



**SANYO Semiconductors**

# DATA SHEET

An ON Semiconductor Company

## LV5223GR — Bi-CMOS IC LED Driver

### Overview

The LV5223GR is 9ch LED driver IC for the cell phones with built-in charge pump circuit.

### Features

- LED driver ×9 channels (3-color 1, 3-color 2, GPO (LED) ×3, 9 channels in total) and on-chip charge pump circuit.
- Each LED driver current level can be adjusted independently over the serial bus.
- Ring tone and 3-color LEDs (3-color 1, 3-color 2) synchronization function.
- Gradation function (3-color 1, 3-color 2, in total 6 channels only)
- RLED2 and GLED2 support strobe mode.
- Miniature package

### Function

- Charge pump circuit ((2 times step up) Output voltage: 5V)
- LED driver 3-color LED ×2 + GPO (LED) LED driver ×3
  - Channel 1 LED current can be switched indecently in 5-bit units (0.5 to 16mA)  
Ring tone synchronization function (forced activation with SCTL: H)  
Gradation function
  - Channel 1 LED current can be switched indecently in 5-bit units (0.5 to 16mA)  
Ring tone synchronization function (forced activation with SCTL: H)  
Gradation function
  - Only RLED2 and GLED2 support strobe mode; LED current output (2.8mA to 44.8mA) (FCTL=high)
  - GPO1 (LED3), GPO2 (LED4), GPO3 (LED5) when GPO1 to GPO3 are used as the LED driver
- GPO output ×3

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

# LV5223GR

## Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V <sub>CC</sub> max		5	V
Maximum voltage	V1 max	LED pins, charge pump pin	6	V
Maximum output current	I <sub>O</sub> max 1	RLED1, GLED1, BLED1 and BLED2 pins	40	mA
	I <sub>O</sub> max 2	RLED2 and GLED2 pins	50	mA
Allowable power dissipation	Pd max	* Mounted on a circuit board	800	mW
Operating temperature	Topr		-30 to +80	°C
Storage temperature	Tstg		-40 to +125	°C

\* Specified board: 40mm × 50mm × 0.8mm, glass epoxy board. (2S2P (4-layer board))

Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V <sub>BAT</sub>		3.0 to 5.0	V
Supply voltage 2	V <sub>DD</sub>		1.65 to V <sub>BAT</sub>	V

Electrical Characteristics at Ta = 25°C, V<sub>CC</sub> = 5.0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Consumption current						
Consumption current	I <sub>CC1</sub>	V <sub>BAT</sub> +V <sub>DD</sub> consumption current RESET:L (when reset)		0	5	μA
	I <sub>CC2</sub>	V <sub>BAT</sub> +V <sub>DD</sub> consumption current RESET:H in serial default		0.5	5.0	μA
	I <sub>CC3</sub>	V <sub>BAT</sub> +V <sub>DD</sub> consumption current charge pump: ON		4		mA
Oscillator block						
Oscillator frequency	Fosc			500		kHz
Charge pump block						
Output voltage	V <sub>O1</sub>	I <sub>O</sub> =30mA	4.8	5.0	5.2	V
Maximum current	I <sub>O1</sub>	V <sub>BAT</sub> =3.3V, V <sub>O1</sub> >4.3V	200			mA
Soft start time	TSS	TSS=1/Fosc × 400 *1		800		μs
LED driver block						
Minimum output current value 1	I <sub>MIN1</sub>	3-color 1, 2 LED driver FCTL=L Serial data=#00 V <sub>O</sub> =0.5V	0.2	0.5	1.0	mA
Maximum output current value 1	I <sub>MAX1</sub>	3-color 1, 2 LED driver FCTL=L Serial data=#FF V <sub>O</sub> =0.5V	15	16	17	mA
Minimum output current value 2	I <sub>MIN2</sub>	RLED2, GLED2 pin LED driver FCTL=H Serial data=#00 V <sub>O</sub> =0.5V	1.8	2.8	3.8	mA
Maximum output current value 2	I <sub>MAX2</sub>	RLED2, GLED2 pin LED driver FCTL=H Serial data=#FF V <sub>O</sub> =0.5V	42.0	44.8	47.6	mA
ON resistance	RON1	GPO1(LED3), GPO2(LED4), GPO3(LED5) pins When LED driver ON I <sub>L</sub> = -40mA		5		Ω
Non-linearity error	LE1	3-color 1, 2 LED driver V <sub>O</sub> =0.5V *2	-2		2	LSB
Differential linearity error	DLE1	3-color 1, 2 LED driver V <sub>O</sub> =0.5V *3	-2		2	LSB
Maximum output current	ΔIL1	3-color LED driver 1, 2 FCTL=L Maximum current setting V <sub>O</sub> =0.35V	-10			%
	ΔIL2	RLED2, GLED2 pin LED driver FCTL=H Maximum current setting V <sub>O</sub> =0.45V	-10			%
Leakage current	IL1	3-color LED driver 1, 2 & GPO(LED) × 3 LED driver: OFF V <sub>O</sub> =5V			1	μA
Control circuit block						
H level 1	V <sub>INH1</sub>	Input H level SCTL	1.3			V
L level 1	V <sub>INL1</sub>	Input L level SCTL	0		0.45	V
H level 2	V <sub>INH2</sub>	Input H level FCTL	1.3			V
L level 2	V <sub>INL2</sub>	Input L level FCTL	0		0.45	V
H level 3	V <sub>INH3</sub>	Input H level serial signal input pin	V <sub>DD</sub> × 0.8			V

Continued on next page.

# LV5223GR

Continued from preceding page.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
L level 3	V <sub>INL3</sub>	Input L level serial signal input pin	0		V <sub>DD</sub> × 0.2	V
H level 4	V <sub>INH4</sub>	Input H level RESET	1.5			V
L level 4	V <sub>INL4</sub>	Input L level RESET	0		0.3	V
H level 5	V <sub>HO5</sub>	Output H level GPO1 GPO2 GPO3 I <sub>L</sub> =1mA When output mode is set to buffer	V <sub>DD</sub> - 0.3			V
L level 5	V <sub>LO5</sub>	Output L level GPO1 GPO2 GPO3 I <sub>L</sub> =-1mA When output mode is set to buffer	0		0.3	V

\*1. Soft start time: Interval from the time the charge pump is started until the time the charge pump output voltage reaches 5V.

