Operation Guide for the CircuitShell GPC1 Board

Power Management: A design priority of this board is use of the alarm feature of the Real Time Clock (RTC) to power-up the board for periodic or scheduled tasks, and allow the microcontroller to power-down after the task is completed, resulting in minimal power use. Nominal 12VDC at up to 500ma is input at J1. The self-resetting fuse F1 and diodes D1 and D2 provide over-current and reverse polarity protection for power transistor Q1. When Q1 is off there is less than one microamp drain on the power input from the battery pack B2. Input power at J1 can range from 6 to 20 VDC but a minimum of 10VDC is required to fully charge battery pack B2. Components R28, D14, Q10, F2, and D3 comprise the charging circuit for battery pack B2. When Q1 is on, power is applied to C1 and linear regulator U2. Use of a Low Drop Out (LDO) regulator insures that 5VDC is maintained even when the 7.2VDC battery pack is near its discharged voltage of 6VDC or less. The 5VDC output of the regulator is filtered by load capacitor C2 and ceramic bypass capacitors C14 through C18. The 5VDC level is monitored for brownout protection by voltage sensor U6. Voltage under 4.5VDC will result in a low level at the output of U6, which causes a reset through diode D9 and power-down through diode D8. Power-down is due to a low level at the gate of Q5, and can also be accomplished by the OFF switch S6, or under program control by a low on microcontroller pin 25. Power-on is initiated by ON switch S5, which draws current from the base of Q1, turning it on. Regulated power rises to 5VDC quickly, turning on Q5 through R10 to sustain the base current of Q1 when the ON switch is released. The base current of Q1 flows through constant current regulator U8 and indicator LED1. A constant current of 10ma from the base of Q1 insures saturation whether the input power is 16VDC from a lightly loaded AC adapter or 6VDC from an almost exhausted battery pack. Power-on can also be initiated by the alarm output of RTC U3 going low turning on Q3 and Q4. The function of Q3 is to insure that out-of-spec voltage is not applied to the alarm output, and the function of Q4 and D7 is to create an interrupt on microcontroller pin 14 (INTO). If power is off, the alarm output will turn power on and interrupt. If power is already on, the alarm output will just interrupt. The alarm output can only be turned off by microcontroller communication with the RTC, so an alarm output interrupt must be serviced to keep it from forcing power continuously on. User buss pin 15 is also connected to the open drain alarm output to allow power-on or interrupt by an external low from another open drain or open collector device.

Resetting and Programming: A unique design allows the processor to be reset or put into the programming mode either by the onboard ON switch or remotely through the serial port. This means that the flash memory can be modified without any physical contact with the board. This feature will be particularly useful in applications where no switches are installed on the board. When power is turned on by ON switch S5, current flows into the base of Q2 turning it on and causing a low on reset capacitor C3. If power is already on, the ON switch just generates a reset. The reset condition persists as long as the ON switch is pressed or as long as a brownout condition is detected by U6. Reset capacitor C3 is charged by the network R14, D10, and R15 from the normally high serial data input into microcontroller pin 11 (RXD0) from pin 12 of transceiver U7. If the serial data input is low for an extended period due to a transmitted break condition, C3 will discharge to reset level just as it does for an ON switch press or brownout, resulting in a high level at pin 10 of U5. This high level reset is applied through R17 to microcontroller pin 10 (RST) and through R18 to C4 and pin 9 of U5. If reset persists long enough to charge C4, pin 8 of U5 will go low. The low level is applied through R19 to microcontroller pin 32 (PSEN) and remains low for a time after reset ends, putting the microcontroller into the programming mode. The low level also enables the sound generator through D11 for an audible indication that reset was sustained long enough to enter programming mode. The reset circuitry makes it possible to reset and enter programming mode either by using the ON switch, or from a remote location by transmitting a properly timed break on the serial port. A break of 200-500ms will cause a reset, and a break of greater than 900ms will cause a reset to the programming mode. A downloadable Windows break generation program BREAKGEN will produce the necessary break times for remote resetting and programming.

