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BROADCAST SOUND

A LINK HOUSE PUBLICATION

Stereo tape machines

Receivers

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A LINK HOUSE PUBLICATION

Cover

The new Revox/ASC PR99 stereo tape machine rates mention in Tim Leigh Smith's overview of such beasts and is subsequently subjected to the very closest of scrutinies by Hugh Ford in a major review article.
Photo-illustration:
Roger Phillips

BROADCAST SOUND

CONTENTS

AM stereo standard for Australia

AM stereo is expected to begin officially in Australia on 1st February following the adoption of a single transmission standard by the Department of Communications.

Australia has set a world precedent by selecting the C-Quam system, developed by Motorola.

The selection follows extensive testing and consultation between the DoC, the Federation of Australian Radio Broadcasters (FARB) and local AM stations.

Since early 1984 several AM stations had been running continuous on-air tests using the four competing systems (Motorola, Magnavox, Harris and Kahn).

The DoC tests showed that although all four systems performed adequately, single system receivers gave a superior performance to multi-system receivers and would be significantly cheaper.

Following C-Quam's acceptance by AM stations in cities such as Melbourne and its increasing domination of the US market, the DoC accepted Motorola's system.

At the time of writing, Motorola's distributors in Australia expect that over 30 AM stations will be on-air by the official date with C-Quam signals.

The expected cost to the stations is around $A17,000 to $A20,000, as long as their studios are wired for stereo production. If a rewiring is required, with the additional stereo equipment the cost can be expected to increase ten-fold.

This is what faces the ABC's AM services, as its studios are nearly all wired in "glorious mono", as one engineer put it.

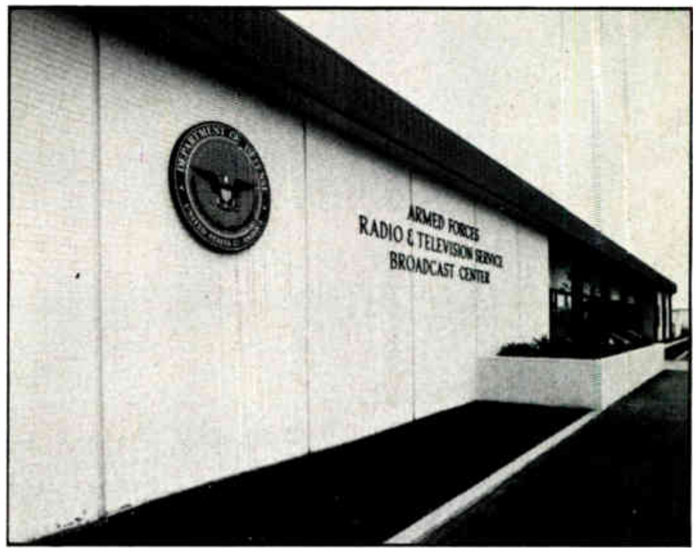
At the time of the announcement, the ABC in Melbourne was running tests on the Harris system, but it soon expects to begin tests on a C-Quam exciter. The cost to the ABC of re-wiring all its AM studios will be enormous and probably outside its short-term budgetary allowances.

The government believes its decision should eliminate confusion among the public when buying new receivers and therefore lead to a more successful introduction of the 'new' broadcast technology.

Shortly before the DoC's announcement, Leonard Kahn in the US was asked by the office of an Australian newspaper whether Australia should adopt a single standard. Apparently Mr Kahn claimed Australia would be "insane" to grant any company a monopoly in the technology.

However, local sources indicate that the government's decision has been well received by most sections in the industry.

(Broadcast Engineering News)



The new 42,000 sq ft Broadcast Center for the US Armed Forces Radio and Television Services (AFRTS) in Sun Valley, California. This facility supports the extensive production and distribution requirements of the AFRTS audience scattered around the world. Included in the facility are radio production studios, automated radio master control, TV post-production, automated TV central programme operations, TV master control, TV origination stage, and both radio and TV quality assurance operations.

The programming is derived from major commercial networks combined with locally originated material, and is distributed to the audience by both satellites and recorded media.

The Broadcast Center is expected to be in operation in 1985.

British Standard for computer RFI

A new British Standard sets limits for spurious signals from computer equipment in both domestic and work environments. BS 6527, titled *Specification for limits and measurements of spurious signals generated by data processing and electronic office equipment,* is the first standard to specify limits for the levels of periodic binary pulsed waveforms coupled via mains cables, signal and other leads, or by direct radiation.

Measurements are made from 150 kHz to 30 MHz for mains borne interference, and from 30 MHz to 1000 MHz for radiated interference. Limits and methods are based on work in progress within the International Special Committee on Radio Interference (CISPR).

Radio Mercury sues Radio Jackie

Radio Mercury, the independent local radio station based in Crawley, West Sussex, UK, is suing the owner of Radio Jackie, Tony Collis, for damages caused by an alleged loss of advertising revenue because of Radio Jackie's unlicensed broadcasts in an overlapping service area.

Radio Mercury also sought an injunction against Mr Collis, to prevent him from future unlicensed broadcasting in the area. Mr Collis, however, has already given an undertaking to the High Court in London that he will no longer operate the station.

Radio Jackie continues to broadcast, apparently without Mr Collis's involvement. The station says it can stay on the air without being in contempt of court. It also intends to fight the action in the EEC European Court of Justice.

France and Luxembourg agree on DBS

The French and Luxembourg governments have reached agreement on the production and reception of programmes from the satellite TDF1, which is due to be launched in 1986. TDF1 will have four channels: at the moment it is projected that three will be French-speaking and one German-speaking. (This may be changed to two and two.)

TDF1 will be capable of covering the whole of France as well as surrounding countries such as Luxembourg.

The two French-speaking countries sought an agreement about the reception and distribution of programmes early on, in order to avoid friction at a later date. The French media greeted the announcement with comments such as "opening up a new era in European broadcasting".

Terry Nelson

Aussat and VH-1 to use Dolby ADM

The Australian Department of Communications has chosen Dolby adaptive delta modulation (ADM) as the sound system for its B-MAC satellite television broadcasts. Up to six audio channels will be available with each vision signal.

The first Aussat will provide ABC's homestead and community broadcasting satellite service (HACBSS) on four spot-beam transponders. The six HACBSS audio channels will be used for two TV sound channels, ABC-FM, two other mono radio services and a weather information and warning channel.

VH-1 is owned by MTV Networks Inc, which will also use the Dolby ADM system for MTV. MTV will continue to transmit the existing Wegener analogue signal, to cater for affiliates which are already taking MTV. MTV says the cost of an ADM receiver is similar to that of a Wegener receiver.

Record attendance at IBC

More than 10,000 people from 58 countries attended the 10th International Broadcasting Convention at Brighton, UK, in September.

In the technical programme, 85 papers were presented in 14 sessions. Papers dealing with satellite broadcasting, cable television and high definition television attracted a lot of interest, but older broadcast media were also the subject of much debate.

There were 144 exhibitors at the convention: there would have been more if there had been space for them. The next IBC, which will be held in Brighton from 19th to 23rd September 1986 will occupy not only the Metropole Centre but also the Brighton Centre, some 150 metres along the seafront. This will provide 25% more floor space as well as improved registration facilities and other services.

Events

Jan 28 to Feb 1
MIDEM '85, Cannes, France.
March 5 to 8
AES Convention, Hamburg, West Germany.
March 24 to 27
Video and Television Techniques Exhibition, Birmingham. UK.
April 14 to 17
NAB Convention, Las Vegas, USA.
April 16 to 18
CAST '85, Birmingham, UK.
May 3 to 6
AES Convention, Los Angeles, USA.
June 6 to 12
International Television Symposium, Montreux, Switzerland.
June 12 to 16
APRS Exhibition, London, UK.
June 30 to July 5
BKSTS '85, London, UK.
July 9 to 11
Cable '85, Brighton, UK.
September 11 to 14
Radio Convention and Programming Conference, Dallas, USA.
November 20 to 22
Inter BEE '85, Tokyo, Japan.

UK ILR News

There have been many developments on the UK ILR scene since our last summary in the September/October 1984 issue:

- ILR is back on the air in Leicester, after a hasty departure when Centre Radio collapsed. Leicester Sound, of which a 51% shareholding is owned by neighbouring Radio Trent, is now providing the service. Some programmes and many staff and resources are shared by the two stations to minimise costs.
- Radio Hallam's franchise has been renewed until 1993, and it gains the Barnsley and Doncaster areas in addition to the original territory of Sheffield and Rotherham.
- Radio Broadland is the new station for Great Yarmouth and Norwich, on 1152 kHz and 97.6 MHz.
- Invicta Sound is on the air in Kent with a network of seven transmitters, and studios in Canterbury and Maidstone. Frequencies are 603 kHz, 1242 kHz, 95.1 MHz, 95.9 MHz, 96.3 MHz, 97.0 MHz and 103.8 MHz.
- ILR has now reached Northampton on 1557 kHz and 102.8 MHz, courtesy of Hereward Radio, which already holds the Peterborough franchise.
- Radio City's franchise for Liverpool has been renewed, subject to agreement on "operating points", until 1993.
- Plymouth Sound has a rival for the Plymouth contract. The IBA received two 'letters of intent' for the area, and is now going through the full application routine.
- Radio Mercury is on the air in and around the Reigate, Crawley, Redhill and Dorking area on 1521 kHz and 103.6 MHz.
- The IBA has received two 'letters of intent' for the Teesside franchise—the present incumbent is Radio Tees.
- Pennine Radio has new transmitters for the Huddersfield and Halifax area on 1530 kHz and 103.4 MHz. Split programming is expected during 1985.

THE BLACK & WHITE C

Time manipulation is one of the most fundamental effects used in modern recording and sound reinforcement. The ability to produce delays, reverberation, phasing and other time-related effects to order, in a creative manner suited to the material, is recognised as a vital factor in adding life, movement and interest to music.

And modern technology allows a vast number of possibilities to be realised; so much so that there is today almost too wide a choice of time-domain systems covering a range of possibilities.

With these possibilities, and the problems of choice firmly in mind, Syco have assembled a collection of time-domain systems which offer the musician, studio, broadcaster or sound reinforcement specialist the widest range of sound possibilities according to your requirements. Each unit has been chosen with creativity, quality and flexibility in mind.

TIME FOR MUSIC

AMS 15 80S is a computer-controlled delay processor with 20Hz to 18kHz bandwidth – essential for today's quality requirements – and the ability to store up to 30 seconds of sound. The sampled sound can be transposed with a keyboard – up or down two octaves. It's more than a delay; it's a creative musical tool.

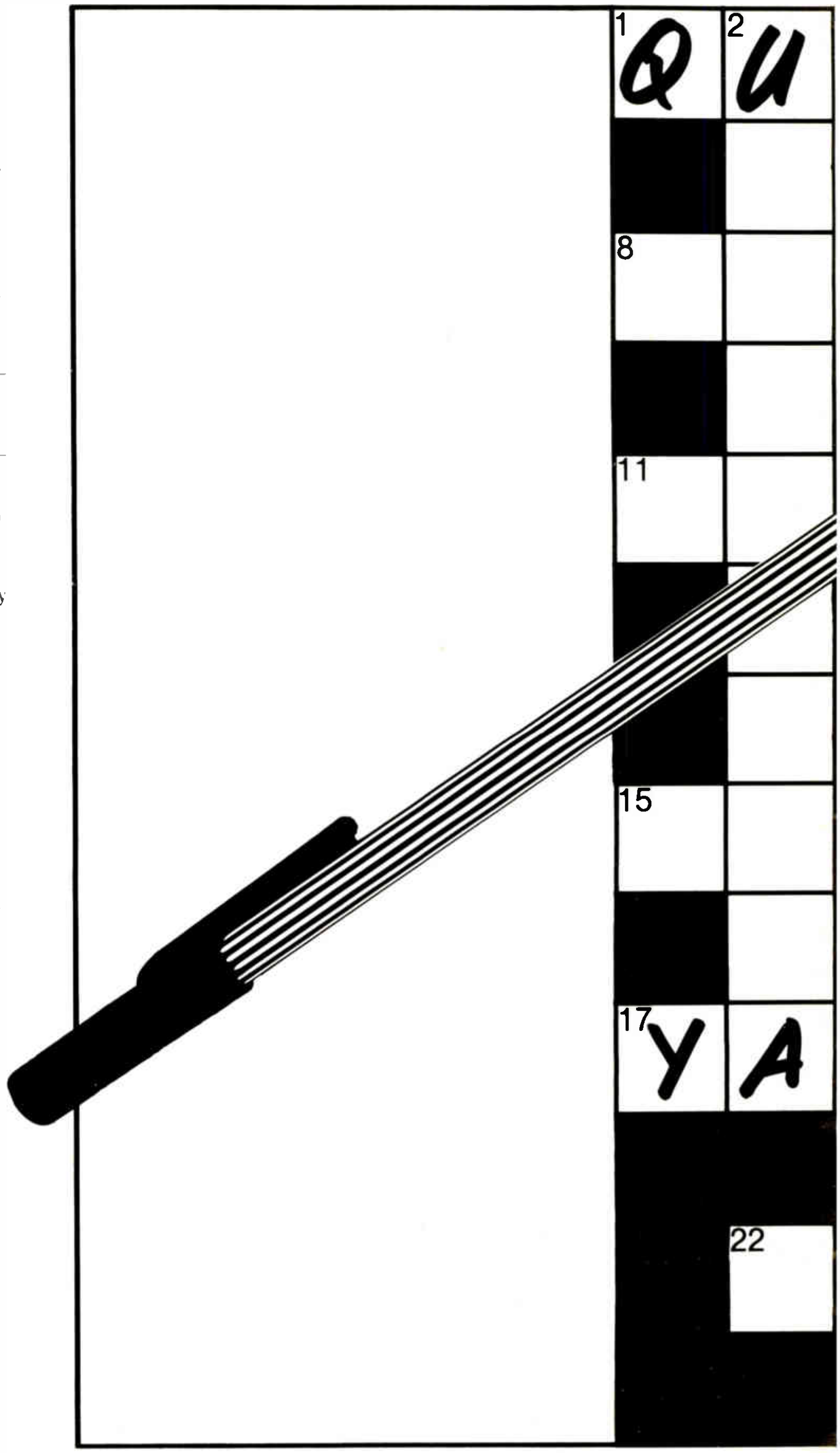
Quantec Room Simulator is renowned for its ability to recreate the sound of a real acoustic environment. You simply dial-up the volume of the room, and add the acoustic treatment, reflections and other effects you desire. What could be simpler?

The QRS is available in two versions: the standard 2-in, 4-out unit is ideal for both stereo and surround-sound applications, while the new QRS/L offers a cost-effective mono-in, stereo-out package for the budget-conscious.

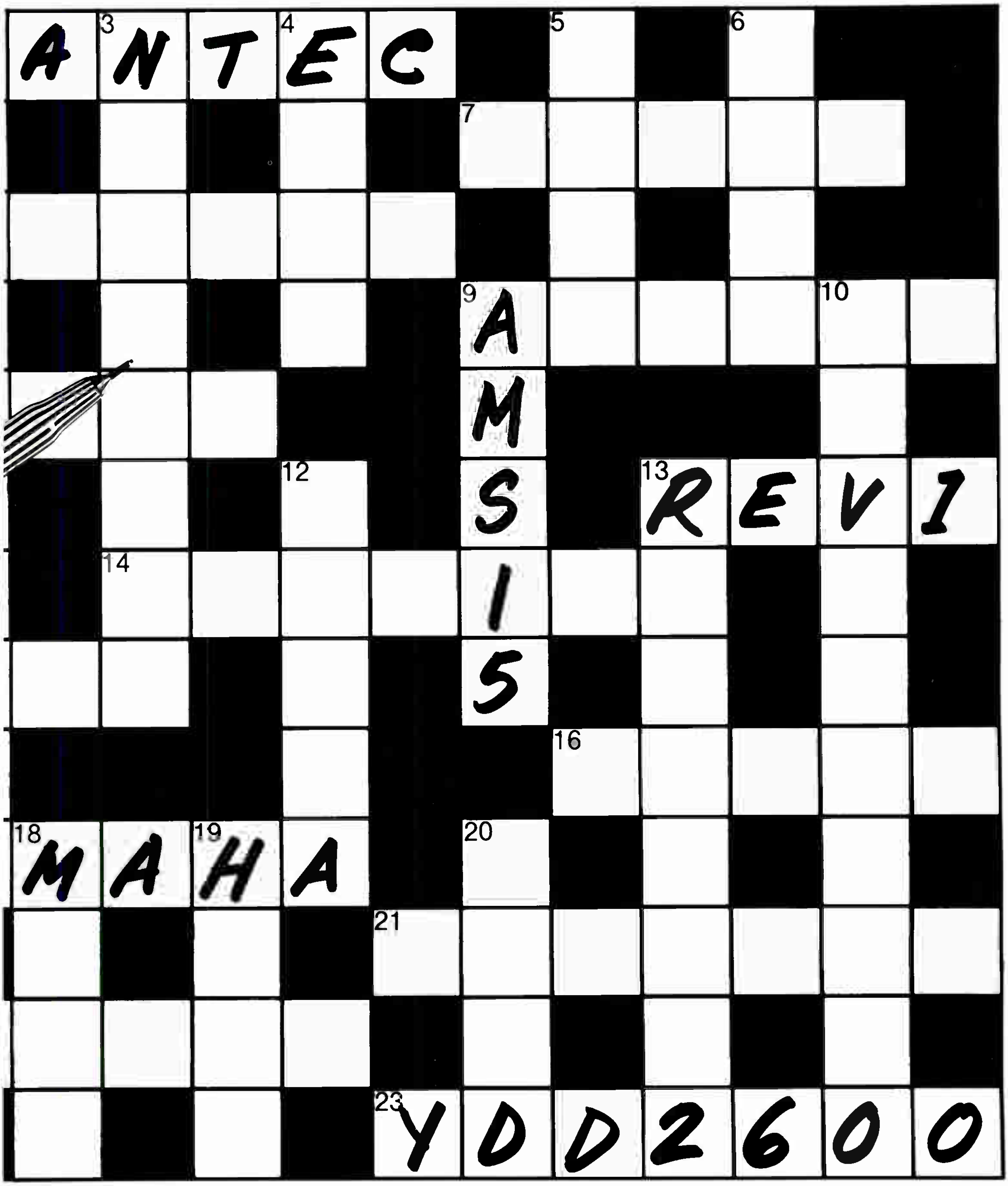
REV-1 and the **YDD 2600** new from Yamaha. The REV-1 is a sophisticated digital reverberation system in which almost every reverberation parameter can be individually tailored to your needs. The unique LCD-display remote unit shows both settings and a graphical analogue of the reverberation characteristics you have established. The YDD 2600 is an unusually flexible delay system with many configuration possibilities especially useful for live sound applications. The unit offers up to eight separately variable delays and up to four inputs, with a maximum delay of 2.6 seconds per channel (the number of delay channels, inputs and the length of the maximum delay depends on configuration).

At Syco you'll find the time-domain system that's right for your needs: systems that offer sophistication, quality and flexibility. At Syco, we've got time for music.

Syco 20 Conduit Place, London W2
Telephone 01-724 2451 for an appointment.
Telex 22278 SYCO G



OLLECTION FROM SYCO



Syco. We are

Philips LHH 2000 CD player

Philips is introducing a new CD player system, the *LHH 2000*, with up to three disc drives and a single control unit. The control unit contains a 'function module', which is linked to a 'command module' for each player. Using the control unit keyboard, in conjunction with LED displays on each module, the operator has fast access to the timecode information contained in the P and Q subcode channels of the disc. Any point on the disc can be accessed in less than two seconds, with an accuracy of 13.3 ms (one frame).

The control unit can be used either free standing or flush-mounted into a desk.

The command module enables communication between the function module and its associated drive, for setting up programmes. It also provides facilities for pre-checking, and creating pauses, as well as playing the discs, which can be done either from the module or by fader start. The command module's LED display gives a countdown of the time to the stop cue, plus an indication of system status—edit, ready, on-line or on-air.

The function module provides search and programming facilities for setting up start and stop cues. These can be at any point. The selected piece is shown as a cue to cue time.

A search dial, which works both forwards and backwards, permits rapid access to any frame. Depending on the speed selected, a turn on the dial represents 1, 30 or 240 seconds of music.

The player has a connector which will handle R to W channel information, enabling the display of accompanying graphics.

Pye TVT Ltd, PO Box 41, Coldhams Lane, Cambridge CB1 3JU, UK. Tel: 0223 245115. USA: Philips Television Systems Inc, 900 Corporate Drive, PO Box 618, Mahwah, NJ 07430. Tel: (201) 529-1550.

ALS free-space infra red link

American Laser Systems Inc has developed a free-space infra red laser communications system capable of transmitting data at 1.544 Mbit/s, over distances up to 2.4 km under clear conditions.

The system, model *ALS829-T1*, consists of separate transmitter and receiver heads, and interface boxes which can be up to 300 m from the head (cable length). The interface box makes the system compatible with any system which follows the Bell T1 standard protocol of no more than 15 consecutive spaces, at least three marks in 24 bits and no more than 250 alternate bits.

The transmitter has an average radiant power of 14 mW on a wavelength of 880 nm. The beam divergence is 3 mR, and the receiver's field of view 3.7 mR.

American Laser Systems Inc, 106 Fowler Road, Goleta, CA 93117, USA. Tel: (805) 967-0423.

Canare cable reels

Canare Cable has introduced a line of cable reels constructed of tubular steel, with an 'E' shaped brace and heavy duty, permanently lubricated bearings.

All models include a 3-position brake lever. In the locked position, used during transportation, the reel will not rotate. In the soft-brake position, cable can be pulled from the reel, but friction prevents excess spillage when the cable is pulled quickly. In the free position, the cable will pull from the reel easily; this position is ideal for rewinding.

The *R380* and *R460* multi-channel reels come with roll-around castors. Reels for single cables, which are smaller and lighter, are designed to be stackable, so they take up a minimum of storage space.

Some cable reels include built-in junction boxes with paired male and female XLRs for each channel of the snake, while others have a cutout and cable holders so the multipin end of the cable can be connected as desired. Multiple reels can be 'chained' for very long cable runs.

Canare Cable Inc, 10834 Burbank Blvd, N Hollywood, CA 91601, USA. Tel: (818) 506-7602.
UK: Future Film Developments, PO Box 3DG, 114 Wardour Street, London W1A 3DG. Tel: 01-434 3344.

Soundcraft TS24 automation

Soundcraft's *TS24* console is to be complemented by three automation options, offering a choice of hardware and price.

The first of the three systems is Soundcraft's proprietary automation for the *TS24*, a conventional tape-based system which uses two tracks of the multitrack to store data. Free VCA sub-grouping is available. The system can be upgraded by future Soundcraft disc systems.

The Audio Kinetics *MasterMix* automation system is now available fitted to the *TS24*. *MasterMix* uses floppy-disc storage rather than tracks on the master tape. Synchronisation with the multitrack recording is achieved with SMPTE timecode.

Soundcraft says the third of its automation options will be available in mid-1985. This is a joint product of Soundcraft and George Massenburg Labs Inc. This *GML* automation will be based on hard disc.

Soundcraft Electronics Ltd, 5-8 Great Sutton Street, London EC1V 0BX, UK. Tel: 01-251 3631. USA: Soundcraft Electronics USA, 1517 20th Street, Santa Monica, CA 90404. Tel: (213) 453-4591.

Otari MX-70

Otari has introduced a series of 1 in tape machines, designated the *MX-70* series, available in 8-track, 8-track prewired for 16-track, and 16-track versions.

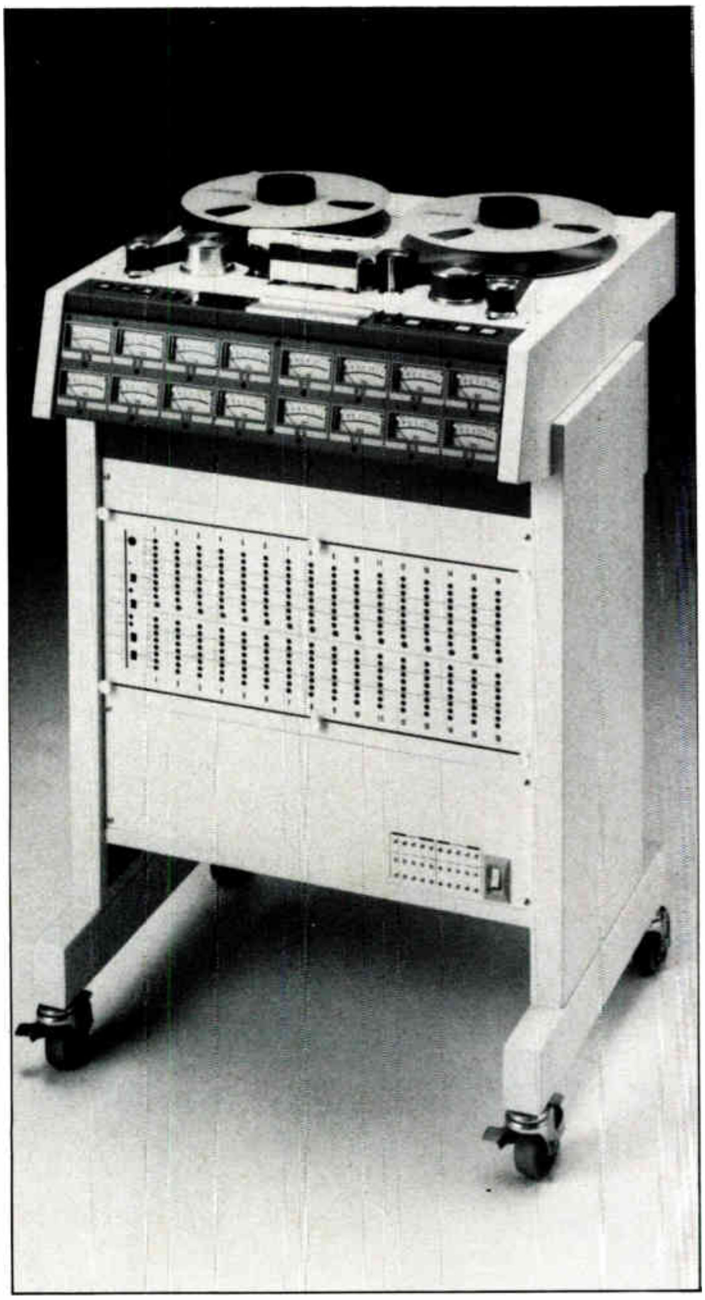
The *MX-70* features a microprocessor governed constant-tension, servo-controlled transport, timed bias ramping for gapless insert recording at any speed, logic-interlocked controls, a remote controller and interface connectors for any SMPTE/EBU timecode-based editing system, controller or synchroniser.

An optional converter allows operation with 1/2 in 8-channel tapes. Modular electronics and head assemblies allow easy conversion of formats. Also, an RS232C and RS422 serial communications port may be ordered.

The machines come with a full-function remote session controller as standard. An optional autolocator with multiple memory storage, search and repeat shuttle capabilities is available.

The machine works at either 7½/15 in/s or 15/30 in/s, the speed pair being field-selectable. It also has adjustable phase compensation, switch-selectable IEC/NAB equalisation, switching logic for interfacing to any noise reduction system, electronically balanced inputs and outputs (+4 or −10 dB) and an LED multi-function tape/time display.

Otari Electric Co Ltd, 4-29-18 Minami-Ogikubo, Suginami-ku, Tokyo. Tel: (03) 333-9631.
UK: Turnkey, Hilltex House, Brent View Road, London NW9 7EL. Tel: 01-202 4366.
UK: ITA, 1 Felgate Mews, Studland Street, London W6 9JT. Tel: 01-748 9009.
USA: Otari Corporation, 2 Davis Drive, Belmont, CA 94002. Tel: (415) 592-8311.



Eventide H969 Harmonizer

Eventide has announced a new Harmonizer effects unit, the *H969*. It employs new software, dubbed *ProPitch*, to deliver cleaner pitch-change performance without glitching over a wider frequency range than ever before. The *H969* is also the first Harmonizer to use 16-bit linear coding.

The *H969* has several new features of particular interest to musicians. A dozen pitch-change presets have been included, enabling the user to set a precise minor third, major third, fifth, seventh, or octave of pitch change. Each can be selected as a sharp or flat. In addition, separate coarse and fine adjust controls enable the user to set precise and stable pitch ratios easily.

Full bandwidth delay has been increased in the *H969* to 1.5 seconds, with 3 seconds available at half bandwidth. The user can choose and save any five delay times for instant recall. The full delay range is also available in repeat and reverse modes. Delay time and pitch ratio are displayed on independent readouts.

Doppler effects have been added to the *H969* and flanging is available.

Eventide has also announced *Generation II* software for the *SP2016* effects processor/reverb, consisting of new programs and a version 2.2 of the operating system.

SPUD is another new package for the *SP2016*, enabling owners to create their own software, using a Hewlett Packard *9816* or other series *200* computer.

Eventide Inc, One Alsan Way, Little Ferry, NJ 07643, USA. Tel: (201) 641-1200.
UK: Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH. Tel: 01-580 4314.
UK: Marquee Electronics, 90 Wardour Street, London W1V 3LE. Tel: 01-439 8421.

Klark-Teknik DN780 reverb

The *DN780* is the first of a new series of digital reverberators from Klark-Teknik.

