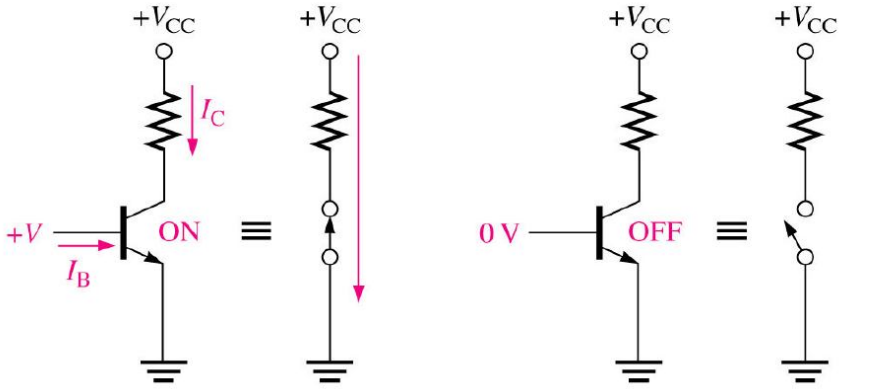
ĐHBK Tp HCM-Khoa Đ-ĐT
BMĐT
GVPT: Hồ Trung Mỹ
Môn học: Dụng cụ bán dẫn

Chương 5

BJT

5.9 Các ứng dụng của BJT

BJT làm khóa điện tử

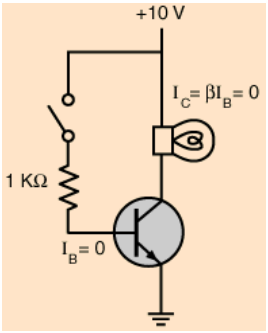


(a) BJT bão hòa (ON) tương tự khóa đóng (b) BJT tắt (OFF) tương tự khóa mở

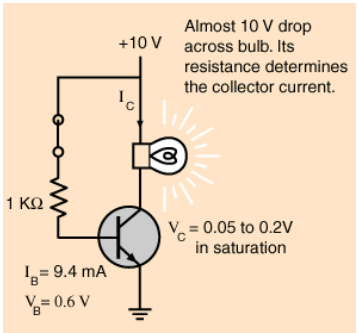
Chú ý:

- Thường có thêm R_B hạn dòng tại B, khi đó có thể chọn R_B theo quan hệ sau
  $\beta I_{Bsat} > I_{Csat}$ (trong thực tế lấy $\beta = \beta_{min}$)
- Dùng điều kiện $V_{CE} \le V_{CEsat}$ =0.2V (Si) để tìm giới hạn của điện trở tải

Transistors as Switches (BJT làm khóa điện tử)

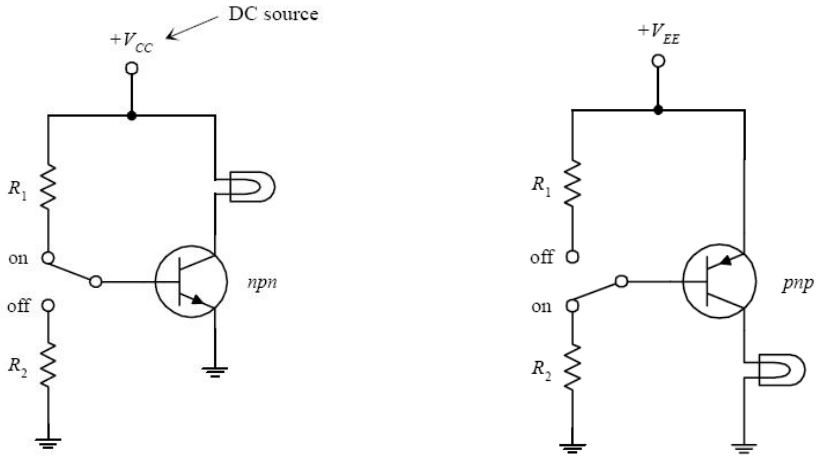


There is no current to the base, so the transistor is in the cut off condition with no collector current. All the voltage drop is accoss the transistor.



The base resistor is chosen small enough so that the base current drives the transistor into saturation.

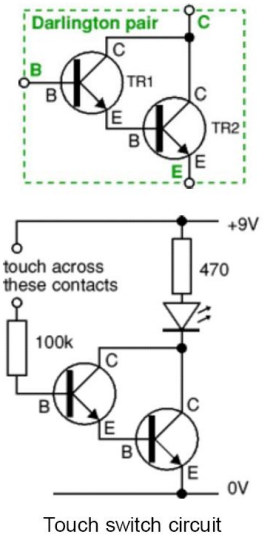
TRANSISTOR SWITCH



Touch switch circuit

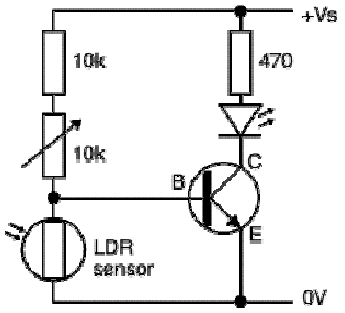
Darlington pairs are available as complete packages but you can make up your own from two transistors; TR1 can be a low power type, but normally TR2 will need to be high power. The maximum collector current Ic(max) for the pair is the same as Ic(max) for TR2.

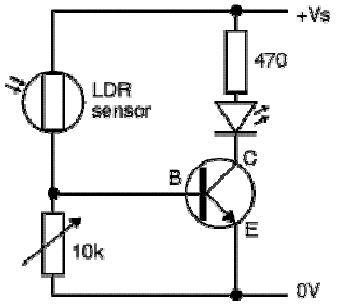
A Darlington pair is sufficiently sensitive to respond to the small current passed by your skin and it can be used to make a **touch-switch** as shown in the diagram. For this circuit which just lights an LED the two transistors can be any general purpose low power transistors. The 100k resistor protects the transistors if the contacts are linked with a piece of wire.



Touch switch circuit

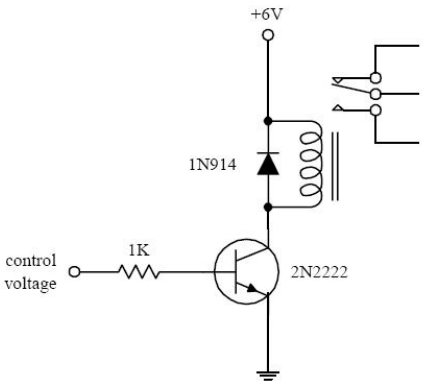
Trong 2 mạch sau thì mạch nào khi ở trong tối thì LED sáng?





RELAY DRIVER (Mạch lái rờ-le)

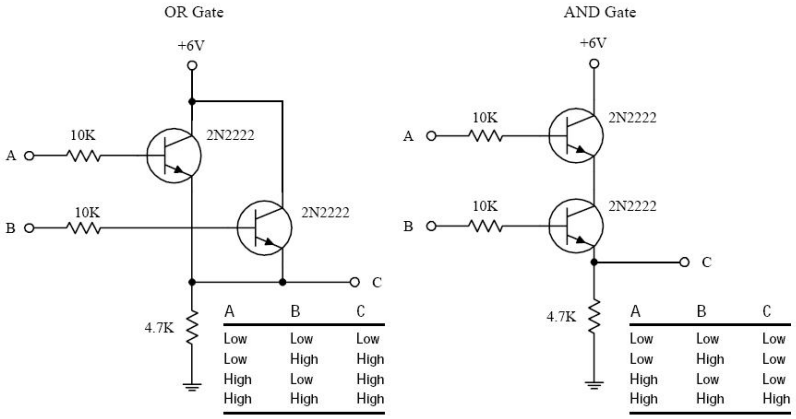
RELAY DRIVER



Here, an *npn* transistor is used to control a relay. When the transistor's base receives a control voltage/current, the transistor will turn on, allowing current to flow through the relay coil and causing the relay to switch states. The diode is used to eliminate voltage spikes created by the relay's coil. The relay must be chosen according to the proper voltage rating, etc.

TRANSISTOR LOGIC GATES

TRANSISTOR LOGIC GATES

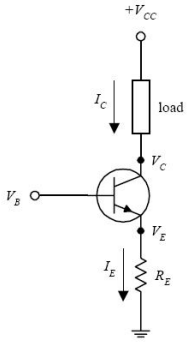


The two circuits here form logic gates. The OR circuit allows the output (*C*) to swing to a high voltage when either *A* or *B* or both *A* and *B* are high. In other words, as long as at least one of the transistors is biased (turned on), a high voltage will appear at the output. In the AND gate circuit, both *A* and *B* must be high in order for *C* to go high. In other words, both transistors must be biased (turned on) for a high voltage to appear at the output.

