

## **LCD Segment Drivers**

# Multi- function LCD Segment Drivers

BU97510CKV-M

MAX 216 Segment(54SEGx4COM)

#### **General Description**

The BU97510CKV-M is 1/4 or 1/3-Duty general-purpose LCD driver that can be used for frequency display in electronic tuners under the control of a microcontroller. The BU97510CKV-M can drive up to 216 LCD. Segments directly. The BU97510CKV-M can also control up to 6 general-purpose output ports.

#### **Features**

- AEC-Q100 Qualified (Note)
- Either 1/4 or 1/3-Duty can be selected with the Serial Control Data.

1/4-Duty Drive: Up to 216 Segments 1/3-Duty Drive: Up to 162 Segments

- Serial Data Control of Frame Frequency for Common and Segment Output Waveforms.
- Serial Data Control of Switching between the Segment Output Port , PWM Output Port and General-purpose Output Port Functions.(Max 6 port)
- Built-in OSC Circuit
- The INHb Pin can force the Display to the off state.
- Integrated Power-on Reset Circuit
- No External Component
- Low Power Consumption Design (Note) Grade 3

## **Applications**

 Car Audio, Home Electrical Appliance, Meter Equipment etc.

## **Key Specifications**

■ Supply Voltage Range: +2.7V to +6.0V

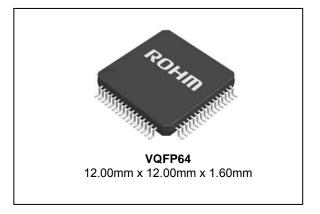
Operating Temperature -40°C to +85°C

Range:

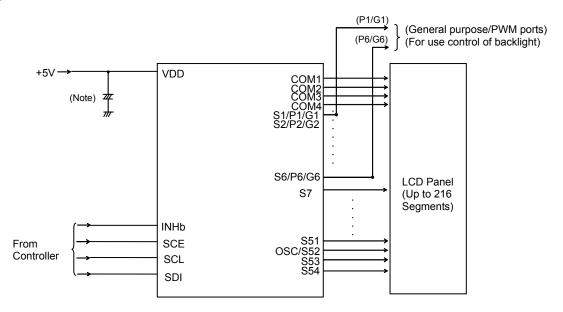
Max Segments: 216 Segments
 Display Duty: 1/3, 1/4 Selectable
 Bias: 1/2, 1/3 Selectable
 Interface: 3wire Serial Interface

## **Packages**

VQFP64  $W(Typ.) \times D(Typ.) \times H(Max.)$ 



## **Typical Application Circuit**



(Note) Insert capacitors between VDD and VSS C≥0.1uF

Figure 1. Typical Application Circuit

## **Block Diagram**

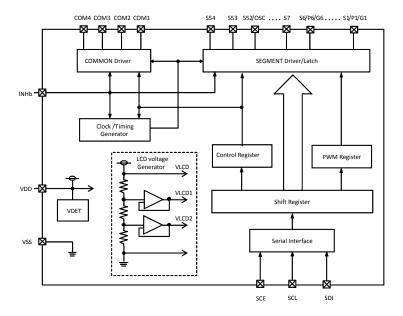


Figure 2. Block Diagram

## **Pin Arrangement**

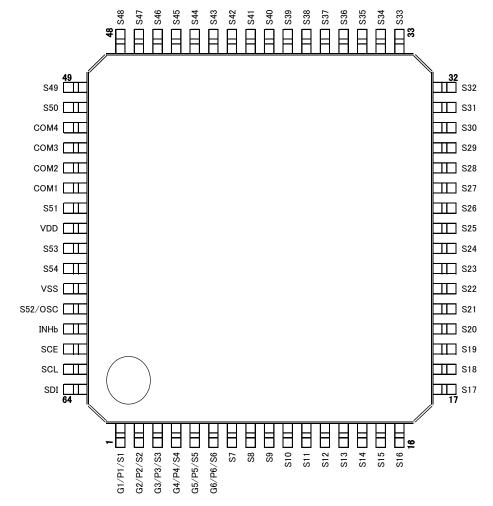


Figure 3. Pin Configuration (TOP VIEW)

Absolute Maximum Ratings(Ta = 25°C, VSS = 0.0V)

Parameter	Symbol	Conditions	Ratings	Unit
Maximum Supply Voltage	VDD max	VDD	-0.3 to +6.5	V
Input Voltage	VIN1	SCE, SCL, SDI, INHb	-0.3 to +6.5	V
Allowable Loss	Pd		1.0 <sup>(Note)</sup>	W
Operating Temperature	Topr		-40 to +85	°C
Storage Temperature	Tstg		-55 to +125	°C

<sup>(</sup>Note) When use more than Ta=25°C, subtract 10mW per degree. (Using ROHM standard board)

(Board size: 70mm×70mm×1.6mm material: FR4 board copper foil: land pattern only)

Caution: Operating the IC over absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Recommended Operating Conditions (Ta = -40 to +85°C, VSS = 0.0V)

Parameter	Symbol	Conditions		Ratings		Unit
Parameter	Symbol	Conditions	Min	Тур	Max	Offic
Supply Voltage	VDD	VDD	2.7		6.0	V

Electrical Characteristics (Ta = -40 to +85°C, VDD = 2.7V to 6.0V, VSS = 0.0V)

Parameter	Symbol	Pin	Conditions	Ratings			
	1		Conditions	Min	Тур	Max	Unit
Hysteresis	VH	SCE, SCL, SDI, INHb, OSC		-	0.03VDD	-	V
Power-On Detection Voltage	VDET	VDD		1.4	1.8	2.2	V
"H" Level Input Voltage	VIH1	SCE, SCL, SDI, INHb, OSC	VDD=4.0V to 6.0V	0.4VDD	-	VDD	V
	VIH2	SCE, SCL, SDI, INHb, OSC	VDD=2.7V to 4.0V	0.8VDD	-	VDD	V
"L" Level Input Voltage	VIL1	SCE, SCL, SDI, INHb, OSC		0	1	0.2VDD	V
"H" Level Input Current	IIH1	SCE, SCL, SDI, INHb, OSC	VI = 6.0V	-	-	5.0	μA
"L" Level Input Current	IIL1	SCE, SCL, SDI, INHb, OSC	VI = 0V	-5.0	-	ı	μA
"H" Level	VOH1	S1 to S54	IO = -20μA	VDD-0.9	-	-	
Output Voltage	VOH2	COM1 to COM4	IO = -100μA	VDD-0.9	-	-	V
	VOH3	P1/G1 to P6/G6	IO = -1mA	VDD-0.9	-	ı	
"L" Level	VOL1	S1 to S54	IO = 20μA	-	-	0.9	
Output Voltage	VOL2	COM1 to COM4	IO = 100μA	-	-	0.9	V
	VOL3	P1/G1 to P6/G6	IO = 1mA	-	-	0.9	
Middle Level	VMID1	S1 to S54	1/2-Bias IO =	1/2VDD	-	1/2VDD	
Output Voltage			±20µA	-0.9		+0.9	
	VMID2	COM1	1/2-Bias IO =	1/2VDD	-	1/2VDD	l
		to COM4	±100μA	-0.9		+0.9	
	VMID3	S1 to S54	1/3-Bias IO =	2/3VDD	-	2/3VDD	l
			±20µA	-0.9		+0.9	V
	VMID4	S1 to S54	1/3-Bias IO =	1/3VDD	-	1/3VDD	7 V
			±20µA	-0.9		+0.9	
	VMID5	COM1	1/3-Bias IO =	2/3VDD	-	2/3VDD	
		to COM4	±100µA	-0.9		+0.9	
	VMID6	COM1	1/3-Bias IO =	1/3VDD	-	1/3VDD	
		to COM4	±100µA	-0.9		+0.9	
Current Drain	IDD1	VDD	Power-saving mode	-	-	15	
	IDD2	VDD	VDD = 5.0V Output open 1/2-Bias Frame Frequency = 80Hz	-	70	150	μA
	IDD3	VDD	VDD = 5.0V Output open 1/3-Bias Frame Frequency = 80Hz	-	95	200	

