CE

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This product complies with the relevant CE directives if used according to the included instructions. The description belongs with the product and must be passed on with it.

Table of Contents

1 Introduction

Specialist trade offers innumerable electronics circuit construction kits that you can solder together yourself. If you want to work with them, you should know how to handle a soldering iron.

This learning package helps discovering the secrets of soldering step by step. In a series of subsequent exercises, you will learn how to solder various components and how to develop and build complete circuits. Before starting on the actual work, the learning package will also teach you all the basics required for successful soldering.

2 Components

2.1 Battery

The battery must be connected to any circuit in the correct polarity. The required battery clip has a red (plus) and black (minus) connection wire each. Both wires must be soldered on according to the required polarity.

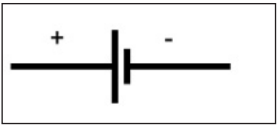


Figure 1: Battery circuit symbol

2.2 Resistors

Resistors are some of the simplest electronic components. They are labelled in a colour code consisting of three rings and to be read from the edge to the centre. A fourth ring, offset slightly, indicates the component tolerance. The impedance value is indicated in Ohm (Ω).

Farbe	Ring 1 1. Ziffer	Ring 2 2. Ziffer	Ring 3 Multiplikator	Ring 4 Toleranz
Schwarz		0	1	
Braun	1	1	10	1%
Rot	2	2	100	2%
Orange	3	3	1.000	
Geld	4	4	10.000	
Grün	5	5	100.000	0,5%
Blau	6	6	1.000.000	
Violett	7	7	10.000.000	
Grau	8	8		
Weiß	9	9		
Gold			0,1	5%
Silber			0,01	10%

Figure 2: Impedance colour code

Figure 3: Resistor

Figure 4: Resistor circuit symbol

2.3 Ceramics Capacitator

The capacitator is another important electronics component. It is available in two versions. The simpler version is the small, round and flat ceramics capacitator. It is secured against polarity reversal. Capacities are indicated in Farad (F). The ceramics capacitator is labelled in a number code. 104 corresponds to 10 x 104, i.e. 100,000 Picofarad (pF).

Figure 5: Ceramics capacitator circuit symbol

Figure 6: Ceramics capacitator

2.4 Electrolyte Capacitator

The larger electrolyte capacitator has a cylindrical body and must be installed in the correct polarity. The minus pole is marked with a white lateral stripe and has a shorter connection wire. If the Elko is installed in the wrong polarity, it will be destroyed. It is labelled in plain text.

Figure 7: Electrolyte capacitator circuit symbol

Figure 8: The electrolyte capacitator must be installed in the correct polarity.

2.5 LED

Always observe polarity when installing a light diode. The LED has two connection wires of different lengths. The longer one is the plus pole. It is called *anode* (A). The minus pole, the *cathode* (K), has the shorter wire.

The polarities are also visible inside the LED. The minus pole has the shape of a large triangle. The plus pole is only very small.

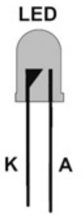


Figure 9: An LED must be installed in the correct polarity.

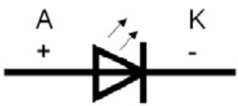


Figure 10: LED circuit symbol

2.6 Transistor

The transistor amplifies small currents. Its connections are called *emitter* (E), *basis* (B) and *collector* (C). The cylindrical casing is flattened on one side. The type designation is printed on here. Looking at the transistor so that the connections point down and the label can be read, the emitter is on the left side. The basis is at the centre.

Figure 11: Transistor with view of the flattened side.
Connections from the left to the right: Emitter (E), basis (B) and collector (C).

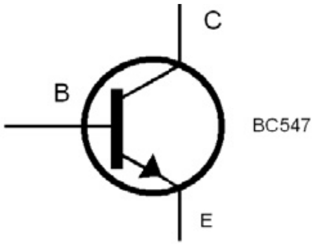


Figure 12: NPN transistor circuit symbol

2.7 Diode

A diode lets current through in one direction only and blocks it in the counter-direction. It can be imagined like a check valve from a water installation.

Conventional diodes are cylindrical like resistors. Their minus pole (cathode) is marked with a dash.

SMD diodes are very small. They are labelled on top with a short designation consisting of a letter and a number. The left end of the label marks the cathode (-), the right one the anode (+).

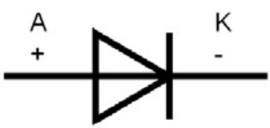


Figure 13: Diode circuit symbol

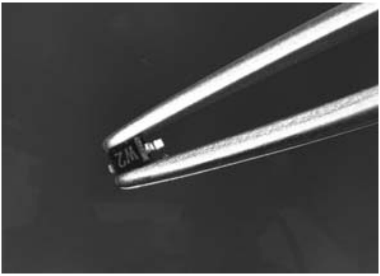


Figure 14: MD diodes are very small.

2.8 Integrated Circuit (IC)

The learning package contains an IC type *LM358* in SMD build. The installation direction must be observed when soldering on the IC. Polarity reversal must be avoided. It may destroy the component. PIN 1 is marked by a point at the top of the casing.

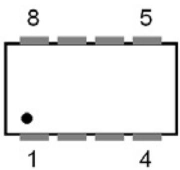


Figure 15: PIN assignment of the SMD-IC LM358

Figure 16: At the SMD-IC, PIN 1 is marked by a point at the top of the casing.

3 Soldering Basics

3.1 What is Soldering?

In electrical engineering, soldering is one of the basic ways of establishing connections. Soldering creates an electrically conductive connection that cannot be disconnected. Using a melted metal binding agent (solder), soldering connects two metal work-pieces - e.g. a PCB onto which an electrical component is soldered. The solder has a lower melting point than the metals to be connected.

Soldering is performed at temperatures of around 340 °C. The metals to be connected do not melt. The solder acts as a kind of adhesive. However, so-called mixed crystals form at the transfer zone between metal and solder, forming a diffusion zone. The solder does not just adhere to the metals to be connected, but enters into a crystalline connection with them.