Klark-Teknik says the *DN780* uses more individual 'reflections' than other reverberators, producing a more natural effect, described as "added density reverberation". It achieves this with 32-bit VLSI circuits, enabling faster numerical operations. (The A/D conversion is 16-bit.)

The *DN780* has a choice of pre-programmed hall, chamber, room and plate sizes—all adjustable. The memory can store up to 50 of the user's settings.

A number of effects are also provided, ranging from straight delay, multi-tap echo to an 'infinite room' effect.

Klark-Teknik Research Ltd, Klark Industrial Park, Walter Nash Road West, Kidderminster, Worcs DY11 7HJ, UK. Tel: 0562 741515.
USA: Klark-Teknik Electronics Inc, 262A Eastern Parkway Farmingdale, NY 11735. Tel: (516) 249-3660.

Inovonics 260 stereo processor

Inovonics' new *260* is a stereo audio processor for FM radio and TV broadcasting.

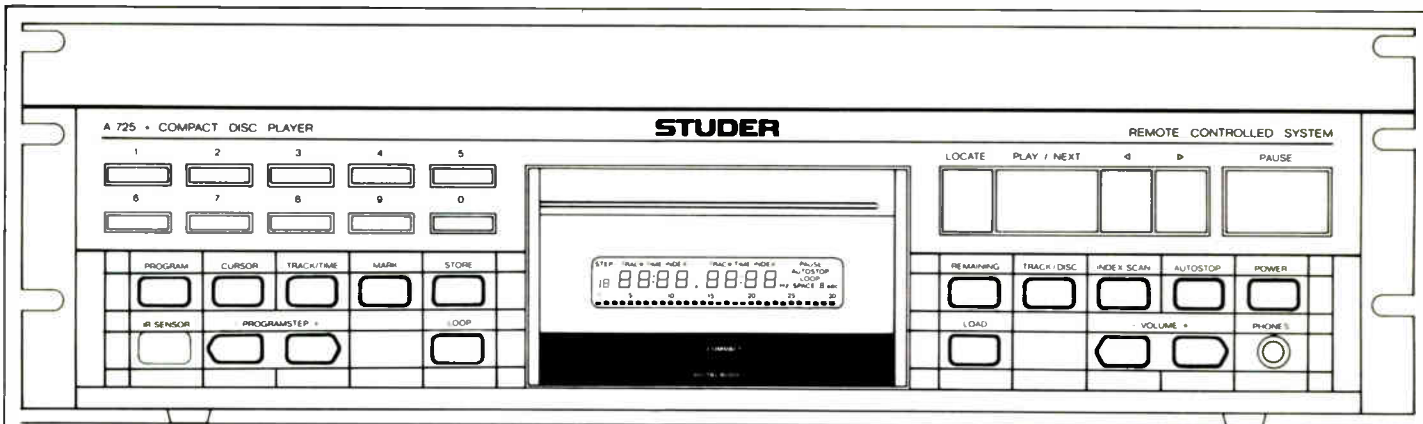
It has three processing functions: slow-acting AGC, gated average level compression and split-spectrum peak control. The *260* uses PWM gain control.

This processor is intended for basic broadcasting situations which still call for ample and consistent transmitter modulation.

User-accessible adjustments have been reduced to only those essential for operation. This discourages fiddling and tweaking to change subjective results.

Suited to educational FM radio and low power TV service, the *260* also has a level alarm which can alert novice operators to 'dead air' and out-of-limits operation.

Inovonics Inc, 503-B Vandell Way, Campbell, CA 95008, USA. Tel: (408) 374-8300.



Studer A725 CD player

Designed for a variety of applications, the *A725* places special emphasis on the needs of the radio broadcaster.

The *A725* provides balanced, floating high level outputs as well as fixed and variable unbalanced outputs. The machine also has fader start, and rack mount flanges, as standard.

The player uses 176.4 kHz over-sampling and digital filtering to avoid the problems associated with high-order analogue low pass filters. The machine also has comprehensive error protection to cope with all but severely damaged discs.

Cueing takes less than three seconds, and start delay from pause is less than 600 ms.

A dual mode liquid crystal display with built-in light provides information on playing status and programming memory. In the normal (playing) mode, the display shows track and index number, time since start of current track (or since start of disc), and status of pause, autostop and loop functions.

In the programming mode, the display shows the number or the step to be executed, track number or timing of start point, and track number or timing of end point. A bar display showing total tracks and tracks remaining is activated in both modes.

Up to 19 program steps may be stored, with playing of consecutive tracks counting as one step. Steps can include stop, pause, loop and power off functions. Program steps may use mixed time and tracks as boundaries.

Other *A725* features include variable level headphone output, peak level calibration tone and remote control.

Studer International AG, Althardstrasse 150, CH-8105 Regensdorf, Switzerland. Tel: 01 840-29-60.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ. Tel: 01-953 0091.
USA: Studer Revox America Inc, 1425 Elm Hill Pike, Nashville, TN 37210. Tel: (615) 254-5651.

Telex PH20 head-worn mic

Designed for hands-free vocal delivery, the *PH20* head-worn mic uses a close-talking electret microphone.

A reversible swivel mount and 180° adjustable boom provide a custom fit for proper mouth-to-microphone distance and the option of wearing the mic on either side of the head.

The *PS10* power supply is included with the *PH20*. This supplies in-line power to the mic from either a 1.4 volts calculator type battery or phantom power from an external source.

Also available are the *PH21* head-worn microphone, without the *PS10* supply, and the *PH22* head-worn mic that connects directly to Telex radio microphone systems, without the *PS10*.

Telex Communications Inc, 9600 Aldrich Avenue South, Minneapolis, MN 55420, USA. Tel: (612) 884-4051.
UK: Avcom Systems Ltd, Newton Works, Stanlake Mews, London W12 7HS. Tel: 01-749 2201.

Quad 510 and 520

Quad Electroacoustics has announced two new power amplifiers, the *510* and the *520*, for professional use. Both are designed for 19 in rack mounting.

The *510* is a single channel amplifier with a bridging input and a multiple-tapped output transformer. Quad says it will deliver at least 100 watts into any load from 2 to 100 ohms, the appropriate output matching being selected by a plug-in card. The *510* is suitable for 70 volt or 100 volt distribution systems. The input and output are isolated so the amplifier can be used as a simple 'power brick' and units can be linked in series to provide greater power.

The *520* is a 2-channel amplifier with an output of 100 watts per channel into 8 ohms and optional balanced inputs.

Both amplifiers use a refinement of the 'current dumping' principle originally used in the *405* amplifier.

Quad Electroacoustics Ltd, Huntingdon, Cambs PE18 7DB, UK. Tel: 0480 52561.
USA: Quad USA, 695 Oak Grove Avenue, Suite 3A, Menlow Park, CA 94025. Tel: (415) 321-2179.

timeflex
(it's about time...)

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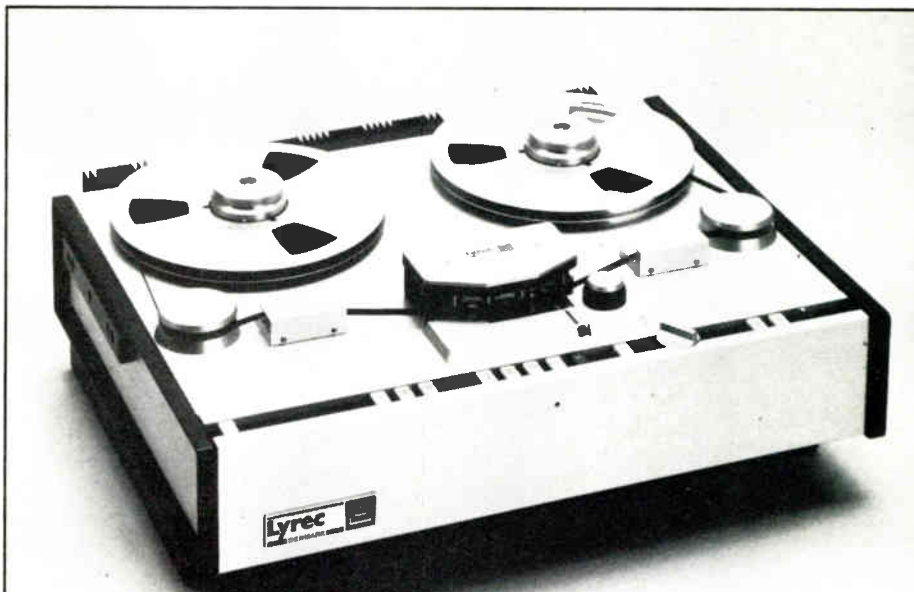
STEREO TAPE MACHINES

These are exciting times for the manufacturers and suppliers of stereo tape machines in Britain, as many radio and TV stations, both BBC and independent, are currently updating. For the first time the analogue machines have a serious challenge from 2-channel digital recorders.

Tim Leigh Smith



LYREC TR55

At one time professional tape machines were huge contraptions, about the size and weight of a British Leyland Mini, and were expected to remain in service for 20 or 30 years. The latest technology has made them smaller, lighter and more rapidly outmoded.

It seems that the appearance of a machine is now almost as important to British purchasers as its sound quality. "All the polished brushed aluminium makes people think it's a good tape machine," a cynical service engineer remarked recently of one well-liked brand. A number of dealers who have had difficulty in arousing the interest of the British market in their wares suggest that their otherwise excellent machines simply do not look sophisticated enough.

Scully multitrack machines from America are to be found in British music recording studios, but the 2-track version has not caught the attention of radio and television stations here. The Danish Lyrec *TR55* is used in European stations, particularly in Scandinavia, but has not sold well in Britain.

Mechanikai Laboratorium of Hungary has recently introduced a multitrack—*700* Series— to complement the Mechlab *STM-600* Series stereo machines which are used in Eastern Europe, parts of Asia, and as far afield as Cuba. The *STM-631* is unusual in that, whereas most machines have a 'dump' facility for out-takes, it has two take-up spools—one for the programme and the other for out-takes. This facility was last seen in Britain on the coal-fired EMI *BTR2*.

The very successful Ampex *ATR 100* was considered by many to be the best sounding 2-track machine on the market. Some 18 months ago Ampex quietly suspended production in favour of 'Lovely stereo audio machines—which incidentally record video at the same time'. Which, translated, means Ampex is making C-format VTRs but not audio machines. The company is still supporting existing machines with spares and may resume production, but it is possible that Ampex will follow the example of Philips and leave this part of the market to others.

Peter Granet of Granet Communications has found the European market quite receptive to the robust CEI *Cuemaster* stereo cart machines from Australia. Their solid construction protects them from presenters who, literally, 'punch the button'. He decided not to import the similarly robust CEI reel-to-reel machines, although they are widely used in Australian broadcasting, mainly because of the strong competition from European manufacturers.

Mechlab STM 600

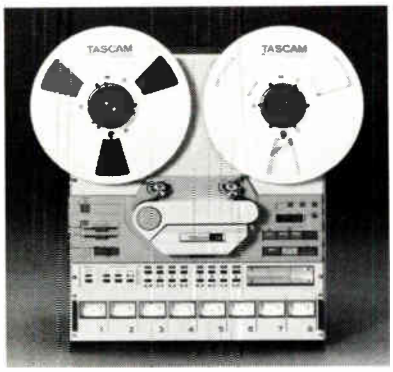
Trust TASCAM

NRK TRUSTS TASCAM

For three or four hours every night, 365 nights a year, a bank of Tascam model 52 recorder/reproducers play at the Norwegian Radio Corporation's (NRK) External Services section in Oslo.

Not a very surprising piece of information.

But NRK have such confidence in the quality and dependability of the 52's that they don't even have an engineer on duty. The Tascam machines were the only broadcast-quality recorder/reproducers that NRK could find that could be linked to a random-access control computer, thus freeing engineers to work where they were really needed.



IN AT THE BIRTH OF TAPE

With over 30 years of tape transport design and manufacture, TEAC/Tascam know from long experience how to make the best, most dependable machines. Where total reliability is of paramount importance, TEAC/Tascam industrial audio, video and data recorders are specified. Even NASA have chosen TEAC onboard video recorders for every space shuttle mission.

The 50 Series recorder/reproducers are the flagships of the Tascam range.

But Tascam sells more professional tape machines than the four biggest rivals put together, so research and tooling costs are spread more widely – the 50 Series machines are considerably less expensive than any of the serious alternatives.

Find out more about how the two-track model 52 or the eight-track model 58 can meet your own broadcast or production requirements. For your nearest Tascam agent, contact:

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TASCAM
TEAC Professional Division

TEAC Corporation
3-7-3, Naka-cho, Musashino, Tokyo, Japan.

Ferrograph Studio 8

Enertec Schlumberger F500

Ferrograph and Revox

The Ferrograph, like the Land-Rover, reached every corner of the circular globe and some early machines are still in service. The company ceased production of the *Series 7* and *Studio 8* recorders in 1981. Although there were thousands of pounds of orders on the books, it had not been possible to make the quantum leap to mass production and each machine was practically hand built.

Cunnings Recording Associates took up the *Studio 8* which is still available with basic line in/line out or with mic and line input mixing facilities. Like most of the machines currently available it has servo-controlled motors. The 'edit' mode releases the brakes and holds the tape by electrical tension to allow hand spooling. The brakes are applied automatically when the tape is removed for cutting.

A recent development is an IEC centre track timecode version. Since Studer first introduced the *A810* with its offset timecode head, there has been a search for ways to avoid the complication and expense of electronic delays to correct the offset. Following research by the tape head manufacturers and the BBC, Cunnings is now producing a version of the *Studio 8* with a stacked twin-track (2×2 mm) audio plus timecode head. One implication of the stacked head is that it can be retro-fitted to existing machines more easily than the offset system.

Cunnings has also taken on the former Ferrograph Pilot Tone Synchroniser which controls a *Studio 8* from Nagra-type pilot tone via an electronic flywheel 'soft lock'. A converter is being produced to derive pilot tone pulses from SMPTE timecode.

The original company, now AVM-Ferrograph, continues to produce the tape recorder test set, tape head defluxer and a range of test tapes, along with a replacement for the *Series 7*. The AVM-Ferrograph *Series 77* is a version of the Revox *B77*, particularly aimed at local broadcasting. It has a flat deck for easy access to the heads and an uncluttered control panel. Modifications include balanced line in/line out with preset levels and optional mic inputs; separate monitor amp for headphones and speaker (so that tape/source switching does not affect line out); integral variable speed control; and optional real time counter.

Revox has for some years offered its own flat deck version of the *B77* as the *PR99*. Audio Systems Components Ltd took this as the starting point in producing what ASC's managing director Len Lewis calls, "The Broadcaster's Revox". The ASC version of the *PR99* has, "a bare minimum of knobs and switches to get wrong"'. It has been said that broadcast studio equipment should be fool proof even if it cannot be bloody idiot proof. ASC take things as far as possible by removing all but five of the fifteen knobs and levers on the *PR99* control panel. Hugh Ford reviews this machine later in this issue of Broadcast Sound.

The modified machine has balanced line in and line out with preset levels, which are secure behind a hinged door to prevent unauthorised tweaking, and a separate monitor amp. The meters are normally removed to clear the deck for editing, but some customers prefer to retain them. One set of machines was ordered with a special stainless steel front panel when it was discovered that staff waiting for despatches down the line, or listening through to find edit points, would use the editing razor blade to whittle away the soft metal front panel.

The original ASC version had exciting options such as a digital real time counter and integral varispeed—these are now standard on the Revox *PR99 Mk II*. Although the original Revox machines have to be imported prior to modification they sell at a competitive price. ASC has even exported machines to Iceland.

Leevers-Rich machines have made their presence felt in broadcasting since they were battery portables, or rather transportables, operating off 12 volt car batteries. The current models are handled by The Professional Recording Equipment Company Ltd, usually shortened to PRECO, from the same address in Wandsworth.

The Proline *Professional 1000* is recognisably the latest version of the traditional design with such refinements as servo controlled capstan and spooling tension arms, as well as updated electronics. The Proline *2000TC* was one of the first machines to use DC motors. It has twin servo controlled capstans which can run at any speed from 6 to 31 in/s and two fixed speeds. Both machines have a single 'spool' mode with continuously variable speed from fast wind to fast rewind—a feature which the makers consider essential on a professional tape recorder for locating cue and edit points.

PRECO has recently become the British agent for the elegant new Enertec Schlumberger *F500* broadcast tape recorder from France. This is one of the advanced microprocessor controlled machines using motion sensors to relate the speeds of the DC motors and ensure correct tape tension in all modes. The *F500* operates at three standard speeds and has an optional wide range (±7 semitones) varispeed. The low mass, high torque DC capstan motor, similar to that used on the Proline *2000*, has a rapid run up to speed with no overshoot and provides quick starting without the need for continuous run capstan. The real time tape counter stores the starting time of each new take for easy location. Enertec offers various sync code options such as Nagra pilot tone and, at the time of writing, an IEC centre track timecode version is being developed.

Soundcraft Magnetics Ltd has also launched a new hi-tech machine. The first *Series 20* model is principally intended for music recording studios operating with 14 in reels at 30 in/s, or video audio post-production (VAPP) studios using one hour tapes at 15 in/s. Several broadcast stations have shown an interest; some are evaluating the present machine and others have enquired about a possible broadcast version with fewer options on the control panel.

Microprocessor control allows 588 variable audio parameters to be stored; covering rec, rep and sync for three tape speeds, three EQ standards and five tape types. A four frequency oscillator is built in for alignment. The 'edit' mode balances tape tension to enable single handed spooling, or the motors may be used to inch the tape in 'varispool' mode. Two types of transport start are provided; 'production start' mode is the usual broadcast style rapid start, and 'studio start' mode handles the tape more gently by accelerating it to speed before the pinch roller is engaged.

Soundcraft Series 20

An IEC centre track timecode option is allowed for on all machines. This will probably be a stacked head system with no offset required. Like other machines of the new generation the *Series 20* has parallel and serial (RS232/422) interfaces for remote control of functions and parameters—it is described by Soundcraft as "virtually future proof".

Otari

Otari has made quite an impression on VAPP studios by way of the *MTR-90 Mk II* multitrack which has no pinch roller and is reputed to be 'synchroniser friendly'. The company has also had considerable success with its *MX-5050-BII* and *MTR-10* in broadcast stations around the world. The *MX-5050-BII* is described as a compact fully professional machine at a budget price. Both the description and some of the facilities offered are similar to those of the Revox *PR99*. The Otari *MX-5050-BII* has mic and line mixing, ±7% varispeed with a servo controlled DC capstan motor, and a built in 1 kHz/10 kHz test oscillator.

The Otari *MTR-10*, and the almost identical *MTR-12* which can accept up to 12½ in reels, is microprocessor controlled with DC-servo motors. The phase locked loop (PLL) capstan motor is capable of three standard speeds with ±20% varispeed and even reverse play for back timing. 'Cue' mode enables both single handed spooling and variable speed shuttle (wind/rewind) for cue or edit location. A cue speaker and headphone socket are standard features. Several different eq settings are provided and a 4-frequency oscillator is built in. Otari is developing a range of in-machine chase and lock synchronisers for use with IEC centre track timecode. Following the *EC-101* designed for the *MTR-90* multi-track will be the *EC-102* for the *MTR-10* and *MTR-12*.

The Otari *MTR* machines were primarily designed for studio mastering and VAPP. In the next few months the company is launching a series of *BTR* machines (no relation to the esteemed EMI machines) intended for broadcast production, editing and on-air use.

The Otari *BTR-5* has the uncluttered control panel required of an on-air machine, but retains many of the features of the *MTR-10* including microprocessor control, DC-servo motors, three speeds, digital tape timer, 'cue' mode with controlled shuttle, cue speaker and headphone socket. Optional extras are: VU meters, pitch control, IEC centre track timecode, autolocator, edit marker and scissors, and RS232/422 serial port. Certain features are particularly aimed at broadcasters, such as remote fader start and switchable flux level for mono or stereo recording. Both DIN stereo (2×2.75 mm tracks) and NAB stereo (2×2 mm) are available, the 2 mm guard band being used with the centre track timecode option.

Otari's new *MTR-20* accepts up to 14 in reels for mastering or VAPP. The *BTR-2* is a broadcast version taking up to 12 in reels. Both machines have four speeds with ±45% varispeed; cue shuttle; speaker and headphone socket; remote fader start. Microprocessor control extends to automatic alignment of record level, HF eq, MF eq, bias and phase compensation; and memory for four cue points. User programmable functions are available for both transport and electronics, such

Studer PCM Dash Recorder

as four variations on the transport control buttons and locate to cue with maximum speed or maximum accuracy. Options include DIN or NAB stereo, centre track timecode and FM pilot tone versions; multiple cue memory; autolocator; edit marker and scissors.

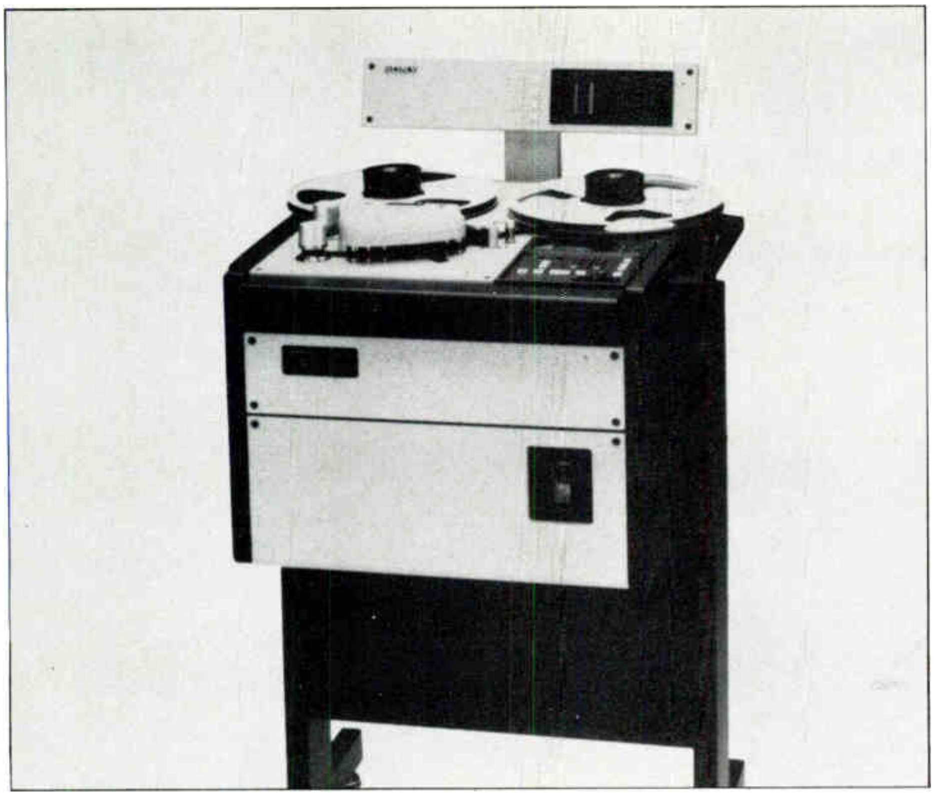
Studer Revox is still producing the tried and tested Studer *A80VU*, now into *Mk IV*, with two speeds, ±7 semitones varispeed (from 5 to 22 in/s on the 7½/15 in/s version), real time counter, controlled shuttle in 'edit' mode, edit marker and scissors.

A recent development is a stereo machine with timecode track using the 1 in transport. Special headblocks are available to suit the audio/timecode tracks of B- and C-format 1 in video tape. This *A80VU-3LB* machine for VAPP layback can be provided with headblocks, counter tacho rollers and capstan servo to handle either format in 625/50 or 525/60 standard. The feed spool motor is reversible to handle B-format (oxide out) and C-format (oxide in). There are obvious advantages in using a real audio machine for VAPP layback, in addition to the saving of head wear and time on an expensive VTR. Sony/MCI offers a similar 1 in stereo machine.

At the budget end of the Studer Revox range is the *B77* which is the basis of the 'compact professional' *PR99*. These are two speed machines which accept up to 10½ in reels, and have switchable inputs for mic, line and track to track copying. Some of the standard features of the *PR99* are available on the *B77* as options. The *PR99 Mk II* has a flat deck for access to the heads; 'edit' mode which defeats tape lifters and prevents latching on wind/rewind buttons (an inexpensive but less than ideal alternative to controlled shuttle); transformer balanced line in and line out, preset (Calibrated) or variable (Uncalibrated) input and output (extra buttons on the deck bypass the input and output level controls); self-sync (rep from rec head); real time counter with simple locator; ±7 semitones varispeed (as on *A80*). It is interesting to note that when ASC and AVM-Ferrograph modify the *PR99/B77* for broadcast work they remove many of the knobs and switches to make the machines more professional.

The middle of the Studer range was occupied by the *B67*. This has been replaced by the *A810* which has all the usual facilities including sync replay and real time counter, plus options such as varispeed, mono/stereo switch, five frequency test oscillator, edit marker and scissors, but not controlled shuttle. Like the *PR99* it has the choice of Calibrated or Uncalibrated input and output levels. The microprocessor control stores and displays (in hexadecimal code on the tape timer) audio parameters for two types of tape, with NAB and IEC eq for up to four speeds. Additional settings can be stored in an external computer via an optional RS232/422 port, on cassette or on the *A810* tape itself. The microprocessor calculates erase delay for gapless drop in and drop out dub edits, and provides a set of user programmable 'soft keys' which can be assigned to enable fader start, remote control, locate to cue, etc.

Studer was the first company to introduce IEC standard 0.38 mm centre track timecode. 90 dB separation between programme and timecode was achieved by using a separate timecode recording head after the audio heads and the capstan. An electronic delay compensates for the physical offset so that the timecode is recorded in sync with its related programme signal to allow for razor blade editing. The timecode replay head was built into the audio erase head, before the audio



Sony PCM-3102

rep head, thus the same delay circuit can be used to keep timecode and programme in sync. The microprocessor adjusts the delay to suit any tape speed, even if varispeed is used.

Studer is now launching its latest analogue machine. The *A820* is a further developed, fully grown mastering recorder version of the *A810* accepting up to 14 in reels. It has three DC motors including a low mass capstan motor for quick acceleration under microprocessor control. To improve tape handling the capstan motor does not start up until the tape is brought onto the capstan by the pinch roller. The capstan motor can be reversed for back timing or to achieve rapid location and lock up with a synchroniser. The new shuttle and set/cue controls, for variable speed spooling and inching in either direction to locate edits or cues, look like an interesting development. The machine has a set of soft keys which can be assigned some 40 functions including control of the optional centre track timecode facility.

Digital machines

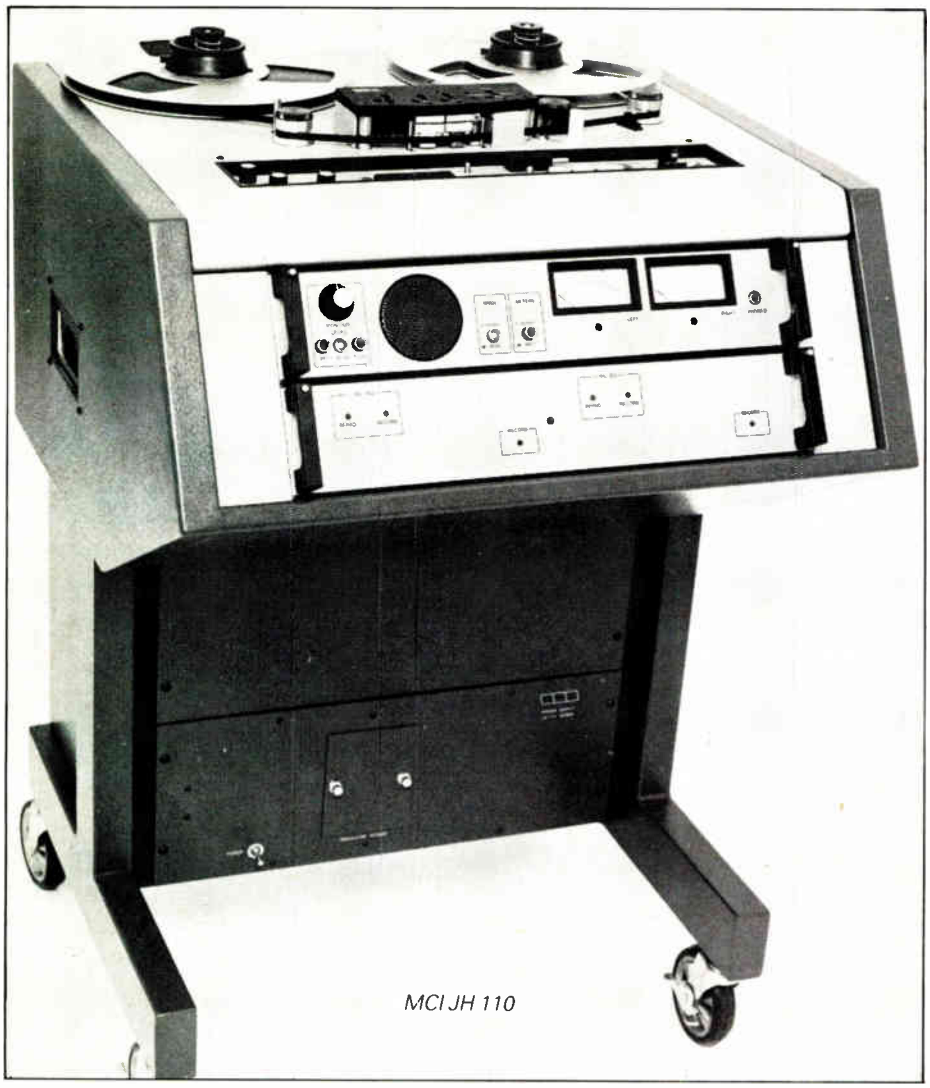
The next step will be the biggest advance for Studer. The *D820* is mechanically similar to the *A820*, but electronically quite different. Whatever it may have stood for in the past, the A now clearly stands for Analogue because the D stands for Digital (what the B stands for in B77 is someone else's problem). The D may also stand for Dash (Digital Audio Stationary Head—as opposed to helical scan) which is the format agreed upon by Studer, Sony/MCI and Matsushita among others.

