

# **User's Guide**

# **VR4**

**Virtual Research Systems, Inc.**

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# Product History

## FLIGHT HELMET

Virtual Research announce the Plight Helmet in August of 1991. It was designed around 2.7" LCD displays and LEEP optics. Virtual reality investigators were drawn to its ease of use, its rugged design and its competitive price.

## EYEGEN3

EYEGEN3 was developed after extensive discussions with Plight Helmet customers. Perhaps the two biggest drawbacks to the Plight Helmet were its weight ( more than three pounds) and its display resolution (360 x 240 color elements, which is equivalent to 240 x 120 full color pixels).

EYEGEN3 is a head mount display (HMD) that utilizes monochrome CRTs (Cathode Ray Tubes) with color wheels to give a full color display with resolution significantly better than currently available LCD (Liquid Crystal Display) displays. Weight of the EYEGEN3 is under two pounds, making it about half the weight of the Plight Helmet.

## VR4

VR4 was introduced in May 1994. It uses the same headband system that has been widely praised in EYEGEN3, but returns to LCD displays and a front shell structure to increase ruggedness and reduce the number of moving parts. 1.3" LCDs have twice the resolution of the Plight Helmet and a field of view that is between that of EYEGEN3 and the Plight Helmet: VR4 = 60° diagonal at full overlap, Flight Helmet = approx. 100° , but with significant distortion at the periphery, EYEGEN3 = 40° at full overlap.

VR4 is intended for high performance immersive applications. The product is proving successful in a broad range of uses, from high end entertainment systems, to medical field training simulators, to telepresence.

# Safety Issues

## **Blocked vision and hearing**

By its nature, a head mount display blocks the user's sight 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. We recommend using VR4 only while seated to avoid tripping hazards.

## **Eyestrain/other optical effects**

VR4 will cause eyestrain if the 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 sources of eyestrain could include optical aberrations, distortion, mismatch of computer imagery with mechanical configuration.

If you experience noticeable eyestrain, review and correct your adjustments and software configuration. If eyestrain persists, limit or end your use of the HMD. Please contact Virtual Research if you have questions or concerns about eyestrain.

## **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.

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.

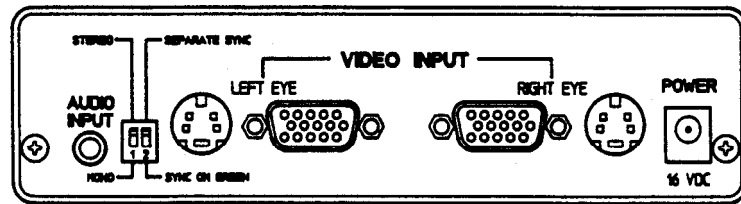
### **Electrical Shock Hazard**

The desktop power supply produces 16Vdc. This voltage is also present on the HMD cable bundle. This voltage should not be a hazard to the user. The circuitry in the HMD produces a high voltage (<500 Vac) spike signal to drive the backlight. This voltage is generated at very low current levels and will cause only a moderate sensation when touched. This voltage is accessible only if the HMD is disassembled.

# Control Box

## Inputs

The VR4 Control box inputs are located on the rear panel of the box.



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 VR4; there is no amplification 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 16VDC, 1Amp to operate. Virtual Research supplies a power supply unit with VR4. This supply is universal input, 16VDC output.

## Video

VR4 accepts either of two signal formats which we will refer to as 'Y/C' and 'RGB'. VR4 accepts only NTSC timing. First a bit of explanation of signal timing and format:

NTSC timing refers to a timing standard that was developed for television and is used in the US, Canada, Mexico, Japan, and several other countries. This timing standard is not used in television systems in Europe and in many other countries. PAL and SECAM are alternatives to NTSC which are used in Europe and elsewhere.

VR4 does not accept PAL or SECAM timing. It also does not accept the common computer video signals--VGA, SVGA, XVGA, etc. Signals of these types must be converted to NTSC timing format before they will be useable with the VR4.

NTSC timing format: Interlaced, 525 lines, 30 frames/sec., 60 fields/set.

