

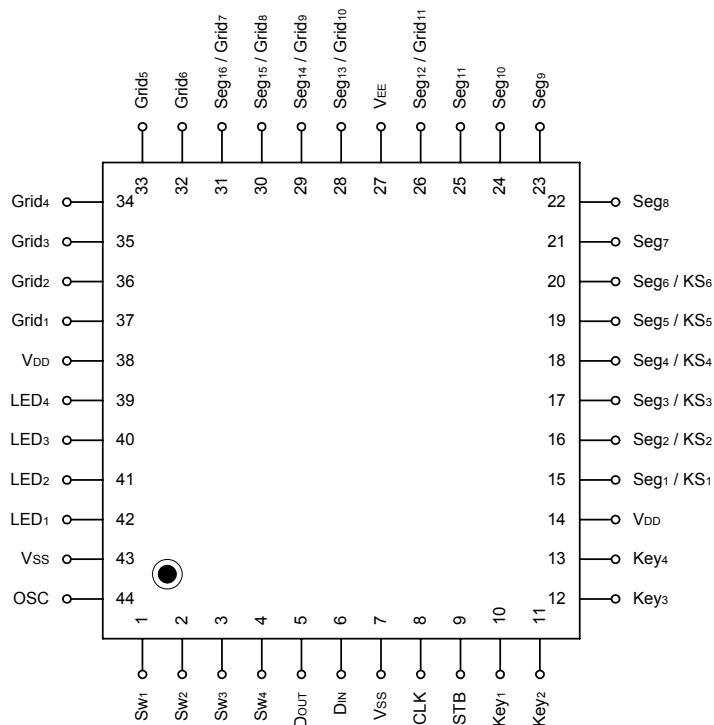
■ Features

- 4-pin serial interface
- Key scanning (6x 4 matrices)
- Programming display modes (11-segments & 11-digits to 16-segments & 6-digits)
- Programming dimming step
- High-voltage output (V_{DD} -35V max).
- 4 channels LED ports.
- 4-pin General-purpose input port
- Built-in oscillator
- No external resistor necessary for driver outputs

■ General Description

The AD6312 is a VFD (Vacuum Fluorescent Display) controller/driver that is driven on a 1/4- to 1/11 duty factor (include key scan). It consists of 5 segment output lines, 6 segment/key scan 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 AD6312 through a four-line serial interface.

■ Pin Assignments

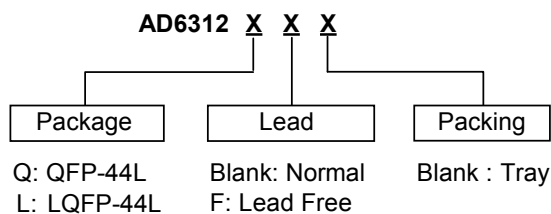


Use all power pins.

