



# LV0223CV

## Monolithic Linear IC Front Monitor OE-IC for Optical Pickups

ON Semiconductor®

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### Overview

The LV0223CV is a front monitor optoelectronic IC for optical pickups that has a built-in photo diode compatible with three waveforms. LV0223CV is small size and type CSP packages.

### Functions

- PIN photodiode compatible with three wavelengths incorporated.
- Gain adjustment (-6dB to +6dB in 256 steps) through serial communication.
- Amplifier to amplify differential output.

### Specifications

#### Maximum Ratings at Ta = 25°C

| Parameter                   | Symbol           | Conditions                                                                                                         | Ratings     | Unit |
|-----------------------------|------------------|--------------------------------------------------------------------------------------------------------------------|-------------|------|
| Maximum supply voltage      | V <sub>CC</sub>  |                                                                                                                    | 6           | V    |
| Allowable power dissipation | P <sub>d</sub>   | Glass epoxy both-side substrate 55mm × 45mm × 1.6mm<br>Copper foil area (head: about 90% Tail: about 90%), Ta=75°C | 143         | mW   |
| Operating temperature       | T <sub>opr</sub> |                                                                                                                    | -20 to +75  | °C   |
| Storage temperature         | T <sub>stg</sub> |                                                                                                                    | -40 to +100 | °C   |

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 |
|--------------------------|-----------------|------------|---------|-----|-----|------|
|                          |                 |            | min     | typ | max |      |
| Operating supply voltage | V <sub>CC</sub> |            | 4.5     | 5   | 5.5 | V    |
| Output load capacitance  | C <sub>O</sub>  |            | 12      | 20  | 33  | pF   |
| Output load resistance   | Z <sub>O</sub>  |            | 3       |     |     | kΩ   |

# LV0223CV

## Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{CC} = 5\text{V}$ , $RL = 6\text{k}\Omega$ , $CL = 20\text{pF}$

