

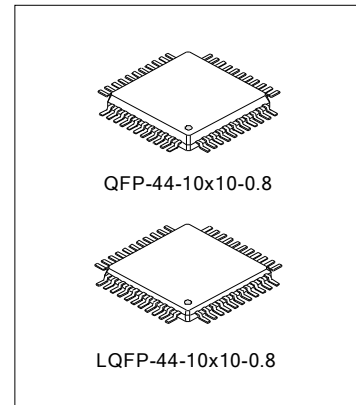
VFD CONTROLLER/DRIVER OF 1/4 ~1/11 DUTY

DESCRIPTION

The SC16312 is a FIP (Fluorescent Indicator Panel, or Vacuum Fluorescent Display) controller/driver, and its duty is 1/4 or 1/11. It includes 11 segment output lines, 6 grid output lines, 5 segment/grid output drive lines, a display memory, a control circuit, and a key scan circuit. Serial data is input to the SC16312 through a three-line serial interface. This FIP controller/driver is ideal as a peripheral device for a single-chip microcomputer.

FEATURES

- * Multiple display modes
- * Key scanning (6x4 matrix).
- * Dimming circuit (eight steps).
- * High-voltage output (VDD – 35V max).
- * LED ports (4 chs., 20 mA max).
- * General-purpose input port (4 bits)
- * No external resistors necessary for driver outputs (P-ch open-drain + pull-down resistor output)
- * Serial interface (CLK, STB, DIN, DOUT)



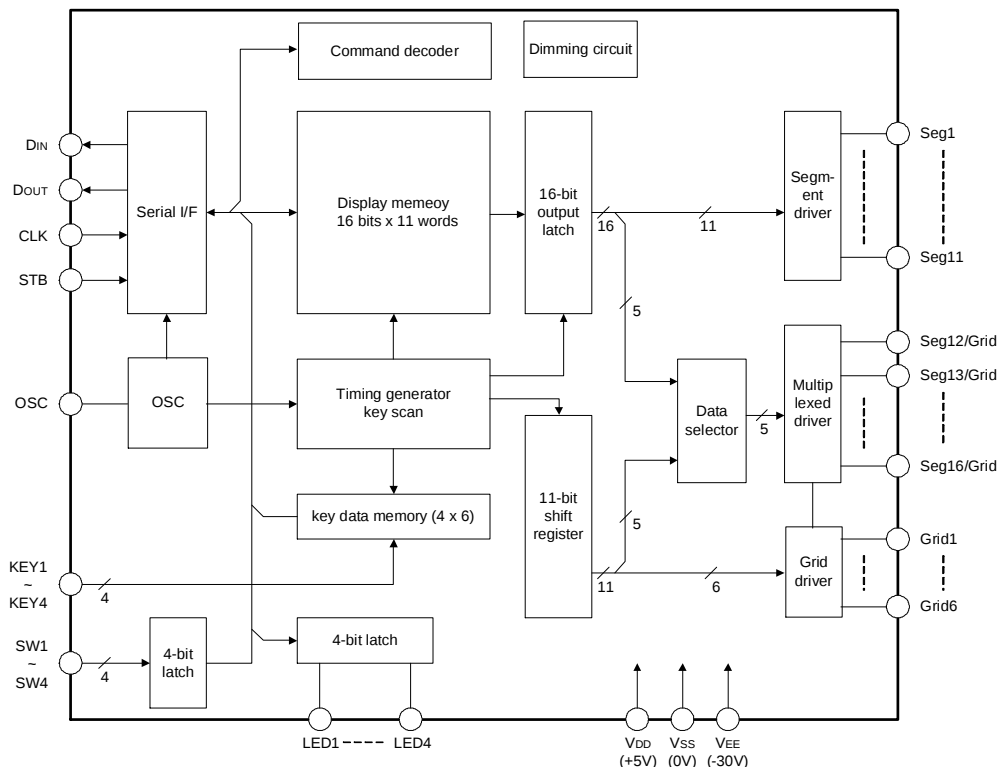
ORDERING INFORMATION

Device	Package
SC16312	QFP-44-10X10-0.8
SC16312L	LQFP-44-10X10-0.8

APPLICATIONS

- * Suitable for telephone, VCD and etc. multiple LCD driver and controller.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING ($T_{amb}=25^{\circ}\text{C}$, $V_{SS}=0\text{V}$)

