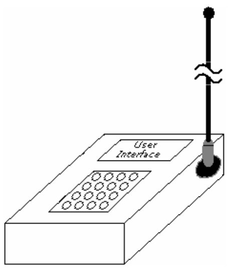
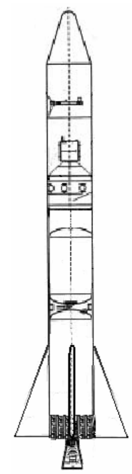


A.Da.M.Rocket



Atmospheric Data Measuring Rocket
Project Hardware Description Draft 1
24 April 2007

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Introduction

Atmospheric weather affects everything. Weather can interfere with television reception, prevent planes from landing, and at its extreme destroy entire towns. It is a continuing effort in the field of science and technology to attempt to predict and properly prepare for the weather. A myriad of electronic devices have been produced over the years to better assist meteorologists in recording and analyzing current weather conditions. One device that would be useful in assisting in atmospheric data measuring is a rocket.

Rockets are used today for a wide variety of field research applications and would be well suited for measuring high altitude atmospheric conditions. The Atmospheric Data Measuring Rocket (ADaM Rocket) is a self-contained electronic device that will take temperature and pressure readings at a defined interval during the rockets decent. The altitude and interval spacing will be determined by an onboard accelerometer based altimeter. The data will be transmitted back to a ground station that will then display and store the information to a user for analysis.

Hardware Overview

The ADaM rocket project hardware consists of two hardware modules, each with their own microcontroller, transceiver and battery power supply. The Hand held Transceiver Processor (HTP) module also has a LCD display and 3 user interface buttons. The ADaM Electronics (ADaM E) module in addition to the basic hardware has a pressure sensor, temperature sensor and a GPS. See figure 1 for the system block diagram. The ADaM E module is a slave system to the HTP and is designed to be disposable after launch.

