

**Phase-out/Discontinued**

### 1/17, 1/25, 1/33 DUTY LCD CONTROLLER/DRIVER

#### DESCRIPTION

The  $\mu$  PD16670 is a LCD controller/driver with 1/17, 1/25 and 1/33 duty capable of displaying a dot matrix LCD. It has 60 segment outputs, 33 common outputs, giving a maximum display capability of 12 columns x 4 lines (at 1/33 duty).

The  $\mu$  PD16670 includes 4 x mode on-chip booster circuit, capable of operating on single 3 V-power supply.

#### FEATURES

- Dot matrix LCD controller/driver
- Able to operate using +3-V single power supply
- 4 x mode on-chip boost circuit
- Display contents
  - 1/17 duty: 12 columns x 2 lines + 60 pictograph displays
  - 1/25 duty: 12 columns x 3 lines + 60 pictograph displays
  - 1/33 duty: 12 columns x 4 lines + 60 pictograph displays
- Serial data input (SCK, STB, DATA)

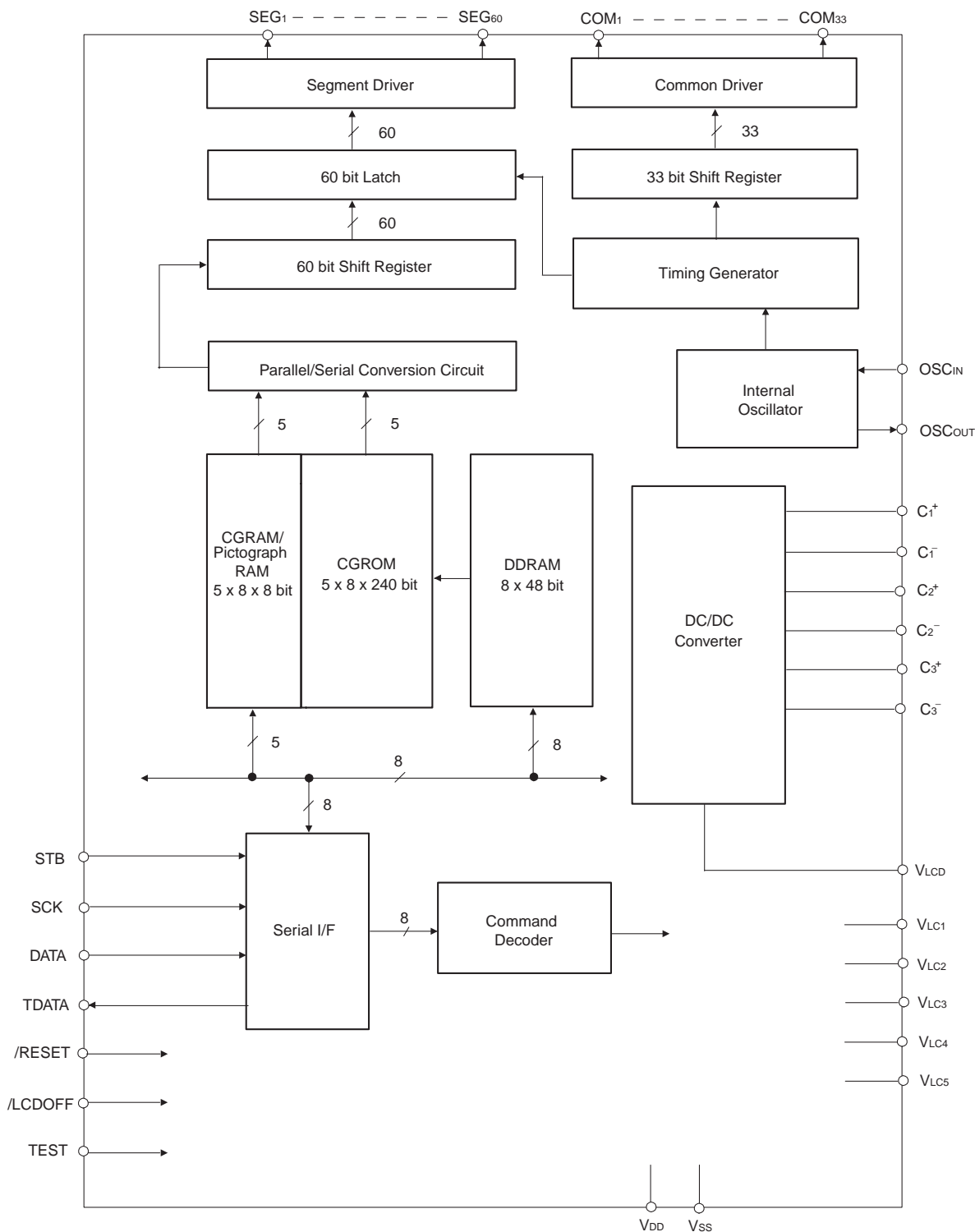
#### ORDERING INFORMATION

Part number	Package
$\mu$ PD16670W-xxx	Wafer
$\mu$ PD16670P-xxx	Chip

- ★ **Remark** Purchasing the above chip/wafer entails exchange of documents such as a separate memorandum or product quality, so please contact one of our sales representatives.

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★ 1. BLOCK DIAGRAM



★ **Remark** /xxx indicates active low signals.

