Construction

The Sudden

A Compact Receiver For The Amateur Bands

From the workshop and pen of George Dobbs G3RJV, we bring you the Sudden, a two-chip single-band receiver.

"...teach us to delight in simple things" wrote Kipling.

Perhaps that's not such bad advice in amateur radio these days. The hobby is becoming more complex. Many radio amateurs do not know what goes on inside their 'boxes', and some even admit to not knowing the function of all the controls on the front panel. Opening the lid of a modern transceiver and seeing what "looks like a robot's vomit", as G3VTT once put it, can discourage many amateurs from taking up a soldering iron in the pursuit of their hobby.

Why Sudden?

I showed the circuit, described later, to Ian Keyser G3ROO, on one of his visits to my house, and he thought it should be called the Sudden receiver. Why Sudden? Well, when I am not soldering up little pieces of radio equipment, I'm the Vicar of Sudden. That is, I live and work in an area of Rochdale, in Lancashire, called Sudden. After all the receiver is very quick to build and I suppose I am still the Vicar of Sudden even when I am soldering!

Small Is Beautiful

One area in which many amateurs still build and experiment in, is QRP operation. During the time I have edited *Sprat*, the journal of the G QRP Club, we have attempted to produce articles that are suitable for the novice constructor. These are projects which cost very little to build, are within the capabilities of a technical beginner, and yet give a sample of the pleasures which can be had from building station equipment. Most of these projects have been simple amateur band transmitters, to be used alongside an existing receiver, to get a home-made signal onto the air.

For some time people have been requesting a simple-to-build receiver suitable for a beginner, yet capable of acceptable results on the amateur bands. In response I have tried out various permutations of the existing circuitry for receivers. The main problems, for a beginner seemed to be: winding coils, a simple oscillator which is stable, and finding suitable mixer circuits which use readily available and cheap devices.

Linked with this request was often the additional request that printed circuit boards, and possibly kits, should be available. The direct conversion seemed ideal for such a project because it holds up the chance of acceptable performance from simple circuitry.

Direct Conversion

Most radio amateurs will be familiar with the technique of radio reception by direct conversion. A block diagram of a basic direct conversion receiver is shown in **Fig. 1**. The signals from the antenna are fed via input tuned circuits to a mixer or product detector. Here the r.f. signals are turned into audio signals, by mixing them with a local oscillator. If that difference is within the audio frequency range, say 50Hz to 5kHz, it will appear as an audio signal out of the mixer.

If a received signal at 3.5600MHz is mixed with a local oscillator tuned to 3.5608MHz, an 800Hz audio tone appears. Incidentally, it will also be possible to produce an 800Hz tone from the same signal by tuning the local oscillator to 3.5592MHz, (800Hz away from the signal on the other side). This is the principle of the product detector for receiving c.w. and s.s.b. signals on superhet receivers.

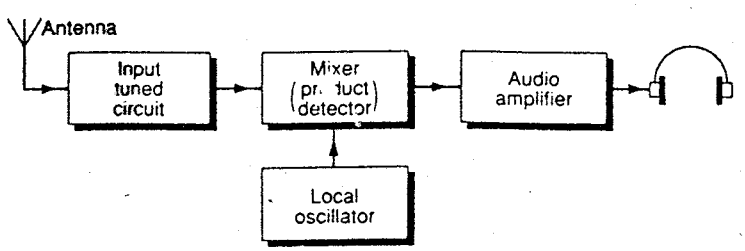


Fig. 1: Block diagram of a direct conversion receiver.

Gilbert Cells

The NE602, see diagrams of **Fig. 2**, is an integrated circuit which contains a balanced mixer with its own on-board local oscillator and voltage regulator. The mixer can provide up to 18dB of gain at 45MHz, and the oscillator will operate up to 200MHz. Compare the block function of the NE602, **Fig. 2(c)**, with the block diagram of the receiver

(Fig. 1). The mixer circuit is of the 'Gilbert Cell' multiplier configuration, offering the choice of balanced or single ended (against ground) mixing. The oscillator circuit uses two pins on the i.c., giving access to the emitter and the base of the oscillator transistor, allowing v.f.o. operation.