Using a looped solder connection, the mix crystal layer, that is, the area where solder and each of the metals melt together, has a width of approx. 0.5 µm. If this transfer layer is too large, the solder connection becomes brittle and porous. If the transfer layer is too thin, the parts that were soldered together may disconnect again once you lift them up.

3.2 The Soldering Iron

Soldering irons are available in different designs and sizes. They must match the task to be performed. For electronics applications, you need a soldering iron with a small soldering tip and low connection power. Both ensures that you will be able to solder small components well without heating them excessively.

Fine soldering iron

Fine soldering irons have a power consumption between 8 and 25 Watt (W). They are best for soldering sensitive electronic components. A fine soldering iron is recommended if you are dealing with small solder points.

Universal soldering iron

Universal soldering irons are slightly larger. Their power consumption is between 20 and 40 W. They are particularly suitable for hobby and craft use. They can also be used well for electronics soldering. They are also the first choice if you want to assemble simple to medium electronics kits.

Standard soldering iron

Standard soldering irons consume about 50 to 150 W and are already too large for electronics hobbyists and handicrafts enthusiasts. They have an angled soldering tip. With their large dimensions and high heat output, they are not suitable for fine soldering work. They are therefore not suitable for electronics soldering.

Soldering stations

Soldering stations are meant for stationary use in a workshop. They consist of the actual soldering iron and a control unit where the soldering temperature can be set between about 150 °C and 450 °C. These are fine soldering irons optimised for electronics use. Therefore, soldering stations are mainly found in advanced electronics enthusiast workshops.

3.3 Soldering Equipment

Soldering will always require some solder. Tin solders are used the most often. Their melting point is at 330 °C. When heated, the tin solder first changes from firm to mushy condition, then melts.

Several solders still contain lead, even though leaded solders are no longer permitted for use in the electronics area since 1 July 2006. Lead is dangerous to health and pollutes the environment. Nevertheless, leaded solders are still permissible for private use and limited industrial uses.

In addition to the soldering iron, you will also need some equipment to solder. One piece of equipment is the soldering iron stand. It is used to securely deposit the hot soldering iron. It consists of a stable base and a solid metal coil into which the soldering iron is put when not in use.

The solder sponge is one of the most important, as well as the most simple accessories of the soldering iron. It is moistened with water and placed in the intended dish of the soldering iron holder. Then you can clean the soldering tip by wiping off contaminations or excess solder.

A fine mechanics' clamp makes soldering easier. It can hold the PCB and keep it in the position where work is easiest for you. This will leave your hands free for the soldering iron and solder.

A de-soldering pump can be practical for de-soldering components. It looks like an oversized ballpoint pen. It is used to extract excess solder from the solder point.

Alternatively, you may also use de-soldering wires. They consist of thin, braided strands and are available at different widths.

An electronics pliers set to bend components in shape and shorten excess lengths of connection wires is also recommended. Pincers can be helpful for small SMD components, as can a magnifying glass.

Figure 17: 15-W fine soldering iron by Conrad Electronic (order no: 588539-62); this makes electronics soldering easiest.

Figure 18: Stable soldering iron stand with solder sponge for cleaning contaminated soldering tips

Figure 19: The fine mechanics' clamp can be used to hold and comfortably solder PCBs.

Figure 20: Soldering aids with magnifying glasses also hold the PCB.

Figure 21: De-soldering pump (order no.: 588502-62) to remove excessive solder

3.4 Too Hot and too Cold Solder Points

Perfect soldering can be recognised by its nice gloss. A cold soldering point looks somewhat matte and often has a lumpy surface. Defective solder points can also be recognised if the small solder cone around the component connection is missing or hardly there. Cold solder points have only low mechanical resistance. If you jiggle a component a little, the connections within the solder cone may come loose, and it will only loosely be stuck in it.

Cold solder points occur if you did not sufficiently heat the solder point and solder. This may happen if soldering is done very fast or if the soldering iron does not provide enough power for larger soldering work. Cold solder points will break open even at very small vibrations.

Bad solder points may also result from high temperatures. The high soldering temperature will cause faster oxidation of the components to be connected. A typical sign for the solder temperature being too high is also so-called *whisker-formation*. Whiskers are solder residue that stands out of the solder point like thin protrusions and that may cause short circuit.

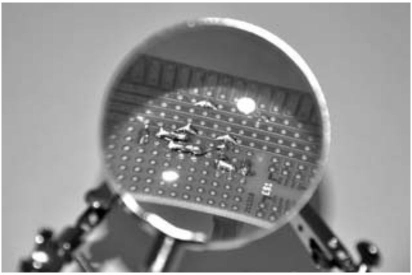


Figure 22: Correct solder points are glossy with a smooth surface.

3.5 The Right Tools

Soldering is best done with suitable equipment. We recommend the 15-W solder iron starter set available from Conrad Electronic (order: no.: 588292-62). In addition to a 15-W soldering iron, it comprises two soldering tips, solder, a deposit stand and a de-soldering pump.

If you only need the soldering iron, we recommend the 15-W hand soldering iron, also available from Conrad Electronic (order no.: 588539-62) and the de-soldering pump (order no.: 588502-62).

Before starting with your soldering practice, prepare an appropriate surface This may be a strip of flooring or stable cardboard.

Figure 23: Starter solder sets (Order no.: 588292-62) contain everything one needs to learn how to solder.

3.6 Before Starting Soldering

Proper soldering is only possible if you keep the soldering tip clean at all times. Regularly wipe it off with a moist sponge. This removes excess solder from the soldering tip.

Figure 24: Over time, solder collects at the soldering tip, which makes soldering considerably more difficult.

Figure 25: Therefore, contaminations need to be wiped off regularly with the moist sponge.

4 Soldering

4.1 Tinning Stranded Wire

Fine-stranded wires are hard to solder because their strands go in all directions when soldering. The battery clip wire ends show how perfectly tinned wires should look. Cut off the tinned parts and strip about 5 mm of the wires. Then twist the strands evenly between your fingers. This makes the wire more stable.

Heat one wire end with the soldering iron and add a little solder. Heating melts the solder immediately and covers the wire piece with a solder film. Don't take too much time when tinning, because extended heating will also cause the wire insulation to melt.

Figure 26: First twist the strands between your fingers.

