REEL THOROUGHBRED—THE STUDER A810

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The advent of new technologies does not necessarily mean that existing techniques are immediately rendered obsolete, a prime example of this in the audio world being that digital does not mean the death knell of the traditional analogue tape recorder. At least, not for the present. With all it's possibilities, digital recording still means a costly investment in a product that is still very much in its evolutionary stages. At the same time the demands of modern recording have increased greatly due to a greater awareness on the part of the people who make the recordings, the audio industry, and the people who listen to—and buy—the end product. While modern equipment can produce very satisfactory results there is always room for improvement and it is with this thought in mind that the Studer *A810* tape recorder was developed.

On the face of it, modern technology has a lot to offer tape recorder design in the way of microprocessors, CMOS chips, new construction materials, rationalised production, etc, at the same time combining the far from negligible aspect of availability and decreasing prices. Rather than rehash existing concepts and techniques, the time was ripe for a return to first principles and a whole new approach to tape recorder design. What is the purpose of a tape recorder and what does it do? Pretty stupid sort of question you may think, but give it a little thought and it is not so silly after all. We need a machine that transfers audio signals onto magnetic tape with the highest possible fidelity and with the capability of recording them with that same fidelity. The design target is now different. It is not 'how can I improve on an existing machine', but a brief to design a tape recorder that uses modern technology and can meet the strenuous demands of today's recording and broadcast industries. The only resemblance with previous machines being that it uses reels, three motors and tape heads.

Design brief

Undertaking the design of a new product involves the establishment of all possible user requirements, plus a few more that the user has not thought about yet! In the case of the *A810*, the design requirements were the following:

- compact 19 in rack mount size;
- no compromise user facilities for all

Table 1a shows the advantages and disadvantages of both electronic (transformerless) and magnetic (with transformer) balancing methods. The choice of one solution rather than the other can be made by taking into account the definitive field of application of the corresponding unit. Table 1b helps to decide whether to go transformerless or not.

TABLE 1a

Parameter (line output amplifiers)	Transformer	Transformerless
Frequency response	••	•••
Intermodulation, IMD	••	•••
Harmonic distortion, THD	••	•••
Transient intermodulation, TIM	•••	••
Phase modulation distortion ØMD	•	•••
Phase response	•••	•••
Radiated stray-field	••	•••
Common mode rejection ratio CMRR	•••	•••/••
Safety	•••	••
Common mode rejection range	•••	•/••

TABLE 1b

Field of application	Transformer	Transformerless
Disc recording studio	••	•••
Mastering studio	•	•••
Film production	•••	•
Film-audio post-production	••	•••
Video production	•••	•
Video-audio post-production	••	•••
Radio live recording	•••	•
Radio broadcasting	•••	••
Logging	•••	•

