STUDER REVOX
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Editorial

Revox and the Swiss economic climate 1983

The political situation

Switzerland is indeed fortunate of having been spared the turmoil of government shuffling and the resulting political reorientation. Political and economic tendencies have a direct influence on our business life and our prosperity. Because our country does not guarantee total social security to its citizens, some concern about financial survival upon retirement remains which forces people to contribute "something" to their own security which in turn has a beneficial effect on the qualitative and quantitative performance of the individual.

A change of the current situation is unlikely for the near or medium term; influences from (surrounding) foreign countries are minimal and are at present limited to economic aspects.

The economic situation

...is constantly hammered into our conscience by the mass media. The claptrap which is not limited to the sensational press, has talked the public into a feeling of crisis. Of course, today's situation does not compare with the (supposed) golden age of the senventies: the years during which the entrepreneurial performance, the willingness to make decisions and to take risks had been replaced by an insensitive technocracy which believed that salvation was to be found only in computer data.
Today however, drive, engagement, and courage for (human) partnership are again dominating factors.

Swiss consumers possess considerable financial means. Although the unemployment rate of 0.8% indicates that many individuals suffer, it has little influence on the national economy. When we look at comparative figures from foreign countries, we become disquieted because we suspect that we will not be spared a similar fate. However, we must also remind ourselves that we possess today all the tools required to maintain our standard for many years to come. We should also disregard the notion that we are not yet over the hump or that the recession has not yet bottomed out, and that the signs of economic recovery are but few. We are not in a temporary decline but an absolutely normal situation: the forces of supply and demand have come into play again, the consumer's buying habits are critical, he compares. Entrepreneurs at all levels rely on their personal decision making ability, and the advocates of a self-destructing throwaway society are slowly being converted. Or they become extinct.

Of course, the return to a stormier economic climate does not have the same impact on all segments of the population and the economy. In addition there are considerable regional differences.

It is general knowledge that for example the Cantons in which the watchmaking industry is concentrated, have been hit especially hard by the recession (or rather: by the establishing of normal market conditions). The Swiss' inclination toward immobility, his clinging to the supposedly tried and true has significantly aggravated the situation.

The watchmaking industry is not the only one forced to adapt to the new competitive situation. Also the machinery industry, the backbone of the Swiss industry, is faced with structural problems. The fact that profit-securing measures have been implemented in some cases at the expense of reduced employment is only an unpleasant secondary phenomenon.

Each region of our country has its specific "moments of crisis". In Northwestern Switzerland, the machinery industry is concerned about its order book. In Northeastern Switzerland, the pinch of the recession will be felt with some delay. Central Switzerland and the Grisons are traditionally dry areas. The French-speaking part of Switzerland is characterized by alarming news from Jura and the Valais.

As far as Revox is concerned, its position can be fixed very easily:

- A high-quality hi-fi product will be able to retain the loyality of the targeted buying group, if Revox can maintain its leading position with respect to performance data and operating convenience.
- Competition by video products will become more severe.
- Our competitors will be found increasingly among companies outside our industry!
- In order to survive the competition with other exclusive products and services, we are forced to seek our niche in prestige values.

Prospects

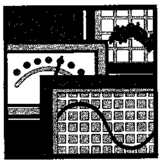
The boom times are definitely over now. Two-digit growth rates are a thing of the past, and so are excessive inflation.

We shall have to adjust to the fact that what we are experiencing is not an exceptional situation but rather the norm. Because the fittest survive, the future belongs to the business that is managed dynamically and with entrepreneurial adaptness. The solution cannot be "throw-away" products but "quality and performance". We will continue to be successful if we keep in mind that we live in a country that is characterized by paucity of natural resources which precludes even the predatory exploitation of domestic resources. This means that we must be innovative and creative. In this vein, consolidation has priority over expansion. Operating profitably and to reinvest the earnings wisely is more important than increasing the turnover at any price.

We will benefit greatly by calling to mind the strategies which – among others – were also decisive in the early days of our company.

Kurt A. Bürki

Kurt A. Bürki is sales manager for Switzerland at Revox ELA AG.



A810 Audio

Phase compensation design considerations

The new amplifier of the A810 features an advanced phase compensation technique. This article outlines the developments that led to optimum treble record equalization without phase error.

Problem definition

The fundamental purpose of all tape recordings is to store the audio signals in a form that is compatible with other recorders and to ensure that they can be reproduced with high fidelity. However, frequency-response errors occur in the recording as well as the reproduction process. In addition, the peak recording level of a tape depends on the ratio of coating thickness to wave length of the recording frequency. For this reason, tape flux has been defined and standardized in such a way that tape saturation can be prevented.

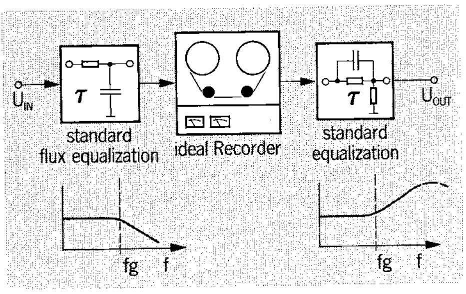


Fig. 1

The simple arrangement illustrated in Fig. 1 ensures that the tape flux remains within the specified standard. It should be noted, however, that current standards refer only to the amplitude response. However, it makes sense to define the phase response as well. In the arrangement illustrated in block diagram 1, both the amplitude response and the phase response are corrected. In our subsequent discussions we simply call this an "ideal recorder".

Recording of the audio signals is disturbed by amplitude errors (treble losses). The most important factors are:
- Coating thickness attenuation
- Self demagnetization
- Attenuation by a recording gap that is not infinitesimally small

These factors produce so-called aperture distortions. A common characteristic is that they do not cause any phase displacement. These treble losses must be compensated in the recording section in order to attain the standard tape flux while simultaneously maintaining the phase response which should also be part of the standard [although it has not (yet) been included]. The following circuit versions illustrate the progress in development that led to the advanced solution.

Implemented circuit versions

1st Version
Recording circuit with record equalization by an RC network.

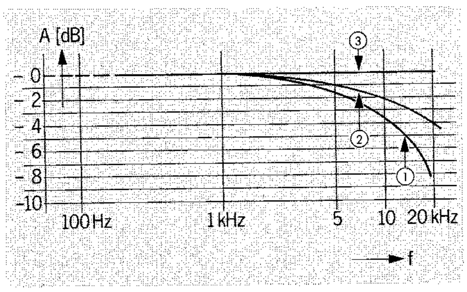


Fig. 2

Curve ① represents the uncorrected frequency response of the "ideal recorder". Frequency response ② results if the norm flux equalization (attenuation), as required to attain the standardized tape flux, is omitted before the signal is processed by the ideal recorder. The remaining boost to obtain a linear frequency response ③ can be accomplished with a simple RC network (Fig. 3).

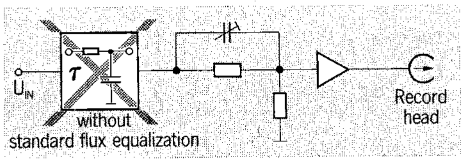


Fig. 3

Advantages:
- Frequency response can be very accurately equalized by any type of network
- Inexpensive

Disadvantages:
- Major errors (required phase response not achieved)
- Adjustment difficult to implement with trimmer potentiometer

2nd Version
Treble boost by adding a differentiated and inverted signal.

