Digital System for Configuration Detection

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Abstract

This paper describes a digital system which detects the configuration of any RS-232C cable that has 25 pin connectors at both ends. The system uses a single chip microcomputer as the system controller for flexibility and cost effectiveness. The system controller sends the configuration information to a PC to be displayed on the CRT screen. A software program which controls the overall operation of the system is also described. The system can be further expanded to a universal configuration detector by adding programmability on the number of pins.

1: Introduction

The ability to communicate with other computers and computer peripherals is essential to nearly every computer system, from micro to mainframe. Because of this need, standard data communication ports are established. RS-232C is by far the most popular serial interface standard. First introduced in 1962, it was intended to describe the interface between a computer terminal and a modem [1]. In RS-232C jargon, the terminal is referred to as a DTE (data terminal equipment) and the modem as a DCE (data communications equipment). In practice, it is widely used to interface a microcomputer and any nonmodem peripherals.

RS-232C is a voltage standard with typical logic levels of -12V for a logic 1 and +12V for a logic 0. The high voltage levels provide 2V noise immunity which ensures reliable operation with long cables routed through noisy environments. To interface RS-232C with TTL, special line drivers and receivers are required. A line driver accepts TTL-level inputs and provides RS-232C output levels. A receiver does the opposite, converting the RS-232C levels on the transmission line to TTL levels. Because of these drivers and receivers, the negative logic aspect of RS-232C is transparent to the user. The specification for RS-232C limits the baud rate to 19,200 with a 50-ft cable. In practice, much longer cables can be accommodated but at lower data rates.

In addition to the electrical characteristics, the standard also defines a 25-pin connector with signals defined for all pins. Usually, a subset of these signals is used for actual interfacing. Thus, the pin exists on the connector does not mean that there is a wire connected to the other side. Testing of a RS-232C cable is not trivial because of the number of pins. Manual testing will take lots of time and effort with error prone results. A digital system which will automatically test a RS-232C cable can be developed using off-the-self IC's. The major concern for the system development is to have flexibility and cost effectiveness.

A microcomputer based digital system has been developed. The number of components in the system controller has been minimized in order to reduce the overall cost of the system. The system uses a PC as the host computer for user interface. The system controller sends the configuration information to the PC to be displayed on the CRT screen. Detailed description for the hardware and software of the system follows.

2: System Description

The basic operation of the system will be to select one pin at a time and detect all pins connected to that particular pin. Open collector buffers and pull up resistors can be used for the detection of all pins connected to a particular pin. Assume that an open collector buffer will be turned on if the input voltage is
low and turned off if the input voltage is high. When a low voltage is applied to the input of an open collector buffer, the buffer will sink current and the output of the buffer will be low. On the other hand, when a high voltage is applied to the input of an open collector buffer, the buffer will not conduct current and the output will be held high by a pull up resistor. Thus, low voltages will be detected at those pins connected to the pin which has low input voltage. An example circuit is given in Fig. 1. In that example, pin 2, pin 4, and pin 5 are connected together. If we select the second pin by applying a low voltage to the input of the second buffer, we will observe low voltages at pin 2, pin 4, and pin 5.

Based upon this circuitry, we developed a digital system which will automatically repeat the basic operation until each and every one of the connector pins is tested. For minimum cost and maximum flexibility, we determined to use a microcontroller chip, 8031, as the system controller. A block diagram for the system is given in Fig. 2. The system controller will generate a select signal for the demultiplexer (DMUX) so that one and only one output of the DMUX becomes low and selects one pin at a time. The controller will also generate a latch enable signal in order to store the connection information into the latches. Then, the controller will read the information from the latches and determine the connectivity among pins.

The outline of the system developed for RS-232C 25-pin connectors is as follows:

(1) Each pin is numbered from 1 to 52 since there are total 50 pins and 2 connector shields for one RS-232C cable. The 2 connector shields are treated as extra pins so that we may simplify overall control of the system.

(2) In this system, an 1-to-52 demultiplexer is required to select one and only one pin out of 52 pins at a time. Since the 1-to-52 demultiplexer is not available, four 1-to-16 demultiplexers (74LS154) are used. Only one demultiplexer is enabled at a time and only one output of that demultiplexer becomes low at a time. An 8 bit control word can be used to control the demultiplexers. Each output of the demultiplexer is buffered by an open collector buffer (74LS07) and is connected to one pin of the 25-pin connectors. An 1K ohm resistor is used as the pull up device for each pin.

(3) The connection information to the selected pin is latched into seven octal latches (74LS373) simultaneously. Then, the controller reads the connection information from the latches, one byte at a time. Each octal latch is considered as an input port which has a unique address.

(4) The controller will send the connection information to the host computer through a serial port at 2400 baud rate. The ‘zero’ value is assigned to the pins connected and ‘one’ to all other pins. The controller will repeat the above operation until all of the 52 pins are checked. Then, the controller will await a signal from the host computer for the next test.

(5) The host computer will not only initiate the system controller but also receive the connection information from the system and display the configuration of the pins on the CRT screen.

The 8031 microcontroller is a ROMless version of the 8051 [2]. An external EPROM is used for the program storage. A flow diagram for the control program in the EPROM is given in Fig. 3. Since the control program can easily be modified by reprogramming the EPROM, the system has the desired flexibility. The system can also be expanded by simply adding demultiplexers, open collector buffers, pull up resistors, and latches.

3: Program Description

A computer program has been developed on the PC which will receive the configuration information through a serial communication port, process the information, and display the configuration on the CRT screen. The program is written in C programming language and consists of a main routine and several subroutines.

A flow diagram for the main routine is given in Fig. 4. After initializing system parameters, the main routine draws the basic frame for two 25-pin connectors on the CRT screen and an option menu. Then, it waits for the user to select an option box. Currently, the program has DRAW, PRINT, CLEAR, and QUIT options. The user can use a mouse to select one of these options.

When the DRAW option is selected, the PC will send a command character to the system controller through the serial communication port in order to initiate the system controller. Then, the PC waits for data to be sent by the system controller. When data is available, the PC reads the configuration information through the serial communication port and stores it into a memory array. Each 8 bit data stored in that array is converted into bit wise form in sequential manner and is
stored into another array. This bit wise information in the second array is used by the PC to draw the configuration of the pins on the CRT or to print on the printer.

When the PRINT option is selected, the program will read the bit wise information obtained by the DRAW option and send to the printer for hard copy. When the CLEAR option is selected, it just clears the CRT screen and starts again. The CLEAR option is for a new test. When the QUIT option is selected, it goes back to the text mode and terminates the program.

4: Summary

A microcomputer based digital system for the configuration detection of 25 pin connectors is described. The configuration information is graphically displayed on the CRT screen. The system can be expanded to a universal configuration detector by adding programmability on the number of pins. Since the system is very cost effective, a PCB board may be developed for mass production. This board level system can also be mapped into a VLSI chip by using ASIC design software.

References


Fig. 3. A flow diagram for the control program.

Fig. 4. A flow diagram for the main program.