User Manual

Landfill Logger

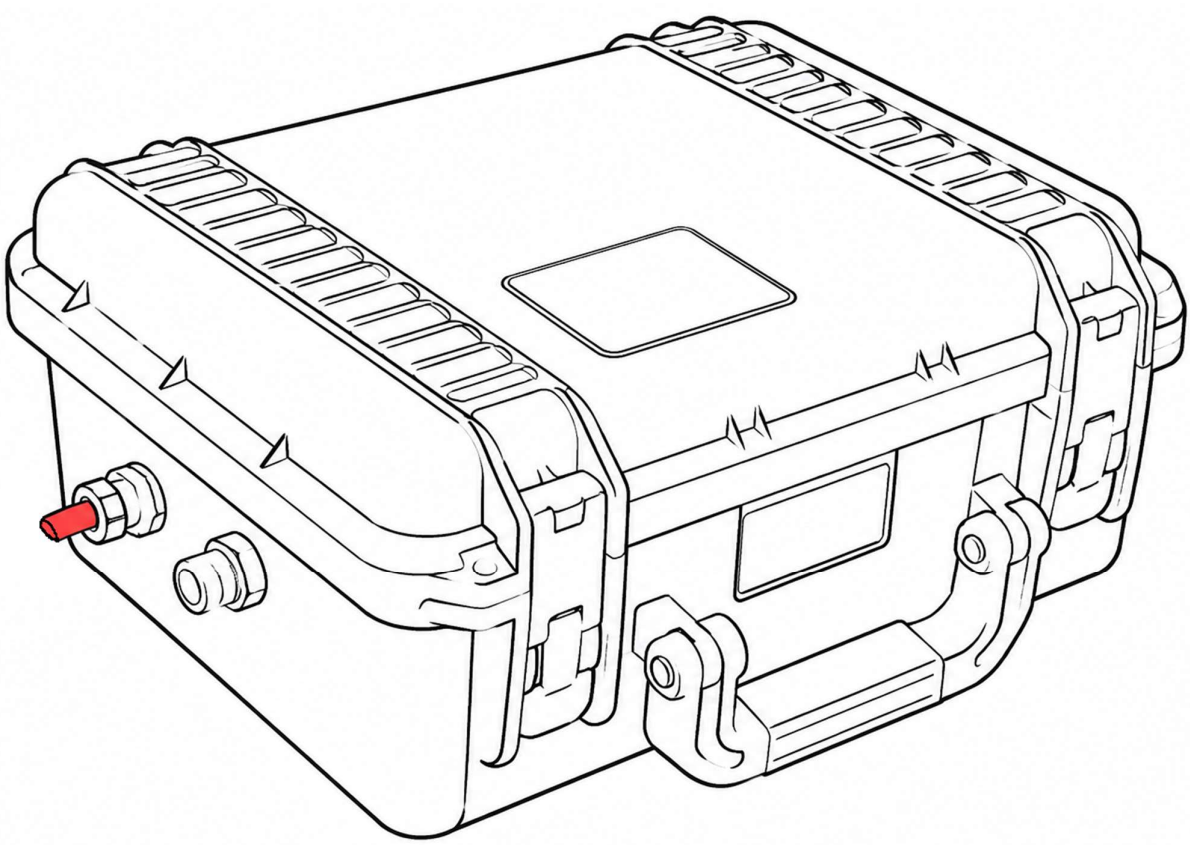


TABLE OF CONTENTS

1 Introduction

Landfill Logger (LFL) is an advanced automatic gas monitoring sampler. It is designed for unsupervised battery powered long-term sampling and measurements in the field.

LFL monitors the concentrations of CH_4 and CO_2 under buildings or in the soil gas phase (in the unsaturated zone) to assess the risk of explosion and suffocation. Additionally, the loggers measure atmospheric pressure, temperature, relative humidity and the vacuum where gas is extracted from.

LFL will analyze air samples and send data live for monitoring to DMR Cloud platform.

This manual will guide the customer using the sampler, how to operate it electronically and mechanically. How to connect tubes for air sampling during field measurements and how to perform a verification with test gas.

2 Operation

Please read all instructions before operating LFL to ensure it performs to its full potential.

2.1 Configurations

Landfill Logger can be configured in two modes. This can be beneficial for field tests where battery consumption is important, for example in remote places or during very long sampling periods. In most cases a time consistent sampling cycle is preferred for simple analyzing and overview.

Configuration	Description
ConstantFrequency	Air sampling is performed at a repetitive interval F.X. each 60 minutes. This gives a good balance between sampling and battery life.
IntelligentSampling	Air sampling is performed with a variable interval based on barometric pressure. During a low-pressure event with falling barometric pressure, gas from soil will often rise and evaporate. This leads to higher gas concentrations, hence better resolution and logger interval is wanted. During barometric high pressure reduced logging interval making battery life prolonged.

