

The Ins & Outs Of Interfacing System Components

If you're the owner of a stereo system using separate components, here's the way to get it all together.

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THE ALL-IN-ONE HOME RADIO-PHONO-graph console began to give way to separate audio components just about 30 years ago; and today, almost anyone who wants a high-quality music reproduction system at home will select either a set of individual components or, at the very least, a group of components chosen by a single manufacturer and sometimes referred to as a compact system. For those who choose separate components, the number of possible combinations and choices is awesome. And even if the neophyte chooses a set of components in which each element is compatible with every other one, the problem of correct or optimum interface still looms.

System options

The simplest stereo component system, both in terms of hookup and in terms of ultimate use is one that uses an integrated receiver as its central component. The components of a basic system using a receiver are shown in Fig. 1. The receiver includes three basic sections, each of which might also have been purchased as a separate component: a tuner (usually AM and FM), a preamplifier control section (that combines the needed extra amplification required for phonograph record reproduction and the controls and switches required for program selection and signal processing), and a power amplifier that further steps up the signals to directly drive a pair of loudspeakers.

Since all three sections of a receiver can be built as separate components, it follows logically that another approach to component assembly would be to purchase a separate tuner and a separate integrated amplifier (which combines the preamplifier/control circuitry and

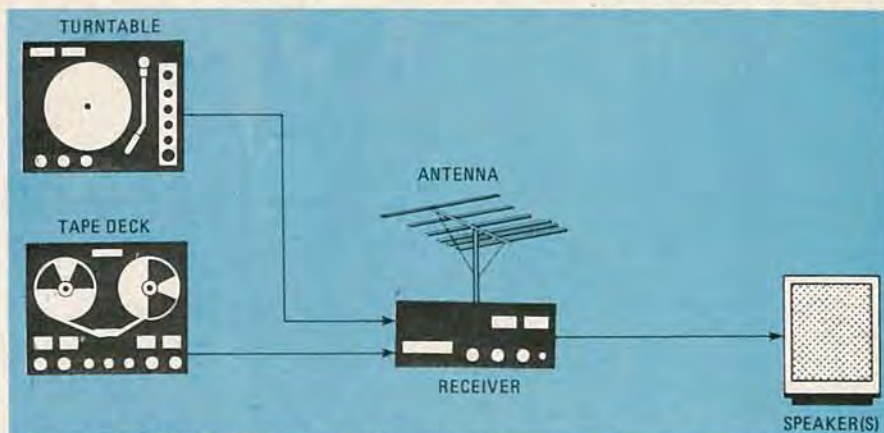


FIG. 1—BASIC HI-FI SYSTEM uses a receiver as its main component. The receiver contains the tuner, preamplifier, and power amplifier.

the power amplifier circuitry on a single chassis). A diagram illustrating the basic hookup using those two main components plus a variety of possible program sources is shown in Fig. 2.

Finally, the most elaborate approach to component-system assembly, shown in Fig. 3, uses a separate tuner, a separate preamplifier/control unit, and a separate power amplifier. Such systems generally cost the most (for a given level of system-power and control features) but also offer a great degree of flexibility and the opportunity to upgrade one element of the system at a later date without having to discard all of the electronic componentry of the system.

Matching the electronics

In the case of a system that uses a receiver as its central component, there is little or nothing that the user need do about interface between the integrated sections of that receiver. You hope that the designers and manufacturers will have seen to it that when you switch

from one program source to another (e.g. from phono to tuner), loudness levels will not change dramatically, nor will signal-to-noise ratios or overall distortion levels. If, however, the system involves a separate tuner, plus an integrated amplifier (Fig. 2), or a preamplifier and amplifier (Fig. 3), it is advisable to consider the input-level/output-level relationships of the different components.

