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UM10729

PCA9955A/B demonstration board OM13483

Rev. 2 — 1 August 2017

User manual

Revision history

Rev	Date	Description
2.0	20170801	Added PCA9955B; updated schematics
1.0	20140723	User manual; initial release.

Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

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1. Introduction

The PCA9955A/B evaluation board features LEDs for color mixing, blinking and dimming demonstrations. A graphical interface allows the user to explore the different functions of the driver easily. The board can be connected in series with other I^{2}C demo-boards to create an evaluation system.

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

2. Features

- A complete evaluation platform for the PCA9955A/B 16-channel Fm+ I^{2}C-bus constant current LED driver
- Easy to use GUI-based software demonstrates the capabilities of the PCA9955A/B
- On-board four white and four 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^{2}C-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 www.demoboard.com)

3.4 Power requirements

The NXP demonstration board I2C 2005-1 and OM13483 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 OM13483 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 www.nxp.com/demoboard/OM6275.html.
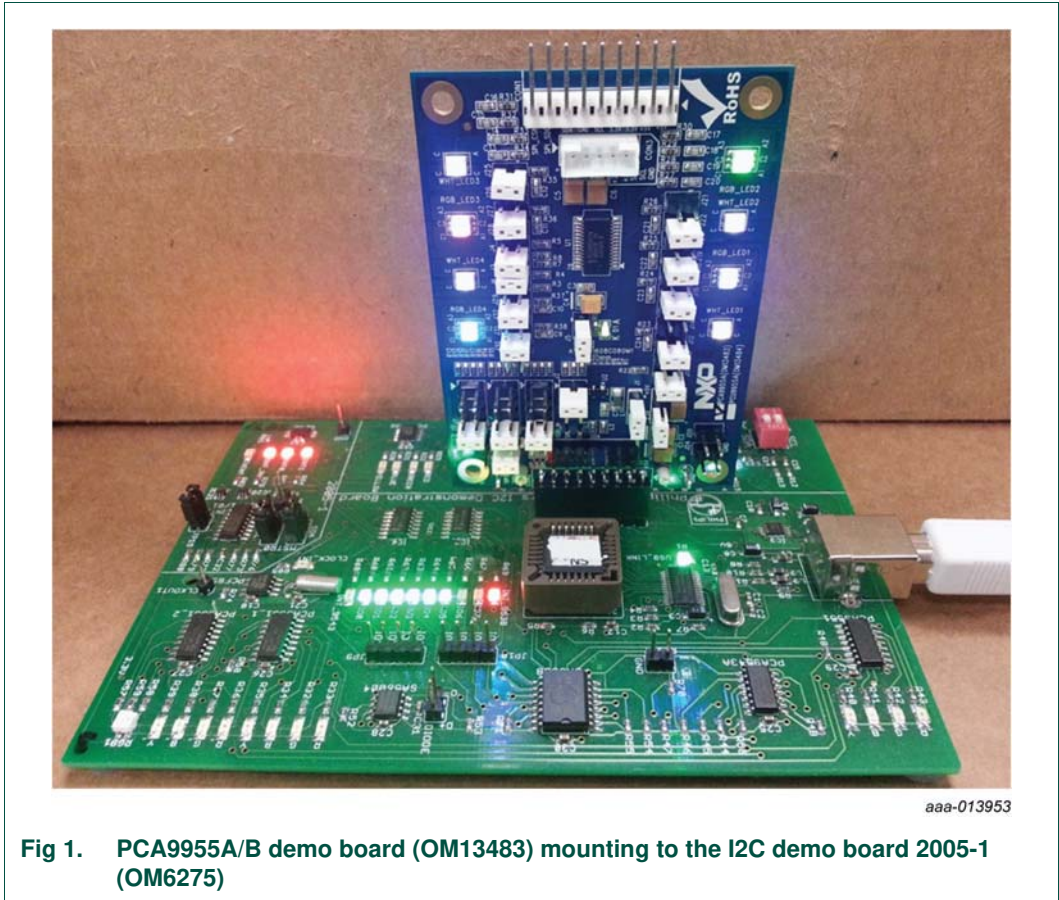
The OM13483 is a daughter card to the OM13260 Fm+ I^2C-bus development board, which is part of the Fm+ development board kit (OM13320). You may download the software, user manual, and find ordering information at the NXP web site: www.nxp.com/demoboard/OM13320.html#documentation.

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 a USB port. The software allows the user to select one of the I^2C-bus devices on the board from a menu. It 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 OM13483 connection to I2C demo board 2005-1

The I2C demo board 2005-1 should be disconnected from your PC before mounting the OM13483 board on to it. The OM13483 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 OM13483 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 PCA9955A/B.

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Fig 1. **PCA9955A/B demo board (OM13483) mounting to the I2C demo board 2005-1 (OM6275)**

4.3 OM13483 connection to Fm+ I2C bus development board

The OM13260 Fm+ I2C bus development board should be disconnected from your PC before mounting the OM13483 board onto it. The OM13483 board has a 9-pin female connector (CON2) that connects to the CN2 male connector on the bridge board (OM13399) as shown in Figure 2.

aaa-014227
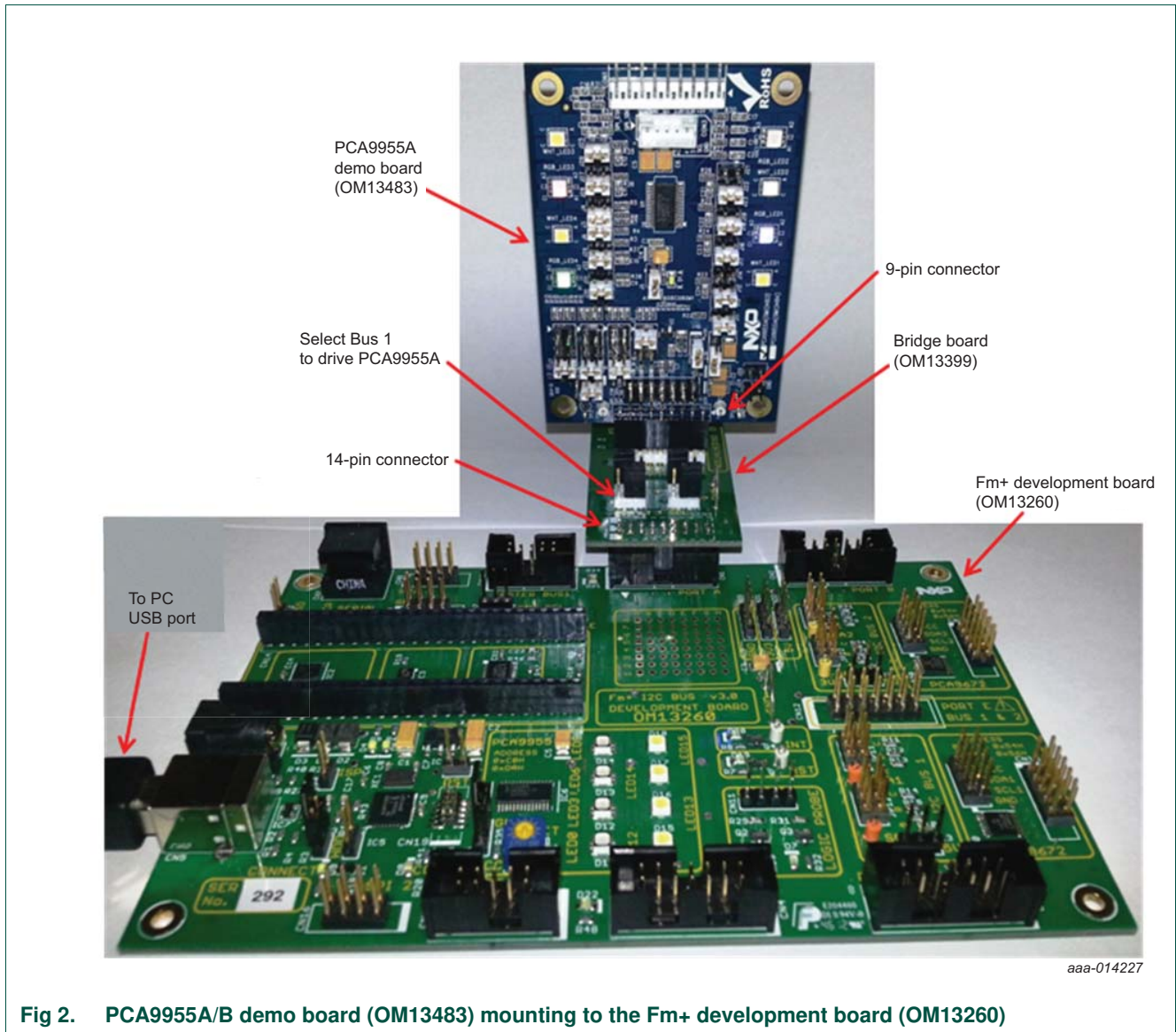
Fig 2.   PCA9955A/B demo board (OM13483) mounting to the Fm+ development board (OM13260)

4.4 OM13483 connection to Win-I2CUSB hardware adapter board

The Win-I2CUSB board should be disconnected from your PC before connecting the OM13483 board on to it. The OM13483 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 3.

