

IC FOR LIQUID CRYSTAL DISPLAY

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1. FOREWORD

Accompanying the growth and popularity of information equipment, the role of the electronic display as a man-machine interface is becoming increasingly larger in many field, from public to industrial. Of these, thanks to its small size, light weight, thinness, low power consumption, and other advantages, the liquid display market has expanded based on a noticeable technological revolution. In the word processor and personal computer fields, it is already replacing the CRT.

Fuji Electric was quick to commercialize an IC for liquid crystal display matched to market needs based on high voltage technology and bump technology. From their application and circuit architecture, these ICs can be divided into three groups as shown in *Table 1*. This article outlines typical general-purpose liquid crystal display IC from each group.

2. CONTROLLER DRIVER IC FOR SMALL SIZE STN LCD PANEL

Accompanying the increase in the demand for character display type small size STN LCD panels as the display device of telephones, facsimile, copy machines, etc. and the rise in the volume of information, the trend toward a greater number of display digits has become stronger. Fuji Electric developed the FC2258K/A controller driver IC for small size STN LCD panel which allows construction of a single-chip 16 columns \times 2 rows display liquid crystal panel without external parts matched to these market needs. This IC is outlined below.

2.1 Features

This IC is a controller driver IC for STN LCD panel which displays alphanumeric, kana-characters, symbols, etc. under the control of a 4-bit or 8-bit MPU. This IC features an on-chip 80-bit SEG driver circuit. An on-chip oscillation resistance circuit and power supply division resistance circuit for liquid crystal drive also allow configuration of a 16 columns \times 2 rows LCD panel without external circuit parts.

Compatibility with large screen display by using an AC

Table 1 Classification of IC for LCD panel

IC function	IC mounted panel application example
Controller driver for small size STN LCD panel	Telephone, facsimile
Driver for active matrix LCD panel	Word processor, personal computer
Driver for active matrix LCD panel	Liquid crystal television, projector

