Radio Astronomy Supplies

UltraCyber™ 406.7 MHz Radio Telescope

Setup and Operation Manual

RAS-406.7

Radio Astronomy Supplies
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CAUTION

BEFORE HOOKING UP YOUR SYSTEM, CONNECT THE POWER CABLE TO THE +12 VDC OUT, LOCATED ON THE REAR PANEL OF THE RECEIVER BACKEND. APPLY POWER USING THE EXTERNAL POWER SUPPLY (110 VAC OR 220 VAC DEPENDING ON THE MODEL) AND CONFIRM THAT +12 VDC IS PRESENT AT THE END OF THE POWER CABLE (NOT SUPPLIED).

AFTER CONFIRMATION, CAREFULLY CONNECT THE POWER CABLE TO THE LOW NOISE AMPLIFIER (LNA) AND THE CONVERTER (No external converter in this system).

THESE MODULES USE GASFET AND HEMT DEVICES, USE CAUTION WHEN CONNECTING THE SIGNAL CABLES, AS NOT TO INDUCE ANY STATIC CHARGE.

IMPORTANT!
"READ"
WARNING

THIS RAIO TELESCOPE HAS BEEN CONFIGURED FOR OPERATION AT 110 OR 220 VAC (U.S. OR EURO VOLTAGE). IT IS STRONGLY SUGGESTED THAT THAT THE BACKEND UNIT NOT BE OPENED DURING OPERATION, TO AVOID SHOCK OR BODILY INJURY FROM CONTACT WITH THE POWER SUPPLY. IN A/DDITION, REMOVE ANY JEWELERY FROM YOUR BODY WHICH MIGHT HANG DOWN OR COME IN CONTACT WITH THE VOLTAGE SUPPLY.

USE EXTREME CAUTION WHEN WORKING WITH VOLTAGE/CURRENT POTENTIALS!

Jeffrey M. Lichtman/Radio Astronomy Supplies will assume no liability for operation of this radio telescope in any unsafe manner. This product has been engineered and tested to insure that the operation is safe and that the product does what it is was built and designed for. The radio telescope is warrenteed for 30 days from the time of delivery. Opening or modifiying will void the warranty unless prior permission is received from Radio Astronomy Supplies.

This system is a highly sensitive research grade system. Please A/Dhere to the enclosed directions, to insure proper operation.

Table of Contents

1. Description of the Radio Telescope:

The Radio Telescope is comprised of two units, one called the front end the other the backend. The front end contains the low noise amplifier and the 406.7 MHz internal converter. Both are powered by +12 Vdc, which is supplied by the backend and the external power supply. This low noise system is constructed with the latest, microwave component technology and, is state of the art for amateur radio astronomy. The 406.7 MHz converter is a dual conversion unit, which converts the 406.7 MHz. hydrogen region down to the 70MHz. IF frequency. The backend contains a high gain IF amplifier, square law diode detector, computer controlled DC amplifier, programmable integration control, adjustable offset, and a 12 bit A/D converter, power supply, all controlled by a Basic Stamp II micro computer! Interface to the outside world is by RS-232 link to an IBM compatible computer on com port #1 or #2. Presently no other com ports are supported.

1.1 Single Antenna Hookup -

The feedhorn should be mounted at the focus of the dish in whatever manner you choose (The focal point of your antenna should be at the mouth of the horn, not inside at the monopole). The LNA should be connected to the feed. A weather proof box should be used to house the front end module (LNA).

Refer to figure 1 for further hookup instructions.

1.2 Interferometer Hookup (Two Antennas) -

For two antenna systems, two feedhorns are supplied as well as two LNA's. Mounting of the feeds and placement of the LNA's are the same as above.
A weather proof box should be used to house the front end module (LNAs).