Connect the OM13483 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 PCA9955A/B.

Fig 3. **PCA9955A/B demo board (OM13483) connecting to the Win-I2CUSB board**

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5. Hardware description

Fig 4.   PCA9955A/B demo board (OM13483)

Figure 4 shows the following items on the hardware:
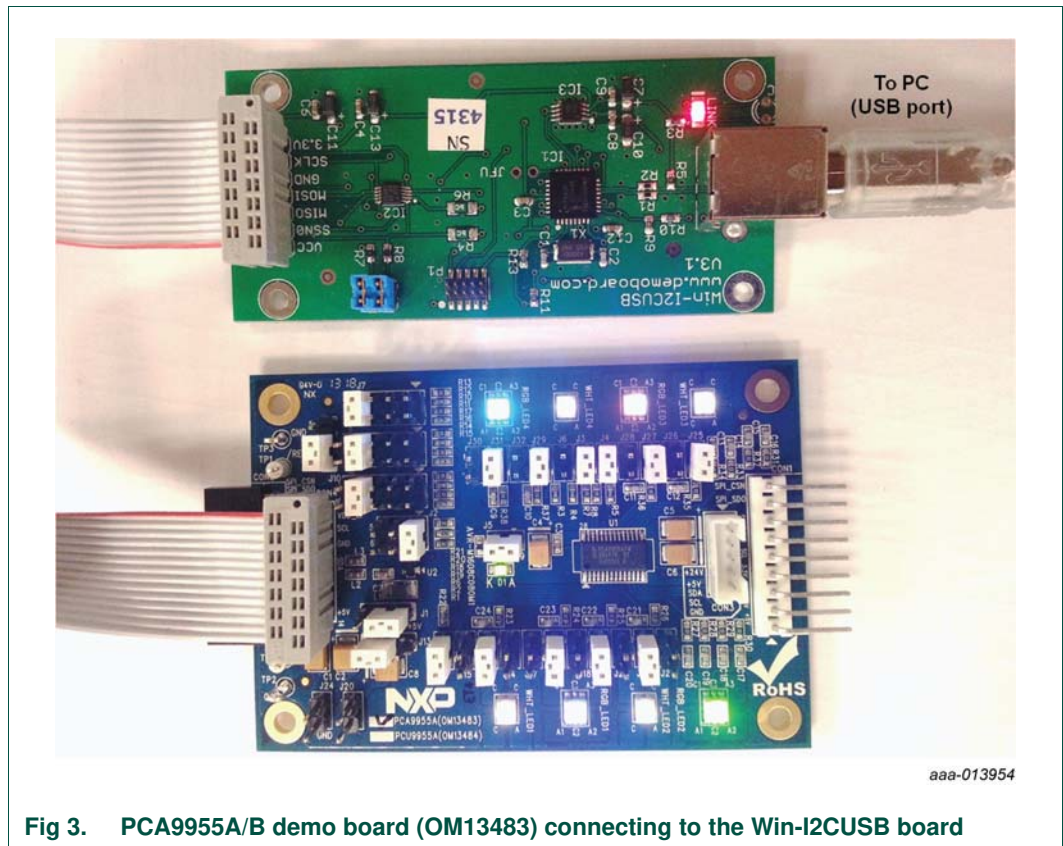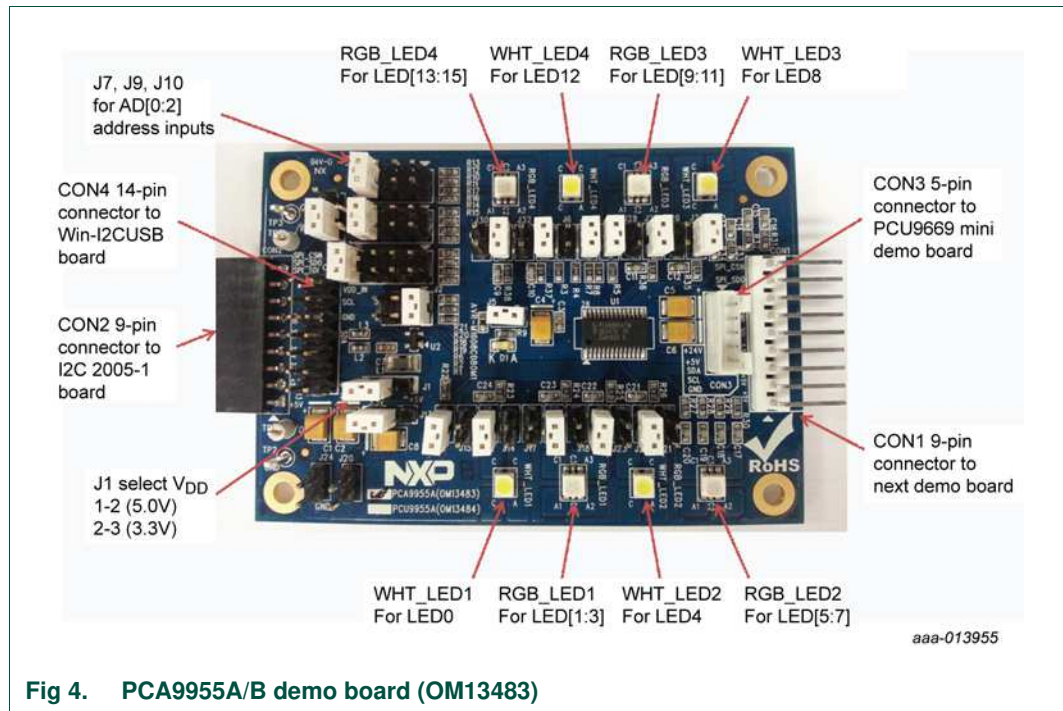
- CON1 (9-pin male connector) is used to daisy-chain to next I^{2}C-bus slave device or demo board.

- 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 I^{2}C-bus master device to drive this demo board.

- CON4 (14-pin male connector) is connected to J1 on Win-I2CUSB hardware board as I^{2}C-bus master device to drive this demo board.

- J1 selects V_{DD} power for PCA9955A/B, connected 1-2 for V_{DD} = 5 V and connected 2-3 for V_{DD} = 3.3 V.

- J7, J9 and J10 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 I^{2}C-bus slave address.

- LED[0:15] 16-channel output to drive four White LEDs (WHT_LED[1:4]) and four RGB LEDs (RGB_LED[1:4]).

- TP2 and TP3 are GND pins for probing use.

- TP1 can be connected as external reset signal to $\overline{RESET}$ pin when J6 is open.

- TP4 can be connected as external output enable signal to $\overline{OE}$ pin for blinking/dimming control when J11 is open.

- All jumpers default setting and function as shown in Table 1.

