Instructions for System 2000 Polarity Checker with Auto-Off Circuitry

Description: The Polarity Checker is a small hand-held audio testing tool. It is powered by a 9-volt battery and designed to determine the direction of cone movement of a dynamic loudspeaker. The device features an internal microphone, a red LED, a green LED and a push-on switch. A very low current circuit automatically turns the Polarity Checker off after approximately five minutes of non-use.

Specialized Polarity pulses are provided on a test CD that accompanies this device. The recorded pulses and the hand-held detector feature a unique method of self-authentication whereby the system actually checks itself to insure proper readings. No other polarity checker has this feature. This means that the Polarity Checker is highly accurate, extremely reliable and very suitable for hobbyists, audiophiles, car audio dealers, home audio listeners, studio and recording system engineers, and pro-audio contractors

Background: When more than one speaker is used in a system, it is important that the direction of cone movement of each and every speaker be the same. Any speaker moving opposite to the rest will detract from the effect in a manner not at all unlike a single boat rower pulling opposite of the majority. Next, consider the boat as a system with two rowers pulling when ten rowers are pushing It is obvious that the boat will function much better with all twelve rowers pulling and pushing together.

Natural sound travels in chain-reaction type waves made up of high-pressure and low-pressure fronts. In nature, all sound waves emanating from a free radiating source travel in the same direction - out and away from that source.

A dynamic loudspeaker is a two terminal device that features a voice coil of wire placed in a permanent magnetic hole. The voice coil is fastened to a rigid speaker cone that is capable of moving in only two directions, forwards and backwards. Basic physics tells us that when an electric current flows in the voice coil, the coil will either be pulled into the magnet or pushed away from the magnet. The determining factor for the direction of coil (and cone) movement is the polarity of the electric current flowing in the windings. This means that simply reversing the direction of current (polarity) will reverse the direction of cone movement.

The Problem: When speakers are manufactured the voice coil terminals are usually marked with respect to their electrical polarity. In most cases, a red dot or a + sign is placed on or near the terminal of the voice coil known as the positive terminal. By default, the other terminal is known as the negative terminal. When a DC potential is applied to the voice coil so that the positive voice coil terminal is connected to the + potential and the negative voice coil terminal is connected to the potential, the cone of the speaker usually moves out and away from the basket and magnet structure. However, this is not always the case because some speaker manufacturers choose to label their terminals otherwise.

Another problem is that, due to phase shift the output of a Passive crossover is delayed with respect to the input at certain frequencies. The amount of delay depends on the order of the filter network. For instance, the output of a second order crossover (12 dB/octave) is shifted by 180 degrees near the crossover frequency. Some crossover manufacturers and some enclosed speaker manufacturers choose to reverse the electrical polarity of the crossover's output to minimize this effect Other manufacturers choose not to reverse the output. This means that the end user of pre-assembled or "home-brew" passive crossovers cannot be sure of the final polarity without actually testing the system.

Many cars and homes are pre-wired for sound systems. Making sure of the wire polarity can be a tedious task. With car audio, removing factory door panels or lifting a dashboard can be a difficult task. For these reasons, we have seen many car audio systems with two or more speakers working against the rest of the system. With woofers, this problem manifests itself as a tremendous lack of bass. With midrange and higher frequency speakers, the problem leads to flaws in the staging and overall poor performance.

Contemporary car audio Often features OEM upgrades and that typically leads to the use of devices known as Line Output Converters, Floating Ground Adapters, and Ground Loop Isolators. The problem here is that many of these inexpensive devices invert the audio signal. This means that a positive signal entering the device becomes a negative signal at the output. Likewise, there are many active electronic components that invert the signal.

Although not necessarily a problem for that individual component as soon as that component is added to a system, the amplifiers and speakers fed by this component will be out of polarity with the rest of the system.

Many components cause a polarity inversion in the signal Power amplifiers are rarely specified for this attribute, yet it can cause difficulty in multiple amplifier systems. Large commercial systems that use hundreds of speakers and complex wiring schema can be easily checked in minutes instead of hours aging the Polarity Checker.

Visibly checking speaker polarity with a small flashlight battery accomplishes little except verifying the factory labels on the voice coil terminals. Proper polarity verification requires checking the speaker wires, the amplifier, the equalizer all the way to the deck.

