Smart, simple solutions for the 12 most common design concerns

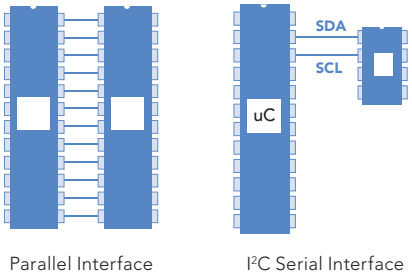
NXP I²C-bus solutions 2013

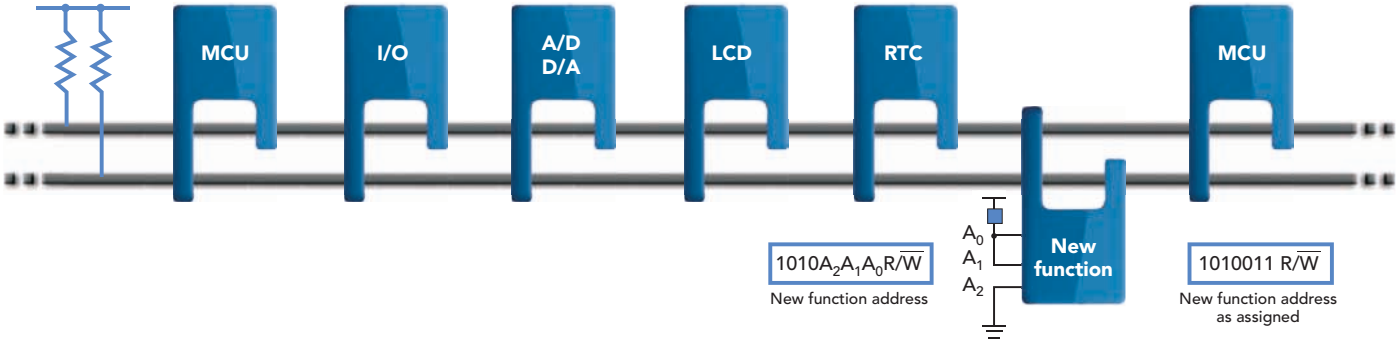
I²C-bus: The serial revolution

By replacing complex parallel interfaces with a straightforward yet powerful serial structure, the I²C-bus revolutionized chip-to-chip communications.

Invented by NXP (Philips) more than 30 years ago, the I²C-bus uses a simple two-wire format to carry data one bit at a time. It performs inter-chip addressing, selection, control, and data transfer. Speeds are up to 400 kHz (Fast-mode), 1 MHz (Fast-mode Plus), 3.4 MHz (High Speed-mode), or 5 MHz (Ultra Fast-mode).

The I²C-bus shrinks the IC footprint and leads to lower IC costs. Plus, since far fewer copper traces are needed, it enables a smaller PCB, reduces design complexity, and lowers system cost.





I²C-bus devices are available in a wide range of functions. Each slave device has its own I²C-bus address, selectable using address pins set high (1) or low (0). Information is transmitted byte by byte, and each byte is acknowledged by the receiver. There can be multiple devices on the same bus, and more than one IC can act as master. The master role is typically played by a microcontroller.

