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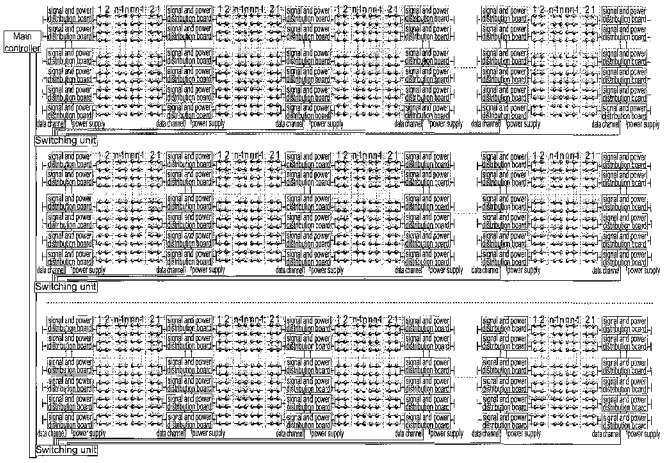
(54) Title: LIGHT EMITTING LED DISPLAY MODULE AND MODULAR LIGHT EMITTING SYSTEM



(57) Abstract: The present invention relates to the light-emitting and LED based display modules. The light emitting module comprises a plurality of electrically connected light emitting elements depicting pixels and a main controller that allows the output, to a light emitting module, of a dynamic and static image from a source of a video signal. Also provided is at least one signal and power distribution board, connected to the main controller and the above mentioned light emitting elements, which supply power and transmit data signals. The signal and power distribution boards, adopted for sequential transmission of the data signal with amplification of the level and correction of the pulse fronts, are provided with drivers and programmable holding registers. Thereby said boards distribute a high-frequency data signal between several light-emitting elements and change a rate feedback signal by means of going-down the frequency of the data transmission, depending on the length of a conductor connecting the light emitting elements. These bias in time range between the desired values the data packets for the general synchronization, hence, the alternating light emission is provided to only the required light emitting element, with the desired intensity and at the predetermined unit of time. Optionally - also a desired color. The module further comprises at least one switching unit, connected to the main controller and the signal and power distribution boards, which supplies the electric power and data signal from the main controller to the signal and power distribution boards, or groups of such boards.

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LIGHT EMITTING LED DISPLAY MODULE AND MODULAR LIGHT EMITTING SYSTEM

Technical Field

The present invention relates to light-emitting display modules and light-emitting diodes based display modules.

Background Art

There exists a variety of created and designed structural solutions of the information display means, built on the electric-powered light sources. This plurality of articles is presented in various demonstration boards, displays, data boards, signs, scoreboards and LED screens of different sizes and resolution.

Restrictions in the creation of radically innovative display systems, built on lighting devices, electric-powered light sources of any known types, including light-emitting diodes, are connected first of all with the principle of creation the systems of the data signals control and electric currents supply to light sources, and also to LEDs feet.

Technically it is not very difficult to create static, or not complex, dynamic image, in which any light source, or a group of sources should be illuminated with the same color, or intensity, simultaneously with some other source, or a group, or, replacing herewith some other group. However, when there is a task to display a real, full-color image, specifically to make each pixel illuminate separately of the other ones over the whole display surface, with individual colored light and intensity, in determined time unit, then without a microcontroller (driver), located in close vicinity to the light source, it is impossible to implement.

In cases, when as such light source in images are used any, more or less, large lighting devices, then to put the driver inside such device does not cause any difficulties. Also, this isn't about the problems of microcontrollers (drivers) position layout, while making standard 'blind' videoscreens and the similar articles, that do not require a transparent light-transmission design.

However, if it is required to create large transparent screens, the developers need to use tiny light-emitting diodes, having not only a high brightness, with a low power consumption level, but also a number of other advantages against other light sources.

