GPC1 OS1 Program

The OS1 program for the CircuitShell GPC1 Controller was written to provide a means of testing all the features of the GPC1 board, and to do it with a useful program that could serve as a basis for follow-up code development. OS1 is a mini-operating system in that it can run in the background and free the developer from having to learn the details of interfacing to the various peripherals such as the LCD, the keyboard, and the I2C connected Real-Time Clock (RTC) and ADC/DAC devices. Source code is provided in case the developer wishes to modify the OS1 program or use portions of the code as a shortcut to building a new program. The OS1 program initializes and then jumps to a self-loop at 0800h, which can be replaced by a user program. The user program will be interrupted by OS1 to perform timekeeping, display, and keyboard tasks, so some attention will have to be given to timing compatibility. Since OS1 interrupts can run for several milliseconds, interrupt priority has been initialized to give higher priority to the serial port and other unused resources. The user will need to take care to avoid conflicts when sharing resources used by OS1. These resources include 0000h-07ffh of code memory, external interrupts EX0 and EX1, Timer 0, data pointer 2, register bank 3, general purpose flag GF2 in SFR 0a2h, RAM locations 060h through 09fh, and the port pins that are not brought out to the user buss. The OS1 interrupt routines push and restore other registers such as ACC, B, and PSW so should not interfere with most user programs. Of course, the flow of multiple interrupt code can be quite complicated so timing incompatibility with a user program is always possible and the OS1 source code would have to be explored to determine the nature of the conflicts.

Installing OS1

GPC1_OS1.hex is the compiled program in Intel Hex Record format. The program can be loaded into the flash memory of the P89C668 mcu using FlashMagic, which is a free download from ESacademy.com. After FlashMagic is downloaded to the PC and the serial ports of the GPC1 and PC are connected, the GPC1 is put into the program mode either by holding down the power-on key, or by using the break generation program BreakGen, which is a download from CircuitShell.com. In either case, the buzzer will sound when program mode is entered. In the FlashMagic window select the COM Port (usually COM 1), the Baud Rate (usually 9600), the Device (P89C668), the Oscillator Freq. (12.00). Select to erase at least block 0, or blocks used by Hex File. Browse to find and select Hex File (GPC1_OS1.hex), and press Start. Once erasing and programming is complete, “Finished” will be displayed. Reset the GPC1 by briefly pressing the power-on key, or by power-off then power-on, or by generating a reset-length break using the BreakGen program. OS1 will now be functioning and the time from the RTC and input voltage from the ADC will be changing when the mode indicator is set to the clock mode.

Display

OS1 uses two display lines of 16 characters each and is compatible with both the 2 x 16 LCD and the 4 x 20 LCD. If the 4 x 20 LCD is installed, the areas not needed by OS1 can be written to by a user program. The top line of the LCD is the time display and the format is normally HHMM:SS:D:MMDDYY where HHMM is the hour and minute in 24 hour time format, SS is the seconds, D is the day-of-week where Monday is 1 and Sunday is 7, and MMDDYY is the date in month, day, and year. The character between minutes and seconds is the mode indicator, which is normally a “:” when the time is displayed and counting. The character between seconds and day-of -week is the backlight status and is normally a “:” when the LCD backlight is on automatic. The character between day-of-week and month is the alarm indicator and is normally a “:” when the alarm is disabled. The bottom line starts with the program name “GPC1 OS1” and ends with the power input voltage read by Channel 0 of the ADC. The cursor left and right keys move the cursor through the display area. The up and down keys increment or decrement the character at the cursor position. The cursor home position at power-up is under the mode indicator.

Operation

Power-Up: In a typical manual power-up, the cursor will be in the home position under the mode indicator which will be a "-" indicating that the clock is stopped. The displayed time at power-up will be the time of the last power-down, which is useful for such things as measuring the life of the battery pack. When the up key is pressed, the "-" will change to a ":" and the current time will be displayed and updated each second.

Setting the Time: To set the clock time, position the cursor under the mode indicator and press the down key to change from a ":" to a "-". The "–" indicates clock-set mode wherein the clock is stopped and the time data can be changed with the up and down keys. Set the correct time, and then, with the cursor again under the mode indicator, press the up key to change from the mode from a "–" to a ":", thereby loading the time to the RTC and enabling once-per-second updates. The RTC will be written only if the time is changed.

Setting the Alarm: To set the alarm, position the cursor under the mode indicator and press the up key to change from a ":" to a "*". The "*" indicates alarm-set mode wherein the the alarm settings are displayed and can be updated. Set the alarm as desired, and then, with the cursor again under the mode indicator, press the down key to change the mode from a "*" to a ":", thereby loading the alarm setting to the RTC and enabling clock updates. The RTC will be written only if the alarm settings are changed.

Some of the characters have different meanings in the alarm mode than in the time mode. The number which was day-of-week in the time display is now the repeat status. This number can be set to 5,4,3,2,1, or 0 to get a repeat alarm every second, minute, hour, day, month, or year. The two numbers which were the year in the time display are now the clock calibration offset. These are two octal digits (0-7) which make up the sign and 5 bit magnitude of oscillator calibration. Unless it is desired to calibrate the oscillator (see ST M41T81M6 RTC datasheet for details) these numbers should both be set to 0. The alarm indicator can be changed only in the alarm set mode. A "*" indicates that the alarm is enabled. The backlight indicator can be changed in any mode. The backlight configuration existing when the alarm settings are changed will be saved for the power-up default. A "-" indicates that the backlight is turned off. A ":" indicates that the backlight will be auto-controlled by the ambient light sensor.

