LV5213LP

Bi-CMOS LSI

3ch LED Driver

ON Semiconductor®

http://onsemi.com

Overview

This LV5213LP is LED driver for cell phones. Each LED driver gets a constant current controlled. The brilliance control becomes possible by changing the current value that flows to LED by the serial bus control.
LV5213LP can achieve various effects of the illumination of a full-color LED display.

Functions

- Three color LED driver circuits.
- The LED current can be switched independently in 5-bit units (0 to 5mA).
- Independent on/off control of the three LED drivers (independent control of the 3 RGB colors).
- Each LED drive current level can be adjusted independently over the serial bus.
- Miniature package.
- Thermal shutdown circuit.

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_{CC} max		6.0	V
Supply voltage 2	V_{DD} max		6.0	V
Allowable power dissipation	Pd max	Mounted on the specified board *	5.5	W
Maximum input current	$V_{IN}B$		6.0	V
Maximum output current	I_O max		12.0	mA
STBY pin voltage	V_{STBY}		6.0	V
Operating temperature	Topr		-30 to +75	°C
Storage temperature	Tstg		-40 to +125	°C

The specified board *: 50mm × 40mm × 0.8mm glass epoxy (4-layer circuit board).

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_{CC}		3.0 to 4.5	V
Supply voltage 2	V_{DD}		1.6 to 3.0	V

Electrical Characteristics

Operating Characteristics at V_{CC} = 3.7V, V_{DD} = 1.8V, RT = 82Ω, Ta = 25°C

Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Overall Characteristics						
Current drain 1	$I_{CC}1$	STBY = L *1			5	μA
Current drain 2	$I_{CC}2$	STBY = H, RON = GON = BON = L *1 With the default serial data settings		0.6	2	mA
High-level input voltage 1	$V_{INH}1$	Serial data signals, each of the "ON" pins	VDD × 0.8			V
Low-level input voltage 1	$V_{INL}1$	Serial data signals, each of the "ON" pins	0		VDD × 0.2	V
High-level input voltage 2	$V_{INH}2$	STBY pin	VDD × 0.8			V
Low-level input voltage 2	$V_{INL}2$	STBY pin	0		VDD × 0.2	V
LED Driver Block						
Minimum output current 1	$I_{min}1$	When the serial data is 00000, V_O = 0.5V		0.54		mA
Maximum output current 1	$I_{max}1$	When the serial data is 11111, V_O = 0.5V		4.74		mA
Linearity error	LE	*2	-3		3	LSB
Differential linearity error	DLE	*3	-2		2	LSB
Maximum output current	ΔIL	At the maximum current setting, V_O = 2 to 0.15V	-10			%
Leakage current	I_{leak}	Drivers: off, V_O = 5V			1	μA

*1. The sum of the V_{CC} and V_{DD} current drain values.

*2. Linearity error: The difference between the actual and ideal current values.

