

# WATERING SYSTEM – USER GUIDE

This document is a complete user guide for the Watering System. It explains how the system operates, how values are measured and displayed, how parameters are configured, and how the TFT screen information should be interpreted.

## 1. What is the Watering System

The Watering System is an automatic irrigation controller that independently decides when and how long to water based on soil moisture, air temperature, and time.

### Hardware Platform

- 1 ESP32 Dev Module – 30-pin version (main system controller).
- 2 4.0" TFT display – graphical presentation of all system information.
- 3 SHT41 – digital air temperature and humidity sensor.
- 4 DS3231 – real-time clock (RTC) module for accurate time and date.
- 5 Soil moisture sensor – resistive type, powered only during measurements.
- 6 24 VAC irrigation valve – watering control output.

## 2. How the system makes decisions

- 1 The system operates only within the allowed watering window (01:00–05:00).
- 2 Air temperature is checked first.
- 3 If the temperature is  $\leq 12^{\circ}\text{C}$ , watering is blocked.
- 4 Soil moisture is then measured.
- 5 If soil moisture is  $\geq \text{TARGET}$ , watering is skipped.
- 6 If soil moisture is below TARGET, the valve is activated for the set duration (DUR).

## 3. When and how soil moisture is measured

The system does not measure soil moisture continuously. Measurements are performed only at defined moments to ensure reliability and to protect the soil probe from degradation.

- 1 Before watering (within the 01:00–05:00 window).
- 2 Immediately after watering has finished.
- 3 Later during the day at 06:00, 12:00, and 18:00.

## 4. Soil moisture before, during, and after watering

Before watering, the system measures soil moisture and decides whether watering is required.

During watering, no new measurement is performed. The last valid moisture value remains displayed while the VALVE status shows ON.

After watering, soil moisture is measured again and the new value is stored as the reference for subsequent decisions.

## 5. Why soil moisture does not increase immediately

After watering, water initially remains near the soil surface. It takes time for moisture to reach the depth where the probe is located. For this reason, an increase in soil moisture is often visible only at the next measurement cycle.

## 6. TFT display – meaning of the information

- 01 TIME – current time and date.
- 02 T / RH / M – air temperature, air humidity, and soil moisture.
- 03 TARGET / DUR – target soil moisture and watering duration.
- 04 AIR – air status (blocked if too cold).
- 05 WINDOW – allowed watering time window.
- 06 VALVE – irrigation valve status.
- 07 SENSE – measurement status and raw ADC value.
- 08 READY – system is idle and ready.



## **7. Buttons: UP / DOWN / ENTER**

UP – increases the selected value (TARGET or DUR).

DOWN – decreases the selected value.

ENTER – confirms a selection or enters a setting mode.

ENTER held during powerup – enters CAL MODE.

## **8. CAL MODE – soil moisture calibration**

CAL MODE is used to calibrate the soil moisture sensor. It is entered by holding the ENTER button while powering on the device. CAL MODE is exited by turning the power off and on again.

## **9. WET / DRY calibration**

Calibration uses fixed resistors: DRY = 150 kΩ and WET = 10 kΩ. The resistors are connected between SENSE and GND through the NPN transistor collector, exactly as in normal system operation. The calibrated values are stored in memory.

## **10. Typical operating scenarios**

- 1 If the temperature is too low, watering will not occur.
- 2 If soil moisture is above TARGET, watering is skipped.
- 3 When READY is displayed, the system is waiting for the next scheduled check.