At the same time, many developers are currently working on, how to put the management drivers, whereas the LEDs have very small sizes, how to design the drivers of such small sizes, if it is necessary to pass through them too large electrical currents.

So far, there are several varieties of such transparent LED screens, that conditionally fulfill this task (US2005233125, EP2025509, EA004517).

This, also, includes different grid designs, LED-based linears, tubes, clusters, or the like, spaced apart from each other at a certain interval, comprising of textolite, aluminum and other types of printed-circuit boards with the conductor strips, on which the light emitting elements (LEDs) and other electronic components are placed, including microcontrollers (drivers).

The module, made according to such technical solution is not a maximally transparent, as boards and electronic components placed on them, have the dimensions, considerably exceeding the LEDs dimensions, that prevents the maximum light-transmission of the articles, in which mentioned elements are mounted.

Some designers have come to the conclusion, to put drivers directly under the LED itself, or the cluster, consisting of the group of LEDs, to achieve increased transparency of the article in whole (WO 2008/074800). Such manufacturing process allows achieving better transparency of the construction, than the above-described embodiments; however it is too expensive, because it requires the existence of a microcontroller (driver) for each depiction pixel in the image.

Herewith, all described embodiments have high maintenance cost.

Disclosure Of The Invention

The purpose of the present invention is to create a maximally transparent light emitting module, which can be used as a videoscreen, with the relatively low cost of its production and the utmost ease of its maintenance, against the existing prior art solutions.

Under maximum transparency of the light emitting module or video screen in the present invention the property of the light emitting module to restrict a through light transmission capacity of the module as little as possible is meant, such that the module setup, for example, on the facade of a building, would minimally restrict a view and a light getting through the external glazing into the room.

The proposed light-emitting module, comprises a plurality of electrically connected light emitting elements, that are the display pixels. Besides the module comprises at least

one main controller, that allows to output onto the light emitting module dynamic and static image from a source of video signal and at least one signal and power distribution board, connected to the main controller and the light emitting elements with ability to provide power supply and data signal transmission. The signal and power distribution boards are intended and adopted for sequential transmission of data signal with amplification of the level and correction of the pulse fronts, are provided with drivers and programmable holding registers, and are designed thereby with ability to distribute high-frequency data signal between several light-emitting elements and to change a rate feedback signal by means of going-down the frequency of data transmission, depending on the length of the conductor connecting the light emitting elements, biasing in time range between the desired values the data packets for general synchronization (video frames clocking), and hence, providing the alternating light emission of only the required light emitting element, with the desired intensity and at the predetermined moment in time; optionally - also the desired color.

The correction of the pulse fronts is made by means of a hysteresis. If the supply voltage is equal to, for example, 5 V, low level of the input signal is taken in the range of 0-0.8 V, and a high level – 2-5 V. In output a low level of the signal is equal to 0 V, and a high level of the signal - 5 V.

According to a preferred embodiment of the present invention, the module in addition comprises at least one switching unit, connected to the main controller and the signal and power distribution boards with ability to supply the electric power and data signal from the main controller to signal and power distribution boards or to the groups of such boards. Signal and power distribution boards are provided with a differential receiver (with the signal unpacking module) and the switching unit or units are provided with at least one differential transmitter-amplifier.

The essence of the invention in the details is described in Fig. 1, which is a schematic circuit of a modular light emitting system.

The present module allows to locate all the active electronic components including microcontrollers (drivers) outside the display surface, to mount them on the signal and power distribution boards, with purpose to create maximally transparent LED module, within the display surface of which, only the light emitting elements (depiction pixel) are placed and the thinnest electrical conductors. The thickness of such electrical conductors may be equal to 0.2 mm or less.

Each depiction pixel might be composed of a single one-color LED, a single multi-color LED, as a rule, but not necessarily, comprising red, green and blue colors (RGB 3 in 1), or a group of LEDs, or any other known light sources.

The light emitting elements are arranged with a certain pitch in relation to each other, and connected in a linear mode, in one direction, (or any other way in a coordinate plane), with thin electrical conductors to distribution boards.

