Record Playback Kit

The Design Brief

An audio equipment manufacturer has developed a record playback module, which allows a short memo to be recorded and played back. The circuit has been developed to the point where they have a working Printed Circuit Board (PCB). Although they are used to the design of stereo equipment, they have not designed a case for a voice memo unit before.

The manufacturer would like ideas for an enclosure for the PCB, and batteries to be mounted in. The manufacturer has asked you to do this for them. It is important that you make sure the final design meets all the requirements that you identify for such a product.

Complete Circuit

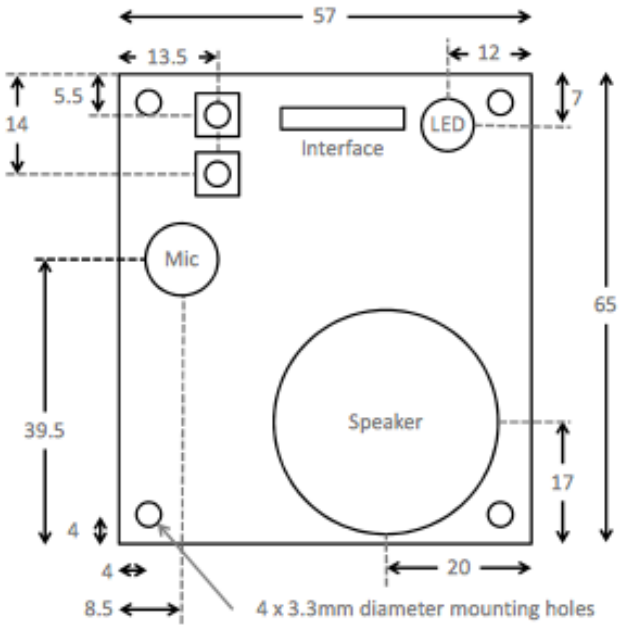
A fully built circuit is shown below.

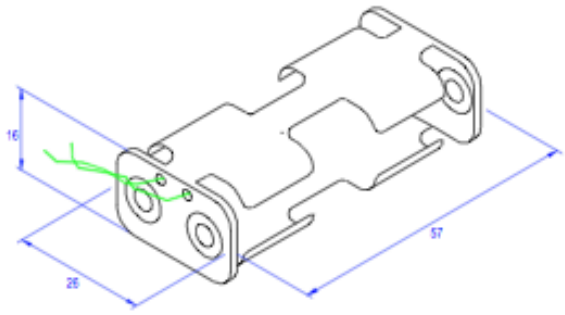
Designing the Enclosure

When you design the enclosure, you will need to consider:

- The size of the PCB (below, height including components = 16.5mm)
- How big the battery holder is.

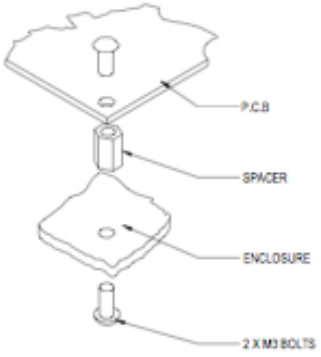
These technical drawings should help you plan this.
All dimensions are in mm.





Enclosure Prototype

Using card board, foam or anything else that is suitable, make proto type of your enclosure design. This will give you the chance of changing any aspects of the design that do not work as well as expected.



Mounting the PCB to the enclosure

The drawing to the left shows how a hex spacer can be used with two bolts to fix the PCB to the enclosure.

Your PCB has four mounting holes designed to take M3 bolts

Soldering In Ten Steps

1. Start with the smallest components working up to the taller components, soldering any interconnecting wires last.
2. Place the component into the board, making sure it goes in the right way around and the part sits flush against the board.
3. Bend the leads slightly to secure the part.
4. Make sure the soldering iron has warmed up and if necessary use the damp sponge to clean the tip.
5. Place the soldering iron on the pad.
6. Using your free hand feed the end of the solder onto the pad (top picture).
7. Remove the solder, then the soldering iron.
8. Leave the joint to cool for a few seconds.
9. Using a pair of cutters trim the excess component lead (middle picture).
10. If you make a mistake heat up the joint with the soldering iron, whilst the solder is molten, place the tip of your solder extractor by the solder and push the button (bottom picture).

Build Instructions

Before you put any components in the board or pick up the soldering iron, just take a look at the Printed Circuit Board (PCB). The components go in the side with the writing on and the solder goes on the side with the tracks and silver pads.

You will find it easiest to start with the small components and work up to the taller larger ones. If you've not soldered before get your soldering checked after you have done the first few joints.

Step 1
Start with the five resistors (shown right):
The text on the PCB shows where R1, R2 etc go. Make sure that you put the resistors in the right place.

