



WHEN ACCURACY IS THE POINT.™

KS-D1

SOIL MOISTURE METER OPERATION MANUAL



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Model KS-D1 **Operating Instructions**

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INTRODUCTION

The Delmhorst soil moisture measuring system consists of two parts: the gypsum soil blocks (sensors) and the measuring instrument, Model KS-D1 moisture tester. The blocks are made of gypsum cast around two concentric electrodes. The gypsum acts as a buffer against the effect that the salts might have on the electrical conductivity and the concentric electrodes confine the flow of current to the interior of the block, eliminating the effects of soil conductivity.

When a block is buried in the soil it absorbs moisture from the soil or releases moisture into the soil, until its moisture content approaches equilibrium with the moisture content of the soil. When the block is connected to the meter, current flows between the electrodes and the electrical resistance of the gypsum is measured. Such readings are an indication of the moisture available to the plants.

For irrigation purposes, the water of importance is that amount which can be extracted from the soil by the roots of the plants, and not the percent moisture content (which is related to the weight of the soil). We refer to this reservoir of moisture as "available moisture."

Each soil has a different capacity to hold water, depending on its structure and texture. The maximum amount of water available to the plants (called Field Capacity) is the amount held by the soil against drainage by gravity. When virtually all available water has been used (that is when no further moisture can be extracted by the plant) soil moisture has reached the level known as the "Permanent Wilting Point." With soil moisture at this level, plants permanently wilt and die.

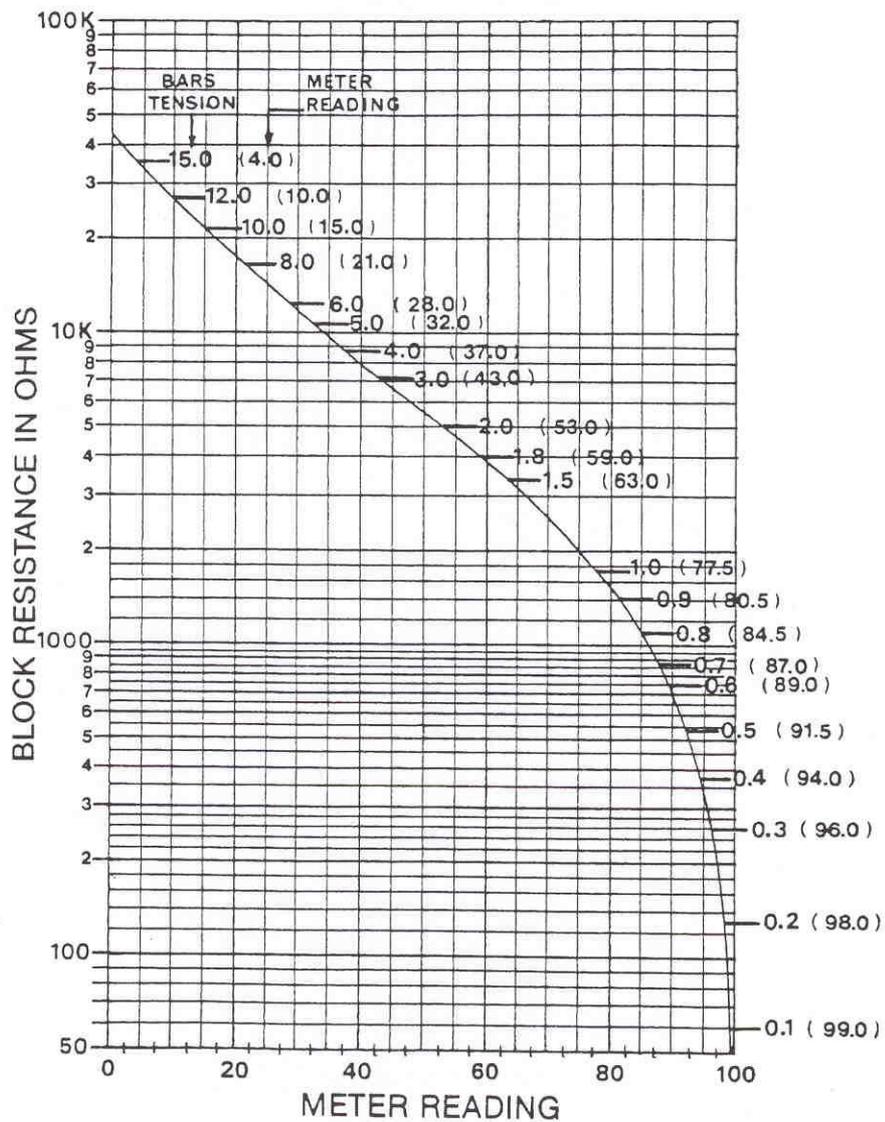
Finely textured soils such as fine sandy loams and clay loams hold a greater amount of water at field capacity than coarsely textured soils such as coarse sandy loams.