I set about trying the 'chip' in several direct conversion circuits. The aim was a simple, reliable, circuit using easily available components. The original circuit used the i.c., with balanced input and output circuits, which precluded the use of commercially available inductors. After trying several circuit combinations, one of the simpler options proved to give good results and worked well on a range of bands using commercial coils.

...perhaps Kipling was right!

The Circuit

The eventual circuit for the receiver is shown in **Fig. 3**. It uses only two i.c.s., the NE602 and an LM386 audio amplifier. The inductors are all commercially available Toko coils. A chart, **Table 1**, gives all the values of the required inductors with their associated capacitors for the five amateur bands from 1.8MHz to 14MHz. With the exception of the local oscillator coil for 7MHz, all the inductors are from the KANK range of short wave coils made by Toko. The 7MHz coil is the KXNK4173AO from the same 10K coil series as the KANK range.

The signals from the antenna are fed through R1, a simple r.f. attenuator, to the input winding on T1. Filters T1 and T2 with their associated capacitors, form a band-pass filter for the required band. The values have been calculated to allow 'flat' tuning across the required band, without the need for a variable capacitor in the input circuit. Once set up by adjusting the cores of T1 and T2, the input circuit requires no further adjustment.

Oscillations

The oscillator circuit is based upon the trusty Colpitts oscillator, and with capacitor C8 provides the coupling to the tuned circuit or T3/C11. A 27KΩ resistor, R2, increases the bias of the oscillator transistor. This is a tip offered by the manufacturers of the NE602 to reduce the oscillator sluggishness. This resistor should not be lower than 22KΩ and 27KΩ, added here, ensures the oscillator works well in any bands.

The audio output from the mixer is fed to a volume control, R4, with some r.f. decoupling provided by C14, to an audio amplifier. The LM386 has probably become the home constructors 'workhorse' audio amplifier as it's simple to use. The total current drawn by the receiver, about 10 to 15mA, makes it ideal for battery operation. The low comsumption reduces the chances of mains ripple appearing as hum in the audio output, a common fault in direct conversion receivers.

Take care with the LM386, some constructors manage to destroy them with supply over-voltage. The common LM386N is rated for 8V maximum on supply pin 6. This receiver is designed for an operating supply of no more than 9V, and should NOT be used on 12V supplies.

Building The Receiver

The track pattern and overlay are shown in **Fig. 4**. The section of the board under the tuning capacitor may be removed if the constructor does not wish to mount the capacitor on the board, or if an alternative variable capacitor is used. The removal of this ground plane section reduces the board size significantly.

Though the board is compact, the layout is not cramped and the project is suitable for a beginner to build. Small, modern components are used to minimise board size. Sockets should be used for IC1 and 2. Even experienced constructors place i.c.s into boards in reverse. I know!

The whole board can be built in one session of soldering, but the more wary constructor might like to build and test the project a little at a time.

Build And Test Method

Begin by building the receiver audio stages from C12 to the output. When the job's completed, connect head-phones, R4, and power from a 9V battery. A finger applied to C12 or the slider of R4, should produce hum in the 'phones. Check that R4, has been wired so it will operate correctly.

