

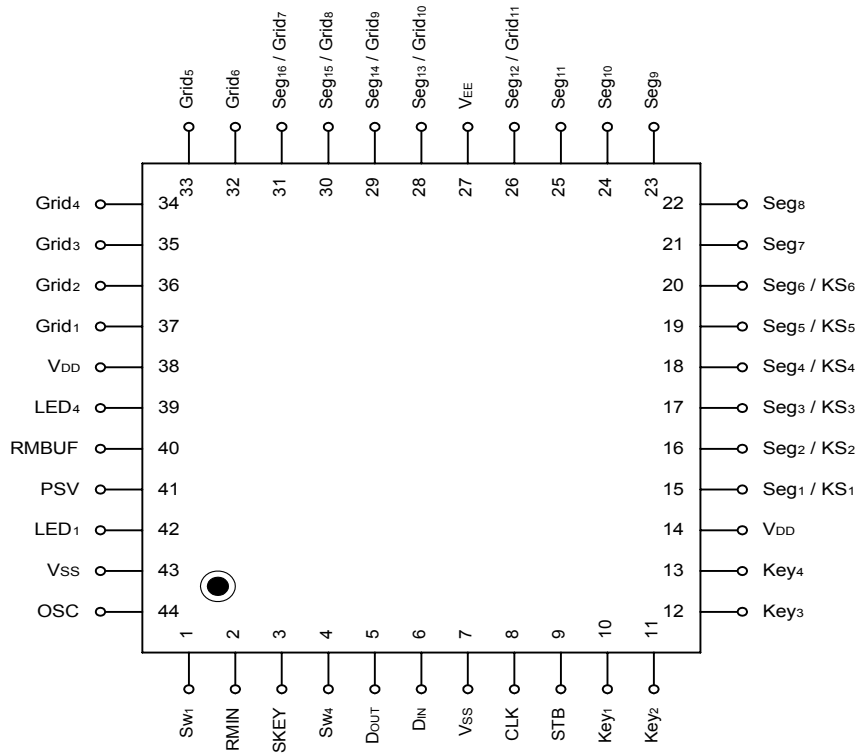
**■ Features**

- Serial interface (CLK, STB, D<sub>IN</sub>, D<sub>OUT</sub>)
- Key scanning (6x 4 matrices)
- Programming display modes (11-digit & 11-segment to 6-digit & 16-segment)
- Programming dimming step
- High-voltage output (V<sub>DD</sub>-35V max).
- 2 channels LED ports.
- 2-pin General-purpose input port
- Built-in oscillator
- No external resistor necessary for driver outputs (provides PMOS open-drain and pull-low resistor output)
- Remote signal input port
- Remote signal output port
- 3 STANDBY master output ports (controlled by remote STANDBY-KEY, STANDBY-KEY and STANDBY SCAN-KEY)
- 8 WAKE UP master output ports (controlled by 2 remote WAKE\_UP-KEY, 3 WAKE\_UP SCAN-KEY, remote STANDBY-KEY, STANDBY-KEY and STANDBY SCAN-KEY)
- NEC 6121/6122 infrared protocol support

**■ General Description**

The AD7312 is a VFD (Vacuum Fluorescent Display) controller/driver with STANDBY controller. It 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, 2 LED output ports, a display memory, a control circuit, and a key scan circuit. In addition, it includes 2 input ports, RMIN and SKEY, RMIN receives the signal from the STANDBY-KEY of remote sensor, SKEY can be controlled by an external switch. Both of them and STANBY SCAN-KEY can control the output level (High) of PSV port to realize the STANDBY function. To leave the standby mode, we can use the 2 remote WAKE\_UP-KEY, 3 WAKE\_UP SCAN-KEY, remote STANDBY-KEY, STANDBY-KEY and STANDBY SCAN-KEY to control the output level (Low) of PSV port to realize the Wake Up function. Serial data is input to the AD7312 through a four-line serial interface.

■ Pin Assignments

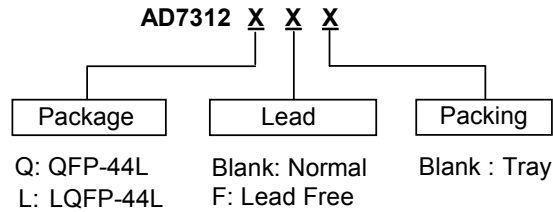


Use all power pins.