Familiarization: The operator should be familiar with the Checker before testing systems. First you'll need to place a 9-volt battery inside your Polarity Checker and then you'll need a quiet room to make some tests. To understand the concept of speaker polarity, place the Polarity Checker on a table or counter top with the Polarity Checker's microphone end slightly protruding over one edge. Press the centered "on" button and notice that the green and/or red LEDs may blink. If the LEDs are blinking, it means that the microphone is picking up too much ambient noise to make valid measurements. Find a quieter location.

Obtain a small flat object such as a book, magazine, CD case, or a plate. Using one hand, hold the book about 1 foot away from, and directly in front of, the Polarity Checker's microphone. Make sure that the Polarity checker's microphone is the closest thing to the book so that reflections will not be entering into this test. With your other hand, sharply tap the book towards the Polarity Checker's microphone. The green LED should light. When the flat surface moves towards the microphone, we call it a positive direction of travel. Try this experiment again and notice that each time you tap the book toward the microphone the green LED lights, indicating that the Polarity Checker received a positive pulse from the book.

Now, tap the book away from the microphone, notice that the red LED lights each time the book is tapped away from the Polarity Checker's microphone. When the book moves away from the Polarity Checker's microphone, we call it a negative direction of travel. Repeat the experiment and notice that each time the book is tapped away from the microphone, the red LED lights, indicating that the Polarity Checker received a negative pulse from the book.

Move the book out farther away from the Polarity Checker and repeat the experiment. Notice that as you get four or more feet away, the LEDs no longer light. This means that the sound energy is insufficient to measure polarity. Although you can slam the book harder to force the LEDs to light, reflections from the floor, walls, tables and your body will begin to affect the measurements. It is best to keep the microphone very close to the flat object and/or the speaker's cone.

Set the Polarity Checker down or the table and sing into the microphone until the LEDs stop blinking. Notice that approximately 5 minutes time has elapsed. This is how the auto-off circuitry works.

Checking Polarity: Place the test software into a CD player, set the repeat track and then use the balance and fader controls so that only one speaker is playing at a time. It is always best to test one speaker at a time. The polarity pulses on the test software are recorded with two consecutive positive pulses immediately followed by a single, equal but opposite negative pulse. The software actually creates the electrical equivalent of the book's positive and negative directions of travel. The timing and duration of the specially recorded pulses makes it possible for the Polarity Checker to actually checks itself so as to accurately verify its readings. Following is the order of the recorded software pulses:

Green	Green	Red	
Green	Green	Red	etc.

With that single speaker playing the test software, position the microphone of your activated Polarity Checker directly in front of the speaker's cone. Be sure to stay away from ports, passive radiators, and reflective surfaces. Adjust the volume of the speaker until the LEDs on the Polarity Checker synchronously blink with the sound of the pulses- Notice that you cannot easily hear the difference in polarity, but the Polarity Checker's circuitry measures the difference. Watch the pattern repeat over and over.

Let's say that your Polarity Checker's LED's are blinking Red Red Green. Well, from your familiarization session, the reason for the reversed pattern is that your sound system is reproducing the exact opposite of the worded pulses. Actually your system is creating a mirror image reproduction of all software not just our test CD. We'll talk more about this later. The important aspect of this test is the repeatable pattern of either Green Green Red, indicating a faithful reproduction of the software or Red Red Green, indicating a mirror image reproduction

If the LEDs are blinking randomly or **all** Red or all Green, then something is wrong with either the sound system, the Polarity Checker, or the way in which you are performing the measurements. Re-read the instructions. Install a fresh 9-volt battery, get out your flat book and check out the Polarity Checker's readings, and repeat this section. Remember that the environment must be quiet and the Polarity Checker must receive the most direct energy from the speaker - no reflections!

Relative Polarity: When all the speakers in a system are working together, we can say that the system is in relative polarity, This means that if all your speakers tested either Green Green Red or Red Red Green, then your system is in relative polarity. Congratulations. If one or more of your speakers tests opposite to the rest, simply reverse the wires on the speaker terminals and recheck the system.

Absolute Polarity: When all the speakers in a System are working together and the Polarity Checker indicates the Green Green Red pattern, then your system is said to be in absolute polarity with the software. This means that a positive pulse on the software ends up in your listening room as a positive pulse. With many non-symmetrical waveforms - particularly male vocals, trumpets, clarinets, etc., - there can be a perceived difference in the acoustic reproduction of the sound. Systems in absolute polarity tend to be more natural sounding.

