

NICAM (Near Instantaneous Companded Audio Multiplex) is a digital audio transmission technique that transmits the television sound with high quality and reliability in stereo. This method is described in detail in: "NICAM Digital Stereo", Electronics and Wireless World, August and September 1989; "NICAM 3 Near-Instantaneously Companded digital transmission system for high quality sound programmes", The Radio and Electronics Engineer, Vol. 50; British Broadcasting Corporation: Specification of a Standard for UK Stereo-with-Television Transmissions, September 1986.

DAB (= Digital Audio Broadcasting, "DAB" is a trade mark for TELEFUNKEN Fernseh und Rundfunk GmbH) is an abbreviation for the digital terrestrial audio broadcasting which is being developed in context of the European research initiative EUREKA 147-DAB. The principles of DAB are described in "Funkschau" issue No. 8, 1990, part: Funkschau Spezial, pages 9 through 18.

In the following, particularly the modulation method of the NICAM audio carrier, which is very similar to the modulation method used with DAB, will be described without demonstrating all details of the NICAM or DAB systems. For transmitting on a restricted band channel, a serial data stream is coded and modulated in a NICAM encoder on the broadcast (station) side by means of the Differential Quadrature Phase Shift Keying (DQPSK) technique (Fig. 4).

This method of modulation is a restricted band width modulation method and enables a comparatively simple construction for the demodulators within the broadcast receiver. Instead of the special DQPSK or QPSK the invention relates to all PSK modulation methods, i.e. also to, for example, 2-PSK, 8 PSK and so forth, which are also being discussed for DAB. In the following, PSK shall be used also as a general term for the various forms of this type of modulation.

On the broadcast side, every two bits of the serial data stream are combined into one dibit (= symbol, baud) in a DAB or NICAM, or DQPSK encoder. The four possible dibit combinations (00, 01, 10, 11) result in a phase shift of a (complex) pointer by 0, -90, -270 or 180 degrees.

The current position of the pointer is expressed by means of the coordinates I and Q (see Figs. 3 and 4). This position changes with the symbol rate which corresponds to half the data rate. In NICAM 728, with a data rate of 728 kbit, this is $728/2 = 364$ kbaud/s. With DAB different data rates are provided depending on the particular use. In the receiver, the data stream can be unambiguously regained in a DAB or NICAM decoder which contains a DAB or NICAM demodulator and is constructed the opposite way (inversely) to the encoder, in that one simply determines the phase difference of two symbol times and assigns one dibit to that according to the above rule. Following that, the pair of signals I and Q is always fed to a low-pass filter. This determines the band width and the spectral form of the audio signal to be transmitted in the transmission channel (spectrum shaping).

A filter which is, as far as possible, identical is used on the receiver side (Fig. 3). The resulting band width and its spectral form are expressed by means of the

so-called roll-off factor in a formula-type representation of the low-pass filter. In this factor, the NICAM systems differentiate themselves according to the I and B/G standards.

In the modulator on the broadcast side, the filtered pair of signals I and Q is brought into the sound IF position by means of modulation using two carriers in quadrature to each other. Here, it can be added to the rest of the spectrum, consisting of picture and FM mono signal, and the total then brought into the VHF or, respectively, UHF position. In the receiver, the pair of signals I and Q or, respectively, the audio data are retrieved in a corresponding decoder, or rather, in the demodulator.

It is the object of the invention, with a television or radio receiver of the afore-mentioned type and upon reception of digitally coded PSK modulated audio signal, to make available at the broadcasting loudspeakers a high quality audio signal.

This task is solved according to the invention by the features according to claim 1. Advantageous further developments are described in the subclaims.

By means of the invention, a known fade regulation or fade regulating circuit is used for the DAB or NICAM audio carrier whereby the regulating voltage variable for the controllable IF amplifier is gained from the nPSK or QPSK or DQPSK demodulator.

With the fade regulation in a television receiver, it is known (DE-A-31 44 097) to obtain from the amplitude of the video signal a regulating voltage and to use this to regulate the amplification of the IF amplifier in such a way

that the video signal has a constant amplitude which is, as far as possible, independent of the received field strength. Such fade regulating circuits are also designated AGC (Automatic Gain Control). The regulating voltage can be obtained in a known manner, for example, from the video signal by means of peak rectification or formation of mean values in a filter section.

