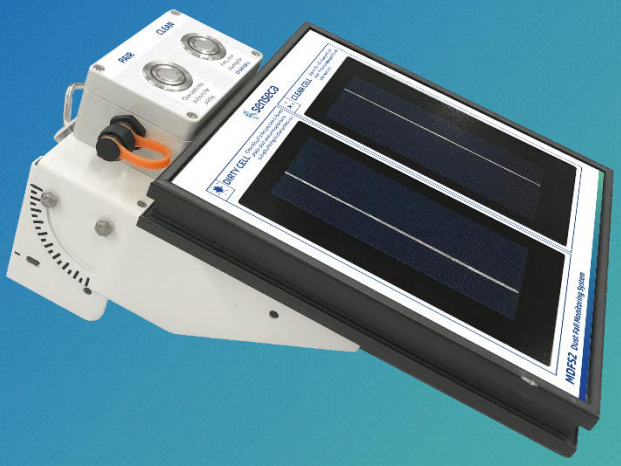
USER MANUAL

MDFS2 / MDFS2-S

Dust Fall

Monitoring System



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V1.1

senseca

Contents

1 Introduction 3
2 MDFS Elements 4
3 MDFS Start Up Procedure 5
3.1 Installation and Connections 5
3.2 Configuration of geographic coordinates 6
3.3 Cells pairing routine 7
4 MDFS Measurements 9
5 MDFS advanced operation 10
5.1 Cleaning routine for "Clean Cell" 10
5.2 Cleaning the PV panels of the solar plant 11
6 Data analysis 12

1 Introduction

The **Dust Fall Monitoring System (MDFS)** has been specifically designed to assist operators in determining when the photovoltaic (PV) panels of a solar plant need to be cleaned.

The MDFS system continuously monitors the radiation levels collected by two temperature-compensated reference cells, which provide output in the form of either voltage (**Model MDFS2**) or Modbus protocol (**Model MDFS2-S**). One of these cells is designated as the "Clean Cell" and must always remain free of dust and debris, while the other, the "Dirty Cell", is subject to the same cleaning schedule as the PV panels of the solar plant.

The MDFS system offers two operating modes:

1. **Basic Mode**
   In this mode, the operator manually analyzes the readings from the "Clean" and "Dirty" cells. Based on these measurements, the operator can assess whether cleaning is necessary to maintain or improve the solar plant"s performance. This mode does not require the use of the control box.

2. **Advanced Mode**
   In this enhanced mode, the datalogger model MTD-4000 is required, which enables the automatic calculation of the attenuation rate (%). This value indicates the impact of soiling on the signal collected by the solar panels. The operator can use this attenuation percentage to determine whether cleaning is required, without the need for additional data processing.

The MDFS system provides five data channels, offering monitoring capabilities to ensure optimal performance of the solar PV plant:

Channel	Unit	Description
Sun elevation	º	Sun elevation angle calculated by the DAS in real time
Clean solar cell radiation	W/m^2	Solar radiation collected by the reference cell labelled as "Clean Cell". This cell must be always clean
Dirty solar cell radiation	W/m^2	Solar radiation collected by the reference cell labelled as "Dirty Cell". This cell must be cleaned at the same time as the PV panels of the solar plant
MDFS2 status	Code	Binary code with 9 flag bits of information including the system diagnosis and cleaning / operation alarms
Attenuation	%	Percentage of solar radiation loss due to soiling

2 MDFS Elements

The elements of MDFS2 system and their respective functions are:

- **MDFS2**
  - Calibrated reference cells: temperature-compensated calibrated cells ("Dirty Cell" and "Clean Cell") to collect radiation information.
  - Control Box: cleaning tasks controlling and view/request pairing process.
  - Support: Mounting bracket for installation on final structures.