\*2. Non-linearity error: The difference between the actual and ideal current values.

\*3. Differential linearity error: The difference between the actual and ideal increment when one low-order bit value is added.

Note) The LED current can be changed by changing the value of RT.

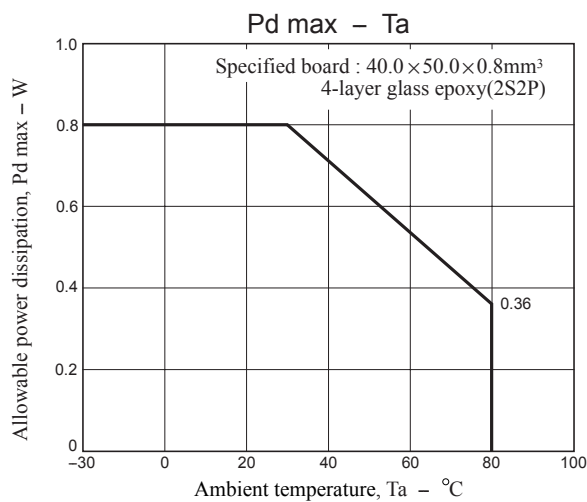
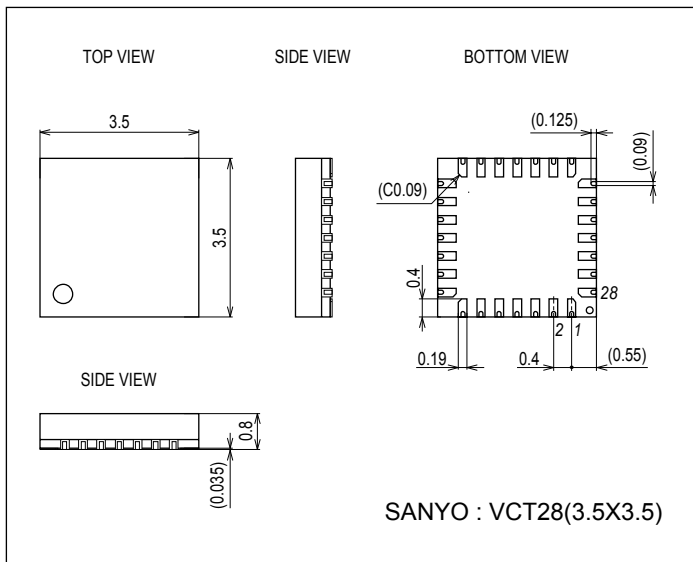
(Example: When RT = 10kΩ, V<sub>O</sub>>0.945V and RGB1&2 LED current is set to 14.5mA, the RGB1&2 current can be set to flow at 14.5mA × 27kΩ / 10 kΩ = 39.15mA)

(When the value of RT has been reduced, adjust the oscillation frequency by increasing the value of CT.)

## Package Dimensions

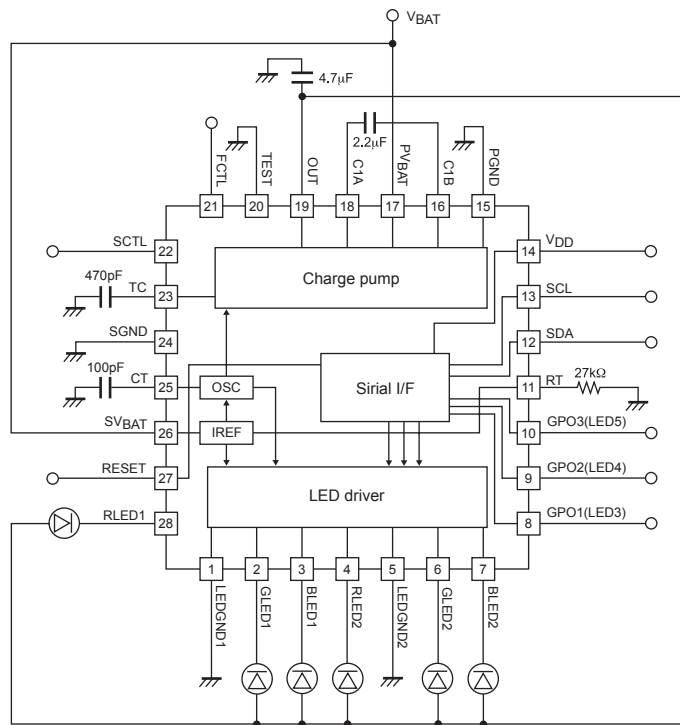
unit : mm (typ)

3357



# LV5223GR

## Block Diagram & Pin arrangement drawing



## Pin Descriptions

Pin No.	Pin name	Description	Protection diode vs. V <sub>BAT</sub>	Protection diode vs. GND
1	LEDGND1	GND pin1 for LED driver		
2	GLED1	GLED1 driver output pin		○
3	BLED1	BLED1 driver output pin		○
4	RLED2	RLED2 driver output pin		○
5	LEDGND2	GND pin2 for LED driver		
6	GLED2	GLED2 driver output pin		○
7	BLED2	BLED2 driver output pin		○
8	GPO1(LED3)	GPO1 output & LED3 driver output pin		○
9	GPO2(LED4)	GPO2 output & LED4 driver output pin		○
10	GPO3(LED5)	GPO3 output & LED5 driver output pin		○
11	RT	Standard current setting resistance connection pin	○	○
12	SDA	Serial data signal input pin	○	○
13	SCL	Serial clock signal input pin	○	○
14	V <sub>DD</sub>	Power supply pin	○	○
15	PGND	GND pin for Charge pump		
16	C1B	Flying capacitor connection pin B for charge pump	○	○
17	P <sub>V</sub> BAT	Power supply for charge pump		○
18	C1A	Flying capacitor connection pin A for charge pump		○
19	OUT	Output pin for charge pump		○
20	TEST	TEST pin	○	○
21	FCTL	Strobe mode pin	○	○
22	SCTL	3-color1 & 3-color2 LED driver external synchronous signal input pin	○	○
23	TC	Charge pump phase amends pin	○	○
24	SGND	GND pin for analog circuit		
25	CT	Setting of frequency of oscillator capacity connection pin	○	○
26	S <sub>V</sub> BAT	Supply voltage for analog circuit		
27	RESET	RESET signal input pin	○	○
28	RLED1	RLED1 driver output pin		○

