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IC FOR LED PRINT HEAD DRIVERS

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1. FOREWORD

The rapid development and popularity of the personal computer, word processor, and other electronic information equipment is continuing and various methods are also being practicalized for the printer, which is the output device, to meet market needs.

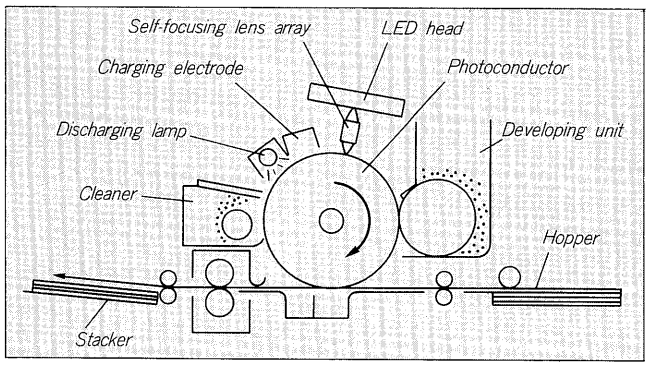
Of these, the electrophotographic optical printer has such features as high printing quality, high speed, and low noise and its market has expanded steadily in recent years and lower price and higher speed are desired. The IC for LED (Light Emitting Diode) printer head drive which is one type of optical printer was developed by Fuji Electric by using high quality and high reliability CMOS process technology and MOS analog circuit technology. It is introduced below.

2. LED PRINTER

An electrophotographic printer using an LED has been studied from times past, but its development has become active in step with improvement of LED production technology and the development of more sensitive photoconductors and similar technologies in recent years. The LED printer uses the same electrophotographic technology as an plain paper copier as shown in *Fig. 1*. Its printing process is described below.

(1) A uniform electric charge is given to a photoconductor.
(2) The LED light is focused onto the photoconductor through a self-focusing lens array.

Fig. 1 LED printer composition



(3) An electrostatic image is formed at the part exposed to the LED light.
(4) Toner sticks to the image and is transferred to the recording paper.
(5) The toner transferred to the recording paper is fixed.
(6) The residual toner on the photoconductor is cleaned.
(7) The residual charge is discharged.

The special feature of the LED printer over the laser printer, which is also an electrophotographic type printer, is that the LED, which is the light source, is solid-state and since there are no mechanical scanning parts and a complex optical system is unnecessary, maintenance is easy. Moreover, since the optical path is short, the device can be made small.

3. IC FOR LED PRINT HEAD DRIVERS

This IC is used at the print head of an LED printer and directly drives the LED that writes the data onto the photoconductor by light.

It is designed to allow reduction of external parts and high-speed operation and can be used in a wide range of applications, from inexpensive devices for OA to high-speed devices for large computers.

3.1 Features

The main features of this IC are:

(1) High-speed operation by CMOS silicon gate process
(2) 64-pin constant current output.
(3) Output current can be controlled by external resistor.
(4) Data transfer direction can be switched.
(5) Built-in LED temperature compensation circuit.
(6) Serial cascade connection possible.
(7) High density packing correspondence (400 DPI).

3.2 Composition

The circuit block diagram of this IC is shown in *Fig. 2*. The functions of the main blocks are:

(1) 64-bit bi-directional shift register

This register converts the serial input data from the outside to parallel data and outputs serial data to cascade connected IC. The data transfer direction can also be switched by direction switching signal.

