FK675 Teacher Resource Guide

This Resource Guide and Kit are intended to aid with the delivery of class room exercises based around the FK675 Kit.

During the construction of this kit, the students will be exposed to the following learning elements:

Element Code	Description	Activity
ELBS1112	Heat transfer (by conduction)	Soldering
ELBS1113	Energy transference	Electricity to Sound (Speakers)
ELBS1115	Transfer of Energy through an electrical circuit	Entire KIT! Also note the speed at which a 9V battery will go flat as volume out increases!

<u>The kit comes with:</u>

- Solder included
- A circuit Diagram
- Instruction sheet (which is aimed at experienced users)
- 9V Battery snap

<u>Extra resources recommended to be used with the kit:</u>

- A copy of the locally written "Student Instruction Sheet" (provided as a soft copy with class sets, and included below).
- A copy of the locally written guide "Towards Better Soldering" (provided as a soft copy with class sets).
- 9V DC power source. *(We recommend using a 9V DC Plug pack if your students want a long operational life, OR please consider a 6 X AA Battery holder.)*
- Soldering Iron
- Soldering Iron Stand with a damp cloth or sponge
- Diagonal Pliers ("Side-cutters")
- Solder sucker or Solder wick (for removing unwanted solder)

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Extension activity suggestions for this kit:

1)Changing the "acoustic coupling" around each speaker.

a. Place the speaker upside down on the table. (Sound diminishes)
b. Lift the speakers off the table and ask two students to hold them in their "cupped hands" (One speaker each student). Usually the sound "quality" will noticeably improve.
c. Hold the speakers up in "free air" with nothing around them. Usually they sound will fainter.

2)Trial different types of batteries.

a. Usually the "lighter" a battery feels, the less energy it will store. Therefore the faster it will "go flat".
b. Encourage students to measure how long the same style of battery will last, if the amplifier is set to different volume levels for long periods.
c. Typically the 9V DC battery (also known as a PP3 style) will not deliver sufficient current for sustained operation at full volume.

3)Understanding amounts of energy storage in different batteries

a. Some better quality batteries will give their capacity on the casing. Usually in milli-ampere hours. (mAh).
b. The larger the mAh , the longer the amplifier will operate .
c. Set up tests to compare and analyze.
d. Some basic relationships you may wish to utilize:
    i. Calculate the current needed from a 9V battery to delivery 2 Watts of power?
    Use Power (P) = Volts (V) x Current in Amps (I)
    Therefore Current drain = 0.222 Amps (222 mA).
    ii. Allow for an "efficiency" of the system at (say) 80% therefore power drain from the battery = 2W / 80% = 2.5 W (approx 278 mA)
    iii. If the battery has a stated capacity of (say) 700mAh , then we would expect a fully charged battery to go flat in (700/278) approx 2 hours and 30 minutes.

4)Understanding different battery technologies and their behaviours.

a. Rechargeable batteries often sacrifice "Storage capacity" for recharge capability.
b. Use different batteries for experiments in the class room.
c. ALSO to avoid later disappointments if students opt to purchase "Cheap" batteries and are then dissatisfied with their usable life time.

Student Sheet with notes inserted:

Below is a copy of the student notes, with some comments and suggestions for teachers. Our comments for the Teacher are inserted in BLUE font.

STUDENT NOTES

What it does:

This circuit is designed to amplify low level audio signals and play them out over the two speakers. It accepts two different channels in (stereo) , and will play them out over separate speakers. It has on-board volume control for each of the channels.

What we are making:

This system is ideal for an audio docking station for mobile phones, radios, computers, etc.

Fig 1: Finished Product

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Technical Specs:

- Power supply: 9-12VDC
- Current Average: 600mA when using 12V DC and driving into 8Ohm speakers .
- Speakers 16Ohms, 4 W max rating
- Max output power: 2W
- Volume control equipped
- Voltage Gain (at Freq 1kHz): 34dB
- S/N ratio: 80dB
- Frequency Response : 25Hz to 20kHz @ -3dB
- Distortion*(Speakers = 8 Ohms, Pout = 500mW, Freq = 1kHz):* < 0.5%
- PCB dimensions: 56.4 x 48.0 mm

How it works:

The system consists of two identical amplifiers. One drives the “Left” Channel, and the other drives the “Right” channel.
We will discuss one channel in depth, and allow the reader to infer the other channel.

The audio input signal is passed through the input capacitor (C1) . It is then “divided” by the volume control potentiometer (VR1) to give anything from full input strength down to almost zero input strength.

The “divided” signal is then fed into the pin3 of the Audio Amplifier IC (TBA820M) .

The output of the Audio Amplifier IC (pin5) is coupled via C8 to the output pin. C3 and R3 are used to remove the risk of any unwanted high frequency oscillations (heard by us as “Squeals”).

