

Features

- Logic voltage: 5V
- High-voltage output: V_{DD} -35V max.
- Multiple display (11-segment & 11-digit to 16-segment & 6-digit)
- 6×4 matrix key scanning
- 8 steps dimmer circuit
- 4 LED output ports
- 4-bit general purpose input port
- No external resistors necessary for driver output (provides PMOS open-drain and pull-low resistor output)
- Serial interface with MCU (CLK, \overline{CS} , DI, DO)
- 44-pin QFP/LQFP package

Applications

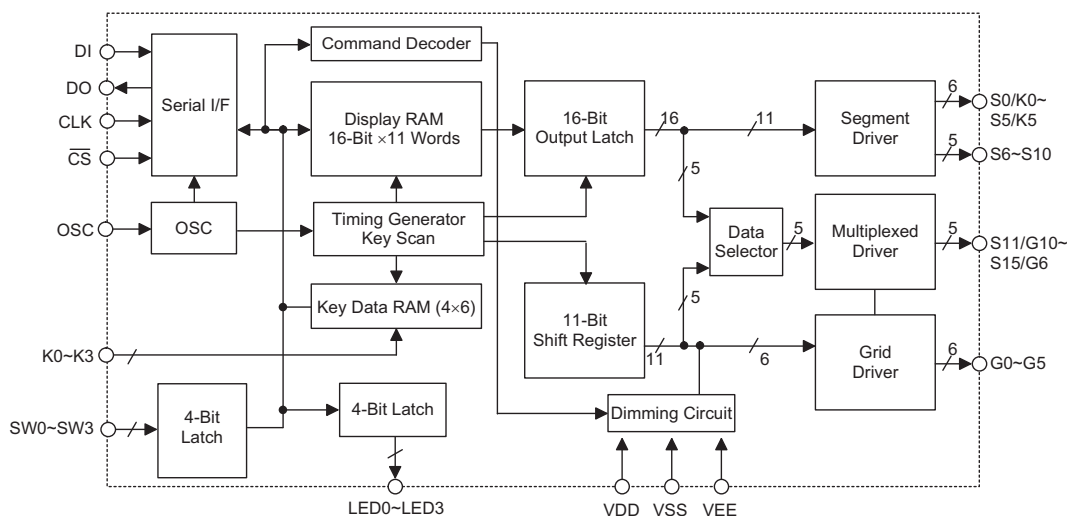
- Consumer products panel function control
- Industrial measuring instrument panel function control
- Other similar application panel function control

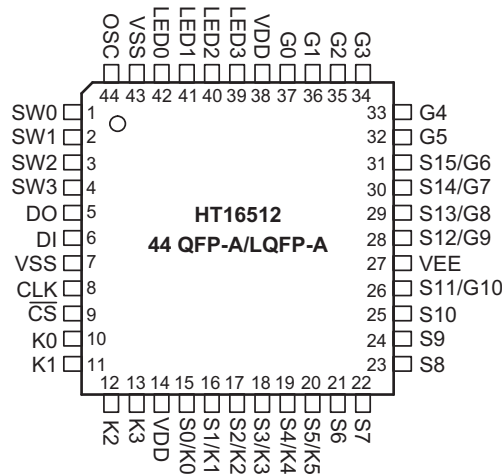
General Description

HT16512 is a VFD (Vacuum Fluorescent Display) controller/driver that is driven on a 1/4 to 1/11 duty factor. It consists of 11 segment output lines, 6 grid output lines, 5 segment/grid output drive lines, 4 LED output ports, a control circuit, a display memory, and a key scan circuit.

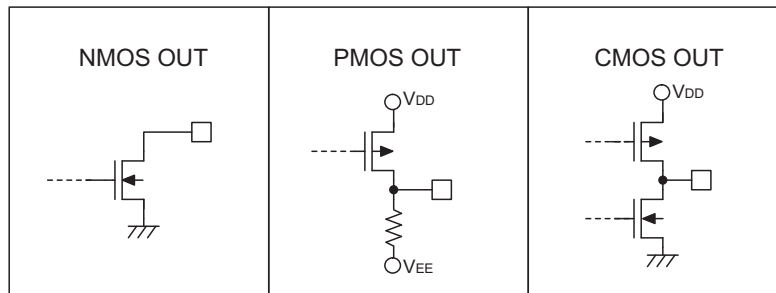
Serial data inputs to the HT16512 through a three-line serial interface. This VFD controller/driver is ideal as a peripheral device for an MCU.

