The TouchTexter Hardware Description

INTRODUCTION
The TouchTexter is a hardware device that allows the blind and deaf-blind community to communicate through a text-message protocol. The device implements several peripheral modules and systems including a microcontroller (MCU), a Braille keypad, a solenoid display system, a vibrating motor system, an RF module, and two voltage regulators.

MICROCONTROLLER
The MCU (U1) is a Freescale MC9S12A128BCFU, which has a 16-bit bus system that operates at a maximum frequency of 25MHz, and contains 128KB of Flash EEPROM, 12KB of RAM, and 2KB of EEPROM. The MCU is powered by a +5V source, and oscillates with a 16MHz quartz crystal. The protocols which the MCU uses to communicate to external peripherals and systems include one serial peripheral interface (SPI) port and nineteen general purpose input/output (GPIO) ports. External components, voltages and grounds connected to power supply pins (VDD1, VSS1, etc.) are so that all possible internal resources in the MCU are available for future device upgrades.

BRAILLE KEYPAD
The Braille keypad includes thirteen alpha-numeric buttons, three user-function buttons, and one punctuation button, all of which are single pole, single throw (SPST) switches. There are also two extra user-function buttons that are the same as the keypad buttons. All keys are contained within rectangular plastic housing manufactured by Mountain Switches. Fifteen of these buttons, which include the thirteen alpha-numeric, the one punctuation, and one user-function, are controlled through the implementation of a keypad matrix (KP1) while the other two buttons (SW1, SW2), which include the remaining two user-functions, are controlled by GPIO ports.
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The keypad matrix is controlled by the rows and columns connected to PB0-PB3 and PB4-PB7 of the MCU, respectively. The remaining two user-function buttons are connected to PJ0 and PJ1. The columns of the keypad matrix and the two remaining buttons are preceded by 10KΩ resistors pulled up by +5V.

**SOLENOID DISPLAY**

The solenoid display utilizes six solenoids (L1-6) made by Magnetic Sensor Systems in conjunction with six inductive load driver integrated circuits (U3A-F) made by ON Semiconductor. These six separate systems are physically located in a way that allows for the Standard English Braille layout to be displayed to the user. The solenoid display system is exclusively controlled by six GPIO ports (PA0-5) from the MCU, which simply toggle the inductive load drivers.

Each NUD3112 inductive load driver is integrated with necessary features such as a MOSFET switch, electrostatic discharge protection, and Zener clamps, all of which are contained in a 3-pin SOT23 package. Since these ICs use MOSFETs to drive the solenoids, the power requirement for switching is minimal and only needs +5V present at the gate. The solenoids being driven contain an internal resistance of 8Ω and require less than 1W of power per elevation. These electro mechanic devices require the most power within the TouchTexter design.

**VIBRATING MOTOR**

The vibrating motor system implements a vibrating motor driver (U4) made by Maxim, a vibrating motor (M1) made by Precision Microdrives, and passive components. This system is communicates to the MCU through a single GPIO port (PA6), which toggles the vibrating motor driver.
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The vibrating motor driver is a MAX1749 and is contained in a 5-pin SOT23 package. It can deliver up to 120mA as well as between +1.25V and +6.5V to its output. The capacitors (C1-2) are used to deter load-transients while the resistors (R6-7) are used to properly set the output voltage to about +3V. With the vibrating motor having a rated voltage of +3V and a rated current of 75mA, this driver matches quite well for the systems design. At these rated values, the vibrating motor performs at a rated speed of about 12,000rpm.

RF MODULE

The RF module is a Nordic nRF24L01+ (U2) that operates between 2.4GHz and 2.4835GHz of the worldwide industrial, scientific, and medical (ISM) radio band, which is virtually unregulated by the FCC. This module is an RF transceiver that contains certain internal features that allow for efficient data transmissions and lower CPU load for the MCU. To communicate properly with the MCU, this module requires a 4-pin SPI port (MISO1, MOSI1, SCK1, SS1_L) and two GPIO ports (PK2-3).

The RF module’s maximum transmitting power is +0dBm with a receiver sensitivity of -94dBm. An important feature contained within the RF module is automatic packet handling, which takes care of assembling or disassembling packets containing a familiar format: preamble, address, packet control, payload, and cyclical redundancy check (CRC). The host interface between the RF module and the MCU operates using SPI at a maximum data rate of 10Mbps.

VOLTAGE REGULATORS

The voltage regulators (U5-6) allow for the MCU and the peripherals to have the appropriate voltage potential for correct functionality. These NCP1117LP are low power adjustable voltage regulators made by ON Semiconductor. These ICs contribute +3.3V and +5V
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to the TouchTexter design while allowing up to 1A each of current to pass through them. The +5V regulator (U6) has two electrolytic capacitors (C14-15) to enhance the output transient response. The +3.3V regulator (U5) also has two electrolytic capacitors (C16-17), but also includes resistors (R8-9) which were selected to appropriately set the output voltage and a capacitor (C18) which was selected to offset the ripple frequency when designed with an AC power source.