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How to Multiplex a 1-Wire Host into Numerous Channels

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Abstract

1-Wire® networks with many 1-Wire nodes can require dedicated 1-Wire channels. This article discusses a method for using only one 1-Wire host in a network while having numerous 1-Wire channels.

Introduction

1-Wire networks are originally designed for communication with a single 1-Wire host and numerous 1-Wire nodes on a single 1-Wire bus. Preferably, a linear topology, which contains insignificant stubs, is best for a 1-Wire network. However, a star topology, which contains long stubs, is often unavoidable and makes it more difficult to determine the effective limitations. A method to eliminate these difficulties is to break up a star topology into numerous channels by using an analog multiplexer (mux). Advantages of using numerous channels include accelerating individual 1-Wire node access time, improving network robustness, and mixing overdrive-only nodes with standard/overdrive nodes on different channels. These advantages can be gained while still having a single 1-Wire host.

Arrangement

When configuring a 1-Wire network to have many channels, the general approach taken uses an Analog Devices' 1-Wire host connected to the common signal of an analog mux. The mux has digital channel select signals to connect the 1-Wire common signal to the desired I/O that contains a channel of 1-Wire node devices. With this arrangement, many more 1-Wire nodes can be networked over the limitations of a single 1-Wire bus. This is due to the elimination of stubs and a decrease in the number of 1-Wire nodes per channel driven by the 1-Wire host.

Examination

Figure 1 shows a 3.3 V system when using the DS2485 1-Wire host. The microcontroller controls both the DS2485 and the mux channel to be selected. In a 1-Wire network, it is critical that the mux used can handle rail-to-rail analog signals. Otherwise, signal distortion can occur and the V_{PUP} parameter requirement of the 1-Wire nodes can be violated. The mux R_{ON} parameter must also be as small as possible to avoid altering the DS2485 active pull-up impedance (R_{APU}). If this is not taken into account, the 1-Wire nodes might not receive the necessary current to operate during a strong pull-up event.

Optionally, the mux (U_2) has external, post-mux, pull-up resistors (RP4 and RP5) to provide power for idle 1-Wire nodes when the switches are open. If this is not done, each time a channel switch is connected, the microcontroller must wait the maximum wake-up time of the connected nodes on that channel (usually 2 ms) before beginning communication. However, it is important to consider the effects of the mux's R_{ON} parameter during a pulldown event by the 1-Wire host when using an external pull-up resistor on each channel. Any effects can be considered negligible by selecting a small R_{ON} to avoid violating the highest 1-Wire input low (V_{IL}) parameter of the 1-Wire nodes. So, for a given post-mux pull-up resistor of R_P and a given mux resistor of R_{ON}, the post-mux output low voltage is expressed as follows:

$$V_{OL\_MUX} = V_{OL} + (V_{CC} - V_{OL}) \times R_{ON}/(R_{ON}+R_P) \quad (1)$$

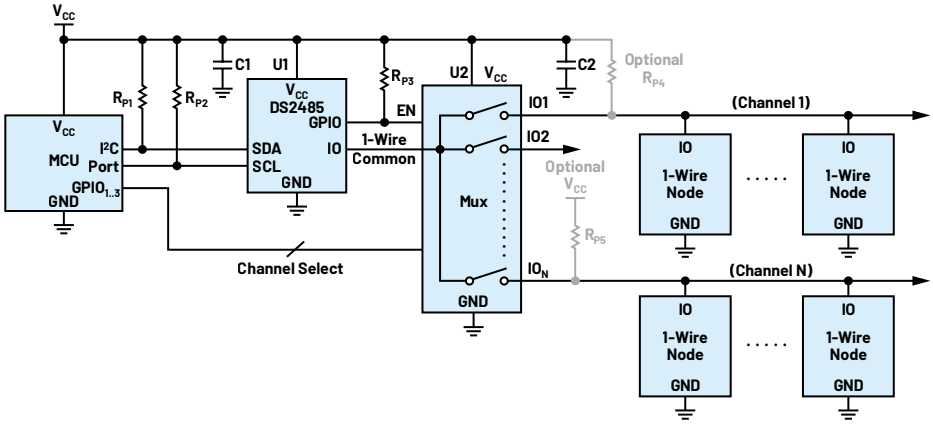

Figure 1. Typical application circuit.