Block Diagram



Pin Assignment

Pin Description

Pin No.	Pin Name	I/O	Description
1~4	SW0~SW3	I	4-bit general purpose input port Whether these pins are used or not, they should be connected to VDD or VSS.
5	DO	O	Output serial data at the falling edge of the shift clock, starting from low order bit. This is an NMOS open-drain output pin.
6	DI	I	Input serial data at the rising edge of the shift clock, starting from the low order bit.
7, 43	VSS	—	Negative power supply, ground Both of the VSS (pin 7 and pin 43) should be connected to ground.
8	CLK	I	Reads serial data at the rising edge, and outputs data at the falling edge.
9	$\overline{\text{CS}}$	I	Initializes serial interface at the rising or falling edge of the HT16512. Then it waits to receive a command. Data input after $\overline{\text{CS}}$ has fallen is processed as a command. While command data is processed, current processing is stopped, and the serial interface is initialized. While $\overline{\text{CS}}$ is high, CLK is ignored.
10~13	K0~K3	I	Keying data input to these pins is latched at the end of the display cycle.
14, 38	VDD	—	Positive power supply
15~20	S0/K0~S5/K5	O	Segment or key source output pins (dual function). This is PMOS open-drain and pull-low resistor output.
21~25	S6~S10	O	Segment driver output pins (segment only). This is PMOS open-drain and pull-low resistor output.
26, 28~31	S11/G10~S15/G6	O	Segment or Grid driver output pins. These pins are selectable for segment or grid driving. This is PMOS open-drain and pull-low resistor output.
27	VEE	—	VFD power supply
37~32	G0~G5	O	Grid driver output pins (Grid only). This is PMOS open-drain and pull-low resistor output.
42~39	LED0~LED3	O	LED driver output ports. This is a CMOS output pin.
44	OSC	I	Connected to an external resistor or an RC oscillator circuit.

Approximate Internal Connections

Absolute Maximum Ratings

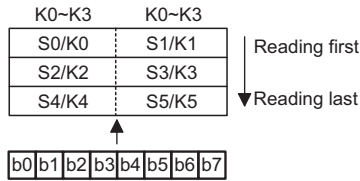
Supply Voltage	$V_{SS}-0.3V$ to $V_{SS}+5.5V$	Operating Temperature	$-25^{\circ}C$ to $75^{\circ}C$
Input Voltage	$V_{SS}-0.3V$ to $V_{DD}+0.3V$	Storage Temperature	$-50^{\circ}C$ to $125^{\circ}C$

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

D.C. Characteristics
 $T_a=25^{\circ}C$

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Logic Supply Voltage	—	—	4.5	5	5.5	V
V_{EE}	VFD Supply Voltage	—	—	0	—	$V_{DD}-35$	V
f_{OSC}	Oscillation Frequency	5V	$R_{OSC}=51k\Omega$	350	500	650	kHz
R_{PL}	Output Pull-low Resistor	5V	Driver output	50	100	150	$k\Omega$
I_{DD}	Operating Current	5V	No load, VFD display off	—	—	5	mA
I_{OL}	Driver Leakage Current	5V	$V_O=V_{DD}-35V$, VFD driver off	—	—	-10	μA
I_{OL1}	LED Sink Current	5V	$V_{OL}=1V$, LED0~LED3	20	—	—	mA
I_{OH1}	LED Source Current	5V	$V_{OH}=0.9V_{DD}$ LED0~LED3	-1	—	—	mA
I_{OH21}	Segment/Key Source Current	5V	$V_{OH}=V_{DD}-2V$ S0/K0~S5/K5, S6~S10	-3	—	—	mA
I_{OH22}	Segment/Grid Source Current	5V	$V_{OH}=V_{DD}-2V$ G0~G5, S11/G10~S15/G6	-15	—	—	mA
I_{OL3}	DO Sink Current	5V	$V_{OL}=0.4V$	4	—	—	mA
V_{IH}	"H" Input Voltage	—	—	$0.7V_{DD}$	—	V_{DD}	V
V_{IL}	"L" Input Voltage	—	—	0	—	$0.3V_{DD}$	V
V_{OH1}	High-level Output Voltage	5V	LED0~LED3, $I_{OH1}=-1mA$	$0.9V_{DD}$	—	V_{DD}	V
V_{OL1}	Low-level Output Voltage	5V	LED0~LED3, $I_{OL1}=20mA$	0	—	1	V
V_{OL2}	Low-level Output Voltage	5V	DO, $I_{OL2}=4mA$	0	—	0.4	V