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

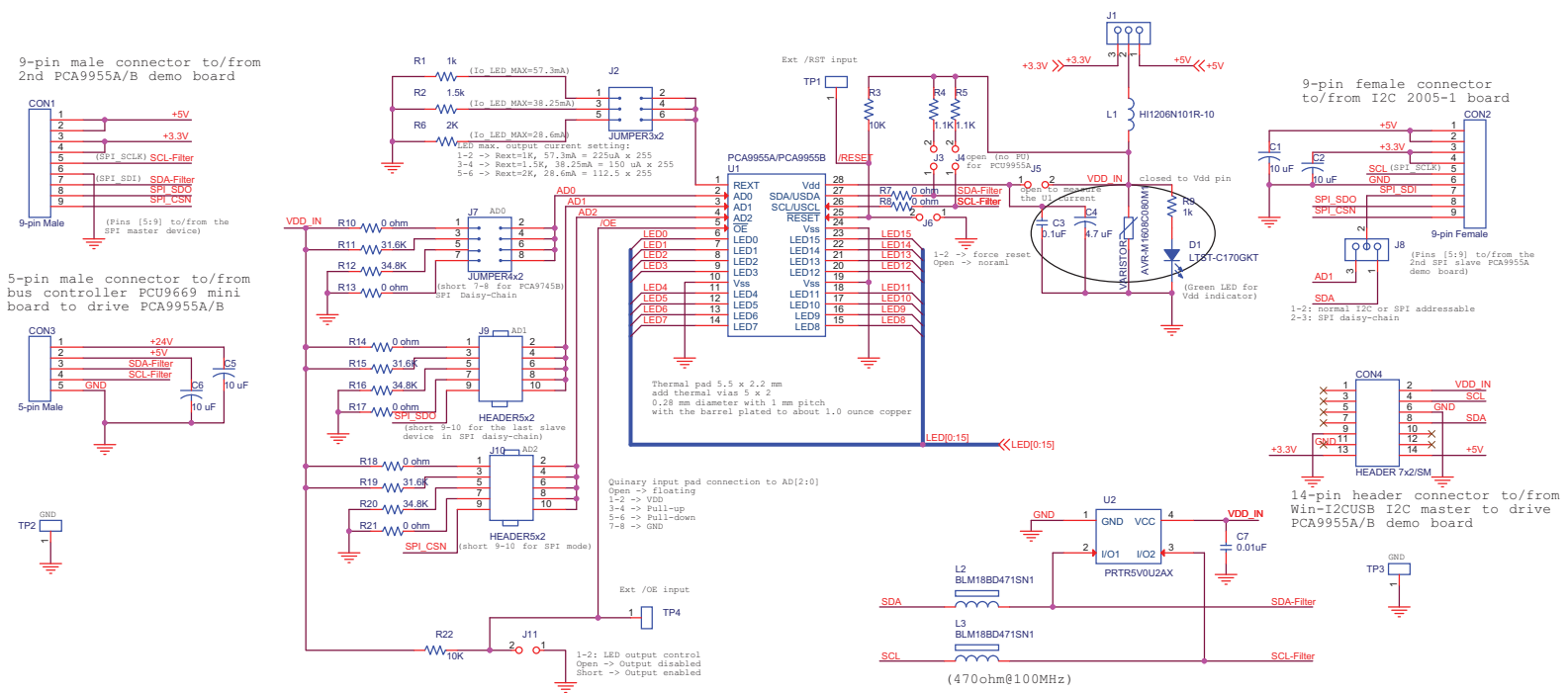| Jumper	Default setting	Comment
J1 (3-pin)	1-2 (V_{DD} = +5 V)	This jumper is used to select V_{DD} for PCA9955A/B. **1-2:** select +5 V **2-3:** select +3.3 V
J2 (3 × 2-pin)	1-2 (REXT = 1 kΩ, 57 mA at max.)	This 3 × 2 jumper is used to select REXT (pin 1) value for PCA9955A/B. **1-2:** select REXT = 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)	Short	**Short:** external 1.1 kΩ pull-up resistor for SDA on PCA9955A/B. **Open:** no external pull-up resistor for SDA on PCA9955A/B. **Remark:** No external pull-up resistor required for PCU9955A.
J4 (2-pin)	Short	**Short:** external 1.1 kΩ pull-up resistor for SCL on PCA9955A/B. **Open:** no external pull-up resistor for SCL on PCA9955A/B. **Remark:** No external pull-up resistor required for PCU9955A.
J5 (2-pin)	Short	**Short:** connect V_{DD} (pin 28) to PCA9955A/B. **Open:** connect current meter to measure the I_{DD} on PCA9955A/B.
J6 (2-pin)	Open	**Short:** force $\overline{RESET}$ (pin 25) to GND. **Open:** 10 kΩ pull-up $\overline{RESET}$ (pin 25) to V_{DD}.
J7 (4 × 2-pin)	7-8[1]	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
J8 (3-pin)	1-2	This jumper is used to select bus mode. **1-2:** select normal I2C or SPI addressable bus mode **2-3:** select SPI daisy-chain bus mode
J9 (5 × 2-pin)	7-8[1]	This 5 × 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 **9-10:** SDO (Serial Data Out) for SPI addressable mode or last slave device in SPI daisy-chain
J10 (5 × 2-pin)	7-8[1]	This 5 × 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 **9-10:** CSN (Chip Select) for SPI bus mode
J11 (2-pin)	Short	**Short:** force $\overline{OE}$ (pin 5) to GND, to enable LEDs output. **Open:** 10 kΩ pull-up $\overline{OE}$ (pin 5) to V_{DD} when applying external clock for blinking/dimming on TP4 (test point).

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

Jumper	Default setting	Comment
J12, J16, J19, J22 (2-pin)	Short	These jumpers are used to open the WHT_LED1 or RGB_LED1 J12 to control White LED, J16 to control Red LED, J19 to control Green LED, J22 to control Blue LED. **Open:** connected the current meter to measure one of the LEDs output current or open one of the LEDs outputs for detecting an LED open condition in one of EFLAGn registers. **Short:** normal operation for WHT_LED1 and RGB_LED1.
J13 (3-pin)	1-2 (V_{LED} = +3.3 V)	This jumper is used to select LED supply voltage. **1-2:** select +3.3 V for all LEDs supply voltage. **2-3:** select +5 V for all LEDs supply voltage. **Open (no jumper):** select external voltage from J20 ($\leq$ +20 V) and J24 (GND)
J14, J18 (2-pin)	Open	These jumpers are used to merge the LED[0:2] outputs together for driving higher LED current. **Open:** normal operation for the LED[0:2]. **Short:** When short J14/J18 and open J16/J19 to combine LED[0:2] outputs to drive LED0. When short J14 only and open J16 to combine LED[0:1] outputs to drive LED0.
J15, J17, J21, J23 (2-pin)	Open	These jumpers are used to short the WHT_LED1 or RGB_LED1 J15 to control White LED, J17 to control Red LED, J23 to control Green LED, J21 to control Blue LED. **Open:** normal operation for WHT_LED1 and RGB_LED1. **Short:** to short one of the LEDs output for detecting an LED short condition in one of EFLAGn registers.
J20 (2-pin)	+20 V input	External $\leq$ +20 V input for LEDs supply voltage. The J13 is **open** to supply this $\leq$ +20 V voltage to all LEDs.
J24 (2-pin)	GND	External GND input for LEDs supply voltage.
J25, J27, J29, J31 (2-pin)	Short	These jumpers are used to open the WHT_LED4 or RGB_LED4. J25 to control White LED, J27 to control Red LED, J29 to control Green LED, J31 to control Blue LED. **Open:** connect current meter to measure one of the LEDs output current or open one of the LEDs outputs for detecting an LED open condition in one of EFLAGn registers. **Short:** normal operation for WHT_LED4 and RGB_LED4.
J26, J28, J30, J32 (2-pin)	Open	These jumpers are used to short the WHT_LED4 or RGB_LED4. J26 to control White LED, J28 to control Red LED, J32 to control Green LED, J30 to control Blue LED. **Open:** normal operation for WHT_LED4 and RGB_LED4. **Short:** to one of the LEDs for detecting an LED short condition in one of EFLAGn registers.
CON1	9-pin male connector	This 9-pin connector is used to daisy-chain to next I²C-bus slave device or demo board.
CON2	9-pin female connector	This 9-pin connector is used to connect to Fm+ I²C development board or I2C 2005-1 evaluation board as master device to drive this demo board.
CON3	5-pin male connector	This 5-pin connector is used to connect to the PCU9669 or PCA9665 mini board as I²C-bus master device to drive this demo board.
CON4	14-pin header	This 14-pin header is used to connect to Win-I2CUSB hardware board as I²C-bus master device to drive this demo board.
TP1	Test Point 1	This TP1 is used to drive $\overline{\text{RESET}}$ input pin 25 from external when J6 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 J11 is **open**.

