

DISPLAY DEVICE

This invention relates to a display device for displaying characters or graphic images received by radio, particularly such a device which is in pocketable form. It relates particularly, but not exclusively to non-alphanumeric (English) languages, ie, general pictographic, written languages including Oriental languages such as the Chinese language and to a radio paging device for use with such languages.

It is known to be extremely difficult to implement a pager receiver for pictographic Oriental languages for the following two reasons:-

a) Most Oriental languages have a huge number of characters or pictograms as compared to English style European languages. In particular, the Chinese language is composed of more than 50,000 different characters. Therefore, without the invention of a special storage technique, it would be impossible to accommodate such a large vocabulary in any form of storage device which would enable the pager to have a size comparable with the size of a pack of 20 cigarettes. This is essential for a pocket radio pager receiver.

b) Normally, longer air-time (which is a valuable factor in the paging business) is required to transmit a character of an Oriental language than a usual alphanumeric character due to the large number of characters which require a longer code to identify individual characters. Unless a special message recognition technique can be devised^{sed} and built into the radio pager receiver, an Oriental language radio pager receiver will be too expensive in terms of running cost for its air-time message transmission.

At present, there are, of course, numerous radio pager receivers which can provide the user with information

in English and alphanumeric characters. There has also, in
 5 -A-2197103 been a proposal for a multi-lingual radio pager
 which is disclosed as being usable to display characters of
 Oriental languages. The invention seeks to provide an
 improved form of display device.

The usefulness and attractiveness of information
 display pagers would be enhanced considerably by the
 provision of a pager, capable of displaying greater amount
 of information to the users in different Oriental languages
 10 especially in the most popular Chinese language.

A further problem with current pagers is that they
 have an "Identification Code" (ID) which has been written
 and fixed permanently into a piece of Read Only Memory,
 called a code plug to enable the paging company to address
 15 individual pager receiver. It would be much more cost
 effective and convenient to have a pager which uses no code
 plug but another innovative concept to signify its own
 identification. At the moment, any change of the pager
 number (ie, ID) requires the replacement of a physical code
 20 plug, which may involve the pager being taken back to the
 paging station physically.

According to the present invention, there is
 provided a display device for displaying alphanumeric and/or
 pictographic characters ^{for example} ~~such as~~ of an Oriental language
 25 including Chinese, Korean and Thai and/or graphic
 information comprising:-

radio receiving circuitry for receiving a radio
 message in which is encoded characters and/or graphic images
 to be displayed;

30 at least one display for displaying the received
~~as such~~ characters and/or ~~as a~~ graphic images; and

processing circuitry for receiving the radio
 message as N-bit message data words from the receiving
 circuitry, the processing circuitry being operative to
 35 convert the data words into displayed characters and/or

graphic images in a manner such as to extend the total number of displayable characters and/or graphic images beyond 2^N (2 raised to the power N) by using at least one of the 2^N possible data words to alter the conversion used to generate the characters and/or ~~usage~~^{images}, the characters and/or graphic images being stored in a memory associated with the processing circuitry, the memory having a fixed part in which data stored therein is fixed and a read/write part, and the processing circuitry including means for altering characters and/or graphical images stored in the read/write part of the memory in response to command data received via the radio receiving circuitry.

The circuitry may include memory means having a capacity to store the codes for at least 1000 Oriental characters, in particular Chinese characters, or for at least 1500 alphanumeric characters.

Optionally, the device may comprise means for storing, between the receipt of radio messages by the radio receiving circuitry, the value of at least one parameter used by circuitry of the device for defining a characteristic of its operation, in particular the Identification Code noted above;

and means responsive to at least one command encoded in a received message to set at least one such parameter to a required value.

The invention is particularly applicable to a radio paging device.

The invention may provide a pager which can receive and display any type of Oriental languages, in particular, the Chinese language and which requires no code plug but yet can still be addressed by the paging company individually. By using a custom made "Single Chip Microprocessor Application Specific Integrated Circuit (ASIC)" controller loaded with a special designed software program, the radio pager receiver can have the capability to

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- store the message data collected by an electronics data reception module via a radio frequency channel into a random access memory device - RAM, and at the same time through
- 5 searching from a character fonts table residing partly in a character generation read only memory - ROM and partly in a read/write memory - RAM by executing an innovative floating storage technique (to be described later) to display the

message received on a graphic LCD module and a dynamic identification (to be described later) concept to identify a particular pager receiver among all receivers.

