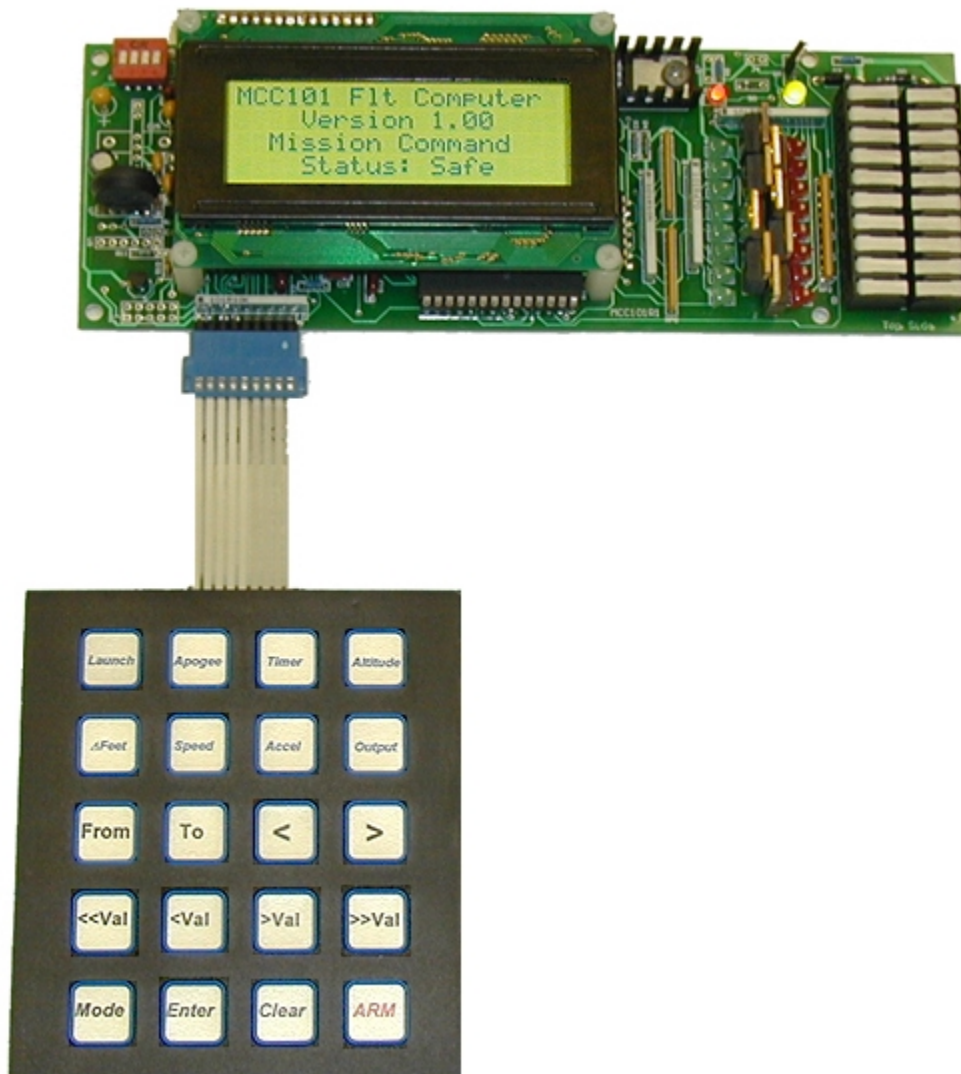


MCC101

The Mission Command Computer 101



Flight Computer
User Manual
Rev. 1.00
April 2001

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Section 1 Introduction

The Mission Command Computer was designed to meet the electronics requirements of the more complex rocketry missions.

The overall design goal was to offer a system that would accurately measure flight parameters, provide high current switches at user programmed intervals and record flight data throughout the boost, apogee and descent.

The system is designed for maximum flexibility, thus providing the user with the capability to choose from a large variety of mission possibilities.

Section 1.1 System Overview

The Mission Command Computer 101 (MCC 101) is a fully programmable flight computer and data acquisition system. The user programs his "mission" into the system using a 20 key membrane keypad and a 4x20 LCD (MCC101-L). An optional Vacuum Florescent Display (VFD) is also available (MCC101-V).

The system incorporates a high performance accelerometer and two temperature compensated barometric sensors. These sensors, in combination, provide accurate altitude, acceleration, speed and linear distance data.

