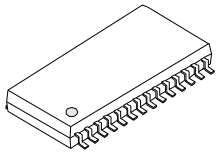
VFD CONTROLLER / DRIVER

DESCRIPTION

SC16313 is a Vacuum Fluorescent Display (VFD) or Fluorescent Indicator Panel (FIP) controller/driver that is driven on a 1/4 to 1/8 duty factor. It consists of 8 segment output lines, 4 grid output lines, 4 segment/grid output lines, one display memory, control circuit, key scan circuit. Serial data is input to SC16313 via a three-line serial interface. This VFD driver is ideal as a peripheral device of a single-chip microcomputer.



SOP-28-375-1.27

FEATURES

* CMOS technology
* High-voltage output
* Key scanning (8 x 2 matrix)
* Multiple display modes: (8 segments & 8 digits to 12 segments & 4 digits)
* 8-step dimming circuitry
* Serial interface (CLK, DIN, DOUT, STB)
* No external resistors needed for driver outputs

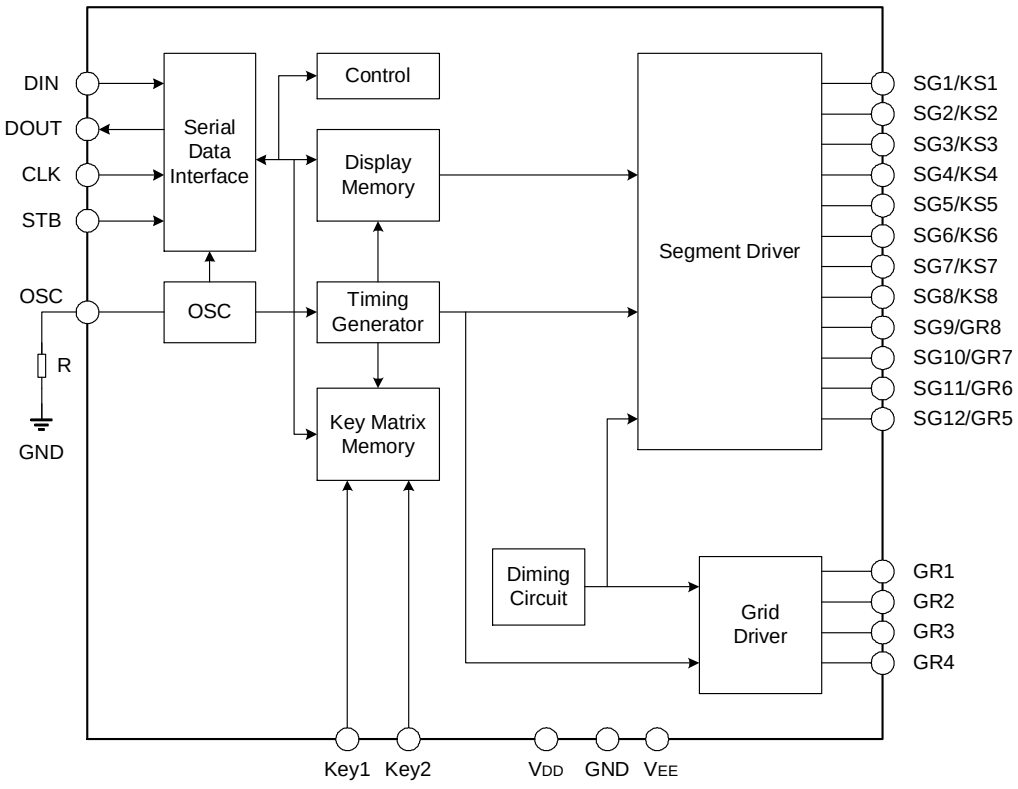
ORDERING INFORMATION

Device	Package
SC16313	SOP-28-375-1.27

APPLICATIONS

* Microcomputer peripheral device.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (unless otherwise stated, T_{amb}=25°C, GND=0V)

