Welcome!
Texas Instruments New Product Update

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- Phone lines will be muted
- Please post questions in the chat or contact your sales person or field applications engineer

New Product Update:
I2C level shifters and IO expanders with introduction on I3C

Chris Griffith

September 9, 2021

Agenda

- Overview of new I2C devices addressing level shifter and I/O expander needs
- Introduction to real-time accelerators
- Discussion on I3C standard and ways to enable it

TCA9416

Ultra-low voltage I2C translator with rise time accelerators

APL Now

Full Release 3Q

Features

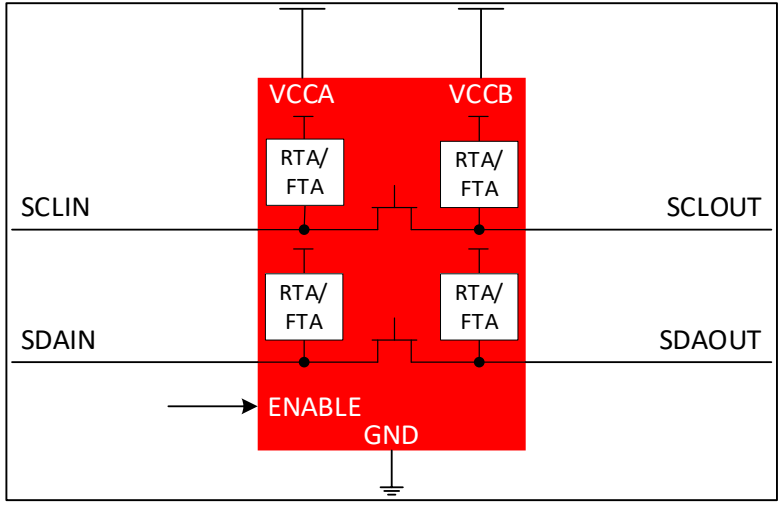
- VCCA and VCCB supply range of 1.08 V to 3.6 V
- Integrated 10kΩ pull-up resistors
- **Integrated rise and fall time accelerators**
- Supports clock stretching, arbitration, and synchronization
- Standard mode, Fast mode and Fast-mode plus I^2C support
- Low ICC current
- Powered-off high impedance for all pins
- Temperature Range: -40˚C to +125˚C
- ESD protection: 2000-V Human-body model (A114-A)
- Packages:
  - Small 8-pin X2SON package (**DTM, 0.8mm x 1.35mm**)
  - 8-pin SOT-23 package (DDF, 1.6mm x 2.9mm)

Applications

- PC & Notebooks
- Portable Electronics
- Mobile Phones
- Consumer Wearables
- Gaming Accessory
- Smart Speaker
- Point of Sales terminal (POS)
- Barcode Scanner
- Network Interface Card (NIC)
- Enterprise Storage
- Routers & Switches
- Factory Automation & Control
- Medical
- Building Automation
- Test & Measurement
- Motor Drives

Benefits

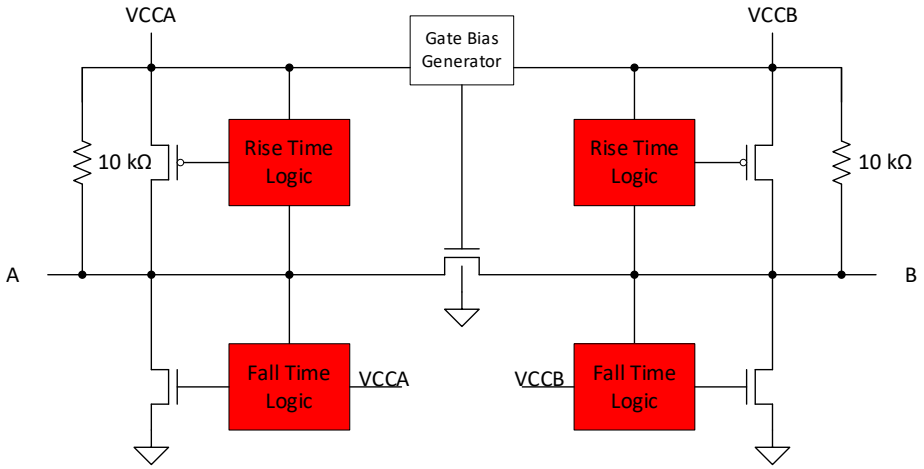
- Integrated pull up resistors save board space and component count for lightly loaded I2C buses
- Rise and fall time accelerators speed up the rise and fall times while keeping a weak external pull up resistor to save power and improve signal integrity
- Symmetrical power supply support allows for low voltage buffering in addition to translation



