Grant-bio



McFarland Densitometers

DEN-1, DEN-1B

Operating Manual

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1. About this edition of the Manual

1.1. The current edition of the operating Manual applies to the following models and versions:

Model	**Version**
DEN-1, McFarland densitometer	V.3GW
DEN-1B, McFarland densitometer	V.3GW

1.2. Edition 3.03 – August of 2024.

2. Safety precautions

Caution! Make sure you have fully read and understood the present Manual before using the equipment. Please pay special attention to sections marked by this symbol.

2.1. General safety

- The protection provided can be ineffective if the operation of the appliance does not comply with the manufacturer's requirements.
- Save the unit from shocks and falling.
- Store and transport the unit at ambient temperatures between -20°C and +60°C and maximum relative humidity of 80%.
- After transportation or storage and before connecting it to the electric circuit, keep the unit under room temperature for 2-3 hrs.
- Use only original parts and accessories, provided by manufacturer for this product.
- Before using any cleaning or decontamination methods except those recommended by the manufacturer, check with the manufacturer that the proposed method will not damage the equipment.
- Do not make modifications in design of the unit.

2.2. Electrical safety

- Connect only to the mains with voltage corresponding to that on the serial number label.
- Use only the external power supply provided with this product.
- Ensure that the power plug is easily accessible during use.
- Disconnect the unit from the mains before moving.
- If liquid penetrates into the unit, disconnect it from the mains and have it checked by a repair and maintenance technician.
- Do not operate the unit in premises where condensation can form. Operating conditions of the unit are defined in the **Specifications** section.

2.2.1. **Batteries** (only for model **DEN-1B**)

Caution! Risk of fire and explosion!

- Use only AA size batteries, rechargeable or non-rechargeable.
- Replace all used batteries in the unit at the same time. Insert batteries properly, with the plus (+) and minus (–) terminals aligned correctly. In case of doubt, turn off the unit immediately and check the polarity.
- Keep all batteries in a safe place away from children and pets.
- Where possible, recycle the batteries. Contact local government for information about the disposal options in the area.
- Remove batteries from the unit if it will not be used for several months to avoid battery leakage.

- Do not mix old and new batteries, batteries of different brands, or batteries of different types (e.g. zinc chloride and alkaline batteries) in the same unit as this may cause the batteries to leak.
- Do not attempt to recharge non-rechargeable batteries. This can cause batteries to overheat or leak.
- Do not place batteries in a refrigerator. This will not 'recharge', increase storage life, or increase batteries' power.
- Do not exceed storage temperature, it reduces battery performance and may also lead to leakage.
- Do not remove the battery label, or attempt to take the battery apart, or dispose of in a fire as this may lead to rupture and/or chemical burns.

2.3. During operation

- Do not operate the unit in environments with aggressive or explosive chemical mixtures. Please contact manufacturer for possible operation of the unit in specific atmospheres.
- Do not operate the unit if it is faulty or has been installed incorrectly.
- Do not use outside laboratory rooms.
- Use **Select** and **Install** buttons only for calibration of the unit. Pressing the buttons can cause loss of calibration.

2.4. Biological safety

- It is the user's responsibility to carry out appropriate decontamination if hazardous material is spilt on or penetrates into the equipment.

3. General information

DEN-1 & **DEN-1B** densitometers are designed for solution turbidity measurement in the range of 0.0 - 6.0 McFarland units or 0 cells/ml - $18x10^8$ cells/ml. **DEN-1** & **DEN-1B** are capable of measuring solution turbidity in a wider range, up to 15.0 McFarland units, however, it is necessary to remember that in this case the measurement error values increase.

DEN-1 & **DEN-1B** densitometers are used as a sample preparation devices for 1) determining concentration of cells in the fermentation process, 2) detection of susceptibility of microorganisms against antibiotics, 3) identification of microorganisms with various test systems, 4) measuring optical density at fixed wavelength and 5) quantitative evaluation of concentration of dyed solutions that absorb green light.

The operation principle is based on optical density measurement with digital result representation in McFarland units.

The unit is calibrated at the factory and saves calibration data when being switched off. However, in can be recalibrated by multiple points in 0.0–6.0 McF range if necessary. We recommend to use Grant standards to ensure full reliability, but it is acceptable to use other commercial as well as self prepared standards (e.g. $BaSO_4$).

Table 1. Interpretation of McFarland Standard results into corresponding numeric values of approximate bacterial suspension concentration and their optical density at 550 nm.

