Forget about trailing cords. Build this

FM wireless transmitter

Forget about tangled microphone and guitar cords. This professional-quality FM wireless link will eliminate all those hassles. Expensive, you ask? How does $12.95 sound?

by BRANCO JUSTIC

One does not have to look far these days to observe the increasing trend towards the use of wireless microphones by professional entertainers and musicians.

The benefit of a wireless link for the "out front" entertainer is obvious, especially in club situations where they often step off the stage and mingle with the audience. In addition, many musicians are also using wireless microphones so that they are free to move around the stage rather than being attached to their amplifiers via connecting cables.

Microphone cables also have other problems. Whether through rough treatment or just through lack of cleaning, they often lead to unreliable operation. The more robust "professional" or "stage" chords are so expensive that a wireless link starts to look like a pretty good proposition.

Although there are lots of low-cost FM wireless microphones on the market, they are mainly limited to domestic situations. Invariably, they suffer from one or more performance deficiencies, including:

(1) excessive change of output frequency when the antenna is moved;

(2) excessive change of output frequency as the battery discharges;

(3) poor signal-to-noise ratio;

(4) microphone inserts which are unsuitable for live performance situations; and

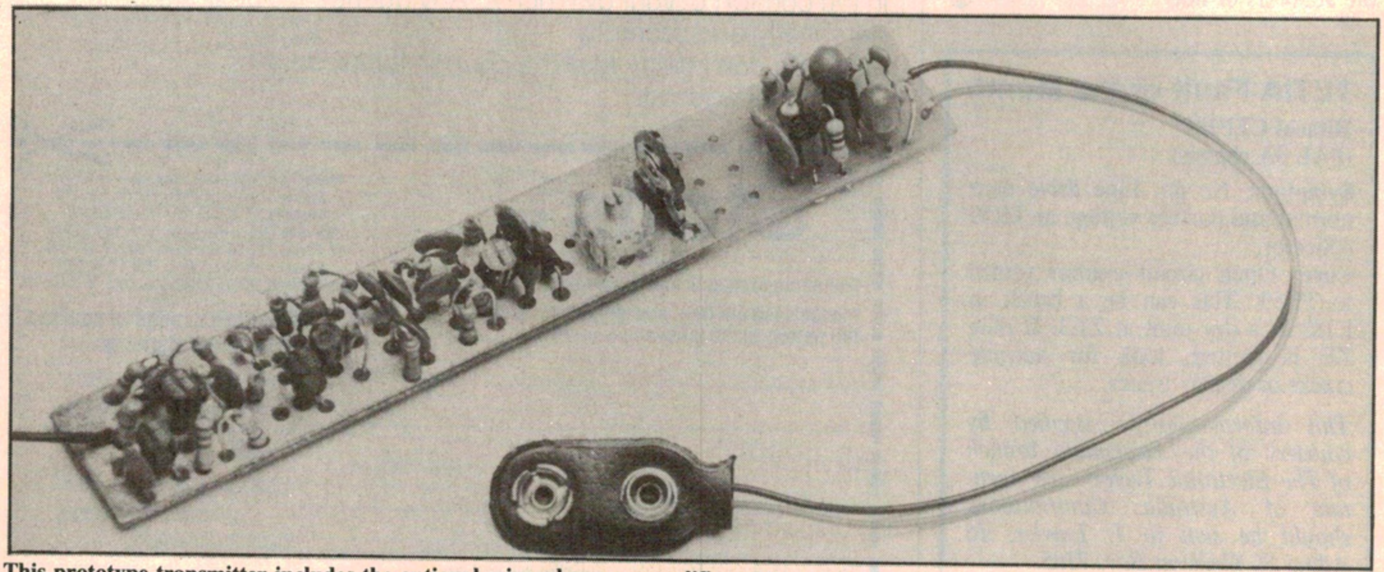
(5) optimal performance over only a small part of the FM broadcast band (usually around the middle of the band).