If the tuner is equipped with its own output-level control, then you can easily adjust the tuner output levels so that they match the input-level requirements of the integrated amplifier or the preamplifier. Let's illustrate with a couple of examples. Suppose that an integrated amplifier has a tuner-input sensitivity of 150 millivolts (stated in the specification sheet for the product) for rated output. This means that, with the volume control fully clockwise on the amplifier, a signal input of 150 millivolts applied to the tuner-input jacks will produce full rated power into the speakers connected to the amplifier.

Now suppose that the tuner being used is equipped with its own output-level control and that with that level control turned fully up, the tuner-signal output level will be 1.0 volt. If you were to operate the tuner with its control to maximum, the chances are very good that you would have to *lower* the master volume control on the amplifier to a point where other program sources, such as phonograph cartridge, would sound too quiet when switching over to them. On the other hand, if you turn *down* the level control on the tuner too far, you will find that you have to *turn up* the master volume control on your amplifier to too high a setting, thereby *increasing* residual noise and hum levels and again requiring readjustment (this time downward) of the control when switching to other program sources.

The ideal setting of the tuner's output-level control is somewhere between those two extremes, and a good way to determine just where that is to experiment by switching to the other most-often used program source (phono, in most cases) and adjusting the tuner's level control until the loudness level from records or FM broadcasts is virtually the same.

It follows that if the separate tuner you intend to buy is *not* equipped with a level control of its own, you should attempt to purchase a tuner whose rated output is not greatly in excess of, or less than, the rated input sensitivity of the associated amplifier or preamplifier. The same rule applies to the purchase of a tape deck, if such a deck is not equipped with its own output-level controls. Don't confuse record-level controls on a tape deck with output-level controls. The former are, of course, present on even the least expensive tape decks, while the output-level control is generally found only on medium to higher priced machines.

Phono cartridge selection

The most important, and most often used program source in any stereo high-fidelity system remains the phonograph record. To be sure, the LP vinyl record of today is but the forerunner of possible digitally recorded, optically tracked discs of the future; but for the moment, at least, selection and proper installation of a phonograph cartridge is of vital importance in assembling any hi-fi component system. And while choosing a phono cartridge to suit your system includes intelligent selection of its output-level rating, there are many other criteria by which a phono cartridge should be judged.

Let's take a look at the simpler problem of output levels first. Moving-magnet cartridges (the type most widely used in hi-fi systems) will have rated output levels ranging from about 1.0 to 5.0 millivolts or even a bit higher for a

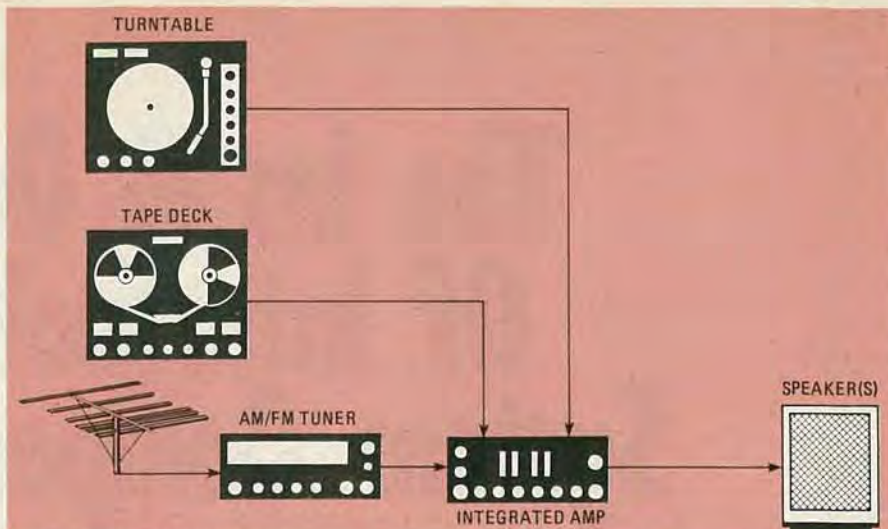


FIG. 2—INTEGRATED AMPLIFIER contains preamplifier and power amplifier. In this case, the tuner is an additional component.