Characteristics	Symbol	Value	Unit
Logic Supply Voltage	V_{DD}	-0.5 to +7	V
Driver Supply Voltage	V_{EE}	V_{DD} +0.5 to V_{DD}-40	V
Logic Input Voltage	V_I	-0.5 to V_{DD}+0.5	V
VFD Driver Output Voltage	V_O	V_{EE}-0.5 to V_{DD}+0.5	V
VFD Driver Output Current	I_{oVFD}	-40 (grid) -15 (segment)	mA
Operating Ambient Temperature	T_{opr}	-40 to +85	°C

RECOMMENDED OPERATING CONDITIONS

(Unless otherwise stated, Tamb=-20 to +70°C, GND=0V)

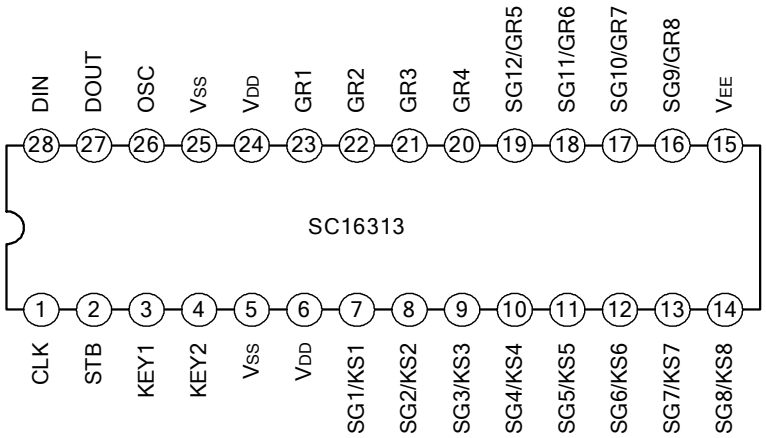
Characteristics	Symbol	Min.	Typ.	Max.	Unit
Logic Supply Voltage	V_{DD}	3.0	5	5.5	V
High-Level Input Voltage	V_{IH}	0.7V_{DD}	--	V_{DD}	V
Low-Level Input Voltage	V_{IL}	0	--	0.3V_{DD}	V
Driver Supply Voltage	V_{EE}	V_{DD}-35	--	0	V

ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, V_{DD}=5V, GND=0V, V_{EE}=V_{DD}-35V, Tamb=25°C)

Characteristics	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Low-Level Output Voltage	V_{OL1}	D_{OUT}, I_{OL2}=4mA	--	--	0.4	V
High-Level Output Current	I_{OH21}	V_O=V_{DD}-2V SG1/KS1 to SG8/KS8	-3	--	--	mA
High-Level Output Current	I_{OH22}	V_O=V_{DD}-2V GR1 to GR4, SG9/GR8 to SG12/GR5	-15	--	--	mA
Input Current	Ii	VI=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
Oscillation Frequency	f_{OSC}	R=51KΩ	350	500	650	KHz
Dynamic Current Consumption	I_{DDdyn}	Under no load Display OFF	--	--	5	mA

PIN CONFIGURATION



PIN DESCRIPTION

Pin NO.	Symbol	Description
1	CLK	Reads serial data at the rising edge and outputs data at the falling edge.
2	STB	After the STB has fallen, The data input can be processed; the first data is regard as a command. When this pin is “HIGH”, CLK is ignored.
3, 4	KEY1 to KEY2	The data input to these pins is latched at the end of display cycle.
5, 25	V_{SS}	Logic ground pin
6, 24	V_{DD}	Logic power supply
7 to 14	SG1/KS1 to SG8/KS8	Segment output pins. It also functions as key source.
15	VEE	V_{DD} – 35 V max
16 to 19	SG9/GR8 ~SG12/GR5	These pins are selectable for segment or grid output
20 to 23	GR4 to GR1	Grid output pins
26	OSC	This pin connects a resistor to V_{DD} to determine the oscillation frequency.
27	DOUT	Outputs serial data at the falling edge of the shift clock (starting from the lower bit).
28	DIN	Inputs serial data at the rising edge of the shift clock (starting from the lower bit).

