To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

RENESAS

MOS INTEGRATED CIRCUIT

μPD16315

1/4- to 1/12-DUTY FIP™(VFD) CONTROLLER/DRIVER

DESCRIPTION

The μPD16315 is a FIP (Fluorescent Indicator Panel, or Vacuum Fluorescent Display) controller/driver that is driven on a 1/4- to 1/12- duty factor. It consists of 16 segment output lines, 4 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 μPD16315 through a three-line serial interface. This FIP controller/driver is ideal as a peripheral device for a single-chip microcomputer.

FEATURES

- Multiple display modes: 16-segment & 12-digit to 24-segment & 4-digit
- Key scanning: 16 x 2 matrix
- Dimming circuit: 8 steps
- High-withstanding-voltage output: V_{DD} – 35 V MAX.
- LED ports: 4 chs., 20 mA MAX.
- No external resistors necessary for driver outputs: P-ch open-drain + pull-down resistor output
- Serial interface: CLK, STB, D_{IN}, D_{OUT}

ORDERING INFORMATION

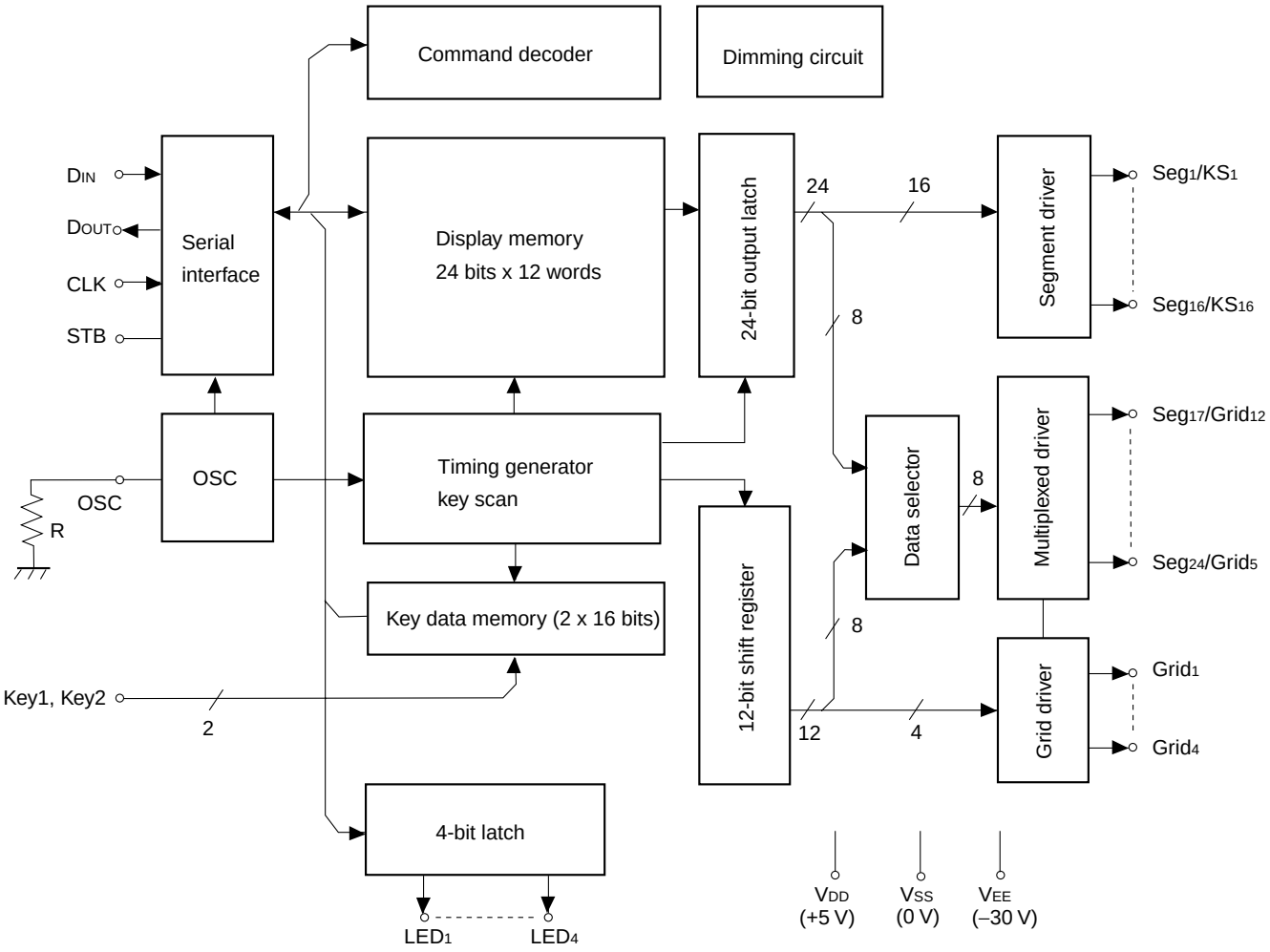
Part Number	Package
μPD16315GB-3BS	44-pin Plastic QFP (10 x 10)

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

Document No. S14074EJ1V0DS00 (1st edition)
Date Published February 2003 NS CP(K)
Printed in Japan

