Operating/Technical Manual

for your

Infinity Servo Control Unit

(p/n .930...3799)

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OPERATING/TECHNICAL MANUAL
IRS SERVO CONTROL UNIT

UNPACKING

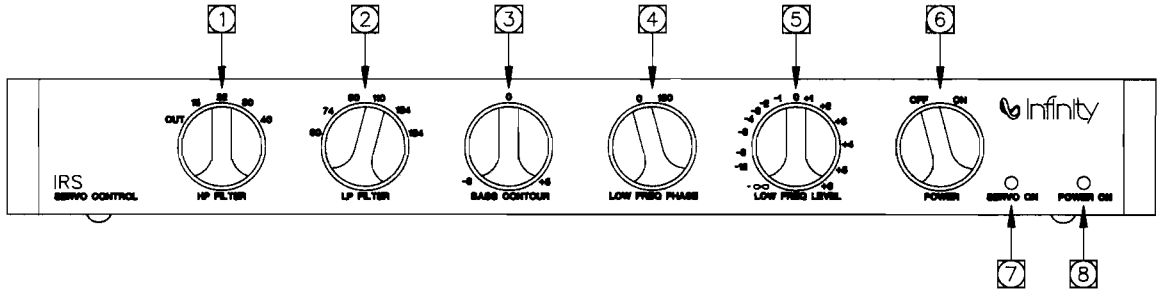
Check the Servo Control Unit carefully. If it has been damaged in transit, contact your Infinity dealer and/or whomever delivered it ***immediately.***

The Servo Control Unit carton contains the following items:

One IRS Servo Control Unit
Two 50' connecting cables
One Operating Manual

Keep the shipping carton and packing in case of future need. (The carton folds flat for easy storage.) Protect the carton from exposure to moisture.

Figure 1: The Front Panel Controls::



BASIC INFORMATION

1. HIGH PASS FILTER: sets the low frequency limit of woofer operation. The numbers refer to the 3 dB-down point of the filters. The normal setting is the "22 Hz" position; adjust to eliminate excessive woofer excursion if necessary.

   NOTE: The filter cutoff in the "OUT" position is 1.5 Hz: DO NOT USE in the "OUT" position with records (to help avoid acoustic feedback) and use the "OUT" position with caution for CD's and tapes.

2. LOW PASS FILTER: sets the upper frequency limit of woofer operation. The numbers are the 3 dB-down point of the filters. The normal setting for the IRS Beta is 110; the Gamma is 134.

3. BASS CONTOUR: sets the boost or cut slope, 20 Hz - 100 Hz, up or down by as high as 5 dB at 20 Hz. This control is useful for contouring the bass range to accommodate differing listening environments.

4. LOW FREQ PHASE: sets the absolute acoustic phase of the woofer output. For a NON-INVERTED signal source, set this control to "0". For an INVERTED signal source, set the control to its "180" position. (Refer to the section on Absoute Phase in the speaker's owner's manual to find out what other changes, if any, need to be made in the connections.)

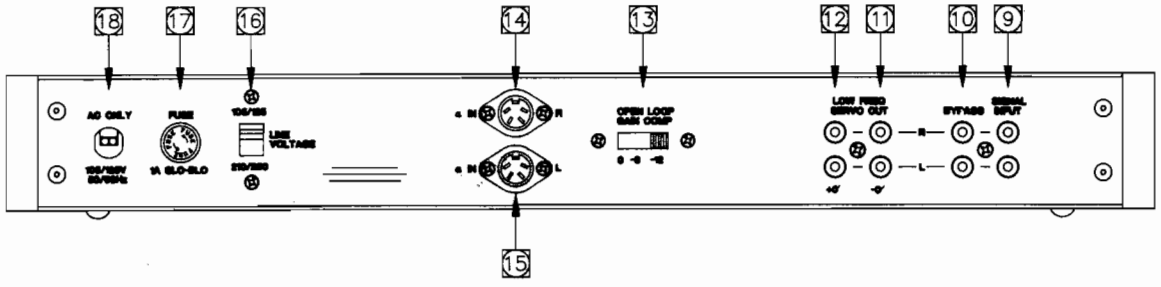
5. LOW FREQ LEVEL: sets the amount of low frequency output from the woofers. Adjust the level to obtain the best balance of bass to mid/high frequencies.

6. POWER: switches the A.C. power to the unit. (There is a 12 to 15 second delay before the woofers begin playing after power is turned on.)

7. SERVO ON INDICATOR: comes on after the 12 to 15 second woofer delay and indicates that the servo is on and active.

8. POWER ON INDICATOR: stays on while the unit is turned on.

Figure 2: The Rear Panel Controls::



9. SIGNAL INPUT JACKS: used to connect the low frequency control system input signal from the pre-amp main output.

10. BYPASS JACKS: used to connect the signal to the inputs of the mid/high frequency power amplifier(s).

11. LOW FREQ SERVO OUT, $-\emptyset$ JACKS: used to connect the low frequency power amplifier(s) when the amplifiers are INVERTING. (Note: Both $+\emptyset$ and $-\emptyset$ are used to bridge drive two stereo amplifiers for more low frequency power; see the speaker's owner's manual.)

12. LOW FREQ SERVO OUT, $+\emptyset$ JACKS: used to connect to the low frequency power amplifier(s) when the amplifiers are NON-INVERTING.

13. OPEN LOOP GAIN COMP: used to compensate for various power amplifiers that have different gains (ratio of output voltage, usually expressed in decibels or dB) so that the amount of motional negative feedback in the woofer system is in the proper range. Most power amplifiers have a gain of 26 to 30 dB. The normal position of the switch is 0 dB. Some power amplifiers have higher gains than this and if used with the switch set at 0 dB, may cause the woofer system to oscillate in the frequency range of 5 to 20 Hz or 500 to 1000 Hz ***even though the system is correctly hooked up.*** This would occur with no signal going through the system (the preamp volume at minimum, for example). If this should occur, place the switch in the -6 dB (middle) position. If the power amps used for the woofer system are operated in the bridged mode (see the speaker's owner's manual), start with the switch in the -6 dB position and if any signs of the aforementioned oscillation occurs, move the switch to the -12 dB position.

