ICs for Liquid Crystal Display

Isao Sano

1. Introduction

In the current highly information-oriented society typified by widespread use of multimedia, electronic displays have been widely used in everyday life as a means of information transmission and as man-machine interfaces. Electronic displays have been used in many fields of consumer goods and industrial equipment and have become indispensable to daily living.

Among the types of electronic displays, the liquid crystal display (LCD) has been applied to various fields because of advantages such as small size, light weight, thinness, and low power consumption. The LCD holds a firm position as a next-generation general-purpose device that will replace the CRT.

Fuji Electric has manufactured a series of integrated circuits (ICs) for LCDs as semiconductor devices for displays that satisfy these market needs.

This paper introduces the product series of ICs for character-display-type, small, simple-matrix LCDs used for the displays of portable telephones, facsimiles, beepers, and copying machines.

2. Outline of the products

Fuji Electric has already mass produced the "FC2258K", a controller driver IC which enables construction of LCD panels of 16 characters by 2 rows with only one chip and without external electronic parts. To meet the needs of different types of displays, Fuji Electric has developed the following product series.

2.1 Features

Four types of character-display-type LCD controller driver ICs are being mass produced and one type, the "FCS2326K", is under development. The main characteristics of these ICs are compared in Table 1. Photographs for three of the four ICs being mass produced are shown in Figs. 1, 2, and 3.

From this group, the "FCS2314AK" was developed as an LCD panel IC for electronic equipment such as desktop telephones, laser printers, facsimiles, and copying machines. The length of the panel allows 20

Table 1 Main characteristics of LCD controller driver ICs

Item \ Device	FC2306K/07K	FCS2314AK	FC2316K	FCS2326K
Display type	16 chars. by 2 rows	20 chars. by 2 rows	16 chars. by 4 rows	12 chars. by 2 rows
Duty	1/18	1/8, 1/16	1/34	1/18
Number of liquid crystal driver outputs	COM:18 SEG:80	COM:16 SEG:100	COM:34 SEG:80	COM:18 SEG:62
Power supply voltage	2.7 to 5.5V	4.5 to 5.5V	2.7 to 5.5V	2.4 to 3.6V
Liquid crystal driving voltage	3.0 to 11.0V	3.0 to 5.5V	3.0 to 11.0V	3.0 to 7.0V
DDRAM	64×8 bits 64 chars, max.	80×8 bits 80 chars, max.	80×8 bits 64 chars, max.	24×8 bits 24 chars, max.
CGROM	9,600 bits 240 data	9,600 bits 240 data	9,600 bits 240 data	9,600 bits 240 data
CGRAM	512 bits 8 data	512 bits 8 data	512 bits 8 data	160 bits 4 data
PGRAM	2×5 bits 10 data	—	4×5 bits 20 data	104+8 bits 112 data
Interface with MPU	4/8 bits	4/8 bits	4/8 bits	1/4/8 bits
Number of instructions	12	11	12	15
RVLCD	Built-in	Built-in	Built-in	Built-in
Oscillator frequency	250kHz	270kHz	250kHz	33kHz
Voltage doubler	Built-in	—	Built-in	Built-in
Voltage divider	—	—	—	Built-in
Voltage follower	—	—	—	Built-in
Stand by mode	Not provided (06K) Provided (100μA)	Not provided	Provided (50μA)	Provided (60μA)
Sleep mode	Not provided	Not provided	Not provided	Provided (5μA)
Current consumption	450/350μA	1.5mA (standard)	500μA (standard)	100μA (max.)
Ratio of chip length to width	1 : 3.14	1 : 2.42	1 : 3.25	1 : 4.64