2. PIN CONFIGURATION (Pad Layout)

Chip size: 4.20 x 5.40 mm<sup>2</sup>

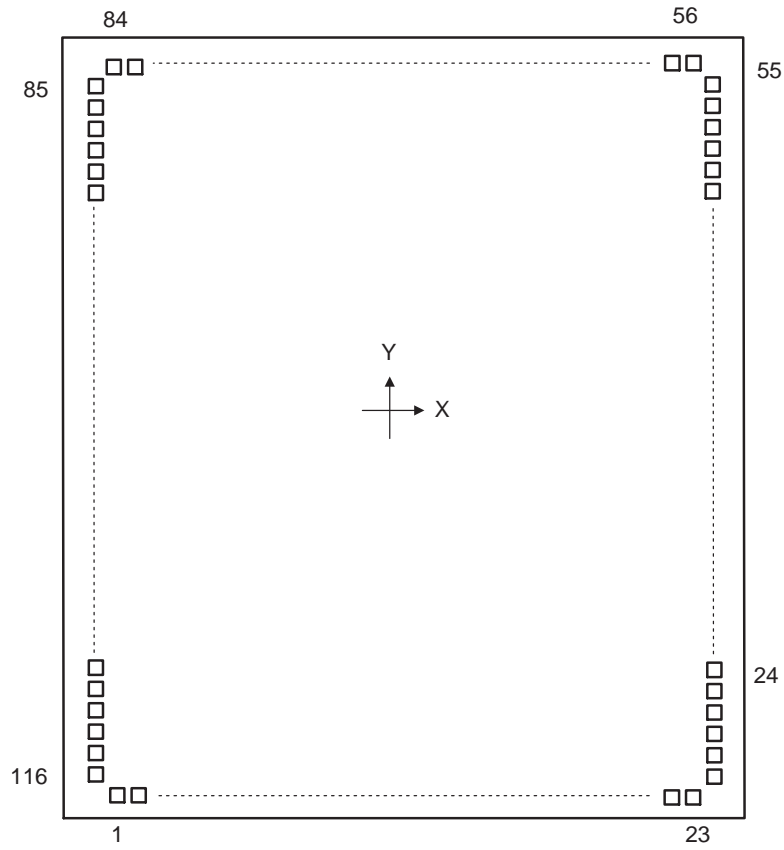


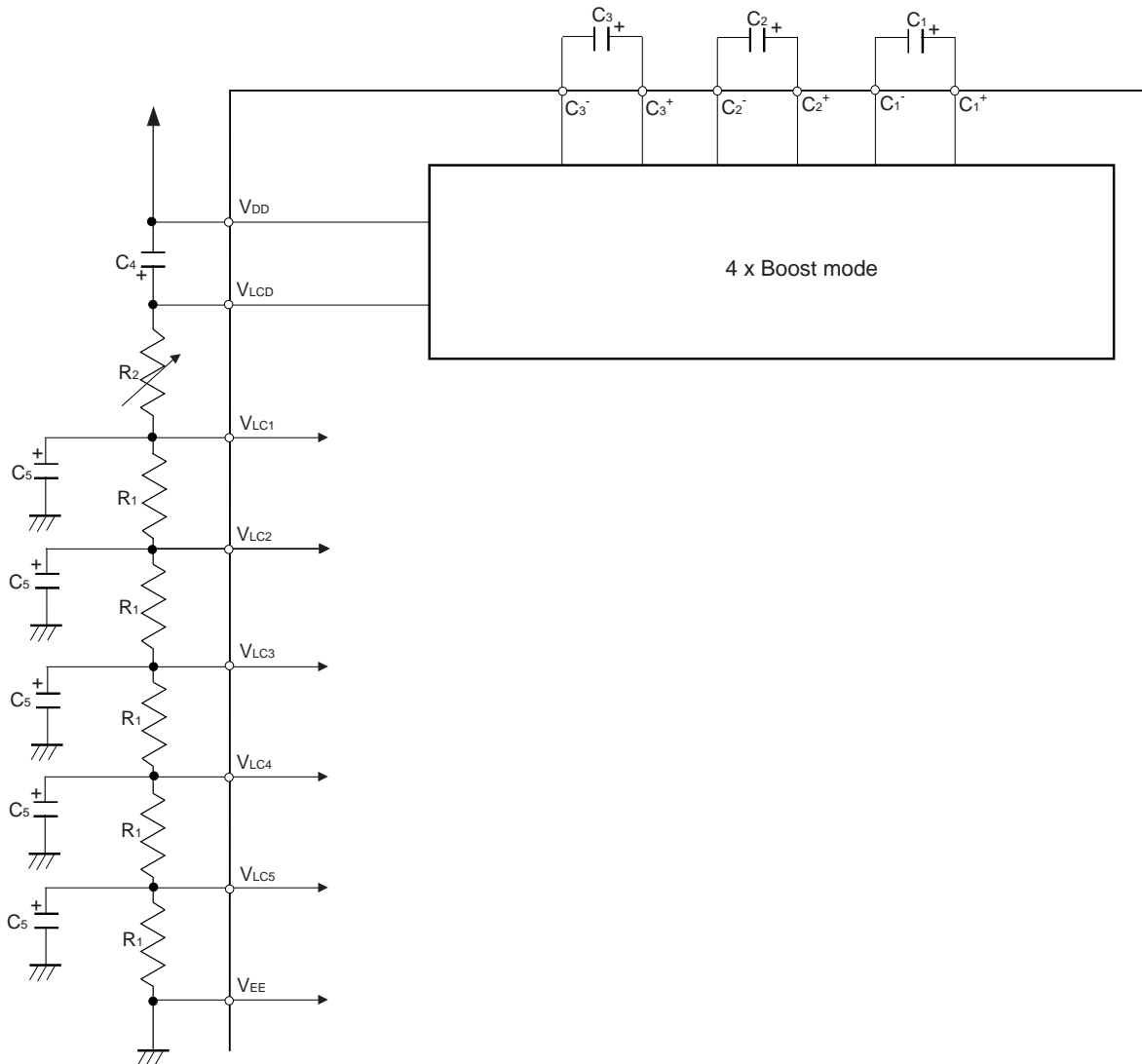
Table 2-1. Pad Layout

PAD No.	Pad Name	X (μm)	Y (μm)	PAD No.	Pad Name	X (μm)	Y (μm)
1	C2 <sup>+</sup>	-1545	-2480	59	SEG41	1319	2479
2	C2 <sup>-</sup>	-1425	-2480	60	SEG40	1199	2479
3	C3 <sup>+</sup>	-1305	-2480	61	SEG39	1079	2479
4	C3 <sup>-</sup>	-1135	-2480	62	SEG38	959	2479
5	C1 <sup>+</sup>	-1015	-2480	63	SEG37	839	2479
6	C1 <sup>-</sup>	-845	-2480	64	SEG36	719	2479
7	VDD	-725	-2480	65	SEG35	599	2479
8	VLCD	-605	-2480	66	SEG34	479	2479
9	VLc1	-435	-2480	67	SEG33	359	2479
10	VLc2	-265	-2480	68	SEG32	239	2479
11	VLc3	-95	-2480	69	SEG31	119	2479
12	VLc4	75	-2480	70	SEG30	-1	2479
13	VLc5	245	-2480	71	SEG29	-121	2479
14	VSS	365	-2480	72	SEG28	-241	2479
15	OSCIN	485	-2480	73	SEG27	-361	2479
16	OSCOU	605	-2480	74	SEG26	-481	2479
17	TEST	775	-2480	75	SEG25	-601	2479
18	TDATA	895	-2480	76	SEG24	-721	2479
19	RESETB	1065	-2480	77	SEG23	-841	2479
20	LCDOFFB	1185	-2480	78	SEG22	-961	2479
21	STB	1355	-2480	79	SEG21	-1081	2479
22	SCK	1475	-2480	80	SEG20	-1201	2479
23	DATA	1645	-2480	81	SEG19	-1321	2479
24	COM18	1837	-1839	82	SEG18	-1441	2479
25	COM19	1837	-1719	83	SEG17	-1561	2479
26	COM20	1837	-1599	84	SEG16	-1681	2479
27	COM21	1837	-1479	85	SEG15	-1837	1880
28	COM22	1837	-1359	86	SEG14	-1837	1760
29	COM23	1837	-1239	87	SEG13	-1837	1640
30	COM24	1837	-1119	88	SEG12	-1837	1520
31	COM25	1837	-999	89	SEG11	-1837	1400
32	COM26	1837	-879	90	SEG10	-1837	1280
33	COM27	1837	-759	91	SEG9	-1837	1160
34	COM28	1837	-639	92	SEG8	-1837	1040
35	COM29	1837	-519	93	SEG7	-1837	920
36	COM30	1837	-399	94	SEG6	-1837	800
37	COM31	1837	-279	95	SEG5	-1837	680
38	COM32	1837	-159	96	SEG4	-1837	560
39	COM33	1837	-39	97	SEG3	-1837	440
40	SEG60	1837	81	98	SEG2	-1837	320
41	SEG59	1837	201	99	SEG1	-1837	200
42	SEG58	1837	321	100	COM17	-1837	80
43	SEG57	1837	441	101	COM16	-1837	-40
44	SEG56	1837	561	102	COM15	-1837	-160
45	SEG55	1837	681	103	COM14	-1837	-280
46	SEG54	1837	801	104	COM13	-1837	-400
47	SEG53	1837	921	105	COM12	-1837	-520
48	SEG52	1837	1041	106	COM11	-1837	-640
49	SEG51	1837	1161	107	COM10	-1837	-760
50	SEG50	1837	1281	108	COM9	-1837	-880
51	SEG49	1837	1401	109	COM8	-1837	-1000
52	SEG48	1837	1521	110	COM7	-1837	-1120
53	SEG47	1837	1641	111	COM6	-1837	-1240
54	SEG46	1837	1761	112	COM5	-1837	-1360
55	SEG45	1837	1881	113	COM4	-1837	-1480
56	SEG44	1679	2479	114	COM3	-1837	-1600
57	SEG43	1559	2479	115	COM2	-1837	-1720
58	SEG42	1439	2479	116	COM1	-1837	-1840