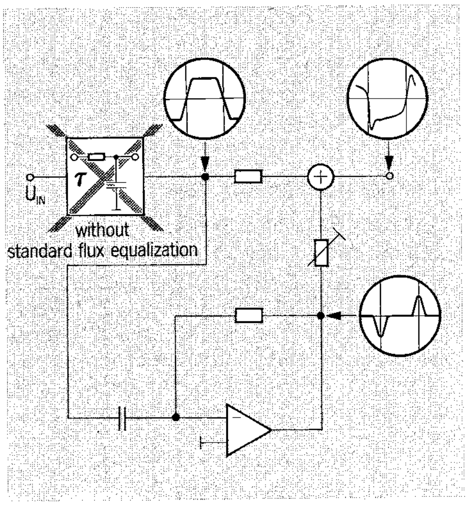


Fig. 4

In this version also, some of the boost is achieved by omitting the standard flux equalization. The additional equalization is better than in version 1 as far as the phase response is concerned.

Advantages:
- Good frequency response achievable
- Control with variable resistor

Disadvantages:
- Residual phase errors
- No limitation of bandwidth

3rd Version
High frequency record equalization by adding a double-differentiated, inverted signal. In this version, the record equalization required for the standard tape flux is not omitted and is left as

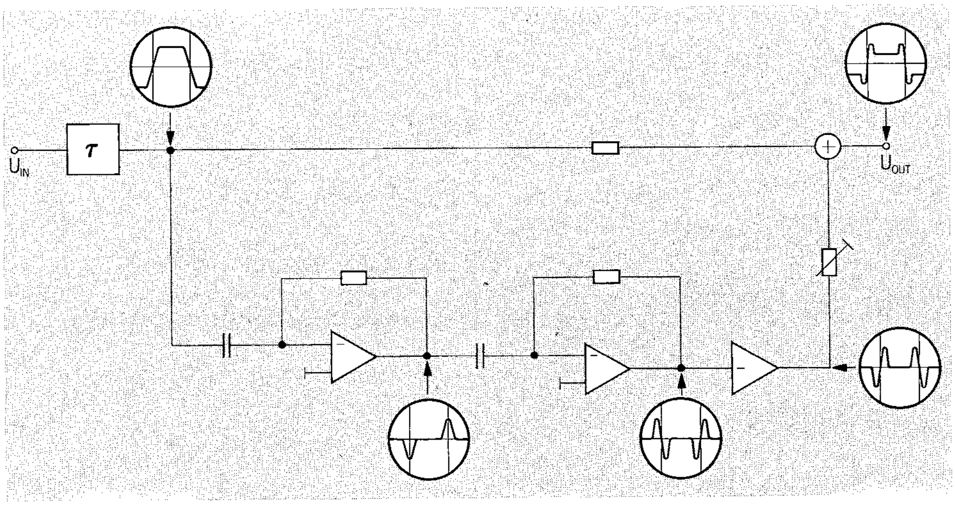


Fig. 5

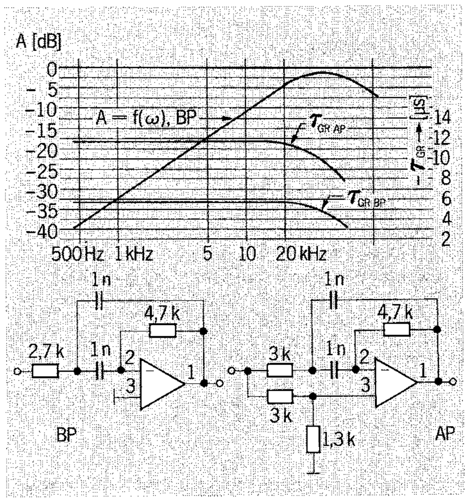


Fig. 8

illustrated in Fig. 1 (Mathematical solution, see Appendix 1).

Advantages:
- Good phase response achievable
- Proper phase relation

Disadvantages:
- No limitation of bandwidth. Whistling noises
- Danger of tape saturation at high frequencies
- High noise levels above 20 kHz alter the bias current

Solution implemented on the STUDER A810

This state-of-the-art solution for optimum phase correction (without the disadvantages of version 3) is based on the following:

① The underlying concept is the same as described for version 3.
② The differentiation stages are replaced by special bandpasses (BP). These feature a frequency-proportional amplitude response in the frequency range of interest.
③ A delay network is inserted into the main branch. Its purpose is to compensate unavoidable bandpass delay.

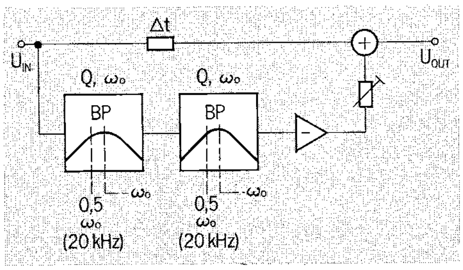


Fig. 6

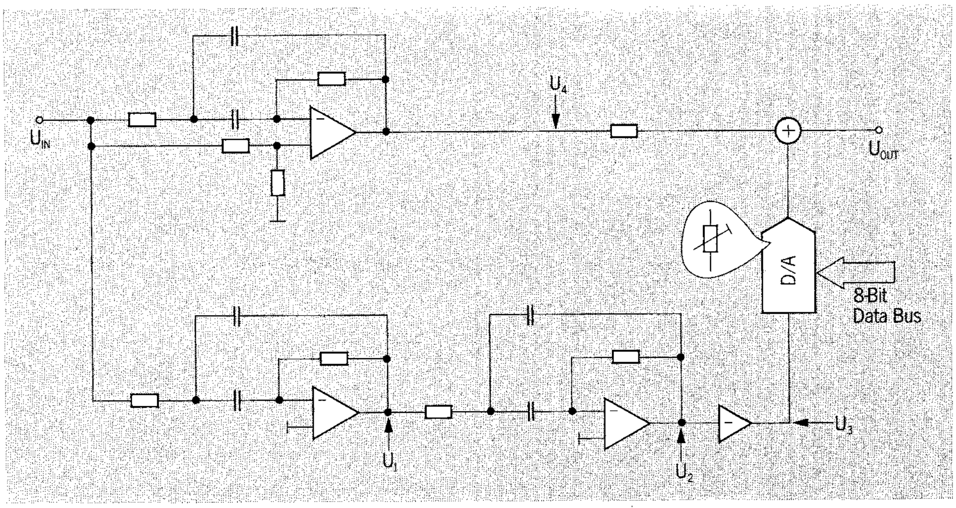


Fig. 7

The operating range is on the lower slope of the bandpasses. For frequencies up to 20 kHz, this slope requires a treble boost with a fixed steepness of 6 dB/octave. Inversion of the frequency response curve limits the bandwidth and unwanted noise above the audio range is consequently eliminated.

With respect to the bandpass filters, the previously mentioned group delay problem must be solved. In the operating range, this delay should be independent of the frequency. This requirement has been satisfied by the accurate definition of the filter Q's (0.57 to 0.6) (mathematical derivation, see Appendix 2). It is thus possible to compensate the group delay of the bandpasses by a delay network in the direct path. The delay correction network is implemented by an allpass of the 2nd order. Mathematically accurate correction of the delay occurs when the Q factors and ω_o of the allpass correspond to those of the bandpasses.

Fig. 8 illustrates the characteristics and the component values of the equalizer section.

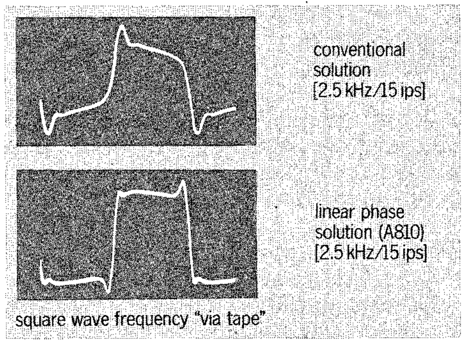


Fig. 9

Fig. 9 gives a comparison of square-wave frequencies via tape (2.5 kHz at 15 ips) obtained with phase compensation (A810) and without (conventional record amplifier).

