HI-FI CHOICE

TUNERS

The most comprehensive guide to buying tuners ever published.

Best Buys Recommended
Over 45 models tested.

£1.50

A major independent research company proved that the ADC XLM MKII incurred no perceivable record wear over the life of your records!
Since then ADC's massive research programme has created a new state-of-the art, top of the line model–the ZLM Aliptic–designed for ultimate stereo performance combined with the concept of zero record wear.

Greatly reduced tip mass

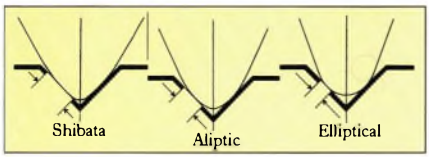
The ZLM has a tinynude diamond with a ·004" x ·008" rectangular shank.
This achieves more lateral strength than the fashionable ·006" square shank, plus a 10% reduction in mass.
The diamond is mounted on a new tapered stylus, which again reduces mass.
In fact, the ZLM has only half the tip mass of the famous ADC XLM MkII.

Less mass by patent

The patented ADC Induced Magnet system, where the magnet is suspended over the moving stylus arm instead of being attached to it, inherently means less mass for the record groove to move. This, coupled with major innovations in the pivot block stylus suspension (which have solved deficiencies in the old system), has resulted in greatly improved frequency response characteristics.

New low-wear ALIPTIC shape

The ZLM has a new tip shape that combines the advantages of the elliptical and Shibata shapes, while eliminating their disadvantages.



It is basically elliptical (·0003" x ·0007"), but its bottom radius has been modified to extend the vertical bearing surface on the groove wall by 100%.
Large enough to greatly reduce record wear, while still small enough to prevent dirt particles being reproduced.
This new shape is called ALIPTIC.™

The best polish available

We decided it was worth the extra cost to get the ultimate polish for the ZLM.
The method involves a cam action to shape and polish evenly while forming the elliptical surfaces simultaneously with the other radii. This Pathe-Marconi method is expensive, but the result makes another important contribution towards reducing record wear.

Spatial sound

You'll notice a distinct difference in sound quality.
Words such as 'open,' 'spatial,' 'uncoloured' and 'true' spring to mind. Individual instruments are easily identified, and there's no hint of listening fatigue.
That's strictly for the competition with its peakier response.

The new ZLM Aliptic

The culmination of all ADC's research has resulted in the new ZLM Aliptic.
Its specifications below are some of the most impressive around, and with each cartridge you receive an individual, signed, frequency response testimonial.
Certain ZLM's fall within a range of ±½db 10Hz to 20kHz and ±1dB out to 26kHz.
These rare cartridges are called ZLM Select and are only available on special order.

The best cartridge we've ever made

The ZLM is without doubt the best cartridge we've ever made, but it's well worth taking a closer look at the new ADC XLM III which incorporates all of the reduced mass accomplishments of the ZLM, but with a tiny elliptical diamond. This also includes an individual specification.
Complementing the range, we have the new four-cartridge QLM Mk III series, incorporating our new design criteria and exciting innovations like the Diasa (diamond + sapphire) elliptical tip.

ZLM Aliptic specifications

Diamond tip	Nude Aliptic
Tracking force	½ to 1¼ gram
Frequency response	10Hz to 20kHz ±1dB 20kHz to 26kHz ±1½dB
Output	1.0mV per cm/sec
Output balance	1dB max. diff.
Channel separation	30dB at 1kHz/20dB at 10kHz
Inductance	580mH
Resistance	820 Ohms
Load resistance	47,000 Ohms
Load capacitance	275pF
Cartridge weight	5.75 grams
Accessories	Stylus brush, screwdriver, all mounting hardware and signed frequency response curve.

Please write for our illustrated brochure.

The new ZLM Aliptic™ cartridge. The difference between playing your records and wearing your records.

ADC

Audio Dynamics Corporation,
A Division of BSR Limited, Pawke Lane, Cradley Heath, Warley, W. Midlands B64 5QH.

Hi-Fi Choice No 9 Tuners by Gordon King

Contents

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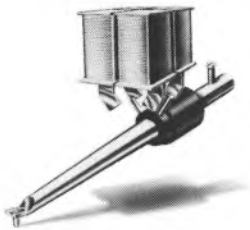


Our big secret.

You're at Audio-Technica's unique Dual Magnet Cantilever.

It's at the heart of every cartridge we make. And there for a very good reason, too.

Because it just so happens that inside the head of every master disc cutter, you'll find exactly the same dual configuration of impulse coils.

Which means our cartridge ends up precisely imitating the cutting head's action in reverse.

Or, if you like, picking the signal up just the way it was put down. Like no other cartridge can.

Sound thinking.

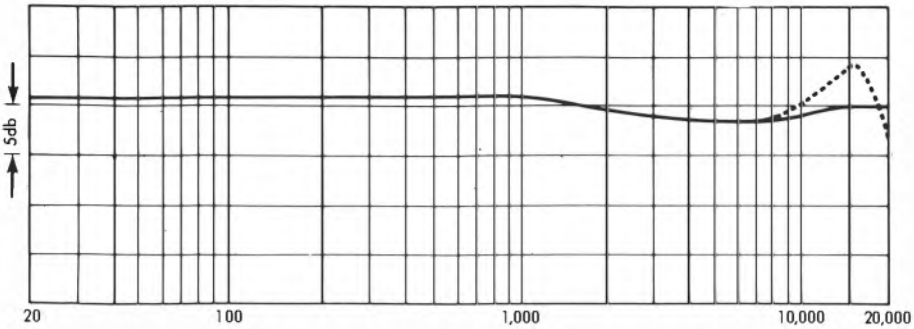
Exactly the kind of thinking, in fact, that we put into every aspect of Audio-Technica cartridge design.

In terms of materials, advanced technology and overall performance, we like to think we're streets ahead of our competitors.

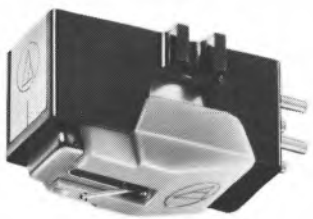
A lot of hi-fi reviewers actually say as much.

May we invite you to listen in to our big secret on your own turntable?

Whichever cartridge you choose, we guarantee you'll be amazed by what you hear.

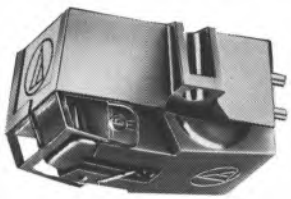


FREQUENCY IN HERTZ — **Typical A-T response** ··· **Typical single-magnet cartridge response**



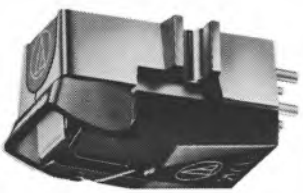
AT11E

Frequency Response	(Hz):	15 - 25,000
Channel Separation	(1KHz):	21
Channel Balance	(dB):	1.5
Stylus Tip Size	(mm):	4 x .7 elliptical
Tracking Force	(gms):	1½ - 2½



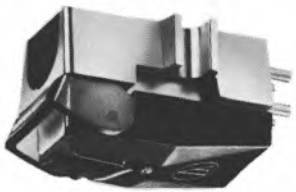
AT13Ea

Frequency Response	(Hz):	10 - 30,000
Channel Separation	(1KHz):	25
Channel Balance	(dB):	1.0
Stylus Tip Size	(mm):	2 x .7 nude elliptical
Tracking Force	(gms):	¾ - 1¾



AT15Sa

Frequency Response	(Hz):	5 - 45,000
Channel Separation	(KHz):	25 minimum
Channel Balance	(dB):	1.5
Stylus Tip	:	Shibata
Tracking Force	(gms):	1 - 2



AT20SLa

Frequency Response	(Hz):	5 - 50,000
Channel Separation	(1KHz):	25 minimum
Channel Balance	(dB):	1.0
Stylus Tip	:	Shibata
Tracking Force	(gms):	1 - 2

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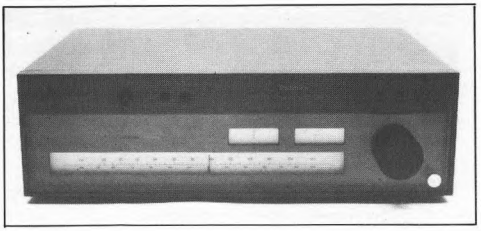
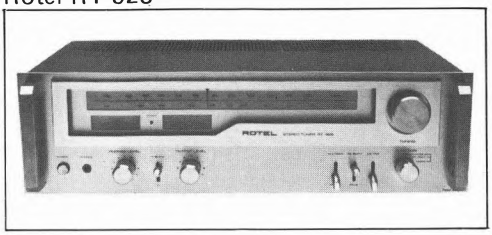
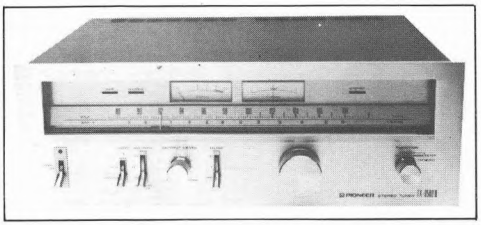
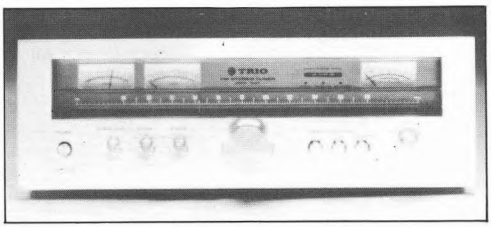


Rotel RT-925





Pioneer TX-9500 II



Trio 600 T

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Tuners by: Akai, Armstrong, Dual, J.V.C., National Pioneer, Revox, Rotel, Sansui, Sony, Technics, Trio, Yamaha.

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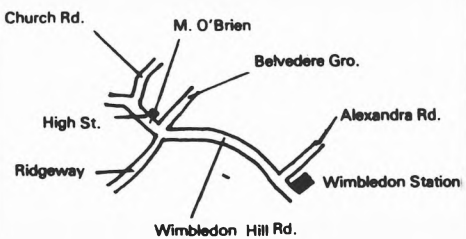

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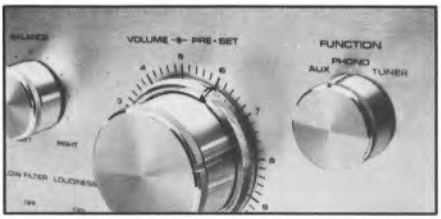
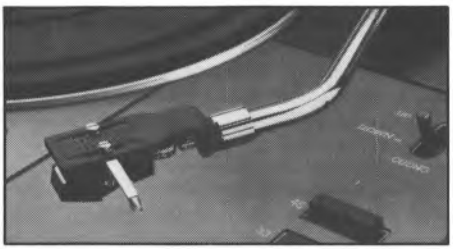
For instance, this magazine; which recommended these Sanyo products and voted them best buys. Take a closer look at Sanyo – it's worth it!

DCA 1001 Stereo Pre-main Amplifier provides 50 watts of continuous power at 8ohms with both channels driven.

BEST BUY HI-FI CHOICE AMPLIFIER



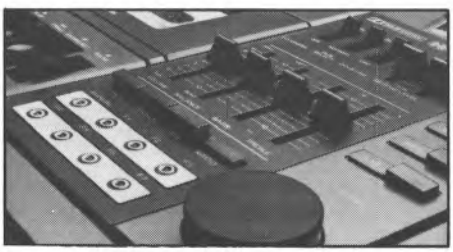


TP 1100 Direct Drive 2 speed stereo turntable. Direct driven platter is operated by a brushless DC Motor. Recessed stroboscope, cueing and anti-skate devices.

BEST BUY HI-FI CHOICE TURNTABLE

G2711 Super 2 Music Centre. Features 2-speed turntable, MW, LW, FM and FM Stereo waveband radio. Versatile built-in Dolby cassette recorder/player.

BEST BUY HI-FI CHOICE MUSIC CENTRE



G2811KL Music Centre. Features belt driven 2-speed turntable, magnetic cartridge and diamond stylus. LW, MW, SW and FM wavebands can be sensor touch pre-selected.

RECOMMENDED HI-FI CHOICE MUSIC CENTRE

RD 4260. This Stereo Cassette recorder combines sleek styling with sophisticated technology and,like all Sanyo products, offers quality and value for money.

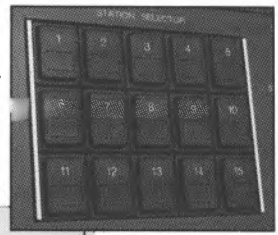
BEST BUY HI-FI CHOICE TAPE DECK

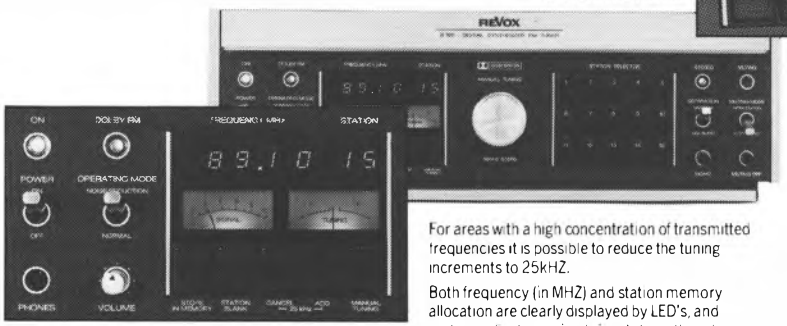
SANYO

at the touch of a switch

B760
Digital Tuner

In addition to being able to tune more than 800 spot frequencies in the FM band, the ReVox B760 can store up to 15 of the frequencies in a digital memory system which allows instant recall at the touch of a button. The CMOS memory can be safeguarded at the flick of a switch to prevent accidental erasure of stored information.

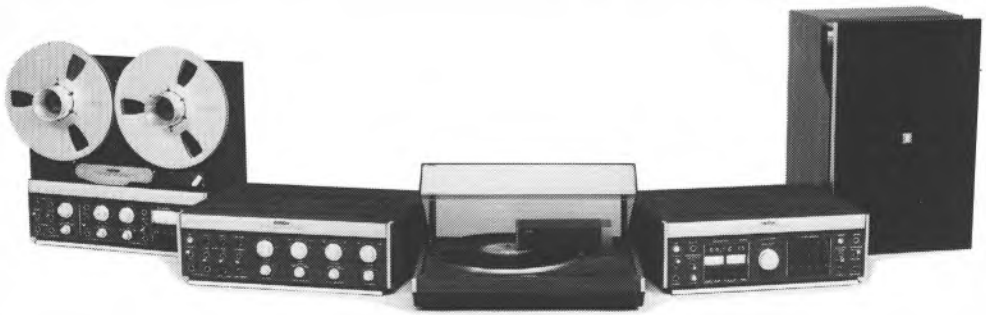




For areas with a high concentration of transmitted frequencies it is possible to reduce the tuning increments to 25kHZ.

Both frequency (in MHZ) and station memory allocation are clearly displayed by LED's, and meters indicate received signal strength and tuning accuracy.

Two more reasons for choosing Revox



REVOX

For full information on the Revox A77, A700 and B ranges, contact Sole U.K. Distributor F.W.O. Bauch Limited, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ

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Secondly, our advice in the Best Buy & Recommendation Section of Hi-Fi Choice is in pure, simple, undistorted English. We won't confuse you with technicalities, or use the jargon. And where can you find this advice?

In your local newsagent, between the covers of Hi-Fi Choise – the most comprehensive guide to buying hi-fi ever published. Currently available there are issues on Receivers, Music Centres, Turntables, Amplifiers and thissbrand new edition on Tuners. Each just £1.50 from your newsagent, (or through the coupon below). Our issues on Loudspeakers and Cassette Decks are sold out. Updated editions of these two issues will be published in the Spring and Summer of 1978.

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Simply a better way of buying hi-fi

This is the first time Hi-Fi Choice has examined tuners. It is also (inevitably) the first time that a detailed survey of this size and scope has ever been tackled on tuners.

The separate tuner is not an essential part of a hi-fi setup, and many people prefer to use a receiver, which combines the functions of tuner and amplifier in one unit. However the separate amplifier is capable of higher quality than the amplifier section of a receiver, in general, and the same argument applies to separate tuners and receiver tuner sections.

The use of separate components rather than receivers may have some disadvantages in user convenience and space saving but it does offer considerable gains in flexibility: it allows someone who may require only limited radio use to add a tuner of modest price and performance to an amplifier of the highest quality; conversely it allows the person with a particular enthusiasm for long range reception to use a tuner with the very best reception performance in an otherwise modest system; it also avoids the inconvenience of losing the use of the system as a whole, should the tuner develop a fault. Depending on the specific home installation, it may be rather easier to site two (or three) smaller boxes than the inevitably larger single receiver.

So although the tuner is not an *essential* part of a hi-fi system, it is nevertheless very widely used, and a major in-depth review of much of the available product was well overdue. The procedure we have adopted is similar to the previous books: we have commissioned one of the country's leading independent consultants, in this case Gordon J. King, to carry out the technical and listening tests, while a second experienced author, Donald Aldous, has written the 'consumer introduction' to explain in simple terms the inevitable technical verbiage and give a practical layman's guide to getting the best results from any tuner.

Gordon J. King will probably be well known to readers of other hi-fi publications, as he is a prolific writer and reviewer. His roots lie in radio, which was the route he took into technical writing, so there is no better choice of reviewer for this issue. Donald Aldous is technical editor of the magazine Hi-Fi News & Record Review, and has been writing about hi-fi for about as long as hi-fi has existed!

Before beginning the testing proper some considerable time and trouble went into determining the most useful tests to conduct, whilst a limited survey was carried out to get an idea of the value placed on the multitude of different features available by tuner-users. The tests, though technical in nature, are designed to represent conditions that may well be encountered in everyday use, while the assessment of features is not merely based on the judgement of one person.

Every effort has also been made to ensure that the selected tuners are representative of those available in the marketplace, and indeed the report covers the majority of models available. Typical retail prices have been included, which we hope are correct at the time we go to press, but naturally these tend to change. Naturally there were some unfortunate omissions for various reasons: for example, the latest Sequerra tuner from the USA, which has an excellent reputation for sound quality but a very high price, was not yet available in the UK, while the Edinburgh Wireless Company tuner, which has also acquired something of a cult following at a more modest price level, was being redesigned as we began the report. Certain other companies for reasons of their own declined to submit their products, but these numbers were small in relation to the total number tested, so the report is certainly valid and covers the vast majority of modern hi-fi tuners.

Before signing off, I had better introduce myself as the new editor of the Hi-Fi Choice series. My contribution to this particular issue has been fairly small, as all the projects take about six months from original inception to final publication. Consequently there are bound to be some changes creeping gradually into these pages, and you, the reader, will have to judge whether they are for better or worse!

Paul Messenger

For all thats best in Hi-Fi – Cavendish is your Choice!

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Pioneer CT-F4040
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Goodmans RB20
Superb true Hi-Fi speakers to suit amplifiers rated at 10-50W undistorted music power

Rotel RA313
Stereo Amplifier 25W per channel input for 2 pairs speakers. Bass and treble filters and loudness control. Tape dubbing. F/R 20-20,000 Hz

Sony STR 2800L
This 20W per channel receiver is fitted with VHF/MW/LW, uniphase IF filter, FM muting & loudness switches

Aiwa AF5080
A powerful 24w per channel Dolby music centre comprising 4 band radio (LW/MW/SW/VHF stereo), belt driven 2 speed auto Dolby cassette deck with LH, CRo2 and FcCr tape selector

Superb selection of Stereo Tuners

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AKAI AT 2400	123.95	SONY ST 11	77.95
HITACHI FT 3005	76.95	SONY ST 2950	83.95
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JVC JTV 31	POA	SONY S 950	219.95
JVC JTV 10	POA	SONY ST 73	49.95
JVC JTV 11	POA	TECHNICS ST 3050	—
MARANTZ 104	89.95	TECHNICS ST 7600	—
NATIONAL ST 2400	—	TECHNICS ST 7300	—
NATIONAL ST 2300	—	TECHNICS ST 8080	—
PIONEER TX 7500	140.95	TRIO KT 1300	72.95
PIONEER TX 9500	180.95	TRIO KT 5300	98.95
PIONEER TX 5500 Mk II	73.95	TOSHIBA ST 420	114.95
PIONEER TX 9500	272.95	YAMAHA CT 410	POA
PIONEER TX 6500	105.95	YAMAHA CT 610	POA
ROTEL RT 425	75.95	YAMAHA CT 810	POA

Prices correct at time of going to press

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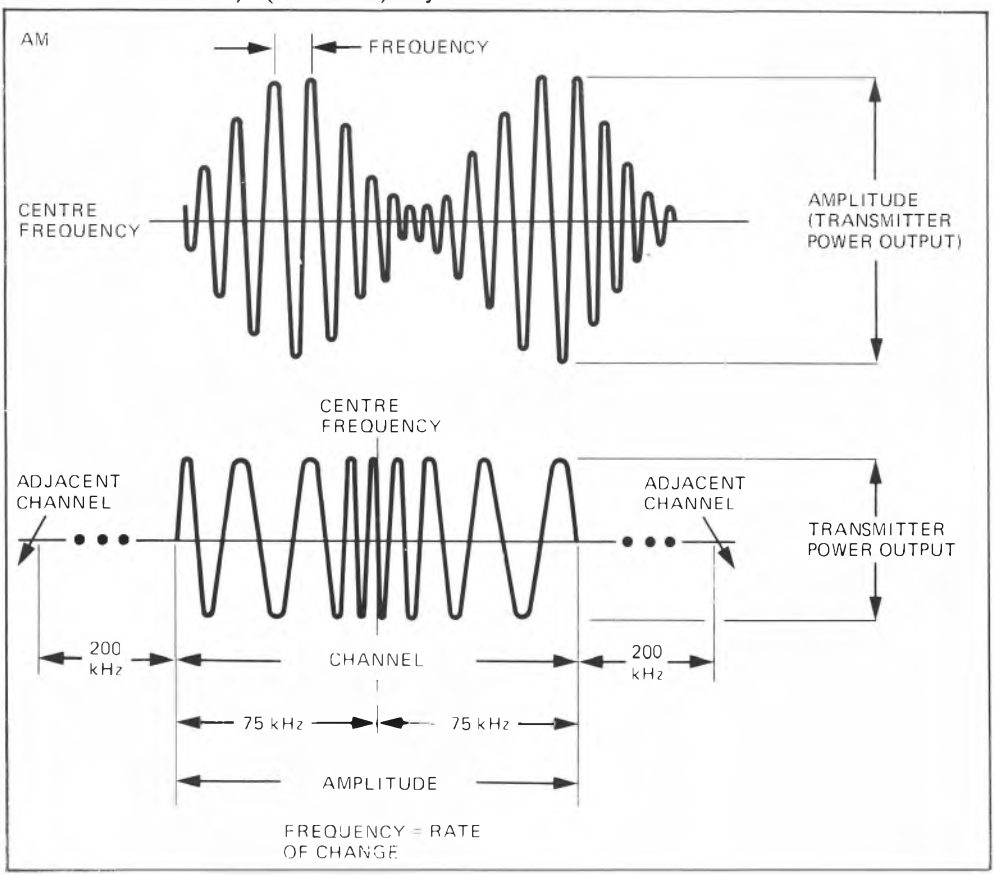
By definition, a tuner is a device that will receive radio transmissions and produce suitable electrical signals to feed an audio amplifier. It can be regarded as the 'radio section' of a hi-fi system, and often contains separate AM, FM, mono and stereo, circuits which are tuned by the same knob, but otherwise independent.

What do AM and FM mean and what is the main difference between the systems?
AM stands for Amplitude Modulation, and refers to a system of broadcasting where the strength, or *amplitude,* of the radio carrier wave is modulated, (ie varied) by the programme signal. The carrier wave vibrates at many thousands of times per second, much faster than the highest sounds to be transmitted. Thus in AM radio this frequency remains constant and only its amplitude is varied. In FM (Frequency Modulation), the amplitude is unchanged, but the number of radio waves per second is varied in accordance with the programme sounds.

What is the principal advantage of FM radio transmissions compared with AM?
With a good FM tuner design, it is possible to achieve a much higher ratio of wanted signal to background noise with FM signals which



Comparison of amplitude modulation with frequency modulation.

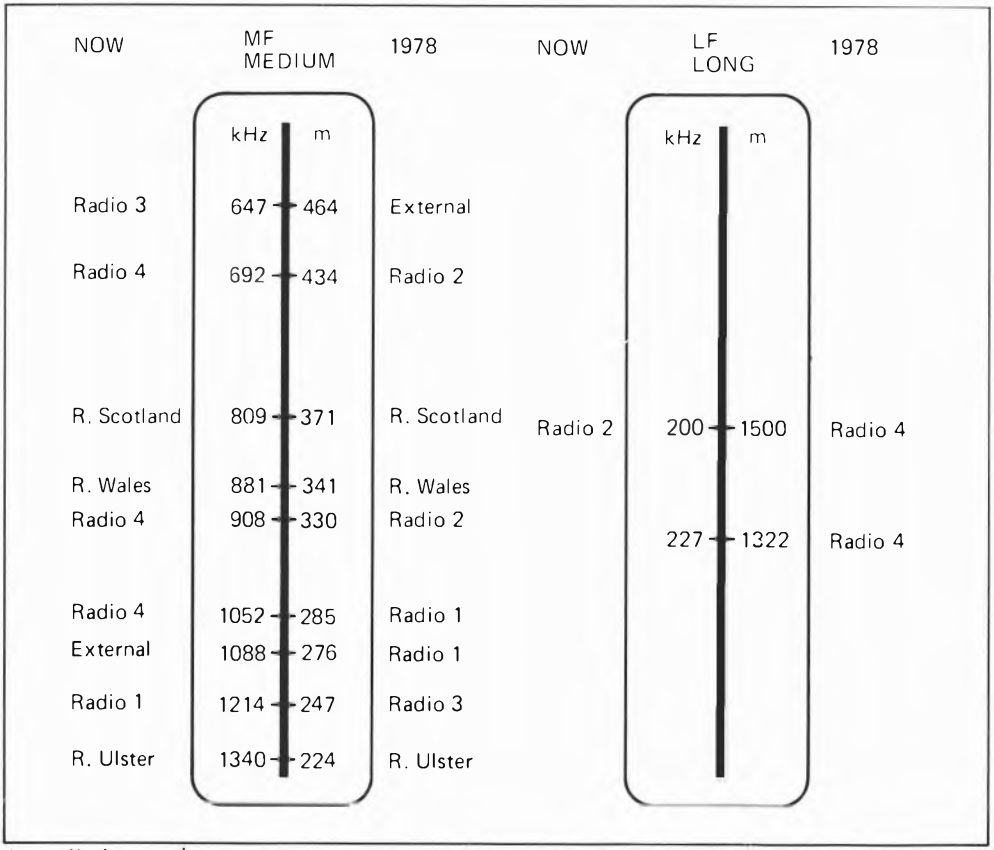
operate on the VHF band, covering frequencies 87 to 108 mHz.

Are there any snags likely to concern the listener in this FM mode of transmission?
As already explained, in AM the amplitude of the radio signal is varied, and at the receiving site locally generated noise cannot be descriminated against. In FM propagation the carrier wave remains at a constant level, and the circuit responds less to unwanted signals since most interfering noises consist of amplitude changes.

The problem is that in fringe VHF reception areas local noise can be a nuisance because the low level of the carrier prevents the circuitry from working at its best. To obtain the full benefits of FM quality, particularly on stereo listening, a good VHF aerial is essential.

What is multipath distortion?
Briefly, this means the arrival of VHF radio signals *via* several paths, due to obstructions, reflections from buildings, etc. This results in differing times of arrival. The best solution for multipath distortion is a good directional aerial system, but a first-class tuner should have such features as a numerically low *capture ratio* and good AM signal rejection.

What does the term 'capture ratio' mean?
This refers to the required difference in the



New radio frequencies.

BBC VHF Radio Transmitting Stations

Engineering Information Department, BBC, Broadcasting House, London W1A 1AA. Tel: 01-580 4468 Ext. 292.

Names of relay stations are inset under the main station of the group.

ENGLAND

	Radio 1/2, Radio 3, Radio 4				Local Radio		
	Frequencies (MHz)			Max		Frequency	Max
	R1/2	R3	R4	erp kW		MHz	erp kW
London and South East							
Oxford	89.5s	91.7s	93.9s	22	Radio London	94.9	16.5
Swingate	90.0s	92.4s	94.4s	7	Radio Medway	96.7	5.6
Wrotham	89.1s	91.3s	93.5s	120	Radio Oxford	95.2	4.5
Midlands							
Sutton Coldfield	88.3s	90.5s	92.7s	120	Radio Birmingham	95.6	5.5
Churchdown Hill	89.0s	91.2s	93.4s	0.025	Radio Derby (main)	96.5*	5.5
Hereford	89.7s	91.9s	94.1s	0.025	(relay)	94.2+	0.01
Northampton	88.9s	91.1s	93.3s	0.06	Radio Leicester	95.1	0.3
					Radio Nottingham	95.4*	0.3
					Radio Stoke-on-Trent	96.1	2.5
East Anglia							
Peterborough	90.1	92.3	94.5	20			
Cambridge	88.9	91.1	93.3	0.02			
Tacolneston	89.7s	91.9s	94.1	120			
South							
Rowridge	88.5s	90.7s	92.9	60	Radio Brighton	95.3	0.5
Brighton	90.1s	92.3s	94.5	0.15	Radio Solent	96.1	5
Ventnor	89.4s	91.6s	93.8	0.02			
West							
Wenvoe	89.95s	96.8s	92.125s	120	Radio Bristol	95.5	5
Bath	88.8s	91.0s	93.2s	0.035			

Stereo Broadcasting in the UK

South West							
Les Platons	91.1	94.75	97.1	1.5			
North Hessary Tor	88.1s	90.3s	92.5	60			
Barnstaple	88.5s	90.7s	92.9s	0.15			
Okehampton	88.7s	90.9s	93.1	0.015			
Redruth	89.7s	91.9s	94.1	9			
Isles of Scilly	88.8s	91.0s	93.2	0.02			
North							
Belmont	88.8s	90.9s	93.1s	8	Radio Humberside	96.9	4.5
Holme Moss	89.3s	91.5s	93.7s	120	Radio Leeds	92.4*	5.2
Scarborough	89.9s	92.1s	94.3s	0.025	Radio Sheffield (main)	97.4*	5.2
Sheffield	89.9s	92.1s	94.3s	0.06	(relay)	88.6	0.05
Wensleydale	88.3s	90.5s	92.7s	0.025			

's' Transmits stereo programmes *Slant polarisation +Vertical polarisation All others use horizontal polarisation

Map of BBC stations

North West							
Holme Moss	89.3s	91.5s	93.7s	120	Radio Blackburn	96.4*	1.6
Douglas	88.4	90.6	92.8	6	Radio Manchester	95.1*	4.2
Kendal	88.7s	90.9s	93.1s	0.025	Radio Merseyside	95.8	5
Morecambe Bay	90.0s	92.2s	94.4s	4			
Windermere	88.6s	90.8s	93.0s	0.02			

North East							
Pontop Pike	88.5s	90.7s	92.9s	60	Radio Carlisle	95.6	5
Weardale	89.7	91.9	94.1s	0.1	Radio Cleveland	96.6	5
Whitby	89.6	91.8	94.0	0.04	Radio Newcastle	95.4	3.5
Sandale	88.1s	90.3s	94.7s	120			

SCOTLAND

Radio 1/2, Radio 3, Radio Scotland

	Frequencies (MHz)					Frequencies (MHz)			
	R1/2	R3	Radio Scotland	Max erp kW		R1/2	R3	Radio Scotland	Max erp kW
Kirk o'Shotts	89.9s	92.1s	94.3s	120	Grantown	89.8	92.0	94.2	0.35
Ashkirk	89.1s	91.3s	93.5s	18	Kingussie	89.1	91.3	93.5	0.035
Ayr	88.7s	90.9s	93.1s	0.055	Orkney	89.3	91.5	93.7	20
Campbeltown	88.6	90.8	93.0	0.035	Thrumster	90.1	92.3	94.5	10
Forfar	88.3s	90.5s	92.7s	10	Rosemarkie	89.6	91.8	94.0	12
Lochgilphead	88.3s	90.5s	92.7s	0.01	Ballachulish	88.1	90.3	92.5	0.015
Millburn Muir	88.8s	91.0s	93.2s	0.025	Fort William	89.3	91.5	93.7	1.5
Perth	89.0	91.2	93.4	0.015	Kinlochleven	89.7	91.9	94.1	0.002
Pitlochry	89.2	91.4	93.6	0.2	Melvaig	89.1	91.3	93.5	22
Rosneath	89.2s	91.4s	93.6s	0.025	Oban	88.9	91.1	93.3	1.5
Toward	88.5s	90.7s	92.9s	0.25	Penifiler	89.5	91.7	93.9	0.006
Meldrum	88.7	90.9	93.1	60	Skriaig	88.5	90.7	92.9	10
Bressay	88.3	90.5	92.7	10	Sandale	88.1	90.3	92.5	120

WALES

Radio 1/2, Radio 3, Radio 4

	Frequencies (MHz)					Frequencies (MHz)			
	R1/2	R3	R4	Max erp kW		R1/2	R3	R4	Max erp kW
Blaenplwyf	88.7	90.9	93.1	60	Llangollen	88.85	91.05	93.25	10
Dolgellau	90.1	92.3	94.5	0.015	Wenvoe	89.95s	96.8s	94.3s	120
Ffestiniog	88.1	90.3	92.5	0.05	Brecon	88.9	91.1	93.3	0.01
Machynlleth	89.4	91.6	93.8	0.06	Carmarthen	88.5	90.7	92.9	0.01
Haverfordwest	89.3	91.5	93.7	10	Llandrindod Wells	89.1s	91.3s	93.5s	1.5
Llanddona	89.6	91.8	94.0	12	Llanidloes	88.1	90.3s	92.5	0.005
Betws-y-Coed	88.2	90.4	92.6	0.01					

NORTHERN IRELAND

Radio 1/2, Radio 3, Radio 4

Divis	90.1s	92.3s	94.5s	60	Larne	89.1s	91.3s	93.5s	0.015
Ballycastle	89.0s	91.2s	93.4s	0.04	Londonderry	88.3	90.55	92.7	13
Brougher Mountain	88.9s	91.1s	93.3s	2.5	Maddybenny More	88.7s	90.9s	93.1s	0.03
Kilkeel	88.8s	91.0s	93.2s	0.025	Newry	88.6s	90.8s	93.0s	0.03

Information courtesy BBC Engineering Information Department and Independent Broadcasting Authority

Independent Local Radio Network

Belfast
Downtown Radio
PO Box 293, Newtownards, Co. Down, N. Ireland
Tel: Newtownards (0247) 815555.
293 metres (1025kHz), VHF 96.0MHz.

Birmingham
BRMB Radio
Radio House, PO Box 555, Birmingham B6 4BX
Tel: 021-359 4481/9
261 metres (1151kHz), VHF 94.8MHz.

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HIFICH

Map of ILR stations

Bradford
Pennine Radio
PO Box 235, Pennine House, Forster Square, Bradford BD1 5NP
Tel: Bradford (0274) 31521
235 metres (1277kHz), VHF 96.0 MHz.

Edinburgh
Radio Forth
Forth House, Forth Street, Edinburgh EH1 3LF
Tel: 031-556 9255
194 metres (1546kHz), VHF 96.8MHz.

Glasgow
Radio Clyde
Ranken House, Blythswood Court, Anderston Cross Centre, Glasgow G2 7LB
Tel: 041-204 92555
261 metres (1151kHz), VHF 95.1MHz.

Ipswich
Radio Orwell
Electric House, Lloyds Avenue, Ipswich IP1 3HU
Tel: (0473) 216971
257 metres (1169kHz), VHF 97.1MHz.

Liverpool
Radio City
PO Box 194, 8-10 Stanley Street, Liverpool L69 1LD
Tel: 051-227 5100
194 metres (1546kHz), VHF 96.7MHz.

London
Capital Radio
Euston Tower, London NW1 3DR
Tel: 01-388 1288
194 metres (1546kHz), VHF 95.8MHz.

London
London Broadcasting Co.,
Communications House, Gough Square, London EC4P 4LP
Tel: 01-353 1010
261 metres (1151kHz), VHF 97.3 MHz.

Manchester
Piccadilly Radio
127-131 The Piazza, Piccadilly Plaza, Manchester M1 4AW
261 metres (1151kHz), VHF 97.0MHz.

Nottingham
Radio Trent
29-31 Castle Gate, Nottingham NG1 7AP
Nottingham (0602) 581731
301 metres (998kHz), VHF 96.2MHz.

Plymouth
Plymouth Sound
Earl's Acre, Alma Road, Plymouth PL3 4HX
Tel: Plymouth (0752) 27272
261 metres (1151kHz), VHF 96.0MHz.

Portsmouth
Radio Victory
PO Box 257, Portsmouth PO1 5RT
Tel: Portsmouth (0705) 27799
257 metres (1169kHz), VHF 95.0MHz.

Reading
Thames Valley Broadcasting
PO Box 210, Reading, Berkshire RG3 5RZ
Tel: Reading (0734) 413131
210 metres (1430kHz), VHF 97.0MHz.

Sheffield & Rotherham
Radio Hallam
PO Box 194, Hartshead, Sheffield S1 1GP
Tel: Sheffield (0742) 71188
194 metres (1546kHz), VHF 95.2MHz.

Swansea
Swansea Sound
Victoria Road, Gowerton, Swansea SA4 3AB
Tel: Gorseinon (0792) 893751
257 metres (1169kHz), VHF 95.1MHz.

Teeside
Radio Tees
74 Dovecot Street, Stockton-on-Tees, Cleveland TS18 1LL
Tel: Stockton-on-Tees (0642) 615111
257 metres (1169kHz), VHF 95.0MHz.

Tyne/Wear
Metro Radio
Newcastle upon Tyne NE99 1BB
Tel: Newcastle upon Tyne (0632) 884121
261 metres (1151kHz), VHF 97.0MHz.

Wolverhampton/Black Country
Beacon Radio
PO Box 303, Wolverhampton WV6 0DQ
Tel: Wolverhampton (0902) 757211
303 metres (989kHz), VHF 97.2MHz.

received level of two FM stations on the same frequency, for the 'wanted' signal to 'capture' the tuner's circuit and reduce the unwanted station to inaudibility. A 'capture ratio' of less than 2 or 3 dB is usually satisfactory, and a few tuners measure as low as 1dB. AM signal rejection may be only some 40dB in a low-priced tuner, rising to 70dB or so for the expensive designs.

It should be noted that AM reception requires a very much larger ratio between the two signals to secure the same 'quiet' background, the same low distortion right up to the full (or peak) modulation (deviation) of the FM broadcast method, and the same frequency response that extends virtually to the transmitter's high-frequency cut-off (around 15kHz).

What are the meanings of such symbols as Hz, kHz, MHz, and c/s, and why are AM bands still included in radio tuners and receivers?

Hz is the abbreviation for Hertz, a term synonymous with the old cycles per second; kHz is 1,000 Hz, and Mhz means 1,000,000 Hz or a Megahertz. AM bands are included in receiving equipment because many users may wish to tune in to more distant stations, and to the BBC programmes which are not available on FM. In the main, Radios 2, 3 and 4 of the BBC network are transmitted on VHF/FM (as well as certain AM wavelengths — see diagram) — each reception area having its own group of transmitters.

The FM band also carries local ILR programmes of the IBA (Independent Broadcasting Authority) and the programmes of local BBC radio stations, the latter from time to time transmitting Radios 1 or 2.

What is the reliable range of a main FM transmitter?

this area is generally considered to be approximately 50 to 60 miles, depending on the elevation of the receiving site and aerial array, linked to the gain — and hence directivity — of the receiving aerial. At the threshold of this range and beyond, the signal strength rapidly weakens and reception becomes less reliable. This means more fading, background 'hiss' particularly on stereo, and interference, as already mentioned.

How does the BBC tackle radio coverage problems in the UK?

To ensure that most listeners are within the range of the BBC's primary programmes, the country is dotted with a network of main transmitters, with lesser-power 'booster' stations at intermediate vantage points to fill in any gaps resulting from 'topographical idiosyncracies' such as hills. There are at present fewer local BBC and ILR stations, so fewer listeners are in reliable range of these transmitters.

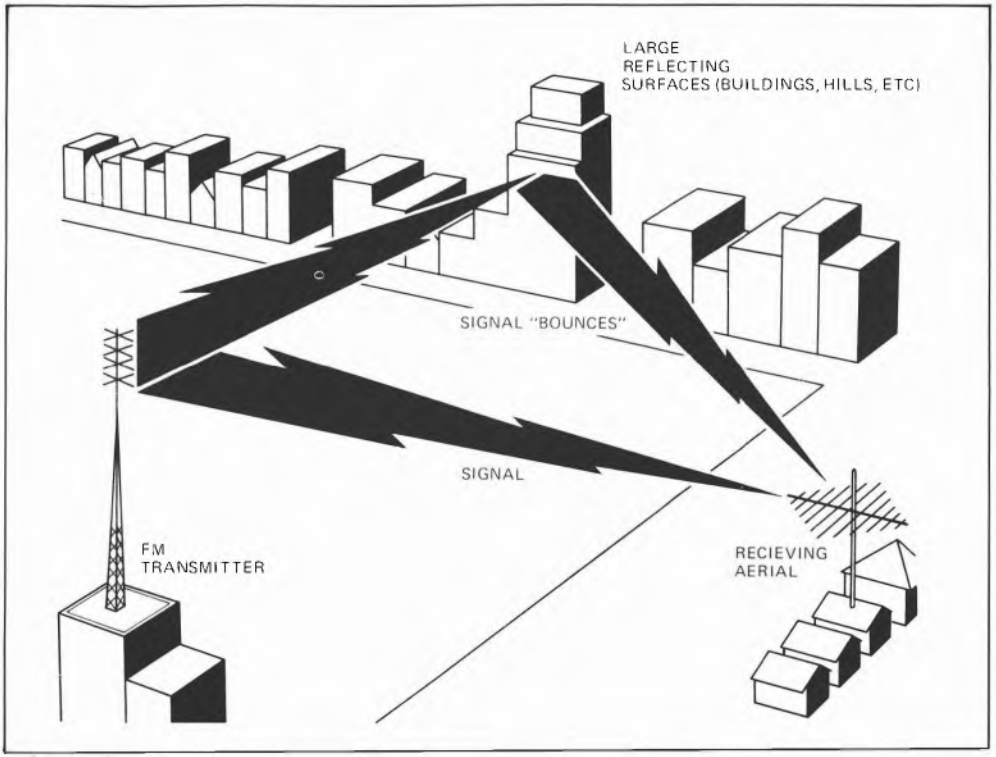
What are the essential characteristics of what is known as VHF propagation?

As the VHF (Very High Fidelity) signal used for FM spreads out from the transmitting aerial, so it diminishes, in much the same way as the intensity of light falls off as we move away from its source, in fact the same laws are involved. Like light rays, but to different degrees, VHF waves are subject to reflection, refraction and diffraction. Intrinsic propagation is in 'straight lines', and because of this the signals can be attenuated or even 'blocked' completely by hills and large structures that fall in the signal path. But for the 'bending' of the waves by refraction in the upper atmosphere (the troposphere) and diffraction round the curved surface of the Earth (caused by waves passing through a changing medium), the range of reception would be limited to the line-of-sight distance between the transmitting and receiving aerials. In practice, this distance is increased by a factor of about 1.5.

A VHF/FM signal thus has a limited propagation range under normal atmospheric conditions. The system must be regarded as a 'local' one and is not normally suitable for long-distance reception. Any buildings or obstructions attenuate the signal.

Is it worthwhile investing in an outside aerial system?

Certainly it is best to mount the FM aerial out of doors if you want high quality reception; it should be as high as possible in an area where the signal is not strong. Almost twice as much signal may be received by an elevated outside



Multipath distortion.

aerial than by the same aerial mounted inside a roof-space on a dry day. Wet weather can reduce the signal from a roof-space aerial by a further 25% or more. Aerial height is important in 'difficult' reception areas because, to a certain extent, the higher the aerial the greater the signal picked up.

What is the basic type of VHF aerial?

This is known as a dipole. It consists of two lengths of metal rod (or wire), lying end to end with a small gap between them, having a total length of about five feet. This dipole picks up signals arriving broadside on to the rods, and thus it needs to be installed with the rods at right angles to the direction of the transmitter.

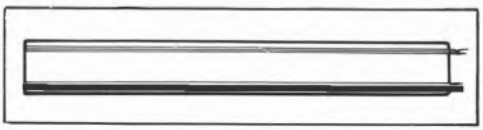
The actual amount of signal delivered to the tuner also depends on the 'gain' of the aerial system. This is sometimes measured by comparing the increase in signal strength to that obtained from a simple dipole, and is expressed in dBs (decibels). An aerial increases its 'gain' by favouring signals arriving from a specific direction rather than other directions. Such an aerial is thus directional and has to be 'beamed' on to the required station for maximum pickup.

The amount of gain you will require of your aerial system will depend upon how far you are from the transmitter you wish to receive, on the topography of your listening site, the amount of elevation you can give to the aerial, and the sensitivity of your tuner or hi-fi receiver. Very roughly, assuming an 'average' tuner, a simple dipole may suffice for up to 10 miles, a two-element aerial up to 20 or 30 miles, a three-element aerial up to 50 miles, and even more elements may be needed beyond 50 miles. The best plan is to seek the advice of a competent radio or hi-fi dealer

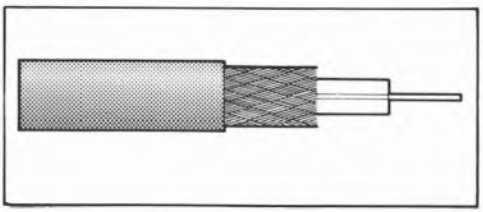
who is conversant with the locally prevailing FM signal conditions. The gain of an aerial rises with an increase in the number of elements, but only to a certain limit as the law of diminishing returns sets in.

Is the coupling lead from the aerial to the tuner or receiver important?
Yes, the aerial should always be connected to the equipment through the best quality downlead (generally coaxial cable) — that you can afford. This ensures that the least signal is lost in its passage from the aerial to the tuner. The importance of this is greater in areas of weak signal and where a long downlead is used. When acquiring an expensive tuner or receiver, it is economic folly to use an inadequate aerial, for this is tantamount to running a high performance motor car with an out of tune engine.

On the other hand, a less sensitive or otherwise limited tuner may demand a reasonably elaborate aerial system, even if used relatively near a transmitter, in order to keep the background noise on stereo down to an acceptable level. However, other design limitations of the tuner may then show up, including how well it can accommodate a multiplicity of strong aerial signals without overloading and generating spurious signals. All these factors are investigated in the following pages.

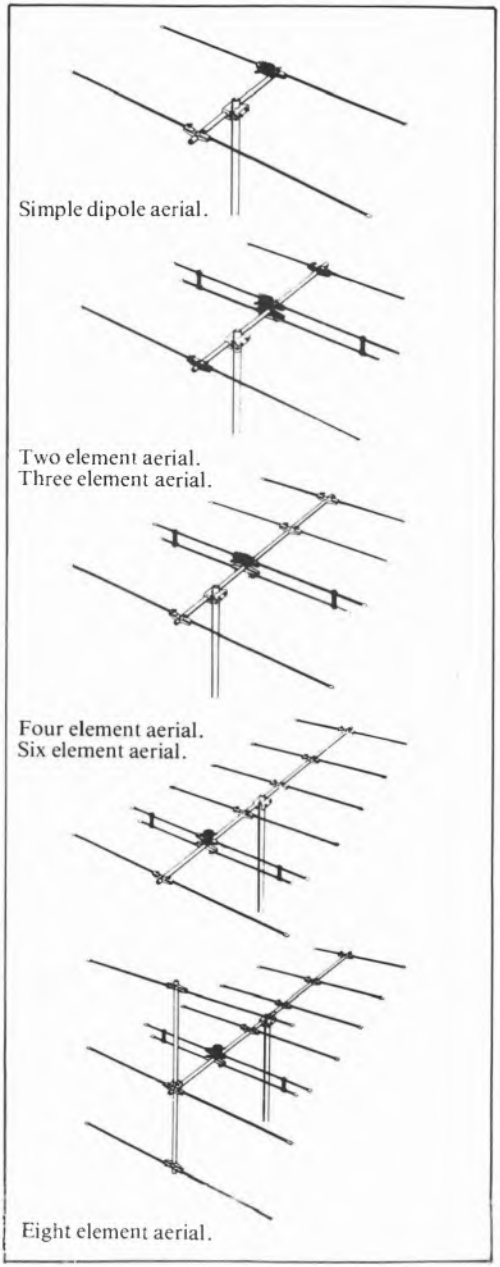


A 300 ohm ribbon aerial.



75 ohm coaxial cable.

In difficult locations, is it practicable to fit special aerials to give noise-free reception?
There may be conditions that require the use



Simple dipole aerial.
Two element aerial.
Three element aerial.
Four element aerial.
Six element aerial.
Eight element aerial.

of a high-gain directional aerial to receive noise-free BBC signals. It may then be found that the aerial orientation is not ideal for another station such as an ILR or local BBC station that you want to pick up. There are ways of coupling together two FM aerials, each pointing in its own required direction, but it is not easy to get optimum results, and needs the advice of a trusted and experienced dealer. The alternative is to use an aerial rotator, so that the direction of the aerial can be changed by remote control. This is usually worked by using an electric motor to rotate the mast with a control unit beside the tuner.

What type of aerial is usually employed for picking up AM signals?
Generally, AM is received with a ferrite rod aerial. Since such an aerial is directional, it is desirable if it can be rotated independently of the tuner as a whole. Some rear-mounted ferrite rods can be pulled out from the back of the tuner and turned, others can only be pulled out away from the metal work and in some cases the ferrite rod is tucked inside the enclosure with the electronics. Most models also have provision for an external AM aerial and earth, and this could be useful if the station sought cannot easily be received on fitted ferrite rod, perhaps due to its fixed position on a tuner that cannot easily be turned.

Tuners seems to have different aerial inputs — is it essential to match these correctly with one's aerial download, etc.?
As already explained, an external aerial of some kind is essential for FM, and many tuners nowadays are equipped with inputs for both 72-ohm (nominal) coaxial cable (the type fitted on your television set), which is employed almost exclusively in the UK, and for 240/300 ohms balanced twin feeder. It is essential to use the correct input for the aerial downlead.

If a tuner or receiver has only a balanced 240/300-ohm input, a dealer can advise on the connection of coaxial type cable; it may be necessary to employ a low-loss coupling transformer called a 'balun', or, in some cases, respectable coupling can be achieved by connecting the inner conductor of the coaxial cable to one of the 300-ohm terminals (leaving the other vacant), and the outer braid to a chassis earthing point. The reviews in this book present appropriate information on aerial inputs.

What is DX-ing?
'DX' reception is a part of radio amateur jargon and is an abbreviation for long-distance reception. Those interested in DX-ing should choose a tuner with a high absolute sensitivity and one that gives a 50dB signal-to-noise ratio with the lowest possible signal. Most tuners have a VHF tuning range from around 88 MHz to 108MHz but this full range is not used for 'entertainment'transmission in the UK at present and certain mobile transmissions operate around the 100MHz mark and above, some radio tuners coming from European countries may not, in fact, tune much above 104 MHz.

For DX-ing other highly desirable features include a smooth and backlash-free tuning mechanism and a relatively long, clearly printed and accurate tuning scale; digital tuning displays are the most accurate, but they are expensive. If the tuner is equipped with AFC (automatic frequency correction) and interstation muting, it should be possible to switch both of these functions off to help when searching for weak signals which may be close to powerful signals from more local transmitters. A tuner needs good selectivity, and should be able to accommodate a multiplicity of strong aerial input signals without drastically overloading and thus generating a rash of spurious signals. These are known as 'burbles', 'birdies', 'beats', and 'whistles', and can mask the weak signals that may be required. A tuning meter giving indication of signal strength is useful, preferably of the type that has a logarithmic action so that weak as well as strong signals will be within its scale range; a 'linear' reading meter often reaches full-scale deflection at a relatively low level of aerial signal which is less useful, and this is another parameter investigated in these reviews.

How has 'birdies' and similar forms of interference been evaluated in these reports?
So far as we are aware, this is the first time a full-scale test has been attempted to evaluate 'birdies' interference. This trouble can be

caused when receiving a stereo programme (tuner's stereo decoder active) while an adjacent or alternate channel signal is also present in the IF (intermediate frequency) passband.

Let us suppose that a stereo signal at 95MHz is being received and that a fairly strong signal is also present at 95.2 MHz, so two signals, displaced by 200kHz, will arrive at the FM detector. Owing to inherent non-linearity, a 200 kHz 'beat' signal may be produced, which is passed along with the signal multiplex to the stereo decoder. The decoder may also reform the sub-carrier frequency from the transmitted pilot tone, which is at twice the 19 kHz pilot tone frequency, ie 38kHz. The fifth harmonic of this is at 190 kHz and this may beat with the 200kHz signal, thus yielding a 10kHz tone. This is not a steady frequency, due to the deviation of the modulation on the signals, and the result is a 'twittering' type of 'birdies' interference, which can be very disconcerting.

The switching action of the stereo decoder produces a wide spectrum of odd-order harmonics; we have just looked at the fifth, but obviously quite a large number of combination conditions could arise to produce 'birdy beats'. Some areas of the country are particularly susceptible to the problems. The trouble can be largely overcome by the inclusion of a low-pass filter between the FM detector and stereo decoder at around 56kHz. Known colloquially as a 'birdies filter', some tuner designs include one while others do not; owing to phase non-linearity, this filter can impair treble-end stereo separation, but this can be counteracted by means of an adjustable 'phasing' network.

A great deal of work has been undertaken on this problem by D. J. Jefferies and I. H. Howle, (Natural Philosophy Department, University of Aberdeen), and there is considerably more to the subject than meets the eye. For example, it has been discovered that a well-engineered 'birdies filter' can also significantly enhance the stereo signal-to-noise ratio. Similarly, a tuner with high selectivity (that is, one that only tunes a narrow frequency band) is less prone to the trouble than another whose selectivity side skirts spread out over a relatively wide spectrum, but the latter tends to sound better under less difficult conditions.

Are there any special problems associated with high selectivity tuner circuits?

When DX reception is considered important, a tuner of high selectivity is needed (ie a model with a high value measured in dB), but if the selectivity is too sharp the higher-order sidebands of the FM signal can be attenuated, which can result in poor harmonic distortion on signal peaks. It is also necessary for the phase shift to be linear over the IF passband for the best stereo separation and the least peak distortion. A tuner of poor or mediocre selectivity may create 'birdies' interference if the wanted station is stereo and there happens to be a fairly powerful mono or stereo station in the adjacent channel; tests have been made to examine this.

What does the term 'muting threshold' mean?

Sensitive tuners produce a loud background hiss when being tuned between stations, and this can be powerful enough to damage the tweeter units of some loudspeakers. To avoid this, a muting switch may be fitted which inhibits audio output below a certain aerial signal input threshold when active; this suppresses the noise and allows 'quiet' tuning from station to station. The parameter measured is the level of aerial signal pd (potential difference) required to overcome the muting action. Another important threshold is that at which the stereo decoder switches on in the presence of a stereo signal and this often corresponds to the muting threshold.

What is 'signal meter saturation'?

This measures how much signal pd (which is the difference in electrical potential, or voltage, across a circuit or component, arising from current passing through it) is required to take the signal strength meter (when fitted to its maximum). A meter that reaches maximum (saturates) on a small signal is less useful than one which reads logarithmically, so that relatively strong as well as weak signals can be distinghished.

AM rejection and pilot-tone rejection — can

these terms be explained simply?
A well designed tuner should be substantially insensitive to AM (amplitude modulation) signals, and the tuner circuits should suppress changes of amplitude in received signals, thereby improving both the signal-to-noise ratios and the ability to reject unwanted stations, even when they are close to or at the frequency of the wanted signal.

When the tuner is reconstituting the stereo signal from the received transmission, ie when the stereo decoder is active, spurious sub-channel components and the 19kHz pilot tone appear at the outputs along with the left and right audio signals. These components can be filtered out in the tuner so that they do not enter the amplifier or tape machine where they can, for example, interfere with Dolby noise-reduction circuitry. Many modern tuners include such filters in the left and right audio output circuits, one feature being that the frequency response should be well down by 19kHz to give good rejection of the stereo pilot signal; care must be taken in design and quality control to avoid these filters unfavourably affecting the treble frequency response.

Our test parameter gives the level of the 19kHz signal on both the left and right channels in dB relative to 100% modulation level. A large amount of pilot tone residual can produce substantial intermodulation products owing to interaction with the audio frequencies, and this is one cause of poor performance with FM tuners.

Are modulation hum and residual hum one and the same thing?
The residual (inherent) hum of the tuner itself may be extremely low, but there is sometimes the tendency for a hum to develop in the background of a tuned station, and this is properly called 'modulation hum'.

Has the BBC any plans to introduce Dolby 'B' noise reduction system on radio transmissions?
So far as we know, it is unlikely that the BBC will introduce Dolby 'B' encoding on their radio transmissions because it is not compatible with existing systems. This means that reproduction by existing tuners or receivers not equipped for Dolby 'B' reception would be degraded. In practice, we have found that switching in a Dolby circuit on a noisy radio signal can offer some improvement in sound quality in some respects even though the transmission has not been encoded.

What special features are incorporated in the more costly tuners or receivers?
Some tuners have outputs for connection to a discrete 4-channel demodulator, for such countries where an acceptable quadraphonic system has been approved and instituted by the controlling bodies and broadcasters. Some models have outputs for coupling to an oscilloscope to indicate multi-path distortion, and as an aid to aerial orientation, and some even more expensive models have an oscilloscope built in.

In technical specifications, the letters PLL appear sometimes — what do they stand for?
In a typical Phase-Locked Loop (PLL) circuit, an internal voltage-controlled oscillator is locked to a harmonic of the input frequency. In an FM detector circuit, the filter ouput is the audio difference between the input frequency and the voltage-controlled oscillator V-CO. These circuits offer improved stereo channel separation.

What is a 'synthesized tuner'?
In these models, the stability and accuracy of the local oscillator are determined by a quartz crystal oscillator, and the frequency is on a digital display, as conventional tuning knobs are not required. This method is not to be confused with normally tuned tuners or receivers in which a frequency counter reads the local oscillator frequency, subtracts 10.7MHz from it, and then shows the tuned frequency on a digital display, which is merely a substitute for a conventional tuning dial. In most synthesized tuners or receivers, channel selection is by means of keyboard or a punched plastic card.

What sorts of tests were carried out on the tuners covered in these pages?
The test results are in two sections — VHF and audio. This procedure was adopted because tuners can be conveniently described in terms

of these two basic functions. The VHF section processes the radio signal from the aerial while the second deals with the audio information of the radio signal after it has been extracted by the detector.

The audio section which includes the stereo decoder, has the greatest impact on the overall subjective performance. The VHF section can also be important in this respect, but essentially determines how well or badly the tuner will perform under diverse reception conditions. That is, how well behaved it is when supplied with a multiplicity of strong signals, and some weaker ones, by the aerial, and whether spurious signals will be generated that could interfere with the picking up of weak, wanted signals. This section also determines how well it will receive very weak signals relative to a given background noise ('hiss'), and how efficiently it will separate the signals in adjacent ((±200kHz) and alternate (±400kHz) channels.

It is therefore possible to achieve good hi-fi reproduction from a tuner which is relatively lacking in VHF performance, but which has a good audio section, provided it is not used under adverse reception conditions, ie, in very weak signal areas or in areas where the signals are very strong and could introduce overloading spuriae. However a tuner with poor audio section performance is unlikely to sound good under any circumstances, however good its VHF performance.

What measurements were made?

The majority of our laboratory measurements concentrated on performance of this group of tuners when receiving FM signals. This is because only FM attempts to satisfy the requirements for hi-fi; moreover, it is the only medium at the moment which provides for two-channel stereophony and (more recently) the BBC's 'Matrix H' and 'HJ' quadrophonic experiments.

Many tuners are also able to receive AM (amplitude modulation) signals, in addition to mono and stereo FM; but these are included essentially for user convenience rather than for hi-fi reproduction. Relative to VHF/FM, the AM system as currently used in the UK suffers from inferior frequency response (early treble roll-off), poorer interference and noise-suppression, inferior signal-to-noise ratio, and greater distortion at the higher modulation levels. Although the AM sections of the tuners under review were not given detailed lab measurements. They were assessed by off-air listening tests, and notes on the performance are given in the reviews.

