Motorcycle Intercom

lets you talk to your passenger

Motorcycling is fun but conversation between rider and passenger is usually just not possible. Build this intercom and you can converse with your passenger at any time while you are on the move. There are no push-to-talk buttons and the circuit is easy to build.

Our motorcycle intercom in use. Note the cables from each helmet

Motorcycling is a unique form of transport and provides an experience that no other form can equal. Apart from the feeling of oneness the rider has with the machine, there comes the exhilaration of just riding. Whether it be travelling to and from work or a fast ride through a winding mountain road, the rider often shares this enjoyment with a pillion passenger. How much more enjoyable if easy communication between passenger and rider is available.

by JOHN CLARKE & LEO SIMPSON

We have had quite a few requests from readers for a motorcycle intercom and we have finally come up with a system which works well and is simple to use. The intercom employs a detachable cable to each rider's helmet which plugs into a small box which houses the electronic circuitry. Power is obtained from the motorcycle battery.

Each rider's helmet is fitted with a microphone and an earpiece and these are terminated in a short cable fitted with a 3.5mm stereo line socket.

Both rider and passenger can speak at the same time because the system is two-way (or duplex) with two separate channels. Each channel has its own volume control which can be adjusted to suit each user. Separate channels eliminate the need for press-to-talk switches or vox (voice-operated switch) circuitry.

Apart from having two separate channels, the intercom circuitry is designed for use in the very noisy environment of a motorcycle. The system has to cope with the acoustic noise from the engine and the electrical noise from the ignition system. Sorting these problems out is not easy. The power supply from the battery has to be well filtered to cope with electrical noise and the frequency response of the system is restricted to cope with extraneous acoustic noise.

The circuit

Only one channel of the intercom, plus the power supply, is shown on the circuit diagram. The system employs one quad operational amplifier IC for handling the low level signals while the two earpieces (one for each rider) are driven by discrete audio amplifier stages.

The signal chain for each channel can be described as follows: An electret microphone (in each helmet) is fed to a bandpass filter and preamplifier employing two op amps. From there the signal passes through a volume control potentiometer and thence to an audio amplifier and earpiece.

Let's look at the circuit in more detail. The electret microphone is fed with DC via a series 4.7kΩ resistor which provides the AC load for the FET stage in the microphone capsule itself. The DC is decoupled from the main 9V supply with a 1kΩ resistor and 47μF capacitor to reduce the possibility of instability.

The low level signal from the electret is fed to IC1a which is a high pass filter

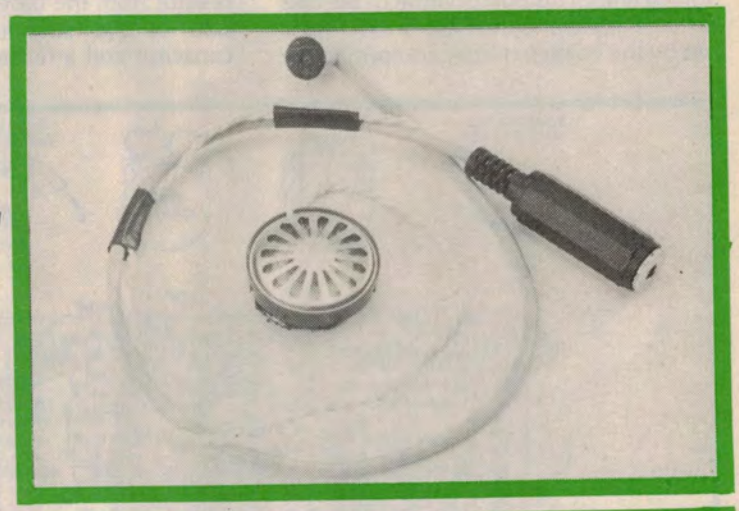
rolling off frequencies below 500Hz. The rolloff slope is 12dB/octave and the gain of the stage is set at 10.

