SEPTEMBER 1988 £1.65

Radio & Electronics World

The communications and electronics magazine

YAESU FT-736R VHF/UHF TRANSCEIVER: A USER REVIEW

AVIATION ELECTRONICS: HYPERBOLIC AIDS TO NAVIGATION

DATA FILE: POWER CONTROL CIRCUITS

3μV/m may be expected in a receiver of 10Hz bandwidth.

When three or more Omega stations are being received, normal hyperbolic techniques may be used for position fixing. Using the 10.2kHz transmissions, the position lines are spaced at 15km intervals, however, those generated by the 13.6kHz transmission will only coincide every third lane. The 11.33kHz signal will further increase this to 135km.

Receivers may also be designed to operate on a comparison frequency of 3.4kHz. This is the difference between 10.2kHz and 13.6kHz and gives a lane width of 45km.

When only two transmissions can be received, normal hyperbolic techniques are not possible and an alternative method known as range-range is applied. This uses an in-build precision clock to obtain intersecting circular (instead of hyperbolic) position lines at 30km intervals.

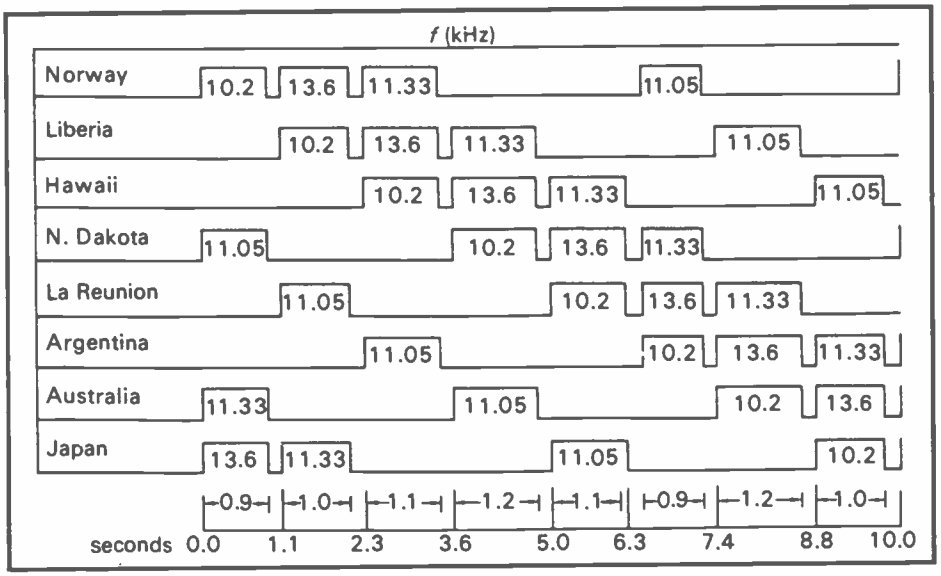


Fig 3: *Omega signal transmission format*

Decca Navigator

Intended as a maritime aid, Decca Navigator was developed towards the end of the second world war. More recently, this aid has been further developed for use in aircraft and hovercraft.

It is a continuous wave hyperbolic system which operates on a combination of frequencies in the LF band. The system is usable up to about 240 miles. Beyond 240 miles, sky wave contamination reduces accuracy.

A Decca Navigator chain comprises four stations: a master and three slaves, designated red, green and purple. These have frequencies according to the relationship:master:6F; red: 8F; green: 9F and purple:5F, where F is of the order 14kHz and varies from chain to chain.

The master station radiates a high – stability transmission at a power of approximately 2kW to a 300ft vertical aerial. The slave stations are of similar design except that their carrier frequencies are synchronised to the master transmission frequency.

In the receiver, the phase comparison is made by frequency multiplying the signal received from each station. The comparison is made at the lowest common multiple of the frequencies being received. The comparison is always made between master and slave.

There were those who believed that the original maritime aid, continuously transmitting from a relatively slow moving vessel, would not require any means of lane identification. They were proved wrong. Lane identification was particularly important for aircraft installations, so a system was introduced in 1948.

This lane identification system makes a comparison at the 14kHz fundamental frequency (F) for half a second for each of the phase comparison systems, producing lanes about seven miles wide at the baseline. During these periods, only one slave transmits at a time and the frequencies used are 8F and 9F.

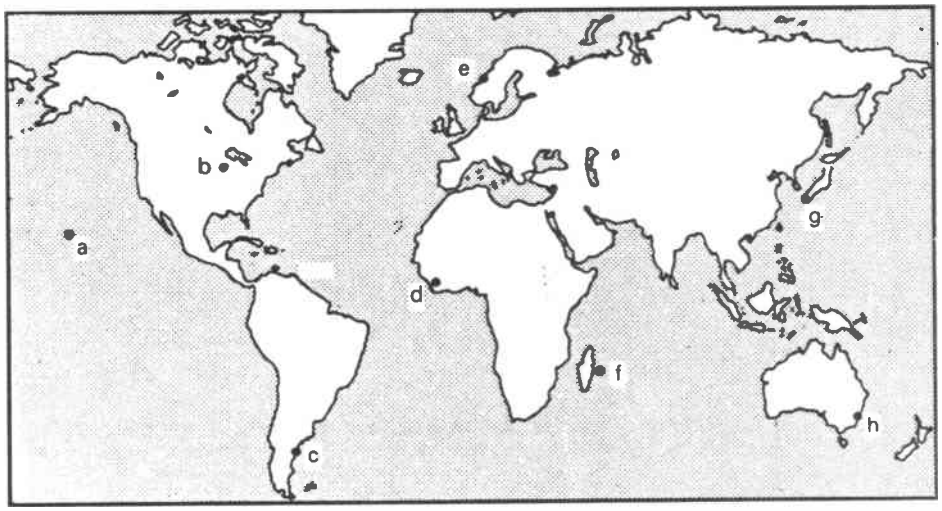


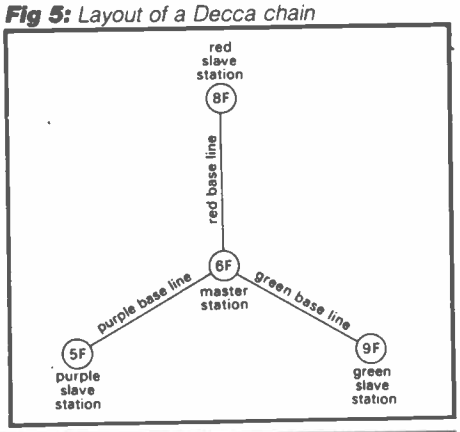
Fig 4: *Location of Omega stations, a Hawaii, b North Dakota, c Argentina, d Liberia, e Norway, f La Reunion, g Japan, h Australia*

The presentation to the navigator was originally three meters (called Deccometers), indicating the relative phase between master and each of the slave stations, plus a lane identification meter. By transferring the readings of the Deccometers to a special chart, the position of the vessel or aircraft may be determined. This method is perfectly satisfactory in slow moving vessels, but it leaves much to be desired in the confined space of an aircraft flight deck.

The first improvement was the Decca flight log, in which charts were produced as a moving strip. The aircraft position was represented by a pen capable of being moved transversely by mechanical gearing. Fore and aft movement was represented by map movement.

I well remember riding as a passenger in a small aircraft on a test flight many years ago. A Decca flight log had just been fitted, and soon after reaching operating altitude, the pilot commenced a series of seemingly wild manoeuvres. After a few minutes, level flight was

Fig 5: *Layout of a Decca chain*



HYPERBOLIC AIDS TO NAVIGATION

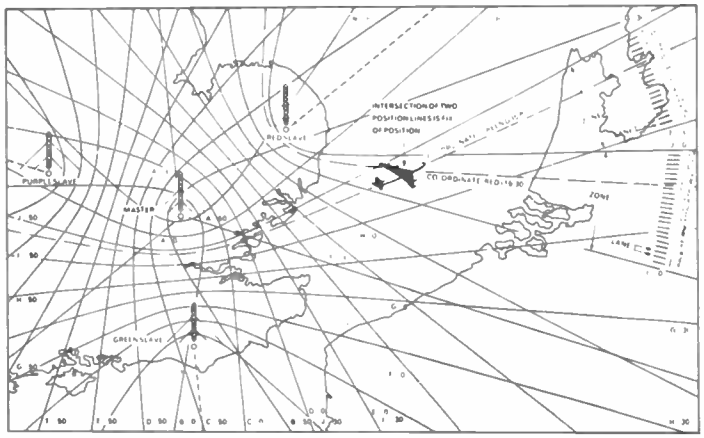


Fig 6: *The layout of the English chain showing how a fix is obtained from the readings of two decometer indicators*

Station	Frequency	Multiplication	Comparison frequency
master (6f)	85.00 kHz	4	(24f) 340 kHz
red slave (8f)	113.30 kHz	3	(24f)
master (6f)	85.00 kHz	3	(18f) 255 kHz
green slave (9f)	127.50 kHz	2	(18f)
master (6f)	85.00 kHz	5	(30f) 425 kHz
purple slave (5f)	70.83 kHz	6	(30f)

Operating and comparison frequencies for a typical Decca Navigator chain where the master station is operating on 85kHz

resumed and I was called urgently to the flight deck. 'Look', said the pilot and pointed to the flight log. There, in large letters, he had written his name!

More recently, display units have been simplified, with all phase comparisons being displayed in turn on a single meter. A further display may also give a left/right indication for flying along a pre-selected lane.

The Decca Navigator can give a position well within 100m when reasonably close to the transmitting stations. At longer ranges, the sky wave can interfere with the ground wave and cause inaccuracies which become intolerable at about 250 miles. Another problem with longer ranges, is the shallow angle of cut between lanes which leads to inaccuracies of up to several kilometres.

Within its limits, Decca Navigator has for many years proved to be an accurate and reliable aid. However, it has now been in use for over 40 years and is coming to the end of its operational life. I should be very surprised if any equipment remains in service after the end of the century.

In my next article, I shall describe aircraft navigational aids which require no external reference – inertial navigation system and doppler navigation. REW

ATV ON THE AIR

Andy Emmerson G8PTH puts you in the picture

Happy third birthday EATWG!

The annual meeting of EATWG (the European Amateur Television Working Group) took place over the weekend 18th/19th June in Friedrichshafen, on Lake Constance in Germany. This coincided with 'Ham Radio', Germany's equivalent of our RSGB national amateur radio exhibition. If this was not enough, it was also the twentieth birthday of AGAF, the German ATV club and the tenth anniversary of Busreferat (a special TV, fax and RTTY sub-group of DARC, the German national radio club)...

As yours truly is chairman of EATWG I should have been there but it was impossible to make it this year. Instead I sent a written report which took a searching look at where ATV has got to – and where it is going.

The year in review

Most of the progress in the world of amateur television in Europe has been subtle, rather than dramatic. Contact between member organisations of EATWG has increased: BATC, AGAF and the Belgian ATV group are circulating their magazines between one another. It was particularly pleasant to hear that France is represented at this year's meeting. For my part, I have written to the IARU, to ATV managers and amateurs in all countries with known ATV activity to tell them about EATWG. Response, however, has been disappointing with only one reply. This was from a Swedish ATVer, who said ATV activity in his country was minimal but that he would act as a contact. This indicates that we have probably made all the connections we can in Europe and can truly claim to represent the European ATV movement. What is more, I believe that we are doing as much as we can for ATV and, apart from AMSAT, we are the best-organised speciality-mode of amateur radio in Europe.

The future

Does this give reason for complacency? Unfortunately not!

If the trends in continental Europe are the same as in Britain, the magical growth era of ATV is over. Amateur radio altogether has stopped expanding in terms of numbers of people involved, if not in decline, and the only area where interest is growing fast is data transmission, in other words packet radio. This does not sound good for ATV.

What is worse is the risk of increased QRM to ATV from packet radio operators. So far this is not a problem in Britain, though I hear it is in Germany and the Netherlands. This can only get worse, because the interest in packet radio is growing all the time and many packet radio operators display little radio knowledge. They may be experts in data matters but many have no awareness of (or interest in) bandplans and reserved frequencies, nor do they listen on a channel before transmitting. Not all packet radio people are like this, but there are sufficient to cause a threat to ATV. (Apologies to you good guys!).

We must educate all radio amateurs about the importance of sharing our valuable resource thoughtfully. We must make more people aware that ATV is fun and the most fully rewarding branch of our radio hobby. This won't happen by itself – we must make ATV more interesting, explain what we are doing and encourage them to join our particular hobby. More repeaters, with more user facilities, are the most dramatic way of demonstrating this. I hope you can think of ideas too. As for avoiding packet radio QRM, I fear the only solution is to 'move to higher bands' – this may not please everyone but it may be the only way to escape PR!

I know you will come up with other practical ideas, and I look forward to receiving them!

Contact with USATVS

An important outcome of our visit to Dayton was meeting Mike Stone WB0QCD, chairman of USATVS, the United States ATV Society. I'm pleased to say that we got on well together. Mike shares our interests and outlook and his members face many problems similar to ours. Packet radio is also becoming the dominant mode in America and there are similar problems of frequency shortage on 70cm (30MHz is not enough where there are lots of hams!). On the other hand, there is little radar QRM on 23cm and in any case they have a 902-928MHz band which is even better for ATV exploitation than 23cm. ATVers have 'befriended' packet radio operators and some ATV repeaters have links enabling them to display packet radio activity.

Following this meeting, we have promised to improve contact between ATVers in north America and Europe. I have said before that I have a vision of a World ATV Working Group: it would not be difficult to make this a reality now.

Videotape exchange

At Dayton, Mike presented us with a superb videotape entitled 'Hello Europe'. This is a long tape demonstrating the very best of ATV operation in the USA and I will send you a copy as soon as we have converted it from NTSC to PAL.

We Europeans are honour-bound to send a tape back – I wonder if we can send an even better one! Many ATVers in Europe will not speak English and will make their tapes in their own language, but ATV is a universal language and I think this will add to the fun rather than detract from it. We can always provide a written translation. The finished tape will make a superb publicity film for ATV, also a useful 'documentary' to put in the ATV archives – in other words, an ambitious but worthwhile project.

Please start making your videotape now if it is to be ready for next year's Dayton Hamvention. Each country should aim to provide thirty minutes' material, in PAL and preferably on U-Matic or 1 inch tape. Please send your contributions to Trevor Brown G8CJS (he's in the callbook) – who will edit the tapes and arrange professional conversion to NTSC.

Test card tape completed

The development of the television test card has been the cherished research project of one or two people in the BATC – it is also the title of a fifty-five minute video production that is now ready.

Filmed by professionals, this tape presents the story of the TV test card in Britain, from the early efforts labelled A and B, through the well-loved Test Card C to the colour patterns of the present day. The story is told by George Hersee, who for many years developed test cards for the BBC. His daughter Carol is featured on Test Card F (she's not a little girl any more!) and George spills the beans on how this and many other well-known test cards were designed and made. Included in the presentation are many old test cards you probably haven't seen for years – and quite a few newer ones too, as well as some foreign examples and some which were never seen outside the BBC.

Since many people will want their own copy of this tape, the BATC will be arranging its distribution on a cost-only basis, so you will be able to afford it! Watch out for details in a future issue...

Trade news

The HS Publications team (7 Epping Close, Derby DE3 4HR) have been taking some new goodies to the rallies this year. Particularly affordable at 50p is a booklet describing DX-TV reception with their D-100 receive converter system. It's called 'The World at Your Fingertips'. The converter itself costs £88 in its deluxe version and connects between your DX aerial system and a normal 625 line TV receiver. Its tuning range covers from Band I through Bands II (special TV channels) and III, 70cm ATV, all through the UHF bands right up to channel 72 (US

Forces 'out of band' TV) – no wonder keen DXers like it. Another desirable feature is switchable IF bandwidth, enabling you to identify clearly signals unwatchable on a normal bandwidth TV. Four sound offsets are provided: 4.5, 5.5, 6.0 and 6.5MHz. The unit comes ready built and tested and is by no means expensive for what it offers.

Keith Hamer, one of its designers, says 'The deluxe D-100 seems to be popular with ATV enthusiasts, though for some reason the amount of ATV activity here in Derby seems to be very low compared with about one year ago. If there is anyone to monitor they usually come on for a few minutes, then suddenly disappear. The D-100s are certainly popular with DX-TV enthusiasts around the world due to their ability to operate in narrow-band mode. This is something that a TV set (even an expensive multi-standard receiver) cannot do. Using the narrow-band setting allows DXers to home in on weak signals, whereas just using a TV set (with its inherent wideband operation) means that a lot of exotic and rare signals can be totally missed. A few years ago I almost missed receiving Greece (which at that time was an extremely rare signal) but it was certainly there when I used a D-100 on narrow-band.'

The Hamer-Smith duo have also just released the second part of their 'DX-TV on Video' tutorials on video tape: I have seen it and it's as good as the first part, containing lots of practical information. If, after watching this, you are not fired into wanting to start DXing, you obviously have no soul! You can get both parts on VHS or Beta tape at the special price of £20 inclusive, otherwise each part costs £14.50.

For details of these products and others send an SAE to the address on the previous page.

Coombe Products (21 Mill Road, Liss, Hants GU33 7BD) have some relationship with Electro-Craft who used to advertise on the back of CQ-TV. They have introduced a new range of video accessories aimed fair and square at the serious video enthusiast. Highlights of this are a vision mixer, video processor and PAL colouriser, each at £199. See their free list for other items. User reports indicate that the gear is expensive (for hobbyists) but good.

Expanding business for LMW Electronics (12 Bidford Road, Braunston, Leicester LE3 3AE) means they have moved to larger premises. As well as Toko coils and hard-to-get microwave transistors and bits, they still stock their well-known kits and modules for 23cm and 13cm transmitting and receiving. Some microwave video gear is also promised.

The Rediffusion 'videobox' (not their own name) is a smartly finished UHF tuner with baseband video and audio outputs; surplus examples can be found at most rallies and hamfests at around £25 (or more!). This year some identical-looking units are on sale as cheap as £3 or £5 for two. It is worth noting that these bargains are translators rather than demodulators: they contain the usual six-channel tuner but the output is RF, in the UHF band. According to one trader, they make a good 70cm converter/upverter for ATV use.

Finally, users of the Atari ST micro will be pleased to know that an SSTV program (receive-only) and interface have been made for them. They are available from J & P Electronics (New Road Complex, New Road, Kidderminster DY10 1AL). Software costs £10 while the radio interface and leads cost £25. Sounds interesting and the screen shots demonstrated look very good.

Poitiers cancelled?

It is reported by Marc F3YX that the biennial VHF 'salon' at Poitiers (France) has been called off and will not be revived. This was the premier UHF and ATV event for French amateurs and a favourite outing for others who wanted to mix a rally with a French holiday. If we hear any more we'll let you have the news.

ATV in the press

If you watch the home computer software charts, you will have noticed that 'ATV Simulator' has been in the upper reaches for a while. It is not made for my machine and I have not noticed it in the shops, so I have not got hold of a copy. It sounded like an excellent idea – probably a bit like 'Doctor DX' on the Commodore, which simulated a live HF contest and you had to get the maximum score. Alternatively, it could be some kind of Morse tutor or its video equivalent.

Oh well, these daft ideas were shattered last week when I finally came across an advertisement for 'ATV Simulator' in *Computer Trade Weekly*. What a let down! ATV stands for all-terrain vehicle, a kind of four-wheeled motorbike. It's a 'classic top ten, best selling, scrolling simulator with exciting two-player action, six course and music by David Whittaker'. The cost is £2.99 from Code Masters so perhaps you'll buy it anyway. But I don't think I'll be doing so . . .

'Government Pushes ATV' was the bold headline across a half-page article in *Electronics Times* which caught my eye. Now, that must be the real thing. But again I was disappointed. It was the US government, not our own, and ATV in their book stood for advanced television (what you and I call HDTV – high definition TV – with 1125 lines and all that). Still, there's an estimated $100 billion to be made worldwide from ATV, according to that article. I wonder if they'll read this column? RCW

NETWORK 934

Andy Emmerson G9BUP

More news on SRR

At one of the regular liaison meetings with the 934MHz user groups (23rd June), the Department of Trade and Industry (DTI) revealed that they hope to start Short Range Radio (SRR) by 1992. What was particularly interesting was that they intended to allow hand-portable sets only – no mobiles or base stations. This would appear to limit the use of SRR to extremely short ranges! For businessmen it will make a convenient on-site paging system and hobbyists will find it excellent for hikers' groups and marshals at sports events. Beyond this it seems fit for very little!

