NIPPON PRECISION CIRCUITS INC.

# SM8610CV

## Laser Switching Driver IC

## OVERVIEW

The SM8610CV is a portable CD player laser driver IC. It uses a laser switching drive that reduces the laser power dissipation, thereby reducing data read current consumption and extending battery life significantly, when compared with existing devices which use a constant-current laser control method with corresponding high dissipation which places limits on battery life.

## FEATURES

- 2.4V supply voltage
- Laser switching driver built-in
- Laser switching frequency range: 8.6 to 26MHz
- Switching pulsewidth duty adjustable
- Laser drive maximum current adjustable
- Laser control loop gain adjustable
- Power-save mode (Laser driver current stop function)
- Package: 16-pin VSOP

## APPLICATIONS

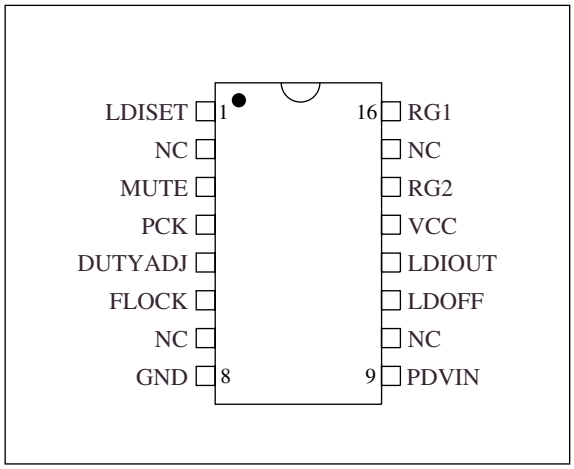
- Portable CD player

## ORDERING INFORMATION

| Device | Package |
|---|---|
| SM8610CV | 16-pin VSOP |

## PINOUT

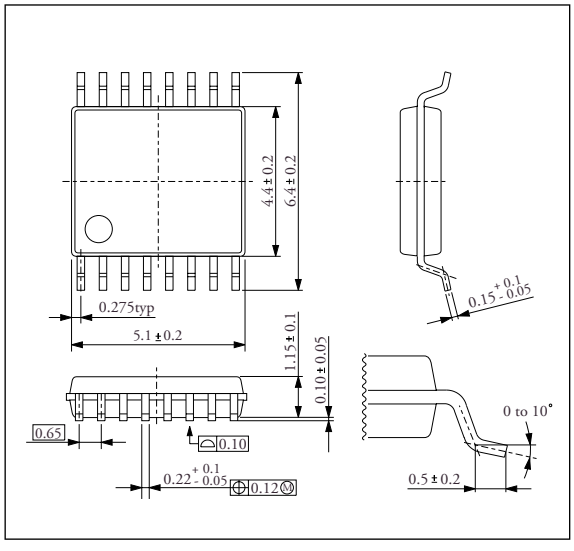
(Top view)



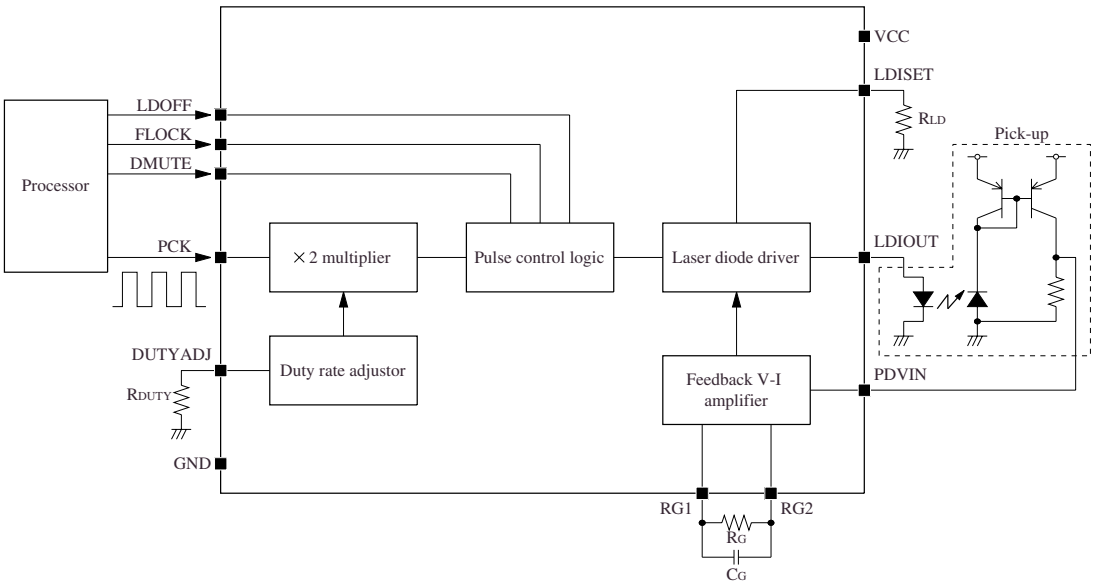

## PACKAGE DIMENSIONS

(Unit: mm)

