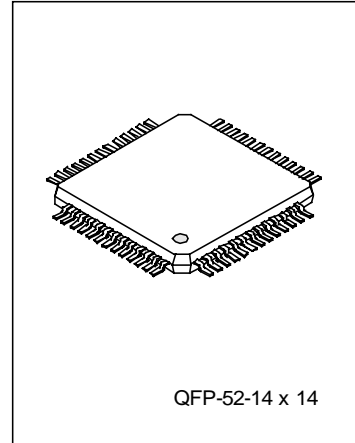


VFD CONTROLLER/DRIVER

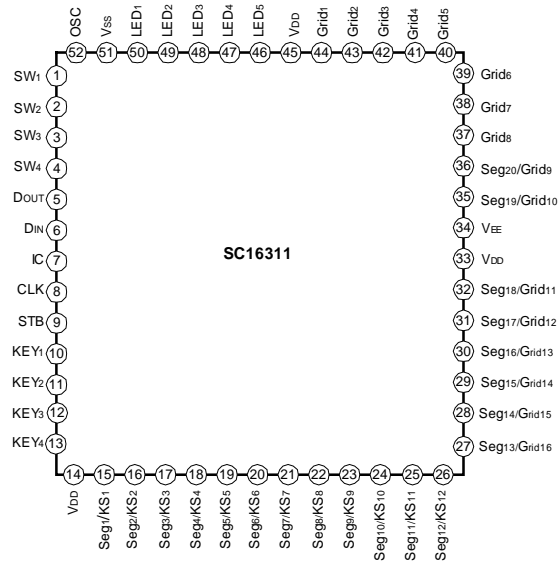
The SC16311 is a FIP (Fluorescent Indicator Panel or Vacuum Fluorescent Display) controller/driver that is driven on a 1/8- to 1/16 duty factor. It consists of 12 segment output lines, 8 grid output lines, 8 segment/grid output drive lines, a display memory, a control circuit, and a key scan circuit. Serial data is input to the SC16311 through a three-line serial interface. This FIP controller/driver is ideal as a peripheral device of a single-chip microcomputer.



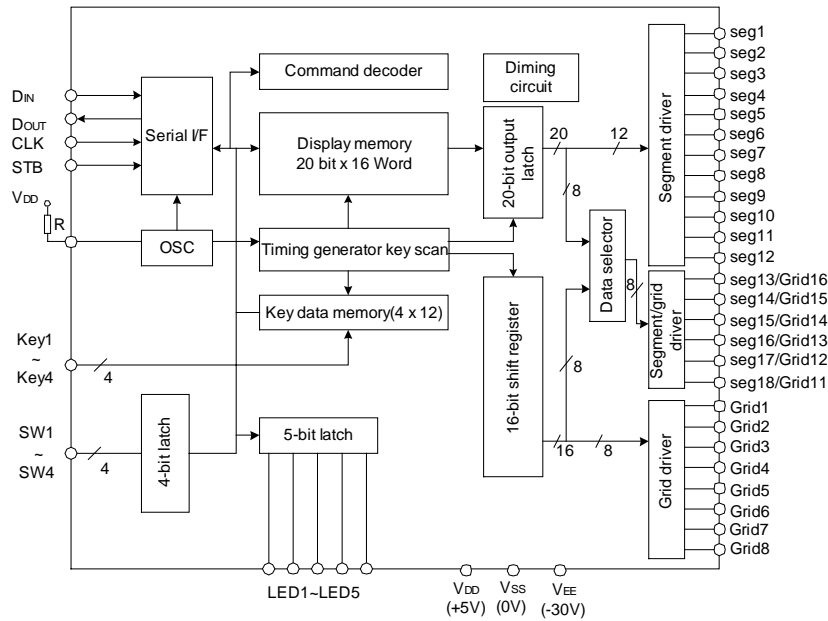
FEATURES

- Many display modes (12-segment & 16-digit to 20-segment & 8-digit)
- Key scanning (12x4 matrices)
- Dimming circuit (eight steps)
- High-voltage output (VDD-35 V max).
- LED ports (5 chs., 20 mA max).
- General-purpose input port (4 bits)
- No external resistor necessary for driver outputs (P-ch open-drain + pull-down resistor output)
- Serial interface (CLK, STB, DIN, DOUT)