Cursor Control Switches: The LEFT, RIGHT, INC, and DEC switches can be monitored by polling microcontroller pins 28 through 31 to detect a low level. Pressing any of these switches will turn on Q7 pulling microcontroller pin 15 (INT1) low and causing an interrupt, if enabled. If pin 15 is configured as an input, Q8 will turn on along with Q7. When Q8 is turned on, Q9 is turned off allowing the switches to generate an interrupt without pulling U5 pin 3 low, causing sound. However, if pin 15 is set low by program control, Q9 will turn on resulting in sound. Thus, pin 15 can be set high to respond to a switch interrupt and then toggled low to generate a sound as audible feedback. An external low at user buss pin 3 can similarly generate an interrupt without causing sound. An external low at user buss pin 2 will cause sound without generating an interrupt. Sound is generated when U5 pin 4 goes high allowing U5 pin 5 to oscillate with U5 pin 6 providing feedback and driving the sound generator SG1.

ADC and I2C: Microcontroller pins 8 and 9 with pull-ups R26 and R27 are the clock and data lines of the I2C link, which is used to communicate with Real Time Clock (RTC) U3 and Analog-to-Digital Converter (ADC) U4. Note that the hardware address pins of U4, A0-A2, are hardwired to levels 101. The I2C link is also available on pins 16 and 17 of the user buss. The ADC U4 has four analog inputs on pins 18 through 21 of the user buss, and one analog output on pin 23. The analog input on pin 18 of the user buss can monitor the power input voltage at U2 if resistors R8 and R9 are installed, forming a divider to scale the voltage to 0.1 volt/count over the 255 count range of the ADC. Monitoring the input voltage will be particularly useful in battery operation since a low battery condition might require measures such as a sound alert, LCD message, turning off the LCD backlight, or an orderly power-down sequence.

LCD: The LCD backlight is automatically controlled by light sensor LS1, which can be a CdS photoresistor or a visible-light phototransistor. Resistor R11 provides current to turn on Q6 during low ambient light. Bright light on the light sensor or an over-riding low from microcontroller pin 24 will turn off Q6, blocking backlight current through current limiting resistors R12 and R13. The LCD is connected to Port 0 as a memory device, but it can also be controlled as a port device if resistor network RN1 is installed to provide pull-ups. Note that timing specifications of the LCD appear to not allow crystal X1 frequencies above 9MHz when the LCD is used as a memory device, but in practice operation has been confirmed to 12MHz. The Read and Write signals from microcontroller pins 18 and 19 are combined by diodes D4 and D5 and inverted out of U5 pin 12 to generate the Read/Write input to the LCD. Microcontroller pins 26 and 27 control the Input/Output and Instruction/Data lines of the LCD. Note that the display can appear blank and inoperative if contrast control potentiometer P1 is out of adjustment.

Serial Communications: The DB9F connector J2 is used for serial communications. Note that conventional pin assignments for serial connectors do not apply, so generic cables should not be used with J2. For a microcontroller with a single serial port, J2 pin 3 is the data input and J2 pin 1 is the data output. For microcontrollers like the P89C699 with two serial ports, J2 pin 6 is the second data input and J2 pin 4 is the second data output. Transceiver U7 interfaces both serial ports to the microcontroller. Resistor R16 is a pull-up for the open-drain transmit data output of the second serial port. Pins 5 and 9 of J2 are ground, pin 7 is fused and polarity protected power from the input jack or battery, and pin 8 is the system 5VDC power. Pin 2 is a general purpose input with termination R24, current limiting R25, and response control C5 into U5 pin 1. The input pin 1 and output pin 2 of U5 are available on user buss pins 6 and 4.

Prototyping Area: Microcontroller pins 2-7, and 16-17 are uncommitted and available on user buss J5. Below the user buss are two prototyping areas, which will each hold up to a 20 pin DIP plus various passive components. The prototyping areas have connection to a DB15F connector at the bottom of the board. The hole in the center of the prototyping area can be used to standoff a daughter board with strip socket connection to the user buss and to the connector. Clips for the 6 AAA cell battery pack are located opposite the prototyping area but should not conflict if prototype component soldered leads are trimmed.