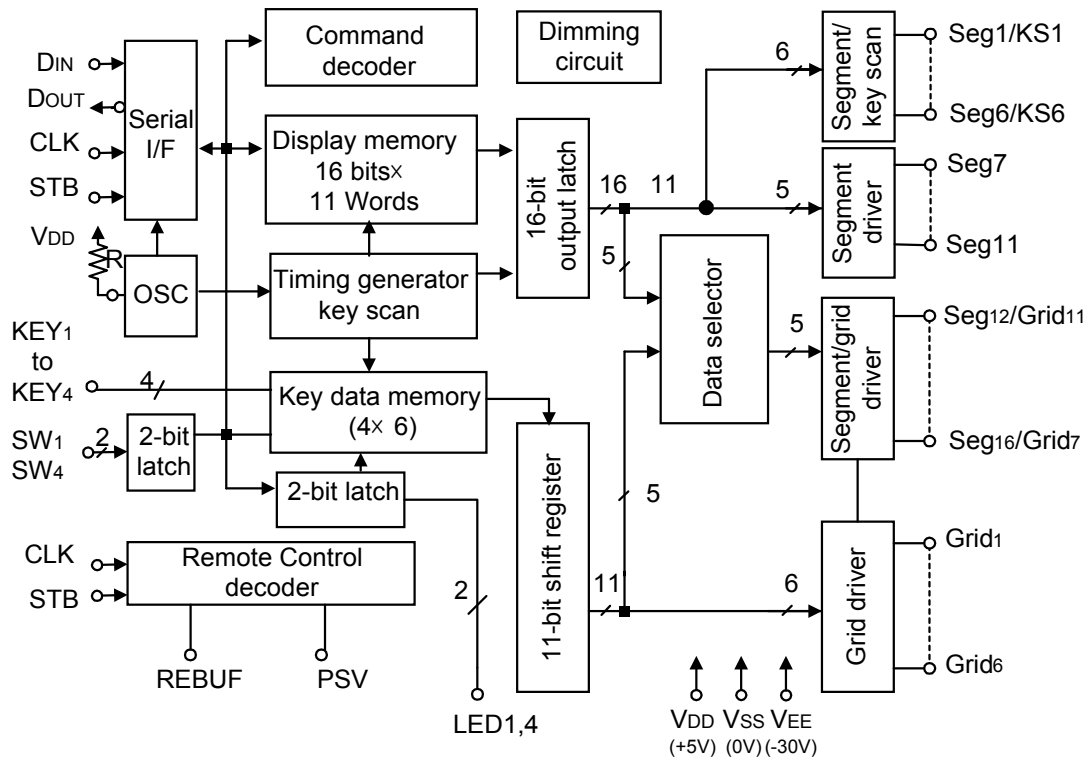
**■ Pin Descriptions**

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 AD7312. 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 <sub>DD</sub> to set up the oscillation frequency.
Seg <sub>7</sub> to Seg <sub>11</sub>	High-voltage output (Segment)	21 to 25	Segment output pins
Seg <sub>1</sub> /KS <sub>1</sub> to Seg <sub>6</sub> /KS <sub>6</sub>	High-voltage output	15 to 20	Multi-function pins, Segment output pins (Dual function as key scan source)
Grid <sub>1</sub> to Grid <sub>6</sub>	High-voltage output (Grid)	32 to 37	Grid output pins
Seg <sub>12</sub> /Grid <sub>11</sub> to Seg <sub>16</sub> /Grid <sub>7</sub>	High-voltage output (Segment/grid)	26, 28 to 31	These pins are selectable for segment or grid driving.
LED <sub>1</sub> and LED <sub>4</sub>	LED output	39 and 42	CMOS output
RMBUF	Remote Control Buffer	40	CMOS output
PSV	Power Saving Output	41	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, 38	Logic power supply
V <sub>SS</sub>	Logic ground	7, 43	Connect this pin to system GND.
V <sub>EE</sub>	Pull-down level	27	Driver power supply
SW <sub>1</sub> and SW <sub>4</sub>	Switch input	1 and 4	These pins constitute a 2-bit general-purpose input port.
RMIN	Remote Control Input	2	Input pin
SKEY	Standby Key Input	3	Input pin