PIN CONFIGURATION



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

| Characteristics | Symbol | Value | Units |
|-------------------------------|------------------|---|-------|
| Logic Supply Voltage | V _{DD} | -0.5~ +7.0 | V |
| Driver Supply Voltage | V _{EE} | V _{DD} +0.5 ~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~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 | PD | 1200* | mW |
| Operating Ambient Temperature | T _{OPT} | -40~+85 | °C |
| Storage Temperature | T _{STG} | -65~+150 | °C |

*: Dreate at -9.6 Mw/ °C at Ta= 25°C or higher.

— HANGZHOU SILAN MICROELECTRONICS JOINT-STOCK CO.,LTD —

Rev: 1.0 2001.11.8.

RECOMMENDED OPERATING CONDITIONS (Ta = -20 to +70°C, VSS = 0 V)

| Characteristics | Symbol | Min. | Typ. | Max. | Unit |
|--------------------------|--------|--------|------|--------|------|
| Logic Supply Voltage | VDD | 4.5 | 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 |

ELECTRICAL CHARACTERISTICS (TA=-20~+70°C, VDD=4.5~5.5V, VSS=0V, VEE=VDD-35V)

| Characteristics | Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------|--------|--|--------|------|--------|------|
| High-Level Output Voltage | VOH1 | LED, IOH1=-1mA | 0.9VDD | | | V |
| Low-Level Output Voltage | VOL1 | LED, IOL1=20mA | | | 1 | V |
| Low-Level Output Voltage | VOL2 | DOUT, IOL2=4mA | | | 0.4 | V |
| High-Level Output Current | IOH21 | VO=VDD-2V, Seg1~Seg12 | -3 | | | mA |
| High-Level Output Current | IOH22 | VO=VDD-2V, Grid1~Grid8, Seg13/Grid16 ~Seg18/Grid11 | -15 | | | mA |
| Driver Leakage Current | IOLEAK | VO=VDD-35V, driver off | | | -10 | μA |
| Output Pull-Down Resistor | RL | driver output | 50 | 100 | 150 | KΩ |
| Input Current | II | VI=VDD or VSS | | | ±1 | μA |
| High-Level Input Voltage | VIH | | 0.7VDD | | | V |
| Low-Level Input Voltage | VIL | | | | 0.3VDD | V |
| Hysteresis Voltage | VH | CLK, DIN, STB | | 0.35 | | V |
| Dynamic Current Consumption | IDDdyn | Under no load, display off | | | 5 | mA |

SWITCHING CHARACTERISTICS (Ta = -20 to +70°C, VDD = 4.5 to 5.5 V, VEE = -30 V)

| Characteristics | Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------|--------|-----------------------|------|------|------|------|
| Oscillation Frequency | tOSC | R=56kΩ | 350 | 500 | 650 | kHz |
| Propagation Delay Time | tPLZ | CLK→DOUT, CL=15pF, | | | 300 | ns |
| | tPZL | RL=10KΩ | | | 100 | ns |
| Rise Time | tTZH1 | CL=300pF | | | 2 | μs |
| | tTZH2 | | | | | |
| Fall time | tTZH | CL=300pF, Segn, Gridn | | | 120 | μs |
| Maximum Clock Frequency | fmax | Duty = 50% | 1 | | | MHz |
| Input Capacitance | CI | | | | 15 | pF |

TIMING CONDITIONS (TA=-20~+70°C, VDD=4.5~5.5V)

| 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↑→STB↑ | 1 | | | μs |
| Wait Time | tWAIT | CLK↑→CLK↓ | 1 | | | μs |

