General Description

The TP6317 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 drivelines, a display memory, a control circuit, stand-by control, and a key scan circuit. Serial data is input to TP6317 through a three-line serial interface. This VFD controller/driver is ideal as a peripheral device for front panel control of green DVD/VCD feature.

Features

- Multiple display modes (11-segment & 11-digit to 16-segment & 4-digit)
- Key scanning (6 × 4 matrices)
- Dimming circuit (eight steps)
- High-voltage output (V_{DD} – 35V max)
- LED ports (3 chs, 20 mA max)
- General-purpose input port (1 bits)
- No external resistor necessary for driver outputs (P-ch open-drain + pull-down resistor output)
- Remote control code coding support NEC format
- Stand-by control
- Serial interface (CLK, STB, D_{IN}, D_{OUT})

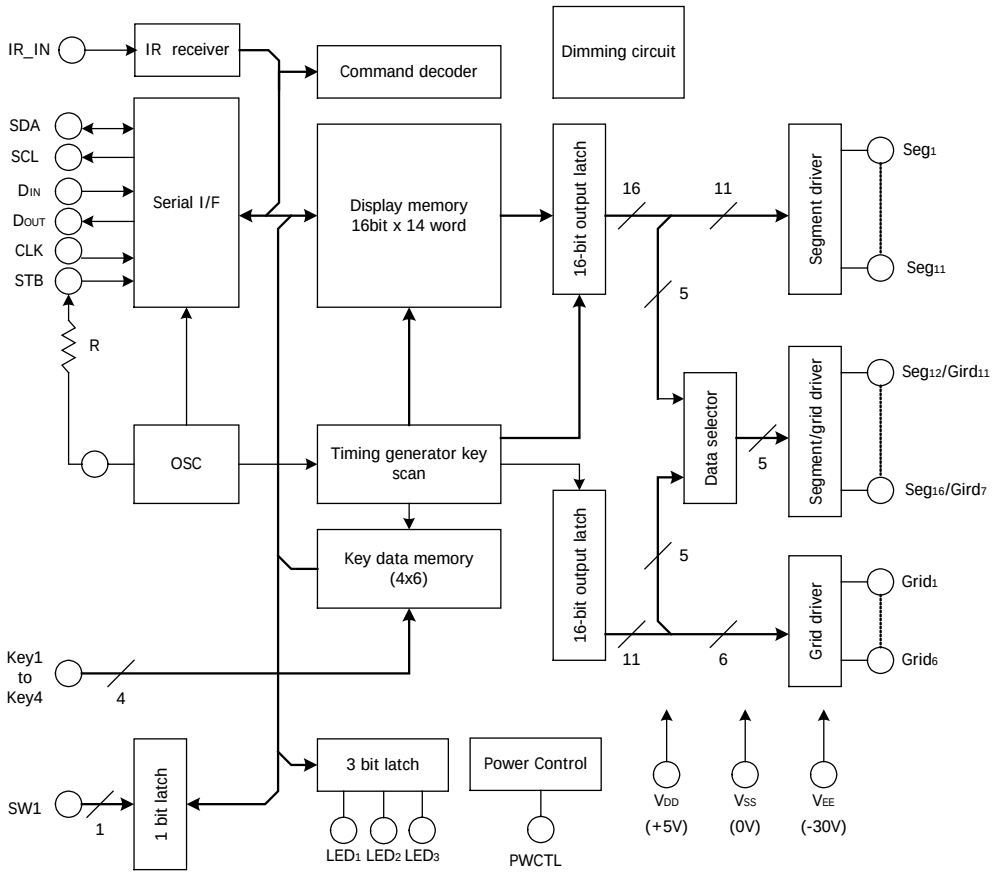
Ordering Information

TP 6317 □ □ □

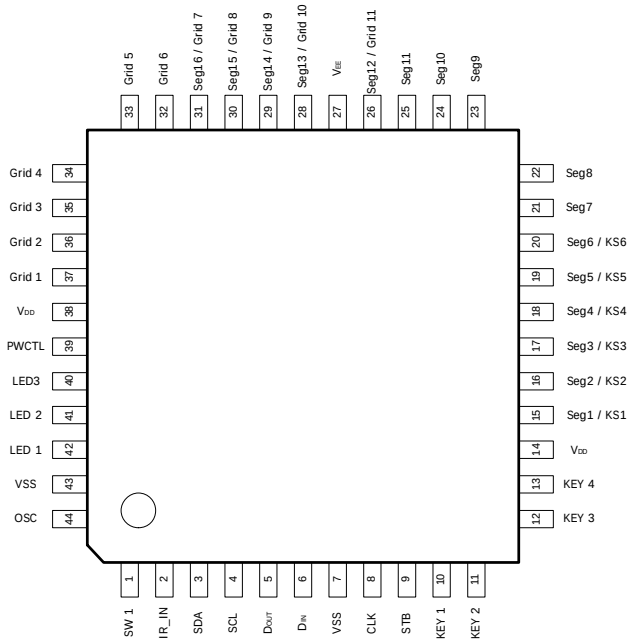
- Footprint
- Version
- Package Type

Package Type	F: LQFP
Footprint	S: 2.0 mm L: 3.2 mm

Block Diagram



Pin Configuration



Pin Description

Pin No.	Symbol	Pin Name	Description
6	D_{IN}	Date input	Input serial data at rising edge of shift clock, starting from the lower bit.
5	D_{OUT}	Date output	Outputs serial data at falling edge of shift clock, starting from the lower bit. This is N-ch open-drain output pin.
9	STB	Strobe	Initializes the serial interface at rising or falling edge to make TP6317 waiting for reception of command. Data input after STB falls 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.
8	CLK	Clock input	Reads serial data at rising edge, and outputs data at falling edge.
44	OSC	Oscillator pin	Connect a resistor to this pin to determine the oscillation frequency to this pin.
15 to 20	Seg_1/KS_1 to Seg_6/KS_6	High-voltage output	Segment output pins (Dual function as key source).
21 to 25	Seg_7 to Seg_{11}	High-voltage output (Segment)	Segment output pins.
37 to 32	$Grid_1$ to $Grid_6$	High-voltage output (Grid)	Grid output pins.