### 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>4</sub> , $I_{OH1}=-1\text{mA}$	$0.9V_{DD}$			V
Low-Level Output Voltage	$V_{OL1}$	LED <sub>1</sub> /LED <sub>4</sub> , $I_{OL1}=12\text{mA}$			1	V
Low-Level Output Voltage	$V_{OL2}$	D <sub>OUT</sub> , $I_{OL2}=2\text{mA}$			0.4	V
High-Level Output Current	$I_{OH21}$	$V_O=V_{DD}-2\text{V}$ , Seg <sub>1</sub> to Seg <sub>11</sub>	-3			mA
High-Level Output Current	$I_{OH22}$	$V_O=V_{DD}-2\text{V}$ , Grid <sub>1</sub> to Grid <sub>6</sub> Seg <sub>12</sub> /Grid <sub>11</sub> to Seg <sub>16</sub> /Grid <sub>7</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 $5.5\text{V}, V_{EE}=-30\text{V}$ )

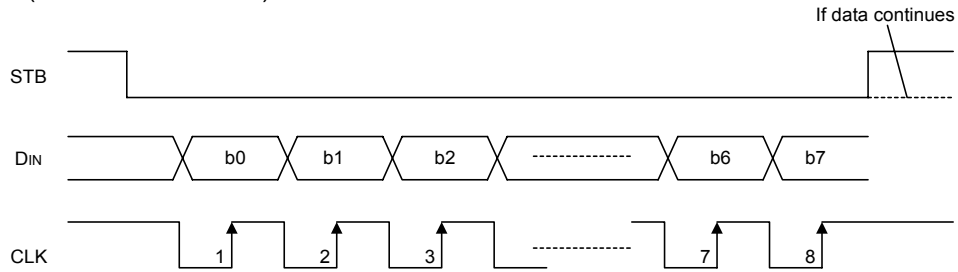
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Oscillation Frequency	$f_{OSC}$	$R=51\text{ k}\Omega$	350	500	650	$\text{kHz}$
Maximum Clock Frequency	$f_{max.}$	Duty=50%			1	$\text{MHz}$
Clock Pulse Width	$PW_{CLK}$		500			ns
Strobe Pulse Width	$PW_{STB}$		1			$\mu\text{s}$
Data Setup Time	$t_{SETUP}$		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			$\mu\text{s}$
Propagation delay time	$t_{PHZ}$	CLK $\rightarrow$ D <sub>OUT</sub>			300	ns
	$t_{PZL}$	$C_L=15\text{pF}, R_L=10\text{ k}\Omega$			100	ns
Rise time	$t_{TZH}$	$C_L=300\text{pF}$ Seg <sub>n</sub> , Grid <sub>n</sub>			2	$\mu\text{s}$
Fall time	$t_{THZ}$				160	$\mu\text{s}$

Note : Refer to page 8.

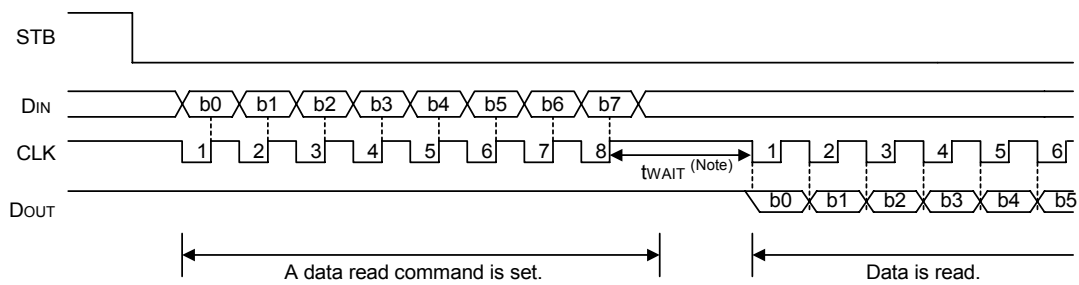
### ■ Timing Diagram

#### (1) Serial Communication Format

Reception (command/write data)