McFarland standard	Composition	Interpretation	
	Concentration of $BaSO_4$	Approximate bacterial concentration[1]	Theoretical optical density[2] at 550 nm
0.5	2.40×10^{-5} mol/L	1.5×10^8 cells/ml	0.125
1	4.80×10^{-5} mol/L	3×10^8 cells/ml	0.25
2	9.60×10^{-5} mol/L	6×10^8 cells/ml	0.50
3	1.44×10^{-4} mol/L	9×10^8 cells/ml	0.75
4	1.92×10^{-4} mol/L	12×10^8 cells/ml	1.00
5	2.40×10^{-4} mol/L	15×10^8 cells/ml	1.25
6	2.88×10^{-4} mol/L	18×10^8 cells/ml	1.50

[1] Bacterial concentration depends on microorganism size. The numbers represent an average value valid for bacteria. For yeasts, which are larger in size, these numbers should be divided by about 30.

[2] Values correspond to optical densities of bacterial suspensions. The $BaSO_4$ solutions optical density values differ, because the particle size and form differ from those of bacteria and light is diffracted differently

4.1. **Unpacking.** Remove packing materials carefully and retain them for future shipment or storage of the unit. Examine the unit carefully for any damage incurred during transit. The warranty does not cover in-transit damage. Warranty covers only the units transported in the original package.

4.2. **Complete set.** Package contents:

4.2.1. Standard set

- **DEN-1 / DEN-1B** Densitometer, suspension turbidity detector..... 1 pce.
- **A-16** adapter for Ø16 mm tubes ..... 1 pce.
- External power supply ..... 1 pce.
- Operating Manual .....1 copy

4.2.2. Optional accessories:

- **A-12** adapter for Ø12 mm tubes ..... 1 pce.
- **CKG16** calibration kit for Ø16 mm glass tubes ..... 1 set
- Calibration kit for Ø18 mm glass tubes ..... 1 set
- Calibration kit for Ø12 mm glass tubes ..... 1 set
- Glass sample tubes without lid ..... 1 set of 78 pcs.

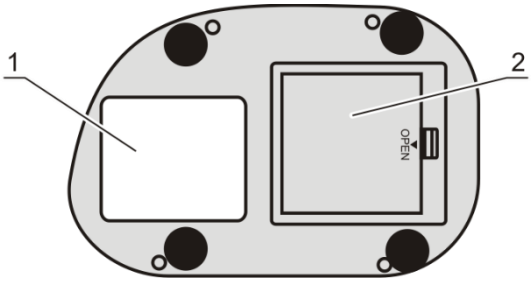


Figure 1. View from below

4.3. **Setup**.

- (for **DEN-1B**) Battery installation. Pull back the pin on the battery compartment (fig. 1/2) on the underside and open lid. Insert 3xAA batteries as shown on the scheme inside, close the lid.
- Place the unit on horizontal even working surface.
- Plug the external power supply into the socket at the rear side of the unit.

Note. For **DEN-1B**, connecting external power supply is optional when the batteries are in use.

- Remove the protective film from the display.

4.4. **Factory calibration**. The device is pre-calibrated at the factory for operation with the glass tubes 16 mm in external diameter (see the label on the bottom side of the unit) at temperature range from +15°C to +25°C and saves calibration data when being switched off.

Note. Recalibrate the unit before using the tubes that are different from factory calibrated (e.g. with different outer diameter, bottom shape or different material such as plastic). See the **Calibration** section of this Manual.

5. Operation

5.1. **Recommendations during operation**:

- Remove the tube with the solution from the socket before switching the unit on or off.
- We recommended keeping the unit switched on for 15 minutes before starting the operation in order to stabilize it in the working mode.
- If flat-bottomed tubes are used, the solution level should be higher than 7 mm from a tube bottom; if round-bottomed tubes are used - higher than 12 mm from a tube bottom.
- Check if the **A-16** adapter is in the socket (fig. 2/1). The device is calibrated for operation with the glass tubes 16 mm in external diameter. To use different tubes, recalibrate the unit, see the **Calibration** section of the Manual.

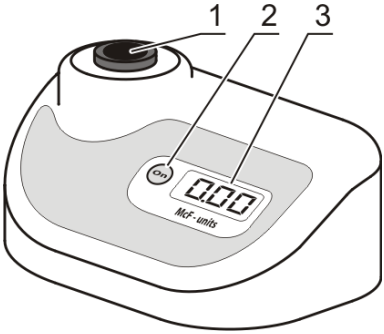


Figure 2. Front view

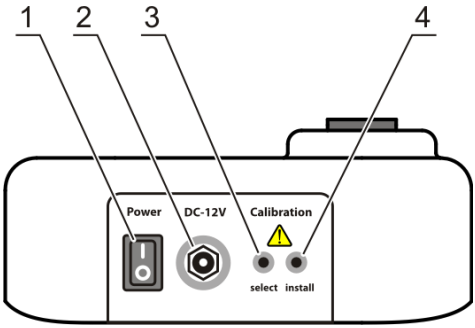


Figure 3. Back view

5.2. Connect the external power supply to electric circuit. Switch on the unit using the **Power** switch (fig. 3/1) on the rear panel.