# LV5223GR

## Pin Functions

Pin No.	Pin Name	Pin function	Equivalent Circuit
1	LEDGND1	GND pin1 for LED driver	
2	GLED1	LED driver pin for RGB1 and RGB2.	
3	BLED1	Feedback is applied so that the current flowing to the output transistor becomes the set current level. When $R_T=27k\Omega$ , the driver output current levels can be independently adjusted from approx. 0.5mA to 16mA in 0.5mA steps by serial setting. In the strobe mode, the current levels can be independently adjusted from 2.8mA to 44.8mA in 2.8mA steps for the RLED2 and GLED2 pins only.	
4	RLED2		
6	GLED2		
7	BLED2		
28	RLED1		
5	LEDGND2	GND pin2 for LED driver	
8	GPO1(LED3)	GPO output/LED driver shared pin. Output can be set to current sink by serial setting or VDD or GND voltage can be output.	
9	GPO2(LED4)		
10	GPO3(LED5)		
11	RT	Reference current setting resistor connection pin. The reference current is generated by connecting an external resistor to GND. The pin voltage is approximately 0.65V. By changing this current level, the oscillation frequency and LED driver current (3-color 1 and 3-color 2 only) can be changed.	
12	SDA	Serial data signal input pin	
13	SCL	Serial clock signal input pin	
14	VDD	Power supply pin	
15	PGND	GND pin for Charge pump	
16	C1B	Charge pump flying capacitor connection pin B This pin is connected to the clock driver side of the charge pump.	

Continued on next page.

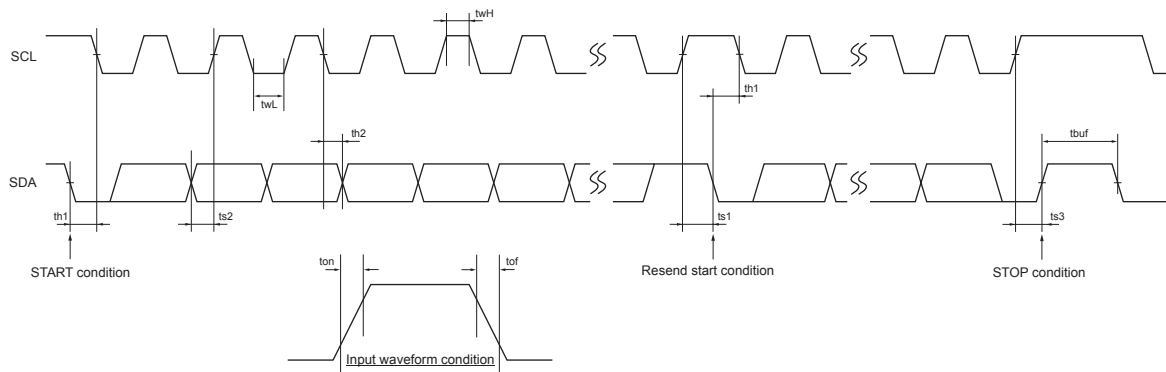
# LV5223GR

Continued from preceding page.

Pin No.	Pin Name	Pin function	Equivalent Circuit
17	PV <sub>BAT</sub>	Power supply for charge pump	
18	C1A	Charge pump flying capacitor connection pin A This pin is connected to the charge transfer driver side of the charge pump.	
19	OUT	Output pin for charge pump	
20	TEST	Test pin. This must always be connected to GND.	
21 22	FCTL SCTL	FCTL: Strobe mode pin. SCTL: 3-color 1 and 3-color 2 LED driver external sync signal input pin. When this pin is not going to be used, it must be connected to GND without fail.	
23	TC	Charge pump phase compensation pin. Stable operation of the charge pump is provided by connecting a capacitor to this pin.	
24	SGND	GND pin for analog circuit	
25	CT	Oscillator frequency setting capacitor connection pin. The oscillation frequency can be changed by changing the capacitance of the capacitor.	
26	SV <sub>BAT</sub>	Supply voltage for analog circuit	
27	RESET	RESET signal input pin. Reset state at L.	

## Serial Bus Communication Specifications

### 1) I<sup>2</sup>C serial transfer timing conditions



#### Standard mode

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
SCL clock frequency	fsc1	SCL clock frequency	0	-	100	kHz
Data setup time	ts1	SCL setup time relative to the fall of SDA	4.7	-	-	μs
	ts2	SDA setup time relative to the rise of SCL	250	-	-	ns
	ts3	SCL setup time relative to the rise of SDA	4.0	-	-	μs
Data hold time	th1	SCL hold time relative to the fall of SDA	4.0	-	-	μs
	th2	SDA hold time relative to the fall of SCL	0	-	3.45	μs
Pulse width	twL	SCL pulse width for the L period	4.7	-	-	μs
	twH	SCL pulse width for the H period	4.0	-	-	μs
Input waveform conditions	ton	SCL and SDA (input) rise time	-	-	1000	ns
	tof	SCL and SDA (input) fall time	-	-	300	ns
Bus free time	tbuf	Time between STOP condition and START condition	4.7	-	-	μs

