

The invention relates to a compatible television transmission process.

Such transmission processes are known from the following publications:

Toth, A.G., Tsinberg, M. Rhodes, C.W.: "NTSC Compatible HDTV System", IEEE Transactions on Consumer Electronics, Feb. 1988;

Isnardi, M.A. et al.: "Encoding for Compatibility and Recoverability in the ACTV System", IEEE Transactions on Broadcasting, Vol. BC-33, No. 4, Dec. 87;

Schreiber, W.F.: "Improved Television Systems: NTSC and Beyond", SMPTE Journal, Vol. 896, No. 8, August 87;

Tonge, Gary: "Compatible HDTV", Broadcast Systems Engineering, July 1988;

Glenn, William E., Glenn, Karen G.: "High Definition Television Compatible Transmission System", IEEE Transactions on Broadcasting, Vol. BC-33, No. 4, Dec. 87;

Nishzawa, T. et al: "HDTV and ADTV Transmission Systems. MUSE and its Family", NAB Las Vegas, April 1988.

For improved television transmission systems, simply for reasons of acceptance by the public it has proved necessary to increase the picture-aspect ratio of television receivers from the previous 4:3 to 16:9 (= recommended picture format of future HDTV standards) without sacrificing compatibility with existing television standards (PAL, NTSC, SECAM).

Various proposals whereby an enlarged picture-aspect ratio can be obtained have been disclosed in the publications mentioned in the introduction, and these will be explained making reference to Fig. 1a to 1i.

1. In the case of the proposal according to Fig. 1a, e.g. in the case of the scanning of wide screen films, by the omission of lines at the upper and lower picture

edges of a 4:3 picture format a portion of the picture is produced in accordance with a 16:9 picture format. For example with the PAL- and SECAM- standards this means a reduction in lines from 575 active lines to 431 active lines. Although the complete picture content would be reproduced on the compatible 4:3 receiver (Fig. 1b), it would comprise only 431 active lines and black bands at the upper and lower picture edges. Although these black bands would disappear on a 16:9 receiver (Fig. 1c), then, because of the reduced number of lines, the resolution is impaired compared to conventional scanning with 575 active lines.

2. In the case of the proposal according to Fig. 1d, during the scanning at the picture source the line length is increased relative to the picture height so that a picture in the 16:9 format is obtained. The side portions which supplement the 4:3 format to form the 16:9 format are transmitted in such manner that they are not processed by a conventional 4:3 receiver (Fig. 1e). Although this leads to reproduction with unreduced vertical resolution (e.g. 575 active lines with the PAL- and SECAM- standard), the picture information contained in the side portions is lost on the 4:3 receiver. The 16:9 receiver (Fig. 1f), on the other hand, reproduces the full picture information with 575 active lines. However, in this case the picture information which is contained in the side portions (Fig. 1d) and which is separately transmitted and received is added on, leading to visible joins.
3. In the case of the proposal according to Fig. 1g (e.g. D2-MAC-specification) again the line length is increased in relation to the picture height during the scanning at the picture source, so that again a picture format of 16:9 is obtained. In contrast to 2),

however, the side portions are transmitted not separately but continuously. Therefore the 16:9 receiver (Fig. 1i) offers an image with the complete picture information and 575 active lines, but without the disadvantage of lateral joins. On the other hand, geometric distortions occur on the known 4:3 receiver (Fig. 1h) unless additional measures are employed. In the case of MAC receivers it is provided that the vertical amplitude or time decompression be changed by the transmission of a control signal, in such manner that the geometric distortions are compensated. However, when the line compression is changed, picture content is lost on a 4:3 receiver. In the case shown in Fig. 1h of a change in the vertical amplitude, although black bands occur at the upper and lower picture edges, the complete picture content is reproduced. However, with the conventional television standards, PAL, NTSC and SECAM, automatic geometric correction is not possible.

The aim of the invention is to provide a television transmission process which is compatible with conventional television standards (PAL, NTSC, SECAM) and which, using 16:9 scanning at the picture source, permits reproduction on a 16:9 receiver with practically full, system-inherent quality without giving rise to picture distortions on conventional 4:3 television receivers.

This aim is fulfilled by the features of Claims 1 and 2. Advantageous further developments of the invention are described in the sub-claims.

