

# **User's Guide**

# **FS5i**

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# FS5i

The FS5i is the integration of our top of the line FS5 HMD and our FSCAN scan converter. The result is an HMD that accepts multiple signal formats without the headache and expense of additional cabling. The FS5i maintains all of the functionality of the two separate devices, incorporating them into a single, rack mountable enclosure. A new feature of the FS5i is a VGA monitor output that replaces the field sequential monitor output of the FS5. This allows the user to drive the HMD and a monitor without a VGA splitter or additional cabling.(monitor out not available with field sequential input format.)

In addition, selectors for input formats and mono/stereo have been relocated to the front panel. The top cover of the enclosure need only be opened to fine tune color adjustments.(normally not needed)

Initially, your FS5i will be shipped with separate manuals for the FS5 and FSCAN. The functionality of the FS5i is the same as the separate units with the above exceptions. By following the guidelines in the separate manuals, one should find the setup of the FS5i HMD to be simpler. A new, integrated FS5i manual will be shipped to you as soon as it is available. If you have any questions or problems please contact Virtual Research for prompt assistance.

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## Introduction to the FS5

FS5 is our new high performance head mount display (HMD). At the heart of the product are 1" cathode ray tubes (CRTs) capable of resolution and image quality far superior to any available flat panel displays. The CRTs are black and white tubes which run field sequentially; red, green and blue are created by color shutters mounted in front of the CRTs. Although most users will drive the FS5 to VGA resolution, the CRTs are capable of up to 800 pixels horizontally.

The FS5 optical system excels as well. A custom design using aspheric surfaces on plastic elements allows us to achieve a 55" field of view (FOV) while maintaining sufficient eye relief for glasses wearers. By using plastic, we avoid the weight problems of glass elements.

Mechanically, the FS5 retains many features developed and perfected in our LCD product, the VR4. The rugged front shell protects the display components and requires only two adjustments--interpupillary spacing and fore/aft positioning. The headband is a proven performer with thousands of hours of trouble free experience in the VR4. The high flex cable has an extruded jacket for abrasion resistance.

Audio rises to a new level with the FS5. These Sennheiser closed cup headphones are the best compact headphone we have found. Whether your source is simple monaural cues or top-of-the-line ~~spacialized~~ stereo, these headphones will perform.

The FS5 control box has superior functionality as well. A set of front panel LEDs give instant status information. Brightness and contrast adjustments that control both eyes together are also available on the front panel. Full right and left RGB setup and gain adjustments are also easily accessed inside the control box if fine tuning is desired.

Standard field sequential input is available from several image generators, including SGI and Division. A similar field parallel format is available from Intergraph platforms. Appropriate connectors are easily accessible at the control box rear panel.

For other signal sources, an optional converter is available. The F-Scan Converter accepts either RS-170 RGB or 60Hz VGA stereo signals and drives the FS-5 directly.

The true test of any product is not the features list, but how it performs in your application. We expect that the blend of features designed into FS5 will work well for you. But if you have any questions or problems or special design requirements, please give us a call. We'll do whatever we can resolve your questions and make your application successful.

# **Safety Issues**

We take pride in building a safe product that will satisfy your requirements. But the nature of our product--an electronic display device that you wear on your head--creates the potential for problems. We strive to understand and minimize the safety hazards associated with our head mount displays.

As an HMD user, you should understand those hazards too. With that understanding, please make an informed decision about using this or any head mount display product.

## **Blocked vision and hearing**

By its nature, a head mount display blocks the user's vision and hearing. The danger of tripping over cables or other obstacles becomes a real concern while immersed in the virtual world. As system manager, you must provide an environment that does not allow the HMD user to fall or otherwise injure him/herself. As a system user, you must survey your physical environment before entering the virtual environment to avoid problems. We recommend using FS5 only while seated to avoid tripping hazards.

## **Eyestrain and other optical effects**

FS5 will cause eyestrain if the interpupillary distance (IPD) is set incorrectly. Like all head mounts, it is likely to cause some eyestrain effects even when correctly adjusted. This eyestrain stems from several causes, with perhaps the most significant being the fixed focal plane which conflicts with the variable depth cues present in the imagery. There is no technology we are aware of that corrects this conflict. Other potential sources of eyestrain include optical aberrations, distortion, mismatch of computer imagery with mechanical configuration and display mismatch.

If you experience noticeable eyestrain, review and correct your mechanical adjustments and software configuration. If eyestrain persists, limit or end your use of this device.

## **Lice/other pest transmission between users**

Although we have not had any instances of user's reporting lice transmission to us, there has been at least one anecdotal report of lice transmission in a public

use HMD. There are sprays available that will kill lice on furniture and clothing. Two of these are RID and A-200. Both are available in drug stores. We don't have information on the effectiveness of these sprays on HMDs and encourage you to research this if you are considering a multiple user application. These sprays are hazardous and you need to judge the benefits vs. risks of using them. Remember to read and follow the manufacturer's directions.

Alcohol wipes are useful for cleaning the HMD between users. Alcohol will remove skin oil and makeup that have transferred to the HMD. As far as we know, alcohol has no effect on lice.

### **Electrical Shock Hazard**

The desktop power supply produces 12V, - 12V and 5V DC. All three voltages are present in the control box. The HMD cable carries the 12V power to the HMD. These voltages are too low to represent a significant hazard, even with the control box open to make color adjustments.

The enclosure at the rear of the HMD contains high voltage circuitry required for the CRTs. This enclosure should be opened only by trained, authorized technicians. The voltage is sufficient to give a significant shock if contacted. The voltage is also sufficient to arc across a few millimeter gap to any conductive surface--like a finger or tool. In our experience the shock from this voltage is bothersome, but not dangerous because the current level is quite low. However, under worst case circumstances the effects would undoubtedly be more severe (e.g. pacemaker users, etc.).

The top bar of the headband contains a cable bundle that carries these high voltages to the front of the HMD. Do not cut, drill, clamp or otherwise damage this portion of the headband.

The front portion of the HMD consists of two display units within a shell. The wiring from the headband to the display units and the display units themselves have the same voltage levels described above. There are no user accessible adjustments at the front of the HMD and no attempt should be made to insert fingers, tools or other potentially damaging/conductive items into the front shell. The shell should be removed only by trained, authorized technicians.

### **Extremely Low Frequency (ELF) and Very Low Frequency (VLF) Emissions**

Magnetic fields generated by electronic devices (Televisions, toasters, shavers, household wiring, high voltage lines, -etc, etc, and HMDs) have been reported to cause a number of severe health problems, including leukemia. There is a great deal of controversy at this time regarding the validity of these studies. A number of other studies have found no correlation between these emissions and health risks.