Table 2 Characteristics of FC2258K/A

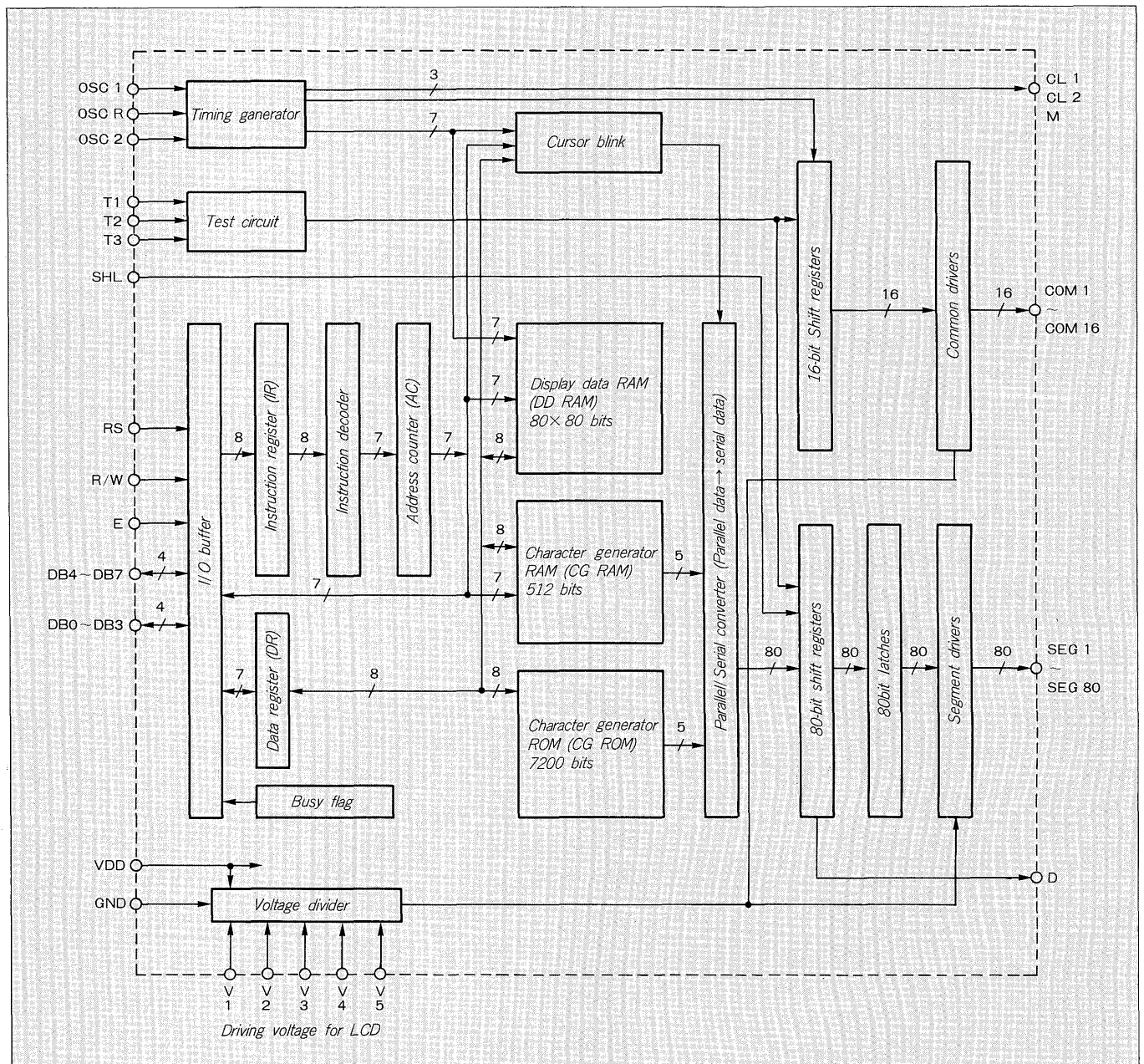
Display capacity	16 columns \times 2 rows (maximum 40 columns \times 2 rows: when FC2257K/A used)
Duty	1/8, 1/11, 1/16 [bias: 1/5, 1/4 (V ₂ , V ₃ connected)]
Output circuit	SEG : 80 bits (bi-directional) COM: 16 bits
DD RAM	80 \times 8 bits/maximum 80 characters)
CG ROM	7,200 bits 5 \times 7 dots: 160 kinds/5 \times 10 dots: 32 kinds
CG RAM	64 \times 8 bits 5 \times 7 dots: 8 kinds/5 \times 10 dots: 4 kinds
Driving frame	Between 2 frames
Instructions	11 kinds
E_{cycle}	1 MHz
V_{DD}	5.0 \pm 0.5V
V_{LCD}	3.0~11.0V
f_{OSC}	350kHz \pm 20% (on-chip resistor), external also possible
R_{VLCD}	2.2k Ω typ. \times 5 (V ₁ - V ₅)
Process	Si gate CMOS
Assembly	Au bump: FC2258K, Al pad: FC2258A, QFP: FD2258F

method between two frames and improvement of the LCD panel substrate design margin by making bi-directional data transfer possible by the SEG shift register circuit are also realized. The main characteristics of this IC are shown in *Table 2*.

2.2 Circuit architecture

As shown in *Fig. 1*, this IC consists of control circuit, which controls the various display modes or display data by means of an interface with the MPU and a driver circuit,

Fig. 1 FC2258K/A circuit diagram



which drives the LCD panel.

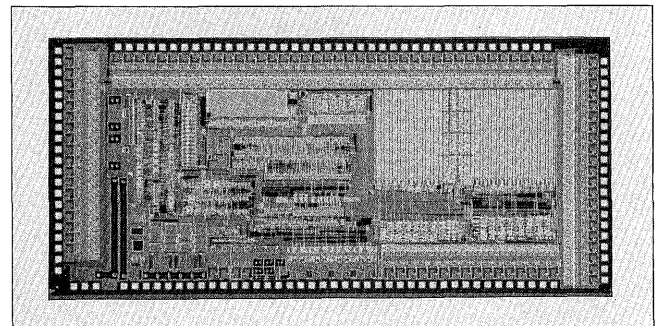
This IC also realizes shrinking of the chip size and low power consumption by application of the Si gate CMOS process. A chip photograph of this IC is shown in Fig. 2.