[1]   Default PCA9955A/B slave address is 0x02h (AD[2:0] = GND).

PCA9955A/PCA9955B (OM13483)
16-ch 57mA/20V CC LED driver Test/Demo Board

9-pin male connector to/from
2nd PCA9955A/B demo board

CON1
+5V
+3.3V
(SPI_SCLK) SCL-Filter
(SPI_SDI) SDA-Filter
SPI_SDO
SPI_CSN
9-pin Male

(Pins [5:9] to/from the
SPI master device)

5-pin male connector to/from
bus controller PCU9669 mini
board to drive PCA9955A/B

CON3
+24V
+5V
SDA-Filter
SCL-Filter
GND
5-pin Male

R1 1k (Io_LED_MAX=57.3mA)
R2 1.5k (Io_LED_MAX=38.25mA)
R6 2K (Io_LED_MAX=28.6mA)

LED max. output current setting:
1-2 -> Rext=1K, 57.3mA = 225uA x 255
3-4 -> Rext=1.5K, 38.25mA = 150 uA x 255
5-6 -> Rext=2K, 28.6mA = 112.5 x 255

J2
JUMPER3x2

VDD_IN

R10 0 ohm
R11 31.6K
R12 34.8K
R13 0 ohm

J7 AD0
JUMPER4x2
(short 7-8 for PCA9745B)
SPI Daisy-Chain)

R14 0 ohm
R15 31.6K
R16 34.8K
R17 0 ohm

J9 AD1
HEADER5x2
(short 9-10 for the last slave
device in SPI daisy-chain)

SPI_SDO

R18 0 ohm
R19 31.6K
R20 34.8K
R21 0 ohm

J10 AD2
HEADER5x2

SPI_CSN
(short 9-10 for SPI mode)

Quinary input pad connection to AD[2:0]
Open -> floating
1-2 -> VDD
3-4 -> Pull-up
5-6 -> Pull-down
7-8 -> GND

AD0
AD1
AD2
/OE

PCA9955A/PCA9955B
U1
REXT   Vdd   28
AD0   SDA/USDA   27
AD1   SCL/USCL   26
AD2   RESET   25
OE   Vss   24
LED0   LED15   23
LED1   LED14   22
LED2   LED13   21
LED3   LED12   20
Vss   Vss   19
LED4   LED11   18
LED5   LED10   17
LED6   LED9   16
LED7   LED8   15

LED0 ... LED15

Thermal pad 5.5 x 2.2 mm
add thermal vias 5 x 2
0.28 mm diameter with 1 mm pitch
with the barrel plated to about 1.0 ounce copper

LED[0:15]

Ext /RST input
TP1

R3 10K
R4 1.1K
R5 1.1K

/RESET

R7 0 ohm   SDA-Filter
R8 0 ohm   SCL-Filter

J3 J4 open (no PU)
for PCU9955A/B

1-2 -> force reset
Open -> noraml

Ext /OE input
TP4
R22 10K
J11
1-2 -> LED output control
Open -> Output disabled
Short -> Output enabled

J1
+3.3V +3.3V   +5V +5V
L1 HI1206N101R-10
VDD_IN
J5 open to measure
the U1 current
J6 closed to Vdd pin

C3 0.1uF C4 4.7 uF
VARISTOR AVR-M16/8C080M
R9 1k
D1 LTST-C170GKT
(Green LED for
Vdd indicator)

GND   U2
GND VCC
I/O1 I/O2
PRTR5V0U2AX

VDD_IN
C7 0.01uF
TP3 GND

L2 BLM18BD471SN1
SDA   SDA-Filter
L3 BLM18BD471SN1
SCL   SCL-Filter
(470ohm@100MHz)

9-pin female connector
to/from I2C 2005-1 board

CON2
+5V
+3.3V
SCL (SPI_SCLK)
GND
SPI_SDI
SPI_SDO
SPI_CSN
9-pin Female

(Pins [5:9] to/from the
2nd SPI slave PCA9955A/B
demo board)

J8
AD1
SDA
1-2: normal I2C or SPI addressable
2-3: SPI daisy-chain

14-pin header connector to/from
Win-I2CUSB I2C master to drive
PCA9955A/B demo board

CON4
VDD_IN
SCL
GND
SDA
+3.3V   +5V
HEADER 7x2/SM

TP2 GND

C5 10 uF
C6 10 uF
C1 10 uF
C2 10 uF

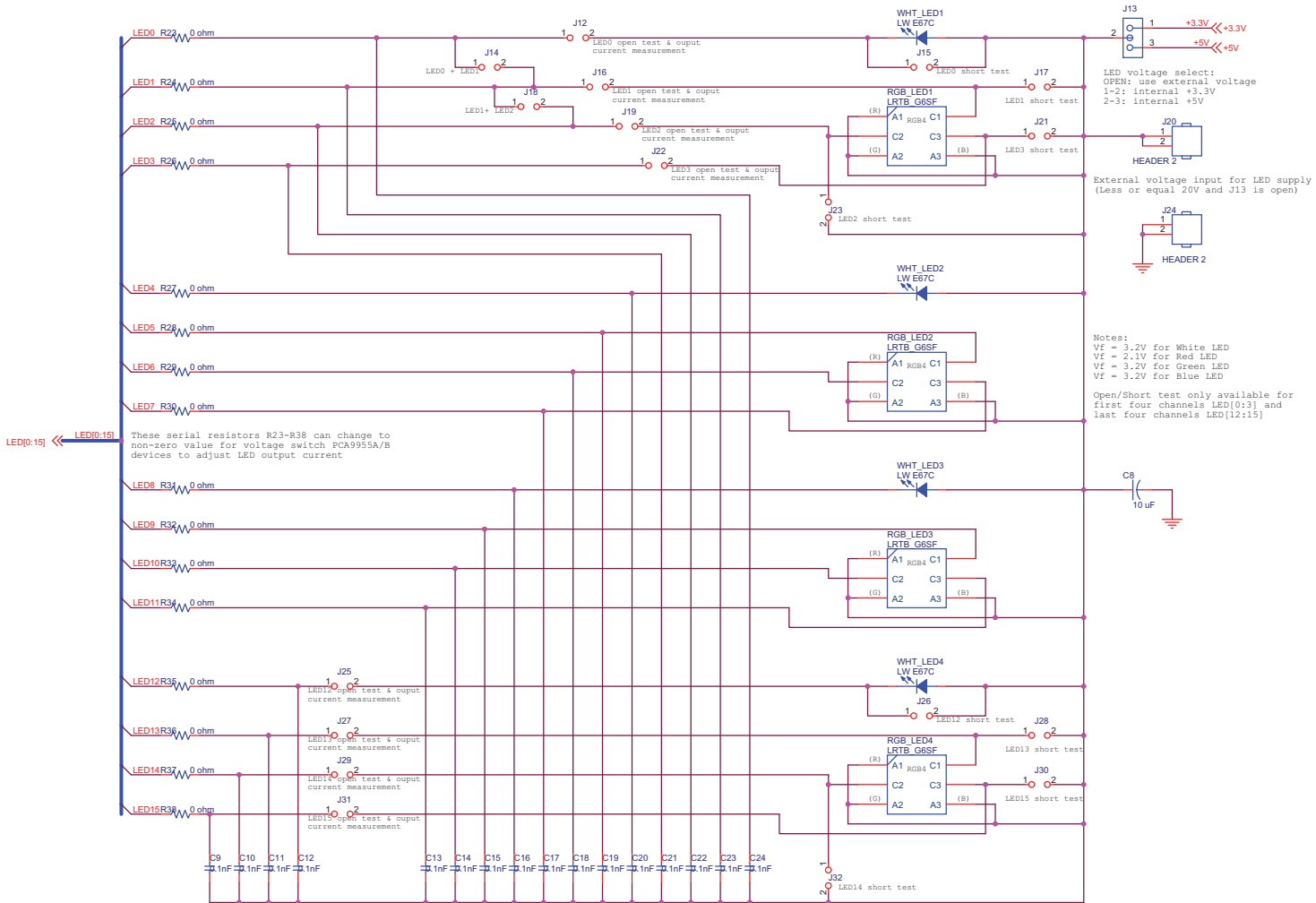| Jumper #	Pin #	PCA9955B (I2C-bus)	PCA9745B (SPI Daisy-Chain)
J7	2	AD0	GND
J9	3	AD1	SDO
J10	4	AD2	/CS
NA	26	SCL	SCLK
J8	27	SDA	SDI