Nguồn dòng hằng

CURRENT SOURCE

CURRENT SOURCE



$V_E = V_B - 0.6\text{V}$

$I_E = \frac{V_E}{R_E}$

$I_C \simeq I_E$ (for large h_{FE})

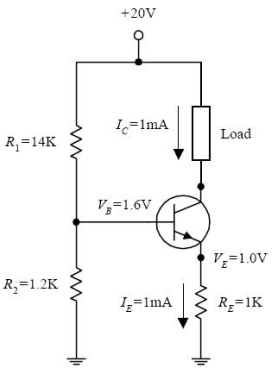
The circuit here shows how an *npn* transistor can be used to make a simple current source. By applying a small input voltage and current at the transistor's base, a larger collector/load current can be controlled. The collector/load current is related to the base voltage by

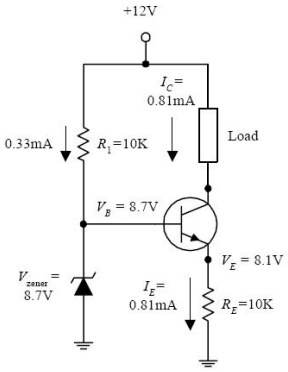
$$I_C = I_{\text{load}} = \frac{V_B - 0.6\,\text{V}}{R_E}$$

The derivation of this equation is shown with the figure.

CURRENT BIASING METHODS

CURRENT BIASING METHODS





Two common methods for biasing a current source are to use either a voltage-divider circuit (shown in the leftmost circuit) or a zener diode regulator (shown in the rightmost circuit). In the voltage-divider circuit, the base voltage is set by R_1 and R_2 and is equal to

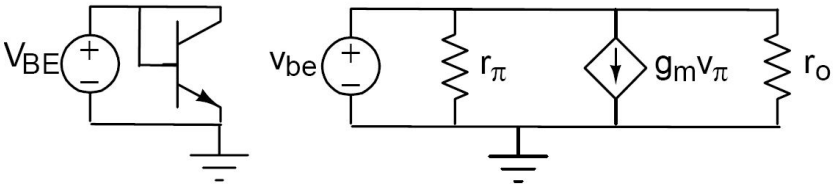
$$V_B = \frac{R_2}{R_1 + R_2} V_{CC}$$

In the zener diode circuit, the base voltage is set by the zener diode's breakdown voltage such that

$V_B = V_{\text{zener}}$

Nguồn dòng dùng BJT
BJT Current Mirror
(Gương dòng điện dùng BJT)

BJT được nối như diode



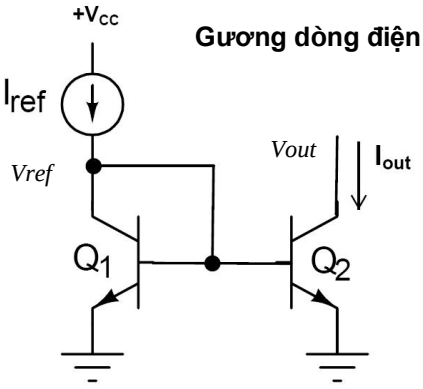
$$I_C = I_s e^{\frac{V_{BE}}{V_t}}$$

$$v_{be} = i_c \left(r_\pi \left\| \frac{1}{g_m} \right\| r_o \right) = i_c \left(\frac{(\beta \| 1)}{g_m} \right\| r_o \Big) = i_c \left(\frac{\alpha}{g_m} \right\| r_o \Big) = i_c \left(r_e \| r_o \right)$$

$$R_{equiv} \equiv \frac{v_{be}}{i_c} = \left(r_e \| r_o \right) \approx r_e$$

Incremental resistance is approximately r_e

Gương dòng điện đơn giản dùng BJT



$$I_{C1} = I_{C2} = I_S e^{\frac{V_{BE}}{V_t}} = \frac{\beta}{\beta+1} I_{E1}$$

$$I_{B1} = I_{B2} = \frac{1}{\beta+1} I_{E1}$$

$$I_{ref} = I_{C1} + I_{B1} + I_{B2} = \frac{\beta+2}{\beta+1} I_{E1}$$

$$I_{out} = I_{C2} = \frac{\beta}{\beta+1}\frac{\beta+1}{\beta+2} I_{ref} = \frac{\beta}{\beta+2} I_{ref}$$

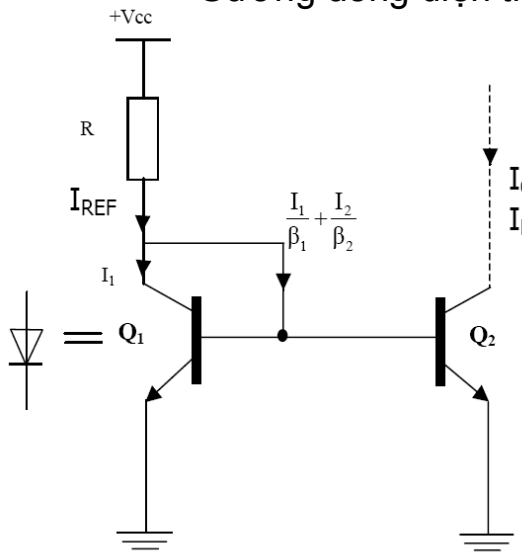
$$\frac{I_{out}}{I_{ref}} = \frac{\beta}{\beta+2} = \frac{1}{1+\frac{2}{\beta}}$$

Output resistance of simple current mirror is r_o of Q_2 current, so assuming perfect matching of Q_1 and Q_2 and ignoring finite β effects, $I_{out} = I_{ref}$ only when $V_{out} = V_{ref}$

$$I_{out} = I_{ref} \frac{\beta}{\beta+2}\left(1+\frac{V_{out}-V_{ref}}{V_A}\right)$$

Nếu $V_A >> V_{out}–V_{ref}$ và $\beta >> 2$ thì $I_{out} \approx I_{ref}$

Gương dòng điện thực tế



$I_O \approx I_{REF}$

$I_{REF} = (V_{CC} - V_{BE})/R = const$

$$R_{OUT} = r_{ce} = \frac{V_A}{I_O}$$

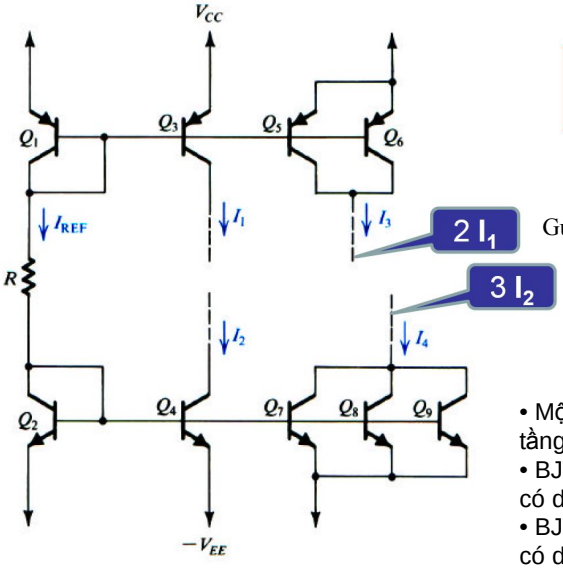
Chú ý: Mạch này dùng 2 BIT có đặc tính giống nhau

Gương dòng điện đơn giản

- Chú ý có nhiều dạng gương dòng điện (xem thêm các tài liệu về “electronic circuits”)

- Một số điểm lưu ý khi thiết kế gương dòng điện như các slide trước:
  1. Hai BJT phải luôn ở **chế độ tích cực**
  2. Để dòng ở tải I_O bằng dòng chuẩn (I_{REF}) thì phải chọn **2 BJT có đặc tính giống nhau**
  3. Có giới hạn trị số điện trở của tải để bảo đảm điều kiện 1 thì mạch mới làm việc như nguồn dòng (ta dùng điều kiện để bảo đảm Q_2 tích cực: **$V_{CE2} > V_{CEsat}$** để suy ra giới hạn của tải)

Gương dòng điện nhiều đầu ra



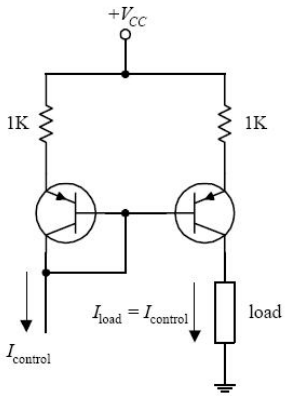
$$I_{REF} = \frac{V_{CC} + V_{EE} - V_{EB1} - V_{BE2}}{R}$$

Gương dòng điện với N đầu ra nối chung

$$\frac{I_O}{I_{REF}} = \frac{1}{1 + (N+1)/\beta}$$

- Một điện trở có thể đặt trị cho nhiều tầng cung cấp dòng hằng.
- BJT NPN cung cấp dòng hằng cho tải có dòng đi từ tải xuống $-V_{EE}$.
- BJT PNP cung cấp dòng hằng cho tải có dòng chạy từ $+V_{CC}$ xuống tải.