Test equipment, a standard procedure and test limits for ELF and VLF emis-

sions for computer monitors have been developed in Sweden. While this test seems relevant to head mount displays, the equipment is unsuitable for measuring the fields around miniature displays. There are no standard test procedures, equipment or standards for electronic devices other than computer monitors.

Because there are so many unknowns surrounding this topic, we elected to contract an expert in the field to develop test equipment and calibrate that equipment for us. We have developed procedures for measuring the fields generated by our products using that equipment. After measuring the fields generated by our components, we add shielding and/or relocate components to minimize the fields. This seems to be the prudent approach in view of the vast lack of solid information in this area.

### **X-Ray Emissions**

CRTs are capable of generating x-ray emissions under some circumstances. Our CRTs operate at voltages below levels that produce x-ray emissions. The CRT production process includes testing to verify this. The U.S. Food and Drug Administration regulates CRT products to ensure adherence to x-ray emission standards. Our product information has been submitted to the FDA for review.

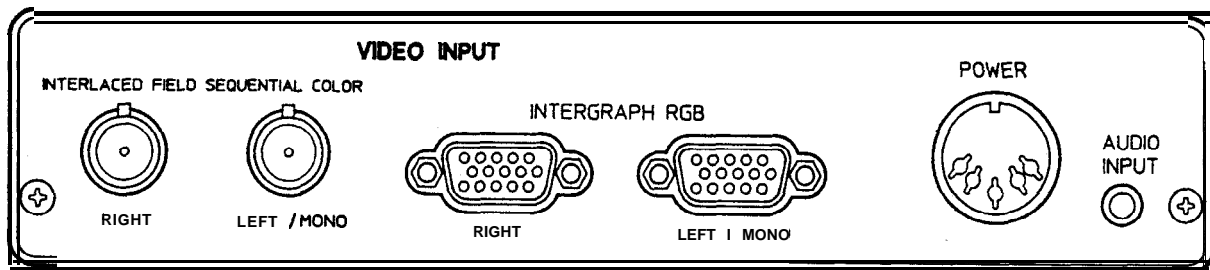
### **Further Information**

If you have questions about any aspect of head mount display product safety, please feel free to contact us directly. Our address, phone number and e-mail address are listed at the front of this document.

# FS5 Control Box

## Inputs

FS5 control box inputs are located on the rear panel:



Control Box Rear Panel

## Audio

The audio jack is a standard stereo 3.5mm mini phone jack. The control box passes the audio signal through directly to the FS5 headphones; there is no amplification or audio adjustment in the control box. Audio signal level supplied to the control box should be the same signal that would be supplied directly to stereo headphones.

## Power

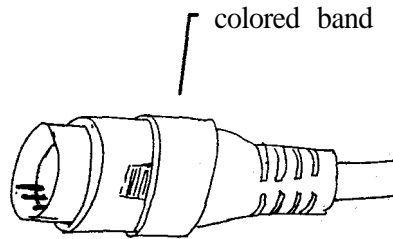
The control box requires +12VDC, -12VDC and +5VDC. A universal power supply comes with FS5. The power plug on the FS5 is a 5 pin DIN plug.

**CAUTION:** IT IS EASY TO DESTROY YOUR FS5--SIMPLY PLUG IN THE WRONG POWER SUPPLY AND TURN IT ON.

TO AVOID THIS UNHAPPY EXPERIENCE, ALWAYS CHECK FOR THE COLOR MATCHED BAND ON THE POWER SUPPLY PLUG AND THE COLOR PATCH ON THE CONTROL PANEL. IF THE POWER SUPPLY DOESN'T HAVE A MATCHING BAND, DON'T PLUG IT IN!

Because the 5 pin DIN plug is used on many power supplies, there is a real hazard of plugging the wrong power supply into the FS5 control box. To reduce the risk of this, we have added a RED colored band to the FS5 power supply and a YELLOW colored band to the F-Scan power supply. Always check for correct color matching before plugging in a power supply to avoid making an expensive mistake.

Power Supply Quick Identification

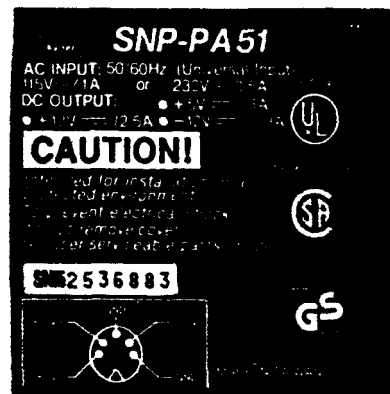


- RED BAND -- Power Supply
- YELLOW BAND -- F-Scan Power Supply
- No Band-- Don't use!

As a further verification of power supplies, compare the label to the copies below:



FS5 Power Supply



F-Scan Power Supply

One particular example of this problem is the Polhemus Fastrak which also uses a 5 pin DIN plug. The Fastrak power supply outputs a higher voltage and can damage the unit

## Video Input

FS5 accepts three video signal formats:

- 1) Field sequential 3xRS 170 RGB composite
- 2) 3xRS170 RGB parallel
- 3) F-scan format

### Background Information on Video Formats

#### **RS170**

RS 170 refers to a timing standard developed for television that uses an interlaced format with 525 lines per frame, 262.5 lines per field. Frame rate is 30Hz while field rate is 60Hz. Line rate is 15,575 Hz (262.5 lines X 60 fields).

#### **RS170 RGB**

The term RS170 RGB refers to red, green and blue on separate wires, with RS 170 timing. RS 170 RGB also requires vertical and horizontal (or composite) sync. We speak of 5 wire RS170 RGB (red, green, blue, horizontal sync and vertical sync); 4 wire RS170 RGB (red, green, blue and composite sync) and 3 wire RS 170 RGB (red, green with sync and blue).

For reference, our previous generation product--VR4--accepts 3 and 4 wire RS170 RGB.

### FS5 Video Formats

#### **Field Sequential 3xRS170 RGB Composite**

This signal is based on RS170 RGB, but is quite different. Rather than transmit red, green and blue in parallel, the three colors are transmitted in sequence. To transmit all the information, the rate of transmission is increased by 3x. The information is transmitted on one wire. To distinguish the three colors, a longer vertical sync pulse is sent before red. The color order is red, green, blue.