Characteristics	Symbol	Value	Unit
Logic Supply Voltage	V_{DD}	-0.5 ~ 7.0	V
Driver Supply Voltage	V_{EE}	$V_{DD} + 0.5 \sim V_{DD} - 40$	V
Logic Input Voltage	V_{I1}	-0.5 ~ $V_{DD} + 0.5$	V
FIP Driver Output Voltage	V_{O2}	$V_{EE} - 0.5 \sim V_{DD} + 0.5$	V
LED Driver Output Current	I_{O1}	+25	mA
FIP Driver Output Current	I_{O2}	-40 (grid) ; -15 (segment)	mA
Power Dissipation	P_D	800 *	mW
Storage temperature	T_{stg}	-65 ~ +150	$^{\circ}\text{C}$
Operating Ambient Temperature	T_{opr}	-40 ~ + 85	$^{\circ}\text{C}$

* Note: Derate at $-6.4 \text{ mW}/^{\circ}\text{C}$ at $T_{amb}=25^{\circ}\text{C}$ or higher

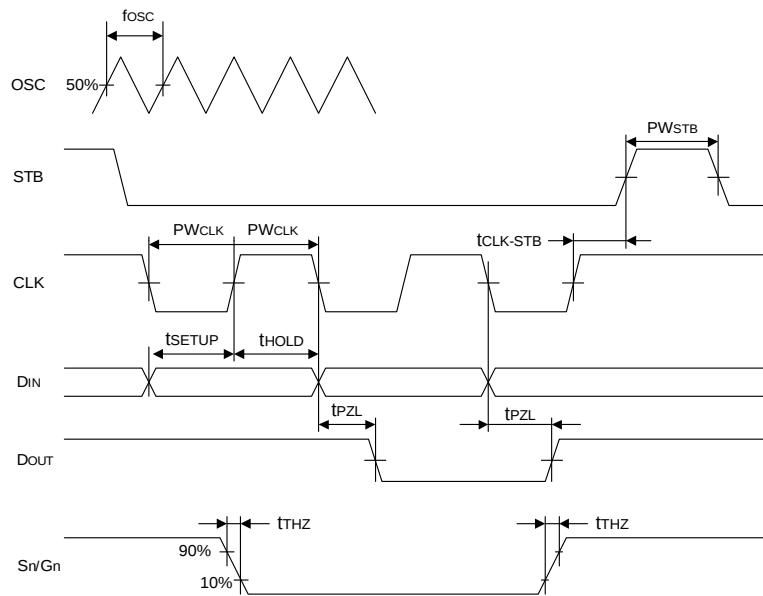
ELECTRICAL CHARACTERISTICS ($T_{amb}=-20 \sim 70^{\circ}\text{C}$, $V_{DD}=3.3 \sim 5.5\text{V}$, $V_{EE}=V_{DD}-30\text{V}$)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Logic Supply Voltage	V_{DD}		3.3	5	5.5	V
Driver Supply Voltage	V_{EE}		0	--	$V_{DD}-35$	V
High-Level Output Voltage	V_{OH1}	LED1- LED4, $I_{OH1}=-1\text{mA}$	$0.9V_{DD}$	--	--	V
Low -Level Output Voltage	V_{OL1}	LED1- LED4, $I_{OL1}=20\text{mA}$	--	--	1	V
Low -Level Output Voltage	V_{OL2}	DOUT, $I_{OL2}=4\text{mA}$	--	--	0.4	V
High-Level Output Current	I_{OH21}	$V_O=V_{DD}-2\text{V}$, Seg1 to Seg11	-3	--	--	mA
High-Level Output Current	I_{OH22}	$V_O=V_{DD}-2\text{V}$, Grid1 to Grid6 Seg12/Grid11 to Seg16/Grid7	-15	--	--	mA
Driver Leakage Current	I_{OLEAK}	$V_O=V_{DD}-35\text{V}$, driver off	--	--	-10	μA
Output Pull-Down Resistor	R_L	Driver output	50	100	150	$\text{k}\Omega$
Input Current	I_I	$V_I=V_{DD}$ or V_{SS}	--	--	± 1	μA
High-Level Input Voltage	V_{IH}	--	$0.7V_{DD}$	--	--	V
Low-Level Input Voltage	V_{IL}	--	--	--	$0.3V_{DD}$	V
Hysteresis voltage	V_H	CLK, DIN, STB	--	0.35	--	V
Dynamic Current Consumption	I_{DDdyn}	Under no load, display off	--	--	5	mA

