Fixing Bad POTS Lines

This document deals with how to get the vest performance out of analog phone lines. Although it was written before POTS codecs hit the market (yes, we were doing high quality audio on phone lines way back then, too!), the principles are the same for frequency extenders, hybrids, codecs, modems or fax machines. For further information on this subject, review the Modem Line Check List technote and the Phone Line Basics technote.

If you are going to use a dial (switched) telephone line for program transmission or for a talk show, you will want it to have good frequency response, low noise and low hum. How much control do you have over what you get when you call up the phone company and ask for a line to be installed? Not a heck of a lot. If your studio is across the street from the telco central office (CO), you are in luck. You'll get frequency response which is as good as you can get, low noise, low hum and a bonus if you are connecting to a hybrid ... a resistive termination. However if your studio is three miles or more from the CO, good frequency response is not a certainty and you may get noise and a good deal of hum.

What can you do if you get poor frequency response or lots of hum or noise? If you are considering calling up the telephone company business office and complaining you might as well write your complaint on a piece of paper and place it in a bottle and throw it in the ocean. The business office will probably tell you that there is nothing that can be done.

When we moved to temporary quarters about 200 yards from our main plant during renovations, we asked the telephone company to extend our lines. This was done was by picking up pairs running out to our temporary location and wiring them in parallel with our regular lines at the central office. The first indication that something was wrong came when a UK customer attempted to send us a fax. It was unreadable. Assuming that the trouble had something to do with the fact that the message was coming in from overseas we asked someone close by to send us a fax. It was also unreadable.

Voice calls sounded OK but when we attempted to send program on a Two Line Frequency Extender, it was unbelievably bad. We called the business office and were told that their test board (located about 25 mi away) had checked our lines and found that they were OK. A telephone repair person was sent out and pronounced our lines fine since they were showing proper level at 1 kHz. We asked if they would measure the overall frequency response of the lines and were told that the phone company could not do this for us.

Meanwhile, the unreadable facsimiles were still pouring in so we unpacked our chart recorder and did the frequency response measurements ourselves. Curve 1 at the bottom of this note shows our results. We called the phone company again and, once again, were told that the test board had determined that the lines were fine and nothing more could or would be done. Never mind that our fax wouldn't work on their lines, maybe we could use semaphore or smoke signals.

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Not willing to take "ho-hum go away!" for an answer, we set about looking for someone who could help us. To our delight, we found that there were telephone company people who were eager to help us. The trick was finding them. Lucky for us, the manager of the the industrial park where we had temporary quarters had the name and phone number of someone at the phone company who had helped him in the past.

We called and explained our problem. That afternoon a very knowledgeable phone man arrived and started checking. It didn't take long for him to determine that our problem was caused by having the lines paralleled at the CO. He installed "BRIDGE LIFTERS" on each of the lines and the problem went away.

The purpose of this engineering note is not to tell you to go have "BRIDGE LIFTERS" put on your lines but rather to say that you do not have to settle for poor performance from telephone lines. There are things that can be done for any line, but you will have to set the process moving yourself. Then you will have to find the person who can help you and you will have to help that person help you.

How do you find out whether your lines are OK? That's easy. Just measure the frequency response, listen for hum and measure the noise. If the frequency response is not as good as Curve 2 in the graph below, then your line is not good enough to use for either program transmission or talk-show applications. Also shown on the graph below is an example of a poor line (Curve 3.) If you hear hum, there is a good chance that your line is not balanced. You probably won't be able to hear hum and some noise on your telephone handset because of its restricted frequency response. To properly detect noise and hum, you will need to connect the line to an amplifier and decent speaker through a telephone line coupler... for example, the Comrex TCB-1A.