The timing for this format is as follows:

full frame rate: 30 Hz (same as standard RS170)  
full field rate: 60Hz (same as standard RS 170)  
individual color field rate: 180Hz (3x full field rate)  
line rate: 47,250Hz (262.5 lines x 180 fields)

Because RS 170 is an interlaced format, there is some added complexity in defining the order of sending field one and field two. From a timing standpoint, the most straightforward order of transmission is as follows:

R field 1  
G field 2  
B field 1

R field 2  
G field 1  
B field 2

This order maintains the field 1, field 2, field 1, field 2 cycle that is defined in RS170 timing. It avoids the timing problems that arise in using the following:

R field 1  
G field 1  
B field 1  
R field 2  
G field 2  
B field 2.

However, FS5 can accept either order.

Video input connectors are BNC type. Connectors are labeled 'RIGHT' for right eye input while using stereo mode, and 'LEFT/MONO' for left eye in stereo mode, or for both eyes in mono mode. These inputs are 75ohm terminated.

### **3xRS170 RGB Parallel (Intergraph RGB):**

**3x RS170 RGB** parallel describes yet another related video format. This format is a 5 wire video (R, G, B, H sync and V sync) which is run at 3x RS170. So the timing is:

Full frame rate: 90 Hz (3x RS 170)  
Full field rate: 180 Hz (3x RS 170)  
Color field rate: 180Hz (3x RS170)  
line rate: 47,250Hz (262.5 lines x 180 fields)

This format has been created because some computer manufacturers (Intergraph in particular) can generate video at 3x RS 170, but do not have hardware configured to support putting all three colors on one wire. To accommodate systems like Intergraph we have developed circuitry to accept 3xRS 170 RGB parallel.

This signal is input on HD15 pin connectors. The FS5 does the work of selecting R, G and B in sequence internally.

The pinout of this connector is given in Appendix 1. Video inputs are 75ohm terminated. Sync inputs are unterminated.

### **F-Scan Format:**

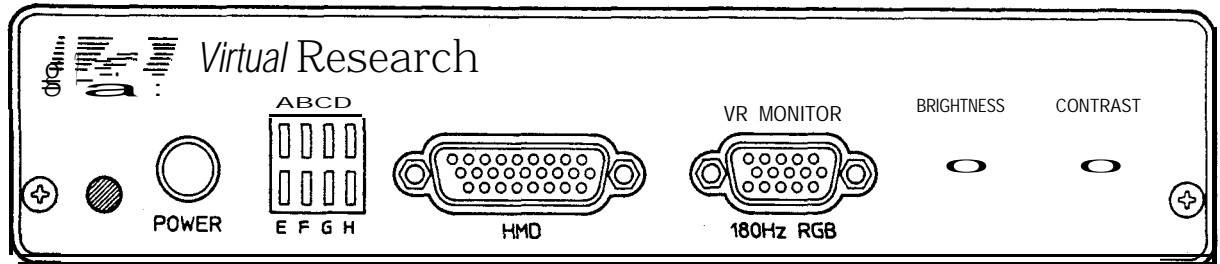
FS5 also accepts a field sequential format that is generated by the F-Scan converter. This format is most similar to the field sequential 3xRS- 170 RGB composite format described above. It differs only in that H sync and V sync are transmitted on separate wires. The signal is transmitted over a 15 pin to 15 pin video cable from the F-Scan converter to the FS5.

The F-Scan Converter accepts 60Hz VGA or RS 170 RGB. It converts these signals to the F-Scan Format. This allows use of the FS5 with graphics sources that cannot generate an FS5 signal format.

For further information about the F-Scan Converter, contact Virtual Research.

### outputs

Control box outputs are located on the front panel of the box.



Control box front panel

### Monitor Output

One channel of monitor output is provided at the front of the control box. The output is from the left eye input. RGB outputs are line driven and 75ohm terminated. Sync outputs are unterminated TTL level signals.

The output signal format is not standard and will not work with most monitors.

The signal is generated by taking the field sequential input used by the FS5, and splitting it out onto separate red, green, blue, H sync and V sync lines. This signal has a field rate of 180 Hz, and the colors are only present on each third field.

There is a drawback to this approach--because the monitor is only receiving color signals in every third field, the picture has about 1/3 the brightness of a normal picture. For many applications, this is not a significant problem. But if your application requires high monitor brightness, this approach would not be recommended.

We have not done any extensive monitor evaluation, but we have not found any monitors that are specified at 180 Hz field rate. And in fact, several monitors we have tested will not accept this field rate.

However, we have discovered that some monitors will operate at this rate. In our lab we have worked extensively with the Hitachi SuperScan pro 21". Although it is specified only to 160Hz, this monitor operates at up to 200Hz.

### HMD Output

The HMD output is a **26** pin AMP connector. Pinout from this connector is given in chapter 7 of this manual.

**CAUTION:** do not plug or unplug the HMD connector while power is ON at the control box. Always power down the control box before disconnecting the HMD.

### Status Indicator Lights

There are eight LED status indicator lights located on the front panel of the FSS control box. These lights are marked with letters A to H. The meaning of each light is given in the following diagram:

| <b>A</b>  | <b>B</b>   | <b>C</b>  | <b>D</b>   |
|---|--|---|--|
| ON: left eye horizontal frequency out of range  | ON: Left eye vertical, problem--<br>HMD disconnected or no video | ON: 15 pin inputs selected<br>OFF: BNC inputs selected                    | ON: no horizontal /, sync. present at video input(s) |
| ON: right eye horizontal frequency out of range | ON: Right eye vertical problem--<br>HMD disconnected or no video | ON: 15 pin F-SCAN input selected<br>OFF: 15 pin Intergraph input selected | ON: monoscopic<br>OFF: stereoscopic                  |
| <b>E</b>  | <b>F</b>   | <b>G</b>  | <b>H</b>   |

