HAZELRIGG INDUSTRIES

VDI

Vacuum Tube DI

Operating Instructions

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HAND-CRAFTED PROFESSIONAL RECORDING EQUIPMENT

HAZELRIGG INDUSTRIES

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Certificate of RoHS Compliance

D.W. Fearn / Hazelrigg Industries is committed to manufacturing products that are fully-compliant with the EU RoHS Directive.

The following products are compliant:

VT-1, VT-2, VT-24, VLC(-1)

VT-3, VT-I/F, VDI

VT-4, VT-5

VT-7

VT-15

LP-1

PDB

This declaration is based on our understanding of the current RoHS Directive and from information provided by the supplier material declarations with regard to materials contained in the component that make up our products.

Douglas W. Fearn

President

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Limited 7-Year Warranty

During the warranty period, D.W. Fearn / Hazelrigg Industries will, at no additional charge, repair or replace defective parts with new parts.

This warranty does not extend to any VDI that has been damaged or rendered defective as a result of accident, misuse, or abuse; by the use of parts not manufactured or supplied by D.W. Fearn / Hazelrigg Industries; or by unauthorized modification of the VDI. Vacuum tubes are excepted from the 7-year warranty, but are warranted for 90 days from date of purchase.

Except as expressly set forth in this Warranty, D.W. Fearn / Hazelrigg Industries makes no other warranties, express or implied, including any implied warranty of merchantability and fit- ness for a particular purpose.

D.W. Fearn / Hazelrigg Industries shall not be liable for technical or editorial errors or omissions in this manual, nor for incidental or consequential damages resulting from the use of this material.

History of the VT-I/F

Vacuum Tube Instrument Interface

As far back as I can remember, taking instruments “direct” has never sounded very good to me. There always seemed to be a lack of dynamics, and a sterile quality to sounds recorded with a direct box (or DI).

Frankly, initially I was not very excited about designing the VT-I/F. I assumed that the lifeless sound I was accustomed to was the nature of direct sounds.

Before beginning the design of the circuit, I spoke to a number of engineers, producers, and musicians about what they felt was lacking in DI boxes. Almost without exception, they all said, “It’s got to have tons of headroom.” How much headroom was enough? I spoke to a number of instrument pickup manufacturers and got an idea of the peak output level of a variety of instruments. These figures were confirmed with an oscilloscope placed directly across the output of various electric guitars, basses, pianos, synthesizers, etc.

The first design goal was to accommodate the full dynamic range of sources likely to be connected to the VT-I/F. Secondly, the design had to be quiet. After that, it was just a matter of designing it to have the type of performance and pack- aging that audio professionals have come to expect from our VT-1/VT-2 Vacuum Tube Microphone Preamplifiers.

The decision was made early on that the output of the VDI would be at micro- phone level. Although a line-level output is not difficult to design, it would increase the cost. Besides, everyone has mic preamps available. Although the VT-I/F will work with virtually any mic preamp, it was designed to complement the VT-1/VT-2 series of preamps.

We tried the first prototype on a solid-body electric guitar, and compared the sound to several other respected DI boxes. We were astonished at first listen! It sounded very close to the sound of the guitar through a good vacuum tube amp.

This prototype was evaluated by a number of studio friends, who made some useful suggestions. These suggestions were incorporated into the second prototype, and the VT-I/F design was complete. By the way, our evaluators were very, very reluctant to return the prototype.

I have seen how direct boxes can be abused in the studio environment, so the VT-I/F was built to take rough treatment. The case is machined from solid quarter-inch thick aluminum plate, and finished with a tough polyurethane aircraft finish.

Why does the VT-I/F sound so good? I’m not entirely sure, but I do know that it provides the proper load to

the instrument. This is vital for an unrestricted sound. The frequency response is flat from 10 cps to 20 kc, with -3 dB points at 0.5 cps and 90 kc. The VDI circuit is very similar to the circuit of the VT-1/VT-2, with a different input design. The output is identical to the VT-1/VT-2 but operates at a lower level. The power supply is virtually identical to that used in the VT-1/VT-2.

The VT-I/F has been used on electric and acoustic (with a pickup) guitars, electric and acoustic (with a pickup) bass, electric pianos, synthesizers, samplers, etc. and it sounds great on all of them. It will not overload on any instrument, although when driven hard, the sound becomes fatter. It has enough gain, and it's quiet enough, for use with very low level instruments, like finger-picked acoustic guitar.