3. PIN FUNCTIONS

Pin Symbol	Pin Name	Pad No.	I/O	Description
★ SEG <sub>1</sub> to SEG <sub>60</sub>	Segment	40 to 99	O	Segment output pins
★ COM <sub>1</sub> to COM <sub>33</sub>	Common	24 to39 100 to116	O	Common output pins COM <sub>1</sub> is assigned to common for pictograph.
SCK	Shift clock	22	I	Data shift clock During the read-in operation, data is captured in the shift register at the signal's rising edge. During a read-out operation, data is read from the shift register at the signal's falling edge.
DATA	Data	23	I	Performs input of commands and data. Input is performed from the MSB on the rise of the shift clock.
STB	Strobe	21	I	Communication is enabled when STB is low.
/LCDOFF	LCD off input	20	I	When at low level, a forced LCD off operation is performed SEG <sub>n</sub> = COM <sub>n</sub> = V <sub>SS</sub>
/RESET	Reset	19	I	This pin is used for internal resets at low level.
TDATA	Test output	18	O	This is a test output pin. Leave this pin open when using the device.
TEST	Test pin	17	I	Test mode is set when at high level.
OSC <sub>IN</sub>	Oscillator pins	15, 16	I	These pins are connected to a 100-kΩ resistance. When using an external oscillator, input to OSC <sub>IN</sub> and leave OSC <sub>OUT</sub> open.
OSC <sub>OUT</sub>		5, 6	O	
C <sub>1</sub> <sup>+</sup> , C <sub>1</sub> <sup>-</sup> C <sub>2</sub> <sup>+</sup> , C <sub>2</sub> <sup>-</sup> C <sub>3</sub> <sup>+</sup> , C <sub>3</sub> <sup>-</sup>	Capacitor connection pins	1 to 6	-	These are capacitor connection pins for the boost circuit. Connect a 1-μF capacitor.
V <sub>DD</sub>	Logic power supply pin	7	-	Power supply pins for logic
V <sub>SS</sub>	Logic ground pin	14	-	Ground pin for logic
V <sub>LCD</sub>	Driver power supply pins	8	-	Power supply pin for driver. Output pin for internal boost circuit. Connect a 1-μF capacitor between this pin and the V <sub>SS</sub> pin for boosting. If not using the internal boost circuit, a direct driver power supply can be input.
V <sub>LC1</sub> - V <sub>LC5</sub>	Reference power supply pins for driver	9 to 13	-	These are reference power supply pins for the LCD driver. Input divided register by each external power supply pin.

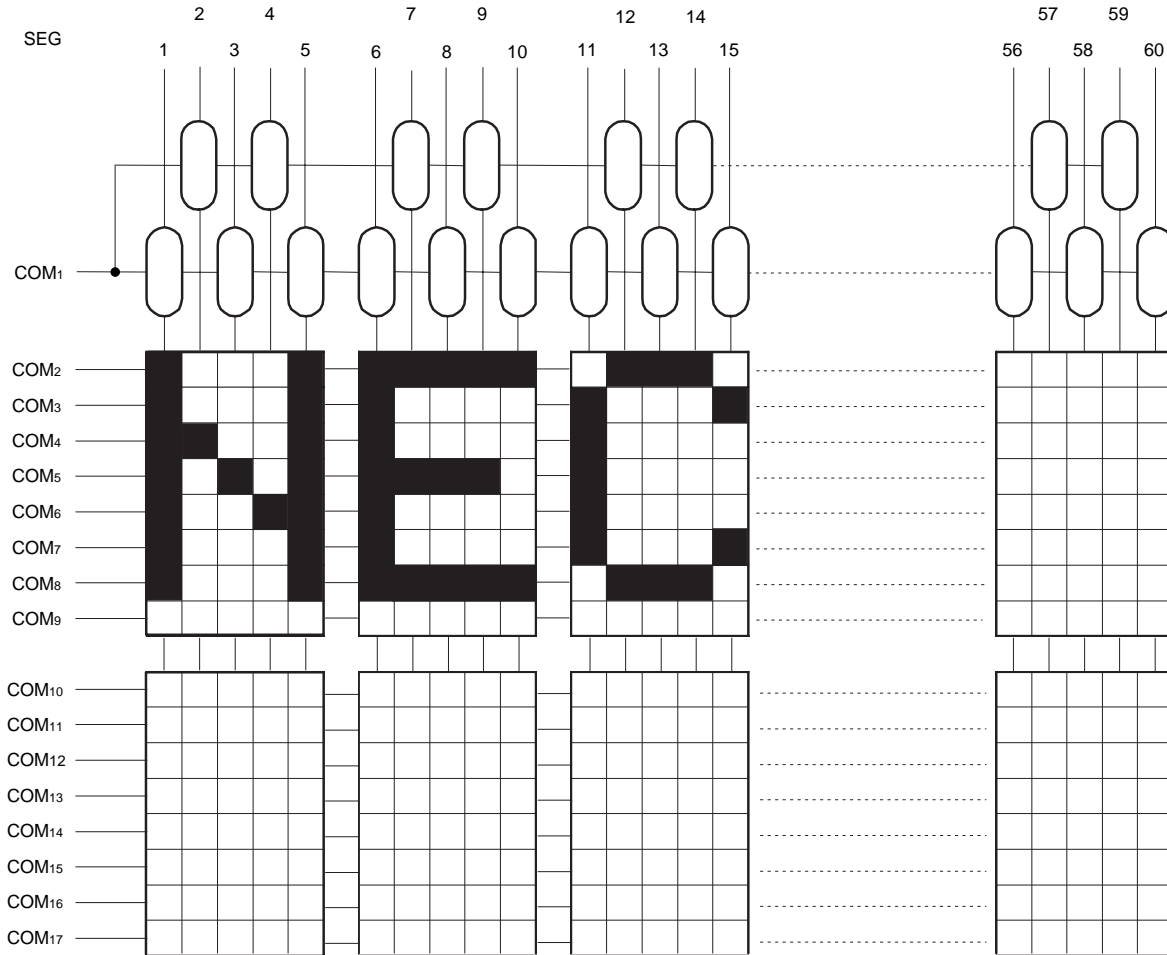
Figure 3-1. Example of LCD driver's circuit and external circuit for boosted circuit



