if transmission failed	 3x 1 sec

NOTE:

If the battery voltage falls below 4.0 V the LED 1 flashes always red.

### 5.1 Measurement Cycle (Active Mode)

During the periodic measurements (read sensor), the device reads the values of the connected KELLER sensor with a user defined sampling period and stores the data in the internal EEPROM (RECORD). Therefore, the ADT1 supplies the pressure transmitter and reads the user-selected channels, when the values have been read out the power supply is switched off again. The device tries automatically to read the values on the I<sup>2</sup>C Interface, if that fails on the RS485 Interface (maximum 5 attempts per Interface/sensor), so the user does not have to care about the connected sensor. Beside these values it is also possible to read out the internal barometer with its pressure and temperature value with will be saves also in the non-volatile memory.

#### 5.1.1 ADT1 with cellular communication

After a user-defined amount of collected measurements the ADT1 sends them. The cellular modem in the ADT1 is powered on, attempts to register with the provider, and transmits the data. Once the transmission is complete, the device powers off the cellular modem. For each measurement, additional internal values, such as signal strength, humidity, battery voltage, and capacity, will also be transmitted.

NOTE:

Establishing the connection and transmitting data are the most energy-intensive processes, even when using energy-efficient technologies such as NB-IoT and Cat-M1. Therefore, it is recommended to set the transmission interval as long as possible to optimize battery life. We recommend an interval of > 6 hours to ensure a runtime of over a year. Further information can be found under 4.5.2 Battery lifetime estimation.

### 5.1.2 ADT1 non-cellular communication (ADT1-LR)

A periodic measurement automatically triggers a transmission, these limitations result from the regulatory requirements of LoRaWAN®.

After a random delay of 0 ... 6 seconds, the ADT1-LR sends the measurements. If the device has not joined the LoRaWAN® network yet, it will try to join until it succeeds (maximum 3 attempts per transmission). Afterward, it will transmit the data. In each transmission, two receive slots are opened (RX1 and RX2). During these time slots, the device is ready to receive data from the network (downlink message).

For each measurement, internal values such as humidity, battery voltage, and capacity can also be transmitted as required (see "Info" message of [Communication Protocol ADT1 LoRaWAN](#)).

**NOTE:**

The lowest sampling period should not be set below 10 minutes, as shorter intervals may result in packet loss due to the airtime limitations of LoRaWAN® technology, which depends on the spreading factor (SF).

### 5.2 Sleep Mode

The unit is in a sleep mode; only the real-time clock is active. In this mode the microprocessor wakes up every second to adjust the time and check if there is an event to react (LED1 is flashing in a 5 second interval).

When the USB interface is connected, the device will automatically switch to active mode (LED flashes every second).

**NOTE:**

During USB connection the power consumption of the ADT1 is much higher (~10 mA) and discharge the batterie rapidly. USB does not supply or charge the ADT1.

## 6 RECORD Data Storage

The record data storage offers the advantage that the measuring data doesn't get lost if the data transfer (connection to the gateway) is temporarily out of function, the data can also be read out on site. All measured values are stored in the ADT1 EEPROM. The memory is organized as a circular memory. This means that always the latest data is available whilst the oldest data is overwritten.