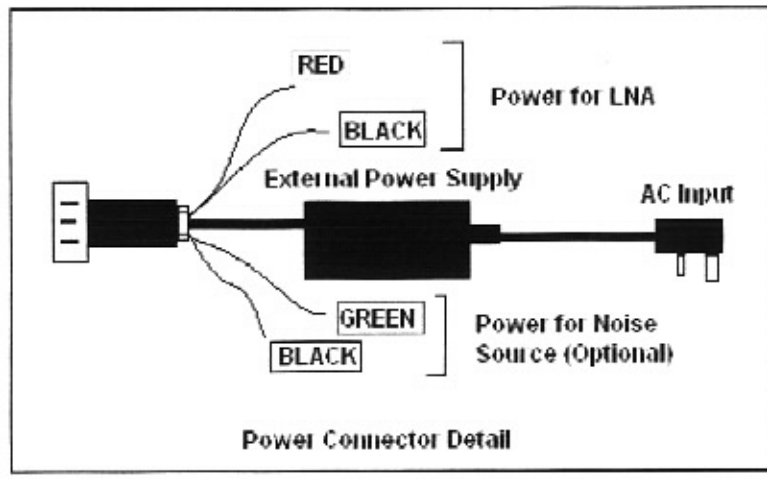
NOTE: Suggested antenna placement should not be more than 25 - 50 feet apart. If more distance is required, a pair of in-line booster amplifiers may be required.

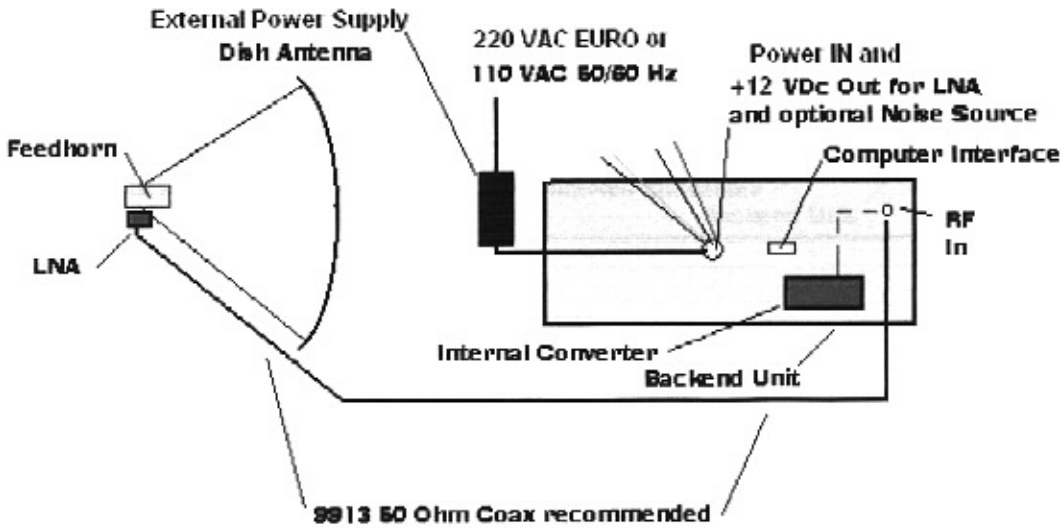
The separate antenna cables are connected via a power combiner which also routes the combined signal to the receiver backend.

Refer to figure 2 for further hookup instructions.

It can not be stressed enough, that outside modules (LNA), which comprises part of the radio telescope front end, ***are not fully weather proof!!!*** The low noise amplifiers must be housed in an additional weather proof box, (such as rubbermaid container) simply painting will not keep the elements out. Damaged electronics may result if these instructions are not followed!

Power for the LNA is obtained from the backend via the power cable. The RF output of the LNA is connected to the coax cable and run into the observation area, to the backend unit. The backend unit is meant to be kept in a shirt sleeve environment such as, a habitable room. This unit is not resistant to the elements and must be kept free of temperature extremes and high humidity. Keep in mind that this unit will be connected to a computer (user supplied), which is also very sensitive to environmental conditions.