Table 1. Analog Muxes for 1-Wire Devices Selector Guide

Part Number	Channels	Supply Voltage (Min) (V)	Supply Voltage (Max) (V)	R_{ON} (Max) (Ω)	Microcontroller—Channel Select	Packages
MAX4634	4-to-1	1.8	5.5	4	2 GPIO	10-lead µMAX, 10-lead TDFN-EP (3 mm × 3 mm)
MAX4734	4-to-1	1.6	3.6	0.8	2 GPIO	10-lead µMAX, 12-lead TQFN (3 mm × 3 mm)
MAX4617	8-to-1	2	5.5	10	3 GPIO	16-lead PDIP, 16-lead SOIC, 16-lead TSSOP
MAX4638	8-to-1	1.8	5.5	3.5	3 GPIO	16-lead TQFN (3 mm × 3 mm), 16-lead SOIC, 16-lead TSSOP
MAX4781	8-to-1	1.8	3.6	1	3 GPIO	16-lead TQFN (3 mm × 3 mm), 16-lead TSSOP
MAX14661*	16-to-1	1.8	3.6	8	I²C/SPI	28-lead TQFN (3 mm × 3 mm)

*The AB_ and COM_ pins provide +10 kV ESD protection (HBM). Any 16 AB_ pins can be connected to either COM_ pins.

Additionally, it is important to consider the flexibility of the 1-Wire host used. Analog Devices recommends the DS2485 1-Wire host for any 3.3 V system because the DS2485 timing, input triggering levels, and internal pull-up resistors are very adjustable. The DS2485 can also be set to a high impedance mode, which can be helpful when using the external resistor option. However, if a system needs 5 V then the next best option is to use the DS2484.

Lastly, during this examination, some systems require a mix of overdrive-only and standard/overdrive 1-Wire node devices. If the overdrive-only and the standard/overdrive devices reside on the same 1-Wire bus, communication faults occur. One simple solution is to use a mux that places overdrive-only devices on different channels than the overdrive/standard devices. The DS2485 can then simply switch to overdrive mode or standard mode between the selection of channels for proper communication.

Analog Mux Selection

There are many requirements a designer considers when selecting the analog mux. These requirements can be the number of channels, interface type, cost, package type, and performance. Table 1 lists the recommended analog muxes for 1-Wire applications. All of the recommended analog muxes handle rail-to-rail analog signals, have a small R_{ON}, and come in various package types. The microcontroller that controls the selected channel must have spare GPIO pins. If the microcontroller does not have any spare GPIO pins, it is possible to use the MAX14661 or a similar device that can be tied to the same I²C bus used by the DS2485.

Conclusion

This article provides a method to break up star topography 1-Wire networks by using an analog mux from the recommended list. As with the selection of any electronic component, the supporting system should carefully examine all device specifications under all use conditions to ensure reliable operation.

Related Parts

DS2477	DeepCover® secure SHA-3 coprocessor with ChipDNA® PUF protection
DS28E50	DeepCover secure SHA-3 authenticator with ChipDNA PUF protection
DS2465	DeepCover secure authenticator with SHA-256 coprocessor and 1-Wire® host function
DS2480B	Serial to 1-Wire line driver
DS2483	Single-channel 1-Wire host with adjustable timing and sleep mode
DS2484	Single-channel 1-Wire host with adjustable timing and sleep mode
DS2485	Advanced 1-Wire host with memory
DS2482-100	Single-channel 1-Wire host
DS2482-800	8-channel 1-Wire host
DS28E16	1-Wire secure SHA-3 authenticator

About the Author

Stewart has been an applications engineer for over 10 years. Prior to joining Analog Devices, Stewart worked at Maxim Integrated, concentrating on embedded security, 1-Wire® devices, and secure/nonsecure telecommunications equipment. He holds a B.S. degree in electrical engineering from Binghamton University in New York.