PALplus

A new trend in TV broadcasting is widescreen TV, with its more natural, panoramic field of view. This new trend started with the 16:9 aspect ratio TV receivers now on the market. The picture quality of this natural image has been improved even more with the introduction of PALplus. With PALplus the viewer gains the full benefit of widescreen, as PALplus improves both the TV receiver and the broadcasting signal.

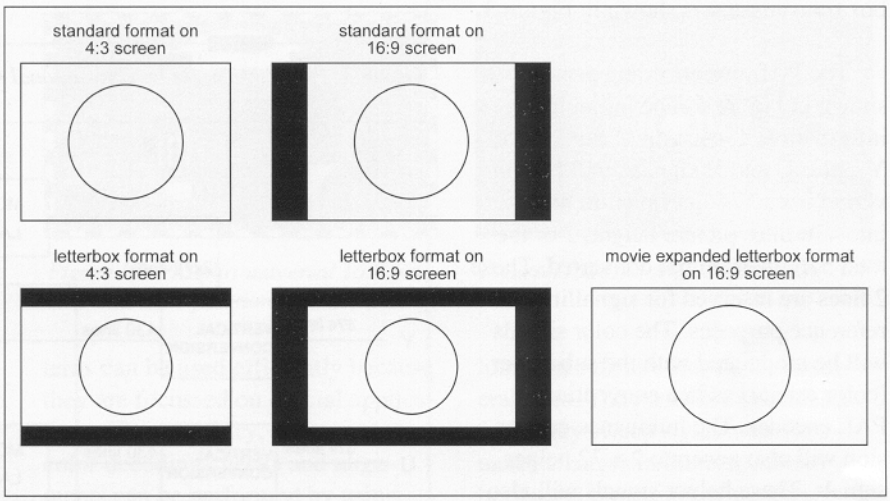

Figure 1: standard 4:3 transmissions on a 4:3 or 16:9 TV receiver.

Widescreen TV offers consumers the benefit of cinemascope style viewing in their own homes, with a panoramic picture that offers a more natural field of view. This natural field of view has an image width - to - height ratio of 16 by 9, also known as a 16:9 aspect ratio. This trend has already been started with TV receivers that can expand a 35 mm cinemascope transmission into a 4:3 'letterbox' format. This movie expand feature is shown in Figure 1 and changes the deflection of the picture tube.

Movie expand has a disadvantage, however, because it does not use the full available resolution of the tube. The PAL TV system normally uses 625 lines for transmission. A few of these lines are used for vertical flyback of the beam and a number of lines are used for data services like teletext. Since only a portion remains available for the image on the picture tube, the visible parts of the video information consist of 576 lines. When a cinemascope program is transmitted in 4:3 letterbox format, the number of lines with image information is further decreased to 430 lines. A TV receiver with movie expand can spread these 430 lines over the complete picture height. The image is now shown over the complete tube. The image quality is not improved, because only 430 lines contain actual video information. However this problem cannot be solved by transmitting a 16:9 aspect ratio image over 576 video lines, because this image will show an incorrect picture on the widely spread 4:3 aspect ratio TV receivers (see Figure 2). So, PALplus has the challenge to maximize resolution and also maintain downwards compatibility with conventional 4:3 TV receivers.

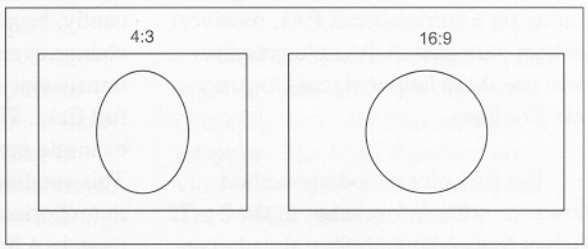

Figure 2: 16:9 transmissions on a 4:3 or 16:9 TV receiver

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PALplus principles

The PALplus concept begins with the letterbox format. However, with PALplus the black bars of the letterbox format are now used to transmit additional video information. While a conventional 4:3 receiver, will display the broadcast as a normal letterbox image, a PALplus receiver will decode this additional information and display a full 16:9 aspect ratio picture with improved resolution. The PALplus encoding is done in such a way that the 2 x 72 lines, also known as vertical helpers, will not disturb the picture on a conventional 4:3 receiver, and that the remaining 430 lines also contain the complete 16:9 picture. The letterbox transmission is shown in Figure 3.

