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NATIONAL AVIATION UNIVERSITY
FACULTY OF AIR NAVIGATION, ELECTRONICS AND TELECOMMUNICATIONS
DEPARTMENT OF AVIONICS

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'___'___________2023

QUALIFICATION PAPER

(EXPLANATORY NOTES)
FOR THE DEGREE OF «BACHELOR»
SPECIALITY 173 'AVIONICS'

Theme: "Plasma panel of the information and entertainment system of aircraft passengers"

Done by: ___________AV-411 Kulikovsky Yaroslav Yurievich _____
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Kyiv 2023

NATIONAL AVIATION UNIVERSITY

Faculty of Air Navigation, Electronics and Telecommunications

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APPROVED

Head of department

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‘___’____________2024

TASK

for execution graduation work

Yaroslav Kulikovsky

1. Theme: «Plasma panel of the information and entertainment system of aircraft passengers», approved by the order of the rector dated 14. 03 2024 р. № 385/st.

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Analysis of flight technical characteristics of passenger aircraft and types of on-board entertainment, Research the structural and functional diagram of the plasma display, Calculation of plasma panel cell.

5. List of mandatory graphic material: Table of aircraft performance characteristics, IFE system diagrams, the scheme and selection of the cell design.

6 . Planned schedule

№	Task	Duration	Signature of supervisor
1	Analysis of flight technical characteristics of passenger aircraft and types of on-board entertainment,	13.05.2024 -	
2	Research of hardware and software tools and characteristics of information and entertainment systems		
3	Research the structural and functional diagram of the plasma display		
4	Calculation of plasma panel cell		
5	Preparation of graphic material		
6	Preparation of an explanatory note		
7	Introduction to the department. Elimination of deficiencies, preparation of an explanatory note		
8	Preparing for the review	05.06.2024	

7. Consultants individual chapters

Chapter	Consultant (Position, surname, name, patronymic)	Date, signature

		Task issued	Task accepted
Labor protection			
Environmental protection			

8. Date of assignment: 14.03.2024

Supervisor _______________ Valerii Bielinskyi
The task took to perform _______________ Yaroslav Kulikovsky

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INTRODUCTION

Actuality. The advancement and optimization of plasma panel technology are crucial for the development of high-quality visual displays that can be used in various applications, including aviation, entertainment, and communication systems. With the growing demand for efficient and high-resolution display technologies, the need to enhance the brightness, efficiency, and overall performance of plasma panels has become more pressing. This research addresses these challenges by exploring innovative design and control mechanisms, making significant contributions to the field of display technology.

The purpose of the work is. The primary purpose of this work is to develop and optimize the functional design and operational principles of plasma panels to achieve high brightness and efficiency. This involves examining various aspects of plasma panel technology, including the arrangement of components, selection of materials, and implementation of control mechanisms, to enhance the performance and reliability of plasma displays.

The object of the research. The object of the research is the plasma display panel, specifically focusing on its components and functional design. This includes the dielectric plates, cathodes, anodes, separating elements, phosphors, and other critical components that influence the panel's performance.

The subject of the research. The subject of the research is the optimization of the plasma panel's brightness and efficiency through innovative design and control strategies. This encompasses the analysis of brightness control techniques, cell design, material selection, and the implementation of advanced control mechanisms.

Research method. The research employs a combination of theoretical analysis, computational modeling, and experimental validation. Theoretical analysis is used to derive optimal design parameters, while computational modeling helps simulate the performance of different design configurations. Experimental validation is conducted to verify the theoretical and computational findings and to assess the practical applicability of the proposed solutions.

Scientific novelty. The scientific novelty of this research lies in the development of new design and control techniques that significantly enhance the brightness and efficiency of plasma panels. This includes the formulation of an optimal distance between cathodes, the implementation of pulse-code modulation for brightness control, and the selection of advanced gas mixtures and phosphors. These innovations contribute to the improvement of plasma display technology, offering potential efficiencies comparable to modern LED displays while maintaining cost-effectiveness.

CHAPTER 1
ANALYSIS OF TYPES OF ON-BOARD ENTERTAINMENT

1.1. Flight and technical characteristics of regional aircraft

The An-148-100 aircraft is designed as a high-wing airplane with D-436-148 engines mounted on pylons under the wing. The design solutions applied to the An-148 family of aircraft provide new airliners with a number of advantages. One of them is a significantly higher level of protection for the engines and wings from damage by foreign objects, due to the aircraft's configuration (high-wing with engines on pylons under the wing). The An-148 can safely operate on poorly prepared, gravel, unpaved, prepared ice, and snowy runways. The presence of an auxiliary power unit, an onboard system for recording the state of systems, as well as a high level of technological sophistication and reliability, allows the aircraft family to be used at virtually any airfields.[3]

Modern flight-navigation and radio communication equipment, the use of multifunctional indicators, and an electro-optical flight control system allow the An-148-100 to be used on any air routes, in simple and complex weather conditions, day and night, including routes with high flight intensity, providing a high level of comfort for the crew.

The comfort level of the An-148 passenger cabin matches that of the most modern long-haul aircraft. Below, Table 1.1 indicates the flight and technical characteristics (FTC) of this aircraft.

Table 1.1

Flight and technical characteristics of the An-148

Crew (persons):	2 пілота, 2(3) бортпровідники
Passenger capacity (persons):	80
Length (m):	29,13
Height (m):	8,19
Wingspan (m):	28,91
Wing area (m^2):	87,32
Fuselage diameter (m):	3,5
Cabin width (m):	3,13
Cabin height (m):	2,0
Maximum takeoff weight (kg):	38550
Maximum fuel capacity (kg):	12050
Number and type of engines	9680
Cruising speed (km/h):	800-870

Average hourly fuel consumption (kg/h):	1550
Required runway length (m):	1560
Operational temperatures (on the ground, °C):	-55…+45
Calendar service life (years):	30
Number of flights:	60000
Number of flight hours:	80000

The Sukhoi Superjet 100 is a next-generation regional aircraft with 100 seats, combining the latest technologies in aviation. The SSJ100 offers comfortable travel for passengers, significant economic benefits for carriers, convenience for the crew, and maximum environmental safety.

The aircraft is built with a conventional layout - a twin-engine, low-wing, turbofan with a swept wing and single vertical tail. The wing features a supercritical profile with single-slotted flaps. Parts of the wing's mechanization, as well as the nose and wing root fairings, are made from composite materials.

Designers opted for a side-stick control for the "Superjet 100" instead of the traditional yoke. The Superjet 100 features an algorithmic tailstrike protection system, eliminating the need for mechanical bumpers.[5]

The maximum flight altitude is 12,100 meters, and the range varies from 3,048 to 4,578 kilometers depending on the modification. Equipped with two PowerJet SaM146 engines mounted under the wings, the aircraft meets all regulations, including noise standards adopted in the European Union. The aircraft is 30 meters long and 10 meters high. The cabin layout is 2+3 seats per row. The seating capacity ranges from 98 to 108 passengers, depending on the number of classes and the seat pitch selected by the customer. The designed payload is 12.245 tons. Below, Table 1.2 lists the flight and technical characteristics (FTC) of this aircraft.

Table 1.2

LTX Sukhoi Superjet 100

Model	SuperJet100-95B	SuperJet100-95LR
Crew (persons):	2 pilots, 2 flight attendants	2 pilots, 2 flight attendants
Passenger capacity (persons):	98 in standard configuration (up to 108)	98 in standard configuration (up to 108)
Length (m):	29.94	29.94
Height (m):	10.28	10.28
Wingspan (m):	27.80	27.80
Wing area (m^2):	77	77
Fuselage diameter (m):	3.54	3.54
Cabin width (m):	3.23	3.23
Cabin height (m):	2.12	2.12
Maximum takeoff weight (kg):	45,880	49,450
Maximum fuel capacity (kg):	15,805	15,805
Payload capacity (kg):	12,245	12,245

The Boeing 737 is the most mass-produced and best-selling jet airliner in aviation history. It is the most popular narrow-body jet airliner in the world, performing short- and medium-haul flights.

All Boeing 737 family aircraft are divided into three groups: 737 Original, 737 Classic (100-500), 737 Next Generation (600-700, 700ER, 800-900, 900ER, BBJ, BBJ2), and Boeing 737-8MAX.

The 737 Original generation aircraft are equipped with an analog avionics suite with system redundancy and electromechanical instruments. The instrument panels of the 737 Classic generation aircraft are equipped with an electronic flight instrument system (EFIS), which includes both electronic and analog indicators. This equipment allows for landings under ICAO CAT IIIA weather minimums.

The avionics suite of the 737 Next Generation is largely similar to that of the 737 Classic. The main difference is the use of the Common Display System (CDS) developed by Honeywell, similar to that used on the Boeing 777. The CDS includes two Display Electronic Units (DEUs), six liquid crystal Display Units (DUs), two control panels, and commutation equipment.[7]

The display can switch information from one screen to another. Besides its primary purpose of creating indications, the CDS serves as a central interface system. The CDS can also be supplemented with a collimator indicator (head-up display) – Head-Up Display (HUD). Below, Table 1.3 lists the flight and technical characteristics (FTC) of this aircraft.

Table 1.3

LTX Boeing 737 Classic

Crew (persons):	2 pilots
Passenger capacity (persons):	108-132
Length (m):	31.1
Height (m):	11.1
Wingspan (m):	28.9
Wing area (m²):	105.40
Fuselage diameter (m):	4.11
Cabin width (m):	3.54
Cabin height (m):	2.20
Maximum takeoff weight (kg):	60,000-85,130
Maximum fuel capacity (kg):	12,050
Payload capacity (kg):	20,540
Number and type of engines:	2x CFM 56
Cruising speed (km/h):	823-828
Average hourly fuel consumption (kg/h):	2,600
Required runway length (m):	2,040
Operational temperatures (on the ground, °C):	-55...+45
Calendar service life (years):	20
Number of flights:	75,000
Number of flight hours:	100,000

The Airbus A320 family is a series of narrow-body aircraft designed for short and medium-haul flights, developed by the European consortium Airbus S.A.S. Released in 1988, it became the first passenger aircraft to feature a fly-by-wire control system.

The aircraft has a single central aisle in the cabin, 4 passenger doors, and 4 emergency exits. The A320 can accommodate a maximum of 180 passengers. In a typical two-class configuration (2+2 in business class and 3+3 seats in economy class), the cabin holds up to 150 passengers. The cargo compartment can fit 7 AKH containers – 3 in the front and 4 in the rear. As its name suggests, the A320 is the foundational model of the successful A320 family. The cruising speed of the A320 is 910 km/h. The average flight range is 4,600 km. Depending on the cabin configuration, with an additional fuel tank, it can cover distances up to 5,500 km.

The official A320 program started in March 1984. The first flight of the prototype A320 with the CFM56-5A1 engine took place on February 22, 1987. By the end of February 1988, the aircraft was certified in Europe, and in December of the same year, it was certified in the USA. In March 1988, Air France received the first aircraft. The A320 was the first passenger aircraft in the world with a fly-by-wire control system, a cockpit equipped with side-sticks instead of traditional control columns, and horizontal stabilizers made entirely of composite materials. Below, Table 1.4 lists the flight and technical characteristics (FTC) of this aircraft.[11]

Table 1.4

LTX A320

Crew (persons):	**2 pilots**
Passenger capacity (persons):	140-180
Length (m):	37.57
Height (m):	11
Wingspan (m):	34.1
Wing area (m²):	122.6
Fuselage diameter (m):	3.95
Cabin width (m):	3.70
Cabin height (m):	2.12
Maximum takeoff weight (kg):	77,000
Maximum fuel capacity (kg):	30,190
Payload capacity (kg):	18,600
Number and type of engines:	2xCFMI CFM56B / 2xIAEV2500-A5
Cruising speed (km/h):	840
Average hourly fuel consumption (kg/h):	2,700
Required runway length (m):	2,000
Operational temperatures (on the ground, °C):	-50...+50
Calendar service life (years):	25
Electrical system:	Three-phase AC network 115/200 volts, 400 Hz

The Embraer E-Jet 195 is the longest and most spacious variant of the twin-engine narrow-body passenger aircraft family for medium-haul flights. A fully loaded Embraer 195 can cover 4,448 km without a refueling stop. The Embraer 195 is the most popular of the four models in the Embraer E-Jet family, capable of carrying between 108 and 128 passengers, depending on the cabin configuration.[1]

This series was developed to compete with major manufacturers Airbus and Boeing, as well as Bombardier (model CRJ-1000), and the Russian-made Sukhoi Superjet 100. Compared to the previous E-Jet 170/175 series, the innovation of the Embraer 195 model includes an increased wing length, upgraded elevator control, and the use of more advanced engines such as the

General Electric CF34. The first test flight of this model was conducted on December 7, 2004.

Embraer 195 aircraft are very popular among European low-cost carriers. The aircraft features reduced pollutant emissions, fuel efficiency, minimized maintenance costs, and a spacious cockpit. Below, Table 1.5 lists the flight and technical characteristics (FTC) of this aircraft.