In this application 12 tracks are recorded on ¼ in tape running at 7½ in/s using sampling frequencies of 48 kHz or 44.1 kHz (compatible with *PCM1610*). Eight tracks are used for the two digital audio channels, one track for timecode, one for reference data, one can be used for compact disc subcode data, and one remains for cueing. 10½ in reels will accommodate two hours, and 14 in reels four hours, of material. The basic Studer *D820* has two heads for off tape monitoring. The advanced version has another rep head before the rec head to provide a sync rep/rec facility. (Is this a digital form of 'sound on sound', multitracking on one machine?) Both analogue and digital (AES/EBU) inputs and outputs are provided, as is an RS232/422 control interface.

The analogue cueing track is a guide to the audio content of the digital tracks for cue and edit location. A high level of error correction, aided by suitable cues on the control track, means that the electronics can even compensate for somewhat approximate razor blade edits.

Sony—the people who gave us the excellent, inexpensive *PCM-F1* and then took it away again—continue to produce the two channel *PCM-1610* processor for use with NTSC U-matic recorders. The video tape based system requires electronic editing. This can be frustrating if there are very few changes in a long recording, or if there are lots of changes in a very short recording. For topping and tailing, or editing up a quick news tape, there is nothing to beat the old fashioned razor blade.

Sony's original Dash machine, the 24-channel PCM-3324, has gained general approval in the music recording business (although there are mumblings about 32-channel—some people are never satisfied). Now Sony are launching a 2-channel Dash format *PCM-3102* with broadcast work and razor blade editing in mind. At the time of writing (November), several prototypes were on trial at NHK in Tokyo.



MCI JH 110

Telefunken M21

The machine uses 1/4 in tape and can accommodate up to three hours on 12½ in reels. The sampling frequency is switchable to 48 kHz or 44.1 kHz, there is a built in SMPTE timecode generator for location and synchronisation, ±12.5% (2 semitones) varispeed, and all the usual input and output ports. The analogue audio tracks are time aligned with the digital audio, and powerful error correction changes a 90° cut to a rapid cross fade. A nice touch is the MCI style MVC—manual velocity control—which is a touch sensitive lever to provide variable speed shuttle.

Sony also offers the latest version of the MCI analogue recorders used in many music studios. The basic *JH-110C* has DC-servo motors, three speeds, ±20% varispeed, MVC shuttle, a 4-memory locator, and optional edit marker and scissors. The *JH-110-3-C* is the centre track timecode or pilot tone version using offset heads with a delay to time align the timecode and audio. The timecode rep head located in the audio erase head has a wideband amplifier and is able to read timecode in fast wind modes. *JH-110-3-LB* is a VAPP layback machine designed to handle 1 in C-format video tape with timecode and two audio tracks.

Matsushita, probably better known in the UK as Technics or National Panasonic, does not noticeably have a 2-channel Dash machine at present.

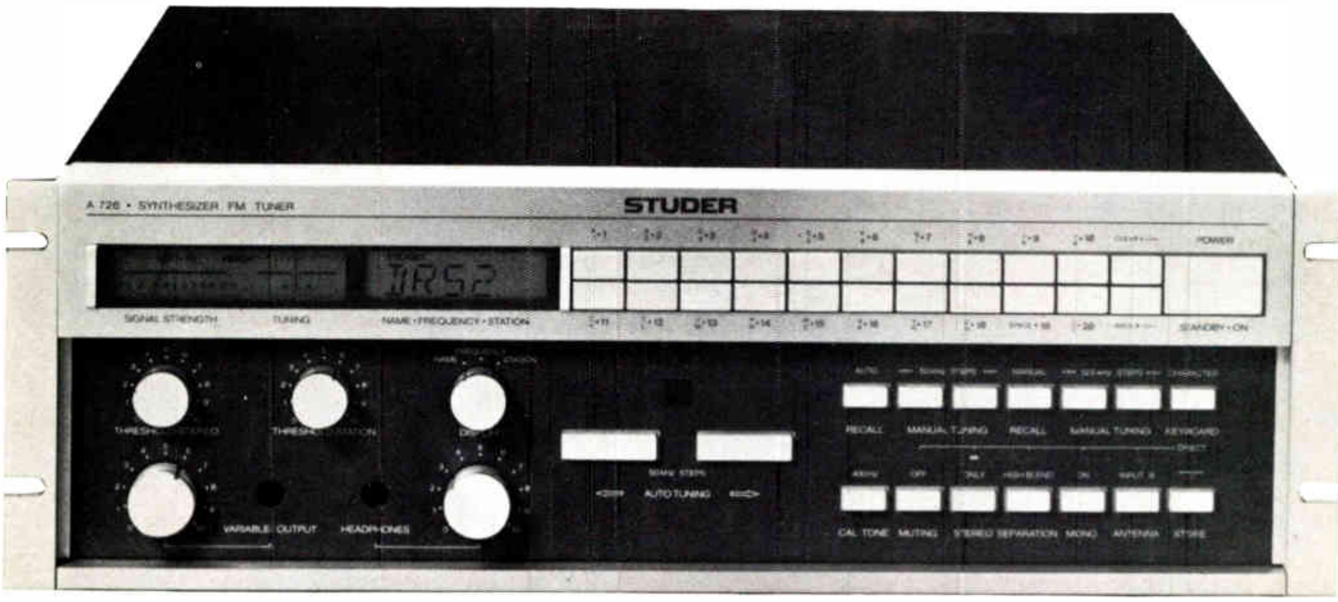
AEG-Telefunken has joined with Mitsubishi to offer the *MX-80A* (studio) and *MX-80* (transportable) digital recorders using ¼ in tape running at 15 in/s for up to one hour on 10½ in reels. This system is not compatible with Dash having a sampling frequency of 50.4 kHz and only ten tracks on the tape—eight digital, one timecode and one analogue cue track. As with the Dash system, the cue track can be used to locate an edit point and the error correction circuits will perform a rapid cross fade where a 90° cut is made.

AEG-Telefunken still offers the *M15A* studio analogue recorder. This has a two speed DC capstan motor and flywheel with optional ±50% varispeed. Spooling speed is continuously variable from fast wind to fast rewind for cue location and editing. A real time counter is standard and options include autolocator, pilot tone heads, edit marker and cutter.

The Telefunken *M21* is a smaller microprocessor controlled unit for studios and mobiles but is capable of accepting up to 12½ in reels. The DC capstan motor offers four speeds with ±10% varispeed and can play backwards to back time, locate to cue or dump tape. In addition to a real time counter there is an alphanumeric read out for selected speed, eq, operating mode, etc. For editing there is continuously variable speed wind and the inevitable optional edit marker and cutter.

With such a glittering array of analogue machines to choose from, it will be interesting to see if digital recorders can capture part of the market. Several stations have Sony *PCM-F1* systems which are used for classical music and concert recording. The need to copy the entire performance just to insert top and tail announcements can make it a time consuming operation. In London, Channel 4 Television uses a pair of F1s to provide the endless hours of music behind the test card transmissions.

One thing is certain: The future lies ahead.□



RECEIVERS

What's the last thing on the list when a radio station contract is drawn up? What's usually remembered in the pub afterwards when everybody's feeling pleased with themselves? Steve Dove defends the much-maligned receiver.

Steve Dove

Receivers really are an unglamourous part of the operation: considering how vital they are it's really a bit sad they just sit in a rack. Their retribution for such shabby treatment can be ruefully just; ever watched the panic in a station when one fails? Suddenly a gas-station giveaway tranny is the most prized possession of a professional lifetime . . .

On a more subtle yet nevertheless real level, the operational staff's and DJ's whole attitude toward the station and their work definitely hangs on what they hear coming back off-air. If it's good, they are at best inspired by it and at least unaffected; if it's iffy, at the best the stuffing gets knocked out of their creativity and at the worst they don't bother to listen to it—potentially leaving embarrassing and expensive dead-air until the MD's daughter asks Daddy why her radio's gone quiet . . .

Stations where the studios and transmitters are co-sited of course don't have any great difficulty; a demodulated feed straight off the antenna feed and a modulation monitor serve the purpose. Two areas of possible degradation—the feed to the transmitters and the receiver characteristics—are as good as eliminated.

The path and hence sources of degradation from station amplifier to monitoring input on the desk is something like:
a) Station line amplifier
b) Common carrier line or STL link
c) Terminating amplifier
d) Signal processing (compression, multiband limiting etc)
e) Stereo encoder
f) Modulation process
g) Antenna (if AM)
h) Propagation
i) Receiver front-end properties
j) Receiver IF bandwidth and group delay
k) Receiver demodulation
l) Stereo decoding
m) Off-air distribution amplifier

Shall we give in now? Let's start by whittling down the things that aren't too significant or that we can't do much about; first candidates are the line-amps and DAs (a, c & m) followed closely by the telecom line (b) (whingeing on the phone is the acknowledged service technique in this case). Signal processing (d) is there for artistic (?) or competitive reasons more than technical, so we'll discount that despite the fact it, more than anything, makes a nonsense of straightening out the rest of the path! Propagation (h) in local-area broadcasting is fairly well defined but multipath reflection is a killer to accurate FM demodulation and stereo decoding; the implication is to reduce it with an appropriate directional antenna. Ionospheric effects such as phasing and fading are very rare on local area AM/MF transmissions.

Anything to do with the transmitters is shoulder-shrug material for ILR contractors. As much as most chiefies would love to get their hands on them, both common-sense and the MD determine it's left to the IBA—after all, that's what the rental money is about. Isn't it? Regardless, the modulation processes are quite fraught, although for a variety of reasons modulation tends to be a more linear process than demodulation. Over-simplistically, an FM exciter costing a few Gs ought to out-perform a ten-bob quadrature detector chip. Practically, FM mod/demod non-linearity is a relation between deviation frequency (150 kHz for broadcast) and centre frequency; 150 kHz is far less of a relative deviation at 100 MHz (as at the transmitter) than it is at 10.7 MHz (the usual receiver intermediate and detection frequency). It is about 10 times easier to achieve modulation linearity than demodulation linearity in the FM broadcast chain.

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MF amplitude-modulation transmission is a slightly different scene. For the most part it falls into the category of 'brutal'. There are a number of practical ways to achieve AM, none of which are spectacularly linear; 3% distortion at full modulation is a pretty generous figure for most cases.

The MF transmitting antenna (g) might come as a surprise to most studio-bound persons as an audio quality determining factor. In the MF band—especially toward the lower end, the bandwidth over which an antenna is efficiently tuned and matched to the transmitter gets narrower and narrower, providing an unhealthy mismatch to extreme modulation sidebands (generated by the higher modulation frequencies). Result: attenuated and/or messy highs. Paradoxically, both a saving grace and the final insult within Europe at least is an ITU requirement to limit bandwidth to within the allotted 9 kHz-wide channels—consequentially nothing much above 5 kHz escapes most stations. Not much of a start to ekeing a listenable monitoring signal from the MF path.

So what's left in the off-air monitoring path that we can do something about?

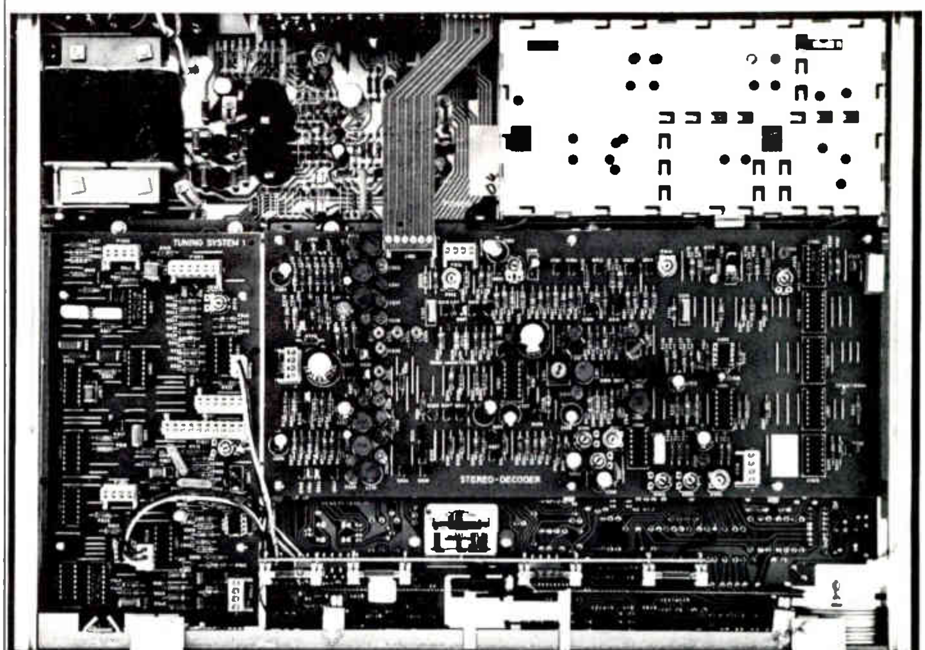
i) Receiver front-end properties
j) Receiver IF bandwidth and group delay
k) Receiver demodulation
l) Stereo decoding

Well I never! It's all to do with the receiver, something we can—and ILR contractors are obliged to—do something about . . .

So we're caught two ways: the operational necessity of off-air monitoring and the artistic, technical and mandatory needs for it to be good. As FM and AM have largely different purposes, technologies and application, it makes sense to deal with them separately.

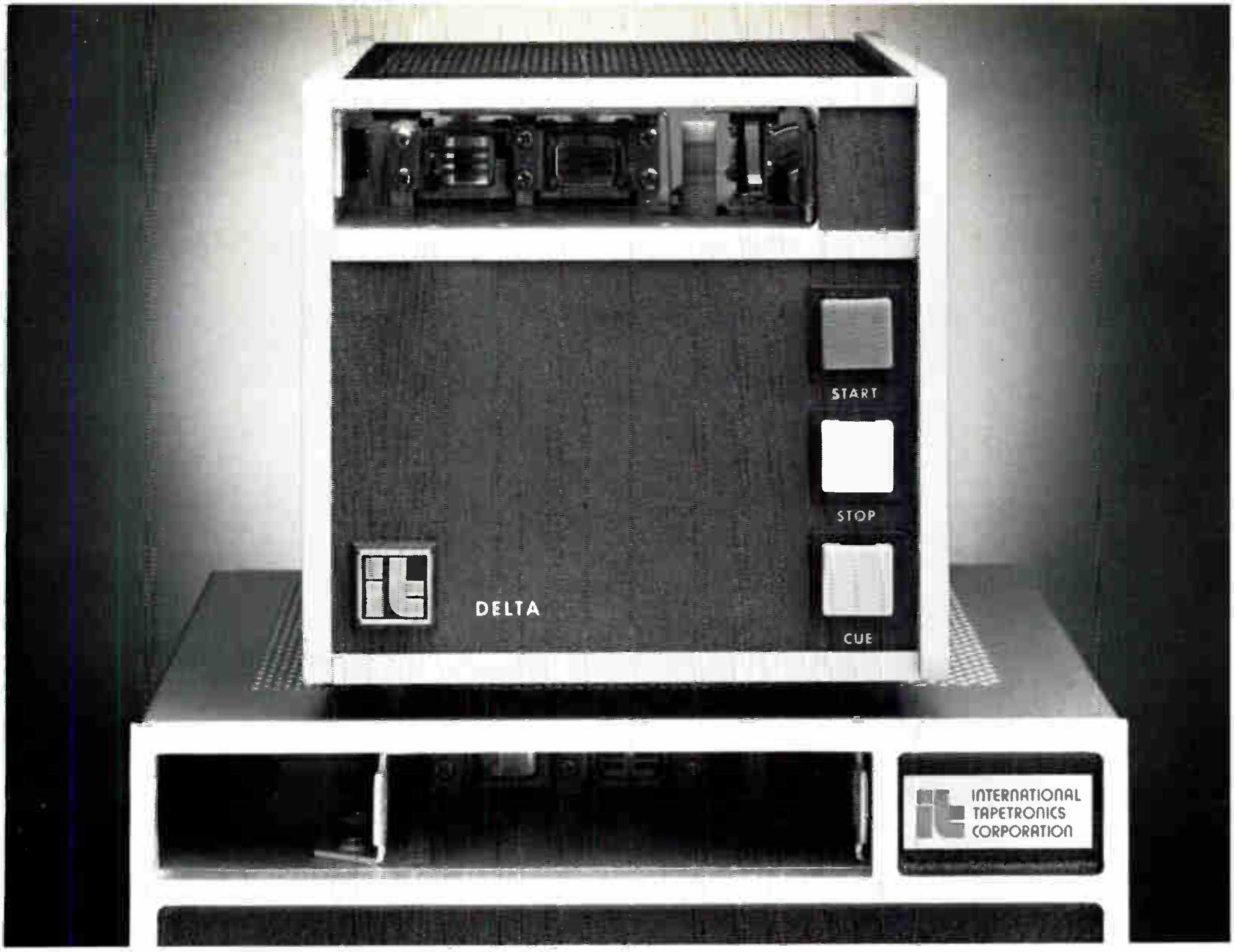
There are commercially available monitoring receivers, specifically designed for off-air reception by radio stations. There are also, about an order less expensive, readily modifiable and often far better performing 'hi-fi' type tuners. This sets the perspective here!

By and large, FM broadcast receivers are not expected to do anything extraordinary in the way of signal processing; the signals they are likely to deal with are fairly (if not very) strong and adjacent strong signals are spaced a nice sanitary distance away (if the frequency planners have done their job). The constraints are not as tight as in communications, ferreting out splintery, weeny signals from between several size-30 Doc Marten boots. Acknowledging the fairly simple requirements, hi-fi tuners then proceed for the most part to get it hopelessly wrong. In the attempt to achieve magnificently futile sensitivity figures, the receiver front-end's ability to deal with other adjacent heavy signals is correspondingly diminished; cross-modulation rules supreme. Under extreme conditions the whole band can just be jammed with constantly repeated local signals. A realistic solution which may or may not be construed as a cop-out is a 'Local/DX' switch that drops the front-end gain to somewhere near sensible. Front-ends that have the good filtering and headroom necessary to withstand the consequences of high sensitivities do not come cheap and generally do not come at all in hi-fi equipment.□



Interior of Tandberg TPT3001

Surrey Electronics Broadcast Receiver



WHY CHANGE A WINNER?

Now, a new generation of cartridge machines is available from ITC: the Delta Series. It represents a major advance in practical technology for the studio, and it took time to develop. Because significant breakthroughs don't happen overnight, especially when they have to supersede such a well-proven and dependable workhorse as the Premium Series.

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BROADCAST TRANSMISSION MONITORING

Chris Daubney

It is clearly important to professional broadcasting organisations that they should be able to monitor their transmissions at all stages, from the initial production of a programme to the last point in the chain—the output of one or more transmitters. Questions arise as to what overall standards a broadcaster should set, how much of these are consumed in the transmission system, and what standard of equipment the broadcaster should use to monitor the performance of his transmissions.

It is a reasonable assumption that most, if not all, people who listen to radio or television sound do so with their ears. Implicit in that simplistic statement is the assumption that some form of transducer will convert the transmitted electrical variations into corresponding air pressure changes. Of course, there are people who like monitoring the sound using objective instruments—which is right and proper and is vital if the transmission of programmes is to be done in a way which optimises transmission equipment. Ultimately however, people listen to sound with their ears rather than with their eyes. So our quality standards must be such that they relate to the subjective effect.

The assessment of the performance of loudspeakers is a subject upon which more has been written than the assessment of the rest of the broadcasting chain put together. I don't propose even to start along the road of loudspeaker performance requirements. The loudspeaker is common to both 'off-line' and 'off-air' monitoring in the studios. Since the ultimate place where the quality of sound is important is at the output of the transmitters, I want to concentrate on the standards which broadcasters might reasonably aim to meet at the output of the transmitter and, in particular, on the monitoring equipment used as part of the assessment of that transmitted quality.

The philosophy of quality

Although sometimes questioned by the purists of the hi-fi world, it is true, in the United Kingdom certainly, that the broadcasting authorities aim for the highest possible technical quality commensurate with economic reality. In some cases, the desire may be self imposed; in others it may be a requirement of an Act of Parliament; and in others specified in a legal contract. Whichever of those is the reason in any particular case, a lot of effort has been expended by broadcasting administrations to establish common standards for the interchange of programmes and for the transmission of these programmes. The international body in which such discussions about common standards surface is the International Consultative Committee for Radio—CCIR.

CCIR

CCIR members are broadcast administrations from all parts of the world; CCIR is part of the International Telecommunications Union which is itself part of the United Nations. CCIR works in four year cycles; at present the 1982-1986 period. The cycle starts and ends with a plenary session held in Geneva. During the four years there is normally an interim meeting after a year to a year and a half, and a final meeting three years along the course—meetings held in Geneva when all members have the chance to discuss two important contributing areas. Firstly, there are national CCIR committees and secondly, interim working parties which are international in make-up and consist of an expert or two from administrations who wish to offer the services of their staff. As with any large organisation the paper work comes in many forms; the two most important ones, as far as CCIR is concerned, are the Recommendations and the Reports.

Recommendations are more important in that they represent international agreement on a particular topic, and administrations use them either as a primary reference or as a legal obligation.

Before a topic achieves Recommendation status it may exist for quite a period of time in Report form. There is, at present, one particular Report (Report 293) which has been in existence for 20 years, but which might in the not too distant future become a Recommendation!

An interim working party of the CCIR (under the chairmanship of Neil Gilchrist of the BBC) is engaged in reviewing Report 293 during this present four year cycle. While the work of that group still has some way to go, progress in updating the tolerances, and particularly the philosophy, has been good.

CCIR Report 293

This particular Report—it is actually 293-5 since we are now in the fifth version of it—is entitled 'Audio Frequency Parameters for the Stereophonic Transmission and Reproduction of Sound'. That grandiose title could cover a multitude of sins. It does! I would commend it as bedtime reading for anyone interested in the efforts broadcasters put into achieving standardisation—but don't forget to follow up the references and the earlier editions.

In **Table 1** is the list of the parameters specified in Report 293; the relevant bands of frequencies for those parameters; and the two most important columns entitled 'Broadcast Signal' and 'Overall Tolerances'.

The column on 'Overall Tolerances' covers the entire chain from microphone output to the input of the loudspeaker—ie including the studio equipment, the links, the stereophonic transmitter and the receiver (which is considered to be a monitoring receiver as would be used in a studio centre).

Under 'Broadcast Signal', the CCIR Report indicates that the tolerances should apply to the chain 'Circuit+Encoder+Transmitter'. They therefore include the elements of the chain extending from the studio output to the transmitter output. The 'circuit' is the hypothetical reference circuit (HRC) defined in Recommendation 502 and specified in Recommendation 505; the tolerances for this HRC are given in **Table 2** with a repeat of the 'Broadcast Signal' tolerance of **Table 1**. At the transmitter output, the signal is still in its modulated radio frequency and is therefore not immediately correlatable to conventional audio parameters. Report 293 goes on to say that "it is understood that all characteristics are measured in accordance with the standard practice, using a high quality apparatus (demodulator and measuring decoder) normally having a very slight, if not negligible, effect on the value measured".

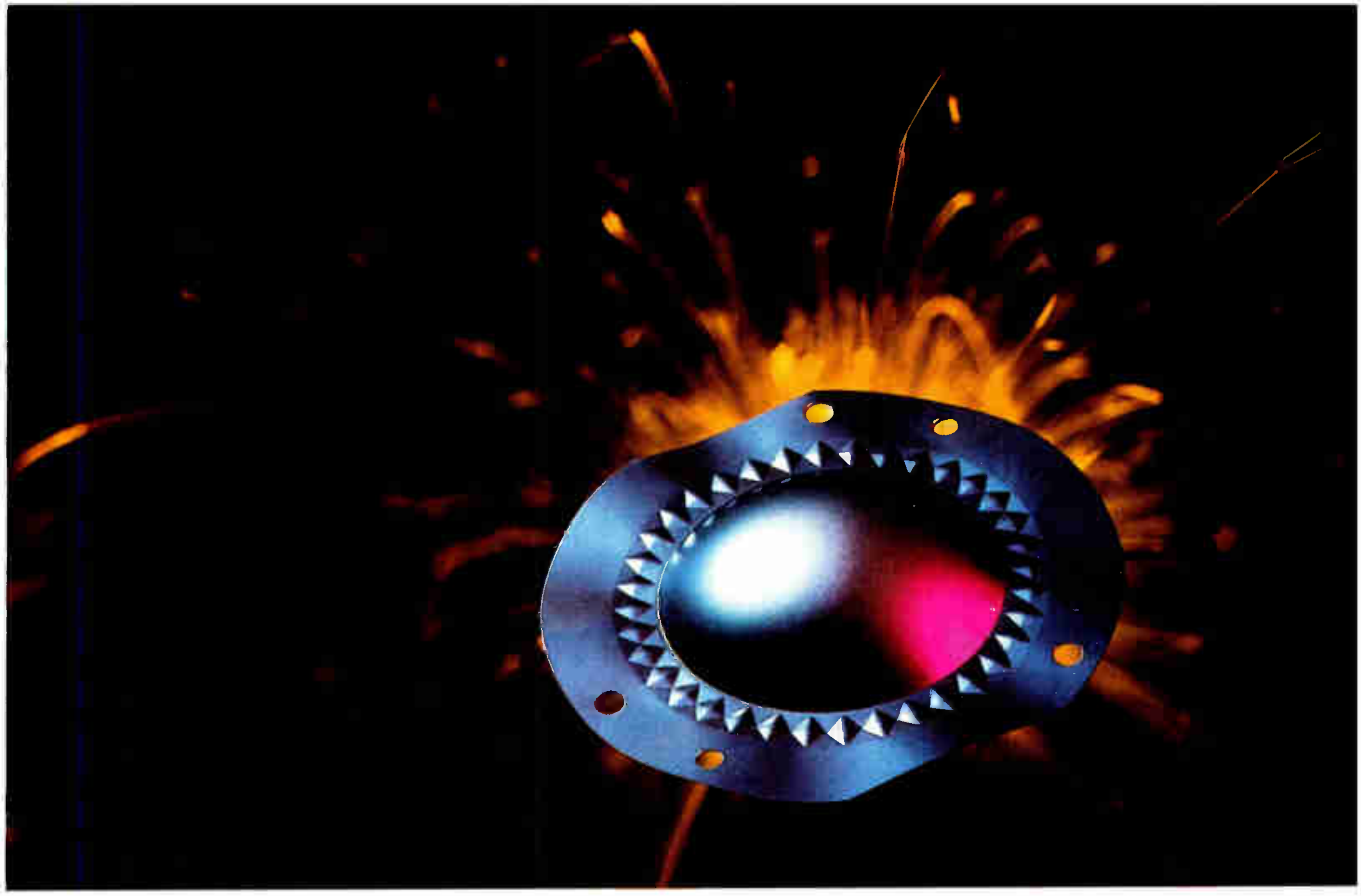
Independent Local Radio and Report 293

The IBA has always been a keen contributor to CCIR, through both national study groups and internationally through the British Government which leads the formal UK delegation at the Geneva meetings. It is therefore not surprising that the IBA has used CCIR tolerances, where applicable, as guidelines in its operation. Indeed, the IBA's Codes of Practice, for both television and radio, refer to CCIR standards in a number of places.

Under the IBA Act, the IBA is responsible for ensuring that both the "matter transmitted" and the "method of transmission" are of a high standard; the IBA is also strictly the broadcaster. It carries out that latter obligation, at least in part, by building, owning and operating the transmitters. Since the transmitters are separated from the programme making facilities, high quality interconnections are needed; in general these are provided by British Telecom. Thus, in the ILR equivalent of the 'Broadcast Signal' chain of CCIR Report 293, the circuit is under the control of BT and the encoder and transmitter under the control of the IBA. What about the receiver?

In the IBA's television services, with the country divided into 14 large areas, it is possible for 13 of the 14 different pictures and sounds to be monitored at one or other of the IBAs four Regional Operations Centres. However in ILR, with more than 40 areas, each of which is relatively small, a similar monitoring system is not realistically possible. To cope with the requirements of the IBA Act, the ILR programme contractors undertake this monitoring on behalf of the IBA. In order that the technial arrangements for so doing are appropriate, the ILR Code of Practice specifies the operating standards for the acoustic environment, for the loudspeakers and for the radio reception equipment.

I will return to the radio reception equipment



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in a moment, but the third part of the ILR equivalent of the 'Broadcast Signal' is, therefore, at the programme companies—remote from the IBA's transmitters.

