Hrachnic

A Publication Especially for Operators and Technicians who service Arachnid Products

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Research & Devel.

This publication is provided as an aid for field technicians and operators who troubleshoot, repair, and maintain Arachnid games. It is a technical tool designed to keep all the latest updates, service bulletins, suggestions, and ideas together in one neat package.

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Galaxy / Dartman and the NDA

Condensed: original by Gene Harlan

Due to the recent changes made at the NDA meeting, Arachnid is providing improvements that will assist in easy data recording on league night and streamlined manual data entry in the Dartman III program for operators who use manual scoresheets.

NEW GALAXY EPROM, VERSION 6.1 - League play changes for easier record keeping

Why were changes required for manual data collections?

Up to now, many of the electronic dart games would show points per dart, points per round, or marks per round at the end of each game. The Galaxy would also show a *summary* at the end of each set of games. It was found that some leagues were taking the points per dart for each game, adding them together, and dividing by the number of games played. THIS WILL NOT GIVE AN ACCURATE CALCULATION!

The only method of accurately calculating Points per Dart is to track TOTAL POINTS and TOTAL DARTS. Likewise, for calculating Marks per Round, TOTAL MARKS and TOTAL DARTS must be tracked. For manual scoresheets this information must be displayed at the end of the game for the player to write down. Our new Galaxy eprom, Version 6.1 will display the required numbers under a new option of LEAGUE PLAY -SCORESHEET.

To use the new feature, ALL league players will select LEAGUE/TOURNAMENT PLAY from the MAIN MENU. Then they will choose whether they are using cards or scoresheets. Information provided with the new software further describes the menu steps involved beyond this point. Make sure your players understand the new procedures and that your score sheets include proper places to enter the new information.

OUT WITH SPRE...IN WITH POINTS PER DART and MARKS PER ROUND!!!

Dartman III V1.2: PPD/MPR Manual Entry...Handicapping Enhancements

THIS UPGRADE IS NOT REQUIRED FOR THOSE US-ING AUTOMATED DATA COLLECTION. THE GAMES (VERSIONS 5.X and 6.X) AND DARTMAN III ALREADY MEET ALL NDA REQUIREMENTS!

Dartman III Version 1.2 has just been released. It provides the user with enhanced manual data entry as well as more versatile handicapping ability.

As described in the previous article, the need for more detailed record keeping for Marks Per Round and Points Per Dart is the main reason for this update. For manual entry of these stats, the league coordinator now has an additional screen where either points remaining or points scored and the total darts (as recorded off of the Galaxy game) can be entered. Dartman III will then perform the proper calculations. IN ORDER FOR PLAYERS TO RECORD THE NECESSARY INFORMATION, GAL-AXY EPROM VERSION 6.1 MUST BE INSTALLED IN ALL GAMES USED FOR MANUAL LEAGUE PLAY.

Handicapping Enhancements of Dartman III V1.2 Spot darts were previously assigned by using a bell curve and/or adjusting the players manually within the partitions of the handicap setup screen. For the people who prefer to set their own breakpoints, a lookup table feature has been added. This allows the breakpoints to be set automatically every week. To use the lookup table, press F7 to add the first line, and enter the numbers for the breakpoints that you would like. Cricket and X01 must be set up separately as with the bell curve method.

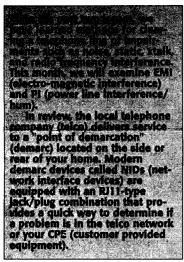
Spot dart reports have also been made more flexible. You may now choose CURRENT or DETAIL. Current prints the new spot dart settings, Detail prints Spot Darts Allowed and Spot Darts Used for the latest set of stats entered into Dartman. More information on this will be included in the next Tech Tips.

SPECIAL FEATURE ARTICLE

Inside Wiring Maintenance, Part 3

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This is the last portion of a 3 part article on phone line wiring and maintenance. It is being provided to you as a learning tool. In today's coin-op world of phone lines, networks, and modems, knowledge of phone installation, service, methods, and applications can be an invaluable tool to technicians in the amusement field. Part 1 was included in Tech Tips, Spring '96, and Part 2 was included in Tech Tips, Summer '96. Reprints are available.



EMI can be described as a buzzing or grinding sound that varies in intensity. Almost any device that contains electronic components will be vulnerable to EMI. Older telephone instruments contained mostly passive components, with just a few non-linear elements. However, newer designs include operational amplifiers and electronic filters that improve the volume level of both normal and interfering signals.