We can now run through all the parameters, which were carefully chosen after considerable deliberation, to see what they mean and how they can affect reception and listening quality.

What about Sensitivity

This reveals the strength of the aerial signal in microvolts (μV, where 1μV is one millionth of a volt) required for a stated background noise signal-to-noise ratio (in dB). All ratios were measured with respect to maximum modulation for sound broadcasting, corresponding to ±75kHz deviation mono and ±67.5kHz deviation stereo, where in the latter case ±7.5kHz deviation (10% modulation level) is occupied by the 19kHz pilot tone and the 38kHz sub-carrier residual. To avoid residual pilot tone from the tuner affecting the stereo signal-to-noise ratio and hence the sensitivity reading, a 19kHz steep notch filter was included in the test setup.

A 30dB signal-to-noise ratio is not very realistic for hi-fi assessment because the background noise is still far too high. The input required for this ratio, though, is a fair indication of the absolute sensitivity. 'Entertainment value' reception is just about possible with a 50dB signal-to-noise ratio. Tuner sensitivity is thus expressed by the aerial inputs demanded by the tuner for these signal-to-noise ratios. The signal input is the potential-difference (pd) across a 72-ohm matching pad connected to the aerial socket of the tuner; thus the lower the aerial voltage the higher the sentivity.

How do I interpret the signal-to-noise ratios?

As the aerial input voltage is increased so the signal-to-noise ratio increases because the relative level of the inherent noise falls. At a high aerial input voltage this is often termed the 'ultimate signal-to-noise ratio'. Our measurements give the signal-to-noise ratio that a tuner is capable of achieving in mono and stereo with a fairly strong signal of

1,000μV ie 1 millivolt (mV) pd. Thus, the larger the dB number, the higher the S/N ratio and the lower the background noise. At low aerial inputs approximately ten times (20dB) more signal is required for stereo than for mono to give say, a 50dB signal-to-noise ratio. As the aerial input is increased, so the difference between the mono and stereo S/N ratios diminishes. As with sensitivity, the signal factor of the signal-to-noise ratio corresponds to 100% modulation, including the pilot tone and sub-carrier residual in the stereo case.

Noise may occur at different frequencies, and some frequencies are considered more annoying than others, so the measurement takes account of this by 'weighting' the noise according to the frequencies present. Middle, upper-middle and certain high frequencies are considered more disturbing than low-frequency noise and hum, and a number of standards exist to 'weight' wideband noise. We have found CCIR weighting provides the most realistic assessment of subjective noise performance. When the unity gain or 0dB point of the filter is set to 2kHz and an average responding meter (ARM) is used to measure the noise, the test setup is known as CCIR/ARM* which we elected to use for our measurements, including the sensitivity signal-to-noise ratios. This appears to have a good chance of becoming the standard for testing consumer equipment.

*A recommendation of Dolby Laboratories which correlates with measurement of Dolby noise reduction now found in some FM tuners and receivers.

What about limiting?

Starting from a low level of modulated aerial signal, the audio output of an FM tuner increases until there is no further rise with increase in signal input. Because the absolute point of maximum limiting is difficult to measure accurately, we elected to discover the input required to bring the output to 1dB below this maximum limited output. If a tuner requires a high signal level to reach this state, then the level of the output signals will change as input signals of different strengths are tuned in or if the signal fades. For example, if you are listening to a weak signal which is prone to fading, the reproduced sound will tend to rise and fall in sympathy with the fade as the signal rides up and down the limiting curve. As neither of these things is desirable, top-grade tuners reach the —1dB limiting point at very low signal strengths — usually round the input required for the 30dB mono S/N ratio. Good limiting also helps with the suppression of impulse interferences, such as produced by motor cars and electrical equipment.

What are the front-end performance measurements?

The three parameters grouped under this heading collectively yield a fair assessment of the tuner's large-signal handling ability, revealing its likelihood of generating spuriae and self-interfering signals when working close to powerful stations.

Each of the first two parameters was measured with two input signals. For the third-order intermodulation test equal amplitude signals at 94 and 95 MHz were applied and increased together until 30dB signal-to-noise ratio (ref. 100% modulation) was obtained on each adjacent response (e.g., 93MHz = 94 x 2 — 95 and 96MHz = 95 x 2 — 94). The signal level in dB above that required for the 30dB mono signal-to-noise was noted in each case, and our parameter is the average of the two responses, which gives a better overall assessment.

Equivalent front-end selectivity ('figure-of- merit') was measured by applying one signal at 50mV and 100MHz and the second round 89.3MHz, which was carefully tuned to the i.f. difference. With the tuner set to 99.5MHz – just outside the influence of the powerful 100MHz signal – the level of the second signal was adjusted to obtain a 30dB signal-to-noise ratio ref 100% modulation. The level of this signal in dB above the level required for the 30dB mono signal-to-noise ratio is the parameter. Because the front-end selectivity substantially determines the i.f. rejection ratio, this capability is also asssessed by the selectivity measurement.

Repeat spot suppression (or half-i.f. response) was measured by applying a high level 100MHz signal and then tuning to the repeat spot response at round 94.65MHz. The

signal was then adjusted to obtain a 30dB signal-to-noise ratio ref 100% modulation, and the resulting input signal in dB above the level required for the 30dB mono signal-to-noise ratio is the parameter. This is a useful measurement because it takes account of the second harmonic yields of both the local oscillator and r.f./mixer stages, while also defining one aspect of the tuner's second-order IM performance.

None of the above ratios was weighted. The greater the dB numbers, the less prone will be the tuner to spurious responses in the presence of a multiplicity of strong aerial signals. Good front-end performance is required when the tuner is to be used for DX-ing in areas where nearby transmitters are producing strong signals. If a tuner tends to overload in strong signal regions, it is possible to eliminate the trouble by using a plug-in aerial attenuator; but then the system is less useful for receiving weak signals, because these will be further weakened by the attenuation.

How about capture ratio?

The 'capture effect' has already been described, and this ratio lets you know how much more powerful the wanted signal needs to be than a co-channel (same frequency) unwanted signal for a S/N ratio of 30dB. Our tests were made relative to a 1mV signal and at 100% modulation level. In this instance, the smaller the dB figure, the better the 'capture' performance of the tuner.

What about selectivity?

Sometimes during a 'tropospheric opening' (when the weather favours long-distance reception on VHF) signals destined for other local areas are picked up farther afield. This means that you may find quite a strong signal residing in the channel next to your 'local' station, e.g., 200 kHz. away. You may decide to tune in on this, and success will depend to some degree on the tuner's overall selectivity and capture ratio.

We measured the selectivity with two signals — both at the adjacent and alternate channels — and the parameter in each case is the average of the responses at the two sides of the response curve. One signal was applied at 10μV pd unmodulated and the tuner adjusted to this one. The second was applied at ±400kHz and then at ±200kHz, and the modulated off-tune signal was increased for a signal-to-noise ratio of 30dB. The difference in dB between the level of this signal and that at 10μV is the parameter; 100% modulation was used as the reference.

What about stereo separation?

This is shown by the solid curve below the frequency response curve, and is scaled at 5dB per main vertical division. By adopting this scaling you can easily see the amount of separation at any frequency over the entire frequency range.

Owing to the inherent distortion on the breakthrough signal (the harmonics not being many dB below the fundamental), it is very desirable for the separation to be as high as possible. When the separation is poor the distortion part of the breakthrough signal might well be audible, which will again tend to impair the tuner's audible performance. If the separation falls significantly at high frequencies, 'transient splutter' can sometimes be detected on the breakthrough signal, which also causes subjective impairment.

The separation can reduce dramatically with mistuning. Our curves were plotted with the tuning adjusted in accordance with the facilities provided — centre-zero tuning meter, afc, etc.

What is the distortion on the breakthrough signal measurement?

The data on each tuner are accompanied by a spectrogram showing the distortion on the breakthrough signal. The left channel was modulated at 1kHz and 100% stereo level and a 0dB datum was established on the analyser. The modulation was then switched to the right channel and the resulting harmonics were plotted on standard logarithmic graph paper over 20Hz-20kHz *but this time with a vertical scale of 10dB per division,* necessary to reveal the low-level components. This range also shows the pilot tone which, along with all the other components, should be referred to the top horizontal line of the graph, which corresponds to the 0dB datum.

Using the Hitachi FT-920 purely as an example, it will be seen that the 1kHz fundamental is about 45dB down from the top

0dB datum line. Thus, referred to the *fundamental,* the second harmonic is about —22dB (7.94%), the third about —8dB (39.8%) and the fourth about —21dB (8.9%). The total distortion on the breakthrough signal with respect to the fundamental breakthrough of the 1kHz driving signal is thus about 41.54%! Hence the need for the best possible separation. The vector sum of the fundamental and all the harmonics gives the overall level of the breakthrough signal relative to the 0dB datum. This may differ from that revealed by the stereo separation curve owing to the different levels of 1kHz modulation.

What is 'birdies' interference?

We tested for the probability of the tuners producing 'birdies' interference by applying a stereo signal at 95MHz (100% total modulation at 1kHz to establish a reference at 2mV pd), and simultaneously a mono signal at 95.2MHz and then at 94.8MHz at 100μV (pd), ie 95MHz ±200kHz. The receiver was tuned accurately to the 95MHz stereo signal and the modulation of both generators was turned off. A spectrum analyser, previously scaled to the 0dB datum for 100% modulation, was then used to detect the beat (if any) at 10kHz, and the peak of the beat is given as the parameter, ref the 100% modulation 0dB datum, taking account only of that measurement (+200kHz *or* —200kHz) which gave the worst result.

Further useful information on tuner use can be found in a 19 page booklet issued by the BBC Engineering Information Department in July 1977. Called 'How to get the best out of BBC stereo radio,' this can be obtained f.o.c. by sending a large s.a.e. to BBC E.I.D., Broadcasting House, London W1A 1AA

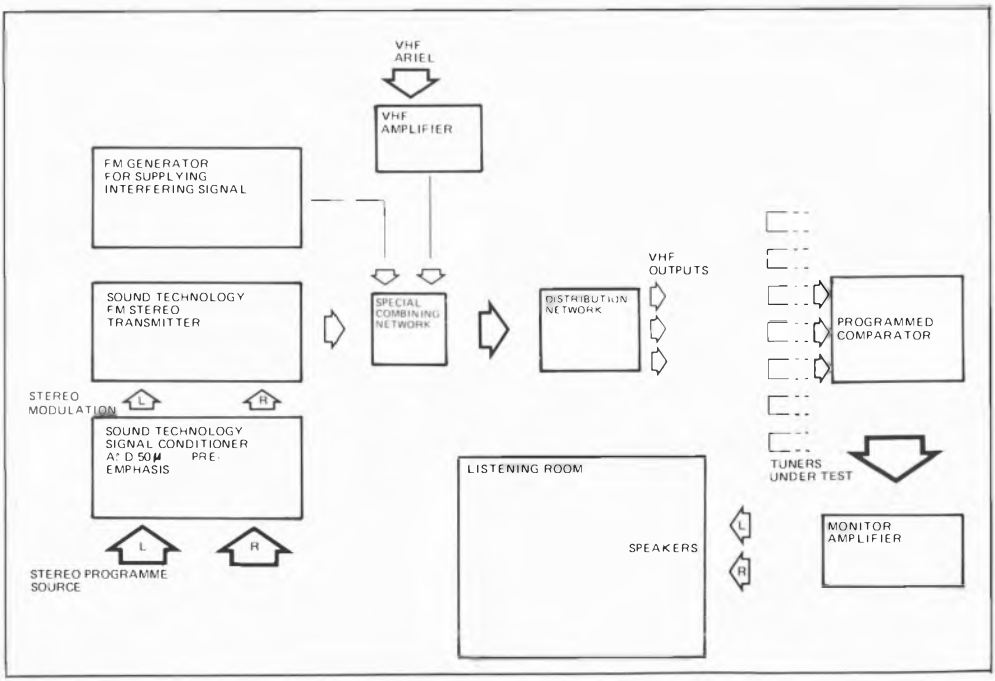
Technical introduction

Now that Donald Aldous has described the requirements of tuners and the ways the various technical considerations are best interpreted, this section of the book deals more with the actual measurements and how they were performed. Measurements alone on tuners do not always give the whole story, though they are important. It is also desirable to audition a tuner under carefully controlled conditions and with a wide range of signals, in order to give a reliable overall appraisal of performance.

For our listening tests we set up a closed-circuit transmission system, which fed signals through coaxial cable to several listening rooms. In each room there were matched outlets capable of accommodating up to ten tuners simultaneously. Signals on this system included the ordinary off-air programmes picked up by a six-element aerial, and 'home-brewed' programmes derived from a transmitting system located in the laboratory. The set-up which was used is shown in fig 1.

A Sound Technology 1000A stereo signal generator with broadcast quality encoder provided the stereo VHF signal, while the programme signals were sub-amplified and pre-emphasised to the standard 50μsec by Sound Technology 1100A Signal Conditioner. A Marconi VHF generator was used to provide an additional signal for assessment of interference susceptibility. The off-air signals were amplified and all three lots of signals were combined and sent to the distribution system after level setting. By these means we were able to control the levels, frequencies and modulation depths of our own signals.

All the tuners under test at any one time were coupled to a Pioneer comparator whose stereo output drove a Technics SU-8600 amplifier which was wired to two pairs of loudspeakers. IMF monitors were used in the main listening room and a pair of Tannoys in a smaller room. Both rooms were sound treated, each having an average reverberation time of about 0.4sec.



1 Set-up used for listening tests.

Programme information was mostly derived from master tapes, including a remarkable tape supplied to our lab by Angus McKenzie Facilities Limited. Various other sounds — in and out of phase and in pure stereo and mono modes — were also used, including percussion transients for assessing 'spitting' effects in the non-speaking channel with both normal and over-modulation (up to ±100kHz deviation).

Also assessed were the effects of interference due to a powerful in-band signal (from the Marconi FT995B/2 generator); whistle or 'fuzz' at 96.3MHz, corresponding to the ninth harmonic of the FM intermodulation frequency; distortion on the breakthrough signal, etc. The tuners were operated under typical domestic conditions on weak and strong signals, with a very strong signal being deliberately fed in from our closed-circuit system to determine the subjective effect of birdies, blocking and so forth.

A number of experienced listeners from our previously established listening panel were consulted for more detailed and subtle assessments; but, frankly, we must admit that the audio differences between many of the tuners were small. Far less than we experienced a while back when similarly assessing amplifiers. In spite of what is sometimes currently being said to the contrary, we did achieve an encouragingly high correlation between the measured parameters and the listening experience.

More differences were revealed when tuners were compared at moderate and low aerial signal levels, and when a simultaneous interfering signal was applied. Differences in background noise could also be detected; but with a reasonable aerial signal most of the tuners were fairly quiet on mono. In stereo, the nature of the noise may affect its subjective annoyance value. This is directly reflected by using CCIR-weighted signal-to-noise ratios, which try to take account of such variations.

Each tuner was assessed subjectively in about ten different ways, in addition to the normal listening tests and domestic type auditioning.

Not a great deal of time was spent on AM listening because, frankly, the attainable sound quality is very poor and certainly cannot be rated as hi-fi. Not only do the transmitters themselves roll-off the treble very early; but the tuners are often arranged to have restricted bandwidths to prevent inter-station whistles and monkey-chatter. This, of course, severely attenuates the sidebands of the AM signals — assuming they were present in the first place!

Nevertheless, we endeavoured to do justice to the unhappy AM designers by listening to AM programmes at different times of the day on the ferrite rod aerial provided or, if necessary, by connecting an external aerial. We tested AM in about four different ways, in addition to the normal type of auditioning.

Engineering quality

Each tuner was opened up and judged on its engineering quality. We looked for factors like robustness, internal screening, printed circuit board quality and construction, component quality, switch and tuning mechanism precision, soldering quality, ease of servicing, etc. A weighting factor was applied to each tuner over a scale of 10 to 1 graduated respectively from poor through fair, average and good to very good. Very few tuners were awarded the highest mark. One would expect a tuner with a high engineering rating to be endowed with a greater reliability factor than one awarded a relatively lower rating. You will, of course, pay extra for this!

Although we did not test specifically for electrical safety we did examine things like the insulation thickness of mains cables, mains on/off switching, earthing, etc.

Feature weighting

The price of a tuner (or, indeed, any item of hi-fi) is significantly affected by the number and complexity of its features. Some of these appear to be little more than gimmicks, and since there is no future in spending good pounds sterling for things you may not use, we composed an exhaustive list of features (some 35 separate items) and dispatched copies to hi-fi magazine staff; normal tuner users, the more enthusiastic user and a few hi-fi dealers, seeking some idea of the priority that they placed upon each item.

The survey amounted to some 100 returns, and the marking range was again from 1 to 10. After analysis, the value placed against each feature was included in the final analysis of value-for-money. It is noteworthy that the standard deviation from the average of many of the high priority items was small, while that of some of the low priority items was large, particularly with respect to the more obscure, technical type of feature. In some cases the user had but a very vague idea of the precise purpose of the item! An unwanted feature will add price to the tuner or detract from the quality elsewhere.

The final results of VHF performance, audio performance, features, engineering quality and value with price are given in the table in the Conclusions section. At this stage, however, it is only fair for the designers, manufacturers and distributors to know how the results were obtained. Before going on to the lab tests, therefore, we shall devote a little space to explaining the technical principles involved.

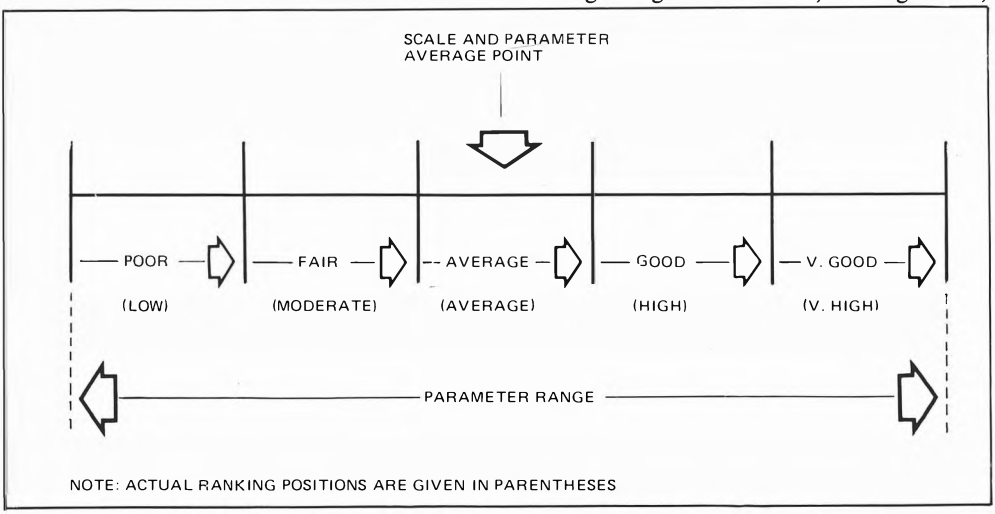
Overall results

In order to keep in line with the presentation adopted in previous *Hi-Fi Choice* books, the ranking was based on five adjectives — poor, fair, average, good and very good. These are equivalent respectively to low, moderate, average, high and very high ranking positions. *At the outset, it should be clearly understood that any such ranking can only be relative to the items of the group.* This is because the parameters selected for analysis need first to be carefully ranked in order of value. This is called ordinal ranking.

Clearly, then, this means that some of the same tuners in a different group or in a group of fewer models might rank differently. It also means that a tuner ranked as, say, poor or good should not be regarded as being intrinsically poor or good, but merely with respect to all the other models of the group.

The marking scale used is shown in Fig. 2. When a ranking value occurred on, or close to, a changeover point we marked poor/fair, fair/average, etc. A good deal of research was directed to the scaling to achieve the simplest yet fairest rankings. We experimented with scales of greater definition, but the extra information so exposed was minimal.

Absolute lab-derived parameters were first standardised to equivalent size scales, and scaled ordinal ranking was then used for subsequent computation. The scale range for this was 1 to 10. The technical assessment of each tuner took account of 61 parameters, including weighted features, tuning error,



2 Marking scale used for assessments.

engineering quality and price.

VHF ranking took account of sensitivity for 30dB mono and 50dB mono and stereo signal-to-noise ratios, limiting, third order IM, equivalent front-end selectivity 'figure of merit', repeat spot ratio, capture ratio and alternate and adjacent channel selectivity.

Audio ranking took account of 1mV mono and stereo signal to noise ratios, AM rejection ratio, pilot tone suppression ratio, stereo sub-channel spuriae, vector sum of the ripple components (fundamental, second and third harmonics), vector sum of mono and stereo distortion, frequency response at 15kHz and 20Hz, stereo separation at 1kHz and 10kHz, and and birdies suppression ratio. For the VHF and audio rankings we transferred the signal to noise ratios (at 1mV) from the VHF to the audio section. This is because signal to noise ratios are particularly important for audio section appraisal, even though they are partly a function of the VHF section.

The 'value' rankings took account of the combined results of the VHF and audio sections, tuning error, weighted features and engineering quality. Although we are confident that the rankings derived from the lab measurements are entirely accurate within the scale range, factors like features and engineering quality cannot be determined with the same precision. *Hence, the 'value' rankings can only be regarded as approximate.*

With the very expensive models you will be paying for high-grade components, 'professional' grade engineering, often guaranteed parameters and a 'prestige factor' that cannot easily be defined in terms of 'value'. Only you can decide whether these things are worth the higher price.

Our presentation allows you to focus quickly on to the aspects which you yourself regard as most important. For example, if you live in a problem reception area or are keen on DX-ing, you may first scan the prices, concentrate on those models satisfying your budget and then locate those models which have the highest VHF rankings. On the other hand, if you are interested mainly in the best possible quality — reception conditions presenting no undue problems — you would specifically seek those models with the highest audio rankings. You may, of course, require both the best VHF and audio. If you are a features man you would concentrate on those models highly ranked in this respect. If you are after 'prestige' allied with good performance, look for the highly-priced models! Assuming a similar standard of engineering, it commonly follows that the higher the price, the better the VHF and audio section rankings. As there are physical limits to the VHF and audio performances, above a certain price the engineering quality and features start to show up more.

When you have sorted out a number of models which seem to suit your requirements, you turn to the review pages to read more about them. Here the information is of a more general nature and includes information on auditioning, AM performance, amplifier interfacing, interference effects, cosmetics and so forth. If you are technically inclined you can also study and compare the absolute values of the measured parameters.

We would like to make it clear that review comment is given only when a specific deviation from average has been detected on any particular aspect. For example, if you read that a tuner was found to have excellent tuning, this is not to imply that all the other tuners where no such comment is given were found to have imperfect tuning!

We can now go on to look at how the lab measurements were made, starting with the parameters of the VHF section.

VHF input signal voltage (definition)

The VHF signal voltage applied to the aerial sockets of the tuners for the following tests refers to *half the emf* (electromotive force) at 75 ohms as measured at the signal generator. This is sometimes colloquially, *though erroneously,* called potential-difference (pd). The pd across the aerial input is equal to half the source emf *only* when the aerial input of the tuner has exactly the same impedance as the signal source feeding it. Where there is a mismatch — even a mild one — half the source emf *does not* correspond to the pd across the aerial input. It is not feasible to measure the real pd across the aerial input owing to the change of impedance evoked by the measuring instrument. Thus, rather than

measuring in terms of input power or full emf, we elected for the more accurate expression of half emf. We used half emf instead of full emf because this correlates more closely with those reviews where signal pd is given (although half emf may be that which has actually been measured).

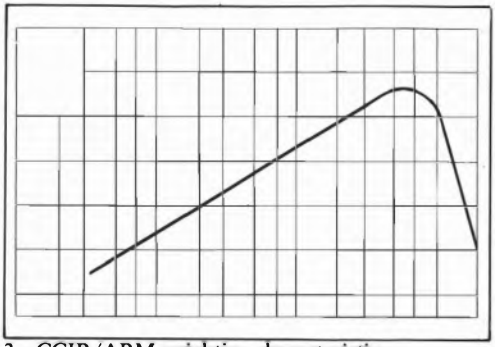
Sensitivity
This test determines the aerial signal inputs required to achieve signal-to-noise ratios of 30dB mono (absolute sensitivity) and 50dB mono and stereo. The ratios were measured with CCIR/ARM weighting with respect to ±75kHz mono deviation and ±67.5kHz deviation of the *audio* component of a stereo signal. To avoid pilot tone interference, the ratios were measured *via* a steep notch filter centred at 19kHz.

Signal-to-noise ratios
These ratios were measured both in mono and in stereo with a 1mV input signal. CCIR/ARM weighting was adopted and a 19kHz notch filter was used to eliminate the pilot tone residual in the stereo mode.

The difference between the basic CCIR weighting and CCIR/ARM weighting lies in the fact that the former adopts a reference of 1kHz and (by rights) a quasi-peak responding meter, while the latter uses a reference of 2kHz and an average responding meter (ARM). The standard CCIR weighting curve with the 2kHz reference is shown in Fig. 3.

Excluding the differences in metering, the CCIR/ARM weighting can be converted to the CCIR weighting merely by subtracting 6dB from the signal-to-noise ratio — thus making our measured ratios about 6dB smaller. The use of a quasi-responding meter and a 1kHz reference can be of importance to the broadcaster and for the evaluation of professional equipment where other network factors have to be taken into account, such as data stream interferences and discrete noises. For consumer equipment evaluation, however, the CCIR/ARM weighting appears to stand a good chance of becoming a standard in the UK, as well as in the US, which is one of the reasons why we decided to use it.

Measuring to the very highest ratio is no easy task because of the masking effects of the noise produced by the stereo signal generator,



3 CCIR/ARM weighting characteristic.

the weighting and notch filters, and the very sensitive meter. A great deal of attention was directed to this area of our measurements, and we are now able to measure better than —80dB.

Limiting —1dB
This test determines the aerial input required to take the tuner to 1dB below its ultimate limiting value. We decided to measure at —1dB rather than endeavouring to establish the absolute limiting point, as the former can be defined with greater precision than the latter.

Third-order IM
For this test equal amplitude signals at 94 and 95MHz were applied to the aerial input *via* a combining and matching pad and increased together until a 30dB signal-to-noise ratio was obtained on each adjacent response (e.g., (94 x 2) —95 = 93MHz and (95 x 2) —96 = 94MHz, which are the third-order IM responses). The signal level in dB above that required for the 30dB mono signal-to-noise ratio was noted in each case, and our parameter is the *average* of the two responses. We decided to use the average instead of just one of the responses because one can differ from the other. The average thus provides a better assessment.

Equivalent front-end selectivity 'figure of merit'
Two signals were again used for this test. One was applied at 50mV and 100MHz and the second round 89.3MHz, carefully adjusted for the 10.7MHz i.f. difference. With the tuner at 99.5MHz (just outside the influence of the

powerful 100MHz signal), the level of the second was adjusted to obtain a 30dB signal-to-noise ratio. The dB difference between this signal level and that for the 30dB mono signal-to-noise ratio is the parameter. Because the front-end selectivity substantially determines the i.f. rejection ratio, this parameter too is assessed by this selectivity measurement.

Repeat spot suppression
This parameter, sometimes better known as half-i.f. response, was measured by applying a high level 100MHz signal and then adjusting the tuner to the repeat spot response round 94.56MHz (e.g., half the i.f. away from the 100MHz signal). The signal was then adjusted to obtain a 30dB signal-to-noise ratio (ref. ±75kHz deviation), and the resulting input signal in dB above the level required for the 30dB mono signal-to-noise ratio is the parameter. This is a useful measurement because it takes account of the second-harmonic yields of both the local oscillator and the rf/mixer stages, while also defining one aspect of the tuner's second order IM performance.

Capture ratio
This is another two-signal test. We used a reference signal of 1mV and a reference modulation equivalent to ±75kHz deviation. One signal was unmodulated and the other modulated, both being applied to the tuner at exactly the same frequency. The level of the unmodulated signal was increased until the modulated signal output from the tuner fell by 30dB. The number of dB above 1mV required for this, divided by two, is the parameter.

Selectivity
The selectivity was also measured with two signals with frequency differences of 200kHz for the adjacent channel and 400kHz for the alternate channel, and the parameter in each case is the average of the response at both sides of the response curve. One signal was applied at 10μV unmodulated and the tuner adjusted to this one. The second was applied at ±200kHz and ±400kHz, and the unmodulated off-tune signal was increased for a signal-to-noise ratio (ref. ±75kHz deviation) of 30dB. The dB difference between the resulting level of this signal and that at 10μV is the parameter. We decided, after many measurements, to adopt the 10μV reference rather than the more common 100μV reference because some tuners require several *volts* of aerial signal to measure the alternate channel selectivity referred to 100μV, and this very large signal has damaged front-end transistors! With modern tuners there is not a great deal of difference between the results with 100μV or 10μV reference signal level.

Tuning error
We set the tuner exactly to 95MHz by its own cursor and then adjusted the frequency of the input signal for accurate 'on-tune' indication. The frequency of the input signal was then measured on a digital frequency counter, and the frequency by which the actual tuning differed from 95MHz is the stated parameter. Any error was taken into account by weighting the overall results.

Output
The audio output was measured from the left and right channels with the tuner driving into an impedance which approximately corresponds to the load that would be presented by a typical amplifier. The maximum voltages are stated. That is, the rms (root mean square) values with respect to ±67.5kHz deviation of audio content of the signal with the level control when fitted turned to maximum. Where a tuner is equipped with a second pair of outputs at fixed audio level, these too were measured as stated in the lab sections of the reviews.

AM rejection
A well engineered FM tuner should be substantially insensitive to AM. We measured the AM rejection ratio ref. ±75kHz deviation on a 30% AM signal applied at an r.f. level of 1mV. Measurement was made with a spectrum analyser, and extra special care was taken to ensure that the AM generator was not yielding excessive spurious FM. This measurement is very difficult as phasing effects of the signals through the modulator and receiver can influence the results; it was made, however, with the tuner adjusted for an 'on-tune' indication.

Pilot tone rejection
We measured this with respect to ±67.5kHz

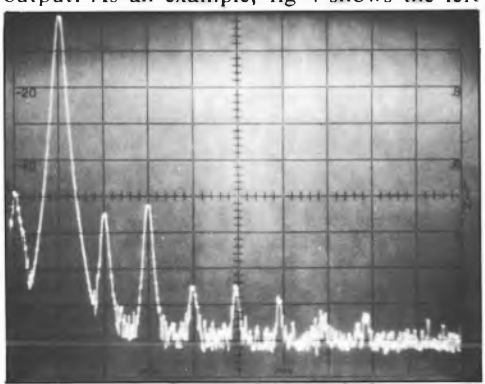
deviation and with 10% pilot tone modulation on a spectrum analyser. You can see one aspect of the results on the spectrograms in the review sections.

Sub-channel spuriae
This was measured with the same references as for pilot tone rejection (see above), but the spectrum analyser was adjusted to sweep up to 50kHz to show components at the 38kHz sub-carrier frequency.

Hum
With a very clean low-hum carrier applied to the tuner, a spectrum analyser was used to measure the ripple frequencies at 50, 100 and 150Hz. Our parameter refers to ±67.5kHz deviation and the vector sum of the three hum components in dB below this.

Distortion
Realistic values of distortion are extremely difficult to measure from FM tuners because of phase cancellation effects within the test equipment and tuner itself, which alter significantly with slight mistuning. To overcome some of these problems we analysed each harmonic up to the fourth in a number of modes which are clearly defined in the test results. A simple test of distortion factor can barely be regarded as adequate for FM tuners.

The measurements were made with the tuning adjusted in accordance with the facility provided — centre-zero meter, dual lights, afc, etc. and with the tuner driving into a simulated amplifier load from the main output. As an example, fig 4 shows the left channel harmonic distortion of one tuner referred to ±67.5kHz deviation at 1kHz. Here the second harmonic is —54dB (0.2%), the third at —52dB (0.25%) and the fourth at —75dB (0.017%). Odd numbered harmonic distortion components can be less palatable than the even numbered ones. Modern tuners of good design do not add much to the distortion of the radio signal, even at full deviation. At average modulation levels the distortion is generally much lower.



4 Distortion analysis: Scale 1kHz/div horizontally and 10dB/div vertically.

However, the distortion harmonics can rise dramatically with mistuning. Moreover, tuners equipped with selectivity switching generally produce far less distortion at high modulation levels using the wide rather than the narrow position, owing to the higher-order sidebands being allowed to develop fully without amplitude and phase distortion. Stereo separation is also usually better in the wide position.

Frequency response
This was measured in stereo at 1mV input and with the modulation subjected to 50μsec pre-emphasis. The modulation was swept logarithmically over the frequency spectrum, and the level was set so that at 10kHz the deviation was about ±50kHz. Signal from the main output, developed across a simulated load, was then fed to a Hewlett Packard digital storage network analyser, which was also providing the synchronised swept signal, and the response of the left channel was plotted. Spot tests were also made at 20Hz and 15kHz of both left and right channels, the response of the worst channels being given in the technical results. The plot is given at both 5dB per div and 1dB per div, the latter for detailing slight response errors.

Stereo separation
The non-speaking channel output was also plotted at 1mV input to show the separation against the frequency response. This measurement was made with the tuning accurately adjusted with the facility provided (centre-zero meter, etc.) and note was made as to whether slight mistuning improved the separation.

Owing to the inherent distortion on the breakthrough signal (the harmonics not being

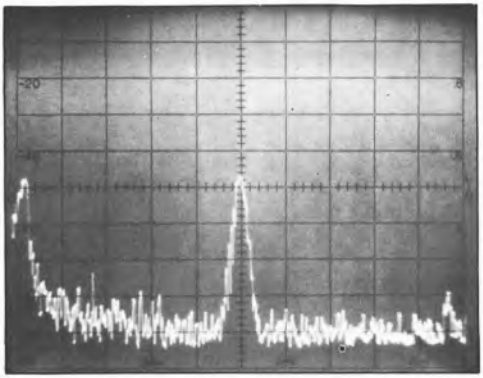
many dB below the fundamental), the crosstalk signal can sound really 'rough' and carry transient 'splutter'.

Breakthrough signal distortion

The left channel was modulated to ±67.5kHz deviation audio content and 10% pilot tone and sub-carrier at 1kHz, and a 0dB reference was established on the spectrum analyser. The modulation was then switched to the right channel and the resulting harmonics were plotted, along with the pilot tone. From the spectrogram accompanying each review it is possible to see the level of the distortion on the breakthrough signal with respect to the full audio modulation in the speaking channel.

Birdies interference

We tested for the probability of the tuners producing 'birdies' interference by applying a 2mV stereo signal at 95MHz (with ±67.5kHz deviation at 1kHz initially to establish a 0dB datum) and simultaneously a 100μV mono signal at 95.2MHz and then a 94.8MHz (the frequency was very accurately controlled). The tuner was adjusted to the 95MHz stereo signal, and the modulation of both generators was turned off. A spectrum analyser, previously scaled to the 0dB datum, was then used to detect the beat at 10kHz, and the peak of the beat is given as the parameter in dB below the 0dB datum, taking account of that measurement (+200kHz or —200kHz) which gave the worst result.



5 Birdies beat: Scale 2kHz/div horizontally and 10dB/div vertically. The beat shown here is 48dB below the 0dB datum which refers to ±67.5kHz deviation of the stereo audio content.

An example spectrogram of a typical 'birdies' beat is given in fig 5, where the graticule scaling is 2kHz/div horizontally and 10dB/div vertically. The beat amplitude in this case is thus —48dB.

RECOMMENDED

Accuphase T-100

Pyser Limited, 102 College Road, Harrow, Middlesex. 01-427 2278.

The outstanding quality of this tuner places it in a category of its own. Constructed virtually to professional instrument standards, it uses high-grade, plug-in printed circuit boards and good quality components. Each primary section is separately screened, and with the aerial removed even strong signals gave barely any response. It ranked high in engineering quality assessment.

In spite of its high price, it is without a wooden cabinet; but one is available as an optional extra. Fascia is brushed aluminium with side pillars, black scale edging and a black flip-down cover retained in position by a magnetic catch. When the cover is lifted a number of secondary controls, including an illuminated multipath meter, are exposed.

The functions are selected by push-keys and the stereo, two muting levels and MPX noise filter operations are indicated by small lights. Tuning is by a large metal knob, and the mechanism is to the same high standard as the rest of the tuner, using flywheel inertia, the cursor being a thin, red-glowing line. Scale length is about 235mm with 250kHz graduations and is of linear calibration. Scale numbers glow softly blue at normal or dim intensity as selected by a sub-switch.

Mains supply is connected through three-core cable, and aerial inputs are available at 75 and 300 ohms, the former being a non-standard coupler which, although inconvenient, retains an excellent impedance match. The plug supplied is not all that easy to fit on certain coaxial cables, and it is possible to end up with a short-circuit unless care is taken.

The design of the AM section surpasses that of less exacting models, but the results are not all that much better owing to the inherent shortcomings of the AM system of broadcasting. It is not possible to swivel the ferrite rod aerial, so for best results you may be obliged to use an external AM aerial.

Measured FM parameters were very good, some taxing our instruments almost to their limits. Sensitivity is high and noise low. Average third order was 80dB (almost 3dB higher on one response). Referred to 30dB signal to noise ratio this means that two 10mV signals can be accommodated before the onset of bad spuriae. Four variable-tuned circuits between aerial and mixer give a very good equivalent front-end selectivity figure of merit, while the very good repeat spot suppression ratio proves that the tuner is free from second order components.

I.F. selectivity was also high; but in spite of this the designers have achieved a commendably low overall distortion in most modes. The worst harmonic (second) in pure stereo mode was 0.5%, but this could be reduced by optimising the tuning — the third then rising a little. Breakthrough signal distortion was intrinsically high, but this was of minimal subjective consequence owing to the good stereo separation; but I would have liked to have measured a lower second harmonic at full test deviation.

Monitoring the breakthrough signal at high gain revealed the distortion, but the signal was clear of transient splash right up to ±100kHz deviation. Frequency response rolls-off smoothly with no violent undulations, and this is allied with good pilot tone rejection. The signal meter is essentially logarithmic and will accommodate up to 8,000μV before reaching full scale. The centre-zero accuracy of the tuning meter, however, could have been better on the test sample.

FM auditioning ranked the tuner high — a completely smooth sound at all frequencies with no

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roughness or stridence on transients. A shortfall was lack of electrical isolation between the variable and fixed outlets.

In summary, a prestige quality tuner for which you will be called upon to pay a prestige price. Although the individual rankings were high, the overall ranking was brought down by the high price.

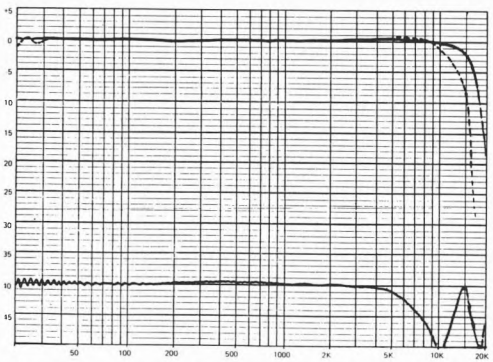
Additional information/comment:
*Also fixed output at 1700/1700 L/R.
Features include AM MW with rear non-swivel ferrite rod aerial; FM *and* AM level controls; 75/300-ohm aerial inputs; two muting levels; MPX filter; two pairs outputs (fixed and variable); signal/tuning/multipath meters; multipath and FM detector outputs; dial light dimming switch (secondary controls beneath front flap).

VHF Section

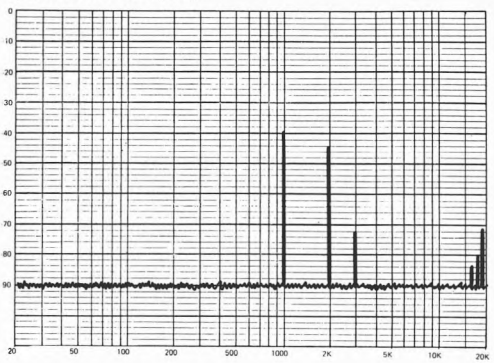
Sensitivity 30dB S/N CCIR mono (μV)	0.8
Sensitivity 50dB S/N CCIR mono (μV)	4
Sensitivity 50dB S/N CCIR stereo (μV)	40
S/N CCIR mono 1mV av. (dB)	82
S/N CCIR stereo 1mV av. (dB)	76
Limiting —1 dB (μV)	0.9
Front-End Performance	
3rd-order RF IM av. (dB)	80
Equiv. select. figure-of-merit (dB)	>96
Repeat spot (dB)	>96
Capture ratio (dB)	2
Select. ±400kHz av (dB)	76
Select. ±200kHz av. (dB)	14
Muting threshold (μV)	12 and 50
Sig. meter saturation (μV)	8000
Tuning error 95MHz (kHz)	—60

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1700 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1700 (max)*
AM rejection 1mV (dB)	58
Pilot tone suppression ref. ±67.5kHz dev. (dB)	72/73
Sub-ch. spuriae ref. ±67.5kHz (dB)	75
Hum ref. ±67.5kHz (dB)	75
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.5
3rd harmonic (%)	0.05
4th harmonic (%)	noise
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.07
3rd harmonic (%)	0.02
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.02
3rd harmonic (%)	0.06
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	noise
4th harmonic (%)	noise
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	44.7
Response 15kHz worst ch. (dB)	—1.6
Response 20Hz worst ch. (dB)	—0.1
Stereo separation 1kHz (dB)	40
Stereo separation 10kHz (dB)	50
Birdies suppression (dB)	70
Dimensions (W x H x D) (mm)	455 x 152 x 355
Typical selling price (£)	£550.00



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

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Accuphase T-101

Pyser Limited, 102 College Road, Harrow, Middlesex. 01-427 2278.

This model is less expensive than the T-100, although it is constructed to the same high standard; one or two frills have been deleted, but it has other features. There is no AM band, which is no hardship to the true hi-fi devotee and VHF performance was marginally below the T-100. An important factor about Accuphase equipment is that the published specifications are guaranteed; this is bound to put up the price because components of high tolerances have to be used. Although our measurements are not quite the same as those used by the manufacturer; we have no reason to believe that the published specs are below par, indeed, if anything they veer towards the conservative side.

The enclosure is black-finished metal, but a wooden 'furniture' enclosure is available as an optional extra (£42.18 including VAT). The fascia is brushed aluminium with polished metal corner pieces and black scale edging. A conveniently large metal knob serves for tuning and a smaller one for level control. Precise black keys select the various functions, and the tuning mechanism is to the same high standard as the T-100. The cursor is red glowing, but it was felt that more brightness would have been advantageous.

Scale illumination is blue of fixed intensity, calibration is linear, but the mid-band calibration error was regarded as too high for a tuner in this price range. Indicator lights show the selection of stereo, muting (one level only), MPX noise filter and selectivity.

The black-finished rear accommodates 'phono' audio sockets and inputs for 75 and 300 ohm aerials, the former using the special coupler of the T-100; a detachable three-core mains cable is fitted. Internal screening is excellent, and the ninth harmonic of the i.f. was undetectable — not a bleep from a very strong 96.3MHz signal.

This model includes switchable i.f. selectivity. In the normal position, which was used for the final analysis, the selectivity is adequate for most requirements and is the position for the least distortion and best separation. However, if you are a DX buff and require maximum discrimination against near-frequency signals you would switch to narrow. In this position it was possible to hear the slight fall in overall quality.

The model was less sensitive than the T-100 and the signal to noise ratios were not so good. Nevertheless, very acceptable front-end parameters were measured; the net result however was a lower ranking than the T-100. The audio performance was very good, but not quite up to the T-100 standard. Stereo second harmonic distortion was lower; as was the distortion in general, including the effect of the breakthrough signal distortion, which was some 53dB below the speaking channel (see spectrogram).

Very good pilot tone and sub-channel spuriae rejection have been achieved with minimal impairment to the upper-frequency response; stereo separation over the entire audio spectrum was also very acceptable. 'Birdies' rejection was measured in both narrow and normal selectivity positions and, as would be expected, the best results were obtained in the narrow position, where the 10kHz beat was down to our —90dB noise floor.

FM auditioning gave encouraging comment. Reproduction at all frequencies was clean and free from stridence. With isolated amplification the distortion on the breakthrough signal was discernible; but in the normal selectivity position there was no hash or splash at normal modulation

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levels. As with the T-100, a short across the fixed outlets cut the signal from the variable outlets.

In summary, a professional quality FM-only tuner of good performance, suitable also for serious DX-ing. Its high-ranking audio performance and lower price gave it the same value for money rating as the T-100.

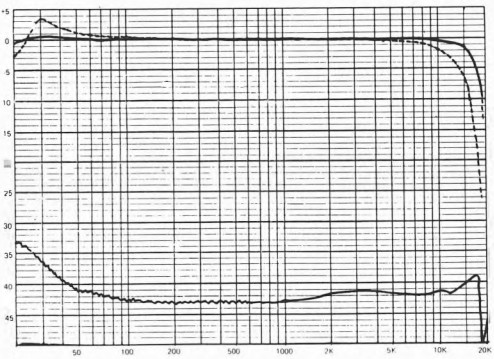
Additional information/comment:
*Also fixed output at 1660/1608 L/R.
**Measured in the wide selectivity position (as included in final analysis).
Features include level control; 75/300-ohm aerial inputs; selectivity switch; muting switch; two pairs outputs (fixed and variable); signal/tuning/multipath meters; multipath and FM detector sockets; mono only and stereo only switches (no AM bands).

VHF Section

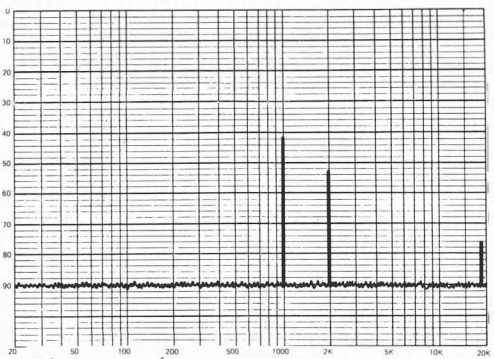
Sensitivity 30dB S/N CCIR mono (μV) 1.78
Sensitivity 50dB S/N CCIR mono (μV) 5.57
Sensitivity 50dB S/N CCIR stereo (μV) 62.5
S/N CCIR mono 1mV av. (dB) 78
S/N CCIR stereo 1mV av. (dB) 72.5
Limiting —1dB (μV) 1.37
Front-End Performance
3rd-order RF IM av. (dB) 71
Equiv. select. figure-of-merit (dB) 86
Repeat spot (dB) . . . . . >90
Capture ratio (dB) 2.5
Select. ±400kHz av (dB) . . . . . 56 (wide); 80 (narrow)
Select. ±200kHz av. (dB) . . . . . 6 (wide); 26 (narrow)
Muting threshold (μV) 4
Sig. meter saturation (μV) . . . . . not working
Tuningerror 95MHz (kHz) . . . . . +109

Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 1669 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 1614 (max)*
AM rejection 1mV (dB) . . . . . >60
Pilot tone suppression ref. ±67.5kHz dev. (dB) 80/76
Sub-ch. spuriae ref. ±67.5kHz (dB) 82
Hum ref. ±67.5kHz (dB) 72
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.25**
3rd harmonic (%) . . . . . noise**
4th harmonic (%) . . . . . noise**
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.08**
3rd harmonic (%) 0.08**
4th harmonic (%) . . . . . noise**
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.03**
3rd harmonic (%) 0.01**
4th harmonic (%) . . . . . noise**
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.06**
3rd harmonic (%) 0.016**
4th harmonic (%) . . . . . noise**
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.06**
3rd harmonic (%) 0.01**
4th harmonic (%) . . . . . noise**
Total on breakthrough signal (%) 28.2**
Response 15kHz worst ch. (dB) . . . . . —1.1**
Response 20Hz worst ch. (dB) . . . . . —0.5**
Stereo separation 1kHz (dB) 43**
Stereo separation 10kHz (dB) 41**
Birdies suppression (dB) 68**
Dimensions (W x H x D) (mm) . . . . . 455 x 152 x 355
Typical selling price (£) £340.00



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Alba AU-800A

Alba (Radio & TV) Limited, Bull Lane, Edmonton, London N18 1SD. 01-803 4451.

This inexpensive British tuner has been around for some time and is shortly to be superceded by a new model. However, as the model is still available from a number of sources at a competitive price we decided it would be a useful subject for this book. In spite of its low price, it includes LW and MW bands with an internal ferrite rod aerial in addition to FM with an auto-switching stereo decoder.

There are no meters but the FM tuning point is approximated by two illuminated arrow-heads. The scheme is to tune over a station with the afc off until both arrow-heads are just extinguished. Illumination of just one implies that the tuning must be adjusted in the direction thus indicated. The lights glow brightly, and most users should have little difficulty in establishing the centre-point tuning; residual error can be subsequently corrected that the tuning point is approximately that required for the least distortion and best stereo separation; but neither of these parameters was very high.

A coaxial socket is fitted for British 75ohm aerial feeder, which matches well, and a single DIN socket delivers the left and right audio signals at a level suitable for most amplifiers. An inter-station muting button is also provided, but the muting comes on progressively rather than being switched suddenly as it is with the more expensive models. Switching threshold of the stereo decoder is round 30-50 μV — again progressive. Obviously, the standard of construction cannot be expected to be as high as the more costly models, but the wooden enclosure, 'silver' trim, matt-black fascia, dark-backed scale with green-illuminated numbers and station identifications, black tuning knob and seven black buttons give an attractive appearance. Printed circuit boards are mounted on a metal frame and the rear consists of a fibre material rather than metal; mains is coupled by three-core cable and the tuner has passed through BEAB (British Electrotechnical Approvals Board).

Tuning scale is approximately 110mm in length and FM tuning marks occur only at 1MHz intervals, which made it impossible to establish precise tuning error. Although the tuning mechanism is devoid of slip and backlash, the frction content is rather high and the tuning cannot be spun as it can on low friction models with flywheel inertia.

Relative to the other models of the group, most ranking values were low, leading to low overall values for vhf and audio and a fair ranking for engineering quality. The signal-to-noise ratios were quite acceptable, though the distortion was high in all modes; average values were measured for sensitivity, but the poor selectivity ratios would tend to limit the viability of the tuner for serious DX-ing. A fair third order IM ratio was measured on both responses, but during the measurements one or two undefinable spurious responses were detected on high signal inputs.

A fair pilot tone rejection ratio has been attained, but the upper-treble started tailing off a trifle early on one channel. Stereo separation was about 25dB over most of the spectrum with the afc active. The spectrogram shows 1% of third harmonic distortion on the breakthrough signal with respect to the speaking channel signal at full test modulation.

AM performance was quite reasonable, with average sensitivity and selectivity. Critical FM auditioning placed reproduction at only fair, and birdies could be evoked with strong in-system signals (see Technical Introduction).

In summary, an inexpensive LW/MW/FM tuner

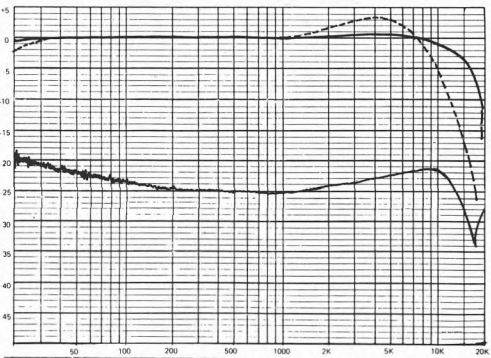
of attractive appearance; though suitable for budget systems, it does not reach the hi-fi standards set by many others of the group.

VHF Section

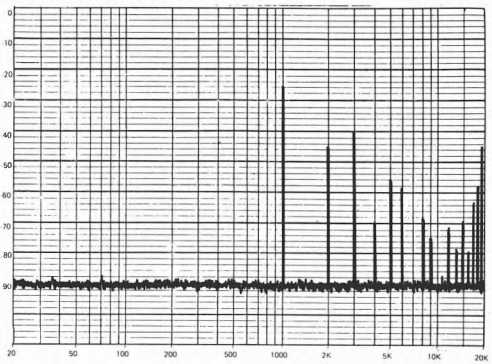
Sensitivity 30dB S/N CCIR mono (μV) 1.5
Sensitivity 50dB S/N CCIR mono (μV) 4
Sensitivity 50dB S/N CCIR stereo (μV) 30
S/N CCIR mono 1mV av. (dB) 78
S/N CCIR stereo 1mV av. (dB) 69
Limiting —1dB (μV) 5
Front-End Performance
3rd-order RF IM av. (dB) 63.5
Equiv. select. figure-of-merit (dB) 35
Repeat spot (dB) 78
Capture ratio (dB) 5
Select. ±400kHz av (dB) 42.5
Select. ±200kHz av. (dB) 4
Muting threshold (μV) . . . . . 5 (progressive); 30 stereo thresh.
Sig. meter saturation (μV) . . . . . —
Tuning error 95MHz (kHz) . . . . . —

Audio Section

Output ±67.5kHz dev. L-ch. (mV) 406
Output ±67.5kHz dev. R-ch. (mV) 408
AM rejection 1mV (dB) 41
Pilot tone suppression ref. ±67.5kHz dev. (dB) 45/52
Sub-ch. spuriae ref. ±67.5kHz (dB) 44
Hum ref. ±67.5kHz (dB) 65
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 1.7
3rd harmonic (%) 1
4th harmonic (%) 0.8
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.8
3rd harmonic (%) 0.2
4th harmonic (%) 0.2
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 1.7
3rd harmonic (%) 3
4th harmonic (%) 2.8
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 1.2
3rd harmonic (%) 0.4
4th harmonic (%) 0.3
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.7
3rd harmonic (%) 0.2
4th harmonic (%) 0.18
Total on breakthrough signal (%) 22
Response 15kHz worst ch. (dB) . . . . . —3.4
Response 20Hz worst ch. (dB) . . . . . —0.4
Stereo separation 1kHz (dB) 25
Stereo separation 10kHz (dB) 23
Birdies suppression (dB) 64
Dimensions (W x H x D) (mm) . . . . . 325 x 100 x 195 approx.
Typical selling price (£) £58.00
Additional information/comment:
Features include LW and MW with internal ferrite rod aerial; afc button; muting button; 75-ohm coaxial aerial input; DIN only audio output.



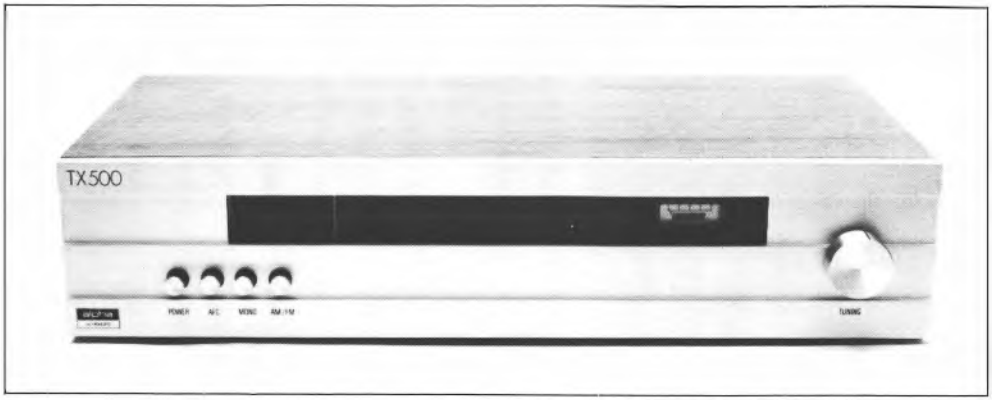
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Alpha TX-500

Highgate Acoustics Limited, 38 Jamestown Road, London NW1. 01-267 4937.



A product distributed by Highgate Acoustics, the inexpensive TX-500 has been selling steadily for some time, and when this book is in print most of the remaining stock will be distributed to the shops. However, since the model is still available, we decided to include it so it can be compared with the more recent FT-650.

It is a tuner which would not be out of place in any hi-fi system, and for the moderate price it includes a wooden sleeve and sports a brushed satin anodised fascia which makes it quite attractive. A metal knob is used for tuning, and 'silver'-fronted push-buttons switch the power, afc, mono mode and change from FM to AM. The tuning includes a small flywheel but the intrinsic friction of the mechanism inhibits a complete spin of the tuning with the flick of the knob. The tuning, though, is quite precise in action and we detected no nasties.

The scales are dark-backed with blue illumination and the length is approximately 160mm. However, because there are no clear calibration marks (numbers only) it is impossible to know with any precision the frequency tuned. We also measured a rather high mid-band calibration error.

There is no FM tuning meter, but since the model includes afc any slight mistuning is automatically corrected by depressing this button. A single meter, with an illuminated stereo indicator backing, resides at the right of the scale, and this will accommodate up to about 250μV before reaching full scale and is also active on AM. Three-core cable connects to the mains.

A good quality printed circuit board is used but the components are not identified, though there should be no undue difficulty in subsequent servicing. Two DIN sockets (one high and the other low signal) deliver audio, but as these are mounted directly on the pcb, excessive stress may fracture the board; overall, the engineering quality was fair/average. The ferrite rod aerial for AM is mounted internally, while an external AM aerial and earth can be connected to a rear IEC socket and a standard coaxial socket is used for a 75 ohm FM aerial.

The general ranking of both the vhf and audio sections were below the average of the group. The former was held back by the third order IM, equivalent front-end selectivity and adjacent channel selectivity results. Higher ranking would have been achieved by the audio section had the stereo frequency response and separation been better; frankly, the results here obtained were very poor.

On the other hand, the distortion performance in all modes was good, and good pilot tone rejection has been engineered into the design — albeit, at the expense of upper-frequency response. Intrinsic breakthrough distortion was relatively small and the worst harmonic (second) was some 54dB below the speaking channel signal, as revealed by the spectrogram. In this case, therefore, the poor separation would tend more to impair the stereo imagery rather than the audio quality.

Off-air AM performance using the internal ferrite rod aerial was about average; whistles and monkey chatter were not too bad during daylight hours. To avoid turning the tuner round, an external AM may have to be used for the best reception of weak signals.

FM reception presented no problems under average signal conditions, but birdies and spurious responses could be evoked with our stronger closed-

circuit system signals. Auditioning of a critical nature revealed slight lack of upper-frequency response and musical attack, accompanied by a higher than average noise and hum background on stereo.

In summary, then, an inexpensive tuner of fair features which should present no problems under normal or average reception conditions, but one in which certain design aspects could be improved. Not suitable for serious DX-ing.

VHF Section

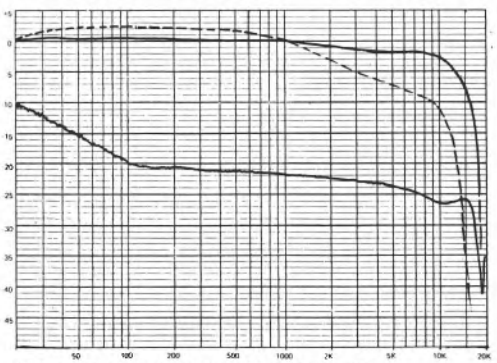
Sensitivity 30dB S/N CCIR mono (μV)	1.2
Sensitivity 50dB S/N CCIR mono (μV)	3
Sensitivity 50dB S/N CCIR stereo (μV)	25
S/N CCIR mono 1mV av. (dB)	73
S/N CCIR stereo 1mV av. (dB)	69
Limiting —1dB (μV)	1.5
Front-End Performance	
3rd-order RF IM av. (dB)	57
Equiv. select. figure-of-merit (dB)	26
Repeat spot (dB)	71.5
Capture ratio (dB)	1.75
Select. ±400kHz av (dB)	51
Select. ±200kHz av. (dB)	4
Muting threshold (μV)	2.5 (internally adjustable)
Sig. meter saturation (μV)	250
Tuning error 95MHz (kHz)	+240 approx. (not easily read)

Audio Section

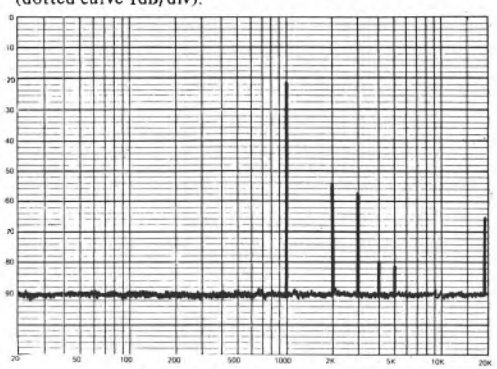
Output ±67.5kHz dev. L-ch. (mV)	1146 (high); 103 (low)
Output ±67.5kHz dev. R-ch. (mV)	1123 (high); 100 (low)
AM rejection 1mV (dB)	60
Pilot tone suppression ref. ±67.5kHz dev. (dB)	63
Sub-ch. spuriae ref. ±67.5kHz (dB)	41
Hum ref. ±67.5kHz (dB)	64 (mostly audio section)
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.2
4th harmonic (%)	0.05
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.04
3rd harmonic (%)	0.22
4th harmonic (%)	0.02
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	0.12
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.07
3rd harmonic (%)	0.2
4th harmonic (%)	0.017
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	2.2
Response 15kHz worst ch. (dB)	—7.5
Response 20Hz worst ch. (dB)	+0.1
Stereo separation 1kHz (dB)	22
Stereo separation 10kHz (dB)	26
Birdies suppression (dB)	66
Dimensions (W x H x D) (mm)	410 x 100 x 210 approx.
Typical selling price (£)	£70.00

Additional information/comment:

Note: Measurements made with internal mute preset turned right off. Features include MW with internal ferrite rod aerial; two DIN outlets (high and low audio); switchable afc; coaxial 75-ohm aerial input; IEC AM aerial socket; mono/stereo switch; signal meter with stereo beacon backing.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Alpha FT-650

Highgate Acoustics Limited, 38 Jamestown Road, London NW1. 01-267 4937.