The radio pager receiver itself can store up
5 multiple messages for the user to examine later. The control means of the pager can be arranged to enable the displayed messages to be viewed one by one either in the forward or reverse directions and when it reaches the end, it will display the first message again, the second message
10 and so forth again. It also enables each message, if too long, to be displayed frame by frame (ie, one display's worth at a time). The user can also select messages to be deleted from the memory. The control means can also enable the user to switch on/off the LCD display background
15 lighting, and switch off the audio tone upon receipt of a message.

The invention enables implementation of the above mentioned floating storage technique (FST) which is an innovative idea by using an optimum number of bits to
20 address a unique entry from a fixed size character fonts table which has the capability to cover an unlimited number of characters or pictograms. This can be explained as follows:-

Let it be assumed that "N" bits are used to
25 represent an address code representing one character of, for example, an Oriental language. An N-bit code can normally address a maximum of " 2 to the power N" entries, each code corresponding to a respective character. The FST involves different usages of the 2^N total number of available codes
30 along the lines of the following. In particular, it may divide the 2^N codes into 4 usages:

	Usage 1	"X" combinations	to address "X" fixed entries with a character font table residing in read only memory (ROM).
5	Usage 2	"Y" combinations	to address "Y" fixed entries with the character font table residing in RAM which can be altered via the system controller through receiving a command from the radio frequency channel.
10			
15	Usage 3	"Z" combinations	to address "phrases" composed of a number of pointers to cascade a sequence of single character entries within the fixed vocabulary from table "X" and "Y". These pointer sequences are located also in RAM which can be altered by the system controller through receipt of a command from the radio frequency channel.
20			
25			
30	Usage 4	"1" combination	in case the required character font does not exist in the "X" and "Y" table or the display of some graphic is required, this specific address code can instruct the system to construct the
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required graphic or character fonts from the direct bit pattern data received from the radio frequency channel; the end of the bit pattern can be indicated in any suitable way, eg, by a bit pattern following it (such as the bit pattern indicating the start of usage 4) or by a preamble which indicates the lengths, width and coordinates of the image being sent.

It is obvious that the sum of "X", "Y", "Z" and 1 will still equal to 2^N . However, this technique offers the following unique advantages over other methods being used:-

- Usage 1 can be used to hold the most frequently used characters/pictograms, in the language in question for efficient and fast processing and translation.
- Usage 2 can be used to expand the system's capability to recognise the whole character/pictogram set of that particular language without any pre-set limit.
- Usage 3 enables the use of just "N" bits to represent a frequently used phrase which might comprise a string of any length of characters or pictograms. This represents a considerable saving of data space and licence transmission time; the transmission time for message transmission is the most expensive and important element in the paging industry.

- Usage 4 further expands the system to recognise information more than text messages, but to any form of graphic information. In the paging business, it makes the pager receiver become a small facsimile receiver.

As an example of applying the FST to the Chinese language in particular to the radio pager receiver application, we found from statistic that by appropriately selecting them, the fixed 4,000 characters can cover over 99% of the vocabulary used in the paging industry. Therefore, it is possible to use a unique 12 bits (one and half byte) address to identify a character font entry. In other words,

15	Where "N" = 12 bits and	
	"X" = 4,000 combinations	to address total 4,000 fixed characters font residing in a 128K x 8 bits ROM.
20	"Y" = 32 combinations	to address a total of 32 programmable characters from a font residing in part of the 8K x 8 bits RAM.
25	"Z" = 63 combinations	to address a total of 63 programmable phrases residing in part of the 8K x 8 bits RAM.
	"1" = 1 combination	to address general graphic information.