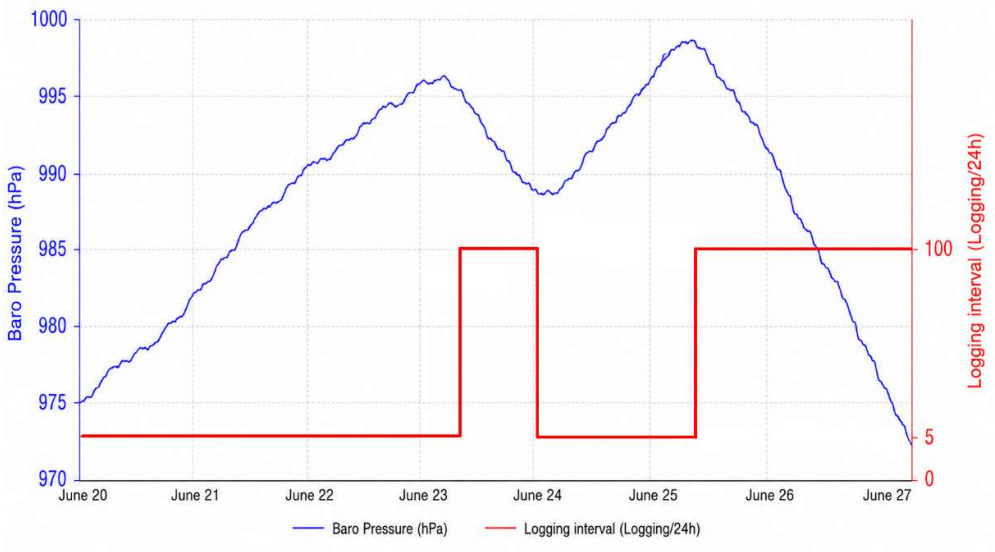
2.1.1 ConstantFrequency configuration

A theoretical illustration of the constant frequency configuration independent of barometric pressure

The blue graph (hPa – hecto Pascal) varies over time.

The red graph (Logging / hour) stays constant over time. The frequency of how often air should be sampled can be configured via DMR Cloud.

2.1.2 IntelligentSampling configuration



A theoretical illustration of intelligent sampling configuration dependent on barometric pressure.

The blue graph (hPa) varies over time. In the example a high pressure for the first 4 days, followed by low pressure 1 day, high pressure 1½ days and ending with a low-pressure change.

The red graph (Logging / 24 hours) shows the 2 interval settings, that can be configured via DMR Cloud. In the example low intervals for high pressure periods the interval is reduced to 5 samples

per day. In barometric pressure changes when low pressure occurs and soil gas concentration naturally will rise; a higher logging frequency will be applied automatically. In this case 100 samples per day.

2.1.3 Purge time and air volume calculations

Purge time is an important parameter that Landfill Logger needs to be configured with.

The user needs to calculate amount of air to refresh between each sample. A guideline is to replace 2.5 times the air in connected tubes for an optimal reading.

If the installation requires metal rods, long tubes or other connections with air volume between the LFL and test site, this needs to be calculated by the user using this formula:

$$t = \frac{\left(\pi \left(\frac{ID}{2}\right)^2 L\right) \times Ar}{Af} \times 60$$

Parameters in the formula are:

- ID = Inner Diameter
- L = Length
- Ar = Air replacement constant
- Af = Air flow

For a simpler formula use this:

$$t = \frac{\pi \left(\frac{ID}{2}\right)^2 \times L \times 10^{-6} \times Ar \times 60}{Af}$$

For your values in an example:

- ID = 4 mm
- L = 1 m
- Ar = 2.5
- Af = 1.6 L/min

Insert correct values in the below formula for exact calculation of purge time in seconds:

$$\frac{\pi \left(\frac{4mm}{2}\right)^2 \times 1m \times 10^{-6} \times 2.5 \times 60}{1.6} = 1.18\,s.$$

Examples of purge time with different materials:

Material & length	Purge time (seconds)
Plastic tube OD 6mm, ID 4mm, length 1 m.	1.18 sec.
Plastic tube OD 6mm, ID 4mm, length 10 m length.	11.8 sec.
Plastic tube OD 6mm, ID 4mm, length 1 m, Metal rod OD 14mm, ID 10mm, length 1 m.	8.54 sec.

2.1.4 Tube system installation

Common guidelines for gas sampling and measurements are advised. These are outside the scope of this manual.

Worth mentioning is the versatile possibilities to extract gas using LFL. Please consult DMR for help or solutions.