### Overall Brightness and Contrast Adjustments

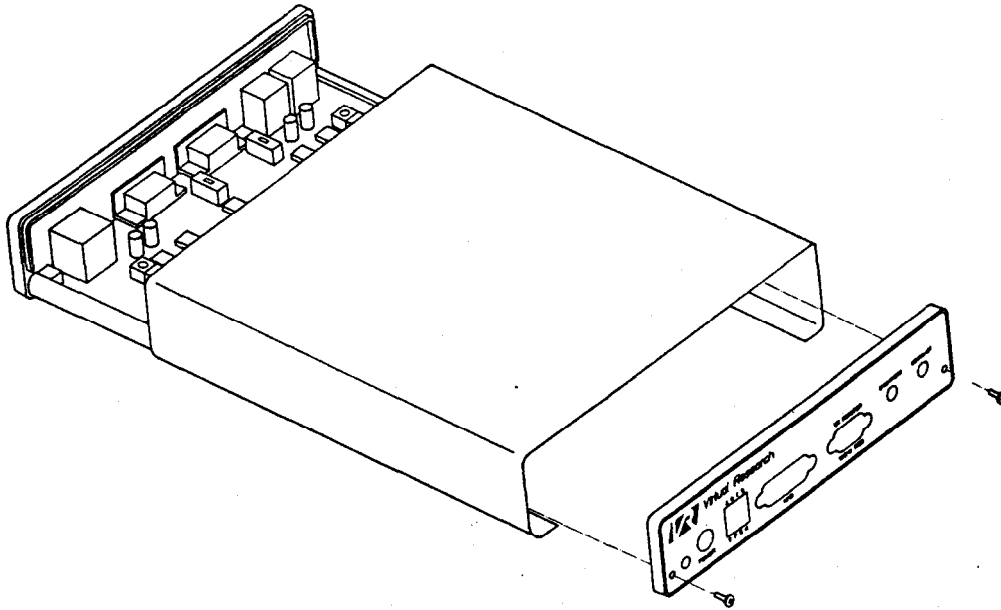
The brightness and contrast adjustments located on the front of the control box will adjust both eyes together. For best image resolution, set brightness so blacks are just black (rather than gray) and keep contrast low. For a standard video input, the brightness can be adjusted so high that the entire image will go to white. Although this should not damage the CRTs, it is a good practice to avoid overdriving the CRTs this way.

### Control Box Internal Adjustments

Selectors for mono/stereo input, F-SCAN/Intergraph input and individual display setup pots are located inside the control box. To access these adjustments, you need to open the control box. To do this:

1. Turn off power at the control box.

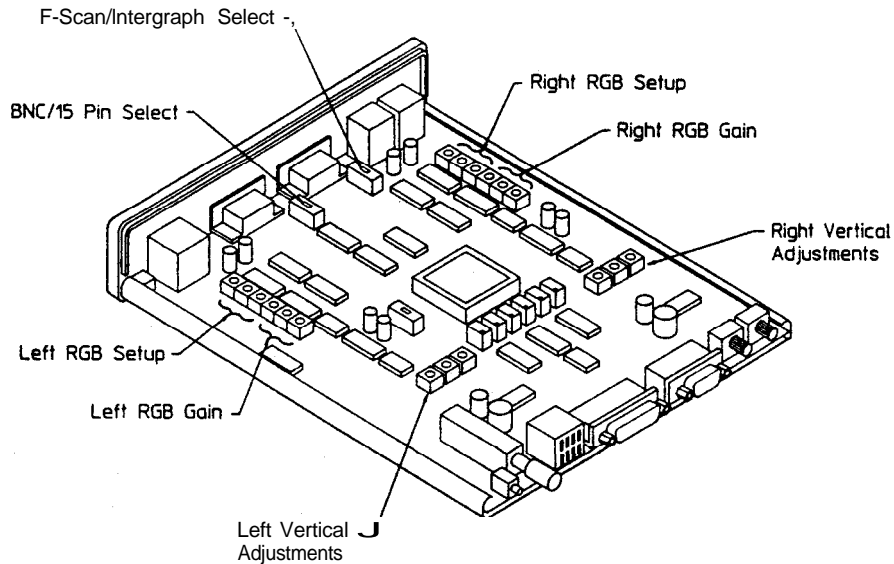
2. Disconnect cables from front of control box.
3. Remove two Phillips screws as shown below from front panel of control box:



4. Remove the front panel and bezel from the control box.
5. Slide the top cover forward and clear of the control box.
6. Reconnect the HMD connector to the control box output.

To reassemble, reverse the above procedure. Be careful to slide the cover into the correct channels on the control box base. Use normal caution in working with the exposed board regarding ESD (electrostatic discharge). The components are not highly susceptible to ESD, but can be damaged if normal precautions are not followed.

Internal Adjustments are located as shown below:



### Color adjustments

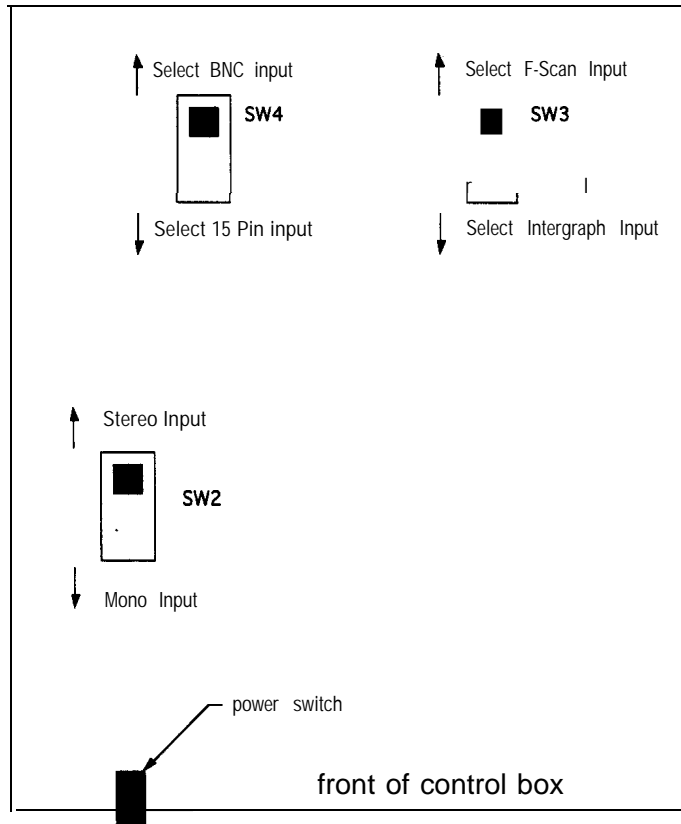
The FS5 SETUP and GAIN pots have been factory set to give a matched output on your HMD. We use an oscilloscope to check output voltage levels for each color. If you feel the colors are off, it is best to start slowly with changes. You may find the mismatch is worse rather than better after casual tweaking.

If you do adjust colors, start first with SETUP pots. These are used to set black level at an even black (rather than greenish black or reddish black for instance). Next use GAIN pots to set white levels (rather than reddish white, etc.).

All adjustments may be made with power ON to the control box and the HMD operating. If you experience any problems, it is best to power down the control box, wait a few seconds, then power up again.