EMI nearly always coincides with the use of an electrical appliance or device in your home/business. EMI is caused by electrostatic and electromagnetic fields induced or radiated from a variety of items such as vacuum cleaners, computers, word processors, lamp ballasts, light dimmers, electric motors and controls, neon lamp power supplies, power tools, electronic air cleaners, and similar devices used around the home. All the items listed above can and do cause varying levels of EMI.

and do cause varying levels of EMI.

Our previous discussions of noise highlighted the need to document times/dates of trouble occurrences. This is true for EMI, also. Sources of EMI are easily determined because they are usually within your own home/business. Troubleshooting begins with a common

turn off the offending appliance while using the phone. However, this is not very practical, and reminds me of the man who went to the doctor complaining, "It only hurts when I do this," at which point the doctor replies, "Well, don't do that!" Scheduling time for corrective action will eliminate the need for emergency repairs.

the need for emergency repairs. When cordless phones first became popular, users often complained of noises caused by EMI. Newer models are improved and allow several channels to be selected for clear reception. However, since cordless phones are two-way radio systems, clarity can be influenced by installation methods. Locating the base unit close to high intensity EMI/RFI items such as computer monitors and television sets will cause noisy reception. Proximity to fluorescent

p o w e r supplies will also diminish signal quality. The answer for reducing EMI on cordless phones is to move the base unit to several locations in the home, searching for the area of least conflict (electrically). Also, make note of areas where the receiver unit

lights and deskt o p

C o r d e d
phones are also
susceptible to
EMI from nearby
electronics.
Modern instruments are
designed with
various amplifier
and signalling cir-

becomes noisy.

and signalling circuits. These designs often accept high levels of EMI. When testing the unit for EMI,
wrap the base, cord, and handset in aluminum foil and place a normal call. During
the conversation, remove the foil and
determine if the noise level changes. If the
foil clears the noise, the instrument is picking up the interference from free air reception. However, if the noise level does not

EMI. This will help determine if the noise signal is carried by the IWs.

EMI problems that are traced to the IW are caused by poor design of the installation. IWs are not shielded from EMI, and should not be installed within 16 inches of the noise sources listed above. In most cases, maintain a minimum of 24 inches of separation. However, 16 inches will suffice for enclosed runs where the electrical wiring is fastened to the electrical wiring is electrical wiring the electrical wiring the electrical wiring the electrical w

Inside Wire Maintenance Part 3

by d.b. le

opposite wall stud. When installing with less than 24 inch separation, add several twists to the entire IW for the length of the exposure. Do not allow IWs to lay across the top of fluorescent light fixtures. This is a common problem for offices with drop/suspended cellings.

If working in an industrial setting, do not locate the IW near electrical conduits serving heavy machinery. Awold the temporary of the condition of the condition of the IW near electrical conduits

If working in an industrial setting, do not locate the IW near electrical conduits serving heavy machinery. Avoid the temptation to fasten wiring along conduit runs. Thin-wall conduit does not offer the EMI shelding effect offered by threaded conduits. However, even small amounts of EMI leakage along the IW can reduce the signal-to-noise ratio to levels that produce audible interference. While this can be a nuisance for voice conversation, it can lead to errors in modem data transmission/reception.

Shielded wiring can reduce or eliminate the effect of EMI on voice/data communications. This can be an expensive solution, so inspection of existing wiring can save money. Also, shield quality varies widely. Select a cable that has layered shield, such as aluminum wrap covered in basket-weave/braided wiring. Inexpensive shielded cable has a loose weave shield conductor that is very "leaky" to electrical signals. Re-routing IWs from noise sources will clear many EMI troubles. If shielded wiring is employed, be sure it is a type intended for telephone service and is of the "twisted pair" design we learned about last month. Ground the shield at both ends of the cable, using an approved ground as directed by the National Electric Code (and

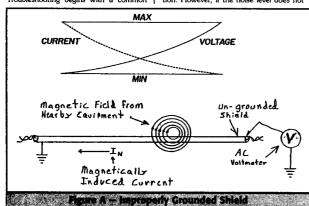
local codes). The use of special wiring types should be approved by local codes and must conform to any fire/safety regulations. Consult your electrical supplier for details. As a rule, grounding the shield at a single end will reduce interference from noise signals. However, for long runs of cabling, this also creates a safety hazard as illustrated in Figure A. As with any circuit, the point of bighest current is also the point of lowest voltage. Conversely, the point of lowest current is the point of highest voltage. For short (<200') cable runs, the result is minimal. However, for lengths of over 200', induced currents can present a harmful concern to the safety of the worker. This is especially true for cables that are extended to other facilities such as those found in a campus arrangement.

those found in a campus arrangement.

