Keywords: 4-Channel 1-Wire Master, 8-Channel 1-Wire Master, 1-Wire mux, 1-Wire Multiplexer, DS2482-800 substitute, DS2477 mux, DS2484 mux

APPLICATION NOTE 6799

HOW TO MULTIPLEX A 1-WIRE MASTER INTO NUMEROUS CHANNELS

Abstract: 1-Wire® networks with many 1-Wire slaves can require dedicated 1-Wire channels. This application note discusses a method for using only one 1-Wire master in a network while having numerous 1-Wire channels.

Introduction

1-Wire® networks are originally designed for communication with a single 1-Wire master and numerous 1-Wire slaves 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 slave access time, improving network robustness, and mixing overdrive-only slaves with standard/overdrive slaves on different channels. These advantages can be gained while still having a single 1-Wire master.

Arrangement

When configuring a 1-Wire network to have many channels, the general approach taken uses a Maxim® 1-Wire master 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 slave devices. With this arrangement, many more 1-Wire slaves 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 slaves per channel driven by the 1-Wire master.

Examination

Figure 1 shows a 3.3V system when using the DS2477 1-Wire master. The µC controls both the DS2477 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 slaves can be violated. The mux RON parameter must also be as small as possible to avoid altering the DS2477 active pullup impedance (R). If this is not taken into account, the 1-Wire slaves might not

APU
receive the necessary current to operate during a strong pullup event.

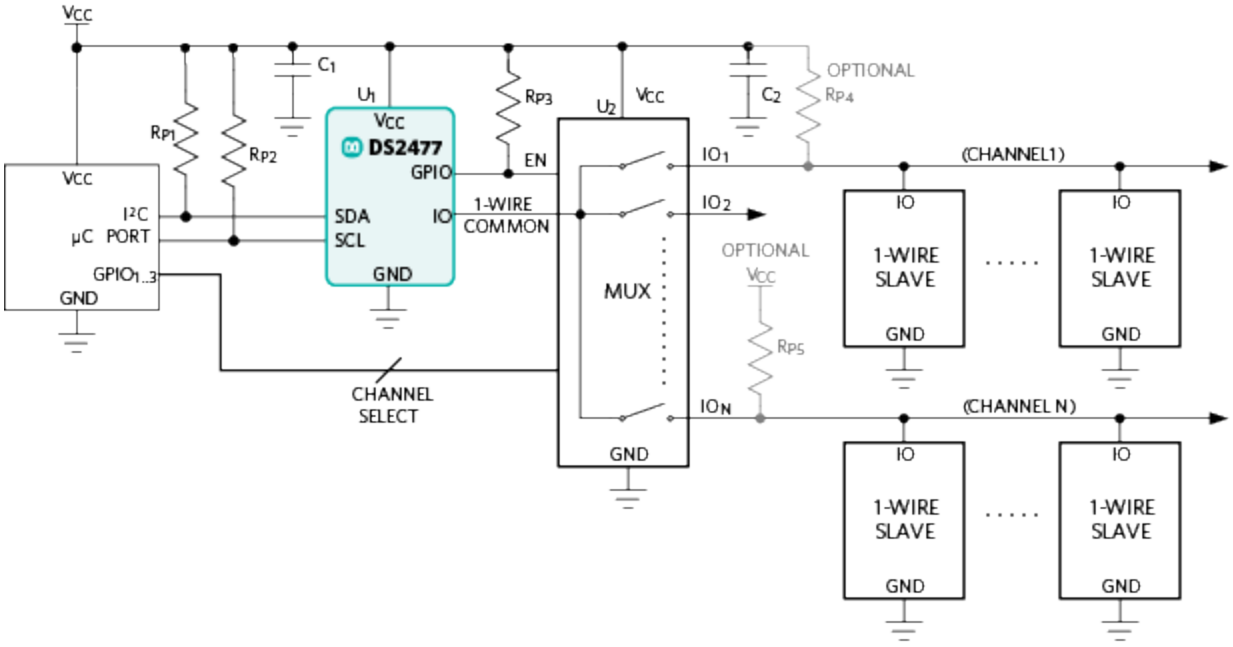

Figure 1. Typical application circuit.

Optionally, the mux (U_2) has external, post-mux, pullup resistors (R_{P4} and R_{P5}) to provide power for idle 1-Wire slaves when the switches are open. If this is not done, each time a channel switch is connected, the µC must wait the maximum wake-up time of the connected slaves on that channel (usually 2ms) 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 master when using an external pullup 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 slaves. So, for a given post-mux pullup resistor of R_P and a given mux resistor of R_{ON}, the post-mux output low voltage is expressed as follows:

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

Additionally, it is important to consider the flexibility of the 1-Wire master used. Maxim recommends the DS2477 1-Wire master for any 3.3V system because the DS2477 timing, input triggering levels, and internal pullup resistors are very adjustable. The DS2477 can also be set to a high impedance mode, which can be helpful when using the external resistor option. However, if a system needs 5V 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 slave 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 DS2477 can then simple 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 Maxim 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 µC that controls the selected channel must have spare GPIO pins. If the µC 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 I^2C bus used by the DS2477.

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)	µC - Channel Select	Packages
MAX4634	4-to-1	1.8	5.5	4	2 GPIO	10 µMAX, 10 TDFN-EP (3x3mm)
MAX4734	4-to-1	1.6	3.6	0.8	2 GPIO	10 µMAX, 12 TQFN (3x3mm)
MAX4617	8-to-1	2	5.5	10	3 GPIO	16 PDIP, 16 SOIC, 16 TSSOP
MAX4638	8-to-1	1.8	5.5	3.5	3 GPIO	16 THIN QFN (3x3mm), 16 SOIC, 16 TSSOP
MAX4781	8-to-1	1.8	3.6	1	3 GPIO	16 THIN QFN (3x3mm), 16 TSSOP
MAX14661*	16-to-1	1.8	3.6	8	I^2C/SPI	28 TQFN (3x3mm)

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

Summary

This application note 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.

Trademarks

Related Parts		
DS2477	DeepCover Secure SHA-3 Coprocessor with ChipDNA PUF Protection	Samples
DS28E50	DeepCover Secure SHA-3 Authenticator with ChipDNA PUF Protection	Samples

More Information
For Technical Support: https://www.maximintegrated.com/en/support
For Samples: https://www.maximintegrated.com/en/samples
Other Questions and Comments: https://www.maximintegrated.com/en/contact

Application Note 6799: https://www.maximintegrated.com/en/an6799
APPLICATION NOTE 6799, AN6799, AN 6799, APP6799, Appnote6799, Appnote 6799