The optional feature of altering an operating parameter of the device can be used to avoid having to change the ID ROM to alter the pager ID. The paging company simply send a command through wireless transmission to the pager to achieve the same result. The removal of the code plug will also save some space so that pager can be made smaller. Thus, this feature of the

invention provides a dynamic identification (DI) technique whereby the pager's identification code (ID) is stored in a portion of the message RAM which is non-volatile, eg by being backed up by a 10 year life lithium battery, instead of being stored in ROM. Through intelligent control by a custom microcontroller, this identification code is no longer pre-fixed but can be changed easily under authorisation of the paging company to simply issue a command to the receiver via the radio frequency channel. In addition, more than one identification code for different purposes of application can be stored simultaneously which makes different categories of news broadcasting to a particular group of subscribers easy and cost effective.

The term "radio paging device" as used in the present description and claims is not intended to be limited to a device dedicated solely to that purpose but is intended to include all devices which provide that function in a personally portable form. In particular, apart from its implementation as a dedicated device, the invention may also be put into effect by providing an accessory, attachment or insert to a personally portable electronic device having a suitable display and effective to receive radio paging transmissions and display them on that display, such as a pocket sized digital radio transmitter, portable telephone, television set or video tape/disc player.

The invention will be further described by way of non-limitative example with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram illustrating the circuitry of a pager in accordance with the invention; and

Figure 2 shows how the different sub-modules are assembled together to form a complete radio pager receiver unit.

The pager illustrated in the attached figures comprises a pocketable housing (not shown) preferably of the order of size of 2 1/2" x 3" x 1/2" (63.5 x 76 x 12.7 mm) which includes a custom one-chip MCU 1 (Microcontroller Unit

HD614080 from Hitachi, Japan) loaded with a specially
 written computer program to implement each of the above
 described functions, a character generator custom masked ROM
 3 (Read Only Memory, HN62321BP from Hitachi, Japan) a
 5 graphic liquid crystal display module capable of showing 16
 x 128 dots graphic or to display one frame of a certain
 number of characters for a particular language (eg, for the
 Chinese language, 8 characters can be shown in 16 x 16 dots
 font) which comprises of 2 drivers IC 4 and 5 (LCD segments
 10 driver HD61102 and LCD common driver HD61103 from Hitachi,
 Japan) and a high contrast LCD display 6 custom made by
 Seiko with which the whole LCD module is powered by a
 specially designed LCD power supply circuit 7, a lithium-
 battery-backed message storage read/write RAM 2 (HN6264FLP-3
 15 from Hitachi, Japan) of capacity 8K x 8 bits for storing
 message data, one or more pager identification codes and
 some programmable Oriental language characters; in
 particular, the Chinese character fonts and phrases. A key
 panel 10 comprises one 3 position sliding mode switch to
 20 activate the pager and 5 push-buttons for users operations.
 A radio frequency (RF) receiver module 8 comprises RF tune
 circuit, amplifier, filters and wave shaping circuits as a
 hybrid unit for capturing data signal from the air, a beeper
 and a light-emitting diode (LED) to generate the audio and
 25 visual alert signal upon message received, one piece of 1.5
 volt AA-size battery 11 to power the RF receiver module 8, a
 DC-DC converter 9 to step up the voltage from battery 11 to
 power the remaining system and finally a small light bulb 12
 or some other lighting device to provide background lighting
 30 to LCD module.

The pager is constructed (refer to Figure 2) and
 programmed so that it can receive specially coded message
 and display characters of the Oriental languages, in
 particular, the Chinese language under user's control. The
 35 following paragraph describes the operation principle of the

pager.

The paging company transforms the message in the Oriental language, in particular, the Chinese language graphic information context using the paging computer system into a binary bit stream based on the floating storage technique coding algorithm, and then associate the message with either a specific pager receiver subscriber or the group broadcasting subscribers plus some redundant bits for self error correction and finally encode all data bits as a complete message packet according to the Universal POCSAG standard (CCIR radio paging code No 1) and broadcast to the air through a particular radio frequency channel.

Assuming the pager has been switched active, the MCU 1 wakes up the RF receiver module 8 from time to time to detect if there is any message which requires its attention by comparing the identification code associated with the message with its own identification stored in the RAM 2 according to the dynamic identification concept. If the result is positive, MCU 1 stores the message into the RAM 2 for later repeated examination, and at the same time, searches the character generator ROM 3 and other programmable characters font or phrases table in RAM 2 to transform the message into the Oriental language or Chinese character or other graphic information then shows the message on the LCD module. In addition, a alert tone is generated by the beeper unit and the LED is flashed inside the RF module 8 which is controlled again by the MCU 1. The user can switch off the tone by hitting any button on the key panel 10; otherwise, the tone will be turned off automatically after about 8 seconds by the MCU 1.

