



Solar Tracker Settings Manual

Tryon Electronics | v1.2 | October 13, 2026

For the ESP32-WROOM controller, both OONO and BTS7960 motor profiles, the local service website, Home Assistant and optional MQTT. This manual explains what each exposed control changes, what is saved, and what belongs in ESPHome YAML.

Start here

Task	Where to configure it
Motor driver and installed pins	Choose the correct YAML package, then rebuild/install.
Array number and initial node identity	YAML array_number selector, 1 through 8.
Calibration, limits, location, tuning	Local controller tabs; many also appear as ESPHome entities.
Wi-Fi and MQTT changes	System tab: stage fields, then apply.
Dashboard layout and status template	Home Assistant card visual editor.
Downloadable connection diagrams	Separate Wiring and Commissioning Guide v1.3.

Three different kinds of setting

Build-time YAML: selects hardware, credentials, compiled node/provider names and defaults. Editing GitHub or YAML does not update a running controller until ESPHome compiles and installs it.

Saved controller settings: calibration, limits, tuning, time zone, name/number and MQTT choices survive normal rebuilds and restart. New initial defaults generally do not replace saved values.

Temporary controls: Service Mode, staging/import fields, countdowns and recent events are not a full saved installation image. Read the relevant section before restoring or testing.

The defaults below describe the package, not a recommended mechanical or structural rating. Use the actual site, sensor mounting, actuator travel and installation wind requirements.

Contents

ESPHome YAML example; secrets and network options; YAML substitutions; location and normal tracking; limits and motion faults; wind and Safety Bus; calibration and network settings; service/actions; backup and diagnostics; Home Assistant card; troubleshooting; source reference.



ESPHome YAML: one controller example

Keep this small configuration in ESPHome Device Builder, with secrets.yaml beside it. This example selects Array 4 and the BTS7960 profile. Change the number and per-device secret names for another installation; secret key names do not define the node identity.

```
substitutions:
  array_number: "4"
  tracker_api_key: !secret solar_array_4_api_key
  tracker_ota_password: !secret solar_array_4_ota_password
  tracker_wifi_ssid: !secret wifi_ssid
  tracker_wifi_password: !secret wifi_password
  tracker_fallback_password: !secret solar_array_4_fallback_password
  tracker_web_username: !secret solar_array_4_web_username
  tracker_web_password: !secret solar_array_4_web_password
  tracker_safety_bus_key: !secret solar_safety_bus_key

packages:
  tryon_solar_tracker:
    url: https://github.com/Tryon-Electronics-Solar/tryon-solar-tracker
    username: !secret github_username
    password: !secret github_read_token
    ref: main
    refresh: 0s
    files:
      - packages/solar-tracker.yaml
```

OONO build: change only the package file to **packages/solar-tracker-oono.yaml**. Do not include both hardware wrappers in one controller. Array numbering does not select pins or motor hardware.

Number range: the YAML selector is strictly 1-8; array_number: "0" is not supported. A filename such as solar-array-00.yaml or a secret named solar_array_0_api_key is independent and can remain local.

Channel: main follows development; refresh: 0s fetches it each build, while 1h caches for an hour. Use an approved published release tag when one exists for production; do not invent a release tag.



YAML secrets, networking and upload

Local reference	Purpose
tracker_api_key	Home Assistant native API encryption key. Keep the matching key in the ESPHome integration.
tracker_ota_password	Password used to install firmware over the network. During a credential change, the running firmware still expects its previous credentials.
tracker_wifi_ssid / tracker_wifi_password	Original Wi-Fi credentials used by the package. Runtime Wi-Fi setup may save another network.
tracker_fallback_password	Password for the controller fallback access point.
tracker_web_username / tracker_web_password	Local tracker website login; unrelated to GitHub or MQTT login.
tracker_safety_bus_key	Shared encryption key for the ESP-NOW Safety Bus. All intended peers need the same key.
github_username / github_read_token	Local secrets for fetching the private firmware repository. The token needs access to that repository; never publish it in a PDF or public YAML.

