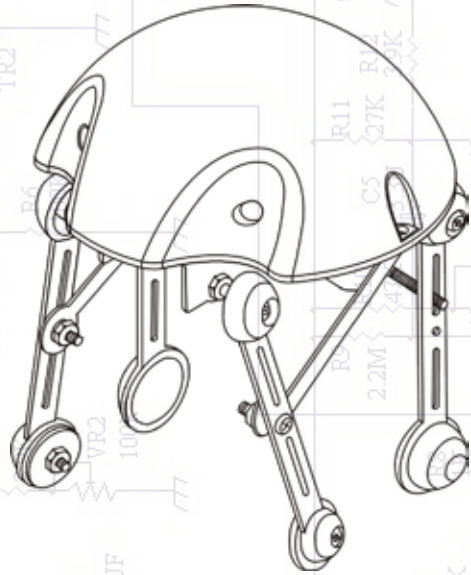
AREXX Engineering

Educational Robot System SW-007

SKY WALKER

Manual: Model SW-007



Contents

The specification, shape and size of the product are subject to change without prior notice.

When you have a pre-soldered Robot (Model SW-007A), please start with Chapter 6 on page 20.

Manufacturer:
Jama Co., Ltd.
Tachung TAIWAN

Importer:
AREXX Engineering
ZWOLLE The Netherlands

Technical assistance during the construction of the robot:
www.arexx.com

1. PRODUCT DESCRIPTION SKY WALKER

The Sky Walker is a striking robot with two sensors. One sensor watches the light intensity, the other listens to sounds. When there is a sound or light effect, the Sky Walker reacts on it by walking for a few seconds and then it automatically stops.

High on his four legs, the Sky Walker walks kind of wobbly. It looks as if he is walking on clouds. Therefore, his name Sky Walker could not be more appropriate.

With this educational robot project, everybody can learn the basic principles of electronics. Building the robot already brings a lot of fun. You feel great building a real working electronic system out of all separate parts, which responds to changes in light and sound.

Specifications:

Power voltage	: 1.5 Volt
Power source	: 1 Penlite battery (not included)
Power consumption (moving)	: About 400 mA
Power consumption (at rest)	: About 130 mA
Height	: 135 mm
Diameter	: 105 mm

Warning

- ▶ No return is possible after having opened the bags with components and pieces
- ▶ Prior to the assembly read the manual thoroughly.
- ▶ Be careful when using tools.
- ▶ Keep this kit away from young children during construction and operation. (They might get hurt by the tools or swallow small components).
- ▶ Observe the correct polarity of the battery.
- ▶ Keep the battery dry. When the Sky Walker gets wet remove the battery and let the Sky Walker dry for some time.
- ▶ Remove the battery when you are not using the Sky Walker for a longer period.
- ▶ Children below 14 should only assemble this product with the help of adults.

2. SOLDERING

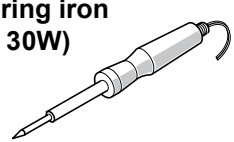
Before you start soldering we will give you some advise and instructions:

Please read the complete soldering instructions before you start. Work accurately and follow the instructions in this manual exactly to avoid problems.

The correct tools already do half of the job!

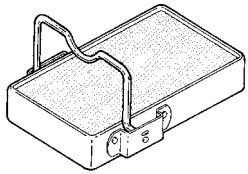
2.1 Necessary Tools:

Soldering iron (15 to 30W)



Use an electronic soldering iron about 20 to 30 Watt. A soldering iron with more power can overheat sensitive components and the PCB traces. When the power is too low, soldering is hard and the solder will not flow well. Normally you also should have a soldering standard to store the iron safely and a sponge to clean the tip of the soldering iron.

Soldering standard with a wet sponge to clean the tip

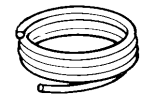


Use a safe and solid standard

Desoldering wick

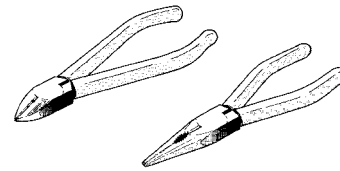
To suck solder from a PCB to remove components for small repairs.

Electronic Solder 0,8- bis 1mm



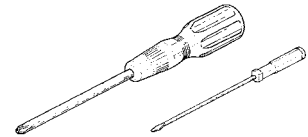
Use thin electronic rosin core solder with a diameter of about 1mm. Do not use liquid flux or an flux solder paste for electronic circuits.

Electronic cutter & flatnose plier



Use electronic tools (150 mm).

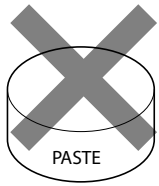
Electronic screwdriver set



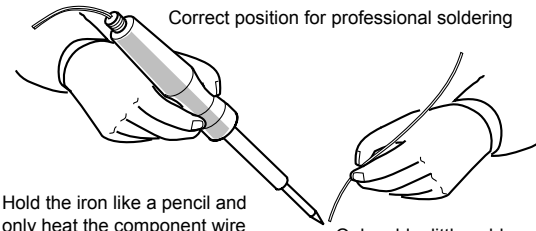
Always use the right type and size screwdriver you need the philips type for M2 and M3 screws.

2.2 Soldering techniques:

Only use lead free ROSIN CORE solder!
Never use any liquid or paste flux!

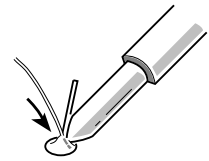
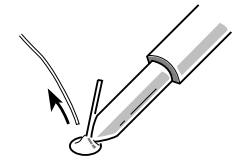
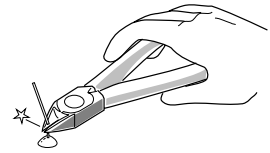


Correct position for professional soldering

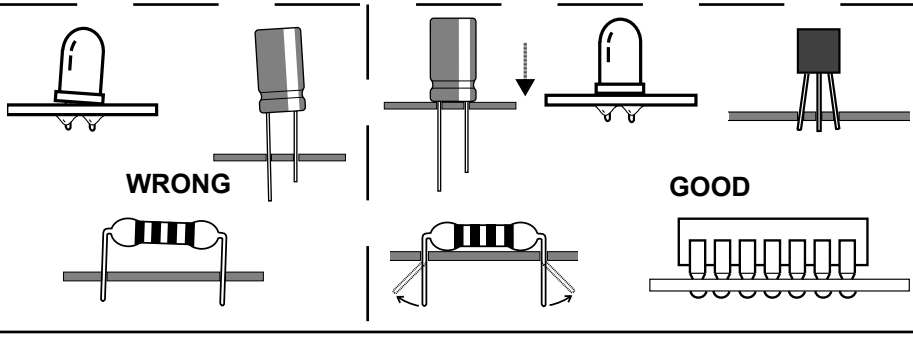


Hold the iron like a pencil and only heat the component wire for a few seconds.

Only add a little solder each time

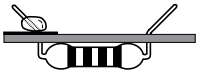
1. Preheat the solder area which must be soldered AND the component wire with the tip of the iron. ***Do NOT overheat it!*** 	2. Add some solder to the soldering area and component wire but NOT TOO MUCH! 	3. Remove the solder and let the hot liquid solder flow. 
4. Take away the soldering iron. DO NOT MOVE the component or PCB! 	5.Cut away the long component wire just above the soldering spot. 	The END RESULT is a nice and shiny soldering spot which is attached to the PCB copper and component wire. 

Please NOTICE the correct positioning of the components, see the drawings below:



2.3 Troubleshoot soldering mistakes:

Cold PCB



Solder is attached to the component wire but not to the PCB copper.

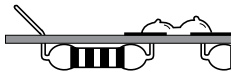
Not enough solder

Solder did not flow

Cold component

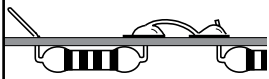
Solder is attached to the PCB Copper but not to the component wire.

Bridge of solder



Two separate solder spots are connected to each other making a short circuit

Wire bridge

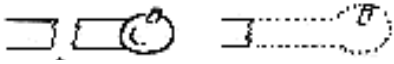


Two separate components are connected with a wire to each other making a short cut

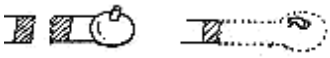
Perfect solder connection

The soldering surface looks nice and shiny!

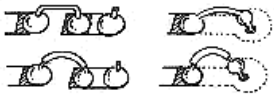
The PCB is made of a copper trace on a non-conductive substrate which connects the components, who are soldered to solder paths, electrically with eachother. Copper surfaces which will not be soldered are often coated with a mask to make it solder resistant. This mask also protects the copper against oxidating. When we overheat the copper traces or solder paths, the copper may vaporate or loosen from the substrate. To repair this we must remove the protective mask carefully with a screwdriver or small knife. See below how you can repair a damaged PCB.



When the trace is broken or the path is damaged,



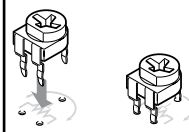
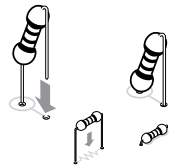
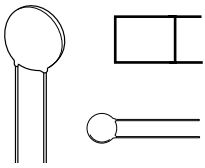
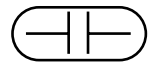
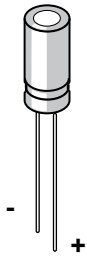
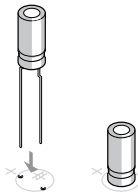
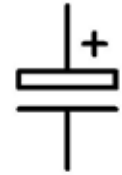
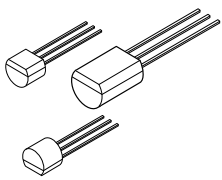
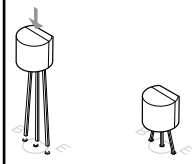
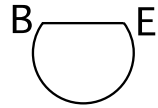
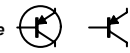
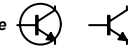
remove the mask on the copper trace with a screwdriver or a knife and bend the component wire to the trace.