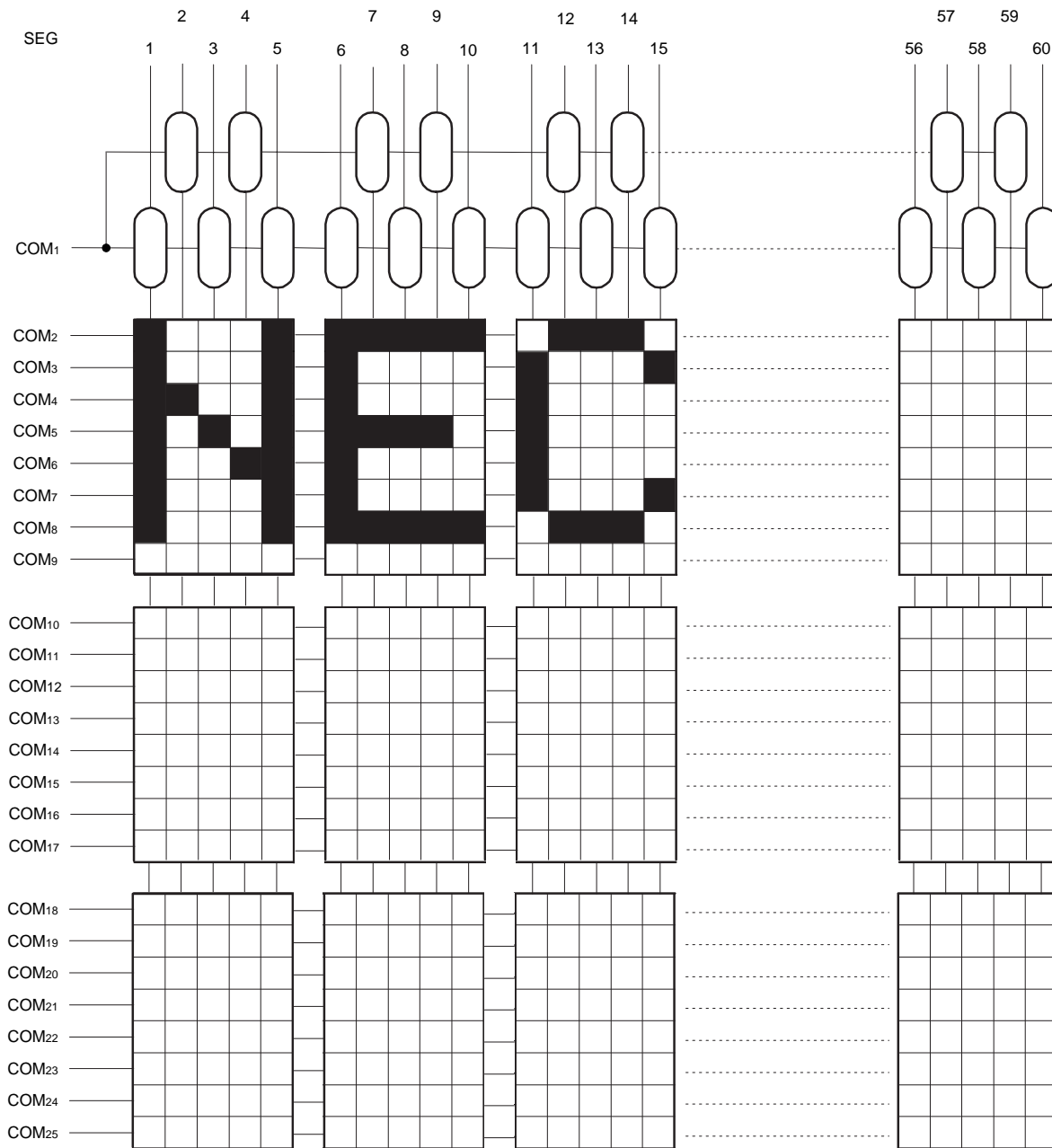
**4. LCD DISPLAY DRIVER**

μ PD16670, a 5 x 8 segment display and pictograph display segments can be driven.