An NTSC video signal can be transmitted in a number of ways:

1 wire: NTSC composite. Commonly used to carry video signals From the home VCR to TV. This format was used in the Plight Helmet and EYEGEN3. Because all of the video information is carried on one wire, the resolution that can be carried is limited. Horizontal resolution of about 240 TV lines is possible in most cases.

2 wire (Y/C): Also known as S-VHS. Y/C refers to an NTSC timing video signal that is carried on two lines, a chroma (C) line, which carries the color signal and a luma (Y) line, which carries the luminance or brightness level. This format is commonly available as an output from higher performance home VCRs and laser disks because the signal quality is improved significantly from NTSC composite. The color image quality is still limited because all information must be placed on only one wire. Horizontal resolution of about 300 TV lines is possible. Y/C signals are typically carried on a cable with a 4 pin round plug called a DIN plug.

3 wire (RGB with sync on green) and 4 wire (RGB with separate sync): This format gives the maximum potential signal quality. There are no limits to the horizontal resolution that is possible, provided the sending and receiving devices can handle it. Vertical resolution is limited by the 525 lines used in the display.

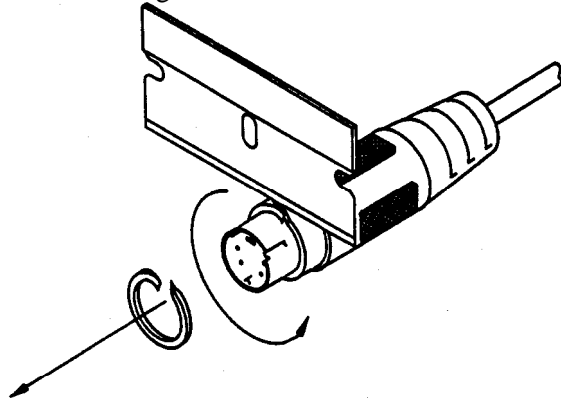
### **Y/C Inputs**

VR4 accepts Y/C signal format at the 4 pin DIN plugs on the rear of the control box. Either one or two signals may be supplied. If only one signal is used, the left eye input is used and the DIP switch marked stereo/mono is switched to mono. If two signal are supplied, the left eye signal goes to the left plug, right eye signal to right plug and the DIP switch is set to the stereo position.

The slide switch on the front of the control box should be set to Y/C.



**NOTE:** Some customers have found that their S-VHS cable plugs will not insert fully into the control box. If you find that the signal is not present, is black and white only, or is intermittent, you may have the same problem. To remedy the problem, cut the last 1/16" off the plastic sheath around your S-VHS plug as shown in the drawing below:



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### RGB

**VR4** accepts RGB signal format at the 15 pin high density D connectors. Either one or two signals may be supplied. If only one signal is used, the left eye input is used and the DIP switch marked stereo/mono is switched to mono. If two signals are supplied, the left eye signal goes to the left plug, right eye signal to right plug and the DIP switch is set to the stereo position.

The slide switch on the front of the control box should be set to RGB.

VR4 can accept an RGB signal with sync on green or with sync separate. See the pinout information at the end of this manual for the correct connector wiring. Set the DIP switch marked 'separate sync/sync on green' to the appropriate position for your signal.

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**NOTE:** Silicon Graphic's MC0 (multi channel option) board commonly is configured to supply sync on green. Spea's Fireboard is not capable of supplying sync on green and will always supply separate sync.

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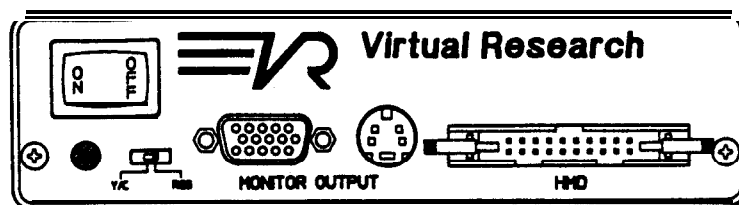
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**NOTE:** You cannot input S-VHS and RS-170 signals simultaneously to the control box, only one or the other should be attached at any time.