2.3 Electrodes

This IC is serialized as the FC2258K with an Au bump electrode construction for TAB mounting which can cope with miniaturization and thinning of the LCD panel and the FC2258A with Al pad electrode construction for COB mounting.

The FD2258F with FC2258A assembled on a 128-pin shrink QFP is also available and a product series compatible with various mounting modes is realized.

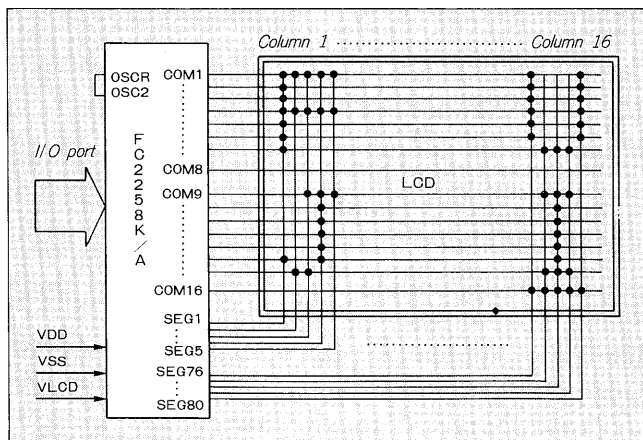
Fig. 2 FC2258K chip photograph



2.4 Application example

An application example of the FC2258K/A to a 16

Fig. 3 FC2258K/A application example



columns \times 2 rows LCD panel is shown in Fig. 3. A built-in CR oscillator and building in LCD drive voltage divider allow the construction of a compact panel without external circuit parts.

3. DRIVER IC FOR LARGE SIZE STN LCD PANEL

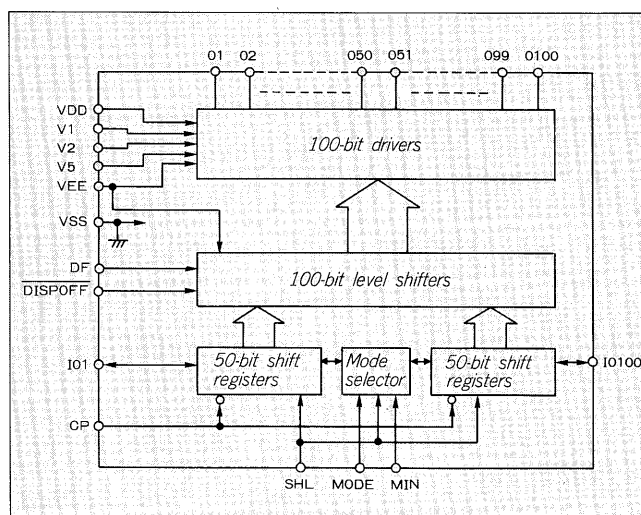
A large size STN LCD panel displays data by controlling a liquid crystal provided at each pixel by time division drive, and to drive a vertical 640 lines, horizontal 480 lines large LCD panel, a higher drive voltage and faster data transfer rate are necessary. Fuji Electric has developed a common driver IC for scan electrode drive and segment driver IC for signal electrode drive capable of up to 1/240 duty drive for large size matrixes. The features and application examples of this driver IC are described below.

3.1 Common driver (FC2261K)

This IC consists of bi-directional shift register, level shifter, and driver circuits as shown in Fig. 4.

The internal circuit is 50 bits \times 2 and five IC can drive a horizontal 480 lines large LCD panel divided into two

Fig. 4 FC2261K block diagram



parts at a 1/240 duty by providing independent carry inputs and their control pins.

The main characteristics of this IC are shown in Table 3. A data shift clock frequency of 1MHz and LCD drive voltage of 28V are realized.

A chip photograph of this IC is shown in Fig. 5. To realize high density packing, Au bump electrodes are provided and the chip is miniaturized.

