Keywords: 1-wire timing, 1-wire, onewire, long line, Improved Network Behavior, noise immunity

APPLICATION NOTE 3925

1-Wire® Extended Network Standard

Oct 26, 2006

Abstract: The 1-Wire standard established in 1989 has been upgraded to accommodate noisy and long-line 1-Wire networks. This application note explains the new standard enhancements, and shows how to make a 1-Wire master that works with both standard and new devices.

Introduction

The 1-Wire bus is a simple signaling scheme that performs two-way communication over a single electrical connection. In any 1-Wire system, there is a single master and one or more slave devices sharing a common data line. Dallas Semiconductor created the 1-Wire standard in 1989 to reduce the contacts for portable data-carrying modules. The result of this was the invention of iButtons®, the 16mm battery-shaped modules that have sold more than 130 million worldwide.

The 1-Wire scheme also enabled other applications such as chip-based tagging and long-line sensor applications. The original 1-Wire front-end did not, however, anticipate the noise levels and line characteristics (e.g., line length) of some of these new applications. Satisfying these new application demands often challenged a 1-Wire implementation in the field. Therefore, to accommodate these applications a new 1-Wire front-end called the *1-Wire Extended Network Standard* was developed, and incorporated into several new devices. **Table 1** lists 1-Wire devices and shows which are supported by the new extended standard.

Important Features of the New Extended Standard

Noise from various sources can result in signal glitching on the 1-Wire line. The noise can come from reflections from network endpoints or branch points. (For more information, please see application note 148, "Guidelines for Reliable Long Line 1-Wire® Networks.") Noise can also come from an external source and get coupled onto the 1-Wire signal. A noise glitch during the rising edge can cause the 1-Wire device to become unsynchronized with the master. The improvements to the extended network front-end address these rising edge issues.

The new 1-Wire front-end incorporates three main components: a lowpass filter for high-frequency noise, voltage hysteresis on low-to-high switching, and a rising-edge hold-off time. Some 1-Wire devices also have slew control on the presence pulse. **Figure 1** illustrates these features. The shaded pink regions show how the device ignores glitches in voltage magnitude and over a period of time during 1-Wire low-to-high transitions.

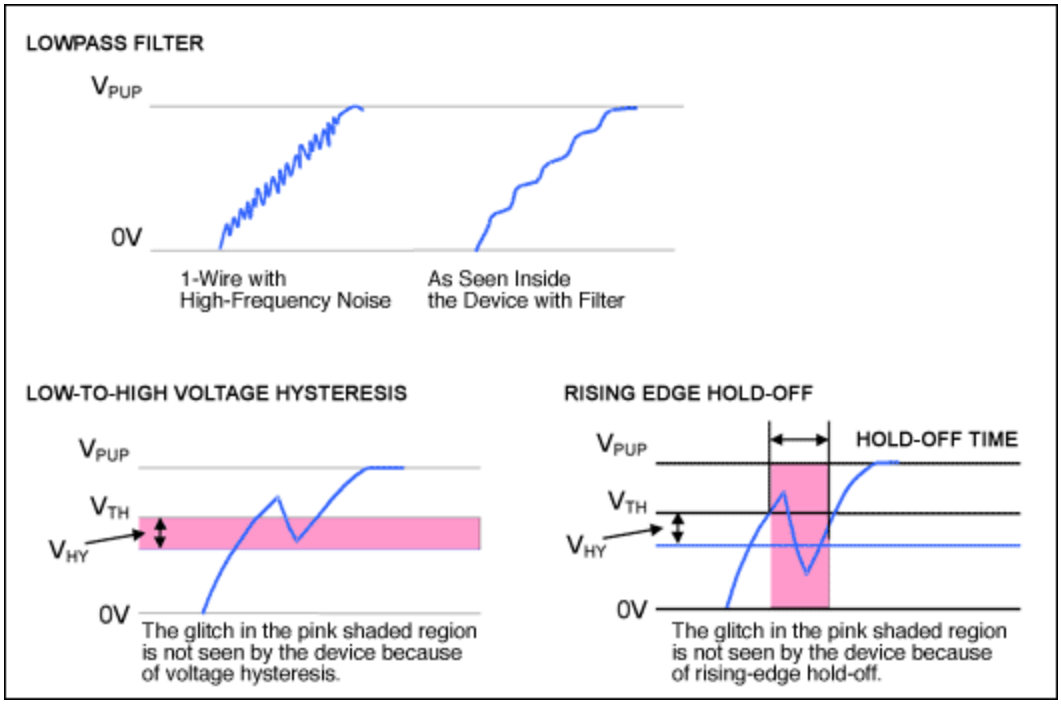

Figure 1. New 1-Wire front-end features.

Table 1. 1-Wire Devices

Device	FC	Description	1-Wire Extended Network Support	Notes
DS1822	22	1-Wire Econo temp sensor		
DS1825	3B	1-Wire thermometer with 4-bit address		
DS18B20	28	Adjustable resolution temperature		
DS18S20	10	Temperature and alarm trips		
DS1904	24	Real-Time Clock (RTC) iButton		
DS1920	10	Temperature and alarm trips		
DS1921G DS1921H DS1921Z	21	Thermochron temperature logger		
DS1922E DS1922L DS1922T DS1923	41	High-Capacity Thermochron and/or Hygrochron temperature and/or humidity dataloggers, respectively	√	
DS1961S	33	1Kb EEPROM memory with SHA-1 engine	√	
DS1963S	18	4Kb NVRAM memory and SHA-1 engine		
		256-bit EEPROM memory and		