The system provides automatic launch detection after arming. Once launched, the mission is executed using a series of software links that have been programmed by the user. The events and links make up user defined chains. The chains always begin with launch or apogee and end with one of eight output events. The software output events correspond to the high current switched outputs located on the main connector. Between the initiating event and the output event the user can link the other six types events. These events include eight timers, eight altitude detectors, eight acceleration detectors, eight change of altitude detectors and eight speed detectors.

Section 1.2 MCC101 Features

- Eight fully programmable high current outputs
- High impedance continuity check circuits on all outputs
- LED continuity indicators on all outputs
- LED output state indicators
- Safety shorting jumper for disabling/enabling outputs
- Four position DIP switch for function options
- Ten position large profile power and output connector
- 20 key membrane keypad for mission programming
- 4x20 LCD display or 4x20 Vacuum Florescent Display option
- Powerful 16-bit microprocessor
- Data storage over 100 seconds of flight and recovery
- Altitude, Speed and Acceleration data stored 10 times per second
- Altitude accuracy to within 20 feet @ 10,000 feet
- RS-232 Serial interface to host PC with interface software
- Automatic beeper output function for external beeper or camera
- External arming function for phono jack arm switch

Section 1.3 Power Requirements

- MCC101 power supply 12V @ 0.5A
- Power supply 12V @ output amperage determined by the user
- Shorting jumper

Section 2 Programming Theory

The MCC101 is programmed using a series of links from event to event that build event chains. Each event chain must begin with either the launch or apogee event and end with an output event. This concept is easily explained using an example mission.

Suppose we want to program a mission that will do the following.

- 1) Five seconds after launch the computer will ignite a device that provides tracking smoke throughout the remainder of the flight.**

To program this, we would provide a link from one of the eight launch events to one of the eight timer events. The timer value would be set to 5 seconds. Then a link would be programmed from the timer event to one of the eight output events. The device would be connected to the corresponding hardware output. The chain might look like the following:

Launch(0) => Timer(0) => Output(0)
Timer(0) value = 5.0 seconds

- 2) At 5000 feet the rocket deploys a large amount of tracking chalk to provide visual verification that the rocket reached this altitude.**

This chain would link the launch event to one of the eight altitude events. The altitude event would be linked to one of the remaining seven output events. The chain might look like the following:

Launch(1) => Altitude(0) => Output(1)
Altitude(0) value = 5000 feet

- 3) At apogee the computer deploys a drogue parachute.**

This chain would link the apogee event to one of the remaining six outputs. The chain might look like the following:

Apogee(0) => Output(2)

4) At 600 feet the computer deploys a main parachute.

This chain would link one of the seven remaining apogee events to one of the remaining seven altitude events. The altitude event would be linked to one of the remaining five outputs. The chain might look like the following:

Apogee(1) => Altitude(1) => Output(3)
Altitude(1) value = 600 feet

Notes:

Events are numbered zero to seven for a total of eight events for each type.

Once an event has been used in a chain, it should not be used again. For example Altitude(0) should not be used in chain 4. However, Altitude(0) and Altitude(1) are two separate events and can be used in two different chains.

The Launch and Apogee events are set automatically by the computer during flight. There are no values for these events.

In chains 2 and 4 the altitude event is used. Note that by linking the launch event to the altitude event in chain 2, the event will become true when the vehicle is going up. By linking the apogee event to the altitude event in chain 4, the event will become true when the vehicle is coming down.