26, 28 to 31	$Seg_{11}/Grid_{11}$ to $Seg_{16}/Grid_7$	High-voltage output (Segment/grid)	These pins are selectable for segment or grid driving.
42 to 40	LED_1 to LED_3	LED output	CMOS output. +20 mA max.
10 to 13	KEY_1 to KEY_4	Key data input	Data input to these pins is latched at the end of display cycle.
1	SW_1	Switch input	This pin is 1-bit general-purpose input port.
2	IR-IN	IR input	Optic receiver input.
3	SDA	Data	Serial data line.
4	SCL	Clock	Serial clock line.
14, 38	V_{DD}	Logic power	5V ± 10%
7, 43	V_{SS}	Logic ground	Connect this pin to system GND.
27	V_{EE}	Pull-down level	V_{DD} – 35 V max.
39	PWCTL	Power control	Power on control

Functional Description

Display RAM and Power control RAM Address

The display RAM stores the data transmitted from an external device to TP6317 through the serial interface, and is assigned addresses as follows, in units of 8 bits:

Seg_1	Seg_4	Seg_8	Seg_{12}	Seg_{16}	
$00H_L$	$00H_U$	$01H_L$	$01H_U$		DIG1
$02H_L$	$02H_U$	$03H_L$	$03H_U$		DIG2
$04H_L$	$04H_U$	$05H_L$	$05H_U$		DIG3
$06H_L$	$06H_U$	$07H_L$	$07H_U$		DIG4
$08H_L$	$08H_U$	$09H_L$	$09H_U$		DIG5
$0AH_L$	$0AH_U$	$0BH_L$	$0BH_U$		DIG6
$0CH_L$	$0CH_U$	$0DH_L$	$0DH_U$		DIG7
$0EH_L$	$0EH_U$	$0FH_L$	$0FH_U$		DIG8
$10H_L$	$10H_U$	$11H_L$	$11H_U$		DIG9
$12H_L$	$12H_U$	$13H_L$	$13H_U$		DIG10
$14H_L$	$14H_U$	$15H_L$	$15H_U$		DIG11
$16H_L$ A0~A3	$16H_U$ A4~A7	$17H_L$ A8~A11	$17H_U$ A12~A15		Pwctl Custom Address
$18H_L$ D0~D3 $SET1_L$	$18H_U$ D4~D7 $SET1_U$	$19H_L$ D0~D3 $SET2_L$	$19H_U$ D4~D7 $SET2_U$		Remote Code Set1~Set2
$1AH_L$ D0~D3 $SET3_L$	$1AH_U$ D4~D7 $SET3_U$	$1BH_L$ D0~D3 $SET4_L$	$1BH_U$ D4~D7 $SET4_U$		Remote Code Set3~Set4
$1CH_L$ D0~D3 $SET5_L$	$1CH_U$ D4~D7 $SET5_U$	$1DH_L$ D0~D3 $SET6_L$	$1DH_U$ D4~D7 $SET6_U$		Remote Code Set5~Set6
$1EH_L$ D0~D3 $SET7_L$	$1EH_U$ D4~D7 $SET7_U$	$1FH_L$ D0~D3 $SET8_L$	$1FH_U$ D4~D7 $SET8_U$		Remote Code Set7~Set8
$20H_L$ Key1~Key4	$20H_U$ Key5~Key8	$21H_L$ Key9~Kry12	$21H_U$ Key13~Key16		Key Code
$22H_L$ Key17~Key20	$22H_U$ Key21~Key24				Key Code