The next stage is to build up the circuitry around the NE602. The input stages and C11, may be

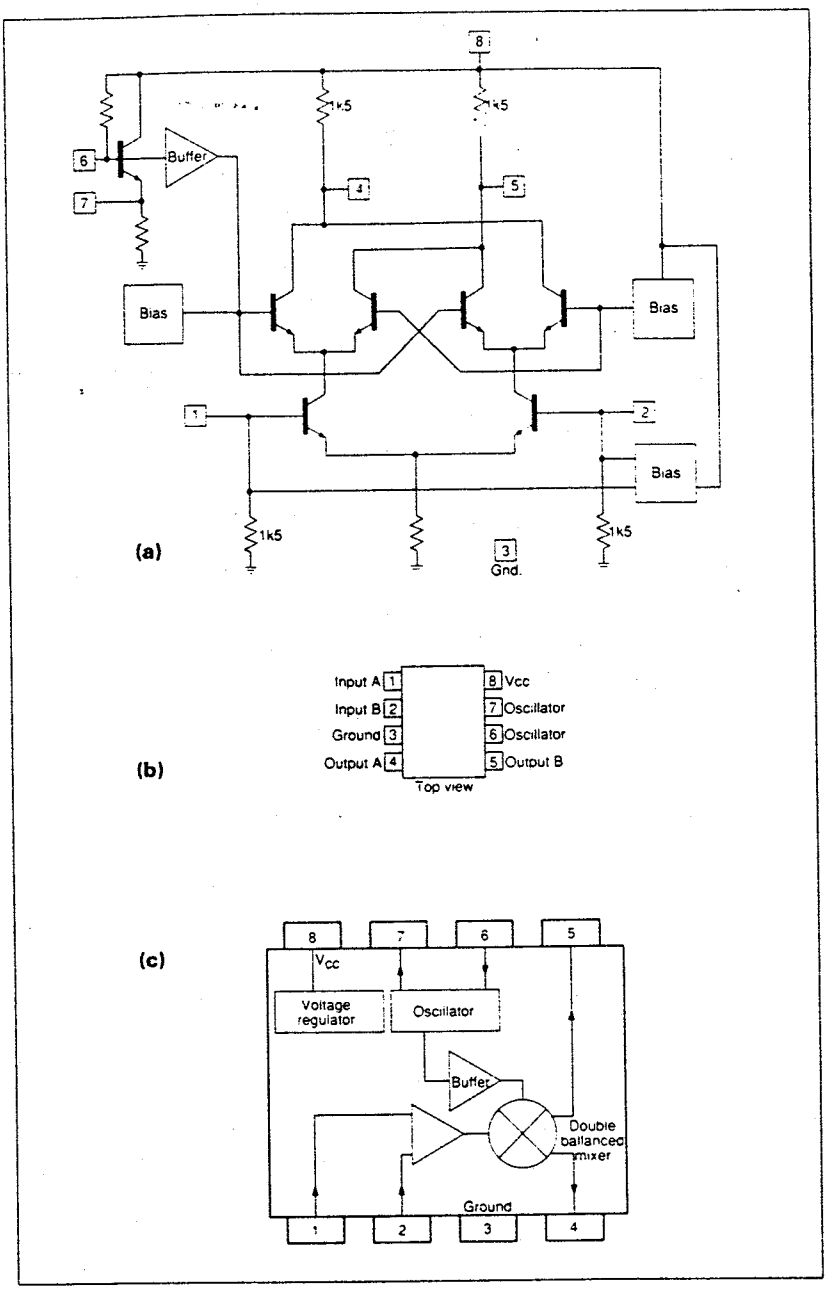


Fig. 2(a): Skeleton internal circuitry of the NE602 showing the 'Gilbert Cell' balanced mixer in the middle, and the oscillator stage top-left.

Fig. 2(b): Pinout of the NE602.

Fig. 2(c): Functional pin connections for the dual-in-line version of the NE602.