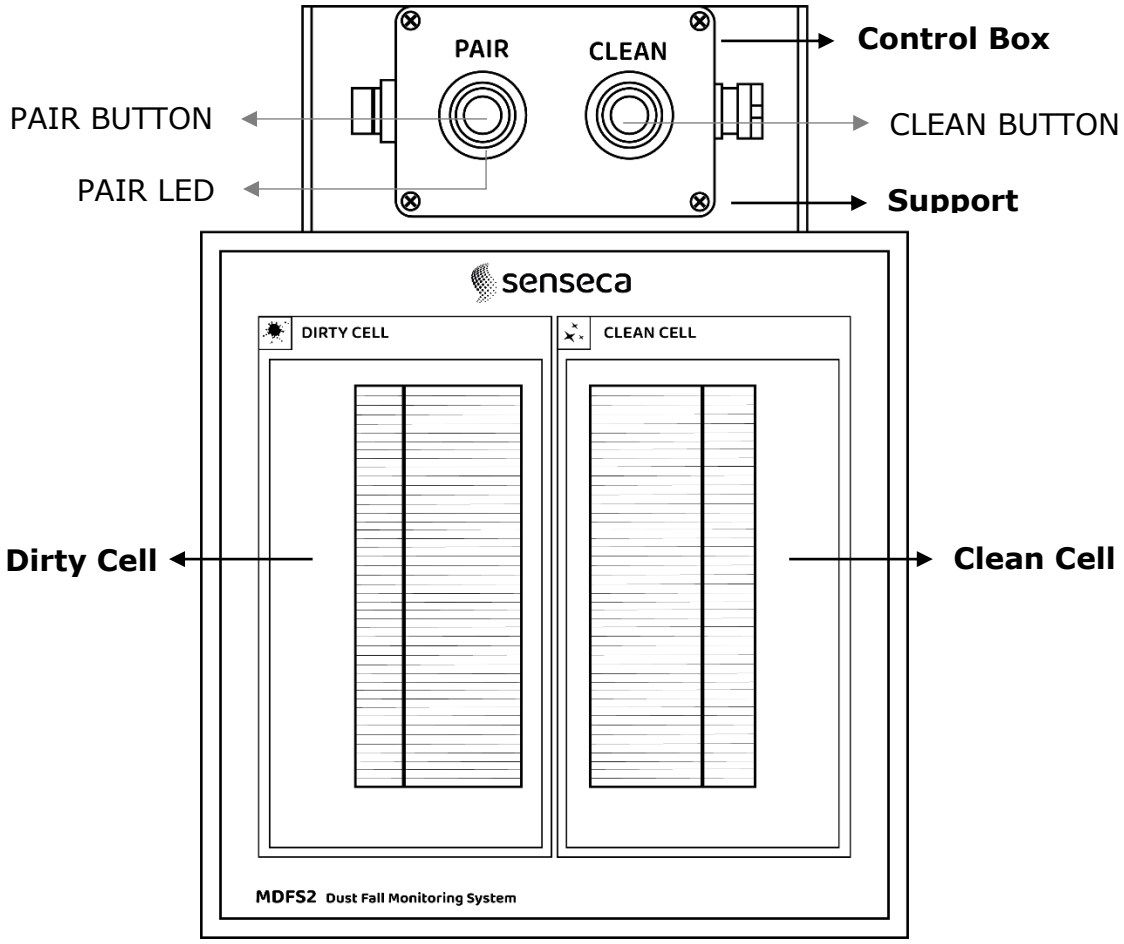


Fig. 2.1: MDFS2 elements

- **Data Acquisition System (DAS) model MTD-4000**
  The model MTD-4000 collects the solar radiation gathered by the "Clean Reference Cell" and the "Dirty Reference Cell" and additional information about tasks performed at the field sensed by the Control Box. All of this information is used to calculate the attenuation due to soiling.

- **GEO-DataView software package**
  The data collected by the MTD-4000 is accessible from the different software applications included in GEO-DataView software package: Geo-DataLink app for smartphones and Webtrans 4K Web platform.