Notes:

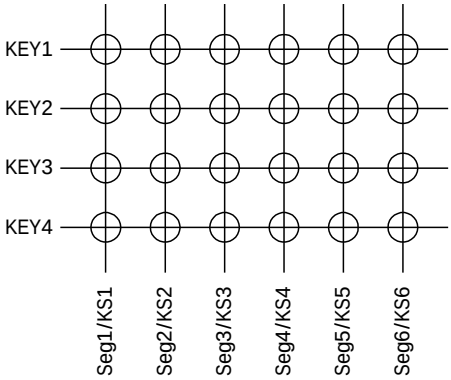
1. Unused remote code must be filled with FFH (Ex.: SET8 unused FFH→ 1FH).
2. Key code must be set “1” for wakeup mode and clear with “0” to unable this function. Key1 is a special key. Non-masking can always have the wakeup function, so recommend using the power key.
   (Ex.: If you want Key2 be set with wakeup mode, then bit 1 of 20H must be set “1”;
   on the other side, if you want key2 be set without wakeup mode, then bit1 of 20H must clear with “0.”)

b_0	b_3 b_4	b_7
XX H_L	XX H_U	

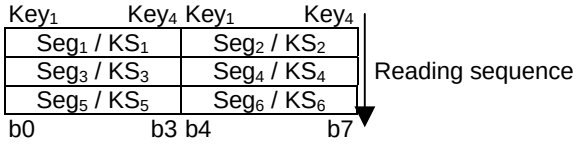
Lower 4 bits Higher 4 bits.

Key Matrix and Key-Input Data Storage RAM

The key matrix is of 6 × 4 configuration, as shown below.

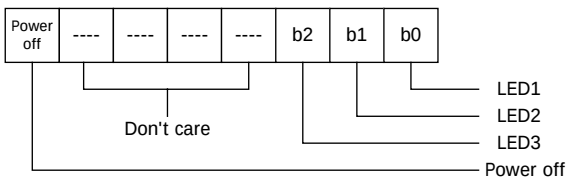


The data of each key is stored as illustrated below, and is read by a read command, starting from the least significant bit.



LED PORT & Power OFF

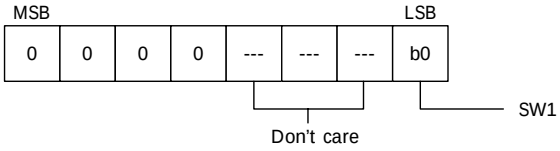
Data is written to the LED port by a write command, starting from the least significant bit of the port. When a bit of this port is 0, the corresponding LED lights; when the bit is 1, the LED goes off. The data of bits 3 through 7 is ignored. When the power is off, the bit is 0; the PWCTL pin goes low (Power Off).

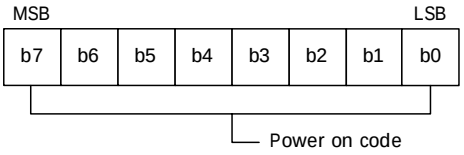


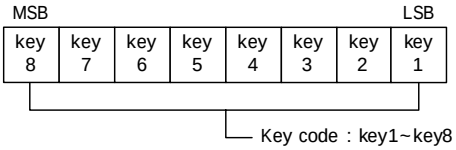
On power application, all LEDs and power off are “1”.

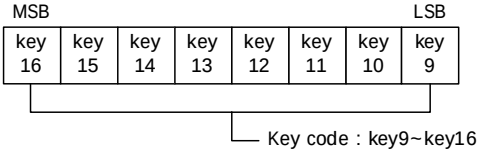
SW, Power on Code and key Data

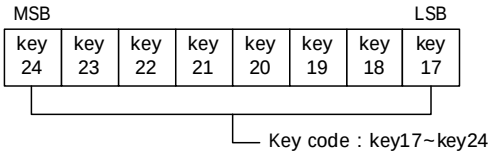
The SW, power on code and key data are read by a read command, starting from the least significant bit. Bits 5 through 8 of the SW data are 0; Bits 2 through 4 of the SW data are skipped (Please refer to application notes in this document).











