GSM Security Camera EYE-02

Solar Powering

Application Note

1. Index

2. WHAT YOU NEED

For building solar energy power system to supply EYE-02 you need following devices. In appendix 1 you can find sample shopping list with links to e-shops where it is possible to buy.

Photovoltaic panel

Sometimes it is called simply “solar” panel. There are several panel types depending on what type of silicon cells it uses. But all of them use the same principle – they transform visible and invisible light from sun directly to electric energy.

Battery

During sunshine the battery accumulates electric energy for time when the sun is not shining. Very often 12V lead-acid batteries are used as they are durable and low cost. It is also possible to use battery normally used in cars.

Power controller

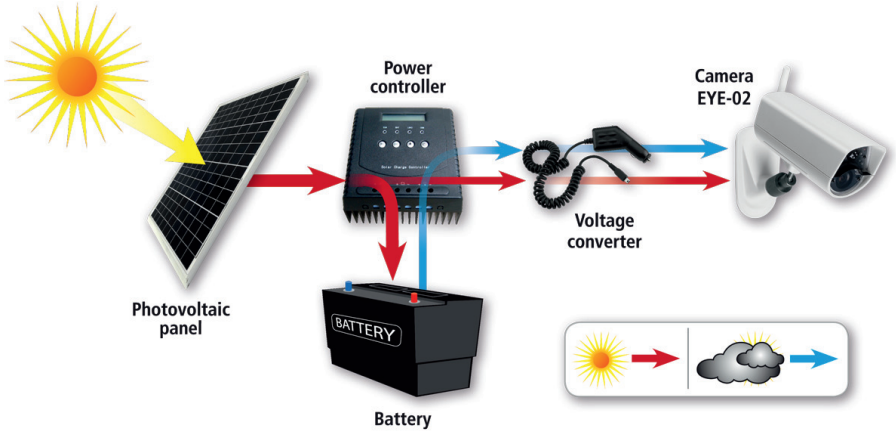
This unit controls flow of electricity between panel, battery and appliance. It also controls correct battery charging and prevents deep battery discharging by disconnecting appliance when battery gets empty.

Depending on how “clever” the controller is, it can also display how much is the battery currently charged, how much energy has been collected from the sun and other measurements that are useful especially in time when you are testing and adjusting your system.

Voltage converter

As the Power controller usually supplies out only battery voltage, there must be something that changes voltage to level used by camera. As the battery voltage is the same as in car, the power converters support connecting car charger adaptors the same way as in car. That’s why you do not need special voltage convertor but just battery charger with USB mini connector that you plug into EYE-02.

The circuit and flows of the electric energy is shown on the following picture.



EYE-02 Solar powering scheme

3. INSTALLATION EXAMPLES

As the consumption of EYE-02 camera depends on configuration (discussed in following sections) it is useful to specify configuration used in following examples.

Camera configuration:

- Used profile **HOME**
- Activated ARC Watchdog function, interval of reporting to server 5 minutes
- IR illumination used during night, camera position: in house, room with windows
- Report to 1 contact, 3 reports (call+MMS) daily

EXAMPLE 1

Location:	Czech Republic, Jablonec nad Nisou
Daylight time for winter:	8 hours (source *http://www.gaisma.com/en/location/jablonec-nad-nisou.html*)
Expected camera daily consumption:	28 Wh/day
Minimal nominal power of photovoltaic panel:	50 W (position: slope 35°, azimuth 0°)
Battery capacity for backup of 7 days without sun:	20 Ah

EXAMPLE 2

Location:	Norway, Oslo
Daylight time for winter:	6 hours (source *http://www.gaisma.com/en/location/oslo.html*)
Expected camera daily consumption:	30 Wh/day
Minimal nominal power of photovoltaic panel:	80 W (position: slope 35°, azimuth 0°)
Battery capacity for backup of 7 days without sun:	22 Ah

Both examples were computed for energetically the “worst” situation (winter) where camera use IR lights for the longest time and the sun delivers the least energy. During summer time both installations will produce some extra energy that can be used also for other appliances.

How to compute numbers shown in examples you can learn in following sections.

4. HOW TO PLAN YOUR SOLAR "POWERPLANT"

The fist you have to know is power consumption (C) of appliance – EYE-02 camera. To find out the consumption you will have to do some simple computations. This section guides you through it using situation of EYE-02 usage on location used in "Example 1" on page 4.