Table1.5

LTX Embraer E-Jet - 195

Crew (persons):	2 pilots, 2(3) flight attendants
Passenger capacity (persons):	80
Length (m):	29.13
Height (m):	8.19
Wingspan (m):	28.91
Wing area (m^2):	87.32
Fuselage diameter (m):	3.5
Cabin width (m):	3.13
Cabin height (m):	2.0
Maximum takeoff weight (kg):	50,790
Maximum fuel capacity (kg):	16,250
Payload capacity (kg):	13,530
Number and type of engines:	2x GE CF34-10E
Cruising speed (km/h):	890
Average hourly fuel consumption (kg/h):	1,550
Required runway length (m):	1,800
Operational temperatures (on the ground, °C):	-45...+54

The Tu-204-300 is a long-range narrow-body aircraft. It features a fuselage that is 6 meters shorter than the base version and significantly increased range. It can accommodate up to 162 passengers. In the standard configuration, it seats 142 passengers (8 in business class and 134 in economy class). Developed in three variants with flight ranges of 3,400 km, 7,500 km, and 9,250 km, the Tu-204-300 is the first Soviet twin-engine aircraft capable of nonstop flights from

Moscow and Saint Petersburg to Vladivostok. The maximum takeoff weight of the aircraft is 107.5 tons. The Tu-204-300 meets current and future ICAO and Eurocontrol requirements, providing comfortable conditions for passengers, including an in-flight audio and video entertainment system.[2]

The Tu-204-300A is a modification for administrative transportation. The maximum range with the calculated number of passengers on board is increased to 9,600 km. The aircraft is equipped with a high-comfort cabin, a shower cabin, a satellite communication system, adjustable main lighting, and programmable full-color cabin lighting. The number of passenger seats is 26. Fuel capacity is 42,000 kg.

The Tu-204/214 family of aircraft are monoplanes with a low-mounted swept wing and two turbojet engines mounted on pylons under the wing. The high-aspect-ratio wing has supercritical profiles, a negative aerodynamic twist, a positive dihedral angle (4°), and is set at an angle of 3°15' to the fuselage reference line. Winglets are installed at the wingtips to reduce induced drag.

The Tu-204-300 complies with ICAO Chapter IV of Annex 16 to the Chicago Convention with a margin of 5.4 dB. Engine emissions also meet current international requirements. The aircraft is equipped with two PS-90A turbofan engines, produced by OJSC "Perm Engine Company," and an auxiliary power unit TA-12-60, produced by NPP "Aerosila." The Tu-204-300 was developed by JSC "Tupolev" and is manufactured by CJSC "Aviastar-SP."[4]

Table 1.6

Main alight and eechnical characteristics of the иase Tu-204-300 Aircraft

Characteristic	Specification
Engines:	2x PS-90A
Engine thrust (kgf):	16,000
Maximum taxiing weight (t):	107.8
Maximum takeoff weight (t):	107.5
Maximum landing weight (t):	88
Maximum fuel capacity (t):	36
Maximum commercial load (t):	18
Range with maximum fuel load (km):	8,200
Range with maximum commercial load (km):	5,620
Maximum flight altitude (km):	12
Airport altitude above sea level (m):	-300...2000
Cruising speed (km/h):	810-850
Operational temperature range (°C):	-45...+45
Required runway length (m):	2,150
Landing category:	II
Number of crew members (persons):	3

The analysis of the flight and technical characteristics tables of these aircraft shows that the cruising speed of modern regional passenger aircraft ranges from 800 to 890 km/h, and the passenger capacity varies from 80 to 180 people, depending on modifications and configurations.

1.2 Analysis of types of on-board entertainment

Moving-map systems. A moving-map system is a real-time flight information video channel broadcast through cabin project/video screens and personal televisions (PTVs). In addition to displaying a map that illustrates the position and direction of the plane, the system gives (utilizing both the imperial and metric systems) the altitude, airspeed, outside air temperature, distance to the destination, distance from the origination point, and origin/destination/local time (using both the 12-hour and 24-hour clocks). The moving-map system information is derived in real time from the aircraft's flight computer systems.

The first moving-map system designed for passengers was named Airshow and introduced in 1982. It was invented by Airshow Inc (ASINC), a small southern California corporation, which later became part of Rockwell Collins. KLM and Swissair were the first airlines to offer the moving map systems to their passengers. The latest versions of moving-maps offered by IFE manufacturers include AdonisOne IFE, ICARUS Moving Map Systems, Airshow 4200 by Rockwell Collins, iXlor2 by Panasonic Avionics, and JetMap HD by Honeywell Aerospace. In 2013, Betria Interactive unveiled FlightPath3D, a fully interactive moving-map that enables passengers to zoom and pan around a 3D world map using touch gestures, similar to Google Earth. FlightPath3D was chosen by Norwegian as the moving-map on their new fleet of Boeing 787 Dreamliners, running on Panasonic's Android-based touch-screen IFE system.[6]

Audio entertainment. Audio entertainment covers music, as well as news, information, and comedy. Most music channels are prerecorded and feature their own DJs to provide chatter, song introductions, and interviews with artists. In addition, there is sometimes a channel devoted to the plane's radio communications, allowing passengers to listen in on the pilot's in-flight conversations with other planes and ground stations. In audio-video on demand (AVOD) systems, software such as MusicMatch is used to select music off the music server. Phillips Music Server is one of the most widely used servers running under Windows Media Center used to control AVOD systems.

Video entertainment. Video entertainment is provided via a large video screen at the front of a cabin section, as well as smaller monitors situated every few rows above the aisles. Sound is supplied via the same headphones as those distributed for audio entertainment. However, personal televisions (PTVs) for every passenger provide channels broadcasting new and classic films, as well as comedies, news, sports programming, documentaries, children's shows, and drama series. Some airlines also present news and current affairs programming, which are often pre-recorded and delivered in the early morning before flights commence.

Personal televisions. Most airlines have now installed personal televisions (otherwise known as PTVs) for every passenger on most long-haul routes. These televisions are usually located in the seat-backs or tucked away in the armrests for front row seats and first class. Some show direct broadcast satellite television which enables passengers to view live TV broadcasts. Some airlines also offer video games using PTV equipment. Many are now providing closed captioning for deaf and hard-of-hearing passengers. Personal on-demand videos are stored in an aircraft's main in-flight entertainment system, whence they can be viewed on demand by a passenger over the aircraft's built-in media server and wireless broadcast system.[16]

In-flight movies. Along with the on-demand concept comes the ability for the user to pause, rewind, fast forward, or jump to any point in the movie. There are also movies that are shown throughout the aircraft at one time, often on shared overhead screens or a screen in the front of the cabin. More modern aircraft are now allowing Personal Electronic Devices (PEDs) to be used to connect to the on-board in-flight entertainment systems.

Closed-captioning. Closed captioning technology for deaf and hard-of-hearing passengers started in 2008 with Emirates Airlines. The captions are text streamed along with video and spoken audio and enable passengers to either enable or disable the subtitle/caption language. Closed captioning is capable of streaming various text languages, including Arabic, Chinese, English, French, German, Hindi, Spanish, and Russian.

In-flight games. Video games are another emerging facet of in-flight entertainment. Some game systems are networked to allow interactive playing by multiple passengers. Later generations of IFE games began to shift focus from pure entertainment to learning. The best examples of this changing trend are the popular trivia game series and the Berlitz Word Traveler that allows passengers to learn a new language in their own language. Appearing as a mixture of lessons and mini-games, passengers can learn the basics of a new language while being entertained. Many more learning applications continue to appear in the IFE market.[5]

The analysis of modern regional aircraft and their on-board entertainment systems reveals significant advancements in both flight technology and passenger experience. Aircraft such as the An-148-100, Sukhoi Superjet 100, Boeing 737, Airbus A320, Embraer E-Jet 195, and Tu-204-300 demonstrate improvements in safety, efficiency, and versatility, allowing operations on various runway types and under diverse weather conditions.

Key technological features, including high-wing designs, advanced navigation systems, and efficient engines, contribute to enhanced operational capabilities and passenger comfort. These aircraft also meet stringent international standards for noise and emissions, ensuring environmental compliance.

On-board entertainment systems have evolved to provide a wide array of multimedia options, catering to different passenger preferences and enhancing the overall travel experience. Systems such as moving-map displays, audio and video entertainment, personal televisions (PTVs), and interactive games offer passengers personalized and engaging content throughout their journey. The introduction of features like closed captioning and educational games further diversifies the entertainment options available.[10]

In conclusion, the integration of advanced flight technologies and sophisticated on-board entertainment systems significantly enhances the safety, efficiency, and comfort of modern regional air travel.

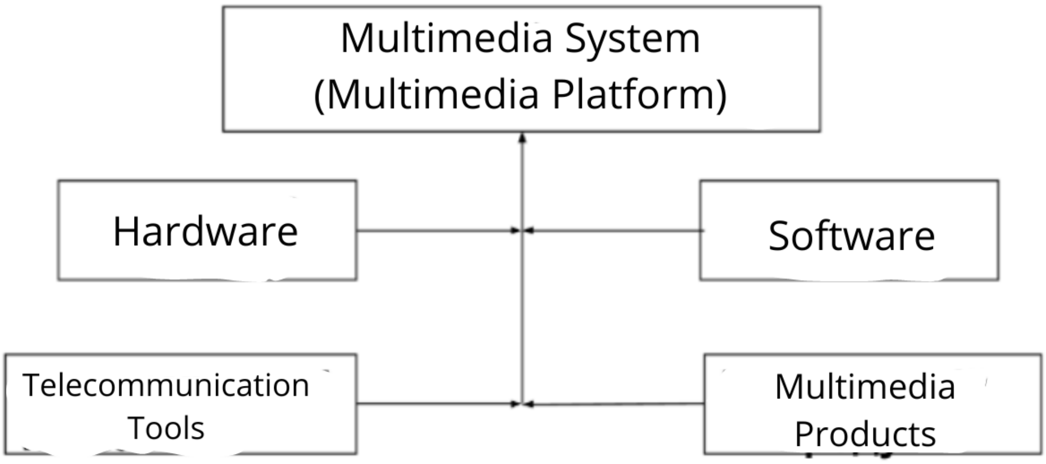
CHAPTER 2
COMPONENTS OF THE AIRCRAFT MULTIMEDIA SYSTEM

2.1. Definition and components of the aircraft multimedia system

The term multimedia system (MMS) in a broad sense refers to a combination of hardware, software, and telecommunication tools that allow the user to interactively work with information presented as multimedia products, including graphics, text, sound, photo, and video files.

Such a combination or complex of multimedia hardware, software, and telecommunication tools constitutes a hardware-software multimedia system or, as commonly referred to, a multimedia platform.

Components of the multimedia system:



Tab. 2.1. Components of the multimedia system

Under the term multimedia system (MMS) in a broad sense, it is understood as a combination of hardware, software, and telecommunication tools that allow the user to interact in a dialog mode with information presented as multimedia products: graphics, text, sound, photo, and video files. Such a combination or complex of multimedia hardware, software, and telecommunication tools constitutes a hardware-software multimedia system or, as it is commonly called, a multimedia platform.

Categories of multimedia tools by integration level

1. Federation of Multimedia Tools (FMT):
   - A collection of various multimedia components.
2. Onboard Passenger Information and Entertainment Systems (OIESP):
   - Comprehensive multimedia systems designed for passenger use.
3. Integrated (Interactive) Multimedia System (IMS or Hypermedia System - HMS):
   - Fully integrated multimedia systems offering extensive interactive capabilities.

The hardware components of OIESP include:

- Tools for creating photo and video images.
- Tools for creating and processing animation, 2D, and 3D graphics.
- Tools for video image processing.
- Tools for creating and processing sound.
- Tools for recording images and sound.
- Tools for playback of images and sound.
- Tools for creating slide shows, advertising clips, presentations.
- Manipulators (input devices).
- Sound cards.
- Video cards.
- Servers.
- Virtual reality tools.

The similarity of multimedia as hardware-software complexes with universal computing systems is also manifested in the presence of a similar hierarchy of software used. Multimedia software (MMSW) can be primarily divided into system and application software.[12]

A separate category is the instrumental MMSW, which supports the development processes of application MMS. Common representatives of instrumental MMSW are specialized and universal tools.

Onboard the aircraft, special systems are installed for information transmission - communication systems. These systems operate according to standards and protocols with analog and digital information. The most common standards, developed by the American Radio Engineers Corporation, include ARINC 429 (simplex mode), ARINC 651 (duplex mode), etc. All information is transmitted via coaxial cables, and video via fiber-optic systems.

Depending on the basic parameters and functional capabilities of the hardware-software multimedia platform, various technologies are applied for the creation, editing, and playback of multimedia products (applications, data).
MMPs traditionally include the following types of data:

- Text: Coded text data.
- Graphics: Static images of artificial and natural origin.
- Animation and Video: Dynamic (moving) images of artificial and natural origin.
- Sound: Synthetic and wave-based audio data.
- Interactivity: Data characterizing feedback with the user.

The onboard information and entertainment system of Ukrainian production MUZA-A is designed to distribute four sound stereo programs and informational messages from the first (second) pilot or flight attendant to passenger seats. On the An-140 aircraft, two programs are involved.

The system provides the formation, distribution, selection, and listening through stereo headphones by each passenger to one of two programs. A passenger control panel is installed in the armrest of each passenger seat, which allows each passenger to select and listen to one of the two programs through headphones, as well as adjust the volume of the listening program.

The system ensures forced listening at each passenger seat to crew and flight attendant announcement signals at a nominal volume level, regardless of the volume control position on the passenger control panel.

2.2. Functional diagram of the MUZA-A System

The MUZA-A system receives a multimedia signal from the "RITM" player, which forms from 2 to 16 stereo sound programs as part of the information-entertainment system and monophonic programs for joint operation with the loudspeaker equipment of passenger aircraft.

"RITM" is designed to work with 120 mm diameter audio compact discs in CD-DA, CD-R formats, compliant with standards.

Components:

- CD Disc Playback Device M-600:
  - Responsible for playing audio CDs.
- Audio System Control Panel PA-500 (PA-500vip, PA-500vip2):
  - Used to manage the audio system.

Onboard Information and Entertainment System “MUZA-AV” (An-148)
The "MUZA-AV" system is designed to distribute stereo audio programs and informational messages to passenger seats, as well as to collectively view a single video program on monitors installed in the aircraft cabins.