Commands

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

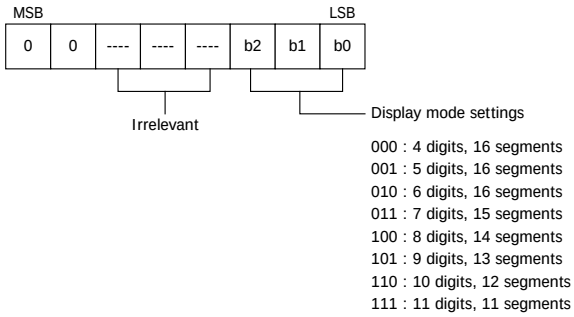
The first 1 byte input to TP6317 through the D_{IN} pin after the STB pin falls is regarded as a command.

If STB is high while a command/data is transmitted, serial communication is initialized, and the transmitting command/data is invalid; however, the command/data already transmitted remains valid.

(1) Display mode setting command

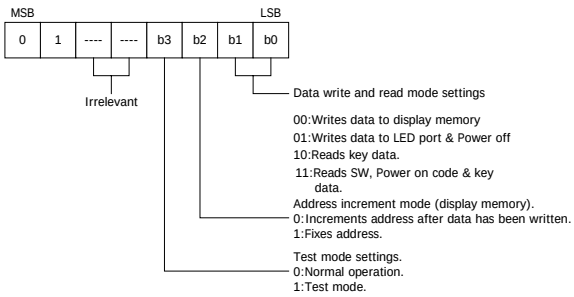
This command initializes TP6317 and selects the number of segments and number of grids (1/4 to 1/11-duty, 11 segments to 16 segments).

On power application, the 11-digit, 11-segment mode is selected.



(2) Data setting commands

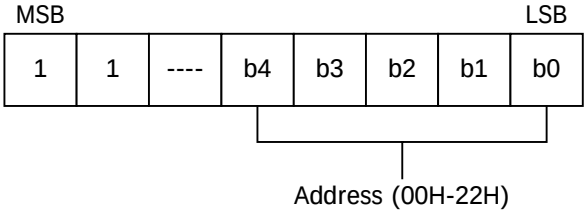
This command sets data write and read modes.



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

(3) Address setting command

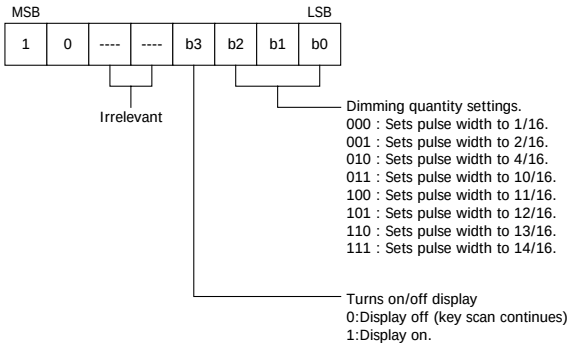
This command sets an address of the display memory or power control data memory.



If address 23H or higher is set, the data is ignored; unit a correct address is set.

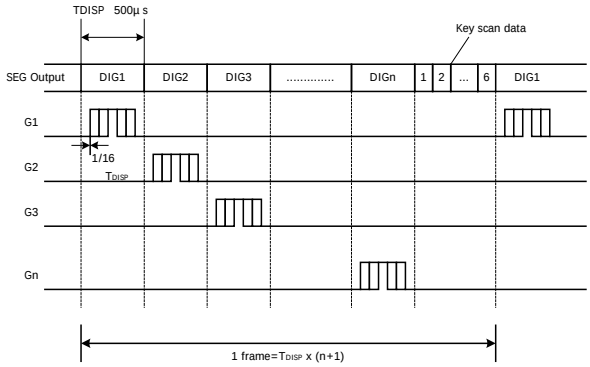
On power application, the address is set to 00H.

(4) Display control command



On power application, the 14/16-pulse width is set and the display is turned off.

