Lab Linc V

COULBOURN

CE

DECLARATION of CONFORMITY

Manufacturer's Name:	Coulbourn Instruments, L.L.C.
Manufacturer's Address:	7462 Penn Drive Allentown, PA 18106 U.S.A. Phone: (610) 395-3771 Fax: (610) 391-1333
Importer's Name:	Various; Contact Coulbourn Instruments or the authorized representative in your country

Declares that the Product(s):

Product Name:	LabLinc V System
Model Number:	V15-17
Product Options:	All V-Series Modules, Transducers, And Accessories

Conforms to the Following Product Specifications:

EMC:	Radiated and Conducted Emissions per EN 55011, Class B at 10 Meters IEC 801-2, ESD at 4kV Direct Contact and 8kV Indirect IEC 801-3, RF Radiated Fields from 80 to 1000 MHz at 3 V/m IEC 801-4, EFT at 1kV on AC Ports and 0.5kV on I/O Lines
SAFETY:	EN 61010-1 : 1993

Supplementary Information:

The products herewith comply with the requirements of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. The products were tested in typical configuration.

Allentown, PA, March 27, 1996

Ed Young

Ed Young, Chief Engineer

Lab Linc V Contents

V-SERIES SYSTEM SPECIFICATIONS

POWER BASE

Dimensions: 12 x 18 x 4.5 inches - 305 X 457 X 114 mm
Weight: 13 lb. - 12 oz. - 6.2 kg
Electrical Requirements: 115 VAC (nominal), 60 Hz, or 220 VAC (nominal), 50 or 60 Hz - (specify)

MODULES

Dimensions: 10.1 x 8 x 1.8 inches - 275 x 203 x 45.7mm
Weight: 1 lb. - 2 oz. typical, 1 lb. - 6-oz. max. - 510 gm typical, 624 gm maximum. ±15 VDC (Powered from base).

DIGITAL SIGNALS

Digital Signals: +5V, Low True logic.
Digital Signal Connections: .040 in - 1mm Pin Lead.
Digital Signal Minimum Pulse: 10 microseconds.

ANALOG SIGNALS

Analog Signals: ±1 to 3 V typical output, ±10 V maximum.
Analog Signal Connections: 098 in - 2.5 mm, Ultraminiature Phono Connector.
Analog Signal - Frequency Response: 20 KHz (Except where limited by specific application filters.)

AMPLIFIERS, TYPICAL DIFFERENTIAL-TYPE

Amplifier Type: Precision instrumentation.
Input Impedance (differential and Common Mode): Restive - 10^7 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 105-dB minimum.
Input Bias Current: 10 nA typical: 50 nA max.
Maximum Input Voltage: 100mV (differential), ±10 volts (common mode)
Noise (referred to input): 0.3 microvolts peak-to-peak.

MATERIALS

Aluminum and UL V94-0 fire-rated plastics.

DESIGN STANDARD COMPLIANCE

UL 544 and CSA 125 listed. CE tested and approved. The *LabLinc V*® system power base and certain modules are listed by Underwriter's Laboratory under UL 544 for laboratory instruments and medical and dental equipment for use with human subjects. The modules listed under UL 544 are marked with a UL sticker. Using unlisted V-Series modules in the system *does not* disqualify the listed modules.

INTENDED USE

The ***LabLinc V*** system is designed to be used by or under the supervision of competent medical, scientific, and technical personnel who have proper education and training in the biomedical, physiological, or scientific disciplines appropriate to the application. The system is designed to be used for data acquisition, recording, stimulus presentation, and test sequence or experiment control.

CAUTION - *LabLinc V* is not to be used alone, or in conjunction with other devices, for human life support!
CAUTION - To reduce the risk of electric shock, do not remove the case cover from the base unit. Refer servicing of the base, modules and accessories to qualified service personnel.
CAUTION - *LabLinc V* should not be used in any environment where there may be explosive gasses in the atmosphere.

WARNING – *Never* make any type of modification to any part of the system.

SYSTEM ARCHITECTURE AND USE

GENERAL

LabLinc V is a modular instrument system for analog data acquisition and experiment control. ("*V*" is for vertical, not the Roman numeral five). It consists of an isolated, medical grade power supply in a base unit, and a number of signal acquisition, processing and control modules, which stack vertically - one on top of the other, on the power base unit. Each module has four spring-loaded jacks on the bottom, which serve both as electrical distribution for module power and physical connection to the next module in the stack. Locking tabs on the rear connection panel secure the modules so that they cannot be separated during use.

The first module in the stack plugs into the female receptacles in the base power unit and each successive module up the stack plugs into the extended receptacles of the module below it.

The power base supply provides +15V and -15V; the other two jacks provide earth ground and a current- sensing interlock safety circuit.

5 Volts, for digital logic and onboard microprocessors in each module, is provided from one of the 15V supplies by regulators or DC to DC converters in those modules requiring it.

NUMBER OF MODULES

The stack may be as high as is practical for the user or until the power supply can no longer supply sufficient current. If **too many modules** are used and the **maximum current** is approached, a **"beep" tone** in the base unit will **alert the user.** If the maximum current is exceeded, the power supply will "fold back" or shut down automatically until the excess load is removed. The number of modules that can be used varies according to their individual current consumption, in no case will that be less than ten modules. With modules of modest to average current consumption, the number will be greater than it is safe to stack them to prevent tipping over. **To prevent tip-over, do not stack higher than 16 modules.**

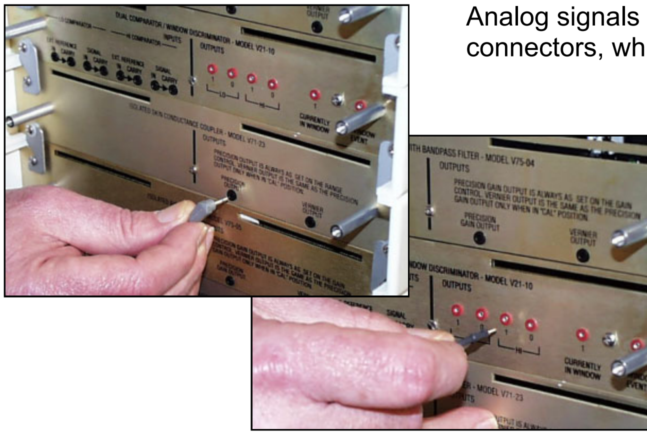
INTERLOCK CIRCUIT

There is a continuity sense line in the system, completed via the power jacks and a switch on each module, that will not allow the power supply to supply power to the modules unless the circuit is complete. **The lid** (which is provided with the base) **must be stacked on the top module** to complete the circuit so that the supply can provide power to the modules. If the stack is "broken" or **separated at any point** between the base and the lid, the **power will be shut off** automatically. This is done for safety when the system is in use; and to prevent inadvertent powering of the stack during setup when circuit boards are exposed to possible electrical damage from contact with metal tools or other objects.

SIGNAL CONNECTIONS

All signals from external sources including electrodes, transducers, sensors and very low level signals are brought into the system on the right side of the modules via various types of connectors mounted on the small metal insert plate toward the rear of the molded plastic side plate.

All module interconnections are made on the rear panels. Each module is provided with a cover plate to fit over the rear panel to secure the interconnect leads. Making connections between modules is done with the rear cover plates removed. There are both analog and digital signal jacks.



Analog signals are carried by ultra-miniature two conductor phono-type connectors, which accept ultra-miniature phono-cords.

The digital logic (+5V) signals are represented on .040 miniature pin jacks, which accept the .040 miniature programming leads. The logic pin receptacles are color-coded; white for the input pairs which are on the left, and red for outputs which are on the right.

POWERING THE SYSTEM

A separate hospital-grade, line (mains) power cord which disconnects at the back of the cabinet as well as at the wall is used with the ***LabLinc V*** system.

The lid with the interlock circuit is shipped installed on the base. It must be removed to install modules. You may remove it before initial power-up or at any time before installing modules.

To power the system, **turn the power switch off** if it is not already so, then **connect the female end** of the line (mains) cord to the line (mains) power input receptacle on the back of the base unit.

Next **connect the male end** of the power cord to a wall outlet. You are now ready to install modules.

INSTALLING MODULES

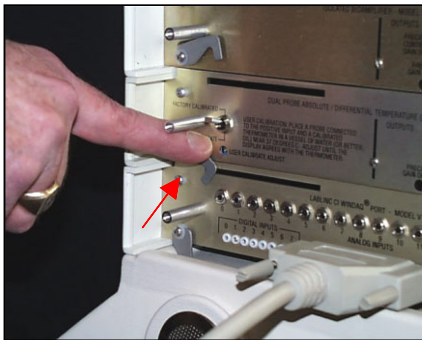
Turn off the power and disconnect all transducers and electrodes before installing or removing modules!

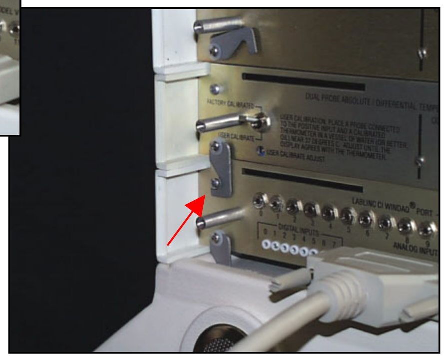
The wire protection **cover plates** on the rear should be **removed** before installing modules to permit access to the locking tabs.

Turn the locking tabs up (toward the center) so that they do not interfere with alignment and insertion of the module. (See the photos on the next page.)

To install a module, hold the module on the sides with two hands. Hold it approximately parallel or pitched slightly rearward to the top plane of the base or to the module below it. Locate the rear two power pin tips by looking into the space in front. Place them into the tops of the two rear receptacles on the base unit or the module below.

Press the module straight down to “plug it into” the base or the module below.





After installing a module **swing the locking tabs on the rear of the module down to capture the post below** (or the slot in the base if it is the bottom module) to lock the module into place. The tabs serve to lock the modules so that the stack cannot be tipped or separated.

We recommend that a LabLinc port module (if you are using one) which has a **cable that goes to the computer, be installed at the bottom of the stack as shown in the two photos to the left.** This will keep the cable from hanging down over the rear panels of the other modules and obstructing access to their rear connections.

CONNECTIONS TO YOUR COMPUTER

Several different types of port modules with associated software are offered. The type you select will depend upon your application(s). Each port comes with a card, which is installed in the back of your computer, and a cable to connect the card to the port module. Again, as shown above in the bottom of both photos, we recommend that the port module be mounted on the bottom of the stack because the cable comes off of the panel on the rear of the module. If mounted above other modules, the cable will partially cover the access to the inputs and outputs of the modules below and make it inconvenient (though not impossible) to install and remove analog and digital interconnection wires between other modules. Instructions for installing and setting the address on each card and port module are provided in the software manual that comes with the unit.

REMOVING MODULES

Turn off the power and disconnect all transducers and electrodes before installing or removing modules!

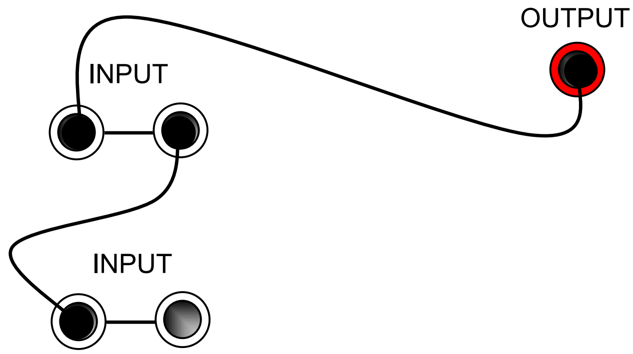
To remove modules, **disengage the locking tabs first**, then from the front of the modules, place your fingers on the sides of the modules and your thumbs under the curved projections (thumb tabs) extending forward from the side plates. Push up with your thumbs forcing the module up and disengaging the power pins. **Do not attempt to lift from the back or from either side first; lift from the front only.** Note that the pins are toward the front of the module rather than at the four corners. This was done so that, when the module is disengaged as described above, it will pivot on the back corners of the case and allow the pins a more vertical route of withdrawal so that they will not bend the standoff receptacles below.

CARRYING OUTPUTS TO MULTIPLE INPUTS

Historically three basic methods have been used for “fanning-out” outputs to more than one input. The first method provides an output receptacle for every anticipated place an output signal can be used. This is obviously impractical for most systems including this one.

The second method uses “Y” connectors and/or stackable leads. The two problems with this approach are that stackable connectors are not available for two conductor analog leads. Also, with this system, there is limited space between the rear panel and the cover plate limiting vertical clearance for stacking. Using "Y" connectors doubles the number of leads for each "2nd" connection and adds the bulk of the "Y" connector itself.

The third method is the method used in this system. We use two shorted, electrically parallel, receptacles for each of the inputs. Any output is then taken to the first module's input, and if the same signal must also go to other modules' inputs, a lead is simply connected to the other (shorted, parallel) input jack of the pair on the first module and then carried forward in daisy chain fashion.

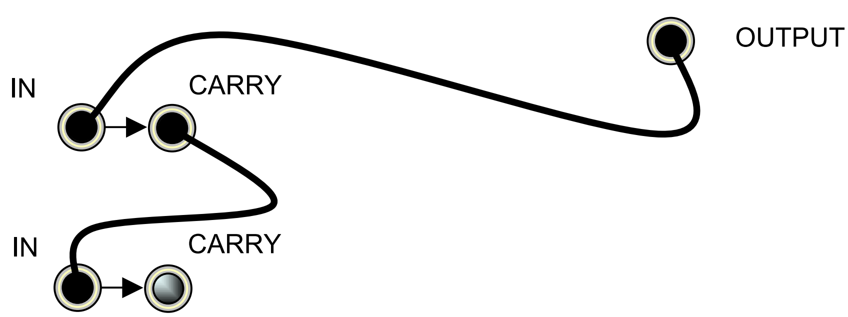


Each of the paired digital inputs is the same; they both go to the input of the circuit inside of the module and may be used interchangeably.

This simple method is used for all digital inputs in the system except the 16 channel port modules where space for jacks is at a premium. These port modules should be placed at the bottom of the stack (as discussed previously) because of the cable which connects them to the computer; and, since this is logically the "last place" to go, we provided only a single receptacle for each input.

Analog inputs are only slightly different. Since they are high gain circuits with very high input impedance, they can't be "noise proofed" like digital inputs, so the input receptacle must be shorted when no lead is in place. This is to prevent the noise signals on an open-circuit input from getting into the module and being taken as a real signal. A spring-loaded finger that shorts the signal lead to the ground lead in the two-conductor receptacle when no lead plug is in place accomplishes this. When a lead is inserted into the receptacle the plug displaces the grounded finger which then contacts the body of the plug to provide the ground potential.

The tip of the plug carries the signal to the now ungrounded terminal and to the input of the circuit. When paralleling two inputs for fan-out purposes, you cannot short both receptacles because with only one lead in place, the other would still short the circuit. The solution is to short only one. But this means that if you only use one (i.e. it is the only input jack you are going to use because it is the last input in a string), **you must use the input that is shorted (the left one) so that you break the short.**



In the ***LabLinc V*** system the shorted receptacle of the input pair is marked "IN". The other, unshorted receptacle of the input pair, is marked "CARRY". The principle is the same as for the digital inputs except that **if you use only on analog input, it must be the left one, marked "IN".**

BASIC CONCEPTS REVIEW

In this section we will review the basic concepts of signal acquisition and manipulation which define the physiological or biomechanical phenomenon of interest, other signal manipulation, and things that interfere with the signal or its acquisition.

SIGNAL TRANSDUCTION

Transduction refers to the conversion of one form of energy to another. Devices that do this are called **transducers.** Since this system acquires and processes electronic signals, the transducers **convert some form of energy**, which represents the phenomenon, **into electrical signals.** This has not always been the case and perhaps some examples from history will serve to give insight to the concept.

In old polygraphs (a term usually referring to "lie detectors"), respiration was transduced by a chest bellows connected to some sort of strap tied all the way around the subject's torso. The bellows, an accordion shaped tube, was stretched by the increase in diameter of the torso occasioned by the drawing air of into the lungs. The attendant increase in volume of the bellows represented the inspiration response. A small diameter hose from the chest bellows was connected to another, smaller, bellows (or a piston) which in turn decreased its volume as the air drawn into the chest bellows was drawn from it. The smaller bellows was mechanically connected directly to one of the pens of the polygraph causing a pen deflection proportional to the chest bellows' volume increase and was representative of breathing.

Another example illustrates direct mechanical coupling; so direct in fact that it is questionable whether the term transduction even applies. To record muscle contractions, an excised muscle was connected, under slight tension, between two clamps. One of the clamps was fixed rigidly with respect to a frame and the other was connected to one end of a first class lever. The other end of the lever was a pinpoint riding on a smoked glass drum turned by a clock mechanism (kymograph). As the muscle contracted the pinpoint scratched the smoke layer off of the drum leaving a trace representing displacement of the lever which was directly proportional to the contraction of the muscle.

These transduction modes are still used today, however modern chart recorders, and now (almost exclusively), computer inputs, are electronic. So today, the devices are connected to transducers, which transduce air pressure in the case of the bellows, or mechanical displacement in the case of the clamp, into electrical signals.

Any device that senses an energy output of the subject reflecting the response of interest is called a transducer. This includes electrodes as well as those devices that respond to heat, acceleration, pressure, position, displacement, light, sound or any form of energy change.

Surface electrodes, implantable needle electrodes, glass capillary electrodes or any type of transducer called an electrode, responds to a complex electrical signal which is a result of the electrochemical behavior of the tissue it is monitoring.

An electrode may be doing something as simple as registering the voltage potential between it and another electrode in much the same way as the leads of a voltmeter work (though in reality there is a much more complex response going on in the tissue to which it is attached).

Electrodes may also be excited, that is; have a voltage or current applied between a pair of them to measure either the current flow that results, in the first case, or the resultant potential across them, in the second. In either case the resulting signal represents a response complex that reflects more than one phenomenon within the preparation. For example, constant current excitation will result in a measured voltage change that reflects changes in DC resistance as well as changes in impedance from capacitive sources (which will also vary as a function of the frequency of the excitation signal). It also forms potentials within the tissue which aid (if the same polarity) or "buck" (if the reverse polarity) the current flow. These potentials may be generated by the subject from underlying muscle or nerve action potentials or be electrochemical in nature owing to tissue chemistry.

Electrochemical responsiveness of the tissue may also cause electrode charging (much like a battery or an electrolytic capacitor) and result in a potential which "bucks" the excitation-current flow. It is for this last reason that skin conductance coupler electronics supply a very low frequency (slowly reversing) AC signal to the electrodes; reversing to equally charge and discharge the electrode sites, and slow so that AC capacitive impedance is negligible or of no consequence.

SIGNAL COUPLING

Couplers are the electronics that **provide excitation**, if any, and **perform manipulations on the signal** acquired by the transducer so that the signal reflects the response of interest as closely as possible. Couplers in the CI system are modules (with, in a few cases, additional remote boxes closer to the subject). These modules have an input connector that is located on the right rear of the module for the transducer cable connection. There are also controls on the module face to allow the operator to perform some of the manipulations that define the response.   The manipulations that may be performed on the signal by a coupler include: **gain**, **filtering** (to a frequency band), **offset** (balancing), **integrating, differentiating,** and **comparing** to a second transducer or a set reference point to generate a difference signal. Signals may also be further defined, compared or added to other signals or set points, inverted, etc., by other modules before they are recorded and/or statistically analyzed.

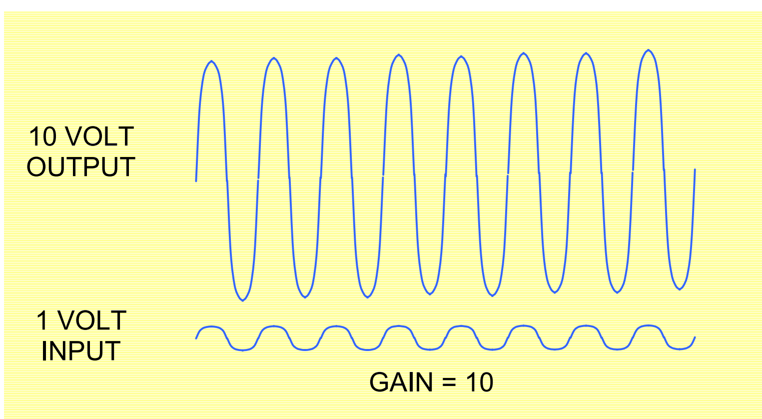
We refer to couplers for biopotentials (voltage signals picked-up by electrodes without excitation) as biopotential amplifiers or just bioamplifiers. Other modules that connect electrodes with excitation, or other types of transducers to the system, are referred to as couplers.

Below are some of the operations that are performed on signals that define the response of interest, and prepare it for other modules and for recording.

GAIN

This is simply the process of making the signal bigger. In the bioamplifiers, gain is usually substantial (in the order of many thousand times) because nerve and muscle potentials are very small, especially when picked-up at the skin surface. Surface electrodes measuring biopotentials generally pickup tens of microvolts to a millivolt or so.

To get these signals to the nominal one-volt range requires gains of hundreds to as high as 50 thousand. Gain ranges on the bioamplifiers therefore reflect these requirements. In other couplers, gain may be called something else; something that relates to sensitivity in the units of measure of the particular transducer(s) it is designed to interface, e.g. degrees F or degrees C, or g (acceleration) etc. Gain may also increase the size of a signal representing a relative measure that has no absolute scale, such as a blood flow signal measured photometricly (interference with a light beam by the opaque components of blood as it flows through capillaries – see page 94).



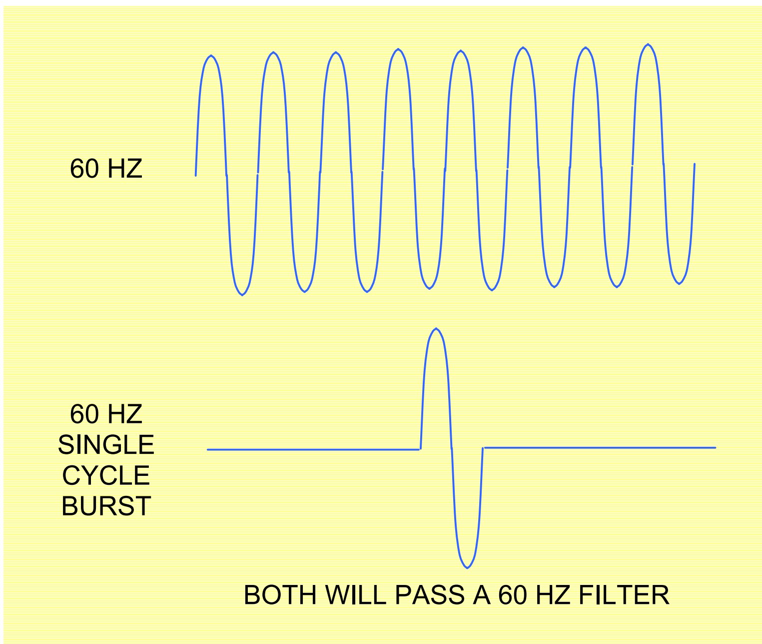
To perhaps oversimplify; the coupler interfaces the transducer and converts the transducer's signal to a voltage. The gain (or sensitivity) control makes the signal bigger. In the non-electrical, direct mechanical coupling examples earlier, it is analogous to changing the leverage so that the muscle or the bellows attachment to the pen is closer to the fulcrum. This places the writing tip much further away so that the writing end travels very far with respect to the "sensor" end.

FILTERING

To understand filtering, it is necessary to understand frequency. Frequency (as generally used in discussing electrical signals) refers to the number of times an AC (Alternating Current) signal reverses direction in one second, or the number of cycles per second (CPS - the old measurement unit). The present measurement unit is Hertz, named for Heinrich Hertz, a German physicist. 1 Hertz or 1 Hz equals one cycle per second, previously designated 1 CPS. (Interesting Note: **C**harles **P**roteus **S**tienmetz did more work with alternating current than did Hertz.)

Hertz refers to a sinusoidal function, the first 180^{o} being positive and 180^{o} to 360^{o} being negative (the sign of the potential being required to cause current to flow in the opposite direction). **It is important to note that Hz does not apply to non-sinusoidal signals.**

A line, or mains frequency of 50 or 60 Hz of sinusoidal configuration is not the same, as far as a filter is concerned, as a "square wave" or a stream of pulse spikes occurring at 50 or 60 times a second. A filter responds to the sinusoid shape and its rate of rise and fall within the confines of the form.



Thus if a single cycle (sinusoid) of, say 60Hz repeating even at only *once* per second (as shown above) is put into a filter set to pass 60Hz, the filter will pass the signal.

If a brief pulse or sinusoid cycle of a higher frequency or noise repeating at 60 times per second is applied to a filter set to pass 60 Hz it *will not pass.* Conversely, as shown in the lower trace in the figure on the next page, *neither will it be rejected* by a 60 Hz notch (narrow band reject) filter used to eliminate 60 Hz from recordings.

This is very important to understand for two reasons. First, there is electrical noise in the environment, radiated from the mains or line, that retains (mostly) the sinusoidal shape. This signal can be eliminated with a very narrow band-reject or notch filter from the physiological signal, but there is also noise derived from the line which may repeat at the frequency driven by the line but is of a different shape and will not be filtered out or rejected.

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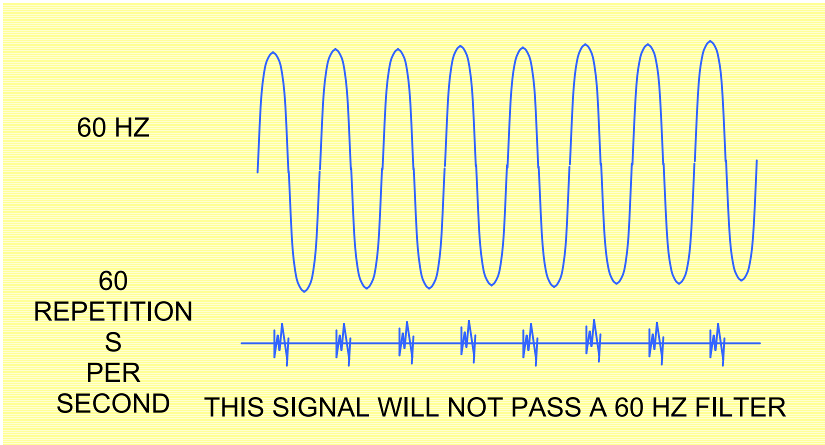
Secondly, physiological signals themselves are not "pure" sine waves. They are composites of many different signals and interactions having a complex of sine-like components.



The most onerous of the noise sources mentioned in the first case (and shown in the drawing above) is fluorescent lighting which serves as a good example. The transformer in the lighting unit (called a ballast in the U.S.A.) which provides the very high voltage necessary for the tubes to form a plasma and conduct to produce light, may be "over-enthusiastically" value engineered for economy. Many of these (cheap) units do not have sufficient insulation; so they "spark through" the insulation when the voltage nears the top of the high voltage peak. This sparking does not cause failure (at least not until the warranty expires) and still provides sufficient voltage and energy to light the light. It does, however, cause a single, high frequency spike once every 1/60 of a second.

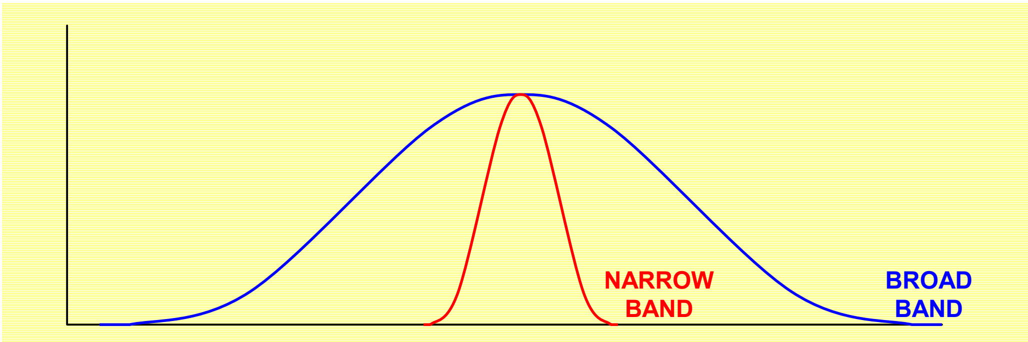
Such signals (illustration on previous page) ***cannot be filtered out with 60 Hz filters*** (even though they repeat at 60 times a second) ***because they are not 60 Hz <u>sinusoids</u>***. In fact, depending on the amplitude of the output at breakdown, the duration of breakdown and the changing resistance across the pinhole path of the spark, it is a complex waveform (somewhat like radio "static" from lightening). (If you are replacing one of these transformers insist on the best quality, do likewise if you have anything to say about specifications on new construction.) Similar noise can come from the collapsing magnetic field incident to the operation of solenoids, relays and other electromechanical devices. (This is why Coulbourn Instruments uses diode coil suppression of those devices in behavioral environments.)

Filters for physiology are most commonly of the Butterworth type. This is both because this type of filter performs best at the relatively low frequencies encountered in physiological applications and because, historically this type has been used to build the general knowledge (informal database) about physiological signals. Other types may be used, but the characteristics of the signals passed will differ.

There are 4 types of filter, low-pass, high-pass, bandpass and band-reject. Filters attenuate signals above or below their nominal pass frequency. High and low pass filters pass signals respectively above and below their nominal setpoints and attenuate other signals. Bandpass filters pass signals above the high-pass and below the low-pass setpoints and attenuate signals outside of this band. Band-reject filters pass signals above and below and reject signals between the set points. Both of the last two are made by simply combining a low-pass and a high-pass filter. A special case of band reject filter is the notch filter. The notch filter has a very narrow band of rejection and is most commonly used to eliminate noise from a source of specific frequency. In our system 50 or 60 Hz (depending on the mains or line frequency in the country where they are to be used), notch filters are built into amplifiers and couplers. This is because the vast majority of unwanted signal is from the power lines in the building and the apparatus it powers. Just remember they only reject sinusoids.

Attenuation of frequencies outside the specified pass frequency of a filter increases the further away from the specified point those signals are. The amount of attenuation, as a function of how different the frequency is, varies according to how many poles the filter has. The attenuation is specified in Decibels, a logarithmic scale of amplitude. Frequency is specified in octaves, a doubling and halving scale referring (in this case) to how far from the set point the attenuated frequency is measured. In a Butterworth filter the attenuation is 6 dB per octave per pole. Thus a single pole Butterworth high pass (low cutoff) filter attenuates a signal at one half the frequency of the setpoint by 6 dB, and a low pass (high cutoff) filter of the same specification attenuates signals at twice the frequency of the setpoint by 6 dB. A 2 pole filter has 12 dB per octave cutoff, a 4 pole 24 dB / octave, and an 8 pole, 48 dB / octave. 12 dB / octave is the minimum required for study of most phenomenon. 24 dB / octave is usual for EEG, with some very narrow bands requiring 48 dB for proper signal definition.

A graph of the curve plotting attenuation as a function of frequency is "bell shaped" due to the logarithmic nature of the scales. The sides if the curves are referred to as "skirts" because of their shape. Sharp skirts refer to greater attenuation; a 48 dB / octave filter has "sharper skirts" than a 12 dB / octave filter.



It may occur to you that it is easier to think of filters in terms of cutoff or attenuated regions rather than in pass regions. A bandpass filter with a low pass of 10 Hz and a high pass of 5 Hz passes signals between 5 and 10 Hz. You may find it easier to think of a 5 Hz low cutoff and a 10 Hz high cutoff that will pass 5 to 10 Hz. If so, you have a lot of company (including me).

Setpoints specify the point of 3-dB attenuation. A bandpass filter set for a "too narrow" pass band (high cutoff and low cutoff too close together) will not pass the center frequency at full level of the input signal) because the "skirts" intersect. Needless to say the sharper the skirt, the closer the high and low cutoff can be set and still pass the center point frequency at full amplitude.

The complex nature of signals, especially those picked-up by electrodes with bioamplifiers, allows filtering to better define what aspect of the signal is pertinent while at the same time it may make the elimination of all unwanted signal and/or the inclusion of all of the wanted signal relatively difficult. This paradox is not quite as perplexing as it may at first seem. Most signals of interest are different enough to achieve significant separation by filtering. Also the signals, though arbitrarily defined with respect to frequency have an historical database due to the (relative) consistency of definition by researchers, clinicians and instrument manufacturers.

Biopotentials are operationally defined by the filters used to study them even though some of the signal may be attenuated by the filter in the interest of separating some of it from other phenomenon.

The location from which the signal is picked-up is another component of the definition. ECG is generally recorded with a 10 to 150 Hz filter at 12 dB / octave while EEG is generally recorded from 1 to 40 Hz at 12 dB / octave, a considerable overlap. Since there is not much cardiac signal across the skull or between an ear and a location on the scalp, and there is not much EEG signal across the chest or a chest site with respect to the limbs, it is not a problem. EMG may be recorded over muscles on the skull (e.g. the frontallis placement). Though there is some electrical potential reflecting muscle tension at lower frequencies, EMG is generally recorded here above 40 Hz to separate it from (defined) EEG. Though there is some EEG above 40 Hz, cutting it off here defines it and limits the contribution of muscle action to the signal. When EMG is recorded on the chest or over long sections of limbs, it is generally recorded with a low cutoff above 90 Hz to minimize contributions from ECG. Recording of signals which have components of interest outside the “conventional” bands, may be accomplished by using other filters with sharper skirts and / or tighter topographical definitions of electrode sites, or in extreme cases, by using more selective electrodes (needle or implantable type).

What is most important to recognize here is that the electrical signal from the organ does not necessarily totally define the signal that can be dealt with practically, and that convention and practice have made major contributions to the definitions of responses. In this system, amplifiers and couplers define the response by their design, with latitude for adjustment by the user. The nature of the transducer and requirements for excitation, if any, is built-in. Adjustment is provided to accommodate different transducers. Controls for gain and frequency are provided for variations in aspect of a named phenomenon to accommodate the study of many different phenomenon. We do not have an EMG amplifier, or a single site EEG amplifier. Our bioamplifiers can be used for either of these functions and many more.

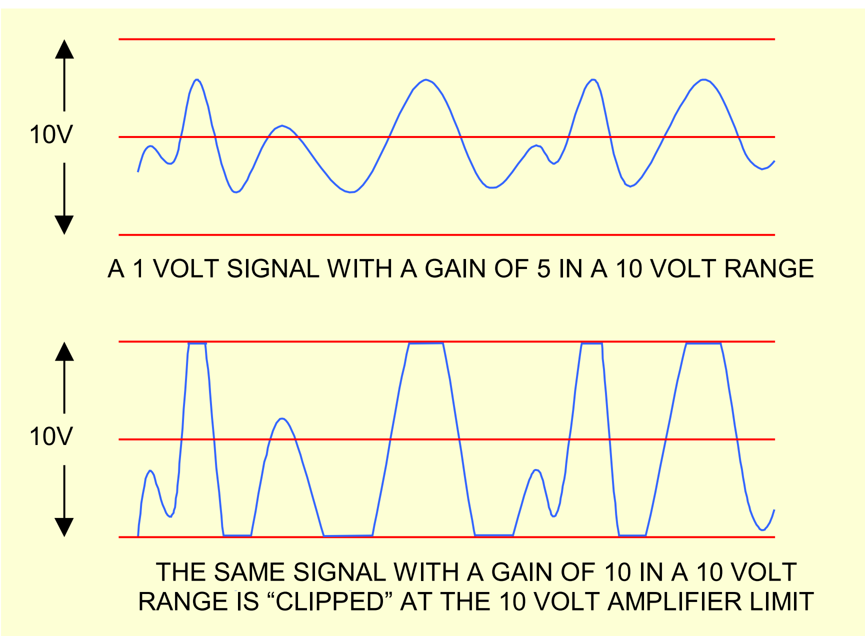
The chart of applications (previous page) shows the amplifier or coupler along with the separate filter or processor modules and transducers suggested or required.

DYNAMIC RANGE

Transducers, couplers and amplifiers all have a dynamic range. This range is the limit beyond which they cannot follow the signal with a corresponding output. For example, if a pressure transducer has an output of 1 millivolt per millimeter of mercury (from the coupler) and has a dynamic range limit of 500 millimeters of mercury, then the output will rise as pressure is applied producing 50 millivolts at 50 millimeters of mercury, 100 mV at 100 mm Hg, 200 mV at 200 mm Hg, etc. up to 500 mV. As the pressure rises above 500 mm Hg the output will not follow. Depending on the transducer it may stop altogether or put out only, maybe 525 mV at 600, 540 at 700, 545 at 800 and then no more. Eventually, perhaps at several thousand mm Hg, the transducer will be damaged.

In the above example, the linear range of the transducer is 0 to 500 mm Hg. If the change in output in the nonlinear region is regular from 500 to 800 mm Hg so that it can be compensated for by electronics or a signal processing algorithm, the dynamic range is said to be 0 to 800 mm Hg. If the output is not same at given points above 500 from trial-to-trial then the useful range is only 500 mm Hg.

For amplifiers and couplers, the absolute limit to range is the voltage of the power supply for the circuit (actually a little less). The circuit simply cannot put out more voltage than that which powers it (at least not without a transformer or an exotic voltage multiplier circuit). The LabLinc V system is powered by ±15 VDC and the maximum output of any module is limited (by design) to about ±10 Volts. Therefore if you have a signal coming into an amplifier with a peak value of 1 Volt with the gain of the amplifier set at 5, the output will have a peak value of 5 Volts, well within the range.