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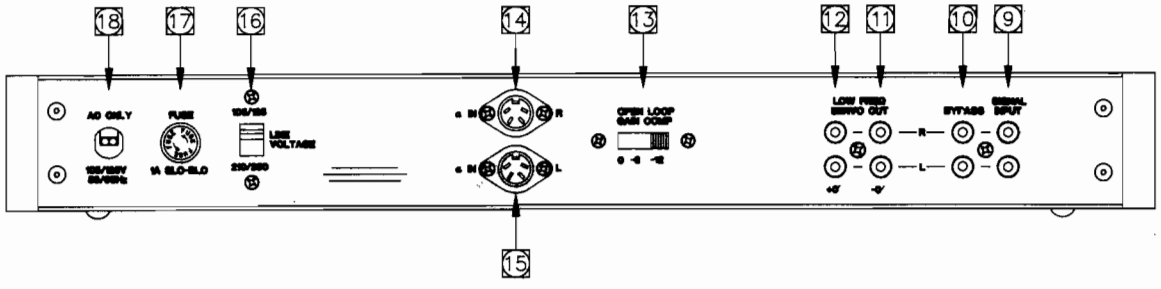

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14. ACCELEROMETER IN, RIGHT: used to connect the right-channel's accelerometer cable between the Servo Control Unit and the right speaker using one of the cables supplied.

15. ACCELEROMETER IN, LEFT: used to connect the left-channel's accelerometer cable between the Servo Control Unit and the left speaker using one of the cables supplied.

16. LINE VOLTAGE SELECTOR: sets the primary strapping of the power transformer for the line voltage to which the unit is connected. Use the tip of a flatblade screwdriver in the slot of the switch to slide it into the proper position.

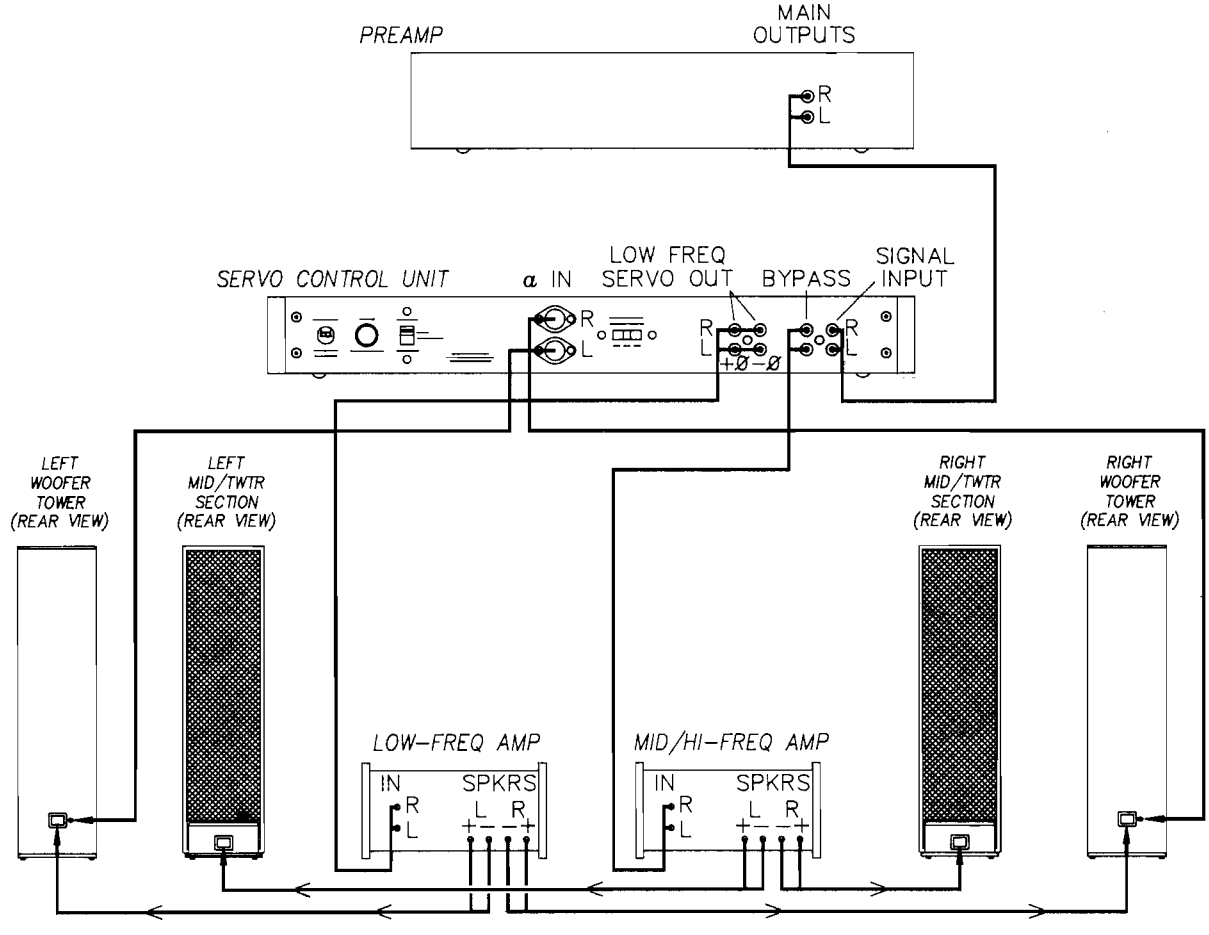
17. FUSE: protects the unit against possible internal damages in the event of power surges or a malfunction inside the Servo Control Unit. To avoid the possibility of electrical shock or other damages, replace the fuse with the specified size and type ONLY:

    105/125 VAC: 1-amp slow-blow
    210/250 VAC: ½-amp slow-blow

18. POWER CORD: connects to a suitable source of A.C. power.

Figure 3 on the following page shows a basic connection diagram, as used with the IRS Beta speaker system. (Refer to the speaker's owner's manual for complete instructions and alternate connection possibilities.)