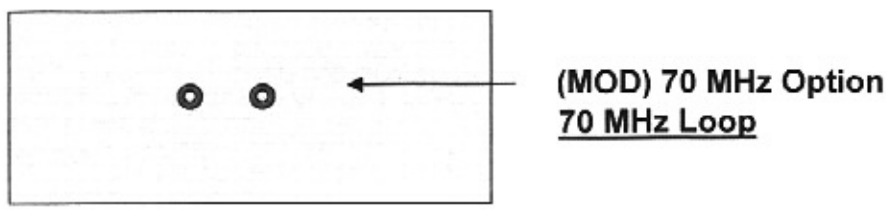


Figure 1. Single Antenna Setup

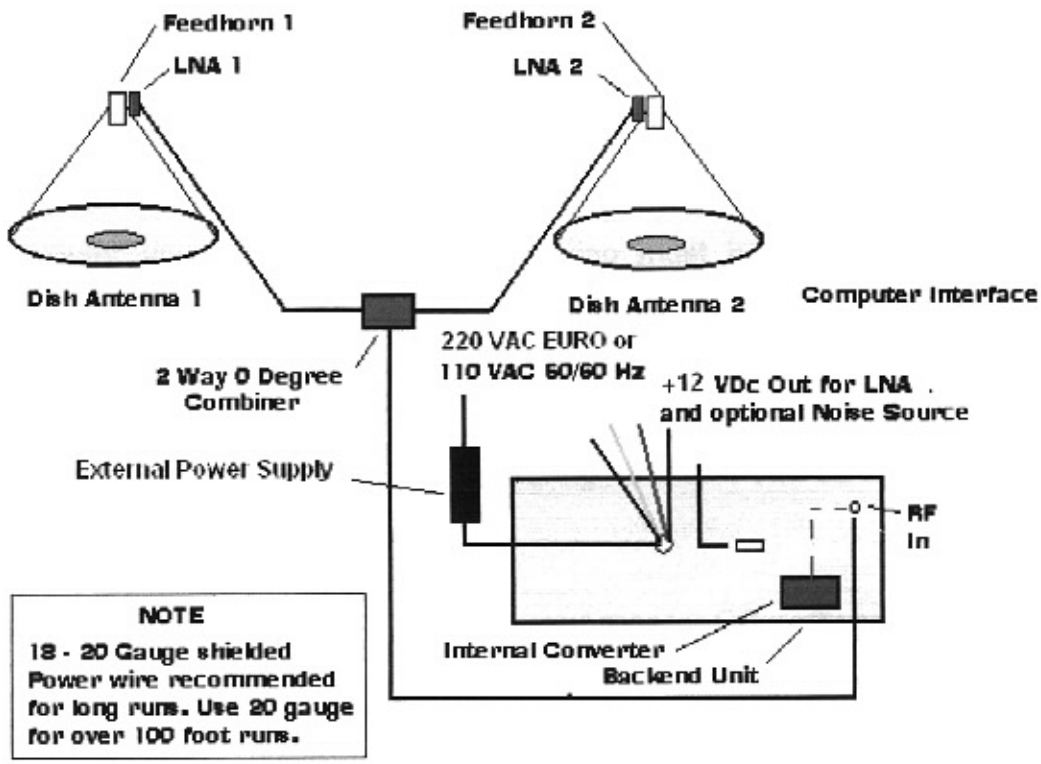


Figure 2. Interferometer Setup

2. Software Installation (DOS or Windows):

The backend is to be connected to the COM1 or COM2 port of the IBM compatible computer which will be gathering the data. The supplied software is meant to be operated from a **Windows or DOS environment**. Both versions are supplied.

2.1 Computer Hardware Requirements:

The computer you use for the data gathering must be an IBM compatible XT,286,386 or 486 (or better) machine. A Microsoft compatible mouse must be installed and a color EGA or VGA screen must be connected. A 3.5 inch disk drive will be needed to load the software. There is no advantage to using a Pentium class cpu for data gathering, 99.99% of the time is spent waiting between data points, this would be a senseless waist of cpu power. Use an old expendable bare bones cpu for data gathering, one that can be sacrificed to a lighting strike!

