

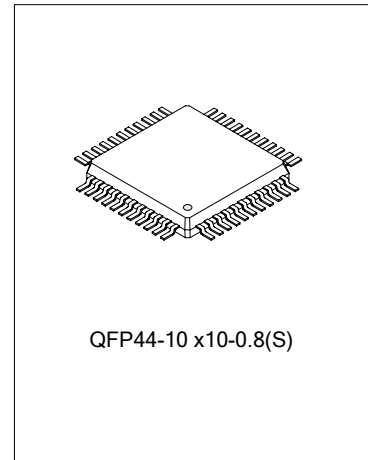
## VFD CONTROLLER/DRIVER

### DESCRIPTION

The SC16315 is a FIP (Fluorescent Indicator Panel, or Vacuum Fluorescent Display) controller/driver that is driven on a 1/4 or 1/12 duty factor. It has 16 segment outputs, 4 grid outputs, 8 segment/grid outputs, a display memory, a control circuit, and a key scan circuit. Serial data comes from a three-line serial interface. This FIP controller/driver is ideal as a peripheral device for a single-chip microcomputer.

### FEATURES

- \* Multiple display modes (16-segment & 12-digit to 24-segment & 4-digit).
- \* Key scanning (16x2 matrix).
- \* Dimming circuit (eight steps).
- \* High-voltage output (VDD – 35V max).
- \* LED ports (4 chs., 20 mA max).
- \* No external resistors necessary for driver outputs (P-ch open-drain + pull-down resistor output)
- \* Serial interface (CLK, STB, DIN, DOUT)



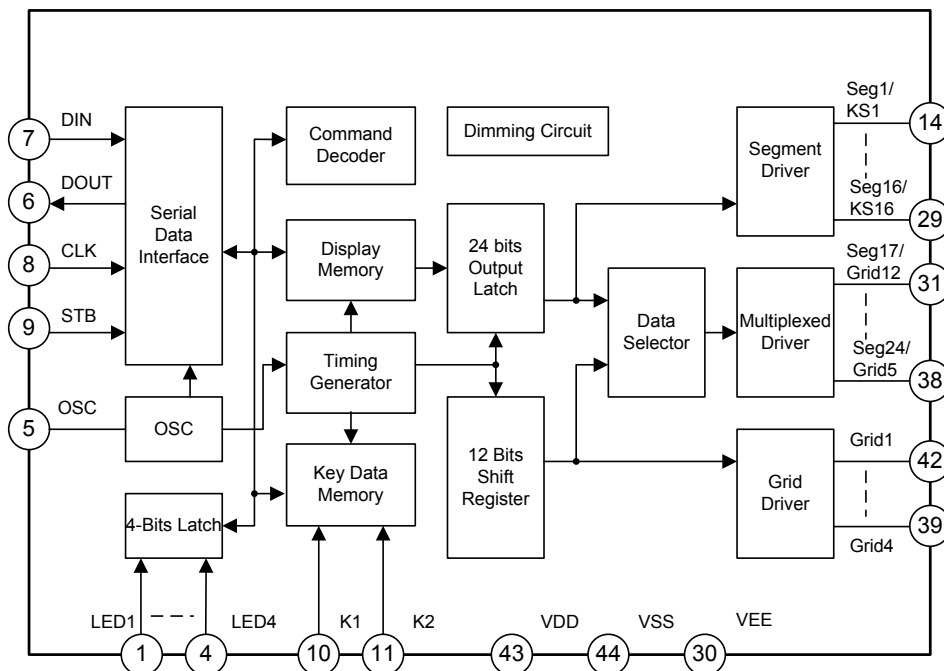
### ORDERING INFORMATION

Device	Package
SC16315	QFP-44-10 X 10-0.8(S)

### APPLICATIONS

- \* Microcomputer peripheral device

### BLOCK DIAGRAM



**ABSOLUTE MAXIMUM RATING** (Unless otherwise specified, T<sub>amb</sub>=25°C, V<sub>SS</sub>=0V)

Characteristics	Symbol	Value	Unit
Logic Supply Voltage	VDD	-0.5 ~ +6.0	V
Driver Supply Voltage	VEE	VDD + 0.5 ~ VDD - 40	V
Logic Input Voltage	VI1	-0.5 ~ VDD + 0.5	V
FIP Driver Output Voltage	VO2	VEE - 0.5 ~ VDD + 0.5	V
LED Driver Output Current	IO1	±20	mA
FIP Driver Output Current	IO2	-40 (grid); -15 (segment)	mA
Power Dissipation	PD	800 *	mW
Storage Temperature	TSTG	-65 ~ +150	°C
Operating Ambient Temperature	Tamb	-40 ~ + 85	°C

\* Note: Derate at -6.4 mW/°C at T<sub>amb</sub>=25°C or higher.