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

Package Dimensions
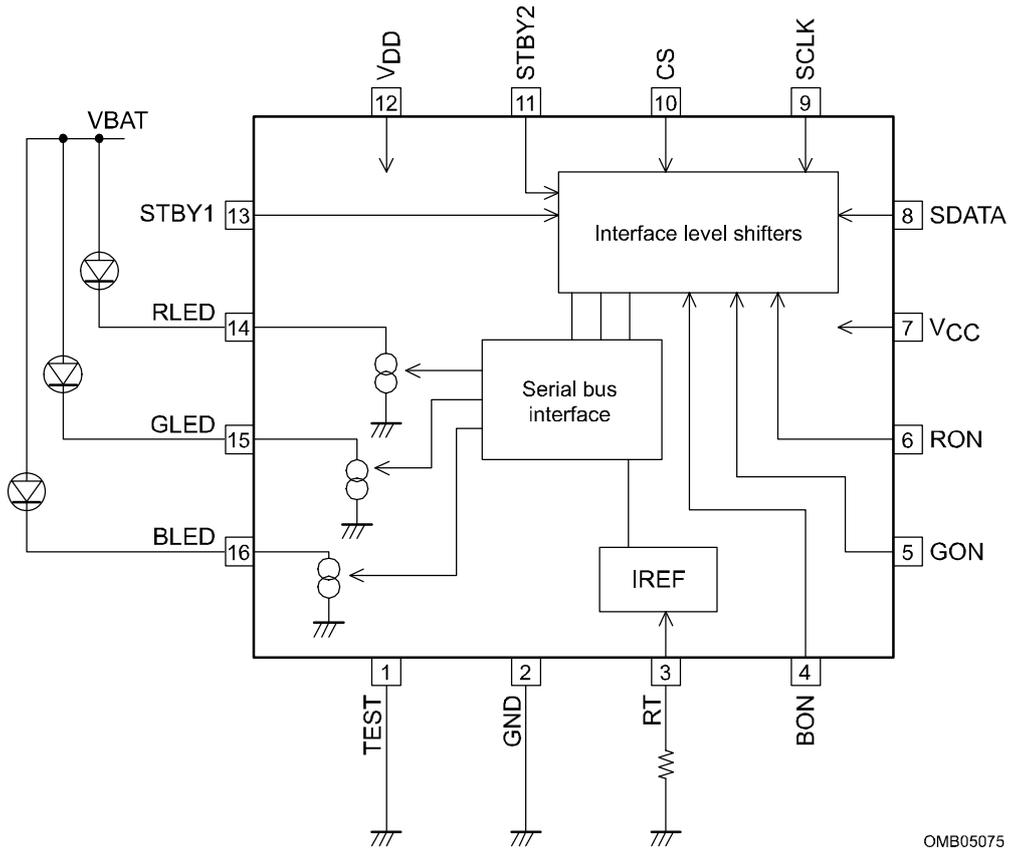
unit : mm

3318

Pd max − Ta

VCT16
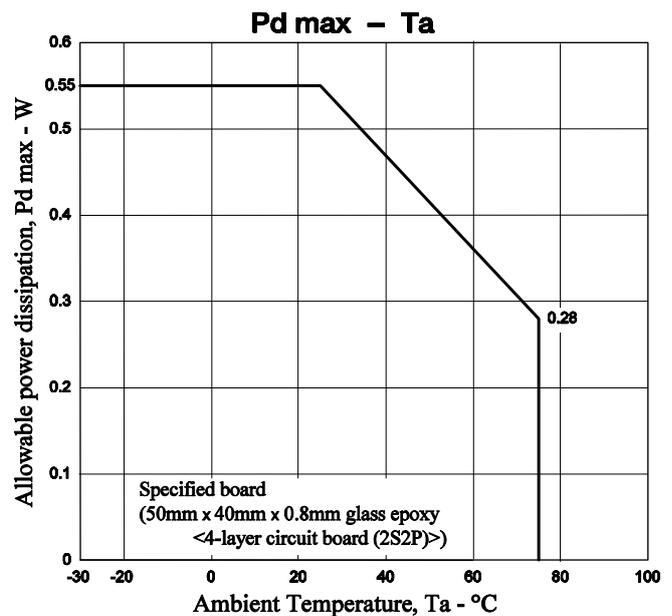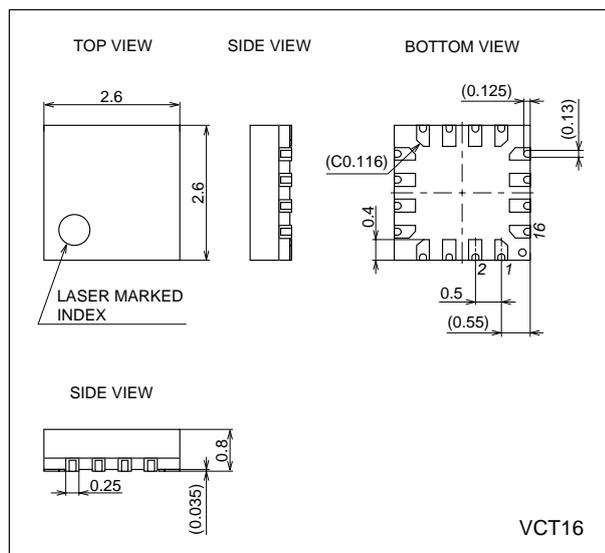
Block Diagram

OMB05075

Note 1: The TEST pin must be tied to ground.

Serial Data Map

Register address								Data							
A7	A6	A5	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0	1	×	×	RSW	R[4:0]				
								0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	×	×	GSW	G[4:0]				
								0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	×	×	BSW	B[4:0]				
								0	0	0	0	0	0	0	0