Figure 3



WARNING! Improper connection will trigger the Servo Control Unit's protection circuit. Such misconnections include:

1. Reversing the accelerometer cables, left accelerometer input to the right speaker and vice-versa.

2. Reversing the signal connecting cables from the LOW FREQ SERVO OUTPUTS of the Servo Control Unit to the INPUTS of the low frequency power amplifier, right to left and left to right.

3. Reversing the left and right channels of the woofer speaker leads.

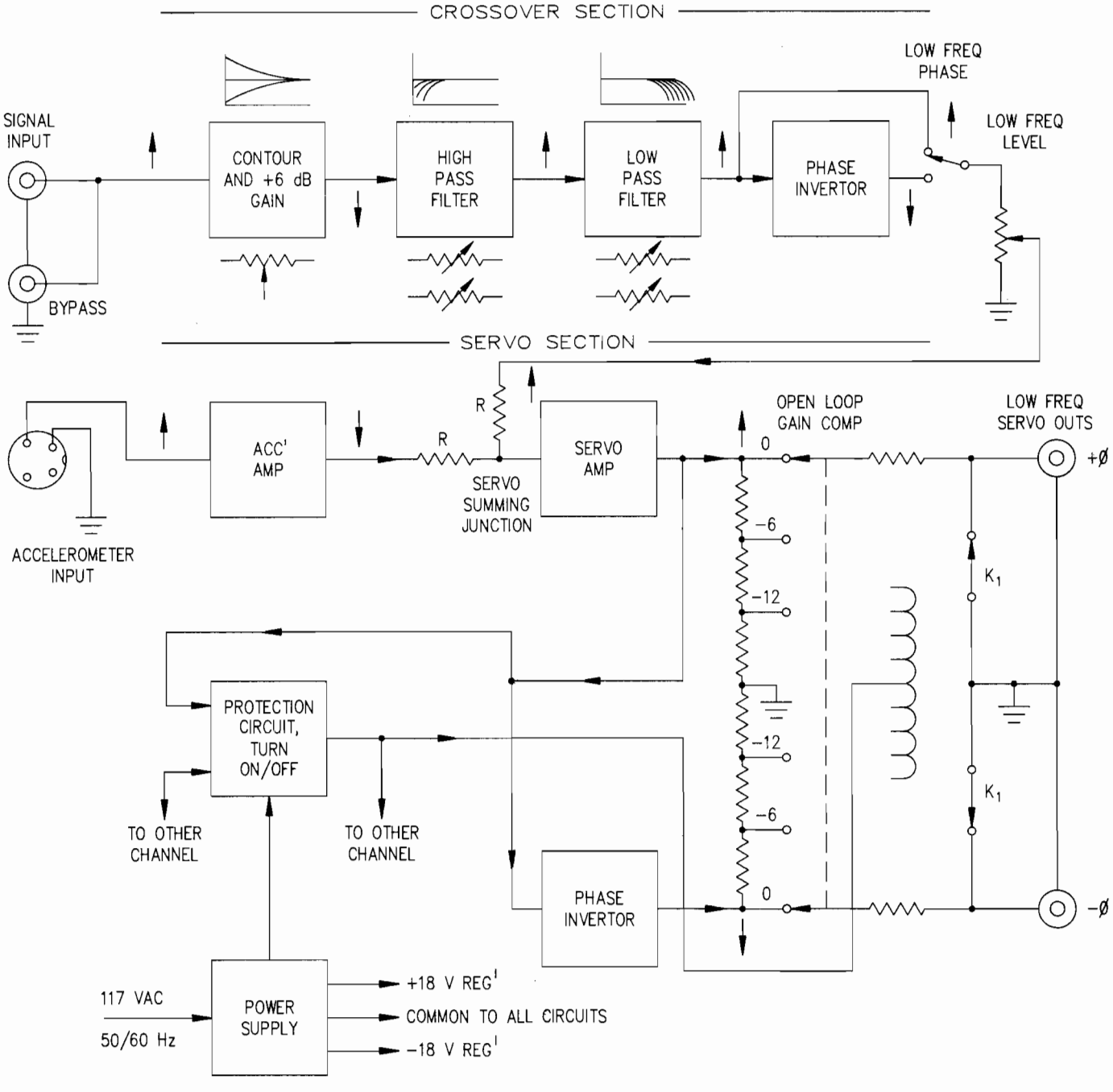
The protection circuit will prevent excessively loud low frequency tones generated by misconnection; however, it is advisable to make every effort to connect the servo system properly.

Always read the speaker's owner's manual for complete installation and operating instructions before attempting to operate the Servo Control Unit.

THEORY OF OPERATION
PURPOSE AND USE OF CONTROLS

Refer to figure 4. Figure 4 is shown for one channel of the servo control unit. The other channel is identical and independent except for the controls affecting them both.

Figure 4



The signal from the signal source (usually a system preamp) enters at the signal input to the crossover section. Output for the system mid/high power amplifier can be taken from the BYPASS outputs or directly from the preamp if it has two output jacks per channel. Within the servo control unit, the first stage that the signal passes through is the contour control circuit. This circuit is similar to a preamp bass boost/cut control but with a turnover frequency of about 100 Hz. This circuit's purpose is to contour the slope of the bass response from 20 to 150 Hz allowing for rising, flat or falling-off bass. See figure 5 on the following page for the effects of this control (shown dotted).

