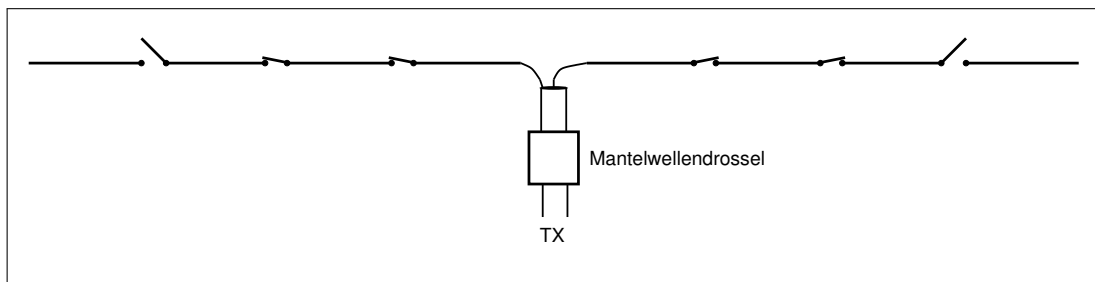


A simple dipole which is switchable to several bands ¹

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This article describes a wire dipole that can be switched by relays to resonate on multiple frequency bands without the need for complex technology or microprocessors.

To make a dipole resonate on multiple bands, you can incorporate blocking circuits that limit the effective length for each frequency. Instead of resonant circuits one can use relays. The problem with this approach is how to power the relays and how to transmit control pulses.



Principle

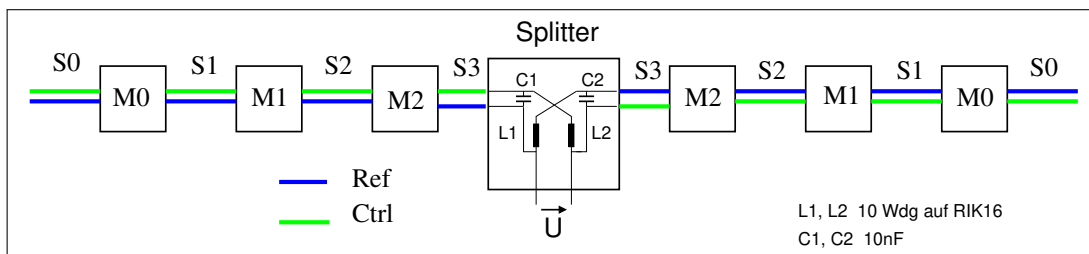
In the recently published article [1], the relays are controlled via Wi-Fi; power is supplied by rechargeable batteries in each relay module, which is not really practical. The problem was solved differently in [2] in 2008. There, a twin cable is used as the antenna wire, through which the relays are powered. Each relay module contains a small microprocessor that controls the relay. It receives its control information in the form of short blanking pulses in the supply voltage. A similar principle is used in [3] to tune a vertical $\lambda/2$ antenna for different frequencies using switchable stub lines.

The complexity of such solutions can be significantly reduced by using bistable relays, which change state when the voltage is inverted and retain their state without a power supply (TQ2SA-L2-5V, for example: www.mouser.de)

Construction principle

As in [2], each dipole half is constructed from a twin cable that is divided into segments of appropriate lengths by the relay modules. The relays are driven by a voltage U , which is applied to the two wires of the twin cable from a control box via the coaxial cable (with a sheath-wave choke) and a splitter, as described in [2].

