EMP-Detector V2.4

DEVICE : **EMP Detector V2.4**

FEATURES : **Detecting high energy pulses**

APPLICATIONS : **Detecting lightning and other types of high energy discharges**

IMPORTANT : **For pin-connections, check page 3**

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INFO

After thorough research and testing several prototypes at SMDking, we proudly present a new type of sensor which got available to the market. It is about our EMP (Electro Magnetic Pulse) sensor. This sensor can be used for a variety of usage :

- **Outdoor events**
  Early warning system for any outdoor sports, like golf, football, soccer, hockey, tennis etc.

- **Domotics**
  Warningsystem for upcomming storms , in order to shut down / activate devices or closing windows etc.

- **Scientific experiments**
  Detecting EMP's for analysis-purposes, like locating the impact of lighting by multiple sensors, or figuring out how lighting works.

- **Photography**
  The sublime way to catch a lighting-event by camera, when triggered by this EMP-detector. Can also be used as trigger for other events, like activating multiple flash-lights.

- **Arduino experiments**
  For the hobbyists who are interested in weather-conditions or detecting other types of EMP-sources.

- **Weather stations**
  Next to rain,- barometric,- temperature,- moisture-sensors, a lighting detector can be included.

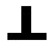
SPECIFICATIONS

Input Voltage (Vcc) : 3.0 to 5.0V DC

Input Current
- No EMP : 27 µA to 142 µA (3.0 to 5.0 V DC)
- Detecting EMP : 3.5 to 20 mA

Dimensions : 20 x 20 x 6 mm / 0.79 x 0.79 x 0.24 inch (W x L x H)

Weight : 4.5 gram / 0.16 ounce

Pinning :
 = Analog output
 = Digital inverted output (sourcing upto 12.5 mA at Vcc)
 = Gnd
Vcc = 3.0V to 5 V DC

Detection range : Lighting upto 45 km / 30 miles radius (theoretical)

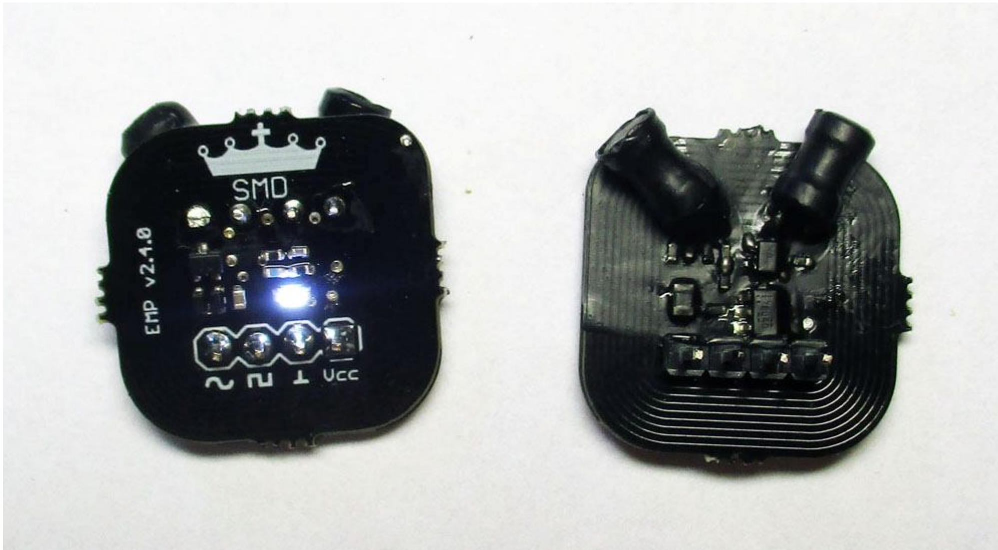
Power ON indicator : No

Visible alarm : Yes (white LED)

Audible alarm : No

Laboratory tested current-consumption		
Voltage (DC)	Min current (No EMP)	Max. current (EMP detected)
5.0 Volts	142 µA	20 mA
3.8 Volts	72 µA	8.7 mA
3.3 Volts	43 µA	5.5 mA
3.0 Volts	27 µA	3.5 mA