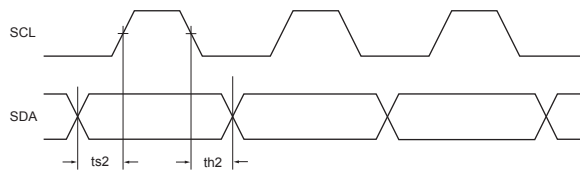
#### High-speed mode

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
SCL clock frequency	fsc1	SCL clock frequency	0	-	400	kHz
Data setup time	ts1	SCL setup time relative to the fall of SDA	0.6	-	-	μs
	ts2	SDA setup time relative to the rise of SCL	100	-	-	ns
	ts3	SCL setup time relative to the rise of SDA	0.6	-	-	μs
Data hold time	th1	SCL hold time relative to the fall of SDA	0.6	-	-	μs
	th2	SDA hold time relative to the fall of SCL	0	-	0.9	μs
Pulse width	twL	SCL pulse width for the L period	1.3	-	-	μs
	twH	SCL pulse width for the H period	0.6	-	-	μs
Input waveform conditions	ton	SCL and SDA (input) rise time	-	-	300	ns
	tof	SCL and SDA (input) fall time	-	-	300	ns
Bus free time	tbuf	Time between STOP and START conditions	1.3	-	-	μs

## 2) I<sup>2</sup>C bus transfer method

### Start and stop conditions

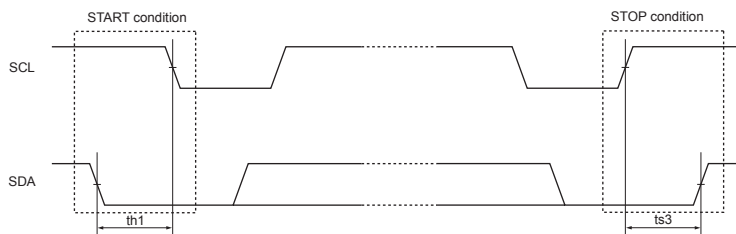
During data transfer operation using the I<sup>2</sup>C bus, SDA must basically be kept in constant state while SCL is "H" as shown below.



When data is not being transferred, both SCL and SDA are set in the "H" state.

When SCL=SDA is "H," the start condition is established when SDA is changed from "H" to "L," and access is started.

When SCL is "H," the stop condition is established when SDA is changed from "L" to "H," and access is ended.



### Data transfer and acknowledgement response

After the start condition has been established, the data is transferred one byte (8 bits) at a time.

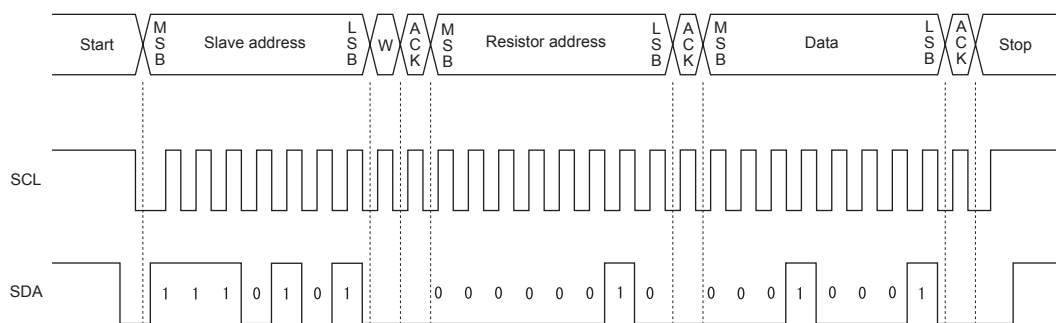
Any number of bytes of data can be transferred continuously.

Each time the 8-bit data is transferred, the ACK signal is sent from the receive side to the send side. The ACK signal is issued when SDA on the send side is released and SDA on the receive side is set to "L" immediately after fall of the clock pulse at the SCL eighth bit of data transfer to "L."

When the next 1-byte transfer is left in the receive state after sending the ACK signal from the receive side, the receive side releases SDA at the fall of the SCL ninth clock.

In the I<sup>2</sup>C bus, there is no CE signal. In its place, a 7-bit slave address is assigned to each device, and the first byte of transfer is assigned to the command (R/W) representing the 7-bit address and subsequent transfer direction. Note that only write is valid in this IC. The 7-bit address is transferred sequentially starting with MSB, and the eighth bit is set to "L" which indicates a write.

In the LV5223GP the slave address is specified as "1110101"





# LV5223GR

## Serial mode setting

	ADDRESS : 00h							
	D7	D6	D5	D4	D3	D2	D1	D0
register name	B2SW	G2SW	R2SW	B1SW	G1SW	R1SW	CPSW	STBY
default	0	0	0	0	0	0	0	0

D0	STBY
0	Standby
1	Active

STBY setting

\*Default

LED operation enabled by releasing STBY (LED can be operated by another power supply)

D1	CPSW
0	OFF
1	ON

Charge pump ON/OFF setting

\*Default

D2	R1SW
0	OFF
1	ON

RLED1 output setting

\*Default

D3	G1SW
0	OFF
1	ON

GLED1 output setting

\*Default

D4	B1SW
0	OFF
1	ON

BLED1 output setting

\*Default

D5	R2SW
0	OFF
1	ON

RLED2 output setting

\*Default

D6	G2SW
0	OFF
1	ON

GLED2 output setting

\*Default

D7	B2SW
0	OFF
1	ON

BLED2 output setting

\*Default

# LV5223GR

	ADDRESS : 01h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	SCTEN1	-	-	R1[4]	R1[3]	R1[2]	R1[1]	R1[0]
default	0	0	0	0	0	0	0	0

D4	D3	D2	D1	D0	current value (mA)
0	0	0	0	0	0.5
0	0	0	0	1	1.0
0	0	0	1	0	1.5
0	0	0	1	1	2.0
0	0	1	0	0	2.5
0	0	1	0	1	3.0
0	0	1	1	0	3.5
0	0	1	1	1	4.0
0	1	0	0	0	4.5
0	1	0	0	1	5.0
0	1	0	1	0	5.5
0	1	0	1	1	6.0
0	1	1	0	0	6.5
0	1	1	0	1	7.0
0	1	1	1	0	7.5
0	1	1	1	1	8.0
1	0	0	0	0	8.5
1	0	0	0	1	9.0
1	0	0	1	0	9.5
1	0	0	1	1	10.0
1	0	1	0	0	10.5
1	0	1	0	1	11.0
1	0	1	1	0	11.5
1	0	1	1	1	12.0
1	1	0	0	0	12.5
1	1	0	0	1	13.0
1	1	0	1	0	13.5
1	1	0	1	1	14.0
1	1	1	0	0	14.5
1	1	1	0	1	15.0
1	1	1	1	0	15.5
1	1	1	1	1	16.0