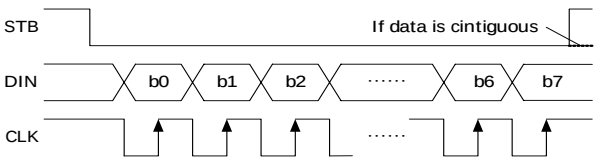
Key Scanning and Display Timing



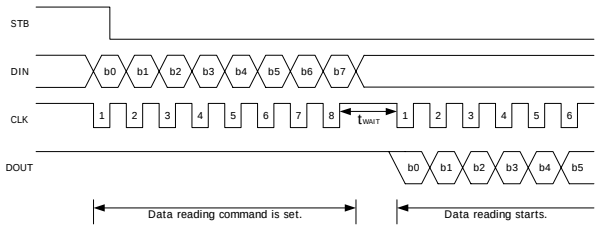
One cycle of key scanning consists of two frames, and data of 6 × 4 matrices is stored in RAM.

Serial Communication Format

Reception (command/data write)



Transmission (data read)



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).

*: When data is read, a wait time (t_{WAIT}) of 1μs is necessary from the rising of the eighth clock that has set the command till the falling of the first clock that has read the data.

Absolute Maximum Ratings (Ta = 25°C, Vss = 0V)

Parameter	Symbol	Ratings	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}	+25	mA
VFD Driver Output Current	I_{o2}	-40 (grid) -15 (segment)	mA
Power Dissipation	P_D	800*	mW
Operating Ambient Temperature	T_{opt}	0 to +70	℃
Storage Temperature	T_{stg}	-65 to +150	℃

* Derate at –6.4 mW/℃ at Ta = 25℃ or higher.

Recommended Operating Conditions (Ta = -20°C to +70°C, Vss = 0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Logic Supply Voltage	V_{DD}	4.5	5	5.5	V	
High-Level input Voltage	V_{IH}	0.7V_{DD}		V_{DD}	V	
Low-Level input Voltage	V_{IL}	0		0.3V_{DD}	V	
Driver Supply Voltage	V_{EE}	0		V_{DD}-35	V	

Maximum power consumption P_{MAX} = VFD driver dissipation + R_L dissipation + LED driver dissipation + dynamic power consumption.

Where segment current = 3 mA, grid current = 15mA, and LED current = 20 mA,

VFD driver dissipation = number of segments x 6 + number of grids/(number of grids + 1) x 30 (mW)

R_L dissipation $(V_{DD}-V_{EE})^2/50$ x (segment+1) (mW)

LED driver dissipation = number of LEDs x 20(mW)

Dynamic power consumption = V_{DD} x 5(mW)

DC Electrical Characteristics

(Ta= -20°C to +70°C, V_{DD} = 4.5V to 5.5V, V_S = 0V, V_{EE} = V_{DD} - 35V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
High-Level Output Voltage	V_{OH1}	0.9 V_{DD}			V	LED_1 – LED_4, I_{OH1} = -1 mA
Low-Level Output Voltage	V_{OL1}			1	V	LED_1 – LED_4, I_{OL1} = 20 mA
Low-Level Output Voltage	V_{OL2}			0.4	V	D_{OUT}, I_{OL2} = 4 mA
High-Level Output Current	I_{OH21}	-3			mA	V_O = V_{DD} –2V, Seg_1 to Seg_{11}
High-Level Output Current	I_{OH22}	-15			mA	V_O = V_{DD} –2V,$Grid_1$ to $Grid_6$, Seg_{12}/Seg_{11} to Seg_{16}/Seg_7
Driver Leakage Current	I_{OLEAK}			-10	µA	V_O = V_{DD} - 35V, Drive off
Output Pull-Down Resistor	R_L	50	100	150	kΩ	Drive output
Input Current	I_i			±1	µA	V_I = V_{DD} or V_{SS}
High-Level Input Voltage	V_{IH}	0.6 V_{DD}			V	
Low-Level Input Voltage	V_{IL}			0.3 V_{DD}	V	
Hysteresis Voltage	V_H		0.35		V	CLK, D_{IN}, STB
Dynamic Current Consumption	I_{DDdyn}			5	mA	Under no load, display off