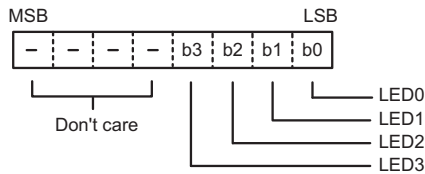
The data of each key is stored as illustrated below, and is read with the read command, starting from the least significant bit.



LED Port

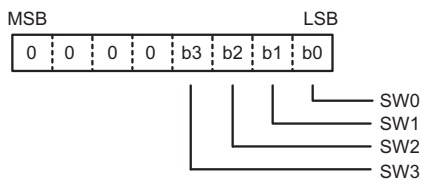
The LED port belongs to the CMOS output configuration.

Data is written to the LED port with the write command, starting from the least port's least significant bit. In our application (see application circuits), the user adopts an internal NMOS device to a driver LED component by connecting VDD. 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.



SW Data

HT16512 provides an extra 4-bit general input port. The SW data is provided with available binary code. The SW data is read with the read command, starting from the least significant bit. Bits 5 through 8 of the SW data are 0.



Commands

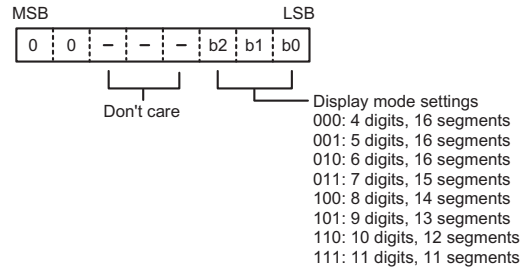
Commands set the display mode and status of the VFD driver.

The first 1 byte input to the HT16512 through the DI pin after the CS pin has fallen, is regarded as a command. If CS is set high while commands/data are transmitted, serial communication is initialized, and the commands/data being transmitted are not valid (however, the commands/data previously transmitted remains valid).

• Display mode setting commands

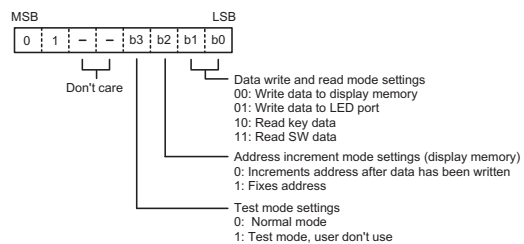
These commands initialize the HT16512 and select the number of segments and the number of grids (1/4~1/11 duty, 11 segments to 16 segments).

When these commands are executed, the display is forcibly turned off, and key scanning is also stopped. To resume display, the display command "ON" must be executed. If the same mode is selected, nothing happens.



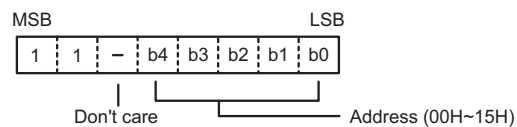
• Data setting commands

These commands set the data write and data read modes.



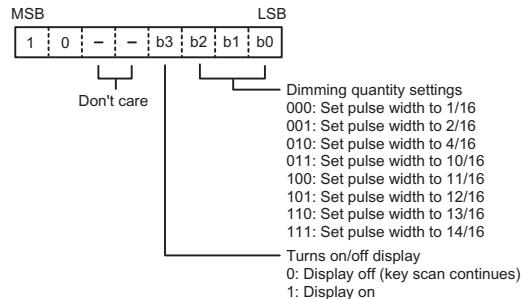
• Address setting commands

These commands set the address of the display memory.