NOTE: We suggest you make copies of your master CD software disk.

2.2 Computer Software:

The operational program is written in Turbo Basic, which is a product of Borland Software. Turbo Basic has been discontinued by Borland and is no longer available. Enclosed is a copy of the software so that you can make changes in the basic program and then compile it into a .EXE file. Turbo Basic has several unique features that are used in this program. QBasic and GW Basic have no equivalent.

NOTE: You will be required to set the following on your computer:

- 8 bit
- 2400 baud
- No Parity
- Flow Control None

Required for communication between the receiver and the Computer.

Start the program by typing (from the C prompt) as follows:

C:\CD CYBER4 (or later version)

The screen will display the following:

C:\CYBER4>

Re-Type

CYBER4

This is what the command should resemble:

C:\CYBER4>CYBER4

Hit Enter
==========

CYBER4.EXE (or later version) is the compiled "basic" program that functions as a digital chart recorder on an IBM compatible computer. The use of "basic" will allow you to make changes in the software to include features that will be useful to you. To setup this software on your hard disk create a sub-directory named RA/Dio or
whatever you wish. Copy the program contents of the floppy into this sub-directory. All data files recorded by your observations will default to this sub-directory.

After connecting the backend to the computer COM port you may energize the systems and start the program by typing **CYBER4.EXE**. You will be asked to enter the # of the com port which the CYBER backend is connected to then a menu will appear on the right side with a choice of functions which can be chosen by moving the mouse cursor on top of or just to the left or right of the desired item. A graph will be drawn with voltage from 0 to 10 on the vertical scale and time from 0 to 360 on the horizontal. The horizontal scale represents 360 time units which can be fractions of a second or seconds. Any time greater than 1 second will be converted into an integer # of seconds. An example would be a time of 60.2 seconds which would be converted to 60.0 seconds. In this case the horizontal scale would represent 0-360 minutes. A short description of each menu function follows:

Change DT: This command prompts you to enter a new sample interval between data points in seconds. The value entered must be .05 seconds or greater and any value above 1 sec. will be truncated to an integer # of seconds.

Change INT: This command allows you to change the integration time of the backend. A menu bar will appear at the bottom of the screen in yellow with choices for new integration times. Place the mouse point over the desired new time and press the left mouse button. The new time will be entered and displayed on the main bar in white. Sometimes the mouse will obliterate part of the menu bar after it is clicked or leave a "tail" of writing over the last point it was at. This is a quirk of the DOS interface to TB, I am working on it! In any event you can refresh the screen by clicking on ***CLR SCREEN***.

Change Gain: This command works just like above except it changes the VDC gain of the programmable amplifier.

Save File: This command will save the chart presently displayed on the screen. You will be prompted to enter a file name (the extension is optional). The file will be stored on the drive, which started CYBER.EXE. You can specify a particular drive by entering the drive letter in the name such as B:SUNPLOT.1 The data is stored in ascii with each data point represented by it's time step from 0 and the voltage measured.

Get File: This command will retrieve a file from disk and display the data on the graph. You may include a drive letter to load from in the name such as B:SUNPLOT.1. If you enter a nonexistent file name then the command will be aborted. You can also load several files on a single graph by repeating "GET" once for each file. This feature will allow you to display very lengthy observations or compare multiple scans.

Start Scan: This command has no other entry. It clears the graph and starts a new scan using the time delay set by "DT".

Rescan: This command is toggled on and off by multiple clicks. When on, as soon as one scan reaches the 360th data point the screen will be cleared and a new scan will start automatically. If set to off when the 360th point is reached the scan will stop and the screen will stay put. At this point you could "**SAVE**" the data if you wish.

Autosave: This command is a unique feature that will automatically save a screen of data after the 360th data point, clear the screen, start another scan and repeat the process until a specified # of screens has been saved. When clicked this command will prompt you for a file name to save the scans under. Do not enter any extension, the program will automatically add a # extension to the file name after the end of each scan. An example could be SUNPLOT.1 SUNPLOT.2 SUNPLOT.3 ETC. After entering a file name you will be prompted to enter the # of scans that you want to save. When the last file has been save

the program returns to the main selection menu. Autosave is toggled on and off by repetitive mouse clicks.