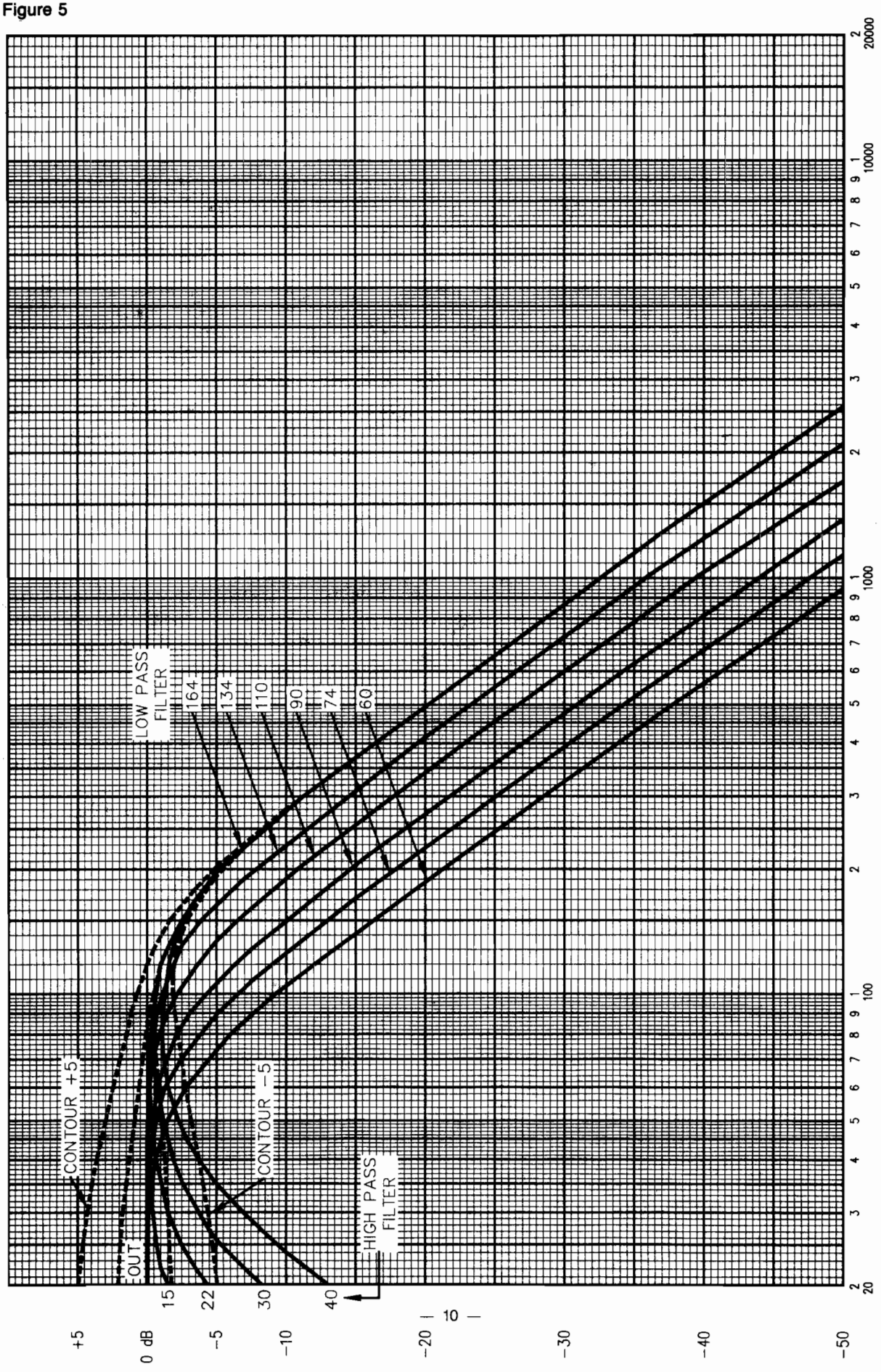
Next, the signal passes through the high pass (low cut) filter whose purpose is to attenuate subsonic and low audio frequency energy and to help shape the bass response from 20 to 60 Hz. To achieve flat near-field acoustic response in a closed box down to some arbitrary low frequency, it requires that the excursion (physical peak-to-peak displacement) of the bass drivers go up four times every time the frequency is halved. When this is carried down to 15 to 20 Hz, as it is in this system, subsonic non-musical energy, mostly from record warps, causes excessive woofer excursion and wastes system low frequency power. Setting the high pass filter from 22 to 30 Hz usually relieves this. The best sound in terms of overall ambience and air is achieved with the high pass filter set to OUT. This can be done with caution (watching for excessive woofer excursion) with CD and tape sources. When playing records always have the high pass filter set to at least 15 Hz. With the high pass filter set to OUT, its cutoff is 1.5 Hz, and the servo system's acoustic output falls off at 12 dB/octave below 15 to 20 Hz. When the high pass filter is set to 15 Hz or above the total acoustic low frequency roll-off is at a rate of 24 dB/octave.

Both the contour and high pass circuits are phase inverting with the result that in band signals are back in phase with the input at the output of the high pass filter. Note that the relative phase of various points in the circuit are shown by arrows — up being in-phase and down being out-of-phase.

The signal now passes through the low pass filter. This stage sets how high in frequency the woofer system operates. It is selectable for low pass cutoff frequencies at 60, 74, 90, 110, 134 and 164 Hz. The nominal frequency settings of the low pass filter for the Beta and Gamma systems are 110 and 134 Hz, respectively. See figure 5 for the family of low pass filter shapes.

