

1/8- to 1/16-DUTY FIP™ (VFD) CONTROLLER/DRIVER

The μ PD16311 is a FIP (Fluorescent Indicator Panel or Vacuum Fluorescent Display) controller/driver that is driven on a 1/8- to 1/16 duty factor. It consists of 12 segment 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 μ PD16311 through a three-line serial interface. This FIP controller/driver is ideal as a peripheral device of a single-chip microcomputer.

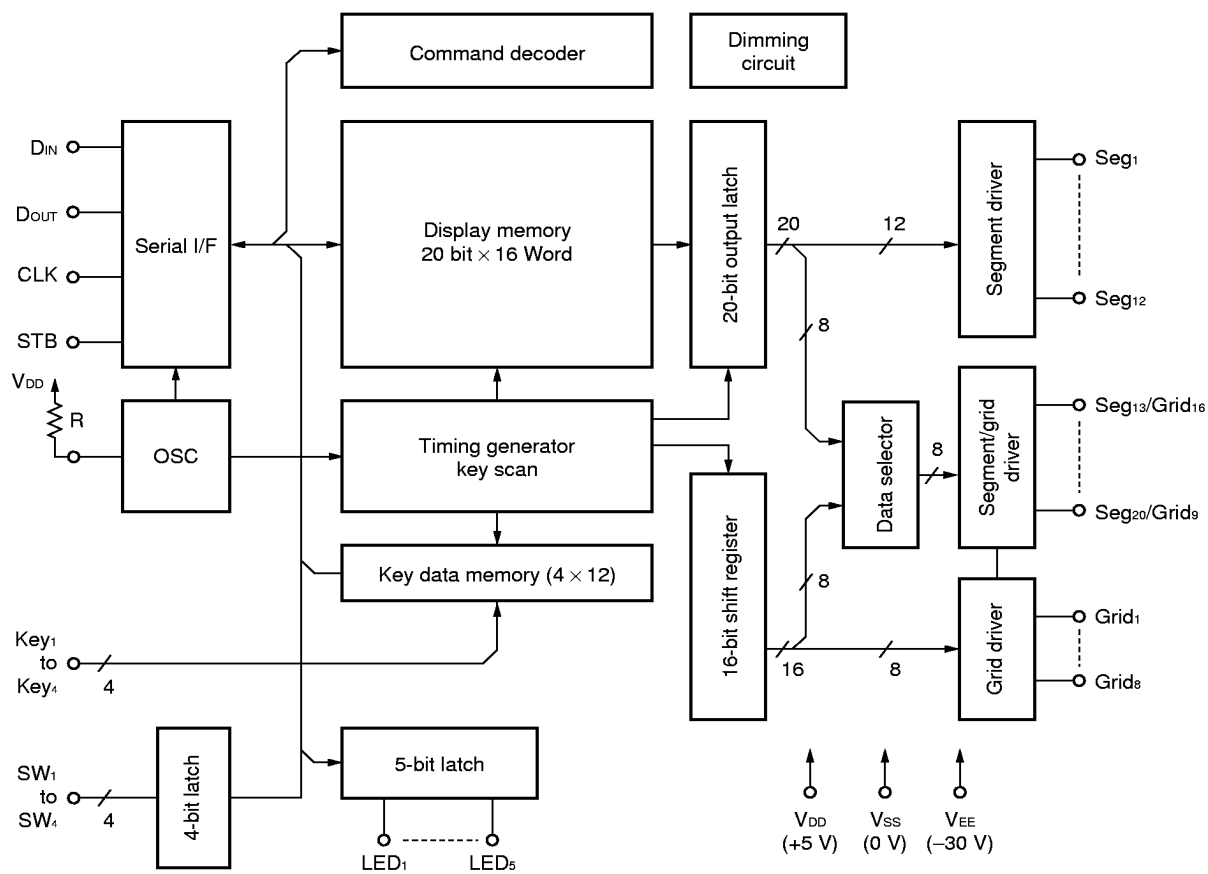
FEATURES

- Many display modes (12-segment & 16-digit to 20-segment & 8-digit)
- Key scanning (12 × 4 matrices)
- Dimming circuit (eight steps)
- High-voltage output ($V_{DD} - 35\text{ V}$ max).
- LED ports (5 chs., 20 mA max).
- General-purpose input port (4 bits)
- No external resistor necessary for driver outputs (P-ch open-drain + pull-down resistor output)
- Serial interface (CLK, STB, DIN, DOUT)