AC (Switching) Electrical Characteristics

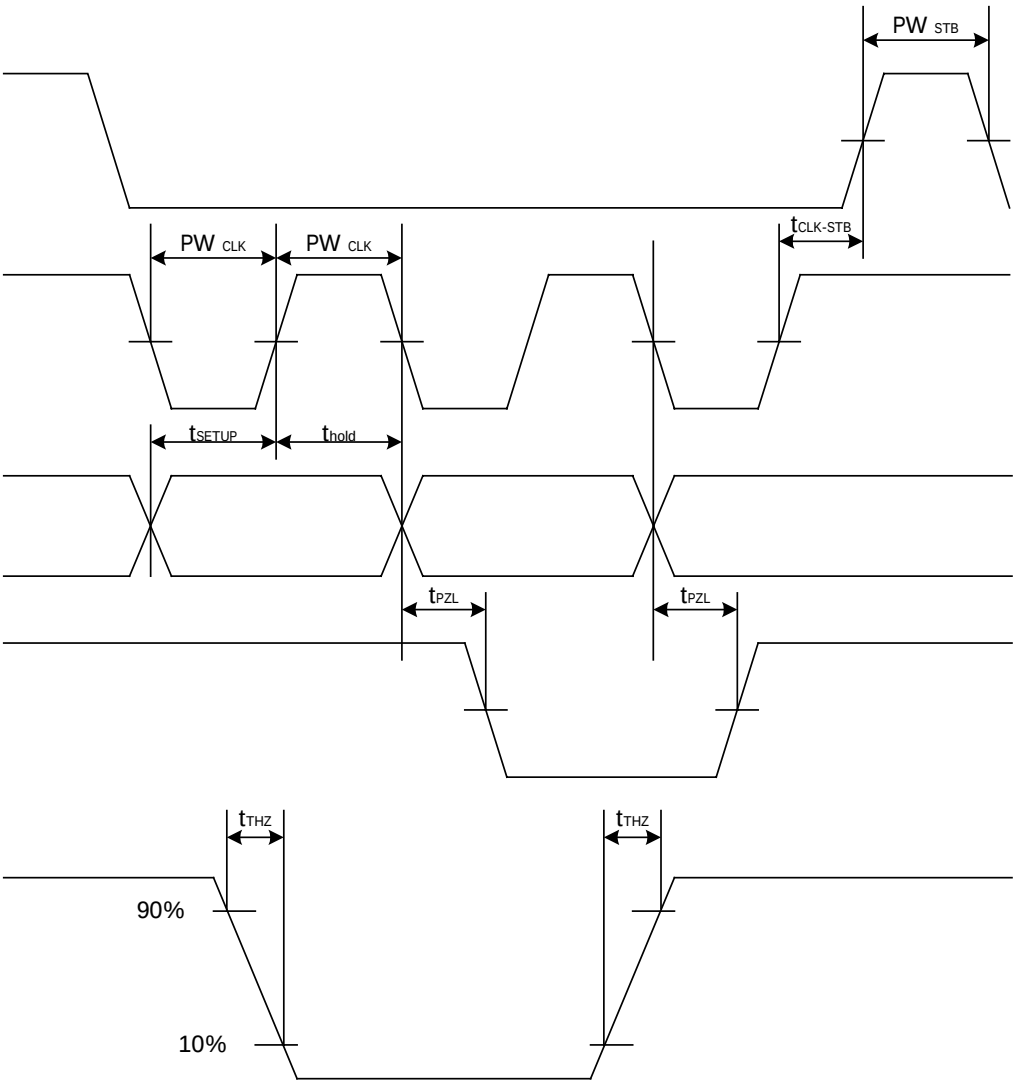
(Ta = -20°C to +70°C, V_{DD} = 4.5V to 5.5V, V_{EE} = -30V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	
Oscillation Frequency	f_{OSC}	350	500	650	kHz	R = 33kΩ	
Propagation Delay Time	t_{PLZ}			300	ns	CLK ⇒ DOUT CL = 15pF,RL = 10kΩ	
	t_{PZL}			100	ns		
Rise Time	t_{TZH1}			2	µs	CL = 300 PF	Seg1 to Seg11
	t_{TZH2}			0.5	µs		Grid1 to Grid6 Seg12/Grid11 to Seg16/Grid7
Fall Time	t_{THZ}			120	µs	CL = 300 pF, Segn, Gridn	
Maximum Clock Frequency	f_{max}	1			MHz	Duty = 50%	
Input Capacitance	C1			15	pF		

Timing Conditions (Ta = -20°C to +70°C, V_{DD} = 4.5V to 5.5V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Clock Pulse Width	PWCLK	400			ns	
Strobe Pulse Width	PWSTB	1			µs	
Data Setup Time	t_{SETUP}	100			ns	
Data Hold Time	t_{HOLD}	100			ns	
Clock-Strobe Time	$t_{CLK-STB}$	1			µs	CLK ↑→ STB ↑
Wait Time	t_{WAIT}	1			µs	CLK ↑→ CLK ↓