FUNCTION DESCRIPTION

DISPLAY RAM ADDRESS

Data transmitted from an external device to SC16313 via the serial interface are stored in the display RAM and are assigned addresses. The RAM addresses of SC16313 are given below in 8 bits unit.

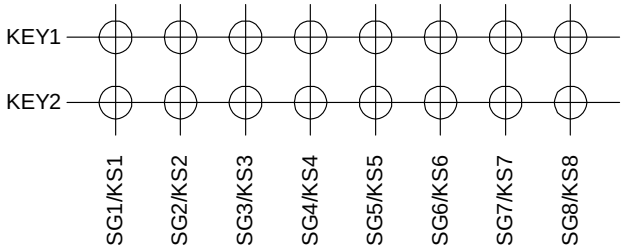
SG1 SG4	SG5 SG8	SG9 SG12	
00HL	00HU	01HL	GR1
02HL	02HU	03HL	GR2
04HL	04HU	05HL	GR3
06HL	06HU	07HL	GR4
08HL	08HU	09HL	GR5
0AHL	0AHU	0BHL	GR6
0CHL	0CHU	0DHL	GR7
0EHL	0EHU	0FHL	GR8

b0 b3	b4 b7
XX HL	XX HU
Lower 4 bits	Higher 4 bits

Only the lower 4 bits of the addresses assigned to SG9 through SG12 are valid, and the higher 4 bits are ignored.

SC16313 KEY MATRIX & KEY INPUT DATA STORAGE RAM

SC16313 key matrix consists of 8 x 2 arrays as shown below:



The data of each key is stored in key-input data RAM as illustrated below. They are read by a READ command, starting from the least significant bit. When the most significant bit of the data (SG8, b7) has been read, then the least significant bit of the next data (SGI, b0) will be read.

KEY1 KEY2	KEY1 KEY2	KEY1 KEY2	KEY1 KEY2	
SG1/KS1	SG2/KS2	SG3/KS3	SG4/KS4	Reading sequence
SG5/KS5	SG6/KS6	SG7/KS7	SG8/KS8	
b0 ---------- b1	b2 ---------- b3	b4 ---------- b5	b6 ---------- b7	

COMMANDS

Commands set the display mode and status of SC16313. The first byte (b0 to b7) inputted to SC16313 via the DIN pin after STB pin has fallen is regarded as a command. If for some reason the STB pin is made “HIGH” while data or commands are being transmitted, the serial communication is initialized, and the

data/command being transmitted is considered invalid. (However, the data/command already transmitted remains valid)

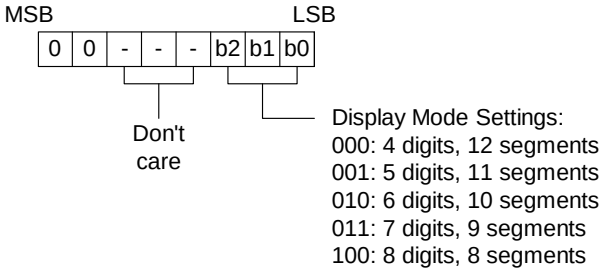
Command 1: display mode setting command

This command initializes the SC16313 and selects the number of segments and number of grids (4 to 8 grids, 12 to 8 segments).

When this command is executed, display is forcibly turned off, and key scanning is also stopped. To resume display, a display ON command must be executed.

SC16313 provides 4 display mode settings as shown in the diagram below. The bits 4 to 6 (b3 to b5) are ignored, bits 7 & 8 (b6 to b7) are given a value of "0".

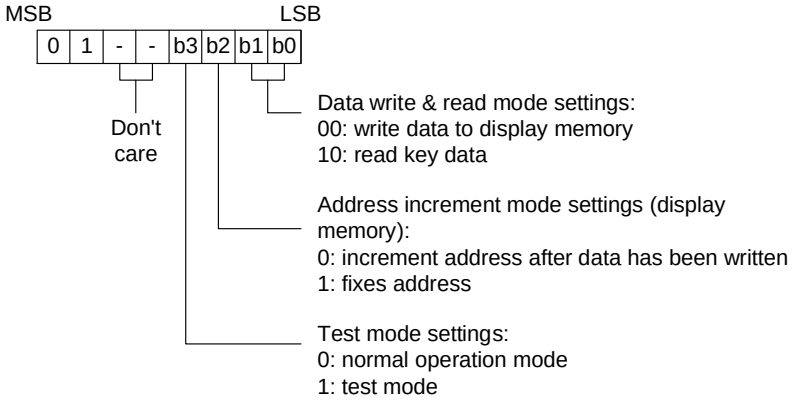
On power application, the 8-digit, 8-segment mode is selected.