The final circuit in the crossover section is a switch selectable phase invertor stage which allows for the correction of absolute woofer phase for a known absolute out-of-phase source. (If the switch is set to 180 for an out-of-absolute phase source, the leads from the mid/high power amp to the mid/high sections of the speakers should be reversed at one end also.)

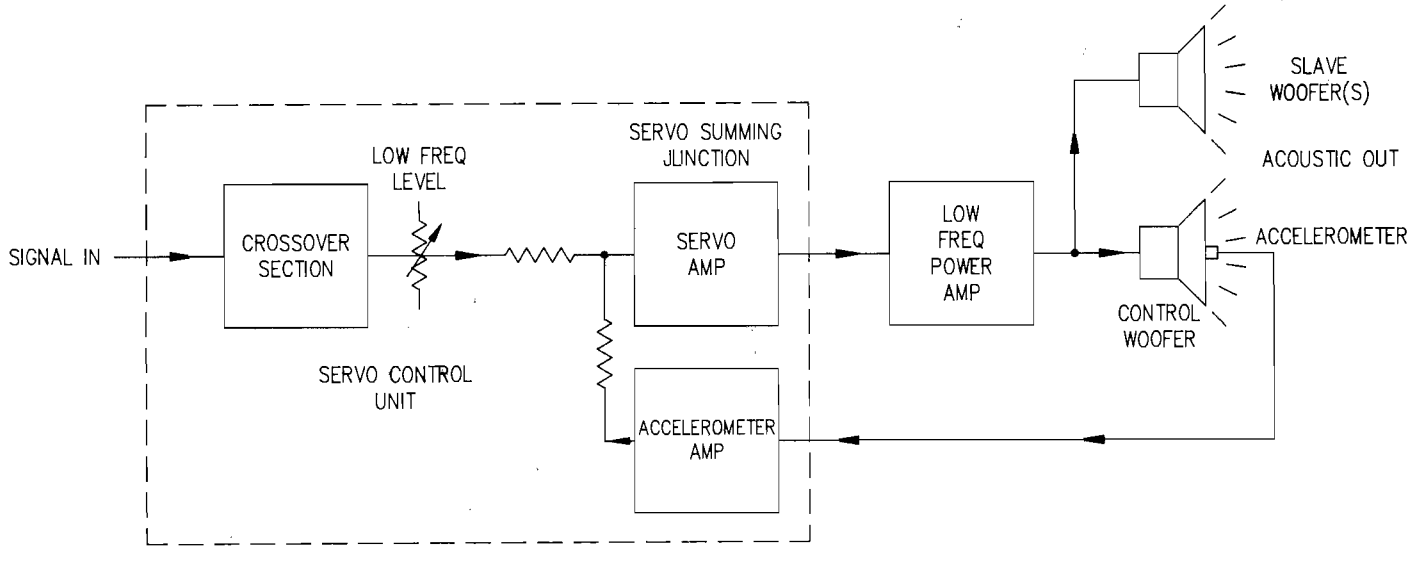
Figure 5


+5
0 dB
-5
-10
-20
-30
-40
-50
10
15
22
30
40
OUT
CONTOUR +5
CONTOUR −5
HIGH PASS FILTER
LOW PASS FILTER
164
134
110
90
74
60
2
3
4
5
6
7
8
9
1
20
100
1000
10000
20000
FREQUENCY IN CYCLES PER SECOND

The low frequency level control allows for overall bass level adjustments for proper blending of the bass to the rest of the range reproduced by the mid/high speakers. The output of the low frequency control feeds the signal input of the servo amplifier summing input junction.

An accelerometer sensor on one of the woofers in each column, called the control woofer, is fed into the servo control unit via connecting cables. We are talking about one channel of the system for discussion purposes. but it is to be realized that the servo system works separately and independently on left and right channels. The accelerometer signal is amplified and signal conditioned by the accelerometer amplifier stage. The output of the accelerometer is applied to the feedback input of the servo amplifier summing junction. A positive going input to the system input causes the woofers to move out. This causes a plus going output from the accelerometer sensor. Since the accelerometer amplifier inverts phase, the signal applied to the servo amp summing junction from the accelerometer amp opposes the signal coming from the crossover section and results in negative feedback through the system low frequency power amplifier around the control woofer. Since the woofers in the columns are closely matched, the correction generated for the control woofer is good for the other "slave" drivers and thus all drivers in the column produce the same corrected acoustic output. See figure 6.

Figure 6



OVERALL BASS SYSTEM
AS FEEDBACK BLOCK DIAGRAM

Why an accelerometer sensor? It turns out that the near-field acoustic pressure response (i.e., the frequency response of the woofer) is directly related to the acceleration of the cone and indirectly related to its displacement or velocity. An accelerometer sensor allows the direct sensing of the variable we wish to make flat in response and low in distortion.

The result of this negative acceleration feedback around the control woofer is to extend the low frequency response of the woofer system from about 50 Hz to 15 to 20 Hz, improve transient response, and reduce non-linear woofer distortion.

The output of the servo amp feeds a three position attenuator and a phase invertor whose output also has a three position attenuator. All four attenuators (two per channel) are controlled together by one rear panel switch labeled "OPEN LOOP GAIN COMP". Two servo output phases are thus available allowing bridging operation of two stereo power amps to drive the woofer columns for increased drive power or the use of an inverting stereo power amp. Being a negative feedback system, the servo control system has to have the open loop gain (gain without feedback) within certain limits for proper operation. If the gain is too high, instability or oscillation may occur at very low frequencies or frequencies near 1 kHz. If the gain is too low, the bass response won't go to the design low frequency limit and transient response and non-linear distortion won't be as good as intended. The variation in open loop gain is caused by various power amplifiers having different voltage gains (the ratio of output voltage to input voltage, expressed in decibels, dB). The three position "Open Loop Gain Comp" attenuator on the rear panel of the servo control unit adjusts for these power amp gain differences. The zero or normal position is for power amp gains of 20 to 28 dB; the −6 dB position is for power amp gains of 28+ to 34 dB. If any stereo power amp is bridged by driving it with the two phase low frequency servo output, the effective gain is doubled and the "Open Loop Gain Comp" switch is to be set 6 dB lower. For example, stereo power amps whose gain is 20 to 28 dB when bridge driven should have the open loop gain comp switch set to −6 dB. Stereo power amps whose gains are 28+ to 34 dB when bridge driven should have the open loop gain comp switch set to −12 dB.