Battery 11, DC/DC converter 9 and LCD power circuit 7 to serve to distribute the power to individual working modules of the pager. If the environment is dark and the LCD cannot be seen clearly, the user can press and hold the "LIGHT" button on the key panel 11 to turn on the light bulb

or to the lighting devices 12 to have display illumination.

The beep tones can be substituted by a vibration alert unit if the user does not wish the tone to disturb other people.

5 The pager may provide both manual and auto time shut-off features to conserve power consumption. Battery low alert/indication is also provided.

10 The program of the MCU 1 can interpret information which has been encoded into a bit stream according to the Oriental language; in particular the Chinese character, coding system specially designed for the present invention based on the said forth floating storage technique and transmitted in standard POCSAG format in 512 baud speed or a higher band speed switchable by the paging company. It can
15 also support standard POCSAG alphanumeric display.

20 During data reception, the pager may provide 2 bits self error correction and 3 bits error detection capability for identification code matching while 1 bit self error correction and 2 bits error detection capability for message recovery to ensure maximum receiving reliability.

25 With RAM 2, the said pager can store up to 32 separate messages, the maximum length of each message is depending on how the floating storage technique is being used, with no practical restriction. Standard alphanumeric messages transmitted in POCSAG format can also be recognised. The screen formats of the LCD module are different between the Oriental language; in particular the Chinese characters, and alphanumeric-characters display mode. In the former, each frame can display a number of Oriental language characters;
30 in particular, 8 Chinese characters in 16 x 16 dot fonts; in the latter, each frame can display 2 lines x 21 characters in 5 x 7 dot font. In addition, the pager can support both small and capital letter alphabets. The next paragraph will describe the detailed user operation of the pager.

35 The pager is suitable programmed so as to operate in

one of the following 4 states:-

a) Active state.

The MCU 1 receives and executes commands from the user via the key panel 10, allocating some spare time periodically to check if any message is coming from the RF receiver. Power is supplied to all components in this state.

b) Sleep state

System will go to sleep state from Active State is NO key on the keyboard has been pressed for approximately 30 seconds or the user has stepped through all the stored messages. In this state, the LCD module will be switched off.

c) Disable stage

The pager will enter this state if a DISABLE command has been received. This state is similar to the Sleep State except that further users' commands will not be effective until an ENABLE command is received through broadcast.

d) Off State

User Switches the pager to this state by sliding the mode switch to the OFF position. All components except the external RAM chip 2 will be cut off. The pager cannot receive any further message until turned back on.

In the following, NORMAL operation refers to operating the pager under Active or Sleep state.

The key panel 10 will be provided with the following keys, switches and buttons, the MCU 1 suitably programmed to produce operation as described.

- 1 Mode switch: A 3 position slide switch with its position to define the different users operation modes:
- ON: The pager is under Active or Sleep stage while an alert tone will be heard and LED will be flashed whenever a call has been received.

M: Same as ON made except the alert tone will be disabled.

OFF: Pager is OFF. All memorised messages will be erased.

- 5 Next button: Enable user to examine individual message in frame by frame basis if the message is too long to be fitted within one frame.
- 10 READ button: Enable user to read next message in FORWARD direction. Latest message will be placed at the top position of the RAM buffer.
- BACK button: Enable user to read next message in BACKWARD direction.
- 15 DELETE button: Enable user to delete the current examined message from the RAM buffer. The delete all messages, user can press both the READ and BACK button.
- 20 Light button: Display illumination will be effective if this button has been pressed and held down.

25 The provision of the above functions, both insofar as they are implemented by programming of the microprocessor and by the illustrated circuitry is a matter of routine for the skilled man.

30 Attention is directed to our co-pending application no. 9114718.1 (Publication no. 2243732) which was divided from the present application and describes and claims features of the above described apparatus.