In no way does it replace the existing simplex system using mobiles and base stations, which has proved very adequate for both local and occasional long-distance communication. With such a small target application it looks unlikely that many of the new SRR sets will be sold, so SRR users are unlikely to 'take over the band' and swamp existing 934MHz enthusiasts. The 12.5kHz frequency offset will further reduce any risk of mutual interference. So, given the minister's assurance that existing users will be allowed to continue using their sets, things are starting to look rosy again!

A request was made at the meeting to retain the MPT 1321 specification (and allow further import of sets of the current pattern) but this was declined. So it looks as if we pioneers will remain a select bunch – and perhaps the resale value of second-hand sets will start to rise, once new ones are no longer available! What an interesting scenario... and we have the DTI to thank for it too, even if that's not what they had in mind.

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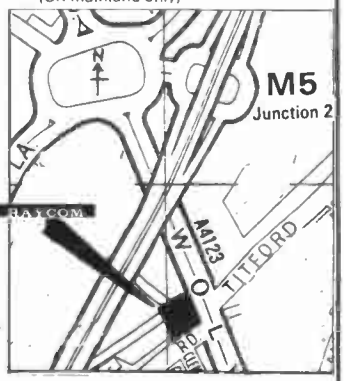

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CONTENTS

6 The Yaesu FT-736R VHF/UHF Transceiver: a User Review

11 Hyperbolic Aids to Navigation

15 ATV on the Air

16 Network 934

20 Data File

25 DX-TV Reception Reports

28 Amateur Radio World

30 Medium Wave DXing

34 Advertisers Index

34 Advertising Rates and Information

ON THE COVER

This month's cover shows: **(top)** the Mark 53 Decca Navigator Receiver, the latest of the Decca Marine receivers, incorporating a fully digital display (photo courtesy of Racal Marine Electronics Ltd). **Bottom:** the Yaesu FT-736R VHF/UHF Transceiver.

Publisher's Announcement

Due to severe editorial production problems, we regret that this issue of ***R & EW*** has to be published with fewer pages than normal.

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Published by
Radio & Electronics World Magazines
Sovereign House
Brentwood, Essex.
CM14 4SE. England
Tel: (0277) 219876

ISSN
0262-2572

Printed
In Great Britain

Newstrade sales
S M Distribution
6 Leigham Court Road
Streatham, London SW16
2PG. Tel: 01-677 8111

Subscriptions
Tel: 01-684 9542

Safety in the shack

Some of the constructional projects featured refer to additions or modifications to equipment; please note that such alterations may prevent the item from being used in its intended role, and also that its guarantee may be invalidated.

When building any constructional project, bear in mind that sometimes high voltages are involved. Avoid even the slightest risk – safety in the shack please, at all times.

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AN214O	2.50	LC7130	3.50	SN76023N	3.95	TAA310A	3.50	TCA830S	1.95	TEA1009	1.35
AN236	1.95	LC7131	6.50	SN76110N	0.99	TAA320A	3.50	TCA900	2.50	UPC41C	3.50
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AN240P	2.50	LM323K	4.95	SN76131N	1.30	TAA550B	1.95	TDA440	2.20		
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AN260	2.95	LM380N	1.50		2.95	TAA621	3.95	TDA10003A			2.75
AN262	1.95	LM380N8	2.95	SN76227N	1.05	TAA6320S	2.95		3.95	UPC10001H	
AN264	2.50	LM383T	2.95	SN76228N	2.95	TAA861B	1.95	TDA10006A			1.95
AN271	3.50	LM390N	3.50	SN75533N	1.65	TAA700	1.70		2.50	UPC1020H	
AN301	2.95	LM1011	3.15	SN76650N	1.15	TAA930	3.95	TDA1010	2.15		2.95
AN303	3.50	M5155L	2.95	SN76660N	0.99	TBA120AS/B/C		TDA10005	2.25	UPC1024H	
AN313	2.95	M51513L	2.30	STK011	7.95		1.00	TDA1035	2.50		1.50
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AN316	3.95	MB3705	1.50	STK015	5.95	TBA395	1.50	TDA1044	2.15		1.95
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AN342	2.95	MB3756	2.50	STK025	11.95	TBA440N	2.50	TDA1180	2.15		1.95
AN362L	2.50	MC1307P	1.00	STK032	7.95	TBA480Q	1.25	TDA1270Q		UPC1032H	
AN612	2.15	MC1310P	1.95	STK078	11.95	TBA510	2.50		3.95		1.50
AN6362	3.95	MC1327	1.70	STK085	8.95	TBA510Q	2.50	TDA1327	1.70	UPC1158H	
AN7140	3.50	MC1327Q	0.95	STK415	7.95	TBA520	1.50	TDA20002	1.95		0.75
AN7145	3.50	MC1351P	1.75	STK433	8.95	TBA520Q	1.75	TDA20003	2.95	UPC1167C2	
AN7145M	3.95	MC1357	2.35	STK435	7.95	TBA530	1.10	TDA2010	1.95		1.95
AN7150	2.95	MC1358	1.55	STK437	7.95	TBA530Q	1.10	TDA2020	2.95	UPC1181H	
AN7151	2.50	MC1495	3.00	STK439	7.95	TBA540	1.25	TDA2030	2.50		1.25
BA521	3.35	MC1496	1.75	STK461	11.50	TBA540Q	1.35	TDA2140	2.95	UPC1182H	
CA1352E	1.75	MC1723	0.50	STK463	11.50	TBA550Q	1.95	TDA2150	2.50		2.95
CA3086	0.46	MC3357	2.75	STK0015	7.95	TBA560C	1.45	TDA2151	1.95	UPC1185H	
CA3123E	1.95	MC3401L	2.50	STK0029	7.95	TBA560Q	1.45	TDA2160	2.50		3.95
CA3131EM		MC14108P	2.95	STK0039	7.95	TBA570	1.00	TDA2524	1.95	UPC1191V	1.50
	2.50	MC14518CP		TA7061AP	1.50	TBA651R	2.50	TDA2530	1.95	UPC1350C	
CA3140s	2.50		7.50	TA7072	2.65	TBA673	1.95	TDA2532	1.95		2.95
CA3140T	1.15	ML231B	1.75	TA7073	3.50	TBA720A	2.45	TDA2540	1.95	UPC1353C	
ETT6016	2.50	ML232B	2.50	TA7108P	1.50	TBA750	1.95	TDA2541	2.15		2.45
HA1137W	1.95	ML239	2.95	TA7120P	1.65	TBA750Q	2.25	TDA2560	2.15	UPC1360	2.95
HA1156W	1.50	MSM5807	6.75	TA7120P	2.50	TBA800	0.99	TDA2571	2.95	UPC1365C	
HA1306	1.50	SAA500A	3.50	TA7130P	1.50	TBA810AS		TDA2581	2.95		3.95
HA1322	1.95	SAA1025	7.25	TA7137P	1.00			TDA2582	2.95	UPC20002H	
HA1339A	2.95	SAA1251	4.95	TA7146P	1.50		1.65	TDA2593	2.95		1.95
HA1366W	2.75	SAA5010	6.35	TA7176AP	2.95	TBA810P	1.65	TDA2600	6.50	UPD2114LC	
HA1377	3.50	SAA5020	6.75	TA7193P	3.95	TBA820M	0.75	TDA2610	2.50		2.50
HA1406	1.95	SAB3210	3.50	TA7203	2.95	TBA820Q	1.45	TDA2611A	1.95	555	0.35
HA1551	2.95	SABB5608	1.95	TA7204P	2.15	TBA890	2.50	TDA2540	3.50	556	0.60
LA1201	0.95	SAS5708	1.25	TA7205AP	1.15	TBA920	1.65	TDA2655	4.50	723	0.50
LA1230	1.95	SA580	2.25	TA7208	1.95	TBA950/2X		TDA2680A	2.75	741	0.35
LA3201	0.95	SA8590	2.75	TA7222AP	1.80		2.38	TDA2690	2.45	747	0.50
LA4101	0.95	SL901B	7.95	TA7227P	4.25	TBA990	1.49	TDA3310	2.95	748	0.35
LA4102	2.95	SL917B	6.65	TA7228P	1.95	TBA990Q	1.49	TDA3510	3.50	7808	0.60
LA4140	2.95	SL1310	1.85	TA7310P	1.50	TCA270	1.50	TDA3560	3.95	7805	0.65
LA4031P	1.95	SL1327	1.10	TA7313AP	2.95	TCA270SQ				7812	0.65
LA4400	3.50			TA7314P	2.95		1.50			7815	0.65
LA4420	3.50			TA7321P	2.25	TCA650	2.50				
LA4422	2.50										

SEMICONDUCTORS

AAY12	0.25	BC182B	0.10	BD237	0.40	BF493	0.38	MRF453	17.50	TV106	1.50
AC126	0.45	BC183	0.10	BD242	0.65	BF595	0.23	MRF454	26.50	TV106/2	1.50
AC127	0.20	BC183L	0.09	BD246	0.75	BF597	0.25	MRF455	17.50	ZRF0112	16.50
AC128	0.28	BC184LB	0.09	BD376	0.32	BFR39	0.23	MRF475	2.95	2N1100	6.50
AC128K	0.32	BC204	0.25	BD379	0.45	BFR40	0.23	MRF477	14.95	2N1308	1.35
AC141	0.25	BC207B	0.25	BD410	0.65	BFR81	0.25	OC16W	2.50	2N1711	0.30
AC141K	0.34	BC208B	0.20	BD434	0.65	BFR88	0.30	OC23	9.50	2N2219	0.28
AC142K	0.45	BC212	0.09	BD436	0.45	BFR90	1.50	OC25	1.50	2N2626	0.65
AC176	0.22	BC212L	0.09	BD437	0.75	BFR91	1.75	OC26	1.50	2N2905	0.40
AC176K	0.31	BC213	0.09	BD438	0.75	BFT42	0.35	OC28	5.50	2N3053	0.40
AC187	0.25	BC213L	0.09	BD510	0.95	BFT43	0.35	OC29	4.50	2N3054	0.59
AC187K	0.28	BC214	0.09	BD518	0.75	BFW10	0.65	OC32	5.50	2N3055	0.52
AC188	0.28	BC214C	0.09	BD520	0.65	BFW11	0.75	OC42	1.50	2N2702	0.12
AC188K	0.37	BC214L	0.09	BD534	0.45	BFW16A	1.15	OC44	1.25	2N3703	0.12
AD142	2.50	BC237B	0.15	BD535	0.45	BFW61	0.50	OC45	1.00	2N3704	0.12
AD143	2.50	BC238	0.15	BD538	0.65	BFW92	0.65	OC70	1.00	2N3705	0.20
AD149	0.70	BC239	0.15	BD575	0.95	BFX29	0.30	OC71	0.75	2N3706	0.12
AD161	0.50	BC251A	0.15	BD587	0.95	BFX84	0.26	OC72	2.50	2N3708	0.12
AD162	0.50	BC252A	0.15	BD588	0.95	BFX85	0.32	OC75	1.50	2N3733	9.50
AF106	0.50	BC258	0.25	BD597	0.95	BFX86	0.30	OC81	1.00	2N3773	2.75
AF114	1.95	BC258A	0.39	BD695	1.50	BFX88	0.25	OC84	1.50	2N3792	1.35
AF121	0.60	BC284	0.30	BD698	1.50	BFY18	1.35	OC139	12.50	2N4427	1.95
AF124	0.65	BC300	0.30	BD701	1.25	BFY50	0.32	OC171	4.50	2N4444	1.15
AF125	0.35	BC301	0.30	BD702	1.25	BFY51	0.32	OC200	4.50	2N5294	0.42
AF126	0.65	BC303	0.26	BD707	0.90	BFY90	0.77	OC201	5.50	2N5296	0.48
AF127	0.65	BC307B	0.09	BDX32	1.50	BLY48	1.75	OC205	10.00	2N5298	0.60
AF139	0.40	BC327	0.10	BDX53B	1.65	BR100	0.45	R2008B	1.45	2N5485	0.45
AF150	0.60	BC328	0.10	BF115	0.35	BR101	0.49	R2009	2.50	2N5496	0.95
AF178	1.95	BC337	0.10	BF119	0.65	BR103	0.55	R2010B	1.45	2SA329	0.95
AF239	0.42	BC338	0.09	BF127	0.39	BR303	0.95	R2322	0.58	2SA715	0.65
AU106	6.95	BC347A	0.13	BF154	0.20	BRC4443	1.15	R2323	0.66	2SC495	0.80
AY102	2.95	BC461	0.35	BF177	0.35	BRY39	0.45	R2540	2.48	2SC496	0.80
BC107A	0.11	BC478	0.20	BF160	0.27	BSW64	0.95	RCA16029	0.85	2SC784	0.75
BC107B	0.11	BC527	0.20	BF173	0.22	BSX60	1.25	RCA16039	0.85	2SC785	0.75
BC108	0.10	BC547	0.10	BF158	0.22	BT100A/02		RCA16181	0.85	2SC789	0.65
BC108B	0.12	BC548	0.10	BF178	0.26		0.85	RCA16334	0.90	2SC931D	0.95
BC109	0.10	BC549A	0.10	BF179	0.34	BT106	1.49	RCA16335	0.85	2SC937	1.95
BC109B	0.12	BC550	0.14	BF180	0.29	BT116	1.20	RCA16572	0.85	2SC1034	4.50
BC109C	0.12	BC557	0.08	BF181	0.29	BT119	3.15	S2060D	0.96	2SC1096	0.80
BC114A	0.09	BC558	0.10	BF182	0.29	BT120	1.65	SKE5F	1.45	2SC1106	2.50
BC115	0.65	BC639/10	0.30	BF183	0.29	BU105	1.95	T602IV	0.45	2SC1124	0.95
BC116A	0.55	BCY33A	19.50	BF184	0.35	BU108	1.69	T6027V	0.45	2SC1162	0.95
BC116A	0.50	BD115	0.30	BF185	0.28	BU124	1.25	T6029V	0.45	2SC1172Y	2.20
BC117	0.19	BD124P	0.59	BF194	0.11	BU125	1.25	T6036V	0.55	2SC1173	1.15
BC119	0.24	BD131	0.42	BF195	0.11	BU126	1.60	T9002V	0.65	2SC1364	0.50
BC125	0.25	BD132	0.42	BF197	0.11	BU204	1.55	T9011V	0.75	2SC1413A	2.50
BC139BC	0.20	BD133	0.40	BF198	0.16	BU205	1.30	T9015V	2.15	2SC1449	0.50
BC140	0.31	BD135	0.30	BF199	0.14	BU208	1.39	T9034V	2.15	2SC1628	0.75
BC141	0.25	BD136	0.30	BF200	0.40	BU208A	1.52	T9038V	3.95	2SC1678	1.50
BC142	0.21	BD137	0.32	BC240	0.20	BU208D	1.85	THY15/80	2.25	2SC1945	3.75
BC143	0.24	BD138	0.30	BF241	0.15	BU326	1.20	THY15/85	2.25	2SC1953	0.95
BC147B	0.12	BD139	0.32	BF245	0.30	BU326S	1.50	TIP25	0.40	2SC1957	0.80
BC148A	0.09	BD140	0.30	BF256LC	0.35	BU407	1.24	TIP29C	0.42	2SC1969	2.95
BC148B	0.09	BD144	1.10	BF257	0.28	BU408	1.50	TIP30C	0.43	2SC1985	1.50
BC149	0.09	BD150C	0.29	BF259	0.28	BU500	2.25	TIP31C	0.55	2SC2028	1.15
BC153	0.30	BD159	0.65	BF271	0.28	BU508A	1.95	TIP32C	0.42	2SC2029	1.95
BC157	0.12	BD160	1.50	BF271	0.26	BU526	1.90	TIP33C	0.95	2SC2091	0.85
BC159	0.09	BD166	0.95	BF273	0.10	BU807	2.25	TIP34B	0.95	2SC2098	2.95
BC161	0.65	BD179	0.72	BF335	0.35	BUY20	2.15	TIP41A	0.45	2SC2314	0.80
BC170B	0.15	BD182	0.70	BF336	0.34	BUY69B	1.70	TIP41C	0.45	2SC2371	0.35
BC171	0.09	BD201	0.83	BF337	0.29	BUY71	2.50	TIP42C	0.47	2SC931D	0.95
BC171A	0.10	BD202	0.65	BF338	0.32	BUV41	2.50	TIP47	0.65	1SDS234	0.50
BC171B	0.10	BD203	0.78	BF355	0.37	MJ3000	1.98	TIP48	0.65	2SD325E	1.65
BC172	0.10	BD204	0.70	BF362	0.38	MJE340	0.40	TIP50	0.65	2SK19	0.55
BC172B	0.10	BD222	0.46	BF363	0.65	MJE350	0.75	TIP120	0.60	2SK33	0.55
BC172C	0.10	BD223	0.59	BF371	0.25	MJE520	0.48	TIP125	0.65	2SK105H	1.50
BC173B	0.10	BD225	0.48	BF394	0.19	MJE2955	0.95	TIP142	1.75	3SK88	0.95
BC174A	0.09	BD232	0.35	BF422	0.32	MPSA13	0.29	TIP146	2.75		
BC177	0.15	BD233	0.35	BF423	0.25	MPSA92	0.30	TIP161	2.95		
BC178	0.15	BD236	0.49	BF457	0.32	MRF237	4.95	TIP2955	0.80		
BC182	0.10			BF458	0.36	MRF450A		TIP3055	0.55		
				DF467	0.65		13.95	TIS91	0.35		

DIODES

AA119	0.08	BYX36-150R	0.20
BA115	0.13	BYX38-600R	0.80
BA145	0.16	BYX55-600	0.30
BA148	0.17	BYX71-600	1.75
BA154	0.06	BZX71	0.15
BA156	0.15	BZX61	0.15
BA157	0.30	BZX88	0.10
BA244	0.75	BZY95C30	0.35
BA301	0.75	CS48	6.00
BA302	0.65	CS108B	16.50
BA313	0.75	MR510	0.65
BA318	2.95	MR512	0.65
BA328	2.95	OA47	0.15
BA521	1.75	OA90	0.10
BAV21	0.30	OA91	0.15
BAW62	0.19	OA95	0.10
BAX13	0.04	OA202	0.40
BAX16	0.12	1N21DR	5.00
BB1206B	0.30	1N23B	2.95
BT151	0.79	1N23C	2.95
BY126	0.10	1N23ER	4.95
BY127	0.11	1N23WE	4.95
BY133	0.15	1N4001	0.04
BY164	0.45	1N4003	0.04
BT176	1.20	1N4004	0.05
BY179	0.83	1N4007	0.06
BY182	0.55	1N4148	0.02
BY184	0.35	1N4448	0.10
BY187	0.45	1N5401	0.12
BY199	0.40	1N5402	0.14
BY206	0.14	1N5403	0.12
BY208-800	0.33	1N5406	0.13
BY210-800	0.33	1N5407	0.15
BY223	0.90	1TT44	0.10
BY298-400	0.22	ITT923	0.15
BY299-800	0.22	ITT2002	0.10
BYX10	0.20		
BYX25-600	1.25		

ZENER DIODES

BZX61 Series	0.15
BZY88 Series	0.20

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Universal Tripler	5.45
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Decca 80	6.95
Decca 100	6.95
Decca 120	6.95
Decca 1730	6.35
GEC 2040	5.45
GEC 2110	6.95
ITT CVC1-9	6.35
ITT CVC20/25/30	6.35
ITT CVC45	6.95
Philips G8 (550)	6.95
Philips G9	6.00
Pye 697	6.50
Pye 713 4 lead	8.50
Pye 713 5 lead	8.50
Pye 731/25	8.50
Rank A774	6.35
Rank A823	6.95
Rank T20A	6.95
Siemens TVK76/1	6.95
Siemens Europa	7.50
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Thorn 1600	5.45
Thorn 3500	7.95
Thorn 8000	6.95
Thorn 8500	7.15
Thorn 9000	8.50
Thorn 9600	8.50
TV11 Stick	0.90
TV13 Stick	1.25
TV18 Stick	1.10
TV20 Stick	1.40

PUSH BUTTON UNITS

Decca/ITT	6 way	7.95	G8 (late)	6 way	14.50
Decca	4 way	7.95	ITT	7 way	10.50
Hitachi	4 way	11.95	Neons	7 way	12.50
Pye	6 way	10.35	Rank	4 way	10.50
GEC 213	6 way	9.50	Rank	6 way	10.50
GEC2110	6 way	10.50	Luxor	6 way	11.00
GEC	6 way	10.50			