The lifeless, restricted sound I thought was part of direct recording is gone. The VDI has depth, fullness, dynamics, and excitement while remaining quiet and under control with any instrument.

Douglas W. Fearn November 1994
(from the original VT-I/F Operating Instructions)

The VDI is a faithful single-channel recreation of the VT-I/F, from the power supply to the tube circuit and output transformer. It has been optimized for use in both live and studio settings.

Specifications

(with 200 mV input)

Input	**200 mV nominal unbalanced**
Input Load Impedance	**1 megohm minimum**
Minimum Input Level	**5 mV nominal**
Maximum Input Level	**2.3 volts P-P for 1% THD**
Gain	**-10 dB**
Frequency Response	**+/- 0.2 dB 10 cps to 20 kc** **-3 dB @ 0.5 cps and 95 kc**
THD + Noise	**<0.3% 20 cps to 20 kc**
Intermodulation Distortion	**<0.01% SMPTE**
Noise	**minimum 90 dB below output** **(22 cps to 22 kc bandwidth)**
Output	**Transformer Balanced** **(matches 150 ohm input)**
Output Level	**-30 dBm nominal**
Maximum Output Level	**-12 dBm**
Power Requirements	**120/220 VAC 50/60Hz 25W**
Dimensions	**6.25"W x 2.25"H x 9.5"D** **(15.9cm x 5.7cm x 24.2cm)**
Weight	**6 lbs. (2.73kg)**

NOTE: Throughout this manual, frequency is specified in cps (cycles per second) and kc (kilocycles per second). These units correspond to Hz and kHz. Specifications subject to change without notice.

Description

The Hazelrigg Industries VDI Vacuum Tube DI is designed to provide recording professionals with a sonically superior method for recording electric and electronic musical instruments by direct injection (DI). Any instrument designed to operate into a “guitar amp” will work perfectly with the VDI. Typical instruments include: electric bass, electric guitar, electric piano, acoustic instruments with a pickup (piano, acoustic guitar, electric violin, etc.), synthesizers, and samplers.

The VDI is a single-channel device that provides the optimum load impedance for these instruments. It is capable of quality reproduction of a wide range of instrument levels. The unit does not have the limitations of passive transformer-type DIs, and has greater headroom and warmth when compared to similar solid-state devices.

It is designed to operate in the professional recording or performing environment. The output level is “hot” mic level (-30 dBm nominal). The output is transformer-balanced, using a custom transformer built for us by Jensen Transformers, Inc., and is designed to match 150 ohm professional mic inputs. Top-quality parts are used throughout. The case is machined from solid quarter-inch thick aluminum plate for ruggedness and durability. Both the filament and plate power supplies are fully regulated.

The VDI is not mass-produced. Each one is hand-made and meticulously test- ed before shipment to the customer.

Installation

The VDI is carefully packed for shipment and should survive all but the most brutal handling. If there is any damage, keep the shipping material for use during any claim for damage with the shipper.

Included in the box:
1) The VDI Instrument Interface
2) Line cord
3) This instruction manual

Mounting

The VDI is designed to be placed on the floor, counter, or tabletop. In most cases, cooling will not be a problem, but avoid placing the unit where it is tightly confined. Do not block the cooling holes. The VDI

runs cool, cooler, in fact, than many solid-state devices.

Rack mounting is possible if a shelf is provided.

Moderate electrical and magnetic fields in the vicinity of the VDI should not cause any degradation in noise performance, due to the well-shielded construction, but proximity to devices with motors or large power transformers (i.e. tape machines or power amps) should be avoided.

Although the vacuum tube in the VDI is selected for minimum microphonic response, it is a good practice to avoid mounting locations that subject the unit to very high sound or vibration levels.

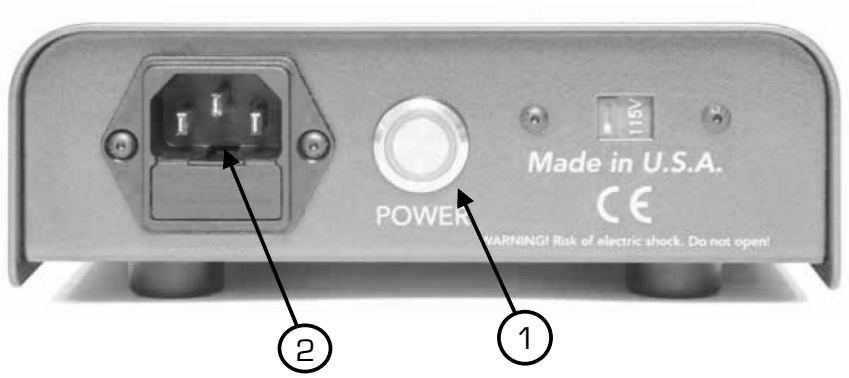

Figure 1. VDI Rear Panel Connections and Controls

REAR PANEL CONNECTIONS (See Figure 1)