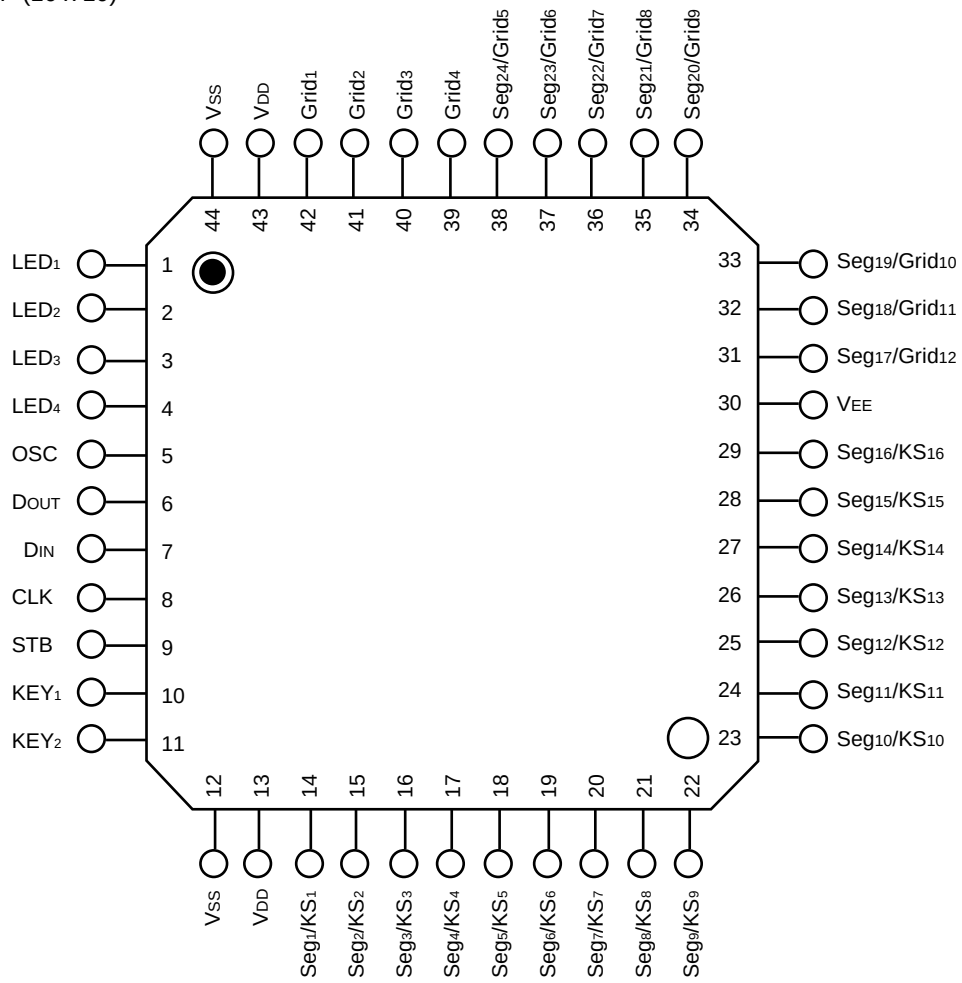
© NEC Electronics Corporation 1999

1. BLOCK DIAGRAM



2. PIN CONFIGURATION (Top View)

44-pin Plastic QFP (10 x 10)



Caution Use all of the power supply pins.

3. PIN FUNCTION

Symbol	Pin Name	Pin No.	I/O	Description
D_{IN}	Data input	7	Input	Input serial data at rising edge of shift clock, starting from the low order bit.
D_{OUT}	Data output	6	Output	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 μPD16315. It then waits for reception of a command. Data input after STB has fallen 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	Input	Reads serial data at the rising edge, and outputs data at the falling edge.
OSC	Oscillator pin	5	–	Connect resistor to this pin to determine the oscillation frequency to this pin. Connect resistor between this pin and GND (V_{SS}).
Seg_1/KS_1 to Seg_{16}/KS_{16}	High-withstanding-voltage output (Segment)	14 to 29	Output	Segment output pins (Dual function as key source)
$Grid_1$ to $Grid_4$	High-withstanding-voltage output (grid)	39 to 42	Output	Grid output pins
$Seg_{17}/Grid_{12}$ to $Seg_{24}/Grid_5$	High-withstanding-voltage output (segment/grid)	31 to 38	Output	These pins are selectable for segment or grid driving.
LED_1 to LED_4	LED output	1 to 4	Output	CMOS output, +20 mA MAX.
KEY_1, KEY_2	Key data input	10, 11	Input	Data input to these pins is latched at the end of the display cycle.
V_{DD}	Logic power	13, 43	–	5 V ± 10%
V_{SS}	Logic ground	12, 44	–	Connect this pin to system GND.
V_{EE}	Pull-down level	30	–	V_{DD} – 35 V MAX.

4. DISPLAY RAM ADDRESS AND DISPLAY MODE

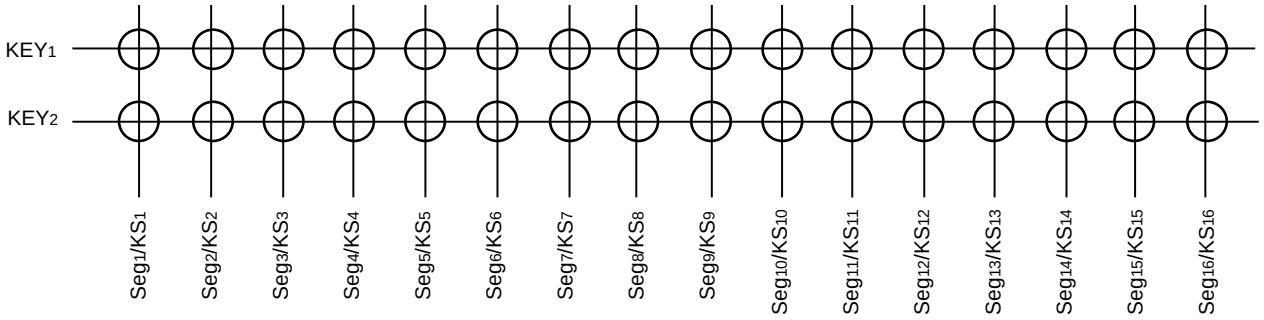
The display RAM stores the data transmitted to the μPD16315 through the serial communication. The addresses are allocated in 8-bit units.

