

The invention relates to a method for the transmission of a signal including a pilot and/or synchronising signal whose frequency lies close to the lower frequency limit of the transmission channel.

In the R-DAT (Rotational Digital Audio Tape) recording method, digital audio signals are recorded along helical tracks of a magnetic tape using a plurality of heads. Thereby, the recording bit rate of the digital audio signal amounts to e.g. 9.4 Mbit/s.

In a recording method of this type, it is known (IEEE Transactions on Consumer Electronics, Vol CE-32, No 3, August 1986, pages 425 - 432) to record, on each occasion, a so-called ATF (Automatic Track Finding) signal, which serves for controlling the heads or the tape transport in the sense of an exact track following during the reproduction, alternately with the wanted signal along parts of the recording track. Since, for an automatic control of the track following, the signals in the adjacent track have to be read, and thus, the so-called azimuth losses which are effective for attenuating cross-talk between adjacent tracks must not be permitted to be effective, a low frequency of approximately 130 kHz which lies at the lower limit of the transmission range is used for an ATF signal of this type.

It has been shown that, when transcribing, an ATF signal of this type causes problems during the erasure of the recorded signal because of its low frequency. Thereby, due to non-erased vestiges of the ATF signal, there is an impairment of the effect of the ATF signal in the course of the control of the track following.

The object of the invention is to so develop the method of the type described that problems do not arise during the erasure process despite the low frequency of the ATF signal and that the effect of the ATF signal for the control of the track following is not disadvantageously affected.

This object is achieved by the invention described in claim 1. Advantageous developments of the invention are described in the appendant claims.

Due to the interruption of the respective half-waves of the pilot or synchronising signal in accordance with the invention by means of the short keying actions at another amplitude value e.g. that of the opposite half-wave, large high frequency spectral components are supplied to the pilot signal. The problems occurring during the erasure of the signal are thereby overcome. Nevertheless, the fundamental wave of the signal can

be evaluated unchanged for the ATF control of the track following. Preferably, the interruption i.e. the keying, of a half-wave is linked on each occasion to the bit rate of the wanted signal that is being recorded. There thus results the advantage that the timing is also maintained during the recording of the ATF signal. Thereby, disturbances of the synchronisation are reduced during the recovery of the clock pulses. If necessary, an additional run-in signal that was previously recorded in connection with the ATF signal can be dispensed with. It has been shown moreover, that the reproduction level for the low pilot frequencies is increased by the interruptions in accordance with the invention. In addition, the effect of the ATF control of the track following or of the synchronising signals is thereby improved.

The invention will be explained hereinafter with the help of the drawing. Therein

Fig. 1 shows the signal waveform using the keying action in accordance with the invention (line C),

Fig. 2 the arrangement of ATF pilot signals on the tape,

Fig. 3 selection curves in the evaluation circuit for the signals in accordance with Fig. 2 and

Fig. 4 the amplitudes of the keyed signals in accordance with Fig. 2

Fig. 1A shows a PCM signal which is transmitted using 8/10 modulation for example. The bit rate of the transmitted signal is f_{ch} . 10 periods of a pilot frequency $f_p = f_{ch}/n$ are inserted into the PCM signal. The level transitions of the pilot signal lie in the time raster specified by the bit rate.

The first period of the pilot signal is illustrated in Fig. 1B for $n = 40$.

The half-waves of the pilot signal are interrupted by short keyings at the amplitude value of the respective opposite half-wave in Fig. 1C. The keying action ensues each time for the duration of one bit. The pilot signal maintains its original amplitude value for the duration of 3 bits between the keying actions.

The pilot signal prepared in this manner provides advantages above all, for the magnetic recording without an erase head by virtue of a better erasure of the old recording. For general signal transmission, the advantages consist in the higher clocking value of the signal. The regeneration of the clock pulses or the maintenance of a synchronous state during the

pilot time is made more certain, or even, is actually made possible.

However, it is also apparent that the energy of the fundamental wave of the pilot signal is reduced by the keying action. In order to clarify what the consequences of this fact are, for a magnetic tape transmission, the experiment exemplified by Figures 2, 3 and 4 was carried out. Above all, through the experiment, it is sought to clarify whether the "chopped pilot" produces any disadvantages as regards the use of the pilot signal for the purposes of track following (ATF).