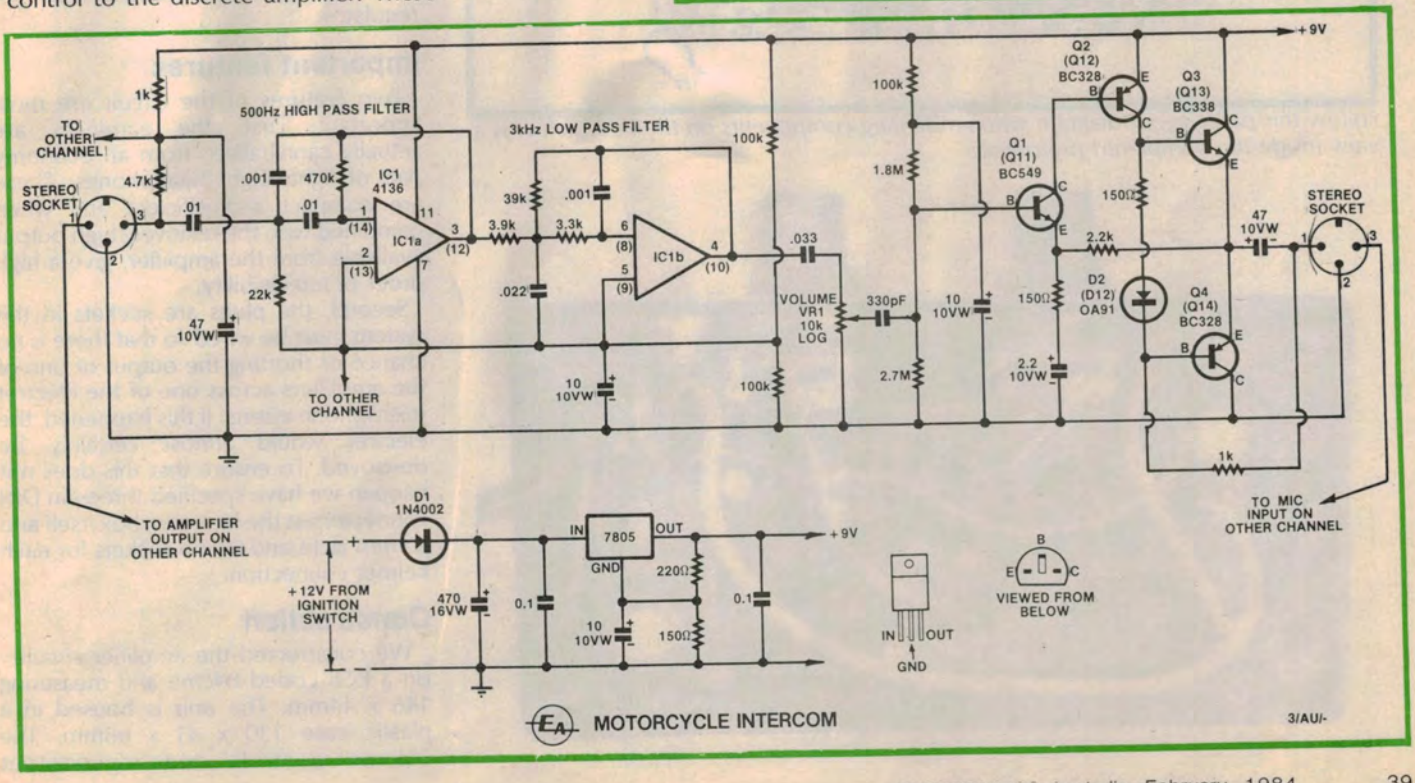
From the high pass filter the signal is fed to IC1b which is a low pass filter which rolls off signals above 3kHz at 12dB/octave. Gain is also 10 giving an overall amplification of 100. So the resultant bandwidth of the system, as far as IC1a and 1b are concerned, is from 500Hz to 3kHz.

Low frequency filtering

Further attenuation of low signal frequencies is provided by the choice of capacitors fromthe output of IC1b to the volume control and from the volume control to the discrete amplifier. These

Above is the completed unit while at right is the speaker and microphone assembly for one helmet. The speaker and microphone are attached to the helmet using Velcro strips.





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two capacitors have been selected to give further rolloff below 500Hz with the result that the ultimate attenuation rate for frequencies below 500Hz is 24dB/octave (or 80dB/decade).

All four op amps in the circuit are biased to mid-supply voltage (4.5V) by a common voltage divider comprising two 100kΩ resistors bypassed with a 10μF capacitor.