••• very good, •• average, • poor

FIG 1
TAPE TRANSPORT AND AUDIO ELECTRONICS MICROPROCESSOR CONTROLLED FUNCTIONS

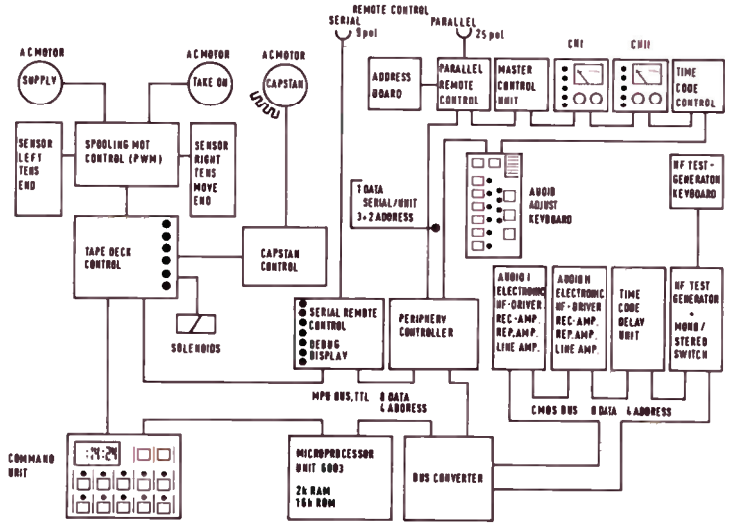


FIG 2
SCHEMATIC TRANSFORMERLESS BALANCED AND FLOATING LINE INPUT

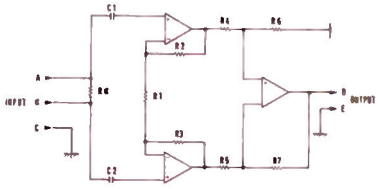


FIG 3
SCHEMATIC TRANSFORMER BALANCED AND FLOATING LINE INPUT

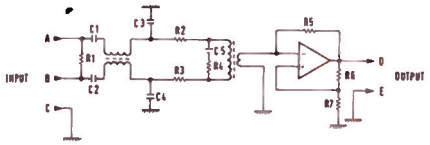
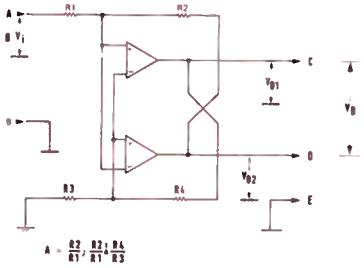


FIG 4
SCHEMATIC TRANSFORMERLESS BALANCED AND FLOATING LINE OUTPUT



operating modes;
- highest possible audio quality;
- extremely easy servicing enabling maintenance to be carried out by non-service engineers (not every audio facility can afford an in-house service dept);
- tape transport to be highly accurate and very reliable;
- basic design to permit a wide range of easily available configurations;
- easy conversion from one version to another;
- the machine to be of low to medium cost resulting in an extremely favourable quality price ratio.

Design solutions

The design brief having been established, the requirements were solved in the following manner.

Compact size. This was realised by the use of a special light alloy diecast chassis, this being the only way to fulfil the requirements for high precision machine tooling with light weight and high stability over long periods of time. Studer have long experience in this kind of chassis and have developed metallurgical techniques where the metal is 'aged' and is thus immune to instability, while at the same time keeping costs to reasonable limits.

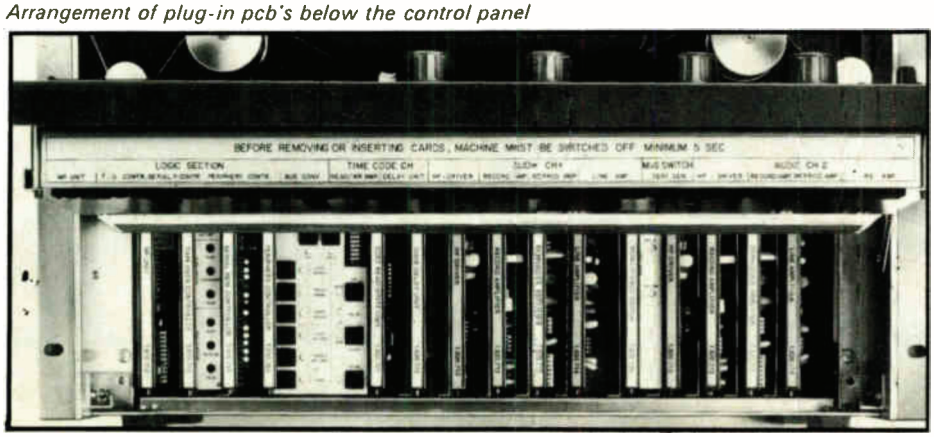
User facilities. The emphasis was on the need for the machine to adapt to the operator and not the reverse. This meant that the push buttons on the front panel had to be kept to the minimum whilst retaining full flexibility. Research showed that the ideal number of controls varied between 10 and 13; the *A810* uses 12. However, the machine has roughly 20 different functions of high importance to the user and this has led to the control 'keyboard' being split into two groups of buttons, one featuring fixed programmed functions and the second with user programmable possibilities (see **Fig. 1**). This ensured that maximum flexibility was guaranteed.

All tape transport and audio switching operations are microprocessor controlled (Ah! The mighty micro!) with all programs being in EPROM. The transport features no less than four speeds. $3\frac{3}{4}/7\frac{1}{2}/15/30$ in/s, each having individually programmable equalisation and adjustments. Two tape types (A and B) are selectable at the touch of a button for all speeds and equalisations, as are NAB/IEC characteristics for all speeds and types of tape. Once on the transport the tape is fully protected from all eventualities (if you drop it on the floor between the tape cupboard and the machine, that's your problem) such as power failures, loose winding, mis-threading or whatever other abuse you can think up. Computers are now a part of daily life and the *A810* is no exception being optionally equipped with a socket to connect any computer terminal to the machine using RS232 or RS422 codes. The software and hardware have been designed to enable full machine remote control, either parallel (basic functions only) or serial RS 232/422 (all functions).