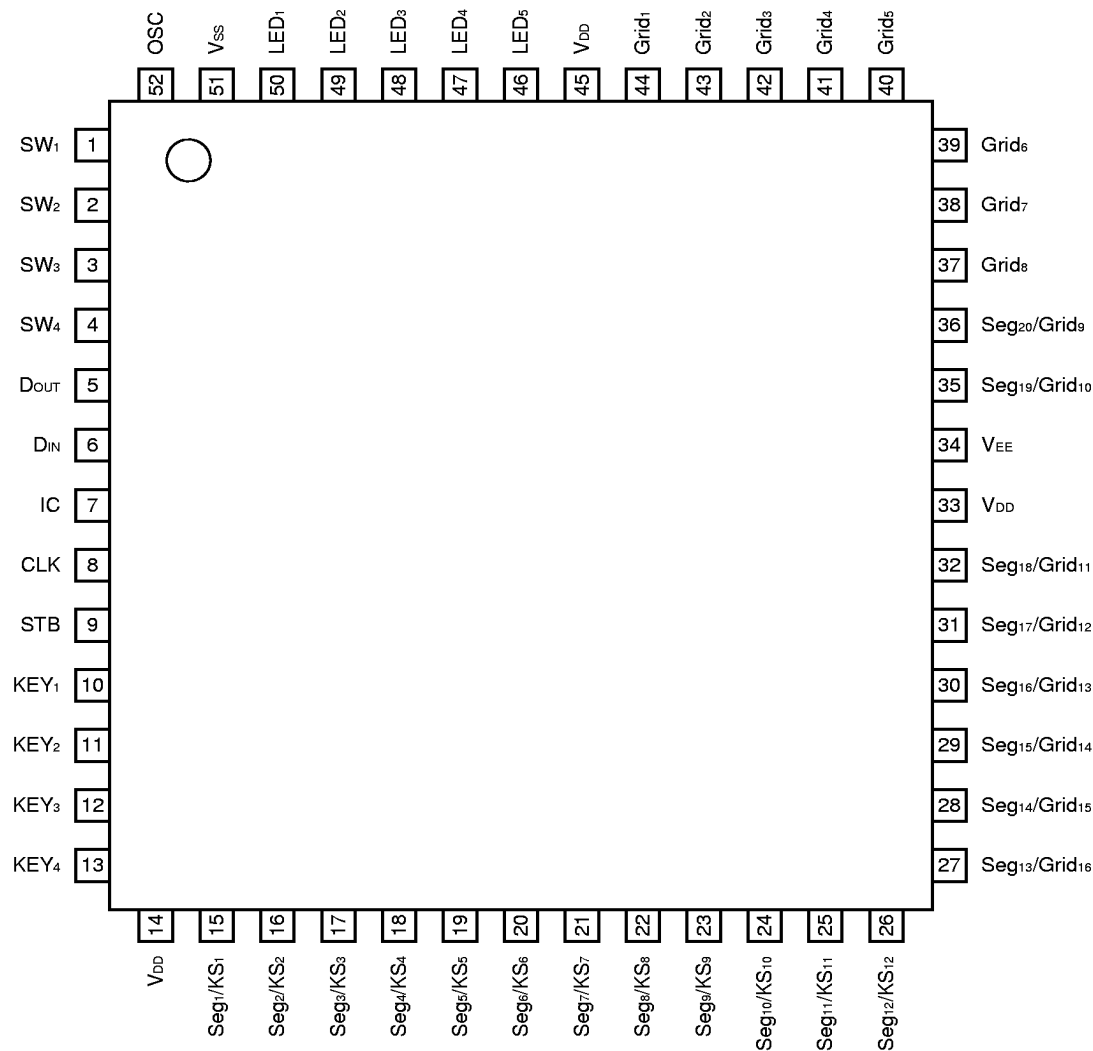
ORDERING INFORMATION

Part Number	Package
μ PD16311GC-AB6	52-pin plastic QFP ($\square$ 14)