Note:
OM13399 can use to connect this 9-pin female connector
and convert to 14-pin for new I2C development board

aaa-013943

Fig 5. PCA9955A/B demo board schematic (part A)

4-white and 4-RGB LEDs connect to PCA9955A/B 16-channel outputs
(The LEDs supply voltage can be selected either internal +3.3V/+5V or external up to +20V)

LED0 open test & ouput current measurement
LED1 open test & ouput current measurement
LED2 open test & ouput current measurement
LED3 open test & ouput current measurement

LED0 + LED1
LED1+ LED2

LED voltage select:
OPEN: use external voltage
1-2: internal +3.3V
2-3: internal +5V

LED0 short test
LED1 short test
LED3 short test
LED2 short test

External voltage input for LED supply
(Less or equal 20V and J13 is open)

Notes:
Vf = 3.2V for White LED
Vf = 2.1V for Red LED
Vf = 3.2V for Green LED
Vf = 3.2V for Blue LED

Open/Short test only available for
first four channels LED[0:3] and
last four channels LED[12:15]

These serial resistors R23-R38 can change to
non-zero value for voltage switch PCA9955A/B
devices to adjust LED output current

LED12 open test & ouput current measurement
LED13 open test & ouput current measurement
LED14 open test & ouput current measurement
LED15 open test & ouput current measurement

LED12 short test
LED13 short test
LED15 short test
LED14 short test

WHT_LED1 LW E67C
WHT_LED2 LW E67C
WHT_LED3 LW E67C
WHT_LED4 LW E67C

RGB_LED1 LRTB_G6SF
RGB_LED2 LRTB_G6SF
RGB_LED3 LRTB_G6SF
RGB_LED4 LRTB_G6SF

aaa-013944

Fig 6. PCA9955A/B demo board schematic (part B)

7. OM13483 demonstration board main components

Table 2.   OM13483 demo board main components

Device	Description	Address/LED	Location
PCA9955BTW	16-channel Fm+ I^{2}C-bus 57 mA / 20 V constant current LED driver	0x02h for I^{2}C demo board (default setting)	U1
PRTR5V0U2AX	ESD protection diode	-	U2
LW-E67C	White LED	4 white LEDs	WHT_LED[1:4]
LRTB_G6SG	RGB LED	4 RGB LEDs	RGB_LED[1:4]
LTST-C170GKT	Green LED for PCA9955A/B power supply either 3.3 V or 5 V indicator	1 green LED	D1

8. PCA9955A/B evaluation steps

The PCA9955A/B is controlled by Win-I2CUSB GUI in Expert mode, as shown in Figure 7.
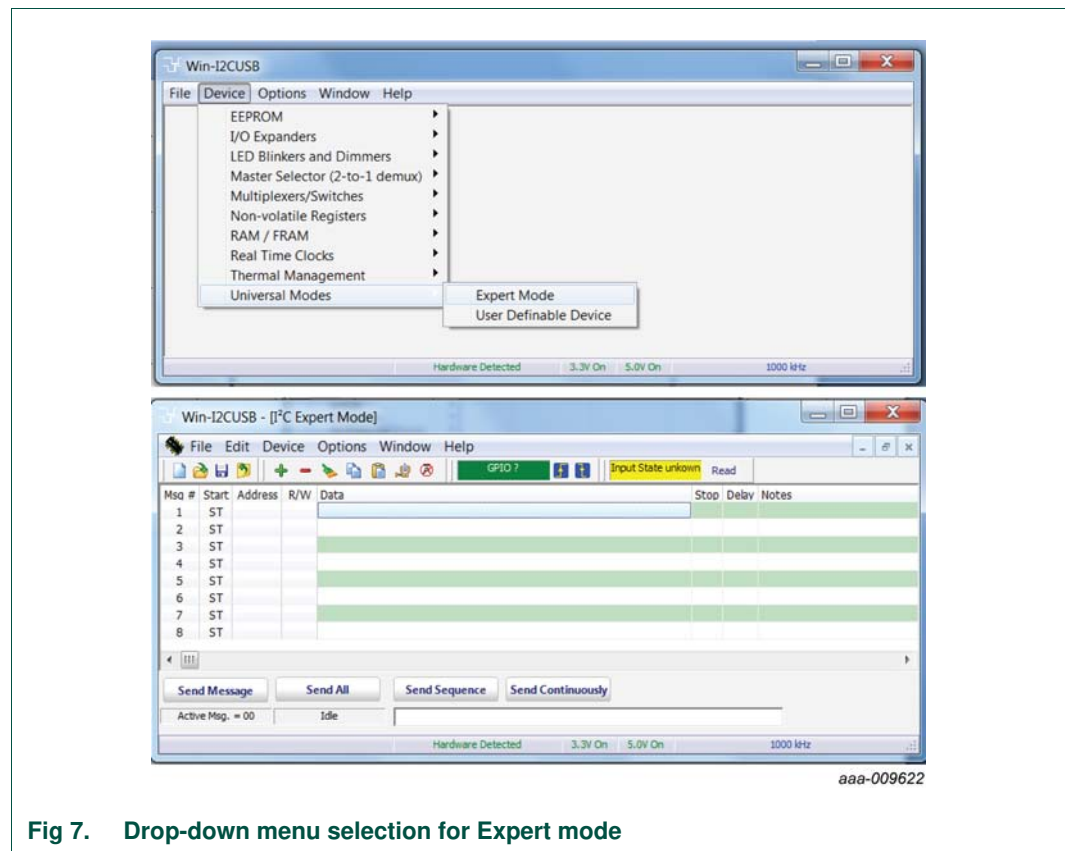
Fig 7.   Drop-down menu selection for Expert mode

Connect the hardware as described in Section 4. All jumpers are in default setting and device address is set to 0x02 on J7, J9 and J10 (set AD[0:2] = GND) for PCA9955A/B 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 7, 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 the 3.3 V or 5.0 V symbols on the bottom of the window. Power supplies are disabled by default and must be enabled before using the I^{2}C-bus devices on the board. I^{2}C-bus frequency is controlled through the 'Options' menu or by double-clicking the frequency symbol on the bottom of the window.

