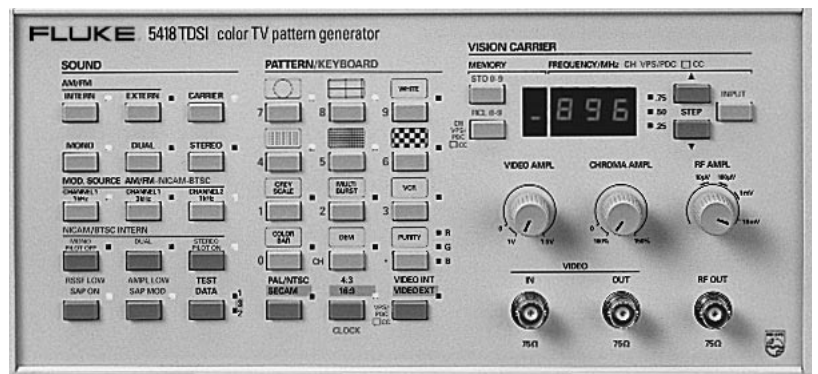
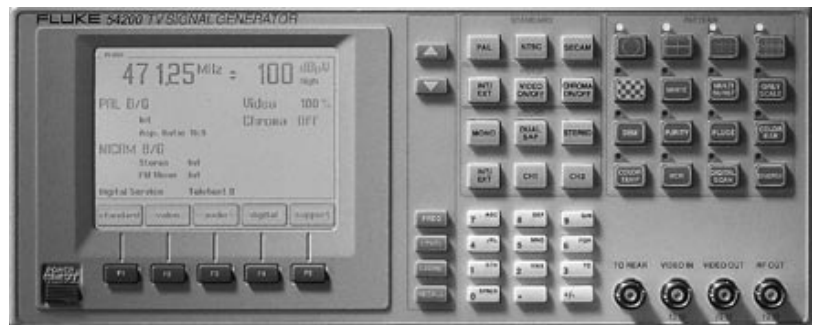


100 Hz Enhanced Definition TV testing

Application Note

An important trend in the TV set market is that of providing more accurate images with fewer disturbances. One of the features to improve picture quality is 100 Hz Enhanced Definition TV. Functions like 100 Hz introduce additional TV testing requirements for developers, manufacturers and service workshops, because it is almost impossible to test these quality improvements with commonly available patterns. A cost-effective solution for testing 100 Hz Enhanced Definition is provided by the PM 5400 and 54000 Series of TV Signal Generators from Fluke.



Manufacturers are continuously designing and developing technical circuitry to improve the picture quality of TV receivers. The digital sampling techniques of today give manufacturers the ability to store the transmitted picture images. These stored images can now be processed before they are displayed on the picture tube of the TV receiver. One of the processing techniques is displaying the 50 Hz transmitted images with a

100 Hz picture tube scan rate. This 100 Hz process doubles the field frequency and avoids typical 50 Hz picture disturbances like line- and image flicker, but also presents new testing challenges.

Conventional display techniques

A normal 50 Hz TV picture consists of 625 horizontal lines. The information is written by an electron beam on the tube from left to right. At the end of each

line, the beam returns to the left of the tube (horizontal flyback). At the end of each field the beam returns to the top position (vertical flyback) and is ready to write the next field. The repetition rate of the lines is 15.625 kHz, which means that each picture has a duration of 40 ms (625/15.625 k). A picture refresh rate of 25 Hz (1/40 ms) is easily distinguished by the human eye.