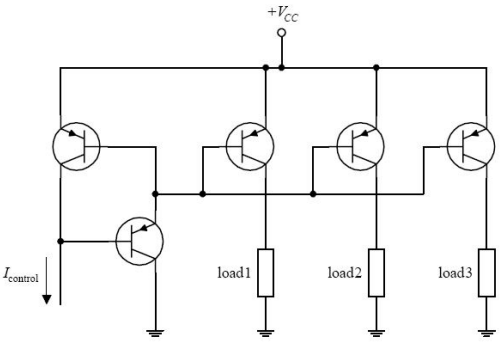
CURRENT MIRROR



Here, two matched *pnp* transistors can be used to make what is called a *current mirror*. In this circuit, the load current is a "mirror image" of the control current that is sunk out of the leftmost transistor's collector. Since the same amount of biasing current leaves both transistors' bases, it follows that both transistors' collector-to-emitter currents should be the same. The control current can be set by, say, a resistor connected from the collector to a lower potential. Current mirrors can be made with *npn* transistors, too. However, you must flip this circuit upside down, replace the *pnp* transistors with *npn* transistors, reverse current directions, and swap the supply voltage with ground.

MULTIPLE CURRENT SOURCES

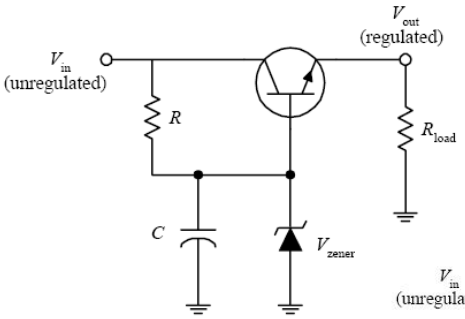
MULTIPLE CURRENT SOURCES



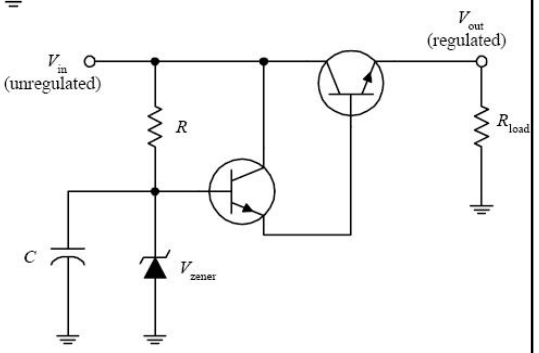
The circuit here is an expanded version of the previous circuit, which is used to supply a "mirror image" of control current to a number of different loads. (Again, you can design such a circuit with *npn* transistor, too, taking into consideration what was mentioned in the last example.) Note the addition of an extra transistor in the control side of the circuit. This transistor is included to help prevent one transistor that saturates (e.g., its load is removed) from stealing current from the common base line and hence reducing the other output currents.

Mạch ổn áp

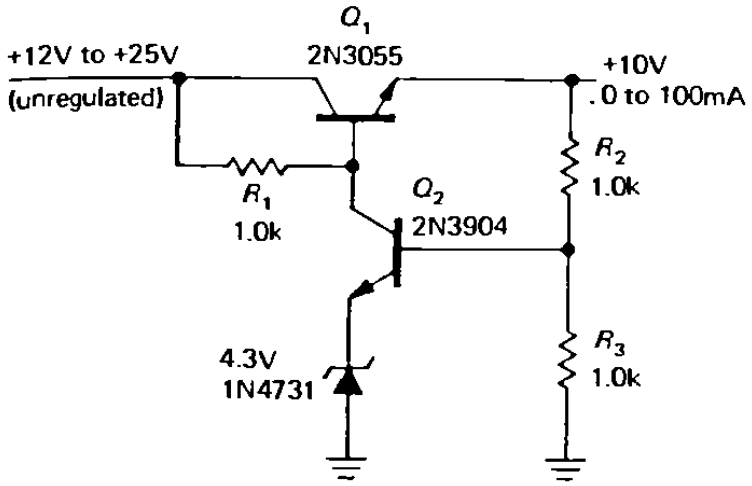
VOLTAGE REGULATOR



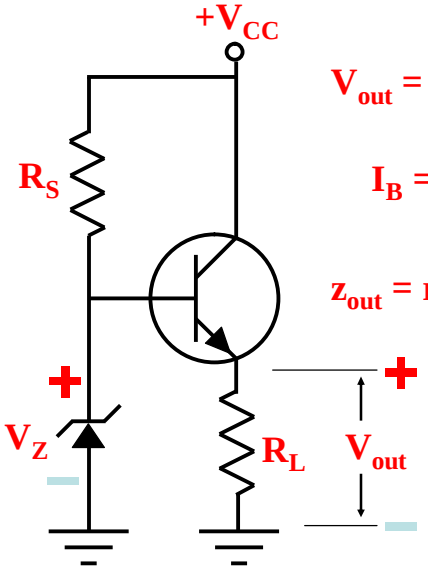
A low-power zener diode can regulate the base voltage of of a transistor that can pass a considerable amount of current. The capacitor is added to reduce the noise from the zener diode and also forms an *RC* filter with the resistor that is used to reduce ripple voltages.



Feedback voltage regulator



Mạch theo Zener (Zener follower)



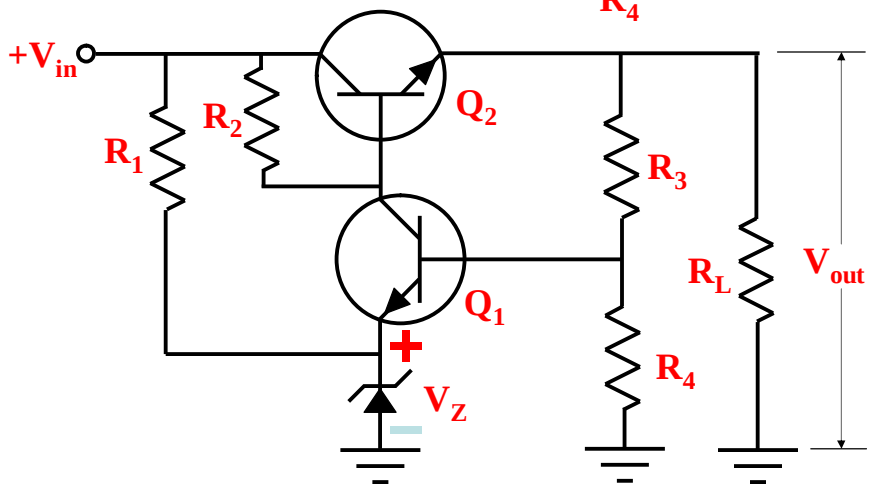
$$V_{out} = V_Z - V_{BE}$$

$$I_B = \frac{I_{out}}{\beta_{dc}}$$

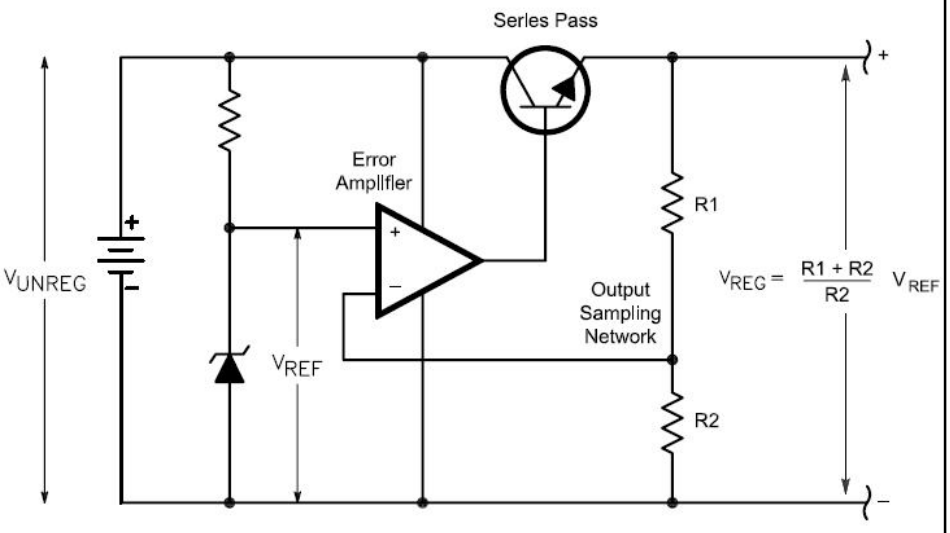
$$z_{out} = r_e' + \frac{R_Z}{\beta_{dc}}$$