AC (Mains) Power (2)

The VDI is designed to operate from 120 or 220 volt, 50/60 Hz power. The unit will be shipped wired for the voltage specified in the order, but may be changed in the field if necessary. The ground pin of the power cord is internally connected to the chassis. This configuration is standard in professional equipment and is required by most electrical codes. If ground loop hum is detected, a careful check of the studio grounding scheme is needed. The VDI is less susceptible to grounding problems than many studio devices.

The Fuse is a 5mm x 20mm type .5 amp for 120 VAC operation, and 0.25 amp for 220 volts.

The AC input connector (2) is used with the mating line cord (supplied). For 120 VAC operation, this cord is a Belden 17250 or equivalent.

FRONT PANEL CONNECTIONS (See Figure 2)

The VDI has one channel. The musical instrument output connects to the VDI INPUT (2) via a standard ¼-inch single-conductor (monaural) phone jack. The input is unbalanced. Since the input cables carry very low-level audio, it is important that well-shielded cables are used. There should be no additional connectors, patch jacks, switches, etc. between the instrument and the VDI inputs. It is important to keep the input lines as short as possible. Avoid locating the VDI where it will be subjected to high sound levels or excessive vibration (such as on a drum riser).

If desired, the musical instrument may be simultaneously connected to the input to an external instrument (guitar) amplifier. The THRU jack (1) is a ¼-inch single-conductor (monaural) phone jack wired directly in parallel with the INPUT jack.

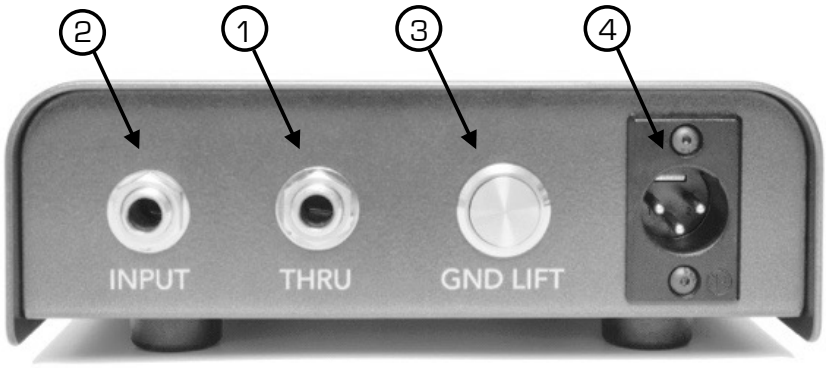

Figure 2. VDI Front Panel Controls and Connections

The OUTPUT connectors (4) are XLR-3 male wired according to AES standard: pin 1 is ground (shield), pin 2 is "high" or "+," and pin 3 is "low" or "-." The out- put is transformer-balanced. The output level is a nominal -30 dBm. This is somewhat higher in level than a typical microphone.

Grounding and Shields

A full discussion of proper studio wiring schemes is beyond the scope of this manual, but, in general, the shield should be connected to pin 1 of the output connector. The shield should be connected to ground at only one end; however, although not recommended, the shields can often be connected at both ends with-out a problem.

OPERATION

REAR PANEL CONTROLS (see Figure 1, page 11) Power switch (1)

Primary power is applied to the VDI circuits when the Power switch (1) is depressed position. The power switch contains a lamp that indicates that the unit is on. It takes about twenty seconds for the Interface to start working, but it is suggested that you turn on the power at least five minutes prior to use. The tubes are often noisy until all the internal elements reach a stable operating temperature.

FRONT PANEL CONTROLS (see Figure 2, page 12)

The only control on the VDI is the GND LIFT switch. This connects or disconnects pin 1 of the OUTPUT connector to the unit internal ground. In most situations, the GND LIFT switch (3) will remain in the 'out' (pin 1 to internal ground) position. In some situations, particularly when an external instrument amplifier is connected to the AMP jack, a ground loop may occur. This causes a hum or buzz in the recording equipment. Placing the GND LIFT switch in the 'in' position may help alleviate this.