SWITCHING CHARACTERISTICS ($T_{amb} = -20 \sim 70\text{ }^{\circ}\text{C}$, $V_{DD} = 3.3 \sim 5.5\text{V}$, $V_{EE} = V_{DD} - 30\text{V}$)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Oscillation Frequency	tOSC	R=51k Ω	350	500	650	kHz
Propagation Delay Time	tPLZ	CLK $\rightarrow$ DOUT	--	--	300	ns
	tPZL	CL=15pF, RL=10k Ω	--	--	100	ns
Rise Time	tTZH1	CL=300pF	--	--	2	μs
	tTZH2					
Fall Time	tTHZ	CL=300pF, Segn, Gridn	--	--	120	μs
Maximum Clock Frequency	fmax.	Duty=50%	1	--	--	MHz
Input Capacitance	CI	--	--	--	15	pF

SWITCHING CHARACTERISTIC WAVEFORMS

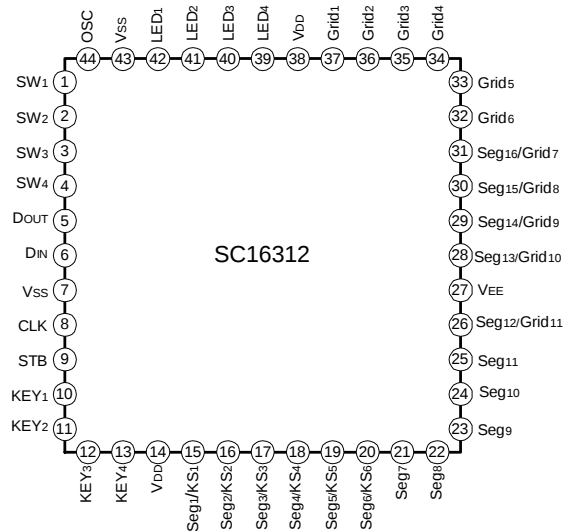


TIMING CONDITIONS ($T_{amb} = -20 \sim 70\text{ }^{\circ}\text{C}$, $V_{DD} = 3.3 \sim 5.5\text{V}$)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Clock Pulse Width	PWCLK	--	400	--	--	ns
Strobe Pulse Width	PWSTB	--	1	--	--	μs
Data Setup Time	tSETUP	--	100	--	--	ns
Data Hold Time	tHOLD	--	100	--	--	ns
Clock-Strobe Time	tCLK-STB	CLK $\uparrow \rightarrow$ STB $\uparrow$	1	--	--	μs
Wait Time	tWAT	CLK $\uparrow \rightarrow$ CLK $\downarrow$ ^{Note}	1	--	--	μs

Note: When data is read, a wait time tWAIT of 1 μs is necessary since the rising of the eighth clock that has set the command, until the falling of the first clock that has read the data.

PIN CONFIGURATION



PIN DESCRIPTION

Pin No.	Symbol	Description
6	DIN	Data input, Input serial data at rising edge of shift clock, starting from the low order bit.
5	DOUT	Data output, Output serial data at the falling edge of the shift clock, starting from low order bit. This is N-ch open-drain output pin.
9	STB	Strobe, Initializes serial interface at the rising or falling edge of the SC16312. It then waits for reception of a command. Data input after STB has fallen is processed as a command. While command data is processed, current processing is stopped, and the serial interface is initialized. While STB is high, CLK is ignored.
8	CLK	Clock input, Reads serial data at the rising edge, and outputs data at the falling edge.
44	OSC	Oscillator pin, Connect resistor to this pin to determine the oscillation frequency to this pin.
15 ~ 20	Seg1/KS1~ Seg6/KS6	High-voltage output, Segment output pins (Dual function as key source).
21 ~ 25	Seg7~ Seg11	High-voltage output (segment), Segment output pins.
37 ~ 32	Grid1 ~Grid6	High-voltage output (grid), Grid output pins.
26,28 ~ 31	Seg12/Grid11 ~Seg16/Grid7	High-voltage output (segment/grid), These pins are selectable for segment or grid driving.
42 ~ 39	LED1 ~ LED4	LED output, CMOS output. +20mA max.
10 ~ 13	KEY1~ KEY4	Key data input, Data input to these pins is latched at the end of the display cycle.
1 ~ 4	SW1 ~ SW4	Switch input, These pins constitute a 4-bit general-purpose input port.
14,38	VDD	Logic power, 5 V $\pm$ 10%
7,43	VSS	Logic ground, Connect this pin to system GND.
27	VEE	Pull-down level, VDD-35V max.