BLOCK DIAGRAM



PIN CONFIGURATION (Top View)



Use all the power pins. Leave the IC pin open.

Pin Function

Pin No.	Symbol	Pin Name	Description
6	D _{IN}	Data input	Inputs serial data at rising edge of shift clock, starting from lower bit.
5	D _{OUT}	Data output	Outputs serial data at falling edge of shift clock, starting from lower bit. This is N-ch open-drain output pin.
9	STB	Strobe	Initializes serial interface at rising or falling edge to make μPD16311 waiting for reception of command. Data input after STB has fallen 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.
52	OSC	Oscillator pin	Connect resistor for determining oscillation frequency to this pin.
15 to 26	Seg ₁ /KS ₁ to Seg ₁₂ /KS ₁₂	High-voltage output (segment)	Segment output pins (Dual function as key source)
44 to 37	Grid ₁ to Grid ₆	High-voltage output (grid)	Grid output pins
27 to 32 35 to 36	Seg ₁₃ /Grid ₁₆ to Seg ₂₀ /Grid ₉	High-voltage output (segment/grid)	These pins are selectable for segment or grid output.
50 to 46	LED ₁ to LED ₅	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 end of display cycle.
1 to 4	SW ₁ to SW ₄	Switch input	These pins constitute 4-bit general-purpose input port.
14, 33, 45	V _{DD}	Logic power	5 V ± 10 %
51	V _{SS}	Logic ground	Connect this pin to GND of system.
34	V _{EE}	Pull-down level	V _{DD} – 35 V max.
7	IC	Internally connected	Be sure to leave this pin open (this pin is at V _{DD} level).

Display RAM Address and Display Mode

The display RAM stores the data transmitted from an external device to the μPD16311 through the serial interface, and is assigned addresses as follows, in units of 8 bits:

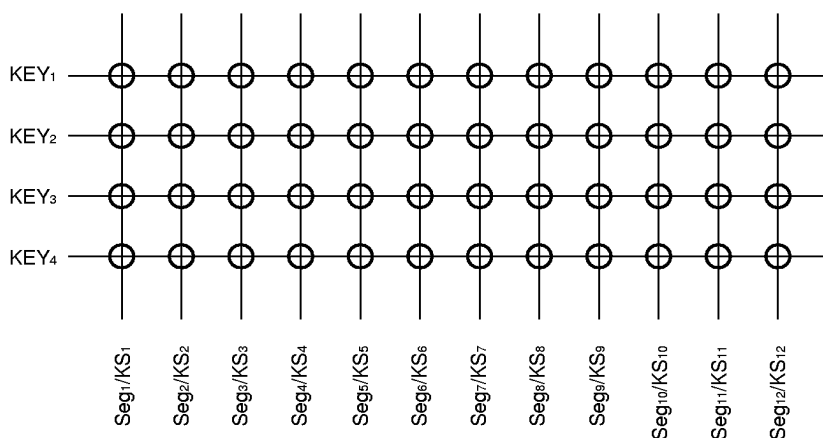
Seg ₁	Seg ₄	Seg ₈	Seg ₁₂	Seg ₁₆	Seg ₂₀	
00 H _L	00 H _U	01 H _L	01 H _U	02 H _L		DIG ₁
03 H _L	03 H _U	04 H _L	04 H _U	05 H _L		DIG ₂
06 H _L	06 H _U	07 H _L	07 H _U	08 H _L		DIG ₃
09 H _L	09 H _U	0 A H _L	0 A H _U	0 B H _L		DIG ₄
0 C H _L	0 C H _U	0 D H _L	0 D H _U	0 E H _L		DIG ₅
0 F H _L	0 F H _U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

