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ALMATY
UNIVERSITY OF POWER ENGINEERING
AND
TELECOMMUNICATION

Department of "Computer and infocommunication security"

PRINCIPLES OF VIDEOIMAGE PROCESSING

Lecture notes for English class students of the speciality
5B071900 – Radio engineering, electronics and telecommunications

Almaty 2016

COMPILERS: Artiukhin V.V., Baigeldinov U.S. Principles of videoimage processing. Lecture notes for English class students of the speciality 5B071900 – Radio engineering, electronics and telecommunications. Almaty: AUPET, 2016 – 29p.

Lectures notes have been intended for students attending bachelor degree courses having specialized in 5B071900 – "The radio engineering, electronics and telecommunication". These notes allow to understand the basic theoretical provisions of TV and radio broadcasting systems, namely: the principles of creation of primary network of TV and radio broadcasting, the principles of construction and key parameters of analog and digital systems standards of TV and radio broadcasting, the principles of action and ways of engineering calculations of separate equipment components and elements transmitting systems of TV and radio broadcasting.

Illustrations - 6, Bibliogr. - 6 neim.

Reviewer: candidate of technical Sciences, Professor A. Z. Aytmagambetov

Introduction

Lectures notes are intended for students attending bachelor degree courses having specialized in 5B071900 – Radio engineering, electronics and telecommunication. These notes allow to understand the basic theoretical provisions of TV and radio broadcasting systems, namely: the primary network construction principles of TV and radio broadcasting, the principles of construction and key parameters of analog and digital systems standards of TV and radio broadcasting, the principles of action and ways of engineering calculations of separate equipment components and elements transmitting systems of TV and radio broadcasting. The gained knowledge will give the chance to apply them in the course of maintenance and arrangement of TV and radio broadcasting system operation, to carry out the main operational measurements of channels parameters, equipment components and elements parameters of TV and radio broadcasting. Besides, it gives the perspective of tendencies of development of television and image processing, use of new technologies in the branch of TV and radio broadcasting systems.

Lecture 1. History of television development

Contents: definitions of television. Comparison of television system with any other systems of information communication. Advantages of television method of information communication.

The term "television" appeared in 1900 for the time. The main history of television development is as follows. 1839 – Becquerel E. carried out transformation of light energy into electric current. 1873 – Smith U. found out that selenium possesses the property of internal photoeffect. 1887 - Hertz found the phenomenon of external photoeffect. 1888 – Stoletov A. published fundamental laws of external photoeffect. 1895 – Popov A. represented the device for registration of lightning discharges. 1878 - 1884 – first projects with serial signaling of the image. 1911 – Rosing B. carried out the first transfer and reception of TV image. 1925 – practical realization of television system. Beck D. in Great Britain, Jenkins Ch. in the USA, Termen L. in the USSR. 1967 – introduction of regular programs in SECAM system. 2015 – a switch of the Republic of Kazakhstan to system of television broadcasting in the DVB – T2 standard – T2 The design of Nipkov's spiral disk and other figure indicated on presentation. Television image transformation into electric signal the optical imaging precedes. This image can be presented by a set of integrated sources, the intensity of each can accept t of various values. The more the number of N elementary sources (image elements), the higher the extremely distinguishable detail of the image, i.e. the elements have to be rather small, and their number for the image has to be rather great in order the eye does not notice discrete structure of the image. The first principle of television consists of splitting the image into separate elements and on fiber-optical imaging of the entire image.

The minimum detail of the image which can be distinguishable and reproduced by TV system is called picture element. The image formed by set of all elements is called as a shot. The second principle on which the television is based, are consecutive communication and display of information of brightness through time (and color) of separate picture elements. It is possible owing to human being vision persistence which is shown that the flashing source of light with a high frequency of flashings seems to be continuously shining. Transfer and reproduction of each picture element have to be carried out synchronously and phase-locked. It is provided by maintenance in specified limits of the scanning law and its periodic forced synchronization on the line and on the shot on the transmitting and answering side of TV system.

Lecture 2. Main light engineering values. Concept of colorimetry

Contents: light-optical values and its measurement units. Peculiarities of visual perception. Eye structure. Spatial characteristics. Energetic performance of vision.

Visible light is a certain part of a range of electromagnetic waves spectrum.

The sources of light may be primary (shine itself) and secondary (reflect light).

Colorimetry is the measurement of color science which is based on the laws of colors mixture. Physiological principles of color vision are based on the theory of three-component vision which was advanced by Lomonosov M. Excitability of a human being eye is uneven on spectrum, and the eye is most sensitive to yellow red site of the spectrum.

All auxiliary colors have been obtained by mixture of the main colors. For determination of color there is a chromaticity diagram (locus). Except the locus there are diagrams of color systems of the single XYZ plane and the chromaticity diagram of ICI (The international committee on illumination) for actual color phasors. They differ from the locus by the size of coefficients and some other conditions. Chromaticity diagram (locus) from actual color phasors R,G,B.

$$E_y = 0{,}3R + 0{,}59G + 0.11B.$$

Lecture 3. Basic parameters of TV system

Contents: main standards of TV broadcasting. Dependences of television spectrum on number of lines and frames. Main systems of chromacoding.

There are 10 standards in television broadcast designated by the Latin letters B, D, G, H, I, K, K1, L, M, N and 3 systems of chromaticity – NTSC, PAL, SECAM, therefore there are about 30 television systems around the world. The main differences of standards are various quantities of lines and shots and as result – emission frequency band. In Kazakhstan the analog TV system, as well as in other CIS countries, came by inheritance from the USSR – D/K SECAM. This standard is characterized by the following parameters.

Picture size. Picture b width relation to its h height is called as picture size

$$k = \frac{b}{h}. \tag{3.1}$$

In television the picture size is chosen as equal to k = 4:3. In modern systems k = 16:9 is used.

Picture. Z picture detail determines the nominal image sharpness, i.e. its detail. These parameters depend on number of elements in N picture.

$$N = z \cdot kz = kz^2 . \tag{3.2}$$

In the USSR z = 625 picture detail was accepted. To some degree this is implements eye resolution if picture viewing is carried out at the optimum viewing distance l_{opt} = (5...6) h, i.e. when viewing the picture at clear vision angle. Generally, the width of television spectrum has been defined by high-frequency cutoff.

$$f_в = \frac{N_{1c}}{2} = \frac{kz^2 n}{2}, \tag{3.3}$$

where n – number of frames transferred per second; $N_{1C} = kz^2$ n – number of picture elements transferred per second.

Number of frames per second. Number of frames is the number of still pictures, transferred per second, - it is selected based on inertial properties of the visual analyzer. The number frames of TV system during line-by-line scanning has to be chosen by n = 50 fps. However, with n = 50 fps through communication channel the excess information has been transmitted that considerably expands picture spectrum:

$$f_в = 13 \text{ MHz}.$$

Reduction of television spectrum due to loss of picture transit velocity (number of frames per second) can achieve by means of interlace scanning. Each of frames has been transmitted by two receptions during interlace scanning: at the first place, odd-numbered lines (first field), then even-numbered lines (second field). Where, k = 4:3, z = 625 , n = 25 fps, the upper frequency of spectrum is equal to 6.5 MHz. Objectively, subject to decreasing coefficients, the emission frequency band occupied by video signal, is 6 MHz. The second transmitter (accompanying sound) is focused on wideband frequency modulation with frequency deviation of 50 kHz. Relation of transmitter powers is 10:1 or 5:1. Width of total television video signal spectrum taking into account guard intervals is 8 MHz.

Lecture 4. Structure, designation and peculiarities of total television signal

Contents: picture signals, synchronization signals and blank signals. TTS structure.

Total television videosignal (TTVS) of black-and-white TV system contains the following components: picture signal (brightness signal), blank signal, synchronization signal of receivers scanning. Oscillograms of TTS with frequencies of oscillograph scanning, divisible by f_z scanning frequency shown on presentation.

The picture signal (brightness signal) settles down in the active part of the T_{za} line and is the main component of TTVS. The format of picture signal has analog character and corresponds to the change of brightness of the picture in the direction of line scanning. Any wave distortion inevitably causes the brightness distortions of details of video picture.