Write data

S	slave address	W	A	data	A	data	A	P

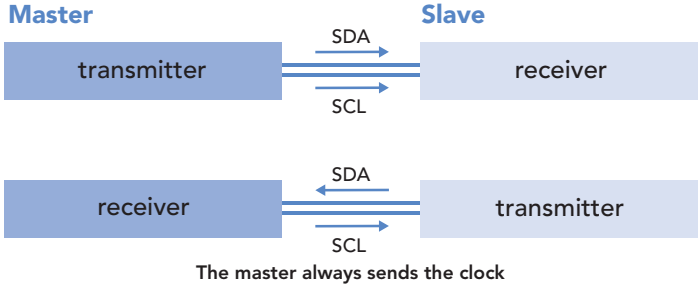
< n data bytes >

Read data

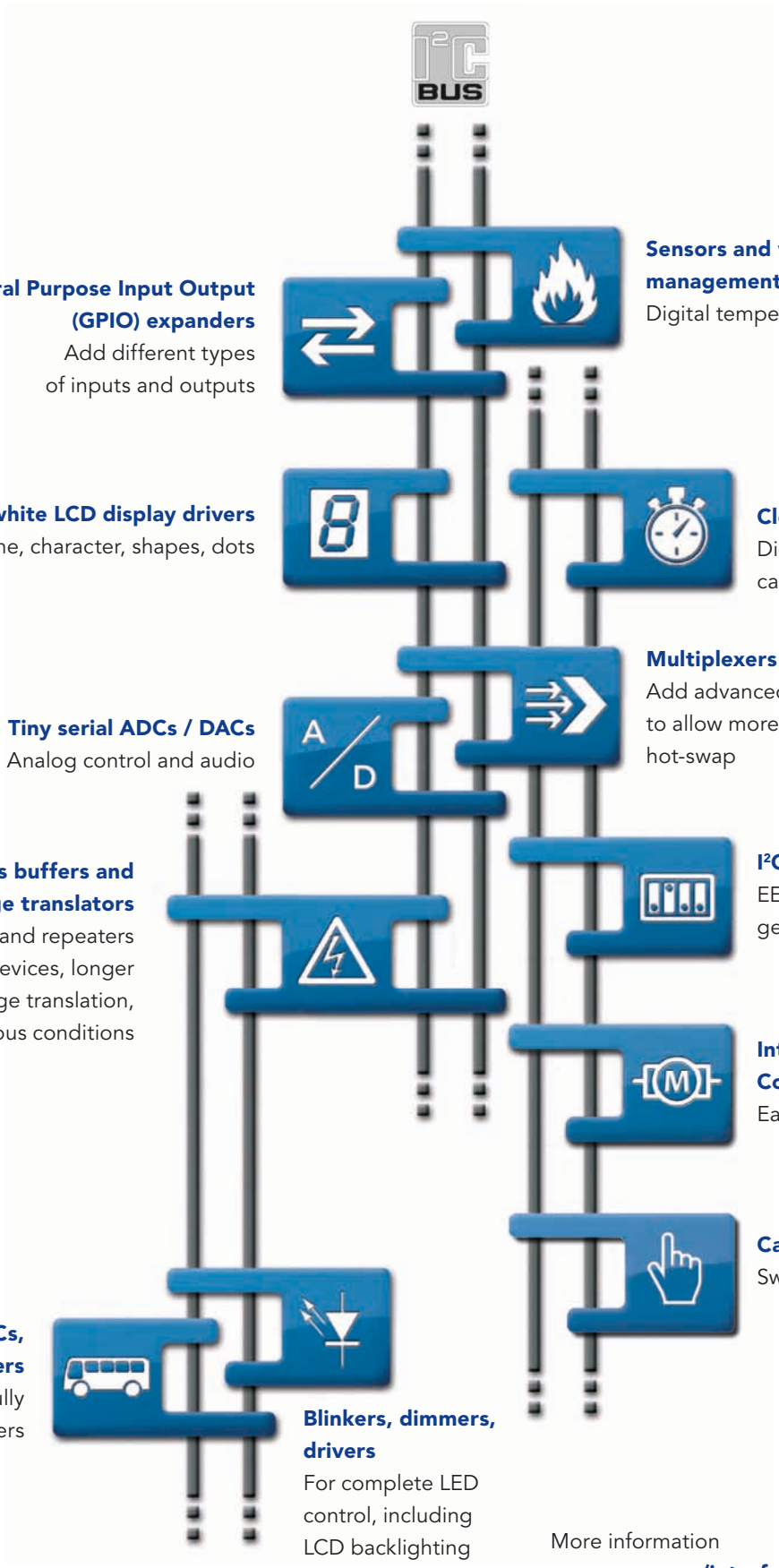
S	slave address	R	A	data	A	data	Ā	P

< n data bytes > last data byte

S = Start condition R/W = read/write
A = Acknowledge Ā = Not acknowledge P = Stop condition



NXP's I²C peripherals portfolio is grouped into twelve families, one for each of the most common, everyday design concerns.



