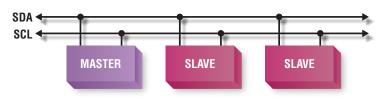
# I<sup>2</sup>C Quick Guide



## I<sup>2</sup>C Standard

The  $I^2C$  (inter-IC) bus is a 2-wire, multi-drop, digital communications link for ICs that has become the defacto standard for many embedded applications. Serial, 8-bit, bidirectional data transfer can occur at speeds up to 3.4Mbps, though 400kHz is usually sufficient. Since only two bus lines are required, a serial data line (SDA) and serial clock line (SCL), building a system with multiple master or slave devices is relatively simple. The number of  $I^2C$  devices that can be connected to a single  $I^2C$  bus segment is limited only by a maximum bus capacitance (400pF) and address space.

### I<sup>2</sup>C vs SMBus vs PMBus

Specification			SMBus			
		I <sup>2</sup> C	High Power	Low Power	PMBus	
	Packet Error Checking (Optional)	-	•			
Signaling	SMBALERT (Optional)	_	•			
	Block Size Limit	-	32 bytes 255 bytes			
Timing	Data Rate (Standard Mode)		100kbps			
	Data Rate (Fast Mode)	400kbps	-	_	400kbps	
	Data Rate (Fast Mode Plus)	1Mbps	-	_	-	
	Data Rate (High Speed Mode)	3.4Mbps	-	-	-	
	Clock Speed	0Hz to 3.4MHz	10kHz to 100kHz 10kHz to 400kHz			
	Bus Timeout	-	25ms to 35ms			
	Bus Master Request Delay (Min)	-	50µs			
	SCL Hold Time (Max)	-	2ms			
	Data Hold Time (Min)	-	300ns			
Electrical	Capacitance Load per Bus Segment (Max)	400pF		_	400pF	
	Rise Time (Max)	1µs at 100kHz, 300ns at 400kHz	1µs		1µs at 100kHz, 300ns at 400kHz	
	Pull-Up Current at 0.4V (Max)	3mA (Standard Mode and Fast Mode)	4mA	350μΑ	4mA	
	Leakage Current per Device (Max)	±10µA	±5µA		±10μA	
	V <sub>IL</sub> Input Logic Low Threshold (Max)	0.3V <sub>DD</sub> or 1.5V	0.8V			
	V <sub>IH</sub> Input Logic High Threshold (Min)	0.7V <sub>DD</sub> or 3V	2.1V			
	V <sub>OL</sub> Output Logic Low Threshold (Max)		0.4V			

### Frequently Asked Questions

#### Q1) How are I<sup>2</sup>C, SMBus and PMBus related?

Answer: Originally developed to facilitate battery management systems, SMBus uses I<sup>2</sup>C hardware but adds second-level software, which ultimately allows devices to be hot swapped without restarting the system. PMBus extends SMBus by defining a set of device commands specifically designed to manage power converters, exposing device attributes such as measured voltage, current, temperature and more. In general, I<sup>2</sup>C, SMBus and PMBus devices can share a bus without any major issues.

#### Q2) How do I build a large system and still meet bus capacitance and rise time specifications?

Answer: Linear Technology's bus buffers resolve common electrical limitations posed by specifications, thereby allowing more devices to be added to the bus. These devices break up large busses into several smaller I<sup>2</sup>C compliant (<400pF) pieces, while still providing simultaneous communications to all bus segments and optionally injecting a boosted pull-up current during positive bus transitions to quickly slew large bus capacitances.

#### Q3) How do I resolve a stuck bus?

Answer: Other than having a host try to manually fix a bus stuck low, Linear Technology's bus buffers provide stuck bus protection which recovers a stuck bus by automatically generating pulses on SCLOUT in an attempt to unstick the bus. Otherwise, a hard reset is required.

#### Q4) How do I increase the number of I<sup>2</sup>C addresses available?

Answer: Linear Technology's address translators and software or hardware controlled I<sup>2</sup>C multiplexers provide the ability to address one of multiple identical devices or simply increase fan-out, thus resolving address conflict issues, while also providing Hot Swap capabilities, bus buffering, rise time acceleration and stuck bus protection.







Linear Technology provides a comprehensive family of I<sup>2</sup>C-enabled devices for a variety of applications. From Hot Swap controllers to bus isolators, these devices provide on-the-fly adjustability, enhance I<sup>2</sup>C performance or simply enable designers to easily manage key system parameters.



#### Hot Swap Controller

- Control inrush current on a live backplane, while monitoring current, voltage, power and energy
- Record past and present fault conditions and configure latchoff or auto-restart



## Power Supply/LED Driver

 Control power-on/-off or dimming and configure mode of operation, output voltage, sequencing and slew rate for single- or multi-topology converters



## Power System Management Controller

- Control, monitor, supervise, sequence and margin multiple power supplies
- Access EEPROM for user configuration, fault logging and telemetry



## Power/Energy Monitor

 Monitor current, voltage, average power, charge and energy, while minimizing software polling with min/max registers and configurable alerts



#### **Temperature Monitor**

- Measure combinations of voltage, current and internal or external temperature
- Trigger single or repeated measurements and change formats (Celsius or Kelvin)



I<sup>2</sup>C

Bus

## Bus Buffer/Multiplexer/Address Translator/Rise Time Accelerator

 Break up bus capacitance, increase fan-out, level shift busses, decrease rise times and nest addresses while providing Hot Swap capabilities and stuck bus protection



#### Bus Isolator

 Break ground loops and isolate logic level interfaces, while also providing Hot Swap capabilities or adjustable isolated power to neighboring components



#### Power over Ethernet Power Sourcing Equipment (PSE)

• Efficiently source up to 90W of power, while configuring PSE mode of operation and monitoring per port status, current, MOSFET health and die temperature



## Battery Charger/Gas Gauge

 Adjust charge current, float voltage and charge termination, while monitoring status, charge, current, voltage or temperature of battery, USB or wall sources



#### ADC/DAC

 Write to or read from data converters with no latency, and select input or output data formats and use of internal or external reference



#### Silicon Oscillator

 Enable and program clock frequency with 0.1% resolution, as well as instantaneously change octaves using DACs with 10-bit monotonicity and less than 1% nonlinearity