RLED1 current value setting

\*Default

D7	SCTEN1
0	RGB1 SCTL valid
1	RGB1 SCTL non valid

RGB1 SCTL signal enable

\*Default

# LV5223GR

	ADDRESS : 02h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	-	G1[4]	G1[3]	G1[2]	G1[1]	G1[0]
default	0	0	0	0	0	0	0	0

D4	D3	D2	D1	D0	current value (mA)
0	0	0	0	0	0.5
0	0	0	0	1	1.0
0	0	0	1	0	1.5
0	0	0	1	1	2.0
0	0	1	0	0	2.5
0	0	1	0	1	3.0
0	0	1	1	0	3.5
0	0	1	1	1	4.0
0	1	0	0	0	4.5
0	1	0	0	1	5.0
0	1	0	1	0	5.5
0	1	0	1	1	6.0
0	1	1	0	0	6.5
0	1	1	0	1	7.0
0	1	1	1	0	7.5
0	1	1	1	1	8.0
1	0	0	0	0	8.5
1	0	0	0	1	9.0
1	0	0	1	0	9.5
1	0	0	1	1	10.0
1	0	1	0	0	10.5
1	0	1	0	1	11.0
1	0	1	1	0	11.5
1	0	1	1	1	12.0
1	1	0	0	0	12.5
1	1	0	0	1	13.0
1	1	0	1	0	13.5
1	1	0	1	1	14.0
1	1	1	0	0	14.5
1	1	1	0	1	15.0
1	1	1	1	0	15.5
1	1	1	1	1	16.0

GLED1 current value setting

\*Default

# LV5223GR

	ADDRESS : 03h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	-	B1[4]	B1[3]	B1[2]	B1[1]	B1[0]
default	0	0	0	0	0	0	0	0

D4	D3	D2	D1	D0	current value (mA)
0	0	0	0	0	0.5
0	0	0	0	1	1.0
0	0	0	1	0	1.5
0	0	0	1	1	2.0
0	0	1	0	0	2.5
0	0	1	0	1	3.0
0	0	1	1	0	3.5
0	0	1	1	1	4.0
0	1	0	0	0	4.5
0	1	0	0	1	5.0
0	1	0	1	0	5.5
0	1	0	1	1	6.0
0	1	1	0	0	6.5
0	1	1	0	1	7.0
0	1	1	1	0	7.5
0	1	1	1	1	8.0
1	0	0	0	0	8.5
1	0	0	0	1	9.0
1	0	0	1	0	9.5
1	0	0	1	1	10.0
1	0	1	0	0	10.5
1	0	1	0	1	11.0
1	0	1	1	0	11.5
1	0	1	1	1	12.0
1	1	0	0	0	12.5
1	1	0	0	1	13.0
1	1	0	1	0	13.5
1	1	0	1	1	14.0
1	1	1	0	0	14.5
1	1	1	0	1	15.0
1	1	1	1	0	15.5
1	1	1	1	1	16.0

BLED1 current value setting

\*Default

# LV5223GR

	ADDRESS : 04h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	SCTEN2	-	-	R2[4]	R2[3]	R2[2]	R2[1]	R2[0]
default	0	0	0	0	0	0	0	0

D4	D3	D2	D1	D0	current value (mA)
0	0	0	0	0	0.5
0	0	0	0	1	1.0
0	0	0	1	0	1.5
0	0	0	1	1	2.0
0	0	1	0	0	2.5
0	0	1	0	1	3.0
0	0	1	1	0	3.5
0	0	1	1	1	4.0
0	1	0	0	0	4.5
0	1	0	0	1	5.0
0	1	0	1	0	5.5
0	1	0	1	1	6.0
0	1	1	0	0	6.5
0	1	1	0	1	7.0
0	1	1	1	0	7.5
0	1	1	1	1	8.0
1	0	0	0	0	8.5
1	0	0	0	1	9.0
1	0	0	1	0	9.5
1	0	0	1	1	10.0
1	0	1	0	0	10.5
1	0	1	0	1	11.0
1	0	1	1	0	11.5
1	0	1	1	1	12.0
1	1	0	0	0	12.5
1	1	0	0	1	13.0
1	1	0	1	0	13.5
1	1	0	1	1	14.0
1	1	1	0	0	14.5
1	1	1	0	1	15.0
1	1	1	1	0	15.5
1	1	1	1	1	16.0

RLED2 current value setting

\*Default

D7	SCTEN2
0	RGB2 SCTL valid
1	RGB2 SCTL non valid

RGB2 SCTL signal enable

\*Default

# LV5223GR

	ADDRESS : 05h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	-	G2[4]	G2[3]	G2[2]	G2[1]	G2[0]
default	0	0	0	0	0	0	0	0

D4	D3	D2	D1	D0	current value (mA)
0	0	0	0	0	0.5
0	0	0	0	1	1.0
0	0	0	1	0	1.5
0	0	0	1	1	2.0
0	0	1	0	0	2.5
0	0	1	0	1	3.0
0	0	1	1	0	3.5
0	0	1	1	1	4.0
0	1	0	0	0	4.5
0	1	0	0	1	5.0
0	1	0	1	0	5.5
0	1	0	1	1	6.0
0	1	1	0	0	6.5
0	1	1	0	1	7.0
0	1	1	1	0	7.5
0	1	1	1	1	8.0
1	0	0	0	0	8.5
1	0	0	0	1	9.0
1	0	0	1	0	9.5
1	0	0	1	1	10.0
1	0	1	0	0	10.5
1	0	1	0	1	11.0
1	0	1	1	0	11.5
1	0	1	1	1	12.0
1	1	0	0	0	12.5
1	1	0	0	1	13.0
1	1	0	1	0	13.5
1	1	0	1	1	14.0
1	1	1	0	0	14.5
1	1	1	0	1	15.0
1	1	1	1	0	15.5
1	1	1	1	1	16.0

GLED2 current value setting

\*Default

# LV5223GR

	ADDRESS : 06h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	-	B2[4]	B2[3]	B2[2]	B2[1]	B2[0]
default	0	0	0	0	0	0	0	0