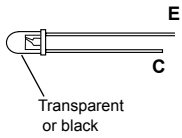
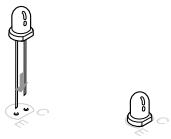
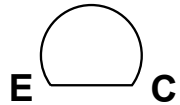
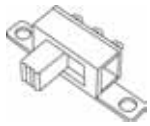
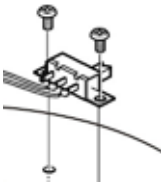
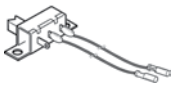
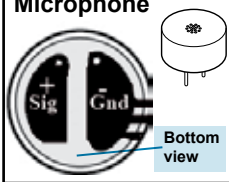
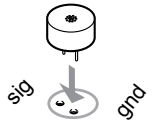
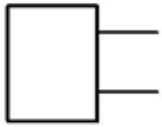
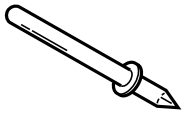
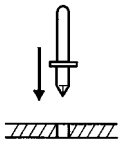
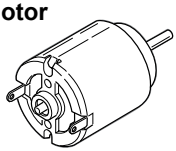
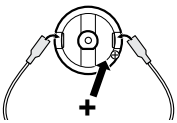
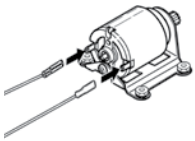
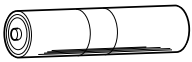
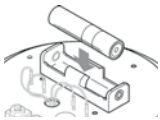


Solder a piece of wire from trace to trace or from component to trace.

3. ELECTRONIC COMPONENTS

When the component has a marking near the legs the polarity is extreme important !
Assembly with the wrong polarity can dammage the component or the complet circuit!

Component	Assembly	PCB symbol	Circuit symbol
Variable Resistor (Potentiometer) 			
Resistor 			
Ceramic capacitor 			
Electrolytic capacitor (ELCO) 			
Transistor 		***B and E are just an example, position can change per type*** 	***PNP type***  ***NPN type*** 

Component	Assembly	PCB symbol	Circuit symbol
PHTR 			
Switch 			
Microphone 	 **Gnd is connected with the metal body**	 ECM	
Lamp 			
Terminal pin 		 MOTOR (terminal) **M1, M2** SW (terminal) **S1, S2**	**No symbol**
Motor 			
Battery **(not included)** 			

3.1 List of electronic parts:

Resistors 0,25 Watt; 5%		**Marking:**	**Quantity:**
… 15 Ω	R13	(Brown, Green, Black, Gold)	1 pc.
… 1 KΩ	R1, R3, R7, R8	(Brown, Black, Red, Gold)	4 pcs.
… 3.9 KΩ	R2, R4, R12	(Orange, White, Red, Gold)	3 pcs.
… 27 KΩ	R11	(Red, Violet, Orange, Gold)	1 pc.
… 47 KΩ	R10	(Yellow, Violet, Orange, Gold)	1 pc.
… 100 KΩ	R5, R6	(Brown, Black, Yellow, Gold)	2 pcs.
… 2.2 MΩ	R9	(Red, Red, Green, Gold)	1 pc.

Variable resistors		**Marking:**	**Quantity:**
… 100 KΩ	VR1, VR2	(104)	2 pcs.

Ceramic capacitors		**Marking:**	**Quantity:**
… 22 nF	C3, C4	(223)	2 pcs.
… 1 nF	C6	***Already soldered to the motor !**	*1 pcs. (motor C)

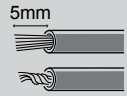
ELCO's		**Marking:**	**Quantity:**
… 3.3 µF	C1, C5	(3.3 µF/50V)	2 pcs.
… 100 µF	C2	(100 µF/16V)	1 pc.

Semi conductors		**Marking:**	**Quantity:**
… A1015 or A733	TR1, TR5	(2SA1015 or 2SA733)	2 pcs.
… C1815 or C945	TR2, TR3, TR4	(2SC1815 or 2SC945)	3 pcs.
… D2001 or D734	TR6	(2SD2001/2SD2120 or 2SD734)	1 pc.
… Phototransistor	PHTR	(SFH309)	1 pc.

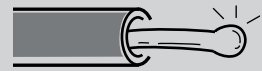
Divers		**Marking:**	**Quantity:**
… PCB	AREXX DG-SKY	(arexx)	1 pc.
… Microphone	EMC	(Condensor type for PCB)	1 pc.
… Switch	SW	(Slide switch with wires)	1 pc.
... Terminal pin	S1, S2, M1, M2	(1 mm Typ)	4 pcs.
… Motor	M	(1,5 Volt DC Motor)	1 pc.
… Motor cable	With terminals at each end	(Blue, Orange)	2 pcs.
… Battery holder	VCC	(1 pc. AA type)	1 pc.
... Light bulb	Lamp1, Lamp2	(red color lamp)	2 pcs.
... Black wire	For lamp assembly	(About 8 cm wire)	1 pcs.
... Tube	White and Black	(About 5 cm tube)	1 pcs./ Color

Wire preparation:

Remove about 5mm of the plastic wire insulation



Twist the copper wires when necessary

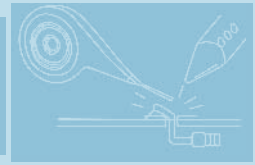


Pre-solder the copper wire. This step makes it more easy to solder the wire later on.

Desoldering

When you made a soldering failure, you can easily remove the mistaken component with wick.

Put the soldering wick on the solder path. Heat the wick and the path with the soldering iron and the copper braid of the wick will suck the solder.



When the wick removed all the solder from the path, pull back the wick and the soldering iron simultaneously

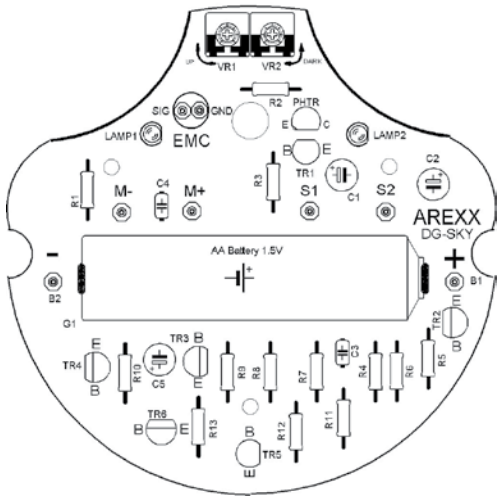
3.2 The soldering job:

First please check if all parts are complete with help of the parts list on page 9 and the circuit on page 18.

The markings on the PCB show exactly at which location you should solder the parts. If you need more information, please check the drawing of the PCB.

We always start to solder the lowest and non critical parts, these are normally the resistors and ceramic capacitors, and finish with the higher critical parts like Elco's and semi-conductors like transistors and LEDs.

We advise to cut the component wires directly after soldering, so they will not be in the way when you start soldering other parts.



THE POSITION AND POLARITY OF THE ICs, ELCOs, DIODES, TRANSISTORS, LEDs AND PHTR ARE MOST IMPORTANT, OTHERWISE THE ROBOT MAY NOT FUNCTION CORRECTLY OR IN THE WORST CASE, COMPONENTS GET DAMAGED!

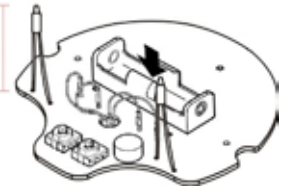
1) Start with the resistors.
2) Then we solder the potentiometers to the PCB.
3) After that, we solder the 4 terminal pins.
4) In this step we solder all ceramic capacitors.

Micophone!
Gnd is connected with the metal body

In the following steps we will solder the more critical parts. It is important to solder the correct type and the correct polarity. Take care not to overheat these parts with your soldering iron.

5) Start with the Elcos and notice the correct polarity with the plus and minus marking.
6) Solder the transistors, be sure you solder the correct types and correct polarity.
7) Solder the microphone and pay attention to the correct polarity!
8) At last you can solder the PHTR. The polarity is very important!

Final PCB soldering are the lamps and the battery holder
The LAMPS must be soldered with 25mm leg length:



**** IMPORTANT NOTICE FOR THE LAMPS:**
Very important is to put a tube (20mm) over each leg of the LAMPS after you solder it! This tube will protect the LAMPS against a short circuit.

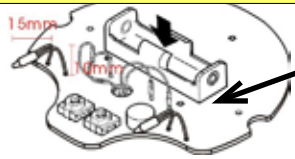
Lamp preparation (only when the lamp wires are to short):

1) Cut 25 mm wire and remove insulation 5mm (see page 9 wire preparation).

2) Solder the wire to the lamp.

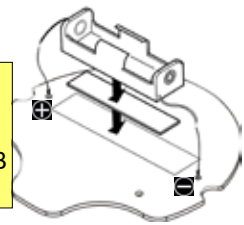
3) cut 2 pcs of 20 mm white tube.

4) Put the tube over the wires so there will be no shortcut between the wires.



Bend the lamps 15mm and 10mm length, same way as shown on the picture.

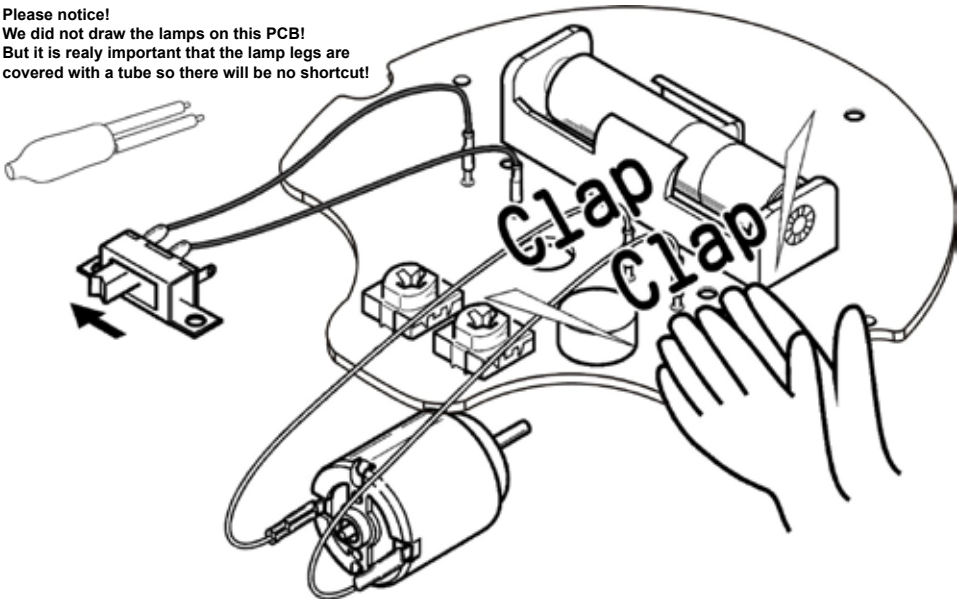
The last part is the battery holder and also here the polarity (red + and black wire -) is realy ***important.***
The battery holder itself is fixed to the PCB with double sided tape.