Audio quality. To meet the standards imposed, totally new audio electronics were required. These feature extremely low-noise circuitry with high headroom/low distortion characteristics. Transformerless fully floating and balanced input and output stages are available, as well as more conventional transformer stages (see **Tables 1a, 1b,** and **Figs 2, 3, 4**). A significant design feature is the use of totally phase compensated circuitry with cascaded all-pass filters to ensure proper time delay compensation instead of simple signal polarity reversal, making for record/reproduce capabilities of the highest quality. For complete serviceability, all audio circuitry is mounted on 100 × 128 mm pcb's, with each channel having separate cards for HF driver, record amplifier, repro and sync amplifier and line amplifier. Another innovation is that all audio parameters are adjusted by the microprocessor via programmable potentiometers, these being linked to a data bus and enabled by an address bus (for example see **Fig 5**). The magnetisation curve of tape vs. frequency is approximated by third order, three pole high frequency boost circuitry, this also being phase compensated. Each of the four available speeds have their respective equalisation characteristics programmable, these varying from 0, 17.5, 35, 50, 70, 90 and 120 µs for high frequency and 3,180 and ∞ µs for low frequency. This ensures correct matching for all norms and standards such as NAB, IEC, DIN, CCIR, etc. Finally, channel meters are switchable VU or peak and correspond to ANSI, NAB, and IEC norms.

Easy servicing. Not every audio facility has

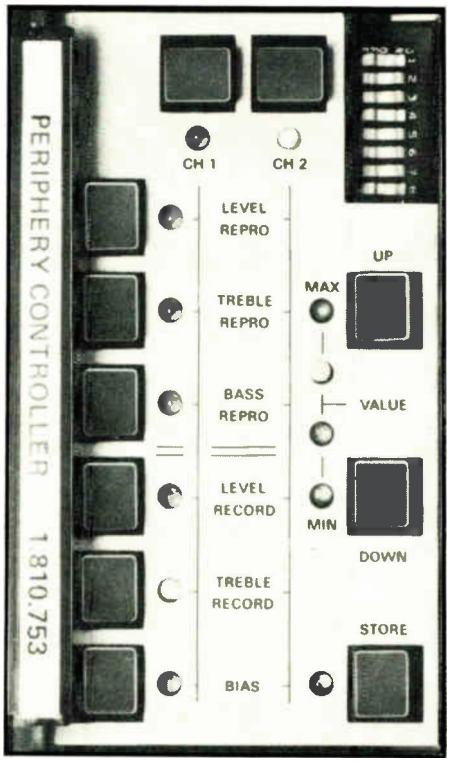
Arrangement of plug-in pcb's below the control panel



the means to keep a permanent service department so it was necessary to produce a machine that could be serviced, or changed from one version to another with the minimum of effort whilst retaining complete reliability and precision engineering. As a start, only two sizes of screwdriver and two sizes of Allen keys are needed to completely dismount and re-assemble most of the machine. Thanks to good all round clearance, access to the three motors is extremely easy and makes motor changing a quick job. Changing the machine from one version to another will certainly often mean changing the head assembly and this is accomplished with the minimum of worry. All heads are mounted on a solid, stable metal die-cast base, eliminating the need to readjust azimuth and zenith when changing headblocks, this latter function only requiring the removal of three screws. A further refinement is that the reproduce preamplifier is included in the headblock to ensure perfect audio matching in the electronics, thus maintaining maximum quality in all configurations with the minimum of fuss. Similarly, the fact that all audio circuit cards are set up and aligned by the microprocessor means that cards can be changed in a matter of seconds and that the machine is ready to go without the need to use up valuable time in re-aligning the machine. To ensure perfect compatibility between cards the maximum deviation permissible from one to another is ±0.2 dB. As a further aid to servicing and reliability, the microprocessor is self analysing and continually checks machine status while running and upon power-up. Should an error or fault occur it is immediately shown on the LCD display with an appropriate code to indicate the malfunction, ie: if you know what is going wrong, you can do something about it immediately!

Further flexibility is added by the serial interface which enables the machine to be connected to the outside world. This enables direct access to all audio parameters giving easy recall, update and store possibilities to any individual function; the hexadecimal position of any programmable potentiometer being recalled is shown on the LCD display. The serial parallel interface also means easy transfer of the RAM contents of the recorder to any other memory medium due to adjustable baud rate, eg compact audio cassette, telephone line, any audio tape, home computer, etc, etc. Thus the machine has full remote control possibilities for all functions as well as remote testing. A built-in test generator with frequencies at 60 Hz, 125 Hz, 1 kHz, 10 kHz and 16 kHz is also available as an option.