The brightness is unipolar physical quantity. Thus such polarity at which the maximum value of signal corresponds to the maximum brightness (white level), and for negative – polarity at which the maximum value of a signal corresponds to the minimum brightness is accepted to positive polarity of the signal (black level).

Picture signal amplitude between real white and black levels characterizes picture contrast. Upper frequency limit of the picture spectrum

$$f_{\text{в}} = \frac{kz^2n}{2},$$

and lower, during interlace scanning,

$$f_{\text{н}} = 2n. \qquad (4.1)$$

Blanking signal. Blanking signal in TTVS has been designated for beams blanking of picture tubes – kinescopes – during line retrace. It consists of the set of the P-shaped blanking pulses of lines frequency of 12 microseconds duration (19% of line duration of T_z = 64 microseconds) and the P-shaped blanking pulses of fields frequency 25 T_z of =1600 microseconds duration (8% of field T_z duration = 20 ms). From 625 lines of TV raster the 50 lines aren't used for picture transmission and have been expended in two field retraces. Polarity and blanking signal amplitude should be chosen such as P-shaped top pulses shall be at the blanking level – on (0... 5) % lower than the level of black TTVS.

Synchronization signal is intended for lockstep synchronization of TV receiver scanning with the corresponding scanning of the imaging camera of TV Center. Synchronization signal consists of the set of P-shaped line synchronizing pulses of 4,7 microseconds duration and frame-synchronizing pulses of 2,5 Tz = 160 microseconds duration. For identity of frame-synchronizing pulses, following at the beginning of second and first fields, there are five serrated pulses with twice-horizontal frequency of 4,7 microseconds duration each of them in the these fields.

Lecture 5. Transmission peculiarities in television broadcasting

Contents: broadcasting Center Enlarged Structure. Broadcast- television Complex. Schematic diagram of television transmitter.

The Broadcasting Center represents a set of technical means for arrangement of TV programs and implementation of TV broadcasting. A distinction is made between production and satellite television centers. The large television center has the Broadcast- television Complex (BTC).

The switching center represents switching distributive point for sources of signals switching with its customers. Radio-transmitting Center has television signals and accompanying sounds transmitters. Each of TV channels has its own couple of transmitters. Picture and sound signals transmitters are combined at the output and delivered to antenna-feeder system.

Lecture 6. Peculiarities of receiving in ground-based broadcasting

Contents: schematic diagram of television receiver, main parameters according to work standard. Schematic diagram of 2000^{th} television receiver.

All television receivers of ground-based broadcasting have been designed according to the identical superheterodyne circuit with single conversion of the vision carrier frequency and double conversion of sound carrier at present time. Its node units working principles in the radio link are similar to loudspeaker receivers. Differences are connected with rather wide spectrum of radio signal and its complicate structure for color image.

The amplifier of high frequency (AHF) located behind the incoming circuit (IC) of selector switch intended for preliminary strengthening of radio signals of the chosen channel. AHF and IC frequency behavior is even within the limits of band channel. Mixing unit (MU) and frequency-change oscillator (FCO) serve for $f_{p.c.}$ picture carrier conversion and $f_{s.c.}$ sound carrier conversion to the corresponding intermediate frequencies of $f_{i.f.p.}$ и $f_{i.f.s.1}$.

Constructively, AHF, MU and FCO have been combined in the single node unit – channel selector (tuner). In the amplifier of intermediate frequency of picture channel (AIFP) the main strengthening of radio signal of picture and some strengthening of intermediate frequency has been performed $f_{i.f.s.1}$. AGC system covers selector switch (AHF) and AIFP. The characteristic of AIFP of color television receiver in comparison with the black-and-white receiver has to provide deeper notch of sound carrier of its own and neighboring channels. Thus high quality of the picture without the specified interfering signals provided by APChG receiver which guarantees the accuracy of receiver setup for the channel and respectively notch accuracy in AIFP of the first sound intermediate frequency $f_{i.f.s.1}$. For the purpose of elimination of quadrature distortions, specific when using the linear amplitude detector in systems with one-band amplitude modulation, in modern receivers of color telecasting in AIFP the quasi-synchronous detector with reference circuit adjusted on intermediate frequency of 38,0 MHz picture carrier is used. It is known that synchronous detecting demands no great amplitudes (about 50 MV) of radio signal. Linearity of strengthening path in AIFP provided much easier, and significantly smaller intermodulation distortions brightness and chromaticity signals have been obtained. Besides, property of the synchronous detector to allocate products from radio signal synchronously and phase-locked with pulse frequency of sample capture provides suppression of products of beats between sound carrier and color carrier. The single-channel scheme of radio path arrangement of television receiver allows to increase significantly quality of reception of accompanying sound due to double conversion of sound frequency carrier. The second intermediate frequency of sound turns out in the separate amplitude detector AD_s (non-linear element) – frequency converter, in which the role of frequency-change oscillator has been performed by great amplitude picture carrier $f_{c.f.p}$. Since $f_{c.f.p}$ presented as amplitude-modulated oscillations, and $f_{c.f.s.1}$ – frequency-modulated, the conversion product частотно модулирована, то продукт преобразования $f_{c.f.s2}$ $f_{c.f.p/(AM)}$ - $f_{c.f.s.1(FM)}$ = 38 - 31,5 = 6,5 MHz should be presented as frequency-modulated sound carrier with additional amplitude modulation from picture signal. It is obvious that in order to avoid entering the frequency detector in output (FD) of amplitude modulation products of picture signal in path of intermediate-frequency amplifier (6,5 MHz) deep restriction on amplitude (autonomous area) which success is guaranteed to GOST 7845-92 providing nonmodulation of picture carrier on white in 7 - 2% from maximum level of radio signal of color television has to be applied. Thus, the main strengthening of sound carrier has been carried out on a rather low (6,5 MHz) frequency due to which path circuit design of intermediate-frequency amplifier has been easily provided. Since the stability of $f_{c.f.s2}$ provided by stability (with total frequency-change oscillator of crystall-controlled) of crystal-controlled $f_{n.p}$ and $f_{n.s.}$, and possible mistuning of intermediate-frequency amplifier path due to temporary and temperature factors of influence on acceptor is no more than 0,1%, it is clear that the scheme of accompanying sound with double conversion is very favorable and world-wide recognized in all standards of TV broadcasting. As a rule, three resonant cascades with b-directional detuning providing the band in the standard of radiation (250 kHz) are used to strengthening of accompanying sound in intermediate-frequency amplifier path. In the last development as oscillatory systems of intermediate-frequency amplifier the ceramic filters on ASW are used. Thus, from the frequency detector of intermediate-frequency amplifier of receiver radio path the low-frequency signal of accompanying sound enter the sound amplifier (SA) and further on the speaker system of the receiver. From the output of the amplitude detector (AD) of AIFP of radio path the complete color video signal separately enters the amplitude and time synchronizing separators for horizontal-deflection oscillators (HDO) locking and vertical oscillators (VO) and to color decoder, where E_Y brightness signal processing has been carried out and E_{R-Y} и E_{B-Y} chroma signs have been decoded. The terminating unit of color decoder in the modern receiver is the picture processor – multifunction controller device of color picture parameters on kinescope screen (brightness, contract, intensity), from its output E_R , E_G and E_B color-separation signals control beams current by means of terminating power kinescope light amplifiers (LA), respectively, brightness of the main colors of phosphor screen.

Lecture 7. Television pick-up equipment (camcorder)

Contents: schematic diagram of color pick-up equipment. Solid pick-up equipment. Schematic diagram of camera channel.

Television pick-up equipment is intended for light quantity conversion reflected from the object and delivered to camera-channel unit, to electric signals of three color-separated images. The equipment consists of an optical head, camera and the electronic view finder. Having passed through the zoom and light filters correcting if necessary lighting source, light quantity enters components of the prism color-separating mechanism. The layers applied on prism planes split light quantity on spectrum separated components which form color-separated images on a photosensitive surface of camera tubes. The light filters attached to prism planes correct spectral characteristics of optical channels.