FUNCTIONAL DESCRIPTION

1. DISPLAY RAM ADDRESS AND DISPLAY MODE

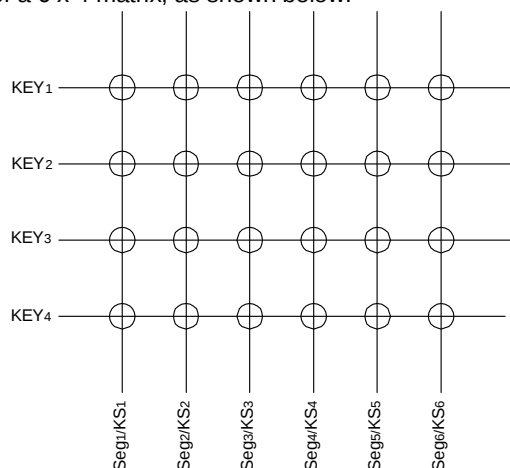
The display RAM stores the data transmitted from an external device to the SC16312 through the serial interface, and is assigned addresses as follows, in 8 bits unit:

Seg1	Seg4	Seg8	Seg12	Seg16	
00HL	00HU	01HL	01HU		DIG1
02HL	02HU	03HL	03HU		DIG2
04HL	04HU	05HL	05HU		DIG3
06HL	06HU	07HL	07HU		DIG4
08HL	08HU	09HL	09HU		DIG5
0AHL	0AHU	0BHL	0BHU		DIG6
0CHL	0CHU	0DHL	0DHU		DIG7
0EHL	0EHU	0FHL	0FHU		DIG8
10HL	10HU	11HL	11HU		DIG9
12HL	12HU	13HL	13HU		DIG10
14HL	14HU	15HL	15HU		DIG11

b0	b3	b4	b7
xxHL		xxHU	
Lower 4 bits		Higher 4 bits	

2. KEY MATRIX AND KEY-INPUT DATA STORAGE RAM

The key matrix is made up of a 6 x 4 matrix, as shown below.



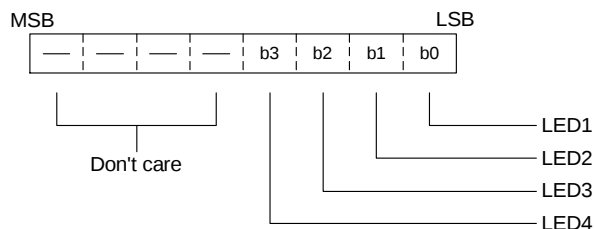
The data of each key is stored as illustrated below, and is read with the read command, starting from the least significant bit.

KEY1 ... KEY4		KEY1 ... KEY4	
Seg1/KS1	Seg2/KS2		
Seg3/KS3	Seg4/KS4		
Seg5/KS5	Seg6/KS6		
b0 ----- b3	b4 ----- b7		

Reading
sequence ↓

3. LED PORT

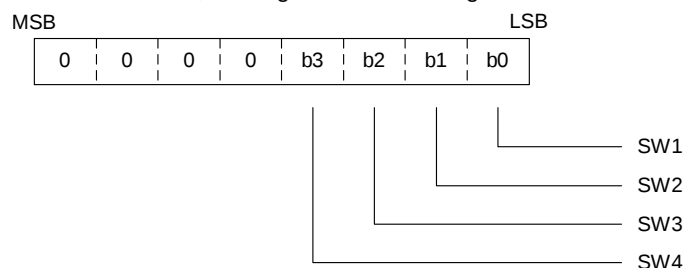
Data is written to the LED port with command, starting from the least port's least significant bit. When a bit of this port is 0, the corresponding LED lights; when the bit is 1, the LED turns off. The data of bits 5 through 8 are ignored.



On power application, all LEDs are unlit.

4. SW DATA

SW data is read with the read command, starting from the least significant bit. Bits 5 to 8 of the SW data are 0.



5. COMMANDS

Commands set the display mode and status of the FIP driver.

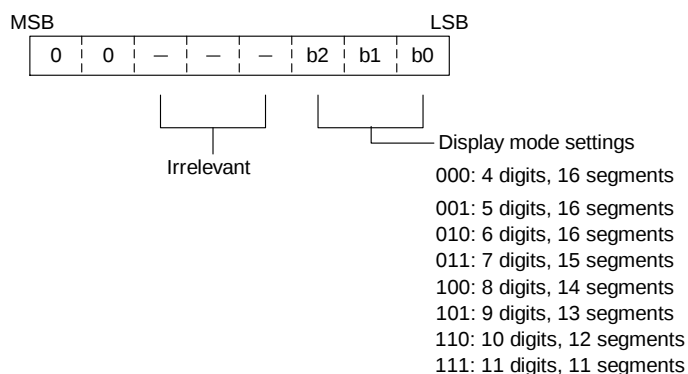
The first 1 byte input to the SC16312 through the DIN pin after the STB pin has fallen is regarded as a command.