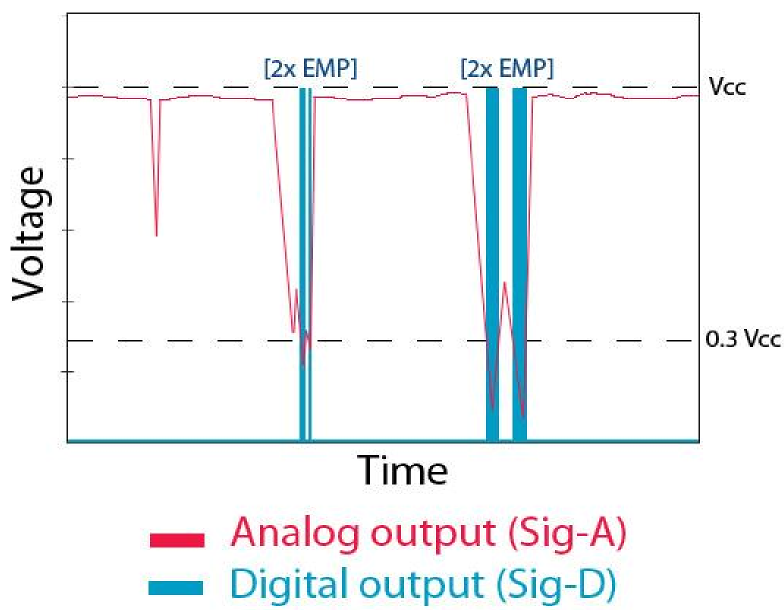
HOW IT OPERATES (pins)



Analog : Analog output. When no EMP is detected, a continuous signal (at Vcc level) will be generated. When minor / low energy EMP activity is detected, the signal will drop / fluctuate slightly.
When high energy EMP is detected, the signal will drop significantly.

Digital : This pin can be used as a trigger-function for high energy EMP's. When no or low activity is detected the pin will remain 0 Volts. When a good strong analog signal is detected, a digital high peek signal (Vcc level) will be generated. (See image below)

GND and Vcc : For activating the sensor, [Vcc] and [Gnd] need to be connected to a powersource. The sensor will operate at 3.3V DC to max. 5.0 V DC. (The lowest, succefull tested Voltage is 3.0 V.
If the EMP-detector is running at 3.0 Volts, a 42 µA is drawn, when no lighting is detected.
When lighting is detected, the detector requires a pulse of 3.5 mA. This peek is required to activate the onboard visible alarm (white LED).



LOCATION at PCB

Flash-LED

Onboard a white LED is present (see image below). This LED is located at the top of the board, near the Gnd-pin. Default, this LED is OFF. Whenever a medium to strong EMP is detected, the LED will flicker as long as the EMP takes place.

Antenna

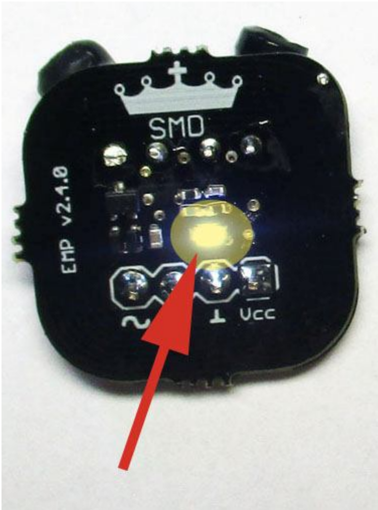
Onboard is an integrated antenna present, tuned for 30 miles detection-range.

Power ON LED

This sensor is designed for ultra low energy-consumption. As a result for this, there's no Power ON LED present.

Buzzer

This sensor is designed for ultra low energy-consumption. As a result for this, there's no buzzer present.



Flash LED (white)

Testing the sensor

If you need to test the sensor, use a digital multimeter, measuring DC Voltage. Connect the sensor to power. When no EMP detected, the analog OUT should be at Vcc-level, while the digital OUT should measure 0 Volts. When an medium to strong EMP is picked up, analog OUT should go low. A medium to strong EMP wil result in a Voltage between 0 x Vcc and 0.5 x Vcc.

To test the sensor, you can :
- switch ON/OFF a tube-light
- use a butane gaslighter / torch with piezo-element (not with flintstone).

Some soldering-irons use a special (high frequency) technique to heat up quickly, like an OKI Metcal solderstation. If the sensor is kept close towards the cable between its station and solder-iron, the sensor might get triggered.

DETAILS ABOUT "DIGITAL PIN" ( )

At the right, you see measurements, while lighting took place, while the sensor was powered at 5V DC.

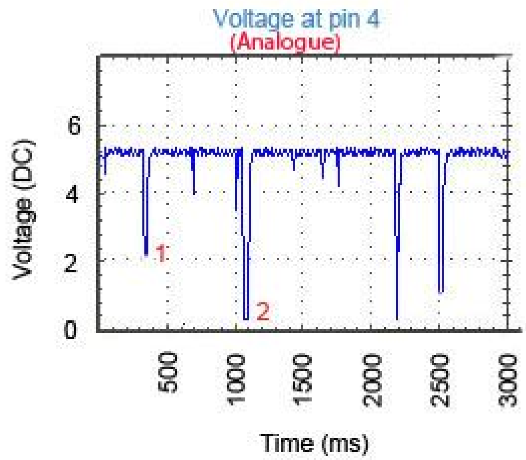
Please, keep the following in mind :

A) for reliable detection of EMPs, a Voltage-drop of nearly 0.7 * Vcc is required at pin "Analogue".