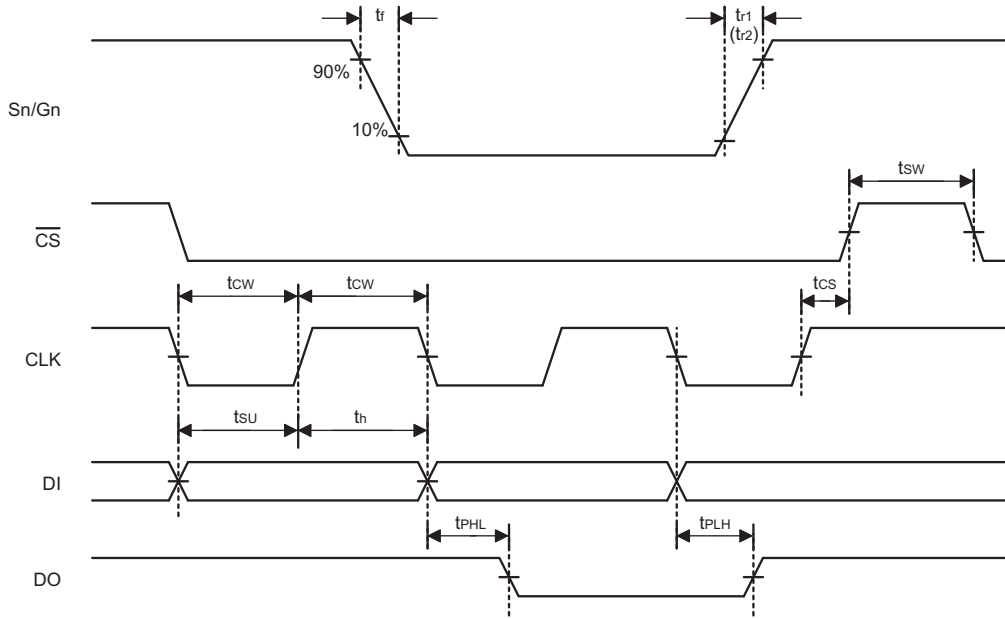


If address 16H or higher is set, data is ignored until a valid address is set.

