Modem Line Checklist

This Comrex Engineering Note discusses problems (and possible solutions) encountered in using modems on dial telephone lines. Such circuits are sometimes called POTS (plain old telephone service) or PSTN (public switched telephone network) lines. It is not applicable to ISDN, SW-56, or DDS lines, or to equalized program circuits.

But first, a little background…

The Comrex BlueBox, Matrix, Vector and HotLine POTS codecs use internal high-speed modems to send audio in digital format over POTS lines. These modems follow the international V.34+ standard, and are very similar to modems used in personal computers. You may remember when 300 bps and 1200 bps modems were considered very fast. Modern V.34+ modems communicate at rates up to 33,600 bps on high quality phone lines. The faster rate is made possible by having the modems make a detailed analysis of technical parameters like frequency response, noise, and time delay at the beginning of the call and at any time they are required to renegotiate the connection. The beeps and "hash" you hear at the beginning of the modem call take about 10 seconds, and are used to set the connect speed and a number of internal parameters.

If the telephone line is fairly "quiet" of noise, the negotiation at the start of the call may be all you need to insure reliable operation for the duration of a broadcast. You should realize, though, that the digital data moving between POTS Codecs must be very error-free, because the audio is being decoded in real time. If much of the data is damaged in transit, you will have gaps or strange noises in the audio. You can eliminate small problems by enabling the Error Correction feature, but there is no time to fix large errors by re-sending data that was missed. The usual remedy is to lower the data rate used for the call, as the slower speeds are more tolerant of errors. On the other hand, you would prefer to have the data rate set as high as practical, as this gives better audio quality. The battle between these approaches starts many users thinking about the "health" of their phone lines.

In most cases, you will have better results with a direct line to the telephone company than through a business phone system. Modems work best if the call is converted once to digital form, and once back to analog. You may get additional analog to digital conversions by running the call through your phone system. This will limit the maximum speed that the modems can achieve. The major exception to the direct line "rule" is in truly large business phone systems where the call is sent to the phone company digitally over a high-capacity trunk like a T1 system.

One more note on in-house telephone systems: modular jacks are used on all kinds of phone systems. If you see multi-line phones with lots of lights and buttons, be very cautious about plugging a BlueBox, Matrix, Vector and HotLine into that jack! The voltages and currents present may "fry" your modem. If you need to borrow a line from a business, try to use a fax or modem line. You might want to bring along a simple tester like the IBM "Modem Saver" or even a cheap phone. It is a lot cheaper to blow up a hardware store phone than a POTS codec!

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If you are having trouble getting good modem connections, we strongly suggest you start your troubleshooting at the studio end. If you have a problem there, it will affect all of your POTS codec broadcasts.

Checklist

- Make a test call to the Comrex POTS codec test number: 978-784-1700. Note the modem connect speed. Listen to the audio for 5-10 minutes. If you notice errors, try using the Qdial (HotLine) or DropRate (Vector, BlueBox & Matrix) key to step down one speed at a time until the audio is stable. You may want to try more than one call, and see if there is any difference. If you are happy with the performance, your problems may be at the other end of your broadcasts. Try the same test there.

- If your POTS codecs work fine on long-distance calls, but have problems on calls within your area code, the real culprit may be the manner in which the phone company routes calls between those offices. You may be "getting stuck" with older microwave circuits, or extra analog/digital conversions at the boundaries of different phone companies. Your ability to solve this problem is limited. You may try to dial the call as a long distance call, either using a calling card or a 10-10-XXX force code. In any case, if you are happy with long distance calls from a particular site, the local part of your telephone circuit is OK! The rest of the information in this checklist may help, but your real problems are elsewhere.

- Since natural events (like thunderstorms) and unnatural events (like interns who plug your expensive POTS codec into electronic key phone systems) can damage the modem or interface circuitry in your HotLine or Vector, you should try to weed out a bad unit. Make calls from each codec to our test number, using the same phone line, if possible. If one unit behaves oddly, call Comrex Tech Support.

- Start at the back of the codec. Try another modular phone cord, even if you have been using the one we supplied. You might also look at the telephone wall jack to see if the pins are straight and the cable connections are OK. You'll feel mighty foolish if you spend lots of time with the phone company, only to find that this is the problem!

- Next, plug a phone into the line jack, and make a call to a cooperative person on another (hopefully clean) line. Listen carefully for hum, buzz, clicks, or cross-talk from other phone lines. Try to do this at a time of day when other phones at that site are in frequent use. If you can hear such noises, you will have a target to aim for. Then try the same call with the phone connected at the demarcation point where the phone lines are terminated by the phone company. Be sure that your other internal wiring is disconnected when you make the call. If the line is clean, the trouble may be in your inside wiring. If the line is still noisy, the problem is either with the phone company or the phone wiring at the other end.

- Check out your inside wiring. How does the line get from the telephone company demarc point to your codec? You may want to route a separate line away from other lines or electrical circuits. Make sure there are no cable staples that go through the cable! What kind of wire is used? We strongly suggest twisted pair phone cables – if you are using "quad wire," you may be picking up extra noise. If you are buying cable, consider using Category 3 (or higher) computer network cable. Are there other phones, modems, fax machines or devices on your line? We suggest that your POTS codec be the only thing on the line. Even if the other equipment is turned off, the extra circuitry on the line may limit your modem performance. If you need to share the line with other equipment, consider putting in a simple switch to isolate the codec.

