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NASA TECH BRIEF

Radio Frequency Baseband Recording Technique

The problem:

To provide inexpensive magnetic tape recording, for historical and analytical purposes, of a 112-channel, phase-locked, multiplexed, baseband signal. Prior techniques for recording this type of signal use a modified transverse scan video recorder, a device which is very complex and expensive and which requires highly skilled operating and maintenance personnel.

The solution:

A new technique that uses a helical-scan video recorder with auxiliary signal-conditioning equipment. This technique provides a high-capacity recording system at less than one-fourth the cost of the older method.

How it's done:

The baseband signal being recorded is a frequency-division multiplexed, single sideband (SSB) signal, transmitted on 75-ohm coaxial cable. The signal is derived by 0.3 to 3.0-kHz audio modulation of a 500-kHz signal which results in a 500.3-to 503-kHz i.f. signal after filtering to remove the unwanted lower sideband. This i.f. signal is then mixed with a locally synthesized frequency in the 516-to 906-kHz range and filtered to remove the upper sideband to result in a 16-to 460-kHz transmitted SSB frequency. The precise synthetic frequency within this 516-to 906-kHz range that is used determines the transmission channel. The 500-kHz fundamental used to derive the i.f. and the synthesized carrier modulation frequency are both derived from a 4-kHz signal carried with the SSB to phase lock all the mixing frequencies and provide system coherence. The SSB frequency of 16 to 460-kHz provides 112 channels of 4-kHz bandwidth of which 3 kHz is in audio information and 1 kHz is in the guard bands. The composite signal amplitude is 180 mV, p-p, of which 30 mV is rf baseband.

The property of the signal which contributes the major problem is the difference in amplitude between the rf portion of the signal which contains all the intelligence and the 4-kHz reference signal which provides phase lock to the system. Recording the signal as transmitted results in a poor signal-to-noise ratio (SNR) between the rf part of the signal and the recorder noise level even though the SNR of the composite signal is more than 35 db.

Signal processing has been developed to overcome the problem in the following manner.

The signal is processed first by a signal separator unit which separates the 4-kHz reference signal and the rf signal. The signal separator consists of a linear-phase, high-pass active filter and a low-pass active filter followed by driver amplifiers to amplify the signals. The 4-kHz reference signal is sent directly to the recorder where it is recorded on one of two auxiliary audio-bandwidth edge tracks. The rf signal is further amplified by an adjustable linear amplifier with built-in overload protection and indication. The amplified signal is recorded then on the helical-scan video track of the recorder.

In the reproduce mode the 4-kHz reference signal from the auxiliary track is used to trigger a variable phase signal generator to produce a new 4-kHz reference signal which is adjustable in phase through 180°. The rf repro signal is sent to one input of a wideband summing amplifier with adjustable gain or attenuation. The regenerated 4-kHz reference signal is sent to the other input of the summing amplifier where the two separate signals are adjusted to correct

(continued overleaf)

amplitudes and added together to result in a composite reproduction of the original signal. Recording the 4-kHz reference signal on the auxiliary track provides coherence to the reproduced composite signal when the reference signal frequency drifts or is degraded by the transmission media. In cases where the received reference signal is stable, the signal generator may be used in free-running mode to generate the new reference signal.

To enhance the long-term, time-displacement error and flutter characteristics of the recorder, which is referenced to the 60-Hz ac power input, a precision ac power source is used which provides 1% line and load regulation and crystal-referenced 0.01% frequency stability. This enables the helical-scan recorder to perform to much closer tolerances than would normally be expected from this type recorder. The recorder used is selected because it is the only helical-scan wideband recorder available using a two-head scanning technique, to provide overlap between successive tracks being scanned. Other helical-scan recorders available are designed for video recording only and, as a result, use a single head scanning technique, relying on the blanking period between video picture frames to mask the gap between one helical track and the next.

Notes:

1. This technique is advantageous for recording any rf baseband signal comprising closely spaced channels of information (e.g., telecommunications logging and historical reference). By use of multichannel multiplexers the recording of many individual voice channels (e.g., aircraft and marine communications bands) can be added.
2. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Headquarters
   National Aeronautics
   and Space Administration
   Washington, D.C. 20546
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Patent status:

No patent action is contemplated by NASA.

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