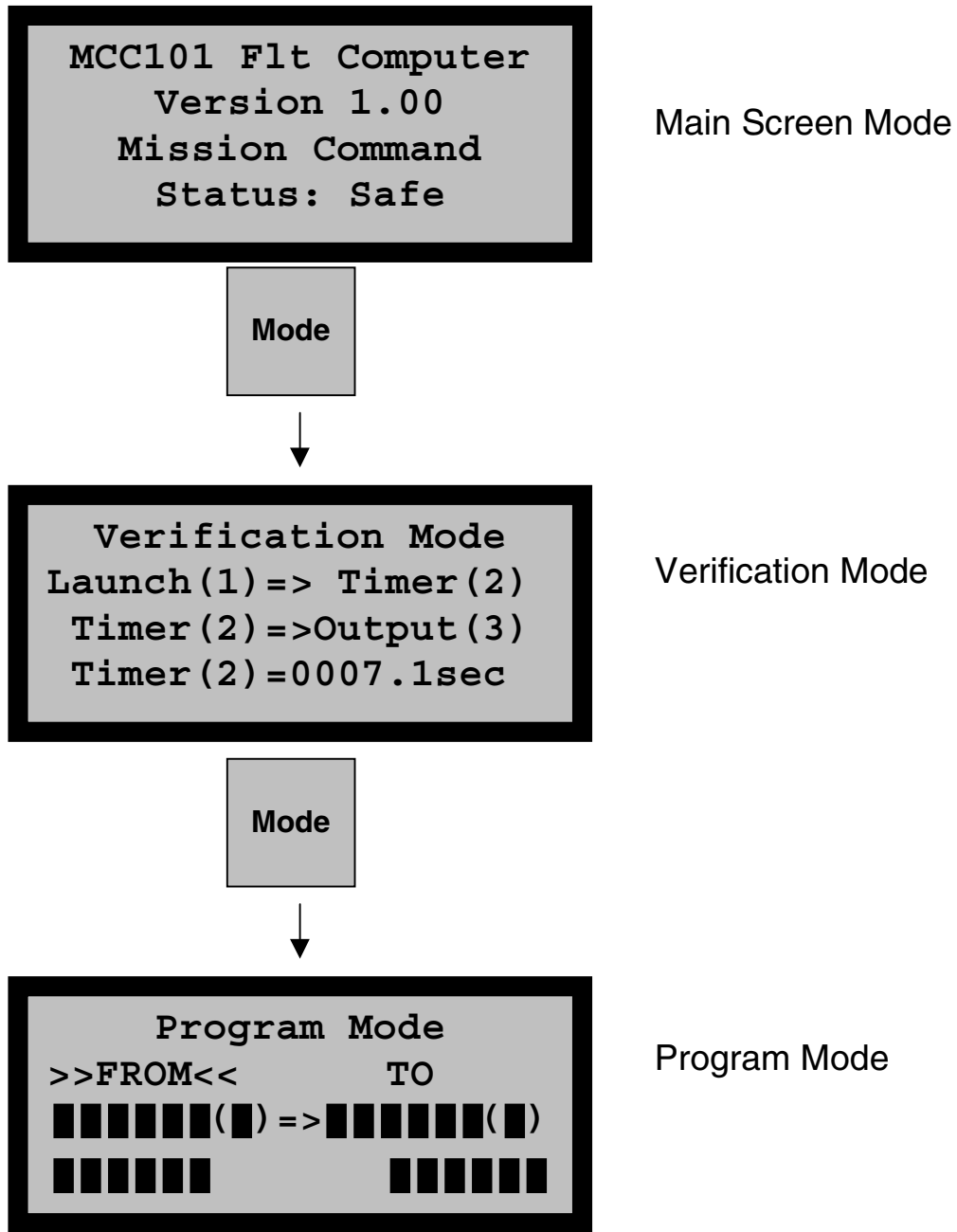
Section 3 User Interface

The user interface to the MCC101 consists of a detachable 20 Key keypad and a 4 X 20 LCD or VFD display. The display and keyboard are used to program the system, download data, display flight data and various other functions described in Section 4.

Section 4 Operating Menus

The operating menus allow the user to configure the MCC101 for flight and perform various other operations. The **Mode** Key on the lower left of the keypad cycles through the menus shown on the display.

The following graphics show the menus and modes currently available in Version 1.00.



Mode



Output Test DANGER!
Outputs are ACTIVE
ARM to Continue
MODE ARM

Output Test Mode

Mode



Download Data
Communications=NONE
CLR to clear comm
MODE ENT CLR

Download Data Mode

Mode



Post Flight Replay
OUTPUTS ARE ACTIVE!!
Exit Step Stop Begin
MODE ENT CLR ARM

Post Flight Mode

Mode



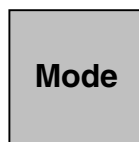
Return to Main Screen Mode

Section 4.1 Main Screen Mode

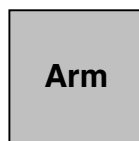
On powerup, the Main Screen shown here is displayed.



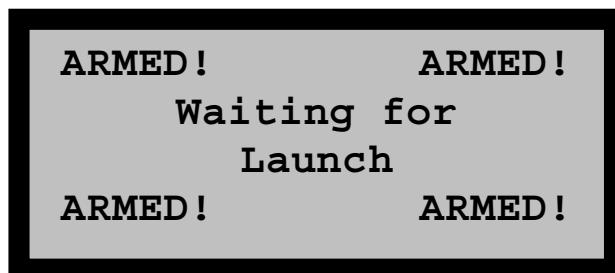
From the Main Screen, there are two key options available.



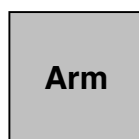
Pressing the **Mode** key from the main menu will change the mode to the Verification Screen.



Pressing the **Arm** key from the main menu will arm the system and display the following Armed Screen.



Armed Screen Mode



Pressing the **Arm** key again will disarm the system and return to the Main Screen.