3 MDFS Start Up Procedure

3.1 Installation and Connections

Install the elements that make up the Remote Station (tower, MTD-4000, MDFS, etc.).

Then, connect the MDFS2 sensor to the MTD-4000 logger according one of the following diagrams (depending on model).

The proper inputs of the datalogger used to read MDFS data are always included in the specific "LIST OF CONNECTIONS" supplied by Senseca.

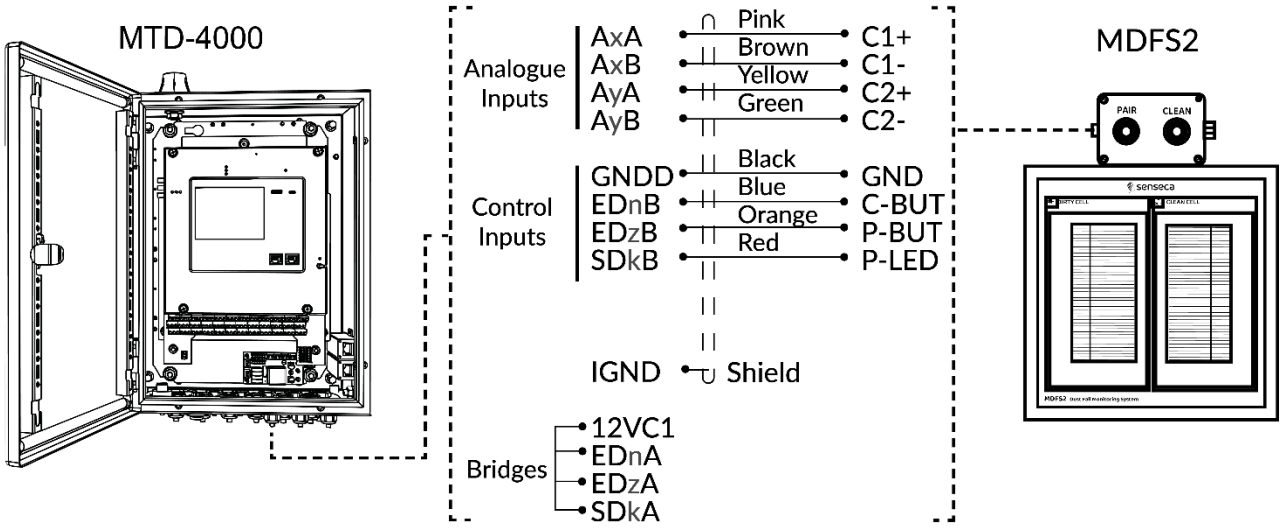


Fig. 3.1: Connections for model MDFS2

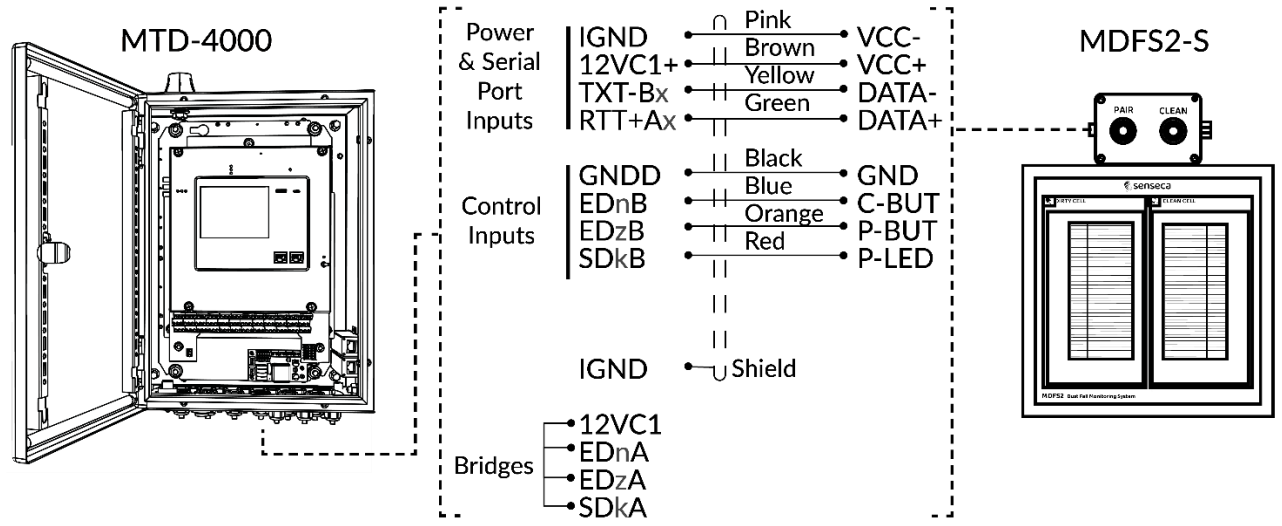


Fig. 3.2: Connections for model MDFS2-S

Attention!

The user can estimate the attenuation due to soiling by manually processing the data collected for the above channels (Clean Solar Cell Radiation and Dirty Solar Cell Radiation). For those users who prefer the MDFS to automatically calculate the attenuation, it is recommended to follow the cells pairing routine described in "3.3" and cleaning routines described in section "5".

3.2 Configuration of geographic coordinates