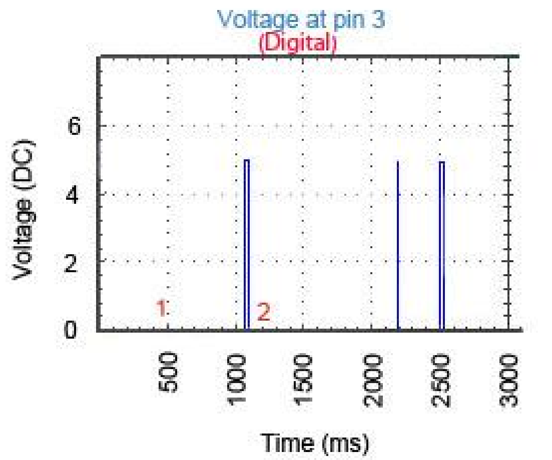
B) if Vcc is 5 Volts, than 0.7 * Vcc = 3.5 Volts.

C) pin "Digital" will shift level when "Analogue" pin is at or below (5 - 3.5 =) 1.5 V

Vcc is the Voltage you use to power the sensor.



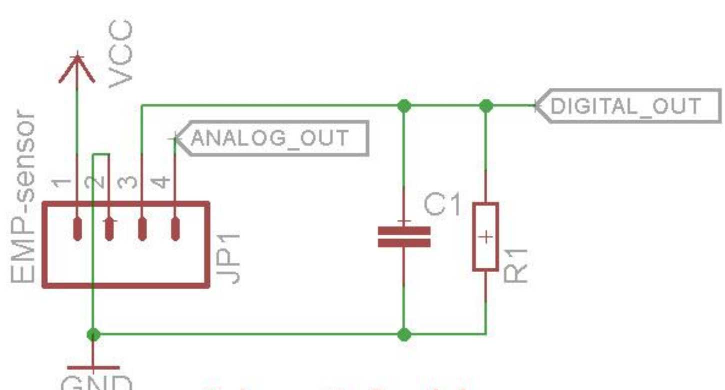
Examples to help understanding.
At the right you can see an actual read-out by an oscilloscope at pin "Analogue" (pin 4) and at pin "Digital" (pin 3).



Example 1)
A *low* or *medium* EMP is detected, and pin "analogue" will drop to 2 Volts.
5 Volts - 2 Volts = 3.0 Volts. This 3 volts is less than the minimum required drop of 3.5 Volts.
Pin "Digital" will stay at 0 Volts.

Example 2)
A *high* EMP is detected, and pin"Analogue" will drop to 0.2 Volts.
5 Volts - 0.2 Volts = 4.8 Volts. This 4.8 Volts is more than the minimum required drop of 3.5 Volts. Pin "Digital" will generate a pulse of 5 Volts.

Good to know (Delay in signal)
In general, pin "Digital" (pin 3) will respond with a delay of approx. **5 ns**, which is pretty fast and makes it very interesting to use it as a trigger-function for activating external electronic devices.
For delay, it's advisable to use the digital OUT signal, (few 100s milli-seconds). Use a capacitor + resistor parallel connected between digital OUT and Gnd (see below).
The time is determined by T = R x C, where R is the resistance in ohms, C is the capacitance in Farads and T is time in seconds.