Setup Que: This is another unique feature that allows you to start gathering data at a pre-determined date and time in the future. The program will prompt you for a start date and time, a name for the data file to save and the # of scans you would like to complete. After entering the date and time in the future the program will prompt "**PRESS ANY KEY TO START**". Once you press any key the program jumps to a loop where it waits until the date and time arrive. The computer will not respond from this point on until the set date and time arrive. Be certain you have entered the correct date and time in the future or you will have to re-boot the computer.

Clr Screen: This command clears the graph area of any data and returns to the selection menu.

Stop Scan: This command will stop the current scan and return to the main selection menu.

NOTE: ***You may have to press and hold the mouse button for several seconds to activate this command.*** **The program only looks for a mouse button press at the end of each sample point. If you enter ten seconds for the "DT" then you may have to hold the mouse button down for this duration to catch the next sample cycle.**

Halt to DOS: This does just what it says, halt the program, clear all data files and go to the DOS prompt. Any scans not saved will be lost.

Name Scan: Each file can be given a short name such as SUNPLOT or SAG A etc. This name will be included with the data file and can be used to help identify the scan.

Reset Back: This command resets the backend processor and restores the gain, int, and offset data to their default values, X1 gain, .1sec int, offset voltage=0.00 and noise source off. The cpu will beep several time to inform you that the command is complete.

Offset A/Dj: A Vdc voltage inverse to the signal is "bucked" against the signal to avoid a high Vdc baseline after further amplification. This signal is adjustable from 0 to 4.09 volts. Its effect is magnified by the Vdc gain setting. At higher gains only a slight change is necessary to move the baseline to a desired setting.

IF Gain: The new Cyber4 system now contains a programmable gain IF amplifier. The gain of the last IF amp can be changed from 10.0 to 26 dB in .25 DB steps. Simply click on this panel and enter a new gain when prompted.

Noise Off/on: In the backend, a transistor switch is controlled by the noise setting. This transistor is a saturated switch and can handle about 100 ma. The external black and green wires on the power plug go to this switch. The coil of a small reed relay can be connected to the green wire and the other side of the relay must be supplied with a proper + power source from the user. This voltage will depend on the relay coil voltage. The black wire is the ground bus in the backend. This change has been mA/De to eliminate the temptation to pull excessive current from the small reed relay which was on the older units. By having the relay external to the backend it may be replaced with much less trouble in the event of contact failure.

2.3 Windows Version

The Windows SpectraCyber/UltraCyber software supercedes the DOS based control software for the SpectraCyber Spectrometer.

NOTE: ***The DOS version is still useable in the UltraCyber. Again, you may either use DOS or Windows.***

The SpectraCyber software can be used to control the SpectraCyber Spectrometer ***as well as the UltraCyber.***

Further Software Information – The software has been designed and tested on Intel 486 equipment or better, *running Windows 95 – 2000 and XP*.

The software provides a control and hardware setting interface to the UltraCyber Additionally, the software has features to play data movies of hundreds of scans at a time, select time coordinate systems for the data files, set the computer clock to within 500 milliseconds of WWV via the internet, change graphical features such as background or the amplitude axis on the data plot.

The software can be completely exercised and tested in an offline mode using real Sagittarius data along with files to play data movies.

NOTE: This software "does not" link with the Windows Registry.