Optical head 2 constructively combined with three camera tubes unit of plumbikon type 4. Each tube unit consists of focusing and shutoff systems (FSS) and pre amplifier. 3. The following units located in the equipment: output cascades 5, scanners 6, remote control 7, power supply 8, beam current control 9 and high-frequency multiplexing 10. For picture control there is rotary monochrome electronic view-finder has been installed on the equipment. At the target of camera tubes the following picture is formed: red (R), blue (B) and W picture (W) of passed object. W signal application instead of green (G) signal allows to improve sensitivity of the camera under admissible deterioration of color transfer. Light-separated signals E_R, E_W, E_B from signal plates of camera tubes enter the appropriate pre amplifiers 3, located directly on FSS of the camera tube 4. Antinoise correction of signals has been carried out in pre amplifiers. From outputs of pre amplifiers the signals enter output cascades unit 5, where they amplify, limited its bands of frequencies, blanking pulses entered and limited, remote supervision pulses involved. The strengthened output signals in the technical equipment enter the camera channel. In modern developments of imaging cameras the solid analogs of camera tubes have been applied– one-line and charge-coupled area image sensors (CCAIS). Passed object picture by the zoom has been projected on light-diving device, which separates light quantity by three components. The principles of picture signal receiving should be considered for one of channels by the example of CCAIS with line-frame transfer. The major element for each of channels is CCAIS matrix. It has been conversed light quantity distribution in fabric plane into surface distribution of photogenerated auxiliary charge carriers – charge pattern (storing section).

Flow of charges in CCAIS matrix – image scanning – has been performed by means of sync source timed pulse, generated in integration pulse formers (IPF), storage pulse formers (SPF) and output register pulse formers (ORPF) sections. The application of vacuum tube cameras in television equipment of solid signals allow materially reduced overall dimensions, weight and consumed power of camera, as well as sufficiently enhance its performance reliability. Color-separated signals enter from camera to camera channel through coaxial units of camera cable. E_W signal in 6.5 MHz frequency content enter directly to amplification path, and E_R и E_B signals enter, in 1.5 MHz frequency content – through interpolator. Setting amplification control, mixing and restriction of blanking pulses for removal of fluctuation noises from reverse site, and directivity signals of line frequency have been performed in amplification path. Further, E_R and E_B signals, enter directly color corrector, and E_W signal enter through enhancer. Color analysis error control has been performed in color corrector, caused by discrepancy of camera spectral characteristics with main color mixing curve of the receiver, and E_R, E_G, E_B signals standardization has been executed. Beam aperture compensation of camera tube has been performed in enhance vertically and horizontally, as well as signal spectrum separation on low-frequency signal in 1.5 MHz frequency content (E_W – 1,5) and high-frequency elements signal. $E_{W\ signal}$ – 1,5 MHz enter color corrector.

From outputs of color corrector unit E_{R0}, E_{G0}, E_{B0} signals in 1,5 MHz frequency content, enter to gamma corrector where it will be conversed according to exponential law into E'_R, E'_G, E'_B signals for correction of the modulation characteristic of kinescope. Following nonlinear conversion to E'_R, E'_G, E'_B signals, the E_W signal shall be entered from the output of enhancer containing information of fine picture details in 1.5 – 6.5 MHz frequency content, as well as signals of vertical and horizontal aperture correction. Thus, at output of gamma corrector the signals have been formed in complete frequency content in compliance with the following equations:

$$E'_R = E'_{R0} + E_{\Delta W};$$
$$E'_G = E'_{G0} + E_{\Delta W};$$
$$E'_B = E'_{B0} + E_{\Delta W}.$$

Blanking pulses of receiving tube have been mixed in picture signal after Gamma corrector in the output amplifier, and blanking pulses restriction has been performed at black level. From amplifier output the signals enter encoder unit and color picture monitors. Any signals have been also enter the bridge from other camera channels.

Lecture 8. Principles of image scanning generation

Contents: types of scanning. Progressive scanning. Interlace scanning. Scanning synchronization.

Linear scanning has been used in television, i.e. scanning with constant speed along lines and by frame. When the beam lines moves in horizontal direction, raster lines have been traced, and when the beam moves in vertical direction, the raster generates from lines combination.

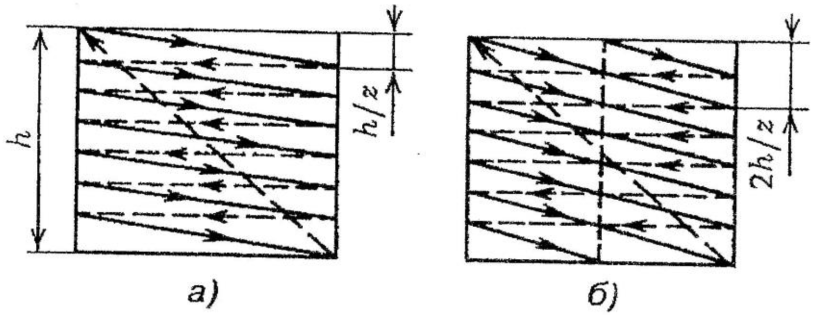
When constructing noninterlaced raster during vertical scanning (T_K) *z* lines have been traced. Frequencies of frame and line deflections during deinterlaced mode of decomposition are connected with each other by the following ratio:

$$f_z = z \cdot f_K, \quad (8.1)$$

where f_z – scanning line frequency;
f_K – scanning frame frequency.

As is known, maximum frequency of television signal should be determined by proportion of $f_{max} = kz^2 f_K/2$, where k = 4/3 – frame formet, a z = 625 – line count. For the purpose of f_{max} reduction the frequency of frame scanning should be chosen as minimum possible, and it is defined by minimum necessary number of phases in transfer of moving image under which the movement perceived as continuous.

It has been experimentally established that for this purpose the frame rate has to be not less than 16-20 Hz. For this reason for the majority of the existing standards of broadcasting television is f_K = 25 Hz. However, in case of such value of frame frequency there is strongly noticeable flashing of brightness of the screen as the critical flicker rate for the average brightness of the television picture is equal 48–50 Hz. Effective method of flicker rate increase of the television image during preservation of invariable vertical frequency is the application of interlaced raster. The frame of interlaced raster has been generated from set of two half-frames (fields). In the first half-frame all odd-numbered lines of raster have been developed: 1, 3, 5 etc., and in the second half-frame – even lines : 2, 4, 6 etc. Thus, during the frame, the picture will be replaced twice. For this purpose vertical scanning frequency should be increased in comparison with the frame rate twofold: $f_n = 2 f_K$, where f_n – vertical scanning frequency, i.e, field frequency (half-frame). During interlaced raster generation, the basic requirement is lines layout of one half-frame strictly between the lines of another one. Most easy this problem is solved under odd-number of lines in the raster: $z = 2k+1$, where k = 1, 2, 3, 4... . In this case in one half-frame the pictures are developed by k lines and yet half of the line (see figure 8.1) and as during scanning of one line the electronic beam manages to move vertically on the thickness of two lines, the lines of the second half-frame beginning with tracing of the second half of the last line of the first half-frame will get to the middle of intervals between lines of this half-frame.



a) noninterlaced scanning; б) interlaced scanning
Figure 8.1 – Raster generation with

Thus, with odd number of lines in the raster and doubled frequency of vertical deviation in comparison with noninterlaced scanning the interlaced raster has been formed automatically. In should be noted that quality of interlaced raster determined by arrangement of lines of the one field strictly in the middle in intervals of lines of other field depends on the accuracy of generators frequencies of horizontal and frame deflection which has to satisfy to the following ratio

$$f_z = \frac{z}{2} f_n. \qquad (8.2)$$

Ratio distortion leads to pairing of lines or even to full twinning of two fields that in turn leads picture sharpness loss in vertical direction.

Lecture 9. Television signal synchronization

Contents: peculiarities of television signal with finite dimensions of picture element. Line and frame synchronization.

