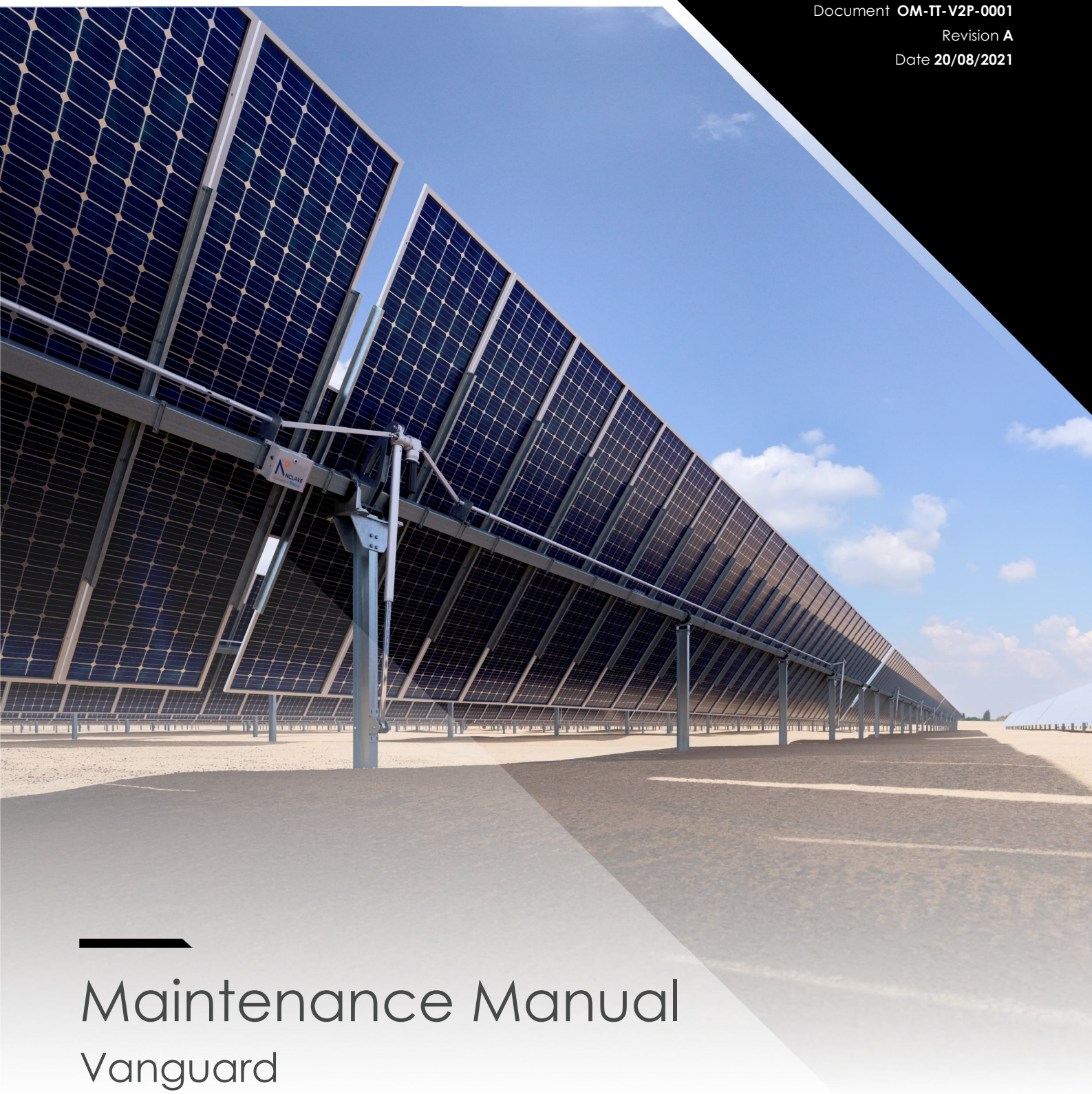
Trina Tracker

PRODUCT SPECIFICATION

Document **OM-TT-V2P-0001**
Revision **A**
Date **20/08/2021**



Maintenance Manual

Vanguard

STANDARD MANUAL

CONTROL REVISION

REV	DATE (dd/mm/yy)	DESCRIPTION	ELABORATED	REVISED	APPROVED
1	04/05/2020	INITIAL DOCUMENT	ILZ	LGA	
A	20/08/2021	TECHNICAL INFORMATION UPDATE	LGA	LGA	