3.3 Electronic circuit test

Before you start with the mechanical assembly we do a simple test to check the function of the electronic circuit.

Please notice!
We did not draw the lamps on this PCB!
But it is realy important that the lamp legs are covered with a tube so there will be no shortcut!



❶ PREPARATION

First we have to connect the switch to the PCB. Connect the 2 black wires of the switch to the SW terminals on the PCB.

Now we have to connect the motor to the PCB. Connect the orange and blue wire to the motor terminals and connect the other end of the wire to the motor terminals on the PCB. The position of the terminals is not so important.

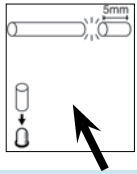
Insert the battery.
PLEASE NOTE THE POLARITY! (+ and -).

When you adjust the variable resistors, please use a good fitting screwdriver. Always rotate it very slowly without any force.

At last: Adjust the variable resistors into the middle position.

❷ TEST

*) Switch on the robot, lamps will glow.
1) Clap your hands.
2) The motor should rotate for a few seconds and then automatically stop.
3) Shade the light sensor with your hand.
4) The motor should rotate for a few seconds and then automatically stop.

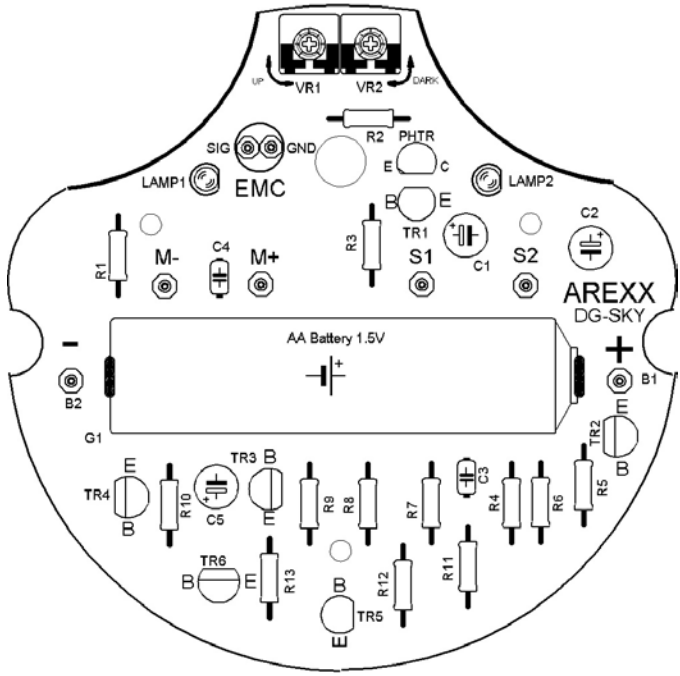


NOTE!
You can adjust the sound sensor sensitivity with VR1.
You can adjust the light sensor sensitivity with VR2.

To improve the sensivity of the light sensor you must put a small piece (5mm) of tube over the PHTR sensor. See drawing above

3.4 Electronic trouble shooting

PROBLEM	CHECK
The lamps do not light.	• Check the polarity of the battery. • Check the battery (is it full). • Check the polarity of the battery holder.
The lamps do light but the Sky Walker does not react on noises.	• Check the sensitivity of the microphone. • Check the parts and solderings involving the microphone circuit: ECM, R1, VR1, R8, C4, TR3, TR4 and TR5, TR6.
The Lamps do light but the Sky Walker does not react on differences of light intensity.	• Check the sensitivity of the lightsensor. • Check the polarity of the PHTR. • Check C1, R2, VR2, TR1, TR8, R4-R7 and C3
Transistors get very warm.	• Check the transistors type, position and polarity.



Tips and Tricks

- When there is a problem ALWAYS check the battery first: Is it full?
- Check the wire connections, only in good wire connections the current can flow freely.
- Try to establish if you have a mechanical problem or an electronic problem.
- Use the trouble shoot tables in this manual.
- Check all electronic parts, see if it is the right type on the right position and check polarities too!
- Check all solderings: Do the parts and the PCB traces make good contact?
- When a problem cannot be solved, best way is to disassemble the robot and build it again. Follow the instructions in the manual very accurately.

4. Information electronic parts

Lamp

A very common part which you can find in each household. Because of the low voltage we are using an incandescent light bulb. This type transfers electricity in light and heat. The efficiency is poor, because the heat is a waste of power which we do not want. Therefore we use more and more LEDs as a lamp. They have a much better efficiency.

Some basic principals and important formula's used in electronics

Quantity:	Symbol:	Value (SI unit) :
Current	I	Ampere (A)
Voltage	V	Volt (V)
Resistor	R	Ohm (Ω)
Power	P	Watt (W)

The relation between them is called "OHMs LAW" :

VOLTAGE = CURRENT TIMES RESISTOR.

Current calculation; **I = U : R**
Resistor calculation; **R = U : I**
Voltage calculation; **U = I x R**

POWER = Voltage times Current

Resistor

The resistor restricts the current in an electronic circuit. When you use Ohm's law, you also can see that they can reduce the voltage in a circuit. When you imagine the current as a water flow in a garden hose, the resistor creates the same effect as pressing in the middle of the water hose. The water does not spray out of the hose so hard anymore.

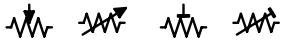
The value of a resistor can be identified by coloured rings. The first and second ring describe a number and the third ring is a multiplying factor, of which you should multiply the previous number. The fourth ring shows the accurancy of the resistor value, which means the possible deviation of the value in %.

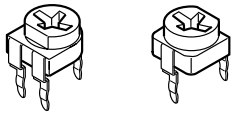
Color	Value	Multiplication
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000
Yellow	4	10000
Green	5	100000
Blue	6	1 Million
Violet	7	10 Million
Grey	8	100 Million
White	9	1000 Million
Gold	x	0,1 of 5 % accurate
Silver	x	0,01 of 10 % accurate

Example: A resistor with colored rings Brown (1), Black (0), Orange (thousand) and Gold has a value of 10000 Ohm (10KΩ) and 5 % accurancy.

TIP:
A trick to remember the the resistor colorcode is;
Buy Better Resistance Or Your Grid Bias May Go Wrong (The first letter mentions the color letter)

Variable resistor

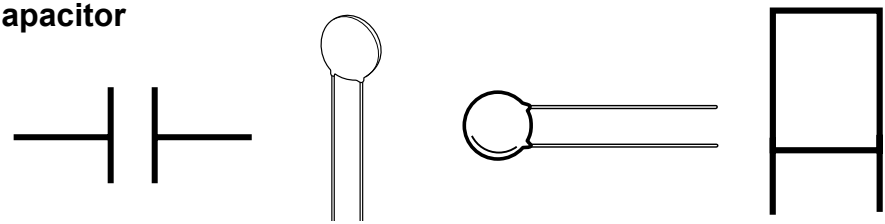




Besides the normal resistors we also have the variable resistor which is also called potentiometer (potmeter).

The variable resistor is available in many types and shapes. One of the most familiar variable resistors is the volume regulator in a radio. The type which is used in our robot is directly placed on the PCB. The maximum value of a potmeter is always given. The potmeter in our robot is used to change the amplification of the sound and light sensor.

Capacitor

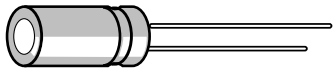


Capacitors can store electronic energy and when you require it they can offer it back without great lost. An other characteristic is that they can block a DC current and let an AC current pass. They will have a certain resistance for AC currents. The symbol for a capacitor is C. The value of a capacitor is named capacitance and the unit is Farad (F). Normally the value of a capacitor is very small and is expressed in Nano-, Micro- or Picofarad:

Abreviation	Meaning	Value
1µf	1 micro Farad	0,000001 Farad
1nf	1 nano Farad	0,000000001 Farad
1pf	1 pico Farad	0,000000000001 Farad

There are many coding systems for capacitors. Ceramic and mylar capacitors which we normally use, have value numbers printed on it.

Electrolytic capacytor (ELCO)

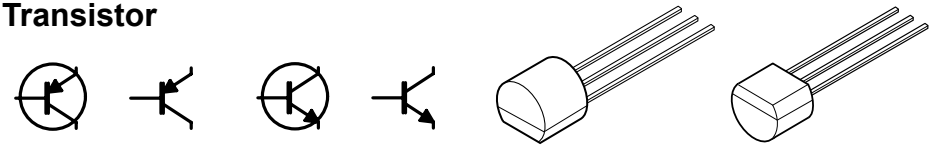


The Elco is a polarized (meaning; direction-depending) capacitor. The manufacturers put several markings on this capacitor to recognize the Plus and Minus pin of this capacitor. Normally one pin is longer (plus) than the other. The minus pin shows a white marking on it.

Diode

The diode allows the current to flow only in one way (from Anode to Cathode). When the current wants to flow in the other direction, it will be blocked.

Transistor



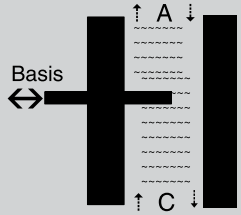
The transistor is a semiconductor which can be used as a switch and for amplification. The transistor has three terminals: Basis, Emitter and Collector. These three terminals are normally marked with the first letter; B, E, and C. The transistor is supplied in many types and shapes. There are 2 important main types: the PNP- and NPN-Transistors. The flow in the NPN-Transistors is different than it is in the PNP-Transistors.