Upload address versus static IP

```
wifi:  
  use_address: "192.168.1.185" # Example upload destination only
```

use_address tells ESPHome where to contact the running device, especially during a rename. It does not reserve that IP or configure manual_ip. Prefer a router DHCP reservation when you want a stable address. After a rename upload, check the new hostname and update/remove temporary use_address as needed.

Optional performance overrides

```
logger:  
  level: INFO  
  
mqtt:  
  idf_send_async: true
```

These are optional top-level overrides alongside packages and wifi. INFO reduces debug logging. On the pinned ESPHome 2026.9.1 ESP32 baseline, idf_send_async moves MQTT publishing to another task rather than blocking the main loop, with extra memory use. They are not required for calibration and were not installed on the controller merely because this manual mentions them.

Keep esp32dev/Arduino and the reviewed pin map unless adapting different hardware. Do not change I2C to the GPIO16/17 labels seen in an older picture: this package uses GPIO21 SDA and GPIO22 SCL.



YAML identity and integration substitutions

Substitution / field	What it changes
array_number	Supported build selector 1-8; defaults to 4 if omitted. Generates solar-array-N, initial name/number, fallback SSID, MQTT root and peer roster excluding itself.
node_name / friendly_name	Advanced overrides of compiled node and friendly names. Copied values can defeat automatic naming. YAML filename remains independent.
fallback_ap_ssid	Fallback hotspot name; generated from the array number unless overridden.
default_tracker_number / default_tracker_name	Initial saved identity. Existing flash values can survive changes to these defaults.
mqtt_default_topic_prefix	Initial MQTT root, normally tryon/solar/arrayN. Verify the actual saved topic after a rename.
peer_slot_1/2/3/5/6/7/8	Historical receive-slot number mappings, generated automatically. Not every slot represents an installed online tracker.
safety_peer_1/2/3/5/6/7/8	Compiled ESP-NOW provider names for those slots. Avoid manual copied rosters; do not include the local controller as its own peer.
ha_tracking_lockout_entity	Home Assistant binary lockout input; initial reference input_boolean.solar_tracking_lock_out.
ha_manual_wind_park_entity	Home Assistant manual wind-park input; initial reference light.zigbeeshedcontroler_light_4. Replace with the intended local entity, not an unrelated copied switch.
ha_wind_speed_entity / ha_wind_gust_entity	Home Assistant network wind sources. Initial Pirate Weather wind_speed/wind_gust references; confirm values are MPH for this implementation.

When adopting array_number, remove copied node_name, friendly_name, fallback_ap_ssid, default_tracker_number/name, mqtt_default_topic_prefix and peer_slot_*/safety_peer_* overrides unless deliberate. Check saved controller values afterward; compile-time identity and saved display identity are distinct.



YAML defaults and fixed service parameters

YAML substitution	Package value	Meaning
default_tracking_start_error	1.0	Initial normal start error, degrees.
default_tracking_stop_error	0.4	Initial stop band, degrees.
default_endpoint_guard	0.75	Initial expected-endpoint timeout allowance, degrees.
default_wind_park_mph	40.0	Initial park threshold, MPH.
default_wind_resume_mph	30.0	Initial wind-latch release threshold, MPH.
default_wind_stale_seconds	600.0	Initial network wind maximum age, seconds.
default_safety_hold_minutes	10.0	Initial post-alert hold, minutes.
default_motor_settle_seconds	1.5	Initial post-stop settling pause, seconds.
default_motion_startup_grace_seconds	4.0	Initial delay before normal movement diagnostics, seconds.
default_motion_evaluation_window_seconds	6.0	Initial diagnostic window, seconds.
default_wrong_direction_threshold	0.75	Initial opposite-direction movement threshold, degrees.
default_wrong_direction_confirmations	3	Initial required wrong-direction confirmations.
default_no_movement_threshold	0.30	Initial minimum movement threshold, degrees.
default_no_movement_confirmations	2	Initial failed-window count.
service_test_wrong_direction_threshold	0.15	Fixed service automatic-test threshold, degrees; separate from normal tracking.
service_test_no_movement_threshold	0.08	Fixed service automatic-test minimum movement, degrees.
service_jog_watchdog_ms	2500	Service pulse watchdog, milliseconds; not normal Motor Timeout.
service_mode_timeout_ms	300000	Service Mode expiry, milliseconds.
max_panel_angle	90.0	Absolute firmware ceiling, degrees. Leave 90.0; use runtime soft limits to fit the mechanism.