CONTENT

1 PREVENTIVE MAINTENANCE

VANGUARD tracker has been designed to reduce maintenance work to a minimum. Nonetheless, to ensure the correct operation and durability of the tracker, implement and record the following works on a regular basis (see Maintenance Checklist below):

Date:	**Responsible person signature:**				**Client:**	
	Estimated time	Frequency	Tracker reg. (1)	Tracker reg. (2)	Tracker reg. (3)	Tracker reg. (4)
1.1 Tightening torque values verification	15 min	Yearly				
1.2 Check of electrical and ommunication connections	Annex I					
1.3 Check of posts Heads alignment	2 min	Yearly				
1.4 Inspection of galvanization in structural elements	5 min	Yearly				
1.5 Bearings status inspection	5 min	Yearly				
1.6 Check of operational parameter	10 min	Yearly				
1.7 Actuator Revision	Annex II					

(*) Estimated time of maintenance per tracker

(**) A representative sample of unions will be checked considering a balanced distribution in the tracker (posts, bearing supports, tubes, purlins, ….) and a balanced distribution in terms of diameter and number.

1.1. Verification of torque tightening values

The verification of a correct torque tightening value for tracker bolts must be performed on annual basis.

Admissible tolerances:

- Rigid joints → tightening torque tolerances must be ±10% respect Assembly Manual value
- Contactless joints → tightening torque tolerances must be +0/-10% respect Assembly Manual value

(*) TrinaTracker reserves the right to modify the tolerance values described in Assembly Manual.

If the tightening torque is not within the specified tolerances, it will be adjusted to a value in accordance with the table below.

REFERENCE	Tightening Torque (Nm/ft. lb.) Quality 8.8
M6 (purlin joint & modules)	(*) 10 / 7.3
M6 (rigid joint)	10 / 7.3
M6 (TCU SS)	4.4 / 3.2
M8 (purlin joint & module joint)	(*) 12 / 8.9
M8 (joints without contact - blocking plates)	17 / 12.5
M10 (TCU SP)	1.7 / 1.2
M10 (screwed joints for purlin-tube)	40 / 22
M10 (U bolts)	25 / 18.4
M10 (rigid joints)	45 / 33.2
M10 (contactless joints between surfaces)	20 / 14.7
M12 (bearings and plastic spheres joints)	10 / 7.3
M12 (rigid joints)	77 / 57
M12 (plastic joints)	40 / 29.5
M14 (rigid joints)	125 / 92
M14 (contactless joints between surfaces)	60 / 44.2
M16 (rigid joints)	190 / 140
M16 (contactless joints between surfaces)	80 / 59
M20 (rigid joints)	420 / 309.7
M20 (contactless joints between surfaces)	270 / 199
M22 (rigid joints)	470 / 346.6
M22 (contactless joints between surfaces)	310 / 228.6

(*) Subject to change depending on the modules. The installer must ensure that there is no damage or deformation when and after applying the torque. The installer must also ensure the torqueing yields the correct installation on the module frame.

N.B. Consider the type of joint when searching for the correct tightening torque:

- Contact joints: are joints where the pieces are in contact, or the separation between them is so small that when tightened to the correct torque they are totally in contact.
- Contactless joints: are joints where the pieces are not in contact after tightening to the correct torque. If they have been tightened excessively and as a result make contact they could break or deform.

Initial pre-tensioning strengths might be reduced due to possible variations in temperature, internal stress, friction or the effect of non-rigid elements between joints.

Procedure for bolt tightening:

1. **Pre-tighten the bolts to 75% of the torque level** in accordance with the tightening torque table above. **Tighten the bolts crosswise** starting with one of the top bolts. Tighten mechanically (with a torque wrench) or manually, in both cases use calibrated impact head tools to prevent erosion of the bolt head. Replace the tool head if damage is detected on the edges of the bolt.
2. **Final tightening**: Use a calibrated and certified torque wrench to apply the specified tightening torque within tolerances as specified in the table above. Once the torque is applied it is mandatory to mark the bolt(s) tightened with a permanent marker.