PIN DESCRIPTION

| Pin NO | Symbol | Pin name | Description |
|--------|---------|----------------------|---|
| 1~4 | SW1~SW4 | Switch input | These pins constitute 4-bit general-purpose input port |
| 5 | DOUT | Data output | Output serial data at falling edge of shift clock, starting from lower bit. This is N-ch open-drain output pin. |
| 6 | DIN | Data input | Inputs serial data at rising edge of shift clock, starting from lower bit. |
| 7 | IC | Internally connected | Be sure to leave this pin open (this pin is at VDD level) |

(To be continued)

(Continued)

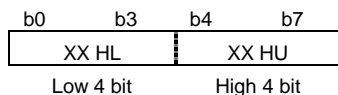
| Pin NO | Symbol | Pin name | Description |
|------------------|------------------------------|--|---|
| 8 | CLK | Clock input | Reads serial data at rising edge, and outputs data at falling edge. |
| 9 | STB | Strobe | Initializes serial interface at rising or falling edge to make SC16311 waiting for reception of command. Data input after STB has fallen is processed as command. While command data is processed, current processing is stopped, and serial interface is initialized. While STB is high, CLK is ignored. |
| 10~13 | Key1~Key4 | Key data input | Data input to these pins is latched at end of display cycle. |
| 14,33,45 | VDD | Logic power | 5V±10% |
| 15~26 | Seg1/KS1~ Seg12/KS12 | High-voltage output (segment) | Segment output pins. |
| 27~32, 35, 36 | Seg13/Grid16~S eg20/Grid9 | High-voltage output (grid/segment) | These pins are selectable for segment or grid output. |
| 34 | VEE | Pull-down level | VDD-35V |
| 37~44 | Grid8 ~ Grid1 | High-voltage output (grid) | Grid output pins |
| 46-50 | LED1~LED5 | LED output | CMOS output. +20mV .max. |
| 51 | VSS | Logic ground | Connect this pin to GND of system. |
| 52 | OSC | Oscillator pin | Connect resistor for determining oscillation frequency to this pin. |

FUNCTION DESCRIPTION

Display RAM Address and Display Mode

The display RAM stores the data transmitted from an external device to the SC16311 through the serial interface, and is assigned addresses as follows, in units of 8 bits:

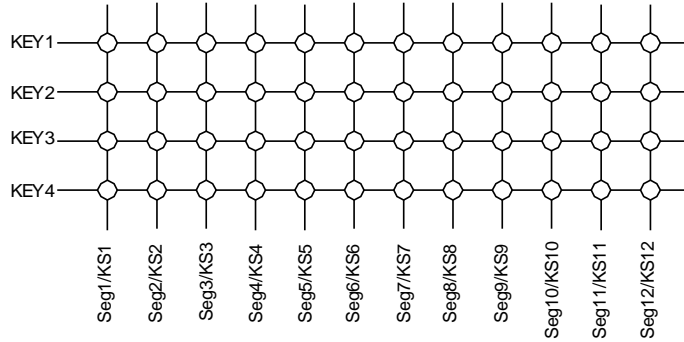
| Seg1 | Seg4 | Seg8 | Seg12 | Seg16 | Seg20 | |
|------|------|------|-------|-------|-------|-------|
| 00HL | | 00HU | 01HL | 01HU | 02HL | DIG1 |
| 03HL | | 03HU | 04HL | 04HU | 05HL | DIG2 |
| 06HL | | 06HU | 07HL | 07HU | 08HL | DIG3 |
| 09HL | | 09HU | 0AHL | 0AHU | 0BHL | DIG4 |
| 0CHL | | 0CHU | 0DHL | 0DHU | 0EHL | DIG5 |
| 0FHL | | 0FHU | 10HL | 10HU | 11HL | DIG6 |
| 12HL | | 12HU | 13HL | 13HU | 14HL | DIG7 |
| 15HL | | 15HU | 16HL | 16HU | 17HL | DIG8 |
| 18HL | | 18HU | 19HL | 19HU | 1AHL | DIG9 |
| 1BHL | | 1BHU | 1CHL | 1CHU | 1DHL | DIG10 |
| 1EHL | | 1EHU | 1FHL | 1FHU | 20HL | DIG11 |
| 21HL | | 21HU | 22HL | 22HU | 23HL | DIG12 |
| 24HL | | 24HU | 25HL | 25HU | 26HL | DIG13 |
| 27HL | | 27HU | 28HL | 28HU | 29HL | DIG14 |
| 2AHL | | 2AHU | 2BHL | 2BHU | 2CHL | DIG15 |
| 2DHL | | 2DHU | 2EHL | 2EHU | 2FHL | DIG16 |