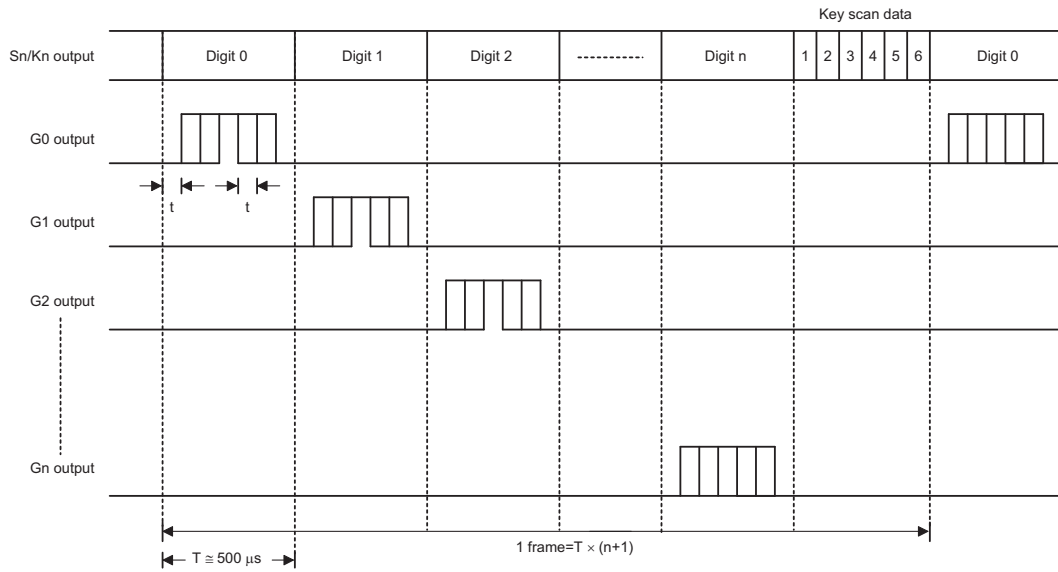
• Display control commands



Timing Diagrams



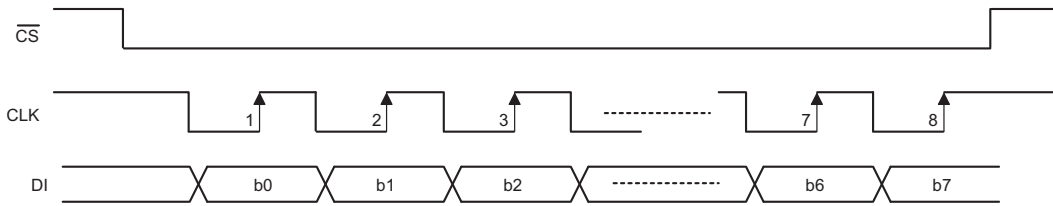
Key Scanning and Display Timing



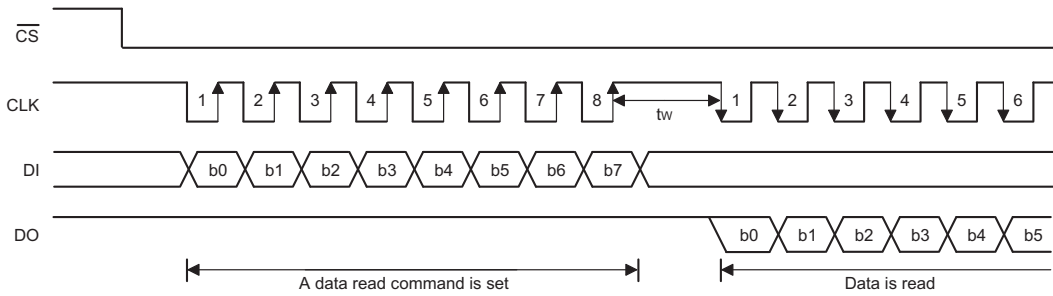
Note: $n=0\sim 5$
 $t=1/16T$
 T : pulse width of segment signal is decided by oscillator frequency
 One cycle of key scanning consists of one frame.

Serial Communication Format

- Reception (command/data write)

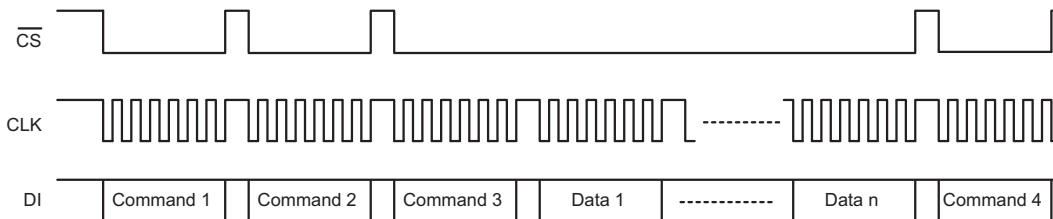


- Transmission (data read)



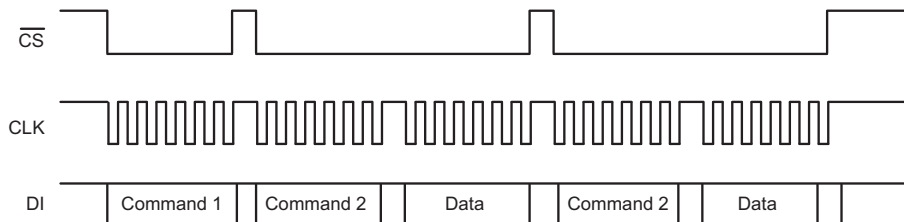
DO must be sure to connect an external pull-high resistor to this pin (1kΩ to 10kΩ).
 Note: When data is read, a wait time "tw" of 1μs is necessary.