Oscillation Characteristics (Ta = -40 to +85°C, VDD = 2.7V to 6.0V, VSS = 0.0V)

Parameter	Symbol	Pin	Conditions		Unit		
Parameter	Syllibol	FIII	Conditions	Min	Тур	Max	Uill
Oscillator Frequency1	fosc1	Internal	VDD = 2.7V to 6.0V	150	-	360	kHz
Oscillator Frequency2	fosc2	Oscillator Circuit	VDD = 5.0V	255	300	345	kHz
External Clock Frequency <sup>(Note3)</sup>	fosc3	osc	External clock mode (OC=1)	30	-	600	kHz

(Note3) Frame frequency is decided external frequency and dividing ratio of FC0-2 setting.

## [Reference Data]

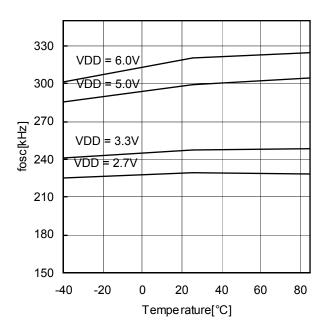
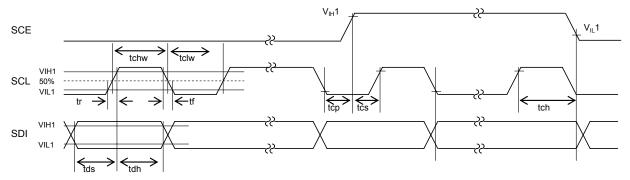


Figure 4. Typical Temperature Characteristics

MPU Interface Characteristics (Ta = -40 to +85°C, VDD = 2.7V to 6.0V, VSS = 0.0V)

Parameter	Cumbal	Pin	Conditions		Unit			
Parameter	Symbol	PIII	Conditions	Min	Тур	Max	Uill	
Data Setup Time	tds	SCL, SDI		160	-	-	ns	
Data Hold Time	tdh	SCL, SDI		160	-	-	ns	
SCE Wait Time	tcp	SCE, SCL		160	-	-	ns	
SCE Setup Time	tcs	SCE, SCL		160	-	-	ns	
SCE Hold Time	tch	SCE, SCL		160	-	-	ns	
High-Level Clock Pulse Width	tchw	SCL		160	-	-	ns	
Low-Level Clock Pulse Width	tclw	SCL		160	-	-	ns	
Rise Time	tr	SCE, SCL, SDI		-	160	-	ns	
Fall Time	tf	SCE, SCL, SDI		-	160	-	ns	
INH Switching Time	tc	INHb, SCE		10	-	-	μs	

## 1. When SCL is stopped at the low level



## 2. When SCL is stopped at the high level

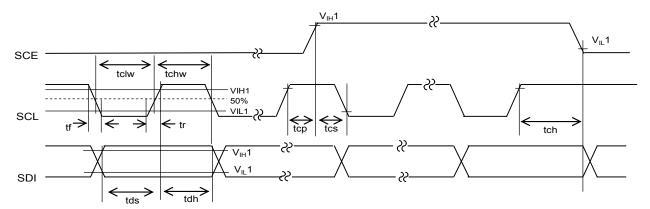


Figure 5.Serial Interface Timing

**Pin Description** 

					Handling
Symbol	Pin No.	Function	Active	I/O	when
					unused
S1/P1/G1 to	1 to 6	Segment output.	-	0	OPEN
S6/P6/G6	7 to 50	The S1/P1/G1 to S6/P6/G6 pins can be used as general			
S7 to S54	55,57,58	–purpose outputs.			
COM1 to COM4	51 to 54	Common driver output pins. The frame frequency is fo[Hz].	-	0	OPEN
		Segment output.	-	I/O	OPEN
S52/OSC	60	The pin S52/OSC can be used external frequency input pin			
		when set up by the control data.			
		Serial data transfer inputs. Must be connected to the			GND
		controller.			
SCE	62	SCE: Chip enable	Н	- 1	
SCL	63	SCL: Synchronization clock		I	
SDI	64	SDI: Transfer data	-	- 1	
INHb	61	Display off control input	L		VDD
		INHb = low (VSS)Display forced off			
		S1/P1/G1 to S6/P6/G6 = low (VSS)			
		S7 to S54 = low (VSS)			
		COM1 to COM4 = low (VSS)			
		Shuts off current to the LCD drive bias voltage generation			
		divider resistors.			
		Stop the internal oscillation circuit.			
		INHb = high (VDD)Display on			
		However, serial data transfer is possible when the display is			
		forced off.			
$V_{DD}$	56	Power supply pin for the logic circuit block.	-	-	-
		A power voltage of 2.7V to 6.0V must be applied to this pin.			
$V_{SS}$	59	Power supply pin. Must be connected to ground.	-	-	-