The “Gain” of the amplifier is controlled by C5 and R1. (Note: this “Gain control” is a function of the TBA820M IC).

Note to Teachers:

We do NOT recommend changing the gain setting components.
This CAN be done, but the specification of the TBA820M should be consulted first. Results of random “trial and error” experiments can be disappointing. There is quite a deal of clever design work inside the IC which makes this a non-intuitive relationship between component values, gain and Audio performance!

Circuit Diagram:

Figure 2. The power amp 2+2W. stereo circuit

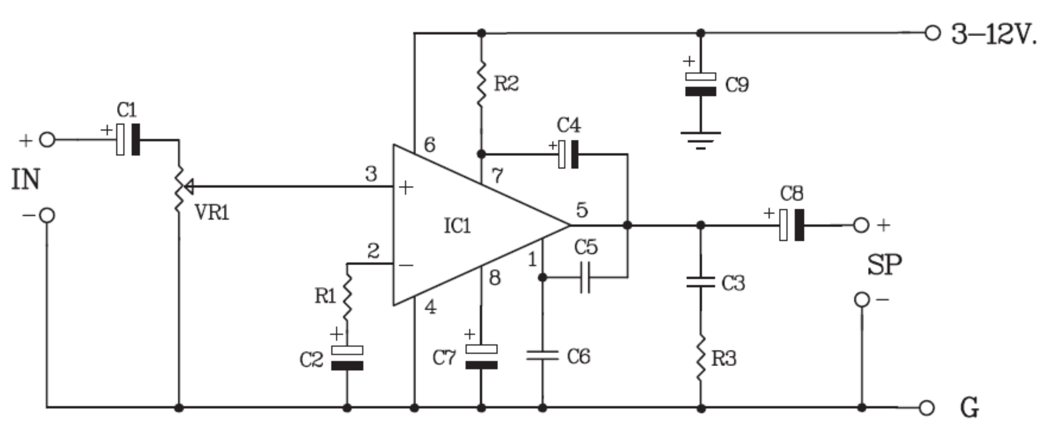

Fig 2: Circuit Diagram for one channel of the system.

How to build it:

Note to Teachers:

We recommend you pre-warn students that they may wish to preserve the cardboard backing of the kit.

Reason: there are some handy hints and clues on the back of the pack..... these may come in handy during the construction phase.

Step 1. Installing the resistors.

Resistors:

R1 (twice)	120Ω	-brown-red-brown-gold
R2 (twice)	56Ω	-green-blue-black-gold
R3 (twice)	1Ω	-brown-black-gold-gold

Fig 3.1 Resistor Values

By referring to *Fig 3.1* determine the value of each resistor and place them in their correct positions as indicated on the printed circuit board (PCB).

Do this by carefully bending their wires down to form a 'U' shape and poke through the holes in the PCB as shown in *Fig3.2*.

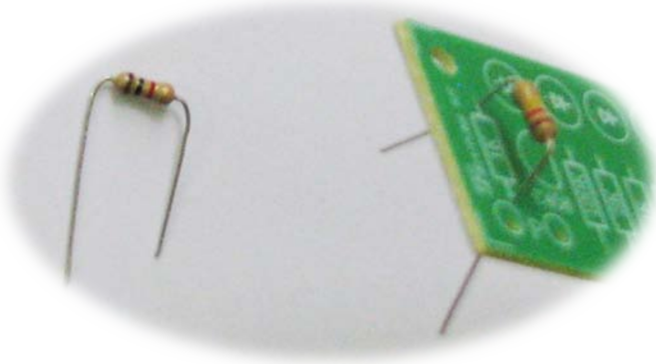

Fig 3.2 Installing Resistors

Note that there are two sets of each resistor which need to be installed!

As far as possible, try to keep the resistors "oriented" in the same direction. (Try to keep the gold band at the same end of the installed resistors.) See Fig 3.3 for a suggested pattern.

Note to teachers:

The reasons for suggesting this are:

- Easier to "fault find" at a later stage if this is required.
- Most professionally built Electronics assemblies try to follow this "guideline".
- Some components are very sensitive to polarity and correct alignment. (Good to set the habit early).
- Most electronics professionals simply consider this as a "Hygiene habit" in the construction of electronics assemblies.