Figure 27: The twisted wire must be heated and some solder added, which melts at once.

4.2 Soldering Together Wires

For both wires to keep their position during soldering and you to have both hands free to work, clamp them into an electronics clamp and put them in position. Then use the soldering tip to heat both wire ends evenly. Now add the solder by moving it to the heated solder point. This solder process also should be completed quickly to keep the wire from heating up too much and the insulation from being damaged.

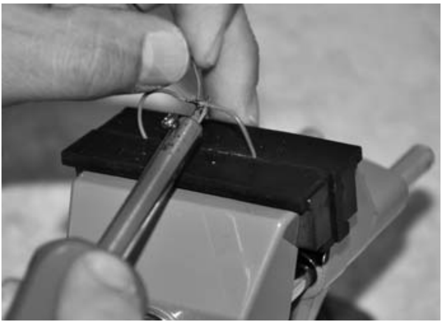


Figure 28: Since the insulation melts quickly, the wires must be soldered together quickly.

4.3 Preparing Components

A circuit soldered together yourself should not only work, it should also be well structured. This facilitates later modification and conversion, as well as repairs to the circuit.

A good structure also means that you prepare the components to be soldered by bending them in shape with a round electronics pliers. The resistor's connections must be bent at a right angle. Consider the hole distance on the PCB so that the component can be pushed into the bores well. The connections must not be bent directly at the casing edge. Danger of destruction. Apply the pliers at the resistor so that it touches the

casing. Then bend the wire end pointing away from the pliers by 90 degrees. Proceed accordingly with the second connection. Both angled wires must point in the same direction now.

Practice first by bending wire pieces with a few millimetres stripped of insulation on either end.

Figure 29: The wire bent to shape with an electrician's round pliers.

Figure 30: For electrical components, the wires should not be bent right at the casing end.

4.4 Soldering Wire Bridges to Strip Grid

There are two types of universal PCBs for constructing self-developed circuits, already applied with the copper layer required for soldering. In a strip grid PCB, all bores aligned below each other are connected conductively. Many wire bridges can be saved this way. Point grid PCBs have a small copper circle around each bore. The bores are not conductively connected. The practice PCB has both types. There are different ways of building and soldering circuits.

The lateral strip grid made up of 19 fields is well suitable for first exercises. You can solder on wire bridges and later components just by placing connection wires on the top half of the contact areas. Place the PCB and the wire bridge on the work surface. Strip a wire bridge end and align it with one of the contact surfaces. Then heat the wire and the solder point with the soldering iron tip and add a little solder. Ensure that there is no connection with the adjacent soldering areas. This is a danger if you add too much solder or if the soldering tip is not precisely pointed to the work area.

Heating the solder point and wire piece takes only a few seconds. The solder melts very quickly.

A good solder connection is only achieved when the solder is well melted. It has a silver gloss then. Therefore, you must not take the soldering tip away from the solder point too early. Otherwise, a cold solder point will result. The ideal time for soldering is about 1-2 seconds. If the solder point is heated much longer, the component, wire insulation and PCB may be damaged.

Let the solder point cool off after each soldering. Do not move it for about 5 seconds. Verify that the first wire end is well attached before soldering the second to the adjacent contact area. Try soldering several wire bridges of approx. 2 cm each. .

Figure 31: Soldering wire bridges to the lateral strip grid

4.5 Soldering Wire Bridges to a Point Grid

If you solder wire bridges to a point grid, push the wire ends to be soldered together through the bores of the hole grid part of the test PCB. Observe that there is only a small metal ring around each bore. It is isolated against the adjacent ones. This is called a land. There is not a lot of space for placing the solder to prevent conductive connections to the adjacent lands.

Clamp the PCB in the fine mechanics clamp so that you can equip and solder it well from above. This is the only way to have both hands free for secure soldering. The wire bridges are installed across the lands. They should have a distance of about 4-5 mm from the PCB surface. This exercise is also about installing the wire bridges in a visually appealing way. They should be about parallel to the PCB surface after soldering in.

Individual solder points should be accessible even after the circuit is completed. This permits subsequent modification, as well as de-soldering and re-soldering of components installed inverted.

Proceed according to exercise 4.4 when soldering. The special challenge is in having to place the soldering iron tip more precisely and holding it still to prevent wetting the adjacent lands with solder or short-circuiting them. Soldering should be completed within about 5 seconds.

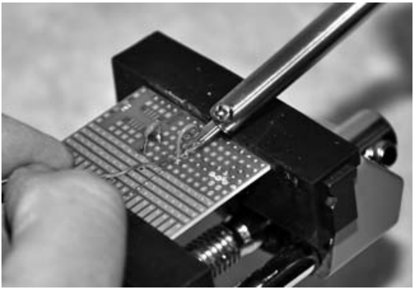


Figure 32: Soldering iron and solder must be moved precisely onto the land. Soldering should only take a few seconds.

4.6 Soldering Wire Bridges to a Point Grid - Version 2

The PCBs included in the learning package are coated on one side, like in most soldering kits. The components are pushed through from the bottom. Only the long connection wires of the components or the ends of the wire bridges will point out of the lands then.

This makes soldering easier because you no longer need to ensure that the hot soldering iron does not touch any adjacent components that are already soldered in and damage them. This does not mean, however, that you can take more time soldering now. The component or wire bridge and the land heat up just as quickly in both soldering methods.

Since you push through the wire bridge from below now, you need to prevent it from falling out again. This can be done by bending the two connection wires slightly to the side right above the lands. Then the wire bridge remains in position and can be soldered well.

Figure 33: To prevent the components pushed through from below from falling out during soldering, bend the connection wires slightly to the side.

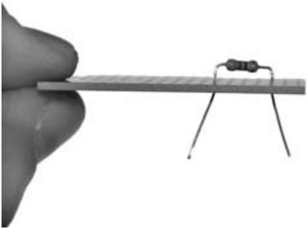


Figure 33: To prevent the components pushed through from below from falling out during soldering, bend the connection wires slightly to the side.

