

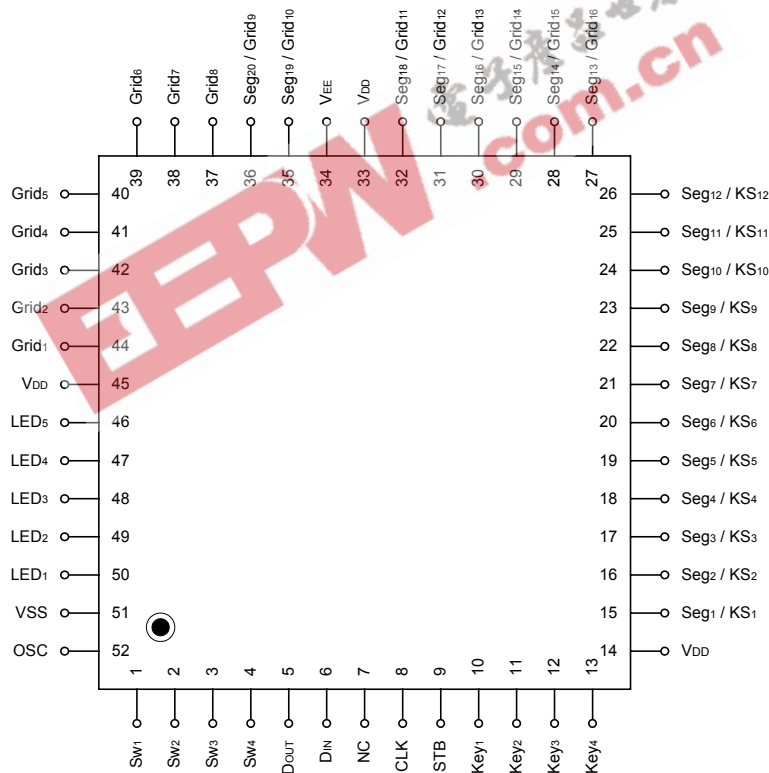
### ■ Features

- 4-pin serial interface
- Key scanning (12x4 matrices)
- Programming display modes (16-digit & 12-segment to 8-digit & 20-segment)
- Programming dimming step
- High-voltage output ( $V_{DD}$ -35V max)
- 5 channels LED ports
- 4-pin general-purpose input port
- Built-in oscillator
- No external resistor necessary for driver outputs

### ■ General Description

The AD6311 is a VFD (Vacuum Fluorescent Display) controller/driver that is driven on a 1/8- to 1/16 duty factor (include key scan). It consists of 12 segment/key scan 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 AD6311 through a four-line serial interface.

### ■ Pin Assignments

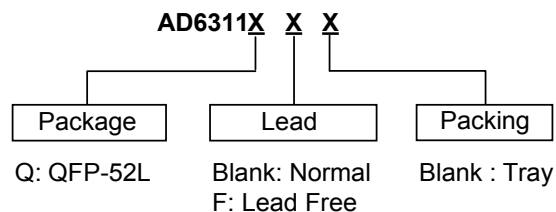


Use all the power pins.