Table 3 shows typical tolerances achieved in ILR for something akin to the Broadcast Signal chain; the relevant tolerances of Report 293 are also included but comparison between them is not totally appropriate due to two significant differences.

Firstly, the 'circuit' length in ILR is shorter than that specified in the hypothetical reference chain. It would, of course, be possible to correct for the circuit length using the normal power laws of addition (but no straight addition/subtraction) for tolerances as specified in CCIR.

Secondly, the siting of the receiver is relevant. In ILR the separation between transmitter and receiver is normally several miles. While considerable work is put into checking the received signal and its strength and into optimising the aerial position and rotation, there will, nevertheless, be a real 'over air' path in the chain. Great care has to be taken in any such 'off-air' measurements to ensure that multipath and other adjacent signals do not confuse the results. It is not explicitly clear in Report 293 but the implication is that, for the 'Broadcast Signal' chain (but possibly not for the 'Overall Tolerances'), the measuring receiver is at the transmitter site.

To some extent, the first and second points will offset one another—but caution is clearly needed in drawing conclusions. With the exception of low-frequency A-B Crosstalk, the ILR figures are better than those in Report 293.

It is interesting that, in the 'Broadcast Signal' chain of Report 293, there is no relaxation in A-B Crosstalk at low frequencies—unlike the 'Overall Tolerances' in the same Report (cf **Table 1**). It has been the experience of most, if not all, broadcasting technical operators/sound balancers/ studio managers/engineers that the A-B Crosstalk at low frequencies is less important than at mid-frequencies. One of the main sources of reference is *BBC Engineering Monograph No. 52*. That paper concludes there is no doubt that a crosstalk separation at low frequencies of only a *very few dB* indeed is all that is required overall. Of course, that overall tolerance has to be apportioned across the whole system—but such a small value at low frequencies gives plenty of scope. I have not seen any evidence to refute the BBC's work—and indeed it correlates with everyday experience

The ILR results in **Table 3** are typical of those obtained on a day-to-day basis in our network. Since the output of the monitoring receiver is at the same place as the source of the signals for this chain, A/B comparisons—the most cruel of all tests—are possible.

Of course, one can detect very small differences on some occasions between the outgoing and returning signals. However hard the ILR programme companies, British Telecom and the IBA try to make each part of the system 'transparent', the *economic* reality is such that full transparency will never be *totally* realisable.

However, both the IBA and the programme companies feel that both the Code of Practice and the allied tolerances for the entire system, (and for the monitoring part in particular), are sufficient to satisfy the obligations of the Act and to allow any problems which may arise either in the programme making or in the transmission parts of the system to be detected with the necessary level of sensitivity.

The ILR Code of Practice, which has been revised very recently, is concerned with minimum day-to-day operating standards. In this review, the opportunity was taken to reassess *all* the requirements, in the light of ten years experience of ILR—and some significant relaxations, particularly in the acoustics section, have been incorporated.

VHF receivers

The new Code sets out in greater detail the requirements for the VHF check receiver—there is now a separate section in the Code solely concerned with these requirements. The criteria chosen for assessing the receivers and the values selected for each of the parameters are listed in **Table 4**.

The tolerances shown in **Table 4** and the

Parameter	Frequency Band	Overall Tolerances	Broadcast Signal
Amplitude/Frequency Response (wrt 1 kHz)	40 Hz–125 Hz	+2 dB/−3 dB	+0.7 dB/−2.5 dB
	125 Hz–630 Hz	+1 dB/−1 dB	+0.7 dB/−0.7 dB
	630 Hz–1.25 kHz	+0.5 dB/−0.5 dB	+0.5 dB/−0.5 dB
	1.25 kHz–10 kHz	+1 dB/−1 dB	+0.7 dB/−0.7 dB
	10 kHz–14 kHz	+2 dB/−3 dB	+1 dB/−2.5 dB
	14 kHz–15 kHz	+2 dB/−3 dB	+1 dB/−3 dB
Gain/Level Difference	1 kHz	1 dB	1 dB
	40 Hz–125 Hz	2 dB	2 dB
	125 Hz–10 kHz	1.5 dB	1 dB
	10 kHz–14 kHz	3 dB	2 dB
	14 kHz	3 dB	3 dB
Phase Difference	40 Hz	90°	40°
	40 Hz–200 Hz	Oblique Seq	Oblique Seq
	200 Hz–4 kHz	45°	20°
	4 kHz–15 kHz	Oblique Seq	Oblique Seq
	15 kHz	90°	40°
A–B Linear Crosstalk	40 kHz	−19 dB	−36 dB
	40 Hz–300 Hz	Oblique Seq	−36 dB
	300 Hz–4 kHz	−30 dB	−36 dB
	4 kHz–15 kHz	Oblique Seq	Oblique Seq
	15 kHz	−19 dB	−25 dB
Signal-to-Noise Ratio (Peak)	Weighted	38 dB	42 dB
Non-Linear Distortion	40 Hz–125 Hz	−34 dB	−37 dB
	125 Hz–7.5 kHz	−40 dB	−43 dB

Table 1 Tolerances quoted in CCIR Report 293-5 for Overall Tolerances of Broadcast Signal

N.B. The Signal-to-Noise Ratio tolerances have been corrected to correspond to the latest measurement techniques. The weighting characteristic is that of CCIR Rec. 468.

Parameter	Frequency Band	CCIR Rep. 293 Broadcast Signal	CCIR Rec. 505 H.R.C.
Amplitude/Frequency Response (wrt 1 kHz)	40 Hz–125 Hz	+0.7 dB/−2.5 dB	+0.5 dB/−20 dB
	125 Hz–630 Hz	+0.7 dB/−0.7 dB	+0.5 dB/−0.5 dB
	630 Hz–1.25 kHz	+0.5 dB/−0.5 dB	+0.5 dB/−0.5 dB
	1.25 kHz–10 kHz	+0.7 dB/−0.7 dB	+0.5 dB/−0.5 dB
	10 kHz–14 kHz	+1 dB/−2.5 dB	+0.5 dB/−2 dB
	14 kHz–15 kHz	+1 dB/−3 dB	+0.5 dB/−3 dB
Gain/Level Difference	1 kHz	1 dB	0.8 dB
	40 Hz–125 Hz	2 dB	1.5 dB
	125 Hz–10 kHz	1 dB	0.8 dB
	10 kHz–14 kHz	2 dB	1.5 dB
	14 kHz	3 dB	3 dB
Phase Difference	40 Hz	40°	30°
	40 Hz–200 Hz	Oblique Seq	Oblique Seq
	200 Hz–4 kHz	20°	15°
	4 kHz–15 kHz	Oblique Seq	Oblique Seq
	15 kHz	40°	40°
A–B Linear Crosstalk	40 kHz	−36 dB	−50 dB
	40 Hz–300 Hz	−36 dB	−50 dB
	300 Hz–4 kHz	−36 dB	−50 dB
	4 kHz–15 kHz	Oblique Seq	−50 dB
	15 kHz	−25 dB	−50 dB
Signal-to-Noise Ratio (Peak)	Weighted	42 dB	51 dB
Non-Linear Distortion	40 Hz–125 Hz	−37 dB	−40 dB
	125 Hz–7.5 kHz	−43 dB	−46 dB

Table 2 Tolerances quoted in CCIR Report 293 for the 'Broadcast Signal chain of Circuits+Encoder+Transmitter (+Receiver)', and for the 'circuit' part, which is a hypothetical reference circuit (HRC)—as specified in CCIR Recommendation 505.

NB: The Signal-to-Noise Ratio tolerances have been corrected to correspond to the latest measurement techniques. The weighting characteristic is that if CCIR Rec. 468.

corresponding methods of measurement—and indeed all the other tolerances and methods of measurement in the Code of Practice—were established by a joint working party of the IBA and the programme companies—four ILR Chief Engineers and three senior members of the IBA's Quality Control Section.

The decision was taken to specify only the audio frequency performance of the VHF receivers, and nothing concerned with the radio frequency aspect. This was a conscious decision based on the fact that these receivers will always be used in places of known radio frequency field strength—unlike domestic receivers which may have to perform in a very wide range of field strengths—and also that it would be the audio frequency performance which would ultimately matter and which would have to be correlated with the other parts of the Code of Practice. The assessment of the radio frequency performance in the very first section entitled 'Definitions and Operational Practices' was covered by noting that it may, if necessary, be the subject of individual discussion between the IBA and the programme companies.

On routine visits to the programme companies by the IBA's quality control engineers, the VHF receiver performance is measured in conjunction with a test transmitter whose performance is of the same high quality as that of the main broadcast transmitters, both of which are in accordance with CCIR Recommendation 450.

The results given in **Table 4** are for the audio performance from the input to the stereo encoder of the test transmitter to the line level output of the receiver, or to the output of the distribution/gain make-up amplifiers as appropriate. The assumption is that a 0 dB reference signal goes into the test transmitter encoder and that the receiver equipment will also deliver 0 dB at its output by one means or another.

The working party reviewing the Code had a wealth of experience upon which to draw—including quite a variety of VHF receivers. Since A/B comparison between the 'input' and 'output' of the transmission chain was possible at each place, *subjective* assessments of any quality differences could be made. The amplitude/frequency response tolerances—which, at first sight, might seem to be rather less than transparent—come from those receivers in which the change in quality was deemed to be just acceptable. Many receivers perform well within those limits—but the Code is only concerned with the *minima* acceptable for high quality.

No set of tolerance listings means anything without the associated methods of measurement. For the ILR tolerances these are as set out in the new Code of Practice—which is to be published in the IBA's *Technical Review*. The measurement methods are also based, where possible, on CCIR methods. Some older CCIR tolerances have been corrected to accord with the latest measurement methods.

Conclusion

A considerable amount of time has been spent by broadcasters over the years trying to decide what are the *threshold* values which relate to the limits of subjective perception for each of the parameters of objective assessment. Some—such as phase difference and A-B crosstalk—have been relatively well defined, at least to a first order; others, like amplitude/frequency response, are almost always sources of trouble.

Given an A/B test, the ear may well detect very small changes in frequency response, even at the extremes of the frequency range. However, in the absence of an A/B test, when the ear has no clue as to the exact spectral distribution of the original signal, the problem is less acute. This is just as well because there is an economic limit to the 'flatness' which can be achieved.

Within ILR, a lot of time has been spent in looking for and/or trying to determine subjective threshold values, and then deciding how the cake might be sliced between the various parts of the broadcasting system. Included in that cake is a slice for the VHF check receiver. The tolerances which are set down allow high quality monitoring, but do not require any unnecessary expense or sophistication in the equipment. □

Acknowledgement. The author is grateful to many colleagues within the IBA and in other broadcasting organisations for all their thoughts, inspiration, and guidance, and to the Director of Engineering of the IBA for permission to publish this article.

Parameter	Frequency Band	Typical ILR Broadcast Signal	CCIR Rep 293 Broadcast Signal
Amplitude/Frequency Response (wrt 1 kHz)	40 Hz–125 Hz 125 Hz–630 Hz 630 Hz–1.25 kHz 1.25 kHz–10 kHz 10 kHz–14 kHz 14 kHz–15 kHz	+0.5 dB/−1 dB +0.5 dB/−0.5 dB +0.5 dB/−0.5 dB +0.5 dB/−0.5 dB +0.5 dB/−0.1 dB +0.5 dB/−2 dB	+0.7 dB/−2.5 dB +0.7 dB/−0.7 dB +0.5 dB/−0.5 dB +0.7 dB/−0.7 dB +1 dB/−2.5 dB +1 dB/−3 dB
Gain/Level Difference	1 kHz 40 Hz–125 Hz 125 Hz–10 kHz 10 kHz–14 kHz 14 kHz	0.5 dB 1 dB 0.5 dB 1 dB 1 dB	1 dB 2 dB 1 dB 2 dB 3 dB
Phase Difference	40 Hz 40 Hz–200 Hz 200 Hz–4 kHz 4 kHz–15 kHz 15 kHz	20° Oblique Seq 10° Oblique Seq 20°	40° Oblique Seq 20° Oblique Seq 40°
A–B Linear Crosstalk	40 kHz 40 Hz–300 Hz 300 Hz–4 kHz 4 kHz–15 kHz 15 kHz	−30 dB Oblique Seq −36 dB Oblique Seq −34 dB	−36 dB −36 dB −36 dB Oblique Seq −25 dB
Signal-to-Noise Ratio (Peak)	Weighted	44 dB	42 dB
Non-Linear Distortion	40 Hz–125 Hz 125 Hz–7.5 kHz	−46 dB* −52 dB**	−37 dB −43 dB

Table 3 Typical tolerances met in ILR for 'circuits+encoder+transmitter and high quality receiver' with reception including an over-air path.

N.B. The Signal-to-Noise Ratio tolerances have been corrected to correspond to the latest measurement techniques. The weighting characteristic is that of CCIR Rec. 468.
* at 80 Hz
** at 1 kHz

Parameter	Frequency Band	ILR Code of Practice VHF Check Receiver	
Amplitude/Frequency Response (wrt 1 kHz)	40 Hz–125 Hz 125 Hz–630 Hz 630 Hz–1.25 kHz 1.25 kHz–10 kHz 10 kHz–14 kHz 14 kHz–15 kHz	+1 dB/−1.5 dB +0.5 dB/−1 dB +0.5 dB/−1 dB +0.5 dB/−1 dB +1 dB/−1.5 dB +1 dB/−1.5 dB	
Gain/Level Difference	1 kHz 40 Hz–125 Hz 125 Hz–10 kHz 10 kHz–14 kHz 14 kHz	0.5 dB 1 dB 0.5 dB 1 dB 1 dB	
Phase Difference	40 Hz 40 Hz–200 Hz 200 Hz–4 kHz 4 kHz–15 kHz 15 kHz	20° Oblique Seq 10° Oblique Seq 20°	
A–B Linear Crosstalk	40 kHz 40 Hz–300 Hz 300 Hz–4 kHz 4 kHz–15 kHz 15 kHz	−14 dB Oblique Seq −32 dB Oblique Seq −20 dB	
Signal-to-Noise Ratio (Peak)	Weighted	48 dB	
Non-Linear Distortion	40 Hz–125 Hz 125 Hz–7.5 kHz	−46 dB* −52 dB**	

Table 4 Minimum day-to-day operating tolerances for VHF Check Receivers used in ILR.

N.B. The Signal-to-Noise Ratio tolerances have been corrected to correspond to the lastest measurement techniques. The weighting characteristic is that of CCIR Rec. 468.
* at 80 Hz
** at 1 kHz

SSL 5000 M SERIES AUDIO PRODUCTION SYSTEM

One of the impressions gathered from visiting almost any television production facility is that the very latest image processors and vision mixers can be found working side by side with audio technology straight out of the 1960s. As the television industry moves to upgrade its audio equipment, a number of problems must be overcome. Doug Dickey and Antony David of Solid State Logic explain how this requirement prompted the development of the new *SSL 5000 M*.

Doug Dickey & Antony David

The emerging requirements for television audio involve meeting subjective listening standards and audience expectations that have been set by the recording and film industries. Broadcasters, however, must meet these expectations within much tighter time and production budget constraints than found in those industries. Indeed, broadcasters require a unique level of operational efficiency and technical reliability to meet the requirements of live mixing for audiences of millions.

Specialised requirements

The success of Solid State Logic's *SL 4000 E* Master Studio System and the *SL 6000 E* Stereo Video System has prompted numerous requests for the development of specialised SSL consoles for use in live news production, continuity suites, television production stages, edit bays and many other areas, each with highly individual requirements. The requirements differ not only in terms of applications, but in the need to accommodate a multitude of international standards, production methods, personal preference and budgets.

Many of the consoles scheduled for replacement over the next five years were placed in service 10 to 15 years ago. At that time, it was common practice for the larger broadcast organisations to either build their own specialised units, or to have them built to exacting specifications—and at an exacting cost. Even then, this approach was sufficiently expensive that the smaller user had to choose the best compromise from available off-the-shelf offerings.

Today however, the sheer number of consoles involved is much greater. The needs of small and large users alike are substantially more sophisticated. The cost of research and development to support those needs has become tremendous. So has the price of reliability and quality control at the component, sub-assembly and final test levels.

While the increasingly complex requirements for advanced television sound dictate replacement of existing gear, custom work has become unaffordable for all but a handful of projects, and standard consoles are all too often unable to meet the broadcasters' needs for production efficiency and versatility.

A solution

The new *SL 5000 M* Series Audio Production System was developed to solve this dilemma. Decidedly not a typical audio console, it is a completely new form of audio console architecture. Its purpose is to meet the advanced requirements of the world's broadcast industry without imposing the functional compromise of off-the-shelf consoles or the economic penalties of custom units. Particular emphasis has been placed on serving stereo and multichannel television sound requirements, but the architecture is easily adaptable to other broadcast needs.

The system is based on a range of 40 x 150mm Eurocard cassettes, each containing the electronics required for a single function such as stereo equalisation or auxiliary sends. These cassettes slot into mainframe positions to form input and output channels and master control facilities.

While there is nothing new about modular consoles, the *SL 5000 M* takes this approach to a new level of sophistication. To a large extent, the facilities it affords have been made possible by development of special thin and thick film hybrids, which in some instances allowed as much as a 10:1 reduction in space requirements as compared to traditional 'op-amp plus component' construction. These new components have enabled the designers to fit all the necessary electronics to support an interlocking system of electronically balanced audio buses, electronic switching, and a network of control logic and data lines which give the *SL 5000 M* its unique production power.

The initial family comprises 28 such cassettes. The use of hybrid technology, combined with an emphasis on production engineering, has allowed each cassette to employ standardised components and sub-assemblies, resulting in significant cost reductions.

A versatile system using similarly standardised sub-assemblies was developed for constructing console mainframes. The width of these frames may be specified in 120mm increments (four channels). Mainframe depths may be specified to accept up to 4, 5 or 6 of the 150mm cassettes (see **Fig. 1**). This architecture yields 36 different console sizes, all of which may be further tailored to cater for patch bays and metering, a producer's table, wing layouts and so forth.

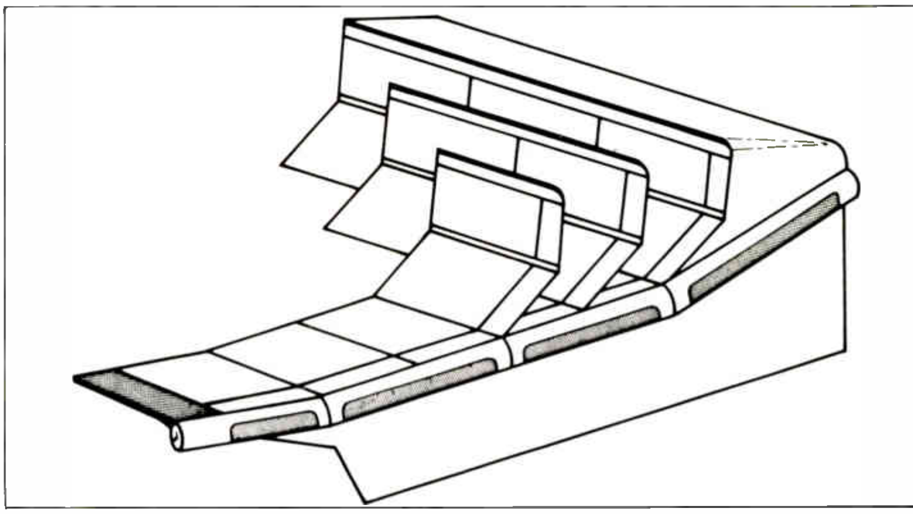


FIG. 1. THE SL 5000 M CONSOLE MAINFRAME IS AVAILABLE IN DEPTHS ACCEPTING UP TO 4, 5 OR 6 EUROCARD CASSETTES, AND IN LENGTHS ACCEPTING FROM 8 TO 56 MONO OR STEREO INPUTS

The final key to the system is a unique horizontal and vertical bus card structure which allows all versions of the mainframe to be fitted with any combination of cassettes. With few constraints, these may be placed in the console in any configuration the user desires. As the bus structure carries both audio and control lines, and because each cassette has been imbued with a degree of 'electronic identity', the integrity of all central controls and computer interfaces is maintained throughout an unlimited variety of control layouts.

Console features

Inherently, there is no such thing as a typical *SL 5000 M* console. There are a number of features common to all versions however, and a description of these will illustrate the operational power of the system.

The smallest mainframe has eight channel positions and eight master positions; the largest has 64 channel positions and 16 master positions. As mentioned, the depth of the mainframe is also a matter of choice. Each channel position will accept either mono or stereo cassettes, and each must be fitted with at least two of these—an input/output cassette and a program output cassette—plus a fader.

The mono I/O cassette provides a choice between one microphone and two mono line inputs. The stereo I/O cassette provides a choice between two stereo line inputs. Each cassette has high and low pass filters and a switchable insertion point for external signal processors.

Each channel must also be fitted with a program output cassette, either mono or stereo as appropriate. Both versions have a large incandescent pushbutton marked 'Channel to Program', and directly beneath this, an 'On' button engraved with the channel number.

Operation of a 'Channel to Program' button routes that channel's output to the main programme mix bus, which provides both stereo and mono outputs. All that remains to do is to press the channel's 'On' button and lift the fader. A central control cassette provides the option of selecting all Channels to 'Program' with a master 'Set' button and then deselecting those that are not desired by using their local buttons. A master 'Clear' button cancels all 'Channel to Program' settings.

Independent Outputs

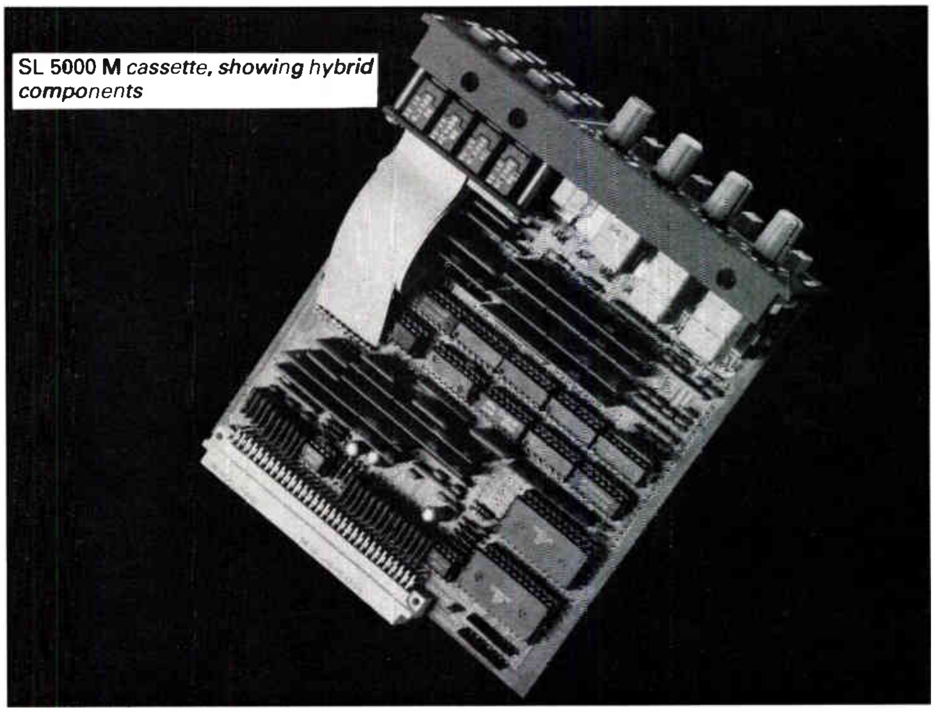
In addition to the main programme outputs, consoles may be specified with up to four stereo Independent Main outputs, each of which also provides a mono output. Each of these IMOs, which are designated 'A' through 'D', requires a single master cassette. Each of these cassettes has two buttons labelled 'Set' and 'Clear'. Operation of the 'Set A' button assigns all channels to Independent Main Output A; 'Set B' assigns all channels to IMO B, and so forth.

Four routing buttons on each I/O cassette are the local assigns to the IMOs. Operation of a master Set button causes the corresponding buttons on all individual I/O cassettes to light, indicating their selection. As is the case with 'Channel to Program' assignment, any individual channels may then be de-selected from the IMO mix by pressing their local buttons.

Each IMO cassette has an AFL button, an 'On' button, and a rotary output level control. The output level of each cassette may be completely independent, or it may be switched to track with the Program Output master fader. This scheme provides an extremely fast and easy way to create the multiple stereo splits, clean feeds, mix-minuses and international sound feeds necessary for efficient multi-channel television.

For the master mix, all channels may be selected to Program using the master Set button. Any elements not desired in this mix may be de-selected locally. To create the 'A' mix-minus, the 'Set A' button is used to select all sources to Independent Main Output A. Again, unwanted channels may be locally deselected. The same procedure is followed for the 'B', 'C' and 'D' clean feeds.

The entire process takes substantially less time to perform than to describe. Equipped with all four IMOs, and *SL 5000 M* console can simultaneously accommodate a main program


SL 5000 M *cassette, showing hybrid components*

mix, a secondary audio program (SAP) mix, and separate feeds such as cast, audience and orchestra or dialogue, music and effects.

Stereo audio subgroups

SL 5000 M consoles may also be specified with up to eight stereo audio subgroups. As is true of channel positions, each subgroup position requires a minimum of two cassettes—a Group Input/Output cassette and a Program Output cassette, which are similar in layout and function to the stereo channel versions of these cassettes. Channels are assigned to subgroups on an individual rather than central basis. Audio subgroups may be assigned to further sub-groups, to the Programme Output, and to any Independent Main Outputs.

Master operating modes

To keep operation simple, the system has only two master statuses. In 'Rehearse' all console functions operate as usual, but a level alignment tone can be inserted downstream from the control room monitors. In the 'On-Air' mode the Programme output replaces the tone and sources such as talkback and test oscillator are locked off the Programme buses. All master Set and Clear functions are locked out, but individual selection and deselection functions remain operative.

Special stereo facilities

Along with the ability to quickly structure multiple stereo programme feeds and stereo audio subgroups, the system offers powerful control for shaping the stereo image of those mixes.

Mono Program Output cassettes have a standard left/right panpot with a −4.5 dB downpoint at the centre detent. Provision is made behind the panel to vary this law to accommodate different standards and preferences concerning mono compatibility.

Stereo Program Output cassettes also have a standard left/right panpot, plus an Image Width pot and two buttons labelled 'Extra Wide' and 'Filter In'. The Image Width pot is labelled 'Stereo' at its full anti-clockwise rotation, 'Mono' at the centre of its travel, and 'Reverse' at its full clockwise rotation. When the Image Width control is set at 'Stereo', its left/right panpot has no effect. Rotation of the Image width Control towards 'Mono' gradually introduces the influence of the panpot. If the panpot is set at its centre, the effect of such rotation is to narrow the stereo effect until it becomes mono.

The interaction of these controls, at their extremes and at various in-between positions, greatly simplifies a number of stereo television sound requirements. The ability to narrow the perspective of stereo sound effects originally recorded for theatrical formats is a tremendous help in matching aural and visual perspectives with a 19 in screen in mind. The ability to tilt this narrowed stereo image left or right by exactly the desired amount is equally useful.

Finally, the 'Extra Wide' button can be used to add selective out-of-phase left and right channel components to create an 'outside of the speakers' effect. The Image Width control can be used to tame this effect, and a 250 Hz low cut filter can be switched into the enhancement circuitry to preserve the integrity of the mono mix.

Remote starts

Each Programme Output cassette is also fitted with a button, nominally labelled 'Start', which can be used to trigger a cart machine or turntable, to operate a cue lamp, or to perform any similar function. As is true throughout *SL 5000* architecture, DIL switches and/or links within the cassette accommodate varying standards or protocols. In this case, these may be set to determine if operation of this switch is seen as momentary or latching.

The remote function may be operated manually, or a button marked 'Fader Start ▷

Enable' may be selected, activating the device as the fader is lifted above −50 dB mark. Optionally, the Start function may be assigned to the SSL *Events Controller*. This is a subsystem of the studio computer which triggers multiple events in a predetermined sequence, reference to SMPTE or EBU timecode.

Auxiliary send cassettes

So far, the functions described are all accomplished using only the two mandatory cassettes required for each channel position and their optional central control and master cassettes. The full custom versatility of the *SL 5000 M* becomes apparent only when the additional system cassettes are discussed.

Auxiliary send capability is an area where widely differing broadcast needs occur. The *SL 5000 M* offers three styles of Aux Send cassettes. One or two of these may be fitted per channel, depending on the mainframe depth. This arrangement provides eight possible configurations per position: 2 stereo plus 2 mono; 4 mono plus 1 stereo; 4 mono plus 4 stereo; 6 mono; 6 mono plus 3 stereo; 8 mono plus 2 stereo; 10 mono plus 1 stereo; or 12 mono sends.

The number and configuration of auxiliary sends per channel determines the required type and quantity of auxiliary send master cassettes. Each Aux Send master includes a level control; high and low frequency shelving equalisation; an AFL button, an 'On' button, and two central control buttons. The first of these switches all of the local channel controls for that send between their pre- and post-positions; the second switches all of the local channel controls for that send between 'On' and 'Off'.

Operation of a local control counters the central selection for that individual send. The central function may be locked out when the console is in the on-air mode.

Signal processing cassettes

The initial family of SSL cassettes includes a 4-band mono equaliser and a 3-band stereo equaliser, each with continuously variable gain and frequency controls, switchable shelving/peaking curves in the high and low bands, and switchable high and low 'Q' in the mid-bands. Mono and stereo dynamics cassettes, with compressor/limiters and expander/noise gates are also available.