| Parameter                                                                     | Symbol           | Conditions                                                                                                                                  | Ratings |       |      | Unit                         |
|-------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------|-------|------|------------------------------|
|                                                                               |                  |                                                                                                                                             | min     | typ   | max  |                              |
| Current dissipation                                                           | $I_{CC}$         |                                                                                                                                             | 13.3    | 17    | 22.1 | mA                           |
| Sleep current                                                                 | $I_{S\text{lp}}$ |                                                                                                                                             |         |       | 0.6  | mA                           |
| Output voltage when shielded                                                  | $V_C$            | At shielding                                                                                                                                | 1.85    | 2.0   | 2.15 | V                            |
| Output offset voltage                                                         | $V_{ofs}$        | At shielding, voltage between VOP-VON                                                                                                       | -30     | 0     | 30   | mV                           |
| Temperature dependence of offset voltage *1                                   | $V_{ofs}$        | $T_a = -10$ to $+75^\circ\text{C}$                                                                                                          | -60     | 0     | 60   | $\mu\text{V}/^\circ\text{C}$ |
| Optical output voltage *1                                                     | VLC              | Low Gain, $\lambda = 780\text{nm}$ , $G = 0\text{dB}$                                                                                       | 0.21    | 0.262 | 0.31 | $\text{mV}/\mu\text{W}$      |
| Voltage between VOP-VON                                                       | VLD              | Low Gain, $\lambda = 650\text{nm}$ , $G = 0\text{dB}$                                                                                       | 0.22    | 0.275 | 0.33 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VLB              | Low Gain, $\lambda = 405\text{nm}$ , $G = 0\text{dB}$                                                                                       | 0.14    | 0.172 | 0.21 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VM1C             | Middle1 Gain, $\lambda = 780\text{nm}$ , $G = 0\text{dB}$                                                                                   | 0.66    | 0.83  | 0.99 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VM1D             | Middle1 Gain, $\lambda = 650\text{nm}$ , $G = 0\text{dB}$                                                                                   | 0.70    | 0.87  | 1.05 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VM1B             | Middle1 Gain, $\lambda = 405\text{nm}$ , $G = 0\text{dB}$                                                                                   | 0.43    | 0.54  | 0.65 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VM2C             | Middle2 Gain, $\lambda = 780\text{nm}$ , $G = 0\text{dB}$                                                                                   | 1.97    | 2.46  | 2.95 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VM2D             | Middle2 Gain, $\lambda = 650\text{nm}$ , $G = 0\text{dB}$                                                                                   | 2.07    | 2.58  | 3.10 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VM2B             | Middle2 Gain, $\lambda = 405\text{nm}$ , $G = 0\text{dB}$                                                                                   | 1.29    | 1.62  | 1.94 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VH1C             | High1 Gain, $\lambda = 780\text{nm}$ , $G = 0\text{dB}$                                                                                     | 3.35    | 4.19  | 5.02 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VH1D             | High1 Gain, $\lambda = 650\text{nm}$ , $G = 0\text{dB}$                                                                                     | 3.52    | 4.40  | 5.28 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VH1B             | High1 Gain, $\lambda = 405\text{nm}$ , $G = 0\text{dB}$                                                                                     | 2.20    | 2.75  | 3.30 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VH2C             | High2 Gain, $\lambda = 780\text{nm}$ , $G = 0\text{dB}$                                                                                     | 5.72    | 7.15  | 8.58 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VH2D             | High2 Gain, $\lambda = 650\text{nm}$ , $G = 0\text{dB}$                                                                                     | 6.02    | 7.52  | 9.02 | $\text{mV}/\mu\text{W}$      |
|                                                                               | VH2B             | High2 Gain, $\lambda = 405\text{nm}$ , $G = 0\text{dB}$                                                                                     | 3.76    | 4.70  | 5.64 | $\text{mV}/\mu\text{W}$      |
| Light output voltage adjustment range *1                                      | G                | G=0dB reference, absolute value of adjustment width                                                                                         | 5.5     | 6.0   | 6.5  | dB                           |
| D range *1                                                                    | VoD              | Voltage between VOP-VON                                                                                                                     | 1700    | 2200  |      | mV                           |
| Frequency characteristics *1, *2                                              | FcC              | -3dB(1MHz reference), $\lambda = 780\text{nm}$<br>Light input = $40\mu\text{W}(\text{DC}) + 20\mu\text{W}(\text{AC})$                       | 60      | 80    |      | MHz                          |
|                                                                               | FcD1             | -3dB(1MHz reference), $\lambda = 650\text{nm}$<br>Light input = $40\mu\text{W}(\text{DC}) + 20\mu\text{W}(\text{AC})$<br>Low/Middle1/2 Gain | 60      | 85    |      | MHz                          |
|                                                                               | FcD2             | -3dB(1MHz reference), $\lambda = 650\text{nm}$<br>Light input = $40\mu\text{W}(\text{DC}) + 20\mu\text{W}(\text{AC})$<br>High1/2 Gain       | 60      | 80    |      | MHz                          |
|                                                                               | FcB1             | -3dB(1MHz reference), $\lambda = 405\text{nm}$<br>Light input = $40\mu\text{W}(\text{DC}) + 20\mu\text{W}(\text{AC})$<br>Low/Middle1/2 Gain | 60      | 85    |      | MHz                          |
|                                                                               | FcB2             | -3dB(1MHz reference), $\lambda = 405\text{nm}$<br>Light input = $40\mu\text{W}(\text{DC}) + 20\mu\text{W}(\text{AC})$<br>High1/2 Gain       | 60      | 80    |      | MHz                          |
| Settling time *1                                                              | Tset             |                                                                                                                                             |         | 10    | 15   | ns                           |
| Response time *1                                                              | Tr, Tf           | $V_o = 0.9V_{p-p}$ , output level 10 to 90%<br>$f_c = 10\text{MHz}$ , duty=50%                                                              |         | 4     | 10   | ns                           |
| Overshoot *1                                                                  | Ovst             | $V_o = 0.9V_{p-p}$ , $G = 0\text{dB}$                                                                                                       |         |       | 15   | %                            |
| Undershoot *1                                                                 | Unst             | $V_o = 0.9V_{p-p}$ , $G = 0\text{dB}$                                                                                                       |         |       | 15   | %                            |
| Linearity *1                                                                  | Lin              | At output voltage 0.5V and 1.0V<br>(Between VOP-VON)                                                                                        | -1      | 0     | 1    | %                            |
| Light-output voltage temperature dependence<br>Voltage between VOP-VON *1, *3 | TC               | $\lambda = 780\text{nm}$ , $25^\circ\text{C}$ reference                                                                                     | 7       | 10    | 13   | %                            |
|                                                                               | TD               | $\lambda = 650\text{nm}$ , $25^\circ\text{C}$ reference                                                                                     | -1      | 2     | 5    | %                            |
|                                                                               | TB               | $\lambda = 405\text{nm}$ , $25^\circ\text{C}$ reference                                                                                     | -1      | 2     | 5    | %                            |

