Remote I²C and SPI Sensor Operation Using the DS28E18

MAXREFDES9000

Introduction

The MAXREFDES9000 is a reference design showcasing the DS28E18 that demonstrates how to both operate and power remote I²C and serial peripheral interface (SPI) sensors using only two wires. The DS28E18 is an easy-to-use bridge integrated circuit (IC) that operates as a 1-Wire® slave device to a host controller. The IC provides a 512-byte command sequencer that is loaded with commands and control data to operate an I²C or SPI device that is interfaced to the DS28E18. Once loaded, the host controller sends a 1-Wire command to autonomously execute the sequence, power, and collect data from the attached peripherals. A subsequent 1-Wire command reads collected data. Power for the attached sensors or peripherals is sourced from the 1-Wire line enabling a very efficient solution to remotely power and control complex devices such as environmental sensors, analog-to-digital converters (ADCs), digital-to-analog converters (DACs), and display controllers. The MAXREFDES9000 is designed to work as a remotely operated environmental monitoring system. This system includes a Liquid Crystal Display (LCD) screen to display the conditions of a variety of remote I²C and SPI sensors, each used to examine environmental conditions such as temperature and humidity.

Features

- Power and communication to I²C and SPI sensors via two wires
- 512-byte command sequencer for autonomous operation
- Up to 10mA at 3.3V sensor power derived from 1-Wire
- Up to 100m distance with the 1-Wire interface
- Raspberry Pi® computer enables a powerful computing platform for creating an expansive system of sensors
- Example source code demonstrates how to interface to various types of I²C and SPI sensors

Hardware Specifications

This reference design includes the following major components: one DS9481P-300, four Phoenix to 6-pin connector adapters, three DS28E18 modules, and three sensor modules. The DS9481P-300 is a USB to 1-Wire adapter that drives the 1-Wire communication to the DS28E18 modules. It includes a 6-pin female connector to support a variety of 1-Wire modules like the DS28E18. This reference design uses a two-wire connection that interfaces multiple DS28E18 modules to the same 1-Wire bus using a daisy-chain configuration. Each DS28E18 module connects to a unique sensor module. The first sensor module is used to examine the environment's temperature and humidity using an I²C interface. The second sensor module uses an SPI accelerometer sensor to examine the changes in vibration felt by the module itself due to potential pests in the environment. Finally, the third sensor module is used to measure the environment's ultraviolet (UV) index using an I²C sensor.

Designed-Built-Tested

This document describes the hardware shown in Figure 1 as well as its supplementing software. It provides a detailed, systematic technical guide to set up and understand the MAXREFDES9000 reference design. The system has been built and tested, details of which follow later in this document.