The experiment was effected with an 8 mm video recording device in the long play mode. Thereby, the pattern of two pilot frequencies P1 and P2 illustrated in Fig. 2 was used. Thus then, the sequence P1, P2, P1, P2 was associated with the one head while the other head received the sequence P2, P1, P2, P1. Each head recorded the sequence allocated to it twice in succession per track whereby the first sequence contained the chopped pilot (Fig. 1C) and the second sequence the pilot in accordance with Fig. 1B. The remainder of the recording consisted of a PCM signal using 8/10 modulation. The recording bit rate amounted to 11.264 Mbit/s i.e. $f_{ch} = 11.264 \text{ MHz}$. The pilot frequencies amounted to $P1 = f_{ch}/72 = 156.4 \text{ kHz}$ and $P2 = f_{ch}/48 = 234.7 \text{ kHz}$. The duration of the individual sections of the pilot amounted to approximately 64 μs i.e. they corresponded to the track displacement that is contingent on the helical track recording.

In the reproduction mode, the head is so guided that it projects equally far over the two adjacent tracks (Fig. 2). Thereby, as a result of the azimuth protection, only the PCM signal from the central track b can induce a signal voltage in the head. The low pilot frequencies are not subject to the azimuth protection. Here, the signals from the adjacent tracks a and c also have an effect on the head in the track b. The scanned signal was represented in the form of an oscillogram (Fig. 4) at the output of two band pass filters whose frequency responses BP1 and BP2 are illustrated in Fig. 3. Each band pass filter was tuned to one of the two pilot frequencies and suppressed the respective other pilot frequency and the PCM signal.

The oscillogram shows the output signal of BP1 above and the output signal of BP2 below. As a result of the rapid fall of the frequency response of the magnetic tape transmission towards the lower frequencies, the amplitude of P1 is markedly smaller than the amplitude of P2. While, for P2, the chopped pilot (region C) is transmitted, as expected, with a lower amplitude than the conventional pilot (region B), the opposite is the case for the lower frequency pilot P1. This indicates that the keying of the

pilot frequency below a specific frequency, which here is approximately 200 kHz, is also advantageous for the magnetic tape transmission as regards the reproduction level.

In the experiment described here, the keying of the pilot half-waves occurred as described in Fig. 1 i.e. on each occasion, after three bits of unaltered half-wave amplitude, the amplitude value of the opposite half-wave was keyed-on for the duration of one bit. Naturally, the keying of the pilot may also occur in other ways. For this, some possibilities are specified in the appendant claims.



Claims

1. Method for the transmission of a signal including a pilot and/or synchronising signal whose frequency (P1, P2) lies close to the lower frequency limit of the transmission channel, characterised in that, the half-waves of the pilot or synchronising signal are interrupted by keying operations, which are short in comparison with the period of the pilot half-waves, of an amplitude value (0 or 1) which deviates from the instantaneous amplitude value of the pilot half-wave.
2. Method in accordance with Claim 1, characterised in that, the keyed-in amplitude value is the amplitude value of the opposite half-wave.
3. Method in accordance with Claim 1, characterised in that, the separation in time of the keying actions is constant.
4. Method in accordance with Claim 1, characterised in that, the separation in time and/or the duration and/or the keyed-in amplitude value of the keying actions corresponds to a further signal.
5. Method in accordance with one or more of the preceding Claims, characterised in that, during the transmission of a digital signal, the keying action is linked to the bit rate of the digital signal.
6. Method in accordance with Claim 5, characterised in that, the keying frequency is equal to the word frequency or equal to an integral multiple of the word frequency of the digital signal.
7. Method in accordance with Claim 4, or 5, characterised in that, the keying action contains an item of information.
8. Method in accordance with Claim 5 or 6, characterised in that, the duration of the keying action coincides with the bit length of the digital signal.
9. Method in accordance with one or more of the Claims 5 ... 8, characterised in that, the number of bits occurring between 2 keying actions does not exceed the maximum run length of the digital signal.
10. Method in accordance with Claim 7, characterised in that, for a recording device in which one or more keyed pilot frequencies are evaluated for the track following (ATF), the item of information contains the propositions required for the evaluation.