General Purpose Input Output (GPIO) expanders
Add different types of inputs and outputs

Sensors and voltage management
Digital temperature information

Black-and-white LCD display drivers
Monochrome, character, shapes, dots

Clocks / RTCs
Digital time, watchdog and/or calendar

Multiplexers and switches
Add advanced I²C networking to allow more devices, backup, hot-swap

Tiny serial ADCs / DACs
Analog control and audio

I²C-controlled DIP switches
EEROMs / RAM combined with general-purpose outputs

Bus buffers and voltage translators
Extenders, hubs, and repeaters to support extra devices, longer distances, bus-voltage translation, or hazardous conditions

Intelligent Stepper Motor Controllers
Easy and versatile control

Capacitive Sensor
Switch action without contact

Bridge ICs, bus controllers
Add extra, fully featured I²C masters

Blinkers, dimmers, drivers
For complete LED control, including LCD backlighting

More information
www.nxp.com/interface

I²C-bus product summary

GPIO Expander		
4-bit	PCA9536	4-bit I²C Fm TP GPIO with PU
	PCA9537	4-bit I²C Fm TP GPIO with INT and RST
	PCA9570	4-bit 1 MHz LV TP GPO
8-bit	PCA6408A	8-bit I²C Fm LV VLT TP GPIO with INT and RST
	PCA8574	8-bit I²C Fm QB GPIO with INT and PU
	PCA8574A	8-bit I²C Fm QB GPIO with INT and PU (Alternate address)
	PCA9500	8-bit I²C Fm QB GPIO with PU and 2-K EEPROM
	PCA9501	8-bit I²C Fm QB GPIO with INT, PU and 2-K EEPROM
	PCA9502	8-bit I²C Fm/SPI TP GPIO with INT and RST
	PCA9534	8-bit I²C Fm TP GPIO with INT
	+ PCA9538	8-bit I²C Fm TP GPIO with INT and RST
	PCA9538A	8-bit I²C Fm LV TP GPIO with INT and RST
	+ PCA9554	8-bit I²C Fm TP GPIO with INT and PU
	PCA9554A	8-bit I²C Fm TP GPIO with INT and PU (Alternate address)
	PCA9554B(C)	8-bit I²C Fm LV TP GPIO with INT and PU
	PCA9557	8-bit I²C Fm TP GPIO with RST
	PCA9571	8-bit 1 MHz LV TP GPO
	PCA9574	8-bit I²C Fm LV VLT TP/OD GPIO with INT, RST, latch and PU/PD
	PCA9621	8-bit I²C Fm+ 65 mA OD GPO with RST
	PCA9670	8-bit I²C Fm+ QB GPIO with RST and PU
	PCA9672	8-bit I²C Fm+ QB GPIO with INT, RST and PU
	PCA9674	8-bit I²C Fm+ QB GPIO with INT and PU
	PCA9674A	8-bit I²C Fm+ QB GPIO with INT and PU (Alternate address)
	PCAL6408A	8-bit I²C Fm LV VLT TP/OD GPIO with INT, RST, latch and PU/PD
	PCAL9538A	8-bit I²C Fm LV TP/OD GPIO with INT, RST, latch and PU/PD
	PCAL9554B(C)	8-bit I²C Fm LV TP/OD GPIO with INT, latch and PU/PD (PU default)
	PCF8574	8-bit I²C Sm QB GPIO with INT and PU
	PCF8574A	8-bit I²C Sm QB GPIO with INT and PU (Alternate address)
16-bit	PCA6416A	16-bit I²C Fm LV VLT TP GPIO with INT and RST
	PCA8575	16-bit I²C Fm QB GPIO with INT and PU
	PCA9535	16-bit I²C Fm TP GPIO with INT
	PCA9535A	16-bit I²C Fm LV TP GPIO with INT
	PCA9535C	16-bit I²C Fm OD GPIO with INT
	+ PCA9539	16-bit I²C Fm TP GPIO with INT and RST
	PCA9539A	16-bit I²C Fm LV TP GPIO with INT and RST
	PCA9539R	16-bit I²C Fm TP GPIO with INT and RST (state machine only)
	PCA9555	16-bit I²C Fm TP GPIO with INT and PU
	PCA9555A	16-bit I²C Fm LV TP GPIO with INT and PU
	PCA9575	16-bit I²C Fm LV VLT TP/OD GPIO with INT, RST, latch and PU/PD
	PCA9671	16-bit I²C Fm+ QB GPIO with RST and PU
	PCA9673	16-bit I²C Fm+ QB GPIO with INT, RST and PU
	PCA9675	16-bit I²C Fm+ QB GPIO with INT and PU
	PCAL6416A	16-bit I²C Fm LV VLT TP/OD GPIO with INT, RST, latch and PU/PD
	PCAL9535A	16-bit I²C Fm LV TP/OD GPIO with INT, latch and PU/PD
	PCAL9539A	16-bit I²C Fm LV TP/OD GPIO with INT, RST, latch and PU/PD
	PCAL9555A	16-bit I²C Fm LV TP/OD GPIO with INT, latch and PU/PD (PU default)
	PCF8575	16-bit I²C Fm QB GPIO with INT and PU
	PCF8575C	16-bit I²C Fm OD GPIO with INT
40-bit	PCA9505	40-bit I²C Fm TP GPIO with INT, RST, OE and PU
	PCA9506	40-bit I²C Fm TP GPIO with INT, RST and OE
	PCA9698	40-bit I²C Fm+ TP/OD GPIO with INT, RST, OE and PU