Do not move to step 2 until step 1 has been finished to all the bolts in the joint. Please bear in mind that symmetrical joints have their own specific tightening sequence (as specified in Assembly Manual)

1.2. Maintenance check of electrical and communication connections

Preventive maintenance for Tracker Control Units (TCUs) must be done on annual basis as well, starting from first year ater its installation, and then every three years thereafter.

Maintenance check list:

- Check that all the mechanical connections of the TCU are adequately adjusted, if they are not, tighten with the appropriate tools. The specific connections may differ from one project to another (for instance, Powered Systems vs Self-powered Systems and/or different control suppliers):
  - > Auxiliary module for battery charging
  - > Tracker control box
  - > Network communication box
  - > Sensors
  - > Panel connection and cleaning (self-power model)

- Check the performance and visual aspect of the TCU, there should not be any signs of corrosion or damage.
- Simulate abnormal behaviour such as wind, axis block, etc. and verify that the alarms activate as expected

TCU maintenance shall only be performed by trained and qualified personnel.

- **For further details see Annex I in this document**

1.3. Verification that Piles heads are within design tolerances

It must be verified that piles heads are aligned (within design tolerances).

It is possible that because of ground settlements piles heads are out of tolerance. If necessary, the required adjustment will be carried out on the bearing supports to keep them aligned and within tolerances, by using piles regulation.

It could happen that regulation in piles is completely used and there is no chance to correct the height misalignment. In this case, please contact with TrinaTracker technical staff to provide other technical solution.

1.4. Inspection of galvanization in structural elements and hardware

Visual inspection for any evidence of rust or corrosion must be carried out annually.

If a component has rust, repair it must be repaired immediately in order to prevent further rusting. To repair rusted areas, follow the following instructions:

- Eliminate the rust particles
- Apply zinc-rich paint to protect the surface.

Check all parts and members for damages especially the most exposed areas of the installation, such as

- The upper side of the piles where the bounding straps are fixed.
- Large parts and members that are at greater risk of being bumped or scratched.
- Knocks or scratches produced by the transport elements used in each project.
- Bolt heads, nuts and threads coating damaged due to assembly works (tightening torque).

1.5. Plastic bearing inspection

Plastic bearings must be inspected annually.

Visual check of bearing's plastic components status that allow rotation of the different rows will be performed.

If cracks are detected, excessive wear observed or misalignment noticed, replacement of affected components will be produced.

1.6. Checking of Operational parameters

Operational parameters of the tracker will be checked annually.

Following parameters will be checked as indicated:

1.6.1. TCU Tilt angle calibration test

Tracker tilt angle will be checked using a digital level on the face of the module (vide illustration 1). The measurement from the module closest to the drive unit will be taken.

Next step will be the comparison between the field value (measured with the digital level) and the value given by the control handy (only for TCU SS) or the application. The value reading difference tolerance is ±1 degree (for TCU SS) and ±1.256 degrees (for TCU SP).

If the difference between the digital level values and the TCU values are greater than the specified tolerance then, the TCU inclinometer will be adjusted following the *step Inclinometer angle adjustment* in the Commissioning Manual.

Illustration 1: Piledriving Works

1.6.2. Anemometer wind signals

The correct operation of the different wind alarms and the thresholds specified on each project, will be checked:

- Low wind
- Medium wind
- High wind

Wind simulation will be performed by triggering the wind sensor. It will be verfifed that all the trackers move to the specified position for each and every alarm.

It will be checked that when the wind alarm is activated, the automatic tracking mode stops for programmed 10 minutes. If the wind alarm is activated again within this stop period, the 10 minutes timer will restart from the beginning.

1.6.3. Backtracking parameters

Backtracking parameters will be verified by visual inspection of the adjacent tracker shadows projection.

1.6.4. UTC Time synchronization

Review and synchronization of TCUs will be carried out, depending on the TCU type supplied at each plant:

- Manual Method: Using the control display.
- Scada: If there is a communication line.

All trackers must remain on the same UTC time to ensure movement synchronization.

Verify that the following information is updated and has not been altered:

- Date
- UTC time

If the trackers have different times to one another, resynchronize all trackers to UTC time.

