continued from p46

should vanish or at least become very noisy.

If a receiver is mains operated, the mains lead brings unwanted signals into the screening box. A power-supply filter is then required. My own receiver is a battery-powered one which can be mains-driven via an external adapter (transformer-rectifier unit) which supplies the required low-voltage d.c. via a long lead. In this case, the appropriate side of the d.c. supply is connected to the screening foil and the 'live' side taken to the receiver via a three-terminal capacitor-type filter (d). A lead from the earthy battery terminal of the receiver is connected to the foil to complete the circuit. A conventional pi-section LC filter can also be used: I had good results from a home-made filter where the series L was a tv frame coil on a ferrite ring core and the Cs were 100nF polyester film capacitors. Whatever arrangement is used it is essential to keep the connections between capacitors and screening foil very short — a centimetre or less. If longer, their inductance impairs filtering. The case of my feed-through filter is the earth terminal and contact with the foil is made by bolting the filter unit to the screening box. The earth connections are made by trapping the bared ends of the earthy d.c. leads between filter and foil.

I have not so far attempted a filter for a receiver with a built-in mains power unit. A balanced filter would presumably be needed, with the earth line connected to the foil and to mains earth. Safety considerations suggest that the screening box should itself be enclosed in an insulating box to avoid contact with the foil.

If the receiver can be battery operated it is useful, when testing power-supply filters, to set up the receiver with the filter in situ but the mains power off. If the receiver is now battery operated it can be seen if signals are getting into the box via the filter.

When operating a well-screened receiver, bringing one's hand to the controls introduces stray signals. This can be an advantage since it allows the receiver to be pretuned to the required frequency before tuning in the loop.

INDOOR LOOP AERIAL

If you happen to live near a powerful radio transmitter you will find that short-wave reception is marred by breakthrough by the local transmission. This can occur even when the wanted station is far removed in frequency from the local transmission, through such mechanisms as intermodulation.

In principle, the directional properties of a loop aerial can be utilized to null the local transmission but, in practice, a simple loop oriented in the vertical plane does not give a complete null. The reason is that the ground wave from the local transmitter is not quite vertically polarized but tilted by wave drag.

The loop null can be improved by tilting the loop away from the vertical to match the interference. Readers who suffer from local-station interference might find it useful to construct short-wave loops in a way which permits some adjustments of tilt. For most cases a tilt range of 0-30° will be sufficient.

R. Jones
Dorchester
Dorset

FFT

Your contributors Larsen and Dyrik express the hope that their article will inspire readers to experiement with machine code f.f.ts and spectral analysis.

We took this path some years ago and can report that indeed many happy hours can be spent optimising an implementation of the f.f.t. algorithm, and one dicovers many subtle issues that do not seem to be covered in the standard literature.

Starting from the Basic program given, the main decision to be made in preparing a machine-code version is how to represent the data arrays D and E. If floating point is used, execution will be little faster than in Basic. With fixed point, however, optimizing the dynamic range is a non-trivial problem, since the data values grow in a way which cannot reasonably be predicted at the outset. Automatic rescaling is thus usual and desirable, but this raises yet another level of subtlety if the rounding or truncation inherent in a rescaling is not to contribute further errors. Welch[1]considers three strategies, none of which is optimal.

For those who are more interested in the finished article than the joys and frustrations of development, we have made our BBC spectrum analyser commercially available through Structured Softare, and will be pleased to supply full details on request.

P.G. Craven
J.C. Davies
Bromborough
Wirral
Merseyside

Reference

1. Welch, P.D., A Fixed-Point Fast Fourier Transform Error Analysis. *IEEE Trans Audio & Electroacoustics* AU-17, 2, 151-157 (JUne 1969).

ADD-ON CURRENT DUMPER

I was very interested to read Erik Margan's add-on circuit to convert a conventional Class B amplifier output into a non-switching type. I have, in the past, tried to develop such a circuit, but have never been fully satisfied with my efforts. Mr Margan's circuit appear to be a very competent solution.

Mr Margan gives no clue regarding the value of R_e. However, analysis of the circuit indicates that if R_c is less than about one fifth of the value of R_e, the circuit current limiting will come into operation before Tr_3 or Tr_4 are turned off.

I would be very interested to know of the effect of Mr Margan's modifications on the distortion figures of a typical Class B amplifier and the extent to which an improvement in sound quality may be heard.

Graham Nalty
Borrowash
Derby

ENERGY TRANSFER

P. L. Taylor (*Wireless World,* p. 15 October 1985) likes the choice between e.m. wave energy transfer through space, as required by the Poynting vector, or through wires, as required by the Slepian vector. There is, in fact, a third choice advocated by Cambridge Professor G. H. Livens. Writing 'On the flux of energy in radiation fields' at p. 313 of his 1926 book 'The Theory of Electricity', published by Cambridge University Press, he argued in favour of an alternative to Poynting's theory. Waves do not need to carry energy at their speed of propagation. Their generation merely adds energy to a common pool of energy in the field medium at the locality of the transmitter and their absorption draws on that pool in the locality of the receiver. I like this third alternative, because it is easier for me to picture creation a a big splash in an existing smooth pool of energy than as a big bang appearing from nowhere in a complete void.