Additional signal processing cassettes are in development. One of the advantages of the *SL 5000 M* architecture is the ability to accommodate new functions by developing only the necessary cassette, rather than having to re-invent a major section of the console. This will enable SSL to facilitate a quick response to changes in operating requirements in a matter of months rather than years.

Other audio and control cassettes

It is not possible in the remaining space to describe all the options open to the purchaser of an *SL 5000 M* console. These range from the addition of up to eight VCA Fader and Cut Control Groups to sophisticated Interrupted Foldback/Cue Select matrices and facilities for establishing communication between all personnel involved in a production. External source selectors, metering cassettes and a variety of multitrack options are also available. Links and DIL switches are provided within many of these cassettes to accommodate different operating requirements.

It is important to keep in mind that the arrangements of these cassettes in the mainframe can be specified in almost any way desired. A news console might have the auxiliary sends immediately at hand, while a drama desk might give this position to the equaliser. Within any given console, these positions may differ in each block of four channels. The integrity of the central control system in maintained for all possible permutations.

Computer options

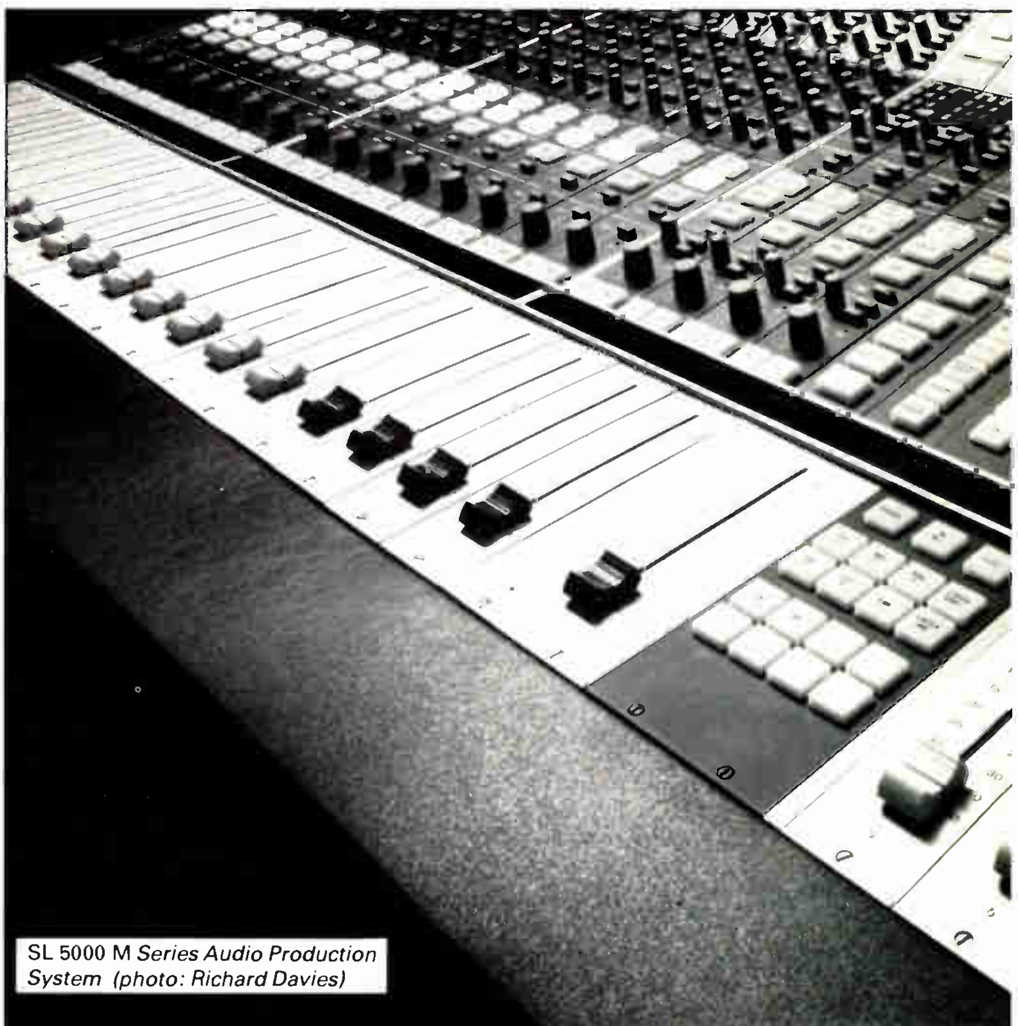
All switching is electronic and the entire switch network can be interfaced with the SSL *Instant Reset* computer. With this arrangement, the engineer can determine and store the optimum set-up for a particular programme or segment. At any subsequent time, all console switches can be instantly reset to their stored status with a single operation. This unique feature allows the console to assume exactly the configuration desired by each mixing engineer for each project, greatly enhancing continuity and efficiency of operation.

In live situations, this function is worth its weight in gold. In post-production, where the same source material may be worked on over the course of many sessions, the addition of a *Total Recall* system may prove equally worthwhile.

Total Recall stores the exact values of all continuously variable controls on the console. An interactive colour graphics system recalls the stored values at any time and displays them along with the current physical settings of the console. The engineer rotates the controls until an overlap of stored and physical settings is confirmed. Control accuracy is 0.25 dB and the function is accomplished independently of the audio paths.

Consoles can also be interfaced with the SSL *Studio Computer System,* which is itself a modular series of software and hardware controllers providing numerous levels of computer assistance. These range from single machine tape location to full control of up to five synchronised audio, video and/or film transports; multi-repeatable events control of up to 32 external contacts; automated mix creation, manipulation and editing; and programmable parametric equalisation and panning for dialogue matching and effects equalisation.

Floppy discs generated from computer-equipped *SL 5000 M* systems are compatible with *SL 4000* and *SL 6000 E* computer systems, and vice-versa.



SL 5000 M *Series Audio Production System (photo: Richard Davies)*

Summary

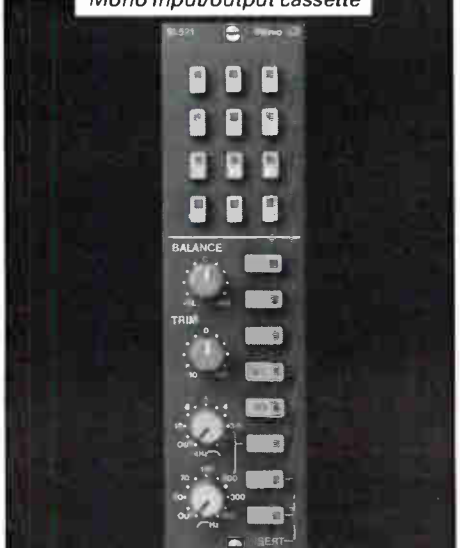
The architecture of the *SL 5000 M* can be used to generate an almost infinite variety of essentially custom consoles at sensible prices. Console sizes may vary from as few as eight mono or stereo inputs to as many as 64. Output configurations may vary from a single stereo/mono programme mix to as many as five such mixes. Up to eight stereo audio subgroups and/or VCA control groups may be fitted. A broad range of auxiliary send configurations is available, as are a variety of signal processing features.

Central control facilities are available in all configurations, and these may be augmented by several levels of computer-assistance, all of which may be retro-fitted in the field as requirements and budgets dictate. The *SL 5000 M* system meets widely different needs through a unified system of modular assemblies.

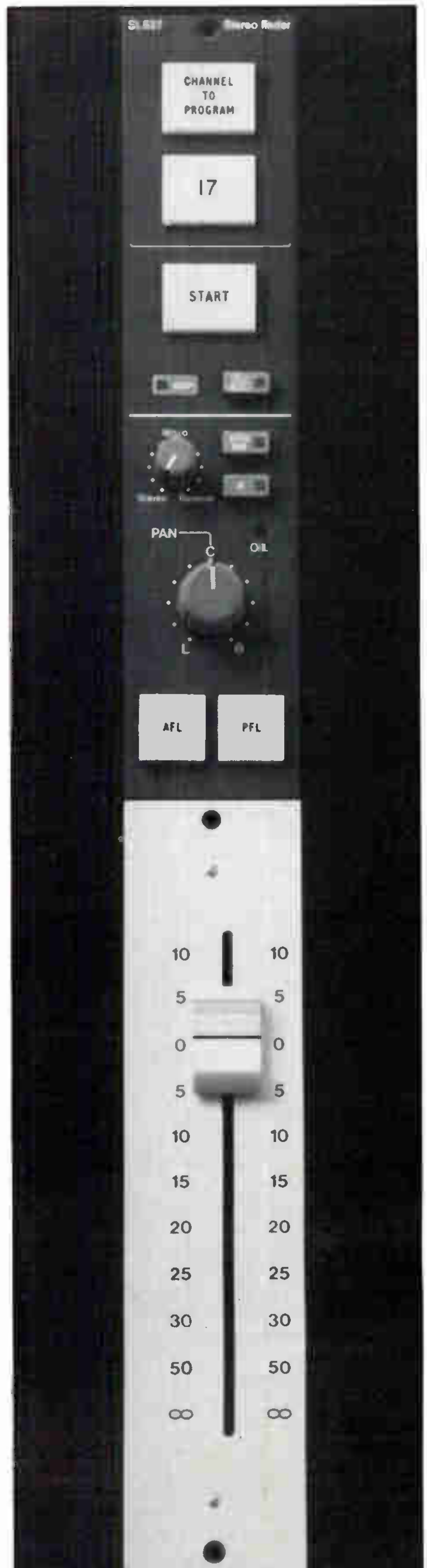
The common elements of all such systems simplify operational and technical training and reduce the spare parts inventory requirements of large organisations. The manufacturing economies afforded by the system's architecture bring the advanced features required for multichannel television sound within the reach of large and small users alike. Systems can be customised to precise needs without paying as much as for a traditional custom console. □

SL 5000 M *independent main output cassette*

Mono input/output cassette



Stereo input/output cassette



Stereo program output cassette with fader

SPECIAL EVENT BROADCASTING

Greenbelt Festival Radio was the first broadcasting station outside BBC/IBA control to be licensed in the UK. The station was on the air for four days last summer and received great acclaim for its broadcasts. Tim Foulsham of Wireless Workshop was involved in providing the transmitter and aerial system, and saw the station in action.

Tim Foulsham

The Greenbelt Festival is an annual festival of 'Christian arts'. Greenbelt '84 attracted 25,000 people to the grounds of Castle Ashby near Northampton during the August Bank Holiday weekend.

The centre of attention, the main stage, featured music of all types, ranging from such recognised Christian forms as gospel, through folk, pop, and rock, to headbanging heavy metal.

The festival also has a large and varied 'fringe' of theatre, dance, craft stalls, and religious seminars. It was into this self-contained world that a radio station fell so naturally.

Creation

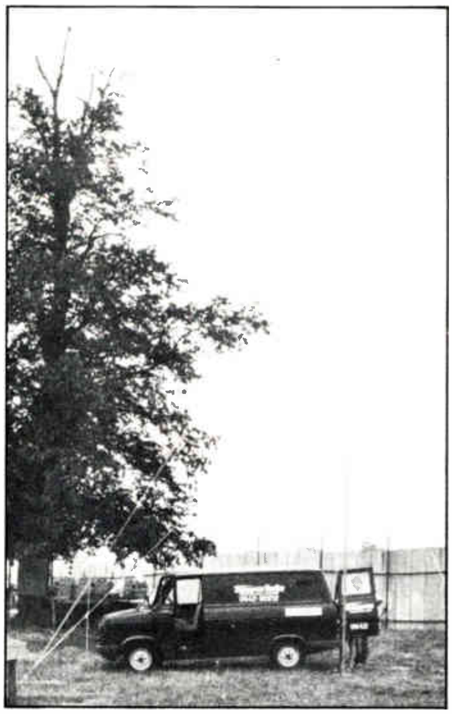
The radio station was the idea of freelance radio journalist Peter Laverock, who campaigned for a licence for several years before being successful. As a Christian, he and his family had been regular 'Greenbelters'. Over the years of going to the festival, he saw the potential for a radio station as something which would complement all the other attractions. He first applied for a licence to run a VHF transmitter at the 1982 Greenbelt Festival, but was turned down by the Home Office. Thus, there was no radio station at Greenbelt '82, but a petition with 1,500 signatures was raised, supporting the idea of a special event station the following year.

At that time, the only legal pathway to the airwaves for a private radio station was to employ an 'induction' system. This sort of system is used by student and hospital broadcasters, and operates on medium-wave, but the transmissions are magnetically induced into a portable receiver's ferrite rod aerial rather than radiated. The 'induction field' signal does not travel very far, so the broadcasts can easily be confined to student halls of residence or hospital wards.

There seemed no alternative way to get on the air, so Radio Greenbelt applied for a licence to use an induction system. The licence was granted, and the station took to the air on 29th August 1983, using 1,400 metres of 'leaky feeder' as an aerial system.

Disaster

It was a disaster. The broadcasts failed to cover most of the campsite, and although a lot of effort went into producing some very good programmes, they were heard by very few people. This was partly due to Radio Caroline occupying the frequency originally assigned to Greenbelt



Greenbelt Festival radio aerial

(963 kHz), but the main reason was the inherent nature of induction systems: the simple fact that the signal doesn't travel very far at the best of times (indeed, they are only licensed *because* the signal dwindles so rapidly). Covering a large open field was simply not practical.

Outside intervention

Greenbelt was not the only event seeking a licence for this type of broadcasting. Various applications to cover sporting events and pop festivals were arising. Although induction systems were considered, they were deemed to be impractical for the same reasons Greenbelt had discovered. By this time special event broadcasting was being seen by more and more people as a serious and useful service. The Home Office, sensing this increasing demand, began looking into the practicalities. In early 1984, radio engineers from the Department of Trade and Industry (DTI) were asked for a technical evaluation. They carried out tests with a low power medium-wave transmitter operating into a simple aerial, and did some calculations on necessary power levels.

Meanwhile, undaunted and confident in the power of prayer, Peter Laverock once again applied for a licence, and this time was told that a licence for a freely-radiating system would probably be forthcoming, and that if it was, he could operate on medium-wave with an effective monopole radiated power of...wait for it...50 mW! 50 mW EmRP didn't seem very much; perhaps they'd got the decimal point in the wrong place? No, it was 50 mW, it was a one-off experimental licence, and that was that.

At this point Wireless Workshop became involved. We make very low power medium-wave transmitters for induction systems, and had been involved in the general discussions on special event broadcasting. With only a few weeks notice, and still no certainty that a licence would be granted, we were asked if we could come up with a transmitter and aerial for Greenbelt.

Aerial

Conventional aerial technology was obviously out of the question: a quarter-wavelength vertical mast would have been nearly 50 metres tall, and we would have had to dig up half the festival site to bury an earth mat. The aerial had to be transportable, easy to erect and dismantle, and repeatable in performance at other sites. The efficiency of the aerial (the amount of power radiated compared with the power supplied to it by the transmitter) didn't matter much, as it would be easier to get our fifty milliwatts by making a more powerful transmitter than by constructing a bigger aerial.

In their experiments, the DTI engineers had used a T-aerial; i.e. a vertical wire radiator five metres tall, with a ten metre horizontal top, slung between a tall building and a pump-up mast. This is a simple 'short' aerial, and is of the type used for BBC Radio 4's long wave transmitter at Droitwich (where 'short' is actually 600 feet tall—but still short compared with the wavelength).

We rejected the idea of using a simple T, the aerial we eventually devised being a single 9.5 metre vertical aluminium pole, insultated at the base, guyed at two levels, and which could be dismantled into three sections to carry on a car roofrack. To improve its efficiency over a straightforward vertical, we surmounted the mast with a capacitive 'hat' of eight one metre radial spokes. This improves the efficiency by increasing the effective height without increasing the actual physical height. To tune out the capacitive reactance of the hat, we fixed a loading coil to the top of the mast beneath the hat. The coil was wound on a low-loss former, and protected from the weather by an enclosure which bore a passing resemblance to a plastic beer bottle, the original contents having borne a passing resemblance to plastic beer! Maximum current in such a short aerial flows at the base, and maximum radiation of signal occurs from the section of the aerial where maximum current flows. If the aerial had been base-loaded (as a simple T would have had to be) this current maximum would have occurred in the base loading coil, which would have been ineffective as a radiator, and the losses due to the coil would have been maximised. Not only that, but the voltages developed across the base loading coil would have meant that the bottom portion of the mast could have had hazardous voltages on it. Top loading minimises coil losses, improves efficiency, and lessens the hazards of exposed high voltage.

The shorter the aerial (compared to the wavelength) the more crucial the ground system is to efficiency. To radiate power, voltage must be developed across the radiation resistance of the aerial. The transmitter 'sees' an impedance which is mainly a combination of this radiation resistance and the ground resistances. A short aerial will have a low radiation resistance, so unless the ground resistances are correspondingly low the radiating efficiency will be low, and the transmitter power merely goes into warming up the surrounding earth. Short aerials can be made efficient, but only by using very elaborate ground systems (for instance, 120 buried radial wires, each 0.2 wavelengths long). Faced with the choice of digging up fields, or lounging around in the sun listening to music, we decided not to have any radial system at all, and simply rely on earth conductivity. We drove four metal stakes into the ground at the base of the mast, and left it at that. This worked satisfactorily at Greenbelt, where the conductivity of the clay soil was good, but it remains to be seen if we can get away with it elsewhere, particularly over chalk or granite.

Transmitter

The transmitter consisted of an *AP01* Audio Processor, and an *MX01* MF Exciter driving a specially-built linear power amplifier. The low-level modulator in the exciter produced a low-distortion signal up to, and even beyond 100% modulation depth. The signal from the exciter passed through an attenuator, variable in 1 dB steps, to a VMOS-output linear amplifier, which was capable of delivering 10W carrier power into 50 ohms. This was more power than we needed to give the 50 mW EmRP, but meant that we would be working well within the rating of the equipment, as well as giving us some scope for adjustment.

With such a low permitted power limit we attached great importance to achieving the greatest clarity and 'punch' of transmitted audio signal. The audio processor was used to impart this all-important clarity, as it compressed and automatically adjusted the tonal balance of the signal, as well as limiting the peak level to prevent overmodulation.

The layout of the Greenbelt Festival site, and the location of the transmitter within it, were unfortunately less than ideal for our purposes. A long avenue leads in a straight line from the main road to the stately home itself. The fields designated for camping lay on either side of this drive, so the site was essentially a strip 2 kilometres long and 200 metres wide. The only secure and convenient site for the transmitter was a fenced-off administration area near one end of the camping strip.

Final preparations

We arrived on site two days before the festival opened, to set up our gear, and to let the radio station team go through a dress rehearsal. The van containing our transmitter was parked about 30 metres from the Portacabin which was to house the studio, and we set to work erecting the aerial. Until then we had never actually extended the aerial to its full height. There were anxious moments when the mast indicated it was not as keen to be vertical as were the three of us who were grappling with it. It eventually saw sense and stood upright for us, looking like a curiously misproportioned umbrella silhouetted against a sky darkened and reddened by a nearby stubble fire.

By five o'clock that evening we were ready to switch on. Earnest dial-twiddlers in deepest Northamptonshire, tuned to 1602 kHz on Wednesday 22nd August 1984, would have heard the strains of a 1 kHz test tone from the first freely-radiating broadcasting station outside BBC/IBA control to be licensed in the UK. Two hours later it all ground to a halt when the generator ran out of petrol. As the studio began to be assembled it became clear that there was a problem. 1 kHz tone was oozing out of everything as the RF found its way back up the cables and was rectified. This sort of problem is inevitable in areas where there are high field strengths of amplitude-modulated RF, but fortunately it can be cured by fiddling with earths and balancing and by judicious use of ferrite toroids as chokes. We reduced the level of breakthrough to an unnoticeable level, but a mixer intended to be used for production work had to be set aside as it was too susceptible.

The Thursday was set aside for test transmissions, for us to apply some final tweaks to the transmitter, and for the presenters to get to grips with the studio. Overnight, the quiet fields of the park suddenly became a blaze of orange, blue, green and red tents.

Blast off

With a few words from a beaming Peter Laverock, the radio station offically started on Friday morning. Many of the presenters and programme-makers had slipped away from jobs with the BBC and commercial radio, so there was a considerable body of experience and talent among the station's 20 volunteers.

The programmes covered a broad range, but the focus and theme of the station was of course the festival itself. Hence, there were magazine programmes with interviews and discussions on religious topics, chat shows with festival performers guesting, and documentaries on, for instance, Christian influences in popular music. Music formed the framework for the station, and again all types featured.

The worth of special event broadcasting was amply demonstrated as the station developed to become a focal point for the dissemination of information, messages, appeals, pleas, and record dedications. There were lost dogs and lost children, fire risk warnings, car parking directions, details of performers on the main stage and the fringe, and bulletins on the status of the water supply and toilet facilities.

The station endeavoured to get out and about among the crowds and OBs were done from all over the site, wherever anything was happening. An audio feed from the main stage enabled concerts to be relayed each evening live. It seemed they were relayed a full two seconds before actually happening because of the long delay from the tremendously loud stage PA, which was almost a kilometre from the radio station.

The studio facilities were not elaborate, but all the essentials for running such a radio station were there: an 8-channel mixer, two record decks, a reel-to-reel tape recorder, a triple-stack cart machine and various microphones. Happenings in the rest of the world were monitored by radio and teletext TV. Also squeezed into the Portacabin were tape machines for editing, a computer, a microwave oven, and a digital audio recorder for logging the highlights of the output.

An enormous effort, and many hours of lost sleep, went into producing the round-the-clock output for four days. In programming terms the station was judged to have been a great success. A formal survey was carried out, which indicated that two-thirds of the 300 people sampled had listened to the station at some time. Rather less formally, breakfast show presenter Jim Hawkins conducted his own audience research by asking listeners to clatter tins, saucepans, and kitchen utensils to make as much noise as possible. The resultant cacophony was an affirmation of success!

There was an almost constant demand for dedications and messages to be read out. Someone even succeeded in getting a lift home to Stornoway as a result of a plea which was aired. This response becomes all the more heartening when it is realised that there was almost no pre-publicity about the station and bringing a transistor radio cannot have been highest on peoples' lists of priorities.

Low power radio in operation.

Technical success?

An examination of the success from a technical point of view was the subject of a report produced by Wireless Workshop after the event. The crucial question discussed in the report concerned the power level. Was 50 mW EmRP sufficient; and if not, what would have been a realistic limit?

The first point to arise as a result of the experience was the practical difficulty in determining how much power was actually being radiated. Two independent methods were used to calculate the radiated power. The first method needed a knowledge of the aerial current (which was easily measured, using a thermocouple ammeter) and the 'effective height' of the aerial. Finding the latter requires quite a complicated mathematical understanding of the aerial, which takes into account the contribution of the capacitive hat in increasing the effective height. This method, although it did produce an answer, was rather unsatisfactory, because of the lack of easily-applied general equations which can be applied to any aerial configuration.

Our second method was to derive the radiated power from measurements of actual field strength. This had the drawback of being very time-consuming (it took the best part of a day to drive around within a ten kilometre radius to get enough measurements to be useful), and the spread of experimental results again gave rather a vague answer.

The answers we derived for the power we were radiating at Greenbelt indicated that it lay between 80 and 125 mW (we had set the power in good faith at what we thought was 50 mW, but could not be sure until we had made the measurements and done the calculations). The field strength data we obtained could be scaled to show the effect of 50 mW, and this is what was done.

The furthest distance which had to be covered was 1.5 km, this being the distance from the aerial to the furthest extremity of the campsite. The field strength at this point, with the transmitter power scaled to 50 mW was 60 dB(μV/m), which is inadequate for a first grade service, although just passable on a good receiver in the absence of interference (i.e. daytime only). We considered that an acceptable criterion for reception should be the 72 dB(μV/m) contour. This is slightly higher than the usually planned-for limit of 66 dB, but we felt that with the miniscule power levels being used, special event broadcasting had a good case for having a loud and outstanding signal in the tiny area it was supposed to cover. The 72 dB contour on the 50 mW-scaled map fell about 600 metres from the transmitter, so in practice about two-thirds of the camp-site was covered as adequately as we would have liked.

The next step was to ask how much power would have been needed if the whole site had been included within the 72 dB contour? The answer, from simple scaling, is 500 mW.

Conclusion

The general conclusion from the Greenbelt experience was that the power limit of 50 mW was a fair first approximation, but that in order to fulfil all the aspirations of the service a more realistic level would be needed: up to 1 W to cover the largest of foreseeable sites. The practical experience of working out radiated power led us to suggest that this was not the best working parameter to specify anyway, and that regulation should be conducted on the basis of limits to received field strenths at given distances, with transmitter power being applied as a broad guideline.

The future?

Greenbelt Festival Radio was granted an experimental licence on a one–off basis. The Home Office has yet to decide if special event broadcasting is to be made a permanent feature of the radio landscape. We hope that the Greenbelt experiment will convince them that it is worthwhile, and that special event broadcasting will be allowed to flourish within a framework of sensible and realistic regulation.□

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WAXY, FLORIDA

John Lumsden

WAXY FM's studios are in downtown Ft. Lauderdale. Located in the Gateway Building on Sunrise Blvd, it occupies one floor with an area of 12,000 sq ft. Of this area, the studios occupy 2,600 sq ft of fully acoustically treated space. It is, of course, fully air conditioned. Within this space, four studios are located.

The on-air studios are well-equipped with Pacific Recorders *BMX* mixing consoles. These are typical of US radio mixers with only the essential controls fitted, and they are extremely well laid out ergonomically. Feeding the *BMX* are *Tomcat* cart machines and MCI *JH110* tape recorders.

All music on WAXY is broadcast off cartridge, not off disc. The carts are recorded in matrix mode with L+R on the left and L–R on the right. This mode of operation allows WAXY to maintain good mono-stereo compatability with minimum phase errors. A consequence of this mode of operation is a reduction in stereo separation, particularly noticeable at 14kHz. Chief Engineer Wayne Diluchente rightly points out that even with the measured separation of 15dB at 15kHz (worst case), it is better than one normally measures off disc.

The DJ microphone used throughout the station is the Electro Voice *RE20*, chosen for consistency of performance and reliability. Listening to WAXY off air, one perceives a feeling of warmth and clarity usually associated with expensive European capacitor microphones.

A separate facility exists within the building where discs are transferred to cartridge. Here is located some of the best equipment that money can buy. The turntable used is a Technics *SP10 Mk2* mounted on an air suspended plinth made by Dennison Electrostatics. This turntable arrangement feeds a spectra pre-amplifier from the output of a Denon *103C* cartridge mounted in a grace tone arm. Recording of the cartridge is done on a Pacific Recorders *Tomcat*, the output of which is monitored by a vector scope real time analyser, and Stax electrostatic headphones.

Choosing the music to fit the format is done, would you believe, by computer, from a playlist 400 strong. The computer takes into account 30 variables and makes a decision based on logic, thereby removing any human influence. The computer is an IBM *PC* and the software package is by *Markutron*. The success of this approach is reflected in the station's ratings.

Production studio

Production facilities at WAXY are of a very high standard. The station offers the facility for hire and it is used by other radio station and TV companies. Most of the equipment is MCI. The mixer is a *JH618* which has 18 input channels and is connected to an MCI 8-track and to two *JH110* tape recorders. Additional peripheral equipment includes an Eventide *Harmonizer*, *Masteroom* reverberation room, Audio+ Design compressors, *SP15* turntables and an Aural exciter. The material produced here is mainly commercials for both radio and television.

Master control

The terminal room, or master control, is very well equipped with Metrotech logging recorders, a number of jack fields and a routing switcher. Audio signals are processed by a 5-band Inovonics unit which features five different programmable program characteristics—voice, commercials, music etc. This equipment can be remotely switched to make this selection automatically.

