FUSIONSEEKER DS-50S6

HIGH ACCURACY SENSORY SOLAR TRACKER CONTROLLER

INSTRUCTION MANUAL

Revision 0

FUSIONSEEKER
SOLAR TRACKER CONTROLLERS

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1. INTRODUCTION

FUSIONSEEKER DS-50S6 is a **universal sensory solar tracker controller** designed to be used with **all** single-axis solar trackers (solar concentrators included) that use permanent magnet DC motors for moving (with additional external relays/drivers other types of tracker's motors or hydraulics drive systems can also be controlled by DS-50S6). Its superiorities are **high tracking accuracy, great electrical capabilities, high reliability, long expected life time and also watertight "2in1" polycarbonate housing that serves as a "shadow maker" for sensors and as an all-weather resistant protection for electronics**. Installation is also very simple - because all components are packed in **one** "2in1" housing. You just fix it on to the solar "receiver", connect two wires to supply voltage and the other two wires to the motor and that's it. And it's maintenance free - install and forget!

The heart of FUSIONSEEKER DS-50S6 is its **100% solid state** (no moving parts inside, no potentiometers, no relays!!!) and software free (all features are implemented with pure hardware – no computer hang-ups, no reset buttons!!!) electronics that for functioning needs so little power that energy consumption (about 0,001 kWh per day) can simply be ignored. DS-50S6 is working on a principle of equalized output signals of its two light sensors. When output signals from sensors are different (solar "receiver" is not faced precisely to the sun - "2in1" housing is shading one light sensor) electronics, with the help of POWER MOS-FET transistors, turns on the motor and keeps it running. Immediately after output signals from sensors equalize (solar "receiver" is again faced precisely to the sun) the motor is turned off and with the help of **electronic brake** instantly stopped. This electronic brake is in function always but it becomes absolutely necessary in case you set DS-50S6's accuracy to highest level (without brake system oscillates!). This sequence is repeating throughout all day till sunset when tracker (motor) stops (tracker is facing to the west). At this point DS-50S6 offers you **2 options for turning the tracker back to the east**. If you choose the first option DS-50S6 will early next morning with its additional (third) **bottom sensor** detect first sun rays and immediately turn on the motor to move the tracker to the east. After some 5 minutes (it depends on tracker's rotation speed) the tracker will be facing to the east and sequence described above will start repeating again. In case you choose the second option DS-50S6 will after sunset with the help of its additional (third) bottom sensor detect that the evening has come (low light conditions) and turn on the motor to move the tracker to the east. After some 5 minutes (it depends on tracker's rotation speed) the tracker will be facing to the east and it will stay there all night. In the morning when first sun rays appear tracking sequence will start repeating again.

In case when clouds cover the sun DS-50S6 can stop tracking or it can turn solar tracker towards the brightest cloud - that depends on what tracking accuracy (sensitivity) you choose (set). And immediately after clouds disappear it will in every case turn the tracker toward the sun. In short, FUSIONSEEKER DS-50S6 is a solar tracker controller that will always satisfy all your single-axis sun tracking needs.

2. TECHNICAL SPECIFICATIONS

FUSIONSEEKER DS-50S6	
Basic description:	**High accuracy "single-axis" sensory solar tracker controller**
Supply voltage (DC):	**Uin = from 8V to 50V DC**
Accepted (applicable) supply voltage sources:	**Any external power supply or battery or PV solar panels (solar cells)**
Output current (max. motor current):	**Iout,cont. = 6A (continuous load!!!)** **Iout,10s = 7A (up to 10 seconds)** **Iout,max = 35A (electronically limited)**
Output voltage (motor voltage):	**Uout = Uin – 0,4V at Iout = 3A** **Uout = Uin – 0,9V at Iout = 6A**
Electronics self-consumption:	**1,0mA at Uin = 12V (0,012W)** **1,3mA at Uin = 24V (0,031W)** **1,6mA at Uin = 36V (0,058W)** **1,8mA at Uin = 48V (0,086W)** **(and intelligently built electronics consume always the same without regard to DC motor being in operation or not!)**
Tracking accuracy:	**up to ±0,05 degree at 1000W/m^2 (it is settable)** Factory defaults: ±1 degree (at 1000W/m^2)
Electronic motor brake:	**YES**
Overload protection	**YES**
Short circuit protection	**YES**
Reverse polarity protection	**YES (maximum continuous reverse current: 3A)**
Over-Voltage surge protection	**YES (motor side and supply voltage side)**
PLC compatibility	**YES**
Housing:	**Material: fiberglass-reinforced polycarbonate (UV and high temperature resistant)** **Cover seal: all-round foamed-in PU seal** **Color: light grey RAL 7035** **IP class: IP 66 from top down and from side, anti-condensation breathing holes on the bottom**
Connection cable:	**4 x 1mm^2, 90cm, UV and high/low temperature resistant**
Operating temperature range:	**from -25°C to +70°C**
Dimensions:	**width: 94mm, height: 57mm, length: 94mm**
Weight:	**0,35kg**
Maintenance:	**It's maintenance free**
Expected life time:	**10 years +**

3. INSTALLATION INSTRUCTIONS

WARNING! Please read those instructions completely - before starting with installation!

WARNING! Installation can be performed by qualified Electrician only!

The FUSIONSEEKER DS-50S6 solar tracker controller package includes **DS-50S6 with anodized aluminium mounting bracket, this instruction manual, warranty page and an invoice (receipt)**.

The following sections will guide you how to set parameters of DS-50S6, how to mount it onto the solar "receiver", how to connect supply voltage and motor and where you have to be careful.
Read all sections step by step and installation will be easy.

Before you start look at **Figure 1** where all important components of FUSIONSEEKER DS-50S6 are marked - for easier understanding.

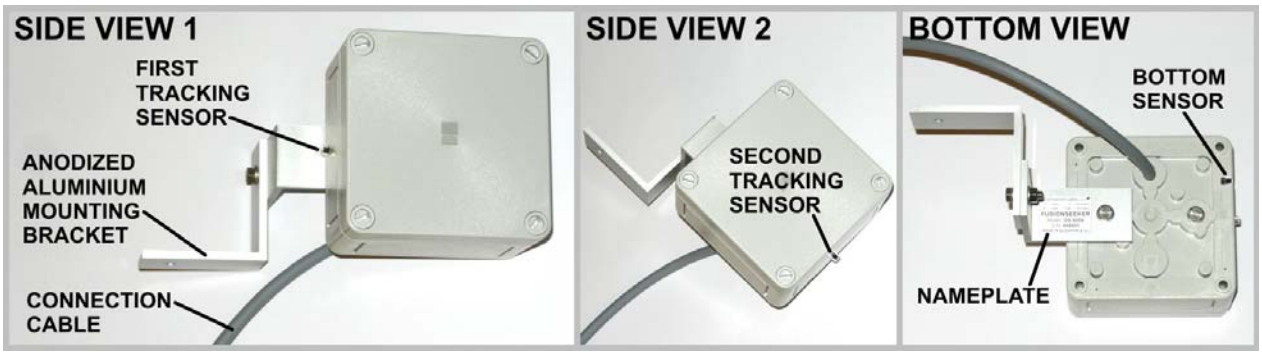


Figure 1: Components of FUSIONSEEKER DS-50S6

3.1 Setting the tracking accuracy

FUSIONSEEKER DS-50S6 is a single-axis solar tracker controller which provides you the possibility to track the sun **by one axis** with high tracking accuracy of up to **±0,05** degree. Tracking accuracy is fully settable but first we are going to explain some facts.