Seg_1	Seg_4	Seg_8	Seg_{12}	Seg_{16}	Seg_{20}	Seg_{24}	
$00H_L$		$00H_U$	$01H_L$	$01H_U$	$02H_L$	$02H_U$	DIG_1
$03H_L$		$03H_U$	$04H_L$	$04H_U$	$05H_L$	$05H_U$	DIG_2
$06H_L$		$06H_U$	$07H_L$	$07H_U$	$08H_L$	$08H_U$	DIG_3
$09H_L$		$09H_U$	$0AH_L$	$0AH_U$	$0BH_L$	$0BH_U$	DIG_4
$0CH_L$		$0CH_U$	$0DH_L$	$0DH_U$	$0EH_L$	$0EH_U$	DIG_5
$0FH_L$		$0FH_U$	$10H_L$	$10H_U$	$11H_L$	$11H_U$	DIG_6
$12H_L$		$12H_U$	$13H_L$	$13H_U$	$14H_L$	$14H_U$	DIG_7
$15H_L$		$15H_U$	$16H_L$	$16H_U$	$17H_L$	$17H_U$	DIG_8
$18H_L$		$18H_U$	$19H_L$	$19H_U$	$1AH_L$	$1AH_U$	DIG_9
$1BH_L$		$1BH_U$	$1CH_L$	$1CH_U$	$1DH_L$	$1DH_U$	DIG_{10}
$1EH_L$		$1EH_U$	$1FH_L$	$1FH_U$	$20H_L$	$20H_U$	DIG_{11}
$21H_L$		$21H_U$	$22H_L$	$22H_U$	$23H_L$	$23H_U$	DIG_{12}

b0	b3	b4	b7
XXH_L		XXH_U	
Lower 4 bits		Higher 4 bits	

5. KEY MATRIX AND KEY-INPUT DATA STORAGE RAM

The key matrix is made up of a 16 x 2 matrix, as shown below.



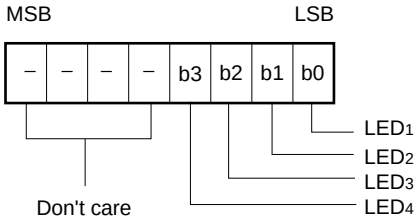
The data of each key is stored as follows, and is read with the read command starting from the least significant bit.

KEY1	KEY2	KEY1	KEY2	KEY1	KEY2	KEY1	KEY2
Seg1/KS1		Seg2/KS2		Seg3/KS3		Seg4/KS4	
Seg5/KS5		Seg6/KS6		Seg7/KS7		Seg8/KS8	
Seg9/KS9		Seg10/KS10		Seg11/KS11		Seg12/KS12	
Seg13/KS13		Seg14/KS14		Seg15/KS15		Seg16/KS16	
b0	b1	b2	b3	b4	b5	b6	b7

Reading Sequence

5.1 LED Port

Data is written to the LED port with the write command, starting from the least significant bit. “L” output when the bit of this port is 0, and “H” output when the bit is 1. The data of bits after the 5th bit are ignored.



Remark Power ON application, all the LED ports are “L” output.

6. COMMANDS

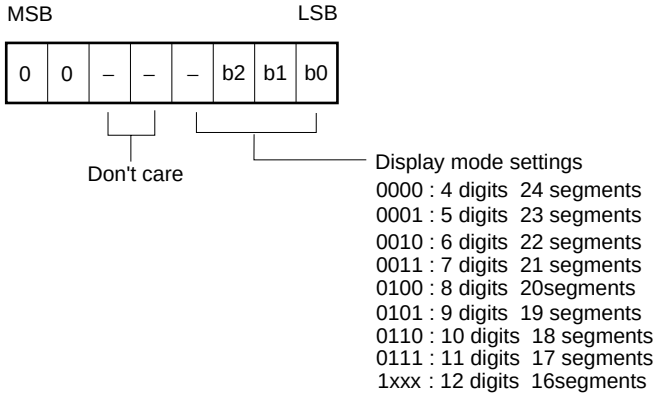
Commands set the display mode and status of the FIP™ (VFD) driver.

The first 1 byte input to the μPD16315 through the D_{IN} pin after the STB pin has fallen is regarded as a command. If STB is set high while commands/data are transmitted, serial communication is initialized, and the commands/data being transmitted are invalid (however, the commands/data previously transmitted remain valid).

(1) Display mode setting commands

These commands initialize the μPD16315 and select the number of segments and the number of grids (1/4- to 1/12-duty, 16 segments to 24 segments).

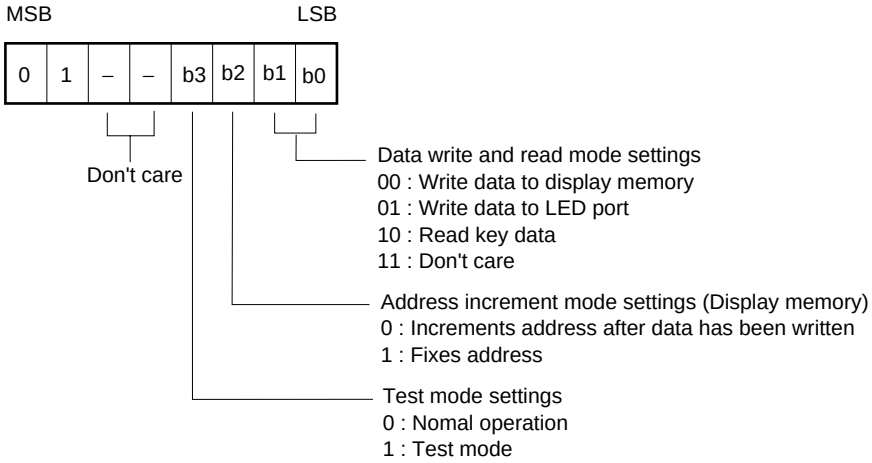
When these commands are executed, the display is forcibly turned OFF, and key scanning is also stopped. To resume display, the display command "ON" must be executed. If the same mode is selected, however, nothing happens.



Remark Power ON application, the 12-digit, 16-segment mode is selected.