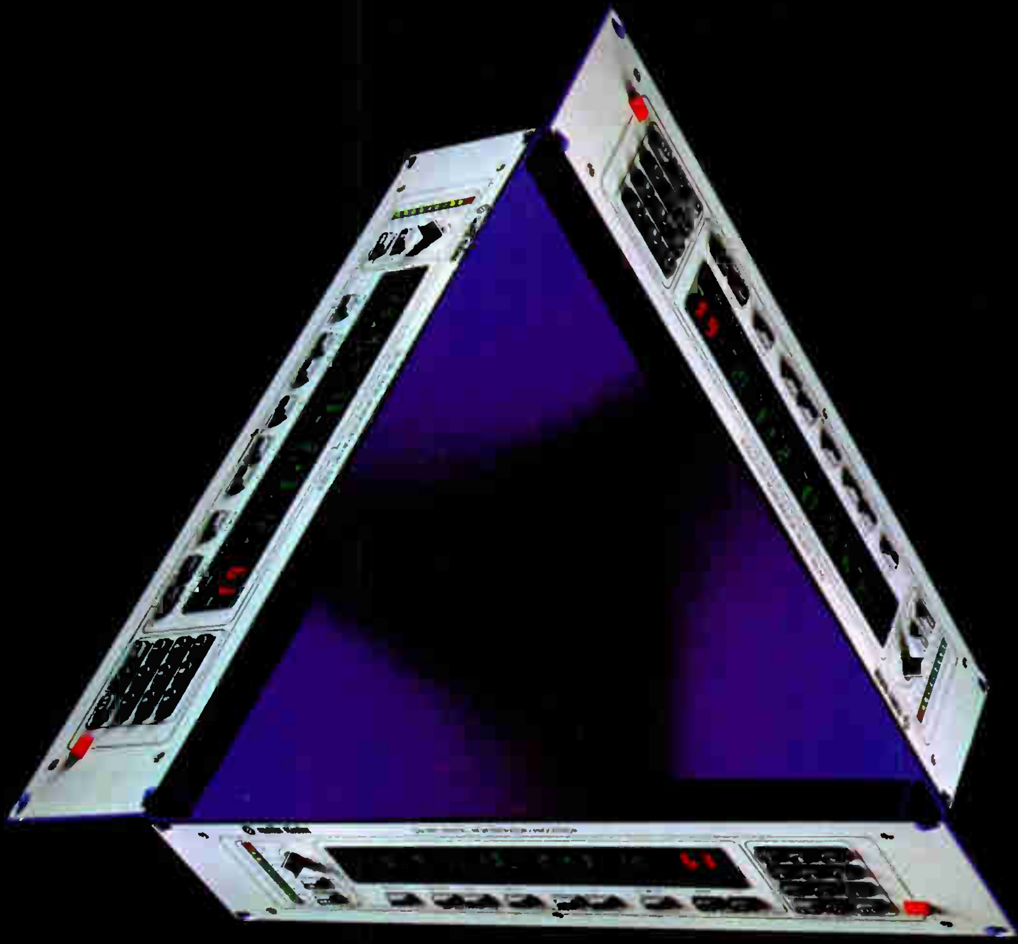
No doubt in time the authorities in the UK will realize the benefits of multi-band processing with the resulting superior coverage of fringe areas. Further advantages of multi-band processing are better car and personal radio reception.

WAXY has a back-up audio chain comprising a Pacific Recorders Multimod and an *Optimod FM*.

Off-air monitoring is by a Time and Frequency Technology monitor system. This is a multi-purpose device allowing the monitoring of carrier level, deviation, pilot tone level etc. Additionally, there is a high quality tuner, amplifier and speaker system. This equipment is used to monitor other stations and has an oscilloscope and

A small universe

325
164



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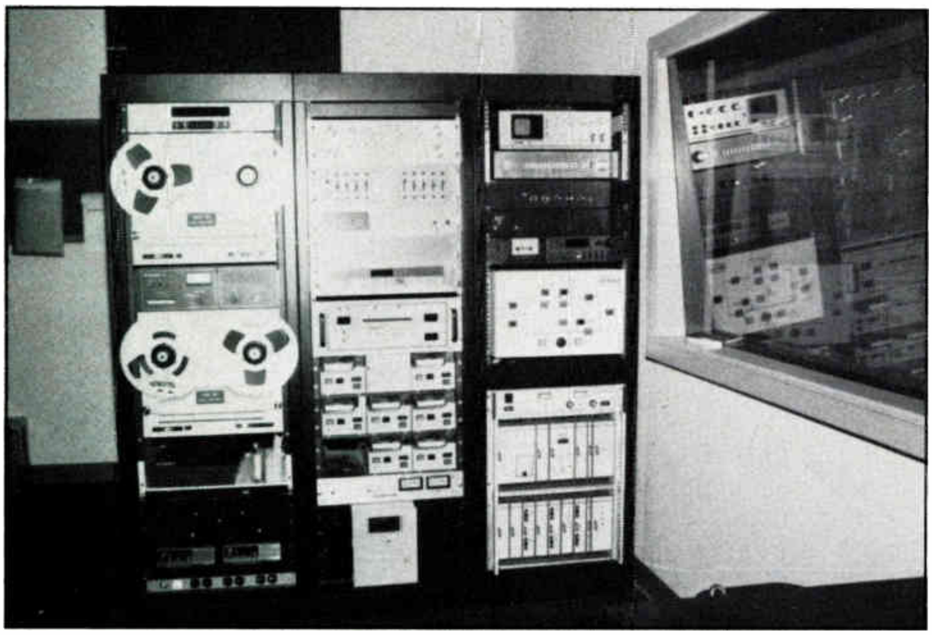

real time analyser permanently connected. The processing used by other stations can thus be ascertained.

Being part of RKO General means that considerable use is made of the RKO distribution network. This network is received off satellite utilizing a *Contec* controller, receiver and antenna system. Overall, this terrestial receiving system is capable of using all 24 transponders from all 16 satellites.

The RKO network is broadcast in digital stereo and is, therefore, of the highest quality. The WAXY mobile can also link back to Ft Lauderdale via this terrestrial station from anywhere in the United States. Studio signals to the transmitters are sent on a 948.5 MHz stereo link with composite modulation.

Extensive use is made of telemetry and full remote control is available over telephone lines. The system, manufactured by Delta Electronics, can be accessed by any phone anywhere in the world simply by dialling the number and an access code. All parameters being monitored at the transmitter site are then relayed to the interrogator by voice synthesised signals. This monitoring equipment also contains a user definable tolerance detector. When the pre-set tolerances are exceeded, the equipment, via a high speed dialler, will call the chief engineer at work or at home and report the situation to him. The equipment could be referred to as intelligent.

The WAXY mobile

The mobile was built by WAXY engineers during 1982-1983. The total cost of the project was $250,000 and the result is a totally self-contained, self-sufficient unit.

The studio in the mobile is a smaller version of the on-air studios at the station. It features six cart machines, two reel to reel tape recorders and a *BMX* mixing console. The mobile has been fully acoustically treated and is air conditioned. Three generators are used to supply a total of 19kW power. One generator supplies the power to all the critical equipment: mixers, carts, tape etc. The second supplies lighting and the third the microwave link and trailer equipment.

A public address system forms part of the mobile and is capable of an SPL of 130dB—equivalent to a small jet aircraft at take off. The speaker system is 'state of the art', and utilizes a four way cross-over feeding HF units, MF units, LF units and sub woofer.

Tropical problems

Life in south Florida may be tropical, but life in a tropical paradise is not without its problems. The area has the highest incidence of lightning strikes in the world and the power company suffers accordingly. There are numerous interruptions of supply. Extremely high transient voltages of very short duration are often present on the power lines. WAXY has surmounted these problems by using a 37.5kVA UPS (uninterruptable power supply) system. This is identical to those used by NASA for shuttle launches at T−24 hours.

AC line voltage is rectified and used to charge batteries. These batteries drive an inverter which converts battery volts to 60Hz sinewave with very low distortion. The batteries are capable of two hours use at full load. Additionally, a diesel generator is used to 'back up' the batteries. This generator will auto start after 12 seconds of failure of incoming line power. Two modes of operation are available, one whereby the generator charges the batteries and the other whereby it feeds the studio complex. Intelligence is built into the system to phase match when switching within the second mode. No interruptions are thus detectable. Since incoming line power never drives the studio equipment, no transients are ever present on the technical supplies. Reliability of the station's technical equipment since installation of this UPS system has dramatically improved.

In the tropics, life exists under the threat of hurricanes and people take these threats very seriously. A hurricane hitting South Florida would cause widespread devastation and a number of deaths would result. No one takes these threats more seriously than WAXY, which chose its present building very carefully, the structure being capable of withstanding the wrath of the fiercest hurricane. From here WAXY would provide community information, help, guidance and co-ordination in the event of a disaster. In the unlikely event of the main building being incapacitated in any way an alternative broadcasting studio and back up transmitter with its own generator is available one mile away in South Florida's highest building—the 360ft Landmark Bank. These back up facilities have cost $250,000—and may never be used. Such is WAXY's committment. Arrangements have been made to link up with one of the main television networks in Miami to utilise its vast news and information gathering facilities should any such calamity ever actually take place.

WAXY is an extremely well equipped and operated radio station with a strong social responsibility to the community it serves. □

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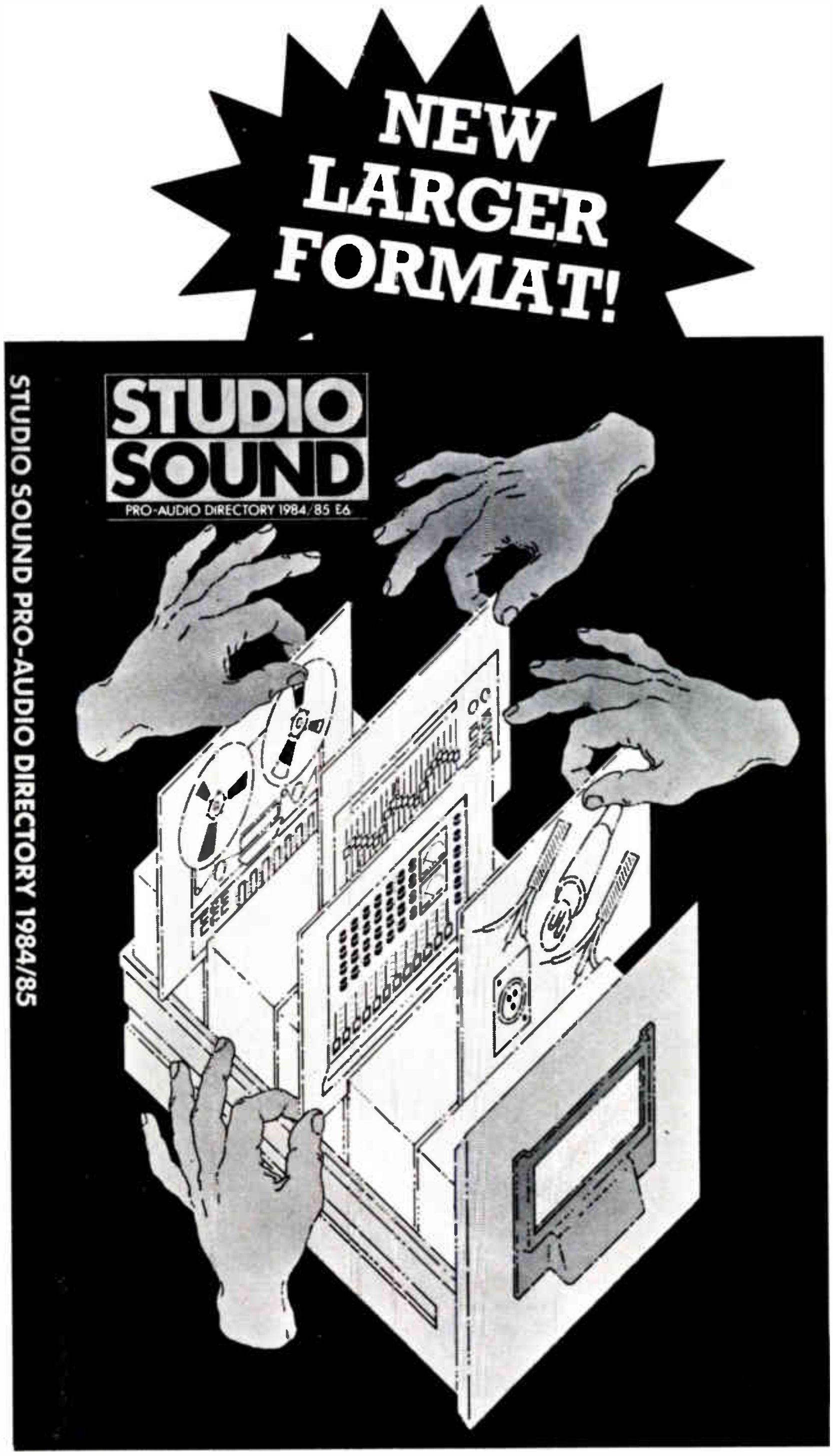

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BANDS I & III AFTER 405 TV

Tim Matthews

Early this year the UK's ageing 405-line black and white television service closed down for the last time. This freed Band I (41–68 MHz) and Band III (174–225 MHz) for private mobile radio users in the UK—with a limited amount of radio spectrum being retained for ancillary services in operational support of broadcasting. But will the reduced supply of spectrum, combined with a growth in demand, seriously hamper programme making in the future?

The release of Bands I and III, as recommended by the 'Merriman Report' on the radio spectrum, constitutes the largest single addition ever made to private mobile radio (PMR) users' facilities, and should provide sufficient room to meet the increasing demands for such services over at least the next ten or fifteen years. At present there are over 300,000 vehicles licensed to use mobile radios in the UK, but that figure is expected to rise eightfold by the year 2000.

All good news for mobile radio users, but what about the poor broadcasters who now find themselves facing a net reduction in facilities?

Broadcasters were invited to put forward their views for consideration by the government's Radio Regulatory Division (RRD), part of the Department of Trade and Industry (DTI). To this end a BBC/IBA/RRD joint group was formed to study requirements for a revised broadcast ancillary frequency plan for the range 30 MHz to 80 GHz.

In preparing their first interim report—incorporated in the consultative 'green paper' presented to Parliament—have the BBC and IBA representatives taken into account the needs of their colleagues, the independent producers?

"At the moment they have not", admits Phil Laven, head of BBC Engineering Information, "because the first part of the work that we have been doing is looking at current use of the spectrum. The primary thrust of the DTI in their investigation was to scrutinise in tremendous detail our existing assignments to make sure that we were using them all and that we could justify the requirement. So a lot of our work, so far, has been entirely on defining *current* usage.

"Now, except for the ancillary services of the BBC and IBA there is very little use of the spectrum at the moment, and so when we were looking at the current situation it wasn't really necessary to look at the independent producers' needs, or indeed at the needs of cable and satellite and foreign broadcasting, theatres, pubs, clubs and so on.

"But the *next* part of our work will go beyond current use and will look at forecasts for future use, and there the intention is to consider the requirements of the smaller users.

"So what we have said in our interim report is 'this is the absolute minimum that we will need to do our job, but we will need more spectrum in the future as things get more complicated *and* other users will also require spectrum'."

The joint study group began work—work which took them some 12 months to complete—but as it began its studies it soon became clear very few people outside the industry (or even inside it) actually understood what 'broadcasting ancillary services' consisted of.

"I believe it is fair to say that at the beginning of the study group's work, the DTI did not really understand the difference between broadcast ancillary services and land mobile services, and to be honest I don't think there were many people within the broadcasting organisations who had ever taken a great interest in explaining to the outside world that there was a difference!"

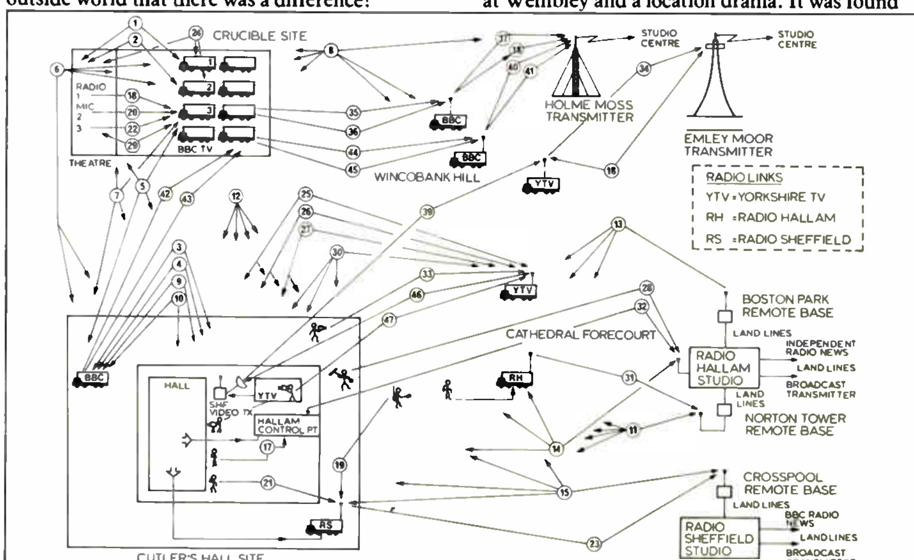

Fig. 1. Sheffield outside broadcasts 28 April 1983

The group therefore took it upon itself to define the three main categories of services.

- **Category A** is for channels conveying programme material. Examples include radio microphones, temporary links from an OB site to a studio centre and temporary links within an OB site. Here there is a requirement for high quality and immunity from interference. Radio microphones require an RF bandwidth in the order of 200 kHz, while other channels carrying programme sound —eg point-to-point RF links—require bandwidths of 25, 50 or 100 kHz depending on the use.
- **Category B** covers channels used in 'programme creation'. These include talkback systems to direct the various groups of people involved in making the programmes, and cue programme for participants. Category B channels need to be intelligible and immediate. For frequencies up to 470 MHz reasonable quality may normally be obtained with the use of 12.5 kHz bandwidth for single frequency simplex, and a pair of 12.5 wide channels for 2-frequency simplex or duplex. Sometimes there is need for a greater bandwidth—25 kHz would be necessary for stability, for example, where UHF hand-portables are used, or in cases where programme material is required for cueing.
- **Category C** channels are used for general purposes such as news crew assignment and control, security and general purpose communications. These services require intelligibility but can tolerate some delay in the transmission of messages and, generally, may be accommodated on normal PMR channels.

The study group decided that the best way to analyse the broadcasters' precise requirements would be by studying actual events. It was then assumed that if the requirements for the representative sample were met in one area, requirements for the rest of the country could be met by using the frequencies in other areas.

Representatives of the joint study group went out with the production teams. On April 2, 1983 for example, they examined in detail the radio and television requirements of events at the University Boat Race, football matches at Fulham and West Ham, racing at Kempton Park, a country festival at Wembley and a location drama. It was found that these events monopolised 59 channels—16×200 kHz channels, 3×100 kHz, 2×50 kHz, 20×25 kHz, and 18×12.5 kHz.

One month later they went to Sheffield and followed a day's events in the Radio Hallam newsroom, on a location drama, at a snooker match, and they observed coverage of the local Cutlers Feast by Yorkshire Television, ITN, BBC News, Radio Hallam, and Radio Sheffield. They found 35 channels in use. Many other similar events were covered in different areas and on different days—on a random basis.

After a year of digesting relevant figures, the group proposed that it was reasonable to suggest that there was an overall requirement for a total of 12.15625 MHz to meet current BBC/IBA needs. This was made up of 2.45625 MHz not suitable for general PMR use and 9.7 MHz to be allocated from Band I (4.70 MHz), Band III (4.40 MHz) and 854–960 MHz (0.60 MHz).

Of this total it was proposed that 4 MHz in Band I and 4.2 MHz in Band III should be available for radio microphones. In Band III it was suggested that these lower power devices should be located in parts of the spectrum unsuitable for normal PMR use because of the interference which they would cause to French and Irish television.

The study group also came forward with a

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TABLE 1
PROPOSED NEW ALLOCATIONS:

Frequency band MHz	**Proposed allocation**	**Proposed use**
Band I	**MHz**	
50–58 (See Notes 1 and 2)	0.35+0.35	Spaced 5 MHz for channels carrying programmes and used directly in programme creation
60–64	4.0	Radio microphones (see Note 3)
Band III		
174–223.5 (See Note 1)	176.50–177.20 184.50–185.20 192.50–193.20 200.50–201.20 208.50–209.20 216.50–217.20	Radio microphones (See Note 3)
	0.1+0.1	Spaced 8 MHz for channel carrying programmes and used directly in programme creation
854–960	0.1+0.1 0.1+0.1 0.1+0.1	Spaced 5 MHz for channel carrying programmes and used directly in programme creation
Proposed existing assignments to be retained:		
69–88	25×12.5 kHz channels	For channels used in programme creation
141–141.9	141–141.9	For channels carrying programmes
160.9–161.9	10×12.5 kHz channels	For channels used in programme creation
420–470	Various small sub-bands shared with other users—mainly geographically restricted areas	For channels carrying programmes and used directly in programme creation

number of other conclusions and recommendations. It suggested, for example, that the best use of available spectrum would result if the allocation of frequencies was managed jointly by the BBC and IBA, rather than by making fixed assignments for particular users or purposes.

The group proposed that the following frequencies in **Table 1** should be allocated to such a 'joint management group', while requirements for Category C services should be met from the general PMR bands.

Notes to Table 1

1. To avoid interference from relatively high power services used in close proximity to radio microphones it is necessary to have a spacing of about 2 MHz between frequency bands for radio microphones and those for channels carrying programmes or used in programme creation.
2. It is desirable to have the frequency allocations in Band I as near the top end of the band as possible.
3. The allocations for radio microphones are to be augmented for use in studios by the use of broadcast bands.

"I think there has been a major element of misunderstanding within the radio industry about the fact that broadcasting ancillary services are actually very different from land mobile radio", says Phil Laven. "I think the land mobile users—with their 12.5 kHz bandwidth—might have felt, in the past, that broadcasters had an immense amount of spectrum already available to them, exclusively, in the broadcasting bands—megahertz and megahertz of them.

"The land mobile lobby have done their best over the years to reduce spectrum, and obviously now look to us asking us why we cannot also reduce spectrum. The reason for the great difference is that we've got a very different job to do and require those higher standards. We expect the audio band in the order of 15 kHz with a very high S/N ratio, and that inevitably requires a wide bandwidth. On the other hand the land mobile lobby require something akin to telephone quality—perhaps 3 kHz bandwidth, and S/N ratio doesn't come into it!"

Then there is the often misunderstood question of radio microphones. "At the BBC we use radio microphones in Band I which are tunable anywhere between 41 MHz and 68 MHz. Well, people then said to us 'you've got 27 MHz worth of radio microphones'. No, we haven't, not really, because we cannot use them all anywhere in the country without causing interference to television broadcasts.

"The bandwidth of a radio microphone is of the order of 200 kHz—that is *sixteen* times as much as one of the 12.5 kHz channels. And that is just one microphone. Yet on a single site we often have many radio microphones—as many as 30 radio microphones may be in use at the BBC Television Centre at one time—and that just compounds the problem.

"The important decisions now relate to Bands I and III. The spare spectrum in those bands has got to be assigned—quickly. To accommodate some of the objections from the land mobile lobby we have, I believe, actually been fairly moderate in our requests for frequencies—in that we are restricting the majority of our requests in Band III for low power radio microphones, which can in fact operate in parts of the band where high-powered land mobile services cannot operate without interfering with French TV'.

The cost of conversion to the new frequencies will be considerable. The group has estimated the additional capital costs of implementing their joint proposals over a five year period, as in **Table 2**.

TABLE 2

ESTIMATED CAPITAL COSTS	**BBC**	**IBA**	**TOTAL (£)**
Radio microphones	400,000	290,000	690,000
Programme sound links	1,210,000	390,000	1,600,000
Camera and other programme data links	40,000	50,000	90,000
Vision links	300,000	—	300,000
Talkback systems	560,000	440,000	1,000,000
Transfer of Category C channels at present in non-PMR bands to PMR bands	200,000	10,000	210,000
Additional equipment holding to provide necessary fiexibility	2,600,000	1,660,000	4,260,000
Additional equipment costs for equipment which has to be specially developed and produced	1,040,000	670,000	1,710,000
TOTALS	6,350,000	3,510,000	9,860,000

Having submitted the first part of its report to the government, the group is now moving on to the second part of its study, *Frequency re-use in* *broadcasting bands II, IV and V.* This will include what should really have been the final part of the first report—a study of future needs.

"The problem, I think, about the whole business of frequency requirement for ancillary broadcasting services is that it's all so intangible, and it is not static," says Phil Laven. "What might have been satisfactory 20 years ago at an OB is not satisfactory today. OBs have become immensely more complicated—to see what I mean, you have only got to look at a golf match where action is taking place simultaneously on different parts of the course.

"Instead of just having one OB vehicle and a few cameras attached to it, you have several OB vehicles and a whole range of programme packages being made simultaneously. And for each of those you need director's talkback, sound talkback, links, caddy-cars, mobile cameras and everything else. And when will that stop? Thirty cameras? Fifty cameras?

"Ideally, of course, we would like to have enough spectrum for the BBC and the IBA to do any conceivable programme—things like the Royal Weddings where we were co-sited. But in fact even in the past we have never had enough to do the job we have wanted to do, and have always been pressed by producers to get more spectrum to allow them to do what they believe is necessary in programme terms. So now it looks as if we might be heading towards the end of that particular road, as the spectrum runs out.

"The crux of the matter is that in the future we'll only be able to use radio when it is absolutely necessary. It will not always be available just because it is convenient. We won't always be able to use radio microphones, for example, when it is possible to put up an ordinary mic."

The situation is not likely to ease. "Over the next 10 to 15 years we can foresee developments which have already started. On the news side, for example, we already see how ENG is hungry for spectrum. Then, inevitably, there will be stereo sound on television OBs which will need more spectrum, because even though we may be able to multiplex the extra sound channel onto the TV signal, the requirement for the distribution of stereo signals within the site of the OB will inevitably require more.

"In the future, digital transmission—terrestrial or DBS—is likely to be the norm, and with that in mind we would require more and more spectrum to satisfy our increasing needs there. In the nearish future, all live music TV OBs will be in stereo. The whole problem is a very, very difficult one—because what are our future requirements? You could say they are infinite.

"Meanwhile, with the imminent arrival of the new Bands I and III frequencies, the mobile radio wagon rolls on from strength to strength".

TABLE 3
CHANNELS IN USE CUTLERS' HALL/CRUCIBLE THEATRE, SHEFFIELD, 28 APRIL 1983

Ch No.	Use	From	To	Organisation
1	Production talkback	BBC OB vehicle MCR1	Crucible Theatre	BBC TV
2	Production talkback	BBC OB vehicle MCR2	Crucible Theatre	BBC TV
3	Production talkback	BBC News OB vehicle @ Cutlers' Hall	Cutlers' Hall	BBC TV
4	Production talkback	BBC News OB vehicle @ Cutlers'Hall	Cutlers'Hall	BBC TV
5	Production talkback	BBC OB vehicle MCR3	Cutlers' Hall/Crucible Theatre	BBC TV
6	Engineering talkback	BBC OB vehicles MCR1/2	Cutlers' Hall/Crucible Theatre	BBC TV
7	Engineering talkback	BBC OB vehicle MCR3	Cutlers' Hall/Crucible Theatre	BBC TV
8	Radio link control	BBC OB vehicles	Wincobank Hill+Holme Moss	BBC TV
9	Engineering talkback	BBC News OB vehicle @ Cutlers' Hall	Cutlers' Hall	BBC TV
10	Engineering talkback	BBC News OB vehicle @ Cutlers' Hall	Cutlers' Hall	BBC TV
11	Production talkback & cue	Cutlers' Hall	Radio Hallam	Radio Hallam
12	Production talkback & cue	Cutlers' Hall	ITN (on site)	ITN
13	Engineering talkback & cue	Cutlers' Hall	Radio Hallam	Radio Hallam
14	Production talkback & cue	Cutlers' Hall	Radio Hallam	Radio Hallam
15	Production talkback & cue	Cutlers' Hall	Radio Sheffield	Radio Sheffield
16	Radio link control	Yorkshire TV OB vehicles	Wincobank Hill	Yorkshire TV
17	Radio microphone	Roving microphone	Radio Hallam OB point on site	Radio Hallam
18	Radio microphone	Crucible Theatre	BBC OB MCR3	BBC
19	Radio microphone	Cutlers' Hall	Local radio car on site	Radio Sheffield
20	Radio microphone	Crucible Theatre	BBC OB vehicle MCR3	BBC TV
21	Radio microphone	Cutlers' Hall	Local radio car on site	Radio Sheffield
22	Radio microphone	Crucible Theatre	BBC OB vehicle MCR3	BBC TV
23	Programme sound	Cutlers' Hall	Radio Sheffield	Radio Sheffield
24	Sound talkback	BBC OB vehicles MCR1/2	Crucible Theatre	BBC TV
25	Production talkback & cue	Yorkshire TV OB vehicles	Cutlers' Hall	Yorkshire TV
26	Sound talkback & cue	Yorkshire TV OB vehicles	Cutlers' Hall	Yorkshire TV
27	Vision talkback & cue	Yorkshire TV OB vehicles	Cutlers' Hall	Yorkshire TV
28	Programme sound	Cutlers' Hall	Radio Hallam	Radio Hallam
29	Sound talkback	BBC OB vehicle MCR3	Crucible Theatre	BBC TV
30	Production talkback	Cutlers' Hall and remote hand-held camera located in adjacent office	Yorkshire TV OB vans	Yorkshire TV
31	Programme sound	Cutlers' Hall	Radio Hallam	Radio Hallam
32	Programme sound	Cutlers' Hall	Radio Hallam	Radio Hallam
33	Hand-held portable TV camera	Outside Cutlers' Hall	Yorkshire TV OB vehicles	Yorkshire TV
34	TV OB programme link	Wincobank	Emley Moor	Yorkshire TV
35	TV OB programme link	BBC OB vehicles @ Crucible	Wincobank Hill	BBC TV
36	TV OB programme link	BBC OB vehicles @ Crucible	Wincobank Hill	BBC TV
37	TV OB programme link	Wincobank Hill	Holme Moss	BBC TV
38	TV OB programme link	Wincobank Hill	Holme Moss	BBC TV
39	TV OB programme link	Cutlers' Hall	Wincobank Hill	Yorkshire TV
40	TV OB programme link	Wincobank Hill	Holme Moss	BBC TV
41	TV OB programme link	Wincobank Hill	Holme Moss	BBC TV
42	TV OB programme link	Cutlers' Hall	BBC OB vehicles @ Crucible	BBC TV
43	TV OB programme link	Cutlers' Hall	BBC OB vehicles @ Crucible	BBC TV
44	TV OB programme link	BBC OB vehicles @ Crucible	Wincobank Hill	BBC TV
45	TV OB programme link	BBC OB vehicles @ Crucible	Wincobank Hill	BBC TV
46	TV OB programme link	Cutlers' Hall	Yorkshire TV OB vehicles	ITN
47	TV OB programme link	Cutlers' Hall	Yorkshire TV OB vehicles	ITN

References *Bands I and III—A consultative document* (Cmnd 9241, HMSO)

RADIO XYZ 1990

Ted Fletcher

The power of the processor is limited only by the ingenuity of the software writer and this simple truism is only now becoming evident to those of us who did not grow up with the little darlings. Applications for computer control are similarly limited only by imagination and ingenuity. The technology of radio stations has by no means stood still. From the simple control systems of early Capital and LBC, the modern station has made use of improvement and rationalisation in the general electronics industry.