D4	D3	D2	D1	D0	current value (mA)
0	0	0	0	0	0.5
0	0	0	0	1	1.0
0	0	0	1	0	1.5
0	0	0	1	1	2.0
0	0	1	0	0	2.5
0	0	1	0	1	3.0
0	0	1	1	0	3.5
0	0	1	1	1	4.0
0	1	0	0	0	4.5
0	1	0	0	1	5.0
0	1	0	1	0	5.5
0	1	0	1	1	6.0
0	1	1	0	0	6.5
0	1	1	0	1	7.0
0	1	1	1	0	7.5
0	1	1	1	1	8.0
1	0	0	0	0	8.5
1	0	0	0	1	9.0
1	0	0	1	0	9.5
1	0	0	1	1	10.0
1	0	1	0	0	10.5
1	0	1	0	1	11.0
1	0	1	1	0	11.5
1	0	1	1	1	12.0
1	1	0	0	0	12.5
1	1	0	0	1	13.0
1	1	0	1	0	13.5
1	1	0	1	1	14.0
1	1	1	0	0	14.5
1	1	1	0	1	15.0
1	1	1	1	0	15.5
1	1	1	1	1	16.0

BLED2 current value setting

\*Default

# LV5223GR

	ADDRESS : 07h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	FOUT1[2]	FOUT1[1]	FOUT1[0]	FIN1[2]	FIN1[1]	FIN1[0]
default	0	0	0	0	0	0	0	0

D2	D1	D0	FIN1
0	0	0	No slope
0	0	1	Slope 1/32
0	1	0	1/16
0	1	1	1/8
1	0	0	1/4
1	0	1	1/2
1	1	0	3/4
1	1	1	Max slope

RGB1 FIN slope setting

\*Default

Max. slope is 1/2 of automatic ON/OFF period of RGB1

D5	D4	D3	FOUT1
0	0	0	No slope
0	0	1	Slope 1/32
0	1	0	1/16
0	1	1	1/8
1	0	0	1/4
1	0	1	1/2
1	1	0	3/4
1	1	1	Max slope

RGB1 FOUT slope setting

\*Default

Max. slope is 1/2 of automatic ON/OFF period of RGB1

	ADDRESS : 08h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	FOUT2[2]	FOUT2[1]	FOUT2[0]	FIN2[2]	FIN2[1]	FIN2[0]
default	0	0	0	0	0	0	0	0

D2	D1	D0	FIN2
0	0	0	No slope
0	0	1	Slope 1/32
0	1	0	1/16
0	1	1	1/8
1	0	0	1/4
1	0	1	1/2
1	1	0	3/4
1	1	1	Max slope

RGB2 FIN slope setting

\*Default

Max. slope is 1/2 of automatic ON/OFF period of RGB2

D5	D4	D3	FOUT2
0	0	0	No slope
0	0	1	Slope 1/32
0	1	0	1/16
0	1	1	1/8
1	0	0	1/4
1	0	1	1/2
1	1	0	3/4
1	1	1	Max slope

RGB2 FOUT slope setting

\*Default

Max. slope is 1/2 of automatic ON/OFF period of RGB2



# LV5223GR

	ADDRESS : 09h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	SYNC	GR1M1	GRON1	AT1[2]	AT1[1]	AT1[0]
default	0	0	0	0	0	0	0	0

D2	D1	D0	AT1
0	0	0	0.262sec
0	0	1	0.524sec
0	1	0	1.049sec
0	1	1	2.097sec
1	0	0	4.194sec
1	0	1	8.389sec
1	1	×	-

RGB1 automatic ON/OFF function setting

\*Default

D3	GRON1
0	OFF
1	ON

RGB1 automatic ON/OFF function setting

\*Default

D4	GR1M1
0	OFF
1	ON

RGB1 is executed one time of the gradation.

\*Default

D5	SYNC
0	OFF
1	ON

Automatic operation ON/OFF cycle and the gradation.

execution setting of RGB2 are done as well as RGB1

\*Default

	ADDRESS : 0ah							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	-	GR1M2	GRON2	AT2[2]	AT2[1]	AT2[0]
default	0	0	0	0	0	0	0	0

D2	D1	D0	AT2
0	0	0	0.262sec
0	0	1	0.524sec
0	1	0	1.049sec
0	1	1	2.097sec
1	0	0	4.194sec
1	0	1	8.389sec
1	1	×	-

RGB2 automatic ON/OFF function setting

\*Default

D3	GRON1
0	OFF
1	ON

RGB2 automatic ON/OFF function setting

\*Default

D4	GR1M1
0	OFF
1	ON

RGB2 is executed one time of the gradation.

\*Default

# LV5223GR

	ADDRESS : 0bh							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	R1Aoff[5]	R1Aoff[4]	R1Aoff[3]	R1Aoff[2]	R1Aoff[1]	R1Aoff[0]
default	0	0	0	0	0	0	0	0

D5-0 RLED1 automatic OFF position setting (default: ALL0)

	ADDRESS : 0ch							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	R1Aon[5]	R1Aon[4]	R1Aon[3]	R1Aon[2]	R1Aon[1]	R1Aon[0]
default	0	0	0	0	0	0	0	0

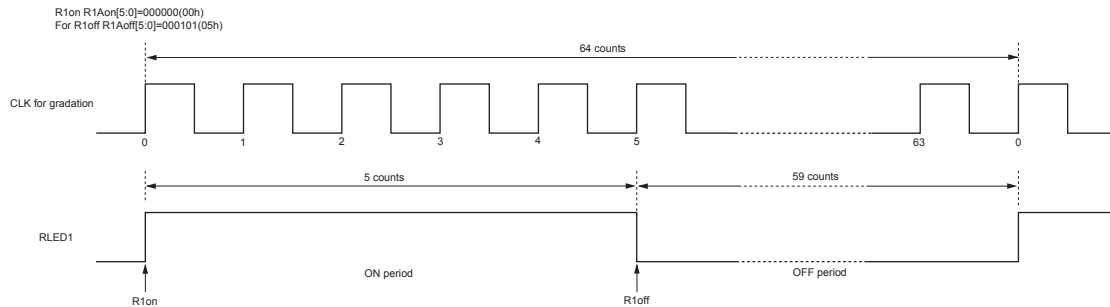
D5-0 RLED1 automatic OFF position setting (default: ALL0)

When R1Aon=R1Aoff, all the periods off.