b ₀	b ₃ b ₄	b ₇
XX H _L	XX H _U	
Lower 4 bits		Higher 4 bits

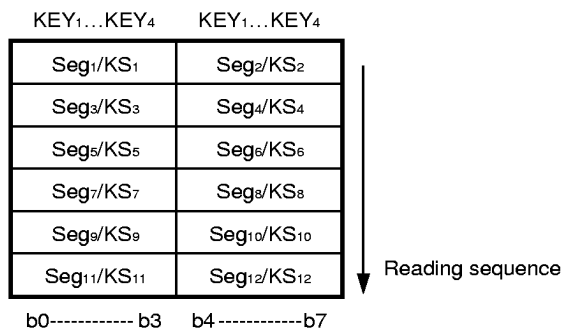
Only the lower 4 bits of the addresses assigned to Seg₁₇ through Seg₂₀ are valid, and the higher 4 bits are ignored.

Key Matrix and Key-Input Data Storage RAM

The key matrix is of 12×4 configuration, as shown below.



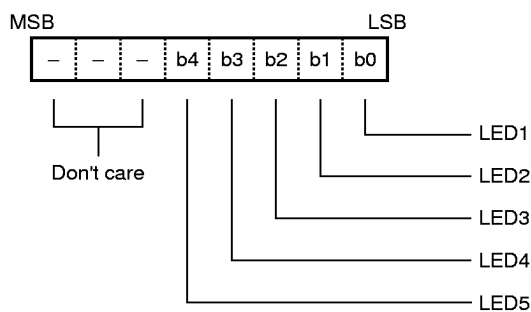
The data of each key is stored as illustrated below, and is read by a read command, starting from the least significant bit.



When the most significant bit of data (Seg₁₂ b₇) has been read, the least significant bit of the next data (Seg₁ b₀) is read.

LED Port

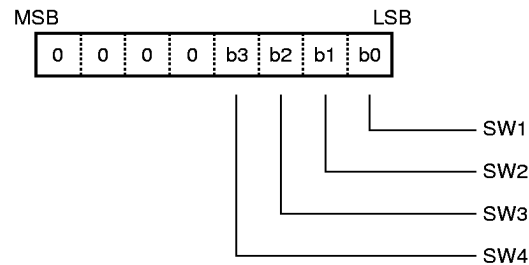
Data is written to the LED port by a write command, starting from the least significant bit of the port. When a bit of this port is 0, the corresponding LED lights; when the bit is 1, the LED goes off. The data of bits 6 through 8 is ignored.



On power application, all the LEDs remain dark.

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.



Command

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

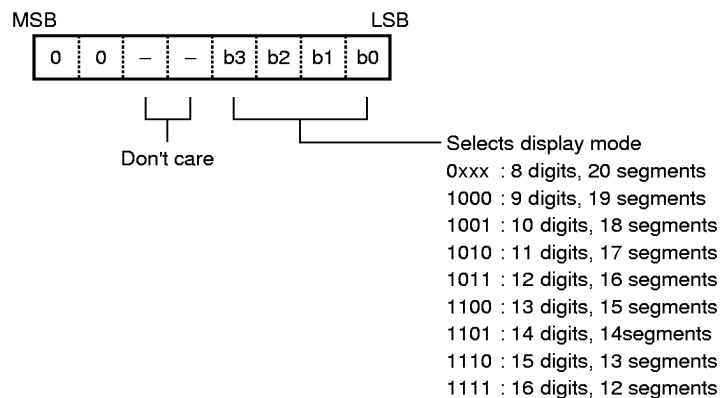
The first 1 byte input to the μPD16311 through the D_{IN} pin after the STB pin has fallen is regarded as a command.