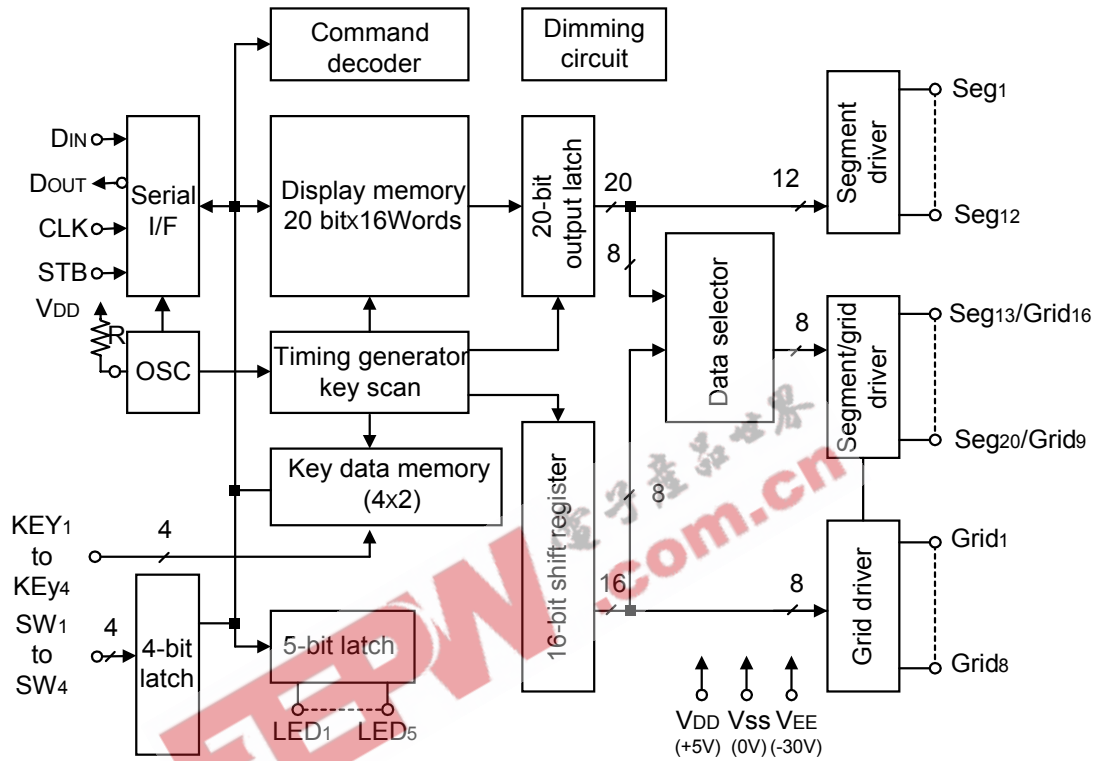
### ■ Pin Descriptions

Symbol	Name	No.	Description
D <sub>IN</sub>	Data input	6	Input serial data at rising edge of shift clock, starting from the low order bit.
D <sub>OUT</sub>	Data output	5	Output serial data at the falling edge of the shift clock, starting from low order bit. This is N-ch open-drain output pin.
STB	Strobe	9	Initializes serial interface at the rising or falling edge of the AD6311. It then waits for reception of a command. Data input after STB falling 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.
CLK	Clock input	8	Reads serial data at the rising edge, and outputs data at the falling edge.
OSC	Oscillator pin	52	Connect resistor in between this pin and V <sub>DD</sub> to set up the oscillation frequency.
Seg <sub>1</sub> /KS <sub>1</sub> to Seg <sub>12</sub> /KS <sub>12</sub>	High-voltage output	15 to 26	Multi-function pins, Segment output pins (Dual function as key scan source)
Grid <sub>1</sub> to Grid <sub>8</sub>	High-voltage output (Grid)	37 to 44	Grid output pins
Seg <sub>13</sub> /Grid <sub>16</sub> to Seg <sub>20</sub> /Grid <sub>9</sub>	High-voltage output (Segment/grid)	27 to 32 35, 36	These pins are selectable for segment or grid driving.
LED <sub>1</sub> to LED <sub>5</sub>	LED output	46 to 50	CMOS output
KEY <sub>1</sub> to KEY <sub>4</sub>	Key data input	10 to 13	Data input to these pins is latched at the end of the display cycle.
V <sub>DD</sub>	Logic power	14, 33, 45	Logic power supply
V <sub>SS</sub>	Logic ground	51	Connect this pin to system GND.
V <sub>EE</sub>	Pull-down level	34	Driver power supply
SW <sub>1</sub> to SW <sub>4</sub>	Switch input	1 to 4	These pins constitute a 4-bit general-purpose input port.
NC	NC	7	No connection