But, if you set the gain at 10 then the signal will exceed the range by a factor of two. The signal will be "chopped off" at the top and you will see only the bottom portion on a chart record. The signal will follow the input to 10 volts at the output and then be flat or clipped above that level. **Another term for this phenomenon is amplifier saturation. An amplifier is saturated when it has reached the limit of its range.**

All amplifiers and couplers in the LabLinc V system have multiple stages of gain, that is, multiple amplifiers in series to achieve the total overall gain required. This is because the high gains needed in these types of applications simply cannot be accomplished in one stage. The gain setting controls several stages of gain including the first stage, but the amplifier can still be saturated before the overall output reaches 10 volts. This is because the preamplifier stage may simply have a signal coming in that is beyond its range. The LabLinc V system minimizes the problem by linking the gain control to the preamplifier stage as well as other stages. If saturation does occur it will be in a range close to the overall range of the amplifier, so that if clipping does occur it will be obvious in the record and easy to correct by simply reducing the gain by one increment. The record can be restored to its prior trace amplitude by increasing the gain of the trace on the chart in software.

NOISE AND ARTIFACT

Undesirable, non-signal, information in the record comes from 3 sources: electromagnetic radiation, transducers (including electrodes), and from the internal circuitry of the amplifier or coupler itself.

Internal noise from the electronics in modern circuitry is usually negligible, especially in high quality systems like the LabLinc V system. However the noise in each component is amplified each time a stage of gain amplifies a signal to a higher level, at extremely high gains there will be some detectable noise in the signal. It is not significant with most signals, but for low level signals such as EMG recorded from a small area with closely spaced electrodes, it may be seen in the record if the amplifier gain and chart display are large enough. This is because the signal levels can be as low as single digits or tens of microvolts requiring a gain of 50,000. There is a method for dealing with this type of noise. It is discussed in the application notes for the integrator V76-23. For almost any other signal it so small that it can be disregarded.

Noise from electromagnetic radiation from power lines, fluorescent lighting (as mentioned earlier), motors, and other electromechanical equipment, may be picked-up anywhere in the system if it is large enough. This may be from the subject, electrodes or transducers, electrode or transducer cables, or the amplifiers and couplers themselves. There are different ways of dealing with noise depending on where it comes from.

Noise pickup at the modules in the LabLinc V system is dealt with by having the first amplifier stage directly adjacent to the input (terminus of the shielded cable bringing the signal into the system). There is also a shield plate between the power supply in the base and the stack of modules so that the lower modules in the stack do not pick up even the small amount of noise generated by the power supply. **It is, however, *not* a good idea to place heavy power consuming devices directly adjacent to the modules.** A computer or similar type of equipment even touching the LabLinc base unit presents no problem at all, but, for example, placing a large motor or transformer a few inches from the module stack should be avoided.

Noise from transducers and electrodes can be generated in several ways. They may simply **pick up electromagnetic radiation**, which is controlled by shielding of the housing or leads and by using a differential amplifier. We have done a very careful job of shielding and we use differential amplifiers with very high common mode rejection so this source of transducer and electrode noise is not a problem in the LabLinc V system.

Noise induced into electrode leads by radiation from voltage sources in the environment (including things like those pesky fluorescent light transformers, brush type motors, etc.) is dealt with by using differential amplifiers. A differential amplifier has 3 input leads - a positive signal input, a negative signal input, and a reference input. With the electrodes arranged with the reference electrode equidistant from the signal leads, the true signal you are measuring generated between each signal lead and the reference lead is the same "shape" but it is of **opposite polarity** with respect to the other. If one of the signals is **inverted and summed** with the other, the result is a signal that is the same "shape" as the original and its mirror image, but **twice the magnitude**.

If the leads are parallel so that the geometry of any magnetic field is the same as it cuts through the leads and induces an **unwanted electrical signal (noise)** in the leads, that signal will be the **same polarity in each lead** (common mode signal). In the **inverting** process these signals become "opposites" and in the summing process, **they cancel-ou**t, effectively getting rid of the noise.

The type of amplifier that does this is a differential amplifier. Desired signals produced by the tissue are called **differential mode signals and are summed;** and signals from electromagnetic radiation picked up by leads and cables are **common mode signals, which cancel themselves out.** The ability of a differential amplifier to cancel-out common mode signals is measured in dB and is specified as **"common mode rejection".**

Internal noise, generated by the sensing elements themselves, is generally not a problem with modern transducers. By using differential amplifiers, shielding well, and filtering (especially mains/line frequency notch filters), noise in the modern recording system is controlled so well that special rooms and/or other precautions are rarely needed.

Mechanically induced noise however, can be a problem. Load (weight) cells such as our ergometric and startle/tremor platforms, and accelerometer transducers are sensitive to vibration. If your are recording tremor or general activity with a platform, background seismic activity is a source of signal that is not generated by the subject (therefore it is noise). The transducer is however, measuring what it is supposed to measure. In cases such as this you must isolate non-subject from subject-generated signals. In most environments the signals are negligible, though you may see a small amount of activity without an animal on the platform. Buildings on concrete slabs near roads with heavy traffic may transmit vibration that is possible to see in the record, elevators near experimental rooms may show the same kind of artifact. Generally these artifacts are insignificant but this discussion illustrates the concept that signals of the same type of energy cannot be discriminated by a transducer. Many of these types of signals can be eliminated by filtering since their frequency differs from the signal of interest generated by the subject.

An analogous situation exists when other types of transducers and electrodes respond to mechanical impacts in much the same way. Electrodes can be a significant problem if good preparation procedures are not followed.

Electrodes, as mentioned before may carry an excitation voltage across the site in some applications; and in voltage potential measurement applications may still develop a charge or potential between the electrode and tissue. When conductive electrode gel is used the electrode, gel and tissue may form a battery-like element producing a voltage potential. You will recall that this potential can resist or "buck" excitation voltages. It can also be modulated by mechanical displacement.

If a surface electrode is struck or its lead is pulled causing displacement, the relative movement between the tissue and the metallic pickup portion of the electrode acts like a variable resistor and/or capacitor and modulates the potential resulting in a "false" signal. Again the amplifier is doing what it is supposed to do, but it (alone) cannot discriminate between "good" and "bad" information. The purpose of electrode gel is not only to minimize resistance but also to minimize *change* in resistance as the electrode moves relative to the tissue. The plastic electrode cup, which recesses the metal electrode disk from the skin, creates a space for the conductive electrode gel. Owing to the constant volume of enclosed gel and two dimensions of fixed geometry, the gel is not responsive to change in position of the electrode because homogeneous-volume conductors have constant resistance provided the two electrodes don't actually touch. See page 83.

Filters can help when the artifact is out of the frequency range of the signals to be studied. However, the magnitude of this type of artifact can also be so great that it saturates the amplifier with the result that there is no signal to filter. Proper electrode site preparation and installation with quality gel, good adhesion of the rim with collars, firm connection of leads as well as restriction of subject movements, which stress the connection, is extremely important. In low gain biopotential recording such as ECG, the problem is minimal; but when you are amplifying at 20 to 50 thousand it can be significant. Good electrode application practices will eliminate the problem in most cases. Also don't discount the benefit of anchoring electrode leads with elastic sweatbands, and the electrode cables with the clothing clip we provide.

Cables and excited transducers are also subject to an analogous phenomenon, it is called the microphonic effect. The wires in the cables and the elements of the transducer may be displaced by impact or vibration, modulating the excitation (or even true signal) voltages to produce artifact.

Insulated wires sliding over one another in a cable as the cable is bent can generate voltages as well. This is almost never a problem; however you are cautioned not to use ordinary cable as electrode cable. Electrode cable is specially made to have a very low voltaic response to vibration and bending.

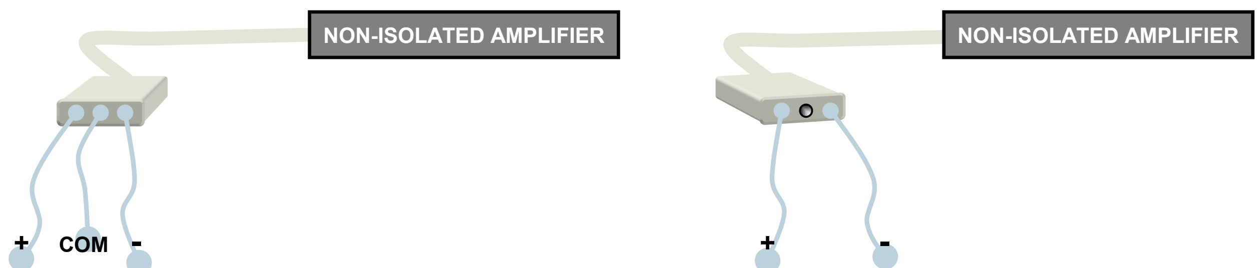
SATURATION

When a signal reaches the maximum input voltage level on an amplifier, the coupling capacitor becomes saturated. When this happens, the capacitor cannot pass any AC signal because it is filled to capacity and "cuts out". If the coupling frequency were 10 Hz or more, the capacitor would discharge rapidly and begin to pass the signal almost immediately. With our bioamplifiers, for example, the lowest coupling frequency is 0.1 Hertz (10 seconds). When the preamplifier saturates with this coupling constant, the output goes to zero for as long as 10 seconds following the artifact. This is unavoidable when *high signal quality* and *low frequency response* are desired; but a compromise can be reached by changing the coupling time constant and/or the gain.

As discussed earlier, preamplifier gain is changed with range, and on some units it may be set separately with a jumper on the circuit board for special applications involving high artifact with low signal amplitudes. It is better to eliminate artifact where possible with, for example, good electrode preparation before compromising data acquisition objectives with amplifier settings.

GROUND LOOPS

Ground loop noise occurs when multiple, non-isolated amplifiers are used on one subject. It is due to having more than one earth grounded electrode and lead referencing the system to the subject. The center lead in the electrode cable is the common and when two or more cables are connected to one subject and then plugged into two of the earth ground referenced amplifiers the loop is established. To avoid this problem use no more than one non-isolated amplifier or use only one common (ground) reference for all of the amplifiers.



Eliminate ground loops when *using non-isolated amplifiers by using only one common* (earth grounded} electrode per system. When using isolated amplifiers, each amplifier must have its own common lead (these are not earth-grounded).

The same tactic is used when using the V75-08, 4-channel EEG amplifier. Each four-channel module has only one common ground, and if you use multiple modules you use the common ground electrode on only one of them. The 9-conductor cable has a positive and negative lead connection for each channel, and the 9th lead is the common (ground) reference for all channels. When using the EEG amplifier with other non-isolated amplifiers, it is best to use the ground on the EEG amplifier as the common reference for all.

For Use and Care of Electrodes, see pages 83 - 85 in the electrode section of this guide.

V19-02 LABLINC WINGRAPH PORT

This module provides input/output interface to V-series modules, interface to outside signals, connection to the data acquisition board supplied with software, and hardware polarity control for signals to and from the computer.

It has 16 analog inputs, 8 digital inputs, 8 digital outputs, and 2 Digital to Analog Converter outputs on the rear panel, It also has an optically isolated input, and a relay on the side plate for communication outside of the system.

The analog inputs can accept signals up to ±10 volts.

The digital inputs and outputs are standard CI, 5V low true, module logic levels. The 12-bit digital to analog converters output signals up to ±10 volts.

The optically isolated side-plate signal input can accept any signal level from +5V to -30 volts. The output on the side plate is a relay that can drive any signal up to a maximum current of 100 mA (resistive). The side plate is used to drive, receive, and isolate an "outside-world" 5V high-true, 28V low-true (behavioral control system), or other signal levels to and from the V-series system.

The side-plate ***output*** jacks represent the normally open contacts of a relay (form-A).

To use the optically isolated side-plate ***input***, connect the more positive of the wires bearing the signal (ground for negative logic or the signal for positive logic) to the black, "+" input jack. Connect the more negative wire to the blue, "-" jack. Any time there is a difference between the two jacks of at least 5 volts (nominal) and no greater than 30 volts with the proper, indicated polarity, the interface will register the signal.

The input on the side plate may be dedicated to any one of the 8 interface input channels by moving a jumper on the board. It is installed in position 3 from the factory. Channel 1 is dedicated as an event marker, and channel 2 as the "remote start-stop". You may move the jumper to any input bit you choose, including one of these two. Just be careful not to assign it to one of the channels you are going to use for a logic input from one of the V-series modules. (If you do, signals from the *either of the two , acting as if through an or gate, will activate the input*.)

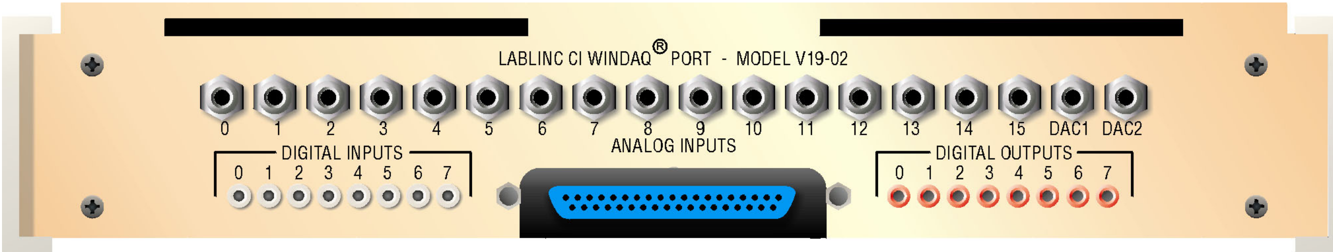
The output relay may also be assigned to any of the 8 output bits. *Both the relay* and its selected, corresponding logic *output* on the back panel, will be *on at the same time*.

The unit has inverters for the inputs and outputs so that the system may easily be used with other instrumentation which has user-accessible "+5 volt" signals (high-true logic for operating outside devices). The inverters are jumper-controlled in banks of four so that you may use all, or only four of either the input or output groups, and the other four for V-series module logic. If using the first four inputs in the inverted mode, note that the logic command for "event" and "remote start-stop" will be inverted and activated when a V-series module goes "off".

NOTE: If you elect to connect other systems' signals to the rear panel using this method you may defeat the system's safety specifications.

The V19-02 should be mounted on the bottom of the module stack so that the cable will not interfere with module-to-module lead connections.

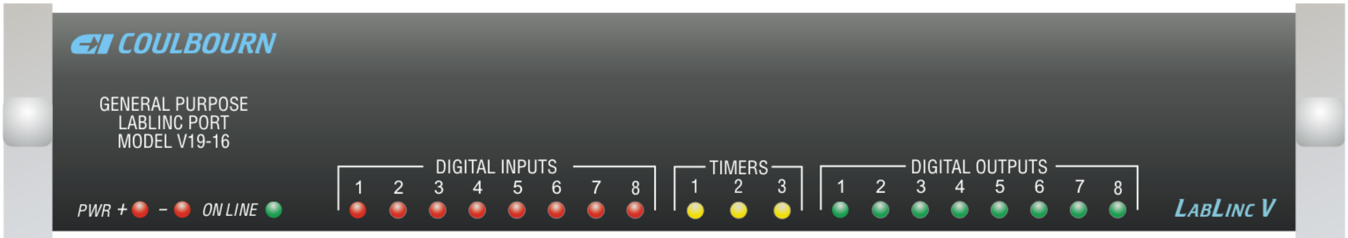
Installing the card in the computer and connecting the cable is discussed in the manual provided with software.



SPECIFICATIONS

Analog Input Impedance: > 1 Megohm
Input Level: ± 10 Volts Max.
Frequency Response: DC to 100 KHz (limited by A/D converter).
Analog Signal Connections: .098 in - 2.5 mm, Ultraminiature Phono Connector.
Digital Signals: +5V, Low True logic.
Digital Signal Connections: .040 in - 1mm Pin Lead.
Digital Signal Minimum Pulse: 10 microseconds.

The interface port should be mounted on the bottom of the stack. (See page 7.)



V19-16 GENERAL PURPOSE LABLINC PORT

This module provides input/output interface to V-series modules, interface to outside signals, connection to the data acquisition board supplied with software, and hardware polarity control for signals to and from the computer.

The V19-16 has 8 analog inputs, 4 analog outputs, 8 digital inputs, 8 digital outputs, and 3 selectable counter/timer outputs on the rear panel. The V19-16 also has an optically isolated input and a relay on the side plate for communication outside of the system (via a V19-91 Real World Interface Box).

The analog inputs can accept signals up to ±10 volts.

The digital inputs and outputs are standard CI, 5V low true, module logic levels. The 12-bit digital to analog converters output signals up to ±10 volts.

The optically isolated side-plate signal input can accept any signal level from +5V to -30 volts. The output on the side plate is a relay that can drive any signal up to a maximum current of 100 mA (resistive). The side plate is used to drive, receive, and isolate an "outside-world" 5V high-true, 28V low-true (behavioral control system), or other signal levels to and from the V-series system.

The side-plate ***output*** jacks represent the normally open contacts of a relay (form-A).

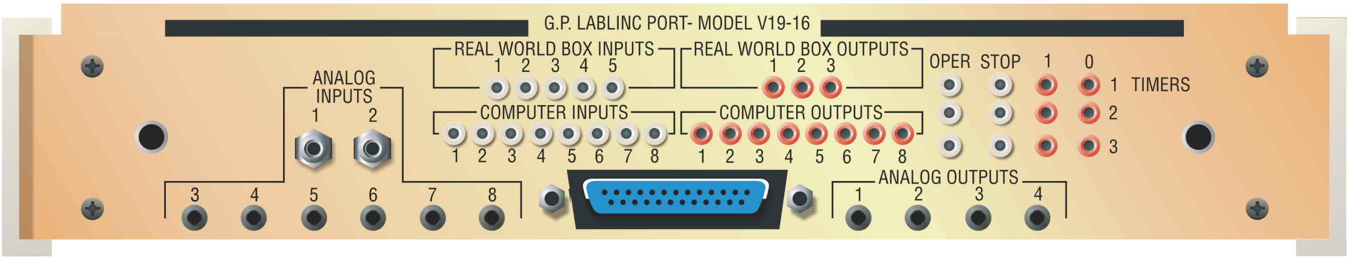
To use the optically isolated side-plate ***input***, connect the more positive of the wires bearing the signal (ground for negative logic or the signal for positive logic) to the black, "+" input jack. Connect the more negative wire to the blue, "-" jack. Any time there is a difference between the two jacks of at least 5 volts (nominal) and no greater than 30 volts with the proper, indicated polarity, the interface will register the signal.

The input on the side plate may be dedicated to any one of the 8 interface input channels by moving a jumper on the board. It is installed in position 3 from the factory. Channel 1 is dedicated as an event marker, and channel 2 as the "remote start-stop". You may move the jumper to any input bit you choose, including one of these two. Just be careful not to assign it to one of the channels you are going to use for a logic input from one of the V-series modules. (If you do, signals from the *either of the two , acting as if through an or gate, will activate the input*.)

The output relay may also be assigned to any of the 8 output bits. *Both the relay* and its selected, corresponding logic *output* on the back panel, will be *on at the same time*.

The unit has inverters for the inputs and outputs so that the system may easily be used with other instrumentation which has user-accessible "+5 volt" signals (high-true logic for operating outside devices). The inverters are jumper-controlled in banks of four so that you may use all, or only four of either the input or output groups, and the other four for V-series module logic. If using the first four inputs in the inverted mode, note that the logic command for "event" and "remote start-stop" will be inverted and activated when a V-series module goes "off".

NOTE: If you elect to connect other systems' signals to the rear panel using this method you may defeat the system's safety specifications.



The V19-16 should be mounted on the bottom of the module stack so that the cable will not interfere with module-to-module lead connections.

Installing the L18-16S/C ISA card in the computer and connecting the cable is discussed in the manual provided with the software.

SPECIFICATIONS

8 Analog Inputs: Single ended
Analog Input Impedance: > 10^9 ohm
Input Level: ± 10 Volts Max.
Converter Resolution: 12 bits

4 Analog Outputs: Single ended
Output Level: ±10V (max.)
Converter Resolution: 12 bits
Output Impedance: < 50 Ω

Analog Signal Connections: .098 in - 2.5 mm, Ultra-miniature Phono Connector.
Digital Signals: +5V, Low True logic.
Digital Signal Connections: .040 in - 1mm Pin Lead.
Digital Signal Minimum Pulse: 10 microseconds.

3 Timers/Counters: User selectable via jumper
Timer Resolution: Jumper selectable .1, 1 & 10 mS
Max Timer (PER COUNTER, 10mS RESOLUTION): 655.35 SECONDS
Computer Programmed Time or External Start / Stop
Complementary Outputs
Event Counter via Operate Jack

9 pin D-SUB provided on side plate for use with V19-91 Real World Interface Box
3 Real World Outputs: +5V, Low True Logic outputs ***from*** Real World Box
5 Real World Inputs: +5V, Low True Logic Inputs ***to*** Real World Box

PROGRAMMING GUIDE

Programming the V19-16 requires the presence of a Coulbourn ISA interface card model L18-16S/C. In the instructions below, the address of the L18-16S/C is referred to as ***addr***.

DIGITAL OUTPUT

Write a byte to ***addr***+4.

DIGITAL INPUT

Read a byte from ***addr***+4.

ANALOG OUTPUT

Given a desired output voltage V, follow these steps.

V_1=V/0.0048-2047
MSB=INT(V_1/256)
LSB=INT(V_1-256*MSB)

Write the LSB and MSB to the addresses in the table below.

DAC NUMBER	Write LSB to	Write MSB to
1	***addr***+8	***addr***+9
2	***addr***+10	***addr***+11
3	***addr***+12	***addr***+13
4	***addr***+14	***addr***+15

Write 0 to ***addr***+5.

ANALOG INPUT

To read a sample from one of the 12-bit A/D channels, perform the following steps.

Write the channel number (0 through 7) to ***addr***+7.
Poll ***addr***+5 to determine that the least significant bit (D_0) is not 1.
Read the LSB from addr+6.
Read the MSB from addr+7.
The value is then calculated as (MSB*16 + LSB/16 – 2047) * 0.0048

TIMERS

To program one of the timers to time *n* milliseconds, perform the following steps.

Determine the LSB and MSB of the desired duration. In the following examples, all values are hexadecimal. The LSB and MSB for 5,000 msec are 88 and 13 respectively since $5{,}000_d$ is 1388_h. Similarly, the LSB and MSB for 3,000 are B8 and B.

Write the counter select byte to addr+3.

Write the LSB and MSB to the appropriate addresses.

Write the appropriate byte to addr+4.

Write 0 to addr+4.

Timer	to ***addr***+3	LSB to	MSB to	to ***addr***+4	to ***addr***+4
0	32	***addr***	***addr***	1	0
1	72	***addr***+1	***addr***+1	2	0
2	B2	***addr***+2	***addr***+2	4	0

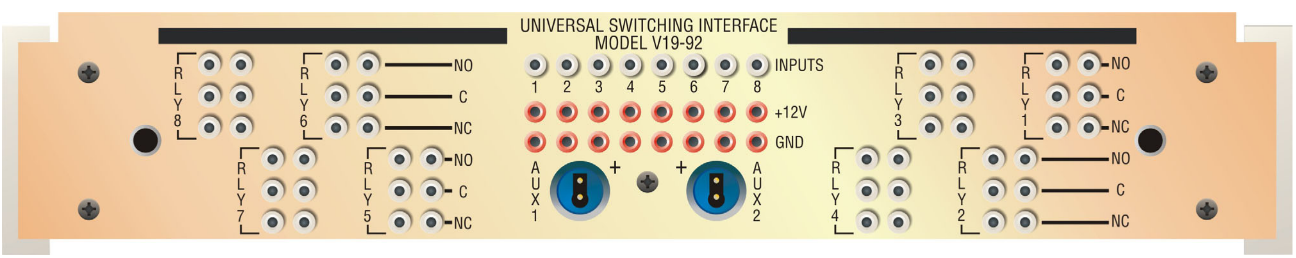
If an output bit is connected to a timer's ***OPER*** input, the timer may be started by pulsing the output bit. The timer may be stopped by pulsing its ***STOP*** input. The status of the timer may be monitored by connecting the ***0*** and ***1*** outputs of the timer to input bits. While the timer is timing, its ***1*** output is true and its ***0*** output is false; while the timer is not timing, its ***0*** output is true and its ***1*** output is false.

V19-92 UNIVERSAL SWITCHING INTERFACE

This module provides an easy interface between the V-Series system and external devices. The module includes 8 DPDT (double pole double throw) relays, which can be independently controlled via the respective digital inputs on the rear panel. The digital inputs can easily be interfaced with the V19-16 General Purpose Port for program control.

Each relay has a front panel indicator to indicate the state of the relay. When the indicator is lit, the relay is switched to the NO (normally open) position. Otherwise the relay is at rest in the NC (normally closed) position. Relays 7 and 8 have an onboard jumper that allows these outputs to be switched from relay control to +12VDC output drivers. This feature is useful when control of an external device is required (e.g. shocker, tone generator, etc.). The +12VDC output drivers also have an indicator on the front panel to indicate when the driver is on. When the front panel indicator is lit, the output driver is on (providing +12VDC output).

The rear panel includes eight .040" jacks for constant +12VDC and eight .040" jacks for ground connection. This allows the user to provide +12VDC drive outputs for each relay contact. Thus, the module not only provides switching relays, it also provides output control capabilities. The +12VDC output has a resettable fuse to prevent overload. The front panel indicator lights when the resettable fuse is tripped and will remain on until the overload is removed.



SPECIFICATIONS

Digital Signals: +5V, Low True Logic, 8 inputs

Relay Contacts: 8A @ 250VAC, 8A @ 30VDC, 8 DPDT

Aux Outputs: +12VDC Output

Constant +12VDC Output: Output current limited to 1A

V19-22 Lab VIEW® PORT

This module provides input/output interface to V-series modules, interface to outside signals, connection to the data acquisition board supplied with National Instruments' **BIOBENCH** which is a **LabVIEW** application program. The port may also (of course) be used to run LabView software.

It has 16 analog inputs, 8 digital inputs, 8 digital outputs, and 2 Digital to Analog outputs on the rear panel, It also has an optically isolated input, and a relay on the side plate for communication outside of the system.

The analog inputs can accept signals up to ±10 volts.

The digital inputs and outputs are standard CI, 5V low true, module logic levels. The 12-bit digital to analog converters output signals up to ±10 volts.

The optically isolated side-plate signal input can accept any signal level from +5V to -30 volts. The output on the side plate is a relay, which can drive any signal up to a maximum current of 100 mA (resistive). The side plate is used to drive, receive, and isolate a "outside-world" 5V high-true, 28V low-true (behavioral control system), or other signal levels to and from the V-series system.

The side-plate ***output*** jacks represent the normally open contacts of a relay (form-A).

To use the optically isolated side-plate ***input***, connect the more positive of the wires bearing the signal (ground for negative logic or the signal for positive logic) to the black, "+" input jack. Connect the more negative wire to the blue, "-" jack. Any time there is a difference between the two jacks of at least 5 volts (nominal) and no greater than 30 volts with the proper, indicated polarity, the interface will register the signal.

The input on the side plate may be dedicated to any one of the 8 interface input channels by moving a jumper on the board. It is installed in position 3 from the factory. Channel 1 is dedicated as an event marker, and channel 2 as the "remote start-stop". You may move the jumper to any input bit you choose, including one of these two. Just be careful not to assign it to one of the channels you are going to use for a logic input from one of the V-series modules. (If you do, signals from the *either of the two, acting as if through an or gate, will activate the input*.)

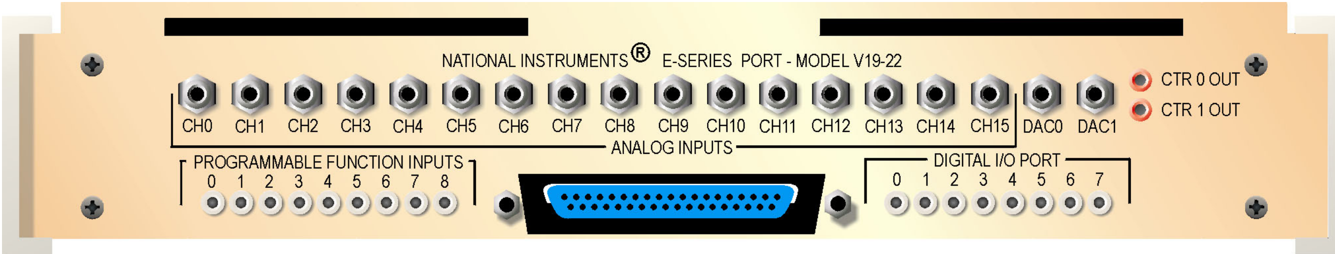
The output relay may also be assigned to any of the 8 output bits. *Both the relay* and its selected, corresponding logic *output* on the back panel will be *on at the same time*.

The unit has inverters for the inputs and outputs so that the system may easily be used with other instrumentation which has user-accessible "+5 volt" signals (high-true logic for operating outside devices). The inverters are jumper-controlled in banks of four so that you may use all, or only four of either the input or output groups, and the other four for V-series module logic. If using the first four inputs in the inverted mode, note that the logic command for "event" and "remote start-stop" will be inverted and activated when a V-series module goes "off".

NOTE: If you elect to connect other systems' signals to the rear panel using this method you may defeat the system's safety specifications.

The V19-02 should be mounted on the bottom of the module stack so that the cable will not interfere with module-to-module lead connections.

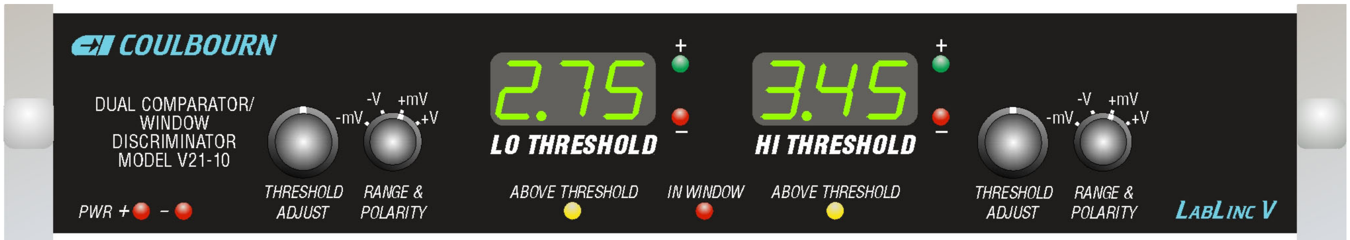
Installing the card in the computer and connecting the cable is discussed in the manual provided with software.



SPECIFICATIONS

Analog Input Impedance: > 1 Megohm
Input Level: ± 10 Volts Max.
Frequency Response: DC to 100 KHz (limited by A/D converter).
Analog Signal Connections: .098 in - 2.5 mm, Ultraminiature Phono Connector.
Digital Signals: +5V, Low True logic.
Digital Signal Connections: .040 in - 1mm Pin Lead.
Digital Signal Minimum Pulse: 10 microseconds.

The interface port should be mounted on the bottom of the stack. (See page 7.)



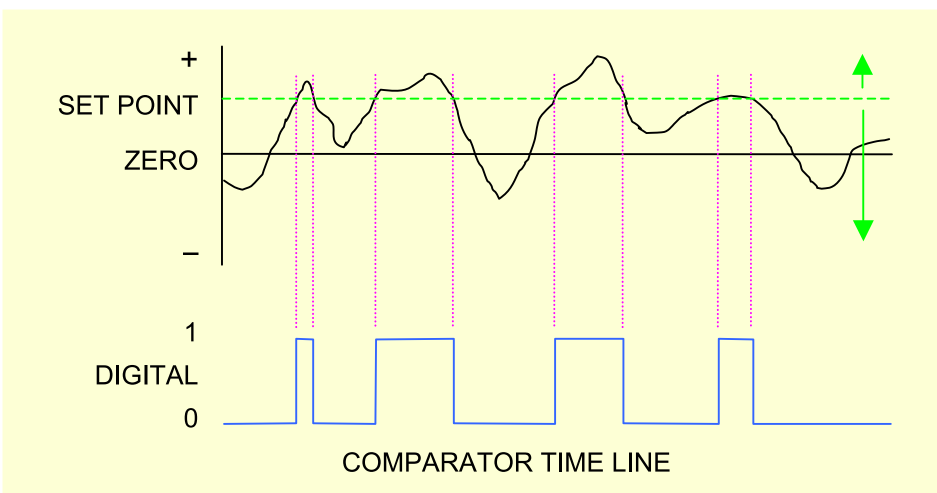
V21-10 DUAL COMPARATOR / WINDOW DISCRIMINATOR

Comparators detect the voltage level of a signal. Other names for this type of circuit are Level Detector, Threshold Detector, Setpoint Detector and Voltage Trigger. Since these comparators are bipolar, they can also be used as zero cross detectors.

A window discriminator discriminates the height of a signal to determine if a rise is of at least one given amplitude but not higher than a second given amplitude before it falls.

This module is a window discriminator with each of the two comparators' inputs and outputs available for independent use. The two comparators are identical, the Hi and Lo designations only refer to the functions relative to the window discriminator output. Each is capable of comparing a signal to a manually set reference voltage or an external voltage (second signal).

To use either comparator in the manually set threshold mode, the signal voltage is connected to the signal input. The threshold value is set using the 10-turn knob threshold control in conjunction with the range and polarity switches. When the signal is **more positive** than the set threshold, the light and the Logic 1 output will be on. When the signal is **more negative** than the set threshold, the light and Logic 1 output will be off.



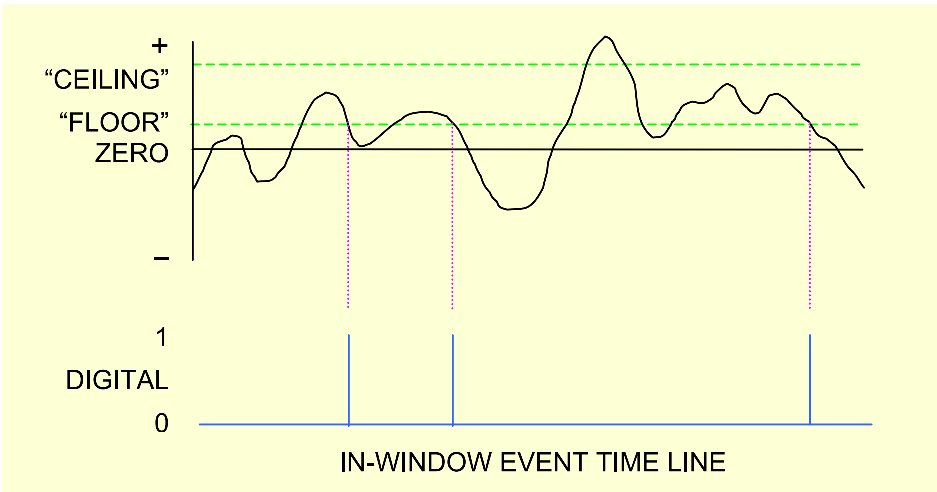
In the two-signal mode, either unit is capable of comparing two signals to one another. One of the signals may be a voltage generated by a digital-to-analog converter connected to the "external reference threshold", permitting a program to define thresholds.

To compare any two signals, one is connected to the "signal" input of either comparator, and the other to the jack labeled "external reference". Insertion of a lead into this jack breaks a connection in the jack and disconnects the manually set threshold reference voltage and replaces it with the external reference signal coming in on the lead. It compares these two signals just as it would a signal to a manually set reference.

When connected, the second lead becomes the source of the threshold reference voltage. As before, when the **signal is more positive than the reference**, the Logic 1 will be on and the Logic 0 off.

The **"in-window event"** function produces an output when a signal rises above one level, but does not rise above a higher level before falling back below the first level. When this sequence occurs, a brief Logic 1 pulse is issued at the "in-window event" output at the instant the signal again falls below the lower threshold.

To use the unit as an in-window event discriminator, simply connect the signal to the "signal" input of the Lo comparator. In a manner similar to the way the "external reference threshold" jacks work, this signal is automatically connected to the Hi comparator's signal input if no lead is in that jack. **The Lo comparator is set to the lower window "floor" and the upper comparator to the higher window "ceiling".**



There is also an output labeled **"currently in window"**. This output is on for the entire duration that the signal is higher than the lower threshold and lower than the higher threshold.

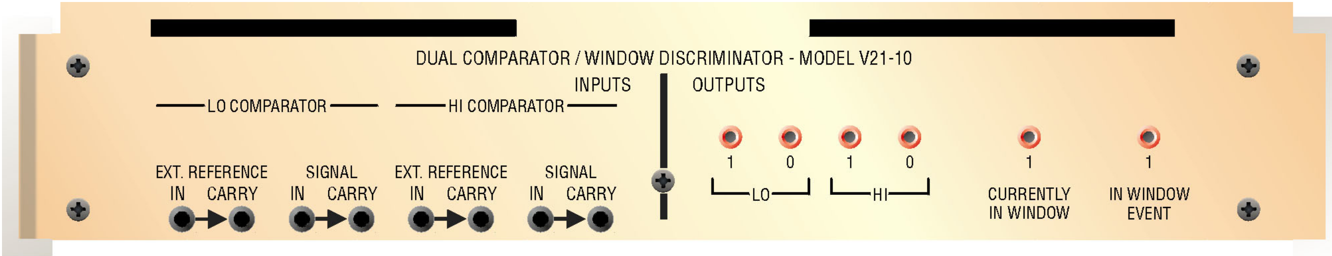
A single signal may be compared to two different setpoints by taking it into only the Lo input because, as mentioned in the paragraph above, when there is no lead in the Hi input it is connected to the Lo input internally. This is the window discriminator mode but you simply do not use the window outputs.