FUSES

2mm Q/B @ 0.06 each
100 MA, 200 MA, 250 MA, 500 MA, 1 AMP, 1.25 AMP, 1.5 AMP, 1.6 AMP, 2 AMP, 2.5 AMP, 3.15 AMP, 4 AMP
Special offer: 100 per type 4.50
20mm A/S @ 0.15 each
100 MA, 150 MA, 160 MA, 250 MA, 500 MA, 800 MA, 1.25 AMP, 1.6 AMP, 2 AMP, 3.15 AMP, 5 AMP
Special offer: 100 per type 11.50
1.25 inch Q/B @ 0.06 each
250 MA, 500 MA, 750 MA, 1 AMP, 1.5 AMP, 2 AMP, 3 AMP, 7 AMP, 10 AMP
Special offer: 100 per type 4.00
1.25 inch A/S @ 0.15 each
50 MA, 60 MA, 100 MA, 150 MA, 250 MA, 500 MA, 750 MA, 1.5 AMP, 3 AMP, 4 AMP, 5 AMP
Special offer: 100 per type 10.00

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Auto Reverse Tape Head	3.95
Stereo Head	3.50
Pye IF Gain Module	6.99
4.433 MHZ Crystal (PAL)	0.45
5.5 MHZ Crystal (Sound)	0.45
Delay Line SL50/TAU82	1.15
Focus Control GEC210	1.50
Focus Control PYE731	1.50
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Anode Cap 27KV	0.69
Solder Mop	0.64

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Decca 1700 Mono	9.95
Decca 1730	8.25
Decca 2230	8.25
GEC2040	7.50
GEC2110	14.50
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ITT CVCZS/30/32	8.20
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Philips G9	8.95
Philips G11	13.95
Pye 691/697	11.50
Pye 713/715	11.50
Pye 725	10.95
Pye 731	9.95
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Rank Murphy A640	8.50
Rank Murphy A823	11.50
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Mains Switch Decca/GEC	1.00
G8 Switch	1.00
G11 Switch	0.95
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G11/12 with Remote and Mains off	1.50

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ELC1043/05 Mullard	8.65
ECL1043/06 Mullard	8.65
U321	8.25
U322	8.25
U324	11.00

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VA1056S	0.23
VA8650	0.45
VA1097	0.25

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7 watt	R47-22K	0.20
11 watt	1R-15K	0.25
17 watt	1R-15K	0.30

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A small selection from our stock of 10,000. Please add £3 additional carriage per tube

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D10-230GH	35.00
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D14-181GM	53.00
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D16-100GH/97	65.00
DG7 32	45.00
DH3-91	55.00
F16-101GM	75.00
F21-130GR	76.00
F31-12LD	75.00
M14-100GM	45.00
M17-151GVR	175.00
M23-112GV	55.00
M31-182GV	53.00
M31-184W	65.00
M31-190GR	55.00
M31-325GH	35.00
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NEW RANGE – LOWER PRICES
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3HSSUIN	For National Panasonic/Philips	29.50
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3HSSH	For Hitachi	35.00
3HSSU3N	For National Panasonic	35.00
3HSSP	For Sharp	35.00
3HSS6NA	For National Panasonic Industrial	75.00
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3HSSR	For Amstrad/Saisho/Triumph	35.00
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PS482S	For Sony SLC20/30 etc	39.50
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Ferguson 3V29/JVC HR7200	2.75
Ferguson 3V31/JVC HR7650	2.75
JVC HR3330/3600	2.75
Hitachi VT11/33	2.75
Hitachi VT5000	2.95
Hitachi VT8000	1.25
National Panasonic NV300/333/340	2.95
National Panasonic NV2000B	3.75
National Panasonic NV777	2.75
National Panasonic NV3000B	3.75
National Panasonic NV7000	2.75
National Panasonic NV8600/8610/8620	3.75
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Sanyo VTC9300	3.75
Sanyo VTC9300P	3.90
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Sharp 8300	3.50
Sharp 9300	3.50
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E180CC	9.50
E180F	6.50
E182CC	9.00
E186F	5.50
E188CC	7.50
E235L	12.50
E280F	19.50
E283CC	12.00
E288CC	17.50
E810F	25.00
E1148	1.00
EA50	1.00
EA52	55.00
EA76	1.95
EA79	1.95
EABC80	1.50
EAC91	2.50
EAF42	1.20
EB34	1.50
EB41	3.95
EB91	0.85
EBC33	2.50
EBC41	1.95
EBC81	1.50
EBC90	1.95
EBC91	1.95
EBF80	0.95
EBF83	0.95
EBF89	0.70
EC95	7.00
EBL1	4.50
EBL21	4.50
EC52	0.75
EC70	1.75
EC81	7.95
EC86	1.95
EC88	1.95
EC90	1.50
EC91	5.50
EC92	1.95
EC93	1.50
EC95	7.00
EC97	1.10
EC8010	12.00
ECC32	3.50
ECC33	3.50
ECC35	3.50
ECC81	1.50
ECC81 Special quality	2.25
ECC82	0.85
ECC82 Philips	1.95
ECC83	0.95
ECC83 Brimar	2.15
ECC83 Philips	1.95
ECC83 Siemens	2.50
ECC83S	3.50
ECC85	1.00
ECC86	2.75
ECC88	1.00
ECC89	1.50
ECC91	2.00
ECC189	2.50
ECC801S	5.95
ECC803S	5.95
ECC804	0.60
ECC2000	7.95
ECF80	1.15
ECF82	1.15
ECF86	1.70
ECF200	1.85
ECF202	1.85
ECF801	0.85
ECF804	6.50
ECF805	2.50
ECF806	10.25
ECH3	4.50
ECH4	4.50
ECH35	3.50
ECH42	1.50
ECH81	1.75
ECH83	1.00
ECH84	1.00
ECH200	1.50
ECL80	0.60
ECL82	1.00
ECL83	2.50
ECL84	0.74
ECL85	0.95
ECL86	0.95
ECL805	0.95
EF37A	2.50
EF39	1.50
EF40	4.50
EF42	3.50
EF50	2.50
EF54	4.50
EF55	4.95
EF70	1.20
EF73	3.50
EF80	0.55
EF83	3.95
EF85	0.80
EF86	2.25
EF86 Mullard	4.50
EF86/CV4085	5.00
EF89	1.50
EF91	1.95
EF92	2.15
EF93	1.50
EF94	1.50
EF95	1.95
EF86/CV4085	8.00
EF97	0.90
EF98	0.90
EF183	0.75
EF184	0.85
EF731	4.50
EF800	11.00
EF804S	19.50
EF805S	25.00
EF806S	25.00
EF812	0.65
EFL200	1.50
EFP60	3.50
EH90	0.72
EK90	1.50
EL32	0.95
EL33	6.00
EL34	2.95
EL34 Mullard matched pair	15.00
EL34 Siemens	4.50
EL36	2.50
EL36 Mullard	3.95
EL37	9.00
EL38	9.00
EL41	3.50
EL42	2.00
EL509 Mullard	7.50
EL71	4.50
EL81	6.95
EL83	7.50
EL84 Mullard	3.50
EL84 Siemens	2.50
EL85	4.50
EL86	1.75
EL90	1.75
EL91	6.00
EL95	1.75
EL152	15.00
EL360	6.75
EL500	1.95
EL504	1.95
EL506	5.95
EL509	5.25
EL519	5.95
EL802	3.65
EL821	5.95
EL822	12.95
ELL80	22.50
EM34	12.50
EM83	1.65
EM84	1.65
EM85	3.95
EM87	2.50
EN32	15.00
EN91	1.95
EN92	4.50
EY51	0.80
EY70	7.50
EY81	2.35
EY82	1.15
EY83	1.50
EY84	5.95
EY86/87	0.50
EY88	0.85
EY91	5.50
EY500A	1.50
EY802	0.70
EZ35	1.00
EZ40	2.75
EZ41	2.75
EZ80	0.75
EZ81	0.75
EZ90	1.50
FW4-800	2.95
G55/1K	9.00
G180/2M	5.95
G240/2D	9.00
GC10B	17.50
GC10D	17.50
GC10/4B	17.50
GC10/4E	17.50
GC12/4B	17.50
GD86W	5.00
GDT120M	5.00
GN4	6.00
GN10	15.00
GR10G	4.00
GS10C	16.50
GS10H	12.00
GS12D	12.00
GT1C	14.00
GU20	35.00
GU50	17.50
GXU1	13.50
GXU3	24.00
GXU50SS	14.50
GY501	1.50
GY802	1.50
GZ32	2.50
GZ233	4.50
GZ234	2.50
GZ237	4.50
HBC90	1.95
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HL41	3.50
HL90	3.50
HL13DD	3.50
KT8C	7.00
KT33C	3.50
KT36	2.00
KT44	4.00
KT45	4.00
KT61	5.00
KT63	2.00
KT66 USA	9.95
KT66 GEC	25.00
KT67	9.00
KT77 Gold lion	11.95
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KT88 USA	10.95
KT88 Selectron	18.00
KT88 Gold lion	22.50
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KTW62	2.50
KTW63	2.00
KTZ63	2.50
LB7-20	95.00
LS9B	6.95
M508	195.00
M5143	165.00
M5199	295.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	5.50
M8099	5.00
M8100	5.50
M8136	7.00
M8137	7.95
M8161	5.50
M8162	5.50
M8163	5.50
M8190	4.50
M8195	6.50
M8196	5.50
M8204	5.50
M8223	4.50
M8224	2.00
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ME1400	3.50
ME1401	29.50
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MHLD6	4.00
MS4B	5.50
MU14	3.50
N37	12.50
N78	9.85
OA2	1.50
OA2WA	2.50
OA3	2.50
OB2	1.50
OB2WA	2.50
OC3	2.50
OD3	2.50
OM4	2.50
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KT88 Selectron	17.50
KT88 Gold lion	18.95
KTW61	2.50
KTW62	2.50
KTW63	2.00
KTZ63	2.50
LB7-20	95.00
LS9B	6.95
M508	195.00
M5143	155.00
M1599	295.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	5.50
M8099	5.00
M8100	5.50
M8136	7.00
M8137	7.95
M8161	6.50
M8162	5.50
M8163	5.50
M8190	4.50
M8195	6.50
M8196	5.50
M8204	5.50
M8223	4.50
M8224	2.00
ME1400	3.50
ME1401	29.50
ME1402	29.50
MHLD6	4.00
MS4B	5.50
MU14	3.50
N37	12.50
N78	9.85
OA2	1.50
OA2WA	2.50
OA3	2.50
OB2	1.50
OB2WA	2.50
OC3	2.50
OD3	2.50
OM4	2.50
OM5B	3.00
OM6	1.75
ORP43	2.50
ORP50	3.95
P61	2.50
P41	2.50
PABC80	0.75
PC86	0.75
PC88	0.75
PC92	3.50
PC97	1.10
PC900	1.25
PCC84	0.40
PCC85	0.55
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.65
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	1.25
PCF200	1.80
PCF201	1.80
PCF801	1.35
PCF802	0.85
PCF805	1.25
PCF806	1.00
PCF808	1.25
PCH200	1.50
PCL82	0.85
PCL83	2.50
PCL84	0.75
PCL85	0.80
PCL86	0.85
PCL805	0.90
PD500	5.95
PE1-100	69.00
PEN25	2.00
PEN40DD	3.00
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	0.95
PL36	1.75
PL38	1.50
PL81	1.25
PL82	0.50
PL83	0.52
PL84	0.78
PL500	1.10
PL504	1.15
PL508	1.75
PL509	4.85
PL519	4.95
PL802	5.00
PL802T	3.50
PL820	2.95
PY32	0.60
PY33	0.50
PY81	0.70
PT82	0.70
PY83	0.70
PY88	0.65
PY500A	1.95
PY800	0.79
PY801	0.79
QB3-300	72.00
QB3-1750	139.50
QB3 5-700	72.00
QB5-3500	595.00
QE03-10	4.95
QE08-200	145.00
QQE02-5	19.50
QQE03-12	7.95
QQE03-20	35.00
QQE06-40	45.00
QQV02-6	19.50
QQV03-10	5.50
QQV03-10 Mullard	15.00
QQV03-20	25.00
QQV06-40A	27.50
QQV06-40A Mullard	39.50
QQV07-50	58.00
QQZ03-20	42.50
QQZ06.40	45.00
QS75/20	1.50
QS75/40	3.00
QS92/10	5.00
QS95/10	4.85
QS108/45	4.00
QS150/15	6.95
QS150/30	1.15
QS150/40	7.00
QS1200	3.95
QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1209	3.15
QS1212	3.20
QS1213	5.00
QS1218	5.00
QU37	9.50
QV03-12	5.50
QV06-20	29.50
QV08-100B	145.00
QY3-125	72.00
QY4-250	72.00
QY4-400	85.00
R10	4.00
R11	4.50
R16	12.00
R17	1.50
R18	2.50
R19	2.50
R20	1.20
R1169	55.00
R5559	9.50
RG1-125	4.95
RG1-240A	14.50
RG3-250A	6.50
RG3-1250A	35.00
RK2K25	62.50
RPY18	2.50
RPY43	2.50
RPY82	2.50
RR3-250	15.00
RR3-1250	35.00
S6F17	5.95
S6F33	28.95
S11E12	38.00
S30/2K	6.50
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S109/1K	15.00
S130P	5.95
SC1/800	5.00
SC1/1100	6.00
SC1/1200	5.00
SC1/1300	6.00
SC1/1400	5.00
SP41	5.00
SP61	3.50
ST11	5.00
STV280/40	11.95
SU42	4.95
TB2-5/300	85.00
TB2-300	195.00
TB3-750	95.00
TB3-2000	450.00
TBL2-300	395.00
TBL2-500	495.00
TC04/10-02	45.00
TD03-10E	35.00
TD03-10F	35.00
TDD2A	4.95
TH328	850.00
TH2321	4.95
TP2620	5.50
TT11	1.50
TT15	45.00
TT21	45.00
TT22	39.50
TT100	69.00
TTR-31MR	65.00
TY2-125A	85.00
TY4.400	85.00
TY7-6000A	600.00
TY8-600W	365.00
TYS2/250	375.00
U18-20	2.75
U19	11.95
U24	2.00
U25	0.90
U26	0.90
U35	3.50
U37	9.00
U41	6.95
U50	2.00
U82	3.00
U191	0.70
U192	1.00
U193	1.00
U251	2.50
U801	3.50
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	3.95
UBC81	1.50
UBF89	1.00
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	2.50
UCH42	3.95
UCH81	1.00
UCL82	1.75
UCL83	2.50
UF41	2.25
UF42	2.25
UF80	1.75
UF85	1.20
UF89	2.00
UL41	7.50
UL44	3.50
UL84	1.50
UL85	0.85
UU5	3.50
UU6	5.00
UU7	8.00
UU8	9.00
UY41	3.50
UY85	0.70
V235A/1K	250.00
V238A/1K	295.00
V246A/2K	315.00
V2406/1K	225.00
V241C/1K	195.00
V453	12.00
VLS631	10.95
VP4B	9.50
VP41	4.95
VR7-30	3.00
VR101	2.50
VR105/30	2.50
VR150/30	2.50
VU29	4.50
VU39	2.50
W21	4.50
W61	4.50
W77	5.00
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7L	1.50
7Q7	4.50
7Y4	2.50
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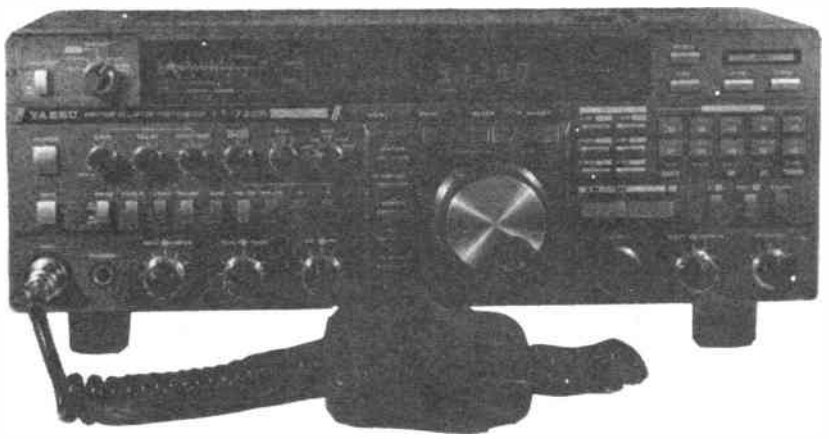
THE YAESU FT-736R Transceiver

A User Review

by Ken Michaelson G3RDG



This is the most recent rig to emerge from the Yaesu stable, being the successor to the well-known FT-726R and seems to have many improvements. However, it requires a good deal of study and careful reading of the operating manual before one can even attempt to drive it.

In essence, it is a solid state frequency synthesized VHF and UHF transceiver which incorporates up to four bands with modules covering the 50, 144, 220, 430 and 1200MHz amateur bands. In its basic form it gives an input of 25W on the 144 and 430MHz bands in SSB, CW and FM modes, with any two of the remaining three bands available as extra options. Power input on the 50 and 1200MHz bands is limited to 10W. The review unit had two of the three extra options fitted: 50MHz and 1200MHz.

The rig is micro-processor controlled with a 4 bit in/out co-processor to provide quite extraordinary digital integration and control. This includes selective tuning rates or mode-dependent channelled tuning in selective steps for each mode, plus a great variety of scanning methods. Unusually, it has facilities which would normally be found on HF transceivers, such as adjustable IF shift and IF notch, noise blanker, all mode VOX and a three speed AGC; all of which can be controlled from the front panel. The circuitry provides for GaAs FET receiver amplifiers in the 430 and 1200MHz modules and a high stability TCXO reference oscillator is incorporated; functioning on all bands. The A4 size operating manual contains 48 pages and shows no trace of 'Japanese English'. In fact, a number of colloquialisms were used. As I mentioned above, the manual had to be looked at carefully, as there were no shórt cuts to getting on the air. I had to make use of one of the top panel switches (memory back-up), to clear the memories and reset the microprocessor on more than one occasion!

However, the index was a great help in sorting out any queries I might have. The manual suggests that it is read through first and then again while actually operating the various switches and buttons. A good idea. No circuits were supplied with the rig, so I am unable to comment. Neither was there a circuit description. This may well be because of the complexity of the unit's design.

Hi-Tech

The rig uses modern technology to such an extent that if its operation is misunderstood, it is almost impossible to obtain reasonable results. There are 49 push-buttons and 18 rotary controls on the front panel including the keypad (which has five extra keys in addition to those marked with the numerals 1 to 0. I shall not list them all, but I will mention them when necessary.

The antenna used for most of the operating was an ICOM AH-7000 discone which covers 25-1300MHz and is installed about 15m above ground level. Mains power input was used, as mobile operation wasn't considered. There is a socket on the rear panel which accepts a 13.8V dc input if required (disconnecting the existing pigtail first). A heavy duty lead is supplied for this purpose and all four antenna sockets are there. The 50MHz and 144MHz modules use SO-239 sockets and the 430MHz and 1296MHz, 'N' type sockets.

On the rear panel is a six pin DIN CAT (Computer Aided Transceiver) socket. This is a serial input/output port for connecting a computer to operate the FT-736R directly from it. The data rate is 4800 bits per second with standard TTL levels. The next socket is a five pin DIN type, which provides transmit/receive lines to control external linear amplifiers. The current limitation here is 50mA.

Above this is a 6.3mm jack socket with which a stereo jack plug must be used. This is because the jack is used for both normal key operation and for the optional electronic keyer. Key-up voltage is 4.5V and key-down current is 2mA. There is also a 3.5mm external speaker socket which can drive speakers of 4 to 8 ohms impedance, but when this is used, the main speaker in the unit is disconnected.

The last two sockets are interesting to data users. The lower one is a standard phono-type which is connected in parallel with the MOX switch on the front panel. This allows operation of the transmitter by external devices such as a packet TNC. Open circuit voltage is 8V dc, closed circuit current is 8mA. The top 3.5mm stereo socket is for data in/out and allows direct connection to an FM transceiver or a TNC. An interesting point is that no pre- or de-emphasis is added to the signals here. This can result in improved performance with certain TNCs. The input sensitivity is 30mV into 600 ohms with an output level of 200mV into 10k ohms. One must remember that this jack is only operative in the FM mode.

Turning briefly to the front panel, there is the standard 8 pin microphone socket which has all the connections for up and down tuning, tone burst (the operation is controlled by a switch on the panel) and PTT. Next to this is the normal 6.3mm headphone socket which accepts both mono and stereo headphones with an impedance range of 4 to 100 ohms.

2m SSB

I started operating at the SSB end of the 2m band. Although there was a large number of controls on the front panel, it was only when operating the unit that I appreciated their use. An example was the monitor control to adjust the CW side tone volume. There are a block of switches to the right of the tuning knob which controls the modes (LSB, USB,

FM, FM-N, CW and CW-N). These six switches have a dual purpose and perform other operations when the F(C) switch is depressed; but more about that later.