Stepper Motor Controller		
1 motor controller	PCA9629	I²C Fm+ Stepper Motor Controller with TP GPIO with INT and RST

Capacitive Sensor		
8-channel touch switch	+ PCA/PCF8885	I²C Fm+ Touch / Proximity Sensor for up to 28 keys

Temp sensors		
Local	LM75A	I²C Fm TS local with ± 2 °C accuracy (NRND)
	LM75B	I²C Fm TS local with ± 2 °C accuracy and SMBus time-out
	SE95	I²C Fm TS local with ± 1 °C accuracy (NRND)
	SE98A	I²C Fm DDR TS local with ± 1 °C accuracy and SMBus time-out
	PCT1075	I²C Fm+ TS with +/- 0.5oC accuracy and SMBus time-out
	PCT2075	I²C Fm+ TS with +/- 1oC accuracy and SMBus time-out
Local and EEP-ROM	SE97B	I²C Fm DDR TS local with ± 1 °C accuracy, 2K SPD and SMBus time-out
Local and remote	NE1617A	I²C Fm TS local with ± 2 °C accuracy and remote with ± 3 °C accuracy
	SA56004	I²C Fm TS local with ± 2 °C accuracy and remote with ± 1 °C accuracy

LED controllers		
Dimmer (2 PWM, 25 mA / 5 V)	PCA9530	2-channel I²C Fm OD LED dimmer with RST
	PCA9531	8-channel I²C Fm OD LED dimmer with RST
	PCA9532	16-channel I²C Fm OD LED dimmer with RST
	PCA9533	4-channel I²C Fm OD LED dimmer
Blinker (2 PWM, 25 mA / 5 V)	PCA9550	2-channel I²C Fm OD LED blinker with RST
	PCA9551	8-channel I²C Fm OD LED blinker with RST
	PCA9552	16-channel I²C Fm OD LED blinker with RST
	PCA9553	4-channel I²C Fm OD LED blinker
8-segment	SAA1064	16-channel I²C Sm current source/sink 4x8-segment LED display
Controller (PWM / Ch, 25 mA / 5 V)	PCA9632	4-channel I²C Fm+ low-power TP LED controller
	PCA9633	4-channel I²C Fm+ TP LED controller with OE
	PCA9634	8-channel I²C Fm+ TP LED controller with OE
	+ PCA9635	16-channel I²C Fm+ TP LED controller with OE
	+ PCA9685	16-channel I²C Fm+ TP LED controller with 12-bit PWMs and OE
Controller (PWM/Ch, 57 mA / 20 V)	PCA9955A	16-channel I²C Fm+ 20 V CS LED controller
	PCU9955A	16-channel I²C UFm 20 V CS LED controller
	PCA9956A	24-channel I²C Fm+ 20 V CS LED controller
	PCU9956A	24-channel I²C UFm 20 V CS LED controller