### Video Input Format Switches

Switch positions as viewed looking down at board are as shown below:

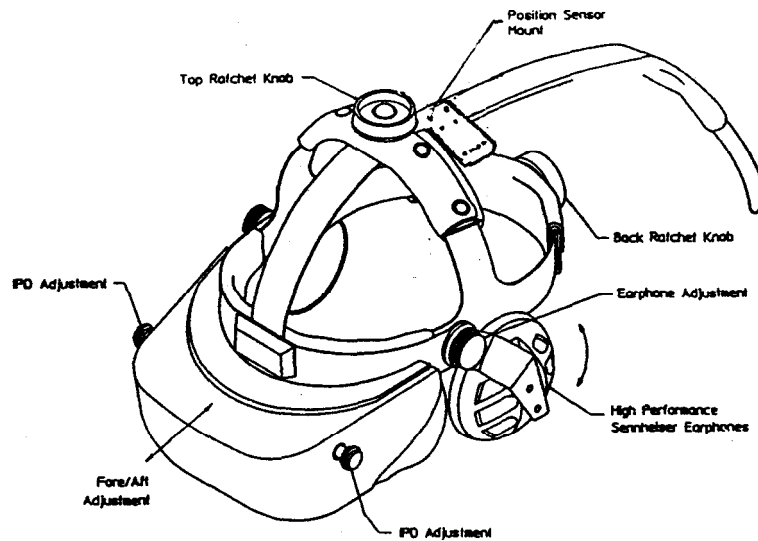


Refer to chapter 8 for system configuration information and to the video input section of this chapter for details of the specific input formats.

In most cases, we will factory set your video mode switches to match the system you are planning to use. You should be able to use your FS5 without any initial changes to the mode switches.

# Mechanical Adjustments

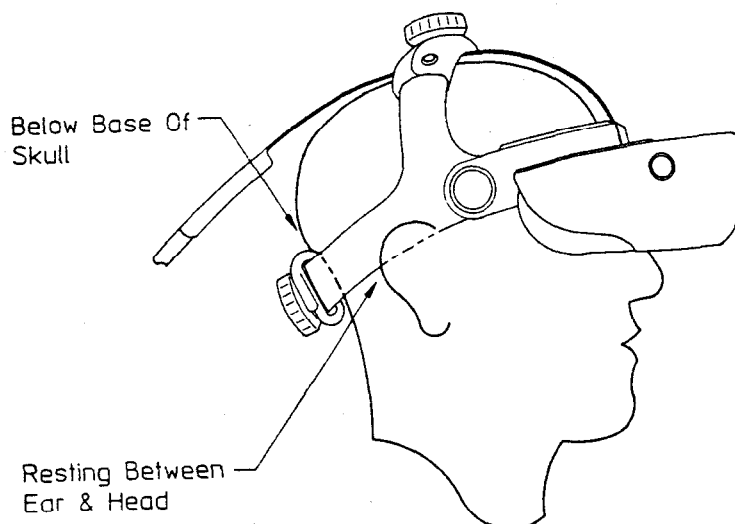
Locations of mechanical adjustments are shown in the following drawing:



## Donning the FS5

There are several things to consider when first donning the FSS.

1. The top ratchet should be adjusted to bring the sides of the headband down to the base of the ear. See diagram:



2. The rear ratchet should sit below the base of the skull, as shown in the diagram above.
3. The cable should fall down the user's back--not over the shoulder. The cable weight provides counterbalancing for the display weight.
4. It is easier to don the **FS5** with the earphones in an up position--out of the way. After the other adjustments are made, it is easy to bring the earphones down. While pulling them down, pull them out away from the head to avoid bending your ear.
5. IPD, display height, and fore/aft motion adjustments are performed together to optimize the view.

## Interpupillary Distance (IPD)

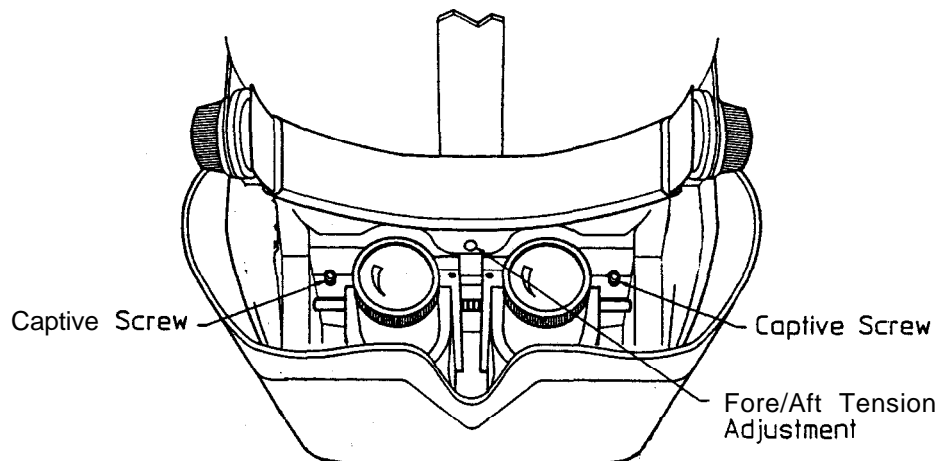
IPD range = 48-73 mm. This range is sufficient to cover from 1st percentile teenager women to 99th percentile adult men. It should also cover a large percent of younger children, but we don't have statistical information on younger population groups.

Adjust until both images are evenly visible. Close one eye to confirm the image is centered in front of the other eye. Incorrect positioning of the IPD adjustment will lead to eyestrain.

## Fore/Aft motion of shell

Pull shell away for easy donning. Push toward face to maximize field of view and to block ambient light. Eyeglasses can be worn with FS5, simply leave fore/aft adjustment near the outer position.

Fore/aft motion is controlled by a detent set screw that is accessible through a hole at the center of the aluminum bracket at the top inside of the shell. It requires a .050" hex head wrench to adjust. This tool is provided with the FS5. The location of the set screw is shown in the diagram below:



The adjustment is slightly easier to make if the fore/aft adjustment is in the close position. Insert the hex head wrench in the hole shown in the diagram. Move the tool around and rotate it until it seats itself in the set screw. Adjustment is somewhat counter intuitive: Turn clockwise to loosen, counterclockwise to tighten the adjustment. If the adjustment gets too loose, the front assembly will slide off the headband. Be careful to avoid this.

Adjust so that tension is sufficient to keep the shell from sliding by itself, but not so tight that a user must push or pull with any significant effort to move the shell.

|   |
|---|
| <p><b>CAUTION: DO NOT OVER -TIGHTEN DETENT SCREW.</b></p> <p>IF DETENT IS OVER -TIGHTENED, USERS MUST APPLY EXCESSIVE INWARD FORCE TO MOVE SHELL TOWARD THE FACE AND EYES. WHILE THIS FORCE IS APPLIED, DETENT MAY DISENGAGE, CAUSING THE USER TO PUSH THE OPTICS INTO HIS/HER FACE AND EYES RESULTING IN INJURY.</p> |
|---|

## Display Height Adjustment

The entire shell structure can be moved vertically relative to the user's face. To do this, grasp the metal headband and move it up or down relative to the leather covered forehead band. When display height is correctly adjusted, the top and bottom of the CRT will be equally visible.