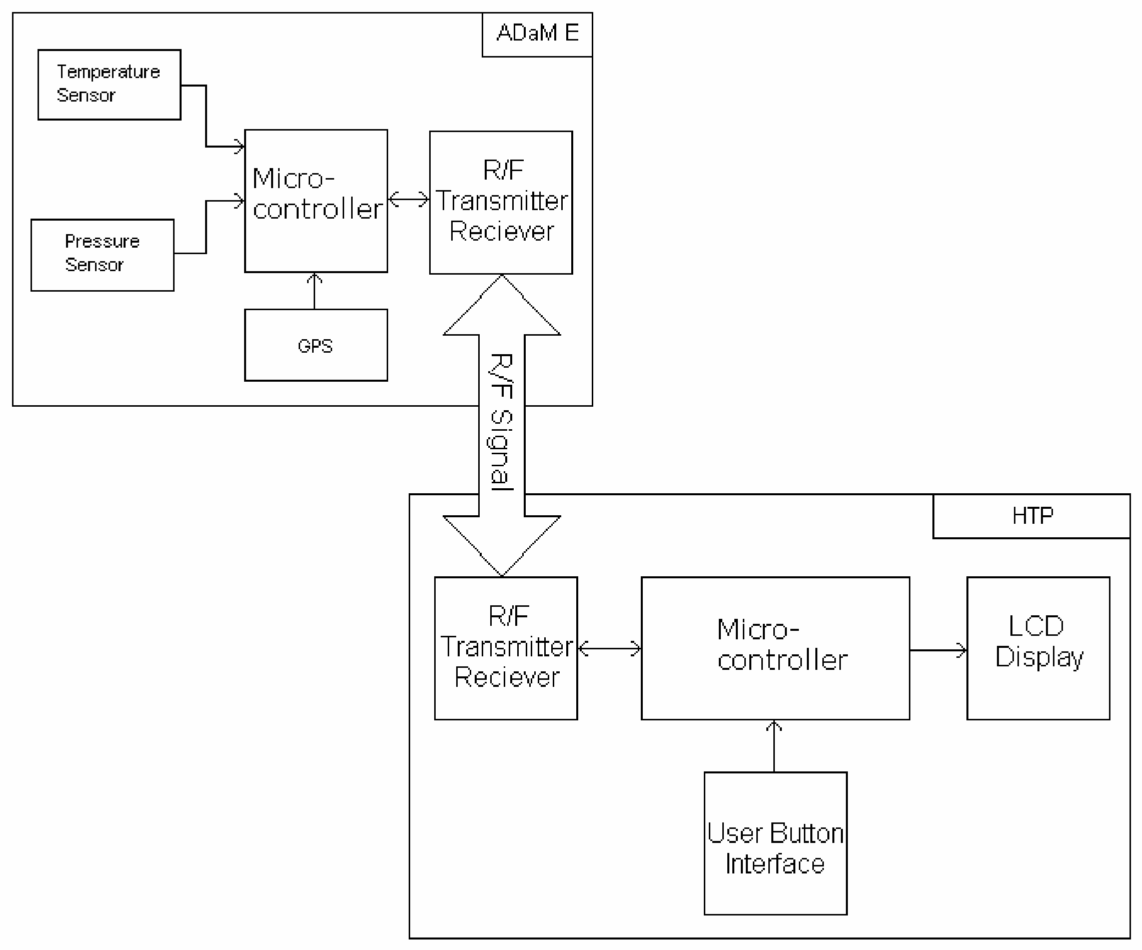

Figure 1: ADaM system block diagram

ADaM E

The ADaM E is a complete embedded system based on the 9S12C32 microcontroller as its central processor. The C32 is a compact microcontroller ideal for small dedicated embedded systems designed to save on cost. Since the ADaM E is overall meant to be non-recoverable this processor is ideal for this application. The C32 interfaces with a temperature sensor, pressure sensor, GPS and RF transceiver using the A/D converter, SPI and SCI interfaces. Power is supplied using a 3.3v switching regulator to all devices in the ADaM E. Atmospheric data is recorded through the

Pressure and Temperature sensors while altitude data is recorded through the GPS module. All of the recorded information is transmitted using an RF transceiver.

The power supply is a Maxim MAX1836 step down voltage regulator. It regulates the battery supply voltage of 9VDC to the ADaM E system wide voltage of 3.3VDC. The switching regulator provides ideal voltage regulation efficiency in case the ADaM E needs to operate over extended periods of time due to launch delays. A regular linear voltage regulator can drain a 9V battery too quickly in these circumstances. All the electronic devices in the ADaM E use this voltage source for power and ground connections.

The temperature sensor used will be a DS1620 digital thermometer by Maxim IC. It will be integrated onto the ADaM E electronics board and interface directly to the C32 micro controller using the SPI. The pins used on the DS1620 are V_{DD}, Ground, Reset_L, Clock/Convert_L & DQ. The DS1620 pins Reset_L, Clock/Convert_L & DQ connect to the C32 AN02, PM5 & PM2 pins respectively. When the ○Reset pin signal is set low the DQ pin is taken out of a high impedance state and begins to transmit data. When the ○Reset pin is set high the DQ pin goes to a high impedance state and effectively acts like a no connect. The Clock/Convert_L pin is used to synchronize the data transmission from the DS1620 to the C32. The data from the DS1620 Temperature readings will be continuously calculated by the DS1620 but will only be recorded and analyzed by the C32 micro controller during initial start up, testing, and descent data recording. There are no other devices that use the SPI so the necessary SPI connections are limited to just a three pin connection to the C32.