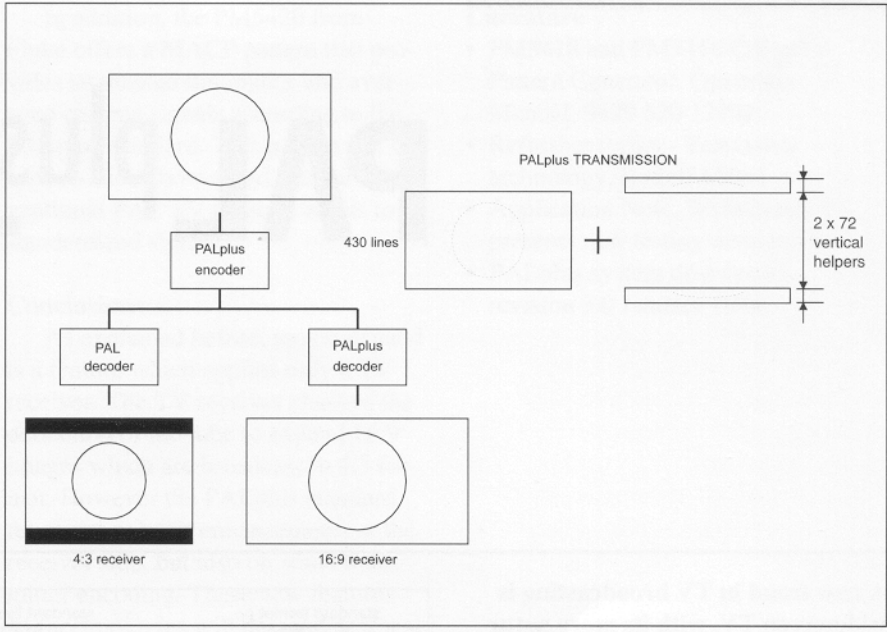

Figure 3: PALplus images on conventional 4:3 and PALplus 16:9 receivers

The PALplus encoding principle is shown in Figure 4. The initial image information, consisting of luminance Y, color U and V signals, will be converted from 574 lines picture height into 430 lines picture height, 2 of the total 576 lines are not converted. These 2 lines are reserved for signalling and reference purposes. The color signals will be modulated with the subcarrier (color carrier) as in a conventional PAL encoder. The luminance conversion will also generate 2 x 72 helper signals. These helper signals will also be modulated with the normal sub-carrier frequency. The luminance value will therefore be present as modulated signal on the CVBS (Color Video Blanking and Synchronization) signal. A conventional receiver will decode this luminance signal as color information. However, these colors are almost invisible because it contains almost no light information, the darkest color (blue) is used and the amplitude (saturation on a conventional PAL receiver) is kept very low. A PALplus receiver will use these helper signals to generate 574 lines.