¹The german version appears in CQ DL 7/2027

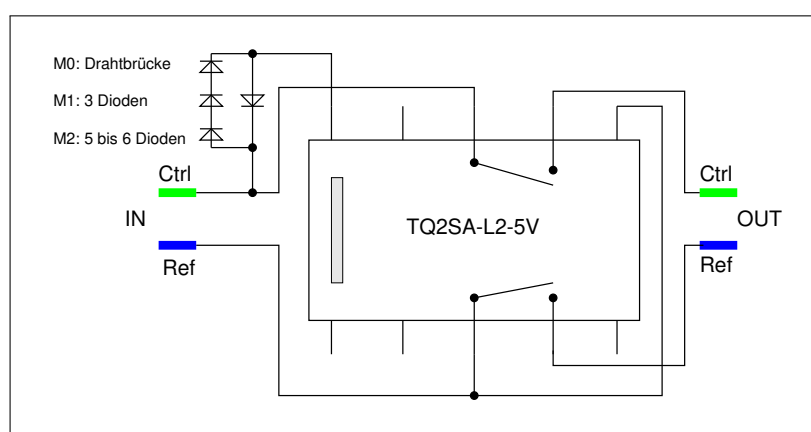


The basic operation is as follows:

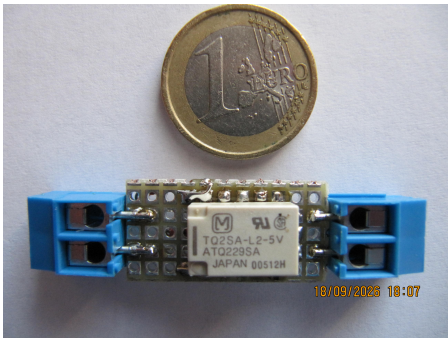
1. Reset: A negative voltage U causes all relays to close their contacts. The dipole is then at its full length.
2. When a positive voltage U is applied, each relay should open its contacts individually, depending on the magnitude of the voltage U . The threshold voltage at which this occurs increases in the modules from the periphery toward the center of the dipole, allowing the desired dipole lengths to be set.

Version 1: A dipole for 4 bands

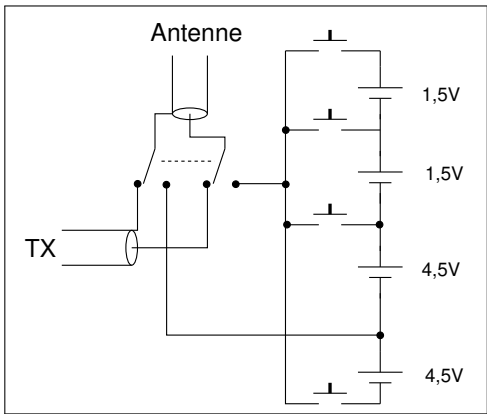
This principle is particularly easy to implement by taking advantage of the relays' switching hysteresis. According to their datasheets, the relays which are used reliably switch to state 0 or 1 at voltages above $+3.75$ V or below -3.75 V, respectively. In fact, this occurs even at approximately ± 2.5 V. At voltages between -2 V and $+2$ V, they do not change their state. The desired threshold voltages can be set by connecting suitable Zener diodes or simply a few diodes in series with the relay coil. This works well if you limit yourself to 3 modules (per dipole half, i.e., 4 frequency ranges) and select the values 4.5 V, 6 V, and 7.5 V as the control voltage U , and -4.5 V as the reset voltage. For the M1 modules, the voltage must be reduced by about 2 V; for the M2 modules, by 4 V. Note that the forward voltage of diodes can vary slightly.