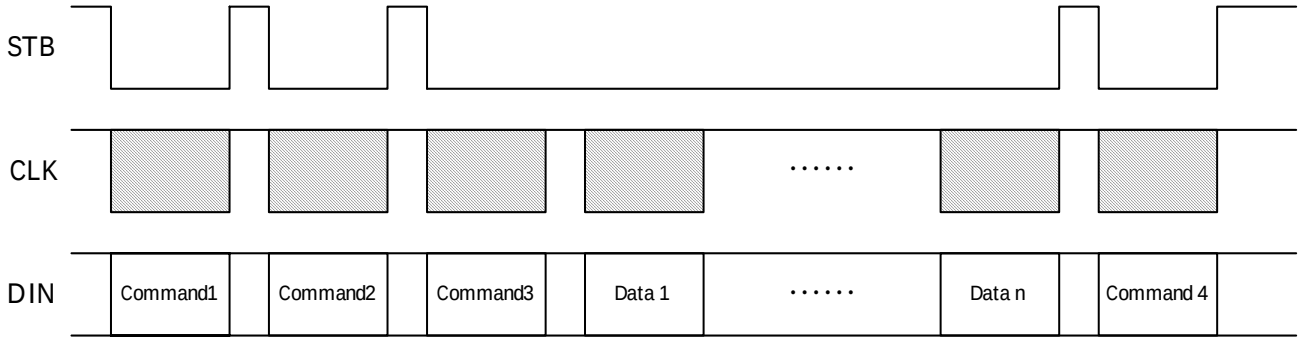
Switching Characteristic Waveform



Application

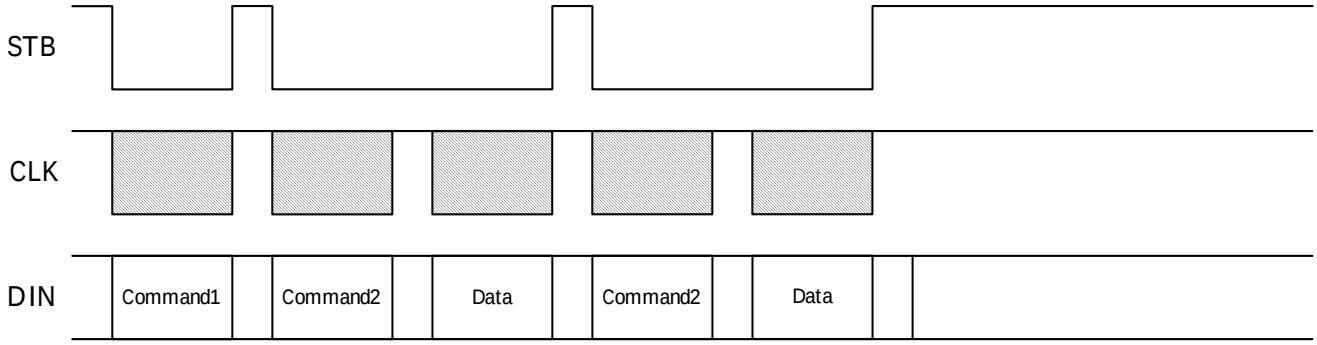
- For green DVD or VCD

Updating Display Memory By Incrementing Address



Command1: sets display mode
Command2: sets data
Command3: sets address
Data 1 to n: transfers display data (22 bytes max.)
Command4: controls display

