ARABLE

Arable Mark 3

Specifications & Measurements

Hardware Specifications

SKUs	880-0002-02 (Global) 880-0002-07 (Brazil)
Compute System	Processor: Dual core CPU (1 core dedicated to machine learning) RAM: 64 MB SDRAM Storage: 1GB embedded flash + 64GB micro-SD card
Power System	USB-C input power: 5V, 2A Solar panel: 6W Rechargeable batteries: 47 Wh lithium iron phosphate Charging temperature: -10°C (14°F) / +65°C (150°F) Operating temperature: -20°C (-4°F) / +85°C (185°F)
Communication System	Wide area: LTE-M: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/ B20/B25/B26/B27/B28/B66/B85 NB-IoT*: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/ B28/B66/B71/B85 2G: 850/900/1800/1900 MHz GNSS: GPS/GLONASS/BeiDou/Galileo Local area: Bluetooth BLE 5.2*: 2.4 GHz **Prepared for future expansion*
Included in Box	Mark 3 device Bird spikes USB charging cable Solar panel and solar panel knob Zip ties Cellular and Bluetooth antennas Start Here card

Ingress Protection Rating	IP67 rated for protection against water and dust ingress
Device Dimensions	Dome: 10.5" diameter (26.7 cm) Height of unit with solar panel: 15.5" (39.4 cm)
Package Dimensions	16.9” x 13.9” x 6.2” (42.9 x 35.2 x 15.8 cm)
Package Weight	Weight: 6 lbs (2.72 kg)
Accessories	Arable Mark 3 Ultrasonic Anemometer Sentek Drill & Drop Soil Moisture Probe Arable Mark 3 Auxiliary Sensor Hub Adapter GEMS Pressure Switch Arable Telescoping Pole Arable Ground Anchor

Sensor and Camera Measurements

Precipitation**	Range: Calibrated 0.1 to 50 mm/hr Accuracy: Within calibrated range ±0.4 mm/hr Precipitation type: Rain, mixed drizzle/rain (sleet, snow and hail excluded)
Temperature**	Range: Calibrated -20°C to 60°C (-4°F to 140°F) Accuracy: Within calibrated range ± 0.5°C (± 0.9°F) / Outside calibrated range ±1.5°C (±2.7°F) Measurement interval: 5 minutes
Relative Humidity	Range: 1 to 100% RH Resolution and units: 0.1% RH Accuracy: ±5% Nominal drift: < 0.25% RH/year
Pressure	Range: 50 kPa to 110 kPa absolute pressure; tested 95 to 102 kPa Resolution and units: ±0.1 kPa Accuracy: < 0.5 kPa Nominal drift: ±0.1 kPa/year
Spectrometry	Four-way net radiometer - Upward and downward shortwave sensors (350 to 1100 nm) - Upward and downward longwave sensors (3 µm to 14 µm) Dual 22 band spectroradiometers spanning 400 nm to 1700 nm Dual SWIR band sensors measuring 1600 nm
Camera	5MP RGB camera Composition: 5P + 1 IR Filter EFL: 1.58mm TTL: 5.75 ± 0.1mm FNO: 2.2 ± 5% FOV: Vertical: 72° Horizontal: 103° Diagonal: 110° Mate Sensor Size: .25” F/#: 2.5 Auto-Focus: Included Auto-Exposure: Included Color: Included

***Accuracy at initial release with continuous machine learning model improvements expected over time.*

Accessory Measurements

Wind Speed	Range: 0.2 - 40 m/s (0.45 - 90 mph) Resolution: 0.5 m/s (1.1 mph) Sampling interval: 3 sec
Wind Direction	Range: 0 - 360° Resolution: 5° Sampling interval: 3 sec
Soil Moisture	Number of sensors: 1, 3, 6, 9 or 12 (10 cm spacing) Resolution (Volumetric Water Content): 1:10000 Accuracy: ±0.03% vol
Soil Temperature	Number of sensors: 1, 3, 6, 9 or 12 (10 cm spacing) Resolution: 0.3° C Accuracy: ±2° C @ 25° C
Soil Salinity	Number of sensors: 1, 3, 6, 9 or 12 (10 cm spacing) Resolution (Electric Conductivity): 1:3000
Irrigation Pressure	Range: 4 - 8 psi (0.28 - 0.55 bar) Accuracy: ±0.35 psi (0.024 bar) +2% of setting

Derived Measurements - Environmental

Vapor Pressure Deficit	Vapor pressure deficit (kPa) is the difference — or deficit — between the amount of moisture in the air and how much moisture the air can hold when it is saturated. VPD is recognized as the evaporative driving force for water transport.
Sunshine Duration	Sunshine duration (hrs) is the length of time each day where direct solar irradiance is greater than 120 W m-2. This is based on the World Meteorological Organization (WMO) guidelines.
Dew Point Temperature	The dew point is the temperature the air needs to be cooled to (at constant pressure) in order to achieve a relative humidity (RH) of 100%.
Sea Level Pressure	Sea level pressure (kPa) is empirically derived from the measured pressure, air temperature, and elevation, as well as from the gravitational acceleration and gas constants.