(2) Data setting commands

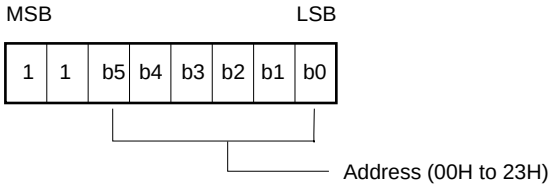
These commands set data write and data read modes.



Remark Power ON application, the normal operation and address increment modes are set.

(3) Address setting commands

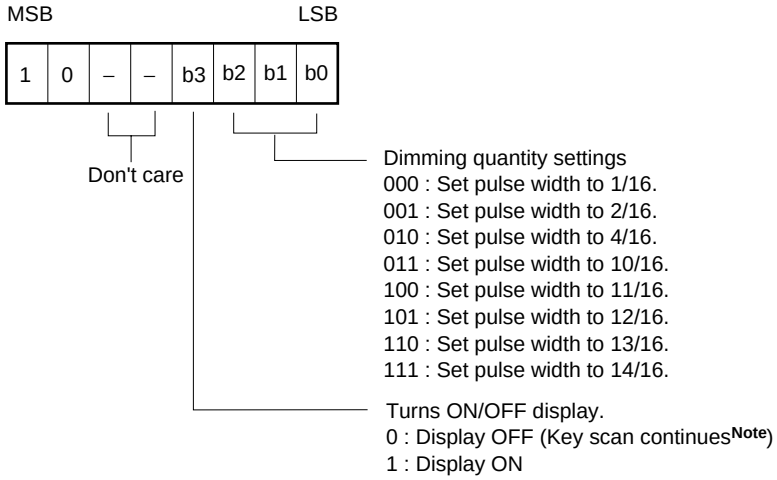
These commands set an address of the display memory.



Remarks 1. If address 24H or higher is set, data is ignored, until a valid address is set.

2. Power ON application, the address is set to 00H.

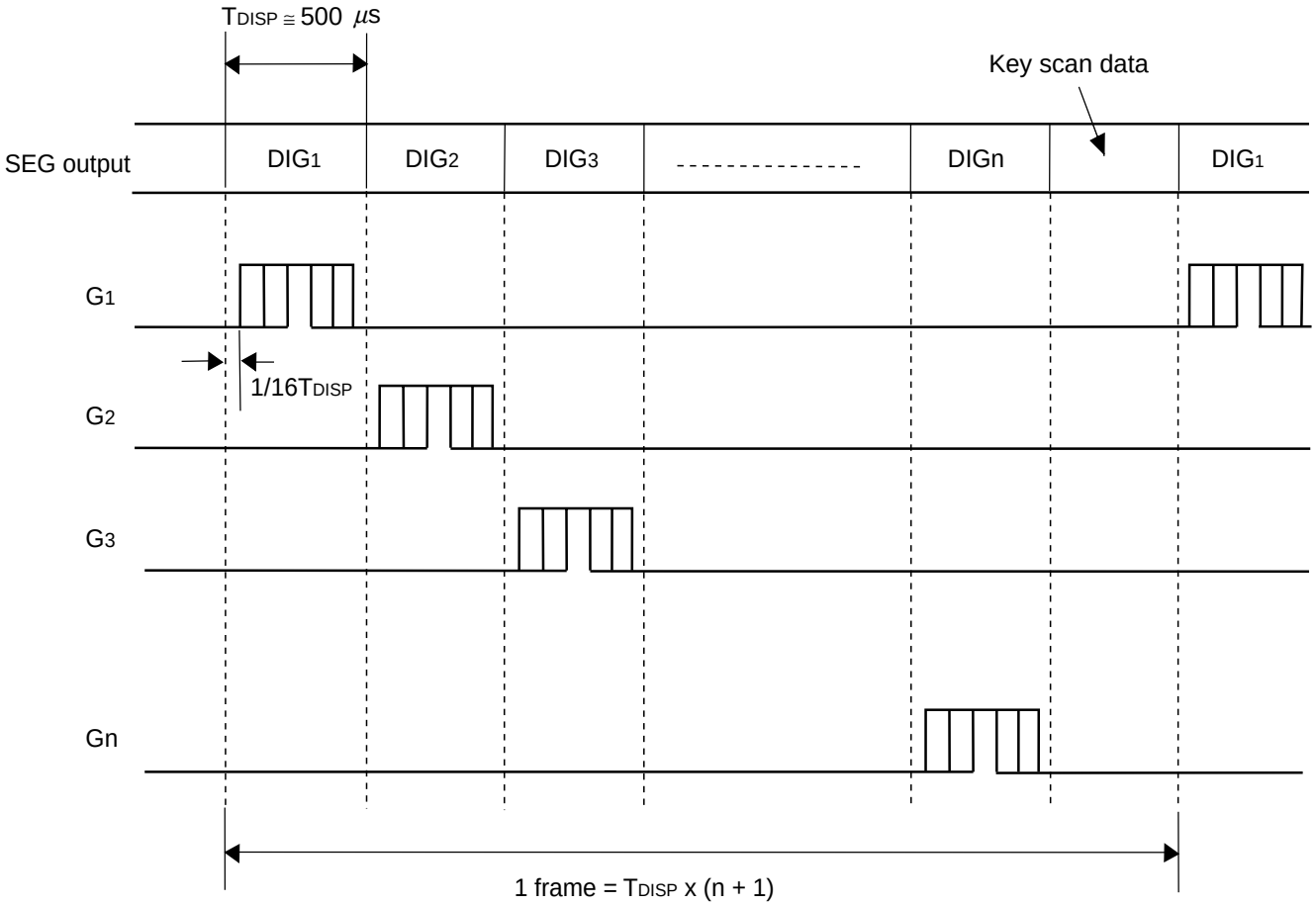
(4) Display control commands



Note Power ON application, key scanning is stopped.

Remark Power ON application, the 1/16 pulse width is set and the display is turned OFF.