Changing default_* usually affects initial/fallback values, not already-saved settings. Prefer runtime tuning for an installed controller. array_identity_number is an internal derived lookup; hardware_* substitutions belong to the selected driver wrapper, not customer pin-selection options.



Setup: identity, location and time

Setting / control	Initial value / limits	Meaning and use
Tracker Number	From array_number; range 1 to 99	Saved numeric display/telemetry identity. The runtime field allows 1-99, but the supported YAML array_number selector and automatic peer roster cover 1-8. Keep identities unique; do not use this alone to change compiled node/provider names.
Site Latitude	41.283815; range -90 to 90	Installation latitude in decimal degrees: positive north, negative south. Used by the sun model. Replace the supplied Omaha-area example with the actual site.
Site Longitude	-96.133799; range -180 to 180	Installation longitude in decimal degrees: positive east, negative west. Used by the sun model. Enter western-US coordinates with a minus sign.
Panel Facing Azimuth	180.0; range 0 to 360	Compass direction of the supported tilt plane. 0/360 north, 90 east, 180 south, 270 west. Default is south. Set for the mechanism, not the sun position at one moment.

Setting / control	Initial value / limits	Meaning and use
Tracker Name	Saved/staged text	Saved display name shared with peers and shown locally. Does not rename the compiled ESPHome node, Home Assistant registry entities or YAML filename. Names from peers may take several telemetry updates to arrive.
Browser Time Epoch	Saved/staged text	Absolute Unix time supplied by browser time controls. Use Sync Time Only to retain the installation zone; Sync Time + Zone adopts the supported phone/browser zone. Manual browser date/time is interpreted in that browser zone.

Setting / control	Initial value / limits	Meaning and use
Time Zone	America/Chicago; 12 supported zones	Saved installation zone for local display and daylight-saving rules. America/Chicago is the initial zone. Network/RTC timestamps are maintained as UTC; changing a zone does not change the physical site.

Supported zones: America/New_York, America/Chicago, America/Denver, America/Phoenix, America/Los_Angeles, America/Anchorage, America/Adak, Pacific/Honolulu, America/Puerto_Rico, Pacific/Guam, Pacific/Pago_Pago, UTC.

Use Sync Time Only to keep the installation zone. Sync Time + Zone adopts a supported phone zone. The RTC and network synchronization provide time; a visible webpage clock alone is not proof of battery-backed RTC operation. Test clock retention without Wi-Fi after commissioning.



Tracker: normal modes and motion timing

Setting / control	Initial value / limits	Meaning and use
Tracking Mode	Auto Sun	Auto Sun calculates a target; Local Angle follows Local Requested Angle; Park Flat requests the saved minimum. Normal motion still requires motor enable, calibration, valid feedback and no active blocking condition.

Setting / control	Initial value / limits	Meaning and use
Motor Enable	Off on first use	Allows normal automatic/manual-mode motor movement. Turning it off stops and disables the motor. STOP PANEL also disables it. Enabled does not guarantee movement: fault, lockout, calibration and target conditions still apply.