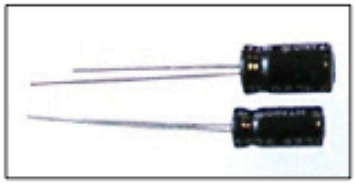
R1 & R2 are 1K (brown, black, red coloured bands)
R3 & R4 are 4.7K (yellow, purple, red coloured bands)
R5 is a 100K (brown, black, yellow coloured bands)

Step 2
Solder the Integrated Circuit (IC) holder in to IC1. When putting it into the board, be sure to get it the right way around. The notch on the IC holder should line up with the notch on the outline marked on the PCB.

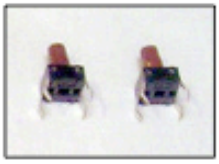
Step 3
The microphone (shown right) should be soldered into the board where it is marked M1.
The microphone is polarized (the two pins are off centre). For it to work the part must go inside the circle marked on the PCB.

Step 4
The four ceramic disc capacitors (shown left) should be soldered into the board as follows:
C1 = 1nF marked 102
C2 – C4 = 100nF marked 104

Step 5
Now solder in the two electrolytic capacitors (shown right). Make sure the capacitors are the correct way around. The capacitors have a '-' sign marked on them which should match the same sign on the PCB. The capacitors have text printed on the side that indicates their value. The capacitors are placed as:
C5 = 220µF.
C6 = 4.7µF.

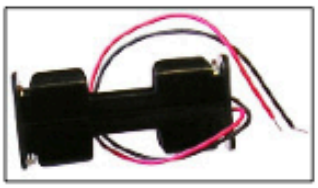


Step 6
The Light Emitting Diode (LED) should be soldered into the board. The LED won't work if it doesn't go in the right way around. If you look carefully one side of the LED has a flat edge, which must line up with the flat edge on the outline on the PCB. Once you are sure it is in the right way around solder it in place.



Step 7
Solder the two switches (shown left) into the board where it is labeled SW1 & SW2. Once you have got the pins lined up with the holes they can be pushed firmly into place and then soldered.

Step 8
The speaker (shown right) should be soldered into the board where it is labeled SP1. Whilst the board and the speaker may have a '+' indication on them it doesn't actually matter which way around the speaker goes.



Step 9
The two times AA battery cage (shown left) should be attached to the terminals labeled POWER. Feed the wires through the strain relief hole from the bottom of the board, then connect the red wire to '+' and the black wire to '-'and solder in place.

Step 10
The IC can now be placed into the IC holder. When doing this make sure that the notch on the IC lines up with the notch on the IC holder.

Checking your Record Playback PCB

Carefully check the following before you insert the batteries:

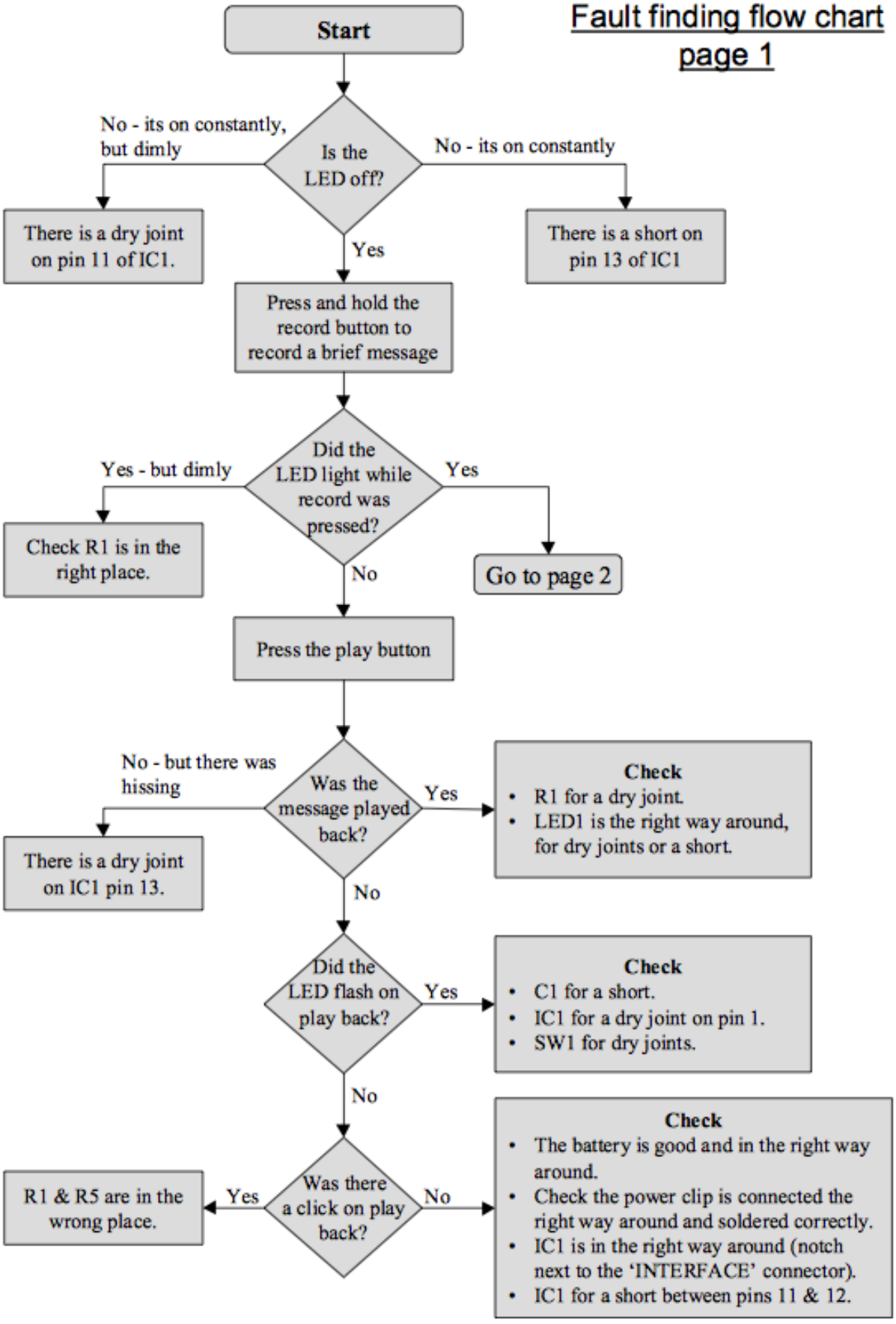
Check the bottom of the board to ensure that:

- All holes (except the 4 large (3 mm) holes in the corners and the interface connections) are filled with the lead of a component.
- All the leads are soldered.
- Pins next to each other are not soldered together.

Check the top of the board to ensure that:

- The '-' on the electrolytic capacitors match the same marks on the PCB.
- The colour bands on R1 & R2 are brown, black, red.
- The colour bands on R5 is brown, black, yellow.
- The LED matches the outline on the PCB.
- The battery clip red and black wires match the red & black text on the PCB.
- The notch on the IC is next to the interface connections.

Fault finding flow chart page 1



Fault finding flow chart page 2

Continued from page 1

Press the play button

Was the message played back?

- Yes - but it was distorted, crackled or hard to hear over the noise
- Yes
- No - there was silence, hiss or a click noise

Check
- C6 for a dry joint.
- IC1 for dry joints on pins 6 or 8.

stop

Was the play back silent?

- No - there was hissing
- No - there was a click at the start of playback
- Yes

Check
- For dry joints on R3 or R4.
- M1 for a short or dry joint.
- IC1 for a short on pin 4.
- IC1 for a dry joint on pin 12.
- C5 for a short.

Check
- R5 is in the right place.
- IC1 for a short between pins 8&9.

Press the play button again

Did the LED light?

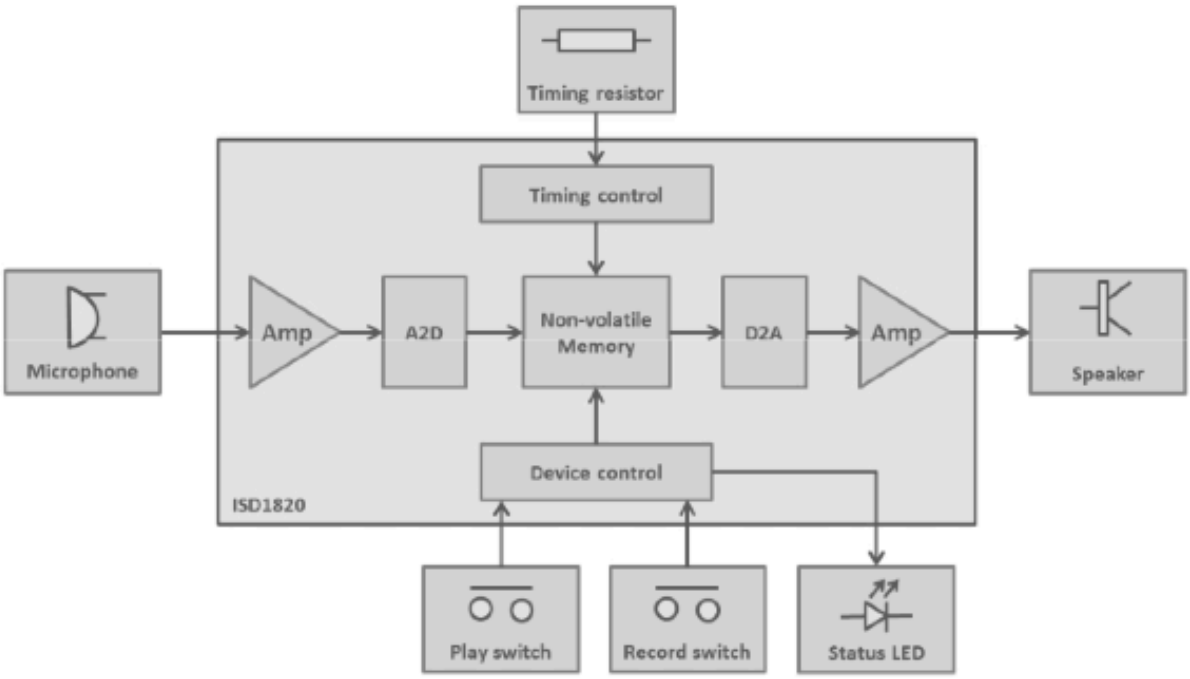
- Yes - whilst the button was pressed
- No
- Yes - at the end of the silence