8.1 PCA9955A/B blinking demo for all White and 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 7.

2. Copy the 'PCA9955A/B WHT_RGB LEDs blinking demo i2c address = 0x02h' text file as shown below. From the 'File' drop-down menus select 'Open', and from the 'open data file' window select the 'PCA9955A/B WHT_RGB LEDs blinking demo i2c address = 0x02h' text file.

```
Expert Mode Data File
00,Write,Yes,0,06,Comments: SW reset
02,Write,Yes,0,45,80,Comments: write IREFALL to 80h (225 uA x 128 = 28.8 mA per
    channel)
02,Write,Yes,500,82,01,01,01,01,Comments: start write LEDOUTx register to turn on
    white LEDs
02,Write,Yes,700,82,04,04,04,04,Comments: start write LEDOUTx register to turn on
    red LEDs
02,Write,Yes,500,82,01,01,01,01,Comments: start write LEDOUTx register to turn on
    white LEDs
02,Write,Yes,700,82,10,10,10,10,Comments: start write LEDOUTx register to turn on
    green LEDs
02,Write,Yes,500,82,01,01,01,01,Comments: start write LEDOUTx register to turn on
    white LEDs
02,Write,Yes,700,82,40,40,40,40,Comments: start write LEDOUTx register to turn on
    blue LEDs
02,Write,Yes,300,82,01,00,00,00,Comments: start write LEDOUTx register to turn on
    white LEDs
02,Write,Yes,300,82,00,05,00,00,Comments: start write LEDOUTx register to turn on
    white, red LEDs
02,Write,Yes,300,82,00,00,51,00,Comments: start write LEDOUTx register to turn on
    white, Blue_Green LEDs
02,Write,Yes,300,82,00,00,00,55,Comments: start write LEDOUTx register to turn on
    white and RGB LEDs
02,Write,Yes,400,82,40,01,04,10,Comments: start write LEDOUTx register to turn on
    white and RGB LEDs
02,Write,Yes,400,82,10,40,01,04,Comments: start write LEDOUTx register to turn on
    white and RGB LEDs
02,Write,Yes,400,82,04,10,40,01,Comments: start write LEDOUTx register to turn on
    white and RGB LEDs
02,Write,Yes,400,82,01,40,10,04,Comments: start write LEDOUTx register to turn on
    white and RGB LEDs
```

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```
02,Write,Yes,0,81,21,FF,FF,FF,FF,Comments: start write 01h register to program the
    DMBLNK=1 for blinking, LDRx=11 for group dimming/blinking controlled by
    GRPPWM, GRPFREQ
02,Write,Yes,0,44,C0,Comments: write PWMALL register to set the PWMx=C0h 75% duty
    cycles for individual LED
02,Write,Yes,2000,86,40,00,Comments: write GRPPWM=40h for duty cycle (ON/OFF ratio
    in 25%) and GRPFREQ= 00h (67 ms for blinking period)
02,Write,Yes,2000,86,80,01,Comments: write GRPPWM=80h for duty cycle (ON/OFF ratio
    in 50%) and GRPFREQ= 02h (131 ms for blinking period)
02,Write,Yes,2000,86,A0,02,Comments: write GRPPWM=C0h for duty cycle (ON/OFF ratio
    in 62.5%) and GRPFREQ= 04h (196 ms for blinking period)
02,Write,Yes,2000,86,C0,03,Comments: write GRPPWM=FFh for duty cycle (ON/OFF ratio
    in 75%) and GRPFREQ= 06h (262 ms for blinking period)
00,Write,Yes,0,06,Comments: SW reset
Sequence:01,02,03,04,05,06,07,08,09,10,11,12,13,14,15,16,17,18,19,20,21,22,23
```

3. After opening the 'PCA9955A/B WHT_RGB LEDs blinking demo i2c address = 0x02h' text file, the Win-I2CUSB GUI in Expert mode screen will be displayed as shown in Figure 8.

4. Click the 'Send All' button. All the valid messages on the screen is sent in order of the row number (Msg #). The action is performed one time.

aaa-013956
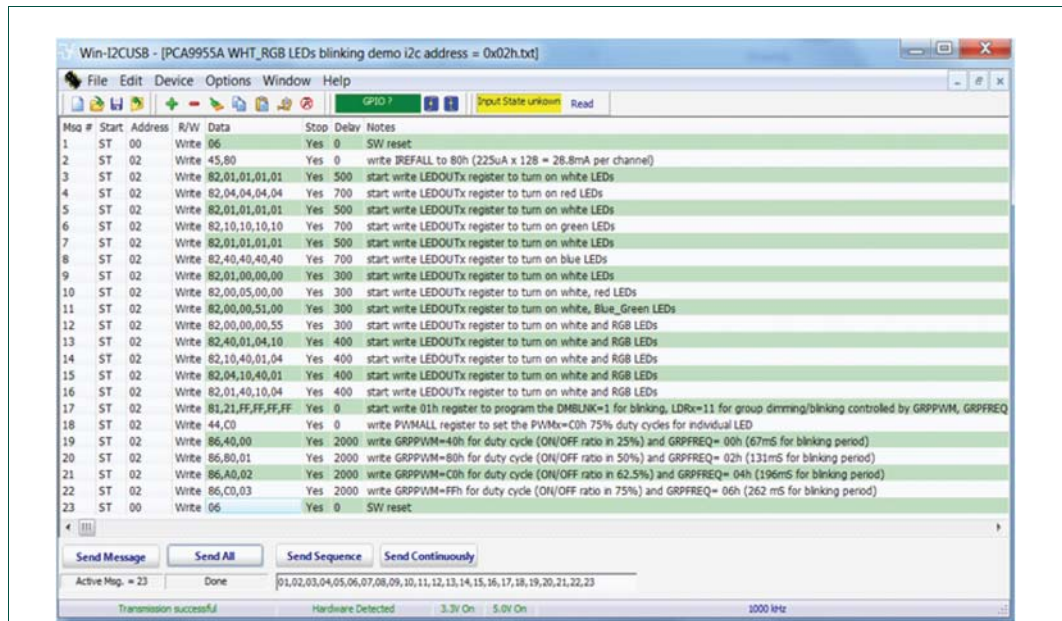
Fig 8. **Message data in Expert mode to demonstrate all White and RGB LEDs for blinking**

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8.2 Test of LED open or short error detection

The PCA9955A/B can detect an LED open or short condition at its open-drain LED outputs. Users 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 16 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 'PCA9955A/B 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 'PCA9955A/B Open or Short test' text file.

