Ordering number : ENA0833A

# LV5217GP

**Bi-CMOS IC**

# 3ch LED Driver

ON Semiconductor®

http://onsemi.com

## Overview

This LV5217GP is 3-channel LED driver for cell phones. Each LED driver current can be adjusted by I2C bus. LV5217GP can perform various illumination effects with a full-color LED display.

## Features

- Three color LED driver circuits.
- The LED current can be switched independently in 7-bit units (0.31 to 25.48mA).
- 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 I²C 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 |
| Maximum input current | $V_{IN}B$ | | 6.0 | V |
| Maximum output current | $I_O$ max | | 30.0 | mA |
| STBY pin voltage | $V_{STBY}$ | | 6.0 | V |
| Allowable power dissipation | Pd max | Mounted on the specified board * | 0.55 | W |
| 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.

**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** Ta = 25°C, $V_{CC}$ = 3.7V, $V_{DD}$ = 1.8V, RT = 56kΩ, Unless otherwise specified.

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| **Overall Characteristics** | | | | | | |
| Current drain 1 | $I_{CC}1$ | STBY = L *1 | | | 5 | μA |
| Current drain 2 | $I_{CC}2$ | STBY = H, LED ON= L *1<br>With the default serial data settings | | 0.7 | 2 | mA |
| High-level input voltage 1 | $V_{IN}H1$ | Serial data signals, LEDON pin | $V_{DD}$×0.8 | | | V |
| Low-level input voltage 1 | $V_{IN}L1$ | Serial data signals, LEDON pin | 0 | | $V_{DD}$×0.2 | V |
| High-level input voltage 2 | $V_{IN}H2$ | STBY pin | 1.4 | | | V |
| Low-level input voltage 2 | $V_{IN}L2$ | STBY pin | 0 | | 0.2 | V |
| **LED Driver Block** | | | | | | |
| Minimum output current | $I_{MIN}$ | When the serial data is 0000001, $V_O$ = 0.5V | 0.0 | 0.2 | 1.0 | mA |
| Maximum output current | $I_{MAX}$ | When the serial data is 1111111, $V_O$ = 0.5V | 23.0 | 25.4 | 28.0 | mA |
| LED current value accuracy | IDIF | When current value is set to 4mA (0010011) | -8 | | 8 | % |
| Differential linearity error | DLE | *2 | -2 | | 2 | LSB |
| LED pin saturation voltage | VLED | At the maximum current setting | | | 0.3 | V |
| Leakage current | ILEAK | Drivers : off, $V_O$ = 5V | | | 1 | μA |

$V_O$ : LED pin voltage.

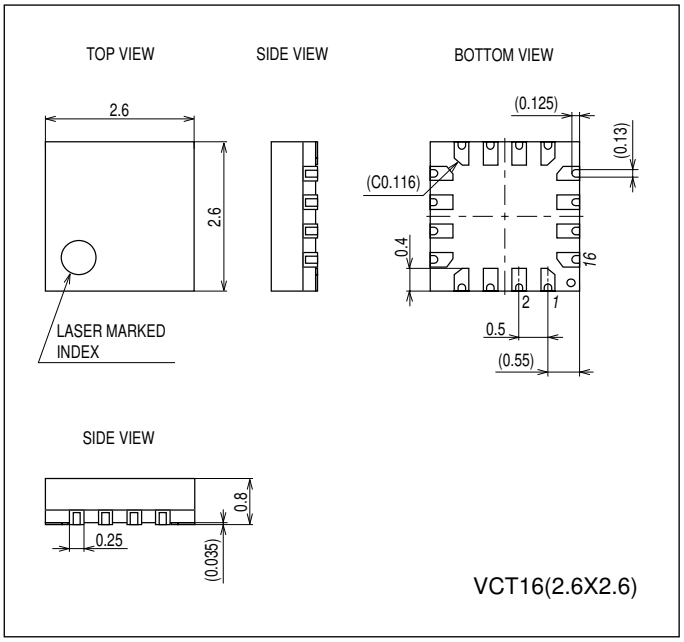
*1. The sum of the $V_{CC}$ and $V_{DD}$ current drain values.

