AN11169

PCA9632 1.8 V I²C-bus and 2.8 V V_{DD} operation

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Document information

Info	Content
Keywords	PCA9632, 1.8 V I2C-bus, 2.8 V supply voltage
Abstract	This application note describes how the PCA9632 interfaces with 1.8 V I²C-bus at V_{DD} = 2.8 V. Bench test result shows the slight increase in both standby and operating leakage current.

Revision history

Rev	Date	Description
v.1	20120326	application note; initial release

Contact information

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1. Introduction

The PCA9632 is 4-bit Fm+ I²C-bus low-power LED driver, optimized for Red/Green/Blue/Amber (RGBA) color mixing in mobile application. Typical operating power supply voltage is in the range of 2.3 V to 5.5 V with low standby current of < 1 μA.

This device also supports out-of-specification limit, 1.8 V I²C-bus. When operating at 1.8 V, there is a slight increase in both the standby and operating currents. The amount of the current increase would depend on the supply voltage applied to the PCA9632. The higher the supply voltage is, the higher the current will be. This application note explains how much current is increased and from where the leakage current comes.

The application note took measurement for 1.8 V I²C-bus at V_{DD} = 2.8 V. When operating at 2.8 V supply and 1.8 V I²C-bus, there is roughly an extra 15 μA leakage current observed at the supply to ground of the PCA9632 when the I²C-bus is at logic HIGH. No leakage is observed when the I²C-bus is at logic LOW.

2. Explanation of extra leakage current cause

The PCA9632 is a CMOS device where the clock and data signal lines of the I²C-bus are CMOS input/output as shown in Figure 1. When input V_{IH} is at 1.8 V and V_{DD} is at 2.8 V, there is −1 V (that is, V_{GS} = 1.8 V to 2.8 V) bias on the PMOS and 1.8 V (that is, V_{GD} = 1.8 V to 0 V) on the NMOS, so the NMOS is turned 'ON' hard, but the −1 V is slightly larger than the threshold of the PMOS (−0.6 V), so the PMOS does not completely turn 'OFF', therefore, there is small current conducting by the PMOS device through the NMOS to ground.

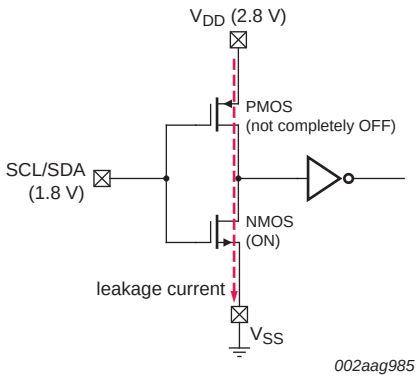

Fig 1. I²C-bus internal connection diagram for PCA9632

Table 1 shows the normal mode current, while Table 2 shows the standby mode current. All data is collected at room temperature.

Table 1. I_{DD} supply current in normal operation mode

I²C-bus	V_{DD}	I_{DD} (normal operating mode)
2.8 V	2.8 V	48 μA
1.8 V	2.8 V	60 μA

Table 2. I_{DD} supply current in standby mode

I²C-bus	V_{DD}	I_{DD} (standby in sleep mode)
2.8 V	2.8 V	< 1 μA
1.8 V	2.8 V	15 μA

3. Conclusion

PCA9632 is able to operate with 1.8 V (± 10 %) for I²C-bus with the 2.8 V supply rail at the expense of slight increase in both standby and operating current.

4. Abbreviations

Table 3. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
Fm+	Fast-mode Plus
I²C-bus	Inter-Integrated Circuit-bus
I/O	Input/Output
LED	Light-Emitting Diode
NMOS	Negative-Channel Metal-Oxide Semiconductor
PMOS	Positive-Channel Metal-Oxide Semiconductor

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