### ■ Ordering Information



### ■ Block Diagram



**■ Absolute Maximum Ratings** ( $T_A=25^{\circ}\text{C}, V_{SS}=0\text{V}$ )

Parameter	Symbol	Rating	Unit
Logic supply voltage	$V_{DD}$	-0.5 to +7.0	V
Driver supply voltage	$V_{EE}$	$V_{DD}+0.5$ to $V_{DD}-40$	V
Logic input voltage	$V_{I1}$	-0.5 to $V_{DD}+0.5$	V
VFD driver output voltage	$V_{O2}$	$V_{EE}-0.5$ to $V_{DD}+0.5$	V
LED driver output current	$I_{O1}$	+15	mA
VFD driver output current	$I_{O2}$	-40(grid) -15 (segment)	mA
Operating ambient temperature	$T_{OPT}$	-25 to +85	$^{\circ}\text{C}$
Storage temperature	$T_{STG}$	-50 to +125	$^{\circ}\text{C}$

**■ Operating Conditions** ( $T_A=0$  to  $+70^{\circ}\text{C}, V_{SS}=0\text{V}$ )

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Logic supply voltage	$V_{DD}$		4.5	5	5.5	V
High-level input voltage	$V_{IH}$		$0.7 \cdot V_{DD}$		$V_{DD}$	V
Low-level input voltage	$V_{IL}$		0		$0.3 \cdot V_{DD}$	V
Driver supply voltage	$V_{EE}$		0		$V_{DD}-35$	V

**■ DC Characteristics** ( $T_a=0$  to  $70^{\circ}\text{C}, V_{DD}=4.5$  to  $5.5\text{V}, V_{SS}=0\text{V}, V_{EE}=V_{DD}-35\text{V}$ )

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
High-level output voltage	$V_{OH1}$	LED <sub>1</sub> -LED <sub>5</sub> , $I_{OH1}=-1\text{mA}$	$0.9V_{DD}$			V
Low-level output voltage	$V_{OL1}$	LED <sub>1</sub> -LED <sub>5</sub> , $I_{OL1}=12\text{mA}$			1	V
Low-level output voltage	$V_{OL2}$	$D_{OUT}, I_{OL2}=2\text{mA}$			0.4	V
High-level output current	$I_{OH21}$	$V_O=V_{DD}-2\text{V}$ , Seg <sub>1</sub> to Seg <sub>12</sub>	-3			mA
High-level output current	$I_{OH22}$	$V_O=V_{DD}-2\text{V}$ , Grid <sub>1</sub> to Grid <sub>8</sub> , Seg <sub>13</sub> /Grid <sub>16</sub> to Seg <sub>20</sub> /Grid <sub>9</sub>	-15			mA
Driver leakage current	$I_{OLEAK}$	$V_O=V_{DD}-35\text{V}$ , driver off			-10	$\mu\text{A}$
Output pull-down resistor	$R_L$	Driver output	50	100	150	$\text{k}\Omega$
High-level input voltage	$V_{IH}$		$0.7V_{DD}$			V
Low-level input voltage	$V_{IL}$				$0.3V_{DD}$	V

**■ AC Characteristics** ( $T_a=0$  to  $+70^{\circ}\text{C}, V_{DD}=4.5$  to  $5.5\text{V}$ )

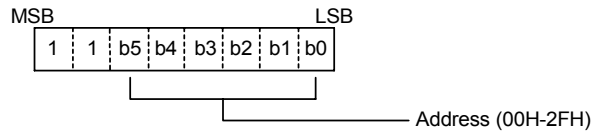
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Oscillation frequency	$f_{OSC}$	$R=51\text{ k}\Omega$	350	500	650	$\text{kHz}$
Maximum clock frequency	$f_{max}$	Duty=50%			1	$\text{MHz}$
Clock pulse width	$PW_{CLK}$		500			ns
Strobe pulse width	$PW_{STB}$		1			$\mu\text{s}$
Data setup time	$t_{SETUP}$		100			ns
Data hold time	$t_{HOLD}$		100			ns
Clock-strobe time	$t_{CLK-STB}$	CLK $\uparrow$ $\rightarrow$ STB $\uparrow$	1			$\mu\text{s}$
Wait time	$t_{WAIT}$	CLK $\uparrow$ $\rightarrow$ CLK $\downarrow$ (Note)	1			$\mu\text{s}$

Note: Refer to page 8.

