

Design and Implementation of Man-Machine Touch Panel Interface for Embedded System devices using PIC32MX575F512L

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Abstract: Touch panels are becoming increasingly critical in more and more embedded applications, such as industrial control systems, transportation systems and others. In this paper design of a man-machine interface which works in cooperation with the touch panel is proposed. This interface has been made using a 3.2 inch 320*240 resolution LCD module with an integrated touch panel. The microcontroller that has been used for interfacing with this LCD module is PIC32MX575F512L. This man-machine interface is capable of communicating with any embedded system device using CAN Bus which is a widely used serial bus communication interface nowadays. This display interface is capable of taking input characters from a qwerty keypad and can performs many functions like displaying graphs, graphical meter, clock etc.

Keywords: Embedded system; CAN Bus; LCD Modules; PIC32MX575F512L; Touch panels (TP).

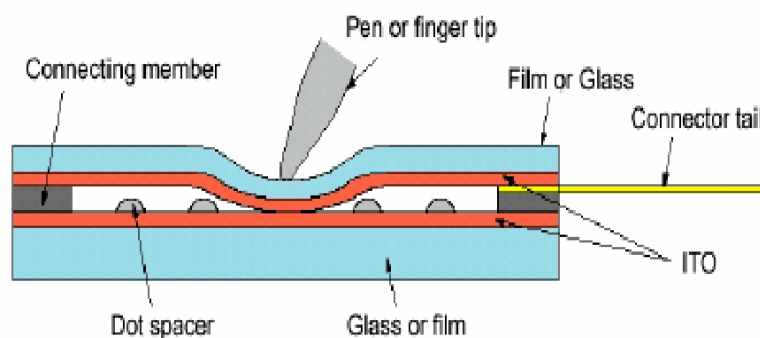
I. Introduction

Touch panel (TP) technology has come into the spotlight in information display systems because it provides a comfortable and intuitive user-interface (UI) and has advantages of easier and faster entry of information [1]. Touch panels provide a particularly interesting form of interactive input device. A display- mounted touch panel allows tight integration of input with output and that is the primary reason behind the success of Touch Panels for the user interface in embedded system device which require man-machine interface. With the evolution of the embedded system, its applications have become more universal [2-3]. The touch panel provides a new control interface for the user and the applications of the touch panel have also become more universal. Companies in a broad cross-section of industries have successfully harnessed the power of a touchscreen for a wide variety of applications. Airlines use them to simulate aircraft cockpits and train their pilots to fly. Realtors use them to put full-color images of homes for sale a fingertip away from homebuyers. Restaurants use them to simplify their point-of-sale terminals. The touch panel can be used to control vehicles which are usually controlled by hand directly [4-5]. The accuracy of the touch panel is also increasing [6]. Many kinds of touch sensing methods, including the acoustic-wave [7], infrared [8], resistive [9] and capacitive methods [10], have been proposed and commercialized. Among them, the resistive and capacitive sensing methods are mainly utilized in consumer electronic products.

A. Resistive touch panels

Resistive Touch panel as shown in Figure 1 is a contact-sensitive operating element provided on the touch panel screen, operated by touching it lightly with your finger or stylus. A specific voltage is loaded across the glass and film. A touch panel controller senses the voltage changes in the "X" and "Y" direction. The controller sends a signal to the LCD through the CPU. This signal identifies the touch location.

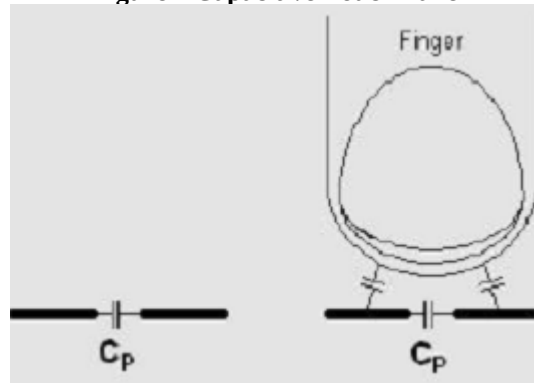
Figure 1 Resistive Touch Panel



B. Capacitive touch panels

As shown in figure 2 on the left, the capacitance C_p between the pad and surroundings is fixed. When a finger touches on the pad, the capacitance between the pads changes, exceeding its set value. This detects the touch position. Capacitance Touch Panel does not need any input force. Just approach it. The capacitance will change, and it will operate.