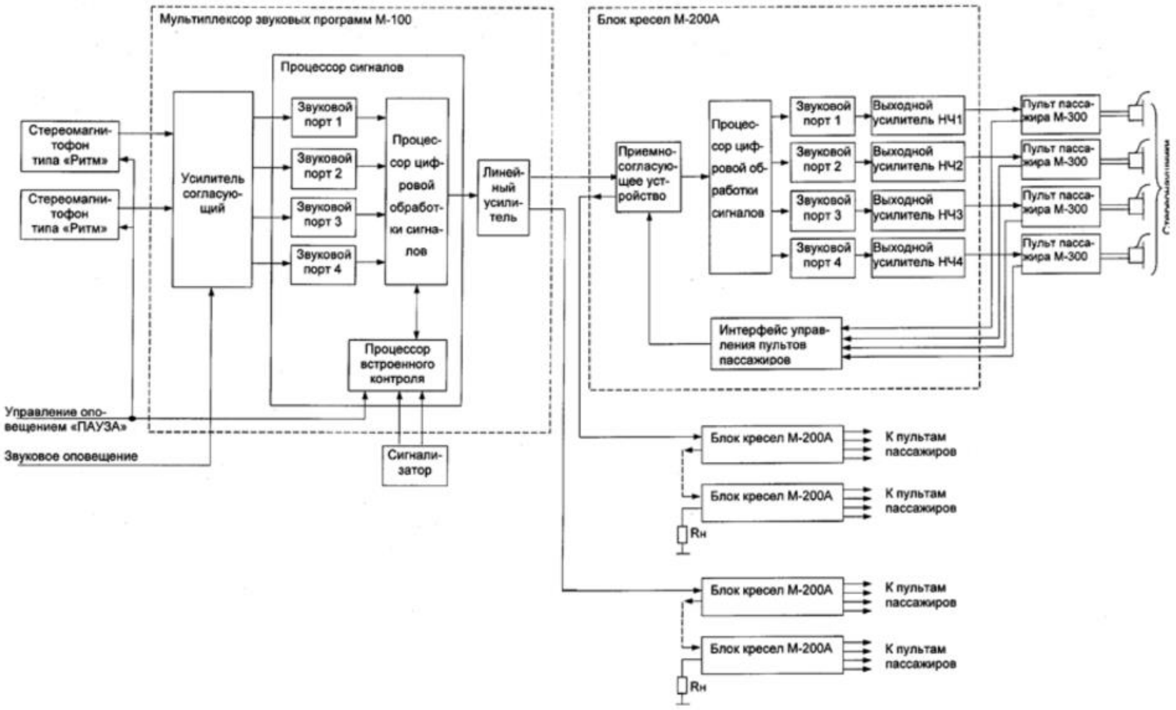
Key Features:

- The system provides each passenger with the ability to individually select and listen to broadcasted music and informational programs, as well as the audio accompaniment of video programs.
- Priority listening to service announcements is ensured.
- Stereo headphones are used for listening to audio programs.

System Components:

- Multiplexer Block M-100: 1 unit.
- Electronic Seat Block M-200: 1 unit per 4 passenger seats.
- Passenger Control Panel: One for each passenger.

Table. 2.2



Tab. 2.2 Functional diagram of the MUZA-A system

System "ETUD.

The "ETUD" system is designed for the formation and playback of video programs in the cabins of passenger aircraft as part of the "MUZA-AV" information and entertainment system.

- The system is designed to work with 120 mm single-sided DVD discs in DVD-VIDEO format.
- It provides continuous sequential playback of video programs and allows quick access to any fragment.
- The system supports both collective and individual viewing of video programs by passengers.

2.3. Main characteristics of the "SIRIUS 06" video system (Tu-204, Il-96)

Individual Interactive Entertainment Video System for Business Class Passengers:

- Viewing video programs on individual monitors (10 inches) located in the central pedestal of the seat block.
- Displaying flight modes and route maps.
- Listening to audio programs from the server's phonotheque.

Upper Information Video System for Economy Class Passengers:

- Viewing video programs on folding monitors (12 inches) mounted in the cabin ceiling.
- Broadcasting movies, clips, and service programs from the server.
- Displaying flight modes and route maps.

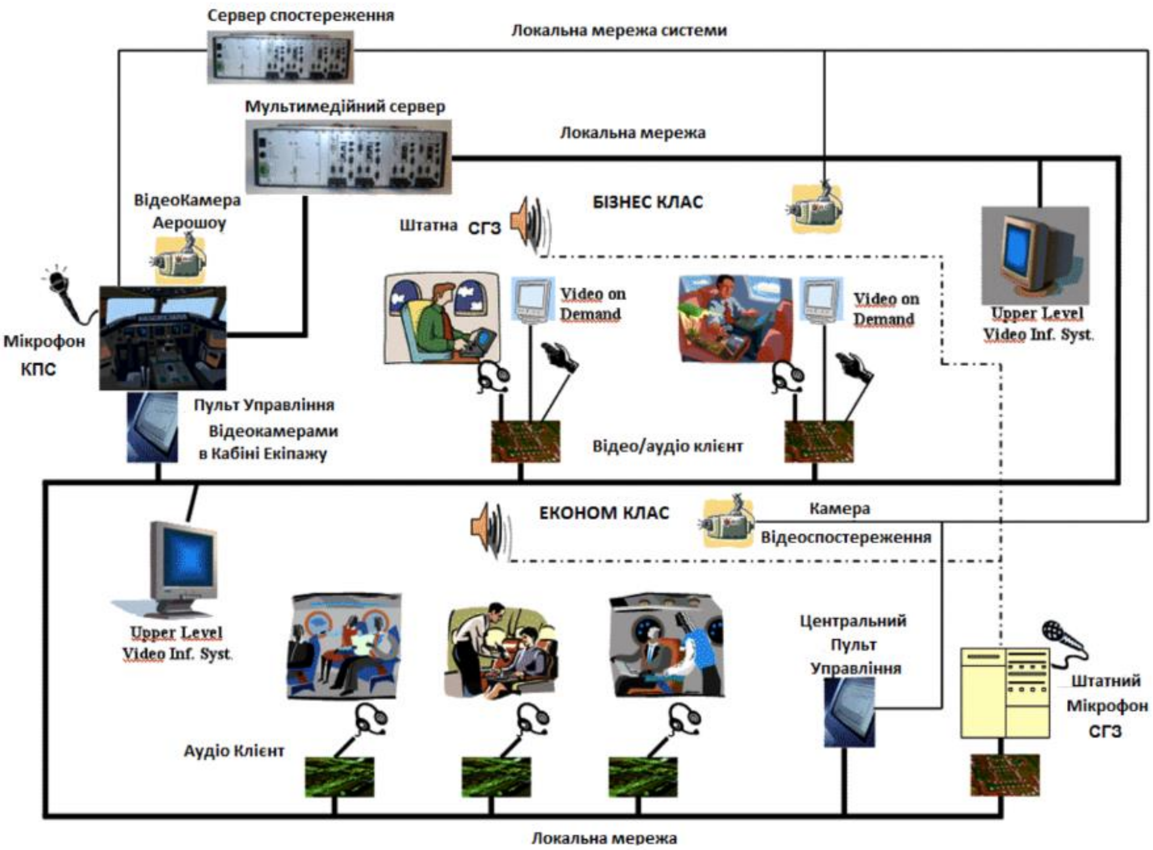
Aeroshow System:

- Information is transmitted to the collective monitors of the upper video system and individual monitors for business class passengers.
- Displaying flight parameters, trajectory, and local maps.
- Video surveillance of the aircraft's course.
- Video viewing of takeoff and landing modes.
- Transmitting information to the upper video system monitors and individual monitors in business class seats.
- Information is provided in two languages.

Flight Characteristics Affected by Overloads or Improper Cargo Placement:

- Maneuverability range.
- Landing speed.
- Increased runway length.
- Maneuverability.
- Rate of climb.
- Controllability.
- Maximum altitude above sea level.
- Stall speed.

Significant attention is paid to the weight characteristics of all onboard systems to ensure the rational use of the aircraft's resources.[13]



Structure of the "SIRIUS 06" onboard entertainment system

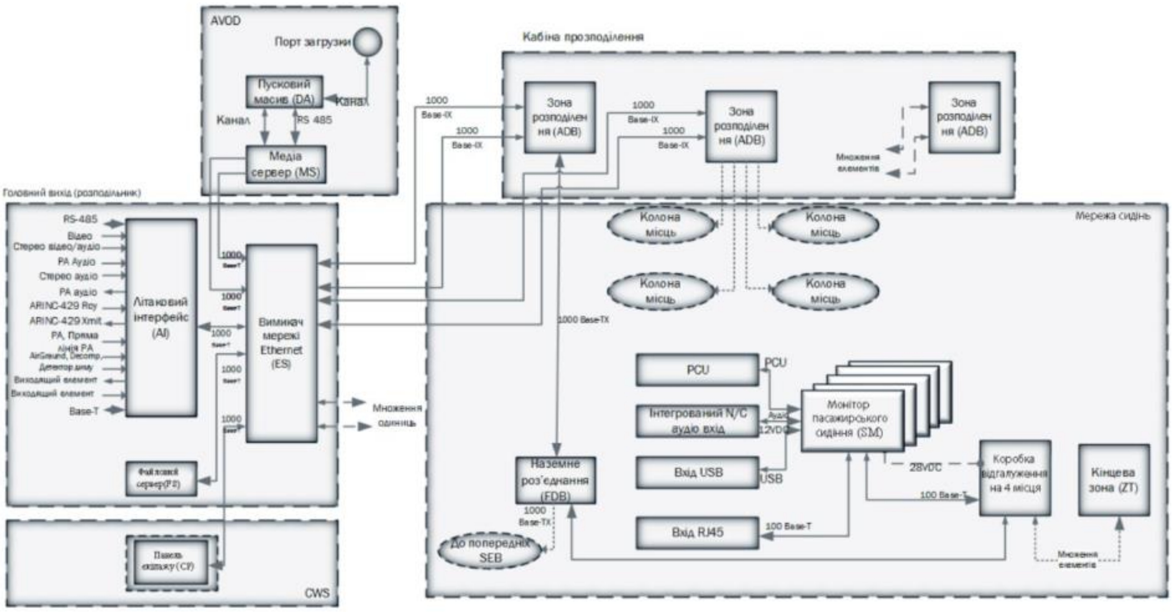
2.4 Panasonic eX2 multimedia system

Starting in December 2009, Etihad Airways aircraft will feature the latest entertainment system, the Panasonic eX2.

The new Panasonic eX2 entertainment system includes:

- An iPOD input built into each seat and an additional RCA jack;
- A user-friendly interactive interface in Arabic and English;
- A multifunctional "Just for Kids" interface for children under 12 years old.

The first of five new Airbus A330-300 aircraft equipped with the new entertainment system will enter service in December 2009. The Panasonic eX2 multimedia system will also be available to passengers on new Boeing 777s, which will begin flying in early 2011.



Structure of the Panasonic eX2 system

The Panasonic eX2 multimedia complex also includes several additional features:

- Personal screens: 23 inches in Diamond First class; 15.4 inches in Pearl Business class; 10.6 inches in Coral Economy class;
- Over 600 hours of entertainment, including 85 movies, 114 popular TV shows, and more than 450 music albums;

Local Ethernet Network:

- More efficient and lighter weight
- No radio frequency coaxial cables
- Linux operating system
- 100% digital seats
- Uses industrial standards and protocols
- Supports MPEG, TCP/IP, and HTML

Universal Serial Information Bus:

- Interface for passenger devices
- Compatible with standard devices such as external keyboards and gaming controls

New Seat Peripheral Design:

- Smart monitor
- Widescreen
- Touchscreen
- More power for applications
- Decoding and compressing audio and video streams for digital video

Network:

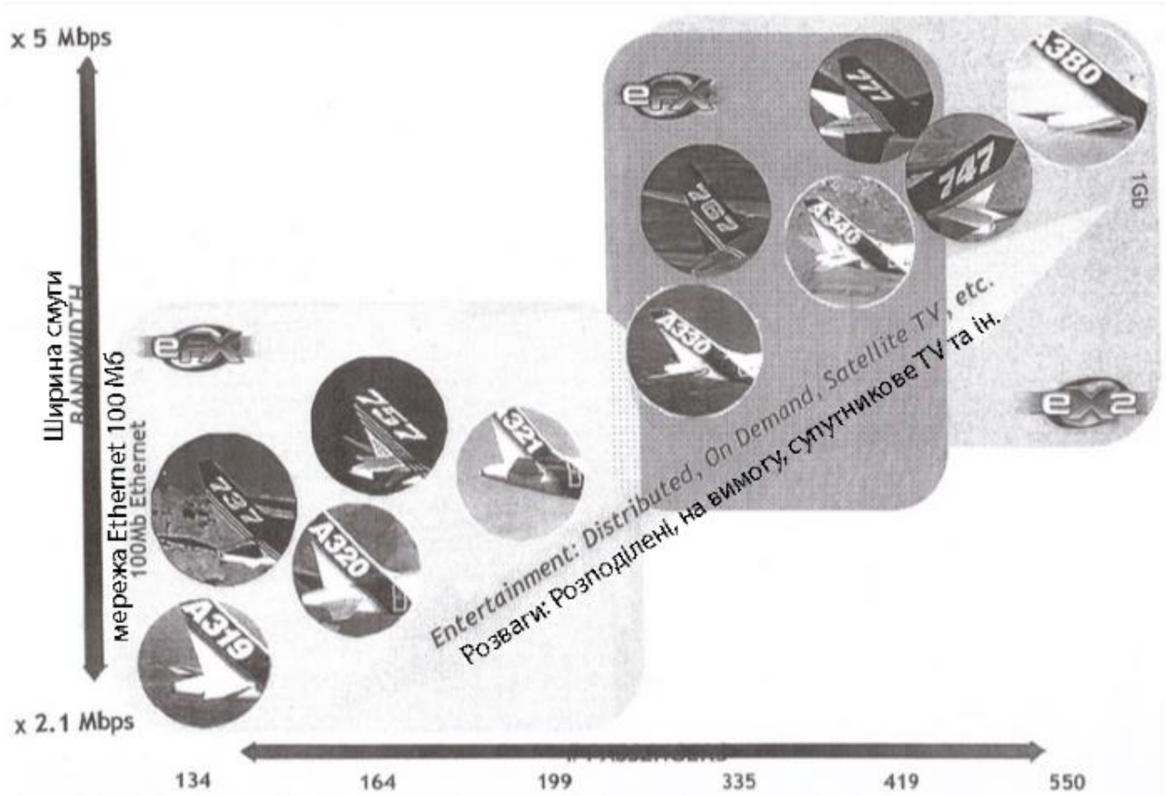
- Main distribution – 1 Gbps Ethernet network via fiber optic
- Local column – Digital copper network
- Local group – 100 Mbps Local Area Network
- Higher efficiency
- 30% less weight
- 30% less power consumption
- 40% less volume

- A gaming portal with over 60 games, including modern 3D versions, with the ability to create your own characters and invite other passengers, as well as the latest news from the gaming world;
- Remote control in Diamond First and Pearl Business classes, providing quick access to all options of the IFE multimedia system;

- An LED display that provides not only all the information about the currently used entertainment element but also constantly updated data on flight time and estimated landing time;
- Support for the "picture-in-picture" function;
- Keyword search capability;
- Service call functions in Diamond First class and "Do Not Disturb" in Pearl Business class, which can be activated through the IFE multimedia system's E-Box;
- A multifunctional "Just for Kids" interface for children under 12 years old;
- "My Video" and "My Audio" functions, allowing the creation of personalized playlists;
- A "Magazine Rack" feature.