Derived Measurements - Plant

Reference Evapotranspiration (ETo)	Evapotranspiration is the amount of water a plant loses in a day. It is the combined loss of water from the processes of evaporation (the movement of water from surfaces or water bodies to the atmosphere) and transpiration (the loss of water vapor through the plant's stomata to the atmosphere). ETo is the hypothetical value under a grass reference surface.
Crop Evapotranspiration (ETc)	Crop evapotranspiration, or ETc, is the total evaporation and transpiration estimated for your specific crop. The value is achieved by multiplying the reference ET (ETo) by a crop coefficient (KcNDVI). The KcNDVI is dynamically derived by measuring the NDVI reflectance (greenness) of the crop growing in your field and captures the crop development throughout the growing season. The resulting ETc value represents the water losses (evaporation and transpiration) specific to your crop system.
Growing Degree Days	Growing degree days (°C-day or °F-day) measure how much heat a crop has received during the season. Since temperature influences many biological processes that determine health and vigor, GDD is strongly correlated to plant development. It is a calculation that represents the passage of physiological time based on temperature. Different biological thresholds and the start of accumulation dates are used for each crop and varietal. Cumulative growing degree days (CGDD) are the sum of GDDs since the beginning of the season, as specified by the user.
Growth Stages	Growth stages are changes in the phenological stages of a crop. Plant growth stages can help you predict crop vegetative development during the life cycle based on the accumulation of growing degree days. Arable keeps a running list of crops and cultivars and the phenological models observed and modeled by many researchers worldwide for use in our web and mobile apps. After calculating GDD for each crop, we can apply it to the known phenological stage.
Leaf Wetness	Hourly leaf wetness is binary, where 1 is defined as wet and 0 as dry. If any length of time within a given hour is deemed wet, then that entire hour is classified as 1. Daily leaf wetness represents the number of whole hours that were defined as wet, determined by summing the results of each hour. Arable calculates leaf wetness based on measured relative humidity and the rate of relative humidity change.

Water Balance	Water balance represents the total amount of water coming into a site through precipitation and irrigation and out of a site via ETc. This can be used to understand the trend of plant-water availability in order to plan irrigation events.
Crop Water Deficit	Crop water deficit is the difference between a site's water loss (ETc) and incoming water through precipitation.
Heat Stress	Heat stress counts the number of daylight hours during which the canopy temperature is above a stress threshold for the crop (default 36° C/ 96°F).
NDVI	NDVI (normalized difference vegetation index) is a generalized index to evaluate green vegetation's overall vigor and is broadly correlated to the canopy leaf area index (LAI). The calculation is performed using the NIR and red band reflectances. This is based on the papers by Tucker (1979) and Rouse et al. (1974).
Chlorophyll Index	Chlorophyll index is a spectral index correlated with nitrogen uptake during peak greenness. The calculation is performed using the comparison of specific spectral ranges that correlate to chlorophyll content based on the paper by Gitelson & Merzlyak (2005).
Kc-NDVI	The crop coefficient is derived from the vegetation cover as measured by NDVI using Arable's spectrometers. Given that NDVI is specific to the crop, Kc-NDVI represents the actual conditions of the crop canopy.
Chill Hours	A chill hour is the amount of chilling received by a plant at 45°F / 7.2°C. The chilling requirement is the total number of hours required during the winter for a particular cultivar to break dormancy and produce flowers.
Daily Crop Images	Images are provided daily at noon from the embedded 5MP RGB camera of the Mark 3.
Canopy Temperature	Canopy temperature is the temperature reported from a downward-facing semi-hemispherical infrared radiometer. If the surface under the unit is completely uniform (e.g., a continuous grass carpet) this measurement represents the temperature of that surface. If the surface under the unit is not completely uniform, this measurement represents the average temperature of all surfaces in the field of view.

Derived Measurements - Water

Irrigation Start & End Times	The start and end times of the irrigation is taken from the opened/closed state of the pressure switch connected to the irrigation drip line.
Total Irrigation Run Time	The irrigation run time is the sum of times when the pressure switch is open across the measurement period.
Last Irrigation Run Time	The date and amount when an irrigation event was last observed using data from the pressure switch or from data that was manually entered on the Water tab for that site.
Applied Irrigation	The applied irrigation is the irrigation runtime multiplied by the flow rate and then divided by the site area. If multiple pressure switches are associated with a site, the amount is a sum total.
Proximity to Refill Threshold	The distance to the soil moisture refill point for a site is expressed as a percentage. This equals the mean soil moisture for the measurement period (as a percentage of field capacity) minus the refill threshold.
Irrigation to Replace ETc	The irrigation hours needed to meet the defined Replacement ETc taking into account any set Replacement ET % percentage for the growth stage.