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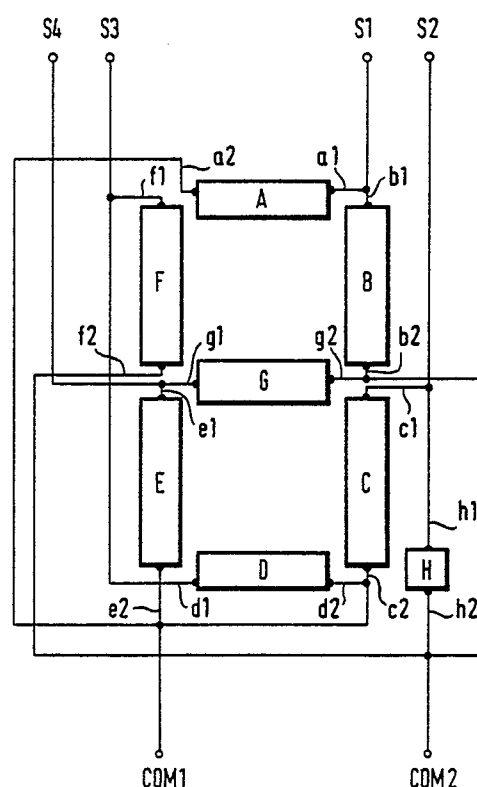
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(54) Display device made up of segments.

(57) In a display device made up of segments (A-H) by applying drive signals to selected segments fixedly associated with the particular valid character to be represented via segment drive lines (a1-h1, a2-h2) connected to the segments characters of a predetermined subset of valid characters from a representable total set are displayed. Each segment is connected to a first segment drive line (a1-h1) and to a second segment drive line (a2-h2) and a segment becoming visible only when a drive signal is applied to both segment drive lines connected to the segment. The first segment drive lines of a plurality of first segment groups are connected together and form first group drive lines (S1-S4). The second segment drive lines (a2-h2) of a plurality of segment groups are likewise connected together and form second group drive lines (COM1, COM2). The segments for forming the segment groups are selected in such a manner that on interruption of one or more group drive lines and on application of the drive signals for representing a character no other character of the predetermined sub set of valid characters is displayed.

FIG. 4



Display device made up of segments

The invention relates to a display device made up of segments for representing a predetermined subset of valid characters from a representable total set by applying drive signals to selected segments fixedly associated with the particular valid character to be represented via segment drive lines connected to the segments, a first and a second segment drive line being connected to each segment and a segment being visible only when a drive signal is applied to both segment drive lines connected to the segment, the first segment drive lines of a plurality of first segment groups being connected together and forming first group drive lines and the second segment drive lines of a plurality of second segment groups likewise being connected together and forming second group drive lines.

For representing characters and symbols, inter alia also measurement results in the form of digits on measurement instruments and meters, display means are frequently used in which the characters to be represented are made up using individually activatable segments.

Displays of this kind are the known LED displays or also the liquid crystal displays recently being employed to an ever increasing extent. The most widespread form of such displays in which the characters to be represented are made up of individually activatable segments is the so called 7 segment display containing seven individually activatable segments; usually, these displays are supplemented by an eighth segment for representing a decimal point.

In the known drive means each segment is connected to a first and a second segment drive line. A segment is made visible by applying a drive signal simultaneously to both segment drive lines. To reduce the number of lines leading to the display device the first segment drive lines of a plurality of segment groups are connected together, the connected lines forming a group drive line which leads to all segments of the particular group. The second segment drive lines of a plurality of second segment groups are also connected together and form second group drive lines. The various segments of the first segment groups belong to different second segment groups so that in spite of the combination of the segment drive lines to group drive lines by a multiplex drive in each case selected segments associated with the characters to be represented can be made visible.

In the event of an interruption of one or more group drive lines it can occur that the desired character to be represented is not displayed but another character of the predetermined subset of

valid character. When using the display device in a measuring instrument this would result in an incorrect measurement reading. It is superfluous to mention that displaying a character which although it belongs to the subset of valid character is the wrong one can lead in certain circumstances to serious consequences.