Transmission (read data)

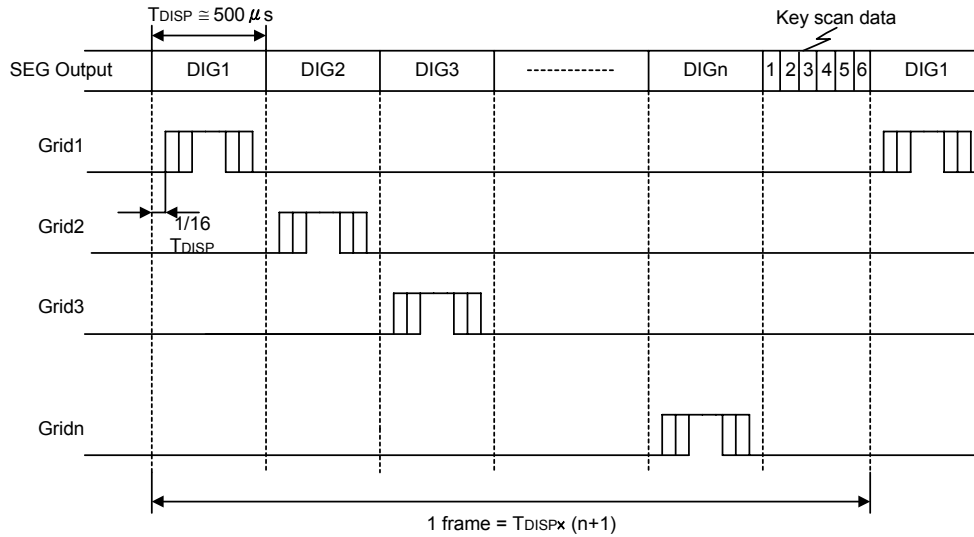


Because the  $D_{OUT}$  pin is an N-ch, open-drain output pin, be sure to connect an external pull-up resistor to this pin ( $1k\Omega$  to  $10k\Omega$ ).

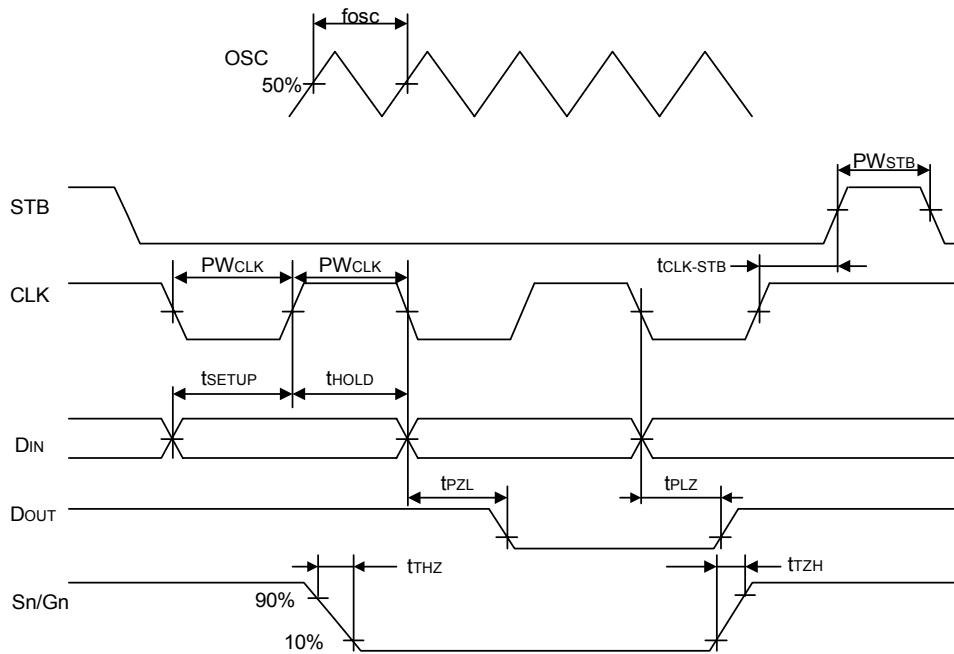
Note : When data is read, a wait time  $t_{WAIT}$  of  $1 \mu s$  is necessary since the rising of the eighth clock that has set the command, until the falling of the first clock that has read the data.