**(1) Example of 1/17 duty connection: 12 columns x 2 lines + 60 pictograph displays**

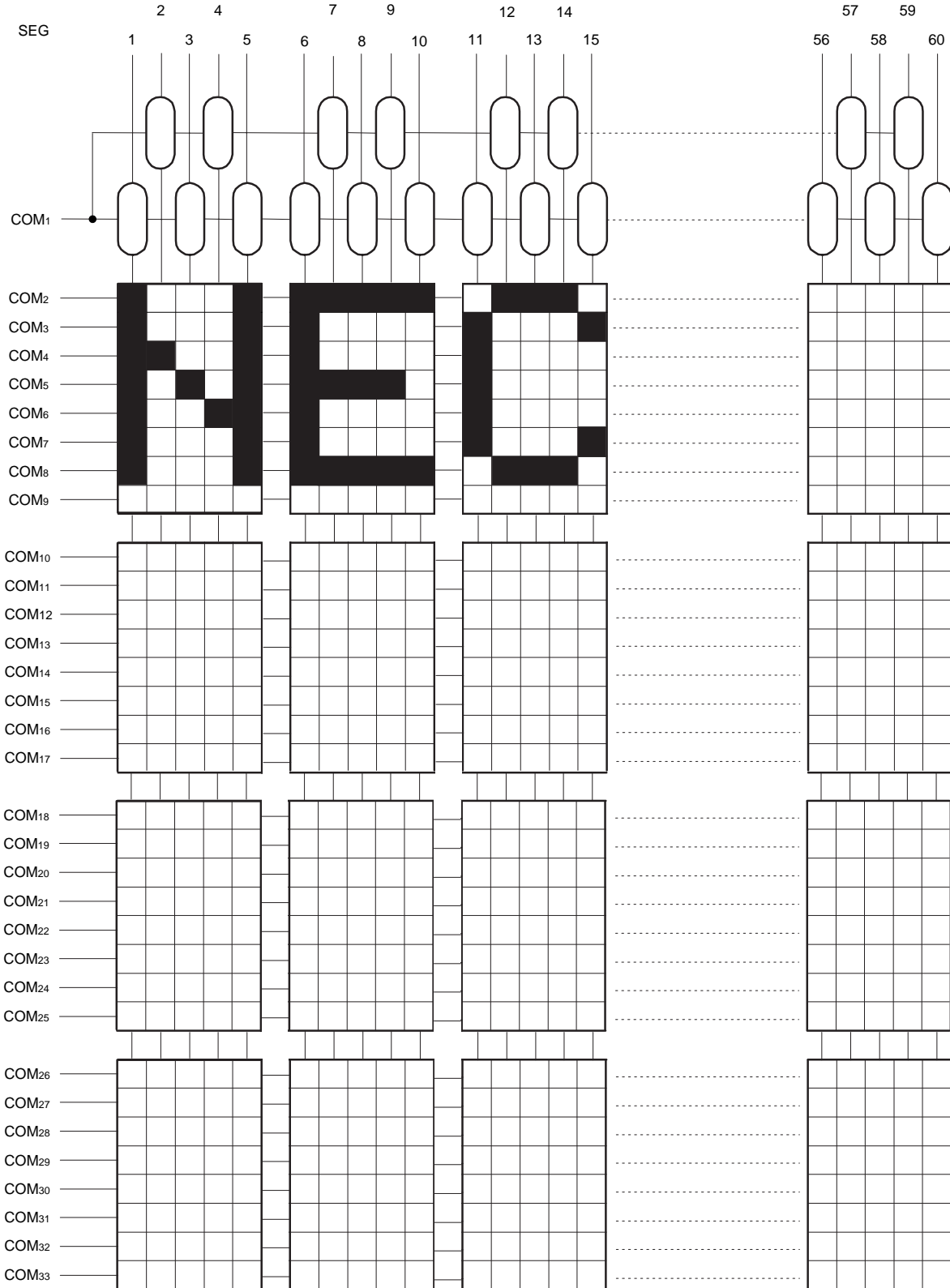


(2) Example of 1/25 duty connection: 12 columns x 3 lines + 60 pictograph displays





(3) Example of 1/33 duty connection: 12 columns x 4 lines + 60 pictograph displays



**5. CHARACTER CODE**

The relation between character codes and character patterns is shown below. Character codes [0xxx] are allocated to CGRAM.

Higher bits Lower bits 4 bits		0000	0001	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
XXXX0000	CG RAM (1)	△		0	A	P	`	P	ˆ	-	9	ε	á	ä	
	(2)	ω	!	1	A	Q	a	9	μ	7	†	ˆ	ε	ö	
XXXX0010	(3)	⊕	"	2	B	R	b	r	ˆ	ı	ı	ı	ı	ı	ı
	(4)	Γ	*	3	C	S	c	s	ı	ı	ı	ı	ı	ı	ı
XXXX0100	(5)	Λ	*	4	D	T	d	t	ı	ı	ı	ı	ı	ı	ı
	(6)	Ω	%	5	E	U	e	u	=	ı	ı	ı	ı	ı	ı
XXXX0110	(7)	π	&	6	F	V	f	v	ı	ı	ı	ı	ı	ı	ı
	(8)	Ψ	'	7	G	W	g	w	ı	ı	ı	ı	ı	ı	ı
XXXX1000	(1)	Σ	(	8	H	X	h	x	ı	ı	ı	ı	ı	ı	ı
	(2)	θ	)	9	I	Y	i	y	ı	ı	ı	ı	ı	ı	ı
XXXX1010	(3)	Ξ	*	#	J	Z	j	z	ı	ı	ı	ı	ı	ı	ı
	(4)	ı	+	;	K	L	k	l	ı	ı	ı	ı	ı	ı	ı
XXXX1100	(5)	Ε	,	<	L	#	ı	ı	ı	ı	ı	ı	ı	ı	ı
	(6)	æ	-	=	M	I	m	i	ı	ı	ı	ı	ı	ı	ı
XXXX1110	(7)	Β	.	>	N	^	n	ˆ	ı	ı	ı	ı	ı	ı	ı
	(8)	É	/	?	O	_	o	_	ı	ı	ı	ı	ı	ı	ı
XXXX1111	(8)	É	/	?	O	_	o	_	ı	ı	ı	ı	ı	ı	ı

**6. DESCRIPTION OF BLOCKS**

**6.1 Display Data RAM (DDRAM)**

DDRAM addresses are allocated as shown below

	1	2	3	4	5	6	7	8	9	10	11	12
1st line	00H	01H	02H	03H	04H	05H	06H	07H	08H	09H	0AH	0BH
2nd line	12H	13H	14H	15H	16H	17H	18H	19H	1AH	1BH	1CH	1DH
3rd line	24H	25H	26H	27H	28H	29H	2AH	2BH	2CH	2DH	2EH	2FH
4th line	36H	37H	38H	39H	3AH	3BH	3CH	3DH	3EH	3FH	40H	41H

**Caution** DDRAM are used 0BH → 10H, 1BH → 20H, 2BH → 30H, 3BH → 00H when in auto increment mode.

**6.2 Character Generator RAM (CGRAM)**

CGRAM is RAM to which the user can freely set character patterns. Eight types of 5 x 8 dot character patterns can be defined. CGRAM is the RAM that contains pictograph display data.

The relation between character codes and CGRAM addresses used to access CGRAM is shown below.

CGRAM address	D4	D3	D2	D1	D0	CGROM address	CGRAM address	D4	D3	D2	D1	D0	CGROM address
00H						00H	20H						04H
01H							21H						
02H							22H						
03H							23H						
04H							24H						
05H							25H						
06H							26H						
07H							27H						
08H						00H	28H						05H
09H							29H						
0AH							2AH						
0BH							2BH						
0CH							2CH						
0DH							2DH						
0EH							2EH						
0FH							2FH						
10H						01H	30H						06H
11H							31H						
12H							32H						
13H							33H						
14H							34H						
15H							35H						
16H							36H						
17H							37H						
18H						02H	38H						07H
19H							39H						
1AH							3AH						
1BH							3BH						
1CH							3CH						
1DH							3DH						
1EH							3EH						
1FH							3FH						

**Caution** Some addresses in 06H and all 07H address in CGROM are shared with pictograph data RAM.

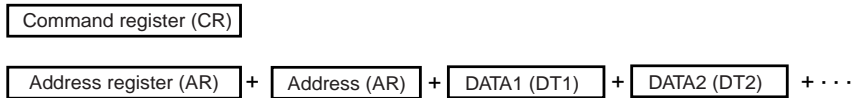
**6.2.1 Pictograph Display RAM (PDRAM)**

Pictograph display RAM addresses used to some parts of CGRAM is shown below.