Fig.1 Photograph of an FC2306K chip

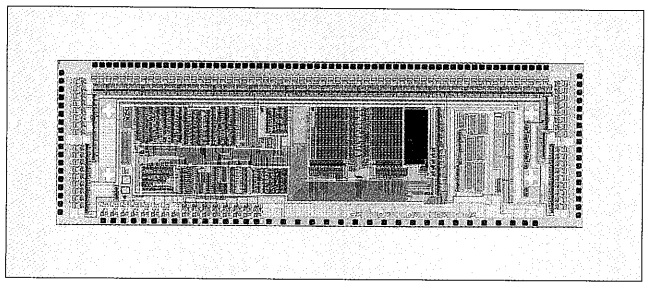


Fig.2 Photograph of an FCS2314AK chip

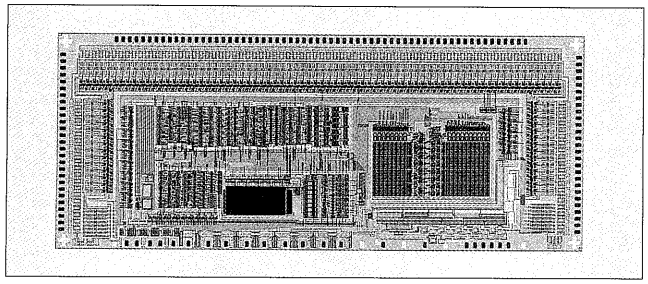


Fig.3 Photograph of an FC2316K chip

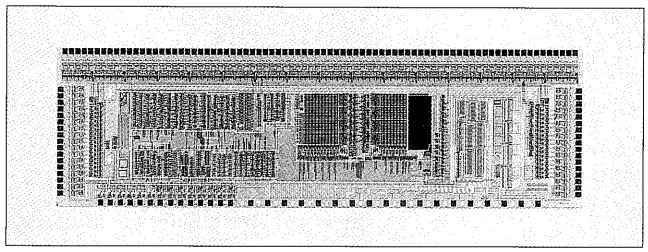


Fig.4 FCS2314AK application block diagram