CLAIMS

1. A display device for displaying alphanumeric and/or pictographic characters ~~such as~~ ^{for example} of an Oriental language including Chinese, Korean and Thai and/or graphic information comprising:-

radio receiving circuitry for receiving a radio message in which is encoded characters and/or graphic images to be displayed;

10 at least one display for displaying the received characters and/or graphic images; and

processing circuitry for receiving the radio message as N-bit message data words from the receiving circuitry, the processing circuitry being operative to
15 ⁿ convert the data words into displayed characters and/or graphic images in a manner such as to extend the total number of displayable characters and/or graphic images beyond 2^N (2 raised to the power N) by using at least one of the 2^N possible data words to alter the conversion used to
20 generate the characters and/or ^{images} ~~usage~~, the characters and/or graphic images being stored in a memory associated with the processing circuitry, the memory having a fixed part in which data stored therein is fixed and a read/write part, and the processing circuitry including means for altering
25 characters and/or graphical images stored in the read/write part of the memory in response to command data received via the radio receiving circuitry.

2. A device according to claim 1 wherein a
30 predetermined number, X, which is less than 2^N , of the possible 2^N combinations are used to address characters in a preset character table.

3. A device according to claim 2 wherein N equals 12
35 and X is approximately 4000.



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4. A device according to claim 1,2 or 3 wherein a predetermined number, Y , which is less than 2^N , of the 2^N possible combinations are used to access characters (a)
- 5 whose image data are held in the read/write memory or (b) which are held in one of a number of preset tables, the table in use being alterable by the processing circuitry.



5. A device according to claim 4, wherein the image data of alternative (a) or the table in use of alternative (b) can be set by command data received as part of the radio-paged message.

6. A device according to claim 4 or 5, wherein Y is about 32.

7. A device according to any one of the preceding claims, wherein a predetermined number, Z, which is less than 2^N , of the 2^N possible combinations are used to address stored sequences of codes which the processing circuitry translates into multiple character displayed messages or portions thereof.

8. A device according to claim 7, wherein Z is about 63.

9. A device according to claim 7 or 8, wherein the stored sequences can be set by command data received as part of the radio-paged message.

10. A device according to any one of the preceding claims, wherein the processing circuitry is responsive to one of the 2^N combinations received as a message word to treat one or more following words as bit-image data to generate a graphical image.

11. A display device according to any one of the preceding claims and comprising:-

means for storing, between the receipt of radio messages by the radio receiving circuitry, the value of at least one parameter used by circuitry of the device for defining a characteristic of its operation;



and means responsive to at least one command coded in a received message to set at least one such parameter to a required value.

- 5 12. A device according to claim 11, wherein the device is a radio paging device and the at least one parameter includes an identification code used by circuitry of the device to determine whether a particular received radio-paged message is addressed to that device.
- 10 13. A device according to any one of the preceding claims and including control means arranged to enable the displayed messages to be scanned in either the forward or backward direction.
- 15 14. A device according to claim 13 wherein the control means is arranged to enable each individual message to be examined frame by frame if its length has exceeded the single frame display capacity.
- 20 15. A device according to claim 13 or 14 wherein the control means is arranged to allow the stored messages or part thereof ^{to} ~~that me~~ be repeatedly displayed.
- 25 16. A device according to any one of claims 13 to 15 wherein the control means is arranged to allow all stored messages or a selected one to be deleted.
- 30 17. A device according to any one of the preceding claims and including memory means having a capacity to store the codes for at least 1,000 Oriental language characters; ^{for example} ~~in patent particular~~, the Chinese characters.
- 35 18. A device according to claim 17 wherein the memory means has a capacity to store the codes for at least 1,500



alphanumeric characters.

19. A portable radio pager incorporating radio paging
circuitry for receiving radio pager messages and a display
5 device according to any one of the preceding claims for
displaying received messages.

20. A device according to any one of the preceding
claims which is of a pocketable size.

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21. A device according to any one of the preceding
claims whose external dimensions are about 2 1/2" x 3" x
1/2".

15 22. A device according to any one of the preceding
claims implemented by means of an accessory, attachment or
insert to a ~~pocket~~ sized digital radio transceiver, portable
telephone, television set or video tape/disc player.

20 23. A radio pager constructed and arranged to operate
substantially as hereinbefore described with reference to
and as illustrated in the accompanying drawings.
