Following the development of software for the Sinclair Spectrum which enables decoding of both weather facsimile and the MSF clock on 60kHz, Mike Rowe G8JVL decided to design a simple v.l.f. converter to fill the gap in the coverage of his h.f. receiver.

The Taw VLF Converter

Author's completed prototype

Circuit Description

As shown in Fig. 1 the heart of the circuit is a double balanced mixer (d.b.m.) which offers advantages over a simple single-ended type. Signals at the intermediate frequency (i.f.) are effectively suppressed. No problems have been encountered with the prototypes with i.f. breakthrough. The output transformer is a centre tapped winding on a T50-6 toroid tuned to the chosen i.f. by C11. A low impedance link winding couples the i.f. to the antenna input of the h.f. receiver which is used as a tuneable i.f. The input at v.l.f. is not tuned but passes through a low-pass filter to attenuate any h.f. signals and prevent overloading of the receiver's front end, also to help to eliminate i.f. breakthrough.

The crystal oscillator is an untuned Colpitts type. The output is taken from the collector and capacitively coupled to the d.b.m. via C7. The crystal is set on frequency by C1. The i.f. is the crystal frequency plus the signal frequency. The choice of crystal is up to the constructor but should be in the region of 10–20MHz 30pF parallel resonance. The p.c.b. is designed to accommodate both HC6U and HC18/25 types. It is advisable to use a 10MHz crystal or at least a crystal frequency which has a whole number of megahertz. This will save on the mental arithmetic when working out where you are in frequency on your h.f. receiver. For i.f.s below 15MHz C11 should be 60pF; above 15MHz 25pF is sufficient.

Construction

It is suggested that the i.f. transformer is wound first using approximately 1m of 36s.w.g. enamelled copper wire. Start by winding 20 turns on the core. At the 20th turn hold the core tightly and fold back a loop of wire approximately 15mm long, then twist the loop together to form the centre tap. Continue winding on the core in the same direction for a further 20 turns. A dab of Superglue at each end will prevent