Command 2: data setting command

This command sets data write or data read modes. The data setting command, the bits 6 and 5 (b5, b4) are ignored, bit 8 and bit 7 (b7, b6) are given the value of "01". Please refer to the diagram below.

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

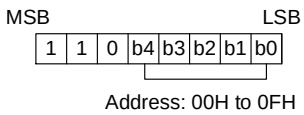


Command 3: address setting command

This command sets an address of the display memory. The address is considered valid if it has a value of "00H" to "0FH". If the address is set to 10H or higher, the data is ignored until a valid address is set.

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

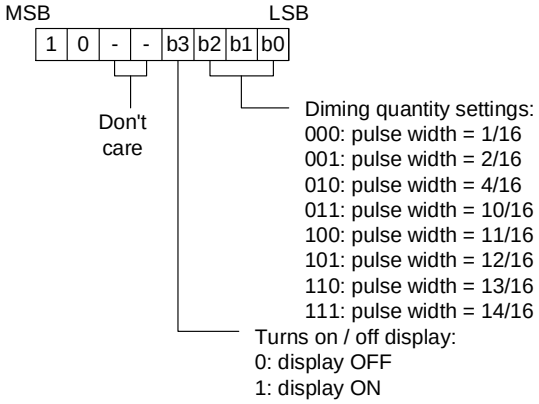
Please refer to the diagram below.



Command 4: display control command

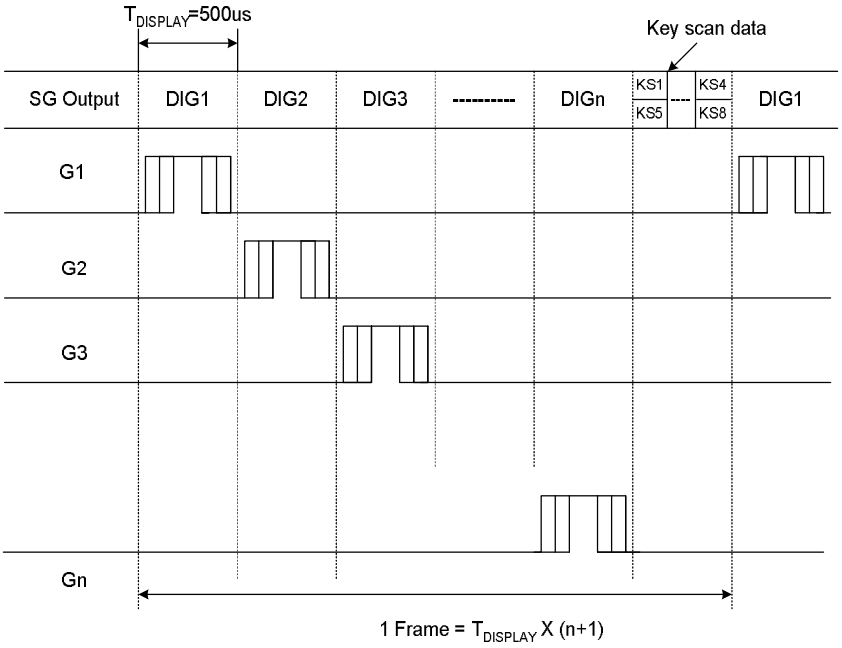
This command is used to turn ON or OFF a display. It also used to set the pulse width. Please refer to the diagram below.

ON power application, the 1/16 pulse width is set and the display is turned OFF (the key scanning starts).