At the lower end of the group's price scale, this more recent Alpha is an impressive-looking tuner. Like the earlier model, it is equipped with a wooden sleeve, but most of the fascia is occupied by a large, dark-backed scale section, whose lower half carries a metal/plastic FM/AM knob and two lever switches for hi-blend noise filtering and muting (the TX-500 has fixed muting). At the left of the scales are two illuminated meters reading signal strength and centre-zero FM tuning. Below the meters is a stereo indicator which glows dull red when a stereo transmission is tuned. The rest of the fascia is satin brushed aluminium, and carries a large metal tuning knob at the right, a small knob for audio level control below, and a red mains on/off button.

The scales are softly illuminated in green, and the overall length is about 130mm. Again, however, there are no clearly defined FM calibration marks — just the MHz numbers — so the frequency-setting accuracy is poor. Although inertia assisted, the tuning mechanism has a higher intrinsic friction than most Oriental models, so the complete band spin, which many people like, cannot be achieved. Nevertheless, the tuning is precise, though some bearing slack was noted on the tuning control. The cursor glows bright orange. Mid-band calibration error was small on this model, but the signal meter was more sensitive, making it difficult to read high signal levels. It was also found that centre-zero tuning failed to coincide with least distortion and best separation.

Relative overall engineering quality was judged to be fair to average. Inexpensive printed circuit boards are used without component identification; but this would not bother the ordinary user because manufacturers do not design for dabblers! The audio signal is delivered by a single DIN socket mounted on the metal back plate, and the aerial is coupled to an IEC socket. This is not good because the input is for 75 ohms unbalanced (coaxial) feeder. There is thus a fifty-fifty chance that the plug will be inserted the wrong way round with a consequent reduction in coupling efficiency. A proper coaxial socket should be used as on the TX-500.

The FM front-end uses a four-gang capacitor, which is reflected by Ühe improved front-end performance parameters. Absolute sensitivity, though, was below that of the TX-500, but the i.f. selectivity was much better. The tuner appears to have less i.f. gain than the TX-500. The distortion, too, was higher; but one would expect this with the sharper selectivity. Costly design is required to achieve the best of both worlds.

The frequency response was better than that of the TX-500; but the designer was still unable to optimise this in conjunction with the pilot tone filter and de-emphasis. Our 1dB per div. frequency response graph shows that the filter comes in too early and that it is incorrectly damped. The net result is a significant peak prior to rapid roll-off and significant attenuation at 15kHz. This is a great pity because the tuner has some good points. I would venture to say that the FT-650 could be improved significantly with not much extra cost.

Stereo separation could also be improved; but as with the TX-500, the intrinsic breakthrough signal distortion was low. The worst harmonic (third) was some 45dB below the speaking channel signal. It is generally found that when the separation is relatively poor the breakthrough signal carries less distortion.

AM was above average, aided by a three-gang capacitor and swivel rear ferrite rod aerial. There

was relative freedom from whistles.

FM auditioning gave such comments as poor stereo imagery, slight dullness in treble register and slightly impaired transient attack. Overall auditioning was fair to average.

In summary, a good-looking tuner of moderate price, but which was retarded in ranking values by relatively poor frequency response and stereo separation. A tuner of good potential, which could be improved with a little more design effort.

VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.5
Sensitivity 50dB S/N CCIR mono (μV)	6
Sensitivity 50dB S/N CCIR stereo (μV)	41
S/N CCIR mono 1mV av. (dB)	69
S/N CCIR stereo 1mV av. (dB)	66
Limiting —1dB (μV)	5
Front-End Performance	
3rd-order RF IM av. (dB)	63
Equiv. select. figure-of-merit (dB)	58
Repeat spot (dB)	>90
Capture ratio (dB)	1.75
Select. ±400kHz av (dB)	73.5
Select. ±200kHz av. (dB)	11.25
Muting threshold (μV)	8
Sig. meter saturation (μV)	25
Tuning error 95MHz (kHz)	—110

Audio Section

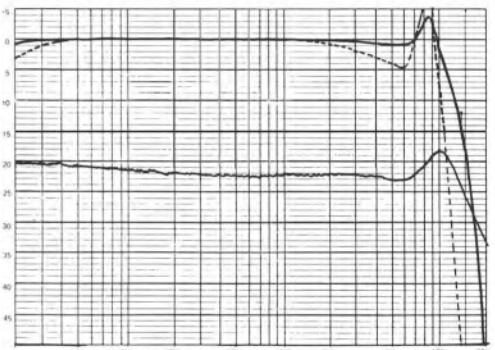
Output ±67.5kHz dev. L-ch. (mV)	770 (max)*
Output ±67.5kHz dev. R-ch. (mV)	773 (max)*
AM rejection 1mV (dB)	54
Pilot tone suppression ref. ±67.5kHz dev. (dB)	58
Sub-ch. spuriae ref. ±67.5kHz (dB)	58
Hum ref. ±67.5kHz (dB)	70
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.3
3rd harmonic (%)	0.5
4th harmonic (%)	0.06
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	1
3rd harmonic (%)	0.16
4th harmonic (%)	0.03
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	1
3rd harmonic (%)	0.7
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	1
3rd harmonic (%)	0.22
4th harmonic (%)	0.02
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.3
3rd harmonic (%)	0.03
4th harmonic (%)	noise
Total on breakthrough signal (%)	3
Response 15kHz worst ch. (dB)	—19.4 (—1.7 at 10kHz)
Response 20Hz worst ch. (dB)	—0.6
Stereo separation 1kHz (dB)	22
Stereo separation 10kHz (dB)	18
Birdies suppression (dB)	73
Dimensions (W x H x D) (mm)	415 x 135 x 250

Typical selling price (£) £110.00

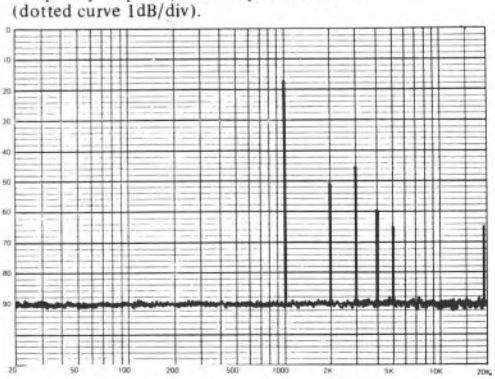
Additional information/comment:

*Maximum setting of level control.

Features include MW with rear swivel ferrite rod aerial; signal/tuning meters; front level control; switchable muting; hi-blend switch (noise filter FM).



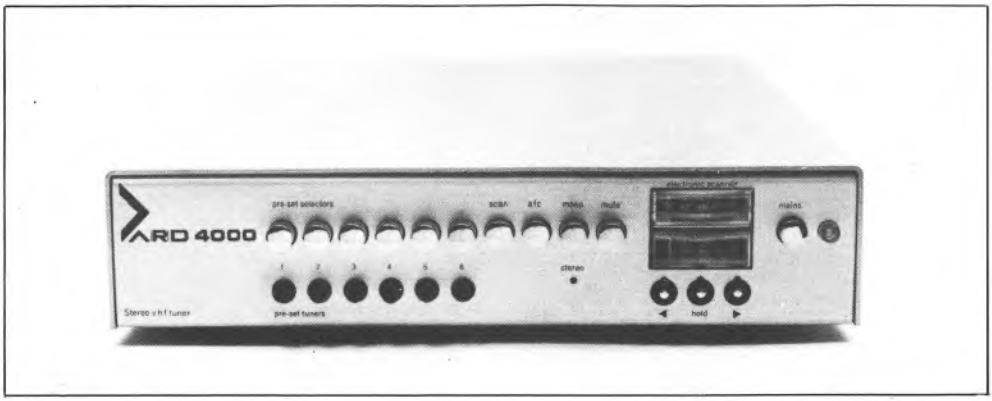
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

ARD 4000

ARD Limited, Navas House, The Maultway, Camberley, Surrey. 0276 24684.



This is a tuner from the British company **Audio Research and Development Limited**. It differs significantly from the general run of models in styling and because station selection is either by press-buttons or 'auto-scan' operation. Instead of a main tuning knob, the fascia is equipped with six mini-preset tuning controls, each associated with a chromium-plated button above. By depressing a button the associated preset is activated and it can then be tuned over the FM band. The tuned frequency is indicated on a small edge-reading meter at the right of the fascia. This is roughly calibrated from 88 to 104MHz. A similar meter below indicates signal strength. It is thus possible to pretune six stations and select any one merely by depressing a button.

Although from our limited survey a greater weighting was given to a main tuning control, there is no doubt that press-button selection can be very convenient. One of the difficulties with FM is that considerable care needs to be taken in tuning a programme. The non-technical and distaff side appear to have most trouble. The problems vanish with press-button selection once the programmes have been pretuned. Indeed, at the time of writing a strong plea was being made by the BBC for more manufacturers to adopt press-button selection. The requirement is for varicap tuning, and because this is used more by British and European rather than Japanese designers, tuners from the Orient are rarely, if ever, equipped with the feature, which seems a pity.

It is also possible to get the ARD-4000 to scan automatically in conjunction with three touch sensors below the meters. Touching one causes a slow tune in one direction which can be halted on the required station by touching the centre sensor. A slow tune in the opposite direction is evoked by touching the third sensor. Scan action is switched by a press-button and indicated by small lights. Press-buttons are also used for power, afc, mono and mute switching.

Light in weight and of low-profile styling, the tuner is attractively presented in satin brushed aluminium. There is no AM, and the rear merely accommodates a DIN audio socket and 75 ohm aerial coaxial socket. A neon glows when the power is on.

The tuner is adequately sensitive for most normal requirements, but is below the absolute standard of some of the other more conventional models. In practice, though, this would not be noticed, for the model is not designed for DX-ing. It will serve in moderately difficult reception areas, nevertheless, and should not evoke undue spuriae unless the local signals are very strong, when aerial attenuation should be used. Lower stereo noise figures would have helped the audio ranking, as also would pilot tone rejection; but regarding the latter we have heard from the manufacturer that later models will be so equipped and that a modified board will be available on an exchange basis to up-date earlier models. We could not really take these things into account in the final analysis; but it can be said that had rejection been present in the model tested, higher rankings would have been achieved. During a previous investigation of the model by our lab certain improvements were suggested, and we are glad to report that these are being taken up by the manufacturer. One must bear these in mind when looking at the ranking table, therefore.

We were very happy with the excellent frequency

response, which extended above 15kHz without droop; also with the low distortion yield in most modes. Distortion on the breakthrough signal was very high, but the stereo separation keeps this in the background. In general, the breakthrough signal was fairly clean.

The tuner was found easy to use once set up and was liked by the distaff side. One thing we did notice, though, was a run-through of stations directly after switch-on, but this was soon over. A switch-on delay would help as this is a feature of many varicap tuners. There was no undue delay on muting lift.

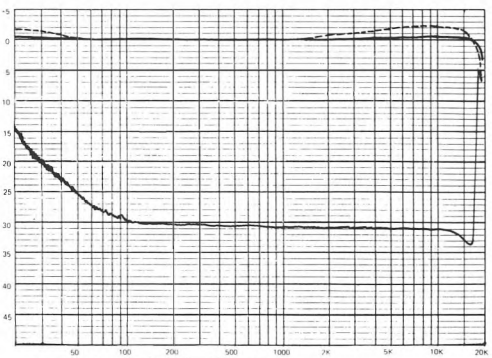
In summary, an FM-only tuner of British make and of original styling which auditions well. The auto-scan feature may be regarded by some as too much of a gimmick — adding to the price. Although failing to reach the absolute parameter standards of the more specialised models, it is a tuner which would satisfy many requirements.

VHF Section

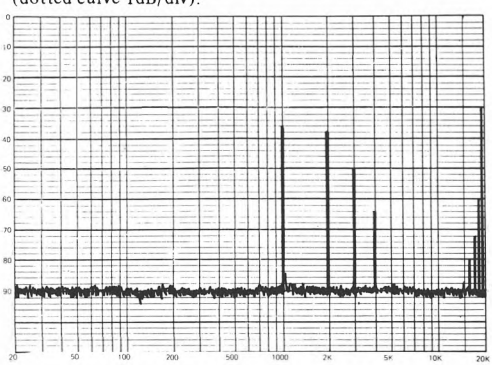
Sensitivity 30dB S/N CCIR mono (μV) 3
Sensitivity 50dB S/N CCIR mono (μV) 6
Sensitivity 50dB S/N CCIR stereo (μV) 45
S/N CCIR mono 1mV av. (dB) 70
S/N CCIR stereo 1mV av. (dB) 65
Limiting —1dB (μV) 2
Front-End Performance
3rd-order RF IM av. (dB) 62.5
Equiv. select. figure-of-merit (dB) 54
Repeat spot (dB) 80
Capture ratio (dB) 1.75
Select. ±400kHz av (dB) 50
Select. ±200kHz av. (dB) 4
Muting threshold (μV) 7
Sig. meter saturation (μV) 1000
Tuning error 95MHz (kHz) . . . . . —

Audio Section

Output ±67.5kHz dev. L-ch. (mV) 200
Output ±67.5kHz dev. R-ch. (mV) 200
AM rejection 1mV (dB) 54
Pilot tone suppression ref. ±67.5kHz dev. (dB) 30
Sub-ch. spuriae ref. ±67.5kHz (dB) 23
Hum ref. ±67.5kHz (dB) 68
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.25
3rd harmonic (%) 0.05
4th harmonic (%) 0.017
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.178
4th harmonic (%) . . . . . noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.16
3rd harmonic (%) 0.1
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.09
3rd harmonic (%) 0.1
4th harmonic (%) 0.04
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.07
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 90
Response 15kHz worst ch. (dB) . . . . . +0.3
Response 20Hz worst ch. (dB) . . . . . +0.3
Stereo separation 1kHz (dB) 31
Stereo separation 10kHz (dB) 30
Birdies suppression (dB) 65
Dimensions (W x H x D) (mm) . . . . . 260 x 60 x 355
Typical selling price (£) £146.00
Additional information/comment:
Features include signal/frequency meters; auto-scan station tuning; press-button station selection; switchable muting and afc; mono/stereo switch; 75-ohm coaxial aerial socket; DIN-only audio output socket.



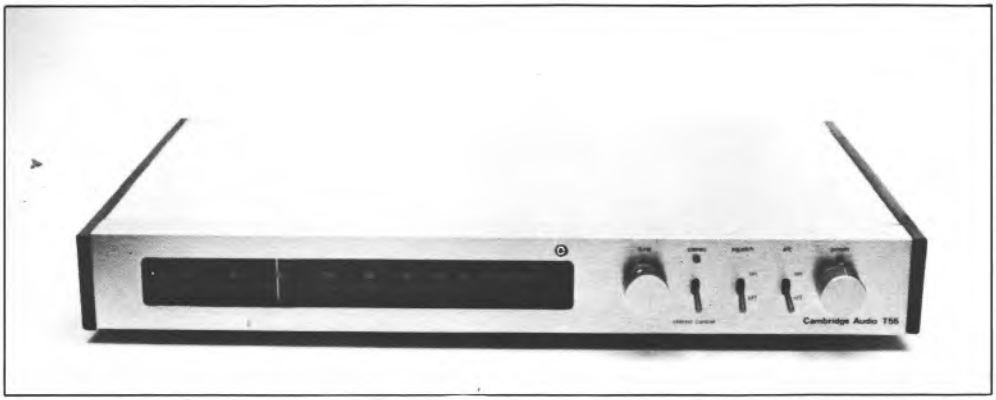
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Cambridge T-55

C E Hammond & Company Limited, 111 Chertsey Road, Byfleet, Surrey.
Byfleet 41131.



This slim-line tuner is styled to match the Cambridge range of amplifiers. It is, however, suitable for use with any other type of hi-fi amplifier since the output signal is controllable and is delivered by a DIN socket in addition to a pair of 'phono' type sockets. The sample had 'silver' trim with brush finish, wooden side pieces and a cream-covered metal top. It is a good-looking little tuner and unobtrusive.

The left-hand section of the 'silvered' fascia carries a dark-backed tuning scale (FM only — there is no AM section on this model) of approximately 170mm in active length, with clearly printed and illuminated markings. There is also a logging scale corresponding to 200kHz divisions, so the tuning setting accuracy is quite good. The cursor is a slender, white pointer. The tuning mechanism is less free than that of some models, though a small flywheel is used to assist. We also detected a fair amount of play on the tuning spindle. Range is from 88 to 108MHz. The tuning error of the sample was very small at a mere —10kHz.

Instead of a tuning meter, two small red lights at the centre of the tuning scale glow equally bright when a station is tuned. This should be the most accurate tuning position, but we found it necessary to tune a little away from this condition to achieve the lowest distortion and best stereo separation, and the afc was found not to help much in this respect. A signal strength meter is not fitted either, but a rear socket allows you to connect an external meter for signal strength indication if so desired. It is also possible to connect an external tuning arrangement, and the instructions give details about such matters.

Slim lever switches (matching those of the Cambridge amplifiers) provide stereo cancel, squelch (which is really inter-station muting) and afc on/off. A knob-operated rotary switch turns on the mains. On the rear there is a small control for adjusting output signal level and aerial sockets for 75 ohms (coaxial type) and 300 ohms balanced (IEC type).

Capacitor diode tuning is employed which allows for the possibility of tuning by remote control. On switch-on, the tuner becomes active almost immediately and stations can be heard being tuned by the voltage build-up across the capacitors; but this is quickly over and the tuned station then locks on. The muting (or squelch) has a slightly delayed action, so you could miss a station by tuning fast with this switch on.

The tuner is sensitive with noise figures about average; but we were disappointed with the third-order IM rejection ratio, and the front-end performance in general. The tuner may tend to overload on strong signals and generate spuriae, so aerial attenuation may be needed close to transmitters. Alternate channel selectivity was good and the AM rejection ratio better than the spec.

A good frequency response allied with good pilot tone rejection has been achieved; but the 38kHz sub-channel residual was only about 30dB below the test modulation, which is poor. Stereo separation could be improved by critically adjusting the tuning (our measurement was made with the afc on).

Intrinsic breakthrough signal distortion was low, so in spite of the mediocre separation this distortion was 55dB below the speaking channel signal, corresponding to about 0.18%, which is good. The audio section ranking was pulled down mainly by the relatively high speaking channel distortion (all modes) and by the high sub-carrier residual.

Mechanical and electrical engineering was about average, and servicing should not be a problem. The inside is easy to get at, and we could see no reason to suspect poor reliability.

We liked the look of the tuner, but felt that Cambridge could achieve better results by some up-to-date design attention, coupled with a different front-end. With carefully adjusted tuning and referred to our critical standard, auditioning was satisfactory, though peak distortion could be heard to rise on heavy modulation.

In summary, a smart little tuner of unobtrusive lines, and one capable of satisfactory reception with certain provisos. Referred to absolute performance, it is a trifle on the expensive side.

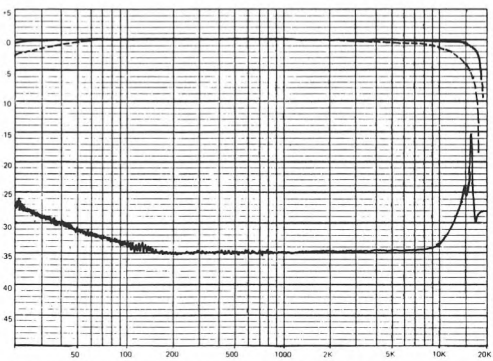
VHF Section

Sensitivity 30dB S/N CCIR mono (μV) 1.9
Sensitivity 50dB S/N CCIR mono (μV) 4
Sensitivity 50dB S/N CCIR stereo (μV) 31.5
S/N CCIR mono 1mV av. (dB) 74
S/N CCIR stereo 1mV av. (dB) 68
Limiting —1dB (μV) 1.8
Front-End Performance
3rd-order RF IM av. (dB) 50
Equiv. select. figure-of-merit (dB) 46
Repeat spot (dB) 76
Capture ratio (dB) 1.5
Select. ±400kHz av (dB) 65
Select. ±200kHz av. (dB) 6.5
Muting threshold (μV) 2.5
Sig. meter saturation (μV) . . . . . —
Tuning error 95MHz (kHz) . . . . . —10

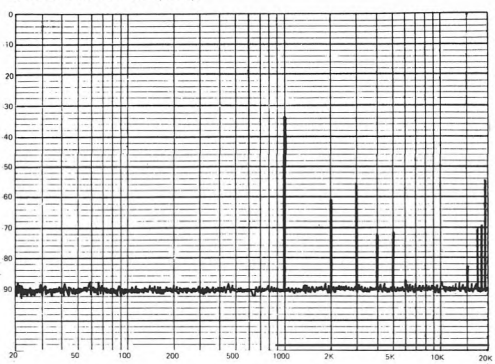
Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 732 (max to zero)
Output ±67.5kHz dev. R-ch. (mV) . . . . . 690 (max to zero)
AM rejection 1mV (dB) 54
Pilot tone suppression ref. ±67.5kHz dev. (dB) 55/60
Sub-ch. spuriae ref. ±67.5kHz (dB) 30
Hum ref. ±67.5kHz (dB) 70
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.31
4th harmonic (%) 0.029
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.45
4th harmonic (%) . . . . . noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.11
3rd harmonic (%) 0.31
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.5
3rd harmonic (%) 0.5
4th harmonic (%) . . . . . noise
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.18
3rd harmonic (%) 0.07
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 10

Response 15kHz worst ch. (dB) . . . . . —0.8
Response 20Hz worst ch. (dB) . . . . . —0.25
Stereo separation 1kHz (dB) 35
Stereo separation 10kHz (dB) 34
Birdies suppression (dB) 72
Dimensions (W x H x D) (mm) . . . . . 412 x 50 x 240 approx.
Typical selling price (£) £125.00
Additional information/comment:
Features include 75/300-ohm aerial inputs; 'phono' and DIN output sockets; switchable squelch (muting); rear output level control; rear sockets for external signal strength meter and remote tuning; dual-light tuning system.
Distortion tends to increase when tuning adjusted for equal intensity of dual-light tuning system.



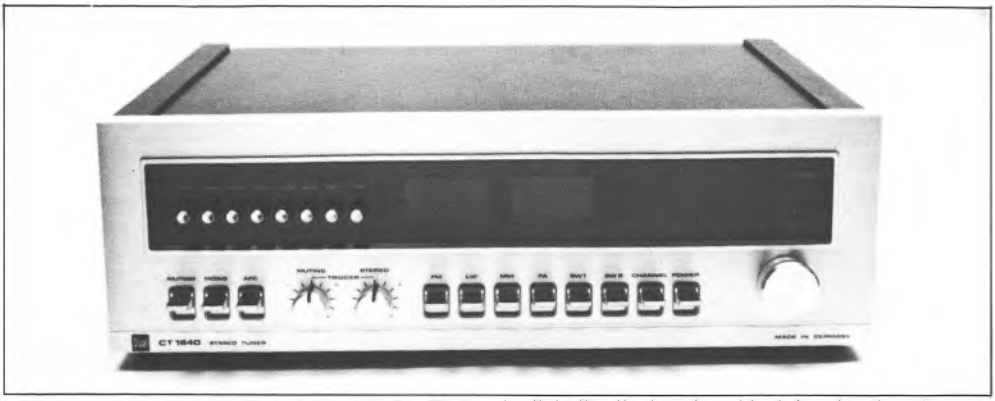
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Dual CT-1640

Audiodecks Limited, P.O. Box 7, Wetherby, Yorks. 0937 5477.



This is a very recent tuner from Dual's Black Forest home in Germany, and in order to get it into this book we were obliged to test and evaluate a pre-production sample. This must be borne in mind when reading the review because it is highly likely that the curios brought to light in our lab will have been resolved by the time the real production models are in the shops. We are grateful to *Audiodecks Limited* for affording us this opportunity of introducing the tuner to you because it is an interesting and moderately-priced electronic digital model, which seconds as a 24-hour clock when the tuner part is switched off.

It is built into a dark-finished enclosure and can be obtained with a fascia of 'brushed aluminium' or metallic brown to suit the home décor. The top section carries a tinted window behind which are large and bright digits at the right and meters for centre-zero tuning and relative signal strength at the centre. At the left are eight push-buttons, one for selecting the main FM tuning and the other seven for FM station selection, which are preset by rotating an outer section. At the right of the lower section of the fascia is an inertia assisted and free-running tuning knob, and along the remainder are press-keys for power, band selection, rear ferrite rod aerial switching (LW and MW only), changing the displayed FM frequency to the corresponding channel number with *plus* or *minus* prefix, afc, mono and muting. In addition, there are two controls for setting the threshold levels of muting and stereo switching. The clock is set by manipulating two mini-presets at the back.

AM bands are LW, MW, SW1 and SW2, the latter two embracing 5.9-16 MHz. FM tunes over 87.5-104 MHz, and the tuned frequency on *all* bands is digitally displayed — ideal for the chap keen to know the precise frequency of a transmission. There are two digits after the decimal point on FM, the last one switching in fives, corresponding to 50kHz increments. On the AM bands the final digit reads kHz. On FM the tuning is adjusted on the station until the tuning meter reads centre-zero, the digits then indicating the correct frequency. This is rather critical as the meter swings swiftly either side of centre as the tuning is adjusted over the signal. The best stereo separation occurred at meter centre, but for the least distortion a slight off-centre tuning point was required. The signal meter handles up to about 1mV before running out of scale.

The tuner is DIN-orientated and only a DIN socket is available for audio output. IEC sockets are used for 240 ohms FM aerial and AM aerial; but the sample was also equipped with a British 75 ohm coaxial socket, which was found to match well. A hinge-out but non-swivel ferrite rod aerial at the rear works on LW and MW, and a front switch disables this when it is required to connect an external aerial. Small lights indicate a tuned stereo signal and also whether the digits are reading MHz or kHz.

A high overall ranking was achieved for vhf. The front-end has a good dynamic range exemplified by the third order IM, equivalent selectivity 'figure of merit' and repeat spot values. I.F. selectivity was also good on both alternate and adjacent channels. Less happy was the audio section, though, the overall ranking of which was retarded by the rather high hum components (appearing to eminate from the audio section), the rather fast roll-off before 15kHz and the mediocre CCIR/ARM-weight signal-to-noise ratios. The audio output also appeared to be influenced more than usual by loading and lead

capacitances — this affecting the upper-frequency response. Distortion was round — or a shade above — average, but the distortion on the breakthrough signal relative to the speaking channel at full test modulation was sanitary at —50dB (corresponding to 0.3% second harmonic) — see spectrogram. Engineering quality was good, based on 'module' construction and plug-in ics.

The AM performance was above average, and the SW bands very likely. Whistles were not unduly troublesome. FM auditioning attracted fair-to-good comment. Even when overmodulating crosstalk splash and stridence were well tamed, but with large loudspeakers and operating at high level a trace of background buzz was audible during soft passages. Small-signal noise performance, upper-treble and transient response could also be bettered.

In summary, an interesting tuner of above average price but failing to reach this in terms of absolute overall performance. Equipped with useful digital tuning and press-button station selection, along with four AM bands.

VHF Section

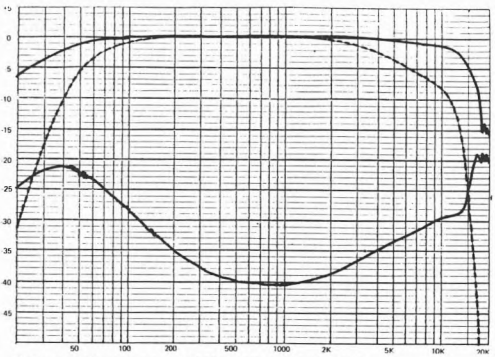
Sensitivity 30dB S/N CCIR mono (μV)	1.3
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	50
S/N CCIR mono 1mV av. (dB)	72
S/N CCIR stereo 1mV av. (dB)	69.5
Limiting —1dB (μV)	1.7
Front-End Performance	
3rd-order RF IM av. (dB)	71
Equiv. select. figure-of-merit (dB)	68
Repeat spot (dB)	89
Capture ratio (dB)	1.5
Select. ±400kHz av (dB)	71
Select. ±200kHz av. (dB)	10
Muting threshold (μV)	4-400 (var.); also st. threshold
Sig. meter saturation (μV)	1000
Tuning error 95MHz (kHz)	zero

Audio Section

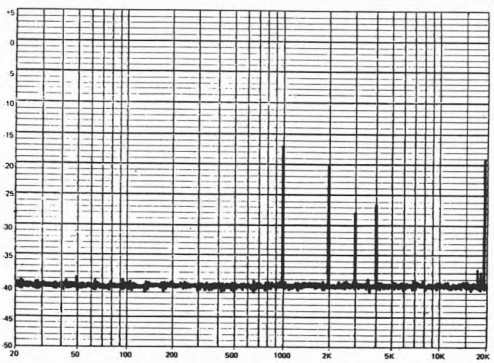
Output ±67.5kHz dev. L-ch. (mV)	1067
Output ±67.5kHz dev. R-ch. (mV)	1082
AM rejection 1mV (dB)	53
Pilot tone suppression ref. ±67.5kHz dev. (dB)	43
Sub-ch. spuriae ref. ±67.5kHz (dB)	59
Hum ref. ±67.5kHz (dB)	65
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.04
4th harmonic (%)	0.01
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.4
3rd harmonic (%)	0.2
4th harmonic (%)	—
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.12
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.4
3rd harmonic (%)	0.25
4th harmonic (%)	0.02
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	—
4th harmonic (%)	—
Total on breakthrough signal (%)	44
Response 15kHz worstch. (dB)	—5.5
Response 20Hz worst ch. (dB)	—5.5
Stereo separation 1kHz (dB)	42
Stereo separation 10kHz (dB)	36
Birdies suppression (dB)	>80
Dimensions (W x H x D) (mm)	435 x 140 x 360 approx.
Typical selling price (£)	£335.00

Additional information/comment:

Features include digital tuning and seven press-button stations; LW, MW, SW1 and SW2 AM bands with non-swivel rear ferrite rod aerial; 75/300-ohm FM aerial inputs; signal/tuning meters; variable muting and stereo switching thresholds. Pre-production sample.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

RECOMMENDED

Eagle T-6000

Eagle International Limited, Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU. 01-902 8832.

New from Eagle, this Korean-made tuner is attractive, well equipped, and ranks round average of the group in overall performance. Like a number of the models in this book, the case is black-finished metal, but the brushed aluminium fascia reflects more of a 'professional' aura owing to a pair of chromium-plated side handles. An overhang facilitates wooden enclosure or cabinet mounting if required.

A large metal knob handles the tuning, and smaller ones output level and selection. FM scale is about 230mm in length, is clearly printed with 200kHz markings and is lit softly by greenish reflected light. Mild take-up slack was detected — nothing serious — and the controls were generally fairly precise. Mid-band tuning error was commendably small — a mere +27kHz, which is less than the thickness of the fine metal cursor. Light emitting diodes (LEDS) indicate stereo, FM and AM, and the mains is connected with three-core cable.

There is no switch-on delay and muting lift is also fairly swift when tuning stations. During the lab and listening room tests the decoder was not always triggered immediately by the stereo signal. When this happened, it became necessary to tune over a stereo station several times to trigger the stereo indicator; the trouble was probably the result of a minor maladjustment.

Some of the measured parameters were useful, including third-order IM, which was good for a tuner in this price category. High rankings were also achieved for 200kHz selectivity and capture ratio. The equivalent good front-end selectivity figure was limited by the use of only two variable-tuned circuits between the aerial and mixer. The signal strength meter was not of much use for indicating strong signals, owing to fairly early saturation, and we also found that slightly lower distortion could be obtained by tuning a little away from the centre-zero position of the tuning meter.

The designers have obtained a good pilot tone rejection ratio together with extended upper-frequency response, which was no more than 1.2dB down at 15kHz on the worst channel; stereo crosstalk held around —35dB over the important part of the spectrum. This, coupled with the reasonable distortion on the breakthrough signal, ensures that the non-speaking channel distortion is some 50dB below the speaking channel signal at full test modulation.

We had no problems in partnering the tuner with any of our test amplifiers — the front level control allowing a signal match to almost any amplifier input sensitivity. A rear switch provides a change from 50 to 25 μsec de-emphasis, the latter for use with Dolby decoding should such a noise reduction system ever be used.

Distortion was measured with the tuning meter at centre-zero, and under this condition was on the high side. However, by detuning slightly better results were obtained. A very powerful signal had to be applied to produce a bleep on the ninth harmonic of the i.f., and at normal modulation levels transient splash on the breakthrough signal was negligible. On our system 'birdies' signals and spuriae could be produced, but then the interfering signal had to be quite strong. Under normal reception conditions this trouble should not arise.

The AM section was not particularly sensitive, and sideband cutting was in evidence owing to deliberately applied selectivity to narrow the

RECOMMENDED

passband as a means of cleaning up the AM reception. The ferrite rod aerial also appeared to be rather sensitive to hum pick up.

Good FM auditioning was obtained, though the panel commented that the upper frequencies were less clean than those obtained from some of the more expensive models, judged under critical music conditions.

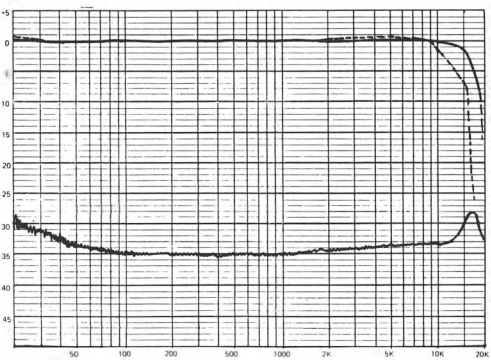
In summary, a tuner whose audio ranking was retarded by the above average centre-zero-tune distortion, but whose overall ranking, taking account of price, was at group average. Some of the parameters allow for interesting DX trials.

VHF Section

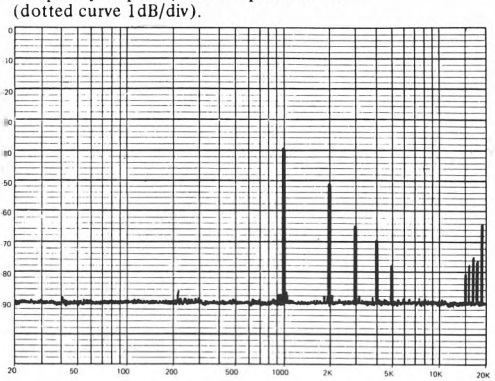
Sensitivity 30dB S/N CCIR mono (μV) 1.8
Sensitivity 50dB S/N CCIR mono (μV) 4.5
Sensitivity 50dB S/N CCIR stereo (μV) 50
S/N CCIR mono 1mV av. (dB) 72.5
S/N CCIR stereo 1mV av. (dB) 68.5
Limiting —1dB (μV) 2
Front-End Performance
3rd-order RF IM av. (dB) 72
Equiv. select. figure-of-merit (dB) 47
Repeat spot (dB) 86
Capture ratio (dB) 1.5
Select. ±400kHz av (dB) 59
Select. ±200kHz av. (dB) 14
Muting threshold (μV) 4
Sig. meter saturation (μV) 50
Tuning error 95MHz (kHz) . . . . . +27

Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 874 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 880 (max)*
AM rejection 1mV (dB) 54
Pilot tone suppression ref. ±67.5kHz dev. (dB) 68/66
Sub-ch. spuriae ref. ±67.5kHz (dB) 70
Hum ref. ±67.5kHz (dB) 68
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.3
4th harmonic (%) 0.07
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.9
3rd harmonic (%) 0.13
4th harmonic (%) 0.04
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.5
3rd harmonic (%) 0.3
4th harmonic (%) 0.02
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.5
3rd harmonic (%) 0.3
4th harmonic (%) 0.02
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 32
Response 15kHz worstch. (dB) . . . . . —1.2
Response 20Hz worst ch. (dB) . . . . . +0.1
Stereo separation 1kHz (dB) 35
Stereo separation 10kHz (dB) 33
Birdies suppression (dB) 62
Dimensions (W x H x D) (mm) . . . . . 400 x 132 x 290
Typical selling price (£) £96.00
Additional information/comment:
*Also fixed output at 388mV left and 380mV right.
Features include AM MW with swivel rear ferrite rod aerial; front level control; two pairs outputs (fixed and variable); MPX filter; muting switch; 75/300-ohm aerial inputs.



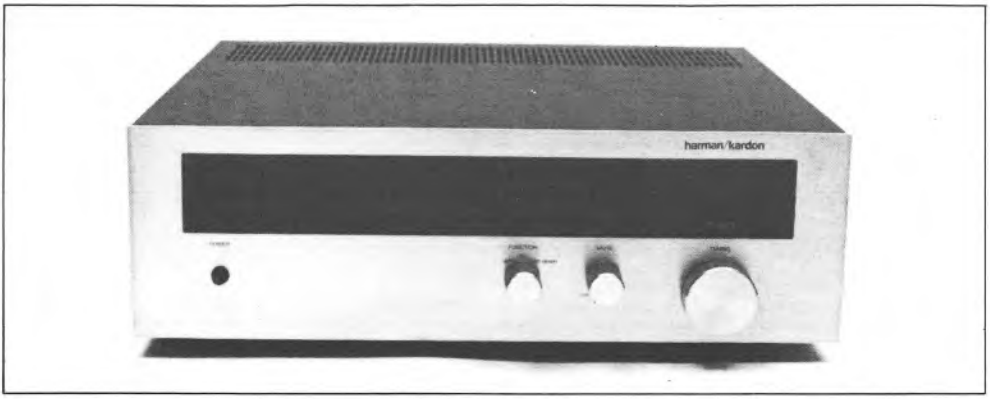
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Harman Kardon T-403

Harman (Audio) UK Limited, St John's Road, Tylers Green, High Wycombe, Bucks. HP10 8HR. 049 481 5221.



This model is different in appearance to most of the Oriental creations. A rather austere brushed aluminium fascia carries a large metal knob for tuning and two smaller versions for function and variable mute. The scale is black-backed with illuminated numbers, and has a length of about 160mm with linear 200kHz frequency divisions. The cursor is also illuminated, but is about the width of a 200kHz division; the sample exhibited a fairly large mid-band calibration error.

Tuning mechanism is smooth and precise with flywheel assistance, and can be spun over the band with a flick of a finger. Controls and switches are also precise, and the press-button mains switch glows red when on.

A single meter at the right of the scale indicates relative signal strength and correct tuning. Although it arrives at its maximum reading on a fairly small signal, the action is very sharp, which means that the tuning has to be within a narrow passband to secure deflection. Stereo is indicated by a red light, which is not very bright and is difficult to see in high ambient lighting. Muting is continuously variable from 8 to 100 μV, and can be defeated by turning the control fully anti-clockwise. There may be times when variable muting could be useful, but the ordinary muting on/off switch is generally adequate.

Absolute sensitivity was not high, and most of the other front-end parameters were about average, with the exception of third order IM, equivalent front-end selectivity and repeat spot suppression ratio. Mono 1mV signal to noise ratio was very good; but the model failed to rank very high on stereo signal to noise ratio owing to intrinsic decoder noise. I.F. selectivity ratios were about average for the group, but it was found that the rejection at one side of the response was better than that at the other side.

On the audio side, the distortion results were very acceptable, being round 0.1% total stereo on the worst channel. Curiously, pure mono distortion was a little higher, as also was the distortion measured in terms of L+R and L—R. It is noteworthy that the second harmonic predominated, which is more palatable than odd harmonics of a higher order.

Upper-frequency response was well maintained, aided by a mild rise from 10 to 15kHz (see graph). The response was found to fall swiftly into the 19kHz pilot tone notch, which provided a moderate rejection ratio.

Breakthrough signal distortion was relatively small which, coupled with the useful stereo separation, placed the distortion some 60dB below (equivalent to 0.1%) the speaking channel signal at full test modulation. Overall, the distortion performance of the model was very good. Audio level can be controlled from one pair of outlets, so the tuner would be suitable for most amplifiers.

AM performance was judged to be a shade above the group average, and because the ferrite rod aerial can be swivelled, an external AM aerial would probably not be required for the regional stations. A whistle was detected on 908kHz.

The tuner can be used with a 75 or 300 ohm FM aerial, the former providing good matching to coaxial cable. Our listeners gave good marks for FM auditioning, commenting on the good musical attack and freedom from upper-frequency stridence at high modulation peaks. It was possible to evoke a mild transient splash on the non-speaking signal by modulating above ±75kHz.

The tuner was fairly easy to operate, and the highly selective signal meter seemed always to give

the tuning point for the least distortion and best stereo separation. A meter of wider dynamic range would be useful.

In summary, a tuner of average measured audio performance, yet one of good auditioning, which failed to rank as highly on vhf or features and was retarded a little by price on overall ranking. Suitable mostly for average reception conditions.

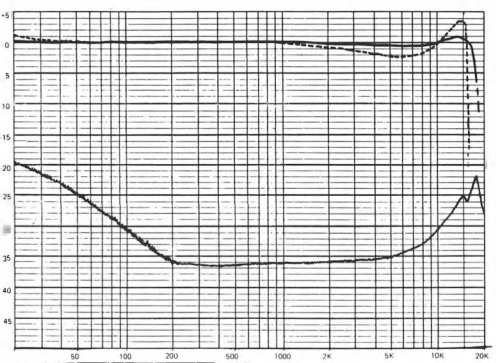
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	2.36
Sensitivity 50dB S/N CCIR mono (μV)	6.25
Sensitivity 50dB S/N CCIR stereo (μV)	80
S/N CCIR mono 1mV av. (dB)	82
S/N CCIR stereo 1mV av. (dB)	68.5
Limiting —1dB (μV)	1.8
Front-End Performance	
3rd-order RF IM av. (dB)	59
Equiv. select. figure-of-merit (dB)	22
Repeat spot (dB)	76
Capture ratio (dB)	1.25
Select. ±400kHz av (dB)	63 (asymmetry noted)
Select. ±200kHz av. (dB)	7 (asymmetry noted)
Muting threshold (μV)	8-100
Sig. meter saturation (μV)	300
Tuning error 95MHz (kHz)	—560

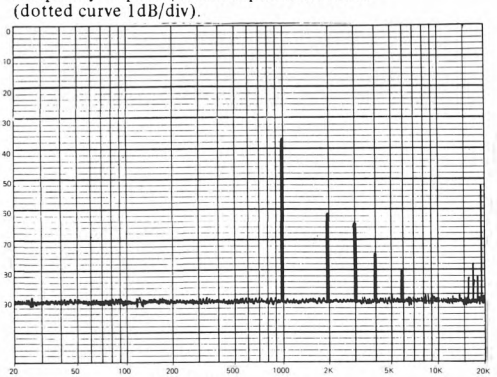
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1304 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1306 (max)*
AM rejection 1mV (dB)	53
Pilot tone suppression ref. ±67.5kHz dev. (dB)	46/51
Sub-ch. spuriae ref. ±67.5kHz (dB)	50
Hum ref. ±67.5kHz (dB)	75
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.08
4th harmonic (%)	0.02
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.03
4th harmonic (%)	0.02
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.14
3rd harmonic (%)	0.05
4th harmonic (%)	0.02
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.25
3rd harmonic (%)	0.05
4th harmonic (%)	0.02
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	10
Response 15kHz worst ch. (dB)	+0.5
Response 20Hz worst ch. (dB)	+0.1
Stereo separation 1kHz (dB)	36
Stereo separation 10kHz (dB)	30.5
Birdies suppression (dB)	60
Dimensions (W x H x D) (mm)	400 x 394 x 140
Typical selling price (£)	£140.00

Additional information/comment:
*Adjustable down to 136/129; also fixed at 1300/1309(L/R).
Features include AM MW with swivel rear ferrite rod aerial; two pairs outputs (fixed and variable); front variable muting level control; 4-ch. decoder (from FM detector) output; 75/300-ohm aerial inputs.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Hitachi FT-340

Hitachi Sales UK Limited, Hitachi House, Station Road, Hayes, Middlesex. 01-848 8787.

At the low end of the price scale, this model has some fair points and is reasonably equipped. It is enclosed in black-finished metal, and has the inevitable brushed aluminium fascia with a large metal knob for tuning and push-buttons for other functions. The fascia slightly overlaps the enclosure, so it would be possible to set it into a wooden cabinet for more of a furniture appearance.

Tuning is very well engineered, being smooth with flywheel assistance and devoid of slip, backlash or cursor wobble. Scale length is about 245mm with 200kHz graduations, but it is not illuminated. Instead, the cursor carries a small light which shines on the part of the scale being tuned. Mid-band calibration error was rather high on the sample.

Two meters below the scale read signal strength and centre-zero FM tuning. However, the dynamic range of the first was rather restricted, while the centre-zero indication of the latter was a little in error for the lowest distortion and best stereo separation. Instead of sockets, the audio signals are delivered through a pair of 'phono' plug-terminated flying leads. This may well reduce manufacturing costs, but is possibly less tidy than sockets and separate cables, and it might be inconvenient if cables of greater length were required to connect to the amplifier. 75 and 300 ohm aerial inputs are fitted, and a standard coaxial socket for 75 ohms.

Muting works only when the selector switch is in the stereo position, but since the muting threshold is 8μV this is of little practical consequence because signals of lower level than this would produce a background noise far above the requirements for stereo entertainment value. The model includes an MPX noise filter which reduces hiss on weak stereo signals at the expense of upper-frequency stereo separation.

Excepting limiting and equivalent selectivity figure of merit, which were below average, most of the other front-end parameters were hovering round the average of the group. The i.f. rejection ratios were not outstanding, but they are adequate for the normal requirements of a tuner of this class.

Both the distortion and stereo separation were measured with the tuning meter at centre-zero. Better results were obtained by tuning slightly to one side of centre-zero, but the average user would not be aware of this. The second harmonic of the breakthrough signal was only about 40dB below (equivalent to 1%) the speaking channel signal at full test modulation. On the other hand, the CCIR/ARM weighted mono and stereo signal to noise ratios were perfectly acceptable.

The designers have achieved a good upper-frequency response coupled with good pilot tone rejection ratio, but at the expense of a —1dB dip round 10kHz (see 1dB/div. frequency response graph). Apart from this and the mild bass roll-off, the response characteristic was acceptable.

AM reception was fair — there being the usual whistle on Radio 4 at 908kHz — and it is not possible to swivel the rear ferrite rod aerial, so for the best of AM an external aerial may be required.

Subjective results on FM were fair. It was possible at times to detect splash on the breakthrough signal at high modulation peaks, though this could be reduced by tuning slightly away from centre-zero on the meter. General noise on a moderate stereo signal was pretty low, while on mono hardly any background noise at all could be detected at normal listening levels.

In summary, a tuner which appears to have had

some corners cut to get it down to a price. There are factors which could be improved, including alignment, signal meter dynamic range and tuning meter calibration; but then the price would probably go up! It is a well made tuner with well-designed circuitry suitable mostly for normal reception conditions, though sensitive and selective enough for interesting DX trials.

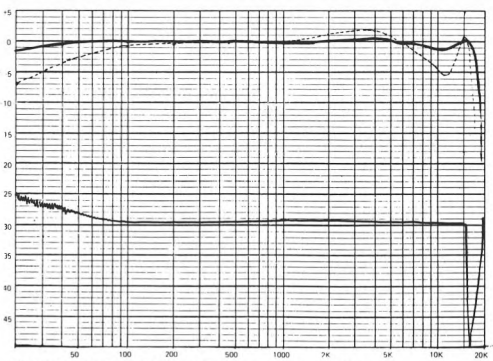
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.38
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	50
S/N CCIR mono 1mV av. (dB)	81.5
S/N CCIR stereo 1mV av. (dB)	74.5
Limiting —1 dB (μV)	2
Front-End Performance	
3rd-order RF IM av. (dB)	72
Equiv. select. figure-of-merit (dB)	34
Repeat spot (dB)	80
Capture ratio (dB)	<2
Select. ±400kHz av (dB)	65
Select. ±200kHz av. (dB)	10
Muting threshold (μV)	8
Sig. meter saturation (μV)	50
Tuning error 95MHz (kHz)	+111

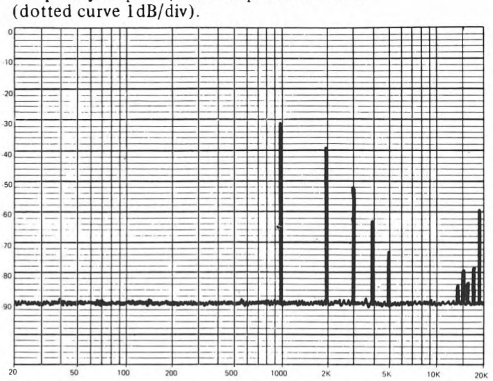
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	983
Output ±67.5kHz dev. R-ch. (mV)	1099
AM rejection 1mV (dB)	54
Pilot tone suppression ref. ±67.5kHz dev. (dB)	60/60
Sub-ch. spuriae ref. ±67.5kHz (dB)	65
Hum ref. ±67.5kHz (dB)	70
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.8
3rd harmonic (%)	0.2
4th harmonic (%)	0.08
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.4
3rd harmonic (%)	0.07
4th harmonic (%)	0.03
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.25
3rd harmonic (%)	0.28
4th harmonic (%)	0.02
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.12
3rd harmonic (%)	0.1
4th harmonic (%)	0.04
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	40
Response 15kHz worst ch. (dB)	0
Response 20Hz worst ch. (dB)	—1.2
Stereo separation 1kHz (dB)	29
Stereo separation 10kHz (dB)	30
Birdies suppression (dB)	70
Dimensions (W x H x D) (mm)	390 x 143 x 369
Typical selling price (£)	£85.00

Additional information/comment:
Features include AM MW with swivel rear ferrite rod aerial; 75/300-ohm aerial inputs; MPX filter; signal and tuning meters; mute stereo mode only.



Frequency response/stereo separation curves (dotted curve 1dB/div).

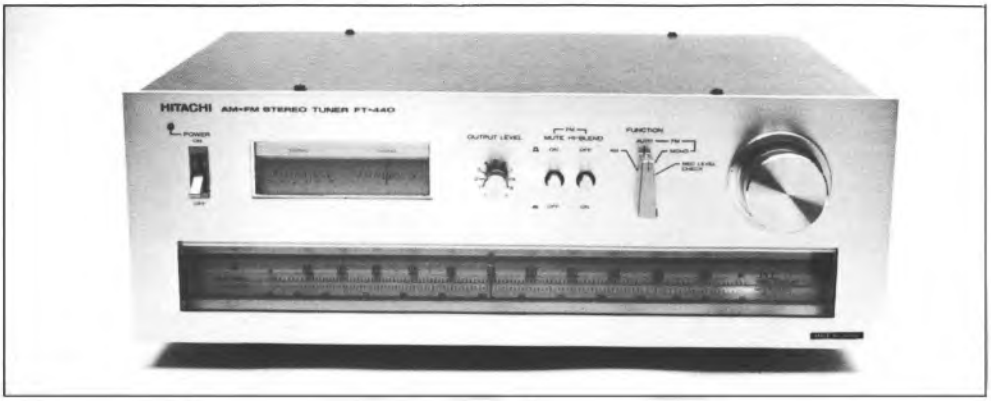


Breakthrough signal distortion

RECOMMENDED

Hitachi FT-440

Hitachi Sales UK Limited, Hitachi House, Station Road, Hayes, Middlesex. 01-848 8787.



Housed in black-finished metal, this middle-of-the-range model is equipped with the usual brushed aluminium fascia with overlap to facilitate cabinet mounting, metal controls, press-buttons and toggle on/off switch. The intertia-assisted tuning runs smoothly without flaw, and the cursor is a thin metal pointer for good frequency definition. The FM scale is about 280mm in length with 200kHz linear divisions. For accurate tuning, parallax error is avoided by a mirror backing. On this sample the mid-band calibration error was very small. The scales are angled slightly off vertical and they are not illuminated; instead the cursor carriage is equipped with a small bulb putting the illumination where it is wanted.

The rear carries 'phono' type sockets and the aerial terminations, including a non-swivel ferrite rod aerial for AM; the mains is connected through three-core cable.

The model is equipped with a switchable tone oscillator delivering harmonic-rich signal from the audio outputs close to the Dolby FM reference level for recording level setting, switchable muting, MPX noise filtering, signal/tuning meters and 75 and 300 ohm aerial inputs.

Average values were measured for absolute sensitivity and capture ratio; but overall, the front-end and vhf section performances were above average. Repeat spot suppression ratio was high which implies that the even-order harmonics generated by the rf and oscillator stages are small. Third-order IM ratio was better on one response than the other, but the average value as stated in the results is quite acceptable. The signal meter would accommodate a very reasonable signal level before saturation.

We were particularly impressed by the low overall distortion of this model. The worst harmonic was the third in stereo L-R mode. The designers have done a good job in holding the distortion at low level while preserving a usefully high selectivity ratio. It is one law of tuner design that unless the designer is both careful and clever, as the selectivity is sharpened so that distortion rises at high deviations. Pilot tone and sub-channel spuriae have also been well tamed.

Stereo separation over the spectrum was very acceptable, so in spite of the high distortion on the breakthrough signal, relative to the speaking channel signal at full test modulation the distortion was some 55dB down (equivalent to 0.18%).

'Birdies' suppression ratio was reasonable; it would require a strong signal in the adjacent channel to incite the effect when listening to an average strength stereo signal. Designers often rely on good adjacent channel selectivity for taming birdies. We prefer the use of an additional low-pass filter between the FM detector and stereo decoder. However, unless such a filter is well engineered, upper-frequency stereo separation will suffer and impair the reproduction. This is yet another compromise of FM tuner design. At 15kHz the frequency response was only —1dB, but before this it dipped slightly owing to the pilot tone filter effect (see frequency response chart).

AM performance was no better than average, and the usual whistle on 908kHz was present. We would have preferred a swivel ferrite rod because after dusk with an external aerial whistles and monkey chatter were troublesome.

FM performance, on the other hand, was above average — plenty of sparkle at the top and clean bass

Hitachi FT-440

RECOMMENDED

at the bottom. Living in a multipath area, we felt that the multipath distortion was a little higher than on other models.

In summary, a fine little tuner of well balanced design and of a subjective performance which matches the good rankings achieved. Suitable for DX-ing, but trouble may be experienced in very strong signal areas without aerial attenuation.

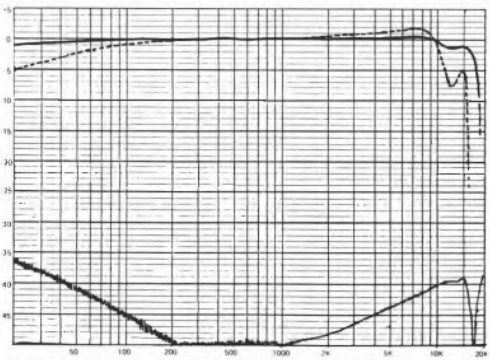
Additional information/comment:
Features include AM MW with non-swivel rear ferrite rod aerial; output level control; recording level oscillator (approx. ±37.9kHz equiv. deviation — rich in harmonics); mute switch; MPX filter, sockets for oscilloscope detection of multipath and 4-ch. decoder (direct from FM detector); signal and tuning meters; 75/300-ohm aerial inputs (including British coaxial socket).

VHF Section

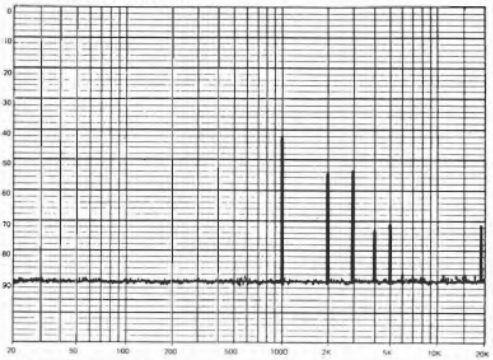
Sensitivity 30dB S/N CCIR mono (μV)	1.4
Sensitivity 50dB S/N CCIR mono (μV)	4.46
Sensitivity 50dB S/N CCIR stereo (μV)	44.6
S/N CCIR mono 1mV av. (dB)	72
S/N CCIR stereo 1mV av. (dB)	70
Limiting — 1dB (μV)	1.75
Front-End Performance	
3rd-order RF IM av. (dB)	69
Equiv. select. figure-of-merit (dB)	56
Repeat spot (dB)	93
Capture ratio (dB)	1.75
Select. ±400kHz av (dB)	71
Select. ±200kHz av. (dB)	9.5
Muting threshold (μV)	5
Sig. meter saturation (μV)	1000
Tuning error 95MHz (kHz)	+18

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	406
Output ±67.5kHz dev. R-ch. (mV)	401
AM rejection 1mV (dB)	56
Pilot tone suppression ref. ±67.5kHz dev. (dB)	76/72
Sub-ch. spuriae ref. ±67.5kHz (dB)	74
Hum ref. ±67.5kHz (dB)	75
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.05
3rd harmonic (%)	0.2
4th harmonic (%)	noise
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	noise
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	0.25
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	noise
4th harmonic (%)	noise
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	0.03
4th harmonic (%)	noise
Total on breakthrough signal (%)	40
Response 15kHz worst ch. (dB)	—1
Response 20Hz worst ch. (dB)	—1
Stereo separation 1kHz (dB)	51
Stereo separation 10kHz (dB)	40
Birdies suppression (dB)	66
Dimensions (W x H x D) (mm)	432 x 150 x 295
Typical selling price (£)	—



Frequency response/stereo separation curves (dotted curve 1dB/div).

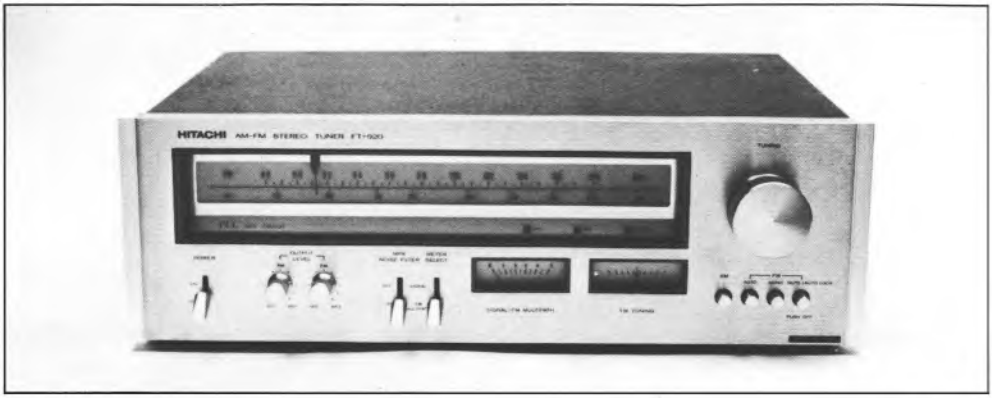


Breakthrough signal distortion

RECOMMENDED

Hitachi FT-920

Hitachi Sales UK Limited, Hitachi House, Station Road, Hayes, Middlesex. 01-848 8787.



Although at the higher end of the range, this Hitachi model is still competitively-priced and is better equipped than the other two models. Overall, however, the FT-440 scored higher on both vhf and audio rankings. The tuner is housed in dark-finished metal and features a brushed aluminium fascia with metal knobs and lever switches. FM tuning scale is extended and easy to read; but the mid-band tuning error was on the high side. The signal meter has a good dynamic range, reading up to 2,000μV before saturating, while the centre-zero tuning meter was accurately aligned on this model.