The invention is therefore based on the problem of further developing a display device of the type outlined at the beginning in such a manner that an incorrect display due to an interruption of one or more group drive lines is immediately recognized by the person reading the instrument.

According to the invention this problem is solved in that the segments for forming the segment groups are selected in such a manner that on interruption of one or more group drive lines and on application of the drive signals for representing a character no other character of the predetermined sub set of valid characters is displayed.

In the display means according to the invention by the particular selection of the segments belonging to the segment groups it is ensured that the interruption of a group drive line never under any circumstances results in the display of a character which although it belongs to the subset of valid characters does not correspond to the character to be displayed.

The invention will be explained by way of example with the aid of the drawings, wherein:

Fig. 1 is an illustration of the arrangement of seven segments A to G of a display device for representing the digits 0 to 9, an eighth segment H being added for representing a decimal point,

Fig. 2 is a table from which it can be seen which segments must be made visible for representing the digits 0 to 9 and the decimal point DP by applying corresponding drive signals,

Fig. 3 is a table which shows eight variants for forming the first and second segment groups and their association with the group drive lines for providing a display means according to the invention, and

Fig. 4 is an example of the connection of the segments to the drive lines and the corresponding combination to form group drive lines according to the variant 1.1 indicated in Fig. 3.

Fig. 1 shows a typical arrangement of segments of a display device as widely used for representing digits in clocks or measuring instruments and meters. The display device comprises seven segments A to G serving to represent the digits and an additional segment H for representing a decimal point. To each segment two drive lines not illustrated in Fig. 1 lead, a segment becoming

visible in the display device whenever between the two drive lines a predetermined potential difference is present. For example, the one drive line in each case may be the ground line whilst a positive voltage is applied to the other drive line to make a selected segment visible. The segments may be light-emitting diodes formed by a semiconductor material and emitting light when said potential difference is established between the two drive lines. The segments may however also be implemented with the aid of a liquid crystal material whose behaviour and possible uses are well known. For example, a liquid crystal material may be chosen which is light-permeable but under the action of an electrical field becomes light-impermeable. To form the segments the liquid crystal material is embedded in a thin layer between two plates, at least the upper plate consisting of glass and having metal electrodes in the form of the segments to be formed vapour deposited on its side facing the liquid crystal material. Metal electrodes are also provided on the side of the plate adjacent the layer formed by the liquid crystal material so that by applying corresponding potentials in the liquid crystal material an electrical field can be generated which causes the aforementioned transition of the material from the light-permeable state to the light-impermeable state.

The table of Fig. 2 indicates to which segments a potential difference must be applied via the drive lines in order to make one of the digits 0 to 9 or the decimal point DP visible. To represent the digit 0 for example the segments A, B, C, D, E and F must be visible. To represent the digit 7 the segments A, B and C must be made visible. The same applies to the other digits. The table of Fig. 2 shows a subset of characters of a representable total set which are assumed here to be considered the valid characters. This means that the valid characters are the digits 0 to 9 and the decimal point. Apart from the digits 0 to 9 and the decimal point other characters can also be represented but it is assumed that these characters belong to the subset of the invalid characters. The subset of the invalid characters includes for example the letters A, C, E, F, H, b, c, d. For example, for representing the character H the segments B, C, E, F, G must be made visible. For representing the letter c the segments D, E and G must be made visible. For the other characters defined to be invalid corresponding other combinations of segments are to be made visible.

Since for each segment of the display device two drive lines are required, the display device of Fig. 1 requires in principle sixteen drive lines in order for each individual segment to be made visible in selected manner by applying the potential difference to two respective drive lines associated

with a segment in accordance with the table of Fig. 2. To reduce the number of drive lines in known manner first drive lines connected to predetermined segments are combined so that for example four first group drive lines are formed. The second drive lines of each segment are also combined in groups so that two second group drive lines are formed. By applying the drive signals in a predetermined time sequence to the group drive lines, as with the provision of sixteen drive lines, the necessary potential differences can be applied to the particular segments to be made visible. This type of drive of a display device of the type outlined is known; it is referred to as multiplex drive and consequently need not be described in detail here.