Our first consideration is for the safety of users and technicians. Noise is a secondary factor that must be dealt with in a manner that does not create a more serious problem.

ous problem.

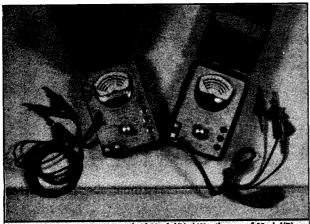
EMI troubleshooting methods closely compare to those outlined for RFI, and should begin with a removal of all CPE at the NID. Connecting a test phone or "butt-in" (discussed in the Jan. '95 issue), place a test call or revert on the line. "Reverting" is a process for calling your own line and may be accomplished by simply dialing your own directory number (DN). After receiving a busy signal or recorded announcement, hang up the phone. The line will ring back and you may answer as if a normal call was received. You may get another recorded announcement, but the



sense review of appliances in use during times of interference.

Once the offending unit has been identified, we can diagnose the reason for the interference. The obvious answer is to

decrease, the EMI is being delivered to the phone via the IW and cords, or another instrument is allowing the interference. As we learned with RFI, remove all CPE from the line while conducting initial tests for



line will become quiet. Some telephone

line will become quiet. Some telephone switching systems require special codes to revert a line. If dialing your own number does not result in a reverted call, consult your telephone directory for instructions.

Once you have established a quiet line termination, connect each IW one at a

time, while listening for the interfering sig-nal. You will determine that a single IW is

nal. You will determine that a single IW is exposed to the noise source, and is backfeeding the signal to other IWs.

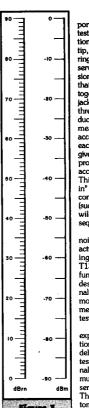
Again, re-routing the IW is the best way to eliminate interference. Causes and cures for EMI are very similar to remedies for RFI. Think of EMI as low frequency RFI. Be sure to thoroughly test any telephone instrument that uses intermal veternal. phone instrument that uses internal/external AC power. Leaky (magnetic fields) transformers or faulty filtering capacitors can cause EMI internally to the unit. Keep telephone line cords separated from pow cords to power extension cords. Do not allow cords to become a tangled mess —

Figure 1 — T136BGMZ Standard Model(L) / Weatherproof Model(R) Most end users test for noise by listening carefully while calling another line (or reverting). While the human ear can be a good troubleshooting tool, it's difficult to produce quantifiable results by just listen-ing for noise. Like any other signal, noise can be detected and measured as an electrical quantity. However, since noise can have infinite bandwidth, special rules must be followed to produce accurate results.

Telephone signal and noise levels are specified in terms of power. Therefore, voltage measurements must be calibrated to read the RMS value. When measuring to read the RMS value. When measuring single frequency signals, an average responding meter can be calibrated to read the RMS value of a sinewave, and will produce satisfactory results. However, noise signals may contain multiple frequencies and a variety of waveforms. We need a compromise between peak and average response for accurate signal measurements. The quasi-RMS detector retains the simplicity of common rectifying circuits, simplicity of common rectifying circuits, and has a response which closely approxi-

ntes true RMS for white noise and most likely occurring wave forms. These signals should be measured in real-time, during an actual call.

Telco technicians conduct noise meaduring rements installation and routine maintenance procedures. For many years, noise measuring sets were large, bulky units that were not considered portable. In the early 1970s Wilcom Instruments began producing a line of portable, battery-powered test sets. The T136b model became the standard instrument for test instrument for test instrument for thousands of telco installer/repairman. (See Figure 1.) This unit offered multiple test functions and was a compact design. Through the 1970s, the unit received sev-eral revisions for increased current measurements, impedance modifica-tions, and added func-tions. Throughout the 1980s (and since), the T136BGMZ has replaced all previous models as the pre-ferred unit. We will examine how this test set satisfies all the requirements for conducting basic noise tests on the local loop, including IWs loop, inc

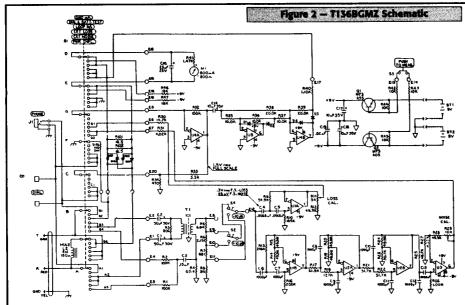


Conversion Chart

The T136BGMZ is a small, compact portable unit that can perform a variety of test functions from the NID or other locations. Test leads provide for connections to tip, ring, and ground conductors. Tip and ring are the two telephone line conductors ring are the two telephone line considerations of the two carbon. Our previous discussion on twisted pair cables (and IWs) noted that these two conductors are twisted together to form a mated pair, and can be together to form a mated pair, and can be jacketed with other pairs. Therefore, a three pair IW will contain three tip conductors, and three ring conductors. Test measurements must be conducted by accessing the tip and ring conductors for each line. Connecting across the tip of a given line, and the ring a second line will produce inaccurate readings. Note the dial access posts on the front of the T136. This offers a connecting point for a "buttin" linesman test set or test phone. Once connected, a test number can be dialed (such as reverting on line), and the T136 will "hold" up the line during testing sequences.