A light in the tunnel

Digital systems in the radio environment have had a start that can generously be called 'patchy'. Theatre lighting control and television have left the 'DC with ripple' brigade far behind. It is true that most new sound switching systems of any note at all incorporate some obeisance to binary, but a full frontal attack to make the tech op's job easier has only been made as an apology rather than a statement from the rooftops.

Unlike lighting or pictures, sound control by digits is neither obvious nor easy. We are still immersed in the unending debate on 'digital audio' or 'digital control of audio', so much so that many of us have just got bored with the whole thing and are carrying on as before. But there is some real sense emerging from the welter of misguided and subjective opinion and experiment. That is that analogue audio will be with us as a useful and much used medium for most of our lives, and that digital control is alive and growing both in minds and laboratories.

Logical Radio

In a small local radio station the main technical systems can be reduced to simple headings as follows:

- Contact with the outside: incoming lines from outside sources; outgoing lines to transmitters and cue feeds to sources.
- Processing: mixing and playing-in of local contributions; selection of studios and facilities; commercial production; programme preparation and recording; training and engineering maintenance.
- Communications: non-programme talkback between technical areas.

It is immediately noticeable that most, if not all 'contact with outside' and 'processing' functions are common to all technical 'mixer' areas. Outside sources and outgoing lines must be accessible to the on-air and preparation control rooms, and it would be an advantage to make them available to all areas in the interests of flexibility.

Mixing and processing are comparatively simple functions in radio, and the facilities required are again common to all areas with additional sophistication required in the production control room.

The odd man out is communications—where the system has to be dedicated, and should work as a 'stand alone' anyway so that any catastrophic breakdown would be limited to one system or the other.

Given this duplication, a centralised system starts to look attractive rather than causing images of severe pain in the wallet.

Radio XYZ-1990

A central switching matrix with both uni- and bi-directional paths is provided close to the line termination rack. It is computer controlled and may be accessed from all technical areas. This matrix controls all audio circuits to and from the radio station irrespective of type or priority (excluding telephone subcriber lines).

So far, this describes an 'outside source switcher', but it is a little more than that: It is the 'window on the world' of the whole system with very much more access on the radio station side than any present day system (with the possible exception of BBC Broadcasting House).

Central audio processing introduces the new thinking to the radio station. As all the audio circuits appear at a central point (grams and carts not presenting too much of a problem) it is only sensible to have the processing circuitry at one point.

Mixers

The central collection of 'mixers' consists of a single block of electronics within which are gain controllers, equalisers, switching systems and anything else that the heart desires.

This starts to sound complicated—it is! One immediately thinks of the whole technical facility as one gigantic complex matrix—the inference being that our wonder processors will 'sort it out' in the software. Most recent research has shown this to be a naive view if one is looking for economy rather than complexity for effect's sake. There are groups of functions in a conventional 'channel' that for operational reasons are always required in the same electrical 'place' in the system, so economies can be achieved by having as part of the central matrix, a bank of 'channel' analogues with their control systems pre-ordained.

The primary matrix provides both input and output routing to the 'mixers' and therefore simulates 'group' function as well as supreme monitoring flexibility.

All this leaves a pretty basic unanswered question: Should the microphone amplifiers be local to the room where the microphones are, or should they be centrally placed as part of the 'mixers'?

The traditionalists go for local with consequent dilution of concept. The hairy young graduates prefer to accept the inferred technical problems and mount centrally. The debate will continue. Even though viable solutions exist for both methods, neither is ideal. Either way, the amplified microphone signals are merely sources to the primary matrix with fine gain adjustment available as part of the 'channel' function.

The 'mixer' then contains all the elements of conventional mixers with implicit ability to perform functions like 'cleanfeed', 'auxiliary send', 'insert', 'voice over', 'programme/audition' and even multi-group and possibly 'inline' operation.

Control

The central processor has instant (within 10 milliseconds) access to any control function in the central frame yet spends most of its life sitting quietly looking for errors in the functioning of the system—ready to jump in and correct them.

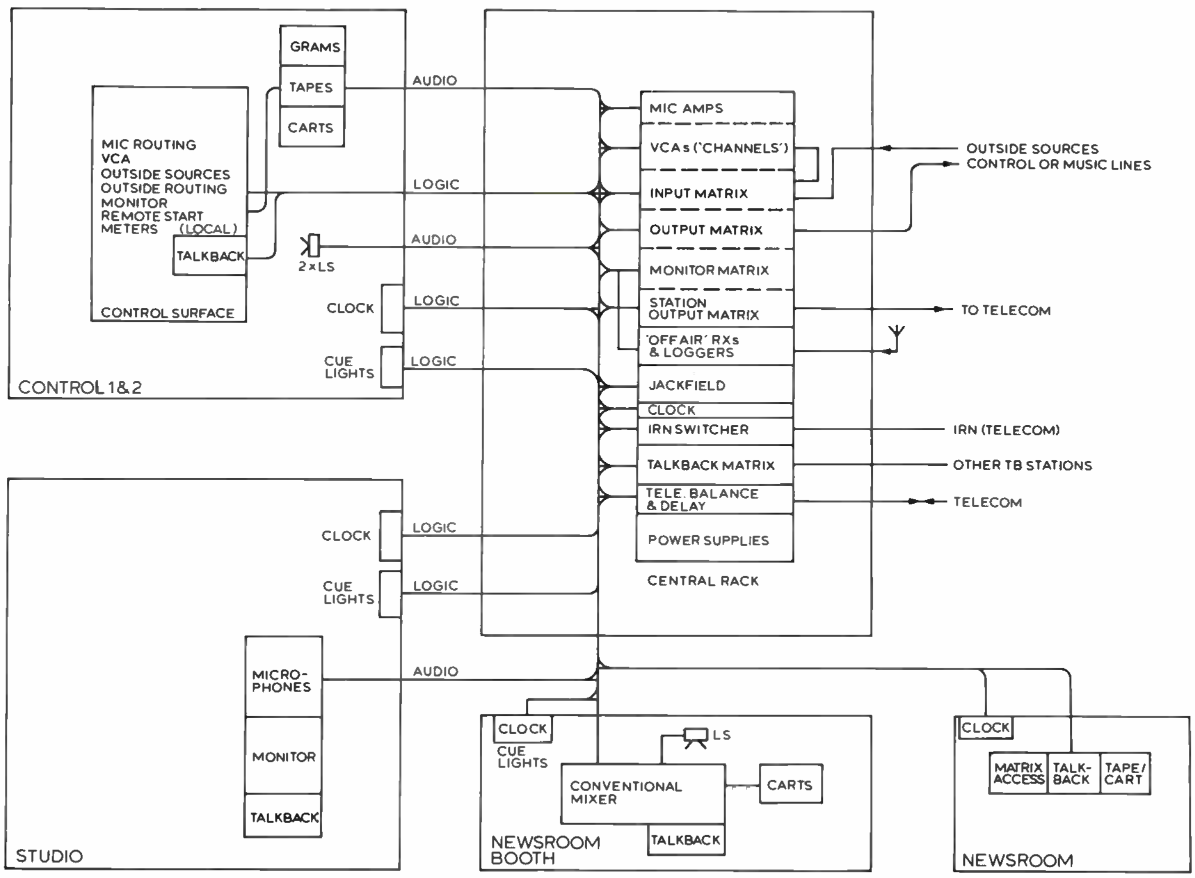
This is achieved by the use of a dynamic computer memory which is accessed by the operators via their controls and switches, and an operational memory which is directly linked to the electronic functions. The computer constantly scans the two memories and if it finds a difference, it changes the operational memory to mimic the dynamic RAM. This arrangement opens the door to a new world of operational speed and facility called 'presets'.

Already loaded on EPROM in the bowels of the computer frame are not only the low level operating systems and routines to make the beast alive, but also banks of data ready for instant up-loading into the RAM; these are the 'presets'. They can reconfigure the whole radio station at the press of a single button, making the Saturday morning change from record show to sports round-up in milliseconds. The number of presets is only limited by the cost of EPROMs, and eventually the software problems involved in dealing with extreme memory location addresses. In reality, 100 presets is not an impossible number.

Control surfaces

In each of the operational areas there is a control surface with an associated VDU. Its similarity to a conventional mixer is because ergonomic design has dictated that controls should be laid out in the conventional manner. Visual display of fader function (what it is controlling) can be provided above each fader with system displays, routings and levels on the VDU. System control is via dedicated buttons—the quickest way to frighten a technician is to give him a keyboard! As all the information to and from the surface is in digital form, its connection to the central computer can be via a few cores of unscreened wire, or down a fibre optic link.

The use of a VDU for most of the status information and also levels (light bar meters) adds to the flexibility of the system operation—what would the operator like to see? Almost anything is



Block diagram of a centralised radio station
The diagram shows a small radio station designed to operate in the Independent Local Radio network of the UK Independent Broadcasting Authority.
There are two control rooms operating each side of a central studio area, duplicating the 'on air' facility and allowing either control room to be a commercial production facility while the other is in transmission mode.
The newsroom booth is used as a general purpose 'carting' or programme preparation area and may be used for direct news inserts to programme. It does not form part of the central control system, but appears as a 'source' to the primary (input) matrix and derives its monitoring either from 'station output' or locally from its own mixer.
For clarity, the various matrix function 'headings' are shown separately although in practise they are combined to be electronically surrounding the 'Mixer' section (VCAs). The computer electronics are integral with the matrices and are accessed for programming update purposes via a plug-in computer terminal.
The jackfield is provided for test purposes and as a final output override in an emergency.
Note—this particular layout uses central microphone amplifiers—see text.

possible, including 'user accessible' text pages as prompts, play lists or commercial schedules.

Communications

As stated earlier, the talkback system is separate from the central mixer. This not only retains redundancy, but also has economic advantages. The operation of 'talkback' can use a simple bi-directional matrix with direct control of crosspoints, so why complicate the outside source matrix with an interlace of nasty old talkback. The other advantage of separation is the removal of the remotest chance of that bane of radio stations; crosstalk to programme.

Technical performance

In spite of the binary ballyhoo from Cambridge, who dares deny that 110 dB dynamic range with insignificant noise, distortion and crosstalk is adequate to drive a radio network that is at least an order of magnitude worse in all respects. 1990 (and even 1985) analogue technology reduces the function of the IBA code of practice to a fault finding exercise (or has it always been that?!). The limiting factors in any audio system, analogue or digital, are the source material (microphone, amplifier), the recording medium, and the output transducer. Ignoring the recording medium (where digital techniques are of course superior), the practical performance of analogue and digital are the same by definition—the only difference is the cost.

When referring to truly 'professional' equipment, we have arrived at the moment when the technical specifications for performance are meaningless to all but the designer.

The pain in the wallet?

The most significant expenses in conventional systems are in the complex metalwork required for console shape and ergonomics, and the sheer mass of complicated wiring behind inconveniently shaped panels.

Radio station XYZ will have slightly less than one 6ft rack unit stuffed with balanced audio circuits looping across arrays of 'eurocard' sockets (wonderful to wire!) and two little rack units of processors, ports, EPROMs, RAMs and interfaces—the whole lot tied together with enough ribbon for a society wedding.

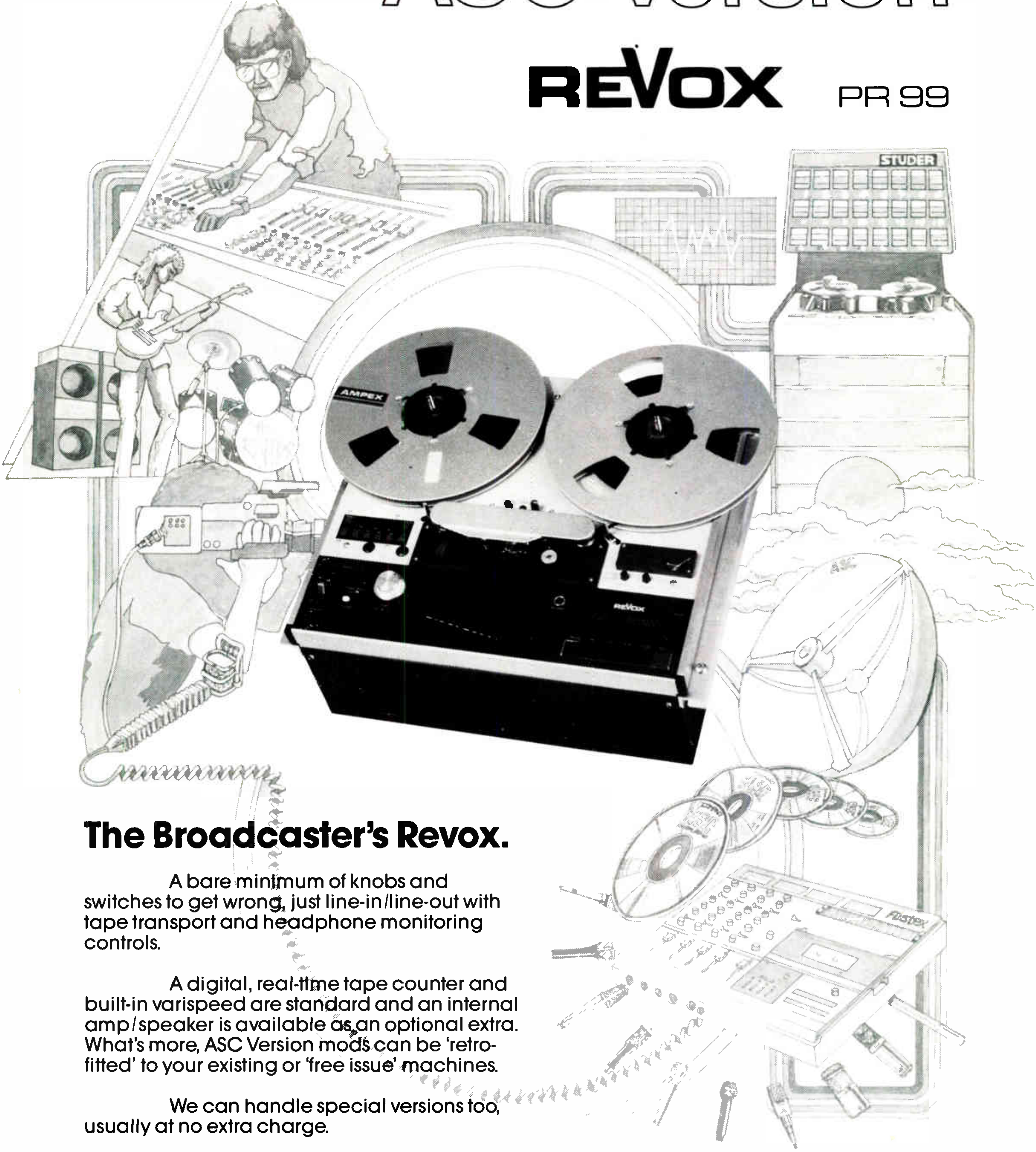
Initial cost calculations put the complete system at about the same as the equivalent conventional system (or a bit less). So who is going to take the plunge?

Postscript

Descriptions and comments above are in many places intentionally sketchy and incomplete as the systems postulated are already in development and some protection is necessary for the hours of development work and thinking that are speculatively spent.□

ASC Version

REVOX PR 99



The Broadcaster's Revox.

A bare minimum of knobs and switches to get wrong, just line-in/line-out with tape transport and headphone monitoring controls.

A digital, real-time tape counter and built-in varispeed are standard and an internal amp/speaker is available as an optional extra. What's more, ASC Version mods can be 'retro-fitted' to your existing or 'free issue' machines.

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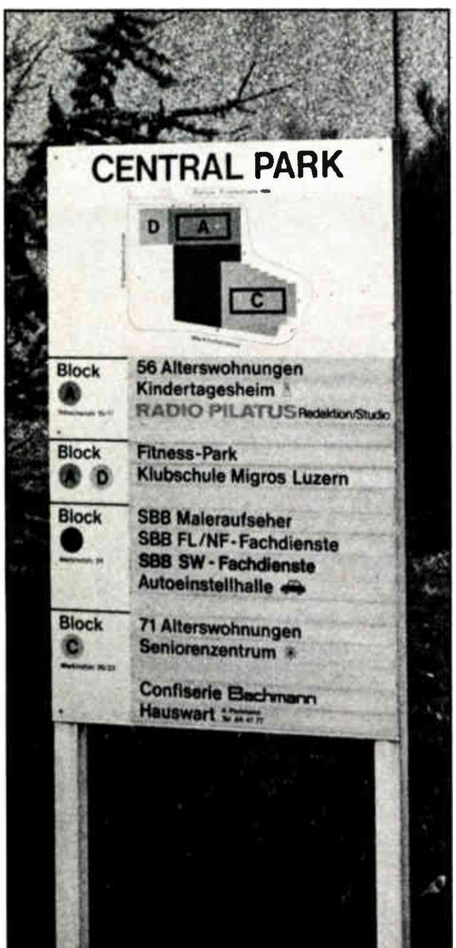
SWISS LOCAL RADIO ONE YEAR ON

Nigel Cawthorne

Although officially not yet born, Swiss local radio has just celebrated its first birthday. Nigel Cawthorne looks at the larger picture (and the problems) via one small station.



Local radio in Switzerland is still in its infancy. Radio Pilatus, one of the 27 newly licensed stations, was just one year old in December 1984.

Taking its name from a local mountain, it provides a 24 hour VHF stereo service and its signal covers a population area of about 220,000 in and around the city of Luzern in central Switzerland.

Local radio has been slow to take off in Switzerland; in fact, officially it has yet to take off, because the current operating licences that have been issued by the PTT are termed as test licences only. Radio Pilatus's licence is valid for five years to the end of 1988.

Its offices and single studio are near the centre of the picturesque and medieval city. A stereo quality PTT leased line carries the programme signal up to the 100 W FM transmitter installation which is sited in a hotel on the local mountaintop of Sonnenberg Kriens.

Being in the heart of a mountainous region, the exact range of the 100 W transmitter in a given direction depends very much on the local terrain. However coverage is claimed to include parts of the inner Swiss cantons of Luzern, Nidwalden, Schwyz and Zug.

The number of staff at Radio Pilatus totals ten, made up of seven programming staff, one secretary, one technician and one advertising manager. The programming staff interchange between programme presenting and local reporting. The station is managed by a board of six part-time directors from the local community.

Advertising

Kurt Vonwil is the advertising manager. His job could be decribed as squeezing juice out of a very small lemon! Swiss local radio is allowed by law only 15 minutes of advertising per day. Radio advertising is a new phenomenon in Switzerland, because the Swiss national radio services do not carry any. The local radio stations are the first to break into this field. However local radio operators feel very restricted by this '15 minute' rule.

There are also restrictions on the type of advertising material that is carried. The rules set down in the provisional test licences stipulate that there should be no more than five minutes of advertising in any one hour. Programmes are not allowed to be broken in order to insert advertising. The advertising may only come between programmes. No advertising may be transmitted on Sundays or on national holidays. The list of forbidden advertising includes alcoholic drinks, cigarettes, jobs, medicines, banks or credit institutions, second hand items, animals, accommodation and soap powders!

Radio Pilatus schedules its small amount of advertising in spots at three minutes before the hour and half-hour. But with only 15 minutes of advertising per day allowed, this works out at an average of less than one minute per hour. At Radio Pilatus a 10 second spot costs 80 SFr (£27) with a full 60 second spot costing 480 SFr (£160).

Programming

Radio Pilatus produces 18½ hours of its own programming from 0530 to 2400. During the small hours it relays the national radio service for which it pays a fee of 16,000 SFr (£5,300) per year.

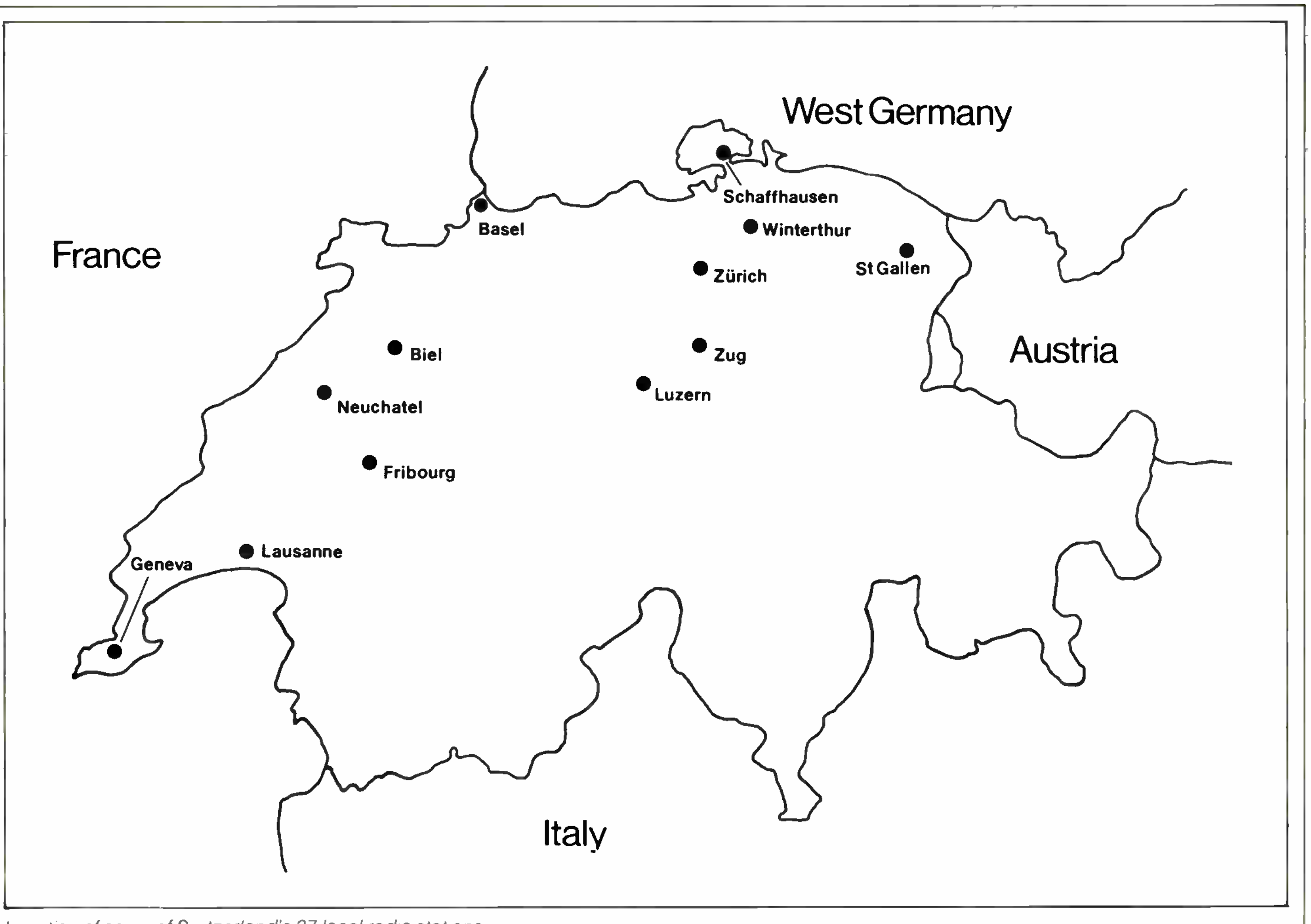
Radio Pilatus's own programming is a mixture of local news, music request programmes and special interest programmes for groups such as young people, pensioners, housewives and drivers. Between 20 and 50 music request postcards are received every day. Being a local station, all programming is in the Luzern Swiss/German dialect.

Languages

Switzerland is a country of multi-linguists. With four national languages packed into a very small area, visitors to Switzerland never cease to be amazed at the ease with which the Swiss are able to switch from one language to another. However within Switzerland itself the language boundaries are very sharply defined. Crossing over from one canton to another often means a change of language. The 27 newly licensed local radios are split between the German speaking and French speaking parts of Switzerland. Of the 27, 16 are in German-speaking Switzerland and 11 in the French-speaking cantons.

Severe constraints

Operating under the very strict limitations imposed by the licence, particularly the amount of advertising that they are allowed to carry, Swiss local radio stations may not be seen as



Location of some of Switzerland's 27 local radio stations

commercially viable in the short term. Thus, there is strong lobbying by the local radio operators to have some of the restrictions lifted. These include the restriction whereby signals from local radio stations may not be relayed by cable services outside the immediate coverage area of the local radio station.

As well as extending the time allowed for advertising, local radio operators want to see the range of advertising allowed extended to include jobs, accommodation, second-hand items and banking services. It is argued that the addition of these types of advertising would increase the quality of service offered to the local community. Local radio operators are also pressing for an increase in the daily total of minutes allowed from 15 up to at least 20, with the possibility of having seasonal adjustments, whereby an average daily total could be used rather than a strict day by day total. Local radio station operators would also like to be able to transmit adverts during programming which is itself a retransmission of another broadcasting authority.

Kurt Vonwil believes that there will not be any significant change in the ground rules under which local radio operates in Switzerland before the present provisional test licences are replaced by permanent broadcast licences. These are not due for renewal until the end of 1988. Will four more years be four more years too late?□

Radio Pilatus on-air

Do it all with a Stellavox!

The New SU-8 Universal Portable Tape Recorder.

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* Mono Centre Stripe.
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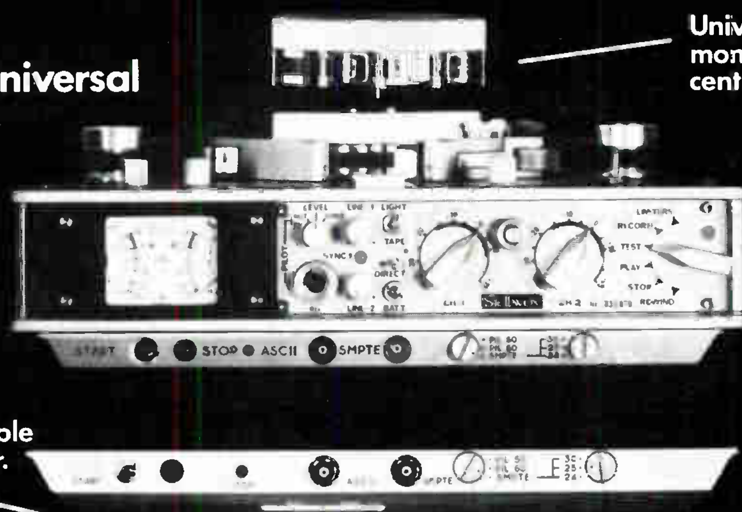

Universal headblock mono/stereo neo-pilot, centre stripe.

SU-8 Machine base 4kg including batteries.

ATC Option removable time code generator.

The lightweight alternative with even more heavyweight features.

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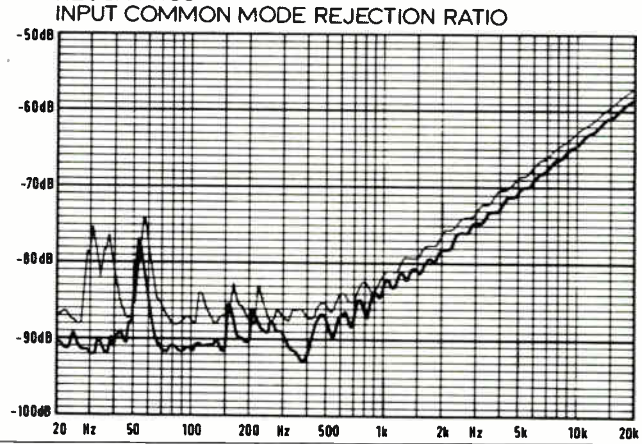
Revox/ASC PR99

Hugh Ford

ASC VERSION

Take a standard Revox *PR99* and remove all knobs, buttons and meters (except h/phone level control and tape transport – speed change buttons optional), fit new, custom made, front panel minus superfluous holes, replace stereo headphone monitor socket with GPO 'B' pattern same, remove case and fit access door to prevent 'preset' alignment twiddling, spray modified case black, scratch resist finish, add separate monitoring amp (off-tape/source). Extras to go with the *PR99*, ASC version: retro-fit plug-in repro-amp c/w tweaks for equalisation, both speeds, to accommodate headwear etc, H.MM.SS digital tape timer, built-in Varispeed, fine/coarse, built-in monitor amp and speaker.

FIG.1
REVOX PR99
INPUT COMMON MODE REJECTION RATIO



MANUFACTURERS SPECIFICATION

Tape transport mechanism: 3 motor tape drive. 2 AC driven spooling motors. 1 AC driven capstan motor, electronically regulated.