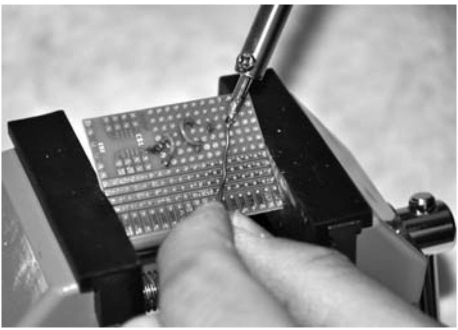


Figure 34: The PCB is turned around for soldering.

4.7 De-soldering Lateral Wire Bridges

De-soldering must be practised. Again, the soldering iron must be heated to operating temperature. Start with the wire bridges soldered to the lateral strip grids in exercise 4. Clamp the PCB into the electronics clamp. Heat the connection to be removed by heating it with the soldering tip. At the same time, pull slightly on the wire to be removed with the other hand. Once the solder liquefies, you can remove it from the PCB. This works best with a flat or round electronics pliers.

When de-soldering, make sure not to touch any adjacent solder points or components with the hot soldering iron. Keep the de-soldering process short. The wire end should be de-soldered within 5 seconds.

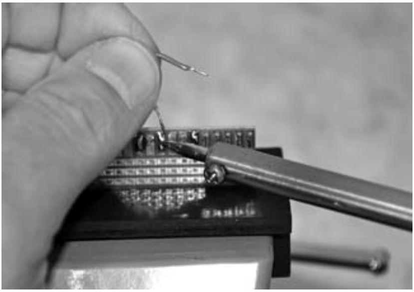


Figure 35: Pull slightly on the wire with your fingers while heating the soldering area, until the wire comes loose.

4.8 De-soldering Soldered-In Wire Bridges

Proceed according to exercise 4.7. The difference is merely that you need to work precisely. Wire bridges soldered into lands require very precise placement of the soldering tip so that it does not touch any adjacent components. Lands may also come loose if heat is applied for too long. Therefore, try to complete de-soldering within a few seconds.

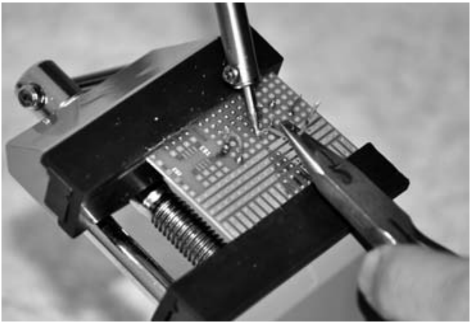


Figure 36: Pull slightly on the wire during heating in this version as well.

4.9 Simple LED Circuit: Preparations

For your first circuit, your circuit plan only requires soldering on the battery clip, a resistor and a diode. In spite of the circuit being simple, the first question is how to transfer it to the PCB. A simple sketch helps with this.

We decide building the circuit at the lateral strip grid. Since every strip also has two bores, the components can be soldered on to it going to the side. The battery clip connections are pushed through bores and soldered on. When drawing the soldering sketch, observe diode polarity. You can also draw its interior showing polarity. For our soldering exercise, we will leave the original length of the component connections and bend them in place according to the strip grid distance.

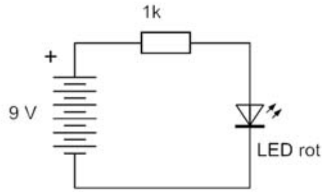


Figure 37: Simple LED circuit diagram

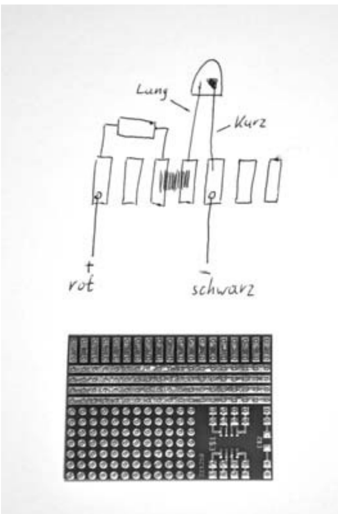


Figure 38: Transfer the circuit diagram to a small sketch to see where and how to solder on the individual components.

4.10 Simple LED Circuit

Use the soldering sketch from before to start soldering. Start with the resistor. It is a resilient component and can be handled like a wire bridge. After soldering on the resistor on both ends, solder the diode anode to the strip grid right at the resistor. Solder the cathode to one of the adjacent strips. When soldering, observe that the lower bores of the strip grid segments remain free. Push the red plus line of the battery clip through the bore of the strip to which the left resistor connection is soldered. Push the black minus wire into the free bore of the segment to which the LED cathode is soldered. Solder on both wires.

Now all you need is a connection between the resistor and LED anode. Solder in a wire bridge here. It is also common that the connection is done with a solder bridge. For this, heat up both contact areas again and supply solder until both contacts are connected. Now connect a 9 V block battery. If you did everything right, the LED will light up.

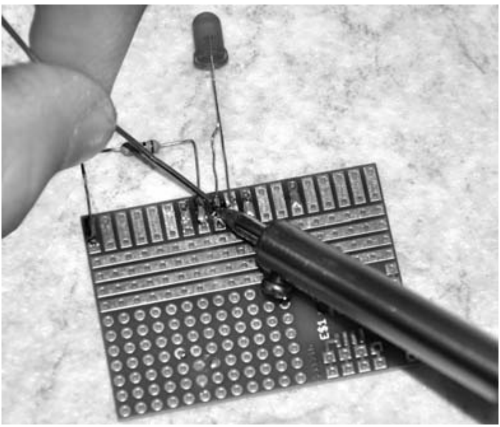


Figure 39: First solder the resistor and LED to the lateral strip grids. Observe LED polarity.

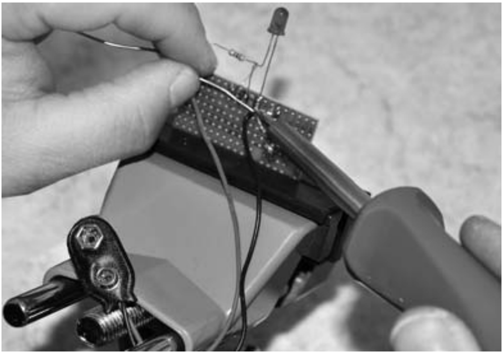


Figure 40: Push the wires of the battery clips through the still-free bores at the two outer contact surfaces and solder them on.