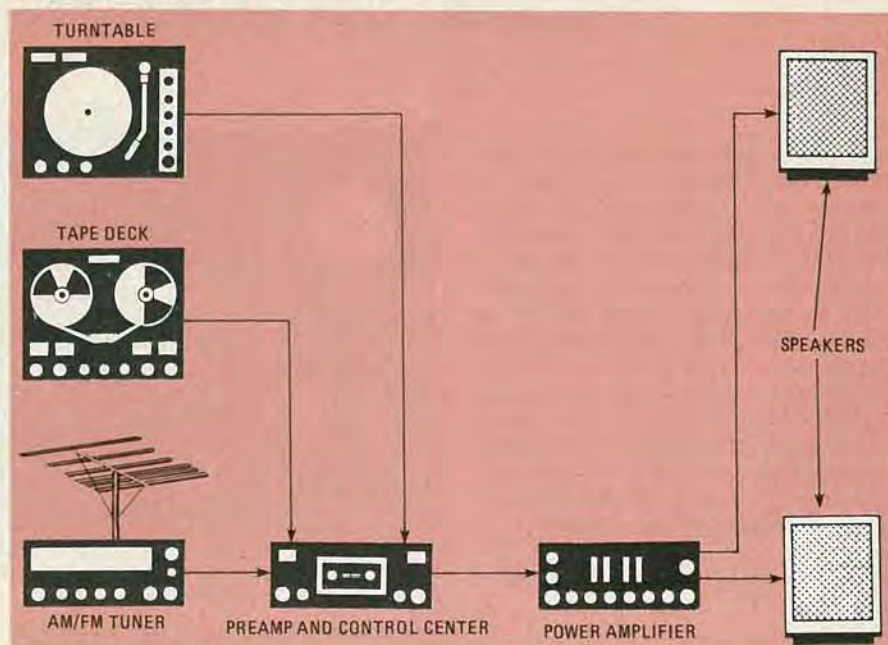


FIG. 3—THE MOST VERSATILE hi-fi system consists of a separate tuner, amplifier, and preamplifier. That approach lets you upgrade any individual portion of the system.

reference groove-modulation velocity of 3.54 cm-per-second. The specifications given for an integrated amplifier or a preamplifier will include a phono-input sensitivity. If that sensitivity is referenced to full output of the component, it may range from around 1.0 to 3.0 millivolts.

In choosing a phono cartridge, it is a good idea to choose one whose nominal output is somewhat higher than the rated sensitivity of the phono-input stage of the preamp or amplifier with which it will be used. If the nominal output of the selected cartridge is *less* than the rated input sensitivity of the component to which it is connected, you may have difficulty driving the system close to its rated output and may find yourself always turning up the master volume control of the amplifier close to its highest setting.

There is another aspect to this

matching problem that should be considered, and that is the matter of possible phono-stage overload. If you select a cartridge having an output that is too high, it is possible that when peaks in a musical selection are traced by the stylus, the output of the cartridge may be so great as to overload the low-level input stages of the preamplifier circuitry. Typically, the loudest moments in a recording may be 20 or more dB greater than the nominal levels of that same recording. With today's greater dynamic ranges of recordings recorded from digital master tapes, or by the popular direct-to-disc methods, the differences between average levels and peak levels may even be greater: 30 or 40 dB. A change in level of 30 dB represents a voltage difference of around 30 to 1, so that a cartridge having a nominal output rating of 3 millivolts may well deliver 90 to 100 millivolts

under peak-signal conditions. It is important that the preamplifier or amplifier selected for use with such a high-output cartridge be able to handle such high-input voltages without producing overload distortion.

More important than the level matching of a phono cartridge to its associated electronic equipment is the proper loading of that cartridge. Most phono-input stages provide a resistive termination for moving magnet cartridges of 47,000 ohms, a value that is perfectly suitable for 99% of currently available moving magnet pickups. However, that type of cartridge also requires a very specific amount of capacitance to be placed across each channel output pair of terminals. The value of that capacitance may range from a low of around 100 pF to a high of 600 pF or more per channel.

