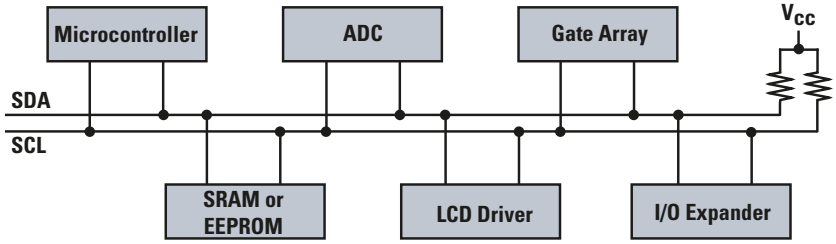
# I²C Serial Bus Devices

## I²C Serial Bus Overview

A complete I²C system usually has at least one microcontroller, peripheral memory, hard disk, graphic chip and other I/O subsystems. The I²C bus is popular in computing, consumer electronics and communications since it allows easy two-line communication between two systems using a Serial DAta line (SDA) and a Serial CLock line (SCL). The I²C bus has three modes of operation: standard mode (0 to 100 kbps), enhanced mode (0 to 400 kbps) and high-speed mode (0 to 3.4 Mbps). Because all successive enhancements to the specification are backward compatible, mixed-mode communication is possible with the speed of the bus being controlled by the Bus Master chip.



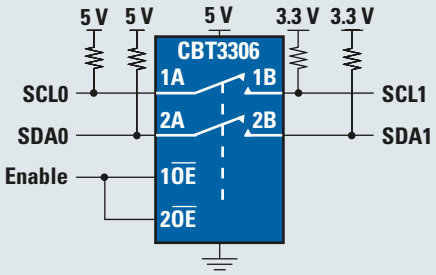

## Common I²C Application Problems

### Mixed-Voltage Levels

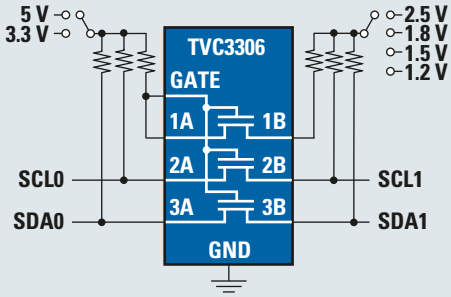
I²C-bus devices currently in the market range in supply voltage from 1.5 V to 5 V with commensurate I/O and threshold levels. Operating mixed threshold-level devices on the same bus requires level translation.

The two level-translation examples here show how dual-channel signal switches can be used to translate I²C signals (SDA and SCL) between mixed-voltage levels typically found in ICs and systems.

**Level-Translation Example 1**




**Level-Translation Example 2**

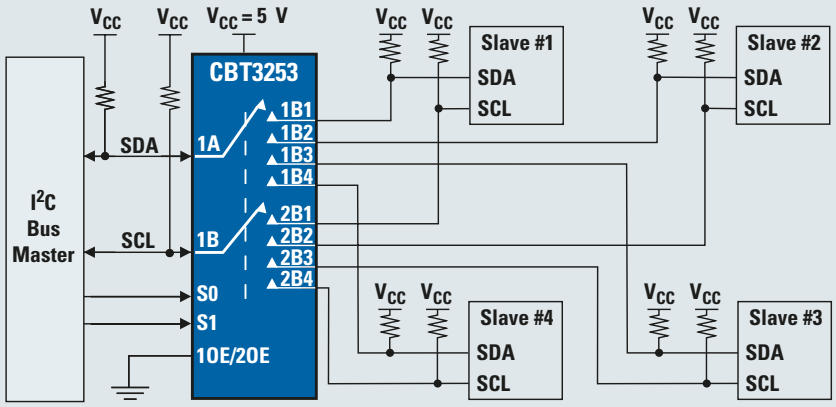



### Address Conflict/Bus Contention

I²C addresses for two different functions, such as LCD controller or temperature sensor, are intentionally unique to prevent bus contention. However, when identical components are used, the designer may be forced to connect two devices with the same address to the bus and cause addressing conflicts because there is no way to isolate one device from the others.

One I²C/SMBus multiplexer solution for address conflicts is to use the CBT3253, a near-zero delay, bi-directional, dual 1:4 multiplexer signal switch that operates at 5 V and is available in a tiny 16-pin QFN package. Data paths are selected through the use of control input select pins (S0 and S1). Using this device, the SDA and SCL signal pair can be fanned out allowing up to four devices with identical addresses. Further, the CBT3253 may be used to decrease the loading seen by the bus master in applications with many I²C devices or larger wiring capacitance to ensure that the 400-pF maximum allowed in the I²C specification is not exceeded.