If STB is set high while commands/data are transmitted, serial communication is initialized, and the commands/data being transmitted are invalid (however, the commands/data previously transmitted remain valid).

(1) Display mode setting commands

These commands initialize the SC16312 and select the number of segments and the number of grid (1/4 to 1/11 duty, 11 segments to 16 segments).

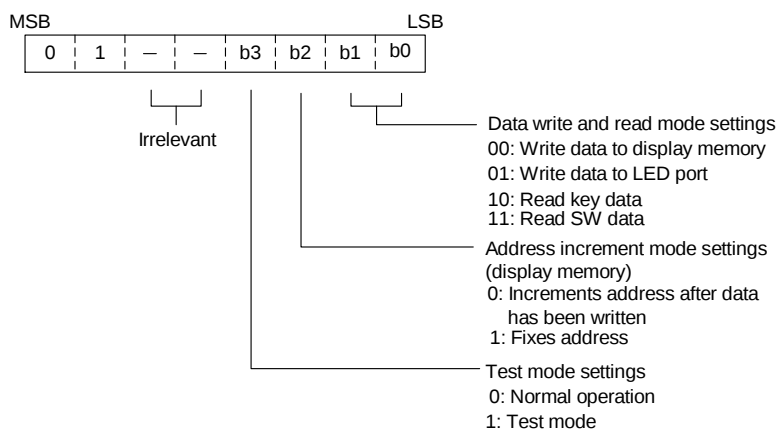
When these commands are executed, the display is forcibly turned off, and key scanning is also stopped. To resume display, the display command "ON" must be executed. If the same mode is selected, however, nothing happens.



On power application, the 11-digit, 11-segment mode is selected.

(2) Data setting commands

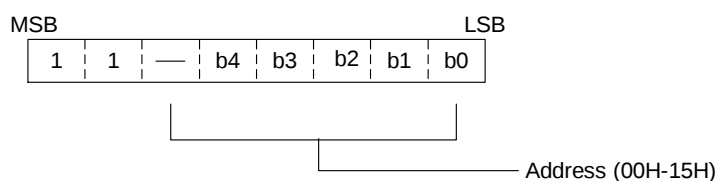
These commands set data write and data read modes.



On power application, the normal operation and address increment modes are set.

(3) Address setting commands

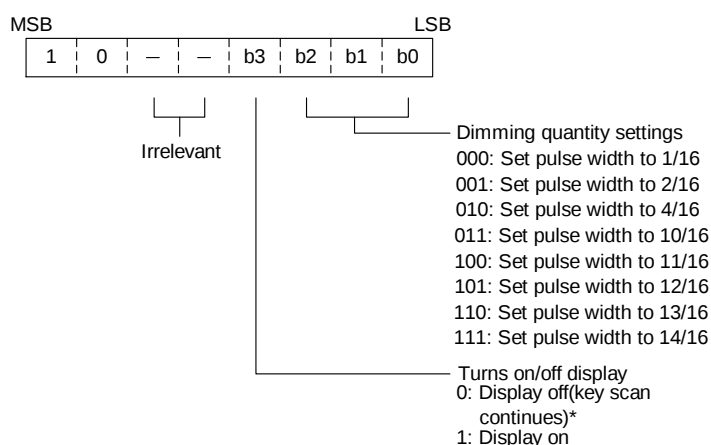
These commands set an address of the display memory.



If address 16H or higher is set, data is ignored, until a valid address is set.

On the power application, the address is set to 00H.