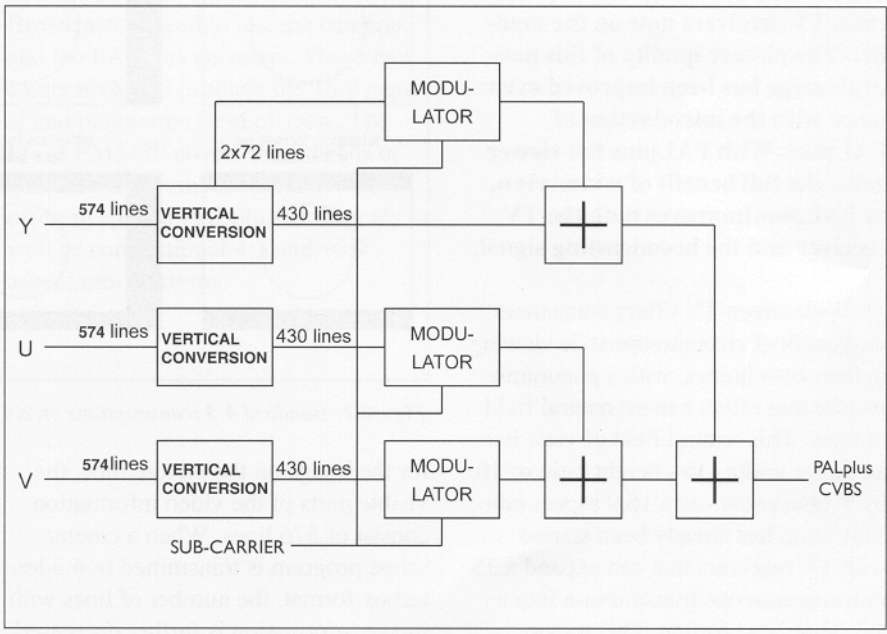

Figure 4: PALplus encoding principle

The PALplus encoding method loses the color information in the 2 x 72 helper lines, although they already contain luminance information. This will not influence the picture image significantly, because color normally does not change every line and it is therefore unnecessary to transmit color for the full field. The bandwidth of color is for example normally limited to 1.5 MHz. This smaller bandwidth limits the maximum horizontal resolution, and approximately 4 lines can be used to provide an equal vertical resolution.

The PALplus decoding is shown in Figure 5. As in a conventional PAL receiver the luminance and chrominance are filtered out of the CVBS signal. The chroma signal also contains luminance information, which is transmitted in the upper and bottom part of the picture. These 2 x 72 lines are decoded and added to the already available luminance information.

These vertical helper lines are used to convert the picture to his original size and with full luminance resolution. The color of the image is extracted from the 430 lines, which cover enough information to convert it to 574 lines.

The conversion principles from 574 to 430 lines and from 430 to 574 lines are given in Figure 6. The algorithm shown uses four lines, which are converted into three lines. For every approximately four lines, one helper line is generated, which is used to convert to a fully covered luminance image. The color information is also converted, but does not use helper lines.

In practice, a more complex color and luminance algorithm is used, but the principle remains the same. The PALplus algorithm, for example, uses more lines and the helpers are used to transmit the luminance difference of several lines. This means that the helper lines contain information only when the signals of accompanying lines are different. An additional 2 lines are used to transmit the widescreen signalling bits and the amplitude reference levels.