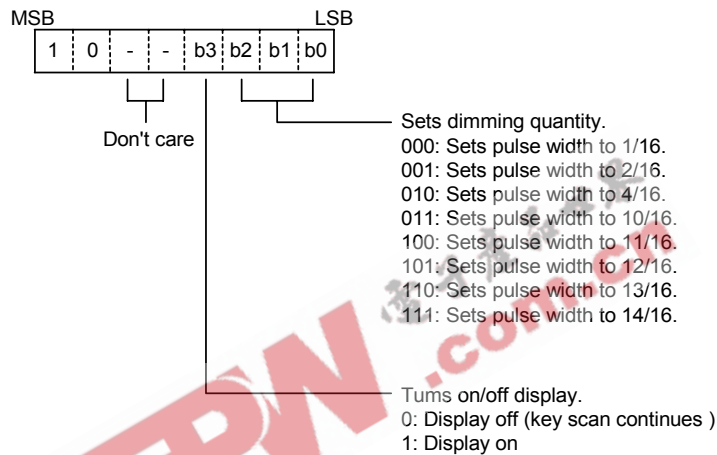


### 1.3 Address setting command

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.



### 1.4 Display control command



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

### 2.0 Display RAM Address and Display Mode

The display RAM stores the data transmitted from an external device to the AD6311 through the serial interface, and is assigned addresses as follows, in units of 8 bits:

Seg <sub>1</sub>	Seg <sub>4</sub>	Seg <sub>8</sub>	Seg <sub>12</sub>	Seg <sub>16</sub>	Seg <sub>20</sub>	
00 H <sub>L</sub>	:00 H <sub>U</sub>	01 H <sub>L</sub>	:01 H <sub>U</sub>	02 H <sub>L</sub>		GRID <sub>1</sub>
03 H <sub>L</sub>	:03 H <sub>U</sub>	04 H <sub>L</sub>	:04 H <sub>U</sub>	05 H <sub>L</sub>		GRID <sub>2</sub>
06 H <sub>L</sub>	:06 H <sub>U</sub>	07 H <sub>L</sub>	:07 H <sub>U</sub>	08 H <sub>L</sub>		GRID <sub>3</sub>
09 H <sub>L</sub>	:09 H <sub>U</sub>	0 A H <sub>L</sub>	:0 A H <sub>U</sub>	0 B H <sub>L</sub>		GRID <sub>4</sub>
0 C H <sub>L</sub>	:0 C H <sub>U</sub>	0 D H <sub>L</sub>	:0 D H <sub>U</sub>	0 E H <sub>L</sub>		GRID <sub>5</sub>
0 F H <sub>L</sub>	:0 F H <sub>U</sub>	10 H <sub>L</sub>	:10 H <sub>U</sub>	11 H <sub>L</sub>		GRID <sub>6</sub>
12 H <sub>L</sub>	:12 H <sub>U</sub>	13 H <sub>L</sub>	:13 H <sub>U</sub>	14 H <sub>L</sub>		GRID <sub>7</sub>
15 H <sub>L</sub>	:15 H <sub>U</sub>	16 H <sub>L</sub>	:16 H <sub>U</sub>	17 H <sub>L</sub>		GRID <sub>8</sub>
18 H <sub>L</sub>	:18 H <sub>U</sub>	19 H <sub>L</sub>	:19 H <sub>U</sub>	1 A H <sub>L</sub>		GRID <sub>9</sub>
1 B H <sub>L</sub>	:1 B H <sub>U</sub>	1 C H <sub>L</sub>	:1 C H <sub>U</sub>	1 D H <sub>L</sub>		GRID <sub>10</sub>
1 E H <sub>L</sub>	:1 E H <sub>U</sub>	1 F H <sub>L</sub>	:1 F H <sub>U</sub>	20 H <sub>L</sub>		GRID <sub>11</sub>
21 H <sub>L</sub>	:21 H <sub>U</sub>	22 H <sub>L</sub>	:22 H <sub>U</sub>	23 H <sub>L</sub>		GRID <sub>12</sub>
24 H <sub>L</sub>	:24 H <sub>U</sub>	25 H <sub>L</sub>	:25 H <sub>U</sub>	26 H <sub>L</sub>		GRID <sub>13</sub>
27 H <sub>L</sub>	:27 H <sub>U</sub>	28 H <sub>L</sub>	:28 H <sub>U</sub>	29 H <sub>L</sub>		GRID <sub>14</sub>
2 A H <sub>L</sub>	:2 A H <sub>U</sub>	2 B H <sub>L</sub>	:2 B H <sub>U</sub>	2 C H <sub>L</sub>		GRID <sub>15</sub>
2 D H <sub>L</sub>	:2 D H <sub>U</sub>	2 E H <sub>L</sub>	:2 E H <sub>U</sub>	2 F H <sub>L</sub>		GRID <sub>16</sub>