J. Marco Egli (34): Basic training as an engineering draftsman in Southern Switzerland. Started his active career by joining a large electronics company in Zurich where he was first assigned to the testing laboratory and subsequently to the development department for microwave technology (radar). During that time he completed his training as a certified electrical engineer (HTL).
Since 1977 employed by Studer as a development engineer. Various assignments with emphasis on RF oscillators and RF amplifiers A800/A810), recording electronics (A810), amplifier output stages (B251), etc.

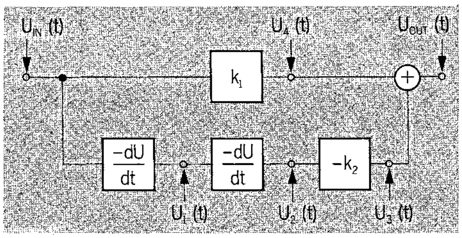


Fig. 10

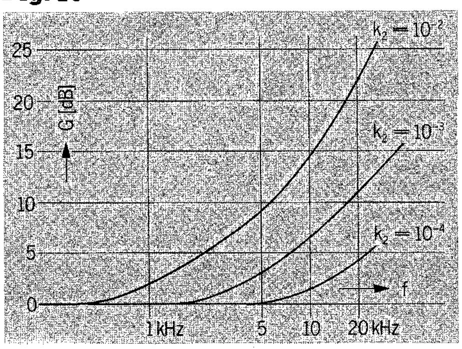


Fig. 11

APPENDIX 1

Fig. 10

$$U_{IN}(t) = A \sin \omega t$$

$$U_4(t) = k_1 A \sin \omega t$$

$$U_1(t) = -\frac{d\,U_{IN}(t)}{dt} = -A\omega \cos \omega t$$

$$U_2(t) = -\frac{dU_1(t)}{dt} = \frac{d^2 U_{IN}(t)}{dt^2} \Rightarrow$$

$$U_2(t) = -A\,\omega^2 \sin \omega t$$

$$U_3(t) = U_2(t)\,(-k_2) \Rightarrow$$

$$U_3(t) = Ak_2\,\omega^2 \sin \omega t$$

$$U_{OUT}(t) = U_4(t) + U_3(t) = k_1 A \sin \omega t + Ak_2\,\omega^2 \sin \omega t$$

$$U_{OUT}(t) = A\,(k_1 + k_2\,\omega^2) \sin \omega t$$

==

$$\vartheta = \frac{U_{OUT}(t)}{U_{IN}(t)} = \frac{A\,(k_1 + k_2\,\omega^2) \sin \omega t}{A \sin \omega t}$$

$$\vartheta = k_1 + k_2\,\omega^2$$

=============

$G = 20\lg(k_1 + k_2\,\omega^2)$ [≙ Real function!]
(i.e. no phase displacement)

Fig. 11

Graphic representation of G; $k_1 = 1$; $\omega = 2\pi f$;

k_2 as parameter

APPENDIX 2

The bandpass of the 2nd order has a transmission response of:

$$G(s) = k \frac{s\frac{\omega_o}{Q}}{s^2 + s\frac{\omega_o}{Q} + \omega_o^2}$$

k = any constant
s = complex, variable frequency
ω_o = resonant frequency circuit
Q = quality factor

The corresponding phase function is:

$$\varphi(\omega) = \text{arc tg} \frac{-\frac{\omega_o}{Q}\,\omega}{\omega_o^2 - \omega^2}$$

It can be represented as a series:

$$\varphi(\omega) = -\left[\,\omega \frac{1}{Q\omega_o} + \omega^3 \frac{1}{\omega_o^3}\left(\frac{1}{Q} - \frac{1}{3Q^3}\right) + \ldots\right]$$

By differentiating the phase after ω we obtain the group delay

$$\tau_{GR} = -\left[\,\frac{1}{Q\omega_o} + 3\omega^2 \frac{1}{\omega_o^3}\left(\frac{1}{Q} - \frac{1}{3Q^3}\right) + \ldots\right]$$

If τ_{GR} at $\omega = 0$ must be retained for as long as possible, the dominating interference term of the 2nd order must disappear. This leads to the condition:

$$Q = \sqrt{\tfrac{1}{3}} \approx 0{,}577.$$

J. Marco Egli

Ken Pohlmann

The Compatibility Solution

Digital demands an absolute absence of incompatibility, yet creates an almost infinite number of opportunities for it to occur.

The Compact Disc [...] is a prime example of a piece of new technology with longrange impact. Its innovation necessitates its incompatibility and we are left to wonder if its advantages truly outweigh its tremendous incompatibility. We know that as far as recorded music goes, the consumer will have to start all over again. The cost of conversion will be tremendous, yet the essential superiority of the system is clear. Ultimately, when all the grooves of vinyl records are worn out, and diamond styli blunted, we will be left with a better product.

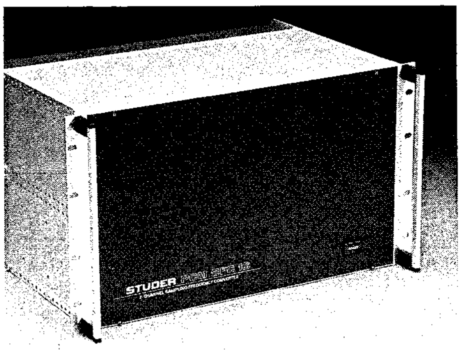
But there is another problem. We must note that the Compact Disc is incompatible with old technology and new technology as well. [...]

While the Compact Disc's incompatibility with grooved records will slowly dwindle as grooved records fall by the wayside, the Compact Disc's incompatibility with the industry's professional sampling standard will remain for perpetuity. [...]

Help arrives

Fortunately, the remarkable technology which creates the problem has also created the means for the remarkable solution. Consider the idea of a box which can accept any arbitrary digital format and sampling frequency and convert it to any other scheme. Such a device would constitute a universal digital matching transformer and thus make compatible all of the various streams of data. It's probably silly to hope for agreement among all audio equipment manufacturers, and even if that could be achieved, it would be unreasonable to think that advancing technology wouldn't soon dictate different formats and rates. Consider that the box hypothesized above could reconcile all present schemes, and make them compatible with future schemes. What more could we ask for?

Consider the Studer SFC 16. It is the first digital sampling frequency converter, covering the whole range of sampling frequencies in use today, and potentially, any sampling frequencies. Conflicting sampling frequencies from 30 kHz to 52 kHz, word lengths from 14 to 18 bits, any arbitrary formats, and phase-locked and unsynchronized systems can all be transferred one to the other. Want to transfer from the professional 48 kHz to the satellite 32 kHz? – the simple ratio of 3 to 2 will do it. How about 44.1 kHz to 48 kHz? – a ratio of 147 to 160 will make it easy. How about two compatible but differing formats, such as two unsynchronized systems? – no problem. The SFC 16 automatically adapts itself according to the clock frequencies present, and performs the correct match with or without a matching ratio. Its front panel illustrates the ultimate in compatibility – one on/off switch.



As with all elegant solutions, the SFC 16 is simplicity itself (relatively speaking). Audio data passes through an input interface, two digital filters connected in cascade, a buffer, two more digital filters, and an output interface. Clock processing and filter control circuitry, being driven by the sampling clocks of both the input and output devices, control the filter operation. The stereo unit consists of eight digital circuit boards – one for interfacing and filter self-testing, one for clock generation and processing and processing circuitry self-testing, and three boards for each channel of digital filters.