Summary: Insuring at least relative system polarity is one of the mat basic of audio tests. However, it has been our experience that such a simple test is often overlooked. Old methods utilized pulse generators, microphones, and oscilloscopes. The Polarity Checking system makes it possible to quickly and accurately get your system into absolute polarity - from the software to the listening environment.

CD Reference Material with most commonly Used CD Tracks:

1 Polarity Pulses
These pulses are wide enough in duration to enable them to be used with most makes of polarity checking devices. The pulses have been sequenced so as to eliminate invalid readings. A single negative pulse follows each group of two positive pulses. The sequence is repeated for five minutes. The third pulse in each group must show opposite polarity in order for the reading to be considered valid.

2 20Hz to 20KHz Slow Sweep
This track contains a very flat low distortion 20-20kHz sweep for testing the frequency response of electronic components. It is not intended for acoustical evaluations where reflections or standing waves may cause interference. Such acoustical measurements are better done with warble sweeps or noise tracks.

3 20 Hz to 20M Fast Sweep
Identical to track 2 except that the sweep occurs faster This will result in less time for the measurement.

4 20Hz to 20kHz Pink Noise
Correlated pink noise. (The exact same noise information in each channel.)

5 200Hz to 5kHz Pink Noise
Correlated, band limited pink noise.
200Hz to 5kHz.

6 1 kHz @ Digital Zero
The tone represents the highest level signal that can be recorded in the CD medium. This maximum signal is useful for checking the output level of the other devices interfaced to the CD player as well as for optimizing the overall gain structure of a complete system.

7 Voice Counting
This is a recording of a person simply counting from 1 to 25. Although it maybe normal for some of us to evaluate system by listening to musical instruments, others may experience difficulty. We all know what a person sounds like. Although you may not know the person doing the counting, your system should lead you to believe that that he is real and in the room with you. Even though the bandwidth of a human voice is not as wide as some instruments, you'll find that vocal realism is not trivial. Choice of microphone type can certainly effect a demo such as this. In order to minimise coloration, we used a B & K instrumentation microphone placed close to the announcer in a very diffuse room. The omni-pattern helped minimize proximity effect. A great use for this track is in systems designed to cover large areas such as sound reinforcement systems, PA systems, etc. By putting this track on repeat and playing it as you walk around the room, information regarding the evenness of coverage and the intelligibility of the speech can easily be evaluated.

8-17 Acoustic Quick Check
The following tracks are intended for an evaluation of the acoustical response of both headphones and loudspeakers Although the signals are sine waves, they have been warbled and standing waves that would otherwise occur with pure sine waves. Each track starts with a 1 kHz reference tone with a duration of one second. The warble lasts for three seconds. In an ideal system, all of the multi-frequency warbles should match the 1kHz

warbles in loudness. The complete sequence will allow a generalized evaluation in less than 43 seconds. The sequence is track 8: 20Hz, track 9: 62Hz, track 10: 125Hz, track 11: 250Hz, track 12: 500Hz, track 13: 2.5kHz, track 14: 5kHz, track 15: 10kHz, track 16: 15kHz, track 17: 19kHz.

18 Sound Stage Description
This track contains a recording of three people describing their location within the sound stageIf your system ==fulfill the descriptions defined by the voices then your system is not reproducing a correct stereo image.

19 Sound Stage Description

This mad contains the same information as track 18 except that all three people are talking simultaneously. Just as if three people were talking at once, your system should rot mix them together. You should be able to understand each individual and concentrate on what each individual is saying while mentally tuning out the other two announcers. This is a particularly difficult test for a sound system but is very revealing. If you are unsure as to how well your system handles this track, try comparing the real thing. Have three friends stand across the front of your listening room and repeat this test for yourself.

20-21 Percussion L-C-R
This track is used for evaluation of the Left, Center, and Right balance and relative placement. The snare drum beats should begin on the left side of the stage and progress to the fight, with the fourth beat being center stage.

22 Subwoofer Test
This track is a warble from 100Hz to 23W for the quick subjective evaluation of subwoofer systems. Response on a good system should be strong down to the lowest frequencies (20Hz) which occur at the end of this track.