## Overlap Adjustment

This adjustment requires factory disassembly. Specify position when you order, or return to Virtual Research for retrofitting.

Partial overlap setting requires stereo video inputs, but allows a wider field of view than 100% overlap.

[As of this writing, the partial overlap position development work is incomplete. Some shell redesign work is needed to allow the outward tilt of the displays. Please contact Virtual Research for up to date information]

## Ratchet Knobs

Tension of ratchet knobs is adjustable by turning the Phillips screw at the center of the knob.

## Headphones

Headphones rotate around the knobs on the sides of the headband. When donning the FS5 unit, rotate the headphones above the headband. After video is adjusted, pull the headphones down. This makes fitting faster and easier.

Rotation tension is controlled by tightening the knobs. Over tightening can cause failure of the knob or the plastic bolt.

## Cable Positioning

FS5 is designed to be lightweight and well balanced. The cable bundle provides a significant counterbalancing effect without adding weight to the product. The cable bundle should drop directly down the user's back. If the cable is draped over the user's shoulder, FS5 will be front heavy. The position sensor cable should follow the cable bundle to add additional counterbalance weight and to minimize the tangle of separate cables.

# Optics

## **Avoid scratching the FS5 Optics.**

**FS5** optics are plastic and are prone to scratching. Eyeglass lenses and eyeglass frames are especially likely to cause damage to your FS5 optics. FS5 is designed with rubber bumpers around the lenses to minimize this contact. But the bumpers won't stop all contact, so be cautious when you wear glasses with your FS5.

If this isn't enough incentive, as your glasses damage the FS5 optics, the FS5 optics may damage your glasses. Be careful.

If worst comes to worst, FS5 lenses are factory replaceable. Contact Virtual Research for details.

## **Eyeglasses: Leave On or Remove?**

In general, it is better to wear the FS5 without glasses. Without glasses, you can bring the optics closer to your eye, but with glasses, you need to leave the optics farther away. The optical exit pupil (the place in space where your eye needs to be to see the screen clearly) is cone shaped and narrows farther from the FS5 optics. As your eye moves farther from the lens, you need to be more careful in adjusting the fit of the HMD to achieve good imagery.

The FS5 optical system is designed to place the image plane at about 5 ft (1.5m). If you wear glasses, but are able to see objects at 5 ft clearly, you will find it is better to wear the FS5 without your glasses. If your vision is blurred at 5 ft, you will probably find it is better to wear your glasses, even though you are farther from the lens. If in doubt, try it both ways, then decide.

Bifocals can be a problem for HMD wearers. Near objects and far objects are really all at the same distance, so bifocals tend to just get in the way.

While we can't seriously recommend it, one customer has used HMD usage as a work related reason that he required radial keratotomy and convinced his insurer to pay for the procedure that is normally not covered.

## **Lens Fogging**

FS5 is supplied with a no-fog cloth to reduce fogging of lenses. To use it, breath on the lens to create a fog, then gently wipe off with no-fog cloth. Keep no-fog cloth in closed pouch so it doesn't dry out. Reapply if fog reappears.

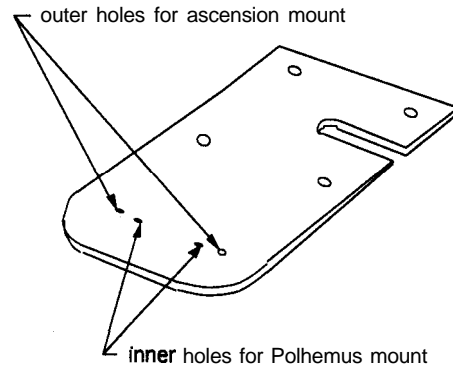
The no-fog cloth leaves a residue on the lens. A thin coating doesn't have an appreciable effect on image quality through the lens. But excessive application will cause some degradation of image quality.

# Position Sensors

## Tracker Mounting

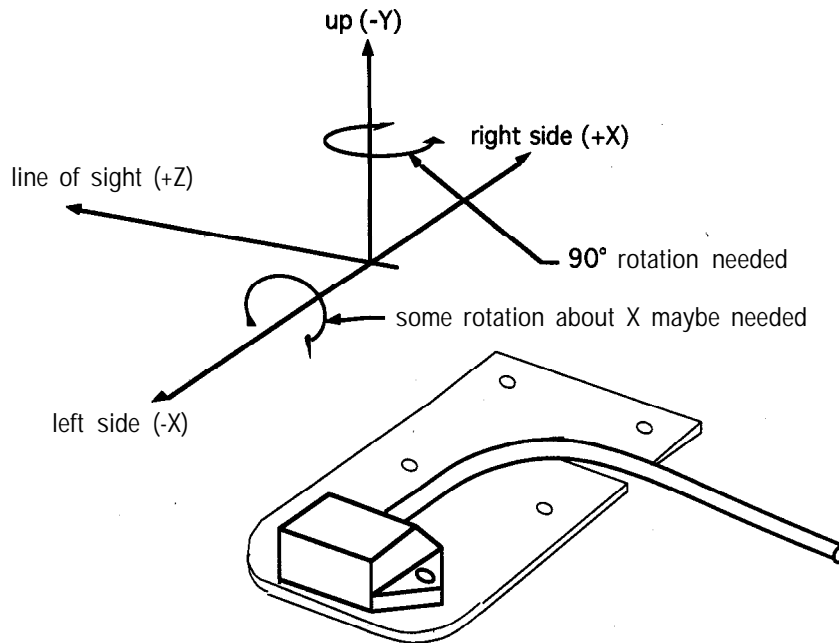
FS5 is designed to be used with a variety of position sensing options. The position sensor mounting bracket behind the top ratchet has mounting screws located for a Polhemus or Ascension receiver. The outer holes are sized for the Ascension, while the inner holes fit the Polhemus.

### Position Sensor Mounting Bracket



The mounting bracket holes are positioned so the tracker is turned 90° from the HMD axis. Using this receiver position requires a software rotation of the receiver position.

### Tracker Rotation (Axes are those used by WorldToolKit)



The correct position will have a 90° rotation about the Y axis. You should set rotation about X after testing the system with no rotation. Exact rotation about X may depend on the user, although we have not worked enough with this to be certain.