The available soil moisture can be measured either in percent of the total potential reserve (Fig. 2) or in terms of suction necessary to draw the moisture from the soil particles. Such suction is referred to as soil moisture tension. (Fig. 1, and 1A).

Fig. 1

KS-D1

Meter Readings vs. Soil Moisture Tension and Electrical Resistance



KS-D1

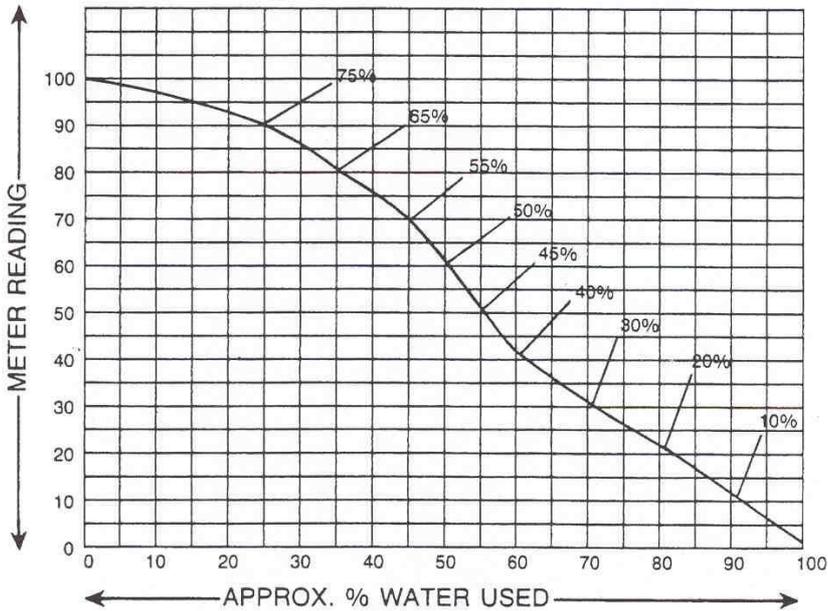
Fig. 1A

Meter Reading vs. Soil Moisture Tension and Electrical Resistance

METER READING KS-D1	MOISTURE TENSION BARS	RESISTANCE OHMS
99.0	0.1	60
98.0	0.2	130
96.0	0.3	260
94.0	0.4	370
91.5	0.5	540
89.0	0.6	750
87.0	0.7	860
84.5	0.8	1100
80.5	0.9	1400
77.5	1.0	1700
63.0	1.5	3400
59.0	1.8	4000
53.0	2.0	5000
43.0	3.0	7200
37.0	4.0	9000
32.0	5.0	10700
28.0	6.0	12500
21.0	8.0	16540
15.0	10.0	21130
10.0	12.0	26270
4.0	15.0	35000

Fig. 2

Meter Reading vs. Available Soil Moisture



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OPERATING PROCEDURE FOR KS-D1

1. To check the meter calibration: Press the "CAL CHK" button. The meter should read 80.0 ± 1.0 . Note: Instrument serial numbers from 0100-0584 require pressing both "READ" and "CAL CHK" buttons simultaneously.