The window discriminator functions are always operative. When using the unit as a single or dual comparator, simply ignore them.

NOTE: If you are using only the Lo comparator, the Hi comparator may also trigger - as before, just ignore it. Computer or other control signals using a digital-to-analog converter to generate external references for the upper and lower window limits may also automatically program the Hi and Lo window values. Simply connect leads bearing these signals to the "external reference threshold" inputs as explained above for use as comparators.

NOTE: The Hi threshold level must be set more positive than the Lo threshold level for proper operation when the module is used as a window discriminator.

The set reference is displayed on the 3-digit display for convenience in setting-up the desired value. The displays indicate 3 digits (000) without a decimal for millivolts, and 3 digits (0.00) for volts (centivolt resolution). The indicator lights beside each digit indicate the selected polarity (+ green or - red). **Please note that the comparator's output will be "on" when a signal is <u>more positive than the reference.</u>** Thus when you are operating in the negative region with the reference set to, say minus 2 volts, and the signal is either plus or minus 1 volt the output will be on. **Both are more positive even though the (unsigned) magnitude of the signal is less than the reference.**



SPECIFICATIONS

ANALOG INPUTS (SIGNAL AND REFERENCE)

Input Impedance: > 1 Megohm
Input Level: ± 10 Volts Max.
Frequency Response: DC to 100 KHz
Slew Rate: 10 Volts/microsecond minimum

MANUAL SETTINGS FOR THRESHOLD AND POLARITY

NOTE: Use of the External Reference inputs disables the manually set reference.

Magnitude: Adjustable in 2 Selectable Ranges - 0 to 1 Volt in millivolts, 0 to 10 Volts in centivolts.
Polarity: Switch Selectable Positive or Negative
Accuracy: ± 1% of Setting
Stability: ± .01%
NOTE: Setpoints will overrange approximately 10%.

COMPARATOR CIRCUITS

Response Time: 2 Microseconds Typical
Hysteresis: 10 millivolts (Provision on PC board to increase if necessary for specific applications.)
Outputs: Standard logic with LED indicator lamps.
Comparator Outputs: Lamp "on" = Logic "1" on. Indicates that input signal is above threshold.

WINDOW DISCRIMINATOR IRCUITS

"Currently In Window" Output: On when the signal is higher than low setting and lower than high setting; i.e. between the setpoints.
"In-Window Event" Output: Lamp "on" = Logic"1" on. Indicates that Window Discriminator input signal has exceeded the lower threshold, but not the upper threshold. Pulse occurs when input signal returns to a level below the lower threshold.
"In-Window Event" Pulse Duration: 4 microseconds.
"In-Window Event" LED Flash Duration: 25 milliseconds (long enough to see).
NOTE: An "In window" event occurring more frequently than every 25 milliseconds will cause the indicator to remain on steadily during the episode, but this does not affect the logic outputs.

V71-23 ISOLATED SKIN CONDUCTANCE COUPLER

This module measures SC, skin conductance (the reciprocal of skin resistance). This is the most used method of measuring the **electrodermal response or EDR*.** The output represents conductance in millivolts per µ Siemens*.

EDR- Electrodermal Response is the collective / generic name for the following: GSR- Galvanic Skin Response, SPR - Skin Potential Response, SR- Skin Resistance, and SC- Skin Conductance. The terms imply the historic methods of measurement. GSR (also used generically in the past) and SPR measure voltage using a bioamplifier; SR and SC use an excitation voltage from a specific coupler and measure resistance expressing the output in Ohms and Siemens respectively. Siemens is the reciprocal of Ohms (formerly Mho; Ohm spelled backwards implying the reciprocal and no longer in use).* ***SC - Skin Conductance, which this module measures, is the method currently in common use to measure the phenomenon.*

The coupling switch allows the user to select either direct coupling (DC) for the measurement of basaltonic - skin conductance level, SCL*, or AC coupling to measure the skin conductance response, SCR*. The SCR time constant is 5 seconds.

A user-selectable 0.5 volt AC, low distortion sine signal or a 0.5 volt DC excitation is applied, via electrodes, across the subject's skin and the resulting current flow (typically in the 5 microamp range) is processed by the coupler into an output voltage signal.

A 10-turn potentiometer balance control permits balancing the current subject tonic (basal) conductance level to zero when the unit is in the DC mode.

The V71-23 has a calibrated output with 5 user-selectable sensitivity ranges. A separate vernier output with a control allows cursive settings from full output to zero within any range.

Either of two calibrate signal reference levels may be introduced to the coupler input **before, or during the time that the subject is connected** by setting the Cal / Ref switch up or down, from the center (run) position. Setting the switch down introduces a 1 µSiemens signal, and setting it up introduces a 10 µSiemens signal, into the circuit by substituting resistors for the subject at the isolated circuit input. **You must calibrate (scale) the coupler with the electrode cable disconnected, but you can add the calibration signal to the present subject value at any time.**

The unit uses a standard Electrode Cable, V91-33 and two V91-01 Electrodes with two V91-11 Electrode Leads. Place the electrode leads in the two outer positions of the cable (the center position is unused).

ELECTRODES

Thoroughly clean the electrode sites and allow a 10-minute stabilization period with the electrodes connected to the subject (they need not be connected to the coupler). Connect the V91-01 Electrodes to the outer two connections of the V91-33 Electrode Cable via the V91-11 Electrode Leads.

Electrode gel for skin conductance recording.
The best electrode gel to use is not available commercially, but it is very easy to make: 2 parts UNIBASE (available in drug stores) - 1 part Standard Physiological Saline - 0.15 molar (0.9% NaCl = 8.75g NaCl in 1L distilled H_2O).
REF: *Psychophysiology, 1981*, Vol. 18, #3, p.232, Fowles et. al.

CALIBRATING (SCALING) THE COUPLER

To balance and scale the coupler, set it to **DC coupling** and **do not connect the cable to the coupler.** The input must be open so that it is at near infinite resistance. Turn the balance control fully clockwise to the stop, which will produce a trace or meter reading which is as close to zero volts as possible. Now to scale your recorder, set the sensitivity to 100, and introduce the calibrating resistor by setting the *CAL/REF* switch to 10 µSiemens. Adjust the trace to read 1 Volt, (100 mV / µSiemens X 10 = 1000mV = 1 Volt).

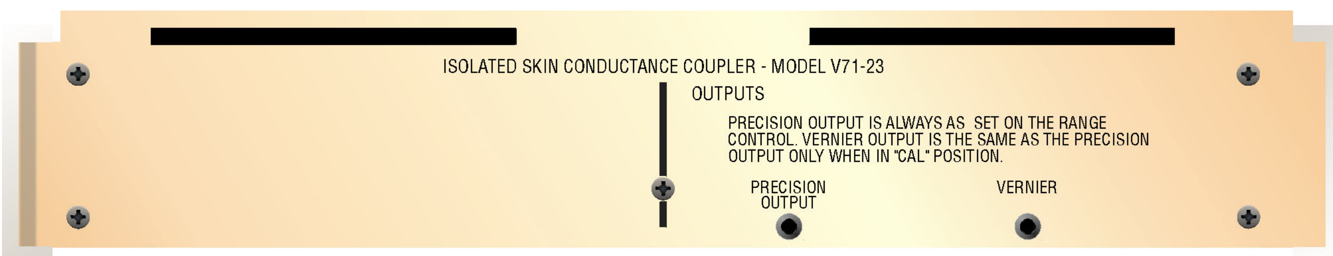
BASALTONIC LEVEL

To read the subject's basaltonic level, leave the amplifier in the DC coupling mode, and the balance control in the fully clockwise position. The output will be equal to the subject's present absolute value of conductance.

BALANCING SUBJECT BASALTONIC LEVEL

The unit must be in the DC coupled mode. The subject must be connected to the coupler and the electrodes stabilized. Use the balance control (turning counterclockwise to bring the trace down to zero) to balance the amplifier to the subject's tonic (basal) level. The setup is balanced (negatively offset) for the present subject conductance when the output reads zero volts on the chart trace or on a meter. Now set the **coupling to AC, if SCR** is desired, or leave it in **DC for SCL** (measurement of deviation from baseline).

The **AC excitation** mode (do not confuse with AC coupling) is generally used so that electrode polarization (charging) effect is minimized. The alternating current equally charges and discharges both electrodes. This prevents a "bucking" potential from building up which would create an offset in the signal.



SPECIFICATIONS

Coupling: DC coupled (SCL); AC coupled (SCR) - 5-second time constant.
Excitation Voltage: Switch selectable - DC: 0.5 volts, - AC: 0.5 volts RMS at 100 Hz (low distortion sine wave)
Accuracy: ±1%
Balance: Tonic level suppression adjustable: 0 to 50 µSiemens (DC coupling only). Settability: 1%
Range: 1 to 50 µSiemens (Absolute)
Sensitivity: Five fixed ranges with Vernier:

1) 10 millivolts/µSiemens
2) 50 millivolts/µSiemens
3) 100 millivolts/µSiemens
4) 500 millivolts/µSiemens
5) 1000 millivolts/µSiemens

Vernier: Permits any intermediate sensitivity setting (separate output).
Response Time (DC): Step input - 5 milliseconds
Calibration/Reference: Internal resistor shunt.
+ 1.0 µSiemens Switch Down
+ 10.0 µSiemens Switch Up

Note: Calibration (scaling) of the coupler must be achieved with the subject cable disconnected from the input; otherwise the calibration resistance will be in the circuit, in parallel with the subject.

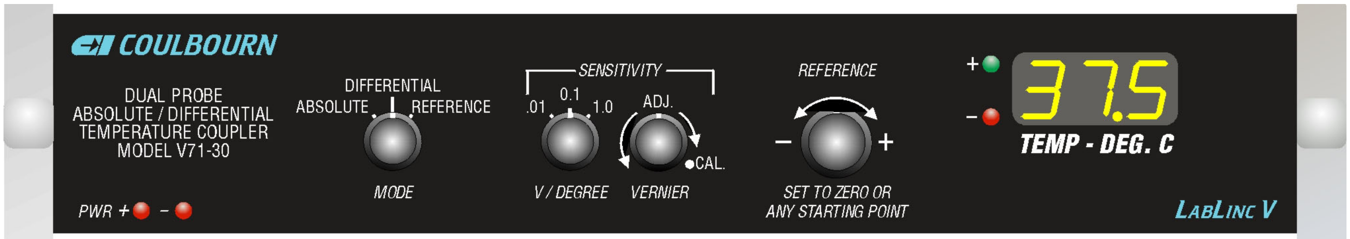
Isolation:

Leakage - 2 microamps max. at 240VAC, 60Hz

CMV Input to output, input to ground - ±2500 volts

NOTE: The measurement of skin conductance with this module involves an excitation current applied to the subject (from an isolated source within the unit). Electrode short circuit current is nominally 35 microamps. Actual current applied to subject will be less, depending on tissue impedance plus electrode impedance.

WARNING - The Input plate on the side of the module is marked to comply with UL544 standards. The excitation current applied across the electrodes can be hazardous when applied to patient-connected devices other than skin surface electrodes (e.g. - catheters, pacemaker leads, etc.) The unit should only be operated by trained, competent personnel.



V71-30 DUAL-PROBE ABSOLUTE/DIFFERENTIAL TEMPERATURE COUPLER

This coupler offers three modes of operation; the reading of the absolute temperature of one probe, reading the difference or change from user defined reference point, and reading the difference between two probes. Temperature is displayed in degrees C in a 3-digit display. There is a calibrated output and a cursively adjustable vernier output.

In the **absolute mode** the temperature of the probe plugged into the positive probe input on the side of the module is displayed in degrees Celsius and the analog outputs respond in accordance with their settings.

In the **differential mode**, the display and associated outputs register the difference between the two (+ and -) probes. Positive numbers indicate that the positive probe is at a higher temperature and negative numbers indicate that the positive probe is a lower temperature than the negative probe.

In the **reference mode,** the display and associated outputs read the difference in degrees Celsius between the set reference and the positive probe. You may set the reference to the current temperature by turning the reference knob to produce a zero reading on the display. At that point any change in the temperature of the positive probe, positive or negative, relative to the starting point, will be displayed. You may set any starting point other than zero as well. If the starting point is in the positive region, the display will go lower for a reduction in temperature of the positive probe. If the reduction in temperature of the probe is greater than the positive offset of the starting point it will go through zero into the negative region; likewise for a negative starting point and positive change in temperature.

The difference and reference modes are ideal for biofeedback and applications involving short-term temperature changes of one degree or so when a large signal is desired. This is possible because in the absolute mode typical changes in temperature are only a few percent of the absolute value. A change from 37 to 38 degrees Celsius is only a little over two percent. If the sensitivity is set to accommodate the total temperature signal, there is only a small change in the overall signal and the change is offset by the absolute value. In the reference mode a higher sensitivity may be used and the signal may be referenced to zero.

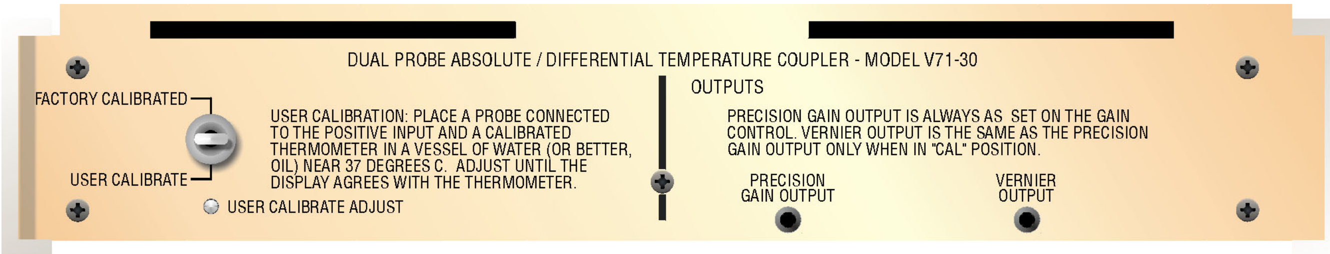
Typical sensitivity settings are .1V / degree C for use in the absolute mode and 1V / degree C in the differential mode or in the reference mode with starting points at or around zero. This will give a calibrated output of 3.80 V for 38 degrees C in the absolute mode, and one to two volts in typical one or two degree difference readings.

The unit's total range is -30 to +100 degrees C so it is not limited to applications involving biological temperature ranges.

The user may calibrate this module, though the factory calibration is acceptable for most applications. Factory calibration is set for the overall best-fit, full-scale calibration for all probes, of any type that may be used. The user calibration allows you to calibrate the unit exactly in the region of your expected use, and for the specific probe you are using. Setting the user calibration does not interfere with factory calibration; you may switch back and forth between the two, and re-calibrate for another region or use or another probe at any time.

When desired, the unit may be calibrated by placing a probe in a vessel of water (or better, oil, because it loses heat less rapidly giving more time to make adjustments) at a temperature within a few degrees of the general intended use range. Place a calibrated glass laboratory thermometer in the vessel along with the probe. Set the switch on the rear panel to the "user calibrate" position. After waiting 5 minutes, adjust the screwdriver calibrate control on the back panel until the display reads the same temperature as the thermometer. When using the unit in the range, and/or with the probe for which you calibrated the unit, use it with the switch in the "user calibrate", position and return to the factory position for general use in wider ranges.

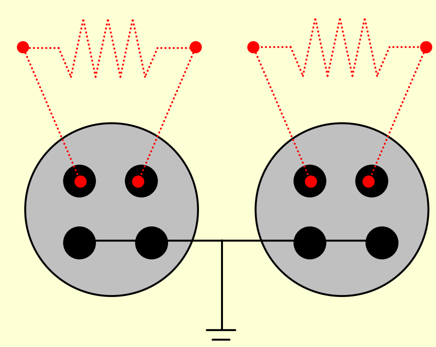
The V93 series temperature probes are used with the V71-30. See page 87 for detailed specifications.



SPECIFICATIONS

Range: -30^{o} to 100^{o}C Absolute
Sensitivity: Selectable 3-Position Switch -
.01V/^{o}C
.1V/^{o}C
1.0V/^{o}C
Plus Vernier Control
Accuracy: ±0.3^{o}C
Noise: Less than 5 microvolt (equivalent 0.005^{o}C)
Stability: ±0.2^{o}C
Mode Control: 3-position switch.
Absolute: Positive probe only - temperature above 0^{o}C.
Differential: Both probes - difference between the two.
Reference: Positive probe only - the difference between the probe temperature and the reference setting.
Sensitivity Control: 3-Position switch - 0.01, 0.1, or 1.0 V / ^{o}C
Vernier Control: Cursive control from .2 to 120% of output.
Reference Control: Sets reference temperature to compare it to the Positive Probe input.
Thermistor: Any V93-series Series Probe

WIRING FOR INPUT CONNECTORS



DUAL PROBE INPUT ON SIDE PLATE

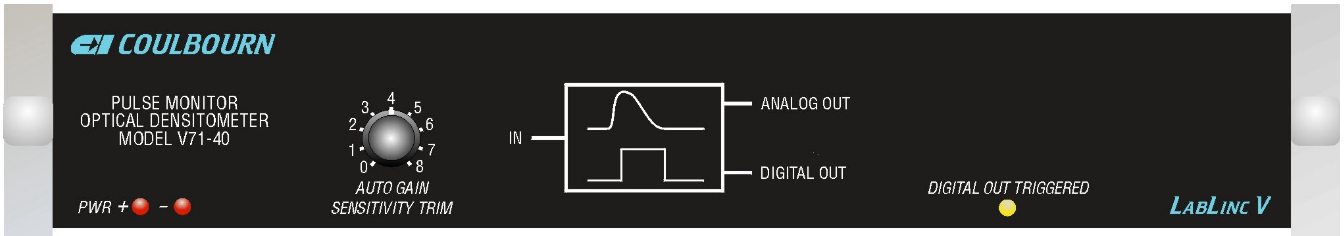
V-93 SERIES THERMISTOR PROBES

One or two probes are used, depending on whether single-point or differential measures are desired. Differential measures may be made with two similar or dissimilar V93-series transducers using the V71-30 module. The resistive element in all units is the same. The time constant (the time it takes for the thermistor to come to a new temperature and stabilize) varies as a function of the mechanical package form and materials. The heavier the package and the less heat conductive the material, the longer it takes.

A complete listing of all of the V93-series thermistors will be found on page 87.

The V93-09 is recommended for most applications involving skin surface temperature.

⚠ WARNING - The Input plate on the side of the module is marked to comply with UL544 standards. The excitation current applied across the thermistor can be hazardous if the insulation on the wires or case of the thermistor fails and current is applied to patient-connected devices (e.g. - catheters, pacemaker leads, etc.) The unit should only be operated by trained, competent personnel.



V71-40 PULSE MONITOR/OPTICAL DENSITOMETER (BLOOD FLOW MONITOR)

The V71-40 operates on a photo-densitometery principle. It accepts the V95-01 light source and phototransistor, which may be used either in the transmissive or reflective mode to measure pulsatile blood flow by optical densitometry. The light is emitted and received by a dual element (photo emitter and photo sensor) mounted in the transducer head. When used on translucent areas, such as the ear, the light is transmitted completely through the tissue and reflected back by the ear clip. When used where there is underlying bone, the bone itself reflects the light back to the sensor. As opaque blood components flow through the light path, they partially obstruct the beam to generate the signal.

The unit may also be used for eye blink and other events producing a pulsatile change of reflectance. It is AC coupled for pulse applications, and will accurately reflect relative pulse volume and relative pulse amplitude.

In addition to AC coupling, the pulse monitor features an exclusive auto-regulated light source to automatically optimize pulse pickup. The circuit regulates the LED-light-source drive current over a time constant longer than the AC coupling to adjust for baseline drift and mechanical decoupling (subject movement) artifact. This makes the unit very easy to use for simple heartbeat pickup. A logic pulse is produced at the digital output for counting purposes, digital heart rate measurement, and biofeedback.

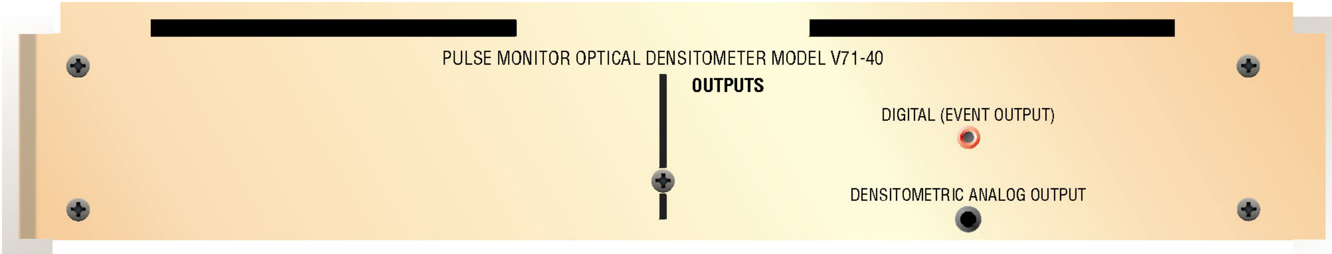
It may also be used with the Tachometer for heart rate measurement, recording and biofeedback. Area under the pulse curve may be measured with the cumulating/resetting section of the Multi-Function Integrator (V76-23).

APPLICATION TIPS

The sensor may be taped over any tissue overlying bone, provided there is sufficient blood flow in the tissue to cause a density change.

If used in a translucent application with no underlying bone or other dense and reflective material, be sure to "back up" the sample with a white or metallic reflective surface so that the light beam can be returned to the transducer head.

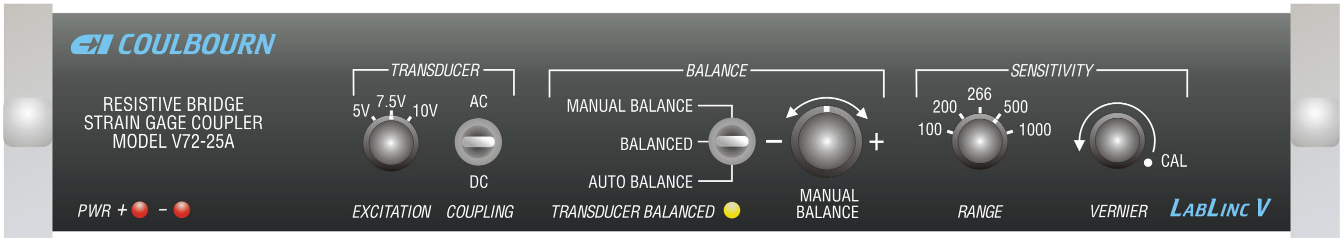
The unit may be used with small, translucent animals to sense fluid flows. It may also be used to sense spatial topography of large tissue movement response, such as eye blinks or things like appendage retraction in very small animals, provided there is enough reflective optical contrast over the course of the response.



SPECIFICATIONS

Transducer Input: (for V95-01 Transducer)
Lamp Current: 1 mA to 30 mA, as required.
Photo Input Impedance: 100 K.
Transducer: CI - Infrared LED and Phototransistor.
Analog Output: Amplified and Filtered Transducer Signal.
Frequency Response: 0.5 Hz to 10 Hz.
Output Impedance: < 50 Ohms.
Sensitivity Trim: Adjusts Analog Output Level.
Digital Output: Complementary Standard Logic Level Pulse. One Pulse per Pulse Wave.

WARNING - The Input plate on the side of the module is marked to comply with UL544 standards. The excitation current applied across the transducer can be hazardous if the insulation on the wires or transducer case fails and current is applied to patient-connected devices (e.g. - catheters, pacemaker leads, etc.) The unit should only be operated by trained, competent personnel.



V72-25B RESISTIVE BRIDGE STRAIN GAGE TRANSDUCER COUPLER

This coupler accepts almost any resistive bridge transducer. It provides for 5, 7.5, or 10-volt excitation.

Coupling may be DC or 1.0 Hz AC. Five sensitivity ranges (plus two board-selectable preamp gain settings) and an off-calibrate vernier sensitivity control afford the user a wide latitude of control.

A major feature of this unit is the auto-balance control. A simple press of the auto-balance switch brings any transducer into zero balance with 20-mV accuracy. Transducer offset errors and weight or tension pre-loads such as encountered in startle, tremor, and ergometric activity or muscle preparations can be instantly zeroed out. The unit may be re-balanced to zero at any time via the manual switch or from program control via the logic input on the rear panel. When the balance switch is pressed the unit goes through an automatic balancing procedure and displays a yellow light indicating it is balanced to within 20 millivolts of zero.

The unit also allows manual balancing. Place the balance switch in the “Manual Balance” position and adjust the balance control knob as necessary. This feature allows for closer tolerances for applications that require more precision.

The resistive bridge coupler is used for applications involving blood pressure, aneroid pressure for respiration and other measures, strain, displacement, and acceleration.

The coupler is designed to couple resistive bridge-type transducers from various manufacturers with excitation voltages of 5, 7.5, or 10 volts into the CI system. It accepts a variety of Coulbourn Instruments and other transducers. A three-position switch permits user selection of the bridge excitation voltage.
Five calibrated sensitivity ranges are selectable and an off-calibrate vernier control permits settings between calibrated points if needed.

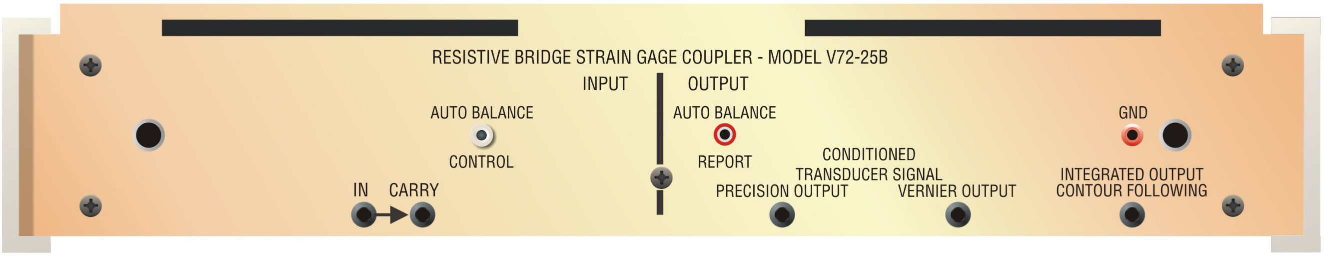
Some of the transducers may be excited by two or even three of the excitation voltages extending the gain/sensitivity options. Each transducer's sensitivity is listed on pages 35 and 36 for usable excitation and sensitivity settings.

An AC/DC coupling switch permits decoupling baseline and/or transducer drift via a 1.0 Hz low cutoff filter when desired.

There is an integrated output in addition to the other outputs. This is a convenience when a small amount of "smoothing" of the signal is needed in applications like startle using our ergometric startle platforms. The unit is shipped with a 10-millisecond integrating time constant but this can be changed by the user. Just change the resistor in the push-in sockets behind the integrated output on the board. (See specifications.)

SPECIFICATIONS

Input Circuit: Precision Instrumentation Amplifier (Differential Type).
Input Resistance: 10^9 Ohms, 10pf.
Maximum Input Voltage: ±2 Volts.
Common Mode Rejection: 110 dB Min. (DC - 60Hz).
Noise (Referred to Input): 1 Hz - 10 Hz: 0.2uV P-P Typical, 0.4uV P-P Maximum. 10 Hz - 1000 Hz: 1.0uV rms Typical, 2.0uV rms Maximum.
Bridge Excitation: Selectable, 3 Voltages - 5.0 Volts, 7.5 Volts, 10.0.
Long Term Accuracy: .002%/Month



COUPLING/FREQUENCY RESPONSE

DC Coupled: DC - 1500 Hz ±3 dB
AC Coupled: 1 Hz - 1500 Hz ±3 dB

BALANCE CONTROL

Manual Balance: Disables auto-balance feature and enables the manual balance control.
Balanced: Enables auto-balance feature.
Auto Balance: Pressing down initiates autobalance.
Auto Balance Accuracy: ±20mV.
"Balanced" LED: Indicates successful balance (in either autobalance or manual balance mode)
Sensitivity Control: 5 Fixed Ranges with Vernier.

Range	Multiplier	Max. Input Level
1	100	100 mV
2	200	50 mV
3	266	37 mV
4	500	20 mV
5	1000	10 mV

VERNIER CONTROL

Output: 100% to 0% adjustment of the full output.
Integrated Output: 10 milliseconds (factory setting). You may replace the resistor on the board to set any desired time constant (1 millisecond for each 100 Ohms).
Accuracy: ±1%.
Output Voltage: ±10V.
Output Impedance: < 50 Ohms.
Temperature Stability: .001% / 0C (after 5-minute warm-up).

*Board jumper provides preamp gain of 1/10 and 10X factory setting.
For additional Range/Sensitivity information refer to appropriate transducer specifications.

STRAIN GAGE TRANSDUCER TIPS

When using any type of transducer with this coupler, balance the coupler with the transducer connected before use. Place the coupling switch in the DC mode and press the auto balance switch to produce a zero volt output. This centers the amplifier dynamic range and allows the maximum excursion before clipping. Switch to the AC mode after balancing, if desired.

NOTE: The unit must be balanced in the DC mode and there must be no force or pressure signal other than intended or unavoidable static preload being applied to the transducer. The auto balance circuit doesn't "know" what's signal and what's not. It will balance out whatever signal is on the transducer at the instant that you press the switch. This property can be useful however, because it allows you to re-zero the baseline at any time over the course of a session when dealing with slow-changing phenomena.

The "auto-balance-report" output on the rear panel is used in conjunction with the "auto-balance-control" input to permit the computer to balance the circuit and receive a report to "know" if balancing was successful in order to proceed with the program.

Balance accelerometers on their side, 90^{O} to gravity, so that the contribution of gravity to the signal is zero while they are being balanced. Accelerometers balanced in the "right-side-up-to-gravity" position will produce a -2g, instead of -1g, output when turned over 180^{O}. If balanced "upside down" they will produce a 2g, instead of 1g, output in the "right-side-up" position (they read -1, and +1 respectively at 90^{O}).

Load cells and other force type transducers should be balanced with beams, string, and as much of the other coupling mechanics as possible attached. It should also be in the use orientation because load cells have mass in their linkages and are therefore responsive to gravity.

The vernier control is used to provide range trim. When resistive strain gage bridges are very far out of calibration, they have usually lost linearity as well. Remember, we call this control "vernier" not "calibrate trim", because it does not calibrate a nonlinear transducer. It is simply used either to compensate for a slope (sensitivity) error in the output voltage swing of a transducer, or to permit the user to set up a full-scale output between the calibrated ranges.

A side panel transducer connector is available for making connections to your own resistive bridge-type transducers. (Order number - V94-99).

WARNING - The Input plate on the side of the module is marked to comply with UL544 standards. The excitation current applied across the transducer can be hazardous if the insulation on the wires or transducer case fails and current is applied to patient-connected devices (e.g. - catheters, pacemaker leads, etc.) The unit should only be operated by trained, competent personnel.

EXCITATION/SENSITIVITY* TABLES FOR RESISTIVE BRIDGE TRANSDUCERS

See next page.

EXCITATION/SENSITIVITY* TABLES FOR RESISTIVE BRIDGE TRANSDUCERS

* All tables values are with preamp jumper set at position J2 (Unity Gain). Position J1: Multiply by 10; Position J3: Divide by 10.
All tables have the 5 sensitivity ranges arranged vertically, 100 at the top and 1000 at the bottom.

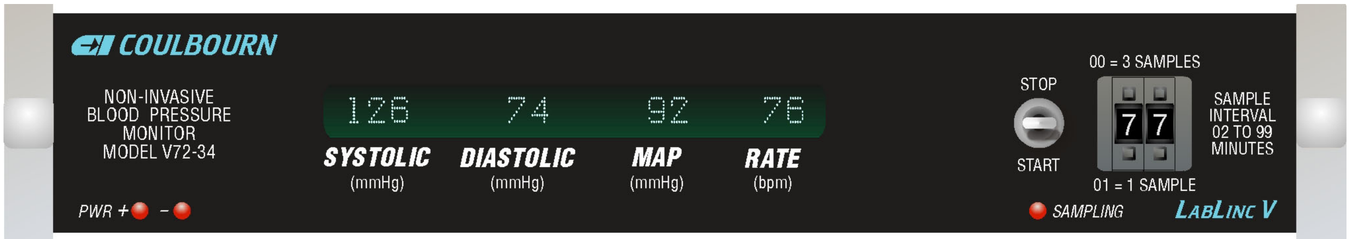
MODEL NO.	EXCITATION VOLTAGES		
	5V	**7.5V**	**10V**
V94-05			
	500mV/PSI	750mV/PSI	1.0V/PSI
	1.0V/PSI	1.5V/PSI	2.0V/PSI
	1.33V/PSI	2.0V/PSI	2.67V/PSI
	2.5V/PSI	3.75V/PSI	5.0V/PSI
	5.0V/PSI	7.5V/PSI	10V/PSI
V94-15			
	334mV/PSI	500mV/PSI	667mV/PSI
	667mV/PSI	1.0V/PSI	1.33V/PSI
	889mV/PSI	1.0V/PSI	1.78V/PSI
	1.67V/PSI	2.5V/PSI	3.34V/PSI
	3.34V/PSI	5.0V/PSI	7.67V/PSI
V94-21			
	10mV/mmHg	15mV/mmHg	20mV/mmHg
	20mV/mmHg	30mV/mmHg	40mV/mmHg
	26.7mV/mmHg	40mV/mmHg	53.3mV/mmHg
	50mV/mmHg	75mV/mmHg	100mV/mmHg
	100mV/mmHg	150mV/mmHg	200mV/mmHg
V94-25			
	25mV/cmHg	37.5mV/cmHg	50mV/cmHg
	50mV/cmHg	75mV/cmHg	100mV/cmHg
	66.7mV/cmHg	100mV/cmHg	133mV/cmHg
	125mV/cmHg	188mV/cmHg	250mV/cmHg
	250mV/cmHg	375mV/cmHg	500mV/cmHg
V94-31			
	10mV/gm	15mV/gm	20mV/gm
	20mV/gm	30mV/gm	40mV/gm
	26.7mV/gm	40mV/gm	53.3mV/gm
	50mV/gm	75mV/gm	100mV/gm
	100mV/gm	150mV/gm	200mV/gm
V94-32			
	1.0mV/gm	1.5mV/gm	2.0mV/gm
	2.0mV/gm	3.0mV/gm	4.0mV/gm
	2.67mV/gm	4.0mV/gm	5.33mV/gm
	5.0mV/gm	7.5mV/gm	10mV/gm
	10mV/gm	15mv/gm	20mV/gm
V94-41			
	0.5V/g	0.75V/g	1.0V/g
	1.0V/g	1.5V/g	2.0V/g
	1.33V/g	2.0V/g	2.67V/g
	2.5V/g	3.75V/g	5.0V/g
	5.0V/g	7.5V/g	10V/g

EXCITATION/SENSITIVITY* TABLES FOR RESISTIVE BRIDGE TRANSDUCERS (Cont'd)

*All tables values are with preamp jumper set at position J2 (Unity Gain). Position J1: Multiply by 10; Position J3: Divide by 10.
All tables have the 5 sensitivity ranges arranged vertically, 100 at the top and 1000 at the bottom.

MODEL NO.	EXCITATION VOLTAGES 5V	7.5V	10V
E45-02			
	0.5V/lb.	0.75V/lb.	1.0V/lb.
	1.0V/lb.	1.5V/lb.	2.0V/lb.
	1.33V/lb.	2.0V/lb.	2.67V/lb.
	2.5V/lb.	3.75V/lb.	5.0V/lb.
	5.0V/lb.	7.5V/lb.	10V/lb.
E45-04			
	0.25V/lb.	0.375V/lb.	0.5V/lb.
	0.5V/lb.	0.75V/lb.	1.0V/lb.
	0.67V/lb.	1.0V/lb.	1.33V/lb.
	1.25V/lb.	1.88V/lb.	2.5V/lb.
	2.5V/lb.	3.75V/lb.	5.0V/lb.
E45-10			
	0.1V/lb.	0.15V/lb.	0.2V/lb.
	0.2V/lb.	0.3V/lb.	0.4V/lb.
	0.267V/lb.	0.4V/lb.	0.533V/lb.
	0.5V/lb.	0.75V/lb.	1.0V/lb.
	1.0V/lb.	1.5V/lb.	2.0V/lb.
E45-11			
	1.0V/lb.	1.5V/lb.	2.0V/lb.
	2.0V/lb.	3.0V/lb.	4.0V/lb.
	2.67V/lb.	4.0V/lb.	5.33V/lb.
	5.0V/lb.	7.5V/lb.	10V/lb.
	10V/lb.	15V/lb.	20V/lb.
E45-12			
	0.5V/lb.	0.75V/lb.	1.0V/lb.
	1.0V/lb.	1.5V/lb.	2.0V/lb.
	1.33V/lb.	2.0V/lb.	2.67V/lb.
	2.5V/lb.	3.75V/lb.	5.0V/lb.
	5.0V/lb.	7.5V/lb.	10V/lb.
E45-15			
	0.2V/lb.	0.3V/lb.	0.4V/lb.
	0.4V/lb.	0.6V/lb.	0.8V/lb.
	0.53V/lb.	0.8V/lb.	1.06V/lb.
	1.0V/lb.	1.5V/lb.	2.0V/lb.
	2.0V/lb.	3.0V/lb.	4.0V/lb.