The audio amplifier

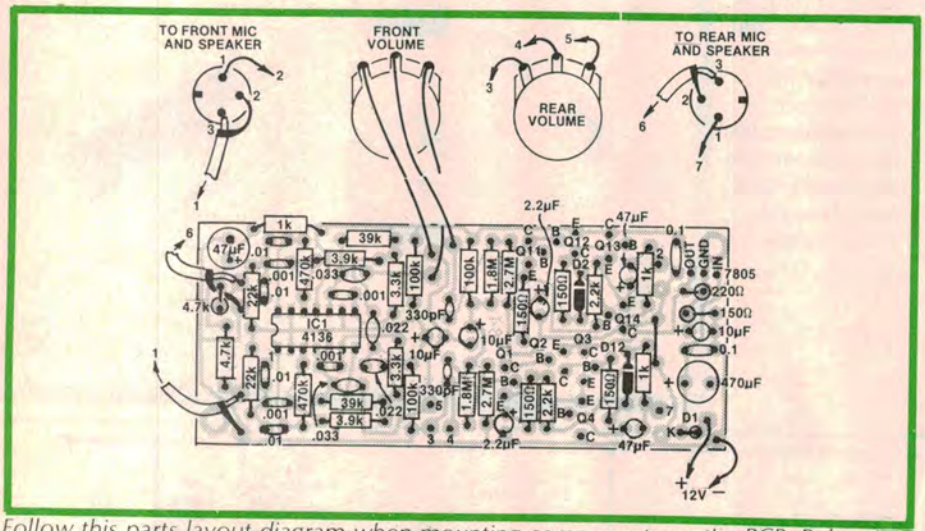
Four transistors are used in the audio amplifier which is a complementary symmetry configuration.

The amplifier is direct-coupled and its DC conditions are set by Q1. Thus the output stage is set to mid-supply voltage for maximum output by virtue of the bias voltage applied to the base of Q1. This is set by the voltage divider comprising the 1.8MΩ and 2.7MΩ resistors. Decoupling for the bias network is provided by a 100kΩ resistor and 10μF capacitor.

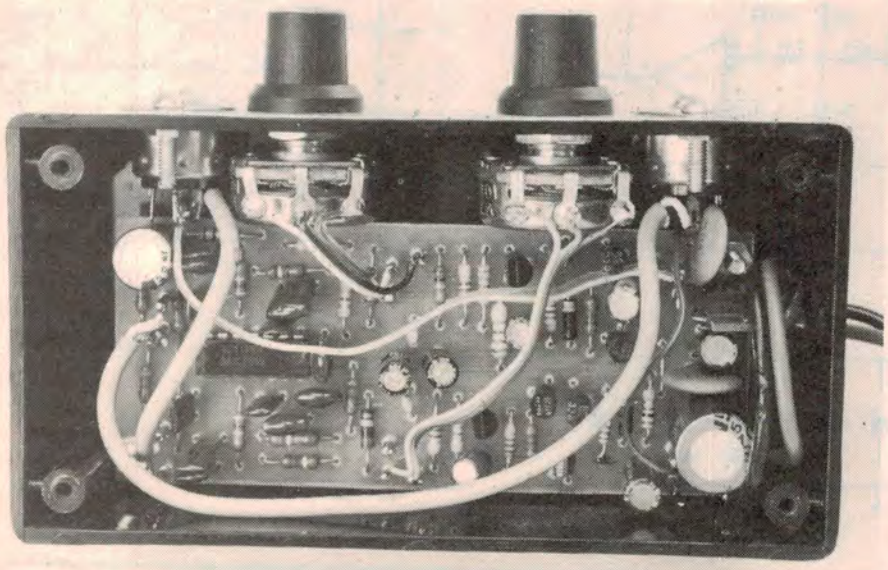
The collector of Q1 is coupled directly to the base of Q2 which drives both output transistors, Q3 and Q4. Crossover distortion in the output stage is minimised by a small forward bias applied by the diode and series 15Ω resistor.

The amplifier output is AC-coupled via a 47μF capacitor which incidentally provides another 6dB/octave rolloff for frequencies below 500Hz. No chance of a low frequency raspberry getting through this system!

Bootstrapping of the output stage drive is provided by connecting the 1kΩ bias resistor from the base of Q4 to the load side of the capacitor. This saves a capacitor and a resistor and also means that the amplifier will draw negligible current (it won't work either) unless a loudspeaker load is connected.



Follow this parts layout diagram when mounting components on the PCB. Below is a view inside the completed prototype.