DS1971	14	64-bit OTP register	√	
DS1972	2D	1Kb EEPROM memory	√	
DS1973	23	4Kb EEPROM memory		
DS1977	37	Password-protected 32kB (bytes) EEPROM	√	
DS1982	09	1Kb EPROM memory		
DS1885	0B	16Kb EPROM memory		
DS1990A DS1990R	01	1-Wire address only		
DS1991	02	Multikey iButton, 1152-bit secure memory		Not recommended for new designs, see application note 4421, "Alternatives to the DS1991L MultiKey iButton®" for alternatives.
DS1992	08	1Kb NV RAM memory		
DS1993	06	4Kb NV RAM memory		
DS1994	04	4Kb NV RAM memory and clock, timer, alarms		Not remommended for new designs, see application note 4506, "Alternatives to the DS1994L 4Kb Plus Time Memory iButton®" for alternatives.
DS1995	0A	16Kb NV RAM memory		
DS1996	0C	64Kb NV RAM memory		
DS2401	01	1-Wire address only		
DS2404	04	4Kb NV RAM memory and clock, timer, alarms		Not recommended for new designs
DS2406	12	1Kb EPROM memory, 2-channel addressable switch		
DS2408	29	8-channel addressable switch	√	
DS2409	1F	Dual switch, coupler		Not recommended for new designs
DS2411	01	Low-voltage, unique 64-bit serial ROM number (requires V_{DD} connection)	√	
DS2413	3A	Dual-channel addressable switch	√	
DS2417	27	RTC with interrupt		
DS2422	41	High-capacity Thermochron/Hygrochron (temperature and humidity) datalogger	√	Not recommended for new designs
DS2430A	14	256-bit EEPROM memory and 64-bit OTP register	√	Not recommended for new designs
DS2431	2D	1Kb EEPROM memory	√	
DS2432	33	1Kb EEPROM memory with SHA-1 engine		
DS2433	23	4Kb EEPROM memory		

DS2438	26	Temperature, ADC		
DS2450	20	Quad ADC		
DS2502	09	1Kb EPROM memory		
DS2505	0B	16Kb EPROM memory		
DS2703	34	Battery-packed authentication IC		
DS2740	36	1-Wire coulomb counter (high precision)		
DS2762	30	1-Wire battery monitor and protector		
DS2775 DS2776 DS2777 DS2778 DS2780 DS2784 DS2788	32	Stand-alone 1-Wire fuel gauge		
DS2781	3D	Stand-alone fuel gauge IC		
DS28E04-100	1C	4Kb EEPROM memory, two-channel addressable switch, 7 address pins	√	
DS28EA00	42	1-Wire digital thermometer with sequence detect and PIO	√	
DS28EC20	43	20Kb 1-Wire EEPROM	√	

Note: New 1-Wire devices are constantly added to the product line. Newer parts may not be in this list. Look for an 'Improved Network Behavior' section in the device's data sheet to see if the device incorporates the new extended network front-end.

The new features in the *Extended Network Standard* are only fully active during standard speed communication, not in overdrive. Adding these features to the 1-Wire front-end can affect the 1-Wire timing specification. Specifically, the new standard introduces an EC table parameter, t_{REH}, that represents the rising-edge hold-off time. This hold-off behavior increases the low time generated by the master and required in a read bit, t_{RL}. See **Table 2**.

Field experience with applications using long lines to communicate with 1-Wire devices demonstrates the importance of adequate recovery between bits. As a result, all of the extended-network devices have longer recovery times, t_{REC}. The recovery-time specification for all devices (standard and extended network) is given for one device on a 1-Wire bus. For a guide to extending this specification to multiple devices, see application note 3829, "Determining the Recovery Time for Multiple-Slave 1-Wire Networks."

Devices that incorporate slew control on the presence pulse include a parameter, t_{FPD}, for Presence Detect Fall Time. While controlling the slew creates less reflections on long lines, it has a significant effect on the window in which a master can detect the presence pulse. Impedance matching on the 1-Wire master can be equally effective in controlling these reflections without incurring the slew-rate delay. Consequently, future devices may not incorporate the presence-pulse slew-rate feature.

Table 2. EC Table Differences

Parameter	Speed	Min/Max	Standard	Extended Network*
t_{REC}	Standard	Min	1µs	5µs
	Overdrive	Min	1µs	2µs
t_{REC} (before reset)	Overdrive	Min	1µs	5µs
t_{REH}	Standard	Min	—	Varies from 0.5µs to 0.6µs
	Standard	Max	—	Varies from 2µs to 5µs
	Overdrive	Min	—	Varies from 0µs to 0.6µs
	Overdrive	Max	—	Varies from 0µs to 2µs
t_{RL}	Standard	Min	1µs	5µs

*See the device data sheets for the actual t_{REH} values.

Summary

A 1-Wire master can work with both standard and extended-network devices. Accommodating the extended-network devices is as simple as extending recovery time between bits and using a longer start pulse for a read bit, t_{RL}. While the longer recovery will slow the throughput, the change in the read-bit start pulse will not affect the throughput. For networks with devices using presence-pulse slew control, t_{FPD}, care must be taken to select the sample point for the presence pulse. For some devices and voltages the sample range may be restrictive.

Application note 126, "1-Wire Communication Through Software," describes a simple 1-Wire master with timing that is already compatible with standard and extended-network devices. The application note includes an Excel spreadsheet for customizing the parameters based on the 1-Wire slave devices and the network conditions such as rise time. Download the afore mentioned Excel sheet.

Also see: all 1-Wire devices

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

Application Note 3925: http://www.maximintegrated.com/an3925
APPLICATION NOTE 3925, AN3925, AN 3925, APP3925, Appnote3925, Appnote 3925