Application Note

How to Configure an I2C Push-Pull IO Expander to Operate as Open Drain

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ABSTRACT

This document walks through the process to configure I2C IO expanders with push-pull outputs to operate as open drain outputs.

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1 Introduction

A common question that comes up about TI's I2C IO expanders is whether or not the portfolio includes open drain output IO expanders. While TI does have IO expanders that include open drain configuration (TCAL series and PCF8575C), in reality all of TI's push-pull IO expanders have the capability to operate as open drain.

2 How to Configure Push-Pull IOs for Open Drain

In a normal push-pull setup, the user can first set the configuration register to be an output then afterwords write to the output register to set the register as an output high or output low. Setting up an open drain configuration is actually very similar.

The following example walks through how to set up using TCA9539 (16-bit IO expander). The command byte table for TCA9539 is provided in Table 2-1 for reference. Examples from this point on can assume TCA9539's device address pins to be tied to V_{cc} and therefore can have an I2C 7-bit target address of 0x77h. An external pull up resistor can be tied to P07 and P17 to allow for the signal to rise to V_{cc}, otherwise the toggling can possibly not be visible from a oscilloscope perspective.

Step 2 and step 3 examples show bits P07 and P17 alternate as open drain output low and high impedance while the other pins (Px6-Px0) alternate relative to the 7th bit (if Px7 is high impedance then Px6-Px0 can open drain out lows and if Px7 is open drain output lows then Px6-Px0 can be high impedance).

Table 2-1. Command Byte

Command Byte	Register	Power-up default	Comments
0x00h	Input Port 0	XXXX XXXX	Not used in this application note
0x01h	Input Port 1	XXXX XXXX	Not used in this application note
0x02h	Output Port 0	1111 1111	Defaults as 1's, 0 = output low
0x03h	Output Port 1	1111 1111	Defaults as 1's, 0 = output low
0x04h	Polarity Inversion Port 0	0000 0000	Not used in this application note
0x05h	Polarity Inversion Port 1	0000 0000	Not used in this application note
0x06h	Configuration Port 0	1111 1111	Defaults as input, 0 = output
0x07h	Configuration Port 1	1111 1111	Defaults as input, 0 = output

1. Write to the output register to set the pins that need to be open drain to be a logic low, this won't actually make the pins output low until the configuration registers are set to output.
   - This step can be thought as initializing the device to be used for open drain.

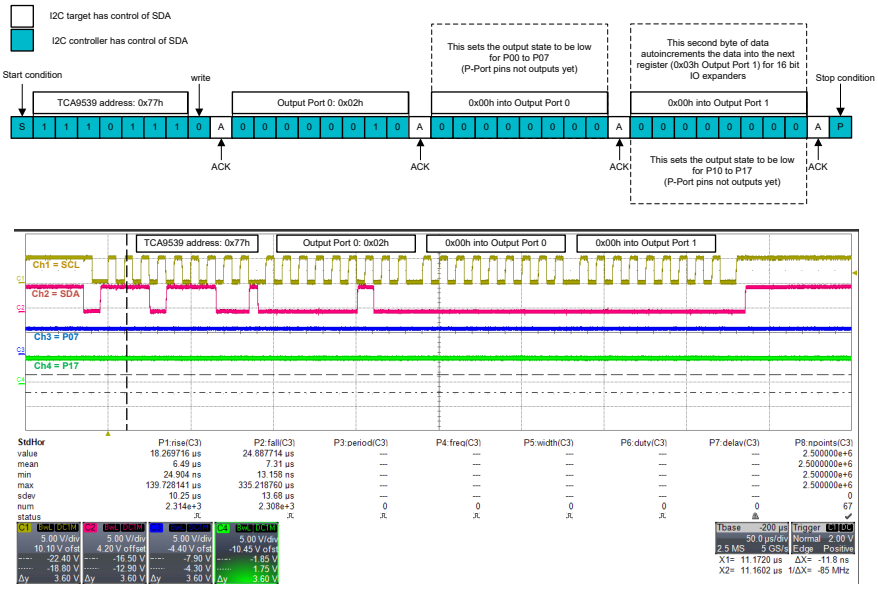

Figure 2-1. Initialize Output Port Example

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2. Write to the configuration register to make the p-port pins either drive low or high-Z.
   - For this example, P07 remains a high impedance input while P06-P00 output low and P17 outputs low while P16-P10 main high impedance.