A turn on/off mute and protection circuit controls the low frequency servo out mute relays. When the power is turned on, the output relays are shorted (no output) for 15 to 25 seconds so that the circuits can stabilize. At the end of the turn on delay period, the relays open up and the green front panel "Servo On" light comes on indicating the system will now play bass. Upon control unit power off, the mute relays immediately come on and short the outputs preventing turn off thumps. This means that bass power amps can be turned on at the same time as the servo control unit is turned on.

If the system is connected incorrectly (bass power amp to woofer columns speaker wire phased wrong, one or both channels, left and right servo out to bass power inputs reversed, bass power amp out to woofer columns reversed left and right, accelerometer cables reversed, wrong phase servo out phase used), the system will attempt to produce full power low frequency oscillation at about 60 Hz. The protection circuit senses excessive servo output amplitude and will mute the output quickly if the condition(s) occur. This is an indication that something is hooked up incorrectly. Further, if the system is being driven very hard with very low frequency bass content, the low frequency power amp may be clipping grossly. This will activate the protection circuit and mute the output. If this occurs, one needs to play the system less loudly, attenuate the low bass with the high pass filter, or get a more powerful woofer amplifier.

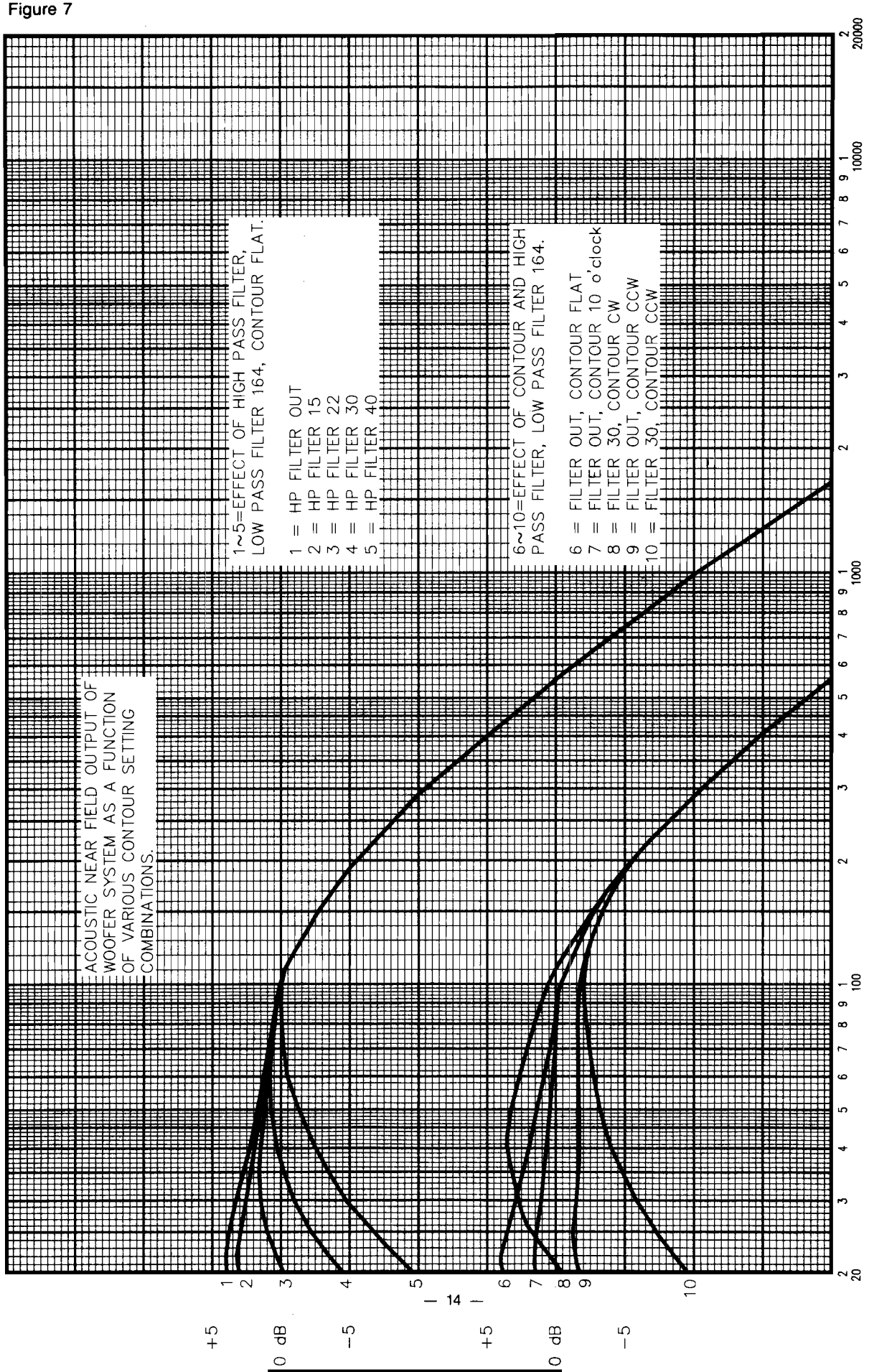
The actual near-field acoustic response of the woofer system rises as the frequency goes down with the servo control set with high pass filter set to 15 Hz, low pass filter set to 110 for Beta and 134 for Gamma, contour set flat. This is a consequence of the way the servo system is stabilized and is also intentional. In general as wavelengths of low frequencies get large (frequencies get lower) compared to the size of the woofers(s), power transfer to the air falls off because the air load becomes increasingly reactive and won't accept power. This results in a reduction of radiated power and a fall off of low bass response. We allow the bass response to rise to help offset this. Refer to figure 7 on the following page.