For complete descriptions and specifications of V-series strain gage transducers refer to pages 91 -96.   For information on the H-series refer to our HABITEST Animal Behavior Environment catalog.



V72-34 NON-INVASIVE BLOOD PRESSURE MONITOR (OSCILLOMETRIC TYPE)

Like the auscultatory method, the non-invasive, oscillometric method of measuring blood pressure employs a cuff. However this method does not use a microphone to "listen" for Korotkoff sounds as pressure falls. Rather, the oscillometric method senses the oscillations in the artery wall caused by turbulent blood flow. Pressure is computed by sensing the changes in oscillations in the air pressure in the cuff line as falling cuff pressure occludes less and less of the blood flow.

A major advantage is that there is no microphone to place. Just place the cuff with its single tube which carries the occluding air pressure, and from which the oscillations in pressure are sensed. It is easier to use, more reliable and has no microphone to pick up ambient acoustic noise to render signal error.

As occluding pressure in the cuff falls, the first flow of blood causes oscillations to begin and systolic pressure is recorded. As pressure falls further, the amplitude of the oscillations increases. The maximum amplitude of oscillation usually corresponds to the mean arterial pressure. Eventually, when flow is no longer impeded, the oscillations cease.

An empirically developed, proprietary algorithm analyzes the oscillations over the course of the cuff deflation cycle and produces the measure. The pressures reported correlate very well with directly measured values from invasive transducers.

The V72-34 consists of the V-module, a remote cuff control unit (Cuff Linc) which contains the pump and a microprocessor to perform the analysis on the pressure signal, and an air-line-connected cuff. The module contains a second microprocessor to generate the display information and synthesize the analog outputs reflecting the measure.

The cuff may be placed over light clothing like a shirtsleeve without compromising accuracy.

OPERATION

The module is powered by the V-Series System Power Base. The Cuff Linc requires an auxiliary wall mount power supply because it requires more current to operate the air-pressure pump than we want to take from the system supply (equivalent to 3 to 5 V-series modules). Be sure that the wall mount supply is connected and the unit is powered. For convenience, the module controls a relay in the Cuff Linc to turn the auxiliary power on when the module stack is powered. This saves having to turn the Linc's power on and off each time you use the system.

Connect the cuff to the air port on the front of the Linc using the supplied hose. The fittings are Luer Lok® type fittings that lock when turned; be sure they are turned fully. Place the cuff over the brachial artery aligning it as indicated by the marking on the cuff.

A nice feature of this unit is that after the first cycle, the microprocessor remembers the pressure and pumps only to that level plus a 50 mmHg margin rather than pumping to the initial target pressure of 180 mmHg. When taking the first reading, it inflates to 180 mmHg and if it detects no pulse, begins the deflate routine. If it does detect a pulse it will increase pressure in 40 mmHg increments until it detects no pulse.

After 50 seconds, if the initial or subsequent target pressure is not reached, the unit will display the "Air Leak" message.

CONTROLS

SAMPLE INTERVAL SWITCH SETTINGS

00 - Causes the unit to take 3 samples as rapidly as possible when the start/stop switch is pressed down to the start position or the program control input is commanded.
01 - Causes the unit to take 1 sample as above.
02 through 99 - Sets the interval between samples in minutes, in a continuous sampling mode, to be taken until the stop switch is pressed.

START/STOP SWITCH

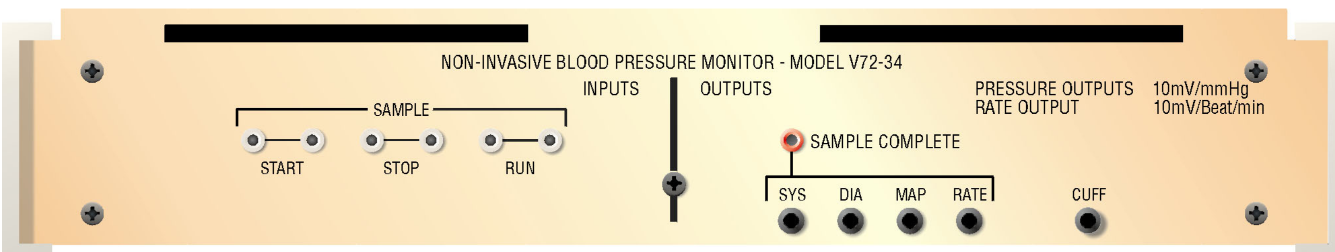
This is a 3-position switch - momentary down for "start", stable in the up position for "stop" and stable in the center position for "run". The stop function will stop a sample in progress, and if left in the up position will prevent a program command or timed cycle from initiating a sample. If start is pressed between timed cycles, an extra sample cycle will be performed without affecting the timed sequence. If a timed sample cycle would have occurred during the extra cycle, it will be ignored without affecting the timing sequence.

If the switch is placed in the up, "stop" position and then returned to the center position once, it will cause the unit to stop the current cycle but allow it to resume at the next timed-cycle command. If left in the up position, it will hold-off the timed cycle command and also prevent any program command from initiating a cycle. If placed in the up position and returned to center twice, it will abort the timed cycle operation and revert to the "Press START to Begin" prompt in the window.

DISPLAY

The display on the front panel shows SYSTOLIC pressure, DIASTOLIC pressure and MAP or mean arterial pressure in mmHg, and heart RATE in beats per minute.

The display is also used to show messages prompting use and diagnostic messages indicating things like reading failures due to a disconnected cuff, an air leak, an out-of-range transducer etc. The results of automatic self-test routines are also displayed. These messages are self-explanatory.



REAR-PANEL INPUTS and OUTPUTS

Digital Inputs: Standard V-system logic signals. START and STOP have functions corresponding to the switch on the front. RUN starts a sample when it goes to logic 1, and follows the cycle selection routine set on the digit switches on the front. When this output goes to logic 0, it stops the routine.

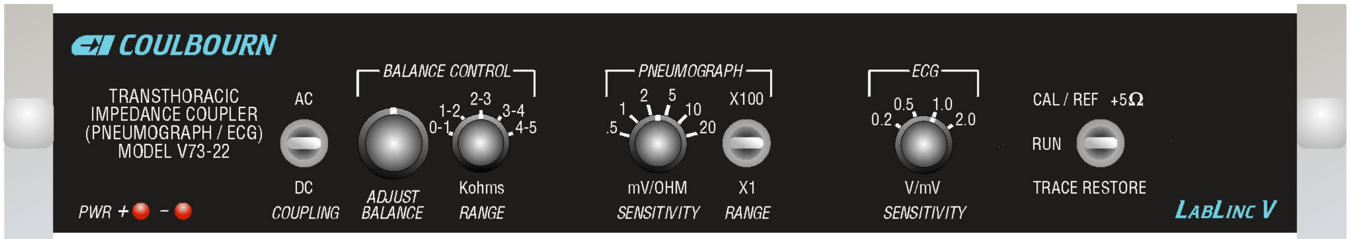
Digital Output: Standard V-system signal. The SAMPLE COMPLETE output goes high at the start of a cycle and goes low at the end remaining low until the onset of the next cycle.

Analog Outputs: SYSTOLIC, DIASTOLIC and MAP outputs are 10 mV/mmHg. RATE is 10 mV/B/Min. They all persist at their updated value for the entire inter-sample interval until they assume a new value, if it changes, upon the completion of the following cycle. The CUFF pressure output is updated every 2 seconds during a cycle and is 10 mV/B/Min.

SPECIFICATIONS:

Cuff Linc Auxiliary Power: 9 VDC from wall-mount supply (supplied with unit).
Operating Environment: $0^{O}C$ to $50^{O}C$, 95% maximum relative humidity, non-condensing.
Accuracy: Monitor meets AAMI-SP10 specifications, ±2% or 3 mmHg, whichever is greater.
Systolic Range: 50-280 mmHg.
Diastolic Range: 10-260 mmHg.
Heart Rate Range: 40-220 BPM.
Safety Systems: Independent hardware circuits and redundant firmware algorithms to limit cuff pressure to less than 310 (± 20) mmHg and to limit cycle durations to less than 160 (+/- 20) seconds.

NOTE: For program control of samples, set the digit switches to 01 to produce a single-sample cycle or to 00 to produce 3-sample cycles per input command from the digital "start" input on the rear panel.



V73-22 TRANSTHORACIC IMPEDANCE COUPLER (PNEUMOGRAPH / ECG)

The Transthoracic Impedance Coupler is used for recording respiratory and ECG activity by measuring the transthoracic impedance between two electrodes. IPG (Impedance pneumography) measures respiration rate and relative volume. Absolute volumes can be measured by first calibrating the V73-22 when using a spirometer. In addition to respiration, the unit also provides simultaneous measurement of ECG, a particularly attractive feature when working with small animals.

Transthoracic impedance is determined by passing a four-microamp, 50 KHz constant current signal through the subject's thorax and measuring the voltage across the electrodes. The voltage, which is directly proportional to transthoracic impedance, reflects changes associated with air volume variation in the lungs. The voltage is amplified and processed to provide a signal suitable for monitoring and recording.

Front panel controls permit adjustment for AC or DC coupling, balancing subject impedance, separate pneumographic and ECG sensitivity, applying a calibrate reference to the input, and restoring the trace to zero when switching coupling or after a major transient

Thoracic impedance changes as small as one tenth of an Ohm can be measured over a baseline range of 10 to 6k Ohms. The ECG output has a sensitivity from 0.2 to 2 volts / millivolt.

Convenience is the most attractive feature of the IPG method for monitoring respiration. No other method is as simple as affixing two electrodes to the subject and connecting them to the coupler. Since the transthoracic impedance change is related to the volume of air moved, the method can be calibrated. Although volume calibration requires the use of a spirometer or other volume-measuring instrument, the calibrating system can be removed from the subject after calibration and respiratory volumes can be measured without obstructing the air stream. Of course, monitoring relative volume or rate does not require calibration.
As with any physiological function that is measured with electrodes, movement can cause variations in impedance and produce unwanted signals. Although the V73-22 contains circuitry to minimize movement artifacts, precautions, including taping down electrode leads, should be taken to avoid this complication.

The V73-22 requires a V91-43 Electrode Cable and is configured to use two electrodes. The electrodes (needle, surface, or plate electrodes) are applied to the thorax of the subject and connected to the outermost inputs of the cable. The center input is not used. Though this cable has the same 3-pin distal end as the V91-33 cable used with the bioamplifiers, the module end uses a 4-pin connector. The V91-33 will not work.

SPECIFICATIONS

Coupling / Frequency Response:
Respiration Range: 0 to 400 per minute (Direct Coupled), 2 to 200 per minute.
ECG: 1 to 40 Hz
Subject Impedance Range: 10 to 5000 Ohms (Direct Coupled), 10 to 6000 Ohms (AC Coupled)
Basal Impedance: Adjustable from 0 to 5000 Ohms in five ranges
IPG Sensitivity: 12 gains selectable from 0.5 mV/ohm to 2.0 V/Ohm(AC Coupled).
ECG Sensitivity: 0.2, 0.5, 1, and 2V/mV
Applied Excitation: Current - 4 microamps RMS (constant), Frequency - 50 KHz
Accuracy: 1% Typical
Linearity: 1% Typical
Noise: Less than .0001% of basal impedance (0.1 Ohm Typical)
Stability: Less than 0.1 Ohm per hour after five-minute thermal stabilization period.

Output Impedance: Less than 50 Ohms
Output Voltage Range: ±10 Volts
Calibrate / Reference: +5 Ohms applied as long as switch is up.
Trace Restore: Baseline restoration (AC Coupled).

WARNING - The Input plate on the side of the module is marked to comply with UL544 standards. The excitation current applied across the electrodes can be hazardous when applied to patient-connected devices other than skin surface electrodes (e.g. - catheters, pacemaker leads, etc.) The unit should only be operated by trained, competent personnel.

OPERATION

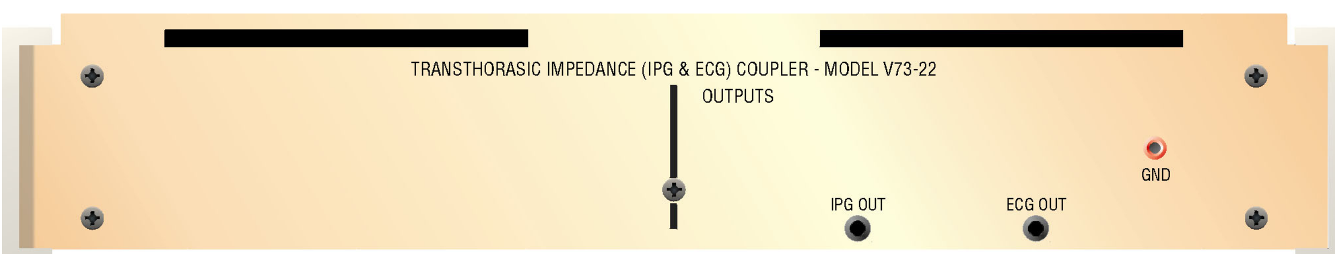
Prior to recording respiration, the unit can be balanced to match the subject's impedance. Set the coupling switch to the Direct Coupled (DC) mode. With the sensitivity (mV/ohm) set at 1mV/ohm, and the range switch set at X1, adjust the subject balance range switch and potentiometer until the signal at the respiration output is centered at zero volts. Since the unit is being balanced while connected to a subject, it is difficult to balance it to zero with an electronic meter or an electronic zero detection circuit. This is because there is a changing signal which is present following respiration. The best way to balance is to watch the chart record or, if you are not using chart software or a hardware strip chart recorder, use an oscilloscope (you can also do a fair job of getting near enough to zero by using a mechanical voltmeter). While watching the trace, center the signal around zero.

Subject impedances between 10 and 5000 ohms can be balanced in the DC mode. To select the appropriate gain choose one of the 12 available sensitivity levels from 0.5 mV/ohm to 2.0 mV/ohm using the sensitivity (mV/ohm) and range (X1, X100) switches. If the sensitivity is increased, it may be necessary to adjust the potentiometer slightly to keep the signal centered at zero volts.

For applications requiring the measurement of respiration rate and/or relative volume only, The V73-22 may be used in the AC coupled mode. It is not necessary to balance the V73-22 when used in the AC coupled mode, but it is a good idea to get it close in the DC mode first to be sure that the signal is not near the limit of dynamic range due to excessive electrode resistance. The unit can accommodate subject impedances from 10 to 6000 ohms in the AC coupled mode. The trace restore switch should be pressed when switching to the AC coupled mode or if a large transient signal appears due to electrode movement artifact or any other type of interference. This will restore the signal to baseline by dumping the saturated coupling capacitor. The trace reset is nonfunctional in the DC coupled mode. An appropriate gain can be selected in the same manner described above.

The calibrate/trace restore switch will provide a 5-ohm input as long as it is in the "up" position. When the unit is connected to a subject, it will add 5 ohms to the subject's impedance. This is useful for selecting the appropriate sensitivity and verifying the gain of the unit.

An ECG can be recorded simultaneously with respiration and operates independently of respiration. The V73-22 offers 4 levels of sensitivity from 0.2 volts to 2.0 volts/mV. No external filtering is required for ECG recording, but the signal does have slightly less bandwidth than a "standard" ECG.



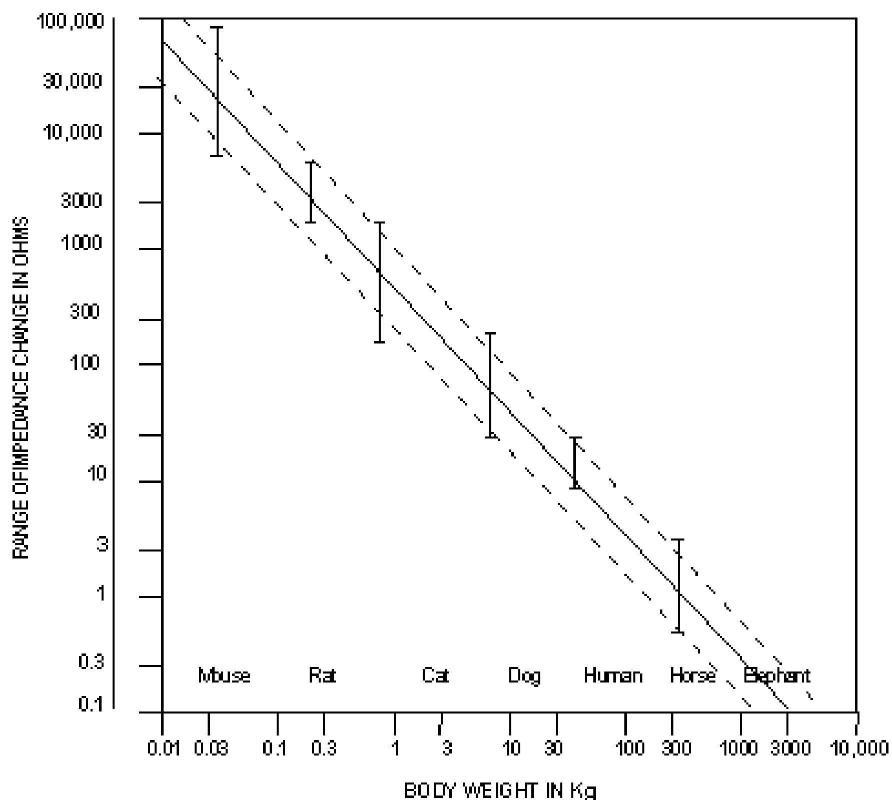
CALIBRATION

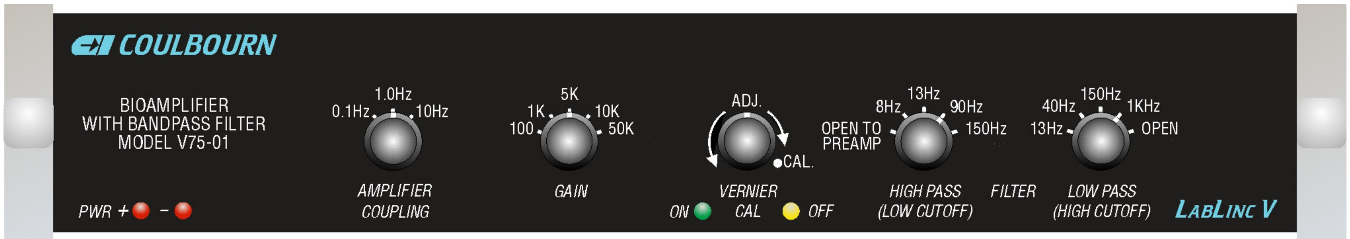
The 5-ohm calibration signal can be used to verify the gain of the V73-22. For external calibration, a precision resistor (1% tolerance) with a value of less than 5K ohms will be required. After allowing for a five-minute thermal stabilization period, connect the resistor to the outer two inputs of the electrode cable, select the DC coupled mode, and set the sensitivity to 1 mV/ohm. While monitoring the respiration output of the V73-22, adjust the subject impedance balance until the respiration output is at zero volts. The set point of the subject impedance balance will now be equal to the value of the resistor.

ELECTRODE PLACEMENT

IPG electrodes for most mammalian species, including humans, should be placed between the 6th and 7th rib as a best compromise between signal amplitude and linearity of the relationship between air volume exchanged and impedance change. Heavy body types show a smaller change as a function of volume and slender body types show a larger change.

Electrodes should be placed opposing one another laterally to allow the shortest path between the electrodes to transect the lung(s).





V75-01 BIOAMPLIFIER WITH ADJUSTABLE BANDPASS FILTER

This Bioamplifier is designed for a wide range of applications. It has a built-in bandpass filter network consisting of 5 high cutoff (low-pass) and 5 low cutoff (high-pass) filter frequencies. A 60 (or 50) Hz notch filter is also built in, as is a coupler filter between the preamp and main amplifier section to permit decoupling when artifact-caused saturation is a problem. The preamplifier coupling circuit also extends the range of the low cutoff side of the pass band. Setting the low cutoff (hi-pass) filter to the lowest setting (open to preamp), allows the coupling filter to set the low cut skirt of the bandpass.

The filters are 2-pole Butterworth type (the best filter type for signals in the physiological spectrum) and provide 12dB per octave attenuation for the most frequently studied phenomena including EMG, ECG, EEG, SPR, and others.

Extremely high gain (50,000 maximum) and low noise make this unit especially useful in low-level signal applications, such as EMG.

This amplifier is also available in an isolated version at higher cost and with a slight increase in the noise specification. The model number is V75-04.

The economy of onboard filters makes this amplifier the best choice for general recording applications when a variety of measures is anticipated. However, for certain functions, separate filters may be required when their features are dictated by the application. These include the V75-48 high performance filter and the V75-50 EEG band separation filter.

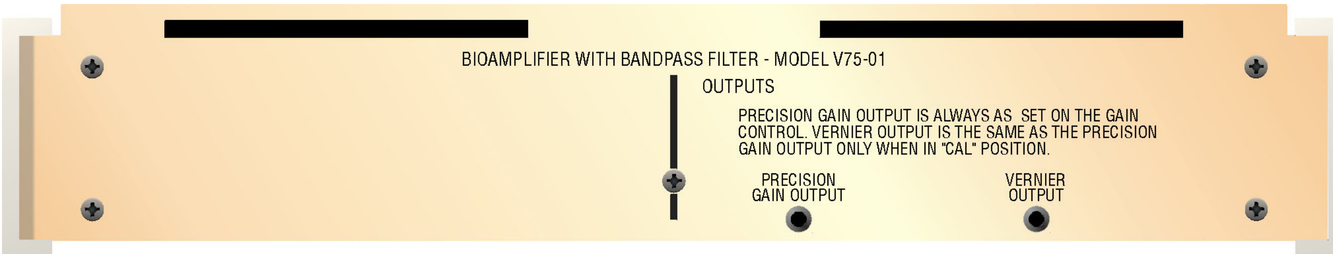
The sharpness of the cutoff "skirts" is greater in the V75-48 (48dB/Octave), and it is necessary for applications like narrow, sharply defined bands of EEG such as SMR (Sensory-Motor response), other narrow-band applications or other applications where "special" hi- and lo-cutoff points are desired. The V75-48 is cursively adjustable permitting the selection of virtually any desired frequency.

The V75-50 EEG Band separation filter is used to separate full band EEG simultaneously into the five bands, delta, theta, alpha, beta , and full band. EEG usually requires sharper filter skirts; to that end this filter has 24 dB/Octave cutoffs.

In any of the above circumstances you may use this amplifier or the more economical V75-02 which has no filters. When using the V75-01 with a separate filter module, don't forget to set the on-board filter skirts wider than the separate filter's skirts so that the separate filter gets a signal that's not "pre filtered" within the selected band.

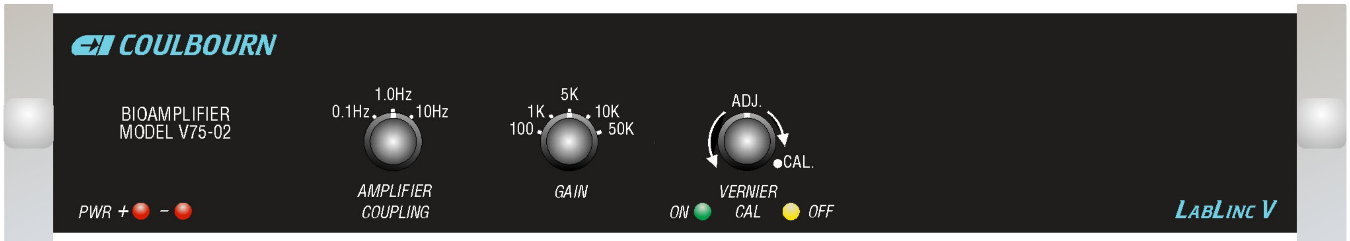
For other than cursory study of EEG, we recommend using the V75-02 Bioamplifier without filters with the V75-48 or the V75-02 with the V75-50 EEG band filter when studying multi-band applications. For full-band multi-site recording of EEG, the V75-04 4-channel EEG amplifier is recommended.

This bioamplifier may be coupled for very low AC frequency response to cover the widest number of research applications. The coupling between the preamplifier and main amplifier may be set for 0.1, 1.0, or 10 Hz for optimum performance and signal quality. When a signal reaches the maximum input voltage level, the coupling capacitor becomes saturated. When this happens, the capacitor cannot pass any AC signal because it is filled to capacity. If the coupling frequency is set to 10 Hz, the capacitor will discharge rapidly and pass the signal almost immediately. With this amplifier, the lowest coupling frequency is 0.1 Hertz (10 seconds). When the preamplifier saturates with this coupling constant, the output goes to zero for as long as 10 seconds following the artifact. This is unavoidable when both high signal quality and low frequency response are desired; but a compromise can be reached by changing frequency.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (differential and Common Mode): Restive - 10^7 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 105-dB min.
Input Bias Current: 10 nA typical: 50 nA max.
Maximum Input Voltage to saturate preamp: 700mV (total – offset plus signal).
Maximum Input Signal (AC) to clip at highest gain: 100mV.
Noise (referred to input): 0.3 microvolts peak-to-peak typical at 0.1 to 10 Hz, 0.2 microvolts RMS typical at 10 to 1000 Hz
Frequency Response: 0.1 to 6,000 Hz (-3 dB)
Amplifier Gain: Adjustable - 5 ranges - 100, 1000, 5000, 10,000, 50,000. Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Preamplifier Coupling: Switch selectable - 0.1, 1 or 10 Hz.
Bandpass Filter: Rolloff 12 dB / O, High Pass - open to preamplifier coupling, 8, 13, 90 & 150. Low Pass 13, 40, 150, 1K, & open (unfiltered – 7KHz, approximately 6 dB/O).
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.
NOTE: The notch filter may be bypassed with a jumper on the circuit board.
Common Mode 50/60 Hz Rejection: 140 dB.



V75-02 BIOAMPLIFIER WITHOUT FILTERS

The V75-02 is identical to the V75-01 except that it does not have a bandpass filter section. It does have the preamplifier coupling filters and the 60 (or 50) Hz notch filter.

Like the V75-01, the V75-02 has high gain and low noise making it useful for all physiological signals.

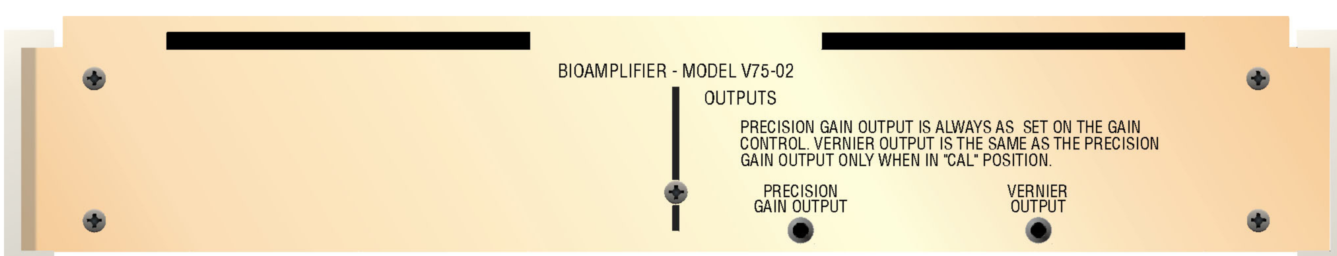
Also, like the V75-01 it has an isolated counterpart, the V75-05 Isolated Bioamplifier Without Filter. The isolated model is higher cost and has a very slight increase in the noise specification.

The V75-02 is used when filtered signals in bands not available on the V75-01 are to be studied or when sharper cutoffs are desired. It can be used with the V75-50 EEG Band Separation Filter or the V75-48 High Performance Bandpass Filter.

The "sharpness" of the cutoff "skirts" is greater for the V75-48 (48dB/Octave), and it is necessary in applications where narrow, sharply defined bands of EEG such as SMR (Sensory-Motor response - 12 to 14 Hz) or other narrow-band applications where "special" frequency hi- and lo-cutoff points are desired. The V75-48 is cursively adjustable from 0.1 Hz to 10 KHz by a manual knob; it displays the set points digitally on the module face.

The V75-50 EEG Band separation filter is used to separate full band EEG simultaneously into the five bands, delta, theta, alpha, beta, and full band. EEG usually requires sharper filter skirts; to that end this filter has 24 dB/Octave cutoffs. The V75-02 with the V75-50 filter is the recommended amplifier for single site, simultaneous, multi-band, EEG analysis. For full-band multi-site recording of EEG, the V75-04 4-channel EEG amplifier is recommended.

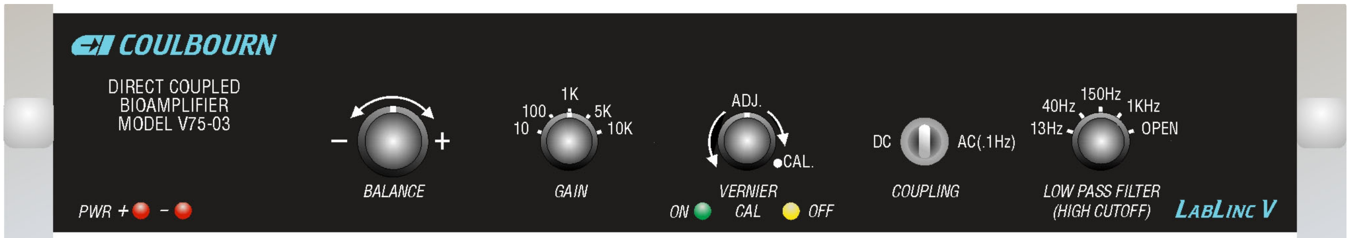
This bioamplifier may be coupled for very low AC frequency response to cover the widest number of research applications. The coupling between the preamplifier and main amplifier may be set for 0.1, 1.0, or 10 Hz for optimum performance and signal quality. When a signal (including noise/artifact) reaches the maximum input voltage level, the coupling capacitor becomes saturated. When this happens, the capacitor cannot pass any AC signal because it is filled to capacity. If the coupling frequency is 10 Hz , the capacitor will discharge rapidly and pass the signal almost immediately. With this amplifier, the lowest coupling frequency is 0.1 Hertz (10 seconds). When the preamplifier saturates with this coupling constant, the output goes to zero for as long as 10 seconds following the artifact. This is unavoidable when both high signal quality and low frequency response are desired; but a compromise can be reached by changing frequency.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Restive - 10^7 Ohms, Capacitive - 10 pF
Common Mode Rejection: 105-dB min.

Input Bias Current: 10 nA typical: 50 nA max.
Maximum Input Voltage to saturate preamp: 700mV (total – offset plus signal).
Maximum Input Signal (AC) to clip at highest gain: 100mV.
Noise (referred to input): 0.3 microvolts peak-to-peak typical at 0.1 to 10 Hz. 0.2 microvolts RMS typical at 10 to 1000 Hz
Frequency Response: 0.1 to 6,000 Hz (-3 dB)
Amplifier Coupling: Switch selectable - 0.1, 1 or 10 Hz.
Amplifier Gain: Adjustable: 5 ranges - 100, 1000, 5000, 10,000, 50,000. Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.
NOTE: The notch filter may be bypassed with a jumper on the circuit board.
Common Mode 50/60 Hz Rejection: 140 dB.



V75-03 DIRECT COUPLED BIOAMPLIFIER

The V75-03 is directly coupled to the input signal without a preamplifier-coupling filter. It is used for very low frequency signals; i.e. those below the lowest preamplifier coupling (0.1 Hz, 10 seconds) in the other bioamplifiers. A 60 (or 50) Hz notch filter is built in. There is an isolated version of this amplifier available, V75-06.

Biopotentials from electrodes on or in a subject may be of very large potential with only a small variation "riding on top" of the overall signal. It is usually the variation that is of interest. AC coupled amplifiers like the other 4 bioamplifiers in our line, decouple the overall, large potential and pass only the variation (above the frequency selected on the preamplifier coupling control) "riding on top". This amplifier is used when the entire signal (absolute level) or very slow variations are of interest.

The signal of interest may be out of the range of the amplifier when the electrodes are first connected, giving a "flat line" record at either the top (positive) or bottom (negative) limits of the chart. The level is unknown and any variations are unseen because this region of the signal is off the scale. The gain of the amplifier could be reduced to a very low value to bring the entire signal into view. But that usually produces a signal so small that variations of interest or the overall slow movement of the trace is imperceptible or in the region where inherent noise in the system becomes a significant part of the record.

The balance control is provided to allow the signal, with relatively high gain, to be offset into the usable region (dynamic range) of the amplifier. If the trace is at the top of the scale when you start, simply turn the balance control counterclockwise until the trace drops into view. Do the opposite for negatively offset signals. If the signal moves into range but "hits" the top and/or bottom of the chart, reduce the gain.

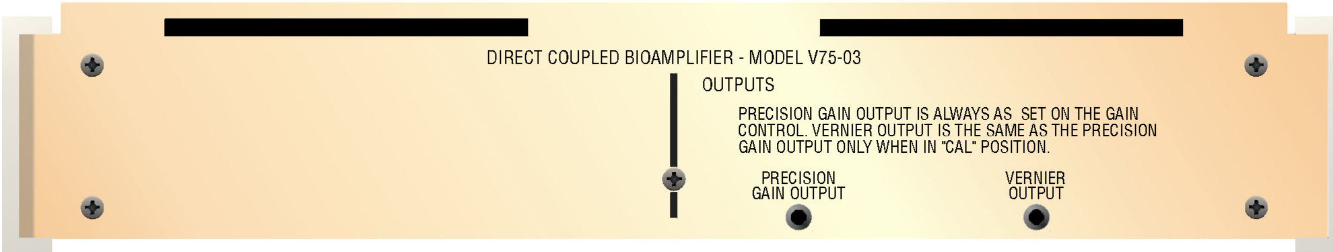
Because the nature of these signals is to move very slowly over a session toward one polarity or the other, they can also eventually saturate the amplifier, so you may have to re-balance the amplifier during the session.

There is a single preamplifier AC coupling selection (0.1 Hz) provided for convenience.

A high cutoff filter control provides for the commonly studied DC coupled biopotentials and for "wide open" use at the full frequency range of the amplifier. The V75-48 High performance filter may be used for other studies, *employing only the high cutoff section* for sharp cutoff or "special" cutoff frequencies not provided for on the V75-03. Be sure to use the V75-03 set at a high cutoff higher than the V75-48 so as not to prefilter the signal below the setpoint of the V75-48.

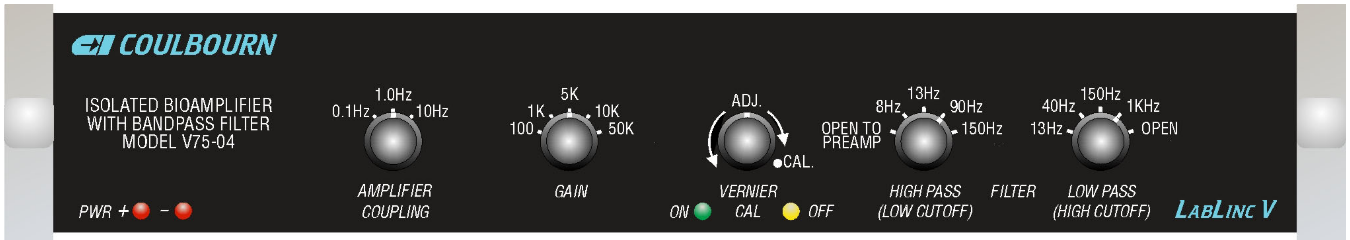
The selection of gains (10 to 10K) is lower in this amplifier because the nature of the signals studied requires a wider dynamic range and because most of the signals are larger than those studied with an AC coupled amplifier.

The vernier control and output work the same way as on the other bioamplifiers; at the calibrated position the vernier output is the same as the main output and in the off calibrate position it goes from 100% of full output to 0 in one turn to the left.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Restive: 10^7 Ohms, Capacitive: 10 pF
Common Mode Rejection: 105dB min.
Input Bias Current: 10 nA typical: 50 nA max.
Maximum Input Voltage: 1.0V (differential) ±10 volts (common mode).
Noise (referred to input): 0.3 microvolts peak-to-peak typical at 0.1 to 10 Hz
0.2 microvolts RMS typical at 10 to 1000 Hz
Frequency Response: DC to 6,000 Hz (-3 dB)
Amplifier Coupling: Switch selectable DC or 0.1 Hz.
Amplifier Gain: Adjustable: 5 ranges - 10, 100, 1000, 5,000, 10,000.
Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.
NOTE: The notch filter may be bypassed with a jumper on the circuit board.
Common Mode 50/60 Hz Rejection: 140 dB.