Section 4.2 Verification Mode

The **Mode** key from the Main Screen displays the Verification Screen.

```
Verification Mode
Launch(1) => Timer(2)
Timer(2) => Output(3)
Timer(2) = 0007.1sec
```

Verification Mode is used to verify the chains that have been programmed into the system. The screen shows one or two links in the chain. Only one link will be shown if the chain is one link long or if the end of the chain has been reached.

From the Verification Screen there are five key options available.

Mode

Pressing the **Mode** key from the Verification Screen will change the mode to the Program Screen.

From

Pressing the **From** key will display the first link in the current chain being displayed.

To

Pressing the **To** key will display the next link in the current chain being displayed.

<

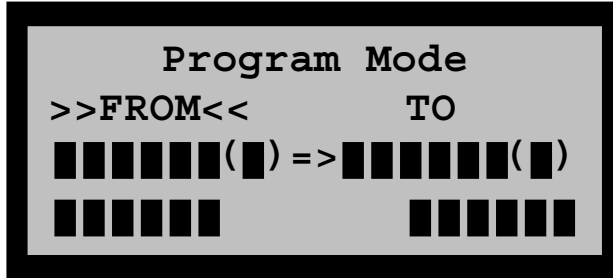
Pressing the **<** key will switch to the previous chain and display the first link in that chain.

>

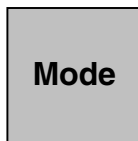
Pressing the **>** key will switch to the next chain and display the first link in that chain.

Section 4.3 Program Mode

The **Mode** key from the Verification Screen displays the Program Screen.



The Program Screen is used to program the links that will make up the chains for a particular mission. From this screen there are nineteen key options available.



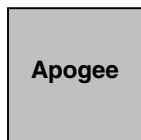
Pressing the **Mode** key from the Program Screen will change the mode to the Output Test Screen.



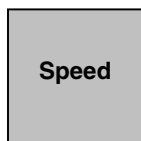
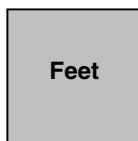
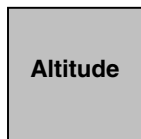
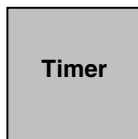
Pressing the **From** key will highlight the FROM on the display with arrows. New information entered about the link will pertain to the FROM event.



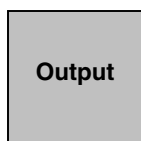
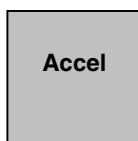
Pressing the **To** key will highlight the TO on the display with arrows. . New information entered about the link will pertain to the TO event.



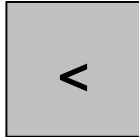
Pressing one of these event keys will determine the type of event that will be programmed. The event will be placed either in the FROM position or the TO position dependent on which side is highlighted with the arrows.




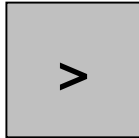
The Launch and Apogee events will not program in the TO position as these events are automatically updated by the computer.




An event type must be entered before an event number can be selected.




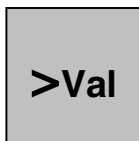
Pressing the  key will decrement the event number in either the FROM or the TO position.




Pressing the  key will increment the event number in either the FROM or the TO position.






Pressing the  key will decrement the value of the event in either the FROM or the TO position.






Pressing the  key will increment the value of the event in either the FROM or the TO position.





Pressing the  key will increase the multiplier of the value that will be added or subtracted to the value when the  or  is pressed.



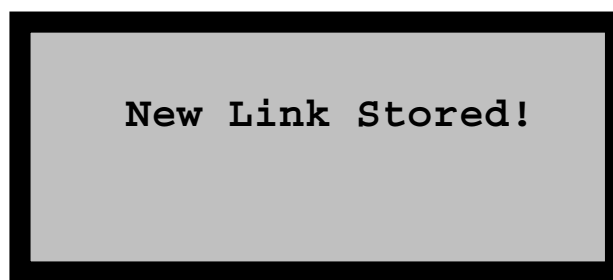
Pressing the  key will decrease the multiplier of the value that will be added or subtracted to the value when the  or  is pressed.



If some of the required fields in the Program Screen have not been filled, pressing the  key will have no effect.

If all required fields have been filled in the Program Screen, pressing the  key will store a new link.

If a new link is stored, the following screen will be displayed for about 2 seconds before returning to the Program Screen.



Clear

If the **Clear** key is pressed after data has been entered in the Program Screen, all data fields will be blanked and the computer will accept new data.

