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AllPlantsData AgroTag

Technical Report: Hardware Version 8

A smartwatch for plants: a battery-free wireless tag that measures the plant and the air around it



1. Overview

The AgroTag is a smartwatch for plants. Like a smartwatch on a wrist, it stays on the plant and keeps track of its condition day and night. It is a small wireless sensor that hangs on a vine, tree or crop row. It measures the plant's own electrical signal and the microclimate around it, and sends the readings by radio to a gateway at the edge of the field, which passes them on to a cloud dashboard.

The tag has no battery. A small solar panel charges a supercapacitor, which stores enough energy for the tag to work through the night and through days of poor light. There is nothing to replace or recharge, and no cable to run to each plant.

Main features

- **Plant signal:** plant bio-electric signal through two pure silver wire electrodes, sampled once a second;
- **Microclimate:** air temperature, humidity and pressure in every tag;
- **Sensor board:** optional plug-on module for photosynthetic light (PAR), light quality and leaf wetness;
- **Battery-free:** solar panel and supercapacitor, average consumption around 20 μ A;
- **Wireless:** Bluetooth Low Energy to the gateway, NFC for a phone tap in the field;
- **Self-monitoring:** the tag reports its own energy level, falls and restarts, so problems are seen remotely.

About this issue. This report describes hardware version 8 (v8), the generation now being prepared for production. v8 uses the same enclosure, sensors and radio as the previous generation (v7), which has been running in vineyards and citrus orchards during 2026, with a lower-power plant front end and improved power supply. The photographs show the current enclosure. Where a figure was measured on v7 or is a design estimate for v8, the text says so. Figures are rounded.

2. How the system fits together

NFC: tap with a phone to read the tag status

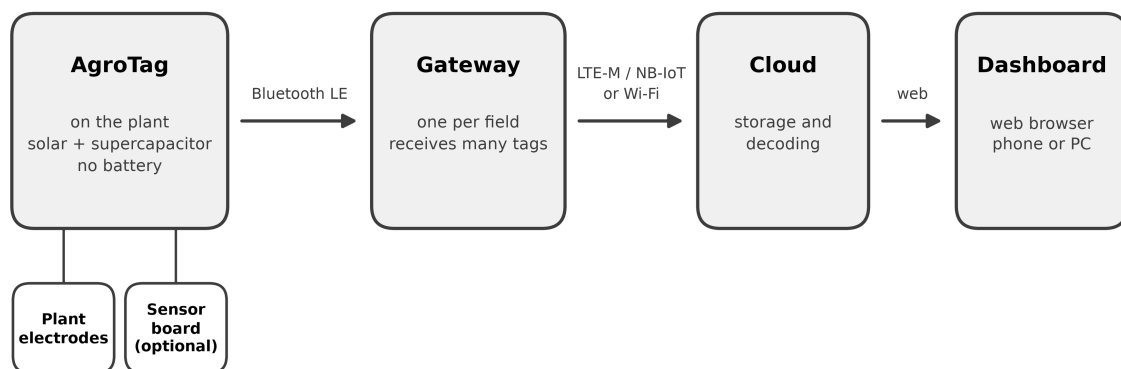


Figure 1. From the plant to the dashboard

Each tag broadcasts short radio messages at a fixed rhythm. It does not pair or connect with anything, so one gateway can listen to many tags at once, and a tag that is out of range for a while simply carries on. The gateway collects the messages and uploads them in batches over the mobile network (LTE-M or NB-IoT) or Wi-Fi. The readings are decoded and stored in the cloud and shown on a web dashboard. The gateway is described in a separate technical report.

3. Two configurations

The AgroTag is offered in two configurations. Both use the same main unit and enclosure; the sensor board is a module that fits on the side of the case.



AgroTag, solar panel side



AgroTag with sensor board

Figure 2. Left: the tag without the sensor board, showing its solar panel. Right: with the sensor board (light sensor window and leaf-wetness sensor)

	AgroTag	AgroTag with sensor board
Plant bio-electric signal	Yes	Yes
Air temperature, humidity, pressure	Yes	Yes, plus a second set on the sensor board
Light for photosynthesis (PAR)	Indication from the solar panel	Yes, measured in $\mu\text{mol}/\text{m}^2/\text{s}$
Light quality (red:far-red, blue, near-infrared)	—	Yes
Leaf wetness	—	Yes, two faces of an artificial leaf
Air quality indication (gas sensor)	—	Optional, off by default to save energy
Wind (under test), tilt and fall detection	Yes	Yes
Typical use	Plant signal and microclimate on many plants	Reference points in a field: light and leaf wetness for disease and irrigation models

4. What the tag measures

4.1 Plant bio-electric signal

Plants produce small electrical signals in response to water stress, light, temperature, wounding and other stimuli. The AgroTag measures the voltage between a working electrode and a reference electrode placed in the stem or trunk, using a low-noise differential front end with a stable reference and a high input impedance (20 M Ω), so that the measurement draws almost no current from the plant. The electrodes are made of pure silver wire, a material widely used for bio-potential electrodes. The electrode cable plugs into the tag with a

standard 3.5 mm jack; on v8 the tag detects when the electrodes are connected and switches plant measurement on and off by itself.