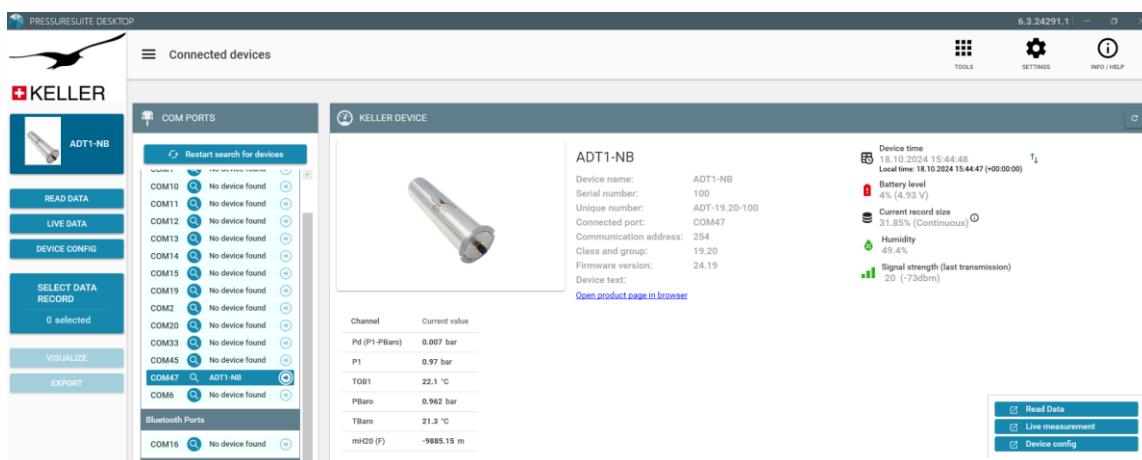
### 6.1 Storage Capacity

The table below shows you how much data can be stored in the ADT1 memory.

Storage interval	Number of channels	Number of measured values per channel	Recording time
1 min	4	24552	8 days
1min	14	8184	2 days
10 min	4	24552	85 days
10 min	14	8184	28 days
1 h	4	24552	510 days
1 h	14	8184	170 days

### 6.2 Read the RECORD data by USB

Connect the ADT1 with the USB interface and start the "PressureSuite Desktop" software. The device should be displayed under "Generic Ports".



The connection to ADT1 is now established automatically and all available RECORDs appear. Select the desired RECORD and click on the button "Start reading selected record from device".



## 7 Configuration

For the configuration of the ADT1 we developed "[PressureSuite Desktop](#)". If the device has already been successfully set up for the [PressureSuite Cloud](#), it can also be adapted remotely. The parameter will be stored permanently in the internal non-volatile memory. The user can configure the device via two interfaces:

- Command line interface: via a Micro USB (Type B) cable connected to a computer with the PressureSuite Desktop.
- Downlink command interface: over the air using PressureSuite Cloud downlink messages

For a full description of this interfaces, please find the specific documents on [Communication Protocol ADT1](#) or on <https://docs.pressuresuite.com/>.

### 7.1 [Configuring a Cellular device from KELLER](#)

The initial configuration is carried out on-site during installation using the "PressureSuite Desktop" program via a Micro USB (Type B) cable from the PC to the ADT1. The settings are saved on the ADT1 and sent to the FTP or e-mail server. Configuration changes can later be made remotely through the "PressureSuite Cloud" or the user's own application. The updated configuration must be saved on the selected server. The ADT1 checks its FTP or e-mail inbox at a configurable interval, and if a new configuration is available, it will be retrieved and saved.

#### 7.1.1 [SIM card and network Access](#)

To use NB-IoT, or LTE Cat M1 networks, you'll need a SIM card that supports the required technology. The SIM card should be activated and have access to the appropriate network of the respective network operator. Some configurations may require additional details depending on the network operator and specific application requirements.

Follow these steps for integration:

1. **Insert the SIM card:** Place the SIM card into the designated slot in the ADT1 with cellular communication (see 4.4 SIM card (only for cellular version)). Ensure that the SIM card is activated with the desired network operator and has an active data plan.
2. **APN configuration:** Depending on the network operator, you need to configure the APN (Access Point Name) via the interface. Some carriers may also require authentication credentials (username and password).

#### 7.1.2 [Select transmission protocol and security](#)

An FTP or e-mail server must be configured so that the device can send data. The configuration of FTP or e-mail settings depends on the desired use case. You will receive the specific FTP or SMTP details, like server addresses, ports and authentication credentials from your provider.

#### NOTE:

We recommend the use of FTP instead of e-mail due to the easier implementation and functionality as this is less prone to errors.

### 7.2 [Configuring a LoRaWAN device from KELLER](#)

The LoRaWAN® module, which can be configured on a country-specific basis, establishes a connection with a LoRaWAN® [Gateway](#) to send the measured values to a LoRa network server. The LoRaWAN provider is freely selectable.

**The ADT1-LR is preconfigured on the open-source, decentralized network called "[The Things Network](#)" on our KELLER TTN account.** TTN is a contributor member of the LoRa Alliance and provides a set of open tools and a global, open network to connect things. This means the ADT1-LR is ready to use without any configuration changes.