The digital filter scheme in the SFC 16 is quite ingenious. The first two filters are synchronous with the input sampling frequency and the last two are synchronous with the output sampling frequency. The difference in bit rates between the two is soaked up with the intermediate buffer. The first filter is a linear-phase FIR filter of 63 length. It performs a conversion from f_s(in) to $f_s \times 2$(in) in the UP mode, and $f_s \times 2$(out) to f_s(out) in the DOWN mode. It has a relative bandwidth of 7/8 of the Nyquist frequency (0 to 21 kHz at 48 kHz sampling frequency, and 0 to 19.3 kHz at 44.1 sampling frequency). The second filter is a linear-phase FIR filter of 15 length. It performs a conversion from $f_s \times 2$(in) to $f_s \times 4$(in) or $f_s \times 4$(out) to $f_s \times 2$ (out) with no bandwidth change. Filter three is an FIR of 255 length and incorporates a synchronous buffer for conversion from $f_s \times 4$(in) to $32.768 \times f_s$(in) and thence to f_s(out), or from f_s(in) to $32.768 \times f_s$(out) and thence to $4 \times f_s$(out). The fourth filter is an FIR filter of 255 length which performs a linear interpolation at the input or output sampling frequency. The four-filter cascade is the mathematical equivalent of a fixed linear-phase FIR filter of 1.18 million length, performing conversion at approximately 1.57 GHz. The first filter has a ripple of ± 0.15 dB, and the other three cumulatively add an additional ± 0.05 dB ripple. The overall phase response is perfectly linear. [...]

While the device itself is a universal converter, its particular application is determined by the choice of interfaces. Thus the digital interface format supported by Studer, Sony, the EBU, and others can be ordered, as well as custom interfaces for specific interfacing applications.

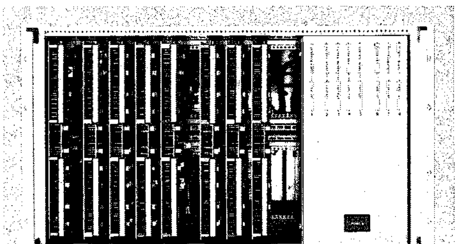
The SFC 16 is the first digital audio processing device with self-diagnostics; in the self-test mode, both channels are fed with a digital noise source and error patterns detected. For example, for errors common to both channels, the clock processing circuitry is checked, and for errors on one channel only, that channel is tested against the functioning channel. An error code is displayed via LEDs to help locate malfunctioning ICs. In any case, its conversion resolution of better than one nanosecond is achieved with non-esoteric digital chips such as low-power Schottky TTL – a piece of cake for a good technician.

The issue of signal degradation in digital sampling frequency conversion is still up for debate. Conversion amplitude and phase response of the SFC 16 are unquestionably excellent. Filter noise is present, but at typical audio signal conditions it occurs at levels close to the quantization noise of 96 dB below clipping, using the 16-bit format, and 108 dB below clipping with the 18-bit format. [...]

The noise level of the SFC 16 is quite good; in the case of a pure sinewave, an output noise floor of 112 microvolts could be expected, whereas the theoretical level for 16 bits would be 88 microvolts. By way of comparison, a good A/D converter might account for 200 microvolts of noise. The overall effect of standards conversion must remain a concern; even theoretically a signal-to-noise ratio loss of 3 dB will occur and, in practical devices such as the SFC 16, the loss will be greater, especially under the worst-case condition of a clipping signal at the upper bandwidth frequency of 21 kHz. The tremendous dynamic range of digital recording minimizes the effect of the loss, but the analog terror of losing even a little S/N is sure to fuel the double-standard controversy. Even a remarkable solution to an incompatibility problem begets more problems.

In conclusion

The Studer SFC 16 is thus the first digital sampling frequency converter to hit the market. Whereas a transformer used to be sufficient to match incompatible audio lines, now a cascade of quadruple digital filters is needed. That might seem like a hard-won victory, but a victory it is. The point is that our modern day complexity does not prohibit compatibility, it merely calls for more complex solutions. In my mind, there is no excuse – the audio industry must rise to the challenge of developing ever-more sophisticated products to satisfy the needs of our ever-more sophisticated society. No one ever said hi-fi was going to be easy – and no one ever said it was going to be cheap. As far as industry compatibility goes, it might happen – but someone will have to pay for it. [...]



Eight digital circuit boards = simplicity itself (relatively speaking).

This article first appeared in **db** april 1983.
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Where do we stand

Digital and Analog at Studer

Digital has dominated the headlines in the past 5 years, each of which has been hailed as the beginning of the era of digital audio. Digital recorders have been available, at a high price, over the same five years. It is rewarding to analyse the sales figures, which may indicate, better than decibels will ever do, how sound a particular technology is.

Of decibels and dollars:

Studer sales of high-quality analog multichannel recorders A800 in the last twelve months exceed the worldwide production and sales of multichannel digital recorders over the past five years. Studer's yearly sales of high-quality analog two-channel mastering recorders compare well with the worldwide sales of professional digital mastering units of the same five years. And so on.

Surprised? Analog serves a huge market, and – if made well, and supported professionally – analog sells well. It is no secret that digital's huge development costs cannot lead to immediate profits.

Where are the standards?

Standards in digital audio are a hope, not a fact. There has been progress: we have one professional sampling frequency; we have an almost-standardised digital audio cable. But no recording format yet, no control interface, no way to design smart systems, as made possible by digital's huge potential. In the three-and-a-half years of its digital audio activities, Studer has given impetus to the long walk towards standards; but much remains to be done. Until there are standards, digital audio will be glamorous, it will be high technology, but it will not be professional.

Some progress:

The real beginning of the digital audio era was marked by the introduction of a consumer product, the compact disc. It is sobering that a consumer product should set the pace for professional standardisation. In standards, one recent progress was the re-definition, based on new developments from Studer and Matsushita, of the DASH (digital audio, stationary heads) format, which now extends its strong features of error protection to the 19.05 cm/s two-channel recorder. Another is the common proposal, by Studer and the BBC, of labels, which extend the concept of user's data to both the transmission and recording of every channel of digital audio. Good news; but there still are more than a dozen formats in daily use for recording digital audio.

Studer's entry in digital audio:

Studer has entered digital audio rather recently, and much money and effort has been invested in learning the state-of-the-art and defining what must be improved. The prototype A808 PCM recorders (which will not be marketed) are examples of this learning phase.

It is significant that Studer's first digital audio products on the market were not recorders, but units for signal processing (the sampling-frequency converter SFC-16, the preview unit DAD-16). In our experience, every major technology used in a professional digital recorder has proved to be inadequate and to require development efforts:

- higher precision mechanics are necessary in handling and winding the very thin tapes of digital audio.
- the electronics, both analog and digital, used in today's digital recorders can and must be improved. The circuits can be made smaller, less power-hungry, more reliable, and cheaper.
- the ergonomy of digital differs partly from that of analog, and must be carefully re-assessed.
- the economics of today's digital recorders just do not add up to a profit. The quantities are too small, the circuits often crude and always expensive, the cost of repair, maintenance and product support too high. A look at today's market, alas, confirms all of the above.

At present, Studer works towards a generation of stationary-head recorders which will be profitable, reliable, reasonably priced, and will receive the same market support as Studer's other professional products. This involves a new concept for both electronics and transport.

Along with the development of digital audio recorders, new areas in digital signal processing, control, and systems design are being studied.

Studer's attitude in analog:

Due to the technical requirements and financial constraints of today's vast majority of users, the dominating technology will remain analog for many years. Not to concentrate a major part of its development effort on further improving analog technology would mean deserting a large and vital market, as well as thousands of professional users. This has never been Studer's policy.

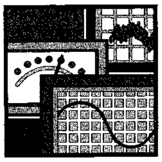
Analog recorders will profit from steady improvements in sound quality and operational comfort. Analog recording and mixing will remain for a long time the basis for healthy sales in the professional area. The profit will help finance developments for both digital and analog technologies.