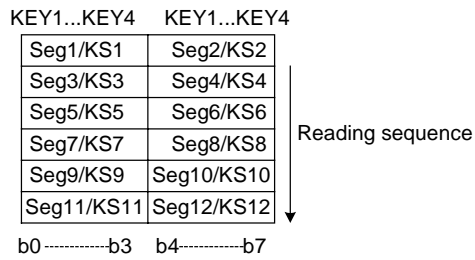
Only the lower 4 bits of the addresses assigned to Seg17 through Seg20 are valid, and the higher 4 bits are ignored.

Key Matrix and Key-Input Data Storage RAM

The key matrix is of 12 x 4 configuration, as shown below.



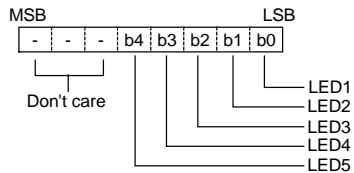
The data of each key is stored as illustrated below, and is read by a read command, starting from the least significant bit.



When the most significant bit of data (Seg12 b7) has been read, the least significant bit of the next data (Seg1 b0) is read.

LED Port

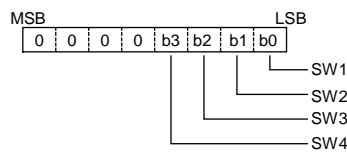
Data is written to the LED port by a write command, starting from the least significant bit of the port. When a bit of this port is 0, the corresponding LED lights; when the bit is 1, the LED goes off. The data of bits 6 through 8 is ignored.



On power application, all the LEDs remain dark.

SW data

The SW data is read by a read command, starting from the least significant bit. Bits 5 through 8 of the SW data are 0.



Command

A command sets the display mode and status of the FIP driver.

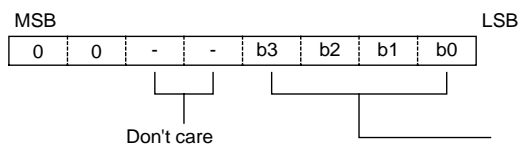
The first 1 byte input to the SC16311 through the DIN pin after the STB pin has fallen is regarded as a command.

If STB is made high while a command/data is transmitted, serial communication is initialized, and the command/data being transmitted is invalid (however, the command/data already transmitted remains valid).

(1) Display mode setting command

This command initializes the SC16311 and selects the number of segments and number of grids (1/8 to 1/16 duty, 12 segments to 20 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. If the same mode is selected, however, nothing is performed.