The internal algorithm that calculates soiling effects requires the Solar Position. For this purpose, the geographical coordinates of the station and its current date-time must be properly configured in the DAS model MTD-4000 using the app Geo-DataLink (GDL).

Follow these steps to configure the appropriate geographic coordinates on the logger MTD-4000:

1. Install GDL on your tablet or smartphone using the QR code or link below.

DOWNLOAD ON THE App Store

GET IT ON Google Play

2. Switch the MTD-4000 station ON and add it into the GDL through the Wi-Fi interface. The app main screen includes a link to a video tutorial explaining how to make the connection with the different communication interfaces of the MTD-4000.

3. Next, click the "SETUP" icon and find the "BASIC DATA" option. Enter the new values for "Latitude", "Longitude" and "Altitude".

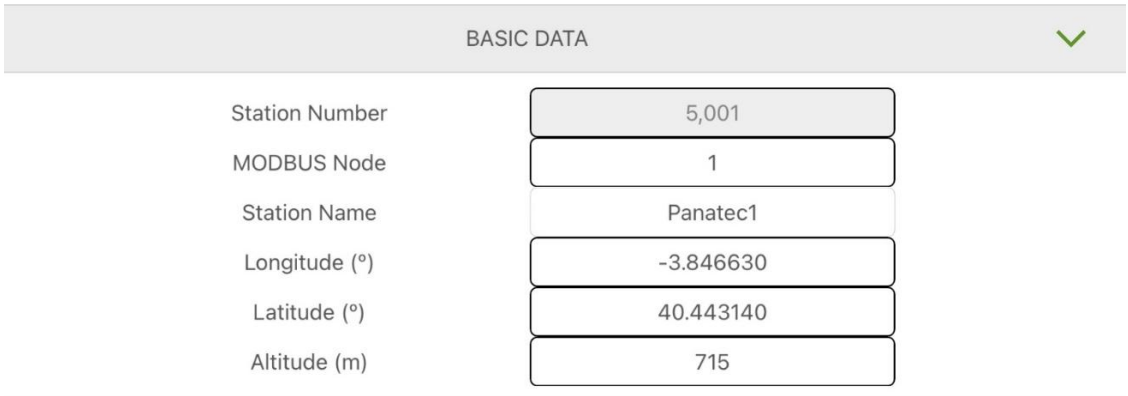


Fig. 3.3: GDL Form for coordinates setup

4. To finish, click "SEND CONFIGURATION".

3.3 Cells pairing routine

Attention!

The cells pairing routine is an optional step. It is recommended for those users that want to obtain more accurate data when using the MDFS2 advanced operating mode.