All scanners of television system operate synchronously and phase-locked. It is provided by forced synchronization in order to deliver the special synchronizing pulses at the beginning of each line and each frame all scanners which force to operate these devices in strictly specified time points. Forced synchronization of scanners of pick-up equipment and television receiver has been performed from general synchronization source – sync source, available in the television center transmission apparatus package. There is substantial difference between methods of synchronization of scanners of television center and television receivers. The scanners of television camera are synchronized directly by pulses of the line and frame synchronization delivered through camera cable. Scanners synchronization of the receivers the lines and frames synchronization pulses should be delivered from television center together with television signal through the same channel. It necessitates for formation of special signal of receivers synchronization having very complicated form. Thus, for transmission of the synchronization pulses the beam dead time has been used, i.e. time of transmission of blanking pulses. Blanking pulses peaks approximately correspond to the level of "black" signal. They often say that the synchronization pulses located in the infra-black region. In this case synchronization pulses can be separated from picture signal and blanking pulses by the ordinary amplitude limiter (amplitude filter). The diagram of the amplitude filter contains locking device for synchronization pulse peaks and the threshold element passing for further processing only synchronization signals. Ease and reliability of the specified process is one of the main advantages of this synchronization method. No less important task is the separation of line synchronization pulses and synchronization pulses of fields from each other. For this purpose they have to differ either on level, or on duration. In the first case the picture synchronization pulses can be allocated by means of the limiter. However because of increase in the general amplitude of signal the radio transmitter power considerably increases therefore it is better to make the synchronization pulses different in duration (duration of line synchronization pulses is much less than duration of picture synchronization pulses). The difference in duration of line pulses and field pulses will be conversed by means of the differentiating and integrating chains to difference of tension. Thus the difference in tension can be made so considerable that the remains of line pulses after integration won't have any impact on picture synchronization.

Allocation of field synchronizing pulses by means of the integrating circuit along with simplicity possesses one more merit - a big noise stability. Interference pulses which have small duration fail to generate of considerable tension on the condenser and as if smoothed out the integrating circuit. The disadvantage of such allocation of the synchronization pulses is the impossibility of sharp edge receiving of the integrated pulses and, as a result, possible instability of synchronization moment. Allocation of line synchronization pulses by means of differentiating circuit is possible, however it should be noted that pulse disturbances will freely pass through circuit condenser and resistance to noise of such way of allocation will be low. With line scanning between fronts of two frame sync pulses z line pulses have been located. Duration of frame synchronization pulse is greater by several fold than period of line. After signal passing u_{in} through differentiating circuit we shall receive u_{dc} signal, where positive pulses can be used for line scanning synchronization of the receiver, and negative pulses – have no impact on operation of scanning generator. During the performance of frame sync pulse in the channel of line synchronization the pulses are absent. There is no line synchronization during this time period, and pulse generator of line scanning of television receiver will operate in the autonomous mode. As a result, some first lines after the termination of frame pulse performance can be "brought down". For preservation of continuity line pulses repetition the rectangular inserts have been entered into frame sync pulse following with line frequency. Duration of inserts on the figure is conditionally equal to duration of line pulses.

Insert edge has to coincide with the front of line pulse which would have to be in this place. After differentiation of such U'_{in} signal the positive pulses are used for synchronization. Thus, they follow without interruption with line frequency, the frame sync pulses are allocated by integrating circuit. Existence of inserts leads to receiving at the output of the integrating circuit of "gear" form of u'_{ic} curve. Such distortion of the form shall be similar for all frame sync pulses. In this basis, under the constant level of operation of frame generator of scanning it won't lead to synchronization violation. With interlaced scanning the number of z lines is odd in the frame, and between fronts of two following one after another of the synchronization pulses of second and first fields the $m = 1/2$ takes place of line frequency periods f_z , where m is the number of complete lines in one field. This one second of the period of line frequency causes appropriate time shift of line inserts concerning synchronization pulse of the second field (field in which even lines are developed). As a result the form of synchronization pulses of second and first fields is unequal. In the pulse of the first fields the time pulse edge to the first insert equal to duration of almost the complete line (with deducting of inset duration), and in the pulse of even fields this time is half of line duration. Due to this the forms of u_{ic} integrated pulses for the second and first fields shall be also different. Its distinction is well visible on the figure when combination of both integrated pulses on the same diagram $u_{icinteg}$.

When frame generator synchronization the undesirable shift in time of the beginning of reverse motions of scanning on fields can happen due to such impulses.

As is clear, such shift is equal to Δ_1 and can attain the part of line duration. Existence of shift will lead to violation of scanning interlace, i.e. rasters of fields will be shifted vertically not precisely on half of distance between the next lines, and there will be a so-called pairing of lines. Line pairing worsens quality of picture. There is noticeable a structure of lines, clearness decreases vertically. In this basis, it is necessary to change form of the synchronization pulses so that distinction between the integrated even and uneven pulses of fields disappeared and shift Δ1 become equal to zero. For elimination of distinction in the form of synchronizing pulses of even and uneven fields of insert in it, it is expedient to make with a double line frequency. The form of even and uneven pulses of field synchronization becomes identical both prior, and after integration identical. During performance of the field-synchronizing pulse the line pulses will follow with the doubled frequency. For steady synchronization the pulse generator of line scanning is adjusted so that the frequency of its fluctuations in the mode without synchronization was lower than the line frequency. Thus, if amplitude synchronization pulses not excessively great, the generator shall not respond to additional impulses and will operate in the mode of frequency separation with coefficient 2. Thus, with full identity of filed-synchronizing pulses the pulses after u_{ic} integration turn out identical too and coincide when overlapping coincide. However, on more closer inspection of the processes it is necessary to make the conclusion that coincidence of integrated impulses is nevertheless incorrect. On the integrating circuit the line synchronizing pulses enter along with filed-synchronizing pulses. The condenser receives a certain charge from each line pulse. The condenser receives a certain charge from each lower case impulse. As line pulses in second and first fields located at different distances from the beginning and the end of the field-synchronizing pulse, they, naturally, have different impact on curve run of charge accumulation on the condenser in the second and first fields. While (continuous line on graphics) the residual charge of the condenser from the last line pulse is almost equal to zero in the synchronization pulses of first fields, in the pulses of second fields it is considerable (dashed line). Initial conditions of integration of frame pulses in the first and second fields turn out different, and it also leads to undesirable temporary shift Δ_2. However, in this case it is small ($\Delta_2<\Delta_1$), but is sufficient to break scanning regularity. To avoid a difference in the form of pulses after integration, it is enough, prior and afterwards, of filed-synchronizing pulses enter a few pulses following with double line frequency. Such pulses are called equalizing pulses. Thus, for receiving steady interlace scanning it is necessary to complicate a form of field-synchronizing pulse.

Duration of pulse of frame synchronization is defined by the standard 2,5 N (160 microseconds), and duration of the equalizing pulses becomes twice as little than the line sync pulses. The standard determines number of pre- and post-equalizing pulses, as well as pulses making frame synchronization signal, equal to five. Synchronization pulses located on blanking pulses peaks and are 43% of amplitude of picture signal from black level to white level. For scanners operation, it is desirable that synchronization pulses located as close as possible to the left edge of blanking pulses so that during reverse motion the screen should be blanked by blanking pulse. If synchronization pulse should be shifted to the right, less time will be allowed for reverse motion of the beam of receiver tube. Upon excess of this time due to any reasons reverse motion of the beam on the screen will be blanked incompletely. So, in synchronization signal of television receivers the most difficult in form is frame synchronization signal. Its form accepted by the domestic standard, as well as by the majority of the European countries and USA is the most perfect one. Such form allows to receive high quality of interlace scanning with easiest way of signal separation - by means of the integrating circuit - and high resistance to noise.

For synchronous and in-phase operation of the receiving scanners the lasts are put in the mode of forced synchronization for which purpose in the device called by the sync pulse generator the synchronization pulses have been formed which manage the operation of scanning. Frequencies of synchronization pulses are defined by the standard of scanning according to the above received ratios. Receiving of synchronization pulses from the general specified generator guarantees rigid communication of frequencies against one, and whereas it provides constancy of lines number in raster even with instability of frequency of specified generator.