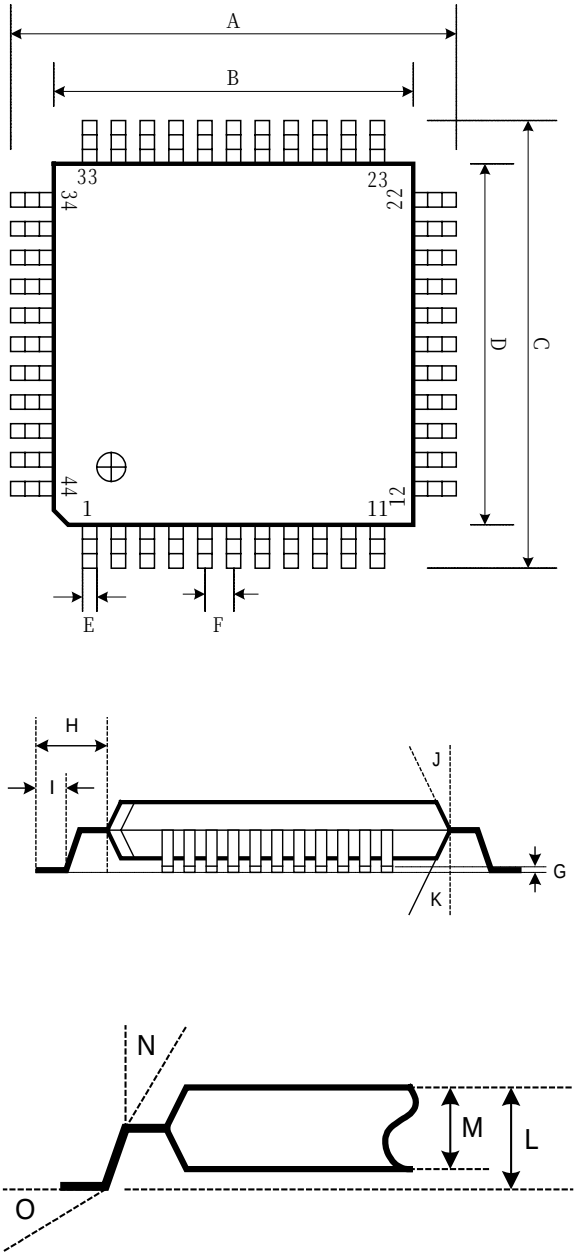
Updating Specific Address



Command1: sets data
Command2: sets address
Data: display data

Package Information

44-Pin Plastic LQFP Long-Lead (Footprint = 3.2mm)



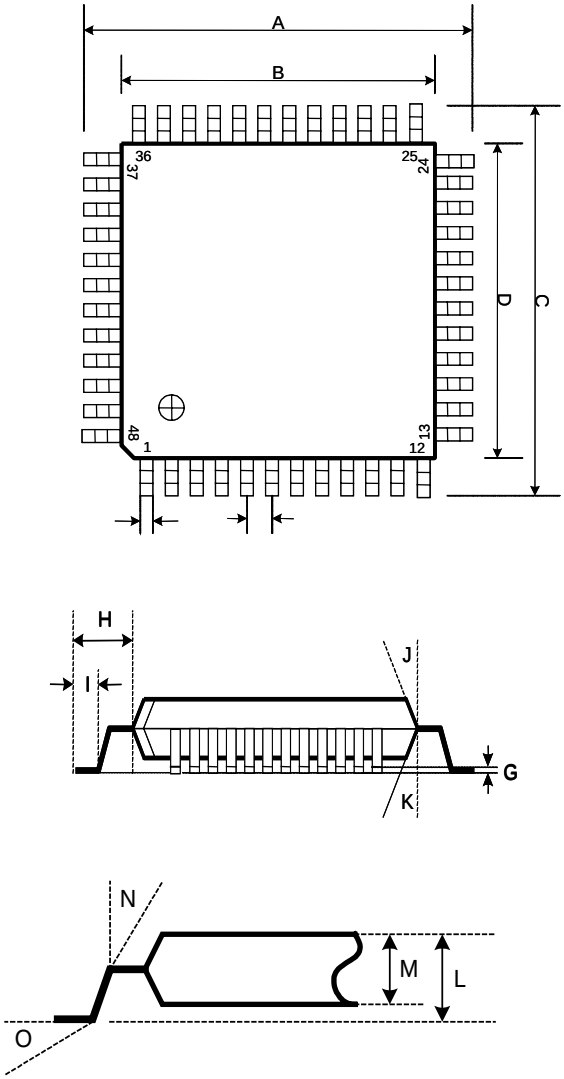
NOTE

Each lead centerline is located within 0.16mm of its true position (T.P.) at maximum material.

(Unit: mm)

Item	Millimeters
A	13.2 ± 0.2
B	10.0 ± 0.2
C	13.2 ± 0.2
D	10.0 ± 0.2
E	0.37(TYP.)
F	0.8 BSC
G	$0.3^{+0.2}_{-0.1}$
H	1.6
I	1.2 ± 0.15
J	$12^{o} \pm 1^{o}$
K	$12^{o} \pm 1^{o}$
L	1.7 MAX
M	1.4± 0.1
N	0^{o} MIN
O	$+3^{o}$ $+7^{o}$ -3^{o}

48-Pin Plastic LQFP Short-Lead (Footprint = 2.0mm)



NOTE

Each lead centerline is located within 0.16mm of its true position (T.P.) at maximum material

(Unit: mm)

Item	Millimeters
A	9.0 ± 0.2
B	7.0 ± 0.2
C	9.0 ± 0.2
D	7.0 ± 0.2
E	0.22±0.05
F	0.5 BSC
G	0.2 +0.05 -0.05
H	1.0
I	0.6 ± 0.15
J	$12^{o} \pm 1^{o}$
K	$12^{o} \pm 1^{o}$
L	1.6 MAX
M	1.4± 0.1
N	0^{o} MIN
O	$+3^{o}$ $+7^{o}$ -3^{o}

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