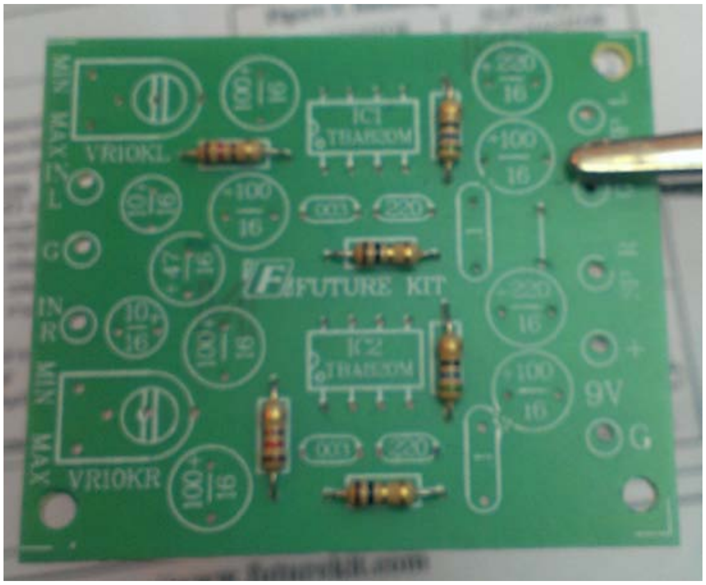

Fig 3.3 Installing Resistors with consistent orientation.

Once they are in the correct positions solder them into place and trim the excess wire.

We strongly suggest that you install the "jumper" at this stage. You can simply use one of the trimmed legs of the resistors for this. The "jumper" is identified in Fig 3.4.

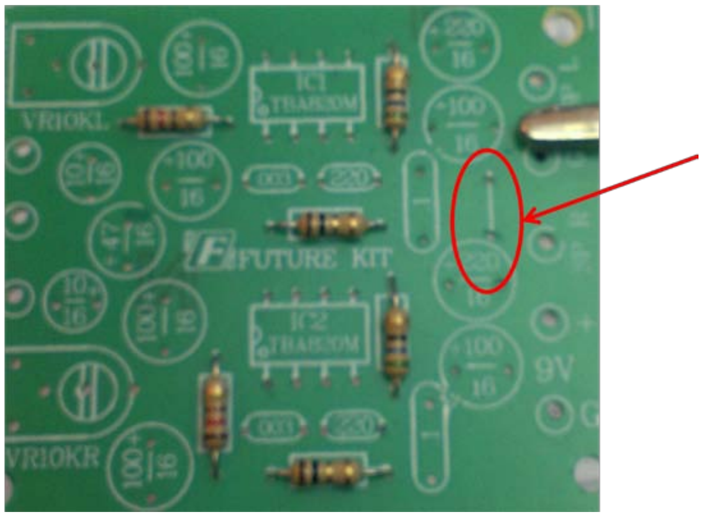

Fig 3.4 Identifying the "Jumper" location .

Step 2. Installing the Capacitors

Carefully identify all the different capacitors to be used.

There are two "families" of capacitors used in this kit. These are "Electrolytic" Capacitors and "Mylar" Capacitors.

Refer to Fig 3.5 to determine the values of the different capacitors.

Notes to teachers:

Electrolytic Capacitors are the larger , cylindrical ones. CAUTION!

These MUST be installed with correct polarity! The longer leg is "+". The "-" leg is marked on the case! The PCB should have the "+" hole marked ! The Green and orange "Mylar" capacitors do not need to be sensitive to polarity.

Please encourage CARE when students are selecting and installing the 220pF and the 3,300pF (3.3nF) capacitors.... They are about the same size, and the markings are very small. BUT if they are inter-changed on the PCB, students will find the Amplifier does not work very well! (PLUS they are annoyingly difficult to change over once the board is fully assembled!)

Capacitors:

Electrolytic Caps:		
C1	10µF	
C2,C4,C7	100µF	
C8	220µF	
C9	47µF	
Mylar Caps:		
C3	0.1µF	Marking = "104"
C5	220pF	Marking = "221"
C6	3nF (or 3.3nF in some kits)	Marking ="302" (or "332")

Fig 3.5 Identifying the Capacitor markings .

Step 3. IC Sockets

Carefully insert the IC Sockets.
Take particular care to identify and then align the "notch" which identifies the orientation for the socket and the IC to follow.

For extra information, please view the drawings on the back of the FK675 packet.

Step 4. The Volume “Trimpots” (Trimmer Potentiometers):

Carefully align the three legs of the Trimpots (VR1 and VR2) with the mounting holes. *(Please note that there are several different styles and sizes of trimpots, hence the board has been laid out to accept any of three different sized trimpots.)*

Refer to Fig 3.6 to see a sample of mounted trimpots.

Fig 3.6 Showing the trimpots installed .

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Step 5. Insert the "Stakes" and Standoffs.

These are the short, thick gold pins which are inserted from the rear of the PCB, and then soldered into place.

Step 6. Install the IC's.

Carefully orient the IC's to ensure that their "notches" are aligned with the markings on the PCB!

Note to teachers:

This is often the most difficult step for many beginners.

Most new IC's have their legs sprung slightly wider that the intended mounting holes. This is to encourage good, natural electrical contact between the legs and the Printed Circuit Board (or IC Socket) when they are inserted.