Sun has a radius of 700.000 km and the distance between earth and sun is on average 149.000.000 km. It is not hard to calculate that viewing angle at which we see sun from earth is ±0,27 degree (absolute value: 0,54 degree) (look at **Figure 2**).

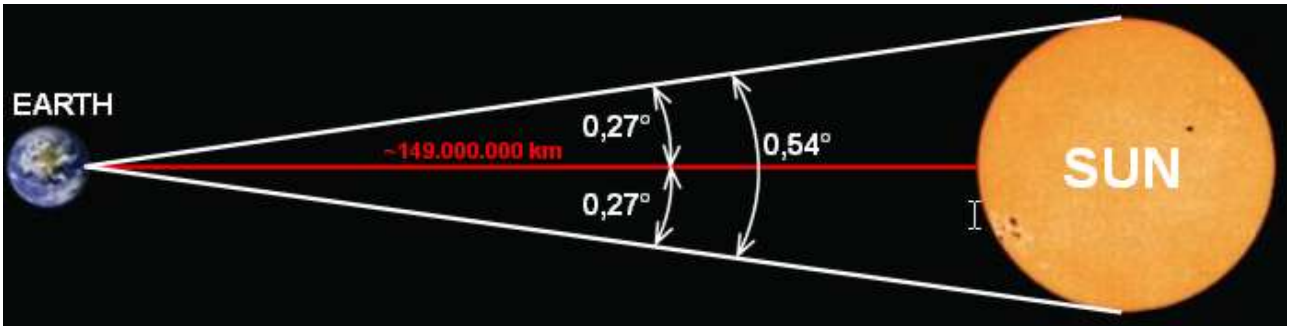


Figure 2: Viewing angle at which we see the sun

When you know the facts you ask yourself: Does single-axis tracking accuracy of better than ±0,27 degree make any sense? The answer is YES and NO – it depends on the type of solar "receiver".

In case of using flat solar "receivers" like are solar cells or water heating solar collectors there is certainly no need for high tracking accuracy - in practice you lose just small amount of energy even with bad accuracy of ±5 degree - but high accuracy will certainly give best results. Situation changes when solar concentrators such are V-through or parabolic through solar concentrators are used. In this case tracking accuracy of at least ±0,27 degree is absolutely necessary because otherwise concentrator can go out of focus and the consequence is drastically decreased output power.

In the beginning of this section it was said tracking accuracy is settable. You change it in the following way:
Open the cover of DS-50S6 as shown on **Figure 4** (step 1). If you look at **Figure 4** (step 2) there are **two equal resistors (marked as R1a and R2a) inserted into gold-plated contact holes of "contact matrix". You change tracking accuracy by changing those two resistors with two of different resistance but same size (1/4W).**

WARNING! You can change resistors R1a and R2a only when FUSIONSEEKER DS-50S6 is not connected to supply voltage!

Before you start setting desired tracking accuracy look at the **Figure 3**. The graph is showing how tracking accuracy depends on different resistance of resistors R1a and R2a.

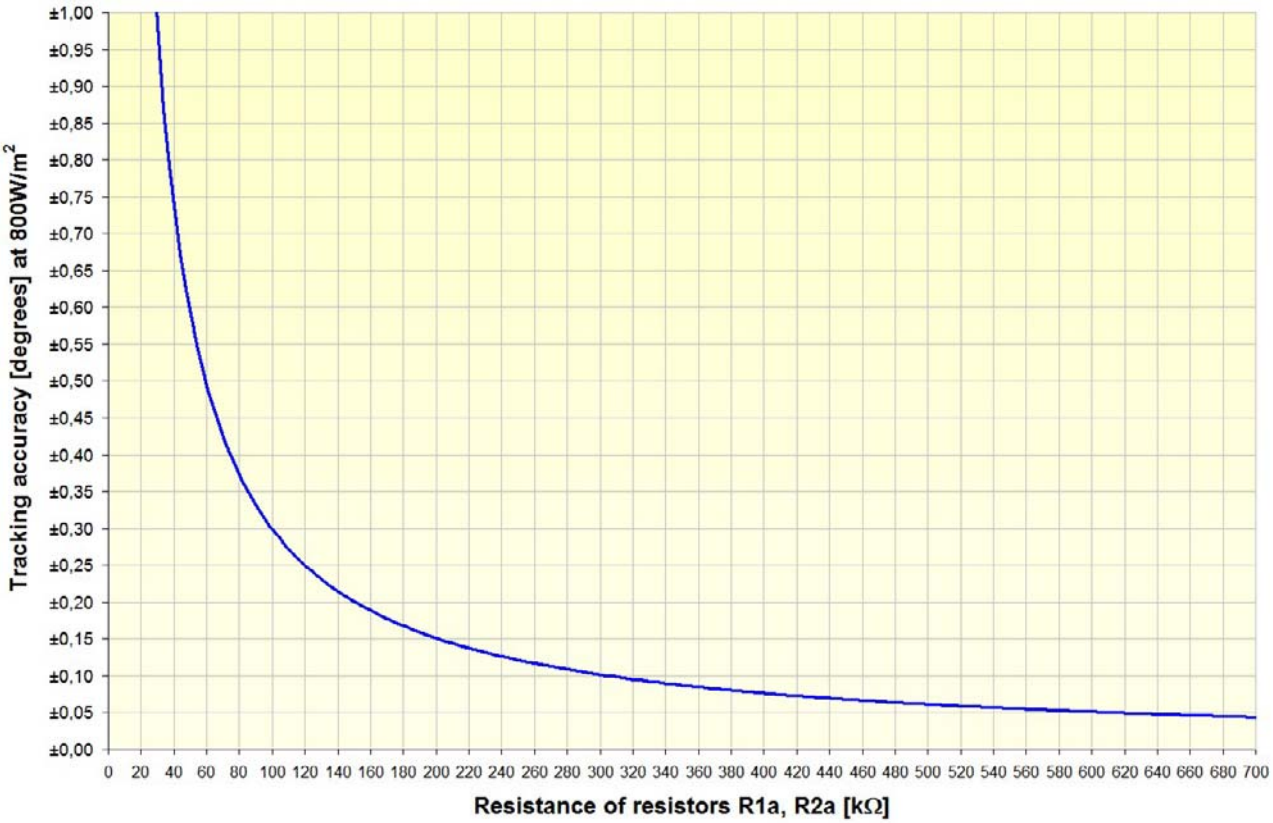


Figure 3: How tracking accuracy depends on different resistance of resistors R1a and R2a at solar irradiance of 800W/m^2

With the help of **Figure 3** it is easy to select resistance of resistors R1a and R2a for desired tracking accuracy. If you need highest tracking accuracy resistance should be higher than 700kΩ or you can simply "use" **no resistors** (infinite resistance). The other characteristic (which is not shown on **Figure 3**) is that tracking accuracy decreases if solar irradiance decreases. This characteristic of DS-50S6 makes sense when clouds cover the sun because tracking stops if "there is nothing to catch". And higher accuracy means that clouds have to be darker to stop the tracking – in other words higher accuracy also means higher overall sensitivity and the opposite.