If in a display device of the type described one of the group drive lines is interrupted it may happen that it is not the desired character which is displayed but another character of the subset of valid characters. As example the representation of the digit 7 will be considered. As apparent from the table of Fig. 2 to represent the digit 7 the segments A, B and C must be made visible. If due to a fault the group drive line responsible for driving the segment A is interrupted the digit 7 will no longer be displayed but the digit 1, for which according to the table of Fig. 2 the segments B and C must be made visible. The interruption of a group drive line thus results in a digit being displayed which although it belongs to the subset of the valid characters is not the same as the digit which should really have been displayed. When using the display device in a measuring instrument this display of the wrong digit can lead to extremely undesirable consequences.

If the first and second group lines are combined to form the first and second group drive lines in the manner illustrated in the table of Fig. 3, the result is that when a group drive line is interrupted which leads to a segment which has to be rendered visible in the character to be represented the display of any other character of the subset of valid characters is avoided with certainty.

The meaning of the table of Fig. 3 will now be explained with the aid of the display device illustrated in Fig. 4 in which all the drive lines and group drive lines are also indicated. The first drive lines connected directly to the segments are designated by a1, b1, c1, d1, e1, f1, g1 and h1. The second drive lines are designated by a2, b2, c2, d2, e2, f2, g2 and h2.

In the table of Fig. 3 eight variants are indicated with regard to how the first and second drive lines of the segments are combined to form group drive lines so that the aforementioned disadvantageous effect of the interruption of a group drive line no longer occurs, the person taking the reading being able to recognize that the drive de-

vice is defective. In particular, in the table of Fig. 3 in the case of the group drive lines S1 to S4 the segments whose first drive lines are to be respectively connected together to form the corresponding group drive line are indicated. In conjunction with the group drive lines COM1 and COM2 the segments are indicated whose second drive lines are to be connected together to form the group drive lines. This means in effect that for the variant 1.1, shown in detail in Fig. 4, to form the group drive lines S1 the first drive lines a1 and b1 of the segments A and B are to be connected together, to form the group drive line S2 the first drive lines c1 and h1 of the segments C and H, to form the group drive line S3 the first drive lines d1 and f1 of the segments D and F and to form the group line S4 the first drive lines e1 and g1 of the segments E and G. To form the group drive line COM1 the second drive lines of the segments A, C, D and E are to be connected together whilst to form the group drive line COM2 the second drive lines of the segments B, F, G and H are to be connected together. It is also apparent from the table of Fig. 3 for the other variants of which segments the first and second drive lines are to be connected together to form the corresponding group drive lines.

If in the display device according to the variant 1.1 shown in Fig. 4 the digit 7 is to be represented, the segments A, B and C must be made visible. This is done in that taking account of the multiplex drive mentioned above in selected manner in succession potential differences are generated between the group control lines S1 to S4 and COM1, COM2. For the case of the digit 7 firstly a potential difference is generated between the group drive line COM1 on the one hand and the group drive lines S1 and S2 on the other. This results in the segments A and C becoming visible. Thereafter a potential difference is generated between the group drive line COM2 and the group drive line S1, resulting in the segment B becoming visible. The application of the potential differences in the manner outlined is carried out alternately at such a high frequency that a flicker-free display is obtained. When the potential differences are applied in the manner outlined the condition of the table of Fig. 2 is fulfilled for the representation of the digit 7, i.e. the segments A, B and C must be made visible.

If in the example outlined the group drive line S1 is interrupted because of a fault, the segment A on application of the potential difference between the group drive lines COM1 and S1 does not become visible and on subsequent application of the potential difference between the group drive line COM 2 and the group drive line S1 the segment B does not become visible. Since therefore only the segment C becomes visible, the person reading the display can see that there is a defect in

the display device. The interruption of the group control line S1 does not lead to another character of the assignment table of Fig. 2 being represented. Display of segment C which becomes visible is one of the invalid characters by means of which the person reading the display can recognise the presence of a fault.

