Autonomous Smart Solar Tracker:

**1-Main Features:**

* Two separate outputs: 12 V output (fused 5A) and a 5V current limited output (1 A when motors are off).
* Two axes tracking with a range of motion of approximately 60° for both the base servo and the panel platform servo.
* **Smart sleep mode feature that halts both the microcontroller (VBAT MODE) and the motors resulting in a very energy efficient design (implemented using the RTC clock of the STM32F1 series).**
* LCD display that informs the user when the tracker has last been active in addition to the current produced by the panel at that time and the scheduled wake up time. It also informs the user whether an under-voltage has occurred (The user can turn off the LCD or its backlight to save more power).
* Night mode feature that disables tracking functionality during the night (turn off time varies according to the season).
* Battery under-voltage protection.
* Reverse polarity protection.

**2-Description:**

This solar tracker – even if built with energy efficiency in mind- has an impeccable LDR based tracking algorithm which focuses on positioning the panel in an ideal angle (and tilt) towards the sun; the motors that were used to accomplish such a task were chosen based on their electrical characteristic, the most prominent ones in this context being the rated current and the stall current. The mechanical design of this tracker allows the panel tilting motor to be passive during the downwards part of the motion (counter-weight on the top of the panel) which allows for a reduced current consumption, as well as a reduced torque requirement; the motor that was chosen for the task is the SG90 servo. The base servo is an SM-S4303R continuous rotation servo that was picked for its cost. Its range of motion is limited by limit switches to prevent stalling and wire entanglement.

The periodic wake up system was implemented using the STM32F103C8T6 (ARM CORTEX –M3) RTC and back up registers that allow for the construction of a calendar that provides time tracking. In daytime, the panel goes to sleep after 15 seconds (depends on the \*sleep condition) of activity and sleeps for exactly one hour before waking up (susceptible to change in the final version); during the night however, the tracker was programmed to sleep until sunrise depending on the season.

\*- sleep conditions: there are in total three separate sleep conditions in addition to Night mode:

-IDEAL: 3-10 seconds, the panel reaches a position where the light is equally distributed among the LDRs (in the range of the chosen threshold).

-WIRES: x seconds, the panel titling servo halts (ideal tilt) while the base servo is in contact with the limit switches.

-JITTER: 15 seconds, none of the above conditions occur, meaning that light disturbances are preventing the panel from reaching an ideal position.

**3-LCD code guide:**

**CD01:R :** The batteries have been over-discharged and need recharging. You are required to charge them using the manual charging wires or simply wait for the panel to recharge them before turning the system ON.

**ON----------**: system ON.

**CND:ID :**The panel reached an ideal position.

**CND:JI**: Jitter condition met.

**CND:WI**: Wires condition met.

**C:** Produced current.

**4-Block Diagram:**

**PV**

**Voltage Monitoring Unit**

**Operational Latch**

**Emergency Latch**

LDQEMOJQSMDL

**LDR**

**Motors**

**BAT**

**STM32F103**

**SWITCH**

**DC-DC REGULATOR**

**SWITCH**

**Li-ion**

**BMS**

**Differential AMP**

**5-Electrical Characteristics:**

Test conditions : T=25°C.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Characteristic : | **Symbol:** | **Min:** | **Typ:** | **Max:** | **Unit:** |
| Rated voltage of The solar panel | VMPP | **11.6** | **12.01** | **12.03** | **V** |
| Rated Current of the solar panel | IMPP | **80.0** | **93.01** | **100.0** | **mA** |
| STM32 Current Draw (ON): | Is | 5 | 7 | 9 | mA |
| STM32 Current Draw (VBAT): | IBAT | 12 | 13.3 | 14 | µA |
| Differential Amp Draw: | Id | - | 0.358 | - | mA |
| LCD Draw(Back light ON): | ILcd | - | 7 | - | mA |
| LCD Draw(Back light OFF): | ILcd(off) | - | 2 | - | mA |
| DC-DC Draw (ON): |  | - | 4.07 | - | mA |
| DC-DC Draw (Standby): |  | 60.u | 80 | - | µA |
| Motors total current draw: | IM | 0.04 | 0.13 | 0.54 | A |
| Energy Lost (1 hour no load ,no LCD): | EL | - | 3.43 | - | mW.H |
| Energy Produced (Maximum power): | Ep | - | 1.08 | - | W.H |
| Net Energy produced In 24 hours( summer-time) | En | - | 10.33 | - | W.H |

6-**Solar Panel Characteristic Curve:**

(x-Axis represents current in mA)

**7-Absolute Maximum Ratings:**

|  |  |  |  |
| --- | --- | --- | --- |
| Output: | Output Voltage: | Maximum Allowed Current Draw: | Maximum Load battery voltage: |
| 1 | 5V±0.5 | 1A | 3.7V |
| 2 | 12V(min 9V) | 5A (FUSED) | - |