Setting / control	Initial value / limits	Meaning and use
Local Requested Angle	0; range 0 to 90	Target used only in Local Angle mode. The controller constrains requests to saved travel limits. It is not a calibration value or a measured angle.
Tracking Start Error	1.0; range 0.5 to 10.0	Minimum normal target error needed to start an adjustment. Larger values reduce frequent small corrections. Keep greater than Tracking Stop Error.
Tracking Stop Error	0.4; range 0.1 to 5.0	Error band where a normal adjustment stops. Keep below the start threshold to avoid chatter. Making it too small can cause repeated corrections around noisy measurements.
Tracking Check Interval	60; range 1 to 36000	How often Auto Sun may START a normal adjustment. The closed-loop safety/position loop remains 500 ms. Wind/night parking, Local Angle, Park Flat and stop/fault handling do not wait for this interval.
Motor Timeout	120; range 10 to 999	Maximum continuous normal motor run before a timeout fault. Set to cover measured full travel without letting a jam run indefinitely. Increasing it does not fix a no-movement fault, wrong direction or a hard mechanical end stop.
Motor Settle Time	1.5; range 0.2 to 10.0	Pause after stopping before another normal movement. Lets mechanics and angle filtering settle; can reduce chatter after an overshoot.

Auto Sun projects sunlight into the single supported tilt plane; low solar elevation can legitimately request a high tilt. Requests are bounded by the mechanism limits. Changing the check interval does not slow the 500 ms safety loop or tune no-movement detection.



Calibration, travel limits and endpoint handling

Setting / control	Initial value / limits	Meaning and use
Calibration Reference Angle	0; range 0 to 90	Physical panel tilt measured with a level. Save this number, then press Calibrate From Known Angle to calculate and save the sensor offset. Entering the reference alone does not calibrate.
Calibration Offset Import	0; range -180 to 180	Temporary offset staging value for backup restoration, not the normal measured panel angle. Follow it with Restore Calibration From Backup; verify the final angle against a level.
Panel Minimum Angle	1.5; range 0 to 15	Lowest permitted normal tilt and target used for flat/night/wind parking. 0 degrees is physically flat. Choose a reachable safe low angle after calibration.
Panel Maximum Angle	84.0; range 60 to 90	Upper permitted normal tilt. Set below the actual actuator/mechanical stop. Default 84 degrees is not a guarantee that your mechanism reaches 84. The current adjustable field has a 60 degree lower bound.
Endpoint Guard	0.75; range 0.1 to 5.0	Near-endpoint allowance used when deciding whether a timeout was an expected endpoint stop. It is not extra permitted physical travel. Normal endpoint stop margin is a separate fixed 0.10 degree behavior.

Setting / control	Initial value / limits	Meaning and use
Capture Panel Flat	Action	Stops/disables the motor, allows the sensor to settle and saves the offset using 0 degrees. Only use when physically flat with the sensor in its final mounting.
Calibrate From Known Angle	Action	Stops/disables the motor, waits for sensor settling and saves offset = entered physical reference minus raw MPU angle. Recheck actual angle before enabling motion.
Restore Calibration From Backup	Action	Validates the staged offset/reference and restores saved calibration. Use only for the same sensor mounting, then compare Actual Solar Angle with a physical level.

Procedure: disable motor, mount the sensor securely, measure real tilt, save the measured reference, calibrate, then compare Actual Solar Angle with the level. Set travel limits inside the reachable mechanical range. A large calibration offset can be valid for an inverted mounting; an old offset may instead produce an invalid angle.



Advanced: movement fault diagnostics

Open Tracking & Safety - Advanced. The local editor is initially locked; hold its unlock button for 2 seconds. It exposes saved bounded installer values. An editor lock is not the same as Service Mode and does not disable automatic tracking.