Weight: 0.07g



## BLOCK DIAGRAM



## PIN DESCRIPTION

<table>
<tr><th>Number</th><th>Name</th><th>i/o</th><th>Description</th></tr>
<tr><td>1</td><td>LDISET</td><td>o</td><td>Laser drive maximum current setting resistor connection</td></tr>
<tr><td>2</td><td>NC</td><td>–</td><td>No connection (must be open)</td></tr>
<tr><td>3</td><td>MUTE</td><td>ip</td><td>Muting signal
<table>
<tr><th>DMUTE</th><th>Laser drive state</th></tr>
<tr><td>L</td><td>Laser switching drive</td></tr>
<tr><td>H</td><td>Laser constant-current drive</td></tr>
</table></td></tr>
<tr><td>4</td><td>PCK</td><td>i</td><td>Data extract clock input</td></tr>
<tr><td>5</td><td>DUTYADJ</td><td>o</td><td>Laser switching pulse duty adjust</td></tr>
<tr><td>6</td><td>FLOCK</td><td>ip</td><td>Focus servo lead-in signal
<table>
<tr><th>FLOCK</th><th>Laser drive state</th></tr>
<tr><td>L</td><td>Laser constant-current drive</td></tr>
<tr><td>H</td><td>Laser switching drive</td></tr>
</table></td></tr>
<tr><td>7</td><td>NC</td><td>–</td><td>No connection (must be open)</td></tr>
<tr><td>8</td><td>GND</td><td>–</td><td>Ground connection</td></tr>
<tr><td>9</td><td>PDVIN</td><td>i</td><td>Laser current monitor voltage input</td></tr>
<tr><td>10</td><td>NC</td><td>–</td><td>No connection (must be open)</td></tr>
<tr><td>11</td><td>LDOFF</td><td>ip</td><td>Laser drive current stop signal input
<table>
<tr><th>LDOFF</th><th>Laser drive state</th></tr>
<tr><td>L</td><td>Laser drive OFF<br>In this state, the SM8610CV is in power-save mode.</td></tr>
<tr><td>H</td><td>Laser drive ON</td></tr>
</table></td></tr>
<tr><td>12</td><td>LDIOUT</td><td>o</td><td>Laser drive current output</td></tr>
<tr><td>13</td><td>VCC</td><td>–</td><td>2.4V supply voltage</td></tr>
<tr><td>14</td><td>RG2</td><td>o</td><td>Laser control loop gain setting resistor connection</td></tr>
<tr><td>15</td><td>NC</td><td>–</td><td>No connection (must be open)</td></tr>
<tr><td>16</td><td>RG1</td><td>o</td><td>Laser control loop gain setting resistor connection</td></tr>
</table>

ip: Built-in pull-down resistor

# SPECIFICATIONS

## Absolute Maximum Ratings

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | – 0.5 to 7.0 | V |
| Input voltage | $V_{IN}$ | – 0.5 to $V_{CC}$ + 0.5 | V |
| Input current | $I_{IN}$ | – 3.0 to + 3.0 | mA |
| Operating temperature | $T_{OPR}$ | – 20 to 70 | °C |
| Storage temperature | $T_{STG}$ | – 40 to 125 | °C |
| Power dissipation | $P_W$ | 96 | mW |

## DC Electrical Characteristics

$V_{CC}$ = 2.3V, Ta = + 25 °C unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit | Test level |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| Guaranteed operating supply voltage | $V_{CC}$ | | 2.3 | 2.5 | – | V | I |
| Current consumption | $I_{CC1}$ | $V_{CC}$ = 2.5V, PDVIN = 0V, $R_{LDISET}$ = 47kΩ, $R_G$ = 33kΩ, LDOFF = HIGH, Excluding LDIOUT current | – | 4.9 | 6.2 | mA | I |
| | $I_{CC2}$ | LDOFF = LOW | – | – | 30 | µA | I |