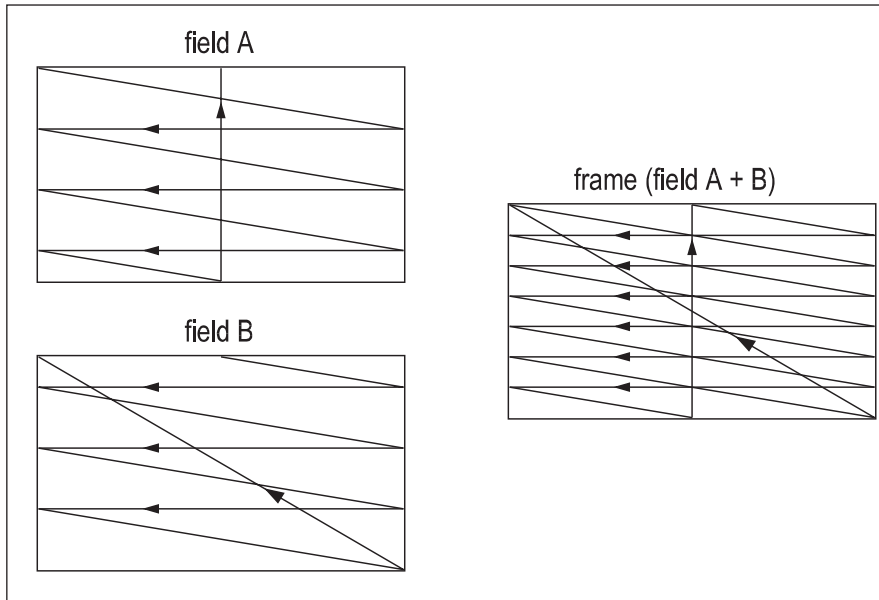


Figure 1: 50 Hz interlacing

A solution was found in dividing the complete picture (one frame) into two separate fields (field A and B). These fields are now written on the screen with a frequency of 50 Hz, see figure 1. This technique is called interlacing and reduces the image flicker to a certain extent. The image flickering on a 50 Hz TV receiver is still noticeable by the human eye in very bright scenes.

Note: The white purity test pattern can be used to visualize the image flicker of a 50 Hz TV receiver.

The interlacing technique reduces image flicker, but also introduces an additional flickering effect, because two successive lines of an object are displayed one after the other, respectively present in field A and field B. This effect is called line flicker and is clearly visible on a normal 50 Hz TV receiver by switching from an interlaced to a non-interlaced test pattern.

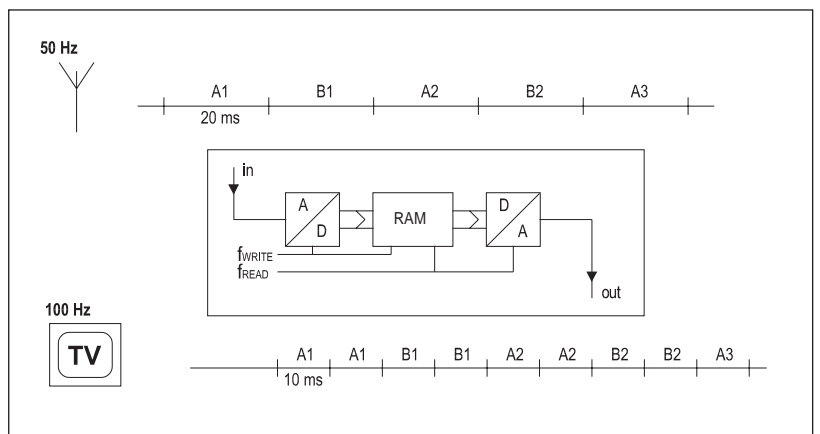
100 Hz Enhanced Definition algorithms

A typical example of a 50 and 100 Hz picture sequence is shown in figure 2. The numbers 1, 2 and 3 represent the different TV frames. Each frame

consists of two fields, indicated by the letters A and B. The 50 Hz picture image is digitized by an A/D-converter and stored in RAM. The data from the memory is fed to a D/A converter to reproduce the picture. A 100 Hz picture sequence is generated by doubling the read clock frequency (f_{READ}) with respect to the sampling frequency (f_{WRITE}). An additional delay is necessary to synchronize the 50 Hz transmission and the 100 Hz picture view.

This process, indicated by algorithm AABB, doubles the field frequency and reduces the effect of image flicker. The image frequency of the picture is 100 Hz instead of the normal 50 Hz and therefore less

Figure 2: 100 Hz, algorithm AABB



noticeable by the human eye. However, the effect of line flicker is not yet reduced by the AABB algorithm. The line flicker frequency remains the same when successive lines contain different information, because there is still a 25 Hz change rate of information (only the duty cycle changes). The line flicker can be reduced by using the algorithm ABAB, see figure 3. The line disturbances will be almost invisible on the picture tube by mixing the different fields. The algorithm ABAB is very useful for steady picture images, but causes additional disturbances when a picture object is moving or transforming on-screen. These disturbances are noticeable as vibrations of the object, but they can be avoided by selecting the AABB algorithm, when motion or transformation of a picture object is detected. Motion or transformation of an object is detectable by continuously comparing the luminance signal of successive lines, respectively present in field A and field B. The television's detector reacts to luminance changes and will automatically determine which algorithm is used for processing. The display quality of steady picture images can be greatly improved by using the ABAB algorithm. Non-steady parts of the picture, reproduced by AABB, will still result in 50 Hz line flicker. The line flicker of non-steady parts can be