7. KEY SCANNING AND DISPLAY TIMING



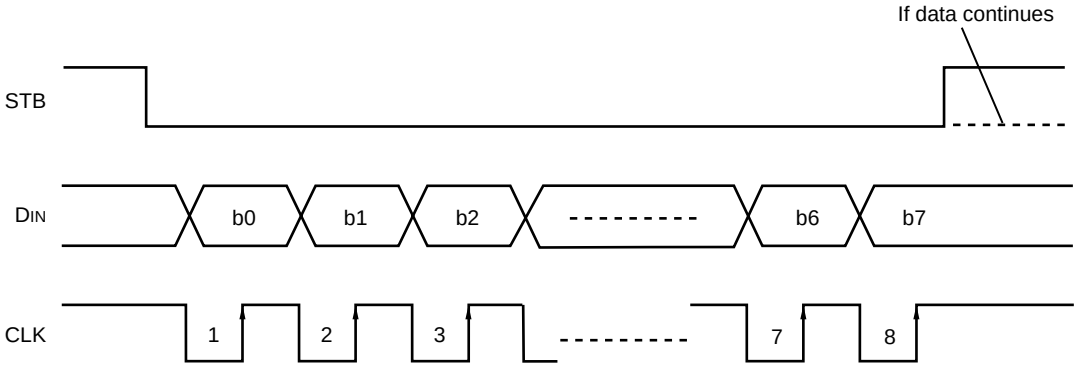
Remark One cycle of key scanning consists of two frame, and data in a 16 x 2 matrix is stored in RAM.

Key Scan Expansion

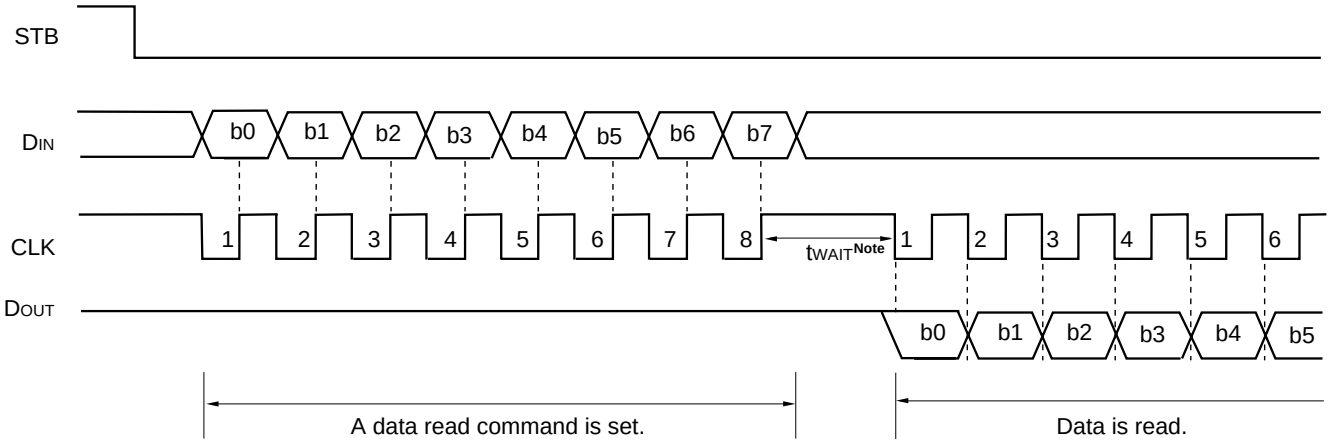
1st frame	DIGn	1	2	3	4	5	6	7	8	DIG1
2nd frame		9	10	11	12	13	14	15	16	

8. SERIAL COMMUNICATION FORMAT

Reception (command/data write)



Transmission (data read)



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.

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

9. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25°C, V_{SS} = 0 V)

Parameter	Symbol	Ratings	Unit
Logic Supply Voltage	V_{DD}	–0.5 to +6.0	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}	±20	mA
FIP Driver Output Current	I_{O2}	–40 (grid) –15 (segment)	mA
Power Dissipation	P_D	800[Note]	mW
Operating Ambient Temperature	T_A	–40 to +85	°C
Storage Temperature	T_{stg}	–65 to +150	°C

Note Derate at –6.4 mW/°C at T_A = 25°C or higher.

Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

Recommended Operating Range (T_A = –20 to 70°C, V_{SS} = 0 V)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
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 Votlage	V_{EE}	0		V_{DD} – 35	V

Remark 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 x 6 + number of grids/(number of grids + 1) x 30 (mW)

R_L dissipation ≅ $(V_{DD} – V_{EE})^2/50$ x (number of segments + 1) (mW)

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

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

Electrical Characteristics (T_A = –20 to +70°C, V_{DD} = 4.5 to 5.5 V, V_{SS} = 0 V, V_{EE} = V_{DD} – 35 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
High-Level Output Voltage	V_{OH1}	LED_1 - LED_4, I_{OH1} = –15 mA	V_{DD} – 1			V
Low-Level Output Voltage	V_{OL1}	LED_1 - LED_4, I_{OL1} = +15 mA			1	V
Low-Level Output Voltage	V_{OL2}	D_{OUT}, I_{OL2} = 4 mA			0.4	V
High-Level Output Current	I_{OH21}	V_O = V_{DD} – 2 V, Seg_1/ KS_1 to Seg_{16}/ KS_{16}	–3			mA
High-Level Output Current	I_{OH22}	V_O = V_{DD} – 2 V, $Grid_1$ to $Grid_4$ Seg_{17} / $Grid_{12}$ to Seg_{24} / $Grid_5$	–15			mA
Driver Leakage Current	I_{OLEAK}	V_O = V_{DD} – 35 V, driver OFF			–10	μA
Output Pull-Down Resistor	R_L	Driver output	40	65	120	kΩ
Input Current	I_I	V_I = V_{DD} or V_{SS}			±1	μA
High-Level Input Voltage	V_{IH}		0.7 V_{DD}			V
Low-Level Input Voltage	V_{IL}				0.3 V_{DD}	V
Hysteresis Voltage	V_H	CLK, D_{IN}, STB		0.35		V
Dynamic Current Consumption	I_{DDdyn}	Under no load, display OFF			5	mA