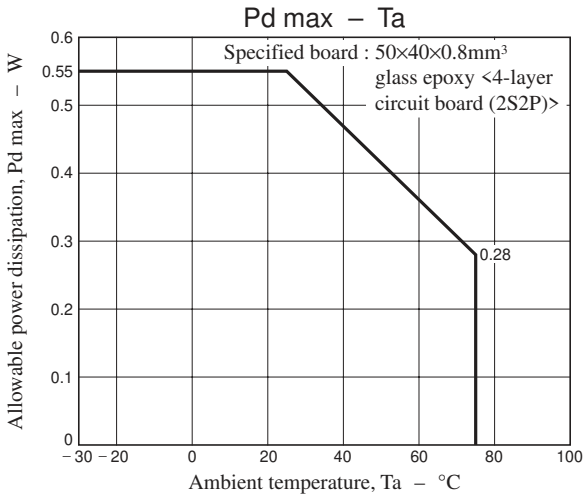
*2. Differential linearity error : The difference between the actual and ideal amounts when one low-order bit value is added.

## Package Dimensions

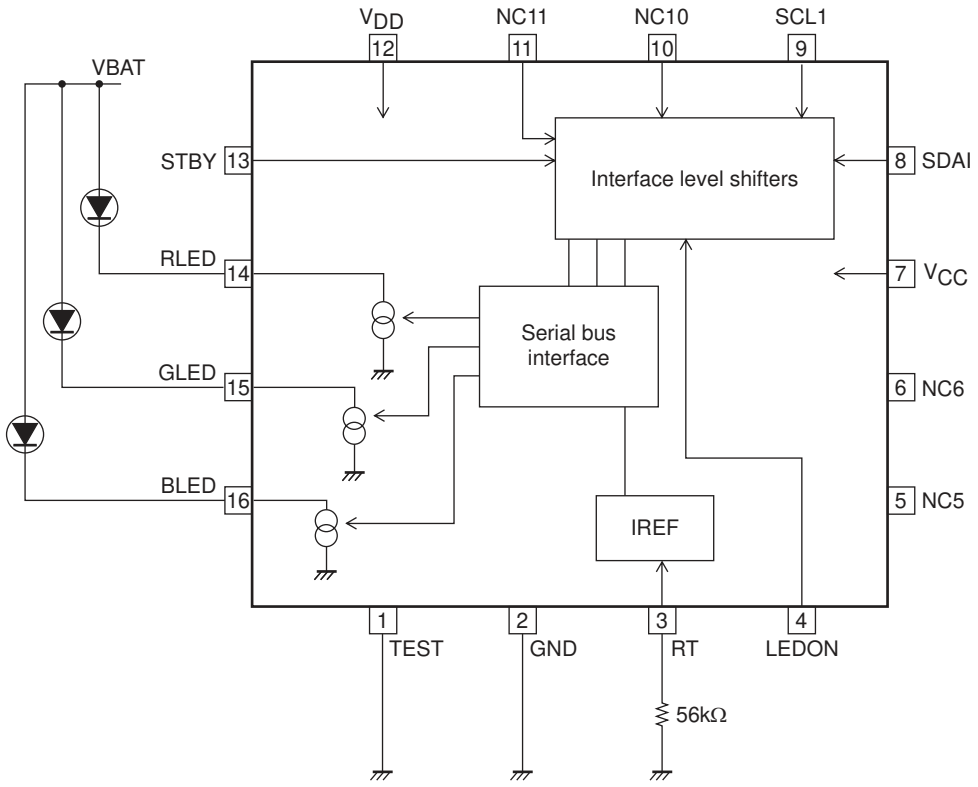
unit : mm (typ)