Figure 2 Capacitive Touch Panel

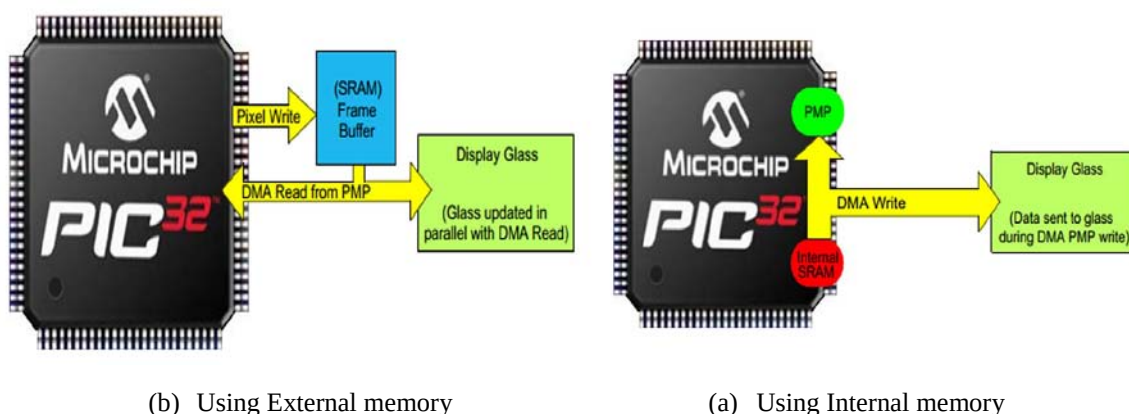


In this paper a design of interfacing a resistive touch panel with PIC microcontroller is presented such that any embedded system device capable of communicating through CAN Bus is able to use the touch panel for man-machine interface.

II. Contollerless Graphics system

Controllerless graphics methods are usually employed to interface touch panel LCD displays with PIC microcontrollers. In general, a controllerless graphics system needs to send a frame of pixel information to a display glass at a certain rate. This refresh rate is usually around 60 Hz. To do this, the system must constantly send frame data to the LCD panel. At first inspection, it seems like this task would take up most of the CPU time in an MCU. However, this is not the case for PIC32 MCUs that contain a DMA for data transfer. With a DMA transferring the pixel data, less than 5% of CPU time can be used to achieve a “virtual” graphics controller. PIC32 MCUs have a built-in Direct Memory Access (DMA) peripheral. This peripheral can transfer data from one location to another without CPU intervention. In a controllerless graphics method, the DMA is set up to transfer one line of frame data at a time through the Parallel Master Port (PMP). Each line consists of many pixels. The DMA sends a portion of the frame buffer during one transfer. A PMP or Timer interrupt request is used to trigger the next DMA transfer until a line is transferred. In PIC32 devices with non-persistent interrupts, a timer is used as the DMA trigger source. During data transfers, the PMP strobes a read or write signal after each pixel transfer. The read/write strobes of the PMP peripheral act as the pixel clock for the display glass. After each line of pixel data is transferred, the CPU is interrupted by the DMA and certain timing signals (e.g., HSYNC, VSYNC, and DEN) necessary for LCD panels are updated. This is repeated continuously until an entire frame has been drawn. The frame is stored in volatile memory so the image can be dynamic. In this setup, SRAM memory is used. This configuration is the foundation for a controllerless graphics system. The system can be set up to use internal SRAM memory or external SRAM memory. A diagram of each system can be seen in Figure 3.

Figure 3 Contollerless Graphics Methods



(b) Using External memory

(a) Using Internal memory

III. System Design

A. Design Components

- a) **Truly TFT320240-91-E** – It is a Truly 320*240 dots TFT display having an integrated resistive touch panel. It comes with an integrated driver IC HX8238-D. This TFT is capable of communicating with two interfaces SPI and RGB parallel.
- b) **PIC32MX575F512L** – It has a 32-bit core with 5-stage pipeline for instructions. It is capable of working at 80 MHz maximum frequency. The operating voltage range of this microcontroller is 2.3V to 3.6V and has 64K to 512K Flash memory. This microcontroller is having many features but that important for our design are Parallel Master and Slave Port (PMP/PSP) with 8-bit and 16-bit data, RS-232, and CAN Module.
- c) **IS61WV51216BLL** – These are high speed, 8M-bit static RAMs organized as 512K words by 16 bits. It is fabricated using high performance CMOS technology.
- d) **ISO1050** – The ISO1050 is a galvanically isolated CAN transceiver that meets or exceeds the specifications of the ISO 11898 standard. The device has the logic input and output buffers separated by a silicon oxide (SiO₂) insulation barrier that provides galvanic isolation. When used in conjunction with isolated power supplies, the device prevents noise currents on a data bus or other circuits from entering the local ground and interfering with or damaging sensitive circuitry. As a CAN transceiver, the device provides differential transmit capability to the bus and differential receive capability to a CAN controller at signaling rates up to 1 megabit per second (Mbps).
- e) **LT1937ES5** – The LT1937 is a step-up DC/DC converter specifically designed to drive white LEDs with a constant current. The device can drive two, three or four LEDs in series from a Li-Ion cell. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors.
- f) **MAX232** – The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ± 30 -V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels.
- g) **SST25VF016B** – SST's 25 series Serial Flash family features a four-wire, SPI-compatible interface that allows for a low pin-count package which occupies less board space and ultimately lowers total system costs. The SST25VF016B devices are enhanced with improved operating frequency and lower power consumption. SST25VF016B SPI serial flash memories are manufactured with SST's proprietary, high-performance CMOS SuperFlash technology.