Knowing the facts you now ask yourself how to choose the resistance of R1a and R2a. The answer is dependent on the type of your solar "receiver":

a) PV solar modules (solar cells):
If you have solar cells we recommend you to simply do nothing – use factory defaults R1a=R2a=24kΩ. At this resistance tracking accuracy is app. ±1 degree at 1000W/m^2 and Fusionseeker DS-50S6 is enough sensitive that it will also “catch” a very bright cloud. This will in most cases give you maximum possible electric energy production from your solar cells (PV solar modules) because DS-50S6 will catch **all available direct solar irradiation and also a lot of diffuse and reflected** solar irradiation. Of course you can always increase accuracy (and thus also a sensitivity) or decrease it. If you want to minimize brightest cloud (diffuse light) tracking use resistors with lower than 24kΩ resistance (down to 20kΩ) and if you want to catch more diffuse and reflected solar irradiation use resistors with resistance between 25kΩ and 200kΩ. As PV solar modules are not very sensitive to accuracy of tracking DS-50S6 will be more than enough accurate no matter what tracking accuracy resistors you decide to use.

b) Water heating solar collectors:
If you have water heating solar collectors you can also use factory defaults R1a=R2a=24kΩ. But as water heating solar collectors do not convert much diffuse solar irradiation to heat we recommend you to use resistors with lower than 24kΩ resistance (down to 20kΩ) in order to minimize brightest cloud tracking and save some energy that would be otherwise used by motor. Like PV solar panels water heating solar collectors are also not very sensitive to accuracy of tracking what means DS-50S6 will be more than enough accurate for this purpose no matter what tracking accuracy resistors you decide to use.

c) Solar concentrators:
When you deal with solar concentrators such are V-through or parabolic through solar concentrators all that matters is tracking accuracy. We recommend you to choose tracking accuracy resistors for desired tracking accuracy according to **Figure 3**. In practice resistors R1a=R2a=100kΩ (better than ±0,3 degree tracking accuracy at 1000W/m^2) almost always provide sufficient tracking accuracy. If not DS-50S6 allows you to increase accuracy (use resistors with resistance of more than 100kΩ) to high levels that will satisfy almost all solar concentrator systems. Absolute maximum possible tracking accuracy (±0,05 degree) is reached when you simply pull out (remove) resistors R1a and R2a.

If you decide **not to change** factory default tracking accuracy settings you just clean (if necessary) the PU seal on the cover, precisely place the cover back and gently screw all four screws down – procedure is finished for you!

If you decide to change tracking accuracy and you have already bought two new resistors (price is negligible) change resistors as it's step by step described on the **Figure 4**.

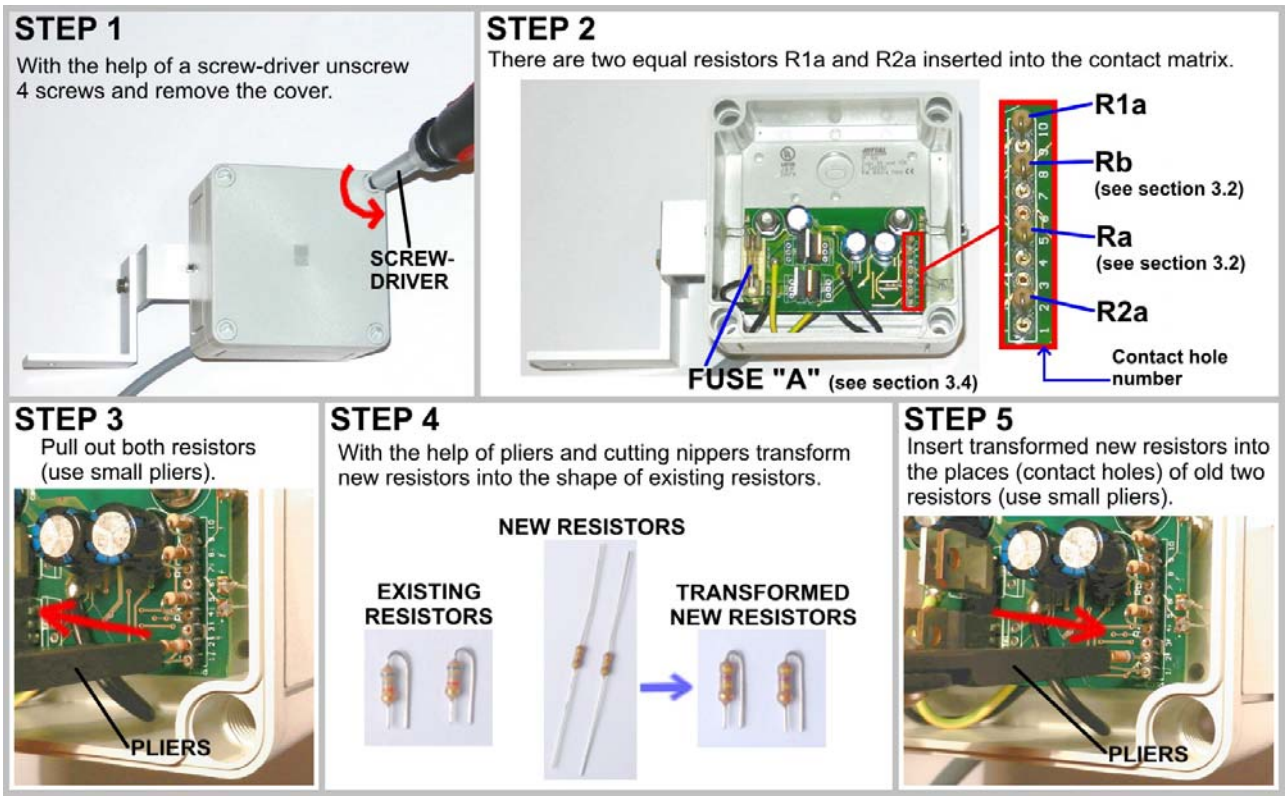


Figure 4: Changing the tracking accuracy (changing R1a and R2a)

When you finish clean (if necessary) the PU seal on the cover, precisely place the cover back and gently screw all four screws down.