Upper row: Register name, Lower row: default value

Serial Data Mode Settings

R mode

Register address								Data							
0	0	0	0	0	0	0	1	0	0	D5	D4	D3	D2	D1	D0

RLED output setting

D5	RSW
0	OFF (Default)
1	ON

RLED current setting

D4	D3	D2	D1	D0	Current [mA]
0	0	0	0	0	0.544 (Default)
0	0	0	0	1	0.679
0	0	0	1	0	0.815
0	0	0	1	1	0.950
0	0	1	0	0	1.085
0	0	1	0	1	1.220
0	0	1	1	0	1.356
0	0	1	1	1	1.491
0	1	0	0	0	1.626
0	1	0	0	1	1.761
0	1	0	1	0	1.897
0	1	0	1	1	2.032
0	1	1	0	0	2.167
0	1	1	0	1	2.302
0	1	1	1	0	2.438
0	1	1	1	1	2.573
1	0	0	0	0	2.708
1	0	0	0	1	2.843
1	0	0	1	0	2.979
1	0	0	1	1	3.114
1	0	1	0	0	3.249
1	0	1	0	1	3.384
1	0	1	1	0	3.520
1	0	1	1	1	3.655
1	1	0	0	0	3.790
1	1	0	0	1	3.925
1	1	0	1	0	4.061
1	1	0	1	1	4.196
1	1	1	0	0	4.331
1	1	1	0	1	4.466
1	1	1	1	0	4.602
1	1	1	1	1	4.737

G mode

Register address								Data							
0	0	0	0	0	0	1	0	0	0	D5	D4	D3	D2	D1	D0

GLED output setting

D5	GSW
0	OFF (Default)
1	ON

GLED current setting

D4	D3	D2	D1	D0	Current [mA]
0	0	0	0	0	0.544 (Default)
0	0	0	0	1	0.679
0	0	0	1	0	0.815
0	0	0	1	1	0.950
0	0	1	0	0	1.085
0	0	1	0	1	1.220
0	0	1	1	0	1.356
0	0	1	1	1	1.491
0	1	0	0	0	1.626
0	1	0	0	1	1.761
0	1	0	1	0	1.897
0	1	0	1	1	2.032
0	1	1	0	0	2.167
0	1	1	0	1	2.302
0	1	1	1	0	2.438
0	1	1	1	1	2.573
1	0	0	0	0	2.708
1	0	0	0	1	2.843
1	0	0	1	0	2.979
1	0	0	1	1	3.114
1	0	1	0	0	3.249
1	0	1	0	1	3.384
1	0	1	1	0	3.520
1	0	1	1	1	3.655
1	1	0	0	0	3.790
1	1	0	0	1	3.925
1	1	0	1	0	4.061
1	1	0	1	1	4.196
1	1	1	0	0	4.331
1	1	1	0	1	4.466
1	1	1	1	0	4.602
1	1	1	1	1	4.737

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B mode

Register address								Data							
0	0	0	0	0	0	1	1	0	0	D5	D4	D3	D2	D1	D0

BLED output setting

D5	BSW
0	OFF (Default)
1	ON

BLED current setting

D4	D3	D2	D1	D0	Current [mA]
0	0	0	0	0	0.544 (Default)
0	0	0	0	1	0.679
0	0	0	1	0	0.815
0	0	0	1	1	0.950
0	0	1	0	0	1.085
0	0	1	0	1	1.220
0	0	1	1	0	1.356
0	0	1	1	1	1.491
0	1	0	0	0	1.626
0	1	0	0	1	1.761
0	1	0	1	0	1.897
0	1	0	1	1	2.032
0	1	1	0	0	2.167
0	1	1	0	1	2.302
0	1	1	1	0	2.438
0	1	1	1	1	2.573
1	0	0	0	0	2.708
1	0	0	0	1	2.843
1	0	0	1	0	2.979
1	0	0	1	1	3.114
1	0	1	0	0	3.249
1	0	1	0	1	3.384
1	0	1	1	0	3.520
1	0	1	1	1	3.655
1	1	0	0	0	3.790
1	1	0	0	1	3.925
1	1	0	1	0	4.061
1	1	0	1	1	4.196
1	1	1	0	0	4.331
1	1	1	0	1	4.466
1	1	1	1	0	4.602
1	1	1	1	1	4.737

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Pin Functions

Pin No.	Pin	Function
1	TEST	Test signal input. This pin must be connected to ground.
2	GND	Ground
3	RT	Reference current setting resistor connection
4	BON	External blue LED control input
5	GON	External green LED control input
6	RON	External red LED control input
7	V_{CC}	Circuit system power supply
8	SDATA	Serial data signal input
9	SCLK	Serial clock signal input
10	CS	Chip select
11	STBY2	Standby mode 2 control
12	V_{DD}	Control system (RON, GON, BON, SDATA, SCLK, and CS pins) power supply
13	STBY1	Standby mode 1 control
14	RLED	Red LED driver output
15	GLED	Green LED driver output
16	BLED	Blue LED driver output