This graph shows the apparent rise at low frequencies and the effects of the contour and high pass filters. Very flat near-field response to 20 Hz is obtained with the contour control full counterclockwise and the high pass filter set at 15 Hz. The purpose of these curves is to show how the response can be altered. In real rooms, the perceived bass response will be considerably modified by the particular room, placement of the speakers and listening position. It is recommended that the starting point for the servo control be:

high pass filter:	15 Hz
contour:	flat
low pass filter, Beta:	110 Hz
low pass filter, Gamma:	134 Hz

Adjust bass level for best balance with the rest of the range. Experiment with speaker and listening positions. If the low bass is too heavy, rotate the contour control counterclockwise and/or raise the high pass filter. If the low bass is too light, rotate the contour control clockwise, take the low pass filter down one position, and raise bass level. If there is too much upper bass, take the low pass filter down one position. If there is too little, move the low pass filter up one position.

Figure 7


ACOUSTIC NEAR FIELD OUTPUT OF WOOFER SYSTEM AS A FUNCTION OF VARIOUS CONTOUR SETTING COMBINATIONS.
1~5=EFFECT OF HIGH PASS FILTER, LOW PASS FILTER 164, CONTOUR FLAT.
1 = HP FILTER OUT
2 = HP FILTER 15
3 = HP FILTER 22
4 = HP FILTER 30
5 = HP FILTER 40
6~10=EFFECT OF CONTOUR AND HIGH PASS FILTER, LOW PASS FILTER 164.
6 = FILTER OUT, CONTOUR FLAT
7 = FILTER OUT, CONTOUR 10 o'clock
8 = FILTER 30, CONTOUR CW
9 = FILTER OUT, CONTOUR CCW
10 = FILTER 30, CONTOUR CCW
+5
0 dB
-5
+5
0 dB
-5
20
100
1000
10000
20000
FREQUENCY IN CYCLES PER SECOND

As a demonstration of how the bass servo system reproduces bass signals, a series of scope photographs are shown. Figure 8 shows the near-field acoustic response, picked up with a microphone, to a prefiltered (through the crossover section of the unit) 50 Hz square wave.

Figure 8

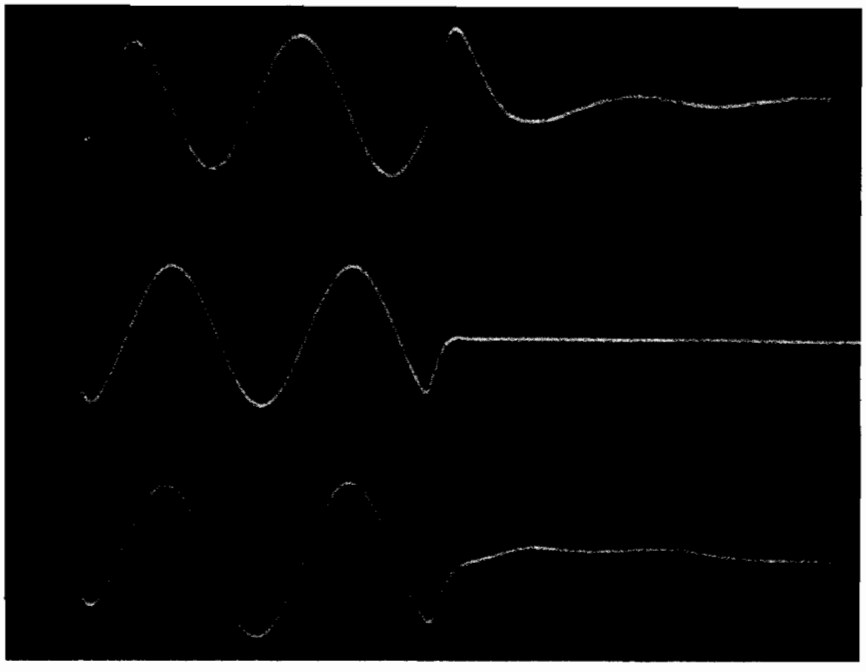
5mS/cm
Settings: OFF, 164
50 Hz square wave

The top trace is for the woofer system without feedback. The middle trace is the output of the crossover section that feeds the servo section. Here, high pass frequency is set to OUT, low pass filter set to 164, contour set FLAT. The bottom trace is the acoustic output of the woofer system in normal operation with its acceleration feedback. The acoustic output in the top trace shows low frequency tilt, i.e., the top of the square wave isn't flat, indicating attenuated bass response and attendant phase shift and time delay. In the bottom trace for normal system operation, some low frequency tilt is present which is because the system does roll off bass frequencies below 15 to 20 Hz. Many pieces of audio electronics have 50 Hz square wave tilt in excess of this ***speaker system.***

Figure 9 on the following page shows the response to a 2 cycle, 40 Hz, sine wave tone burst, where the start and stop amplitudes are near the minus peak amplitude, instead of the more common start/stop at zero amplitude. The middle trace is the prefiltered signal driving the servo system. Crossover settings per figure 8.