Switching Characteristics (T_A = –20 to +70°C, V_{DD} = 4.5 to 5.5 V, V_{EE} = –30 V)

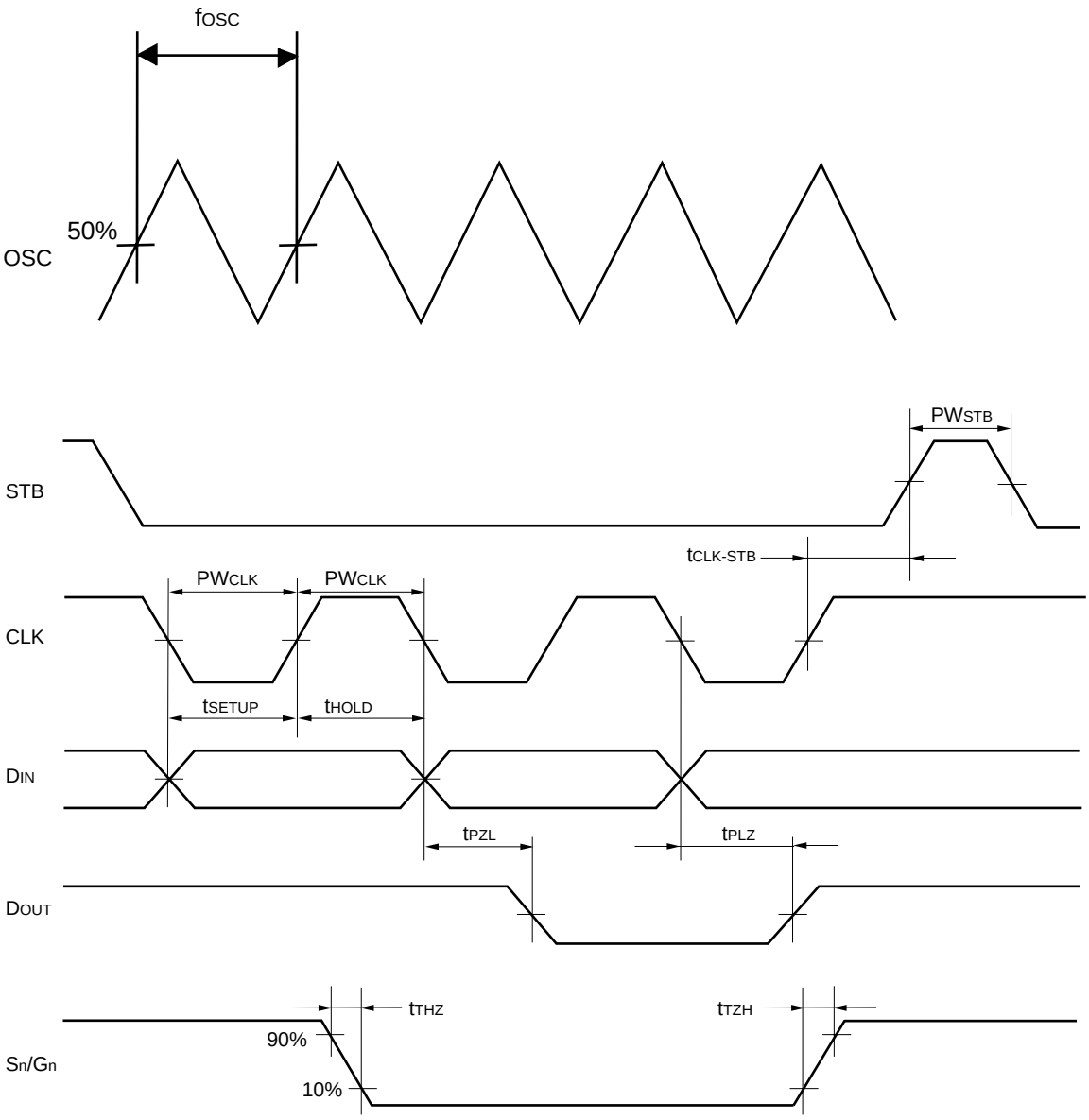
Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Oscillation Frequency	f_{OSC}	R = 82 kΩ		350	500	650	kHz
Propagation Delay Time	t_{PLZ}	CLK → D_{OUT}				300	ns
	t_{PZL}	C_L = 15 pF, R_L = 10 kΩ				100	ns
Rise Time	t_{TZH1}	C_L = 300 pF	Seg_1/KS_1 to Seg_{16}/KS_{16}			2	μs
	t_{TZH2}		$Grid_1$ to $Grid_4$, Seg_{17}/$Grid_{12}$ to Seg_{24}/$Grid_5$			0.5	μs
Fall Time	t_{THZ}	C_L = 300 pF, Seg_n, $Grid_n$				160	μs
Maximum Clock Frequency	$f_{MAX.}$	Duty = 50%		1			MHz
Input Capacitance	C_I					15	pF

Timing Conditions (T_A = –20 to 70°C, V_{DD} = 4.5 to 5.5 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Clock Pulse Width	PW_{CLK}		400			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 ↑ → STB ↑	1			μs
Wait Time	t_{WAIT}	CLK ↑ → CLK ↓ **Note**	1			μs

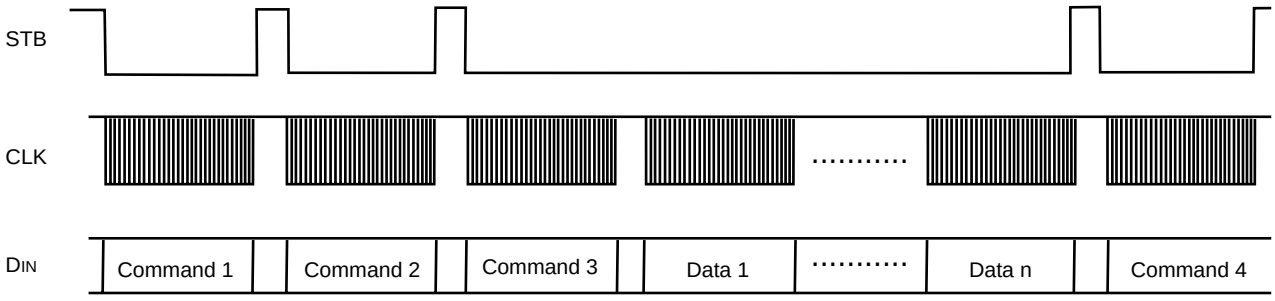
Note Refer to the **SERIAL COMMUNICATION FORMAT**.