Having selected USB, there are four ways in which the VFO can be tuned, apart from the 1MHz steps controlled by two switches below the mode controls and marked up and down. These are the main tuning knob, the large up/down keys just above the tuning knob, the microphone up/down keys which act in the same manner and the channel knob on the bottom line. Tuning steps for these different methods are determined by the mode in use and can be selected by the step key and also by the FM CH and SSB CH switches to the left of the main tuning knob. In the SSB (and CW) mode the main control tunes in either 10 or 100Hz which is selected by the step key.

You can directly alter the frequency by using the keypad for the required frequency. This is done by pressing the Ent(D) key when the MHz digit starts flashing (or 10MHz on the 430 and 1200MHz bands). You now key in the new frequency without altering the existing one and when you are ready, just press Ent(D) again and the new frequency is displayed.

There is a bank of five switches arranged vertically to the left of the tuning knob, each with its own orange indicator light. Two of these are labelled FM CH and SSB CH (the other three are dial lock, noise blanker and notch filter). When in the SSB mode, turning the channel knob will tune the VFO in either 2.5kHz or 5kHz, toggled by the step key.

In the FM mode, the control will tune in programmable 5, 10, 12.5, 15, 20, 25, 30 or 50kHz steps. VOX operation is provided on both SSB and FM and the controls for gain, delay and anti-trip are on the front panel. These controls also adjust the semi break-in keying in the CW mode.

Functions

The display area gives a great deal of information about the rig's operation. There are 23 different functions which are illuminated at the appropriate time, nine are in reverse video. This is apart from the main digital frequency display to four decimal places. The now common dimmer switch is incorporated in the row of controls. The meter has a five way selector switch with the three far left positions intended for satellite (full duplex) operation.

For simplex, repeater SSB and FM operation, use one of the two right hand settings, S/PO or DISC/ALC. S/PO shows received signal strength and transmitter power output in all modes. The DISC/ALC selection also shows 'S' units in the SSB and CW modes. In the FM mode it indicates discriminator centre tuning and when transmitting displays the ALC (automatic level control voltage) in the SSB and CW modes, including relative power output in FM. Since I had chosen the SSB mode, the meter switch was turned to the DISC/ALC position so that I could make sure that the ALC voltage did not go beyond the ALC zone on voice peaks (shown as a heavy blue line on the meter scale).

I had a number of satisfactory QSOs around the 144.300MHz calling channel. I do not have a beam so the RF speech processor was activated. The ALC was also kept within its limits. The drive (output power) can be adjusted from near zero to full power. The modulation level in SSB and the FM deviation is adjusted by the mic control.

The ability to adjust the FM deviation is unusual and the correct position is when the green BUSY indicator is just glowing on voice peaks. The reports I received were all complimentary, remarking on the clarity of speech. I found no trouble in tuning using the channel knob and the IF shift, notch filter and squelch function in all modes. I found the IF shift helpful in one or two QSOs, where there was trouble with adjoining stations.

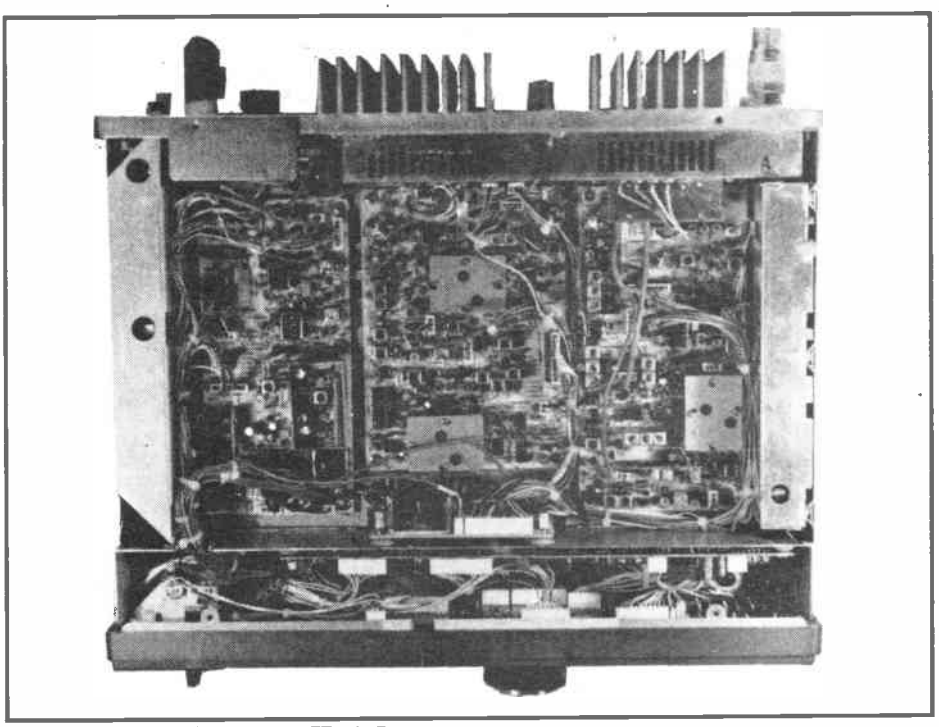
The clarifier was very helpful. This is brought into operation by pressing CLAR. When in circuit the main transmit frequency is not moved. The tuning knob can alter the receive frequency by ±10kHz.

The unit functioned perfectly using Packet on a frequency of 144.65 using the FM mode. The data controller was the PK-232 and audio was fed to the microphone input with the PTT line being connected to the normal PTT pin on the microphone input socket. The audio from the receiver section was taken from the phone socket.

Next I tried the FM section of 2m. This mode can select a narrower filter when troubled by adjacent signals. The standard IF bandwidth is 15kHz and this can be reduced to 8kHz by pressing the FM-N button on the front panel. However, when the transmitting deviation is reduced from 5kHz to 2.5kHz, it is questionable whether any great advantage can be obtained from the extra filtering. Only if the other station had the same facility, would any advantage be gained.

The FT-736R micro-processor is pre-programmed with the standard 600kHz shift on this band, either + or − according to the version of the transceiver used. For any 2m band splits not conforming to the ARS (automatic repeater shift) settings, and for any other band, you can program and select any valid repeater shift using the second meaning (reversed printing) on LSB (+RPT) or CW−N (−RPT) mode keys.

To activate the split just press F(C) (left hand group of three keys below the keypad) and then either LSB (+RPT) to shift the transmit frequency up, or CW−N (−RPT) to shift it down. A small + or − then appears in reverse video above the far left digit on the display. When you transmit, the displayed frequency will shift up or down by the programmed amount. You can use the REV key (right hand side, top line of keypad) to reverse the transmit and receive frequencies. To display and change the offset if necessary, press F(C) and BAND (offset); the current offset will appear with the far left digit blinking. A new shift can be 'input'



The interior view of the Yaesu FT-736R

by using the keypad. When you have done this, press ENT(D) and it is entered. If you don't want to alter the shift after having displayed it, just press ENT(D) or RESET (top right next to orange AQS) and you are back to the original settings.

Channel frequency

As I mentioned earlier, the channel frequency stepping can be pre-programmed between 5 and 50kHz. To re-program the tuning (and scanning) press the step key when in the FM mode and the current step size will then be displayed. The step size is altered by pressing one of the numerals on the keypad. Number 1 = 5kHz, 2 = 10kHz and so on. The new step selection is displayed for one second before reverting to the normal VFO setting. Number 6 = 25kHz, which was the stepping rate I used.

The toneburst is automatically controlled when the PTT switch on the microphone is operated, provided that the switch marked BURST is depressed. An indicator light just below the display area is illuminated when it is switched on. The period of the toneburst on the review example was too long, being approximately 1.5 seconds instead of the more usual 0.5 seconds. Otherwise, you can press T CALL which manually transmits the tone for as long as the switch is depressed.

The simplex channels can be activated by pressing F(C) followed by the FM-N key (group of mode keys) which has the word SIMP alongside, printed in reverse lettering. If you want to use the normal VFO tuning, all you need to do is to cancel the FM CH operation by pressing the switch once. The indicator light goes out and the tuning can now be carried out by using the main tuning knob. To restore the channel method of tuning you just press the switch once more and you are back using the channel control. The same method applies to SSB. A number of satisfactory phone QSOs were successfully completed on this section of the band.

70cm

I now moved to 432MHz (70cm). The only thing that had to be altered was the antenna, which had now to be connected to the N type socket on the 432MHz module, the same Icom discone being used as the antenna. I worked into ten of the repeater channels on this band, reaching quite some distance away, such as GB3BN (Bracknell), GB3KB (Farnborough), GB3BK (near Reading) and GB3RE (Chatham). These were all accessed from this QTH which is in London NW11.

Not a great deal of activity took place while I used the rig, so other than saying that perfectly satisfactory contacts through all ten repeaters took place, I have no other comment to make.

The next band up was 50MHz. I had proposed to use the discone for this band but I was informed that the majority of signals here are horizontally polarised. Therefore, I erected a horizontal dipole in the roof space. However, 50MHz was not a success with me, the only station I received was the RSGB beacon on 50.050MHz; transmitting its identity GB3NHQ IO91VQ in CW. This is not to suggest that there was any fault with the FT-736R, but that my antenna arrangements for this band were not suitable.

The FT-736R is also designed to operate using satellites with full duplex operation. Two special full duplex VFOs are available for crossband operation. These VFOs are called A and B but

FT-736R Specification

Operating frequency ranges:		*50 – 53.9999 144 – 145.9999 *220 – 224.9999 430 – 439.9999 *1240 – 1299.9999
Emission types:		LSB/USB (J3E), CW (A1A) FM (F20 FSK, F3E phone) TV (A3F for 1.2GHz)*
Antenna impedance:		50 ohms unbalanced
Supply voltage:		85 – 132 or 170 – 264 VAC, 50/60Hz or 13.8 VDC ± 10% negative ground
Power consumption/current required:		Maximum 250/VA Receive 1.5A Transmit 8A
Dimensions (WHD):		368 × 129 × 286mm
Weight:		9kg (19.8lbs)
Transmitter power input:		30W dc at 50MHz* 60W dc at 144, 220*, 430MHZ 45W dc at 1.2GHz*
Modulation methods:		SSB balanced filtered carrier (FM variable reactance (±5kHz or ±2.5kHz max deviation) (*ATV low level carrier)
Receiver circuit type:		50*, 144MHz bands: double conversion. Other bands: triple conversion superhet
Selectivity (–6/–60dB):	SSB, CW	2.2/4.5kHz
	CW-N (optional)	600/1200Hz
	FM	12/25kHz
	FM-N	8/19kHz
Sensitivity:	SSB/CW	better than –15dBu for 12dB S+N/N
	FM	better than –9Bu for 12dB SINAD

* = requires optional extra unit

The above information is taken from the manufacturer's operating manual and is only given as a guide

should not be confused with the VFOs I mentioned earlier. Quite separate from the 100 memories which are available in other modes, there are ten full duplex memories numbered 0 to 9. These memories can be distinguished from the normal 100 memories because only one digit is displayed instead of two, for example, 9 instead of 09.

Each memory can store a complete pair of satellite up and down link frequencies and modes. In order to get into the satellite mode, the rotary control labelled SAT is turned to one of the four available positions. There are five positions for this control: OFF, RX, TX, NOR and REV. OFF disconnects all the satellite circuitry, RX displays the receiving (downlink) frequency but the transmitting frequency is fixed and not displayed.

TX displays the transmit (uplink) frequency and the receive frequency is fixed and not displayed. NOR displays the receive (downlink) frequency, but both VFOs track together in the same direction when tuning.

Finally, REV displays the receive frequency but the VFOs track in opposite directions when tuning. Another of the many facilities available is a transmit/receive switched dc supply line for a masthead pre-amplifier, which applies 13.2V dc at a maximum of 300mA to the centre conductor of the antenna sockets during reception.

Altogether, a large range of options are available to the operator.

Internal keyer

Tone squelch operation is available with the optional FTS-8 unit which enables silent monitoring of busy channels in the FM mode. Different tone frequencies (in pre-arranged steps from 67.0Hz to 250.3Hz) and encode/decode status can be set for each VFO, then stored in one of the memory channels. For CW enthusiasts, an internal electronic keyer is available which is used by connecting the keyer paddles to the KEY jack on the rear panel. You can also use an external straight key or electronic keyer, in which case the internal keyer must be switched off. The speed of the internal keyer can be adjusted by a control on the front panel.

Each time the relevant switch is pressed, a green indicator light appears next to the name of the switch just below the display area. The delay between removing your hand from the key and the receiver being activated, can be adjusted by using the VOX DELAY control.

Digital MSK

The FT-736R incorporates the latest AQS feature which is a digital MSK (minimum shift keying) packet system providing automatic callsign identification, digital squelch, group calling and automatic clear channel access (CAC), when used with other AQS equipped stations in the FM mode. But there was a problem. I did not find anyone who was running the same type of transmission. The system operates by sending a 0.2 second packet burst every time the PTT switch is pressed. There are 21 digital code memories provided. Ten are for callsigns up to eight ASCII characters long, ten for group squelch codes up to five digits long and one for CQ. One extra memory is available for the owner's callsign. The facility is controlled by the four buttons at the top right hand side of the front panel and when activated, the different functions are illuminated in the display area.

The various callsigns are entered into the memories by converting the characters into the ASCII code using the keypad. Fortunately, there is a table showing Decimal to ASCII equivalents in the operating manual and it is a simple matter to store them. When this becomes popular it will be a very useful facet of the rig; when using it the only calls the receiver will respond to are those which send the necessary packet and open the digital squelch. There is also a Fast Scan Television adaptor, TV-736, for use on the 1.2GHz band. Unfortunately, it is arranged to work on AM to American standards and is not suitable in this country.

Low orbit satellites

The test I chose for satellite operation was the Japanese satellite, Fuji Oscar 12. According to the forecast figures, it made two orbits in the analogue mode on May 14th at 1410 and 1606 UTC. The test was carried out with the help of Richard Limebear G3RWL.

The rig was brought into the satellite mode by rotating the SAT switch to RX. The downlink is between 435.900 and 435.800MHz and the uplink between 145.900 and 146.000MHz. The rig tracks well when rotating the tuning control but a major disadvantage is trying to accommodate low orbit satellites, which have a large Doppler shift during the time they can be worked. In the case of the particular orbit of Oscar 12, the Doppler shift was as much as 10kHz during the 15 minutes it was heard and this required constant retuning of both the transmit and receive frequencies. The duplex operation would function well with Oscar 10 for example, but was very frustrating in this instance.

Within a short time the beacon was heard sending figure groups and at a frequency slightly above this, a CQ call was heard. We went back to the caller, Pascal HB9RHV in Berne, and exchanged signal strengths. We got 5/7 and we were able to give him 5/9. Almost immediately afterwards we had another contact with PA0AND Adri, who gave his location as JO33gd. We only got 5/1 from him and gave him 5/6. We tried CW and sent out several CQ calls, but by that time the satellite had disappeared over the horizon.

In general, the unit performed excellently. Its sensitivity on 2m was equal to an Icom-271E which was fitted with a Mutek front-end (using the same antenna and tuned to GB3VHF at Wrotham). It is certainly equal to an Icom IC-471E on 70cm, using the same antenna. Of course these were rough approximations while using the 'S' meter as a guide but it showed that the FT-736R was certainly working well. It is interesting to know that the Fuji Oscar 12 is a very small satellite. It is only 400mm wide and 470mm high. It has 26 sides and weighs approximately 50kg. This makes it no larger than a medicine ball!

As far as the rig's operation was concerned, I found the receiver very much alive. As I commented earlier on 70cm, I was surprised at the ease with which I accessed repeaters some distance from this QTH. Two metres brought some very satisfactory contacts in spite of not having a beam.

I have mentioned operation on 50MHz and, unfortunately, no results were obtained with the microwave repeaters. This was obviously due to the lack of suitable antennas.

As far as amateur TV is concerned, it is a shame that the band coverage only went up to 1299.99MHz and only accepted AM, as the outputs of RMT1, 2 and 3 are all above 1300MHz.

Since I was using the Icom AH-7000 discone, I had to disconnect it each time I wanted to change bands and re-connect it to the appropriate module.

The main tuning control was too light in action and there was no means of increasing the drag, unlike some contemporary rigs. This is my own opinion and doubtless other operators would say it was fine.

In conclusion, I would think this would be the ideal rig for the VHF/UHF enthusiast as it offers every facility imaginable for use in the bands it covers. The operation of the various sections of the rig is quite amazing, as it gives the prospective owner the choice of what bands he/she is interested in with the option to increase the coverage at a later date. There is everything to be said for it, however, the operating manual *must* be read and understood.

It was a most interesting rig to review. The basic price is £1,450, complete with 2m, 70cm and duplex. The 50MHz module (FEX736/50) is £239; the 1.2GHz module (FEX736/1.2) is £425; the CTCSS unit (FTS8) is £49.95 and the AQS message unit (FMP1) costs £189. All prices include VAT.

Thanks are due to SMC, SM House, School Close, Chandlers Ford Industrial Estate, Eastleigh, Hants SO5 3BY, for the loan of the review rig.

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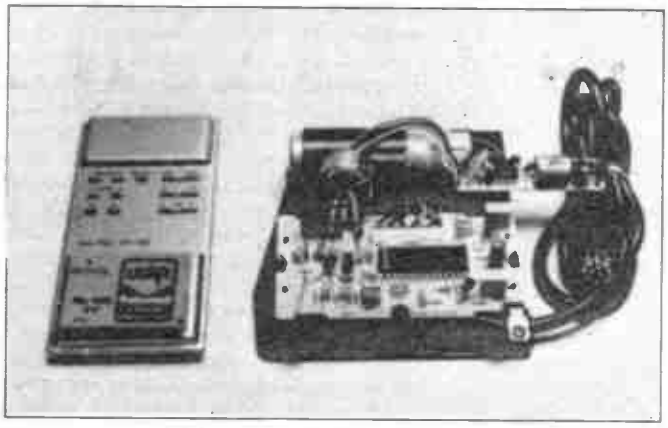

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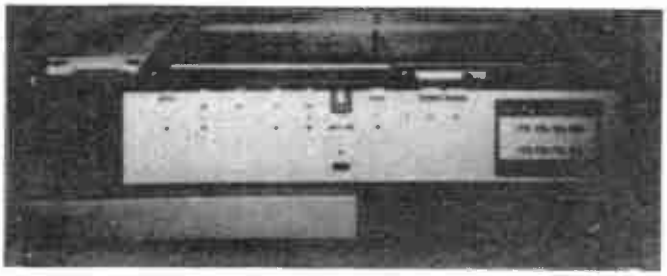

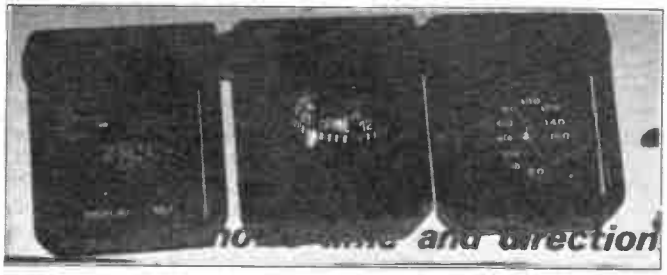

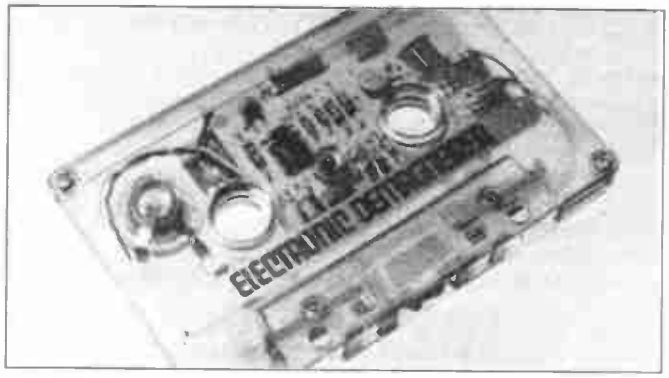

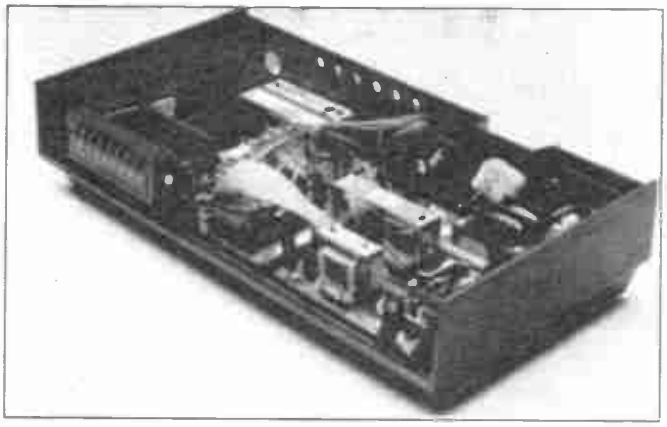

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HYPERBOLIC AIDS TO NAVIGATION

BY BRIAN KENDAL G3GDU

AVIATION ELECTRONICS

Part Seven

The radio navigational aids considered in previous articles (eg VOR/DME, NDB) have relatively short ranges. They are perfectly adequate for short haul airline operations over densely populated areas, but there are many parts of the world where their installation is either uneconomic or impracticable.