A problem often encountered by the non-technical user is tuning in an FM station for the best reproduction. Even a centre-zero meter does not help much (push-buttons are better). Hitachi is one firm which has sought to combat the problem by auto-lock tuning (Optonica and Yamaha are others). This is activated by a front press-switch; the station is roughly tuned by the meters, and then when the hand is removed from the tuning knob a strong afc circuit takes over and automatically corrects error. There is a small delay after removing the hand, and when the lock takes effect a small red light glows on the tuning cursor. The auto-lock can be defeated, as would be necessary when seeking a weak station close to a powerful one.

A switch working in conjunction with the signal meter provides one mode of multipath detection, while another method uses rear sockets to allow the use of an external oscilloscope. Other features include separate front level controls for FM and AM, MPX noise filter, two pairs of audio outputs and 75 and 300 ohm FM aerial inputs.

The model ranked average for overall vhf performance, pulled down a little by the third order IM and equivalent front-end selectivity figure-of-merit results. On the other hand, good rankings were obtained for absolute sensitivity, limiting, and alternate channel selectivity. The adjacent channel selectivity was less good, which is one reason why the 'birdies' suppression ratio was no better than 66dB (still a good value, though).

An average ranking was also obtained by the audio section, the worst results being the signal to noise ratios and overall hum residual. Upper-frequency response was smoother than that of the other two models, while the stereo separation was 51dB mid-spectrum. Intrinsic breakthrough signal distortion was high, but owing to the very good separation, the effect of this distortion on stereo reproduction was negligible — about 54dB down from the speaking channel signal. The designers have also achieved a high pilot tone rejection ratio of 78dB (worst channel) and a sub-channel spuriae ratio of similar order.

The design adopts excellent quality components and is to a good engineering standard. One would expect a high reliability factor and relative ease of subsequent servicing.

The AM section seemed to be marginally less sensitive than that of some of the other models of the group, based on the use of the ferrite rod aerial, which can be hinged away from the metal back but not swivelled.

The tuner was ranked highly by our panel on listening tests. Transient splashing caused no comment even when our locally-generated stereo FM signals were peaking well over ±75kHz deviation. Background noise was low with an aerial input of 1mV and above. No problems were experienced due to rf overloading or spuriae generation, and the

Hitachi FT-920

RECOMMENDED

model was found sensitive and selective enough for long-distance reception, conditions permitting.

In summary, a tuner of good FM quality and of good features for the price. Suitable for interesting DX-ing. The auto-lock tuning could well dispell some of the frustrations of unnecessary distortion arising from lack of accurate tuning by those of the family less sensitive to such things!

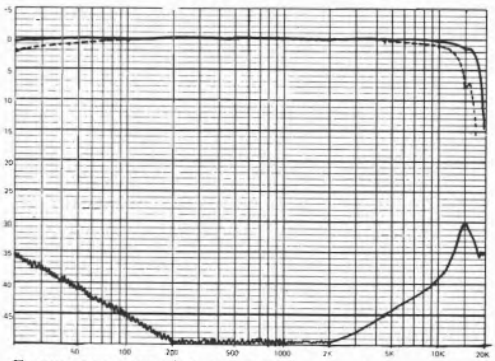
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.2
Sensitivity 50dB S/N CCIR mono (μV)	3.8
Sensitivity 50dB S/N CCIR stereo (μV)	56
S/N CCIR mono 1mV av. (dB)	72
S/N CCIR stereo 1mV av. (dB)	68.5
Limiting —1dB (μV)	1.2
Front-End Performance	
3rd-order RF IM av. (dB)	63
Equiv. select. figure-of-merit (dB)	46
Repeat spot (dB)	93
Capture ratio (dB)	<2
Select. ±400kHz av (dB)	80
Select. ±200kHz av. (dB)	6
Muting threshold (μV)	15
Sig. meter saturation (μV)	2000
Tuning error 95MHz (kHz)	+282

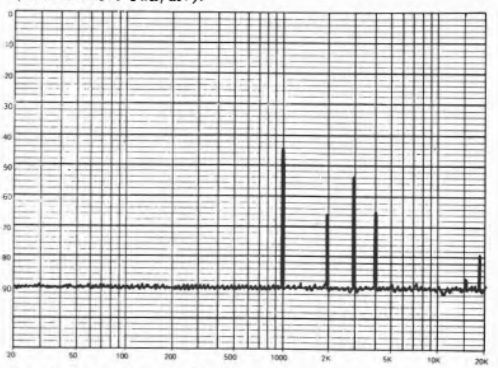
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1200 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1200 (max)*
AM rejection 1mV (dB)	66
Pilot tone suppression ref. ±67.5kHz dev. (dB)	78/79
Sub-ch. spuriae ref. ±67.5kHz (dB)	80
Hum ref. ±67.5kHz (dB)	68
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.18
3rd harmonic (%)	0.2
4th harmonic (%)	0.06
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.07
4th harmonic (%)	0.01
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.25
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.18
3rd harmonic (%)	0.05
4th harmonic (%)	0.01
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	41
Response 15kHz worst ch. (dB)	—1.3
Response 20Hz worst ch. (dB)	—0.2
Stereo separation 1kHz (dB)	51
Stereo separation 10kHz (dB)	30
Birdies suppression (dB)	66
Dimensions (W x H x D) (mm)	435 x 144 x 394
Typical selling price (£)	£114.00

Additional information/comment:
*Also fixed outputs at 600/600mV L/R.
Features include AM MW with non-swivel rear ferrite rod aerial; front level controls for FM *and* AM; signal and tuning meters; multipath detection; autolock afc tuning; 300/75-ohm aerial inputs.



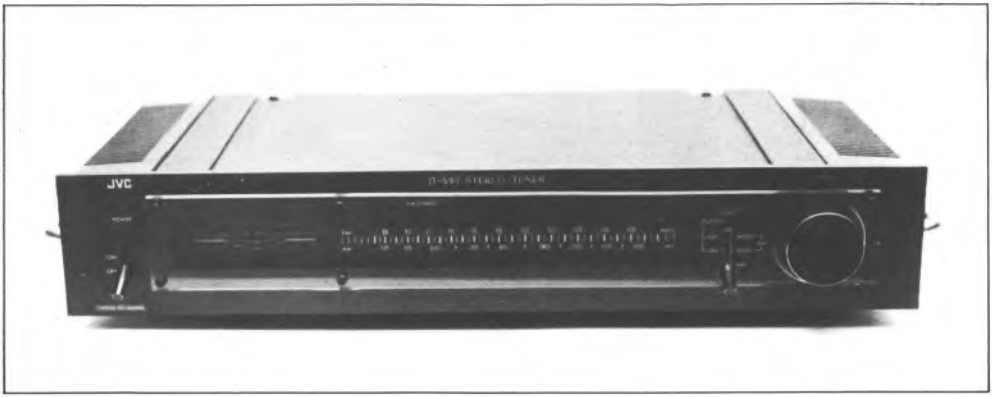
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

JVC JT-V10

JVC (UK) Limited, Eldonwall Trading Estate, Staples Corner, 6/8 Priestley Way, London NW2 7AF. 01-450 2621.



This lowest-priced tuner in the JVC range, with a suggested price just below £70, is of different styling from the other models, and its lower price is reflected by some corner-cutting. It has low profile, all-black presentation consisting of a plastics moulding containing a fairly well-made printed circuit board and a black-crackle metal top. The black-backed scale section has an active length of approximately 150mm and is clearly printed in white numbers and divisions, which are essentially linear but in increments of 500kHz, making accurate frequency setting difficult; the scale section is fronted by a transparent plastics window. Large handles protrude from the sides, which give the tuner a quasi-scientific appearance. An illuminated meter for FM centre-zero tuning and AM signal strength resides at the left of the scale section.

The tuning is fairly free and inertia assisted, but is not to the engineering standard of more expensive Oriental imports. Lever switches are fitted for power and selection, the latter having three positions for FM mono, FM auto and AM (MW only). The muting is ganged to this switch, is always active in the FM auto mode and disabled only when the switch lies in the FM mono position. The rear is equipped with FM aerial terminals at 75 and 300 ohms and an external AM aerial terminal; there is a shrouded ferrite rod aerial for normal AM, but this cannot be swivelled. Left and right audio signals are delivered by 'phono'-plug-terminated flying leads of about 800mm in length.

Lab results were consistent with a tuner in this price range, with the overall vhf and audio rankings falling a little below the group average. The lack of features also resulted in a low ranking, and the engineering quality was judged about average. The tuner is not unduly sensitive and a little on the noisy side with moderate and weak signals, particularly on stereo; a low adjacent channel selectivity ratio was also measured, which pulled down the birdies rejection ratio. The FM front-end features two variable-tuned circuits between the aerial and mixer, revealed by the relatively low front-end selectivity figure of merit.

On the other hand, the distortion was commendably low for a tuner of this price, but this was outweighed by the fairly poor pilot tone and sub-channel rejection ratios. The frequency response was a little droopy, being 2.8dB down at 15kHz on the worst channel. Breakthrough distortion was not excessive, the spectrogram showing that the worst harmonic was some 55dB below the speaking channel signal at full test modulation, corresponding to about 0.18% second harmonic distortion. The audio signal was remarkably free from 50Hz ripple or its harmonics, the vector sum up to the third being 77dB below the test modulation.

We were pleased with the good stereo separation over the spectrum, though both this and the distortion could be changed significantly by mistuning slightly within range of the centre-zero meter indication.

AM performance was a shade below average overall owing to a fairly strong whistle on Radio 4 908kHz. Selectivity was around the average of the group and the sensitivity with the rear ferrite rod a shade above average. FM auditioning was quite fair, though on weak stereo signals the background noise could be a problem at high levels. The model was rather prone to birdies effects under difficult reception conditions, we also detected a slight lack of music attack, and on stereo car interference

tended to show up more than on the higher price models.

In summary, a low price tuner of attractive presentation, which is worth considering when looking at the ranking values. It is not a particularly spectacular performer and requires an aerial signal above the group average for reasonably low-noise stereo; not really suitable for DX trials.

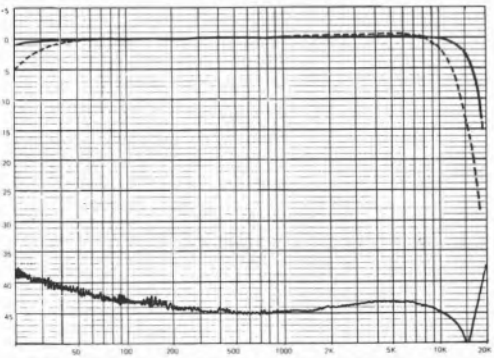
Additional information/comment:
Features include MW with rear enclosed ferrite rod aerial (non-swivel); FM tuning meter seconding as AM signal meter; ganged muting/mono switch (muting off in mono position); 75/300-ohm aerial inputs.

VHF Section

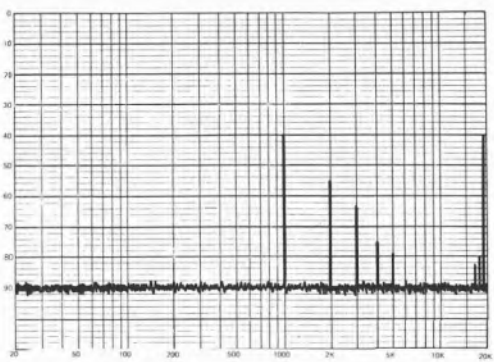
Sensitivity 30dB S/N CCIR mono (μV)	2
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	45
S/N CCIR mono 1mV av. (dB)	72.5
S/N CCIR stereo 1mV av. (dB)	67
Limiting —1dB (μV)	1.6
Front-End Performance	
3rd-order RF IM av. (dB)	66
Equiv. select. figure-of-merit (dB)	38.5
Repeat spot (dB)	84
Capture ratio (dB)	1.4
Select. ±400kHz av (dB)	53
Select. ±200kHz av. (dB)	2
Muting threshold (μV)	2.5
Sig. meter saturation (μV)	—
Tuning error 95MHz (kHz)	—89

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	573
Output ±67.5kHz dev. R-ch. (mV)	575
AM rejection 1mV (dB)	57
Pilot tone suppression ref. ±67.5kHz dev. (dB)	40
Sub-ch. spuriae ref. ±67.5kHz (dB)	45
Hum ref. ±67.5kHz (dB)	77
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	0.125
4th harmonic (%)	0.01
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.08
4th harmonic (%)	0.011
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.16
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.11
4th harmonic (%)	0.011
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.07
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	15.9
Response 15kHz worst ch. (dB)	—2.8
Response 20Hz worst ch. (dB)	—1
Stereo separation 1kHz (dB)	45
Stereo separation 10kHz (dB)	45
Birdies suppression (dB)	52
Dimensions (W x H x D) (mm)	496 x 91 x 274
Typical selling price (£)	£65.00



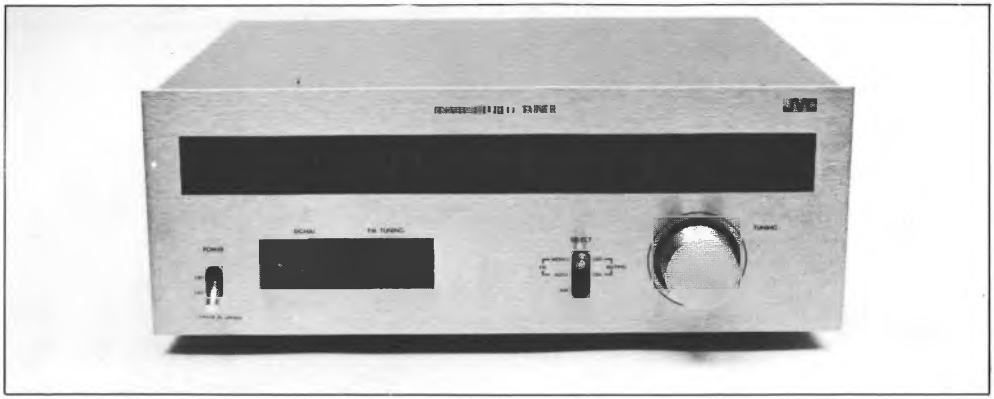
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

JVC JT-V11

JVC (UK) Limited, Eldonwall Trading Estate, Staples Corner, 6/8 Priestley Way, London NW2 7AF. 01-450 2621.



This model from the lower-priced area of JVC's current range returned absolute performance values below those of the more costly models. VHF ranking was marginally better than the audio ranking, but the two sections of the test sample were not too badly matched. The low price is also reflected by the average engineering quality and fewer features.

Enclosure is dark-grey-finished metal and the fascia brushed aluminium, with a large metal knob for tuning and lever switches. The fascia overlaps the enslosure slightly and the corners are a little sharp. The tuning mechanism is well up to Japanese standard, exhibiting a smooth inertia-assisted action, allowing it to be spun over the whole scale with one flick of the fingers.

The FM scale is about 235mm in length but is not fully illuminated; instead, the cursor carries a light which also causes the tip of the cursor to glow brightly for ease of tuning. Frequency setting accuracy is not all that good because the scale is marked only at 500kHz intervals; mid-band tuning error was just over 100kHz.

Rear 'phono' type sockets deliver fixed-level audio signals suitable for most anplifiers. Two-core mains cab__e of double insulation thickness is used and the mains switch is also two-pole.

Front-end performance was about average, and there was no particular parameter which stood out. The equivalent front-end selectivity figure-of-merit indicated a tuner with two variable-tuned circuits between the aerial and mixer, and this was confirmed by examination. The signal meter would accommodate up to 400μV before reaching saturation, while the centre-zero tuning meter was found to correlate with the least distortion and best separation.

The audio section ranked lower than the vhf section due to the droopy high-frequency response and below average signal to noise ratios and sub-channel spuriae rejection ratio. Average values were obtained for mono and stereo distortion and pilot tone rejection ratio, while 40dB of stereo separation was achieved over a good part of the spectrum, and the breakthrough signal distortion was relatively mild.

As shown by the spectrogram, the second harmonic of the breakthrough signal was some 52dB below the speaking channel signal at full test modulation level, so under normal stereo conditions this contribution of distortion would be small. Listening to the breakthrough signal through a high gain amplifier confirmed this. The signal was, in fact, fairly clean and free from transient splash right up to ±100kHz deviation. 'Birdies' suppression appears to rely on the i.f. selectivity; the ratio was reasonable, but twitterings could be evoked by injecting a fairly strong signal into our closed-circuit system 200kHz away from a tuned stereo signal.

The muting is active with the selector in the stereo position and inactive in the mono position (this is common with other inexpensive tuners). We noted a small muting release delay, so if the tuning is spun quickly over the band with the muting active it is possible to miss stations.

AM performance was average in quality and a little below average in sensitivity using the ferrite rod aerial. It is possible, however, to swivel the rod for optimum response or the best signal/interference ratio.

FM results indicated a tuner of average sensitivity but with a slight 'dullness' in the high frequency register, though otherwise clean and free from

upper-treble harshness. Our aerial system picked up distant stations with relative ease, and provided they were not too close to powerful stations the tuner reproduced them quite well.

In summary, a tuner which failed to rank very well in competition with the other models of the group on the audio side, but did rather better on vhf. Not wholly suitable for serious DX-ing, but capable of responding to distant stations under favourable conditions.

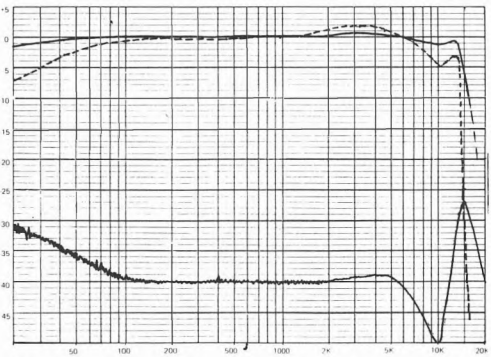
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.5
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	50
S/N CCIR mono 1mV av. (dB)	72.5
S/N CCIR stereo 1mV av. (dB)	69
Limiting —1 dB (μV)	1.25
Front-End Performance	
3rd-order RF IM av. (dB)	67
Equiv. select. figure-of-merit (dB)	43
Repeat spot (dB)	86
Capture ratio (dB)	2
Select. ±400kHz av (dB)	58
Select. ±200kHz av. (dB)	5.5
Muting threshold (μV)	6
Sig. meter saturation (μV)	400
Tuning error 95MHz (kHz)	+101

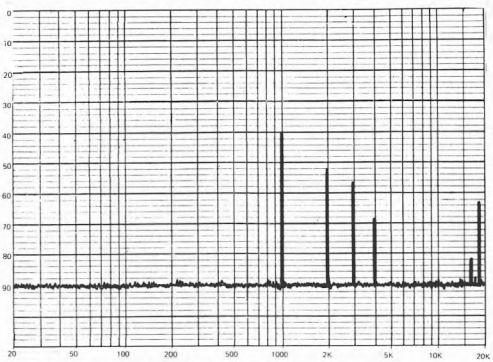
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	661
Output ±67.5kHz dev. R-ch. (mV)	628
AM rejection 1mV (dB)	51
Pilot tone suppression ref. ±67.5kHz dev. (dB)	61/66
Sub-ch. spuriae ref. ±67.5kHz (dB)	50
Hum ref. ±67.5kHz (dB)	70
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.126
3rd harmonic (%)	0.126
4th harmonic (%)	0.016
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.035
4th harmonic (%)	0.017
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.126
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.04
4th harmonic (%)	0.016
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	23
Response 15kHz worst ch. (dB)	—5.4
Response 20Hz worst ch. (dB)	—1.4
Stereo separation 1kHz (dB)	40
Stereo separation 10kHz (dB)	50
Birdies suppression (dB)	62
Dimensions (W x H x D) (mm)	390 x 152 x 358
Typical selling price (£)	£86.00

Additional information/comment:
Features include AM MW with swivel rear ferrite rod aerial; 75/300-ohm aerial inputs; tuning and signal meters.



Frequency response/stereo separation curves (dotted curve 1dB/div).

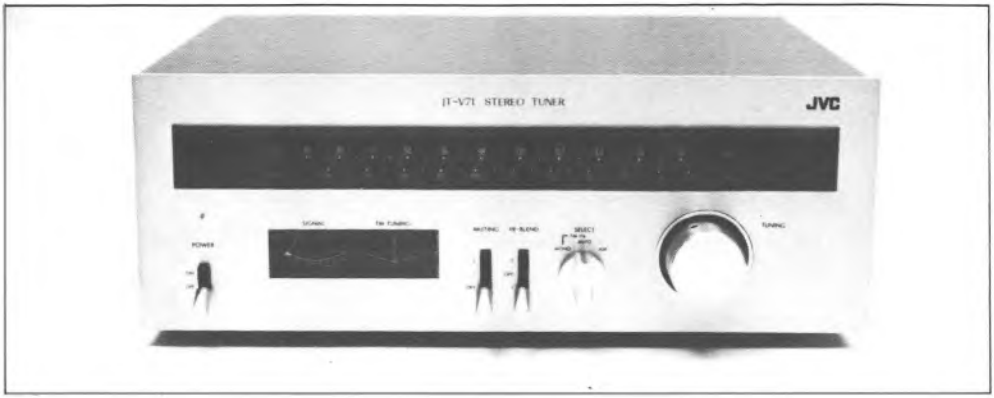


Breakthrough signal distortion

RECOMMENDED

JVC JT-V71

JVC (UK) Limited, Eldonwall Trading Estate, Staples Corner, 6/8 Priestley Way, London NW2 7AF. 01-450 2621.



Approximately twice the price of the JT-V11, this model boasts more features and was found to have significantly better vhf and audio performances. It is a little larger than the less expensive model but similar in appearance. The enclosure is metal of dark-grey finish and the fascia of brushed aluminium slightly overlaps the enclosure, allowing cabinet mounting. Tuning is by a large metal knob, while mains on/off, muting and hi-blend (sometimes called MPX noise filter) are controlled by lever switches. A flat-shaped knob selects the wavebands, and both muting and hi-blend switches have two positions in addition to off.

The controls are conveniently disposed, and the tuning is free and smooth with flywheel inertia. While muting and hi-blend can be useful in their way, it is difficult to substantiate two settings for each of these. By deleting these dubious value extras, the manufacturer could probably have reduced the cost a trifle and made the model more competitive.

The scale is black with white numbers, but is not wholly illuminated. The cursor carries a light which moves across the scale with the tuning. Behind a slot dividing the FM and AM scales is a further scale for logging purposes. The cursor is a red line on transparent plastics and does not show up as well as the brightly lit cursor tip of the JT-V11. Scale length is approximately 240mm with substantially linear 500kHz graduations, which are too far apart for accurate frequency setting.

The fascia carries two black-backed illuminated meters for signal strength and FM tuning: the latter was accurate at centre-zero for the least distortion and best stereo separation, but the former runs into saturation fairly early. Two pairs of 'phono' audio outputs are fitted at the rear with adjacent presets for controlling the signal level from one pair. An internal switch allows switching over 25/50/75 μsec de-emphasis.

Some favourable results were measured at vhf, including a high absolute sensitivity. Enhancement is given to the vhf performance by three variable-tuned circuits between the aerial and mixer, while the high sensitivity and selectivity ratios make this model suitable for DX-ing difficult reception areas.

Audio section results were also encouraging. The designers have achieved good pilot tone and sub-channel rejection ratios without clipping too much of the upper-frequency response, the response going above 10kHz before starting to drop into the 19kHz notch. Distortion, too, was commendably low, the worst harmonic in pure stereo being the second. Residual hum was mostly second harmonic (100Hz) while the good adjacent channel selectivity yielded a 'birdies' rejection ratio as high as 80dB. Distortion on the breakthrough signal with respect to the speaking channel signal was 50dB at full test modulation level, corresponding to 0.3% second harmonic distortion.

Engineering quality was average, and three-core cable is used for the mains supply. Aerial inputs are fitted for 75 and 300 ohms, with good impedance matching. Using the swivel ferrite rod aerial, the AM results were not outstanding and a trace of 908kHz whistle plagued Radio 4 during daylight hours.

Overall FM quality was ranked above average, but on moderate strength stereo signals background noise could be heard when monitoring at high levels. The tuner would respond to weak stereo signals without adjacent channel interference or 'birdies'

RECOMMENDED

and the reproduction was free from stereo splash and high modulation stridence.

In summary, a tuner of above average performance, of average features but probably a shade above average price for its class, which could be due to some of the less vital features, such as double positions for muting and blend.

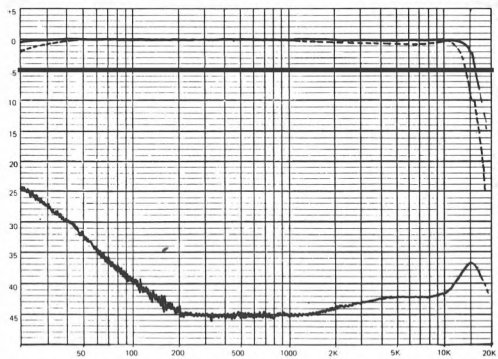
Additional information/comment:
*Also fixed outputs at 612mV(L)/618mV(R) — isolated.
Features include AM MW with rear swivel ferrite rod aerial; two pairs audio outputs (fixed and variable by rear presets); 4-ch. decoder socket (from FM detector); two levels of switched muting; signal/tuning meters; two levels of MPX (high blend) filtering; internal de-emphasis switching over 75/50/25μsec.

VHF Section

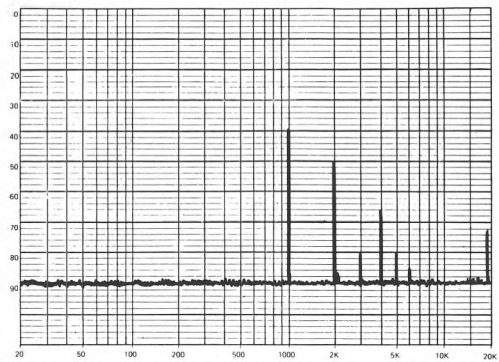
Sensitivity 30dB S/N CCIR mono (μV)	0.8
Sensitivity 50dB S/N CCIR mono (μV)	3
Sensitivity 50dB S/N CCIR stereo (μV)	31.5
S/N CCIR mono 1mV av. (dB)	73.5
S/N CCIR stereo 1mV av. (dB)	70
Limiting —1dB (μV)	1
Front-End Performance	
3rd-order RF IM av. (dB)	69
Equiv. select. figure-of-merit (dB)	55
Repeat spot (dB)	89
Capture ratio (dB)	1.25
Select. ±400kHz av (dB)	72.5
Select. ±200kHz av. (dB)	10.5
Muting threshold (μV)	5 and 25
Sig. meter saturation (μV)	315
Tuning error 95MHz (kHz)	+94

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1252 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1267 (max)*
AM rejection 1mV (dB)	60
Pilot tone suppression ref. ±67.5kHz dev. (dB)	73/69
Sub-ch. spuriae ref. ±67.5kHz (dB)	80
Hum ref. ±67.5kHz (dB)	71
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.3
3rd harmonic (%)	0.03
4th harmonic (%)	0.04
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.18
3rd harmonic (%)	0.03
4th harmonic (%)	0.02
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.05
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.04
4th harmonic (%)	0.025
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	32
Response 15kHz worst ch. (dB)	—2
Response 20Hz worst ch. (dB)	—0.2
Stereo separation 1kHz (dB)	45
Stereo separation 10kHz (dB)	42
Birdies suppression (dB)	80
Dimensions (W x H x D) (mm)	420 x 162 x 361
Typical selling price (£)	£180.00



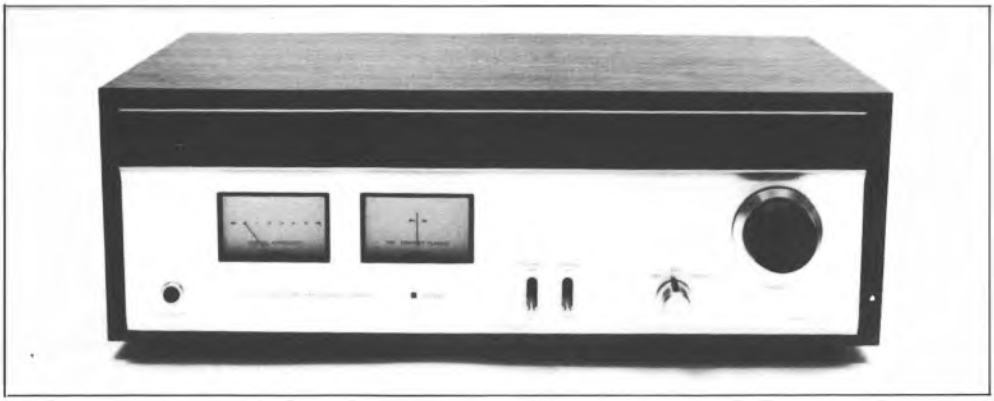
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

L&G T-1400

Metrosound Audio Products Limited, Audio Works, Cartersfield Road, Waltham Abbey, Essex EN9 1JF. 01-971 2712.



This Japanese tuner is distributed in the UK by Metrosound of North London and is one of the few models which comes complete with a wooden enclosure. The fascia is satin-brushed aluminium and there is a narrow black-backed tuning scale of approximately 240mm active length at the top. The cursor consists of two orange-illuminated arrow heads, one relating to the FM scale and the other to the MW AM scale.

The scales themselves are softly illuminated, the FM one carrying essentially linear calibration dots at 200kHz intervals; calibration accuracy was good so it is possible to achieve an accurate frequency setting. The tuning mechanism is flywheel assisted, and the intrinsic friction is sufficiently low to permit a tuning spin from one end of the scale to the other; no aberrations were noted.

The fascia proper is black-edged, as also are the two large meters for signal and centre-zero tuning, the former accommodating up to 500μV and the latter providing indication for the least distortion and best separation. There is a large black tuning knob with 'silver' edging on the extreme right, band-change uses a small metal knob, while hi-blend and muting are activated by metal lever switches and a black press-button switches on power.

Engineering quality was judged to be a shade above average. At the back are terminals for FM and AM aerials, 'phono'-type sockets for audio and oscilloscope (for multipath detection), and a small knob which adjusts the signal level at one pair of outputs; but a short across one pair kills the signal across the other pair as there is no resistive isolation. It was also found that the 75ohm aerial input failed to match a 75ohm feeder or source properly, and different values for absolute sensitivity occurred by shifting the signal cable (indicating standing waves). This is caused by one conductor of 300ohm feeder being used for 75 ohms, while the other conductor is a length of wire connected to chassis! A proper coaxial coupling should be used inside the tuner for best results. As mentioned in the Technical Introduction, any mismatch is revealed by our tests as an impairment is absolute sensitivity.

This mismatch tended to pull the overall vhf ranking a little below average, in spite of some of the other parameters being better. A good result was obtained for alternate channel selectivity and although the adjacent channel measured rather lower than might be expected this did not encourage birdies unduly. In practice, it is unlikely that the aerial mismatch would be noticed under normal reception conditions. Absolute matching is more important when a tuner is to be used for DX-ing or distant-station reception.

Overall audio ranking fell right in the middle of scale average. Distortion in all modes was reasonably low, while the crosstalk signal distortion corresponded to about 0.5% third harmonic referred to the speaking channel at full test modulation (see spectrogram). The pilot tone was well attentuated and there was only one IM product due to this; no spitting at normal modulation level was detected on the crosstalk. Frequency response was 1.5dB down at both terminal frequencies, which is not bad, and the separation was good.

AM performance was below average (internal ferrite rod aerial) due mainly to the presence of multiple whistles over the band. Under audition on FM the tuner received some good comments: it was liked for its smooth treble and musical attack, but on certain types of high-energy high-frequency

music, like piano and strings, mild stridence was detected at peak modulation. The tuner also appeared to have a higher susceptibility than some to car interference.

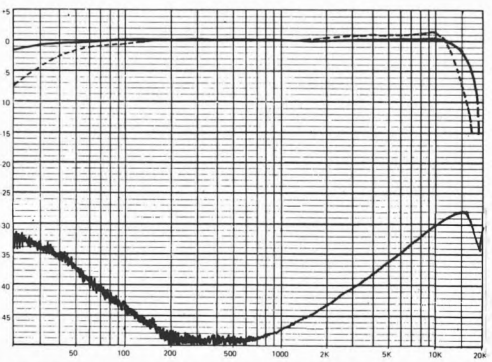
In summary, a pleasant-looking and well engineered tuner which could be improved by better 75ohm aerial matching and with resistive isolation between the two pairs of audio outputs. Adequate for normal reception conditions and with sufficient potential sensitivity for DX-ing, given improved aerial coupling.

VHF Section

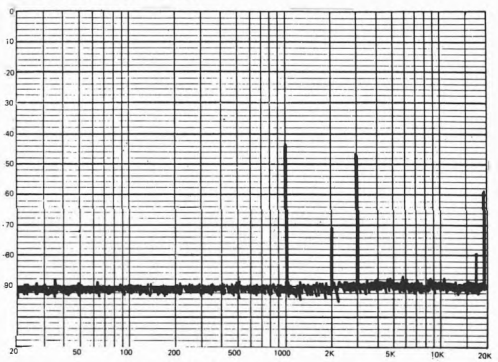
Sensitivity 30dB S/N CCIR mono (μV) 2*
Sensitivity 50dB S/N CCIR mono (μV) 5
Sensitivity 50dB S/N CCIR stereo (μV) 50
S/N CCIR mono 1mV av. (dB) 83.5
S/N CCIR stereo 1mV av. (dB) 71
Limiting —1dB (μV) 2.5
Front-End Performance
3rd-order RF IM av. (dB) 65
Equiv. select. figure-of-merit (dB) 55
Repeat spot (dB) 90
Capture ratio (dB) ..... <2
Select. ±400kHz av (dB) 71.5
Select. ±200kHz av. (dB) 5
Muting threshold (μV) 8
Sig. meter saturation (μV) 500
Tuning error 95MHz (kHz) ..... +12

Audio Section

Output ±67.5kHz dev. L-ch. (mV) ..... 1824 (level control max)**
Output ±67.5kHz dev. R-ch. (mV) ..... 1793 (level control max)**
AM rejection 1mV (cB) 54
Pilot tone suppression ref. ±67.5kHz dev. (dB) 59/60
Sub-ch. spuriae ref. ±67.5kHz (dB) 79
Hum ref. ±67.5kHz (dB) 77
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.31
3rd harmonic (%) 0.22
4th harmonic (%) 0.018
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.4
3rd harmonic (%) 0.06
4th harmonic (%) 0.03
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.13
3rd harmonic (%) 0.28
4th harmonic (%) ..... noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.4
3rd harmonic (%) 0.08
4th harmonic (%) 0.03
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.15
3rd harmonic (%) ..... noise
4th harmonic (%) ..... noise
Total on breakthrough signal (%) 70
Response 15kHz worst ch. (dB) ..... —1.5
Response 20Hz worst ch. (dB) ..... —1.5
Stereo separation 1kHz (dB) 47
Stereo separation 10kHz (dB) 30
Birdies suppression (dB) 70
Dimensions (W x H x D) (mm) ..... 450 x 163 x 273
Typical selling price (£) £170.00
Additional information/comment:
*75-ohm aerial mismatch recorded.
**Down to zero; also fixed outputs same level.
Features include MW with internal ferrite rod aerial; two pairs 'phono'-type audio outputs; sockets for 'scope detection of multipath; rear level control; signal/tuning meters; muting and hi-blend switches; 75/300-ohm aerial inputs.



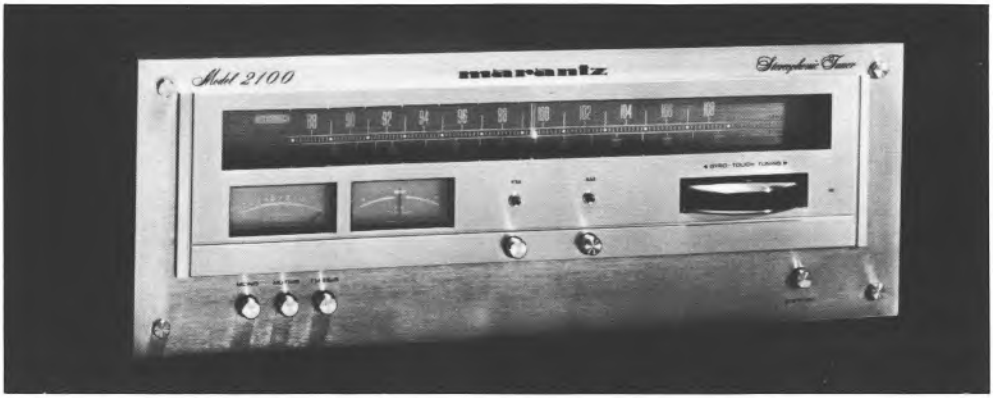
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Marantz 2100

Marantz Audio (UK) Limited, 203 London Road, Staines, Middlesex. Staines 50132.



Marantz tuners and receivers are distinctive in that a horizontally-orientated flywheel with rubberised edge protruding through a slot in the fascia is used for tuning, instead of the more conventional control knob. Marantz call this 'gyro touch tuning'. The flywheel is finely balanced and pivoted so that it is possible to spin the tuning smoothly from one end of the band to the other. In practice, it is marginally easier to tune accurately with this edge-type control than the more conventional knob.

The model 2100 falls at the lower end of the price scale, but in spite of this the construction and engineering are to a good standard. The components are identified on the printed circuit board, and wrap-round joints are adopted for inter-connections. Enclosure is of black-covered metal and the fascia of brushed aluminium, with a slightly protruding scale and meter section. Slight fascia overlaps permit cabinet-mounting, and details of how this can be done are given in the instructions.

Tuning scale is approximately 245mm in active length and the frequency markings are blue illuminated. However, in spite of the good mechanical accuracy of the tuning it is not possible to obtain tightly controlled frequency readouts because the calibration is only at 1MHz intervals. The cursor is of clear plastic with a red-glowing tip and alignment accuracy was quite reasonable with a mid-band error of —75kHz. Meters below the scale provide signal strength indication over a wide range and FM centre-zero tuning, which was accurate. Press-buttons operate the functions and small lights signify the switching of FM and MW; the usual stereo indicator lights up on receiving encoded transmissions.

Three-core cable connects to the mains supply *via* a small transformer, which was found to run rather warm. The rear accommodates 'phono'-type sockets for audio and FM detector signal (for application to a four-channel decoder, for example), terminals are provided for aerial connections. Weighted feature ranking was not very high.

The tuner was found to provide a fair to average vhf performance and about average audio performance. Absolute sensitivity and limiting were not outstanding, and we were a little disappointed with the CCIR stereo signal to noise ratio at 1mV input. On the other hand, the third-order IM was good for a tuner of this price, being as high as 72dB on one response — better than the more expensive 2120. Front-end selectivity correlated with two variable-tuned circuits only between aerial and mixer, as did the repeat spot. Alternate channel selectivity was round average for the group, but the below average adjacent channel ratio reflected a poorish 'birdies' suppression ratio.

Overall distortion was low. The worst harmonic (second) occurred in mono at ±67.5kHz deviation with the tuning set for centre-zero on the meter. The audio section ranking was pulled back by the signal-to-noise ratios and AM rejection ratio. Very good results were obtained on stereo separation over pretty well the whole of the spectrum, with the ratio maximising at an astonishingly high 54dB (again, centre-zero on the meter). The designers appeared to have had minor trouble in maintaining an extended high frequency response consistent with good pilot tone rejection ratio. Distortion on the breakthrough signal was 53dB below the speaking channel (or 0.22%).

AM performance was fair, whistles being noted at various frequencies over the band. The whistle on

Radio 4 at 908kHz was also prominent.

Good results were obtained from FM listening tests. In spite of the —1.5dB droop at 15kHz, the reproduction had plenty of attack and transient performance was fine. Background noise level on stereo was a trifle troublesome on lowish signal inputs, but the breakthrough signal distortion was below audibility at normal gain setting (owing to the very good separation).

In summary, a well engineered tuner at a moderate price. Not boasting a particularly outstanding performance, and not really suitable for serious DX-ing, but capable of giving satisfactory FM reception in many areas in the UK.

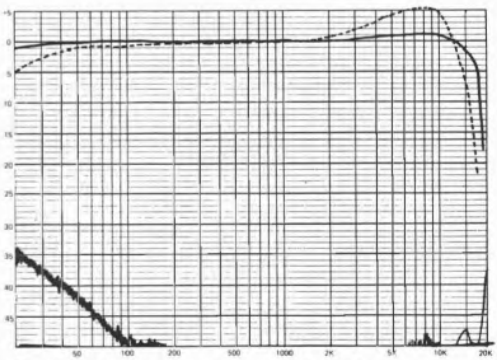
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.4
Sensitivity 50dB S/N CCIR mono (μV)	4.5
Sensitivity 50dB S/N CCIR stereo (μV)	45
S/N CCIR mono 1mV av. (dB)	72
S/N CCIR stereo 1mV av. (dB)	66.5
Limiting —1dB (μV)	1.4
Front-End Performance	
3rd-order RF IM av. (dB)	70.5
Equiv. select. figure-of-merit (dB)	34
Repeat spot (dB)	79
Capture ratio (dB)	1.25
Select. ±400kHz av (dB)	62.5
Select. ±200kHz av. (dB)	4.25
Muting threshold (μV)	10
Sig. meter satur ation (μV)	2000
Tuning error 95MHz (kHz)	—75

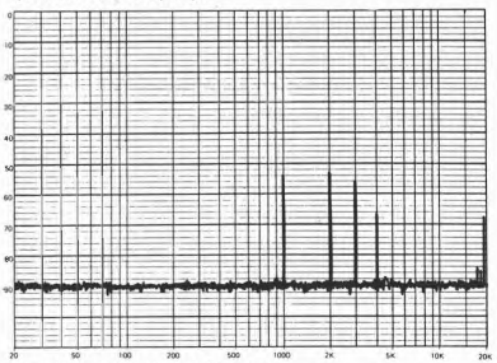
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	982
Output ±67.5kHz dev. R-ch. (mV)	947
AM rejection 1mV (dB)	46
Pilot tone suppression ref. ±67.5kHz dev. (dB)	70/68
Sub-ch. spuriae ref. ±67.5kHz (dB)	80
Hum ref. ±67.5kHz (dB)	74
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.11
4th harmonic (%)	0.05
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.07
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.11
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.09
4th harmonic (%)	0.01
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Tot al on breakthrough signal (%)	100
Response 15kHz worst ch. (dB)	—1.5
Response 20Hz worst ch. (dB)	—1.0
Stereo separation 1kHz (dB)	58
Stereo sep aration 10kHz (dB)	63
Birdies suppression (dB)	63
Dimensions (W x H x D) (mm)	415 x 145 x 260
Typic al selling price (£)	£115.00

Additional information/comment:
Features include MW with non-swivel rear ferrite rod aerial; 'phono'-type sockets (one pair) for audio and 4-ch. decoder; signal/tuning meters; switchable muting; 75/300-ohm aerial inputs.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

RECOMMENDED

Marantz 2120

Marantz Audio (UK) Limited, 203 London Road, Staines, Middlesex. Staines 50132.

This model has more features and measures better on some of the parameters than the 2100, which is why it costs more! General quality of construction and engineering are similar, so the 2120 also gains a high ranking in this respect. The components are identified on the printed circuit boards and normal servicing should not be difficult. The mains transformer is similar in size to that in the 2100, but we were rather surprised at first to discover this running at 52deg.C (in an ambience of 20deg.C) after three hours operation on the test bench. However, some recent small transformers are engineered to run at such temperatures without ill effect, and because the transformer is clamped on a solid chassis member, well clear of small electrolytics, etc, which might dry up, it is unlikely to affect the reliability.

Enclosure and fascia styling are similar to the less expensive model. There is the same free-running 'gyro touch tuning', blue-glowing scale and meter numbers, red-tipped cursor, etc. More graduation marks are included on the scale, but these appear to correlate more with the AM rather than the FM scale. Retuning accuracy is thus not very high, but the intrinsic alignment error was very small mid-band at a mere +7Hz. DX-ers like to be able to identify stations in terms of absolute frequency as far as possible, and this is not easily possible with the scale graduations as they are.

The model would, in fact, be suitable for DX-ing owing to its high sensitivity and good front-end parameters, and also because it is possible to switch over wide and narrow i.f. selectivity. As with all models with switchable selectivity, the best distortion performance is achieved in the wide position and the best station discrimination in the narrow position. In our final analysis we have used the parameters obtained in the wide position, which generally favours the audio performance; but it is just as well to bear this in mind when comparing switchable selectivity models with non-switchable models.

The 2120 thus ranked fair to average for vhf and very good for audio. Good rankings were obtained for absolute sensitivity and signal-to-noise ratios. This example did less well on third-order IM on an average basis, which is curious. It has three variable-tuned circuits between aerial and mixer which is reflected in the good equivalent front-end selectivity and repeat spot suppression ratio; but some models with the same number of variable-tuned circuits have come out better.

Asymmetry was noted during the i.f. selectivity measurements — the ratio one side being significantly higher than our tabulated average value. The centre-zero tuning meter tended to alter deflection slightly when switching from wide to narrow on a fixed signal and tuning. In practice, the narrow setting does provide enhanced discrimination against adjacent stations and better 'birdies' suppression ratio, but at the expense of distortion and stereo separation.

We liked the wide dynamic range of the signal meter, the low level of the residual hum components, and the low distortion and very good stereo separation in the wide position. The designers also managed to achieve minimal treble droop at 15kHz with a pilot tone rejection ratio as high as 70dB (with sub-channel spuriae virtually at noise level), but there is still mild overshoot prior to filter action.

Intrinsic breakthrough distortion was less than on

RECOMMENDED

the 2100, but since the separation was not *quite* as good, the breakthrough signal distortion was still round 0.22% relative to the speaking channel signal.

AM performance was average, with the usual beat whistle on 908kHz.

In the 'wide' mode very good FM quality was obtained from various signals. The quality deteriorated slightly in narrow mode, but then the probability of 'birdies' interference was reduced. No splash was detected on the breakthrough signal even up to ±100kHz deviation in wide mode.

In summary, a high quality tuner suitable for DX-trials and a wide variety of reception conditions. Aerial attenuation would only be required in exceptionally high signal strength areas.

VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	0.85
Sensitivity 50dB S/N CCIR mono (μV)	3.6
Sensitivity 50dB S/N CCIR stereo (μV)	31.5
S/N CCIR mono 1mV av. (dB)	79
S/N CCIR stereo 1mV av. (dB)	72.5
Limiting —1dB (μV)	1.6
Front-End Performance	
3rd-order RF IM av. (dB)	62.5
Equiv. select. figure-of-merit (dB)	41.5
Repeat spot (dB)	83.5
Capture ratio (dB)	1.5 (narrow); 2 (wide)
Select. ±400kHz av (dB)	70 (narrow); 52 (wide)
Select. ±200kHz av. (dB)	10 (narrow); 5 (wide)
Muting threshold (μV)	12.5
Sig. meter saturation (μV)	10,000
Tuning error 95MHz (kHz)	+7

Audio Section

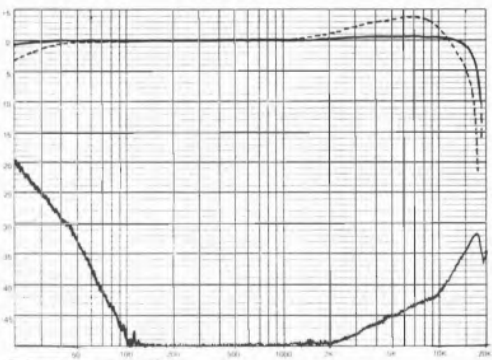
Output ±67.5kHz dev. L-ch. (mV)	2000
Output ±67.5kHz dev. R-ch. (mV)	1929
AM rejection 1mV (dB)	53
Pilot tone suppression ref. ±67.5kHz dev. (dB)	73/70
Sub-ch. spuriae ref. ±67.5kHz (dB)	>90
Hum ref. ±67.5kHz (dB)	80
*Distortion (shown in wide mode)**	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.18
4th harmonic (%)	0.11
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	0.08
4th harmonic (%)	0.025
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.16
4th harmonic (%)	0.028
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	0.1
4th harmonic (%)	0.025
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on break through signal (%)	35
Response 15kHz worst ch. (dB)	—0.9
Response 20Hz worst ch. (dB)	—0.6
Stereo separation 1kHz (dB)	54 (wide)/41 (narrow)
Stereo separation 10kHz (dB)	42 (wide)/38 (narrow)
Birdies suppression (dB)	60 (wide)/70 (narrow)
Dimensions (W x H x D) (mm)	415 x 145 x 280 approx.
Typical selling price (£)	£180.00

Additional information/comment:

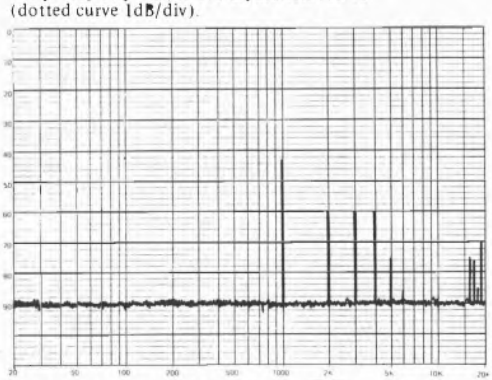
*Distortion significantly higher at narrow.

Features include MW with rear swivel ferrite rod aerial; 'phone'-type audio outputs and 4-ch. decoder output; signal/tuning meters; MPX noise filter; switchable muting; 400Hz tone oscillator for tape recording level setting (exactly at Dolby level — ±37.5kHz equiv. deviation); switchable i.f. selectivity; 75/300-ohm aerial inputs.

Note: Final analysis in wide selectivity position.



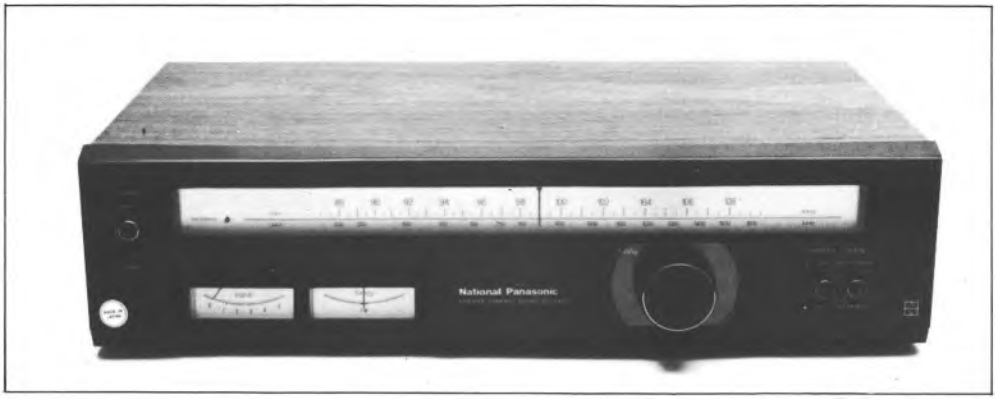
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

National Panasonic ST-2400

National Panasonic (UK) Limited, 308-318 Bath Road, Slough, Berks.
Slough 34522.



This fairly small tuner is attractive but reveals some aspects of cost cutting which are reflected in the fairly moderate price. It is built within a plastics moulding of attractive dark finish over which is a metal cover of very well simulated wood finish. The screening is not as good as some models because the front, back and sides are of plastics. The rear carries terminals for 75/300-ohm FM and AM aerial inputs, with the ferrite rod aerial for AM being located on the printed circuit board inside. Instead of audio output sockets there are two 'phono'-type-plug-terminated leads. In spite of the elementary design, the engineering quality was regarded as good. The components are identified on the pcb and servicing should present no undue problems. The model is not particularly well equipped and the ranking for features was low.

Scale length is round 210mm with frequency intervals occurring only every 500kHz. Neither the scale section nor either meter is illuminated. Tuning mechanism is reasonable and flywheel assisted, but marginally less smooth than some of the more expensive models of this survey. The cursor is a black pointer which contrasts fairly well with the gold-coloured backing of the scales. Meters for signal strength and FM tuning are similarly backed, and the black fascia is complemented by a black, 'silver'-ringed tuning knob and smaller matching press-buttons for power, FM/AM and muting with mono/stereo switching, such that the muting is defeated in mono mode only. Signal meter has a usefully wide dynamic range, while centre-zero of the tuning meter was found to correlate with least distortion and best separation. Tuning error was small; but one mechanical point which should be corrected is 'locking' of the cursor carriage and hence tuning when pressure is applied to the metal top. Mains is connected through two-core cable, and it would appear that the design is to BSI class II insulation requirement.

Overall ranking of the vhf section was slightly below average, and it seemed that the 75 ohm aerial input failed accurately to match into 75 ohms. The design uses a ferrite balun which appears to be affecting the 75 ohm impedance loading; but in practice it is unlikely that this would ever be detected. The best vhf parameter was capture ratio. The values measured render the tuner suitable for use in normal signal areas, with sufficient sensitivity for weak signal reception provided a powerful signal is not present on a near frequency, but less suitable for very strong signal areas unless external aerial attenuation is adopted to reduce possible spuriae and stereo birdies. During the lab measurements slight breakthrough from an rf shipping beacon was noticed all over the FM band.

Audio section results were also below average (but the price must always be kept in mind!), with relatively low results being obtained for AM rejection, pilot tone and sub-channel rejection. On the other hand, good results were obtained for mono distortion at full test modulation level. Stereo distortion was not too bad, either. Mid-spectrum stereo separation was perfectly sanitary, but the rather heavy breakthrough distortion placed the second harmonic of this about 45dB below full test modulation speaking channel signal, corresponding to about 0.56%.

Worst channel hf frequency response was —1.7dB at 15kHz (0.4dB at 10kHz), which is not all that bad for a tuner of this price. We also measured a fairly swift bass roll-off (see frequency plots). Birdies

suppression ratio was on the low side owing to the relatively small adjacent channel selectivity ratio.

AM performance was a shade below average and whistles were detected on 908kHz and some other stations. The ferrite rod cannot be adjusted. FM was about average but with a slight loss of treble attack and mild harshness at high modulation levels.

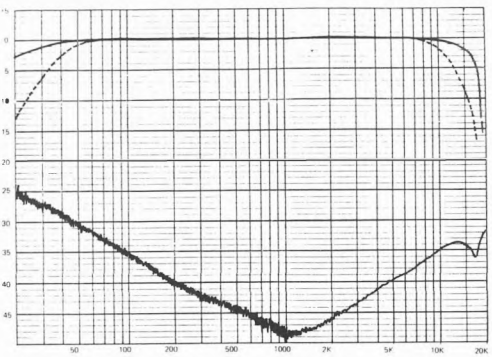
In summary, a moderately-priced tuner of good looks but exhibiting some price cutting. Suitable for normal reception areas and sensitive enough for weak signals under some conditions. Less suitable for very strong signal areas, where spuriae and birdies could be troublesome without aerial attenuation.

VHF Section

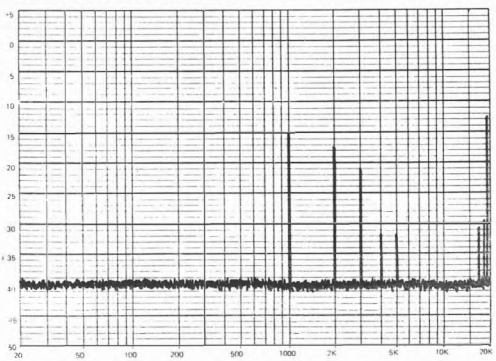
Sensitivity 30dB S/N CCIR mono (μV) 1.2
Sensitivity 50dB S/N CCIR mono (μV) 5
Sensitivity 50dB S/N CCIR stereo (μV) 50
S/N CCIR mono 1mV av. (dB) 73
S/N CCIR stereo 1mV av. (dB) 69
Limiting —1dB (μV) 1.9
Front-End Performance
3rd-order RF IM av. (dB) 63
Equiv. select. figure-of-merit (dB) 32
Repeat spot (dB) 78
Capture ratio (dB) 1.2
Select. ±400kHz av (dB) 49.5
Select. ±200kHz av. (dB) 3
Muting threshold (μV) 2.5
Sig. meter saturation (μV) 1500
Tuning error 95MHz (kHz) . . . . . +48

Audio Section

Output ±67.5kHz dev. L-ch. (mV) 504
Output ±67.5kHz dev. R-ch. (mV) 480
AM rejection 1mV (dB) 44
Pilot tone suppression ref. ±67.5kHz dev. (dB) 38/35
Sub-ch. spuriae ref. ±67.5kHz (dB) 41
Hum ref. ±67.5kHz (dB) 75
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.63
3rd harmonic (%) 0.25
4th harmonic (%) 0.028
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.089
3rd harmonic (%) 0.05
4th harmonic (%) . . . . . noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.039
3rd harmonic (%) 0.31
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.13
3rd harmonic (%) 0.05
4th harmonic (%) 0.0126
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.1
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 56
Response 15kHz worst ch. (dB) . . . . . —1.7
Response 20Hz worst ch. (dB) . . . . . —2.6
Stereo separation 1kHz (dB) 48
Stereo separation 10kHz (dB) 35
Birdies suppression (dB) 56
Dimensions (W x H x D) (mm) . . . . . 415 x 105 x 250
Typical selling price (£) £85.00
Additional information/comment:
Features include MW with internal ferrite rod aerial; signal/tuning meters; 75/300-ohm aerial inputs; muting with off ganged to mono. Slight 75-ohm aerial mismatch noted.



Frequency response/stereo separation curves (dotted curve 1dB/div).

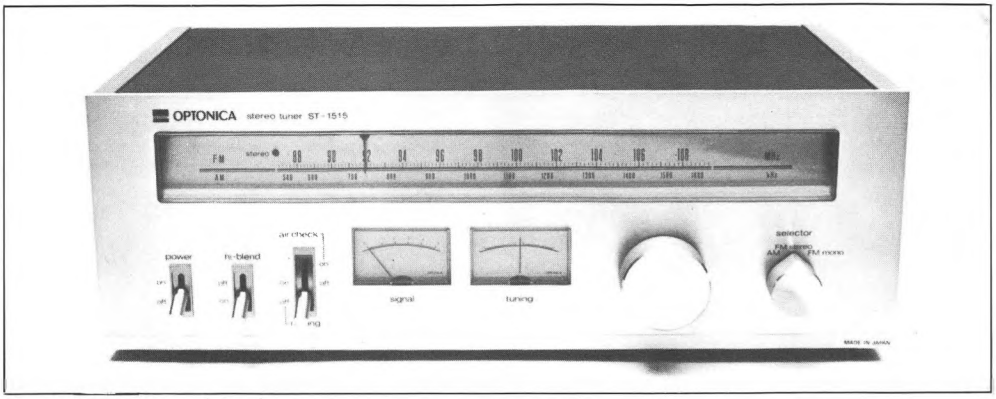


Breakthrough signal distortion

RECOMMENDED

Optonica ST-1515

Sharp Electronics Limited, Sharp House, 107 Hulme Hall Lane, Manchester, M10 8NL. 061 205 7321.



In spite of this model falling towards the lower end of the price scale, parameters of useful values were measured. The tuner cannot truthfully said to be short of features, but it ranked lower than the more expensive ST-3636H in this respect on our weighted scale. It is a neat little tuner with a well balanced brushed aluminium fascia, metal top covered with a dark material and attractive wooden side pieces. Tuning is by means of a large metal knob, while a smaller contoured metal knob serves for selection, and lever-type switches for power on/off, hi-blend and a recording-level-setting test tone.

Tuning scale is round 220mm in length with almost linear 200kHz graduations. The scale itself is not illuminated, but instead the cursor carries illumination which shines blue/green on that section of the scale being tuned. Tuning mechanism is free of flaw and has low friction, with flywheel inertia allowing it to be spun from one end of the scale to the other.

Meters are fitted for signal strength and FM tuning and both are illuminated; stereo reception is signified as usual by the glowing of a small light. Power is connected through three-core cable which provides an earthing circuit. Audio signals are delivered by 'phono' type sockets and inputs are available for 75 and 300 ohm aerials.

Absolute FM sensitivity was a little above average, while the small-signal signal-to-noise ratios were about average. The 1mV signal-to-noise ratios, however, could have been better. Early limiting was measured, which is a good thing when receiving weak or fading signals. A four-gang FM tuning gang is used so that three variable-tuned circuits are present between aerial and mixer. This gave a good front-end selectivity 'figure of merit'. The repeat spot suppression ratio was also good, and the third-order IM acceptable. The signal meter will accommodate a large signal before running into saturation. All these front-end attributes, coupled with good selectivity of the i.f. channel and ease of frequency setting, render the model suitable for DX-ing and fairly difficult reception conditions.

General distortion in all modes was small, the best condition resulting with the tuning meter at centre-zero; which was true also of the best stereo separation. Upper-frequency response was less than 1dB out, yet the pilot tone rejection was better than 60dB. Distortion on the breakthrough signal was very high, but because of the good separation the distortion here relative to the fundamental of the speaking channel at ±67.5kHz deviation was not much more than an equivalent 0.3%.

