TI-RSLK MAX

Texas Instruments Robotics System Learning Kit

Texas Instruments

Module 11

Introduction: Interfacing graphical displays

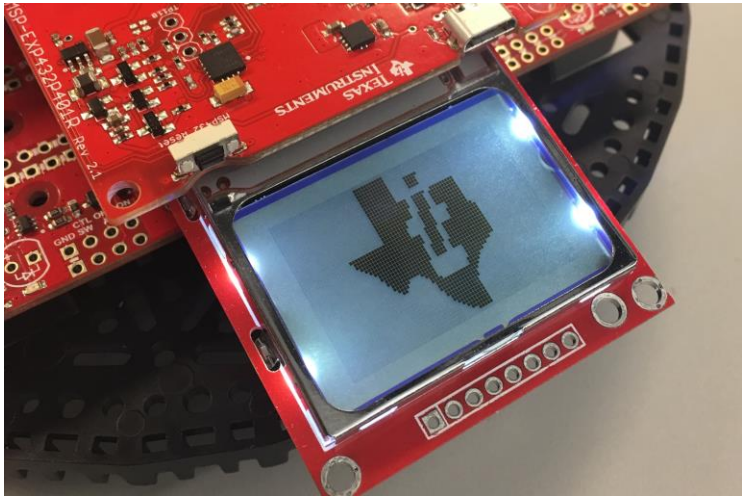
Introduction: Interfacing graphical displays

Educational Objectives:

REVIEW Software/hardware synchronization with busy-wait
UNDERSTAND synchronous serial communication
DEVELOP a set of display output functions
LEARN how to display characters on an LCD/OLED screen
DESIGN, BUILD & TEST A SYSTEM
Interface an LCD/OLED to the microcontroller

Prerequisites (Modules 1, 4, and 6)
- Running code on the LaunchPad using CCS (Module 1)
- Basic C programming (Module 4)
- GPIO (Module 6)

Recommended reading materials for students:
- Chapter 11, **Embedded Systems: Introduction to Robotics**, Jonathan W. Valvano, ISBN: 9781074544300, copyright © 2019



Microcontrollers employ multiple approaches to communicate synchronously with peripheral devices and other microcontrollers. The synchronous peripheral interface (SPI) system can operate as a master or as a slave. The channel can have one master and one slave, or it can have one master and multiple slaves. In this module, the MSP432 will be the master and the LCD will be the slave. The master initiates all data communication.

A universal asynchronous receiver transmitter (UART introduced here and covered in more detail later in Module 18) implements an asynchronous protocol, meaning the data are transmitted without timing information and the receiver derives time from the data. SPI implements a synchronous protocol, meaning transmitter and receiver operate off the same clock. Two devices communicating with asynchronous serial interfaces operate at the same frequency (baud rate) but have two separate clocks. With a UART protocol, the clock signal is not included in the interface cable between devices. Two devices communicating with SPI operate from the same clock (synchronized). With an SPI protocol, the clock signal is included in the interface cable between devices. Typically, the master device creates the clock, and the slave device(s) uses the clock to latch the data (in or out.)

The SPI protocol includes four I/O lines. The slave select STE is an optional negative logic control signal from master to slave signal signifying that the channel is active. The second line, CLK, is a 50% duty cycle clock generated by the master. The slave in master out (SIMO) is a data line driven by the master and received by the slave. The slave out master in (SOMI) is a data line driven by the slave and received by the master. In order to work properly, the transmitting device uses one edge of the clock to change its output, and the receiving device uses the other edge to accept the data.

In the lab associated with this module, we will interface one of three possible devices: a Nokia 5110 LCD using SPI, an SSD1306 LCD using SPI, or the PC using UART. Each will use busy-wait synchronization. Before we output data or commands to the display, we will check a status flag and wait for the previous operation to complete. Busy-wait synchronization is very simple and is appropriate for I/O devices that are fast and predicable. Debugging is a critical task when developing complex systems. The motivation for this lab is to provide a real-time monitoring, so you can visualize debugging parameters as the robot is exploring its world.

ti.com/rslk

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265