Application Note

Multiplexers & Switches for Fast Mode Plus I2C Applications

ABSTRACT

The purpose of this document is to highlight the TCA984X I2C multiplexer and switch family capabilities and implementation in Fast Mode Plus I2C applications.

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Trademarks

1 Introduction

Modern systems use different protocols to communicate between parts. One of those protocols is I2C, where there is a controller communicating with different targets on the I2C bus. Usually, such systems leverage I2C multiplexers to allow communication with more targets without worrying about address conflicts or bus capacitance. Advancements in technology have improved the I2C protocol, allowing communication to be faster than before. Fast Mode Plus allows the I2C bus to transfer signals at 1MHz speeds compared to older modes operating at only 400kHz. To still be able to leverage the benefits of implementing a multiplexer in I2C systems, it must be able to support faster speed communications introduced by the Fast Mode Plus. The TCA984X family can provide such a design.

2 Application

Data centers and AI accelerators implement I2C controlled systems using a controller that initiates communication and sends commands or addresses to multiple targets. They respond to the controller when addressed and act as data sources or sinks (for example sensors). Communication between the controller and targets is done on the I2C bus. Due to advancements in complexity of modern design, the number of targets in systems increased. More targets are present per bus lane. This can result in issues such as address conflicts where there are not enough available register addresses to be able to communicate to all targets (target addresses are fixed). I2C uses static, or fixed, addressing that can lead to potential problems. Another issue is that the I2C protocol has a bus capacitance limitation of 400pF to maintain signal integrity and clean communication without too many parasitics on the communication bus. The additional targets per bus increase the total capacitance and can exceed the limit, leading to communication issues in the system.

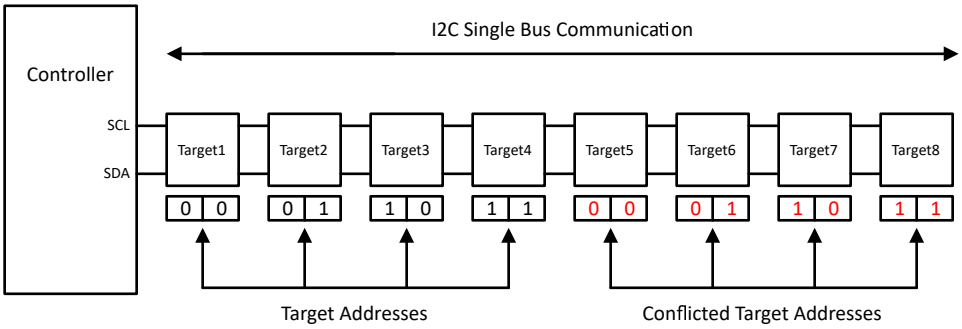

Figure 2-1. I2C Address Conflicts

A common design to counter these issues is to implement an I2C multiplexer or switch such as the TCA9848. This allows the splitting of the I2C communication bus to different lanes depending on the configuration. Instead of having a single bus with many targets, there can be multiple I2C communication lanes with few targets in each one. It benefits the system by reducing the parasitic capacitance per lane. The mux also has its own I2C addresses correlated to its channels. It allows for more targets to be communicated to without the concern of having address conflicts.

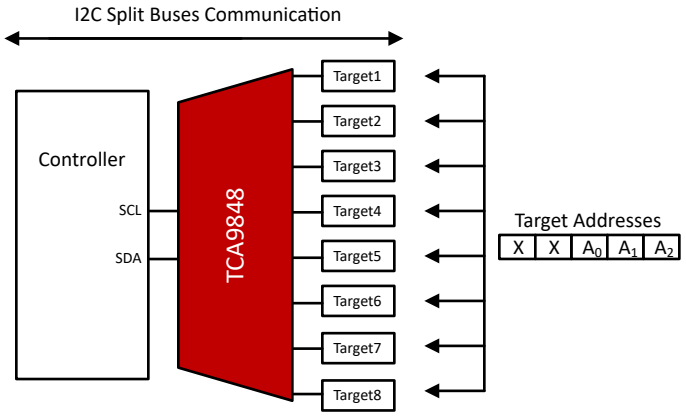

Figure 2-2. I2C Switch Solution

Switches such as the TCA9846 and TCA9848 can communicate directly to all targets at the same time, while the TCA9847 and TCA9849 muxes can communicate to only one target at a time. The caveat with the switches is that the same I2C signal is sent to all targets.

I2C standard communication is usually at 400kHz clock frequency. Advancements in the protocol introduced a newer mode called *Fast Mode Plus*. The communication was ramped up to 1MHz clock frequency, allowing the transfer of information to up to 1Mbps. To support these modes and faster speeds, the TCA984X family was developed. It is backward compatible and supports Fast or Standard mode for bidirectional communication in a mixed-speed I2C bus system.

An additional aspect of I2C is where a controller and the targets use different supply voltages. The TCA9848 or any other I2C switch or mux from the TCA984x family, allows the system to select each channel and translate up or down the bus signals to match the voltage level the controller and targets are passing and operating at. These devices can translate from 0.65V up to 3.3V.

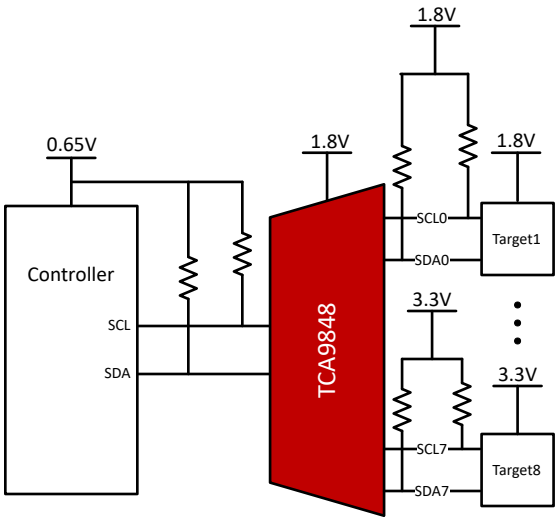

Figure 2-3. I2C Switch Voltage Translation

3 Summary

The TCA984X I2C switch, and mux family provides a design for address conflicts and exceeded bus capacitance in I2C communication systems. This supports standard and fast mode plus communication with backward compatibility as well as voltage translation as low as 0.65V.

Table 3-1. TCA984X Family Selection Table

Specification	TCA9846	TCA9847	TCA9848	TCA9849
Operating Range	1.65V to 3.6V	1.65V to 3.6V	1.65V to 3.6V	1.65V to 3.6V
Translation Range	0.65V to 3.3V	0.65V to 3.3V	0.65V to 3.3V	0.65V to 3.3V
Max I2C Frequency	1MHz	1MHz	1MHz	1MHz
Temperature Range	-40C to 125C	-40C to 125C	-40C to 125C	-40C to 125C
Configuration	4:1 Switch	8:1 Mux	8:1 Switch	4:1 Mux

4 References

- Texas Instruments, I2C and I3C Protocol Aware Multiplexers and Switches, product page.
- Texas Instruments, I2C and I3C GPIO Control Multiplexers and Switches, product page.

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