CGRAM address	D5	D4	D3	D2	D1	CGROM address
30H	45	44	43	42	41	06H
31H	50	49	48	47	46	
32H	55	54	53	52	51	
33H	60	59	58	57	56	
34H						
35H						
36H						
37H						
38H	5	4	3	2	1	07H
39H	10	9	8	7	6	
3AH	15	14	13	12	11	
3BH	20	19	18	17	16	
3CH	25	24	23	22	21	
3DH	30	29	28	27	26	
3EH	35	34	33	32	31	
3FH	40	39	38	37	36	

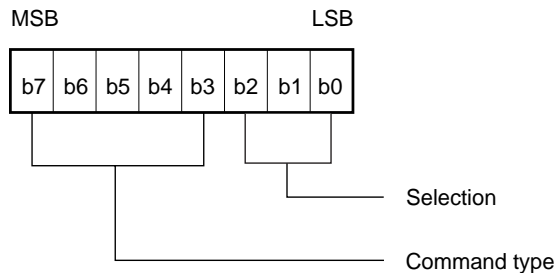
**7. COMMANDS**

**7.1 Basic format**



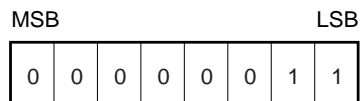
**7.2 Command register**

The command register's basic configuration is as follows.



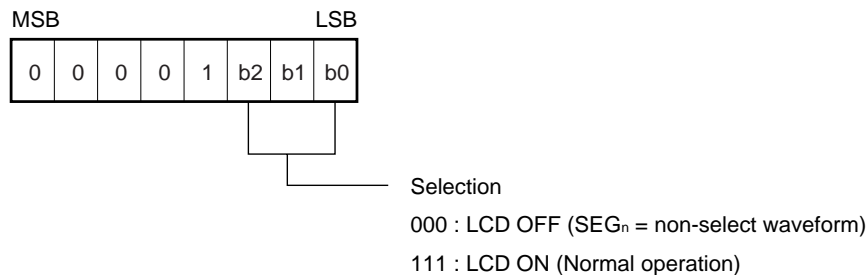
**7.2.1 Reset**

This command resets all of the commands in the μ PD16670.



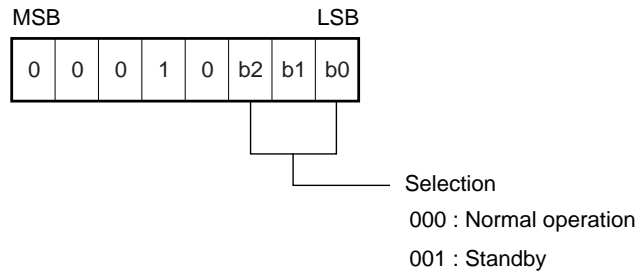
**7.2.2 Display ON/OFF**

This command controls the display's ON/OFF status.



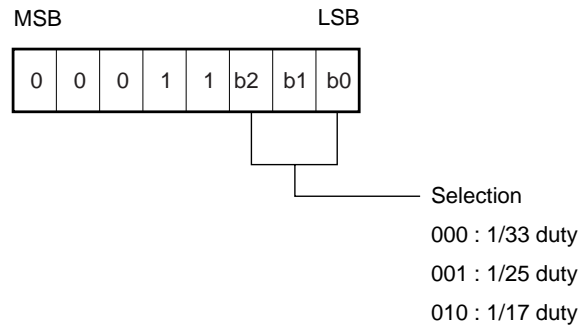
**7.2.3 Standby**

This command stops the DC/DC converter, which reduces the supply current. The display is set to OFF mode (SEG<sub>n</sub>, COM<sub>n</sub> = VLcs).



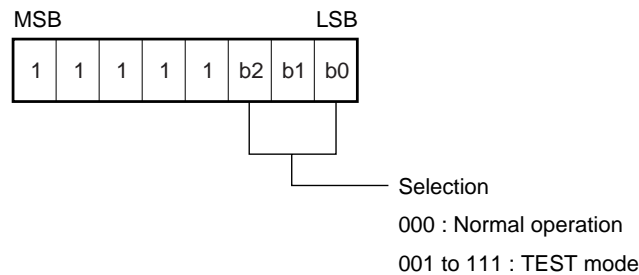
**7.2.4 Duty setting**

This command specifies the duty setting.



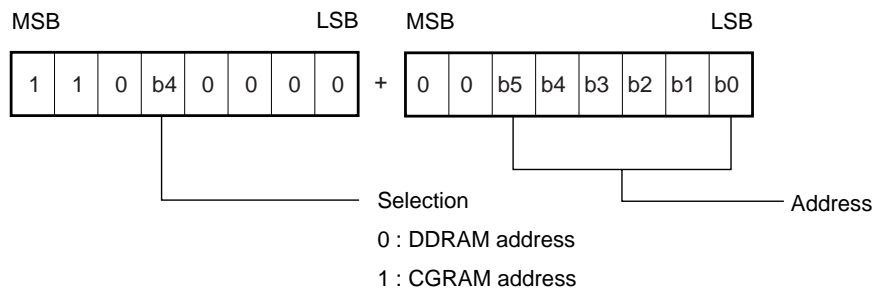
**7.2.5 Test mode**

This command sets the test mode. The test mode is only for confirming the IC's operation. Regular or continuous use while in test mode is not guaranteed.



**7.3 Address Register**

This command selects the address type and specifies addresses.



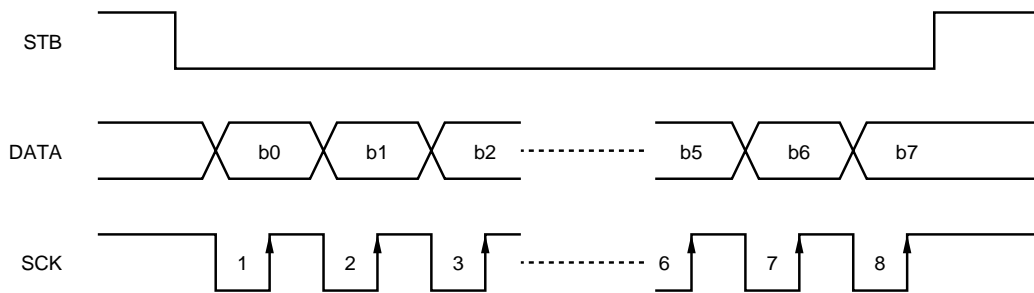
**Caution** Operation is not guaranteed if an invalid address is set.