The recording level oscillator (called 'air check' by Optonica) produced an audio output corresponding to a deviation of ±32kHz, which is about 1.5dB below Dolby level. 'Birdies' suppression was better than —70dB, and during the tests no such interference was experienced. Transient splash was detected on the breakthrough signal at high modulation peaks, and the breakthrough signal was rather noisy. There is a small switch-on delay of about 2sec but no tuning drift was detected.

The AM section uses a simple two-gang tuning capacitor and the performance seemed to be a little above average, though it is necessary to turn the whole tuner to beam on to a station or reduce interference. It may thus be necessary to employ an external aerial for the best results. The 908kHz beat whistle was not unduly troublesome on this model.

With the muting active it takes a short time for the

Optonica ST-1515

circuits to de-mute on tuning a station, so it is possible to miss a station by tuning over the band swiftly.

FM auditioning was about average; but on moderately strong stereo signals the background hiss seemed to be a trifle higher than from some of the other models of the group. Selectivity was sharp enough to discriminate against a moderately powerful signal in the adjacent channel. To evoke 'birdies' on our system, the unwanted signal in the adjacent channel had to be as powerful as the wanted stereo signal.

In summary, a moderately-priced tuner of good vhf performance and average audio performance, pulled back in the latter respect by higher than average stereo noise, high distortion on the breakthrough signal and a slightly drooping bass response.

VHF Section

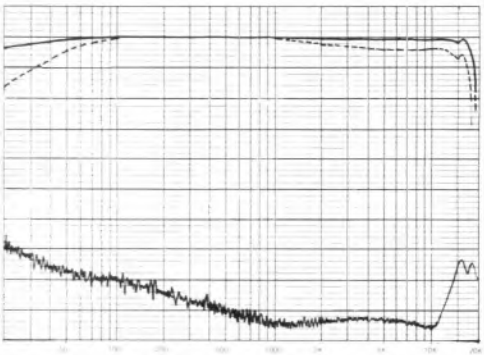
Sensitivity 30dB S/N CCIR mono (μV)	1.1
Sensitivity 50dB S/N CCIR mono (μV)	4.46
Sensitivity 50dB S/N CCIR stereo (μV)	44.6
S/N CCIR mono 1mV av. (dB)	71.5
S/N CCIR stereo 1mV av. (dB)	66.5
Limiting —1dB (μV)	1
Front-End Performance	
3rd-order RF IM av. (dB)	64
Equiv. select. figure-of-merit (dB)	54
Repeat spot (dB)	92
Capture ratio (dB)	1.5
Select. ±400kHz av (dB)	>74
Select. ±200kHz av. (dB)	13
Muting threshold (μV)	5
Sig. meter saturation (μV)	2000
Tuning error 95MHz (kHz)	—90

Audio Section

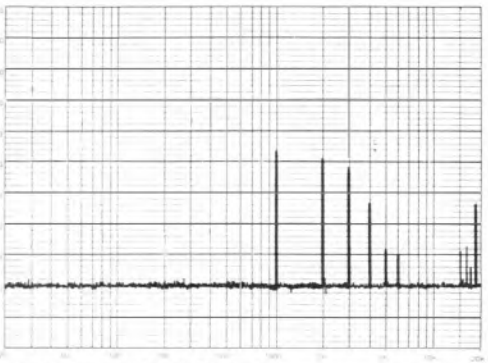
Output ±67.5kHz dev. L-ch. (mV)	818
Output ±67.5kHz dev. R-ch. (mV)	785
AM rejection 1mV (dB)	58
Pilot tone suppression ref. ±67.5kHz dev. (dB)	64/64
Sub-ch. spuriae ref. ±67.5kHz (dB)	70
Hum ref. ±67.5kHz (dB)	76
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.18
4th harmonic (%)	0.07
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.13
3rd harmonic (%)	0.09
4th harmonic (%)	0.03
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.16
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.07
3rd harmonic (%)	0.08
4th harmonic (%)	0.03
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	79
Response 15kHz worst ch. (dB)	—0.7
Response 20Hz worst ch. (dB)	—1.8
Stereo separation 1kHz (dB)	48
Stereo separation 10kHz (dB)	48
Birdies suppression (dB)	72
Dimensions (W x H x D) (mm)	408 x 144 x 275 approx.
Typical selling price (£)	£100.00

Additional information/comment:

Features include AM MW with fixed and covered ferrite rod aerial; 'off air' recording setting oscillator (corresponding approximately to ±32kHz deviation); switched muting; 75/300-ohm aerial inputs (including coaxial socket); high blend switch; meters for signal and FM tuning.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

BEST BUY

Optonica ST-3636H

Sharp Electronics Limited, Sharp House, 107 Hulme Hall Lane, Manchester, M10 8NL. 061 205 7321.

Selling round the £162 mark, this up-market Optonica warrants further exploration. It is good looking in the Oriental style and is well equipped. The sample was metal encased with a hard-gloss speckled enamel finish. There is the usual brushed aluminium fascia, this time with extra wide side overlaps, fairly sharp corners and black markings. The scale spans the fascia width and is angled from the vertical beneath a window for ease of reading. Length is about 220mm with 200kHz divisions and this, coupled with the excellent calibration, facilitates accurate frequency setting.

Two fairly large meters reside below the scale section, and controls are provided by knobs and lever switches of good precision. The tuning is flywheel assisted with the expensive 'silky' feel. Illumination is from an upper diffused light. Overall engineering quality is good, but the mains is connected through two-core cable which presumes class 2 insulation.

This model includes a selectivity switch providing normal and narrow modes; but we found that the effective ratio between the two could have been different, as we would have preferred improved adjacent channel selectivity in the narrow mode. At wide, however, both stereo separation and distortion improve dramatically. There is also an auto-afc circuit (similar to that of the Hitachi FT920, for example). The afc activates after a small delay when the hand is removed from the tuning knob, thereby correcting mild tuning error. This is shown by the glowing of a mini light on the scale. Other such lights indicate wide bandwidth and stereo modes.

Features include a hi-blend switch (giving high-frequency cross-coupling between channels to cut noise on weak stereo signals) and a recording level calibration tone. The level of the tone can be adjusted by a rear control and is monitored by a second scale on the signal strength meter, calibrated in percentage modulation. Sadly this was found not to be very accurate at all levels, and we would have preferred a fixed level corresponding to the Dolby level of ±37.5kHz deviation. Two pairs of 'phono' type outputs are included, the output from one pair being adjustable by a front level control.

The measured parameters revealed a tuner of good performance in both vhf and audio areas. Sensitivity and selectivity render the tuner suitable for distant station reception, while the remarkably low distortion in the wide bandwidth mode, allied with the very good separation, ensures the highest of audio quality on good transmissions. Although the signal-to-noise ratios do not quite reach the pinnacle achieved by some other models, the background noise under ordinary listening conditions was very small.

In spite of the good rejection given to the pilot tone and sub-carrier spuriae, the designers have maintained an upper-frequency response to 15kHz with an error of less than 0.5dB, which is commendable. At the bass end, however, the response started to diminish a little more rapidly than some models, being 1dB down at 40Hz.

AM performance was slightly above average with a relative freedom from whistles; but it is not possible to swivel the ferrite rod aerial. A three-gang tuning capacitor is used.

A five-gang capacitor is used on FM, hence the good front-end figures. Components are identified on the printed circuit boards, and servicing should not present too much of a problem.

Our listening panel was impressed with the audio

BEST BUY

quality in the wide bandwidth mode, and distortion on the breakthrough signal in this mode was so small as to be totally inaudible, the third-harmonic being less than 0.1% ref. the speaking channel's fundamental (see the spectrogram).

All-in-all, then, a well balanced tuner of good overall performance and useful features. Suitable for high quality service area reception and, at a lower quality, DX-ing under difficult reception conditions. A tuner that can be recommended.

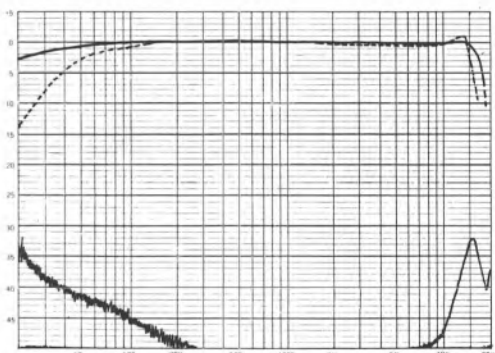
VHF Section

Sensitivity 30dB S/N CCIR mono (μV) 1
Sensitivity 50dB S/N CCIR mono (μV) 3.1
Sensitivity 50dB S/N CCIR stereo (μV) 25
S/N CCIR mono 1mV av. (dB) 76
S/N CCIR stereo 1mV av. (dB) 71.5
Limiting —1dB (μV) 1.2
Front-End Performance
3rd-order RF IM av. (dB) 69.5
Equiv. select. figure-of-merit (dB) . . . . . >100
Repeat spot (dB) . . . . . >100
Capture ratio (dB) . . . . . 2.2 (normal); 2 (wide)
Select. ±400kHz av (dB) . . . . . 78 (normal); 34 (wide)
Select. ±200kHz av. (dB) . . . . . 8 (normal); 6 (wide)
Muting threshold (μV) 2.5
Sig. meter saturation (μV) 4000
Tuning error 95MHz (kHz) . . . . . —12

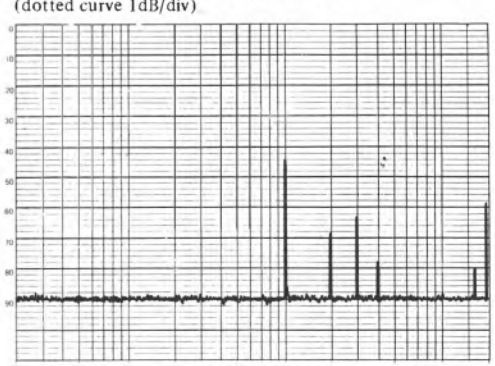
Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 1125 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 1259 (max)*
AM rejection 1mV (dB) 53
Pilot tone suppression ref. ±67.5kHz dev. (dB) 59/60
Sub-ch. spuriae ref. ±67.5kHz (dB) 65
Hum ref. ±67.5kHz (dB) 77
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
. . . . . Values given for 'wide' mode**
2nd harmonic (%) 0.08
3rd harmonic (%) 0.05
4th harmonic (%) 0.014
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.126
3rd harmonic (%) 0.022
4th harmonic (%) 0.0126
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.04
3rd harmonic (%) 0.08
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.025
3rd harmonic (%) 0.04
4th harmonic (%) 0.022
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.05
3rd harmonic (%) 0.03
4th harmonic (%) 0.022
Total on breakthrough signal (%) . . . . . 11.2 (wide)
Response 15kHz worst ch. (dB) . . . . . —0.45
Response 20Hz worst ch. (dB) . . . . . —2.8
Stereo separation 1kHz (dB) . . . . . 56 (wide); 38 (narrow)
Stereo separation 10kHz (dB) . . . . . 48 (wide); 35 (narrow)
Birdies suppression (dB) . . . . . 62 (wide); >80 (narrow or normal)

Dimensions (W x H x D) (mm) . . . . . 442 x 144 x 373 approx.
Typical selling price (£) £165.00
Additional information/comment:
*Also fixed outputs at 826/810(L/R)mV.
**Distortion harmonics greater in normal mode.
Features include MW with non-swivel rear ferrite rod aerial; signal/tuning meters; two pairs outputs 'phono' (fixed and variable); front level control; calibration tone oscillator with meter monitoring and rear level control; switchable bandwidth; multipath detection; hi-blend filter; 75/300-ohm aerial inputs (including coaxial socket); afc auto-lock. Note: narrow = normal.



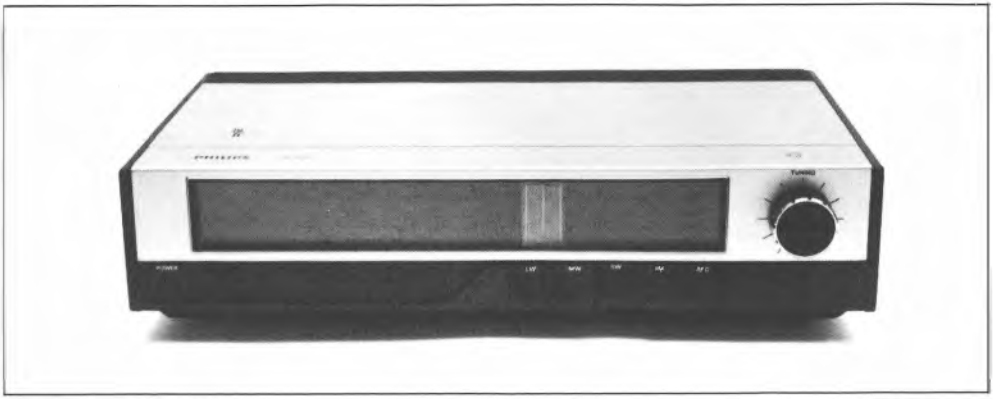
Frequency response/stereo separation curves (dotted curve 1dB/div)



Breakthrough signal distortion

Philips RH-640

Philips Electrical Limited, Arundel Great Court, 8 Arundel Street, London WC2R 3DT. 01-836 4360.



As with most other Philips hi-fi products, the specification is engineered to satisfy the German DIN minimum requirements for hi-fi equipment. Based on these requirements, the tuner certainly meets the specification. Measured more critically using our methods however, in direct comparison with all the other models of the group, it failed to shine very brightly. However having said that, the tuner *is* capable of acceptable FM reception, and has the advantage over most of the other models in that it is equipped with LW, MW and SW AM bands.

In spite of these additional bands, though, it failed to rank very highly in terms of our weighted features for two reasons: primarily because the weighting is relatively low for AM bands in general; and secondly because there is a distinct dearth of FM features. For example, the tuner is devoid of signal and tuning meters; it is not equipped with a 75 ohm FM aerial input (we used an external low-loss 'balun' transformer for our measurements and off-air tests); there is no inter-station muting; and instead of 'phono' audio output sockets at the rear, there is merely a DIN-plug-terminated flying lead. For this reason, the tuner would best partner a DIN-orientated amplifier (such as one of the Philips models); however, the signal is suitable for driving almost any contemporary hi-fi amplifier.

It is built into a plastics enclosure with 'silvered' top and upper section of the fascia. It uses two-core mains cable and is designed to satisfy the BSI class II insulation requirements. The scales are marked in frequencies, with additional channel numbers for FM and the metre wavebands for SW. The SW band tunes over 6-9.7MHz, thereby covering the 31, 41 and 49 metre bands. An internal ferrite rod aerial provides good pick up on the LW and MW bands, while the FM aerial couples-in on SW. IEC aerial sockets are fitted for both FM aerial and external AM aerial/earth.

Scale length is about 205mm but there are no definite frequency marks (just numbers). The tuning is pretty precise, but is without the inertia assistance of Oriental models, and we also detected very mild slack. The scales are softly illuminated and front lights indicate mains-on and stereo.

The FM section was intrinsically sensitive, but the higher-signal signal-to-noise ratios were not very good. Excluding the third-order IM performance, which was average, the front-end performance in general was low. I.F. selectivity was also below average, and although the pilot tone rejection ratio was only 39dB (worst channel), the designers failed to achieve a very good upper-frequency response, which was 4dB down at 15kHz (worst channel). Distortion was measured with the afc on, and in all cases the second harmonic predominated. Intrinsic breakthrough signal distortion was good, and owing to the good separation the worst harmonic (second again) was 53dB below the speaking channel signal (0.22%). The breakthrough was also free from excessive transient 'splash'.

Performance of the AM section appeared to be above average. The LW and MW bands were clear of bad whistles, and the SW band was remarkably sensitive working from the FM aerial. At the correct times of the day we were able to pick up very distant stations, but for serious SW DX-ing the tuner falls down owing to the restricted frequency range.

Some good comment was given for certain aspects of FM reception; but most listeners agreed that there was a mild lack of transient attack, and the reproduction was also a little light in the bass. The

good sensitivity was revealed by the reception of French stations, even during a bad tropospheric spell. FM stations are a little less easy to tune than on the models with flywheel assistance; and mild hysteresis was also detected on the tuning. The afc was found to have a good lock-on range, and by roughly tuning with the afc off, the tuning is fairly accurately pulled on to tune when the afc key is depressed.

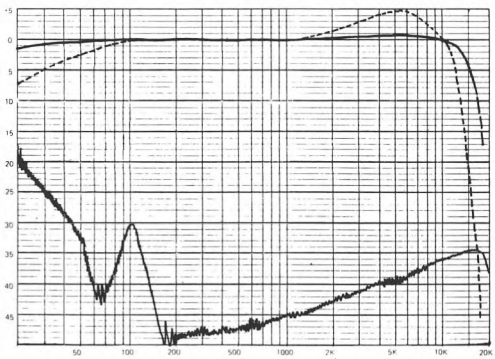
In summary, a tuner which failed to do particularly well on the FM tests, but one which would suit listeners requiring 'all-wave' AM bands in addition.

VHF Section

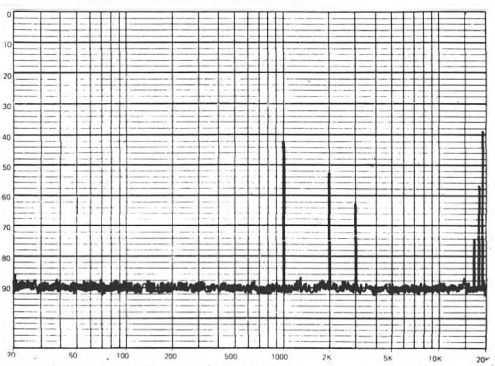
Sensitivity 30dB S/N CCIR mono (μV) 1.4
Sensitivity 50dB S/N CCIR mono (μV) 6
Sensitivity 50dB S/N CCIR stereo (μV) 50
S/N CCIR mono 1mV av. (dB) 69
S/N CCIR stereo 1mV av. (dB) 64
Limiting —1dB (μV) 1.4
Front-End Performance
3rd-order RF IM av. (dB) 64
Equiv. select. figure-of-merit (dB) 36
Repeat spot (dB) 74
Capture ratio (dB) 1.75
Select. ±400kHz av (dB) 38
Select. ±200kHz av. (dB) 4.5
Muting threshold (μV) . . . . . 25 (stereo switching only)
Sig. meter saturation (μV) . . . . . no meter
Tuning error 95MHz (kHz) . . . . . cannot be defined

Audio Section

Output ±67.5kHz dev. L-ch. (mV) 1623
Output ±67.5kHz dev. R-ch. (mV) 1638
AM rejection 1mV (dB) 50
Pilot tone suppression ref. ±67.5kHz dev. (dB) 39
Sub-ch. spuriae ref. ±67.5kHz (dB) 57
Hum ref. ±67.5kHz (dB) 63
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.4
3rd harmonic (%) 0.03
4th harmonic (%) . . . . . noise
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.63
3rd harmonic (%) 0.12
4th harmonic (%) . . . . . noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.06
3rd harmonic (%) 0.05
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.71
3rd harmonic (%) 0.13
4th harmonic (%) . . . . . noise
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.28
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 10
Response 15kHz worst ch. (dB) . . . . . —4
Response 20Hz worst ch. (dB) . . . . . —1.4
Stereo separation 1kHz (dB) 45
Stereo separation 10kHz (dB) 36
Birdies suppression (dB) 60
Dimensions (W x H x D) (mm) . . . . . 360 x 92 x 204
Typical selling price (£) £95.00
Additional information/comment:
Features include LW/MW/SW bands; internal ferrite rod aerial for LW/MW; internal coupling from FM aerial for SW; switchable afc.



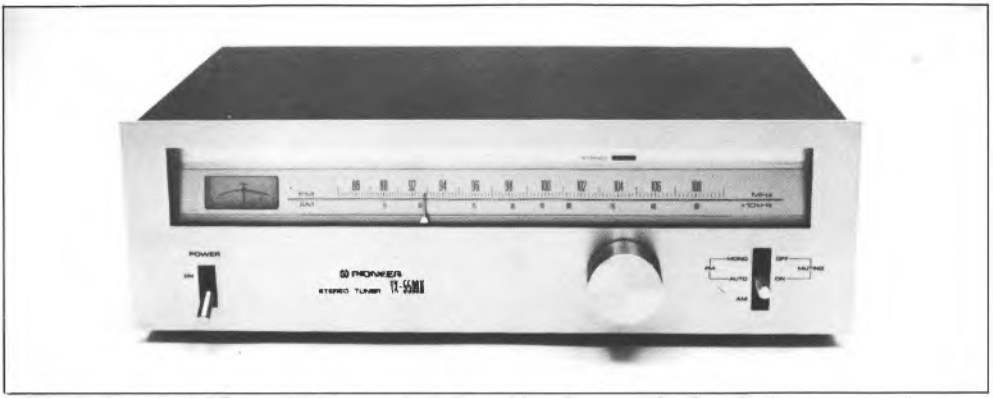
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Pioneer TX-5500 mkII

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222



This FM/AM model lies at the lower end of the price scale, and as a consequence has fewer features and is less dramatically specified than some of the more expensive models. It uses a single meter for FM centre-zero tuning, and this also deflects from centre to the right in accordance with the AM signal strength. An uncluttered brushed aluminium fascia carries a full length tuning scale, large tuning knob and lever switches for power, mono, stereo and AM. This switch also operates the muting which is active only in the stereo position, so like many of the inexpensive tuners the muting is defeated with the switch in the mono position.

The enclosure is metal of dark mottle-finish, and the top of the scale and meter are illuminated. A pair of 'phono'-type sockets at the rear deliver fixed level audio suitable for most amplifiers. 75 and 300 ohm FM aerial inputs are provided, while for AM there is an internal ferrite rod aerial. Three-core cable connects to the mains supply.

Although perfectly suitable for average reception conditions, the measured parameters are not outstanding when ranked against those of the more expensive tuners. In fact, most of the parameters scored low ranking values, though on most counts the manufacturer's specification was met. The best vhf section parameter was the 50dB stereo sensitivity, and the worst the adjacent channel selectivity, which was reflected also by the poor 'birdies' suppression ratio. Average values were obtained for repeat spot and capture ratio. These things mean that, although fine for normal or average reception conditions, the tuner is not really suitable for serious DX-ing or for use in notoriously difficult reception areas.

Low rankings were also obtained on the audio side; but, curiously, both mono and stereo distortions were ranked with the highest of the group! This is to some extent a reflection of the relatively wide i.f. bandwidth and hence the low selectivity values. The 1mV CCIR/ARM weighted signal-to-noise ratios were not very good, and it appears that the model is devoid of pilot tone rejection since the pilot tone signal was only 36dB below the test modulation level.

Apart from a little bass lift, the overall frequency response was acceptable, being no more than 2dB down at 15kHz with a smooth roll-off. Stereo separation, too, held at 40dB over most of the spectrum. As is normal, the intrinsic distortion on the breakthrough signal was pretty high, but owing to the good separation the worst harmonic (third) was 57dB below the speaking channel signal at full test modulation level (see spectrogram), corresponding to 0.14% third harmonic distortion. The breakthrough distortion could be heard by listening to this signal at high gain and in isolation, but under normal stereo listening conditions the effect was insignificant. The breakthrough signal was also free from splutter or hash at normal modulation levels.

The AM section provided above average sensitivity and below average selectivity, and for the best results an external aerial was required (terminals are available for aerial and earth). We also detected the usual 2kHz heterodyne whistle on Radio 4.

In spite of the low ranking values, the tuner gave a good account of itself on FM in the listening room. There was a little transient and upper-frequency dullness, but the reproduction generally was very smooth and free from stridence, aided, no doubt, by the very good distortion performance.

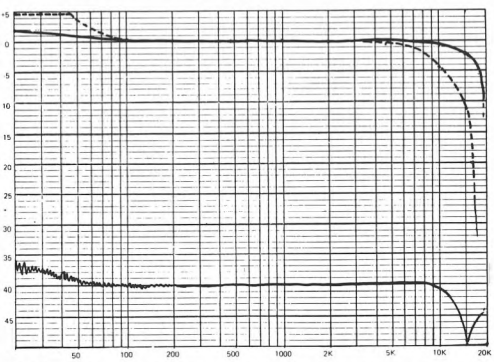
In summary, a tuner which failed to rank very well in the group, but one which has good FM audio performance although less suitable for difficult reception areas.

VHF Section

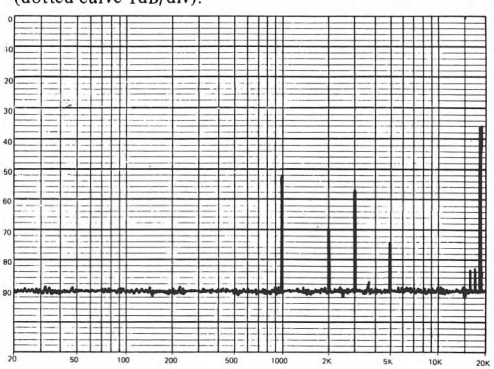
Sensitivity 30dB S/N CCIR mono (μV) 2.2
Sensitivity 50dB S/N CCIR mono (μV) 5.6
Sensitivity 50dB S/N CCIR stereo (μV) 35
S/N CCIR mono 1mV av. (dB) 71.5
S/N CCIR stereo 1mV av. (dB) 66.5
Limiting —1dB (μV) 2.3
Front-End Performance
3rd-order RF IM av. (dB) 66
Equiv. select. figure-of-merit (dB) 34
Repeat spot (dB) 83
Capture ratio (dB) . . . . . <2
Select. ±400kHz av (dB) 55
Select. ±200kHz av. (dB) 4
Muting threshold (μV) 1.5
Sig. meter saturation (μV) . . . . . —
Tuning error 95MHz (kHz) . . . . . +44

Audio Section

Output 67.5kHz dev. L-ch. (mV) 460
Output ±67.5kHz dev. R-ch. (mV) 470
AM rejection 1mV (dB) 62
Pilot tone suppression ref. ±67.5kHz dev. (dB) 36/36
Sub-ch. spuriae ref. 67.5kHz (dB) 40
Hum ref. ±67.5kHz (dB) 69
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.04
3rd harmonic (%) 0.14
4th harmonic (%) . . . . . noise
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.11
3rd harmonic (%) 0.04
4th harmonic (%) . . . . . noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.05
3rd harmonic (%) 0.22
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.08
3rd harmonic (%) 0.05
4th harmonic (%) . . . . . noise
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.05
3rd harmonic (%) 0.03
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 50
Response 15kHz worst ch. (dB) . . . . . —2
Response 20Hz worst ch. (dB) . . . . . +1.5
Stereo separation 1kHz (dB) 40
Stereo separation 10kHz (dB) 41
Birdies suppression (dB) 50
Dimensions (W x H x D) (mm) . . . . . 380 x 124 x 269
Typical selling price (£) £77.00
Additional information/comment: Features include AM MW and *internal* (non-adjustable) ferrite rod aerial; fixed muting stereo (no mono muting); 75/300-ohm aerial inputs.



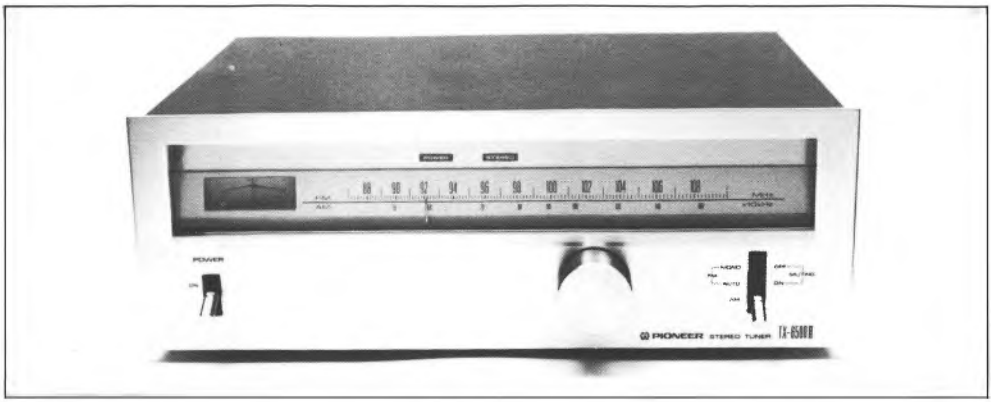
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Pioneer TX-6500 mk II

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222



This model is a little more expensive than the TX-5500II. It is rather better on features, but the measured parameters were similar to those of the less costly model with one or two exceptions. One has to rise to the TX-9500II to secure a significant improvement in overall performance. Greatest differences with respect to the TX-5500II were better pilot tone rejection and third-order IM. One feature difference is that the TX-6500II has a rear swivel ferrite rod aerial for AM. Listening room comparisons failed conclusively to reveal which model auditioned the best; but probably with a little imagination one might say that the TX-6500II had the edge on the TX-5500II at the treble end.

The tuner is enclosed in a black-finished metal case, and the brushed aluminium fascia has an overlap to faciltate cabinet mounting. A large metal knob controls the tuning; it is mechanically sound and free from backlash or slip and employs flywheel inertia for spinning over the band quickly. Lever switches are used for power and mode, the latter selecting mono, stereo and AM. As with the TX-5500II, the muting is active in the stereo position of the switch, and can only be defeated by switching to mono.

Tuning scale is about 200mm in length and carries 20kHz linear divisions. The cursor is a metal pointer, and the tuning accuracy is good, though the mid-band calibration error of this sample was greater than that of the TX-5500II. Audio signal is delivered at a fixed level from a pair of rear 'phono'-type sockets, and the output is suitable for interfacing with the vast majority of contemporary amplifiers. Terminals and a standard 75 ohm coaxial socket accommodate 300 ohm and 75 ohm aerials with no trouble. Illuminated indicators are fitted for mains-on and stereo and, like the TX-5500II, there is just the one meter for FM centre-zero tuning, and this doubles as a signal strength meter on AM.

Overall, the vhf section ranking was very close to that of the TX-5500II. We measured a shade more absolute sensitivity and better repeat spot and capture ratios; but one or two of the other parameters were slightly below those of the TX-5500II. Thus, although the tuner would be suitable for normal and average reception conditions, it cannot be recommended for DX-ing or bad reception areas.

On the audio side we measured signal-to-noise ratios close to those of the TX-5500II and distortion in the various modes as low as that from the less costly model. The designers have also fitted a pilot tone rejector to this model, the measured ratio on the worst channel being as good as 70dB (see spectrogram). In spite of this, the upper-frequency response was no more than 0.8dB down at 10kHz, dropping to a ledge of —2dB at 15kHz, thereafter falling swiftly into the 19kHz notch (see the frequency response pen chart).

Stereo separation was not quite to the standard of the TX-5500II, being nominally 35dB over most of the spectrum. The breakthrough signal distortion characteristics were such that the second harmonic was about 52dB below the speaking channel signal at full test modulation (see spectrogram), which is equivalent to 0.25% second harmonic distortion.

AM performance was round average for this class of tuner, and because the ferrite rod aerial can be swivelled it is possible to beam on to a station or adjust the acrial for the best signal/interference ratio.

FM quality was very close to that of the TX-

5500II. There was a mild lack of sparkle compared with the more expensive TX-9500II, and the distortion could be heard on the breakthrough signal monitored in isolation, but it was not obtrusive or hash-prone under normal stereo conditions.

In summary, a tuner perhaps only a shade better than the TX-5500II. Suitable mostly for average or normal reception conditions, and not high in competitive ranking values.

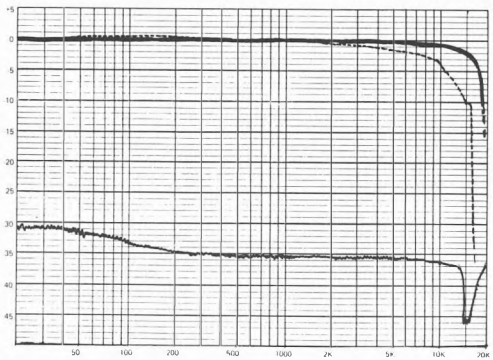
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	2
Sensitivity 50dB S/N CCIR mono (μV)	6.25
Sensitivity 50dB S/N CCIR stereo (μV)	80
S/N CCIR mono 1mV av. (dB)	70
S/N CCIR stereo 1mV av. (dB)	67
Limiting —1dB (μV)	2
Front-End Performance	
3rd-order RF IM av. (dB)	66
Equiv. select. figure-of-merit (dB)	36
Repeat spot (dB)	86
Capture ratio (dB)	1.5
Select. ±400kHz av (dB)	56.5
Select. ±200kHz av. (dB)	8.5
Muting threshold (μV)	2
Sig. meter saturation (μV)	—
Tuning error 95MHz (kHz)	—73

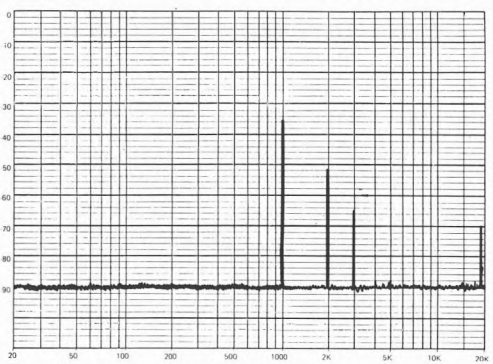
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	543
Output ±67.5kHz dev. R-ch. (mV)	524
AM rejection 1mV (dB)	50
Pilot tone suppression ref. ±67.5kHz dev. (dB)	70
Sub-ch. spuriae ref. ±67.5kHz (dB)	72
Hum ref. ±67.5kHz (dB)	68
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.3
3rd harmonic (%)	0.03
4th harmonic (%)	—
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.02
4th harmonic (%)	—
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	—
4th harmonic (%)	—
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.03
4th harmonic (%)	0.01
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	—
4th harmonic (%)	—
Total on breakthrough signal (%)	28
Response 15kHz worst ch. (dB)	—2
Response 20Hz worst ch. (dB)	0
Stereo separation 1kHz (dB)	35
Stereo separation 10kHz (dB)	31
Birdies suppression (dB)	54
Dimensions (W x H x D) (mm)	380 x 139 x 322
Typical selling price (£)	£110.00

Additional information/comment:
Features include MW with swivel ferrite rod aerial; centre-zero tuning meter for FM which seconds as signal meter on AM; stereo-mode muting; 73/300 ohm aerial inputs including British coaxial socket.



Frequency response/stereo separation curves (dotted curve 1dB/div).

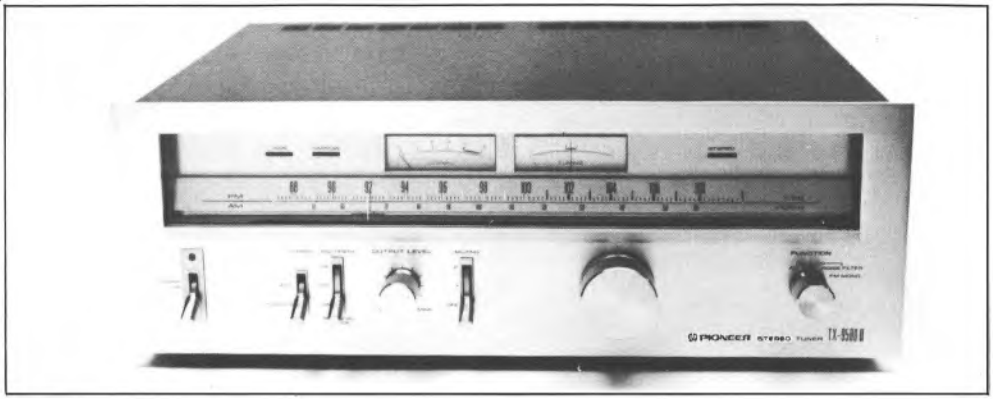


Breakthrough signal distortion

BEST BUY

Pioneer TX-9500 mkII

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222



This is Pioneer's state-of-art tuner which is naturally more costly than either of the other two models investigated. It is very well specified and our measured results easily met those issued by the manufacturer. The model includes an i.f. selectivity switch which provides either sharp selectivity for maximum discrimination against unwanted side-frequency stations at the expense of absolute audio quality, or a wide bandwidth for the very best audio quality when interference is not troublesome, so it is suitable for difficult as well as service area reception conditions. The final analysis was computed on the basis of the results obtained in the wide position.

Engineering is to a high standard using modern components, including an integrated circuit which cancels the pilot tone without the need for deep notch filtering and a surface acoustical wave (SAW) i.f. filter, in addition to four-pole phase-linear filtering. There is also a switchable tone oscillator for setting recording levels prior to an off-air recording session, and it is possible to detect — and hence cure — multipath distortion. A front switch renders the FM section sensitive to AM so the multipath can be heard as bad distortion; one may then re-orientate the aerial to reduce the distortion.

The model was one of the most sensitive of the group and it also returned very good signal-to-noise ratios. Front-end performance was very good, but not quite up to the standard of the more expensive Accuphase T-100, for example. Third order IM was worse on one response than the other, but the 72dB average value recorded cannot really be criticised. Multiple variable-tuned circuits between the aerial and mixer are responsible for the high spurious rejection ratios, some of these measurements taking our signal generators to their limits! The design adopts an oscillator buffer stage which, along with the rf stage, has a very low second harmonic content, as witnessed by the high repeat spot suppression ratio.

In the wide selectivity position the distortion was remarkably low. The worst harmonic was the second in pure stereo, but even this was a mere 0.16% at full test modulation. The self-cancelling pilot tone ic cut the 19kHz signal down to our —90dB noise floor and was not visible (see spectrogram). Frequency response was well maintained to 15kHz, though on one channel a —1dB mini-ledge was noted (see the frequency response chart). Stereo separation could have been better for a model of this price, but at 34dB over most of the spectrum it is acceptable, particularly in view of the relatively low harmonic yield of the breakthrough signal. The spectrogram shows that the second harmonic is 55dB below the speaking channel signal at full test modulation, corresponding to 0.177% second harmonic distortion. Stereo birdies in the wide selectivity position were —70dB undetectable in the narrow position.

AM performance was a little above average, although there was still the 2kHz heterodyne whistle on 908kHz. Selectivity was better than that of some AM sections and the ferrite rod aerial can be turned for the best reception.

In the wide selectivity position FM subjective quality was very good. Distant stations were received with minimal background noise, and adjacent channel stations which could not be defined in the wide selectivity position came right into focus when the selectivity was switched to narrow.

In summary, a tuner which can be adjusted for the best of quality or for optimising reception under

Pioneer TX-9500 mkII

BEST BUY

difficult conditions. A modern tuner of state-of-art design, and one which was highly ranked on both vhf and audio.

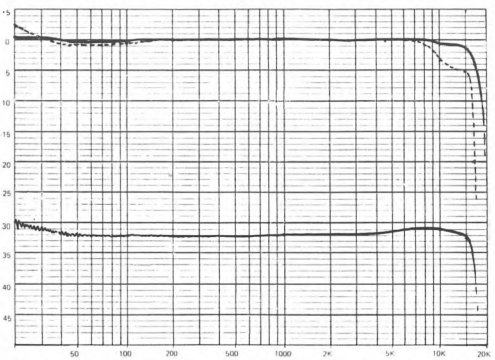
VHF Section

Sensitivity 30dB S/N CCIR mono (μV) 0.84
Sensitivity 50dB S/N CCIR mono (μV) 2.8
Sensitivity 50dB S/N CCIR stereo (μV) 28
S/N CCIR mono 1mV av. (dB) 82.5
S/N CCIR stereo 1mV av. (dB) 74.5
Limiting—1dB (μV) 0.6
Front-End Performance
3rd-order RF IM av. (dB) 72
Equiv. select. figure-of-merit (dB) 91
Repeat spot (dB) . . . . . >96
Capture ratio (dB) . . . . . <1
Select. ±400kHz av (dB) . . . . . 37 (>80 narrow)
Select. ±200kHz av. (dB) . . . . . 4 (10 narrow)
Muting threshold (μV) . . . . . 5 and 50
Sig. meter saturation (μV) 400
Tuning error 95MHz (kHz) . . . . . —119

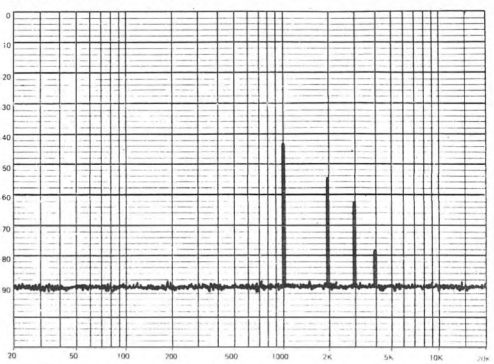
Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 1100 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 1100 (max)*
AM rejection 1mV (dB) 58
Pilot tone suppression ref. ±67.5kHz dev. (dB) . . . . . >90/>90
Sub-ch. spuriae ref. ±67.5kHz (dB) 85
Hum ref. ±67.5kHz (dB) 80
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.16**
3rd harmonic (%) 0.07**
4th harmonic (%) 0.01**
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.05**
3rd harmonic (%) 0.18**
4th harmonic (%) . . . . . noise**
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.03**
3rd harmonic (%) 0.1**
4th harmonic (%) . . . . . noise**
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.08**
3rd harmonic (%) . . . . . noise**
4th harmonic (%) . . . . . noise**
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.08**
3rd harmonic (%) . . . . . noise**
4th harmonic (%) . . . . . noise**
Total on breakthrough signal (%) 25
Response 15kHz worst ch. (dB) . . . . . —1
Response 20Hz worst ch. (dB) . . . . . +0.25
Stereo separation 1kHz (dB) 32
Stereo separation 10kHz (dB) 32.5
Birdies suppression (dB) . . . . . 70 (wide); below noise (narrow)
Dimensions (W x H x D) (mm) . . . . . 420 x 150 x 395
Typical selling price (£) £250.00
Additional information/comment:
*Also fixed output at 570/570mV L/R
**Measured in wide band condition
Features include AM MW swivel rear ferrite rod aerial; front output level control; switchable i.f. bandwidth; aerial inputs 75/300 ohms; two muting levels; MPX filter; tone oscillator level check for recording; two pairs outputs (fixed and variable); signal/tuning meters.

Notes: Hum level changes slightly with setting of level control. Final analysis made in wide i. f. bandwidth condition.



Frequency response/stereo separation curves (dotted curve 1dB/div).

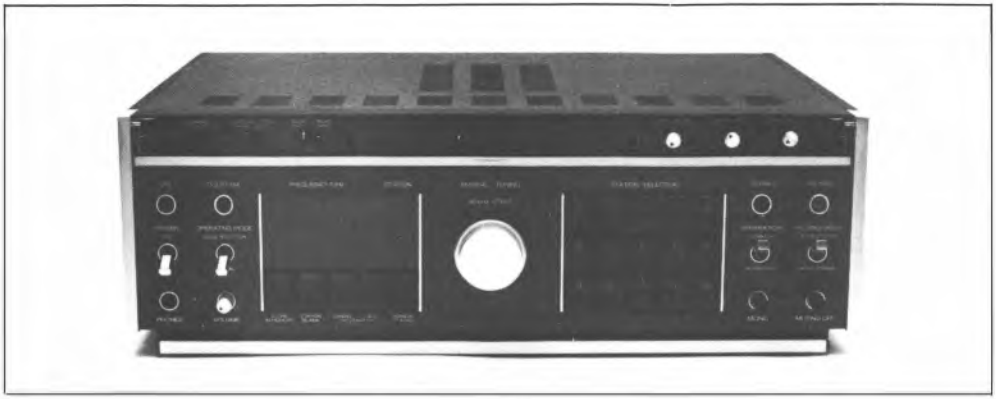


Breakthrough signal distortion

BEST BUY

Revox B760

F W O Bauch Limited, 49 Theobald Street, Boreham Wood, Herts. WD6 4RZ.



This is a digital FM-only tuner engineered to professional standards. It is metal encased with a dark crackle finish and bristles with switches and indicator lights. The appearance is a little refreshingly different from the norm and from performance, engineering quality and prestige standpoints it has a good deal going for it.

The tuned frequency is indicated by a five-digit red electronic display, reading MHz one side of the decimal point and kHz the other side. Maximum readout definition is tens of kHz, and operation of the main tuning knob changes these in increments of 50kHz. As the knob is turned, magnetic pulses (which can be detected by the 'feel') change the frequency by 50kHz; but for tuning stations of closer spacing, it is possible to add 25kHz to the frequency by pressing a button (the last digit is not displayed).

It is also possible to select fifteen stations and store tham all in an inbuilt memory for later use. The station buttons are numbered and the number of the button depressed also shows up by the side of the frequency on the electronic display. To avoid the memory from fading in the event of mains failure or when the mains is switched off at the socket, it can be continuously energised by three small cells which are fitted into a pull-out compartment at the front. The memory is retained without batteries, however, so long as only the tuner is switched off.

There are facilities for fitting a Dolby FM module and it is also possible to switch the de-emphasis over 75/50/25 μsec., the latter when using Dolby on an encoded transmission. Muting is available between any stations or between stereo stations only and the tuner also includes a headphone monitoring amplifier with jack socket and level control. Also fitted are output level and muting threshold level controls, a hi-blend noise filter, two pairs of 'phono'-type output sockets and sockets for oscilloscope detection of multipath reception. For a tuner in this category we were surprised to find that a short across one pair of outputs, as may be introduced by an amplifier muting switch, puts a short across the other pair!

Overall vhf performance was well up to the standard of the top tuners of the group. Most of the issued parameters are based on the DIN measurements, sometimes using ±40kHz deviation. Using our standard deviation, results in some areas were below those specified, including selectivity and capture ratio; but checking to DIN verified the manufacturer's results. VHF results on an *overall* basis were very close to those of the Accuphase T-100 — in real figures there being a mere two points difference between them.

Audio section results were not quite to the standard measured on some of the other expensive models, but the *overall* ranking of this section easily reached the high end of the scale in the very good region. Distortion performance was not outstanding and not to the standard achieved by the Yamaha CT-7000, for example. On one channel a slight peak was detected at 10kHz followed by a fall to 0.7dB at 15kHz. Mid-spectrum separation was very good, and the second harmonic of the breakthrough signal distortion was 51dB below the speaking channel signal at full test modulation, corresponding to 0.28% second harmonic distortion.

The tuner auditioned extremely well and was easy to use after becoming accustomed to the controls. It is difficult to tune actually to the audible signal, because when the tuning knob is turned fairly fast

the muting is activated. It is thus best to tune to the known frequency of transmission, which is what digital tuning is all about. Accuracy is very high and under crystal control.

In summary, an expensive tuner of very good performance and engineering, using state-of-art electronics.

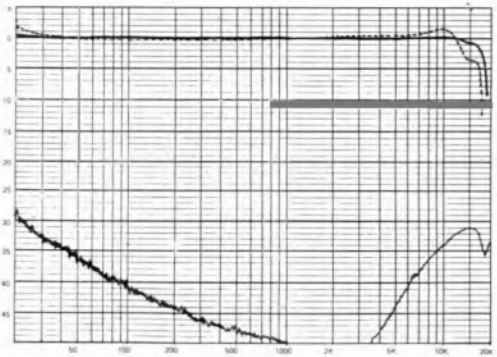
Additional information/comment:
*Down to zero; also fixed o/ps (non-isolated).
Features include digital tuning with memory; press-button and main knob station selection; facilities for Dolby; switchable inter-station and inter-stereo muting with threshold controls; output level control; switchable de-emphasis (72/50/25μsec.); two pairs 'phono' output sockets (fixed and variable); DIN output socket; sockets for 'scope multipath detection; 75/300-ohm aerials inputs (including coaxial socket); headphone amp and jack with level control; signal/tuning meters.

VHF Section

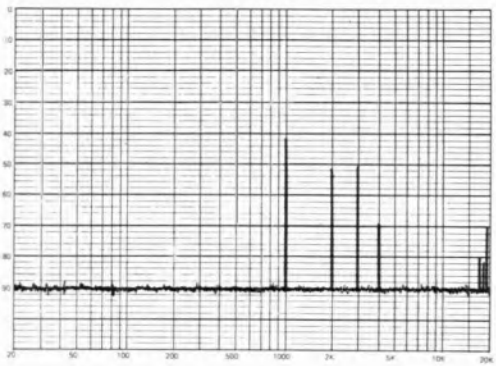
Sensitivity 30dB S/N CCIR mono (μV)	0.9
Sensitivity 50dB S/N CCIR mono (μV)	2.8
Sensitivity 50dB S/N CCIR stereo (μV)	26
S/N CCIR mono 1mV av. (dB)	78
S/N CCIR stereo 1mV av. (dB)	71
Limiting —1dB (μV)	1.1
Front-End Performance	
3rd-order RF IM av. (dB)	73
Equiv. select. figure-of-merit (dB)	>100
Repeat spot (dB)	>100
Capture ratio (dB)	2
Select. ±400kHz av (dB)	72
Select. ±200kHz av. (dB)	12
Muting threshold (μV)	11 to 75 (15 to 400 st.)
Sig. meter saturation (μV)	50,000+ (logarithmic)
Tuning error 95MHz (kHz)	zero

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1065 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1046 (max)*
AM rejection 1mV (dB)	55
Pilot tone suppression ref. ±67.5kHz dev. (dB)	70
Sub-ch. spuriae ref. ±67.5kHz (dB)	74
Hum ref. ±67.5kHz (dB)	80
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.3
3rd harmonic (%)	0.28
4th harmonic (%)	noise
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.18
3rd harmonic (%)	0.022
4th harmonic (%)	0.01
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.09
3rd harmonic (%)	0.4
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.025
4th harmonic (%)	0.012
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	31
Response 15kHz worst ch. (dB)	—0.7
Response 20Hz worst ch. (dB)	+0.3
Stereo separation 1kHz (dB)	50
Stereo separation 10kHz (dB)	34
Birdies suppression (dB)	>90
Dimensions (W x H x D) (mm)	425 x 151 x 348
Typical selling price (£)	£520.00



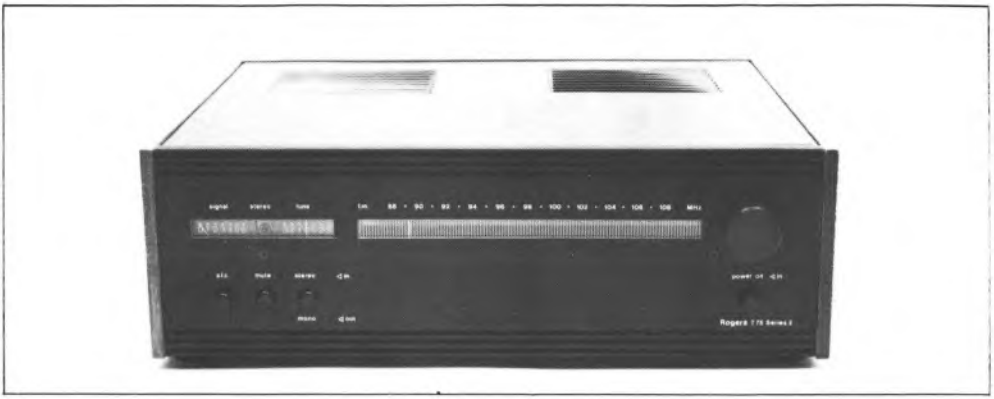
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Rogers T75/2

Swisstone Electronics Limited, 4/14 Barmeston Road, London SE6 3BN.
01-697 8511.



We were pleased to have had the opportunity of testing this up-dated design from a respected British manufacturer. The version submitted for the review was FM-only; but by the time this book is in print an FM/AM version will also be available. A new front-end is being used, and our detailed measurements revealed that the firm is well up to date with current hi-fi FM tuner design thinking.

The model differs completely in looks from its Oriental competitors. It is housed in a black-finished metal case with top vent slots and has a somewhat austere matt-black front panel carrying a couple of meters, black tuning knob, black push-buttons and an unusual scale arrangement. The cosmetics are enhanced by wooden side pieces, and the appearance is pleasantly unorthodox. In fact, the Rogers was sometimes preferred to the more usual package.

The scale is printed in white numbers directly on to the black fascia, while the tuning cursor operates behind a slim window of multiple, close-spaced vertical lines. These lines have no direct relationship to the tuned frequency and can only be regarded as guide lines. It would have been better had lines been arranged to correspond, say, to 200kHz intervals, taking account of intrinsic tuning non-linearity. The window is illuminated, as also are the meters and the usual type of indicator glows when a stereo transmission is tuned in. The tuning mechanism lacks the ultimate finesse of most Japanese models, but is, nevertheless, precise and devoid of backlash, slip or overshoot. It employs a small flywheel, but the mass of this is inadequate to allow the tuning to be spun over the band against the friction of the mechanics.

Engineering quality is good, the press-switches being of reasonable precision. A four-gang capacitor is used for FM, and when the AM band is present this will be tuned by a three-gang section. Components are indentified on the printed circuit boards and the componenets used are of good quality.

The audio output is delivered by a DIN socket and the 75 ohm aerial is connected by a British type coaxial socket. A European type socket is also available for connecting 300ohm twin feeder.

We were encouraged by some of the parameters measured. The absolute sensitivity in on a par with some of the most sensitive Japanese designs, and the small-signal signal-to-noise ratios were commendable. Mono 1mV signal-to-noise ratio was also very acceptable; but the sample was not quite as good on 1mV stereo signal-to-noise ratio.

The third order IM was as good as 70dB on one response, the average of the two being 69dB, which is good for a tuner in this price category. Front-end selectivity 'figure-of-merit' was good in keeping with three variable-tuned circuits between aerial and mixer, while the excellent repeat spot suppression ratio indicates good rf and local oscillator design.

The signal strength meter was favoured for its logarithmic response, allowing it to indicate low as well as high signal strengths before saturating. The tuning meter was also well aligned, least distortion and best stereo separation occurring at centre-zero (also with afc on). Overall selectivity was about average, and although the adjacent channel ratio was not too high, birdies rejection was virtually infinite owing to the use of a low-pass filter between detector and decoder, This tended, as is usual, to impair hf stereo separation a little.

In summary, a tuner of good vhf performance and lower audio performance, limited on our sample by

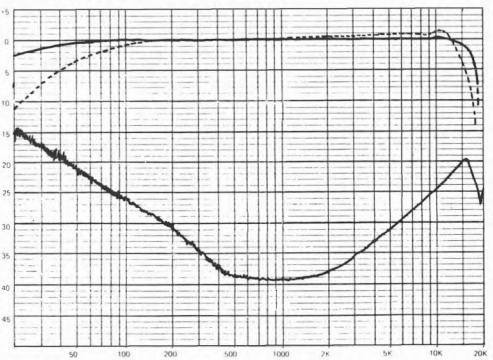
the separation, stereo signal-to-noise ratio, and the highish breakthrough distortion. Nevertheless, it received average acclaim for auditioning, and is a tuner suitable for DX trials, though limited in this respect by the nature of frequency calibration and scaling.

VHF Section

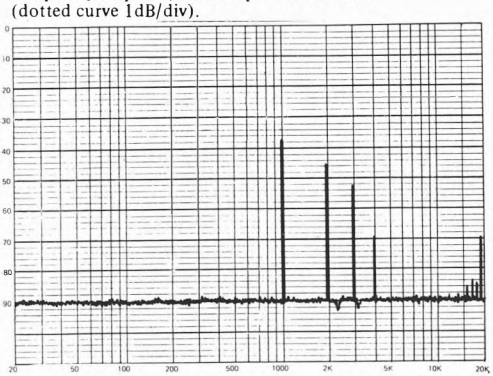
Sensitivity 30dB S/N CCIR mono (μV) 1
Sensitivity 50dB S/N CCIR mono (μV) 3.6
Sensitivity 50dB S/N CCIR stereo (μV) 36
S/N CCIR mono 1mV av. (dB) 77
S/N CCIR stereo 1mV av. (dB) 66
Limiting —1dB (μV) 1.2
Front-End Performance
3rd-order RF IM av. (dB) 69
Equiv. select. figure-of-merit (dB) 62
Repeat spot (dB) . . . . . >94
Capture ratio (dB) . . . . . <1.5
Select. ±400kHz av (dB) 66
Select. ±200kHz av. (dB) 6.5
Muting threshold (μV) 2
Sig. meter saturation (μV) 12500
Tuning error 95MHz (kHz) . . . . . —127

Audio Section

Output ±67.5kHz dev. L-ch. (mV) 938
Output ±67.5kHz dev. R-ch. (mV) 900
AM rejection 1mV (dB) 56
Pilot tone suppression ref. ±67.5kHz dev. (dB) 70
Sub-ch. spuriae ref. ±67.5kHz (dB) 59
Hum ref. ±67.5kHz (dB) 77
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch. . . . . (Distortion with afc on)
2nd harmonic (%) 0.25
3rd harmonic (%) 0.4
4th harmonic (%) 0.04
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.28
4th harmonic (%) 0.03
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.5
4th harmonic (%) 0.01
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.28
4th harmonic (%) 0.03
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.14
3rd harmonic (%) 0.05
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 50
Response 15kHz worst ch. (dB) . . . . . —0.75
Response 20Hz worst ch. (dB) . . . . . —2.2
Stereo separation 1kHz (dB) . . . . . 38 (afc on)
Stereo separation 10kHz (dB) . . . . . 25 (afc on)
Birdies suppression (dB) . . . . . >80
Dimensions (W x H x D) (mm) . . . . . 362 x 286 117 approx.
Typical selling price (£) £125.00
Additional information/comment:
Features include 75/300-ohm aerial inputs (including coaxial socket); DIN output socket only; rear level control; buttons for mute, afc, stereo/mono, power and aerial attenuator (rear).



Frequency response/stereo separation curves (dotted curve 1dB/div).

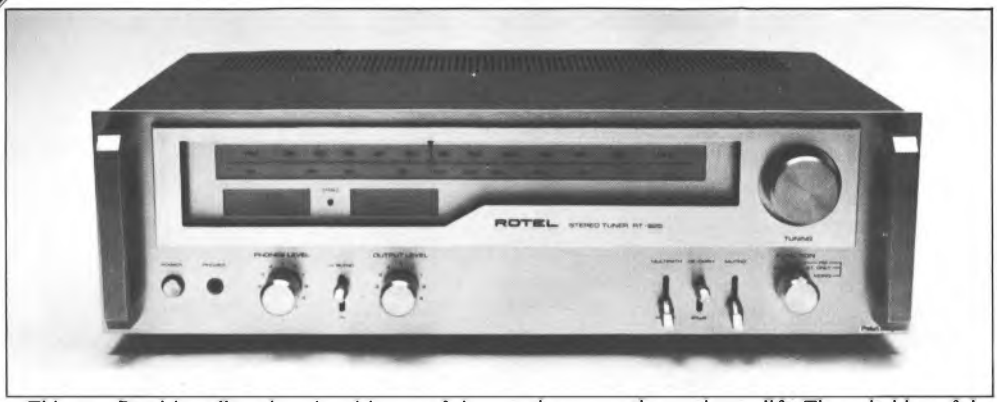


Break through signal distortion

RECOMMENDED

Rotel RT-925

Rank Audio Products Limited, P O Box 70, Great West Road, Brentford, Middlesex. 01-568 9222.



This new Rotel is well equipped and is one of the few tuners featured in this book which includes a jack socket for headphone listening and associated volume control. It is metal-encased of dark-grey crackle finish, and the brushed aluminium fascia has a slightly raised scale section of 'silvered' plastics material. At the sides of the front are two large handles which give a sort of professional effect. The model includes MW with a swivel-type rear ferrite rod aerial.

Controls and switches are metal and of good precision. A large tuning knob is ergonomically disposed at the top right-hand corner, with smaller counterparts for function, signal level and headphone volume below. Power is switched by a press-button and lever switches are used for high-blend, multi-path, 25μsec. de-emphasis and muting.

The multipath switch works in conjunction with the FM tuning meter, and the degree by which the reception is being effected by reflected signals is shown by the amount the meter deflects to the right of centre with the multipath switch on. With the switch off, the normal centre-zero tuning facility is provided. Tests showed that slightly reduced distortion can be obtained with the meter a shade away from centre-zero. The signal strength meter will accommodate a fair signal level before running out of scale. The 25μsec. de-emphasis switch would only be used with a Dolby decoder on a Dolby-encoding transmission. The function switch has positions for auto-FM, stereo-only, FM-mono and MW AM. In the stereo-only position all transmissions other than stereo-encoded ones are muted.

Both in this position and with the ordinary muting on it is necessary to tune very accurately on to a station to get the muting to lift. The switching of the stereo decoder also appeared to be a little sluggish, the switching not occurring unless the station is carefully tuned.