Pressing the **Clear** key when Program Mode is initially invoked, or pressing the **Clear** key twice after entering data will clear all links stored in the computer. The following screen will be displayed.

Verify Clear Links!
Links will be erased
Press ENT to Clear
Any Key to return

Pressing the **Enter** key will clear all stored links.

Pressing any other key will return the Program Screen.

If the **Enter** key is pressed at the Clear Links Warning Screen, the following screen will appear after about six seconds. Pressing any key will return the Program Screen.

Clearing All Links
All Links Cleared

Section 4.4 Output Test Mode

The **Mode** key from the Program Screen displays the Output Test Screen.

```
Output Test DANGER
Outputs are ACTIVE
ARM to Continue
MODE CLR=OFF ARM=ON
```

The Output Test Screen is used to test the hardware outputs from the computer. Outputs can manually be turned on or off from the keypad to test devices connected to the computer.

Mode

Pressing the **Mode** key from the Output Test Screen will change the mode to the Download Data Screen.

ARM

Pressing the **ARM** key will enable the outputs and display the following Arm Screen.

```
Output Test Mode
Output (1) OFF
< > to change Output
MODE CLR=OFF ARM=ON
```

Mode

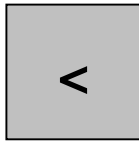
Pressing the **Mode** key from the Output Test Screen will change the mode to the Download Data Screen.


Clear

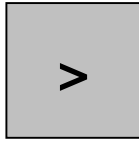
Pressing the **Clear** key will turn the selected output off.

ARM

Pressing the **ARM** key will turn the selected output on.




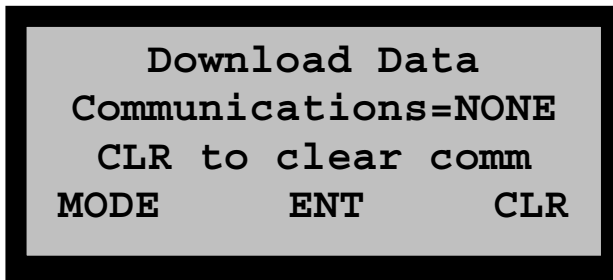
Pressing the  key will select the previous output.



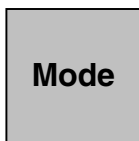
Pressing the  key will select the next output.


Section 4.5 Download Data Mode

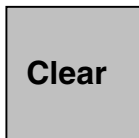
The  key from the Output Test Screen displays the Download Data Screen.




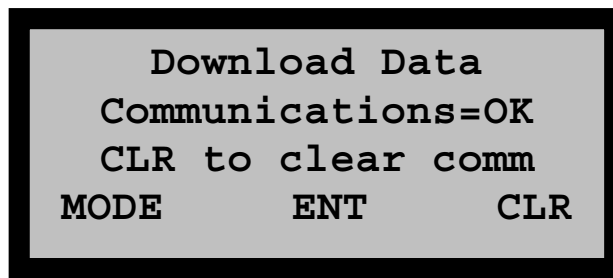
The Download Data Screen is used to download recorded flight data to a PC. The MCC101 must be connected to host computer serial port with the serial cable. The host computer must be running the MCC101 Interface software. From this screen there are three options available from the keypad.



Pressing the  key from the Download Data Screen will change the mode to the Post Flight Screen.



Pressing the  key will attempt to establish clear communication with the PC. If communication is established the following screen will be displayed.



Enter

If communication has been established, pressing the key will initiate an automatic transfer from the MCC101 to the host PC. The following screen will be displayed.

```
Download Data  
Communications= OK  
CLR to clear comm  
Transmitting Data
```

When the transmission is complete, the following screen will be displayed.

```
Download Data  
Communications= OK  
CLR to clear comm  
Transmit Complete
```

Section 4.6 Post Flight Mode

The **Mode** key from the Download Data Screen displays the Post Flight Screen.

```
Post Flight Replay
OUTPUTS ARE ACTIVE!!
Exit Step Stop Begin
MODE ENT CLR ARM
```

Post Flight Mode

The Post Flight Screen is used replay a recorded flight, observing the elapsed time, speed, altitude and state of the outputs throughout the flight. From this screen there are four options available from the keypad.

Mode

Pressing the **Mode** key from the Post Flight Screen will change the mode to the Main Screen.

ARM

Pressing the **ARM** key will begin the playback of the flight in real time and display the following.

```
LAUNCHED! LAUNCHED!
Acquiring Data
Flight Time= 001.8s
0008.0mph 000010ft
```

Clear

Pressing the **Clear** key will start or stop the playback in real time.

Enter

Pressing the **Enter** key will stop the playback (if running) and advance the flight time by 0.1 seconds each time it is pressed.