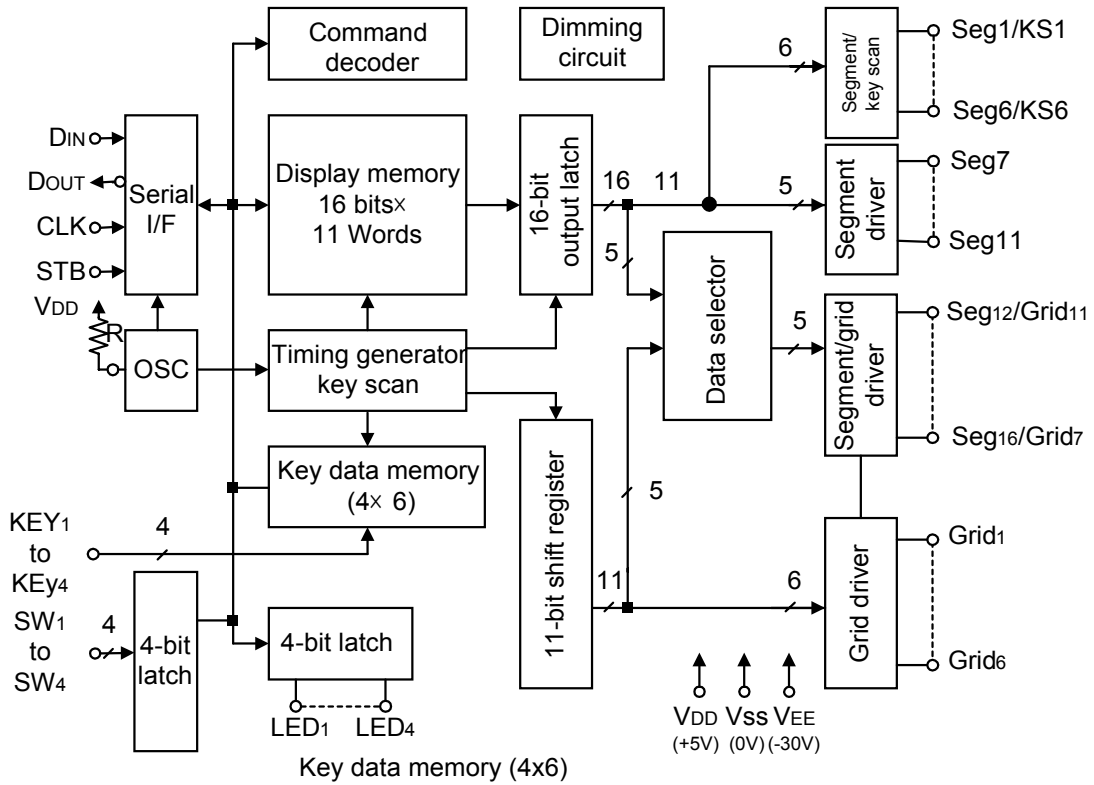
■ Pin Descriptions

| Symbol | Name | No. | Description |
|---|------------------------------------|--------------|---|
| D _{IN} | Data input | 6 | Input serial data at rising edge of shift clock, starting from the low order bit. |
| D _{OUT} | 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 AD6312. 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 | 44 | Connect resistor in between this pin and V _{SS} to set up the oscillation frequency. |
| Seg ₇ to Seg ₁₁ | High-voltage output (Segment) | 21 to 25 | Segment output pins |
| Seg ₁ /KS ₁ to Seg ₆ /KS ₆ | High-voltage output | 15 to 20 | Multi-function pins, Segment output pins (Dual function as key scan source) |
| Grid ₁ to Grid ₆ | High-voltage output (Grid) | 32 to 37 | Grid output pins |
| Seg ₁₂ /Grid ₁₁ to Seg ₁₆ /Grid ₇ | High-voltage output (Segment/grid) | 26, 28 to 31 | These pins are selectable for segment or grid driving. |
| LED ₁ to LED ₄ | LED output | 39 to 42 | CMOS output |
| KEY ₁ to KEY ₄ | Key data input | 10 to 13 | Data input to these pins is latched at the end of the display cycle. |
| V _{DD} | Logic power | 14, 38 | Logic power supply |
| V _{SS} | Logic ground | 7, 43 | Connect this pin to system GND. |
| V _{EE} | Pull-down level | 27 | Driver power supply |
| SW ₁ to SW ₄ | Switch input | 1 to 4 | These pins constitute a 4-bit general-purpose input port. |

■ Ordering Information



■ Block Diagram



1/4- to 1/11 Duty VFD Controller/Driver
■ 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 ₁ -LED ₄ , $I_{OH1}=-1\text{mA}$ | $0.9V_{DD}$ | | | V |
| Low-Level Output Voltage | V_{OL1} | LED ₁ -LED ₄ , $I_{OL1}=12\text{mA}$ | | | 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 ₁ to Seg ₁₁ | -3 | | | mA |
| High-Level Output Current | I_{OH22} | $V_O=V_{DD}-2\text{V}$, Grid ₁ to Grid ₆ Seg ₁₂ /Grid ₁₁ to Seg ₁₆ /Grid ₇ | -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 | $\text{k}\Omega$ |
| 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 $5.5\text{V}, V_{EE}=-30\text{V}$)