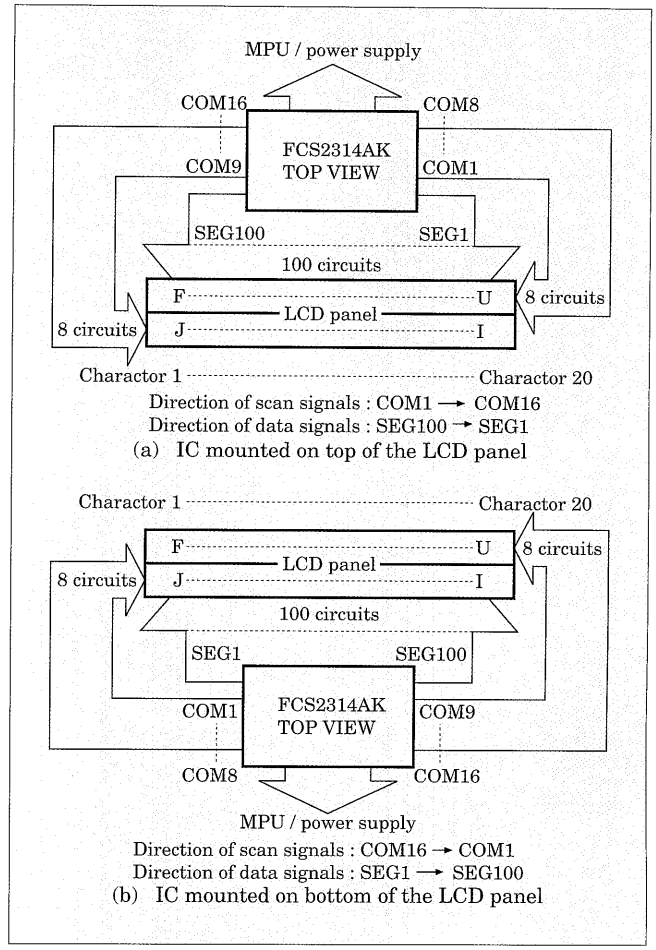


Fig.5 FCS2326K block diagram

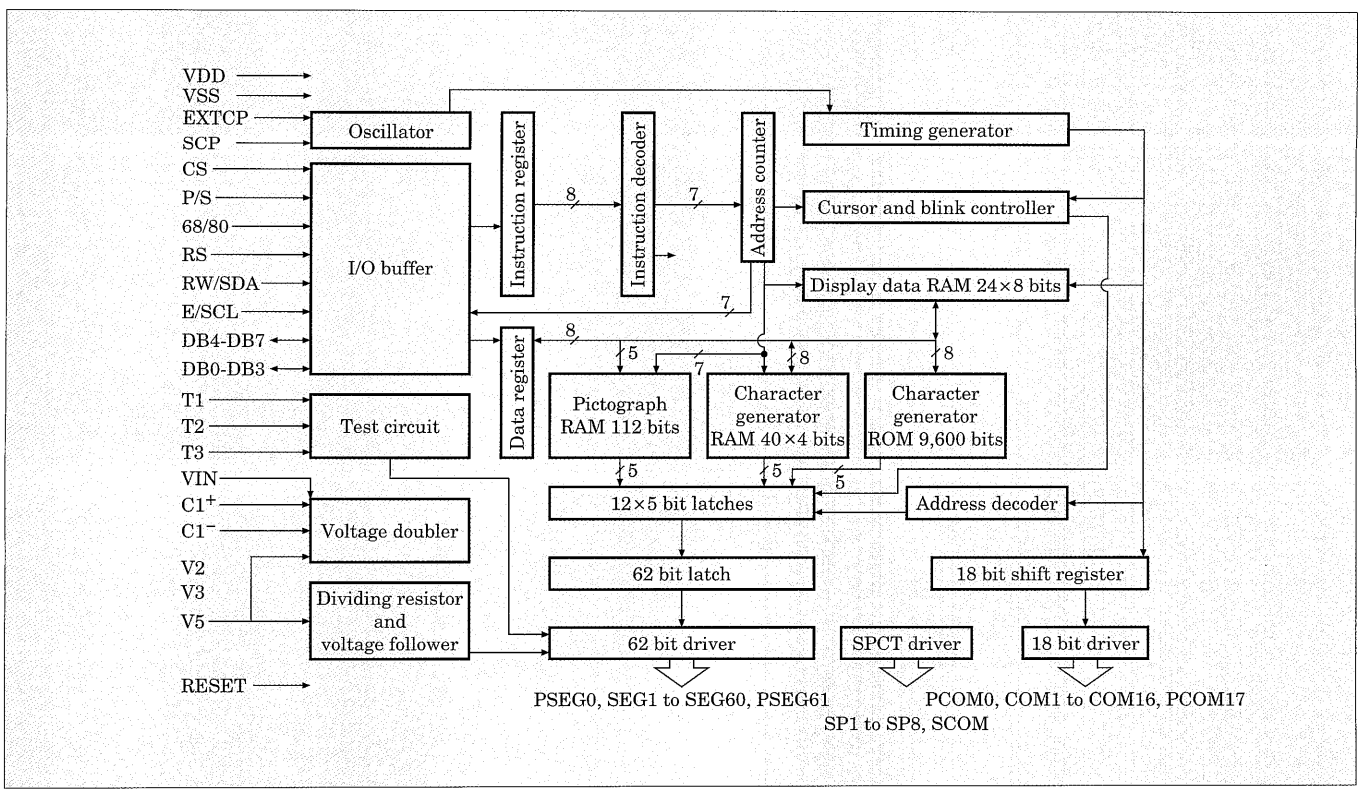


Fig.6 Dividing resistor circuits to drive LCD

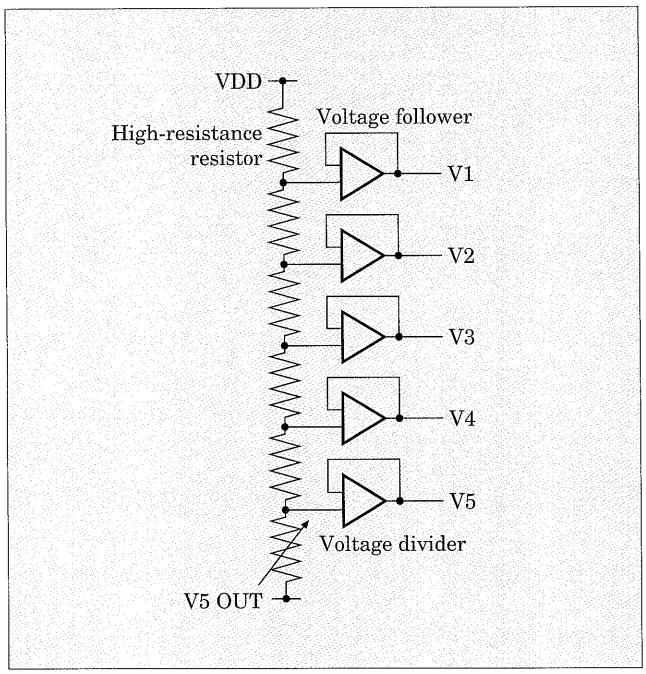
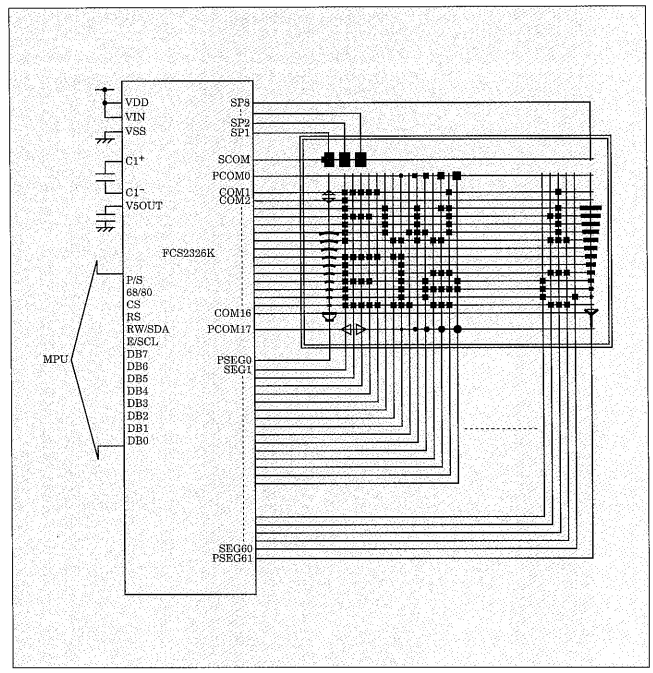