The musical instrument is connected to the INSTRUMENT jack (2), an optional guitar amp is connected to the AMP jack (1), and the external preamp (VT-1/VT- 2 or other) is connected to the OUT jack (4).

HUMS AND BUZZES

Unfortunately, it is the nature of high-impedance, unbalanced instrument output to be highly susceptible to hum and buzz. Some of this is often unavoidable — the instrument pickup(s) are very sensitive to the omnipresent AC fields in our environment. Experiment with the orientation of the instrument to minimize this source of noise. Most guitar and bass players will do this automatically, but with keyboards it may be necessary to rotate and/or move the instrument to find the quietest spot.

Fluorescent lights and SCR dimmers are terrible electrical noise generators. Turn off the fluorescents. If SCR dimmers must be used, they will generally produce the least noise in their full-on (brightest) position.

Another source of these hums and buzzes is ground loops caused by the inter- connection of various AC (mains) powered equipment. A properly-wired studio should not create a ground loop between the VDI and the studio equipment, but often a loop is formed when the VDI is connected to an instrument and guitar amp simultaneously. In this case, use the GND LIFT (3) switch to find the proper position for minimum noise. If the guitar amp has a "Ground" switch, experiment with it as well. Be sure to try all combinations

of all switches.

IMPORTANT:
When using the VDI with the D.W. Fearn VT-1 or VT-2 Vacuum Tube Microphone Preamplifier, the VT-1/VT-2 Input switch must be in the -20 dB position (unless the instrument level is extremely low). With other preamps, use the input pad and/or reduce the gain of the preamp.

The VDI and the guitar amp (if used) should be on the same electrical circuit (same circuit breaker or fuse) as the studio equipment to minimize ground loop potential.

Suggestions

You have chosen to use the VDI because of the superior sound it provides. To gain the maximum benefit from your investment, it is important that you hook up the VDI so that other factors do not adversely affect the sound quality.

The VDI must be located near the instrument. Ten feet of cable between the instrument and the VDI should be considered the maximum.

1. Use the best quality cables you can. We don't believe you have to use esoteric wire, but do use good quality, well-shielded cables. The input cable shielding is particularly important. The output cable should be a standard balanced mic cable designed for use with low-Z microphones. Gold-contact phone and XLR connectors are recommended.

2. There should be no additional cables, connectors, junction boxes, patch jacks, punch blocks, etc. between the VDI output and the VT-1/VT-2 Input.

3. The outputs of the VT-1/VT-2 should be fed directly to the recorder through the shortest practical lengths of quality cables. Avoid additional cables, connectors, junction boxes, punch blocks, or patch jacks. Use gold contact connectors if possible. *Do not go through the mixing console unless you absolutely need its features for the track you are cutting.*

4. In general, for superior sound, we recommend recording directly to the recorder with no processing (compression, equalization, gating, etc.). Any processing can be added in the mix, if

necessary. You may find that far less processing is required when using the VDI. If processing is required while recording the track, insert the processing device after the VT-1/VT-2 and before the recorder.

5. Feeding the VDI into the studio console will negate some of the benefits of the VDI. Use a premium-quality microphone preamplifier (such as our VT-1/VT-2). Go through the console only if it is absolutely necessary.

THEORY OF OPERATION

Input section

The INPUT jack is fed directly to the grid of the first amplifier stage, a selected 6072 or selected 12AY7. The input impedance is very high (1 megohm) for proper loading of the musical instrument.

The first stage is capacitively-coupled to the grid of the output stage.

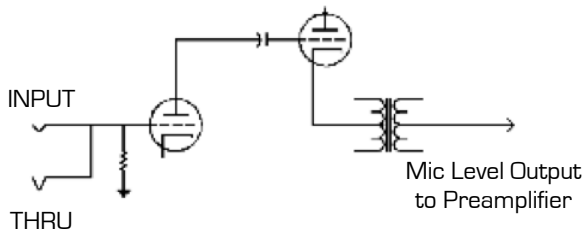

Figure 3. VDI Block Diagram

Output Stage

The output tube is the second section of the 6072/12AY7. It is operated as a cathode follower, capacitively-coupled to the custom output transformer. A resistive network on the secondary of the transformer provides proper loading and matching to the input of the external microphone preamplifier.