You can also imagine the transistor as a water tap (Basis) in a waterstream, which flows between A (Collector) and C (Emitter). The water flows;

- from Collector to Emitter in a NPN-Transistor
- from Emitter to Collector in a PNP-Transistor

With the tap regulator which you can imagine as the Basis, we can regulate the Flow between A and C.

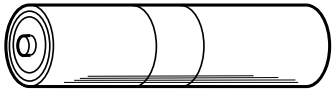
It is even possible to switch the flow on and off.



A and **C** can be the Transistors E (Emitter) or C (collector), depending on the NPN or PNP type.

When you imagine above waterflow, you can understand that with a small current on the Basis, we can regulate the flow of a big current between Emitter and Collector. Now you can also imagine that we can switch off the flow between Emitter and Collector completely so it will act like a switch.

Battery



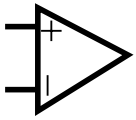
See also Appendix A for more information.

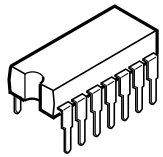
We already mentioned the battery on page 13. The one we are using in the Sky Walker has a voltage (V) of 1.5 Volts. Voltage means the difference of the electrical potential between the PLUS and MINUS pole of a battery. When you see electricity in analogy with water, you can imagine that voltage is almost the same as pressure. When the battery is in a closed circuit, the electrons will flow from - to + and generate a current (I) which will flow in the circuit. The current value is measured in Ampere.

The Power consumption (P, in Watts) in a circuit is Voltage x Current: ***P=UxI***
When the Sky Walker is moving, it will use a current of 200 mA (0.2A). The battery voltage is 1.5 Volt.

P = U x I P = 1.5V x 0.2A
So the Sky Walker's power consumption is 0.3 Watt = 300 mW

IC = Integrated Circuit

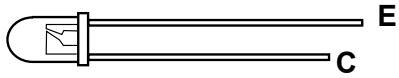




"Integrated Circuit" means a complete electronic circuit on a silicon chip. With the name IC we describe a complete circuit which normally contains several transistors and other electronic parts like resistors and capacitors in one building block. There are many different types and shapes of ICs. A few ICs together often build a complete product. For example only one small receiver IC and a small amplifier IC can make a very small but complete radio.

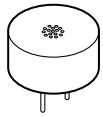
This electronic part is so important in modern electronics that we have to mention it even though we do not use it in the Sky Walker robot.

Phototransistor (PHTR)



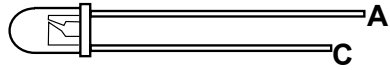
The PHTR is a light sensitive device. It works a bit like a transistor but instead of a basis which controls the flow with a current it has a light sensitive basis. With a PHTR, the current flow between Emitter and Collector is controlled by the intensity of light.

Microphone



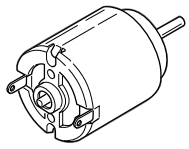
The microphone is maybe the most familiar part in the Sky Walker. Almost everybody knows what a microphone is. We see it often on TV and all radio makers and pop-stars have to use it. But do you also know how it works? The microphone changes soundwaves into electronic signals. These electronic signals can be used in electronic circuits for example in an amplifier. In the Sky Walker, the microphone detects sounds and when the Sky Walker detects a sound, the electronic circuit will be activated.

LED = Light Emitting Diode



The name LED already says it all, "Light Emitting Diode" which means a diode who produces light. This diode has the same features as a normal diode but it will light when a current flows from Anode to Cathode. There are many different colored LEDs and there are all so many different shapes, sizes and brightnesses. LEDs are often used in control panels but also in traffic lights because their power consumption is very low.

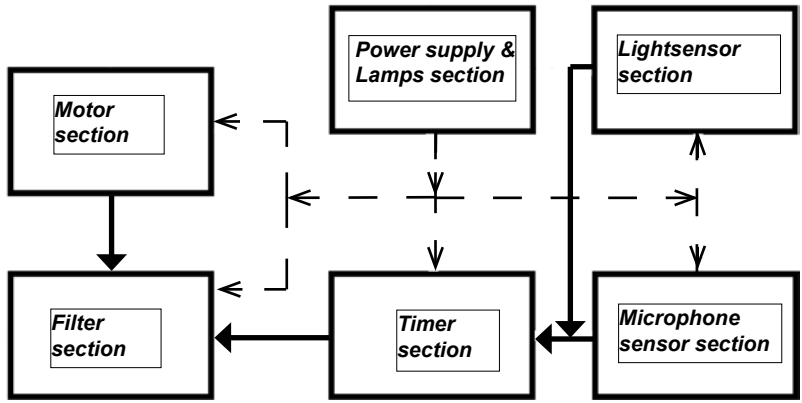
Motor



A motor transforms electrical energy into mechanical energy. A well-known technical frase for mechanical energy is kinetic energy. Kinetic comes from Greek (kinesis) and means motion.

5. ELECTRONICS

5.1 Blockdiagram



Big electronic schematic diagrams can be very complicated. To simplify such a complex diagram we often use a blockdiagram. In a blockdiagram we imagine several electronic circuits as a block with their own function. So with the above blockdiagram we can see the function of the Sky Walker electronics. We will explain each block more detailed now.

5.2 Explanation blockdiagram

Power supply and Lamp section
Provides all electronic circuits with power. The Lamps are an ON/OFF indicator

Light sensor section
Detects a difference in light intensity

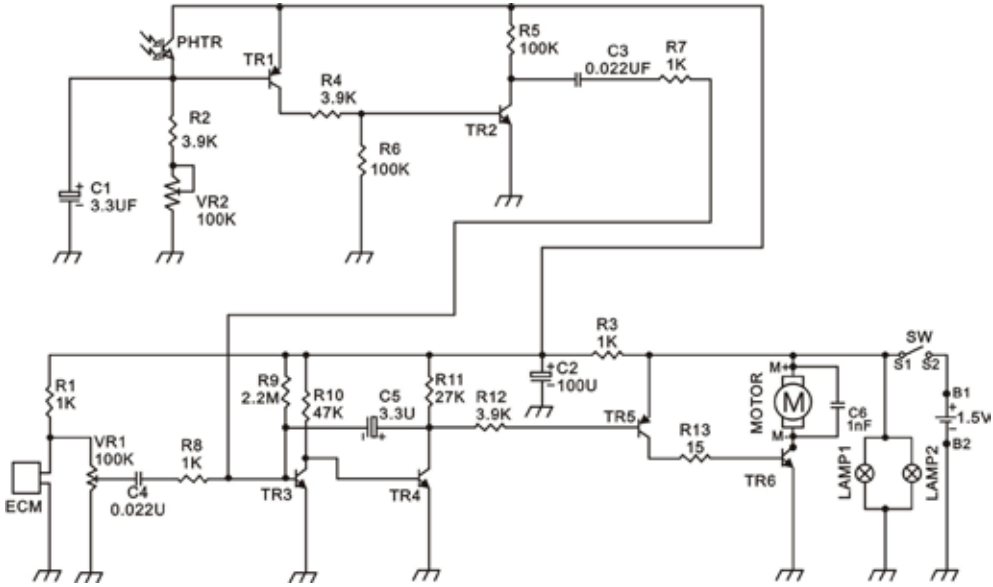
Sound sensor section
Detects sounds

Timer section
An RC network, regulates the walking time

Filter section
Filters the disturbing power supply signals from the motor

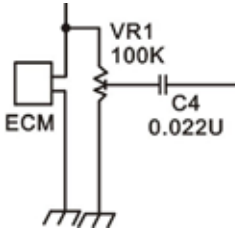
Motor section
Switches the Motor ON and OFF

5.3 Function description of electronic parts:



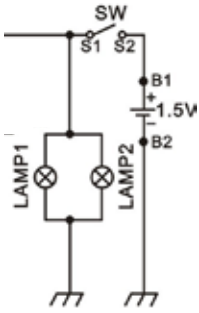
Above you can see the complete circuit diagram of the Sky Walker. As you can see it is much more complex than the blockdiagram we discussed on the previous page.

Microphone section



The microphone section consists of an electronic condensor microphone ECM which detects the soundwaves. The electronic signal goes through a volume regulator VR1. The capacitor C4 has 2 functions. First it blocks the DC voltage from the power supply. Second and together with resistor R8 it is a filter so the sound of a handclap can be detected better. A condensor microphone can only work with a power supply. This power is supplied by R1.

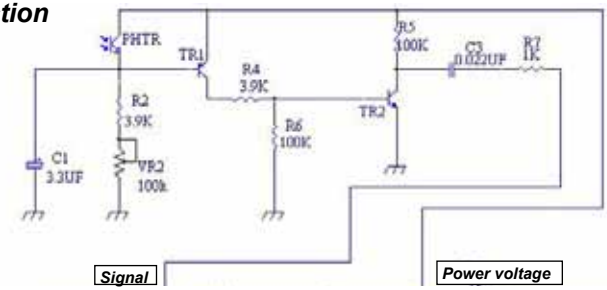
Power & lamps section



This is the most simple, but also the most important section. In the blockdiagram you can see that the power section is connected with all other sections. The reason is simple, all electronic circuits need power to work. The power of the Sky Walker comes from a 1.5 Volt battery and can be switched on and off with SW.

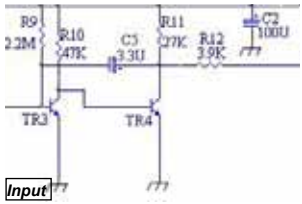
The 1.5 Voltage is too low to use LEDs, so instead we have used 2 small light bulbs. So the only function of the lamps is to see if the Sky Walker is switched ON or OFF. So, here the lamps are used as an indicator light.

Lightsensor section



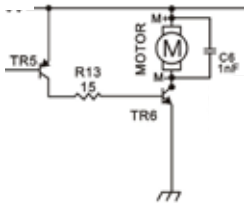
The phototransistor can see the difference between light and dark. When it is light, there is a small current flow through the PHTR and the Collector to Emitter is almost fully open. When it is dark, there is a very small current flow, and C/E is almost closed. The current (and the sensitivity of this circuit) can be adjusted with VR2. The elco C1 takes care that it will not react on very little and short light changes. Because the current flow difference between light and dark in the phototransistor is so small, we have to amplify this signal in two transistor stages, TR1 and TR2. The capacitor C3 and Resistor R7 both have the same function as C4 and R1 in the microphone sensor circuit.