The signal and power distribution boards, to which the conductors, leading to the light emitting elements, are connected, distribute high-frequency (1 GHz or more) signal, that can serve simultaneous several light emitting elements, by means of cascading distribution of the data signal and going-down the frequency of the transmission. Therefore, high carrier frequency, generated by the distributor board, comprises several packets with a lower frequency and is transmitted to the conductor, with placed on it several pixels. The device and control system is made in such way, that a high frequency signal, received from the switching units to the distribution boards, containing temporary registers, would be divided into several packages with lower frequencies displaced in time range to the desired size (1-8 MHz). This provokes hence, the lighting just the required pixel, of selected color, with the desired intensity and at the predetermined unit of time.

Simultaneously with the effect described above, the invention allows to minimize the cross-section of current carrying conductors. The generated high frequency, despite the fact, that carries the power to several pixels on its own line, in reality, lights the pixels one-by-one, and thus doesn't simultaneously lead to a high current consumption. The conductor section, under given control system, can be calculated based on the consumption of only the single pixel, and not a group of pixels, connected thereto. The conductor strips may have a diameter of 0.1-0.2 mm and even less, that makes them practically invisible for to the naked human eye.

Alternate ignition of pixels happens so fast (100-300 Hz or more), that the human eye cannot notice the similar effect, and sees a continuous true image.

Due to this invention, there is achieved not only maximum light transparency, but also maximum reliability and service durability of the device with low cost of its manufacturing and with more easiness of its maintenance.

The system-wide control of the modules is carried out from the main controller. The main controller has a set of inputs, preferably, of all popular formats such as Composite, VGA, HDMI, DVI, SDI, HD SDI and other, allowing to display on the light-

emitting modules full-color dynamic and static image from different video signal sources (computer, DVD, video camera and the like).

The signal from the main controller is supplied to the switching units, which comprise a group of the data outputs with differential amplifiers, that allows increasing the distance of the data lines to 100 and more meters. It gives the opportunity to put the switching unit not in close proximity to the light emitting modules, but in any convenient for usage place. The switching unit may manage a group of modules, arranged separately, or sequentially connected together, without gaps, both horizontally and vertically.

The signal and power distribution boards, placed outside the modules, have a differential receiver (receiving data signal in the far distance), and distribute data and power supply between LED pixels in the modules, and transmit the serial data to the next signal and power distribution boards.

Data and power supply from the distribution boards, can be supplied to the modules from 2, 3, or 4 sides and transmitted sequentially to the following modules, which greatly reduces the number of required wires and cables.

The present LED modules can be widely used in various fields; can be applied as an independent article, be installed into any flat, convex, concave and similar surfaces; might be used as a composite part of the other products, for example, be installed to any surface of the external glazing of buildings, including, installation inside the existing standard hermetic glazing units or any glazing area, be adapted as architectural illumination with dynamic lighting effects, and be served as large-sized video screens, displaying any information and the like. The light-emitting elements can also be placed in an hermetic, or nonhermetic, transparent or semi-transparent, rigid, flexible or resilient case or shell. The case or shell if needed may be provided with a frame or substrate; wherein the main controller, signal and power distribution boards and switching units are preferably located outside of the mentioned glazing unit, case or shell.

The proposed modular light emitting system includes a plurality of the above described light emitting modules and configured as shown in Figure 1, with the ability to output onto the light-emitting modules a full-color dynamic and static image from different video signal sources.

