NXP 2-, 4-, and 8-channel I²C/SMBus muxes and switches PCA954x

Add design flexibility with multi-channel I²C/SMBus muxes and switches

Designed for systems that use multiple I²C/SMBus devices with identical addresses, these multi-channel devices enable I²C multiplexing, voltage level shifting, capacitive load sharing, and more.

Key features

- Multi-channel multiplexers and switches for use in I²C/SMBus systems
- Muxes (PCA9540B, PCA9542A, PCA9544A, PCA9547)
- Switches (PCA9543A/B/C, PCA9545A/B/C, PCA9546A, PCA9548A)
- Cross-bar switch (PCA9549)
- Bi-directional translation directs upstream pairs to 2, 4, or 8 downstream channels
- Interrupt pins enable AND function
- Hardware address pins allow up to 8 devices to share I²C bus
- External pull-up resistors set channel voltage
- All I/O tolerant to 6.0 V
- SO, TSSOP, and HVQFN package options
- Operating voltage range of 2.3 to 6.0 V
- Operating temperature range of -40 to 85 °C
- Maximum operating frequency of 400 kHz

Applications

- I²C multiplexing: split a single I²C address without conflicts
- Voltage level shifting: translate between 1.65 and 5.5 V
- Capacitive load sharing: reduce sytsem load by isolatin idle devices

PCA954x multiplexers (muxes) and switches fan the input I²C/SMBus signals to two, four, or eight downstream channels of SCx/SDx pairs. Control is performed directly through the I²C/SMBus, so there's no need for an additional control pin. The muxes select one downstream channel at a time; the switches can select one or more. Some devices have an external active-low hardware reset pin ($\overline{\text{RESET}}$). If the bus locks up or communication with the master is interrupted, the $\overline{\text{RESET}}$ pin can be used to reset the downstream channels to their default values ("not selected").

I²C BUS

NXP founded by Philips

I²C multiplexing

PCA954x devices split a single I²C-bus into several sub-branches so the I²C master can select and address devices with identical addresses one at a time without raising address conflict issues.

Voltage level shifting

The PCA954x family can be used to translate voltages between 1.65 and 5.5V. The channel pass gates let the V_{DD} pin limit the maximum voltage to be passed by a device, so different bus voltages can be used on each pair. That way, 5-V devices can coexist with devices of 1.8, 2.5, or 3.3 V without any additional protection or external voltage translators. External pull-up resistors on the upstream and downstream channels are used to set the desired voltage levels for each channel, and all I/O pins are tolerant up to 6.0 V. PCA954x switches can have multiple downstream channels active simultaneously, so they're an excellent choice for this application, as well as for broadcast applications.

Capacitive load sharing

When the number of I²C/SMBus devices risks exceeding the 400-pF limit for system loading, PCA954x devices can be used to isolate idle devices and reduce the overall load. Active channels function as wires, so the cumulative capacitive loading of the upstream channel, along with all the active downstream channels, needs to be taken into account.

2-to-1 I²C master selector with interrupt logic and reset PCA9541

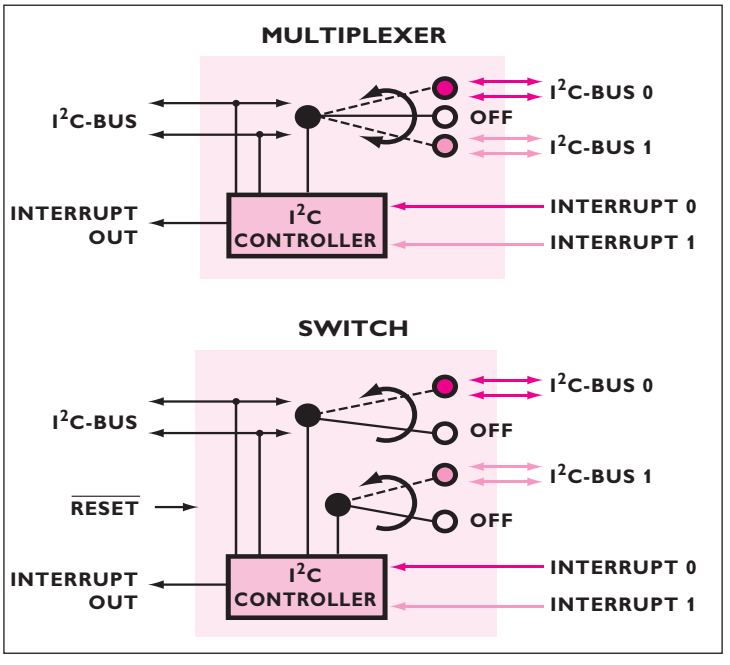
The PCA9541 is designed for use in high-reliability, dual-master I²C applications that require continuous operation even if one master fails or if its controller card is removed for maintenance. I²C commands are sent via the primary or back-up master and either master can, at any time, gain control of the downstream slave devices. If a master fails, it's isolated from the system and doesn't impact communication between the on-line master and the downstream slave devices. Two versions, /01 and /03, are available:

- PCA9541/01 – Master Channel 0 is selected after power-up/reset
- PCA9541/03 – No master channel (off) is selected after power-up/reset and either master can take control of the bus

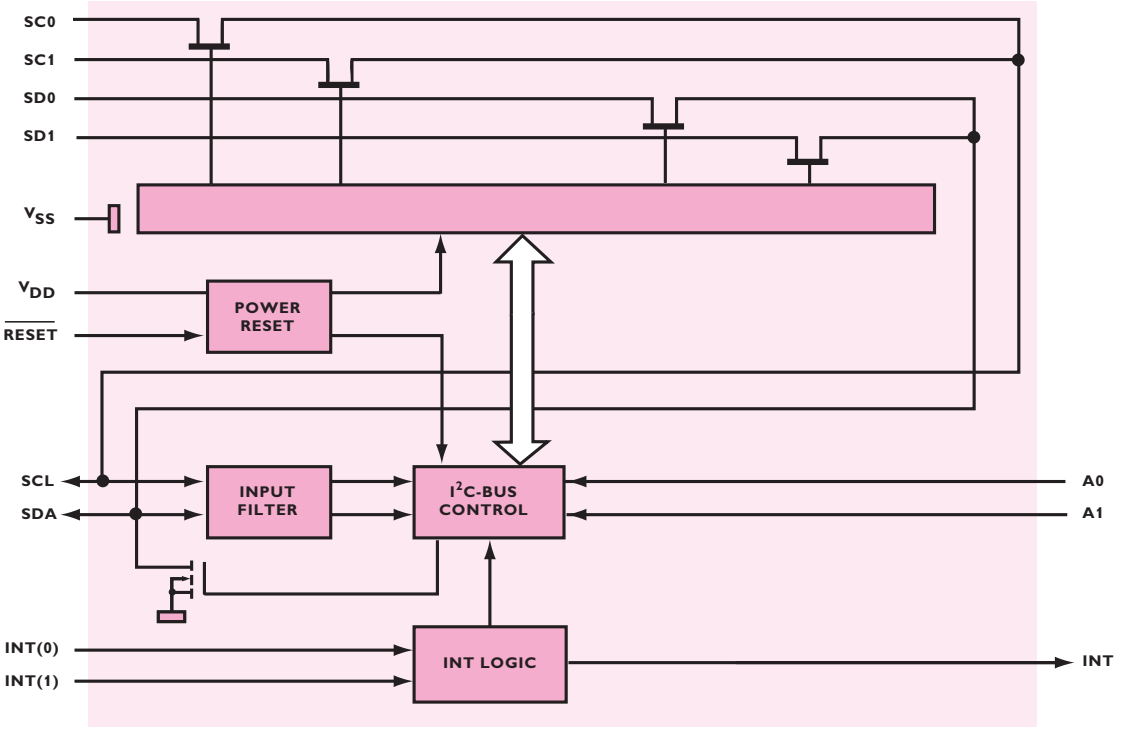
PCA9549 I²C 8-bit bus switch (CBT) with reset

The PCA9549, a CBT with hardware reset, powers up with all bits in a HighZ off state. Each bit can then be turn on or off individually via I²C-bus commands. Pulling $\overline{\text{RESET}}$ low disables the device, resets the I²C state machine, and turns off all bits.

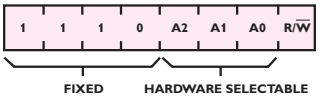
Multiplexer and switch functions



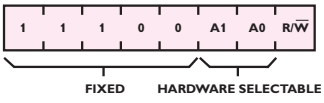
PCA9543A block diagram



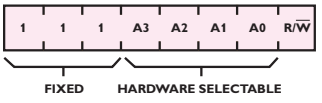
I²C slave address



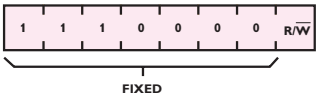
PCA9542A, PCA9544A, PCA9546A
PCA9547, PCA9548A, PCA9549