**RECOMMENDED OPERATING RANGE** (T<sub>amb</sub>= -20 ~ 70 °C, V<sub>SS</sub>=0V)

Characteristics	Symbol	Min.	Typ.	Max.	Unit
Logic Supply Voltage	VDD	3	5	5.5	V
High-Level Input Voltage	VIH	0.7VDD	--	VDD	V
Low-Level Input Voltage	VIL	0	--	0.3VDD	V
Driver Supply Voltage	VEE	0	--	VDD-35	V

Maximum power consumption P<sub>MAX.</sub> = FIP driver dissipation + RL dissipation + LED driver dissipation + dynamic power consumption

Where segment current = 3mA, grid current = 15mA, and LED current = 20mA,

FIP driver dissipation = number of segments x 6 + number of grids/ (number of grids + 1) x 30(mW)

RL dissipation = (VDD-VEE)<sup>2</sup> /50 x (number of segments + 1) (mW)

LED driver dissipation = number of LEDs x 20(mW)

Dynamic power consumption = VDD x 5(mW)

**ELECTRICAL CHARACTERISTICS** (T<sub>amb</sub>= 25 °C, VDD =5V, V<sub>SS</sub>=0V, VEE=VDD-35V)

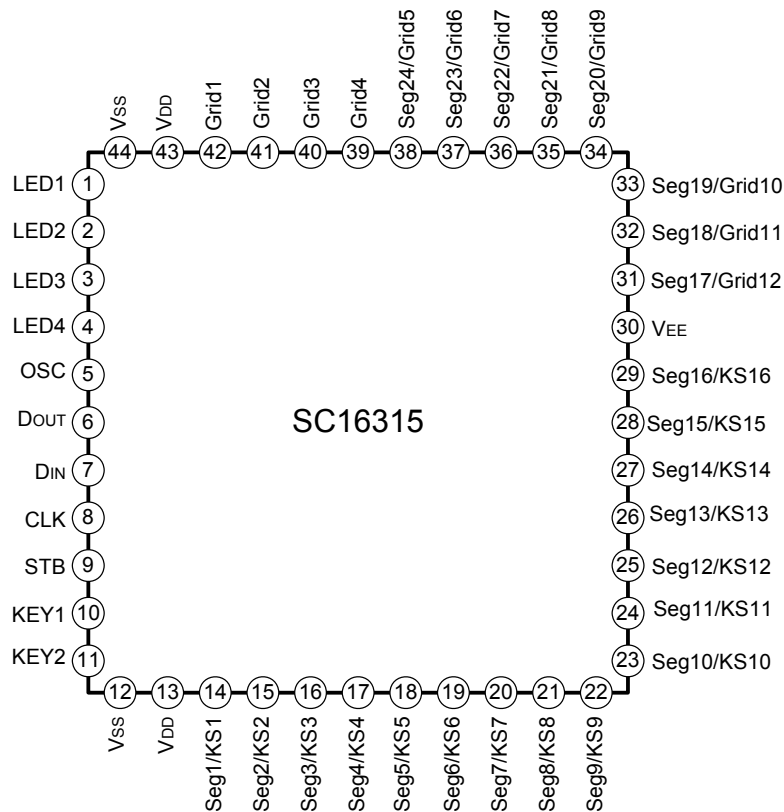
Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
High-Level Output Voltage	VOH1	LED1- LED4, IOH1=-12mA	VDD-1	--	--	V
Low-Level Output Voltage	VOL1	LED1- LED4, IOL1 =+15mA	--	--	1	V
Low-Level Output Voltage	VOL2	DOUT, IOL2=4mA	--	--	0.4	V
High-Level Output Current	IOH21	Vo=VDD-2V, Seg1/KS1 to Seg16/KS16	-3	--	--	mA
High-Level Output Current	IOH22	Vo=VDD-2V, Grid1 to Grid4 Seg17/Grid12 to Seg24/Grid5	-15	--	--	mA
Oscillation Frequency	FOSC	R=82K Ω	300	500	650	KHz

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Schmitt-Trigger Transfer Voltage(+)	V <sub>T+</sub>	V <sub>DD</sub> =5V (DIN,CLK,STB)	2.7	3.0	3.3	V
Schmitt-Trigger Transfer Voltage(-)	V <sub>T-</sub>	V <sub>DD</sub> =5V (DIN,CLK,STB)	0.7	1.0	1.3	V
Hysteresis Voltage	V <sub>H</sub>	V <sub>DD</sub> =5V (DIN,CLK,STB)	1.4	2.0	-	V
Input Current	I <sub>I</sub>	V <sub>I</sub> =V <sub>DD</sub> or V <sub>SS</sub>	-	-	±1	μA
Dynamic Current Consumption	I <sub>DDdyn</sub>	Under no load, Display Off	-	-	5	mA