## **IO Equivalence Circuit**

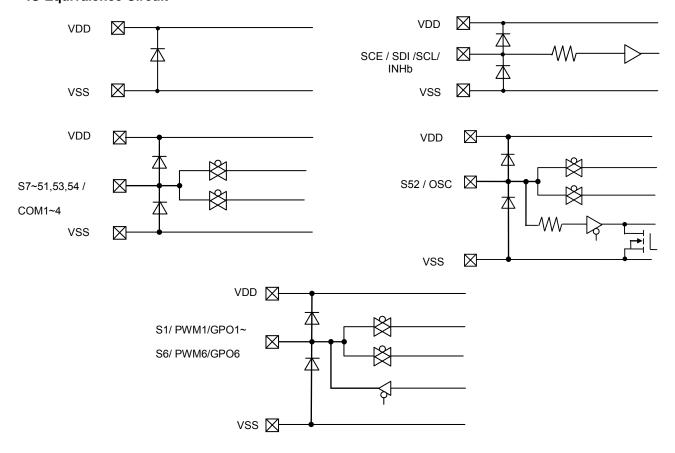


Figure 6. I/O Equivalence Circuit

## **Serial Data Transfer Formats**

- 1. 1/4-Duty
- (1) When SCL is stopped at the low level

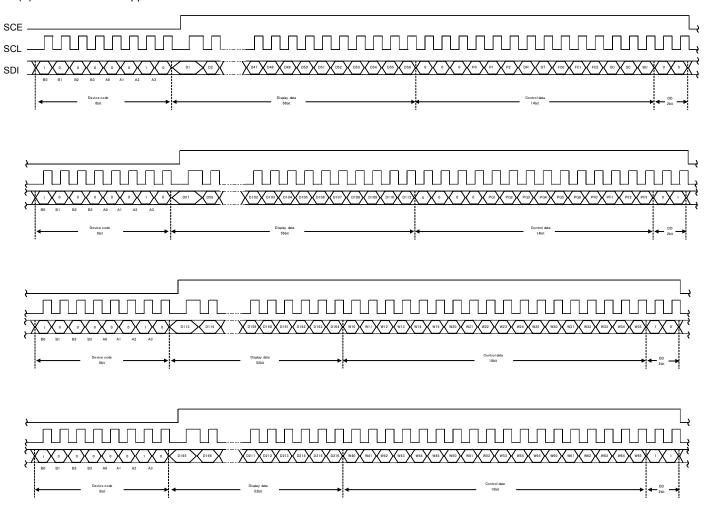


Figure 7. 3-SPI Data Transfer Format

(2) When SCL is stopped at the high level

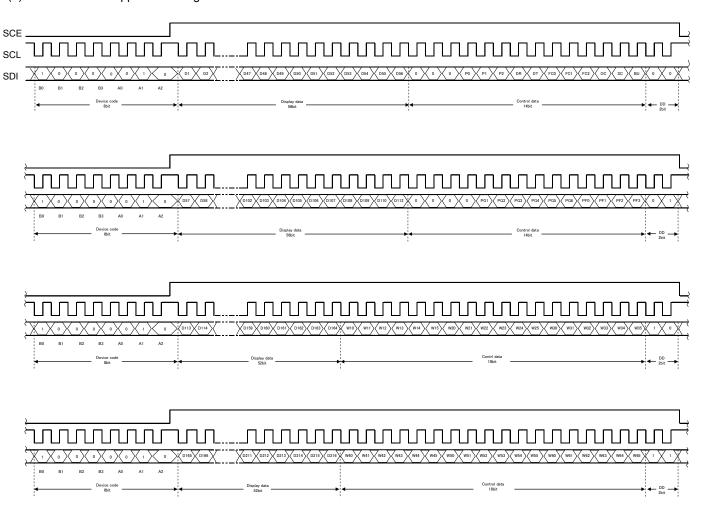


Figure 8. 3-SPI Data Transfer Format

• Device code·································41H"
· D1∼D216······Display data
• P0~2·····Segment / PWM / General Purpose output port switching control data
• DR······1/3-Bias drive or 1/2-Bias drive switching control data
• DT······ 1/4-Duty drive or 1/3-Duty drive switching control data
• FC0~FC2·····Frame frequency switching control data
• OC · · · · · · · · · · · Internal oscillator operating mode/External clock operating mode switching control data
SC · · · · · Segment on/off switching control data
BU······ Buring control data
PG1~PG6·····PWM/General Purpose output switching control data
• PF0~PF3······PWM output waveform frame frequency switching control data
• W10~W15, W20~W25, W30~W35,W40~W45, W50~W55, W60~W65
······PWM output waveform duty switching control data

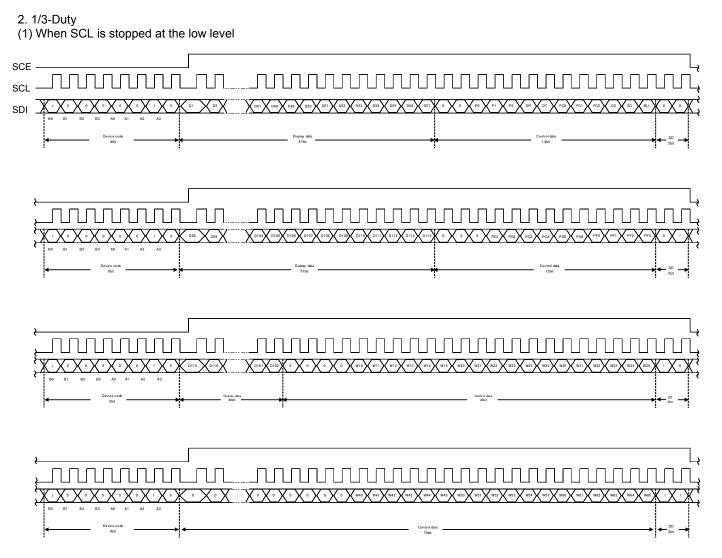


Figure 9. 3-SPI Data Transfer Format

(2) When SCL is stopped at the high level

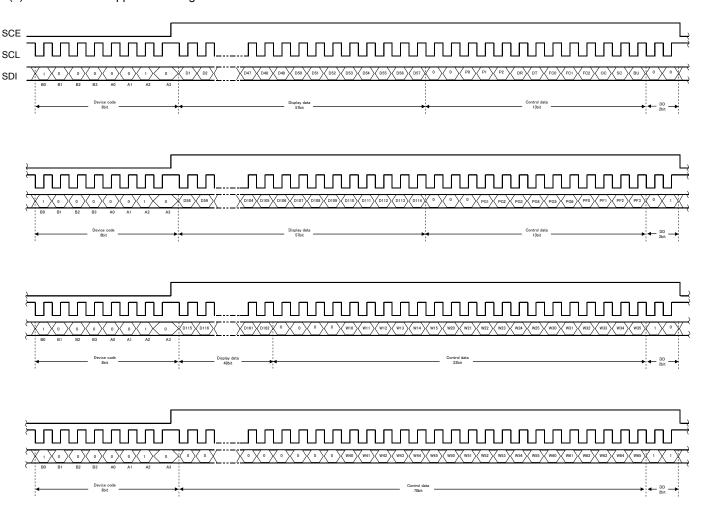


Figure 10. 3-SPI Data Transfer Format

• Device code····································
· D1~D162·····Display data
P0~2·····Segment / PWM / General Purpose output port switching control data
• DR······ data
DT······ DT····· 1/4-Duty drive or 1/3-Duty drive switching control data
• FC0~FC2·····Frame frequency switching control data
• OC · · · · · · · · · · · · Internal oscillator operating mode/External clock operating mode switching control data
SC·····Segment on/off switching control data
BU······Normal mode/power-saving mode switching control data
PG1~PG6·····PWM/General Purpose output switching control data
<ul> <li>PF0~PF3······PWM output waveform frame frequency switching control data</li> </ul>
· W10~W15, W20~W25, W30~W35,W40~W45, W50~W55, W60~W65
······ PWM output waveform duty switching control data

#### **Control Data Functions**

1.P0[ P2:Segment / PWM / General Purpose output port switching control data

These control bits are used to select the function of the S1/P1 to S6/P6 output pins (Segment Output Pins or PWM Output Pins or General Purpose Output Pins).

Please refer to the table below.