```
Expert Mode Data File
00,Write,Yes,5,06,Comments: software reset
02,Write,Yes,0,98,80,80,Comments: set current to 50% of max in IREF0/IREF1
02,Write,Yes,50,02,05,Comments: set LED0 and LED1 are fully ON
02,Write,Yes,1,01,11,Comments: Clear all error status bits in EFLAGn registers by
     writing bit4=1 in MODE2
02,Read,Yes,0,01,Comments: read ERROR status (bit6) in MODE2
02,Write,Yes,0,46,Comments: set EFLAG0 register address
02,Read,Yes,0,00,Comments: Read EFLAG0 status (bit1/0 for LED 0 and bit 3/2 for
     LED1 error status)
02,Write,Yes,1,01,11,Comments: Clear all error status bits in EFLAGn registers by
     writing bit4=1 in MODE2
02,Write,Yes,0,98,00,00,Comments: set output current to zero in IREF0/IREF1
Sequence:01,02,03,04,05,06,07,08,09
```

2. After opening the 'PCA9955A/B Open or Short test' text file, the Win-I2CUSB GUI in Expert mode screen will be displayed as shown in Figure 9.

3. Click the 'Send All' button. All the valid messages on the screen is sent in order of the row number (Msg #). The action is 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 J12 and J16 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 J15 and J17 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.

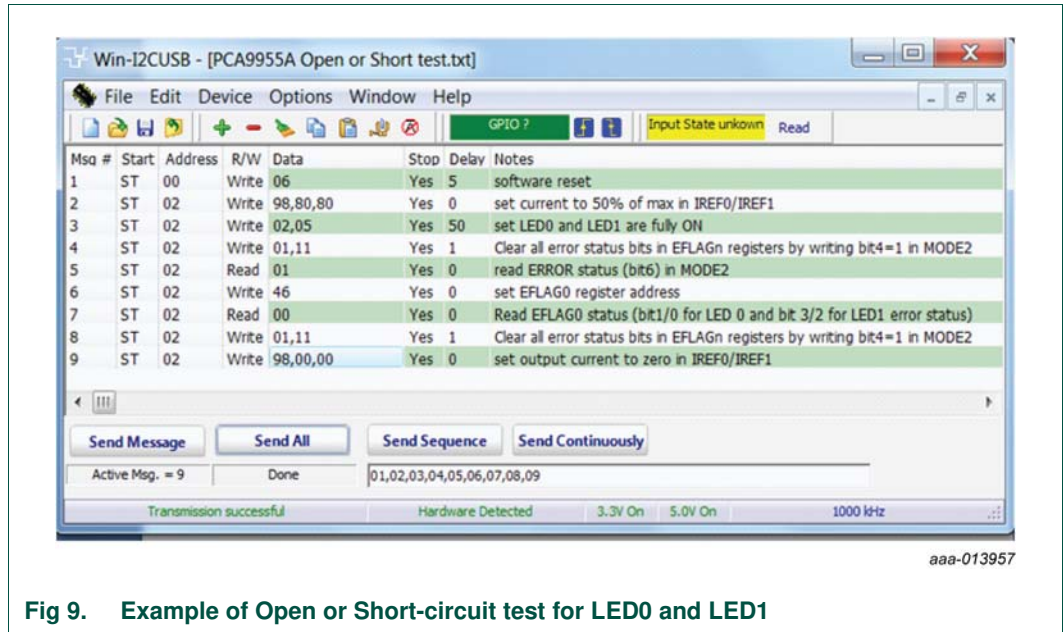**Fig 9.** **Example of Open or Short-circuit test for LED0 and LED1**

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9. PCA9955A/B evaluation steps with Fm+ development board

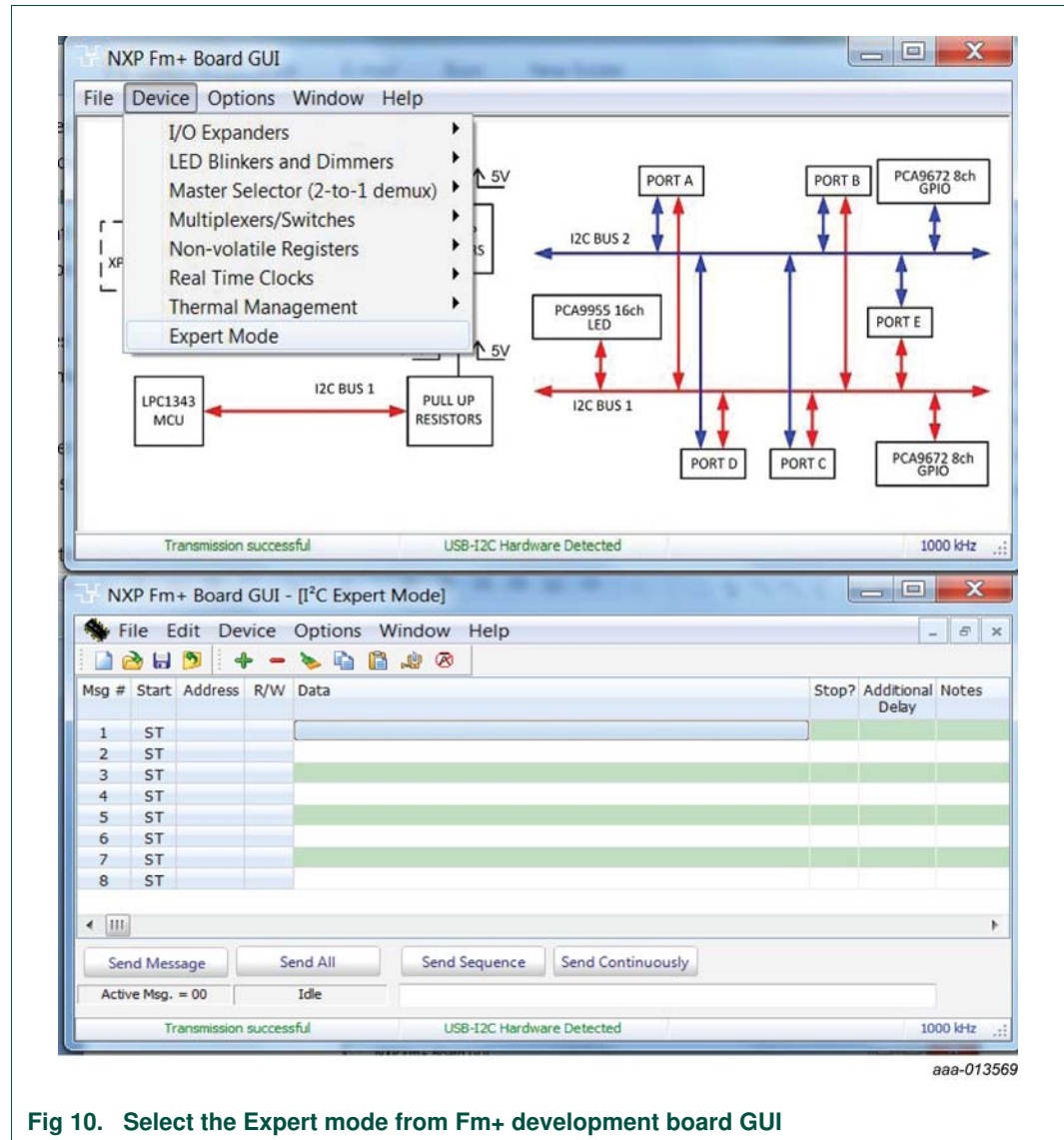The PCA9955A/B is controlled by Fm+ development board GUI in Expert mode, as shown in Figure 10.

Fig 10. Select the Expert mode from Fm+ development board GUI

Connect the hardware as described in Section 4.3. All jumpers are in default setting and device address is set to 0x02 on J7, J9 and J10 (set AD[0:2] = GND) for PCA9955A/B demo board. When you have correctly installed the software and the demonstration board hardware is connected and recognized by the computer, start the Fm+ development board software. As shown in Figure 10, when the demonstration board hardware is correctly connected to the USB port and the computer recognizes it, the message 'USB-I2C Hardware Detected' is displayed on the bottom of the window.

9.1 PCA9955A/B blinking and gradation demo for all LEDs

1. From the 'Device' drop-down menus select 'Expert Modes' as shown in <u>Figure 10</u>.

2. Copy the 'PCA9955A/B WHT_RGB LEDs blinking & gradation demo i2c address = 0x02h' text file as shown below. From the 'File' drop-down menus select 'Open', and from the 'open data file' window to select the 'PCA9955A/B WHT_RGB LEDs blinking & gradation demo i2c address = 0x02h' text file.

Expert Mode Data File
```
00,Write,Yes,0,06,Comments: SW reset
02,Write,Yes,0,45,80,Comments: write IREFALL to 80h (225uA x 128 = 28.8mA per
        channel)
02,Write,Yes,500,82,01,01,01,01,Comments: start write LEDOUTx register to turn on
        white LEDs
02,Write,Yes,700,82,04,04,04,04,Comments: start write LEDOUTx register to turn on
        red LEDs
02,Write,Yes,500,82,01,01,01,01,Comments: start write LEDOUTx register to turn on
        white LEDs
02,Write,Yes,700,82,10,10,10,10,Comments: start write LEDOUTx register to turn on
        green LEDs
02,Write,Yes,500,82,01,01,01,01,Comments: start write LEDOUTx register to turn on
        white LEDs
02,Write,Yes,700,82,40,40,40,40,Comments: start write LEDOUTx register to turn on
        blue LEDs
02,Write,Yes,300,82,01,00,00,00,Comments: start write LEDOUTx register to turn on
        white LEDs
02,Write,Yes,300,82,00,05,00,00,Comments: start write LEDOUTx register to turn on
        white, red LEDs
02,Write,Yes,300,82,00,00,51,00,Comments: start write LEDOUTx register to turn on
        white, Blue_Green LEDs
02,Write,Yes,300,82,00,00,00,55,Comments: start write LEDOUTx register to turn on
        white and RGB LEDs
02,Write,Yes,400,82,40,01,04,10,Comments: start write LEDOUTx register to turn on
        white and RGB LEDs
02,Write,Yes,400,82,10,40,01,04,Comments: start write LEDOUTx register to turn on
        white and RGB LEDs
02,Write,Yes,400,82,04,10,40,01,Comments: start write LEDOUTx register to turn on
        white and RGB LEDs
02,Write,Yes,400,82,01,40,10,04,Comments: start write LEDOUTx register to turn on
        white and RGB LEDs
02,Write,Yes,0,81,21,FF,FF,FF,FF,Comments: start write 01h register to program the
        DMBLNK=1 for blinking, LDRx=11 for group dimming/blinking controlled by
        GRPPWM, GRPFREQ
02,Write,Yes,0,44,C0,Comments: write PWMALL register to set the PWMx=C0h 75% duty
        cycles for individual LED
02,Write,Yes,2000,86,40,00,Comments: write GRPPWM=40h for duty cycle (ON/OFF ratio
        in 25%) and GRPFREQ= 00h (67mS for blinking period)
02,Write,Yes,2000,86,80,01,Comments: write GRPPWM=80h for duty cycle (ON/OFF ratio
        in 50%) and GRPFREQ= 02h (131mS for blinking period)
02,Write,Yes,2000,86,A0,02,Comments: write GRPPWM=C0h for duty cycle (ON/OFF ratio
        in 62.5%) and GRPFREQ= 04h (196mS for blinking period)
```