Fig.7 FCS2326K application block diagram



characters to be displayed per row. A 5-V system is specified for the power supply voltage.

The other devices were developed as LCD panel ICs for portable information devices such as portable telephones, personal handy phone systems (PHSs), and beepers. These ICs are designed to be powered by 3-V systems to meet requirements for battery applications. Each device incorporates a voltage doubler to generate the necessary voltage to drive an LCD, thus reducing the need for external power supply circuits.

2.1.1 Methods of low power consumption

The devices for portable information apparatus are provided with a standby mode that reduces power consumption when the display is off by cutting off the current to the dividing resistor circuit that drives the LCD.

The "FCS2326K" (under development) is being designed with the following features to further reduce power consumption.

(1) Low oscillator frequency
(2) Built-in power supply circuit for the voltage follower
(3) Addition of a sleep mode to stop oscillating operation during standby

2.1.2 Reduction of mounting area

(1) The common/segment (COM/SEG) driver circuits are changed to bidirectional circuits. As shown in Fig. 4, even when the mounting position of the IC on the LCD panel is changed, normal display can be attained, thereby enhancing the ease of substrate mounting.
(2) High density mounting is achieved with the construction of gold bump electrodes that enable chip on glass (COG) and tape-automated bonding (TAB) mounting.
(3) Dimensions are changed to increase the length-to-width ratio of the chip and to decrease the mounting area that is not part of the display.

2.1.3 Icon display function

Newly provided is the icon display function which can be controlled independently of the character display and used to indicate whether the battery of a portable telephone is dead, etc. The "FCS2326K" is provided with an 8-bit driver for the exclusive use of displaying icons even when the character display is off in the standby mode. The "FCS2326K" has a low power consumption and is easy to use.

2.2 Circuitry configuration

The block diagram of the "FCS2326K", a typical example of an LCD controller driver IC, is shown in Fig. 5.

This IC is composed of control circuits that interface with the MPU to control the display modes or data, and drivers that drive the LCD panel.

As shown in Fig. 6, the dividing resistor circuit to drive an LCD composed of voltage followers to convert the impedance of the voltages divided by the high-resistance resistors and a 4-bit voltage divider to adjust the display contrast.

2.3 Application example

An application example of an LCD panel displaying 12 characters in 2 rows using the "FCS2326K" is shown in Fig. 7.

Because the dividing resistor circuit that powers the LCD and the voltage divider that adjusts the display contrast are built-in, a single external power

supply and external capacitor can generate the required driver voltages with the built-in voltage doubler and can operate the LCD panel display.

The icon display can be controlled independently of the character display. Icons can be displayed to the top, bottom, right, or left of the character display.

3. Conclusion

This paper presented an outline of five character-display-type, small LCD panel controller driver ICs, one group of Fuji Electric's ICs for use with LCDs.

The LCD is predicted to meet the requirements for diversified operating environments and multimedia, and expand the range of its applications in the future. This will be accompanied by demands for lower power consumption, more advanced functions and lower prices.

Fuji Electric will continue to develop ICs for use with LCDs that meet these market needs.