

Extremely Accurate Digital Wall Clock

The extreme accuracy! Definitely this is a feature of Maxim DS3231, a extremely accurate I²C real time clock (RTC) with integrated temperature compensated crystal oscillator (TCXO) and crystal. The integration of the crystal resonator inside the chip enhances the long-term accuracy of the device - the maximum error in a year is less than 64 second - over a temperature range 0 to 40°C. The device incorporates a battery input which maintains running of the device in the absence of main power.

A PIC16F873A micro controller is used to interface the RTC and to drive seven segment LED displays. The micro controller has an I²C port which makes easy interfacing to the RTC. The design is simple 24/12 hour clock which incorporating six seven segment LED's and two input switches. The individual segments of each display are connected together. The displays are numbered from left to right, the 2nd and 4th displays are flipped upside down to align decimal points in the displays to makes clock colon between hours – minutes and minutes – seconds. The PCB design takes care for this and tied together all segments at same position in the display.

The power supply for the micro controller is regulated with a 5V linear regulator and the LED displays are connected to a higher (9V) unregulated supply. This makes the design to capable of driving bigger displays which has large voltage drop per segment – such as 6.8V (Each display segments consists number of LED's in series). The common anode of each display is drive with help of two general purpose transistors, not only to meet high current requirement but also to isolate micro controller outputs form higher voltage. The PORTB pins are activate LED segments with help of a switching transistor.

Real Time Clock (RTC) DS3231

The DS3231 is a serial RTC driven by a temperature compensated 32 kHz crystal oscillator (TCXO), and provides a stable and accurate reference clock. Temperature sensor, oscillator, and control logic form the TCXO. The controller reads the output of the on-chip temperature sensor and uses a lookup table to determine the capacitance required, adds the aging correction in AGE register (Not used in this project - use of the aging register is not required to meet the given accuracy) and then sets the capacitance selection registers. With the clock source, the RTC provides seconds, minutes,

hours, day, date, month, and year information, and these can be accessed via I²C bus. The device monitors the level of VCC to detect power failures and to automatically switch to the backup supply when necessary.

On first power up, the micro controller initialize the RTC to generate a 1Hz square wave at the INT/SQW pin by writing 0x00 to the control register of RTC. This is connected to the external interrupt (INT) of the micro controller hence to interrupt the micro controller at each high to low transition at RB0/INT. This interrupt is used to initiate reading of time registers in the RTC. A 1Hz clock also generates from polling the status of RB0/INT. The displays are multiplexed at a frequency of 1kHz.

DISPLAY

One of the attraction of this design is its big (2.4”) and brighter seven segment LED displays, so the clock can be read easily from a reasonable distance. The displays are multiplexed but provided sufficient average currents for high brightness. A bi-color LED is used to show AM (green), PM (red) if the clock operates in 12 hour format.

OPERATION

Only two push buttons are in this circuit to make adjustments. Pressing down SW1 for 1 second brings the circuit into time adjusting mode. Now the digits start to blink, meaning these digits are editable. The blinking digits can be selected via a short press of SW1, from seconds, through minutes – hours – 24/12 hour selection - to exit. Pressing SW2 increments the selected digits to its upper limits then turns around, except for the “seconds” digits, these will be set zero, and if the seconds are greater than 30, it will increment minute’s digits by one. If the device is not in time adjustment mode a short press of SW2 shows the temperature in °C with sign. The temperature sensor has accuracy of ± 3 °C and with a resolution of 0.1 °C.

CONCLUSION

The circuit provided here is a basic wall clock with big displays, and features such as alarm,

remote control for adjusting time and alarm, synchronization between PC via infrared connections are possible. The circuit, pcb design, and the source code written in C are attached with this document. A 9V, 500 mA unregulated power supply is sufficient for the circuit operation with a good brightness, and a CR2030 lithium battery is used as a backup supply for the RTC.