Studer's attitude in digital:

The development of a family of digital audio recorders is a high-priority task at Studer. The Studer range of professional analog recorders will be supplemented by a range of digital recorders based on the same concepts. The transports will be of high quality, with a new design tailored to the requirements of digital. The electronics will bear the mark of Studer's efforts in digital audio development. The digital products will be, in today's state-of-the-art, invariably priced higher than the analog counterparts: better signal quality has its price. As to which products, analog or digital, have the better sound, the users will decide.

Dr. Roger Lagadec,
Product Manager, Digital Audio & New Technologies

Bruno Hochstrasser,
Product Manager, Professional Analog Recorders



REVOX B251 amplifier

Quiescent-current control of the output stage

The basic problems are well known and countless solutions have been implemented with more or less success. For the new B251 amplifier, we have developed a dynamic quiescent-current generating circuit which has a number of interesting features for high-quality output stages.

It is the function of the quiescent-current control to achieve an optimum compromise between the power dissipation and the linearity of the output stage. Class B output stages are characterized by their extremely low power dissipation and consequently minimum heat generation, but by high distortion. By contrast, class A output stages feature very low distortion but high power dissipation. Class A/B output stages, a compromise, produce relatively low distortion and their power dissipation is only little greater than that of class B circuits. The quiescent-current control of the B251 output stage is also an A/B circuit with low power dissipation but with much more stringent requirements with respect to the absence of distortion.

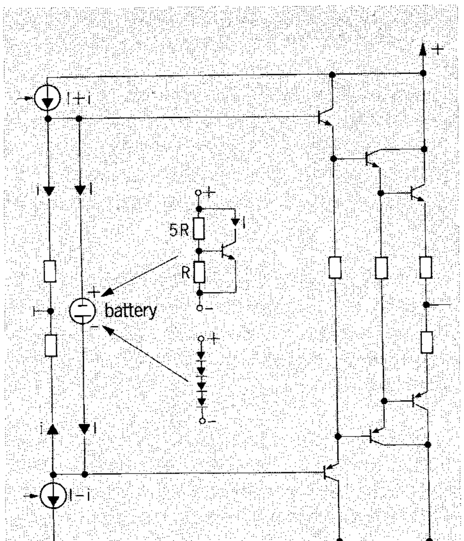
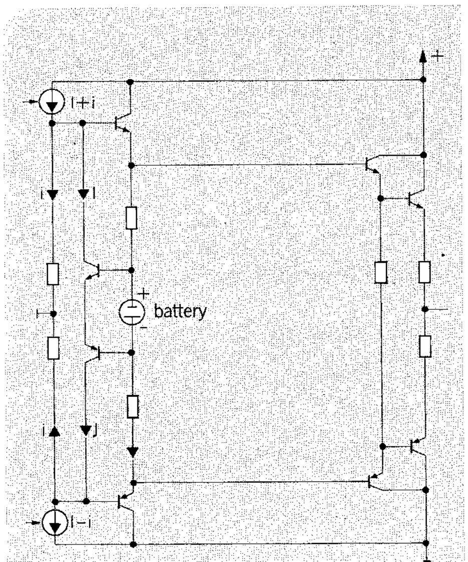


Fig. 1

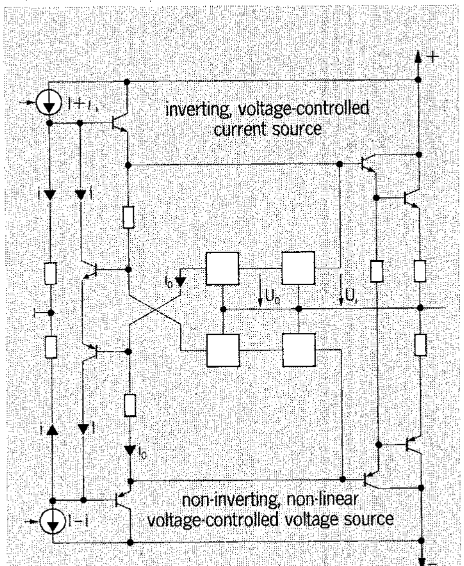
Fig. 1 illustrates the typical A/B circuit arrangement. In this arrangement the bias voltage for the emitter follower of the output stage is kept at a fixed value by conducting a constant current I, e.g. through a suitable number of diodes. The diode path can also be replaced by a transistor in a U_{BE} multiplication circuit. The constant current I must flow through the transistor of the battery, for which purpose a very specific base-to-emitter voltage is required. This voltage occurs across resistor R and is available across resistor 5R at 5 times the magnitude, i.e. it is multiplied by the voltage divider 5R/R. In Fig. 1 three emitter follower pairs are connected in series which means that 6 diode voltages are required to accomplish the battery voltage.



quiescent-current control through diode-voltage multiplication

Fig. 2

Fig. 2 illustrates an alternate solution of the traditional A/B circuit. Here again, three emitter followers are connected in series, however, the battery only needs to determine the bias voltage of the last two transistors. The battery is implemented symmetrically by U_{BE} multiplication: the constant current I must flow through the two battery transistors. Two corresponding base-to-emitter voltages are built up for this purpose on the output of the base voltage divider. These two voltages are multiplied and available at the input of the voltage divider. They serve as control voltages for the output emitter followers. The advantage of the circuit in Fig. 2 over the circuit in Fig. 1 is, that the transistors of the battery need to be thermally coupled only to two emitter followers of the output stage.

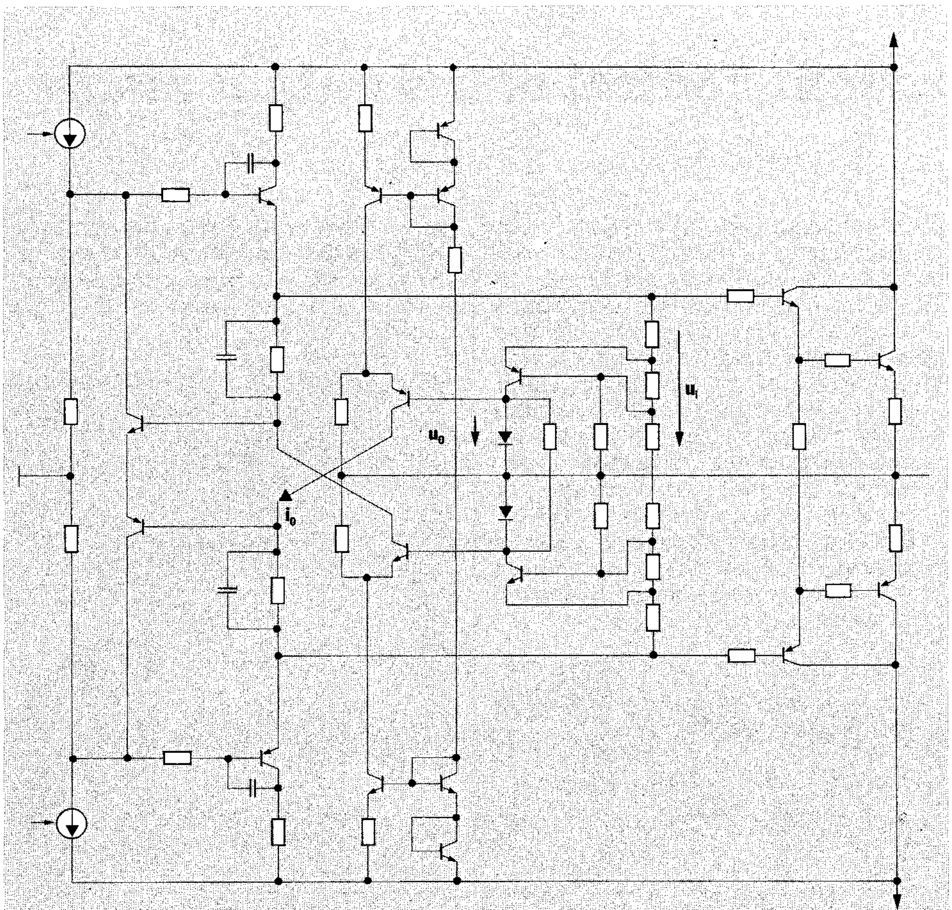


new quiescent-current control; basic circuit diagram

Fig. 3

Fig. 3 illustrates the basic circuit diagram of the new quiescent-current control. In this circuit the battery voltage is not kept stable but controlled depending on the signal to ensure that **both emitter followers of the output stage carry a certain minimum current** and thus can be controlled rapidly. In addition to this signal-dependent control, the output current is detected and reprocessed as the input voltage u_1 in 2 two-terminal networks. The first two-terminal network is a non-inverting, non-linear, voltage-controlled voltage source with the input voltage u_1 and the limited output voltage u_0. The second two-terminal network is an inverting, voltage-controlled current source with the input voltage u_0 and the control current i_0. The battery voltage is made up of three components: The sum of the two base-to-emitter voltages (corresponding to the constant current I) and the two voltages across the base resistors of the battery transistors (generated by the control currents i_0 in the current sources).