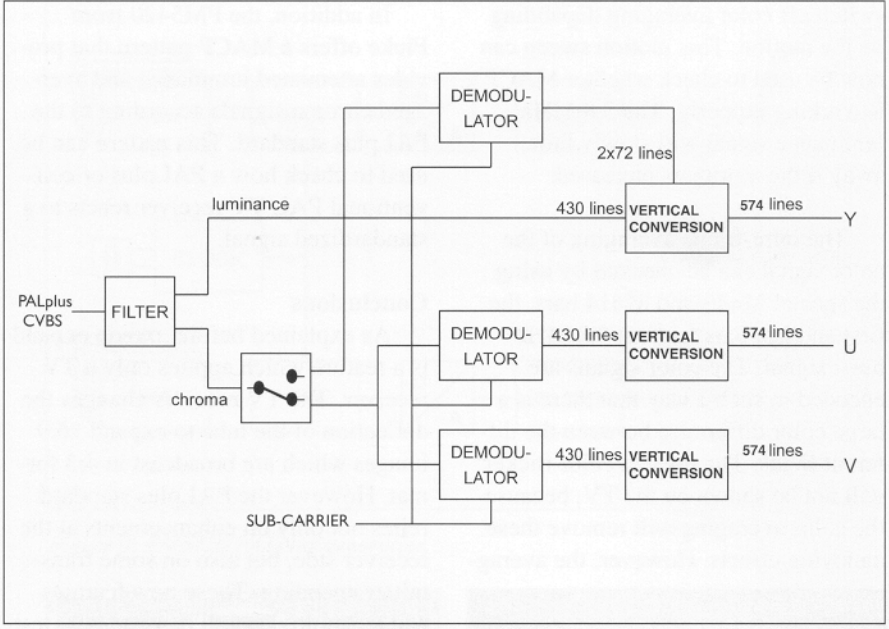

Figure 5: PALplus decoding principle

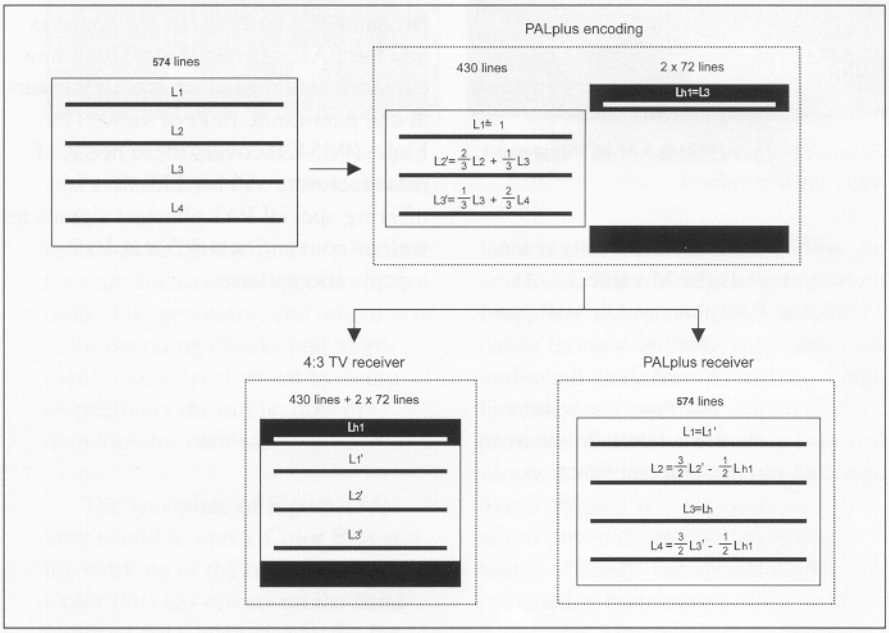

Figure 6: PALplus conversion principle

Color Plus

With PALplus, viewers can benefit from the full resolution capability of the 16:9 receivers. In addition to this transmission method, Color Plus has been introduced. The Color Plus technique enables the full channel bandwidth to be used. The bandwidth can be improved by using one of the basic PAL transmission principles, which means that the chroma signals between lines in two sequential fields have an opposite phase. By adding these CVBS signals, a full bandwidth luminance signal can be extracted without any cross-color effects. Subtracting the CVBS signals will result in a full-bandwidth chrominance signal without any cross-luminance effects. The Color Plus technique, using the delay principle, is shown in Figure 7. The method can be implemented by either analog or digital circuits. Digital circuits have the advantage that attenuation in the delay line path can be avoided and that the timing can be set more precisely. The separation of U (B-Y) and V (R-Y) can be performed in a similar way.

Remark:
Interference between luminance and color are divided into cross-color and cross-luminance. Cross-color is the effect that normal luminance information is visible as color and can for example be shown by using the multiburst signal. Cross-color effects are clearly noticeable when a person for example wears a striped shirt. Conventional PAL receivers will show a blue bar instead of normal black and white

transitions (especially for signals above 3 MHz). Color information which is visible as luminance is also known as a cross-luminance effect. Cross-color is present at color transitions, especially at the green-magenta transition of the color bar.