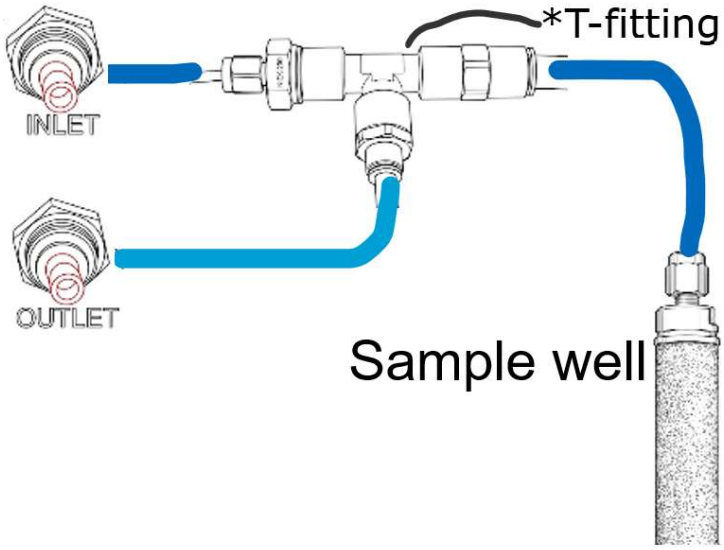
2.1.5 Gas extraction installation

The simplest way to monitor gas concentration is via a single sample point. This is done with the inlet tube. It can be placed under a building, a gas sampling point in the unsaturated zone or a monitoring well. **Note**: If using it in a monitoring well or other almost airtight places the purge time will affect air pressure.

2.1.6 Closed loop installation

For pressure sensitive gas measurements F.X. airtight soil well, DMR has a unique dualtube solution where inlet and outlet are both connected in a T-fitting.

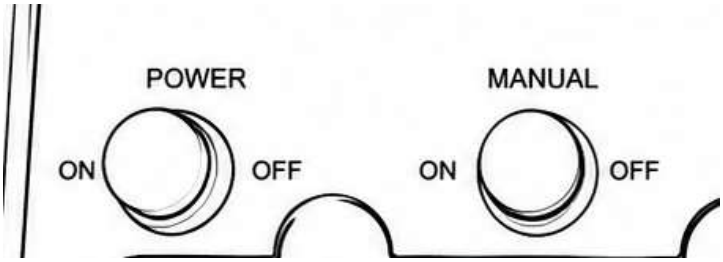
This allows a constant air pressure at the sampling point. At the same time the concentration will remain the same, even during purge and logging.



2.2 Operating modes

The operation panel consists of two ON/OFF switches and one display.

The display will only power on and show information during sampling. After each sampling in normal mode, display will turn off.



2.2.1 Normal mode

For field test sampling and normal operation only Power switch must be in on position.

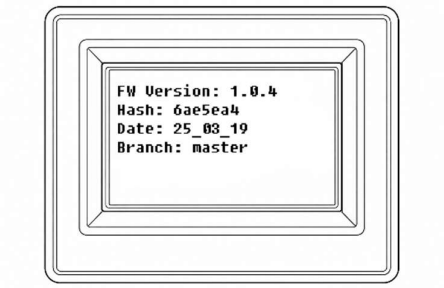
If the sampler has been operated in Manual mode it is important to turn off the sampler, move all switches in off position and then Power switch in on.

- Power (Off) – wait at least 15 seconds
- Power (On)

In normal mode the screen cycles through informative status menus to report status in real time.

The steps are:

Initializing system screen display when power is applied.



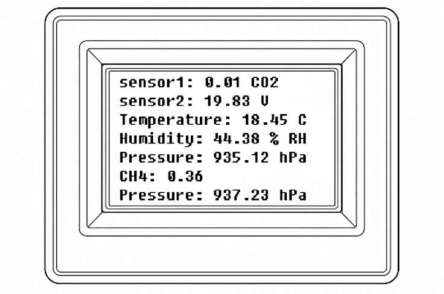
Firmware Metadata Screen

Displays firmware Version with other relevant information.

Warming up and purge

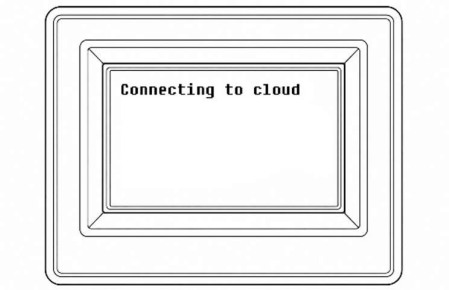
Warming up to make accururate and temperature independent measurements.

Purging air tubes to allow measurement on new sampled air.



Measuring

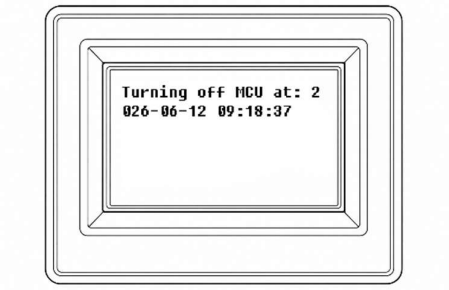
Prompts LFL registered sensors with present values.



Connecting to cloud

Establishing an online cell connection to the remote server.

Uploads data parameters to DMR Cloud server.