Setting / control	Initial value / limits	Meaning and use
Motion Startup Grace	4.0; range 1.0 to 10.0	Time allowed after a normal motor start before movement diagnostics begin. Covers relay/actuator startup delay and initial slack; it is not the total allowed run time.
Motion Evaluation Window	6.0; range 2.0 to 15.0	Span over which normal movement is evaluated. Longer windows let a slow actuator produce a measurable angle change, but delay fault detection.
Wrong Direction Threshold	0.75; range 0.2 to 2.0	Opposite-direction angle change needed to count a wrong-direction result. Increasing it reduces sensitivity; first check polarity and whether SOUTH increases the reported angle.
Wrong Direction Confirmations	3; range 1 to 5	Number of confirmed wrong-direction results before latching a fault. More confirmations delay detection. Review alongside the threshold, startup grace and evaluation window.
No Movement Threshold	0.30; range 0.1 to 1.5	Minimum measured angle change used by normal movement diagnostics. A lower value tolerates slower motion, but must still distinguish movement from sensor noise.
No Movement Confirmations	2; range 1 to 5	Required failed movement windows before a no-movement fault. More windows give a slow mechanism longer to move. Check mechanical stops and wiring before changing sensitivity.

If the panel moves but faults: first check reported angle movement, sensor mounting, direction and a mechanical endpoint. A slow actuator may need a longer startup grace/window or lower minimum movement threshold. Adjust one value at a time and verify the actual diagnostics. Increasing Motor Timeout alone does not change these checks.

The local Restore Tryon Large-Array Defaults control sets 4 s grace, 6 s window, 0.75 degree / 3 confirmations for wrong direction, 0.30 degree / 2 confirmations for no movement, and 10 min safety hold. Recheck values after restoring defaults.



Wind protection and ESP-NOW Safety Bus

Setting / control	Initial value / limits	Meaning and use
Wind Park Threshold	40.0; range 10 to 100	Effective fresh wind/gust peak at or above this value requests parking. Defaults are a starting point, not a structural wind rating for the array.
Wind Resume Threshold	30.0; range 5 to 95	Fresh wind peak at or below this value releases the numeric wind latch; post-alert hold may still apply. Keep below the park threshold.
Wind Data Max Age	600.0; range 30 to 3600	Age after which a network wind reading is stale. Default 600 seconds. Stale network wind is not a permanent tracking lockout; missing weather does not provide measured wind protection.
Safety Hold Duration	10.0; range 0 to 30	Post-alert delay before tracking resumes once park sources clear. Zero removes the extra hold; active wind/manual park still wins. The countdown is volatile rather than a saved wall-clock timer.

Setting / control	Initial value / limits	Meaning and use
ESP-NOW Send Test Pulse	Action	Sends a radio test request to online peers. TX/RX/ACK counters and Last Test report reception. It is a radio test, not a motor movement command.
ESP-NOW Manual Safety Park All	Action	Requests a real minimum-angle park locally and on peers via ESP-NOW. Manual park remains a distinct signal from wind and test pulses.
ESP-NOW Release Manual Safety Park All	Action	Releases manual park locally and on peers. An active wind condition, other park source or remaining hold can still prevent tracking.
Clear Safety Hold	Action	Requests clearing the post-alert hold locally and over ESP-NOW. Active wind/manual park sources refuse or override a clear; this is not a wind-safety bypass.

The higher fresh speed/gust from native API and MQTT wins. Shared MQTT weather topics are `tryon/solar/weather/wind_speed` and `tryon/solar/weather/wind_gust`; send plain nonnegative numeric MPH, without a unit suffix. The parser accepts 0-250 MPH and rejects invalid text. Avoid retained stale weather messages.

BTS7960 profile only: GPIO33 pulled to GND requests immediate wind parking and broadcasts an alert. OONO does not assign that input. GPIO32 remains reserved. Normal motor disable or fault still prevents movement even when parking is requested.

Manual park, wind alerts, test/ACK and hold-clear are distinct bus messages. Local manual park is saved; the countdown is volatile. Only online peers with received telemetry appear in the service table; offline/uninstalled slots are hidden. All intended trackers need a shared key, matching identities and compatible Wi-Fi channel.