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### 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 on the front of the control box. The output signal is either Y/C or RGB, depending on the input. It is not possible to output RGB if you input Y/C or vice versa. The output is from the left eye input. Output is line driven and 75ohm terminated.

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Note: The only modification to output vs. input, is that sync will be added to green by the control box if sync was initially separate. Separate sync is also output from the monitor output if it was present on the input.

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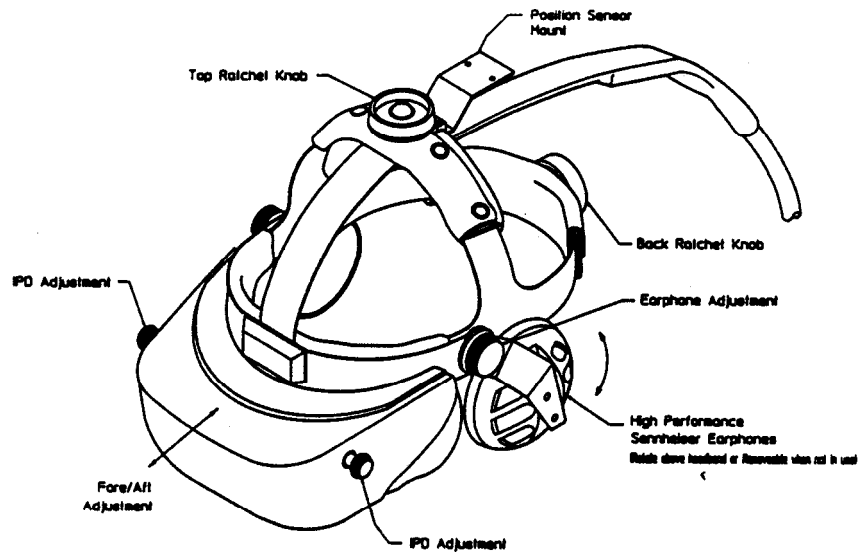
### HMD output

The HMD output is a 22 pin locking ribbon cable connector. The pin out information from this connector is available from Virtual Research. The locking sides of this connector should be snapped to the closed position when the HMD is to be used.

chapter 4

# Mechanical Adjustments

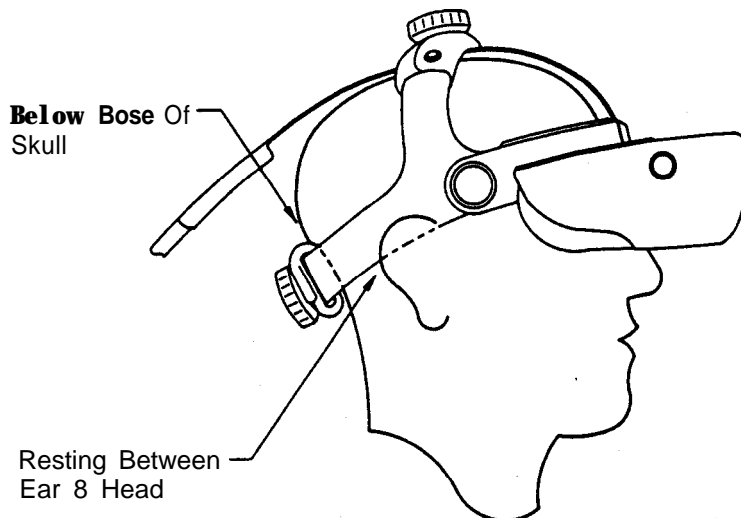
Locations of mechanical adjustments are shown in the following drawing:



## Donning the VR4

There are several things to consider when first donning the VR4.