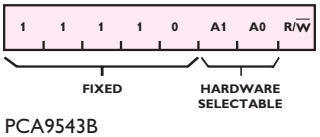
PCA9543A, PCA9545A



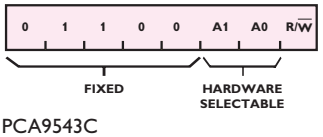
PCA9541



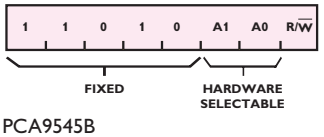
PCA9540B



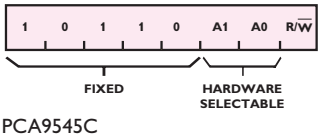
PCA9543B



PCA9543C

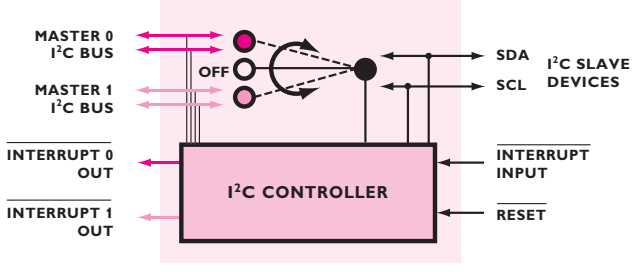


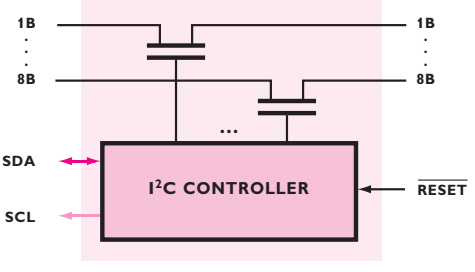
PCA9545B



PCA9545C

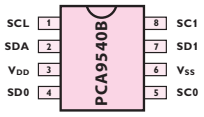
PCA9541 and PCA9549 block diagrams



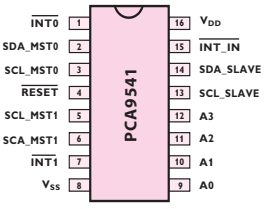


Pinout diagrams

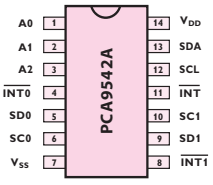
2 channel



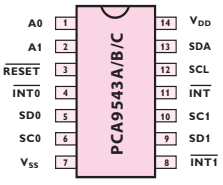
2-to-1 master selector with reset



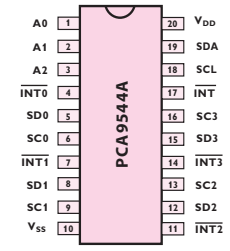
2 channel with Interrupt



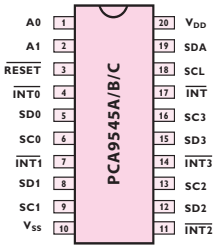
2 channel with Interrupt and reset



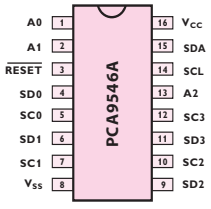
4 channel with Interrupt



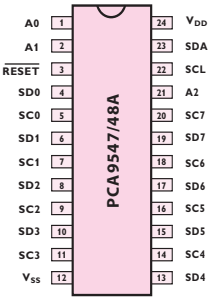
4 channel with Interrupt and reset



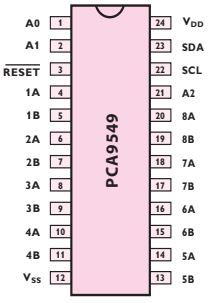
4 channel with reset



8 channel with reset



8-bit bus switch with reset



Device	Mux (I/O)	Switch (I/O)	Features				PackageOptions				
			Number of Addresses	Interrupt (I/O)	Hardware RESET	PinCount	SO (tube)	SO (tape-and-reel)	TSSOP (tube)	TSSOP (tape-and-reel)	HVQFN (tape-and-reel)
PCA9540B	1-2	—	1	—	—	8	D(N)	D-T	—	DP-T	—
PCA9541	2-1	—	16	1-2	Yes	16	D(N)	D-T	PW	PW-T	BS-T
PCA9542A	1-2	—	8	2-1	—	14	D(N)	D-T	PW	PW-T	—
PCA9543A/B/C	—	1-2	4	2-1	Yes	14	D(N)	D-T	PW	PW-T	—
PCA9544A	1-4	—	8	4-1	—	20	D(W)	D-T	PW	PW-T	BS-T
PCA9545A/B/C	—	1-4	4	4-1	Yes	20	D(W)	D-T	PW	PW-T	BS-T
PCA9546A	—	1-4	8	—	Yes	16	D(N)	D-T	PW	PW-T	BS-T
PCA9547	1-8	—	8	—	Yes	24	D(W)	D-T	PW	PW-T	BS-T
PCA9548A	—	1-8	8	—	Yes	24	D(W)	D-T	PW	PW-T	BS-T
PCA9549	—	8-bit	8	—	Yes	24	D(W)	D-T	PW	PW-T	BS-T

www.nxp.com/i2clogic

www.nxp.com

founded by PHILIPS

Date of release: July 2008
Document order number: 9397-750-16529
Printed in the Netherlands