b0	b3 b4	b7
XX H <sub>L</sub>	XXH <sub>U</sub>	

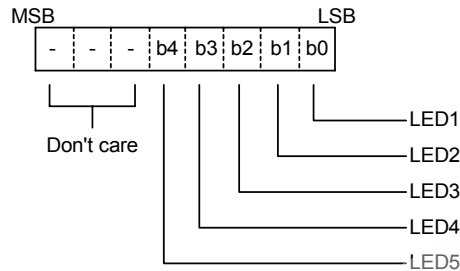
## 1/8- to 1/16 Duty VFD Controller/Driver

Lower 4 bits      Higher 4 bits

Only the lower 4 bits of the addresses assigned to Seg<sub>17</sub> through Seg<sub>20</sub> are valid, and the higher 4 bits are ignored.

### 3.0 LED Port

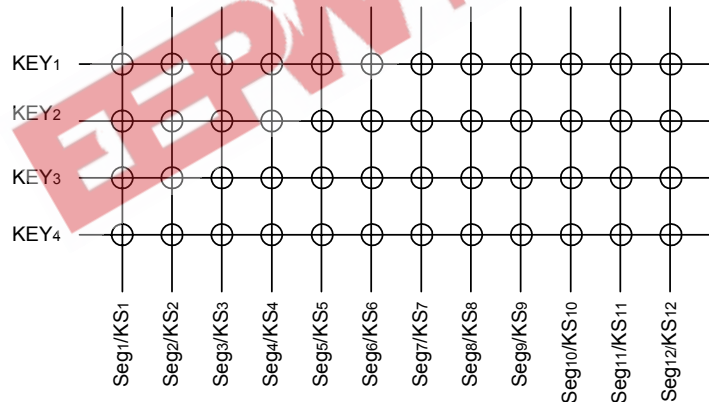
Data is written to the LED port by a write command, starting from the least significant bit of the port. When a bit of this port is 0, the corresponding LED lights; when the bit is 1, the LED goes off. The data of bits 6 through 8 is ignored.



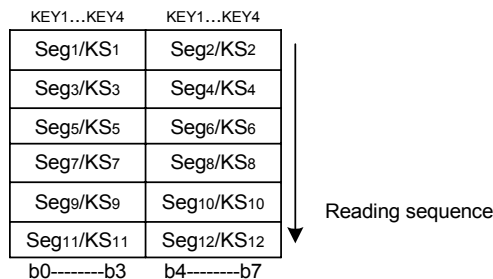
On power application, all the LEDs remain dark.

### 4.0 Key Matrix and Key-Input data Storage RAM

The key matrix is of 12x4 configuration, as shown below.