If your software has difficulty with this rotation, we can send you a mounting plate with holes at 90° rotation from those shown above. For a quick fix, customers have used velcro with adhesive backing.

The Logitech Ultrasonic tracker requires a triangular mounting hole pattern. We can supply (at no charge) an adapter plate for the Logitech receiver.

Other trackers are becoming widely available. If you would like to mount another tracker on your FS5, let us know. We can probably supply basic hardware for mounting. We are always glad to have feedback on your experience with new trackers.

Position sensor cabling is most easily handled if you attach it to the FS5 cable bundle. This can be done with electrical tape wrapped at about 18" intervals around both cables. However, this does leave some sticky residue when you remove the tape. You can lay the smooth tapesurface against the cables and finish by doubling the tape back on itself to avoid this residue. We don't recommend plastic cable ties since they tend to snag on everything.

## Reducing Tracker Jitter

Electromagnetic trackers are prone to jitter. This effect can be subtle, or horrendous, depending on the conditions in which the tracker is used. A good place to start is with a diagnostic setup. Place the receiver and transmitter near each other and well away from other possible sources of interference. We find it is easiest to diagnose if we view a virtual scene on a large monitor and watch for image jitter in that scene. Don't use the HMD display for this; it's hard to move equipment while looking into an HMD and impossible to test for HMD interactions. While watching the monitor, move the transmitter and receiver apart and watch the jitter increase. You should now have a fair sense of your ambient jitter.

Now bring suspect pieces of electronics or metal into the area of the receiver. Turn the electronics on and off. Move the transmitter/receiver farther apart and the electronics closer to the receiver, then try again. Notice how objects cause warpage of the electromagnetic field--causing the sensor output position to change, as well as jitter.

Bring the FS5 near the receiver. Notice that the jitter becomes severe when the receiver is near the CRTs or the circuitry at the rear end of the HMD. At the tracker mount, the sensor should be nearly unaffected by the HMD.

Try the following jitter reduction steps if you are having problems:

1. Keep the source and receiver as close together as possible. More than anything else you do, the distance from source to receiver will effect you performance.
2. Turn off or move away equipment that causes interference. Monitors and computers (especially computers that are partially open) produce fields that will add jitter to your tracker.
3. Mount the transmitter above the receiver. This will maintain a clearer line of sight from transmitter to receiver and reduce field warpage due to metal parts of the FS5.
4. If the I-IMD seems to be a significant source of jitter or field warpage, mount the receiver on a plastic arm that moves it farther from the electronics of the HMD. Use the diagnostic setup described above to figure out the position that works best for your situation.

## Chapter 7

# Pin Out Information

## Intergraph Innut and Monitor Outnut connector format 15 pin high density D female connector

| <u>Pin</u> | <u>Signal</u>   |
|------------|---|
| 1          | RedVideo  |
| 2          | Green Video   |
| 3          | Blue Video  |
| 4          | <b>nk</b>   |
| 5          | ground  |
| 6          | ground  |
| 7          | ground  |
| 8          | ground  |
| 9          | reserved for auto enable of intergraph mode--do not connect |
| 10         | ground  |
| 11         | n/c   |
| 12         | <b>nk</b>   |
| 13         | horizontal sync   |
| 14         | vertical sync   |
| 15         | reserved for auto enable of F-Scan mode--do not connect     |

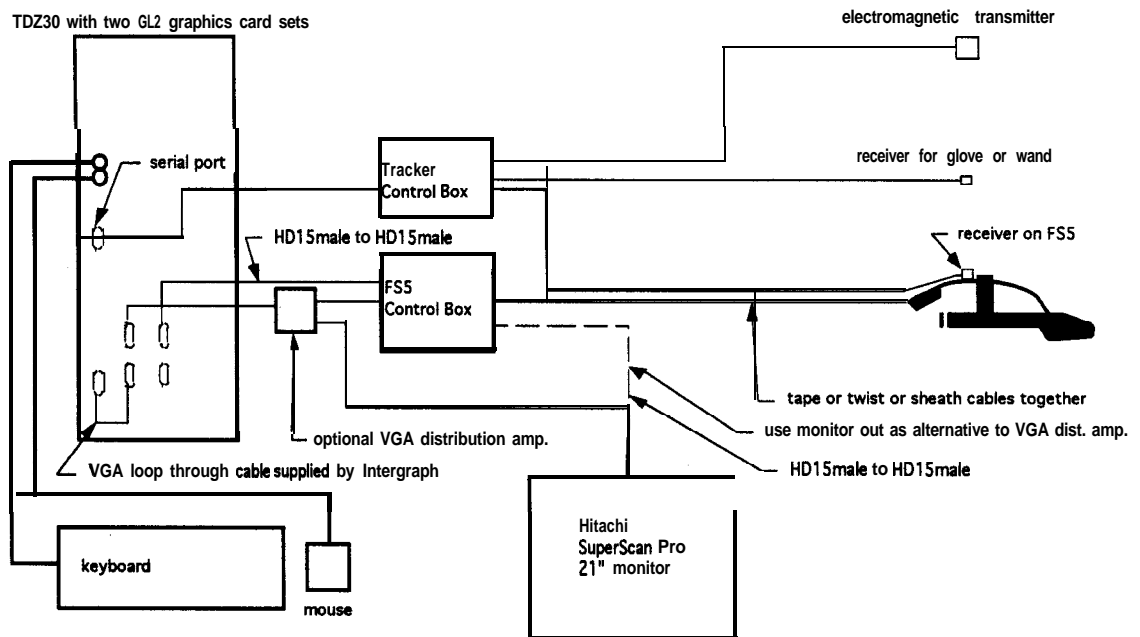
# System Configuration Information

The following information is intended to help describe system configurations that have been successfully used by Virtual Research, or by other FS5 customers. If you find an alternative configuration works better or have problems with a configuration described here, please let us know.

## Intergraph Platforms

Virtual Research is currently using the following system configuration for FS5 testing:

### INTERGRAPH SYSTEM CONFIGURATION



Our current system configuration uses a Polhemus Fastrak tracker and Sense8 WorldToolKit software.



The problem you are most likely to face is portrayal of imagery in black and white on the HMD that should be in color. This problem results from a limitation of the SGI software to generate field sequential color. SGI engineers assure us that the problem should not occur in windows that are generating graphic images, but we don't have any real confirmation of this yet.

The Onyx multi-channel option (MCO) for the RE2 cannot drive the FS5. Although it is theoretically possible, SGI efforts are focused on the RE3, which will provide a more flexible support for products like the FS5. Unfortunately, MCO software for the RE2 is a lower priority. To run stereo from an RE2 with MCO, output VGA and use an F-Scan converter.