Scale for FM is about 215mm in length with fairly linear calibration at 1MHz intervals. A series of small dots below the main scale approximate 200kHz intervals. Scale and meters are clearly printed and fairly brightly illuminated with yellowish light. Tuning mechanism is inertia assisted, free-running and free from aberration. Stereo transmissions are revealed by the glowing of a small red light, which is barely bright enough. Mains is connected through two-core cable, and the insulation would appear to be to class II standard.

Terminals and a coaxial socket are provided for FM aerials, and 'phono' type sockets for audio and four-channel decoder. There are two pairs of audio outputs, the signal from one pair adjustable by a front control.

Overall ranking was high for the vhf section, with most of the parameters being above average. The tuner is remarkably sensitive and selective, so would be suitable for DX-ing. A good overload immunity is also provided for strong signal areas. Audio section ranking was lower owing to a higher than average CCIR/ARM noise output, pilot tone and sub-channel spuriae (on the worst channel). Stereo distortion was good, as also was the FM frequency response.

Engineering quality was judged to be upper-average. Inside the fuses are identified but not the component numbers on the printed circuit boards, though this will barely bother the normal enthusiast. The FM aerial was found to match very well indeed to the coaxial socket 75 ohm input.

RECOMMENDED

AM reception was judged to be close to average, though the model appeared to be a trifle more sensitive than some. A whistle was present at our site on 908kHz (Radio 4).

FM reception could not be faulted under normal reception conditions. Some listeners felt that the stereo noise floor was a trifle high, but this was marginal. Stereo birdies could be incited with a strong signal applied 200kHz from a tuned stereo signal — more one side than the other owing to a little asymmetry of the adjacent channel response.

In summary, a well appointed tuner with headphone monitoring, good FM sensitivity, selectivity and overload immunity, and one which gave a good account of itself in the listening room.

VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	0.9
Sensitivity 50dB S/N CCIR mono (μV)	3.2
Sensitivity 50dB S/N CCIR stereo (μV)	28
S/N CCIR mono 1mV av. (dB)	71.5
S/N CCIR stereo 1mV av. (dB)	69
Limiting —1dB (μV)	0.9
Front-End Performance	
3rd-order RF IM av. (dB)	67
Equiv. select. figure-of-merit (dB)	54
Repeat spot (dB)	85.5
Capture ratio (dB)	1.5
Select. ±400kHz av (dB)	>75
Select. ±200kHz av. (dB)	10
Muting threshold (μV)	1.25
Sig. meter saturation (μV)	1,200
Tuning error 95MHz (kHz)	+67

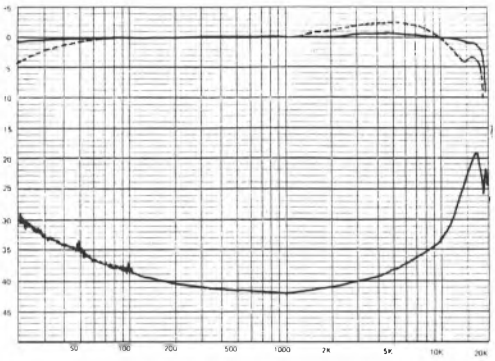
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	937 (max)*
Output ±67.5kHz dev. R-ch. (mV)	929 (max)*
AM rejection 1mV (dB)	50
Pilot tone suppression ref. ±67.5kHz dev. (dB)	46/55
Sub-ch. spuriae ref. ±67.5kHz (dB)	65/64
Hum ref. ±67.5kHz (dB)	72 (mainly 3rd harmonic)
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.17
3rd harmonic (%)	0.05
4th harmonic (%)	0.04
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.35
3rd harmonic (%)	0.063
4th harmonic (%)	0.001
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.028
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.31
3rd harmonic (%)	0.063
4th harmonic (%)	0.028
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	63
Response 15kHz worst ch. (dB)	—0.8
Response 20Hz worst ch. (dB)	—0.8
Stereo separation 1kHz (dB)	42
Stereo separation 10kHz (dB)	33
Birdies suppression (dB)	62
Dimensions (W x H x D) (mm)	480 x 150 x 350
Typical selling price (£)	£165.00

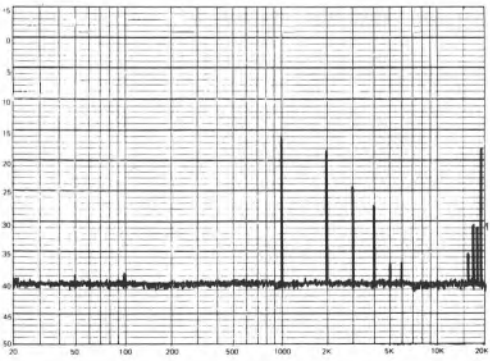
Additional information/comment:

*Level control max. Also fixed at 579/572m V(L/R).

Features include MW with rear swivel ferrite rod aerial; 75/300-ohm aerial inputs, including 75-ohm coaxial socket; tuning/signal meters; multipath switch working with tuning meter; normal muting and muting all but stereo; front level control with two pairs outputs; 4-ch. decoder output from FM detector; 25μsec. de-emphasis switch at front; headphone jack socket with associated level control.



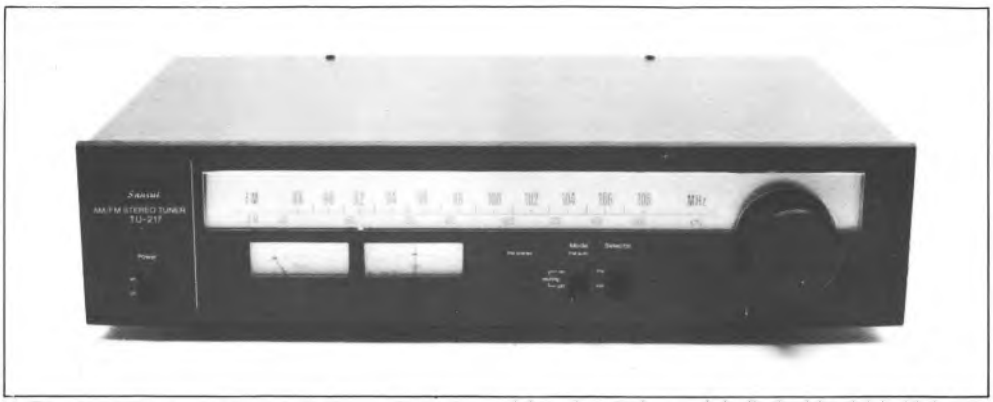
Frequency response/stereo separation curves (dotted curve 1dB/div)



Breakthrough signal distortion

Sansui TU-217

Sansui London Showroom, 39/41 Maple Street, London W1P 5FU. 01-580 5353.



This model lies at the lower end of the price scale. Presentation is similar to the other models of the series, with a black-finished fascia and light-coloured scale and meter backings, and a metal enclosure of 'chocolate-brown' colour with side-screw fixing. As with the other Sanui models, side adaptors are provided to facilitate rack-mounting, but this low-profile model occupies minimal space. For the price, it is slightly better than average in engineering quality, but obviously lacks some of the features and ultimate performance capabilities of the more expensive models.

Tuning precision is good, aided by the usual flywheel inertia, and the scale, whose active length is about 220mm, is almost linear in calibration at 200kHz intervals. Mid-band calibration error of the sample was remarkably small at a mere —8kHz. Neither the scales nor the meters are illuminated, but a small indicator light on the fascia tells when the tuner is switched on, and a similar indicator is used to signify a tuned stereo transmission. The rear carries 'phono' type sockets for audio and terminals for aerial; there is a swivel ferrite rod for AM and a three-core cable for power. The components are identified on the printed circuit board to facilitate servicing.

Absolute sensitivity was below the average of the group, while the 50dB stereo signal-to-noise ratio was relatively poor. In normal reception conditions these shortfalls should not bother you, but we would have liked to have measured a better 1mV stereo signal-to-noise ratio, however. Front-end performance is fairly typical of a tuner at the lower end of the price range, so this model would be most suitable for normal or average reception conditions. The audio section measured a little better than the vhf section, being mainly limited by fairly high sub-channel spuriae and highish inherent ripple levels.

On the other hand, the distortion in all modes was relatively small, the worst harmonic being the second in pure stereo mode at 0.32%. The least distortion and the best stereo separation occurred with the tuning meter at centre-zero. Stereo separation did not quite make 40dB, but because the intrinsic distortion on the breakthrough signal was relatively small, 47dB separates the speaking channel fundamental from the worst second harmonic of the breakthrough signal at ±67.5kHz deviation.

The designers have achieved better rejection of the 19kHz pilot tone than the 38kHz sub-channel, and even though the measured ratio of the former was as good as 58dB (see spectrogram), the upper-frequency response of the worst channel was only 0.8dB down at 15kHz (0.2dB on the other channel). Low bass end response was also well maintained on this model.

There would appear to be no low-pass filtering between the FM detector and stereo decoder, so rejection of birdies interference relies essentially on the i.f. rejection ratio. On the adjacent channel this was 7.5dB, which is why a birdies rejection ratio of only 64dB was measured, though tests using our controlled system signals failed to reveal undue transient splash from the non-speaking channel.

AM performance was below average and a rather bad whistle plagued Radio 4 on 908kHz although the swivel rear ferrite rod aerial was useful. Although the FM performance was good, our listening panel was a little worried about the slightly higher than average background fizz on weak or only moderately strong stereo signals. Where there were

no adjacent channel interfering stations, the tuner pulled in distant stations, albeit, with a fairly high background noise.

In summary, a neat little tuner capable of good quality FM on strong signals, but less accommodating on weaker signals. Not particularly suitable for serious DX-ing, but should not give trouble in most average signal areas.

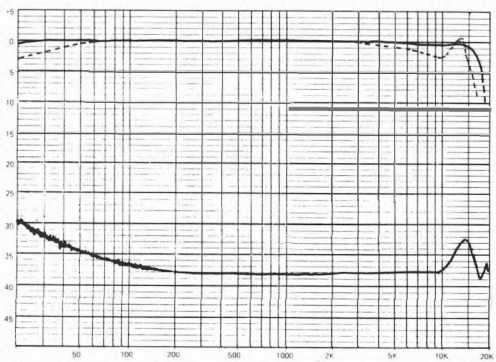
Additional information/comment:
Features include AM with swivel rear ferrite rod aerial; signal/tuning meters; 75/300-ohm aerial inputs.

VHF Section

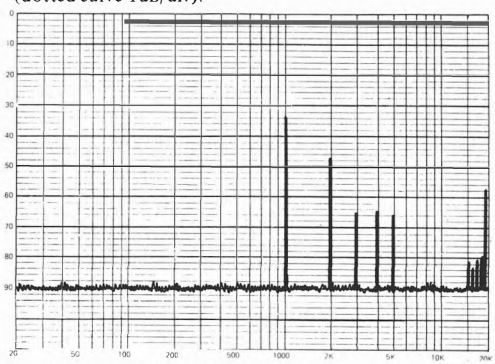
Sensitivity 30dB S/N CCIR mono (μV)	1.78
Sensitivity 50dB S/N CCIR mono (μV)	4.46
Sensitivity 50dB S/N CCIR stereo (μV)	80
S/N CCIR mono 1mV av. (dB)	73
S/N CCIR stereo 1mV av. (dB)	66
Limiting —1dB (μV)	2.94
Front-End Performance	
3rd-order RF IM av. (dB)	60.5
Equiv. select. figure-of-merit (dB)	34
Repeat spot (dB)	73
Capture ratio (dB)	1.6
Select. ±400kHz av (dB)	61
Select. ±200kHz av. (dB)	7.5
Muting threshold (μV)	2
Sig. meter saturation (μV)	250
Tuning error 95MHz (kHz)	—8

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	857
Output ±67.5kHz dev. R-ch. (mV)	820
AM rejection 1mV (dB)	60
Pilot tone suppression ref. ±67.5kHz dev. (dB)	58/58
Sub-ch. spuriae ref. ±67.5kHz (dB)	36
Hum ref. ±67.5kHz (dB)	67
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.32
3rd harmonic (%)	0.05
4th harmonic (%)	0.05
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.03
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	0.18
4th harmonic (%)	0.03
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.01
4th harmonic (%)	0.01
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	18
Response 15kHz worst ch. (dB)	—0.8
Response 20Hz worst ch. (dB)	—0.6
Stereo separation 1kHz (dB)	38
Stereo separation 10kHz (dB)	38
Birdies suppression (dB)	64
Dimensions (W x H x D) (mm)	430 x 110 x 307 approx.
Typical selling price (£)	£114.00



Frequency response/stereo separation curves (dotted curve 1dB/div).

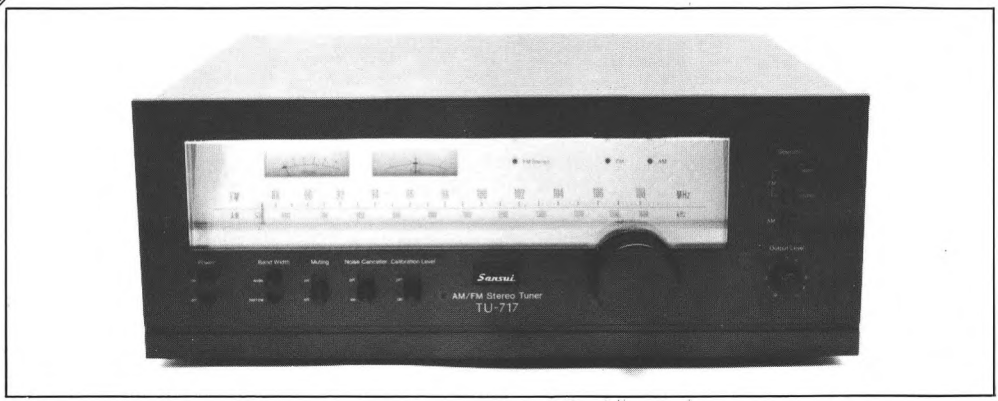


Breakthrough signal distortion

RECOMMENDED

Sansui TU-717

Sansui London Showroom, 39/41 Maple Street, London W1P 5FU. 01-580 5353.



A significant step in price above the TU-217, this model reflects proportionally more facilities and improved performance. The black-fascia-look is adopted, and adaptors are provided for rack-mounting with other components of the hi-fi system, which seems to be the current trend. Behind a large glass window on the fascia lies a clearly-printed light-coloured scale with indicator lights and two illuminated meters at the top-left. The tuner is enclosed in 'chocolate'-coloured metal with side-screw fixing; press-switches are used for band selection and lever switches for the other functions while a small knob controls the audio level.

The FM scale has an active length round 250mm with slightly non-linear 200kHz calibration marks. Alignment accuracy was good at mid-band, and the very smooth tuning is geared-down a little more than usual, which aids the selection of closely-spaced stations.

This model is equipped with switchable i.f. bandwidth and a tape machine level setting calibration tone whose output is close to Dolby level. Bandwidth is switchable over wide and narrow; but we felt that the wide could have been wider and the narrow narrower to provide a larger ratio on the adjacent channel.

High sensitivity and good signal-to-noise ratios were measured which, allied with the good front-end performance and switchable bandwidth, makes the tuner suitable for use in difficult as well as average reception areas. There are three variable-tuned circuits between aerial and mixer, and this is partly responsible for the good front-end selectivity 'figure-of-merit' and the very good repeat spot rejection ratio; a good third order IM ratio was also measured.

In the wide bandwidth position the distortion in all modes was very small, the worst harmonics being the second in stereo L+R and pure mono at full test deviation. In the narrow position, however, the upper-order FM sidebands are constrained which causes a rise in distortion and a fall in stereo separation. We analysed in the wide position; had the final results been obtained in the narrow position the vhf performance would have been better than the audio performance. With this tuner, then, you can make your own choice. Normally, you would only select narrow when endeavouring to separate a weak signal from a close-frequency strong one.

In the wide positiion, however, the second harmonic of the breakthrough signal had the same amplitude as the fundamental (see spectrogram); but owing to the astonishingly high stereo separation at wide (outside the range of our 50dB graph!), the breakthrough harmonic was still virtually 60dB below the speaking channel's fundamental, corresponding to 0.1% relative distortion.

High frequency response could have been better for a tuner of this price at —1.4dB (wide) and 15kHz (worst channel). The broken-line response shows that the output rises a trifle owing to the pilot tone filter action before dropping rapidly into the 19kHz notch. No birdies response could be evoked. The tuner is also equipped with a stereo 'noise cancelling' filter, which is a hi-blend MPX filter.

AM performance was slightly above average, but we detected no benefit in front-end selectivity. There were still the usual whistles and monkey chatter after dark. Operating in the wide position, the tuner yielded very clean audio signals, though on our transient-type distribution system test signal we required to apply a trace of treble boost at the

RECOMMENDED

amplifier to reproduce the full attack of the music. We also noticed a slightly longer than normal muting delay, and when the muting lifted with the amplifier at fairly high volume an annoying 'plop' was fed to the loudspeakers.

To summarise, a tuner which is capable of good quality audio under a wide variety of reception conditions. It is suitable for DX-ing and is averagely-equipped for the price.

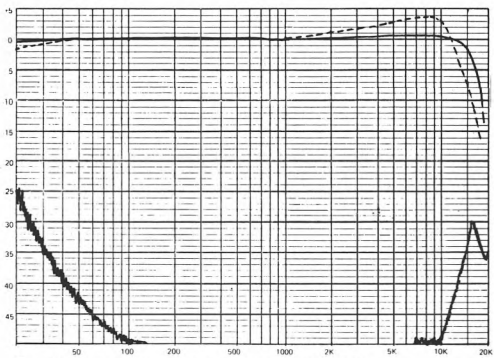
VHF Section

Sensitivity 30dB S/N CCIR mono (μV) 1.25
Sensitivity 50dB S/N CCIR mono (μV) 3.5
Sensitivity 50dB S/N CCIR stereo (μV) 32
S/N CCIR mono 1mV av. (dB) 77.5
S/N CCIR stereo 1mV av. (dB) 75.5
Limiting —1dB (μV) 1.3
Front-End Performance
3rd-order RF IM av. (dB) 69.5
Equiv. select. figure-of-merit (dB) 50
Repeat spot (dB) 93
Capture ratio (dB) ..... <1.5 (wide)
Select. ±400kHz av (dB) ..... 59 (wide); >80 (narrow)
Select. ±200kHz av. (dB) ..... 6.5 (wide); 10 (narrow)
Muting threshold (μV) 5
Sig. meter saturation (μV) 250
Tuning error 95MHz (kHz) ..... +50

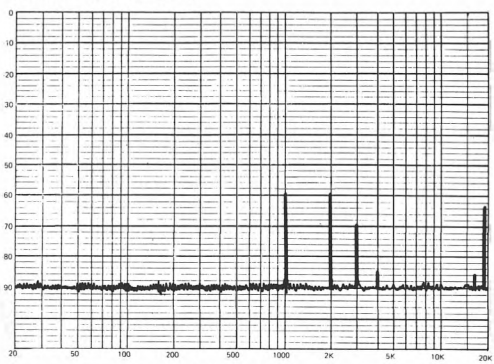
Audio Section

Output ±67.5kHz dev. L-ch. (mV) 1110
Output ±67.5kHz dev. R-ch. (mV) 1088
AM rejection 1mV (dB) ..... 55 (wide and narrow)
Pilot tone suppression ref. ±67.5kHz dev. (dB) 63/64
Sub-ch. spuriae ref. ±67.5kHz (dB) 78
Hum ref. ±67.5kHz (dB) 75
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) ..... 0.08 (wide)
3rd harmonic (%) ..... 0.04 (wide)
4th harmonic (%) ..... noise (wide)
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) ..... 0.14 (wide)
3rd harmonic (%) ..... 0.02 (wide)
4th harmonic (%) ..... noise (wide)
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) ..... 0.09 (wide)
3rd harmonic (%) ..... 0.04 (wide)
4th harmonic (%) ..... noise (wide)
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) ..... 0.14 (wide)
3rd harmonic (%) ..... 0.022 (wide)
4th harmonic (%) ..... noise (wide)
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) ..... 0.1 (wide)
3rd harmonic (%) ..... noise (wide)
4th harmonic (%) ..... noise (wide)
Total on breakthrough signal (%) ..... 12.6 (narrow); 100 (wide)
Response 15kHz worst ch. (dB) ..... —1.5 (narrow); —1.4 (wide)
Response 20Hz worst ch. (dB) ..... —0.3 (narrow and wide)
Stereo separation 1kHz (dB) ..... 33 (narrow); >60 (wide)
Stereo separation 10kHz (dB) ..... 34 (narrow); 50 (wide)
Birdies suppression (dB) ..... bo birdies
Dimensions (W x H x D) (mm) ..... 420 x 168 x 402 approx.
Typical selling price (£) £207.00

Additional information/comment:
Features include MW with rear swivel ferrite rod aerial; wide/narrow bandwidth switch; noise canceller (MPX filter); calibration tone oscillator; front output level control; 75/300-ohm aerial inputs.
Notes: Distortion greater at high deviations in narrow bandwidth. Tone oscillator level approximately equivalent to ±50kHz deviation.



Frequency response/stereo separation curves (dotted curve 1dB/div).

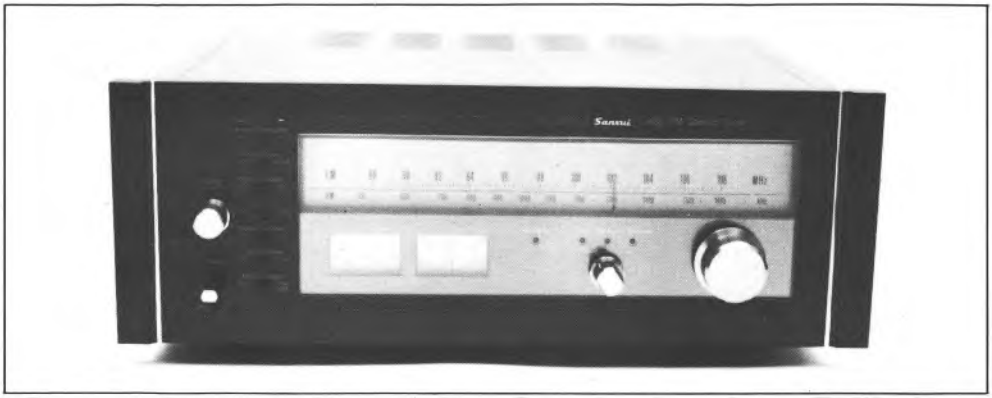


Breakthrough signal distortion

BEST BUY

Sansui TU-9900

Sansui London Showroom, 39/41 Maple Street, London W1P 5FU. 01-580 5353.



We are now looking at a tuner which is about £100 more expensive than the above-average-price TU-717. Whether a £300 investment for a tuner alone can be justified is often queried; but this is by no means the highest price you can pay as witnessed, for example, by the Accuphase T-100. There is no doubt that the TU-9900 is a very good performer, of good engineering standard and well equipped. Ignoring any 'prestige factor', and based on sheer value-for-money, we feel that it has a good deal going for it.

Presentation follows the black-look of its more modest sisters. A large window at the front displays a clearly-printed tuning section, two usefully-sized meters and four indicator lights. A large tuning knob is located at bottom-right, while a vertical column of press-switches at the left activate a variety of functions. Mains is switched by a lever, above which is an output level control. The bands are switched by a smaller knob at the left of the tuning knob.

It is a rather large tuner and the black presentation is not favoured by everyone, so it would best partner an amplifier of similar styling, such as Sansui's AU-9900 or AU-11000A. The softly illuminated FM scale carries 200kHz graduations, but we were disappointed by the +152kHz calibration error at 95MHz; for a tuner of this price one would expect better. We would also have liked to have recorded a higher aerial input signal before saturation of the signal meter, but the more useful tuning meter was well calibrated, and the centre-zero position gave correct indication of the least distortion and best stereo separation.

Switchable wide and narrow i.f. selectivity is provided, with the narrow mode giving a higher adjacent channel ratio than the TU-717. Although the distortion in the wide mode was very small, we would have appreciated a somewhat wider bandwidth in this position. As is usual, in the narrow mode the distortion increased and the separation fell dramatically compared to the wide mode. For normal reception the wide position would therefore be used, bringing in the narrow for more difficult reception conditions. No birdies response could be evoked in the narrow position.

Overall, the vhf performance was very good, some of the finest figures of the group being obtained in the lab. The third order IM performance failed to reach the Accuphase T-100 standard, but in the unlikely event of being troubled by spuriae you merely press a button to introduce aerial attenuation. A special noise cancelling circuit is fitted which uses a light-emitting diode and CdS light cell which varies the inter-channel crosstalk in proportion to signal strength — the coupling automatically increasing with fall in signal. The pilot tone filter is switched but we prefer a fixed filter carefully engineered with the de-emphasis so as not to affect the hf response. You will see that with the filter active, this model has a —2.8dB droop at 15kHz; to get a better response the filter has to be switched off! The bass response also tends to fall away a trifle early.

In spite of these points, the overall audio performance results were very good, big factors in favour being the very low distortion, high rejection ratios and good separation. It should be noted that the results were derived in the wide mode and with the pilot tone filter active. Distortion on the breakthrough signal was incredibly low (see spectrogram), which put the worst harmonic

BEST BUY

(second) 76dB below the speaking-channel's fundamental.

AM performance was a little above average, but whistles plagued some stations. FM auditioning in wide mode with filter off prompted very encouraging panel comment. Under these conditions the TU-9900 produced some of the finest sounds of the group.

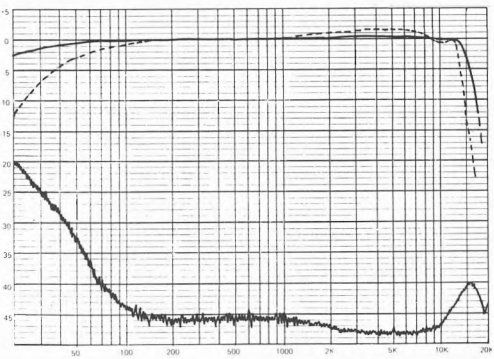
In summary, a top-flight tuner, but with some odd points that could be improved. A model which would be at home in almost any reception area and also with very good sound quality, it is not too highly-priced in terms of performance and features.

VHF Section

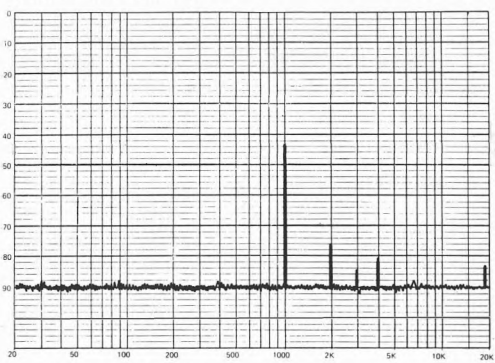
Sensitivity 30dB S/N CCIR mono (μV) 0.9
Sensitivity 50dB S/N CCIR mono (μV) 2.5
Sensitivity 50dB S/N CCIR stereo (μV) 25
S/N CCIR mono 1mV av. (dB) 83
S/N CCIR stereo 1mV av. (dB) 78
Limiting —1dB (μV) 0.85
Front-End Performance
3rd-order RF IM av. (dB) 69
Equiv. select. figure-of-merit (dB) . . . . . >100
Repeatspot (dB) . . . . . >100
Capture ratio (dB) . . . . . 1 (wide); <2 (narrow)
Select. ±400kHz av (dB) . . . . . 60 (wide); >90 (narrow)
Select. ±200kHz av. (dB) . . . . . 10 (wide); 20 (narrow)
Muting threshold (μV) 3.15
Sig. meter saturation (μV) 300
Tuning error 95MHz (kHz) . . . . . +152

Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 1204 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 1234 (max)*
AM rejection 1mV (dB) 57
Pilot tone suppression ref. ±67.5kHz dev. (dB) . . . . . 83 (filter on); 32 (filter off)
Sub-ch. spuriae ref. ±67.5kHz (dB) . . . . none (filter on); 40 (filter off)
Hum ref. ±67.5kHz (dB) 80
*Distortion (measured wide mode)***
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.05
3rd harmonic (%) . . . . . noise
4th harmonic (%) 0.01
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.28
3rd harmonic (%) 0.02
4th harmonic (%) 0.12
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.08
3rd harmonic (%) 0.01
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.06
3rd harmonic (%) 0.01
4th harmonic (%) 0.01
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.09
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 3.6
Response 15kHz worst ch. (dB) . . . . . —2.8 (filter on); 0 (filter off)
Response 20Hz worst ch. (dB) . . . . . —2.5 (filter on); —2.1 (filter off)
Stereo separation 1kHz (dB) . . . . . 46 (wide); 24 (narrow)
Stereo separation 10kHz (dB) . . . . . 47 (wide); 25 narrow)
Birdies suppression (dB) . . . . . —70 (wide); none (narrow)
Dimensions (W x H x D) (mm) 460 x 160 x 310 approx)
Typical selling price (£) £300.00
Additional information/comment:
*Also 426/460 (L/R) Dolby outputs.
**All harmonics significantly higher narrow mode.
Features include MW with swivel rear ferrite rod aerial; front level control; tuning/signal meters; 75/300-ohm aerial inputs; low-pass (pilot tone) filter switch; noise canceller switch; FM bandwidth switch; calibration tone oscillator; multipath switch and sockets; muting switch; aerial attenuator switch; sockets for Dolby unit (25μsec. de-emphasis) and 4-ch. decoder; internal de-emphasis switch.



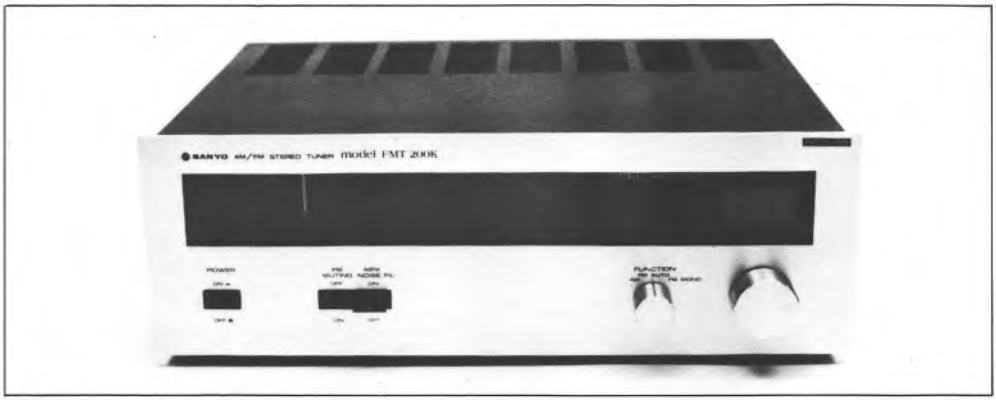
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Sanyo FMT-200K

Sanyo Marubeni (UK) Limited, 8 Greycaine Road, Watford, Herts. Watford 46363.



Although unable to rival the performance of some of the more expensive models, the new Sanyo FMT-200K is nevertheless an attractively-styled little tuner of very moderate price. It would appear to be more suitable for a 'budget' hi-fi system than one with greater pretensions; even so, it is capable of working with pretty well any amplifier, though certain quality reservations need to be taken into account.

The scale section occupies almost the whole length of the brushed aluminium fascia, and is dark-backed, clearly printed and illuminated, and has an active length round 200mm. FM scaling is substantially linear, but calibration points occur only at 500kHz intervals; the accuracy of mid-band calibration was remarkably high — the error being a mere +8kHz. a single meter is located at the right-hand side of the scale section for FM centre-zero tuning, seconding to indicate relative signal strength on AM. FM stereo is indicated by the glowing of the word stereo at the top-left of the scale.

Tuning mechanism is fairly free and inertia assisted, but the friction of the sample was too great to permit a complete spin over the band. The cursor is made of a plastics material whose tip glows red. A conveniently-sited metal knob operates the tuning, while a smaller counterpart switches the bands and FM functions. Black press-buttons are used for mains on/off, muting and MPX noise filter switching (the latter consisting merely of a switched capacitor across the left and right channels). Encasement is dark-finished metal and the fascia overlaps the enclosure slightly; the corners are rather sharp.

General engineering is to a fair quality and the electronics are built upon a single printed circuit board with the components identified. Servicing should not present too much of a problem. Overall performance of the vhf section was better than that of the audio section. The tuner is not outstandingly sensitive and the stereo signal-to-noise ratio of the sample was not too good; but we did obtain very good results on some parameters, including a very high repeat spot rejection ratio, overall alternate channel selectivity and third-order IM, where one sideband was up to 76dB.

On the audio side, the stereo distortion was fairly high at ±67.5kHz deviations; stereo separation was also pretty poor with the tuning set for centre-zero on the meter although slight improvements resulted from tuning away centre-zero slightly. The designers have achieved good pilot tone and sub-channel spuriae rejection ratios, but the former at the expense of a —1.5dB droop in 15kHz frequency response (the other channel was better at —0.1dB). In spite of the reasonable adjacent channel selectivity, the birdies rejection ratio was not too good, and birdies interference could be coaxed from the tuner by our distribution system signals.

Fortunately, the distortion on the breakthrough signal was pretty small compared with some other models of the group, and the spectrogram shows that the worst (second) harmonic is some 44dB below the speaking-channel's fundamental. The distortion and noise on the breakthrough signal is monitored at fairly high amplifier gain.

The AM section had about average performance, though on the ferrite rod (which cannot be swivelled) the sensitivity appeared to be a little below average. A whistle was present on 908kHz Radio 4.

The two pairs of audio outputs are not isolated — a short across one attenuating the signal across the other. General FM reception was quite reasonable

bearing in mind the price. Master tape quality was somewhat below the top standard of the group, with some stridence and breakthrough 'splash' at high modulation levels, but the fair vhf section renders the tuner suitable for DX trials. With the muting on, a 'plop' occurred from the loudspeakers each time a station was tuned in.

In summary, a reasonable little tuner at the low end of the price scale. It obviously has shortfalls due to the low price, but would certainly be suitable for a 'budget' system.

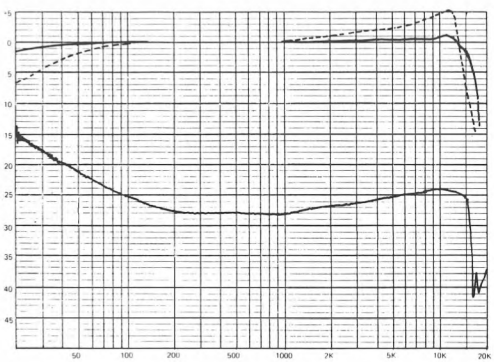
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.7
Sensitivity 50dB S/N CCIR mono (μV)	6.25
Sensitivity 50dB S/N CCIR stereo (μV)	72
S/N CCIR mono 1mV av. (dB)	75
S/N CCIR stereo 1mV av. (dB)	63
Limiting —1dB (μV)	1.5
Front-End Performance	
3rd-order RF IM av. (dB)	69.5
Equiv. select. figure-of-merit (dB)	42
Repeat spot (dB)	>96
Capture ratio (dB)	2
Select. ±400kHz av (dB)	74
Select. ±200kHz av. (dB)	8.5
Muting threshold (μV)	8
Sig. meter saturation (μV)	—
Tuning error 95MHz (kHz)	+8

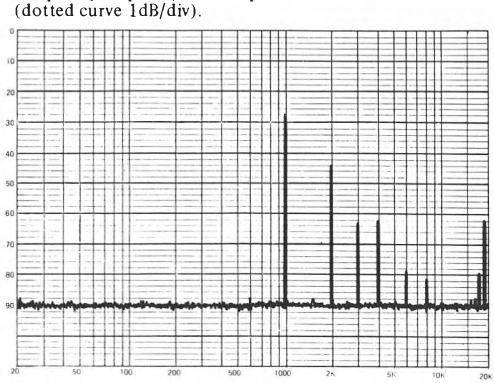
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	487
Output ±67.5kHz dev. R-ch. (mV)	482
AM rejection 1mV (dB)	54
Pilot tone suppression ref. ±67.5kHz dev. (dB)	63
Sub-ch. spuriae ref. ±67.5kHz (dB)	80
Hum ref. ±67.5kHz (dB)	70
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.5
3rd harmonic (%)	0.28
4th harmonic (%)	0.03
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.35
3rd harmonic (%)	0.25
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.18
3rd harmonic (%)	0.25
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.25
3rd harmonic (%)	0.28
4th harmonic (%)	0.016
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.12
3rd harmonic (%)	0.03
4th harmonic (%)	noise
Total on breakthrough signal (%)	15.9
Response 15kHz worst ch. (dB)	—1.5
Response 20Hz worst ch. (dB)	—1.3
Stereo separation 1kHz (dB)	28
Stereo separation 10kHz (dB)	24
Birdies suppression (dB)	60

Dimensions (W x H x D) (mm) . . . . . 350 x 270 x 115 approx
Typical selling price (£) £80.00
Additional information/comment:
Features include MW with non-swivel rear ferrite rod aerial; 75/300-ohm aerial inputs; MPX noise filter; switchable muting; two pairs audio outputs and rear preset level control for one pair.



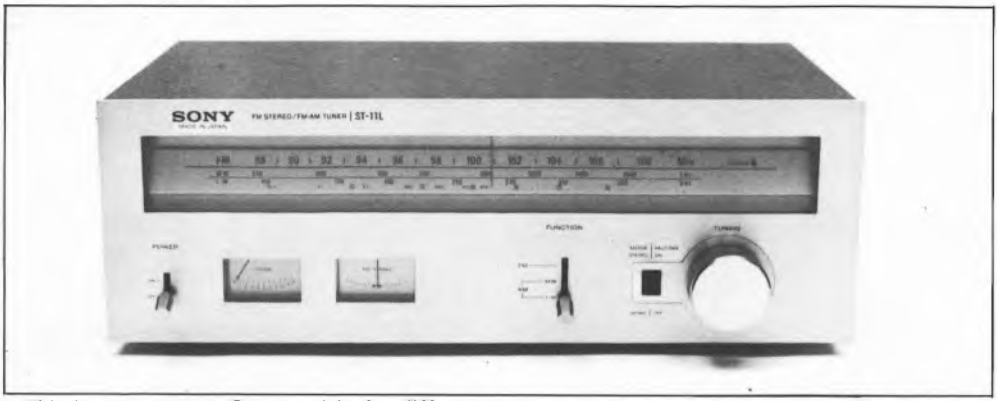
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Sony ST-11L

Sony London Showroom, 134 Regent Street, London W1R 0DJ. 01-439 3874.



This is a very recent Sony model of a different series from the others reviewed in this book. It is also less costly than any of the other Sony models reviewed here, and this is reflected by somewhat poorer measured parameters and an average ranking for engineering quality. Overall rank was also pulled down a bit by the rather large mid-band alignment error. On the whole, however, the parameters of the manufacturer's specification were met.

The tuner is in a matt-grey finish metal enclosure with negligible overlap and side-screw fixing. Fascia is the 'standard' brushed aluminium, with a large metal knob for tuning, metal lever switches for power and function, and a black switch adjacent to the tuning knob for muting, ganged with mono/stereo switching (in the stereo position the muting is always active, for disablement it is necessary to switch to mono.)

Tuning mechanism is inertia assisted, and is free and without slip or backlash. Scale length is approximately 210mm but with frequency graduations only at 1mHz intervals; it is softly illuminated by top reflected light and angled slightly off the vertical. The cursor is a slim 'silvered' metal pointer.

Two illiminated meters for signal strength and FM tuning reside below the scales at the left of the fascia, the former marked zero to ten handling a fairly large signal before saturating, and the latter accurately set for the best results at centre zero. The rear is hardboard but not flimsy, and an internal ferrite rod aerial is fitted for AM signal pick up; The 'L' suffix indicates the presence of a LW band in addition to MW. No frequency drift was detected, but the muting was found to be marginally sluggish and stations can be missed when tuning fast in the stereo position. As with some of the Hitachi models, cost has been cut by the use of 'phono'-plug-terminated flying leads instead of rear panel sockets. 75 and 300 ohm and AM aerial terminals are fitted, complemented by a coaxial socket.

Sensitivity was about average and stereo 50dB quieting good but we were unhappy with the 1mV mono and stereo signal-to-noise ratios, as neither was good. Front-end performance generally was below the group's average. Audio output would be suitable for most hi-fi amplifiers. We were particularly unhappy with the pilot tone residual and residual sub-carrier spuriae, the latter in particular which was only 22dB below our test modulation. This should really be improved. On the other hand, bearing in mind the price, the distortion performance even at full stereo modulation was quite reasonable. In the stereo mode the worst harmonic (third) occurred on the difference signal, and the same harmonic also predominated in pure mono mode; but all harmonics quickly collapsed with reducing modulation level.

Distortion on the breakthrough signal was high, and slight 'splutter' could be detected on the signal at high modulation peaks. The spectrogram shows that both the second and third harmonics of the breakthrough signal are 50dB below the speaking channel signal, so distortion under normal stereo listening conditions would not be much of a problem. In spite of the lack of pilot tone filtering, the upper-frequency response was not very flat, and rose by about 2dB as shown by the dotted line response; there was also some bass loss. Stereo separation held at 40dB over most of the spectrum.

AM performance was about average with relative freedom from whistles, and the LW band could be

useful next year when the programme frequencies change. FM auditioning was not unduly exciting judged critically. Traces of distortion and 'tizz' could be detected at high peak modulation levels, and mild spuriae were generated from high aerial input levels. Reproduction also seemed to be a little light in bass.

To summarise, as a fairly inexpensive tuner the overall sound quality was acceptable; it also has the 'attributes' of long and medium wavebands. On overall assessment, however, it failed to rank as highly as other Sony models.

VHF Section

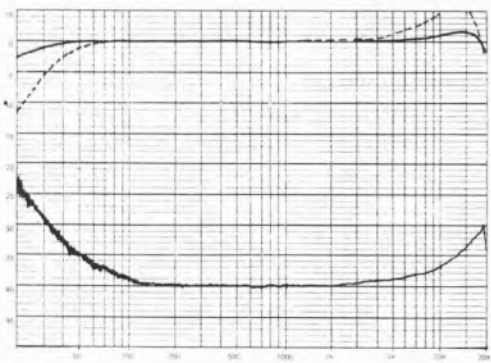
Sensitivity 30dB S/N CCIR mono (μV)	1.4
Sensitivity 50dB S/N CCIR mono (μV)	4
Sensitivity 50dB S/N CCIR stereo (μV)	32
S/N CCIR mono 1mV av. (dB)	71.5
S/N CCIR stereo 1mV av. (dB)	67
Limiting —1dB (μV)	1.4
Front-End Performance	
3rd-order RF IM av. (dB)	61.5
Equiv. select. figure-of-merit (dB)	38
Repeat spot (dB)	72
Capture ratio (dB)	1.5
Select. ±400kHz av (dB)	58
Select. ±200kHz av. (dB)	4.5
Muting threshold (μV)	2
Sig. meter saturation (μV)	1500
Tuning error 95MHz (kHz)	+244

Audio Section

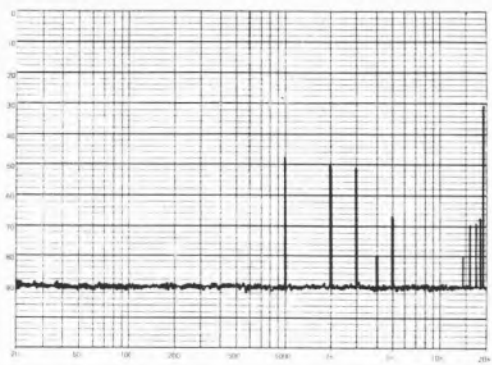
Output ±67.5kHz dev. L-ch. (mV)	761
Output ±67.5kHz dev. R-ch. (mV)	732
AM rejection 1mV (dB)	49
Pilot tone suppression ref. ±67.5kHz dev. (dB)	32/30
Sub-ch. spuriae ref. ±67.5kHz (dB)	22
Hum ref. ±67.5kHz (dB)	70
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.14
3rd harmonic (%)	0.25
4th harmonic (%)	0.07
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.14
3rd harmonic (%)	0.04
4th harmonic (%)	0.016
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.35
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.07
3rd harmonic (%)	0.035
4th harmonic (%)	0.12
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.05
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	90
Response 15kHz worst ch. (dB)	+1.8
Response 20Hz worst ch. (dB)	—2.3
Stereo separation 1kHz (dB)	40
Stereo separation 10kHz (dB)	37
Birdies suppression (dB)	68
Dimensions (W x H x D) (mm)	406 x 145 x 249
Typical selling price (£)	£90.00

Additional information/comment

Features include AM LW and MW with non-swivel internal ferrite rod aerial; 75/300-ohm aerial inputs (with standard coaxial socket); muting stereo only position; signal/tuning meters.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

COMMENDED

Sony ST-2950

Sony London Showroom, 134 Regent Street, London W1R 0DJ. 01-439 3874.

This is an 'all-wave' tuner which covers the LW, MW and SW bands as well as FM. It would thus be of particular interest to those listeners who attach a fair degree of importance to AM and who are keen on SW exploration over 6 to 18MHz. The FM section is below the standard of that of other Sony models.

A metal enclosure of dark-grey top and wooden side pieces sets off a brushed aluminium fascia with black markings and black edging round the signal and tuning meters. Tuning control is precise, being inertia assisted and free-running. Scale length approximates 200mm but the lack of frequency graduations between the MHz intervals makes it difficult exactly to determine the tuned frequency, though the mid-band alignment error was small. The meters and scale are well illuminated and the stereo indicator glows bright red.

Features include a mono switch, which also defeats the muting, and an MPX noise filter. Aerial inputs are available for 75 and 300 ohms and a swivel ferrite rod aerial for the long and medium wavebands is incorporated.

Although the absolute sensitivity and 50dB signal-to-noise ratios were about average, the overall vhf ranking was retarded by the poor third-order IM and the mediocre selectivity ratios. The front-end equivalent selectivity figure-of-merit is compatible with the use of only two variable-tuned circuits between the aerial and mixer. In strong signal areas, therefore, the tuner might exhibit spuriae; this could of course, be cured by aerial attenuation, but then the weaker signals would be attenuated as well. A tuner capable of wide input dynamic range requires to be more complex, which is why it costs more!

Audio section ranking was also below group average as the result of the low 1mV signal-to-noise ratios and mediocre pilot tone rejection ratio. Upper-frequency response was also of a relatively low order (see 1dB/div. frequency response graph). Other parameters, including distortion, were not too bad, and the stereo separation for a tuner of this price was above average. The spectrogram shows that the second harmonic of the breakthrough signal was 51dB below the speaking channel signal at full test modulation, corresponding to about 0.4% second harmonic distortion, which is not too bad.

AM performance was a shade above average with the swivel ferrite rod aerial, and there was a relative freedom from heterodyne whistles, including that which often plagues Radio 4 on 908kHz. It is possible to connect an external AM aerial, as with most other tuners with AM, but the Sony has a front switch which disconnects the rod and couples in the external aerial, which is a good idea. For SW reception an external aerial is essential, and for this there is a separate terminal. We were surprised at the good sensitivity of the SW section, particularly with a good aerial, and although we detected some images and spuriae they were not excessive. It was a trifle frustrating, though, to be confined to the 6 to 18MHz frequency range!

FM results were below average. With our system signals we detected a few spuriae as the result of strong signals. A/B comparison tests confirmed that the stereo background noise was higher than average at moderate signal strengths; reflected signals also appeared to cause more than average distortion. Upper treble and transient attack was judged to be poor, and overmodulation caused heavy splashes from the non-speaking channel.

In summary, a useful tuner if you are keen on AM

RECOMMENDED

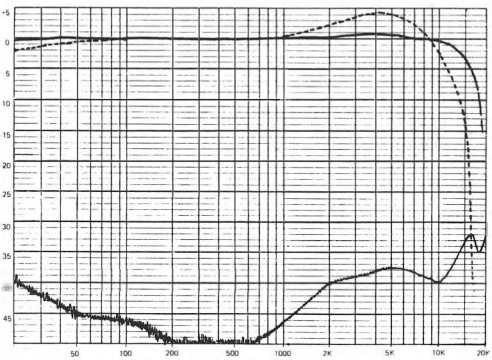
reception and SW exploration; but not a tuner that is really happy on FM.

VHF Section

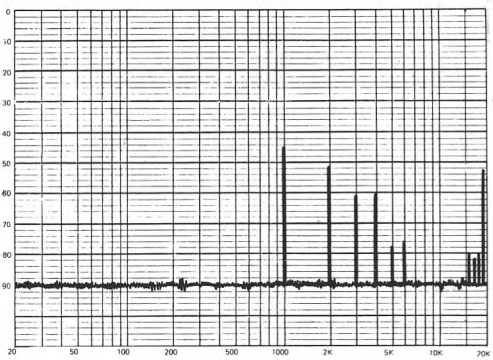
Sensitivity 30dB S/N CCIR mono (μV) 1.25
Sensitivity 50dB S/N CCIR mono (μV) 4.46
Sensitivity 50dB S/N CCIR stereo (μV) 44.6
S/N CCIR mono 1mV av. (dB) 71
S/N CCIR stereo 1mV av. (dB) 66.5
Limiting —1dB (μV) 1.3
Front-End Performance
3rd-order RF IM av. (dB) 57
Equiv. select. figure-of-merit (dB) 40.5
Repeat spot (dB) 73.5
Capture ratio (dB) 1
Select. ±400kHz av (dB) . . . . . 52 (asymmetrical)
Select. ±200kHz av. (dB) . . . . . 7.5 (asymmetrical)
Muting threshold (μV) 2
Sig. meter saturation (μV) 500
Tuning error 95MHz (kHz) . . . . . +82

Audio Section

Output ±67.5kHz dev. L-ch. (mV) 660
Output ±67.5kHz dev. R-ch. (mV) 689
AM rejection 1mV (dB) 54
Pilot tone suppression ref. ±67.5kHz dev. (dB) 50/53
Sub-ch. spuriae ref. ±67.5kHz (dB) 65
Hum ref. ±67.5kHz (dB) 70
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.45
3rd harmonic (%) 0.13
4th harmonic (%) 0.1
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.05
4th harmonic (%) 0.02
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.16
3rd harmonic (%) 0.06
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.32
3rd harmonic (%) 0.06
4th harmonic (%) 0.05
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.18
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 44.7
Response 15kHz worst ch. (dB) . . . . . —2.5
Response 20Hz worst ch. (dB) . . . . . —0.2
Stereo separation 1kHz (dB) 46
Stereo separation 10kHz (dB) 40
Birdies suppression (dB) 60
Dimensions (W x H x D) (mm) . . . . . 390 x 145 x 310
Typical selling price (£) £95.00
Additional information/comment:
Features include AM LW, MW and SW with swivel rear ferrite rod aerial and aerial switch; signal and tuning meters; MPX filter; 75/300-ohm aerial inputs; muting stereo mode only.



Frequency response/stereo separation curves (dotted curve 1dB/div).

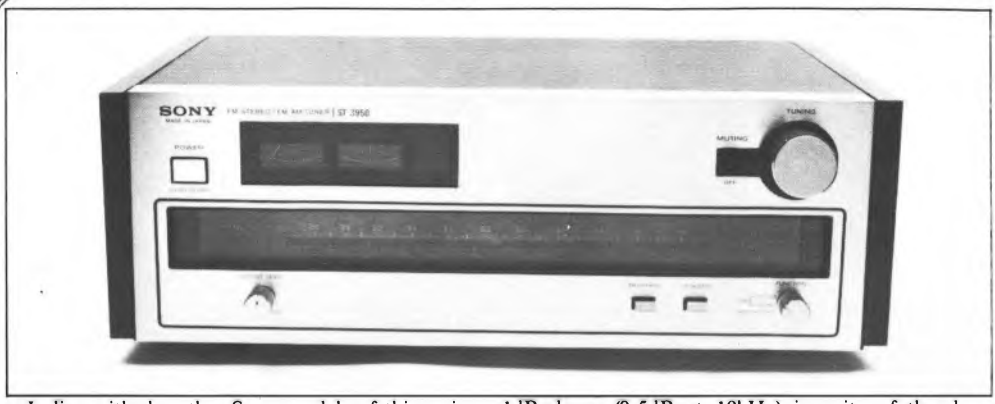


Breakthrough signal distortion

BEST BUY

Sony ST-3950

Sony London Showroom, 134 Regent Street, London W1R 0DJ. 01-439 3874.



In line with the other Sony models of this series, the dark-grey metal top of the enclosure is complemented by wooden side pieces, while the dark-backed meters and scales contrast pleasantly with the brushed aluminium fascia. The inertia type tuning is well engineered, and the red-glowing cursor incorporates an upper section which switches on when a station is accurately tuned in, and this was found to correspond to the centre-zero of the tuning meter. Scale length is about 220mm with slightly non-linear 200kHz graduations; station setting accuracy was good and the mid-band alignment error of the sample small; scale numbers are illuminated against the black background.

Overall, the vhf section was found to have a very acceptable performance, ranking high amongst the group. Three variable-tuned circuits are used between the aerial and mixer, and this is responsible for the above average front-end selectivity figure-of-merit. The parameter which did less well was the third-order IM, and we formed the impression that the sample aas a trifle unconfortable when presented with two or nore fairly strong signals. This was probably because one of the IM responses gave a smaller ratio than the other. It will be recalled from the Technical Section that we quote the average of the two responses in the lab results. On the other hand, the repeat spot suppression ratio was very good. The tuner also arrived at —1dB limiting pretty quickly.

Overall audio ranking was about average, being limited by the 1mV signal-to-noise ratios. Nevertheless, the results are not bad and some respectable parameters were measured. The 1dB/div. frequency response graph shows that on the worst channel the response at 15kHz was only 1dB down (0.5dB at 10kHz) in spite of the deep notch filter which provided a pilot tone attentuation of 64dB (worst channel again).

Stereo separation measured a good 45dB over the important part of the spectrum, and, as shown by the spectrogram, the third harmonic of the breakthrough signal was 55dB below the speaking channel signal at full test modulation, corresponding to about 0.18% 3rd harmonic distortion. No problems were experienced in matching the tuner with our range of test amplifiers.

The ranking of the features on our weighted scale also came out about average. The model is equipped with two pairs of audio outputs and a level control, four-channel decoder sockets and sockets for connecting to an external oscilloscope for detecting multipath reception. It is also possible to switch the signal meter to respond to multipath, but the test sample was not all that successful in this respect (the ST-5950SD was better). With the muting active it is possible to miss stations by tuning too fast, but many tuners are like this. The signal meter has only a small dynamic range, but the centre-zero meter and the cursor light were accurately aligned to the point of least distortion and best stereo separation, which is more important.

Off-air AM performance was fair although with the ferrite rod aerial the sensitivity seemed to be a little less than other models; selectivity was reasonable, however, and there was a relative freedom from whistles and monkey chatter. FM auditioning was good, with the treble, transient attack and bass being well maintained. Average off-air signals caused no spuriae, but stepping up the level of our test signals could induce them; quite strong off-air signals would be required for bad

Sony ST-3950

BEST BUY

trouble.

In summary, a reasonably-priced tuner of useful features, good auditioning and acceptable parameters which, when related to the price represents a good buying proposition.

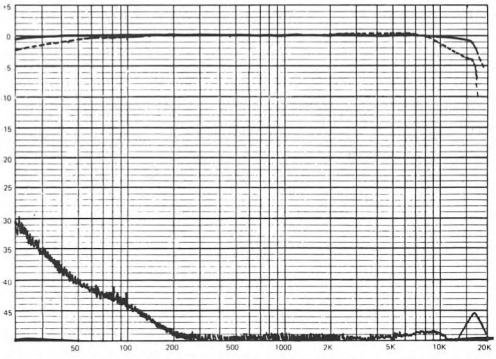
Features include AM MW with swivel rear ferrite rod aerial; front level control; two pairs outputs (fixed and variable); 4-ch. decoder (from FM detector) sockets; muting switch; multipath buttons; MPX filter; 75/300-ohm aerial inputs; internal de-emphasis switch.

VHF Section

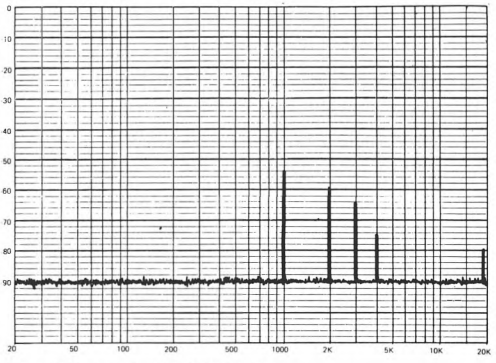
Sensitivity 30dB S/N CCIR mono (μV) 1.1
Sensitivity 50dB S/N CCIR mono (μV) 3.2
Sensitivity 50dB S/N CCIR stereo (μV) 32
S/N CCIR mono 1mV av. (dB) 71
S/N CCIR stereo 1mV av. (dB) 66
Limiting —1dB (μV) 0.9
Front-End Performance
3rd-order RF IM av. (dB) 65
Equiv. select. figure-of-merit (dB) 62
Repeat spot (dB) 100
Capture ratio (dB) 1.25
Select. ±400kHz av (dB) 76
Select. ±200kHz av. (dB) 9
Muting threshold (μV) 4
Sig. meter saturation (μV) 50
Tuning error 95MHz (kHz) . . . . . +69

Audio Section

Output ±67.5kHz dev. L-ch. (mV) . . . . . 1375 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 1369 (max)*
AM rejection 1mV (dB) 53
Pilot tone suppression ref. ±67.5kHz dev. (dB) 68/64
Sub-ch. spuriae ref. ±67.5kHz (dB) 70
Hum ref. ±67.5kHz (dB) 70
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.25
3rd harmonic (%) 0.04
4th harmonic (%) 0.03
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.3
3rd harmonic (%) 0.13
4th harmonic (%) . . . . . noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.18
3rd harmonic (%) 0.18
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.35
3rd harmonic (%) 0.14
4th harmonic (%) 0.02
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.2
3rd harmonic (%) 0.06
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 31
Response 15kHz worst ch. (dB) . . . . . —1
Response 20Hz worst ch. (dB) . . . . . —0.3
Stereo separation 1kHz (dB) 45
Stereo separation 10kHz (dB) 37
Birdies suppression (dB) 72
Dimensions (W x H x D) (mm) . . . . . 460 x 170 x 335
Typical selling price (£) £138.00
Additional information/comment:
*Also fixed output at 650mV left and 653mV right (non-interacting). Click position on level control identifies setting where variable output same as fixed output.



Frequency response/stereo separation curves (dotted curve 1dB/div).

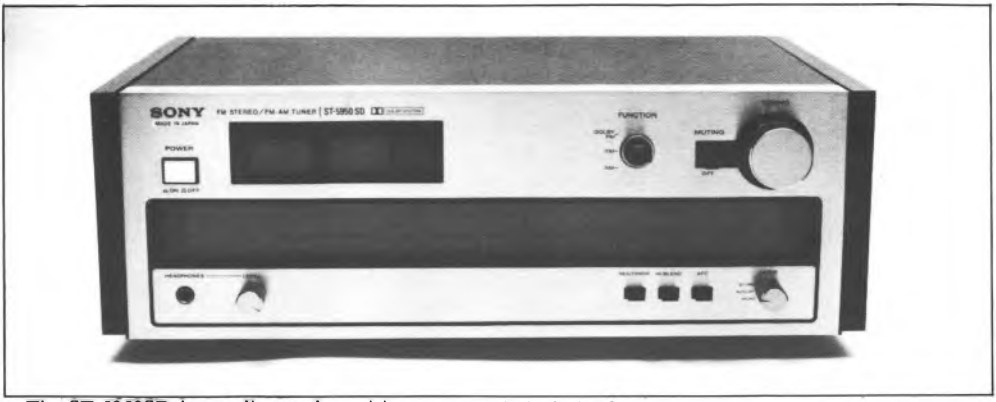


Breakthrough signal distortion

BEST BUY

Sony ST-5950SD

Sony London Showroom, 134 Regent Street, London W1R 0DJ. 01-439 3874.



The ST-5950SD has styling and precision on par with the other two Sony models of this series but more potent circuitry and includes Dolby B noise reduction. It is thus more expensive, but bearing in mind the overall performance and features provided we regard it as very good value for money.

Scale length is about 230mm with essentially linear calibration, and the cursor consists of a thin red-glowing line, the upper part of which also glows red when a station is accurately tuned.

Overall ranking of the VHF section was very high, falling well into the very good section of our ranking order. Except for the third order IM, which was about the average of the group, all the other parameters were well above average. In fact, the real figure score was a shade above that of the Accuphase T-100. The tuner would thus be suitable for difficult reception areas and DX trials, while being perfectly happy in normal reception areas. Aerial inputs are provided for 75 and 300 ohm aerials, but the socket for the former is a special screw type for which a plug is provided: it is inconvenient to fit but ensures a good match to the aerial.