The table shows parts of camera consumption.

Camera "part"	Power consumption	Timed consumption
IDLE (home profile)	543 mW	13.0 Wh per 24 hours
+ **IR** illumination active	+881 mW	0.881 Wh per 1 hour
+ **ARC** watchdog function (5 min)	+36 mW	0.870 Wh per 24 hours
1 **ALARM** report (*)	11 mW	0.011 Wh per 1 alarm report

(*) Alarm report consists of 1 notification call and 1 MMS (125k - medium picture resolution)

Description of each part of consumption in table

IDLE

- Each day EYE-02 consumes about 13.0 Wh if it is left in WATCH or SLEEP mode without doing anything else. This is basic part of consumption that must be always added.

IR illumination

- You probably use integrated IR illumination for night time. The daily consumption of IR light depends how many hours per day it is used.
- In dark room when it is ON whole day you have to add 21.1 Wh (0.881 * 24). In place where you have night for 8 hours add 7 Wh (0.881 * 8).
- Keep in mind you have to count on the worst situation – probably long winter nights.

ARC

- This is consumption that camera uses for sending periodical reports to ARC.
- In case you use ARC WATCH-DOG function you have to add 0.87 Wh.

ALARM reports

- In most situations you do not need to add ALARM consumption to total daily consumption, because you do not expect that you will have false ALARMs. And possible real ALARM caused by intruder can be easily covered from camera internal battery.
- In rare case if you expect that camera will make ALARMs frequently (you watch gate and you want to register each car going through in e-mail) you have to add also consumption for the ALARMs reporting. The number in table multiplies with number of alarms.
- Table value was measured for standard alarm report consisting of 1 notification call and 1 MMS (with 5 pictures in medium resolution, approx. 125kb)

Figure up all the numbers and you get the total daily consumption of camera (C). You will use this number in next computations.

Example:

- *Dark time 16 hours per day,*
- *Expected 3 alarms per day,*
- *ARC watchdog used*

*C = 13 + 16*0.881 + 3*0.011 + 0.87 = 28 Wh / day*
In our situation from Example 1 (city in the Czech Republic), the consumption of camera is 28 Wh each day.

5. HOW BIG PANEL DO I NEED?

The photovoltaic panel has to produce at least the same amount of energy as camera consumes. This is simple rule that you have to follow when choosing power of the panel (P).

It is not easy to estimate how much power you can get from your panel in real situation. Two methods are described in this section – computation based on sunny days per month or using special internet application.

FIND SUNNY HOURS PER MONTH

If you have knowledge about average sunshine time per month (S) in your place, you can count how much power you can get. This computing is really rough and many factors (latitude, altitude, obstacles in sky view, position of the panel, ambient temperature) are simply omitted.

The sunshine hours are always defined for each month in the year. Find the month with the lowest number of sunny hours and you can compute how much energy (E) the sun gives you with panel (P) in locality with sunshine (S).

Example:

In Jablonec nad Nisou in the Czech Republic, it is 27 hours in January.

Any electric appliance does not use all energy that comes into. The nominal panel power is for ideal environment. In real situation the electricity production is usually lower. Some of electric energy is always lost and transformed into heat. Also storing energy into battery is very inefficient – during charging a lot of energy is lost. We expect that with standard equipment you will lose about 30% of energy. That's why there is constant 0.7 in formula.

E = P * S / 30 * 0.7

Knowing how much electric energy the panel produces (E) you can compare it with camera power consumption (C) you have computed in previous section. If the E is greater than C the panel is sufficient for you. If number E is smaller than C you have to you use bigger panel or use more panels. For using more panels you should study manual of used Power Controller if it is possible.

Example:

- *We will use panel with 15W nominal power.*

*E = 15W * 27h / 30 * 0.7 =* **9.45 Wh**.

Our 15W panel, that can give us 9.45 Wh/day, is not suitable for powering camera in the location during winter because we counted that camera needs minimally 28 Wh/day. It would be good to find panel 3 times more powerful (something about nominal 45 - 50 W power) or to buy and use three 15W panels.

FIND REAL POWER YOU CAN GET FROM PANEL ON INTERNET.