Section 5 Events

The key to MCC101 programming and operation is the event driven chains. When an event becomes true and a link to another event is programmed, the next event will be enabled. This section explains each type of event.

Section 5.1 Launch

The launch event is enabled when the system is armed. If the system is armed the computer will automatically make the launch event true when 1.2 gee's of acceleration are present for 0.5 seconds. There is no value associated with the acceleration event.

Section 5.2 Apogee

The apogee event is enabled after the system is launched. After launch the computer checks for a level or decreasing altitude change. This altitude change must continue for about 1.5 seconds. This is also crossed checked with the calculated speed to eliminate false ejection due to sudden pressure changes such as the firing of ejection charges or supersonic pressure transients. There is no value associated with the apogee event.

Section 5.3 Timer

A timer event is enabled by a link from another event. When a timer is enabled, a countdown begins with the programmed value stored for that timer. When the countdown reaches zero, the timer event becomes true and any event that has been linked from that timer event will become enabled.

Section 5.4 Altitude

An altitude event is enabled by a link from another event. When an altitude event is enabled, the computer will begin continuously checking the altitude and comparing the measurement to the value programmed for the associated altitude event. When the values match, the altitude event will become true and any event that has been linked from that altitude event will become enabled.

Section 5.5 • Feet

A • Feet event is enabled by a link from another event. When a • Feet event is initially enabled, the computer will store the current altitude reading. After this, the computer will compare new altitude measurements from the initially stored altitude. When the difference between these two values equals the value programmed for the associated • Feet event, the event will become true and any event that has been linked from the • Feet will become enabled.

Section 5.6 Speed

The speed event is enabled by a link from another event. When the speed event is enabled, the computer will begin continuously checking the speed and comparing the measurement to the value programmed for the associated altitude event.

There is an important difference between the speed event from the other events. All speed events, when enabled, compare the current speed value to the programmed value. However, event numbers 0-3 become true when the measured value is less than or equal to the programmed value. Event numbers 4-7 become true when the measured value is greater than or equal to the programmed value.

For example, if the rocket were to eject a smoke charge if the speed reached 500 mph or more, event numbers 4-7 could be used for the speed event. If the rocket were to eject a parachute when the speed went below 20 mph, event numbers 0-3 could be used.

Section 5.7 Acceleration

An acceleration event is enabled by a link from another event. When an acceleration event is enabled, the computer will begin continuously checking the acceleration and comparing the measurement to the value programmed for the associated acceleration event. When the values match, the altitude event will become true and any event that has been linked from that acceleration event will become enabled.

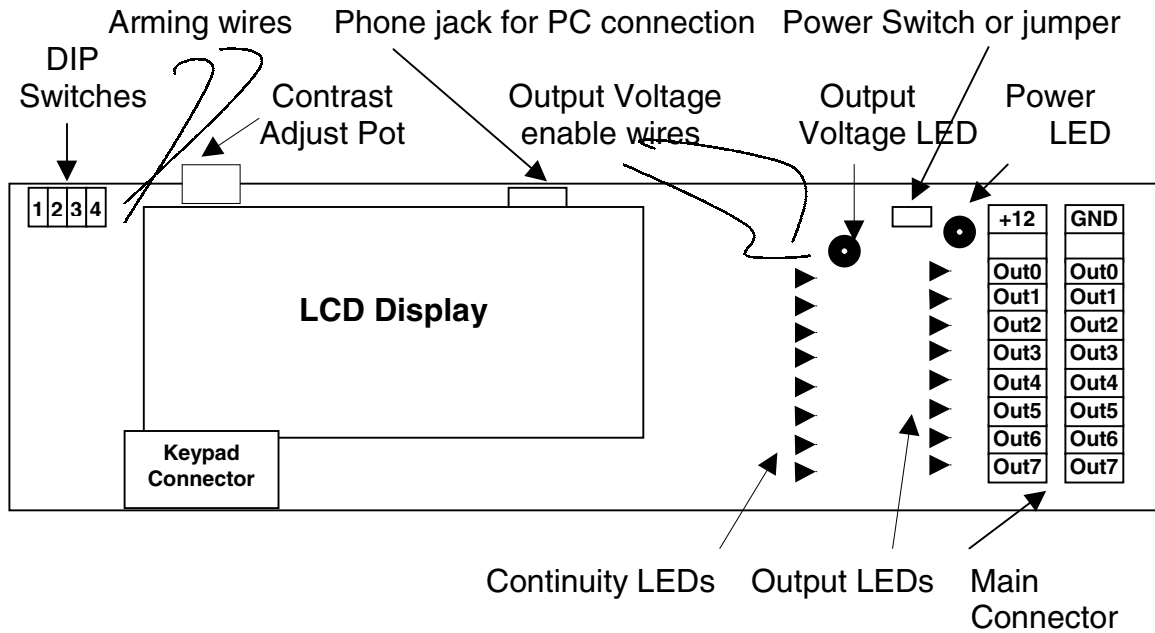
The acceleration events, when enabled, compare the current acceleration. However, like the speed events, numbers 0-3 become true when the measured value is less than or equal to the programmed value. Event numbers 4-7 become true when the measured value is greater than or equal to the programmed value.