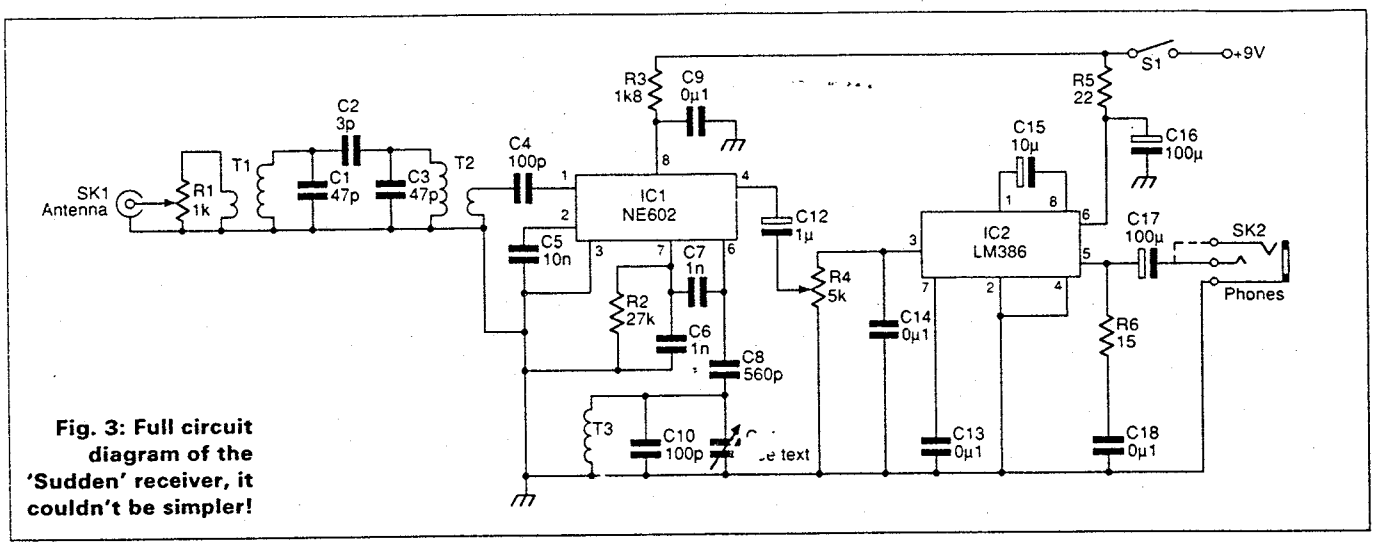


Fig. 3: Full circuit diagram of the 'Sudden' receiver, it couldn't be simpler!

omitted at this point. It's easiest to mount the inductor, T3, first and then the other components. Insert the NE602, apply power again and place a finger on pin 1 of the NE602, or the input of C7. Again, this should produce noise in the 'phones.

Add C11, and apply power. Rotating C11 should now produce a change in the 'noises' in the 'phones. Try adding a short antenna to pin 1, C11 should then show evidence of receiver tuning when rotated. At this point, without input filtering, all manner of broadcast stations will probably then break through. The final operation is to add the input filter components around T1 and T2.

Setting The Range

Setting up the receiver is simple and it can be done with or without test equipment, although the minimum requirement is a receiver which covers the required band.

The first operation is to ensure that the local oscillator covers the required frequency range. This is achieved by adjusting the core in T3. To do this you should take a short wire from the antenna socket of a receiver, tuned to the required band, and lay the end near to pins 6/7 of IC1.

The receiver you're using for testing should be set to receive c.w. or s.s.b. signals at the low edge of the required band. You should then rotate the tuning capacitor C11, until the vanes are fully meshed. Using a plastics trimming tool, rather than a metal bladed screwdriver, rotate the core of T3 very slowly until the oscillator is heard on the test receiver. This marks the low end of the band. Turn C11 to the minimum capacity position, and tune the test receiver to re-find the 'Sudden's' oscillator. The 'Sudden' should cover the required band with the combinations in **Table 1**, but if using an alternative variable capacitor, some experimentation may be required.

If the coverage is too great, a series (padding) capacitor may be added to C11 to reduce the capacitance swing. The more confident constructor may wish to remove vanes from the variable capacitor to give a smaller coverage, but replacements are expensive if this procedure goes wrong.