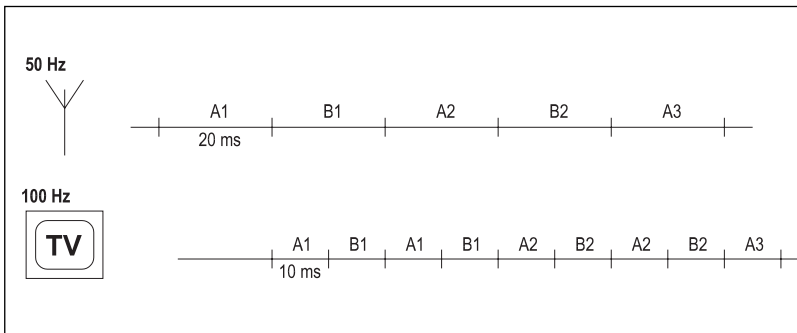


Figure 3: 100 Hz, algorithm ABAB

reduced effectively by using a complex licensed processing method, indicated by algorithm AB'A'B. This algorithm (a median filter) is shown in figure 4 and improves the display quality without introducing vibration effects. The additional fields, represented by B' and A', make smooth transitions possible. Three successive lines are used for the filtering, a field B' line is derived from a field B line and the two nearest field A lines. A field A' line is derived from a field A line and the two surrounding lines of field B. In addition to the AB'A'B-algorithm, manufacturers also implement a noise reduction feature. Noise reduction is often user-selectable, and operates by continuously averaging the luminance and chrominance signals. The feature is very useful for weaker signals.

100 Hz test capability

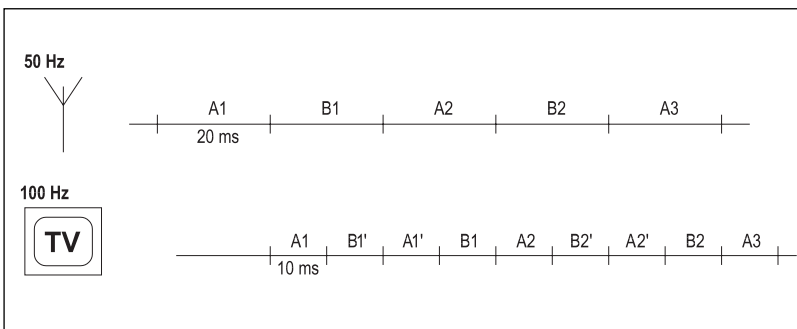
Fluke's TV Signal Generators provide a special test pattern to test 100 Hz Enhanced Definition. The test pattern is shown in figure 5 and consists of four horizontal, vertical, diagonal and sloping white lines. Each set of

lines contains a 25 Hz and a 50 Hz test signal. The first white line is only present in the first field, this will result in a 25 Hz test signal. The second line is composed of a line in the first and second fields, (present in fields A and B). The second horizontal line will produce a normal 50 Hz signal, because the line is present in each field. The third and fourth white lines are combinations of the first two lines. The transmitted test pattern will show differently on a 50 Hz or 100 Hz TV receiver. In general, the 100 Hz TV receivers will display a stable picture when using this test signal, while the normal 50 Hz TV sets will show a very unstable picture with line and image flicker.

Note: The test pattern contents can be examined more closely by using the Picture In Picture (PIP) facility of some TV receivers. This display capability usually uses only one of the fields for down scaling (field A or B).

The screen results of the first horizontal white line of the test

Figure 4: 100 Hz, algorithm AB'A'B



pattern, a 25 Hz test signal, are shown in figure 6. The signal at the top represents the actual emission of a normal 50 Hz TV receiver, the light emission will decay after switch-off of the electron beam. The signal contains white information in each A field and black information in each B field. The test signal will be recognized by the detectors as a moving or transforming object, because the luminance signal changes continuously (luminance field A \neq field B). Some 100 Hz TV receivers will automatically select the AABB algorithm to display the moving or transforming objects on the screen. The image flicker will be reduced, but the line flicker remains the same. As shown in figure 6 (second time axis), the light beam is written on the tube twice, but the line frequency is not yet doubled. The second horizontal white line of the test pattern, a 50 Hz test signal, will introduce a 50 Hz flicker on the picture tube of a normal 50 Hz TV receiver. A 100 Hz TV receiver will show a 100 Hz flicker, the frequency is doubled and will not be noticeable. The different light emission signals are shown in figure 7. A 100 Hz TV receiver will automatically use algorithm ABAB, because the luminance signal of the 50 Hz transmission does not change. The vertical, sloping and other horizontal lines of the 100 Hz test capability of Fluke's TV Signal Generators can be used the same way. These lines are also very useful to observe additional effects of the 100 Hz processing. The type of processing is automatically selected by the detectors. The algorithm selection for the horizontal lines takes place during the invisible part. The selection of the algorithm for the vertical and sloping lines takes place during the visible part. These lines can be used to check or measure the dynamic characteristics of the process selection.