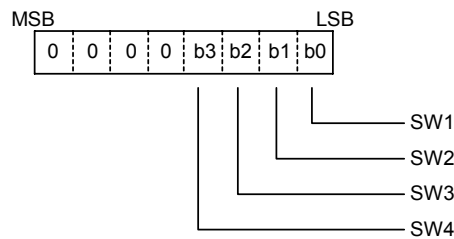


The data of each key is stored as illustrated below, and is read by a read command, starting from the least significant bit. When the most significant bit of data (Seg<sub>12</sub> b<sub>7</sub>) has been read, the least significant bit of the next data (Seg<sub>1</sub> b<sub>0</sub>) is read.



### 5.0 SW Data

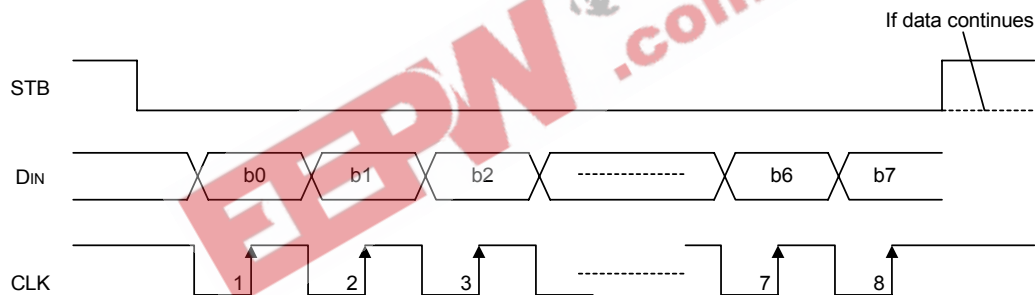
The SW data is read by a read command, starting from the least significant bit. Bits 5 through 8 of the SW data are 0.



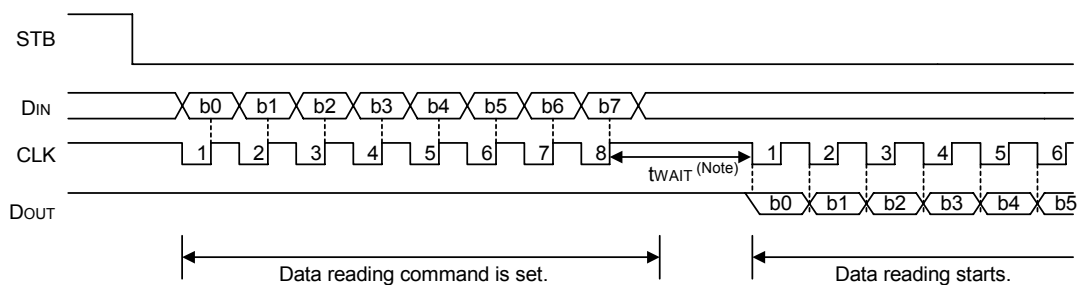
### ■ Timing Diagram

#### (1) Serial Communication Format

Reception (command/write data)



Transmission (read data)