Timer section



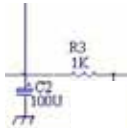
The signals from the sound and light sensor will activate the timer circuit. If there is no sound and not a big light difference detected, the input signal on the base of TR3 is low. This means that the signal on the collector of TR4 is high. Because of a positive feedback from C5, the TR3 base will stay low for a while and the collector output of TR4 stays high. The duration of this positive feedback is called RC time. The RC time can be calculated R9xC5 = time; so 2200000 x 0,0000033 = 7.26 seconds

Motor section



In the explanation of the timer section we just calculated that there will be a low signal for about 7 seconds. This low signal will activate TR5. This is an amplifier because the current of the timer section is too small to drive the transistor TR6 directly. TR6 will function like a switch and the motor will start to rotate for these 7 seconds.

Filter section



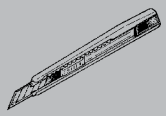
This important section takes care that no disturbing signals from the motor will enter the other sensitive electronic circuits. Often there are disturbing signals with RC networks and small capacitors. We can filter the power supply lines from disturbing signals.

6. MECHANICS

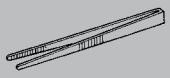
IMPORTANT: First read all the instructions about the mechanics !

Follow the step-by-step instructions for the mechanical assembly as shown in this manual. Read and work very accurately. This is the best way to avoid assembly failures. When you follow these instructions and study the drawings and comments carefully, you have a big chance the robot will work directly and without any problems. Also a great help is the picture on the package. You can see very clearly how the robot should look like. Best is that you only take out the parts from the packages and frames when you need them! Sometimes parts or bags are numbered. All parts fit perfectly so you do not need to use force to assemble this robot! Do not hurry and once more, best is to read all instructions first before you actually start to assemble.

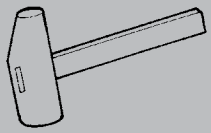
Possible extra tools which can be handy:



Hobby knife

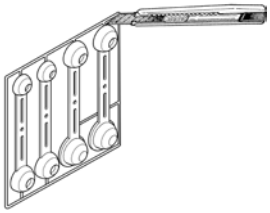


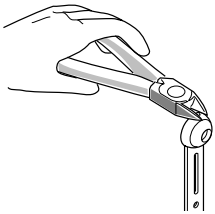
Tweezer



Small plastic hammer

How to cut the plastic parts

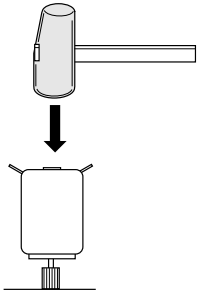




To take out the plastic parts from a frame, use a sharp hobby knife or a cutting plier. Cut carefully and take of the bosses with a knife to make it smooth.

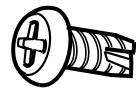
Do not cut parts from a frame when you do not need them directly!

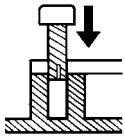
Assembly of a gear to an ax



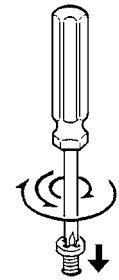
When you install a gear or a pinion to an ax or shaft, like the pinion to the motor shaft, you must be very careful. Be 100% sure you put the right gear onto the right ax. Best way is always to press the gear on the shaft with your hands. When you cannot manage it this way, use a very small plastic hammer. When you use a hammer, you can protect the gear or the shaft by putting a piece of wood or carton between the hammer and the part you will hit on.

Self-tapping screws (Parker)





A self-tapping screw looks similar to a wood screw. When you screw it in a hole, it can cut the threads at the same time. Never try to screw it down all the way for a first time, because it may easily become stuck or you will damage its head.

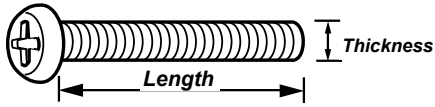


Tapping screws always have a sharp point, sometimes with a small carve. They look almost the same as screws which we use for wood, only the thread is more fine. The best way is to screw it in and out a bit.

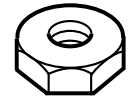
1. Screw in
2. Screw out a bit
3. Screw in further and continue step 1 and 2

Do not screw a tapping screw in and out too often because the screw hole may become enlarged and the screw will loose all grip and proper function.

Screws and nuts



Lock nut



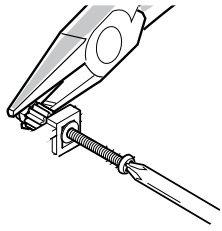
Nut

In a moving environment, screws and nuts must be tightened properly. A lock nut is a special nut with nylon inside which will lock itself automatically.

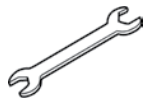
Another easy way to lock a screw is to use ordinary fingernail polish. A big advantage of nail polish is that you always can loosen it quite easily again. A professional way to lock a screw is to use for example locktite a sort of glue especially made for screws, but it is very difficult to unlock such a screw afterwards.

The size of a screw is expressed by thickness and length. A screw with the marking M2 x 10 means 2mm thick. The length of the thread is 10mm. A M2 nut means it is used for a M2 screw so the nut always corresponds with the screw thickness.

Lock nut fixation



Wrench



This kit includes a small wrench. Please use this wrench to fit the M2 and M3 nuts in a proper way. You can use it instead of a plier.

To lock the lock nut in a proper way, use a plier or the wrench which is supplied in this kit. See drawing on the left!

6.1 List of mechanical parts:

Please check all parts before you start assembly!

Screw long

- ☐ M3x30 4 Pcs.
- ☐ M3x20 2 Pc.

Screw short

- ☐ M3x12 6 Pcs.

Nut M3

- ☐ 18 Pcs.

Washer M3

- ☐ 4 Pcs.

Spring washer

- ☐ 8 Pcs. M3

Metal Washer M3

- ☐ 2 Pcs.

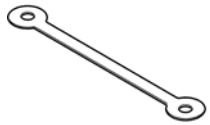
Rubber Washer

- ☐ 2 Pcs. M3

Crank

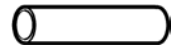
- ☐ 2 Pcs.

Joint strip



- ☐ 2 Pcs.

Pipe spacer



- ☐ ø3x12 2 Pcs.

- ☐ ø3x5 10 Pcs.

Screw M2

- ☐ 14 Pcs. M2x5

Nut M2

- ☐ 6 Pcs.

Spring washer M2

- ☐ 4 Pcs.

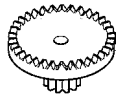
L Bracket

- ☐ 4 Pcs.

Pinion gear

- ☐ 1 Pc.

Crown gear



- ☐ 1 Pc.

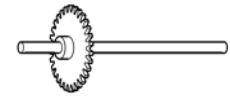
Flat spur gear big

- ☐ 1 Pc.

Flat spur gear small

- ☐ 1 Pc.

Gear shaft

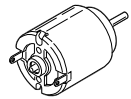


- ☐ 1 Pc.

Assembled PCB

- ☐ 1 Pc.

Motor



- ☐ 1 Pc.

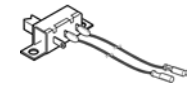
Motor holder

- ☐ 1 Pc.

Wrench M2/M3

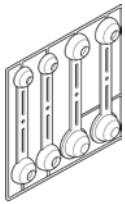
- ☐ 1 Pc.

Switch



- ☐ 1 Pc.

Leg set

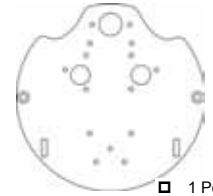


- ☐ 1 Pc.

Cover

- ☐ 1 Pc.

Chassis panel

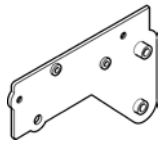


- ☐ 1 Pc.

Rubber tube

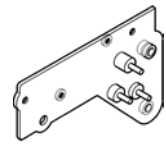
- ☐ 1 Pc.

Sidepanel right



- ☐ 1 Pc.

Sidepanel left



- ☐ 1 Pc.

Self-tapping screw

- ☐ M2.3 x 5 1 Pc.
- ☐ M2.6 x 6 3 Pcs.

6.2 Instructions mechanical assembly

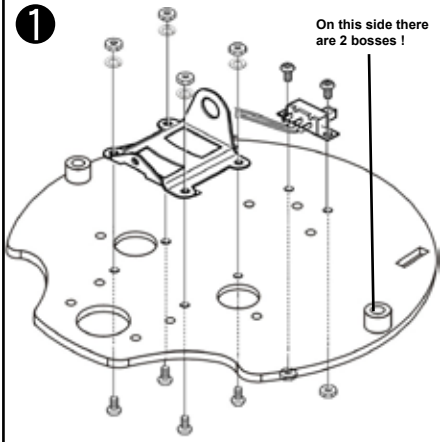
For the assembly of the motor you need;

1 pc. Motor
1 pc. Pinion gear (for motor)
1 pc. Switch
1 pc. Chassis panel
1 pcs. Motorbase
1 pc. Self-Tapping screw M2.3x5
6 pcs. Screw M2x5
4 pcs. Nut M2
4 pcs. Spring washer M2

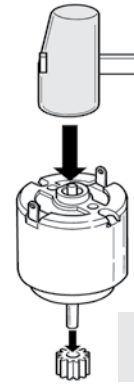
First always collect all the parts, as mentioned in the "parts you need list", before you start the assembly!

Install the motorbase and switch

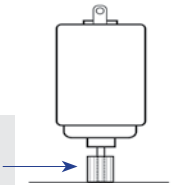
❶



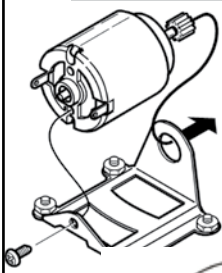
❷ Assembly motor pinion



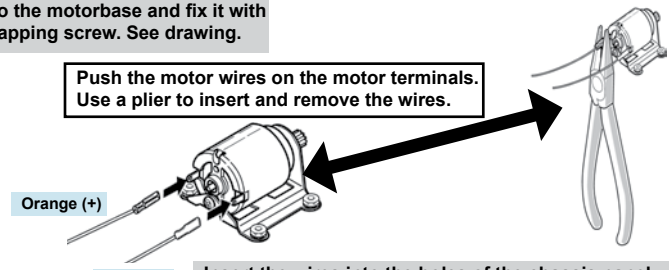
Hit slightly with the hammer, do not hit the terminals!
OR BETTER:
Push the gear on the shaft with your hands.