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 VR4 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)

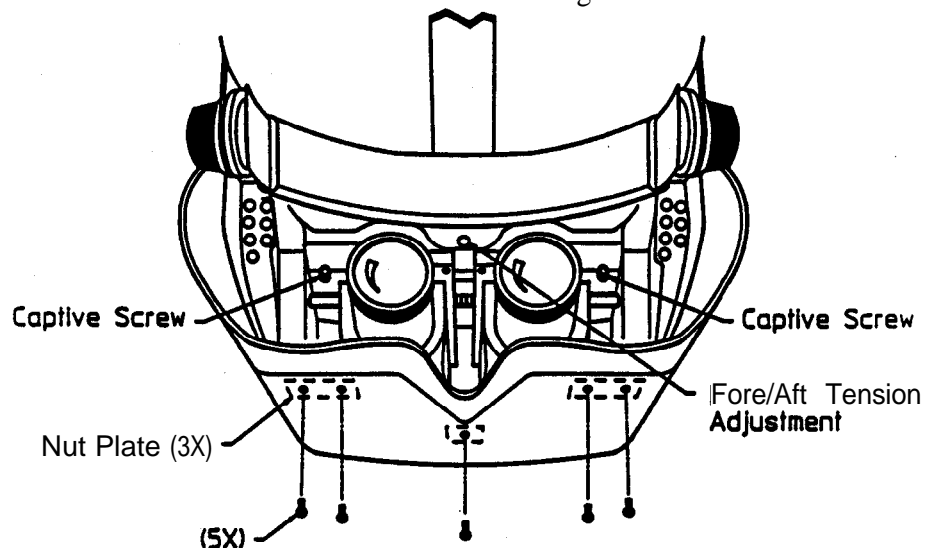
range = 52-74mm

Adjust until both images are evenly visible. Close one eye at a time to confirm the image is centered in front of the 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 maximum field of view and to block ambient light. Eyeglasses can be worn with VR4, simply leave fore&t 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 VR4. 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. Fore/aft tension adjustment generally requires only a slight turn of the set screw.

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.

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**CAUTION: DO NOT OVER TIGHTEN DETENT SCREW. 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.**