Tape transport. A three motor tape deck is used to ensure gentle tape handling and eliminates the need for mechanical transmission systems such as belts or gears. Brushless motors are powered by a switching power supply with pulse width modulation operating at a sampling frequency of 76 kHz, which in turn means no heating, high efficiency, high torque and, most importantly, very little maintenance. All mechanical parts are die-cast and high precision machine tooled. This ensures a high accuracy of moving parts



Periphery controller card and access keys

with low wear, without too high an inertia or mechanical skew. The metals used in construction are specially selected so that the effects of temperature are mostly self compensated. This again means that nominal specifications are guaranteed over a wide temperature range. High precision positioning of the capstan motor and shaft also means that field replacements can be carried out without adjustments.

Available configurations. Through the use of modular construction any option can be produced to the requirements of the user. Versions available are:

- mono full track;
- stereo—2 × 2.75 mm track width;
- two track—2 × 2.00 mm track width with separate erase and sync;
- two track TC—as for two track machine, but with centre track for timecode record replay;
- VU—all versions with meter panel included;
- VUK—all versions with separate meter panel so that the machine can be console or rack mounted.

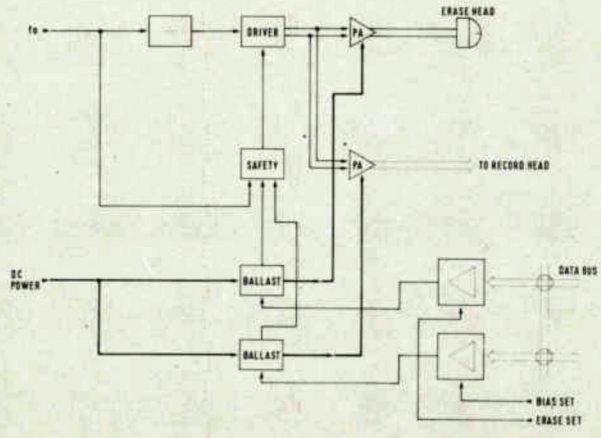
Due to it's wide range of configurations, the *A810* recorder can be used perfectly in the following applications: direct stereo recording (stereo version); radio drama (2-track); audio-visual post-production (2-track plus timecode); film sound editing (as for AV work); TV simulcasting (again 2-track plus timecode); and AM radio broadcasting (mono full track).

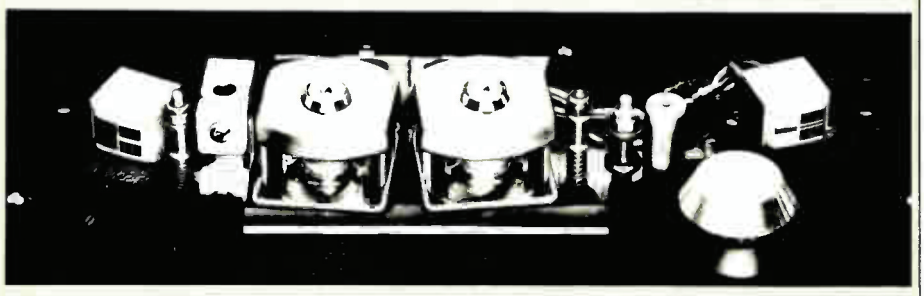
Easy conversion. The modularity of both the electrical and mechanical forms of construction ensure fast and easy changeovers. Actual hard wiring is kept to the bare minimum and connection between modules is made via flexible flat ribbon cable for maximum flexibility and freedom of mechanical tolerance. All *A810* configurations are programmed in the EPROM's of the microprocessor, meaning that any change in configuration is controlled by the microprocessor software at the simple flick of a switch.

Cost effectiveness. The construction of the machine relies only on components and materials that are readily available in all parts of the world and that are offered on the market by at least two or more independent manufacturers. This ensures freedom from technological and or political changes in the world, whilst competition in the market place between manufacturers means long life availability coupled with reasonable prices. This ensures that the prospective client is offered a machine with built-in long life at a low to medium price and is thus offered the maximum return on initial investment.

The result of the foregoing solutions is the Studer *A810* ¼ in master recorder, the first in a totally new generation of tape recorders. Available in a wide variety of versions, the machine can be equipped with either high or

FIG 5
MICROPROCESSOR CONTROLLED BIAS AND ERASE CURRENT ADJUSTMENT





Centre track timecode headblock. Note the pair of ferrite combi-heads—left: TC repro/audio erase; right: TC erase/TC record