All that now remains, is the 'peaking' of the input stages. Constructors with a signal generator might like to inject a suitable signal for this operation. Though I have a signal generator, I actually prefer to tune up 'live', using antenna signals. You should connect a suitable antenna to the 'Sudden's' input and tune the receiver until a signal is heard. Begining with T2, you can now adjust the cores on T1/T2 to peak the signal, reducing the signal with R1 as necessary. The input filter is now basically tuned. A better tune-up is by 'peaking' a not-too-strong signal in the centre of the band, followed by a signal at either end of the tuning range. Finally, return to the centre for a final check and re-tune, if required.

Using The Receiver

The 'Sudden' is a simple receiver, but it's capable of good results on the bands if wisely used. The input, in common with most amateur radio equipment, is designed for 50Ω impedance. Using an a.t.u., or antenna matching unit, with a simple receiver is generally a wise procedure, as it assists in the reduction of unwanted signal breakthrough.

Take a tip from me - careful use of the two gain controls improves the operation of this receiver. To provide further help, resistor R1 is an attenuator, as direct conversion receivers are prone to overloading. Too much signal, reaching the mixer, causes distortion.

In use, the best operational procedure is to set the audio volume control quite high, just short of the point where the internal noise of the audio amplifier becomes obtrusive, then using R1 as the main gain control. Keeping the setting of R1 to the minimum usable level really does help the performance of the 'Sudden'.

Several versions of the 'Sudden' have been built for all bands from 1.8 to 7MHz, and so far the comments received express surprise that so few

Continues on page 43 ➡

Table 1: These are the components which may be changed to suit the desired band.

Band MHz	C1/C3 pF	C2 pF	T1/T2 KANK	C11 sections (Original)	C10 pF	C6/C7 pF	C8 pF	T3 KANK
1.8	220	10.0	3333	all sections	100	1000	560	3333
3.5	47	3.0	3333	all sections	100	1[illegible]0	560	333
7.0	100	8.2	3334	1 section	47	560	560	**
10.1	47	3.0	3334	1 section	68	680	220	3335
14.0	100	3.0	3335	1 section	68	220	68	3335

** Type KXNK 4173A0

➡ *Continued from page 38*

components, on such a small board, can produce such a useful little receiver.

PW

How Much £25(approx)
How Difficult Beginner +

Shopping List

Resistors
Carbon Film 5% 0.25W

15Ω	1	R6
22Ω	1	R5
1.8kΩ	1	R3
27kΩ	1	R2

Rotary Panel Mounting

1kΩ	1	R1 (linear carbon track)
5kΩ	1	R4 (logarithmic track)

Capacitors
Miniature disc ceramic

C1-3	see Table 1	
100p	1	C4
10n	1	C5
0.1µ	4	C9,13,14,18

Miniature Polystyrene

C6-8,10	see Table 1	

Miniature Electrolytic 16V (radial leads)

1µ	1	C12 (50V this size)
10µ	1	C15
100µ	2	C16,17

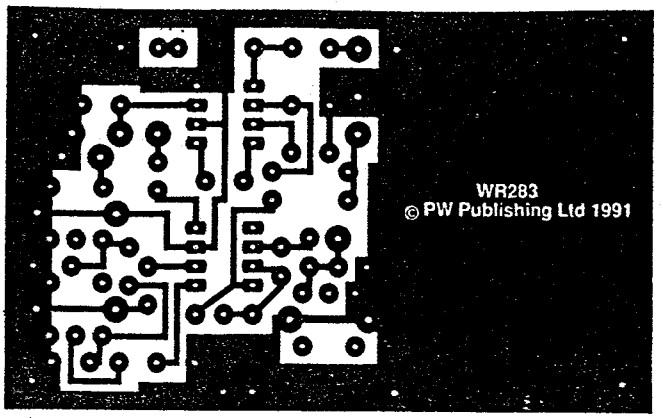
Variable Capacitor
10p+10p+20p (three gang)§

Semiconductors:

LM386	1	IC2
NE602	1	IC1 ‡

Miscellaneous
Sockets for both i.c.s, a suitable box (Minffordd), p.c.b. (*PW* services), miniature coaxial cable, other connecting wire, suitable plugs and sockets for r.f. and audio. Various knobs for controls, slow-motion reduction drive for C11.