2. To "read" the blocks:

Push the tinned ends of the lead wires of the block into two springloaded binding posts on the meter.

Press the "READ" button, recording the "reading" on the "Soil Moisture Observation Chart."

NOTE: Only readings between 5.0 and 100.0 are valid. Readings outside this range should be disregarded.

INTERPRETATION OF METER READINGS

Meter readings are interpreted in terms of "Soil Moisture Tension," or "Blocks Resistance" by referring to figure 1 and 1A; in terms of "available soil moisture" by referring to figure 2.

The data in the chart below provides guidelines of "Available Moisture" and "Irrigation Requirements" for three groups of soil in terms of their texture make-up.

Since soils are not strictly divided into three groups only, but changes from "fine" to "coarse" soil are gradual, the information below should be used as a guideline. Consideration should be given to other factors such as:

- A. Type of crop;
- B. Stage of crop growth and root system;
- C. Climactic conditions;
- D. Structure of sub-soil.

METER READING GUIDELINES

Soil Type	No Irrigation Required	Irrigation to be Applied	Danger Zone Insufficient Soil Moisture
Fine	80-100	60-80	Below 60
Medium	88-100	70-88	Below 70
Coarse	90-100	80-90	Below 80

The above guidelines are determined by the fact that different soils have a different capacity to hold and release moisture to the plants.

Fine textured ones (clay soils) store a larger amount of water, but they also hold a larger amount of residual water than do coarse textured (sandy soils). In the overall picture, clay soils hold more available moisture than sandy soils. Loam and sandy loam-type soils fall in between.

For these reasons, irrigation in sandy loam is normally applied at higher meter readings than in clay loam soils, since available moisture can be used up more rapidly by the plants and dry climatic conditions in sandy loam.

There is an optimum range of moisture for optimum plant growth. Over irrigation, which tend to prevent adequate root aeration and possibly lead to root rot, can be prevented with proper irrigation scheduling. This entails recording and observing soil moisture meter readings, recording of rainfall, knowledge of the soil and of the crops involved.

A grower with a good understanding of soil moisture meter readings and of all the other factors playing a role in plant growth will, in a short time, be able to establish his own guidelines for optimum irrigation scheduling in relation to his soil(s), crop and climate.

HOW TO USE IRRIGATION CHARTS

Irrigation charts are provided with each instrument. Additional charts are available on order. Regular use of the charts helps in planning irrigation.

All readings should be recorded using a line of different identity to indicate the readings of each particular block.

As readings are made and recorded, a curve of soil moisture changes will result. By extending the slope of the lines, it will be possible to see well in advance when the soil moisture will reach the level at which irrigation is required. In addition, the chart will also indicate how much water is needed to restore the moisture to field capacity.

To give an example, assume that irrigation should be applied when a block planted at 18" and yielding a reading of 63, indicates roughly 1.5 in terms of bars tension. Soon after irrigation, this block may read 96; a few days later (without irrigation or rainfall) it may read 88; the next day 80. If these three readings are plotted on the irrigation chart, and a line extended through them, it is possible to project the time at which the 1.5 bars tension level (or irrigation point) will be reached; in this case it would be less than three days.

NOTE: It is recommended that the blocks must be soaked in water for 1 hour and allowed to dry as soon as received. This additional wetting-drying cycle will improve their uniformity. Before "planting the blocks, they should be soaked again for 2 to 3 minutes to improve contact with the soil. See 'Installation of the blocks'.