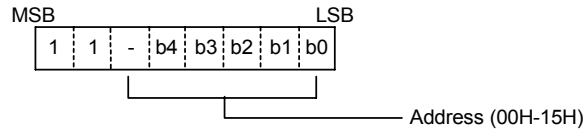
| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|-------------------------|---------------|--|------|------|------|---------------|
| Oscillation Frequency | f_{OSC} | $R=51\text{ k}\Omega$ | 350 | 500 | 650 | KHz |
| Maximum Clock Frequency | f_{max} | Duty=50% | | | 1 | MHz |
| Clock Pulse Width | PW_{CLK} | | 500 | | | ns |
| Strobe Pulse Width | PW_{STB} | | 1 | | | μs |
| 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 | | | μs |
| Wait Time | t_{WAIT} | CLK \uparrow \rightarrow CLK \downarrow (Note) | 1 | | | μs |

Note : Refer to page 8.

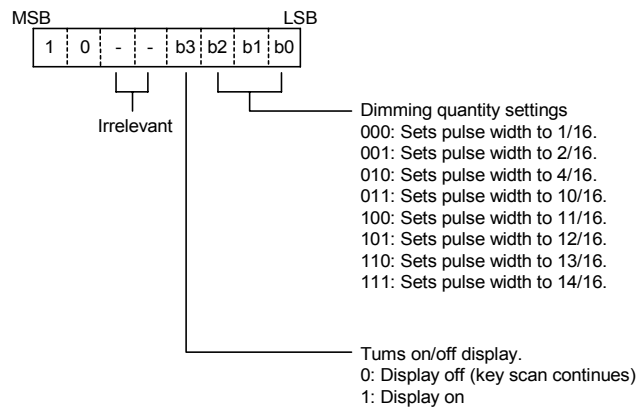
1/4- to 1/11 Duty VFD Controller/Driver

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



1.4 Display control commands

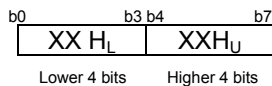


On power application, the 1/16-pulse width is set, the display is turned off and key scanning is stopped.

2.0 Display RAM Address and Display Mode

The display RAM stores the data transmitted from an external device to the AD6312 through the serial interface, and is assigned addresses as follows, in 8 bits unit:

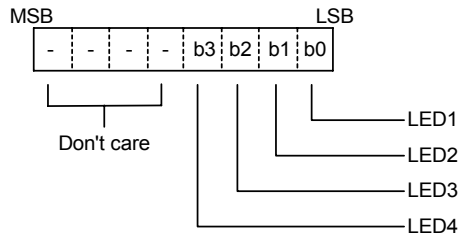
| Seg ₁ | Seg ₄ | Seg ₈ | Seg ₁₂ | Seg ₁₆ | |
|--------------------|--------------------|--------------------|--------------------|-------------------|--|
| 00 H _L | 00 H _U | 01 H _L | 01 H _U | DIG ₁ | |
| 02 H _L | 02 H _U | 03 H _L | 03 H _U | DIG ₂ | |
| 04 H _L | 04 H _U | 05 H _L | 05 H _U | DIG ₃ | |
| 06 H _L | 06 H _U | 07 H _L | 07 H _U | DIG ₄ | |
| 08 H _L | 08 H _U | 09 H _L | 09 H _U | DIG ₅ | |
| 0 A H _L | 0 A H _U | 0 B H _L | 0 B H _U | DIG ₆ | |
| 0 C H _L | 0 C H _U | 0 D H _L | 0 D H _U | DIG ₇ | |
| 0 E H _L | 0 E H _U | 0 F H _L | 0 F H _U | DIG ₈ | |
| 10 H _L | 10 H _U | 11 H _L | 11 H _U | DIG ₉ | |
| 12 H _L | 12 H _U | 13 H _L | 13 H _U | DIG ₁₀ | |
| 14 H _L | 14 H _U | 15 H _L | 15 H _U | DIG ₁₁ | |



1/4- to 1/11 Duty VFD Controller/Driver

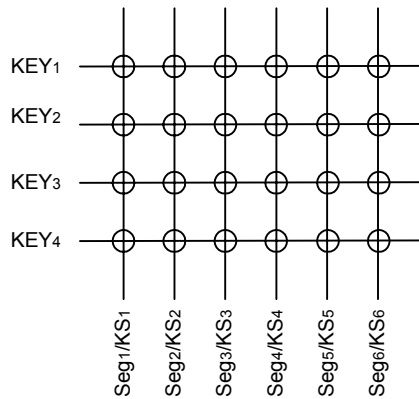
3.0 LED Port

Data is written to the LED port with the write 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.