Turn off MCU

Upload finished; cloud connection is safely closing.

UTC timestamp for present measurement is prompted.

Prepares shut down until automatic wake up interval.

Shut down.

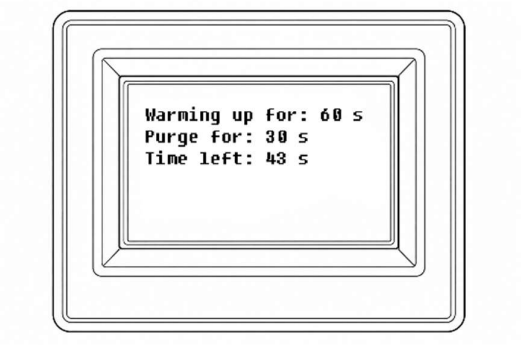
2.2.2 Manual mode

To operate the sampler in manual mode, the sampler must first be powered off, then turn Manual switch on and afterwards turn Power on.

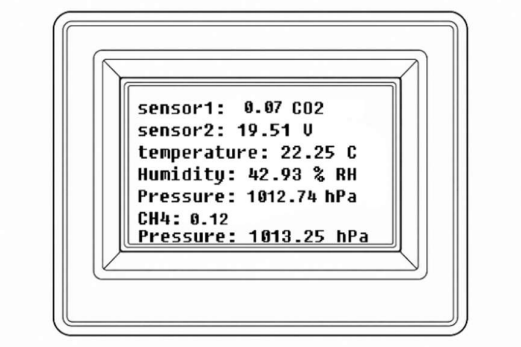
- Power (Off) – wait at least 15 seconds
- Manual (On)
- Power (On)

After this procedure the sampler will start in manual mode.

First run will always initiate warmup and purge with configured values.



After warmup and purge all configured sensors will update each 5 seconds.



Display headline	Description
sensor1:	CO2 value in percent.
sensor2:	Battery voltage.
temperature:	Landfill Logger temperature.
Humidity:	Relative humidity
Pressure:	Tube pressure at sensors location. This is within the sampling system.
CH4:	CH4 value in percent.
Pressure	Atmospheric barometric pressure.

2.3 Data Logging

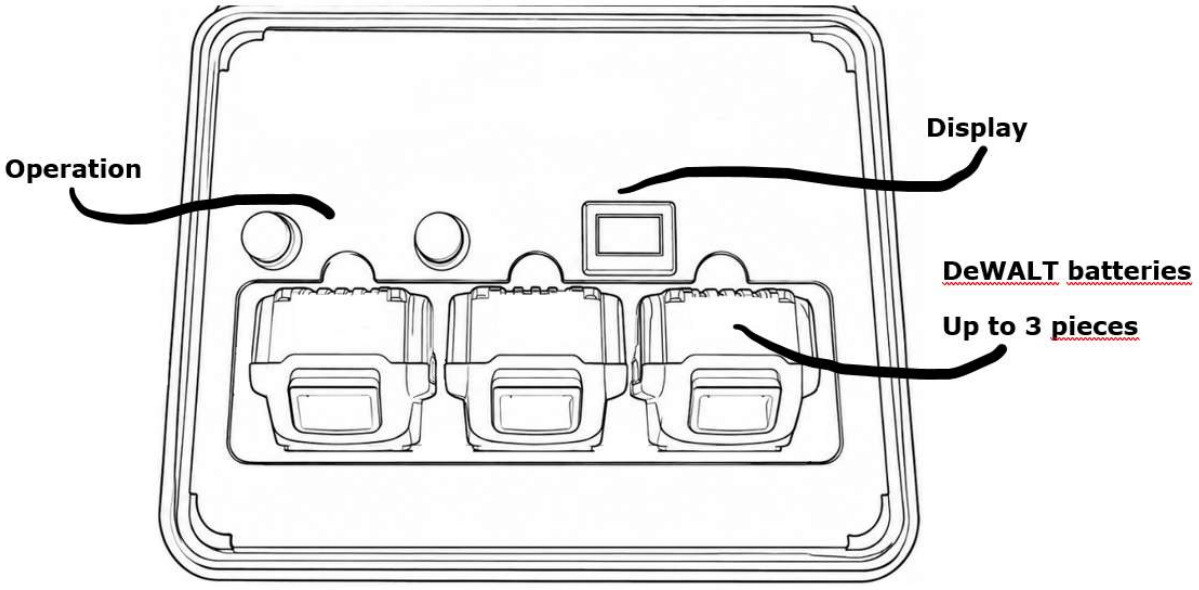
Data is send to DMR Cloud and also saved local on a micro SD card.