Section 5.8 Output

An output event is enabled by a link from another event. An output event is the last event in an event chain. When an altitude event is enabled, the corresponding output at the output connector will be energized.

Section 6 DIP switches and connections

The following diagram shows the location of the DIP switches, connectors and connector points on the MCC101. The contrast adjust potentiometer adjusts the contrast of the LCD display.



Section 6.1 DIP switch functions

A four position DIP switch is located on the upper left corner of the MCC101 printed circuit board. The diagram shows the number for each switch. An arrow on the switch indicates the ON position of each switch.

Switch number 1 enables the external beeper option. An external 12V beeper should be connected to Output #7. When this switch is in the ON position, Output #7 will cycle on and off. When the system is disarmed, the cycle rate is one beep per second. When the system is armed, the cycle rate is four beeps per second. When the system has detected launch, the cycle rate is ten beeps per second while acquiring data. After the data acquisition is complete, the output is continuous on. If this option is not used, Output #7 can be used normally as a programmed output.

Switch number 2 enables the external arming option. Two wires should be soldered to the pads immediately to the right of the DIP switch. When switch number 2 is ON the computer will check the status of the wires connected to this switch and arm the system automatically.

Switch number 3 determines how the arming wires will arm the system. If switch number 3 is ON the system will arm when the arming wires are shorted together. If switch number 3 is OFF the system will arm when the arming wires are not connected to each other. This allows use of either a normally closed or normally open switch to arm the system. The arming wires are shown on the layout diagram.

Switch number 4 enables the external camera relay option. An external 12V relay should be connected to Output #6. This relay can then be used as a switch for a camera. When this switch is in the ON position, Output #6 will cycle on and off after launch. The cycle rate is one switch per second. If this option is not used, Output #6 can be used normally as a programmed output.

Section 6.2 Connections

A power switch or jumper is shown on the layout diagram. If an external switch is used a jumper is installed in place of the switch.

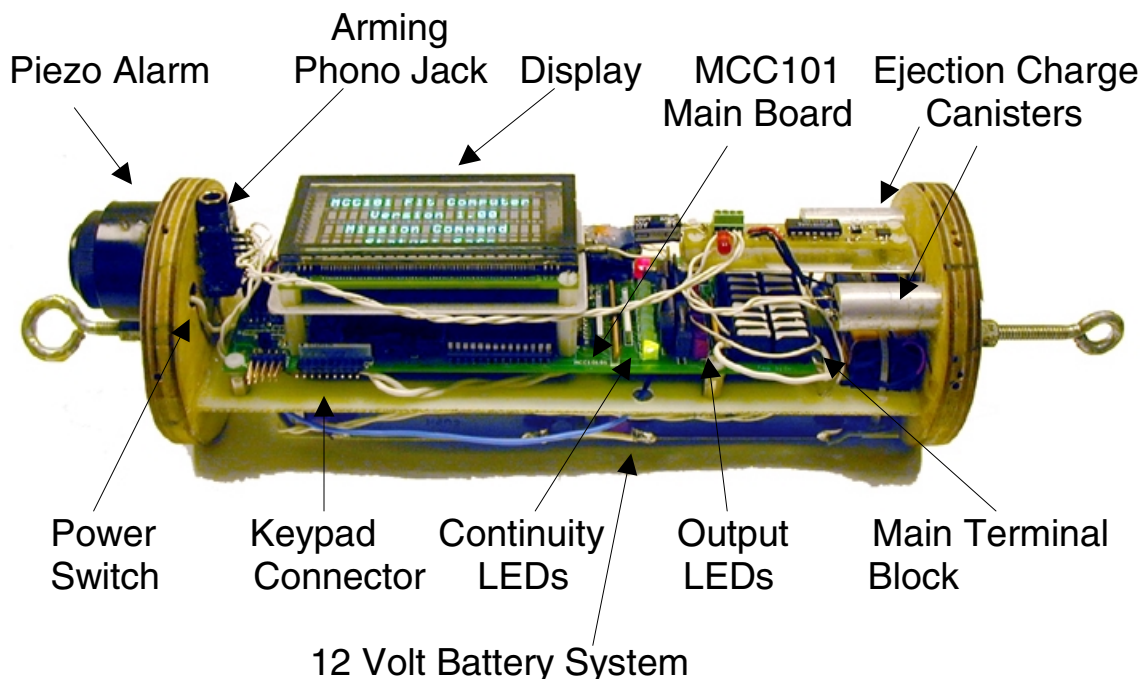
The voltage enable wires are used as another safety for the outputs.