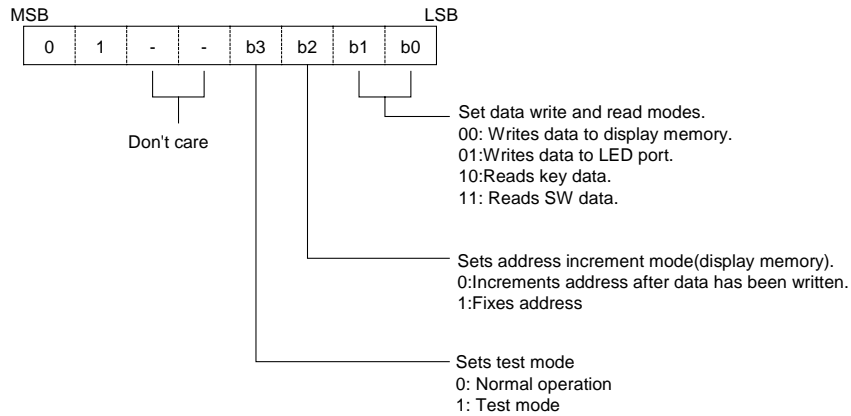


- Selects display mode
- 0XXX: 8 digits, 20 segments
 - 1000: 9 digits, 19 segments
 - 1001: 10 digits, 18 segments
 - 1010: 11 digits, 17 segments
 - 1011: 12 digits, 16 segments
 - 1100: 13 digits, 15 segments
 - 1101: 14 digits, 14 segments
 - 1110: 15 digits, 13 segments
 - 1111: 16 digits, 12 segments

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

(2) Data setting command

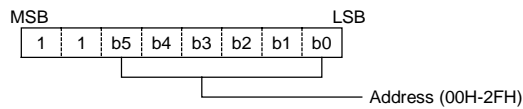
This command sets data write and data read modes.



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

(3) Address setting command

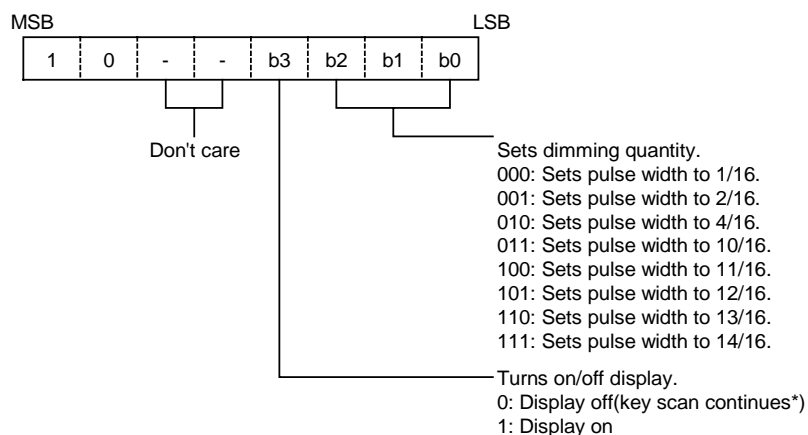
This command sets an address of the display memory.



If address 30H or higher is set, the data is ignored, until a correct address is set.

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

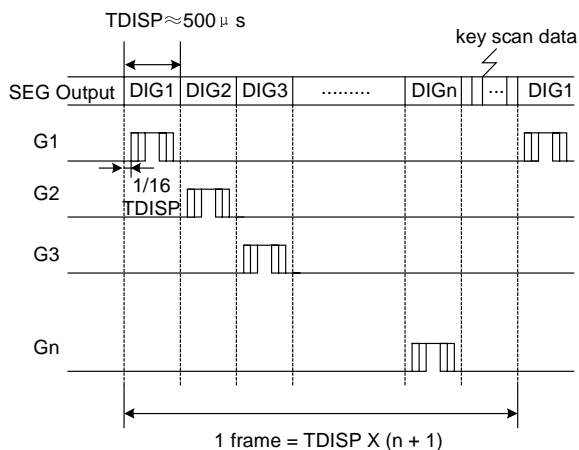
(4) Display control command



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

*: On power application, key scanning is stopped.

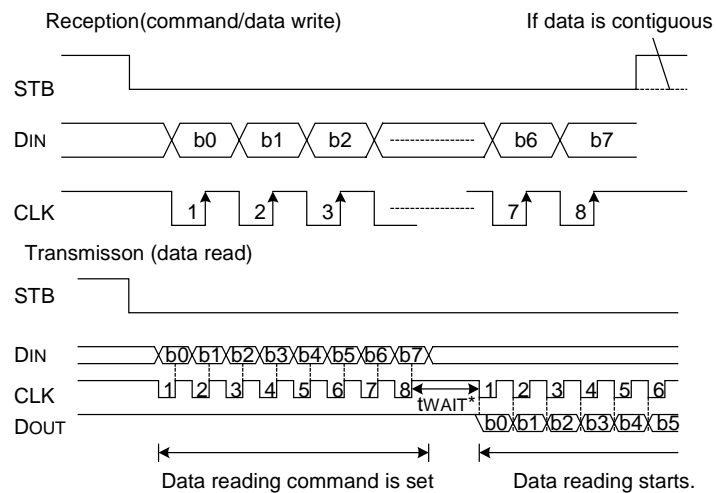
Key Scanning and Display Timing



One cycle of key scanning consists of two frames, and data of 12 x 4 matrices is stored in RAM.