3 System

3.1 Components

3.1.1 Inside parts

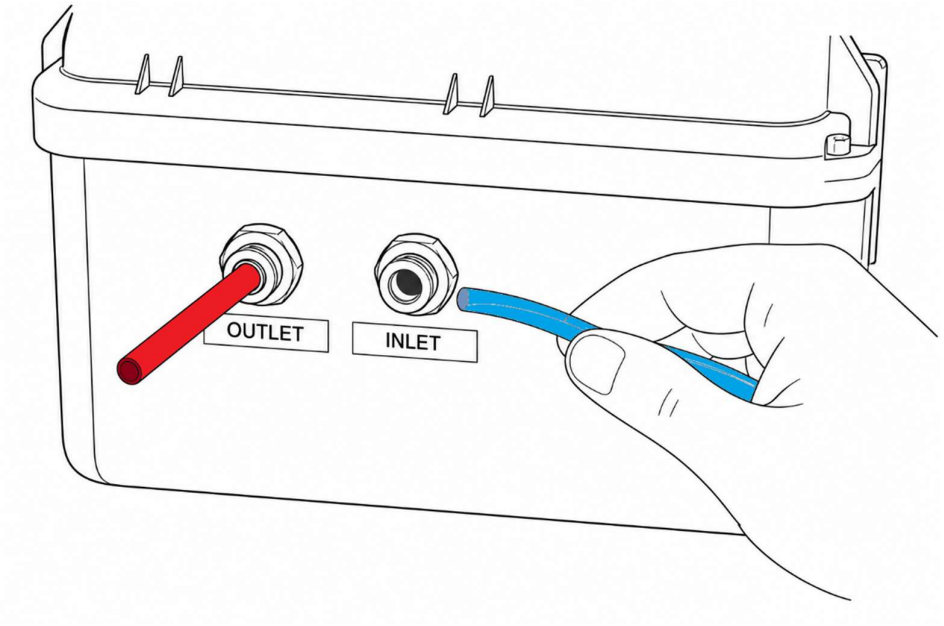
Inside the sampler 3 x DeWALT batteries are mounted in battery holders. They can be hot-plugged while the logger is turned on. The sampler can run on a single, two or three batteries. Return to DMR for any other maintenance.



3.1.2 SD Card

A sampler must have a micro-SD card. The size must be 32GB or below. SD Card is formatted as FAT32.

3.1.3 External connections



Side connectors have following naming:

OUTLET: Air outlet from vacuum pump. It is pre-mounted with a 6 mm red tube.

INLET: Air inlet for sampling. It is ready for a 6 mm outer diameter tube.

3.2 Specifications

Specifications	
Size:	334.6x232.4x155.2(mm) – 13.17x11.93x6.11(in)
Weight empty:	No batteries: 5.8 Kg – 12.79 lbs.
Weight full:	3 x batteries: 7.7 Kg – 16.98 lbs.
Operating temperature:	-15°C to 60°C.
IP rating:	IP23 (IP65 with optional hydrophobic air filters).
Battery type	DeWALT 18V, 1-3 pcs.
Operating voltage:	16V to 25V.
Current max:	1.2A @ 22V.
Estimated operating life:	20 to 60 days depending on purge time.

3x5Ah DeWALT, 60 min. logging interval:	
Air flow during sampling:	1.6 – 2.2 L/min
CO2:	0 to 20% +-0.5%
CH4:	0 to 5% +-0.5%
Temperature:	-15°C to +60°C +-1°C
Relative humidity:	0 to 95%RH +-1.8%
Pressure:	800 to 1100 hPa +-0.06 hPa

4 DMR Cloud

4.1 Local SD card backup

The system features an automated data backup architecture that writes log files directly to a local Micro SD card. SD card size must be 32GB or below. SD Card is formatted as FAT32.

The Micro SD Card slot has a push-push for inserting and releasing it. Do not pull.

It is highly recommended to contact DMR service center if SD card backup needs to be retrieved.

The system automatically modifies and updates four structural files to provide an offline data backup:

SD Card file	Description
datalog.jsn	Offline recorded sampling. All measured data is backup up in this file.
event.jsn	Chronologic recording each sampler step with timestamps.
sensors.jsn	Active sensors to be sampled and backed up.
settings.jsn	Operating modes, sampling intervals, pressure and vacuum levels, weight etc.