You noticed that changing accuracy with the help of ordinary resistors is somehow unusual. You are right, usually things like that adjust with potentiometers. But potentiometers are not reliable enough because its resistance can change in a few years (oxidation) and parameters of certain device also. For the ultra reliable FUSIONSEEKER that is intolerable. But in the other hand ordinary resistors have very time stable resistance. That's why we invented this unique setting of accuracy. The "contact matrix" has simultaneously another advantage. If you screw up something you can always insert old resistors and return old tracking accuracy what is in case of potentiometers practically impossible.

3.2 Setting the "return to east" options

Fusionseeker DS-50S6 offers you **2 OPTIONS for turning the tracker back to the east**:

a) OPTION 1 – morning return to east (factory default setting):
In case you choose this option Fusionseeker DS-50S6 will early next morning with its additional **bottom sensor** (see **Figure 1**) detect first sun rays and immediately turn on the motor to move the tracker to the east. After some 5 minutes (it depends on tracker's rotation speed) the tracker will be facing to the east and regular tracking sequence described in Chapter 1 will start repeating again. In case there are clouds (or fog, snow,…) in the morning with no sun passing through (when there is nothing to "catch") the tracker won't return to the east and thus save some energy that would be otherwise unnecessary used by motor.

If you take a look at **Figure 4** (step 2) you will also see there are two resistors marked as **Ra** and **Rb**. To set "**morning return to east**" function you have to insert resistor **Ra** between **gold-plated contact holes** number **4** and **5** and resistor **Rb** between **gold-plated contact holes** number **7** and

8 (contact holes of the matrix are clearly numbered from 1 to 10). You will find those settings are factory defaults.

Fusionseeker DS-50S6 also allows you to **adjust the sensitivity of the bottom sensor** in order to freely set the level of solar irradiation at which DS-50S6 turns on the motor in the morning to return the tracker to the east. You adjust sensitivity by changing the resistor **Ra** (factory default resistance of the resistor **Ra** is 100Ω) while resistor **Rb** (default resistance is 100Ω) does not have any influence on bottom sensor sensitivity.

WARNING! You can change/reposition resistor Ra and resistor Rb only when FUSIONSEEKER DS-50S6 is not connected to supply voltage!

You now ask yourself how to choose the resistance of the **Ra**. That depends on **what tracking accuracy resistors R1a and R2a you choose**. In case of tracking accuracy resistors R1a and R2a that have resistance of 24kΩ a default 100Ω resistor **Ra** gives good results what means your tracker will start turning to the east when morning solar irradiation reaches about **80W/m^2** (that is what comes with DS-50S6 as factory default). If you would like to increase the sensitivity of the bottom sensor insert **Ra** with **lower** resistance and if you would like to decrease the sensitivity of the bottom sensor insert **Ra** with **higher** resistance. But you have to be careful because in case bottom sensor becomes too sensitive **it can happen that during cloudy conditions the tracker will rotate to the east in the middle of the day**. If bottom sensor is not sensitive enough it may happen that your tracker in the morning won't return to the east.
We recommend that Fusionseeker's bottom sensitivity sensor is set in the way tracker starts turning to the east when morning **direct** solar irradiance reaches about **50 to 150W/m^2**. In Table 1 below there are a recommended (usable) resistance ranges for resistor **Ra** for some most common resistances of the tracking accuracy resistors.

R1a, R2a	Ra
20kΩ	from 1Ω to 750Ω
24kΩ	from 100Ω to 1kΩ
30kΩ	from 1kΩ to 1,5kΩ
39kΩ	from 1,3kΩ to 1,8kΩ
51kΩ	from 1,8kΩ to 2,5kΩ
68kΩ	from 2,5kΩ to 3,3kΩ
100kΩ	from 3,6kΩ to 5,1kΩ
150kΩ	from 5,6kΩ to 7,2kΩ
220kΩ	from 7,5kΩ to 10kΩ
330kΩ	from 11kΩ to 13kΩ
470kΩ	from 13kΩ to 16kΩ
680kΩ	from 16kΩ to 20kΩ
∞ (no resistors)	from 30kΩ to 43kΩ

Table 1: Recommended usable resistance range for Ra for some typical resistances of tracking accuracy resistors R1a and R2a (those settings are valid for start of the morning return to east when morning direct solar irradiance reaches about 50 to 150W/m^2)

If you choose lower than recommended resistance for **Ra** you will get maximum possible bottom sensor sensitivity and if you choose higher than recommended resistance for **Ra** your bottom sensor will not be enough sensitive to detect morning sun. You can in any case also totally **disable** bottom sensor function by simply removing the resistor **Ra**.

We recommend you to use this "morning return to east" option for all types of regular non-concentrator solar trackers that are located in places where there are more cloudy than sunny days. The main advantage of OPTION 1 is that your tracker won't return to the east in case there is no sun in the morning (as we say "there is nothing to catch) what saves some energy that would be otherwise used by motor. **And only in case of OPTION 1 you can power DS-50S6 directly from PV solar modules that are mounted on the tracker** (for details see Section 3.4).

b) OPTION 2 – evening return to east:
In case you choose this option DS-50S6 will after sunset with the help of its additional (third) bottom sensor detect that the evening has come (**when diffuse solar irradiation decreases below 5W/m^2**) and turn on the motor to move the tracker to the east. The tracker will stop when limit switch (**limit switches are absolutely necessary!** – see Section 3.7) will be activated and will stay there all night. In the morning when first sun rays appear tracking sequence described in Chapter 1 will start repeating again.

If you take a look at **Figure 4** (step 2) you will also see there are two resistors marked as **Ra** and **Rb**. To set "**evening return to east**" function you have to insert resistor **Ra** between **gold-plated contact holes** number **3** and **4** and resistor **Rb** between **gold-plated contact holes** number **6** and **7 (contact holes of the matrix are clearly numbered from 1 to 10).**

WARNING! You can reposition resistor Ra and resistor Rb only when FUSIONSEEKER DS-50S6 is not connected to supply voltage!

The default resistance of the resistor **Ra** is 100Ω and default resistance of the resistor **Rb** is also 100Ω. Those default resistors shall be used for any tracking accuracy settings you may choose.

We recommend you to use this "evening return to east" option for all types of regular non-concentrator solar trackers that are located in places where there are more sunny than cloudy days. In any case we also strongly recommend you to use this OPTION 2 for all types of solar concentrators. Using OPTION 2 will mean your tracker will start collecting all available solar energy immediately after sunrise without losing app. 5 minutes needed to return the tracker from west to east like in case of OPTION 1. But you have to know that this **OPTION 2 does not allow you to power DS-50S6 directly from PV solar panels** (for details see Section 3.4). OPTION 2 can only be used if DS-50S6 is powered from battery or any type of power supply.