Nevertheless, the ADT1-LR can be easily reconfigured through the PressureSuite Desktop to other network servers like [Actility](#), [Loriot](#), etc.

### 7.2.1 Integration with the Things Network (TTN)

Before a device can communicate via The Things Network you need to register it with an application.

NOTE:

To avoid conflicts or duplicate registrations, it's recommended to change the AppEUI (JoinEUI) if moving the device to a new TTN account or a different server. This step ensures that the device is no longer associated with KELLER's original TTN account and can securely connect to the desired network server.

To use the default **Over the Air Activation** (OTAA) you will need to register your device with its Device EUI:

1. Access the TTN portal <https://www.thethingsnetwork.org/>. An account is free, and the entry page is <https://console.thethingsnetwork.org/>. If you don't have an application yet, you need to create one. For more information on how to do this have a look at the network server information.
2. Open the application to which you wish to add a device and click **add end device**. Select "KELLER Druckmess-technik AG" as a Brand and select the model according to our device. Set the Profile parameter of our region.

Register end device

From The LoRaWAN Device Repository      Manually

1. Select the end device

Brand **Brand** \*      Model **Model** \*      Hardware Ver. **Hardware Ver.** \*      Firmware Ver. **Firmware Ver.** \*      Profile (Region) **Profile (Region)** \*

KELLER Druckmess...      ADT1 Tube      Unknown      all      EU\_863\_870

**ADT1 Tube**  
LoRaWAN Specification 1.0.2, RP001 Regional Parameters 1.0.2 revision B, Over the air activation (OTAA), Class A

The KELLER ADT1-Tube is a remote transmission unit with a data logger compatible with selected KELLER level probes and pressure transmitters. It is suitable for use in groundwater level monitoring, flood early warning systems, tank level monitoring, and pressure monitoring applications.

[Product website](#) | [Data sheet](#)

- Choosing a **frequency plan**. In Europe choose "Europe 863-870 MHz (SF9 for RX2 - recommended)"
- Insert the **App EUI (JoinEUI)**, from the device and press the "Confirm" button.
- For **Device EU and App Key**, copy-paste the one you retrieved from your device.

2. Enter registration data

Frequency plan **Frequency plan** \*  
Europe 863-870 MHz (SF9 for RX2 - recommended)

AppEUI **AppEUI** \*  
70 B3 D5 7E D0 B2 17 9F ee

DevEUI **DevEUI** \*  
35 38 31 35 6C 38 91 02

AppKey **AppKey** \*  
E9 D4 71 4F 16 5E 54 7D 57 3F 79 BB AE 0A 24 BB

End device ID **End device ID** \*  
353831356c389102

After registration

View registered end device  
 Register another end device of this type

**Register end device**

3. Click **Register end device** to finish.

## 7.2.2 Activation

LoRaWAN devices have a 64-bit unique identifier “Device EUI” that is assigned to the device by the chip manufacturer. However, all communication is done with a dynamic 32-bit device address “Device Address” a procedure called **Activation**.

### 7.2.2.1 Over-the-Air Activation (OTAA / default)

Over-the-Air Activation (OTAA) is the preferred and most secure way to connect with the LoRa network. Devices perform a join-procedure with the network, during which a dynamic Device Address is assigned, and security keys are negotiated with the device.

### 7.2.2.2 Activation by Personalization (ABP)

In some cases, you might need to hardcode the Device as well as the security keys in the device. This means activating a device by personalization (ABP). This strategy might seem simpler because you skip the join procedure, but it has some downsides related to security.

## 7.2.3 LoRaWAN Security

When a device joins the network (this is called a join or activation), an application session key and a network session key are generated. The network session key is shared with the network, while the application session key is kept private. These session keys will be used for the duration of the session.

The **Network Session Key** is used for interaction between the Node and the Network Server. This key is used to validate the integrity of each message by its Message Integrity Code (MIC check). This MIC is like a checksum, except that it prevents intentional tampering with a message. For this, LoRaWAN uses AES-CMAC. In the backend of The Things Network, this validation is also used to map a non-unique device address to a unique Device EUI and Application EUI.