**ELECTRICAL CHARACTERISTICS** (T<sub>amb</sub>= 25 °C, V<sub>DD</sub> =3.3V, V<sub>SS</sub>=0V, V<sub>EE</sub>=V<sub>DD</sub>-35V)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
High-Level Output Voltage	V <sub>OH1</sub>	LED1-LED4,I <sub>OH1</sub> =-6mA	V <sub>DD</sub> -1	-	-	V
Low-Level Output Voltage	V <sub>OL1</sub>	LED1-LED4,I <sub>OL1</sub> =+15mA	-	-	1	V
Low-Level Output Voltage	V <sub>OL2</sub>	DO <sub>UT</sub> ,I <sub>OL2</sub> =4mA	-	-	0.4	V
High-Level Output Current	I <sub>OH21</sub>	V <sub>O</sub> =V <sub>DD</sub> -2V,SEG1/KS1 To SEG16/KS16	-1.5	-	-	mA
High-Level Output Current	I <sub>OH22</sub>	V <sub>O</sub> =V <sub>DD</sub> -2V, Grid1 to Grid4 ,SEG17/Grid12 To SEG24/Grid5	-6	-	-	mA
Oscillation Frequency	F <sub>OSC</sub>	R=82KΩ	300	500	650	KHz
Schmitt-Trigger Transfer Voltage(+)	V <sub>T+</sub>	V <sub>DD</sub> =3.3V (DIN,CLK,STB)	1.8	2.0	2.2	V
Schmitt-Trigger Transfer Voltage(-)	V <sub>T-</sub>	V <sub>DD</sub> =3.3V (DIN,CLK,STB)	0.2	0.4	0.6	V
Hysteresis Voltage	V <sub>H</sub>	V <sub>DD</sub> =3.3V (DIN,CLK,STB)	1.0	1.6	-	V
Input Current	I <sub>I</sub>	V <sub>I</sub> =V <sub>DD</sub> or V <sub>SS</sub>	-	-	±1	μA
Dynamic Current Consumption	I <sub>DDdyn</sub>	Under no load Display Off	-	-	3	mA

**PIN CONFIGURATION**



**PIN DESCRIPTION**

Pin No.	Pin Name	Description
7	DIN	Data input pin. Input serial data at rising edge of shift clock, starting from the low order bit.
6	DOUT	Data output pin. 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 pin. Initializes serial interface at the rising or falling edge of the SC16315. 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 pin. Reads serial data at the rising edge, and outputs data at the falling edge.
5	OSC	Oscillator pin. Determine the oscillation frequency by the resistor connecting this pin and GND (VSS).
14 ~ 29	Seg1/KS1 to Seg16/KS16	High-voltage output (segment). Segment output pins (Dual function as key source).
39~42	Grid1 to Grid4	High-voltage output (grid). Grid output pins.

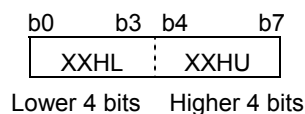
Pin No.	Pin Name	Description
31~38	Seg17/Grid12 to Seg24/Grid5	High-voltage output (segment/grid). Segment or grid driving.
1 ~4	LED1 to LED4	LED output pin. CMOS output. +20mA max.
10 ~ 11	KEY1 to KEY2	Key data input. Data input to these pins is latched at the end of the display cycle.
13, 43	VDD	Logic power pin. 5V±10%
12, 44	VSS	Logic ground. Connect this pin to system GND.
30	VEE	Pull-down level. VDD-35V max.

## FUNCTIONAL DESCRIPTION

### 1. DISPLAY RAM ADDRESS AND DISPLAY MODE

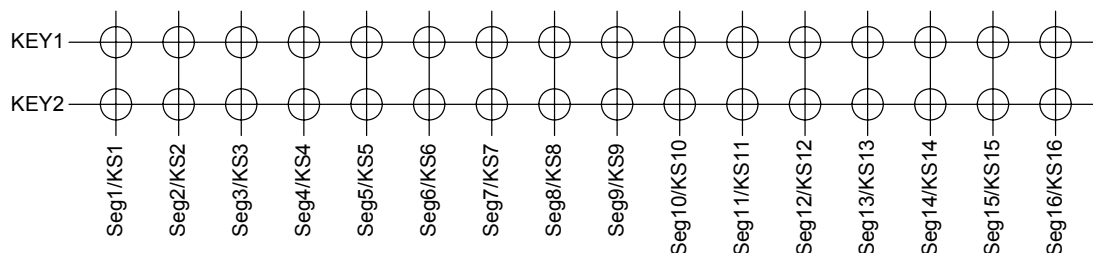
The display RAM stores the data transmitted from an external device to the SC16315 through the serial interface, and is assigned addresses as follows, in 8 bits unit:

Seg1	Seg4	Seg8	Seg12	Seg16	Seg20	Seg24	
00HL	00HU	01HL	01HU	02HL	02HU		DIG1
03HL	03HU	04HL	04HU	05HL	05HU		DIG2
06HL	06HU	07HL	07HU	08HL	08HU		DIG3
09HL	09HU	0AHL	0AHU	0BHL	0BHU		DIG4
0CHL	0CHU	0DHL	0DHU	0EHL	0EHU		DIG5
0FHL	0FHU	10HL	10HU	11HL	11HU		DIG6
12HL	12HU	13HL	13HU	14HL	14HU		DIG7
15HL	15HU	16HL	16HU	17HL	17HU		DIG8
18HL	18HU	19HL	19HU	1AHL	1AHU		DIG9
1BHL	1BHU	1CHL	1CHU	1DHL	1DHU		DIG10
1EHL	1EHU	1FHL	1FHU	20HL	20HU		DIG11
21HL	21HU	22HL	22HU	23HL	23HU		DIG12



### 2. KEY MATRIX AND KEY-INPUT DATA STORAGE RAM

The key matrix is made up of a 16 x 2 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.

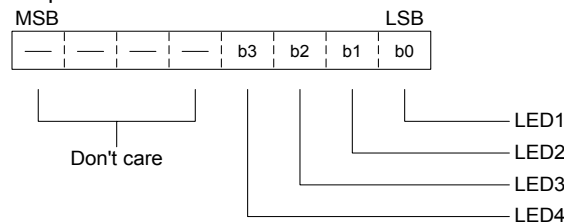
KEY1	KEY2	KEY1	KEY2	KEY1	KEY2	KEY1	KEY2
Seg1/KS1	Seg2/KS2	Seg3/KS3	Seg4/KS4	Seg5/KS5	Seg6/KS6	Seg7/KS7	Seg8/KS8
Seg9/KS9	Seg10/KS10	Seg11/KS11	Seg12/KS12	Seg13/KS13	Seg14/KS14	Seg15/KS15	Seg16/KS16

b0 ----- b1      b2 ----- b3      b4----- b5      b6 ----- b7

↓ Reading sequence

### 3. LED PORT

Data is written to the LED port with command, starting from the least port's least significant bit. "L" output when the bit of this port is 0, and "H" output when the bit is 1. The data of bits after the 5<sup>th</sup> bit are ignored.



Remark: On power application, all the LED ports are "L" output.

### 4. COMMANDS

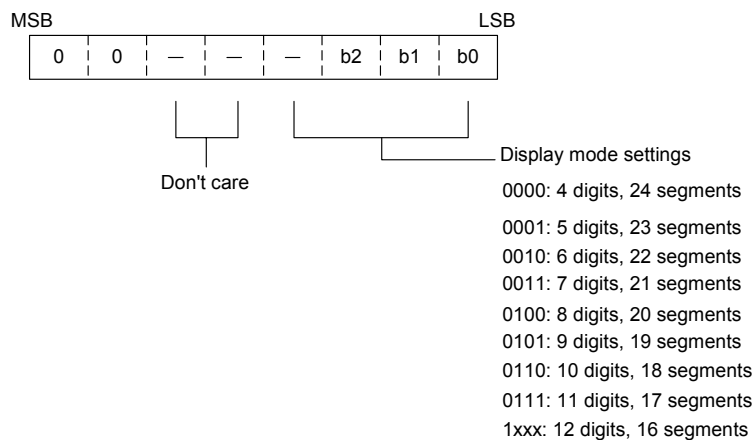
Commands set the display mode and status of the FIP driver.

The first 1 byte input to the SC16315 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 SC16315 and select the number of segments and grids (1/4- to 1/12- duty, 16 segments to 24 segments).