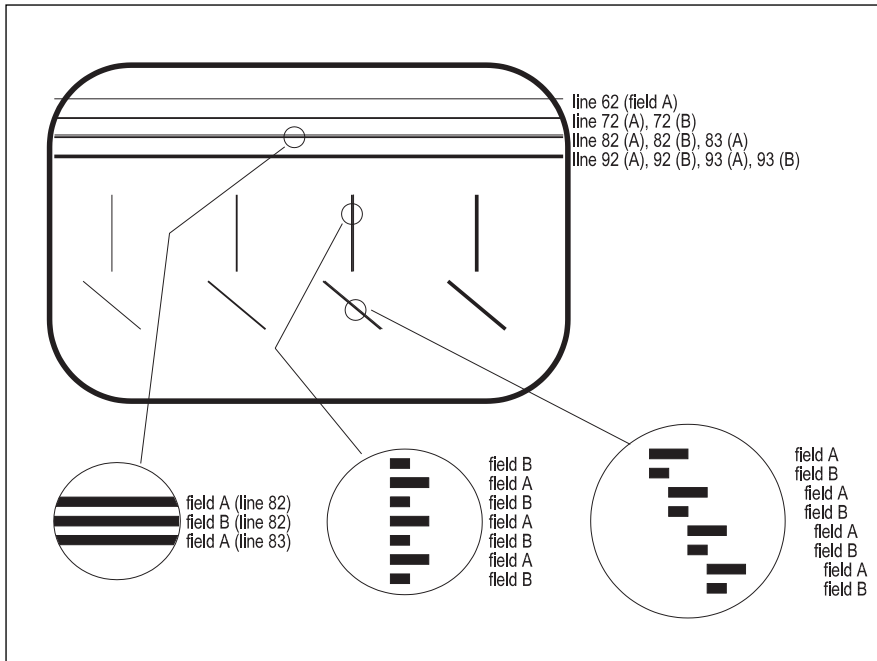


Figure 5: PM 5400 & PM 54000 TV Signal Generator test pattern (inverse drawing)

