I2c   Pros and Cons   Electronics   Electrical Engineering

What are the pros and cons of I2C versus SPI interface?

5 Answers

Yuan Gao, Engineer

5.1k Views • Upvoted by Mikael Bengtsson, Electrical Engineer. VLSI/Digital design
Yuan has 170+ answers in Electrical Engineering.

I2C pros/SPI cons

- I2C needs fewer connections: only 2 signal wires needed, versus 3+n for SPI where n is the number of slave devices that need SSEL or CS lines (i.e. on SPI, if you have five devices, you need 3+5 lines).

- I2C uses chip addressing, which means that there is no need for SSEL/CS lines (same as above), and I2C devices can easily be added to the bus. To add a device to an SPI bus, you would need to add an extra SSEL/CS line, and you would need to know exactly which SSEL/CS lines are connected to which devices.

- I2C uses an open collector bus, which allows some flexibility in bus voltage (in many cases, but not all cases, 3.3V and 5V logic devices can be mixed). On SPI, the bus voltage must be whatever is supported by all devices.

- I2C is multi-master. It is possible for multiple devices on the bus to be the master device, and also to switch a device between master and slave device (if supported), without needing to change the wiring. On SPI, the master/slave relationships are fixed by the wiring.

SPI pros/I2C cons

- SPI has a simpler protocol, and on most microcontrollers has lower processing overheads. I2C on most microcontrollers requires a software-driven stack to control the protocol.

- SPI has faster speeds and longer ranges. SPI can use push-pull, and therefore can drive lines faster than I2C, whose open-collector design means that slew rates are limited, and affected by line capacitance.

- SPI runs full-duplex since it has separate lines for transmit and receive. I2C is half-duplex only.

- SPI uses SSEL/CS lines, allowing multiple chips of the same kind to be connected. On I2C, there are usually only a limited number of user-selectable address combinations for a chip (and requires the address to be selected at the circuit design stage), and address conflicts are possible between two different chips.

Summary: I2C is more flexible. SPI is faster.

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I2C pros: simple addressing, only two lines per bus one clock and one data for all connected devices.

I2C cons: slow communication speeds 100 kHz and 400 kHz for fast mode. I have seen 1.2 MHz though.

SPI pros: No upper limit on communication speed in the protocol itself. It is only limited by its electrical interface and connected devices. 50 MHz and up are used with SD cards in SPI mode. Note that most PCs use MMC with SD cards at much higher speeds.

SPI cons: A separate chip select is required to address each device thus using up precious gpio pins. This can be mitigated with an IO multiplexer.

Lower levels of the interface must be considered, such as most significant byte vs least significant byte, clock phase and polarity. However, this also gives it versatility in communicating with client devices.

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1. I2C requires only 2 pins for as many as 128 devices(theoretically speaking) because it uses addressing in software. SPI requires 3+N pins for where N is the number of devices connected(chip selects).
2. I2C can be used for inter board communication as well over longer distances compared to SPI.
3. Bandwidth of I2C is limited compared higher bandwidth of SPI.

With these major differences normally in any implementation, the deciding factor is #1 said above.

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Yuan Gao's answer is well written, accurate and thought out and complete.

I agree completely.

Written 31 Mar • Answer requested by Chaitanya Anvk

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