If in the present example the group drive line S2 or the group drive line S4 is interrupted, this has no effect on the representation of the digit 7 to be displayed because these group drive lines are associated with segments not required for the representation of the digit 7. The display device therefore correctly displays the digit 7 and it is therefore not necessary to draw the attention of the person reading the device to a fault. Only when a digit is to be represented in which segments associated with the group drive lines S3 and S4 are to be made visible, the person reading the device can recognise the fault. This can be illustrated with the aid of a further example. For representing the digit 4 according to the table of Fig. 2 the segments B, C, F and G must be made visible. To achieve this in succession alternately potential differences are applied between the group drive line COM1 and the group control line S2 and between the group drive line COM2 and the group drive lines S1, S3 and S4. If in this example the group drive line S3 is interrupted, the segment F is no longer visible so that none of the digits indicated in the table of Fig. 2 can be represented. The segments B, C and G made visible do not give a character from the subset of valid characters and consequently the person reading the device can immediately detect the presence of a fault.

The display device described also comprises a separate segment H for the representation of a decimal point and this segment H is also included in the fail safe function. This means that whenever it is desired to represent digits with a decimal point, only a representation with decimal point is considered a valid display. When the decimal point is not present this means that one of the group drive lines is interrupted.

For the variants 1.2 to 2.4 examples could be given like the examples described above in conjunction with variant 1.1. However, in all cases the objective is achieved, i.e. on failure of a group drive line no other character from the subset of the valid characters can be displayed.

Claims

1. Display device made up of segments for representing a predetermined subset of valid characters from a representable total set by applying drive signals to selected segments fixedly asso-

ciated with the particular valid character to be represented via segment drive lines connected to the segments, a first and a second segment drive line being connected to each segment and a segment being visible only when a drive signal is applied to both segment drive lines connected to the segment, the first segment drive lines of a plurality of first segment groups being connected together and forming first group drive lines and the second segment drive lines of a plurality of second segment groups likewise being connected together and forming second group drive lines, characterized in that the segments (A-H) for forming the segment groups are selected in such a manner that on interruption of one or more group drive lines (S1-S4, COM1, COM2) and on application of the drive signals for representing a character no other character of the predetermined sub set of valid characters is displayed.

2. Display device according to claim 1, characterized in that seven segments (A-G) are provided for representing the digits 0 to 9 and one segment (H) for representing a decimal point (DP).

3. Display device according to claim 2, characterized in that four first segment groups each comprising two segments are in connection in each case with a first group drive line (S1, S2, S3, S4), that two second segment groups each comprising four segments are in connection in each case with a second group drive line (COM1, COM2) and that the two segments of each first segment group each belong to a different one of the two second segment groups.