Figure 9

10mS/cm
40 Hz, 2 cycle tone burst

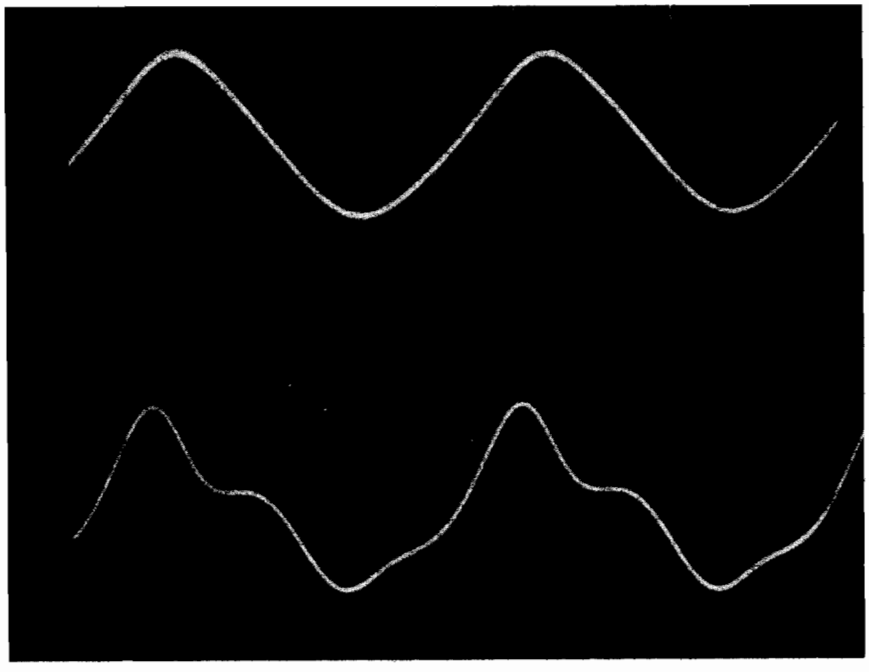


The top trace is for the near-field acoustic output of the woofer system without feedback. Note the smaller than the input first negative halfcycle, the phase shifted output (phase lead-peaks are to the left of the input peaks representing phase shift of about +90 degrees) and finally the ending transient and ring at the resonant frequency of the system at about 50 Hz. This ending transient is in the wrong sense, i.e., plus going and spurious compared to the input drive (middle trace) and would represent in itself a non-musical noise and time smear not present in the input signal. Finally, the bottom trace with system feedback in operation shows the acoustic output providing a good replica of the system input.

Lastly, figure 10 on the following page is for a 20 Hz sine wave driving the woofers to 0.5″ peak-to-peak excursion. This represents approximately .1 acoustic watts from the four woofers in one Beta column.

The top trace is the near-field acoustic output with feedback. The bottom trace is without feedback and shows the acoustic output is severely distorted. The acoustic output being generated here is a loud 20 Hz level in a room and would no doubt be rattling windows and walls, etc.

Figure 10



with feedback

10mS/cm
20 Hz sine wave
½" peak-to-peak excursion

without feedback

Infinity strives always to improve existing products, as well as create new ones. Therefore the specifications and construction details in this and other Infinity publications are subject to change without notice.

LIMITED WARRANTY

Who is protected by the warranty?

Your Infinity warranty protects the original retail purchaser and all subsequent owners for a period of five (5) years (parts and labor) from any failure as a result of an original manufacturing defect so long as: (1) your Infinity loudspeakers were purchased within the fifty United States or by military personnel from an authorized military outlet and (2) the *original dated bill of sale* is presented whenever service is required during the warranty period. This warranty does not apply to products purchased elsewhere; other purchasers should contact their local Infinity distributor for warranty information. All electronics devices are covered for a period for one (1) year (parts and labor) from any failure as a result of an original manufacturing defect.

What does the Infinity warranty cover?

Except as specified below, this warranty covers all defects in original materials and workmanship. The following are *not* covered: damage caused by accident, misuse, abuse, neglect, product modification; damage occurring during shipment; damage caused by failure to follow instructions in the owner's manual, including failure to perform recommended periodic or routine maintenance; damage resulting from repairs by someone not authorized by Infinity; claims based upon any misrepresentations by the seller; and any Infinity product on which the serial number has been altered, defaced or removed.

Who pays for what?

During the period of this warranty, subject to the above conditions, Infinity will pay all of the labor and material expenses to repair a warrantable defect.

How can warranty service be obtained?

In the event that your Infinity loudspeaker(s) should require service, you should first contact the Infinity dealer from whom the product was purchased or, if this is not practical, contact Infinity directly (ATTN: Customer Service) at 9409 Owensmouth Avenue, Chatsworth, CA 91311 (818) 709-9400. We may direct you to an authorized service center for Infinity products or ask you to send them to us for repair. In either case you will have to present your *original dated bill-of-sale* to establish warranty coverage. Do not send your speaker(s) to us without prior authorization from our Customer Service department!

You are responsible for transporting your product to either Infinity or an authorized service center and for payment of all shipping charges; however, Infinity will pay the return shipping charges (in the event you return the product to us) if the repairs are covered by the warranty. If you experience difficulty in transporting your product or are in need of packing materials, please advice us and we may be able to suggest alternative procedures and/or provide adequate packaging materials.

LIMITATION OF IMPLIED WARRANTIES: All implied warranties, including fitness for a particular purpose and merchantability are limited in duration to the length of the warranty period for your product.

LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES: Infinity is not responsible for any incidental or consequential damage of any kind. Our liability is limited to the repair or replacement, at our option, of a defective product.

Some states do not allow limitations on how long an implied warranty lasts and/or do not allow the exclusion of incidental or consequential damage, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

NOTE: In the event that there is difference between this warranty and the provisions in any advertisements, product brochures or packaging cartons, the terms of this warranty will prevail.

INFINITY SYSTEMS, INC.
9409 Owensmouth Avenue, Chatsworth, CA 91311 U.S.A. • (818) 709-9400 • TLX 188126