As we continue our discussion of noise measurements, let's examine the actual circuitry that allows real-time testing. Figure 2 is a schematic of the T136BGMZ and illustrates contacts for sixfunction switch settings. The set is designed to measure current and tone signal losses, as well as metallic and common mode noise. We will explore the noise measuring circuits now and discuss other test functions in our next article.

For review, noise signals are expressed in terms of power. communicaexpressed in terms of power. communications channels are tested for signal power delivered to the customer by transmitting a test tone at the input, while measuring signal power at the circuit output. In telecommunications, the circuit input is the teleo serving the CO (central office) or remote. The output is the NID, located at the customer location. Without knowing the Input power, the output reading is useless. For example, a reading of 5dB does not indicate a loss or gain of signal, since the input could be higher or lower than -5dB. Therefore, a standard was adopted by imposing 1mW (milli-Watt) of power across an impedance of 600 ohms. This level is called OdBm. All test signals are transmitted (unless otherwise stated) at a level of OdBm. Therefore, an output reading of OdBm. Therefore, an output reading of -5dB is expressed as -5dBm, indicating a signal power loss of 5dB. Noise readings are very small when compared to test tone measurements, in the area of -70dBm to -90dBm. These numbers are somewhat cumbersome, and a noise reference was



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express, not impress, allowing a
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published a book entitled. Tech
Notes from a Telephone Engineer.
a 125 page, large-format book covering all aspects of home and
office telephone repair, including
fax and PC modem troubles.
Enjoyed by thousands, the book
contains actual case studies and
over 50 illustrations and charts.
The book is available for \$18.95
\$5.50 \$&H by check or money order
to: db levels, PO. BOX 1125.
Tallevast, FL 34270-1125. The
author may also be reached at
\$BMF11F - PRODIGY.COM.

established at -90dBm. Therefore, -90dBm is 0dBm, where m denotes dB at reference noise level. (See Figure 3.) Conversely, +90dBm equals 0dBm, and +20dBm equals -70dBm, etc. Most noise signals on a telephone line measure between 0dBm and +30dBm. There is no need to measure levels below 0dBm, so there will be no-dBm measurements, such as -3dBm, etc. Since all noise measurements are expressed as positive numbers, we will drop the + symbol from the reading, as it is always implied.

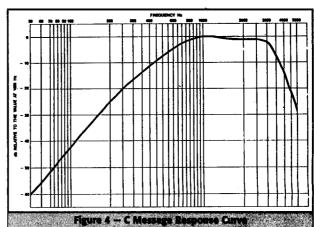
The human ear is sensitive to a wide

The human ear is sensitive to a wide range of frequencies, generally 20Hz-20KHz. While younger listeners can easily detect signals above 16KHz, those of increased maturity may be unable to hear above 10-12KHz. The frequency response of the ear is not flat, and can be expressed as a curve when testing the annoyance (or interfering) effect of various frequencies (as compared to 1,000Hz) during a voice telephone call. In other words, when listening to a variety of low and high frequency tones, at what amplitude level do they

1,000Hz. The average person hears best when the received signal is near 1,000Hz, and noise is maximum when the frequency of the noise is near 1,000Hz. At a frequency of 200Hz, a signal of a given power is 25dB less disturbing than a 1,000Hz signal of the same amplitude. This characteristic response is also duplicated as a filter in every telephone instrument. Since we desire to measure noise signals that interfere with voice communications, we must conduct measurements with a test set which approximates the C message filter. The T136 contains a C message filter for noise measurements. Therefore, our noise measurements are actually expressed in dBmc, meaning decibels above reference noise, C message weighting (filtering).

The previous information is intended

The previous information is intended to be a primer that will allow meaningful interpretation of noise measurements. Noise measuring sets are available from a number of manufacturers and belong to a class of instruments called TIMS (transmission impairment measuring sets). While most TIMS can be purchased for \$2,000



Arcadia, FL 33821; phone 1-800-922-1959 — is your best source for used/surplus T136s (or other telco test equipment). Normal used price is \$150.00, but the manager is offering a 15% discount for Nuts & Volts subscribers (includes warranty). If you are serious about IW maintenance, you can't live without one.

ty). If you are serious about IW maintenance, you can't live without one.