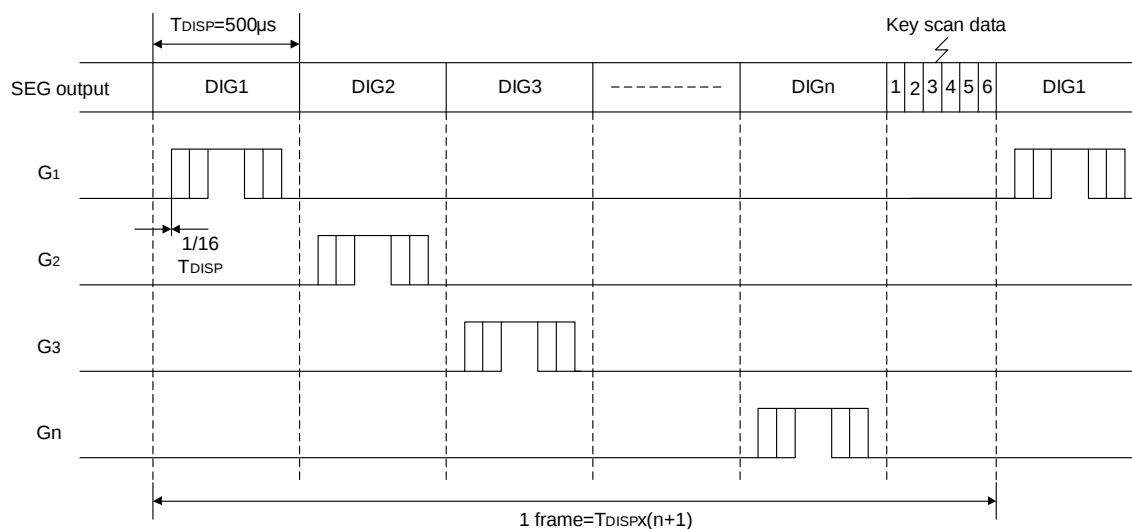
(4) Display control commands



On power application, the 1/6 pulse width is set and the display is turned off.

*Note: On power application, key scanning is stopped.

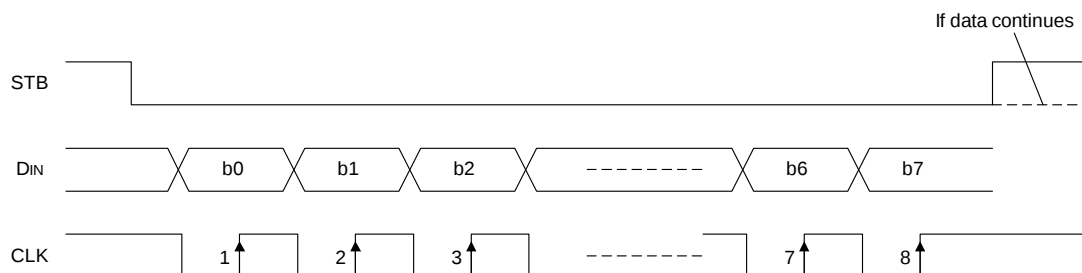
KEY SCANNING AND DISPLAY TIMING



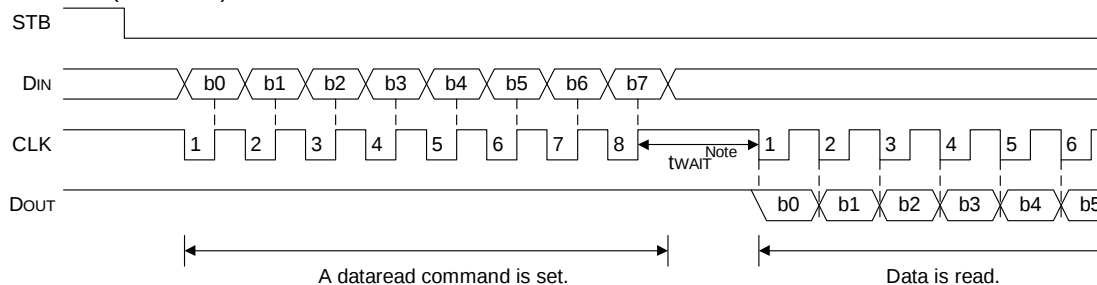
One cycle of key scanning consists of one frame, and data in a 6x4 matrix is stored in RAM.

SERIAL COMMUNICATION FORMAT

Reception(command/data write)



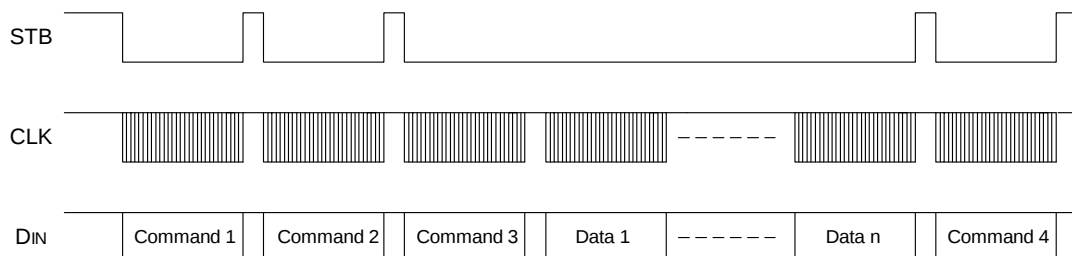
Transmission(data read)



Because the DOUT pin is an N-ch, open-drain output pin, be sure to connect an external pull-up resistor to this pin (1kΩ to 10kΩ)..