3318



## Block Diagram

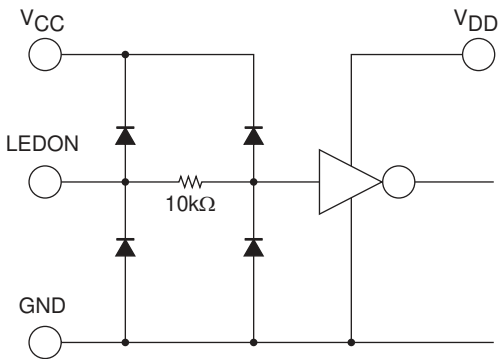
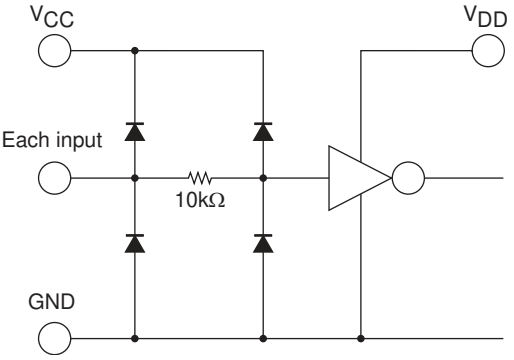
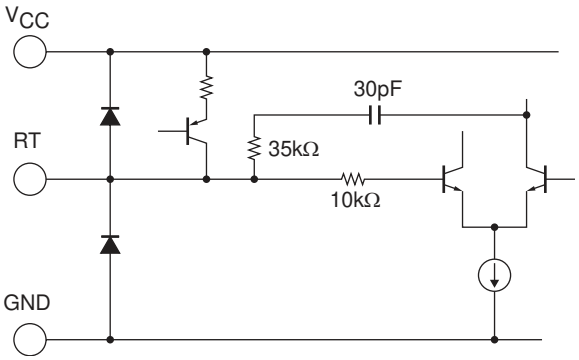
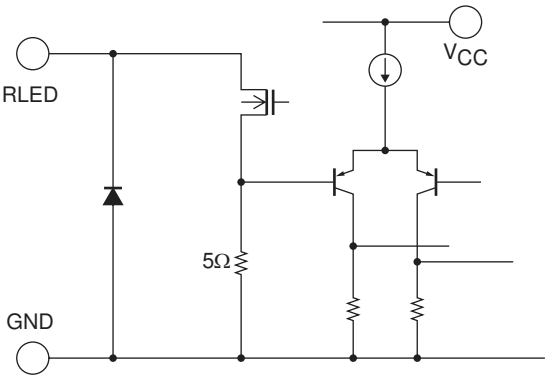



Note 1 : The TEST pin must be tied to ground.

### Pin Functions

| Pin No. | Pin name | Function |
|---|---|---|
| 1 | TEST | Test signal input: This pin must be connected to ground. |
| 2 | GND | Ground |
| 3 | RT | Reference current setting resistor connection |
| 4 | LEDON | External LED control pin |
| 5 | NC5 | No connection |
| 6 | NC6 | No connection |
| 7 | $V_{CC}$ | Circuit system power supply |
| 8 | SDAI | Serial data signal input |
| 9 | SCLI | Serial clock signal input |
| 10 | NC10 | No connection |
| 11 | NC11 | No connection |
| 12 | $V_{DD}$ | Power supply for logic system |
| 13 | STBY | Standby mode control |
| 14 | RLED | Red LED driver output |
| 15 | GLED | Green LED driver output |
| 16 | BLED | Blue LED driver output |

## Pin Functions

| Pin No. | Symbol | Description | Equivalent circuit |
|---|---|---|---|
| 4 | LEDON | 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<br>9 | SDAI<br>SCLI | $I^2C$ signal inputs |  |
| 3 | RT | Reference current setting resistor connection.<br>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<br>15<br>16 | RLED<br>GLED<br>BLED | Driver outputs for the three color LEDs.<br>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. |  |