INSTALLATION OF THE BLOCKS

1. Before planting the blocks, they should be soaked again for 2 to 3 minutes to improve contact with the soil.
2. Dig a hole in the ground with "1" soil auger or better, a 7/8" soil probe.
3. Make a soil and water slurry of creamy consistency and place 1 or 2 tablespoons of the slurry in the hole.
4. Push the block to the bottom of the hole, forcing the slurry to envelop the block. The block can be pushed by using a tube (plastic or aluminum will suffice) or a slotted rod.
5. Back fill the hole and tamp in small increments.
6. Install only one block in each hole and fasten the leads to a stake so that they can be kept clean and are easily located for reading. Identify the lead wire according to the depth of the blocks. This can be accomplished by a coloured tag or by making a knot on the shallow block, 2 knots on the deep one (3 knots on the next, if three blocks are used in the same station).

WHERE TO PLACE BLOCKS

It is not possible to give precise instructions, which apply to all cases. The location and depth of the blocks depends on the nature of the crops, its potential root zone, the type of soil with regard to texture and subsurface formation, and the profile of the field. However, there are some guidelines to be followed: (A "string" of blocks 2, 3, or 4, depending on the depth to be reached, is called "station").

Locate the stations in the representative areas of the field. Don't place the blocks in low or high spots or near changes in slope of the irrigation run unless you wish to measure variability in water penetration caused by such differences. Select a station location where the plant population is representative of the field.

Keep the soil around the stations from becoming compacted when taking readings especially where blocks are planted near the surface. Don't walk in furrows in which soil moisture readings are being measured. Walk in the next furrow. Mark each "walk" furrow when installing the blocks.

When using sprinkler systems, make sure the blocks are set so they will not be damaged when the sprinkler is moved. Inaccurate readings can also result if the blocks are placed too close to the sprinkler head.

The blocks should not be shielded by any low hanging branches nor in an area that may be flooded by run-off. In the case of row crops, the blocks should be located directly in the row. As for orchards, the blocks are located at the drip line of a tree.

It is also suggested that a second "string" of a few blocks be placed in the ground not far from the first – 10" to 20" apart. This will serve as a control on the blocks and on other factors. If

the readings of two adjacent blocks at the same depth show a significant discrepancy, the cause should be determined. It may be poor distribution of water from the sprinkler system, or difference in sprinkler distribution caused by wind, differences in root concentration surrounding the block installations, or difference in the soil.

DEPTH OF INSTALLATION

The active root zone of the crop determines the depth at which to place the blocks. Type of crop, soil depth, and state of growth should also be considered.

When seeds are first planted, irrigation is necessary to assure quick and uniform seed germination. Visual inspection of the soil near the seeds will indicate whether irrigation is needed at that time. A minimum of two blocks per station is recommended; one shallow, one deep. The table below gives recommended depths for setting the blocks according to soil depth or active root zone.

Recommended depths for placing electrical resistance blocks according to soil depth or active root zones.

Soil depth or active root zone (Inches)	Shallow blocks (Inches)	Deep blocks (Inches)
18	8	12
24	12	18
36	12	24
48	18	36

CARE OF YOUR METER

To keep your meter in good working order:

- ⊕ Store your meter in a clean, dry place.
- ⊕ The protective carrying case provided is an ideal storage place when the meter is not in use.
- ⊕ Change the 9-Volt battery as needed. Continued use with a low battery may cause the meter to go out of calibration.
- ⊕ Clean the meter with any biodegradable cleaner. Use the cleaner sparingly and on external parts only. Keep the cleaner out of the external connector.
- ⊕ DO NOT IMMERSE THE METER IN WATER.
- ⊕ Remove the battery if the meter will not be used for one month or longer.