The pressure sensor is a Freescale MPX2100ASX. Like the temperature sensor it will also be integrated onto the ADaM E electronics board but will interface to the C32 micro controller through two A/D ports. Two A/D ports are needed because the MPX2100ASX uses the difference between its two output voltages for scaled pressure readings. The pressure sensor uses an instrumentation amplifier to properly scale the output of the MPX2100ASK pressure sensor to the A/D ports. The instrumentation amplifier has a gain of 1.8 which scales the differential voltage output of the sensor to 0mV at 0 PSI and 20.0mV at 14.5 PSI. The pin connections of the MAX2100ASX are Ground, V_S, $+V_{out}$ and $–V_{out}$. The $+V_{out}$ and $–V_{out}$ pins connect to an operational amplifier with a gain of 1.8 and then to pins AN00 & AN01 respectively.

To measure the altitude during the ADaM E descent a Lassen IQ GPS is used. The GPS interfaces to the ADaM E micro controller using the SCI*. The GPS has an 8 pin interface of which only 4 pins will be used: power, ground, RXDA and TXDA. The RXDA and TXDA pins are the direct SCI interface pins to the C32 TXD and RXD pins (respectively). The other pins will be left floating as this will no affect the operation of the GPS. The reason for choosing the RXDA/TXDA connections over the RXDB/TXDB connections is due to the preference of using the TSIP protocol (GPS serial ports A) verses NEMA protocol (GPS serial ports B).

The ADaM E uses a MaxStream XCite RF digital transmitter. The digital transmitter uses the SCI* to interface with the C32 in order to receive and transmit data to and from the HTP on the ground. The pins used on the XCite to interface to the C32 are DI, DO, DI2 & DO2. The DI & DO pins are the direct SCI interface pins to the C32 TXD and RXD pins (respectively). The DI2 pin carries the request to send signal. When the DI2 pin is high the data will be queued to transmit. The DO2 pin acts as a flow control signal. When its signal is high data can be transmitted. DO2 and DI2 interface to the C32 through the PT4 & PT5 pins respectively. All the other pins on the XCite are to be left floating.

*Note: Since the Lassen IQ GPS and MaxStream XCite both use the SCI an analog switch is used to alternate the SCI port between them. The analog switch used is a PI5C3125 by Pericom. The SCI RXD pin from the C32 connects to pins A0, A2 and outputs through pins B0, B2. The SCI TXP pin from the C32 connects to pins A1, A3 and outputs through pins B1, B3 for the TXD. The C32 used pins PT0 through PT3 to control the switches. When the C32 needs to communicate to the GPS, PT0 and PT2 are set high while PT1 and PT3 are set low. When the C32 needs to communicate to the XCite, PT1 and PT3 are set high while PT0 and PT2 are set low.

HTP

The HTP embedded system is based on the 9S12DP256 microcontroller. The DP256 is a powerful microcontroller well suited for the HTP and its potential future add-ons. The DP256 interfaces with a LCD, 3 button interface, and RF transceiver using the SCI and I/O ports. Power is supplied using a 3.3v switching regulator to all devices in the HTP running off of 4 C type batteries. System information is displayed on the LCD to the user. The 3 button interface is used to interface with the HTP's user functions. The RF transceiver will transmit command data to and receive recorded data from the ADaM E.

The HTP's power supply is a Maxim MAX1836 step down voltage regulator identical to the one used in the ADaM E. It regulates the battery supply voltage of 6VDC from 4 1.5VDC C cell type batteries to a system wide voltage of 3.3VDC. The switching regulator provides ideal voltage regulation efficiency in case the HTP needs to operate over extended periods of time due to launch delays or data analysis. A regular linear voltage regulator would drain the 6VDC battery supply too quickly in these circumstances. All the electronic devices in the HTP use this voltage source for power and ground connections.

The HTP's transceiver is a MaxStream XCite RF digital transmitter. The digital transmitter uses the SCI to interface with the DP256 in order to transmit and receive data to and from the ADaM E in the rocket. The pins used on the XCite to interface to the DP256 are DI, DO, DI2 & DO2. The DI & DO pins are the direct SCI interface pins to the DP256 TXD and RXD pins (respectively). The DI2 pin carries the request to send signal. When the DI2 pin is high the data will be queued to transmit. The DO2 pin acts as a flow control signal. When its signal is high data can be transmitted. The DO2 and DI2 pins interface to the DP256 through the PJ1 & PJ0 pins respectively. All the other pins on the XCite are to be left floating.