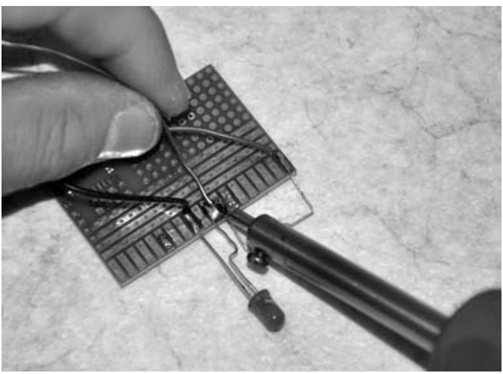


Figure 41: Last, solder the connection between resistor and LED with lots of solder.

During your first de-soldering exercises, you will have noticed that some residual solder remains at the solder point after de-soldering of a component or wire bridge. Is usually collects in the bore, so that no connection wires can be pushed through anymore.

This is where the de-soldering pump comes in. Tension it first. For this, push down the sliding piston until it catches. The pump's tip has a small opening and must be held right at the working point while heating the excess solder with the soldering iron. The distance between the soldering iron tips and de-soldering pump is only a few millimetres. Once the solder melts, press the unlocking button at the pump. The sliding piston moves back and a vacuum forms in the pump, extracting the liquid solder. Several working steps may be required until all excess solder is removed.

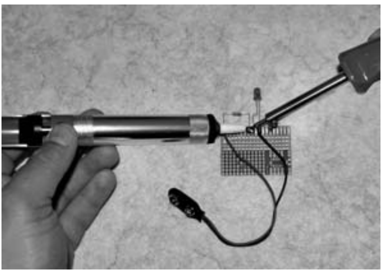


Figure 42: Large amounts of solder, like this solder bridge between resistor and LED, can only be removed with a de-solder pump.

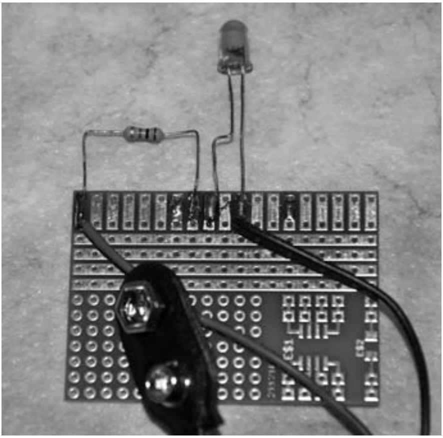


Figure 43: After using the de-solder pump once, the solder bridge is removed.

4.11 Soldering SMD Diode

SMD means „surface mounted device". SMD components usually have no wire connections but are soldered right to the PCB. they are also very small. The SMD diode *1N4148* included in the soldering course is only 3 mm long, including lateral connections. Their component body is even only approx. 1.5 mm long. The brief designation printed on the top is used to determine polarity. The left end is called the cathode (minus pole).

Special contact areas, so-called *pads*, are provided for soldering on SMD components. They are small, coated fields without bores, located on the lower right of the exercise PCB.

First, tin a pad with a little solder. For this, first heat the pad and add solder while the solder tip is still on it. This process should not exceed one second.

Place the SMD diode on the installation area with pincers and continue to hold it while fixating it with a soldering iron. For this, heat the diode at the side with the pre-tinned pad for a second. Now the SMD diode is soldered on on one side. Last, solder the second diode end as already known. Again, soldering should not exceed one second.

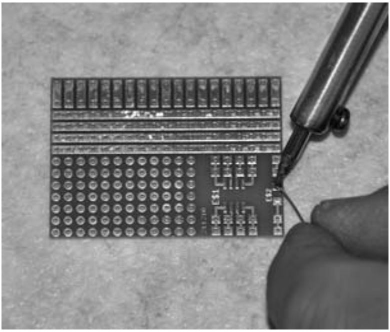


Figure 44: First, tin a pad with a little solder.

Figure 45: The SMD diode is very small even under a magnifying glass.

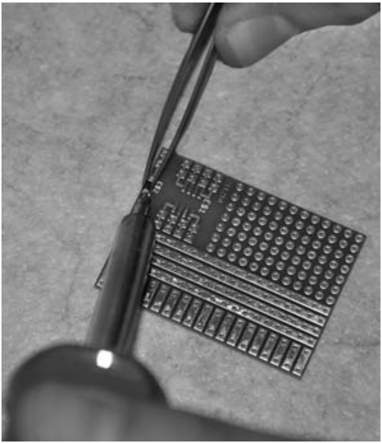


Figure 46: Keep the SMD diode in place with pincers while heating the pre-tinned pad and the diode connection resting on it.

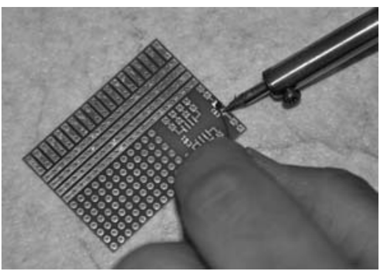


Figure 47: Last, solder on the second end by adding a little solder.

4.12 Soldering SMD Operational Amplifier

SMD-ICs like the operational amplifier LM358 are soldered similarly to small SMD diodes. It is a little easier because they are slightly larger. First, pre-tin an IC field pad with a little solder. After determining the IC installation position by the mark, align it on the PCB with pincers so that its connections are located precisely on the contact surfaces. Keeping the IC in position with the pincers, heat the connection on the pre-tinned pad. Now the SMD-IC is attached. Solder on the other connections in sequence by placing the soldering tip precisely and adding a little solder. Ensure that no conductive connection to the adjacent soldering areas is created. Clean the soldering tip thoroughly after each soldering process by wiping it at the moistened sponge.