P0	P1	P2	S1/P1/G1	S2/P2/G2	S3/P3/G3	S4/P4/G4	S5/P5/G5	S6/P6/G6
0	0	0	S1	S2	S3	S4	S5	S6
0	0	1	P1/G1	S2	S3	S4	S5	S6
0	1	0	P1/G1	P2/G2	S3	S4	S5	S6
0	1	1	P1/G1	P2/G2	P3/G3	S4	S5	S6
1	0	0	P1/G1	P2/G2	P3/G3	P4/G4	S5	S6
1	0	1	P1/G1	P2/G2	P3/G3	P4/G4	P5/G5	S6
1	1	0	P1/G1	P2/G2	P3/G3	P4/G4	P5/G5	P6/G6
1	1	1	S1	S2	S3	S4	S5	S6

PWM output or General Purpose output is selected by PGx(x=1[6] control data bit.

When the General Purpose Output Port Function is selected, the correspondence between the output pins and the

respective display data is given in the table below.

Output Pine	Corresponding Display Data			
Output Pins	1/4-Duty mode	1/3-Duty mode		
S1/P1/G1	D1	D1		
S2/P2/G2	D5	D4		
S3/P3/G3	D9	D7		
S4/P4/G4	D13	D10		
S5/P5/G5	D17	D13		
S6/P6/G6	D21	D16		

When the General Purpose Output Port Function is selected, the respective output pin is output a "HIGH" level when it corresponding display data is set to "1". Likewise, it will output a "LOW" level, if its corresponding display data is set to "0".

For example, S4/P4/G4 is used as a General Purpose Output Port, if its corresponding display data – D13 is set to "1", then S4/P4/G4 will output "HIGH" level. Likewise, if D13 is set to "0", then S4/P4/G4 will output "LOW" level.

2. DR: 1/3-Bias drive or 1/2-Bias drive switching control data

This control data bit selects either 1/3-Bias drive or 1/2-Bias drive.

DR	Bias drive scheme
0	1/3-Bias drive
1	1/2-Bias drive

3. DT: 1/4-Duty drive or 1/3-Duty drive switching control data

This control data bit selects either 1/4-Duty drive or 1/3-Duty drive.

THE CONTROL GATE DISCOULT CHARGE IN	1 Daty and of he Daty and	
DT	Duty drive scheme	
0	1/4-Duty drive	
1	1/3-Duty drive	

4. FC0, FC1, FC2: Frame frequency switching control data

These control data bits set the frame frequency for common and segment output waveforms.

FC0	FC1	FC2	Frame Frequency fo(Hz)
0	0	0	fosc/6144
0	0	1	fosc/5376
0	1	0	fosc/4608
0	1	1	fosc/3840
1	0	0	fosc/3072
1	0	1	fosc/2304
1	1	0	fosc/1920
1	1	1	fosc/1536

Note: fosc: Internal oscillation frequency (300 [kHz] typ.)

5. OC: Internal oscillator operating mode/External clock operating mode switching control data

<u> </u>		
OC	Operating mode	In/Out pin(S52/OSC) status
0	Internal oscillator	S52 (segment output)
1	External Clock	OSC (clock input)

6. SC: Segment on/off switching control data

This control data bit controls the on/off state of the segments.

SC	Display state
0	On
1	Off

Note that when the segments are turned off by setting SC to "1", the segments are turned off by outputting segment off waveforms from the segment output pins.

7. BU: Normal mode/power-saving mode switching control data

This control data bit selects either normal mode or power-saving mode.

BU	Mode
0	Normal Mode
1	Power-saving Mode

Power-saving mode status: S1/P1/G1 to S6/P6/G6 = active only General Purpose output

S7 to S54 = low(VSS)

COM1 to COM4 = low(VSS)

Shut off current to the LCD drive bias voltage generation circuit

Stop the Internal oscillation circuit

However, serial data transfer is possible when Power-saving mode.

8. PG1, PG2, PG3, PG4, PG5, PG6: PWM/General Purpose output switching control data

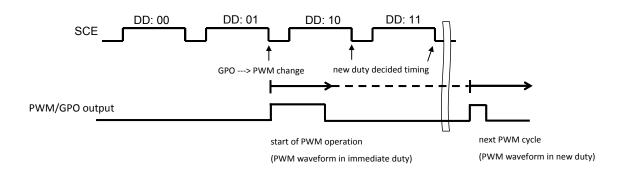
This control data bit select either PWM output or General Purpose output of Sx/Px/Gx pins.(x=1~6)

PGx(x=1[ 6)	Mode
0	PWM output
1	General Purpose output

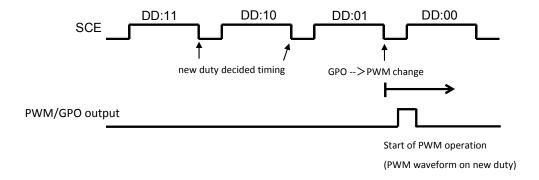
<Note: PWM<->GPO Changing function>

Normal behavior of changing GPO to PWM is below.

- PWM operation is started by command import timing of DD: 01 during GPO ---> PWM change.
- Please take care of reflect timing of new duty setting of DD: 10, DD: 11 is from the next PWM.



In order to avoid this operation, please input commands reversely as below.



9. PF0, PF1, PF2, PF3: PWM output waveform frame frequency switching control data

These control data bits set the frame frequency for PWM output waveforms.

PF0	PF1	PF2	PF3	PWM output Frame Frequency fp(Hz)
0	0	0	0	fosc/2048
0	0	0	1	fosc/1920
0	0	1	0	fosc/1792
0	0	1	1	fosc/1664
0	1	0	0	fosc/1536
0	1	0	1	fosc/1408
0	1	1	0	fosc/1280
0	1	1	1	fosc/1152
1	0	0	0	fosc/1024
1	0	0	1	fosc/896
1	0	1	0	fosc/768
1	0	1	1	fosc/640
1	1	0	0	fosc/512
1	1	0	1	fosc/384
1	1	1	0	fosc/256
1	1	1	1	fosc/128

10.W10~W15, W20~W25, W30~W35, W40~W45, W50~W55, W60~W65: PWM output waveform duty switching control data

These control data bits set the high level pulse width(duty) for PWM output waveforms.