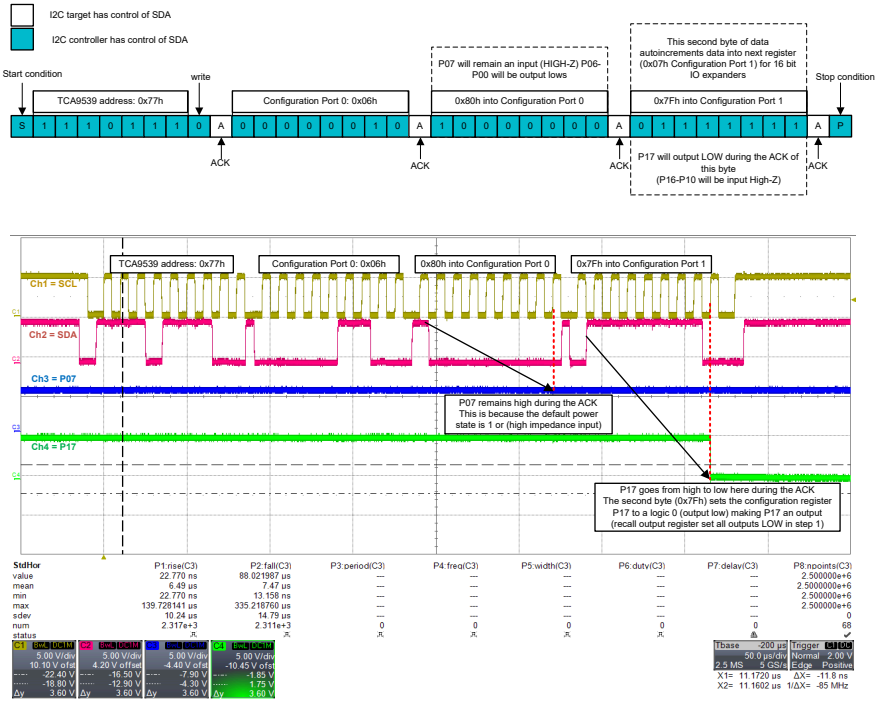

Figure 2-2. Setting the Configuration Registers Example

3. Write to the configuration register to change the p-port pins either drive low or high-Z.
   - For this example, P07 is changed to be an outputs low while P06-P00 change to high impedance inputs and P17 is set as a high impedance input while P16-P10 are output lows.

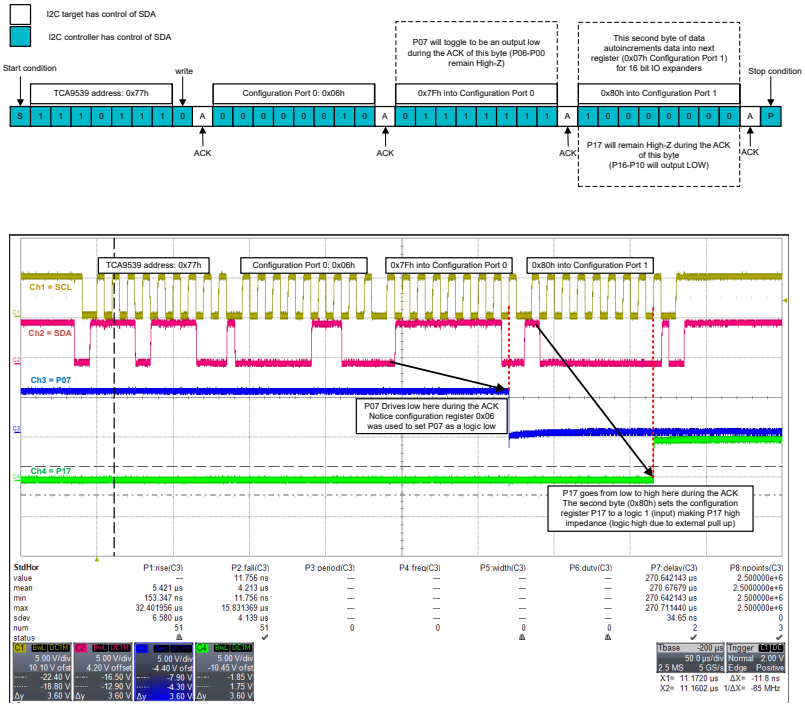

Figure 2-3. Flipping Configuration Register Example

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3 What Differences are There Between the Dedicated Open Drain IO Expanders and This Method?

Other devices with the same device address and the same register set can function the same way if the I2C software were written or setup in the way described in this document. This means hardware dedicated open drain IO expanders and push-pull IO expanders can use the same I2C library if the output register were set to be output lows and then the device were controlled using only the configuration registers.

For dedicated open drain IO expanders, if the code were written to set the device to be an output through the configuration register and then used the output register to toggle between output low and high (can be high impedance) then the push-pull IO expanders can possibly not be able to sit on the same socket and can generate an active high on the output instead.

4 Summary

In summary, any I2C I/O expander can be programmed through the configuration register to individually control the output structure of the I/O pin. The output can be either push-pull or open-drain for individually selected pins.

5 References

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- Texas Instruments, *TCAL9538 8-Bit I2C-Bus, SMBus I/O Expander With Interrupt Output, Reset, and Agile I/O Configuration Registers*, data sheet.
- Texas Instruments, *TCAL9539-Q1 Automotive Low-Voltage 16-Bit I2C-Bus, SMBus I/O Expander with Interrupt Output, Reset, and Configuration Registers*, data sheet.
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- Texas Instruments, *TCA6408A-Q1 Low-Voltage 8-Bit I2C and SMBus I/O Expander With Interrupt Output*, data sheet.
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- Texas Instruments, *TCA9554 Low Voltage 8-Bit I2C and SMBus Low-Power I/O Expander With Interrupt Output and Configuration Registers*, data sheet.
- Texas Instruments, *TCA9554A Low Voltage 8-Bit I2C and SMBus Low-Power I/O Expander With Interrupt Output and Configuration Registers*, data sheet.
- Texas Instruments, *TCA6424A Low-Voltage 24-Bit I2C and SMBus I/O Expander With Interrupt Output, Reset, and Configuration Registers*, data sheet.
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