Module schematics



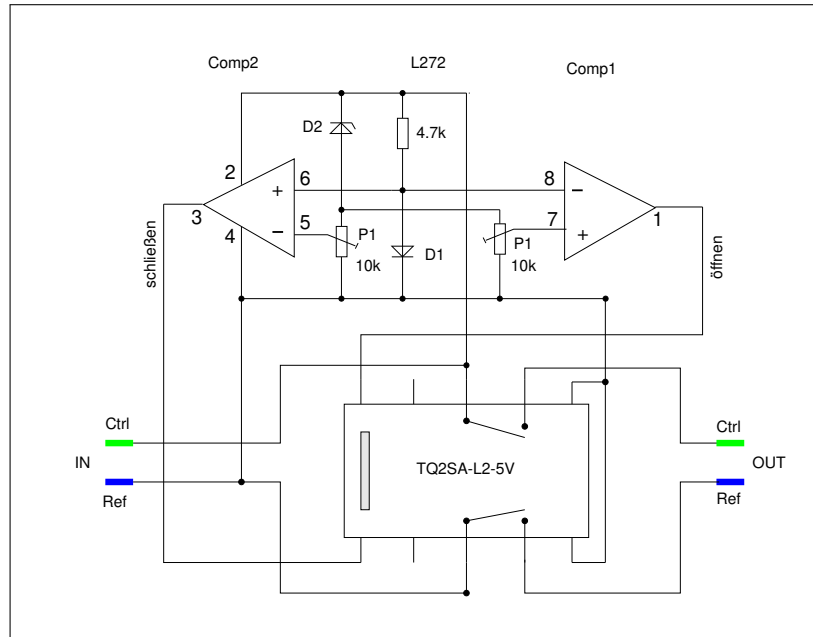
These voltage values can be obtained from a stack of AAA batteries (from which current is drawn only when the frequency is changed). The procedure for switching the dipole's frequency is then as follows. When $U = -4.5\text{ V}$ is applied, all relays close their contacts in sequence, starting with M2. If then $U = 4.5\text{ V}$ is selected, the relays in M0 open; the others remain closed. If subsequently $U = 6\text{ V}$ is applied, the relays in M1 open, and at $U = 7.5\text{ V}$, those in M2 open as well.



Control box for version 1

Version 2: More Bands

To cover more frequency bands, you need a greater number of segments and relay modules. With this principle, that would require using higher voltages, thereby exceeding the maximum allowable voltage of 7.5 V for the relay coils. A possible solution is to use an operational amplifier as a voltage comparator in each module, which allows for the distinction of finer voltage steps. It is then even possible to eliminate the need for a negative control voltage for the reset by driving the second coil in the relay via a second voltage comparator, which toggles the relay when the control voltage is less than 4.5 V (but, of course, at least 4 V to ensure the relay responds reliably).



Module for version 2

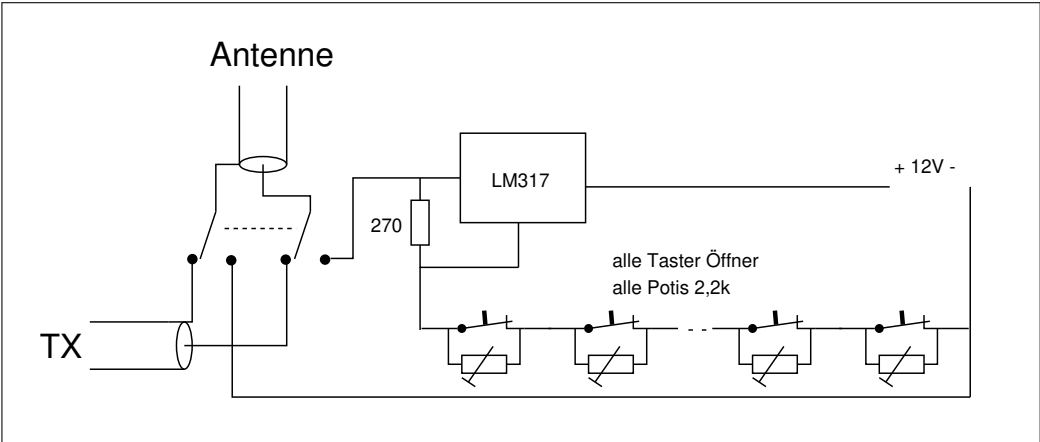
Hence the control panel does not need to supply a negative voltage for the reset; it only needs to supply a positive voltage between 4V and 7.5V. If you choose voltage steps spaced 0.5V apart, for example 4.5V, 5.0V, 5.5V, 6.0V, 6.5V, 7.0V, 7.5V, you can control 6 modules separately which is sufficient for 7 frequency bands. These voltages can be easily derived from a 12V supply using a voltage regulator. However, note the short-term current draw. The resistance of the relay coil is approximately 180 ohms. Each relay therefore draws between 22 mA and 42 mA, depending on the voltage. The voltage drop across diode D1 serves as a reference for the switching threshold. Due to the different values of the control voltage U , the current and the voltage across the diode vary slightly, with a Zener diode more than with a standard Si diode. The Zener diode D2 serves to lower the voltage level without reducing the differences between the control voltage levels. As a result, P1 and P2 do not need to produce such high division ratios, and immunity to interference is improved. Zener voltage is approximately 3 V.