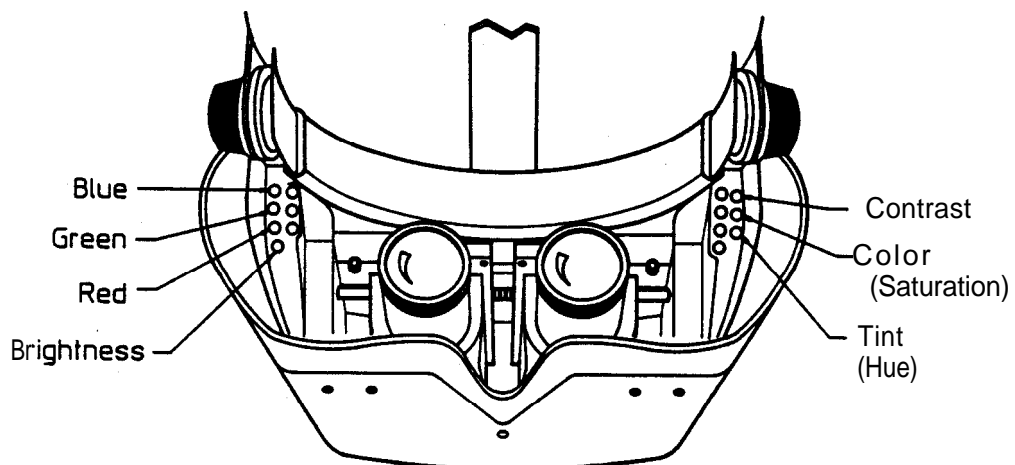
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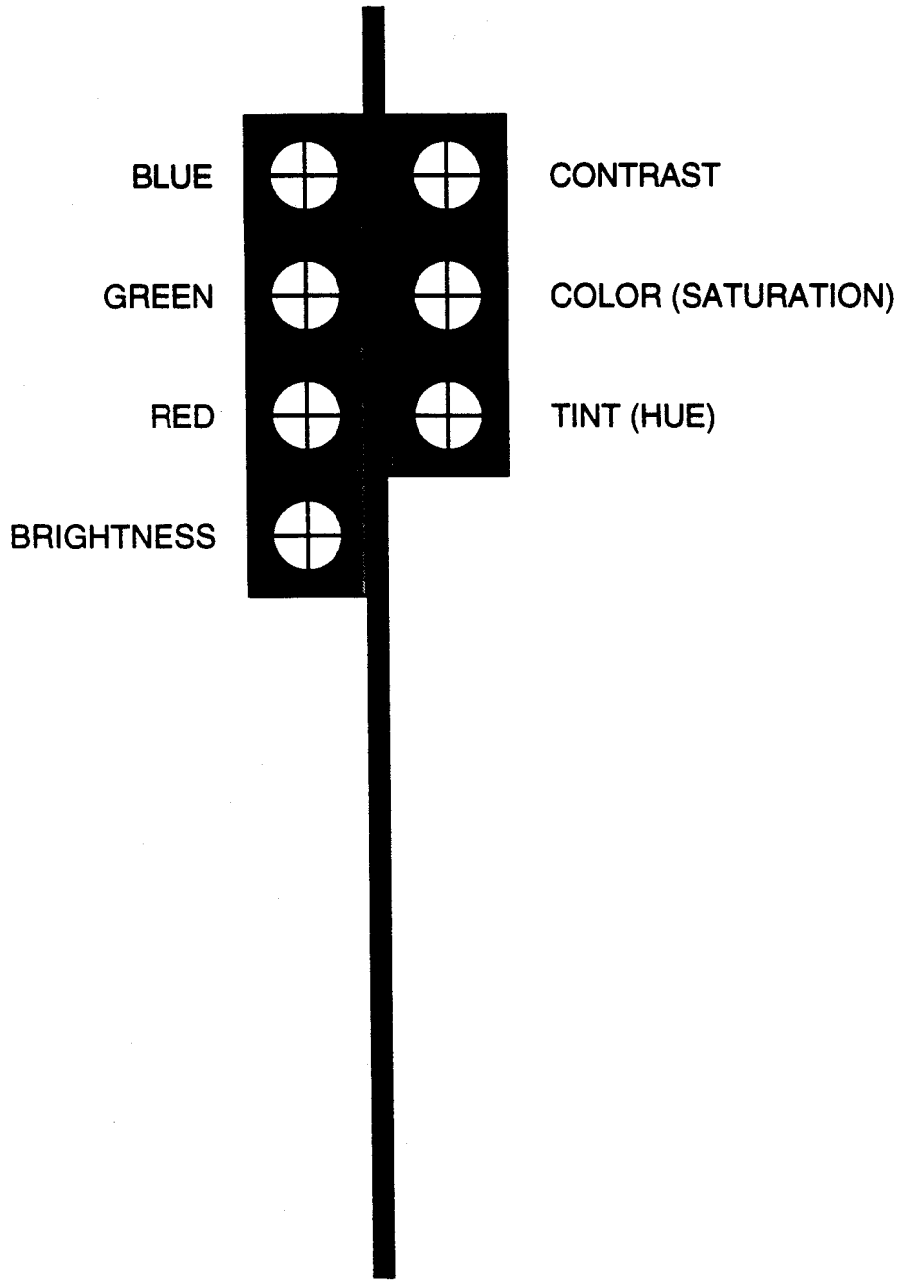
### Display Height Adjustment

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 LCD will be equally visible.

### Color adjustments

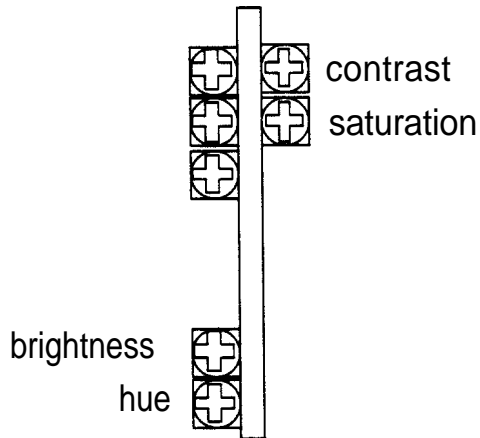
Color adjustment pots are located at each side of the inner shell of VR4, as shown below:



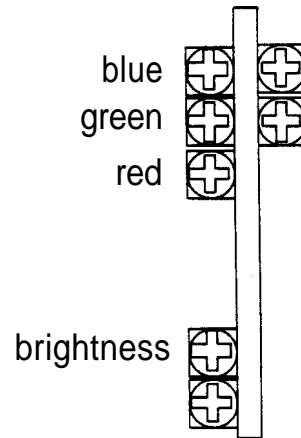


Use a pot adjusting tool to gently rotate them. Pots are surface mount components; if you push too hard on them, you can tear them off the circuit board.

### S-VHS ADJUSTMENTS



### RS-170 ADJUSTMENTS



It is difficult to achieve color settings that work for both S-VHS and RS-170. We recommend that you work with one input format, and adjust your colors for that format specifically.

## 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.

## Ratchet Knobs

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

## Headphones

Headphones rotate around the knobs on the sides of the headband. When donning the VR4 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

VR4 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, VR4 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.



## **Some Technical Information**

### **Headphone removal/upgrades**

If you are not using audio with your system, you can remove your headphones to make the VR4 a little simpler to use. There are two ways to do this.

**Remove earphone only:** The earphone is connected to the earphone arm by a ball and socket connection. The earphone will snap off the earphone arm if you rotate the earphone relative to the earphone arm. The earphone cable can be unplugged from the earphone. Pull firmly on the red (right side) or black (left side) connector to remove the cable. Tuck the cable into the end of the padded leather on the headband to keep it from dangling.

**Remove earphone and earphone arm:** Unscrew the black plastic nut that attaches the earphone arm to the headband. Remove washer and earphone arm, then replace washer and nut. Unplug earphone as above.

Sennheiser offers several headphones in their line. The HD440 model that comes with the VR4 is considered midrange in performance. Higher performance earphones can be purchased from Sennheiser dealers or from Virtual Research. Open cup earphones can be installed in place of HD440's without any modification to the VR4. Large closed cup earphones require a modified mounting part, which we can supply.

### **Optics and Fogging**

VR4 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.

VR4 optics are glass and are not prone to scratching. Rubber bumpers around lenses also provide protection. However, if you wear glasses, it is possible to scratch the VR4 lenses or your glasses if they come in contact. Try to avoid this contact when donning the VR4.

**chapter 6****Position Sensors**

**VR4** 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 Receiver (Fastrak, Isotrak, Insidettrak).

Ascension Flock of Birds uses a slightly larger receiver with wider mounting hole spacing. We can supply (at no charge) an adapter plate for the Ascension receiver.

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 VR4, 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 VR4 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. We don't recommend plastic cable ties since they tend to snag on everything.

If you are using an electromagnetic tracker, you will get better tracker performance if you mount the transmitter above the user's head rather than below and to the side. The clear path from transmitter to receiver reduces noise induced by the VR4 wiring and distortion caused by the metal in the VR4.

If you or&r a VR4 and a position sensor, we can incorporate your tracker cable into the VR4 cable sheath at the time of cable assembly. Retrofitting of tracker cable into cable bundle is more difficult, but possible.

**A p p e n d i x 1**

# Pin Out Information

## RS-170 Input connector format

15 pin high density D female connector

<u>Pin</u>	<u>Signal</u>
1	Red
2	Green
3	Blue
4	ground
5	n/c
6	ground
7	ground
8	ground
9	n/c
10	ground
11	ground
12	n/c
13	composite sync
14	n/c
15	n/c