4.2 NB-IoT usage

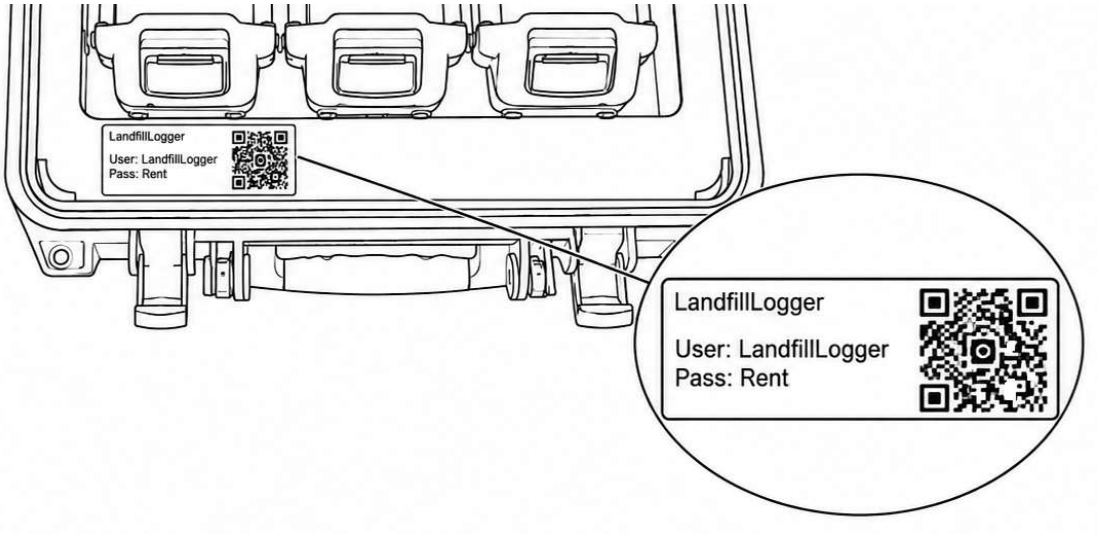
Landfill Logger uses Narrowband IoT cell connection to online cloud and configuration. If mobile operator or cell tower has bad coverage, this will not affect LFL ability to operate and sample as configured. It will only postpone DMR Cloud data. No data will be lost.

4.3 DMR Cloud management

4.3.1 Remote Access

Through our secure online cloud platform, users can remotely access all logged data parameters from any active, deployed SWS unit. The portal allows you to easily view, manage, and analyze your field operations directly within your web browser.

Cloud data can be accessed by scanning the QR code on the sampler. Username and password are written on the same label.



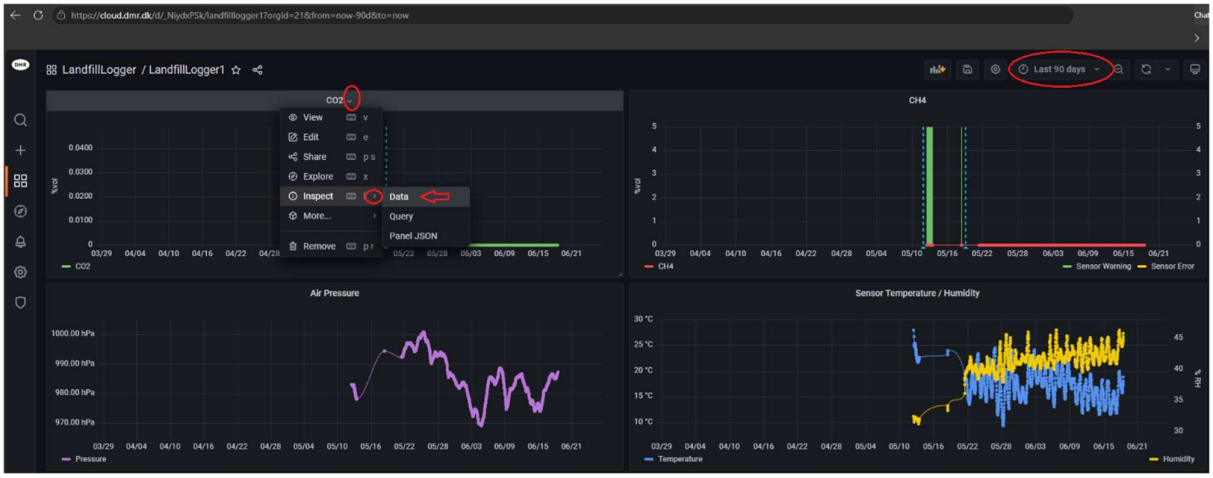
If access is necessary from a computer, same URL can be typed in a browser.

4.3.2 Data Export Functionality

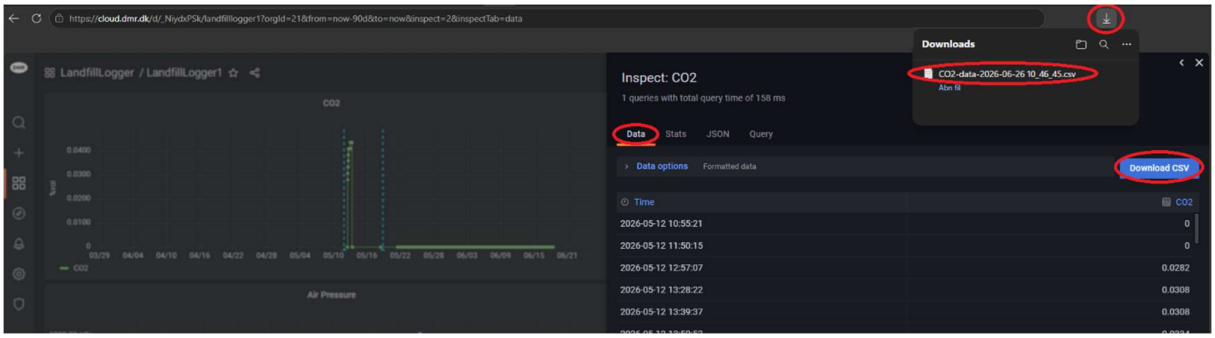
Users can export historical field data sets directly into a universal CSV file format. This allows for external evaluations, custom visualization configurations, or seamless integration into environmental reports using software like Microsoft Excel. Delivering these sampling data together with the analysis report from the laboratory gives detailed insight into the sampling conditions.