A very large output current should



new quiescent-current control; circuit diagram

Fig. 4

have little influence on the battery voltage. A very small output current should increase the battery voltage in such a way that the output current can never drop below a certain minimum value. **The battery voltage is thus primarily controlled by the transistor with the smallest quiescent-current.**

Fig. 4 contains the circuit diagram of the new quiescent-current control. The 2 two-terminal networks are shown together with the elements illustrated in Fig. 3. Fig. 5 illustrates the transfer characteristics of the 2 two-terminal networks. A large output current of the corresponding emitter follower results in a large input voltage u_i from the voltage source and causes a large control voltage u_0 which is, however, limited with respect to its value. Small output currents cause small control voltages u_0 which, because of the pronounced steepness of the characteristic, vary extremely sensitively with the input voltage u_i.

The second two-terminal network supplies large control currents i_0 for small voltages u_0, and small control currents i_0 for large voltages u_0. Small output currents thus cause small control voltages u_0 and large control currents i_0. Depending on the magnitude of i_0, the battery voltage consequently varies much more with small output currents than with large output currents which, with a large u_0, cause only small control currents i_0. The quiescent current of the last emitter follower is 42 mA (14 mA per transistor), resulting in a power dissipation of 5 W per output stage. The minimum current is larger than 1 mA even with a current of 12 A at the complementary emitter follower. Distortions are consequently less than 0.01 % even at 50 mW.

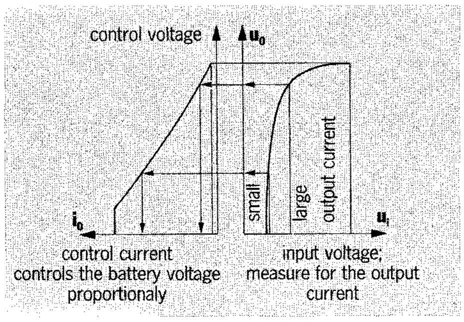


Fig. 5

Urs Zogg

The Studer Group of Companies

"Who is who"

This column has been reserved for introduction of personalities of our affiliated companies and representations in Europe and Overseas.

Introducing:

Michel Ray

Managing Director of Revox ELA AG • with Studer Revox since 1961 • born 1938 and grown up in Romont (FR), Switzerland • studies of civil engineering at ETH (Federal Institute of Technology), Zurich • married, two children (22 and 17).

Michel Ray's association with the company group goes back to 1961 when he sold REVOX hifi equipment in the French part of Switzerland. In 1962, he opened a Revox affiliate in St. Sulpice and took over management to intensify business in the Western area.

Two years later – 1964 – a department was established for the distribution of language laboratories in Switzerland, a new and promising business branch finally integrated in the company group in 1969.

At the age of 29, Michel Ray accepts the responsibilities of managing Revox ELA AG. With a relatively small team, a turnover of 10 million Swiss Francs was mastered in 1967.

In the sixties, the basis for technical perfection and progress was laid: Revox development presented machines like A77 (production volume between 1967 and 1980: 400,000 machines!) – absolute bestsellers worldwide. With the introduction of the tuner A76 (successor: A78), and amplifier A50, complete REVOX hifi systems were offered. Along with technical advancement, responsibilities and turnover grew. Revox ELA AG was reorganized to absorb expansion.

Today, Michel Ray heads three main areas of operation in the Revox company: "Product Marketing and Technical Management" (incl. service, special projects, technical competition), "Sales and Advertising" (incl. commercial market research), and "Administration".

To fulfill organisational requirements, Michel Ray is also responsible for affiliated branches in France (Revox France), Austria (Studer Revox Wien GmbH), and the coordination with the German company (Studer Revox GmbH, Löffingen).

With one exception, REVOX hifi products and language laboratories are distributed in Europe and Overseas by nine daughter companies who also handle STUDER professional audio equipment, and by more than 90 exclusive distributors.

In addition to his responsibilities within the company group, Michel Ray has been a member of the "Trade Commission of the Association of Suppliers of the Radio and Television Industry" since 1957, and also member of the "Organisation Committee of FERA", the Swiss Radio, Television and Hifi Exhibition in Zurich. In this organisation, he has held the position of the FERA president from 1981 to 1983.

There is, consequently, not much time left for his hobbies which are craftwork, cooking, wine testing, piano playing, skiing. His skill is reduced to doing things around the house; he takes cooking lessons, but leaves the laurels to his wife who in his opinion is the better cook. His knowledge of wine of any origin is exceptional. He plays the piano – preferably jazz, and goes skiing in the colder periods of the year.

By principle, he values tolerance and humanity.

Referring to business, he states: "Already in the sixties, REVOX was the essence of highest quality, perfection and technical progress. Mediocrity should never occur with REVOX – as difficult as it may prove to avoid this; 35 years of hard work and dedication would have been wasted."

Renate Ziemann

STUDER A80 RC-2-1/2" / A80 VU-2-1/2"

Why 1/2" two track mastering?

1. Interfacing parameters between the ear and sound recording technology.

The human hearing takes many parameters into account to recognise an audio wave; however two of them stand out especially, namely frequency and sound pressure level. Proper reproduction of program material relies on the accuracy of these parameters within a certain range.

Example 1:
In a tape recorder, the frequency of a recorded signal should be reproduced with an accuracy of ±0.2% from 50 to 15'000 Hz. (Depending on tape speed accuracy and wow and flutter.)

Example 2:
In the same tape recorder, the signal level should have a difference of no more than ±1 dB from the original signal within a 60 dB range. (Depending on s/n and headroom.)

In order to fully comply with the needs of the human hearing for comfortable listening of program material, it is necessary to define it's limitations (range).

2. Some limitations of the human hearing:

- The human hearing is a very complex system; it's spectral sensitivity is huge, ca. [10.5 octaves x 120 dB]^2 and it has many specific properties.
- The following diagram shows the sensitivity spectrum of the ear in sound pressure level versus frequency.

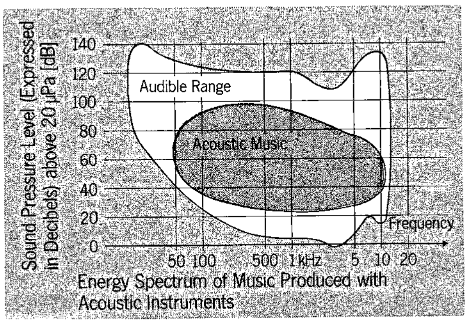


Fig. 1

It can be seen that the dynamic range at 1 kHz is around 120 dB. This range however is covered due to the combination of two operating modes. Interestingly enough, the ear functions in a manner very similar to that of a microphone amplifier in a mixing console: the dynamic range is split into two parts.