Overall ranking of the audio section was also high, the score in real figures was equal to that of the Accuphase T-100. Stereo separation was better than 50dB mid-spectrum, and as is usual when the separation is high, the intrinsic distortion on the breakthrough signal was also high at about 50%. However, as revealed by the spectrogram, the worst harmonic was 60dB below the speaking channel signal at full test modulation, which corresponds to a mere 0.1% second harmonic distortion under peak modulation stereo conditions. Happily, one does not normally listen to the breakthrough signal amplified in isolation!

The spectrogram also shows the pilot tone 80dB below full test modulation level, which is excellent. In spite of this the designers have achieved a very commendable upper frequency response which is less than 1dB down at 15kHz. Distortion generally was also very low as will be appreciated by the lab results; the worst harmonic was the second in pure stereo mode at 0.28%.

We also made tests to discover the noise advantage of the Dolby decoder. For a 60dB stereo signal-to-noise ratio an input of 89μV was required without Dolby; with Dolby, the same ratio was obtained with 45μV. Dolby certainly extends reception range and it is a pity we cannot take advantage of it; frequency integrity requires transmission encoding and 25μsec pre-emphasis, and no British station is operating like this permanently. We tried Dolby on noisy non-encoded signals, and the noise reduced dramatically so we feel sure that a UK listener keen on DX-ing or obliged to suffer weak stereo signals might find the facility useful in spite of the frequency distortion due to lack of encoding. The family of curves shows how the frequency response is affected over the dynamic range when the transmission is not encoded.

The tuner is well equipped as indicated at the bottom of the lab results and it was also ranked highly on engineering quality. AM quality was about average, the swivel ferrite rod aerial being useful, but the FM was very good and on par with the best sounding tuners of the group.

In summary, a well equipped tuner with top-flight parameters, suitable for headphone listening direct. It is Dolby-ready should the encoding day ever arrive in the UK!

Sony ST-5950SD

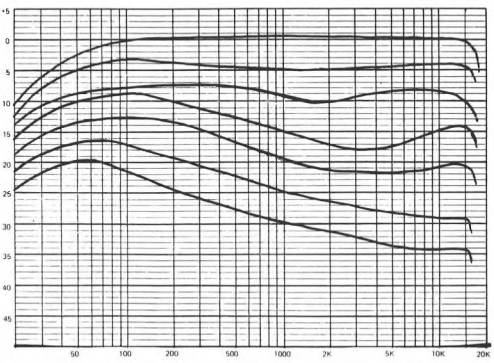
BEST BUY

VHF Section

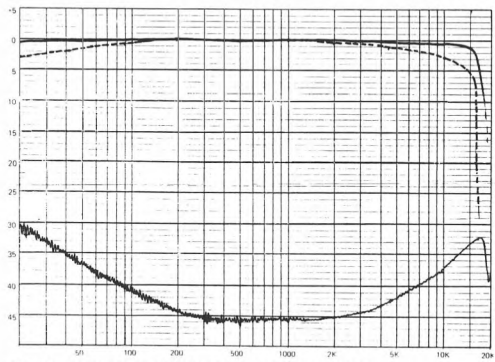
Sensitivity 30dB S/N CCIR mono (μV) 0.8
Sensitivity 50dB S/N CCIR mono (μV) 2.8
Sensitivity 50dB S/N CCIR stereo (μV) 28
S/N CCIR mono 1mV av. (dB) 77.5*
S/N CCIR stereo 1mV av. (dB) 75*
Limiting —1dB (μV) 0.9
Front-End Performance
3rd-order RF IM av. (dB) 68
Equiv. select. figure-of-merit (dB) 92
Repeat spot (dB) . . . . . >100
Capture ratio (dB) 1.1
Select. ±400kHz av (dB) . . . . . >80
Select. ±200kHz av. (dB) 10
Muting threshold (μV) 3.15
Sig. meter saturation (μV) 500
Tuning error 95MHz (kHz) . . . . . +67

Audio Section

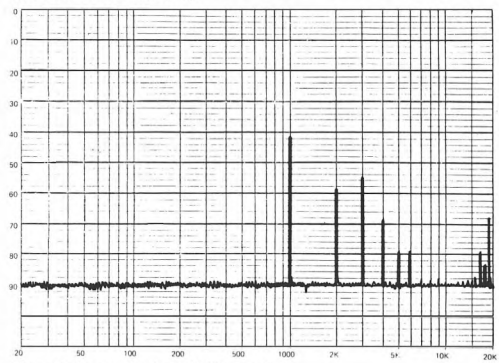
Output ±67.5kHz dev. L-ch. (mV) . . . . . 1829 (max)*
Output ±67.5kHz dev. R-ch. (mV) . . . . . 1844 (max)*
AM rejection 1mV (dB) 54
Pilot tone suppression ref. ±67.5kHz dev. (dB) 82/82
Sub-ch. spuriae ref. ±67.5kHz (dB) 80
Hum ref. ±67.5kHz (dB) 75
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.28
3rd harmonic (%) 0.08
4th harmonic (%) 0.02
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.13
3rd harmonic (%) 0.03
4th harmonic (%) 0.01
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.07
3rd harmonic (%) 0.13
4th harmonic (%) . . . . . noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.1
3rd harmonic (%) 0.13
4th harmonic (%) . . . . . noise
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.1
3rd harmonic (%) . . . . . noise
4th harmonic (%) . . . . . noise
Total on breakthrough signal (%) 50
Response 15kHz worst ch. (dB) . . . . . —0.7
Response 20Hz worst ch. (dB) . . . . . —0.2
Stereo separation 1kHz (dB) . . . . . >50
Stereo separation 10kHz (dB) 49
Birdies suppression (dB) 68
Dimensions (W x H x D) (mm) . . . . . 460 x 168 x 311
Typical selling price (£) £225.00
Additional information/comment:
*Details of S/N with Dolby active given in text.
**Also fixed output at 600mV left and 668mV right (non-interacting).
Features include AM MW with swivel rear ferrite rod aerial; Dolby noise reduction; muting switch; rear level presets; headphone socket with front level control; afc switch; multipath switch; two pairs outputs (fixed and variable); 75/300-ohm aerial inputs; 4-ch. decoder (FM detector output) socket.



'Dolby' performance



Frequency response/stereo separation curves (dotted curve 1dB/div).

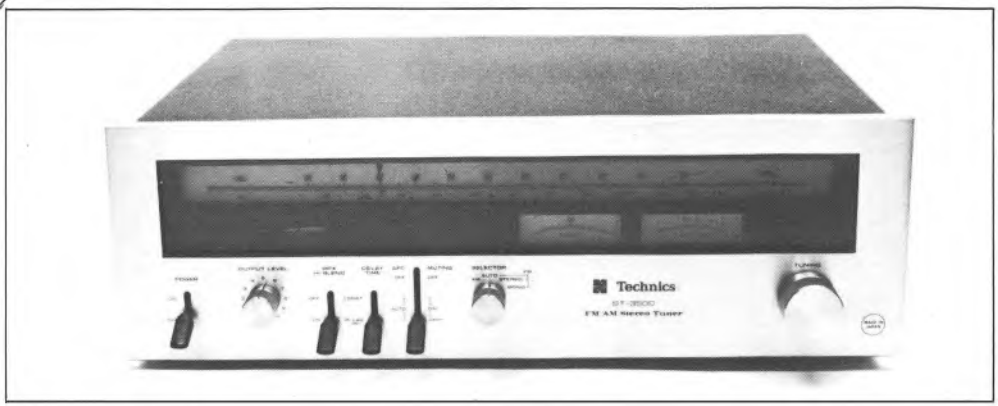


Breakthrough signal distortion

BEST BUY

Technics ST-3500

National Panasonic (UK) Limited, 107-109 Whitby Road, Slough, Berks. Slough 27516.



Although now superseded by newer models, we decided to include the moderately-priced ST-3500 because it is still available, and we know enthusiasts who are keen on its performance. There are a few odd points which could be improved, but the model lives up well to its reputation in the market place!

Housed in a black-finished metal case with a brushed aluminium fascia, the model is fairly conventional looking. The fascia has a small overlap so that the tuner can be fitted into a wooden cabinet if required. Alignment accuracy of the sample was good, and the mid-band error was a mere +60kHz, less than the width of the cursor. The softly illuminated scale is substantially linear, and the tuning mechanism is smooth and free from snatch.

Two levels of muting and AFC on a common switch are provided. With the switch in either of the muting postions the AFC is activated, but it does not take effect until about 5 seconds after a station has been tuned in. This avoids the tuning pulling on to strong stations when looking for weaker ones. With the switch off both AFC and muting are disabled.

There are meters for signal strength and FM tuning. The former is essentially logarithmic permitting the indication of signals as strong as 3,000μV before saturating. Centre-zero of the tuning meter was found to correlate with the least distortion and best stereo separation.

It is possible to switch the tuner to respond only to stereo signals. Another feature is the so-called hi-lag filter, which is a switchable pilot tone filter. With this switched off the high frequency response is extended but there is minimal attenuation of pilot tone, while the pilot tone falls to —64dB with the filter on. Most manufacturers nowadays find such a filter unnecessary because it is possible to design for an extended treble response while maintaining 19kHz rejection.

A good total ranking for the VHF section was achieved, with particularly good values being measured for absolute sensitivity, limiting, repeat spot and selectivity. These things mean that the tuner would be suitable for difficult as well as service area reception conditions. The third-order IM result was less good, so in extremely strong signal locations aerial attenuation would be required should the tuner tend to generate spuriae, but this is not particularly likely.

Audio section ranking was below that of the VHF section, and lined up with the group average. Even so, quite reasonable results were obtained, including a good birdies rejection ratio (aided by the good selectivity of the sample) and very acceptable 1mV signal to noise ratios on both mono and stereo. General distortion was also fairly low, the worst harmonic (second) being at 0.35% in stereo L-R mode. Distortion on the breakthrough signal was a shade better than average, the spectrogram showing that the second harmonic is some 53dB below the speaking channel signal at full test modulation, corresponding to 0.22% second harmonic distortion.

The designers have achieved a flat frequency response with a —1.5dB point at 15kHz, while also providing a pilot tone rejection ratio of 64dB with the hi-lag filter on; stereo separation is also reasonable at 40dB mid-band. It was found that the AM performance was a shade above average, with the 908kHz whistle being well tamed; a swivel ferrite rod aerial is fitted.

Top marks were given for FM quality, and only a small amount of stereo splash was detected on the

BEST BU

breakthrough signal at high modulation levels. The model has been in domestic use for a number of months and has been well accepted by the users.

In summary, a well designed and equipped tuner of good FM quality. Although not of current design it is still available and worth seeking. Its overall performance was found to be better than that of the more recent ST-7300.

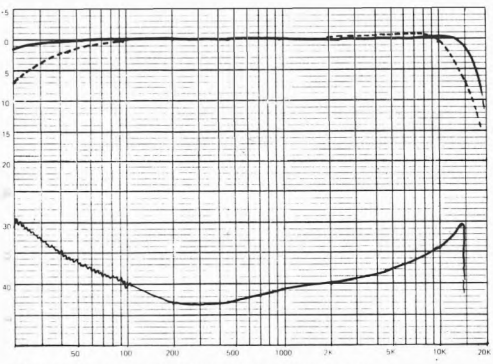
Additional information/comment:
*Also fixed at 500/500mV L/R.
**With 'hi-lag' filter on.
Features include AM MW with swivel rear ferrite rod aerial; two muting levels; switchable afc; switchable pilot tone (hi-lag) filter; 75/300-ohm aerial inputs; MPX filter; front level control; sockets for multipath; two pairs outputs (fixed and variable); signal/tuning meters.

VHF Section

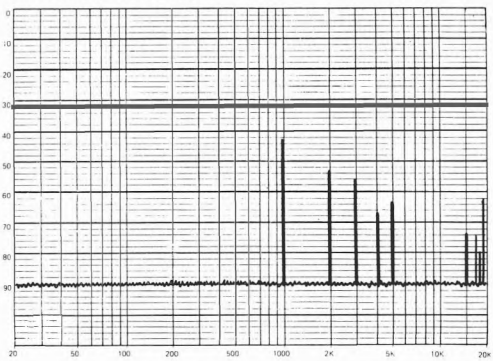
Sensitivity 30dB S/N CCIR mono (μV)	1.12
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	50
S/N CCIR mono 1mV av. (dB)	77.5
S/N CCIR stereo 1mV av. (dB)	72.5
Limiting —1dB (μV)	1.1
Front-End Performance	
3rd-order RF IM av. (dB)	62
Equiv. select. figure-of-merit (dB)	54
Repeat spot (dB)	98
Capture ratio (dB)	2
Select. ±400kHz av (dB)	>80
Select. ±200kHz av. (dB)	10
Muting threshold (μV)	8 and 5
Sig. meter saturation (μV)	3000
Tuning error 95MHz (kHz)	+60

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	2000 (max)*
Output ±67.5kHz dev. R-ch. (mV)	2100 (max)*
AM rejection 1mV (dB)	58
Pilot tone suppression ref. ±67.5kHz dev. (dB)	64/64**
Sub-ch. spuriae ref. ±67.5kHz (dB)	68
Hum ref. ±67.5kHz (dB)	70
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	0.07
4th harmonic (%)	0.03
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.2
4th harmonic (%)	0.016
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.35
3rd harmonic (%)	0.28
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.2
3rd harmonic (%)	0.19
4th harmonic (%)	0.2
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.1
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	40
Response 15kHz worst ch. (dB)	—1.2**
Response 20Hz worst ch. (dB)	—1.2**
Stereo separation 1kHz(dB)	41
Stereo separation 10kHz (dB)	39
Birdies suppression (dB)	72
Dimensions (W x H x D) (mm)	410 x 140 x 360
Typical selling price (£)	£160.00



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Technics ST-7300

National Panasonic (UK) Limited, 308-318 Bath Road, Slough, Berks. Slough 34522.

Weighted feature ranking of this recent Technics model is below that of the earlier ST-3500; although preferred on one or two isolated parameters, but overall performance the ST-7300 scored less favourably on both VHF and audio. You would be hard pushed, though, to discern any differences in a practical situation.

In looks the two models are similar: a clearly printed white-backed scale spans almost the full length of the brushed aluminium fascia and both this and the two meters below are edged in black. A conveniently large metal knob operates the tuning and three press-switches are used for FM/AM selection, stereo/mono switching with muting, and recording level tone switching, while a lever switch operates the power. Muting is active only in stereo mode, but since the threshold is a mere 2.5μV this is of little moment.

The sample was equipped with a veneered wood enclosure and three core mains cable. We found the tuning smooth and free of vices, aided by the usual flywheel inertia. Scale length is approximately 195mm, but the calibration is slightly non-linear with 500kHz divisions. Re-setting to a specific frequency can thus only be approximate. The scales are softly illuminated by reflected light. Both meters are similarly illuminated and a small indicator shines when a stereo station is tuned in.

General construction is to a good standard, the rear accommodating 'phono' type sockets for audio output and terminals for connecting the FM aerial. The internal electronics, which are built upon a main printed circuit board bearing component references, and the AM ferrite rod aerial leave plenty of fresh air inside the case, and servicing accessibility is good.

Sensitivity of the sample was about average for the group, as were most other of the parameters. As there are only two variable-tuned circuits between aerial and mixer, the front-end equivalent selectivity figure-of-merit was not all that exciting; neither was the repeat spot suppression, which was not as high as that of the ST-3500. However, the third order IM rejection was a little better. Under normal reception conditions, therefore, the tuner would behave admirably; but it could get into trouble in areas of large signal field, calling for aerial attenuation to tame spurious responses.

Overall selectivity was perfectly sanitary for a tuner of this standard, which resulted in adequate suppression of stereo birdies. Upper-frequency response was extremely well maintained in spite of the intrinsically high 19kHz pilot tone suppression. Because of the heavy distortion on the breakthrough signal the second harmonic was only about 42dB below the speaking channel's fundamental at ±67.5kHz deviation, corresponding to about 0.8% relative distortion. Speaking channel stereo distortion was also rather high (0.71% second harmonic) with the tuning meter at centre-zero. It is note-worthy that both the distortion and stereo separation improved with the tuning slightly away from centre-zero.

However, we detected no undue non-speaking channel hash or splash even at high modulation levels. Working under domestic conditions audio quality was to a high standard, with plenty of treble and 'zip' to the music. Using system-controlled signals at fairly high peak modulation, shades of distortion could sometimes be heard when quickly compared with the results from a more expensive tuner. We also found that the stereo decoder

switching threshold was a little on the high side, and at times it was necessary to switch between mono and stereo to get the decoder to trigger. AM performance was slightly below average, requiring an external aerial for the best results.

In summary, a tuner of good construction and of sufficiently high sensitivity and selectivity for DX trials; but a trifle disappointing in some respects, though capable of acceptable audio performance.

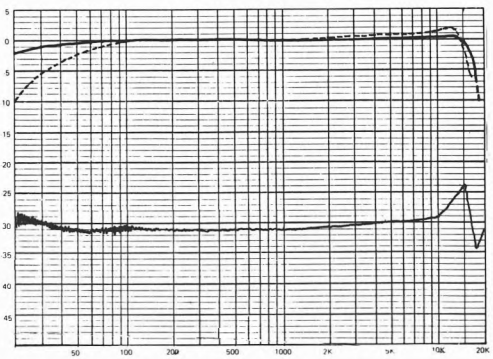
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.4
Sensitivity 50dB S/N CCIR mono (μV)	4.4
Sensitivity 50dB S/N CCIR stereo (μV)	45
S/N CCIR mono 1mV av. (dB)	75
S/N CCIR stereo 1mV av. (dB)	70
Limiting —1dB (μV)	1.3
Front-End Performance	
3rd-order RF IM av. (dB)	64
Equiv. select. figure-of-merit (dB)	40
Repeat spot (dB)	66
Capture ratio (dB)	>1
Select. ±400kHz av (dB)	74
Select. ±200kHz av. (dB)	10
Muting threshold (μV)	2.5
Sig. meter saturation (μV)	400
Tuning error 95MHz (kHz)	—98

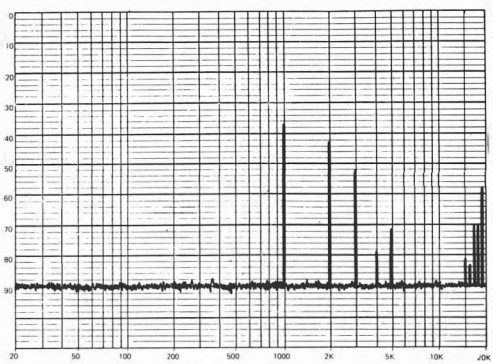
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	565
Output ±67.5kHz dev. R-ch. (mV)	539
AM rejection 1mV (dB)	54
Pilot tone suppression ref. ±67.5kHz dev. (dB)	58/59
Sub-ch. spuriae ref. ±67.5kHz (dB)	73
Hum ref. ±67.5kHz (dB)	72
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.71
3rd harmonic (%)	0.25
4th harmonic (%)	0.02
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.32
3rd harmonic (%)	0.1
4th harmonic (%)	0.02
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	0.2
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.32
3rd harmonic (%)	0.1
4th harmonic (%)	0.02
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.16
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	56
Response 15kHz worst ch. (dB)	—0.3
Response 20Hz worst ch. (dB)	—2
Stereo separation 1kHz (dB)	31
Stereo separation 10kHz (dB)	29
Birdies suppression (dB)	73
Dimensions (W x H x D) (mm)	410 x 139 x 317 approx.
Typical selling price (£)	£108.00

Additional information/comment:
Features include MW with internal ferrite rod aerial (non-adjustable); recording level check (calibration) oscillator at Dolby FM level (±37.5kHz equivalent deviation); signal/tuning meters; 75/300-ohm aerial inputs.



Frequency response/stereo separation curves (dotted curve 1dB/div).

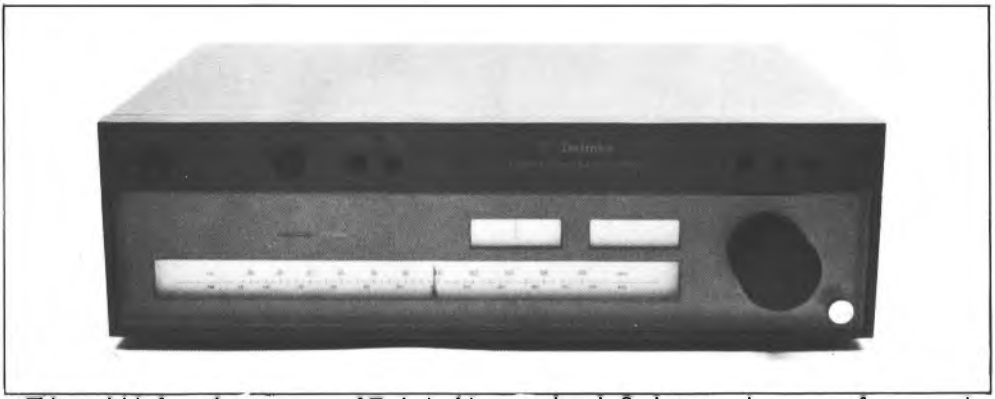


Breakthrough signal distortion

RECOMMENDED

Technics ST-8080

National Panasonic (UK) Limited, 308-318 Bath Road, Slough, Berks. Slough 34522.



This model is from the new range of Technics hi-fi. Although metal clad, an aesthetic appeal results from the softly illuminated, white-backed scale section and meters which contrast pleasantly with the dark-finished fascia and enclosure. The scale section and two meters are behind a window occupying most of the bottom part of the fascia. The upper part carries non-obtrusive press-buttons for selecting FM/AM and a tone oscillator for tape recorder level setting, muting ganged with the mono/stereo switching and a small knob for level control of the audio output from one pair of rear 'phono'-type sockets. A neat lever switch is used for power on/off. As with some of the less expensive models of this survey, the muting is defeated only when the button lies in the mono position. In the auto-stereo position the muting is always active.

The tuning mechanism is inertia assisted and very free running and could not be faulted. The tuning scale has an active length of about 210mm but with frequency marks only at 500kHz intervals, which makes it difficult to determine the actual frequency of a tuned station. Calibration error mid-scale was small. The cursor is a thin, black pointer which shows up well against the white scale.

The two meters provide centre-zero FM tuning and relative signal indication. The former was found to correlate closely with the least distortion and best stereo separation, but the signal meter would be better with a wider dynamic range. The recording level tone oscillator produced a low-frequency signal corresponding to an FM deviation of ±33.32kHz — not too far from the Dolby FM reference level. The 'phono'-type sockets at the rear are well anchored, one pair giving a fixed audio level output — the other pair being under the level control as mentioned. Sockets are also present for connecting an oscilloscope for multipath detection, and as one communicates with the FM detector this can be used to couple to a four-channel decoder, should FM transmissions ever be quad-multiplexed.

Engineering quality is good with the components being identified on the pcbs. Good results were obtained from the vhf section, the net ranking surpassing that of the other two (ST-3500 and ST-7300) models. Third order IM performance has been improved and very good results were measured for repeat spot and i.f. selectivity. Absolute sensitivity was below that of some models.

On the audio side good results were obtained for distortion and birdies suppression, the latter aided by the very good adjacent channel selectivity. Signal-to-noise ratios could have been better with CCIR/ARM noise focusing. Relative breakthrough distortion was not high, and with the fair stereo separation, values round 0.3% were obtained for the second and third harmonics (see spectrogram). 75 ohm aerial coupling appeared to be slightly in error, being more like 52 ohms at the test frequency. Very good pilot tone rejection was measured, yet in spite of this the upper-frequency held to 15kHz with a mild lift round 10kHz (see frequency response plots).

AM performance was slightly above average with fewer heterodyne whistles than some models. Swivel rear aerial was useful.

Very good FM performance was noted by the listeners, though there was some comment regarding slight lack of tightness of the stereo image and very mild 'splash' on heavily modulated bass drum. Operating at high reproducing level on a moderate FM stereo signal very slight background hiss was

RECOMMENDED

noted during *ppp* intervals (not with stronger input). There were no birdies.

In summary, a well engineered tuner of adequate sensitivity for DX-ing and selectivity and overload immunity for strong signal areas. Well equipped and attractively styled, and with a vhf section slightly in advance of the audio section.

VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.4
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	50
S/N CCIR mono 1mV av. (dB)	72
S/N CCIR stereo 1mV av. (dB)	67.5
Limiting —1dB (μV)	1.25
Front-End Performance	
3rd-order RF IM av. (dB)	73
Equiv. select. figure-of-merit (dB)	54
Repeat spot (dB)	>100
Capture ratio (dB)	1.25
Select. ±400kHz av (dB)	>80
Select. ±200kHz av. (dB)	11
Muting threshold (μV)	4
Sig. meter saturation (μV)	250
Tuning error 95MHz (kHz)	+20

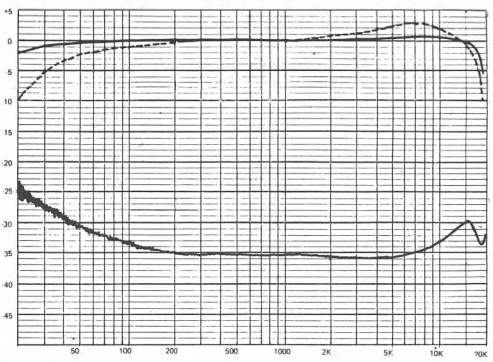
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1047 (max)*
Output ±67.5kHz dev. R-ch. (mV)	990 (max)*
AM rejection 1mV (dB)	54
Pilot tone suppression ref. ±67.5kHz dev. (dB)	80/78
Sub-ch. spuriae ref. ±67.5kHz (dB)	76
Hum ref. ±67.5kHz (dB)	72
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.25
3rd harmonic (%)	0.22
4th harmonic (%)	0.01
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.022
3rd harmonic (%)	0.079
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.079
3rd harmonic (%)	0.28
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.07
3rd harmonic (%)	0.1
4th harmonic (%)	0.018
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.079
3rd harmonic (%)	0.03
4th harmonic (%)	0.025
Total on breakthrough signal (%)	18
Response 15kHz worst ch. (dB)	—0.1
Response 20Hz worst ch. (dB)	—2
Stereo separation 1kHz (dB)	35
Stereo separation 10kHz (dB)	33
Birdies suppression (dB)	78
Dimensions (W x H x D) (mm)	450 x 140 x 367
Typical selling price (£)	£180.00

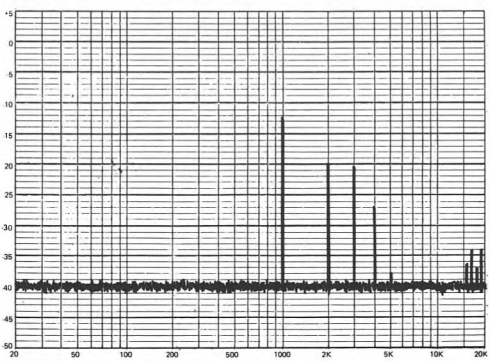
Additional information/comment:

*Level control reduces to ±0. Also fixed outputs at 496mV(L); 496mV(R).

Features include MW with rear rear swivel ferrite rod aerial; signal/tuning meters; record setting tone oscillator corresponding to ±33.32 kHz deviation; two pairs outputs; front level control; rear sockets for 4-ch. decoder and oscilloscope connections for multipath; 75/300-ohm aerial inputs.



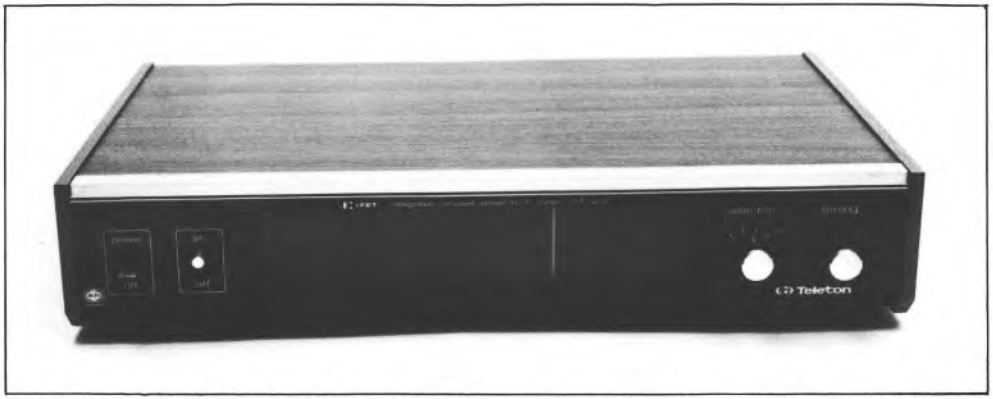
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Teleton GT-202

Teleton-Electro (UK) Limited, Teleton House, Water House Lane, Chelmsford, Essex. LN1 3DW. 0245 66739.



This low-profile tuner is housed in a well made wooden enclosure; at the top of which a strip of aluminium trim nicely sets off the matt-black fascia. The control functions are indicated by white print, and the scales and frequency numbers show through the 'blacked-out' type of scale section when the tuner is switched on. The frequencies are illuminated in green, while the main LW and MW stations are displayed in red light. Although there is an FM logging scale, the frequencies themselves are not clearly graduated since there are 2MHz divisions between the numbers and no intermediate calibration lines. It was thus impossible to define with any accuracy the degree of mid-band calibration error.

Scale length is approximately 125mm, and the cursor shows up white against the black scale backing. One of two small 'silver'-fronted black knobs at the right of the scales operates the tuning, while the other adjacent knob is for band selection. Although the tuning is not flywheel assisted, the mechanism is precise and easy to operate, but cannot be spun.

For the price, the general construction is acceptable, slightly above the average of the group. The chassis is robustly tailored from generous gauge metal, and the pcb is of about average quality. An internal ferrite rod aerial serves the long and medium wavebands, with provision for an external aerial, while 75 and 300 ohm terminals are provided for FM. Fixed-level audio suitable for most amplifiers is delvered by a rear DIN socket. The model is short of features — no meters or muting, for example — and thus falled to rank very highly in this respect.

Although reasonably sensitive, a stronger than average signal was required for a respectable stereo signal to noise ratio. The limiting was also a little slow in arriving at the —1dB value. FM front-end uses a three-gang capacitor with two variable-tuned circuits between the aerial and mixer. This is reflected by the lowish front-end selectivity figure-of-merit ratio. These factors, along with the low repeat spot suppression ratio, retarded the VHF ranking. However, a well-biased FET is used for RF amplification, which resulted in the very good third order IM rejection ratio.

I.f. selectivity and pilot tone rejection ratios were rather poor; it was also found that the frequency response extremes fell off rather quickly at each end of the spectrum. On the other hand, stereo separation was commendable for a tuner in this price range and this meant that the breakthrough distortion was some 45dB below the speaking channel signal.

Speaking channel distortion at full test modulation, however, was not very exciting in stereo mode; though the results were better in mono. The relatively poor i.f. selectivity tended to encourage birdies interference on stereo in the presence of a fairly strong adjacent channel signal.

AM performance was judged to be slightly above average, there being a relative freedom from heterodyne whistles and monkey chatter. However, because the ferrite rod aerial cannot be swivelled, it may be necessary to use an external aerial. The presence of a LW band in addition to the MW band could prove advantageous when the frequencies change at the end of the year.

With a sufficiently strong stereo signal, the FM results were perfectly acceptable. Overall quality was below the standard provided by the more expensive

models, and a slight high-modulation harshness was noticed on stereo; the droop in high frequency response was also detectable.

In summary, an attractive little tuner which failed to reach high ranking values owing to certain shortcomings. Suitable for average or normal reception conditions, but may produce birdies under difficult conditions. Not suitable for serious DX-ing.

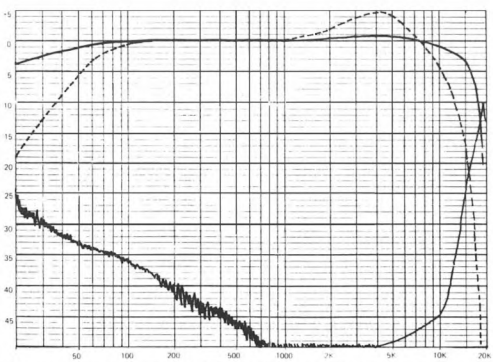
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.4
Sensitivity 50dB S/N CCIR mono (μV)	5
Sensitivity 50dB S/N CCIR stereo (μV)	50
S/N CCIR mono 1mV av. (dB)	73.5
S/N CCIR stereo 1mV av. (dB)	(improves with signal)/63
Limiting —1dB (μV)	6
Front-End Performance	
3rd-order RF IM av. (dB)	76
Equiv. select. figure-of-merit (dB)	39
Repeat spot (dB)	67
Capture ratio (dB)	4
Select. ±400kHz av (dB)	27
Select. ±200kHz av. (dB)	4
Muting threshold (μV)	no muting (12 stereo)
Sig. meter saturation (μV)	no meter
Tuning error 95MHz (kHz)	not discernible

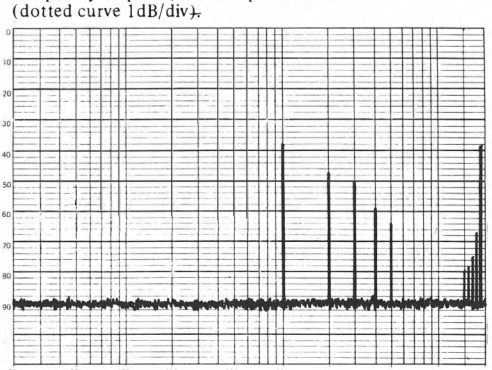
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1081
Output ±67.5kHz dev. R-ch. (mV)	1125
AM rejection 1mV (dB)	55
Pilot tone suppression ref. ±67.5kHz dev. (dB)	38
Sub-ch. spuriae ref. ±67.5kHz (dB)	50
Hum ref. ±67.5kHz (dB)	68
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.6
3rd harmonic (%)	0.5
4th harmonic (%)	0.09
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.25
3rd harmonic (%)	0.22
4th harmonic (%)	0.04
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.56
3rd harmonic (%)	0.4
4th harmonic (%)	0.07
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.2
4th harmonic (%)	0.03
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.11
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	35
Response 15kHz worst ch. (dB)	—3.2
Response 20Hz worst ch. (dB)	—3.8
Stereo separation 1kHz (dB)	52
Stereo separation 10kHz (dB)	45
Birdies suppression (dB)	54
Dimensions (W x H x D) (mm)	389 x 80 x 250 approx.
Typical selling price (£)	£49.00

Additional information/comment:
Features include LW and MW with internal ferrite rod aerial; switchable afc; 75/300-ohm aerial inputs; single DIN audio output socket.



Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

RECOMMENDED

Trio model 600T

B H Morris & Company Limited, Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU. 01-902 9422.

This is Trio's up-market FM-only tuner. Although relatively expensive, it is well equipped and returned some very good test results. Housed in a metal case with side-screw fixing, the front panel is attractively presented with a mirror-backed, clearly printed tuning scale extending almost its whole length. The mirror backing is useful because it reduces error due to parallax when tuning (the same sort of scheme used on test meters). A high degree of tuning accuracy can thus be achieved, as the alignment error measured on the sample mid-band was small.

Two illuminated meters at the top-left of the scale section indicate signal strength and centre-zero tuning. The former is calibrated in dB referred to 1μV seemingly across 300 ohms. The instructions contain conversion tables both for 75 ohms feeder and for IHF signal power expression referred to femtowatts on a dB scale —dB (fw) or dBf. The dB graduations are linear and the meter has a wide dynamic range, which makes it very useful. Incidentally, 1fW is equal to 10^{-15} watt.

Complementing these two meters is a third meter at the other side of the scale. This one can be switched to give an indication of multipath reception or signal deviation (e.g., FM depth). The scale is calibrated in modulation percentage, and this includes the 10% pilot tone on stereo. The centre-zero tuning meter is also calibrated over ±400kHz (from centre either side) and can be used to indicate approximately the degree of mistuning.

The mechanism, operated by a large metal knob at the middle of the fascia is silky smooth and totally free from any aberrations. Smaller metal knobs are used for switching mode, i.f. bandwidth, muting over two levels and off, and for adjusting the audio output level. Press-buttons are used for power on/off, scale dimming, normal/25μsec. de-emphasis and deviation/multipath meter switching.

The i.f. band switch has three positions of normal, narrow and wide. In the narrow position the selectivity is very sharp, making it possible to discriminate against a station close in freqency to the wanted one. In the normal position the selectivity is round average and in the wide position the very best audio quality is produced, because then the upper-order signal sidebands have plenty of room into which to expand fully without inciting amplitude or phase distortion. Overall analysis was made in the wide mode, as with the other tuners of the group equipped with switchable selectivity.

The lab results reveal a tuner of the utmost sensitivity (almost to the theoretically attainable absolute), with good signal-to-noise ratios and very good front-end performance. The tuner should not get into difficulties owing to excessive spuriae generation, even in areas of high signal field.

Other measured parameters — like pilot tone and stereo sub-carrier rejection, overall hum, etc. — were also good. The graph shows that careful attention has been directed by the designers for a flat upper-frequency response consistent with a rapid fall into the 19kHz pilot tone notch. Separation was also acceptable, and because of the relatively small intrinsic breakthrough signal distortion, this distortion relative to the speaking channel signal can be virtually discounted under ordinary stereo listening conditions — see spectrogram. These measurements were again made in the wide mode.

The tuner was found to be very pleasant to use and remarkably sensitive, responding to very weak signals even when these were close to more powerful signals, aided by the narrow selectivity setting. In the

RECOMMENDED

wide mode the quality of reception on programmes of normal signal strength was very good. Some high ranking positions were awarded, but the overall ranking was reduced owing to the high price.

In summary, a very good tuner that is capable of high quality audio, while at the same time being suitable for serious DX-ing by the switchable selectivity.

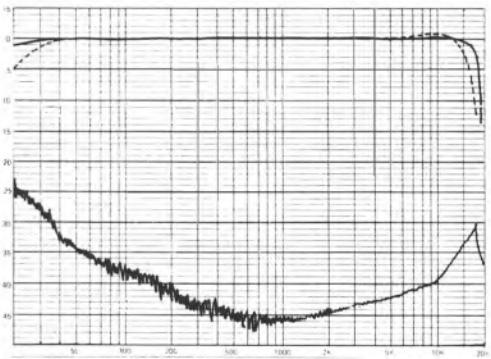
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	0.85
Sensitivity 50dB S/N CCIR mono (μV)	4
Sensitivity 50dB S/N CCIR stereo (μV)	36
S/N CCIR mono 1mV av. (dB)	79
S/N CCIR stereo 1mV av. (dB)	75
Limiting —1dB (μV)	0.7
Front-End Performance	
3rd-order RF IM av. (dB)	76
Equiv. select. figure-of-merit (dB)	>100
Repeat spot (dB)	>100
Capture ratio (dB)	<2
Select. ±400kHz av (dB)	51 (normal); 75 (narrow); 32 (wide)
Select. ±200kHz av. (dB)	7 (normal); 15 (narrow); 4 (wide)
Muting threshold (μV)	5 and 50
Sig. meter saturation (μV)	5000
Tuning error 95MHz (kHz)	—12

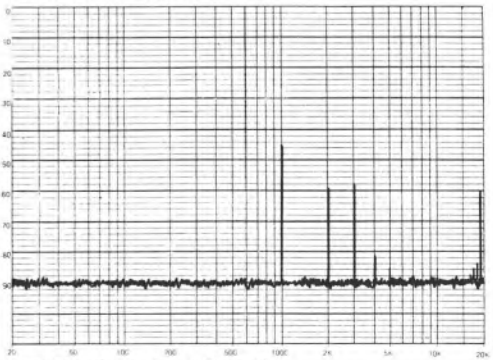
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1350 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1342 (max)*
AM rejection 1mV (dB)	56
Pilot tone suppression ref. ±67.5kHz dev. (dB)	60
Sub-ch. spuriae ref. ±67.5kHz (dB)	80
Hum ref. ±67.5kHz (dB)	76
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.09
3rd harmonic (%)	0.06
4th harmonic (%)	noise
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.06
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.09
3rd harmonic (%)	0.07
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	noise
4th harmonic (%)	noise
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	20
Response 15kHz worst ch. (dB)	—0.5
Response 20Hz worst ch. (dB)	—1.0
Stereo separation 1kHz (dB)	46 (wide)
Stereo separation 10kHz (dB)	40 (wide)
Birdies suppression (dB)	70 (wide)
Dimensions (W x H x D) (mm)	440 x 154 x 388
Typical selling price (£)	£495.00

Additional information/comment:
*Also fixed outputs.
Features include three-position i.f. bandwidth switch; signal/tuning meters; separate meter reading FM deviation (e.g., percentage modulation level) or multipath (switchable); 75/300-ohm aerial inputs; MPX noise filter; 25μsec. front button; two audio outputs; front level control; two switchable muting levels; scale illumination dimming switch.



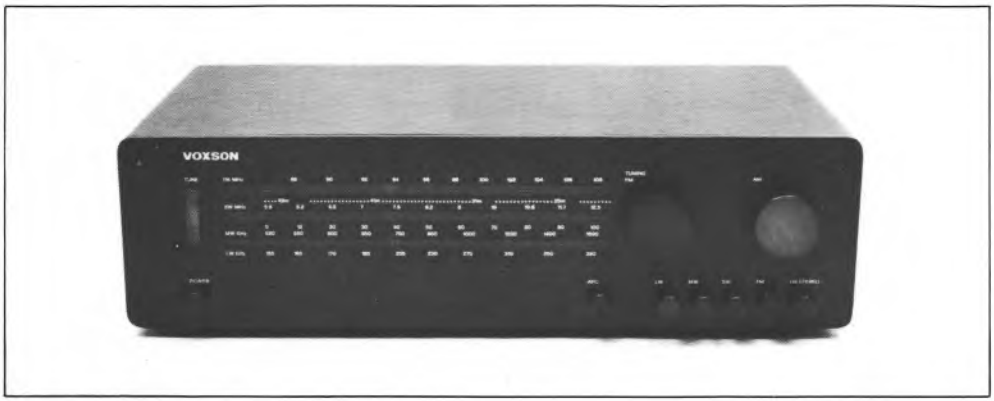
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Voxson R-303

The Centre of Sound, 120 Notting Hill Gate, London W.11.



Voxson equipment was originally manufactured for EMI. The situation now, however, is that the entire stock has been acquired by The Centre of Sound, 120 Notting Hill Gate, London, W11 — the exclusive and only seller. Because we were informed by the firm that the R-303 would continue to be available into 1978, that spares are being retained for this and other items of the Voxson range, and that each item is being sold with a two-year free-parts-and-labour guarantee, we decided to include the tuner in this book.

It is an interesting tuner because it includes long, medium and short wavebands and separate tuning mechanisms for FM and AM. It is also well constructed and completely shrouded in black-anodized brushed-aluminium, including the fascia. Four metal bolts release the enclosure to expose both the upper and lower sides of the printed circuit board, thereby facilitating servicing. The components are also identified.

The two tuning scales are formed by cut-outs along the length of the fascia, on which the FM and AM frequencies are printed in white. The cursor of the band selected glows softly through the slots against engraved tuning lines.

Although small flywheels are used in the mechanisms, it is not possible to spin the tuning over the band. Nevertheless, the tuning action is precise, but having minimal readout accuracy. Mid-band tuning error of the sample was also fairly large. IEC-type sockets are used for FM and AM aerials, but for LW and MW a rear swivel type ferrite rod aerial gathers a fair amount of signal. An external aerial, of course, is required for SW reception. Although it is possible to connect 75-ohm coaxial cable to the IEC FM aerial socket, the best results call for a balun transformer. These are not very expensive, and such a device was used for our lab measurements and listening tests.

Bearing in mind the selling price of the tuner and the quality of construction with the three AM bands, the performance was not too bad in real terms. Absolute FM sensitivity was good, as also were the 50dB signal-to-noise ratio sensitivities. A shortfall was the limiting action, which was rather late in arriving at full effect. The stereo 1mV signal-to-noise ratio could have been better; but the mono ratio was all right.

Front-end performance was consistent with a design using two variable-tuned circuits between aerial and mixer, and with the rather poor third-order IM performance, the tuner cannot be recommended for long-range DX activities. Alternate channel selectivity can only be classified as fair, and the signal meter dynamic range was not very large. There is no FM tuning meter, but there is switchable afc. The idea, then is to tune roughly using the signal meter with the afc off, and then switch the afc on to correct mild tuning error. The pull-in range of the afc was substantial.

The audio section failed to gain a very high relative ranking owing to the fairly high distortion, undulation in frequency response and poorish stereo separation. However, we would stress that the distortion was reduced and the separation increased by slightly detuning from the optimum provided by the afc.

The designers have achieved a good pilot tone rejection ratio (at the expense of upper-frequency response accuracy), but less rejection at the sub carrier frequency. In troublesome areas birdies interference could cause problems.

AM performance was around average or, perhaps, a little above. Fewer whistles were detected than on some models. The SW sensitivity seemed extra good, but one of two image responses were detected with an external aerial.

FM quality was not up to the standard achieved by some of the more expensive models with fewer AM bands. The fall in treble response tended to take the edge off upper-frequency transient information; but using system and off-air signals of average modulation level, the distortion was not distressing. The level of the breakthrough distortion referred to the speaking channel signal was round 0.5% (at full modulation), which is not bad.

In summary, a tuner suitable for non-difficult reception areas, and one which would probably satisfy the enthusiast requiring three AM wavebands.

VHF Section

Sensitivity 30dB S/N CCIR mono (μV) 1.6
Sensitivity 50dB S/N CCIR mono (μV) 4
Sensitivity 50dB S/N CCIR stereo (μV) 35
S/N CCIR mono 1mV av. (dB) 72
S/N CCIR stereo 1mV av. (dB) 67
Limiting —1dB (μV) 10
Front-End Performance
3rd-order RF IM av. (dB) 61
Equiv. select. figure-of-merit (dB) 32
Repeat spot (dB) 76
Capture ratio (dB) 3
Select. ±400kHz av (dB) 40
Select. ±200kHz av. (dB) 4
Muting threshold (μV) ..... 2 (stereo thresh.)
Sig. meter saturation (μV) 250
Tuning error 95MHz (kHz) ..... +160

Audio Section

Output ±67.5kHz dev. L-ch. (mV) ..... 958 (max)*
Output ±67.5kHz dev. R-ch. (mV) ..... 903 (max)*
AM rejection 1mV (dB) 51
Pilot tone suppression ref. ±67.5kHz dev. (dB) 66
Sub-ch. spuriae ref. ±67.5kHz (dB) 45
Hum ref. ±67.5kHz (dB) 70
Distortion
Stereo 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.35
3rd harmonic (%) 0.56
4th harmonic (%) ..... noise
L+R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.35
3rd harmonic (%) 0.5
4th harmonic (%) ..... noise
L—R 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.13
3rd harmonic (%) 0.8
4th harmonic (%) ..... noise
Mono 1kHz ±67.5kHz dev. worst ch.
2nd harmonic (%) 0.4
3rd harmonic (%) 0.6
4th harmonic (%) ..... noise
Mono 1kHz ±22.5kHz dev. worst ch.
2nd harmonic (%) 0.18
3rd harmonic (%) ..... noise
4th harmonic (%) ..... noise
Total on breakthrough signal (%) 17.8
Response 15kHz worst ch. (dB) ..... —10
Response 20Hz worst ch. (dB) ..... —8
Stereo separation 1kHz (dB) 32**
Stereo separation 10kHz (dB) 23**
Birdies suppression (dB) 60
Dimensions (W x H x D) (mm) ..... 385 x 105 x 203
Typical selling price (£) £90.00***

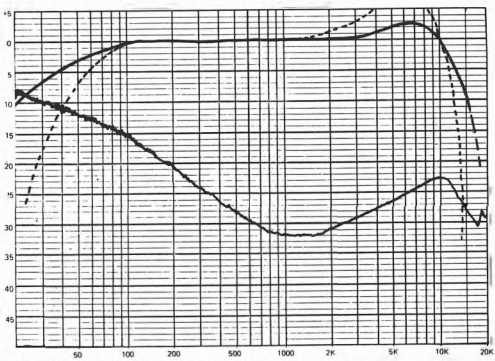
Additional information/comment:

*Also DIN output.

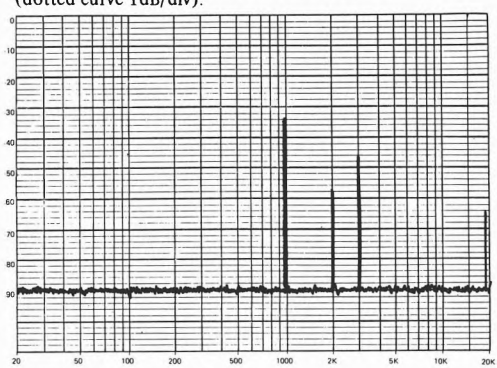
**Better with slight detuning.

***Available only from The Centre of Sound, 120 Notting Hill Gate, London W11.

Features include LW, MW & SW with rear, encapsulated swivel ferrite rod aerial; separate tuning mechanisms for FM and AM bands; 'phono' & DIN outputs; rear level presets; switchable afc; signal meter; 300-ohm aerial input only.



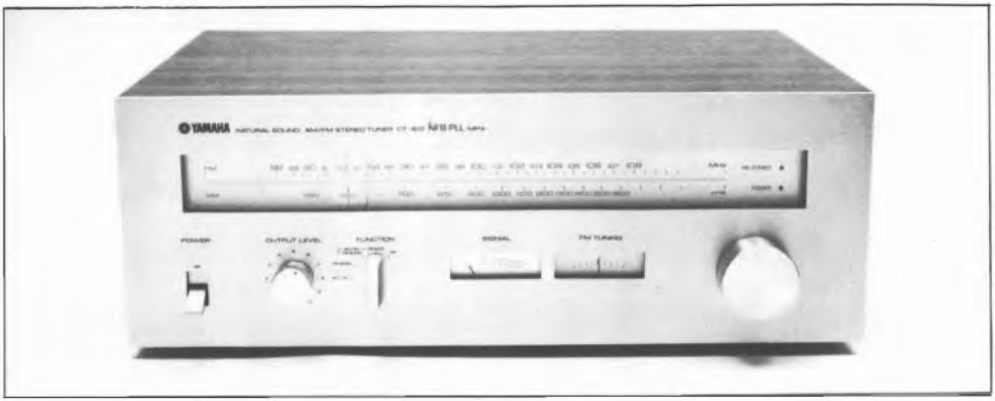
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Yamaha CT-610

Natural Sound Systems Limited, 10 Byron Road, Wealdstone, Harrow, Middlesex. 01-863 8622.



Yamaha hi-fi is easy to pick out by its clear-cut appearance, and this moderately-priced model is no exception. The smooth, brushed satin aluminium fascia is equipped with metal knobs and a clearly printed scale, and is nicely finished by a well-fitting wooden enclosure, in contrast to the stark metal encasements and fascia overlaps of some models. Tuning is precise and smooth-running, but the scale could be better defined in frequency divisions. Both signal and tuning meters are illuminated, the former having a reasonable dynamic range and the latter an acceptable centre-zero accuracy. The tuning cursor carries a bulb which illuminates that part of the scale being tuned, and small lights indicate stereo on and mains on conditions.

The muting is active when the switch is at stereo, so it is necessary to switch to mono to defeat the muting. The model includes a switchable tone oscillator for tape recording level setting, and the output is approximately equivalent to ±37.5kHz deviation, corresponding to the FM Dolby level.

VHF performance was not to the standard now achieved by the more recent models, the overall results falling about average on the ranking scale. Nevertheless, the tuner has sufficient sensitivity to respond to weak signals and front-end overload immunity to prevent spuriae in all but very strong signal areas. Birdies interference might be a little troublesome in difficult reception areas due to a strong adjacent channel signal owing to the relatively poor adjacent channel selectivity, reflected as a mediocre birdies rejection ratio. On the other hand, the alternate channel selectivity ratio was good.

On the audio side the ranking was retarded a little by below average results on pilot tone and stereo sub-channel rejection ratios and by the stereo separation, which could have been better mid-spectrum. On the other hand, good results were obtained on distortion in all modes, the worst being the third harmonic in L-R stereo at 0.3%. Had the adjacent channel selectivity been tighter, then the distortion results would probably have been less good.

Frequency response was smooth though upper-frequency roll-off tended to occur a trifle early on one channel in spite of the poor pilot tone rejection ratio. Intrinsic breakthrough signal distortion was not too high, which is just as well with the poor separation; relative to the speaking channel signal at full test modulation the third harmonic of the beakthrough signal was 48dB, corresponding to 0.4% third harmonic distortion. Sufficient audio signal is available for the least sensitive of amplifiers, the level being adjustable by a front control.

AM performance was a little above average in sensitivity working from the rear ferrite rod aerial, which can be swivelled. The usual 2kHz heterodyne whistle was experienced on Radio 4 908kHz.

FM listening tests revealed a tuner of good potential quality, though very slightly lacking in the sparkle and transient attack afforded by some models. Breakthrough signal distortion or hash had little effect on the net results, though the stereo image could sometimes have been of better definition. The MPX noise filter worked all right, but at the expense of stereo separation and audible distortion rise on the breakthrough signal. We were also able to evoke stereo birdies on our closed-circuit transmission system signals by applying a moderately strong mono signal 200kHz away from

the tuned stereo signal.

In summary, an attractive FM/AM tuner of moderate performance and features which, in relation to engineering quality and price, scored an average rank on an overall basis.

VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	1.26
Sensitivity 50dB S/N CCIR mono (μV)	4.34
Sensitivity 50dB S/N CCIR stereo (μV)	43.4
S/N CCIR mono 1mV av. (dB)	79.5
S/N CCIR stereo 1mV av. (dB)	71.3
Limiting —1dB (μV)	1.3
Front-End Performance	
3rd-order RF IM av. (dB)	67
Equiv. select. figure-of-merit (dB)	40
Repeat spot (dB)	82
Capture ratio (dB)	<2
Select. ±400kHz av (dB)	71
Select. ±200kHz av. (dB)	3
Muting threshold (μV)	5
Sig. meter saturation (μV)	900
Tuning error 95MHz (kHz)	—57

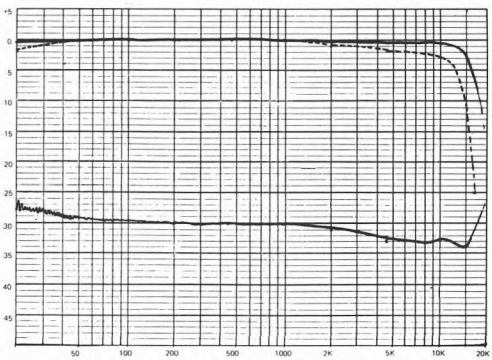
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	800 (max)*
Output ±67.5kHz dev. R-ch. (mV)	780 (max)*
AM rejection 1mV (dB)	56
Pilot tone suppression ref. ±67.5kHz dev. (dB)	43/42
Sub-ch. spuriae ref. ±67.5kHz (dB)	45
Hum ref. ±67.5kHz (dB)	72
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.8
4th harmonic (%)	0.12
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.08
3rd harmonic (%)	0.01
4th harmonic (%)	0.02
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.22
3rd harmonic (%)	0.3
4th harmonic (%)	0.01
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.11
3rd harmonic (%)	0.12
4th harmonic (%)	0.03
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	0.02
4th harmonic (%)	noise
Total on breakthrough signal (%)	22.4
Response 15kHz worst ch. (dB)	—2
Response 20Hz worst ch. (dB)	—0.2
Stereo separation 1kHz (dB)	30
Stereo separation 10kHz (dB)	34.5
Birdies suppression (dB)	60
Dimensions (W x H x D) (mm)	435 x 160 x 349
Typical selling price (£)	£120.00

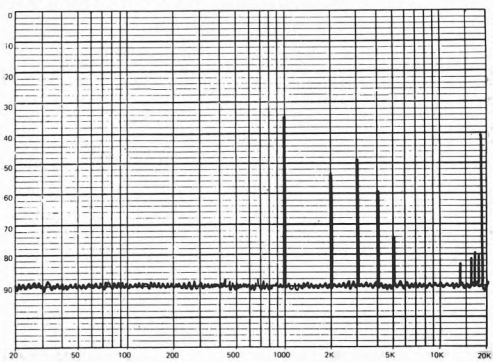
Additional information/comment:

*Variable outputs only.

Features include AM MW with swivel rear ferrite rod aerial; signal and tuning meters; 75/300-ohm aerial inputs; tone oscillator for tape level setting; MPX noise filter; switchable muting; multipath detection.



Frequency response/stereo separation curves (dotted curve 1dB/div).

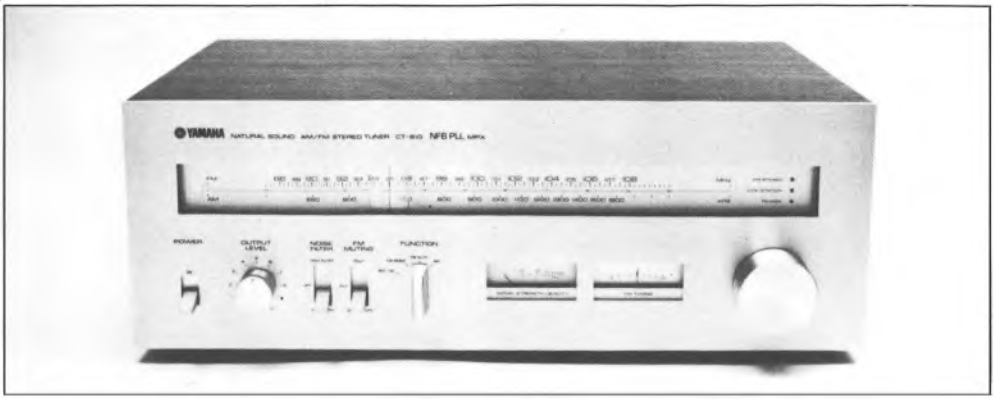


Breakthrough signal distortion

RECOMMENDED

Yamaha CT-810

Natural Sound Systems Limited, 10 Byron Road, Wealdstone, Harrow, Middlesex. 01-863 8622.



More expensive than the CT-610, this is one of Yamaha's latest designs. The same clean-cut styling is adopted, including the wooden enclosure, and the feature ranking is similar to the CT-610. The brushed satin aluminium fascia carries a conveniently-sited tuning knob, a smaller version for level control, and a flat knob for function. Lever switches with a precision 'feel' are used for filters, muting and mains. Tuning is remarkably smooth with flywheel assistance. The illuminated cursor is a thin line on transparent plastics which rides close to the scale thereby minimising parallax error.

Scale length is approximately 240mm with essentially linear 250kHz divisions and frequency identification every 1MHz. Retuning is aided by a logging scale, and mid-band alignment accuracy was good.

The muting switch has two level positions and an off position. When either of the muting positions is selected an auto-afc — called an optimum tuning system (OTS) — circuit is activated and indicated by the glowing of a light. When the required station has been roughly tuned by the meters and the hand is removed from the tuning knob the light intensity rises, indicating that the afc has taken effect. This circuit and the muting are disabled with the switch in the off position.

The filter switch also has two positions in addition to an off position. In one position a treble-cut filter is introduced, while the other position provides the usual inter-channel crosstalk increasing with frequency for reducing stereo noise without affecting frequency response.

The function switch also has a calibration tone position which activates a 333Hz oscillator delivering a Dolby level reference signal from the audio outputs. The level was measured as an equivalent deviation of ±35.4kHz, which is a mere 0.5dB below the Dolby calibration level.

Illuminated signal and tuning meters are also present, the latter having a good centre-zero accuracy and the former catering for about 500μV before saturating. This meter also seconds as a multipath meter, giving a fluctuating reading when reflected signals are affecting the reproduction, though no precise level of multipath interference is indicated.

Terminals and a coaxial socket accommodate 75/300 ohm aerials and 'phono'-type sockets deliver audio signals. No matching problems were encountered.

Overall vhf results were good, the model exhibiting almost the maximum realisable sensitivity with good signal-to-noise ratios. Main weaknesses were adjacent channel selectivity, which also tended to retard the birdies rejection ratio, and the equivalent front-end selectivity figure-of-merit.

On the audio side astonishing results were obtained with some of the lowest distortion levels measured. Mono signal-to-noise ratio was also very good. The 1dB/div. response graph shows good maintenance of the upper frequencies allied with a respectable pilot tone rejection ratio. The same graph also shows the remarkable stereo separation. Intrinsic breakthrough signal distortion was high, but owing to the good separation the second harmonic is 59dB below the speaking channel signal, corresponding to 0.11% second harmonic distortion.

AM performance was not outstanding, but a swivel ferrite rod aerial allows beaming on to the station. A slight whistle was heard on 908kHz.

