Single-Wire Communication Host With MSP430™ MCUs

TEXAS INSTRUMENTS

Introduction

Several features commonly used in microcontroller (MCU) designs, such as external EEPROMs, SHA-1 authenticators, temperature sensors, digital switches, and battery system monitors, use a single bidirectional line to transfer data between itself and a master device. Commonly referred to as 1-wire or SDQ™ single-wire serial interfaces, this communication peripheral reduces the number of physical hardware connections required while adhering to a protocol that can be easily achieved with MSP430™ MCUs acting as the function's master. Commands can be basic enough to operate with the MSP430FR2000 MCU, which contains 512 bytes of main memory, or expanded to service a multitude of operations and slave devices. A code example that demonstrates the initialization of such an interface is below. To get started, download project files and a code example demonstrating this functionality.

Implementation

Most single-wire devices operate using parasitic power: they supply the required power from the I/O line in which they also communicate bidirectionally. This is accomplished through a pullup resistor whose value depends on the single-wire device being used. The data sheet should be referenced as some devices require a dedicated V_{CC} connection. The MSP430 MCU uses bit-banging to achieve communication on the single line and can therefore use any available GPIO pin. Figure 1 shows a typical wiring diagram.

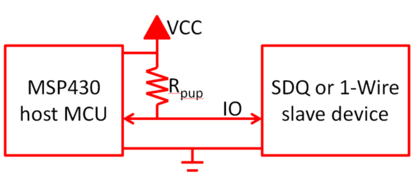

Figure 1. Single-Wire Block Diagram

Single-wire communication follows a widely adopted protocol that is publicly available. Three basic types of operations are allowed on the single line: reset, write, and read. All single-wire devices also follow a transaction sequence which dictates how these devices should be accessed through initialization, identification, functional commands, and additional data transfers. Identification usually involves a 64-bit identification number unique to each device which, much like an I^2C slave address, allows for multiple single wire devices on a bus and lets the master device identify the number of slaves present and select between them. Please refer to the specific device datasheet for a list of functional commands.

The purpose of the code example provided with this document is to simply detect the presence of a single wire slave device and receive its identification number. Cycle delays or a Timer B peripheral can used to control the timing requirements, but no other modules are incorporated. The function starts by sending a reset pulse, after which a presence pulse is sent by the slave to confirm its existence. The MSP430 MCU then follows to issue a Send ROM command so that it may receive the 64-bit identification number (consisting of the family number, ROM code, and CRC) that shortly follows. A new sequence begins when a reset pulse is issued on the communication line. Further functionality is intended to be designed by the user for their end application, and to this extent functions have been created in the code for issuing resets as well as byte writes and reads. Figure 2 and Figure 3 show this transaction.

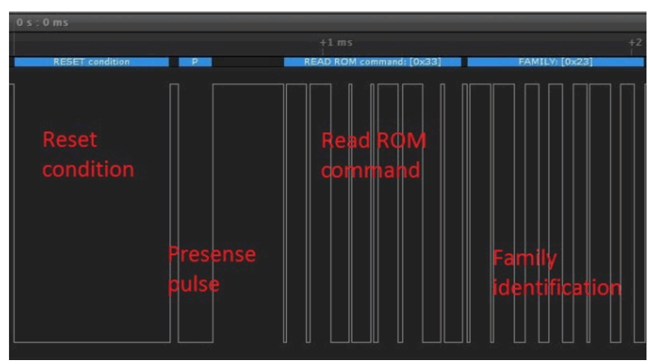

Figure 2. Single-Wire Reset Pulse, Presence Pulse, and Send ROM Command

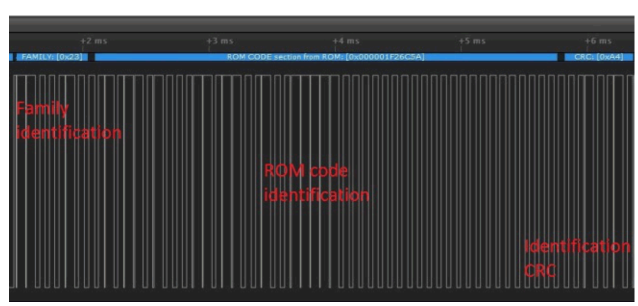

Figure 3. Single-Wire Reception of 64-bit Identification Number

Performance

Most of the code examples main memory consumption is due to the software implementation of the single-wire bus. Further read and write commands do not require much more space since the functions have already been defined, so it is possible to create basic applications to use with the MSP430FR2000 MCU. It may become difficult to encapsulate all necessary commands and other peripheral actions into 512 bytes. In these cases the code can easily be transferred to a larger MSP430 MCU such as the MSP430FR2111 device.

A system frequency of 4 MHz or greater is needed to maintain the required communication protocol. Cycle delays must be used to save memory space on the MSP430FR2000 MCU, but for other devices where Timer B can be utilized then low-power mode 0 (LPM0) is used during an active sequence. LPM3 and LPM4 cannot be used because their wake-up time exceeds the minimum response time required. But once idle, the device can enter these modes. Active mode and LPMx current consumption varies due to system requirements (system frequency, clocks available, SVS usage, and so on) and are documented in the device data sheet. The example provided, which operates at 8 MHz when active, consumes an average of 1.2 mA at 3 V while communicating and 18 µA when idle [LPM3 sourced by the internal trimmed low-frequency reference oscillator (REFO)]. For information on using MSP430 FRAM devices to emulate single-wire slave applications, see the TIDM-1WIREEEPROM.

Device Recommendations

The device used in this example is part of the MSP430 Value Line Sensing portfolio of low-cost MCUs, designed for sensing and measurement applications. This example can be used with the devices shown in Table 1 with minimal code changes. For more information on the entire Value Line Sensing MCU portfolio, visit www.ti.com/MSP430ValueLine.

Table 1. Device Recommendations

Part Number	Key Features
MSP430FR2000	0.5KB FRAM, 0.5KB RAM, eComp
MSP430FR2100	1KB FRAM, 0.5KB RAM, 10-bit ADC, eComp
MSP430FR2110	2KB FRAM, 1KB of RAM, 10-bit ADC, eComp
MSP430FR2111	3.75KB FRAM, 1KB RAM, 10-bit ADC, eComp

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