## **SGI Indigo2 Impact System Configuration**

The Indigo2 Impact is not capable of driving the FS5 directly. However, the Impact Channel Option (ICO) which is still in development as of this writing, will drive the FS5 directly. It will be capable of stereo as well as mono.

We don't yet have details of the exact system configuration. Contact SGI for further details on availability of the ICO.

## **Other Platforms and the F-Scan Converter**

PC, Apple Macintosh, Sun, Evans and Sutherland, and SGI platforms not named above are not currently able to output a video format directly useable by the FS5. To allow a broad range of platforms to drive the FS5, we have developed the F-Scan Converter. See chapter 9 for further details on the F-Scan Converter.

## The F-Scan Converter

The F-Scan Converter will allow you to drive the FS5 with a VGA or RS 170 RGB source. Input to the F-Scan Converter is one or two channels of video. Video may be 3,4 or 5 wire. Output from the F-Scan Converter is one or two channels of field sequential video in 3xRS 170 RGB format.

VGA format video must be 60Hz, 640x480. Higher frame rates will not work.

RS 170 RGB is the same format accepted by the VR4. With an F-Scan Converter, you should be able to substitute an FS5 directly for a VR4 in your application.

Contact Virtual Research for further information on the F-Scan Converter.

# Troubleshooting

| PROBLEM  | CHECK FOR   | COMMENTS   |
|--|---|--|
| yeen power light not on at control box when switch is In | correct power supply--check color coded ring on plug<br><br>power supply not plugged into a live circuit  | fuses in FS5 control box are self resetting, so the problem is not due to a blown fuse   |
| power light blinks on and off                            | this is probably a serious problem requiring factory service. Try powering down and back up. If the problem persists or returns, contact virtual research   | If there is a short somewhere in the circuit, the resettable fuse may blow and reset repeatedly  |
| <b>HO VIDEO</b>  |   |  |
| no video at HMD  | check status lights--see descriptions of lights on manual page 10.<br><br>check that video source is plugged into correct channel of control box.<br><br>check input switch settings inside control box for correct configuration see page 13 of manual |  |
| Horizontal status light error                            | This is probably due to incorrect video format sent to the FS5. Recheck your video format. Check with Hitachi monitor if available. Monitor will show 47kHz, 180Hz if video timing is correct   | Another quick test: Send the signal to a regular monitor. If you see a good image, you are not sending FS5 format, which will not work on most monitors. |

|   |  |  |
|---|--|--|
| vertical status light error                               | commonly due to HMD unplugged from control box. Use likely result of incorrect video feed to HMD. If HMD is plugged in, recheck video format.        |  |
| no video at HMD, status lights show no problem with video | adjust control box front panel brightness and contrast pots<br><br>video source may be sending black image--check with oscilloscope or 180Hz monitor | horizontal and vertical timing<br>If video signal are correct and sync signals are present.    |
| left eye working, but right eye dark                      | may be in stereo mode when expected to be in mono mode   |  |
| intergraph left eye working, but right eye dark           | intergraph graphics must be configured for stereo and dual display   |  |
| <b>VIDEO PRESENT BUT NOT CORRECT</b>                      |  |  |
| Image appears all blotchy with colors changing            | This is normal shutter behavior when it is first turned on. The problem should disappear within 30 seconds   |  |
| Video images present, but hazy overall                    | CRT may be blooming. Turn down brightness and contrast. The image quality should improve   | Maximum image quality will always be achieved at the lowest contrast level that is acceptable. |
| Displays are completely bright white                      | turn down brightness and contrast at control box front panel.<br><br>If this doesn't help, you may be sending an incorrect video signal              |  |
| intergraph image appears in black and white               | control box is configured for F-Scan input rather than intergraph input. Check status lights. Change SW 3 position                                   |  |
| Shutter appears stuck on one or two colors                | Power down HMD, wait a few seconds, then power UP*   | Shutter can latch if power down cycle is too short   |

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|--|--|--|
| on SGI Onyx, portions or all<br>If the scene are black and<br>white on the HMD           | this is a software limitation<br>of the SGI. Contact Virtual<br>Research for further details.  |  |
| <b>MECHANICAL IMAGE<br/>PROBLEMS AND<br/>IMAGE MISMATCH</b>                              |  |  |
| video image is blurry at one<br>edge or corner   | your eye is off to one side<br>from the exit pupil of the<br>optics. Try adjusting the<br>IPD or vertical position of<br>the displays again.   |  |
| corners of image are lost  | your eye is too far from the<br>lens. Pull the shell closer to<br>your face.   | This is more of a problem<br>or those who wear eye-<br>glasses.  |
| Colors appear smeared or<br>rainbow like at edges of dis-<br>play                        | this is a normal limitation of<br>the lens design. Different<br>light colors are bent differ-<br>ently by the lens. The ef-<br>fect, chromatic aberration, is<br>more severe the farther from<br>the center of the display               | If you are reading text, keep<br>it toward the center of the<br>display.<br><br>make sure you have the dis-<br>plays aligned to your eyes<br>and as close to your eyes as<br>possible to limit all aberra-<br>tions. |
| One eye is brighter than the<br>other, or colors are different<br>in the two eyes        | switch video signals if you<br>are running in stereo to see if<br>the problem is caused at the<br>control box, or at the com-<br>puter<br>if the problem is control box<br>related, adjust SETUP and<br>GAIN pots inside control<br>box. |  |
| image in the two eyes are<br>different widths or are ro-<br>tated relative to each other | This is an image alignment<br>problem that requires factory<br>service. Please contact vir-<br>tual research.  | image mismatch problems<br>will cause eyestrain and<br>should be fixed promptly  |
| images are different heights   | this can be adjusted at the<br>control box, but please con-<br>tact virtual research before<br>making any adjustment   | image mismatch problems<br>will cause eyestrain and<br>should be fixed promptly  |

|  |  |   |
|--|--|---|
| stereo input, images aren't fusing into one stereo image | make sure everything is OK with the HMD by testing in MONO mode. If this is OK and the problem persists, it is due to software configuration. Adjust convergence/parallax as appropriate | image mismatch problems will cause eyestrain and should be fixed promptly |
| <b>MECHANICAL PROBLEMS</b>                               |  |   |
| front shell fore/aft motion too loose or too tight       | adjust detent screw at front of headband--see manual for instructions  |   |
| HMD seems front heavy                                    | HMD cable and tracker cable should fall down user's back, not over shoulder. With cable at back, weight should be centered   |   |
| headband ratchet knobs too loose or too tight            | adjust ratchet tightness with phillips head screw at center of ratchet knob  |   |