

OB2-PBA-4

Circuit Description & Schematic

1/17/99

Power Supplies

Power enters the board from 16 AA batteries in series (nominal 24 volts) and is filtered by C4. The 24 volts is fed into a low power regulator U5, and to a high current regulator U4.

U5 is turned on by pressing the external push-button which sends current through R5 to the shutdown terminal of the regulator. When this voltage rises to the operation threshold for the shutdown pin, U5 comes out of sleep mode and provides regulated 3.75 volts to the microprocessor and RF receiver. When the microprocessor U2 is operating, it supplies current from pin 7 through isolation diode D71 which maintains regulator U5 in active mode. When the scoreboard is turned off by pressing a button on the remote control, the processor turns off the voltage from pin 7 thus putting regulator U5 back into sleep mode. R4 and C8 hold the regulator inactive when the processor is not operating.

U4 is turned on by the microprocessor U2 outputting a "high" on pin 3. It is only turned on when needed (to change the displays) in order to conserve power. U4 provides regulated voltage of nominally 15 volts, set by R1 and R9, to operate the displays. C3 stabilizes the regulator U4 and U1. The 15 volts is also fed into voltage regulator U1 to provide 5 volts to the logic circuits and power drivers for the displays. C3 stabilizes the output of U1. R3 holds the regulator inactive when the processor is not operating.

Microprocessor

U2 is an 8 bit CMOS single chip microprocessor, which contains an integrated processor, program and data memory, an oscillator circuit, two timer/counters, and 24 bits of I/O. The supply current of the processor is very low to allow operation from batteries. The processor is used to decode the incoming serial bit stream from the RF receiver and to control the operation of the solenoids that display the score.

Processor Oscillator

Crystal X1 and C10 and C11 form control the frequency of the oscillator circuit built into the microprocessor. The frequency of the oscillator is 4.000 MHz. The oscillator in the microprocessor is programmed to operate in "Low EMI" mode to reduce emissions and reduce power consumption.

RF Receiver

The RF receiver U11 used here is an integrated RF receiver from RF Monolithics, Inc. This receiver uses the ASH design which has no local oscillator and an input SAW filter and thus has very low spurious emissions. Diode D73 reduces the voltage from 3.75 to approximately 3.2 volts to meet the supply voltage specification of RFM. C15 filters the supply voltage for voltage to U2. C16 sets the data rate filter rolloff, and C15 filters the internal reference voltage for U2.

Miscellaneous I/O

Jumpers JP1 and JP2 which are pulled up by R7 and R8 and fed to the microprocessor input pins 11 and 12, are used to set the unit address of the scoreboard in the case where there are more than one unit operating within radio range of each other. Their input

LED1 is controlled by the microprocessor output pin 16 and current limited by R12, is used for general diagnostics.

U3 is used to detect low battery condition. R10 and R11 set the trip point (nominally 13.5 volts) of the detector. When the battery voltage has dropped enough to cause the voltage from U4 to drop below 13.5 volts, it pulls the voltage to processor input pin 13 low through pull up resistor R2 to signal low battery.

Solenoid Driver Circuits

The displays all use electromagnets which move painted cards in various patterns to display the scores. The circuit for driving them uses a multiplexing scheme to be able to drive the 84 electromagnetic solenoids from only 14 microprocessor outputs. U6, U9, and U10 are current sourcing drivers that provide current to the selected rows of solenoids. U8 is an eight channel inverter that provides complimentary data to alternate rows of solenoids. U7 is a sinking driver that sinks one or more columns of solenoids. Diodes D1 to D70 provide isolation for rows of solenoids to prevent "sneak" paths of current through other solenoids. Z1 provides a place for the inductive "kick" current to flow when turning off the solenoids. In the operation of the scoreboard, the solenoids are powered only when it is necessary to change the displayed information.