Tag, hanger, electrode cable and leaf-wetness sensor



Electrodes in the stem of a plant, May 2026

Figure 3. Left: the electrode cable with its 3.5 mm plug and silver wire electrodes. Right: the electrodes placed in a plant stem and plugged into the tag

Plant signal	Value
Measurement	Differential voltage between two electrodes
Range	About ± 160 mV, extended automatically to +260 mV
Resolution of the reported value	10 μ V
Sampling	One sample per second, sent in groups of nine every 9 seconds
Input impedance	20 M Ω between the electrodes
Electrodes	Pure silver wire, working and reference electrode
Also reported	Potential of the reference electrode, to show drying or a poor contact
Electrode connection	3.5 mm jack; automatic detection of the plug (v8)

4.2 Microclimate and status

Quantity	Reported as	Notes
Air temperature	$^{\circ}$ C	Every message
Relative humidity	%RH	Every message
Barometric pressure	hPa	Every message
Wind	Speed and 16-point direction	From the swing of the hanging tag; under test, indicative only
Solar panel voltage	V	Shows light reaching the tag and energy income
Energy store voltage	V	Shows how much energy the tag has left
Fall or knock	Alarm	Raised if the tag is knocked or falls from its hook

4.3 Sensor board

Quantity	Reported as	Notes
Photosynthetic photon flux density (PAR)	$\mu\text{mol}/\text{m}^2/\text{s}$	Light in the 400 to 700 nm band; full sun is about 2000
Red:far-red ratio	ratio	Shading by the canopy (about 1.1 in open sun, much lower under leaves)
Blue fraction	% of PAR	Light quality
Near-infrared:visible ratio	ratio	Light quality
Leaf wetness, upper and lower face	0 to 100 %	Capacitive artificial leaf
Temperature, humidity, pressure	°C, %RH, hPa	Second set, at the sensor board
Air quality indication	Gas resistance	Optional; off by default because it costs energy

The sensor board readings are sent about every 4 minutes, or about every 11 minutes while the plant signal is being recorded.

5. Communications

Link	Details
Tag to gateway	Bluetooth Low Energy 5 advertising. One-way broadcast: no pairing, no connection, any number of tags per gateway. Transmit power up to +8 dBm.
Message rate	Microclimate every 9 seconds. With the plant signal on: a plant message every 9 seconds (nine samples) and a microclimate message about every 27 seconds. Sensor board: every 4 to 11 minutes.
Alarms	Sent at once, as a short burst, then repeated while the condition lasts.
NFC	Tap with a phone to read the tag's identity, firmware version and status in the field, without opening the case. A tap also restarts the tag.
Gateway to cloud	Mobile network (LTE-M or NB-IoT) or Wi-Fi, with batching to save data. See the gateway technical report.
Data	Compact binary messages, decoded in the cloud.

Range depends on the site: line of sight, the height of the tag and gateway, and the density of the foliage. One gateway is normally placed per field or block.

6. Power

The tag runs only on light. A solar panel on the case (2 V, 160 mA) charges a supercapacitor through an energy-harvesting power manager. The supercapacitor does not wear out with daily charging the way a battery does. The tag switches itself on when the store has enough energy and off before it runs empty, so it always restarts cleanly when light returns.

Power	Value	Basis
Energy source	Solar panel on one face of the case: 2 V, 160 mA (about 0.3 W in full sun)	—
Energy store	Supercapacitor; no battery	—
Average current, microclimate only	Under 20 μ A	Measured on v7
Average current, plant signal on	About 20 μ A	v8 design estimate (v7 measured about 24 μ A)
Sleep current	About 5 μ A	Measured on v7
Operation with no light at all	At least 2 days (48 hours)	Measured on v7, see below
Start-up	Automatic once there is light	—

Run-down test without light (October 2026). The solar panel of a field tag was fully covered and the tag was left sending normally every 9 seconds. Starting from a partly charged store, it kept working for 48 hours without a gap or a restart before it stopped. This was the tag with the highest consumption in our field group; the others drain at about half that rate, so 2 days is the minimum we have measured, not the typical figure. A tag that starts fully charged lasts longer, and any daylight, even overcast, extends it.