Switching Characteristic Waveforms



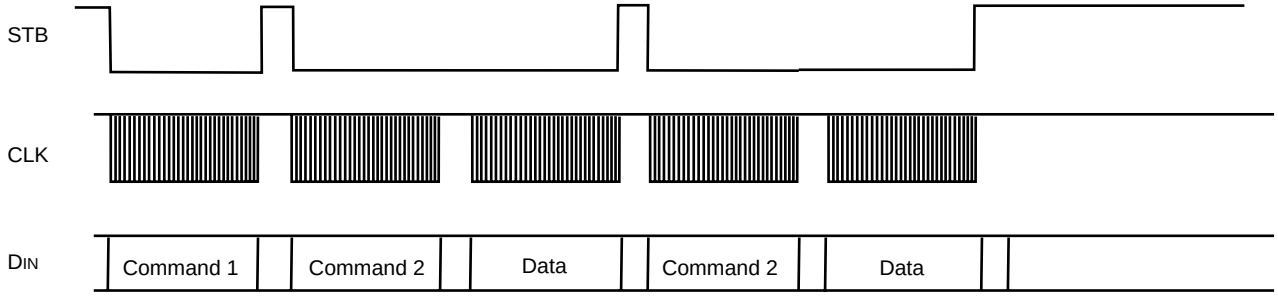
10. APPLICATIONS

Updating display memory by incrementing address



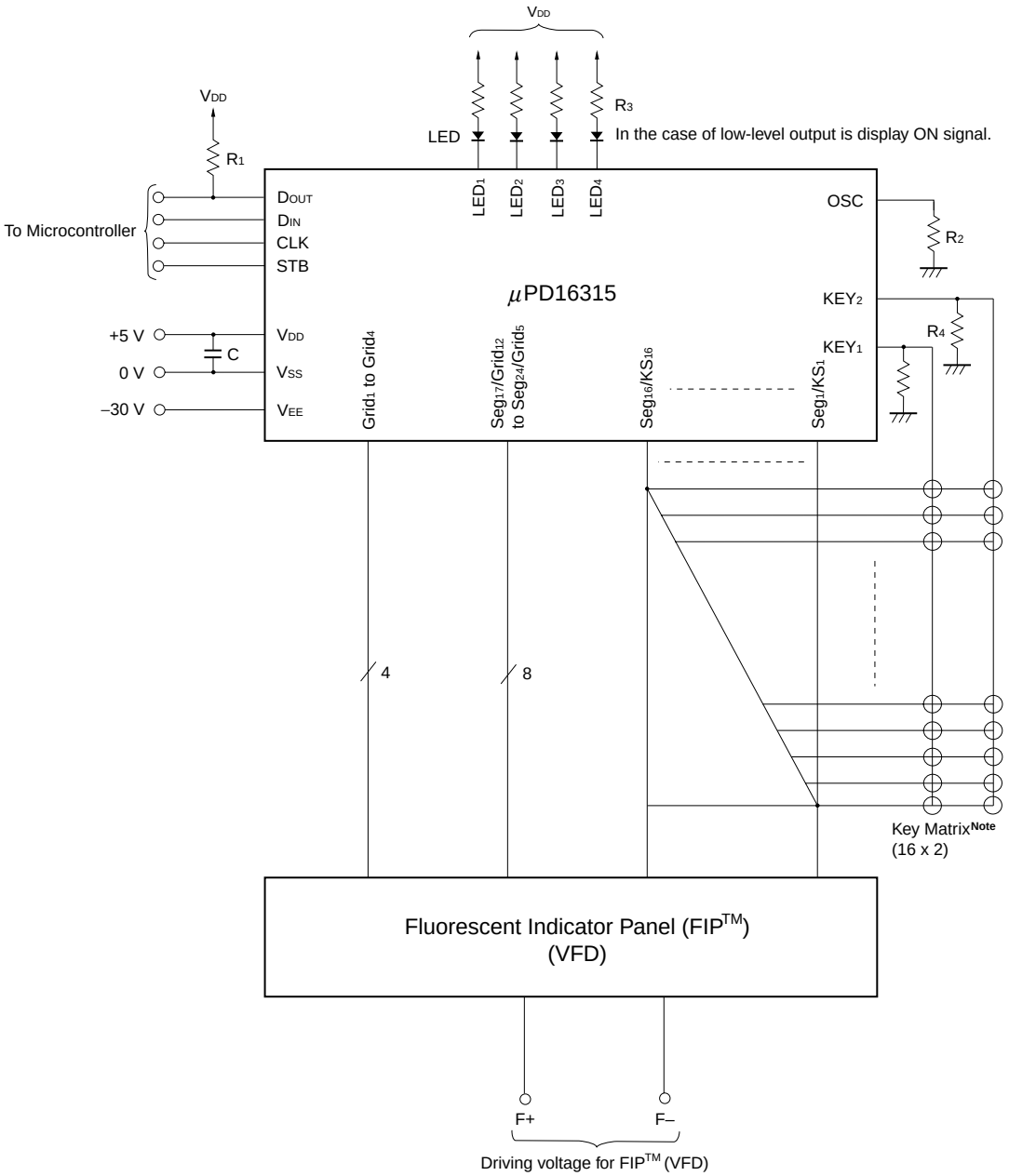
Command 1 : sets display mode
Command 2 : sets data
Command 3 : sets address
Data 1 to n : transfers display data (36 bytes MAX.)
Command 4 : controls display