- Updating display memory by incrementing address



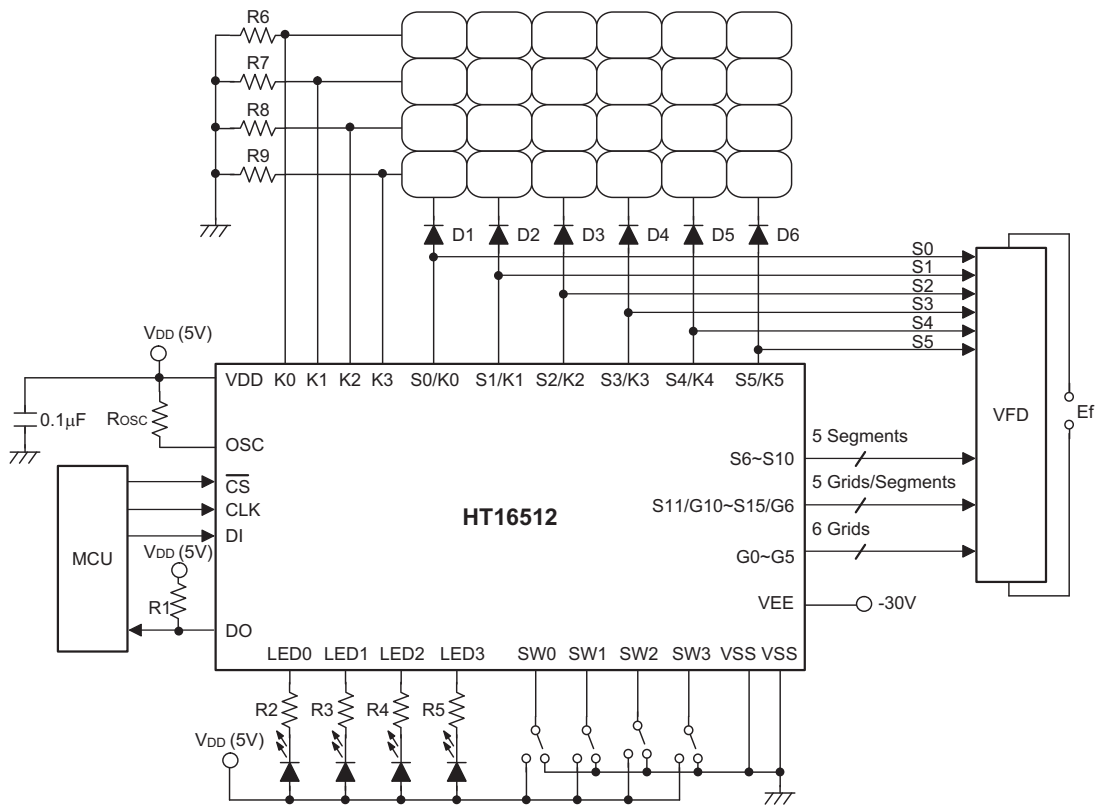
Command 1: sets display mode
 Command 2: sets data
 Command 3: sets address
 Data 1 to n: transfers display data (22 bytes max.)
 Command 4: controls display