Additionally, all guests, regardless of flight class, can use the built-in phone to make calls to any part of the world or contact other passengers on board. The cost per minute of conversation is USD 6, payable by credit card.[14]

Through the new system, guests can also leave their comments and feedback on Etihad Airways services, obtain information on connecting flights, and check arrival times.



eX2 Characteristics and Functionality

Electronic Boxes (SEB)

- Acts as a router for distribution and data for LAN
- Supports up to 4 seats
- Integrated with Smart Monitor (monitors <15) & SPM
- Weight: 0.59 kg, Power: 10.5 W, Dimensions: 7.52 x 0.98 x 5.61

Power Supply Module (SPM)

- Connected to SEB, ZT, and PSEB
- Single LRU is a backup for all equipment at the location, including power for IFE and PED, directly connecting to drive controllers.
- Significant reduction in weight, power consumption, and system dimensions, allowing for flexible integrated hardware.
- Weight: 1.58 kg, Power: 40 W, Dimensions: 7 x 1.6 x 9.8

Terminal Zone (cable) (ZT)

- Duplicates all SEB and Smart Monitor functions designed for LAN ports
- Installed in the last seat group, on seatbacks where displays are absent
- Eliminates the need for forward cable routing, reducing the overall system weight
- Weight: 1.33 kg, Power: 17 W, Dimensions: 9.58 x 1.3 x 5.61

Premium Class Electronic Boxes (PSEB)

- Includes processor, memory, and decoding function
- Serves only one seat
- Integrated with built-in remote for LCD Monitor (all monitors ≥15) & SPM
- Weight: 1.86 kg, Power: 33 W, Dimensions: 9.5 x 2 x 9.5

The analysis of various aircraft multimedia systems highlights significant advancements in enhancing passenger experience and operational efficiency. The integration of modern hardware, software, and telecommunication tools allows for a comprehensive and interactive multimedia environment on board, catering to diverse passenger needs.[15]

A multimedia system (MMS) combines hardware, software, and telecommunication tools to enable interactive engagement with multimedia products. This comprehensive setup, often referred to as a multimedia platform, supports various types of data, including graphics, text, sound, photos, and video files.

Components include tools for creating and processing images, sound, animations, and video, as well as input devices, sound cards, video cards, servers, and virtual reality tools.

Multimedia tools are categorized by integration levels into Federations of Multimedia Tools (FMT), Onboard Passenger Information and Entertainment Systems (OIESP), and Integrated Multimedia Systems (IMS or Hypermedia

Systems - HMS). Each category represents varying degrees of complexity and integration in multimedia offerings.

The hierarchy of multimedia systems is akin to universal computing systems, with system and application software playing pivotal roles. Instrumental multimedia software supports the development of application-specific MMS, showcasing a blend of specialized and universal tools.[11]

Onboard communication systems adhere to standards and protocols for analog and digital information transmission. Coaxial cables and fiber-optic systems are essential for transmitting audio and video data. Multimedia products (MMPs) include text, graphics, animation, video, sound, and interactive data, offering a comprehensive suite of entertainment and informational content for passengers.

The MUZA-A system, used in aircraft like the An-140, provides stereo audio programs and informational messages, ensuring forced listening to important announcements. The MUZA-AV system, used in the An-148, extends capabilities to include video program distribution and individual audio program selection.

The SIRIUS 06 system, implemented in aircraft like the Tu-204 and Il-96, offers both individual and collective viewing options for business and economy class passengers. Features include flight mode displays, route maps, and video surveillance of the aircraft’s course.

The Panasonic eX2 system, featured in Etihad Airways aircraft, includes iPOD inputs, RCA jacks, interactive interfaces, and a "Just for Kids" interface. It supports various applications with personal screens, extensive entertainment content, efficient networking, and additional features like gaming portals and service call functions.

The comprehensive analysis underscores the pivotal role of advanced multimedia systems in enhancing passenger experience and operational efficiency in modern aircraft. The evolution from basic audio systems to complex, interactive platforms reflects the industry's commitment to leveraging technology for improved in-flight comfort and engagement. Systems like MUZA-A, SIRIUS 06, and Panasonic eX2 set new standards in onboard entertainment, combining robust hardware, sophisticated software, and efficient telecommunication tools to create a seamless and enriching travel experience. The focus on modular and scalable solutions ensures adaptability to various aircraft types and passenger needs, highlighting the importance of multimedia systems in the future

CHAPTER 3
RESEARCH OF THE STRUCTURAL AND FUNCTIONAL DIAGRAM OF THE PLASMA DISPLAY

3.1. Analysis of the layout scheme.

To develop a functional diagram of a video system based on a plasma panel, it is first necessary to show the layout scheme of the plasma panel assembly, as shown in Figure 2.1.

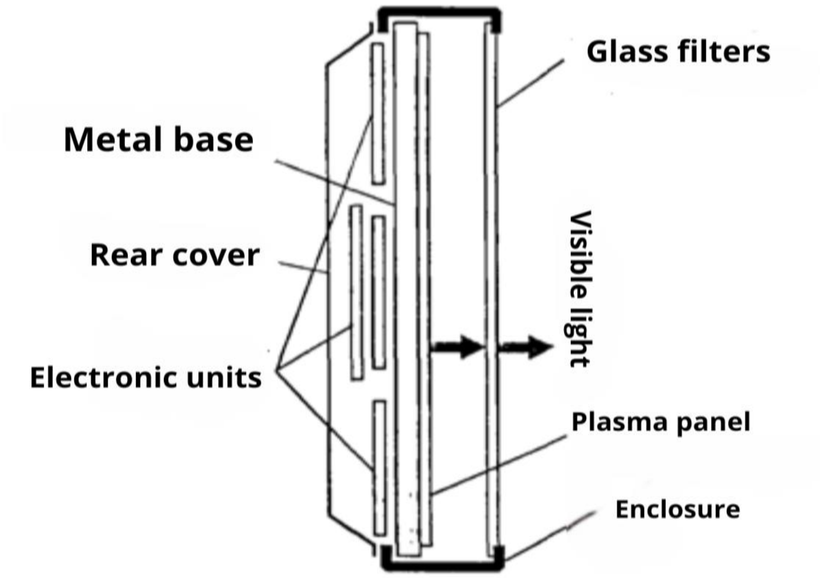


Figure 3.1. Layout scheme of the plasma panel assembly.

It can be added that filters made of glass are designed to reduce the impact of ultraviolet and electric fields. The plasma panel includes the following components:

- plasma panel on a metal base;
- printed circuit boards of electronic units;
- enclosure;
- console and wall mounting elements;
- control panel;
- connection panel for external devices.

There are also structural parts that are part of the plasma panel, such as:

- front panel;

- sound amplification panel;
- interference filter panel;
- power supply unit;
- VGA connector;
- fan and electronic unit mounting frame;
- plasma panel on a metal base;
- input/output control panel.

The placement of the structural parts of the plasma panel can be seen in Figure 3.2.

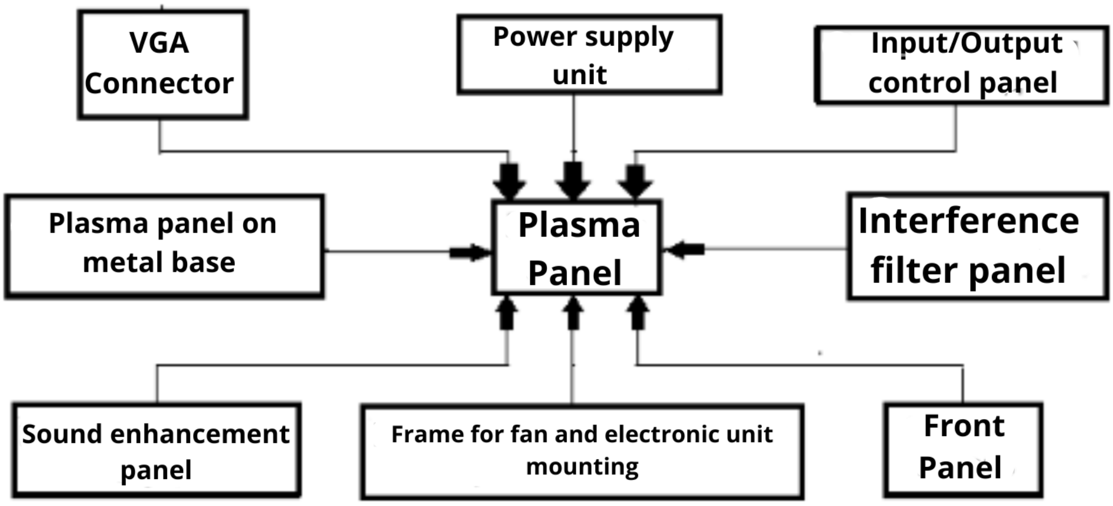


Figure 3.2. Block Diagram of the Structural Components of the Plasma Panel.

After examining the structural composition of the plasma panel and its components, a functional diagram of the video system using the plasma panel can be constructed. The diagram is shown in Figure 2.3.

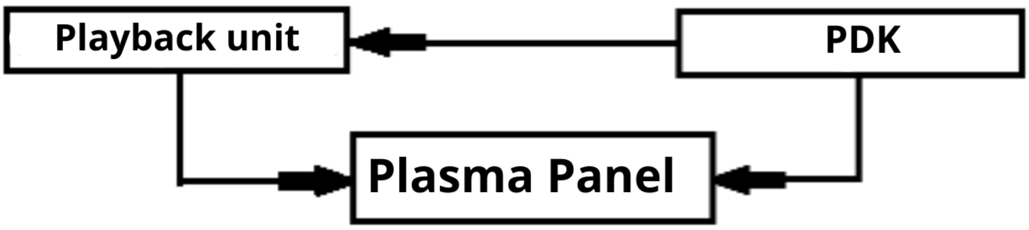


Figure 3.3. Composite structural-functional diagram of the video system using the plasma panel.

3.2 Analysis of the functional diagram of the plasma panel

The functional diagram of the plasma panel (Figure 2.4) consists of the following boards:

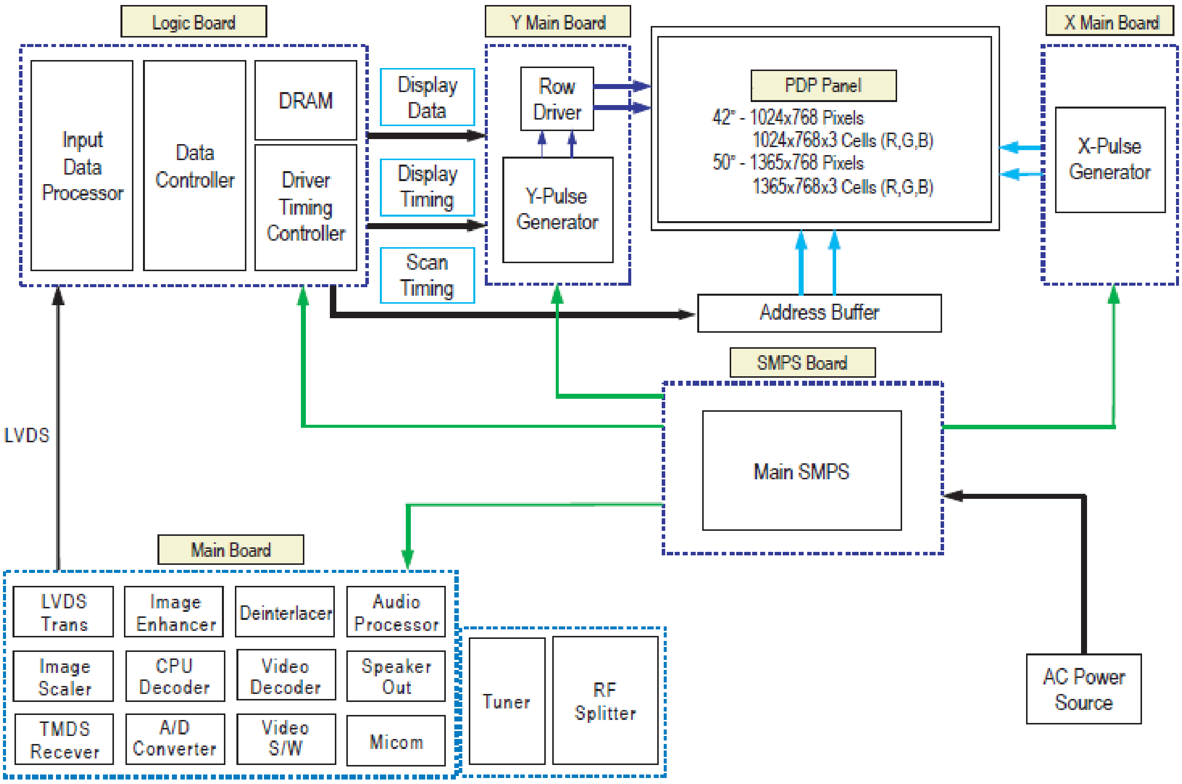


Figure 3.4. Functional diagram of the plasma panel

1. LOGIC Board - consists of the main control logic for the address buffer. The main control logic decodes the video signal, encodes the video board, outputs the address data signal for each module, and generates X and Y drive signals. It consists of the following blocks: input data processor; data controller; DRAM; driver timing controller. The address buffer board transmits the output signal:
    - LVDS with built-in video signal processing (W / L, error diffusion, APC, FCR, etc.) application and 1 ASIC chip;
    - outputs address Drive IC control and data signals to the buffer board;

- outputs signals for X and Y Drive boards;
- monitors the main drive voltages (Micom Circuit Block), detects overvoltage;
- adaptive operating mode temperature.

