

Recorder having a rotating head drum

For the recording of digital audio or video signals on magnetic record carriers, the signal must be supplied to the recording heads either by using a dc voltage coupling, or, recording codes have to be used which are not only free of dc voltage but also possess the least possible low frequency spectral components. The transmission using the dc voltage components is referred to hereinafter as dc coupling ("direct current"). This requirement will be described with the aid of Fig. 1.

Fig. 1a shows a binary signal which is supplied to the recording heads using dc coupling. The signal amplitude corresponds to the optimal recording current ORC ("optimal recording current"). This is the current with which the greatest reproduction amplitude is achieved for the shortest half waves of the signal. In Fig. 1b, the feeding of the signal occurs without dc coupling. It is apparent that the maintenance of the optimal modulation range for the magnetic tape and the heads is no longer possible. If overloading is to be avoided, then recording can only be effected using half of the signal amplitude. For long half waves, the head current drops to zero so that a recording which is already present is no longer erased when overwriting.

Fig. 1c shows the read signal for a recording carried out using dc coupling. The magnetisation of the recording layer corresponds to the signal in accordance with Fig. 1a. The flux changes at the pulse edges produce the voltage waveform illustrated in Fig. 1c during scanning. By integration of the signal in accordance with Fig. 1c, the signal in accordance with Fig. 1d results. By sampling the signal in accordance with Fig. 1d using the regenerated clock rate in accordance with Fig. 1e, the original binary sequence in accordance with Fig. 1a is reconstituted. This is illustrated in Fig. 1f.

For the magnetic recording using rotating heads, it is known to transmit the recording signal through rotary transformers to the heads arranged on the rotating head drum. DC coupling is not possible here. With the known R-DAT system ("rotating digital audio tape") for the digital recording of sound signals, an 8/10 transmission code is therefore used. Thereby, the bit rate is increased from 8 to 10 bits i.e. by 25%, per data word. This increase of the bit rate is avoidable if one can succeed in supplying the recording signal to the rotating heads using dc coupling.

It is known (DE-A 33 18 987) to use different transmission means for the recording and the reproduction, e.g. separate transducers for recording and reproduction.

For the voltage supply for the active elements on the rotating drum, it is also known (DE-A 35 16 527) to form this drum as a generator which generates the operating voltages for the active semiconductors.

Furthermore, it is known (Patent Abstracts of Japan, Vol 9, No 195 corresponding to JP-A 50-61901) to utilise various, but not different, types of transducer means for the recording and the reproduction, e.g. opto-couplers for both modes of operation.

Some particularly effective combinations of these possible transmission means for the recording and the reproduction are summarised in Table 1. These possible combinations are the combinations numbered 2 - 5. In so far as active elements e.g. amplifier circuits, are required on the drum, the energy needed for the production of the operating voltage must be transmitted to the drum. In the Table 1, the following matters should be taken into consideration:

The rotary transformer is synonymous with non-dc signal transmission. This transmission could also be carried out using a fixed and a rotating capacitive layer or by using ultrasonic sound. The ultra sonic transmission would be expedient for example for a head drum that executed an axial sweep with the help of a hydraulic system. A solution of this type is described in the DE-OS 36 18 661. Therein, ultra sonic transmitters and receivers are in contact with the hydraulic fluid which serves as the medium for the transmission of the signal from the fixed to the rotating part of the head drum. In a so-called matrix type recording in accordance with the DE-OS 35 09 584, successive blocks are written on the tape in tracks running parallel to the edge of the tape by a rotating head drum which is also moved with a sweep motion transversely to the longitudinal direction of the tape. In such a recording, the alterations of the bit rate occurring in dependence on the direction of the sweep are negligible. For non-dc transmission, a signal regeneration i.e. a re-establishment of the dc components, must be carried out on the rotating head drum. For this, the drivers for the generation of the writing current must likewise be located on the head drum. An operating voltage must therefore be available on the head drum. The energy for the production of this operating voltage must likewise be transmitted to the drum. Since the bit rate is required for a correct regeneration of the signal, the operating voltage may be

obtained from the bit rate transmitted to the drum. A different solution consists in that the alternating voltage for the production of the operating voltage has a frequency and phase such that the bit rate can be derived therefrom.

The slip rings are synonymous with a dc transmission, i.e. a signal transmission to the rotating drum using dc coupling. The dc transmission could occur through the bearings of the drum shaft or via mercury contacts.

The opto-coupler is synonymous with carrier frequency transmission. In the case of the opto-coupler, we are concerned with an amplitude modulated electromagnetic wave. It is also possible to envisage an AM or FM transmission over one of the non-dc transmission paths mentioned under 1. In each case, the modulation signal must be reconstituted at the rotating head drum. Basically, a passive circuit using demodulator diodes is sufficient for this. In general however, an amplifier circuit will additionally be required in order to produce the recording current. This is why, as for point a), a means for the transmission of energy for the operating voltage needed on the rotating drum has to be provided here. For a directly driven head drum, a rotor winding of the drive motor may also be used for the transmission of the energy.

Commentary on the possible combinations given in Table 1:

1. The transmission via slip rings for the recording current is relatively simple and advantageous because of the dc coupling. The apparatus is particularly cheap if the slip rings are also used for the transmission of the reproduction signals.