## Input Specifications

$V_{CC}$ = 2.3V, Ta = + 25 °C unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| PCK HIGH-level voltage | $V_{IHPCK}$ | | $V_{CC} \times 0.7$ | – | – | V |
| PCK LOW-level voltage | $V_{ILPCK}$ | | – | – | $V_{CC} \times 0.3$ | V |
| PCK HIGH-level sink current | $I_{HPCK}$ | | – | – | 20 | µA |
| LDOFF HIGH-level voltage | $V_{IHLDOFF}$ | | $V_{CC} \times 0.7$ | – | – | V |
| LDOFF LOW-level voltage | $V_{ILLDOFF}$ | | – | – | $V_{CC} \times 0.3$ | V |
| LDOFF HIGH-level sink current | $I_{HLDOFF}$ | | – | – | 20 | µA |
| FLOCK HIGH-level voltage | $V_{IHFLOCK}$ | | $V_{CC} \times 0.7$ | – | – | V |
| FLOCK LOW-level voltage | $V_{ILFLOCK}$ | | – | – | $V_{CC} \times 0.3$ | V |
| FLOCK HIGH-level sink current | $I_{HFLOCK}$ | | – | – | 20 | µA |
| MUTE HIGH-level voltage | $V_{IHDMUTE}$ | | $V_{CC} \times 0.7$ | – | – | V |
| MUTE LOW-level voltage | $V_{ILDMUTE}$ | | – | – | $V_{CC} \times 0.3$ | V |
| MUTE HIGH-level sink current | $I_{HDMUTE}$ | | – | – | 20 | µA |

## Electrical Characteristics

$V_{CC}$ = 2.3V, Ta = + 25 °C unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit | Test level |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| PCK minimum input frequency | $f_{PCKMIN}$ | | – | – | 4.3 | MHz | I |
| PCK maximum input frequency | $f_{PCKMAX}$ | | 13 | – | – | MHz | I |
| Laser switching frequency range | $f_{LD}$ | | 8.6 | – | 26 | MHz | I |
| LDOFF response time 1 | $t_{LDOFF1}$ | LDOFF HIGH → LOW | – | 12 | 15 | µs | III |
| LDOFF response time 2 | $t_{LDOFF2}$ | LDOFF LOW → HIGH | – | – | 15 | µs | III |
| FLOCK response time 1 | $t_{FLOCK1}$ | FLOCK HIGH → LOW<br>DMUTE = LOW | – | – | 15 | ns | III |
| FLOCK response time 2 | $t_{FLOCK2}$ | FLOCK LOW → HIGH<br>DMUTE = LOW | – | – | 15 | ns | III |
| DMUTE response time 1 | $t_{DMUTE1}$ | DMUTE HIGH → LOW<br>FLOCK = HIGH | – | – | 15 | ns | III |
| DMUTE response time 2 | $t_{DMUTE2}$ | DMUTE LOW → HIGH<br>FLOCK = HIGH | – | – | 15 | ns | III |
| LDIOUT maximum output current | $I_{LDMAX}$ | $R_{LD}$ = 27kΩ, $R_G$ = 33kΩ,<br>V(PDVIN) = DC, 0V fixed | 40 | – | – | mA | I |
| LDIOUT rise time | $t_{rLDIOUT}$ | | – | – | 15 | ns | III |
| LDIOUT fall time | $t_{fLDIOUT}$ | | – | – | 15 | ns | III |
| LDISET voltage | $V_{LDISET}$ | | – | 1/3$V_{CC}$ | | V | I |
| PDVIN convergence voltage | $V_{PDVIN}$ | $R_G$ = 33kΩ, $V_{CC}$ = 2.5V | 150 | – | 180 | mV | I |
| PDVIN input impedance | $Z_{PDVIN}$ | | 1 | – | – | MΩ | I |
| APC loop cutoff frequency | $f_{APC}$ | $R_G$ = 3kΩ, $C_G$ = 1000pF | – | 53 | – | kHz | I |
| Minimum duty ratio | Dutymin | PCK = 13MHz, $R_{DUTY}$ = 15kΩ | – | 26 | – | % | I |
| Maximum duty ratio | Dutymax | PCK = 4.3MHz, $R_{DUTY}$ = 3kΩ | – | 69 | – | % | III |
| Minimum LD pulsewidth | $T_{LDON}$ | | – | 15 | – | ns | III |

Note 1) LDOFF has internal pull-down resistor.
Note 2) FLOCK has internal pull-down resistor.
Note 3) DMUTE has internal pull-down resistor.
Note 4) LDISET is in high-impedance state when LDOFF is HIGH.
Note 5) DUTYADJ is in high-impedance state when LDOFF is HIGH.