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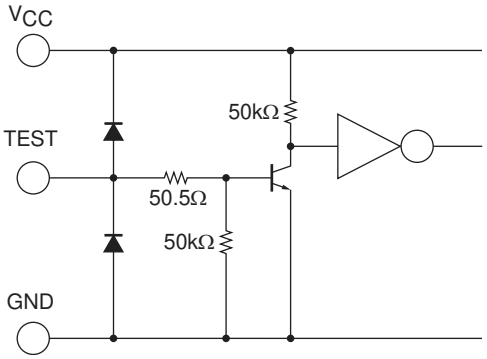
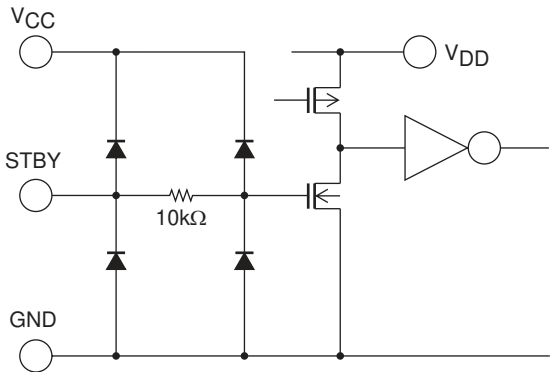
| Pin No. | Symbol | Description | Equivalent circuit |
|---|---|---|---|
| 1 | TEST | Test signal input.<br>This pin must be connected to ground. |  |
| 13 | STBY | Standby mode pin.<br>The LV5217GP goes to standby mode when the STBY pin is at the low level. |  |
| 7 | $V_{CC}$ | Circuit system power supply | |
| 12 | VDD | Power supply for Logic | |
| 3 | GND | Ground | |

### 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.

### 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 | 0 | RSW | R[6:0] | | | | | | |
| | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | GSW | G[6:0] | | | | | | |
| | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | BSW | B[6:0] | | | | | | |
| | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Upper row : Register name, Lower row : default value

### Serial Data Mode Settings

#### R mode

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

LEDR output setting

| D7 | RSW |
|---|---|
| 0 | OFF (default) |
| 1 | ON |

#### G mode

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

LEDR output setting

| D7 | GSW |
|---|---|
| 0 | OFF (default) |
| 1 | ON |

#### B mode

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

LEDR output setting

| D7 | BSW |
|---|---|
| 0 | OFF (default) |
| 1 | ON |

D6-D0 current setting (Common to R, G and B)

| D6 | D5 | D4 | D3 | D2 | D1 | D0 | Current [mA] |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 (Default) *1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.31 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.52 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.72 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0.93 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1.13 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1.34 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1.54 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1.74 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1.94 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2.14 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 2.34 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2.54 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 2.74 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 2.95 |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 3.15 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3.35 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 3.46 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 3.76 |
| 0 | 0 | 1 | 0 | 0 | 1 | 1 | 3.97 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 4.17 |
| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 4.37 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 4.57 |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 | 4.76 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 4.97 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 5.17 |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 5.37 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 5.57 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 5.78 |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 5.98 |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 6.18 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 6.39 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 6.60 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 6.80 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 6.99 |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 | 7.19 |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 7.39 |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 7.60 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 7.80 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 7.99 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 8.19 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 8.40 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 8.60 |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 8.80 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 | 9.00 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 9.20 |
| 0 | 1 | 0 | 1 | 1 | 1 | 0 | 9.40 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 | 9.60 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 9.80 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 10.00 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 10.20 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 | 10.40 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 10.60 |
| 0 | 1 | 1 | 0 | 1 | 0 | 1 | 10.80 |

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| D6 | D5 | D4 | D3 | D2 | D1 | D0 | Current [mA] |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 11.00 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 11.20 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 11.40 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 11.60 |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 11.80 |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 12.00 |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 12.20 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 12.40 |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | 12.60 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 12.80 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12.99 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 13.19 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 13.39 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 13.59 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 13.79 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 13.98 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 14.18 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 14.38 |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 14.58 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 14.78 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 14.97 |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 15.17 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 15.37 |
| 1 | 0 | 0 | 1 | 1 | 0 | 1 | 15.57 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 15.77 |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 15.96 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 16.16 |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 | 16.36 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 16.56 |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 16.76 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 16.96 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 17.15 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 17.35 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 17.55 |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 17.75 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 17.95 |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 18.15 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 18.34 |
| 1 | 0 | 1 | 1 | 1 | 0 | 0 | 18.54 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 18.74 |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 18.94 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 19.14 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 19.33 |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 19.53 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 19.73 |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | 19.93 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 20.13 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 | 20.32 |
| 1 | 1 | 0 | 0 | 1 | 1 | 0 | 20.52 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 20.72 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 20.92 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 21.12 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 21.31 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 21.51 |
| 1 | 1 | 0 | 1 | 1 | 0 | 0 | 21.71 |