The pairing routine sets an initial relationship between the signal measured by the clean cell and the signal measured by the dirty cell. This routine is not necessary for the system to start calculating the attenuation (%) due to soiling but it is highly recommended as it allows more accurate data to be obtained.

In order to perform the MDFS pairing, these steps must be sequentially followed:

1. Ensure both reference cells "Clean Cell" and "Dirty Cell" are in the best possible cleaning conditions.

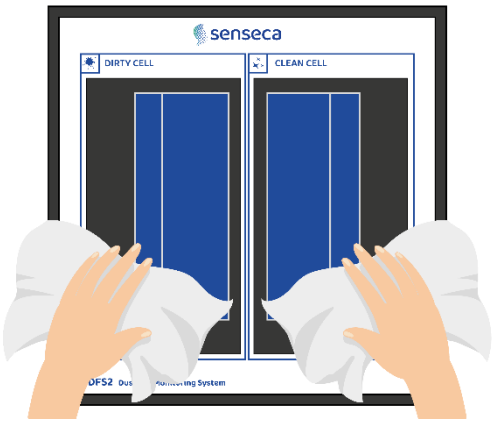


Fig. 3.4: Clean both cells

2. Then, press the "PAIR" button located at the "Control Box". To init the pairing process, **press the pairing button during at least 1 second**.

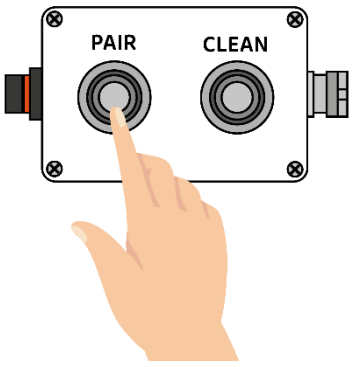
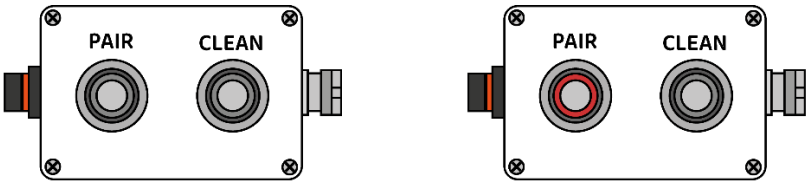


Fig. 3.5: Press "PAIR"

3. The system will be performing the automatic pairing during 60 seconds. During this time the LED located at the "Control Box" will be blinking.

4. After this time, the system will show the pairing results through the LED located in the "Control Box" and also by means of the info provided by the "MDFS Status" channel at the DAS.

   If the pairing procedure fails, a red LED located at the "Control Box" is turned ON to warn the operator on the field.



Successful **Failed**

Fig. 3.6: Pairing result

Warning!

During the pairing process make sure that no element casts a shadow on any of the two cells (including the shadow of the operator pressing the PAIR button).

Attention!

A yearly pairing routine is recommended to obtain more precise data.

Pairing operation conditions

The MDFS system will be only perform a successful pairing if the external conditions meet these criteria:

(a) The "Sun Elevation" shown by the MTD-4000 exceeds 15º. Never proceed pairing early in the morning or late in the afternoon.

(b) The solar radiation collected by the "Clean Cell" exceeds 400 W/m^2.

(c) The solar radiation collected by the "Dirty Cell" exceeds 400 W/m^2.

(d) The solar radiation collected by the "Clean" and "Dirty" cells do not differ more than 10%. Higher values would imply defective solar cells operation.

(e) The "Dirty Cell" radiation does not exceed the "Clean Cell" solar radiation more than 5%. Higher values would imply unproper cells cleaning.

These criteria are stated by the MTD-4000 to obtain the best SNR conditions for the measurements carried out by the system.