The **Application Session Key** is used for encryption and decryption of the payload. The payload is fully encrypted between the Node and the Handler/Application Server component of The Things Network (which you will be able to run on your own server). This means that nobody except you can read the contents of messages you send or receive.

These two session keys (network and application session keys) are unique per device, per session. If you dynamically activate your device (OTAA), these keys are re-generated on every activation. If you statically activate your device (ABP), these keys stay the same until you change them.

The **Application key** is only known by the device and by the application. Dynamically activated devices (OTAA) use the **Application Key** to derive the two session keys during the activation procedure.

## 7.2.4 Data Rate

There are some knobs you can turn: **transmission power** and **spreading factor**. If you lower the transmission power, you'll save battery, but the range of the signal will obviously be shorter. The other knob is the data rate. This determines how fast bytes are transmitted. If you increase the data rate you can transmit those bytes in a shorter time. For those, the calculation is approximate as follows: Making the spreading factor 1 step lower (from SF10 to SF9) allows you to send 2x more bytes at the same time. Lowering the spreading factor makes it more difficult for the gateway to receive a transmission, as it will be more sensitive to noise.

## 7.2.5 LoRaWAN Adaptive Data Rate

Adaptive Data Rate (ADR) is a mechanism for optimizing data rates, airtime, and energy consumption in the network. ADR should be enabled for static devices, like the ADT1-LR.

To determine the optimal data rate, the network needs some measurements (uplink messages). The network calculates the so-called “margin”, which is used to determine how much the network can increase the data rate or lower the transmit power, which means more airtime- and energy efficiency. The network could even lower the transmit power to save more energy and cause less interference.

## 8 Perform water level configuration with ADT1 devices

### 8.1 Description

This document is intended to show how to determine the installation parameters needed for the calculation of the water level, especially the installation length. At the same time the different types of water level calculation are listed. The focus of the description is for ADT1 data transmission units with a level probe and the determination of the installation length.

### 8.2 Basics for level measurement with pressure sensors

Level probes detect water levels based on a pressure measurement. If a pressure probe (level probe) is immersed in water, the pressure acting on the pressure probe increases in proportion to the immersion depth with the water level. Per 1cm water height a pressure of about 1 mbar (0.001 bar) results.

The pressure signal of the level probe can be read out via the digital interface. The read-out pressure value can then be converted into one of the three levels explained in more detail below.

$$\text{Pascal's law} \quad p = r \times g \times h \quad h = \frac{p}{r \times g}$$

$p$  = Hydrostatic pressure as a function of height [m]  $r$  = density of water ( $\sim 998.2 \text{ kg/m}^3$ )  $g$  = acceleration due to gravity ( $\sim 9.80665 \text{ m/s}^2$ )

The density of the water depends on the type of water (fresh water, saltwater, ...), as well as on the temperature of the water. Mostly a value of  $998.2 \text{ kg/m}^3$  is used for the density. The acceleration of gravity varies depending on the place on earth where you are. Usually a value of  $9.81 \text{ m/s}^2$  is used for the calculation. With these parameters the following results are obtained for  $1 \text{ bar} = 10.212 \text{ mWS}$  or  $1 \text{ mbar} = 1.0212 \text{ cmWS}$ .

### 8.3 Air pressure dependence

When using a relative pressure sensor for level measurement, the air pressure compensation is done through the reference opening to the pressure sensor. Measured and output from the pressure sensor ( $P_1$ ), the air pressure is thus independent of the air pressure.

When measuring with an absolute pressure sensor, the air pressure (barometer) ( $P_2/P_{\text{Baro}}$ ) must also be recorded. This air pressure must be subtracted from the recorded pressure measurement  $P_1$  (water level). This eliminates air pressure fluctuations. For this reason, our ADT1 devices are equipped with a barometer that measures and can record the barometric air pressure ( $P_2/P_{\text{Baro}}$ ).

For the calculation the pressure difference  $P_1-P_2$  or  $P_1-P_{\text{Baro}}$  is then used instead of  $P_1$ , as pressure value for water level calculation.