### (2) Key Scanning and Display Timing

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

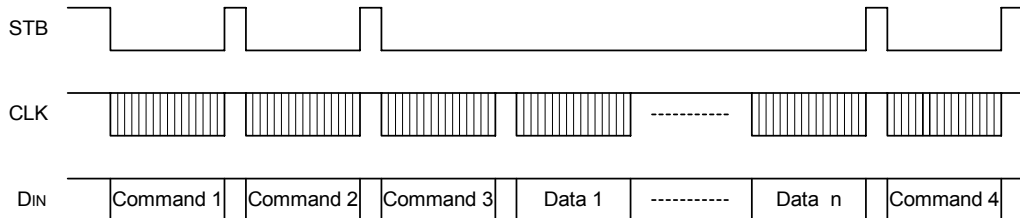


### Switching characteristic waveforms



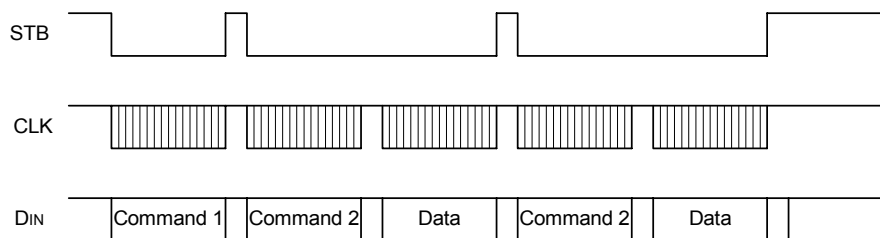
### Applications

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 and write registers

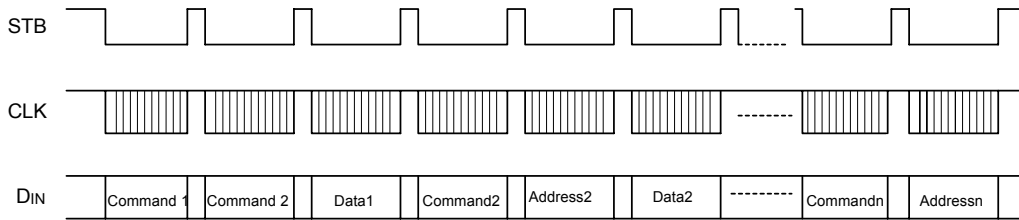


- Command 1: sets data
- Command 2: sets address
- Data: display data





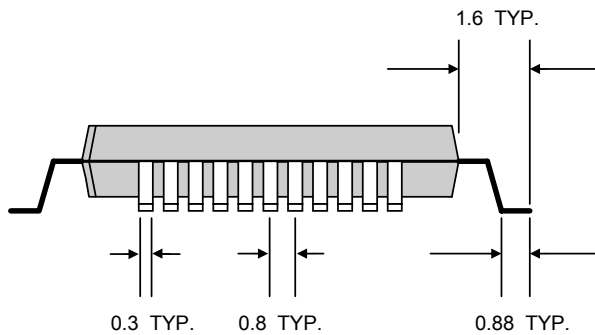
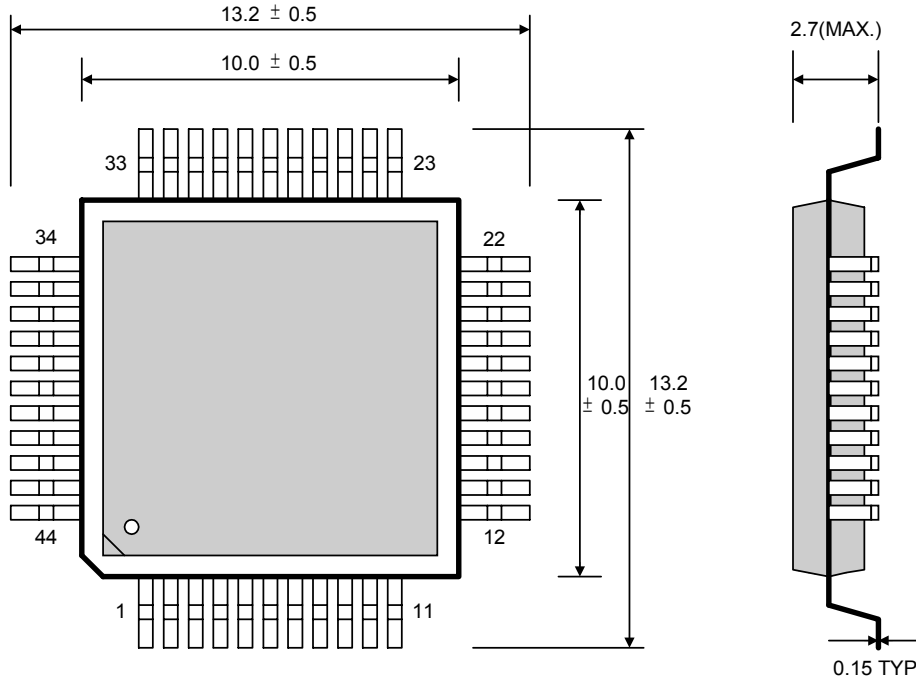
Reading specific registers