Controller (PWM / Ch, 57 mA / 40 V)	+ PCA9952	16-channel I²C Fm+ HV CS LED controller with OE
	+ PCA9955	16-channel I²C Fm+ HV CS LED controller
	PCU9955	16-channel I²C UFm HV CS LED controller
Controller (PWM / Ch, 100 mA / 40 V)	PCA9624	8-channel I²C Fm+ HV OD LED controller with OE
	PCA9622	16-channel I²C Fm+ HV OD LED controller with OE
	PCA9626	24-channel I²C Fm+ HV OD LED controller with OE
	PCU9654	8-channel I²C UFm HV OD LED controller with OE
	PCU9655	16-channel I²C UFm HV OD LED controller
	PCU9656	24-channel I²C UFm HV OD LED controller with OE
LED flash	SSL3250A	I²C Fm 500 mA sink dual LED flash with torch mode
	SSL3252	I²C Fm 500 mA source dual LED flash with torch mode

Real-time clocks		
Low-power	PCA8802	I²C Fm RTC for One Time Password generation and smart cards
	PCF85063	I²C FM / Tiny RTC with 30s, 60s interrupt
	PCF85063A	I²C FM / Tiny RTC with Alarm and 30s, 60s interrupt
	PCF8523	I²C FM+ Ultra low-power RTC with loss of main power detection and automatic battery back-up
	PCF8563	I²C Fm Ultra low-power clock/calendar
Normal	+ PCA8565	I²C Fm High temperature clock/calendar -40°C…+125°C
	PCF8583	I²C Sm Clock/calendar resolution: 0.01 s, with 256x8 SRAM
Temp-compensated	PCF2127(A)	I²C Fm High-accuracy, low-voltage RTC with 512x8 RAM
	+ PCA/PCF2129(A)	I²C Fm High-accuracy RTC

Muxes and switches		
2-channel	PCA9540B	2-channel I²C Fm mux
	PCA9542A	2-channel I²C Fm mux with INT
	PCA9543A/B	2-channel I²C Fm switch with INT and RST (B and C Alternate address)
2-to-1 demux	PCA9541A/01	2 to 1 I²C Fm demux with INT and RST (channel 0 default)
	PCA9541A/03	2 to 1 I²C Fm demux with INT and RST (no channel default)
4-channel	PCA9544A	4-channel I²C Fm mux with INT
	PCA9545A/B/C	4-channel I²C Fm switch with INT and RST (B and C Alternate address)
	PCA9546A	4-channel I2C Fm switch with RST
	PCA9646	4-channel I²C Fm+ No Offset buffer/switch with RST
8-channel	PCA9547	8-channel I²C Fm mux with RST (channel 0 default)
	PCA9548A	8-channel I²C Fm switch with RST