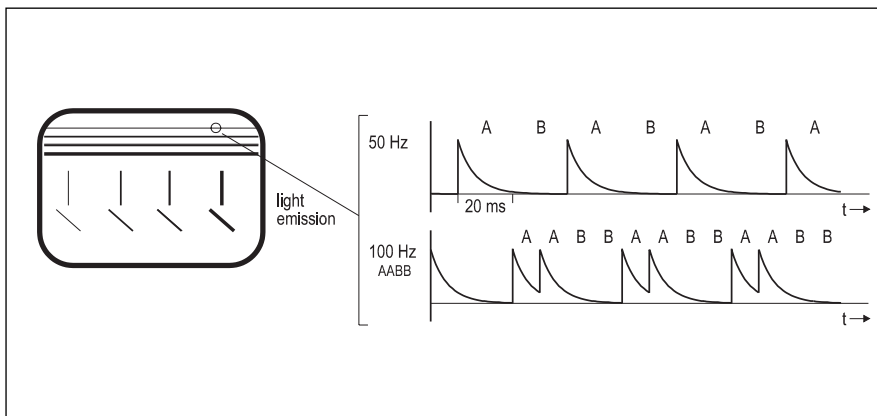


Figure 6: PM 5400 & PM 54000 test pattern reproduced by algorithm AABB

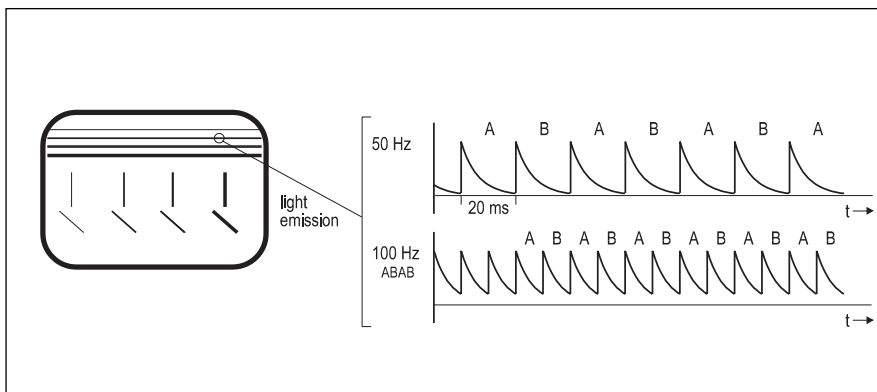


Figure 7: PM 5400 & PM 54000 test pattern reproduced by algorithm ABAB

Digital scan testing

Newer 100 Hz TV receivers use the AB'A'B-algorithm (digital scan), in any circumstances where video might contain motion, while steady images are reproduced with algorithm ABAB. The digital scan mode will show a clear image without any flicker. However, when details become vertically so small that they are only transmitted in the A or B fields, then flicker occurs similar to the 50 Hz original. It is simply due to the absence of other flickering effects that the visibility of this flicker is slightly higher than with a 50 Hz set. The effect of the line flicker reduction can be demonstrated by switching off the digital scan mode and observing the pattern, an AABB representation is used in the off position.

In addition to the algorithm, these TV receivers have an ability to reduce noise. The noise reduction feature averages the signal, while the algorithm handles the transition between the different fields. These TV sets will show a clear image without any flicker. The operation of the noise reduction can be tested very easily by attenuating the signal until a noisy signal is visible on the screen. The color-bar pattern is very useful for this purpose, because this pattern also contains color information. The noise on the color-bar should be reduced while the operator increases the noise reduction factor on the TV set. This factor is normally limited because a disadvantage of this feature is that it slows the motion of the image (fading or smearing of the object).

The test pattern reproductions of the AB'A'B algorithm are displayed in figures 8, 9 and 10. Besides the normal decaying of the light emission after switch-off of the electron beam (see figures 6 and 7), the algorithm has some additional effects. Fields A and B are displayed directly without any processing. The intermediate fields B' and A'

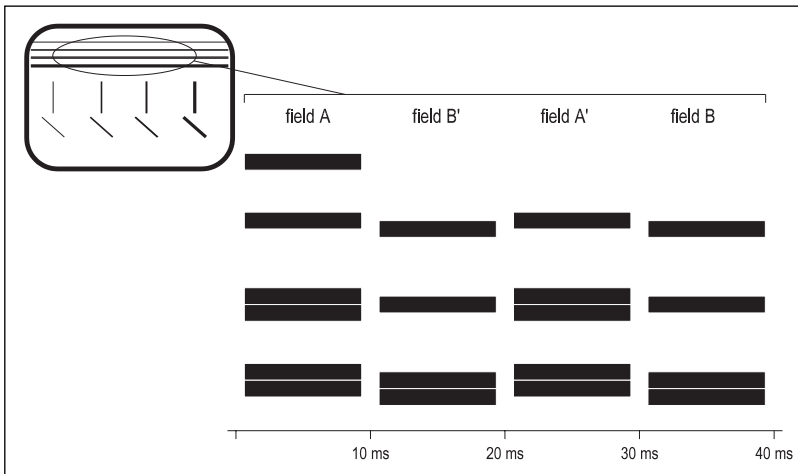


Figure 8: Test pattern reproduced by algorithm AB'A'B (horizontal lines)

are the processed results. The processing smoothens the picture transitions and removes annoying vibrations, line and image flicker. The test pattern has horizontal, vertical and sloping white lines to determine the separate processing results.

The white horizontal lines are shown in figure 8 and are useful to check the processing in the TOP-BOTTOM direction. The B field lines are drawn just below the A field lines to clarify the present interlacing. As figure 8 shows, the horizontal lines are represented as a normal ABAB-sequence, except for those lines that are vertically very small (see first horizontal line). The AB'A'B algorithm may not influence the signal when the

luminance levels of the different fields are equal. This situation is simulated by the second and fourth lines, the light emission frequency is doubled only (see also figure 7).

The LEFT-RIGHT processing can be observed by using the vertical white lines. The top and bottom of these white lines can better be omitted because these parts are also influenced by the vertical processing. The results of the processing on the middle parts of the vertical white lines are drawn in figure 9. The time axis in the figure is rotated to simplify comparison of the lines. The lines on the screen are displayed in AABB sequence, see also figure 6. The effect is noticeable in the first and the third line. However, the

interlacing is according to ABAB, which reduces the image flicker with respect to a normal AABB algorithm. The electron beam writes on two different tube locations instead of twice on the same location.