**I²C/SMBus Multiplexer Example**




| Inputs S1 | Inputs S0 | Function | Selection |
|---|---|---|---|
| L | L | 1A = 1B1, 2A = 2B1 | Slave #1 |
| L | H | 1A = 1B2, 2A = 2B2 | Slave #2 |
| H | L | 1A = 1B3, 2A = 2B3 | Slave #3 |
| H | H | 1A = 1B4, 2A = 2B4 | Slave #4 |

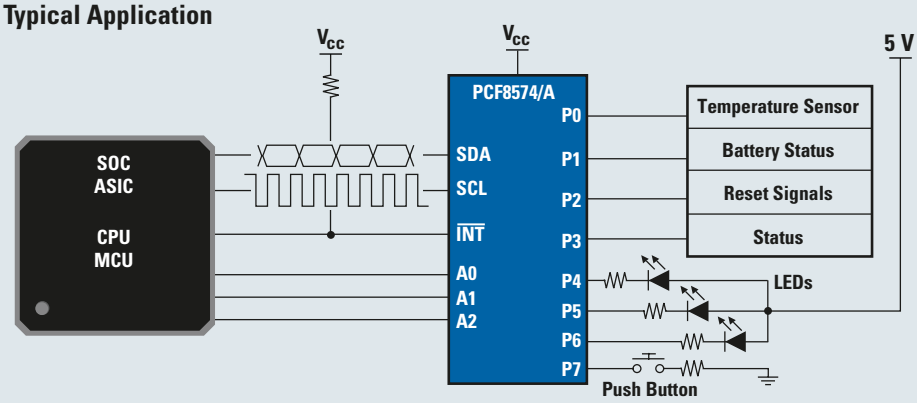
# PCF8574/A (8-Bit I/O Expander for I²C-Bus)

The PCF8574 and PCF8574A, which comply with Philips I²C protocol, provide an 8-bit, general-purpose, remote I/O expander for the I²C bus. These I/O expander devices have low-current consumption and include latched outputs with high-current drive capability for directly driving LEDs. The only difference between the devices is the I²C address. The PCF8574 has an I²C address of 0100XXX and the address for the PCF8574A is 0111XXX.

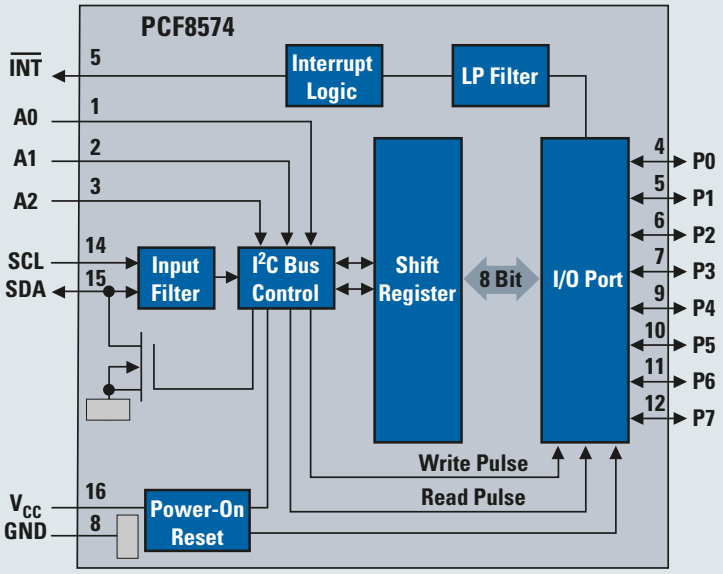
## Features

- Pin-to-pin compatible and functionally equivalent with Philips PCF8574 and PCF8574A (SOIC and TSSOP packages)
- Smallest industry package options:
  - 20-pin QFN package (62% smaller than 20-pin TSSOP)
  - 20-pin TVSOP package (23% smaller than 20-pin TSSOP)
- Two-wire I²C-bus to 8-bit bidirectional parallel-bus expander
- Operating supply voltage from 2.5-V to 6-V $V_{CC}$
- Low standby-current consumption of 10 µA maximum
- Open drain interrupt output to signal a change on an I/O pin
- Latched outputs with high-current drive capability for driving LEDs
- Addressed by three hardware-address pins
- The difference between the PCF8574 and PCF8574A is the I²C address
  - PCF8574: 0x20 – 0x27 (up to 8 may be used on same I²C bus)
  - PCF8574A: 0x38 – 0x3F (up to 8 may be used on same I²C bus)
  - A total of 16 PCF8574 and PCF8574A devices may be used on the same I²C bus
- Top applications:
  - Fan control
  - LED control
  - System monitoring
  - Temperature sensor monitoring
  - Push button monitoring
  - 8-bit bidirectional expansion

## Typical Application




## PCF8574/A Functional Block Diagram*




## Pin Descriptions*

| Symbol | Pin | Description |
|---|---|---|
| A0 | 1 | Address Input 0 |
| A1 | 2 | Address Input 1 |
| A2 | 3 | Address Input 2 |
| P0 | 4 | Bi-direction I/O 0 |
| P1 | 5 | Bi-direction I/O 1 |
| P2 | 6 | Bi-direction I/O 2 |
| P3 | 7 | Bi-direction I/O 3 |
| GND | 8 | |

| Symbol | Pin | Description |
|---|---|---|
| P4 | 9 | Bi-direction I/O 4 |
| P5 | 10 | Bi-direction I/O 5 |
| P6 | 11 | Bi-direction I/O 6 |
| P7 | 12 | Bi-direction I/O 7 |
| $\overline{INT}$ | 13 | Interrupt Output (Active Low) |
| SCL | 14 | Serial Clock Line (SCL) |
| SDA | 15 | Serial Data Line (SDA) |
| $V_{CC}$ | 16 | Supply Voltage |

*All pin numbers shown are for 16-pin SOIC and PDIP packages. See datasheets for 20-pin package options.



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