Although the manufacturer of the cartridge nearly always specifies the optimum value of capacitance with which his product should be loaded, few users bother to insure that the cartridge is properly loaded capacitively. Yet the variation in response, particularly at the high-frequency end

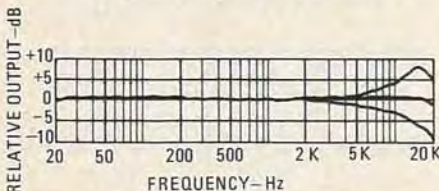


FIG. 4—A PHONO CARTRIDGE must be properly loaded to obtain optimum response. The frequency-response curve shows the effect of too little (top curve) and too much (bottom curve) load capacitance.

of the spectrum, that can occur because of errors in cartridge loading can be quite severe, as illustrated in the frequency-response plots of Fig. 4. The upper curve shows a severe peak in the high-frequency response of a cartridge that requires 500 pF of loading capacitance per channel but has only 100 or 150 pF of capacitance across its terminals. The center curve is for a properly terminated cartridge while the low curve, which shows a sharp attenuation of high frequencies, is for a cartridge which required only 200 pF of loading capacitance but which was loaded with more than 500 pF of capacitance per channel.

The audio cables normally supplied with turntable systems have a given number of picofarads (pF) of capacitance per foot, and most users of turntable/cartridge systems rely solely upon the cable-associated capacitance to properly load their cartridges. Capacitance per foot may vary greatly, however, from one type of shielded audio cable to another. More often than not, the retail salesperson will not be able to tell you how much capacitance is being contributed by the included audio cables, but that information is now more often found in the owner's manual that accompanies your turntable.

If the information cannot be obtained from the owner's manual or by writing a letter to the manufacturer of the turntable system, the only alternative is to purchase or borrow a low-cost capacitance meter. The Heath Company offers an inexpensive RLC Bridge, model IB-5281, in kit form for under \$40.00. Besides enabling you to read values of

capacitance from 10 pF to 10 μ F, it can also serve as an accurate bridge for measuring inductance and resistance.

To measure the capacitance of audio cables and internal pickup-arm wiring (the two must be considered together, as one overall loading value of capacitance) be sure to *remove* the cartridge from the pickup arm and make certain that there is no continuity between the outer shield and the inner conductor of the audio cable/pickup arm wiring. In most cases, the small amount of parallel capacitance that exists at the phono inputs of the amplifier or preamplifier can be ignored, but if you want to add that amount in to your calculations, this low value of parallel capacitance can be measured separately and added to the results obtained when measuring the combined audio cable/pickup arm wiring capacitance.

If the total capacitance-per-channel is less than the amount required for proper cartridge loading, it is a simple matter to wire a fixed capacitance across the input jacks of the preamplifier or amplifier to make up the difference. If the total capacitance measured is greater than that required for your cartridge, you may be able to obtain audio cables having lower capacitance-per-foot than the cables supplied, or you may be able to shorten the cable lengths between the turntable system and the phono inputs on your preamplifier or amplifier or receiver. If that is not possible, your only remaining alternative is to purchase a cartridge whose capacitance-loading requirements are consistent with the minimum loading capacitance which you are able to achieve with your existing cables and turntable.

Room for expansion—the tape-monitor switch

Originally intended as a simple circuit-interruption point so that a tape deck could be interposed in the signal path of a high-fidelity component system, the tape-monitor circuit on your amplifier, preamplifier or receiver has become an important access point to the system. It is at this access point that a growing variety of add-on components can be connected, thereby increasing the effectiveness of the system itself. In another article in this series, we will examine the many accessory items that can be connected to a hi-fi system via this useful circuit point and unscramble the mystery of which of the many signal processors goes ahead of which other ones. For the moment, however, it is important to understand just how a tape monitor in/out system works and where it is positioned in the signal path.