## 8.4 Water level calculation types

There are essentially 3 different calculation types.

### 8.4.1 Water height above probe

At water height above probe (E) the water column/water height above the probe is measured.

Water height [E]

$$E = \frac{P1 - P2}{\rho * g} + \text{Offset}$$

Diagram illustrating the calculation of water height (E) above a probe. The probe is at a depth of  $B$  below the water surface. The water column above the probe has a height of  $E$ . The pressure at the probe is  $P1$  (hydrostatic pressure), and the pressure at the water surface is  $P2$  (barometric pressure).

Parameter	Value	Unit
$P1$ (Hydrostatic pressure)	<input type="text"/>	[Pa]✓
$P2$ (Barometric pressure)	<input type="text"/> PBaro	[Pa]✓
$\rho$ (Density)	<input type="text"/> 998.2	[kg/m³]
$g$ (Gravitation)	<input type="text"/> 9.80665	[m/s²]
Offset	<input type="text"/> 0	[m]

### 8.4.2 Depth to water

At depth to water (F) the distance from the upper edge of the measuring point to the water surface is determined. For the calculation of the depth upper edge of the measuring point to the water surface the installation length B must be known.

Depth to water (F)

$$F = B - \frac{P1 - P2}{\rho * g} + \text{Offset}$$

Diagram illustrating the calculation of depth to water (F). The probe is at a depth of  $B$  below the water surface. The water surface is at a reference level (Earth Surface). The pressure at the probe is  $P1$  (hydrostatic pressure), and the pressure at the water surface is  $P2$  (barometric pressure).

Parameter	Value	Unit
$P1$ (Hydrostatic pressure)	<input type="text"/>	[Pa]✓
$P2$ (Barometric pressure)	<input type="text"/> PBaro	[Pa]✓
$B$ (Installation length)	<input type="text"/> 10	[m]
$\rho$ (Density)	<input type="text"/> 998.2	[kg/m³]
$g$ (Gravitation)	<input type="text"/> 9.80665	[m/s²]
Offset	<input type="text"/> 0	[m]

### 8.4.3 Water height related to sea level

At water level related to sea level (G) the water level/water level related to sea level is calculated. With this information the measured values from different locations can be compared with each other. For this calculation the installation length B and the height above sea level of the upper edge of the measuring point are required.

Height of water ASL (G)

$$G = A - B + \frac{P1 - P2}{\rho * g} + \text{Offset}$$

Diagram illustrating the calculation of height of water ASL (G). The probe is at a depth of  $B$  below the water surface. The water surface is at a reference level (Earth Surface). The sea level is at a reference level above sea level (A). The pressure at the probe is  $P1$  (hydrostatic pressure), and the pressure at the water surface is  $P2$  (barometric pressure).

Parameter	Value	Unit
$P1$ (Hydrostatic pressure)	<input type="text"/>	[Pa]✓
$P2$ (Barometric pressure)	<input type="text"/> PBaro	[Pa]✓
$A$ (Reference level above sea)	<input type="text"/> 500	[m]
$B$ (Installation length)	<input type="text"/> 10	[m]
$\rho$ (Density)	<input type="text"/> 998.2	[kg/m³]
$g$ (Gravitation)	<input type="text"/> 9.80665	[m/s²]
Offset	<input type="text"/> 0	[m]

## 8.5 Determining the installation length by measuring with a tape measure

The installation length (B) can be determined by measuring from the upper edge of the remote transmission unit to the level probe (marker) with a tape measure.

For this purpose, the level probe must be mounted to the remote transmission unit and then laid out on the ground. Make sure that the cable of the level probe is taut, so that measurement errors are avoided. The length is measured from the upper edge of the remote transmission unit to the marking of the level probe. This measured value corresponds to the installation length (B).

This method for determining the installation length is only suitable for shorter cables, because the stretching of the level probe cable is difficult to manage with a long cable and an appropriate space must also be available.

We recommend determining the installation length (B) at the measuring point, as explained below. The advantage of this method is that all influences such as a not completely stretched cable etc. are corrected and during the installation it can be checked whether the water level calculation is correct with the determined parameters.