- Check date and UTC time and replace if it´s necessary.

1.7. Linear Actuator inspection

Check list as follows:

1. Inspection for structural damage, deformations, cracks or broken components.
2. Worm gear box, outer tube, and rod ends inspection.

3. Check for rust evidence at the rod ends and shaft.
4. Check lever piles bearings clearance with the torque tube. Bearings of upper fixing to the solar tracker should be in good condition, there should not be excessive radial room relative to the shaft.
5. Check for leakages of grease. Worm gear box, outer tube, sealing system, rod sealing system and rod ends, will be specially inspected.
6. Check the greasing / degreasing plugs on worm gear box, outer tube, worm shaft and rod ends.
7. Check that the joining bolts between gearmotor and worm gear box are tightened correctly and are not loose.

For Actuator maintenance details please refer to Annex II of this document.

1.8. Battery working mode and preservation *(for Self-powered trackers)*

1.8.1. Battery life preservation

The state of health (SoH) of batteries depends on the charge/discharge cycle amount and the charge/discharge depth (DoD). Deep charges and discharges can reduce battery lifetime, so the tracker´s TCU tries to maintain an intermediate state of charge (SoC). The best state of charge region for this type of battery depends on the TCU model used 30%-75% (TCU SP) or 35%-80% (TCU SS). The TCU is programmed to maintain the state of charge (SoC):

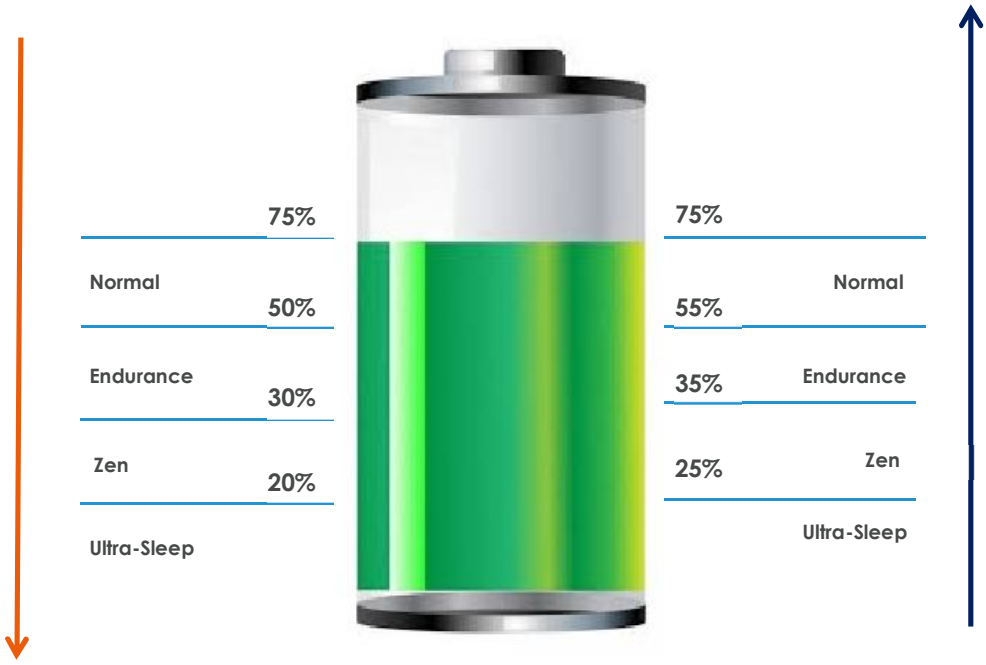
- It stops the charging process if the upper limit is reached with some exceptions: when the system is first installed, the battery must be charged to 100% so that the measurement of its state of charge (SoC) is adjusted. This operation shall be repeated periodically.
- It moves the tracker to the stow position when it detects that the state of charge (SoC) is not enough to keep operating in the recommended range. Once the tracker is stowed the TCU reduces the battery consumption by turning off the system.