Table 3 Characteristics of Driver IC for large size STN LCD panel

Function	Common	Segment
Type	FC2261K	FC2262K
Output circuit	100	80
LCD driving voltage	28V	28V
Output resistance	1 k Ω	1 k Ω
Clock frequency	1 MHz	8 MHz

Fig. 5 FC2261K chip photograph

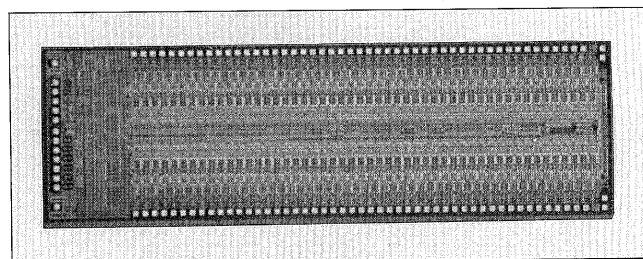


Fig. 6 FC2262K block diagram

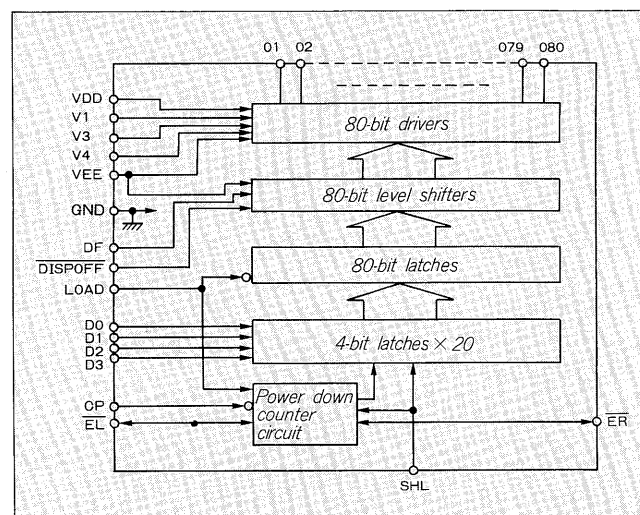


Fig. 7 FC2262K chip photograph

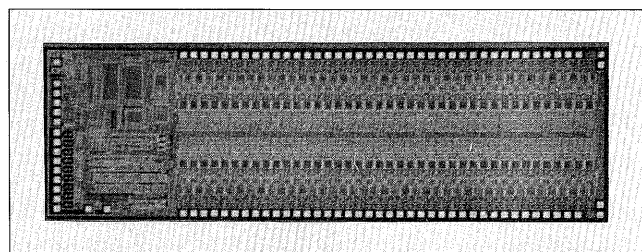


Fig. 8 Application example of driver IC for large size STN LCD panel

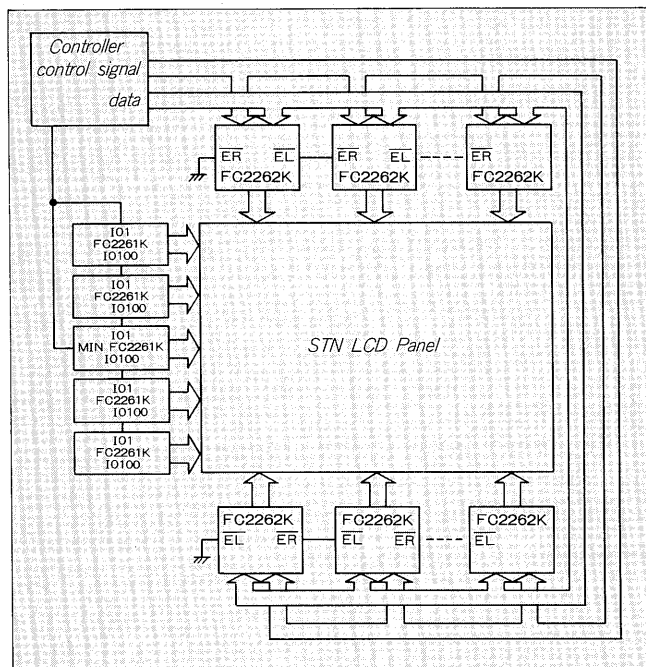
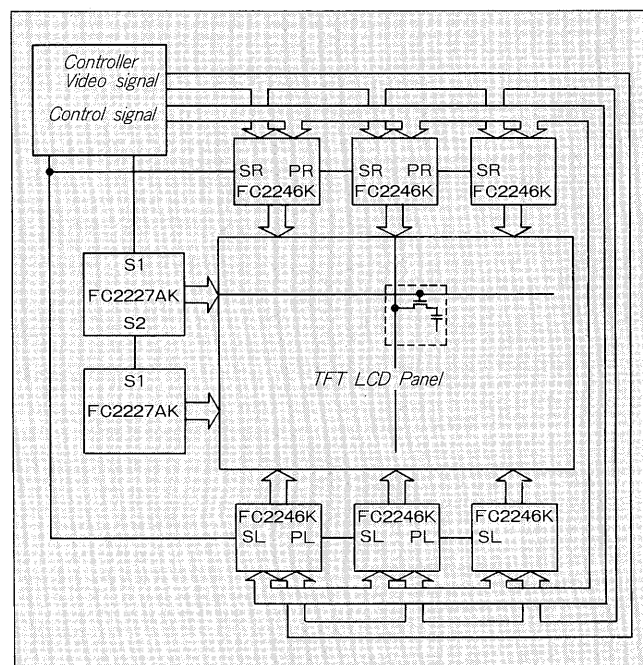