Serial Data Transfer Timing Conditions
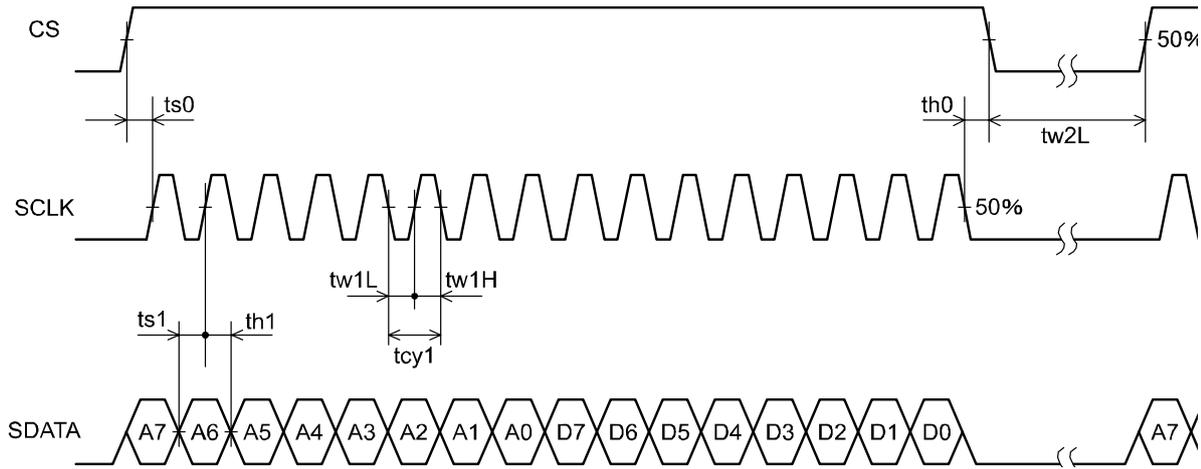
Parameter	Symbol	Conditions	min	typ	max	unit
Cycle time	tcy1	SCLK clock period	330			nS
Data setup time	ts0	The CS setup time from the SLCK rising edge	150			nS
	ts1	The SDATA setup time from the SLCK rising edge	100			nS
Data hold time	th0	The CS hold time from the SLCK falling edge	300			nS
	th1	The SDATA hold time from the SCLK rising edge	100			nS
Pulse width	tw1L	SCLK low period pulse width	150			nS
	tw1H	SCLK high period pulse width	150			nS
	tw2L	CS low period pulse width	1.0			µS

Data length: 16bits
Clock frequency: Up to 2MHz

After 16 clock cycles have been input with CS at the high level, SDATA is acquired on the fall of CS.

Note: SDATA will not be acquired if 15 or fewer clock cycles were input during the CS high-level period. If 17 or more clock cycles are input, the SDATA for the first 16 cycles are acquired and the SDATA following those 16 cycles is ignored.

Power Supply Application

1. Either bring up V_{CC} and V_{DD} at the same time, or bring up V_{CC} first then V_{DD}.
2. Then, set the serial data. (After the serial data has been set, a period of about 2µs is required as the startup time for the IC internal circuits.)
3. Finally, clear the STBY pin states.

Pin Descriptions and Equivalent Circuits

Pin No.	Symbol	Equivalent circuit	Description
4 5 6	BON GON RON	OMP05194	Control inputs for the three external colored LEDs When an RSW, GSW, or BSW bit in the serial data is set to 1, the corresponding LED will be on when the voltage applied to the corresponding pin is high, and off when the voltage applied is low.
8 9 10	SDATA SCLK CS	OMP05195	Serial data system inputs
3	RT	OMP05196	Reference current setting resistor connection A reference current is created by connecting an external resistor between this pin and ground. The pin voltage is roughly 1.2V. The LED driver current can be changed by changing this current value.
14 15 16	RLED GLED BLED	OMP05197	Driver outputs for the three color LEDs Feedback is applied to control the current flowing in the output transistors to be the set value. Each of the driver output current levels can be set independently with the serial data.

Continued on next page.

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Pin No.	Symbol	Equivalent circuit	Description
1	TEST	OMP05198	Test signal input This pin must be tied to ground.
11 13	STBY2 STBY1	OMP05199	Standby mode pins The LV5213LP goes to standby mode when both the STBY1 and STBY2 pins are at the low level.
7	V_{CC}		Circuit system power supply
12	V_{DD}		Control system (serial data inputs and "ON" inputs) power supply
3	GND		Ground