4 MDFS Measurements

Once the MDFS sensor is configured in the MTD-4000 datalogger, the following data is supplied:

- **Sun Elevation** (º)
- **Clean Cell Radiation** (W/m^2)
- **Dirty Cell Radiation** (W/m^2)
- **Attenuation** (%)
- **MDFS Status** (Code)

Attention!

"Attenuation" channel delivers "Not available" or "-32000" readings under these conditions:

- Solar Elevation is below the threshold (15 º).
- The solar radiation collected by the "Clean Cell" does not exceed 400 W/m^2.

In case of values displayed as "Not Available", read and interpret the MDFS Status code to obtain the cause of the absence of attenuation calculation.

For a proper long time operation, the "Clean Cell" must be periodically cleaned according the instructions described in "5.1". When the attenuation reaches a threshold defined by the user, the solar plant panels should be cleaned. Then, do not forget to perform the tasks described in "5.2".

The "MDFS Status" channel provides information on the overall status of the MDFS system encoded in bits. The resulting values of the active bits are stored in a Real type variable accessible from Modbus.

Use the following online sheet to interpret the code based to the information in the table.

LINK TO "MDFS STATUS" DECODER

Bit (Dec.)	Description
Bit 0 (1)	Pressing of the pairing button ("PAIR") detected.
Bit 1 (2)	Pressing the cleaning button ("CLEAN") detected.
Bit 2 (4)	Cleaning not detected in the last 7 (default) days.
Bit 3 (8)	Last pairing process failed.
Bit 4 (16)	Insufficient solar elevation angle (threshold: 15º factory default).
Bit 5 (32)	Insufficient solar radiation (threshold: 400W/m^2 factory default).
Bit 6 (64)	Tolerance in signals from clean and dirty cells exceeds the predefined threshold (+/-10% factory default) for pairing.
Bit 7 (128)	Last pairing failed: The number of valid samples was below the user predefined threshold (10 samples factory default).
Bit 8 (256)	Signal incoherence: The radiation collected by the "Clean Cell" is considerably below the radiation collected by the "Dirty Cell".

5 MDFS advanced operation

5.1 Cleaning routine for "Clean Cell"

Attention!

In order to obtain appropriate results for the attenuation rate due to soiling automatically calculated by the MDFS of Senseca, the operator must ensure that the "Clean Cell" is always clean.

In order to ensure that the "Clean Cell" is always in the best possible cleaning conditions, periodic cleaning tasks are strongly recommended. The cleaning period depends on the environment conditions (dust, rain, haze, etc.). By default, diary cleaning tasks of the "Clean Cell" are recommended.

Every time that a the "Clean Cell" is going to be cleaned, the steps below must be followed:

1. Clean only the reference cell labelled as "Clean Cell".

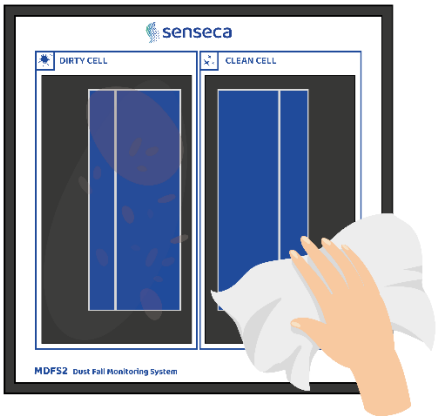


Fig. 5.1: Clean the "Clean Cell"

2. Press the button labelled with "Clean the CLEAN CELL".

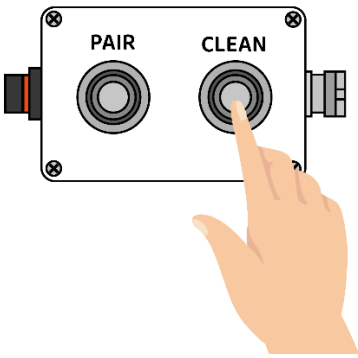


Fig. 5.2: Press "CLEAN"

Attention!

To register the cleaning, press the cleaning button during at least 1 second.

Attention!