★ **7.4 Reset**

The contents of the various registers appear as shown below after a reset (command reset or hardware [pin] reset).

Command	Register Contents								Description
	b7	b6	b5	b4	b3	b2	b1	b0	
Display ON/OFF	0	0	0	0	1	0	0	0	LCD OFF
Standby	0	0	0	1	0	0	0	0	Normal operation
Duty setting	0	0	0	1	1	0	1	0	1/33 duty
Test mode	1	1	1	1	1	0	0	0	Normal operation

**7.5 Serial communication format**





**8. CPU ACCESS EXAMPLES**

Examples of access procedure are shown below.

**8.1 Initialize and Data Write**

Parameter	STB	Command/data								Description
		b7	B6	b5	b4	b3	b2	b1	b0	
Start	H	X	X	X	X	X	X	X	X	
Reset	L	0	0	0	0	0	1	1	1	All commands initialized
	H	X	X	X	X	X	X	X	X	
Duty setting	L	0	0	0	1	1	0	0	1	12 columns by 3 rows + 60 pictographs (1/25 duty)
	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	1	0	0	0	0	CGRAM
Address register 2	L	0	0	0	0	0	0	0	0	CGRAM address = 00H
Data 1 to CGRAM data48	L : L	X : X	X : X	X : X	D4 : D4	D3 : D3	D2 : D2	D1 : D1	D0 : D0	CGRAM data
	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	1	0	0	0	0	Pictograph data RAM
Address register 2	L	0	0	1	1	0	0	0	0	Pictograph data RAM address = 30H
Pictograph data 1 to Pictograph data 4	L : L	X : X	X : X	D5 : D5	D4 : D4	D3 : D3	D2 : D2	D1 : D1	X : X	Pictograph data
	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	1	0	0	0	0	Pictograph data RAM
Address register 2	L	0	0	1	1	0	0	0	0	Pictograph data RAM address = 38H
Pictograph data 5 to Pictograph data 12	L : L	X : X	X : X	X : X	D4 : D4	D3 : D3	D2 : D2	D1 : D1	D0 : D0	Pictograph data
	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	1	0	0	0	0	Display data RAM
Address register 2	L	0	0	0	0	0	0	0	0	Display data RAM address = 00H
Character data 1 to Character data 36	L : L	D : D	D : D	D : D	D : D	D : D	D : D	D : D	D : D	Display data
	H	X	X	X	X	X	X	X	X	
Display ON/OFF	L	0	0	0	0	1	1	1	1	LCD ON (at the STB rising edge)
End	H	X	X	X	X	X	X	X	X	

★ **Remark** X = Don't care, D = Data

**8.2 Initialize and Data Write (unused pictograph)**

Parameter	STB	Command/data								Description
		b7	b6	b5	b4	b3	b2	b1	b0	
Start	H	X	X	X	X	X	X	X	X	
Reset	L	0	0	0	0	0	1	1	1	All commands initialized
	H	X	X	X	X	X	X	X	X	
Duty setting	L	0	0	0	1	1	0	0	1	12 columns by 3 rows + 60 pictographs (1/25 duty)
	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	1	0	0	0	0	CGRAM
Address register 2	L	0	0	0	0	0	0	0	0	CGRAM address = 00H
CGRAM data1 to CGRAM data 64	L : L	X : X	X : X	X : X	D4 : D4	D3 : D3	D2 : D2	D1 : D1	D0 : D0	CGRAM data
	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	0	0	0	0	0	Display data RAM
Address register 2	L	0	0	0	0	0	0	0	0	Display data RAM address = 00H
Character data 1 to Character data 36	L : L	D : D	D : D	D : D	D : D	D : D	D : D	D : D	D : D	Display data
	H	X	X	X	X	X	X	X	X	
Display ON/OFF	L	0	0	0	0	1	1	1	1	LCD ON (at the STB rising edge)
End	H	X	X	X	X	X	X	X	X	

★ **Remark** X = Don't care, D = Data

**8.3 Change display data**

Parameter	STB	Command/data								Description
		b7	b6	b5	b4	b3	b2	b1	b0	
Start	H	X	X	X	X	X	X	X	X	
Address register 1	L	1	1	0	0	0	0	0	0	Display data RAM
Address register 2	L	0	0	0	1	0	0	0	1	Display RAM address = 11H (2 lines 2 clumns)
Character data 1	L	0	0	1	0	0	0	0	0	Display RAM address = 11H, Data write: character code (20H: space)
Character data 2	L	0	1	0	0	1	1	1	0	Display RAM address = 12H, Data write: character code (4EH: "N")
Character data 3	L	0	1	0	0	0	1	0	1	Display RAM address = 13H, Data write: character code (45H: "E")
Character data 4	L	0	1	0	0	0	0	1	1	Display RAM address = 14H, Data write: character code (43H: "C")
Character data 5	L	0	0	1	0	0	0	0	0	Display RAM address = 15H, Data write: character code (20H: space)
End	H	X	X	X	X	X	X	X	X	

★ **Remark** X = Don't Care

**8.4 Standby mode**

Parameter	STB	Command/data								Description
		b7	b6	b5	b4	b3	b2	b1	b0	
Start	H	X	X	X	X	X	X	X	X	
Standby	L	0	0	0	1	0	0	0	1	Standby
	H	X	X	X	X	X	X	X	X	
Standby off	L	0	0	0	1	0	0	0	0	Normal operation <sup>Note</sup>
End	H	X	X	X	X	X	X	X	X	

**Note** When in standby mode, DC/DC converter is stop.

If the display operation mode is set before entering the standby mode, it may not be normally working until DC/DC converter, which set after cleaning the standby mode.

★ **Remark** X = Don't Care

## 9. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$ )

Parameter	Symbol	Rating	Unit
Logic power supply voltage	$V_{DD}$	-0.3 to +7.0	V
Logic input voltage	$V_{IN}$	-0.3 to $V_{DD}+0.3$	V
Driver supply voltage	$V_{LCD}$	-0.3 to +16.0	V
Driver reference supply input voltage	$V_{LC1}-V_{LC5}$	-0.3 to $V_{LCD}+0.3$	V
Logic system output voltage ( $SEG_n$ , $COM_n$ )	$V_{OUT}$	-0.3 to $V_{DD}+0.3$	V
Operating ambient temperature	$T_A$	-40 to +85	$^\circ\text{C}$
Storage temperature	$T_{sig}$	-55 to +150	$^\circ\text{C}$

- ★ **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 ( $T_A = 25^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$ )

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Logic power supply voltage	$V_{DD}$	2.7	3.0	3.6	V
Logic system input voltage	$V_{IN}$	0		$V_{DD}$	V
Driver supply voltage	$V_{LCD}$	2.7		14.4	V
Logic system input voltage	$V_{LC1}-V_{LC5}$	0		$V_{LCD}$	V
Output capacitance	$C_1-C_3$	0.05	0.1	1.0	$\mu\text{F}$
	$C_4$	0.05	0.1	1.0	$\mu\text{F}$
Oscillation frequency	$f_{osc}$	245	350	455	kHz