Now we come to the question of what can be done to fix your line if it has one of the ills listed above. Assuming that you have found a friendly, able and willing telephone person, you will have to explain your problem in terms that will help to locate a fixable cause. (To digress for a moment: the telephone system that we have in the United States was designed by some of the best engineers, scientists and mathematicians in the world. And it is managed in a most careful way to the result that we have the most reliable system in existence. One of the keys to the reliability that we enjoy is standardization. Everything that the telephone installers and operators do is carefully thought out and telephone company standards are rigidly enforced. Were it not so, a system with telephones numbering in the hundreds of millions would be impossible to maintain. That being the case, the telephone installer is limited to making modifications which fit into the uniform telephone company standards.)

Let us see what can be done about poor frequency response. It is very unlikely that you will find defects in the low frequency response unless you are using one of the "cut rate" telephone carriers. The type of response we described in the last issue of ACCESS is also rarely seen and is easily fixed with the "bridge lifters" which we mentioned above. In almost all cases, it will be the high frequency response that suffers. If your response is something like that of curve 3, it is almost certain that there is a "bridged tap" on your line. If you are to get a response as good as curve 2, the tap will have to be removed. Whatever you do, don't call up the telephone company and demand that "that bridged tap" be removed. The response of curve 3 will have almost no noticeable effect on a telephone call and the phone company doesn't have to remove it. Rather, we suggest that you summon all your diplomatic powers to enlist help from one of the "noble" installers to remove it.

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You might ask what equipment is needed to make proper frequency response measurements. We recommend that you use two of our model TCB-1 couplers, a sine wave generator and an audio voltmeter. If you are lucky and have one of the automatic curve tracer systems, by all means use it. Then you can make a plot on paper which can be saved for future reference in case something changes. If you do not have two couplers we will be happy to loan you a pair.

HUM - what can you do about it? Before you call the telephone company you might want to make certain that your equipment is not the cause of the problem. Is the coupler which you are using balanced? Are you coupling directly to the telephone line without any intervening gadgetry? If you determine that you are not causing your hum problem, then it's time to get the phone company in. Ask them to make sure that you have a legitimate pair, i.e. a pair that is twisted together for the full length of the cable. Sometimes one of the wires in a pair becomes shorted either to ground or to the other wire. If the telephone company is short of pairs in the cable which serves you and the above fault occurs in one of the pairs which you are using, someone might be tempted to use a wire from another defective pair to make up a "pair." This pair will not be a balanced pair and hum will likely result. You will need to convince the phone people that you must have a "balanced" pair.

NOISE - how much is too much? The telephone company standard for noise is approximately -57dBm. This is the level which the line can produce in a 600 Ohm load and still be considered usable for telephone service. If it is worse than this, your line could be wet or the splices in it might be corroded. Maybe the phone company can find you another pair.

Please note that the lines we are writing about are those that run from the telephone company central office nearest you to your studio. At the central office, your line will be connected to your "SLIC" (subscriber loop interface circuit). This turns the analog audio which you send from your studio or telephone into digital form and sends it to whomever you are calling, whether they are across the world or next door to you. It also converts received digital audio back into analog audio and sends it down the same line to you. Because you send and receive on a 2-wire pair and the central offices send to each other on 4-wire circuits, a "hybrid" is included on your SLIC card. This hybrid converts 2-wire audio to separate send and receive 4-wire. Frequency responses between central offices are held to quite close tolerances no matter how long or short the circuits are and gains are held to within very close limits. Therefore, you can count on toll (long distance) circuits to be very good - no matter how long. In almost all instances, poor frequency response, hum and noise occur in the line from your studio and your CO and in the line of the called party to its CO.

If you choose to connect to the telephone lines through a PABX or a call controller or a "little gem eureka," all we can do is wish you luck. None of the equipment which we make is designed to connect to a telephone line through any "foreign" equipment. We leave that to the "breakthrough" boys.