A full kit of parts for a 3.5MHz version of the Sudden, including p.c.b., but less hardware, is available from: Kanga Products, 3 Limes Road, Folkestone, Kent CT19 4AU for £17.45 (+ 85p postage/packing).
§ Capacitor C11: 3 gang (10/10/20pF) J. Birkett, The Strait, Lincoln LN2 1JF. Tel: (0522) 20767.
‡ NE602N: BCD Electronic Services, Somerset House, Somerset Street, Hull HU3 3QH. Tel: (0482) 225437.
Minffordd All-Aluminium Box type A32: Minffordd Engineering, Sun Street, Ffestiniog, Gwynedd, LL41 4NE. Tel: (0766) 762572.



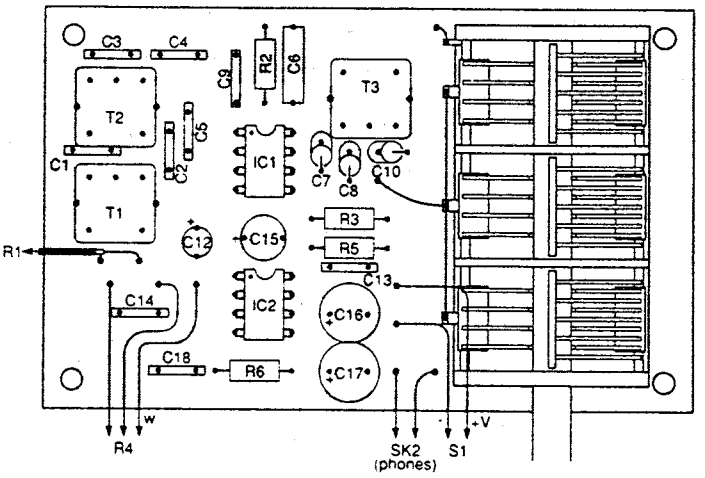
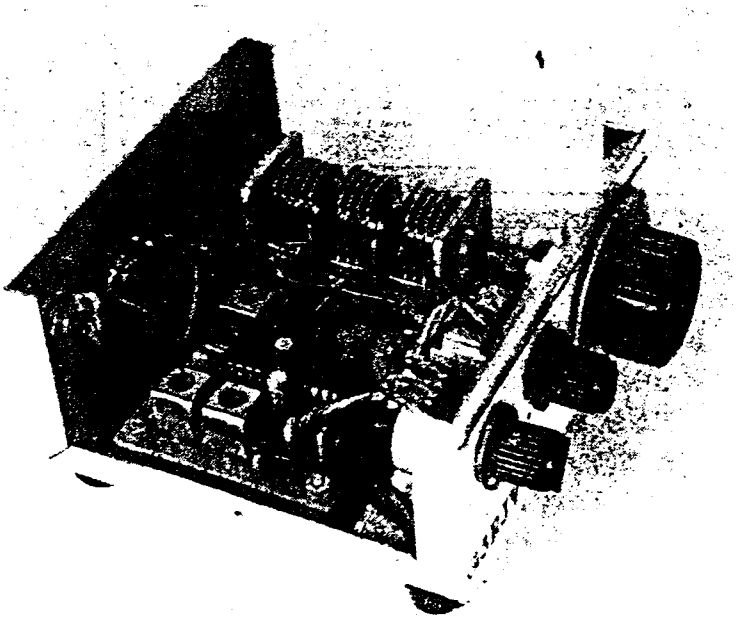


Fig. 4: Track pattern and overlay of the p.c.b. The section under the tuning capcitor may be trimmed off, if not required.



The completed receiver.