Another way how to compute size or power of panel is to find information on how much power you can get from 1 W nominal power of photovoltaic panel in your locality. You can do it on the web page:

http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php

This application has data only for Europe, but there most likely exists a similar source for the other parts of world. This application can also help you to optimize position of the panel.

Example:

Location Jablonec nad Nisou, Czech Republic

- *Panel directed to the south with 35 degrees slope.*
- *The worst month is December with average daily electricity production 10.5 Wh for 15W crystal-silicon panel.*

The result is very similar to the result from previous chapter. When choosing 50W nominal power the result shows that even in December there will be a small excess of power production to keep EYE-02 working.

YOU WANT TO KNOW MORE

In case you want to get more knowledge in this topic it is worth starting on wikipedia page http://en.wikipedia.org/wiki/Solar_power.

There is a lot of references and search sources writing about planning and building solar power plants. You can find there a lot of useful information that you don't know or do not realise that they are important to consider also.

6. HOW BIG BATTERY DO I NEED?

This question "how big battery?" has simple answer: You need battery with capacity that covers "dark" days (D).

The main problem is to find reliable source of "dark" days.

- Some local metrological authority can answer this question very precisely but you should probably have to search in your memory.
- The sources mentioned in previous paragraphs are oriented to producing electricity and they usually do not solve this question.
- You should also ask yourself if it is problem or not if the camera shuts down for couple of days during winter. Sometimes it is not effective to build big backup system just because of one or two days that may happen every 10 years or less. This is very important question that this document cannot answer as it depends only on you and how you used camera.

Example:

We know that during winter in our imaginary location there can be 7 days without sun and we do not want to backup longer time.

To compute needed battery capacity (B) use following formula.

B = D * C / V * 1.25

Variable V is voltage of the battery you use. In most cases you will use 12V battery.

The constant 1.25 that increases results is in equation because of losses of power in power adapter that converts battery voltage into camera voltage. Average efficiency of such adapters is about 80% so the battery capacity (B) has to be 25% higher than the camera needs.

The result (B) is battery capacity in Ah. This number you can be found on label on each battery. After voltage it is the second main parameter you have to know when you want to buy a suitable battery.

Example:

Camera with consumption 28 Wh per day. Battery is 12V lead-acid type.
*B = 7 * 28 / 12 * 1.25 = 20.4 Ah*
For keeping camera powered during 7 "dark" days we need battery 12V / 20.4 Ah.

7. WILL IT WORK ALL TOGETHER WELL?

In previous sections you selected panel that can feed up the EYE-02 in average situation and battery that (if it is fully charged) can backup power for some days. But there is the problem with fast recharging battery that was not considered.

After the battery has been almost discharged due to "dark days" it has to be recharged quickly to be ready for next period of "dark" So the panel that is right enough to cover EYE-02 consumption should be theoretically able to keep system running even if the sun power is delivered in short batches.

Anyway it is always recommended to use panel with higher power then you selected in previous parts. It is also important to make decision if you need to have system working without any black out or you can accept that during the worst period (winter) the system shuts down for one or some days. Depending on the answer you have to increase power of the panel.

Note that panels of the same type can be connected together. So when you are not sure and do not want to buy the panels right now, you can buy one and check how system works and add second panels later to double system power if you find problems during problematic periods.

Important thing that has to be mentioned is also aging. The battery capacity decreases during the usage. Also photovoltaic panel during time loses its ability to convert light energy to electricity due to the cover of panel that is getting less transparent. So you should always count on these facts if you plan to use your solar system in the long term.

8. APENDIX 1 - SAMPLE CONFIGURATION

The sample setup is based on components mainly offered by e-shops
http://eshop.jablopcb.cz/vlastni_c?lang=en&mena=USD and
http://www.pixmania.com/

Sample buy-list

Component	Name	Order code / link
Solar panel	Solar Panel TPS-103 / 12W	*330P+SOL-003.00*
Power controller	Portable power center MEC-3000	*620MEC-3000*
Battery	Sealed Lead-Acid (SLA) battery 12V	any type, car type battery can be used
Voltage converter	USB car charger with mini USB plug	*mini USB car charger*

Example:

For location in Jablonec nad Nisou from Example 1we should buy at least 3 pieces of 12W solar panels to keep the system running during winter.