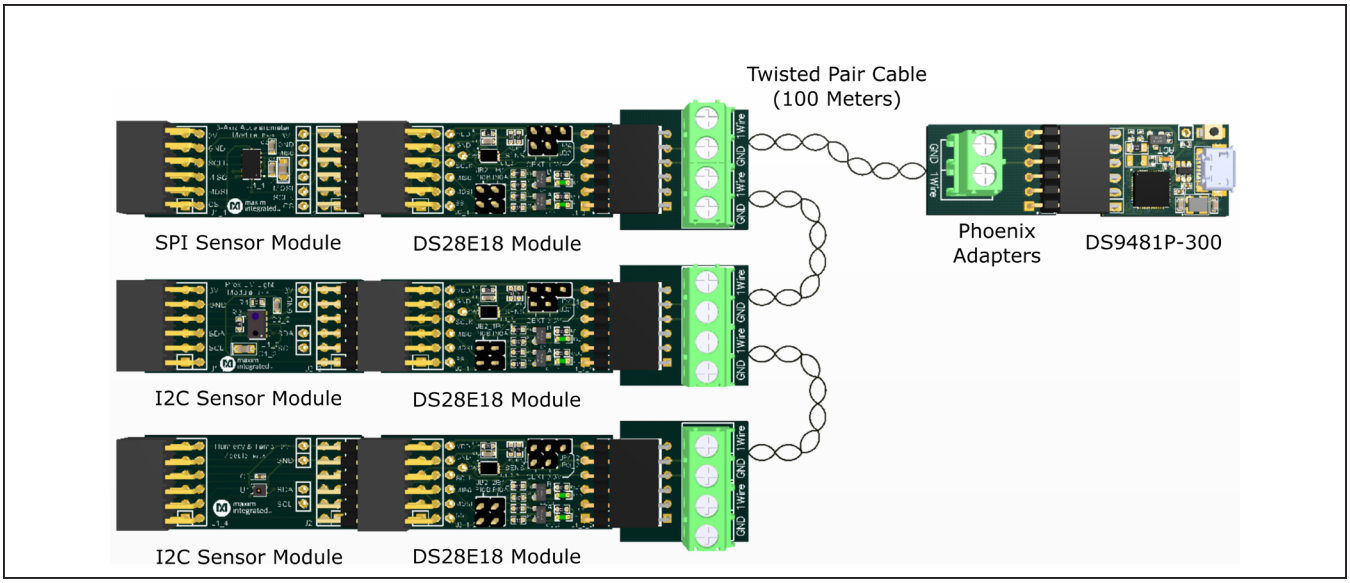

Figure 1. MAXREFDES9000 hardware.

Design Procedure for MAXREFDES9000

The following procedure outlines a step-by-step process for developing the MAXREFDES9000 reference design.

Step 1: Select the Host Processor

One of the major components in this design is the host processor. Since this reference design is used as an environmental monitoring system, it is important to consider how the information is displayed. The MAXREFDES9000 uses the Raspberry Pi as it is a versatile computer that supports a variety of peripherals. This makes it a suitable option for developing a simple monitoring station by connecting a display via the onboard display serial interface (DSI) connector.

Step 2: Integrate the 1-Wire Driver

There are many ways to integrate a 1-Wire driver, such as by using a programmable input/output (I/O) pin from the host microcontroller. However, for this design, a DS9481P-300 USB-to-1-Wire adapter handles the 1-Wire processing. This device makes it easy to develop a 1-Wire library for the DS28E18 using the DS9481P-300 application program interface (API) included in the design's resources page. Since it is a USB device, the DS9481P-300 can be connected to most USB-compatible devices such as the Raspberry Pi making it easy to integrate the DS28E18 and sensors.

Step 3: Select the I²C and SPI Sensors

Once the DS28E18 is ready to be used, the next step is to select an appropriate set of I²C and SPI sensors to examine the environment's conditions. Apart from picking a set of environmental sensors, it is also necessary to consider each sensor's operating power requirements. Since the DS28E18 provides the power to the I²C and SPI sensors, it is important that each sensor uses no more than 10mA and operates at a typical 3.3V range. After this evaluation, the MAXREFDES9000 uses a set of sensors that can measure the following environmental conditions: temperature, humidity, UV index radiated by the sun, and any motion caused by potential pests.

Step 4: Set Up the Remote Connection

Once the major components are established, the final step is to set up a remote connection between the host and the environment. Creating the remote connection is as simple as using common 24 AWG twisted pair since the DS28E18 only requires two wires (1-Wire and GND) to operate the attached sensors. The MAXREFDES9000 demonstrates this by connecting the DS9481P-300 and a remote DS28E18 device at a distance of approximately 30m. From there, additional DS28E18 devices are daisy-chained together essentially allowing the system to examine three different locations in the environment. By doing this, the system can demonstrate how the sensors are powered and controlled from a long distance while using only a two-wire connection.