If STB is made high while a command/data is transmitted, serial communication is initialized, and the command/data being transmitted is invalid (however, the command/data already transmitted remains valid).

(1) Display mode setting command

This command initializes the μPD16311 and selects the number of segments and number of grids (1/8 to 1/16 duty, 12 segments to 20 segments).

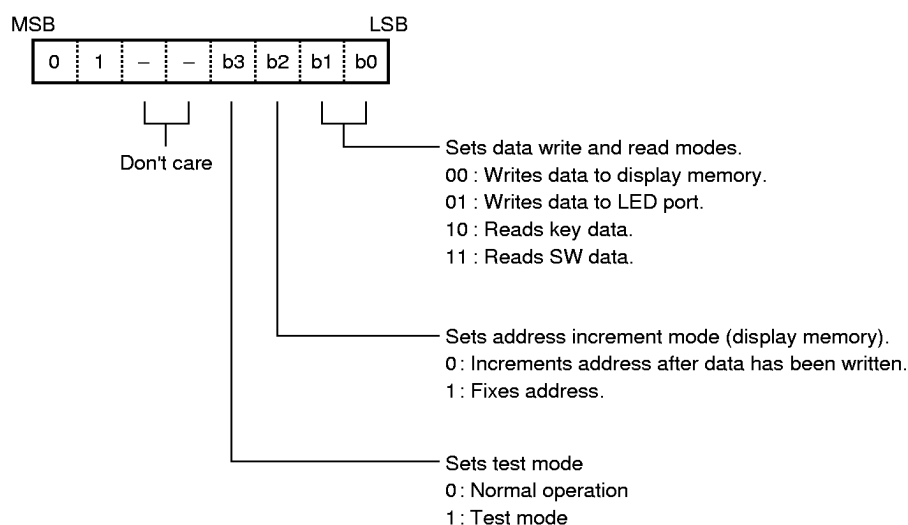
When this command is executed, display is forcibly turned off, and key scanning is also stopped. To resume display, a display ON command must be executed. If the same mode is selected, however, nothing is performed.



On power application, the 16-digit, 12-segment mode is selected.

(2) Data setting command

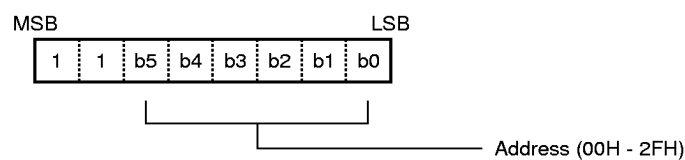
This command sets data write and data read modes.



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

(3) Address setting command

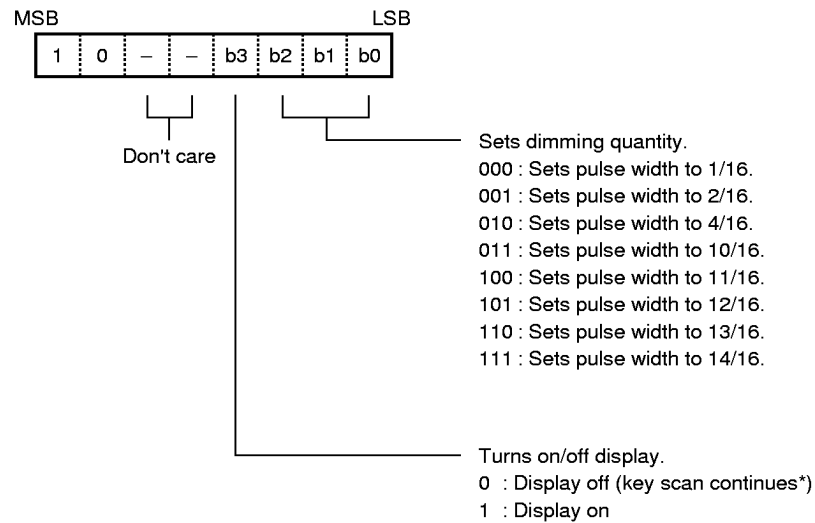
This command sets an address of the display memory.