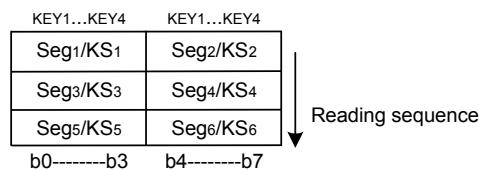


4.0 Key Matrix and Key-Input data Storage RAM

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

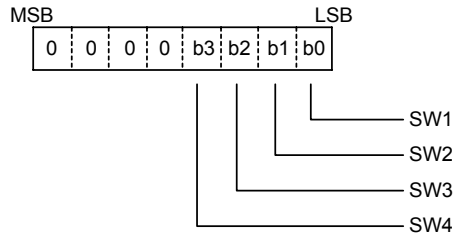


The data of each key is stored as illustrated below, and is read with the read command, starting from the least significant bit.



5.0 SW Data

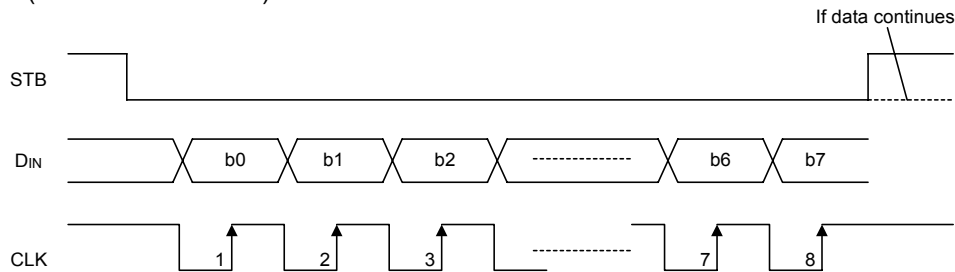
SW data is read with the read command, starting from the least significant bit. Bits 5 through 8 of the SW data are 0.



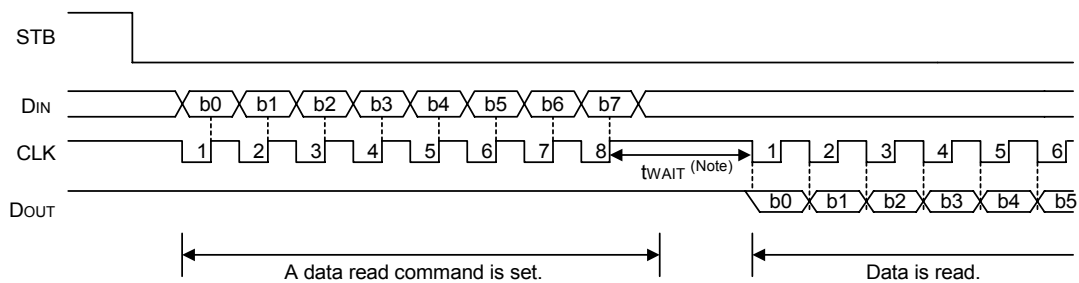
■ Timing Diagram

(1) Serial Communication Format

Reception (command/write data)



Transmission (read data)