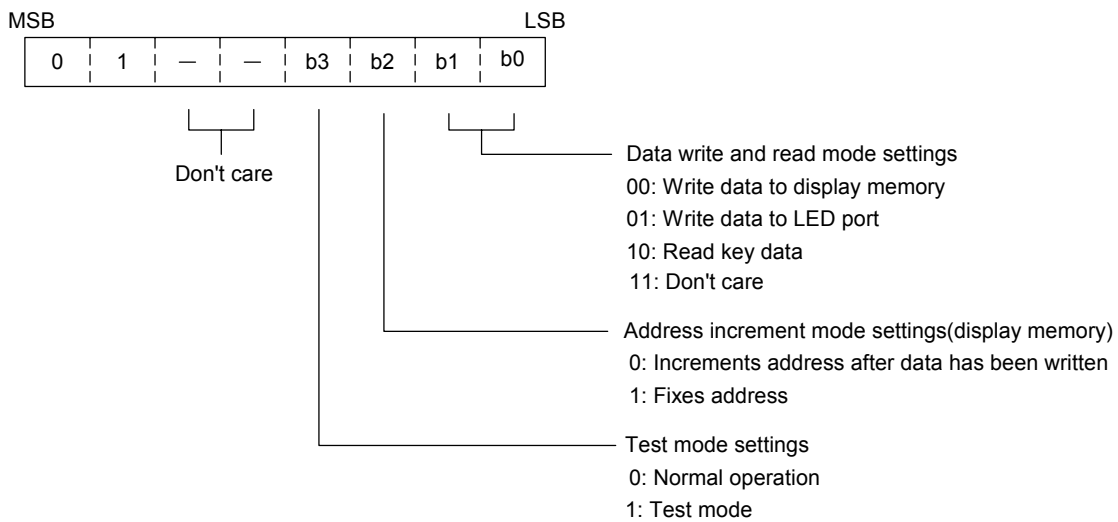
When these commands are executed, the display and key scanning are forcibly turned off. Therefore, in order to resume display, the display command "ON" must be executed. If the same mode is selected, however, nothing will happen.



On power application, the 12-digit, 16-segment mode is selected.

## (2) Data setting commands

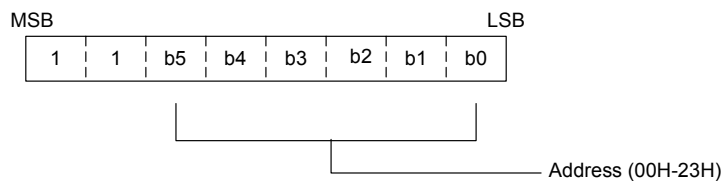
These commands set data write and data read modes.



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

## (3) Address setting commands

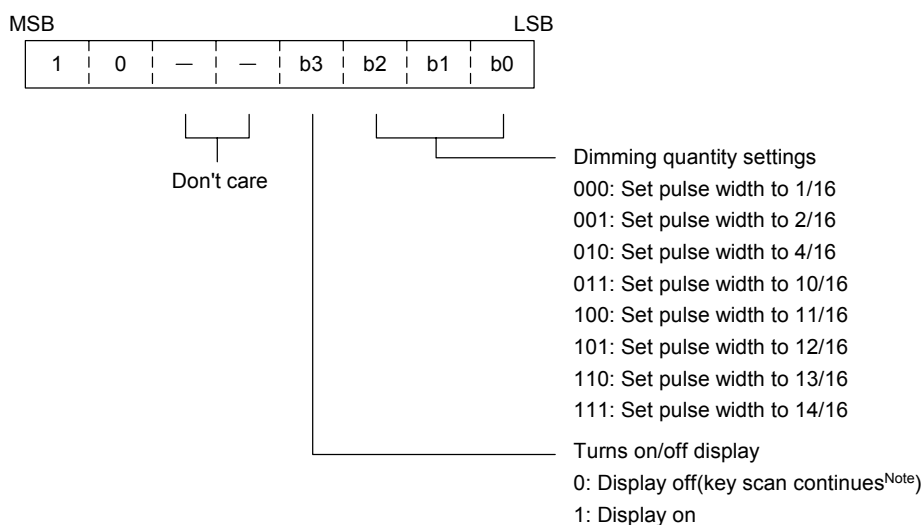
These commands set an address of the display memory.



Remarks 1. If address 24H or higher is set, data is ignored, until a valid address is set.