J.N. Kidman
Southampton

NAVAL MARCONI

In the November issue you had an article by Nigel Cawthorne, which I am happy to say was complimentary to Marconi in most respects, but did rather belittle the Marconi Fast Tune (MFT) range of equipment. I would like to point out that in addition to the drive and 10kW amplifiers we also have a 50kW i.s.b. amplifier, a 1kW amplifier and a transceiver based on the drive/receiver in development. But by far the most important part of MFT2 is the remote computer control system that goes along with the basic hardware; this system allows for automation in service selection which includes frequency, mode, audio source and antenna selection, along with any other aspect that needs controlling.

I would also take this opportunity to point out that our new Swordfish transceiver is not, as depicted in the picture caption Redifon's R800 v.l.f. receiver.

P.A.T. Turrall,
Publicity Manager,
Marconi Communication Systems
Chelmsford

RELATIVELY BORING

H. Morgan complains in your July issue that relativity is boring. This view will be shared by many physicists, but they do not seem to have noticed that one cause of the confusions and contradictions is that it is not a scientific theory. This Einstein made quite clear when he said that the "real basis of the special relativity theory" was the Lorentz equations (*Bull. Amer. Math. Soc.*, 41, 1935). Physics is based on matter, motion and force: equations in physics are only relations between terms that represent numbers obtained by measurement; and these are put into Nature by ourselves. They can never tell us, just as Einstein could not, whether an ether was a necessary physical assumption or not: at one time he had said not; and then later "space without ether is unthinkable". Moreover, Lorentz's times were dates and these do not enter into physical laws.

Many other confusions are caused by lack of linguistic care. If we think carefully about light, for example, we realise that we never see light, or anything moving, and that beams and rays cannot be found in highly evacuated regions, so that reflection may be re-radiation. One fact about light has, however, been verified sufficiently to give us considerable confidence in its truth; this that if we have a source and a receiver at a fixed distance from one another on a rigid body, the time delay of interaction between them is always d/c where c is a universal constant. I have suggested that c should be called the *constant of interaction*: no hypothetical element is then involved (such as ether, waves, photons and the rest) and action at a distance is not ruled out (as Maxwell admitted long ago). This one fact allows us to settle the thought experiment involving a train passing an embankment, which relativists use to 'prove' the supposed relatively of simultaneity.

The train and the embankment are said to be struck by lighting at two places a distance apart. An observer on the embankment, half-way between the two flashes, is said to find them both simultaneous, but the observer on the train is said not to agree. In this case there are two rigid bodies — the embankment and the train — and both observers are at a distance d/2 from both flashes. The time for interaction is thus the same for both flashes so that both observers should find simultaneity. If the sources are said to be moving with respect to the observer on the train, this should cause no difference, since the 'velocity of light' is held to be independent of the motion of the source.

As length-contraction is 'proved' in thought experiments by founding it in the supposed relativity of simultaneity, is clear that length contraction is also delusory.

A note of interest is a recent statement from a colleague of Einstein's who says that in his later years Einstein abandoned material consequences implied by relativity, which included his thought experiment purporting to show that people can get younger by rushing about — the Twins Paradox (Foundations of Physics, 15, 9, 1985).

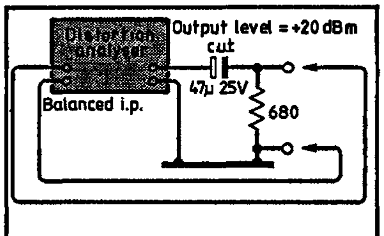
G. Burniston Brown
Padstow
Cornwall

ELECTROLYTICS AND DISTORTION

Since both Mr Curl and Mr Armstrong (Letters, November 1985) are writing on the same topic, it seems logical to try to answer their complaints in the same letter.

I hoped that by now I had made it clear that I am perfectly well aware that it is possible to use electrolytic capacitors in such a way as to generate disturbances in an applied audio signal; the point I wish to make is that there is nothing new or mysterious about this. The effect (low-frequency harmonic distortion when an electrolytic is allowed to cyclically depolarize) is logical and predictable, and therefore avoidable. It should not arise in a properly-executed audio design.

To recapitulate, the important point is simply to ensure that there is no significant a.c. voltage across the capacitor in question. When an electrolytic is used as a coupling or dc-blocking component there is no reason why there should be; if there is then you have, accidentally or otherwise, made a high-pass filter of dubious accuracy due to the wide tolerance of electrolytics. The a.c. voltage across the capacitor can then give rise to unpleasant effects, of which depolarization is probably the worst, as it has depressing implications for the longevity of the component.