FIG 6
TWO TRACK AND CENTRE TIMECODE TRACK CONFIGURATION

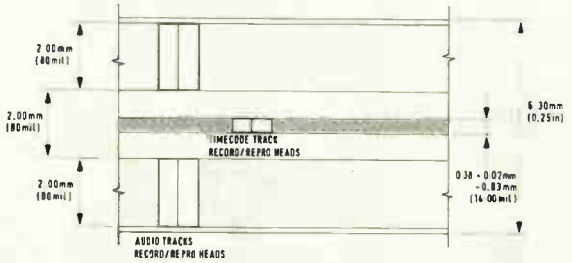


FIG 7
HEAD CONFIGURATION FOR SIMULTANEOUS RECORD/REPRO OF AUDIO AND TIMECODE SIGNALS WITHOUT TIME OFFSET

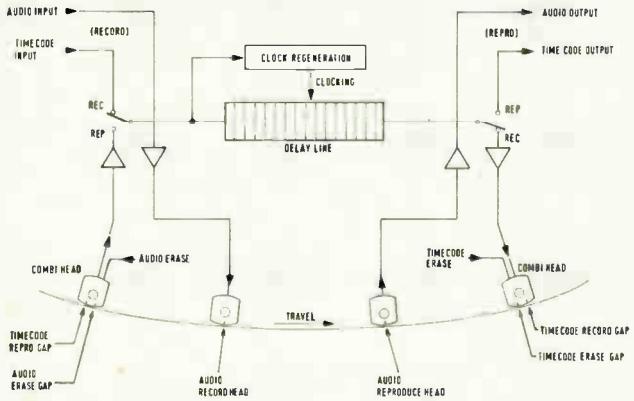
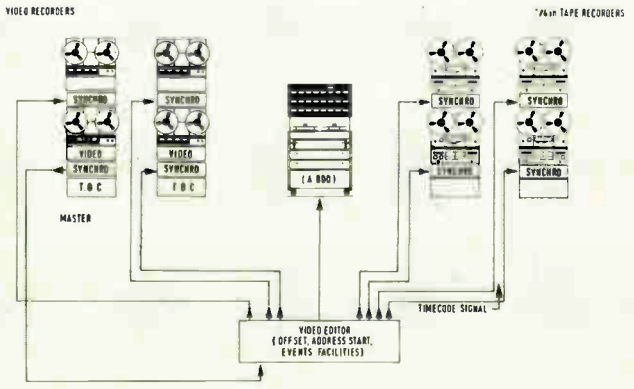


FIG 8
TYPICAL SMPTE SYNCHRONISED AUDIO/VIDEO POST-PRODUCTION SYSTEM



low speed motors. Another feature is full varispeed control over a range of ± seven semitones, available by applying a discrete frequency (nominal 9.6kHz) to the servo loop of the capstan motor. As well as gentle tape handling controlled by separate tape tension sensors, the machine offers ease in mechanical and electronic editing with four spooling speeds and full locator functions.

Innovative features

The two innovations that really set the *A810* apart from other studio recorders are complete microprocessor control and the possibility of recording timecode on a centre track (see **Fig 6**).

By being able to programme all parameters—and transfer them to outside storage—means that one machine is capable of fulfilling a maximum of functions. Indeed, if simultaneous use is not required, one basic machine with spare cards can do the work of three or four separate recorders, with the necessary conversions being done in a matter of minutes, ensuring a minimum of down time. No worry about re-alignment, either, as the microprocessor is taking care of that. Remote work is no longer a problem either, as thanks to the serial interface, the machine (or series of machines) can be controlled from a central point with machine status available on a display for all parameters.

Once the prerogative of multitrack machines, timecode working with a master recorder is now possible with the *A810*, complete with real-time encoding or programmed offset (see **Fig 7**). This means that the recorder can be fully integrated into an audio-visual system, TV or film, under timecode control and or with multitrack recorders (see **Fig 8**). In fact you could probably do some very fancy effects with locked up recorders by making use of the programmable facilities.

Conclusion

While a machine for today's demands—and for the forseeable future—the *A810* takes into account some very important practical considerations. High return for a moderate investment, wide flexibility coupled to maximum reliability and worldwide serviceability. Whilst modern technology produces some pretty astounding electronics in the form of specialised chips, it is also true to say that obtaining these same chips can often be fraught with difficulty. The use of modern techniques with readily available components means long service life and confidence by the customer in the product. The audio industry likes workhorses that in can rely on without worry—the *A810* would appear to be the first of a new generation of such horses! □

Biography

Andre Bourget is a physics graduate of the Swiss Federal Institute of Technology in Lausanne. Prior to joining Studer International AG in 1980, he was with Kudelski SA (Nagra) where he became head of the Technical Training Department. Mr Bourget is currently head of the Systems Engineering Department at Studer's headquarters in Regensdorf.