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

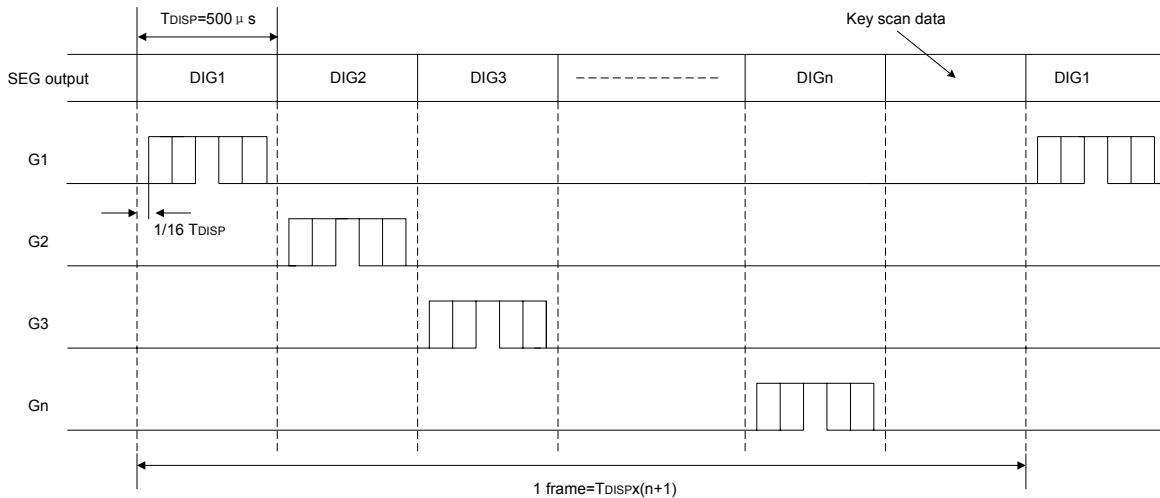
## (4) Display control commands



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

**Remark** On power application, the 1/16 pulse width is set and the display is turned off.

**KEY SCANNING AND DISPLAY TIMING**



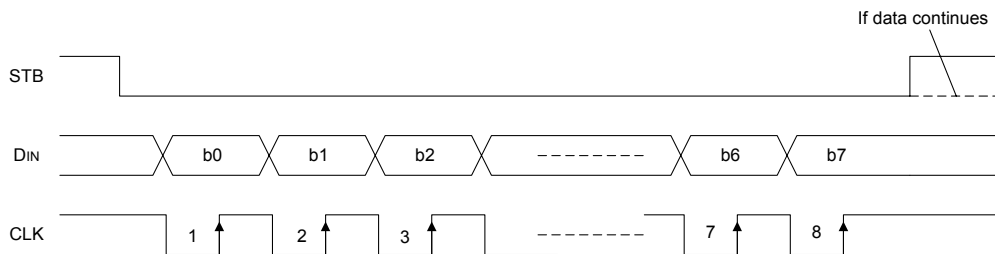
**Remark** One cycle of key scanning consists of two frames, and data in a 16 x 2 matrix is stored in RAM.

**Key Scan Expansion**

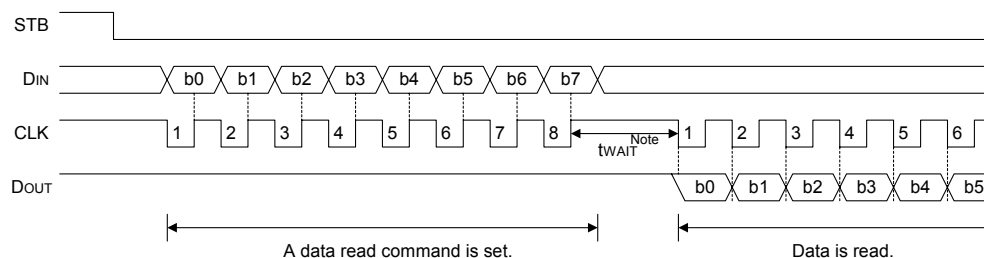
1st frame	DIGn	1	2	3	4	5	6	7	8	DIG1
2nd frame		9	10	11	12	13	14	15	16	

**SERIAL COMMUNICATION FORMAT**

**Reception (command/data write)**



**Transmission (data read)**

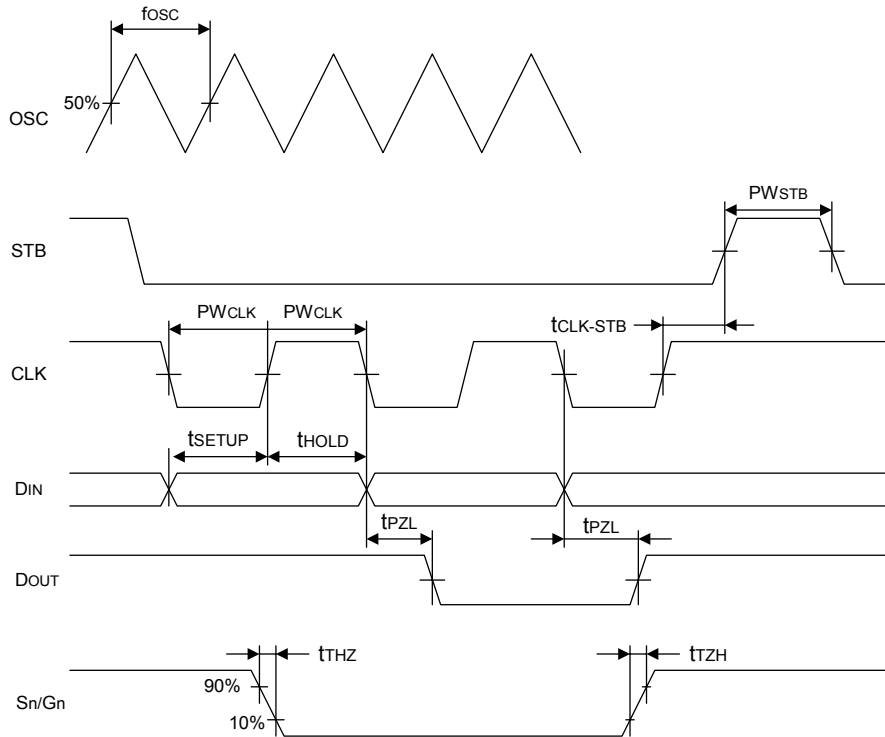


**Note** When data is read, a wait time  $t_{WAIT}$  of 1  $\mu$ s is necessary since the rising of the eighth clock that has set the command, until the falling of the first clock that has read the data.