Serial Communication Format

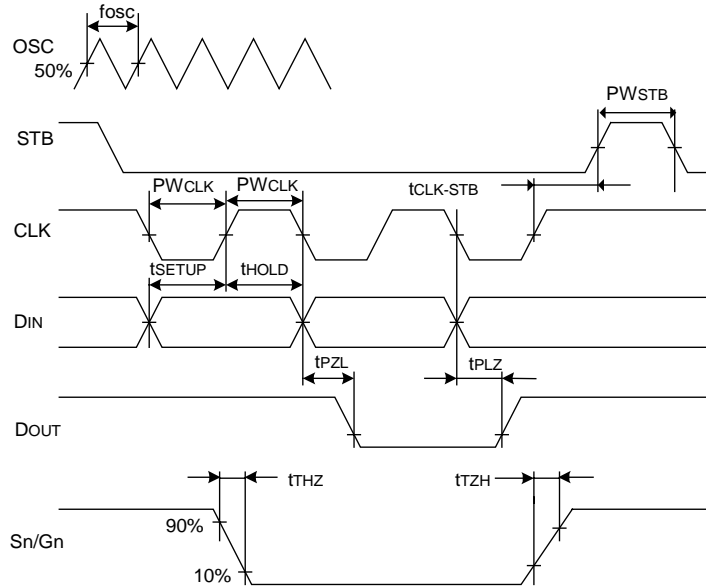
Reception (command/data write)



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

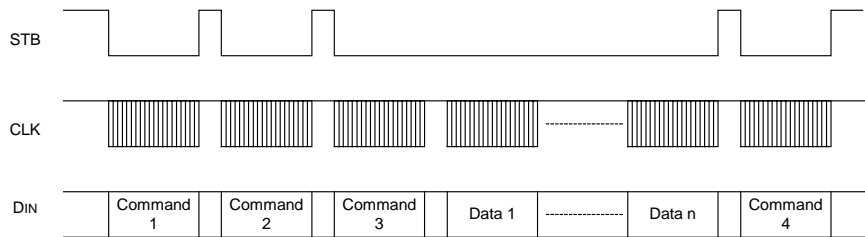
*: When data is read, a wait time t_{WAIT} of 1 μ s is necessary since the rising of the eighth clock that has set the command, until the falling of the first clock that has read the data.

Switching Characteristic Waveform



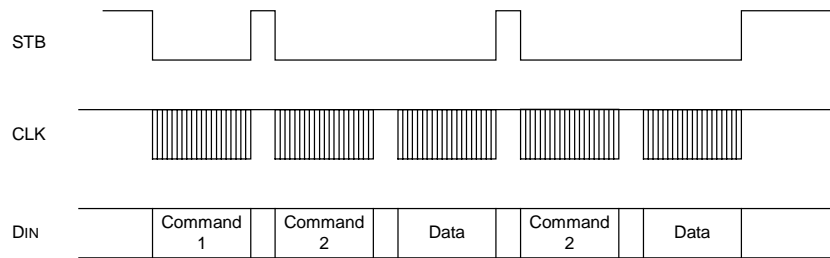
Applications

Updating display memory by incrementing address



- Command 1: sets display mode
- Command 2: sets data
- Command 3: sets address
- Data 1 to n: transfers display data (48 bytes max.)
- Command 4: controls display

Updating specific address



Command 1: sets data

Command 2: sets address

Data: display data

PACKAGE OUTLINE