However, the regulating voltage variable is according to the invention preferably made available at the outputs I and Q of the demodulation filters in the PSK demodulator. Herefor, the pair of signals Q and I is fed to a suitable circuit in the PSK demodulator at the output of which the variables I and Q or I^2 and Q^2 corresponding to the regulating voltage can be picked up.

By means of the invention, a clear improvement in audio quality is achieved, whereby an effective solution to sound/picture problems in a television receiver is achieved, in a surprisingly simple way, through the feedback of the signal pair Q and I. Moreover, the existence of other possible signals, in particular analog signals, does not have a disturbing effect on the amplification regulation so that the entire fade regulation is very stable and not susceptible to interference.

In the following, an embodiment example of the invention is better illustrated by means of a diagrammatic representation. Illustrated in the drawing are:

- Fig. 1 an arrangement of a fade regulating circuit in the signal path to the NICAM demodulator;
- Fig. 2 one possibility for realizing the fade regulating circuit;
- Fig. 3 the internal structure of a NICAM-QPSK demodulator;

- Fig. 4 a block circuit diagram of a NICAM encoder;
Fig. 5 a block circuit diagram of a NICAM decoder;
Fig. 6 a block circuit diagram of a fade regulation
in the DAB signal path.

Fig. 1 shows a block circuit diagram consisting of a television receiver in which a controllable amplification stage 1, "Gain Control Stage", is situated in the signal path of the NICAM sound carrier the output of which is connected to the QPSK input of a NICAM-QPSK demodulator 17 (in this case an MAS7A101 NICAM-QPSK demodulator).

One possible way of realizing the switchable amplification stage 1, according to Fig. 1, is illustrated in Fig. 2. The intermediate frequency signal 3, which contains the QPSK signals Q and I from the Q/I output of the demodulator 17, is amplified via a transistor 2. This amplification is regulated in accordance with an AGC. For this, the amplification of this stage must be altered. This is possible by means of a displacement of the operating point at the base of the transistor 2, but also by means of a reverse feedback. One possibility herefor is to realized the reverse feedback using the resistor 4. If the reverse feedback is altered, the amplification is correspondingly modified. A capacitor 5, connected, like the resistor 4, to the emitter of the transistor 2, also serves for the reverse feedback, but only for high frequencies. The high frequencies are fed in via a field effect transistor 6, the source electrode of which is connected to the capacitor 5. The drain terminal of the field effect transistor is grounded. The gate input of the field effect transistor connected with a capacitor 7 which is also grounded. Apart from that, the gate electrode is connected with the emitter of a transistor 9 via a resistor 8.

If there is no current flowing in the field effect transistor (FET), then the capacitor 5 is practically disconnected from the emitter of the transistor 2. The reverse feedback is then at maximum and the amplification at minimum. The collector of the transistor 2 is connected with a resistor 14, to which a supply voltage V_S is applied. Moreover, the collector of the transistor 2 forms the output for the fade regulating circuit and is connected to the input or, respectively, the inputs of the QPSK demodulator (Fig. 3; pins 3, 12 and 13). Thus, the reverse feedback is only altered for high frequencies.

In order to suitably process the signals from the Q/I output of the QPSK demodulator for the fade regulating circuit, the pair of signals Q and I from the output Q (pin 14 in Fig. 3) and I (pin 11 in Fig. 3) of the NICAM-QPSK demodulator 17 is fed firstly to a capacitor 10, as shown in Fig. 2. The capacitor is connected with the base of the transistor 9, with a resistor 11, and with a further capacitor 12. The resistor 11 is grounded just like the emitter of the transistor 9. The collector of the transistor 9 is connected with the capacitor 12, with the resistor 8, and a further resistor 13, to which the supply voltage V_S is applied.