## S-VHS Input connector format

4 pin DIN connector

<u>Pin</u>	<u>Signal</u>
1	ground
2	ground
3	luma
4	chroma

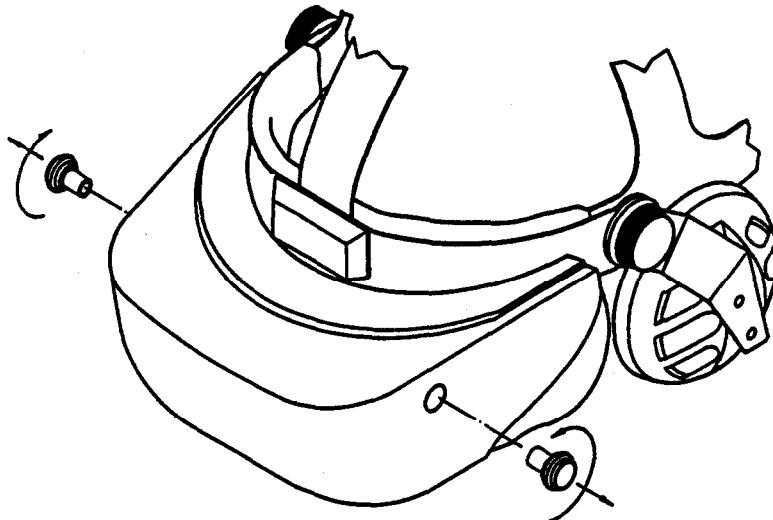
**A p p e n d i x 2**

# Basic Disassembly Procedure

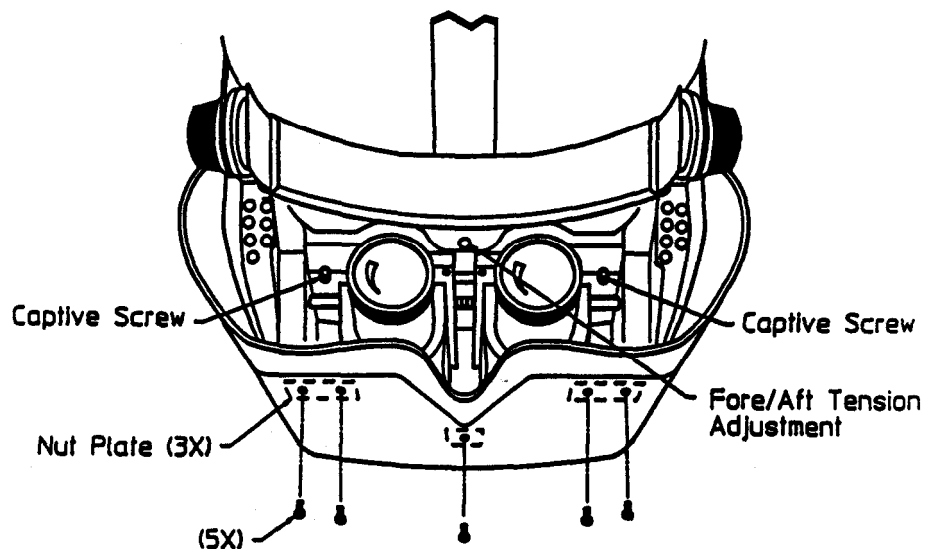
Disassembly of your VR4 will void your warrantee. The following information is intended for trained service personnel only.

## Shell Removal

1. Remove IPD knobs as shown in the following diagram:



2. Remove screws (5) from bottom of shell. Remove nut plates from inside of shell after screws are removed. See diagram below:

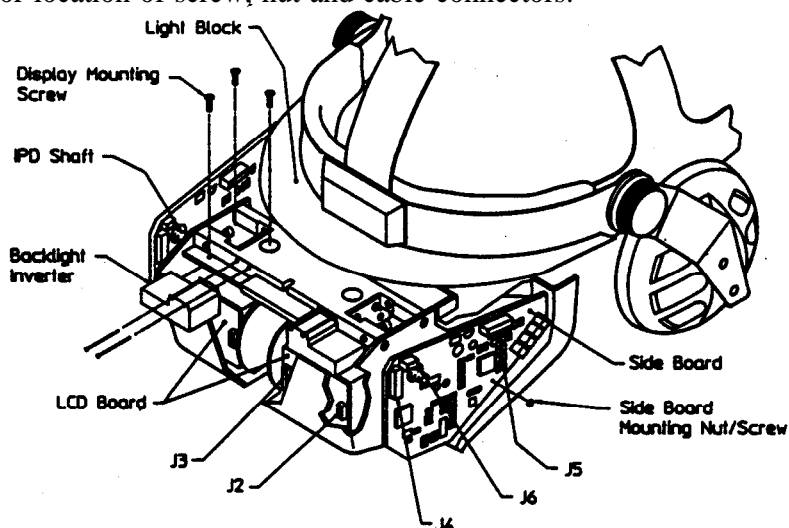


3. Use 3/32" hex wrench to loosen captive screws inside top portion of shell. See diagram above.

Shell will now slide off.