The FM transmitter described here overcomes all of these problems. It boasts excellent frequency stability, has a power output of about 10mW, and can be tuned across the entire FM broadcast band.

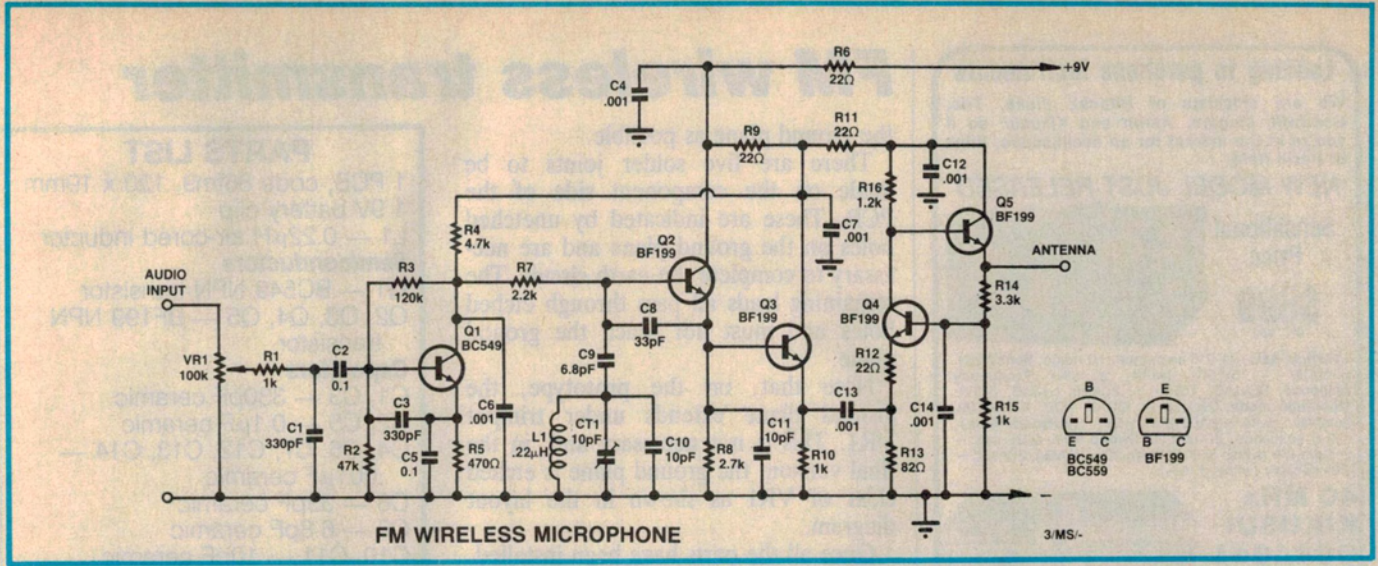
At the same time, it is very easy to build. There are no complex RF transformers to be wound; only one inductor is used in the circuit and this can be purchased prewound.

In its simplest form, the circuit is designed for use with high-impedance dynamic microphones. Alternatively, by adding a simple two-stage transistor amplifier, it can also be used with high-quality low-impedance microphones. Provision has been made on the PCB for this option.

As can be seen from the photograph, the PCB has been made quite narrow (19 x 120mm) so that it can be built into a piece of plastic conduit. The preamplifier section can be trimmed off if not required (see wiring diagram).



This prototype transmitter includes the optional microphone preamplifier. (Note: C10 not shown in this photograph.)



The circuit consists of common emitter stage Q1, Colpitts oscillator and output stage Q3, Q4 and Q5.

Circuit description

Refer now to the main circuit diagram. Input signals from the microphone are first applied to VR1 and then fed via a low pass filter to the base of common emitter stage Q1. VR1 allows the overall sensitivity to be tailored to suit different microphones or guitars. Its setting determines the maximum deviation of the FM signal.

R1, C1, C3 and C6 form the low pass filter stage. This ensures that the RF signal is eliminated from the input audio amplifier (Q1). C5 increases the gain at high audio frequencies to provide the necessary 50μs pre-emphasis.