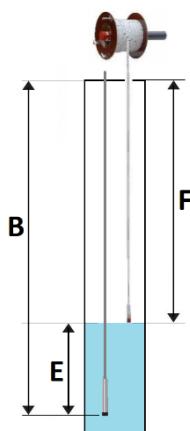
## 8.6 Determining the installation length (B) at the measuring point

The installation length B is most easily determined on site at the measuring point by measuring the distance F from the upper edge of the measuring point to the water surface with a tape measure/light plummet.

The water level E is read out by the pressure sensor/level sensor.

$$B = E + F$$

By addition of distance upper edge to water surface F and water height E, the installation length B results, which is needed for the water level calculation depth to water (tap) F and water height related to sea level G.



## 8.7 Electric contact gauge

A electric contact gauge is a tape measure on a roll, which is lowered into the measuring point with a weight. As soon as the weight, which also includes an electrical contact, touches the water surface, a sound is generated. When the sound is heard, the exact distance to the water surface can be read off the measuring tape at the upper edge of the measuring point.



## 8.8 Determining the installation length with ADT1 remote transmission unit

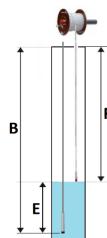
Since the ADT1 remote transmission unit has no external connector for the interface, the level measurement must be performed with the open housing. To determine the installation length with the ADT1 remote transmission unit, here's a possible step-by-step instruction:

### 8.8.1 Set up the ADT1 device and measure the tap (F):

Install the ADT1 device with connected level probe in the level measuring point.

Measure and note the distance **F** from measuring point to water surface with a electric contact gauge, a tape measure/light plummet or similar.

In the example the upper measuring point to the water surface is  $\rightarrow F = 0.48 \text{ m}$



NOTE:

The measured installation length is **0.8695 m** and should finally correspond to the calculated installation length **B** at the end.

### 8.8.2 Measure water column height (E)

Connect the ADT1 device to the computer. To get access to the internal USB interface the ADT1 device must be opened.

The housing sleeve can remain in the measuring point, place the inner part with the electronics on the housing sleeve.

NOTE:

As the inner part of the ADT1 is pulled out, the position of the level probe changes by 16.5 cm, i.e. the length of the inner part. These 16.5 cm must be added later to the measured level over probe "E", so that the correct installation length can be determined.

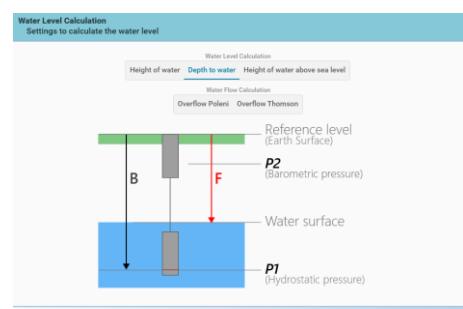
Now the height of the water column **E** above the sensor can be measured via the interface.



### 8.8.3 Water level configuration with "PressureSuite Desktop"

Start software "PressureSuite Desktop" and change to "Water level configuration" (assuming all other ADT1 measurement settings are done).

- Select desired calculation method
- Fill in the needed parameters, i.e. density
- Select the measuring channel that is responsible for the water level measurement. For absolute pressure measurement select  $P_1 - P_{\text{Baro}}$ , for relative pressure measurement select  $P_1(\text{relative})$ . In this example, a relative sensor is used
- Press the "Measure" button, the current measured value is displayed



In order for the installation length B to be calculated correctly, the distance F "Depth to water" (wellhead to water surface) must be entered. Here the inner part of the ADT1 housing, 16.5 cm, must be added to the value F = 0.48m.

$$\rightarrow 0.48 \text{ m} + 0.165 \text{ m} = 0.645 \text{ m}$$

If the "Calculated installation length" matches the measured calculated length, everything has been done correctly.

$$\Rightarrow 0.8695 \text{ m}$$



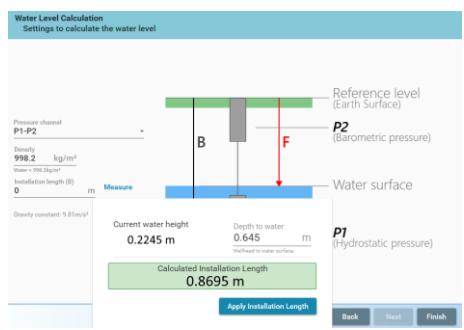
The plug can now be removed from the interface, the remote transmission unit reassembled, and the level measuring point closed with the level cap.