The way in which the pair of signals Q and I are obtained in the QPSK demodulator is shown in Fig. 3. This illustrates the internal structure of a NICAM-QPSK demodulator 17, in this case an MAS7A101. The QPSK subcarrier demodulator according to Fig. 3 consists of an input amplifier with two outputs, a switch-type multiplier, a voltage-controlled crystal oscillator and a 90 degrees phase shifter. The crystal oscillator oscillates at four times the QPSK intermediate carrier frequency, for example,

26.408 MHz in the I-system and 23.4 MHz in the B-/G-systems (for example, Germany, Scandinavia).

The demodulated data is fed to a Nyquist filter which provides a 100 per cent roll-off answer with a system B and G. Following phase detection and low-pass filtering, the pair of signals Q and I is available at the outputs 11 and 14 of the demodulator. The output values of Q and I or Q^2 and I^2 are fed back, as described above, for automatic amplification regulation 1 to the input of a corresponding fade regulating circuit as shown in Fig. 2. The same data is also sent via the inputs 12 and 13 into the decision and bit clock regaining block of the demodulator according to Fig. 3..

Fig. 4 illustrates a NICAM encoder on the broadcast side. A corresponding NICAM decoder 16 for retrieving the signal is provided in the broadcast receiver and this contains or is connected downstream from, for example, the NICAM-QPSK demodulator according to Fig. 3.

The auxiliary carriers used in a NICAM system are regenerated in the tuner and IF demodulator section of a television apparatus. The auxiliary carrier signal is then clamped onto the NICAM module which is responsible for the three functions QPSK demodulation, NICAM decoding and digital-to-analog conversion. In the demodulator block the serial bit stream is separated from the modulated carrier signal. For this, different demodulation filters are used, depending on the frequency. Noise caused by FM signals and video carriers as well as the number of possible bit errors are vitally determined by the quality of the filter construction. Subsequent to the filtering, the demodulated data stream is fed to the NICAM decoder MAS7D102 which

executes exactly the reverse function as the transmitter or, respectively, encoder. Fig. 5 shows the internal design of of the NICAM decoder MAS7D102. The decoded data from the decoder are fed to a converter (MAS7A103) adapted to the decoder which carries out the digital-to-analog conversion. All three specific NICAM components may also be integrated together with the AGC regulation circuit 1 in one component.

Fig. 6 shows the fade regulation according to the invention for an application in a DAB receiver with which the signals from the I and Q output of the QPSK demodulator 17 are first fed each to a squaring element 19a and 19b, subsequently to an adder 20 and, thereafter, to a low pass 21. Then, using the regulating voltage ($I^2 + Q^2$) so obtained, a double or two-stage fade regulation is performed whereby the first AGC stage 22 of the fade regulation is provided in the tuner and the second AGC stage 23 between the tuner and the demodulator, similarly to the above described NICAM example.

The digital broadcasting signals fed to the tuner are first fed to a band pass 29 and then, under consideration of the regulating voltage variable $I^2 + Q^2$, amplified in an amplifier 22, the first AGC stage. The amplified signal is fed from the output of the amplifier 22 to an input of a mixer 24 which in turn is controlled by a VCO 25 (voltage controlled oscillator). Subsequently, the output signal of the mixer 24 is fed to, successively, a further band pass 26, an amplifier 27 and a SAW filter 27 (Surface Acoustic Wave) and then to the second AGC stage 23. The output of the second AGC stage is connected to the data input of the PSK demodulator.

Instead of the two squaring elements 19a and 19b and the adder 20 it is also possible to provide one single

circuit 19, 20 taking over the functions of the squaring
elements 19a, 19b and the adder 20 (see Fig. 6a).



CLAIMS

1. A television or radio receiver with intermediate frequency amplifier means (1, 23) having automatic regulation of the amplification and, subsequently, signal demodulator means containing an audio signal demodulator, in which the audio signal demodulator is a digital signal demodulator (17, 19, 19a, 19b, 20) for receiving a PSK or QPSK or DQPSK signal, **characterised in that** the automatic regulation of amplification for the intermediate frequency amplifier means (1, 23) and for the automatic regulation of amplification of a tuner unit or a tuner-amplifier (22) is derived from the output signal or signals (I, Q) of the digital signal demodulator (17, 19, 19a, 19b, 20).
2. A television or radio receiver according to claim 1, **characterised in that** the digital signal demodulator (17, 19, 19a, 19b, 20) is a NICAM or DAB demodulator.
3. A television or radio receiver according to claim 1 or 2, **characterised in that** the digital signal demodulator (17, 19, 19a, 19b, 20) has two quadrature carrier output signals (I, Q) which are each squared (19a, 19b) and summed (20) in order to form the regulating signal for the amplification.