**Remark** Be sure to connect an external pull-up resistor (1k $\Omega$  to 10k $\Omega$ ) to this pin because the Dout pin is an N-ch, open-drain output pin.

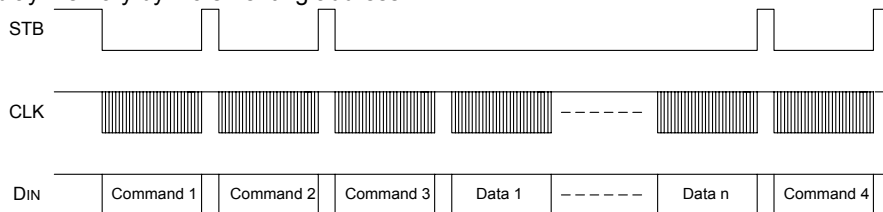


**SWITCHING CHARACTERISTIC WAVEFORM**



**APPLICATIONS**

Updating display memory by incrementing address



Command1: sets display mode

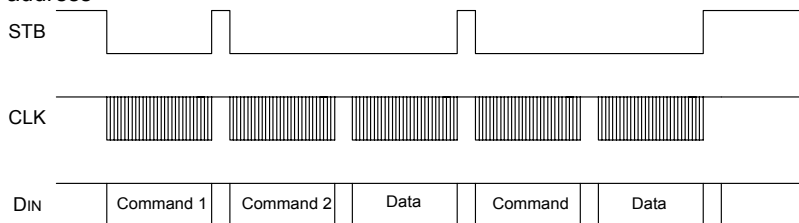
Command2: sets data

Command3: sets address

Data 1 to n: transfers display data (36 bytes max.)

Command4: controls display

Updating specific address

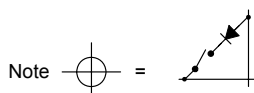
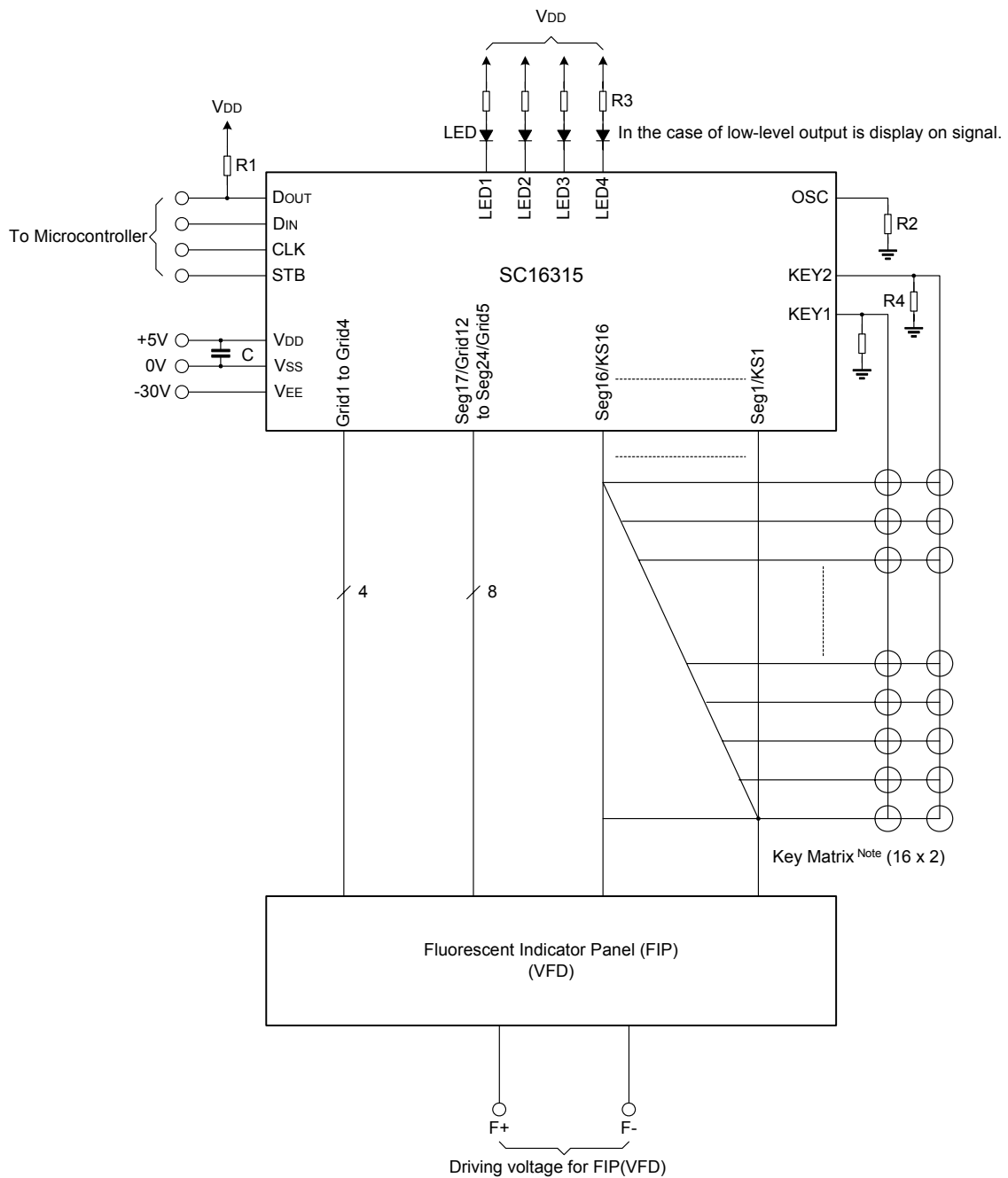