Note. For **DEN-1B**, connecting external power supply is optional when the batteries are in use.

5.3. The following indication may be shown on the display (fig. 2/2):

- 0.00 – the unit is calibrated and ready for operation.
- LO BAT (**DEN-1B**) – low batteries, replace the batteries as described in **4.3** or connect the external power supply.

Note. The display of **DEN-1B** switches off if the socket is empty for longer that one minute. Press the **On** key (fig. 2/2) to activate the unit.

5.4. Shake the tube with the solution. It is recommended to use a vortex for shaking, e.g. **PV-1**. Insert the tube into the socket of densitometer (fig. 2/1). The McFarland value for the solution will be shown on the display (fig. 2/3).

Caution! Recalibrate the unit before using the tubes that are different from factory calibrated (e.g. with different outer diameter, bottom shape or different material such as plastic). See the **Calibration** section of this Manual.

5.5. To ensure measurement precision, check that the external diameter of tubes is 16 mm (with **A-16** adapter) or 18 mm.

5.6. After finishing the operation switch OFF the unit using the **Power** switch (position **O**). If the external power supply is used, disconnect it from electric circuit.

6.1. The unit is pre-calibrated at the factory for operation with the glass tubes 16 mm in external diameter (see the label on the bottom side of the unit, fig. 1/1) at temperature range from +15°C to +25°C and saves calibration data when being switched off. To use different types of tubes, recalibrate the unit as shown below.

6.2. Before using the standards, prepare them by the instructions from the manufacturer.

6.3. Perform calibration from lower to higher calibration value. Use at least 2 points for calibration. Different calibration points are available: 0.00, 0.50, 1.00, 2.00, 3.00, 4.00, 5.00, 6.00.

6.4. Connect the external power supply to electric circuit. Switch on the unit using the **Power** switch (fig. 3/1) on the rear panel.

Note. **DEN-1B** can operate without external power supply on battery power.

Caution! Make sure that the tube socket is empty. For Ø12 mm or Ø16 mm tubes, place the **A-12** or **A-16** adapters, accordingly.

6.5. Press the **Select** button (fig. 3/3) on the rear of the unit.

Note. Use a thin pin of maximum diameter of 2 mm for pressing the **Select** and **Install** buttons.

6.6. It is necessary to set values for an empty socket -.-- and transparent standard 0.00.

6.6.1. **Empty socket**. Display shows -.-- indication. Press **Install** button (fig. 3/4) to save empty socket value. Display shows next required calibration value.

6.6.2. **Transparent standard**. Display shows 0.00 indication. Insert standard for **0.00** value into the socket (fig. 2/1) of the unit. If the standard for 0.00 value is not available, fill the tube (of the kind that is used for operations) with distilled water. Use the tube as the **0.00** value standard. Press **Install** button to save transparent standard value. Display shows next required calibration value.

Note. Calibrate the unit using as many points as possible to obtain precise results. Minimum requirement are 2 points closest to the working range limits (e.g. 0.00 and 6.00 for operation in 0.00–6.00 McF range).

6.7. **Common calibration rules**. Display shows indication of necessary calibration value. Insert the necessary standard into the socket (fig. 2/1) of the unit and press the **Install** button to save the value for current standard.

Note. If pressing the **Install** button does not switch to the next standard value, it means that the current standard in the socket has lower turbidity value than the previous standard. Shake or replace the standard.

6.8. If a standard is not available, press the **Select** button to skip to the next calibration value without recording the value.

6.9. Repeat steps **6.7-6.8** until the calibration is complete. After recording or skipping the last value, unit automatically exits calibration mode and is ready for operation.

6.10. **Reset to factory calibration**. To reset the calibration of the unit to factory settings, ensure that you are in the working mode and the socket of the unit is empty. Press and hold **Install** key for 5 seconds. The unit displays a dot **.** , then changes it to 0.00. The values are now reset.

6.11. Switch off the unit using the **Power** switch (position **O**). If an external power supply is used, disconnect it from electric circuit.

7. Specifications

The unit is designed for operation in cold rooms, incubators (except CO_2 incubators) and closed laboratory rooms at ambient temperature from +4°C to +40°C in a non-condensing atmosphere and maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C.

Grant is committed to a continuous programme of improvement and reserves the right to alter design and specifications of the equipment without additional notice.