3.3 Mounting FUSIONSEEKER on the solar "receiver"

First look at the **Figure 6** where the most common types (rotation axes) of single-axis tracking are shown:

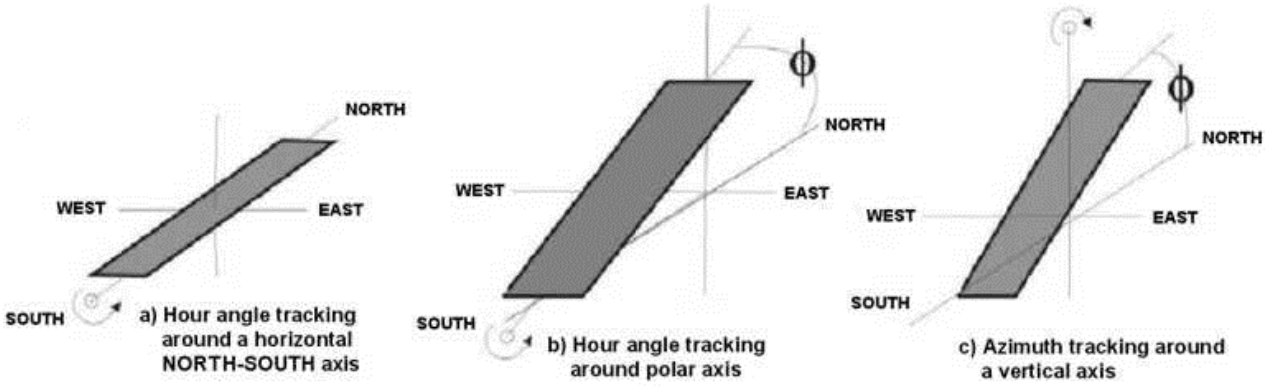


Figure 6: Rotation axes of single-axis tracking (shown for northern hemisphere)

Each of those rotation axes has some advantages and also some disadvantages. But what is important FUSIONSEEKER DS-50S6 **is suitable for all possible rotation axes**.

Essential for tracking is the location on the solar "receiver" where DS-50S6 shall be mounted on. That location depends on global position of the tracker (solar "receiver") as follows:

a) If your tracker (solar "receiver") is located somewhere in the northern hemisphere of the earth mount DS-50S6 on the north-east corner of your solar "receiver" as it's shown on Figure 6:

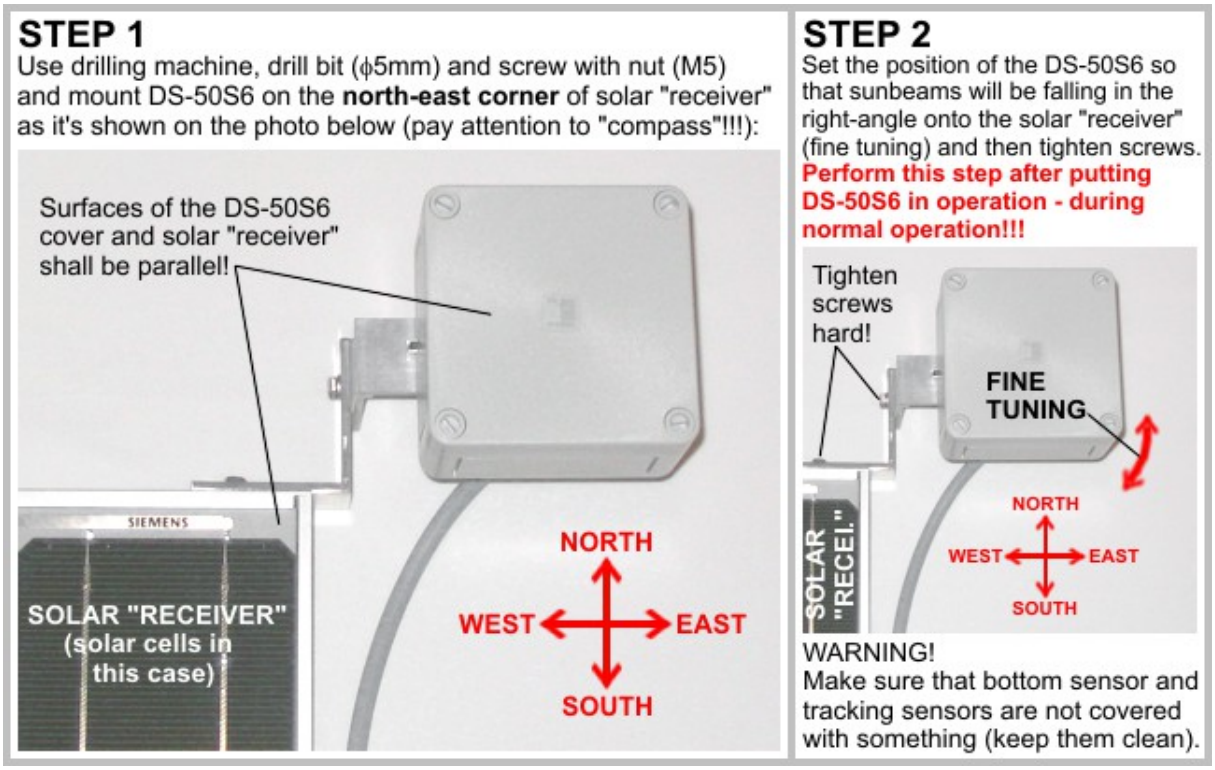


Figure 6: Mounting DS-50S6 on the solar "receiver" (northern hemisphere)

b) If your tracker (solar "receiver") is located somewhere in the southern hemisphere of the earth mount DS-50S6 on the south-east corner of your solar "receiver" as it's shown on Figure 7:

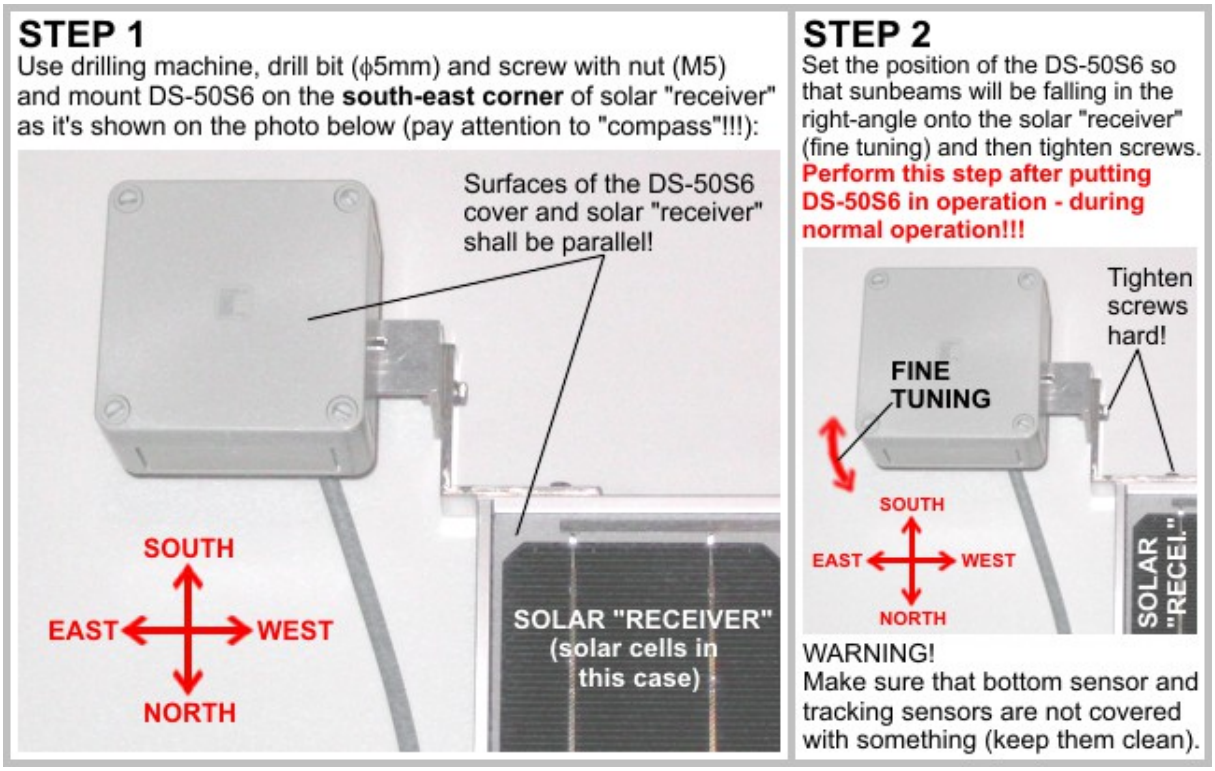


Figure 7: Mounting DS-50S6 on the solar "receiver" (southern hemisphere)

Figures 6 and 7 are showing the ideal mounting location for the DS-50S6. The other very good mounting location is also on the **middle top** of the solar receiver in case of **azimuth trackers** and down the whole **east line** of the solar receiver in case of **horizontal north-south axis trackers** no matter where the tracker is located (northern or southern hemisphere). Middle top mounting location on the azimuth trackers usually ensures that extension cables to the motor and power source are the shortest possible what saves material and installation costs. For the horizontal north-south axis trackers it is feasible to mount the DS-50S6 on the location (on the east line of the solar receiver) where extension cables to the motor and power source are the shortest what saves material and installation costs.

3.4 Connecting FUSIONSEEKER to DC supply voltage and motor

FUSIONSEEKER DS-50S6 has **one 4-wire connection cable** that has to be connected in the following way:

Connect 4 lead wires of the Connection cable (it's marked on the Fusionseeker's nameplate – see Figure 1) one after another as follows:

- To wire marked with **"3"** connect **one motor lead**
- To wire marked with **"yellow/green"** color connect **the other motor lead**.
- To wire marked with **"2"** connect **negative DC power source lead (-U)**
- To wire marked with **"1"** connect **positive DC power source lead (+U)**

When you finish FUSIONSEEKER DS-50S6 starts working. If you don't have luck your tracker will be turning in the opposite direction. Don't worry, just disconnect DS-50S6 from power source, swap motor wires in the wrong working motor's junction-box, connect power supply back and the system will now work properly. We would tell you how to properly connect motors in the first "attempt" but it's impossible due to a very large number of different actuators/gear drives on the market.

WARNING! Always connect FUSIONSEEKER's number **"1"** lead wire to positive terminal of power source and number **"2"** lead wire to negative terminal of power source!!! Although DS-50S6 has built-in reverse polarity protection this is not a 100% protection and in case your power source is capable of providing more than 3A of current DS-50S6 can be permanently damaged if you swap + and -. Be very careful that you do not accidentally connect power source lead wires to one or both "motor" leads as this can also permanently damage DS-50S6 if your power source is capable of providing more than 3A.

If you do not make a mistake when connecting it to power source and motors you can not damage DS-50S6 but in order to get optimum performance you have to know the following:

1. Fusionseeker DS-50S6 needs **DC (direct current) power source** in order to operate**.** It can be powered from any **AC/DC external power supply, battery and also DIRECTLY FROM PV SOLAR MODULES (solar cells).** In case of powering DS-50S6 from power supply or battery you only have to make sure that **power supply or battery output voltage matches acceptable Fusionseeker and motor input voltage and that it's capable of providing at least the same current (power) that motor consumes**.

Fusionseeker DS-50S6 **was designed to also accept PV solar modules output voltage as a power source** what means **you do not need any additional power supply or battery** in case you have a tracker with PV solar modules. But to successfully use this great feature you have to know some facts (there are certain limitations):

- Only setting DS-50S6 to "morning return to east" option (Option 1 – see Section 3.2) enables the possibility for powering DS-50S6 (…and motor) directly from PV solar module/s (solar cells)!

- When powering DS-50S6 directly from PV solar modules you have to be aware that maximum output voltage (open circuit voltage) of the so called 12V solar module (36 solar cells in case of crystalline Si cells) is around 22V and maximum output voltage of 24V solar module (72 solar cells in case of crystalline Si cells) is around 44V. As you know the maximum input voltage for DS-50S6 is 50V what means you can use only PV solar modules that have an open circuit voltage less than 50V in order to properly power the DS-50S6! You also have to choose a motor that can accept certain PV solar module's output voltage.
- If you have a stand alone (off-grid) tracking system with solar panels and batteries and you use a PWM charge controller to charge those batteries you can not power DS-50S6 directly from PV modules because when batteries are full PWM charge controller makes short circuit on solar panel's output to prevent battery overcharging. That means output voltage from panel is 0V and DS-50S6 like any other electrical device cannot work without power. But this is not big trouble because you already have batteries and you can simply connect DS-50S6 to batteries and you still do not need a separate power supply. In case you have grid connected tracker system there are no such limitations – grid connected PV inverters do not behave like PWM battery charge controllers.
- **The most important limitation: The maximum actual CURRENT consumption of the motor that can be (via DS-50S6) powered by a certain PV solar module shall not be higher than 5% of the RATED CURRENT of the PV solar module that it's connected to.** To get actual motor CURRENT consumption you have to measure current while it's rotating the tracker. This is very important as actual measured motor current is usually lower than rated motor current listed on motor's nameplate. Background for this limitation lies in the fact that PV solar modules on the tracker are in the morning usually oriented towards the west but first morning sunshine comes from the east what means there is not a lot of power available from the PV solar module. But this little power from the PV solar module shall be enough to start the motor (Fusionseeker DS-50S6 consumes almost nothing anyway) in order to start rotating the tracker to the east. Note that this is our recommendation. You can freely try your configuration as you can not do any damage to the Fusionseeker DS-50S6 or your motor!

WARNING! As there are usually a lot of PV solar modules mounted on the tracker that are electrically connected in series (HIGH VOLTAGES!!!) you always have to connect DS-50S6 to the PV solar module that has one lead connected to SYSTEM GROUND. This is applicable only for systems that have such connection to SYSTEM GROUND.