System: Wi-Fi and MQTT settings

Setting / control	Initial value / limits	Meaning and use
WiFi SSID Setup	Saved/staged text	Staging field for a new Wi-Fi network name. Apply WiFi Settings tests and saves it. Compiled substitutions provide the original/fallback configuration; do not confuse staging text with active network status.
WiFi Password Setup	Saved/staged text	Write-only new Wi-Fi password staging field. Enter only when changing Wi-Fi, then Apply WiFi Settings. The local interface does not retrieve saved password text.
MQTT Broker	Saved/staged text	Broker hostname or address reachable from this controller. Saved locally. Apply MQTT Settings reconnects with the edited settings.
MQTT Username	Saved/staged text	Optional broker username, saved locally. Separate from web-login and GitHub-fetch credentials.
MQTT Topic Prefix	Saved/staged text	Unique root for this tracker, for example tryon/solar/array4. A rename/build may keep an older saved prefix. It does not change shared weather topic names or compiled node identity.
MQTT Password Setup	Saved/staged text	Write-only broker password staging field. A blank field when applying settings keeps the stored password; Clear Stored MQTT Password removes it.

Setting / control	Initial value / limits	Meaning and use
MQTT Port	1883; range 1 to 65535	Broker TCP port; saved initial value is 1883. The current pilot is normal LAN MQTT. Editing the port alone does not configure TLS.

Setting / control	Initial value / limits	Meaning and use
MQTT Enabled	Off	Turns the optional MQTT client on/off; its saved choice survives restart. First use defaults off. Native encrypted ESPHome API remains enabled. Configure broker settings before enabling.



System: apply settings and integration behavior

Setting / control	Initial value / limits	Meaning and use
Apply WiFi Settings	Action	Tests staged network credentials. Expect a disconnect; reconnect by hostname or the new router IP. ESPHome restores previous Wi-Fi on a failed test; fallback AP is available if neither network works.
Apply MQTT Settings	Action	Applies stored broker, port, user, password and prefix; reconnects if MQTT is enabled. Saving settings and enabling MQTT are separate choices.
MQTT Test Publish	Action	Sends a test on the saved prefix/test topic when connected. Check the Last MQTT Test result; this does not test motor wiring.
Clear Stored MQTT Password	Action	Erases the saved MQTT password and reconnects accordingly. It does not erase Wi-Fi, API, OTA or web-login secrets.

MQTT discovery entities coexist with native ESPHome entities. Prefer one integration path per card to avoid selecting duplicate readings from different devices. Compact custom telemetry also publishes every 10 seconds under the saved prefix: status, angle, target_angle, motor, wind_speed, wind_gust, wind_source, wind_park, fault, temperature and online. These status topics are not a new generic command API.

The package disables API/MQTT reboot timeouts. Wi-Fi retains its 5-minute recovery reboot and 30-second fallback-AP delay. The service page is embedded in flash: do not add external CDN assets or web_server.local: true, which can replace the intended interface.

Open status, protected changes: the dashboard, live readings and non-secret settings open without login. Select Unlock controls and use the existing tracker_web_username / tracker_web_password credentials before sending commands. The tracker_web_access component authenticates writes on the ESP32, including fallback-portal Wi-Fi saves; login alone sends no motor or settings command. Keep components/tracker_web_access with the package. Do not add web_server.auth, which would also lock the dashboard and event stream.

Browser login: Lock controls makes this page view-only; it does not erase cached HTTP Digest credentials. Your browser may reuse them when unlocking again. Close the browser/private session to clear the login. Native ESPHome API and OTA retain separate authentication; browser OTA uploads are unsupported. Install the updated firmware to enable this behavior on an existing controller.



Service mode, timed jogs and controller actions

Setting / control	Initial value / limits	Meaning and use
Service Mode	Off	Installer mode for timed motor tests; normal tracking is disabled. Hold the local enable control for 2 seconds. It auto-locks after 5 minutes and is not restored on restart. Its jog path bypasses normal wind/travel/angle/lockout checks.