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FIG.1

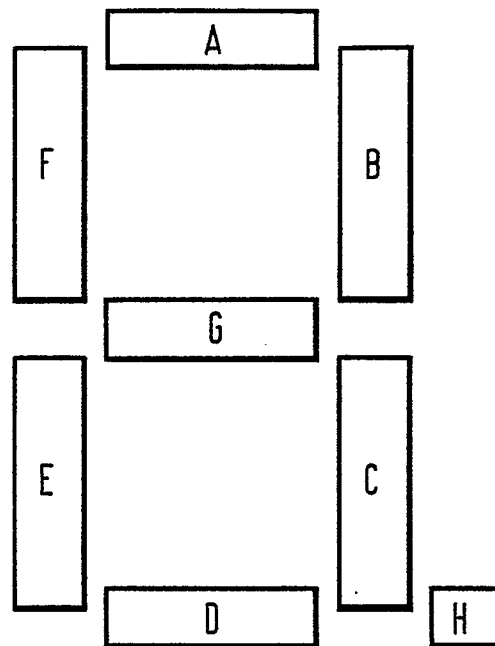


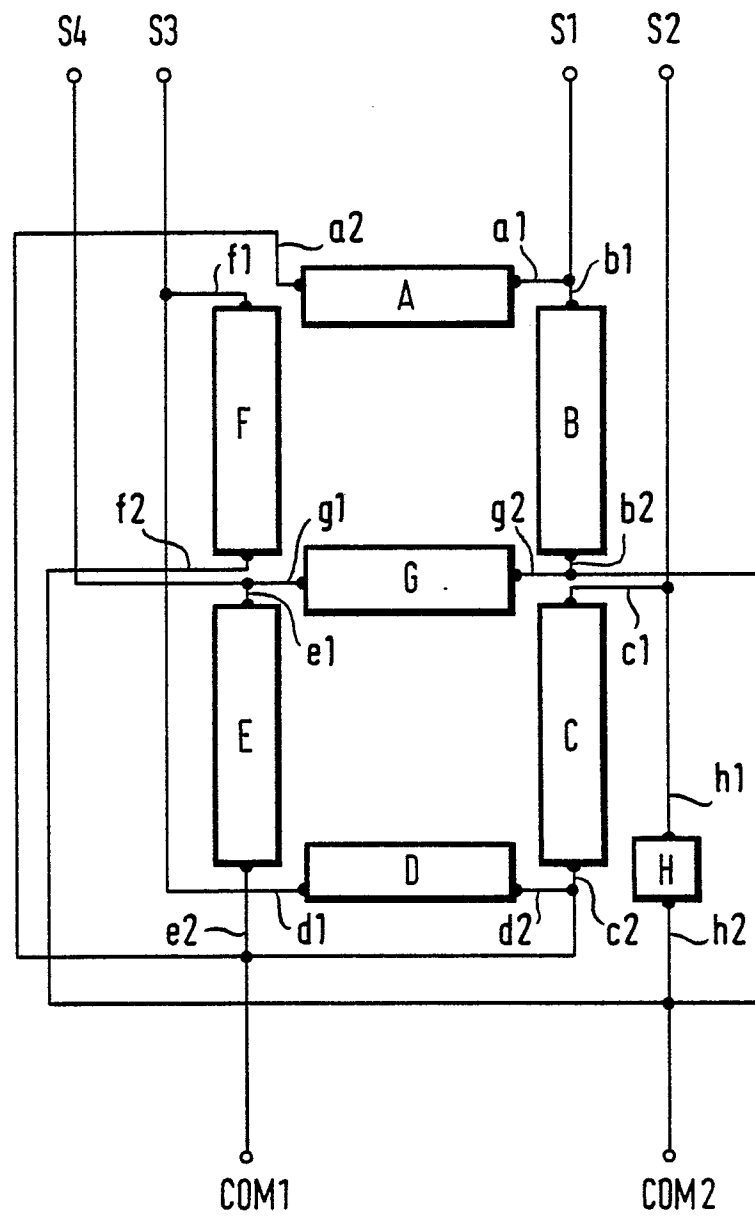
FIG.2

DIGITS	SEGMENT
0	A B C D E F - -
1	- B C - - - - -
2	A B - D E - G -
3	A B C D E - G -
4	- B C - - F G -
5	A - C D - F G -
6	A - C D E F G -
7	A B C - - - - -
8	A B C D E F G -
9	A B C D - F G -
DP	- - - - - H

FIG. 3

VARIANTS	S1	S2	S3	S4	COM1	COM2
1.1	AB	CH	DF	EG	ACDE	BFGH
1.2	AB	CH	DF	EG	ACDG	BEFH
1.3	AB	CH	DF	EG	ACEF	BDGH
1.4	AB	CH	DF	EG	ACFG	BDEH
2.1	AC	BF	DH	EG	ABDE	CEGH
2.2	AC	BF	DH	EG	ABDG	CEFH
2.3	AC	BF	DH	EG	ABEH	CDFG
2.4	AC	BF	DH	EG	ABGH	CDEF

FIG. 4





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	SID INTERNATIONAL SYMPOSIUM, DIGEST OF TECHNICAL PAPERS, 1977, pages 54,55, Los Angeles, US; L.E. TANNAS Jr.: "5.6: Fail-safe matrix-fonts" * Page 54, left-hand column, "Problem" - right-hand column, "Fail-safe"; figures 2,4A,4B *	1	G 09 F 9/30 G 09 G 3/04
A	--- ELECTRICAL DESIGN NEWS, vol. 10, no. 8, July 1965, pages 126,127, Denver, US; H.L. MARTINS: "Segmented-type readout has fail-safe feature" * Page 126, text; page 127, fig- ure *	1	
A	--- US-A-3 717 867 (W. ROSENZWEIG) * Claim 4; column 3, lines 24-35; figures 1,2 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 09 F G 09 G H 03 K
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23-10-1986	Examiner FRANSEN L.J.L.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			