Light source	LED
Wavelength	λ = 565 ± 15 nm
McFarland unit range	0.00–15.00 McF
Resolution	0.01 McF
Accuracy, in the factory calibration range	±3% of the full scale
Measurement time	1 s
Sample volume	2 mL minimum
External diameter of tubes	12 mm (with **A-12**), 16 mm (with **A-16**) or 18 mm
Display	LCD
Dimensions (L x W x H)	165 x 115 x 75 mm
Weight, within ±10%	0.7 kg
Power consumption	0.1 W
Input voltage and current	12 V, 7 mA
External power supply	input 100–240 V~, 50–60 Hz; output 12 V=
Batteries (only **DEN-1B**)	3 x AA

8. Ordering information

8.1. Models and versions available:

Model	Version
DEN-1	V.3GW
DEN-1B	V.3GW

8.2. To inquire about or order the optional accessories or the replacement parts, contact Biosan or your local Biosan representative.

8.2.1. Optional accessories:

Description
A-12, adapter for Ø12 mm tubes
CKG16, calibration kit for Ø16 mm glass tubes. Latex particles
Calibration kit for Ø12 mm glass tubes. Polymer particles
Calibration kit for Ø18 mm glass tubes. $BaSO_4$ suspension
Glass sample tubes without lid, Ø16x100x0.8 mm, 78 pcs. Valid for factory-calibrated units.

8.2.2. Replacement parts:

Description
A-16, adapter for tubes of 16 mm in external diameter

9. Guarantee and Service

9.1. **Guarantee**. When used in laboratory conditions and according to this working Manual, this product is guaranteed for TWO YEARS (excluding items mentioned in the Optional Accessories table) against faulty materials or workmanship.

9.2. **Service**. There are no user-serviceable parts inside the unit. For all maintenance and repairs (except as defined below) return to our service department in the UK or in other countries, our distributor.

9.3. **Cleaning & Disinfection**.

9.3.1. **Cleaning the outside parts**. Use mild soap and water with a soft cloth or sponge for cleaning the exterior. Rinse remaining washing solution with distilled water. Wipe dry the excess water with clean, soft cloth or sponge. This maintenance operation is performed by the user.

9.3.2. **Disinfecting the exterior plastic parts.** Use 75% ethanol or DNA/RNA removing solution (e.g., PDS-250). After disinfecting it is necessary to wipe the surfaces dry. This maintenance operation is performed by the user.

9.3.3. **Internal (optical parts)**. Do not use liquids to clean optical parts. Use air from a rubber siphon to blow away any particles.

9.3.4. **Autoclave**. The unit and its accessories are not autoclavable.

9.4. **Decomissioning of the unit.** The user is responsible for the decontamination of the unit before decommissioning. Dispose of the appliance as electronic equipment in accordance with the relevant national laws.

EU Declaration of Conformity

All the products covered by this Manual comply with the requirements of the EU harmonised legislation verified using the following standards

Low Voltage Directive (2014/35/EC) for Electrical safety.	LVS EN 61010 Part 1
EMC directive (2014/30/EC) for Electromagnetic compatibility	LVS EN 61326-1
RoHS Directive (Directive 2011/65/EC including 2015/863) for Hazardous substances	LVS EN 50581

UK Declaration of Conformity

All the products covered by this Manual comply with the requirements of UK statutory requirements verified using the following standards.

Electrical Equipment (Safety) Regulations 2016	BS EN 61010 Part 1
Electromagnetic Compatibility Regulations 2016	BS EN 61326-1
The Restriction of the Use of Certain Substances in Electrical and Electronic equipment Regulations 2012	BS EN 50581

Waste Electrical and Electronic Equipment (WEEE)



All the products covered by this Manual are marked with the crossed-out wheelie bin symbol indicating they must not be disposed of with unsorted waste. Safe recycling of WEEE helps conserve natural resources and protect human health.

Grant Instruments complies fully with the UK Waste Electrical & Electronic Equipment (WEEE) regulations 2013. We are a member of the B2B compliance scheme (Scheme Approval Number WEE/MP3338PT/SCH), which handle our WEEE obligations on our behalf. Grant Instruments have been issued with a unique registration number by the Environmental Agency, this reference number is WEE/GA0048TZ.

For information regarding WEEE collections in the UK please contact our B2B Compliance Scheme directly on 01691 676 124 or **www.b2bcompliance.org.uk**

In the EU, Grant Instruments complies with WEEE Directive 2012/19/EU.
Contact your local equipment supplier for WEEE collections.

REACH Regulations

This product does not contain any Substances of Very High Concern (SVHCs) at greater than 0.1% that have to be identified in accordance with Regulation (EC) No 1907/2006 and therefore does not have an entry in the SCIP database.

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