Product Overview

How to Support Two Controllers on the I2C Bus, Avoid Bus Contention, and Prevent Controller Failures

TEXAS INSTRUMENTS

Multiplexers in I2C Applications

In I2C applications, analog multiplexers can allow for two controllers to communicate at different speeds and identify and isolate faulty devices from the rest of the bus. These devices have logic control inputs that allow the toggling of signal paths which alters the flow of communication without the need to write I2C commands or go through controller bus arbitration. These devices do not have internal pull-ups and when implementing I2C communication with these devices, there must be pull-up resistors on both the controller and target sides to prevent glitching when switching channels. Additionally, many TI analog switches and multiplexers provide sufficient bandwidth to support various I2C speeds, including standard mode (100kHz), fast mode (400kHz), high-speed mode (3.4MHz), and ultra-fast mode (5MHz).

Bus Contention

Bus contention can occur in I2C communication applications where multiple controllers operate at different communication speeds. For instance, in an I2C application, one controller can communicate with the target device in standard mode (100kHz), while another controller attempts to communicate in fast mode plus (1MHz). This situation, if not properly managed, can lead to bus contention, where multiple controllers try to communicate with the target simultaneously. This contention can result in inaccurate data being written to or read from the target device.

To prevent this issue, we can implement a 2:1, 2-channel multiplexer between the controllers and the target. The multiplexer provides isolation between each controller, maintaining that only one controller is allowed to send data on the bus at any given time.
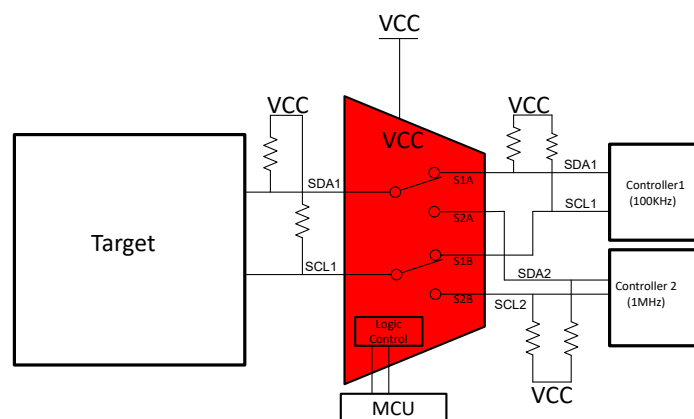

Figure 1. Example Application of 2:1 2 Channel Multiplexers for I2C Communication

How to Support Two Controllers on the I2C Bus, Avoid Bus Contention, and Prevent Controller Failures

Controller Device Failure

To maintain continuous communication among devices on an I2C bus, system designers require a method to identify and eliminate faulty devices from the signal line. To demonstrate how a multiplexer can address this issue, consider a vision sensor for autonomous driving as the target device in Figure 2. This particular sensor is critical for maintaining reliable communication, as any failure can pose significant risks to the driver. If for any reason, there is a malfunction in controller 2 while communicating over lines SDA2 and SCL2, the MCU can easily adjust the select bits to deactivate inputs S2A and S2B and activate S1A and S1B signals. This switches the flow of communication to a controller that is still actively working, providing a quick fix to a loss of communication for an important control system sensor.
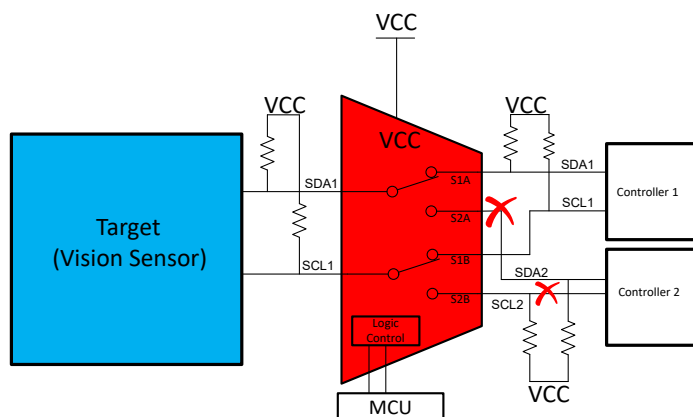
Figure 2. Protection Against Controller Failure Using 2:1 2 Channel Multiplexers for I2C Communication

In addition, other analog multiplexers that support I2C applications are also available as seen in Table 1.

Table 1. Recommended Parts

I2C Voltage Levels	Supply Voltage Levels	Part Number	Additional Features
1.2V 1.8V 3.3V 5V	1.8V, 3.3V, and 5V	TS5A23157-Q1	Automotive qualified
	1.8V, 3.3V, and 5V	TS5A23159	Powered-off protection
	3.3V	TMUX121	1.8V compatible control inputs and powered-off protection
	3.3V	TMUX154E	1.8V compatible control inputs, powered-off protection and Supports input voltage beyond supply
	3.3V and 5V	TMUX1072	1.8V compatible control inputs, overvoltage protection, powered-off protection, and supports input voltage beyond supply

References

• Texas Instrument, *Understanding the I2C Bus* application report
• Texas Instrument, *I2C Bus Pullup Resistor Calculation* application report

IMPORTANT NOTICE AND DISCLAIMER