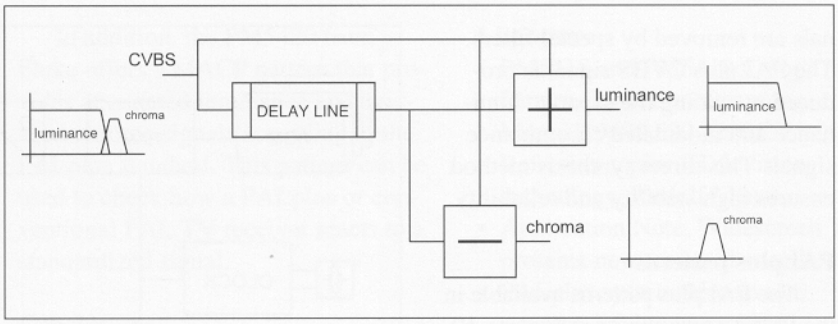

Figure 7: Color Plus technique

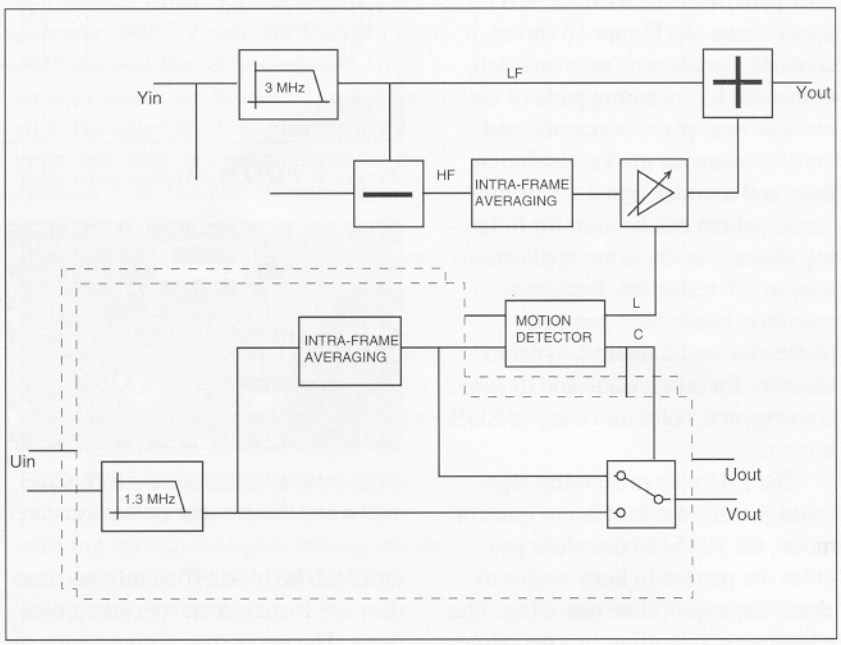

Figure 8: MACP principle

Motion Adaptive Color Plus

Color Plus improves the effective bandwidth of the luminance and chrominance paths of TV receivers. It results in sharp color transitions, such as striped shirts. A disadvantage however is that the Color Plus method only works properly when no motion is present in the image. When motion is present the information of lines in two sequential fields is not equal, which will still result in color and luminance interference. These interference effects can be avoided by attenuating the higher frequency components of the luminance signal. The attenuation will hardly be visible because fast movements are already difficult to trace on screen. The attenuation dependent on motion is known as Motion Adaptive Color Plus (MACP). Figure 8 shows the MACP principles. The higher frequency components of the averaged luminance signal will be attenuated according to a specific motion table. The table contains 16 different motion situations which are also known as the M values. In fast movements the higher frequencies (above 3 MHz) will be filtered totally, while the original luminance signal will be produced if no motion is detected. For the chroma signals U and V the MACP unit will switch averaging on or off, depending on the level of motion in the image.

The PALplus standard defines two different modes: film mode and camera mode. In film mode a television shows two fields of information which are scanned from the same picture. Since the same picture or photo is read, no motion can be present between two fields. Motion detecting can therefore be skipped, MACP will be disabled and the Yout signal will also contain the averaged HF component. The color signals U and V will also contain the averaged information when film mode is broadcast. The averaging in combination with Color Plus is also called Fixed Color Plus, because the Motion dependent averaging is disabled.