## Test level description

| | |
|---|---|
| **Test level I** | 100% of devices tested at 25°C |
| **Test level II** | Samples tested only |
| **Test level III** | Specifications guaranteed according to design and evaluation tests. |
| **Test level IV** | Parameter typical values only guaranteed. |

# FUNCTIONAL DESCRIPTION

## LD Driver Control

The laser diode is controlled by 3 logic-level input signals: LDOFF, FLOCK, and MUTE. When LDOFF is HIGH, the laser diode driver is ON, and the mode is controlled by FLCOK and MUTE. When LDOFF is LOW, the laser diode drive is OFF and the IC is in power-save mode (LDIOUT output current = 0mA).

The LD has a chopper drive input when FLOCK is HIGH and MUTE is LOW.

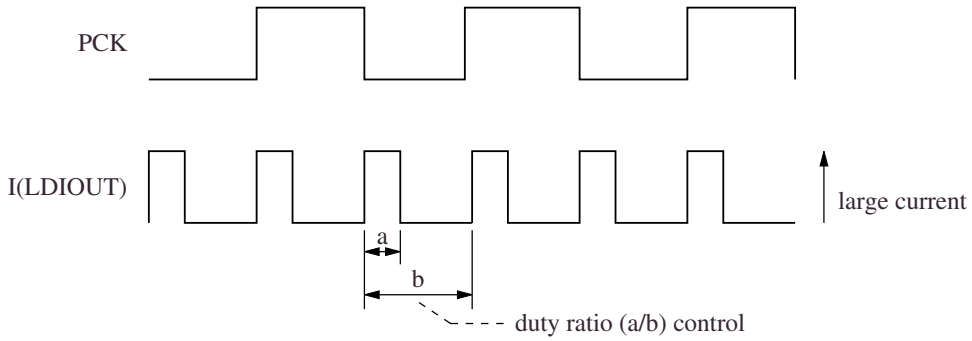
Table 1. Laser diode control signals

| LDOFF | FLOCK | MUTE | Laser drive state |
|---|---|---|---|
| H | L | L | LDIOUT constant-current output |
| H | L | H | LDIOUT constant-current output |
| H | H | L | LDIOUT chopper current output |
| H | H | H | LDIOUT constant-current output |
| L | × | × | LDIOUT = 0mA (power-save mode) |

Note) × : Don't care.

## Pulsewidth Adjust and Frequency Multiplication Function

The SM8610CV internal waveform processor multiplies the PCK input signal frequency by 2, and the pulse-width of this signal can be adjusted to control the duty ratio.




The output pulse current (LD chopper signal) on LDIOUT is automatically adjusted to maintain roughly constant duty ratio, even for changes in frequency. The LD chopper signal duty ratio can be adjusted by changing the resistance $R_{DUTY}$ connected between the DUTYADJ and GND pins, as given by the following equation.

$$dutyratio = \left(1 - \frac{\frac{3}{2}V(DUTYADJ)}{\frac{1}{2}VCC(\approx Vth)}\right) \times 100 = \frac{22[\mathrm{k\Omega}] - 2 \times R_{DUTY}}{R_{DUTY} + 22[\mathrm{k\Omega}]} \times 100\ [\%]$$

$$V(DUTYADJ) = \frac{R_{DUTY}}{R_{DUTY} + 22[\mathrm{k\Omega}]} \times VCC\ [\mathrm{V}]$$

$R_{DUTY}$ : DUTYADJ connected resistance [kΩ]

## Laser Diode Drive Current Mid-value Set Function

The laser diode drive current mid-value can be adjusted by changing the resistance $R_{LD}$ connected between the LDISET and GND pins. The laser diode drive current mid-value base value $I_{LDSET}$, given by the following equation, is set to the LDIOUT output current when the PDVIN voltage is in balance state (147 to 193mV). Note that the actual LDIOUT current may change due to feedback gain, and laser diode/photo diode variations.

$$I_{LDSET} = I_{LDSET} \times 1000 = \frac{800[\mathrm{V}]}{R_{LD}} \ [\mathrm{A}]$$