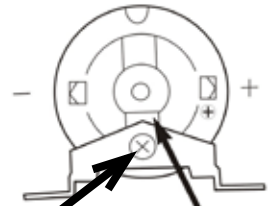
❸ **Install the motor to the motorbase and fix it with the 2.3x5mm selftapping screw. See drawing.**



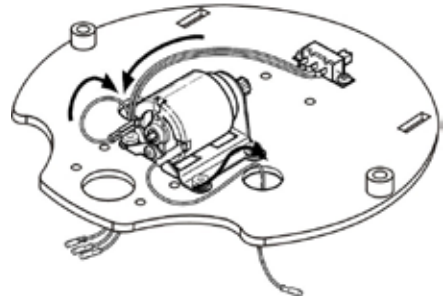
Push the motor wires on the motor terminals. Use a plier to insert and remove the wires.



Insert the wires into the holes of the chassis panel. See drawing.



Be sure the motor is fixed properly with the 2.3 x 5 mm tapping screw.



Assembly of the left and right sidepanel:

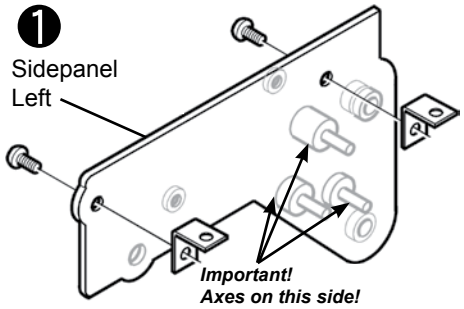
To assemble the sidepanels you need;

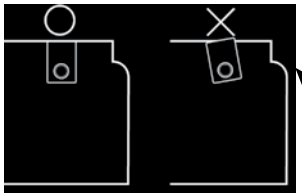
2 Pcs. Sidepanel L & R
4 Pcs. L Bracket
4 Pcs. M2x5 screws

Assemble in numerical order:

❶ Sidepanel Left

❷ Sidepanel Right



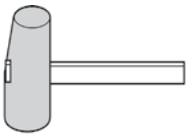


NOTICE! The L Brackets should be assembled very straight to the side panels.

Install gear shaft and crank:

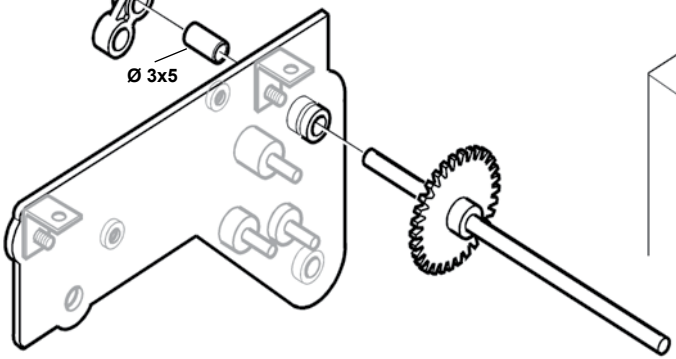
For this assembly you need;

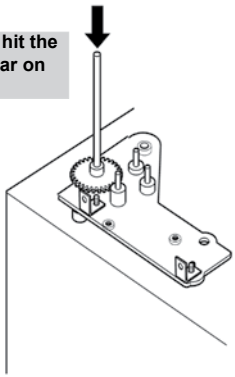
1 Pc. Sidepanel Left
1 Pc. Pipe spacer Ø 3x5
1 Pc. Gear shaft
1 Pc. Crank



Hit slightly with the hammer, do not hit the terminals! *OR BETTER,* Push the gear on the shaft with your hands.

❸

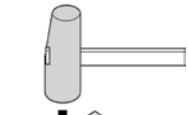




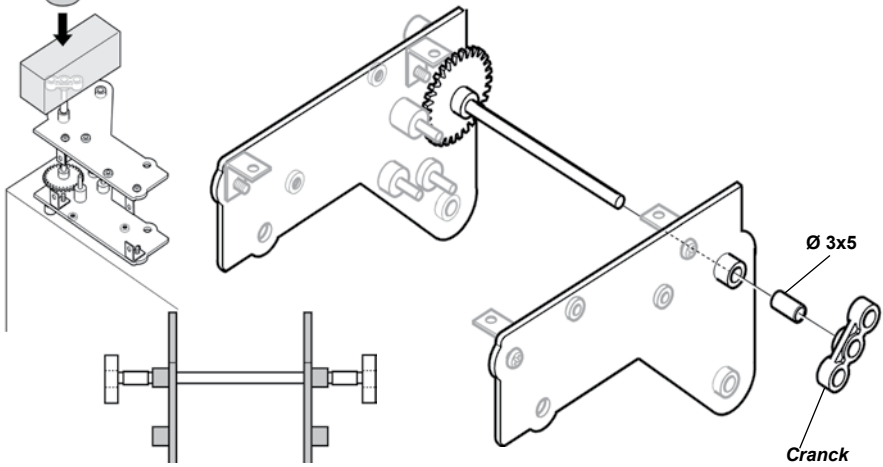
Assembly of the sidepanels:

For the assembly of the sidepanels you need;

1 Pc. Sidepanel left
1 Pc. Sidepanel right
1 Pc. Pipe spacer Ø 3x5
1 Pc. Crank



Push the right sidepanel, pipe spacer and crank on the gearshaft. Hit slightly with the hammer, do not hit the terminals! *OR BETTER,* Push the gear on the shaft with your hands. See drawing.



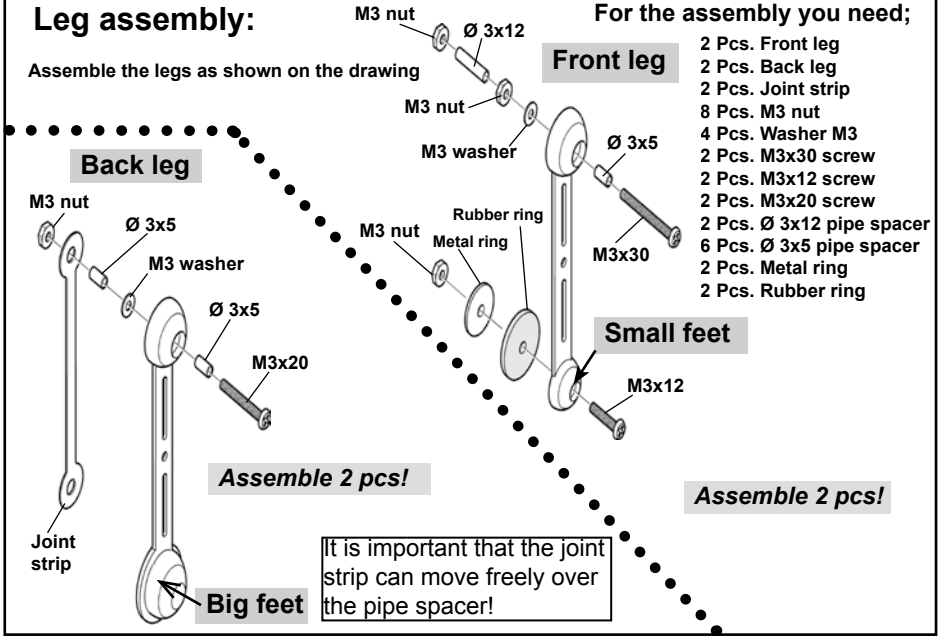
WARNING!
Make sure that the cranks are 100% parallel.

Leg assembly:

Assemble the legs as shown on the drawing

For the assembly you need;

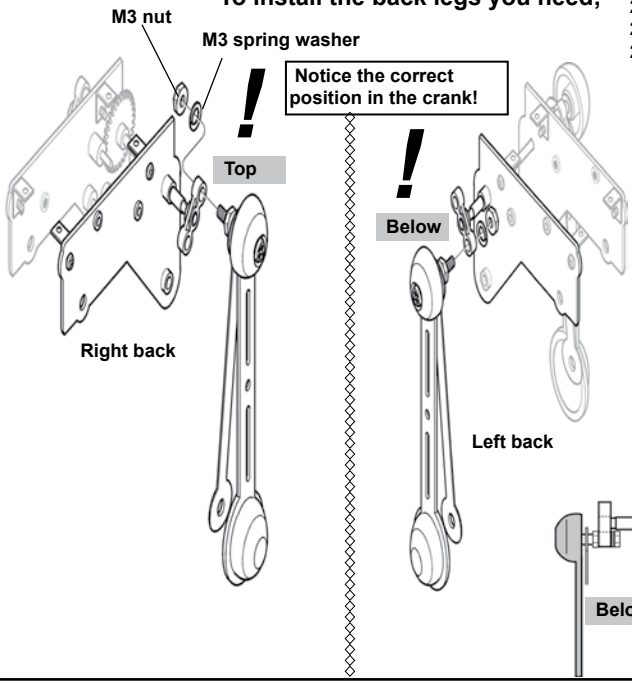
2 Pcs. Front leg
2 Pcs. Back leg
2 Pcs. Joint strip
8 Pcs. M3 nut
4 Pcs. Washer M3
2 Pcs. M3x30 screw
2 Pcs. M3x12 screw
2 Pcs. M3x20 screw
2 Pcs. Ø 3x12 pipe spacer
6 Pcs. Ø 3x5 pipe spacer
2 Pcs. Metal ring
2 Pcs. Rubber ring



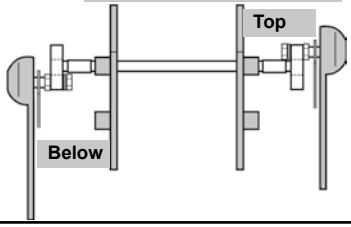
Install the back legs to the sidepanels:

To install the back legs you need;

1 Pc. Assembled side panels
2 Pcs. Assembled back legs
2 Pcs. Spring washer M3
2 Pcs. M3 nut



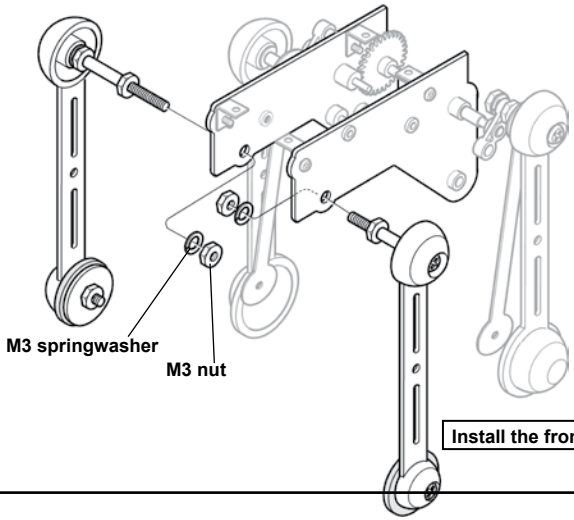
WARNING!
Make sure that the rear legs are installed into the cranks 180º apart (see drawing).