Claims

1. A light emitting module, comprising (i) a plurality of electrically connected light emitting elements, that are the depiction pixels, (ii) at least one main controller, that allows to output on a light emitting module dynamic and static image from the source of video signal and (iii) at least one signal and power distribution board, connected to the main controller and said light emitting elements with the ability of power supply and data signal transmission, characterized in, that the signal and power distribution boards are adopted for sequential transmission of the data signal with amplification of the level and correction of the pulse fronts, are provided with drivers and programmable holding registers, and are designed thereby with ability to distribute a high-frequency data signal between several light-emitting elements and to change a rate feedback signal by means of going-down the frequency of the data transmission, depending on the length of the conductor connecting the light emitting elements, biasing in time range between the desired values the data packets for the general synchronization, hence, providing the alternating light emission of only the required light emitting element, with the desired intensity and at the predetermined time; optionally - also the desired color.

2. The module according to claim 1, characterized in, that it further comprises at least one switching unit, connected to the main controller and the signal and power distribution boards with ability to supply the electric power and data signal from the main controller to signal and power distribution boards or groups of such boards.

3. The module according to claim 1 or 2 , characterized in, that the light-emitting elements are built into a glazing unit or a hermetic, or nonhermetic, transparent or semi-transparent, rigid, flexible or resilient case or shell; optionally - equipped with a frame or substrate; wherein the signal and power distribution boards have a differential receiver, and the switching unit or units are provided with at least one differential transmitter – amplifier, moreover the main controller, signal and power distribution boards and switching units are placed outside of the mentioned glazing unit, case or shell.

4. The module according to any one of the preceding claims, characterized in, that the light emitting elements are spaced apart from each other at a certain pitch, wherein, the

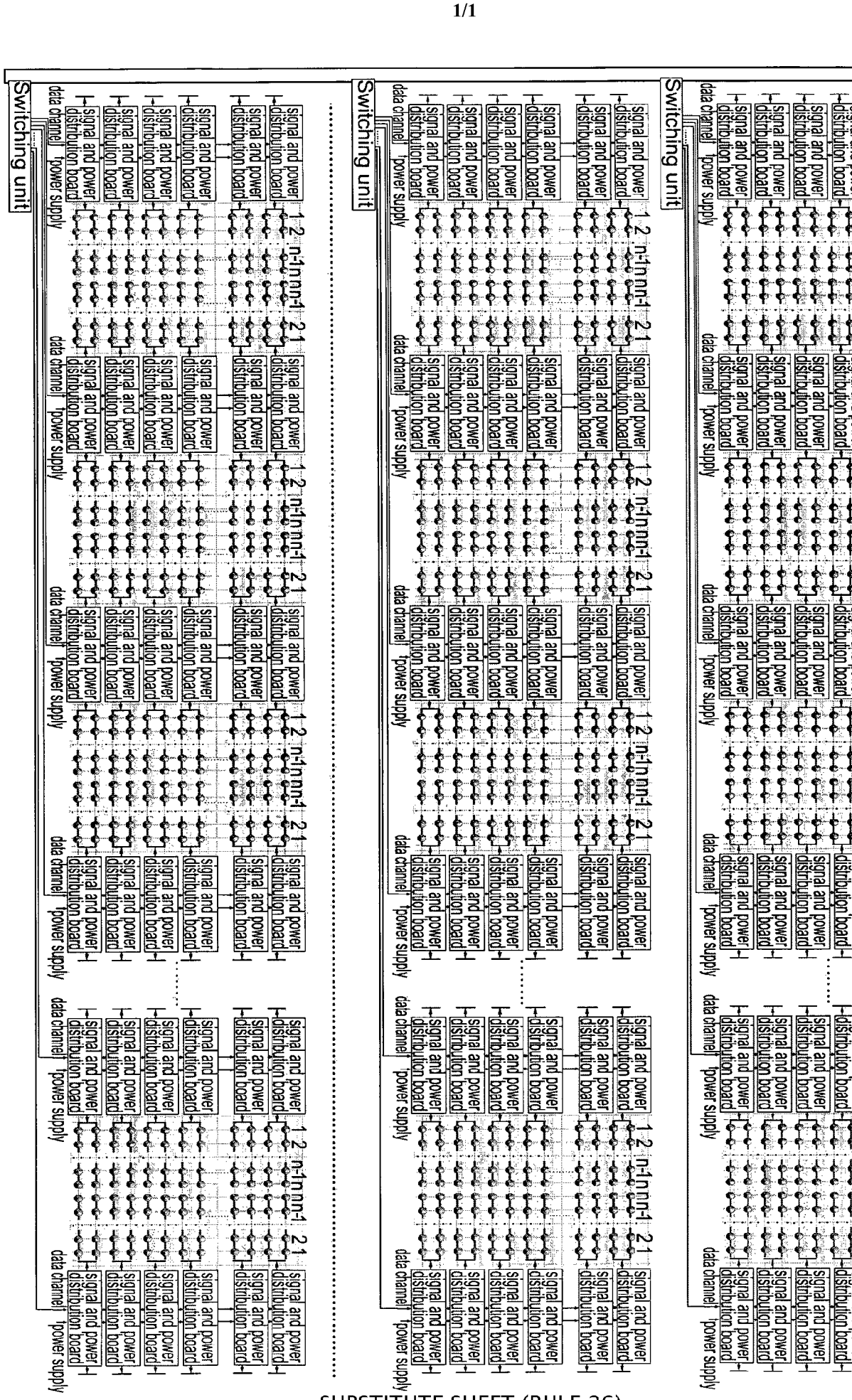
conductor cross-section, linking the light emitting elements, is calculated based on the consumption of only the single light emitting element of the pixel, but not a group of the light emitting elements, connected thereto.