We estimate the current cost of parts for this project to be

$40

This includes sales tax.

Power supply

Since the motorcycle battery voltage fluctuates widely and is very noisy it needs to be well filtered and regulated. This is achieved with a three-terminal regulator and associated components. An isolating doide, D1, prevents supply reversal and, in conjunction with a 470μF capacitor, provides initial filtering of the 12V supply.

The regulator circuit is a conventional arrangement using a 5V three-terminal regulator to provide a 9V supply. This is done by connecting the GND terminal of the regulator to a voltage multiplier network consisting of 220Ω and 150Ω resistors.

This works as follows: The normal output of the regulator is 5V and this is applied to the 220Ω resistor. Thus the current through this resistor is 23 milliamps or thereabouts. Both this current and a 6mA current from the GND terminal flow through the 150Ω resistor which "jacks up" the GND terminal by about 4V. Thus the output voltage is set to around 9V.

The 0.1μF capacitors in the power supply circuit improve filtering and improve transient response of the regulator.

Important features

Two features of the circuit are most important. First, the earpieces are actually cannibalised from an economy pair of lightweight headphones. These are compact and efficient and when combined with the relatively high output available from the amplifier, give a high order of intelligibility.

Second, the plugs are sockets in the system must be wired so that there is no chance of shorting the output of one of the amplifiers across one of the electret microphone inserts. If this happened, the electret would almost certainly be destroyed. To ensure that this does not happen we have specified three-pin DIN connectors at the intercom box itself and 3.5mm jacks and in-line sockets for each helmet connection.

Construction

We constructed the amplifier circuitry on a PCB coded 84cm5 and measuring 146 x 44mm. The unit is housed in a plastic case 130 x 41 x 68mm. The volume controls and input/output

sockets are mounted on one side of the case together with a Scotchcal label measuring 40 x 125mm.

Start construction by fitting all the low profile components to the PCB first. This includes the resistors, diodes and IC. Next the transistors and capacitors can be inserted. note that the voltage setting resistors for the regulator stand end-on. Take care with the orientation of polarised components such as the electrolytic capacitors, diodes, transistors and IC. We used PC stakes to terminate the external wiring.

Before the PCB can be mounted inside the case, the case itself must be drilled to accept the two potentiometers and two three-pin DIN sockets. Holes for these can be drilled after the Scotchcal label has been affixed. The two holes for the PCB mounting screws should also be drilled at this time.

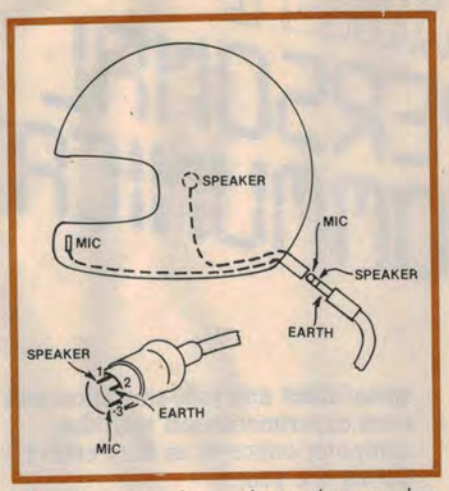
Mount the hardware before installing the PCB, as it cannot be done in reverse order. Don't forget to cut the potentiometer shafts to a suitable length to suit the knobs.

With the sockets installed, solder a short length of shielded cable to each one. The shield of each cable should go to pin 2 of each socket while the central conductor of each cable goes to pin 3 of each socket.

A short length of hookup wire can now be soldered to the remaining pin 1 of each socket.

With this preliminary wiring complete, the PCB can be shoehorned into the case. It is supported on two 9mm tubular spacers and secured with screws and nuts. Note that all screws should be fitted with shakeproof washers and painting the screws threads with Loctite would be a good idea too.

With the PBC in place the rest of the internal wiring of the intercom can be completed.



This diagram shows how the speaker, microphone and connector are wired.

Installation

The intercom case can be mounted at any convenient location on the bike where it will be easily accessible. It could, for example, be mounted underneath the seat or in one of the pannier bags. Two connections are made to the bike; one to the chassis and one to the 12V supply via the ignition switch. In this way, the intercom will be turned on whenever the ignition is on.