1) The dynamic sensitivity of the ear ≅ 80 dB (equivalent to amplifier output dynamic range).
2) The adaptive range of the ear ≅ 40 dB (equivalent to the microphone sensitivity adjustment potentiometer, usually ±20 dB).

This results in a total hearing dynamic range of about 120 dB (mid frequencies), which is the equivalent of the dynamic range of a good microphone amplifier.

However, it is interesting to note that the ear's 40 dB adjustment range cannot be changed within milliseconds; in fact, attenuation attack time is between 0.1 and 10 sec and release time is between 30 sec and several hours according to the previous noise exposure.

As a first conclusion we can say that if an audio program has a dynamic range in excess of 80 dB, the human ear will not be able to distinguish anything outside this range within short periods of time, the fact that it may be 100, 90 or 85 dB making a minimal difference.

As a second conclusion: one should never listen to very loud audio programs when one is under the influence of alcohol or drugs, because in these states the ear's adaptive process is disabled and one's hearing may be impaired for life.

Of course, things are obviously not so simple and many other parameters have to be taken into account to properly and accurately describe the sensitivity characteristics of the ear.

3. Mix-down problems:

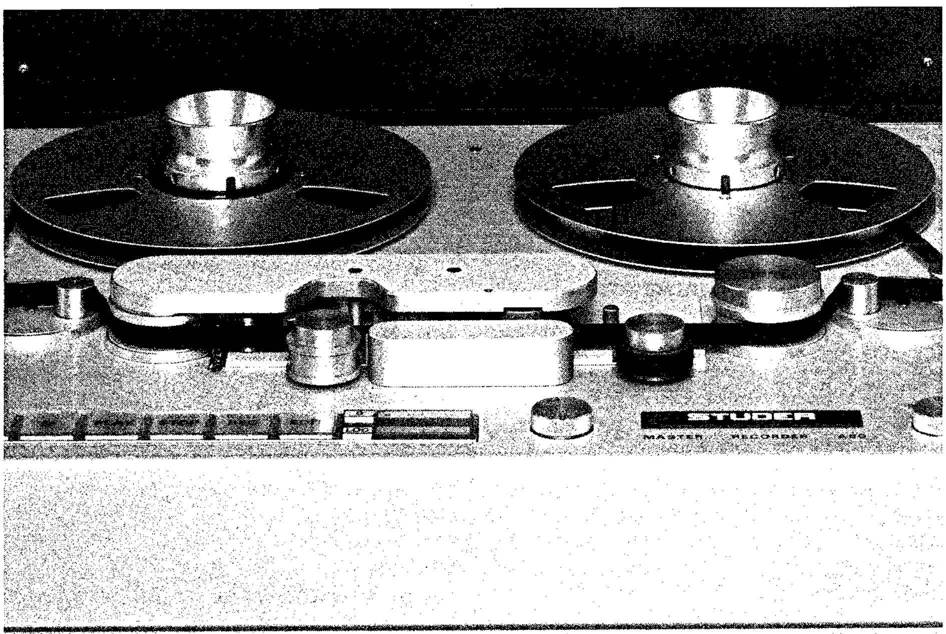
- Mix-down of multitrack tapes can be done very cleanly today, with an expected signal-to-noise ratio in excess of 81 dB at the output of the mixing console (assuming multitrack 16/24 original).
- In order to preserve the integrity of the final mix it is necessary to have a master recorder which is able to retain the entire dynamic range of the mixed signal.
- In addition, signal processing is often required during the mastering process according to the desired end product: LP, Single, Maxi Single, CD or Compact

Cassette. Thus, if maximum flexibility has to be available, the integrity of the total dynamic range of the final mix must be preserved.

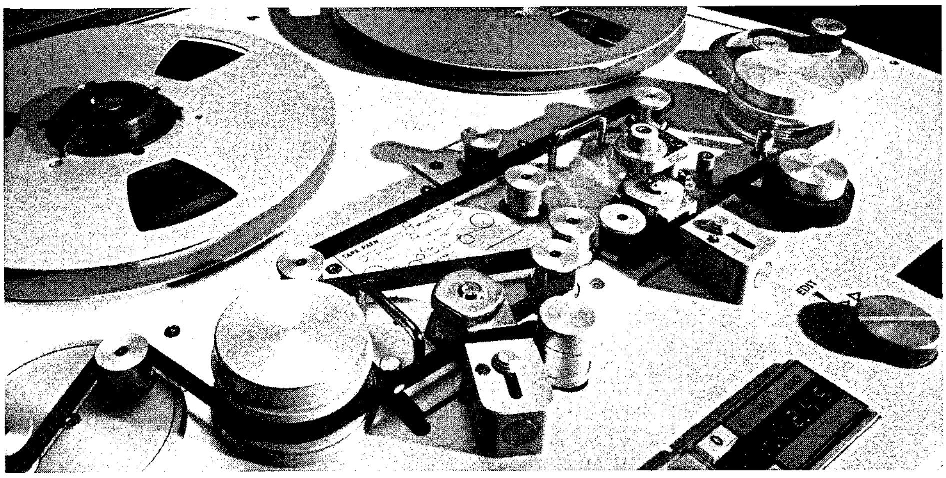
● Very often recording engineers or producers, not to mention artists, are dissatisfied with mix-down because what they are getting out of the master recorder is not identical to what they heard during the direct mix. The situation is aggravated if the intended dynamics of the mix are reduced by the use of companding/limiting systems between the console and master recorder in order to preserve program audibility. A frustrating, self-defeating situation.

4. The solution

Until now many recording studios were mixing down onto 1/4" tape machines. The typical dynamic range of such a recorder operating at 15 ips with NAB equalisation and 2 x 2 mm tracks, is:
D ≅ 73 dB (THD 3 % – A weighting)
This means that some 8 to 10 dB compression has to occur before the master recorder input. (If program material has an 80 dB dynamic e.g: classical music.)



STUDER A80 VU-2-1/2" and STUDER A80 RC-2-1/2": mastering of highest quality, reasonably priced. The analog alternative!



A80 VU-2-1/2" for prelistening.

Today, <u>half inch two track master recorders</u> offered by Studer solve this problem.
These offer more than +81 dB dynamic range and are currently available on the market with a very reasonable price tag.

They offer not only some extra 6 to 8 dB's (at 30 ips) over conventional master recorders but also have superior quality in many other respects. Artists, producers and recording engineers comment: «When such recorders are used, there is no longer any difference between the monitor signal coming directly from the console or from the tape ... I feel at ease, there is punch, it's got a great sound ... what goes in comes out exactly the same way and that's where it's at.»

The main advantages offered by 1/2" two-track format are:

- Superior audio quality (S/N)
- Simple mix-down procedure (No more compression needed)
- Low running cost (Standard 1/2" audio tape)
- Conventional manual editing (Scissors cut and splice)
- Extremely good technical specs (Dynamic)
- Better mechanical stability (30 ips / 1/2" tape)
- World wide acceptance (One single standard)
- Easy half-speed mastering (No special Digital Delay Unit required)

In addition, the A80 VU and A80 RC half inch recorders offer:

- Full LP side capacity on a single reel at 30 ips for high quality (±50 µm Hub) mastering. 12.5" tape reel ⌀ = 3'300 ft tape length = 22 min at 30 ips.
- Easy conversion of 1/4" machines into 1/2" ones with Studer genuine 1/2" conversion kit. Also available for mastering (preview) machines.

5. 1/2" two track is no compromise

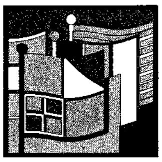
The 1/2" two track recording format as represented by the STUDER A80 VU-2-1/2" and A80 RC-2-1/2" master recorders is a definitive improvement over previous formats and offers the ultimate in audio quality from conventional analog technique.