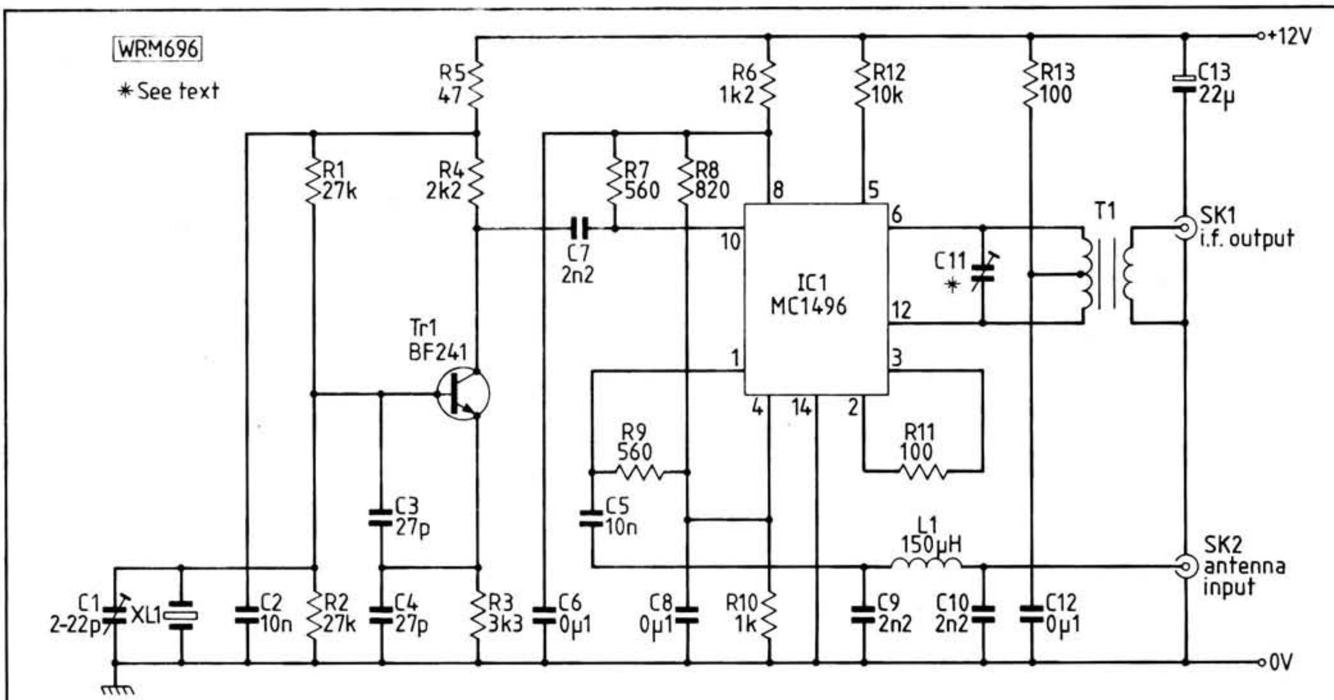

Fig. 1: Circuit diagram

the coils from unwinding. Next wind the secondary coil on the opposite side of the core as shown in Fig. 4. The secondary winding consists of 8 turns of the same gauge wire with its ends secured with Superglue. Lay T1 aside for the moment to allow the glue to dry.

Now insert the i.c. holder and the resistors, followed by the fixed capacitors. Finally fit Tr1, C1, C11, XL1 and the completed i.f. transformer T1. One point of note is all the enamel on the leads from T1 must be removed to ensure good solder joints to the p.c.b. Check the completed p.c.b. for any solder bridges or dry joints. Do not fit IC1 at this stage.

Adjustment

Set C1 and C11 in mid position. Connect 12V to the power pin preferably via a current limited supply. Check the oscillator is working either by connecting a frequency counter or a receiver to pin 10 of the i.c. socket. Trimming capacitor C1 is used to adjust the frequency of XL1. Switch off the power and fit IC1 into its socket taking care to ensure correct orientation. At this stage the converter is ready for boxing up, the prototype was housed in a small aluminium project box with its input and output terminated in SO239 sockets. The power lead enters the case through a small hole lined with a rubber grommet.

Testing

Connect a receiver to the i.f. output of the converter and about 10m of wire to the converter input. Then tune to a known low frequency signal, BBC Radio 4 is on 200kHz. With a 10MHz crystal, Radio 4 should appear at 10·2MHz on your receiver. If it appears slightly off-tune then adjust C1 accordingly. Next tune C11 for maximum S-meter reading.

For any receiver to work well it needs an efficient antenna, and an efficient earth system too at low frequencies, so before you start listen-

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SHOPPING LIST

Resistors

¼W 5% Carbon film

47Ω	1	R5
100Ω	2	R11,13
560Ω	2	R7,9
820Ω	1	R8
1kΩ	1	R10
1·2kΩ	1	R6
2·2kΩ	1	R4
3·3kΩ	1	R3
10kΩ	1	R12
27kΩ	2	R1,2

Capacitors

Miniature ceramic

2·2nF	1	C7
10nF	2	C2,5

Miniature ceramic plate

27pF	2	C3,4

Miniature Mylar

2·2nF	2	C9,10

Polyester

0·1μF	3	C6,8,12

Miniature foil trimmers

2-22pF	1	C1
2-22pF	1	C11*

Electrolytics 25V radial

22μF	1	C13

Semiconductors

Transistors

BF241	1	TR1

Integrated Circuits

MC1496	1	IC1

Miscellaneous

XL1 HC18U 10MHz (1); T50-6 r.f. toroid (1); 150μH 7BS series inductor (1); SO239 sockets (2); 14-pin d.i.l. socket(1); aluminium case 100 × 70 × 40mm (1); p.c.b. (1); 36s.w.g. enamelled copper wire; 100mm miniature coaxial cable; Veropins (4); 6BA × 15mm screws (4); 6BA nuts (4); 6BA pillars (4); connecting wire.