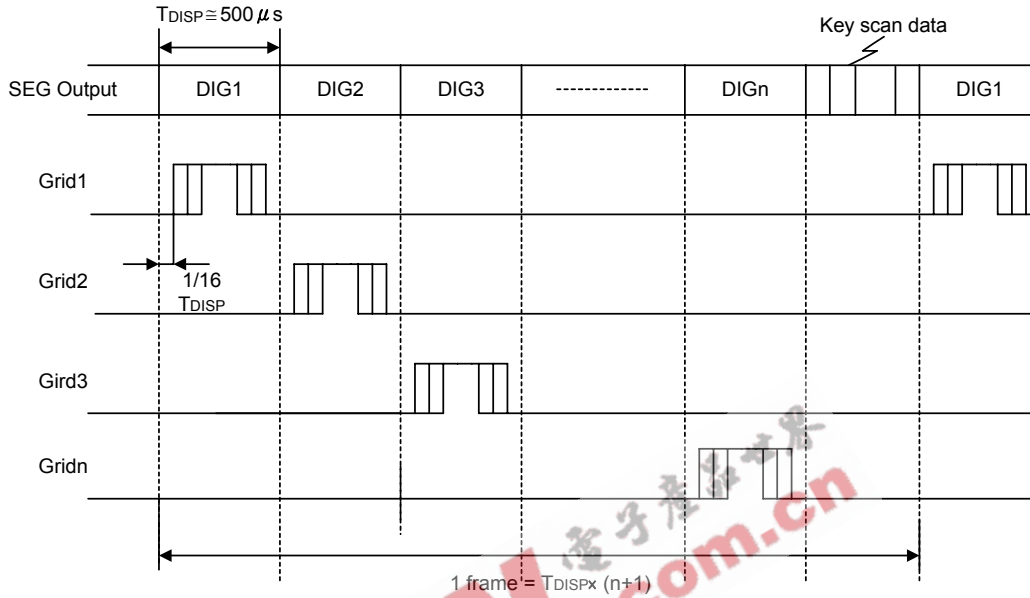


Because the  $D_{OUT}$  pin is an N-ch, open-drain output pin, be sure to connect an external pull-up resistor to this pin ( $1k\Omega$  to  $10k\Omega$ ).

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.

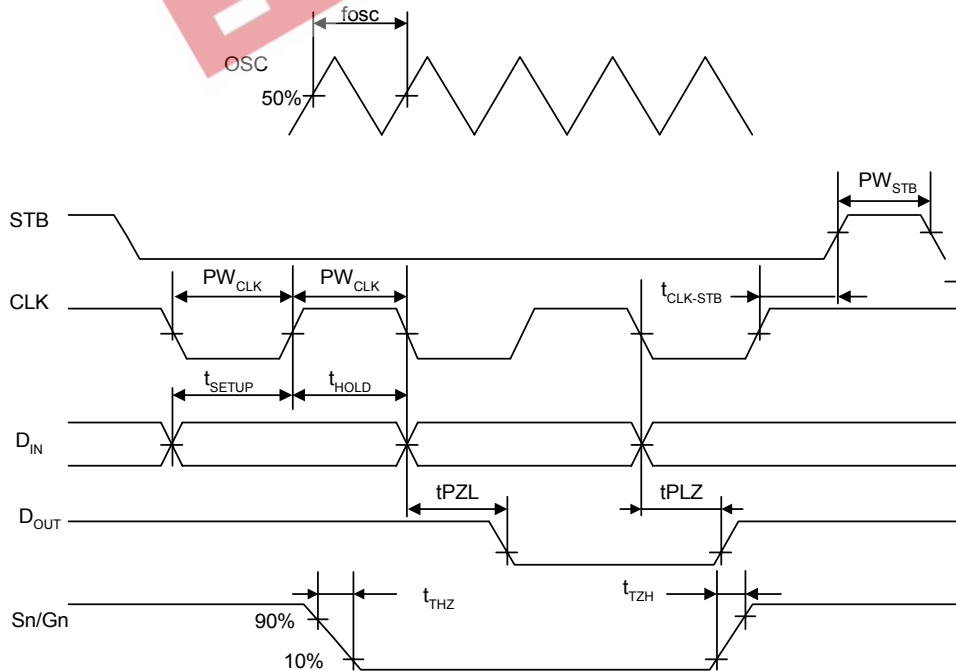


### (2) Key Scanning and Display Timing



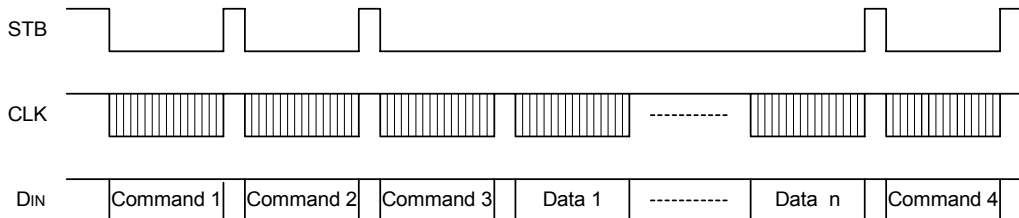
One cycle of key scanning consists of two frames, and data of 12x 4 matrices is stored in RAM.