Long haul aircraft must carry long range position-finding equipment. This may belong to any of three families: long range hyperbolic systems such as Decca, Omega or Loran; internal sensors such as inertial (INS) or doppler radar systems; or spaceborne systems such as Global Positioning System (GPS) which uses the Navstar satellites.

This article is about hyperbolic systems; the others will be described in future articles.

History

The basic principles of hyperbolic navigation were suggested by R J Dippy, one of Robert Watson-Watt's original radar team. These principles led to the development of Gee, the first hyperbolic system which was introduced in early 1942.

The Gee system operated on frequencies between 25 and 90MHz, so its range was limited to about 250 miles.

Gee was followed by Decca Navigator, operating on the LF band, and also by the American-developed Loran which used frequencies around 2MHz.

Loran was withdrawn from service in the late 1970s and was replaced with an updated system, Loran-C, which operates on 100kHz. Meanwhile a further aid, Omega, on the VLF band, was being developed by the United States Navy to provide worldwide coverage for aircraft, ships and submarines.

Basic principles

The two types of hyperbolic aid are pulse and CW. The only other differences are in the frequencies and the methods of implementation.

To understand the basic principles, consider a hypothetical pulse system in which two radio stations, A and B, are spaced by about 100km with an aircraft somewhere between. Each station simultaneously radiates a short pulse of RF. If the aircraft receives both pulses at exactly the same time, it is obvious that its position is on a line equidistant from the stations. If, however, it receives the signal from station A first, then it is nearer to A and the time difference between the arrival of the signals from A and B will correspond to its position relative to the stations. In this instance, the aircraft's position will lie along a hyperbola the focus of which is either station A or station B (see *Figure 1*). The hyperbolae are sometimes called position lines.

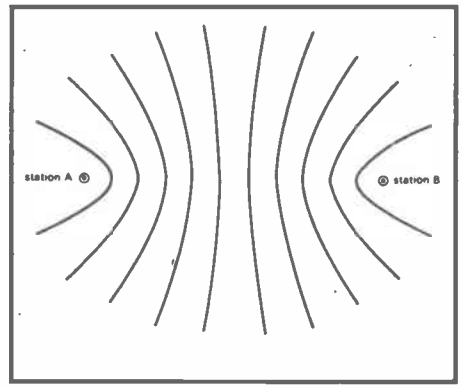


Fig 1: *A family of position lines. In the Decca Navigator system these would correspond to the in-phase condition at the comparison frequency whilst, in a pulse system they would be derived from the relative times of arrival of pulses from the stations A and B*

If station A transmits another pulse, this time simultaneously with another station, then another hyperbola can be derived. The two hyperbolae intersect at two points and the aircraft's position is at one of these intersections.

It is usually obvious which intersection is the position of the aircraft as the intersections are well spaced and there is little possibility of confusion. Nevertheless, this ambiguity can be resolved by adding a fourth station to the system.

In such a system, Station A would be termed *master* and stations B, C and D *slaves*.

At this point, the question arises: how does the aircraft determine from which transmitting station the pulses were received? This may be achieved either by operating each station on a separate frequency or, instead of radiating simultaneously, by transmitting at precisely defined intervals, varying the number, length or phase of the radiated pulses to achieve individual station identification.

In the Gee system the relative arrival times of the signals were compared manually using a special oscilloscope; and the master station was identified by radiating a second *ghost* pulse. All modern systems use fully automatic techniques.

In the alternative CW system the stations each radiate a continuous carrier. If each is radiating in phase on precisely the same frequency, a standing wave pattern will be set up between each pair of stations. By noting *in phase* conditions, the navigator will be able to determine a series of position lines (known as lanes) and where the in phase condition does not apply, measure the phase difference and so determine his relative position between the position lines.

Total confusion would reign if all stations in such a chain were on the same frequency, however, if each radiates on a discrete frequency, which bears a mathematical relationship to the others, the received frequency can be processed (eg multiplied or divided) within the receiver to obtain a common frequency for comparison.

Loran-C

All Loran-C transmissions are on a frequency of 100kHz; this enables the master and slave stations to be separated by distances of up to 800 miles so the operational range is well in excess of 1000 miles. However, there is a penalty to pay for achieving this range: powers of order 4MW are required to feed vertical aerials typically 1350ft high.

A pulse transmission of such power could cause considerable interference on adjacent channels unless the transmitters confined their output to a specified spectrum. In fact, the transmitters confine 99% of their radiated energy within the spectrum 90 to 110kHz. This is achieved by arranging a slow build-up and decay of the transmitted pulse.

The received signal may be contaminated by sky waves about 30μs after the leading edge of the pulse is received. This is why more accurate equipment uses only the first three cycles of the received pulse.

The master station radiates a group of nine pulses at a repetition rate of 10 to 25 groups per second. The pulses within each group are separated by 1000μs. Then there is a delay, in excess of the

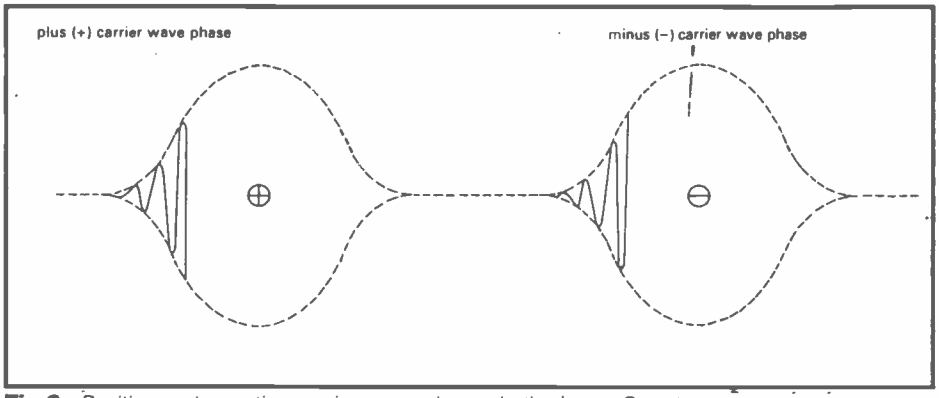


Fig 2a *Positive and negative carrier wave phases in the Loran-C system*

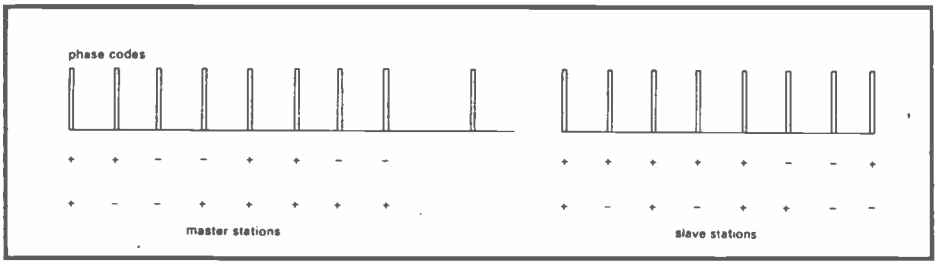


Fig 2b *Typical phase codes for identifying individual Loran-C stations showing use of positive and negative carrier wave phases*

propagation time between the master and slave stations plus a further 2000μs. After this delay, the first slave transmits a group of eight pulses at the same spacing. Still later, the next slave transmits a similar group.

The transmission of groups of pulses has the advantage of increasing mean equipment power output without excessive transmitter power.

Individual chains and stations are identified by phase coding, whereby the first cycle of any pulse is positive – or negative – going. It is possible to identify each transmission by arranging that each station emits a unique sequence of positive and negative pulses.

At the operational frequency of this system, modern techniques enable the radio frequency phase to be measured to an accuracy of about 0.03μs. Consequently, the accuracy of a fix is determined mainly by the angle of cut of the position lines, and the stability of propagation of the transmitted signal. Experience shows that variations of up to about 0.5μs may be caused by propagation instabilities, but this can be partially compensated by adjusting the relative timing of master and slave transmissions.

Though it is apparently simpler to operate all transmitters on the same frequency, there are other factors that intervene which more than compensate for the simplified tuning arrangements.

On the LF bands, signals are frequently very weak and the strength may be as low as 20dB below the noise within the 20kHz bandwidth of the receiver. Furthermore, interfering signals, either pulse or CW, may be as much as 35dB higher, whilst the signal strength of the desired stations may vary as much as 120dB.

Such selectivity cannot be obtained from conventional passive filters, so use is made of slow response servo loops with long integration times which track the desired signal. In addition, automatic notch filters scan the receiver bandwidth and are directed to the strongest interference.

The equipment will acquire a signal 6dB below atmospheric noise and maintain tracking down to 20dB below noise. Once locked, the equipment will indicate time differences down to 1/10μs on a digital display.

However, this is not the display that is presented to the pilot. Instead, it is used to drive a complete navigation system in which the parameters of the various chains are held on a database, enabling a direct display of latitude and longitude. Furthermore, waypoints may be inserted into the system and distance and direction to a selected waypoint indicated.

In common with other LF and VLF equipment, the aerial requirements for a Loran receiver are not severe, for the only requirement is that the incoming atmospheric noise substantially exceeds that generated within the receiver. This is usually achieved with an effective aerial height of considerably less than one metre.

Omega

The Omega system has been established by the United States Navy as a worldwide navigational aid. The system operates in the very low frequency (VLF) spectrum on frequencies between 10 and 14kHz (30 to 20km wave length).

The mode of propagation at VLF is completely different from that at higher frequencies with the ionosphere and the earth below acting as a waveguide. The optimum mode of propagation at Omega frequencies is known as TM, this is where the electric field forms a half loop between earth and ionosphere. The extremely long range of the Omega signals is due to the very low attenuation of this mode of propagation.

The range is also affected by the terrain over which the signal passes, the height of the ionosphere, atmospheric noise and several other factors.

Even when signals are strong, they may not be suitable for navigational guidance, as spurious propagation modes may be excited within the vicinity of the transmitter. The most significant of these is TM2 (one and a half loops between earth and ionosphere), which interferes with the desired TM mode. For this reason an Omega signal cannot be used within 1000km of the transmitting station in daylight and for proportionately greater distance at night.

An interesting property of VLF signals is that they penetrate sea water to a considerable depth. The attenuation of one metre of water is approximately equivalent to 1000km of atmospheric path (about 4dB). Water attenuates both signal and noise by the same amount, so the signal to noise ratio in water will be the same as on the surface and the sensitivity of the receiver will be limited only by its internally generated noise. These frequencies can therefore be used for navigation and communications in submerged submarines.

Each Omega station radiates four bursts of signal on different consecutive frequencies: 10.2kHz; 13.6kHz; 11.33kHz and 11.05kHz. The length of each burst varies between 0.9s and 1.2s. This is one of several ways to identify individual stations.

Furthermore, at half-minute intervals, the carrier frequency currents at all transmitting stations pass through zero with a positive slope. This synchronisation is achieved by the use of four caesium frequency standards at each station.

Each transmitter gives an output of 150kW, but as the aerials are electrically small, the actual radiated power is only in the region of 7% of this figure.

The phase difference between the signals from different stations is measured in the receiver, the propagation corrections are applied, and the observer's position derived.

At VLF, noise levels are very high, so receivers must be extremely selective for long range reception. Signals are also strong; at a range of 8000 miles from the transmitting station, a signal strength of 30μV/m and a noise level of

United we stand. . .

There are two national groups representing the interests of 934MHz users; the 934MHz Club UK (PO Box 424, Althorne, Chelmsford, Essex) and the Personal Radio Club of Great Britain (41 Twyford Avenue, Shirley, Southampton SO1 5NZ). Both have their strengths and weaknesses but together they do a good job, with the best interests of band users at heart. Your interests are served by belonging to one – or both. There are a number of regional groups, too, often offering local meetings, PO boxes and social get-togethers.

One of these which I came across recently is the Black Diamond Circle of Castleford in Yorkshire. The black diamond is in honour of the miners of Yorkshire, by the way, and membership is mainly within this county. They started about a year ago with a 'use it or lose it' spirit and now have around fifty members. They are not a club, more a friendship circle, and although they do not have regular meetings they organise rallies and also meet at other people's rallies. New people receive a welcome pack, worth several pounds I am told, and you can have personal QSL cards printed if required. Membership costs just £1 and it is left to members' goodwill to pay extra for the other benefits, which include a monthly newsletter. If you are in this part of the country and would like to join, drop an SAE to Stevie, BDC 01, who will be delighted to send you details. Her address is PO Box 4, Normanton, Yorks WF6 2Y2.

Hilltopping

I picked up this information last month when I took out my trusty Delta-One for a rare mobile airing. The occasion was the Denby Dale mobile rally and on the way back I thought I would see who I could work from the top of Holme Moss. In case you don't know this spot, it is the location of a BBC transmitter and one of the highest (and bleakest) spots in Yorkshire. From the car park you can see for miles – and work even further by radio!

I know hilltopping – operating mobile from a hilltop site – is a popular pursuit but luckily I was the only mobile operator on 934 there. My CQ calls were answered by Stevie BDC 01 and also Keith BDC 49 (UK 72) who was 80km away in the Yorkshire Wolds near Pocklington. If you are tired of working the same old people, why not try operating from your local mountain top? It might be quite rewarding – the only snag is getting the people who promise they QSL 100 per cent, to actually do this (hint!).

Commercial spot

Specialist manufacturers of UHF radio equipment are *Down East Microwave* (Box 2310, RR1, Troy, Maine 04987). Their products are for the American 33cm band but it's interesting to see what's available 'across the pond'. They sell loop yagi antennas with 33 or 47 elements. Gain is 18.5 and 20dBi respectively, while prices are $99 and $140 (or $82 and $118 as self-assembly kits). Stacking frames, power dividers and matched phasing lines are also available.

Linear power amplifiers are also made by *Down East*: 24W out for 1W in, will cost you $255, while 40W out for up to 10W in, will set you back $310. The pursuit of power is therefore not cheap! The low noise (typically 0.8dB) preamplifier costs $80 and has 12dB gain, a more realistic figure than the higher gain (and higher noise figure) products supplied here.

Sign off

That's all for this month. Even if summer finished two months ago, try and get out mobile and send in details of your favourite hilltop location. Don't forget the QSL card for our gallery! NEW

ICOM

The ICOM "75" Series

ICOM have a winning line-up for fixed, portable and mobile operations. The deluxe "75" series of transceivers offers a new standard of excellence from VHF to UHF communications. Each compact all mode unit delivers maximum performance, reliability and ease of operation.

The "75" series transceivers feature 99 tunable memories, twin VFO's, pass band tuning, I.F. notch, noise blanker and CW break-in. The scanning modes include memory scan, mode scan, programmable scan and frequency skip.

These transceivers can be used in a variety of ways, for propagation experiments, satellite communications, moonbounce, D'xing or straight rag chewing contacts. When high speed digital systems such as PACKET or AMTOR data communications are used then the ICOM DDS system provides a lock-up time of just 5msec.

2 Meters

ICOM's 25 watt IC-275E is a superb transceiver for contest operating and for general DX working. This prestige 144MHz multimode is also available as a IC-275H 100 watt version, which requires an external AC supply.

70cms

Enjoy 430MHz operation with the 25 watt IC-475E, or go high power using the IC-475H. An optional CT-16 Satellite Interface Unit is available for combining ICOM "75" transceivers for easy tuning.

6 Meters/10 Meters

The 10 watt IC-575 covers 28-30MHz and 50-54MHz and includes the AC supply. Join in with the recent openings to the U.S.A. with this superb transceiver. Also to be released soon is the IC-575H 50/100 watt high power version, which will operate with an external AC supply.

With the introduction of the "75" series you now have all the technical quality you'll need to enjoy VHF and UHF communications. For more detailed information on these transceivers contact your local ICOM dealer of ICOM (UK) Ltd.

Icom (UK) Ltd.
Dept REW, Sea Street, Herne Bay, Kent CT6 8LD. Tel: 0227 363859. 24 Hour.

Count on us!

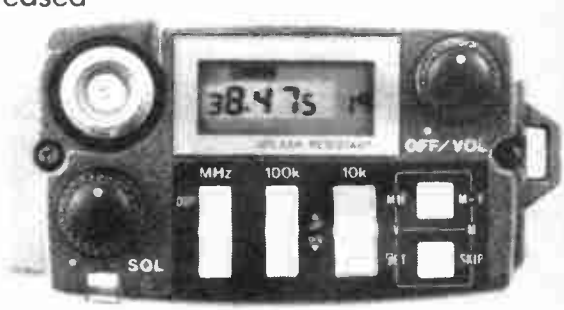
NEW IC-2GE/4GE FM Handportables

Features:

- **Rugged and compact**
- **High Power option**
- **Power saver circuit**
- **20 memories**
- **Scanning**
- **Compatible with ICOM accessories**

The latest range of handportables from ICOM fulfill the most important criteria for a handheld transceiver. They are small, rugged and easy to operate.
The 3 watt RF output is a compromise on battery life against power output, but for those who require extra punch, these sets can deliver 6/7 watts when used with the BP7 or external 13.8v DC. On receive, the power saver circuit reduces current drain automatically but can be overridden for packet operation.
The 20 memory channels can store all your favourite simplex and repeater frequencies, and with the programmed scan and memory scan functions there is no need to manually search for activity. The IC-2GE/4GE utilise most existing ICOM handheld accessories plus a new line of carrying cases. If you are expecting to be outdoors this summer or looking for your first handportable transceiver, the ICOM "G" series will take a lot of beating.
Shortly to be released is the IC-12GE 23cm portable equally as exceptional as the IC-2GE and IC-4GE.

◄ Actual Size ►



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DATA FILE

Ray Marston looks at electrical/electronic power control principles and devices in the first part of a mini-series on power control circuits

An electrical or electronic power control circuit can be defined as any circuit that is used to control the distribution or the levels of ac or dc power sources. Such circuits can be used to control (either manually or automatically) the brilliance of lamps, the speed of motors, the temperature of heating devices (such as electric fires or radiators), or the loudness of audio signals, etc. They can also be used to manually switch power to these or other devices, or to switch power automatically when parameters such as temperature or light intensity etc, go beyond pre-set limits.

A variety of devices can be used in power control applications. These range from simple switches and electromechanical devices such as relays and solenoids, which can be used as low-speed power switches, to solid-state devices such as transistors, FETs, CMOS multiplexers, SCRs or TRIACs, or power ICs, which can be used as high-speed power switches or magnitude controllers. In this new mini-series we will show a wide variety of practical power control circuits. We start this month by describing basic electronic power control principles, and looking at some electromechanical power control devices.

Power switching circuits

All electric power control circuits can be fitted into two distinct categories: power switching circuits (such as a lamp on/off switch), or power level control circuits (such as a lamp dimmer). *Figure 1* shows examples of three basic types of power switching circuit, and *Figures 2* to *5* illustrate the operating principles of four different types of power level control circuit.

The three basic types of power switching circuit are the simple on/off controller (*Figure 1a*), which is used to switch power to a single load; the power distributor (*Figure 1b*), which is used to switch power to one or other of a number of alternative loads; and the power selector *(Figure 1c)*, which is used to feed one or other of a number of alternative power sources to a single load.

Note in *Figure 1* that power switching is shown conducted via ordinary mechanical switches, but that in practice these can easily be replaced by sets of relay contacts or by any of a variety of types of solid-state switch.

dc power control

Figure 2 shows the basic circuit of a simple dc power level controller, in which a variable 0 to 12 volts is available on RV1 slider and is fed to the load via a current-boosting voltage follower buffer stage. Note that this type of circuit is not very efficient, since all unwanted power is 'lost' across the buffer stage. Suppose, for example, that the load is fed with 1 volt and draws 1 amp, thus consuming 1 watt. Under this condition 11 volts are lost across the buffer, which passes the full 1 amp of load current and thus consumes 11 watts of power, so the circuit operates with an overall efficiency of only 8.33%.