To download data from DMR Cloud follow pictures below:

1. Choose time period in upper right corner.
2. Zoom in graph area for specific time period wanted.
3. Click small down-arrow to the right of graph
4. Click small right-arrow at “Inspect”.
5. Click “Data”.



6. A new window will open with “Inspect ….” Data chosen.
7. Choose “Data”.
8. Click “Download CSV”.
9. File has been downloaded and can be opened in Excel or another sheet program.



5 Service

5.1 Calibration

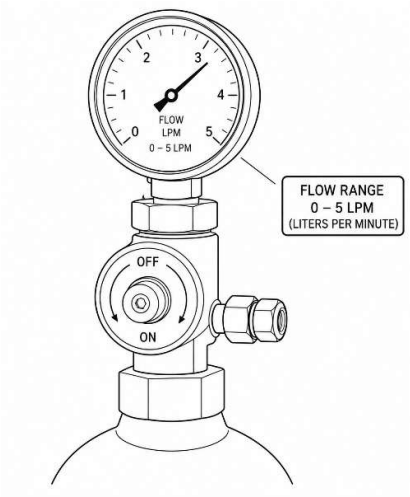
Landfill Logger has many sensors and its mechanics and electronics needs special knowledge. This is why calibration can only be carried out by an authorized DMR service center.

5.2 Test and validation

It is possible to perform validation during field tests. This can be carried out with test gas.

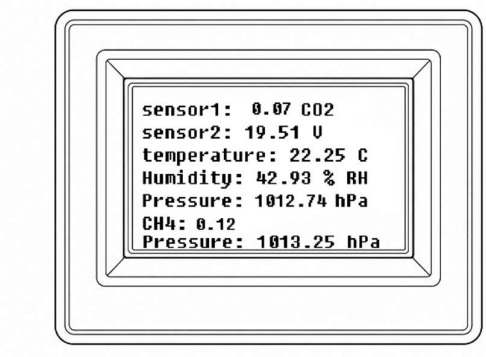
Prerequisites required for field test validation:

- Regulator of type: Demand flow regulator. Capable of delivering at least 5 liters per minute. **NOTE: Constant flow regulator will NOT work!**
- 1 meter tube 6 mm outer diameter.

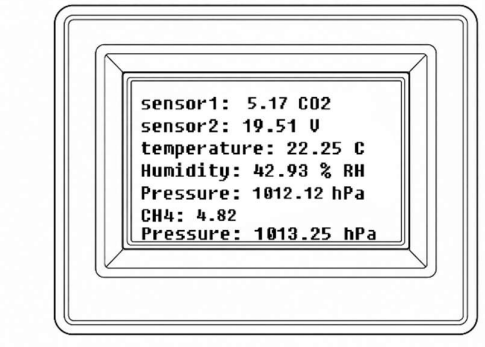


Test gas contains following gas:

- 5% CH4 (Methane)
- 5% CO2 (Carbon dioxide)
- 5-6% O2 (Oxygen)
- 83-84% N2 (Nitrogen)