2. To connect Fusionseeker DS-50S6 to power source and motor you will need extension cables. The cross-sectional area of lead wires of the power source extension cable shall be chosen in the way that cable's voltage drop from power source to the Fusionseeker connection cable lead wires will not exceed **5%**. And the cross-sectional area of lead wires of the motor extension cable shall be chosen in the way that cable's voltage drop from the motor to the Fusionseeker connection cable lead wires will not exceed **3%**. Please note that the motor extension cable size is very important because of the built in electronic brake for the motor which is more instant in case of "stronger" cables (less resistance!).

3. Fusionseeker DS-50S6 has a built-in **overload and short circuit protection**. That means that you cannot damage DS-50S6 in case you accidentally make short circuit between output (motor) wires or you connect a motor that is too powerful for the DS-50S6. This protection is **true 100% protection** without any duration limits! It works in the way the DS-50S6 goes to so called protection mode (it shuts down the output) if overload or short circuit occurs. After a second or two DS-50S6 **resets automatically** and tries to turn the motor on. If overload or short circuit condition is still present then it goes to protection mode again and this sequence can repeat infinitely. After you remove the fault DS-50S6 will start to work normally.
In case you have a powerful power source also a FUSE can blow in case of overload or short circuit condition – DS-50S6 is equipped with **fast acting fuse rated at 6,3A (5x20mm glass fuse)**;

FUSE "A" (please look back at **Figure 4** (step 2)). If so, replace a blown fuse and it will work again. The purpose of the fuse is to protect a cable and/or power source in case of serious failure.

3.5 Controlling other types of motors

Fusionseeker DS-50S6 was designed to directly drive low voltage permanent magnet DC motors only. Those motors are most widely used but its output can also be used to control other types of motors or hydraulic drive systems. Figure 8 is showing the example how can DS-50S6 control a 3-phase induction motor and a high power permanent magnet DC motor that can't be controlled by DS-50S6 directly. As you can see only 2 contactors/relays, 2 diodes and some wiring per DS-50S6 is needed additionally. This principle can be used to control any motor or hydraulic drive system. Additionally those relay output contacts can also be used to provide a totally potential free input signal (Fusionseeker's tracking command) for the PLC (Programmable Logic Controller).

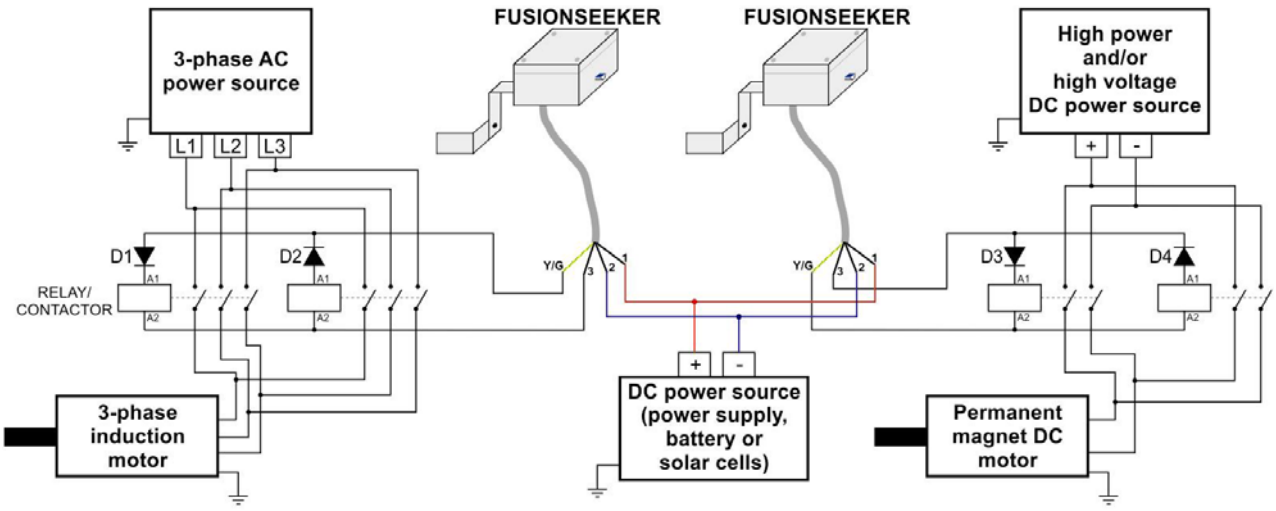
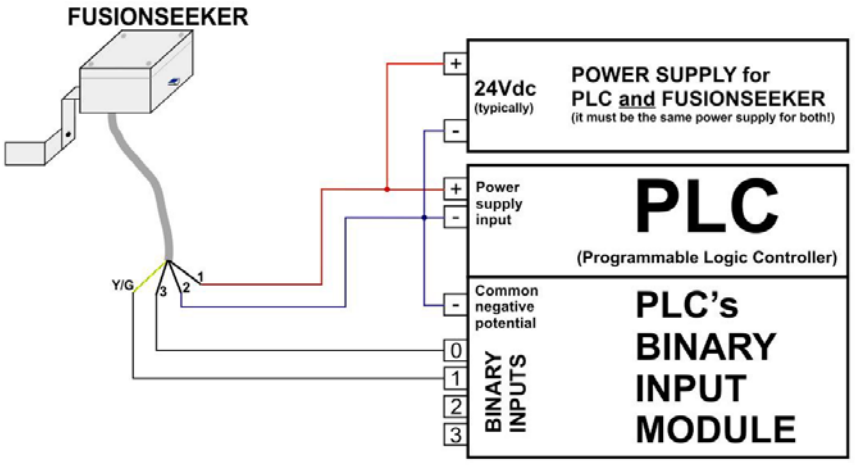


Figure 8: Fusionseeker DS-50S6 controlling a 3-phase induction motor and a high power permanent magnet DC motor

3.6 PLC connection

Another useful feature is to just use DS-50S6 as a **"sun sensor"** and connect its output to the **binary (digital) inputs** (DS-50S6 can only provide a digital signal) of the PLC (Programmable Logic Controller). An example is shown on Figure 9.



The program that has to be implemented in the PLC		
Binary Input **0** status	Binary Input **1** status	MOTOR ACTION
"1"	"1"	STOP
"0"	"1"	ROTATE IN ONE DIRECTION
"1"	"0"	ROTATE IN THE OTHER DIRECTION
"0"	"0"	STOP

Figure 9: Fusionseeker DS-50S6 used as an input for the PLC

This is a typical example that applies to most PLCs on the market. Before connecting it to the particular PLC it is strongly recommended that you check compatibility.

3.7 The limit switches

Limit switches are always important part of each tracker because they protect actuator (motor) by stopping it slightly before mechanical rotational limits of the tracker are reached. Rotational limits could be reached in case something goes wrong or when the tracker mechanics is normally not capable of rotating for example more than ± 70 degrees. So, install limit switches as it's shown on **Figure 10**.