$R_{LD}$ : LDISET connected resistance [Ω]

## APC Loop Gain Setting

The APC (Auto Power Control) loop gain can be adjusted by changing the external gain set resistance ($R_G$) connected between the RG1 and RG2 pins. The PDVIN voltage-to-laser drive current open-loop gain is given approximately by the following equation.

$$Gm_{PDVIN} = 9.1 \times 10^{-5} R_G \ [\mathrm{S}]$$

ΔLDIOUT current /ΔPDVIN voltage ratio [S]
$R_G$ : Resistance connected between RG1 and RG2 [Ω]

## APC Loop Cutoff Frequency Setting

The APC loop cutoff frequency fc is determined by the external resistance $R_G$ and the capacitance $C_G$, connected between RG1 and RG2.

$$f_{C1} = \frac{1}{2\pi R_G C_G} \ [\mathrm{Hz}]$$

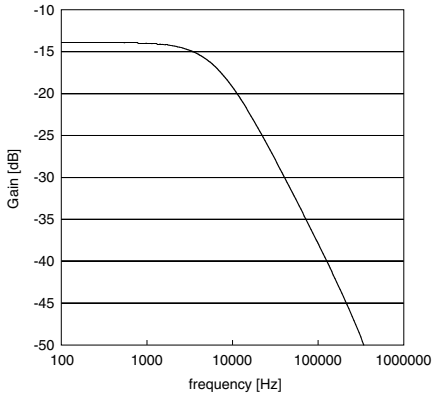
If $C_G$ is connected between RG2 and VCC, the cutoff frequency is given as follows.

$$f_{C2} = \frac{1}{2\sqrt{2}\pi R_G C_G} \ [\mathrm{Hz}]$$

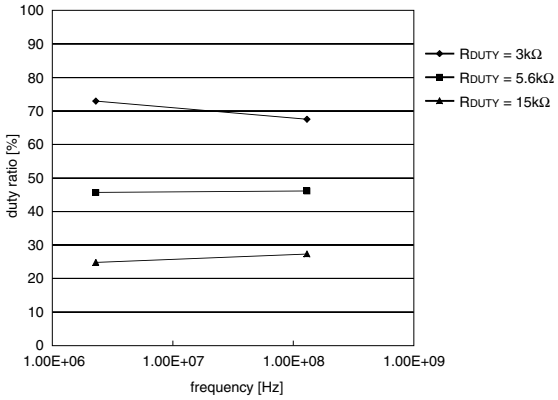
## TYPICAL PERFORMANCE CHARACTERISTICS

Conditions: $V_{CC}$ = 2.4V, $R_{LD}$ = 12kΩ, $R_{DUTY}$ = 2.5kΩ, $R_G$ = 2.5kΩ

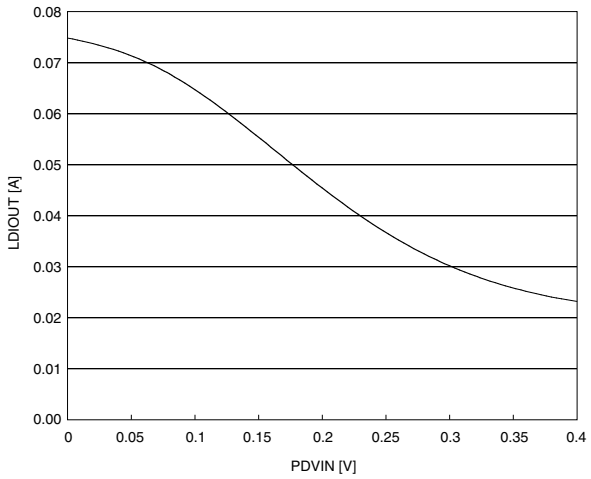
### APC loop cut-off frequency ($C_G$ = 0.01μF)

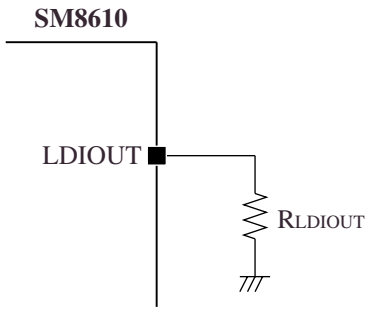



### Output duty ratio




### Open loop gain and LDIOUT maximum output current ($R_{LDIOUT}$ = 20Ω)



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