A PALplus TV receives information about the mode by decoding the widescreen signalling bits. These widescreen signalling bits are transmitted in line 23. In camera mode, motion can influence the image and the MACP processing will be active automatically after receiving the correct widescreen signalling bits. In addition, the PALplus standard uses line 623 as amplitude reference. These white and black level reference signals are used as amplification level.

PALplus generation

The PALplus signal generation of the Fluke PM5420 is shown in Figure 9. The different patterns are pre-programmed in ROM, the luminance and modulated chrominance signals are stored separately. When a pattern is selected the contents of the luminance and chrominance ROM are copied into high-speed RAM. These RAM values are read and converted from digital to analog signals. Disturbances in the analog sig-

nals are removed by special filters. The PALplus CVBS signal is produced by adding the separate luminance and modulated chrominance signals This direct synthesis method ensures high stability and reliability.

PALplus patterns

The PALplus patterns available in the PM5420 are shown in Figures 10, 11 and 12. The PALplus universal 16:9 pattern can be used for several applications. As Figure 10 shows, it contains signals such as crosshatch, corner circles including parts of the circular zone plate, horizontal and vertical overscan marks, resolution lines and decoder signals. This universal pattern can be used for following aligning or checking applications such as RF reflection, frequency response, bandwidth, geometry (deflection and linearity), synchronization, focusing, static and dynamic convergence, color decoding or RGB setting.

The PALplus processing algorithm is different for film or camera mode, the PM5420 therefore provides the pattern in both modes to check the appropriate decoding. The widescreen signalling bits decoding can of course also be tested, because these bits are automatically changed when the mode is toggled. For the decoding of the picture in both modes, the helper lines are used. The usage of the helper lines can be checked very easily, because the generator provides special helper signals. When the helper lines are used correctly the white rectangle (below the PALplus indication) shows the capitals DEC. If the TV receiver does not use the helper information, the DEC indication (patent pending) does not appear.

Since the PALplus to conventional PAL signal decoding is covered by a part of the PALplus TV receiver, the available 16:9 and 4:3 aspect ratio patterns remain also very usefull. These dedicated patterns can be used efficiently because they are focussed on special applications. The geometry, convergence or color decoding checks and alignments can be performed by using respectively the circle, dots or demodulator patterns.

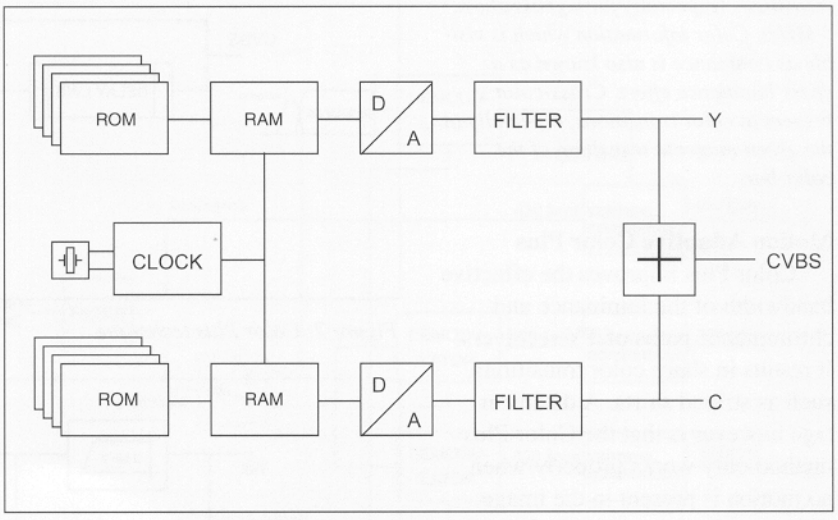

Figure 9: PM5420 PALplus generation

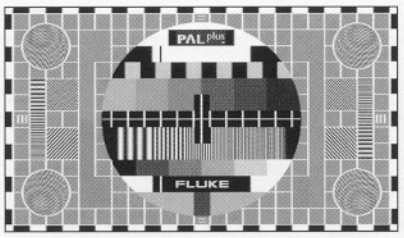

Figure 10: PALplus universal 16:9 pattern with DEC function (patent pending)