Wn0	Wn1	Wn2	Wn3	Wn4	Wn5	PWM duty
0	0	0	0	0	0	(1/64) x Tp
1	0	0	0	0	0	(2/64) x Tp
0	1	0	0	0	0	(3/64) x Tp
1	1	0	0	0	0	(4/64) x Tp
0	0	1	0	0	0	(5/64) x Tp
1	0	1	0	0	0	(6/64) x Tp
0	1	1	0	0	0	(7/64) x Tp
1	1	1	0	0	0	(8/64) x Tp
0	0	0	1	0	0	(9/64) x Tp
1	0	0	1	0	0	(10/64) x Tp
0	1	0	1	0	0	(11/64) x Tp
1	1	0	1	0	0	(12/64) x Tp
0	0	1	1	0	0	(13/64) x Tp
1	0	1	1	0	0	(14/64) x Tp
0	1	1	1	0	0	(15/64) x Tp
1	1	1	1	0	0	(16/64) x Tp
0	0	0	0	1	0	(17/64) x Tp
1	0	0	0	1	0	(18/64) x Tp
0	1	0	0	1	0	(19/64) x Tp
1	1	0	0	1	0	(20/64) x Tp
0	0	1	0	1	0	(21/64) x Tp
1	0	1	0	1	0	(22/64) x Tp
0	1	1	0	1	0	(23/64) x Tp
1	1	1	0	1	0	(24/64) x Tp
0	0	0	1	1	0	(25/64) x Tp
1	0	0	1	1	0	(26/64) x Tp
0	1	0	1	1	0	(27/64) x Tp
1	1	0	1	1	0	(28/64) x Tp
0	0	1	1	1	0	(29/64) x Tp
1	0	1	1	1	0	(30/64) x Tp
0	1	1	1	1	0	(31/64) x Tp
1	1	1	1	1	0	(32/64) x Tp

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1       1       0       0       1       1       (52/64) x Tp         0       0       1       0       1       1       (53/64) x Tp         1       0       1       0       1       1       (54/64) x Tp         0       1       1       0       1       1       (55/64) x Tp         1       1       1       0       1       1       (57/64) x Tp         0       0       0       1       1       1       (58/64) x Tp         1       0       0       1       1       1       (59/64) x Tp         0       1       0       1       1       1       (60/64) x Tp         0       0       1       1       1       (61/64) x Tp         0       0       1       1       1       (62/64) x Tp         1       0       1       1       1       (62/64) x Tp         0       1       1       1       1       (63/64) x Tp	1		0	0	1		(50/64) x Tp
0         0         1         0         1         1         (53/64) x Tp           1         0         1         0         1         1         (54/64) x Tp           0         1         1         0         1         1         (55/64) x Tp           1         1         1         0         1         1         (56/64) x Tp           0         0         0         1         1         1         (58/64) x Tp           1         0         0         1         1         1         (59/64) x Tp           0         1         0         1         1         1         (60/64) x Tp           0         0         1         1         1         (61/64) x Tp           0         0         1         1         1         (62/64) x Tp           1         0         1         1         1         (63/64) x Tp           0         1         1         1         1         (63/64) x Tp	0	1	0	0	1	1	(51/64) x Tp
1 0 1 0 1 1 (54/64) x Tp 0 1 1 1 (55/64) x Tp 1 1 1 1 0 1 1 (55/64) x Tp 0 0 0 1 1 1 (55/64) x Tp 0 0 0 1 1 1 (57/64) x Tp 1 0 0 1 1 1 (57/64) x Tp 1 0 0 1 1 1 (58/64) x Tp 0 1 0 1 1 1 (58/64) x Tp 1 0 1 0 1 1 1 (60/64) x Tp 1 1 0 1 1 1 (60/64) x Tp 0 0 0 1 1 1 1 (61/64) x Tp 1 0 0 1 1 1 1 (61/64) x Tp 1 0 1 1 1 1 (62/64) x Tp 0 1 1 1 1 1 (63/64) x Tp	1	1	0	0	1	1	(52/64) x Tp
0 1 1 0 1 1 (55/64) x Tp 1 1 1 1 0 1 1 (56/64) x Tp 0 0 0 1 1 1 (56/64) x Tp 1 0 0 1 1 1 (57/64) x Tp 1 0 0 1 1 1 (58/64) x Tp 0 1 0 1 1 1 (58/64) x Tp 1 1 0 1 1 1 (60/64) x Tp 0 0 1 1 1 1 (61/64) x Tp 0 0 1 1 1 1 1 (61/64) x Tp 1 0 1 1 1 1 (62/64) x Tp 0 1 1 1 1 1 (63/64) x Tp	0	0	1	0	1	1	(53/64) x Tp
1     1     1     1     (56/64) x Tp       0     0     0     1     1     (57/64) x Tp       1     0     0     1     1     1     (58/64) x Tp       0     1     0     1     1     1     (59/64) x Tp       1     1     0     1     1     1     (60/64) x Tp       0     0     1     1     1     (61/64) x Tp       1     0     1     1     1     (62/64) x Tp       0     1     1     1     1     (63/64) x Tp       0     1     1     1     1     (63/64) x Tp	1	0	1	0	1	1	(54/64) x Tp
0     0     0     1     1     1     (57/64) x Tp       1     0     0     1     1     1     (58/64) x Tp       0     1     0     1     1     1     (59/64) x Tp       1     1     0     1     1     1     (60/64) x Tp       0     0     1     1     1     (61/64) x Tp       1     0     1     1     1     (62/64) x Tp       0     1     1     1     1     (63/64) x Tp	0	1	1	0	1	1	(55/64) x Tp
1     0     0     1     1     1     (58/64) x Tp       0     1     0     1     1     1     (59/64) x Tp       1     1     0     1     1     1     (60/64) x Tp       0     0     1     1     1     (61/64) x Tp       1     0     1     1     1     (62/64) x Tp       0     1     1     1     1     (63/64) x Tp       0     1     1     1     1     (63/64) x Tp	1	1	1	0	1	1	(56/64) x Tp
0     1     0     1     1     1     (59/64) x Tp       1     1     0     1     1     1     (60/64) x Tp       0     0     1     1     1     1     (61/64) x Tp       1     0     1     1     1     1     (62/64) x Tp       0     1     1     1     1     (63/64) x Tp	0	0	0	1	1	1	(57/64) x Tp
1 1 0 1 1 (60/64) x Tp 0 0 1 1 1 1 (61/64) x Tp 1 0 1 1 1 1 (62/64) x Tp 0 1 1 1 1 1 (63/64) x Tp	1	0	0	1	1	1	(58/64) x Tp
0 0 1 1 1 1 (61/64) x Tp 1 0 1 1 1 1 (62/64) x Tp 0 1 1 1 1 1 (63/64) x Tp	0	1	0	1	1	1	(59/64) x Tp
0 0 1 1 1 1 (61/64) x Tp 1 0 1 1 1 1 (62/64) x Tp 0 1 1 1 1 1 (63/64) x Tp	1	1	0	1	1	1	(60/64) x Tp
1 0 1 1 1 1 (62/64) x Tp 0 1 1 1 1 1 (63/64) x Tp		0	1	1	1		
	1	0	1	1	1	1	
		1	1	1	1	1	(63/64) x Tp
	1	1	1	1	1	1	

Note:W10~W15:S1/P1/G1 PWM duty data

W20~W25:S2/P2/G2 PWM duty data

W30~W35:S3/P3/G3 PWM duty data

W40~W45:S4/P4/G4 PWM duty data

W50~W55:S5/P5/G5 PWM duty data

W60~W65:S6/P6/G6 PWM duty data

n = 1~6

Tp = 1/fp

# **Display Data and Output Pin Correspondence** 1. 1/4-Duty

D4 D8 D12
D8 D12
D12
D16
D20
D24
D28
D32
D36
D40
D44
D48
D52
D56
D60
D64
D68
D72
D76
D80
D84
D88
D92
D96
D100
D104
D108
D112
D116
D120
D124
D128
D132
D136
D140
D144
D148
D152
D156
D160
D164
D168
D172
D176
D180
D184
D188
D192
D196
D200
D204
D208
D212
D216

Note: The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S6/P6/G6.