Le's continue our discussion by conducting sample noise tests on a working leephone line. Accessing the NID, disconnect all CPE by removing the RJ plug. Place a Harris-Dracon 10210-000 test fixture into the jack. (See Figure 5A.) This test fixture is similar to the unit pictured in the Jan. '95 installment of this series, only this model contains its own RJ jack for "pass through" monitoring. With the test fixture installed and all CPE disconnected the T136 meter by placing yellow lead to ground, green lead to test fixture tab "G," and red lead to test fixture tab "G," and red lead to test fixture tab "G," and red lead to test fixture tab "T136. If your test phone is not equipped with alligator clips, construct a test fixture by connecting the RJ11 jacks back-to-back, as shown in Figure 6.

Rotate the T136 Function switch to "dial & batt test," and revert on line. Onc.

Rotate the T136 Function switch to "dial & batt test," and revert on line. Once the line rings back and has been answered (by you), move the function switch to the "CKT noise" position and depress "push to meas" button. Observe the meter reading on the second scale from bottom, labeled "CKT Noise. Continue to depress meas. button for several minutes, looking for noise "spikes" or variations in the reading. If the noise reading is above 30dBrn with all CPE removed, contact telco repair. If readings are OdBrn-20dBrn, connect CPE by plugging CPE feed RJ plug into the end of the test fixture. (See Figure 5B.) Readings may now be obtained with

If readings are 0dBm-20dBm, connect CPE by plugging CPE feed RJ plug into the end of the test fixture. (See Figure 5B.) Readings may now be obtained with all CPE connected to line. In our example, Figure 5A indicates a noise reading of 10dBmc with CPE removed. When CPE is connected, reading jumps to 31 dBmc, indicating trouble in wiring, jacks, or instruments. The "push to meas" button has been internally shorted for these photographs. Continue to observe readings, again looking for spikes or swinging measurements. If noise increases with CPE connected, begin removing CPE units one at a time, while observing the noise meter. Once defective/improperly installed IWs or instruments have been removed from the line, reconnect all other CPE while observing measurements. This test will help locate any EMI caused by CPE wiring or instruments.

Continue noise investigation by restoring NID, moving the T1.36 to all jack locations in your home/business. Conduct noise measurements at all jack locations with CPE connected and disconnected looking for changes in meter readings. Do not lift the receiver on any telephone during the measurement, because the normal voice signal will look like noise to the T136. If you desire to verify this, lift a receiver during test, using care not to "peg" the needle on the T136. Remember that the T136 is very sensitive to all signals while set to "CKT" Noise" position. Also, be sure the line is reverted before switching the function knob from "dial" to "CKT noise" position. This test method will also locate IWs with series faults, as described in the January article. Now let's consider now the T136 actually measures noise signals. (See Figure 2.) While connected to the telephone line, and function switch is set to "dial & batt test," notice that the dial posts are across tip and ring. In any position other than "dial" or "current" measurement settings, a 180ohm coil is bridged across the line, which maintains a "hold" current without affecting the signal measurements. Circuit noise is the noise actually heard by the user and is measured across the line (differential mode). Therefore, the measurement is not refer-

The release to ground.

The noise signal is coupled to transformer T1 through two 50 micro-Farad capacitors, shunted by a resistance of 806ohms. Notice the secondary winding is connected to ground with an effective

Future installments of this series include a lesson on the use of fiber optics in communications. To provide a better understanding of these tutorials, it will be helpful for you to acquire a 50/100 power microscope (or magnifying glass) and a section of fiber. The author has purchased sample lengths of optical fiber and prepared them for viewing. To receive a 12-inch, single mode/125 micron prepared optical fiber, send \$1.00 and (business size) self-addressed, stamped envelope to: db levels, P.O. Box 1125, Tallevast, FL 34270-1125.