When the wires are connected together no voltage is allowed to the outputs even if the computer turns the output on. When the wires are not connected together the outputs will supply voltage when the computer turns the outputs on. The output voltage LED indicates whether voltage will be present at the outputs when turned on.

The phone connection is shown on the layout diagram. The MCC101 is connected to a PC using the supplied serial cable.

Section 7 Flying the MCC101

The MCC101 should be mounted securely to a platform in the rocket using #6 nylon machine bolts and nuts through the four mounting holes. A 12V battery system must be installed to and connected to the power inputs on the computer. **The main connector must be facing forward in the rocket.** The following shows a typical installation of the MCC101 computer.



Section 7.1 Arming

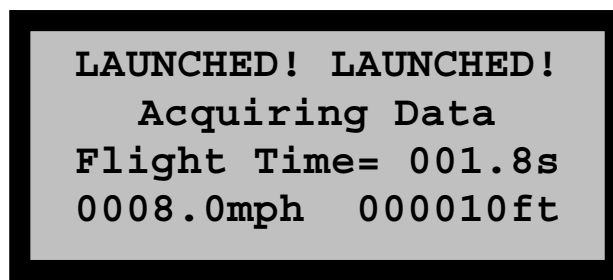
The MCC101 can be armed either with the keyboard or an external arming switch. A phono jack can be used to provide a normally open or normally closed contact. Inserting a phono plug into the jack will disarm the computer and can be removed immediately before flight to arm the computer.

The MCC101 must be armed with the rocket in an upright position. When the computer is armed, an initial acceleration and pressure reading is stored as a reference. If the computer is not pointed straight up, the initial acceleration value will be wrong leading to inaccurate flight data and possibly enabling the launch event at the wrong time.

A second safety feature is provided in the voltage enable circuit. When the voltage enable wires are connected together, the circuit is disabled and no voltage is available at the outputs. Therefore, a switch can be used to short the wires together for safe and opened immediately before launch. If this feature is not required, the voltage enable wires can be removed. The voltage enable can be enabled with the computer at any orientation.

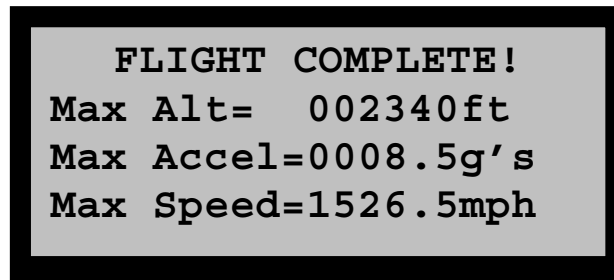
Section 7.2 Launching and Data Acquisition

After arming the rocket should be launched as soon as possible to conserve battery life. The computer will automatically detect the launch event and begin the data acquisition process. Two seconds of prelaunch data is logged and new data will be logged for about 100 seconds throughout the flight. The display will show the progress of the data acquisition during this time.



```
LAUNCHED! LAUNCHED!  
Acquiring Data  
Flight Time= 001.8s  
0008.0mph 000010ft
```

After the data acquisition time is complete the display will show the following.



```
FLIGHT COMPLETE!  
Max Alt= 002340ft  
Max Accel=0008.5g's  
Max Speed=1526.5mph
```

It is important to allow the data logging process to run to completion. Interrupting the write cycle to the memory by turning off power to the unit can result in corruption of data.

Section 8 Data Download

After a flight, the logged data can be downloaded to a PC using the supplied serial cable and interface software. After connecting the MCC101 to a PC the download data screen is used to transfer the data.

The interface software is run in DOS or in a DOS window. Running the MccInt.exe file launches the program. Data is transferred automatically and can be viewed in the program. The viewing utilities are somewhat limited, however the program allows the user to store the data to a file that can in turn be imported by Microsoft Excel. The powerful graphing utilities in Excel can allow the user to create custom for graphs of altitude, acceleration, speed, and linear distance using the data imported from the MCC101.