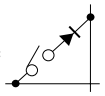
Updating specific address



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

11. CIRCUIT EXAMPLE FOR APPLICATION

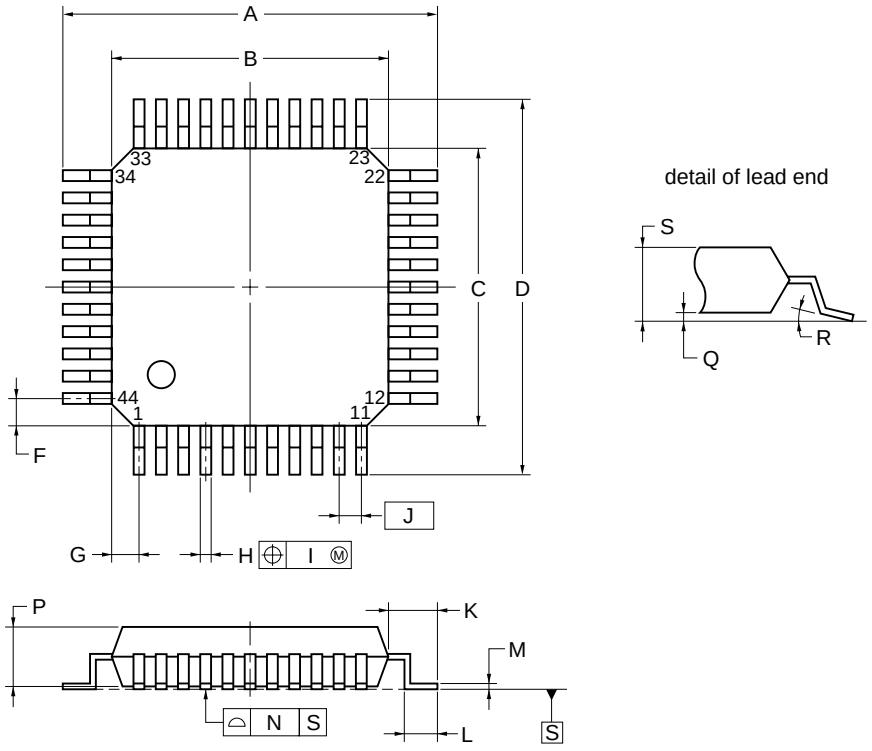


Note ⊕ = 

Remark R_1, R_4 = 1 k to 10 kΩ
R_2 = 82 kΩ
R_3 = 330 to 1 kΩ
C = 0.1 μ to 1.0 μF

12. PACKAGE DRAWING

44-PIN PLASTIC QFP (10x10)



NOTE

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

ITEM	MILLIMETERS
A	13.2±0.2
B	10.0±0.2
C	10.0±0.2
D	13.2±0.2
F	1.0
G	1.0
H	$0.37^{+0.08}_{-0.07}$
I	0.16
J	0.8 (T.P.)
K	1.6±0.2
L	0.8±0.2
M	$0.17^{+0.06}_{-0.05}$
N	0.10
P	2.7±0.1
Q	0.125±0.075
R	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$
S	3.0 MAX.

S44GB-80-3BS-2

13. RECOMMENDED SOLDERING CONDITIONS

The following conditions must be met for soldering conditions of the μPD16315.

For more details, refer to the **Semiconductor Device Mounting Technology Manual (C10535E).**

Please consult with our sales offices in case other soldering process is used, or in case the soldering is done under different conditions.

Type of Surface Mount Device

μPD16315GB-3BS : 44-pin plastic QFP (10 x 10)

Soldering process	Soldering conditions	Symbol
Infrared ray reflow	Peak package's surface temperature: 235°C or below, Reflow time: 30 seconds or below (210°C or higher), Number of reflow process: MAX.3	IR35-00-3
VPS	Peak package's temperature: 215°C or below, Reflow time: 25 to 40 seconds (200°C or higher), Number of reflow process: MAX.3	VP15-00-3
Wave Soldering	Solder temperature: 260°C or below, Flow time: 10 seconds or below Temperature of pre-heat: 120°C pr below (Plastic surface temperature) Number of flow process: 1	WS60-00-1
Partial heating method	Terminal temperature: 300°C or below, Time 3 seconds or below (per side of pin position)	–

Caution Do not apply more than a single process at once, except for partial heating method.

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

Reference Documents

NEC Semiconductor Device Reliability/Quality Control System (C10983E)

Quality Grades On NEC Semiconductor Devices (C11531E)

FIP™ is a trademark of NEC Corporation

- **The information in this document is current as of February, 2003. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC Electronics data sheets or data books, etc., for the most up-to-date specifications of NEC Electronics products. Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.**
- No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Electronics. NEC Electronics assumes no responsibility for any errors that may appear in this document.
- NEC Electronics does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC Electronics products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Electronics or others.
- Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of a customer's equipment shall be done under the full responsibility of the customer. NEC Electronics assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.
- While NEC Electronics endeavors to enhance the quality, reliability and safety of NEC Electronics products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC Electronics products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment and anti-failure features.
- NEC Electronics products are classified into the following three quality grades: "Standard", "Special" and "Specific".

  The "Specific" quality grade applies only to NEC Electronics products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of an NEC Electronics product depend on its quality grade, as indicated below. Customers must check the quality grade of each NEC Electronics product before using it in a particular application.

  "Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.

  "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support).

  "Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC Electronics products is "Standard" unless otherwise expressly specified in NEC Electronics data sheets or data books, etc. If customers wish to use NEC Electronics products in applications not intended by NEC Electronics, they must contact an NEC Electronics sales representative in advance to determine NEC Electronics' willingness to support a given application.

(Note)

(1) "NEC Electronics" as used in this statement means NEC Electronics Corporation and also includes its majority-owned subsidiaries.

(2) "NEC Electronics products" means any product developed or manufactured by or for NEC Electronics (as defined above).