5. The module according to any one of the preceding claims, characterized in, that the light emitting elements between each other and the signal and power distribution board or boards are connected in a linear way, in one direction.

6. The module according to any one of the preceding claims, characterized in, that each light emitting element comprises a single one-color LED or a single multicolor LED or a group of LEDs.

7. The module according to any one of the preceding claims, characterized in, that it is made with the ability of transmission the data signal and power supply from the signal and power distribution board from 2, 3 or 4 sides, as selected, with the possibility of the serial transfer to the following light emitting module.

8. A modular light emitting system comprising a plurality of the light emitting modules according to any one of the preceding claims, configured with ability to display onto the light emitting modules a full-color dynamic and static image from different video signal sources.


Main controller
Switching unit
Switching unit
Switching unit
signal and power distribution board
1 2 n-1 n
n n-1 2 1
data channel
power supply

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/073478

A. CLASSIFICATION OF SUBJECT MATTER
INV. G09G3/32 G09G3/20
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/052373 A1 (DEVOS BRUNO [BE] ET AL) 10 March 2005 (2005-03-10) paragraph [0016] - paragraph [0039]; figures 1-3	1-8
Y	US 2013/120232 A1 (TU MING-HUNG [TW] ET AL) 16 May 2013 (2013-05-16) paragraph [0002] - paragraph [0005] paragraph [0020] - paragraph [0029]; figure 3	1-8
Y	DE 199 50 839 A1 (FRAUNHOFER GES FORSCHUNG [DE]; KOWALSKY WOLFGANG [DE]) 23 May 2001 (2001-05-23) column 5, line 11 - column 7, line 44; figures 1-9	1-8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
19 March 2014	01/04/2014

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/073478

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2 483 485 A (CAMBRIDGE DISPLAY TECH [GB]) 14 March 2012 (2012-03-14) page 10, line 4 - page 12, line 4; figure 1b page 14, line 16 - page 17, line 18; figures 3-5	1-8
Y	US 2012/236509 A1 (COPE RICHARD [US] ET AL) 20 September 2012 (2012-09-20) paragraph [0067] - paragraph [0069]; figures 9-12 paragraph [0079] - paragraph [0082]; figures 24-30	1-8
Y	WO 02/095723 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]) 28 November 2002 (2002-11-28) page 6, line 1 - page 8, line 21; figures 2-4 page 12, line 21 - page 17, line 6; figures 7a, 7b, 8-12	1-8
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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