Install front legs to the side panels:

To install the front legs you need;

1 Pc. Assembled side panels
2 Pcs. Assembled front legs
2 Pcs. Spring washer M3
2 Pcs. M3 nut

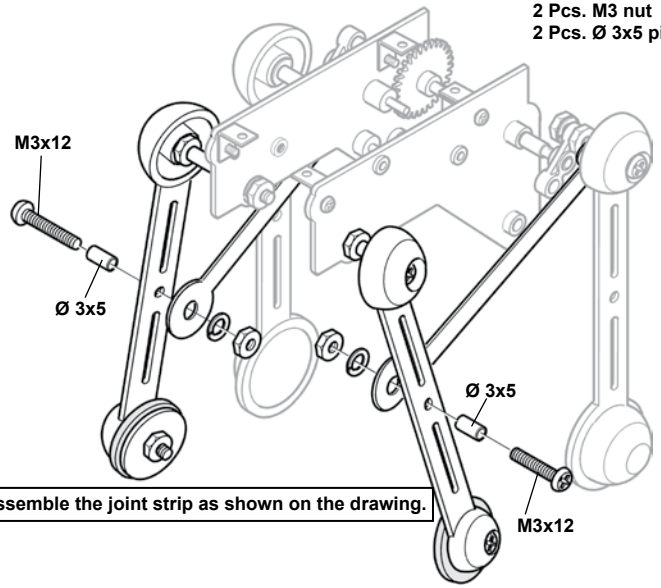


Install the front legs as shown on the drawing.

Install the joint strip of the front legs:

To install the joint strip you need;

1 Pc. Assembled side panels
2 Pcs. M3x12 screw
2 Pcs. Spring washer M3
2 Pcs. M3 nut
2 Pcs. Ø 3x5 pipe spacer

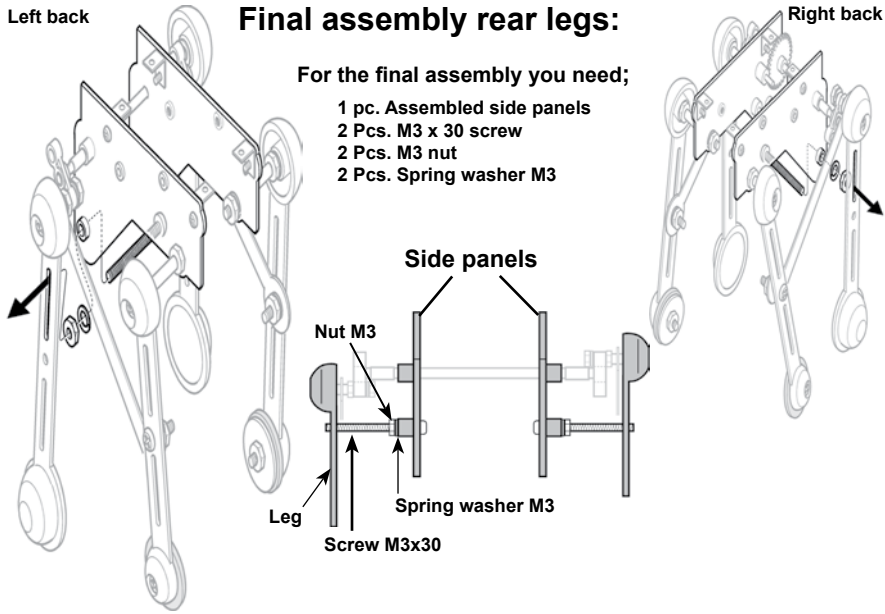


Assemble the joint strip as shown on the drawing.

Final assembly rear legs:

For the final assembly you need;

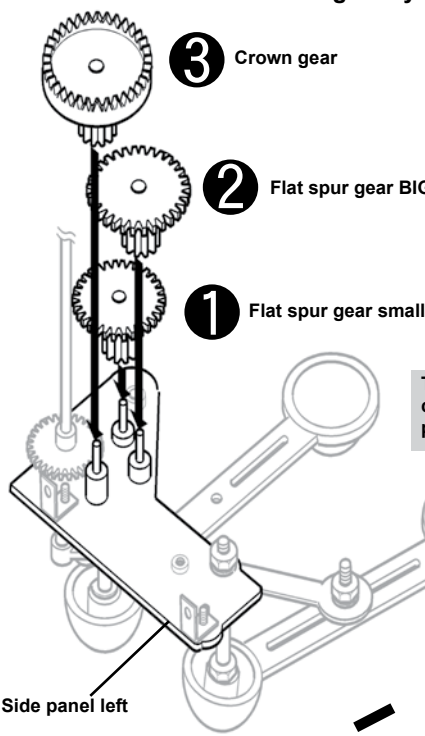
1 pc. Assembled side panels
2 Pcs. M3 x 30 screw
2 Pcs. M3 nut
2 Pcs. Spring washer M3



Installing the gears:

To install the gears you need;

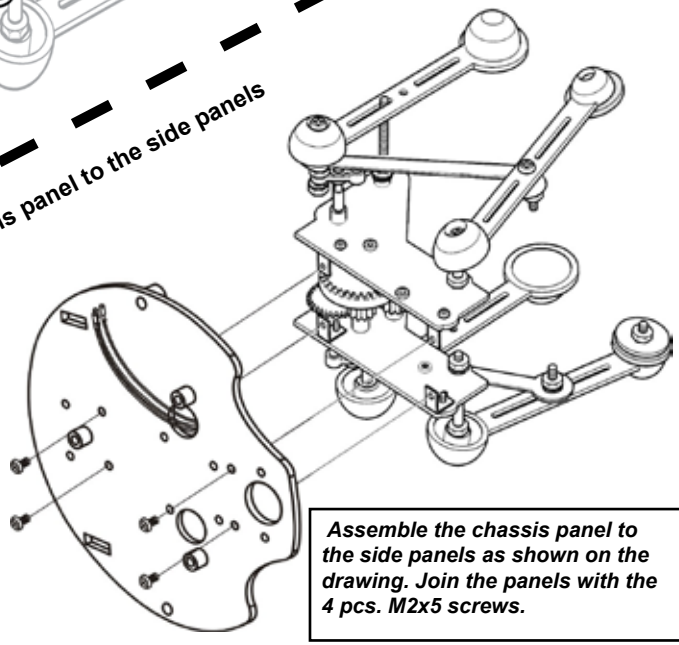
1 Pc. Assembled side panels
1 Pc. Chassis panel
1 Pc. Crown gear with pinion
1 Pc. Flat spur gear with pinion BIG
1 Pc. Flat spur gear with pinion small
4 pcs. M2x5 screw



Install the gears in numerical order 1-2-3.

To make this assembly step more clear we have omitted the right side panel from this drawing.

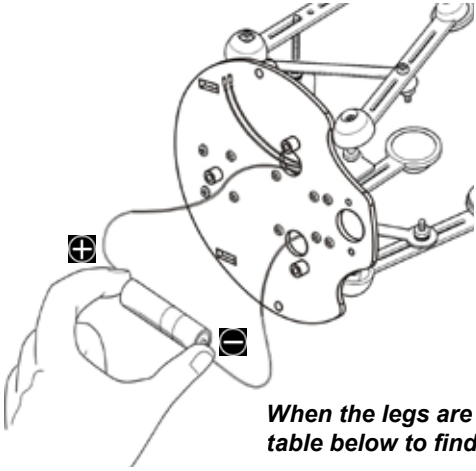
Install chassis panel to the side panels



Assemble the chassis panel to the side panels as shown on the drawing. Join the panels with the 4 pcs. M2x5 screws.

7. TEST OF THE SKY WALKER

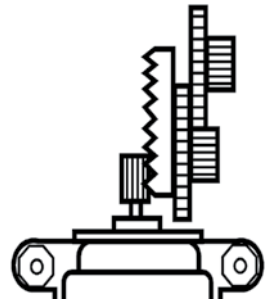
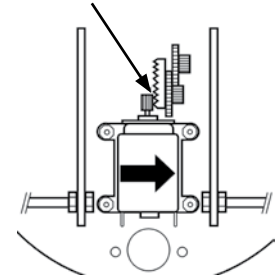
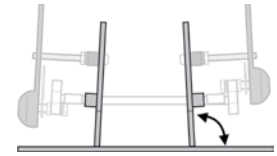
7.1 Mechanical test:



This is a very simple test to see if the legs are moving.

Connect the battery directly to the blue and orange motor wire, as shown on the drawing.
In this step the POLARITY is not really important!

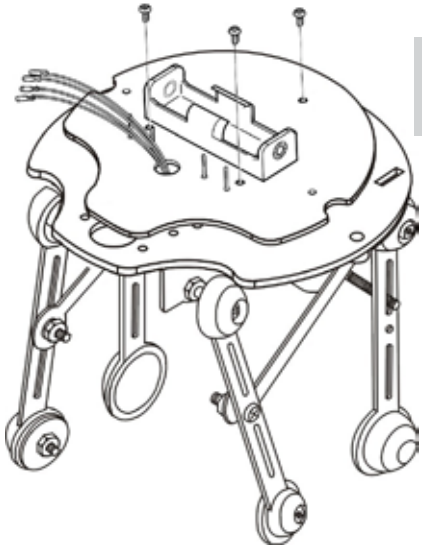
When the legs are not moving correctly, please use the table below to find the problem.

