

# USB I<sup>2</sup>C Interface Board Reference Manual

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Application Note 1840  
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## Introduction

The USB I<sup>2</sup>C Interface board interacts with your application hardware via an USB port in a PC. The Microcontroller with flash memory enables to control your application hardware and develop specific application functions via software. (*National Semiconductor does not provide interaction software, which networks both application board and I<sup>2</sup>C board.*)

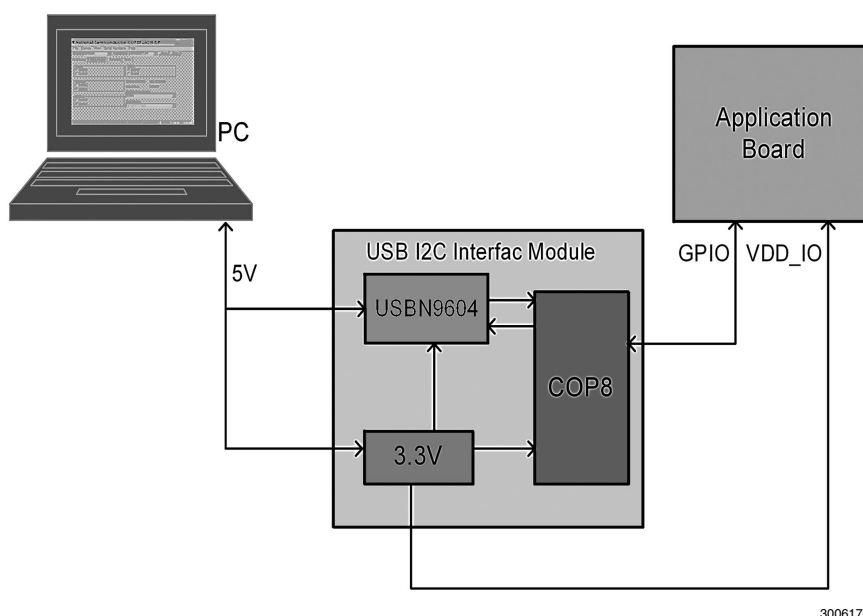
## USB I<sup>2</sup>C Interface Board Key

### Features

- National's COP8CBE9 microcontroller in a TSSOP package
- National's USBN9604 IC in a 28-pin CSP package
- USB 2.0 compatible
- Bus Powered
- 24 MHz clock from crystal
- 8-pin Analog inputs for A/D converter

## Block Diagram

Figure 1 shows basic connections between the PC, USB I<sup>2</sup>C Interface Module, and application board.



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FIGURE 1. Block Diagram

## System Requirements

The following requirements are vital in order to use the USB I<sup>2</sup>C Interface Module:

### SYSTEM REQUIREMENTS

- Windows Operating System (Win98/ME/2000/XP)
- 32 MB RAM (Minimum)
- 2 MB available for disk space

### HARDWARE REQUIREMENTS

- 5-Pin Mini-B USB 2.0 cable (sold separately)