* See text

How Much? & How Difficult?
£10
Intermediate

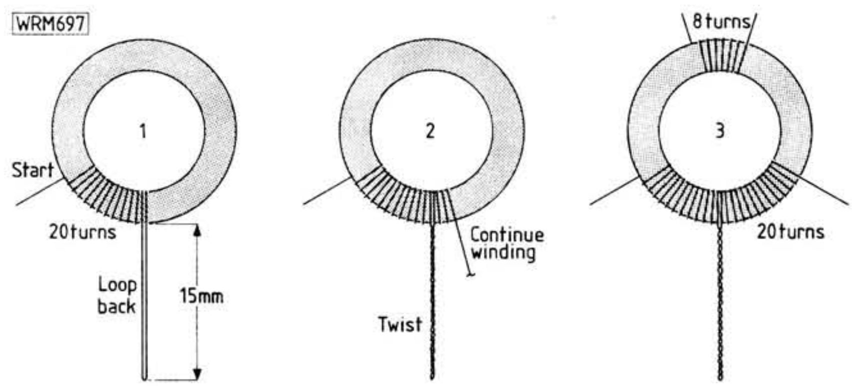


Fig. 4: Transformer construction

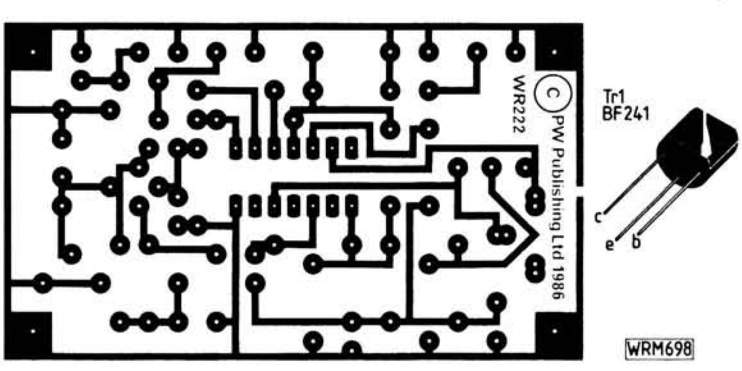


Fig. 2: Full-size p.c.b. track pattern

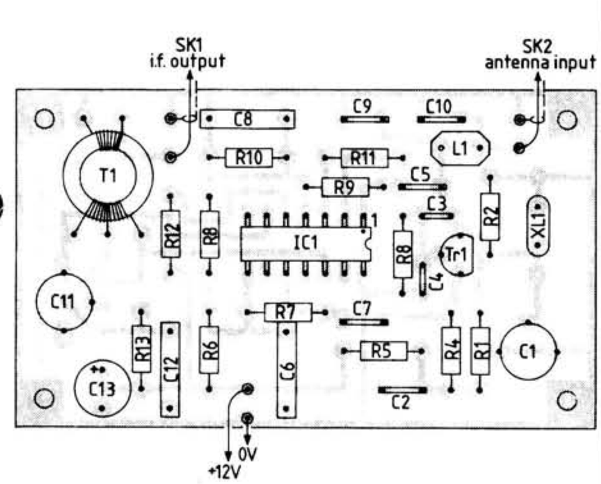


Fig. 3: Component layout

bands. The helical can be replaced by suitable external antennas for improved results. A separate socket is provided for connection of an external wire or whip antenna for the AM band.

A wide range of power sources can be used to drive the AIR-7. These can be internal dry batteries (4 × R6 or Size AA); an internal rechargeable battery pack; a 12V or 24V car battery (using the appropriate battery adaptor cord); an external dry battery pack; an a.c. mains adaptor. When an external power source is used, the internal batteries must remain installed in order to back up the built-in microcomputer memories.

Results

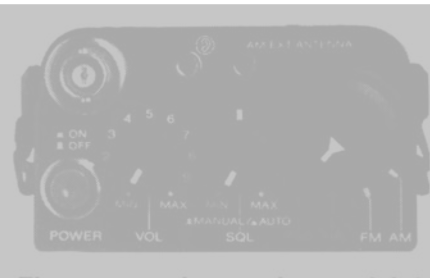
As mentioned earlier, the AIR-7 is very easy to use. The memory functions are not quite self-evident, but are readily understood from the operating instructions leaflet. The leaflet is helpful and written for the most part in good colloquial English.

On-air testing revealed good sensitivity and adequate selectivity on all bands. At the time that we had the receiver on review, the rebuilding of our screened test-room following office relocation was not quite complete, which limited severely the lab-tests we could carry out, especially on the AM band with its internal ferrite bar antenna. A quick run through on the bench showed sensitivities on the other bands of around 2μV e.m.f. for 20dB signal-to-noise ratio on FM, and 1·25μV and 0·5μV e.m.f. respectively for 12dB SINAD on the AIR and PSB bands. The operating instructions warn of internally-generated spurii at 109·875, 166·17 and 167·08MHz, and at 455kHz. The only other "nasty" of note which I came across was when a "rock-crushing" 2m signal from a local amateur appeared also (weakly) in the marine v.h.f. band above 156MHz. Apart from being able to confirm in the lab that the fault was with the receiver, and not with the amateur's transmitter, I was not able to pursue this one further.