Bus buffers		
Incremental Offset	PCA9510A	I²C Fm Incremental Offset hot-swap bus buffer (no RTA)
	PCA9511A	I²C Fm Incremental Offset hot swap-bus buffer
	PCA9512A	I²C Fm Incremental Offset VLT hot swap bus buffer
	PCA9513A	I²C Fm Incremental Offset hot-swap bus buffer (92 µA CS)
	PCA9514A	I²C Fm Incremental Offset hot-swap bus buffer (0.8 V offset)
Amplifier	P82B715	I²C Fm HV bus extender
No Offset	PCA9525	I²C Fm (1 MHz) No Offset bus repeater
	PCA9605	I²C Fm+ No Offset bus repeater
	PCA9646	4-channel I²C Fm+ No Offset buffer / switch with RST
Static Offset (1 side)	P82B96	I²C Fm HV bus buffer
	PCA9507	I²C Fm VLT DDC buffer with accelerator
	PCA9508	I²C Fm VLT hot-swap bus repeater
	PCA9509	I²C Fm 1.0V LV VLT bus buffer with current source
	PCA9509A	I²C Fm 0.8V LV VLT bus buffer with current source
	PCA9509P	I²C Fm 0.8V LV VLT bus buffer
	PCA9517A	I²C Fm 0.9V LV VLT bus repeater
	PCA9519	4-channel version of PCA9509
	PCA9527	I²C Fm DDC VLT buffer with accelerator and CEC
	PCA9600	I²C Fm+ HV bus buffer
	PCA9601	I²C Fm+ HV bus buffer with stronger 15 mA local side drive to support multiple Fm+ slaves
	PCA9617A	I²C Fm+ 0.8 V LV VLT bus repeater
Static Offset (All sides)	PCA9515A	I²C Fm bus repeater
	PCA9516A	I²C Fm 5-channel hub
	PCA9518A	I²C Fm expandable 5-channel hub
Voltage translator (doesn't isolate capacitance)	GTL2000	22-bit I²C Fm+ VLT
	GTL2002	2-bit I²C Fm+ VLT
	GTL2003	8-bit I²C Fm+ VLT
	GTL2010	10-bit I²C Fm+ VLT
	PCA9306	Dual I²C/SMBus Fm+ VLT
	NVT2001	1-bit I²C Fm+ VLT
	NVT2002	2-bit I²C Fm+ VLT for I²C/SMBus applications
	NVT2003	3-bit I²C Fm+ VLT for two power supply applications
	NVT2004	4-bit I²C Fm+ VLT for SPI applications
	NVT2006	6-bit I²C Fm+ VLT
	NVT2008	8-bit I²C Fm+ VLT
	NVT2010	10-bit I²C Fm+ VLT

Decode table

	Bus Speed		Features
Sm	100 kHz Standard-mode I²C-bus	LV	Supply voltage <2.3 V
Fm	400 kHz Fast-mode I²C-bus	TP	Totem-pole (push-pull)
Fm+	1 MHz Fast-mode Plus I²C-bus	QB	Quasi-bidirectional
HSm	3.4 MHz High Speed-mode I²C-bus	OD	Open drain
UFm	5 MHz Ultra Fast-mode I²C-bus	CS	Current source
		INT	Interrupt
+	AEC-Q100 compliance	RST	Reset
GPIO	General Purpose I/O Expander	OE	Output enable
TS	Thermal Sensor	Latch	Input latch
RTC	Real Time Clock	PU	Pull-up resistors
LCD	Liquid Crystal Display	PU/PD	Pull-up/pull-down resistors
DAC	Digital Analog Converter	HV	Outputs >10 V
ADC	Analog Digital Converter	VLT	Voltage Level Translator – 2 Supplies
		COG	Chip on Glass