As shown in Fig. 5, the tape monitor circuit or circuits (some receivers and amplifiers may have two or even three such complete circuits) is nothing more

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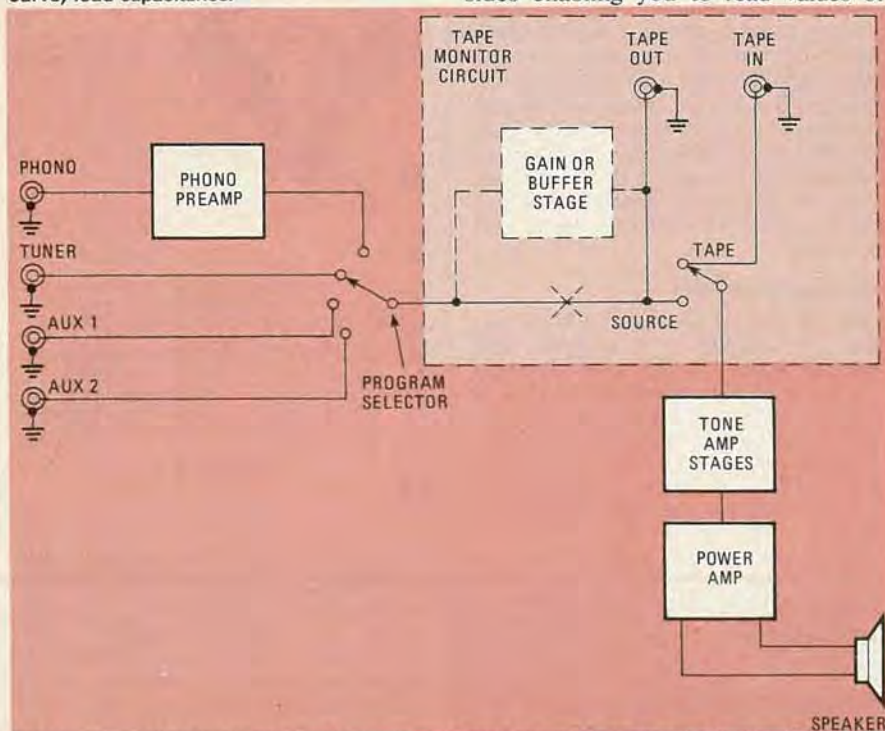


FIG. 5—THE TAPE-MONITOR CIRCUIT is actually a point of access to the signal path within the preamplifier. Although originally used for connecting a tape deck, many signal processors and add-on accessories are connected to the hi-fi system at this point.

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than a switchable circuit-interruption point in the long signal path from program source to loudspeaker terminals. Usually, the tape-monitor interruption point occurs immediately after the program-source selector switch. In some components, an additional stage of gain or a stage used as a buffer amplifier may be added, as shown by the dotted lines of Fig. 5. In either case, the jack labelled "tape out" (only one channel is shown for convenience, but in a stereo component, the identical configuration would appear for the alternate channel) is intended for connection to the *input* of an accessory component or a tape deck, while the jack labelled "tape in", "monitor" or "tape play" connects to the *output* of either a tape recorder/deck or the output of one of the many auxiliary devices or accessories.

If nothing is connected to the tape-monitor circuit and the front-panel tape-monitor switch is depressed or moved to the "tape" setting, it is clear from Fig. 5 that the signal path will be completely broken or interrupted and nothing will be heard from the system's loudspeakers. On the other hand, if a tape deck (for example) is connected to the tape-monitor loop and the "tape" position of the front-panel tape-monitor switch is chosen, only the output of the tape deck will be fed to the succeeding amplification stages and ultimately to the loudspeakers, regardless of the setting of the main-program selector switch on the front panel of your receiver or amplifier.

Often, users forget those important facts and, when they turn on their systems and discover that no sound is coming from the loudspeakers, they panic and place a call to their local service technician. Only when he arrives and simply restores the tape-monitor switch to its "out" or "source" position do they realize that they have wasted a service call.