NOTE:

All measured values and parameters should be noted down for safety's reasons, preferably with date and time.

The parameters can now be safed to the device by pressing the "Write Configuration" button. It is possible to transfer the complete settings to the PressureSuite Cloud by remote transmission, by sending the configuration.

The water level configuration is needed for the PressureSuite Desktop and Cloud to convert pressure to the desired water level. With the PressureSuite Cloud the parameters can be entered or changed. The cloud also receives the parameters, which are transmitted via remote transmission (configuration messages).



## 9 ADT1 order information

### 9.1 Accessories

Description	Product number	Picture
<b>Locking Unit</b> 2" 3" 4" 5" 6"	509210.0001 509210.0002 509210.0003 509210.0004 509210.0005	
<b>Adapter ring suitable for the locking unit</b> 3" 4" 5" 6"	506810.0118 506810.0119 506810.0102 506810.0120	
<b>Micro USB cable (B-Type)</b>	309010.0134	
<b>Antenna</b> with SMA connection	331005.0005	
<b>Antenna for manhole cover</b> with SMA connection  Cable length: 2m	320020.0133	
<b>O-Ring</b> (35x1.5 mm / Nitril / 70°Shore)	508620.0023	
<b>Silicagel bag</b> 5 g	702505.0007	

## 10 Approvals Compliance

### 10.1 Americas Approvals

#### 10.1.1 FCC Certification

Model	FCC ID
<b>ADT1-Tube-M1&amp;NB</b>	Contains transmitter module FCC ID: RI7ME310G1W1
<b>ADT1-Box-M1&amp;NB</b>	
<b>ADT1-Tube-LR</b>	Contains transmitter module FCC ID: VPYCMABZ
<b>ADT1-Box-LR</b>	

The FCC Grants can be found here: <https://www.fcc.gov/oet/ea/fccid>

#### 10.1.2 IC/ISED Certification

Model / Modèle	ISED Certification Number / Num. de certification ISDE
<b>ADT1-Tube-M1&amp;NB</b>	Contains IC / Contient IC: 5131A-ME310G1W1
<b>ADT1-Box-M1&amp;NB</b>	
<b>ADT1-Tube-LR</b>	Contains IC / Contient IC: 772C-CMABZ
<b>ADT1-Box-LR</b>	

The products ISED certified can be found here:

Les produits certifiés ISED peuvent être trouvés ici:

<https://sms-sgs.ic.gc.ca/equipmentSearch/searchRadioEquipments?execution=e1s1&lang=en>

### 10.2 FCC/ISED Regulatory notices / Avis réglementaires de FCC et ISED

#### 10.2.1 Modification statement / Déclaration de modification

KELLER Druckmesstechnik AG has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

KELLER Druckmesstechnik AG n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

#### 10.2.2 Interference statement / Déclaration d'interférence

This device complies with Part 15 of the FCC Rules and Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference, and
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### 10.2.3 Wireless notice / Wireless avis

This device complies with FCC/ISED radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the ISED radio frequency (RF) Exposure rules. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body.

Le présent appareil est conforme à l'exposition aux radiations FCC / ISED définies pour un environnement non contrôlé et répond aux directives d'exposition de la fréquence de la FCC radiofréquence (RF) et RSS-102 de la fréquence radio (RF) ISED règles d'exposition. L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur. L'antenne doit être installée de façon à garder une distance minimale de 20 centimètres entre la source de rayonnements et votre corps.

#### 10.3 Brazil ANATEL

Agência Nacional de Telecomunicações (ANATEL) of Brazil



ME310G1-W1 Homologation # 01333-23-02618

#### 10.4 EMEA Approvals

##### 10.4.1 EU RED Declaration of Conformity

KELLER Druckmesstechnik AG declares that the equipment is in compliance with the Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address:

<https://www.keller-pressure.com/en/downloads?types=Declaration-of-Conformity>

Text of 2014/53/EU Directive (RED) requirements can be found here:

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0053>

##### 10.4.2 UK UKCA Declaration of Conformity

KELLER Druckmesstechnik AG declares that the equipment is in compliance with the Radio Equipment Regulations 2017 for UKCA.