Rise Time & Fall Time Accelerator Feature

A rise time and fall time accelerator circuit speeds up the output slew rate by monitoring the input edge for transitions

- Helps maintain the data rate through the device.
- Helps lower the rise time and fall time (I2C spec)
- Allows system designer to use weaker pull up resistors
  - This lowers VOL levels because IOL is much lower

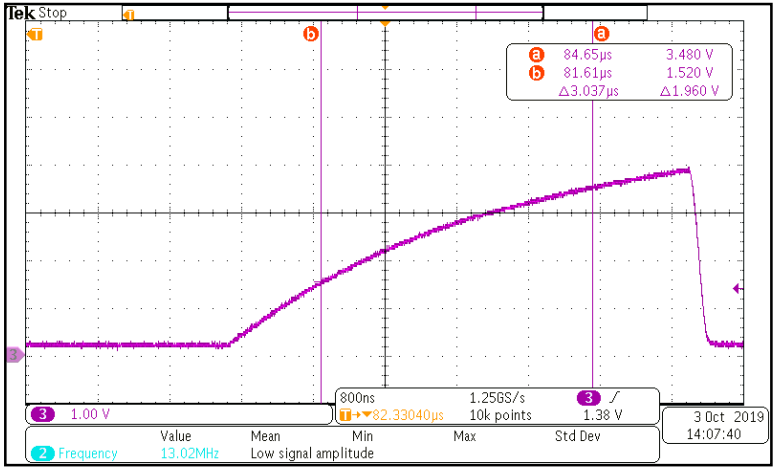


Example of Rise Time & Fall Time Accelerator Circuit

Rise Time Accelerator Example

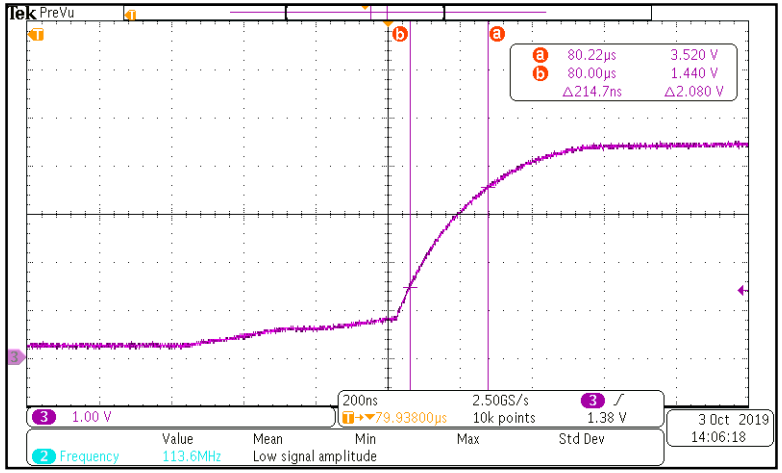
Frequency	100kHz	400kHz
Rise time requirement specified by I2C Spec	1000ns	300ns

360pF bus load with a 10k pull up resistor



With TCA9511A disabled (without an RTA)

- Rise time = 3037 ns

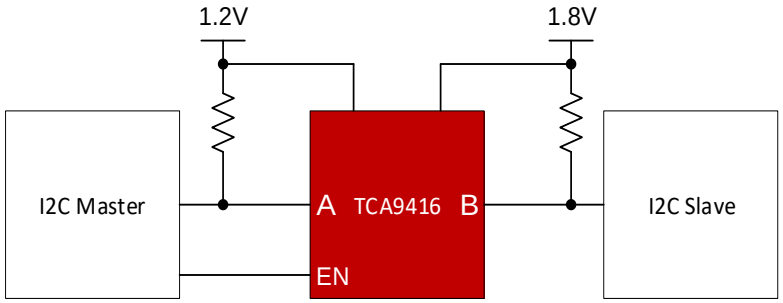


With TCA9511A enabled (RTA on)