Q2 and its associated components form a standard Colpitts oscillator with tuning provided by L1 and trimmer capacitor CT1. This stage derives its bias voltage from the output of the audio amplifier via R7. For this reason, the resistor values around Q1 were chosen carefully in order to produce minimal changes in oscillator frequency with changes in supply voltage.

The oscillator output appears at the emitter of Q2 and is direct-coupled to emitter-follower stage Q3. This stage provides buffering for the oscillator signal and a low impedance drive to the following output stage (Q4 and Q5).

Q4 and Q5 form a rather incestuous

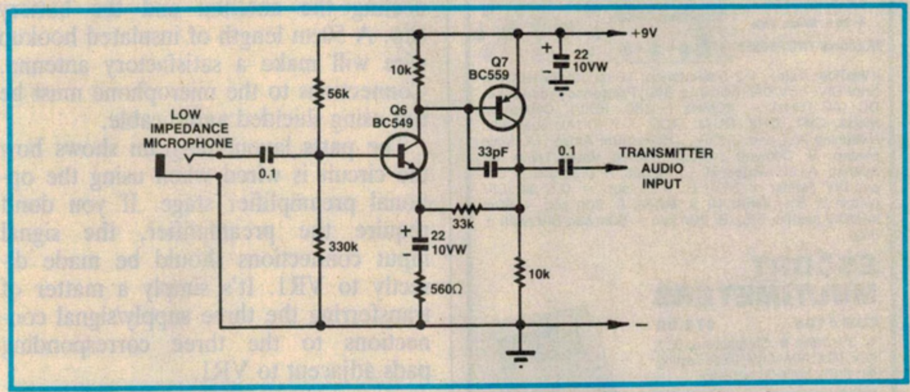


Fig.1: this preamplifier is used with low-impedance (600-ohm) microphones.

arrangement. Although they share common biasing components, they actually form two separate stages. Q4 functions as a common-base amplifier while Q5 is an emitter follower.

Preamplifier

Fig.1 shows the optional microphone preamplifier circuit. This is a fairly conventional two transistor circuit with an input impedance of around 30kΩ and an overall voltage gain of about 60.

Q6 and Q7 form a direct-coupled feedback arrangement with both transistors operating as common emitter amplifiers. Negative AC and DC feedback is applied from the collector of Q7 to the emitter of Q6 via a 33kΩ resistor.

Specifications

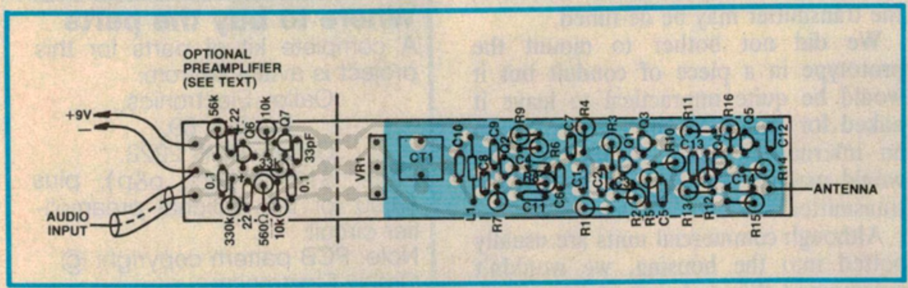
Output Power	....10mW
Tuning Range	....80-110MHz
Frequency Response	..........20Hz to 15kHz
Frequency Stability	..............less than .025% drift
Range	.... 50 metres (approx.)

The ratio of this resistor to the 560Ω resistor sets the voltage gain of the circuit while the 22μF electrolytic capacitor in the emitter circuit of Q6 rolls off the low frequency response.

Construction

Construction is straightforward with all the parts mounted on a small PCB coded 86fm9 and measuring 120 x 19mm. Note that a ground plane is provided for the FM transmitter circuit, so the board is double-sided.