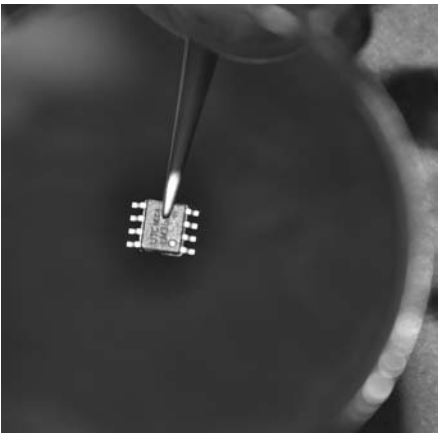


Figure 48: SMD-IC under the magnifying glass - Pin 1 is marked with a circle here.

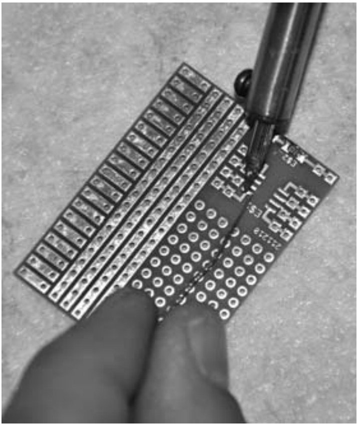


Figure 49: Pre-tin a pad first.

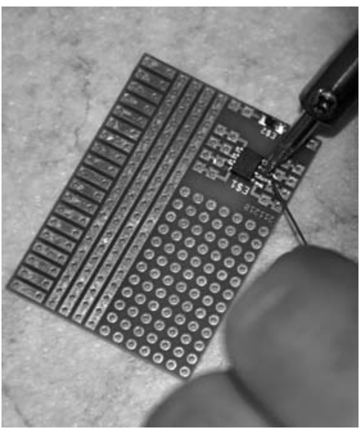


Figure 50: Every connection must be soldered on individually.

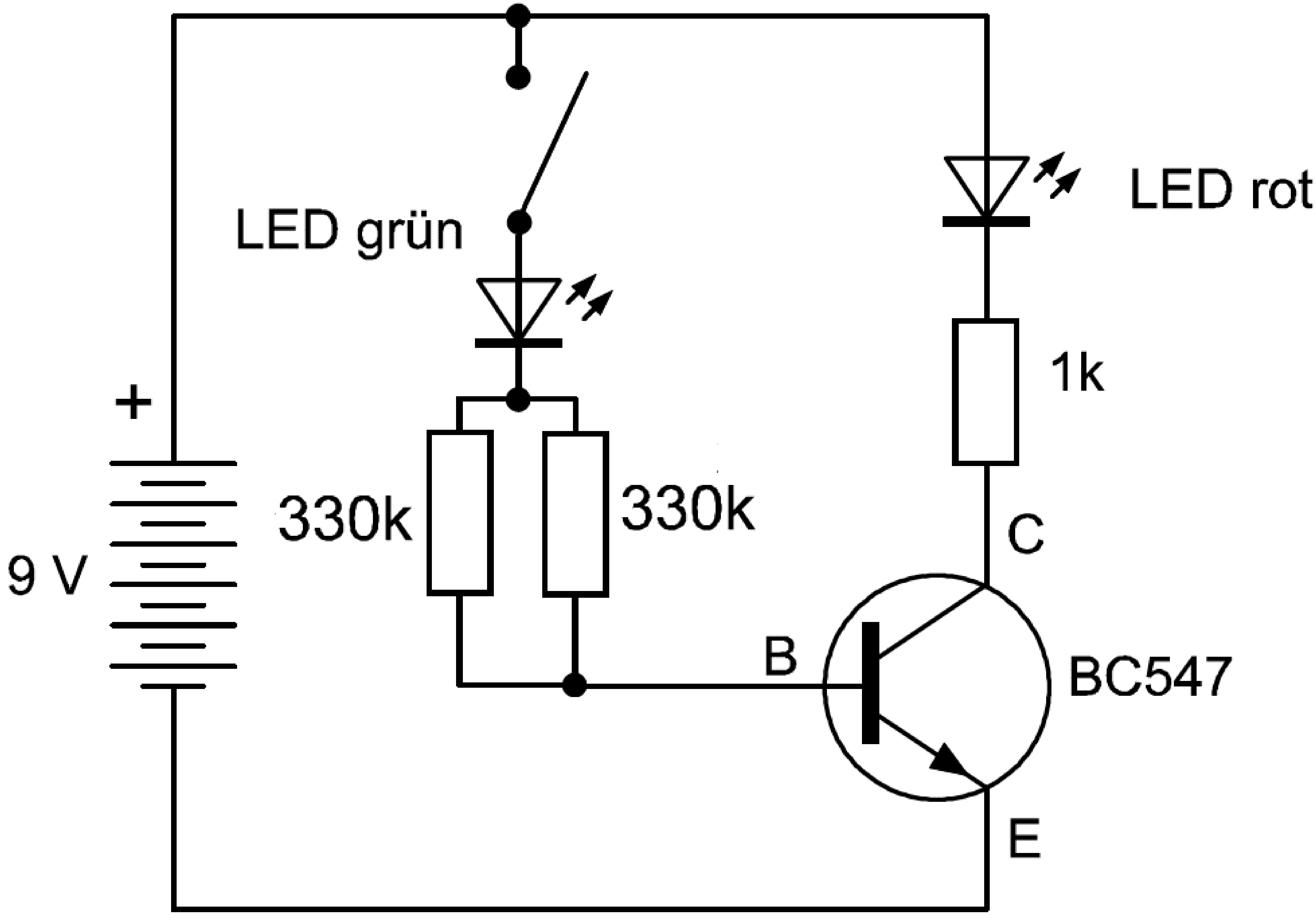
4.13 Soldering Components Close Together

This exercise starts the step-by-step construction of a transistor circuit. If you install all components in the last required position from the first, you will reach a completed circuit step by step.

Sometimes, individual components must be soldered close together or their connections require soldering them in directly adjacent bores or lands. Since there is little space, the soldering tip and solder must be placed precisely. Handling is all the more difficult the more components are already soldered in. Therefore, work from the PCB centre towards the edge and first solder on low components like resistors and diodes. High components like transistors and LEDs are the last. When soldering components that are close together, avoid touching adjacent parts with the hot soldering iron.

Also observe that the liquid solder does not generate any conductive connection to adjacent components or contact areas.