To illustrate further, the states of the S21 output pin is given in the table below.

Display data			Chata of COA Output Dia		
D81	D82	D83	D84	State of S21 Output Pin	
0	0	0	0	LCD Segments corresponding to COM1 to COM4 are OFF.	
0	0	0	1	LCD Segment corresponding to COM4 is ON.	
0	0	1	0	LCD Segment corresponding to COM3 is ON.	
0	0	1	1	LCD Segments corresponding to COM3 and COM4 are ON.	
0	1	0	0	LCD Segment corresponding to COM2 is ON.	
0	1	0	1	LCD Segments corresponding to COM2 and COM4 are ON.	
0	1	1	0	LCD Segments corresponding to COM2 and COM3 are ON.	
0	1	1	1	LCD Segments corresponding to COM2, COM3 and COM4 are ON.	
1	0	0	0	LCD Segment corresponding to COM1 is ON.	
1	0	0	1	LCD Segments corresponding to COM1 and COM4 are ON.	
1	0	1	0	LCD Segments corresponding to COM1 and COM3 are ON.	
1	0	1	1	LCD Segments corresponding to COM1, COM3 and COM4 are ON.	
1	1	0	0	LCD Segments corresponding to COM1 and COM2 are ON.	
1	1	0	1	LCD Segments corresponding to COM1, COM2, and COM4 are ON.	
1	1	1	0	LCD Segments corresponding to COM1, COM2, and COM3 are ON.	
1	1	1	1	LCD Segments corresponding to COM1 to COM 4 are ON.	

## 2. 1/3-Duty

1/3-Duty			
Output pin	COM1	COM2	COM3
S1/P1/G1	D1	D2	D3
S2/P2/G2	D4	D5	D6
S3/P3/G3	D7	D8	D9
S4/P4/G4	D10	D11	D12
S5/P5/G5	D13	D14	D15
S6/P6/G6	D16	D17	D18
S7	D19	D20	D21
S8	D22	D23	D24
S9	D25	D26	D27
S10	D28	D29	D30
S11	D31	D32	D33
S12	D34	D35	D36
S13	D37	D38	D39
S14	D40	D41	D42
S15	D43	D44	D45
S16	D46	D47	D48
S17	D49	D50	D51
S18	D52	D53	D54
S19	D55	D56	D57
S20	D58	D59	D60
S21	D61	D62	D63
S22	D64	D65	D66
S23	D67	D68	D69
S24	D70	D71	D72
S25	D73	D74	D75
S26	D76	D77	D78
S27	D79	D80	D81
S28	D82	D83	D84
S29	D85	D85	D87
S30	D88	D89	D90
S31	D91	D92	D93
S32	D94	D95	D96
S33	D97	D98	D99
S34	D100	D101	D102
S35	D103	D104	D102
S36	D106	D107	D108
S37	D109	D110	D111
S38	D112	D113	D114
S39	D115	D116	D117
S40	D118	D119	D120
S41	D121	D122	D123
S42	D124	D125	D126
S43	D124	D128	D120
S44	D130	D131	D123
S45	D133	D134	D135
S46	D136	D134	D133
S47	D139	D137	D138
S48	D139	D143	D141
S49	D145	D143	D144 D147
S50	D148	D149	D147
S51	D146	D149 D152	
S52	D151	D152	D153 D156
S53	D154 D157	D155	D156
S54	D160	D161	D162

Note: The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S6/P6/G6.

To illustrate further, the states of the S21 output pin is given in the table below.

Display data		ata	Ctate of C24 Output Din		
D61	D62	D63	State of S21 Output Pin		
0	0	0	LCD Segments corresponding to COM1 to COM3 are OFF.		
0	0	1	LCD Segment corresponding to COM3 is ON.		
0	1	0	LCD Segment corresponding to COM2 is ON.		
0	1	1	LCD Segments corresponding to COM2 and COM3 are ON.		
1	0	0	LCD Segment corresponding to COM1 is ON.		
1	0	1	LCD Segments corresponding to COM1 and COM3 are ON.		
1	1	0	LCD Segments corresponding to COM1 and COM2 are ON.		
1	1	1	LCD Segments corresponding to COM1, COM2 and COM3 are ON.		

## Output Waveforms (1/4-Duty 1/3-Bias Drive Scheme)

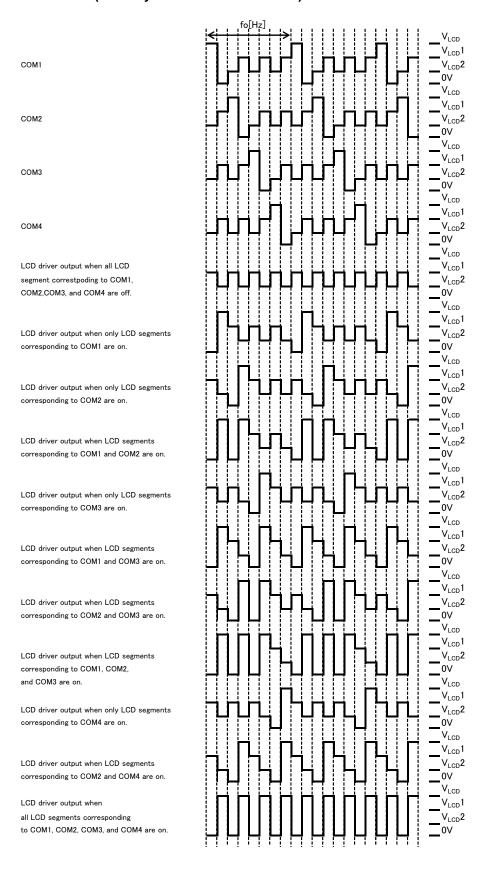


Figure 11. LCD Waveform (1/4-Duty, 1/3-Bias)

## **Output Waveforms (1/4-Duty 1/2-Bias Drive Scheme)**

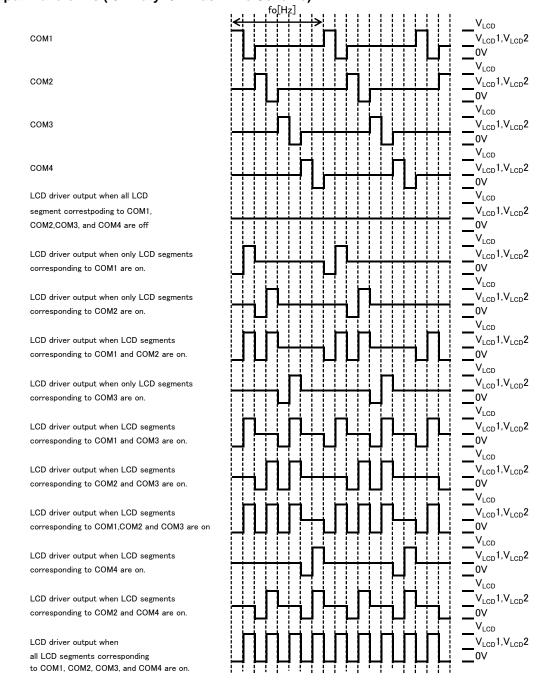


Figure 12. LCD Waveform (1/4-Duty, 1/2-Bias)