The HTP's 3 button interface will consist of an enter button, up arrow button and down arrow button. They are manufactured by Schurter and their part numbers are 1241.1108.7 050, 1241.1108.7 049, & 1241.1108.7 058 for up arrow, down arrow and enter respectively. Each button is of a single pole single throw type. The buttons are all tied to Vcc through 10K resistors each. The up, down and enter buttons connect to pins PB0 through PB2 respectively on the DP256.

The display of the HTP is a 2 line by 16 characters LCD. It is controlled by a Hitachi HD44780U LCD controller. The LCD will operate in 8-bit mode. The pin connections of the LCD are DB0 – DB7, E, R/W, RS, GND, VCC & VEE. The pins DB0 – DB7 connect to the DP256 using port A pins PA0 – PA7 respectively. The LCD pins E, R/W & RS connect to port K pins PK0 – PK2 respectively. GND, VCC and VEE connect to a voltage divider circuit to provide power and properly set the gamma of the LCD. The Voltage divider is V_{cc} to a 16KΩ resistor in series with a 680KΩ resistor to digital ground. The VCC pin is connected to V_{cc}. The VEE pin is connected at the point in between the two resistors and the GND pin is connected to digital ground.

ADaM E Parts List			
Item	Quantity	Part Description	Designators
10	1	Battery, 9V type	B1
20	3	Cap-Mono,X7R,10%,.1μF/50V	C1,C5,C6
30	3	Cap-Mono,X7R,10%,22pF/50V	C2,C3,C4
40	1	Cap-Mono,X7R,10%,10F/50V	C7
50	1	Cap-Mono, Electrolitic, RAD, 10%, 100uF/10V	C10
60	1	Diode, EP05Q03L	D2
70	1	Inductor, CDRH5D28, 30%	L2
90	1	Res, 1K87, 1/8W, 1%	R1
100	2	Res, 1K96, 1/8W, 1%	R2,R3
120	1	IC, Microcontroller, 8Bit, MC9S12C32	U1
130	1	IC, Transmitter, XC09, 9600Baud	U2
140	1	IC, GPS, IQ, NEMA & TSIP	U3
150	1	IC, Analog Switch, PI5C3125	U4
160	1	IC, Digital Temp Sen, DS1620	U5
170	1	IC, V-Reg switching, MAX1836	U6
180	1	IC, Pres Sen, MAX2100ASX	U7
190	1	IC, Op-Amp, instrument, MC33272	U8

Table 1: ADaM E Parts List

HTP Parts List			
Item	Quantity	Part Description	Designators
10	4	Battery, 1.5V, C-cell type	B1,B2,B3,B4
20	1	Cap-Mono,X7R,10%,.1μF/50V	C5
30	2	Cap-Mono,X7R,10%,22pF/50V	C3,C4
40	2	Cap-Mono,X7R,10%,10F/50V	C2,C6
50	1	Cap-Mono, Electrolitic, RAD, 10%, 100uF/10V	C1
60	1	Diode, EP05Q03L	D1
70	1	Inductor, CDRH5D28, 30%	L1
90	3	Res, 10K, 1/8W, 1%	R1,R2,R3
100	1	Res, 16K, 1/8W, 1%	R4
101	1	Res, 680K, 1/8W, 1%	R5
102	1	Res, 47K, 1/8W, 1%	R7
103	1	Res, 22R, 18W, 1%	R8
110	3	Switch, SPST, MSPS103B	SW1,SW2,SW3
120	1	IC, Microcontroller, 16Bit, MC9S12DP256B	U2
130	1	IC, Transmitter, XC09, 9600Baud	U1
170	1	IC, V-Reg switching, MAX1836	U6
200	1	LCD, HD44780U, 2 line x 16 char	LCD1

Table 2: HTP Parts List