The GND LIFT switch disconnects pin 1 of the OUTPUT connector from the internal ground when the switch is in the depressed position.

Power Supplies

Primary power from the AC mains is connected to the VDI through a standard IEC power input connector. The Power switch energizes all power supplies. A fuse, accessible on the IEC input, protects the VDI.

The pilot lamp is incorporated into the power switch.

The power transformer is custom made for the VDI and has primary taps for 120 or 220 volt operation. A switch on the rear makes it quick and easy to go between voltages.

Filament supply

The power transformer output is rectified by a bridge rectifier and filtered before being regulated to 12.0 volts by a three-terminal regulator. The negative output of this supply is grounded. Although the tube filament is rated for 12.6 volts, utilization of 12.0 volts has no effect on the operation of the VDI.

B+ supply

Two separate regulated voltages are required for the plates of the VDI. The B+ is filtered with long-life, low-leakage computer-grade filter capacitors before being regulated and extensively bypassed and decoupled. The negative side of the supply is grounded.

MAINTENANCE

The VDI is built with only the highest quality parts and will prove to be extremely reliable. Vacuum tubes and electrolytic capacitors, however, have a finite useful life and must be periodically replaced.

Top Cover Removal

Removing the top cover allows access to the vacuum tube. Six 4-40 machine screws must be removed.

Vacuum Tubes

A single 12AY7 tube is used in the VDI. (A 6072 may be used. This is the low-noise industrial version of the 12AY7.) There can be as much as a 15 dB difference in noise level among an assortment of tubes, and the tube used in the VDI should be carefully chosen to maintain low noise. Selected low- noise tubes are available from D. W. Fearn.

Tube life is difficult to predict, but it will probably be measured in years. Catastrophic tube failure is rare

with this type of device, but a gradual increase in noise or distortion, or a reduction in headroom, should indicate the need for replacement. It is recommended that you periodically perform a quick noise and distortion check on the VDI and compare the results to previous measurements.

Tubes also sometimes develop a microphonic response — they will respond to ambient noise and vibration. This can be an insidious problem since measurements in a quiet room will indicate perfect performance. Gently tapping the tube shields while listening to the output at a normal monitor level should reveal nothing more than a slight "clank." On a peak reading meter connected to the VDI output, any microphonic response above -55 dBm is excessive. Replacement is indicated unless the VDI always operates in a quiet and vibration-free environment.

Although you could purchase a batch of 12AY7s and select the quietest one(s), it may be cost effective to buy a low-noise tube from the us. Current prices are $25.00 for a selected low-noise 6072/12AY7. We test the tubes in a VDI after a burn-in period and grade them according to noise, microphonic response, and other characteristics. A low-noise tube from us will meet the original VDI specifications.

The base pins of vacuum tubes supplied by D.W. Fearn have been chemically treated for low contact resistance and oxidation prevention. When handling these tubes, care should be taken to avoid removing or contaminating the treatment. Use a lint-free cloth or paper towel to avoid direct contact between any part of the tube and your fingers.

Remember that vacuum tubes may be quite hot during operation. Protect your fingers during tube replacement. The VDI should be turned off before removing tubes. Allow at least one minute for the filter capacitors to discharge before tube removal or insertion.

Tubes are made of glass and will break if dropped or even bumped in a critical area. Handle with care.

Electrolytic Capacitors

The VDI is designed and built to last for a long, long time, and it is possible that some components (e.g. electrolytic capacitors) may reach the end of their life long before the equipment becomes obsolete. The electrolytic capacitors used in the VDI typically will last at least twenty years. If there is a measurable and/or audible increase in 120 cps noise, the filter capacitors should be suspected. They should be replaced with new capacitors of equivalent capacitance and voltage rating, and the replacements should be specified for a minimum ten-year service life.

Electrolytic capacitors are also used as plate and cathode decouplers. In choosing a replacement, the same considerations as with the filter capacitors should be followed.

TROUBLESHOOTING

Most problems will be traced to defective vacuum tubes. However, if normal tests do not easily reveal the problem, feel free to call the factory for assistance. If you lack access to a qualified service technician with vacuum tube equipment repair experience, you may return the VDI to the factory for repair. Call first, however, for shipping information.

WARRANTY REPAIR

If the VDI should develop a problem during the five-year warranty period, call the factory for return shipping instructions. We will repair and return your VT- I/F quickly. Note that the warranty does not cover vacuum tubes, which must be periodically replaced.