2. X-MAIN Board - connects to the X terminal block. It provides:
   - signal voltage support (including ERC);
   - supports Ve bias in the scan section.
3. Y-MAIN Board - connects to the Y block. It provides:
   - signal voltage support (including ERC);
   - generates Y rise and fall rate signals;
   - supports Vscan bias.

The Y-MAIN Board includes the following blocks: row Driver; Y-Pulse Generator.

- The Address Buffer Board provides the data signal and control signal to the TCP.

4. Main Board - is the main board of the plasma panel. It consists of the following blocks: LVDS trans; image enhancer; deinterlacer; audio processor; image scaler; CPU decoder; video decoder; spear out; TMDS receiver; A/D Converter; video S/W; micom; tuner; RF splitter.

3.3 Development of the functional diagram of the electronic part of the plasma panel.

The electronic part of the plasma panel consists of units, modules, and cascades of various purposes. Given the complexity of the schematic diagram, we will only consider the features of some characteristic units. The electronic part of plasma panels is structurally located on their rear side and includes large blocks such as power supply converters, logic block, X and Y backlight signal modules, X and Y backlight buses, addressing buses, and others. The developed structural diagram of the electronic part is shown in Figure 3.5.

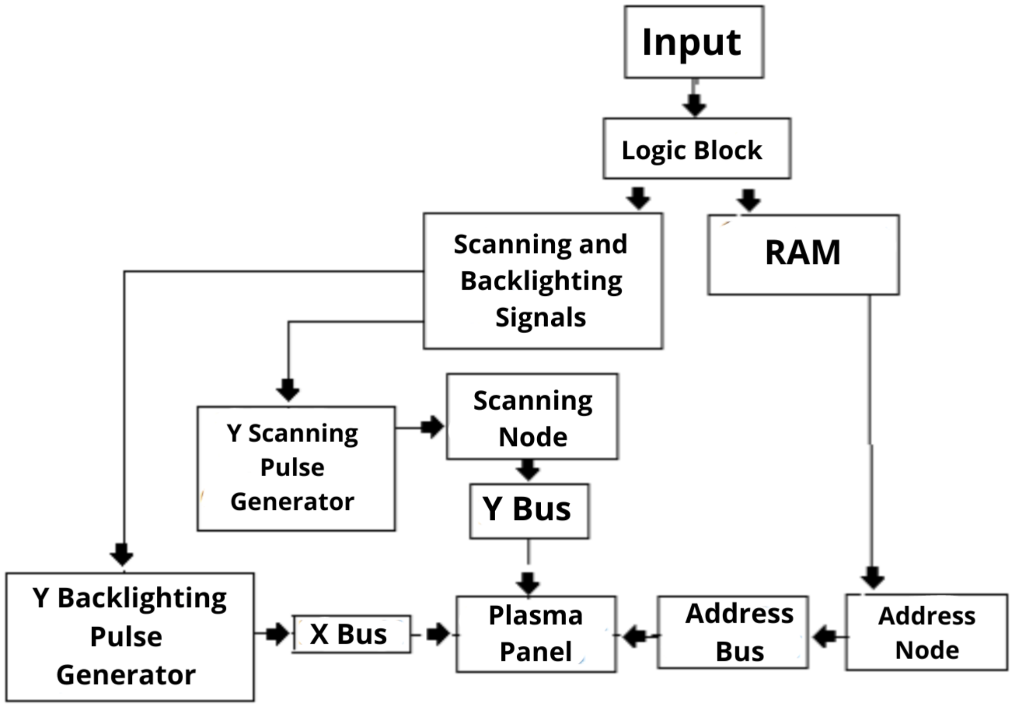


Figure 3.5. Developed functional diagram of the electronic part of the plasma panel

The principle of operation of the functional diagram is as follows: The addressing device, which includes a control processor and a data converter of the logic block, is designed to supply current address potentials to those electrodes whose addresses correspond to the pixels of the sub-field of the image. The addressing electrodes are connected to the left and right addressing buses, which are connected to the data converter, forming and storing the address information of the sub-field sequence of the image.[8]

The signal at the input of the logic block, which contains complete information about the image, goes to the data processing processor, where preliminary distortions (the so-called Y-correction) are introduced, signal amplitudes are increased, and address pulse instability (flicker) is eliminated. Then, the image signals are distributed by the data converter to the addresses of the sub-fields of the current image, and the current addressing is stored.

In the logic block, the scan controller clocks both the data processing processor and the data converter, forming scan signals that are sent to the inputs of the X-board and Y-board. The structural diagrams of these boards can be seen in Figures 2.6 and 2.7.

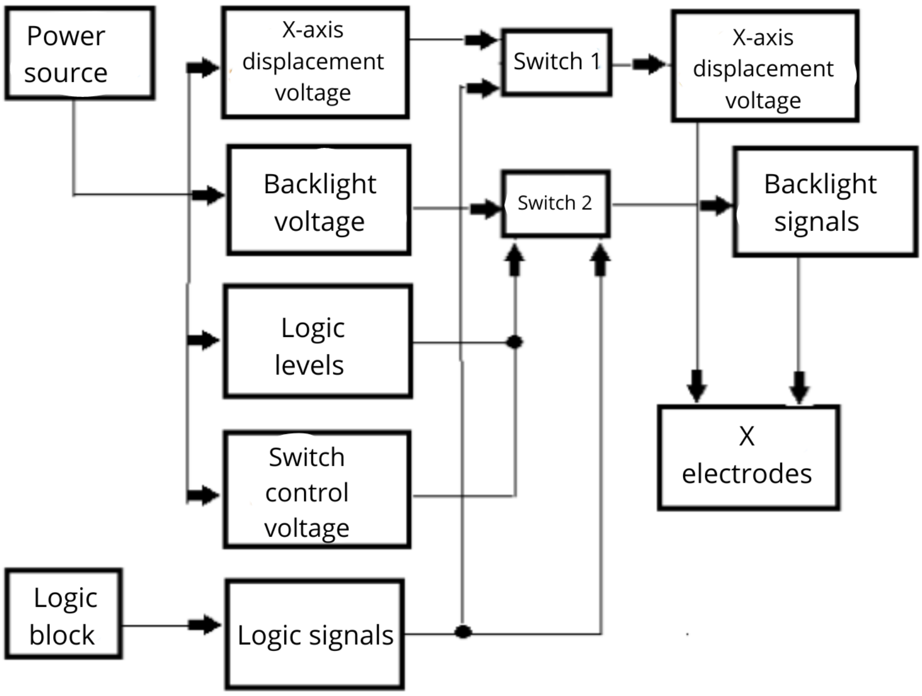


Figure 3.6. Structural diagram of the X-board.

The pulsed nature of the X signal is created using an accumulation capacitor, the voltage on the plates of which is used to form the bias voltage, backlighting, and control of the switches.

Similar to the X-board is the functional composition of the Y-board (Figure 2.7). In addition to the pulsed backlight signals, this board also produces reset and scan signals.

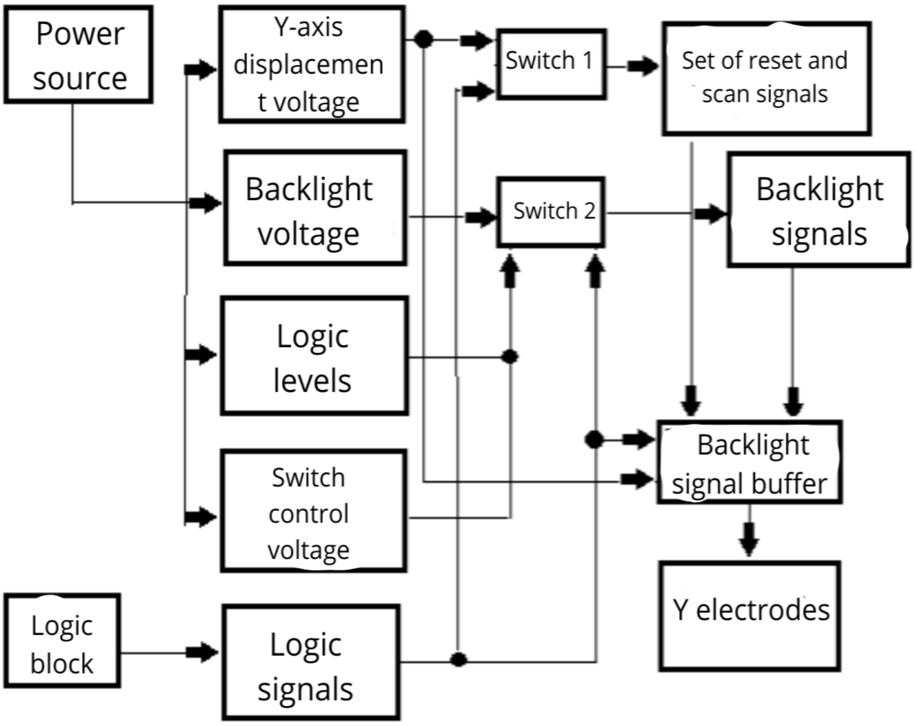


Figure 3.7. Structural Diagram of the Y-Board.

The shape and amplitudes of the reset, addressing, and backlight signals that are applied to the X and Y electrodes are shown in Figure 2.9.

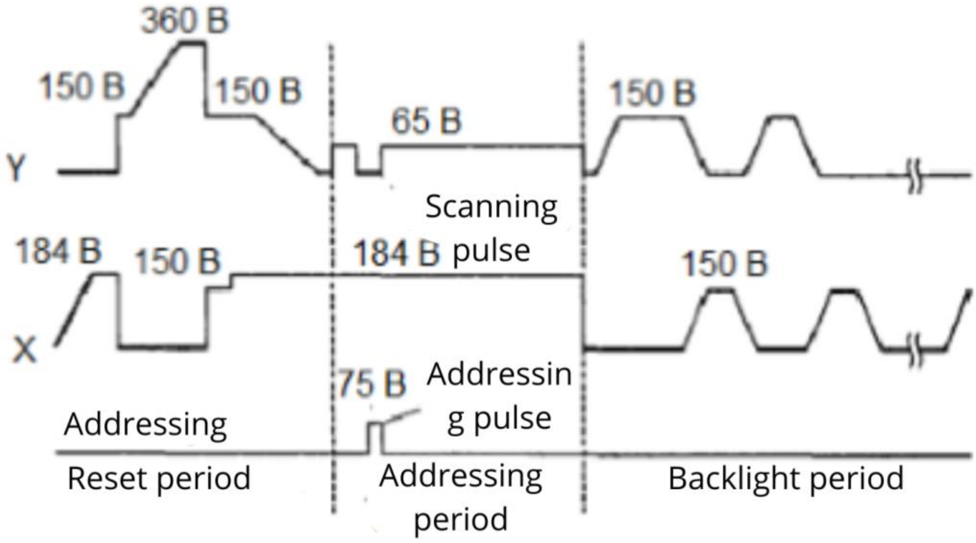


Figure 2.8. Shape of X and Y Signals.

When displaying information, the operation of the plasma panel occurs in cycles, during which pulse signals of a specific amplitude and shape are applied to the electrodes.

The peculiarity of the plasma panel lies in its relatively large geometric dimensions, resulting in an increase in the length of all types of electrodes and the appearance of significant distributed parasitic capacitances between them. In turn, parasitic capacitances, due to charging/recharging phenomena, affect the shape and amplitudes of the electrode pulses.[20]

The electronic part of the plasma panel allows tracking the routes of the signals and noting the stages of their transformation to perform the panel's specified functions, which is more conveniently done using the structural diagram shown in Figure 3.8.