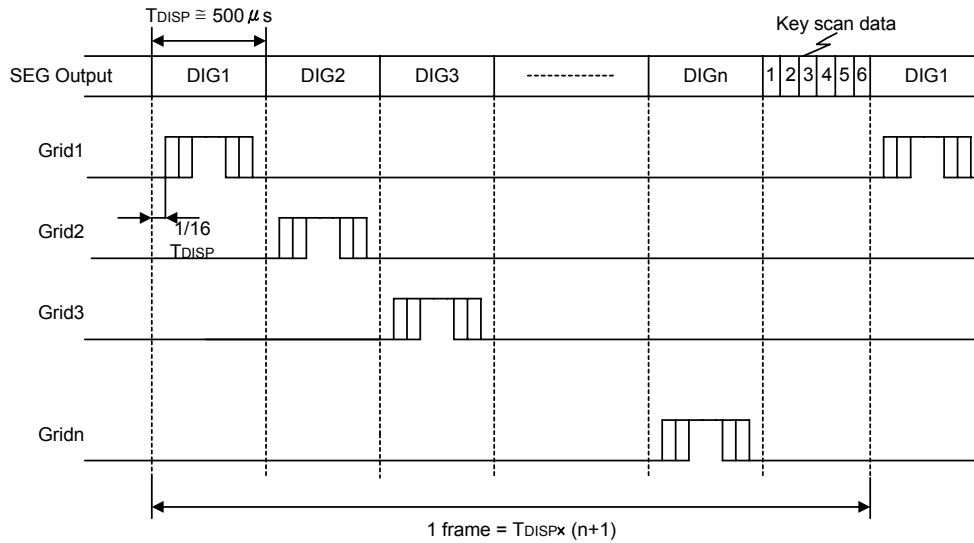


Because the D_{OUT} pin is an N-ch, open-drain output pin, be sure to connect an external pull-up resistor to this pin (1kΩ to 10 kΩ).

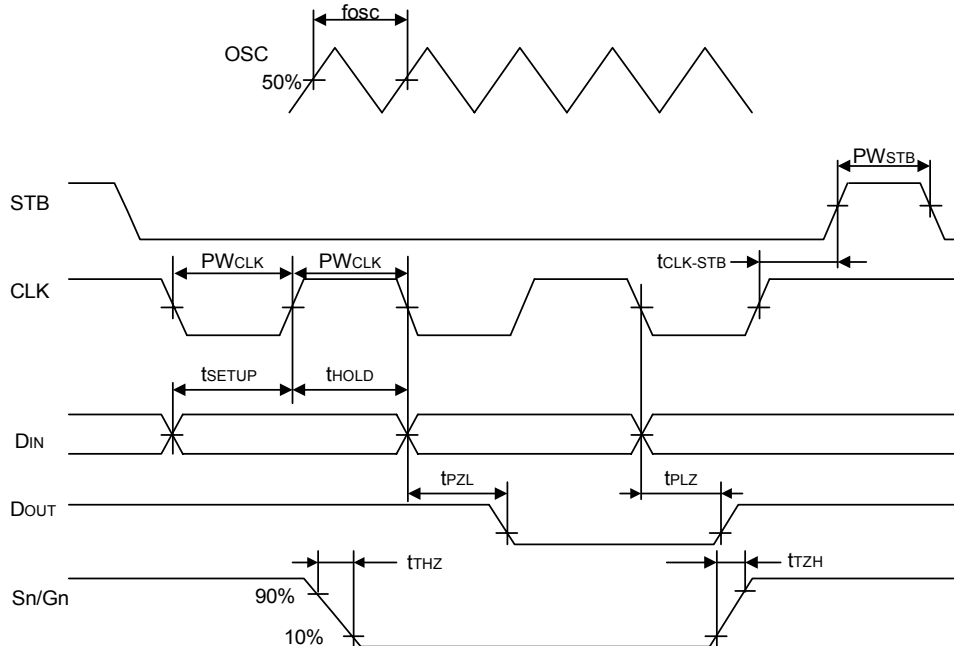
Note : When data is read, a wait time t_{WAIT} of 1 μs is necessary since the rising of the eighth clock that has set the command, until the falling of the first clock that has read the data.

(2) Key Scanning and Display Timing

On cycle of key scanning consists of one frame, and data in a 6 × 4 matrix is stored in RAM.