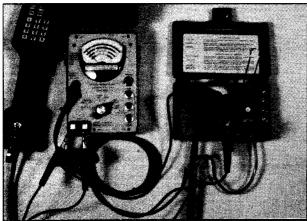


Figure 5A — Noise Reading with CPE Removed

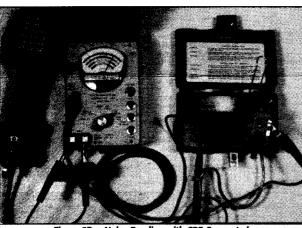
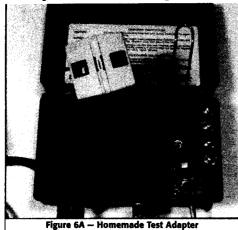


Figure 5B - Noise Reading with CPE Connected

become as annoying as a given level of 1,000Hz tone? The quantified average response to this hypothesis was presented as the industry standard "C message" response curve. (See Figure 4.) Notice that the curve assigns a OdB reference to

\$2,500, the T136 was designed for mass market (technicians) prices of around \$250-\$350. These units are still available from Plantronics/Wilcom with excellent factory support/service. Jan-Tech Communications — 5577 S.E. Hwy 31,



bridge resistance of 10Kohms. The parallel combination of 806 and 10Kohms equates to an input impedance of 735ohms. The telco uses two types of line to serve your location. One has an impedance of 900ohms, the other 600ohms. The input impedance of 735ohms allows the T136 to be preserved the property of the parallel on either time of line with measure signals on either type of line without significant error. Following the unity turns ratio input transformer is a divider chain which allows for "+10dB," "+20dB" range extension. Normal signal flow is picked off at terminal E9 and connected to C6 via terminal E12. Integrated amplifier U1B is a two-pole, high-pass filter, fol-

the quasi-RMS detector section of U4A, U5, and U4B. U5 is a precision diode, delivering

current to the inverting input of U4B through R38 and R39. This current is proportional to the instantaneous absolute value of the voltage at C14. The current is amplified by U4B and delivered across the movement and ground via R40, R41.

If C16 were omitted, the meter would be average responding. If placed at the cathode of D3, voltage would rise to follow peaks, discharging more slowly through

Install Screus Telephone Line thru Cover for test clip access cord WSRI Plug G Standard RJ-11 Jacks Fasten back-to back when wired 4

Figure 68 — Homemade Test Fixture devices. Some of you have judged that I never fault the telco for any troubles you may experience. On the contrary, there are a number of noise types that cannot be controlled by the end user. Telcos employ special crews for noise mitigation efforts, and conduct their prefer enduction are and conduct joint noise reduction pro-grams with area power companies. So far, we have only examined noise problems over which you have

direct control and responsibility. Before we move onto other subjects in telephony, we must review another type of noise

another type of noise that is very annoying to end users. PI (power line inter-ference) has been around since day one of the telephone business. Millions of dollars have been spent to train technicians, correct plant design, and install protective devices to alleviate this trouble some complaint.
Complicating the
matter are changes
in loads on power
lines, causing telephones to become noisy only under cer-tain conditions. Once a fix has been deter-mined, the load changes again, send-ing you back to the drawing board. However, this is a science that has pro-duced well-defined

gations. The following information will help you learn how CPE can be the cause, but not the cause.

help you learn how CPE can be the cause, but not the source of PI.

The telco CO is usually located in the approximate geographical center of a majority of the customers it serves. This was especially true in the 1950s-1970s, however, urban sprawl has caused residential sub-divisions to pop up miles from the

serving CO. Prior to the 1980s, telcos merely extend-ed large cables to these areas, with capability for senting up for serving up to 3,000 customers.

However. installing large cables was not always practical, and "pair gain" systems became the preferred method for serv-ing these areas. Pair gain allows a concentration of customer lines to be served by fewer cable pairs.
Prior to pair
gain devices, gain devices, lines were con-ditioned by adding lumped inductances (called "load coils"). The load

coils were installed at measured points along the cable route to offset capacitive reactance associated with long cable runs. Load coils reduced usable bandwidth and restricted service offerings. Cable runs were usually installed in the same right-of-

were usually installed in the same right-of-way as power lines, where exposure became a catalyst for Pl.

Throughout the 1980s and this decade, a new design has reduced Pl caused by exposure to long runs beneath power lines. Telcos routinely extend fiber optic cables to sub-divisions, installing remote units to serve hundreds (or thou-sands) of customers. In many cases, this arrangement actually removes racks of arrangement actually removes racks of switching equipment from the serving CO and installs them into a building, underground vault, or above ground enclosure located at or near the new sub-division. This reduces the amount of copper cables, and allows customers improved service and access to advanced features. With the access to advanced features. With the reduced runs of copper comes a reduction in noise complaints caused by Pl. However, some areas still experience interference, and the fiber-fed remote will not correct problems caused by the "last mile"

of cable.