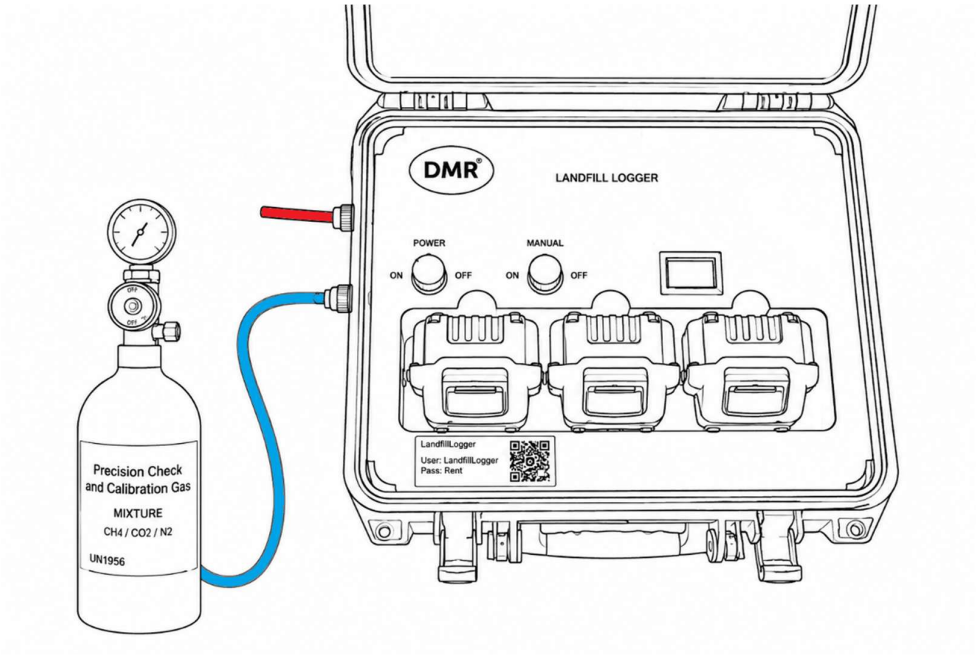


Expected results in reading of CO2 and CH4 sensors with normal air.



Expected results in reading of CO2 and CH4 sensors with test gas.

Tests can be done in two modes:



5.2.1 Validation -Manual mode

Measurement will only be displayed locally on the present logger during test period. It is possible to see live updates in sensor readings. This can be beneficial for fast reading results with test gas attached and removed to see the difference.

1. Connect test gas from demand flow regulator through 1 meter 6 mm O.D. tube to inlet.
2. Open flow regulator.
3. Turn on logger (See below options)
   3.1. Power (off) – wait 20 seconds.
   Manual (on)
   Power (on)
4. After sensor warmup and purge time has elapsed, measurement is performed and displayed
   4.1. Purging of new air through inlet and sensors will update until step 5.
5. Turn off logger (See below options)
   5.1. Power (off)
6. Close flow regulator.
7. Remove test gas from logger.

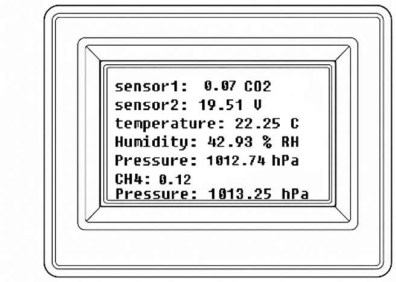
5.2.2 Validation -Normal mode

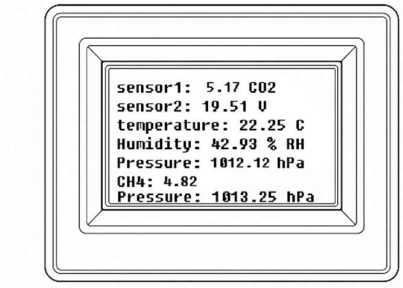
Measurement will be stored on the SD card and sent to DMR Cloud as a normal single sampling point.

Proceed with the steps below for validation test.

1. Connect test gas from demand flow regulator through 1 meter 6 mm O.D. tube to inlet.
2. Open flow regulator.

3. Turn on logger
   3.1. Power (off) - wait 20 seconds
   3.2. Power (on)
4. After sensor warmup and purge time has elapsed, measurement is performed and displayed
5. Turn off logger
   5.1. Wait until logger shows: "Turning off MCU…"
   5.2. Power (off)
6. Close flow regulator.
7. Remove test gas from logger.





5.3 Maintenance

Landfill Logger may be returned to DMR for maintenance to perform system inspection and cleaning. Parts replacement except for batteries can only be done if returned to DMR.

5.4 Cleaning

Only clean the inside of Landfill Logger with deionized water and only a small amount of water on a soft cloth. Avoid leaving or spilling water inside the sampler at any time. Highly sensitive electronics can corrode in high humidity. Avoid opening the sampler lid during heavy rain.

Brush soil or sand off the rubber gasket in the lid to make it rain proof.

After each field measurement brush off any dirt. Especially around the external fittings.

5.5 Troubleshooting

5.5.1 No SD card

5.5.2 Low battery

Cause	Solution
Batteries empty.	Replace batteries.

5.5.3 Sudden tube pressure rise

Cause	Solution
Sample tube blocked.	Inspect and / or replace sample tube.
Sample tube filled with water.	Empty / replace sample tube. Reposition sample tube end higher to reduce risk of soil water entrance.
Water block filter filled.	Moist and / or water drops has entered internal water blocking filter. Filter needs replacement at DMR facility.

5.5.4 DMR Cloud data not showing

Cause	Solution
LFL batteries empty	Replace batteries.
Cell phone coverage weak in NB-IoT	If possible try placing LFL 0.5-2m above ground.
DMR Cloud service down	Refresh browser and login and return later.

5.6 Technical Support & Contact

EUROPE

Customer service representatives are available for questions, problems or feedback Monday through Friday 9:00 to 15:00 Central European time.

Email equipment@dmr.eu

Phone +45 30 22 50 55

Website dmr.eu