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

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APPLICATION NOTE 3925

1-Wire® Extended Network Standard

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 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.

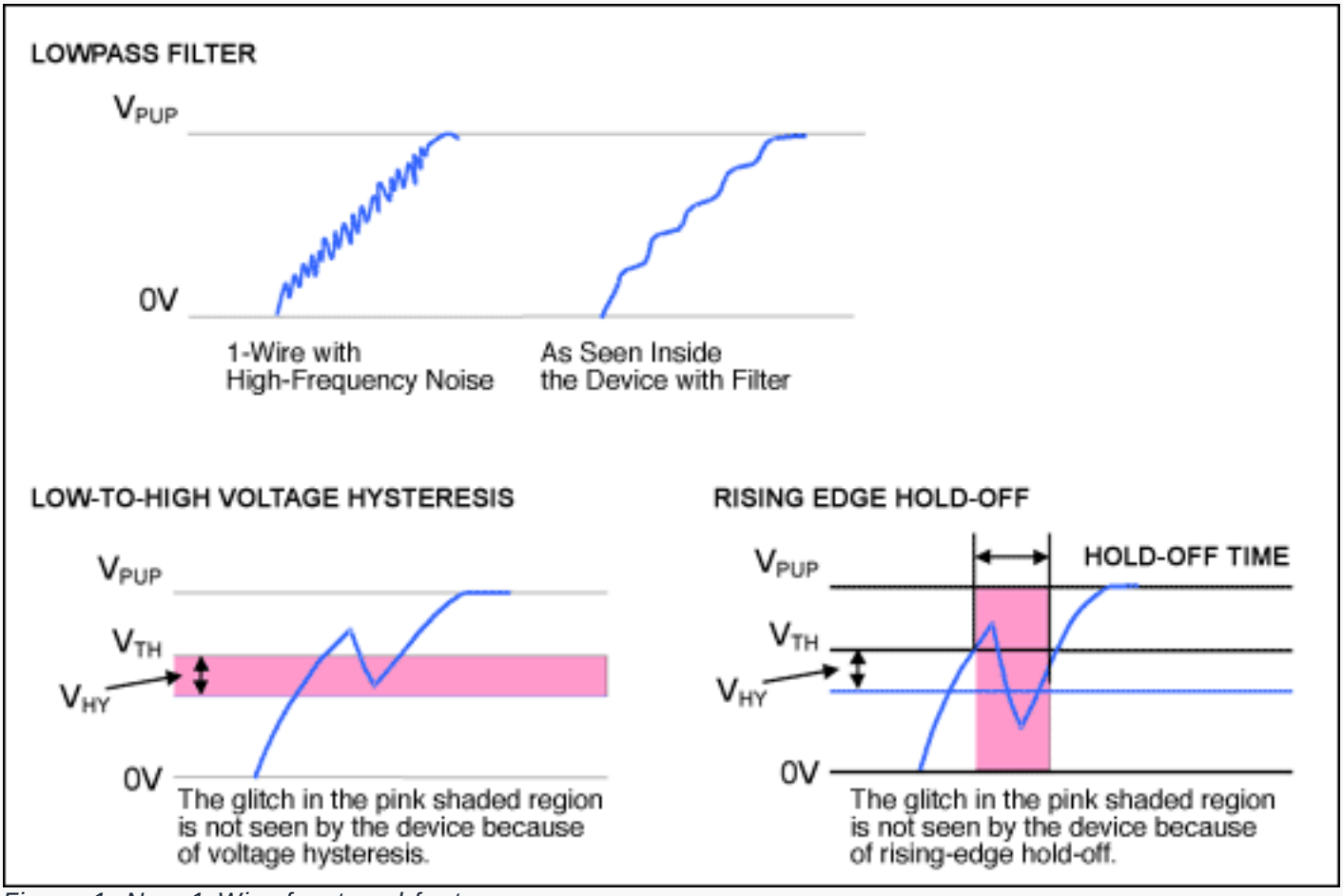

Figure 1. New 1-Wire front-end features.