Fig. 2 Block diagram

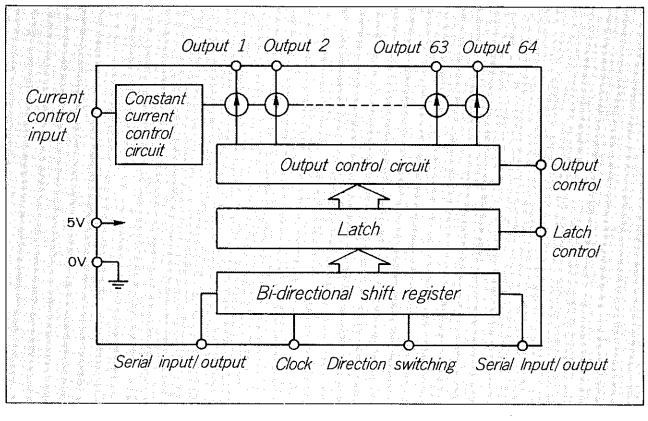


Fig. 3 Shift register output waveforms

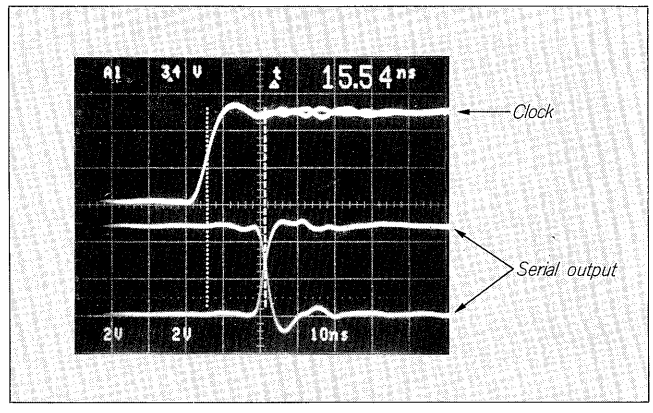


Table 1 Absolute maximum ratings (T_a = 25° C)

Item	Symbol	Rating	Units
Supply voltage 1	V_{DD1}	6.0	V
Supply voltage 2	V_{DD2}	6.0	V
Input voltage	V_I	$-0.3 \sim V_{DD1}+0.3$	V
Output voltage (logic)	V_O	$-0.3 \sim V_{DD1}+0.3$	V
Output voltage (output 1-64)	V_{OD}	$-0.3 \sim V_{DD2}$	V
Output current	I_O	10	mA
Operating temperature range	T_{opr}	−20~70	°C
Storage temperature range	T_{stg}	−40~125	°C

Fig. 4 Output section operation waveforms

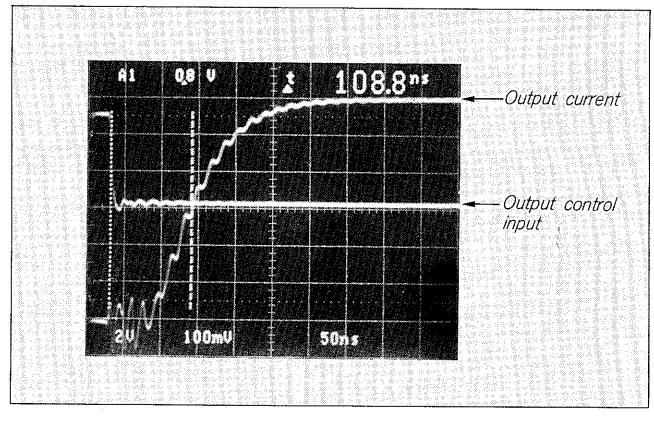


Table 2 Electrical characteristics (T_a = 25° C)

	Item	Standard characteristic	Units	Remarks
Logic section	Supply current	4	mA	f_{CLK}=10MHz
	Input leak current	10	μA	
	Input voltage	V_{IH}=3.5, V_{IL}=1.5	V	CMOS level
	Maximum frequency	10	MHz	
	Propagation delay	80	ns	CLK reference
Output section	Number of output	64		
	Breakdown voltage	5	V	
	Output current variation width	3~8	mA	
	Propagation delay	100	ns	
	Output current variation	±10	%	Output 1~ Output 64
Operating temperature range		−20~+70	°C	

(2) 64-bit latch

The parallel data converted by the shift register is held in this circuit by means of a latch control signal.

(3) Output control circuit

This circuit turns the output current on and off by means of an output control signal. Signal input pins for three systems are provided. Output control in 32-bit units is possible.

(4) 64-bit constant current output circuit

The LED is driven directly by a constant current. Therefore, an LED current limiting resistor is unnecessary.

(5) Constant current control circuit

This circuit controls the current value of the constant current output circuit. The current value can be arbitrarily set with the resistance value of an external resistor which is connected to the current setting pin. An LED light intensity temperature compensation circuit is also built-in and a drop of the light output by heat generate in head and printer mainframe is prevented.

3.3 Main characteristics

The absolute maximum ratings of this IC are shown in *Table 1* and its main electrical characteristics are shown in *Table 2*.