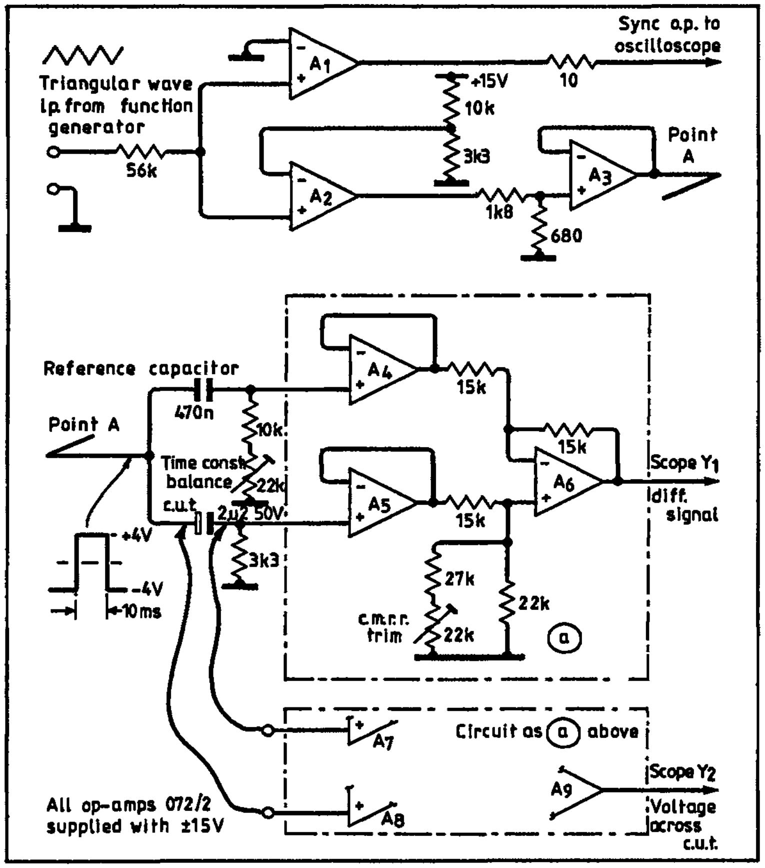


Frequency	Sig. loss	t.h.d.	V. across cut(pk)
50 Hz	0·1 dB	<·0012%	0·93
30 "	0·2 "	·0032 "	1·48
25 "	0·3 "	·0050 "	1·84
20 "	0·4 "	·0086 "	2·19
15 "	0·7 "	·018 "	2·82
10 "	1·4 "	·047 "	3·67

Figure 1 shows my own, simpler, method of demonstrating that capacitors generate distortion when misused. This is a simple high-pass filter; below it is shown a table of the distortion produced, against input frequency.

Harmonic distortion is unmeasurable from 20kHz down to 30Hz, where things suddenly start to go wrong. Under these conditions, it is at this point that the peak voltage across the capacitor reaches 1.4V. This seems to be the threshold at which the capacitor dielectric film starts to come undone, though dielectric absorption effects could be playing a part. Perhaps a capacitor manufacturer would like to contribute some information on this point.

Experimenting with different values of R and C confirms that the crucial factor is the peak a.c. voltage across the capacitor. The conclusion to be drawn is simply that you must avoid using electrolytics (including tantalums) as filter elements, for which purpose they are quite unsuitable anyway, due to their wide tolerances, and confine them to coupling duties, where it is easy to arrange for there to be no significant signal voltage across them. Simply ensuring that there is no premature l.f. roll-off is normally sufficient to take care of this point.



The use of unbiased electrolytics for coupling purposes has a history of at least twelve years, going back to the introduction of the first really practical op-amps. It was clear that the use of +/- power rails, while giving designs a greatly appreciated freedom from d.c. standing currents flowing down signal earths, would demand the use of electrolytics operating under zero-bias conditions.

There were many hasty consultations with capacitor manufacturers before it became clear that reliability would not normally be a problem. This is attributable to the absence of signal voltage across the capacitors in a well-designed coupling arrangement.

Having studied the test-circuit provided by Mr Curl, I can confirm that a non-nullable pulse residual is indeed produced; my own test assembly produced waveforms similar to those accompanying Mr Curl's letter in *HiFi News* [1]. It is not necessary to use exotic and expensive devices such as the AD524 — a conventional instrumentation-amplifier arrangement using TL072s gives exactly the same results in this case, providing close attention is paid to trimming the c.m.r.r. My arrangement is shown in Fig. 2. However, I am inclined to think this is just a complicated way of demonstrating the same effect that Fig. 1 produces. Taking, for example, a 10ms input pulse at point A, the change in voltage across the capacitor under test (c.u.t.) is 5.8 volts peak to peak, the c.u.t. being reverse-biased by about 2 volts for part of the cycle; the capacitor is not being treated kindly. This voltage is measured using A7,8,9, which forms a second instrumentation-amp. across the c.u.t. However, I submit that this ingenious test has no relevance to properly-designed audio coupling networks, as I have explained above. The lifetime of a capacitor used in such a way will be very uncertain.

Consider in what the circumstances this effect could constitute a real problem; the most obvious is the case of a warped record feeding its signal through to a preamplifier. However, it is normally considered that even a badly warped disc is unlikely to produce subsonic levels greater than −20dB below the general levels in the audio band,[2] and it will be noted that in Fig. 1 it is necessary to use signal levels only