LCD drivers		
Segment driver	PCA/PCF85162	I²C Fm 128-segment LCD driver
	PCA/PCF85176	I²C Fm 160-segment LCD driver
	PCA/PCF85134	I²C Fm 240-segment LCD driver
	PCA/PCF8536	I²C Fm 320-segment LCD driver with LED backlight control, programmable frame frequency
	PCA/PCF8537	I²C Fm 352-segment LCD driver, programmable frame frequency, charge pump, VLCD temperature compensation
	PCA9620	I²C Fm 480-segment LCD driver, programmable frame frequency, charge pump, VLCD temperature compensation
	PCA/PCF8576D	I²C Fm 160-segment COG LCD driver
	PCA8576F [2)]	I²C Fm 160-segment COG LCD driver
	PCA/PCF85133	I²C Fm 320-segment COG LCD driver, selectable frame frequency
	PCA85233 [2)]	I²C Fm 320-segment COG LCD driver, selectable frame frequency
	PCA/PCF85132	I²C Fm 640-segment COG LCD driver, programmable frame frequency
	PCA85232	I²C Fm 640-segment COG LCD driver, programmable frame frequency
	PCA/PCF8538 [1)]	I²C Fm 918-segment COG LCD driver, programmable frame frequency, charge pump, VLCD temperature compensation
Character driver	PCF2113	I²C Fm 1/2-line, 12-character, 120-icon LCD driver, charge pump, VLCD temperature compensation
	PCF2116	I²C Sm 1/2-line, 24 characters per line, or 2/4 line, 12 characters per line, charge pump
	PCF2119	I²C Fm 1/2-line, 16-character, 160-icon LCD driver, charge pump, VLCD temperature compensation
	PCA/PCF2117 [2)]	I²C Fm 1/2-line, 20-character, 200-icon LCD driver, programmable frame frequency, charge pump, VLCD temperature compensation
Graphic driver	PCA/PCF8539 [2)]	I²C Fm 18 x 100-pixel LCD driver, programmable frame frequency, charge pump, VLCD temperature compensation
	PCF8531	I²C Fm 34 x 128-pixel LCD driver, charge pump, VLCD temperature compensation
	PCF8811	I²C Fm 80 x 128-pixel LCD driver, programmable frame frequency, charge pump, VLCD temperature compensation

[1)] release H1 2013 - [2)] release H2 2013

A/D-D/A converters		
8-bit ADC	PCF8591	I²C Sm 4-channel ADC and 1-channel DAC

EEPROMs		
2-kbit	PCA9500	I²C Fm 256 x 8-bit EEPROM
	PCA9501	I²C Fm 256 x 8-bit EEPROM
	PCF85103C	I²C Sm 256 x 8-bit EEPROM (No programming time control output with ALT address)
	PCF8582C	I²C Sm 256 x 8-bit EEPROM
	PCF8570	I²C Sm 256 x 8-bit RAM
4-kbit	PCF8594C	I²C Sm 1024 x 8-bit EEPROM
	SL3S4001	I²C Fm 3.6K bit EEPROM with dual Gen2 RFID interface
8-kbit	PCA24S08A	I²C Fm 1024 x 8-bit EEPROM with access protection
DIP switch	PCA8550	I²C Fm 4-bit 1-of-2 mux & 5-bit EEPROM
	PCA9558	I²C Fm 5-bit MP/1-bit latch & 6-bit EEPROM with 2K EEPROM and 8-bit GPIO
	PCA9559	I²C Fm 5-bit mux/1-bit latch & 6-bit EEPROM
	PCA9560	I²C Fm 2 x 5-bit mux/1-bit latch & 6-bit EEPROM
	PCA9561	I²C Fm 4 x 6-bit mux & 6-bit EEPROM

Bridge and bus controllers		
Bridge	SC16IS740	I²C Fm/SPI-to-UART bridge with IrDA
	SC16IS741	I²C Fm/SPI-to-UART bridge with IrDA
	SC16IS750	I²C Fm/SPI-to-UART bridge with IrDA and GPIO
	SC16IS752	I²C Fm/SPI-to-DUART bridge with IrDA and GPIO
	SC16IS760	I²C Fm/SPI-to-UART bridge with IrDA and GPIO
	SC16IS762	I²C Fm/SPI-to-DUART bridge with IrDA and GPIO
	SC16IS850L	1.8 V I²C Fm/SPI-to-UART bridge with IrDA
	SC18IM700	UART-to-I²C Fm master bridge with GPIO
	SC18IS600	SPI-to-I²C Fm master bridge, 4 M with GPIO
	SC18IS602	I²C Fm slave-to-SPI master bridge
Controller	PCF8584	I²C Sm bus controller with bus snoop
	PCA9564	I²C Fm bus controller
	PCA9661	1-channel I²C Fm+ bus controller with 4 K-byte buffer
	PCA9663	3-channel I²C Fm+ bus controller with 4 K-byte buffer per channel
	PCA9665	I²C Fm+ bus controller with 68-byte buffer
	PCA9665A	I²C Fm+ bus controller with 68-byte buffer and restart condition fix
	PCU9661	1-channel UFm bus controller with 4 K-byte buffer
	PCU9669	1-channel Fm+ and 2-channel UFm bus controller with 4 K-byte buffer per channel