- Rise time = 215 ns

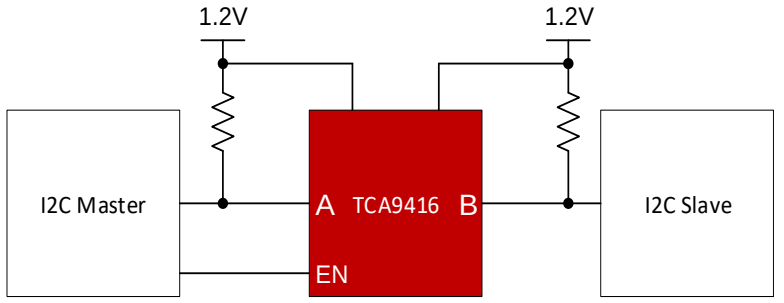
TCA9416 | Typical Use Case

I2C/SMBus Voltage Level Translator
(Different voltage on each side)



Benefits:
- Resolves voltage level mis-match between A-side / B-side
- No supply voltage dependency between A-side / B-side
- Improves Rise time / Fall time transition between A-side / B-side
- Allows bi-directional operation upto 1Mhz (FM+) speed
- Internal 10Kohm pullup resistor on all SCL/SDA pins
- Hi-Z outputs A/B pins when EN or Supply is 0V

I2C/SMBus Accelerator (Pseudo-Buffering)
(Same voltage on each side)



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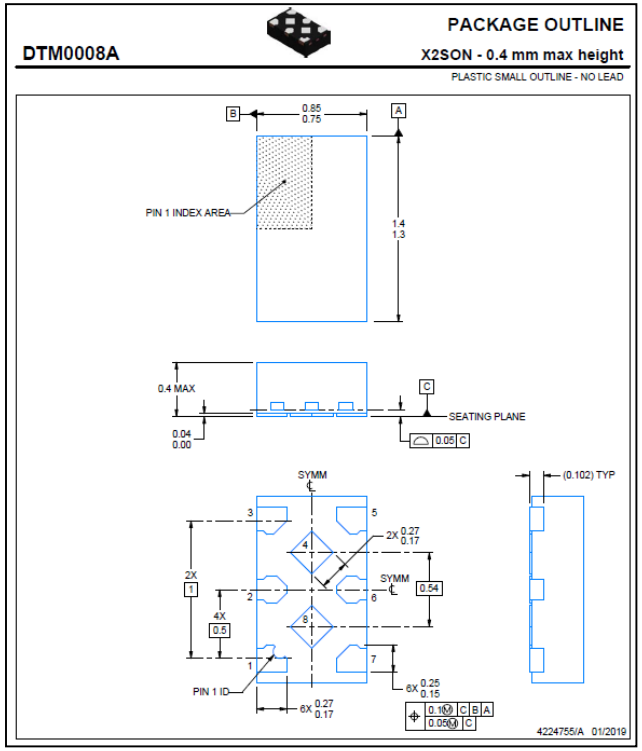
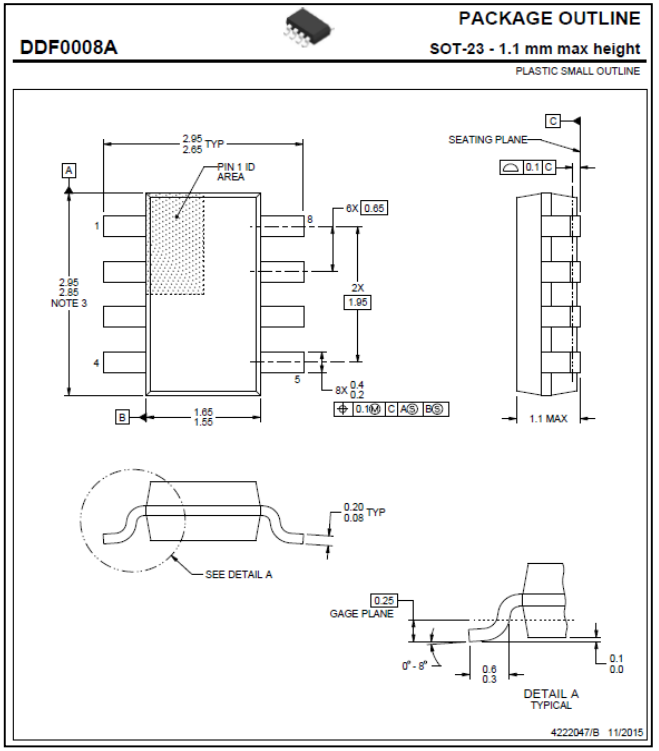
- Hi-Z outputs A/B pins when EN or Supply is 0V
- No supply voltage dependency between A-side/B-side