LED control output waveform (RLED1). Same for GLED1, BLED1, GLED2, GLED2 and BLED2

When D5 to D0 ALL0: Clock 0 rise position.

When D5 to D0 ALL1: Clock 63 rise position.



	ADDRESS : 0dh							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	G1Aoff[5]	G1Aoff[4]	G1Aoff[3]	G1Aoff[2]	G1Aoff[1]	G1Aoff[0]
default	0	0	0	0	0	0	0	0

D5-0 GLED1 automatic OFF position setting (default: ALL0)

	ADDRESS : 0eh							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	G1Aon[5]	G1Aon[4]	G1Aon[3]	G1Aon[2]	G1Aon[1]	G1Aon[0]
default	0	0	0	0	0	0	0	0

D5-0 GLED1 automatic OFF position setting (default: ALL0)

When G1Aon=G1Aoff, all the periods off.

## LV5223GR

	ADDRESS : 0fh							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	B1Aoff[5]	B1Aoff[4]	B1Aoff[3]	B1Aoff[2]	B1Aoff[1]	B1Aoff[0]
default	0	0	0	0	0	0	0	0

D5-0 BLED1 automatic OFF position setting (default: ALL0)

	ADDRESS : 10h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	B1Aon[5]	B1Aon[4]	B1Aon[3]	B1Aon[2]	B1Aon[1]	B1Aon[0]
default	0	0	0	0	0	0	0	0

D5-0 BLED1 automatic OFF position setting (default: ALL0)

When B1Aon=B1Aoff, all the periods off.

	ADDRESS : 11h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	R2Aoff[5]	R2Aoff[4]	R2Aoff[3]	R2Aoff[2]	R2Aoff[1]	R2Aoff[0]
default	0	0	0	0	0	0	0	0

D5-0 RLED2 automatic OFF position setting (default: ALL0)

	ADDRESS : 12h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	R2Aon[5]	R2Aon[4]	R2Aon[3]	R2Aon[2]	R2Aon[1]	R2Aon[0]
default	0	0	0	0	0	0	0	0

D5-0 RLED2 automatic OFF position setting (default: ALL0)

When R2Aon=R2Aoff, all the periods off.

	ADDRESS : 13h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	G2Aoff[5]	G2Aoff[4]	G2Aoff[3]	G2Aoff[2]	G2Aoff[1]	G2Aoff[0]
default	0	0	0	0	0	0	0	0

D5-0 GLED2 automatic OFF position setting (default: ALL0)

	ADDRESS : 14h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	G2Aon[5]	G2Aon[4]	G2Aon[3]	G2Aon[2]	G2Aon[1]	G2Aon[0]
default	0	0	0	0	0	0	0	0

D5-0 GLED2 automatic OFF position setting (default: ALL0)

When G2Aon=G2Aoff, all the periods off.

# LV5223GR

	ADDRESS : 15h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	B2Aoff[5]	B2Aoff[4]	B2Aoff[3]	B2Aoff[2]	B2Aoff[1]	B2Aoff[0]
default	0	0	0	0	0	0	0	0

D5-0 BLED2 automatic OFF position setting (default: ALL0)

	ADDRESS : 16h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	-	-	B2Aon[5]	B2Aon[4]	B2Aon[3]	B2Aon[2]	B2Aon[1]	B2Aon[0]
default	0	0	0	0	0	0	0	0

D5-0 BLED2 automatic OFF position setting (default: ALL0)

When B2Aon=B2Aoff, all the periods off.

	ADDRESS : 17h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	GTO3EN	GPO2EN	GPO1EN	-	-	GPO3	GPO2	GPO1
default	0	0	0	0	0	0	0	0

D0	GPO1	GPO1(LED3) output setting
0	GPO1 (LED3) output: Open when GPO1EN=0, low when GPO1EN=1	*Default
1	GPO1 (LED3) output: LED-Drv ON when GPO1EN=0, high when GPO1EN=1	

D1	GPO2	GPO2(LED4) output setting
0	GPO2 (LED4) output: Open when GPO2EN=0, low when GPO2EN=1	*Default
1	GPO2 (LED4) output: LED-Drv ON when GPO2EN=0, high when GPO2EN=1	

D2	GPO3	GPO3(LED5) output setting
0	GPO3 (LED5) output: Open when GPO3EN=0, low when GPO3EN=1	*Default
1	GPO3 (LED5) output: LED-Drv ON when GPO3EN=0, high when GPO3EN=1	

D5	GPO1EN	GPO1(LED3) output
0	When GPO1 (LED3) output is used as LED-Drv	Setting for using GPO or LED-Drv
1	When GPO1 (LED3) output is used as GPO	*Default

D6	GPO2EN	GPO2(LED4) output
0	When GPO2 (LED4) output is used as LED-Drv	Setting for using GPO or LED-Drv
1	When GPO2 (LED4) output is used as GPO	*Default

D7	GPO3EN	GPO3(LED5) output
0	When GPO3 (LED5) output is used as LED-Drv	Setting for using GPO or LED-Drv
1	When GPO3 (LED5) output is used as GPO	*Default

\*GPO1EN must be set to 1 without fail when the GPO1 (LED3) pin is to be used as GPO.

When GPO1EN is set to 1, do not apply a voltage higher than the V<sub>DD</sub> voltage to the GPO1 (LED3) pin.

The same applies to the GPO2 (LED4) and GPO3 (LED5) pins.