The degree of power line interference is affected by three factors: 1) power influence; 2) coupling; and 3) susceptibility. The telco has no control over power influence, which is the amount and frequency of energy emitted by the power system into the environment. Power influence is a measure of the induced voltage appearing on nearly metallic conductors such as telenearby metallic conductors, such as tele-phone cables. (See Figure 8.) This causes a longitudinal current flow along the cable pairs which must be canceled, or it will become audible (depending on the interfer-

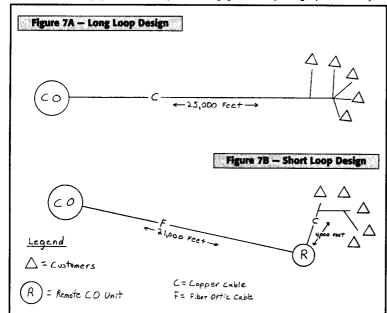
Have a telephone problem that can't be solved?

If you are in the middle of a bad experience, drop us a note at Nuts & Volts. Daniel Levels will analyze your trouble, offering suggestions for test procedures and corrective action.

Send your questions to Nuts & Volts, Dept db, 330

Princeland Court, Corona, CA 91719.

Questions will be answered in the next available issue.

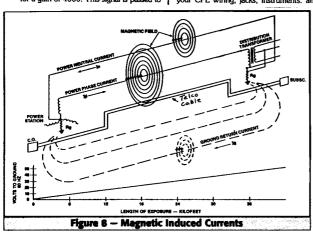


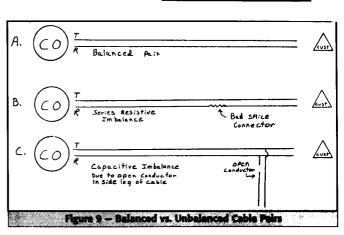
lowed by two two-pole, low-pass sections (U2A & U2B). Finally, U3 is a passive response shaping amp with adjustable output for calibrating the circuit. These four sections perform C message weighting to noise signals, and are passed onto amplifier U4A. The 1,000Hz gain of the C message section and amplifier U4A is pre-set for a gain of 4000. This signal is passed to

R40, R41. For this reason, the ratio of R40, R41 was carefully chosen by the designer to provide the best response for a

wide variety of waveforms.

Over the last three months, we have Over the last three montns, we have discussed troubleshooting methods and corrective measures to eliminate noise caused by problems within the scope of your CPE wiring, jacks, instruments. and





ing frequency). Inductive interference can also cause mechanical follows: also cause mechanical failures in electronic equipment, such as PBXs, moderns, and key systems. Balance of power line phase cur-rents has a profound effect on this problem. When phase currents are balanced, little cur-rent flows in the neutral. However, heavy rent flows in the neutral. However, heavi-loading on any phase conductor causes sig-nificant current to flow in the neutral, and also through the earth. This is called ground return current. When phases are unbal-anced, the magnetic field about the phase conductor is also out of balance with other magnetic phase fields. The uncanceled field cuts across the telephone cable, inducing a current as the field expands and collagons. In current as the field expands and collapses. In a perfectly balanced cable, there would be no adverse effect, however, there are no perfect

Coupling can be affected by bonding Coupling can be affected by bonding and shielding practices of the telco, and most low-frequency induction problems can be corrected by a thorough investigation and test plan for shield effectiveness. One open cable sheath bond can cause inductive noise in an entire cable. In some cases a single open shield connection has caused an entire remote sustem to become caused an entire remote system to become noisy. The telco has direct control over per formance of shielding/bonding and

grounding issues.

Susceptibility is the measure of how well balanced a circuit is before becoming adversely affected by an induced longitudinal current. A longitudinal current is a current that flows along a cable pair with respect to ground (common mode). Common mode signals can be measured with the T136. If the pair is well balanced, the currents cancel and no noise is heard. However if the pair is unbalanced (even a However, if the pair is unbalanced (even a little), noise will become audible and can be little), noise will become audible and can be effectively measured and quantified. (See Figure 9.) This metallic (transverse mode) signal is the measurement we described as "CKT noise." Therefore, both signal types can be measured with the T136 test meter.

The circuit design for PI measurement is the same as with CKT noise with a major difference in the input section. (See Figure 2.) For PI testing, the tip and ring conductors are each in series with a 100 Kohm resistance, shurted together and

conductors are each in series with a 100Kchm resistance, shunted together and fed through capacitor C3 to the secondary side of T1. The signal is imposed across 60.4ohms and ground, which is coupled with the 50Kohm (effective 100K/2) to form a voltage divider.