As it was specified, with interlace scanning, the frequency of fields has to be doubled in comparison with frame frequency. In this case it is difficult to design the sync pulse generator according to the left scheme of figure 9.6 as for receiving pulses with f_n frequency it should divide the frequency of specified generator by fractional number of z/2 that is technically difficult. It is reasonable to make the frequency of specified generator equal to $2f_z$, and to receive line and frame sync pulses with division by 2 and on z respectively. The value of oscillatory frequency of specified generator equal to $2f_z$, is minimum necessary. In modern sync pulse generators the specified generator is adjusted on frequency, which is many times that $2f_z$. Thus, however, the condition of frequency multicplicity has been maintained of specified generator of double line frequency.

Lecture 10. Linear distortion of television signal

Contents: amplitude-frequency characteristic of distortions in low-frequency range. Amplitude-frequency characteristic of distortions in high-frequency range.

Linear (frequency) distortions of television signal have been connected with discrepancies of amplitude-frequency characteristics to perfect forms. The picture signal from rather large details of the original represents a signal of rather long duration therefore the range of such signal also contains rather low frequencies. Distortions of the specified signals are defined by form of the amplitude-frequency characteristic (AFC) of the path in the low-frequencies range (or form of the transitional characteristic in large times range – horizontal part of unit step). It is known that with the fall (rise) of AFC in low-frequencies range, the fall (rise) has been observed of the pulse of relatively long duration for plain part, and behind the pulse there is lasting continuation "black follows white" ("white follows white").

Smooth change of brightness of large detail in the direction of line scanning arising because of inclination of pulse flat part, visually relatively is low-observable. And here distortions of brightness of a background – the lasting continuation behind a detail in the form of peculiar "tail" – is noticeable much more strongly. Moreover, distortions of background brightness – the lasting continuation behind detail in the form of peculiar "tail" – is noticeable much more strongly. Black and white details in the center of the table are provided in UEIT for assessment of low-frequency distortions of picture signal. Distortions of high-frequency components of picture signal cause change of image sharpness in the horizontal direction and emergence of false patterns on the picture (plasticity, repetitions of contours of details, etc.). Image sharpness is defined: vertically – by number of lines of z scanning and quality of interlace scanning, and horizontally – by bandwidth of picture signaling channel (or form of transitional characteristic in short times range – duration of the front edge of the transitional characteristic). Practically image sharpness is estimated by size of minimum component reproduced by means of TV system. Sizes of components are measured by relative units (in relation to h frame height), and detail – in conventional units – by lines. For example, if visually the details have been differ on reproduction with size not less (1/550) h, image sharpness shall be 550 lines. For assessment of image sharpness the line target from black-and-white lines with one, two and three black line bars of identical thickness has been used, as well as the multi-line targets with the identical thickness of bars in the center and corners of TIT. Nearby such targets the numbers of conventional units of measurement of image sharpness were plotted corresponding to the relative thickness of bars in this place. For quantitative assessment of image sharpness the observer defines the area where line targets cease to differ separately. AFC fall in high-frequencies range and corresponding increasing of front edge duration of transitional characteristic are the main reason for reduction of horizontally image sharpness.

When AFC rise in high-frequencies range the duration of the front edge response decreases, but there can be attenuating oscillating process. According to distortions of edge response the image details are also distorted, i.e. after sharp change of brightness on the line there can be repetitions of component contour with gradually decreasing intensity on reproduction. If oscillating process is aperiodic, i.e. if there is only one (first) emission, component borders as if emphasized by itself. Such distortions carry the name "plastic". In some cases small plasticity even is useful as it improves objects distinguishability.

Lecture 11. Nonlinear distortions of television signal

Contents: geometric distortion of picture due to signal non-linearity. Nonlinear distortion correction.

Nonlinear distortions of television signal arise in photoelectronic and electronic-optical converters due to nonlinearity of light and modulation characteristics respectively, as well as in the electric channel of transmission (modulating equipment of transmitter, cascades of video amplifier, etc.). In practice, such distortions are defined mainly by nonlinear characteristics of terminals – the transferring and receiving tubes. The light characteristic of the transferring tubes isn't linear and generally with accuracy, sufficient for practice, can be considered by k1 - coefficient of proportionality and γ 1 – exponent of power, defining the form of light characteristic. Value γ1 can change in some limits when adjustment of the tube operating mode or the content of input picture. The modulation characteristic of kinescope represents the dependence of brightness intensity of screen on tension on the modulating electrode and expressed by following correlation: $L_{pic} = f(U_c)$ where L_{pic} – picture brightness. It is known that the modulation characteristic of kinescope is not also linear and can be considered with k_2 accuracy, sufficient for practice, – proportionality coefficient. Usually for receiving tubes γ2 = 2... 3. The resultant gamma coefficient of nonlinearity γ is equal to index of power product γ 1 and γ 2. Brightness of real objects can reach several thousand candelas per square meter, and contrast – 1000 and over. Kinescopes can provide the maximum brightness of 100-200 cd/m^2 with 100–200 contrast. Therefore, the dynamic range of reproduction brightness generally is less than the range brightness change of transmitted object. Moreover, at reproducing process the number of gradation on reproduction will be less, than on the object. We will consider graphically distortions of gradation of picture brightness with γ >1 coefficient. For convenience of quantitative assessment of nonlinear distortions the voltage of equal jump signal is delivered to the input of examining device. On figure 11.1, the generation of nonlinear distortions with γ >1 coefficient is shown.

It can be seen that nonlinear distortions will be present under any γ values. In that specific case with γ >1, apparently from figure 11.1, differences of brightness of the first several steps will be almost invisible in practical terms, and they will combine. These distortions are corrected by special gamma correctors. For correction of half-tone image distortions, i.e. receiving certain form of nonlinear amplitude characteristic, the crispener with the amplitude characteristic described entered into television path which has been described by the following equation:

$$U_{вых} = kU_{вх}^{\gamma_к} , \qquad (11.1)$$

where $\gamma_к$ – index of power determining the form of crispener amplitude nonlinearity.

The nonlinearity factor line equalizer is necessary for obtaining of linear amplitude characteristic of entire television path, where γ_3 - nonlinearity factor of television path:

$$\gamma_к = \frac{1}{\gamma_1 \cdot \gamma_2 \cdot \gamma_3}. \qquad (11.2)$$

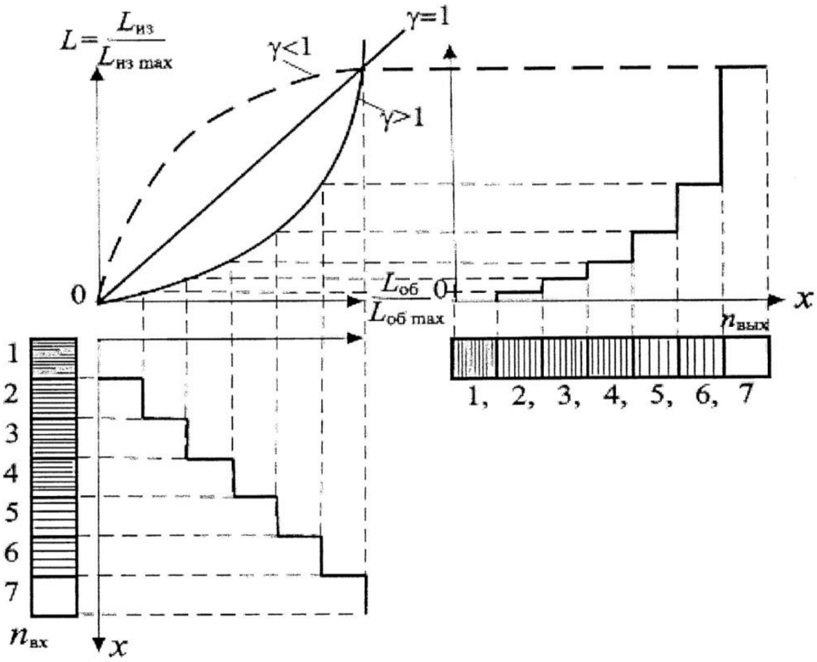
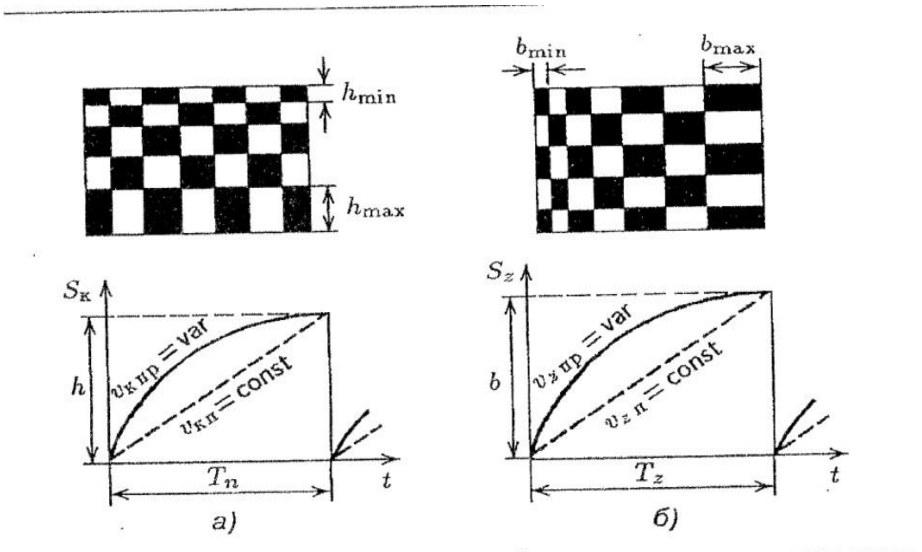