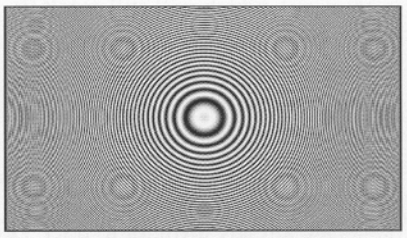

Figure 11: 16:9 PALplus Zoneplate

The zoneplate of Figure 11 is very useful to check Color Plus and the working of the helper lines. Since Color Plus has effects on the bandwidth of the CVBS signal, the frequency sweep in the horizontal direction can be used for the Color Plus check. The pattern will show no color when Color Plus is active. Color, as a result of cross-color effects, will be visible on screen when the Color Plus circuit is faulty or not working properly. The frequency sweep in both directions can be used to check the helper line algorithm. As already stated, the helper lines contain information about the luminance differences between several lines. The zoneplate provides a frequency sweep signal with luminance changes in the vertical and horizontal directions. If the helper lines are used correctly, the receiver provides maximal resolution. The screen is able to show these luminance changes at maximum bandwidth (when the maximum resolution is offered). The zoneplate is provided in both camera mode and film mode. This because the decoding depends on the mode, and the bandwidth of both modes has to be tested.

The MACP pattern (patent pending) of Figure 12 is very useful for checking the Color Plus motion adaption. The MACP pattern provides a 3.8 MHz luminance signal. The MACP circuits in the TV receiver automatically attenuate the luminance signal above 3 MHz and

switch off color averaging depending on the motion. This motion sweep can now be used to check whether MACP is working properly. The 3.8 MHz luminance signal will slowly fade away if the motion is increased.

The intra-frame averaging of the color signal can be checked by using the special M=13 and M=14 bars, the first and last bars without 3.8 MHz burst signal. The color signals are encoded in such a way that there is a large color difference between the different fields. The present color flicker will not be shown on the TV, because the color averaging will remove these annoying effects. However, the averaging will be switched off totally if the motion exceeds the M value 13. At M=14, the PALplus module will pass the color signal directly without averaging and the TV will show the color flicker clearly. The function is therefore also indicated as intra-frame averaged and direct color test function.

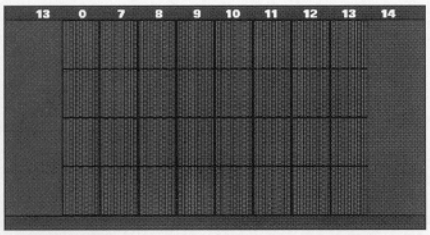

Figure 12: 16:9 PALplus MACP test pattern (patent pending)

In addition, the PM5420 from Fluke offers a MACP pattern that provides attenuated luminance and averaged chroma signals according to the PALplus standard. This pattern can be used to check how a PALplus or conventional PAL TV receiver reacts to a standardized signal.

Conclusions

As explained before, movie expand is a feature which applies only a TV receiver. The TV receiver changes the deflection of the tube to expand 16:9 images which are broadcast in 4:3 format. However the PALplus standard relies not only on enhancements at the receiver side, but also on some transmitter encoding. These new features and technologies will demand new test solutions. At the receiver side, the decoding should be checked. Broadcasters need to test the cameras and the PALplus encoders. These new cameras should produce the 16:9 natural and panoramic field of view. The Fluke PM5420 covers these needs of manufacturers and broadcasters by offering special PALplus test signals as well as conventional 4:3 and 16:9 aspect ratio patterns.

Literature

- PM5418 and PM5418 Color TV Pattern Generator, Operating Manual, 9499 520 12901.
- Refresher topics - Television technology, Rudolf Mäusl.
- Application Note, Widescreen TV presents new testing demands.
- PALplus system description, revision 3.0 January 1994.

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