1.8.2. Power modes

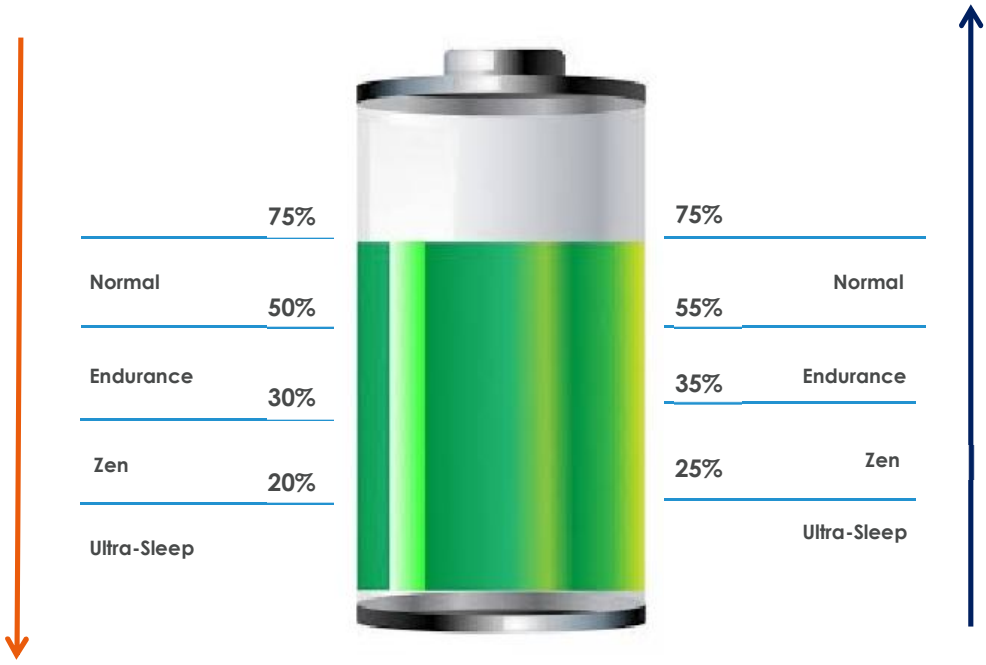
1.8.2.1. TCU *(from P4Q)*

The system operates in 4 different power modes depending on the battery's state of charge (SoC). Some of these modes involve stowing the tracker. However, when the TCU is being controlled manually, with the West/East buttons on the TCU interface or a connected computer, the requests to stow and power reduction procedures are ignored, therefore the user is responsible if the battery is discharged.

- **If manual control is active the battery could discharge as stow commands and power reduction procedures are deactivated. Remember to change the mode back to automated settings after finishing with manual operations.**



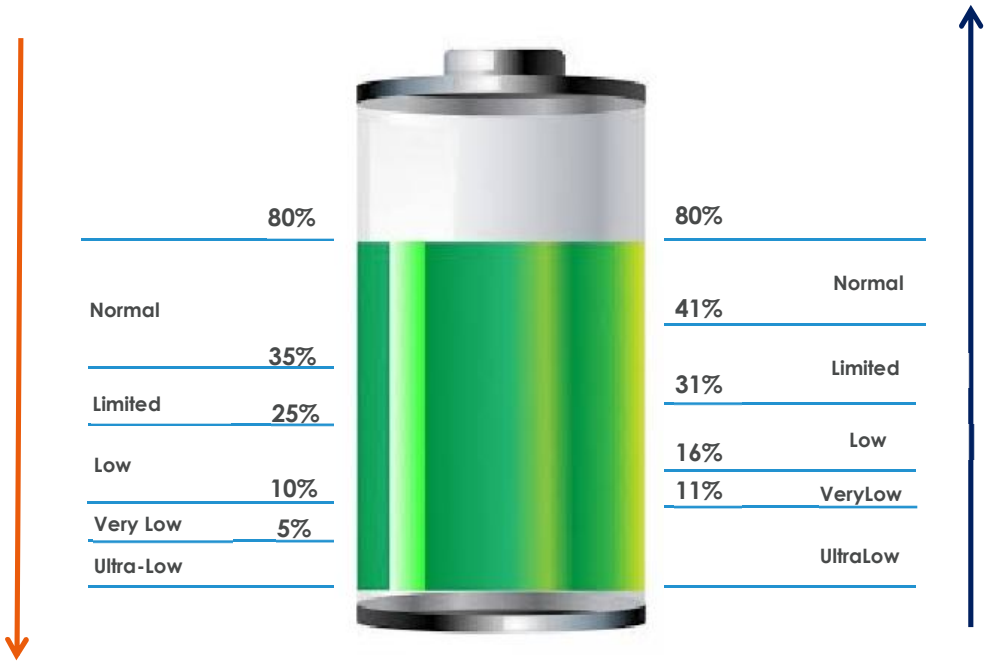
NORMAL OPERATION (POWER MODE 3)		The system does not reduce power consumption. It keeps moving as usual. It monitors the state of charge (SoC) to detect if it needs to change the power mode.
ENDURANCE (POWER MODE 2)		When charge reaches 50% the TCU enters Endurance power mode. It keeps operating in a similar way to the normal operation power mode, but it tries to reduce motor starting, as it uses a different dead band. This dead band must be configured to a wider value than the one used for normal operation. In this mode it can also decide to stow the tracker if it detects that the charge is not enough to ensure the minimal value of 40%. This means that it needs to estimate how much charge it needs to go back to stow position and take the decisions to stow when charge is 40%+estimated charge to stow to ensure that, once the system is stowed, charge will still be above or equal to 40%. The system changes the operation mode back to normal operation when the charge is above 55%.