TCA9416 | Package Options



0.8mm x 1.35mm x 0.4mm,
0.5mm pitch



1.6mm x 2.9mm x 1.1mm,
0.65mm pitch

TCA39306

FM+ I2C Bus and SMBus Voltage Translator

APL Now

Full Release 3Q

Features

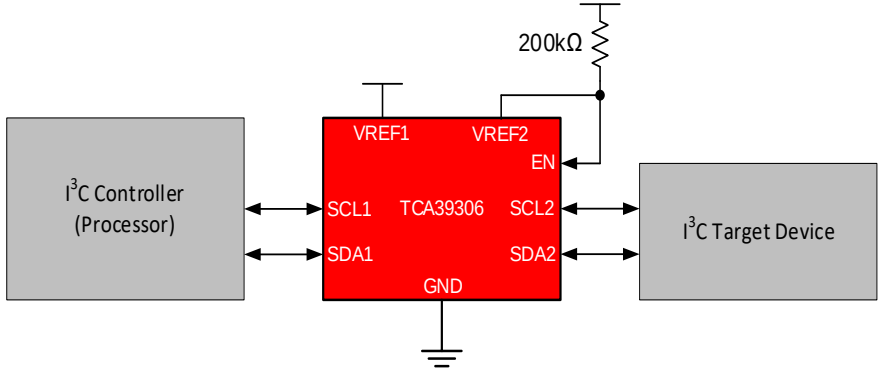
- I2C and SMBus/PMBus compatible
- **Wide supply voltage range of 0.85 V to 5.5 V**
- Fast-Mode and Fast-Mode-Plus I2C Interface (up to 1 MHz)
- **I3C compatible with 12.5 MHz**
- 5 V tolerant I/Os
- Ultra-low power consumption
- Provides bidirectional voltage translation with no direction pin
- Operating temperature: -40 to 125C
- ESD protection:
  - 2000-V Human-body model (A114-A)
  - 1000-V Charged-Device model (C101)

Benefits

- Lower power consumption
- Easy setup with bidirectional support with no direction pin
- Compatible with I3C, I2C and similar protocols

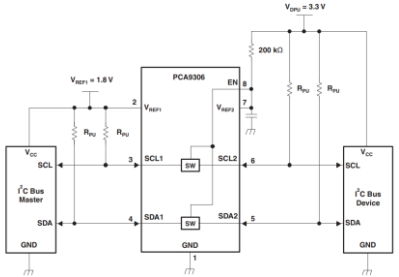
Applications

- I2C, SMBus, PMBus, MDIO, UART, low-speed SDIO, GPIO and other two-wire interfaces
- Splitting I3C and I2C bus
- Servers
- Routers (Telecom switching equipment)
- Computing segments
- Industrial Automation



Why TCA39306 over PCA9306

- Wider supply voltage down (0.85V to 5.5V)
- Faster speeds
  - FM+ (1Mhz)
  - I3C compatible (12.5Mhz)
- Lower delta between input and output with lower Ron
- Support extended temperature range up to 125C
- Factory capacity – new latest technology and newest fabs



Features/ Feedback: I2C vs I3C

Features	I2C	I3C
Freq	400KHz	SDR up to 12.5MHz
Typology	Open Drain only	Open Drain & Push-Pull
Multi-Host	1 Host	Multi-Host/ 1 Host at a time
Operation Modes (SDR, HDR-DDR)	High Speed Mode	HDR mode (send data on both +ve & -ve edge of the clock) ➔ 2* BW
Capacitive Load per bus line	400 pF for FM; 550 pF for FM+	50 pF
Dynamic Addressing	Static	Dynamic (plug and play)
Voltage Levels	1.8, 3.3, 5.0V	1.2, 1.8, 3.3 V
In band Interrupt (reduce pin#)	Host initiate Alert pin	Target request control
Hot Join	Not supported	Supported