Figure 11.1 – Nonlinear distortion correction

Working principle of nonlinearity equalizer (gamma corrector) explained on figure 11.1. It is based on application of nonlinear elements so that, during its regulating, it was possible to change the gamma characteristic in appropriate limits. The signal of input picture distorted by nonlinear characteristic of television path (signal with uneven voltage drops), enters gamma corrector input which nonlinear characteristic is calculated so that the signal on output results in necessary form. Geometrical nonlinear distortions are connected with form distortions of raster, nonlinearity of scanning circuit (see figure 11.2).



a) frame scanning; b) line scanning.
Figure 11.2 – Geometric distortion due to signal nonlinearity

Lecture 12. Principles of generation and picture transmission in SECAM system and its general properties

Contents: sequential video signal transmission system. Schematic diagram of transmitting and receiving part in SECAM system. Peculiarities of PAL and NTSC encoding process.

SECAM (Sequence de Coleurs Avec Memoire - French)- sequential color with memory.

SECAM system design concept. Possibility of sequential transmission of color signals based on sense of vision peculiarity of color perception up to 1,5 MHz band. Since the components, minimum by the size, have been transmitted to fv = 6 MHz (E_Y), the painted components have the size on line of 6 MHz/1,5 MHz = fourfold than the minimum b/w details. On color TV camera output - E_R, E_G, E_B signals have been conversed in E_Y, $E_{R—Y}$ and E_{B-Y} signals by means of coder matrix. E_Y signal has been continuously transmitted, and signals $E_{R—Y}$ and $E_{B—Y}$ - one-by-one. The half of line are in color signal of component $E_{R—Y}$, the other half is $E_{B—Y}$. For chromaticity signals in the frame there are half as much of lines that increases the sizes of the painted components in vertical direction. But general definition in vertical direction shall remain since E_Y signal has been transmitted in full spectrum.

When reproduction of the color image each signal of chromaticity has been used twice: once - from DL input, another — from output. Chromaticity signals on DL input and output are different, i.e. there are always simultaneously both signals of chromaticity. It is supposed that in missed lines the color signal almost doesn't differ from the next signals. $E_{R—Y}$, $E_{B—Y}$ and $E_{G—Y}$ chrominance video signals have been generated in TV receiver from accepted TTVS. From detectors output the signals enter the matrix generating third chrominance video signal $E_{G—Y}$. For electronic commuter (EC) management the squared pulses have been used. Total switching cycle - t = 2lines (fp= f_{line}/2). For EC synchronization it is necessary that switching of commutor corresponds to sequence of chrominance video signals. For this purpose, EC in TV receiver has to operate phase-locked with EC of coding device therefore the signal of color synchronization additionally transmitted to the receiver.

Frame-scan and line scan generators synchronization in TV receiver has been performed by means of line and frame sync pulses. Chrominance video signals have been conversed in D_R, D_B signals, according to equation D_R ,= - 1,9 E_{R-Y}; D_B = 1,5 E_{B-Y} and have been subjected to gamma correction. Coefficients k_R = -1,9 and k_B = 1,5 coefficients improve commonality and increase system noise resistance.

Signal values have been changes with the limits of: $E`_{R—Y}$ from – 0,7 to + 0,7, $E`_{B—Y}$ from – 0,89 to + 0,89. General frequency content of the modulated signal of chromaticity shall be defined, first of all, by $E_{B—Y}$ signal. $E`_{R—Y}$ signal, having smaller extreme values shall occupy the smaller band that can worsen noise resistance of R—Y channel, therefore to smooth conditions of chrominance video signals transmission k_R and k_B coefficients have been entered.

$D`_R / D`_B = 1,9\ E_{R—Y} / 1,5\ E_{R—Y} = (1,9\times 0,7) / (1,5\times\ 0,89) = 1.$

$D`_R$ and $D`_B$ and E_Y summation the amplitude of color carrier is 25% from the amplitude of brightness signal, and that provides small visibility of noise waves on the screen of the b/w receiver.

Coding device carries out the following functions: allocates frequency content from picture signal in which chromaticity signal components are concluded; detects chromaticity signals; corrects high-frequency and low-frequency signal predistortions, entered the coding device; forms commands for black-and-white and color television receiving and performs color synchronization on authentication signal. Total television signal of E_P enter the high-frequency predistortions line equalizer of waveguide-to-coaxial adapter which presents the oscillatory contour adjusting on 4,286 MHz frequency. The form of the frequency characteristic of a contour is picked up so that completely to compensate high-frequency predistortion of subbearing, entered in the coding device. Form of loop frequency response selected so as to compensate fully high-frequency predistortions of carrier entered the coding device.

Lecture 13. Liquid crystal and plasma panels

Contents: electron-optical switching by liquid crystal. Conversion diagram in light-optical units. TFT and plasma panels structure.

The Austrian botanist of Friedrich Reinitzer found liquid crystals in 1888. In 1963 Williams investigated polarizing effects in liquid crystals in RCA company.

In 1973 the first display on liquid crystals (EL 8025) was developed for transportable computer. Liquid crystal molecules are spiky organic compounds (see figure 13.1) and are in various orientations in such phases/

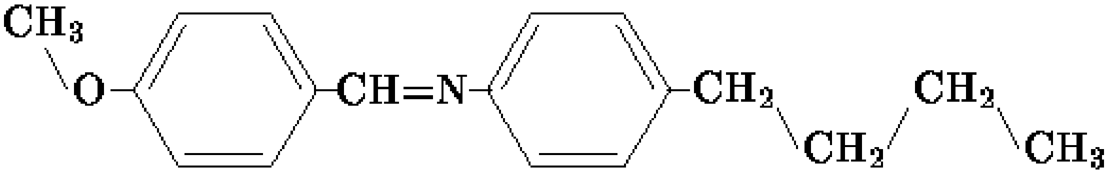


Figure 13.1- Chemical structure of liquid crystal

Molecular position and orientation under increasing of temperature in isotropic phase (liquid) are occasional.

Due to optical and electric anisotropy of liquid-crystal molecules the refraction ratio depends on the direction of light polarization about molecule axis. This property is used for turn of polarization when passing the light through the twisted liquid-crystal structure. It is known that the light doesn't pass through two crossed polarizers. Molecules in nematic phase twisted forcibly due to its location between two glass plates which have mutually perpendicular line engraving. On the glass surface molecules forcedly take place along engraving and since engravings are mutually perpendicular, the overwound chains of liquid-crystal molecules are formed between the plates. The distance between plates is about 10 microns. Depending on distance between the plates and LCD-crystal type the twist is (90 – 270)º (twisted nematics and super-twisted nematics, TN and STN). Distance between the plates is approximately 10 mkm.