By using a 2 μm CMOS silicon gate process, a shift register propagation delay of 15 ns and output propagation delay of 100 ns were realized as shown by the shift register output waveforms of *Fig. 3* and output section operation waveforms of *Fig. 4*. Higher speed can be obtained by improvement the peripheral circuit.

Concerning the constant current output circuit, which is one of the special features of this IC, high accuracy is

Fig. 5 Output characteristics

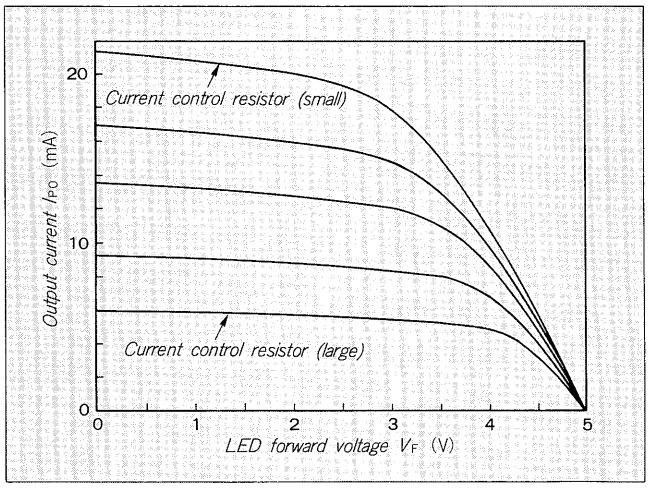
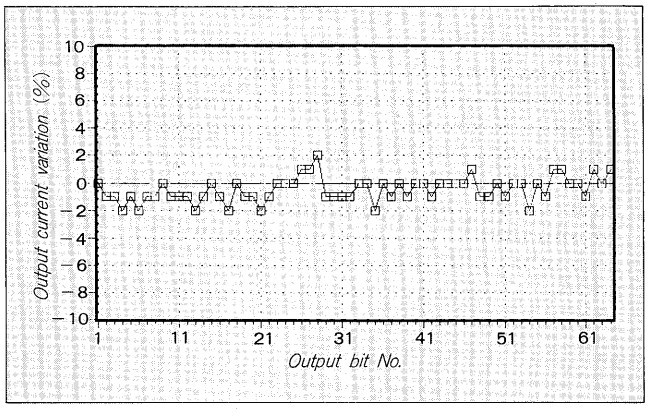
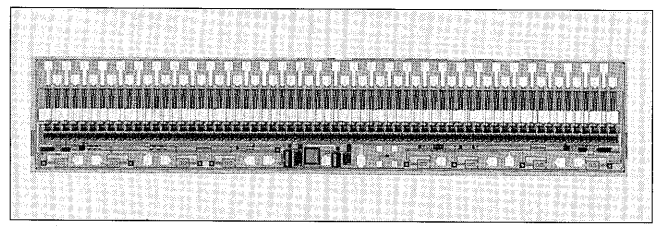


Fig. 6 Output current variation of each output bit



demanded to improve printing quality of the printer. To realize this, various conditions were optimized in MOS analog circuit design, wafer process conditions, the mask design. The output characteristics are shown in *Fig. 5*. A constant current characteristic is realized at 0 to 3 V, which exceeds the forward voltage drop range of the LED. The output current variation of each output bit is shown in *Fig. 6*. This variation is distributed within approximately 2% and sufficient accuracy is realized even for a plotter, which demands high accuracy, in addition to printer application.

Fig. 7 IC chip photograph



3.4 High density packing

With an LED printer, high printing quality is realized by arranging many LEDs at a high density. This IC is designed for 400 DPI, which is considered to become the mainstream of the future. The size and pitch of the IC electrodes were selected to allow both wire bonding and TAB (Tape Automated Bonding).

A chip photograph of the IC developed this time is shown in *Fig. 7*.

4. CONCLUSION

The IC for LED print head drivers was introduced above. We think that a high cost-performance printer can be realized by using this product. The speed and printing quality of the LED printer will increase in the future and it is expected to be used in the graphic printer, plotter, and other new fields.

Fuji Electric plans to promote development of products matched to these market needs in the future.