2. It is more favourable, for reasons of the signal to noise ratio, to transmit the unamplified reproduction signal via a rotary transformer. If the same heads are used for the recording and the reproduction, the change over can be effected by relay contacts whereby the current for the relay winding is supplied e.g. via an additional slip ring.

3. The slip rings which are not being used during the reproduction may serve to supply the head drum, during the reproduction, with the operating voltage for the amplifiers located directly on the heads.

4. If amplifiers are located on the rotating part of the head wheel, the reproduction signal may also be supplied via opto-couplers.

5. If, for the transmission of the recording signal via opto-couplers, the operating voltage energy required therefor on the head drum is delivered via a rotary transformer, then this transformer may be used for the signal transmission during the reproduction.

6. - 9. If opto-couplers are used for the recording and the reproduction, an operating voltage is required on the rotating head drum in both cases. The operating voltage energy is transmitted in the same manner for the recording and for the reproduction. Examples for the arrangement of the opto-couplers are illustrated in Figs. 2 and 3. The rotating head drum 3 is driven by the shaft 2 of the motor 1. The opto-coupler 4, 5 serves for the transmission of the recording signal from the fixed transmitter 4 to the receiver 5 rotating with the drum 3. The reproduction signal is transmitted via the opto-coupler 6, 7. Due to the axial arrangement, the transmitter 6 located on the drum 3 requires less power. By equipping the motor 1 with a hollow shaft, both opto-couplers could then be arranged axially. For the purpose of controlling the changing over of the heads in a head drum equipped with a plurality of heads, a piece of information regarding the rotational phase of the drum 3 may be supplied to the circuit on the head drum via the fixed transmitter 8 and the receiver 9 rotating with the drum 3.

In Fig. 3, each head has its own recording and reproducing amplifier as well as an own light receiver 5 and a light transmitter 6. The changing over of the signal transmission is effected by the fixed diaphragm 11 provided with a sector shaped opening. The optical signal transmission is then especially advantageous if different heads are simultaneously operative in the recording and reproducing modes. The light transmission paths for the two directions of transmission may be decoupled as much as desired by shields 10.

10. - 13. If the signal transmission in both directions takes place via the rotary transformer, an operating voltage for a signal regenerating circuit on the rotating drum must be available during the recording. The reconstitution of the dc components by a passive circuit e.g. clamping the signal with the help of a level diode, leads to signal distortions because of the finite slope of the level transitions. Since, for a trouble free signal regeneration, the bit rate is required, this has to be regenerated at the drum or transmitted to the drum. The latter is certainly expedient, whereby, the bit rate must be transmitted with such high power that the operating voltages required on the drum can also be derived from it. The digital signal may be supplied in the form illustrated in Fig. 1c via

the rotary transformer. The correct digital signal for the production of the recording current is then recovered on the drum by integration (Fig. 1d) and scanning at the clock rate e .

During reproduction, the heads may be coupled directly to the rotary transformer in the conventional manner. Since an operating voltage is available on the drum, the arrangement of the pre-amplifiers directly on the heads only means a minimal increase in cost.

In order to "buffer" the increased energy requirement during recording, an operating voltage accumulator, which is charged at times of lower energy requirement e.g. on standby or during reproduction, may be arranged on the drum.



Claims

1. Recorder having a rotating head drum in which the signal is transmitted by means of a transmission member between a stationary part and the head drum (3), characterised in that, the signal transmission is effected during the recording and during the reproduction via different types of transmission members (4 - 9) that are allocated to the head drum (3) and which operate in accordance with different forms of physical coupling.
2. Recorder in accordance with claim 1, characterised in that, the signal transmission is effected during the recording via slip rings and during the reproduction via a non-conductive transmission member and the slip rings serve for the supply of an operating voltage for signal amplifiers arranged on the head drum (3) during the reproduction.
3. Recorder in accordance with claim 2, characterised in that, the non-conductive transmission member is a rotary transformer or an opto-coupler (4 - 9) (Figs. 2, 3).
4. Recorder in accordance with claim 1, characterised in that, for the transmission of the recording signal via an opto-coupler, an operating voltage is supplied to the head drum (3) via a rotary transformer which serves for the signal transmission during the reproduction.
5. Recorder in accordance with claim 1, characterised in that, the operating voltage for signal amplifiers arranged on the head drum (3) is derived from a rotor winding of the drive motor (1) for the drum (3).
6. Recorder in accordance with claim 1, characterised in that, an operating voltage for signal amplifiers arranged on the head drum (3) is obtained from a clock bit pulse of the signal transmitted to the drum (3).
7. Recorder in accordance with claim 1, characterised in that, the head drum (3) contains an accumulator which is discharged during the operating mode having the highest energy requirement (e.g. recording) and is charged during the remaining times.
8. Recorder in accordance with one or more of the preceding claims, characterised in that, the signal transmitted to the drum (3) is regenerated during the recording before it is supplied to the heads.



9. Recorder in accordance with one or more of the preceding claims, characterised in that, the transmission member not currently being used for the transmission of signals serves for the transmission of energy.