V75-04 ISOLATED BIOAMPLIFIER WITH BANDPASS FILTER

This Bioamplifier is an isolated version of the V75-01 and like the V75-01 it is designed for a wide range of applications. It has a built-in bandpass filter network consisting of 5 low-pass and 5 high-pass filter frequencies. A 60 (or 50) Hz notch filter is also built in, as is a coupler filter between the preamp and main amplifier section to permit decoupling when artifact-caused saturation is a problem. The preamplifier coupling circuit also extends the range of the low cutoff side of the pass band. Setting the hi-pass (low cutoff) filter to the lowest setting (open to preamp) allows the coupling filter to set the low cut skirt of the bandpass.

The filters are 2-pole Butterworth type (the best filter type for signals in the physiological spectrum) and provide 12 dB per octave attenuation for the most frequently studied phenomena including EMG, ECG, EEG, SPR, and others.

Extremely high gain (50,000 maximum) and low noise make this unit especially useful in low-level signal applications, such as EMG.

Isolated amplifiers like this one, the V75-05 and V75-06 are indicated when isolation from earth ground for safety is required in situations where other sources of voltage with respect to earth ground are present in the environment and represent a hazard to the subject. Isolation is also required to prevent interference when multiple signals are being recorded from one subject; especially when one or more of the other signals is being generated by another module that places an excitation voltage across the subject. Two such signals are skin conductance (V71-23) and transthoracic impedance pneumography and cardiography (V73-22) but because this is a fairly common application both of those units are isolated, so the bioamplifier doesn't have to be. It is highly recommended that this amplifier or the V75-05 be used when stimulating and recording from the same subject.

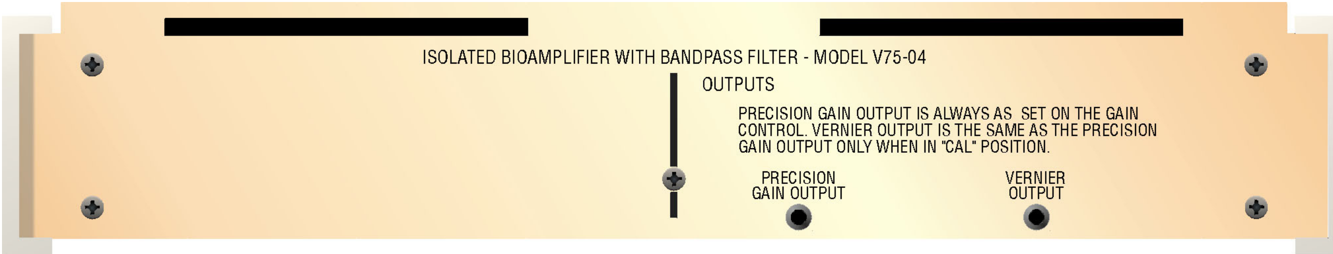
The economy of onboard filters makes this amplifier the best choice for general recording applications when a variety of measures is anticipated and isolation is required. However, for certain functions, separate filters may be required when their features are dictated by the application. These include the V75-48 high performance filter and the V75-50 EEG band separation filter.

The sharpness of the cutoff "skirts" is greater in the V75-48 (48dB/Octave), and it is necessary for applications like narrow, sharply defined bands of EEG such as SMR (Sensory-Motor response), other narrow-band applications or other applications where "special" hi- and lo-cutoff points are desired. The V75-48 is cursively adjustable permitting the selection of virtually any desired frequency.

The V75-50 EEG Band separation filter is used to separate full band EEG simultaneously into the five bands, delta, theta, alpha, beta , and full band. EEG usually requires sharper filter skirts; to that end this filter has 24 dB/Octave cutoffs.

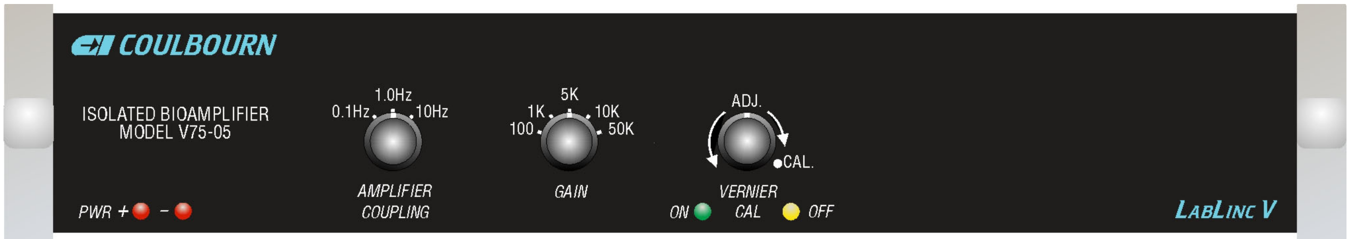
In any of the above circumstances you may use this amplifier or the more economical V75-05 isolated unit which has no filters. When using the V75-04 with a separate filter module, don't forget to set the on-board filter skirts wider than the separate filter's skirts so that the separate filter gets a signal that's not "pre filtered" within the selected band.

For other than cursory study of EEG when isolation is required, we recommend using the V75-05 Bioamplifier without filters with the V75-48 or the V75-05 with the V75-50 EEG band filter when studying multi-band applications. For full-band multi-site recording of EEG, the V75-04 4-channel EEG amplifier is recommended.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Resistive: 10^7 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 105dB min.
Input Bias Current: 10 nA typical: 50 nA max.
Maximum Input Voltage to saturate preamp: 700mV (total – offset plus signal).
Maximum Input Signal (AC) to clip at highest gain: 100mV.
Noise (referred to input): 4 microvolts RMS typical at 10 to 1000 Hz
Frequency Response: 0.1 to 6,000 Hz (-3 dB)
Amplifier Coupling: Switch selectable - 0.1, 1 or 10 Hz.
Amplifier Gain: Adjustable: 5 ranges - 100, 1000, 5000, 10,000, 50,000. Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Bandpass Filter: Rolloff 12 dB / O, High Pass - open to preamplifier coupling, 8, 13, 90 & 150. Low Pass 13, 40, 150, 1K, & open (unfiltered – 7KHz, approximately 6 dB/O).
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.
NOTE: The notch filter may be bypassed with a jumper on the circuit board.
Common Mode 50/60 Hz Rejection: 140 dB.
Maximum Common Mode Voltage: 2500 VAC rms at 60 Hz., ±3500 VDC
Leakage Current (input to output): 2mA max @ 240 V rms, 60 Hz.



V75-05 ISOLATED BIOAMPLIFIER WITHOUT FILTERS

The V75-05 is identical to the V75-04 except that it does not have a bandpass filter section. It does have the preamplifier coupling filters and the 60 (or 50) Hz notch filter.

This amplifier is used when filtered isolated signals in bands not available on the V75-04 are to be studied or when sharper cutoffs are desired. It can be used with the V75-50 EEG Band Separation Filter or the V75-48 High Performance Bandpass Filter.

Like the V75-04, it has high gain and low noise making it useful for all physiological signals.

Also, like the V75-04 it has an unisolated counterpart, the V75-02 (unisolated) Bioamplifier Without filter.

Isolated amplifiers like this one and the V75-04 are indicated when isolation from earth ground for safety is required in situations where other sources of voltage with respect to earth ground are present in the environment and represent a hazard to the subject. Isolation is also required to prevent interference when multiple signals are being recorded from one subject; especially when one or more of the other signals is being generated by another module that places an excitation voltage across the subject. Two such signals are skin conductance (V71-23) and transthoracic impedance pneumography and cardiography (V73-22) but, because this is a fairly common application both of those units are isolated, so the bioamplifier doesn't have to be. It is highly recommended that this amplifier or the V75-04 be used when stimulating and recording from the same subject.

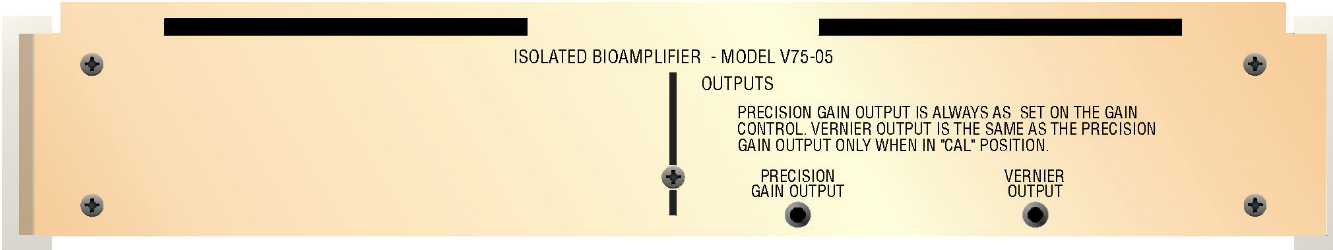
A separate V75-48 high performance filter or the V75-50 EEG band separation filter filters is required for this amplifier.

The sharpness of the cutoff "skirts" is greater in the V75-48 (48dB/Octave), and it is necessary for applications like narrow, sharply defined bands of EEG such as SMR (Sensory-Motor response), other narrow-band applications or other applications where "special" hi- and lo-cutoff points are desired. The V75-48 is cursively adjustable permitting the selection of virtually any desired frequency.

The V75-50 EEG Band separation filter is used to separate full band EEG simultaneously into the five bands, delta, theta, alpha, beta , and full band. EEG usually requires sharper filter skirts; to that end this filter has 24 dB/Octave cutoffs.

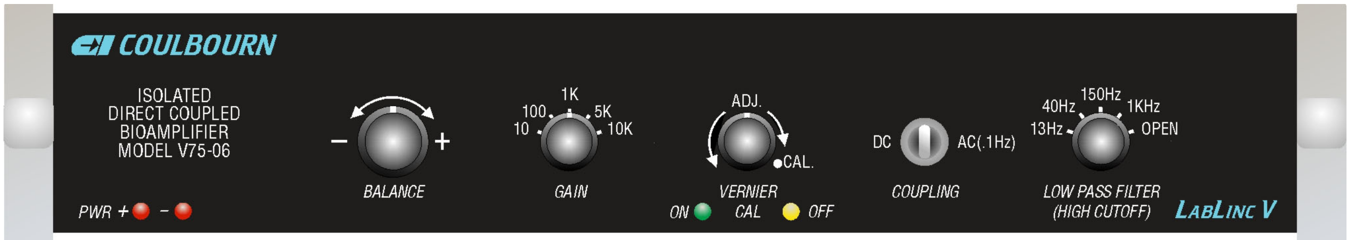
For full-band multi-site recording of EEG, the V75-04 4-channel EEG amplifier is recommended.

This bioamplifier may be coupled for very low AC frequency response to cover the widest number of research applications. The coupling between the preamplifier and main amplifier may be set for 0.1, 1.0, or 10 Hz for optimum performance and signal quality. When a signal (including noise/artifact) reaches the maximum input voltage level, the coupling capacitor becomes saturated. When this happens, the capacitor cannot pass any AC signal because it is filled to capacity. If the coupling frequency is 10 Hz , the capacitor will discharge rapidly and pass the signal almost immediately. With this amplifier, the lowest coupling frequency is 0.1 Hertz (10 seconds). When the preamplifier saturates with this coupling constant, the output goes to zero for as long as 10 seconds following the artifact. This is unavoidable when both high signal quality and low frequency response are desired; but a compromise can be reached by changing frequency.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance: (**Differential and Common Mode**): Restive: 10^7 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 105dB min.
Input Bias Current: 10 nA typical, 50 nA max.
Maximum Input Voltage to saturate preamp: 700mV (total – offset plus signal).
Maximum Input Signal (AC) to clip at highest gain: 100mV.
Noise (referred to input): 4 microvolts RMS typical at 10 to 1000 Hz.
Frequency Response: 0.1 to 6000 Hz (-3 dB)
Amplifier Coupling: Switch selectable - 0.1, 1 or 10 Hz.
Amplifier Gain: Adjustable: 5 ranges - 100, 1000, 5000, 10,000, 50,000. Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.
NOTE: The notch filter may be bypassed with a jumper on the circuit board.
Common Mode 50/60 Hz Rejection: 140 dB.
Maximum Common Mode Voltage: 2500 VAC rms at 60 Hz., ±3500 VDC
Leakage Current (input to output): 2mA max @ 240 V RMS, 60 Hz.



V75-06 ISOLATED DIRECT COUPLED BIOAMPLIFIER

The V75-06 is directly coupled to the input signal without a preamplifier-coupling filter. It is used when isolation is required for very low frequency signals; i.e. those below the lowest preamplifier coupling (0.1 Hz, 10 seconds) in the other bioamplifiers. A 60 (or 50) Hz notch filter is built in. There is an unisolated version of this amplifier available, V75-03.

Isolated amplifiers like this one, the V75-04 and V75-05, are indicated when isolation from earth ground for safety is required in situations where other sources of voltage with respect to earth ground are present in the environment and represent a hazard to the subject. Isolation is also required to prevent interference when multiple signals are being recorded from one subject; especially when one or more of the other signals is being generated by another module that places an excitation voltage across the subject.

Biopotentials from electrodes on or in a subject may be of very large potential with only a small variation "riding on top" of the overall signal. It is usually the variation that is of interest. AC coupled amplifiers de-couple the overall, large potential and pass only the variation (above the frequency selected on the preamplifier coupling control) which is "riding on top". This amplifier is used when the entire signal (absolute level) or very slow variations are of interest.

The signal of interest may be out of the range of the amplifier when the electrodes are first connected, giving a "flat line" record at either the top (positive) or bottom (negative) limits of the chart. The level is unknown and any variations are unseen because this region of the signal is off the scale. The gain of the amplifier could be reduced to a very low value to bring the entire signal into view. However this usually produces a signal so small that variations of interest on the overall slow movement of the trace are imperceptible or are of a size where "downstream" noise in the signal processing section of the system becomes a significant part.

The balance control is provided to allow the signal, with relatively high gain, to be offset into the usable region (dynamic range) of the amplifier. If the trace is at the top of the scale when you start, simply turn the balance control counterclockwise until the trace drops into view. Do the opposite for negatively offset signals. If the signal moves into range but "hits" the top and/or bottom of the chart, reduce the gain.

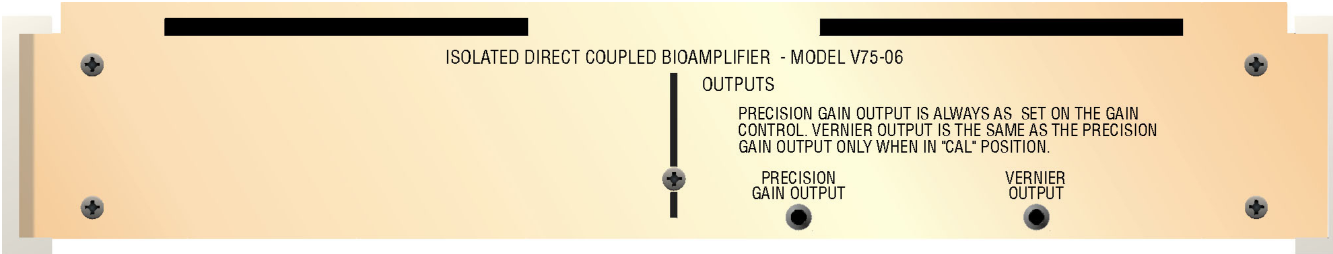
Because the nature of these signals is to move very slowly over a session toward one polarity or the other, they can also eventually saturate the amplifier, so you may have to re-balance the amplifier during the session.

There is a single, preamplifier AC coupling selection (0.1 Hz) provided for convenience.

A high cutoff filter control provides for the commonly studied DC coupled biopotentials and for "wide open" use at the full (10KHz) frequency range of the amplifier. The V75-48 High performance filter may be used for other studies, employing only the high cutoff section for sharp cutoff or "special" cutoff frequencies not provided for on the V75-06. Be sure to use the V75-06 set at a high cutoff higher than the V75-48 so as not to prefilter the signal below the setpoint of the V75-48.

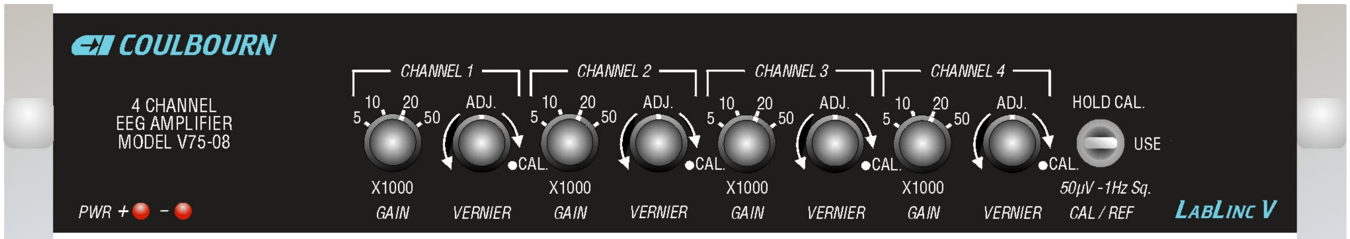
The selection of gains (10 to 10K) is lower in this amplifier because the nature of the signals studied requires a wider dynamic range and because most of the signals are larger than those studied with an AC coupled amplifier.

The vernier control and output work the same way as on the other bioamplifiers; at the calibrated position the vernier output is the same as the main output and in the off calibrate position it goes from 100% of full output to 0 in one turn to the left.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Restive: 10^7 Ohms, Capacitive: 10 pF
Common Mode Rejection: 105dB min.
Input Bias Current: 10 nA typical: 50 nA maximum.
Maximum Input Voltage: 1.0V (differential), ±10 volts (common mode).
Noise: (referred to input): 4 microvolts RMS typical at 10 to 1000 Hz.
Frequency Response: DC to 6,000 Hz (-3 dB).
Amplifier Coupling: Switch selectable DC or 0.1 Hz.
Amplifier Gain: Adjustable: 5 ranges - 10, 100, 1000, 5,000, 10,000. Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.
NOTE: The notch filter may be bypassed with a jumper on the circuit board.
Common Mode 50/60 Hz Rejection: 140 dB.
Maximum Common Mode Voltage: 2500 VAC rms at 60 Hz., ±3500 VDC
Leakage Current: (input to output): 2 mA maximum @ 240 V RMS, 60 Hz.



V75-08 4-CHANNEL EEG AMPLIFIER

The V75-08 features four totally independent (no multiplexing) amplifiers for EEG recording. This allows multi-site recording of high fidelity, full band EEG in a minimum amount of space and with great economy. Continuous-recording sleep studies using 16 channels can be accomplished with just 5 modules (4 4-channel amplifiers and a computer interface, port-connection module).

The unit has a gain control for each channel consisting of a 4-range switch and a vernier control. Maximum gain is 50 thousand. Gain ranges of 5, 10, 20 or 50 thousand are set with the switch and are precisely calibrated. The vernier control may be switched off of the calibrated position and used to set any gain from the full gain selected with the switch to zero by turning counterclockwise.

The "Cal/Ref" switch permits the user to inject a 50 microvolt calibrated reference signal into the input of each of the 4 amplifiers simultaneously. The up position applies a 1 Hz "square wave" signal continuously and the momentary down position applies the same signal for as long as it is pressed.

Each amplifier has its own built-in, true Butterworth filter (no DSP) for the full EEG band from 1 to 45 Hz. The 45Hz upper cutoff may be bypassed with a board jumper and the unit is available with .01Hz AC coupling and/or an 80Hz high cutoff on request. The filters are two-pole, offering 12-dB/octave attenuation, which is adequate and generally used for full band recording.

This amplifier is recommended for use in multi-site applications where full band recording is needed. It may also be used with a separate filter module such as the V75-48, or V75-50 for one or more of its output channels to further define frequency bands.

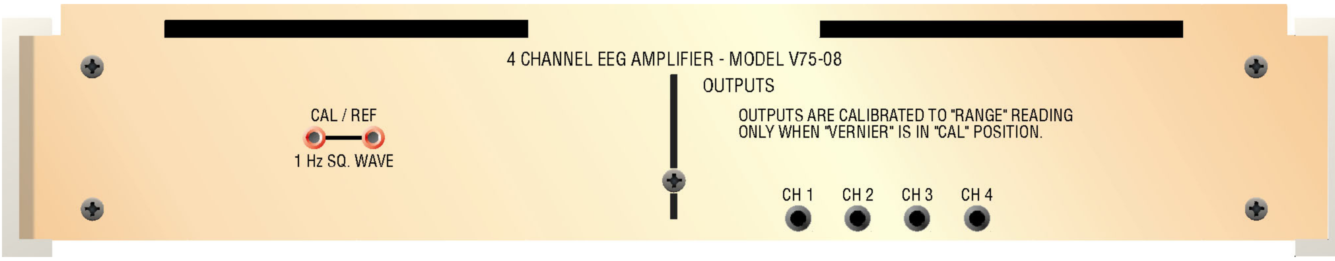
The sharpness of the cutoff "skirts" is greater in the V75-48 (48dB/Octave), and it is necessary for applications like narrow, sharply defined bands of EEG such as SMR (Sensory-Motor response), other narrow-band applications or other applications where "special" hi- and lo-cutoff points are desired. The V75-48 is cursively adjustable permitting the selection of virtually any desired frequency.

The V75-50 EEG Band separation filter is used to separate full band EEG simultaneously into the five bands, delta, theta, alpha, beta , and full band. Specific EEG band recording usually requires sharper filter skirts; to that end the V75-50 has 24 dB/Octave cutoffs.

ELECTRODES AND CABLE

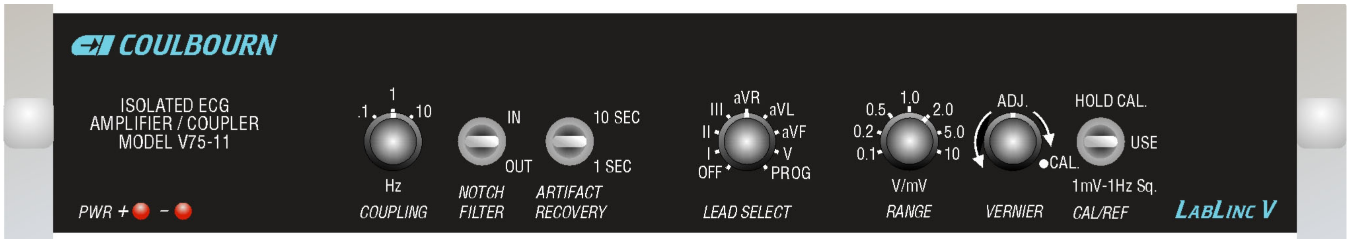
Each 4-channel unit has one ground lead. This is necessary to avoid ground loops (see page 17). When using two or more V75-08 amplifiers, the second and successive units should not employ a ground reference. Simply do not connect the ground electrode on these additional units. All of the amplifiers will be referenced to the single ground (common reference) electrode via system ground. The subject end of the cable has 9 receptacles for electrode leads. There are 4 pairs of differential (+ and -) inputs and one ground input which is common to the shield and all four amplifiers.

V91-12 Mini-Pinch electrode leads are recommended because of their low-bulk design. The standard pinch electrode leads are too bulky to be convenient when using an EEG cap. The Mini-Pinch leads may be used with our V91-01 or other snap compatible reusable or disposable electrodes. Leads for other types of electrodes that are compatible with our cable are available from other suppliers. Ask for the type of electrode connection you want with a DIN safety cable-end connector on the other end.



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Resistive: 10^7 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 105dB min.
Input Bias Current: 10 nA typical: 50 nA max.
Maximum Input Voltage to saturate preamp: 700mV (total – offset plus signal).
Maximum Input Signal (AC) to clip at highest gain: 100mV.
Noise (referred to input): 0.3 microvolts peak-to-peak typical.
Frequency Response (Filtered): 1 to 45 Hz (-3 dB) at 12 dB/Octave (45Hz lo-pass may be bypassed with a board jumper and the unit may be ordered with 0.1 Hz AC coupling and/or a 80 Hz low pass).
Amplifier Coupling: 0.5 Hz.
Amplifier Gain: 4 ranges - 5,000, 10,000, 20,000 & 50,000. + Vernier gain output goes from switch setting in the cal. position to 0% of setting in one turn of the knob.
Calibration / Reference: Toggle switch inserts a 50 microvolt 1Hz square wave continuously in the up position and, when pressed down, for the duration it is held down.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.)



V75-11 ISOLATED ECG AMPLIFIER/COUPLER

The V75-11 ECG Isolated Amplifier/Coupler performs all the standard multi-lead ECG monitor functions by either manual or program control. The sensitivity must be selected manually; however, lead selection and calibration may be performed manually or by program control. To program lead selection, provide a 3-bit binary code from the computer via a LabLinc port. The legend on the rear panel indicates the lead configuration selected.

Switch selectable options are available to make the module meet the requirement of almost any application. These options include: a notch filter (50Hz or 60Hz) with on or off select switch, a low frequency cutoff filter switch for 0.1, 1.0 or 10 Hz, and a lead switch. There is also an artifact-suppression/time-constant select switch for 1.0 seconds or 10 seconds to choose the length of time the output signal is suppressed after lead select change.

ELECTRODES AND LEADS

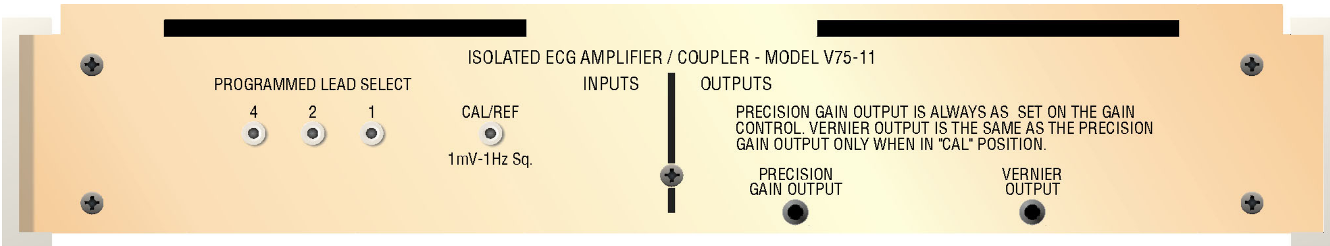
To record an electrocardiogram, five electrodes are affixed to the body of the subject (see next page). The electrodes are connected to the ECG amplifier via the electrode input using a V91-35 5-Conductor ECG Electrode Cable. These electrodes are usually called leads. The electrode applied to the right leg of the subject, for example, is called the RL lead. For the recording of the electrocardiogram, two electrodes (or one electrode and an interconnected group of electrodes) are selected and connected to the input of the recording amplifier. It is somewhat confusing that the electrodes and the way in which they are connected are both referred to as a lead. To avoid this ambiguity we use the term lead to refer to a particular group of electrodes and how they are connected to the amplifier. For the individual lead wire, as well as the physical connection to the body of the subject, the term electrode is used. Be careful of the double meaning that the term lead can have in normal clinical usage.

The V75-11 also features an isolated and defibrillator protected electrode input circuit. In addition to meeting all patient safety requirements, the electrode inputs are also protected against damage from defibrillator discharge.

SPECIFICATIONS

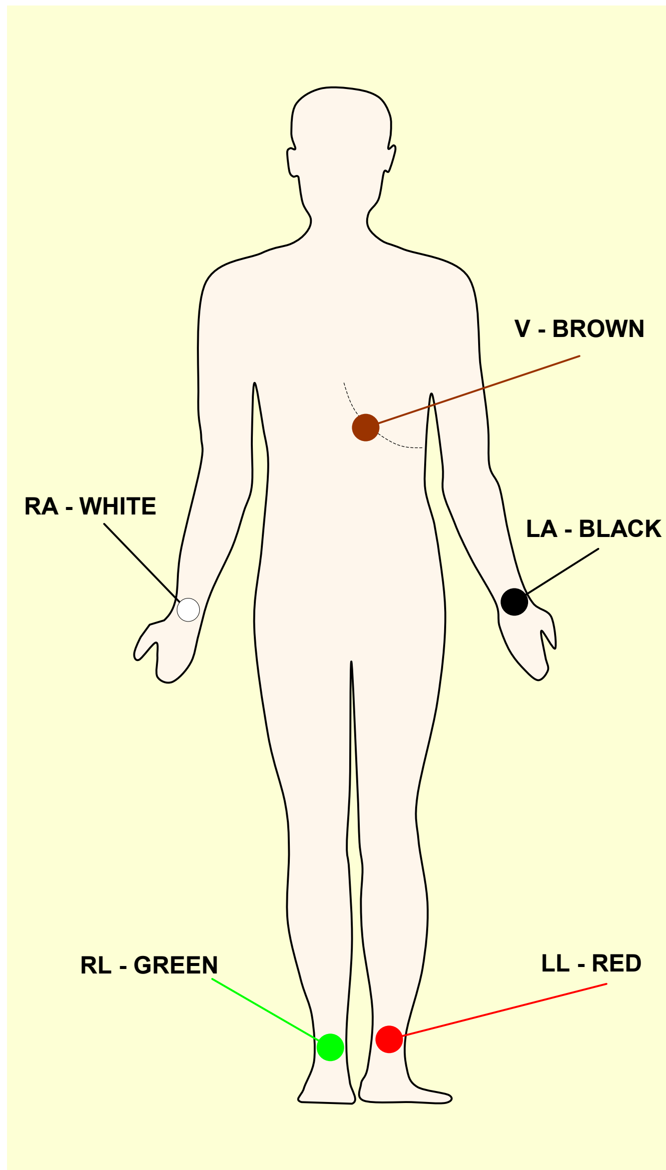
Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Restive: 10^7 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 105dB min.
Input Bias Current: 50 nA maximum.
Maximum Input Voltage to saturate preamp: 700mV (total – offset plus signal).
Maximum Input Signal (AC) to clip at highest gain: 100mV.
Noise: Referred to input - 10 microvolts typical.
Input Configuration: Standard five electrode sites - RA, LA, LL, RL, and V (C).
Frequency Response: 0.1 to 150 Hz ±3 dB, 1.0 Hz to 100 Hz ±1 dB.
Lo Frequency Cutoff: Switch selectable at 0.1 Hz, 1.0 Hz, or 10 Hz.
Notch Filter: (50 or 60 Hz, please specify): Switch Selectable IN or OUT.
Notch Depth: 28 dB typical.
Lead Switch Artifact Suppression Time Constant: Switch Selectable - 1 or 10 seconds (length of time output signal is suppressed after lead select change).
Lead Selection: Manual or Program Control - Off, I, II, III, aVR, aVL, aVF, and V.
Sensitivity: 7 calibrated ranges - 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, and 10 V/mV (separate vernier output and control).
Calibrate: Manual or Program Control - 1 millivolt, Accuracy: ±1%
Isolation: Meets UL Standard 544 leakage requirement. 2 μA maximum at 240 VAC, 60Hz ±2500 Volts CMV input / output and lead-to-lead isolation.

Accuracy: ±1%, Stability: ±0.1%
Output Voltage Range: ±10 Volts
Maximum Input Safety Voltage: Continuous - 400 Volts peak to peak, defibrillator - 2.5KV for 20 msec.



ELECTRODE PLACEMENT

With the electrode placement shown to the right, four electrodes are used to record the electrocardiogram. The electrode on the right leg is only for ground reference. Because the input of the internal amplifier has only two terminals, a selection must be made among the available active electrodes. The configuration of the 12 standard leads is shown on the opposing page.



LEADS

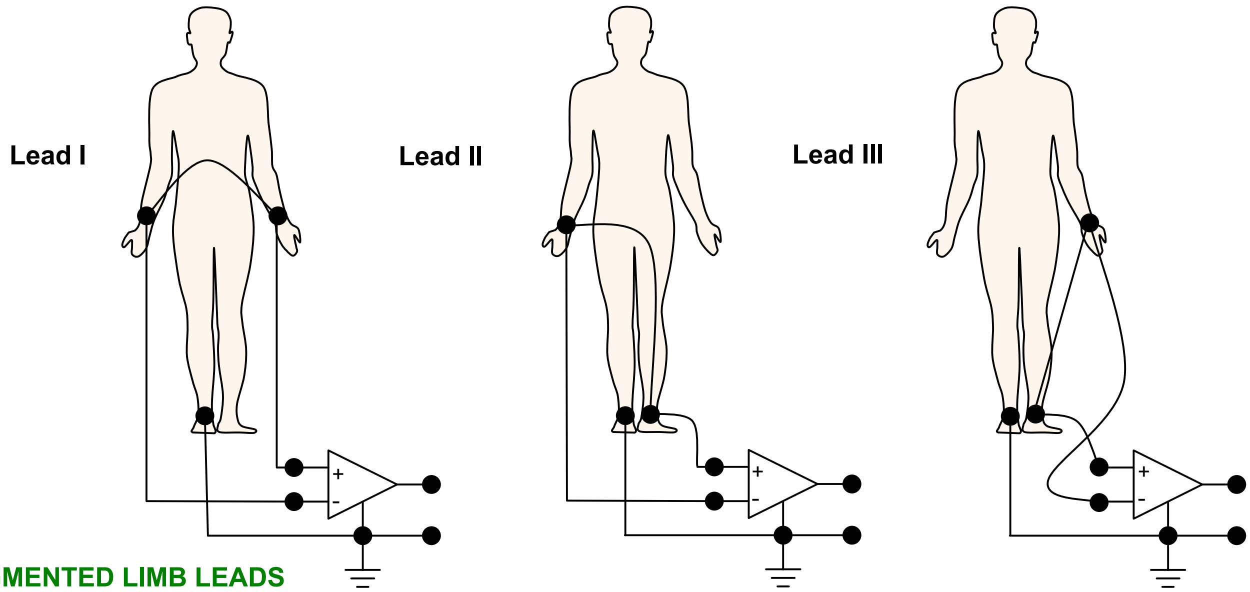
		BINARY CODE
Bipolar Limb Leads		
I	LA - RA	001
II	LL - RA	010
III	LL - LA	011
Augmented Unipolar Leads		
aVR	RA - 1/2 (LA + LL)	100
aVL	LA - 1/2 (RA + LL)	101
aVF	LL - 1/2 (RA + LA)	110
Pericardial Chest Leads		
V1	V1 - 1/3 (LA + RA + LL)	111
V2	V2 - 1/3 (LA + RA + LL)	111
V3	V3 - 1/3 (LA + RA + LL)	111
V4	V4 - 1/3 (LA + RA + LL)	111
V5	V5 - 1/3 (LA + RA + LL)	111
V6	V6 - 1/3 (LA + RA + LL)	111

The movable, "V" electrode is the positive electrode in lead configurations 7 through 12. To select for leads 7 through 12, use the "V" position of the select switch or the corresponding program code (1 1 1) on the jacks on the rear of the module. Then manually place the "V" electrode as indicated in the listing shown on the diagram on the next page.

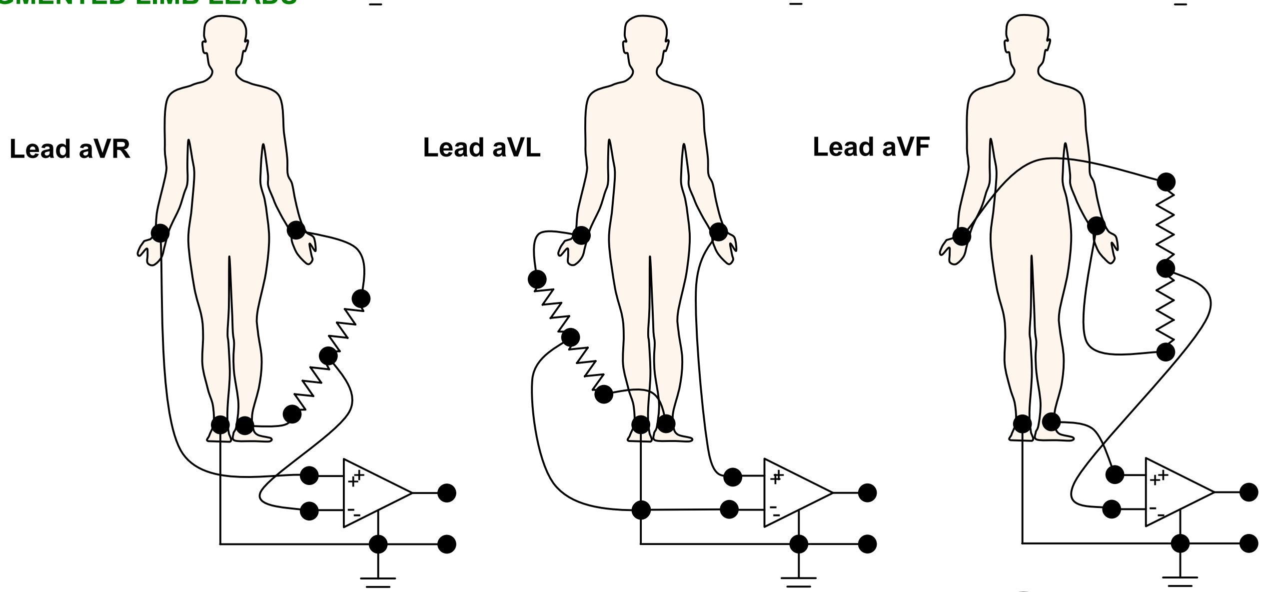
The placement of electrodes and the color code used to identify them is shown in the diagram above.

ECG LEAD CONFIGURATIONS

BIPOLAR LIMB LEADS



AUGMENTED LIMB LEADS



UNIPOLAR CHEST LEADS

V_1 Fourth intercostal space, at right sternal margin.