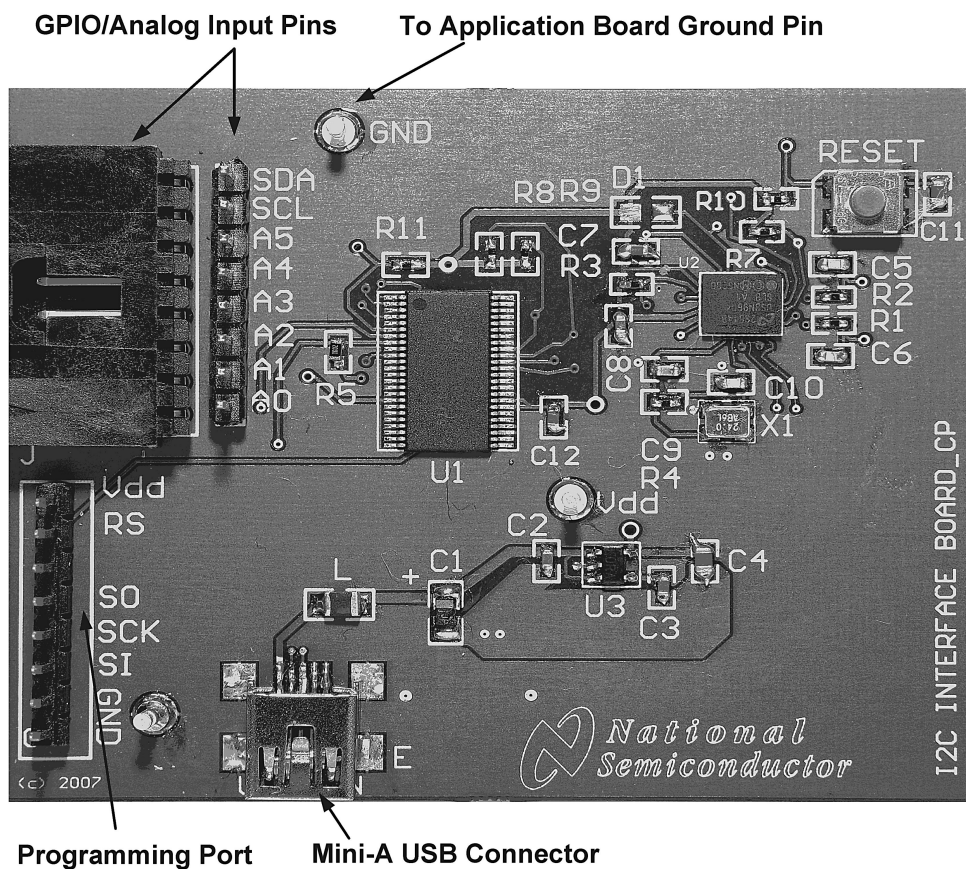


FIGURE 2. USB I<sup>2</sup>C Interface Module

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## Serial Interface and Programming Connectors

### SERIAL INTERFACE “J”

The table below shows the pin configuration for the COP8 controller for all interface modes.

TABLE 1.

Pin Name	I <sup>2</sup> C Board Pin/COP8 Pin	Comment
SDA (Data out)	SDA / 40	R = 2 k $\Omega$ (Note 1)
SCL (Clock)	SCL / 39	R = 2 k $\Omega$ (Note 1)
Analog Ch. 6/GPIO	A5 / 38	*
Analog Ch. 5/GPIO	A4 / 37	*
Analog Ch. 4/GPIO	A3 / 36	*
Analog Ch. 3/GPIO	A2 / 35	*
Analog Ch. 2/GPIO	A1 / 34	*
Analog Ch. 1/GPIO	A0 / 33	*

**Note 1:** Must have a pull-up resistor on application hardware for SCL and SDA lines.

**Note 2:** Do not use any of A5 - A0 pins as a ground connection. Connect both application and I<sup>2</sup>C grounds together to make a good ground connection between the two boards. (Refer to I<sup>2</sup>C picture for GND pin.)

### ELECTRICAL CHARACTERISTICS OF I<sup>2</sup>C

The USB I<sup>2</sup>C board requires 5V from a computer to function correctly. The maximum current that the I<sup>2</sup>C board will draw from the computer is 500 mA. This I<sup>2</sup>C board will function within the temperature range of 0°C  $\leq$  T<sub>A</sub>  $\leq$  70°C.

- COP8CBE0 — <http://www.national.com/ds/CO/COP8CBE9.pdf>
- USBN9694 — <http://www.national.com/opf/US/USBN9604.html>
- LP2985 — <http://www.national.com/mpf/LP/LP2985.html>

For further information about the devices on the I<sup>2</sup>C board, refer to the following links:

## I<sup>2</sup>C Compatible Interface

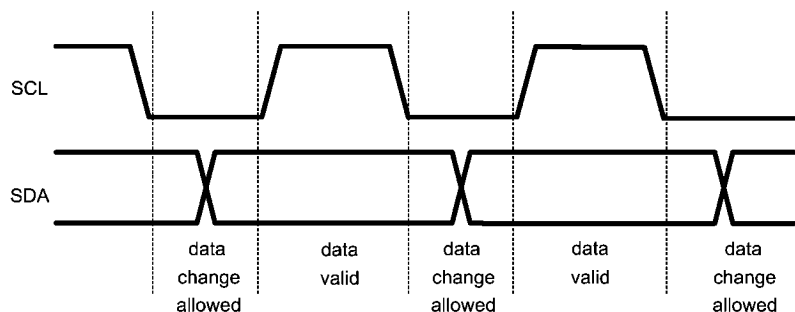
### I<sup>2</sup>C SIGNALS

In I<sup>2</sup>C-compatible mode, the SCL pin is used for the I<sup>2</sup>C clock and the SDA pin is used for the I<sup>2</sup>C data. Each of these signals need a pull-up resistor according to I<sup>2</sup>C specification. The values of the pull-up resistors are determined by the capacitance of the bus (typ. ~2k). See I<sup>2</sup>C specification from Phillips

for further details. Signal timing specifications are according to the I<sup>2</sup>C bus specification. Maximum frequency is 400 KHz.

### I<sup>2</sup>C DATA VALIDITY

The data on SDA line must be stable during the HIGH period of the clock signal (SCL). In other words, state of the data line can only be changed when CLK is LOW.



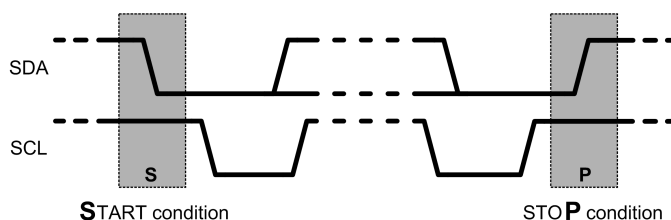
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I<sup>2</sup>C Signals: Data Validity

### I<sup>2</sup>C START AND STOP CONDITIONS

START and STOP bits signify the beginning and the end of the I<sup>2</sup>C session. START condition is defined as SDA signal transitioning from HIGH to LOW while SCL line is HIGH. STOP condition is defined as the SDA transitioning from LOW to HIGH while SCL line is HIGH.

The I<sup>2</sup>C master always generates START and STOP bits. The I<sup>2</sup>C bus is considered busy after START condition and free after STOP condition. During data transmission, I<sup>2</sup>C master can generate repeated START conditions. First START and repeated START conditions are equivalent, function-wise.



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START and STOP Conditions

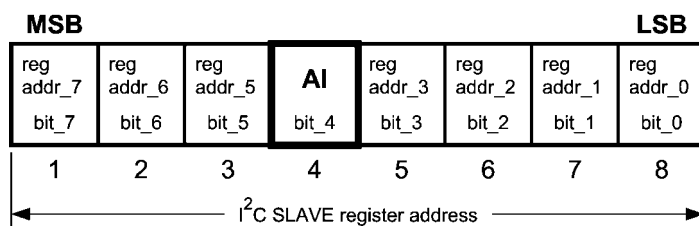
### TRANSFERRING DATA

Every byte put on the SDA line must be eight bits long, with the most significant bit (MSB) being transferred first. Each byte of data has to be followed by an acknowledge bit. All clock pulses are generated by the master. The transmitter releases the SDA line (HIGH) during the acknowledge clock pulse. The receiver must pull down the SDA line during the

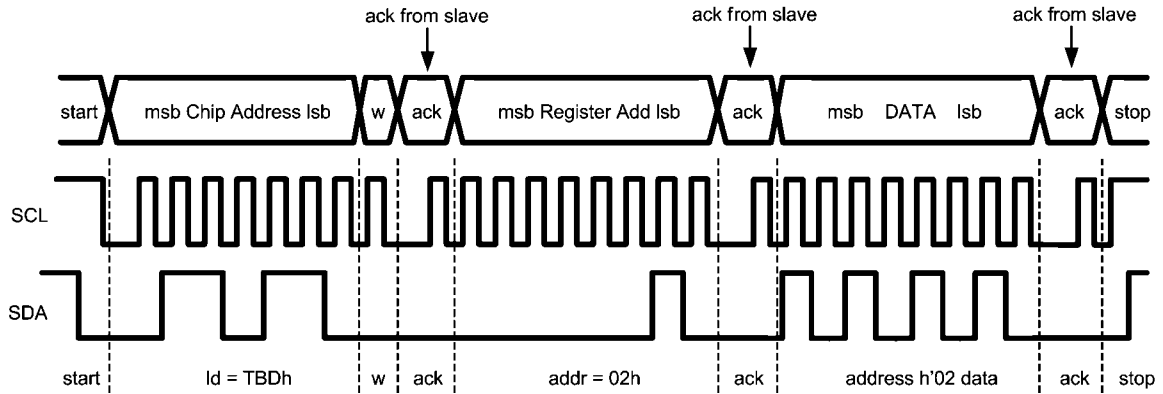
9th clock pulse, signifying an acknowledge. A receiver which has been addressed must generate an acknowledge after each byte has been received.

After the START condition, the I<sup>2</sup>C master sends a chip address. This address is seven bits long followed by an eighth bit which is a data direction bit (R/W). The second byte selects the register to which the data will be written. The third byte contains data to write to the selected register.

### I<sup>2</sup>C Chip Address



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I<sup>2</sup>C Write Cycle

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w = write (SDA = '0')

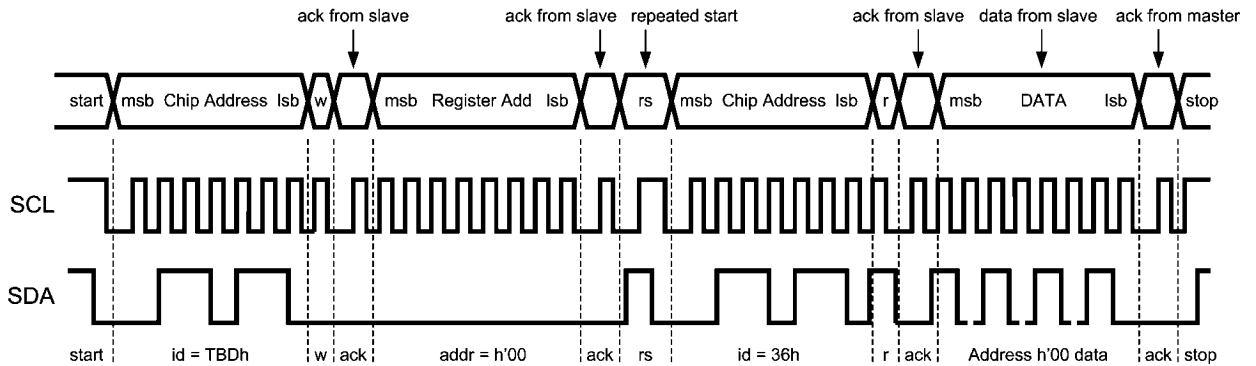
r = read (SDA = '1')

ack = acknowledge (SDA pulled down by either master or slave)

rs = repeated start

id = chip address

When a READ function is to be accomplished, a WRITE function must precede the READ function, as shown in the Read Cycle waveform.

I<sup>2</sup>C Read Cycle

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# Notes

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Products		Design Support	
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Audio	<a href="http://www.national.com/audio">www.national.com/audio</a>	Analog University	<a href="http://www.national.com/AU">www.national.com/AU</a>
Clock Conditioners	<a href="http://www.national.com/timing">www.national.com/timing</a>	App Notes	<a href="http://www.national.com/appnotes">www.national.com/appnotes</a>
Data Converters	<a href="http://www.national.com/adc">www.national.com/adc</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
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Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Feedback	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>		
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>		
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>		
PowerWise	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>		
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