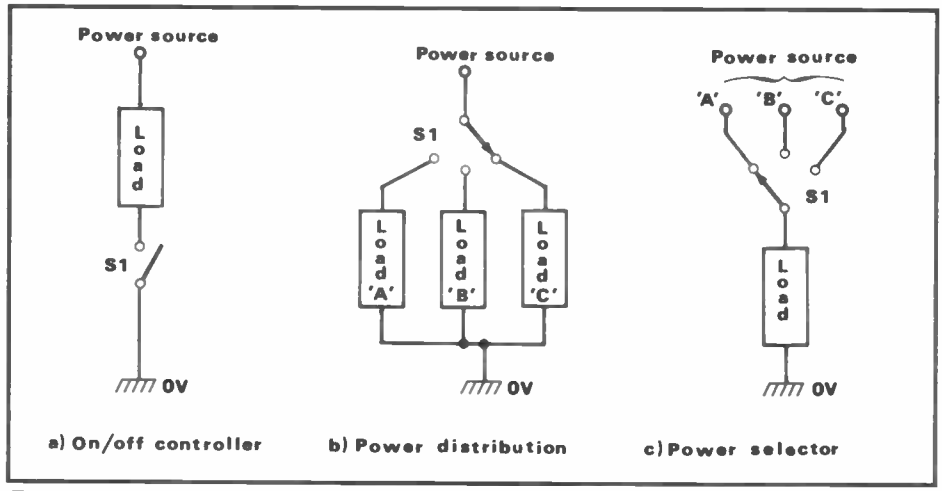

Fig 1: *Three basic types of power switching circuit*

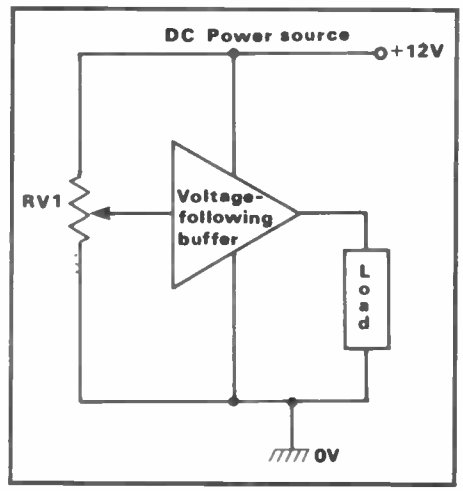

Fig 2: *Simple dc power level controller*

Figure 3 shows an alternative type of dc power controller, which operates with a typical efficiency of about 95%. In this case power is fed to the load via a high-speed, solid-state power switch, which is activated via a square-wave generator with a variable mark-space (M/S) ratio or duty cycle. For explanatory purposes, assume that the duty cycle is fully variable from 5% to 95% via RV1, and that the solid-state switch is 100% efficient. In this case the circuit operates as follows. When the solid-state switch is open, zero volts are generated across the load, and when it is closed the full 12 volts supply

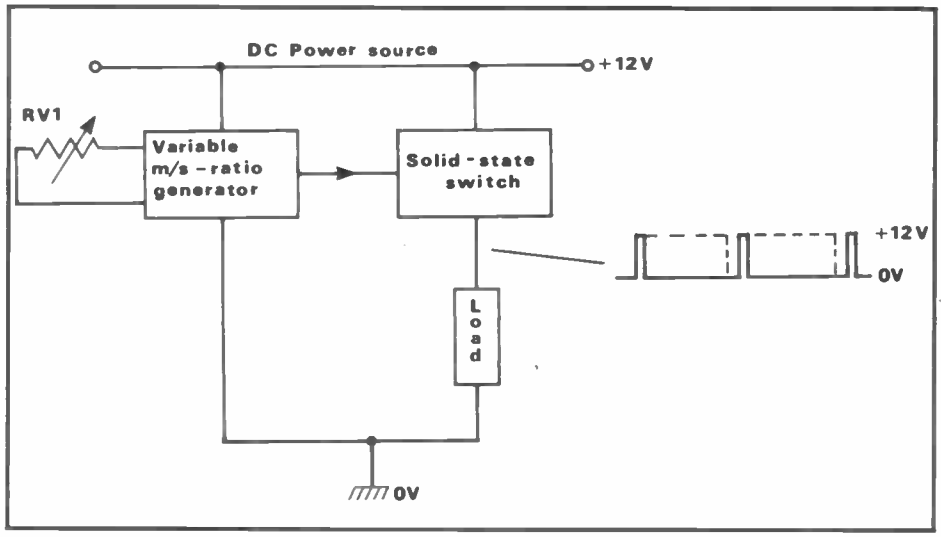

Fig 3: *Switched-mode dc power level controller*

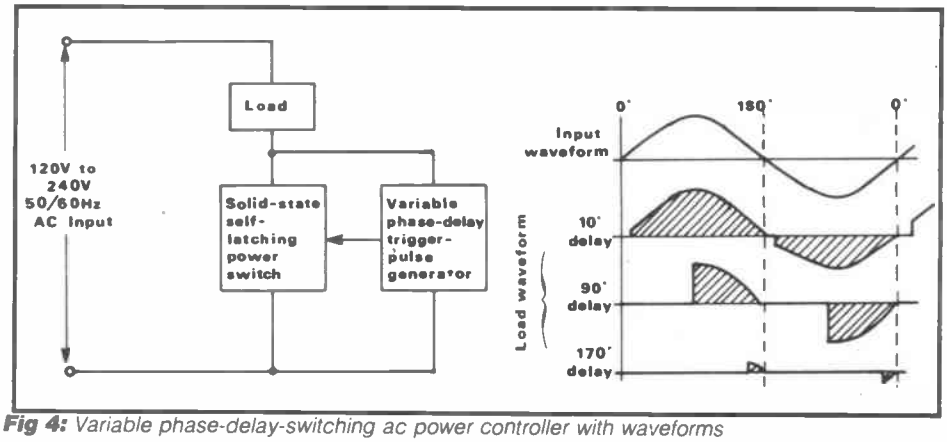

Fig 4: *Variable phase-delay-switching ac power controller with waveforms*

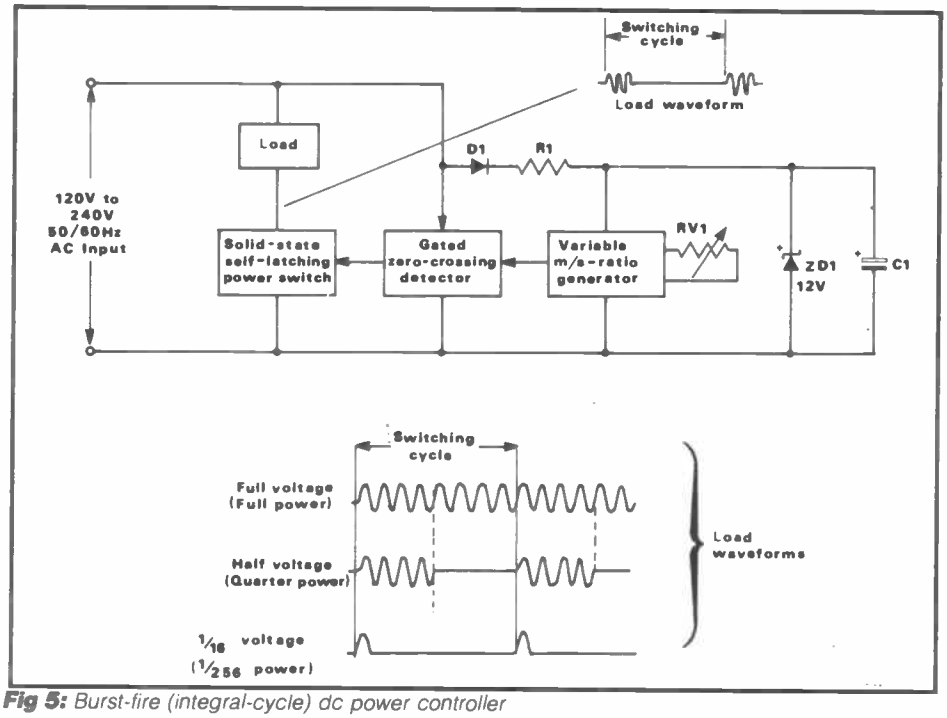

Fig 5: *Burst-fire (integral-cycle) dc power controller*

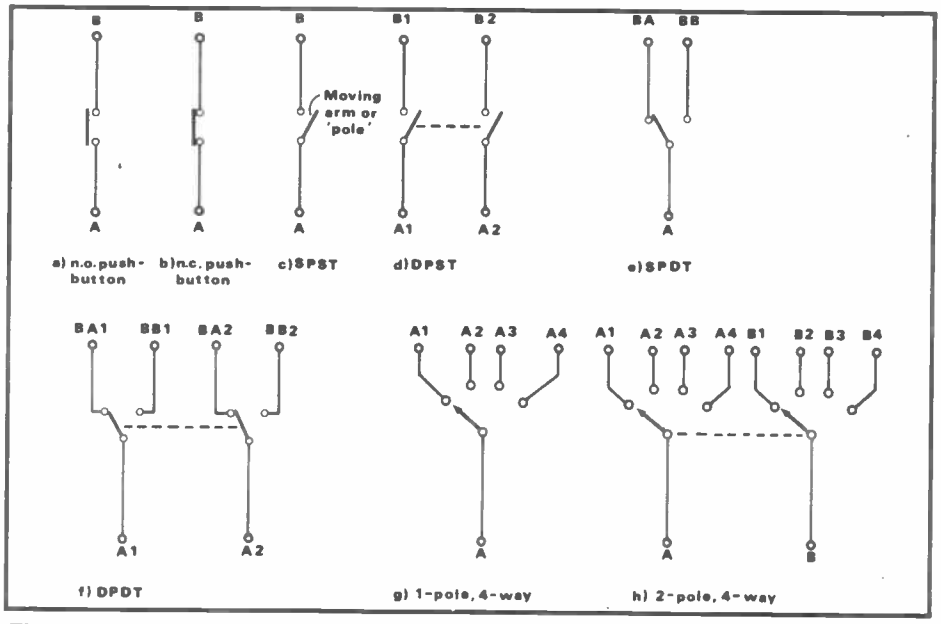

Fig 6: *Some basic switch configurations*

line voltage is generated across the load. When the switch is activated via the variable M/S-ratio generator, the mean voltage of the load (integrated over one duty cycle) is proportional to the duty cycle of the generator.

Thus, if the generator is operated with a 50% duty cycle (ie with a 1:1 M/S-ratio, or equal on and off times), the mean load voltage equals 50% of the 12V supply value, or 6 volts. Similarly, if the duty cycle is 5%, the mean load voltage is 600mV, and if the duty cycle is 95%, the mean load voltage is 11.4 volts. Since power consumption is proportional to the square of the mean supply voltage, it can be seen that this circuit enables the load power to be varied from 0.25% to 90.25% of maximum via RV1.

In practice, a peak of only 200mV or so is usually 'lost' across the solid-state power switch, so this circuit operates with a typical efficiency of about 95% at all times. This type of circuit is widely used in dc lamp-brilliance and motor-speed control applications.

ac power control

Figures 4 and *5* show two different ways of adapting the above switched-mode variable-duty-cycle power control technique for use in ac applications. The *Figure 4* circuit uses a so-called 'phase-triggered' switching technique that is widely used for controlling the ac power feed to filament lamps etc, which have moderately long thermal time constants, and to electric power drills and motors, which have high mechanical inertia. The *Figure 5* circuit uses a 'burst-fire' technique that is widely used for controlling electric fires etc, which consume high current and have very long thermal time constants.

In *Figure 4*, power is fed to the load via a fast-acting, self-latching, solid-state power switch (such as a TRIAC). This can be triggered and self-latched (via a variable phase-delay network and a trigger pulse generator) at any point during each power half-cycle, but which automatically unlatches again at the end of each half-cycle as the ac voltage falls momentarily to zero. The diagram shows the resulting voltage waveforms that can be generated across the load.

Thus, if the power switch is triggered shortly after the start of each half-cycle (with near zero phase delay), the mean load voltage will nearly equal the full supply voltage, and the load will thus consume near maximum power. If the switch is triggered half way through each half-cycle (with 90 degrees phase delay), the mean load voltage will equal half the supply voltage, and the load will thus consume one quarter of maximum power. Finally, if the switch is triggered near the end of each half-cycle (with near 180 degrees phase delay), the mean load voltage will be near zero, and the

load will consume minimal power.

The *Figure 4* phase-triggered power control technique is highly efficient (typically better than 95%), enables the load power to be fully varied over a wide range, and, since switching occurs at the power line frequency, enables lamp brilliance to be varied with no sign of flicker. Its main disadvantage is that, since power may be switched abruptly from zero to high peak value (particularly at about 90 degrees delay), the resulting high current surges can generate substantial RFI (radio frequency interference). Therefore, this type of circuit is not suitable for feeding high-current loads such as electric fires etc.

Burst-fire control

High-current loads such as electric fires can be efficiently power-controlled without generating significant RFI by using the *Figure 5* burst-fire technique. With this, power bursts of a number of complete half-cycles are fed to the load at regular line-frequency-related intervals. Thus, if bursts are repeated at 8-cycle intervals, the mean load voltage will equal the full supply line value if the bursts are of 8-cycle duration, or half voltage (equals quarter power) at 4-cycle duration, or 1/16th voltage (equals 1/256th power) at one half-cycle duration etc.

The burst-fire technique generates near zero RFI because power is switched to the load only very near the start of line half-cycles, when the instantaneous line voltage (and thus the load current) is very low. This is achieved by using a line-driven, zero-crossing detector, which is gated via a variable M/S-ratio generator and gives an output only when it is gated on and the instantaneous line voltage is below 7 volts or so. The detector output is used to trigger the self-latching solid-state power switch (TRIAC) that is used to switch power to the load. Note that the M/S-ratio generator is powered from a 12V dc supply derived from the ac power line via DI-RI and ZDI-CI.

The burst-fire or 'integral cycle' power control technique is highly efficient, but enables the load's power consumption to be varied only in a number of discrete half-cycle steps. When driving electric heaters, however, this last-mentioned factor is of little importance, and the system can easily be used to give precise, automatic, room-temperature control with the aid of suitable temperature-sensing thermistors or thermostats etc.

Electric switch basics

The simplest type of power control device is the ordinary electric switch, which comes in a variety of basic versions, as shown in *Figure 6*. The simplest switch is the push-button type, in which a spring-loaded conductor can be moved so that it does or doesn't bridge (short) a pair of fixed contacts. These switches come in either normally-open (no) form (*Figure 6a*), in which the button is pressed to short the contacts, or in normally-closed (nc) form (*Figure 6b*), in which the button is pressed to open them.

The most widely used switch is the moving arm type, which is shown in its simplest form in *Figure 6c*. This comprises a spring-loaded (biased) moveable metal arm or 'pole' that has permanent contact with terminal 'A' but either has or hasn't got contact with terminal 'B', thus giving a simple on/off switching action between these terminals. This type of switch is known as a single-pole single-throw, or SPST, switch. *Figure 6d* shows how two of these switches can be mounted in a single case, with their poles 'ganged' together so that they move in unison, to make a double-pole single-throw, or DPST, switch.

Figure 6e shows a switch in which the pole can be 'thrown' so that it connects terminal 'A' to either terminal 'BA' or 'BB', thus enabling the 'A' terminal to be coupled in either of two directions or 'ways'. This type of switch is generally known as a single-pole double-throw (SPDT) switch.

Figure 6f shows a ganged double-pole or DPDT version of the above switch. Note that these multi-way switches can be used in either simple on/off or multi-way power distribution/selection applications.

Figure 6g shows a switch in which the 'A' pin can be coupled to any one of four different terminals, thus giving a '1-pole, 4-way' action. Finally, *Figure 6h* shows a ganged 2-pole version of the same switch. In practice, switches can easily be designed to give virtually any desired number of poles and 'ways'.

Two other widely used types of electric switch are the pressure-pad type, which takes the form of a thin pad that can easily be hidden under a carpet or mat and activated by body weight, and the microswitch. The latter usually takes the form of a biased switch that can be activated via slight pressure on a button

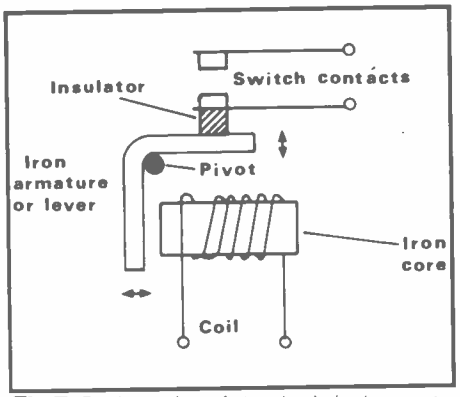

Fig 7: *Basic design of standard electromagnetic relay*

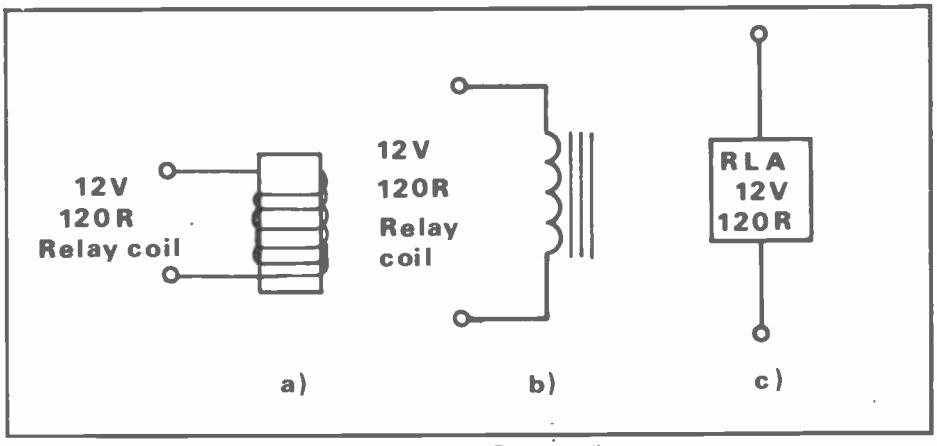

Fig 8: *Alternative ways of representing a 12V 120R relay coil*

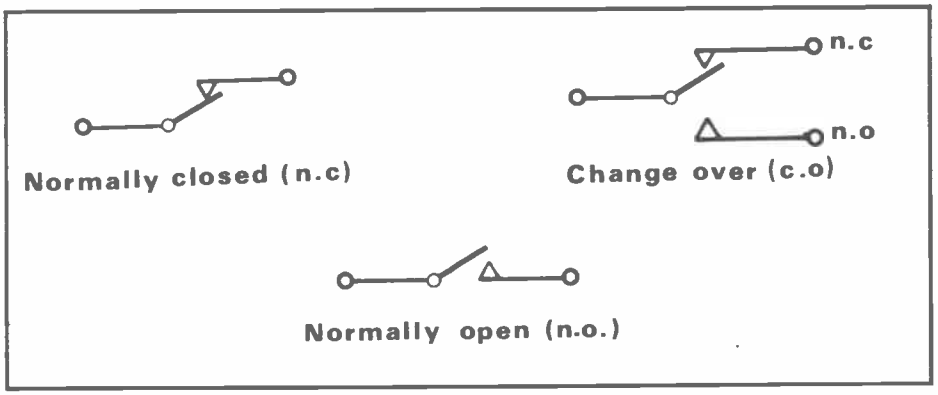

Fig 9: *Three basic types of contact arrangement*

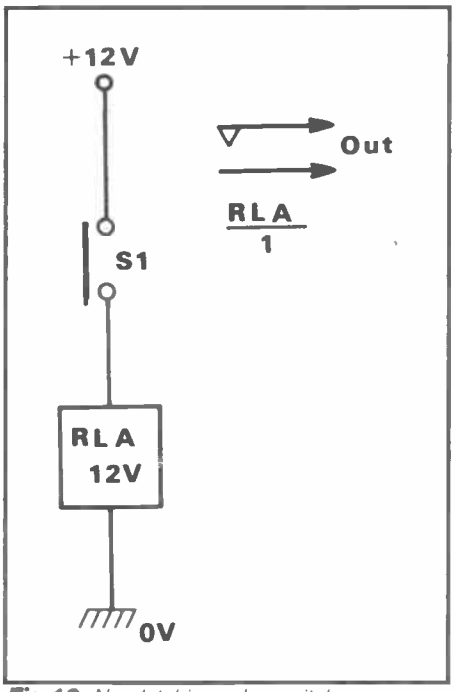

Fig 10: *Non-latching relay switch*

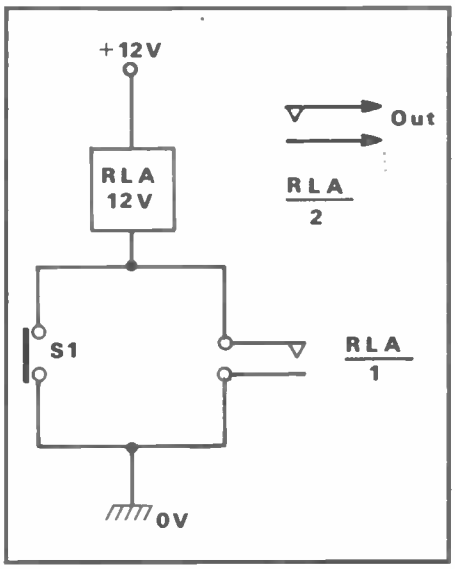

Fig 11: *Self-latching relay switch*

or lever on its side, thus enabling the switch to be activated by the action of opening or closing a door or window or moving a piece of machinery etc.