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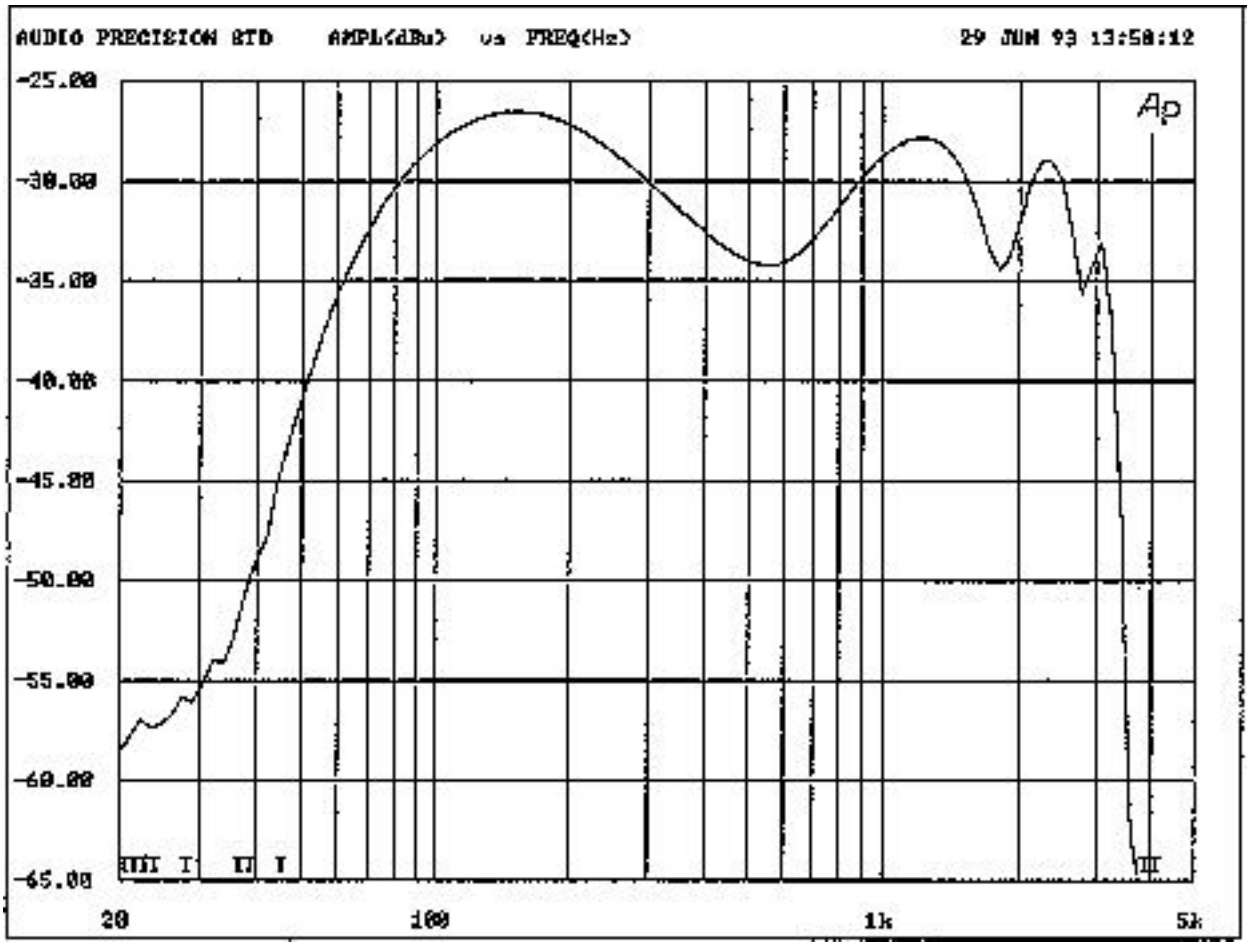
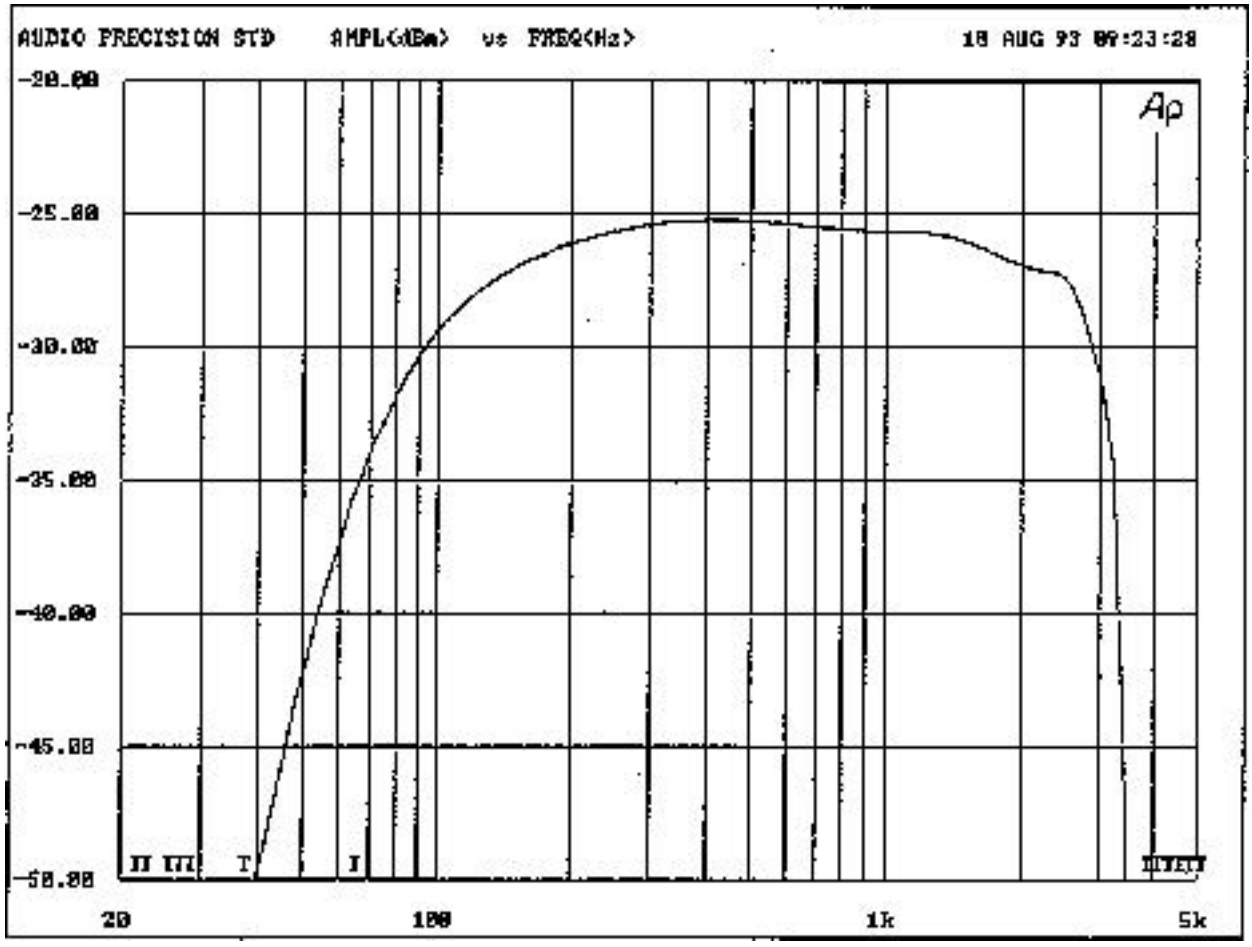
If you are technically minded and wish to have available a good “bible” may we suggest: SUBSCRIBER LOOP SIGNALING AND TRANSMISSION HANDBOOK - by Whitman Reeve, Reeve Consulting Engineers. Available from IEEE Customer Service Dept. 445 Hoes Lane PO Box 1331 Piscataway, NJ 08855-1331 USA Phone 1-800-678-IEEE. Outside the USA: 908-981-0060. Fax: 908-981-9667. Telex: 833-233. Product # PCO2683-PVB ISBN # 0-87942-274-2. LIST PRICE $59.95 IEEE MEMBERS PRICE $48.00 - IEEE CATALOG-1993.