Note also that the parts are tightly packed on the PCB, with the resistors all mounted end-on in order to save space. Follow the layout diagram carefully when installing the parts on the PCB and mount the parts as close to



Above: parts layout for the PCB. Don't forget the five solder joints to the groundplane.

FM wireless transmitter

the ground plane as possible.

There are five solder joints to be made on the component side of the PCB. These are indicated by unetched holes on the ground plane and are necessary to complete the earth circuit. The remaining leads all pass through etched holes and must not touch the ground plane.

Note that, on the prototype, the ground plane extends under trimpot VR1. This is not necessary and, in the final version, the ground plane is etched clear of VR1 as shown in the layout diagram.

Once all the parts have been installed, construction can be completed by connecting the antenna and the battery clip. A 50cm length of insulated hookup wire will make a satisfactory antenna. Connections to the microphone must be run using shielded audio cable.

The parts layout diagram shows how the circuit is wired when using the optional preamplifier stage. If you don't require the preamplifier, the signal input connections should be made directly to VR1. It's simply a matter of transferring the three supply/signal connections to the three corresponding pads adjacent to VR1.

Testing

Only two components require adjustment: CT1 which sets the transmitter frequency, and VR1 which sets the input signal level.

Initially, set VR1 to mid-range and place the transmitter near an FM receiver which is tuned to a vacant spot on the FM band. Now speak into the microphone and adjust the trimmer capacitor (CT1) until the transmitter is correctly tuned. Finally, adjust VR1 until the volume is similar to that which is obtained on the FM stations.

Note that good quality microphones have a huge dynamic range, so it is best to allow a reasonable amount of headroom; ie err on the low side in setting the level. If the input signal is excessive, the transmitter may be de-tuned.

We did not bother to mount the prototype in a piece of conduit but it would be quite impractical to leave it naked for long term use. Conduit with an internal diameter of about 23mm would make a suitable housing for the transmitter.

Although commercial units are usually potted into the housing, we wouldn't recommend this as being of any value. Perhaps a small amount of epoxy to seal each end of the tube would be OK — as long as you can still adjust the trimmer capacitor through a hole.

Next month, we plan to describe how to convert a commercial FM "Walkman" receiver for use with this transmitter. Together, the two form a very economical FM wireless link.

PARTS LIST

1 PCB, code 86fm9, 120 x 19mm
1 9V battery clip
L1 — 0.22μH air-cored inductor

Semiconductors
Q1 — BC549 NPN transistor
Q2, Q3, Q4, Q5 — BF199 NPN transistor

Capacitors
C1, C3 — 330pF ceramic
C2, C5 — 0.1μF ceramic
C4, C6, C7, C12, C13, C14 — .001μF ceramic
C8 — 33pF ceramic
C9 — 6.8pF ceramic
C10, C11 — 10pF ceramic
CT1 — 10pF trimmer

Resistors (0.25W, 5%)
R1, R10, R15 — 1kΩ
R2 — 47kΩ
R3 — 120kΩ
R4 — 4.7kΩ
R5 — 470Ω
R6, R9, R11, R12 — 22Ω
R7 — 2.2kΩ
R8 — 2.7kΩ
R13 — 82Ω
R14 — 3.3kΩ
R16 — 1.2kΩ
VR1 — 100kΩ 10mm vertical trimpot

Preamplifier Parts

1 BC549 NPN transistor
1 BC559 PNP transistor

Capacitors
2 22μF 10VW tantalum or low-leakage electrolytic
2 0.1μF monolithic
1 33pF ceramic

Resistors (0.25W, 5%)
1 x 330kΩ, 1 x 56kΩ, 1 x 33kΩ, 2 x 10kΩ, 1 x 560Ω

Where to buy the parts

A complete kit of parts for this project is available from:
Oatley Electronics,
PO Box 89,
Oatley, NSW 2223.
Price: $12.95 (incl. p&p), plus $3.00 for the optional preamplifier circuit.
Note: PCB pattern copyright © Oatley Electronics.