KEY SCANNING AND DISPLAY TIMING

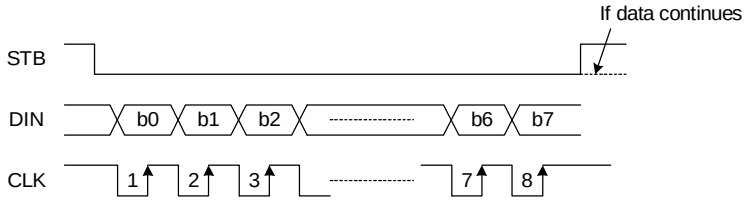
The key scanning and display timing diagram is given below. One cycle of key scanning consists of 2 frames. In the first frame, those keys connected to KS1~KS4 are scanned, while the second frame scans KS5~KS8. The data of the 8 x 2 matrix is stored in the key-input RAM.



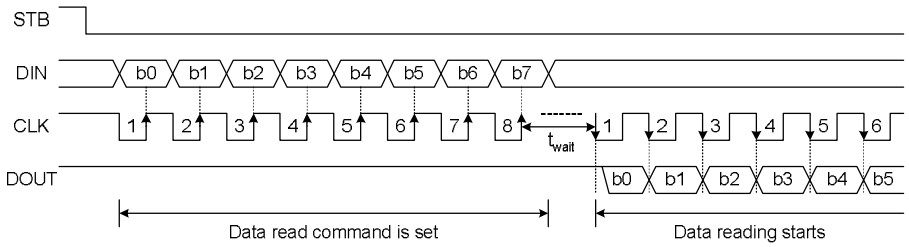
SERIAL COMMUNICATION FORMAT

The following diagram shows the SC16313 serial communication format. The DOUT pin is an N-channel, open-drain output pin. Therefore, it is highly recommended that an external pull-up resistor (1kΩ to 10kΩ) must be connected to DOUT.

RECEPTION (COMMAND/DATA WRITE)