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- Are you located at an AM transmitter site? If so, we strongly suggest using a telephone line RF filter with good attenuation in the AM broadcast frequency range. In really stubborn cases, you may need to filter the line at the telephone company demarc point and at the back of the codec. Assuming that the inside wiring checks out OK at each end, it probably is time to start talking with the phone company. Just a caution, though: they are now being deluged with calls from Internet users who feel that their modem performance is being affected by their phone lines. It is probably not in your best interest to stress the word modem in your conversations with the telephone company. They will probably just give you a terse dissertation on how they are not required to support modems above the 2400 bps level.

- If there is audible noise on the outside line, go right ahead and report it. If the problem is weather related (such as with rainy weather), make the call when the line is actually acting up. They will do an initial test through their computer system. If they see something wrong, they will dispatch a repair person to deal with it. The problem will likely be some imbalance between the line and ground, maybe due to a bad cable, or a bad line protection device. If they don't see a significant problem by looking through their computer system, you may have to do some talking to get them to dispatch someone. Be persuasive, but don't try to dazzle them with your technical competence or assertiveness training.

- If a repair person visits you, make the most of the situation. Don't just send them to the closet at the end of the hall. Clean it out in advance so they can get in there without danger. Stay with them. Gently explain your problem. Offer coffee. Even if they don't find the problem, you may wind up with a better friend the next time. Try to get them to check the line for "balance," even if you are a little shaky as to what that means. See if you can find out how the line gets to you from the telephone company office. In order for this conversation to make sense, we suggest that you read the following:

Phone Line 101

The simplest phone line is just a pair of copper wires running from the telephone company office to your location. Part of the line may run above ground suspended on phone poles, and part may be underground, either directly buried or in conduit pipes. Both are subject to weather-related problems. Water can enter improperly sealed cables and cause partial connections between your wires and ground, or other wires in the cable. Small animals can chew at cables and damage the insulation on the wires, with the same result. Lightning strikes can damage protective devices on the lines, resulting in partial connections from the wires to ground.

Even the simple phone line is actually fairly complicated. If the line is over 3 miles in length, the phone company will insert "loading coils" which help equalize the frequency response of the line. These loading coils don't introduce any extra noise, but they will limit modem performance to 21,600 bps or so. A nastier thing is the addition of "bridge taps" on the line. These are simply other pairs of wires connected across your line. They may run down other streets and end on poles, in manholes, or inside other buildings. Nothing is connected at the other end, but the extra capacitance of that cable will cause peaks and valleys in the frequency response of your line. Bridge taps may also introduce extra noise or crosstalk as well. A "worst case" scenario would be for you to be assigned a cable pair that was previously used at another location, and still has inside wiring connected in that building.

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As telephone use has expanded, phone companies have found it impractical to keep running more copper lines, particularly in urban and large suburban areas. This has led to the increased use of "SLIC" (Subscriber Line Interface Concentrator) cabinets connected by conventional copper wire to homes and businesses in a neighborhood. You have seen these cabinets (usually green or gray) at street corners. The equipment in the cabinet converts the local call into digital format so that individual pairs are not necessary all the way back to the telephone company office.

There are two basic types of SLICs: integrated and non-integrated. An integrated SLIC is connected by fiber-optic cable or copper wire to the telephone office. It is a high capacity digital device that is actually part of the phone company switching equipment. Your call undergoes an analog to digital conversion in the cabinet, and stays in that form all the way through the telco switch. An integrated SLIC is very modem-friendly, as it shortens that analog part of your phone line, avoiding loading coils and extra bridge taps.

A non-integrated SLIC is not tied directly to the switch, but requires a companion unit at the telco office that will introduce another set of digital/analog conversions, and that will limit modem performance. It may be better than an excessively long copper line, but it will not be as good as an integrated SLIC.

And Now Back to the Checklist!

- If the phone company believes that you have a bad cable pair, they will probably switch you to another pair. This is a good opportunity to request (don't demand) the shortest possible routing for the line, hopefully without loading coils and with a minimum number of bridge taps. You can also plead not to be put on a non-integrated SLIC, as that may worsen the situation.

- If the phone company thinks your line is OK, you may want to try an "end run" around the regular people. The telco folks have higher-level customer service people who can advocate for you within the company. If your monthly bills are substantial enough, you can request that such a person be assigned to your account. If that fails, you might contact the person in charge of media relations in your area. They want to stay friendly with radio and TV stations, and may be able to connect you with an influential "inside person." As always, be friendly and diplomatic. Mugs and T-shirts might be an idea for people who seem to be working on your behalf. It wouldn't hurt to have your call letters on their desk!

- Attention "tech types": if you used to order equalized phone lines for remotes, and you still remember which cable pairs the telephone company used for the lines to your studio, you might try requesting one of those pairs for your POTS codec line. Equalized lines are usually free of loading coils and bridge taps, and are tested more rigorously for noise and balance.

- If you are absolutely stuck with a lousy phone line to your studio, you might want to try creating a "perfect" phone line from an ISDN line (assuming that's available). All you will need is a computer-type external terminal adapter with at least one POTS port. that port will have ringing and dial tone just like a regular phone line and will be all-digital to the phone company. You will need to program the TA with a computer, entering switch type, SPIDs and LDNs. After that, no computer connection is necessary. (See Document #216 for more information on this.)

- If you have read this far, you are infinitely wiser than when you started. Before this document was created, it was necessary to climb to the top of an obscure Tibetan peak and consult the Modem Master. Oh, yes… we did obtain his permission to deliver this information. He is currently on a sabbatical in Tahiti, and does not have a phone.