- Updating specific addresses

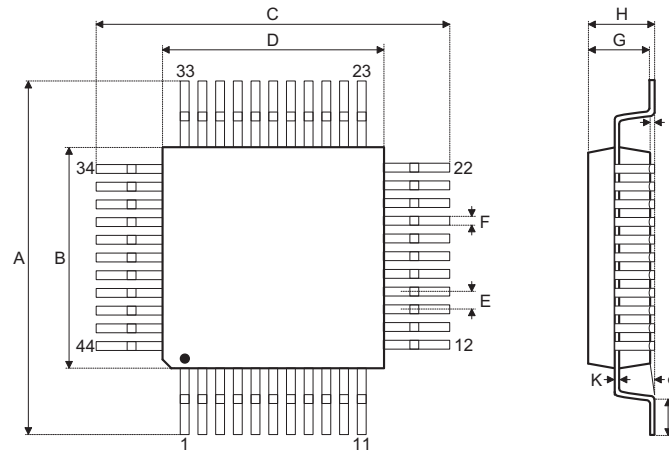


Command 1: sets data
 Command 2: sets address
 Data: display data

Application Circuits

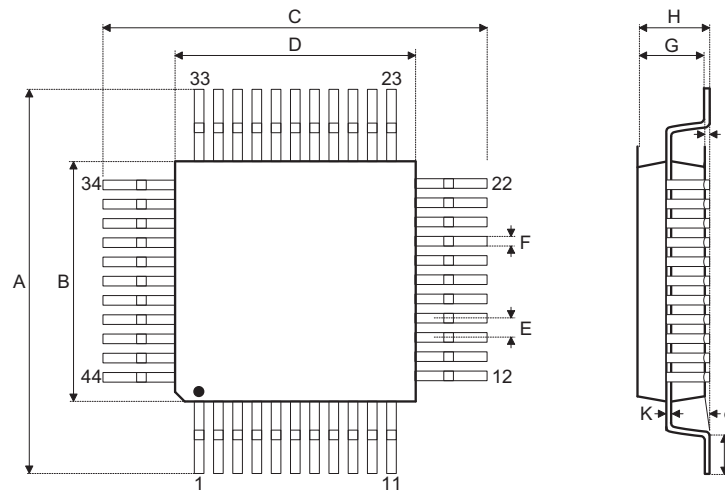


- Note:
- R_{OSC}=51kΩ for oscillator resistor
 - R1=1~10kΩ for external pull-high resistor
 - R2~R5=750Ω~1.2kΩ
 - R6~R9=10kΩ for external pull-low resistor
 - D1~D6=1N4001
 - Ef=Filament voltage for VFD
 - Both of the VSS (pin 7 and pin 43) should be connected to ground.

Package Information
44-pin QFP (10mm×10mm) Outline Dimensions


Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.512	—	0.528
B	0.390	—	0.398
C	0.512	—	0.528
D	0.390	—	0.398
E	—	0.031	—
F	—	0.012	—
G	0.075	—	0.087
H	—	—	0.106
I	0.010	—	0.020
J	0.029	—	0.037
K	0.004	—	0.008
L	—	0.004	—
α	0°	—	7°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	13.00	—	13.40
B	9.90	—	10.10
C	13.00	—	13.40
D	9.90	—	10.10
E	—	0.80	—
F	—	0.30	—
G	1.90	—	2.20
H	—	—	2.70
I	0.25	—	0.50
J	0.73	—	0.93
K	0.10	—	0.20
L	—	0.10	—
α	0°	—	7°

44-pin LQFP (10mm×10mm) (FP3.2mm) Outline Dimensions


Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.512	0.520	0.528
B	0.390	0.394	0.398
C	0.512	0.520	0.528
D	0.390	0.394	0.398
E	—	0.031	—
F	—	0.012	—
G	0.053	0.055	0.057
H	—	—	0.063
I	0.004	—	0.010
J	0.041	0.047	0.053
K	0.004	—	0.008
α	0°	—	7°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	13.00	13.20	13.40
B	9.90	10.00	10.10
C	13.00	13.20	13.40
D	9.90	10.00	10.10
E	—	0.80	—
F	—	0.30	—
G	1.35	1.40	1.45
H	—	—	1.60
I	0.10	—	0.25
J	1.05	1.20	1.35
K	0.10	—	0.25
α	0°	—	7°

Holtek Semiconductor Inc. (Headquarters)

No.3, Creation Rd. II, Science Park, Hsinchu, Taiwan
Tel: 886-3-563-1999
Fax: 886-3-563-1189
<http://www.holtek.com.tw>

Holtek Semiconductor Inc. (Taipei Sales Office)

4F-2, No. 3-2, YuanQu St., Nankang Software Park, Taipei 115, Taiwan
Tel: 886-2-2655-7070
Fax: 886-2-2655-7373
Fax: 886-2-2655-7383 (International sales hotline)

Holtek Semiconductor Inc. (Shenzhen Sales Office)

5F, Unit A, Productivity Building, No.5 Gaoxin M 2nd Road, Nanshan District, Shenzhen, China 518057
Tel: 86-755-8616-9908, 86-755-8616-9308
Fax: 86-755-8616-9722

Holtek Semiconductor (USA), Inc. (North America Sales Office)

46729 Fremont Blvd., Fremont, CA 94538
Tel: 1-510-252-9880
Fax: 1-510-252-9885
<http://www.holtek.com>

Copyright © 2010 by HOLTEK SEMICONDUCTOR INC.

The information appearing in this Data Sheet is believed to be accurate at the time of publication. However, Holtek assumes no responsibility arising from the use of the specifications described. The applications mentioned herein are used solely for the purpose of illustration and Holtek makes no warranty or representation that such applications will be suitable without further modification, nor recommends the use of its products for application that may present a risk to human life due to malfunction or otherwise. Holtek's products are not authorized for use as critical components in life support devices or systems. Holtek reserves the right to alter its products without prior notification. For the most up-to-date information, please visit our web site at <http://www.holtek.com.tw>.