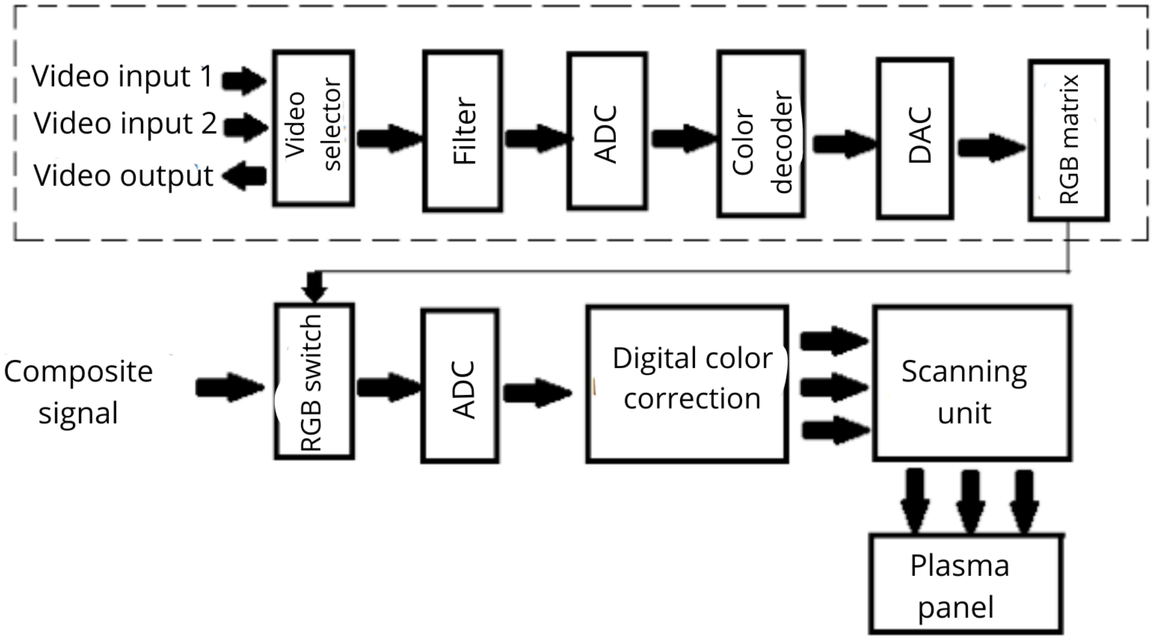


Figure 3.8. Structural Diagram of the Electronic Part of the Plasma Panel.

From the full-color television signal received at the video input, digital sequences are extracted through conversion, ensuring the formation of image sub-fields: scan and blacklight pulses are generated, and address signals are cyclically entered into the random-access memory (RAM).

Structural Features of the Electronic Part of Plasma Panels.

The designs of plasma panels from different manufacturers differ slightly and are mainly determined by the panel's diagonal, overall design solution, dimensions, and the arrangement of boards.[16]

The mechanical basis of the device is a box-shaped metal frame to which functional blocks and auxiliary units, both electrical and mechanical, are attached. Most often, the placement of functional boards inside the device is done as shown in Figure 2.10.

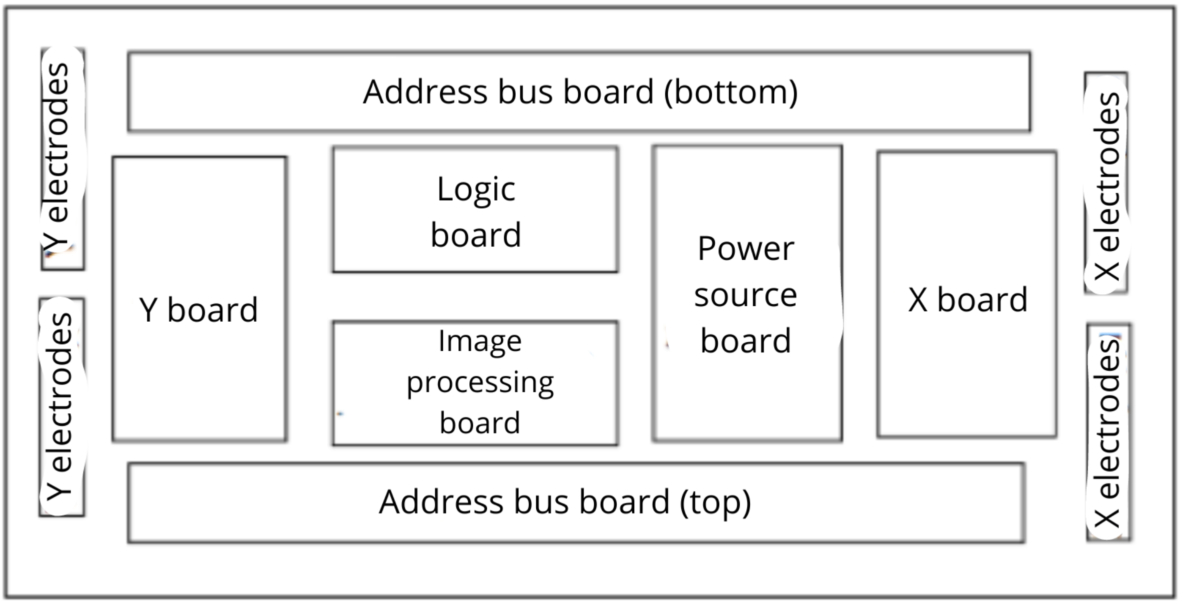


Figure 3.10. Placement of Functional Boards Inside the Device.

The design of the electronic units has several features. The intensive generation of electrical interference caused by the switching of backlight electrodes at levels exceeding 100V necessitates measures to shield individual units and the device as a whole. The contact unit between the metal base of the panel, the front glass, and the external shielding cover is implemented around the entire perimeter of the device.

The integrated circuits that function as switches for the scan and backlight electrodes belong to the class of chip-on-board (COB) devices. To protect against external contaminants, moisture, and mechanical damage, these integrated circuits are coated with a special compound, which unfortunately makes them non-replaceable in the event of a failure. For this reason, some manufacturers have returned to using encapsulated integrated circuits.

During operation, the electronic part of the plasma panel dissipates significant thermal energy. To prevent overheating of thermally loaded components and to protect heat-sensitive components, methods to intensify natural convection, thermal radiation, and thermal conductivity are used, including the application of heat sinks and forced exhaust ventilation.[17]

The presence of powerful sources of low-frequency electrical and magnetic fields within the device can cause mechanical vibration of components whose mounting points are far from their center of mass. To avoid vibrations, such components are mechanically secured with compound to firmly fixed and closely located components, or special mounting is used.

The analysis of the structural and functional schemes of the plasma panel and its components reveals the complexity and interdependence of various elements that ensure the operation of the video system based on the plasma panel. The study demonstrates a high level of integration of hardware and software tools necessary to achieve optimal performance and ensure high-quality video playback.

The plasma panel consists of various components, such as the plasma panel on a metal base, printed circuit boards of electronic units, enclosure, mounting elements, control panel, and connection panel for external devices. The placement of these components ensures the reduction of the impact of ultraviolet and electric fields.[3]

The functional scheme consists of the logic board, X-MAIN board, Y-MAIN board, and the main board. Each of these boards performs specific functions related to video signal processing, signal voltage support, generating pulse signals, and other critical tasks.

The logic board provides the main control logic for the address buffer, decodes the video signal, encodes the video board, and generates control signals.

The X-MAIN and Y-MAIN boards support signal voltages and generate pulse signals for lighting and scanning.

The electronic part of the plasma panel includes power supply converters, logic blocks, X and Y backlight signal modules, addressing buses, and other components. The operation principle involves processing address signals, distributing image signals, and generating lighting and scanning pulses.

The main functional blocks ensure the formation and storage of address information, data processing, signal distribution, and monitoring of signal transformation stages.

The designs of plasma panels from different manufacturers may vary slightly, mainly determined by the panel's diagonal, overall design solution, dimensions, and board arrangement.

The metal frame ensures reliable mounting of functional blocks and auxiliary units. Intensive generation of electrical interference necessitates shielding of individual blocks and the device as a whole.

To prevent overheating, methods to intensify natural convection, thermal radiation, and thermal conductivity are used, including heat sinks and forced ventilation.

The analysis of the structural and functional schemes of the plasma panel highlights the complexity and technological sophistication of modern video systems based on plasma panels. The high level of integration of hardware and software tools, along with the application of advanced technologies, ensures reliable system operation and high-quality video playback. Considering electrical, thermal, and mechanical factors during the development of plasma panels allows achieving optimal performance and long service life. These technologies enhance user experience and improve the overall efficiency of video systems used in various fields, including aviation and entertainm

CHAPTER 4

CALCULATION OF THE PLASMA PANEL CELL

4.1. Analysis of the operating principle, design, and brightness calculation of a typical plasma panel

The technical result is the high brightness of the display cells in the gas
$l=(5.5-16)\times(X_k+X_{ntc})$(3.1)
Xk is the extent of the cathode fall potential, mm;
$Xntc$ is the extent of the negative glow, mm.

The objective of the invention is to create a direct current plasma panel with high brightness display cells.

The specified technical effect is achieved by implementing a direct current plasma panel, which contains two dielectric plates with display cells located between them, formed at the intersection of anodes and cathodes grouped by display cells, with separating elements that delimit the display cells. The distance l between the cathodes in the display cells is determined according to the expression:

$l=(5.5/16)\times(X_k+X_{ntc})$ (3.2)

where Xk is the extent of the cathode fall potential, mm;
$Xntc$ is the extent of the negative glow, mm.

The proposed design of the direct current plasma panel allows for increased brightness of the display cells by optimizing the distance between the cathodes in the display cell.

Figure 4.1 shows the proposed version of the direct current plasma panel.

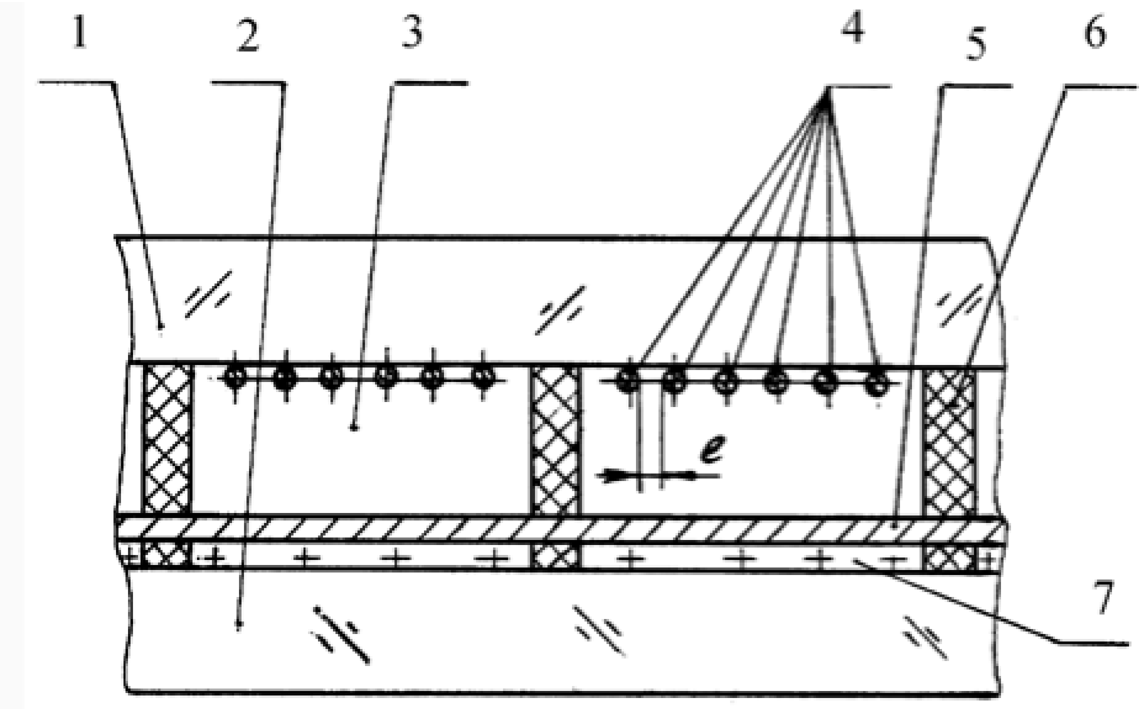


Figure 4.1. Structure (Cross-Section) of the direct current plasma panel.

The plasma panel contains the upper 1 and lower 2 dielectric plates, display cells 3, formed at the intersection of wire cathode 4 and anode 5 electrode systems, separating elements 6 that delimit the display cells, and phosphor coating 7 on the lower dielectric plate 2.

The panel operates as follows. When voltage pulses are applied to the corresponding cathode 4 and anode 5 electrodes, a gas discharge occurs in the corresponding display cells, and the ultraviolet radiation (UVR) from this discharge excites the phosphor of a certain color, causing the display cell to glow.[19]

Ensuring the distance between the cathodes in the display cell according to formula (3.2) provides the maximum brightness of the direct current plasma panelIf $l<5.5(X_k+X_{ntc})$, the display cells exhibit unstable operation at low brightness levels. This is due to the fact that with a large cathode area, the discharge does not have enough time to fully develop and cover the entire cathode area in a short operating time of the display cell. The decrease in the brightness of the display cells is also observed because the distance between neighboring cathode elements is small, and the UVR of the negative glow discharge (NGD) of two neighboring cathodes overlaps significantly. This causes mutual absorption and reduces the portion of UVR that reaches the phosphor.

If $l > 16(X_k + X_{ntc})$, the brightness of the display cell sharply decreases because the UVR and NGD of two neighboring cathode elements in the cell do not overlap. As a result, non-glowing or dimly glowing zones appear in the display cells, located between the brightly glowing zones. Additionally, there is a significant unevenness in brightness across the display cell area, which degrades the quality of the reproduced information.

4.2. Development of the brightness control scheme for the plasma panel

An interesting technological feature of a plasma cell is the fundamental impossibility of smoothly adjusting the brightness of a pixel. The issue lies in the fact that a plasma discharge either exists or does not, while it is impossible to control the intensity of the flow. This is where pulse-code modulation (PCM) comes into play. Its essence is as follows.

Brightness control is characterized by the number of brightness gradations (shades) for each color. For modern displays, this is 256 gradations per color, corresponding to 16,777,216 color shades.