The alarm will sound whether or not the alarm is enabled. If the alarm is not enabled, it will not turn the GPC1 on when power is off. If the alarm is enabled, it will turn the GPC1 on for 10 seconds at the time of each alarm. The time of the last power down will be displayed for the first second.

User Display: The first 11 characters of the bottom line are written to the LCD each second and can be changed as desired by the user, without affecting OS1 operation, either by the increment and decrement keys or by writing to the equivalent RAM locations 090h-09ah. The default display on power-up for these 11 characters is the program name "GPC1 OS1".

Auto-Off: The first time the displayed input voltage falls below 5.5V, OS1 turns off the backlight. The next time voltage falls below 5.5V OS1 disables the alarm and turns off the power. This will prevent the batteries from over-discharging and keep the alarm from attempting further power-ups when the batteries are low. The alarm output can only be turned off under processor control, so without safeguards an unsuccessful power-up by alarm will be sustained until the batteries are totally depleted.

Battery Life: Some typical battery life situations for the 7.2V NiMH battery pack are as follows:
Continuous On with 4 x 16 display and backlight on (250ma): 3 hours
Continuous On with 2 x 16 display and backlight on (150ma): 5 hours
Continuous On with backlight off (50ma): 15 hours
10 seconds per minute alarms with backlight off (10ma): 120 hours

Oscillator Stop: The RTC oscillator can be stopped by setting the time with an 8 or 9 in the tens of hours location. This sets the ST bit in the RTC and extends the life of the lithium back-up battery when the RTC is not in use. The stop condition is removed on the next GPC1 power-up.

User Access

An image of the two 16 character LCD display lines is maintained in RAM locations 080h through 09fh. The top line is at 080 through 08fh. A user program can read or modify (with caution) these locations to access data or change the settings. The first 11 characters of the bottom line (RAM locations 90h-9ah) can accept user data for display each second along with the input voltage at the end of the line. Care should be taken to synchronize accesses with the one-per-second updates. An image of the RTC memory is maintained in RAM locations 060h through 073h, which corresponds to RTC memory locations 00h through 014h as described in the RTC data sheet. The flag register settings are useful in determining the RTC status. For instance, after an alarm power-up the HT flag will be set for one second to indicate that the time displayed during that second is the time of the last power-down.

RAM locations 074h through 079h are used for various OS1 control functions such as the last key at 78h and the cursor position at 79h. RAM locations 07ah through 07fh are used for ADC/DAC data. Data placed in location 07ah will be written to the D/A converter each second, location 07bh contains the previous Ch0 A/D reading, and locations 07ch through 07fh contain the current Ch0 through Ch3 A/D readings. Ch0 is the input voltage, which is converted to a 0-25.5 volt scale and displayed at the end of the bottom LCD line.

A user program can write its own data to the LCD by calling subroutine sub_dsp with the RAM address of the first character to be written in r1, the LCD address for the first character in r2, and the number of characters to be written in r3. Note that while 080h is both the RAM image address and the LCD address for the first character of the top line, the LCD address for the first character of the second line is 0c0h. For the 4 x 20 LCD, the first character of the third line is 094h and the first character of the fourth line is 0d4h. OS1 will overwrite data that is written directly to the LCD in areas it uses.

A user program can write one character of the RAM LCD image to the LCD by calling subroutine sub_dc with the RAM image address in r1.

A user program can generate a sound by calling subroutine sub_ctr with the sound duration in 75h, A sound duration of 80h will yield about 0.5 second of sound.

A user program can transfer code to RAM by calling subroutine sub_wrm with the code start address in the dptr, the ram start address in r1, and the number of bytes in r2.

Register r7 of register bank 3 (1fh) is the power down counter which is set to a default value of 10 on power up. The counter decrements each second if the alarm is enabled, so the GPC1 will power up for 10 seconds on each alarm. A user program can extend the power-on time by writing another count to the register, or the program can initiate an immediate power down at any time by clearing port 2.1.

The upper three of the SQW bits RS0-RS3 in location 13h of the RTC memory (RAM image location 73h) are not otherwise used and are available as battery-backed user flags. Bit RS0 is used to save the backlight setting, and is low for backlight on. If the bits are set in the RAM image they will be saved to the RTC whenever the alarm is set.

A low on the alarm interrupt pin of the RTC can only be removed through program control. If the program is faulty and cannot clear the interrupt, both the main and backup power to the RTC will have to be simultaneously removed to restore the RTC to its initial condition with the interrupt disabled.

Limitations

OS1 is offered by CircuitShell, Inc as a complimentary test and evaluation program for the CircuitShell GPC1 board to demonstrate the CircuitShell enclosures in a microcontroller application. The OS1 source code and GPC1 hardware specification can be downloaded from CircuitShell.com. Regrettably, CircuitShell is not staffed to provide additional technical support. No warranties are made as to suitability for in-whole or in-part integration into a user application, or as to the accuracy of the documentation.