Mạch ổn áp hai transistor

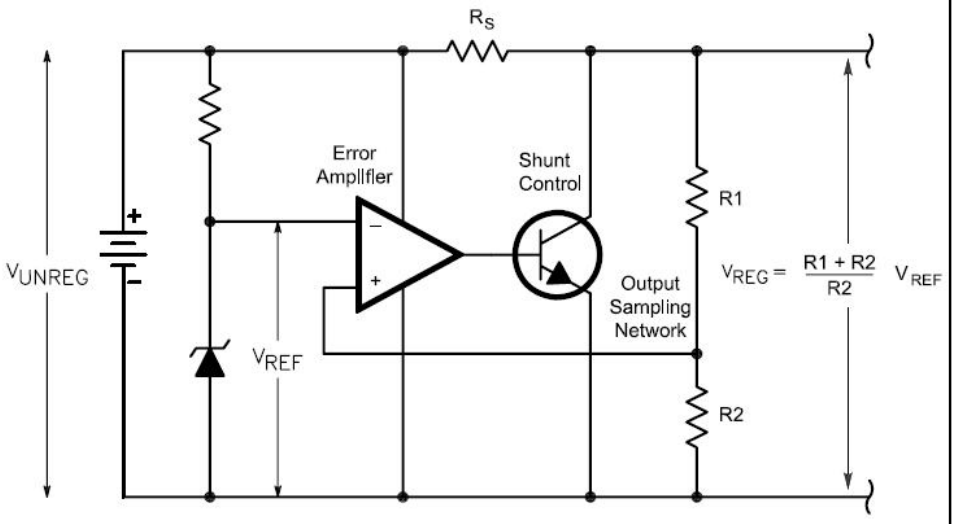
$$V_{out} = \frac{R_3 + R_4}{R_4}(V_Z + V_{BE})$$



Mạch ổn áp nối tiếp (series voltage regulator)



Mạch ổn áp song song (shunt voltage regulator)



Tăng dòng cấp cho tải

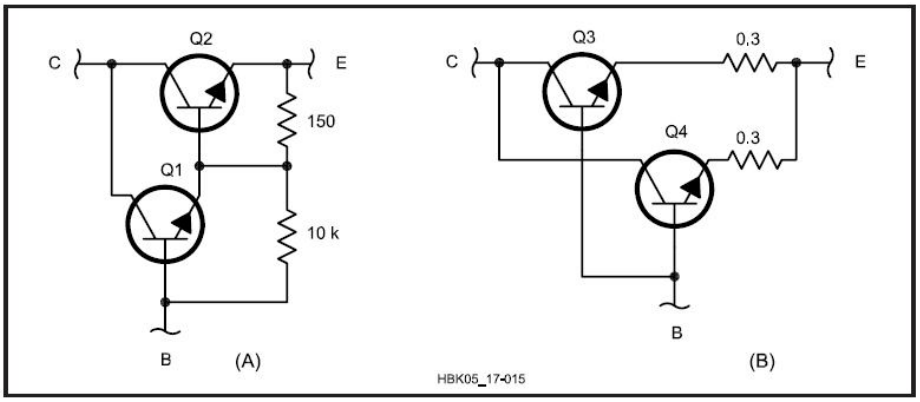


Fig 17.15 — At A, a Darlington-connected transistor pair for use as the pass element in a series-regulating circuit. At B, the method of connecting two or more transistors in parallel for high-current output. Resistances are in ohms. The circuit at A may be used for load currents from 100 mA to 5 A, and the one at B may be used for currents from 6 A to 10 A.

Q1 — Motorola MJE 340 or equivalent **Q2 - Q4 — Power transistor such as 2N3055 or 2N3772**

Mạch ổn áp có bảo vệ quá tải

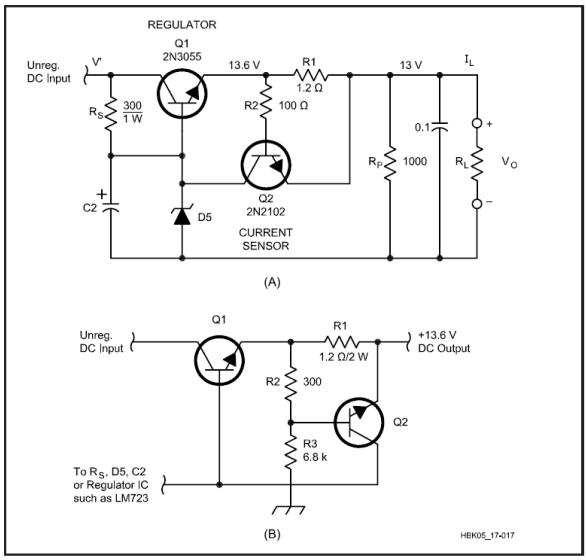


Fig 17.17 — Overload protection for a regulated supply can be implemented by addition of a current-overload-protective circuit, as shown at A. At B, the circuit has been modified to employ current-foldback limiting.

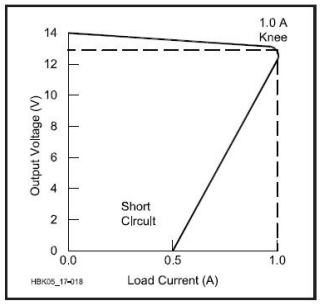


Fig 17.18 — The 1-A regulator shown in Fig 17.17B will fold back to 0.5 A under short-circuit conditions.

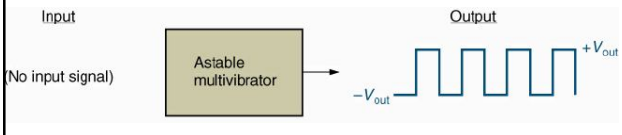
Mạch dao động đa hài

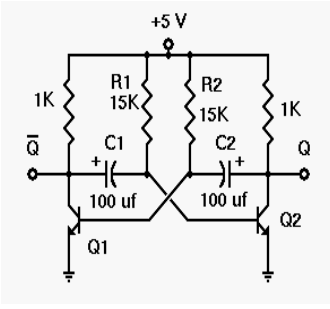
Multivibrators (Mạch dao động đa hài)

- Multivibrator – A circuit designed to have zero, one, or two stable output states.
- There are three types of multivibrators.
  - Astable (or Free-Running Multivibrator) **[bất ổn]**
  - Monostable (or One-Shot) **[đơn ổn]**
  - Bistable (or Flip-Flop) **[lưỡng ổn = 2 trạng thái bền]**

Astable Multivibrators

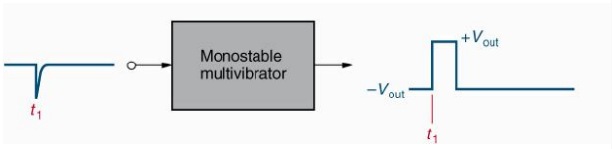
- Astable multivibrator – A switching circuit that has no stable output state.
  - The astable multivibrator is a rectangular-wave oscillator.
  - Also referred to as a free-running multivibrator.

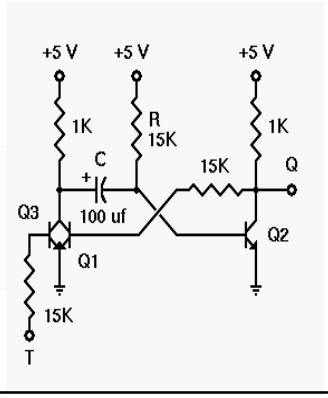




Monostable Multivibrators

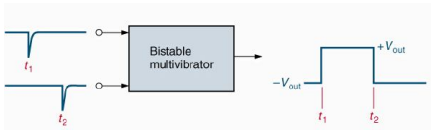
- Monostable multivibrator – A switching circuit with one stable output state.
  - Also referred to as a one-shot.
  - The one-shot produces a single output pulse when it receives a valid input trigger signal.

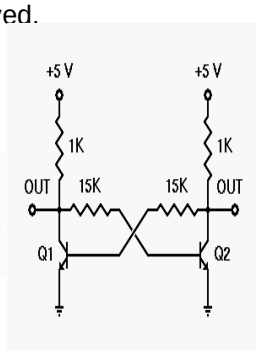


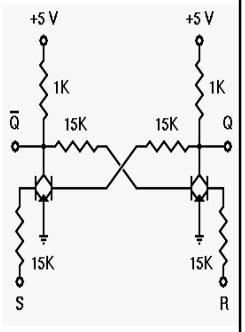


Bistable Multivibrators

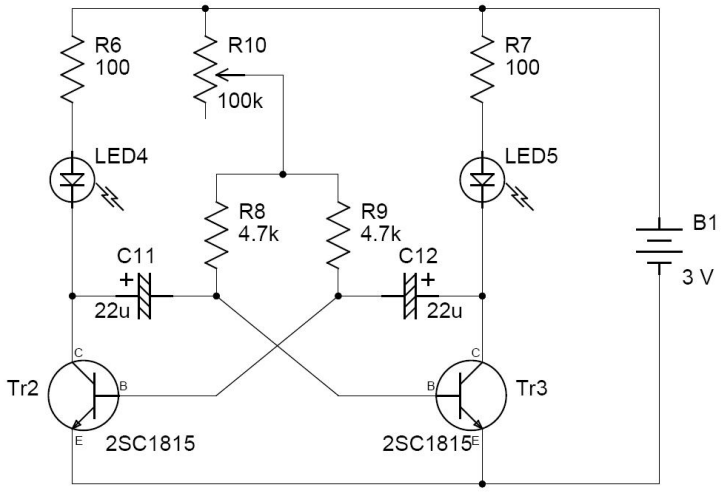
- Bistable multivibrator – A switching circuit with two stable output states.
  - Also referred to as a flip-flop.
  - The output changes state when it receives a valid input trigger signal, and remains in that state until another valid trigger signal is received.