Algorithm AB'A'B has a clear preference for an ABAB sequence in TOP-BOTTOM direction and prefers AABB with an ABAB interlacing in LEFT-RIGHT direction. The TOP-BOTTOM in combination with the LEFT-RIGHT processing can be observed with the sloping lines, see figure 10. The B fields are again shifted in the figure to indicate the interlacing. A TOP-BOTTOM processing dominance is noticeable in the first line, while a LEFT-RIGHT processing dominance can be seen in the third line. The AB'A'B algorithm may not influence the signal when the luminance levels of the different fields are equal. This situation is again simulated by the second and fourth line, the light emission frequency is doubled only (see also figure 7).

Dynamic Behavior

All above features can be found in both the Fluke 5400-series and the 54000-series of video- and TV-signal generators. In addition, the 54000-series has patterns to diagnose the dynamic behavior of TV receivers. These patterns provide moving horizontal, vertical and diagonal lines, where the 5400-series gives steady lines only.

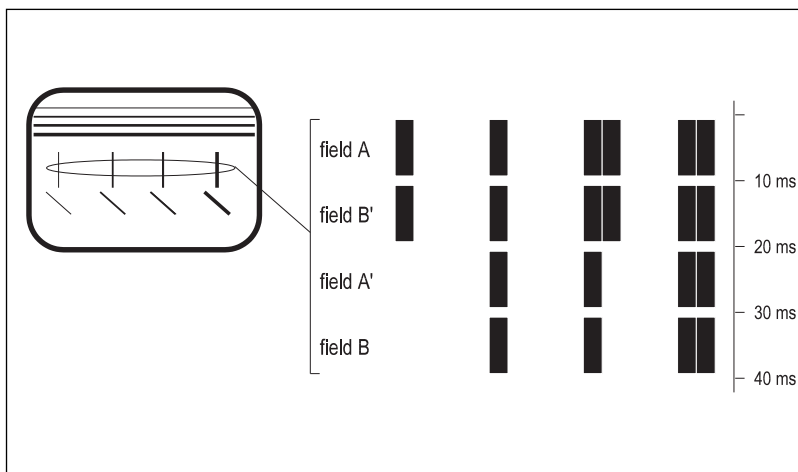


Figure 9: Test pattern reproduced by algorithm AB'A'B (vertical lines)

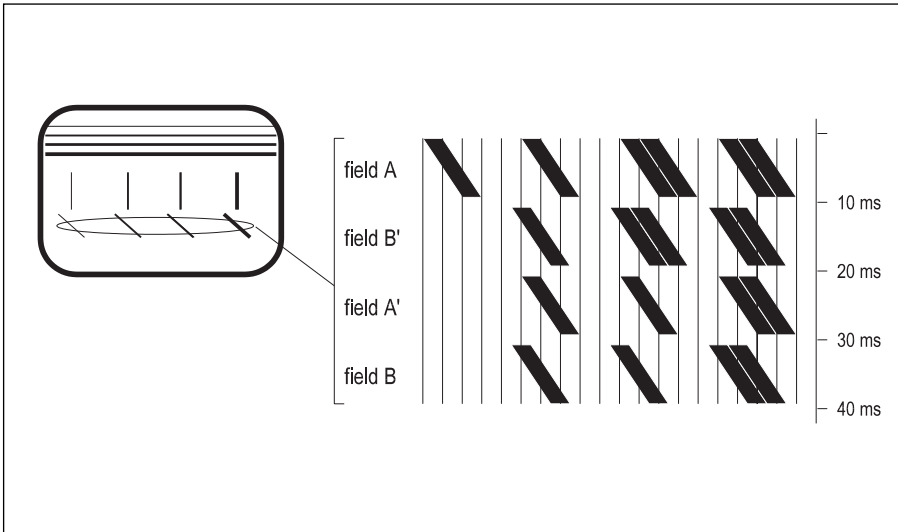


Figure 10: Test pattern reproduced by algorithm AB'A'B (sloping lines)

Conclusion

The 100 Hz capability of TV receivers doubles the display rate of a normal 50 Hz transmission. Normal broadcasts and patterns are unsuitable to test this feature. The Fluke 5400-series and 54000-series of Video- and TV Signal Generators provide the necessary test signals to test the 100 Hz display systems and the various processing systems that are used to convert a 50 Hz broadcast to a 100 Hz repetition rate image, using patterns that contains 50 Hz and 25 Hz test signals, as well as dynamic patterns.

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