APPLICATION

Updating display memory by incrementing address



Command1: sets display mode

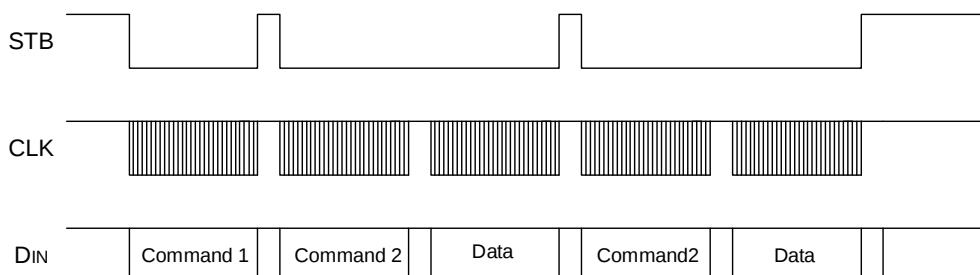
Command2: sets data

Command3: sets address

Data 1 to n: transfers display data (22 bytes max.)

Command4: controls display

Updating specific address

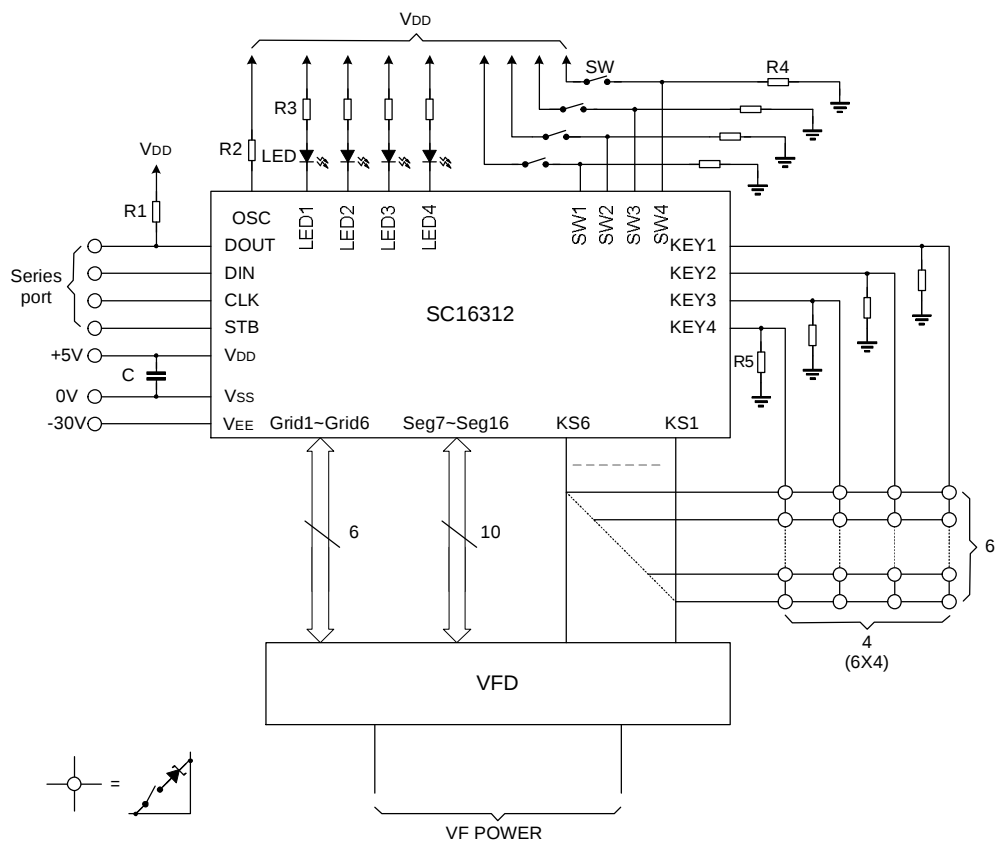


Command1: set data

Command2: sets address

Data: display data

TYPICAL APPLICATION CIRCUIT

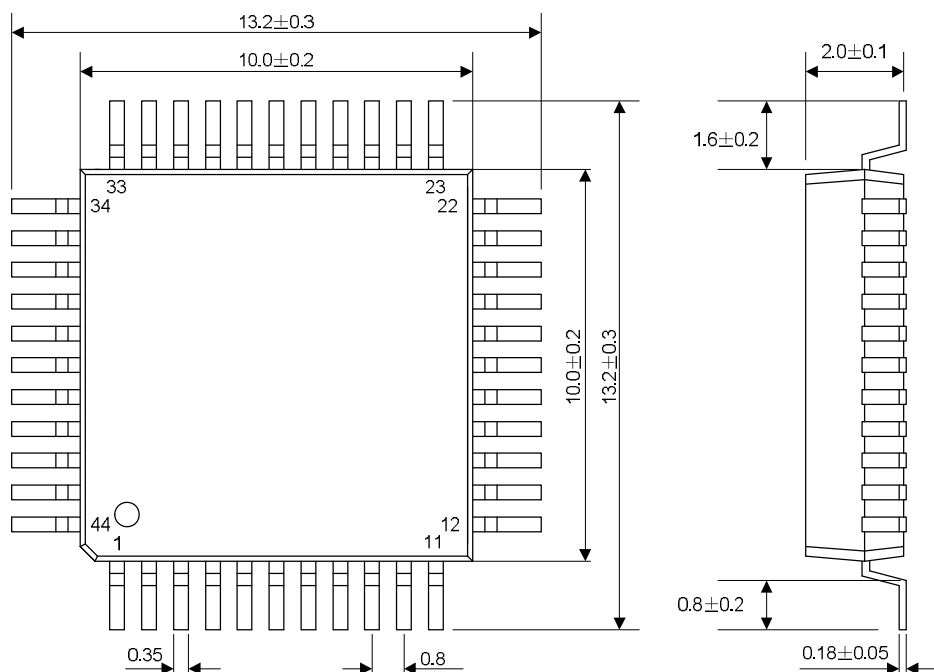


Note: the VF in this application circuit is fluorescence indicator, and VF Power is the power drive fluorescence indicator.