ZEN (POWER MODE 1		When charge reaches 30% the TCU enters Zen power mode. In this mode the tracker keeps stowed or it stows if it was not already stowed. The TCU turns off the system, and it periodically turns it on, to maintain communication, and to verify if the operation mode should be modified due to changes in power levels. The system changes operation mode back to endurance operation when charge is above 35%.
ULTRA-SLEEP (POWER MODE 0)		When charge reaches 20% the TCU enters Ultra- Sleep power mode. In this mode the tracker keeps stowed or it stows if it was not already stowed. The TCU turns off the system, and it only turns it on if an increase in battery voltage is detected. If the charge is still too low, it turns the system off again and waits for an increase of voltage. The system changes operation mode back to Zen operation when charge is above 25%.

1.8.2.2. TCU (from SDC)

All automatic mode states of the TCU are subject to the energy level available, taking into account both, energy generated by PV panels and the energy stored in the battery. If the available energy is limited, the system will reduce tracker functions until the charge level is high enough for optimal operation.



NORMAL STATE	Normal functioning for all operating modes.
Limited energy	Tracking with inclination limit of 15º.
Low energy 1	The tracker moves to the stow position with the rotation speed limited, in order to save energy. All control and supervision functions remain active in the TCU.
VERY LOW ENERGY	CU functions limited. Only PV panel energy management and battery charge remain active
ULTRA LOW ENERGY	System hibernates. Battery disconnected to preserve its integrity

As with the available energy, all automatic mode states of the TCU are subject to the temperature registered by the system. The presence of extreme temperatures, both high and low, negatively affect the battery lifetime.

The controller manages the following temperature limitation states:

- High temperature discharge:

  Battery energy consumption at high temperatures can reduce the battery lifetime. In order to avoid this, the controller limits the tracker rotation speed to reduce power consumption until the temperature level decreases and reaches normal values.

- Low temperature discharge:

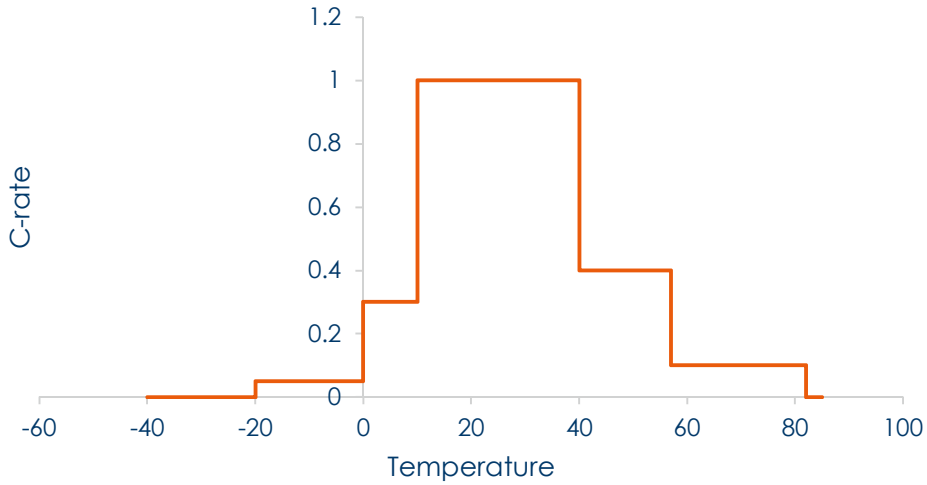
  Battery energy consumption at low temperatures can reduce the battery life. In order to avoid this, the controller limits both the tracker rotation speed and also the maximum inclination to reduce power consumption, until the temperature level increases and reaches normal values.