The invention will be explained in the form of an exemplary embodiment illustrated in the drawings. In the drawings:

- Fig. 2a is a block circuit diagram of the transmitter-end embodiment of a television transmission system using the process according to the invention;
- Fig. 2b is a block circuit diagram of the receiver-end arrangement in the television transmission system according to Fig. 2a.

In Fig. 2a a picture source 10 scans a picture in a raster with a 16:9 picture ratio. In the illustrated example the picture signals generated by the picture source 10 correspond to a standard of 625/50/2:1, 625/50/1:1 or 1250/50/2:1, corresponding to a number of lines of 625 or 1250, a frame frequency of 50 Hz and progressive (1:1) or interlaced scanning (2:1). The band width of the picture signal at the output of the picture source 10 amounts for example to 10 MHz in the case of 625/50/2:1 and to 20 MHz in the two other cases.

In the case of 625/50/1:1 and 1250/50/2:1 the picture source 10 is followed by a first down conversion stage 20 by which the picture signal at the output of the picture source 10 is converted into a picture signal corresponding to a conventional television standard of 625/50/2:1.

The 625/50/2:1 picture signal is fed to a picture signal processing stage 30 which represents the crux of the invention at the transmitter end. The picture signal processing stage 30 comprises a second down conversion stage 31 which in each case selects three of four lines of the incoming picture signal. This can take place in that either every fourth line of the picture signal is separated out or, as will be explained in the form of an example, of four consecutive lines of the incoming picture signal three lines are interpolated. As a result of this 4:3 conversion in the second down conversion stage 31, from the 575 active lines of the input picture signal, 431 active lines are produced.

The signal at the output of the second down conversion stage 31 is fed both to a selection stage 33 and to a multiplexer 32 (store). By comparing the picture signal at the input of the picture signal processing stage 30 with the down-converted picture signal at the output of the second down conversion stage 31, the selection stage 33 processes those 144 lines and picture contents which are lost by the down conversion in the second down conversion stage 31. In the multiplexer 32 the picture signals of the second down conversion stage 31 and of the selection stage 33 are arranged in such manner that the lines of the down-converted signal of the second down conversion stage 31 are disposed symmetrically in relation to the picture centre and are spatially compressed, and that in each case half of the 144 lines from the selection stage 33 are added in the spatial gaps released at the upper and lower edges of the picture.

The output signal of the multiplexer 32 and of the picture processing stage 30 is coded in a following PAL coder 40. The lines from the selection stage 33 which are added in the spatial gaps at the upper and lower picture edges can be scrambled in the scrambling stage 50 following the PAL coder 40 in order to be reproduced on a conventional 4:3 receiver 120 (Fig. 2b) in the form of noise bands at the upper and lower picture edges. These are not so disturbing to the viewer of a 4:3 receiver 120 as a strongly compressed picture content comprising the fourth lines in these strips.

The signal at the output of the picture signal processing stage 30 possesses a band width of 10 MHz corresponding to a band width of the signal at the output of the first down conversion stage 20. In order to produce a compatible PAL signal from the 10 MHz picture signal, the PAL coder 40 can carry out frequency splitting, in accordance with which the signal spectra up to 5 MHz are processed in a first channel and the signal spectral from 5 to 10 MHz are processed in a

second channel. This can for example advantageously take place in accordance with a process corresponding to DE-PS 33 38 192 in order to avoid cross-talk effects between luminance- and chrominance components. The second channel can be transmitted in a substantially unutilized spectral space within the first channel. However, the band width of the picture source can also be reduced by half, whereby a band width of 5 MHz is utilized for the reproduction on the 16:9 receiver.

Alternatively to the embodiment illustrated in Fig. 2a, the first down conversion stage 20 can also be arranged following the picture signal processing stage 30, which can have advantages for the down conversion in the second down conversion stage 31. Furthermore, the scrambling stage 50 can alternatively be arranged in the signal arm between the selection stage 33 and the multiplexer 32.

The down conversion provided in the case of the embodiment according to Fig. 2a (first down conversion stage 20) either from a progressive picture signal standard (625/50/1:1) or from a picture signal standard with a larger number of lines (1250/50/2:1) permits correct vertical pre-filtering of the output signal of the television picture source 10. This serves to reduce alias disturbances. Advantageously this pre-filtering can be carried out movement-adaptively.

In the spatial gaps at the upper and lower picture edges, in accordance with DE 3929967, coefficients of a vertical discrete cosine transform can also be transmitted, with the aid of which in the 16:9 receiver 575 active lines are obtained from the 431 active lines and on a 4:3 receiver appear more similar to a noise signal.

