Doorbell Jukebox Hardware Description

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Introduction

The Doorbell Jukebox serves as a fun and innovative way to welcome your household guests – instead of the ordinary jingle one would hear with a common doorbell, one would hear a song that the household owner has handpicked themselves.

The components involved with the Doorbell Jukebox range from Digital-to-Analog converters to regular discrete part setups utilizing resistors and capacitors. Each part will be described in this document along with their respective uses.

Power

Power to the system will be supplied via a 120VAC to 12VDC plug-in AC adapter [T1]. These 12V will then also be further modified to voltage levels required by various system components: 5V and 3.3V. This will be accomplished by utilizing an LM7805 5V regulator [U2] and a LM7833 3.3V regulator [U3].

This setup will follow very closely with how the final product will be configured as this will be for household use using standard power outlets.

Microcontroller

Doorbell Jukebox will be utilizing the MCF52233 ColdFire board [U1]. With its V2 Core, it was deemed a well suited microcontroller for audio processing. Along with its V2 Core, this board boasts a 60 MHz clock frequency and 256KB of Flash memory.

Power is supplied through VDDX1, Pin 1 on the boards J1 pin out. The voltage levels here will be scrutinized very closely as there is no type of protection through this configuration.

For this system, we will be using the 80 LQFP. With this package, we are offered 37 General Purpose I/O pins to establish communication between components. Pins PAN[0-6] handle the connection to the LCD running in 4-bit mode. Pins PTC[0-3] and PUB2 will be used as inputs for the user interface. The General Purpose Timing I/O module pins PTA[0-3] will handle connection to the Digital-to-Analog converter with PTA3 specifically serving as a pulse accumulator. As for communication with the MMC reader, the system will be utilizing serial peripheral interface -- specifically QSPI_DIN, QSPI_DOUT, QSPI_CLK, and QSPI_CS0. Onboard software will be used to decode MP3 data received from the MMC reader.
User Input

Input from the user will be primarily from the interface buttons designated SW[1-5]. These buttons will help navigate the user interface displayed on the LCD – UP, DOWN, SELECT, Cont. PLAY, and ACTIVATE. Pull-up resistors are used for each button to keep logic levels stable and from adversely affecting the microcontroller. These buttons are fed 3.3V.

MMC Reader

The Multi-Media Card (MMC) Reader [P1] will allow the system to gather the MP3 music data that has been uploaded to the users MMC. It will be using the SPI offered by the microcontroller – CS serves as the chip select and is connected to QSPI_CS0, CLK serves as the clock and is connected to QSP_CLK, DO serves as the data output and is connected to QSPI_DIN, and DI serves as data in and is connected to the QSPI_DOUT.

The rest of the pins [CD, WP, IRQ, P9] are not connected as they aren’t needed with the current system configuration – for example WP is write protection and writing data is not what the system was designed for so it is NC. The MMC reader is fed 3.3V through its VCC pin.

LCD

The LCD [LCD1] serves as a display for the user to select which MP3 they would want to play when the doorbell is pressed. It is connected in 4-bit mode to use less pin real estate. To do this, pins DB[0-3] and R/~W are tied to ground, leaving DB[4-7], RS, and E to communicate with the board.

To deal with contrast, a voltage divider is used to provide exact control. Resistors R10 and R18 handle this. The LCD is fed 5V through its VCC pin.

Crystal Oscillator

Since the onboard pulse width modulator is unable to provide the correct frequency required by the system, an ASM-11.2896M-T crystal oscillator is utilized [X1]. The crystal oscillator provides a frequency of 11.2896 MHz to both the microcontroller pin PTA[3] and the D-to-A converter through its OUTPUT pin to MCLK of the D-to-A converter.

Since there is a need for oscillation, the TRISTATE pin is left unconnected so the component doesn’t enter High-Z mode, effectively cutting it off from the system. The crystal oscillator is fed 5V through its VDD pin.
Digital-to-Analog Converter

Appropriate Digital-to-Analog conversion for audio applications is not readily available on the MCF52233 ColdFire board. To remedy this, a CS4335 [U4] Digital-to-Analog converter is used. SDATA, ~DEM/SCLK, and LRCLK are connected to the board’s general purpose timing module in pins PTA[0-2]. MCLK is connected to the crystal oscillator in order for the component to receive the right frequency.

SDATA is where the audio data is fed into the converter, clocked in via SCLK. ~DEM/SCLK is either used for filter demodulation or as an external serial clock. The serial clock function will be used to synchronize data being converted. LRCLK delineates which audio output will receive what information.

AOUTL and AOUTR are the audio out left and the audio out right, respectively. Both are connected to identical low-pass filter networks constructed with discrete components. These signals are then connected to our LM386 audio amplifier to be brought to sufficient levels. The Digital-to-Analog converter is fed 5V through its VA pin.

Audio Amplification and Output

The signal coming from the Digital-to-Analog converter is typically 3.5 volts peak-to-peak. This needs to be amplified before reaching the speaker so the signal is fed through an LM386 audio amplifier [U5]. The LM386 has a minimum gain of 20 and we want a 12 volt signal going to the speaker so there is a voltage divider at the amplifier positive input to drop the signal level to .6 volts before amplification. The negative input of the amplifier is grounded as is pin 4. Pin 6 powers the amp with +5 Volts. Pins 1 and 8 control the gain of the amplifier and leaving them open sets the gain to the minimum of 20. Pin 7 is an optional bypass pin for additional protection. The output of the amplifier comes out of pin 5 and a capacitor and resistor to ground creating a high frequency noise filter.

The speaker is a simple 8 ohm speaker [SP1] and receives the audio signal through a coupling capacitor connected to the output of the amplifier. It is rated for 350 mA of current and is recommended for 12 volts.