Sound Quality

The received sound quality and volume (maker's figures 400mW into the internal 70 × 35mm elliptical speaker) were very acceptable. The receiver can be held up to the ear for listening in noisy surroundings, but be sure to press the KEY PROTECT button to disable the keypad before you do. Otherwise, you will find that you have unwittingly pressed a button with your head, and the receiver will have shot off to some other channel, to your great frustration!

The AIR-7 measures approximately 90 × 179 × 50mm overall (excluding the helical antenna) and weighs around 600g including batteries, shoulder-strap and helical antenna. An earpiece for personal listening is also included in the supplied accessories.



The top-panel controls are tightly packed, but laid out to give good access for adjustment

I was impressed with the performance and facilities of this receiver whilst we had it on review. It would be nice if the AM band could be extended to cover the short-wave broadcast bands, but then I suppose we'd be after an s.s.b. capability, too. Just never satisfied, that's our trouble!

Price

The AIR-7 is available from advertisers in *PW* at around £250 including VAT. Apart from its great appeal to s.w.l.s, it would make an excellent auxiliary receiver for yachtsmen, covering as it does the long, medium and v.h.f. broadcast bands, plus the air and marine v.h.f. bands. ***PW***

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ing for some of the signals listed in Table 1 you would be well advised to provide both. Unfortunately the lower that one goes in frequency, the more inefficient an antenna and earth system becomes. A compromise will have to be struck; a random length of wire over 10m long will provide adequate results at 16kHz when used in conjunction with an efficient earth system. For most situations the earth may be several feet of old metal water pipe driven in to the ground and periodically moistened. If you live in a very dry area then you may have to lay an earth mat from a 1m square of chicken wire or similar, which may be laid on or just below the surface of the ground.

The converter is now ready for use. At the author's home in southern England the 60kHz MSF time signal from Rugby was received at 59+20dB using a Trio TS-430S as a tuneable i.f.

Licence

Although there are no restrictions on listening to standard time transmissions such as those listed in Table 1, there are restrictions on the reception of weatherfax signals, for which a special licence is required. For details see Weather Watch-1, *PW* April 1986. ***PW***

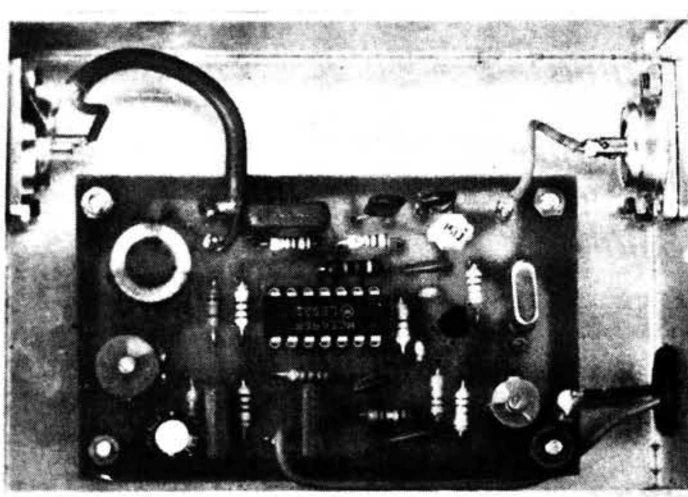
Internal view of the prototype converter

Table 1.

Country of Origin	Call	Freq. kHz	Data
Canada (Halifax)	CFH	122·5	FAX
Czechoslovakia	OMA	50	Time
Czechoslovakia	OLT21	100·95	FAX
France (Paris)	FYA31	131·8	FAX
France	FTA91	91·15	Time
Germany FDR	DCF77	77·5	Time
Sweden (Karlsborg)	SAY2	119·85	FAX
Switzerland	HBG	75	Time
United Kingdom	MSF	60	Time
USSR (Moscow)	RBU	66·67	Time
USSR (Arctic coast)	-	227	FAX

All weatherfax transmissions have a frequency shift of 150Hz.

Signals around 10kHz form part of the world-wide navigation system called Omega.