23 "Stranger In My Bed"
UPFRONT • The Power of Seven (10033-2-F)
You should be able to define many different levels of percussion intermingled with the keyboard work. Note the cowbells just behind and below the vocals at all times. Listen to the back-up vocals as they sing "I got trouble..." at 1:17 can you pick out all 6 voices? Remember all these vocals and different instruments were recorded in real time - your system should deliver some pretty intense SPL readings, so listen carefully!

24 "Dish Rag"
GOT THE MUSIC IN ME
THELMA HOUSTON & PRESSURE COOKER (I0002-2-M)
The 1975 original direct disc LP version of this project sold more then a quarter million copies before exhausting the masters, and is widely credited with starting the entire audiophile recording industry. During the opening 30 seconds notice how well you can distinguish the individual voices of the two keyboards. Then notice the vertical lift in the entire sound as the horns come in over the keys. Can you bear the tambourine (panned far left) from :29 to :42? See if your system does a good job of property staging the trumpets (predominantly in the left channel, e.g. 1:13), with the "fat" lower sound of the trombone on the right (reference the trombone solo at 1:29)

25 "Dance Of The Knights- from Prokofiev's Romeo & Juliet THE LIENSDORF SESSIONS, VOL. 1 (10043-2-G)
Los Angeles Philharmonic, Erich Leinsdorf conducting. Recorded at the legendary MGM Sound Stage One. You should be able to recreate the orchestra sitting in a semi-circle around you: the concert grand in the upper left corner of the stage. The Violins and cellos in front followed by the woodwinds further up towards the back of the stage and on a higher elevation and in the very back rows, the trombones, and percussion (including the massive timpani drums) Notice in the first 20 seconds how the sound "seesaws" front to back between the violins and cellos. Beginning at 8:27, in the upper left corner of the stage, notice the sharpness of the tight drum rolls, punctuated by the raspy horns and strings.

26 "Dirty Blue" THE NAME IS MAKOWICZ
ADAM MAKOWICZ WITH PHIL WOODS
(10021 -2-V)
Notice the presence of the vibes even with the busy and intricate piano work. Listen in the transition between notes 1:07, as sax legend Phil Woods bites down and charges the sound of the note. At to end of the track, Woods steps back and swings around, points the horn upstage and center to guide the band out.

27 "Wishing Well"
SPEAKING IN MELODIES
MICHAEL RUFF (10035-2-F)
Here's what Sheffield chairman and mastering engineer, Doug Sax, has to say about the track: "Sheffield's own pre-amps and line level mics really shine through. Notice the clarity of the piano, the natural but extended cymbals, the clarity and warmth of the vocals. Notice the astonishing percussion presence, without artifact, a combination of Coles ribbon mics into GML transformerless pre-amp. I am extremely proud of the sound we achieved on this project."

28 "Dock Of The Bay"
MAYORGA &
DISTINGUISHED COLLEAGUES,
VOL. III (10001-2-V)
This was actually a bonus track on the CD version: During rehearsals for the original direct disc recording sessions, the dynamics of Jim Keltner's kick drum were so extreme that groove excursions from the cutting lathe became too wide to fit on the album side. The song had to be eliminated! What you hear on this track is an actual take with the band beginning to block out parts and solos. When the guitar comes in at :57 with fairly equal force in both channels, you should really get a tremendous sense of stereo separation and "liveness" around the instruments. At 1:33 the horn comes in on the right channel; if you are listening in your car, the hornplayer sounds like he is sitting right about on top of your glove box. Notice the somewhat crude-sounding fade at the end of the cut. When recording in 1973, they mixed with fader knobs the size of your steering wheel!

Channel Identification Tracks

This test CD also contains several audio tracks for locating and identifying the separate channels in home theatre systems These tracks have been encoded for the popular matrix systems used in film (or video) multichannel soundtracks. Track 29 through 33 are encoded for 4 channel matrix systems. Tracks 34 through 39 are coded for "Circle Surround" 5 channel matrix systems. Each channel is announced and the sound should appear on the same speaker that is identified by the announcer. A tone will follow each announcement to help identify the channel.

29 4 Channel SurroundAnnouncement 40Hz Tone

30 Left Stage Speaker

31 Center Stage Speaker

32 Right Stage Speaker

33 Surround Channel

34 5 Channel Circle Surround Announcement 40Hz tone

35 Left Stage Speaker

36 Center Stage Speaker

37 Right Stage Speaker

38 Left Surround Channel

39 Right Surround Channel