Table 1. 1-Wire Devices

Device	FC	Description	1-Wire Extended Network Support
DS1425*	02	Multikey iButton, 1152-bit secure memory	
DS1427*	04	4k NV RAM memory and clock, timer, alarms	
DS1820	10	Temperature and alarm trips	
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	
DS1982	09	1k EPROM memory	
DS1985	0B	16k EPROM memory	
DS1986	0F	64k EPROM memory	
DS1904	24	Real-Time Clock (RTC) iButton	
DS1920	10	Temperature and alarm trips	
DS1921G DS1921H DS1921Z	21	Thermochron temperature logger	
DS1922L DS1922T DS1923	41	High-Capacity Thermochron and/or Hygrochron temperature and/or humidity dataloggers, respectively	√
DS1961S	33	1k EEPROM memory with SHA-1 engine	
DS1963L*	1A	4k NV RAM memory with write cycle counters	

DS1963S	18	4k NVRAM memory and SHA-1 engine	
DS1971	14	256-bit EEPROM memory and 64-bit OTP register	
DS1972	2D	1k EEPROM memory	√
DS1973	23	4k EEPROM memory	
DS1977	37	Password-protected 32kB (bytes) EEPROM	√
DS1990A DS1990R	01	1-Wire address only	
DS1991*	02	Multikey iButton, 1152-bit secure memory	
DS1992	08	1k NV RAM memory	
DS1993	06	4k NV RAM memory	
DS1994*	04	4k NV RAM memory and clock, timer, alarms	
DS1995	0A	16k NV RAM memory	
DS1996	0C	64k NV RAM memory	
DS2401	01	1-Wire address only	
DS2405	05	Single switch	
DS2404*	04	4k NV RAM memory and clock, timer, alarms	
DS2406 DS2407	12	1k EPROM memory, 2-channel addressable switch	
DS2408	29	8-channel addressable switch	√
DS2409*	1F	Dual switch, coupler	
DS2411	01	Low-voltage, unique 64-bit serial ROM number (requires V_{DD} connection)	√
DS2413	3A	Dual-channel addressable switch	√
DS2415	24	RTC	
DS2417	27	RTC with interrupt	
DS2422	41	High-capacity Thermochron/Hygrochron (temperature and humidity) datalogger	√
DS2423*	1D	4k NV RAM memory with external counters	
DS2430A*	14	256-bit EEPROM memory and 64-bit OTP register	
DS2431	2D	1024-bit EEPROM memory	√
DS2432	33	1k EEPROM memory with SHA-1 engine	
DS2433	23	4k EEPROM memory	
DS2436	1B	1-Wire battery ID with temperature and voltage monitor	
DS2438	26	Temperature, ADC	
DS2450	20	Quad ADC	
DS2502	09	1k EPROM memory	
DS2505	0B	16k EPROM memory	
DS2506	0F	64k EPROM memory	
DS2740	36	1-Wire coulomb counter (high precision)	
DS2751	51	1-Wire fuel gauge for 1-cell Li+ or 3-cell NiMH	
DS2760	30	Temperature, current, ADC	

DS2761	2B	1-Wire Li+ monitor	
DS2762	30	1-Wire battery monitor and protector	
DS2780	32	Stand-alone 1-Wire fuel gauge	
DS28E01	2F	1Kb Protected 1-Wire EEPROM with SHA-1 Engine	√
DS2890*	2C	Single-channel digital potentiometer	
DS28E04-100	1C	4096-bit EEPROM memory, two-channel addressable switch	√
DS28EC20	43	20KB 1-Wire EEPROM	√

*This device is no longer recommended for new designs.

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.

Application note 3925: www.maxim-ic.com/an3925

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Related Parts

DS1922L: QuickView -- Full (PDF) Data Sheet

DS1922T: QuickView -- Full (PDF) Data Sheet

DS1923: QuickView -- Full (PDF) Data Sheet

AN3925, AN 3925, APP3925, Appnote3925, Appnote 3925