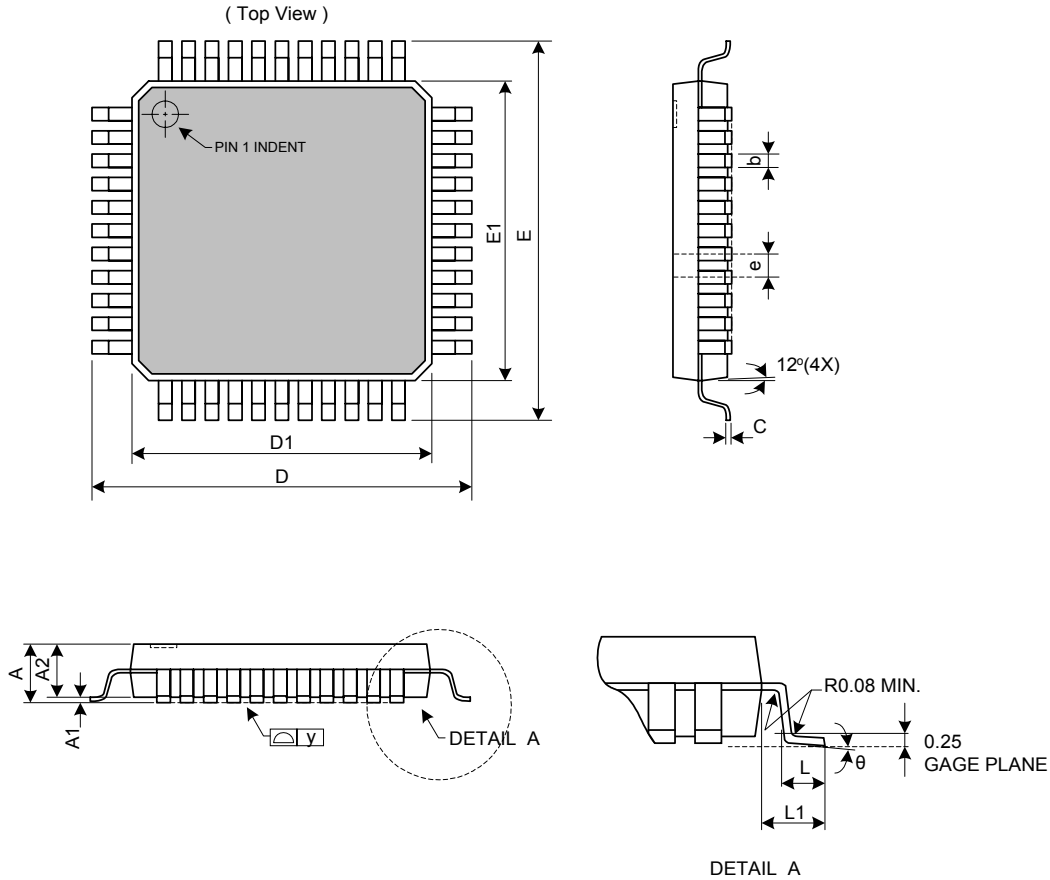
■ **Package Information**

(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**