SERVICE FOR YOUR METER

- ⊕ Pack your meter securely. Enclose a purchase order or letter with a brief description of the problem.
- ⊕ There is no need to call us for a return authorization number if you are within the EU. Customers outside the EU must contact us for more specific instructions prior to returning a meter.
- ⊕ Include your name, address, daytime phone and fax numbers or e-mail address. If you believe the meter is under warranty, please provide the original sales slip or invoice.
- ⊕ Ship via UPS, Express Mail, Priority Mail or any overnight courier who provides prompt service. Do not use standard parcel post.
- ⊕ Insure your instrument for its full value and ship prepaid. We are not responsible for damage in transit.
- ⊕ We do not accept COD shipments or cover any incoming freight or duty charges on returned merchandise
- ⊕ Turnaround time on repairs is approximately two weeks.
- ⊕ We will call you with an estimate if you specifically request one, or if we determine that the meter may be too costly to repair.
- ⊕ Non-warranty repairs will be returned via UPS/COD unless you have already established other payment terms. There is no COD service outside the EU.
- ⊕ Payments have to be made by Bank transfer prior to the return shipment. A proforma invoice will be raised in advance.
- ⊕ Warranty repairs will be returned at no charge if shipped within the EU via UPS Ground Service. Freight charges for expedited services (i.e., Federal Express, UPS/2 Day, UPS/1 Day, etc.) are the customer's responsibility and will be charged as per the above terms.

WARRANTY

Delmhorst Europe, referred to hereafter as Delmhorst, guarantees the meter for one year from date of purchase and any optional electrodes against defects in material or workmanship for 90 days. If, within the warranty period you find any defect in material or workmanship return the meter following the instructions in the "Service for Your Meter" section. This limited warranty does not cover abuse, alteration, misuse, damage during shipment, improper service, unauthorized or unreasonable use of the meter or electrodes. This warranty does not cover batteries, pin assemblies, or pins. If the meter or any optional electrodes have been tampered with, the warranty shall be void. At our option we may replace or repair the meter. Delmhorst shall not be liable for incidental or consequential damages for the breach of any express or implied warranty with respect to this product or its calibration. With proper care and maintenance the meter should stay in calibration; follow the instructions in the "Care of Your Meter" section.