The full text of the UKCA declaration of conformity is available at the following internet address:

<https://www.keller-pressure.com/en/downloads?types=Declaration-of-Conformity>

The UKCA requirements can be found here:

<https://www.gov.uk/guidance/using-the-ukca-marking>

#### 10.5 Antenna

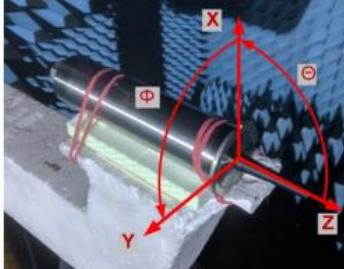
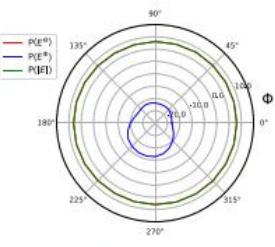
This radio transmitter has been approved under RED, UKCA, FCC and ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio a été approuvé par RED, UKCA, FCC and ISED pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

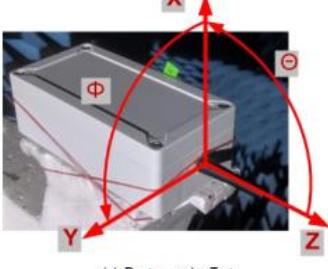
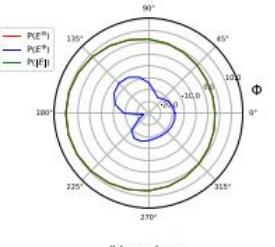
Model / Modèle	Antenna Type / Type d'Antenne
<b>ADT1-Tube- M1&amp;NB</b> <b>ADT1-Box- M1&amp;NB</b>	Omnidirectional Antenna Gain 2.14 dBi Omnidirectionnelle Gain de l'antenne 2.14 dBi
<b>ADT1-Tube-LR</b> <b>ADT1-Box-LR</b>	Omnidirectional Antenna Gain 1.04 dBi Omnidirectionnelle Gain de l'antenne 1.04 dBi

## 11 RF Performance measurements

### 11.1 ADT1-Tube-LR

UL-Frequency:	863099890 Hz																																																				
TRP:	10.1 dBm																																																				
max. EIRP ( $\Theta$ ):	14.4 dBm at ( $\Theta=120.0^\circ$ , $\Phi=0.0^\circ$ )																																																				
max. EIRP ( $\Phi$ ):	-8.6 dBm at ( $\Theta=180.0^\circ$ , $\Phi=-90.0^\circ$ )																																																				
max. EIRP (abs):	14.4 dBm at ( $\Theta=120.0^\circ$ , $\Phi=-165.0^\circ$ )																																																				
																																																					
(a) Device under Test		(b) xy-plane																																																			
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### 11.2 ADT1-Box-LR

UL-Frequency:	863100000 Hz																																																				
TRP:	9.6 dBm																																																				
max. EIRP ( $\Theta$ ):	14.3 dBm at ( $\Theta=120.0^\circ$ , $\Phi=-165.0^\circ$ )																																																				
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## 12 Version History

Version	Date	Description
<b>11/2024</b>	<b>20.11.2024</b>	Merge Manual ADT1-M1&NB_EN_10_2024 and ADT1-LR_EN_12_2023 KELLER "KOLIBRI" is now called "PressureSuite" New and revised content
12/2023	08.12.2023	Update layout Add 3.5 SIM Card Update 5 Configuration Update torque for 3.7 Cable gland / level sensor connection Update 4.3 Battery lifetime estimation adding the paragraph on battery capacity. Add 9 Ingrees Protection – IP
03/2023	28.03.2023	Remove 8.2 Accessories / O-Ring 37x1.5 mm (Antenna side) PN: 508620.0022
10/2022	04.10.2022	New document

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