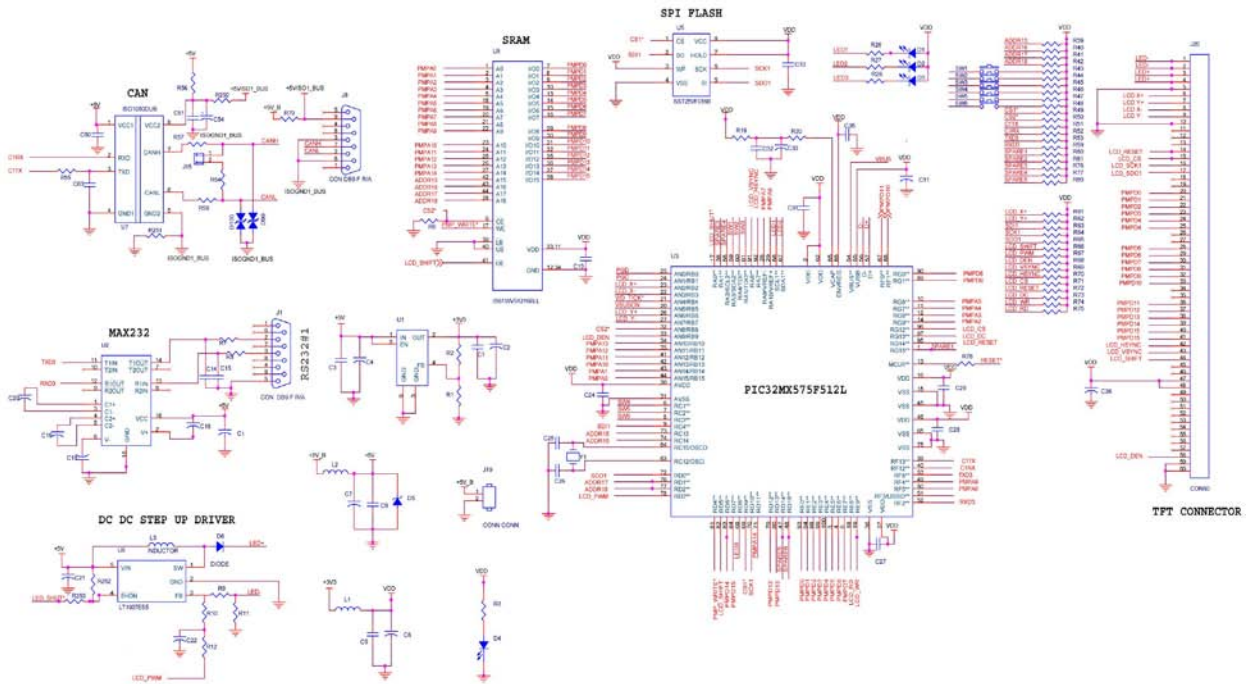
B. Schematic Design

The schematic of the system has been shown in Figure 4. The power supply to the system is provided through CONN connector which is connected to any +5V power supply. The PIC microcontroller works at 3.3V so +5V is regulated to +3.3V using a TPS73733 IC named U1 in the schematic. To communicate with other using CAN module ISO1050 has been interfaced with the C1RX and C1TX pins of the microcontroller and DB9 connector has been used is to provide hardware interface with the communicating device. To display the data on the TFT the microcontroller will send the pixel data to the driver IC HX8238-D of the TFT. In the design external SRAM memory has been used by the help of IS61WV51216BLL chip. This chip will save the pixel data coming from the PIC controller and send it to TFT through the TFT connector which is internally connected with the driver IC HX8238-D so that data between the microcontroller and TFT is not lost as the speed of microcontroller is faster than the displaying speed of TFT. LT1937ES5 has been connected with the backlight LED's of the TFT display to control the backlight of the TFT. For making display screen many images are required to be stored in a memory so SST25VF016B flash memory has been used to store them. The data in this flash memory is transferred from computer through serial UART communication for which MAX232 has been used. This flash memory is interfaced with microcontroller using SPI module.