If the MDFS detects that the "Clean Cell" has not been cleaned in the last 7 days (factory default), the bit 2 of the "MDFS Status" parameter is enabled.

After 7 days with no cleaning the "Clean Cell" may not be as clean as necessary for a good performance.

5.2 Cleaning the PV panels of the solar plant

Monitoring the attenuation value provided by the MDFS system will help the operator deciding the best moment to clean the panels of the solar plant.

Then, once the solar plant PV panels have been cleaned, clean both cells: "Dirty Cell" and "Clean Cell".

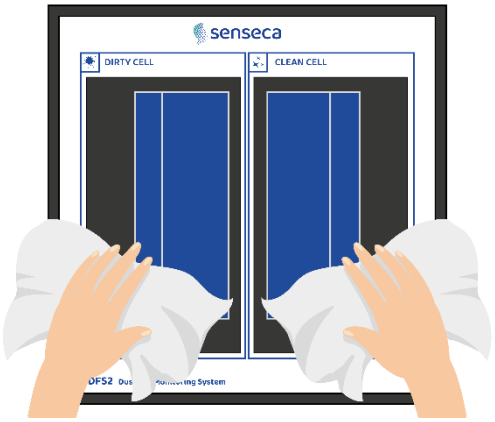


Fig. 5.3: Clean both cells

Optionally, the cells pairing routine described in section 3.3 can be performed.

6 Data analysis

The data processed by the MDFS can be accessed from Modbus Protocol, Geo-DataLink app or from Webtrans-4K Web Platform. The user can view this data in tables ready to export and graphs.

Attention!

The attenuation percentage supplied by the MDFS of Senseca is only calculated when the elevation is above 15º (factory default) and the solar radiation collected by the "Clean Cell" exceeds 400 W/m^2 (factory default).