Let $U(j)$ be the threshold voltage at which the relay in the j th module is to open. The $U(j)$ values are chosen in ascending order, e.g., $U(j) = 4.5 + j \times 0.5$ volts. Let $U(0)$ be the control voltage below which all relays are to close.

The potentiometers P1 and P2 are then set as follows:

1. In each module, P1 is set such that when $U(0)$ is applied as the control voltage, the voltage at Pin 5 is slightly below that at Pin 6, but when $U(j)$ is applied (with $j > 0$), it is slightly above.
2. In the j -th module, potentiometer P2 is set such that when the control voltage $U(j)$ is applied, the voltage at Pin 7 is slightly higher than that at Pin 8, but when $U(j-1)$ is applied, it is lower than that at Pin 8.

Instead of the power op-amp L272 you can also use the TL272 or a dual voltage comparator such as the LM393; however, in that case, you'll need an additional transistor to drive the relay. Do not forget a flyback diode.



Control box for version 2

Adjustement of segment lengths

Compared to the theoretical length of half-wave dipoles, the length is reduced because the relay contacts create a capacitive coupling to the subsequent segment so forming a dipole with terminal capacitance. The insulated wire used also contributes to this shortening. The impedance of the twin cable, however, plays no role because it does not function as a twin wire for RF transmission.

The best way to adjust the segment lengths is as follows. To start, select the segment lengths so that they correspond to the dimensions of standard half-wave dipoles. Then, first adjust the lengths of the two innermost segments until the innermost dipole between modules M2 is resonant. Next, adjust the next segments until the dipole between modules M1 is resonant, and so on. Changes to these segments have only a minor effect on the segments further inward, so that after at least one more round of adjustments, you will usually have achieved the desired result.

The following values result for the segment lengths of a dipole for the bands 20m, 17m, 15m, and 10m when the feed point is at a height of approximately 7m and the two halves are suspended as inverted-V at an angle of about 45 degrees downward. If the dipole is stretched out and suspended at a great height, S3 is nearly 10 cm shorter.

Segment	S0	S1	S2	S3
	124cm	54cm	74cm	225cm

A rotary multiband dipole

The modules are lightweight and can be assembled so narrowly that they, along with the twin-wire, can be inserted into a fiberglass tube or a thicker fishing rod. This creates a rotary multiband dipole.



A rotary 4-band dipole above the roof

Features

- No continuous power consumption; power is consumed only during frequency changes
- Very simple design without microprocessors
- With the specified components, the antenna can withstand 100W SSB without damage. In principle, it can also be used for higher power levels if suitable relays are employed.
- Low cost

References

- [1] P. Guatelli IK4PKK, V. Bussow IK4ICE: *Multiband-Drahtdipolantenne mit ferngesteuertem Bandwechsel* Funkamateure 6/2026, 474f
- [2] J. Weit, KI8BV: *An All Band HF Dipole Antenna*, QST Sept. 2008
- [3] V. Aurich DK3PK: *Eine portable Vertikalantenne ohne Radiale für 20m bis 10m*, www.dk3pk.de//ham/SwitchDipol15a.pdf