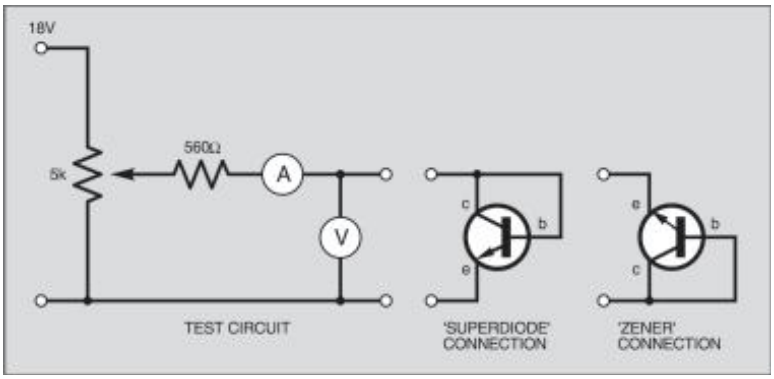


2 LED Blink circuit (Astable Multivibrator)
F = 0.3-7Hz



Sử dụng BJT như diode

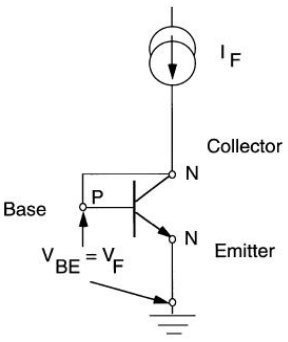
Sử dụng BJT như diode

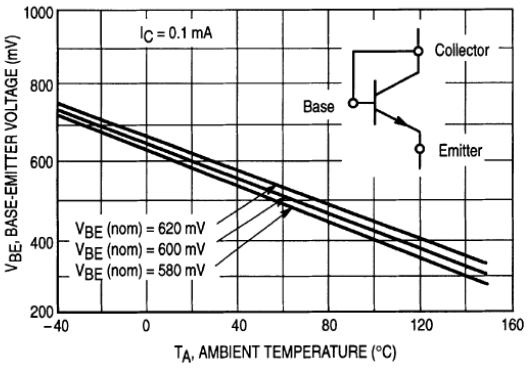


Mạch thử cho BJT-NPN dùng làm "siêu diode" và Zener

BJT được mắc như diode để làm cảm biến nhiệt độ (temperature sensor)

$V_{BE} = f(T_A)$





Base–emitter voltage vs. ambient temperature for a silicon temperature sensor.

The overall forward voltage drop has a temperature coefficient of approximately $TCV_{BE} = -2$ mV/ °C.

Table 1: Forward voltage drop comparisons

Diode	*Construction*	*Emitter-base junction at 100μA*	*Superdiode at 100μA*
OA91	Germanium diode	0·184V	
1N914	Silicon diode	0·509V	
2N1307	Germanium transistor	0·137V	0·077V
AC128	Germanium transistor	0·105V	0·046V
OC71	Germanium transistor	0·097V	0·038V
BC107	Silicon transistor	0·610V	0·553V
BCY31	Silicon transistor	0·511V	0·487V
2N3904	Silicon transistor	0·640V	0·627V

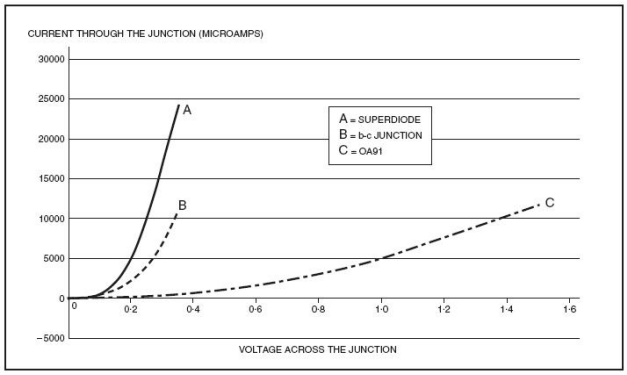


Fig.2. Forward biased germanium junctions.

Dùng BJT làm diode Zener

Table 2: Transistors as Zener diodes

Transistor	*Voltage*	*Transistor*	*Voltage*
2N3553	5·57	BFY18	8·11
2N3703	6·06	BSY26	8·15
2N2846	6·18	2N13l07	8·22
2N4037	6·35	BC148	8·38
BFX29	6·40	BFX85	8·44
2S847	7·16	BSX23	8·72
BSY27	7·38	BC639	8·83
2N3904	7·66	BC109	9·05
BC107	7·97	2N696	9·21
2N1613	8·08	BSY85	9·43

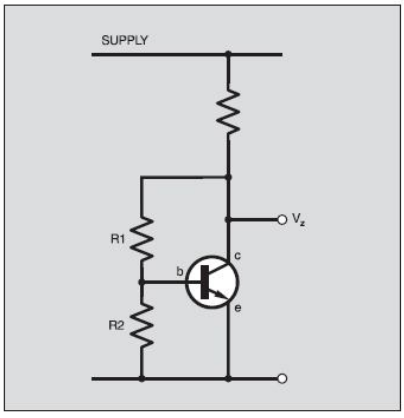


Fig.3. Circuit for selecting the Zener voltage by varying the ratio of R1, R2.

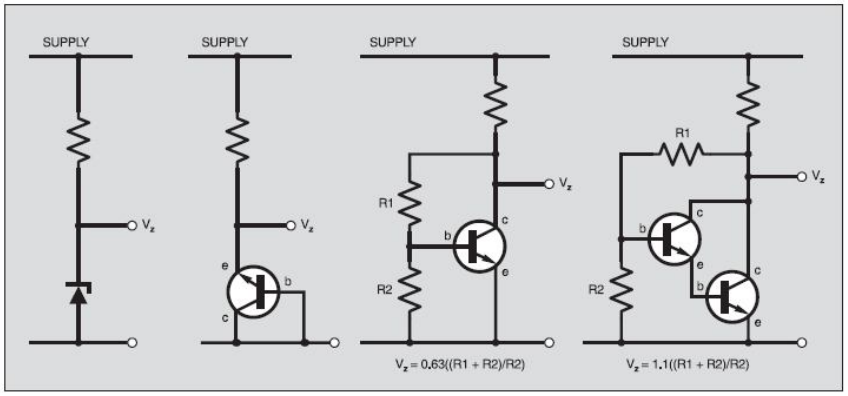


Fig.4. The use of transistors as Zener diodes.

Table 3: Transistors as varicap diodes

Transistor	*Measured Frequency*		*Calculated Capacitance*	
	Max MHz	*Min MHz*	*Min pF*	*Max pF*
2N1132	5·82	5·65	6·4	13·0
2N1303	5·92	5·86	2·8	4·9
2N1307	5·93	5·83	2·4	6·0
2N4036	5·77	5·55	8·3	17·2
BCY31	5·81	5·47	6·78	20·7
BFX29	5·81	5·75	6·8	9·1
OC201	5·76	5·52	8·7	18·5

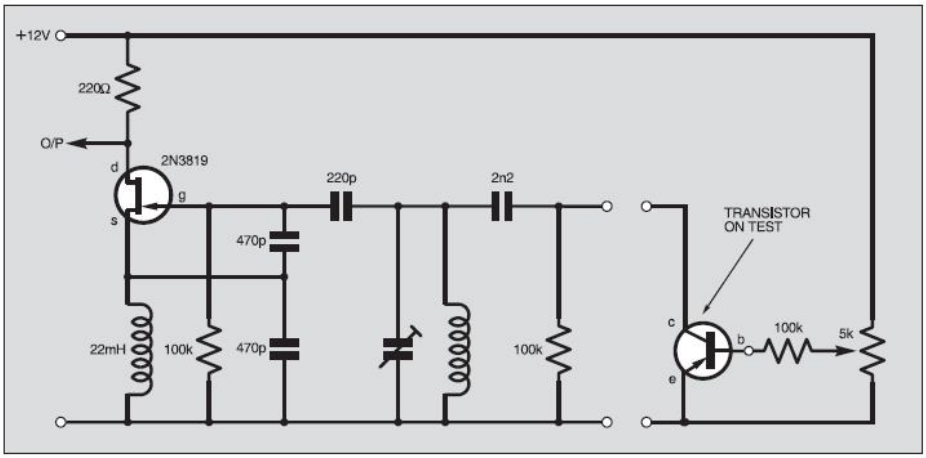
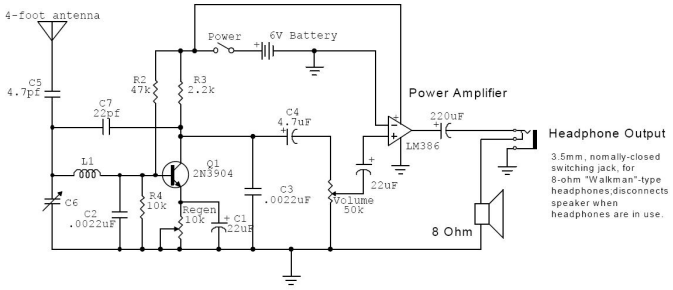


Fig.5. Test circuit for using transistors as varicap diodes.