PACKAGE OUTLINE

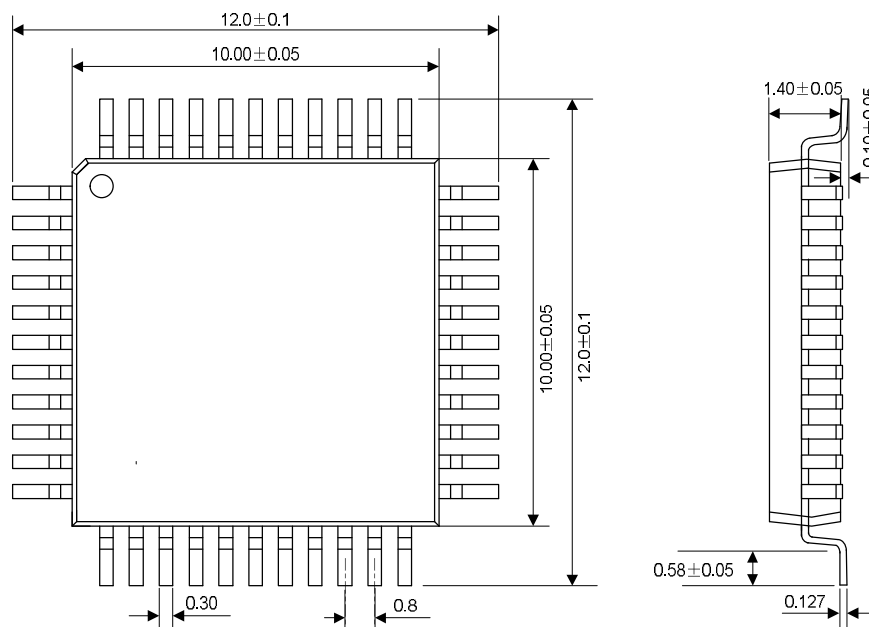
QFP-44-10x10-0.8

UNIT: mm



LQFP-44-10x10-0.8

UNIT: mm



**HANDLING MOS DEVICES:**

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.

ATTACHMENT

Revision History

Data	REV	Description	Page
2004.08.03	1.0	Original	
2004.09.16	1.1	Modify the "PACKAGE OUTLINE"	14
2005.08.09	1.2	Change the min. supply voltage, 4.5V→3.3V	3
2005.12.29	1.3	Add the package of "LQFP-44-10X10-0.8"	
2006.02.27	1.4	Modify the package of "QFP-44-10X10-0.8"	