Command1: sets data

Command2: sets address

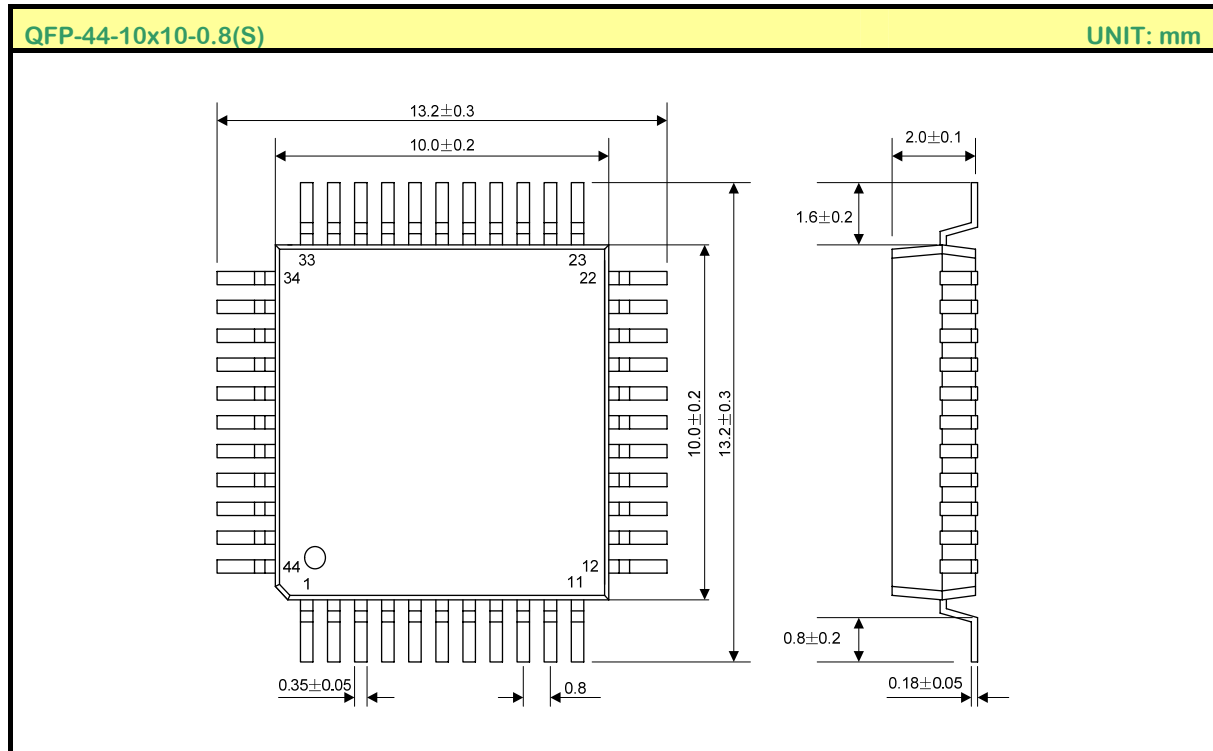
Data: display data

TYPICAL APPLICATION CIRCUIT



Remark R1,R4=1k to 10k  $\Omega$   
R2=82K  $\Omega$   
R3=330 to 1k  $\Omega$   
C=0.1  $\mu$  to 10  $\mu$  F

PACKAGE OUTLINE



**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.