Figure 51: This exercise starts the construction of a transistor circuit.


LED grün
LED rot
1k
+
9 V
330k
330k
C
B
BC547
E

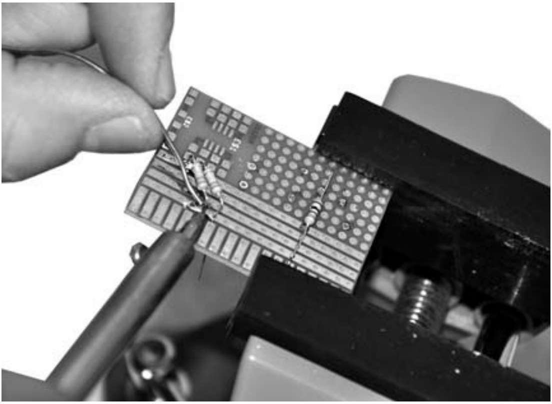


Figure 52: Working form the centre to the edge makes it easy to solder in components close together.

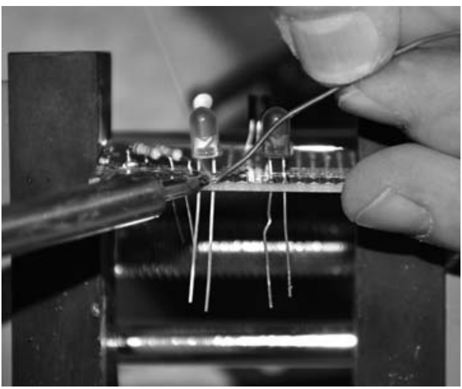


Figure 53: Keep a calm hand to solder on higher components (like this LED) to directly adjacent lands.

4.14 Soldering Sensitive Components

Transistors and ICs are sensitive components that must not be heated for long. They would be destroyed by it. Soldering must be performed quickly and precisely for this. The faster you can solder a pin on sensitive components, the less thermal load is placed on them. Soldering should be finished within 2-3 seconds.

When installing a transistor or IC, ensure correct installation position. Incorrectly soldered components will not only lead to the circuit not working - they also may be destroyed.

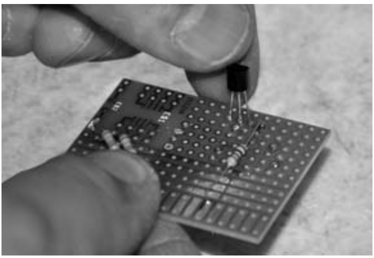


Figure 54: Observe correct installation position when inserting the transistor.

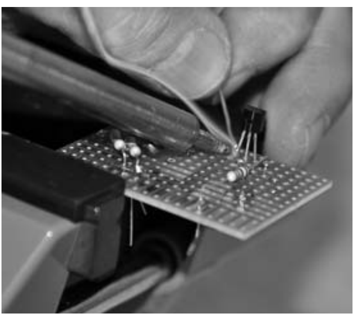


Figure 55: The transistor connection should be soldered in within a few seconds.

4.15 Removing Short Circuits Caused in Soldering

When soldering points and components, conductor paths, etc. are close together, it is possible that a conductive connection is created by the solder during soldering. The circuit is not destroyed by this. You can still repair the circuit by removing the excess solder. The easiest way of removing it depends on amount and position.

The de-soldering pump will help in most cases. It can be used to remove most solder lumps between two lands or connections of an IC or transistor the easiest way. Heat the solder lump to be removed with the soldering tip. Once it liquefies, release the arresting button of the soldering pump after holding it to the working place. Usually the solder can be removed in a single work step.

Small solder amounts on the PCB can also be removed with the previously cleaned soldering tip. For this, heat the solder and move the tip slightly back and forth. To be safe, use a fine electronics flat screwdriver or needle to scratch off residues. This removes even the last, tiny solder residue.

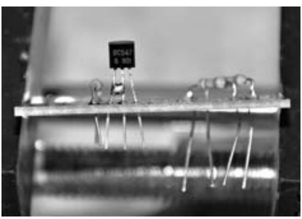


Figure 56: Here, a solder lump between two transistor connections causes a short circuit.

Figure 57: Solder lumps can be removed by heating them and applying the de-soldering pump.

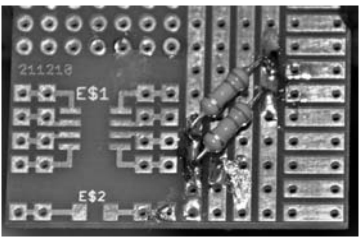


Figure 58: Here, solder short-circuits two strip grids. There is only little solder. It can be removed with the soldering iron.

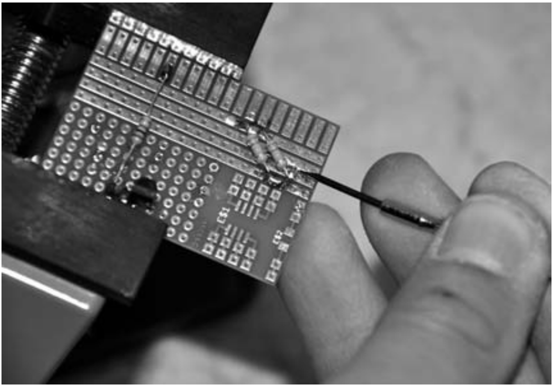


Figure 59: The last residue can be scratched off with a small electronics screwdriver or a needle.

4.16 Completing Transistor Circuit

After soldering the resistors, LEDs and the transistor to the PCB, all you need now is the battery clip, some wire bridges and a switch. Form the latter from two wire pieces that are only soldered onto the circuit at one end. strip the free ends a little. Touch them to each other to close the switch.

The challenge when completing the circuit is in the PCB already being tightly equipped. You therefore need to be especially careful when you move the hot soldering tip to a new work-site. If it is still too narrow, you can bend the higher components aside a little.

The circuit shows the basic function of the NPN transistor. There are two circuits. A low basic current flows in the control circuit, a larger collector current in the load circuit. The LEDs indicate the currents. The red LED is brightly lit, the green weakly. The basic current can only be seen as a low light in the green LED in a darkened room. The difference indicates the strong current amplification. .