3. Windows Software

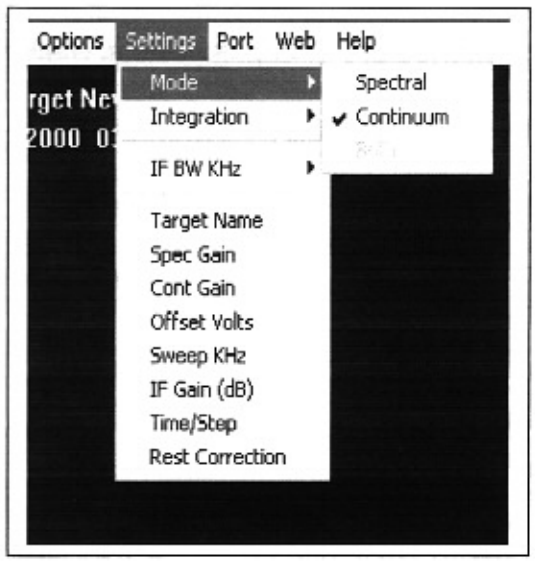
In addition to the DOS software, the UltraCyber will run in Windows. Supplied on the CD, you will also find the following:

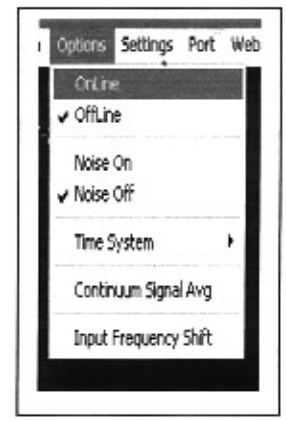
- Windows
- Windows II

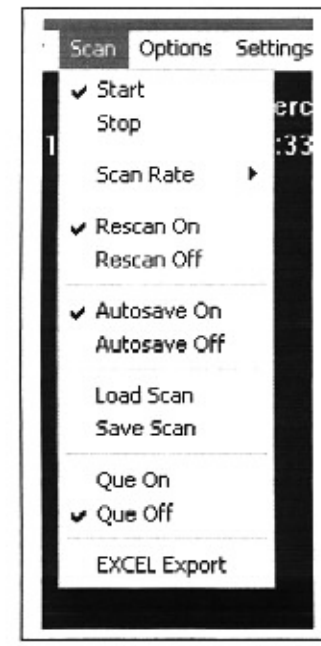
These programs are used with the SpectraCyber system but will run nicely with the 406.7 MHz Radio Telescopes in **"CONTINUUM" mode ONLY!**

Two types of software are provided that will operate this system. **One is Windows (SpectraCyber) based and the other is DOS**. The DOS software will operate on any 286 or better machine. This will allow you to dedicate an expendable machine to the data gathering process (in case of a lightning strike). You may have both software packages resident on the same machine at the same time. Both are on the supplied disk. To install the Windows version just place the disk in the floppy drive and click on the windows folder. The software will self install and create a sub directory called spectracyber. The DOS version requires you to manually create a folder called **Specyber**. Copy the entire contents of the DOS sub directory located on the supplied floppy into the folder you have created. The windows version requires you to manually set the com port parameters under control panel. **They are 2400 baud, 8 bit data, no parity and flow control, none**. When the Windows version software starts it is in a demo mode and requires you to select on line mode by clicking the options tab and selecting online. If the port is set correctly and the VLF receiver is connected you should see the red status bar switch to online. The cpu is now talking to the receiver. Click the settings tab and select mode then select continuum mode. You may now select start scan or view the included help file on the software operation.

The operator may select the following menus:







4. A Note on System Setup:

The front end and backend have been built with excessive gain to compensate for the long run of coax cable into the observation area. With the system pointing at cold sky and the Vdc gain set to 1 a voltage of about 2Vdc should be observed. If this value is near *4Vdc or more you should add a small amount of attenuation in line with the IF coax*. This can best be done by placing a BNC attenuation pad of 1 to 2 dB (or more if required) in series with the coax coming from the dish. These pads can be purchased from Mini Circuits Labs for about $10 ea. (add enough attenuation to drop the signal near 2Vdc). This will ensure that the backend is operating in the square law area of the detector diode.