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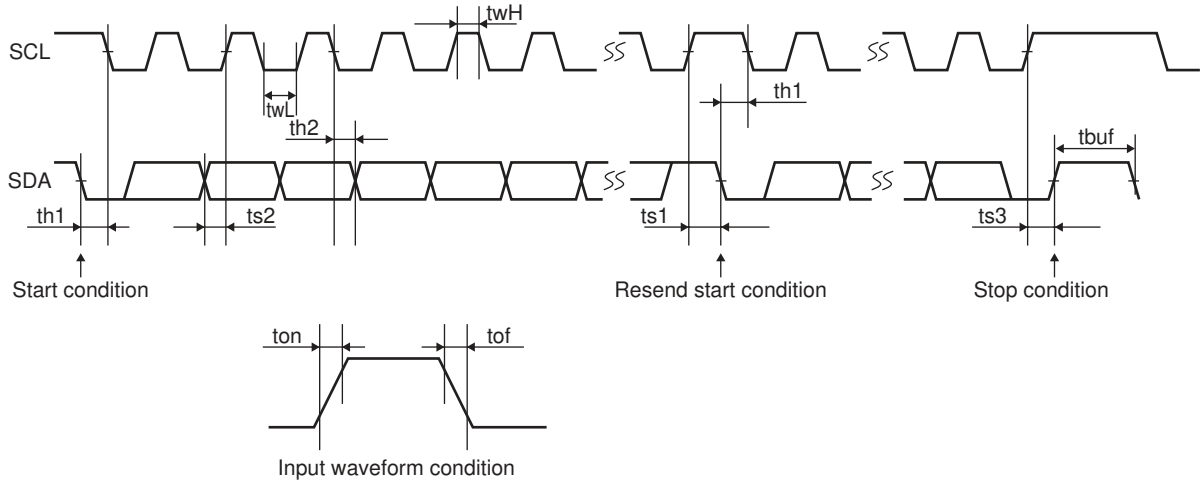
| D6 | D5 | D4 | D3 | D2 | D1 | D0 | Current [mA] |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 1 | 0 | 1 | 21.91 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 22.11 |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 22.30 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 22.50 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 22.70 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 22.90 |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | 23.10 |
| 1 | 1 | 1 | 0 | 1 | 0 | 0 | 23.29 |
| 1 | 1 | 1 | 0 | 1 | 0 | 1 | 23.49 |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 | 23.69 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 23.89 |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 24.09 |
| 1 | 1 | 1 | 1 | 0 | 0 | 1 | 24.29 |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | 24.48 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 24.68 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 24.88 |
| 1 | 1 | 1 | 1 | 1 | 0 | 1 | 25.08 |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 25.28 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 25.48 |

* Note 1 : There is significant current variance, so care should be taken for use. The current value can be set when D7 is “0.”

## Serial Bus Communication Specifications

I²C serial transfer timing conditions




### Standard mode

| Parameter | symbol | Conditions | min | typ | max | unit |
|---|---|---|---|---|---|---|
| SCL clock frequency | fscl | SCL clock frequency | 0 | | 100 | kHz |
| Data setup time | ts1 | The SCL setup time from the SDA rising edge | 4.7 | | | µs |
| | ts2 | The SDA setup time from the SCL rising edge | 250 | | | ns |
| | ts3 | The SCL setup time from the SDA rising edge | 4.0 | | | µs |
| Data hold time | th1 | The SCL hold time from the SDA falling edge | 4.0 | | | µs |
| | th2 | The SDA hold time from the SCL falling edge | 0 | | | µs |
| Pulse width | twL | SCL low period pulse width | 4.7 | | | µs |
| | twH | SCL high period pulse width | 4.0 | | | µs |
| Input waveform conditions | ton | SCL, SDA (input) rising time | | | 1000 | ns |
| | tof | SCL, SDA (input) falling time | | | 300 | ns |
| Bus free time | tbuf | Time between STOP and TART conditions | 4.7 | | | µs |