Setting / control	Initial value / limits	Meaning and use
Jog Panel South	Action	Legacy diagnostic SOUTH jog requiring Service Mode. Prefer the clearly timed service jogs. Direction means more tilt, not geographic travel.
Jog Panel North	Action	Legacy entity name for the FLAT/REV jog (id jog_panel_flat); it is not an additional north-tilt capability. Requires Service Mode. Prefer the timed Flat jog controls.
Service Jog South 250ms	Action	Service-only 0.25-second SOUTH pulse; inspect movement and angle direction. A jog is real movement, not a simulation.
Service Jog South 1s	Action	Service-only 1-second SOUTH pulse. Stay clear and keep Stop Panel available.
Service Jog Flat 250ms	Action	Service-only 0.25-second FLAT pulse; should reduce measured tilt.
Service Jog Flat 1s	Action	Service-only 1-second FLAT pulse; independent of normal tracking mode.
Run Service Motor Test	Action	Checks calibration, feedback, faults and initial position more than 2 degrees inside both limits. Firmware uses 2-second pulses per direction plus settling; do not rely on older browser text that says 1 second.
Stop Panel	Action	Stops motor outputs, exits service motion and disables normal motor operation. Use before calibration, maintenance or a backup restore.
Reset Motor Fault	Action	Clears latched timeout/wrong-direction/no-movement faults. Correct the cause before resetting and commanding motion; it does not repair wiring or recalibrate feedback.
Restart Controller	Action	Restarts the ESP32. Outputs are forced off early in boot; saved settings remain. It is not a factory reset.

Service jogs use a separate path before normal wind, soft-limit, angle and lockout checks. They may run on an uncalibrated bench setup. Use short pulses with physical clearance; service watchdog is 2.5 seconds and mode expires after 5 minutes. Service Mode is not a safe way to bypass a mechanical end stop.

A two-second automatic service test pulse can differ from older one-second browser confirmation text. The firmware timing above is authoritative. A reset action clears a latch; it does not fix the underlying fault.



Backups, diagnostics and what the readings mean

Use the local export/backup controls to record the controller before changes. Backup format v1 excludes credentials and is not a complete firmware or flash image. Keep the local YAML, secrets and package version separately. Confirm the panel is stopped/disabled before importing; do not rely on the browser import sequence alone to enforce a successful stop.

Restore only compatible values for the same mechanism and sensor mounting. Recheck limits, identity, MQTT root, site/time and physical calibration afterward. Service Mode, fresh wind ages, recent event history and running countdowns are not permanent installation data.

Reading / indicator	Meaning
Requested / Actual / Tracking Error	Target, calibrated measured angle, and target-minus-actual error. NaN/unavailable is invalid feedback, not a real zero.
Raw Panel Angle / MPU Accel X/Y/Z	Uncalibrated orientation and sensor measurements; use to separate a sensor failure from incorrect calibration.
Panel Calibration Offset / Reference Used	Saved offset and the physical reference used in calibration. Offset magnitude alone is not a fault.
Solar Ideal / Sun elevation / Sun azimuth	Calculated solar geometry; a low sun may need a steep panel. Mechanism limits still constrain requested travel.
Time Valid / Panel Calibrated	Whether required clock and calibration conditions are present.
Wind Fresh / Source / Peak / Age	Freshness and source of weather data; distinguish API and MQTT age. Stale is not a measurement of calm wind.
At Target / Motor State / Runtime / Timeout Remaining	Target band, direction/run state and motor timing. Enable does not mean actively moving.
Motor Fault / Angle Sensor Fault / Wrong Direction / No Movement	Latched motion problems or invalid feedback. Some detailed diagnostic entities are disabled by default in HA; Motor Fault still aggregates normal motor faults.
Safety Bus Park / Reason / Source / Hold countdown	Active park request and its origin; a clear local wind reading can coexist with a peer/manual request or remaining hold.
Peer Link / Name / Wind / Calibration / Motor / Test counters	Received peer status and radio diagnostics; a configured peer is not necessarily online.
Controller temperature / Wi-Fi signal / IP / MAC / Heap / Uptime / Reset reason	Device health and network identity. Review timing warnings and reset reason when diagnosing responsiveness or repeated startup.
Last motor start/stop angle / movement / direction / diagnostic event	Recent action records; not a replacement for observing the mechanism.