Item with \*1 mark indicate the design reference value.

Item with \*2 mark indicate the frequency characteristics when VOP and VON are applied individually.

The frequency characteristics are for the output voltage adjustment range is -6 to +6dB

Item with \*3 mark indicates the temperature dependence for the case of High2 / High1 / Middle2 / Middle1 / Low gain and for the case when the temperature is 25 to  $75^\circ\text{C}$  for the output voltage adjustment range of -6 to +6dB

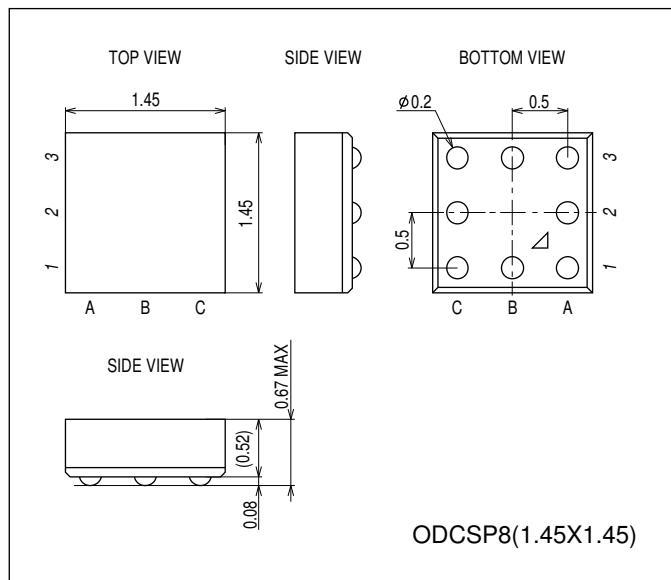
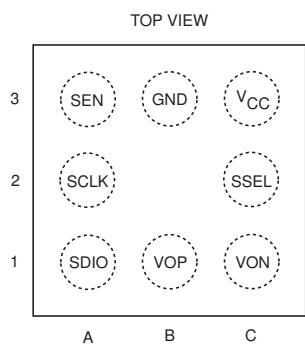
[Expression of output voltage]

$$V_N = (\text{sensitivity} / 2) \times 5400 / (5400-16 \times \text{GCAstep}) \times \text{light intensity} (\mu\text{W})$$

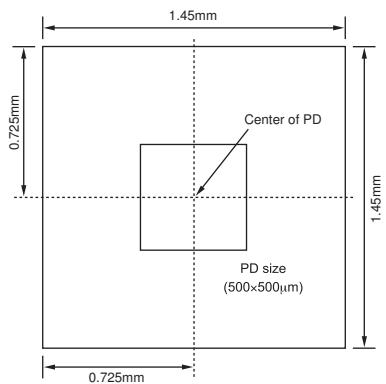
**Package Dimensions**

unit : mm (typ)

3407

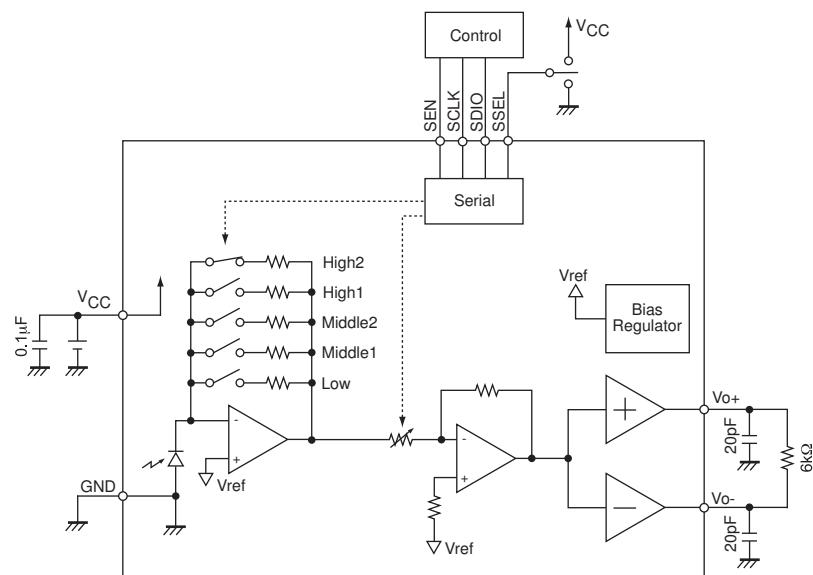
**Pin Assignment**

| Pin No. | Pin name        | Function                             |
|---------|-----------------|--------------------------------------|
| 1A      | SDIO            | Serial communication Data pin        |
| 1B      | VOP             | Positive side output pin             |
| 1C      | VON             | Negative side output pin             |
| 2A      | SCLK            | Serial communication Clock pin       |
| 2C      | SSEL            | Register selection pin               |
|         |                 | SSEL = Low : Address 00 to 0Fh used  |
|         |                 | SSEL = High : Address 10 to 1Fh used |
|         |                 | SSEL = Open : Address 70 to 7Fh used |
| 3A      | SEN             | Serial communication Enable pin      |
| 3B      | GND             | GND pin                              |
| 3C      | V <sub>CC</sub> | Power supply voltage pin             |

**PD assignment**

\*PD size for reference to be used for design

## Block diagram and Test circuit diagram



## Register table

Enable selection of the register group from the SSEL pin.

**SSEL = Low**

**SSEL = High**

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Continued on next page.

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## SSEL = Open

|         | Address | 7                               | 6 | 5 | 4                  | 3 | 2 | 1                              | 0  |
|---------|---------|---------------------------------|---|---|--------------------|---|---|--------------------------------|----|
| Name    | 70h     | <b>POWER</b>                    |   |   | <b>IV GAIN SEL</b> |   |   | <b>GAIN SEL</b>                |    |
| Default |         | 00                              |   |   | 00                 |   |   | 1                              | 0  |
| Value   |         | 11: Power on<br>00/01/10: Sleep |   |   | *4                 |   |   | 00/01: BD<br>10: DVD<br>11: CD | *4 |
| Name    |         | <b>BD GAIN</b>                  |   |   |                    |   |   |                                |    |
| Default | 71h     | 1                               | 1 | 1 | 1                  | 1 | 1 | 1                              | 1  |
| Value   |         | 00000000 to 11111111            |   |   |                    |   |   |                                |    |
| Name    | 72h     | <b>DVD GAIN</b>                 |   |   |                    |   |   |                                |    |
| Default |         | 1                               | 1 | 1 | 1                  | 1 | 1 | 1                              | 1  |
| Value   |         | 00000000 to 11111111            |   |   |                    |   |   |                                |    |
| Name    | 73h     | <b>CD GAIN</b>                  |   |   |                    |   |   |                                |    |
| Default |         | 1                               | 1 | 1 | 1                  | 1 | 1 | 1                              | 1  |
| Value   |         | 00000000 to 11111111            |   |   |                    |   |   |                                |    |
| Name    | 7Eh     | <b>TEST1 (*1)</b>               |   |   |                    |   |   |                                |    |
| Name    | 7Fh     | <b>TEST2 (*1)</b>               |   |   |                    |   |   |                                |    |

\*1 TEST1 and TEST2 are either the time when power is applied or “00000000” is set. Do not attempt to change “00000000” during operation.

“00000000” is returned when reading is made.

\*2 No problem in terms of operation occurs even when writing is made to the address 04h to 0Dh and 14h to 1Dh and 74h to 7Dh.

“00000000” is returned when this address is read.

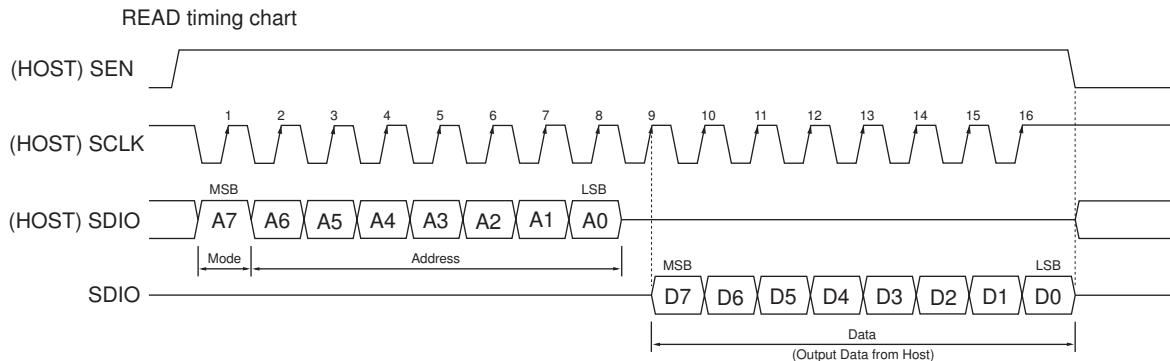
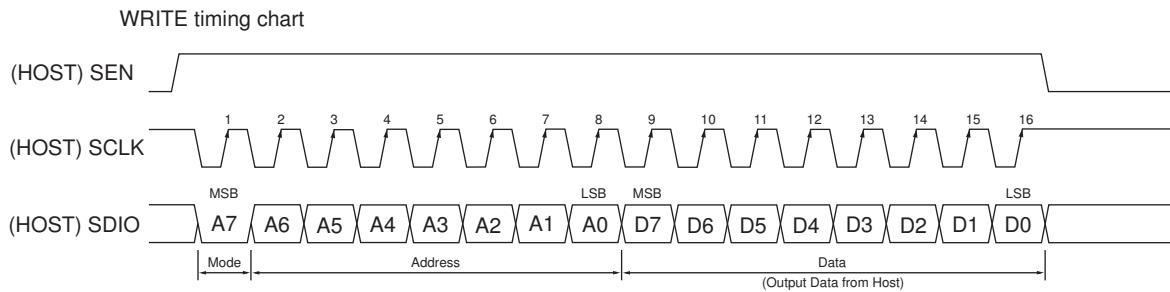
\*3 When I performed address reading except the register group set by an SSEL terminal, I keep Hi-Z without paying a value.

\*4 Please set the gain setting of the I/V amplifier referring to the table below.

## I/V amplifier gain setting table

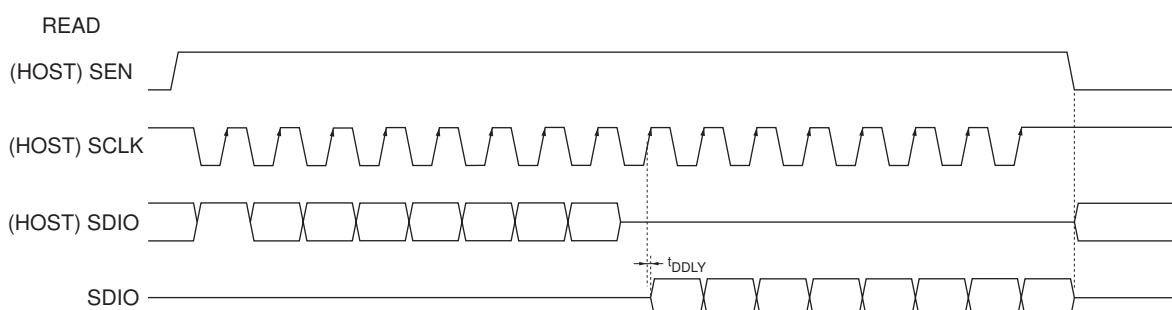
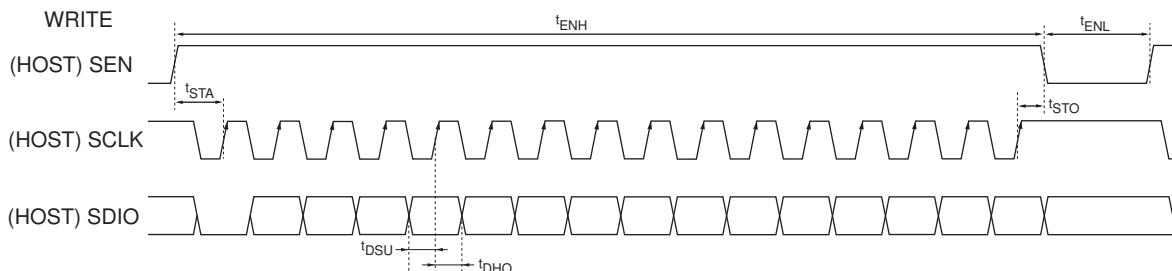
| 00h/10h/70h |         | 5                   | 4 | 1               |
|-------------|---------|---------------------|---|-----------------|
| Name        |         | <b>IV GAIN1 SET</b> |   | <b>IV GAIN2</b> |
| Default     |         | 00                  |   | 1               |
| IV GAIN     | High2   | 00/01               |   | 1               |
|             | High1   | 10/11               |   | 1               |
|             | Middle2 | 00/01               |   | 0               |
|             | Middle1 | 10                  |   | 0               |
|             | Low     | 11                  |   | 0               |

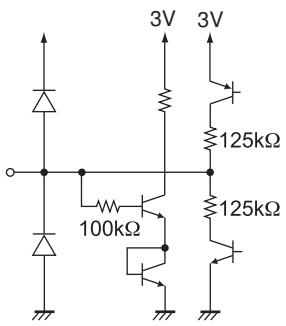
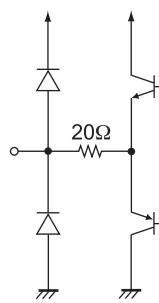
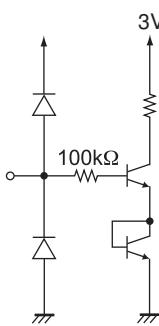
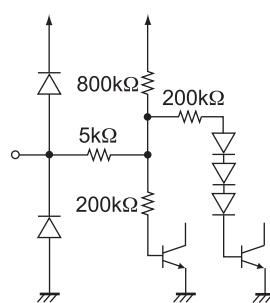
## Serial protocol



SDIO pin load / CL=20pF (The table below shows the design reference value.)

| Parameter                          | Symbol     | Min. | Typ. | Max. | Unit    |
|------------------------------------|------------|------|------|------|---------|
| SCL clock frequency Write          | $f_{SCL}$  | 0    |      | 10   | MHz     |
| SCL clock frequency Read           | $f_{SCL}$  | 0    |      | 4    | MHz     |
| SDIO data setup time               | $t_{DSU}$  | 50   |      |      | ns      |
| SDIO data hold time                | $t_{DHO}$  | 50   |      |      | ns      |
| SDIO output delay                  | $t_{DDLY}$ |      | 10   | 80   | ns      |
| SEN "H" period                     | $t_{ENH}$  | 1.6  |      |      | $\mu$ s |
| SEN "L" period                     | $t_{ENL}$  | 200  |      |      | ns      |
| SCL rise time after SEN rise       | $t_{STA}$  | 60   |      |      | ns      |
| SEN fall time after final SCL rise | $t_{STO}$  | 100  |      |      | ns      |
| Serial input "H" voltage           | $V_{IH}$   | 2.4  |      | 3.7  | V       |
| Serial input "L" voltage           | $V_{IL}$   |      |      | 0.6  | V       |
| SDIO output "H" voltage            | $V_{OH}$   | 2.5  | 2.9  | 3.3  | V       |
| SDIO output "L" voltage            | $V_{OL}$   | 0    | 0.3  | 0.8  | V       |



| Pin         | Type            | Equivalent circuit diagram                                                           |
|-------------|-----------------|--------------------------------------------------------------------------------------|
| SDIO        | Input<br>Output |    |
| VOP<br>VON  | Output          |    |
| SCLK<br>SEN | Input           |   |
| SSEL        | Input           |  |

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