Rất nhiều ứng dụng khác dùng BJT



3.5mm, nomally-closed switching jack, for 8-ohm "Walkman"-type headphones;disconnects speaker when headphones are in use.

L1 and C6

L1=36 turns of #22 on a 4-inch form; C6=365pf

or

L1=72 turns; C6=125pf

Procedure: Tune R1 until oscillation occurs; back off until is ceases. Now tune C6 for a station, retuning R1 as necessary.

One Transistor Regenerative AM Receiver

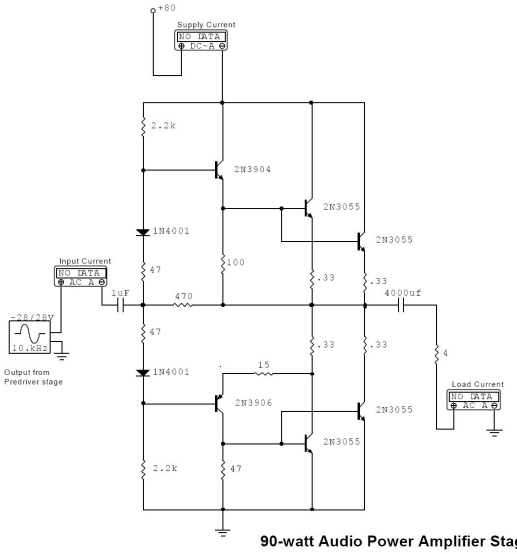
This classic design, revamped to use a transistor instead of a vacuum tube applies the principles of Regenerative Receivers-- which essentially means that the transistor stage has high levels of positive feedback at a certain frequency--the frequency of desired tuning. The stage is operated right below the point of oscillation.

In addition to amplifying the signal, the stage also provides the "detector" function.

Use four "AA" penlight cells in series as a power source, or, in a pinch, a single, 9V battery. In either case, use alkaline.

1000-mile range with a four-foot antenna.

Based on a circuit that appeared on page 8, of "Electronics Now", magazine, July, 1997.

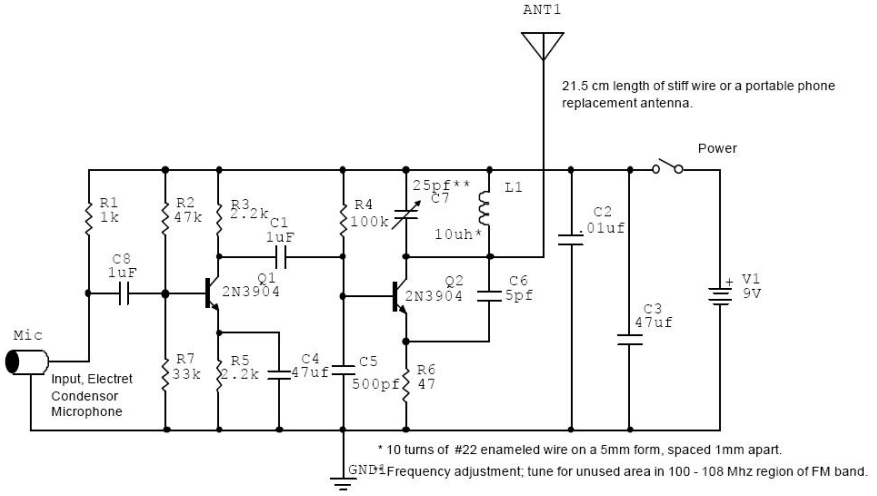


90-watt Audio Power Amplifier Stage

This is a simple, 90-watt, Quasi-complimentary audio power amplifier. The final output transistors are paralleled 2N3055s, which deliver about about 90 wrms of clean power to an four-ohm load. The stages starts going into clipping when the input from the pre-driver reaches about 28 volts peak-to-peak.

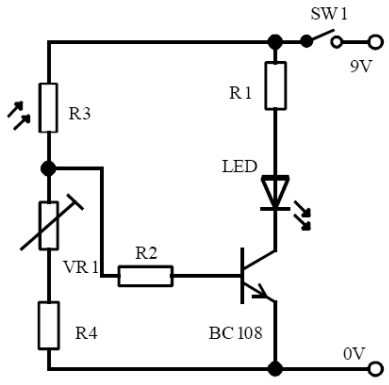
Input, output and supply meters monitor current

Micro không dây FM
FM WIRELESS MICROPHONE
By Len Galasso



Light Sensor

- *Function*
  At a predetermined light level



Components

SW1 = Toggle switch

R1 = 470 ohm

R2 = 2200 ohm

R3 = LDR

R4 = 100 ohm

VR1 = 4700 ohm

Transistor = (BC 108)

5mm LED

QUALITY FM TRANSMITTER

TAPAN KUMAR MAHARANA

This FM transmitter for your stereo or any other amplifier provides a good signal strength up to a distance of 500 metres with a power output of about 200 mW. It works off a 9V battery.

The audio-frequency modulation stage is built around transistor BF494 (T1), which is wired as a VHF oscillator and modulates the audio signal present at the base. Using preset VR1, you can adjust the audio signal level. The VHF frequency is decided by coil L1 and variable capacitor VC1. Reduce the value of VR2 to have a greater power output.

The next stage is built around transistor BC548 (T2), which serves as a Class-A power amplifier. This stage is inductively coupled to the audio-frequency modulation stage. The antenna matching network consists of variable capacitor VC2 and capacitor C9. Adjust VC2 for the maximum transmission of power or signal strength at the receiver.

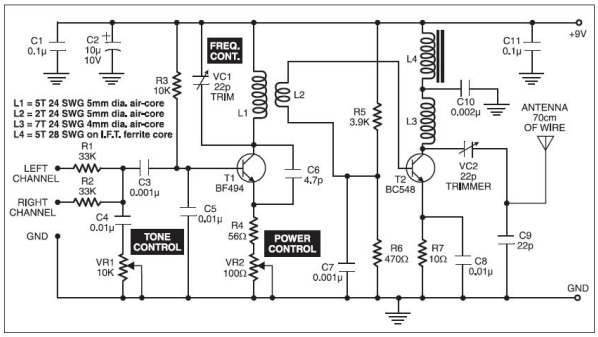
For frequency stability, use a regulated DC power supply and house the transmitter inside a metallic cabinet. For higher antenna gain, use a telescopic antenna in place of the simple wire. Coils L1 and L2 are to be wound over the same air core such that windings for coil L2 start from the end point for coil L1. Coil winding details are given below:

L1: 5 turns of 24 SWG wire closely wound over a 5mm dia. air core

L2: 2 turns of 24 SWG wire closely wound over the 5mm dia. air core

L3: 7 turns of 24 SWG wire closely wound over a 4mm dia. air core

L4: 5 turns of 28 SWG wire on an intermediate-frequency transmitter (IFT) ferrite core



Máy trợ thính rẻ tiền

LOW-COST HEARING AID

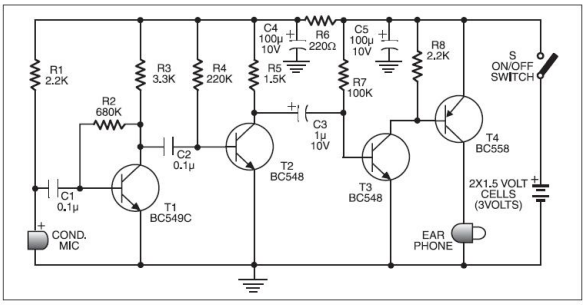
PRADEEP G.

Commercially available hearing aids are quite costly. Here is an inexpensive hearing aid circuit that uses just four transistors and a few passive components.

On moving power switch S to 'on' position, the condenser microphone detects the sound signal, which is amplified by transistors T1 and T2. Now the amplified signal passes through coupling capacitor C3 to the base of transistor T3. The signal is further amplified by pnp transistor T4 to drive a low-impedance earphone. Capacitors C4 and C5 are the power supply decoupling capacitors.