Electro-mechanical relay basics

The conventional electro-magnetic relay is really an electrically operated switch, and is thus a very useful power-control device. *Figure 7* illustrates its operating principle. Here, a multi-turn coil of wire is wound on an iron core, to form an electromagnet that (like a solenoid) can be used to move an iron lever or armature which in turn can be used to close or open one or more sets of switch contacts. Thus, the operating coil and the switch contacts are electrically fully isolated from one another, and can be shown as separate elements in circuit diagrams.

The main parameters of the relay coil are its operating voltage and resistance values. *Figure 8* shows alternative ways of representing a 12V, 120Ω coil; the symbol of *Figure 8c* is the easiest to draw, and carries all vital information. Practical relays may have coils designed to operate from a mere few volts dc, or at the fall ac power line voltage etc.

There are three possible basic types of relay contact arrangement, these being normally closed (nc), normally open (no), and change-over (co), as shown in *Figure 9*. Practical relays often carry more than one set of contacts, with all sets ganged; thus, the term 'dpco' simply means that the relay carries two sets of change-over contacts. Actual contacts may have electrical rating up to several hundred volts, and up to tens of amps.

Relay configurations

Figures 10 to *13* show useful basic ways of using ordinary relays. In *Figure 10*, the relay is wired in the basic non-latching mode, in which push-button switch S1 is wired in series with the relay coil and its supply rails, and the relay closes only when S1 is closed.

Figure 11 shows how to modify the above circuit to give self-latching operation. Here, normally open (no) relay contacts RLA/1 are wired in parallel with activating switch S1. RLA is thus normally off, but turns on as soon as S1 is closed, causing contacts RLA/1 to close and lock RLA into the on state even if S1 is then re-opened. Once the relay has locked on it can be turned off again by briefly breaking the supply connections to the relay coil.

Note in these two circuits that the relay can be operated in the AND mode by wiring several activating switches in series, so that the relay turns on only when all switches are closed, or can be operated in the OR mode by wiring several activating switches in parallel, so that the relay turns on when any of these switches are closed. *Figure 12* shows how this can be used to implement a simple burglar alarm, in which the relay turns on and self-latches (via RLA/1) and activates an alarm bell (via RLA/2) when any of the S1 to S3 'switches' are briefly closed (by opening a door or window or treading on a mat etc). The alarm can be enabled or turned off via key switch S4.

In practice a relay coil can often be activated via only a few volts and milliamps, thus enabling it to be turned on and off via simple transistor (or IC) circuitry if desired, as shown in the example of *Figure 13*. Note here that if the coil needs an activating current of 100mA, this can be obtained via an S1 current of less than 4mA. Also note that relay coils are highly inductive and can generate large back-emfs (hundreds of volts) when their coil currents are

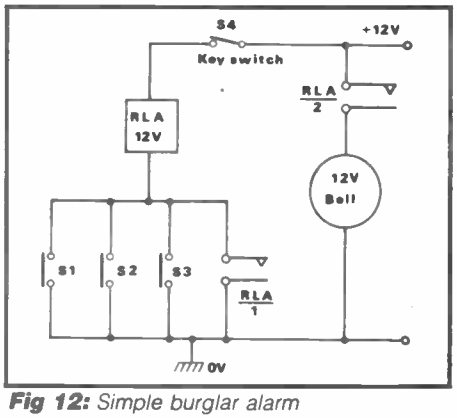

Fig 12: *Simple burglar alarm*

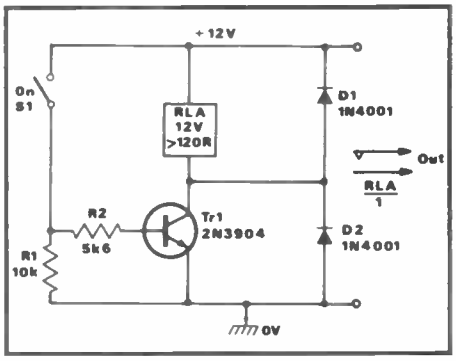

Fig 13: *Transistor driven relay with two-diode coil damper*

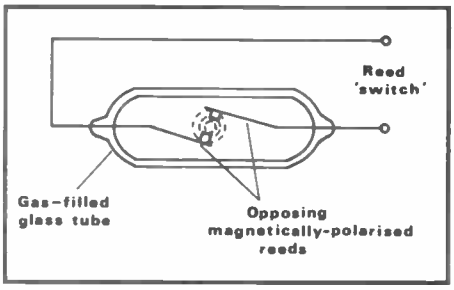

Fig 14: *Basic structure of reed relay*

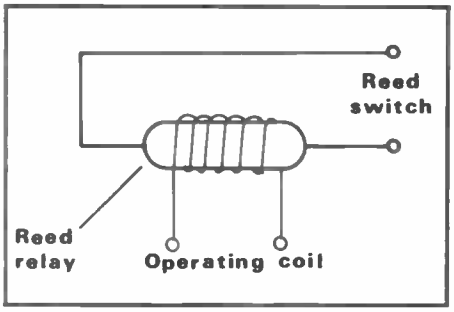

Fig 15: *Reed relay operated by coil*

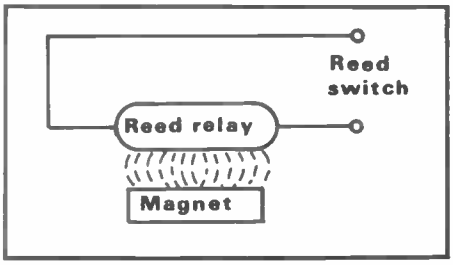

Fig 16: *Reed relay operated by magnet*

suddenly broken. These voltages can easily damage electronic drivers that are connected to the coil. This danger can be overcome by connecting protective 'damping' diodes D1 and D2 to the coil as shown. D1 prevents the RLA-Q1 junction from swinging more than 600mV above the positive supply rail value, and D2 stops it from swinging more than 600mV below the zero-volt rail value.

Reed relay basics

A second type of electro-mechanical relay is the 'reed' type, which consists of a springy pair of opposite-polarity magnetic reeds with gold- or silver-plated contacts, sealed into a gas-filled glass tube as shown in *Figure 14*. The opposing magnetic fields of the reeds normally hold their contacts apart, so they act as an no switch. However, these fields can easily be cancelled or reversed (so that the switch closes) by placing the reeds within an externally-generated magnetic field. This can be derived from either an electric coil surrounding the glass tube, as in *Figure 15*, or by a permanent magnet that is placed within a few millimetres of the tube, as shown in *Figure 16*.

Practical reed relays are available in both no and co versions, and their contacts can normally handle maximum currents of only a few hundred mA. Coil-driven types can be used in exactly the same way as conventional relays, but typically have a drive-current sensitivity ten times greater than that of a standard relay.

A major advantage of the reed relay is that it can be 'remote activated' at a range of several millimetres via an external magnet, thus enabling it to be used in many home-security applications; *Figure 17* illustrates the basic principle. Here, the reed relay is embedded in the frame of a door or window, and the activating magnet is embedded adjacent to it in the actual door/window, so that the relay changes state whenever the door/window is opened or closed. Several of these relays can be interconnected and used to activate a suitable alarm circuit, if desired.

In next month's edition of Data File we will continue the Power Control theme by looking at a variety of electronic power control devices and principles.

NEW

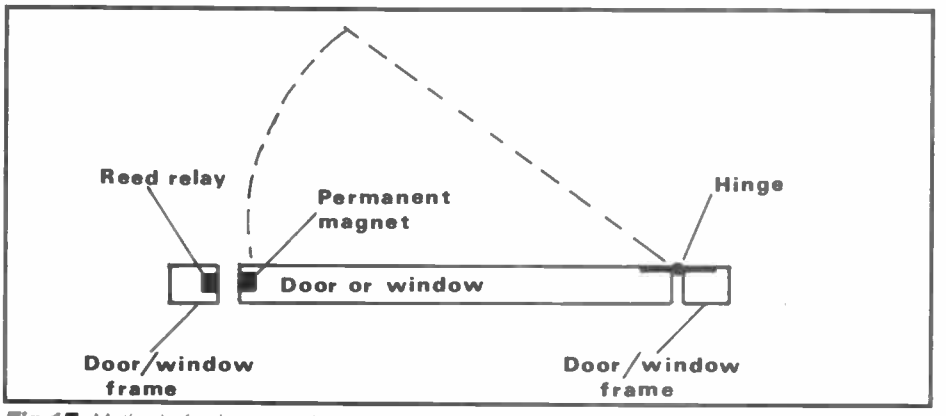

Fig 17: *Method of using a reed relay/magnet combination to give burglar protection to a door or window*

DX-TV RECEPTION REPORTS

Compiled by Keith Hamer and Garry Smith

Italian private stations

Simon Hamer of New Radnor reports an excellent Sporadic-E opening on the 15th with an Italian private station on test card on channel 1A with 'TELE UNO' identification. As we mentioned in last month's Service Information, the station also relays Canale 5 programmes displaying an on-screen logo in the form of a number 5 with a small rectangle or crown above.

On the 19th, Ray Davies of Happisburgh in Norfolk saw a 'TELE RADIO' caption on channel E2 but the signal was too weak to decipher the other words below. Chris Howles (Lichfield) saw a similar caption on the 23rd.

Another private station seen by several enthusiasts is called 'TELEMARKET', it broadcasts using a special channel just *below* E2, presumably to prevent the sound carrier from causing interference to channel 1A vision at 53.75MHz. The on-screen identification is difficult to read but at times 'Super Channel' is relayed with 'SUPER' in the top left-hand corner of the screen.

There may be yet another new private transmitter this season on channel 1A. On May 15th at 1351, Arthur Owen noted a programme carrying a 1 logo in the top right-hand corner co-channel with another Italian signal.

Reception reports

On May 19th at 1527, Bob Brooks of South Wirral noted a mystery black bar with identification on E3. It sounds like Norway showing the 'BRUDD MED STUDIO' (break in transmitter link) caption.

On the 26th, Kevin Jackson noticed the Austrian 'ORF FS1' PM5544 on channel E2. At the moment there is no logical explanation, unless it had been switched through to a West German or Swiss transmitter by mistake. ORF was seen on E2 many years ago in East Anglia but the mystery was never solved.

Tony Mancini of Belpar (near Derby) resolved Icelandic programmes on E4 at 2130 on May 19th. Signals faded at 2150 but shortly after 2200 a 'weak but rolling' picture was resolved just below E4. It sounds like Canadian or American DX on channel A3, especially with the loss of frame sync. A mystery test card with 'shapes' in each corner came up briefly out of the noise on channel E4 at 0645 BST on the 24th. There was Arabic script across the centre and the transmission came from the south-east.

Perhaps not too much of a mystery, Andy Webster of Billinge, near Wigan, watched a concert via Russian TV on channel R1 on May 27th followed by closedown at 0020 (0320 Moscow time). This was possibly a regional opt-out because the main TSS network was seen to close at 2130 BST with a rather abrupt showing of the clock (two seconds of it) before the transmitter was switched off.

Record-breaking DX

During the preparation of this column in the early part of June, some incredible DX reception occurred on the 6th and 7th, which we feel must represent an important milestone in DX-TV reception history. Between 2245 and 0200 during the reception of Iceland, channels A2, A3, A4 and A5 (77.25MHz) became active with signals from Canada and the United States of America. The A4 signal was the strongest and identified as CJCN-TV, Grand Falls, Newfoundland. On A3 the WTKR-TV callsign (CBS Norfolk, Virginia) was heard while, on the amateur bands, signals from Trinidad were monitored.

The excitement continued the following day with Band III Sporadic-E reception from Algeria (E5 and E7), Tunisia (E6) and Libya (E6). The latter two countries were showing the test card at the time. The Algerian reception lasted some 90 minutes at high strength. More details next time.

Danish locals

The 100-104MHz portion of the FM radio band will no longer be reserved for local radio in Denmark. All the existing local stations remain low-powered even though the whole of the FM spectrum (87.5-108MHz) is in use. Over 300 radio stations are on the air in Denmark catering for a wide variety of tastes. Some play pop and rock: 'Radio Jazz' in the heart of Copenhagen plays jazz from 2200-0100 daily. Some stations discuss left-wing political issues while others concentrate on religious broadcasting.

Nationwide movie channel

The Minister of Culture (who is also in charge of the Danish P&T/PTT) has suggested that a nationwide movie channel may be introduced, financed by revenue from decoders. The existing DR network might be transferred to UHF to make way for the movie-channel at VHF, or it may use the TV-2 transmitters after TV-2 programmes have ended. This latter option is the most likely. As the P&T owns the masts and buildings, etc, they may also be used to carry other transmissions such as those from car telephones.

TV in Finland

Miika Keipi of Finland has described the TV set-up in his country. Programmes are broadcast via two main networks (TV1 and TV2) with contributions from two companies. The state-owned station, *Yleisradio* (YLE), actually owns the channels and rents air time to a commercial company called MTV. These initials stand for 'Manios TV' – the word 'manios' means both advertisement and commercial. MTV would eventually like to run their own independent network, but at the moment this is not allowed.

The test pattern radiated by YLE is the FuBK with the appropriate network identification across the centre, for example, 'YLE TV1' for the first network, Systems B (VHF) and G (UHF) are used with PAL colour.

As in most countries, most of the first network transmissions are at VHF in Bands I and III while the second network operates at UHF. There are a few exceptions:

Espoo and Turku have TV2 transmitters in Band III. Until the mid-seventies there was a TV2 outlet on channel E2 (Band I) which could be received in the UK via Sporadic-E propagation. There was also a TV1 transmitter using this channel but it eventually closed. The only outlets currently using Band I channels are Tervola E3, Vuokatti E4 and Ruka E4.

A third network (partly owned by YLE, MTV and a few other large companies) operates from transmitters which are located in the south of the country. The TV3 network carries commercials and many of the programmes are imported.

Soon a fourth network is to be implemented and the first outlet will commence broadcasting in December 1988 from the Espoo transmitter. The proposed network should be complete by 1992. The programming will be a mixture of Swedish broadcasts extracted from their first and 2nd networks. The aim is to provide a Swedish language service in the bilingual areas of Finland. This will provide a similar arrangement to that already in operation in Stockholm, where there is a high-power transmitter radiating Finnish programmes for the benefit of the large number of Finns living there.

Details of some of the channel listings for the proposed fourth network have already been released and the transmitters will be co-sited with the other networks. Channel and location details of the TV3 and TV4 networks are in *table 1*.

Service information

United Kingdom: The Government has revealed some results from a study into the feasibility of additional terrestrial TV services in the UK. The study is the result

of the combined efforts of the IBA, BBC, Home Office and DTI. Lord Young, the Trade and Industry Secretary, claimed that any new service would not use the old VHF Bands I and III because of serious mutual interference with mobile radio services, but a fifth channel could be accommodated at UHF for up to 70% of the population and could be on the air after 1992.

The one certainty about using UHF bands is that it will not be possible to have another national service to provide the same coverage as the present four. In many areas it is already difficult trying to squeeze in small relays to extend existing coverage. Channels 35, 36, 37 and 38 seem the likely choice for a fifth service, despite the fact that many video recorders and home computers will have to have their modulators retuned to avoid interference!

Could channels 35, 36, 37 and 38 be used? Channel 38 has traditionally been used for radio astronomy because it is unique in the UHF bands and is a 'quiet' channel, allowing radio astronomers to listen to signals from the stars without interference from man-made sources. It is unlikely that this channel would be assigned to a fifth network.

For many years the other channels have been used for airport radar systems. However, these radar systems have already vacated channel 35 and are expected to stop using 37 in the near future. Channel 36 will continue to be used, so that leaves 35 and 37 to provide a limited UK coverage. Unfortunately, it is up to the Government, not the broadcasters, to consider how best to use the different parts of the radio frequency spectrum.

Yugoslavia: Late evening transmissions called 'Program Plus' continue to be broadcast by JRT Zagreb. Many of the programmes are familiar to British viewers and include a selection of comedy classics (with subtitles) such as *The Benny Hill Show* and *Only Fools and Horses*.

Hungary: Since February 20th this year, three regional TV services have been broadcasting each Monday between 2000 and 2100 via MTV-2 transmitters (note that MTV-1 and MTV-2 do not transmit on Mondays). The test card used is the EBU bar and PM5544 without identification. The new services are as follows.

TV PéCS – via Pecs R32, Kabhegy R22 and Szekszard R30.

TV SZEGED – via Szentes R23, Komadi R32 and Csavoly R7 (V).

TV BUDAPEST – via Szechenyi-hegyi R24.

See *Table 2* for the transmitters operating in Latvia.

This month's Service Information was kindly supplied by Gösta van der Linden (Rotterdam, Netherlands), Michael Summers Larsen (Copenhagen, Denmark) and the Benelux DX Club (Netherlands).

An active day

May 26th was an extremely active day for most DXers. At 0934, Kevin Jackson saw two Italian stations fighting on channel IA. Yugoslavian signals followed with programmes from Bēograd on E3 and Zagreb on E4. At 1153 a private Italian station called 'TELEMARKET' was resolved just below E2 and 'TELE-UNO' on channel IA with '5' logo a little later at 1213. Russian colour bars were seen on channel R1 at 1227, eventually changing to the UEIT test card.

DX-TV log for May

This month we are featuring details of reception noted by Garry Smith at his location in Derby.

01/05/88: TVP (Poland) on channel R1 with 'Przerwa' (Interlude) caption.

02/05/88: CST (Czechoslovakia) on channel R2 displaying the 'RS-KH' EZO test card received via Meteor-Shower propagation.

04/05/88: SVT-1 (Sweden) on E2 showing the 'KANAL 1 SVERIGE' PM5534 test pattern; RAI (Italy) programme received on channel IA via Sporadic-E.

06/05/88: Sporadic-E from 1755 with TVR (Romania) R2, TSS (Russia) R1 and R3, RAI (Italy) IA and IB; TVE-1 (Spain) E2, E3 and E4.

07/05/88: RAI IA, West Germany E2; TVE-1 E2, E3 and E4; TSS on channel R1 radiating the UEIT test card; TDF (France) on channel L2; unidentified signals on R2. All reception was via Sporadic-E.

10/05/88: SVT-1 E3 'KANAL 1 SVERIGE' PM5534.

11/05/88: TSS R1 UEIT test card; TVP R1 PM5544; NDR-1 (West Germany) E4 showing the FuBK test card with a digital clock; DR (Denmark) on channels E3 and E4 with the PM5534; CST on R1 with the EZO test card; SVT-1 on E3 and E4 with 'KANAL 1 SVERIGE' PM5534.

12/05/88: CST on R1 showing the EZO test card; TVP on R1 broadcasting the PM5544.

15/05/88: 'TELE UNO' on channel IA; TVE-1 E2, E3 and E4; TVR R2 and R3; TSS R1, R2 and R3; unidentified signals on Band II channels R3, R4 and R5.

16/05/88: DR on channel E10; NED-1 E6 and E7; many NED-1, NED-2 and NED-3 stations at UHF, received via enhanced tropospheric conditions.