## Output Waveforms (1/3-Duty 1/3-Bias Drive Scheme)

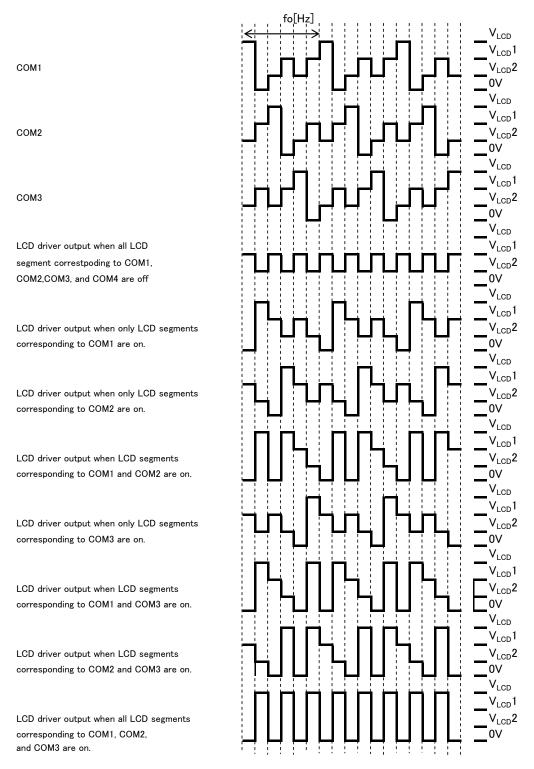


Figure 13. LCD Waveform (1/3-Duty, 1/3-Bias)

XCOM4 function is same as COM1 at 1/3-Duty.

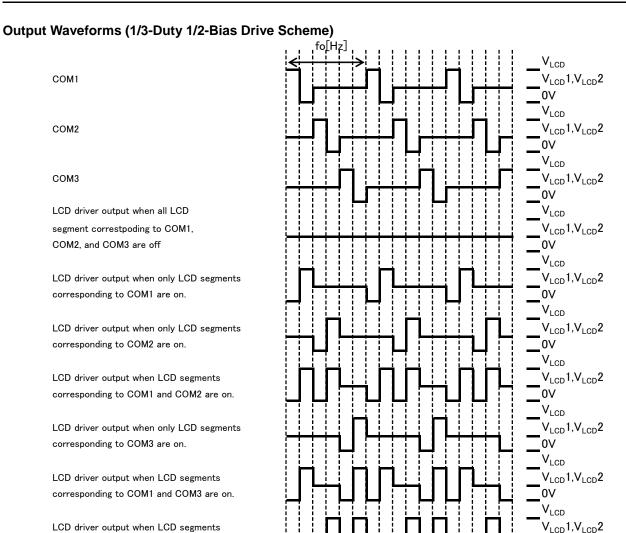


Figure 14. LCD Waveform (1/3-Duty, 1/2-Bias)

\*COM4 function is same as COM1 at 1/3-Duty.

corresponding to COM2 and COM3 are on.

LCD driver output when all LCD segments

corresponding to COM1,COM2 and COM3 are on

 $\begin{matrix} 0V \\ V_{\text{LCD}} \end{matrix}$ 

0٧

 $V_{LCD}1,V_{LCD}2$ 

## The INHb pin and Display Control

Since the IC internal data (1/4-Duty: the display data D1 to D216 and the control data, 1/3-Duty: the display data D1 to D162 and the control data) is undefined when power is first applied, applications should set the INH pin low at the same time as power is applied to turn off the display (This sets the S1/P1/G1 to S6/P6/G6, S7 to S54, COM1 to COM4 to the VSS level.) and during this period send serial data from the controller. The controller should then set the INH pin high after the data transfer has completed. This procedure prevents meaningless displays at power on.

## 1. 1/4-Duty

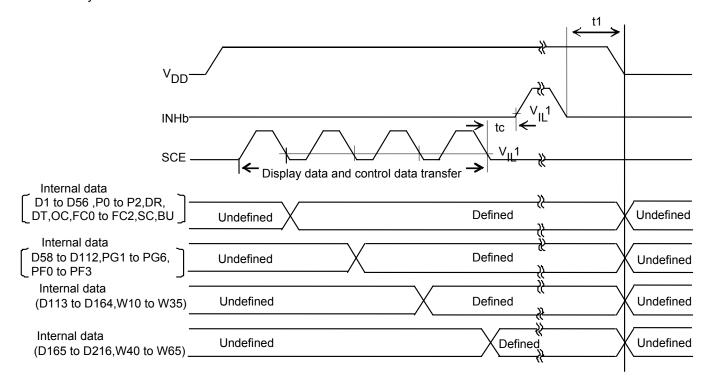


Figure 15. Power ON/OFF and INHb Control Sequence (1/4-Duty)

## 2. 1/3-Duty

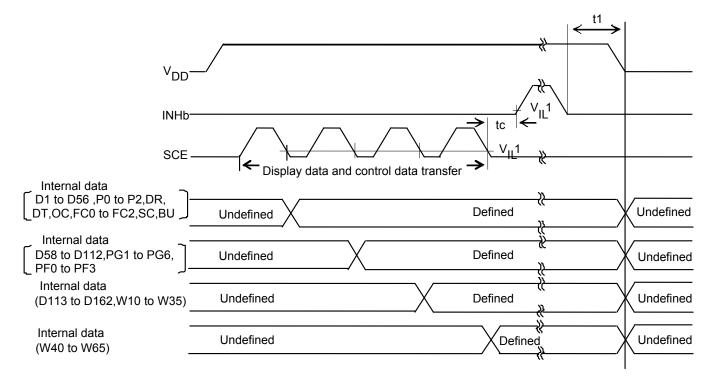


Figure 16. Power ON/OFF and INHb Control Sequence (1/3-Duty)

Note: t1≥0, tc: min 10us

#### Oscillation Stabilization Time of the Internal Oscillation Circuit

It must be noted that the oscillation of the internal oscillation circuit is unstable for a maximum of 100µs (oscillation stabilization time) after oscillation has started.

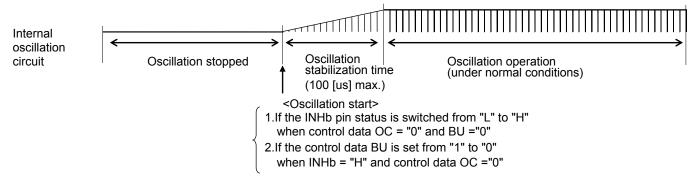


Figure 17. Oscillation Stabilization Time

#### **Voltage Detection Type Reset Circuit (VDET)**

The Voltage Detection Type Reset Circuit generates an output signal and resets the system when power is applied for the first time and when voltage drops (that is, for example, the power supply voltage is less than or equal to the power down detection voltage (VDET = 1.8V typ.). To ensure that this reset function works properly, it is recommended that a capacitor must be connected to the power supply line so that both the power supply voltage (VDD) rise time when power is first applied and the power supply voltage (VDD) fall time when the voltage drops are at least 1ms.