Electrical characteristics (Unless otherwise specified,  $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{SS} = 0$  V,  $V_{DD} = 2.7$  to  $3.6$  V)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
High-level input voltage 1	$V_{IH1}$	SCK,STB,DATA,/RESET,/LCDOFF	$0.8 V_{DD}$		$V_{DD}$	V
Low-level input voltage 1	$V_{IL1}$	SCK,STB,DATA,/RESET,/LCDOFF	0		$0.2 V_{DD}$	V
High-level input voltage 2	$V_{IH2}$	TEST,OSC <sub>IN</sub>	$0.7 V_{DD}$		$V_{DD}$	V
Low-level input voltage 2	$V_{IL2}$	TEST,OSC <sub>IN</sub>	0		$0.3 V_{DD}$	V
High-level input current	$I_{IH}$	SCK,STB,DATA,/RESET,/LCDOFF, OSC <sub>IN</sub>			1	$\mu\text{A}$
		TEST	3	15	75	$\mu\text{A}$
Low-level input current	$I_{IL}$	SCK,STB,DATA,TEST,OSC <sub>IN</sub>			-1	$\mu\text{A}$
		/RESET,/LCDOFF	-3	-15	-75	$\mu\text{A}$
High-level output voltage	$V_{OH}$	TDATA, $I_{OH} = -100 \mu\text{A}$	$0.8 V_{DD}$		$V_{DD}$	V
Low-level output voltage	$V_{OL}$	TDATA, $I_{OL} = 100 \mu\text{A}$	$V_{SS}$		$0.2 V_{DD}$	V
Common output ON resistance	$R_{COM}$	COM <sub>1</sub> to COM <sub>33</sub> , $I_{ol} = 50 \mu\text{A}$			15	$\text{k}\Omega$
Segment output ON resistance	$R_{SEG}$	SEG <sub>1</sub> to SEG <sub>60</sub> , $I_{ol} = 50 \mu\text{A}$			30	$\text{k}\Omega$
Current consumption (Normal mode)	$I_{DD1}$	$V_{DD} = 3$ V, $f_{osc} = 350$ kHz, 4-fold voltage mode, no load		200	300	$\mu\text{A}$
Current consumption (Standby mode)	$I_{DD2}$	$V_{DD} = 3$ V, no load			100	$\mu\text{A}$
Driver voltage (boost voltage)	$V_{LCD}$	No load	$3.5 V_{DD}$		$4.0 V_{DD}$	V

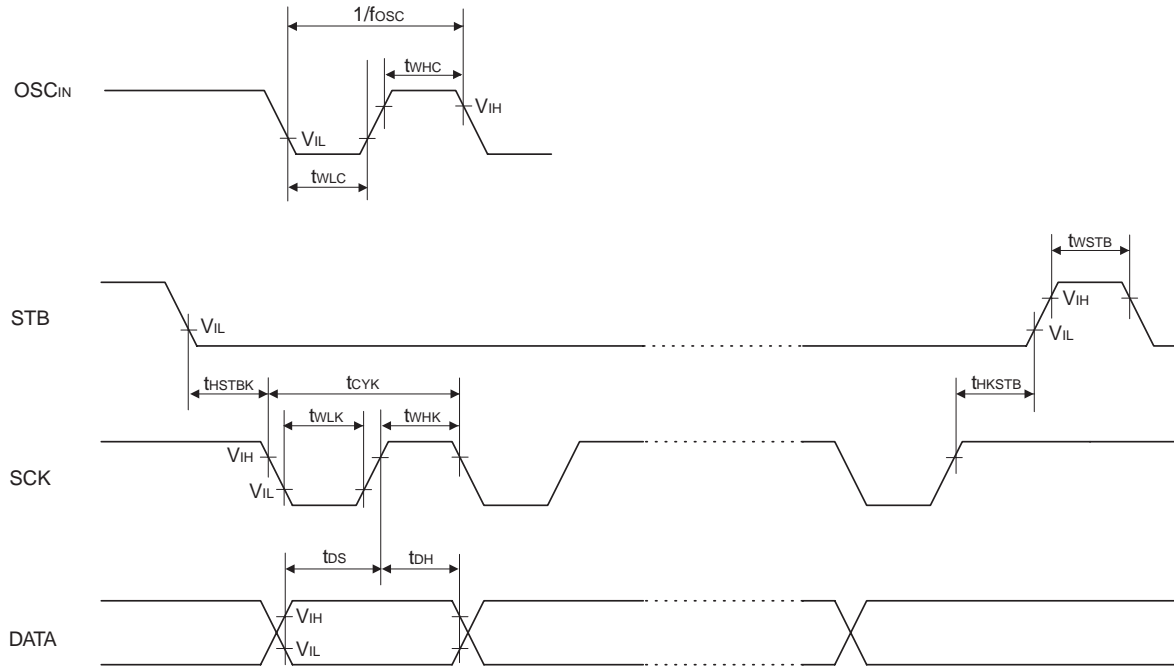
**Switching characteristics (Unless otherwise specified,  $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 2.7$  to  $3.6\text{ V}$ )**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Oscillation frequency	$f_{osc}$	Self-oscillation, $V_{DD} = 3\text{ V} \pm 10\%$ , $R = 100\text{ k}\Omega$	245	350	455	kHz

**Required timing conditions (Unless otherwise specified,  $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 2.7$  to  $3.6\text{ V}$ )**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Clock frequency	$f_{osc}$	OSC <sub>IN</sub> external clock	245	350	455	kHz
High-level clock pulse width	$t_{WHC}$	OSC <sub>IN</sub> external clock	$0.4 f_{osc}$		$0.6 f_{osc}$	–
Low-level clock pulse width	$t_{WLC}$	OSC <sub>IN</sub> external clock	$0.4 f_{osc}$		$0.6 f_{osc}$	–
Shift clock cycle	$t_{CYK}$	SCK	1.2			ns
High-level shift clock pulse width	$t_{WHK}$	SCK	350			ns
Low-level shift clock pulse width	$t_{WLK}$	SCK	350			ns
Shift clock hold time	$t_{HSTBK}$	STB ↓ → SCK ↓	350			ns
★ Data setup time	$t_{DS}$	DATA ↑↓ → SCK ↑	100			ns
★ Data hold time	$t_{DH}$	SCK ↑ → DATA ↑↓	450			ns
STB hold time	$t_{HKSTB}$	SCK ↑ → STB ↑	350			ns
STB pulse width	$t_{WSTB}$		350			ns

**Switching characteristic waveform**



## 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)

Semiconductor Device Mounting Technology (C10535E)

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