The circuit can be easily assembled on a small, general-purpose PCB or a Vero board. It operates off a 3V DC supply. For this, you may use two small 1.5V cells. Keep switch S to 'off' state when the circuit is not in use. To increase the sensitivity of the condenser microphone, house it inside a small tube.

This circuit costs around Rs 65.



Tai nghe không dây hồng ngoại

Infrared Cordless Headphone

PRADEEP G.

Using this low-cost project one can reproduce audio from TV without disturbing others. It does not use any wire connection between TV and headphones. In place of a pair of wires, it uses invisible infrared light to transmit audio signals from TV to headphones. Without using any lens, a range of up to 6 metres is possible. Range can be extended by using lenses and reflectors with IR sensors comprising transmitters and receivers.

IR transmitter uses two-stage transistor amplifier to drive two series-connected IR LEDs. An audio output transformer is used (in reverse) to couple audio output from TV to the IR transmitter. Transistors T1 and T2 amplify the audio signals received from TV through the audio transformer. Low-impedance output windings (lower gauge or thicker wires) are used for connection to TV side while high-impedance windings are connected to IR transmitter. This IR transmitter can be powered from a 9-volt mains adapter or battery. Red LED1 in transmitter circuit functions as a zener diode (0.65V) as well as supply-on indicator.

IR receiver uses 3-stage transistor amplifier. The first two transistors (T4 and T5) form audio signal amplifier while the third transistor T6 is used to drive a headphone. Adjust potmeter VR2 for max. clarity.

Direct photo-transistor towards IR LEDs of transmitter for max. range. A 9-volt battery can be used with receiver for portable operation.

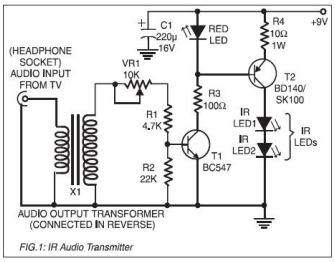


FIG.1: IR Audio Transmitter

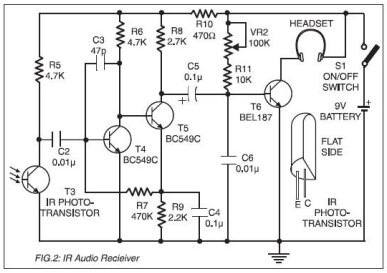


FIG.2: IR Audio Recieiver

Mạch nạp dùng năng lượng mặt trời cho nguồn điện của bộ đèn LED nhỏ

SOLAR PANEL BASED CHARGER AND SMALL LED LAMP

■ P.V. VINOD KUMAR THEKKUMURI

You can save on your electricity bills by switching to alternative sources of power. The photovoltaic module or solar panel types of batteries: lead acid, Ni-Cd and Li-ion. The lead-acid batteries are commonly used in emergency lamps and UPS.

The working of the circuit is simple. The output of the solar panel is cuit for charging a lead-acid battery, replace it with a normal pulsating DC charger once a week. Keep checking the water level of the lead-acid battery. Pure DC voltage normally leads to deposition of sulphur on the plates of lead-acid batteries.

For charging Ni-Cd cells, shift switches S1 and S3 to 'on' position and use connector 'B.' Regulator IC 7806 (IC1) is wired as a constant-current source and its output is taken from the middle terminal (normally grounded). Using this circuit, a constant current goes to Ni-Cd cell for charging. A total of four 1.2V cells are used here. Resistor R2 limits the charging current.

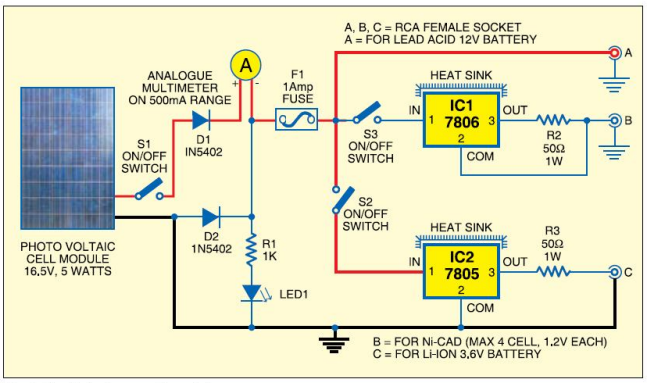


Fig. 1: Circuit of solar panel based charger

Mạch nạp dùng năng lượng mặt trời cho nguồn điện của bộ đèn LED nhỏ

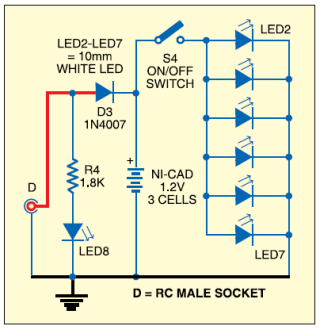


Fig. 2: LED lamp circuit

described here is capable of delivering a power of 5 watts. At full sunlight, the solar panel outputs 16.5V. It can deliver a current of 300-350 mA. Using it you can charge three fed via diode 1N5402 (D1), which acts as a polarity guard and protects the solar panel. An ammeter is connected in series between diode D1 and fuse to measure the current flowing during charging of the batteries. As shown in Fig. 1, we have used an analogue multimeter in 500mA range. Diode D2 is used for protection against reverse polarity in case of wrong connection of the lead-acid battery. When you connect wrong polarity, the fuse will blow up.

For charging a lead-acid battery, shift switch S1 to 'on' position and use connector 'A.' After you connect the battery, charging starts from the solar panel via diode D1, multimeter and fuse. Note that pulsating DC is the best for charging lead-acid batteries. If you use this circuit for charging Li-ion battery (used in mobile phones), shift switches S1 and S2 to 'on' position and use connector 'C.' Regulator IC 7805 (IC2) provides 5V for charging the Li-ion battery. Using this circuit, you can charge a 3.6V Li-ion cell very easily. Resistor R3 limits the charging current.

Fig. 2 shows the circuit for a small LED-based lamp. It is simple and low-cost. Six 10mm white LEDs (LED2 through LED7) are used here. Just connect them in parallel and drive directly by a 3.6V DC source. You can use either pencil-type Ni-Cd batteries or rechargeable batteries as the power source.

Assemble the circuit on a general-purpose PCB and enclose in a small box. Mount RCA socket on the front panel of the box and wire RCA plug with cable for connecting the battery and LED-based lamp to the charger. ●

Tai nghe TV không dây

WIRELESS TV HEADPHONE CIRCUIT

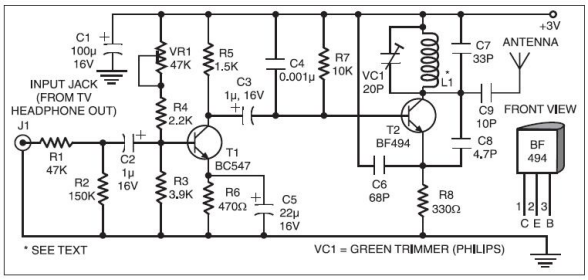
SƯU TẦM VÀ DỊCH BỞI SANI THEO

PRADIPTA BANERJEE

This circuit allows you to watch your favourite TV programmes late at night without disturbing other family members. As against imported stereo wireless TV headphones available in the market for around Rs 1200, it costs just Rs 30, or even less, if the components are taken from a discarded transistor receiver, with no compromise on performance.

The unit is basically a simple FM transmitter housed in a plastic or metal enclosure. Transistor T1 acts as an audio preamplifier. Transistor T2 works as an FM oscillator and modulator in conjunction with other passive components. Trimmer capacitor VC1 connected across inductor L1 can be varied to achieve the desired frequency. Inductor L1 comprises 4 to 6 turns of closely wound 25SWG enamelled copper wire on a 4mm dia. air core. A 20-30cm long wire serves as an antenna.

Most modern TVs are nowadays



equipped with audio-in/out and video-in/out RCA sockets. Using an RCA-to-RCA cord, connect the audio output of your TV to the transmitter's input. Adjust the gain of the audio preamplifier with the help of preset VR1 for clear reception in a portable FM receiver equipped with an earphone socket. Use a good-quality earphone.

This transmitter draws only a few milliamperes of current and doesn't require on/off switch. It can be fabricated on a small piece of stripboard. All connectors should be firm and as short as possible to prevent unwanted oscillations. The circuit operates off two AA-size penlight torch cells.

The circuit is meant for mono reception. ***EFY note.*** All TVs don't have headphone jacks.