# LV5223GR

	ADDRESS : 18h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	FCTENR2	-	-	-	FCTR2[3]	FCTR2[2]	FCTR2[1]	FCTR2[0]
default	0	0	0	0	0	0	0	0

D3	D2	D1	D0	Current value(mA)
0	0	0	0	2.8
0	0	0	1	5.6
0	0	1	0	8.4
0	0	1	1	11.2
0	1	0	0	14.0
0	1	0	1	16.8
0	1	1	0	19.6
0	1	1	1	22.4
1	0	0	0	25.2
1	0	0	1	28.0
1	0	1	0	30.8
1	0	1	1	33.6
1	1	0	0	36.4
1	1	0	1	39.2
1	1	1	0	42.0
1	1	1	1	44.8

Strobe mode: RLED2 current level established when FCTL is high.

\*Default

D7	FCTENR2
0	FCTL non valid
1	FCTL valid

RLED2 FCTL signal enable

\*Default

	ADDRESS : 19h							
	D7	D6	D5	D4	D3	D2	D1	D0
resister name	FCTENG2	-	-	-	FCTG2[3]	FCTG2[2]	FCTG2[1]	FCTG2[0]
default	0	0	0	0	0	0	0	0

D3	D2	D1	D0	Current value(mA)
0	0	0	0	2.8
0	0	0	1	5.6
0	0	1	0	8.4
0	0	1	1	11.2
0	1	0	0	14.0
0	1	0	1	16.8
0	1	1	0	19.6
0	1	1	1	22.4
1	0	0	0	25.2
1	0	0	1	28.0
1	0	1	0	30.8
1	0	1	1	33.6
1	1	0	0	36.4
1	1	0	1	39.2
1	1	1	0	42.0
1	1	1	1	44.8

Strobe mode: GLED2 current level established when FCTL is high.

\*Default

D7	FCTENG2
0	FCTL non valid
1	FCTL valid

GLED2 FCTL signal enable

\*Default

### Precautions for serial transmission and usage note

- \* ON operation of the charge pump must be performed when the LED is off.
- \* Do not turn ON the LED for 800 $\mu$ s typ. (soft start time) after the charge pump has been turned on.
- \* When the fade operation of LED is performed, turn off the charge pump after the fade-out has been completed.
- \* Gradation level must be selected without fail when gradation is OFF.
- \* When the charge pump is operating, use the LED driver in such a way that the total current flowing to the LEDs.
- \* Even in the strobe mode (FCTL=H), the gradation operation is performed for RLED2 and GLED2 when RLED2 and GLED2 are set to gradation ON.
- \* Even in the strobe mode (FCTL=H), current flows to RLED2 and GLED2 in synchronization with the SCTL signal when SCTL is valid.
- \* When the LED pins are not to be used  
When LEDs are not connected to the LED pins, connect the LED driver pins to VBAT or GND.
- \* Precaution when using the SCTL pin or FCTL pin  
When the SCTL pin or FCTL pin is set to high, current flows to the SCTL or FCTL input circuit.  
(This is also true in the STBY or reset mode.)  
When the pin is not going to be used, it must be set to low without fail.
- \* By default, the GP01 (LED3) pin is left open.  
When the GP01 (LED3) pin is to be set high by default, connect a pull-up resistor to the pin.  
Conversely, when the GP01 (LED3) pin is to be set low by default, connect a pull-down resistor to the pin.  
Connect pull-up or pull-down resistors to the GP02 (LED4) and GP03 (LED5) pins as well in the same way.

# LV5223GR

## LV5223GR serial map

• Table upper row: Register name      Table the lower: Default value

		Register address								data							
		A7	A6	A5	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
00h		0	0	0	0	0	0	0	0	B2SW	G2SW	R2SW	B1SW	G1SW	R1SW	CPSW	STBY
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01h		0	0	0	0	0	0	0	1	SCTEN1	×	×	R1[4:0]				
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
02h		0	0	0	0	0	0	1	0	×	×	×	G1[4:0]				
		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
03h		0	0	0	0	0	0	1	1	×	×	×	B1[4:0]				
		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
04h		0	0	0	0	0	1	0	0	×	×	×	R2[4:0]				
		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
05h		0	0	0	0	0	1	0	1	×	×	×	G2[4:0]				
		0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
06h		0	0	0	0	0	1	1	0	×	×	×	B2[4:0]				
		0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
07h		0	0	0	0	0	1	1	1	×	×	FOUT1[2:0]			FIN1[2:0]		
		0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
08h		0	0	0	0	1	0	0	0	×	×	FOUT2[2:0]			FIN2[2:0]		
		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
09h		0	0	0	0	1	0	0	1	×	×	SYNC	GR1M1	GRON1	AT1[2:0]		
		0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
0ah		0	0	0	0	1	0	1	0	×	×	×	GR1M2	GRON2	AT2[2:0]		
		0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
0bh		0	0	0	0	1	0	1	1	×	×	R1Aoff[5:0]					
		0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
0ch		0	0	0	0	1	1	0	0	×	×	R1Aon[5:0]					
		0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
0dh		0	0	0	0	1	1	0	1	×	×	G1Aoff[5:0]					
		0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
0eh		0	0	0	0	1	1	1	0	×	×	G1Aon[5:0]					
		0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
0fh		0	0	0	0	1	1	1	1	×	×	B1Aoff[5:0]					
		0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
10h		0	0	0	1	0	0	0	0	×	×	B1Aon[5:0]					
		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
11h		0	0	0	1	0	0	0	1	×	×	R2Aoff[5:0]					
		0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
12h		0	0	0	1	0	0	1	0	×	×	R2Aon[5:0]					
		0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
13h		0	0	0	1	0	0	1	1	×	×	G2Aoff[5:0]					
		0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
14h		0	0	0	1	0	1	0	0	×	×	G2Aon[5:0]					
		0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
15h		0	0	0	1	0	1	0	1	×	×	B2Aoff[5:0]					
		0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
16h		0	0	0	1	0	1	1	0	×	×	B2Aon[5:0]					
		0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
17h		0	0	0	1	0	1	1	1	GPO3EN	GPO2EN	GPO1EN	×	×	GPO3	GPO2	GPO1
		0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0
18h		0	0	0	1	1	0	0	0	FCTENR2	×	×	×	FCTR2[3:0]			
		0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
19h		0	0	0	1	1	0	0	1	FCTENG2	×	×	×				
		0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0
		Register address								Data							

- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of July, 2011. Specifications and information herein are subject to change without notice.