Home Assistant card and visual options

Install the public Tryon Solar Tracker card through HACS as a dashboard repository/resource, following its current README. Select this controller's Actual Solar Angle entity. The card detects related entities on that device; optional overrides handle renamed or alternate readings.

Card option	Meaning
entity	Required Actual Solar Angle sensor used as the tracker anchor.
title	Optional card heading; does not rename the controller.
show_controls	Whether the card offers control actions.
controls_expanded	Whether controls are initially open rather than behind the Controls button.
Entity overrides	Explicit sensors/selects/switches/buttons for readings and controls. Select only entities belonging to the intended controller, except deliberate alternate readings such as PV power.
Tracking Status / status	Selected sensor for the top-right label; its unit is appended in normal entity mode.
Tracking Status template / status_template	Optional native Home Assistant Jinja text. entity refers to the selected status sensor; tracker_entity refers to the angle anchor. Fault/safety/disabled messages retain priority.
Settings / STOP PANEL	Settings opens the HA device page; STOP PANEL sends a real stop command. Card settings are separate from firmware/YAML settings.

```
{{ states(entity) ~ ' ' ~  
  (state_attr(entity, 'unit_of_measurement') or '') }}
```

Enter the template in the visual editor directly below the Tracking Status selector. Leave it empty to use normal sensor-plus-unit display. Templates render as text, not HTML, and update through Home Assistant subscriptions. This card does not simulate the real tracker's state when angle feedback is unavailable.



Troubleshooting and source reference

Symptom	First checks
Clock visible but no angle	I2C scan must find 0x68 and 0x69. MPU AD0 to 3.3 V. Confirm raw angle, then calibration; network time can make the clock visible even with a failed RTC.
Panel moves but No Movement Fault	Watch Actual and Raw angles; check a hard endpoint, mounting and direction. Review grace/window/thresholds only after physical causes.
Park Active with local wind clear	Check Park Reason/Source and hold countdown. Inspect peer alerts/manual park. A restart can preserve a manual park request.
Renamed YAML shows Offline / update queued	Contact the existing hostname/IP with use_address or upload to its actual IP. Match running OTA credentials. Editing YAML does not rename running firmware until upload succeeds.
Website / logs are slow	Look for multi-second component/MQTT timing warnings, disconnections and memory. Close unnecessary log streams; optional INFO logging and async MQTT can be evaluated, not assumed installed.
Saved name/topic stays old after build	Correct saved identity/topic in Setup/System; changing initial defaults does not overwrite saved preferences.
Unexpected high target near sunrise/sunset	Check location, facing, clock and soft limits. Tilt is measured from horizontal, so a low sun can require a steep tilt.
HACS says entities missing	Use the correct angle anchor and entity overrides. Enable optional detailed diagnostics on the ESPHome device if wanted; do not treat missing fault data as clear.

Source baseline: firmware main commit d1c936444f40; packages/solar-tracker-core.yaml, hardware wrappers, solar_tracker_web/solar_tracker.js and docs/safety-behavior.md. ESPHome validation baseline: 2026.9.1. UI reference revisions and package versions are distinct from this manual version.

Firmware and installation: github.com/Tryon-Electronics-Solar/tryon-solar-tracker (permission may be required).

Card: github.com/Tryon-Electronics/tryon-solar-tracker-card. Public downloads: tryonelectronics.com/downloads.