When switching off voltage the crystal during about from tens to hundreds of milliseconds reverts to the original state. Important feature of liquid crystals is that during flow of direct current the crystal is exposed to electrolytic dissociation and loses its properties therefore liquid crystal indicators are powered by alternating voltage, with constant component no more than ten millivolts. Color LCD displays use three raster cells for pixel formation. Light intensity for each component defines color shade. LCD displays with active matrix in which each pixel is supplied with independently operated thin-film transistor (thin-film transistor - TFT) were developed for problem solution of operation speed. Such displays much more ultrafast, but are high-priced as the color display 800×600 requires 1 440 000 defect-free transistors.

Due to the latest technological developments on quality of the image (brightness and contrast) plasma TVs are practically equal to VDT-TVs, and in the sizes of screens outranked it long ago. Instead of electron stream intensifying luminophor, this function is carried out by inert gas (helium or xenon) bringing to the of plasma. There is a charge between electrodes, and its ultra-violet light intensifies luminophor. Each pixel consists of three points of different color. In fact, it very much reminds working principle of fluorescent lamp. The plasma panel displays about 16 million tones.

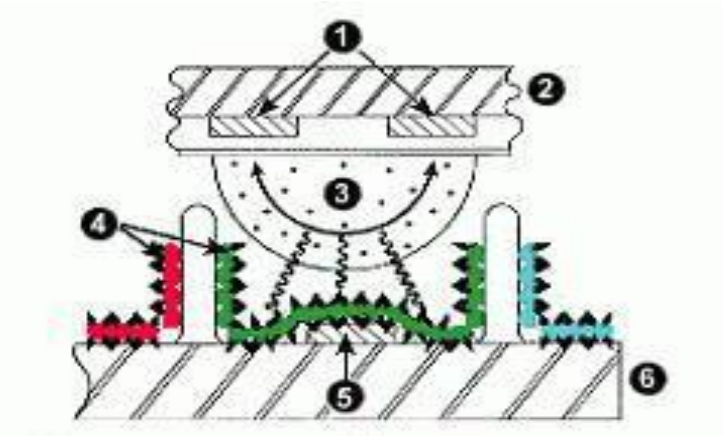


Figure 13.3 – Plasma panel structure

On Figure13.3 the electrodes marked by numbers 1 and 5, 2 and 6 - glass plates (front and back part of the panel), the gap between it is ≅ 0,1 mm, 3 – charge area, 4 - lunimophor. Cells don't glow all simultaneously, but the algorithm and time of management are chosen by it so that the eye doesn't notice the blinking. The design of the plasma screen is very complicated. Each cell, and the standard 42-inch panel containing it about one million, represents the separate device isolated from others and filled with gas.

Comparison of characteristics of kinescope and plasma panel:

1) The maximum size of kinescope is 46 inches, PDP - 80 inches.

2) Image sharpness. The clearness depends on the accuracy of focusing of EBT in kinescope (operation time, quality of radio components. Focusing is uneven on the entire screen (corners). Image sharpness of PDP is constant and very high.

3) Geometrical distortions. They initially exist in kinescope and over time grow because of its aging, the geometry is broken and when viewing the nonplanar image sideways. In "flat-square" kinescopes due to large glass thickness of the screen the effect of lens has been observed. PDP - displays have no geometrical distortions.

4) It isn't subject to influence of external magnetic fields.

5) Picture resolution. Plasma screen always has higher permission than kinescope. The resolution of screens of high-definition television TVs doesn't correspond to signal resolution.

6) Image brightness. It is maximum for kinescope - 400 cd/m^2. For "plasma" it is higher than 600 cd/m^2.

7) Blinking. Only 100-hertz TV receivers provide its absence, more precisely, the greatest invisibility. PDP flash invisibly for our sight.

8) Brightness of the plasma display falls. Design service life for "plasma" is about 50 000 hours. It is claimed that during this time the brightness shall fall no more than twice (if turn on the display daily for 8 hours, its resource will be enough at least for 17 years).

9) Phosphorus on the plasmas screen burns out, but not faster, than for ordinary TV receivers. Now most of producers of displays provide there the functions protecting screen luminophor from burning out.

10) On picture contrast "plasma" refers to the finest technology. Standard value of this parameter is 1500:1 against 600:1 for LCD.

11) “Plasma” makes noise. It is intended the noise of cooling system, including, now and then, up to 5 fans. But all producers already pass to fanless cooling systems, noise from which even below, than of ordinary TV receivers.

12) Plasma display doesn't belong to economy class devices. Standard consumption of energy for "42 inch planks" is about 350 W.

Lecture 14. Digital video broadcasting - DVB

Contents: vehicular flow organization. Formation and OFDM signal spectrum. Radio signals generation in DVB-T and 8VSB-AM system.

DVB project activities (to Digital Video Broadcasting - Digital video broadcasting) began in 1993. As a result, basic provisions of the DVB-C standard (C - Cable, cable) for cable TV broadcasting and DVB-S (S - Satellite - the satellite) for satellite TV broadcasting, DVB-T ground-based broadcasting were as a result developed (Terrestrial – Terrestrial broadcasting). At the heart of DVB - is the standard of coding of moving images and MPEG-2 accompanying sound. The DVB standards provide conditional access to transmitted programs that allows to organize paid TV broadcasting.

Conditional access system includes TV programs scrambling, storage subsystem about users, encapsulation subsystem and key passing, for of an encryption and transfer of keys, for the correct scrambling of receiving programs, by users, paid for viewing.

The interactive operating mode is necessary for many types of service implementing within DVB standards. The specified interaction can consist of commands transmission by phone, in data exchange on the Internet etc. According to the DVB standard the organized vehicular flow scrambled for elimination of package mistakes and encoding. Further data string enters Read Solomon coder (external coding). This step of coding of transport MPEG-2 packages also covers starting synchronization patterns of packages, and as a result duration of transport package increases from 188 to 204 bytes. Afterwards the data to which control bits have been added, enter channel coding units (internal coding) and carrier modulations. DVB-T standard uses OFDM-Orthogonal Frequency Division Multiplex - orthogonal frequency multiplexing. Two modes are possible: 8K (6817 carriers) and 2K (1705 carriers).

OFDM advantages:

- equal distribution of energy in the channel band;
- possibility of more important information transmission (synchronization, brightness signal audio components) on frequencies where there are less interfering signals from the neighboring canals, and frequency content carrying the image and sound carrier of usual TV broadcasting not to use at all;
- influence of the reflected signals decreases when multipath reception, since the subchannels are narrowbanding.

Communication channels in the DVB-S, DVB-C standards differ in frequency passband and noninterference therefore in the satellite channel with analog signal the frequency content of 27-36 MHz is used. Therefore QRSK-modulation that provides sustained transmission $\geq$ 6 dB is applied for digital satellite channel. The band of 8 MHz is typical for cable networks (Europe, Asia, Africa, Australia) therefore for cable applications QAM64 - modulation is used with $\geq$24 dB.

Lecture 15. Picture testing procedures

Contents: test pictures for image quality assessment. Major color locus with optimum and actual color triangles.

Tests include objective measurements: brightness and picture contrast, brightness and color definition, color coverage, linearity of the brightness characteristic and preservation of color balance when change of image brightness, uniformity of brightness and color on the screen area and sensitivity of the television tuner. Brightness of LCD television has been measured upon reproduction of the check pattern consisting of equal quantity of black and white squares. For plasma TV the measurement of brightness has been performed on two signals: check pattern and the image of white rectangles on black background with 15 percent filling with white color (see figure 15.1). Measurements results of color coverage are presented in the form of graphs on which the color space in coordinates (x, y) has been shown representing all spectrum of the light observed by human eye. White triangle on all graphs represents the border of such color range which has to be reproduced by TV receiver when transmitting on it the control signal. Black triangles are constructed on the basis of the performed measurements of chromatic coordinates of each device of the tested group. For assessment of linearity of the brightness characteristic and preservation of color balance when change of picture brightness on outputs of TV receivers the test images have been transmitted sequentially containing grey sites with intensity from 0 to 100 percent. Uniformity of brightness and color on the screen has been assessed by measurement of values of brightness and color temperature in nine control points of the table. Sensitivity of television tuners has been measured by means of generator attenuator tube of TV signals upon occurrence of color on signal of vertical color bands for the fifth and thirtieth terrestrial channels (HF and UHF bands).