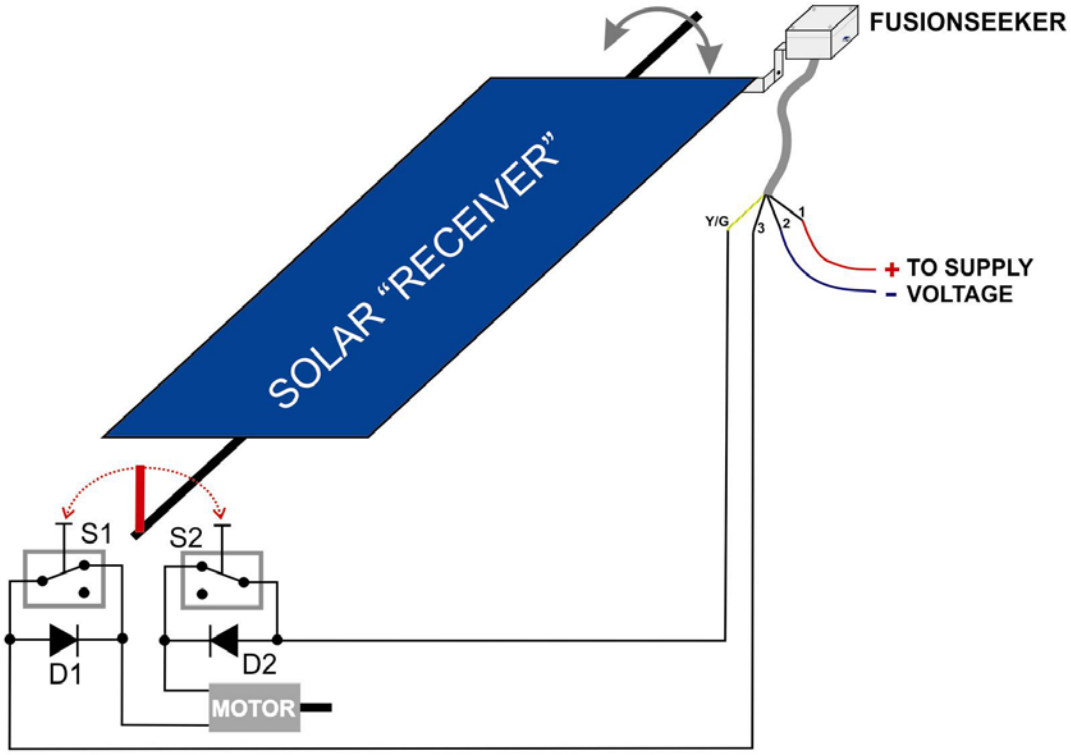


Figure 10: Installing the limit switches

During installation of limit switches S1 and S2 you have to be careful to set them in the way they will turn off the actuator motor slightly before rotational limits of the tracker are reached. Also be careful to use enough powerful limit switches (S1 and S1) and diodes (D1 and D2).
If you don't have luck limit switches, although properly activated, won't turn off the motor. In this case immediately disconnect DS-50S6 from the power source, then swap leads of diode D1 and/or swap leads of diode D2, connect power supply back and limit switches will work properly.

3.8 Grounding

The housing of FUSIONSEEKER DS-50S6 is made of polycarbonate and thus cannot be grounded. The only conducting part of DS-50S6 is its anodized aluminium mounting bracket which **must be connected to system ground**.

WARNING! Never ground motor wires! Motor wires must be connected to motor terminals and nowhere else as this could permanently damage the DS-50S6.

4. RECOMMENDATIONS FOR SOLAR TRACKER STRUCTURE

- **The solar tracker structure including actuator shall be so strong that it can withstand even strongest winds!**
- **The solar tracker structure shall be as stiff as reasonably achievable!** Explanation: Stiff structure assures that tracker can not sway in the wind – left, right, left, right, left,... FUSIONSEEKER DS-50S6 can detect this swaying as deviation in sun tracking and it every time turns on the motor in one and the other direction what means that tracker **oscillates**. Oscillations can harm actuator's motor. Take into account that stiffness of the tracker structure has to be higher if higher accuracy is set.
- **Actuator (or gear drive) has to be high quality – without clearance!** Explanation: Actuator's clearance can cause oscillations in windy conditions in the same way as low stiffness.
- **The speed of rotation of the solar tracker shall not be faster than 0,1 RPM (5 minutes for 180° turn) in general.** Explanation: The motor cannot stop in zero seconds and it rotates a little bit further (because of persistence). DS-50S6 can detect this as deviation in sun tracking and it turns on the motor in the other direction to "repair" the error. If this is repeating oscillations are here. But if recommended tracker's speed of rotation is considered this type of oscillation cannot occur because DS-50S6 has built in electronic motor brake which stops the motor immediately after it's turned off (almost in zero seconds!)!
- **Install the solar tracker in the location where nearby objects can never shadow it!**

5. WARRANTY

Fusionseeker Solar Tracker Controllers *(a division of Soncna energija d.o.o., Kidriceva ulica 25, 3000 Celje, SLOVENIA (E.U.))* warrants its product to the original consumer purchaser that it will repair, or replace, any product that is determined to be defective for the following terms:

One year from date of purchase on all components.

To be eligible for repair or replacement under this warranty, the product in question must be sent to Fusionseeker Solar Tracker Controllers (to workshop – address is shown below) within the warranty period and the original consumer purchaser must comply with the following conditions:

- The product thereof must not have been modified or altered in any way by an unauthorized source.
- The product thereof must have been installed in accordance with the installation instructions.

This limited warranty does not cover:

- Damage due to improper or installation;
- Accidental or intentional damage;
- Misuse, abuse, corrosion, or neglect;
- Product impaired by severe conditions, such as excessive wind, ice, storms, lightning strikes or other natural occurrences;
- Damage due to improper packaging on return shipment.

Any and all labor charges for troubleshooting, removal or replacement of the product are not covered by this warranty and will <u>not</u> be honored by Fusionseeker Solar Tracker Controllers.
Return shipping is to be pre-paid by the original consumer purchaser. Fusionseeker Solar Tracker Controllers will pay the normal return shipping charges within the European Union countries only.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES OF ANY KIND, EXPRESSED OR IMPLIED, INCLUDING (WITHOUT LIMITATION) ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND OF ANY NONCONTRACTUAL LIABILITIES BASED UPON NEGLIGENCE OR STRICT LIABILITY. IN NO EVENT SHALL FUSIONSEEKER SOLAR TRACKER CONTROLLERS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING (WITHOUT LIMITATIONS) ANY DAMAGE FOR PERSONAL INJURY OR PROPERTY DAMAGE OR OTHER PRODUCT LIABILITIES BASED UPON ALLEGED NEGLIGENCE OR BREACH OF EXPRESS OR IMPLIED WARRANTIES OR STRICT LIABILITY. FUSIONSEEKER SOLAR TRACKER CONTROLLERS NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER OBLIGATION IN CONNECTION WITH THE SALE OF ITS PRODUCTS. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU ALSO MAY HAVE OTHER RIGHTS THAT MAY VARY FROM COUNTRY TO COUNTRY. SOME COUNTRIES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY WILL LAST OR THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU.

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