Detailed Description of Hardware

The high-level block diagram of the MAXREFDES9000 hardware is shown in Figure 2. This system is divided into two sections, a Monitoring Station and an Environmental Station, connected via a long two-wire cable. In the Environmental Station resides a group of components that are responsible for examining the ecological conditions and transmitting the measurements back to the Monitoring Station. This region includes the following major components: three DS28E18, one I²C temperature and humidity sensor, one I²C UV light sensor, and one SPI accelerometer sensor. On the other end of the two-wire cable resides the final group of components making up the Monitoring Station. In this region, the data being transmitted from the Environmental Station is processed and displayed onto an LCD screen for viewing the measured data. The major components in the station include the following: a Raspberry Pi computer, a Raspberry Pi-compatible touchscreen display, and a 1-Wire master-side driver.

Detailed Description of GUI

The MAXREFDES9000 software is a program designed specifically for this reference design. It works in conjunction with the hardware to process and display the information captured by the environmental sensors. The software runs on the Raspberry Pi's OS and uses an open source Python framework to develop the graphical user interface (GUI). Figure 3 shows what the GUI looks like when running on the hardware's touchscreen display. The green house image is used to depict the environment in which the remote sensors are located. The three buttons in the center of the screen represent each sensor module. Tapping on any of the three buttons queries the corresponding DS28E18 to begin taking measurements from its attached sensor. Once finished, the GUI displays the measurements onto a separate window for the user to monitor. See Table 1 for more details on each functionality. See the *Design Resources* section to download the software and source code.

Table 1. GUI Controls

DESCRIPTION	FUNCTION NUMBER	DETAILS
Home Button	1	Navigates back to the main screen
Connect Button	2	Initialize the DS28E18 devices
Log Toggle Button	3	Enable or disable the 1-Wire communication log
Temp. and Humidity Button	4	Displays the environment's temperature and humidity
Motion Button	5	Displays the sensor module's acceleration
UV Index Button	6	Displays the environment's UV Index
Status Bar	7	Indicates if DS28E18 initialization was successful

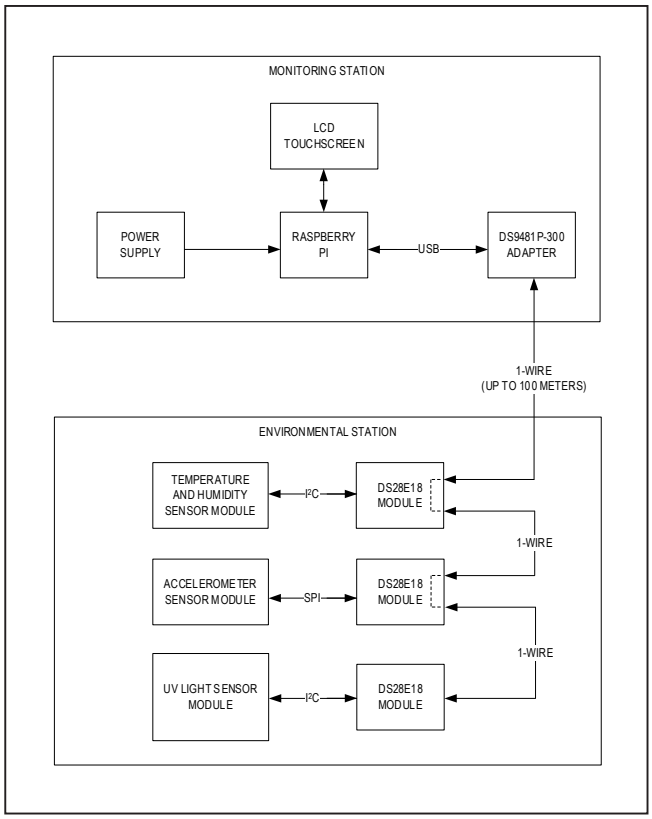

Figure 2. High-level block diagram of the MAXREFDES9000.

Figure 3. Main display of the MAXREFDES9000 GUI.

Design Resources

Download the complete set of **Design Resources** including schematics, bill of materials, PCB layout, and test files.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/20	Initial release	—