Demo boards		
e-Tools	OM6270	SPI/I²C-to-UART bridge demo (SC16IS750)
	OM6271	SPI-to-I²C-master bridge demo (SC18IS600)
	OM6272	UART-to-I²C-master bridge demo (SC18IM700)
	OM6273	SPI/I²C-to-DUART/IrDA/GPIO demo (SC16IS752)
	OM6274	I²C-to-SPI-master bridge demo (SC18IS602)
	OM6275	I²C 2005-1 evaluation board with PC controller
	OM6276	PCA9633 demo board
	OM6277	PCA9564 evaluation board
	OM6278	I²C 2002-1A evaluation board with PC controller
	OM6281	PCA9698 daughter card for I²C 2005-1
	OM6282	PCA9633 daughter card for I²C 2005-1
	OM6285	I²C 2002-1A evaluation board without PC controller board
	OM6290	LCD driver evaluation board: PCF8576D, PCF2119, PCF8531, PCA9633
	OM6292	PCA21125, PCF8562 demoboard
	OM6293	PCA9600 daughter card for I²C 2005-1
	OM6297	PCF2123, PCF8562 demoboard
	OM11051	PCF2127A demo board
	OM11056	Two x PCF8885 evaluation board
	OM11057	PCF8885/86 capacitive sensor and PCF8536 LCD/LED driver
	OM11057A	OM11057 add-on board with high sensitivity slider
	OM11059A	PCF85063A evaluation board
	OM13260	I²C Fm+ development board (RoHS)
	OM13401	PCA9617A bus buffer board (RoHS)
	OM13303	GPIO target board (RoHS)
	OM13399	Bridge board (RoHS)
	OM13285	PCA9629 demo board
	OM13320	I²C Fm+ development kit (RoHS)

OM6275
I²C 2005-1 evaluation board

OM6278
I²C 2002-1A evaluation board

OM6277
PCA9564 evaluation board

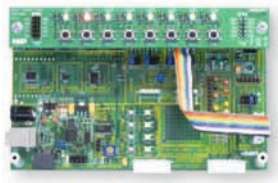
OM6293
PCA9600 daughter card for I²C 2005-1

OM6276
PCA9633 demo board

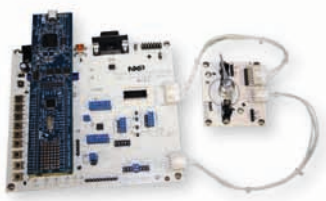
Our I²C-bus website (www.nxp.com/interface) is a valuable resource for device information and training programs. It gives you direct access to a comprehensive handbook, application notes, information about evaluation kits and training materials, links to application and design support, and more.

The I²C Fm+ development board and daughter cards make it easy to program new peripherals and are a quick way to learn about the I²C-bus protocol.

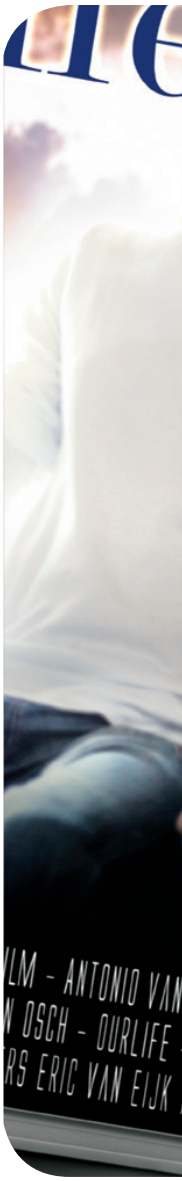
OM13320 Fm+ Demonstration Kit which includes the OM13260 Fm+ Development Board with two OM13303 GPIO Target Boards and one each of the the OM13399 Bridge and OM13401 PCA9617A bus buffer daughter boards



OM13285 PCA9629 stepper motor demonstration board



OM11057 PCF8885/86 touch switch with PCF8536 LCD/LED driver



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