Schematic for delay

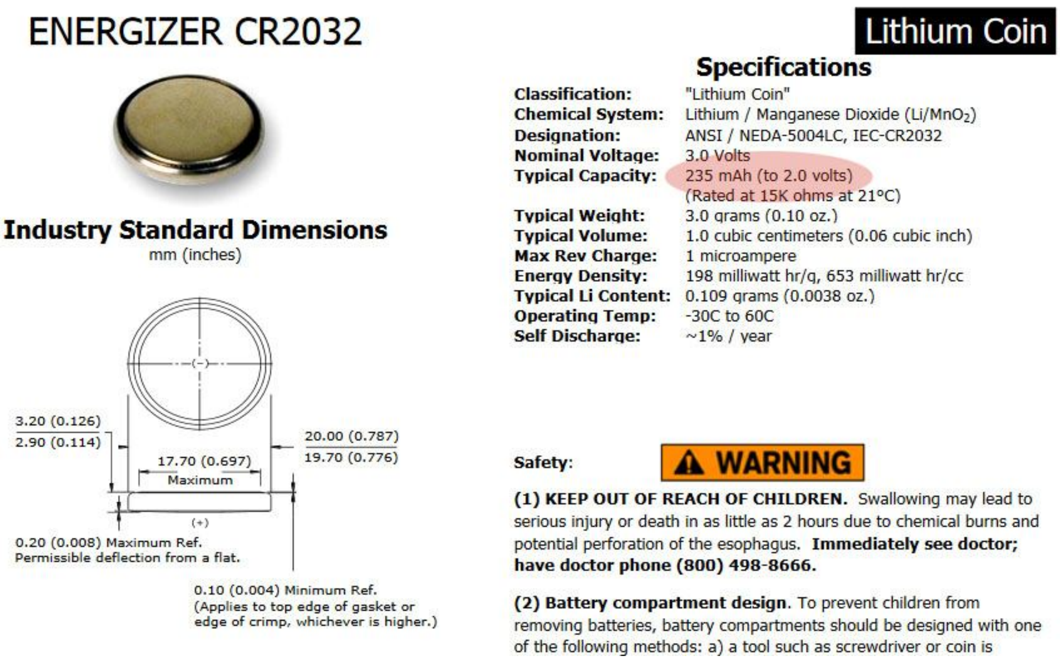
BATTERY OPERATED SENSOR

This sensor can be battery operated. You can use several types of batteries, like coin-cells, Lithium cells and rechargeable Li-Ion batteries. It's important the total Voltage will be 3.0 Volts or higher, but not exceeding 5 V DC.
To calculate the estimated time the sensor will operate, you need to know the capacity of a battery.

CR2032 example

As an example, lets assume you plan to use a CR2032 3V Lithium coin-cell (brand : Energizer).

Below is a part of the datasheet for this cell :



ENERGIZER CR2032

Lithium Coin

Industry Standard Dimensions
mm (inches)

Specifications

Classification:	"Lithium Coin"
Chemical System:	Lithium / Manganese Dioxide (Li/MnO_2)
Designation:	ANSI / NEDA-5004LC, IEC-CR2032
Nominal Voltage:	3.0 Volts
Typical Capacity:	235 mAh (to 2.0 volts) (Rated at 15K ohms at 21°C)
Typical Weight:	3.0 grams (0.10 oz.)
Typical Volume:	1.0 cubic centimeters (0.06 cubic inch)
Max Rev Charge:	1 microampere
Energy Density:	198 milliwatt hr/g, 653 milliwatt hr/cc
Typical Li Content:	0.109 grams (0.0038 oz.)
Operating Temp:	-30C to 60C
Self Discharge:	~1% / year

Safety: **WARNING**

(1) KEEP OUT OF REACH OF CHILDREN. Swallowing may lead to serious injury or death in as little as 2 hours due to chemical burns and potential perforation of the esophagus. **Immediately see doctor; have doctor phone (800) 498-8666.**

(2) Battery compartment design. To prevent children from removing batteries, battery compartments should be designed with one of the following methods: a) a tool such as screwdriver or coin is

It's rated as 235 mAh at 3V (red marked area). This means, it can source 235mA for 1 hour.
The sensor requires 27 µA for minimal operation at 3.0 Volts.
A capacity of 235 mAh is equal to 235.000 µAh (converting from mAh to µAh : times 1000)
So, how long will the sensor run at such battery ?
For hours : 235.000 µAh / 27 µA = 8.703 hours.
For days : 8.703 hours / 24 hours per day = 362 days.

Important note : The datasheet shows also the battery will drop in Voltage from 3.0 Volts (full) to 2.0 Volts (dead). The sensor requires 3.0 Volts. This means the Voltage of the CR2032 will drop below 3.0 Volts at a certain time while the sensor needs at least 2.8 Volts. The datasheet is not providing any info about this, which turns above calculation into an estimate. It's very likely the sensor will stop operating somewhere in between.

Rechargeable Li-Ions
These batteries are a better choice. They're rated as 3.7V DC. This actually means they're 4.15 Volts (full) and 3.2 Volts (empty). Both values are acceptable for the sensor to operate.
Assume you use a 100 mAh rechargeable Li-Ion.

Remember, 100 mAh is equal to 100.000 µAh. Calculation will show the following :

Hours (minimum) : 100.000 µAh / 96.5 µAh = 1036 hours or 43 days (*)
Hours (maximum) : 100.000 µAh / 37.6 µAh = 2660 hours or 110 days (**)

(*) Interpolated current-usage at 4.15 V (see table at page 3 => 5.0 V and 3.8 V)
(**) Interpolated current-usage at 3.2 V (see table at page 3 => 3.8 V and 3.0V)

In other words, the sensor will theoretically operate for 43 to 110 days on a fully charged 100 mAh rechargeable Li-Ion.

Note :
You might wonder what effects the drastic higher current-consumption refer to (3.5 mA upto 20 mA) in the table at page 3.
You are fully correct about this. However, in general an EMP from lighting is a milli-second "event". This means the EMP will draw for a few milli-seconds this rated current. Because this event is very short and likewise will have minimal effects for the battery. By this, you're correct the battery will last less hours as calculated. Therefore, it is to emphasize the calculated values are theoretical values.