There is a short on IC1 between pins 1&2.

Check
- R5 for a dry joint.
- SW2 for dry joints.
- IC1 for a short or dry joint on pins 2 or 10.

Check
- SP1 for dry joints.
- IC1 pins 7 & 9 for dry joints.

How the Record Playback Module Works



The main component in the circuit is the ISD1820, which is a record playback IC. This is the main boxed section in the block diagram above. During the record phase, the chip amplifies the signal from the microphone and digitizes this allowing the recording to be stored in memory. This memory is non-volatile, which means that the information is retained even when the power is removed. During playback the data is taken out of the memory, converted back from a digital signal into an analogue signal which is then amplified before it is output to the speaker.

The timing control section of the chip uses a resistor / capacitor network to set how fast the data is stored or retrieved from the on board memory. The timing resistor (R5) along with an internal capacitor sets the record / playback time to 10 seconds. This can be adjusted from 8 seconds to 16 seconds, however the longer the record time the worse the quality of the audio as the sample rate is reduced.

The device control block checks the state of both the play switch and the record switch and either plays back the current message or records a new message. The device control block also turns the LED on to show that recording is in progress or that playback has finished. When neither record nor playback is in progress the device control block puts the whole unit in to sleep where it takes virtually no current, thus allowing the battery to remain connected when the device is not in use.

The switches SW1 & SW2 are connected to the positive supply and the IC. There are internal pull down resistors for both inputs inside the IC. A 1nF capacitor (C1) is present on the record line to remove any switch bounce that could cause a brief re-record to take place as the switch is released at the end of recording. The status LED requires a current limit resistor (R1) and there is a 100nF capacitor (C4) connected across the power supply to make sure it is smooth. All the remaining resistors and capacitors are used to power the microphone and filter the audio from it.

Record playback IC pins on the ISD1820

The following table indicates what each pin on the record playback IC does:

Pin No	Name	Description
1	REC	The record input, when taken and held high causes the device to re-record the message. The IC contains a pull down resistor on this input.
2	PLAYE	The play (edge activated) input, when taken from low to high, the device plays back the full message. The IC contains a pull down resistor on this input.
3	PLAYL	The play (level activated) input, when held high, the device plays back the message, if taken low during playback, playback stops immediately. The IC contains a pull down resistor on this input.
4	MIC	Microphone input. The microphone is AC coupled to this pin via a series capacitor. The IC contains amplification, so external amplification is not required.
5	MIC REF	Microphone reference, the negative microphone connection, used to reduce noise. This is also AC coupled through a series capacitor.
6	AGC	Automatic gain control, used to set the gain of the pre-amp. Connecting a 4.7uF capacitor between the AGC pin and Gnd, gives good all round performance.
7	SP-	Speaker out-, the negative speaker output signal, min impedance 8 ohms.
8	Gnd	Ground, the zero volts connection.
9	SP+	Speaker out+, the positive speaker output signal, min impedance 8 ohms.
10	Rosc	Resistor oscillator, the resistor that sets the oscillator speed. Connected between Rosc and Gnd. Rosc = 80K gives 8 seconds (min record time), Rosc = 160K gives 16 seconds (max record time)
11	Vcc	The positive voltage connection, typically 3V but will operate from 2.7V to 4.5V.
12	FT	Feed through, this pin is held in a low state by an internal pull down resistor in normal operation. However can be taken high if the pre-amp stage needs to be bypassed. In this case the input signal is feed through directly to the analogue to digital converter.
13	RECLED	Record LED, this output is normally high and goes low during record, for the duration of the recording. It also goes low upon completion of playback and can be used to make the IC continually replay the message.
14	Gnd	Ground, the zero volts connection.