```
02,Write,Yes,2000,86,C0,03,Comments: write GRPPWM=FFh for duty cycle (ON/OFF ratio
    in 75%) and GRPFREQ= 06h (262 mS for blinking period)
00,Write,Yes,0,06,Comments: write SW reset
02,Write,Yes,0,81,01,Comments: set linear curve
02,Write,Yes,0,82,05,05,05,05,Comments: set LDR= 01, turn white & red LED ON
02,Write,Yes,1,A8,C1,47,C9,78,00,00,00,00,00,00,00,00,00,00,00,00,33,33,00,00,00,
    00,03,Comments: set group0 in continuous mode, IREF_GRP=120x225=27mA,
    60-step, 64ms & 450ua per step, ramp up/dn time 3.9s & hold on/off (0.25s)
02,Write,Yes,8200,45,01,Comments: set IREFALL not 0 to enable LED outputs
00,Write,Yes,0,06,Comments: write SW reset
02,Write,Yes,1,81,05,Comments: set exponential curve
02,Write,Yes,0,82,11,11,11,11,Comments: set LDR= 01, turn white & green LED ON
02,Write,Yes,1,A8,C1,47,C9,78,00,00,00,00,00,00,00,00,00,00,00,00,55,55,00,00,00,
    00,03,Comments: set group0 in continuous mode, IREF_GRP=240x225=27mA,
    60-step, 64ms &450ua per step, ramp up/dn time 3.9s & hold on/off (0.25s)
02,Write,Yes,8200,45,01,Comments: set IREFALL not 0 to enable LED outputs
00,Write,Yes,0,06,Comments: write SW reset
02,Write,Yes,1,81,05,Comments: set exponential curve
02,Write,Yes,0,82,41,41,41,41,Comments: set LDR= 01, turn white & blue LED ON
02,Write,Yes,1,A8,C1,47,C9,78,00,00,00,00,00,00,00,00,00,00,00,00,99,99,00,00,00,
    00,03,Comments: set group0 in continuous mode, IREF_GRP=240x225=27mA,
    60-step, 64ms &450ua per step, ramp up/dn time 3.9s & hold on/off (0.25s)
02,Write,Yes,8200,45,01,Comments: set IREFALL not 0 to enable LED outputs
00,Write,Yes,0,06,Comments: write SW reset
Sequence:01,02,03,04,05,06,07,08,09,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,
    25,26,27,28,29,30,31,32,33,34,35,36,37,38
```

3. After opening the 'PCA9955A/B WHT_RGB LEDs blinking & gradation demo i2c address = 0x02h' text file, the 'NXP Fm+ Board GUI' in Expert mode screen is displayed as shown in Figure 11.

4. Click the 'Send All' button. All the valid messages on the screen will be sent in the order of the row number (Msg #). The action will be performed one time.
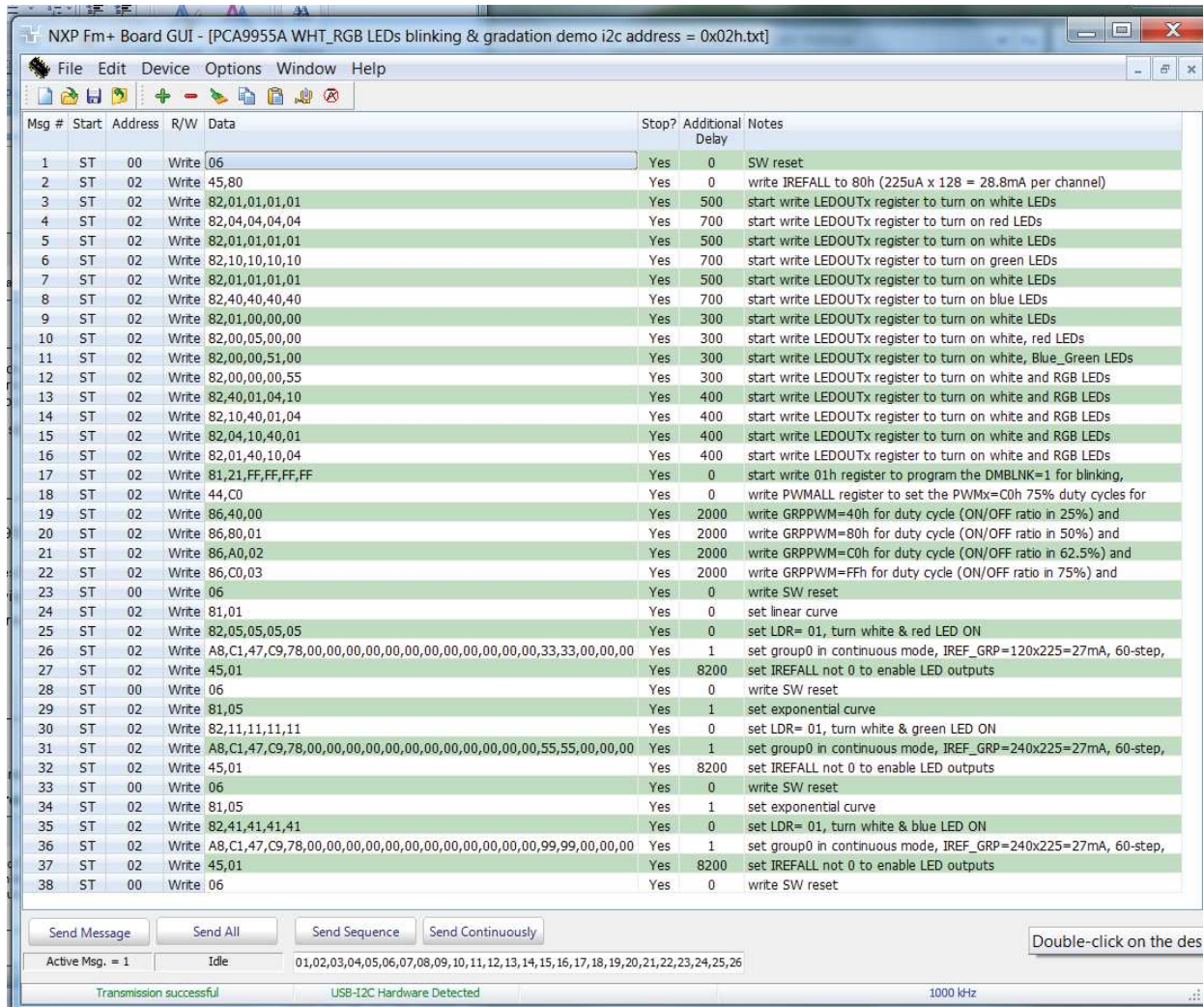
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Fig 11. **Message data in Expert mode to demo all White and RGB LEDs for blinking and gradation**

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10. Support

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

11. Abbreviations

Table 3.   Abbreviations

Acronym	Description
ESD	ElectroStatic Discharge
Fm+	Fast-mode Plus
GUI	Graphical User Interface
I^{2}C-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
RGBA	Red/Green/Blue/Amber
SMBus	System Management Bus
USB	Universal Serial Bus

12. References

[1]   **PCA9955A, 16-channel Fm+ I^{2}C-bus 57 mA / 20 V constant current LED driver —** Product data sheet; NXP Semiconductors; www.nxp.com/documents/data_sheet/PCA9955A.pdf

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

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