Among the several possible ways to control brightness (by current, duration, number of pulses), brightness control by the number of pulses has become widespread in plasma panels. In a simple case of such control, the image frame with a period *Tk* is divided into

N subframes of equal duration, the number of which is determined by the expression:

$$N = T_к / nT_р = 16/480 \times 3 \quad (3.3.)$$

where *n* is the number of rows in the panel;

Tr is the duration of a row.

For our plasma panel, I use the following values:

Tk =16 ms,

n=480,

Tr =3 μs, resulting in

N=11.

Since this number is clearly insufficient for obtaining a high-quality image, all modern PDPs use a memory effect for brightness control. In this case, the image frame is divided into 8 subframes with different sustain durations corresponding to the 8-bit planes, as shown in Figure 4.2.

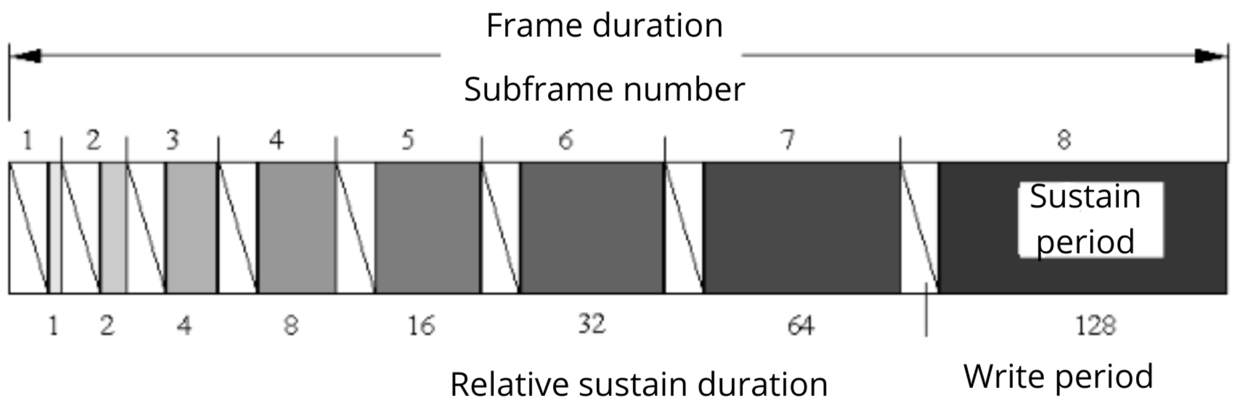


Figure 4.2. Brightness control diagram of the plasma panel.

The duration of the recording period is 0.003×480=1.44 ms, and the sustain duration varies from 0.016 to 2.048 ms. The total frame duration is approximately 16 ms.

4.3. Justification of the scheme and selection of the cell design

First, let's consider the existing types of cells by design:

- AC plasma panel cell with surface discharge;
- Cell with a three-electrode structure;
- Inverted cell with a three-electrode structure;

- DC plasma panel cell.

For the calculation of the plasma panel cell with a DC source, we choose the DC plasma panel cell shown in Figure 4.3.

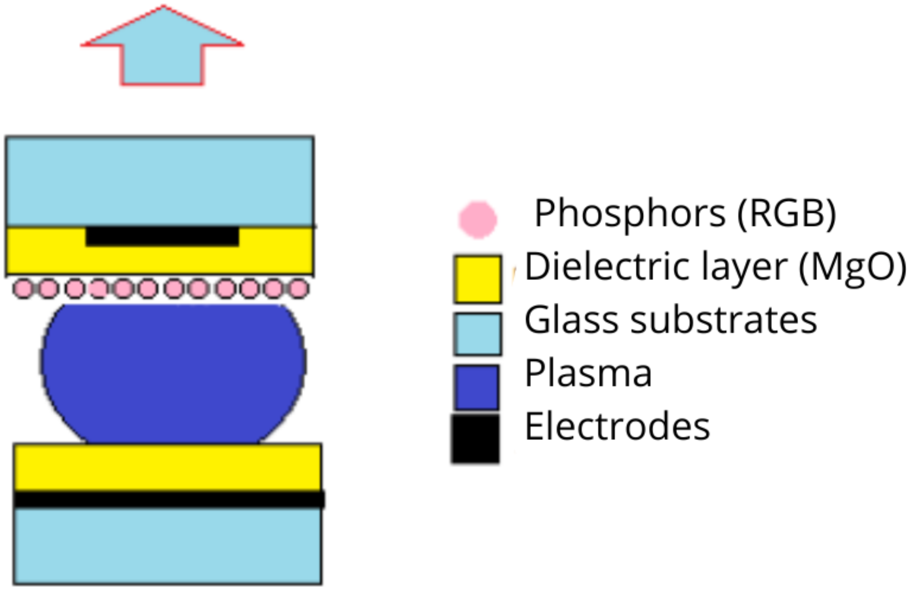


Figure 4.3. View of the DC Plasma Panel Cell

The DC plasma panel contains lower and upper dielectric plates. On the lower dielectric plate, phosphor elements are arranged in strips of primary colors: red, green, and blue.

4.4. Calculation of the dimensions of the elementary cell. Selection of the gas mixture.

Let's choose the gas filling and the gas pressure. For a DC plasma panel at a pressure of about 105 mm Hg, to reduce the breakdown voltage, it is advisable to use mixtures with a coefficient *A* of about 1 (1 / (mm * mm Hg)). It is well known that such mixtures are Penning mixtures (the ignition voltage for the mixture is lower than for each of the gases individually) of the type Ne +1% Xe, He +1% Xe, He +1% Ar. In the He-Ne-Xe mixture, with an optimal content of Ne +25%, He +15%, the brightness and light efficiency values show excellent performance. Several conditions are imposed on the glass plates:

1. They must be opaque to UV light;
2. The thickness should be as small as possible, but the glass must withstand a pressure of 200 Torr;
3. They should have a low refractive index.

We choose KD-type quartz glass with a thickness of 15mm. "Optical quartz glass, transparent in the visible and infrared regions of the spectrum, without an absorption band in the wavelength range of 2600-2800 nm."[18]

4.5. Selection of phosphor

The improvement of fluorescent lamps and plasma color displays largely depends on the choice of photoluminescent phosphor. Typically, phosphor screens are excited by electron or photon beams of appropriate energies. This leads to quite standard requirements for such pumping systems, which determine the overall efficiency of light-emitting devices. The energy of the electrons bombarding the phosphor or the quantum of light must possess certain selectivity and correspond to the photoluminescence excitation spectra of phosphors, emitting in specified spectral regions to generate light with specific color characteristics.

The intensity of color phosphor illumination will depend on the efficiency of the chosen pumping system, the quantum yield of the phosphors, and the geometric characteristics of the phosphor and thin-film technological coatings forming the phosphor screen to output radiation with specified spectral parameters. When using R, G, B phosphors in color plasma displays, a pulse-width modulation scheme is used to encode the brightness level when forming halftone images. In this case, it is necessary for the phosphor to emit all the energy invested in it during the period of the ultraviolet pumping pulses. Therefore, the time of phosphor emission becomes an important characteristic.

As phosphors, we will choose the standard ones:

- FGI-420-1 (B-blue);

- FGI-528-1 (G-green);
- FGI-93/597 (R-red).

Let's calculate the quantum and spectral efficiency. The quantum efficiency of a photoluminescent phosphor is determined by how many visible light photons are excited by one UV spectrum photon. For conventional photoluminescent phosphors, the quantum yield is close to one, meaning that one UV spectrum photon that reaches the excitation center of the phosphor causes the emission of one visible light photon. The spectral efficiency of a phosphor is determined by the ratio of excitation and emission wavelengths. For the phosphors considered below, with a UV radiation wavelength of 190 nm, the quantum efficiency will be:

- For the red phosphor:

$$Eqr = 190/597 = 0.318$$

- For the green phosphor:

$$Eqg:= 190/528 = 0.360$$

- For the blue phosphor:

$$Eqb = 190/420 = 0.452.$$

The luminescence spectra obtained for these types of phosphors when excited at a wavelength of 193 nm are shown in Figure 3.5.

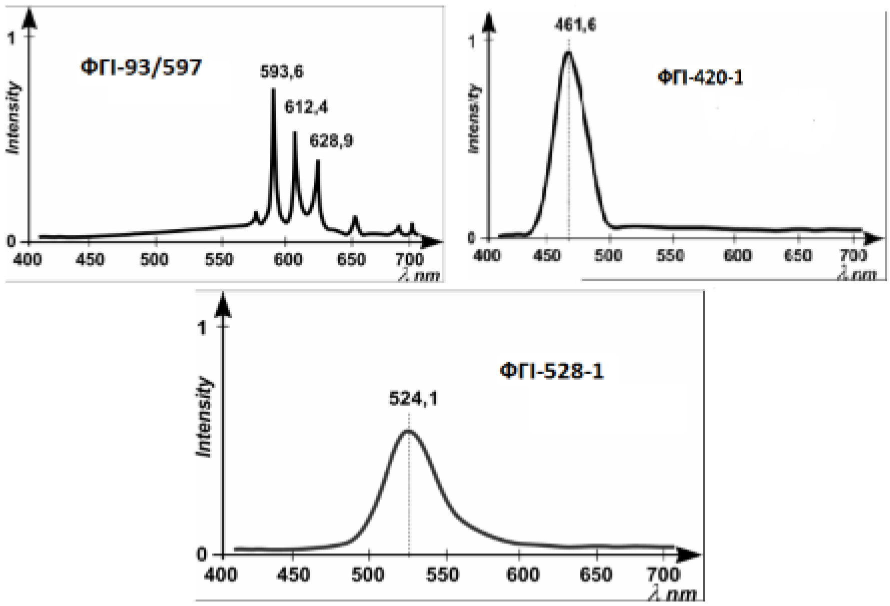


Figure 4.5. Emission spectrum of phosphors

The luminescence spectrum for phosphors FGI-420-1 (blue) and FGI-528-1 (green) represents a broad band with maxima at 457 nm and 523 nm, respectively. The luminescence spectrum of the FGI-93/597 (red) phosphor represents a system of narrow bands. This last circumstance imposes increased restrictions on matching the emission spectrum of the discharge with the photoluminescence absorption spectrum of the phosphor to minimize losses when converting the energy of ultraviolet discharge radiation into visible radiation emitted by the phosphor. It is also worth noting the insufficient brightness of the green phosphor.[20]

From the work conducted, the characteristics of the DC plasma panel cell can be determined as follows:

- Phosphor element pitch: 6 mm;
- Size: 1.4 x 5.4 mm in the form of strips of primary colors: red, green, and blue;
- Phosphor types: FGI-93/597; FGI-528-1; FGI-420-1;
- Phosphor thickness: 0.07 mm;

- Pitch between phosphor strips: 2 mm;
- Anode diameter: 0.12 mm;
- Anode pitch: 2 mm;
- Distance between anodes and cathodes: 0.24 mm;
- Cathode pitch: 6 mm;
- Cathode diameter: 0.12 mm;
- Number of cathode elements in a display cell: 6;
- Distance between cathodes in a display cell: 0.6 mm;
- Display cells are isolated from each other by separating elements (in the form of a matrix) with a width of 0.6 mm;
- Information capacity of the DC plasma panel: 3296 display cells;
- The plasma panel is filled with a mixture of Ne +25% He +15% Xe with mercury vapor up to a pressure of 105 mm Hg;
- (Xk+$Xntc$)=0.1 mm;
- Brightness of the DC plasma panel: 150 cd/m^2.

4.6. Calculation of plasma panel efficiency

The efficiency of a DC plasma panel is less than 1 lm/W. Let's verify this statement and calculate the efficiency for the "Macroprocessor" DC panel. The panel has dimensions of 193 x 193 mm and contains 48 cells horizontally (pitch 4 mm) and 16 cells vertically (pitch 12 mm). The internal size of a cell is 11.2 x 3.2 mm. A pixel contains three cells with red, green, and blue photoluminescent phosphors, located at the bottom of each cell. A cross-section of a cell is shown in Figure 4.6.

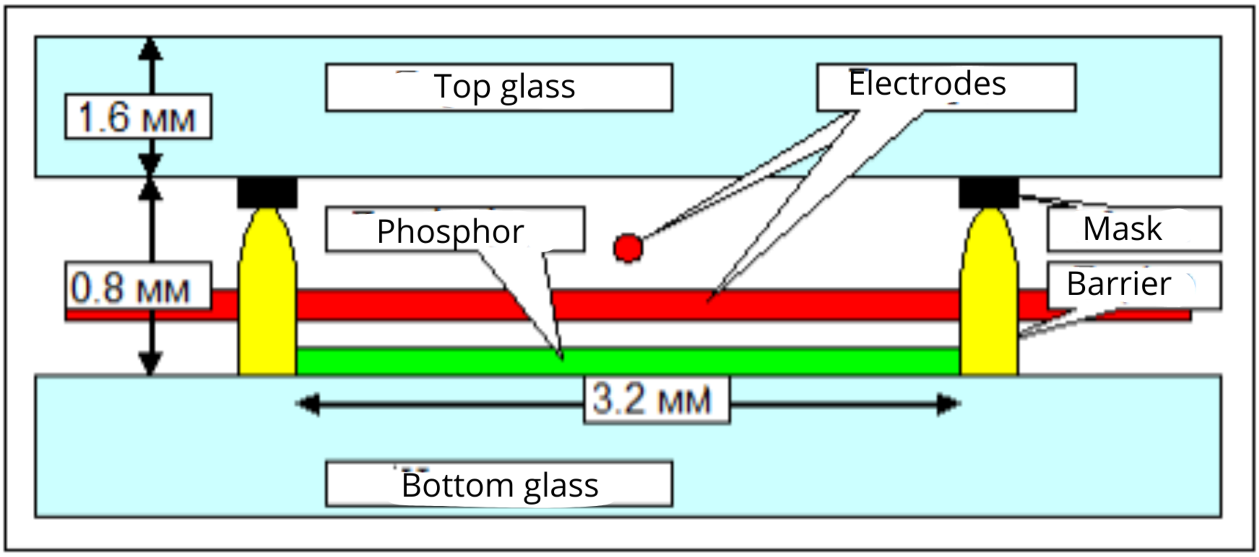


Figure 4.6. Cross-Section of the Plasma Panel Cell.