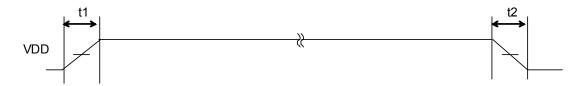


Figure 18. VDET Detection Timing

Power supply voltage VDD rise time: t1 > 1ms Power supply voltage VDD fall time: t2 > 1ms

## **Reset Condition**

When BU97510CKV-M is initialized, the internal status after power supply has been reset as the following table.

Table 1. control data reset condition

Instruction	At Reset Condition	
S1/P1/G1 to S2/P2/G2 pin	[P0,P1,P2]=[0,0,0]:all segment output	
LCD bias	DR=0:1/3-Bias	
LCD duty	DT=0:1/4-Duty	
DISPLAY frequency	[FC0,FC1,FC2]=[0,0,0]:fosc/6144	
Display clock mode	de OC=0:Internal oscillator	
LCD display	SC=1:OFF	
Power mode	BU=1:Power saving mode	
PWM/GPO output	GPO output PGx=0:PWM output(x=1~6)	
PWM frequency	PWM frequency [PF0,PF1,PF2,PF3]=[0,0,0,0]: fosc /2048	
PWM duty	[Wn0~Wn5]=[0,0,0,0,0,0]	
	$:(1/64)xTp(n=1\sim6,Tp=1/fp)$	

#### **Operational Notes**

#### 1. Reverse Connection of Power Supply

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

#### 2. Power Supply Lines

Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

#### 3. Ground Voltage

Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

#### 4. Ground Wiring Pattern

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

#### 5. Thermal Consideration

Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

#### 6. Recommended Operating Conditions

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

#### 7. Inrush Current

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

## 8. Operation Under Strong Electromagnetic Field

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

#### 9. Testing on Application Boards

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

#### 10. Inter-pin Short and Mounting Errors

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

## **Operational Notes - continued**

#### 11. Unused Input Pins

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

#### 12. Regarding the Input Pin of the IC

In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input pins have voltages within the values specified in the electrical characteristics of this IC.

#### 13. Ceramic Capacitor

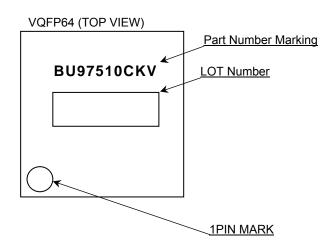
When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

#### 14. Data transmission

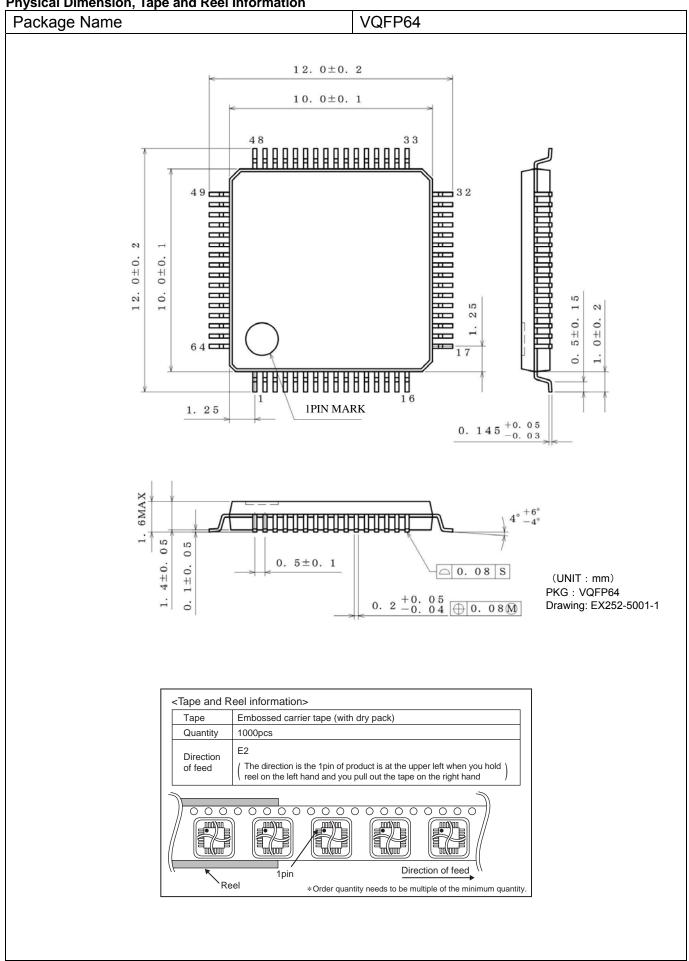
To refrain from data transmission is strongly recommended while power supply is rising up or falling down to prevent from the occurrence of disturbances on transmission and reception.

**Ordering Information** В 9 7 5 1 0 C K ME2 Part Number Package Product Rank M: for Automotive KV: VQFP64 Packaging Specification E2: Embossed tape and reel (VQFP64)

## **Marking Diagram**



Physical Dimension, Tape and Reel Information



**Revision History** 

,					
Version	Date	Date Description			
001	001   25.Feb.2014   New Release				
002	31.Mar.2014	Change the condition of VIH1 and VIH2 in page 3.			
002	02 Apr 2015	Add Note on AEC-Q100 Qualified in page 1.  Modify INHb Handling when unused of Pin Description in page 6.			
003	02.Apr.2015	Modify INHb Handling when unused of Pin Description in page 6.			

## **Notice**

#### **Precaution on using ROHM Products**

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

Ì	JÁPAN	USA	EU	CHINA
Γ	CLASSⅢ	CLASSIII	CLASS II b	CL ACCIII
Γ	CLASSIV		CLASSⅢ	CLASSⅢ

- 2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
  - [a] Installation of protection circuits or other protective devices to improve system safety
  - [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- 3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
  - [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [h] Use of the Products in places subject to dew condensation
- 4. The Products are not subject to radiation-proof design.
- 5. Please verify and confirm characteristics of the final or mounted products in using the Products.
- 6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- 7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
- 8. Confirm that operation temperature is within the specified range described in the product specification.
- 9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

- 1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- 2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

#### **Precautions Regarding Application Examples and External Circuits**

- 1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
- 2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

#### **Precaution for Electrostatic**

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of lonizer, friction prevention and temperature / humidity control).

## **Precaution for Storage / Transportation**

- 1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
- Even under ROHM recommended storage condition, solderability of products out of recommended storage time period
  may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is
  exceeding the recommended storage time period.
- 3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
- 4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

## **Precaution for Product Label**

QR code printed on ROHM Products label is for ROHM's internal use only.

#### **Precaution for Disposition**

When disposing Products please dispose them properly using an authorized industry waste company.

#### **Precaution for Foreign Exchange and Foreign Trade act**

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

#### **Precaution Regarding Intellectual Property Rights**

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#### **General Precaution**

- 1. Before you use our Products, you are requested to care fully read this document and fully understand its contents. ROHM shall not be in an y way responsible or liable for failure, malfunction or accident arising from the use of a ny ROHM's Products against warning, caution or note contained in this document.
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Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

## Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов:
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001:
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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