1.8.3. TEMPERATURE DEPENDENT OPERATION

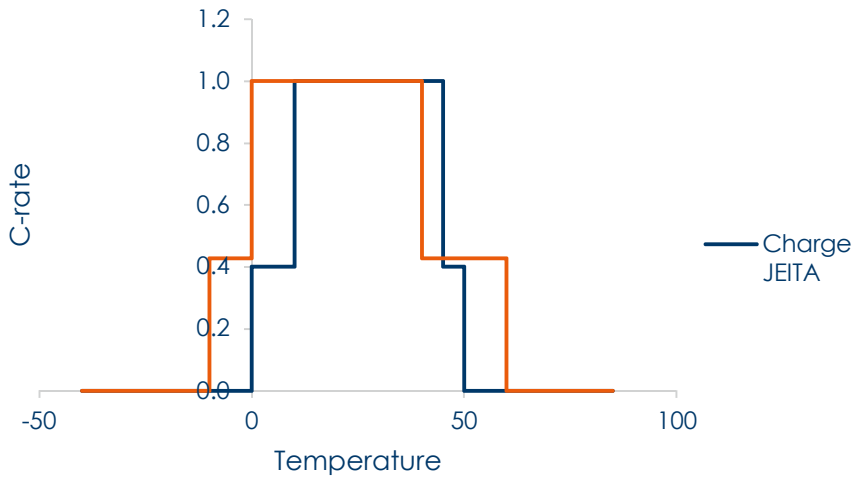
The Self-Powered tracker TCU variant offers temperature dependent current drain and charging current limitations. This allows installations to function correctly in adverse environmental conditions.

The configurable software has temperature pre-sets available to make the device JEITA compliant. As a result, batteries will continue to work efficiently even in suboptimal temperatures.

1.8.3.1. TCU *(from P4Q)*



1.8.3.2. TCU (from SDC)



1.8.4. Battery lifetime expectancy

Estimated battery lifetime expectancy based on testing:

1.8.4.1. TCU *(from P4Q)*

DoD (Charge / Discharge)	#of cycles at 0.2 C	# of cycles at 1C
100%	1.000	800
80%	1.200	1.000
50%	2.500	2.000
20%	5.000	4.000

1.8.4.2. TCU *(from SDC)*

DoD (Charge / Discharge)	#of cycles at 0.2 C	# of cycles at 1C
100%	1.000	800

The cycles are the number of times that the battery is discharged at the DoD level, not necessarily the number of motor cycles.

The client will have to estimate the number of discharge cycles that may occur over the lifetime.

This is determined by the number of cloudy days, cold days etc... In other words, unless there are 2 or 3 cloudy days in a row, the battery will not discharge to 20%.

This increases the number of motor cycles available over the lifetime of the battery.

2 EMERGENCY MAINTENANCE

In cases of 'acts of god' or accidental damage:

- Check that the tightening torques are correct. If necessary, correct the tightening torques to avoid any future damage to the tracker. Please refer to *1.1 TIGHTENING TORQUE*
- Check the foundations to verify correct alignment and performance of the tracker. If there is any misalignment please refer to *1.3 BEARING SUPPORTS PLASTIC* and *1.5. BEARING INSPECTION*
- A general inspection must be performed on the joints, and if there is damage to any structural element, replace them with new parts. Please refer to *1.2 TCU, 1.4.STRUCTURE AND GALVANIZED PROTECTION INSPECTION, 1.6. OPERATIONAL PARAMETERS* and *1.7. ACTUATOR INSPECTION or 1.8. SLEWING DRIVE*