To summarise the advantages of 1/2" two track machines:

- **Superb audio performance** (Dynamic range)
- **Ease of operation** (Signal processing)
- **Ease of editing** (Manual editing)
- **Low running costs** (Standard tape)
- **Ease of mastering** (Half speed and processing)

whilst closely approaching the performance of digital (PCM) recorders.

André Bourget



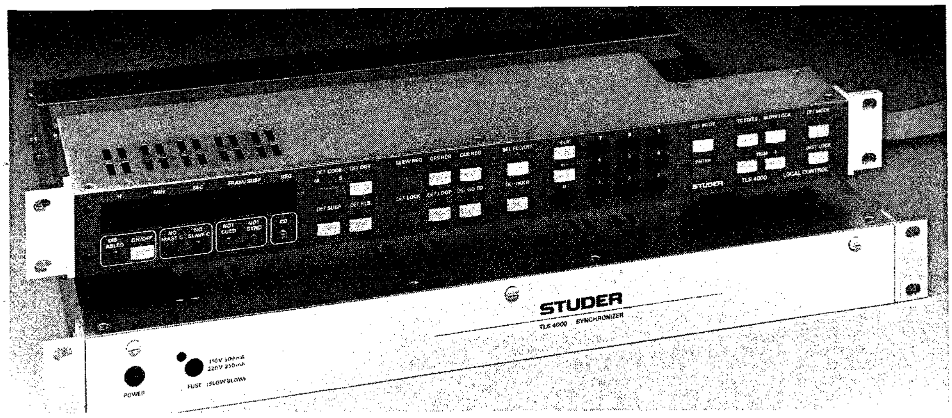
October 25 – 27, 1983

Studer Revox Japan (SRJ) at INTER BEE Tokyo

Our Japanese daughter, established in December 1982, will for the first time exhibit STUDER professional products at 1983 INTER BEE Tokyo.

The SRJ booth will be specially designed for demonstration of post-production facilities in video and film; a STUDER 902-24/8 mixing console will be the heart of the system.

Synchronisation is effected with the lately developed "TLS 4000" system and will complement the professional recording machine STUDER A810 to perfection. Various versions will be introduced.



Above all, SRJ will show the STUDER A800, with TLS 2000 and video recorder – an almost classical set-up for post production in Japan.

We wish SRJ all success for their first exhibition.

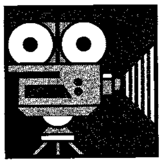
Paul Meisel

Great success

Revox at the Fera 1983

Revox stand 1983: atmosphere of exclusiveness.

At this years Fera (Swiss hifi and video exhibition) Revox ELA AG went to great expenses and the positive reactions proved well worth the effort. Many visitors were attracted by the fact that they were allowed to actually work with every component on display. The highlights at this years exclusive stand were the now "definite" prototype of the Revox CD player as well as the new series 200 units (tuner B261, amplifier B251). Over 16,000 leaflets were given away. This, along with the ever packed auditorium for the acoustical demonstrations indicated the unbroken interest in high quality audio products "made in Switzerland". In looking back, the whole exhibition has been a total success.



Radio Rail

Outside Broadcasting – the Swiss way

Since its pioneer days, the railway has brought people together, be it through point to point links or indirectly through personal contacts among fellow passengers. A new type of railway connection has been established in Switzerland during the summer of 1983: Radio Rail, radio programs from the train.

In cooperation with the Swiss Federal Railways (SBB), broadcasting corporation of Western Switzerland has converted 6 railway cars into a full-scale radio studio. The train composition accommodates 2 audio mixing units, 2 studios, a parlor with bar plus editorial and administrative "rooms".

The technical equipment includes tape recorders STUDER A80 and mixing consoles STUDER 269. The aim of this experimental operation, which had been scheduled as a 9-week tour through Switzerland by Radio Rail, was to become better acquainted with the country and its inhabitants and to create more people-oriented programs.

Studer in the Far East

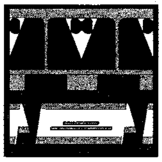
New Generation Mixing Consoles in Hong Kong and P. R. of China

Our Hong Kong team, Studer Revox Far East Ltd. (SRFE), has successfully launched the new mixing console concept in their markets. As the winner of a tender of RTHK (Radio TV Hong Kong), SRFE will in December 1983 install a STUDER 902 mixing console in Hong Kong. Tender specifications ask for "a console required for both live recording and post production operation, in mono and in stereo".

Following a symposium in Canton, P.R. of China, the first STUDER 901 mixing console went to a Chinese customer.

We are pleased about the positive development in the Far East areas.

Paul Meisel



We live and learn

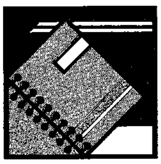
DEUTSCHE WELLE brings African engineers to Switzerland

Only up-to-date knowledge is useful knowledge.

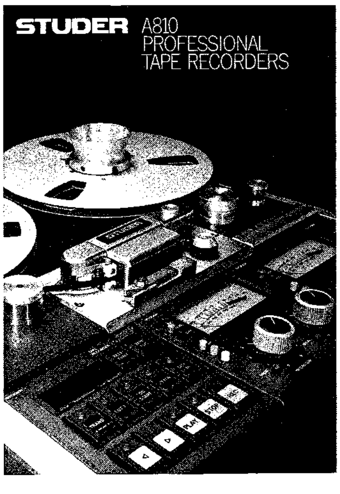
This could have been the basic idea of an information and maintenance symposium which was recently held at Studer International AG. Within the framework of a refresher course offered by the DEUTSCHE WELLE, 12 engineers from 9 French-speaking African countries were acquainted with the tape recorder B67 and the mixing console STUDER 169. The same radio and television engineers had participated in training course conducted by the DEUTSCHE WELLE a few years ago.

In parallel to the course, the entire STUDER product line was introduced. Especially the mobile mixing console STUDER 069 and the local studio generated much interest.

From the printers



10.23.3522 **A810,** Leaflet (e)
10.23.3511 **A810,** Leaflet (d)
10.23.2941 **A810,** OI (d)
10.23.2960 **A810,** OI/SI (d)
10.23.2951 **A810,** OI (e)
10.23.5210 **A810,** OI/SI (e)
10.27.0060 **CAR 3040,** OI/SI (d)
10.23.2610 **A80 VU-PRE,** additional instr. (d/e)
90.148.0 **Revox product catalog** (Spanish)
90.149.0 **Revox product catalog** (Danish)
90.150.0 **Revox product catalog** (Swedish)
90.151.0 **Revox product catalog** (Dutch)
90.152.0 **Revox product catalog** (Italian)
29.001.0 **CD Player,** Leaflet (d)
29.004.0 **CD Player,** Leaflet (e)
30.003.0 **IR Remote Control,** Leaflet (d/e/f)
18.238.0 **B261,** SI (d/e/f)

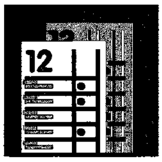


REVOX B251

Design Award

At this years CES (Consumer Electronics Show) in Chicago the new integrated amplifier REVOX B251 won the design and engineering award. In previous years already the receiver B780 and the cassette deck B710 have been honored with this distinction.

Coming events



1983 October 9 - 12: **74. AES New York,** USA
1983 October 18 - 20: **Tokyo Audio Fair,** Japan
1983 October 25 - 27: **INTER BEE Tokyo,** Japan
1983 Oct. 26 - Nov. 1: **TELECOM 83 Geneva,** Switzerland
1983 Oct. 30 - Nov. 4: **SMPTE Technical conference and Equipment exhibition Los Angeles,** USA

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PI = Product information
OI = Operating instructions
SD = Set of diagrams
SI = Service instructions

Sets of diagrams, operating and service instructions available at nominal charge.

For further information please contact