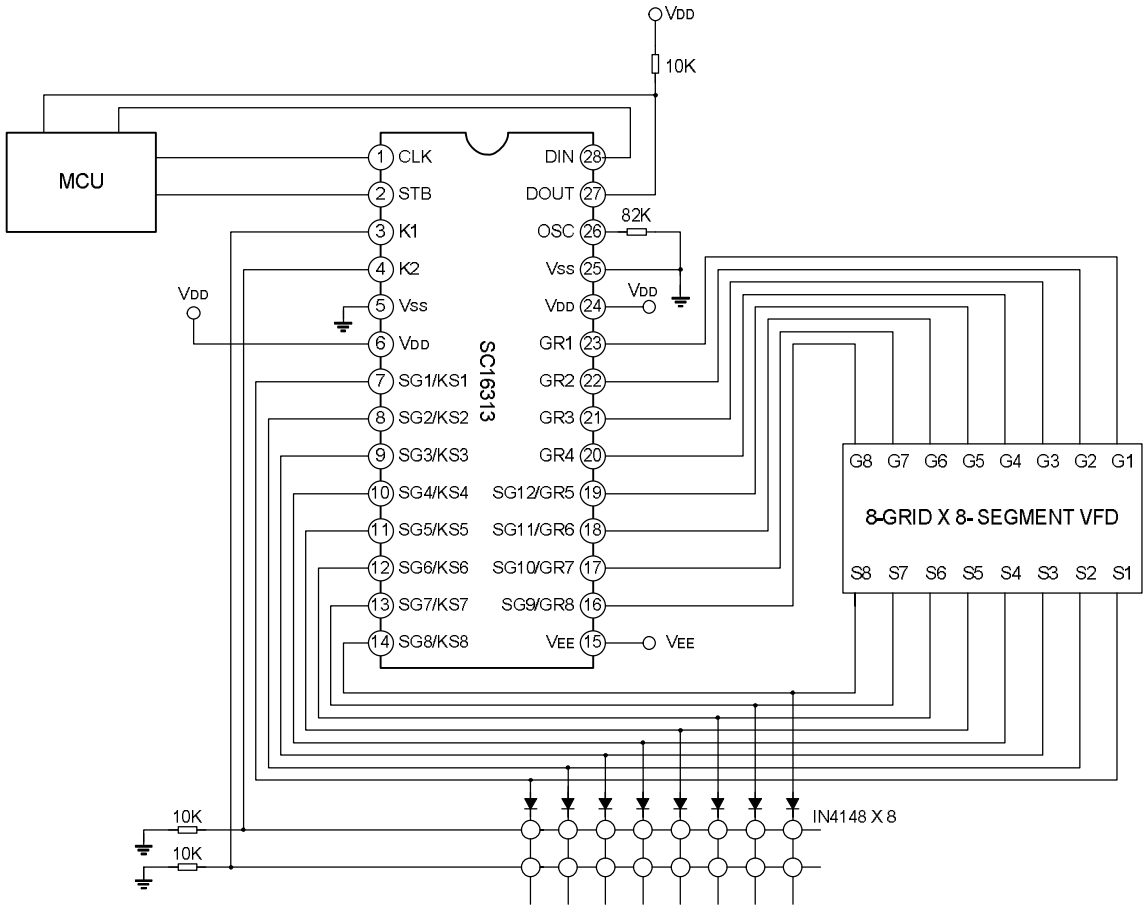


TRANSMISSION (DATA READ)



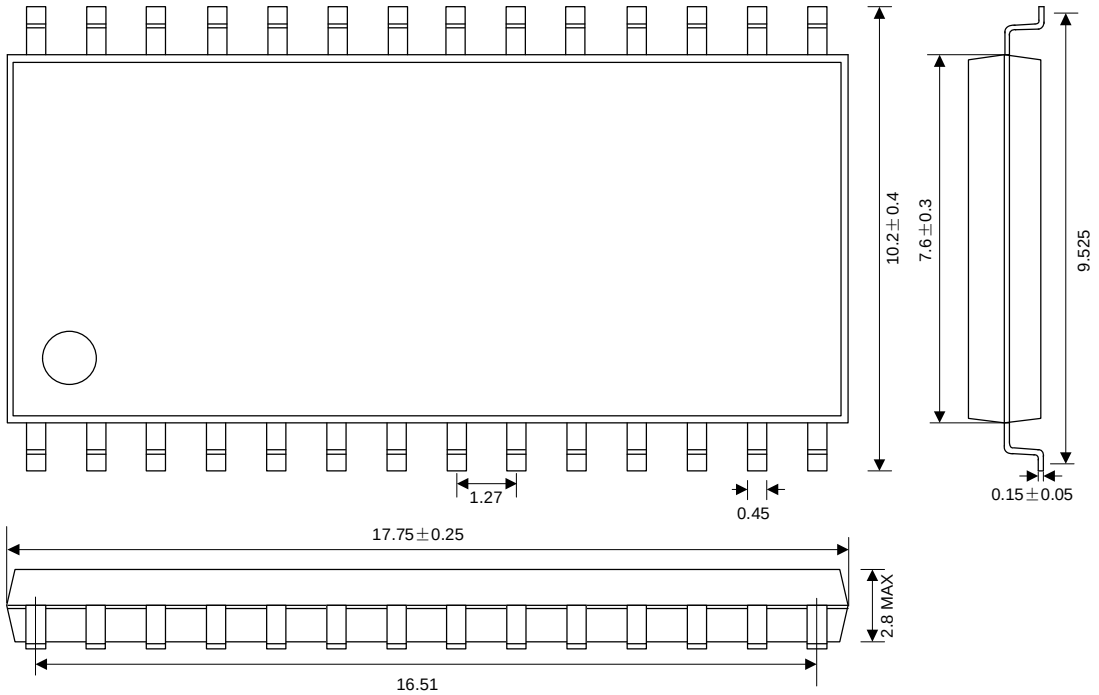
It must be noted that when the data is read, a waiting time t_{wait} of 1μs is necessary between the rising of the eighth clock that has set the command and the falling of the first clock that has read the data.

TYPICAL APPLICATION CIRCUIT



PACKAGE OUTLINE

SOP-28-375-1.27 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.