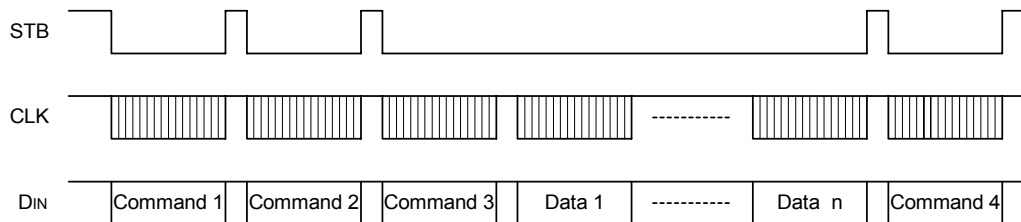


Switching characteristic waveforms



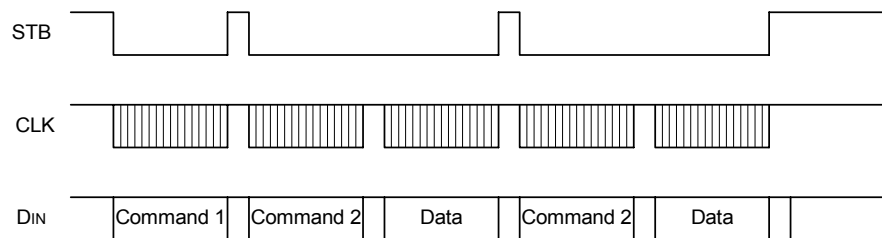
Applications

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 (22bytes max.)
 Command 4: controls display

Updating specific display memory

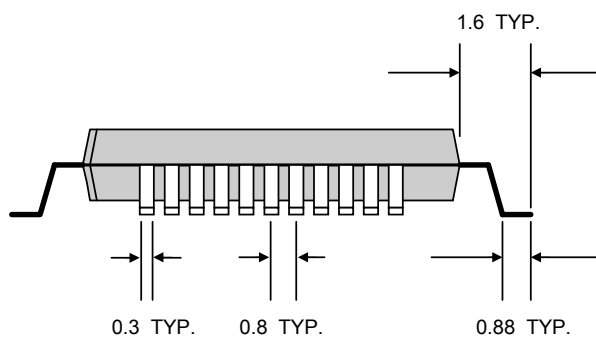
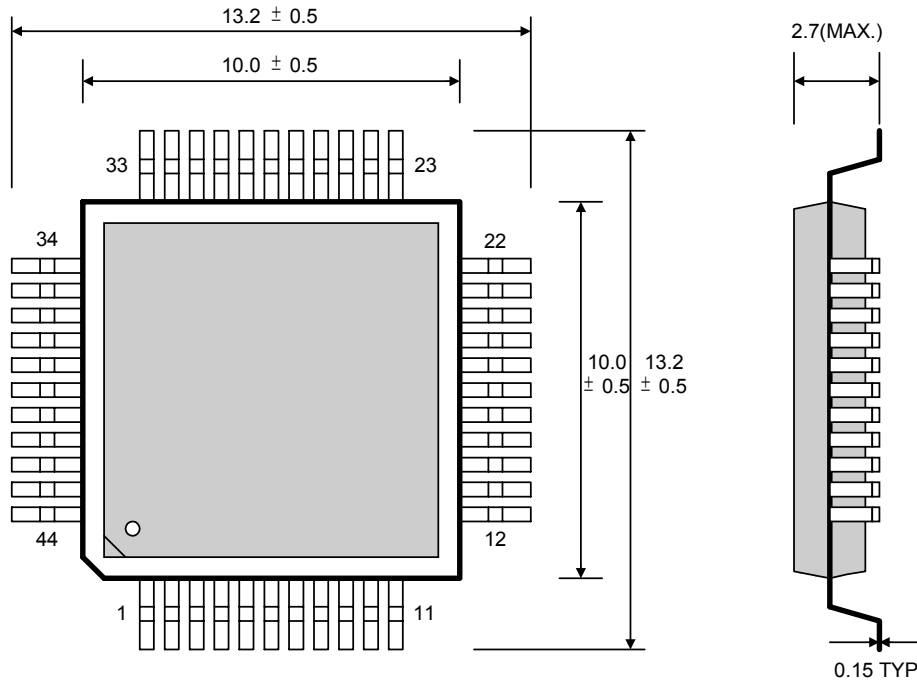