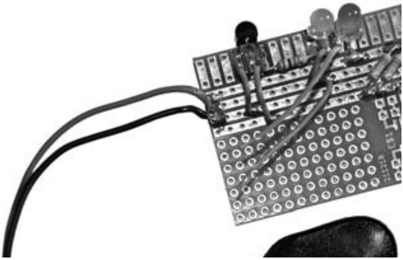


Figure 60: The finished circuit

4.17 Checking Circuit and Shortening Excessive Lengths

Before taking the circuit into operation, check by way of visual inspection that all components are correctly installed and that no solder points were forgotten. Now shorten the excess lengths of the component connection wires with an electronics wire cutter.

Leave about 1 mm of excess length at the back of the PCB. If you equipped the PCB from the rear and the connection wires stand out over the coated side of the PCB, shorten them so that they protrude over the solder cones by 0.5 - 1 mm. If you have to de-solder a component to install a different one, the connections are still long enough to handle them well.

The circuit must not be taken into operation before the excess lengths are removed. Pressing both wire ends together and thus closing the switch will make the green LED light up very weakly, the red one brightly. You can see how the transistor amplifies current. You installed everything correctly.

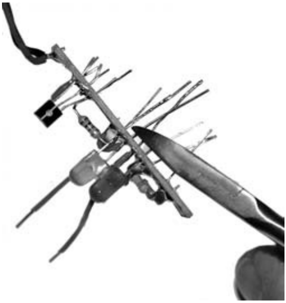


Figure 61: Excess connection wire lengths must be cut off after completing and inspecting the circuit.

Figure 62: The cut connections should protrude over the PCB by 0.5 to 1 mm.

Figure 63: Cut off the connection wires closely to the solder cones.

4.18 De-soldering Components with Several Legs

Simple components like wire bridges or resistors can be de-soldered easily. This becomes more difficult when a component like a transistor has several connections close together. It is no longer sufficient to heat up one soldering point and pulling out the component when the solder liquefies. You will need to use the de-soldering pump.

First, heat one of the solder points for the three transistor connections, and keep the de-soldering pump ready at the work-site. Once the solder has liquefied, trigger the pump to remove part of the solder. Repeat this process until the bore is solder-free. Then take on the other two connections. In the end, all three bores should be free and you can simply pull the transistor from the PCB.

LED and IC can be de-soldered the same way.

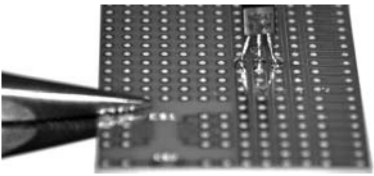


Figure 64: Multi-legged components cannot be de-soldered easily.

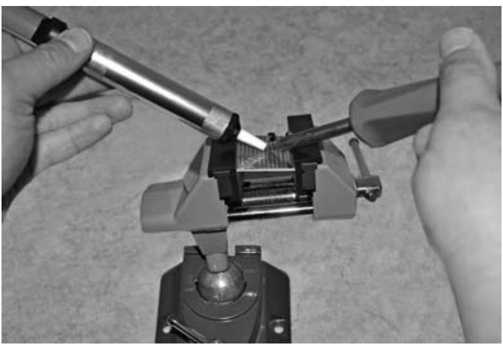


Figure 65: De-soldering requires the de-soldering pump.

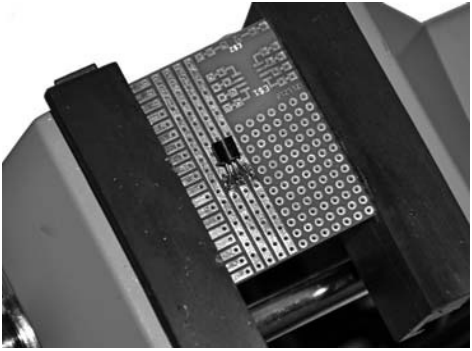


Figure 66: The de-soldering pump removes the solder completely from all three solder points in several goes.

4.19 The Masterpiece

Build your own light-sensitive circuit according to the following circuit diagram. This circuit will let you practice everything you learned in this soldering course. This includes transferring the circuit to the PCB, installing LEDs, transistor, SMD-IC and SMD diode correctly and soldering correctly. You also need to install a few wire bridges.

The circuit: The transistor amplifies current for the LED light sensor. The green LED is used as a photo element and delivers a low current. The high current amplification of the transistor now makes a low environmental brightness sufficient to switch off the LED. Using this as a light-sensitive switch will activate the LED automatically in the evening.

If your circuit reacts as described, you passed your „master test“!

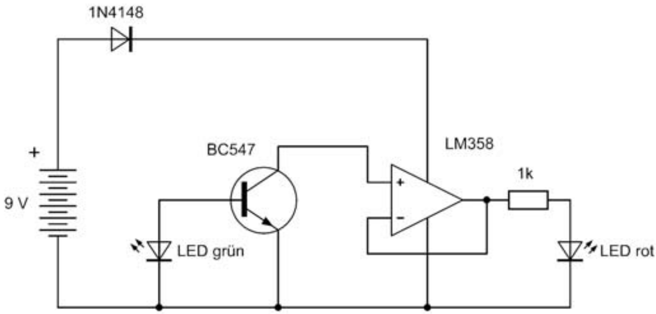


Figure 67: Light-sensitive switch circuit diagram

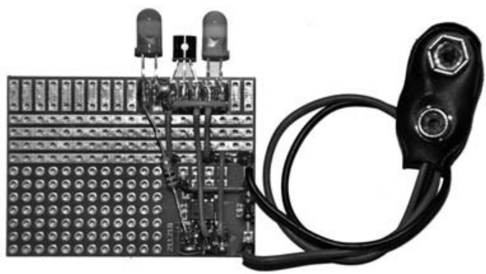


Figure 68: The finished circuit should look about like this.

4.20 Other Circuits

The components in the soldering learning package permit soldering a great number of other circuits as well, such as most circuits of the Conrad-Electronic advent calendars from the years of 2008, 2009 and 2010.

You can download the circuit templates from *http://www.elo-web.de/ergaenzungen*.