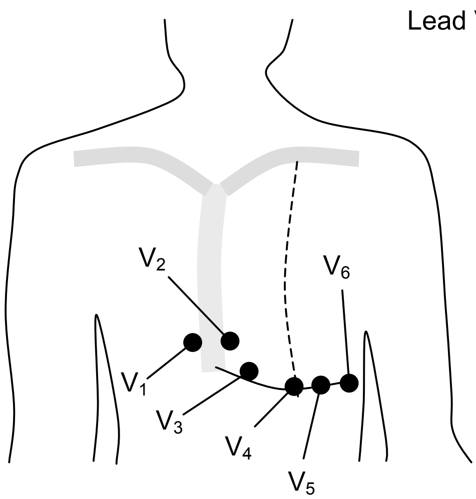
V_2 Fourth intercostal space, at left sternal margin.

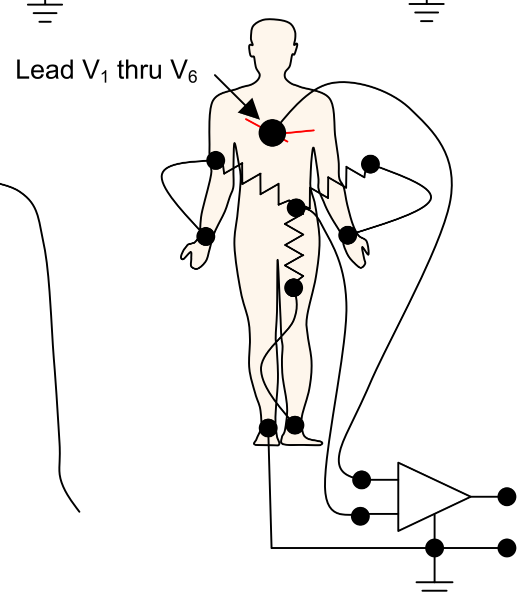
V_3 Midway between V_2 and V_4.

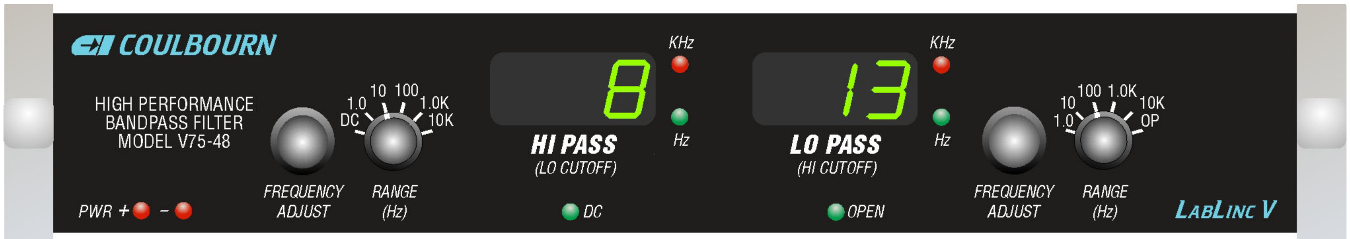
V_4 Fifth intercostal space, at mid-clavicular line.

V_5 Same level as V_4, on anterior axillary line.

V_6 Same level as V_4, on mid axillary line.







V75-48 HIGH PERFORMANCE BANDPASS FILTER

The V75-48 consists of independent low pass (high cutoff) and high pass (low cutoff) filter sections. When used as a bandpass filter, the output of the high pass is connected to the input of the low pass section by an internal connection (indicated by the dashed line). This connection is broken when a lead is inserted into the-lo pass input. The sections then function independently.

Each filter is continuously adjustable. The high pass is adjustable from DC to 10 KHz. The DC range switch position simply bypasses the high pass section and routes the incoming signal to the low pass section. The other five ranges of the high pass section allow continuous adjustment within each decade range. The low pass section is analogously configured with the 6th position being a bypass of the low pass section; routing the output of this section directly to the module output.

A 0 to 1-Volt signal from a DAC within each decade range may also program the filter setpoint. This allows computers to automatically select the set points of the filter.

The filter is a Butterworth type, the indicated filter type for signals in the physiological spectrum. The 8-pole design yields very sharp 48 dB/octave cutoffs The sharpness of the cutoff skirts is greater in the V75-48 than it is in the onboard filters of the V75-01 and V75-04 bioamplifiers (12 dB/octave). This makes it useful for applications like narrow, sharply defined bands of EEG such as SMR (Sensory-Motor response - 12 to 14 Hz),.

The filter is also indicated for applications where "special" frequency hi- and lo-cutoff points, not available on the switch selectable filters, are required.

This module may be used to filter signals from any of the signal conditioning modules, including all of the bioamplifiers (especially the V75-02 and V75-05), transducer couplers, and the V79-01 General Purpose Interface.

The extremely narrow bands and sharp skirt attenuation, along with the cursively adjustable feature that allows a near-infinite selection of bands, make this filter the best choice for the serious investigator.

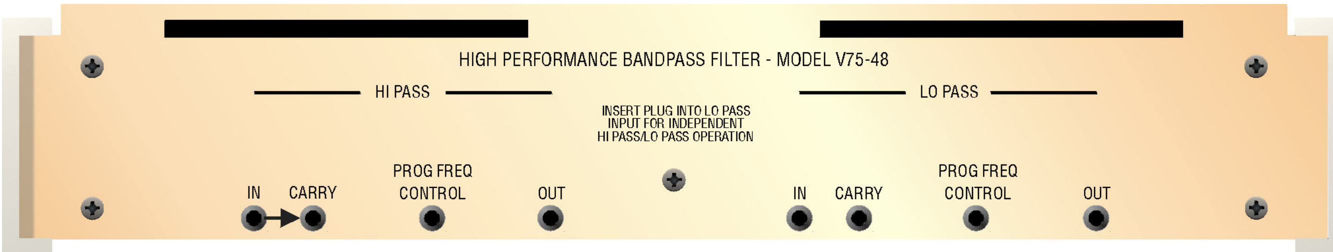
The shortcomings of DSP (digital signal processing) filters, especially in real-time computer based virtual instrument systems and especially in physiology, make this an ideal module for the "front ends" of those systems.

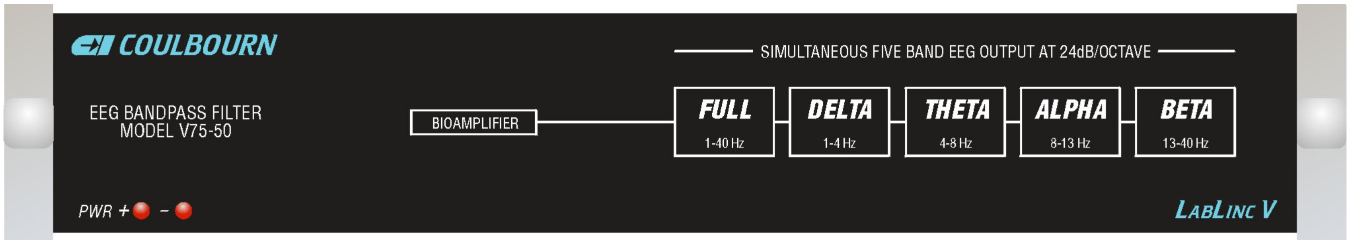
SPECIFICATIONS

Filter Type: 8 pole (48 dB/Octave) Butterworth.
Input Impedance: 1 Megohm typical.
Maximum Input signal: ±10 Volts.
Passband Gain: ±0.2 dB.
Frequency Tuning Limit: 0.1 to 9.99 kHz*.
Frequency Stability: .01% / 0C.
Noise: 150 microvolts rms, DC to 10 KHz.
Frequency Accuracy: ±2% of setting.
Attenuation at Setting: 3dB.
Output Impedance: less than 10 Ohms.
Output Signal: ±10 volts max.

Frequency Adjust: Cursive adjustment within each range. NOTE: Hi Pass and Lo Pass sections can be used independently. See the description above and look at the module's rear panel.
Range Selection: 1 - .10 to .99, **10** - 1.0 to 9.9, **100** - 10 to 99, **1000** - .10k to .99k, **10000** - 1.0k to 9.9k.

NOTE: *The DC selection bypasses the high pass filter; the OPEN selection bypasses the low pass filter.*





V75-50 EEG BANDPASS FILTER (With Simultaneous Five-Band Output)

This filter separates EEG signals into five bands simultaneously. The input may come from any bioamplifier capable of amplifying signals between 1 and 40 Hz (all of Coulbourn Instrument's bioamplifiers amplifiers are capable of considerably wider band performance than this).

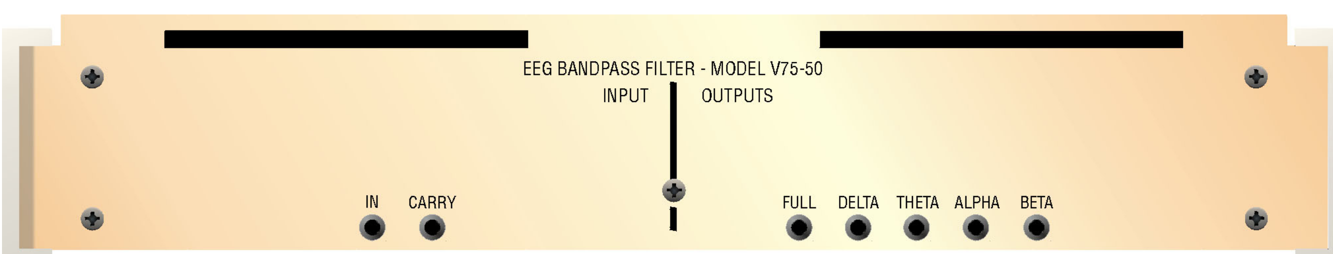
4-pole Butterworth bandpass filters are used in this amplifier which give 24 dB/octave cutoffs. This is considerably higher than the 12 dB/octave afforded by the onboard filters of the V75-01 and V75-04 bioamplifiers. This level of attenuation is adequate at the nominal pass bands of this filter for nearly any purpose. The V75-02 and V75-05 bioamplifiers without filters are recommended for use with this filter owing to the economy of not paying more for the models with onboard filters; but if you have them, use them. Just be sure to set the bioamplifier's filters at "open to preamp" for a low cutoff of 1 Hz or lower, and to 40 Hz or higher for high cutoff so that you will not lose part of the signal.

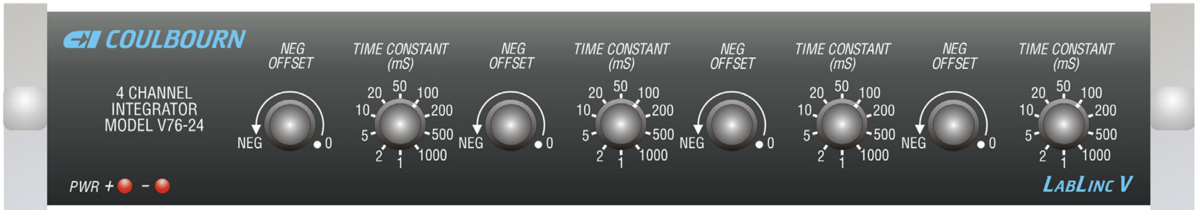
For other defined EEG responses (especially for narrow band signals like Sensory Motor Response - 12 to 14 Hz) use the V75-48 High Performance Filter and any bioamplifier.

This filter (one or more) may be used on single channels of the V75-08 8-Channel multi-site EEG amplifier (as of course, can any of the three separate filters).

SPECIFICATIONS

Filter type: 4-pole Butterworth, 24 dB/Octave.
Maximum Input: ±10 Volts.
Outputs: ± 10 Volts maximum. Output amplitude is attenuated 24 dB/O, 3 dB down at the indicated nominal cutoffs.
Full Band: 1to 40 Hz.
Delta: 1to 4 Hz.
Theta: 4 to 8 Hz.
Alpha: 8 to 13 Hz.
Beta: 13 to 40 Hz.





V76-24 4-CHANNEL INTEGRATOR

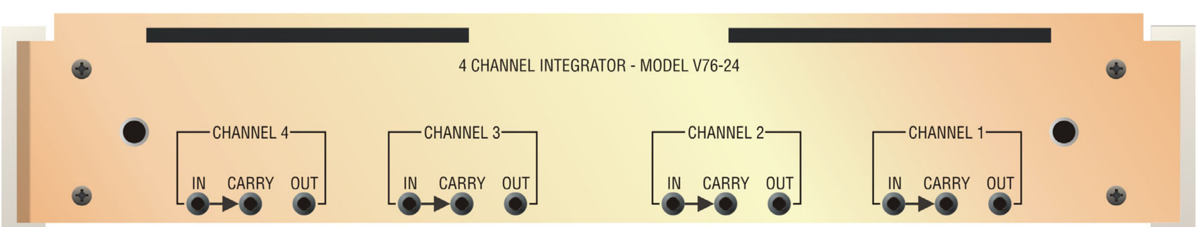
This module was designed to meet the needs of multi-channel integration requirements. This unit provides four independently controlled contour following integration channels all in one module. Each channel has a time constant rotary switch, negative offset adjust and on board jumpers for positive, negative and full-wave rectification.

The contour following integrator is used to “smooth out” high frequency signals such as EMG where the contour or “envelope” of the signal is of interest. This makes a more readable trace, showing the contour of the signal. The integrator also provides a precise measure of area under the curve as the root mean square of the instantaneous amplitude of the signal.

The integrator makes it possible to record aspects of such signals without impossibly high analog-to-digital conversion rates, large data files, and massive amounts of statistical processing. It also permits viewing meaningful data in real time with computer-based chart recorder software. This is especially important in applications involving multiple simultaneous physiological measures.

Application Note: The negative offset allows you to “zero out” background noise and/or unwanted baseline signal coming from the input source. For example, when recording EMG, bio-amplifier and electrode cable pickup noise may contribute a small amount of signal to the input of the integrator. This can be zeroed out by shorting the electrode leads together before attaching them to the subject and then setting the negative offset to produce zero output. When the subject leads are connected, the offset effectively eliminates the contribution of noise to the true signal.

The negative offset can also be used to offset subject baseline response or “tonic level” as well as to eliminate other noise and background signal that you do not want to appear in the record. e.g.: seismic signal from ergometric activity or tremor platforms, preload from strain-gage force transducers, and the gravity contribution from accelerometers.

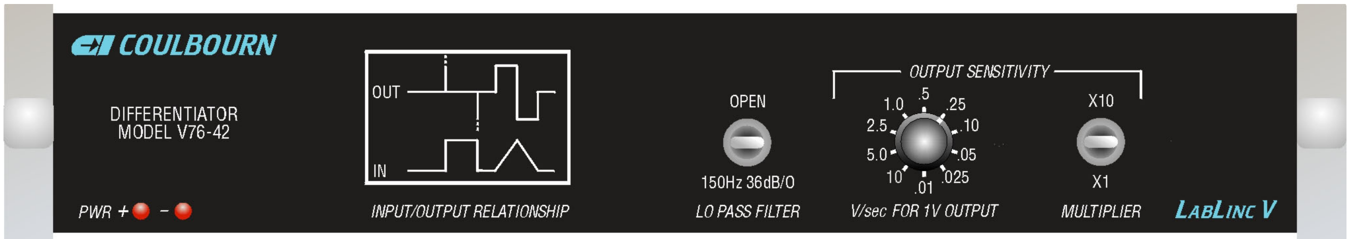


Note: A contour following integrator is a rectifier and a single-pole low pass filter. The rectifier section of this unit rectifies “full-wave” or “half-wave” for either the positive or negative (above or below 0 volts) component of bipolar signals. It is important to note that the negative portion of a signal is inverted to the positive region when “negative half” is selected, just as it is in the “full-wave” mode. All positive and/or negative regions of the original signal will be in the positive region (absolute amplitude) and will not charge and discharge the capacitor in the filter. Un-rectified signals (of equal positive and negative swing) going through a low pass filter result in a near zero output for signals many times the frequency of the filter. After all, that’s what a filter does.

This is not simply a low pass “smoothing filter” referred to in EMG literature. It is both a rectifier and a low pass filter which gives an average RMS value for that portion of the signal passed within the most recent time constant filter. As a complete circuit we call it a contour following integrator.

SPECIFICATIONS

Input Impedance: 1 Megohm
Max. Input Signal: +/- 10 Volts Peak
Input Frequency Range: DC – 50 kHz
Rectifier Control: on-board jumpers – positive region only, negative region only, and full signal
Analog Output Impedance: < 50 Ohms
Integrator Time Constant: Switch selectable to: 1, 2, 5, 10, 20, 50, 100, 200, 500, or 1000ms



V76-42 DIFFERENTIATOR

The function of the differentiator is to produce a voltage (level) at the output as a function of linear rate of change (slope) of a voltage at the input. It is used in physiology to produce derivative signals, such as acceleration and velocity for ECG, blood flow, eye movement, tremor, respiration, and integrated EMG.

This module is unique among differentiators. Its state of the art design offers a very broad dynamic range and ultra high precision. Slope is determined by two high-speed sample and hold circuits driven by a high frequency quartz clock. Each pair of time spaced samples is compared for the difference in voltage over the known time and held in a third sample and hold circuit to produce the output.

Multiple units may be connected in series to generate the second and third derivatives.

A high cutoff filter is provided for extreme precision in lower frequency applications such as ECG. It may be bypassed by setting the front panel switch to "open".

Each sensitivity range will produce an output up to ten times the rage of change listed to yield a ten-volt output. A positive change at the input yields a positive output voltage, while a negative change at the input yields a negative output voltage.

The unit is used with the WinDac or other interface to save processing time and for direct display of the processed signal with other real time traces.

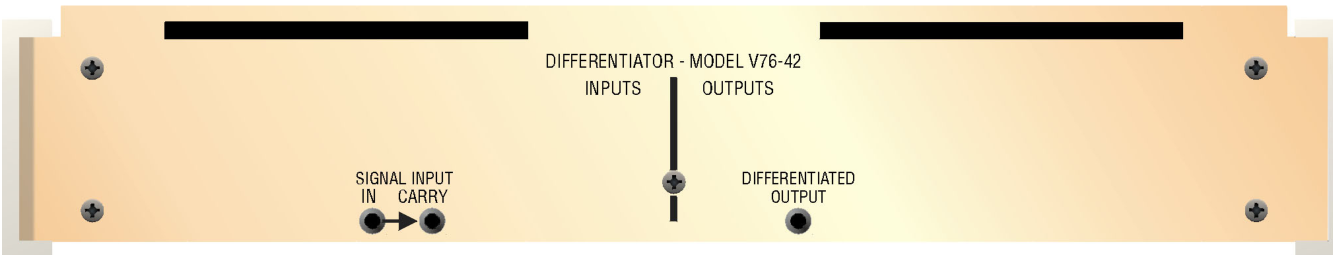
SPECIFICATIONS

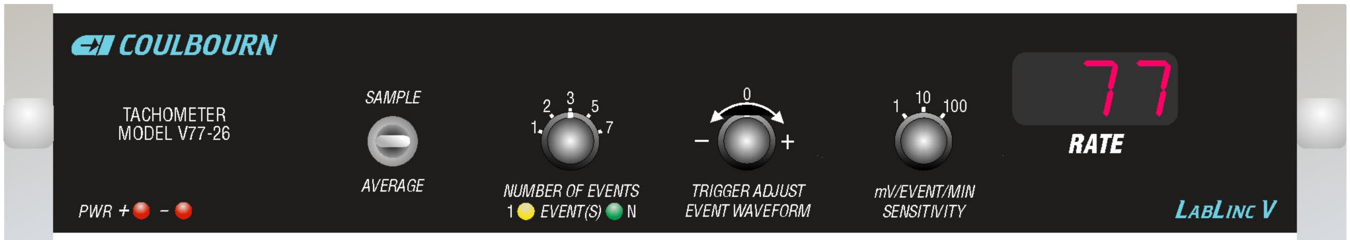
Input Impedance: 1 Megohm
Maximum Input Signal: ±10 Volts Peak
Maximum Input Frequency: 100 Hz Sinusoid
Filter: 150 Hz Low Pass, 36 dB/Octave roll-off.
Differentiator Sensitivity: Adjustable - 13 Ranges
Maximum Input Frequency for each Range: Input Signal 1 VRMS Sine Wave

Range		**Input Signal Frequency**			
Slope (Volts/Sec.)		@ 1 Volt Output		@ Full Scale Output (10 Volts)	
X1	**X10**	**X1**	**X10**	**X1**	**X10**
.01	.1	.001 Hz	.01 Hz	.01 Hz	.1 Hz
.025	.25	.0025 Hz	.025 Hz	.025 Hz	.25 Hz
.05	.5	.005 Hz	.05 Hz	.05 Hz	.5 Hz
.1	1.0	.01 Hz	.1 Hz	.1 Hz	1.0 Hz
.25	2.5	.025 Hz	.25 Hz	.25 Hz	2.5 Hz
.5	5.0	.05 Hz	.5 Hz	.5 Hz	5.0 Hz
1.0	10.0	.1 Hz	1.0 Hz	1.0 Hz	10 Hz
2.5	25.0	.25 Hz	2.5 Hz	2.5 Hz	25 Hz
5.0	50.0	.5 Hz	5.0 Hz	5.0 Hz	50 Hz
10.0	100.0	1.0 Hz	10 Hz	10 Hz	100 Hz

Accuracy: ±1% of Full Scale
Nonlinearity: 0.1% of Full Scale
Output Impedance: 10 Ohms
Maximum Output Signal: ±10 Volts Peak

NOTE: *Use x1 range whenever possible for best signal quality. Other low pass filter cutoff frequencies and differentiator ranges are available upon special request. Consult factory for details.*





V77-26 TACHOMETER

The V77-26 is a microprocessor-based tachometer that produces an analog (voltage level) output proportional to the rate of events on the input and displays the number of events per minute on the module face. It is used when a digital display of rate is desired and you don't want to clutter a chart recorder emulation screen with windows or to sacrifice processing speed in multi-channel recording to calculate and display, or record, a channel of cursive rate data. It is also used when there is no computer in use and is especially useful in biofeedback for rapid-change stimulus synthesis.

The unit can operate in an averaging mode or a sampling mode.

In the sample mode, the "number of events" control sets the number of the event since the last event to be sampled. Hence if set at five, the elapsed time between the fourth and fifth event will be converted to rate, displayed immediately upon the occurrence of the fifth event and held until the occurrence of the tenth event. At that time the elapsed time between the ninth and tenth event will be converted and replace the number in the display. This is useful when averaging is not desired and readability of the display is important. Sampling allows the viewer to read the display more readily because it is not changing as frequently. If the display is not important and the analog trace on a chart is more important, use a setting of one; it provides more data to the computer file for analysis and makes a smoother trace.

In the average mode the "number of events" control sets the number of events to be averaged and displayed. The averaging is done on the basis of elapsed time between events and is a rolling average. If the control is set at three, the elapsed time between event one and four is divided by three, converted to rate and displayed on the occasion of the fourth event. Then on the occurrence of the fifth event, the elapsed time between the second event and the fifth is divided by three, converted to rate and the display is updated and so on.

The analog output may be set to 1, 10, or 100 millivolts per event per minute. If set at 10, 138 events per minute produces 1.38 volts at the output. The display is unaffected by the output sensitivity setting. It always displays the actual number of events per minute.

An interesting, and valuable, feature of this tachometer is its ability to "account for missing events". Rather than holding the rate between the last two events indefinitely it will "anticipate" rate and follow what the rate should be if an event did occur. If an event does not occur in an interval equal to twice the last interval it will go immediately to one half the rate. If no event occurs in twice the new interval it will go to half of that rate. It will do this four times and then go to zero*. Thus if inputs stop altogether, it will be at zero in a time equal to 62 times the inter-event interval of the last two inputs. For example, if it is being used for heart rate and inputs stop at a rate of let's say, 120 bpm, it will be at zero in 31 seconds. With the sensitivity set at 10 mV / E / Min., the output will start at 1.2 volts reflecting the last inter-beat interval of 1/2 second and then go to 600 millivolts one second later (one missed beat at 60). Two seconds later it will go to 300 millivolts (two missed beats at 60 bpm or 4 additional elapsed seconds which is a rate of 30 bpm). Another four seconds later (two missed beats at 30) it will go to 150 millivolts, and after an additional 8 seconds, to 75 millivolts and 16 seconds later, to zero. In the averaging or sampling modes this is done for every beat regardless of the average or sample setting (otherwise it could be a very long time). If a beat does occur at any time during this sequence, the output will immediately go to the actual or averaged value for the interval between it and the last actual beat.

* If this mode gives a final drop to zero which is too abrupt for your application, there is a jumper on the circuit board which can be moved to more approximate an asymptote to zero by changing the number of "halvings" to 6, or 254 times the last interval before going to zero. In either jumper position, the absolute maximum interval is 60 seconds. Regardless of rate the output will go to zero if no input event is registered within 60 seconds of the last.

There are two inputs to this module, an analog event input and a digital event input. The analog event input is controlled by a trigger adjustment on the front panel. This allows analog signals like ECG or respiration to be brought into the unit and be used as an event trigger. The trigger adjustment control sets a threshold triggering circuit (comparator). It is adjusted until the event light reliably flashes at the top portion of the analog "event curve" e.g. the R wave of an ECG signal. It is best to have the "number of events" switch set to one for this setup procedure.

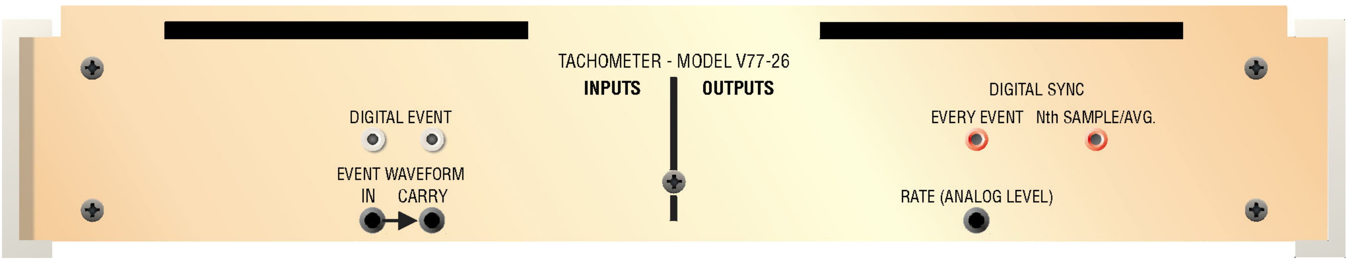
The digital event input is easier to use since you can bypass the trigger adjustment setup, and of course it is more reliable, not being subject to artifact spikes. Use the digital output of a module where there is a choice (as in the V71-40 blood flow pulse monitor) because there is signal conditioning onboard the source module, ahead of the digital output, which is more definitive of the signal of interest.

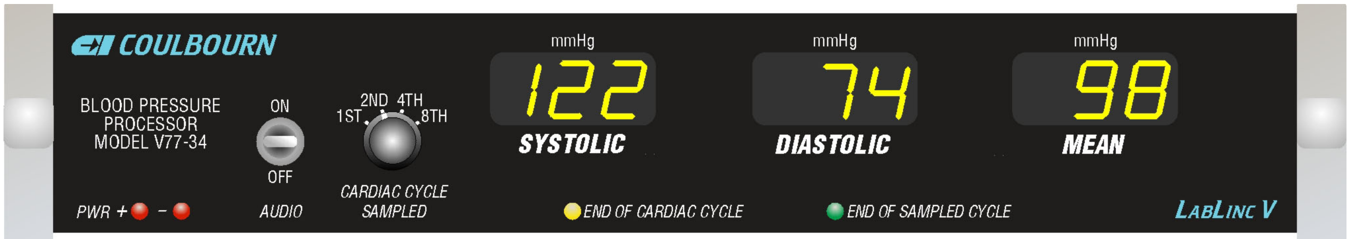
To define signals from other sources more rigorously, it may be necessary to filter and/or integrate them before bringing the signal into the analog input of the tachometer. This may have to be done to eliminate "ambiguous", multiple spikes riding on the portion of the signal of interest. ECG signals are generally reliable triggers, but if you are using a bioamplifier with onboard filters, and the rest of the ECG wave form is of no interest, set the low cutoff to 90 Hz and the high cutoff to 150 to look at just the main spike of the R wave.

SPECIFICATIONS

Analog Input: ±10 Volts, through an adjustable comparator control labeled - Trigger Adjust/Event Waveform.
Digital Input: Standard logic level, leading edge.
Sample / Average Control: Selects mode.
Number of Events Control: Selects the number of the event sampled, or the number of events averaged in a rolling* average.
Trigger Adjust: Sets the trigger amplitude for the analog event input.
Range: 1 to 999 events per minute.
Output Sensitivity: 3-position rotary switch.
1 mV / E / Min. (Use for high heart rates, e.g. mice.)
10 mV / E / Min. (Use for human heart rate.)
100 mV / E / Min. (Use for respiration.)
NOTE: Sensitivity setting does not affect display.
Accuracy: Better than 1 event per minute
Output: 10 millivolts / event / minute, maximum 9.9 V.
Display and Output Update: On the occasion of every "Nth" input in the "sample" mode, or every input in the "average" mode.

**A rolling average means the average of the last "N" events calculated on the occurrence of every event (see text).*





V77-34 BLOOD PRESSURE PROCESSOR

The Blood Pressure Processor is designed to accept a pressure waveform signal from a CI or other transducer coupler. The 3 displayed, computed outputs are stable state, analog "staircase" values, calculated between each pressure pulse, updated on each beat, and held in memory until the next beat-update cycle.

Three displays show the current value of systolic, diastolic and mean pressure. Indicator lights flash at the end of each cardiac cycle (to confirm reliable triggering) and at the end of the sampled cardiac cycle. An audio tone pulse, coinciding with the end-of-cardiac-cycle light flash, may be turned on or off using the front panel switch. A control on the front panel permits the user to select a sample on every cardiac cycle, or on the 2nd, 4th, or 8th cycle.

The "staircase" outputs represent the actual value of each function thereby eliminating raw trace interpolation and producing a very clean and easy-to-read trace on the chart record.

When no real-time chart is needed, the staircase data format and data-valid sync pulse permits a single sample to be taken of each function, rather than taking high-speed A/D samples, and using software to find the peak, trough, or other critical value. The reduction in bus traffic and computational time is 1,000 to 1 or more.

The integrated average output is not a staircase. It represents a rolling time/amplitude integral. The circuit for this function is similar to the contour following section of the V76-23 Multi-Function Integrator.

The differentiated output is a dp/dt waveform (the first derivative of pressure). It is uncalibrated, but may be used in the 50 - 200 mmHg range and give an acceptable trace. It is used for internal triggering functions and is brought out to the rear panel as a convenience. For accurate differentiated waveforms, the V76-42 Differentiator module is recommended.

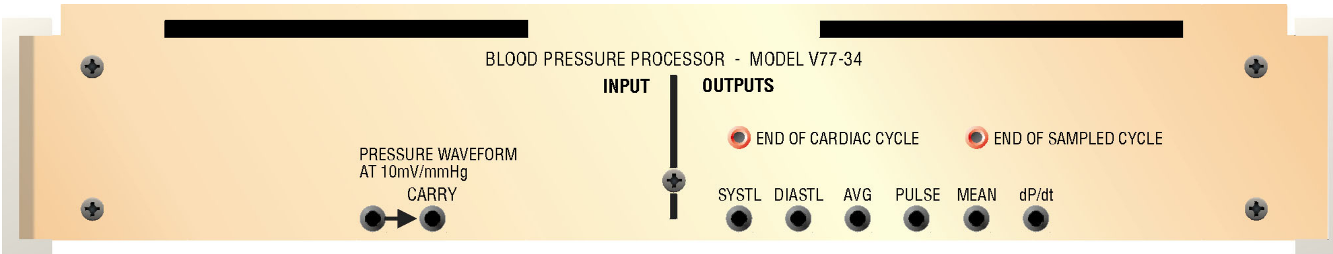
SPECIFICATIONS

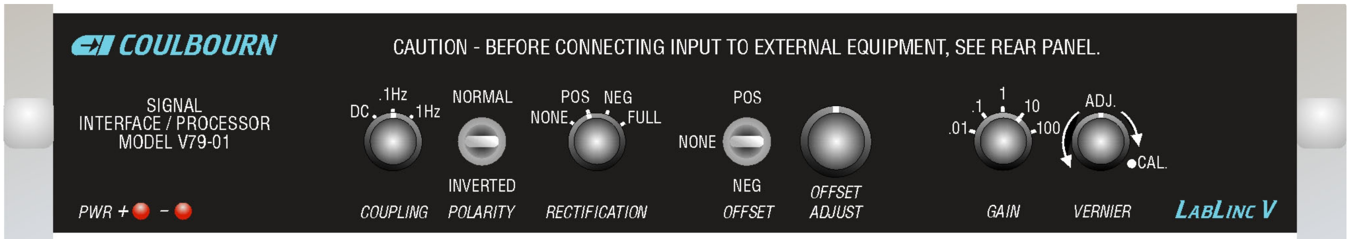
PRESSURE WAVEFORM INPUT

Input Impedance: 1 Megohm.
Maximum Input Signal: ±8 Volts.
Typical Input Signal: 10 mV/mmHg.
Pulse Rate Range: 10 bpm to 1200 bpm.

PRESSURE OUTPUTS
Systolic
Diastolic
Pulse: Derived from Systolic minus Diastolic.
MAP (Mean Arterial Pressure): Derived from Diastolic pressure plus 1/3 Pulse Pressure.
Average: Derived from active averaging integrator.
First Derivative of Pressure (dp/dt): Not calibrated; used only for triggering.
Accuracy: ±1% Typical - ±2% Maximum.
End of Cardiac Cycle Output: Standard Logic Level Output: Five-millisecond pulse occurring at the end of each cardiac cycle. Can be used for triggering data acquisition modules, LED flashes at the end of each cardiac cycle indicating that the input pressure waveform has met the internal triggering requirements.

NOTE: *Systolic, Diastolic, Pulse, and Mean outputs are updated at the end of each sampled cardiac cycle and held stable until the end of the next sampled cycle. Average and dp/dt outputs follow the input pressure waveform dynamically.*





V79-01 SIGNAL INTERFACE/PROCESSOR (NON-ISOLATED)

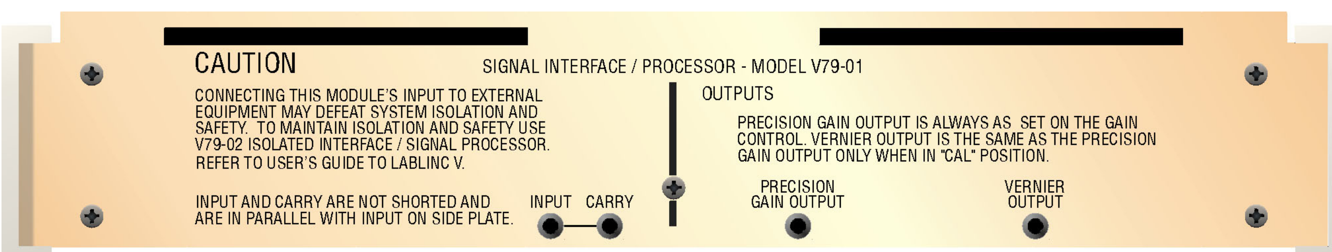
The V79-01 is designed to take signals either from outside the system or from the other system modules and perform basic signal manipulations on them.

It can accept positive, negative or bipolar signals from millivolt levels up to 100 Volts peak from external amplifiers and signal sources and bring them into the system, via the three binding posts on the side plate, for recording or interaction with other modules. External signals are referenced to earth ground through the system. An isolated version is available, V79-02.

Signals from other modules are brought into the system on a standard analog jack on the rear panel in the same manner as all inter-module connections.

Signals from either source may have the following operations performed upon them:

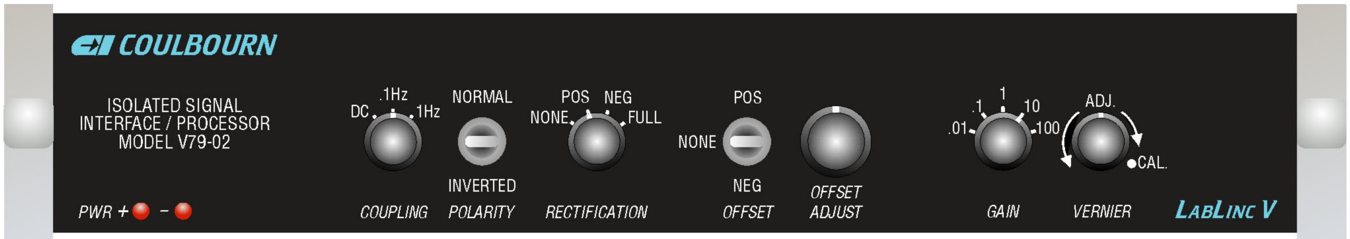
- ✓ Coupling: Preamp (high pass); DC, 0.1 Hz AC or 1 Hz AC
- ✓ Polarity: Normal or inverted.
- ✓ Offset: Plus or minus 0 to 10V (full-scale output.
- ✓ Rectification: Positive half, negative half, or full wave.
- ✓ Gain: 5 Ranges from X1/100 (attenuated) to X100 plus vernier control.
- ✓ Note: Gain is inoperative for the rear panel input. The side panel input is present on (connected to) the "carry" jack on the rear panel. It is shunted-out upon introduction of a signal at the rear panel input in the normal fashion. (See page 8).