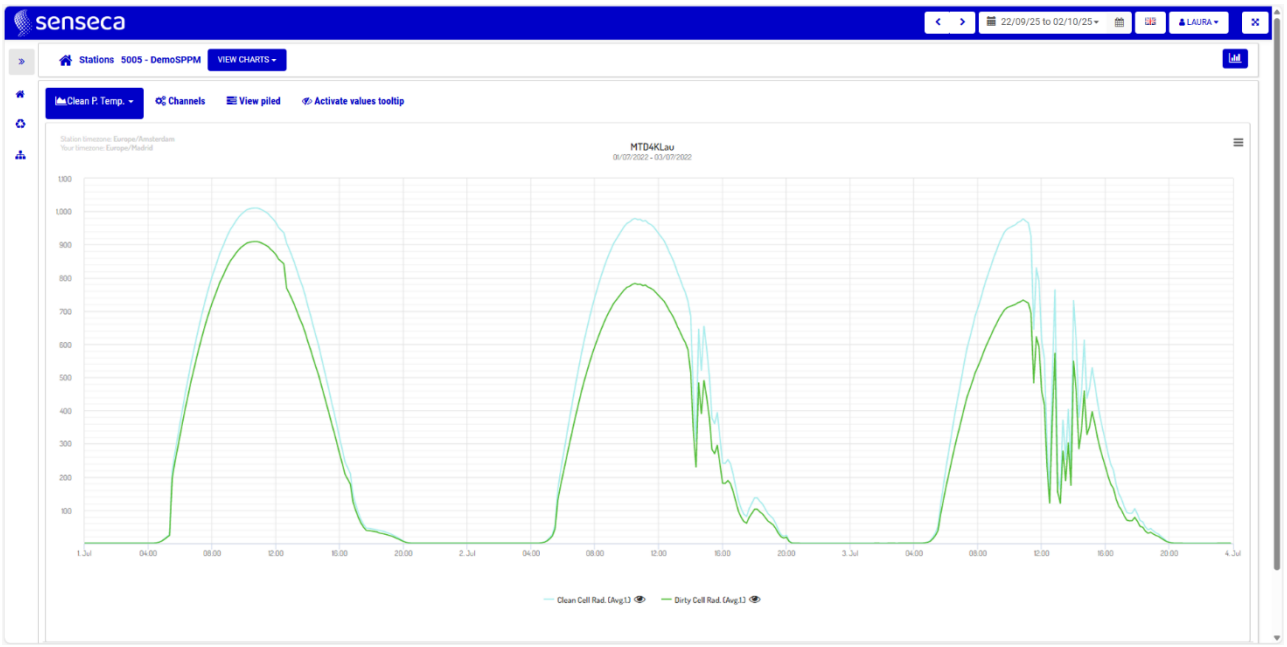


Fig. 6.1: Radiation signals on Webtrans 4K

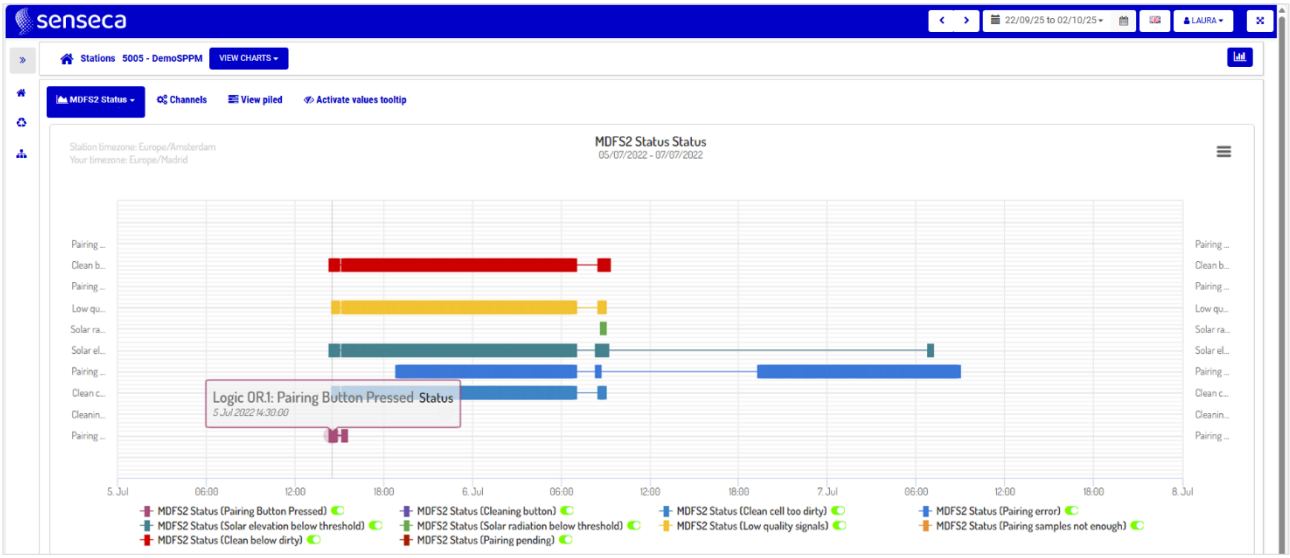


Fig. 6.2: MDFS Status info on Webtrans 4K

NOTES

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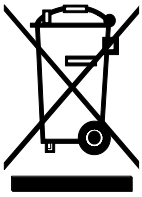
WARRANTY

The manufacturer is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (24 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product. Solutions, probes, electrodes and microphones are not guaranteed as the improper use, even for a few minutes, may cause irreparable damages.
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.
We reserve the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION



Electrical and electronic equipment marked with specific symbol in compliance with 2012/19/EU Directive must be disposed of separately from household waste. European users can hand them over to the dealer or to the manufacturer when purchasing a new electrical and electronic equipment, or to a WEEE collection point designated by local authorities. Illegal disposal is punished by law.

Disposing of electrical and electronic equipment separately from normal waste helps to preserve natural resources and allows materials to be recycled in an environmentally friendly way without risks to human health.

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