17/05/88: CST on R1 with the EZO test card. The following were received via

Transmitter Location (Finnish/Swedish name)			
ESPOO/ESBO:	TV3	Ch 24	600/1000kW (100kW at present – operational)
	TV4	Ch 35	600/1000kW (proposed)
TAMMISAARJ/EKENÄS:	TV3	Ch 58	100kW (not yet in service – commences with TV4)
	TV4	Ch 23	100kW (proposed)
TURKU/AABO:	TV3	Ch 54	1000kW (on low-power at present)
	TV4	Ch 57	1000kW (proposed)
LOVIISA/LOVISA:	TV3	Ch 55	100kW (not yet in service – commences with TV4)
	TV4	Ch 26	100kW (proposed)
TAMPERE/TAMMERFORS:	TV3	Ch 59	1000kW (operational)
JYVÄSKYLÄ:	TV3	Ch 35	500kW (operational)
LAHTI/LAHTIS:	TV3	Ch 51	Enters service during summer 1988

There are no TV4 details available for the latter three transmitters

Table 1 *Channel location details of the TV3 Network*

Transmitter	Riga TV	CT-1	CT-2	Transmitter	Riga TV	CT-1	CT-2
Riga	R3	R10	R7	Rezekne	R10	R27	R6
Valmiera	R33	R21	R11	Preilos		R4	R2
Ventspili	R5	R9	R12	Stucka	R1		
Liepaja	R5	R12	R35	Kandava	R12		
	R33	R21		Sabile	R8	R5	R11
Dagavpili	R7	R10	R40	Roja	R8		
Cesvaine	R8	R5	R41	Koika		R8	
Kuldiga	R6	R1	R4	Kraslatva		R4	

Table 2 *Transmitters operating in Latvia*

tropospheric conditions; DR E7; NED-1, NED-2 and NED-3 on UHF channels, plus transmissions from many WDR-3 outlets.
19/05/88: SVT-1 on channels E2 and E3 radiating the PM5534 test card; TSS on R1 and R2; TVR R2; JRT (Yugoslavia) on E3. All reception via Sporadic-E.
20/05/88: TSS on channel R2 with the UEIT test card.
21/05/88: TVE-1 E2 and E3 with a pop music programme at approximately 1530.
22/05/88: RAI on channel IA; Canal Plus (France) on L2; TSS R1 and R2.
23/05/88: TSS R1, R2 and R3 with the UEIT test card (LRRTPC identification noted on channel R2); RAI IA.
24/05/88: TSS on R1 noted using the old monochrome '0249' test card co-channel with colour bars, the UEIT test pattern and the CST EZO test card; NRK (Norway) on channel E2 from the Melhus transmitter; CST on R2 with the EZO test card.
26/05/88: EPT (Greece) on E3 radiating the PM5534 test card; JRT E3 and E4; TSS R1 and R2; RAI IA; NRK E2 (Steigen); SVT-1 E2 and E3; a Sporadic-E opening during the evening with TSS on R1, R2 and R3; TVE-1 E2 and E3 after 2300.
27/05/88: PM5534 on channel E3 from the south-east at 0745; CST on R1 and R2 showing the EZO test card; TSS R1 and R2; RAI IA; TVR R3 at 1745 with colour bars and the FuBK test card – also TVR sound on channel R5! Unidentified signal on channel R4 at 1805.

Over-exposed

On the 26th, at 0745 on channel E3 the Greek PM5534 was present, with the initials 'EPT' at the top. It was complete with a video fault at the transmitter, making it appear over-exposed or bleached! The fault was corrected, but only when the signal strength had reduced. At 0835 the 'EPT' logo was shown followed by a flag during the station opening sequence. A cartoon followed.

On the 28th, on channel E3, a musical programme with Greek subtitles was seen at Derby accompanied by the Rumanian FuBK test card on R2. Unfortunately, the suspected Greek reception faded, thus preventing definite identification. Sightings of programmes with Greek subtitles have also been reported by other DXers.

Canal Plus sightings

It seems that the French 'Canal Plus' network in Band I has expanded with at least two new high-power outlets coming into service. During the 1986 season, Canal Plus was often received on channel L3 (just above R2) from the south during Spanish openings; presumably from the Carcassonne outlet.

Already this season the remaining two French Band I allocations, channels L2 (slightly above E3) and L4 (above E4) have been evident, particularly during openings to the south-east. We assume that the proposed Bastia channel L2 transmitter and Ajaccio L4 outlet have now entered service, or have increased their power. Both transmitters are located in Corsica which would explain why they often accompany Italian signals.

Vision and sound are encrypted which means that the picture verticals appear ragged with almost inaudible sound. The sound carrier is situated 6.5MHz (AM) *below* the vision frequency for Canal Plus transmissions in Band I and it can produce confusing carriers when encrypted. For instance, the L2 sound carrier is on 49.25MHz and when received during such transmissions it resembles cordless telephone interference over channel R1. The vision signal is very easy to recognise as it appears in the negative because of the inverted video modulation used for the French system. NEW

AMATEUR RADIO WORLD

Compiled by Arthur C Gee G2UK

Many readers will no doubt be aware by now that the AMSAT-Oscar Phase 3C satellite was successfully launched from the European Space Agency Launch Site at Kourou, Guyana, on 15th June at 1119 UTC. The launch vehicle was the ESA's new launcher, Ariane-4. It placed three satellites into orbit, with a combined mass of 3513kg: ESA's own European Weather Satellite, Meteosat P-2, the communications satellite Pan American Satellite 1 and the amateur radio satellite AMSAT 3C. The latter will now be designated Oscar 13.

The flight was a demonstration flight for the new launcher. The version used was the 44 LP, which has two liquid and two solid propellant boosters. This flight was the conclusion of the six year Ariane-4 development programme, aimed at providing Europe with a launcher which will meet the foreseeable demand through the 1990s. Ariane-4 is able to place payloads of 1900 to 4200kg in a geostationary transfer orbit and is thus almost twice as powerful as its predecessor Ariane-3.

With the great flexibility afforded by six versions of the launcher and a multiple launch system of performance and volume, it can be tailored exactly to payload requirements. A special feature of this launcher is a new bearing structure for multiple launches known as SPELDA, a large egg-shaped enclosure mounted on top of the third stage.

The success of this flight clears the way for commercial use of Ariane-4, which will now become Europe's 'space workhorse' for the next ten years. In an increasingly competitive climate, this launcher will enable Europe to consolidate its share – roughly 50% – of the world's launch service market. Already twenty Ariane-4s have been ordered to launch 42 satellites already on Arianespace's order book and a further 50 are in the process of being ordered. Professor R Lüst, Director General of ESA, commented: 'I extend my warmest congratulations to the teams from EAS, CNES, Arianespace and the European Space industry. This Ariane-4 flight is a very important chapter in the story of Europe gaining access to space'.

Not only was the launch vehicle a European project but Oscar 13 was itself very much a European project in that much of the credit for its successful construction goes to the German AMSAT Group, AMSAT-DL, under the supervision of AMSAT-DL President, Dr Karl Meinzer DJ4ZC in Marburg, West Germany. AMSAT-UK also had a hand in its launch in that it contributed £13,000 towards the cost of transporting the satellite to Kourou.

The actual launch was broadcast from Kourou with good TV coverage. AMSAT-UK had access to the launch site by both amateur radio and a telephone link. The latter was used by Richard Limebear G3RWL to give a commentary on the 80m amateur band, which was listened to widely throughout the country and was favourably reported on.

Radio amateurs listened expectantly for the first signals from Oscar 13, which came from one of its beacons on 145.812MHz about six hours after launch. It was with delight and relief that I copied the Morse code signals saying: 'AMSAT Oscar 13 QTC 001. No transponder operation before end of orbit manoeuvres. First motor firing and raise of perigee during first orbit. Beacon operations are effective as follows. CW on the hour and plus 30. RTTY on plus 15 and 45. Listen daily to this beacon'.

Full operation on Oscar 13 is expected in a few weeks time when the transponders will be switched on for amateur band communication. More of this later.

Weather satellite reception authority

I commented on the Weather Map Fax licence requirements in the last issue. Since then, I have received a letter from the DTI about the reception of signals from weather satellites. It reads as follows:

'I am very pleased to be able to tell you that we have no objection to your proposed reception of signals emitted by satellites operated and exploited by the European Space Agency (as opposed to ESA satellites exploited by commercial-type entities), and any artificial earth satellites engaged in scientific space research operated by the US government's National Oceanographic and Atmospheric Administration.

'This letter should be regarded as formal authority to receive such signals for the purpose of making observations on their technical characteristics or otherwise carrying on technical investigations into the radio technique.

'It must be understood that the permission conveyed in this letter does not, in any way, afford your receiving station protection from interference. The frequency bands for this service are 135-138MHz and 1698-1700MHz'.

I am often asked what the position in this matter is. It seems the situation is much the same as that relating to the reception of radio signals generally. You are not supposed to listen to transmissions of a 'private' nature. If you should hear them, you must not tell anyone else about what you've heard. If the transmission is intended for broadcast use then all is well. You can listen to them and tell or show others what you have received.

Privatising the radio spectrum

Rumours have been circulating about attempts being made to privatise the radio frequency spectrum in the UK! A London based firm of management consultants was asked by the DTI to look into the possibility of deregulating the radio spectrum in the UK. Their report was submitted to a number of interested parties for their reaction.

Not surprisingly the report, produced by Communications Studies and Planning International Ltd, has not found much favour with those to whom it was submitted. Of over 180 pages in length, this CSPI Report, as it has become known, received a pretty hostile reception based chiefly on its impracticality and the consequent feeling that economists are not qualified to deal with such matters as radio frequency allocations.

One very material criticism made was that the report contained a large number of technical mistakes and therefore its credibility could not be ranked very highly. Other objections were that European Radio Regulatory Bodies would not wish to deal with non-government 'authorities', that there were weaknesses in the data from which the Report was compiled and the conclusions drawn were therefore suspect. Further objections raised were that administrative arrangements for 'spectrum management' would lead to increased costs, and that in a free market system the highest bidder would get the greatest slice of the available spectrum and thus squeeze out the smaller potential user – such as amateur radio no doubt. The general

opinion seems to be that this idea is a non-starter.

Is amateur radio of use?

With almost every activity coming under economic evaluation these days, and with talk of accountability and acceptance in the market place, it is not to be wondered at that there is concern about the value of amateur radio and the onslaught it is soon likely to face from those who covet its frequency allocations.

At a recent conference I attended, the American delegate present made a very strong plea that amateur radio should present its activities in the emergency radio communications field as the prime reason for retaining its frequencies. In the June issue of *Radio Communication*, Pat Hawker G3VA, notes a similar plea from Frank Hughes VE3DOB, in his editorial in *The Canadian Amateur Radio Magazine* of January 1987. He writes that the description of amateur radio as a hobby should be avoided. He recalls that VE7AHB had stated in an earlier issue that the reason why we retain our immensely valuable spectrum, despite the enormous commercial and military pressure for ever more channels, is set out in the ITU Radio Regulations as Regulation No 640, where the only reason for exclusive amateur bands is given as the service radio amateurs render during emergencies.

No doubt in large countries like America and Canada where communications are stretched in times of emergency and where natural disasters are more frequent than in our part of the world, the real help amateurs can give the community on such occasions is a very genuine reason for keeping amateur radio intact. In our own country we are more concerned with reminding the authorities of the value of amateur radio in stimulating interest in the fields of electronics and science.

As Pat Hawker says: 'Instead of "hobby", we should perhaps, wherever possible, use the term "the amateur radio service", recognising that this is defined in the Radio Regulations – which has the force of an international treaty – as "A radio communication service for the purpose of self-training, inter-communication and technical investigation carried out by amateurs, solely with a personal aim and without pecuniary interest" '.

Solar flares

Of the various eruptions which are visible on the sun's surface with suitable equipment, some of the most spectacular are the solar flares. They occur in the vicinity of the sunspots and have an enormous amount of energy, which they blast high into the corona producing 'coronal holes', and pass out through them into space. Some of the energy they emit is at radio frequencies. They travel at such a speed that they reach the earth within half an hour or so of their formation.

The energy is thought to be in the form of particles. The lower energy particles take longer to reach the earth than the higher energy ones, so the effects of these flares may be spread over several days. Fortunately, there are two layers – the Van Allen Belts'– which absorb much of the energy. However, with large flares, some get through these layers and reach the earth's surface where they are directed by the earth's magnetic force towards the magnetic poles. There they are responsible for auroral displays and affect radio propagation. They also influence the magnetic field within the earth.

Towards the end of June, a pigeon race was held from France to the north of England. Some two to three thousand pigeons took part, but only a couple of hundred made it back to their bases within the expected time. During the next few days numbers of them turned up in the most unexpected places, such as amongst the pigeons in Trafalgar Square and in Ireland. The theory for this unusual event is that pigeons are thought to navigate by using the earth's magnetic field. Because this was affected by a solar flare many pigeons lost their sense of direction. Radio amateurs experienced bizarre conditions over this period too, with very severe fading and complete blackouts at times. REW

MEDIUM WAVE DXING

by Steve Whitt

If this is the first time you've picked up *Radio and Electronics World* and are wondering what MW DXing is, hold on and all will become clear. If our more regular readers will excuse me, this month I intend to return to some basics; especially for the newcomer.

What is MW DX?

Well, those four letters are actually a piece of jargon that describes the hobby of listening on the medium wave radio band to faraway radio stations. There are many thousands of people around the world who regularly tune the short wave bands, listening with relative ease to stations that may be located on the other side of the globe. For some, this is the only way to find out what is going on in the world, but for many others short wave listening is a pastime or hobby. Many of these listeners also enjoy DXing which can be loosely defined as the art of hearing faraway radio stations.

At first sight MW DXing is a contradiction in terms since the basic meaning of DX is distance and MW frequencies are generally used for local or regional broadcasting. However, one listener's local station is a DX station to another, and being able to eavesdrop on someone else's local radio station is one of the attractions that DXers find in listening to the MW band.

Why MW DX?

At some stage, every SW listener will have noticed that the SW broadcast bands are dominated by a small number of international broadcasters radiating a large number of high power signals. These stations try to plan their broadcasts so that listeners worldwide can hear programmes in their native language at convenient times of the day.

In complete contrast, the MW band is full of thousands of local stations the world over. Despite mutual interference it is possible to hear stations at distances well in excess of their normal coverage area. In fact, it might come as a surprise to realise that MW signals can be heard over distances exceeding 10,000km.

The medium wave frequencies also provide a real challenge to the avid DXer wishing to hear countries and stations which, for a variety of reasons, could never be heard on the SW bands. It is often this challenge that encourages the experienced SW listener to 'have a go' at MW DXing and before long the MW bug will have bitten.

Getting started

To get started on the MW band all you need is a radio and some idea where and when to listen. If you are hunting for a specific station, there are many thousands of local stations worldwide operating in just over one MHz of radio bandwidth.

MW DXers are fortunate in that they can start listening with very cheap and simple equipment; any domestic radio will tune the MW band and it is quite easy to hear 50 – 100 different stations at night using an internal aerial. However, it is probably better to use a quality domestic radio, or a good car radio to get started. With this equipment, stations from all over Europe and North Africa will be heard. If radio conditions are favourable and you listen at the right time, reception of some North American stations should be possible. In this way you can have a go at DXing the MW band before committing yourself to any more sophisticated (or expensive) equipment.

On the other hand, if you are already a practising short wave listener, all you need to get going on MW is a change of waveband. Indeed, many SW listeners tend to overlook the fact that their radios can usually tune the MW band and that their outdoor aerials are also effective in picking up distant MW signals. For the SW listener who has grown tired of the mega-watt propaganda stations (and their associated jammers) a fresh challenge can be found on the MW band.

Keeping a log

As you tune around the band you will hear all sorts of interesting stations and programmes and unless you have a perfect memory, you'll find some sort of written record to be invaluable. Station logs take many forms but basically they are chronological records of what you have heard, when and how.

The sort of information worth recording might include reception conditions, details of programming heard and any other comments that come to mind. Of course the date and time in GMT as well as station frequency should be noted accurately. Rather more difficult to assess is the received signal quality. A variety of schemes are used by radio listeners and amateur radio operators in an attempt to quantify this subjective condition. Whatever method is chosen, it is worth noting reception quality so that comparisons can be made under differing propagation conditions. One of the most widespread and understood methods is known as the SINPO code which is illustrated in the table.

Receivers

The choice of a receiver for MW use is nearly always a compromise between performance and price. Even if money were no object, finding a truly 'no compromises' MW tuner is probably the 'Holy Grail' of the hobby.

Nowadays, however, there are some extremely good value for money receivers available that leave earlier units in the shade when it comes to features and price. That is not to say that a twenty year old valve receiver is of no use; indeed, such a device will often out perform a modern transistorised receiver. Sadly, the older receivers lack some of the convenience features like digital frequency read-out and memories.

For the DXer there has never been a better time to buy a new receiver than today since, like all things electronic, prices have fallen dramatically in real terms over the years. Let's take a look at what a typical basic DXer's receiver would have cost:

1953: Eddystone 750, 11 valves; £68. R1155 ex Air Ministry, 10 valves; £11 9s 6d.
1964: Codar CR66, 6 valves; £23 15s. HE30, 8 valves; 40 guineas.
1968: Trio 9R59DE, 8 valves; £39.
1971: Eddystone EB35, transistors; £99 9s. Eddystone EC10, transistors; £74 10s.
1980: Yaesu FRG7, transistors; £199.

In 1988, the choice of receivers has never been wider and the DXer could pay anything up to a couple of thousand pounds for a semi-professional unit. If value for money is at the top of your list then I don't think anything will beat the Matsui MR4099 which is available for £99.99 from Currys. This receiver is a portable with digital read-out, synthesized tuning, no gaps tuning from 150-30,000kHz, selective bandwidth, BFO and signal meter. Actually the MR4099, which was based on the more expensive Sony ICF2001, is built in Korea by Sangean and is available under a range of names and prices but the Currys' offer is by far the most attractive. So much for its paper specifications but how does the MR4099 fare in use? Well, in a recent independent receiver survey conducted by *Radio Nederland*, the MR4099 was awarded the joint highest rating given to a portable receiver.

SINPO CODE TABLES

S	I	N	P	O
Signal Strength	**Interference (man-made)**	**Noise**	**Propagation Disturbance**	**Overall Merit**
5 =Excellent	Nil	Nil	Nil	Excellent =5
4 =Good	Slight	Slight	Slight	Good =4
3 =Fair	Moderate	Moderate	Moderate	Fair =3
2 =Poor	Severe	Severe	Severe	Poor =2
1 =Very Weak	Extreme	Extreme	Extreme	Unusable =1

For example the SINPO rating for a local station could be 55555.

Summertime

Many countries operate summertime or daylight saving time (DST) and the experienced DXer can exploit the variations in timing to catch some rare stations. This is particularly true around the equinoctial periods when countries advance or retard their clocks. This usually means that local broadcasting hours (sign off and sign on times) will move relative to GMT. However, different countries adjust clocks on different dates and during the resulting transition period it may be possible to hear stations normally obscured by interference. Here are some examples:

3 September Israel.
10 September China (PR).
11 September Falklands Islands.
24 September Continental Europe plus Azores, Canaries, Cyprus, Faroes, Greenland, Iceland, Madeira, Malta, Tunisia, Mongolia, Spanish North Africa, Turkey and USSR.
25 September Vanuatu.
30 September Iraq, Libya.
1 October Paraguay.
6 October Jordan.
8 October Cuba, Republic of Korea.
9 October Chile, Easter Island.
23 October Brazil, Ireland and United Kingdom.
29 October Bahamas, Bermuda, Canada and USA (except Arizona, Saskatchewan, most of Indiana and some Canadian cities which do not adopt DST), Haiti, Mexico, St Pierre et Miquelon, Turks and Caicos.
30 October Australia, Chatham and Cook Isles, New Zealand, Syria.
31 October Lebanon.
14 December Uruguay.

On the above dates, countries in the Northern hemisphere (ending DST) will turn their clocks back 1 hour, whilst those south of the equator (starting DST) will advance their clocks by the same amount. This means, for example, that in June there is 4 hours difference between Brazil and the UK, whilst after October the difference is only 2 hours. In Canada, USA, Greenland, Mexico and Australia, there are regions which do not adopt DST. All countries make an adjustment of 1 hour – except the Cook Islands which shift by 30 minutes.

Normally the clocks on the Continent run one hour ahead of those in Britain, but because the two areas change from summer to winter time on different dates, there is a period during most of October when no time difference exists.

During this transition period European stations sign on in the morning at roughly the same time as UK stations, rather than an hour earlier which is more usual. The keen DXer will realise that because there will be less interference than usual between (approx) 0300 and 0500hrs UTC, some good DX may be heard.

That rounds off the column for another month and I hope that maybe your appetite for MW DX has been whetted. If you have any specific queries or problems don't hesitate to drop me a line c/o the editorial department at *Radio and Electronics World*. NEW

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BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
BD49 10 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD59 2 Flat solenoids—you could make your multi-tester read AC amps with this.
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BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
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BD283 3 Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
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BD296 3 Car plugs with lead, fit into lighter socket.
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PROBLEM SOLVED!

We have obtained from the manufacturers of the 9" Mondor, the TTL converter which makes it composite input suitable to work with any computer. We have had the printed circuit board made and have all the components and can supply this converter in kit form price £6. Our ref. 6P4.

AN ALLAOIN'S CAVE

We have opened another shop in Hove, the address is number 12 Boundary Road which is between Hove and Portslade fairly close to the seafront, When you want to see before you buy and when you want to browse around the special bargains available, this is where you should make for as the Portland Road shop in future will be just mail order. You can of course collect from Portland Road but you should bring in an order complete with reference numbers so that the stores can attend to it easily.

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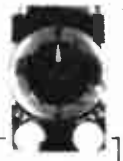

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