Share of the average current in plant mode (v8 design estimate)

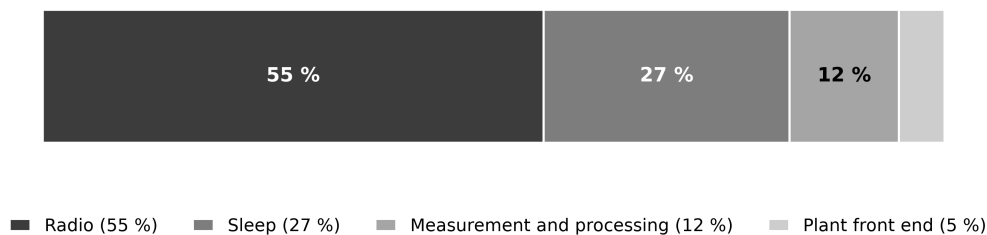


Figure 4. Where the current goes in plant mode. The radio is the largest part, which is why the plant samples are grouped into one message every 9 seconds

7. Self-monitoring and alarms

Every tag reports its own health, so a problem in the field shows up on the dashboard before the data stops.

Alarm	Meaning
Low energy	The energy store is getting low (for example after several dark days)
Supply dip	The supply sagged during a radio message
Temperature out of range	Air temperature below -10°C or above 60°C
Fall or knock	The tag was hit or fell from its hook
Restart	The tag restarted, with the reason (watchdog, power loss or an internal fault)

A watchdog restarts the tag automatically if the software ever stops responding.

8. Mechanical



On its hook



Electrode socket and side module

Figure 5. The enclosure

Item	Details
Enclosure	Triangular case, about 9 × 9 × 7 cm, solar panel (2 V, 160 mA) on one face
Mounting	Hangs from a hook on a trellis wire or branch; the shape keeps the solar panel facing outwards
Plant connection	3.5 mm jack on the case for the electrode cable
Sensor board	Plug-on module on the side of the case, with a light window and an artificial leaf
Outdoor use	Designed for outdoor use in the field; formal ingress (IP) rating not yet tested

9. Field experience

Earlier generations of the AgroTag were tested in vineyards from January 2025. The current enclosure with v7 electronics has been running in citrus orchards and vineyards since August 2026, with and without the sensor board, reporting through the AllPlantsData gateway to the dashboard.



Vineyard, September 2026, with a gateway in the background



Earlier generation in a vineyard, January 2025

Figure 6. Tags in the field

10. Data and dashboard

The readings are shown on the AllPlantsData web dashboard, which works in any browser on a phone or PC. A customer account gives:

- **Live view:** every tag listed under its gateway, with its latest readings and status;
- **History:** charts over any time range, comparison of up to six devices, zoom;
- **Derived values:** dew point, vapour pressure deficit, Delta T, growing degree days, chill hours, daily light integral and an evapotranspiration estimate, among others;
- **Export:** raw readings as CSV files;
- **Maps:** a map of the installed devices;
- **Alerts:** an email when a device stops reporting;
- **Languages:** English, Greek and Arabic.

Tags are registered by tapping them with an Android phone. Readings are kept without a time limit and backed up monthly.

11. Specification summary

	AgroTag v8
Measurements	Plant bio-electric signal; air temperature, humidity, pressure; wind (under test); fall detection; solar and energy-store levels
With sensor board	Adds PAR, red:far-red ratio, blue fraction, near-infrared:visible ratio, leaf wetness (two faces), second temperature, humidity and pressure, optional air-quality indication
Plant signal	About ± 160 mV (to +260 mV), 10 μ V resolution, 1 sample per second, 20 M Ω input impedance
Electrodes	Pure silver wire, on a cable with a 3.5 mm plug
Radio	Bluetooth LE 5, broadcast, up to +8 dBm
Message rate	Microclimate every 9 s; plant signal every 9 s (9 samples); sensor board every 4 to 11 min
Field access	NFC: status by phone tap, restart by tap
Power	Solar panel (2 V, 160 mA) and supercapacitor, no battery
Average current	Under 20 μ A (microclimate), about 20 μ A (plant signal on)
Operation without light	At least 2 days (minimum measured, solar panel fully covered)
Enclosure	About 9 × 9 × 7 cm, hanging mount, 3.5 mm electrode socket
Backhaul	Through the AllPlantsData gateway: LTE-M / NB-IoT or Wi-Fi to the cloud dashboard
Status	v8 in preparation for production; v7 in field use since 2026

Figures are typical and rounded. Measured values come from the previous hardware generation (v7) and will be confirmed on v8 production units. Specifications may change without notice.

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