TCA9536

4-bit Low Voltage I/O Expander with Configuration Control Register

APL Now

Production 4Q21

Features

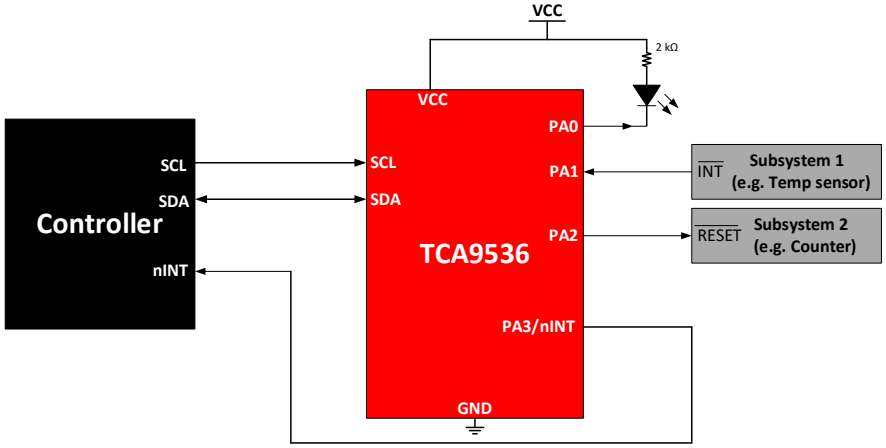
- 4-bit I2C bus GPIO expander
- **Small 8 pin package (1.35 mm x 0.8 mm)**
- Wide supply voltage range of 1.65 V to 5.5 V
- Fast-Mode Plus I2C Interface (1000 kHz)
- Low typical standby current 0.5 µA (1.8 V typ)
- 25 mA current sink capability on all ports
- Operating temperature: -40 to 125C
- Additional features
  - **Software selectable PA3 or nINT**
  - **Software selectable pull-up resistor disable/enable**
- 4 address variants (TCA9536/TCA9536A/B/C)
- ESD protection:
  - 2000-V Human-body model (A114-A)
  - 1000-V Charged-Device model (C101)

Applications

- Wearables
- System monitoring:
  - LED driving
  - Button input
- Industrial automation, Factory automation, Building automation, Protection relay
- Telecom baseband
- Computing segments

Benefits

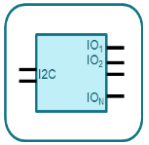
- Lower power consumption
- Small package saves board space
- High current sink capability allows direct driving of LEDs



Translator & Buffer | Newest Devices, more at TI.com

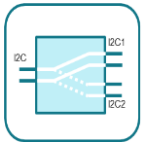
Parameter/Feature	Unit	TCA39306 NEW	TCA9416 NEW	PCA9306	TCA9406	TCA9517	TCA9517A	TCA9617B	TCA9509	TCA980x x=0,1,2,3	TCA9511A	TCA4307 NEW	P82B715	P82B96
Function		Translator	Translator	Translator	Translator	Buffer, Translator	Buffer, Translator	Buffer, Translator	Buffer, Translator	Buffer, Translator	Buffer	Buffer	Buffer	Buffer
Output Mode		N/A	N/A	N/A	N/A	Static offset	Static offset	Static offset	Static offset	Static offset	Dynamic offset	Dynamic offset	Cable extender	Cable extender
Max Capacitive load	pF					400	400	400	400	400	400	400	3000	4000
I2C-bus speed	kHz	12,500	1000	400	1000	400	400	1000	400	400	400	400	400	400
Hot-swappable (w/ idle detect)											●	●		
Stuck bus recovery												●		
Voltage translation		●	●	●	●	●	●	●	●	●				
Min. supply voltage (VCCA)	V	0.85	1.08	1.2	1.65	0.9	0.9	0.8	0.9	0.8	2.3	2.3	3	2
Max. supply voltage (VCCA)	V	5.5	3.6	5.5	3.6	5.5	5.5	5.5	5.5	3.6	5.5	5.5	12	15
Min. supply voltage (VCCB)	V	1.65	1.08	1.8	2.3	2.7	2.7	2.2	2.7	1.65	-	-	-	-
Max. supply voltage (VCCB)	V	5.5	3.6	5.5	5.5	5.5	5.5	5.5	5.5	3.6	-	-	-	-
Integrated pull-up on A-side			10kΩ, RTA		10kΩ, RTA				1mA		RTA	RTA		
Integrated pull-up on B-side			10kΩ, RTA		10kΩ, RTA					0.5, 1, 2, 3mA	RTA	RTA		
Hi-Z SDA, SCL pins @ VCC=0V			●		●	●	●	●	●	●	●	●	●	●
Supply Dependency (VCCA w.r.t VCCB)		VCCA <= VCCB	None	VCCA <= VCCB	VCCA <= VCCB	VCCA <= VCCB	VCCA <= VCCB	VCCA <= VCCB	VCCA <= (VCCB-1)	None	None	None	None	None
Automotive Option		●		●			●							
Package Group		SOT-23|8, VSSOP|8, X2SON|8	SM8|8, VSSOP|8	DSBGA|8, SM8|8, VSSOP|8, X2SON|8	DSBGA|8, SM8|8, VSSOP|8	SOIC|8, VSSOP|8	VSSOP|8	VSSOP|8	VSSOP|8, X2QFN|8	VSSOP|8	VSSOP|8	VSSOP|8	PDIP|8, SOIC|8	PDIP|8, SOIC|8, TSSOP|8, VSSOP|8