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance: (**Differential and Common Mode**). Resistive - 10^6 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 76 dB minimum.
Input Bias Current: 10 pA typical: 20 pA maximum.
Maximum Input Voltage: Rear panel input - ±10V, Side plate input - ±100V, differential.
Noise (referred to input): 4 microvolts RMS typical at 10 to 1000 Hz.
Frequency Response: 0.1 to 10,000 Hz (-3 dB)
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order).
NOTE: *The notch filter may be bypassed with a jumper on the circuit board.*
Amplifier Coupling Switch selectable - DC, 0.1, or 1 Hz.
Amplifier Gain: Affects the side input only. 5 ranges; 1/100, 1/10 (attenuated), Unity, 10 and 100.

Vernier Gain: Vernier gain affects both signal sources. Output reflects gain from external signal gain control or the input amplitude of the signal introduced from the rear panel. It represents 100% of the precision output with switch set in the cal. position, and ranges form 120% down to 20% of the setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Common Mode 50/60 Hz Rejection: 140 dB.
Signal Processing Sequence: Coupling, gain range, inversion, rectification, offset and gain vernier. Jumpers on PC board provide for reversing rectification and offset.



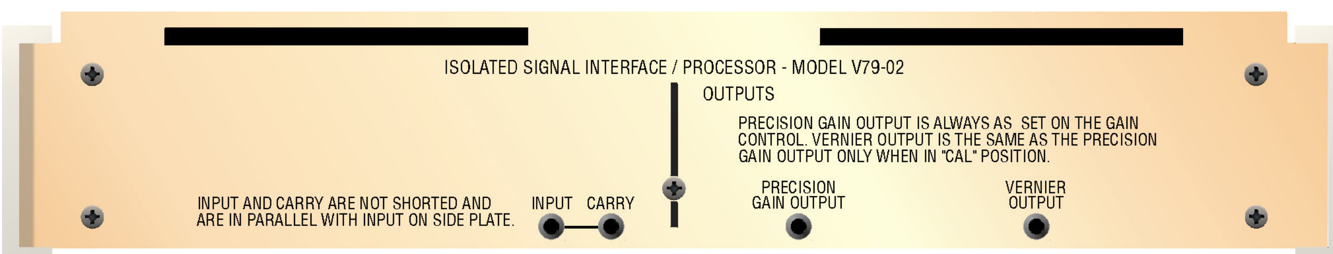
V79-02 ISOLATED SIGNAL INTERFACE / PROCESSOR

The V79-02 is designed to take signals either from outside the system or from the other system modules and perform basic signal manipulations on them. It can accept positive, negative or bipolar signals from millivolt levels up to 100 Volts peak from external amplifiers and signal sources and bring them into the system, via the three binding posts on the side plate, for recording or interaction with other modules.

This unit maintains isolation of an external signal from the ground reference of the system. A non-isolated version is available at lower cost, V79-01.

Signals from other modules are brought into the system on a standard analog jack on the rear panel in the same manner as all inter-module connections. Signals from either source may have the following operations performed upon them:

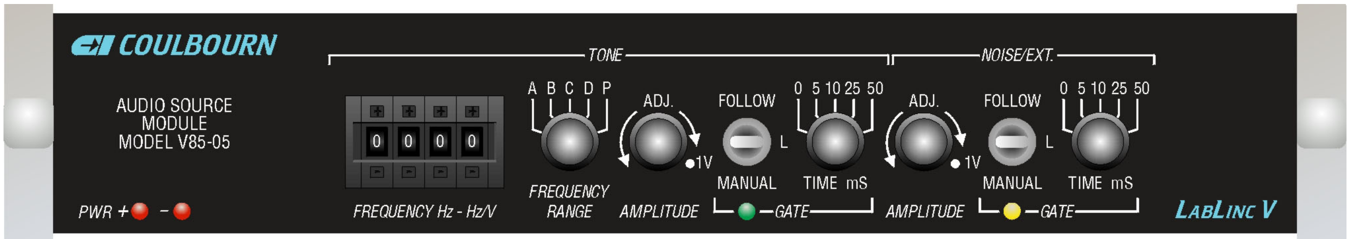
- ✓ Coupling: Preamp (high pass); DC, 0.1 Hz AC or 1 Hz AC.
- ✓ Polarity: Normal or inverted.
- ✓ Offset: Plus or minus 0 to 10V (full-scale output) via polarity switch and 10-turn adjustment.
- ✓ Rectification: Positive half, negative half, or full wave.
- ✓ Gain: 5 Ranges from X1/100 (attenuated) to X100 plus vernier control.
- ✓ Note: Gain is inoperative for the rear panel input. The side panel input is present on (connected to) the "carry" jack on the rear panel. It is shunted-out upon introduction of a signal at the rear panel input in the normal fashion. (See page 8).
- ✓



SPECIFICATIONS

Amplifier Type: Precision instrumentation, differential.
Input Impedance (Differential and Common Mode): Resistive - 10^6 Ohms, Capacitive: 10 pF.
Common Mode Rejection: 120-dB min.
Input Bias Current: 30 pA typical: 10 nA max.
Maximum Input Voltage: Rear panel input - ±10V, Side plate input - ±100V, differential.
Noise (referred to input): 4 microvolts RMS typical at 10 to 1000 Hz.
Frequency Response: 0.1 to 10,000 Hz (-3 dB)
Line (Mains) Frequency Notch Filter: 30dB rejection at 50/60 Hz. (60 Hz standard, 50 Hz - specify on order.)
NOTE: *The notch filter may be bypassed with a jumper on the circuit board.*
Amplifier Coupling: Selectable - DC, 0.1, or 1 Hz.
Amplifier Gain: Affects the side input only. 5 ranges - 1/100, 1/10 (attenuated), Unity, 10 and 100.

Vernier Gain: Vernier gain affects both signal sources. Output reflects gain from external signal gain control or the input amplitude of the signal introduced from the rear panel. It represents 100% of the precision output with switch set in the cal. position, and ranges form 120% down to 20% of the setting in one turn of the knob.
Gain Accuracy: ±1% of setting.
Output Impedance: Less than 50 Ohms.
Output Voltage Range: ±10 Volts.
Common Mode 50/60 Hz Rejection: 140 dB.
Maximum Common Mode Voltage: 2500 VAC rms at 60 Hz., ±3500 VDC
Leakage Current: (input to output): 2 mA maximum @ 240 V rms, 60 Hz.
Signal Processing Sequence: Coupling, gain range, inversion, rectification, offset and gain vernier. Jumpers on PC board provide for reversing rectification and offset.



V85-05C AUDIO SOURCE MODULE

The V85-05C is very nearly a complete audio lab in one module. This dual-channel module has a tone source and a white noise source with these signal synthesis and control features:

- Manual and programmed control of tone frequency and amplitude.
- Manual control of noise amplitude.
- Programmable dB attenuation of tone, noise and external signals.
- Shaped-rise gating of tone, noise and external signals.
- Shaped attenuation-level transitions of tone, noise and external signals.
- Shaped frequency transitions of tone.
- Mixing of tone, noise and external signals.

Tone frequency may be set manually or by analog program control. The analog signal that controls frequency may be generated by computer using a D/A converter output, or by another module's analog output.

Changing from one frequency to another frequency using the D/A converter in a "step" fashion will not produce a "transition click" because the change is shaped by integration (0.1 sec.). Using another module's output as the controlling source permits frequency modulation of the signal within the limits of this shaping time constant (see specifications) therefore frequency modulation above 10 Hz is not possible.

When using another module's output to modulate, for example an integrator, where the input signal is a biopotential, using the contour following output to modulate frequency generates a proportional frequency audio stimulus for biofeedback.

Tone amplitude may also be set manually or externally controlled in a similar manner. The input may be controlled by a D/A converter or another module. Amplitude modulated stimuli may thus be synthesized. Because there is no shaping here, no limitation is imposed as upon frequency modulation (noted above).
Like tone amplitude, noise amplitude may be manually set but it may not be programmed or amplitude modulated at the source.

Tone, noise and external signals may be attenuated by a pair of independent, programmable attenuators. The attenuators offer shaped transitions from level to level and may also be used for modulation within the shaping time constant limitations.

The noise channel may be broken and another signal inserted beyond the source but ahead of the attenuator, shaped-rise gate and mixer, at the jack labeled "EXTernal SIGNAL". This permits a second tone from another V85-05C module, or a signal from any other audio source to be introduced. The external signal may then be passed through the attenuator associated with the noise source, then independently gated and mixed with the tone from this module. Yet another signal may be introduced after the attenuators at the input marked "EXTernal SIGnal" and mixed with the two attenuator's outputs.

The signals are then available separately and mixed as audio-industry-standard "line" outputs on the side panel for connection to a power amplifier. The same signals are available on the rear panel at LabLinc standard levels.

SETTING TONE FREQUENCY

The block of four digit switches is used to either manually set the tone frequency, or to set the range of frequency as a function of the analog control signal amplitude. The push buttons above each digit increment by one when pressed, and the buttons below decrement by one. The switch to the right is a multiplier function. In the "C" position, the frequency will be the number set on the 4-digit switch bank. It will be 0.01 times in the "A" position, 0.1 times in "B", and 10 times in "D". Position "P" allows range to be program controlled by the two binary range-control jacks to the left of the box labeled "Tone Source" on the rear panel.

When a lead is inserted in the jack on the back labeled "PROGram FREQuency", the function of the switch block is automatically redefined and no longer controls frequency directly. Rather, frequency is now controlled by the analog level (voltage) on the control lead. The digit switches now control the ratio or amount of control that the control voltage has over frequency. The manual settings now control how many Hertz per volt the input signal's amplitude will produce. This is a voltage to frequency slope control.

To use the module with manual settings only, don't insert a lead in the "PROGram FREQuency" input.

SETTING TONE AMPLITUDE

The amplitude is set by the amplitude adjust knob. The switch point at the most clockwise point of rotation of the amplitude control knob is a calibrated, 1V RMS signal level. Clicking off of this position allows setting the signal level from slightly above 1V down to zero as the knob is turned counterclockwise.

Like the frequency controls, the function of the manual amplitude control is redefined by the insertion of a lead in the "PROGram AMPLitude" input on the back panel. With a lead in place, the knob controls the slope of the tone amplitude as a function of the control signal amplitude in a manner analogous to the frequency controls. Use a signal here to control amplitude modulation. There is no shaping of controlled amplitude transitions so amplitude modulation will follow the modulator signal. Shaped transitions in the amplitude domain are used in the "Gate" and "Attenuation" functions (see below).

To use the module with manual settings only, don't insert a lead in the "PROGram AMPLitude" input.

SETTING NOISE AMPLITUDE

Noise amplitude is manually set in a manner analogous to setting tone amplitude but it is not programmable at the source.

GATING SIGNALS ON AND OFF

Signals are gated on and off (presented) by the shaped-rise gate control. The gate control for each channel may be operated manually from the front panel or by a digital logic input from a computer port or another module. The logic inputs are next to each attenuator's diagram on the rear panel. Gating the signal on and off is accomplished by using a nonlinear acoustic shaped rise-fall envelope for click-free switching. There are 5 independent, switch-selectable shaping time constants available for each of the 2 channels.
These time constants also determine the level-to-level shaping when using the programmable attenuators.

To have a signal be on constantly for the entire session, use the "manual" position of the switch above the "gated on" light in each section.

USING THE ATTENUATORS

The attenuator sections associated with each signal are not manually settable; manual control of signal levels is accomplished by using the amplitude control. The attenuators are set at zero dB attenuation when no lead is connected to the attenuator input on the rear panel. The level of attenuation may be controlled by the amplitude of the signal on this input; 5.080 V equaling full amplitude and 0 V equaling full attenuation.

The 3-position switch associated with each attenuator on the front panel allows the attenuator to: 1) be gated on manually, or 2), latch the value of the attenuation control signal at the onset of a gate signal, or 3), follow the changing attenuation control signal for the duration that the gate is asserted. Manual presentations are latched.

The "Latch" mode assures that the amplitude will not vary slightly with small changes in the control signal's amplitude during a presentation. The "Follow" mode allows the attenuator to follow programmed changes in attenuation during a single presentation (gate "on" interval). In the "Follow" mode, the program can step through a "staircase" of dB levels, or access random levels without interruption. When following, the shaped-rise-gating time constant is used to shape the change in attenuation level, thus there is a limitation on "modulation" following rate analogous to that for frequency modulation noted earlier. Here the limits depend upon the selected time constant. The shaped transition from level to level of attenuation has a time constant of 1/128th of the value selected for the gate for each dB of attenuation change.

CONTROL OF EXTERNAL SIGNALS

An external signal (a tone or tone-noise mix from another V85-05C, a signal from a tape recorder or other source) may be gated and/or attenuated, and/or mixed with a tone from this module. Just introduce the signal at the "EXTernal Signal" input. If another V85-05c module is used, the tone-noise mix may be controlled at its source module as well as this module, ultimately allowing two tone signals and a noise signal to be mixed, attenuated, and gated (with both tones' amplitudes and frequencies modulated), in any combination. This signal can then be mixed with still another signal from the input marked "EXTernal SIGnal". Add a third module and the possibilities are too numerous to list here!

AMPLITUDE RANGE

The range of absolute Sound Pressure Level amplitudes available for stimulus presentation is not limited to the dB attenuation range of the attenuator section. The signal source voltage level can be set independently, ahead of the attenuator section. Thus, the reference amplitude is set by manual control (or in the case of tones, also by program control) at the source before the attenuation is applied permitting very small changes and very low absolute levels of output with minimum noise. Set the signal source amplitude control and your power amplifier to produce the desired starting amplitude in dB-SPL in the environment, and then attenuate from that point.
The amplitude control knob (or in the case of tones, the programmed amplitude input as well) may be used to set the desired maximum signal level going to an external amplifier and the output transducer. This sets the source amplitude prior to routing through the programmable attenuators to control programmed sequences of presentations of different (attenuated) amplitudes. Since amplitude levels may also be programmed at the source, you may change absolute values of the reference dB-SPL and attenuate over any range all under program control.

MODULATION

Modulation of either tone frequency (with limitations - see specifications) or amplitude may be accomplished at the tone source. Tone, noise and external signals may be modulated across the dB scale by the attenuators. The modulator signal, if it is bipolar, must be offset because the negative regions of control inputs for frequency, amplitude and attenuation cannot effect changes in the signal.

MONOPHONIC, BINAURAL AND STEREOPHONIC OPERATION

Use the mixed output to a single ear for monophonic presentations. Connect the mixed output to both channels of a stereo amplifier with a "Y" connector for binaural use. Connect the two unmixed outputs to separate channels of a stereo amplifier for stereo operation.

FRONT PANEL CONTROL FUNCTIONS

4-Digit Switch Bank - Sets frequency directly in the manual mode (no lead in the program input) and controls the frequency as a function of the voltage present on the program input when a lead is in place. In the program mode (lead in place) the switches set Hz per Volt of the control signal. Note: The absolute minimum setting is 10 Hz; below this the oscillator may stop oscillating and will have to be set to a higher value to resume.

Frequency Range Switch - Multiplier for the 4-digit frequency switch, 0.01 times, 0.1 times, 1 times and 10 times the digital setting.

Amplitude Adjust Knob, Tone - Adjusts the amplitude of the tone source from 0 to 1.2 Volts when no lead is in the program input on the rear panel. The switch position at the end of travel sets a calibrated 1V RMS signal.

With this switch setting and a lead in the control input, the knob control gives 250 mV RMS of tone amplitude per Volt of control signal amplitude.

Amplitude Adjust Knob, Noise - Adjusts the amplitude of the tone source from 0 to 1.2 Volts. The switch position at the end of travel sets a calibrated 1V RMS signal.

Gate/Attenuator Control Switches (2) - These 3-position switches, one each in the tone section and the noise section, control how the attenuator behaves during a presentation (gate "on") and also allow manual presentation of a signal.

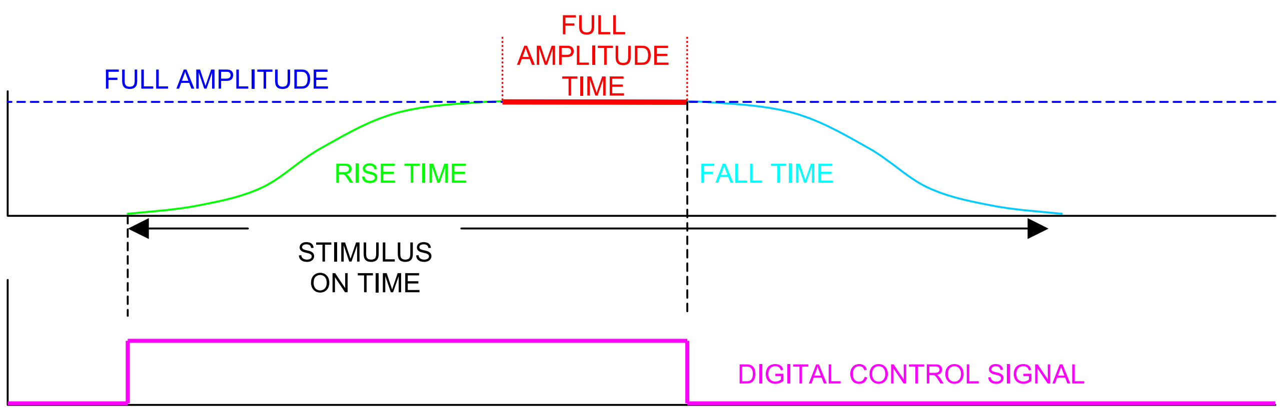
The up, "Follow", position allows the attenuator to follow changes in the attenuator program control input during a presentation. In the "Follow" position, the transitions are shaped by 1/128th of the selected time constant of the rise/fall shaping control for each dB step of change. This allows signals to be modulated in dB as a function of a linear control voltage provided the modulator is of lower frequency than the rate of change of the shaping time constant.

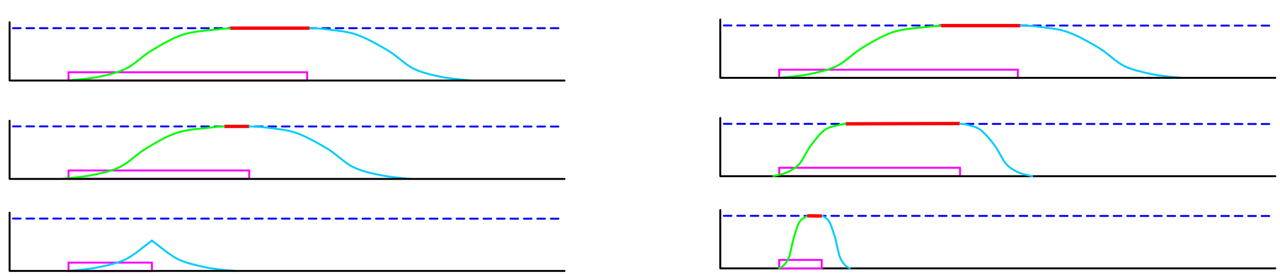
The center position, "L", causes the attenuator to latch the value on the program control input at the onset of a gate command and to hold that level through the entire presentation regardless of changes in the program control voltage during presentation. This permits setup of the next level during presentation.

The down, "Manual", position, turns the channel gate "on". Manual presentations are latched.

"Gated On" LED Lights (2) - These lights are on for the duration that a signal is being presented.

Shaped-Rise Gate Control Switches (2) - These allow the user to select the time constant for the shaping envelope. Select instantaneous (<1 millisecond), 5 millisecond, 10 millisecond, 50 millisecond or 100 millisecond time constants. This control also selects the attenuation-transition shaping at the rate of 1/128th of the selected value per dB-step of change.





Progressively shorter control signal on-times with the same rise-time, reduces the full-amplitude time to the point that the signal can never reach full amplitude.

With shorter control signal on-times *and* shorter rise-times, the signal can still reach full amplitude.

REAR PANEL CONNECTION FUNCTIONS (LEFT TO RIGHT)

PROGram FREQuency - An analog voltage on this input sets the frequency of the tone. Inserting a lead in this input automatically changes the direct frequency-control function of the 4-digit switch and range toggle switch. Frequency is now controlled by the voltage present on this input (from 0 to 9.6V) times the switch settings. For example, 4000 on the 4-digit switch and "B" on the range switch with a 2.5 volt input on this lead will produce a 1K Hz tone (400 x 2.5 = 1000 Hz).
Bandwidth Limit, "A" position - 10* Hz to 99 Hz.
Bandwidth Limit, "B" position - 50 Hz to 999 Hz.
Bandwidth Limit, "C" position - 500 Hz to 9999 Hz.
Bandwidth Limit, "D" position - 5K Hz to 99.99 KHz.
*Note the minimum settable or programmable frequency is 10 Hz (see specifications).

PROGram AMPLitude - When a lead is in this input it automatically changes the function of the amplitude control knob to multiply the voltage on the input by approximately .250 times the control setting. Thus it takes approximately a 4-Volt control signal to produce a 1 Volt RMS tone when the control is in the switch-locked (1 Volt calibrated) position. This range may be adjusted cursively from 0 to 120% of the value by setting the knob in an "off calibrated" position.

Tone Out - This is the oscillator output, manually or program controlled for frequency and amplitude. It is unmodified by attenuation and is not gated.

Noise Out - This is the raw noise source output as set by the manual amplitude control. It is unmodified by attenuation and is not gated.

EXTernal Signal - This is an input for an external signal from any other source including another V85-05C module. It is provided so that other signals may be attenuated and gated and/or mixed with the tone channel. Using this input disconnects the noise source and replaces it, allowing this signal to be passed through attenuator, gate, and mixer to the outputs. Since two noise sources are generally not used in audio signal complexes, the noise source is the one to sacrifice. If a complex signal consisting of more than one tone along with noise is desired, the noise and first tone along with initial amplitude control, attenuation, gating and mixing is synthesized at another V85-05C module. Then it is introduced to this module at the EXTernal Signal input to be further attenuated, gated, etc. and finally mixed with the second tone, synthesized here.

Programmable Attenuator In (2) - The two attenuators, one each in the tone and noise channels, function identically. The analog signal on this input controls the level of attenuation of the signal from the sources. Attenuation is controlled in 1-dB steps from 0 to -127 dB. 1 dB of attenuation is produced for each 40 mV of control signal amplitude. To minimize the possibility of a noisy control signal producing one more or one less level of attenuation than intended, the transitions start at 20 mV, giving an ample 20 mV margin for noise riding on the control signal.

0 dB = 5.080 V
-1 dB = 5.040 mV
-2 dB = 5.000 mV
-126 dB = 40 mV
-127 dB = 0 V

An envelope equal to 1/128th of the gate-envelope time per dB step shapes attenuation transitions accomplished during a presentation (gate on).

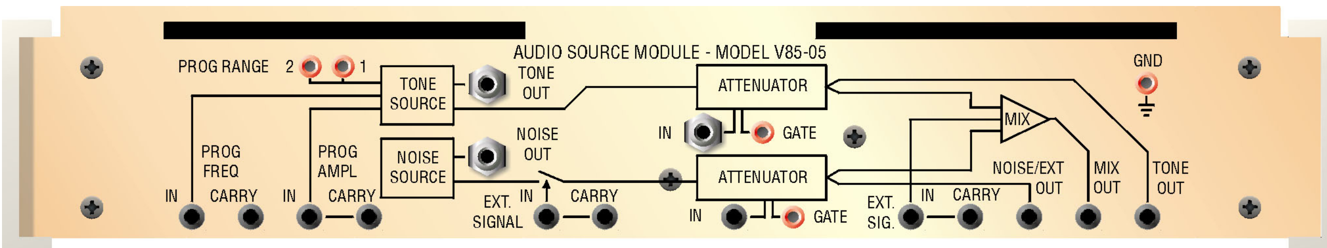
Gate Controls (2) - The gate controls associated with each channel require a standard system logic 1 (low true) to operate. When operated, the channel is gated on and the signal is presented. The gate uses shaped rise circuitry to produce click-free onsets and offsets of the stimulus. Select instantaneous (<1 millisecond), 5 millisecond, 10 millisecond, 25 millisecond or 50 millisecond time constants.

EXTernal SIGnal Input - This input is available for introducing yet another signal (in addition to the one ahead of the attenuator and gate) into the stimulus complex. This one is introduced past the attenuators and gate controls and taken only to the mixer. As with the other input, EXTernal Signal to the left, it may be from any source including another V85-05C where all functions may be performed before introduction to this input.

Noise/EXTernal Out - This is the attenuated and gated noise source signal or the attenuated and gated EXTernal Signal output prior to mixing with other signals.

Mix Out - This is a linear (even) mix of the 3 signals, (tone), (noise / EXTernal Signal), and (EXTernal SIGnal). There is no gain in any channel or in the mixer. Signals are summed at the levels present on the inputs to the mixer stage.

Tone Out - This is the manual or programmed frequency and/or amplitude, attenuated and gated tone signal output prior to mixing with other signals.



SPECIFICATIONS V85-05C (Rev. C on PC board)

TONE SOURCE

Frequency - 4 Ranges -

Manual control
"A" position - 10* Hz to 99 Hz.
"B" position - 50 Hz to 999 Hz.
"C" position - 500 Hz to 9999 Hz.
"D" position - 5K Hz to 99.99 KHz
"P" position - Permits program control via jacks on the rear panel adjacent to the "Tone Source" box.
Program control (Right jack is LSB)
00 = "A" = 10* Hz to 99 Hz.
01 = "B" = 50 Hz to 999 Hz.
10 = "C" = 500 Hz to 9999 Hz.
11 = "D" = 5K Hz to 99.99 KHz

Amplitude: 0 to 1.5 V RMS - 1.00 V RMS calibrated.
Frequency Control Voltage: 40 mV* to 9.6 V (depends on settings of frequency control switches).
Amplitude Control Voltage: 0 to 4 V
Control Input Impedance: > 1 MW
Frequency Accuracy: The greater of 2% or 2Hz.
Frequency Linearity: 10:1 Sweep - 2%
Frequency Linearity: Full Range Sweep - 8%
Amplitude Modulation Linearity: 2%
Amplitude Stability: 0.5 dB
Sine Wave Distortion: 0.5%

NOISE SOURCE

Amplitude: 0 to 1.5 Volt peak max.
Frequency Band: 10 Hz to 20 KHz (White)
Flatness: ± 2 dB

ATTENUATORS

Attenuation Control Range: 0 to -127 dB (Dynamic Range 100dB - noise floor to clip.)
Attenuation Step Size: 1 dB
Attenuation Shaping (in follow mode): 1/128th of selected rise/fall shaping time constant per dB step.
Channel Separation: 80 dB
Noise Floor: 90 dB.
Total Harmonic Distortion + Noise: 0.01%
Control Voltage: 0 to 5.080 V
Control Voltage Step Size: 40 mV
Control Input Impedance: > 1 MW
Mute Voltage: 0 V

GATE CONTROL (Standard Logic Levels)

Gate Attenuation: -95 dB
Shaping Time Constants: <0.1, 5, 10, 25, 50 ms (Time from 10% to 90% of full amplitude).

EXTERNAL AUDIO SIGNAL INPUTS

Input Voltage: 0 to 1.2 V RMS
Input Impedance: > 1 MW

SIGNAL OUTPUTS

Output Voltage: 0 to 1.2 V RMS
Output Impedance: (>10 Hz) - 2 kW

* PERFORMANCE LIMITATION NOTES V85-05C (Rev. A)

***NOTE: THIS UNIT REQUIRES A POWER AMPLIFIER TO DRIVE SPEAKERS*.**

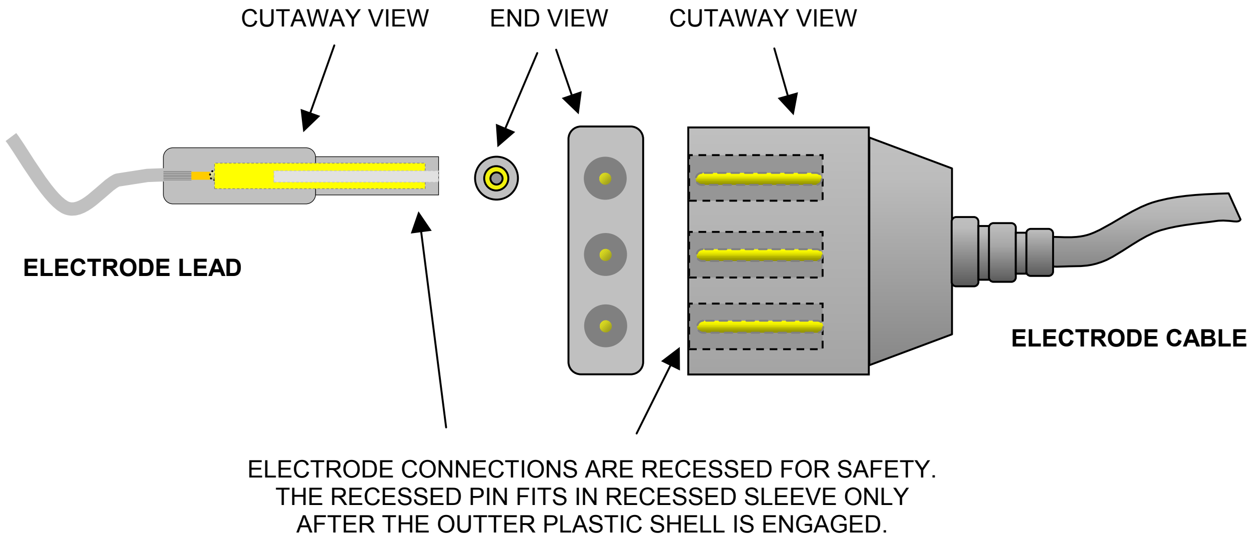
1 - Due to frequency-transition and attenuation-transition shaping circuits, frequency and attenuation modulation is limited in frequency by the time constants of these circuits (15 Hz). Amplitude modulation is not limited to this frequency.

2 - The minimum settable or programmable frequency of the oscillator is 10 Hz. If you set it or program it below this value it may cease to oscillate and not resume until the (manually set or controlled) frequency returns to a value above 10 Hz.

3 - Although there are 4 digits in the frequency control switch bank, this does not imply the precision of the set points. See pages E and F.

V91-SERIES ELECTRODES, LEADS AND CABLES

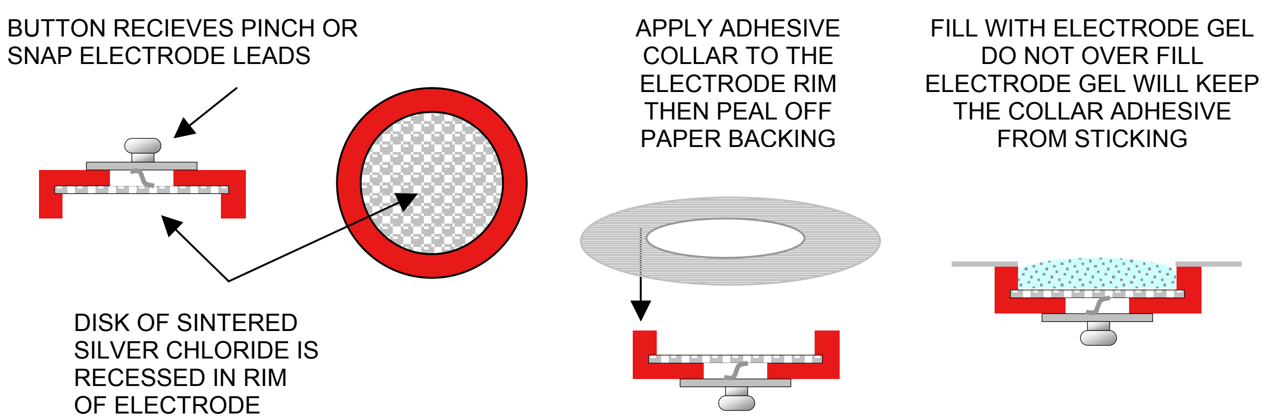
SAFETY SHIELDED CABLES



REUSABLE ELECTRODES

V91-01 REUSABLE ELECTRODE 8 mm (AgCl)
V91-02 REUSABLE ELECTRODE 4 mm (AgCl)

These are sintered-pellet silver chloride electrodes to be used for general skin surface signal pickup applications. The raised-button connection dome on either electrode is compatible with old snap-type electrode leads or with either of our V91-11 or V91-12 DIN safety leads.



Well (Sensor) Diameter: V91-01 - 8 mm, V91-02 - 4 mm.
Well Depth: V91-01 - 2 mm, V91-02 - 1 mm.
Outside Diameter: V91-01 - 16 mm, V91- 02 - 13 mm.
Electrode Collar Required: V91-01 - X11-70, V91-02 - X11-72.
Electrode Gel Required: X11-71 Microlyte™ or equal.

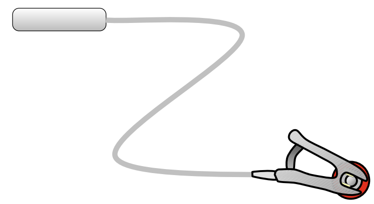
X11-70 ELECTRODE COLLARS - 8MM AND X11-72 ELECTRODE COLLARS - 4MM

Rolls of 1000 double-faced-adhesive electrode collars. Use to attach V91-01 and similar electrodes.

V91-11 PINCH TYPE ELECTRODE LEAD AND V91-12 MINI-PINCH ELECTRODE LEAD

These leads feature the DIN safety termination and connect the electrode to a DIN safety electrode cable, which in turn, connects to the input on the side plate of the amplifier.

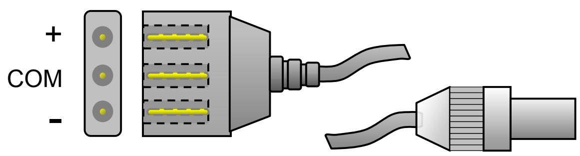
Both pinch-type heads provide a positive, firm grip on the attachment dome of the V91-01 electrode as well as other snap-compatible electrodes, including disposable types. This firm grip eliminates one of the most significant sources of artifact, specifically that caused by slippage of the connection.

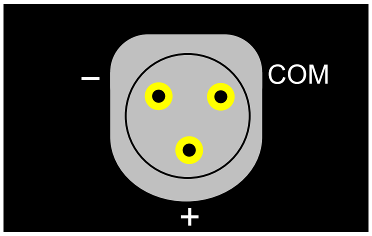


The standard pinch is recommended for most applications and the mini-pinch for EEG where its low profile and small size are assets.

Length: 24 in. (61 cm).

V91-33 3-CONDUCTOR ELECTRODE CABLE





This cable is used for all amplifiers and couplers employing 3 electrodes. It accepts three V91-11 electrode leads, and features the DIN safety termination which completely shields the metal contacts between the electrode leads and cables to prevent them from contacting voltage sources which could be a hazard to the subject. The connector for the amplifier/coupler-end of the cable and the receptacle on the side of the module also have recessed connection pins to insure safety.

Cable Length: 10-ft. (4.58 m).

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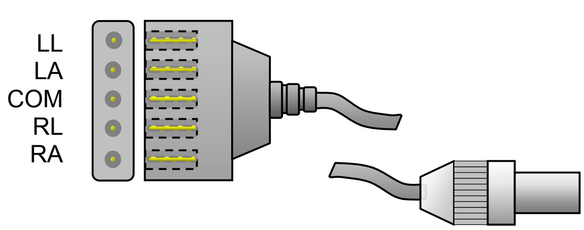
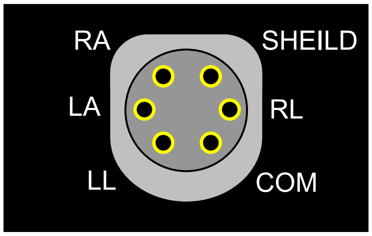
V91-35 5-CONDUCTOR ECG ELECTRODE CABLE

This cable is used on the Isolated ECG Amplifier, V75-11. It accepts five V91-11 electrode leads. Like the V91-33 above, it also features the DIN safety terminations. The connector for the amplifier/coupler end of the cable and the receptacle on the side of the module also have recessed connections like the V91-33. The connector's breakdown voltage rating is 25K VAC to prevent arc-over shorting of defibrillator outputs.



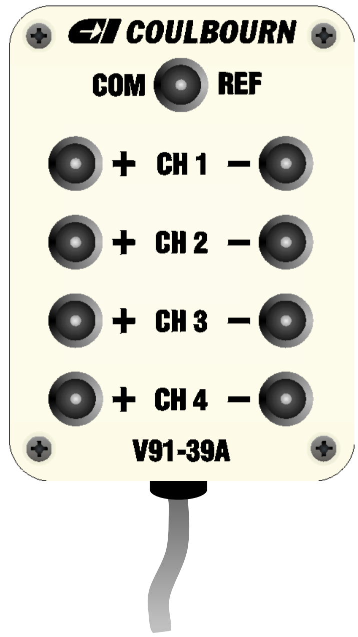


Cable Length: 10-ft. (3 m).

V91-39 9-CONDUCTOR EEG ELECTRODE CABLE

This cable is used on the 4-channel EEG amplifier, V75-08. It accepts nine V91-11 electrode leads. Like the V91-33 above, it also features the DIN safety terminations. The connector for the amplifier-end of the cable and the receptacle on the side of the module also have recessed connections like the V91-33. It provides for a single, common ground reference electrode and 4 differential inputs.