Curve 1 - Phone line with extension, before “Bridge Lifters” were installed. POTS



Curve 2 - Frequency sweep of a “good” phone line. POTS



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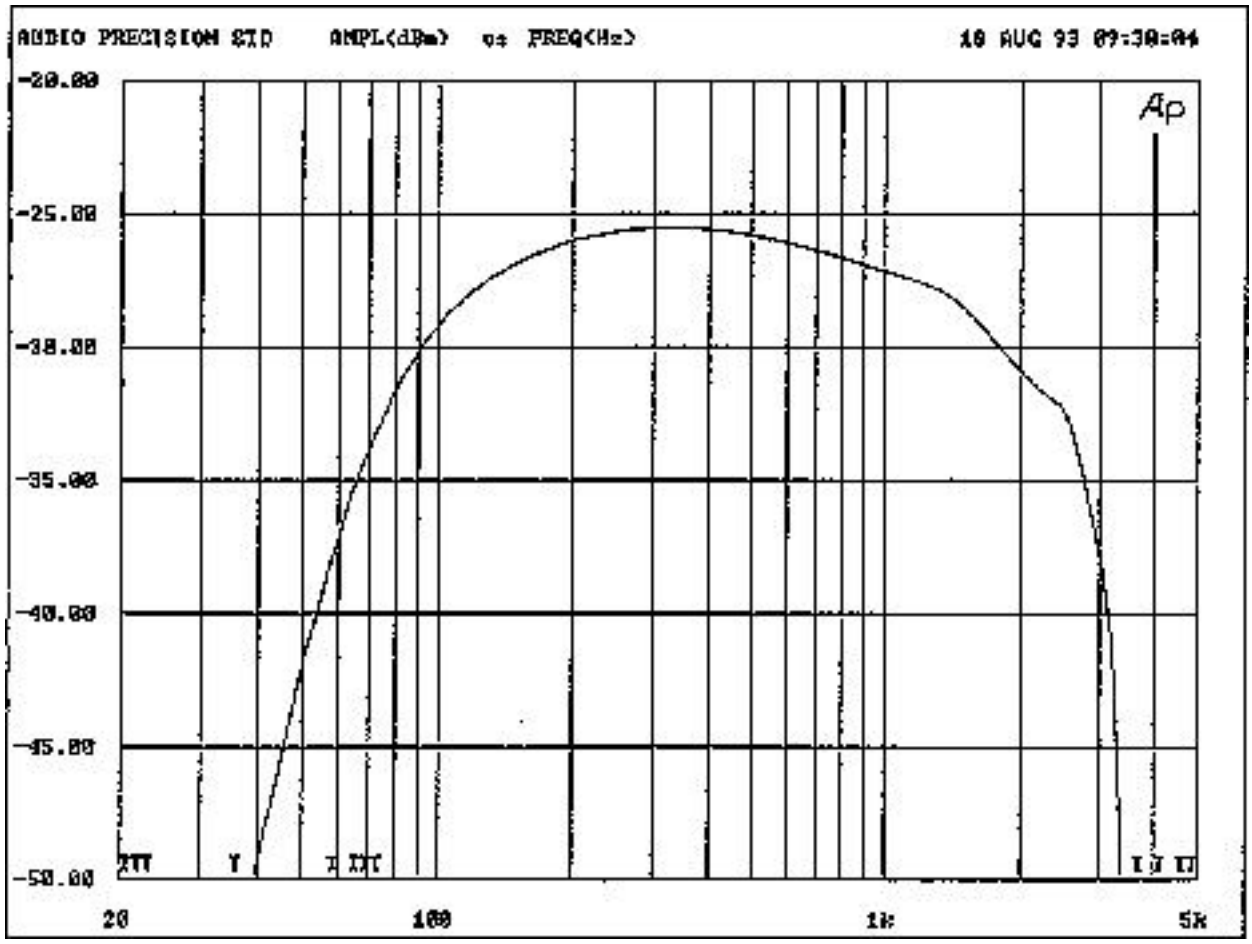
Curve 3 - Frequency sweep of a phone line with a “Bridge Tap” causing poor high frequency response.
POTS



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