Two cables are needed to connect the DIN sockets to be stereo line sockets on each helmet. These comprise about 1.5 metres of twin shielded cable terminated at one end by a 3.2mm stereo jack and by a three-pin DIN line plug at the other end. It is important when wiring these to connect the microphone terminal of the DIN plug, pin 3, to the tip end of the stereo jack. This removes the possibility of momentarily connecting the amplifier output to the microphone when the jack is inserted into the stereo socket on the helmet.

The helmet wiring diagram shows this wiring convention.

PARTS LIST

1 PCB, code 84mc5, 146 x 44mm
1 plastic utility case, 130 x 41 x 68mm
2 electret microphone inserts
1 low cost miniature headphone set (DSE Cat. G4106)
1 Scotchcal label, 125 x 40mm
2 10kΩ (log) potentiometers
2 knobs
2 3-pin DIN sockets and plugs
2 3.2mm stereo line plugs
2 3.2mm stereo line sockets
3 metres of single or twin shielded cable
2 9mm standoffs

SEMICONDUCTORS
4 BC328 PNP transistors
2 BC338 NPN transistors
2 BC549 NPN transistors
1 1N4002 silicon diode
2 OA91 germanium diode
1 7805 5V regulator
1 4136 quad op amp

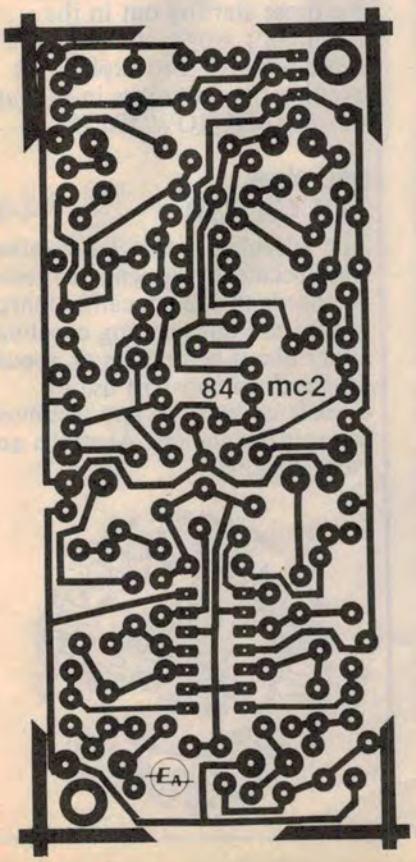
CAPACITORS
1 470µF/16VW PC electrolytic
3 47µF/10VW PC electrolytic
3 10µF/10VW PC electrolytic
2 2.2µF/10VW PC electrolytic
2 0.1µF disc ceramic
2 .033µF metallised polyester
2 .022µF metallised polyester
4 .01µF metallised polyester
4 .001µF metallised polyester
2 330pF ceramic

RESISTORS (¼W 5%)
2 x 2.7MΩ, 2 x 1.8MΩ, 2 x 470kΩ, 3 x 100kΩ, 2 x 39kΩ, 2 x 22kΩ, 2 x 4.7kΩ, 2 x 3.9kΩ, 2 x 3.3kΩ, 2 x 2.2kΩ, 3 x 1kΩ, 1 x 220Ω, 5 x 150Ω.

MISCELLANEOUS
Hookup wire, shielded hookup wire, PC stakes, machine screws and nuts, Velcro material, solder etc.

The earpieces were taken from a low cost miniature headphone set. We used the Dick Smith Cat C-4106 headphones which contain earpieces small enough to fit within the helmet where the securing straps tie to the helmet shell.

(Continued on p. 142)



At left is the full-size PCB pattern while below is the front panel artwork.

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Velcro material can be used to secure the microphone and earpiece to the inside of the helmet. The loop half of the Velcro is glued in place inside the helmet with contact adhesive and the hook half glued to the back of the microphone and earpiece.

Leads for the microphone should be shielded cable while those for the earpiece can be unshielded. Run the leads down to the side rim of the helmet and connect the stereo socket to these leaving several centimetres length below the base of the helmet. The wires can be secured by stitching with cotton thread to the lining of the helmet.

Do not be tempted to omit the helmet socket connections and just use a cable from helmet to intercom. This could make an accident even more hazardous if the cable connections do not break. And make sure that the intercom leads are bundled out of the way when the intercom is not in use.