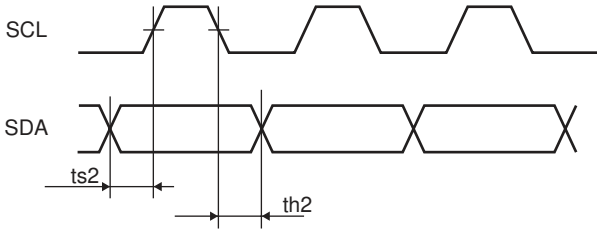
### High-speed mode

| Parameter | Symbol | Conditions | min | typ | max | unit |
|---|---|---|---|---|---|---|
| SCL clock frequency | fscl | SCL clock frequency | 0 | | 400 | kHz |
| Data setup time | ts1 | The SCL setup time from the SDA rising edge | 0.6 | | | µs |
| | ts2 | The SDA setup time from the SCL rising edge | 100 | | | ns |
| | ts3 | The SCL setup time from the SDA rising edge | 0.6 | | | µs |
| Data hold time | th1 | The SCL hold time from the SDA falling edge | 0.6 | | | µs |
| | th2 | The SDA hold time from the SCL falling edge | 0 | | | µs |
| Pulse width | twL | SCL low period pulse width | 1.3 | | | µs |
| | twH | SCL high period pulse width | 0.6 | | | µs |
| Input waveform conditions | ton | SCL, SDA (input) rising time | | | 300 | ns |
| | tof | SCL, SDA (input) falling time | | | 300 | ns |
| Bus free time | tbuf | Time between STOP condition and TART condition | 1.3 | | | µs |

I²C bus transmission method

START condition and STOP condition

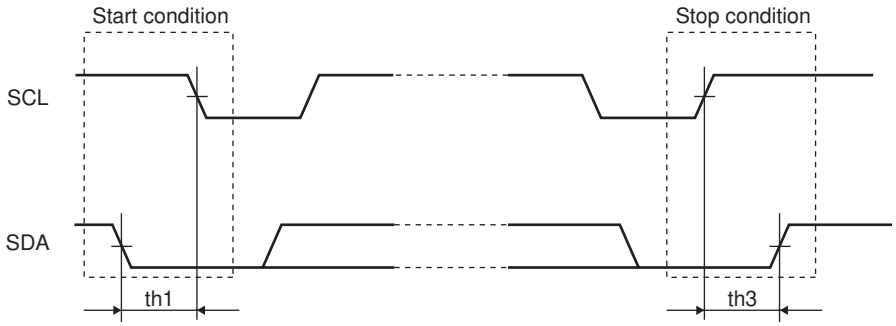
When transferring data over an I²C bus, SDA must basically be held in certain states while SCL is High, as shown in the figure below.




Both SCL and SDA are high when not performing data transfer.

When both SCL and SDA are high, changing SDA from high to low generates the START condition and starts access.

Changing SDA from low to high while SCL is high generates the STOP condition and ends access.




Data transfer and confirmation response

After the START condition is generated, data is transferred one byte (8 bits) at a time. Data can be transferred continuously for any number of bytes. The ACK signal is sent from the receiving to the transmitting side each time 8 bits of data are transferred.

The transmitting side releases the SDA line immediately after the SCL clock pulse corresponding to the 8th data transfer bit as it falls to Low, and the receiving side then sends the ACK signal by setting SDA Low.

After the receiving side sends the ACK signal, if the next byte transfer is still in receive mode, the receiving side releases the SDA line at the falling edge of the 9th SCL clock.

The I²C bus does not have a CE signal, so instead a 7-bit slave address is assigned to each device. The first byte of each transfer is assigned to this 7-bit slave address and a command (R/W) indicating the transfer direction of the following data. Note that only Write mode is valid for this IC.

The 7-bit address is transferred in order from the MSB, and the 8th bit is Low to indicate Write mode.

The LV5217GP slave address is prescribed as “1110101.”