Tape speeds: 3¾ in/s and 7½ in/s or 7½ in/s and 15 in/s.

Tape speed tolerance: ±0.2%.

Varispeed with external accessory: low speed version 2.5–11 in/s, high speed version 5–22 in/s.

Wow and flutter (DIN 45507): at 3¾ in/s less than 0.1%, at 7½ in/s less than 0.08%, at 15 in/s less than 0.06%.

Tape slip: maximum 0.2%.

Reel size: up to 10½ in diameter (min hub diameter 2.36 in); tape tension switchable (for small hub diameters).

Winding time: approximately 120 sec for 2500 ft of tape.

Tape transport control: integrated control logic with tape motion sensor provides for any desired transition between different operating modes. Contactless electronic switching of all motors. Remote control of all functions and electric timer operation are possible. Fader start facilities. Tape dump mode.

Equalisation: 3¾ in/s – NAB 90–130 µs, 7½ in/s and 15 in/s–NAB 50–3180 µs.

Frequency response: at 3¾ in/s – 30 Hz to 16 kHz +2/–3 dB; 50 Hz to 10 kHz ±1.5 dB. At 7½ in/s – 30 Hz to 20 kHz +3/–3 dB; 50 Hz to 15 kHz ±1.5 dB. At 15 in/s – 30 Hz to 22 kHz +2/–3 dB; 50 Hz to 18 kHz ±1.5 dB.

Frequency response of guide track reproduction: at 15 in/s – 100 Hz to 12 kHz +2/–3 dB. At 7½ in/s – 100 Hz to 8 kHz +2/–4 dB.

Operating level: 250 nWb/m OVU.

Level metering: VU meter in accordance with ASA standard plus LED peak level indicators (6 dB above operating level, adjustable).

Distortion:

	at	OVU	OVU+6 dB
	nWb/m	250	500
	3¾ in/s	<1%	<2.5%
	7½ in/s	<0.6%	<1.5%
	15 in/s	<0.6%	<1.5%

Signal to noise ratio (measured via tape, ASA-A weighted referred to 500 nWb/m): half track at 3¾ in/s >63 dB, half track at 7½ in/s >66 dB, half track at 15 in/s >66 dB.

Crosstalk (at 1000 Hz): stereophonic – better than 45 dB, monophonic – better than 60 dB.

Erase depth: at 7½ in/s better than 75 dB (1 kHz).

Line inputs: balanced. Input impedance ≥5 kΩ. Calibrated: +4 dBu (adjustable –10 to +10 dBu, referred to operating level). Uncalibrated: sensitivity external variable up to 10 dB above calibrated input. Maximum line input level: +22 dBu (>40 Hz).

Microphone inputs: unbalanced. Input impedance 100 kΩ. MIC LO –70 dBu (maximum –24 dBu). MIC HI –42 dBu (maximum +4 dBu).

Option: microphone inputs balanced. Input impedance >1.2 kΩ, 40 Hz to 15 kHz. MIC LO –82 dBu (maximum –36 dBu). MIC HI –54 dBu (maximum –7 dBu).

Output per channel: line outputs balanced (source impedance 50 Ω. Calibrated +4 dBu (load 600 Ω). Adjustable –20 to +9 dBu, referred to operating level. Uncalibrated – output level external variable up to 10 dB above calibrated output. Maximum line output level +22 dBu/600 Ω, +20 dBu/200 Ω.

Connectors: remote control of tape transport functions. Remote control of variable tape speed. Fader start.

Electric current supply (voltage selector): 100 V, 120 V, 140 V, 200 V, 220 V, 240 V. 50 Hz to 60 Hz, maximum 90 W.

Primary power fuse: 100 V to 140 V, 1 A slow-blowing. 200 V to 240 V, 0.5 A slow-blowing.

Weight: 18.5 kg (40 lbs 12 ozs).

Ambient temperature range: +7°C (+40°F) to +40°C (+104°F).

Working position: any, between horizontal and vertical.

Manufacturer: Willi Studer, CH-8105 Regensdorf, Switzerland.

Audio Systems Components Limited (ASC), 4a King Street, Mortimer, Reading, Berkshire, UK.

While the Studer/Revox *PR99* is a standard semi-professional machine complete with associated facilities, the ASC version is modified for broadcast and similar uses where the semi-professional facilities are a hinderance.

Thus ASC removes all the front panel audio controls except the A/B monitoring switch and the headphone monitoring level control. In addition the level metering is removed and the mechnical tape timer replaced with a rather more sophisticated device.

The position of the original tape timer is used for the added varispeed facility in addition to which a modified replay amplifier is fitted – this includes replay equalisation and replay level presets for both speeds – the original version only having a single pair of level controls and no equalisation controls.

In the ASC version a new top panel is fitted to conceal the holes where components have been removed, and a hinged section is fitted to the main case to discourage knob twiddlers from attacking the preset controls.

Effectively these features are options which may be retro-fitted to existing machines, as may an internal loudspeaker and monitoring amplifier.

Also available is a solid trolley which accepts any rack mount equipment including the *PR99*, which can be rotated through 360° for servicing, editing or operation at any angle.

Turning to the tape transport, this is typical of several Revox models, being based on a fairly substantial alloy casting. The AC reel and capstan motors bolt directly to the casting with the head area components being supported on a separate casting which bolts to the main casting.

The electronically controlled reel motors are fitted with solenoid operated band brakes working on brake drums onto which are screwed fittings for cine type spools – adaptors being necessary for NAB spools which may have a maximum diameter of 10½ in.

From either spool the tape passes over a spring loaded tension arm before entering the head area which starts with a 19 mm diameter ball bearing roller guide, the width of which is shimmed to be just on the nominal tape width.

Next in the tape path there is an infrared tape presence detector before the stereo track format ferrite erase head. This could well have been replaced with a full track erase head as crosstalk can occur if a tape has been previously used full track without subsequent bulk erasure.

Metal stereo format record and replay heads follow before the fixed ceramic sided edge guide and the 9.06 mm diameter capstan which is an integral part of the long shaft capstan motor (A 4.51 mm capstan is fitted to the low speed version). Capstan speed is servo-controlled via a magnetic tachometer pickup but is not referenced to a crystal or the power line frequency.

The head mounting is a stable spring loaded arrangement. The replay head has a hinged screen which comes into position in the replay mode. So do the tape lifter pins on either side of the audio heads in the fast modes, the actuation being via the substantial pinch roller solenoid mechanism. A 'slide switch' lever near the head block allows the tape lifters to be inhibited for editing in the fast modes where rock and roll editing may be employed. Reverting to the play mode reactivates the tape lifters.

Finally, at the exit from the head block an approximately 19 mm diameter roller drives an optical tachometer used as a tape move sensor for the control logic and for the tape timer in the ASC version.

ASC fits the varispeed unit between the reels. This comprises a pushbutton in/out switch with a red warning LED and a potentiometer speed control. To the lower right of the transport section a small splicing block was fitted next to the reel size switch. This switch, as standard, alters the reel motor torque to cater for small and large diameter hubs.

FIG. 2
REVOX PR99
15 in/s RECORD/REPLAY FREQUENCY RESPONSE

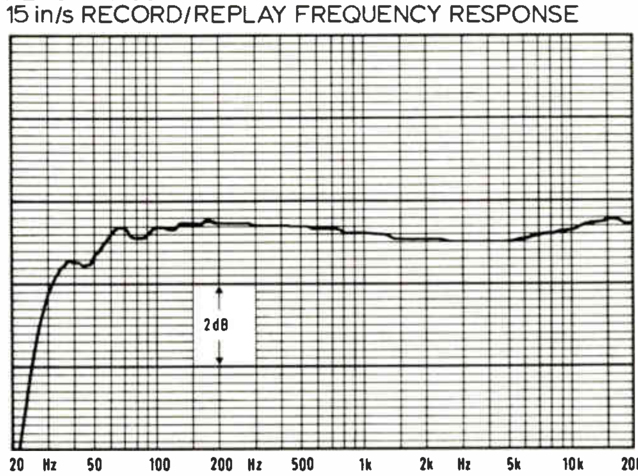
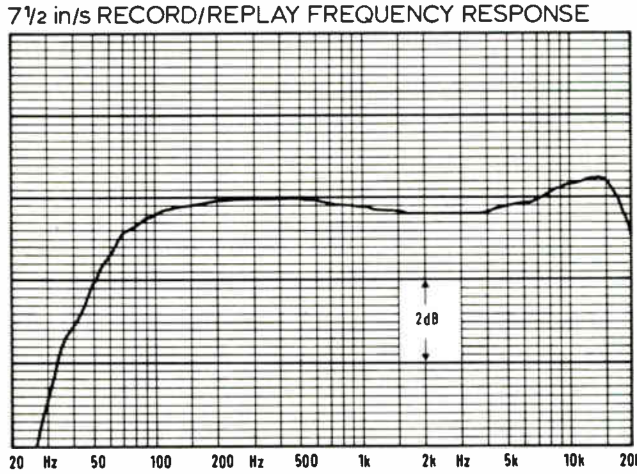


FIG. 3
REVOX PR 99
7½ in/s RECORD/REPLAY FREQUENCY RESPONSE



In practice, tape tension at the beginning of a correct size reel was satisfactory for standard play tape at 80 g, but as constant torque motors are used this fell to about 40 g at the end of a reel – more modern designs achieve constant tension.

Next to the tension switch a second locking pushbutton provides a tape dump edit function – this could well be associated with a warning lamp and more interlocking, as not only can one easily enter play by mistake in the dump edit mode, but funny things can happen if dump edit is punched in fast wind or record modes.

In a similar position to the left of the machine are synch/repro-locking buttons for the two channels. These did not appear to be active in the review machine.

Above these buttons is the modified tape timer working from tach pulses from the tape move sensor, this being a vast improvement on the original mechanical position indicator. The timer indicates H,MM,SS positive or negative time and automatically updates itself if the tape speed is changed such that the tape positions are retained in the stores.

Momentary pushbuttons control the timer which has two time stores; the zero locate store and a tape position 'A' store.

Pressing a reset button resets the zero locate store. Pressing ZERO-LOC or A-LOC locates the appropriate tape positions. The time in the 'A' store can be set in a number of ways, by pressing a TRANS button on the fly or with the tape static or by using three further switches. Pressing SET allows the timer indication to be adjusted by means of a STEP button, which increments one digit, and a SET button which selects the desired digit. The desired setting can then be transferred to store 'A'.

Finally in this section, a repeat button allows the section of the tape between zero and the time in store 'A' to be repeated indefinitely.

To the bottom right the common tape movement controls are fitted together with a red record activated lamp. A momentary pause button which operates in record or replay is also fitted. It is possible to enter record at tape time zero by using the repeat function while pressing record.

The remaining front panel features are optional tape speed buttons allowing 15 and 7½ in/s for the high speed version or 7½ and 3¾ in/s for the low speed version, an A/B monitor switch and coaxial monitor level control working with the headphone jack – a GPO type 'B' jack replacing the original in the ASC version.

Removing two non-captive (why not captive – anyone heard of cracks between floor boards?) self tapping screws allows the front panel to be hinged down to give access to the preset controls located on the plug-in printed circuit boards.

All controls are 270° type skeletons operated by a screwdriver through holes, which were none too well aligned with the controls. The normal PR99 includes record bias controls and equalisation controls for the two channels at both tape speeds plus a record level control and sync level control for each channel.

Normally the replay department only has a level control for each channel, but the ASC version is modified to include level and equalisation controls for each channel at each tape speed – a useful improvement.

To the rear the line inputs and outputs are at balanced XLR connections with the original microphone inputs being blanked off. Other than this the interfaces are standard with the facilities including fader start, remote speed control, remote tape movement control and an external monitor connection.

Within the unit the standard of construction is semi-professional but tidy, with all boards being plugged rather than soldered into place. While full circuits were included for the original machine no details of the modifications were provided and none of the boards had component identifications to ease servicing. Furthermore, no information was included about mechanical servicing or parts.

In operation, other than the noise from the pinch roller solenoid, the machine was quiet. Tape handling was quite good except in the fast wind modes where the tension was low at times resulting in a loose wind and leafing particularly

FIG.4 REVOX PR 99
REPLAY EQUALISER RANGE 15 in/s

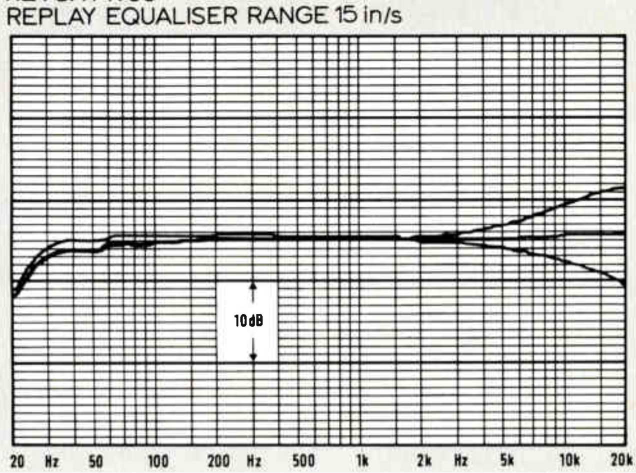


FIG.5
REVOX PR 99
REPLAY EQUALISER RANGE 7½ in/s

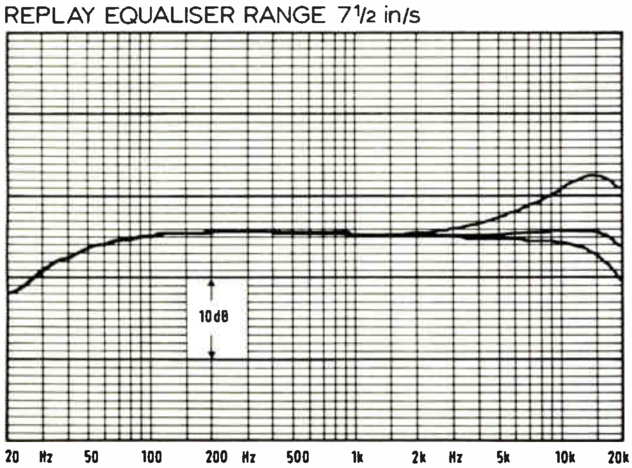


FIG.6
REVOX PR 99
RECORD EQUALISER RANGE 15 in/s

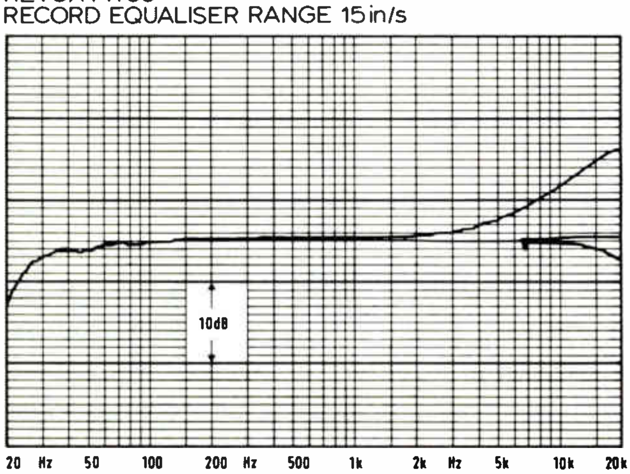
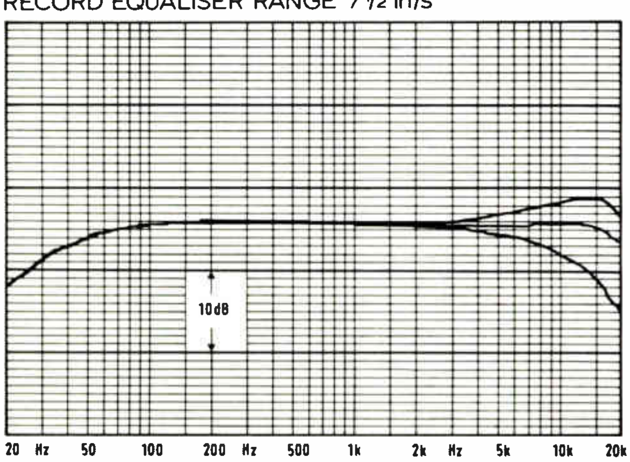


FIG.7
REVOX PR 99
RECORD EQUALISER RANGE 7½ in/s



with some tapes, those without a matte back being worst.

Access to the heads for editing is good but I found the dark grey material of the splicing block a disadvantage when splicing dark coloured tape as it was difficult to see the gap when butting-up the ends.

Inputs and outputs

The balanced audio inputs had an impedance of 6.25 kΩ with a maximum input level capability of +22.5 dBm and a good common mode rejection performance, as shown in **Fig 1**.

The input sensitivity for recording 320 nWb/m on 3M type *206* tape could be set to a maximum of −7 dBm with the controls being of the full range type.

As received, the outputs delivered +5 dBm with the output level controls having a range from −4 dBm to +11 dBm from a source impedance in the order of 75 Ω. A similar level was available at the unbalanced monitor outputs from a source impedance of 270 Ω.

The headphone monitor jack could deliver +18.5 dB.7V into an open circuit from a source impedance of 220 Ω with the gain being such that the output could be clipped from a recorded flux of 320 nWb/m.

Frequency response

As received, the replay frequency response at 15 in/s corresponded to the CCIR 35 μs standard with that at 7½ in/s being well out of adjustment to any standard. The label on the rear of the machine incorrectly indicates that it was set to the NAB standards. In addition to this the heads and guides were particularly filthy, needing three double ended cotton buds to clean them.

Using BASF calibration tapes the replay equalisation was readily adjusted to within ±0.5 dB up to 20 kHz at 15 in/s or 18 kHz at 7½ in/s. The available range of the equalisers at the two tape speeds is shown in **Figs 4** and **5**, these being quite satisfactory.

Having set the bias to the manufacturer's recommendation of 3 dB over bias at 15 in/s and 5.5 dB over bias at 7½ in/s, both at 10 kHz, using 3M type *206* tape the record/replay frequency response could be adjusted very flat, as shown in **Figs 2** and **3**. The range of the record equalisers varied widely for the two tape speeds, as shown in **Figs 6** and **7** with the range being rather unnecessarily wide at 15 in/s. Both the record equalisers and the bias adjustments were rather sensitive and accurate settings required great care.

Checking the response from the inputs to the headphone output showed this to be flat, as it was to the monitor output.

Distortion

Third harmonic distortion at 320 nWb/m with 3M type *206* tape biased as above was 0.75% at 15 in/s or 0.6% at 7½ in/s for both channels, with the second harmonic being about 15 dB lower.

Three percent third harmonic occured at +4.5 dB ref 320 nWb/m at 15 in/s or +4.0 dB at 7½ in/s, with the second harmonic again being on the high side, even after degaussing the machine. The maximum head drive capability was satisfactory at +16 dB reference, the drive required to record 320 nWb/m on 3M *206*.

Distortion from the line inputs to the headphone monitor output was minimal at any level below clipping and at any frequency, being

Table 1

Measurement method	15 in/s Tape	15 in/s No tape	7½ in/s Tape	7½ in/s No tape
	320 nWb/n to noise			
22 Hz to 22 kHz RMS	60.5 dB	63.5 dB	61 dB	64 dB
A weighted RMS	65.5 dB	71.5 dB	65.5 dB	71.5 dB
CCIR weighted RMS	57.5 dB	64.5 dB	57 dB	64.5 dB
CCIR weighted quasi-peak	53.5 dB	60.5 dB	53.5 dB	61 dB
CCIR/ARM ref 2 kHz	65.5 dB	71.5 dB	64.5 dB	71.0 dB

less than 0.01%.

The replay electronics could happily cope with + 14 dB above 320 nWb/m giving a satisfactory margin for all existing tape types.

Noise

Noise was measured in the outputs referred to 320 nWb/m with and without tape to determine the available margin between machine noise and the noise from machine erased 3M type *206* tape without any audio signal.

Both channels gave a virtually identical performance at each tape speed, so **Table 1** refers to either channel.

Provided that the machine was kept a reasonable distance from stray fields, transformers etc, hum in the output was at a low level and no other unwanted signals were present.

While the overall noise performance is adequate, this is certainly not the quietest of modern machines, with good machines offering a 10 dB margin between machine noise and a biased tape noise.

Wow, flutter and speed

Wow and flutter to the IEC peak weighted standard was measured at the beginning, middle and end of a full NAB reel of 3M *206* tape at both tape speeds with the machine vertical in **Table 2**.

Table 2

Tape speed	Peak weighted wow and flutter Beginning	Middle	End
7½ in/s	0.10%	0.08%	0.10%
15 in/s	0.03%	0.035%	0.03%

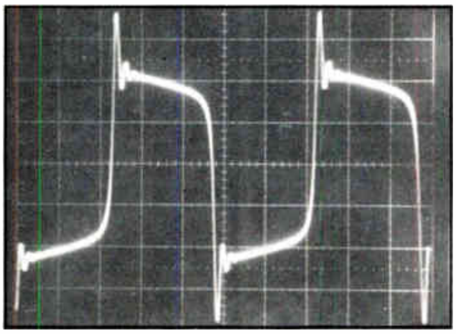
Having regard to the excellent results at 15 in/s, the 7½ in/s performance was disappointing. However, with the machine in the horizontal plane the results improved to around 0.07%.

The relation between the two speeds was to within better than 0.01%, with the drift from one end of a reel of tape to the other being 0.025%.

The variable speed facility offered 4.9 to 11.37 in/s in the 7½ in/s setting or 9.8 to 22.75 in/s in the 15 in/s setting – a very wide range which will probably find little use.

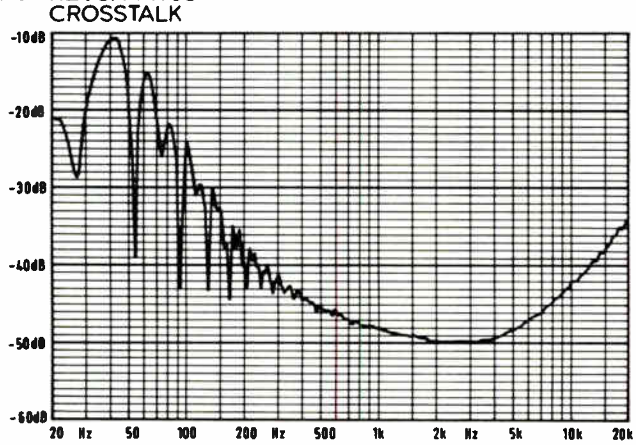
Other matters

The result of recording and replaying a 1 kHz square wave at 15 in/s is shown in **Fig 8** and was the same irrespective of output loading.



Erasure at 1 kHz and 15 in/s was good at greater than 90 dB with the crosstalk between the two channels in the record/replay process, as shown in **Fig 9**.

FIG.9 REVOX PR99
CROSSTALK



Summary

The ASC version of the Revox *PR99* makes this semi-professional machine much 'safer' for professional use in broadcast and similar applications where many of the original facilities just lead to operational errors.

When judging this machine it is important to consider that a fully professional machine is very much more expensive. Performance and the life of the machine will be better, but, in many applications the extra cost cannot be justified.

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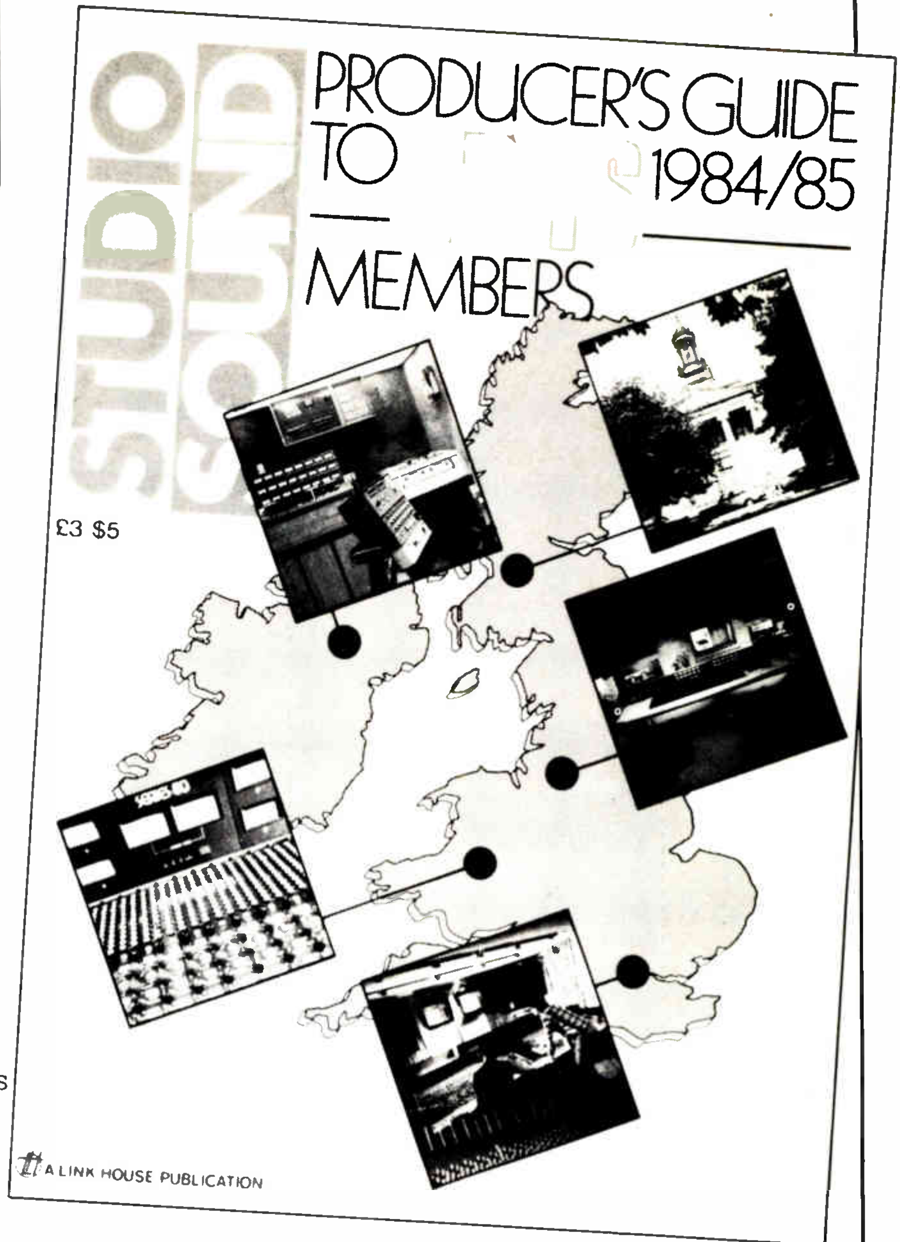

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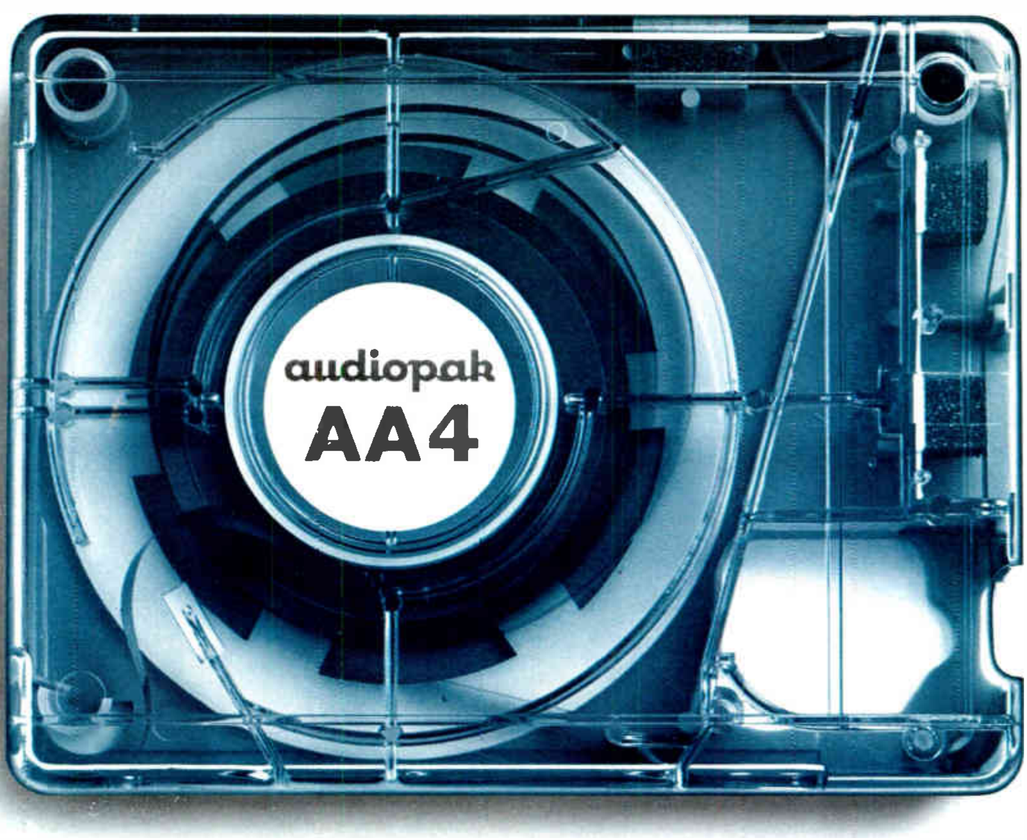

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