HOWEVER ... for electronics beginners, there is a temptation to try to "force" the pins in to the holes before they are properly aligned.

Many students experience bent pins and other electrical problems which arise due to inappropriate use of force at this stage.

We strongly recommend carefully aligning the pins along one side of the IC, with the Socket, then Slightly "Flexing" them so that the second side can be inserted.

Step 7. Connecting wires, speakers and Battery snap.

Once the standoffs are set, 'tin' each with solder. *(For more information on "tinning", please refer to our separate document "Towards Better Soldering").* The battery snap can be soldered into place by 'tinning' the leads and ensuring the black wire is attached to the 'ground' (G) or negative (-) pole and the red wire to the positive (+).

The input should be soldered onto the three input stakes.

Finally the four standoffs can be connected to the speakers. Take note to connect the "-" side of each speaker to the Ground standoff. (Marked "G").

The "+" pin of one speaker should be connected to the "Speaker Right" standoff (marked "SP R"), and then the other speaker connected to the "Speaker Left" standoff (marked "SP L").

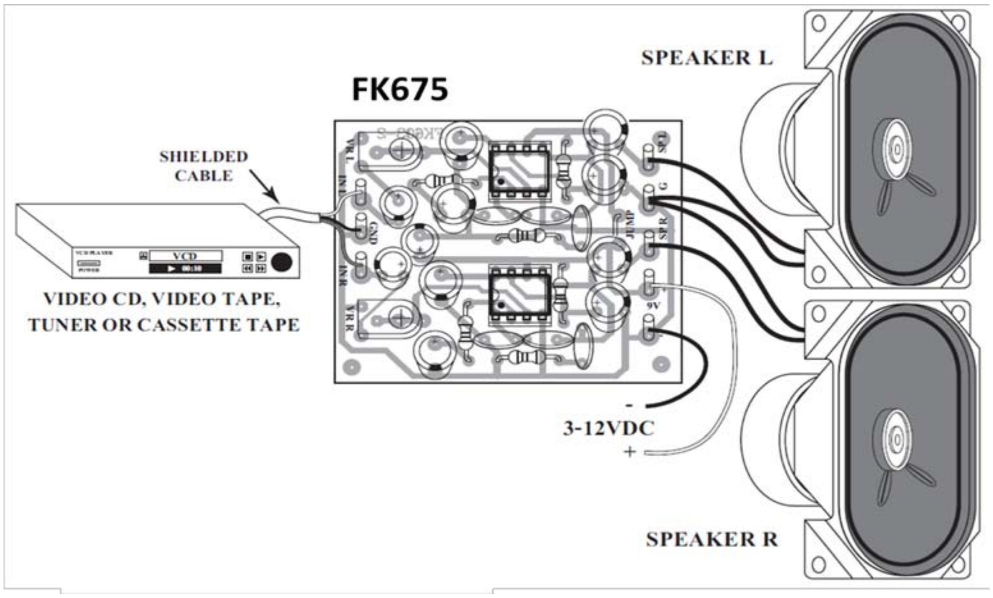

Fig 4 Attaching the wires

Testing:

Do not connect any input sound source yet!

We must first check the system has been constructed correctly!

Apply the power supply at 9V DC.

Watch for any sparks or signs of overheating.

If you see any sparks:

- Do not worry (yet). It is common for many circuits which have a lot of capacitors in them (like this one) to draw a large “inrush” current at the first contact.
- Disconnect the power immediately.
- Test for any “hot spots”.
- If no obvious hot spots, then
  - Reconnect the power and watch for sparks a second time.
  - If NO sparks a second time, this is normal! Things are looking good!
  - If you continue to see sparks, you will need to recheck all your soldering for any “short Circuit” bridges.
- If you find a “hot spot” :
  - Check for solder bridges which are causing a short circuit somewhere.
  - Check that all components have been inserted correctly.
  - Check for any loose “wire” off cuts which may be causing a short circuit.

Once you have the power connected and no signs of other problems, it is time to apply an audio signal.

-Turn the trimpots fully anticlockwise (Volume is down as much as possible).

- Now apply the audio source .

- Slowly turn the volume trimpot clockwise.

- The volume of the output should rise with the trimpot turning.

- If the quality of the output sound starts to deteriorate, it is possible that the volume of the input is exceeding the limits of the system. Therefore it may be that you have reached the usable limit of the input!

Care and Warnings:

The audio amp IC (TBA820M) is rated to a maximum of +12V DC. Do not apply any voltage above this. *(We recommend operating with a 9V DC battery as the power source for the first testing!)*

Most of the problems we have experienced with this kit are one of three kinds:

1) Soldering induced problems. (Short circuit bridges as well as poor quality "cold solder joints")
2) Component misplaced or misaligned.
3) Wire connections intermittent