Command 1: sets data
 Command 2: sets address
 Data: display data

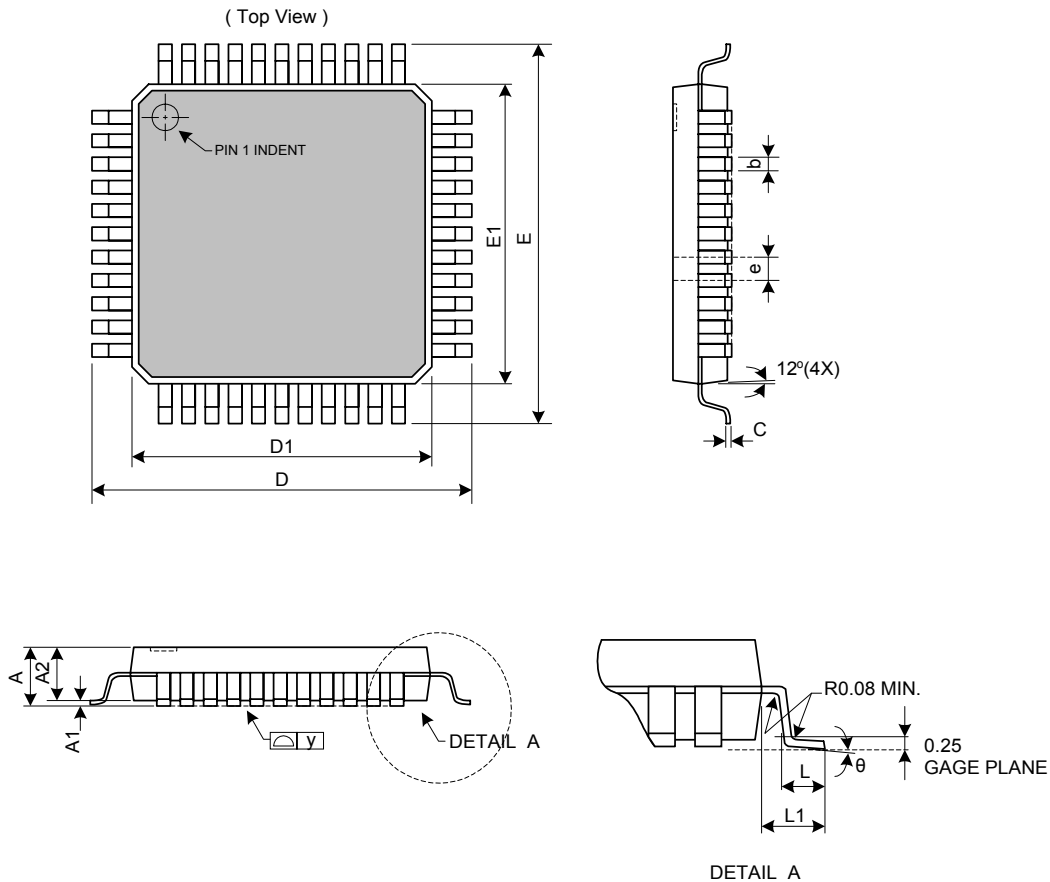
■ Package Information

(1) Package Type: QFP-44L

Dimension in millimeter (mm.)



(2) Package Type: LQFP-44L



| Symbol | Dimensions In Millimeters | | | Dimensions In Inches | | |
|--------|---------------------------|-------|-------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | - | - | 1.60 | - | - | 0.063 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 1.35 | 1.40 | 1.45 | 0.053 | 0.055 | 0.057 |
| b | 0.30 | 0.37 | 0.45 | 0.012 | 0.015 | 0.018 |
| C | 0.09 | - | 0.20 | 0.004 | - | 0.008 |
| E | 11.50 | 12.00 | 12.50 | 0.453 | 0.472 | 0.492 |
| E1 | 9.50 | 10.00 | 10.50 | 0.374 | 0.394 | 0.413 |
| D | 11.80 | 12.00 | 12.20 | 0.465 | 0.472 | 0.480 |
| D1 | 9.90 | 10.00 | 10.10 | 0.390 | 0.394 | 0.398 |
| e | - | 0.80 | - | - | 0.031 | - |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | - | 1.00 | - | - | 0.039 | - |
| θ | 0° | 3.5° | 7° | 0° | 3.5° | 7° |
| y | 0.00 | - | 0.08 | 0.000 | - | 0.003 |

■ Marking Information