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.

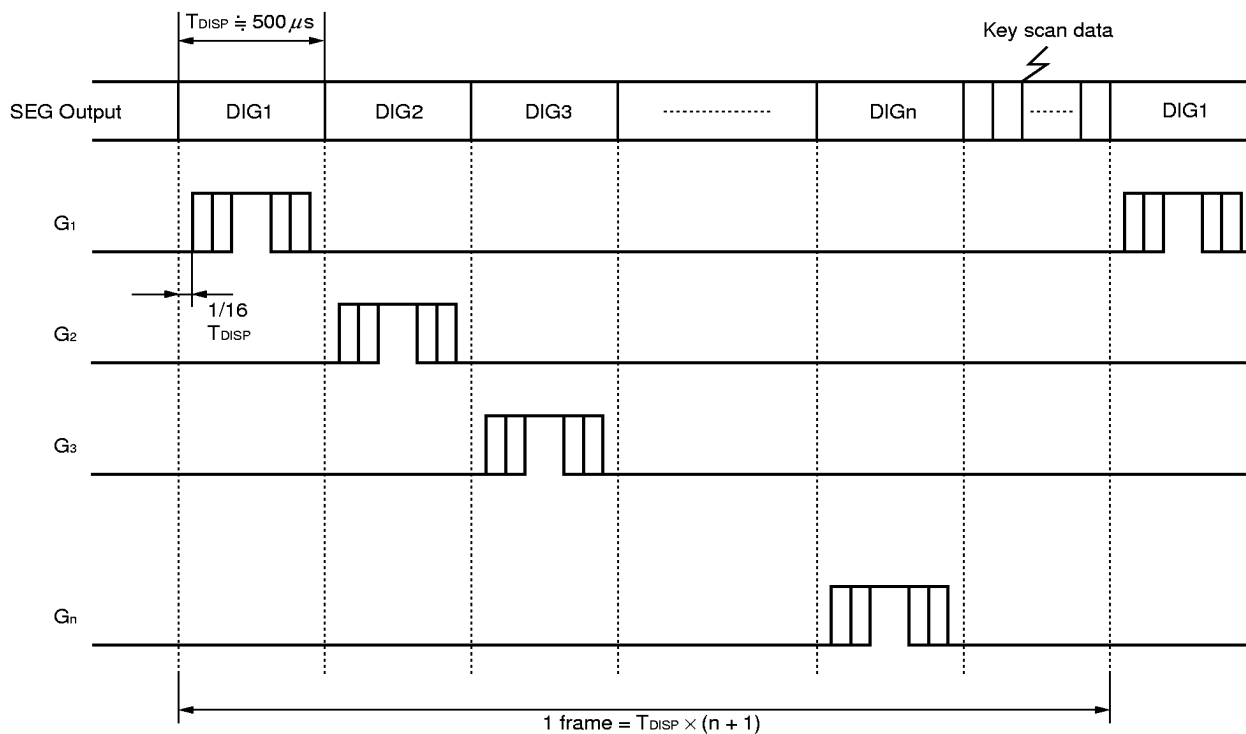
(4) Display control command



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

*: On power application, key scanning is stopped.