### AC characteristic waveform



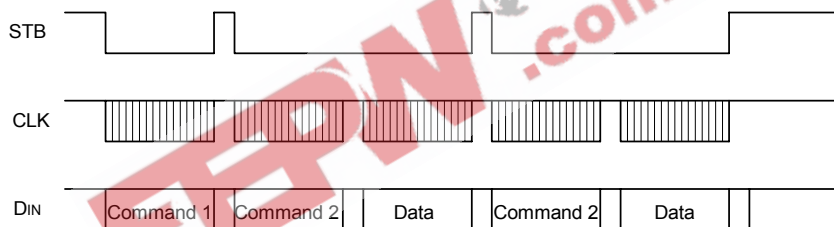
### Applications

Updating display memory by incrementing address



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

Updating specific display memory

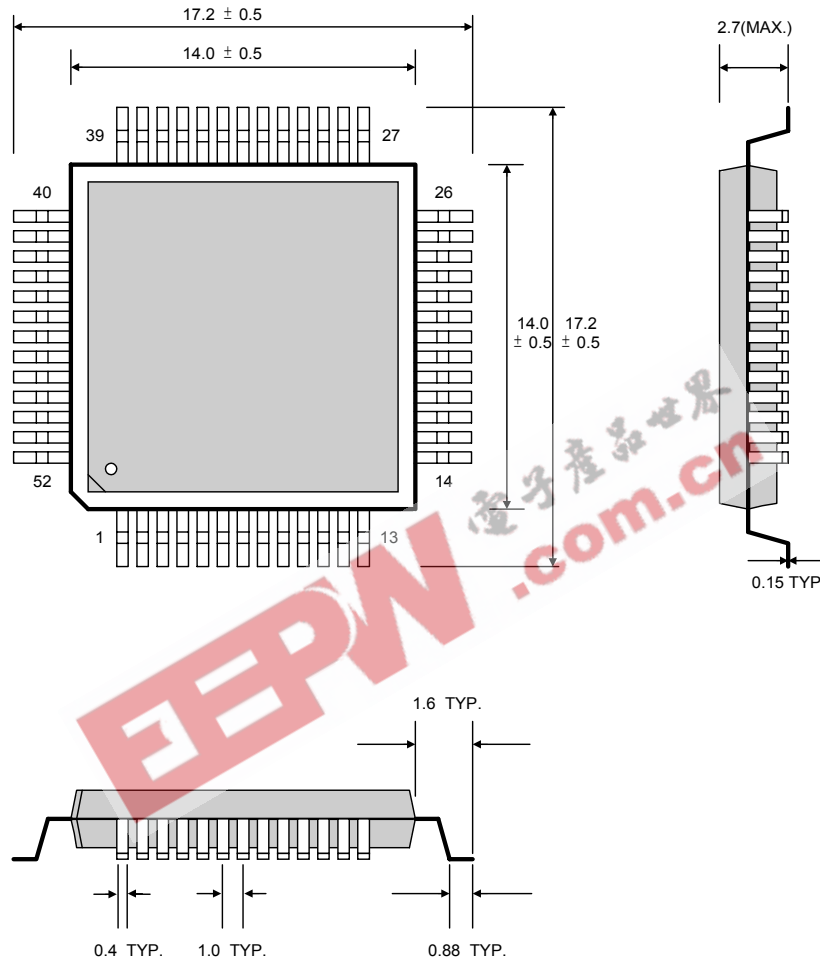


- Command 1: sets data
- Command 2: sets address
- Data: display data

### ■ Package Information

52 pins QFP dimension

Unit: mm



### ■ Marking Information