Fig. 9 Application example of driver IC for TFT LCD panel



3.2 Segment driver IC (FC2262K)

This IC consists of a counter, latch, level shift, and driver circuits, as shown in Fig. 6.

The data input is made a 4-bit parallel transfer type and high-speed data transfer is realized. A power down counter is also built in and since an enable chain can be built, a substantial power reduction is possible when many chips are connected in cascade.

The main characteristics of this IC are shown in Table 3. A data shift clock of 8MHz and LCD drive voltage of 28V are realized.

A chip photograph of this IC is shown in Fig. 7. A high-speed logic circuit and high-voltage output are realized on the same chip.

3.3 Application example

An application example of large size matrix driver IC introduced above is shown in Fig. 8. With a 640×480 dots panel, the panel is divided into two parts, top and bottom, and is driven at 1/240 duty by using five FC2261K and 16 FC2262K.

Fuji Electric is also developing a higher voltage large size matrix driver IC capable of 1/480 duty drive so that the same panel can be drive by a smaller IC.

4. DRIVER IC FOR ACTIVE MATRIX LCD PANEL

Since static drive is possible and a picture with little crosstalk is obtained by arranging TFT and other dynamic devices and hold capacitors for each pixel as shown in Fig. 9, the active matrix LCD panel is used in many liquid crystal television sets, etc. A high voltage scan driver which controls the TFT gate and a high-speed data driver to write

Fig. 10 FC227AK block diagram

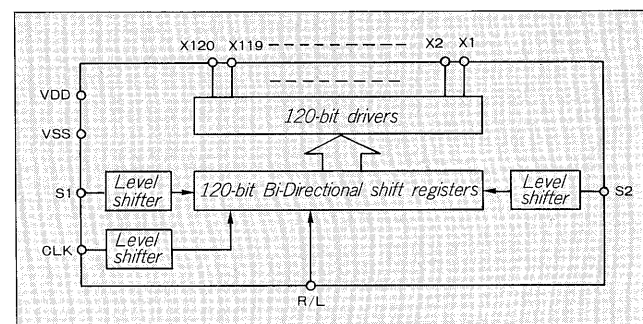


Fig. 11 FC227AK chip photograph

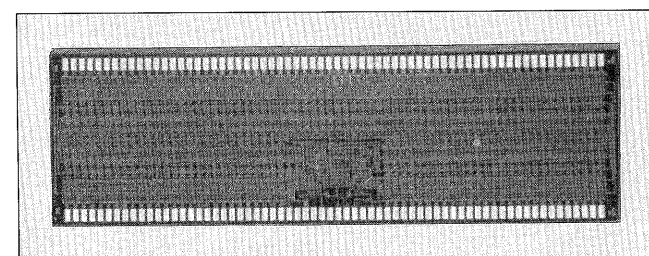
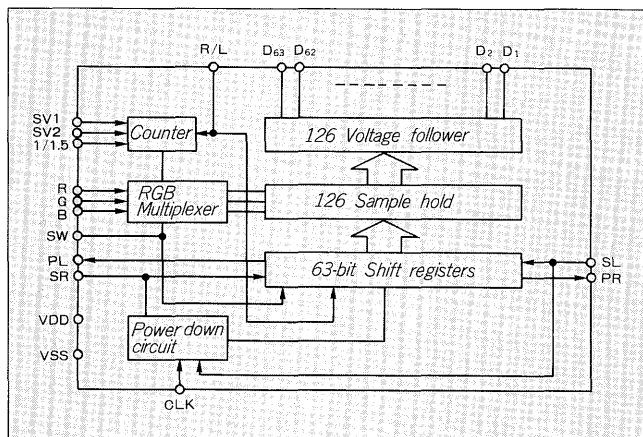