Cable Length: 10-ft. (3 m).



APPLICATION NOTE:

CARE, PREPARATION AND USE OF SURFACE ELECTRODES

1) Prepare the skin surface by rubbing briskly with an alcohol cleaning pad. The alcohol will remove skin oils and brisk rubbing will remove dead epithelial cells and other debris. For extremely low-level signals such as EMG, cleaning with an abrasive prep pad or abrasive hand soap followed by the alcohol pad is recommended. For EEG signals, a cotton swab with abrasive soap followed by one with alcohol will serve the same purpose.

2) Select the appropriate size washer (adhesive collar or disk). Remove it from the backing strip. Align the disk over the center of the electrode and firmly press it onto the rim of the electrode.

3) Fill the electrode cavity with gel (CI Microlyte) level to the rim. Overfilling will cause the gel to "squish out" over the adhesive and cause it to fail to stick (see the diagram on page 83). Make sure not to trap any large air bubbles, they will reduce conductivity.

4) Hold the adhesive collar's blue tab and remove the paper covering. Apply the assembled and filled electrode/washer to the skin. Gently press the electrode against the skin and smooth out the edges of the washer. The lead may be attached to the electrode either before or after application of the electrode to the skin; whichever is easier for you.

The skin surface electrodes we carry are of sintered pellet silver chloride design. *Unlike old silver-disk electrodes that had to be chloridized before use to provide the proper electrochemical characteristics, these electrodes are solid silver chloride pellets. The old electrode design had only a thin film of silver chloride over the silver disk, which wore off or was rubbed off easily during cleaning. The sintered-pellet type is totally silver chloride and may be scrubbed briskly with a soft toothbrush to clean it.*

Electrodes should be cleaned between each use for sanitary reasons and to insure good electrical performance. Gel should not be allowed to dry on the electrodes, but if it is, it can be removed by soaking the electrode with dried gel in water and scrubbing it with a soft toothbrush.

Electrodes may be sterilized chemically with a variety of agents including:
1) Ethylene oxide gas (EtO).
2) Gluteraldehyde/Phenol combinations (Sporicidin®).
3) Hydrogen peroxide/Peroxyacetic acid solution.
Do not leave the electrodes soaking in sterilizing solution longer than necessary.

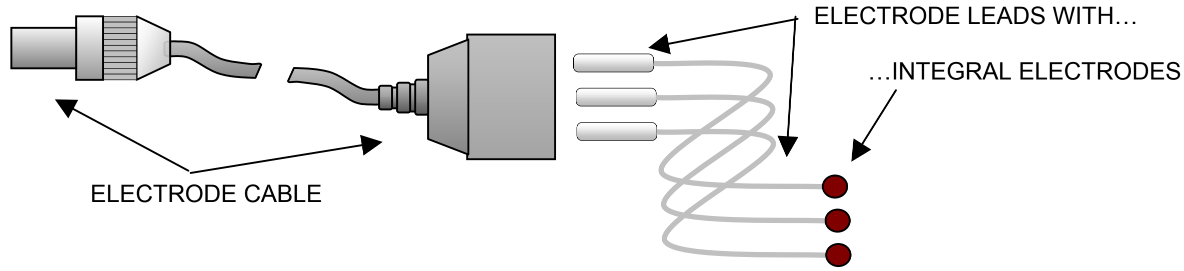
Always rinse electrodes with distilled or de-ionized water after cleaning or chemically treating. The type sold in supermarkets by the gallon is fine.

Electrodes, ***but <u>not</u> lead*** *wires, may be* ***autoclaved.***

Do not soak electrodes in saline solution, corrosion will result.

Electrodes that have not been used regularly can form a brown coating on the sensor element. This coating should be removed by gently scrubbing the surface with a nonmetallic material or wiping it with a mild ammonium hydroxide solution. Again, rinse the electrodes thoroughly with distilled water, let them dry and store them in a clean, dry container.

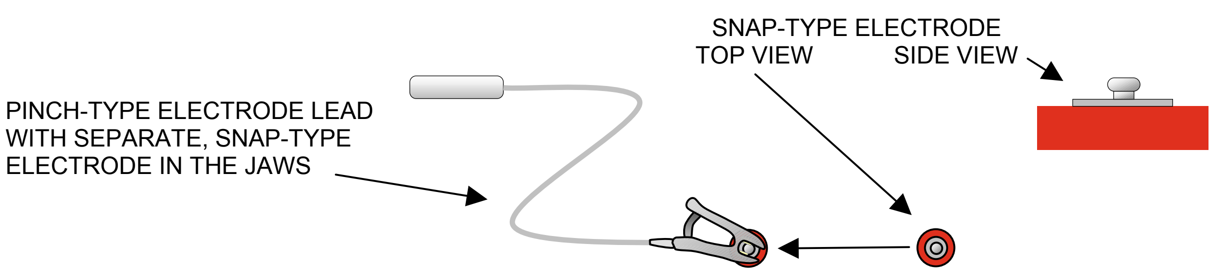
ELECTRODE TERMINOLOGY



Electrode cable, one per module. Modules have only one electrode cable input connector. The **electrode <u>cable</u>** from the module **accepts the <u>leads</u> from the electrodes** connected to the subject.

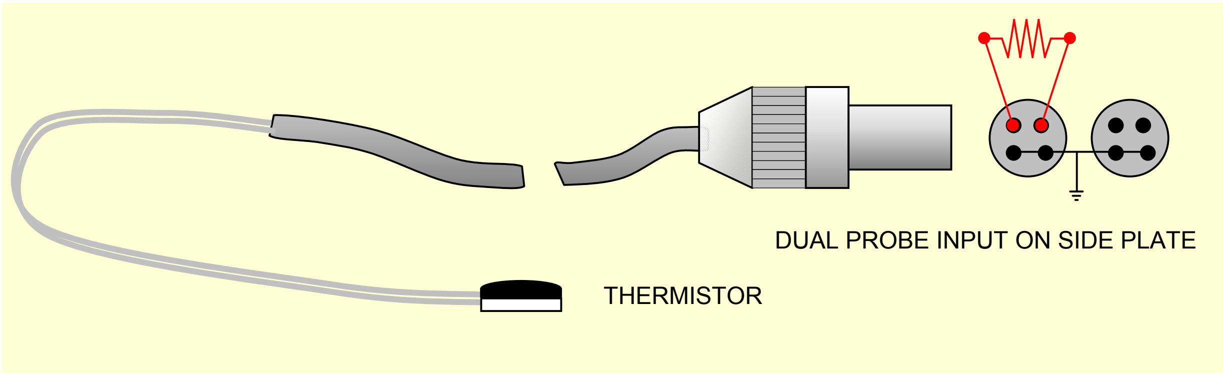
Electrode leads - 2, 3, 5 or 9 per cable are needed depending upon the application and V-series module being used. A 3-lead cable is shown above along with leads having integral electrodes. Coulbourn does not supply this type of lead. Some manufacturers refer to leads with integral electrodes as simply "electrodes" or as "terminated electrodes". Electrode leads not having integral electrodes terminate in a connector (snap, clip, pinch, etc,) to receive a separate electrode. This is the type of lead and electrode system Coulbourn supplies.

Electrodes - one per lead. Some modules require only two leads and electrodes even though they use 3-lead cables. The leads for these modules always go in the outer two terminal positions of the "paddle" or distal end of the cable.



The snap-type electrode is compatible with a variety of leads in addition to the pinch-type shown above. There are pinch, mini-pinch, snap- and clothing-snap types, all of which are available in various designs from a dozen or more manufacturers.

V93-SERIES THERMISTOR PROBES



One or two probes are used, depending on whether single-point or differential measures are desired. Differential measures may be made with two similar or dissimilar transducers using the V71-30 module. The resistive element in all units is the same. The time constant (shown for each unit) varies as a function of the mechanical package form and material. The V93-09 is recommended for most applications involving skin surface temperature.

Model No. V93-01 - General Purpose Flexible
9.0 sec. Vinyl insulated probe. Usable for short-term water and subsoil readings.

Model No. V93-02 - Small Flexible General Purpose
3.6 sec. Small diameter, vinyl insulated probe. Often used for esophageal or cuvette temperatures. For short-term liquid immersion.

Model No. V93-04 - Tubular Pyrex Glass
5.0 sec. Glass portion is chemically inert for continuous immersion. Thermometric titration. Freezing point determination.

Model No. V93-05 - Air Temperature (With Guard)
0.6 sec. Stainless steel probe suitable for test rooms, incubators, remote air readings, monitoring of gas streams, etc.

Model No. V93-08 - "Banjo" Surface Temperature
1.0 sec. Skin, oral, water-bath, air and surface temperatures. Stainless steel.

Model No. V93-09 - Attachable Surface Temperature (Illustrated)
1.1 sec. Stainless steel cup, epoxy backed. Easy to tape on flat surfaces.

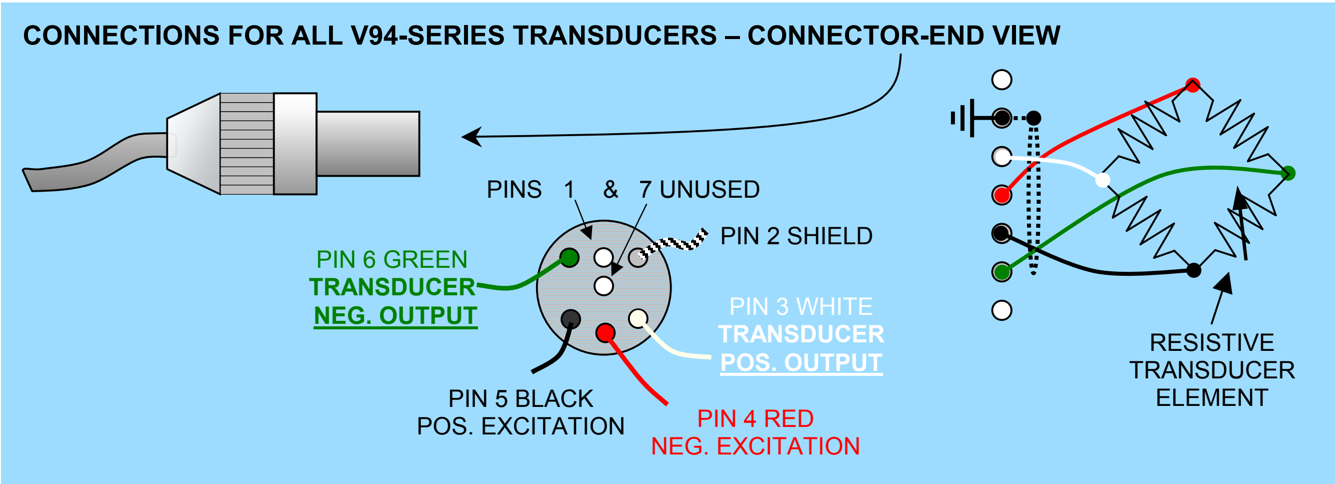
Model No. V93-29 - Small Surface Temperature
0.3 sec. Cuvette, water bath, leaf, and other surfaces. 24-inch PTFE-covered flexible wire. Stainless steel disc with epoxy back.

SPECIFICATIONS FOR ALL THERMISTORS

Maximum Operating Temperature: 100^{O}C
Accuracy / Interchangeability: ±30^{O}C to +100^{O}C
Time constants: Listed individually above.
Electrical Isolation: Sensing elements are isolated from the outer probe surfaces for maximum safety.

V94-SERIES RESISTIVE BRIDGE TRANSDUCERS

The V94-series transducers are all resistive bridge type transducers. The illustration below shows the wiring for any resistive bridge transducer from the V94-Series or for other manufacturer's transducers of this type.



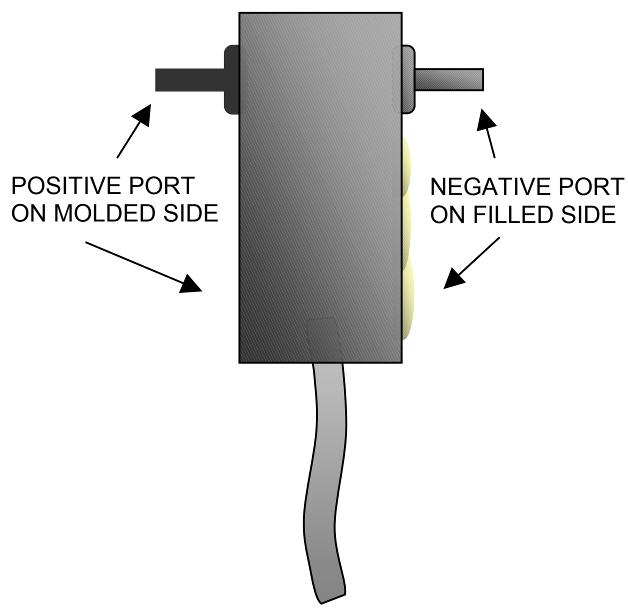
V94 PRESSURE TRANSDUCERS

V94-05 DIFFERENTIAL ANEROID PRESSURE TRANSDUCER - 5PSI
V94-15 DIFFERENTIAL ANEROID PRESSURE TRANSDUCER - 15PSI

Used for monitoring either gage (single input port pressure with respect to ambient air pressure) or differential pressure between two ports. It may be used with a cuff for blood-pressure waveforms, with the V94-19 chest bellows for respiration, or balloon devices for gastric and similar applications.

These units have been used for a variety of novel applications including:

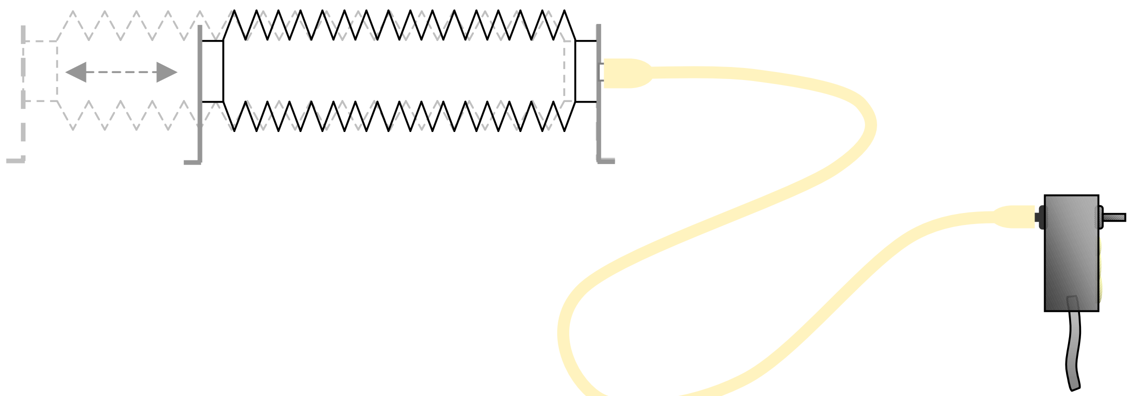
- Hand squeezing and biting responses, using a closed-end, firm, flexible hose.
- Sucking pressure, with the transducer ported to a closed vessel above the liquid.
- Nursing pressure, with the transducer ported to a hemispherical balloon diaphragm, pierced by a delivery tube (nipple) cemented and sealed in place in the center.



SPECIFICATIONS:

Range: V94-05 -5 to +5 PSI, V94-15 -15 to +15 PSI.
Overpressure: V94-05 - 20 PSI, V94-15 - 45PSI
Operating Temperature: -55^{O}C to +125^{O}C
Repeatability and Hysteresis: ± 0.15%

V94-19 ANEROID CHEST BELLOWS



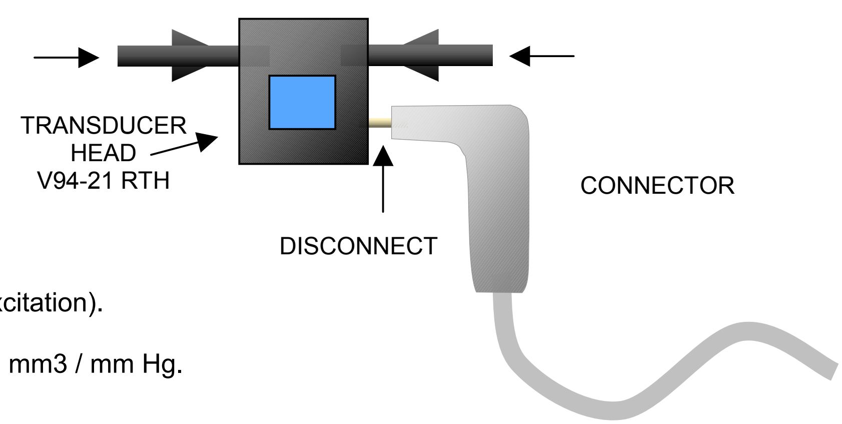
This rubber bellows is used with the aneroid pressure transducer for measurement of respiration. The bellows is secured with the attached chain, around the chest under slight tension. As the chest expands the bellows is stretched. The change in volume causes a change in pressure which is sensed by the transducer via the surgical rubber tubing supplied with the transducer.

V94-21 LOW-COST BLOOD PRESSURE TRANSDUCER
V94-21RTH REPLACEMENT TRANSDUCER HEAD FOR V94-21

In addition to blood pressure applications, this transducer may be used for other aneroid or fluid pressure applications. It may be chemically sterilized and is an excellent blood pressure transducer for the animal lab.

The transducer head may be interchanged with another head when changing subjects, or replaced without the cost of a cable and connector assembly.

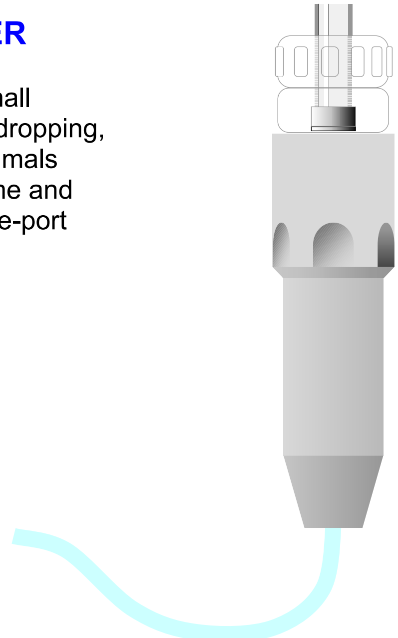
Note that though it has two port connections it is not a differential transducer. The port configuration is of flow-through (or flush-through) design; either connection may be "in" or "out". It measures gage pressure referenced to a protected vent (port) in the housing.



SPECIFICATIONS

Range: -50 to +300 mm Hg.
Overpressure: 1000 mm Hg.
Sensitivity: 200mV / mm Hg (at 10V excitation).
Linearity & Hysteresis: ±1% full scale
Volume Displacement: Less than .001 mm3 / mm Hg.

V94-25 LOW-VOLUME BLOOD PRESSURE TRANSDUCER



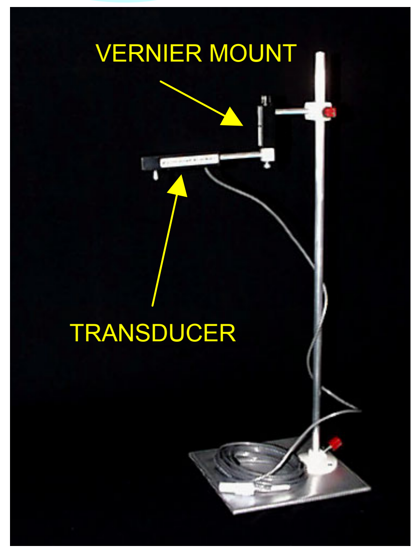
This transducer is lightweight, extremely small in size and has a very small volume displacement. It is of rugged solid-state design and withstands dropping, overpressure and other abuse. It is designed for use with very small animals (rats, mice, etc.). It features low fill volume, and low displacement volume and has a high frequency response for high pressure rise rates. It is of single-port gage-pressure design with a reusable dome.

SPECIFICATIONS

Range: -50 to +300 mm Hg.
Overpressure: 6000 mm Hg.
Sensitivity: 500mV / mm Hg (With V72-25 at 10V excitation)
Linearity & Hysteresis: ±0.5% FS (Fluid Coupled)
Volume Displacement: 0 .002 mm3 / 100 mm Hg
Frequency Response: Min. 100 Hz
Long Term Stability: ±1% FS / 24 Hr., 32 to 420C
Sterilization: Ethylene Oxide Gas.
Physical Dimensions: 1.5 in. (4.8 mm) long X .375 in.(1mm)diam.

V94 FORCE TRANSDUCERS

V94-31 ISOMETRIC FORCE TRANSDUCER (50GM)
V94-32 ISOMETRIC FORCE TRANSDUCER (500GM)



These transducers are used to measure force with near-zero displacement (movement of the transducer's sensing member). They may be mounted directly on the V99-50 Mounting Stand or mounted to the V94-38 which, in turn, is mounted to the V99-50 stand (both of these devices are on the next page). A nylon clevis pin is provided to simplify load attachment. All other parts are aluminum and stainless steel.

When used with the V72-25 Transducer Coupler, either unit may be used in any of the 5 ranges and at any of the 3 excitation voltages. This provides 12 ranges (plus the cursive vernier of the V72-25) for each unit. The V94-31 can be used from 10 mV per gram to 200 mV per gram, and the V94-32 from 1 mV per gram to 20 mV per gram. Between the two it is possible to measure from 1/100 of a gram to 500 grams. Either unit may be used with the coupler in the AC mode to measure instantaneous changes in force as the baseline load changes over a longer interval.

Applications include in-vivo exerted force and in-vitro tissue contractility measurements. Pre-loading is easily accomplished by using the V94-38 Vernier Controlled Mount while reading the output on the computer screen or with a meter.

SPECIFICATIONS

Range: V94-31 - 0 to 50 gm, V94-32 - 0 to 500 gm.
Sensitivity: V94-31- 20 mV/V/gm, V94-32- 2 mV/V/gm.
Sensitivity Using V72-25: (at 10V excitation) V94-31 - 200 mV per gram. V94-32 - 20 mV per gram.
Deflection at full-scale output: .03 in.
Resonant Frequency: 65Hz.
Temperature Coefficient: .03% / ^{O}C
Overload Limit: 5% Full Scale
Dimensions: 0.75 X 0.75 X 4.25 in. (1.9 X 1.9 X 10.8 cm.)
Weight: 2.2 oz. (65 gm.)

V94-38 VERNIER CONTROLLED MOUNT

This precision, linearly-adjustable mount permits accurate positioning and pre-loading (tensioning) of preparations for the V94-31 and V94-32 force transducers (previous page).

The V94-38 provides over one inch of adjustment travel with a resolution of 25 thousandths of an inch per turn of the dial. Preparations are usually pre-tensioned while reading the trace provided by the signal from the V72-25 Transducer Coupler.

SPECIFICATIONS

Mechanical Adjustment Range: 1 inch (-0.5 to +0.5 on the scale).
Resolution: .025 inch per turn of control knob.
Mounting Hole: 3/8-inch diameter (supplied with a set screw).
Mounting Rod: 5/16 X 3 inch (integral to the case).

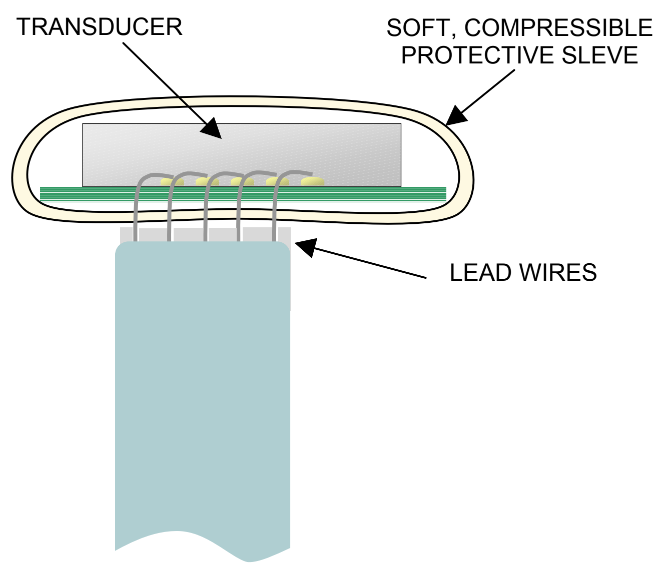
V99-50 MOUNTING STAND

This stand is used to mount the V94-31, -32, and -38. It may be used as a general-purpose ring stand to mount any devices normally mounted on ring stands. Conversely, the transducers may be mounted on any stand you already have.

SPECIFICATIONS

Height: 18 inches.
Rod Diameter: 1/2 inch.

V94-41 ACCELEROMETER - (10 G)



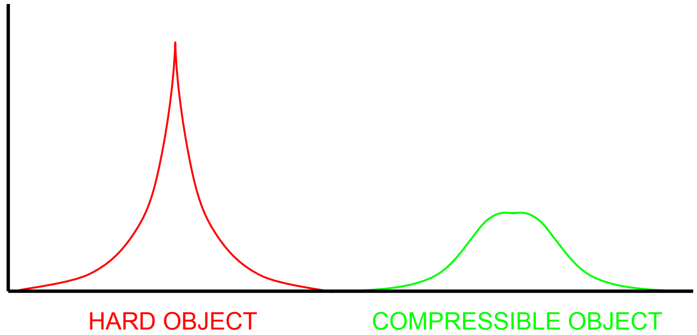
The V94-41 is a miniature solid-state piezoresistive accelerometer. When used with the V72-25 Transducer Coupler it is capable of measuring acceleration up to ±10 g and offers a resolution of .01 g.

! WARNING ! Although this transducer features overrange protection to 200 g, accelerometers are inherently extremely sensitive devices. The fact that they must measure fractions of one g and the fact that typical deceleration of rigid objects dropped from 3 feet can be in the range of 5000 g, means that it is a very good idea to handle accelerometers with care.

When a dropped object is not rigid or is wrapped in a non-rigid material, the deceleration on impact is spread out over time as the material compresses. Mass being the same, the stored kinetic energy lost by a rigid object on impact is the same as that lost by a compressible object. Thus the area under the curve is the same. So a longer time means a lower peak. The amplitude of the curve is g.

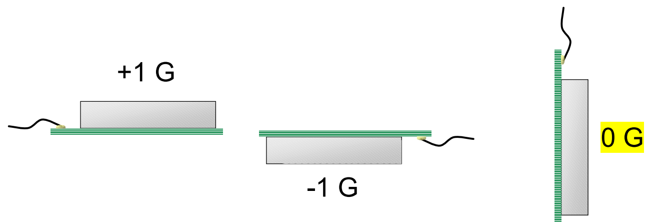
The accelerometer may be mounted on a mechanical device or directly on a subject by a variety of techniques using brackets, straps or tape. If it does not create an application problem, the unit can be used in the protective sleeve. For example, if it is applied to the wrist with tape or an elastic band or bandage, just leave it in the sleeve to reduce the risk of damage in the event it is dropped in the course of installation or strikes a hard surface when the subject makes a vigorous move during use. The sleeve is less compressible than tissue; so doing this will not "distort" the measure. Spreading out the energy loss over even a brief time interval can reduce the peak g-force considerably. This means it is also a good idea to store accelerometers in the (compressible) sleeves in which they are shipped.

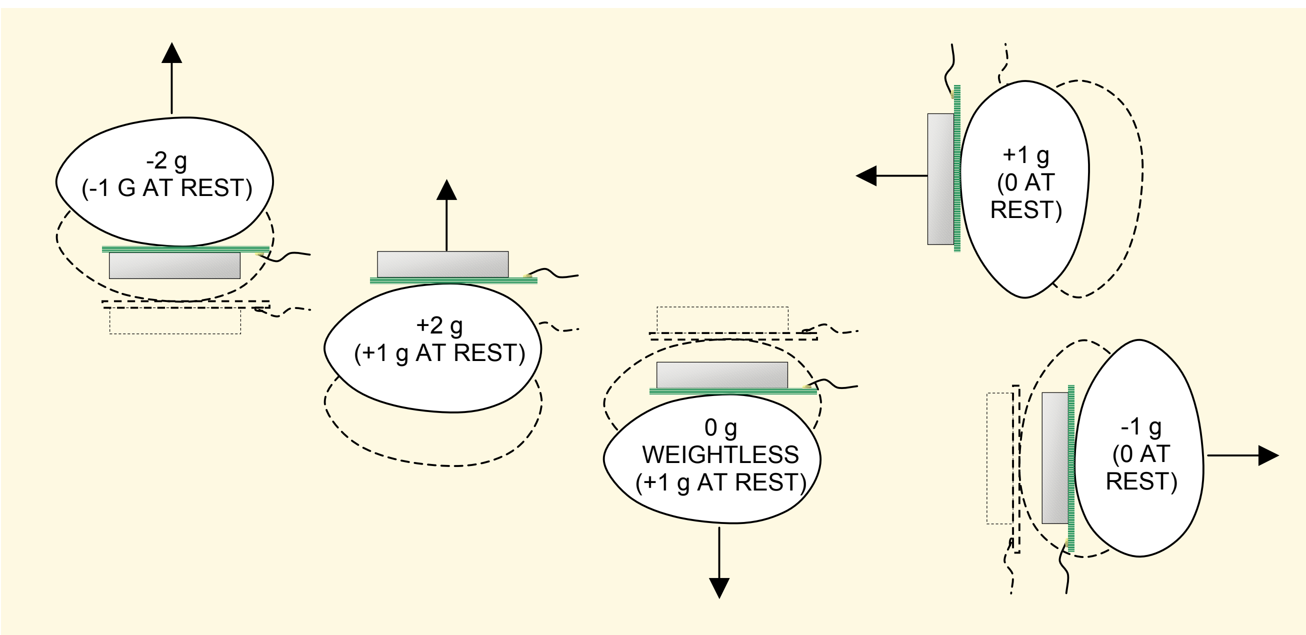
When measuring small forces of the movement of a hard surface, remove the sleeve.



Acceleration upon impact of two objects of the same mass when dropped onto the same hard surface

To balance the accelerometer you must remember that gravity is acceleration. With the transducer in the upright position (the base plate on the bottom and horizontal), the output will indicate one g. Likewise, if you turn it over 180 degrees (base plate on top) the output will equal minus one g. When the unit is 90 degrees to gravity (plumb = base plate vertical) the output is zero. ***Therefore, to balance the unit to zero, it must be 90 degrees to gravity.***





CALIBRATION

Connect the transducer to the V72-25A Strain Gage Transducer Coupler and refer to the V72-25A (Page 32). Set the desired excitation voltage (5 volts is recommended) and the coupling switch to DC. With the transducer in the orientation shown in the rightmost position (output 0g) in the figure above, press the "Auto Balance" switch. This will automatically balance the transducer for zero g in the vertical-to-gravity position.

The transducer may also be balanced in the horizontal-up orientation shown in the leftmost position above. Balancing in this position will offset the contribution of gravity; the resting output will equal 0g. In other words you will introduce a one-g negative offset to your signal. Even at the highest sensitivity, this represents only 10% of the dynamic range of the transducer; you still have 90% to work with. You may wish to do this in applications such as tremor, etc., where you want to use the DC mode so that you can use an outboard filter like the V75-48 to define (especially low) response frequency parameters.

APPLICATION TIPS

For maximum accuracy, transducers may be empirically calibrated (scaled) with the coupler for each application. This will set up the whole transducer/coupler system accounting for transducer error and any gain error in the coupler. To do this, first go through the balancing operation with the transducer in the 90-degree-to-gravity position explained above. Then, with the coupler in the DC mode and the sensitivity in the range you expect to use (100, 200, 266, 500, or 1000), place the transducer in the "positive" position shown in the leftmost illustration so that it registers one g. Check for the desired scale output. If the output is off, adjust either the chart gain or vernier control on the module to place the trace correctly. Refer to the table on pages 35 - 36 for excitation and sensitivity when used with the V72-25A coupler.

If you need a calibrated (scaled) signal to use within the V-series system modules (for filtering, integrating etc.), you must use the vernier output. Adjusting the chart gain will not scale the module output. While reading this output, adjust the "Vernier" control until it reads the desired voltage representing one g and then send this signal along to other modules for whatever operations are to be performed upon it. After balancing your accelerometer and scaling your system, you may switch to the AC coupled mode to measure quick-change accelerations, minimizing the contributions of gravity and its attendant 1g offset.

It is a good idea to perform the above procedures each time the transducer is disconnected, stored or used elsewhere, or if a long time lapses between uses.

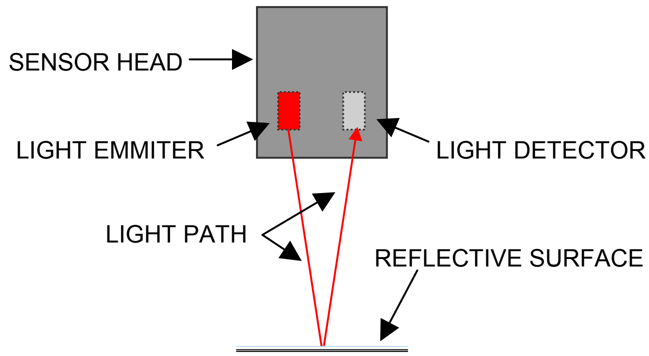
SPECIFICATIONS:

Excitation Voltage: 5 Volts recommended.
Sensitivity: 1 mV/V/g.
With 5V excitation, and sensitivity = 100: 1g = 500 mV, 10g (Full Scale) = 5V
Frequency Response: 0 to 500 Hz typical.
Resonant Frequency: 850 Hz, ±15%
Linearity & Hysteresis: ± 0.2% max, full range.
Temperature Coefficient: 0.022% / 0^{O} C typical.
Dimensions: 0.6 x 0.6 x 0.2 in. (15 X 15 X 0.5 cm).
Weight: 1.2 grams (Sensor head only, wires excluded)

A calibration and data sheet is provided with each transducer.

V95-01 OPTICAL PULSE TRANSDUCER (FOR V71-40)

This transducer is a reflective photodensitometer consisting of a 940-nanometer LED light source and phototransistor in a single head. It is designed primarily for measurement of blood flow by reflective densitometry but may also be used to monitor eye blinks.

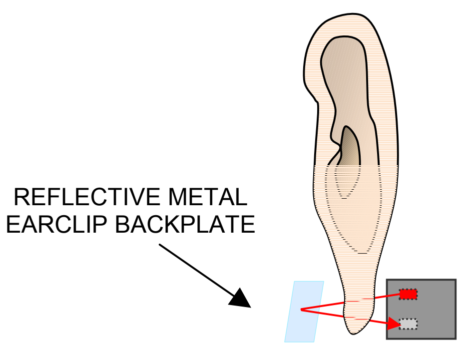


SENSOR OPERATION

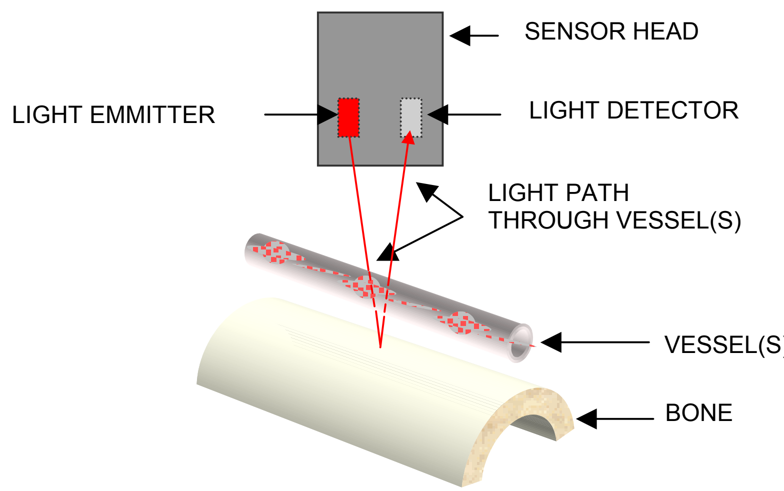
It measures blood flow by transmitting a light beam through vascular tissue which reflects off of underlying bone (as in the finger) or a reflective surface (such as the backer of an ear clip) on the other side of the tissue. The reflected beam of light returns to the sensor head and causes the phototransistor to conduct in proportion to the amount of light received.

As blood surges through the tissue, the opaque components of the blood interfere with the passage of light and create the signal.

The unit is supplied with finger and ear clips.

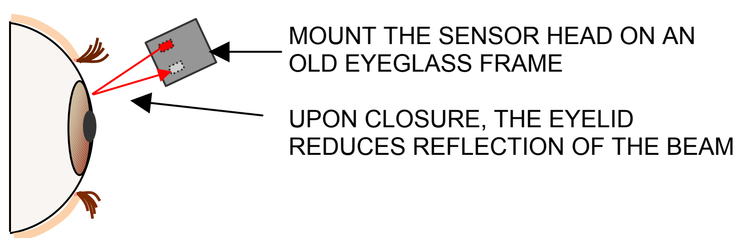


DETECTING EAR-LOBE BLOOD FLOW



BLOOD FLOW IN TISSUE WITH UNDERLYING BONE

The unit has been used successfully to monitor eye blink in adult and infant humans using eyeglass frames, helmets, and restraint fixtures. It has also been used with small animals for startle, and classical conditioning.



MONITORING EYE BLINK

SPECIFICATIONS

Excitation: Variable, controlled by the auto-range circuit adjusted for relative sensitivity by the control knob. (See page 30.)