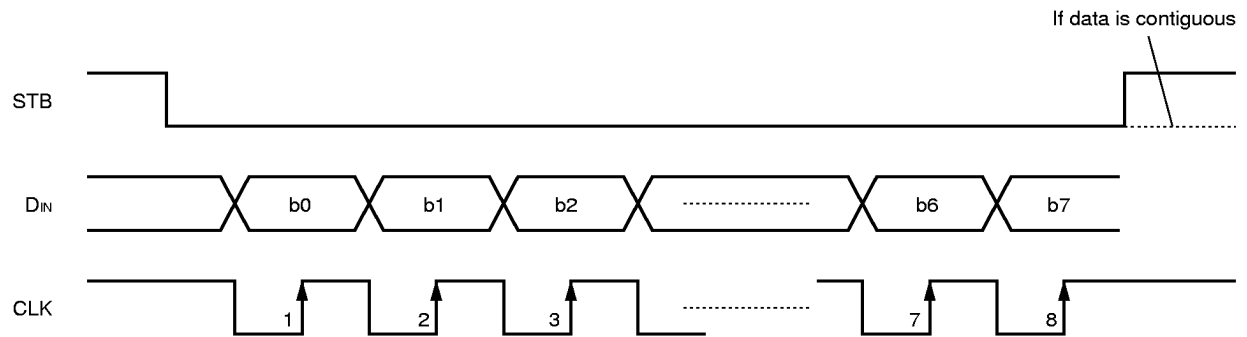
Key Scanning and Display Timing



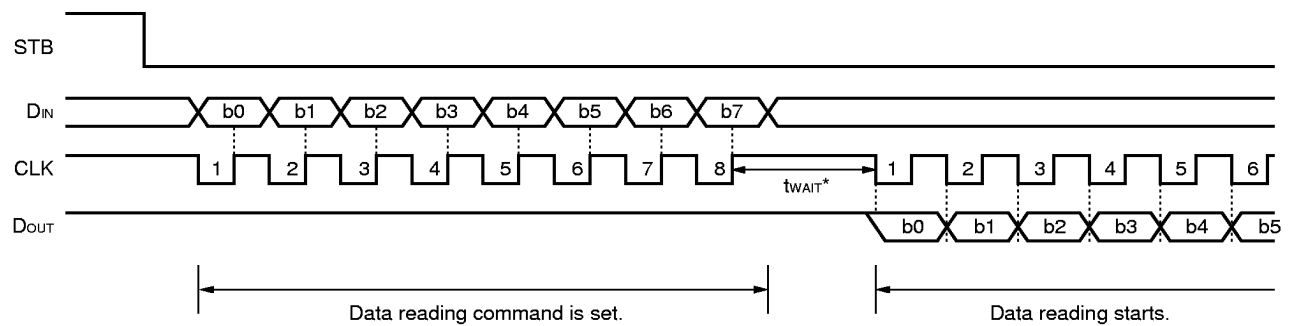
One cycle of key scanning consists of two frames, and data of 12×4 matrices is stored in RAM.

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 (1 kΩ to 10 kΩ).

*: 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.

ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C, V_{SS} = 0 V)

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
FIP Driver Output Voltage	V _{O2}	V _{EE} −0.5 to V _{DD} +0.5	V
LED Driver Output Current	I _{O1}	+25	mA
FIP Driver Output Current	I _{O2}	−40 (grid) −15 (segment)	mA
Power Dissipation	P _D	1200*	mW
Operating Ambient Temperature	T _{opt}	−40 to +85	°C
Storage Temperature	T _{stg}	−65 to +150	°C

*: Derate at −9.6 mW/°C at T_a = 25 °C or higher.

RECOMMENDED OPERATING CONDITIONS (T_a = −20 to +70 °C, V_{SS} = 0 V)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Logic Supply Voltage	V _{DD}	4.5	5	5.5	V	
High-Level Input Voltage	V _{IH}	0.7 • V _{DD}		V _{DD}	V	
Low-Level Input Voltage	V _{IL}	0		0.3 • V _{DD}	V	
Driver Supply Voltage	V _{EE}	0		V _{DD} − 35	V	

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

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

FIP driver dissipation = number of segments × 6 + number of grids/(number of grids + 1) × 30 (mW)

R_L dissipation = (V_{DD} − V_{EE})²/50 × (segment + 1) (mW)

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

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

Example

Where V_{EE} = −30 V, V_{DD} = 5 V, and in 16-segment and 12-digit modes,

FIP driver dissipation = 16 × 6 + 12/13 × 35 = 128

R_L dissipation = 35²/50 × 17 = 417

LED driver dissipation = 5 × 20 = 100

Dynamic power consumption = 5 × 5 = 25

Total 670 mW