Table 4 Characteristics of driver IC for active matrix LCD panel

Function	Scan driver	Data driver
Type	FC2227AK	FC2246K
Output circuit	120	63
LCD driver voltage	25V	5V
Output current	2.8mA	50 μA
Clock frequency	100KHz	4.5MHz
Output voltage deviation	—	±50mV

Fig. 12 FC2246K block diagram



the video signal to the hold capacitor are necessary for driver IC.

Fuji Electric has developed a scan driver and data driver capable of driving a 3-4 inches TFT. The features and application examples of these driver IC are described below.

4.1 Scan driver IC (FC2227AK)

This IC consists of level shift circuits, bi-directional shift register, and driver circuit as shown in Fig. 10. The logic system 5V power supply pin is omitted and packing restrictions are reduced by providing a level shift circuit at the first stage of the input.

The main characteristics of this IC are shown in Table 4. This IC has 120 lines LCD drive output and realizes a data shift clock frequency of 100Hz and LCD drive voltage of 25V.

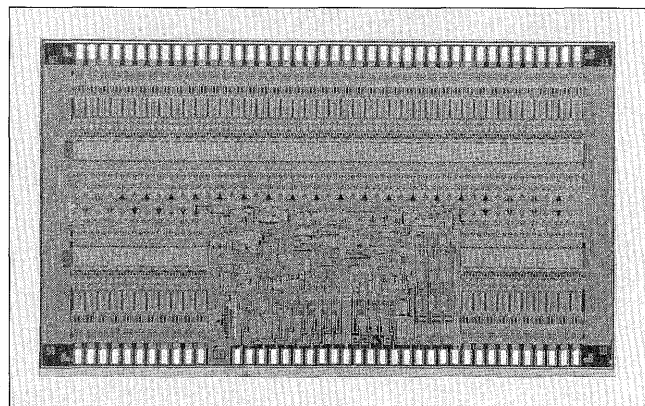
A chip photograph of this IC is shown in Fig. 11. Au bump electrodes are provided for high density packing. The IC mounting section around the LCD panel can be made narrow by concentrating the input pins at the long side of the chip.

4.2 Data driver IC (FC2246K)

This IC consists of shift register, sample hold, voltage follower, RGB multiplexer, and power down circuits as shown in Fig. 12.

The output signal deviation is reduced by using two voltage followers per output. By building in an RGB multiplexer, application to stripe, mosaic, and delta color filter arrangements is possible. Since an enable chain can be formed by building in a power down circuit, the power

Fig. 13 FC2246K chip package



consumption of the set can be reduced.

Since the sampling pulse phase can be shifted one half cycle, sampling of double the clock rate can be realized.

The main characteristics of this IC are shown in Table 4. This IC has 63 LCD drive outputs and realizes a data shift clock frequency of 4.5MHz and LCD drive voltage of 5V and an output signal deviation of $\pm 50\text{mV}$.

A chip photograph of this IC is shown in Fig. 13. It has the same electrode construction and layout as the scan driver IC.

4.3 Application example

An application example of the drive IC for active matrix LCD panel introduced above is shown in Fig. 9. For a 378×240 dots panel, two FC2227AK and six FC2246K are used and the panel is divided into two parts, top and bottom and driven and a sampling rate of double the clock rate is obtained.

Fuji Electric is developing a higher speed data driver which drives a large 10 inches class TFT LCD panel.

5. CONCLUSION

Three fields and five types from among Fuji Electric's IC for liquid crystal display were introduced above. Fuji Electric has also started production of products in the TAB state, in addition to the chips with bump described above.

The fields in which the liquid crystal display is used is expected to expand with the advance of the technological revolution oriented toward larger screens and higher display quality.

Fuji Electric plans to promote development of special IC matched to market needs in such a flow in the future.