ONE TRANSISTOR AUDIO MIXER

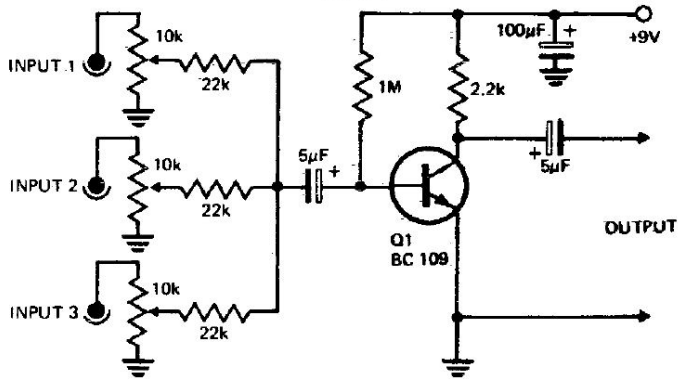


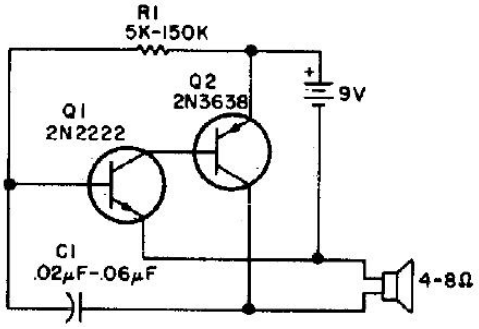
Fig. 6-7

Circuit Notes

Three or more inputs with individual level controls feed into the base of Q1 that provides a voltage gain of 20.

Mạch dao động tần số âm thanh

AUDIO OSCILLATOR



Circuit Notes

Almost any transistor will work.
R1 and C1 will vary the tone.

Mạch dao động dịch pha

PHASE SHIFT OSCILLATOR

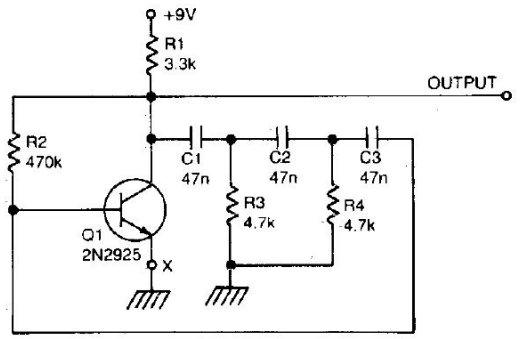


Fig. 7-12

250 Hz

Circuit Notes

A single transistor makes a simple phase shift oscillator. The output is a sine wave with distortion of about 10%. The sine wave purity can be increased by putting a variable resistor (25 ohms) in the emitter lead of Q1 (x). The resistor is adjusted so the circuit is only just oscillating, then the sine wave is relatively pure. Operating frequency may be varied by putting a 10 K variable resistor in series with R3, or by changing C1, C2, and C3. Making C1, 2, 3 equal to 100 nF will halve the operating frequency. Operating frequency can also be voltage controlled by a FET in series with R3, or optically controlled by an LDR in series with R3.

WIDE RANGE OSCILLATOR (FREQUENCY RANGE OF 5000 TO 1)

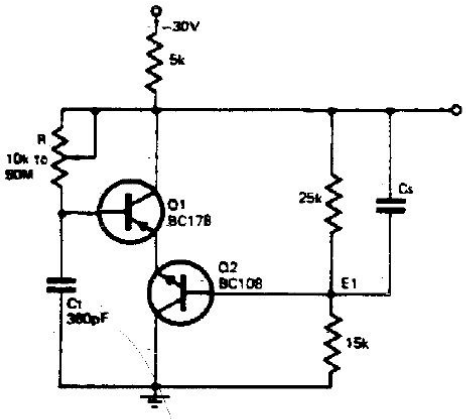


Fig. 7-15

Circuit Notes

Timing resistor R may be adjusted to any value between 10 K and 50 M to obtain a frequency range from 400 kHz to 100 Hz. Returning the timing resistor to the collector of Q1 ensures that Q1 draws its base current only from the timing capacitor Ct. The timing capacitor recharges when the transistors are off, to a voltage equal to the base emitter voltage of Q2 plus the base emitter drops of Q1 and Q2. The transistors then start into conduction. Capacitor Cs is used to speed up the transition. A suitable value would be in the region of 100 pF.

Mạch nạp pin Ni-Cad 12V, 20mAh

200 mA-HOUR, 12 V NI-CAD BATTERY CHARGER

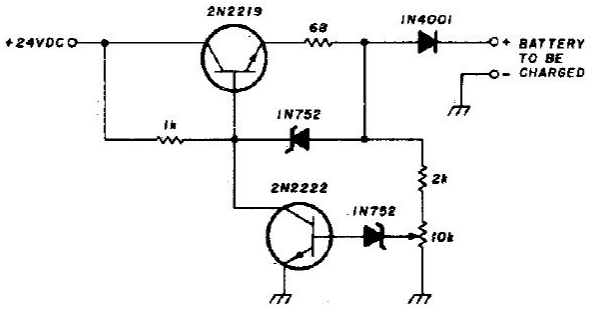


Fig. 11-6

Circuit Notes

This circuit charges the battery at 75 mA until the battery is charged, then it reduces the current to a trickle rate. It will completely recharge a dead battery in four hours and the battery can be left in the charger indefinitely. To set the shut-off point, connect a 270-ohm, 2-watt resistor across the charge terminals and adjust the pot for 15.5 volts across the resistor.

DC-TO-DC/AC INVERTER

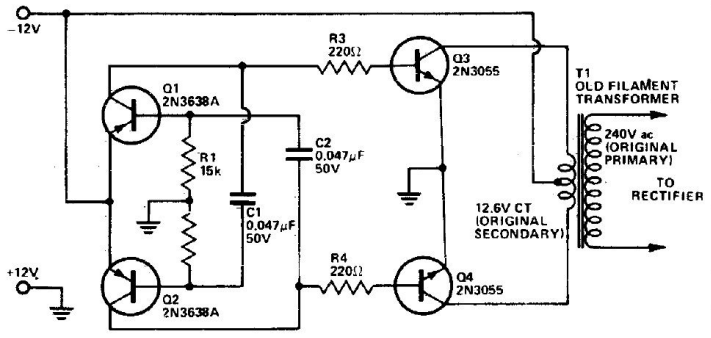


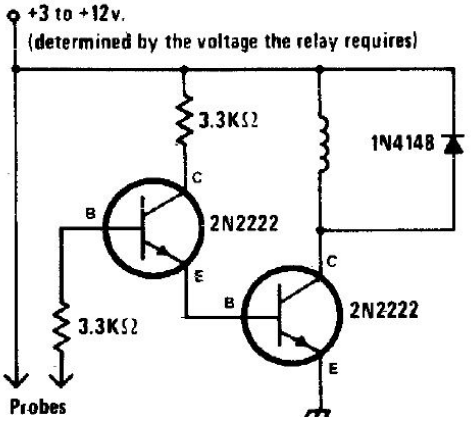
Fig. 22-1

Circuit Notes

This inverter uses no special components such as the torodial transformer used in many inverters. Cost is kept low with the use of cheap, readily available components. Essentially, it is a power amplifier driven by an astable multivibrator. The frequency is around 1200 Hz which most 50/60 Hz power transformers handle well without too much loss. Increasing the value of capacitors C1 and C2 will lower the frequency if any trouble is experienced. However, rectifier filtering capacitors required are considerably smaller at the higher operating frequency. The two 2N3055 transistor should be mounted on an adequately sized heatsink. The transformer should be rated according to the amount of output power required allowing for conversion efficiency of approximately 60%.

Mạch phát hiện mức chất lỏng

LIQUID LEVEL DETECTOR

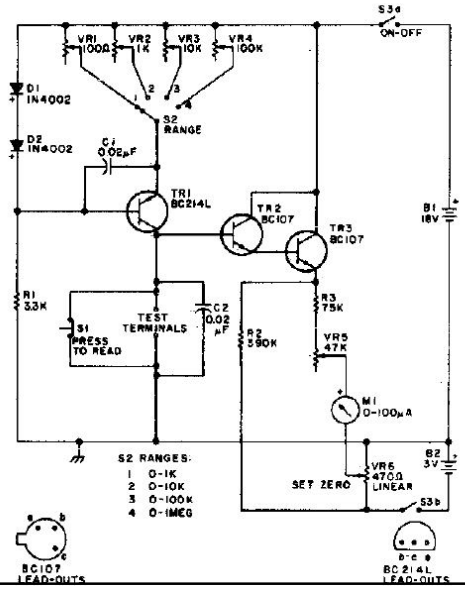


Circuit Notes

When liquid level reaches both probes, alarm is turned on. When water level recedes it goes off.

Mạch đo Ohm với thang đo tuyến tính

LINEAR SCALE OHMMETER



Circuit Notes

This circuit is designed to provide accurate measurement and a linear resistance scale at the high end. The circuit has four ranges. Another meter with a current range of 10 μA to 10 mA and sensitivity of 10,000 ohms per volt is needed for setting up.

Fig. 72-1