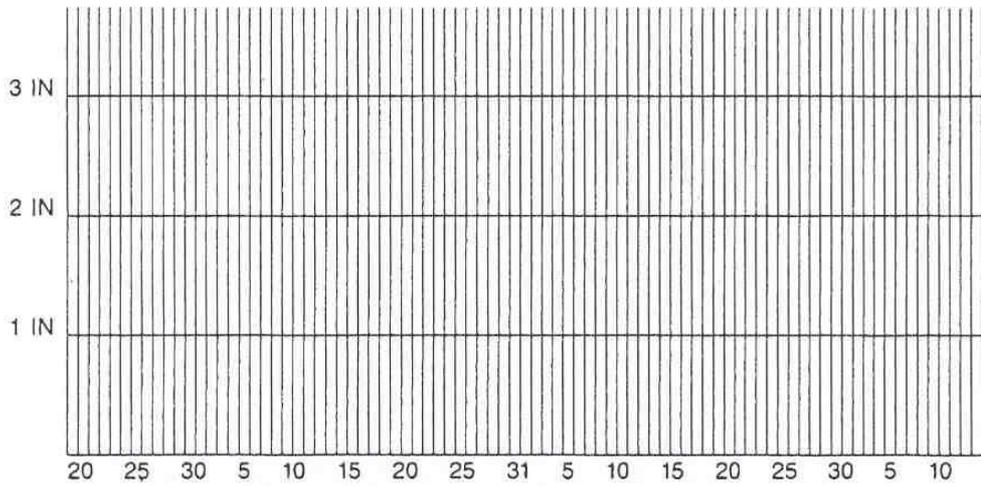
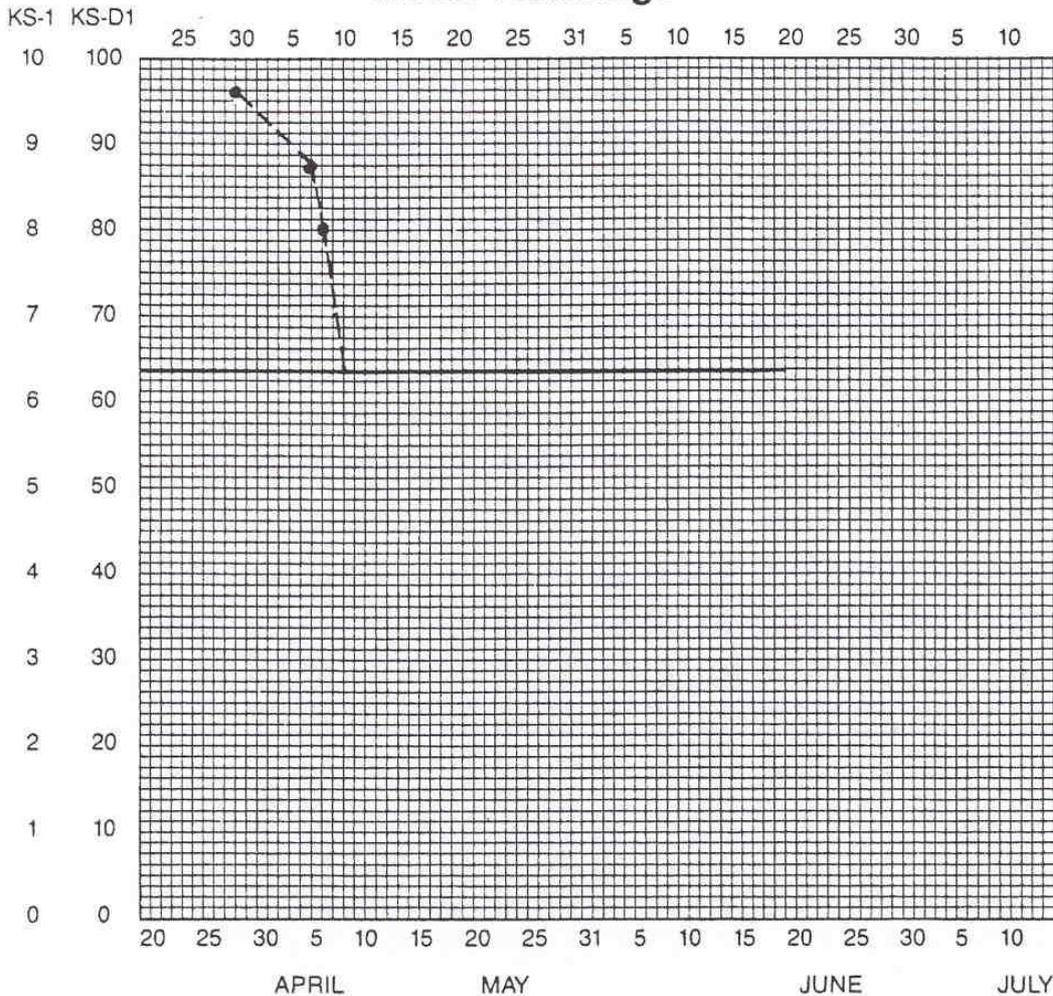
Under no circumstances shall Delmhorst be liable for any incidental, indirect, special, or consequential damages of any type whatsoever, including, but not limited to, lost profits or downtime arising out of or related in any respect to the meters or electrodes and no other warranty, written, oral or implied applies. Delmhorst shall in no event be liable for any breach of warranty or defect in this product that exceeds the amount of purchase of this product. The express warranty set forth above constitutes the entire warranty with respect to Delmhorst meters and electrodes and no other warranty, written, oral, or implied applies. This warranty is personal to the customer purchasing the product and is not transferable.

DELMHORST TESTNOLOGY

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For 65 years, Delmhorst has been the leading manufacturer of high-quality resistance moisture meters. We offer a complete line of portable moisture meters for woodworking/lumber, agriculture, construction and paper.

Fig. 3 Meter Readings



Stake No. _____	Year _____
Farm _____	Soil Type _____
Crop _____	County _____

RAINFALL

IRRIGATION

NOTE: Actual Chart Covers Over 5 Months

Scale 1/2" Vertical = 1" Moisture