4.1 Operation of the Backend:

For those of you who like to "roll your own" software I encourage you to do so! To this end you will find enclosed on this disk a copy of the Basic Stamp II operation manual as well as the program contained in it to operate the backend. This program is called BACKEND4.BS2. The text manual for the BS2 is manual.txt. A short summary of the commands that the backend recognizes is given below. Each command to the backend is preceded by a ! symbol which is an "attention flag" to the BS2 controller. All commands are composed of a capitol letter and 3 numbers. The 3 numbers are in hex and contain data to the d/a converter or from the A/D converter. This simple command scheme is easily carried out using strings in basic. When the backend receives a command it echoes the command back (less the ! symbol) to the IBM. The 3 digit number will reflect the data as a result of the command. The backend contains a 12 bit A/D converter. The A/D has a 0-5 Vdc input (no negative inputs allowed) and the converted value returned will be from 000-FFF hex. The d/a converter likewise

generates a DC offset from 0-5 Vdc by receiving a 3 digit string of data from 000-FFF hex.

Here is an example of the command sequence.

- All commands are sent to the backend in 8 bit ascii at 2400 baud no parity.
- To turn on the noise source send the command string !N001
- The backend will reply N001
- This echo lets you know that the command was received.
- To turn off the noise source send the command string !N000
- The backend will reply N000

If you wish to experiment "talking" with the backend I suggest you use a dumb terminal or a terminal emulator package on the IBM. Just type in the command string and watch the returned answer.

Here is a summary of the commands which the backend recognizes.

!N000 NOISE SOURCE POWER OFF
!NOO1 NOISE SOURCE POWER ON

!OXXX SET VDC OFFSET 000=0VVDC---FFF=5.0VVDC

!G00X SET VDC GAIN 4=X1 8=X5 0=X10 2=X20 1=X50

!I00X SET INT. TIME 9=.1SEC A=.9SEC C=5SEC 8=10SEC 0=20SEC

!D002 GET DATA FROM AUX A/D CHAN
ECHO DXXX 000=0VVDC---FFF=5VVDC

!D000 GET DATA FROM TELESCOPE A/D CHAN
ECHO DXXX 000=0VVDC---FFF=10.0VVDC

!R000 RESET BACKEND GAIN=1 INT.=.1 OFFSET=0.00VVDC NOISE=OFF
ECHO R000 COMMAND DONE

!Z000 THIS PERFORMS AUTO BASELINE AND RETURNS A HEX OFFSET VALUE NEEDED TO GIVE A BASELINE OF .7VVDC
ECHO ZXXX 000=0VVDC---FFF=5.00VVDC

FURTHER EXAMPLES:

!I009 SETS INTEGRATION TIME OF .1 SECOND

!OFFF SETS VDC OFFSET TO 5.00 VOLTS VDC

!D000 STARTS THE A/D CONVERTER ON THE TELESCOPE OUTPUT.
THE BACKEND ECHOES BACK (MAKE BELIEVE DATA) D800 WHICH WOULD REPRESENT A TELESCOPE SIGNAL LEVEL OF 5.00VVDC. (REMEMBER THE TELESCOPE CHAN IS 0-10VVDC)

!D002 GET AN A/D VALUE FROM THE REAR PANEL JACK
THE BACKEND ECHOES (MAKE BELIEVE) D800 WHICH IS 2.5VVDC

!G001 SETS VDC GAIN TO X50
BACKEND ECHOES G001

!Z000 PERFORMS AN AUTO BASELINE A/DJUSTMENT
BACKEND ECHOES (MAKE BELIEVE) Z0FF WHICH IS AN OFFSET
OF .3125 VVDC.

By modifying the program in the Basic Stamp II you could invent custom commands to be added to the backend's language. The BS2 is easy to program in a form of basic. Refer to Parallax corp. for further details on this chip.

5. Engineering Support

Carl Lyster, RAS Engineer (United States)

If you require assistance on any of the above information, Email to:

ctlyster@comcast.net

Please report any bugs in CYBER.EXE to the above email or phone:
865 588-7120 (6 - 9 PM EST)

J.- Peter Riese, RAS Representative/Engineer (Europe)

Jobst-Peter.Riese@t-online.de

406.7 MHz Dipole and LNA Mounting Instructions