The receiving-end part of the television transmission system shown in Fig. 2b is connected to the input of a 16:9

receiver 100. Here the transmitting-end signal processing is carried out in reverse order, in that the received signal is fed to a descrambling stage 60 which cancels the scrambling of the lines added at the upper and lower picture edges. The following PAL decoder 70 generates a YUV signal, identified in Fig. 2b by the digit "3", at the signal output of the PAL decoder 70. The YUV signal at the output of the PAL decoder 70 is fed to a picture signal processing stage which embodies the receiving-end crux of the invention. The picture signal processing stage 80 comprises a demultiplexer 81 (store) by which the 431 lines transmitted symmetrically in relation to the picture centre are spatially decompressed (first output 83) and the 144 lines transmitted at the upper and lower picture edges are separated and spatially correctly assigned (second output 84). In the following line combiner 82, the 144 lines (second output 84) are introduced in the correct line sequence into the spatially decompressed 431 lines (first output 83).

The output signal of the picture signal processing stage 80 can be converted in an up conversion stage 90 movement-adaptively from the transmission signal 625/50/2:1 into the reproduction standard 625/50/1:1, 1250/50/2:1, 625/100/2:1 or 1250/100/2:1, in order to obtain an improved picture reproduction on a following 16:9 receiver 100. The picture reproduction corresponds to the illustration in Fig. 1i with the picture-aspect ratio of 16:9 and 575 active lines in the case of the standard 650/50/2:1 or 650/50/1:1 or 625/100/2:1.

Fig. 2c also illustrates the example of a compatible picture signal reproduction with a conventional 4:3 television receiver 120 which contains a conventional PAL decoder 110. The picture reproduction corresponds to the illustration in Fig. 1h where - as already explained in the foregoing - the $2 * 72 = 144$ lines reproduced at the upper and lower picture

edges appear as noise bands as a result of the scrambling (scrambling stage 50). No information is lost as a result of the reproduction in the 16:9 format on the 4:3 receiver 120.

The 16:9 receiver 100 is expediently constructed as a multi-standard receiver in order in particular to be capable of also reproducing conventional television signals with a picture-aspect ratio of 4:3, as is the case in particular with archive video material. For this purpose the 16:9 receiver 100 can be designed in such manner that it fully represents the picture width, with the result that information is lost at the upper and lower picture edges. Alternatively, the 16:9 receiver 100 can also be designed in such manner that with a reduced raster size (or reduced vertical amplitude and compression) black bands are formed at the left- and right-hand picture edges.

As already mentioned, the selection of three out of four lines of the picture signal incoming at the input of the picture signal processing stage can alternatively take place in that of in each case four consecutive lines three lines are interpolated. An example of such interpolation is shown in the following Table I.

TABLE I

No. of lines	Line identification	Interpolated 431 lines	Separated 144 lines
1	A	A	
2	B		
		$2/3*B + 1/3*C = B'$	
3	C		C
		$1/3*C + 2/3*D = C'$	
4	D		
5	A	A	

The compatible 4:3 receiver analyzes only the 431 lines in the 16:9 format. In the improved 16:9 receiver all 575 active lines are reconstructed in accordance with the following Table II:

TABLE 2

No. of lines	Reconstruction from the 431 lines and the 144 lines	Line identification
1	A	A
2	$3/2*B' - 1/2*C$	B
3	C	C
4	$3/2*C' - 1/2*C$	D

For television transmission systems with different numbers of lines, for example 525 (NTSC), the numbers of lines and

frequencies referred to in the description are adapted accordingly.

Claims

1. A television transmission process compatible with conventional television standards, wherein at the picture source end scanning is carried out with a raster corresponding to an enlarged picture-aspect ratio, in particular of 16:9, characterised by the following process steps:
 - a) Every fourth one of the active lines of the picture signal is separated and the remaining active lines are correspondingly vertically compressed, so that these remaining lines are arranged one beside another again in the raster;
 - b) in the lines thus released at the upper and lower picture edges the separated fourth lines are added, for example in scrambled form;
 - c) the resultant picture signal is transmitted in coded form and
 - d) from the received, decoded picture signal the original picture signal with the enlarged picture-aspect ratio is reconstructed again in that the lines added at the upper and lower picture edges, optionally following descrambling, are inserted in the correct line sequence into the other, vertically decompressed lines,wherein the signals can be decoded both with conventional 4:3 receivers (Figure 2c) and with receivers (Figure 2b), adapted to the system, for the enlarged picture-aspect ratio, and in the case of conventional 4:3 receivers the separated fourth lines are arranged at the upper and lower picture edges and the remaining active lines are arranged in between.
2. A television transmission process compatible with conventional television standards, wherein at the picture source end scanning is carried out with a raster corresponding to an enlarged picture-aspect ratio, in