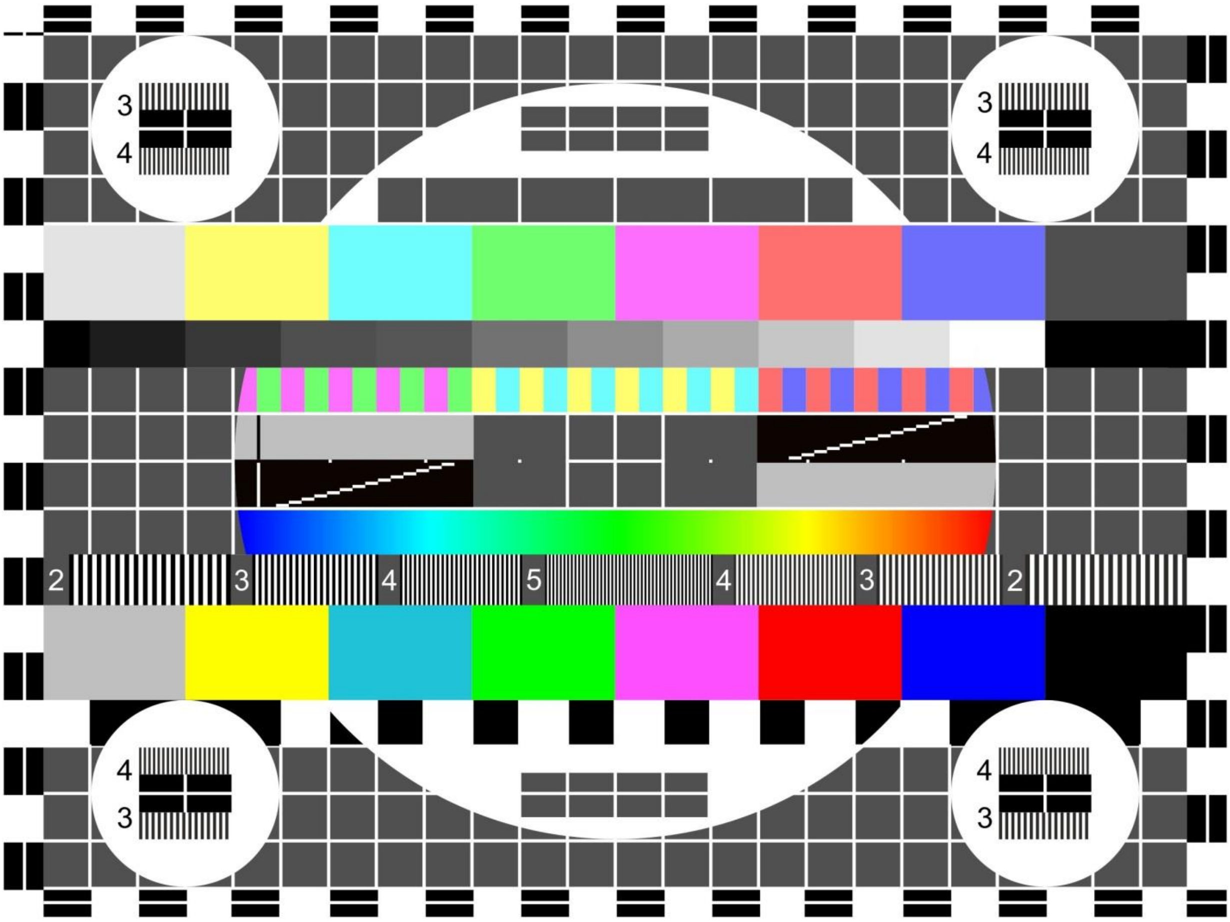


Figure15.1 – Test pictures for image quality

Test questions for self-checking

1. Explain the purpose of all total television signal components.
2. Explain the reason why parameters of picture decomposition define frequency passband of TV signal transmission path.
3. What distortions of TV signal forms will take place when falling (rise) of amplitude-frequency characteristic in the low- high frequency range of passband and how they will be shown on TV image?
4. Specify TV system parameters and its influence on the quality of the image.
5. Specify distortions of TV image and main reasons of its distortion.
6. Why does the application of interlaced raster allow to lower the requirement to frequency content of TV path?
7. Denote two main conditions necessary for formation of interlaced raster?
8. Explain the distinction in structures of sync pulse generator when forming interlaced and noninterlaced rasters.
9. What will happen with interlaced raster if to replace frequency divider (z) to divider (z+1)?
10. What is the frequency range of ground-based broadcasting?
11. What receiver radio path unit characteristic determines the selectivity by second and additional receiving channels?
12. What receiver radio path unit characteristic determines the selectivity by the next channel?
13. Why does radio path AFC of the receiver have obviously expressed asymmetrical form?
14. What are the advantages of the single-channel diagram of super heterodyne reception of picture and sound compared with the two-channel diagram?
15. What are the principles of reception of accompanying sound in the single-channel TV receiver?
16. In what amplitude range the supersync signals (SSS) are transmitted?
17. What is the form of SSS?
18. For what purpose the equalizing pulses and inserts have double line frequency?
19. How SSS has been allocated from full TV video signal?
20. What circuits and why are they used for allocation of frame-synchronizing pulses?
21. What are the advantages and disadvantages of line synchronization methods.
22. For what account does noise resistance of APCh and F rise?
23. What elements of EM path have been nonlinear distortions brought?
24. What characteristics of TV channel have been defined nonlinear distortions?
25. How to define resultant coefficient of nonlinearity of TV path?
26. How does the gamma corrector work with amplitude-dependent negative feedback?

27. What is the color purity in relation to characteristics of color television?

28. How to explain the necessity of formation of the brightness signal?

29. How to determine the coefficients of the equation of the brightness signal?

30. What are the advantages of chroma signs in comparison with signals E_R and E_B?

31. What signals have been transmitted in color compatible system of television and why?

32. Why in the narrow-band frequency modulation has been used narrow-band in SECAM system?

33. What signals and what way are the signals condensed in color television system of SECAM?

34. What corrections of signals and for what purpose have been such signals performed in SEMAM system in transmission and receiving?

35. What is the purpose and working principle of authentication signal in SECAM system?

36. What is the advantage of television cameras on CCD matrixes?

37. What are the advantages of the prism color-separating mechanism?

38. Specify types of correction of video signal in the camera channel.

39. What are the functions of color corrector?

40. What unit nonlinearity of television path corrects the gamma corrector?

41. Explain the purpose of all total television signal components.

42. Explain why do the parameters of image scanning define pass-band of TV signal transmission path.

43. What distortions of TV signal form will take place upon falling (rise) of the amplitude-frequency characteristic in the low (high)-frequency passband range and how it will be shown on TV image?

44. Specify parameters of TV system and its influence on quality of the image.

45. Specify distortions of TV image and its main causing reasons.

46. Why does the application of interlaced raster allows to level down requirement for frequency content of TV path?

47. Specify two main conditions necessary for interlaced raster formation?

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PRINCIPLES OF VIDEOIMAGE PROCESSING

Lecture notes for English class students of the speciality
5B071900 – Radio engineering, electronics and telecommunications

Editor G. Nurzhaubaeva
Standardization specialist Moldabekova N.K.

Signed on the seal __.__.__.
Edition___20__ ex.
Volume__1,88_

Format 60x84 1/16
Typographical paper №1
Order_____. Price 940 т.

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Copying-multiplier Bureau
Non-Commercial Joint Stock Company
"Almaty University of Power Engineering and Telecommunications"
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