As the signal passes through the secondary winding, the primary acts as a 735ohm termination. From this point, the signal follows the same convention as with

signal follows the same convention as with CKT noise measurements. Notice the scale

for power influence is much higher than for circuit noise. Longitudinal currents are more significant in terms of power than those of transverse mode orientation. Typical readings are from 65dBrnc-75dBrnc, rather than the 5dBrnc-10dBrnc of circuit noise. Remember, circuit noise measurements represent noise caused by longitudinal currents that are not canceled or attenuated by prop-er circuit balance, while PI readings directly quantify the entire longitudinal currents.

er circuit balance, while PI readings directly quantify the entire longifuldual currents.

PI measurements are acquired in the same manner as described for CKT noise. After completing the CKT noise reading, rotate the T136 function knob to the "PWR INF" setting and depress "push to meas" button. Record readings for both measurements, comparing results with tests with/without CPE connected.

The telephone circuit (line) balance can be determined by subtracting the CKT noise reading from the power influence reading. For example, a PI reading of 65dBmc and CKT noise measurement of 5dBmc yields a balance of (65-5) =60dB. The target for balance is 60dB or above. A balance of 50-60dB is good, 40-50dB is fair, and anything less than 40dB is poor. The higher the balance, the higher amount of inductive currents can be tolerated withof inductive currents can be tolerated with

of inductive currents can be tolerated with-out interference.

Unbalanced equipment provides a path to ground for longitudinal currents. Early models of answering machines had ring detectors triggering to ground, creat-ing a slight unbalance condition. Remember that a path to ground invites current flow into your equipment, which may not be designed to handle the power. Telcos can maintain balance by reduc-ing bridged taps (multiple appearances of a

reicos can mantan balance by reduc-ing bridged taps (multiple appearances of a pair in different cable sheaths) and repair-ing series and shunt faults in other con-ductors. Well balanced cables can with-stand higher amounts of PI and even make up for poor shielding. However, all para-meters must be dealt with effectively. Another method for determining the

Another method for determining the degree of balance is to measure the AC signal voltage with a VOM. While this is not a very accurate method for noise investigations, it will give you a clue about the severity of the problem. Remove all CPE at the NID, connecting one lead of a VOM to ground. Measuring for AC Volts, set the multiplier at a high setting, stepping down to reasonable range after connection. This will keep from peoping the needle.

will keep from pegging the needle.

Using the Harris-Dracon test plug (or equivalent), touch the free meter lead to the tip side of the line. (See Figure 10.) Record the voltage measurement, repeating the procedure for the tip side of the line. Next,

measure across tip and ring for any metallic voltage. Be sure the VOM is in "AV volts" mode. Most VOMs pass a meter lead through a blocking capacitor in AC mode, removing any DC component from the measurement. Remember there is nearly

surement. Kernember there is nearly 50VDC on the ring conductor, so be sure your meter removes this DC component from the reading.

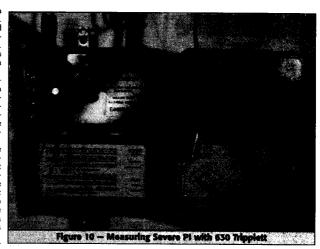
Most lines will measure just a few millivolts of common mode voltage with little or no metallic signal. Lines with moderate PI will measure careful wolks to group and will. Lines with moderate PI will mea-sure several volts to ground, and will not see much metallic if well bal-anced. Severe PI will provide read-ings of 15-35 volts to ground, yet measure little metallic voltage if the line is well balanced.

However, if unbalanced, several volts may be measurable across tip and ring, resulting in power line hum. Certain circuit elements, such as PBX and key system line cards, will often fail to operate with more than 10 colts AC (for ground present on the line cards). volts AC (to ground) present on the line.

The previous discussion should convince you to maintain balance in your CPE. Since CPE is considered part of the circuit, balance can be affected by equipment con-nected to the line. For this reason, T136 readings for CKT noise and PI should be conducted with CPE both removed and

In some instances, readings will be in some instances, readings will be acceptable with CPE removed, but degrade severely when CPE is reconnected. This can be especially true for home-brew projects that do not consider the effect of balance.

If the telco cannot reduce or eliminate ommon mode voltages from your line, contact SNC Manufacturing Co., Inc. (101 Waukau Ave., Oshkosh, WI 54901; 414-231-7370), for information on their 30L & 70L series noise chokes. These are tuned, RF sealed dual chokes and can be installed at the NIII to impress the large states. RI's sealed dual chokes and can be insumed at the NID to improve balance at power line frequencies. They are very effective at creating a high series impedance for noise signals, while causing no effect on performance of normal telephone line signals. nalling/functionality



Again, while most PI troubles can be corrected by the telco, you are responsible for maintaining a balanced termination and may be the cause, but not the source of PI.

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