## Side Circuit Board Removal

Side circuit boards are held in place by one screw and nut. Remove this screw and nut. Carefully disconnect cables (4) from circuit board. See diagram below for location of screw, nut and cable connectors:



**CAUTION: Cables connecting J5 to J2 and J4 to J3 are both 6 pin. It is possible to interchange them (i.e. connect J5 to J3 and J4 to J2). This will destroy the large IC on the LCD board. Always double check that you have correctly connected these cables before applying power to the VR4. Correct connection order is listed on the side board near connectors. J5 and J4.**

On all VR4 units produced in 1994, side boards have the shape shown in the above diagram. Right side boards and left side boards are not interchangeable because the connectors are always to the inside (toward the displays) of the board.

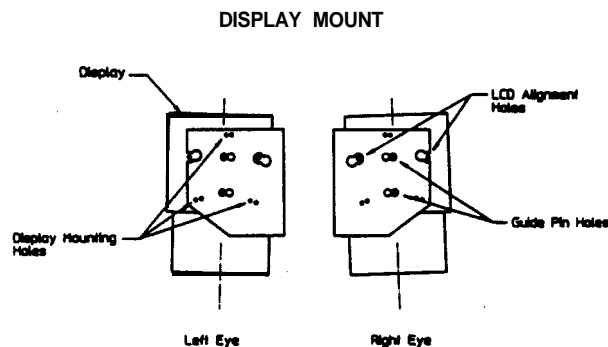
Beginning in January or February 1995, the side boards will change to an interchangeable (right to left) design with a large diameter hole that the IPD shaft passes through. These new circuit boards will not be interchangeable with the

old circuit boards without a change of the plastic circuit board cover. The risk of cross-connecting wires is also eliminated with this design change.

## Display Removal

It is possible to replace the display assembly for the right or left eye of the VR4. Refer to diagram above for location of parts to be removed. Either display can be removed.

1. Remove two screws holding backlight inverter housing to VR4.
2. Disconnect cables at connectors J7 on the side board and J2 and J3 on the LCD board. (This is easiest if you first adjust the IPD to the innermost position). See Caution above before reconnecting these cables.
3. Move IPD until 3 Display mounting screws are visible from above. See diagram below for the location of these screws.



4. With mounting screws removed, display assembly can be extracted from the VR4.

Reattachment of display is the reverse of removal. Note that there are two possible positions for each display in the diagram above. The position shown is the factory set position of the display. This outer position is used for 100% overlap displays. The inner position cants the displays inward an additional 3" and is used for 85% overlap. To use this position, you will need stereo video sources. Contact Virtual Research for further information if you intend to configure your VR4 for partial overlap.

## Display Assembly Teardown

The display assembly includes the following:

top housing/bottom housing

LCD

backlight

lens

LCD Board

Backlight Inverter circuit in shielded enclosure

Display disassembly is fairly easy, there are just 4 screws holding the top and bottom housings together. However, because you risk getting dust in the enclosure, scratching the display, or misaligning the optics, we do not recommend teardown except by Virtual Research trained personnel with access to a dust free environment.

## FCC Statement

This equipment has been tested and found to comply with the limits for a class A Digital Device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against interference if installed and operated properly in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if not properly installed and used in accordance with instructions in this manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

Only peripherals (computer I/O devices, terminals, printers, etc.) tested and complying with Class A Limits should be attached to this device with shielded I/O cables.

Finally, any changes or modifications to the equipment by the user not expressly approved by the grantee or manufacturer could void the user's authority to operate such equipment