IO Expander | Newest Devices, more at TI.com



Parameter/Feature	Unit	TCA9536/37 NEW	PCA9536	TCA9534/A	TCA9535	TCA9538	TCA9539, TCA9539-Q1	TCA9554/A	TCA9555	TCA6408A, TCA6408A-Q1	TCA6416A	TCA6424A	TCA6418E	TCA8418E
Function		IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	IO Expander	Key board Controller
Number of I/Os		4	4	8	16	8	16	8	16	8	16	24	18	18
Min. supply voltage	V	1.65	2.3	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Max. supply voltage	V	5.5	5.5	5.5	5.5	5.5	5.5 / 3.6**	5.5	5.5	5.5 / 3.6**	5.5 / 3.6**	5.5	3.6	3.6
Level Translation										•	•	•		
Reset Input						•	•			•	•	•	•	•
Interrupt output				•	•	•	•	•	•	•	•	•	•	•
Internal pull-up resistor	kΩ	100	100					100	100					100
I2C-bus speed	kHz	1000	400	400	400	400	400	400	400	400	400	400	1000	1000
Number of Addresses		4	1	8	8	4	4	8	8	2	2	2	1	1
Special Features		nINT/P3 configurable											Controllable pull-down	80-input key pad scan, Controllable pull-up
Automotive							•			•				
Operating Temperature	°C	-40 to 125	-40 to 85	-40 to 85	-40 to 85	-40 to 85	-40 to 85, -40 to 125**	-40 to 85	-40 to 85	-40 to 85, -40 to 125**	-40 to 85, -40 to 125**	-40 to 85	-40 to 85	-40 to 85
Package Group		X2SON|8, VSSOP|8, VSSOP|10	SOIC|8, VSSOP|8	SOIC|16, TSSOP|16	SSOP|24, TSSOP|24, VQFN|24, WQFN|24	SSOP|16, TSSOP|16	TSSOP|24, VQFN|24, WQFN|24	SOIC|16, SSOP|16, TSSOP|16	SSOP|24, TSSOP|24, VQFN|24, WQFN|24	TSSOP|16, UQFN|16, VQFN|16	TSSOP|24, WQFN|24	UQFN|32	DSBGA|25	DSBGA|25

Switches & Muxes | Newest Devices, more at TI.com



Parameter/Feature	Unit	TCA9543A	TCA9544A	TCA9545A	TCA9546A	TCA9548A
Function		Switch	Mux	Switch	Switch	Switch
Number of Channels		2	4	4	4	8
Number of Addresses		4	8	4	8	8
Min. supply voltage	V	1.65	1.65	1.65	1.65	1.65
Max. supply voltage	V	5.5	5.5	5.5	5.5	5.5
Level Translation		•	•	•	•	•
Reset Input		•		•	•	•
Interrupt Output		•	•	•		
I2C-bus speed	kHz	400	400	400	400	400
Automotive						•
Operating Temperature	˚C	-40 to 85	-40 to 85	-40 to 85	-40 to 85	-40 to 85
Package Group		SOIC|14, TSSOP|14	TSSOP|20	TSSOP|20	SOIC|16, TSSOP|16	TSSOP|24, VQFN|24

More I3C coming!!!

Mux vs Switch

- Mux only on channel can be enabled at one time
- Switch more then one channel can be enabled at one time

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