RECOMMENDED

FM auditioning attracted favourable comment from the panel by such remarks as clean top, no stridence on piano or strings, and accurate bass. On our system of signals we were able to incite birdies interference when simulating difficult reception conditions.

In summary, a tuner of good engineering, average features and above average vhf and audio rankings. At the price the net result was good value.

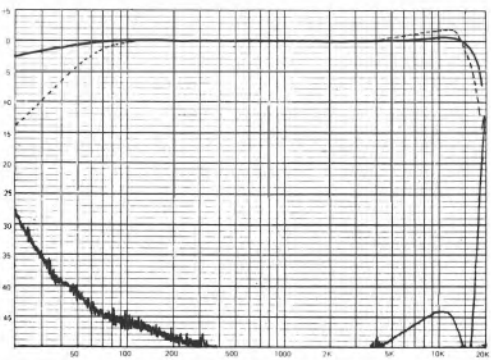
VHF Section

Sensitivity 30dB S/N CCIR mono (μV)	0.7
Sensitivity 50dB S/N CCIR mono (μV)	3
Sensitivity 50dB S/N CCIR stereo (μV)	31
S/N CCIR mono 1mV av. (dB)	80
S/N CCIR stereo 1mV av. (dB)	72
Limiting —1dB (μV)	1.125
Front-End Performance	
3rd-order RF IM av. (dB)	65
Equiv. select. figure-of-merit (dB)	48
Repeat spot (dB)	85
Capture ratio (dB)	1.125
Select. ±400kHz av (dB)	66
Select. ±200kHz av. (dB)	5
Muting threshold (μV)	4 and 30
Sig. meter saturation (μV)	500
Tuning error 95MHz (kHz)	+48

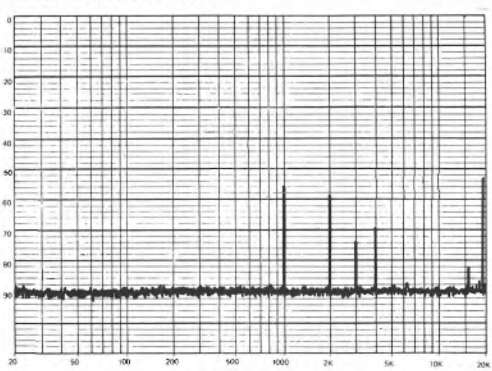
Audio Section

Output ±67.5kHz dev. L-ch. (mV)	690 (max)*
Output ±67.5kHz dev. R-ch. (mV)	712 (max)*
AM rejection 1mV (dB)	55
Pilot tone suppression ref. ±67.5kHz dev. (dB)	60/53
Sub-ch. spuriae ref. ±67.5kHz (dB)	59/65
Hum ref. ±67.5kHz (dB)	78
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.13
3rd harmonic (%)	0.04
4th harmonic (%)	0.04
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.04
3rd harmonic (%)	0.05
4th harmonic (%)	0.012
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.04
3rd harmonic (%)	0.03
4th harmonic (%)	0.025
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	0.016
4th harmonic (%)	0.01
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.03
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	79
Response 15kHz worst ch. (dB)	—0.4
Response 20Hz worst ch. (dB)	—2.8
Stereo separation 1kHz (dB)	57
Stereo separation 10kHz (dB)	44
Birdies suppression (dB)	62
Dimensions (W x H x D) (mm)	435 x 160 x 349
Typical selling price (£)	£170.00

Additional information/comment:
*down to approx. 100mV.
Features include MW with rear swivel ferrite rod aerial; front level control; high and high-blend filters; two muting levels and off; signal/tuning meters; record level calibration oscillator equivalent to ±35.4kHz deviation as measured (0.5dB below Dolby reference); auto afc (OTC); 75/300-ohm aerial inputs.



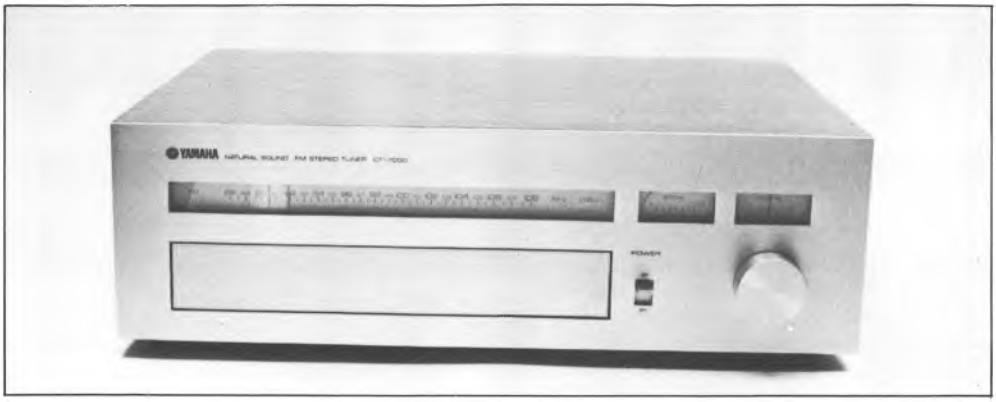
Frequency response/stereo separation curves (dotted curve 1dB/div).



Breakthrough signal distortion

Yamaha CT-7000

Natural Sound Systems Limited, 10 Byron Road, Wealdstone, Harrow, Middlesex. 01-863 8622.



This is Yamaha's well established tuner at the top end of the price scale. Its styling is similar to the other models in the range, but it is FM-only. There is a hinge-down cover on the fascia which exposes three small knobs, a headphone jack socket and six press-buttons: the knobs provide headphone volume control, output level control and adjustable muting; the buttons switch muting, i.f. selectivity, the meter for multipath detecting, auto hi-blend, mono and scale illumination. This is one of the few tuners on the market with headphone monitoring facilities. The tuner is housed in a well made wooden cabinet, and the tuning and control precision are well on a par with the other models. Scale is approximately 190mm in length, with essentially linear 500kHz divisions and frequency numbers every 1MHz. For a tuner of this quality we would have favoured 200kHz divisions, but there is a logging scale.

Two illuminated meters reside at the right of the scale: the signal meter is logarithmic and reading up to 20,000μV, and the tuning meter is accurate at centre-zero. The hi-blend is automatic when switched; that is, the degree of hf inter-channel crosstalk adjusts according to the signal strength. Measurements revealed that the main switching point was round 500μV.

Marginally more generator emf was required for the 30dB absolute signal to noise ratios than the CT-810; but it is wrong to judge the intrinsic sensitivity on this by assuming that the aerial input is actually 'seeing' half the emf (e.g. pd). This can only be true when the tuner accurately matches the standard generator pad, as explained in the Technical Section. Our method of half emf measurement thus takes account of tuner mismatch.

Overall vhf results were very good and within the range of such models as the Accuphase T-100, Sony ST-5950SD, Sansui TU-9900 and Revox B760. In *real* figures, it may be of interest to note that our results were four points only in favour of the Accuphase. The CT-7000 can thus be recommended as a tuner suitable for difficult as well as service area reception conditions. It is also aided in this respect by switchable selectivity from normal to wide; but apart from a slight fall in distortion there seems to be little point in switching to wide! Final analysis was thus made in the normal position.

Audio section results were two points better overall than the Accuphase T-100 and four points below the Sansui TU-9900; but here we are dealing with nth degree differences which are not necessarily subjectively discernible. The lab results show a tuner of remarkably good audio parameters. No distortion harmonic rose to 0.1%, and the vector sum of all the harmonics in all the modes still places the stereo distortion at a mere 0.12% in the normal selectivity position — less still in the wide position! It may seem curious to see that the second harmonic of the breakthrough signal was about 5dB above the fundamental. In other words, the breakthrough carries more intrinsic distortion than pure tone! This need not worry you because, as shown by the spectrogram, the second harmonic is 60dB below the speaking channel signal, corresponding to a mere 0.1% second harmonic distortion.

The frequency response is well extended in spite of the excellent 74dB of pilot tone rejection. On one channel, though, as shown in the frequency response graph, a 1dB lift occurs at 15kHz. This is not good for a tuner of this class.

FM quality was amongst the best models of the group, and on master-tape music we found it

impossible to detect any difference between the direct tape signal and the tuner signal at 1mV aerial input.

In summary, a tuner of top quality and performance — and this in spite of the design being some four years old. A tuner which would satisfy the most critical; but one whose overall ranking was affected by its inevitably high price.

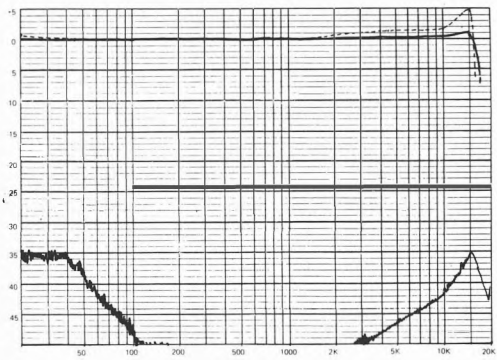
Additional information/comment:
*Down to 50mV; also fixed o/psat 694/664 mV.
Note: measured in normal i.f. position unless otherwise stated. Distortion less in wide position. Auto-blend switchpoint 500μV.
Features include signal/tuning meters; auto-afc; front level control; headphone jack and level control; switched variable muting; selectivity switch; autoblend; scale illumination switch; meter display switch; two pairs audio o/ps; sockets for 4-ch. decoder and multipath; 75/300 aerial inputs including coaxial socket.

VHF Section

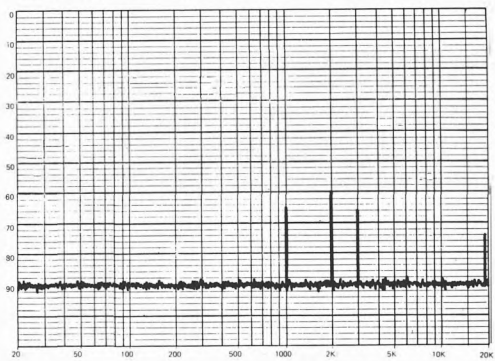
Sensitivity 30dB S/N CCIR mono (μV)	1.2
Sensitivity 50dB S/N CCIR mono (μV)	3.7
Sensitivity 50dB S/N CCIR stereo (μV)	30
S/N CCIR mono 1mV av. (dB)	84.5
S/N CCIR stereo 1mV av. (dB)	76.5
Limiting —1dB (μV)	0.9
Front-End Performance	
3rd-order RF IM av. (dB)	81
Equiv. select. figure-of-merit (dB)	>96
Repeat spot (dB)	>96
Capture ratio (dB)	1.25
Select. ±400kHz av (dB)	>74 (36 wide)
Select. ±200kHz av. (dB)	6 (3.5 wide)
Muting threshold (μV)	1.5-40 (variable)
Sig. meter saturation (μV)	20,000 (logarithmic)
Tuning error 95MHz (kHz)	+75

Audio Section

Output ±67.5kHz dev. L-ch. (mV)	1894 (max)*
Output ±67.5kHz dev. R-ch. (mV)	1843 (max)*
AM rejection 1mV (dB)	48
Pilot tone suppression ref. ±67.5kHz dev. (dB)	74
Sub-ch. spuriae ref. ±67.5kHz (dB)	82
Hum ref. ±67.5kHz (dB)	81
Distortion	
Stereo 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.06
3rd harmonic (%)	0.03
4th harmonic (%)	noise
L+R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.05
3rd harmonic (%)	0.05
4th harmonic (%)	noise
L—R 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.029
3rd harmonic (%)	0.055
4th harmonic (%)	noise
Mono 1kHz ±67.5kHz dev. worst ch.	
2nd harmonic (%)	0.04
3rd harmonic (%)	0.05
4th harmonic (%)	0.01
Mono 1kHz ±22.5kHz dev. worst ch.	
2nd harmonic (%)	0.05
3rd harmonic (%)	noise
4th harmonic (%)	noise
Total on breakthrough signal (%)	2nd harmonic 5dB above fund
Response 15kHz worst ch. (dB)	+1
Response 20Hz worst ch. (dB)	+0.2
Stereo separation 1kHz (dB)	55
Stereo separation 10kHz (dB)	42
Birdies suppression (dB)	70
Dimensions (W x H x D) (mm)	436 x 144 x 352
Typical selling price (£)	£532.00



Frequency response/stereo separation curves (dotted curve 1dB/div).



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Having measured and auditioned a wide range of tuners from around £50-£60 comparatively **(Teleton GT-202, Alba UA-800A** and **JVC JT-V10)** to approximately £550 **(Accuphase T-100),** the age-old maxim 'you only get what you pay for' certainly seems to hold true when the analysis is based on an overall ranking scale as described in the **Technical Introduction.**

Average price of all the models explored works out to £170. The very expensive models have their prices boosted by factors often other than absolute performance, such as professional quality construction and engineering, high grade components and expensive extra features.

Excluding all models of £300 and above (regarding these as 'prestige' tuners), then the average price falls to £124. All models ranking very high and most models ranking high were above this average price.

Average price of the models of average overall ranking works out to approximately £102, which is not all that far removed from the average price of those models below £300.

Excluding models above £120, the average price of tuners of moderate overall ranking works out to approximately £94. It will be seen that no model costing less than £96 scored an overall ranking above average. This must not be taken to imply that all these models are intrinsically 'poor' value. The lower ranking merely demonstrates that, on a comparative basis, the more expensive models have a higher technical performance, are more exactingly engineered and probably possess features of higher weighted ranking. There would be something amiss with the system if this were not so!

As stressed in the **Technical Introduction,** The overall ranking values given in the chart should be regarded only as a rough guide. Moreover, we prefer to translate 'poor' to **low,** 'fair' to **moderate,** 'good' to **high** and 'very good' to **very high.** This is because the latter adjective in each case refers to the actual ranking position on the scale (see the illustration of the scale which was used).

Auditioning differences between tuners were found to be less dramatic than between wide-price-ranging receivers, amplifiers and loudspeakers. Using closely-controlled 'transmitted' programme material differences can be detected, however, and our impressions and opinions on the subjective performance of the tuners are given in the reviews. We must stress that we were often endeavouring to judge very small differences which, to some extent, were related to the personal preferences of the listeners concerned.

Even a very slight stereo background noise troubles some listeners, while others appear to be relatively immune to the effect; similarly, while some young listeners get really bothered if the pilot tone leakage and associated intermodulation products are high, older listeners attach less importance to this subjective effect. Young people have more extended high-frequency hearing, and although they are not usually able to describe exactly what they are hearing, they are aware that something is not quite right, and lab measurements then often show that the tuner is letting through quite a bit of pilot tone signal. Some designers appear not to use any pilot tone rejection at all (relying on the natural de-emphasis to take the signal some 30dB below full modulation level).

As with any component, the net subjective result is significantly influenced by the other items in the hi-fi chain. Major subjective differences as far as tuners are concerned are related to:

(i) the nature of the upper-frequency roll-off at the frequency where the response drops swiftly into the 19kHz pilot tone notch filter (improved auditioning is sometimes secured without pilot tone filtering than with a poorly designed or mistuned filter provided the listener is not sensitive to 19kHz whistle!); (ii) whether the filter response rises again after it has attenuated the pilot tone (some tuners have a reasonable 19kHz attenuation but give lesser attenuation to sub-carrier spuriae, the two spurious signals encouraging in-band intermodulation products in conjunction with the audio modulation); (iii) the accuracy of the de-emphasis in conjunction with the 19kHz filter when used (these two factors work together and some designers appear to have a job to get them both right); (iv) the intrinsic i.f. bandwidth and phase characteristics over this bandwidth (tuners with switchable bandwidth or selectivity invariably audition

most favourably in the widest position, but then their ability to discriminate against unwanted side-frequencies is diminished); (v) the degree of background 'hiss' 'mush' or 'birdies' in stereo mode on moderate aerial signal; and (vi) the amount of distortion carried by the breakthrough signal and the percentage that the significant harmonics of this relate to the speaking channel signal. All these important aspects of tuner auditioning have been investigated in the lab and subsequently analysed.

Clearly, optimisation of all design aspects costs hard cash, and it is impossible for any designer to make everything just right — much as we would like him to — when he is working to a budget price. Cost is therefore the prime determinant of tuner quality.

Quite startling subjective differences can arise, nevertheless, when *any* given tuner is operated first under ideal conditions (such as from a tightly-controlled closed-circuit 'transmission' system) and then under adverse conditions. Multipath reception is one of the biggest hazards in this respect, and even expensive tuners will yield singularly unpalatable program signals when they are confused by delayed signals bouncing off hills and large buildings; though it is possible that less sophisticated designs would audition even more poorly under such conditions. Multipath distortion, as it is called, is reduced by a good capture ratio.

One must be aware that the FM system of broadcasting is not meant for long-distance reception or for problem reception conditions. It falls within the responsibility of the broadcasting people to ensure that the latter are eliminated or, at least, reduced. At the time of writing (December 1977), in the Torbay area of Devon, we have just been given 'clean' stereo from our 'local' North Hessary Tor transmitter. Up until then it has been necessary for us to use more distant transmitters over virtual DX-ing paths to get our stereo beacons to glow.

Most manufacturers design tuners to suit normal or average reception conditions, so they cannot really be held to blame for shortcomings in performance in those areas which deviate considerably from the norm or average. In a book of this nature, which is technically oriented, it has been necessary to rank all the tuners investigated comparatively. Because there are, in fact, tuners specifically designed for difficult reception conditions, allowing DX-ing trials, these obviously rank higher in terms of technical parameters than those models designed more for average conditions. Such models obviously cost more and they may be equipped with more features (useful or not) than the average tuner.

When hi-fi equipment is ranked it is often necessary to pay some attention to differences which are fairly small in absolute terms. This means that very small (perhaps to some subjectively insignificant) differences (perhaps of less than 1dB) may be analysed! In extreme cases, on a cumulative basis, this could mean that a model given a 'best buy' or 'recommended' tag may be subjectively very similar to a model with no such recognition. There is also the danger that a parameter with minimal subjective significance may affect overall analysis results.

As far as possible we have (hopefully) avoided major aberrations of this kind; but if you are in any doubt please also refer to the lab results. In our opinion, no matter what is said to the contrary, final analysis can at best only be regarded as a rough guide. This is in no way suggests that our method of ranking and analysis are in question; a great deal of time and energy were spent on this section of the book, which we regard as equally important as the lab work.

After reading the foregoing you may (wrongfully) feel that we found nothing to criticise. This, of course, is not true as you will gather from the individual reviews. Regardless of price, front-end IM performance is one area where some models could be improved. There are designs in which remarkably good IM ratios have been achieved, whereas in others there is room for improvement. A high ratio makes a tuner suitable for strong signal areas without the need for aerial attenuation, and hence without robbing its owner of the advantages of high sensitivity; but any tuner no matter how good will overload given sufficiently strong aerial signals.

Stereo separation which is essential for top-flight audio quality owing to the high intrinsic distortion carried by the breakthrough signal

is improving. Some designers could improve the second order IM performance, leading to better equivalent selectivity 'figures of merit'. Some models were found to yield relatively high second harmonic content at the local oscillator and rf stages, showing as mediocre repeat spot suppression ratios.

Models with switchable i.f. selectivity will appeal to enthusiasts who demand the very best audio under normal and good reception conditions, in addition to good reception under difficult conditions, DX capabilities, and high discrimination against near-frequency, unwanted signals — ie the best of both worlds (but not necessarily at the same time). We would stress that the final analysis was made in the wide postiion. In all instances this produced a high audiδ ranking owing to the resulting low distortion and often the astonishingly high stereo separation ratio. Had the analysis been made at narrow, the vhf ranking would have been better owing to the improved adjacent- and alternate-channel selectivity ratios, but at the expense of the audio ranking.

While some designers have combined very high pilot tone rejection ratios with excellent upper-frequency responses, others have been much less successful, either obtaining a reasonable response with minimal rejection or a singularly poor response with excellent rejection. There is no merit in our opinion in extending the response much above 15kHz, since no broadcasting authority modulates above that frequency anyway. Bass-end performance was reasonable all round — only a few models rolling-off too early; but, again, nothing much is modulated below 30Hz. Some models with good pilot tone rejection showed a rising response again above 19kHz to the 38kHz sub-carrier frequency and thus threw up a lot of spuriae, which is not good.

Most models were found to have fairly low pure stereo and mono distortion; but this did not correlate with the correct tuning indication or with the afc switched on in all cases. There are a few models where the distortion is well above average however the tuning is adjusted. Few models (apart from the British Rogers, for example) include 'birdies' filtering in the true sense between the FM detector and stereo decoder. Most designs rely on the selectivity ratios to suppress stereo birdies. Apart from those models with poor adjacent channel selectivity, the birdies suppression ratio was found to be of a reasonably high standard all round, no doubt aided by the recent generation of ceramic filters and surface acoustic wave filters.

We must emphasise that none of the tuners here presented can, in the general sense of the term, be classified as 'bad buys'. Obviously some are better (or much better) than others; but all the models tested are capable of satisfying the requirements for which they were designed. In terms of absolute performance you must be prepared to spend more (often much more) for performance parameters that approach the maximum theoretically attainable; but there is not much point in spending this sort of money if you live in average, reception areas and provided you will be satisfied by 'average' audio quality and performance. You will also have to spend much more for the models equipped with 'space-age' circuitry and numerous features. Only you can decide whether these things, coupled with the 'prestige' which for some reason often accompanies them, are for you.

Operating under good conditions, in our opinion even the most 'golden' of ears would be hard-pushed to detect a great deal of difference between a well designed model round the £100 mark and a 'super' model bristling with features costing £500 or more. For difficult reception conditions you will require a tuner above average vhf ranking for the least trouble; but we know of FM devotees with tuners of £100 or so and perfectly happy with them; they can still receive distant stations when the tropospheric conditions are favourable. In comparison with some of the 'super' models in this book that sort of tuner would probably rank as 'average' or, perhaps, a little lower!

As already explained in the **Technical Introduction,** our method of ranking allows you to choose a tuner on the precise basis of requirements; but remember to look through the reviews to get detailed comment.

We have endeavoured to be as fair as possible to the firms concerned and to our readers in the preparation of this work. In essence, all the tuners tested met their

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specifications so far as could be judged within the range of the searching tests that our lab applied to them (the manufacturers' tests and quoted specifications often differ from those that we use). We had no reason to believe that any model was untypical of the product actually on sale.

At least £20,000 of specialised lab equipment is required to conduct exhaustive tests on FM tuners. This means that it costs well over £100 of lab time per tuner to get the results to you! It is not generally possible for a person to run a wide range of measurements on a tuner that he has recently purchased to prove its spec; the same applies to the car buyer. It is the duty of the manufacturer to ensure that each tuner leaving his factory is up to specification.

Since many of the tuners in this book emanate from distant places, it is feasible that mild misalignment may occur during shipping. It is not generally realised that very small misalignment can dramatically affect the measured result. Different results can also be obtained by very slight mistuning within the 'capture range' of a station (this applies particularly to distortion and stereo separation.) On receipt of product from the distant places, therefore, it would be good if the distributors could check the spec of each and every tuner dispatched to the shops; unhappily this is uneconomic particularly for the cheaper models as it would necessarily incur costs that would have to be passed on.

Thus some of the points noted in the reviews could be the result of slight maladjustment. This certainly does not mean that the tuner is untypical. It could, however, show up as a higher-than-average scale inaccuracy, for example; or slightly less stereo separation than the optimised design is capable of providing. These are not intrinsic design faults by any means; reputable dealers would put any superficial shortcomings like this right very quickly and without cost; but on no account should one be tempted to alter the internal adjustments of a tuner without the necessary knowledge and suitable instruments. A shop cannot be expected to remedy troubles caused by untutored tampering without charge.

Remember, too, that the full attributes of the FM system of broadcasting will be fully realised only when the tuner is partnered with an amplifier of comparable quality and served by an aerial adequately suitable for the prevailing signal and reception conditions. Latter-day tuners are very sensitive, and quite a few approach the theoretical maximum, which can be shown to be be close to 0.68μV for 30dB mono signal-to-noise ratio at 75 ohms aerial input (if you want more technical details on this, please refer to page 251 of my *Audio Handbook* published in 1975 by Newnes-Butterworths). Absolute sensitiviy, however, is of relatively small importance these days. With the increasing exploitation of Band II (the FM band), a wide input dynamic range and overload and spuriae immunity are of far greater importance. It is unlikely that any difference would be noticed in a practical situation between a tuner close to the maximum theoretical sensitivity and one with a measured sensitivity of, say, 2μV for 30dB signal-to-noise ratio.

I am unhappy to say that there are some very respected hi-fi names that are not represented in these pages. Having been an evaluator and reviewer of equipment for 25 years or more, I am deeply saddened by the effects that variations of opinion and dogma are having on the industry to which I have devoted my life since the pioneering days of hot PX4s. Some people proclaim that the industry is hell-bent on self-destruction; others are less polite! As my past writings bear witness, it has always been my aim to present to the consumer my unbiased findings in a positively authorative and balanced manner, nurtured by experience at all levels over many years, having always in mind that the subject is consumer electronics as distinct from professional electronics. Sad it is, then, that today I find myself frustrated by decisions not to submit certain tuners that I would have liked to have featured.

In conclusion, I would like to thank Donald Aldous for introducing this book to you; the manufacturers for supplying the tuners for review without any idea of their relative rankings; Sally Peberdy for editing (wishing her all the luck in her new appointment); Paul Messenger the new Editor; all my helpers on this protracted, though interesting exercise; and the publishers for affording me this opportunity of placing our findings and our views on tuners before you.

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Seeking so-called 'best buys' for tuners is not as straightforward as it may seem; there are numerous aspects which need to be taken into account. However, when operated as the designers intended, most of the tuners explored in this book can be regarded as hi-fi signal sources, ranging from the inexpensive models of low ranking at the 'budget' end of the range, to the very expensive, high ranking 'prestige' models. The majority of models investigated in this book fall somewhere between these two extremes.

As well as comparatively-ranking **all** the models, we further analysed in six price ranges: £100 or less; £101 to £200; £201 to £300; £301 to £400; £401 to £500 and £500 and above. At this juncture we must stress that the prices quoted can only be approximate as we go to press as there are no longer recommended retail prices. As far as we have been able to judge the prices are 'typical average', but they can vary from source to source and change with time, so please take these factors into account.

£100 or Less

Although all the models in this price group rank overall from good **downwards,** some interesting and useful tuners nevertheless reside in the group. The higher ranking models appropriate to the group include the following. The **Eagle T-6000** (with MW) has some encouraging vhf parameters, the stereo signal-to-noise ratio was not very high, and we found that the distortion can be higher than average unless carefully tuned; an interesting tuner nevertheless. The **Optonica ST-1515** (with MW) is attractively priced for its performance and includes a recording-level-setting oscillator. Its high vhf rank would give it the edge on the others in certain reception areas; but it was not too good on stereo signal-to-noise ratio. The **Sony ST-2950F** (with LW, MW and SW) too falls short, owing to higher-than-average noise level, but the distortion is acceptable.

If you are particularly interested in more than one AM band you might also consider the **Alba UA800A** (with LW and MW) which is one of the least expensive models, **Sony ST11L** (LW and MW), **Teleton GT-202** (LW and MW) and **Voxson R-303** (LW, MW and SW; see review for availability). Compared with the more expensive models, all these tuners exhibit obvious FM limitations.

£101 to £200

There are more higher ranking models in this price group, and those shining most brightly include the following. The **Hitachi FT-440** (with MW) which is recommended, but would have ranked even higher had the stereo signal-to-noise ratio been better. The **Hitachi FT-920** (with MW) which also includes auto-lock tuning (often appreciated by the distaff side), is another recommendation, but the **FT-440** came out best on vhf. The **JVC JTV71** (with MW) is above the Hitachi models in price, and is recommended for its high overall parameters; but it could have been better so far as stereo noise was concerned. The **Marantz 2120** (with MW) is recommended for its high audio ranking, but was less well placed on vhf owing to slight response asymmetry pulling down the average selectivity; it is another model with a recording-level-setting tone oscillator. The **Optonica ST-3636H** (with MW) was particularly highly ranked, best of all the models in this price range, and is thus one of the few best buys in this book. We employed it as one of the reference tuners for some of the comparative listening tests. It is equipped with switchable selectivity, auto-lock tuning and a tone oscillator for recording-level-setting, working in conjunction with the signal meter for level monitoring. It is certainly good value for money. The **Rotel RT-952** (with MW) is recommended for its high rankings on all but audio, which was only moderate comparitively. It is soundly engineered but a trifle larger than some models. The **Sansui TU-717** (with MW) gave a good account of itself on audio and is of good engineering standard. It also includes a tone oscillator and, although towards the top of the price group, is worthy of recommendation. The **Sony ST-3950** (with MW) is recommended for its very high vhf ranking which makes it suitable for difficult areas and DX trials. Other parameters fell close to the average, but there was a shortfall in terms of above-average noise; distortion, on the other hand, was commendably low. It is reasonably-priced, towards the bottom end of this price

range. **Technics ST-3500** (with MW): we have no hesitation in recommending this early design (still available). It showed up in good light in spite of its 'whiskers' and is liked by many people. The **Technics ST-8080** (with MW) is another recommendation, which on absolute figures ranked a shade higher than the earlier model on vhf; the third order IM was also better but it is not quite as good on audio. Both of these Technics models scored higher than the less expensive **ST-7300,** which probably shows that to remain competitive (in price) something has to suffer nowadays. The **Yamaha CT-810** (with MW) can be recommended on good all-round performance, though a shade better on vhf than audio. It is well engineered and good looking.

It will be noted that these models include MW. There are fewer models in the higher price bands with multiple AM bands. Mention should also be made of the unique British **ARD-4000** which, although failing to rank as highly on absolute terms as some of its Oriental competitiors, nevertheless includes useful press-button station selection and auto-scan tuning — features not yet found on Japanese models. The proposed changes noted in the review will certainly help to improve the overall ranking. The model is FM-only and auditioned well.

A number of models in this price group scored average ranking. When AM is taken into account the **Rogers T75/2** would probably rank a little higher (the model we looked at was FM-only); but even in FM-only guise it was only one real point away from the 'recommended' section of the marking scale. The design appears to include a low-pass birdies filter between the FM detector and stereo decoder — birdies just not existing!

Other models ranking high in the **average** region include the **Yamaha CT-610, Marantz 2100** and the **LG T-1400** — all respectable auditioners. The **Pioneer TX-5500II** and **TX-6500II** also produced acceptable programme signals but were pulled back by other things.

£201 to £300

All three models in this price range were awarded best buy tags owing to their very high overall rankings with respect to price, namely the **Pioneer TX-9500II, Sansui TU-9900** and **Sony ST-5950SD** (all with MW). The **Sony** is also equipped with FM Dolby decoding which, although not of particularly high value to UK listeners at the present time, might have limited application under certain adverse reception conditions (see the review). The **Pioneer** and **Sony** are fairly close in price, but the **Sansui** is close to the next price range up. The **Pioneer** and **Sansui** are equipped with switchable selectivity and so are particularly suitable for the best audio and the best signal discrimination under problem reception conditions and when DX-ing. The **Sony** is one of the best equipped tuners in the book, and is one of the few models with headphone monitoring.

£301 to £400

We are now entering the 'prestige' area and of the two models in this price group, the **Accuphase T-101** had the highest overall ranking, but its price held it back a little so it consequently received a recommendation. This model also includes switchable selectivity, and the final analysis was made in the wide position; the vhf ranking is enhanced in the narrow position but at the expense of audio ranking.

£410 to £500

The only model in this price range is the excellent **Trio 600T** which was highly ranked. It is certainly a tuner worthy of recommendation, although its rather high price prevented it from receiving a best buy tag. It is another model with switchable selectivity, this time with three positions; agian, the final analysis was made in the wide postion. In the narrower positions a higher vhf ranking could be expected but at the slight expense of audio ranking. It is a tuner which auditions well and one which would not easily get into trouble in problem reception areas; it is FM-only.

£500 or More

We are now well into the 'prestige' area where we find up-market and high ranking models such as the **Accuphase T-100, Yamaha CT-7000** and **Revox B760.** The **Accuphase** includes MW, while the other two models are

FM-only. Although all scored very high for vhf, audio and engineering quality and high for weighted features (with the exception of the **Revox** which again scored very high), the overall ranking values were reduced a trifle by the high prices. Consequently, the **Accuphase** and **Yamaha** reached the 'recommended' category while the **Revox** just made the 'best buy' category. This is where the 'prestige' factor really starts coming into play. If I had the money I would find it difficult to decide between the **Accuphase** and the **Yamaha;** however, the state-of-art electronics of the **Revox** interest me so I might veer in favour of that model. I like the **Accuphase** for its robustness and instrument-like engineering and for its excellent screening. Both this and the **Yamaha** are good looking tuners in the traditional sense, the latter in particular while the **Revox** has more of a scientific appearance. There is not a great deal of difference between the three performance-wise, though the **Revox** just has the edge on the others in absolute terms. The frequency-synthesised digital tuning and memory of this could be useful, as could the switchable selectivity of the **Yamaha,** which the other models are without.

Statistical Analysis Summary

Tuners of Highest Rankings
Based on all the technical parameters, weighted features and engineering quality, the highest ranking models in the six price groups in order of ranking are:

£100 or Less
1) Optonica ST-1515
2) Eagle T-6000
3) Sony ST-2950F

£101 to £200
1) Optonica ST-3636H
2) Sansui TU-717
3) Technics ST-8080
4) JVC JT-V71, Sony ST-3950, Technics ST-3500 and Marantz 2120

£201 to £300
1) Sony ST-5950SD
2) Sansui TU-9900
3) Pioneer TX-9500II

£301 to £400
1) Accuphase T101

£401 to £500
1) Trio 600T

£500 or More
1) Revox B760
2) Accuphase T-100 and Yamaha CT-7000

Tuners of Highest VHF Rankings Including Tuning Accuracy (given in order of ranking)
£100 or Less
1) Optonica ST-1515
2) Eagle T-6000

£101 to £200
1) Sony ST-3950
2) JVC JT-V71 and Optonica ST-3636H

£201 to £300
1) Sony ST-5950SD
2) Sansui TU-9900

£301 to £400
1) Accuphase T101
2) Dual CT-1640

There are two decisions to make when buying hi-fi: One is what to buy. The second is where to buy it.

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£401 to £500
1) Trio 600T

£500 or More
1) Accuphase T-100
2) Yamaha CT-7000
3) Revox B760

Tuners of Highest Audio Rankings (given in order of ranking)
£100 or Less
1) Optonica ST-1515
2) Sony ST-2950F

£101 to £200
1) Marantz 2120
2) Optonica ST-3636H
3) Sansui TU-717
4) JVC JT-V71

£201 to £300
1) Sansui TU-9900
2) Pioneer TX-9500II

£301 to £400
1) Accuphase T-101

£401 to £500
1) Trio 600T

£500 or More
1) Accuphase T-100
2) Revox B760

Tuners of Highest Weighted Features Rankings (given in order of ranking)
£100 or Less
1) Eagle T-6000

£101 to £200
1) Optonica ST-3636H and Rotel RT-952
2) Hitachi FT-920, Technics ST-3500 and Technics ST-8080

£201 to £300
1) Sony ST-5950SD
2) Sansui TU-9900
3) Pioneer TX-9500II

£301 to £400
1) Accuphase T-101
2) Dual CT-1640

£401 to £500
1) Trio 600T

£500 or More
1) Revox B760
2) Yamaha CT-7000
3) Accuphase T-100

Highest-Ranked Tuners of all Including all Parameters but Excluding Price (given in order of ranking)
1) Revox B760
2) Accuphase T-100 and Yamaha CT-7000
3) Sony ST-5950SD
4) Sansui TU-9900

Highest-Ranked Tuners of all Including Price and Weighted Features (given in order of ranking)
1) Sony ST-5950SD
2) Pioneer TX-9500II and Sansui TU-9900

Overall comparison chart

	VHF	Audio	Features	Eng. Qual.	Price	Value for Money
Accuphase T-100	v.good	v.good	good	v.good	£550	good
Accuphase T-101	fair	v.good	good	v.good	£340	good
Alba UA-800A	poor	poor	poor	fair	£58	poor
Alpha TX500	poor/f	average	poor	fair	£70	fair
Alpha FT-650	average	fair	fair	fair	£110	fair
ARD-4000	poor	average	poor	good	£146	fair
Cambridge T-55	fair	fair	fair	average	£125	fair
Dual CT-1640	good	poor	average	good	£335	fair
Eagle T-6000	average	fair	average	average	£96	good
Harman-Kardon T-403	poor	average	fair	average	£138	fair
Hitachi FT-340	fair	average	poor	average	£85	average
Hitachi FT-440	good	good	average	average	£117	good
Hitachi FT-920	average	good	good	good	£114	good
JVC JTV10	fair	average	poor	average	£65	fair
JVC JTV11	fair	fair	poor	average	£86	average
JVC JTV71	good	good	average	average	£180	good
LG T-1400	fair	average	average	good	£145	average
Marantz 2100	average	average	poor	good	£115	average
Marantz 2120	average	v.good	average	good	£180	good
National ST-2400	fair	poor	poor	good	£85	fair
Optonica ST-1515	good	good	fair	average	£99	good
Optonica ST-3636H	good	v.good	good	good	£162	v.good
Philips RH-640	fair	poor	poor	fair	£95	poor
Pioneer TX-5500II	poor	fair	poor	fair	£77	fair
Pioneer TX-6500II	poor	average	poor	f/average	£110	poor
Pioneer TX-9500II	good	v.good	good	good	£250	v.good
Revox B760	v.good	v.good	v.good	v.good	£520	v.good
Rogers T75/2(FM)	good	fair	fair	good	£125	average
Rotel RT-925	good	fair	good	good	£165	good
Sansui TU-217	poor	average	fair	average	£114	fair
Sansui TU-717	good	v.good	average	good	£207	good
Sansui TU-9900	v.good	v.good	good	v.good	£300	v.good
Sanyo FMT-200K	average	fair	fair	fair	£80	average
Sony ST-11L	fair	fair	poor	average	£90	fair
Sony ST-2950F	fair	average	fair	good	£95	good
Sony ST-3950	v.good	average	average	good	£138	v.good
Sony ST-5950SD	v.good	v.good	v.good	good	£225	v.good
Technics ST-3500	good	good	good	good	£160	v.good
Technics ST-7300	average	fair	poor	good	£108	fair
Technics ST-8080	good	average	good	good	£180	good
Teleton GT-202	poor	poor	poor	good	£78	average
Trio 600T	good	v.good	good	good	£495	good
Yamaha CT-610	average	average	average	good	£120	average
Yamaha CT-810	good	average	average	good	£170	good
Yamaha CT-7000	v.good	v.good	good	v.good	£532	good
Voxson R-303	poor	poor	poor	average	£90	fair

WHY GUILDFORD HI-FI HAS A NUMBER OF PROBLEMS

SALESMEN	Sales personnel at this establishment have a disconcerting habit of treating the customer as though they were human-beings and capable of rational actions. On occasion they have recommended equipment when it was not in sock and have even recommended that customers listen to the equipment in their own homes prior to purchase.
LOCATION	This shop is unwisely located more than twenty miles from Tottenham Court Road out in the wilds of Surrey. Customers are even allowed to park within walking distance which is unfortunate since the customer is not completely exhausted upon entering the shop and might not purchase the first item that is thrust at him.
PRICES	Prices at this shop tend to be higher than those of well-known discounters. They try to justify this devious practice by offering generous trade-in allowances, hire-purchase facilities, delivery, installation, home-demonstrations and an extravagent guarantee.
BRAND-NAMES	There is a genuine dearth of reassuring, well-known, household brand names at this establishment. Instead they make the iconoclastic and highly improbable claim that many other smaller, less touted manufacturers make equipment that actually sounds better, costs less, lasts longer and represents better value for money than the well known brands.
TECHNOLOGY	This is going to be hard to believe but this shop actually stocks valve equipment. Everyone knows that valves have been dead for the past ten years, and no wonder! They are bulky, noisy, hot and they wear out. Their specifications are inferior to solid-state designs and to top it all they cost more than transistors. But these guys say that although this is true, Valve equipment still sounds superior and they intend to cater to people who care about listening to accurate music reproduction rather than those who are interested in mere technological innovations. To show that they mean business they now stock such outlandish brands as dB Systems, Paragon, Futtermans and Lux valve equipment and they threaten to bring in even more esoteric gear in the future.

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Glossary

Aerial input: Type of aerial socket(s) used. May be designed for 72 ohms coaxial feeder or 300 ohms balanced feeder (or both).

Amplitude modulation (AM): Where the audio signal is carried by amplitude variations of the radio wave. Not suitable nowadays for hi-fi reproduction.

AM rejection: Degree of rejection provided by an FM receiver to AM signals.

Audio section: Section of an FM tuner which processes the sound information after its reception.

Automatic frequency correction (afc): A special circuit which automatically corrects for mild tuning error or tuning drift.

Afc switch: A switch for defeating the afc. Desirable when attempting to receive weak signals close to powerful ones.

Automatic tuning: Circuit artifice for tuning an FM tuner automatically.

Average output voltage: Signal voltage delivered by the left and right channels of a tuner on average level modulation (ie average sound intensity).

Bandwidth: Frequency range over which a tuner or stage in a tuner is responsive.

'Birdies' suppression: Degree of attenuation afforded by an FM tuner to a warbling type of interference (called 'birdies' interference) when a near station is affecting the wanted stereo station.

Blend filter: Dodge used in FM tuners to decrease stereo background noise on weak signals by the deliberate introduction of inter-channel crosstalk, increasing with audio frequency. Sometimes called MPX filter.

Capture ratio: Ability of FM tuner to latch on to the wanted signal even when a weaker unwanted signal is present at the same frequency. The *ratio* refers to the greater strength required of the wanted signal to adequately suppress the unwanted one.

Coaxial cable: Type of downlead or feeder used to connect the FM aerial to the tuner. The impedance matches that of the 72 ohms aerial input.

Decoder sockets: Sockets fitted to an FM tuner permitting the subsequent fitting of a four-channel quadraphonic decoder. Not applicable at the present time to the UK.

Decibel (dB): Logarithmic ratio between two signals. Corresponds to the ear's response to sound. A change in level of 1dB is barely detectable.

De-emphasis: A cut given to the higher audio frequencies at the tuner as a means of enhancing FM signal-to-noise ratio. For correction, corresponding pre-emphasis is applied at the transmitter.

Digital tuning: A tuner employing calculator-type electronic digits instead of a tuning cursor and scale for station selection. Tuning is sometimes automatic by press-buttons.

DIN: German standards authority upon which some hi-fi specifications are based.

DIN socket: Multi-connector socket to the DIN standard sometimes used in place of, or to complement, the 'phono' type socket.

Distortion: Change in character of a signal as the result of harmonic components or the production of new signals due to non-linearity when more than one signal present.

Dipole aerial: FM aerial composed of a single, tuned element.

Dolby decoder: Circuit sometimes fitted to FM tuners for the decoding of Dolby B encoded radio signals for improving the signal-to-noise ratio. Not at this time applicable to the UK on FM radio.

DX (DX-ing): Code used for describing long-distance reception.

Equivalent front-end selectivity (figure-of-merit): Test evolved by the author's company for the assessment of the selectivity of the tuned circuits of an FM receiver prior to the mixer stage (e.g., between the aerial and mixer).

Ferrite rod aerial: AM aerial wound on ferrite rod which has a high pick up efficiency. Avoids the need for an external long-wire aerial. Not at the time of writing used for FM; however, a new ferrite material is now making this feasible and future tuners may include

such an aerial for FM as well.

Filter: Circuit network used for attenuating unwanted signals while having minimal effect on wanted signals.

Frequency modulation (FM): Where the audio signal is carried by frequency variations of the radio wave. Used for high quality and stereo radio transmissions.

FM tuning meter: Usually a centre-zero meter which indicates the correct FM tuning point when at zero deflection. Other schemes, including small lights, are also used for indicating correct FM tuning. However, the accuracy of indication depends on the correct alignment of the tuner circuits internally.

Frequency indicating meter: Meter calibrated in frequency (MHz) for indicating tuned frequency. Sometimes used for pre-tuning pushbuttons.

Frequency response: Curve revealing variations of amplitude of loudness (usually in dB) of a signal with respect to frequency.

Harmonic: Harmonic content of signal. For example, the second harmonic of 1kHz is 2kHz, the third harmonic 3kHz and so on.

Harmonic distortion: Strength of the harmonics produced by a tuner relative to an essentially harmonic-free (pure, non-distorted) input signal. Generally measured in percent.

Hum: The fundamental and harmonics of the power supply frequency.

Intermodulation distortion (IMD): pProduced by non-linearity when two or more signals passing simultaneously. IMD is less palatable in audio circuits than harmonic distortion owing to the lack of harmonic relation between the products and fundamentals.

Impedance: Simply, the electrical resistance afforded a signal when passing into or through certain circuits. Measured in ohms, as pure resistance. However, impedance is frequency dependent.

Level control: Front panel main control or preset control for adjusting the level of the audio signals delivered by a tuner.

Limiting: A condition whereby the output signal fails to increase with increase in input signal. Used in FM receivers for preventing changes in output level with changing strength of input signal. Also reduces the effect of AM interference by slicing off the amplitude variations.

Long wave (LW): AM waveband, unsuitable for hi-fi.

Matching: Term used when coupling one circuit to another. For example, the FM aerial needs to match the tuner's aerial input for optimum signal transfer. Also used for signal levels — ensuring, for instance, that the output of a tuner matches the input requirements of the amplifier. In general, the tuner's output should be several times the radio socket input sensitivity of the amplifier. It is also desirable for the tuner's output impedance to be significantly less than the amplifier's radio socket input impedance.

Modulation hum: Power supply frequency fundamental or harmonics modulating the radio signal passing through the tuner.

Mono switch: This translates a stereo signal to a mono signal and is sometimes desirable on a weak stereo signal which may be too 'noisy' for entertainment value reception.

MPX noise filter: See under blend filter.

Multi-element aerial: FM aerial consisting of dipole *plus* one or more additional elements (called director and reflectors). This sort of aerial is more directional than an FM dipole and provides signal gain in the forward direction. Useful for discriminating against interfering signals and for 'boosting' weak signals.

Muting: Circuit technique which mutes the audio section while tuning between stations thereby eliminating the loud inter-station hiss.

Muting thresholds: Threshold point at which the muting is released. This should not be above weak stations otherwise these will not be received. It should be above very weak stations, however, because the background noise on these makes them unsuitable for listening to. Some tuners are equipped with adjustable or switchable threshold level.

Glossary

Muting switch: Switch for activating the muting, allowing it to be completely defeated if required for DX-ing; or switch for adjusting the threshold level.

Medium wave (MW): An AM waveband unsuitable for hi-fi radio reception.

Millivolt (mV): Thousandth of one volt (1V). Aerial signal level is sometimes measured in mV or *microvolts* (μV), which are a millionth of a volt.

Noise: Spurious signal produced by the random movement of electrons in a conductor, device or circuit. Manifests as 'hiss' (like the 'hissing' of car tyres on a wet road) on the background of a radio programme as the result of inadequate signal level (e.g., poor signal-to-noise ratio).

Phono socket: Two-conductor socket found at the rear of tuners for connecting to amplifiers. The centre pin is signal 'live' and the outer conductor earthy.

Pilot tone filter: Steep 'notch' filter tuned to 19kHz for attenuating stereo pilot tone signal. Each channel should include such a filter; but in some tuners inaccurate tuning fails to provide sufficient pilot tone attenuation.

Potential-difference (pd): Closed circuit potential of a voltage source. The signal applied to the aerial input of a tuner when the generator is corrected matched to the aerial input impediance. The open-circuit voltage is called electromotive force (emf). It is generally assumed that the test voltage applied to the aerial input of a tuner is pd.

Pre-emphasis: A boost given to the higher audio frequencies at the transmitter. This allows a cut (de-emphasis) to be applied at the tuner with a corresponding improvement in signal-to-noise ratio (see under de-emphasis).

Repeat spot: A type of spurious response at a frequency removed from the tuned frequency by half the *intermediate-frequency (i.f.).* An FM tuner should have a high repeat spot rejection ratio (large dB number) for the least possibility of interference in strong signal reception areas.

Selectivity: The ability of a tuner to discriminate against side-frequency signals, with FM at ±200kHz (adjacent channel) and ±400kHz (alternate channel). However, the smaller the selectivity passband, the greater the harmonic distortion at high modulation; and the greater the selectivity passband, the greater the probability of side-station interference.

Selectivity switch: Switch changing the selectivity passband to suit the requirement and to avoid the compromise indicated under selectivity.

Sensitivity: The amount of aerial signal required in mono and stereo for a given signal-to-noise ratio. The less the signal, the greater the sensitivity.

Signal meter saturation: The strength of aerial signal that the signal strength meter is capable of indicating before reaching full-scale deflection.

Signal strength meter: Meter on tuner arranged to provide relative indications of the strength of tuned signals.

Short wave (SW): An AM band, not suitable for hi-fi reception.

Signal-to-noise (S/N) ratio: dB ratio of the signal to the noise at the output of a tuner. The greater the ratio (larger the dB number), the less the noise relative to the signal. Hence the S/N ratio can be improved either by increasing the signal or reducing the noise.

Stereo only switch: Switch on FM tuner which when set to the 'stereo only' position mutes all signals other than stereo-encoded signals.

Stereo separation: A measure in dB, or as shown by a graph, of the ratio between the signal in the speaking channel and the breakthrough signal in the non-speaking channel.

Third-order intermodulation: Adjacent intermodulation sidebands falling either side of two signals as the result of non-linearity. A measurement for assessing the spurious response and overload characteristics of an FM tuner front-end.

Tone oscillator: Audio oscillator built into an FM tuner to facilitate the correct setting of the recording levels controls of a tape machine prior to recording off-air. The level of the oscillator signal at the tuner output should desirably correspond to the FM Dolby level, which is ±37.5kHz deviation, corresponding to 50% audio signal or 59% total deviation. Set at this level, the oscillator would also be suitable for setting a Dolby FM decoder.

Twin feeder: Aerial downlead of 240 or 300 ohms impedance. This feeder is balanced as distinct from unbalanced coaxial cable.

Weighted noise: A network for measuring noise which gives more weight to some noise components relative to others, thereby producing a reading which relates more closely to the annoyance value of noise (i.e. how it is discerned subjectively). The weighting used for the measurements of the tuners in this book is to CCIR/ARM (ARM standing for average responding meter).

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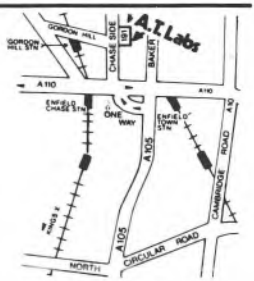

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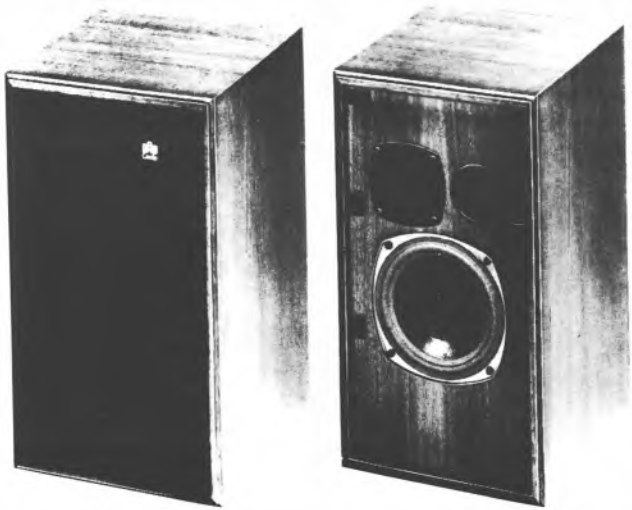

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Summary and index of products reviewed

Accuphase T-100
An expensive tuner ranking very high on technical parameters and engineering quality. Very good FM auditioning; includes MW; *Recommended.*

Accuphase T-101
Less costly than the T-100 with lower vhf ranking. Very good engineering quality. Very good FM auditioning; FM-only; *Recommended.*

Alba AU-800A
One of the least expensive tuners of the group, and of corresponding low relative rankings, failing to reach the level of true hi-fi. Includes MW and LW.

Alpha TX-500
Inexpensive model with fair features. Certain aspects could be improved. Not suitable for serious DX-ing; fair FM auditioning; includes MW.

Alpha FT-650
An improvement on the TX-500 and of moderate price. A tuner of good potential which could be further improved; Fair/average FM auditioning; includes MW.

ARD-4000
Interesting tuner of British design featuring press-button station selection and auto-scan tuning. Although ranking low, capable of above average FM auditioning; FM-only.

Cambridge
Slim-line tuner of British design and fair ranking values, capable of satisfactory reception with certain provisos. Trifle on the expensive side for features an results; FM only.

Dual CT-1640
Interesting digital tuner of above average price but failing to equivalent quality on the audio side. High ranking vhf and useful press-button station selection. Includes LW, MW and two SW bands. *Note:* the model supplied for review was a pre-production one; improvements might thus be noted in production models.

Eagle T-6000
An average-ranking tuner of moderate price and one of the higher ranking models in the below £100 price group. Average FM auditioning and suitable for DX-trials; includes MW. *Recommended.*

Harman-Kardon T-403
A tuner of average measured audio performance yet capable of good FM auditioning. Less highly ranked on vhf and features. Suitable mainly for average reception conditions; includes MW.

Hitachi FT-340
A fair tuner of less than £100 which shows some evidence of corner cutting. Well made but certain shortfalls noted. Suitable for normal reception conditions and has DX-ing potential; fair FM auditioning; includes MW.

Hitachi FT-440
A well designed tuner of good vhf and audio balance and average weighted features. Good FM auditioning. In strong signal areas aerial attenuation may be required; includes MW. *Recommended.*

Hitachi FT-920
A well featured and performing tuner for the price. Good FM auditioning. VHF performance a shade below that of the FT-440; includes MW. *Recommended.*

JVC JT-V10
A low price tuner of average overall ranking but not strongly featured. Not a particularly spectacular performer and a trifle on the noisy side; below average FM auditioning; includes MW.

JVC JT-V11
A fair-ranking model with average weighted features. Not wholly suitable for problem reception areas without aerial attenuation. Average FM auditioning. Includes MW.

JVC JT-V71
A high-ranking tuner with average weighted features and engineering quality, though a shade above average price for its class. Better than average FM auditioning. Includes MW. *Recommended.*

L & G T-1400
A tuner of average overall ranking and good engineering quality, but less well placed on vhf. Aerial matching could be improved; above average FM auditioning; includes MW.

Marantz 2100
Not a very well featured tuner but one of good

engineering quality and average vhf and audio rankings. Not suitable for very difficult reception areas, though adequate for all normal conditions. Good FM auditioning but slightly noisy on weak signals; includes MW.

Marantz 2120
More costly than the 2100 but a better performer and of higher weighted features ranking. Very high audio ranking in the wide selectivity mode. Very good FM auditioning. Suitable for a wide variety of reception conditions but aerial attenuation may be required in very strong signal areas; includes MW. *Recommended.*

National Panasonic ST-2400
A moderately-priced tuner of good appearance but exhibiting some price cutting. May require aerial attenuation in very strong signal areas. Average FM auditioning; includes MW.

Optonica ST-1515
A model of average overall ranking with high vhf and audio rankings, though the latter was pulled back a shade by above average stereo noise. Above average FM auditioning; includes MW. A model above the average amongst tuners costing below £100. *Recommended.*

Optonica ST-3636H
A tuner of very high overall ranking for the price and with well balanced vhf and audio sections. Very good FM auditioning. Suitable for most reception conditions, though aerial attenuation may be required in exceptionally strong areas; includes MW. *Best buy.*

Philips RH-640
A tuner which failed to score very high on technical parameters but one which would suit listeners requiring LW, MW and SW bands. FM auditioning about average and good sensitivity for price.

Pioneer TX-5500II
Although this tuner failed to score high ranking values in competition with the more expensive models, it was judged to have acceptable FM audio performance. Not suitable for difficult reception areas and not very strongly featured; includes MW.

Pioneer TX-6500II
Slightly better featured but more expensive than the TX-5500II and exhibiting some better parameters. Suitable for average reception conditions; includes MW.

Pioneer TX-9500II
A state-of-art tuner of high and very high ranking values. FM auditioning was judged to be very high in the wide selectivity mode. Suitable for a diversity of reception conditions; includes MW. *Best buy.*

Revox B760
Another state-of-art model with frequency-synthesised digital tuning and pre-selected station memory. Very high ranking values on all counts. Very high FM auditioning; FM-only. In spite of the high price a *best buy.*

Rogers T75/2
A British tuner selling for a little above £100. Overall ranking came out average, as also FM auditioning. The model tested was FM-only. FM/AM version is also to be available.

Rotel RT-925
A well appointed tuner with headphone monitoring. High overall ranking but with only fair audio ranking. However, FM auditioning was judged to be above average; includes MW. *Recommended.*

Sansui TU-217
A pleasant-looking tuner of the 'all-black' style. Capable of good FM audio quality on strong signals. Not wholly suitable for very strong signal areas; includes MW.

Sansui TU-717
This tuner had a high overall ranking with very high ranking for audio and engineering quality. Weighted features were average. Good FM auditioning and suitable for DX trials; includes MW. *Recommended.*

Sansui TU-9900
A very highly ranked model with a good features ranking. Although there are one or two things that could be improved for the price, the model was judged highly for FM auditioning. Suitable for use in most reception areas; includes MW. *Best buy.*

Summary and index of products reviewed

Sanyo FMT-200K
Of average overall ranking, this fairly low price tuner would be suitable for the 'budget' system. FM auditioning was fair/average; includes MW.

Sony ST-11L
This Sony model failed to reach the standard of the more expensive Sony tuners. However, it has the advantages of including LW and MW bands. Below average FM auditioning.

Sony ST-2950F
Although this model scored better than the ST-11L, the FM auditioning failed quite to reach the average level. Stereo background noise was on the high side. A useful tuner, nevertheless, if the requirements include the LW, MW and SW bands. *Recommended* for price and AM bands.

Sony ST-3950
Of high overall ranking, this model exhibited a very good vhf performance and good engineering quality. It is reasonably-priced and was found capable of good FM auditioning; includes MW. *Best buy.*

Sony ST-5950SD
The tuner scored a very high overall ranking with very high vhf, audio and weighted features rankings. It includes Dolby B FM decoding and MW. It is also suitable for headphone listening. Very good FM auditioning. *Best buy.*

Technics ST-3500
Although this model has been in the market place for some time, it still ranked well against its competitors — scoring high rankings on all counts. It is capable of good FM auditioning; includes MW. A *best buy* at around £160.

Technics ST-7300
This model seems to be a little out of character with other Technics models. It failed to score as highly as the earlier ST-3500 and was also judged to be slightly worse in FM sound quality. It is of lower price, though; includes MW.

Technics ST-8080
This model behaved more like the earlier ST-3500 which, presumably, it is to replace (but at a higher price than that for which the ST-3500 is currently on offer). A high rating was given for FM auditioning. Suitable for most signal conditions; includes MW. *Recommended.*

Teleton GT-202
An attractive inexpensive tuner which failed to score very highly owing to certain shortfalls. Below average FM auditioning and not suitable for very difficult reception areas; includes LW and MW. Average ranking for price.

Trio 600-T
An excellent up-market tuner with switchable selectivity. High ranking values scored on all counts. Suitable for a diversity of reception conditions. Capable of good FM auditioning; FM only. *Recommended.*

Voxson R-303
Originally made for EMI now marketed exclusively by *The Centre of Sound, 120 Notting Hill Gate, London, W.11,* this tuner was not very highly ranked but has the attributes of two separate tuning systems for FM and AM, the latter covering LW, MW and SW bands. It is well made but not suitable for very difficult FM reception areas.

Yamaha CT-610
This model has been around for some time and scored average overall ranking. FM auditioning was judged slightly to lack the 'sparkle' of some of the more recent models of the range; includes MW.

Yamaha CT-810
Higher up the price scale than the CT-610, yet displaying the same 'clean cut' appearance, this model gained a high overall ranking. It is a model of average features and was deemed to have above average FM auditioning; includes MW. *Recommended.*

Yamaha CT-7000
Another model which has been around for some time, but one which gave a very good account of itself both in the lab and the listening room. Although expensive at about £532, it is a model that would satisfy the most critical tuner user. FM auditioning was very high and the tuner would not easily get into trouble in problem reception areas; FM only. *Recommended*

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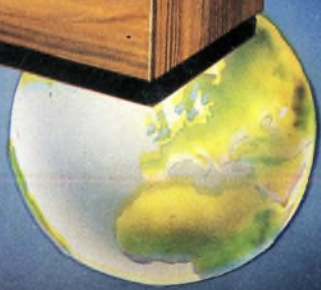

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