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particular of 16:9, characterised by the following process steps:

- a) for four respective consecutive active lines of the picture signal, three lines are formed by vertical interpolation;
- b) for each group of four consecutive lines one line is separated and added, for example in scrambled form, in the lines released by the vertical interpolation at the upper and lower picture edges;
- c) the resultant picture signal is transmitted in coded form and
- d) from the received, decoded picture signal the original picture signal with the enlarged picture-aspect ratio is reconstructed in that the lines added at the upper and lower picture edges, optionally following descrambling, are inserted in the correct line sequence into the other vertically correspondingly inversely interpolated lines,

wherein the signals can be decoded both with conventional 4:3 receivers (Figure 2c) and also with receivers (Figure 2b), adapted to the system, for the enlarged picture-aspect ratio, and in the case of conventional 4:3 receivers the separated fourth lines are arranged at the upper and lower picture edges and the remaining active lines are arranged in between.

3. A television transmission process as claimed in Claim 1 or 2, wherein at the picture source end scanning is carried out without interlacing, characterised in that prior to step a) or following step b) a conversion into the desired television standard with interlacing takes place.

4. A television transmission process as claimed in one of Claims 1 to 3, wherein at the picture source end scanning is carried out with double the number of lines, characterised in that prior to step a) or following step b) a down



conversion into the number of lines corresponding to the desired television standard takes place.

5. A television transmission process as claimed in one of Claims 3 or 4, characterised in that in step d) a conversion into a picture signal which has a higher number of lines and/or is non-interlaced takes place.

6. A television transmission process as claimed in one or several of Claims 1, 2, 3 and 5, characterised in that in the released lines at the upper and lower picture edges items of digital additional information are transmitted, with which, from the lines transmitted in vertically compressed or interpolated fashion, a non-interlaced picture signal or a picture signal with increased horizontal resolution can be formed.

7. A television transmission process as claimed in Claim 6, characterised in that the items of additional information contain coefficients of a monodimensional, vertical, discrete cosine transform.

8. A television transmission process as claimed in one or several of the preceding claims, characterised in that horizontal frequency components of the raster scanned at the picture source end, the frequency of which exceeds the known, maximum transmittable frequency of the transmission channel, are arranged within substantially unused multidimensional spectral spaces of the transmitted television signal.

9. A coder for a television signal which can be transmitted so as to be compatible with conventional television standards, wherein the source picture signal has been scanned with a raster corresponding to an enlarged



picture-aspect ratio, in particular of 16:9, and which comprises:

- a picture signal processing stage (30) which by vertical interpolation (31) for four respective consecutive active lines of the picture signal forms three consecutive lines and which, for each group of four consecutive active lines of the picture signal, separates (33) one line and adds (32) this line, for example in scrambled form, in the lines, released by the vertical interpolation, at the upper and lower picture edges;

- a following colour coder (40), wherein the colour-coded signals can be decoded both with conventional 4:3 receivers and with receivers, adapted to the system, for the enlarged picture-aspect ratio, and in the case of conventional 4:3 receivers the separated fourth lines are arranged at the upper and lower picture edges and the remaining active lines are arranged in between.

10. A decoder for a television signal which can be transmitted so as to be compatible with conventional television standards, wherein the source picture signal has been scanned with a raster corresponding to an enlarged picture-aspect ratio, in particular of 16:9, and the coded picture signal can be decoded both with conventional 4:3 receivers and also with receivers for the enlarged picture-aspect ratio, and in the case of conventional 4:3 receivers separated lines are arranged at the upper and lower picture edges and the remaining active lines are arranged in between and which comprises:

- a colour decoder (70);
- a following picture signal processing stage (80) which vertically decompresses the remaining active lines with a factor $4/3$, where the separated lines, optionally following descrambling corresponding to scrambling carried out at the coder end, are combined with these



vertically decompressed lines in such manner that the line sequence corresponding to the source picture signal is restored.



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