In the programming section first of all the images that are required for man-machine interface display are stored into the flash memory. Then PIC microcontroller is programmed to display the Welcome screen first. This is done by taking the required image from the flash memory and then sending its pixel data to the SRAM which sends it to the TFT driver IC and the Welcome screen appears. Then the second screen is menu screen. All the steps are performed in the similar way as for the Welcome screen. Now the microcontroller starts communicating with the master device for which the man-machine interface has to be used. In the menu screen there are five icons clock, keyboard, display data, graph and meter. When the user selects the clock icon, a digital clock starts running whose time can be set by the user. If the user wants to send some data to the master device he can select the keyboard data to get a QWERTY keypad and type the data using it, this data is stored

by the microcontroller in a buffer. Whenever the user selects back option from this screen all the data is send to the master through the CAN module. The response of the master to the input can be read by the user by selecting the display data icon. If the user wants to see the data being sent from the master in the graphical form he can select it by using graph or meter icon. The images of these different screens have been shown in the Results section.

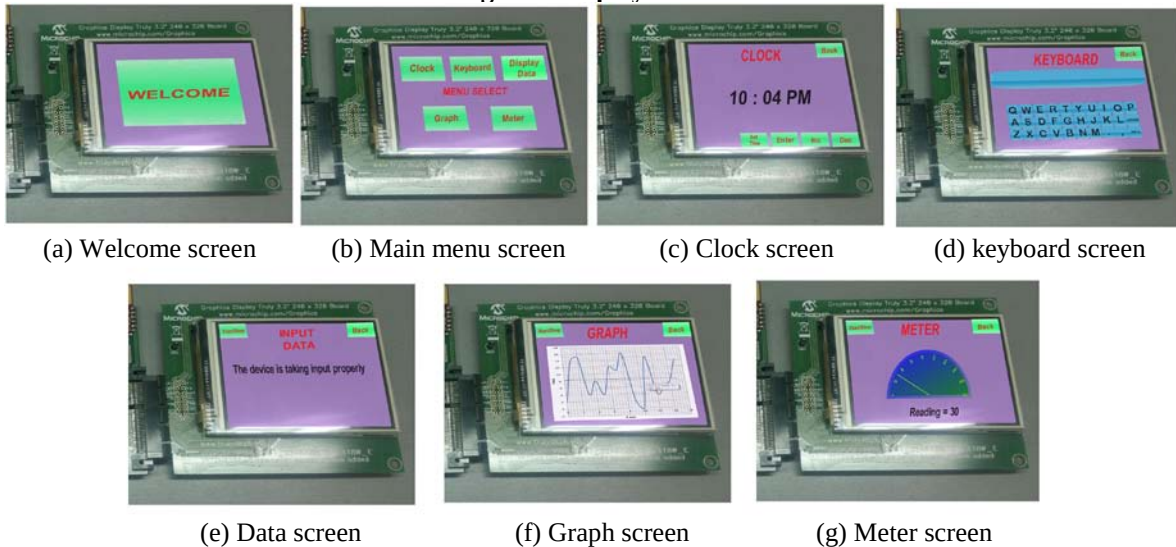
Figure 4 Schematic Design



IV. Results

The various display screens of man- machine touch interface have been shown in Figure 5. The Figure 5(a) shows the first screen of the display interface when it is turned on. Then the screen for selecting the menu appears after 2 seconds and is shown in Figure 5(b). When clock icon is selected digital clock screen appears and is shown in Figure 5(c). In this screen time setting option has been provided, user can go back to the main menu screen by selecting back icon at top right corner. When user wants to send any data to master device keyboard icon is selected and the QWERTY keypad appears as shown in Figure 5(d). The data can be seen through Display data screen and the screen for it is shown in Figure 5(e). When user wants to see the data sent by master in graphical form he can select the graph and meter icons in the main menu screen and the graph and meter screens that appear are shown in Figure 5(e) and Figure 5(f) respectively.

Figure 5 Display screens



V. Conclusion

In this paper design of a man-machine touch panel interface was presented. This design provides a very simple and user friendly touch panel interface between man and machine and provides options of taking input from user using QWERTY keypad and display the resultant data into graphical form.

VI. References

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