PROBLEM	CHECK	SOLUTION
The motor shaft rotates but the gears are not rotating.	***The gears are possibly not correctly assembled.***	***Install all gears again.***
NOTICE! **GOOD ALIGNMENT of the GEARS and a smooth rotation of the gears is very important for a good function!** **You can put some plastic grease on the gears to make the rotation more smooth!**		***Loosen the selftapping screw from the motorbase and move the motor to the right.*** 
Legs do not move.	***Legs installed in the wrong way.***	***Install the legs again.***
The rear panel screw M3x28 will come off the opening guide in the rear leg.	***The L Brackets are not installed correctly.*** ***See chapter 6 page 24***	 ***Be sure that the L Brackets are correctly assembled in a 90 degree angle!***

7.2 Final assembly:

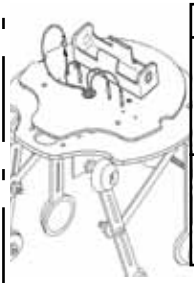
For the final assembly you need;

1 pc. Assembled Chassis
1 pc. Assembled PCB
3 pcs. M2,6x6 selftapping screw



Insert the four wires to the hole in the PCB and install the PCB with the 3 selftapping screws to the chassis.

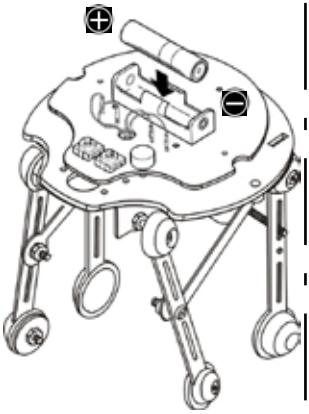
Connect the wires according the table below



Wire color	*Terminal marking*
Blue (Motor)	*M-*
Orange (Motor)	*M+*
Black (Switch)	*SW*
Black (Switch)	*SW*

USE A PLIER TO CONNECT THE WIRES!

Insert battery:



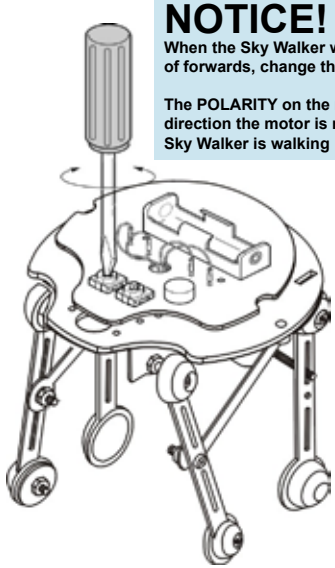
Check the battery polarity, see drawing.

Adjustment variable resistors;

NOTICE!

When the Sky Walker walks backwards instead of forwards, change the motor wires.

The POLARITY on the motor decides in which direction the motor is rotating and the Sky Walker is walking



Adjust the variable resistors to the middle position.

FINAL TEST AND ADJUSTMENT OF THE SKY WALKER;

*) Switch on the robot, the lights start glowing.
1) Clap in your hands.
2) The Sky Walker should walk forwards for a few seconds and then stop automatically.
3) Shade the light sensor with your hand
4) The Sky Walker should walk forwards for a few seconds and then stop automatically.

You can adjust the sound sensor sensitivity with VR1.

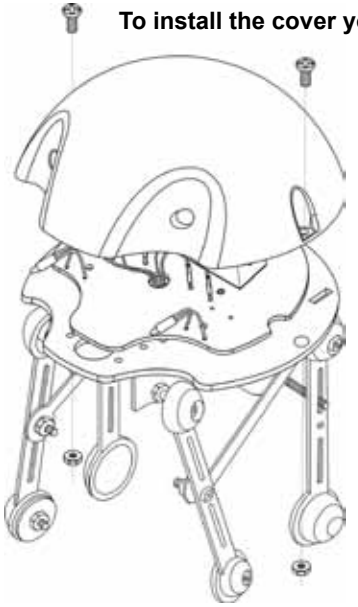
You can adjust the light sensor sensitivity with VR2.

If the Sky Walker does not function correctly because of a gear problem, you should check the mechanical test again on page 29. As a last option, disassemble the robot and build it again. Study each step and all drawings very accurately. This is the best way to find the failure. When there is an electronic problem, do the electronic test on page 11 again and use the trouble shoot table on page 12.

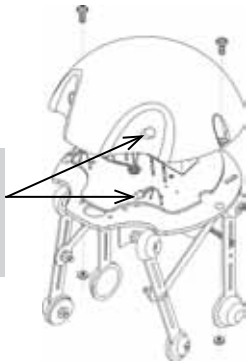
Install the cover:

To install the cover you need;

1 Pc. Cover
2 Pcs. M3x12 Screw
2 Pcs. M3 nut
1 Pcs. Robot Chassis



First insert the two lamps carefully into the holes in the Sky Walker cover!



Finally, we will install the Sky Walker cover:

Before you fix the cover, be sure that the two lamps are put into the front holes of the cover correctly.

Install the cover to the chassis with the 2 pcs. M3 screws and nuts.

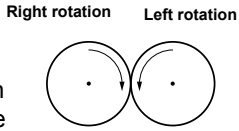
8. INFORMATION ABOUT GEARS

The mechanics of the SKY WALKER ROBOT consists of two parts. The first part is the gear box, which takes care that the power from the motor shaft is converted to the crank. The second part is to convert the rotation of the crank into a movement of the feet.

The transmission of power

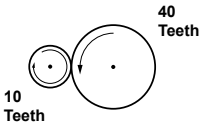
Gears, transmission belts, shaft, crank, chains: They all can transmit power. In the Sky Walker, four gears transfer the motor power into the crank. Such a transmission is called a gear box. The Sky Walker motor rotates very fast with only a little torque. However, for the crank we need low rotation speed and high torque. The power is transmitted by the teeth of the gears. At the same time, three conversions take place:

a. Change in rotating direction
b. Change in rotating speed
c. Change in torque

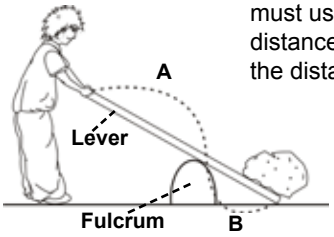


a. Change in rotating direction
When two gears are connected, there will be a change in rotation direction. One gear will rotate clockwise, the other gear will rotate counterclockwise.

b. Change in rotating speed
The change in rotating speed depends on the relation of the teeth in the gear. As an example we describe a gear with 10 teeth and a gear with 40 teeth. When the first gear (10 teeth) makes a full rotation, the second gear 40 (teeth) only makes a quarter of a rotation. So before the second gear makes a full rotation, the first gear already makes four rotations. You may understand that this effect also changes the rotating speed.

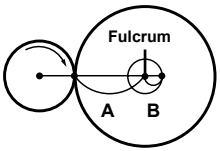


c. Change in torque
The torque can be seen as a lever construction with a fulcrum. Imagine a person who lifts a stone with a lever.



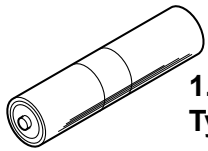
The person who lifts the lever must use more force when the distance A gets shorter or when the distance B gets longer.

$$\text{Gear ratio} = \frac{\text{Motor rotation}}{\text{Number of last gear rotation}}$$



Appendix A

AC AND DC POWER SOURCES



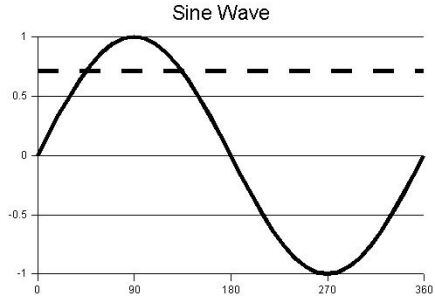
1.5 Volt battery
Type AA or AAA

On page 15 we already gave some information about the battery power source, but... there is more to explain about this item. The voltage of a battery is a quite low DC voltage. It is not dangerous when you touch it. The mains power voltage on a wall socket in our homes however is a VERY DANGEROUS AC voltage of 120 or 230 Volts (depending on the country you live in). ***You already know and may understand that you must never make contact with this dangerous household voltage (mains power).***

We introduced 2 new terms, AC and DC, which are abbreviations of Alternating Current and Direct Current (also called continuous current).

AC MAINS power is often called household power or household electricity. The direction (polarity) of the AC voltage changes periodically. Mostly, the shape of such voltage is a sinus waveform.

Picture of a sine wave voltage:
The dotted line shows a DC voltage



The DC power is a constant voltage with a constant polarity. DC voltage is supplied by all kind of batteries like radio, MP3 player and even big car batteries. They all have a DC voltage.

SI-Prefix

In this manual and in electronics in general, we use the SI-prefix a lot. It is a way to present the unit of measure of a quantity or value with a lot of zeros.
For example weight; Kilo (K) means 1000 so 1 Kg means 1000 grams.
Important prefix are;

M =	**Mega**	**= 1000 000**
K =	**Kilo**	**= 1000**
m =	**milli**	**= 0.001**
µ =	**micro**	**= 0.000 001**
N =	**Nano**	**= 0.000 000 001**
P =	**Pico**	**= 0.000 000 000 001**

PERSONALIZE THE SKY WALKER

If you like, you can personalize the Sky Walker. You can cut symbols and characters from paper (or colored tape) and fix it with transparent tape or glues,

This way you can simply make a personalized Sky Walker. You can also use a special paint which is suitable for plastics!

You will have a lot of fun making your own unique robot!

The personalized Sky Walker on this picture was made by Mara from Nijmegen the Netherlands.

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Taichung, TAIWAN

European Importer:
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ZWOLLE, THE NETHERLANDS

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TO TRAIN SCIENTIFIC MINDS

IMPORTANT: