UM10709

PCA9956B demonstration board OM13321

Rev. 2 — 11 August 2017 **User manual**

Document information

Info	Content
Keywords	Fm+ I2C-bus, PCA9956B, RGB and White LEDs, 24-channel x 8-bit PWMs
Abstract	The OM13321 is an add-on to 9-pin connector of the NXP I2C demo board 2005-1 or Fm+ I2C Bus development board. This daughter board makes it easy to test and design with the PCA9956B, a 24-channel Fast-mode Plus (Fm+) 57 mA constant current and outputs allow up to 20 V for LED supply. This demo board, along with the Win-I2CUSB Lite GUI (PC based), provides an easy to use evaluation platform.

Revision history

Rev	Date	Description
2.0	20170811	Changed PCA9956A to PCA9956B throughout; updated Figure 3, Figure 4, Figure 5
1.0	20131216	User manual; initial release.

Contact information

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1. Introduction

The PCA9956B evaluation board features LEDs for color mixing, blinking and dimming demonstrations. A graphical interface allows the user to easily explore the different functions of the driver. The board can be connected in series with other I^2C demo-boards to create an evaluation system.

The IC communicates to the host via the industry standard I^2C-bus/SMBus port. The evaluation software runs under Microsoft Windows PC platform.

2. Features

- A complete evaluation platform for the PCA9956B 24-channel Fm+ I^2C-bus constant current LED driver
- Easy to use GUI-based software demonstrates the capabilities of the PCA9956B
- On-board eight RGB LEDs for visual experience
- Convenient test points for easy scope measurements and signal access
- USB interface to the host PC
- No external power supply required

3. Getting started

3.1 Assumptions

Familiarity with the I^2C-bus is helpful, but not required.

3.2 Static handling requirements

CAUTION

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling. You must use a ground strap or touch the PC case or other grounded source before unpacking or handling the hardware.

3.3 Minimum system requirements

- PC Pentium 60 processor (or equivalent), 8 MB RAM, 10 MB of hard drive space
- One USB port (either 2.0 or 1.1 compatible)
- Windows 98SE, ME, 2000, XP, or Vista
- I2C demonstration board 2005-1 (OM6275) or WIN-I2CUSB board (from http://www.demoboard.com)

3.4 Power requirements

The NXP demonstration board I2C 2005-1 and OM13321 hardware obtain power from the PC USB port. Care should be taken not to exceed the USB port current capabilities.

4. Installation

4.1 I2C demo board 2005-1 and WIN-I2CUSB Lite software

The OM13321 is a daughter card to the OM6275 I^2C demo board 2005-1. You may download the WIN-I2CUSB Lite Software, the OM6275 user manual UM10206, and find ordering information at the NXP web site http://www.nxp.com/demoboard/OM6275.html.

The Win-I2CUSB Lite software from The Boardshop runs on Windows 98SE, ME, 2000, and XP and is compatible with any PC hardware having a minimum of a Pentium processor and an USB port. The software allows the user to select one of the I^2C-bus devices on the board from a menu and also provides a Universal mode (I^2C Expert mode) to allow users to create their own I^2C-bus commands with the same I^2C-bus devices.

4.2 OM13321 connection to I2C demo board 2005-1

The I2C demo board 2005-1 should be disconnected from your PC before mounting the OM13321 board on to it. The OM13321 board has a 9-pin female connector (CON2) that connects to the JP1 male connector on the I2C demo board 2005-1 as shown in Figure 1.

With both boards facing you, and with USB connector on the right-hand side as shown in Figure 1, connect the OM13321 board to the I2C demo board 2005-1 before connecting the USB cable. Once the board is connected, connect the USB cable and start the WIN-I2CUSB Lite software. You are now ready to evaluate the PCA9956B.

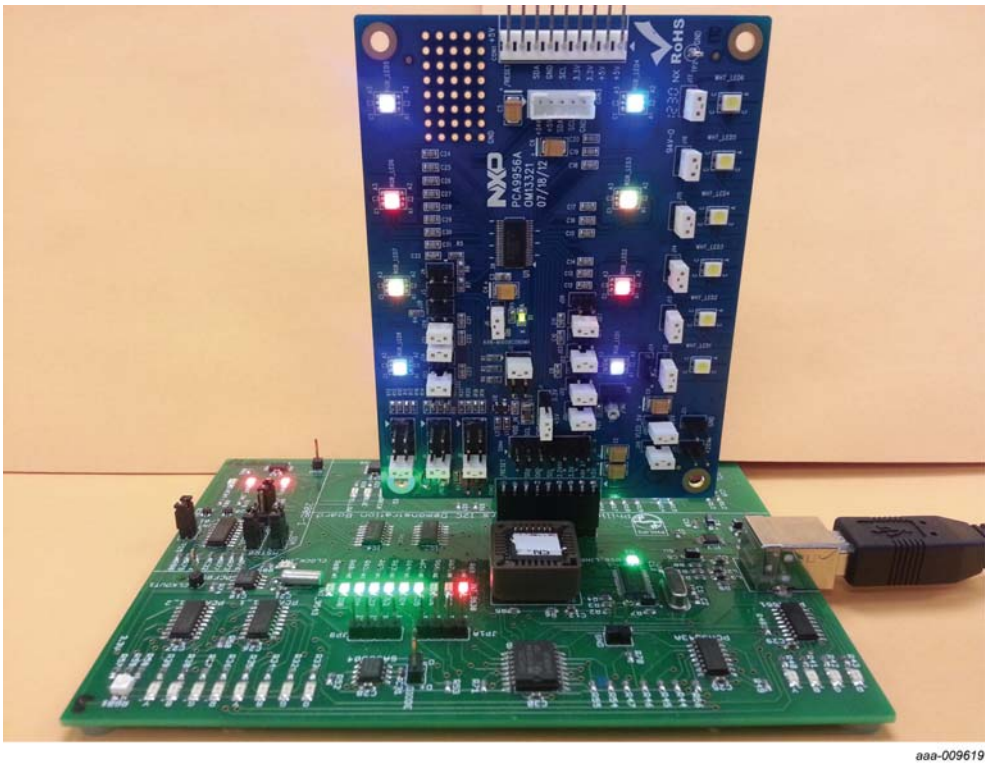

Fig 1. PCA9956B demo board (OM13321) mounting to the I2C demo board 2005-1 (OM6275)

4.3 OM13321 connection to WIN-I2CUSB hardware adapter board

The Win-I2CUSB board should be disconnected from your PC before connecting the OM13321 board on to it. The OM13321 board has a 14-pin male connector (CON4) that connects to the 14-pin male connector (J1) on the Win-I2CUSB board as shown in Figure 2.

Connect the OM13321 board to the Win-I2CUSB board before connecting the USB cable. Once the board is connected, connect the USB cable and start the WIN-I2CUSB Lite software. You are now ready to evaluate the PCA9956B.

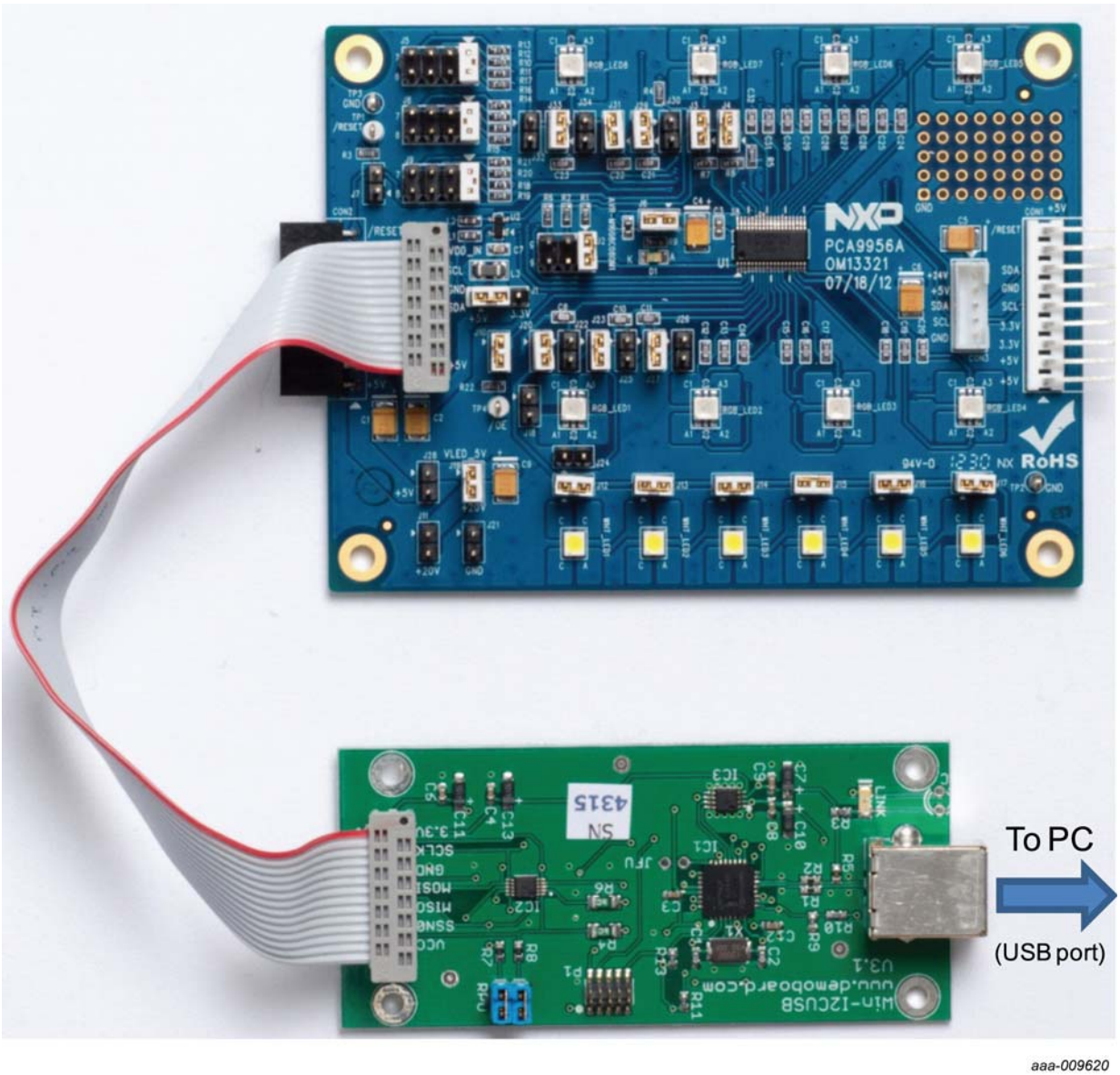

Fig 2. PCA9956B demo board (OM13321) connecting to the WIN-I2CUSB board

5. Hardware description

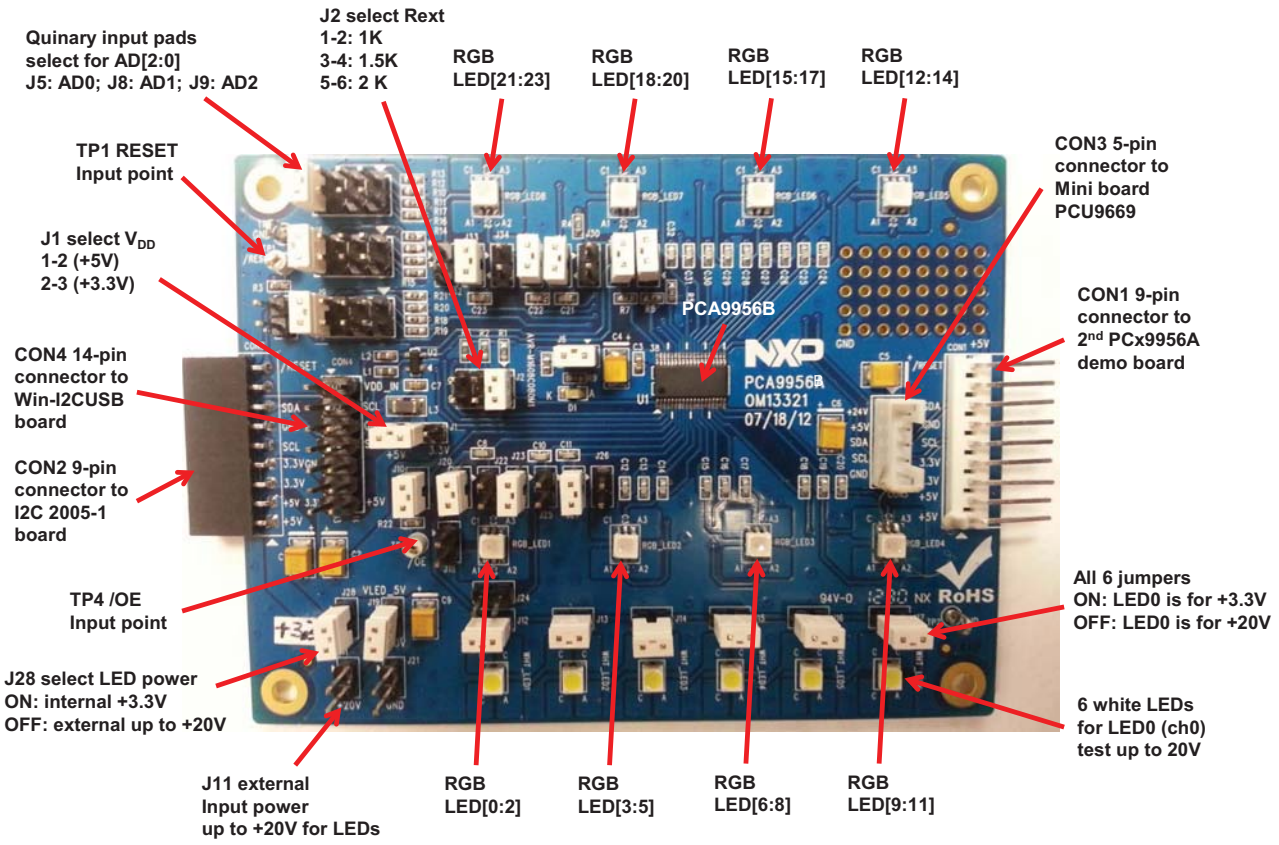

Fig 3. PCA9956B demo board (OM13321)

Figure 3 shows the following items on the hardware:

- CON1 (9-pin male connector) is used to daisy-chain to next I²C-bus slave device or demo board.
- CON2 (9-pin female connector) is connected to JP1 on I2C demo board 2005-1 as master device to drive this demo board.
- CON3 (5-pin male connector) is connected to the PCU9669 or PCA9665 mini board as I²C-bus master device to drive this demo board.
- CON4 (14-pin male connector) is connected to J1 on WIN-I2CUSB hardware board as I²C-bus master device to drive this demo board.
- J1 selects V_{DD} power for PCA9956B, connected 1-2 for V_{DD} = 5 V and connected 2-3 for V_{DD} = 3.3 V.
- J5, J8 and J9 to select one of the five (GND, Pull-down, Floating, Pull-up and V_{DD}) input levels to address inputs AD[0:2] for a maximum of 125 possible programmable I²C-bus slave address.
- LED[0:23] 24-channel output to drive eight RGB LEDs (RGB_LED[1:8]).
- TP2 and TP3 are GND pins for probing use.

- TP1 can be connected as external reset signal to $\overline{\text{RESET}}$ pin when J7 is open.
- TP4 can be connected as external output enable signal to $\overline{\text{OE}}$ pin for blinking/dimming control when J10 is open.
- All jumpers default setting and function as shown in Table 1.

Table 1. Jumper settings for test and evaluation

Jumper	Default setting	Comment
J1 (3-pin)	1-2 (V_{DD} = +5 V)	This jumper is used to select V_{DD} for PCA9956B. **1-2:** select +5 V **2-3:** select +3.3 V
J2 (3 × 2-pin)	1-2 (REXT = 1 kΩ, 57.3 mA at max.)	This 3 × 2 jumper is used to select REXT (pin 1) value for PCA9956B. **1-2:** select REXT = 1 kΩ and maximum output current is 57.3 mA **3-4:** select REXT = 1.5 kΩ and maximum output current is 38.25 mA **5-6:** select REXT = 2 kΩ and maximum output current is 28.6 mA
J3 (2-pin)	1-2 (short)	**Short:** external 1.1 kΩ pull-up resistor for SDA on PCA9956B. **Open:** no external pull-up resistor for SDA on PCA9956B.
J4 (2-pin)	1-2 (short)	**Short:** external 1.1 kΩ pull-up resistor for SCL on PCA9956B. **Open:** no external pull-up resistor for SCL on PCA9956B.
J5 (4 × 2-pin)	1-2[1] (V_{DD})	This 4 × 2 jumper is used to select quinary input value for AD0 (pin 2). **Open:** floating. **1-2:** select V_{DD}. **3-4:** select pull-up with 31.6 kΩ **5-6:** select pull-down with 34.8 kΩ **7-8:** select GND
J6 (2-pin)	1-2 (short)	**Short:** connect V_{DD} to pin 38 (power supply) of the PCA9956B. **Open:** connect current meter to measure the I_{DD} on PCA9956B.
J7 (2-pin)	1-2 (open)	**Short:** force $\overline{\text{RESET}}$ (pin 35) to GND to reset device. **Open:** 10 kΩ pull-up the $\overline{\text{RESET}}$ (pin 35) to V_{DD} and the TP1 can be used as external reset input signal.
J8 (4 × 2-pin)	1-2[1] (V_{DD})	This 4 × 2 jumper is used to select quinary input value for AD1 (pin 3). **Open:** floating. **1-2:** select V_{DD}. **3-4:** select pull-up with 31.6 kΩ **5-6:** select pull-down with 34.8 kΩ **7-8:** select GND
J9 (4 × 2-pin)	1-2[1] (V_{DD})	This 4 × 2 jumper is used to select quinary input value for AD2 (pin 4). **Open:** floating. **1-2:** select V_{DD}. **3-4:** select pull-up with 31.6 kΩ **5-6:** select pull-down with 34.8 kΩ **7-8:** select GND
J10 (2-pin)	1-2 (short)	**Short:** force $\overline{\text{OE}}$ (pin 5) to GND, to enable LEDs output. **Open:** 10 kΩ pull-up $\overline{\text{OE}}$ (pin 5) to V_{DD} when apply external clock for blinking and dimming control on TP4 (test point).

Table 1. Jumper settings for test and evaluation *…continued*

Jumper	Default setting	Comment
J11 (2-pin)	External supply voltage input to LED0 or all LEDs	External supply voltage (≤ +20 V) input to LED for test only. The external supply voltage (≤ +20 V) connects to LED0 only when J19 is **open**. The external supply voltage (≤ 3.3 V) connects to all LEDs when the J19 is **short** and J28 is **open**.
J21 (2-pin)	GND input	External supply voltage ground input to LED.
J12, J13, J14, J15, J16, J17 (2-pin)	1-2 (short)	These jumpers are used to connect or disconnect white LEDs (WHT_LED[1:6]) on LED0 output for test only. **Open:** connected the white LED on LED0 output **Short:** bypass the white LED on LED0 output
J18, J24, J26 (2-pin)	1-2 (open)	These jumpers are used to test short-circuit for RGB_LED1. J18 is used to set short error for Red LED (LED0). J24 is used to set short error for Green LED (LED1). J26 is used to set short error for Blue LED (LED2). **Open:** normal operation for the RGB_LED1. **Short:** short one of the RGB_LED1 to test an LED short-error condition in EFLAG register.
J19 (2-pin)	Short	This jumper is used to select LED0 supply voltage. **Open:** select external ≤ +20 V input from J11 (to LED0 only). **Short:** select either internal +3.3 V when J28 is **short** or external ≤ +20 V when J28 is **open** (to all LEDs).
J20, J23, J27 (2-pin)	Short	These jumpers are used to test open-circuit for RGB_LED1. J20 is used to set open error for Red LED (LED0). J23 is used to set open error for Green LED (LED1). J27 is used to set open error for Blue LED (LED2). **Open:** User can connect current meter to measure one of the LED[0:2] output current or open one of the RGB_LED1 for detecting an LED open-error condition in EFLAG register. **Short:** normal operation for the RGB_LED1.
J22, J25 (2-pin)	Open	These jumpers are used to merge the LED[0:2] outputs together for driving higher LED current for test only. **Open:** normal operation for the RGB_LED1. **Short:** When short J22/J25 and open J23/J27 to combine LED[0:2] outputs to drive LED0. When short J22 only and open J23 to combine LED[0:1] outputs to drive LED0.
J28 (2-pin)	Short	This jumper is used to select LEDs supply voltage. **Open:** select external ≤ +20 V input from J11 when J19 is **short** (for all LEDs). **Short:** select internal +3.3 V for LED[1:23] supply voltage when the J19 is **open** or for all LED[0:23] supply voltage when the J19 is **short** (J11 is no input).

Table 1. Jumper settings for test and evaluation *…continued*

Jumper	Default setting	Comment
J29, J31, J33 (2-pin)	Short	These jumpers are used to test open-circuit for RGB_LED8. J29 is used to set open error for Red LED (LED21). J31 is used to set open error for Green LED (LED22). J33 is used to set open error for Blue LED (LED23). **Open:** user can connect current meter to measure one of the LED[21:23] output current or open one of the RGB_LED8 for detecting an LED open-error condition in EFLAG register. **Short:** normal operation for the RGB_LED8.
J30, J32, J34 (2-pin)	Open	These jumpers are used to test short-circuit for RGB_LED8. J30 is used to set short error for Red LED (LED21). J32 is used to set short error for Green LED (LED22). J34 is used to set short error for Blue LED (LED23). **Open:** normal operation for the RGB_LED8. **Short:** short one of the RGB_LED8 to test an LED short-error condition in EFLAG register.
TP1	Test Point 1	This TP1 is used to drive $\overline{\text{RESET}}$ input pin 35 from external when J7 is **open**.
TP2, TP3	Test Point 2/3	These two test points are GND for probe ground connection.
TP4	Test Point 4	This TP4 is used to drive $\overline{\text{OE}}$ input pin 5 from external when J10 is **open**.

[1] Default PCA9956B slave address is 0xFAh (AD[2:0] = V_{DD}).

6. Schematic

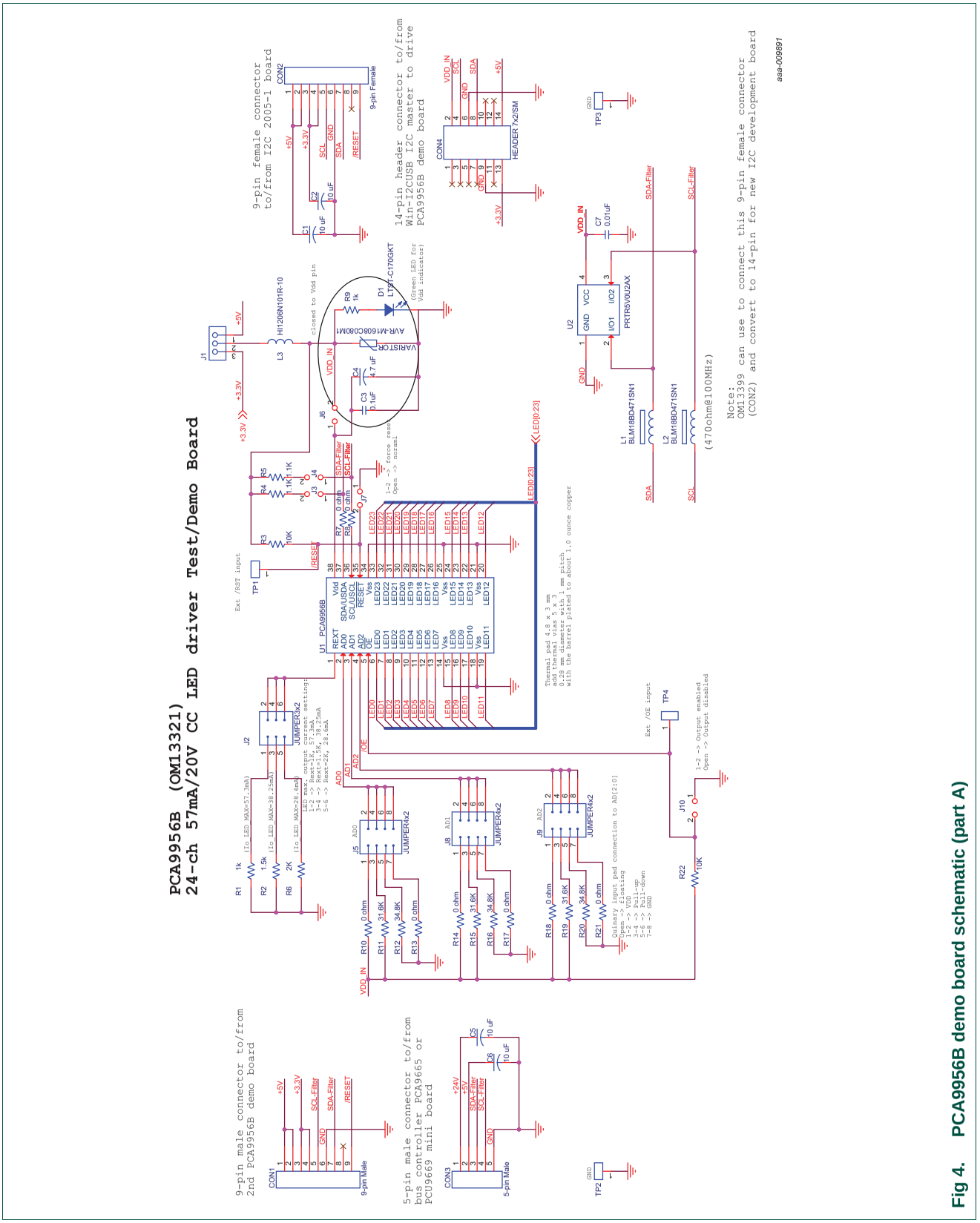

Fig 4. PCA9956B demo board schematic (part A)

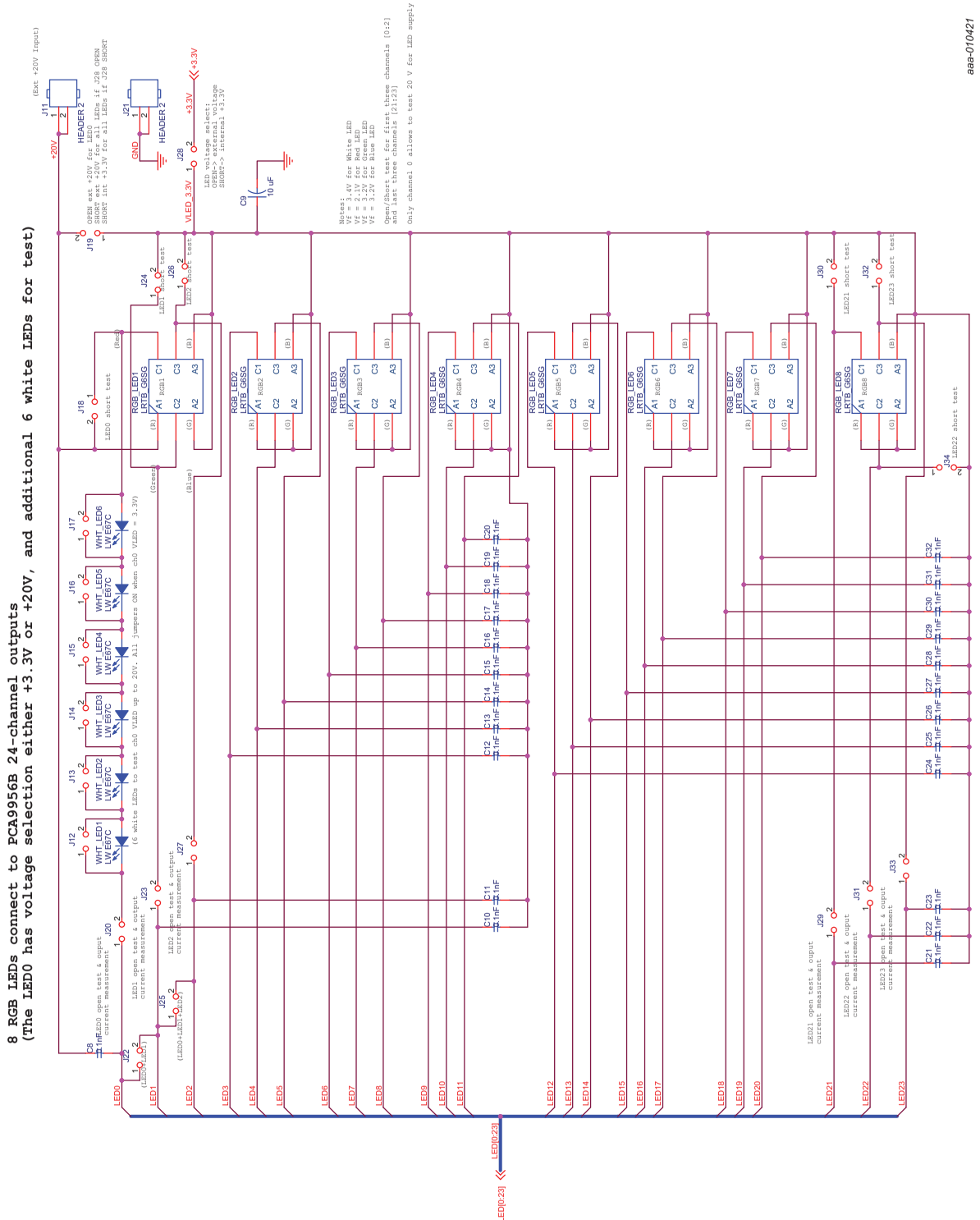

Fig 5. PCA9956B demo board schematic (part B)

7. OM13221 demonstration board main components

Table 2. OM13321 demo board main components

Device	Description	Address/LED	Location
PCA9956BTW	24-channel Fm+ I^2C-bus 57 mA / 20 V constant current LED driver	0xFAh for I^2C demo board	U1
PRTR5V0U2AX	ESD protection diode	-	U2
LW-E67C	White LED	6 white LEDs	WHT_LED[1:6]
LRTB_G6SG	RGB LED	8 RGB LEDs	RGB_LED[1:8]
LTST-C170GKT	Green LED for PCA9956B power supply either 3.3 V or 5 V	1 green LED	D1

8. PCA9956B evaluation steps

The PCA9956B is controlled by WIN-I2CUsB GUI in Expert mode, as shown in Figure 6.

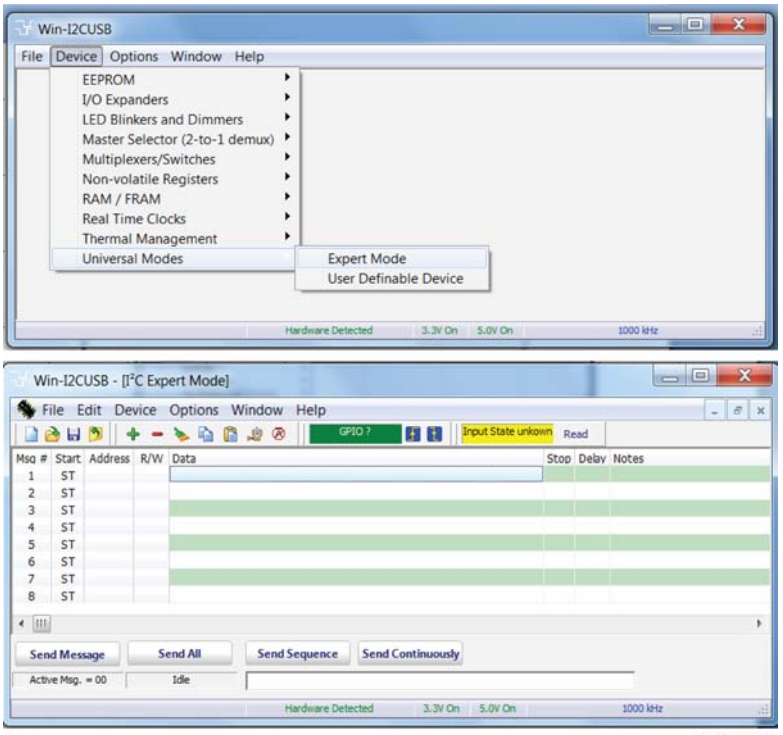

Fig 6. Drop-down menu selection for Expert mode

Connect the hardware as described in Section 4. All jumpers are in default setting and device address is set to 0xFA on J5, J8 and J9 (set AD[0:2] = V_{DD}) for PCA9956B demo board. When you have correctly installed the software and the demonstration board hardware is connected and recognized by the computer, start the Win-I2CUSB Lite software. As shown in Figure 6, when the demonstration board hardware is correctly

connected to the USB port and the computer recognizes it, the message ‘Hardware Detected’ is displayed on the bottom of the window.

Switched 3.3 V and 5.0 V power supplies are controlled through the ‘Options’ menu or by double-clicking on the 3.3 V or 5.0 V symbols on the bottom of the window. Power supplies are disabled by default and you must enable them before using the I^2C-bus devices on the board. I^2C-bus frequency is controlled through the ‘Options’ menu or by double-clicking on the frequency symbol on the bottom of the window.

8.1 PCA9956B blinking demo for all RGB LEDs

1. From the ‘Device’ drop-down menus select ‘Universal Modes’, and from the subsequent drop-down menu select ‘Expert Mode’ as shown in Figure 6.
2. Copy the ‘PCA9956B RGB LED blinking demo i2c address = 0xFAh’ text file as shown below. From the ‘File’ drop-down menus select ‘Open’, and from the ‘open data file’ window select the ‘PCA9956B RGB LED blinking demo i2c address = 0xFAh’ text file.

```
Expert Mode Data File
00,Write,Yes,5,06,Comments: SW reset (00h + 06h) and wait 5 ms
FA,Write,Yes,0,40,3F,Comments: write IREFALL = 0x3Fh = 225ua x 63 = 14 ma per
     channel if Rext = 1k
FA,Write,Yes,800,82,41,10,04,41,10,04,Comments: set LDRx=01 in LEDOUT register for
     all red LEDs on for 800 ms
FA,Write,Yes,800,82,04,41,10,04,41,10,Comments: set LDRx=01 in LEDOUT register for
     all green LEDs on for 800 ms
FA,Write,Yes,800,82,10,04,41,10,04,41,Comments: set LDRx=01 in LEDOUT register for
     all blue LEDs on for 800 ms
FA,Write,Yes,0,81,25,FF,FF,FF,FF,FF,FF,Comments: Set DMBLNK=1 in MODE2 register
     for blinking and LDRx=11 for group blinking controlled by GRPPWM, GRPFREQ
FA,Write,Yes,0,3F,C0,Comments: write PWMALL = 0xC0h to set the PWMALL at 75% duty
     cycles for all LEDs
FA,Write,Yes,2000,88,40,00,Comments: write GRPPWM=0x40h for duty cycle (ON/OFF
     ratio in 25%) and GRPFREQ= 0x00h (66mS for blinking period) wait for 2 s
FA,Write,Yes,2000,88,80,03,Comments: write GRPPWM=0x80h for duty cycle (ON/OFF
     ratio in 50%) and GRPFREQ= 0x03h (0.26 s for blinking period) wait for 2 s
FA,Write,Yes,2000,88,C0,06,Comments: write GRPPWM=0xC0h for duty cycle (ON/OFF
     ratio in 75%) and GRPFREQ= 0x06h (0.46 s for blinking period) wait for 2 s
FA,Write,Yes,3000,88,F0,09,Comments: write GRPPWM= 0xF0h for duty cycle (ON/OFF
     ratio in 94%) and GRPFREQ=0x09h (0.65 s for blinking period) wait for 3 s
FA,Write,Yes,0,81,Comments: set control register start 01h to read MODE2 register
FA,Read,Yes,0,25,Comments: read MODE2 register, check the OVERTEMP (bit7=0) and
     ERROR (bit6=0)
FA,Write,Yes,0,40,00,Comments: write IREFALL = 00h to turn off all LEDs
Sequence:01,02,03,04,05,06,06,07,08,09,10,11,12,13,14
```

3. After opening the ‘PCA9956B RGB LED blinking demo i2c address = 0xFAh’ text file, the WIN-I2CUSB GUI in Expert mode screen will be displayed as shown in Figure 7.
4. Click the ‘Send All’ button. All the valid messages on the screen will be sent in order of the row number. The action will be performed one time.

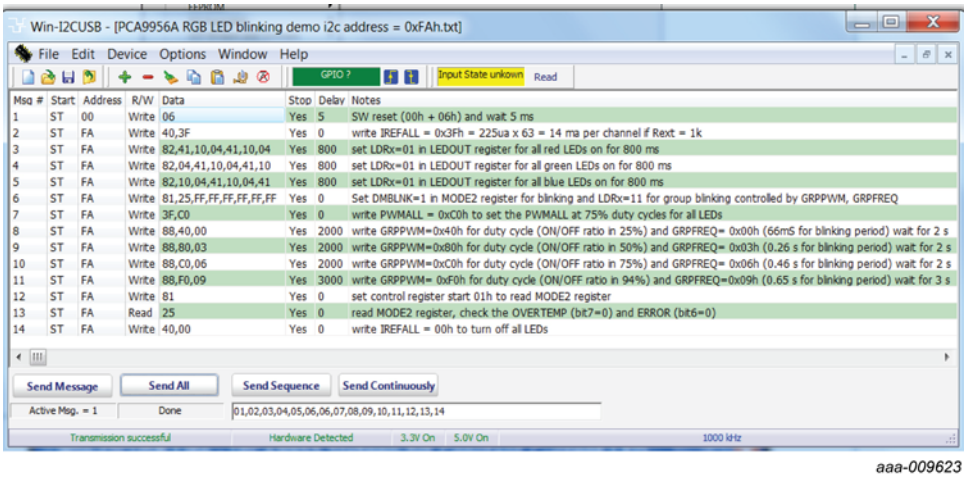

Fig 7. Message data in Expert mode to demonstrate all RGB LEDs for blinking

8.2 Test of LED open or short error detection

The PCA9956B is capable of detecting an LED open or short condition at its open-drain LED outputs. Users will recognize these faults by reading the status of a pair of error bits (ERRx) in error flag registers (EFLAGn) for each channel.

The user can poll the ERROR status bit (bit 6 in MODE2 register) to check if there is a fault condition in any of the 24 channels. The EFLAGn registers can then be read to determine which channels are at fault and the type of fault in those channels.

1. Copy the ‘PCA9956B Open or Short test’ text file as shown below. From the ‘File’ drop-down menus select ‘Open’, and from the ‘open data file’ window select the ‘PCA9956B Open or Short test’ text file.

```
Expert Mode Data File
00,Write,Yes,5,06,Comments: software reset
FA,Write,Yes,0,A2,80,80,Comments: set current to 50% of max in IREF0/IREF1
FA,Write,Yes,0,02,05,Comments: set LED0 and LED1 are fully ON
FA,Write,Yes,1,01,15,Comments: Clear all error status bits in EFLAGn registers by
     writing bit4=1 in MODE2
FA,Read,Yes,0,05,Comments: read ERROR status (bit6) in MODE2
FA,Write,Yes,0,41,Comments: set EFLAG0 register address
FA,Read,Yes,0,00,Comments: Read EFLAG0 status (bit1/0 for LED 0 and bit 3/2 for
     LED1 error status)
FA,Write,Yes,1,01,15,Comments: Clear all error status bits in EFLAGn registers by
     writing bit4=1 in MODE2
FA,Write,Yes,0,A2,00,00,Comments: set output current to zero in IREF0/IREF1
Sequence:01,02,03,04,05,06,07,08,09
```

2. After opening the ‘PCA9956B Open or Short test’ text file, the WIN-I2CUSB GUI in Expert mode screen will be displayed as shown in Figure 8.
3. Click the ‘Send All’ button. All the valid messages on the screen will be sent in order of the row number. The action will be performed one time.

4. To verify the read data on message line 5 for ERROR status and line 7 for EFLAG status.
5. To open the J20 and J23 for open-circuit test on LED0 and LED1, repeat steps 3 and 4 to find the error report in message line 5 and line 7.
6. To short the J18 and J24 for short-circuit test on LED0 and LED1, repeat steps 3 and 4 to find the error report in message line 5 and line 7.

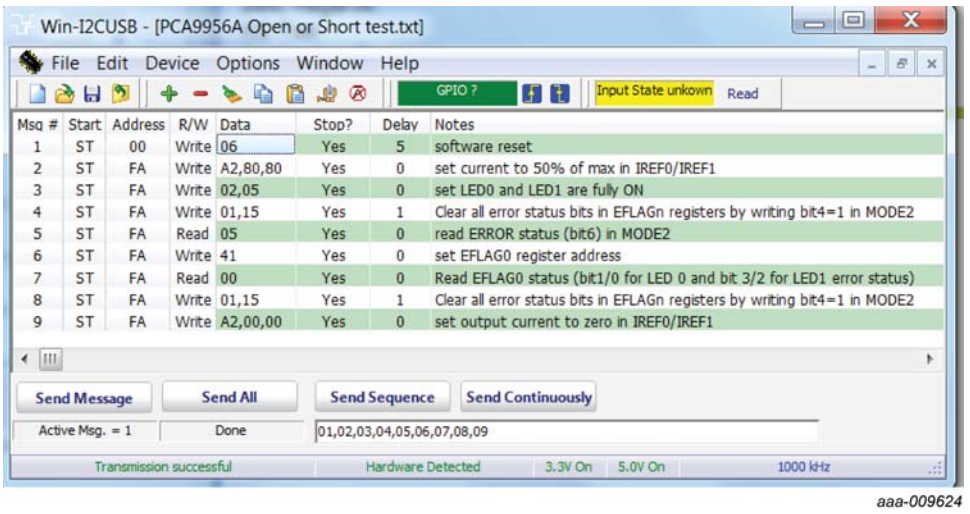

Fig 8. Example of Open or Short-circuit test for LED0 and LED1

9. Support

For support, please send an e-mail to: **i2c.support@nxp.com**

10. Abbreviations

Table 3. Abbreviations

Acronym	Description
ESD	ElectroStatic Discharge
Fm+	Fast-mode Plus
GUI	Graphical User Interface
I^2C-bus	Inter-Integrated Circuit bus
IC	Integrated Circuit
LED	Light Emitting Diode
PC	Personal Computer
PWM	Pulse Width Modulator
RAM	Random Access Memory
RGB	Red/Green/Blue
SMBus	System Management Bus
USB	Universal Serial Bus

11. References

[1] **PCA9956B, 24-channel Fm+ I²C-bus 57 mA / 20 V constant current LED driver —** Product data sheet; NXP Semiconductors

[2] **UM10206, I2C Demonstration Board 2005-1 Quick Start Guide —** NXP Semiconductors; www.nxp.com/documents/user_manual/UM10206.pdf

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