For calculations, it is necessary to know the half-brightness angle of the panel. Calculation of the half-brightness angle and light losses in the cell:

To calculate the half-brightness angle and light losses in the cell, the computer program "Graph Cell" was used. The following coefficients were used:

- Light absorption coefficient by phosphor: 0.1
- Light absorption coefficient by barriers: 0.1
- Light absorption coefficient by the lower boundary of the upper glass: 0.1
- Refractive index of the glass: 1.45

The modeled directional diagram is shown in Figure 4.7.

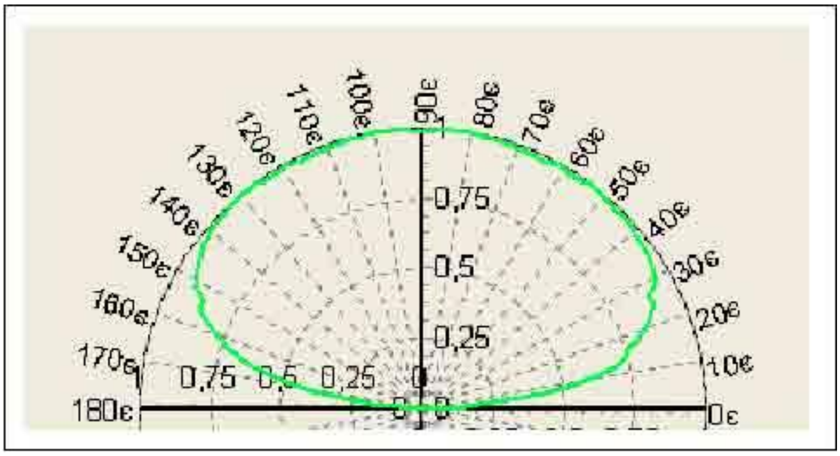


Figure 4.7. Modeled Directional Diagram.

The half-brightness angle is 170 degrees. Radiation losses in the cell amount to 18%.

1.Calculation of the total efficiency of the panel

To calculate the total efficiency, the following are necessary:

- Brightness of the panel;
- Power consumption;
- Half-brightness angle;
- Area of the panel.

The brightness of the panel (for white color E) is
B=275 cd/m², power consumption
P=30 W, half-brightness angle α=170 degrees (solid angle Ω=5.73 sr), area S=0.03725 m².

Energy balance of the DC plasma panel

Let's calculate the energy balance from the panel input, without considering energy losses in the control drivers.

Transport electrical losses are ohmic, capacitive, and inductive losses incurred during the transportation of energy from the panel input to the cells (losses in the electrode system). These losses can be approximately estimated at 5%.

2. Efficiency of the DC plasma discharge

The efficiency of the discharge is determined by numerous factors, such as electron emission from the cathode, the composition and ionization of gases, discharge structure, and generation of vacuum ultraviolet radiation. The main power losses occur in the cathode layer of the discharge. Since calculating the discharge efficiency is very complex, it is determined residually in this balance. The estimated efficiency is 0.15, meaning that power losses amount to 85%.

3. Geometric Losses of UV Radiation

The area of the inner surface of one cell is 94 mm², and the phosphor covers only the bottom of the cell - 36 mm². Assuming that UV radiation is evenly distributed in the cell, only 35% of the total UV radiation will hit the phosphor (3% losses added for UV absorption by the electrodes).

4. UV Radiation Absorption Losses by Phosphor

These losses are associated with UV absorption in the phosphor layer. The losses can be approximately estimated at 50%.

5. Quantum efficiency of the phosphor

More precisely, it is necessary to speak about quantum and spectral efficiency. The quantum efficiency of photoluminescent phosphors is determined by how many visible light photons are excited by one UV spectrum photon. For conventional photoluminescent phosphors, the quantum yield is close to unity, meaning one UV spectrum photon reaching the excitation center of the phosphor causes the emission of one visible light photon. The spectral efficiency of the phosphor is determined by the ratio of excitation and emission wavelengths. For the phosphors considered below, with a UV radiation wavelength of 147 nm, the quantum efficiency will be:

For the red phosphor:

- □□□=(147593+0.6×147611+0.4×147623)/2=0.245

For the green phosphor:

- □□□=147520=0.283

For the blue phosphor:

- □□□=147455=0.323

6. Optical Losses in the Cell

This type of loss is associated with the absorption of visible radiation by the inner surface of the cell and losses when the radiation passes through the upper glass. These losses can be calculated using the "Graph Cell" computer program. The calculation yields a loss figure of 18%.

7. Luminous Efficiency of the Phosphor

The luminous efficiency is determined by the so-called visibility curve and the emission spectra of the phosphors. Plasma panels use photoluminescent phosphors FDM-455 (blue), FDM-520 (green), and FGI-627/593 (red). The modeled spectra of these phosphors (after balancing for white) are shown in Figure 4.8. The spectral models were built based on reference spectra and measured chromaticity coordinates.

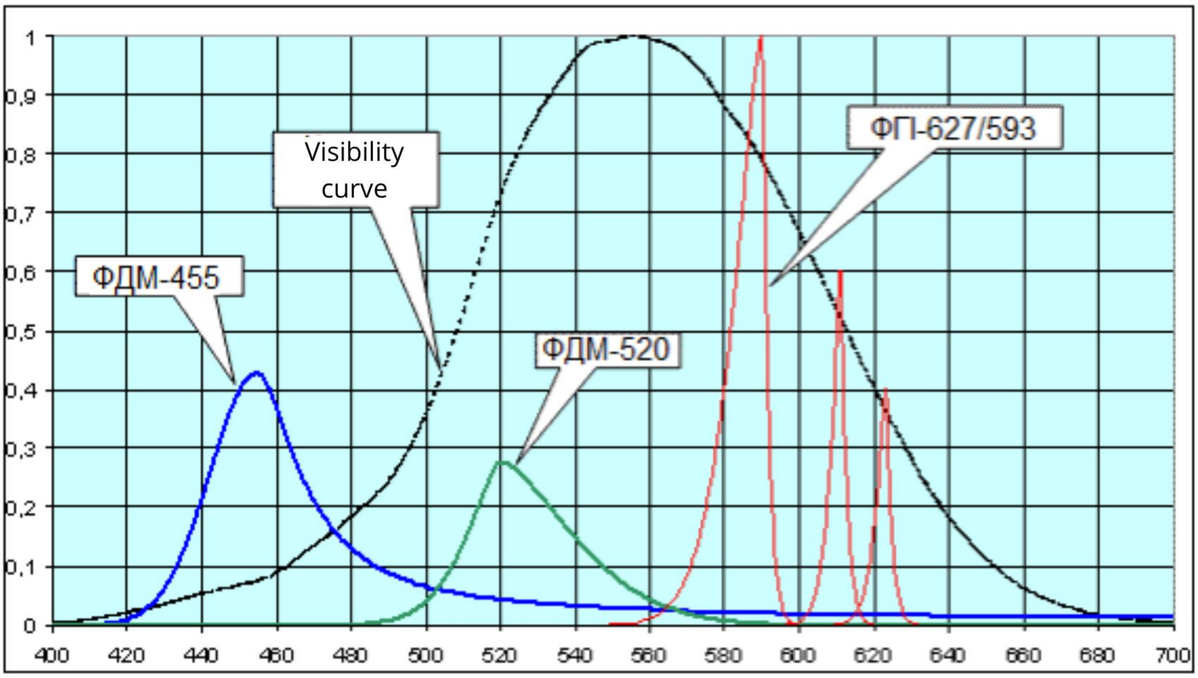


Figure 4.8. Phosphor spectra.

After balancing for white color E (Xw = 0.333, Yw = 0.333), the light balance (chromaticity equation) looks as follows:

Rv:Gv:Bv = 0.49:0.32:0.19

To achieve white balance, it is necessary to significantly reduce the proportion of green, i.e., the power supplied to the cells with green phosphor. The efficiency of the panel for white light is:

Ew = 344 lm/W

The energy balance table allows us to clearly see the ways to improve the panel's efficiency. Let's note some possibilities:

- Using a transitional type of plasma discharge in combination with increasing pressure can raise the plasma discharge efficiency by 2 - 3 times.

- Placing a semi-transparent layer of phosphor on the upper glass (already implemented) allows for a 20 - 30% increase in efficiency (increasing the phosphor area reduces geometric losses). Additionally, methods to increase the internal surface area of the cell can be used.

- Applying new types of phosphors (more precisely matched to the excitation and emission frequencies, with fewer losses) can reduce UV absorption losses and increase luminous efficiency.

As a result, the efficiency of DC plasma panels can be increased to 5 - 10 lm/W, comparable to the efficiency of LEDs. Moreover, considering that the cost of a plasma panel pixel is $0.15 - $0.2, and the cost of an LED pixel is $0.6 - $1.5, it turns out that DC plasma panels are cost-effective.

The detailed analysis of the operating principles, design, and brightness control of plasma panels provides a comprehensive understanding of the complexities and advancements in plasma display technology. The investigation covers various aspects, from the optimization of display cell brightness to the selection of appropriate materials and control mechanisms, leading to several key conclusions.[17]

Achieving high brightness in display cells is critical for the performance of plasma panels. By optimizing the distance between cathodes using the formula l=(5.5/16)×(Xk+Xntc)l = (5.5/16) \times (X_k + X_{ntc})l=(5.5/16)×(Xk+Xntc), it is possible to enhance the brightness and stability of the display cells, resulting in improved image quality.

The design of plasma panels involves a careful arrangement of dielectric plates, cathodes, anodes, and separating elements. The proposed direct current plasma panel design, which includes these components, ensures high brightness and stable operation, making it suitable for high-quality display applications.

Brightness control in plasma panels is effectively managed using pulse-code modulation (PCM), which divides the image frame into multiple subframes. Modern displays utilize a memory effect for brightness control, allowing for 256 gradations per color and over 16 million color shades, thus enhancing image quality.

The choice of cell design and gas mixture is crucial for the efficiency and performance of plasma panels. The selected DC plasma panel cell design, combined with Penning gas mixtures (e.g., Ne +1% Xe), reduces breakdown voltage and improves display brightness and efficiency.

Current plasma panels have an efficiency of less than 1 lm/W. However, potential improvements, such as transitional plasma discharge, semi-transparent phosphor layers, increased internal surface area, and advanced phosphors, can boost efficiency to 5-10 lm/W, making plasma panels competitive with LED displays.[16]

The advancements in plasma panel technology, encompassing design optimization, material selection, and innovative control mechanisms, underscore the potential of plasma displays to deliver high-quality images with enhanced brightness and efficiency. Despite current challenges in efficiency, ongoing research and development in materials and design techniques promise significant improvements, positioning plasma panels as a viable and competitive technology in the display market. The integration of these advancements will not only enhance the user experience but also broaden the application scope of plasma panels in various fields, including entertainment, aviation, and more.

CONCLUSION

The detailed analysis presented across these chapters illustrates significant advancements in the technology and functionality of modern regional aircraft and their associated on-board entertainment systems. Key findings from this comprehensive study are summarized as follows.

Modern regional aircraft such as the An-148-100, Sukhoi Superjet 100, Boeing 737, Airbus A320, Embraer E-Jet 195, and Tu-204-300 exhibit enhanced safety, efficiency, and operational versatility. These aircraft are capable of operating on various runway types under diverse weather conditions, owing to advanced design features and cutting-edge flight-navigation and communication systems. The implementation of high-wing configurations, sophisticated avionics, and efficient engines significantly enhances their operational capabilities and passenger comfort, adhering to international noise and emission standards.

The evolution of on-board entertainment systems reflects a commitment to enhancing the passenger experience. These systems now offer a wide array of multimedia options, including moving-map displays, audio and video entertainment, personal televisions (PTVs), and interactive games. Innovations like closed captioning and educational games further diversify the entertainment options, ensuring a personalized and engaging travel experience. Systems such as MUZA-A, SIRIUS 06, and Panasonic eX2 exemplify the integration of robust hardware, sophisticated software, and efficient telecommunication tools to deliver high-quality entertainment and information services to passengers.

The analysis of plasma display technology reveals the complexities and advancements in achieving high brightness and efficiency in display cells. The optimization of design elements such as the distance between cathodes and the selection of appropriate gas mixtures and phosphors is crucial for enhancing display performance. The implementation of pulse-code modulation (PCM) for brightness control and the development of efficient cell designs demonstrate significant progress in plasma display technology. Although current plasma panels have an efficiency of less than 1 lm/W, ongoing research and innovative approaches promise substantial improvements, potentially reaching efficiencies comparable to LED displays.

The integration of advanced flight technologies and sophisticated on-board entertainment systems significantly enhances the safety, efficiency, and comfort of modern regional air travel. These innovations set new standards for the aviation industry, ensuring a more enjoyable and informative experience for passengers. The continuous development and refinement of plasma display technology further contribute to the evolution of high-quality visual systems, expanding their application scope in various fields, including aviation and entertainment.

In conclusion, the advancements detailed in this study underscore the pivotal role of technological innovation in shaping the future of aviation and multimedia entertainment. The commitment to improving passenger experience and operational efficiency through state-of-the-art systems and materials highlights the dynamic nature of these industries and their potential for continued growth and enhancement.

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